2024 UPDATE
Winneshiek Hydrologic Monitoring System Plan

Winneshiek County Landfill
Decorah, Iowa

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September 2024

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Certification

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Certification page (PE or groundwater scientist signature) **113.10(1)"d"**

For the purposes of this rule, a "qualified groundwater scientist" means a scientist or an engineer who has received a baccalaureate or postgraduate degree in the natural sciences or engineering and has sufficient training and experience in groundwater hydrology and related fields demonstrated by state registration, professional certifications, or completion of accredited university programs that enable that individual to make sound professional judgments regarding groundwater monitoring, contaminant fate and transport, and corrective action.

1 Introduction and Winneshiek County Landfill Site Background

This report presents the Hydrologic Monitoring System Plan (HMSP) for Winneshiek County Landfill. The HMSP has been designed to comply with IAC 567-113.10(455B). The following sections comprise the report:

Section 1	Introduction and Winneshiek County Landfill Site Background
Section 2	Conceptual Site Models
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Section 9	Assessment of Corrective Measures
Section 10	Annual Groundwater Quality Reports
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1.1 Winneshiek County Landfill Location

The Winneshiek County Landfill is in rural Winneshiek County approximately 5 miles southeast of the City of Decorah, Iowa, in the SE ¼ of Section 9 and the NE ¼ of Section 16, T 97 N, R 7 W (Figure 1). Winneshiek County Landfill was opened in 1974 by Nishna Sanitary Services as a privately owned and operated facility. In 1991, the Winneshiek County Solid Waste Agency purchased the facility. The facility accepts non-hazardous municipal solid waste.

1.2 Winneshiek County Landfill History and Construction

At the Winneshiek County Landfill, the different areas (cells) were constructed over time due to different regulations and, as a result, there are differences in the liner, leachate-collection, and landfill gas systems. In addition, construction, excavation, filling, and capping activities have locally altered the surficial groundwater system, affecting present day shallow groundwater monitoring at the site.

The present landfill consists of a closed area and an active composite lined cell C5 EXP, see (Figure 2).

Area 1 was constructed in 1974 without a liner or leachate collection system, but a leachate toe drain (Figure 2 – West Toe Drain) was installed around the east, west and north perimeter in 1993. Area 1 was permanently closed in 2017 with a soil cover along the 4:1 slope and a composite cover over the lesser slope.

Area 2 was developed beginning in 1982 and was used until 1994, except for some construction and demolition (C&D) disposal that continued in a small portion of Area 2 until 2000-2002. Area 2 was constructed without a liner or leachate collection system, but a leachate toe drain (Figure 2 – West Toe Drain) was installed around the west perimeter in 1993 and a landfill gas collection trench along the south side. Area 2 was permanently closed in 2017 with a soil cover along the 4:1 slope and a composite cover over the lesser slope.

Development of Area 3 began in 1988 and continued until 1994. Area 3 was constructed without a liner or leachate collection system, but it has a leachate toe drain (Figure 2 – Central Toe Drain) along the eastern side and a landfill gas collection trench along the south side. Area 3 was permanently closed in 2017 with a soil cover along the 4:1 slope and a composite cover over the lesser slope.

Development of Cell 4 began in 1994 and continued until 2017. It is constructed with a clay liner and leachate collection system. An abutment liner was installed across Cell 4 in 2017. The side slopes have temporary cover.

Development of Cell 5 began in 1996 and is incorporated into C5 EXP. It is constructed with a composite liner and leachate collection system.

Development of Cell 5 Expansion (C5 EXP) Area began in 2016 and continues to the present. It is a small, 1-acre cell located between the east side of Area 1 and the north side of Cell 5. It is constructed with a composite liner and leachate collection system.

C5 EXP is the active cell. It is constructed with a composite liner and leachate collection system. This cell consists of the following:

- Abutment Liner
  - East Slope of Area 1
  - East Slope of Area 3
  - Cell 4
- Cell 5
- Cell 5 Expansion Area

Areas 1, 2, and 3 have a passive gas venting system, and there is a landfill gas collection trench with gas vents south of Areas 2 and 3. The passive venting system will be continued over the active area as it is closed.

1.3 Winneshiek County Landfill Geology and Surface Drainage

Winneshiek County Landfill is located on a generally eastward sloping upland that is part of an interfluve bordered on the east by an unnamed, northward flowing tributary to the Trout River and on the northwest by a different unnamed, northward flowing drainageway that drains to the Trout River (Figure 1). In this part of Winneshiek County, thin Quaternary-age deposits overlie Ordovician-age bedrock.

In uplands, the thin Quaternary deposits include loess overlying either remnants of Pre-Illinoian-age glacial diamicton ("till") that locally contains isolated lenses of fluvioglacial material or Quaternary-age colluvium. On side slopes, the loess overlies either Quaternary-age colluvium or, where the colluvium is absent, bedrock. In lowlands, the thin Quaternary-age deposits consist of fine-grained alluvium. In portions of the site area, such as east of Area 4, landfill construction activities have removed the Quaternary deposits, and fine-grained, construction-derived soil fill associated with the landfill road overlies Ordovician-age Maquoketa Formation bedrock. Fine-grained, construction-derived soil fill overlies loess and Ordovician-age Galena Group Dubuque Formation bedrock east of Area 5.

The Quaternary-age deposits overlie a gently dipping Ordovician-age bedrock sequence that consists of the upper and lower Elgin Member of the Maquoketa Formation and the underlying Galena Group Dubuque Formation. In parts of the northeastern portion of the site, the Maquoketa Formation is eroded away and absent. In that area, the Galena Group Dubuque Formation is the uppermost bedrock unit.

Groundwater is monitored in one water-bearing zone: (1) the shallow groundwater measured by the water table, and (2) the deep groundwater measured in the Ordovician-age upper and lower Elgin Member of the Maquoketa Formation and, where the Maquoketa is absent, the Ordovician-age Galena Group Dubuque Formation. Shallow wells are screened in different geologic units because the water table occurs in successively different stratigraphic horizons downslope. The water table and bedrock groundwater are interconnected and act as one water-bearing zone transitioning to only water table on the eastside of the landfill with groundwater discharging to tributary of Trout River.

2 Conceptual Site Models

Conceptual Site Models (CSMs) of a hydrogeologic system provide an overall understanding of groundwater and contaminant flow beneath landfills based on an interpretation of available regional and site hydrogeologic data. CSMs are based on consideration of site area topography, landfill construction, site geology (including geologic units beneath the landfill area and their thickness, extent, and properties), the water table in the uppermost sediments, and groundwater flow in the uppermost bedrock.

The Winneshiek County Landfill consists of five different areas that are regulated by the Iowa DNR (Figure 2). These differ in topography, landfill construction, and water table relationships. Consequently, separate CSMs will be presented for these different settings: Area 1, Areas 2 and 3, Cell 4, and C5 EXP.

Common to the different landfill areas are the topography, site geology, water table flow across the site, and groundwater flow in the uppermost bedrock. The landfill areas differ in location and landfill construction.

The common topography, geology, site water table, and bedrock groundwater flow conditions will be discussed first, then separate conceptual models will be developed for the various areas based on the differences in landfill construction.

2.1 Common Conditions Across the Winneshiek County Landfill

2.1.1 Topography

The Winneshiek County Landfill lies within the Paleozoic Plateau region of northeastern Iowa. Deep valleys, numerous rock outcroppings, high bluffs, and an angular step relief characterize the Paleozoic Plateau's terrain where bedrock is the primary control on topography (Horick 1989; Prior 1991).

The landfill is located on a generally eastward sloping upland that is part of an interfluve bordered on the east by an unnamed, northward flowing tributary to the Trout River and on the northwest by an unnamed, northward flowing drainageway that drains to the Trout River. Figure 1 shows the topography of the site area on a USGS 7.5 Minute Topographic Map prior to landfill development, and Figure 3 shows the topography of the landfill site in 2019 inside of the C5 EXP boundary and IDNR LiDAR dated 2010 outside the boundary. Total relief prior to landfill construction was on the order of 80 feet. The landfill was constructed sloping to the east-northeast from a hillslope summit in the southwestern part of the site.

2.1.2 Site Geology

The geology of site wells is included with the boring logs and monitoring well/piezometer documentation forms (Iowa DNR Form 542-1277) presented in Appendix A. Boring and well locations are shown on Figure 4. Geologic cross-sections were created using site stratigraphy logged and described from all site borings. Figure 5 presents the locations of the geologic cross-sections. Geologic cross-sections are presented in Figures 6 through 20.

As noted in Section 1, in uplands, the thin Quaternary deposits include loess overlying either remnants of Pre-Illinoian-age glacial diamicton ("till") that locally contains isolated lenses of fluvioglacial material or Quaternary-age colluvium. On side slopes, the loess overlies either Quaternary-age colluvium or, where the colluvium is absent, bedrock. In lowlands, the thin Quaternary-age deposits consist of fine-grained alluvium. In portions of the site area, such as east of Cell 4, landfill construction activities have removed the Quaternary deposits along the road, and fine-grained, construction-derived soil fill overlies Ordovician-age Maquoketa Formation bedrock. Fine-grained, construction-derived soil fill overlies loess and Ordovician-age Galena Group Dubuque Formation bedrock east of C 5 EXP.

Beneath the Quaternary-age deposits is a gently dipping Ordovician-age bedrock sequence that consists of the upper and lower Elgin Member of the Maquoketa Formation and the underlying Galena Group Dubuque Formation. The contact between the Maquoketa Formation and the underlying Galena Group Dubuque Formation is an unconformity (an uneven erosion surface). In parts of the northeastern portion of the site, the Maquoketa Formation is believed eroded away and absent. In that area, the Dubuque Formation is the uppermost bedrock unit.

2.1.3 Water Table

Figure 21 presents the water table in May 2023 which is representative of water table conditions at the site. Different geologic units are present while traversing downslope, west to east, from the uplands toward the Trout River at the Winneshiek County Landfill, and the water table crosscuts these units which include Quaternary-age loess, Pre-Illinoian-age glacial deposits, Quaternary-age colluvium, Maquoketa Formation shale, and Galena Group Dubuque Formation limestone. In the Trout River lowlands east of the landfill, the water table is in the Quaternary-age alluvium or top of weathered Galena Group Dubuque Formation limestone. Over the site, there is a groundwater divide present in the water table. On the east part of the site or divide, shallow water table flow is downslope to the northeast toward the tributary of the Trout River; along the western and northwestern part of the site adjacent to Area 1 and Area 2, shallow water table flow is to the northwest toward a surface water drainageway and then to an unnamed tributary of the Trout River. Landfill areas at the Winneshiek County Landfill were constructed above the water table.

2.1.4 Deep Groundwater Flow in the Uppermost Bedrock

Figure 22 presents groundwater levels measured in bedrock for May 2023 which is representative of bedrock groundwater conditions at the site. The uppermost bedrock beneath the site is a gently dipping Ordovician-age bedrock sequence that consists of the upper and lower Elgin Member of the Maquoketa Formation and the underlying Galena Group Dubuque Formation. The contact between the Maquoketa Formation and the underlying Dubuque Formation is an unconformity (an uneven erosion surface). The Maquoketa Formation is composed of significant thicknesses of shale and claystone, acting as a regional aquitard. The Galena Group, composed of limestone and dolomite, is part of a regional Galena aquifer system. In parts of the northeastern portion of the site, the Maquoketa Formation is largely eroded away and absent. In that area, the Dubuque Formation is the uppermost bedrock unit.

Groundwater flow within the Maquoketa Formation aquitard is primarily downward, to the top of the Galena Group and then groundwater flow in the Galena Group aquifer is primarily horizontal to the northeast. Regional groundwater flow in the Galena Group is expected to be primarily east toward the Trout River, the regional groundwater discharge point.

2.1.5 Groundwater Geochemistry

Winneshiek groundwater monitoring wells, surface water, underdrains, and leachate manholes were sampled for major anions and cations in June 2023. The major ionic species in most natural waters are Na^{+}, K^{+}, Ca^{+2}, Mg^{+2}, Cl^{-}, CO_3^{-2}, HCO_3^{-} and SO_4^{-2}. The sample results were used to create piper and stiff diagrams.

Figures 23, 24 and 25 are a piper diagrams of anion and cation sample data for the Winneshiek groundwater, surface water, underdrain, and manhole monitoring points. The plots demonstrate different hydrochemical facies related to groundwater flow through different lithologies. On the west side of the landfill and mapped water table divide, wells MW-1, MW-2R, MW-3, MW-34A, MW-37A, MW-41A, MW-4, and MW-4B are similar in geochemistry because groundwater flows from upgradient MW-1 toward downgradient MW-41A (Figure 23). On the east side of the landfill, groundwater wells MW-7A, MW-24A, MW-25A, MW-29A, MW-31A, MW-35, MW-38A, MW-39A, MW-40A, MW-42A, MW-43A, MW-44A, and MW101 and surface water SW-1, SW-2 and SW-5 are similar in geochemistry because groundwater flows from MW-19 toward MW-40A, on the east side of water table divide and represent another hydrochemical facies (Figure 24). Last, bedrock wells MW-19, MW-22 and MW-35 located on the east side of the landfill, represents groundwater flow from Cell 4 towards the groundwater discharge to creek as reflected by surface water SW-1, SW-2 and SW-5 (Figure 25). The eochemistry confirms that shallow and deep groundwater are interconnected and combine as grondwater flows from west (MW-1 and MW-19) to east (MW-35 and MW-40A).

In terms of cations, most of the groundwater monitoring wells are calcium type. The exceptions are well MW-31A and manhole MH-4-2 are sodium or potassium type. In terms of anions, most of the groundwater monitoring wells and manholes are bicarbonate type. The exception is monitoring well MW-11 which is sulfate type. The trilinear plot shows a relationship between manhole MH-4-2 and downgradient monitoring well MW-31A, with these two sample points plotting close to each other.

Figures 26, 27 and 28 are a stiff diagrams of anion and cation sample data for the Winneshiek groundwater, surface water, underdrain, and manhole monitoring points. The plots are similar to the piper diagram, demonstrating different hydrochemical facies related to groundwater that flows through different lithologies. The stiff diagram supports the water table well groupings presented above.

The stiff plot shows a relationship between downgradient monitoring wells MW-31A, MW-42A and MW-43A and surface water at SW-5. The polygonal shape and area show a decrease in ion concentrations as groundwater flows from MW-31A downgradient to MW-42A and then discharging as measured at SW-5. This affirms that concentrations are attenuating as groundwater moves towards and discharges to the tributary of the Trout River.

2.2 Area 1 Site Conditions and Conceptual Site Model

2.2.1 Landfill Construction

Waste disposal at the Winneshiek County Landfill began in 1974 with the development of Area 1. Area 1 is now closed and has a vegetated intermediate cover, installed in 1994.

Base grade elevations for Area 1 are shown on Figure 29. The base grades were set above the water table, and base grade elevations decline downslope to the east-northeast from an elevation of about 1,172 feet to 1,160 feet above mean sea level (MSL). Area 1 was constructed without a liner or leachate collection system, but a leachate toe drain was installed around the western, northern, and eastern perimeter in 1993. Area 1 has a passive landfill gas system.

2.2.2 Conceptual Site Model for Area 1

The CSM for Area 1 is based on the site topography, landfill construction, underlying site geology, water table conditions, and groundwater flow in the uppermost bedrock units discussed in the previous sections.

The CSM for Area 1 is depicted on site cross-sections in Figures 6, 7, 8, and 15. Most of the precipitation at the site is intercepted by the landfill cap and the surface water drainage system and then routed to drainageways draining off-site to the west, north, and east. A portion of the precipitation is lost to the atmosphere by evapotranspiration. A limited amount of precipitation infiltrates to the water table in the Quaternary-age loess and fine-grained Pre-Illinoian-age glacial diamicton.

The landfill has been constructed on a hillslope with base grades that follow the natural slope to the east-northeast. Area 1 does not have a liner or leachate control system, but leachate flow is predominantly downslope along the base grade to the east-northeast. A leachate toe drain was constructed around the western, northern, and eastern perimeter of Area 1 (Figure 4) to intercept leachate. Leachate intercepted by the toe drains is directed to the leachate lagoon where it is evaporated and re-circulated back into the landfill cells. Any constituent not intercepted by the leachate toe drain is expected to slowly migrate downward to the water table. A water table divide splits Area 1 into two water table flow directions; the east half of Area 1 shallow groundwater flows toward the east-northeast; the west half of Area 1 shallow groundwater flows toward the west-northwest. Shallow groundwater quality is monitored by downgradient water table wells. Bedrock groundwater flow is east toward the Trout River. Deep groundwater quality is monitored by downgradient bedrock wells. The groundwater monitoring points for the Winneshiek County Landfill (see Section 4) have been placed in accordance with this Conceptual Site Model.

2.3 Area 2 and Area 3 Site Conditions and Conceptual Site Model

2.3.1 Landfill Construction

Area 2 was developed beginning in about 1982 and was used until 1994, except for some C&D disposal that continued in a small portion of Area 2 until 2000-2002. Development of Area 3 began in about 1988 and continued until 1994. Both Area 2 and Area 3 are closed. Area 2 and Area 3 have a vegetated intermediate cover, installed in 1994. Area 2 and Area 3 have a passive gas venting system, and there is a landfill gas collection trench with gas vents south of Areas 2 and 3.

Base grade elevations for Area 2 and Area 3 are shown on Figure 29. Base grades follow the natural slope to the north-northeast, and base grade elevations range from about 1,200 feet MSL to 1,160 feet MSL.

Area 2 and Area 3 were constructed above the water table and have no liner or leachate collection system, but a leachate toe drain is installed along the western perimeter of Area 2 and the eastern perimeter of Area 3 (Figure 4).

2.3.2 Conceptual Site Model for Area 2 and Area 3

The CSM for Area 2 and Area 3 is based on the site topography, landfill construction, underlying site geology, water table conditions, and groundwater flow in the uppermost bedrock units discussed in the previous sections.

The CSM for Area 2 and Area 3 is depicted on a site cross-section on Figures 9, 10, 11, 12, 13, 14, and 15. Most of the precipitation at the site is intercepted by the landfill cap and the surface water drainage system and routed to drainageways draining off-site to the north, south, east, and west. A portion of the precipitation is lost to the atmosphere by evapotranspiration. A limited amount of precipitation infiltrates to the water table in the Quaternary-age loess, fine-grained Pre-Illinoian-age glacial diamicton, and Maquoketa Formation claystone.

The landfill has been constructed on a hillslope with base grades that follow the natural slope to the north-northeast. Areas 2 and 3 do not have a liner or leachate control system, but leachate flow is predominantly downslope along the base grade to the east-northeast. Leachate toe drains are constructed along the western perimeter of Area 2 and the eastern perimeter of Area 3 to intercept any leachate. Leachate intercepted by the toe drains is directed to the leachate lagoon where it is evaporated and re-circulated back into the landfill cells. Any constituent not intercepted by the leachate toe drain is expected to slowly migrate downward to the water table. A water table divide splits Areas 2 and 3 into two water table flow directions; the east half of Area 3 shallow groundwater flows toward the northeast; the west half of Area 2 shallow groundwater flows toward the west-northwest. Shallow groundwater quality is monitored by downgradient water table wells. Bedrock groundwater flow is east toward the Trout River. Deep groundwater quality is monitored by downgradient bedrock wells. The groundwater monitoring points for Areas 2 and 3 (refer to Section 4) have been placed in accordance with this Conceptual Site Model.

2.4 Cell 4 Site Conditions and Conceptual Site Model

2.4.1 Landfill Construction

Development of Cell 4 began in 1994 and is closed. It is constructed above the water table with a clay liner and leachate collection system.

The base grade elevations for Cell 4 are shown on Figure 29. Base grades follow the natural slope to the northeast, and base grade elevations range from about 1,184 feet MSL to 1,162 feet MSL.

Cell 4 is not active and has a passive landfill gas system installed.

2.4.2 Conceptual Site Model for Cell 4

The CSM for Cell 4 is based on the site topography, landfill construction, underlying site geology, water table conditions, and groundwater flow in the uppermost bedrock units discussed in the previous sections.

The CSM for Cell 4 is depicted on a site cross-section on Figures 10, 11, 12, 16, and 17. Most of the precipitation at the site is intercepted by the landfill cap and the surface water drainage system and routed to drainageways draining off-site to the east. A portion of the precipitation is lost to the atmosphere by evapotranspiration. A limited amount of precipitation infiltrates to the water table in the Quaternary-age loess and Ordovician-age Maquoketa Formation.

The landfill has been constructed on a hillslope with base grades that follow the natural slope to the east and northeast. Cell 4 has a clay liner and leachate control system, and leachate flow along the liner is downslope to the northeast where it is collected at the leachate lagoon. Any constituent not intercepted by the leachate control system is expected to slowly migrate downward to the water table. Water table and bedrock flow for Cell 4 is predominantly to the east, toward the Trout River. Shallow groundwater quality is monitored by downgradient water table wells, while deep groundwater quality is monitored by downgradient bedrock wells. The groundwater monitoring points for Cell 4 (refer to Section 4) have been placed in accordance with this Conceptual Site Model.

2.5 C5 EXP Site Conditions and Conceptual Site Model

2.5.1 Landfill Construction

Development of Cell 5 began in 1996 and continues to the present. The area is now referred to as C5 EXP but also includes the abutment liner as described in Section 1.2. It is constructed above the water table with a composite liner and leachate collection system.

The base grade elevations for C5 EXP are shown on Figure 29. Base grades follow the natural slope to the northeast, and base grade elevations range from about 1,160 feet to 1,122 feet MSL.

Cell 5 EXP is still active and will have a landfill gas system installed when it is closed.

2.5.2 Conceptual Site Model for C5 EXP

The CSM for C5 EXP is based on the site topography, landfill construction, underlying site geology, water table conditions, and groundwater flow in the uppermost bedrock units discussed in the previous sections.

The CSM for C5 EXP is depicted on site cross-sections in Figures 7, 8, 9, 16, 17, 18, 19, and 20. Most of the precipitation at the site is intercepted by the landfill cap and the surface water drainage system and routed to drainageways draining off-site to the north and east. A portion of the precipitation is lost to the atmosphere by evapotranspiration. A limited amount of precipitation infiltrates to the water table in the Quaternary-age loess and Ordovician-age Maquoketa Formation claystone.

The landfill has been constructed on a hillslope with base grades that follow the natural slope to the northeast. C5 EXP has a composite liner and leachate control system, and leachate flow is downslope along the liner to the northeast where it is collected at the leachate lagoon. Two sections of C5 EXP have a groundwater drainage layer which intercepts water table groundwater lowering groundwater levels below the landfill base grade. Any constituent not intercepted by the leachate control system, or the groundwater drainage layer is expected to slowly migrate downward to the water table. Water table and bedrock flow for C5 EXP is predominantly to the east, toward the Trout River. Shallow groundwater quality is monitored by downgradient water table wells, while deep groundwater quality is monitored by downgradient bedrock wells. The groundwater monitoring points for C5 EXP (see Section 4) have been placed in accordance with this Conceptual Site Model.

2.6 Reference

Horick, P. J. 1989. Water Resources of Northwest Iowa, Iowa Department of Natural Resources, Water Atlas Number 8, 145 p.
Prior, J.C., 1991. Landforms of Iowa: University of Iowa Press, Iowa City, 153 p.

3 Theoretical Release Evaluation

The theoretical release evaluation for the Winneshiek County Landfill is based upon the landfill area conceptual site models (CSM) discussed in Sections 2.2 through 2.5, on an understanding of landfill construction (base grades slope and direction, presence or absence of leachate collection systems, landfill cap, relationship to the water table), regional and site-specific geologic and hydrogeologic conditions and groundwater flow modeling results.

All the Landfill areas at the Winneshiek County Landfill were constructed above the water table in the surficial sediments and were constructed to promote leachate drainage downslope. Area 1 does not have a liner or leachate control system, but leachate flow is predominantly downslope along the base grade to the west-northwest. A leachate toe drain is constructed around the western, northern, and eastern perimeters of Area 1 (Figure 2) to intercept any leachate. Area 2 does have the leachate toe drain for leachate control, with leachate flow predominantly downslope along the base grade to the west-northwest and to the toe drain. Area 3 does have the leachate toe drain for leachate control, with leachate flow predominantly downslope along the base grade to the east-northeast and to the toe drain. Leachate toe drains are constructed along the western perimeter of Area 2 and the eastern perimeter of Area 3 to intercept any leachate. A release of leachate not intercepted by the leachate toe drains for Areas 1, 2, and 3 is expected to slowly migrate downward to the water table.

Cell 4 has a clay liner and leachate control system, and leachate flow along the liner is downslope to the east-northeast. C5 EXP has a composite liner and leachate control system, and leachate flow is downslope along the liner to the east-northeast. A release of leachate not intercepted by the leachate control system for Cells 4 and C5 EXP is expected to slowly migrate downward to the water table.

Because the Landfill areas and cells were constructed above the water table, the water table is considered the primary pathway for any release from the Landfill. Water table gradients promote downslope groundwater flow toward shallow Quaternary-age loess, Pre-Illinoian-age glacial deposits, Quaternary-age colluvium, and Maquoketa Formation shale downslope of the Landfill. Over most of the site, shallow water table flow is downslope to the northeast; along the western and northwestern part of the site, shallow water table flow is to the west-northwest. Shallow groundwater quality is monitored by downgradient water table and bedrock monitoring wells. Surface water is monitored at upstream staff gauge SW-1 and downstream at staf gauges SW-2, SW-4 and SW-5. The groundwater monitoring points for the Winneshiek County Landfill (see Section 4) have been placed at approximately 300-foot spacings in accordance with the IAC 567 113.10(2)e(2).

A release of leachate not following the leachate collection system, leachate toe drains, and water table could potentially migrate slowly downward through the Ordovician-age Maquoketa Formation aquitard toward the Galena Group aquifer. Because of the hydraulic conductivity contrast between the surficial Quaternary-age loess, Pre-Illinoian-age glacial deposits, Quaternary-age colluvium, and lower hydraulic conductivity Ordovician-age Maquoketa Formation, the primary direction of groundwater flow is laterally within the water table, flowing downslope toward tributaries of the Trout River on the east and west sides of the landfill and the Trout River east of the landfill. The water table also occurs within top of bedrock on the east side of the landfill. Given that, downgradient bedrock aquifer wells are installed to provide information on groundwater head, groundwater quality, vertical gradients, and vertical flow as groundwater from the water table flows toward bedrock and, as such, bedrock will be monitored over time.

3.1 Theoretical Release Model

As part of the theoretical release modeling, groundwater flow was evaluated using GFLOW, a groundwater flow model. GFLOW was used to evaluate flow path lines from each of the five cells which comprise the Winneshiek County Landfill.

3.1.1 Groundwater Flow Model Construction

The conceptual model, numerical simulation code, and the numerical model construction details are described in this section.

3.1.1.1 Code Selection

A numerical groundwater flow model was selected as the method to simulate groundwater flow for the landfill area. The model is the mathematical representation of groundwater flow in an aquifer using a numerical analysis computer code. The computer code solves the governing systems of equations for groundwater flow.

The model, GFLOW (Haitijema, 2018), was chosen to simulate groundwater flow for the Winneshiek County Landfill theoretical release modeling. GFLOW uses an analytical element method to model groundwater flow. Analytic element methods use direct solutions to mathematical equations that represent hydrogeologic features in a groundwater flow model.

GFLOW was used to develop a regional-site model. GFLOW uses a stepwise approach that models steady-state groundwater flow in a single, heterogeneous aquifer. The GFLOW model was used for estimating aquifer parameters, setting boundary conditions, and provides theoretical release analyses.

3.1.1.2 GFLOW Regional-Site Model

A binary base map derived from USGS digital line graphs (DLG), and site CAD maps were imported directly into the modeling software to serve as the geographic basis and reference for the model domain. The units for the base map are in meters and geodetic reference is Universal Transverse Mercator (UTM) coordinate system, North American Datum (NAD), 1983, Zone 15. Units for groundwater modeling are in feet and days.

The GFLOW model domain (Figure 30) includes all major drainage basins in the vicinity of the project area, ranging from the unnamed tributary of the Trout River on the east side of site, the Trout River on the east model boundary, an unnamed tributary of the Trout River on the west side of the site, and Trout Creek on the west model boundary. The geometry of the model layer includes a bottom elevation of 1,000 ft above mean sea level (AMSL). The single layer represents a composite of the unconsolidated Quaternary sediments and weathered sedimentary bedrock.

The GFLOW model includes "far field" and "near field" line sinks. In the far field, streams and lakes are simulated with coarse line sinks having little or no leakage (resistance) between the surface water feature and the groundwater system. The purpose of simulating the far field is to have the model explicitly define the regional groundwater flow in the vicinity of the area of interest. The near field represents the area of interest and includes several of the streams adjacent to and including Trout River. Near-field streams are simulated using slightly more detailed line sinks with streambed leakage (resistance) to control groundwater/surface water interaction. The line sinks representing streams were assigned stages based on site data and USGS 7.5-minute quadrangle maps. Near field line sinks were assigned stream widths (ranging from 5 to 100 feet) based on field measurements and stream order.

Other input parameters to the GFLOW model include recharge, transmissivity, drains, and pumping wells. The transmissivity and recharge zones extend over both the near field and far field of the model. There are no large capacity pumping wells within the model boundary. Table 1, GFLOW Model Parameters, presents the settings and boundary conditions applied to the GFLOW model.

Table 1
Winnesheik GFLOW Model Input Parameters

Aquifer Properties		
Base Elevation	1000	feet
Thickness	200	feet
Hydraulic Conductivity	0.024459	feet/day
Porosity	0.2	[dimensionless]
Recharge	6	inches/year

3.1.1.3 Model Input Parameters

Aquifer Properties

The sediments above bedrock and weathered bedrock are the only geologic units in the groundwater model. Aquifer properties are based on field measurements collected during the site investigation for landfill permit. The aquifer properties required by GFLOW are aquifer thickness and hydraulic conductivity. Aquifer thickness was determined from boring logs presented in the hydrogeological investigation reports (JMM 1990; RUST 1993; RUST 1997; Earth Tech 2000) and from geologic cross-sections as described in Section 2. The aquifer thickness was set to 200 feet based on geologic cross-sections and the relief across the site. The bottom elevation of the model represents the groundwater discharge elevation at tributary of Trout River on the downgradient side of landfill area.

Hydraulic conductivity measurements were collected during the hydrogeological investigation at wells screened in the sediments above bedrock and bedrock monitoring wells. Hydraulic conductivity measurements were estimated by the slug test method.

Hydraulic conductivities estimated from slug tests conducted in wells screened in the loess/till/alluvial deposits range from approximately 2.1×10^{-5} to 9.6×10^{-3} cm/sec (0.06 to 27.2 ft/day). For the model, the hydraulic conductivity was varied up to one order of magnitude higher (faster) than the results of slug test analyses. The slug test method estimates hydraulic conductivity based on a small area surrounding the well, and studies indicate that slug tests are approximately one order of magnitude lower than pump tests conducted on the same aquifer.

Surface Water

Several surface water bodies were included in the groundwater model: Trout River and Trout Creek. The rivers and creeks were modeled as streams using line sinks with specified head and stream flow routing. Stream elevations were estimated based on USGS gauging stations and the staff gauges located at the site. Streambed width and depths were based on USGS gauging stations, USGS topographic maps, and site data. Streambed resistance is the thickness of the resistance layer between the surface water feature and the aquifer divided by the average vertical hydraulic conductivity of the resistance layer. Resistance values were calculated using site hydraulic conductivity data.

Recharge

Recharge is the portion of precipitation that does not become surface runoff, and percolates through the ground surface to the water table. The recharge was estimated using 6 inches/year.

Leachate Toe Drain

The leachate tow drain installed around Areas 1, 2, and 3 is not modeled. This conservative approach assumes the leachate toe drain does not exist in order to model natural groundwater flow directions pre-installation of the tow drain.

3.2 Model Results

3.2.1 Groundwater Elevations and Flow

The modeled water table is shown in Figure 32. In the site area, the groundwater flow system is closely approximated by the groundwater model. As measured at the site, groundwater flows toward an unnamed tributary of the Trout River on the northwest and the Trout River on the east. Surface water flow discharges to an unnamed tributary of the Trout River on the northwest and the Trout River on the east.

3.2.2 Model Calibration

The groundwater flow model was calibrated using a manual calibration approach whereby the model hydraulic parameters were optimized to minimize the difference between the model-predicted heads and stream flows and actual field measured heads and stream flows. The initial model input consisted of hydraulic parameters, recharge rates, and boundary conditions. Hydraulic conductivity, resistance and recharge rates were the parameters varied during the calibration. Specified head boundary conditions were also revised to achieve calibration. Model verification was also performed by using the calibrated hydraulic parameters and boundary conditions to perform a simulation of the conditions observed in August 2022.

3.2.2.1 Calibration Procedure

The calibration was performed by repeatedly running the model while varying the hydraulic conductivity, resistance, and recharge between each run, until the difference in model-predicted heads and surface water flows and field measured heads and surface water flows (the "residuals") were minimized. A calibration strategy using manual calibration was chosen because the high hydraulic gradients, thin saturated thicknesses, and high degree of variation in measured heads at the site. Use of an inverse model such as UCODE or PEST (automatic calibration) to check calibration and perform sensitivity analyses will be investigated during future modeling tasks.

Calibration parameter values were initially assigned to the model based on field measured values and, if measured values were not available, ranges of values for each hydrogeologic zone. These parameters were then adjusted between each model run to reduce the model residual. In many cases, physical constraints associated with the site determined the range over which calibration parameters could be varied.

3.2.2.2 Calibration Criteria

Due to the significant range of measured water table elevations, three statistical methods for analyzing the residuals were used, along with visual comparison of measured heads to model-predicted heads, to determine the calibration. The average error (AE), median error (ME), mean absolute error (MAE), the root mean square (RMS) error and sum of squared differences (SSD) were the statistical methods used to evaluate the model residual. The AE, which is the mean of all the residuals, indicates if the overall model response is high (a positive AE) or low (a negative AE) with respect to the measured values. The MAE, which is the mean of the absolute value of all the residuals, indicates the absolute average error in the model. The RMS error, which is the square root of the mean of the squared residuals, is usually represented as a percentage of the total head difference in the hydrologic system. The total head difference in the system is defined as the range of values observed in the measured heads. As described by Anderson, Woessner and Hunt (2015), if the percent RMS error is small, the errors represent only a small part of the overall model response. The goal of the calibration was to reduce model AE to less than 5 feet, RMS error to less than 10 feet, and individual residuals at each well to less than 5 feet.

3.2.2.3 Calibration Data

The model was calibrated to the water levels measured in 33 monitoring wells at the site on August 11, 2022. Calibration targets were randomly distributed across the model.

3.2.2.4 Calibration Results

Model calibration was performed until no significant reductions in the AE, ME, MAE, RMS, and SSD errors were being achieved with additional calibration simulations. Graphically, Figure 31 presents modeled head versus observed head. Targets aligning with the center 45-degree lines are those with no residual, i.e., exact calibration. Those targets falling above the centerline have simulated elevations greater than the target elevations. Those water levels falling below the centerline have simulated elevations less than the target elevations. In general, most of the targets for each layer plot along the 45-degree line which further demonstrates a reasonable calibration. A summary of the calibration statistics is tabulated in Table 2.

Figure 31 - Winneshiek County Landfill
Modeled Head vs. Observed Head

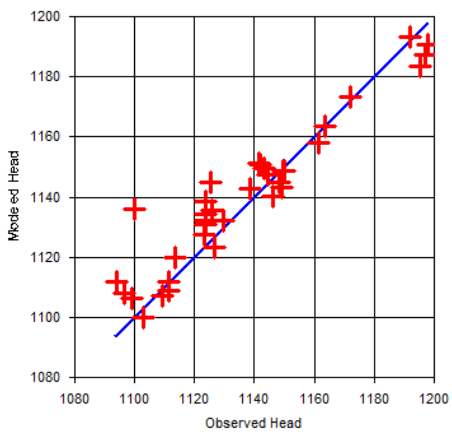

Table 2
Summary of Calibration Statistics for
Winneshiek County Landfill Groundwater Head

Number of Observations:	20
Maximum Difference:	35.8 ft
Minimum Difference:	-12 ft
Average Difference (AD):	3.8 ft
Median Difference (MAD):	3.3 ft
Mean Absolute Difference:	7.2 ft
RMS Difference:	9.9 ft
Sum of Squared Differences:	3,444.4

3.3 Theoretical Release Particle Path Lines

As part of the theoretical release, particle tracking was conducted to assess the groundwater migration pathways and travel times under steady-state conditions at the site. Particles were tracked in steady-state flow domains, both forward and reverse, using August 2022 groundwater levels. Particles were introduced into the flow domain in six areas of the model: Area 1, Area 2, Area 3, Cell 4, Cell 5, and Cell 5 EXP.

The particle tracking was conducted using GFLOW (Haitijema 2018). The GFLOW tracking timestep was set to 1 year (365 days), with a maximum of 1000 years (365,000 days) for forward tracking and 1000 years for reverse tracking. Particle tracking tic marks were set to 50-yr (18,250 days) increments. Recharge was treated as a distributed source in GFLOW, and all particles were stopped when they entered strong internal sinks. Particles which encountered weak sinks passed through.

3.3.1 Theoretical Release: Area 1

Figure 33 presents the results of the theoretical release from closed landfill Area 1. Particles were placed within the footprint of Area 1 and at upgradient well locations corresponding to MW-1, MW-37A, and MW-19R. The results of the particle path line modeling show the groundwater flow paths from Area 1. The flow paths show that there is a groundwater divide where the west half of Area 1 flows toward the northwest, and the east half of Area 1 flows toward the northeast. Wells MW-1 and MW-37A are upgradient of Area 1 on the west side of groundwater divide. There are no upgradient wells for the east side of Area 1. Area 1 is monitored by downgradient water table wells MW-41A, MWII-2, MW-4, MW-4B, MW-34A, and MW-45A, and by bedrock well MW-18. Travel times from Area 1 towards the northwest drainageway are approximately 300-years.

3.3.2 Theoretical Release: Area 2

Figure 34 presents the results of the theoretical release from closed landfill Area 2. Particles were placed within the footprint of Area 2 and at upgradient well locations corresponding to MW-1, MW-37A, and MW-19R. The results of the particle path line modeling show the groundwater flow paths from Area 2. The flow paths show that there is a groundwater divide where the north half of Area 2 flows toward the northwest, and the south half of Area 2 flows toward the east and northeast. Wells MW-1 and MW-37A are upgradient of Area 2 on the north side of groundwater divide. MW-1 acts as an upgradient well for the southeast side of Area 2. Area 2 is monitored by downgradient water table wells MW-2, MW-2R, MWII-2, MW-4, MW-4B, MW-3, MW-33A, MW-34A, MW-41A and MW-45A, and by bedrock well MW-18. Travel from Area 2 to the east would be intercepted by the leachate toe drain on east side of Area 3. Travel times from Area 2 towards the northwest drainageway are approximately 100-years.

3.3.3 Theoretical Release: Area 3

Figure 35 presents the results of the theoretical release from closed landfill Area 3. Particles were placed within the footprint of Area 3 and at upgradient well locations corresponding to MW-1, MW-32A, MW-37A, and MW-19R. The results of the particle path line modeling show the groundwater flow paths from Area 3. The flow paths show that there is a groundwater divide where the north half of Area 3 flows toward the northwest and the south half of Area 3 flows toward the east and northeast. MW-32A acts as an upgradient well for the southeast side of Area 3. Area 3 is monitored by downgradient water table wells MWII-2, , MW-4, MW-4B, , MW-7A, MW-45A, MW-46A, and by bedrock well MW-22. Travel from Area 3 to the east would be intercepted by the leachate toe drain on north side of Area 1 and east side of Area 3. Travel times from Area 3 towards the northeast toe drain are approximately 100-years.

3.3.4 Theoretical Release: Cell 4

Figure 36 presents the results of the theoretical release from closed landfill Cell 4. Particles were placed within the footprint of Cell 4 and at upgradient well locations corresponding to MW-1, MW-37A and MW-19R. The results of the particle path line modeling show the groundwater flow paths from Cell 4. The flow paths show that groundwater for Cell 4 flows toward the east. MW-32A acts as an upgradient well for Cell 4. Cell 4 is monitored by downgradient water table wells MW-8A, MW-12A, MW-26A, MW-27A, MW-31A, MW-38A, MW-39A, MW-40A and MW-42A, and by bedrock wells MW-11, MW-35, and MW-36. Travel times from Cell 4 towards the tributary of Trout River are approximately 100-years.

3.3.5 Theoretical Release: Cell 5

Figure 37 presents the results of the theoretical release from landfill Cell 5. Particles were placed within the footprint of Cell 5 and at upgradient well locations corresponding to MW-1, MW-37A and MW-19R. The results of the particle path line modeling show the groundwater flow paths from Cell 5. The flow paths show that groundwater for Cell 5 flows toward the east. There are no direct upgradient wells for Cell 5. Cell 5 is monitored by downgradient water table wells MW-7A, MW-24A, MW-25A, MW-29A, MW-31A, MW-42A, MW-43A, MW-44A, MW-46A, MW-100, and MW-101, and by bedrock wells MW-11, MW-22, and MW-30. Travel times from Cell 5 towards the tributary of Trout River are approximately 200-years.

3.3.6 Theoretical Release: Cell 5 EXP

Figure 38 presents the results of the theoretical release from landfill C 5 EXP. Particles were placed within the footprint of C 5 EXP and at upgradient well locations corresponding to MW-1, MW-37A and MW-19R. The results of the particle path line modeling show the groundwater flow paths from C 5 EXP. The flow paths show that groundwater for C 5 EXP flows toward the northeast and east. There are no direct upgradient wells for C 5 EXP. C 5 EXP is monitored by downgradient water table wells MWII-2, MW-7A, MW-24A, MW-25A, MW-29A, MW-31A, MW-42A, MW-43A, MW-44A, MW-45A, MW-46A, MW-100, and MW-101, and by bedrock wells MW-11, MW-22, and MW-30. Travel times from C 5 EXP towards the tributary of Trout River are approximately 700-years.

3.4 References

Anderson, M. P., Woessner, W. W., and Hunt, R. J. 2015. Applied Groundwater Modeling, Simulation of Flow and Advective Transport, 2nd Edition. Elsevier, London, UK. 564 p.

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4 Monitoring Points

4.1 Geologic Setting

The Winneshiek County Landfill lies within the Paleozoic Plateau region of northeastern Iowa. Deep valleys, numerous rock outcroppings, high bluffs, and an angular step relief characterize the Paleozoic Plateau's terrain where Quaternary sediments mantle bedrock, and bedrock is the primary control on topography (Prior, 1991).

The landfill is located on a generally eastward sloping upland that is part of an interfluve bordered on the east by an unnamed, northward flowing tributary to the Trout River and on the northwest by an unnamed, northward flowing drainageway that drains to the Trout River (Figure 1).

The geology of site wells is included with the boring logs and monitoring well/piezometer documentation forms (Iowa DNR Form 542-1277) presented in Appendix A. In the Winneshiek County Landfill area, Quaternary-age deposits mantle Ordovician-age bedrock, and the geologic sequence of the Quaternary deposits differs between uplands and valleys. In the uplands, the sequence includes Wisconsin Episode loess overlying either patchy remnants of pre-Illinoian age glacial diamicton ("till") which locally contains discontinuous sand bodies, Quaternary colluvium developed on bedrock, or Ordovician-age bedrock. In the valleys, the sequence consists of alluvium overlying Ordovician-age bedrock. The Ordovician-age bedrock varies across the landfill site. Maquoketa Formation claystone and shale is the uppermost bedrock underlying most of the site, but in the northeastern corner of the landfill area, the Maquoketa Formation is absent because of erosion, and the older Ordovician-age Galena Group Dubuque Formation dolomite is the uppermost bedrock.

4.2 Groundwater Occurrence and Movement

Groundwater is monitored in an interconnected water-bearing zone at the Winneshiek County Landfill: (1) the shallow groundwater measured by the water table, and (2) the deep groundwater measured by the potentiometric surface in the Ordovician-age upper and lower Elgin Member of the Maquoketa Formation and, where the Maquoketa Formation is absent, the Ordovician-age Galena Group Dubuque Formation. Shallow wells are screened in different geologic units because the water table occurs in successively different stratigraphic horizons downslope.

4.2.1 Water Table Occurrence and Groundwater Movement

The water table occurs in successively different stratigraphic units downslope at the Winneshiek County Landfill, including Quaternary-age loess, undifferentiated Pre-Illinoian glacial diamicton ("till"), colluvium, alluvium, Ordovician-age Maquoketa Formation and Galena Group.

Water table elevations are measured in 31 water table wells (Table 3) at the Winneshiek County Landfill. Figure 21 shows the water table elevations for September 2023, which is representative for site conditions. In the immediate landfill area, groundwater generally flows east, northeast, and north from a high near the southwest corner of the landfill area toward the tributaries to the Trout River. Water table wells include:

Upgradient water table wells near the southwest corner of the landfill:

- MW-37A completed in Quaternary-age loess and the underlying pre-Illinoian-age glacial diamicton; this well provides groundwater representative of upgradient water table conditions. This well provides upgradient background only for the west half of Area 1 and Area 2. The well does not provide upgradient background for the entire landfill.
- MW-1 completed in pre-Illinoian-age glacial diamicton and interbedded fluvioglacial material; at this location, landfill activities have affected groundwater quality in MW-1. This well provides upgradient background only for the west half of Area 1 and Area 2. The well does not provide upgradient background for the entire landfill.

- MW-32A completed in pre-Illinoian-age glacial diamicton and the underlying Elgin Member of the Ordovician-age Maquoketa Formation

Water table wells downgradient of Areas 1, 2, and 3 include:

- MW-2 completed in pre-Illinoian-age glacial diamicton and the underlying upper Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-2R completed in the upper Elgin Member of the Ordovician-age Maquoketa Formation bedrock.
- MW-3 completed in pre-Illinoian-age glacial diamicton.
- MW-4 and MW-4B completed in pre-Illinoian-age glacial diamicton and interbedded fluvioglacial material.
- MW-45A completed in the Quaternary Wisconsinan Episode Peoria Loess.
- MW-41A completed in pre-Illinoian-age glacial diamicton and the underlying Ordovician-age upper Elgin Member of the Maquoketa Formation.
- MW-33A completed in pre-Illinoian-age glacial diamicton and the underlying Ordovician-age upper Elgin Member of the Maquoketa Formation.
- MW-34A completed in pre-Illinoian-age glacial diamicton and the underlying Ordovician-age upper Elgin Member of the Maquoketa Formation.

Water table wells downgradient of Cells 4 and 5 EXP include:

- MWII-2 completed in Quaternary Wisconsinan Episode Peoria Loess..
- MW-7A completed in pre-Illinoian-age glacial diamicton.
  MW-24A and MW-25A completed in fine-grained construction fill overlying thin loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-29A completed in pre-Illinoian-age glacial diamicton and the underlying Galena Group Dubuque Formation.
- MW-31A completed in pre-Illinoian-age glacial diamicton and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.

- MW-38A completed in Quaternary-age loess and colluvium, the underlying Elgin Member of the Ordovician-age Maquoketa Formation, and the Ordovician-age Galena Group Dubuque Formation.
- MW-39A completed in Quaternary-age loess and colluvium, and the underlying Elgin Member of the Ordovician-age Galena Group Dubuque Formation.
- MW-40A completed in Quaternary-age loess and colluvium, the underlying Ordovician-age Maquoketa Formation.
- MW-42A completed in Quaternary-age loess and colluvium, the underlying Ordovician-age Maquoketa Formation.
- MW-43A completed in Quaternary-age loess and colluvium, and the underlying Elgin Member of the Ordovician-age Galena Group Dubuque Formation
- MW-44A completed in Quaternary-age loess and colluvium, and the underlying Elgin Member of the Ordovician-age Galena Group Dubuque Formation
- MW-45A completed in Quaternary-age loess and colluvium
- MW-46A completed in Quaternary-age loess and colluvium, and the underlying Elgin Member of the Ordovician-age Galena Group Dubuque Formation

Water table wells downgradient of the leachate lagoon include:

- MW-100 and MW-101 completed in Quaternary-age loess and colluvium, and the underlying Elgin Member of the Ordovician-age Galena Group Dubuque Formation.

- MW-43A and MW-44A completed in Quaternary-age loess and colluvium, and the underlying Elgin Member of the Ordovician-age Galena Group Dubuque Formation.

4.2.2 Groundwater Occurrence in the Uppermost Bedrock

Piezometric elevations are measured in the uppermost Ordovician-age bedrock at the Winneshiek Landfill, which includes the upper and lower Elgin Member of the Maquoketa Formation and, where the Maquoketa Formation is absent because of geologic erosion, the geologically older Galena Group Dubuque Formation. Bedrock groundwater elevations are measured in 8 bedrock wells at the Winneshiek County Landfill (Table 3). Figure 22 shows the bedrock groundwater elevations for September 2023, which is representative for site conditions.

Eight wells are completed in the uppermost Ordovician-age bedrock at the Winneshiek County Landfill:

Two upgradient bedrock wells located west of the landfill:

- MW-18 completed in the lower Elgin Member of the Maquoketa Formation.
- MW-19R completed in the lower Elgin Member of the Maquoketa Formation.

Bedrock wells located down gradient of the landfill include:

- MW-11 completed in upper and lower Elgin Member of the Maquoketa Formation.
- MW-22 completed in the Galena Group Dubuque Formation.
- MW-30 completed in the Galena Group Dubuque Formation.
- MW-35 completed in upper and lower Elgin Member of the Maquoketa Formation.
- MW-36 completed in the Galena Group Dubuque Formation.

4.3 Water Table Monitoring Points

The water-table detection monitoring program for the Winneshiek County Landfill, Table 3, includes the monitoring wells shown on Figure 21.

4.3.1 Detection Monitoring

Detection monitoring of water table conditions at Winneshiek County Landfill is comprised of 23 water table wells, and includes:

- Upgradient water table wells MW-1 and MW-37A completed in loess and the underlying pre-Illinoian-age glacial diamicton.
- MW-2R, downgradient of Area 2, completed in the upper Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-3, downgradient of Area 1, completed in pre-Illinoian-age glacial diamicton.
- MW-4 and MW-4B, downgradient of Area 1, completed in pre-Illinoian-age glacial diamicton and interbedded fluvioglacial material.
- MW-7A, downgradient of Cell 5 EXP, completed in pre-Illinoian-age glacial diamicton.
- MW-24A, downgradient of Cell 5 EXP, completed in fine-grained construction fill overlying thin loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-25A, downgradient of Cells 4 and 5 EXP, completed in fine-grained construction fill overlying thin loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-29A, downgradient of Cell 5 EXP and leachate lagoon, completed in fine-grained construction fill overlying thin loess and the underlying Galena Group Dubuque Formation.
- MW-31A, downgradient of Cell 5 EXP, completed in overlying thin loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.

- MW-33A, downgradient of Areas 2 and 3, completed in fine-grained construction fill overlying thin loess, diamicton and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-34A, downgradient of Areas 2 and 3, completed in fine-grained construction fill overlying thin loess, diamicton and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-38A downgradient of Cell 4, completed in Quaternary-age loess and colluvium, the underlying Elgin Member of the Ordovician-age Maquoketa Formation, and the Ordovician-age Galena Group Dubuque Formation.
- MW-39A downgradient of Cell 4, completed in Quaternary-age loess and colluvium, and the underlying Elgin Member of the Ordovician-age Galena Group Dubuque Formation.
- MW-40A downgradient of Cell 4, completed in Quaternary-age loess and colluvium, the underlying Ordovician-age Maquoketa Formation.
- MW-41A completed in pre-Illinoian-age glacial diamicton and the underlying Ordovician-age upper Elgin Member of the Maquoketa Formation.
- MW-42A downgradient of Cell 5 EXP, completed in overlying thin loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation.
- MW-43A downgradient of the leachate lagoon completed in fine-grained construction fill overlying thin loess and the underlying Galena Group Dubuque Formation.
- MW-44A downgradient of the leachate lagoon completed in fine-grained construction fill overlying thin loess and the underlying Galena Group Dubuque Formation.
- MW-45A downgradient of Cell 5 EXP, completed in overlying thin loess
- MW-46A downgradient of Cell 5 EXP, completed in overlying thin loess and the underlying Galena Group Dubuque Formation
- MW-101 downgradient of the leachate lagoon completed in fine-grained construction fill overlying thin loess and the underlying Galena Group Dubuque Formation.

4.3.2 Water Table Assessment Monitoring

There are ten monitoring wells in assessment monitoring. Monitoring wells MW-7A, MW-24A, MW-29A, MW-31A, MW-33A, MW-40A, MW-42A, MA-43A, MW-44A, and MW-46A are all shallow water table monitoring wells. Monitoring wells MW-29A, MW-31A, MW-42A, and MW-43A are currently being evaluated as part of an assessment of corrective measures (ACM) based on Appendix I inorganic metal SSLs (cobalt).

4.3.3 Leachate Manhole Monitoring

There are two leachate manholes, MH-1AA and MH-4-2, which are being monitored as part of an assessment of corrective measures (ACM). These two manholes are being sampled for Appendix I parameters.

4.3.4 Water-Level Measurement Only

Water-level measurement only is performed in the following water table wells:

- MWII-2, downgradient of Area 1 and sidegradient of Area 5, completed in the pre-Illinoian age glacial diamicton.
- MW-2, downgradient of Area 2, completed in the upper Elgin Member of the Ordovician-age Maquoketa Formation. Groundwater levels are too low (<0.1 ft) to sample the well.
- MW-12A, downgradient of Cell 4, completed in fine-grained construction fill and the underlying Elgin Member of the Ordovician-age Maquoketa Formation. Groundwater levels are too low (<0.1 ft) to sample the well.
- MW-26A, downgradient of Cell 4, completed in fine-grained construction fill overlying thin loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation. Groundwater levels are too low (<0.1 ft) to sample the well.

- MW-27A, downgradient of Cell 4, completed in fine-grained construction fill overlying thin loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation. Groundwater levels are too low (<0.1 ft) to sample the well.
- MW-32A, sidegradient of Cell 4, completed in loess and the underlying Elgin Member of the Ordovician-age Maquoketa Formation. Groundwater levels are too low (<0.1 ft) to sample the well.
- MW-100 downgradient of the leachate lagoon completed in fine-grained construction fill overlying thin loess and the underlying Galena Group Dubuque Formation. Groundwater levels are too low (<0.1 ft) to sample the well.

4.4 Bedrock Monitoring Points

As shown in Table 3, groundwater quality in the uppermost Ordovician-age bedrock is monitored in four detection monitoring wells and four water-level only measurement wells. The location of these monitoring points is shown on Figure 22.

4.4.1 Detection Monitoring

The four detection monitoring wells in bedrock include:

- Upgradient monitoring well MW-19R completed in the lower Elgin Member of the Maquoketa Formation.
- Upgradient monitoring well MW-18 completed in upper Elgin Member of the Maquoketa Formation
- Downgradient monitoring well MW-11 completed in the upper and lower Elgin Member of the Maquoketa Formation.
- Downgradient monitoring well MW-22 completed in the Galena Group Dubuque Formation.
- Downgradient monitoring well MW-35 completed in upper and lower Elgin Member of the Maquoketa Formation.

4.4.2 Water-Level Measurement Only

The five water-level measurement only wells in bedrock include:

- Downgradient monitoring well MW-30 completed in the Galena Group Dubuque Formation. Groundwater levels are too low (<0.1 ft) to sample the well.
- Downgradient monitoring well MW-36 completed in the Galena Group Dubuque Formation. Groundwater levels are too low (<0.1 ft) to sample the well.

4.4.3 Bedrock Assessment Monitoring

Well MW-19R has replaced upgradient bedrock monitoring well MW-19. Monitoring well MW-19 was in assessment monitoring due to detections for inorganic parameters of arsenic, barium, and nickel, and organic detections for benzene and chlorobenzene. Fall 2023 results and groundwater levels for MW-19R confirm that there were no detections for benzene and chlorobenzene. No parameters were above a GPS.

4.5 Surface Water Monitoring Points

Three surface water locations are monitored (Figure 2). SW-1 is upstream and located on the east by an unnamed, northward flowing tributary to the Trout River. SW-2 is located downstream at the confluence of an unnamed, northward flowing tributary to the Trout River and the Trout River. SW-5 is downstream of SW-1 located on the east an unnamed, northward flowing tributary to the Trout River.

There are two surface water level and flow only monitoring points, SW-3, and SW-4 (Figure 2). Staff gauge SW-3 is downstream of SW-1 and a surface water impoundment on the east side of the landfill. Staff gauge SW-4 is downstream of surface water impoundment on west side of landfill, near the landfill gate.

4.6 Landfill Cell Groundwater Underdrain Monitoring Points

Two landfill cell groundwater drainage layers are monitored (Figure 2). GU-1 is a groundwater drainage layer monitoring location which monitors a section of original landfill Cell 5. GU-2 is a groundwater drainage layer monitoring location which monitors a section of landfill C5 EXP.

4.7 Leachate Head Monitoring Points

Ten landfill leachate head piezometers are monitored (Figure 2). The locations monitor leachate levels for Areas 1, 2, and 3, Cell 4 and Cell 5 EXP.

4.8 Reference

Prior, J.C., 1991. Landforms of Iowa: University of Iowa Press, Iowa City, 154 p.

5 Semi-Annual Groundwater Level Measurement

Groundwater levels will be measured semi-annually at the Winneshiek County Landfill wells in compliance with Iowa Department of Natural Resources Permit No. 96-SDP-1-74P. In addition, leachate head, groundwater underdrain, and surface water elevations are measured. Table 4 lists the monitoring points that will be measured.

For each semi-annual sampling event, field Water Elevation forms, such as the example in Appendix B, will be used to document:

- Well Number
- Elevation of the Top of the Well Casing
- Measured Depth to Water from the Top of Casing
- Measured Depth to the Bottom of the Well

Two sets of groundwater level measurements will be collected from each well prior to groundwater sampling. The first water level measurement will be collected as part of a full round, in which groundwater levels will be collected from all permitted wells within a 24-hour time period for use in evaluating groundwater elevations and flow across the site. A second groundwater level measurement will be collected from each well directly before groundwater sampling.

In preparation for collecting groundwater level and depth to bottom measurements, the groundwater sampling technician shall review the site-specific planning documents to obtain the following information:

- Identification number(s) of the well or wells to be monitored (found in sampling protocols presented in the HMSP);

- Locations of the wells as shown on a site map;

- Records listing the most recent groundwater level measurements and constructed depth to bottoms for the well(s); and

- Reference point information (e.g., top-of-casing elevation, state plane coordinates, marked location of measurement reference point).

Prior to collecting groundwater level measurements, the sampler will visually inspect the measuring tape/probe to ensure that it is not missing sections and the numbers are accurate. The sampler will then decontaminate the water-level indicator in its entirety, including the recessed chamber the probe sits in. Once decontaminated, the probe of the electric water level indicator will be lowered into the riser casing until water is encountered, as indicated by the instrument signal. The instrument signals encountering top of water by illuminating a light on the side of the instrument and by sounding with a continuous beep. The water level will then be measured to the nearest 0.01 foot with respect to the marked “top-of-casing” reference point and entered on the field log. Measurement reference points have been clearly marked on the north side of the top-of-casing for each well. As part of the measurement process, additional consecutive water level measurements will be made by field personnel to verify the initial reading obtained.

The water level measurement will be compared to the most recent water level obtained for the well (previous sampling event). If the measurements differ by more than 0.5 foot, the depth to water will be measured a second time for verification purposes. A remark will be made on the field form if a probable cause for the discrepancy is known (e.g., period of drought, rainfall event, or start-up of a nearby pumping well).

Field measurements of water levels for a given well shall be recorded on the field form including the following information:

- The type of measurement device used;
- Date and time of the measurement; and
- Any pertinent remarks concerning the well condition, instrument malfunction, variation of the measured depth versus the installed depth of the well, soft bottom, etc.

When groundwater-level measurements are taken at the same time as groundwater sampling, the static water level will be taken first; the depth to the bottom of the well will not be taken until after the completion of groundwater sampling to minimize any effects of any sediment on groundwater turbidity and to avoid mixing of groundwater in the well casing prior to groundwater sample collection.

During the groundwater level measurements, other notes will be recorded about the well integrity and recorded on the Water Elevation form. These notes will include information about the status of the well as locked and capped, and any notes about well integrity regarding cracks, obstructions, presence of sediment at bottom of well, presence of insects, or other observed features in the well and surface seal.

Field measurements of surface water levels for a staff gauge shall be recorded on the field form including the following information:

- The type of measurement device used;
- Date and time of the measurement; and
- Any pertinent remarks concerning the staff gauge condition, instrument malfunction, etc.

Annually, photographs of each monitoring location will be taken and a photo log with notes will be completed. The photo log will be part of annual well inspection and submitted as part of the annual monitoring report.

6 Groundwater Sampling and Analysis

This section describes groundwater sampling and analysis at the Winneshiek County Landfill. The sampling and analysis are designed to comply with IAC 567-113.10(455B)(4) and are developed to ensure that monitoring results provide an accurate representation of groundwater quality at the wells at the Landfill.

6.1 Sample Collection and Preservation

Groundwater sample collection will be accomplished using low-flow sampling techniques as described below.

Sample integrity will be maintained by decontaminating field equipment prior to sampling and in between wells, and adhering to the EPA sample collection, preservation, packaging, and chain-of-custody protocols.

6.1.1 Low-Flow Sampling Techniques

For the semi-annual sampling events, low-flow sampling techniques will be used for groundwater sampling. The equipment to be used for this technique will consist of:

1. Low-Flow sampling pump and controller (e.g., impeller type pump) (i.e., Proactive Mega-Monsoon) with back-flow check valve, dedicated or non-dedicated bladder pump (i.e., Geotech Portable Stainless-Steel Bladder Pump).
2. Disposable tubing made of inert materials for low-flow sampling pump.
3. Disposable bladders (if non-dedicated bladder pumps are used).
4. Stainless steel bailers or disposable Teflon bailers.
5. Electronic water level indicator (two-wire electrical sounder), equipped with a sufficient length of water level tape to reach the deepest anticipated water level; the water level tape should be graduated into 0.01-foot intervals.
6. Extra batteries for the water level indicator.
7. Disposable nylon rope.
8. Liquinox or other non-phosphate detergent.
9. Deionized water.
10. Pressurized deionized water sprayer.
11. Other decontamination equipment, as needed (e.g., brush, plastic bucket, clean spray bottles, paper towels, clean plastic sheeting).
12. Five-gallon graduated bucket for collecting and measuring purge volumes.
13. Sample containers (provided with appropriate preservatives by Eurofins TestAmerica, Inc.).
14. Two coolers for shipment of water samples.
15. Ice.
16. Myron Ultrameter II or equivalent combination water quality meter (pH, temperature, conductivity).
17. LaMotte or equivalent turbidity meter.
18. In-Situ Aqua Troll 500 Multiparameter Sonde low-flow system.
19. Field data sheets.
20. Sample labels.
21. Chain-of-custody forms.
22. Personal protective equipment (PPE).
23. Garbage bags for PPE, filters, and disposable tubing.
24. Keys for locked protective casings.
25. Tools (e.g., wrenches), as needed, to enter well vault boxes.
26. Health and safety monitoring equipment, as needed.

6.1.2 Calibration of Field Equipment

Calibration of all field instruments used to measure and monitor pH, conductivity, turbidity, and temperature will be performed.

The Myron Ultrameter II pH/Conductivity Meter will be calibrated at the beginning of each sampling day. The meter will be calibrated using the manufacturer's specifications. If instrument calibration indicates damage or sensor degradation over time, the instrument will be replaced.

The LaMotte turbidity meter will be calibrated at the beginning of each sampling day. The meter will be calibrated in the field office using the manufacturer's specifications. If instrument calibration indicates damage or sensor degradation over time, the instrument will be replaced.

The In-Situ Aqua Troll 500 probe will be calibrated annually by the manufacturer prior to deployment. The meter will be maintained by the manufacturer using the manufacturer's specifications. A "Quick Cal" which calibrates the basic sensors simultaneously using a single "universal" calibration solution will be performed daily. This will provide the field technician with information on stability of the sensor. If the instrument indicates damage or sensor degradation, the instrument will be replaced.

Prior to sampling, the water level measurement will be compared to the previous day's water level obtained for the well. If the measurements differ by more than 0.5 foot, the depth to water will be measured a second time for verification purposes. A remark will be made on the field form if a probable cause for the discrepancy is known (e.g., rainfall event, drought, or start-up of a nearby pumping well).

Depth to bottom of the well will be measured to the nearest 0.01 foot in a similar manner, but only after groundwater sampling has been completed to minimize the disturbance of any fine-grained sediment which may be present at bottom of well. As part of the measurement process, additional consecutive depth to bottom measurements will be made by field personnel to verify the initial reading obtained. Any discrepancy between the measured well depth and constructed well depth shall be noted as a remark on the form; such a discrepancy may indicate the presence of a possible obstruction or break in the casing or sedimentation at the bottom of the monitoring well.

Prior to groundwater sampling, the well depth to water will be measured. The pump and its tubing will then be slowly lowered into the monitoring well until the pump intake is situated at a predetermined level within the screened interval of the water column. The discharge line from the pump will then be connected to the flow-through cell, and the discharge line from the flow-through cell will be directed to a container to collect wastewater. Pump flow rates will be set to maintain a steady flow with the goal of maintaining a drawdown of no more than 0.33 feet. Flow rates will be measured using a graduated cylinder or beaker and a stopwatch.

The flow-through cell will be used to monitor several parameters directly. One tubing volume of water will be pumped to the waste container before readings will be initiated. Stabilization will be considered to have occurred when the parameters listed in Table 5 have stabilized on three successive readings within the listed criteria:

Table 5
Low-Flow Sampling Stabilization Parameters

Parameter	Stabilization Criteria	Reference
pH	±0.1	Puls and Barcelona, 1996; Wilde et al, 1998
Specific electrical conductance	±3%	Puls and Barcelona, 1996
Oxidation-reduction potential	±10 millivolts	Puls and Barcelona, 1996
Turbidity	±10% (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al, 1998
Dissolved oxygen	±0.3 mg/L	Wilde et al, 1998

Table 6 summarizes the sample containers and preservatives to be used. All samples will be stored in coolers containing ice in a secure area until custody is relinquished.

Table 6

Bottle and Preservation Requirements

Test Parameters	Sample Container	Preservation	Holding Time
Total Organic Halogens	760 ml Amber Glass	$H2SO_4$ to pH<2	28 Days
Total Organic Carbon	500 ml Amber Glass	$H2SO_4$ to pH<2	28 Days
Total Chromium and Lead	250-ml HDPE	HNO_3 to pH<2	180 Days
Total Metals	1,000-ml HDPE	HNO_3 to pH<2	28 Days Mercury 180 Days All Others
Total Cyanide	500-ml HDPE	NaOH to pH>12	14 Days
Volatile Organic Compounds	3 50-ml Glass Vials	HCl to pH <2; cool to 4°C	14 Days
Base Neutral Semi-Volatile Organic Analytes	1,000-ml Amber Glass	--	7 Days
Acid Semi-Volatile Organic Analytes	1,000-ml Amber Glass	--	7 Days
PCB/Pesticide Analytes	1,000-ml Amber Glass	--	7 Days

Following sampling, well integrity will be checked by measuring the well depth to bottom. The well depth to bottom and static water level will be compared to previous monitoring events to check for potential changes to well depth to bottom. Any changes to well depth to bottom or well integrity will be noted on field data forms.

6.1.3 Decontamination

The outer parts of the bladder pump that have been in contact with groundwater will be cleaned prior to sampling and in between wells by being rinsed with deionized water. The inner parts of the pump will be cleaned by pumping ½ gallon of deionized water through the pump head. The pump uses a disposable bladder and tubing, which is replaced after each well. Rinsates will be discharged to a 5-gallon water bucket and ultimately disposed of by discharging to the landfill surface.

Personal protective equipment (PPE) that is generated throughout sampling activities shall be placed in plastic garbage bags. All PPE should be disposed as non-hazardous waste in the designated on-site roll-off box at the Landfill. Trash that is generated as part of field activities may be disposed of in the Landfill as long as the trash was not exposed to hazardous media.

Disposable Teflon bailers will not require decontamination. If used, they will be disposed with the PPE in a plastic garbage bag.

PPE will be used during decontamination. PPE will include nitrile gloves, safety glasses, steel-toe boots, and poly-coated Tyvek, if necessary, to protect against dermal contact with groundwater.

6.1.4 Quality Control

To verify the quality of the sampling process, sample blanks and duplicates will be collected. One equipment (rinsate) blank will be collected for every 20 samples or a minimum of once per sampling event. The equipment blank will be collected after the decontamination process (described in Section 6.1.3) by collecting deionized water through the sampling device in the appropriate bottles listed in Table 6.

Field duplicates will be collected for every 10 or fewer samples. When a field duplicate sample is collected, it will be a second sample collected consecutively from a well using the sampling device.

To assess the degree and type of accidental contamination by volatile organics during the sample collection and shipment procedures, two 40-ml volatile trip blank samples per cooler will be filled completely with distilled water by the laboratory prior to mobilization to the site and stored with the sample volatile vials to be used during field sample collection.

Field documentation will undergo an internal QC review after the completion of field activities. Field forms will be reviewed by the AECOM QA Manager for completeness, accuracy, and compliance with this document. Upon completion of the field sampling events, field documentation will be relinquished to the Project Manager and digital copies stored on an AECOM computer server.

6.1.5 Documentation

Data collected and observations made during groundwater sampling will be recorded on the Well Purging and Sample Collection Field Data Sheet (see Appendix C).

6.2 Sample Shipment

Samples will be collected from each monitoring point and submitted by AECOM personnel to Eurofins Environment Testing North Central, LLC (Eurofins – Cedar Falls)., located in Cedar Falls, Iowa at the end of each sampling day or in the morning the day after sampling.

6.3 Analytical Procedures

Measurements of pH, conductivity, turbidity, and temperature will be performed in the field using a pH/conductivity/turbidity/temperature meter. Eurofins – Cedar Falls, will conduct all other analyses. Table 7 provides a list of all field and laboratory (IDNR Appendix I) analyses that will be performed along with method detection limits and reporting limits.

6.4 Chain-of-Custody Control

The following sections summarize the sample handling and chain-of-custody procedures that will be used for this project and include an example Chain-of-Custody (Appendix D) form. The Chain-of-Custody (COC) form is the written documented history of a sample and is initiated at the time of sampling. This form will be completed by AECOM sampling personnel and will accompany the samples to the laboratory where it will be received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from AECOM to the laboratory. The COC form also acts as a purchase order for analytical services when no other contractual agreement is in effect.

The information the AECOM sampler will provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form will be completed and must be legible. This form will include the following information:

- Client name, address, phone number, and fax number (if available).
- Project Name and/or Number.
- The sample identification.
- Date, time, and location of sampling.
- Sampling plan, if applicable.
- Sample collector's name.
- The matrix description.
- The container description.
- The total number of each type of container.
- Preservatives used.
- Analysis requested.
- Requested turnaround time (TAT).

- Any special instructions.
- Purchase order number or billing information (e.g., quote number), if available.
- The date and time each person received or relinquished the sample(s), including their signed name.

Samples will remain solely in the possession of the AECOM field technician until delivery to laboratory personnel. Samples are stored in a cooler with ice, as applicable. The sample collector will assure that each container is always in his/her physical possession/view or stored in such a place and manner to preclude tampering. The field technician will relinquish the samples in writing on the COC form to laboratory sample control personnel. Samples are only considered to be received by the lab when personnel at the laboratory have physical contact with the samples.

Samples delivered to the laboratory must meet the following criteria:

1) Samples must be properly labeled.

   - Use durable labels (labels provided by Eurofins – Cedar Falls are preferred).
   - Include a unique identification number.
   - Include sampling date and time and sampler ID.
   - Include preservative used.
   - Use indelible ink.

2) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested.

3) Samples must be preserved according to the requirements of the requested analytical method.

4) Most analytical methods require chilling samples to 4°C (exceptions would include samples submitted for metals analysis). For methods requiring temperature preservation to 4°C, the criteria are met if the samples are chilled to at or below 6°C and above freezing. For methods with other temperature criteria, the samples must arrive within ±2°C of the required temperature, or within the method specified range. Note: Samples that are hand-delivered to the laboratory immediately after collection may not have had time to cool sufficiently. In this case, the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

5) All samples submitted for Volatile Organic analyses should have a Trip Blank submitted with the samples. Eurofins – Cedar Falls will supply a Trip Blank, if requested, with all bottle orders containing Volatile Organic analyses.

6) The Eurofins – Cedar Falls project manager will be notified if any sample is received in damaged condition. Eurofins TestAmerica will then contact AECOM with the details of the sample condition upon receipt and request further instructions.

6.4.1 Sample Receipt

When samples arrive at the laboratory, designated sample-receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented and brought to the immediate attention of AECOM. The COC; shipping documents; documentation of any non-conformance, irregularity, or compromised sample receipt; record of client contact, and resulting instructions become part of the project record.

6.4.2 Sample Storage

To avoid deterioration, contamination, or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators suitable for the sample matrix. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards, or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every 2 weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. All samples are kept in the refrigerators for 2 to 4 weeks after analysis, which meets or exceeds most sample holding times. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists in dealing with legal matters or regulatory issues.

Access to the laboratory is controlled such that sample storage need not be always locked unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of Eurofins TestAmerica.

6.5 Quality Assurance and Quality Control

6.5.1 Field Quality Control

The field team will be responsible for inspecting sample containers before leaving for the field. Only new sealed sample containers accompanied by the manufacturer's certification of precleaning will be used. The sample containers will also be inspected for cracks, ill-fitting lids, and other obvious defects before use and will be discarded if defects are found to be present.

The pH/conductivity meter will be calibrated at the beginning of each sampling day. The meter will be calibrated using the manufacturer's specifications. The calibration for the pH function will be at least a 2-point calibration (pH 7.0 and pH 4.0 solutions) and will occur in the office (except for the initial calibration check which will be done at the time of checkout). Calibration for the conductivity function will be performed with a potassium chloride (KCl) solution in the office. The meter does have temperature compensation; therefore, temperature differences between the sample and the calibration standards will not be an issue.

During water quality sampling, one equipment blank will be collected for every 20 or fewer groundwater samples when non-dedicated sampling equipment is used. Field duplicate samples will be at a frequency of 1 per 10 groundwater samples. A trip blank will be included in each shipment of samples collected for volatile organic compounds (VOCs).

Field quality control samples will be evaluated during data validation and the appropriate qualifiers assigned. For detections in blanks at concentrations below the reporting limit, the associated sample results that are less than the reporting will be qualified non-detect (U). For detections in the blanks that are greater than the reporting limit, associated sample concentrations within five times the blank concentration will be qualified non-detect.

Field equipment requiring testing, inspection and maintenance includes the pH/conductivity meter. This meter will be used to measure pH, temperature, and conductivity for water samples while in the field. The manufacturer's operating manual for this instrument describes the procedures for testing and inspecting the meter. These procedures include a battery check, verification that the meter was successfully calibrated during its previous use and ensuring preventative maintenance has been completed per the manufacturer's recommendations.

An inspection checklist and initial calibration check will be completed by a field team member upon checkout of the meter. Calibration standards and commonly needed spare parts will also be obtained upon checkout. Any preventative or corrective maintenance done will be documented in the equipment log.

Other field equipment includes the bladder pump with back-flow check Valve. Inspection and maintenance of the pump will consist of checking for degradation, replacing the bladder, replacing the tubing, and cleaning the pump. Cleaning will include an Alconox (or Liquinox) wash and rinse, followed by a deionized water rinse of both the exterior and interior.

6.5.2 Laboratory Quality Control

Eurofins – Cedar Falls, procedures include reviewing the instrument log for any notations regarding problems experienced during the previous use and verifying the preventative maintenance has been completed per the manufacturer's recommendations. Any preventative or corrective maintenance done will be documented in the maintenance log. Spare parts are kept in the laboratory's supply room and are available when needed.

Eurofins – Cedar Falls, internal standards address the calibration for the laboratory instruments. Information regarding the standards used will be documented in the instrument log.

Eurofins – Cedar Falls, analyst assigned to conduct the analysis will be responsible for inspecting equipment and supplies upon receipt. The manufacturer's specifications for product performance and purity will be used as the acceptance criteria.

6.6 References

Puls, R.W., and M.J. Barcelona. 1996. Low Flow (Minimal Drawdown) Ground Water Sampling Procedures. USEPA/ORD EPA/540/S-95/504. Washington, DC: US Environmental Protection Agency.

Wilde, F.D., D.B. Radtke, J. Gibs and R.T. Iwatsubo. Eds., 1998. National Field Manual for the Collection of Water-Quality Data; U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9, Handbooks for Water-Resources Investigations, Variously Paginated.

7 Detection Monitoring Program

The detection monitoring program for the Winneshiek County Landfill has been established in accordance with the IDNR regulations in 567-113.10(5).

7.1 Monitoring Points

The detection monitoring system consists of 27 monitoring wells, including 23 shallow (water table) wells:

MW-1
MW-2R
MW-3
MW-4
MW-4B
MW-7A
MW-24A
MW-25A
MW-29A
MW-31A
MW-33A
MW-34A
MW-37A
MW-38A
MW-39A
MW-40A
MW-41A
MW-42A
MW-43A
MW-44A
MW-45A
MW-46A
MW-101

It also includes four deeper wells in the uppermost bedrock:

MW-11
MW-19R
MW-18
MW-22
MW-35

In addition to the monitoring wells, underdrain outlets (GU-1 and GU-2) are also monitored as part of the water table monitoring system. Surface water is monitored by upgradient surface water monitoring point SW-1 and downgradient surface water monitoring points SW-2 and SW-5, located just east of the landfill on an unnamed tributary to the Trout River. Leachate manholes, MH-1AA and MH-4-2 are also monitored as part of the ACM.

A summary of the hydrologic monitoring system is provided in Table 3. Locations of detection monitoring points are shown in Figure 2.

7.2 Comparison of Monitoring Points

7.2.1 Shallow (Water Table) Monitoring Points

Background Points

Based on the site hydrogeology, the Landfill overlies a groundwater divide in the water table (Figure 21). On the west side of the divide, water table flow is toward the west-northwest. MW-1 and MW-37A are hydraulically upgradient of Landfill Areas 1 and 2; and these wells are screened in Quaternary loess and the underlying glacial diamicton. However, these wells are not hydraulically upgradient of the monitoring wells located on the eastern side of the groundwater divide.

In the past, MW-1 has been used as an upgradient background well. In October 2009, a confirmed detection of chlorobenzene, below the 100 µg/L GPS, occurred at this location, and the well was placed in assessment monitoring. Since November 2014, MW-1 has not had any chlorobenzene or other organic detections. MW-1 is not currently in assessment monitoring and has returned to semi-annual Appendix I sampling.

Well MW-32A is hydraulically upgradient of Landfill Area 3, and Cells 4 and 5EXP; and is screened in Quaternary loess and the underlying glacial diamicton. However, this well has insufficient groundwater for sampling.

Given that, wells MW-1 and MW-37A will be used as upgradient background for all water table wells.

Downgradient

The downgradient water table wells at the Landfill are generally screened in different hydrostratigraphic units than those of the upgradient wells (Table 3). The groundwater geochemistry also naturally varies between the different hydrostratigraphic units as discussed in Section 2.15. Interwell (upgradient vs. downgradient) comparisons of groundwater quality is the statistical comparison method for the downgradient water table at the Landfill.

Historical groundwater sampling data has shown two water table wells which have displayed impacts due to landfill activity: MW-4, and MW-4B. MW-4 and MW-4B were installed due to organic parameters detected in groundwater. A leachate toe drain was installed to intercept leachate from Areas 1, 2, and 3 and mitigate interaction of leachate with groundwater from these unlined cells. The remedy has been effective in reducing and eliminating organics detected in groundwater as shown in historical sample results for MW-4 and MW-4B. As a result, MW-4 and MW-4B have returned to semi-annual Appendix I sampling.

7.2.2 Deep (Uppermost Bedrock) Monitoring Points

Upgradient

Based on the site hydrogeology, the Landfill overlies groundwater occurring deep in a bedrock aquitard (Figure 21). Upgradient wells MW-18 and MW-19R are the only upgradient deep detection wells at the Landfill; both wells are screened in the Ordovician-age lower Elgin Member of the Maquoketa Formation shale. The groundwater geochemistry also naturally varies between the different hydrostratigraphic units as discussed in Section 2.15. Based on bedrock groundwater flow, bedrock wells MW-18 and MW-19R are used for upgradient background. Interwell well comparisons of current groundwater quality to previous years' background data is the statistical comparison method for bedrock groundwater at the Landfill.

Downgradient

Deep downgradient well MW-11 and MW-35 are screened in the Ordovician-age lower Elgin Member of the Maquoketa Formation shale. Deep downgradient well MW-22, is screened in the Galena Group Dubuque Formation dolomite. Wells MW-30 and MW-36 have insufficient groundwater for sampling. Two of the five downgradient bedrock wells are screened in a different hydrostratigraphic unit than that of the upgradient well (Table 3). Regardless, interwell comparisons of groundwater quality is the statistical comparison method for the downgradient bedrock at the Landfill.

7.2.3 Surface Water Monitoring Points

Monitoring point SW-1 is upgradient (upstream) of the Landfill, and interwell comparisons of current surface water quality to previous years' background data is the statistical comparison method used for this location.

Monitoring points SW-2 and SW-5 are downgradient (downstream) from the Landfill and is compared statistically to the upstream monitoring point SW-1.

7.3 Statistical Analysis

Statistical analysis for the detection monitoring program for the Winneshiek County Landfill has been established in accordance with the IDNR regulations in 567-113.10(4).

Groundwater samples from the detection monitoring points will be sampled and analyzed semi-annually, weather dependent, in Spring (March/April/May) and Fall (September/October/November) for IDNR Appendix I parameters. Monitoring data and statistical evaluations will be submitted to IDNR within the required 14 days (Subrules 113.10(5) and 113.10(6)) as they are completed.

Prior to statistical analysis, the data will be examined to observe results that may be artificially high or low (outliers) due to potential field sampling, transportation, laboratory, or transcription errors.

Low flow sampling began in the fall of 2014. Therefore, interwell background levels of parameters detected in the current sampling year will be established by pooling all available historical data collected since Fall of 2014 from the appropriate background data set through the end of the preceding year (i.e., 2014 – 2023 for AWQR 2024). Measurements of turbidity and total suspended solids (TSS) which can affect measurement of inorganic metals parameters also began in Fall of 2014. For the detection monitoring program, current-year compliance data will be statistically tested against the background data using prediction limit methods that utilize the comparisons described in Section 7.2. The procedure used to determine the appropriate prediction limit method will be as follows:

1. If a monitoring well's background for a given parameter contains more than 50 percent non-detects, a nonparametric prediction limit will be used to test the interwell compliance data against interwell background, and the reporting limit (RL) will be used for nondetect values to account for non-detects.

2. If a monitoring well's background for a given parameter contains between 20 percent and 50 percent non-detects, Cohen's adjustment will be used to account for nondetect values.

3. If a monitoring well's background for a given parameter contains less than 20 percent non-detects, the RL will be used to account for nondetect values.

4. If monitoring well's background for a given parameter contains less than 50 percent non-detects, the background data will be tested for lognormality and normality using the Shapiro-Wilk procedure and probability plots. If background for a given parameter is consistent with a lognormal or normal distribution (defined as a nonsignificant result for the Shapiro-Wilk method at a 95 percent confidence level) and contains less than 50 percent non-detects, a parametric prediction limit (USEPA Unified Guidance 99 percent Confidence One-Sided) will be used to test the interwell compliance data against interwell background.

5. If a monitoring well's background data for a given parameter is not found to be either lognormal or normal in statistical distribution (defined as a significant result for the Shapiro-Wilk procedure at a 95 percent confidence level), a distribution-free (nonparametric) prediction limit (99 percent confidence level) will be used to test the interwell compliance data against interwell background.

A pass 1-of-2 verification resampling scheme will be utilized for sampling locations which statistically exceed (SSI) the interwell background prediction limit and for wells which exceed a GWPS. For current year monitoring well compliance data, an exceedance of the appropriate interwell prediction limit for a given Appendix I inorganic constituent will trigger a retest for that constituent as part of a verification resampling event. If the retest result also exceeds the prediction limit, a statistically significant increase (SSI) over background levels at that well will be considered to have occurred. If it cannot be demonstrated that a source other than a landfill unit caused the change in concentration or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality, the well will enter assessment monitoring.

Because Appendix I organic constituents are anthropogenic, detection of a given organic constituent at a single detection monitoring well will trigger a retest for that constituent as part of a verification resampling event. If the retest result also indicates a detection, a confirmed SSI over background levels will be considered to have occurred. If it cannot be demonstrated that a source other than a landfill unit caused the change in concentration or that the SSI resulted from error in sampling, analysis, statistical evaluation or natural variation in groundwater quality, the well will enter assessment monitoring.

7.4 Site-specific Groundwater Protection Standards (GWPS)

This purpose of this section is to present the results of estimating a site-specific groundwater protection standard for cobalt. Background data for cobalt is based on upgradient interwell shallow groundwater monitoring wells. Wells included are: MW-1, MW-1R, MW-19R, and MW-37A. Except for MW-19R, sample dates span from May 2014, when low-flow sampling began, through June 2024.

Sampling from these non-impacted monitoring points has indicated the measured background concentrations of total cobalt are occasionally above the GWPS in wells screened in the groundwater monitoring zone. Previously described site conceptual groundwater flow is recharge from precipitation moves vertically downward into glacial aged sediments consisting of loess, glacial tills, colluvium, and recharges bedrock composed of Maquoketa shale and claystone and Galena Group limestone. The Maquoketa bedrock has been eroded as part of last glaciation from west to east across the site as part of development of the Trout River to where the top of bedrock on the east side consists of Galena Group limestone. The Galena Group limestone is a uniform microcrystalline limestone with few fractures. Hence groundwater flows along the Maquoketa Group claystone and shale contact with Galena discharging as springs to tributary of Trout River. As such, groundwater chemistry is a mix of upgradient water table and bedrock groundwater flowing and mixing to east which then discharging to the Trout River.

Given the above, development of a site-specific background GWPS for cobalt is suitable. The paragraphs below provide a detailed discussion and justification for a background GWPS for cobalt.

The process for estimating GWPS for annual sample results comparisons includes analysis for trends, outliers, goodness-of-fit (GOF), and prediction limits (PL). Currently, background for the facility includes data from May 2014 through Spring 2024.

First, detection monitoring data for each monitoring well used in site-specific GWPS were tallied for sample size (n), count of nondetects and percentage of nondetects per well for cobalt. For wells with 90-100% nondetect per parameter, no outliers, trends or goodness of fit.

Next, detection monitoring data, both raw and log transformed, for each monitoring well used in site-specific GWPS were analyzed for outliers using Rosner's or Dixon's methods depending on sample size. If there are significant outliers in the detection monitoring data which may be attributed to errors in field sampling, lab methods, changes in lab detection limits, or lab data recording, identified errors, which can be resolved, would be corrected and outliers removed. If not, the outlier, would remain in the data set.

Next, if there were no significant outliers, the monitoring well detection monitoring data was analyzed for trends using the Helsel (2012) NADA Akritas-Theil-Sen slope and Kendall's tau methods. If there were no significant trends within the past 10 years of detection monitoring data, the background data set was pooled to estimate the site-specific cobalt GWPS.

Next, if there were no significant outliers, the pooled background chemistry data would be analyzed for statistical distribution using goodness-of-fit tests. Data will be tested for normal, lognormal and gamma distributions. If the data did not follow one of those distributions, nonparametric methods were used to estimate the nonparametric prediction limits.

Based on goodness-of-fit (distribution), nonparametric prediction limits were estimated. The site-wide prediction limit for cobalt in groundwater is estimated to be 3.40 µg/L and is being used in lieu of IDNR GWPS of 2.1 µg/L for all groundwater comparisons.

8 Assessment Monitoring Program

Assessment monitoring at the Winneshiek County Landfill will be completed in accordance with IDNR regulations in 567-113.10(6).

8.1 Sampling Program

Within 90 days of being triggered into assessment monitoring, as described in Section 7 of this document, groundwater from the assessment monitoring point will be analyzed for IDNR Appendix II constituents. For any Appendix II specific constituent detected at or above the reporting limit, in the monitoring point's sample as a result of the complete Appendix II analysis, a minimum of five quarterly samples from the monitoring point will be collected and analyzed to establish background for detected constituents.

Wells that are in assessment monitoring will be analyzed annually for all detected IDNR Appendix II constituents, and five quarterly background samples from wells with detected Appendix II constituents will be obtained to establish background levels for analytes. After obtaining the sampling results, a notice will be placed in the operating record within 14 days identifying the Appendix II constituents that were detected and the IDNR will be notified that the notice has been placed in the operating record. Wells which have no detections of Appendix II only constituents after two Appendix II sampling events will be re-tested for complete Appendix II list once every five years.

8.2 Statistical Analysis

At assessment monitoring points, comparisons of all constituents detected in the current monitoring year will be made to interwell background levels as detailed in Sections 7.2 and 7.3 of this document.

In addition to comparisons to background, comparisons of all constituents detected in the current monitoring year to the appropriate statewide standards for a protected groundwater (GWPS) source will be performed using either a parametric or a nonparametric confidence interval as appropriate at a 99 percent confidence level ($\alpha = 0.01$). The current statewide groundwater protection standards (GWPS) for a protected groundwater source used in the comparisons will be obtained from the following IDNR web site:

https://programs.iowadnr.http://programs.iowadnr.gov/riskcalc/pages/standards.aspx.

Prior to statistical analysis, the data will be examined to observe results that may be artificially high or low (outliers) due to field, transportation, laboratory, or transcription errors.

Levels of parameters detected in the current sampling year will be established by pooling all available historical data collected since the fall of 2014 (i.e., 2014 – 2023 for AWQR 2024). The procedure used to determine the appropriate prediction limit method will be as follows:

1. If the monitoring well's historical data for a given parameter contains more than 50 percent non-detects, a nonparametric confidence interval will be used to test the intrawell compliance data against the GWPS, and the reporting limit (RL) will be used for nondetect values to account for non-detects.

2. If the monitoring well's historical data for a given parameter contains between 20 percent and 50 percent non-detects, Cohen's adjustment will be used to account for nondetect values.

3. If the monitoring well's historical data for a given parameter contains less than 20 percent non-detects, the RL will be used to account for nondetect values.

4. If the monitoring well's historical data for a given parameter contains less than 50 percent non-detects, the historical data will be tested for lognormality and normality using the Shapiro-Wilk procedure and probability plots. If the monitoring well's historical data for a given parameter is consistent with a lognormal or normal distribution (defined as a nonsignificant result for the Shapiro-Wilk method at a

95 percent confidence level) and contains less than 50 percent non-detects, a parametric confidence interval will be used to test the intrawell compliance data against the GWPS.

5. If the monitoring well's historical data for a given parameter are not found to be lognormal or normal in statistical distribution (defined as a significant result for the Shapiro-Wilk procedure at a 95 percent confidence level), a nonparametric confidence interval (99 percent confidence level) will be used to test the intrawell compliance well data against the GWPS.

If the concentrations of all Appendix II constituents are statistically shown to be at or below a monitoring well's background values and below the applicable GWPS for three consecutive sampling events, the IDNR will be notified of this finding and the monitoring point will return to detection monitoring.

If the concentrations of any Appendix II constituents are above a monitoring point's background values, but all concentrations are statistically shown to be below the applicable GWPS, the monitoring point will continue in assessment monitoring.

If one or more Appendix II constituents are detected at statistically significant levels above the applicable GWPS in any sampling event, within 14 days of this finding, a notice will be placed in the operating record identifying the Appendix II constituents that have exceeded the GWPS, and IDNR and all other appropriate local government officials will be notified that the notice has been placed in the operating record.

If one or more Appendix II constituents are detected at statistically significant levels above the applicable GWPS in any sampling event, an attempt will be made to determine whether a source other than a landfill unit caused the change in concentration, or whether the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. If this is found to be the case, a report documenting this demonstration will be certified by a qualified groundwater scientist and submitted to IDNR for approval, and assessment monitoring will continue. If the concentrations of all Appendix II constituents are subsequently shown to be at or below a monitoring point's background values for two consecutive sampling events, the IDNR will be notified of this finding and may return to detection monitoring.

If the monitoring point's detections cannot be demonstrated to be unrelated to Landfill activities, the following actions will be taken within 90 days:

1. Characterize the nature and extent of the release by installing additional monitoring wells, as necessary, until the horizontal and vertical dimensions of the groundwater concentrations have been defined to establish the spatial extent of the changed groundwater concentrations;

2. Install at least one additional monitoring well at the facility boundary in the direction of changed groundwater concentrations and sample this well to determine if changed concentrations are migrating off site;

3. Notify all persons who own the land or reside on the land that directly overlies any part of the changed groundwater concentrations if the spatial extent of the changed concentrations has migrated off-site when indicated by sampling of wells; and

4. Initiate an assessment of corrective measures (ACM).

Assessment of corrective measures (ACM) is discussed in Section 9 of this document.

9 Assessment of Corrective Measures

9.1 Assessment of Corrective Measures (ACM)

An assessment of corrective measures will be completed once it has been determined that any of the Appendix I or Appendix II constituents have been detected and confirmed at a statistically significant level that exceeds the groundwater protection standards (SSL). This assessment will be completed in accordance with the IDNR regulations in 567-113.10(7).

An ACM will be initiated within 90 days of finding that any of the constituents listed in Appendix I or Appendix II have been detected at a statistically significant level exceeding the groundwater protection standards (GWPS). Within 180 days of the initial finding, an ACM will be completed and submitted to the IDNR for review and approval unless otherwise authorized or required by the IDNR. Monitoring will continue in accordance with the assessment monitoring program as outlined in Section 6.

The ACM will analyze the effectiveness of potential corrective measures in addressing the following:

1. The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;
2. The time required to begin and complete the remedy;
3. The costs of remedy implementation; and
4. The institutional requirements, such as state or local permit requirements or other environmental or public health requirements, that may substantially affect implementation of the remedy(remedies).

Within 60 days of approval from the IDNR of the ACM, and prior to the selection of a remedy, a public meeting will be held with interested and affected parties to discuss the results of the corrective measures assessment. The IDNR may establish an alternative schedule for completing the public meeting requirement. Notice of the public meeting will be sent to all owners and occupiers of property adjacent to the permitted boundary of the facility, the IDNR and the appropriate IDNR field office. A copy of the minutes of this public meeting and the list of community concerns will be placed in the operating record and submitted to the IDNR.

9.2 Selection of Remedy

Based on the results of the ACM described above, a remedy will be selected in accordance with the IDNR regulations in 567-113.10(8) within 60 days of holding the public meeting that, at a minimum, meets the following standards:

1. Be protective of human health and the environment;
2. Attain the groundwater protection standards described in Section 8 of this document;
3. Control the source(s) of releases to reduce or eliminate, to the maximum extent practicable, further releases of Appendix I or Appendix II constituents into the environment that may pose a threat to human health or the environment; and
4. Comply with standards for management of wastes that are protective of human health and the environment, and that comply with applicable RCRA, state and local requirements.

IDNR may establish an alternative schedule for selecting a remedy after holding the public meeting. Within 14 days of selecting a remedy, a report will be submitted to IDNR describing the selected remedy and explaining how the selected remedy meets the standards listed above.

In selecting a remedy, the following evaluation factors will be considered:

1. The long-term and short-term effectiveness and protectiveness of the potential remedy(remedies), along with the degree of certainty that the remedy will prove successful.

2. The effectiveness of the remedy in controlling the source to reduce further releases.

3. The ease or difficulty of implementing a potential remedy(remedies).

4. Practicable capability of the owner or operator, including a consideration of technical and economic capabilities.

5. The degree to which community concerns, including but not limited to the concerns identified at the public meeting, are addressed by a potential remedy(remedies).

The selected remedy will include a schedule(s) for initiating and completing remedial activities. Such a schedule will require the initiation of remedial activities within a reasonable time period. The following factors will be considered in determining the schedule of remedial activities:

1. Extent and nature of contamination;

2. Practical capabilities of remedial technologies in achieving compliance with groundwater protection standards, and other objectives of the remedy;

3. Availability of treatment or disposal capacity for wastes managed during implementation of the remedy;

4. Desirability of utilizing alternative or experimental technologies that are not widely available, but which may offer significant advantages over already available technologies in terms of effectiveness, reliability, safety, or ability to achieve remedial objectives;

5. Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;

6. Resource value of the aquifer;

7. Practicable capability of the owner or operator; and

8. Other relevant factors.

9.3 Implementation of Corrective Action Plan

Once the remedy has been selected, the corrective action plan will be implemented in accordance with the IDNR regulations in 567-113.10(9). Based on the schedule, the owner or operator will:

1. Establish and implement a corrective action groundwater monitoring program that meets the requirements of an ACM, indicates the effectiveness of the corrective action remedy, and demonstrates compliance with groundwater protection standards.

2. Implement the selected corrective action remedy; and

3. Take any interim measures necessary to ensure the protection of human health and the environment. Interim measures will, to the greatest extent practicable, be consistent with the objectives of and contribute to the performance of any remedy that may be required. The following factors will be considered in determining whether interim measures are necessary:

   - Time period required to develop and implement a final remedy;
   - Actual or potential exposure of nearby populations or environmental receptors to hazardous constituents;
   - Actual or potential contamination of drinking water supplies or sensitive ecosystems;

- Further degradation of the groundwater that may occur if remedial action is not initiated expeditiously;
- Weather conditions that may cause hazardous constituents to migrate or be released;
- Risk of fire or explosion, or potential for exposure to hazardous constituents as a result of an accident or the failure of a container or handling system; and
- Other factors that may pose threats to human health and the environment.

In the case, where the selected remedy fails to achieve the goals of remediation, the owner or operator will notify the IDNR and implement other methods or techniques that could satisfy the goals, unless it is determined that achieving the goals cannot be practicably achieved with any currently available methods. The notification to IDNR will either explain how the proposed alternative methods or techniques will meet the goals, or else it will indicate that the goals cannot be practicably achieved with any currently available methods. Within 90 days of approval by the IDNR for the proposed alternative methods or techniques or the determination of impracticability, the owner or operator will implement the proposed alternative methods or techniques or implement alternative measures.

In the case of a determination of impracticability, the owner or operator will:

1. Obtain certification of a qualified groundwater scientist and approval by the IDNR that compliance cannot be practicably achieved with any currently available methods;

2. Implement alternate measures to control exposure of humans or the environment to residual contamination, as necessary to protect human health and the environment;

3. Implement alternate measures for control of the sources of contamination, or for removal or decontamination of equipment, units, devices, or structures that are technically practicable and consistent with the overall objective of the remedy; and

4. Notify the IDNR within 14 days that a report justifying the alternate measures prior to implementation has been placed in the operating record.

Remediation will be considered complete when:

1. The owner or operator complies with the groundwater protection standards at all points within the plume of contamination that lie beyond the groundwater monitoring well system.

2. Compliance with the groundwater protection standards has been achieved by demonstrating that concentrations of Appendix II constituents have not exceeded the groundwater protection standard(s) for a period of 3 consecutive years. The IDNR may specify an alternative length of time during which the owner or operator must demonstrate that concentrations of Appendix II constituents have not exceeded the groundwater protection standard(s).

3. All actions required by the IDNR to complete the remedy have been satisfied.

Upon completion of the remedy, the owner or operator must notify the department within 14 days that a certification has been placed in the operating record verifying that the remedy has been completed. The certification must be signed by the owner or operator and by a qualified groundwater scientist and approved by the IDNR.

When, upon completion of the certification, the owner or operator determines that the corrective action remedy has been completed in accordance with IDNR regulations, the owner or operator will be released from the requirements for financial assurance for corrective action.

10 Annual Water Quality Reports

An annual report will be submitted to the IDNR in accordance with IDNR regulations in 567-113.10(10) detailing the water quality monitoring sampling locations and results, assessments, selection of remedies, implementation of corrective action, and the results of corrective action remedies to address SSLs, if any, during the previous year. The report will be due on March 31 of the current year for the previous monitoring year (i.e., March 31, 2025 for AWQR 2024).

The report will include:

- A site map delineating all monitoring points where water quality samples were taken.
- Map of contamination plumes, if any.
- A narrative explaining and interpreting all the data collected during the previous year.

Biennially, the report will also include monitoring well maintenance and performance evaluation information as detailed in Section 11.0. This was initiated with the 2013 AWQR. That information will include:

- Biennial evaluation of high and low water levels and their relationship to the well screen interval of individual wells.
- Biennial evaluation of Landfill operations and water level conditions to evaluate if there have been any changes to the hydrologic setting and resultant groundwater flow paths.
- Measurement of well depths to ensure that wells are physically intact and not filling with sediment.
- Biennial examination of well recharge rates and chemistry to determine if well deterioration is occurring.

11 Monitoring Well Maintenance and Performance Evaluation Plan

The monitoring well maintenance and evaluation plan for the Winneshiek County Landfill is designed to comply with IAC 567-113.10(455B)(2)f to ensure that all monitoring wells remain reliable. The plan includes:

- Physical examination of the well, protective casing, and upper well seal for well integrity
- Biennial evaluation of high and low water levels and their relationship to the well screen interval of individual wells.
- Biennial evaluation of landfill operations and water level conditions to evaluate if there have been any changes to the hydrologic setting and resultant groundwater flow paths.
- Measurement of well depths to ensure that wells are physically intact and not filling with sediment.
- Biennial examination of well recharge rates and chemistry to determine if well deterioration is occurring.

Monitoring well maintenance and evaluation has been reported in each year's Annual Water Quality Report since 2013.

11.1 Monitoring Well Maintenance and Performance Evaluation Reporting Schedule

Annual reports will be made of:

- The physical integrity of the wells.
- For wells without a dedicated pump, the evaluation of well depth and any indications that wells are filling with sediment will be completed annually. For wells with a dedicated pump, the evaluation will be made every 5 years.

Biennial reports will be made of:

- High and low water levels and their relationship as either above or within the well screen interval.
- Landfill operation activities that may have changed the hydrologic setting and the resultant groundwater flow paths.
- Evaluation of well recharge rates and chemistry to determine if well deterioration is occurring.

11.2 Physical Well Examination

The physical integrity of the wells will be evaluated semi-annually when water-level measurements are taken, and the wells are sampled. Notes will be made regarding:

- Protective casing status as locked or unlocked.
- Well cap condition.
- Presence of any obstructions in the well casing.
- Well casing integrity: presence or absence of cracks.
- Upper well seal integrity: intact or cracked.
- Any other items of note regarding well integrity.

Results of the physical well evaluation will be reported annually in the annual water quality report. If the integrity of any of the wells is in question, appropriate maintenance and rehabilitation procedures will be taken.

11.3 Evaluation of High and Low Water Levels and Their Relationship to the Well Screen Interval

The evaluation of water levels and their relationship to the well screen interval will be done to comply with IAC 567-113.10(455B)(2)f(1). Water levels will be measured to the nearest 1/100 of a foot as part of the semi-annual groundwater-level measurement program. The water-level depth will then be compared to the well screen depth to evaluate if well screens are placed appropriately in relationship to groundwater levels. Water table wells should have water levels within the well screen interval unless the water table is so shallow that it occurs in the upper seal interval. Deep wells should have water levels above the well screen interval. Results of the evaluation will be reported biennially in the AWQR for that year.

11.4 Evaluation of Landfill Operations on Groundwater Levels

To comply with IAC 567-113.10(455B)(2)f(2), landfill operations will be reviewed to determine if there have been any changes that would affect groundwater depth and flow. Such operational changes might include landfill excavation activities, installation of underdrain systems, etc. Results of the evaluation will be reported biennially in the AWQR for that year.

11.5 Evaluation of Well Depth Changes

Evaluation of the bottom of the well depth changes will be done to comply with IAC 567-113.10(455B)(2)f(3). In wells that do not have dedicated sampling pumps, the depth to the bottom of the well will be measured monthly to the nearest 1/100 foot using a weighted tape. For wells with dedicated sampling pumps, measurement of the depth to the bottom of the well will be made every 5 years.

For each well, comparison of the depth to the bottom of the well will be made over time to determine if sediment is building up in the well. If significant sediment build-up occurs, appropriate rehabilitation techniques, such as redevelopment by surging and bailing or other methodology, will be completed. If the monitoring well cannot be redeveloped or rehabilitated, the well will be abandoned and replaced. The results of the evaluation of well depth changes will be reported biennially in the AWQR for that year.

11.6 Evaluation of Well Recharge Rates and Groundwater Chemistry

To comply with IAC 567-113.10(455B)(2)f(4), well recharge rates and groundwater chemistry will be evaluated to determine if well deterioration is occurring.

Well recharge rates will be determined biennially during one of the groundwater sampling events. To estimate the recharge (recovery) rate, at least one, and preferably several, time, and depth to water (D.T.W.) measurements will be recorded after removal of the final purge volume to gauge recovery relative to the static water level. Recording the time, depth to water, and the volume removed during the purge and sampling cycle will provide for an estimate of well recharge (recovery) rates. If time permits, measurements will be taken until the well is fully recovered and the time that the well returned to static water level will be recorded. As an example:

- Depth to water (D.T.W.) is measured prior to purging/sampling (i.e., static water level) and is at 10 feet below ground surface.
- At the end of the purge/sample cycle, the measured D.T.W. = 12 feet below ground surface.
- 30 minutes later, D.T.W. = 10.5 feet below ground surface.
- Therefore, the well recovered 1.5 feet in 30 minutes.
- Considering that the gallons of water per foot in a 2-inch diameter well is 0.16 gal/ft results in an estimated recharge rate of 0.008 gpm ((1.5 ft x 0.16 gal/ft) / 30 min).

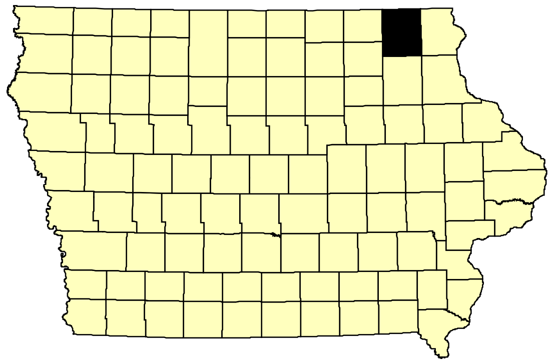
Estimates calculated in this manner for each sampling event can be used to determine if well recovery rates are decreasing over time, indicating well deterioration may be occurring because of infilling of the well with sediment, biofouling of the filter pack, etc.

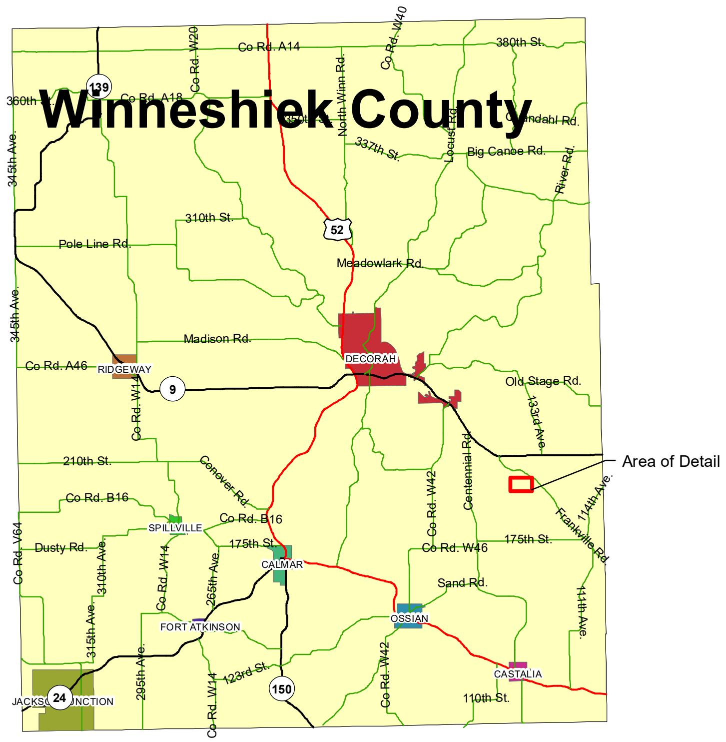
In addition, detection monitoring wells which are sampled semi-annually may be analyzed using the slug test method once per 5 years. A slug test is an aquifer field test performed by groundwater hydrogeologists to estimate the hydraulic properties of aquifers and aquitards. The slug test is a method in which the water level in a monitoring well is caused to change suddenly (rise or fall), and the subsequent water-level response (displacement or change from static) is measured through time in the monitoring well. Other terms sometimes used instead of slug test include bail-down test, slug-in test, and slug-out test.

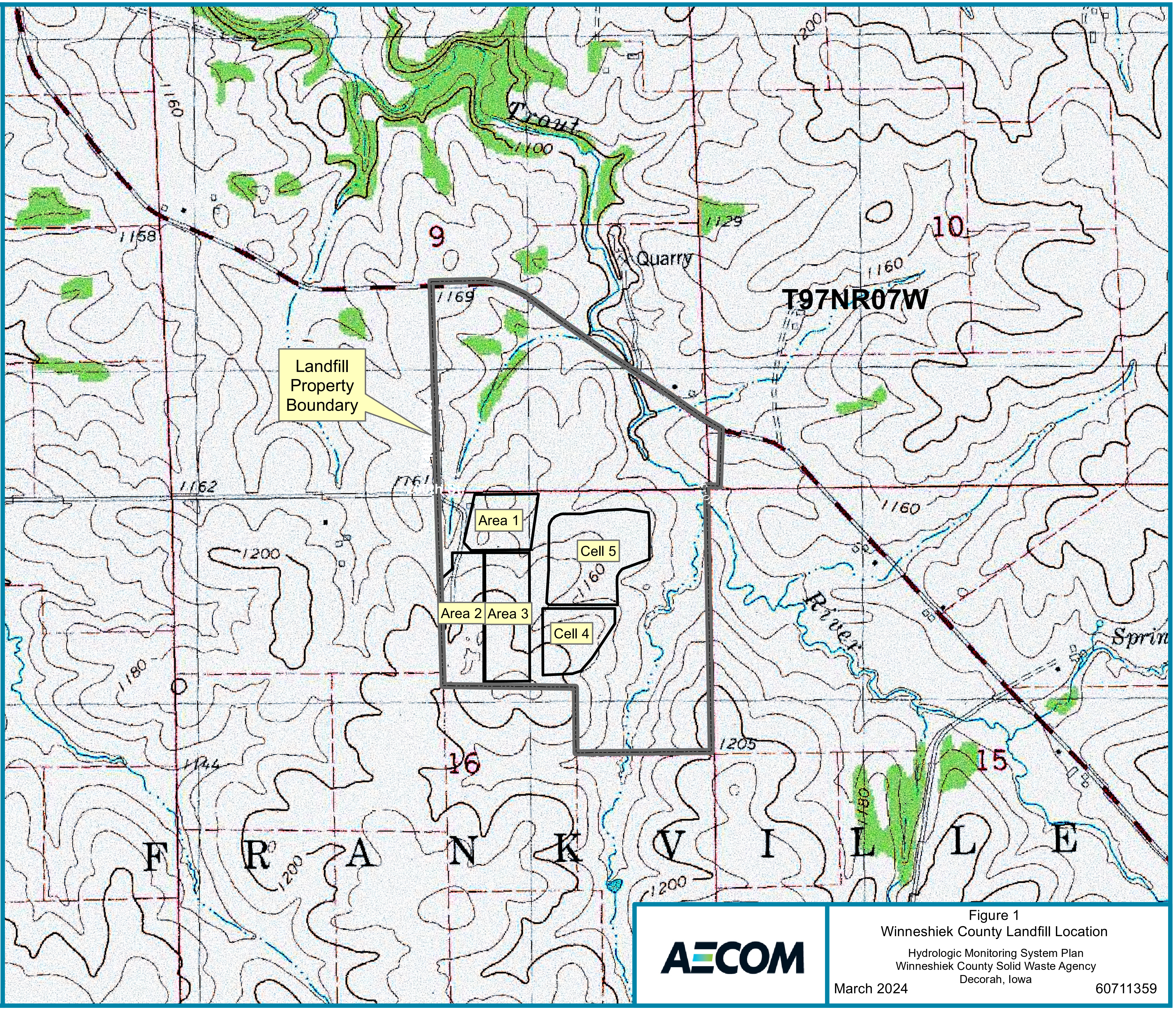
The goal of a slug test is to estimate hydraulic properties of a monitoring well's formation and development of the well’s filter pack. A change in the hydraulic properties of the monitoring well's formation, the filter pack or well screen may indicate that that well deterioration is occurring because of infilling of the well with sediment, biofouling of the filter pack, etc.

Groundwater chemistry changes over time will also be evaluated to determine if there are any physical or chemical indicators affecting groundwater quality. Physical indicators include encrustation, biofouling, corrosion, and change in turbidity. Chemical indicators include changes in redox potential (Eh), pH, conductivity, and dissolved gases (such as oxygen, carbon dioxide, nitrogen, hydrogen sulfide, and methane) that may affect groundwater chemistry.

FIGURES







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Feet

N W E S

Basemap: USGS Postville NW 7.5-Minute Quadrangle, 1981. Contour interval 10 ft.

AECOM

Figure 1
Winneshiek County Landfill Location

Hydrologic Monitoring System Plan
Winneshiek County Solid Waste Agency
Decorah, Iowa

March 2024 60711359

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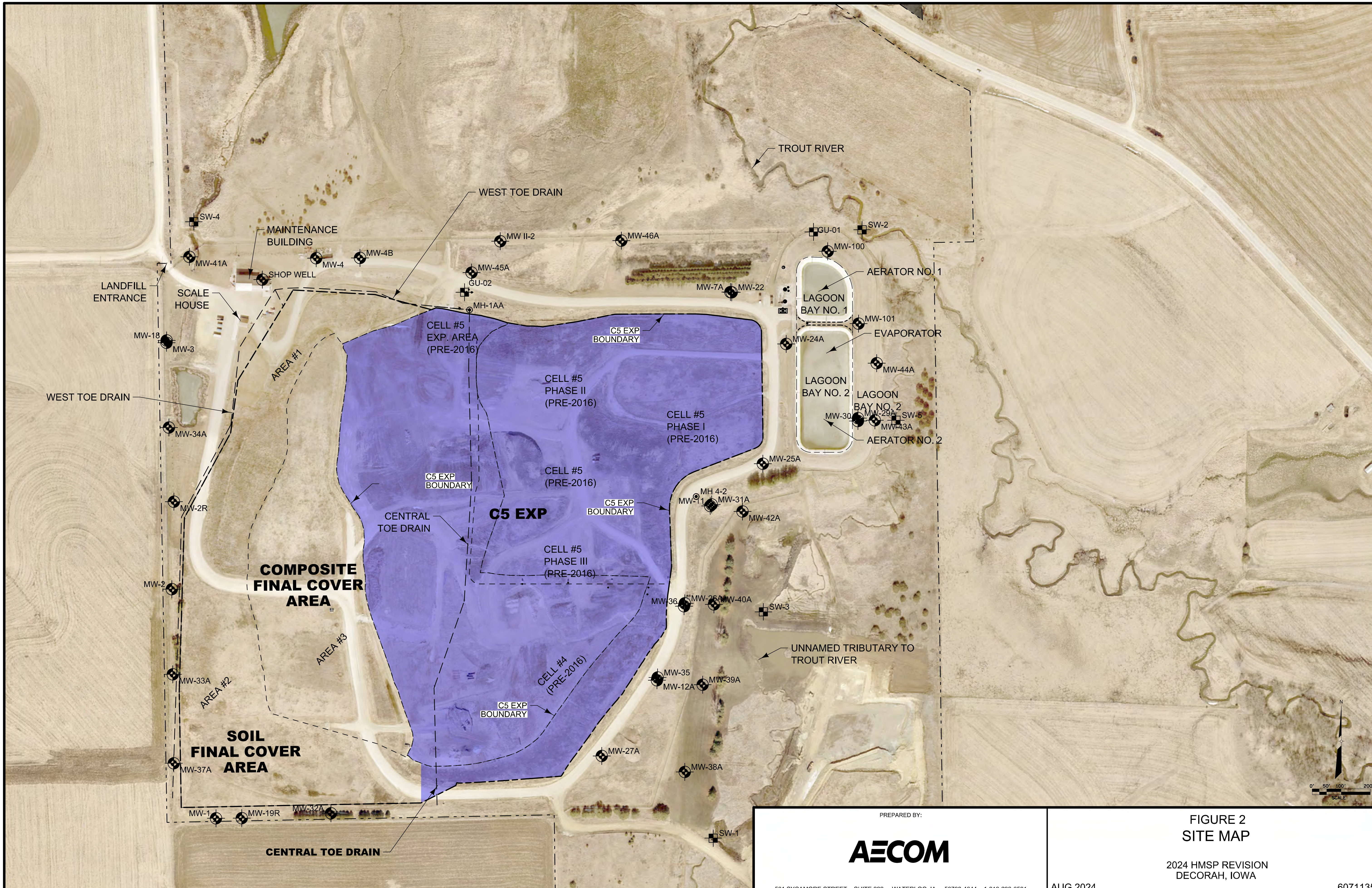

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501 SYCAMORE STREET SUITE 222 WATERLOO, IA. 50703-4644 1-319-232-6531

FIGURE 2
SITE MAP

2024 HMSP REVISION
DECORAH, IOWA

AUG 2024

60711359

Waterloo, Iowa
Printed from MicroStation V8i
Design File L:\DCS\Projects\TRN\60711359_Winn_FY_24-26_Engineering\900_CAD_GIS\02-HMSP\Winne-HMSP OR.dgn, Model 02

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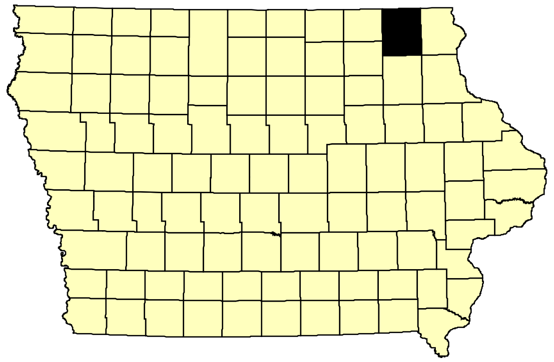

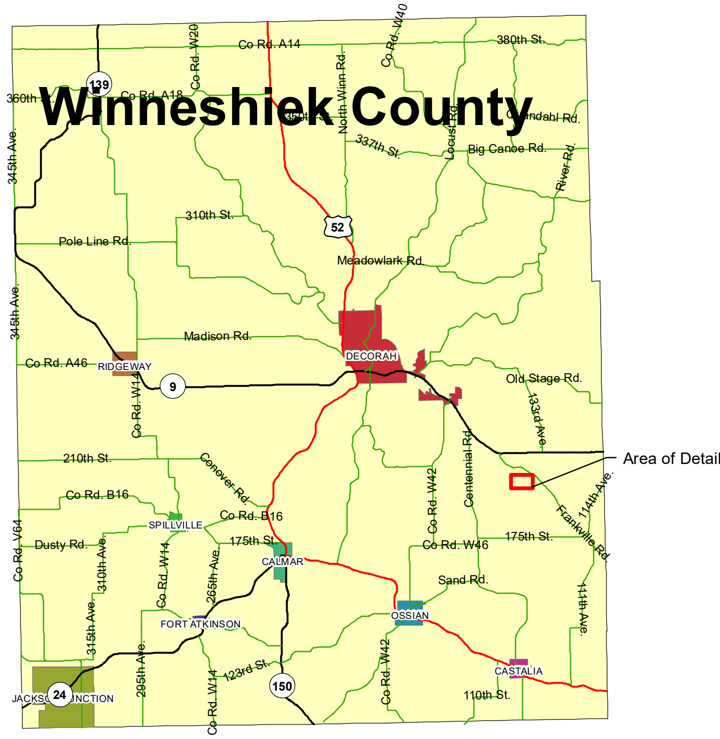

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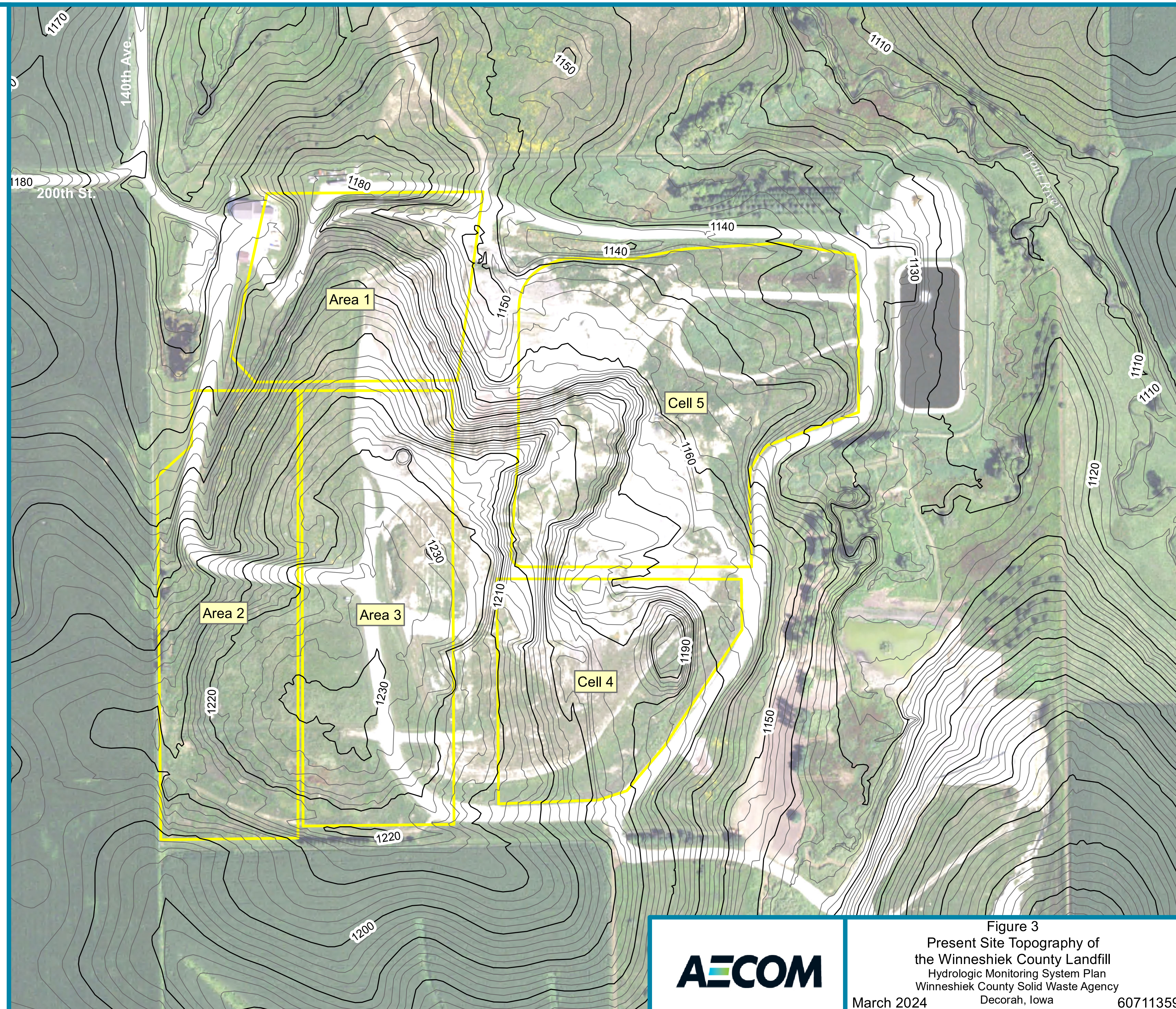

Aerial Photography Source: USDA National Agriculture Imagery Program, 2021

Topographic Contours obtained from Iowa DNR, published 2010.
Contour interval 2 ft.

AECOM

Figure 3
Present Site Topography of
the Winneshiek County Landfill
Hydrologic Monitoring System Plan
Winneshiek County Solid Waste Agency
Decorah, Iowa

March 2024

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501 SYCAMORE STREET SUITE 222 WATERLOO, IA. 50703-4644 1-319-232-6531

FIGURE 4
BORING LOCATIONS

2023 HMSP REVISION
DECORAH, IOWA

APR 2023

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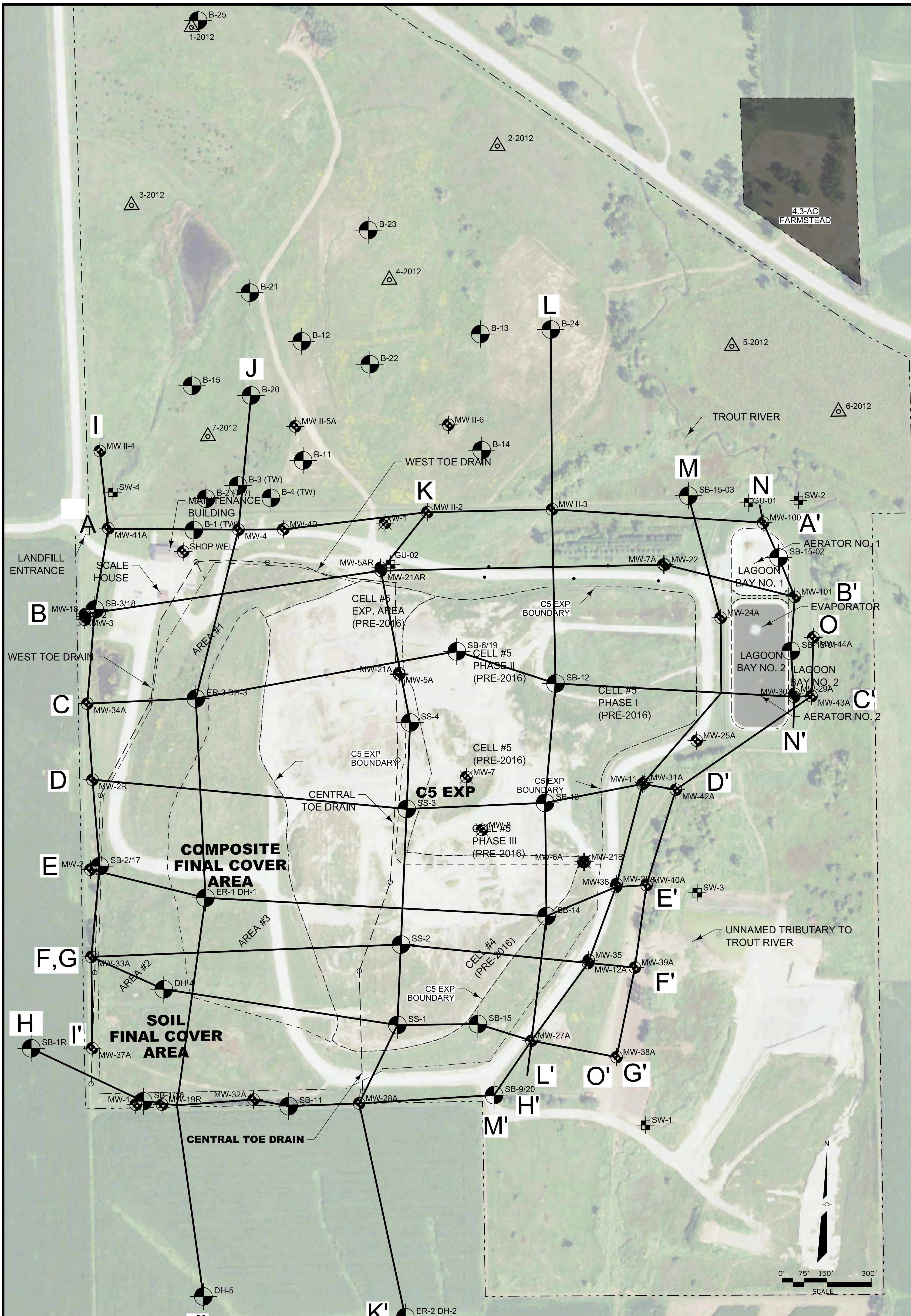

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501 SYCAMORE STREET SUITE 222 WATERLOO, IA. 50703-4644 1-319-232-6531

FIGURE 5

CROSS-SECTION LOCATIONS

2023 HMSP REVISION
DECORAH, IOWA

APR 2023

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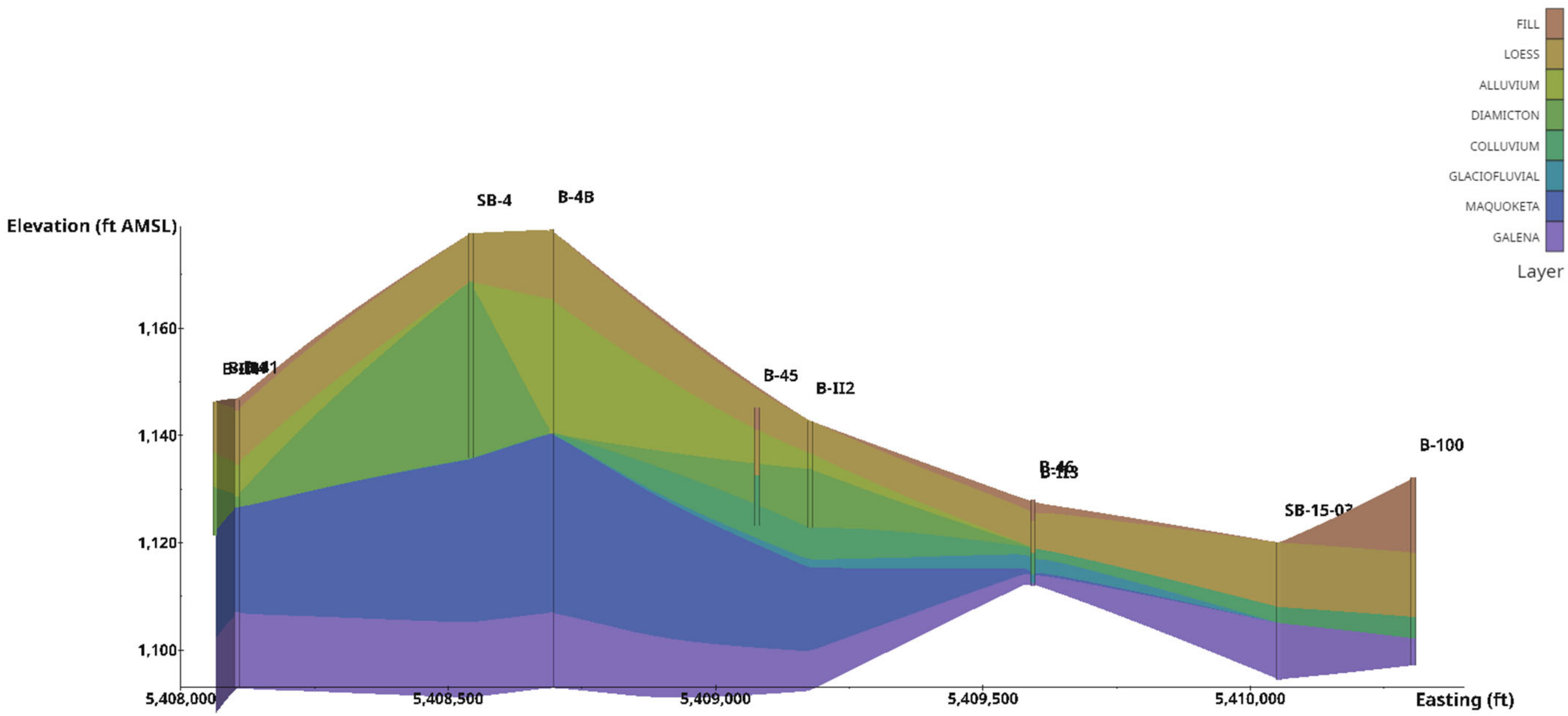

Vertical Exaggeration = 10X

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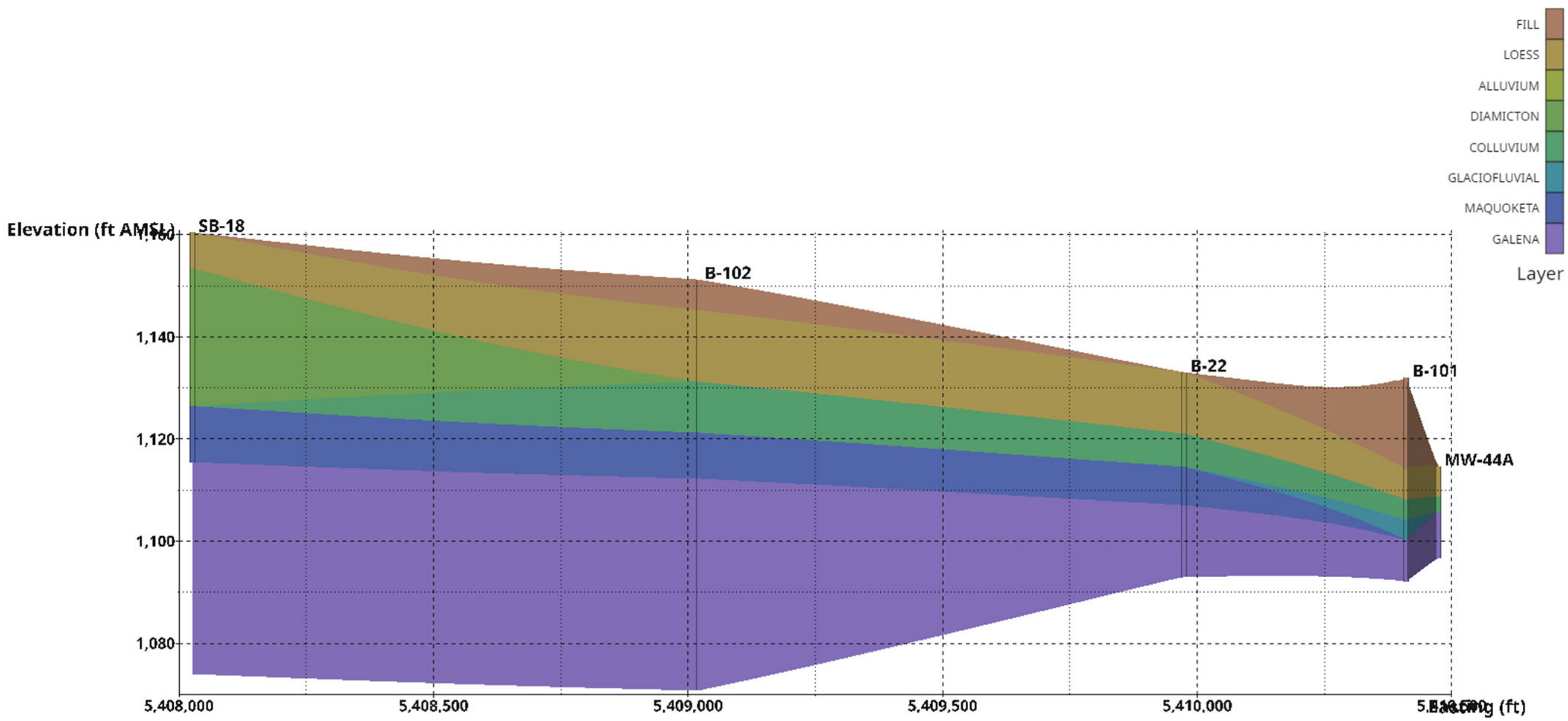
FIGURE 6
Geologic Cross-Section A-A'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



Vertical Exaggeration = 10X

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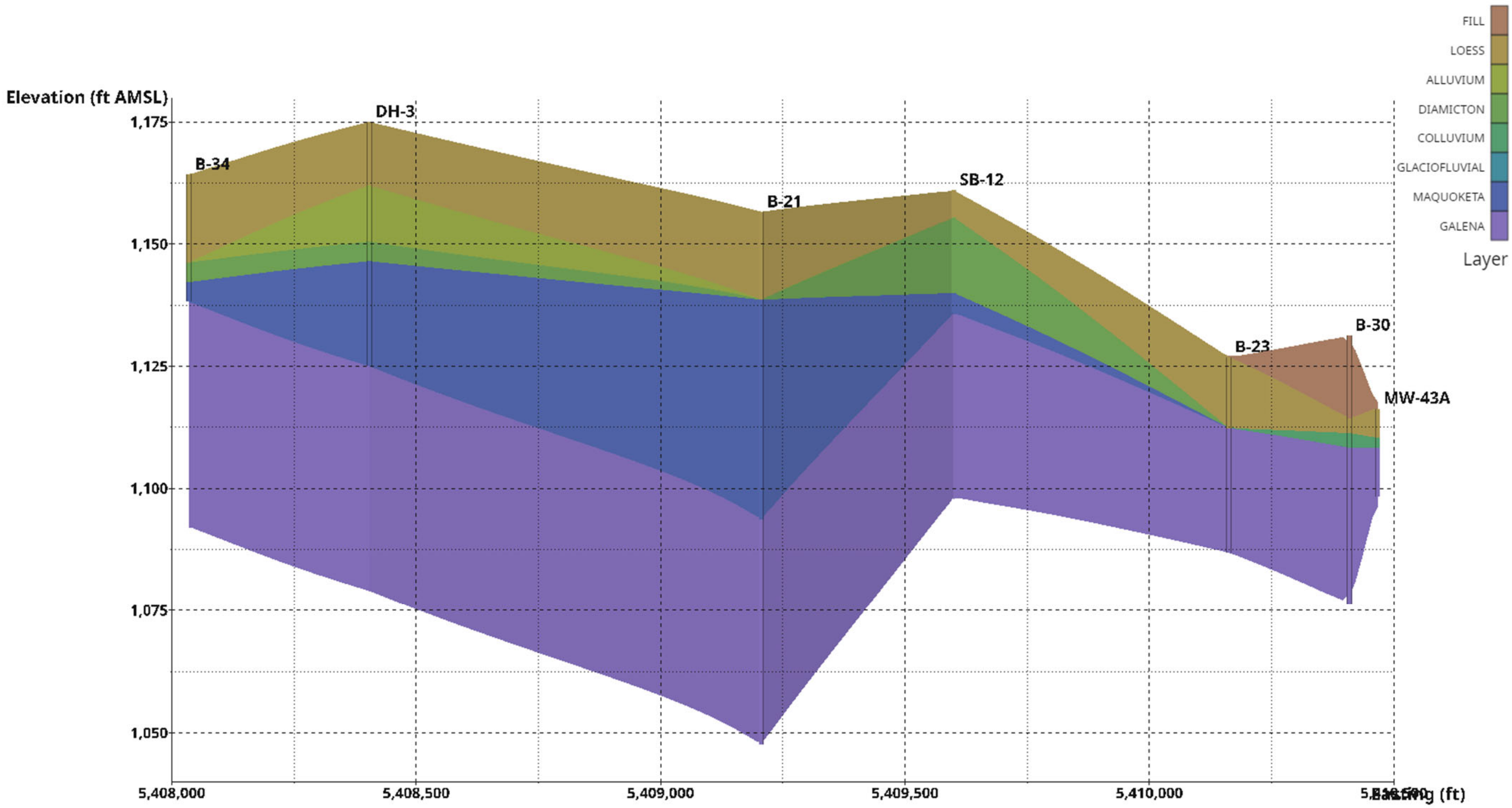
FIGURE 7
Geologic Cross-Section B-B’

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



Vertical Exaggeration = 10X

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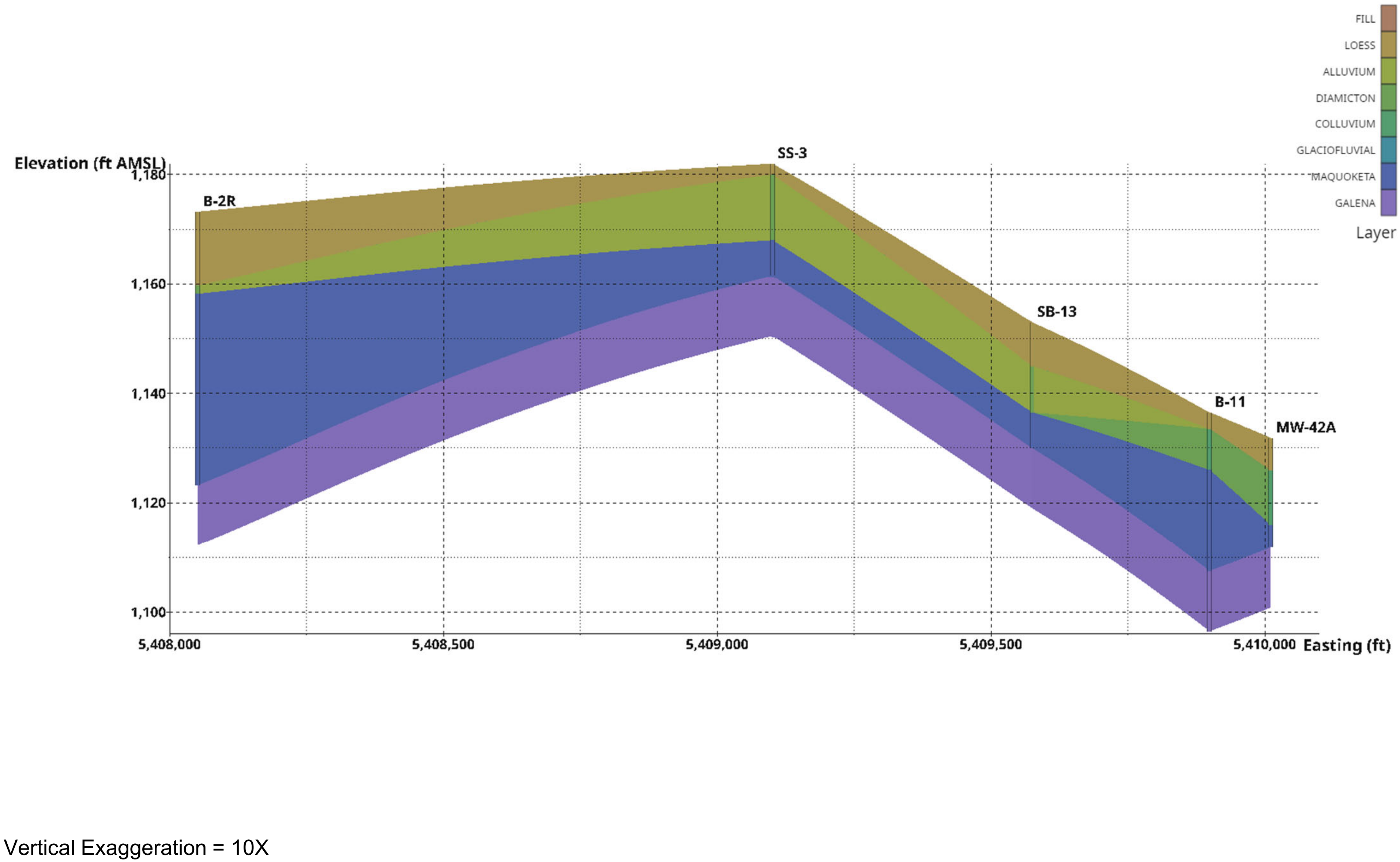
FIGURE 8
Geologic Cross-Section C-C'

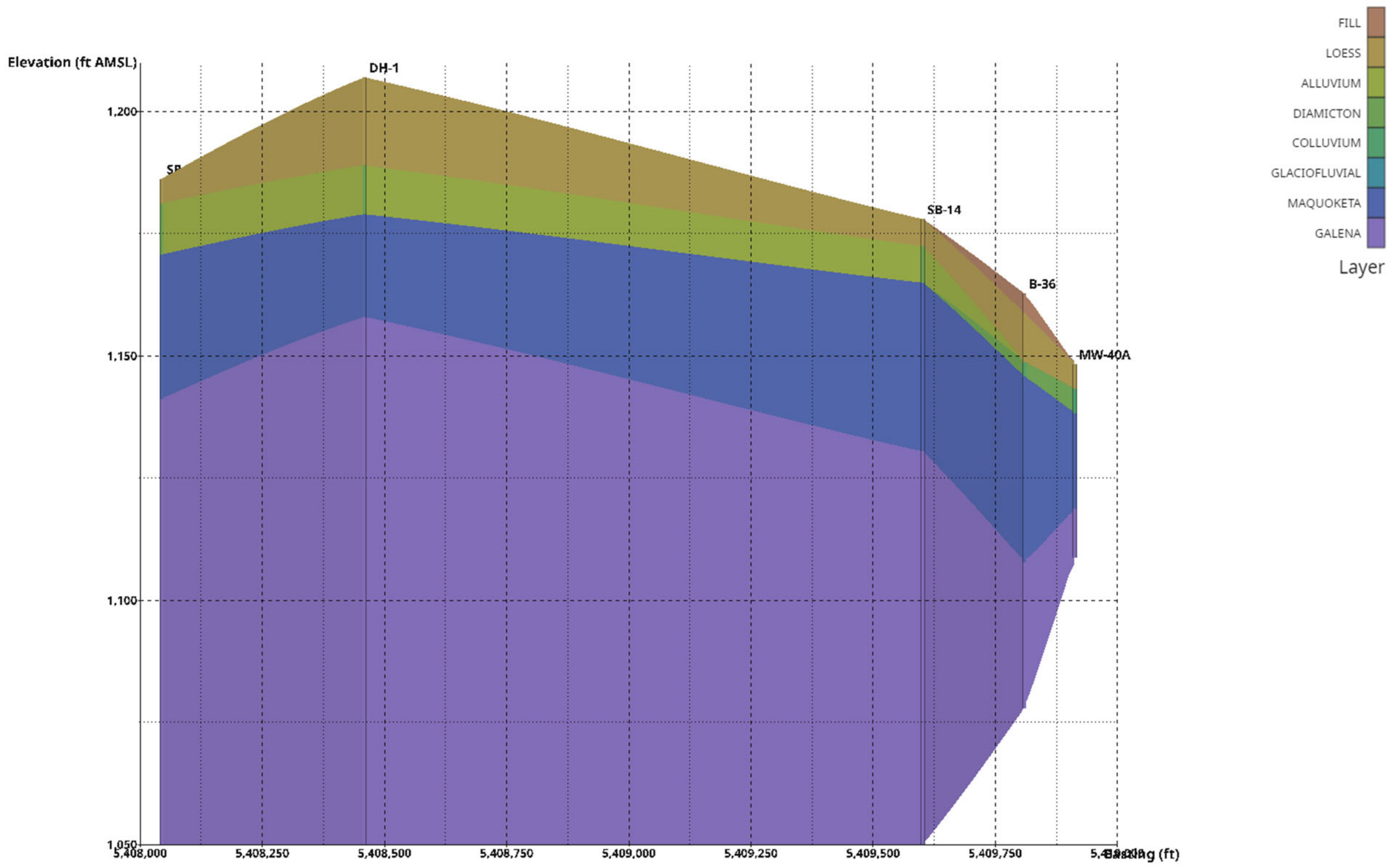
WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



AECOM

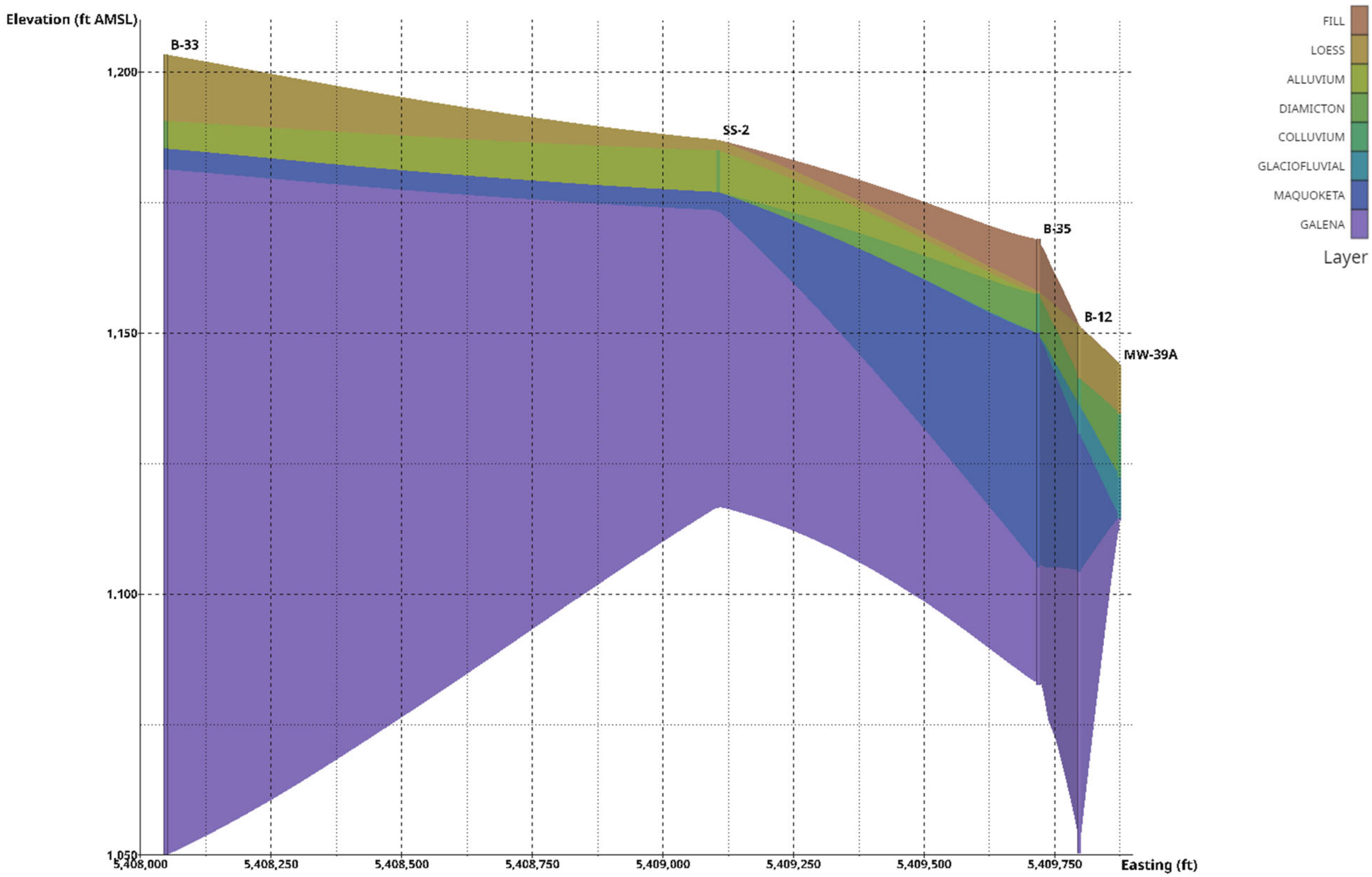
FIGURE 9
Geologic Cross-Section D-D'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



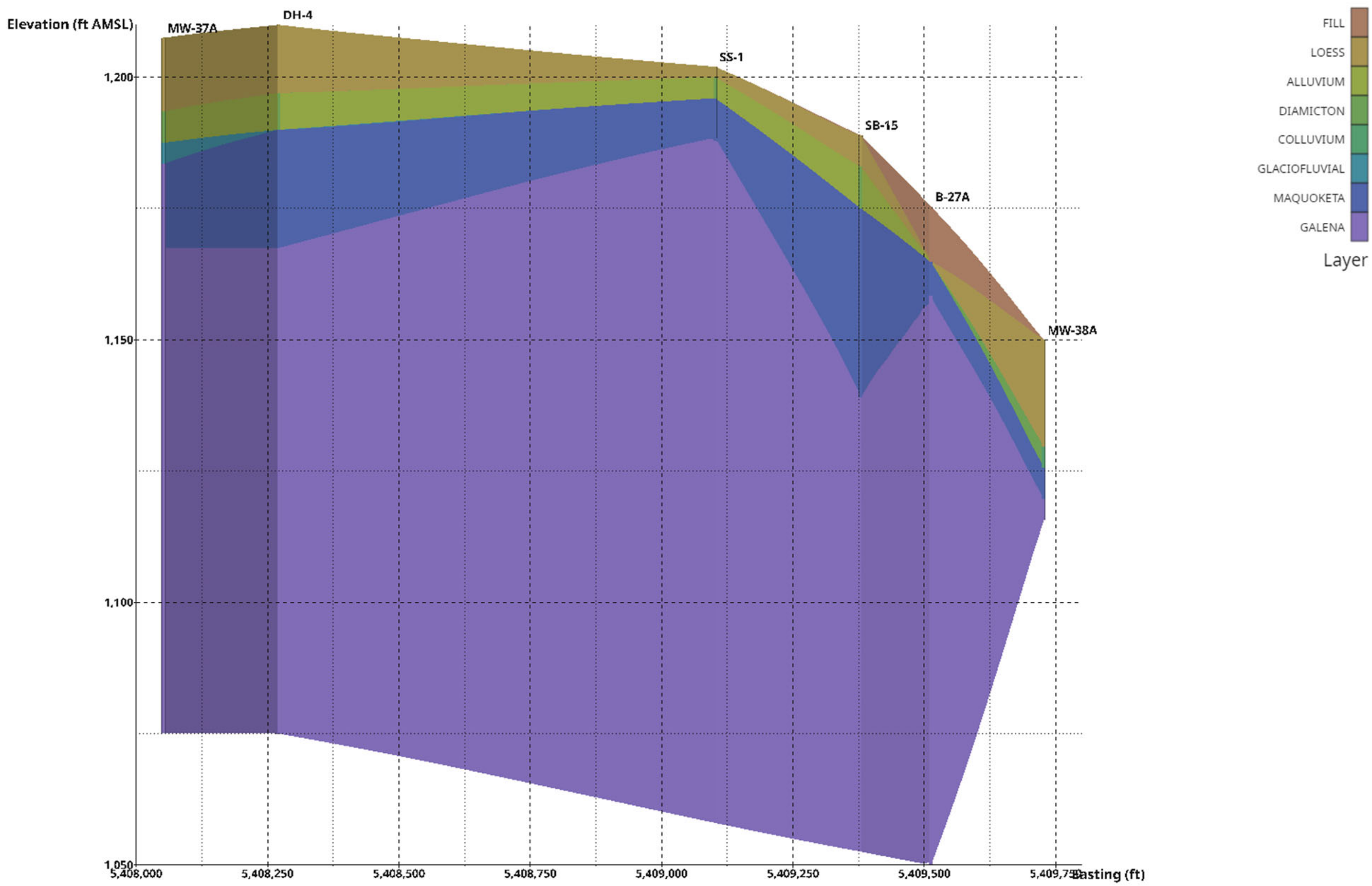
Vertical Exaggeration = 10X

AECOM	FIGURE 10 Geologic Cross-Section E-E'	WINNESHIEK COUNTY LANDFILL 2024 HMSP SEPTEMBER 2024 60711359



Vertical Exaggeration = 10X

AECOM	FIGURE 11 Geologic Cross-Section F-F'	WINNESHIEK COUNTY LANDFILL 2024 HMSP SEPTEMBER 2024 60711359

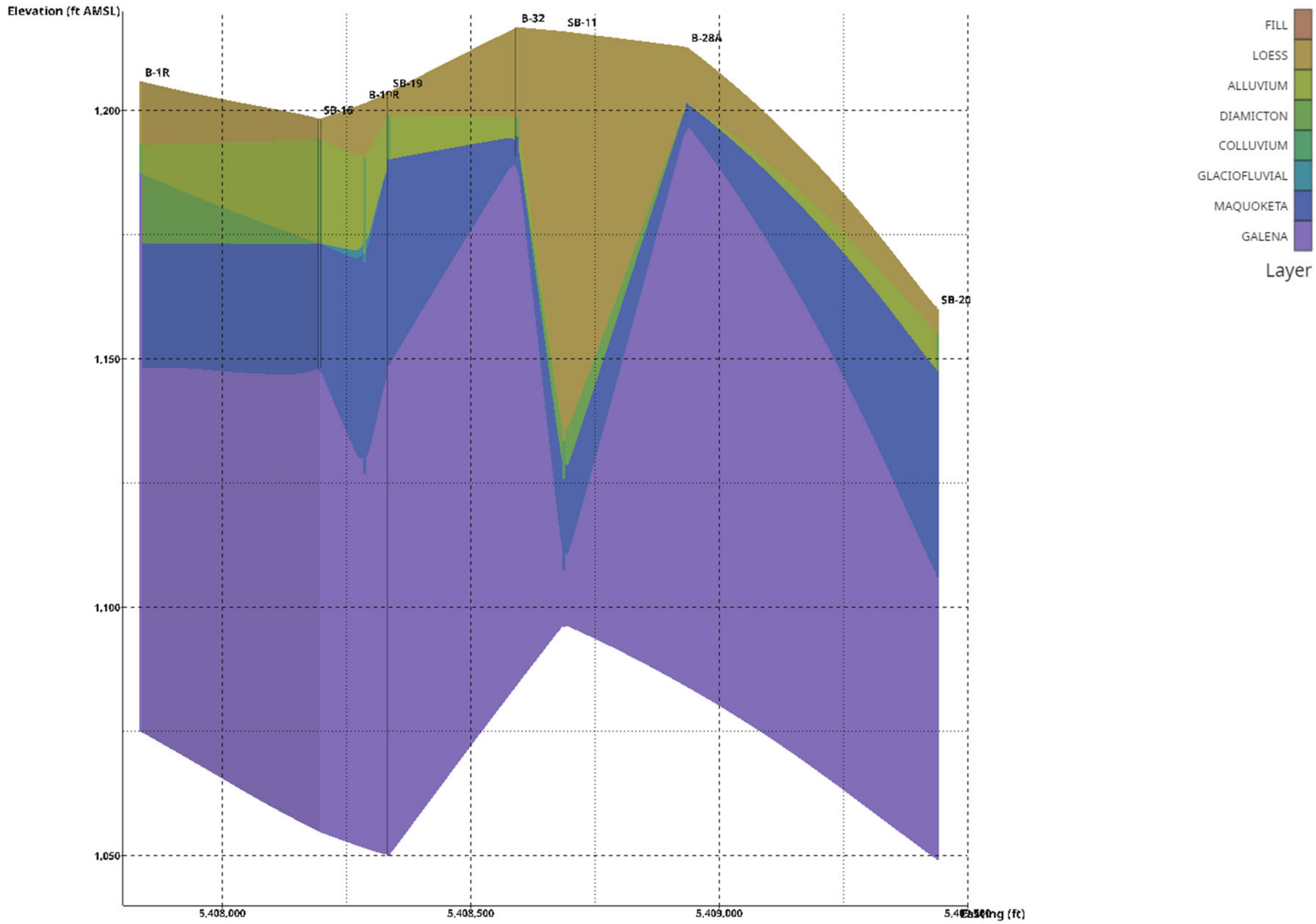


Vertical Exaggeration = 10X

AECOM

FIGURE 12
Geologic Cross-Section G-G’

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359

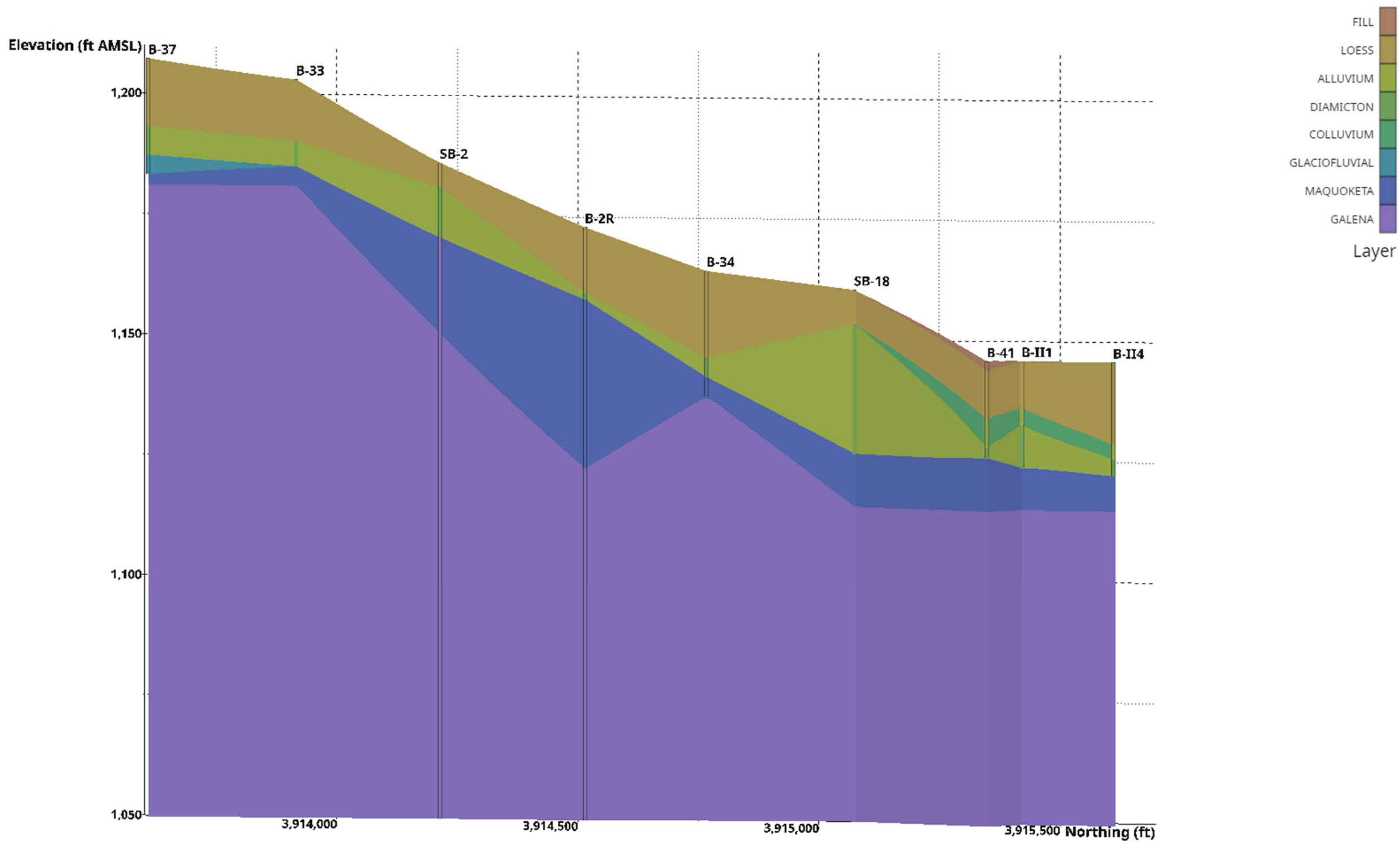


Vertical Exaggeration = 10X

AECOM

FIGURE 13
Geologic Cross-Section H-H'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359

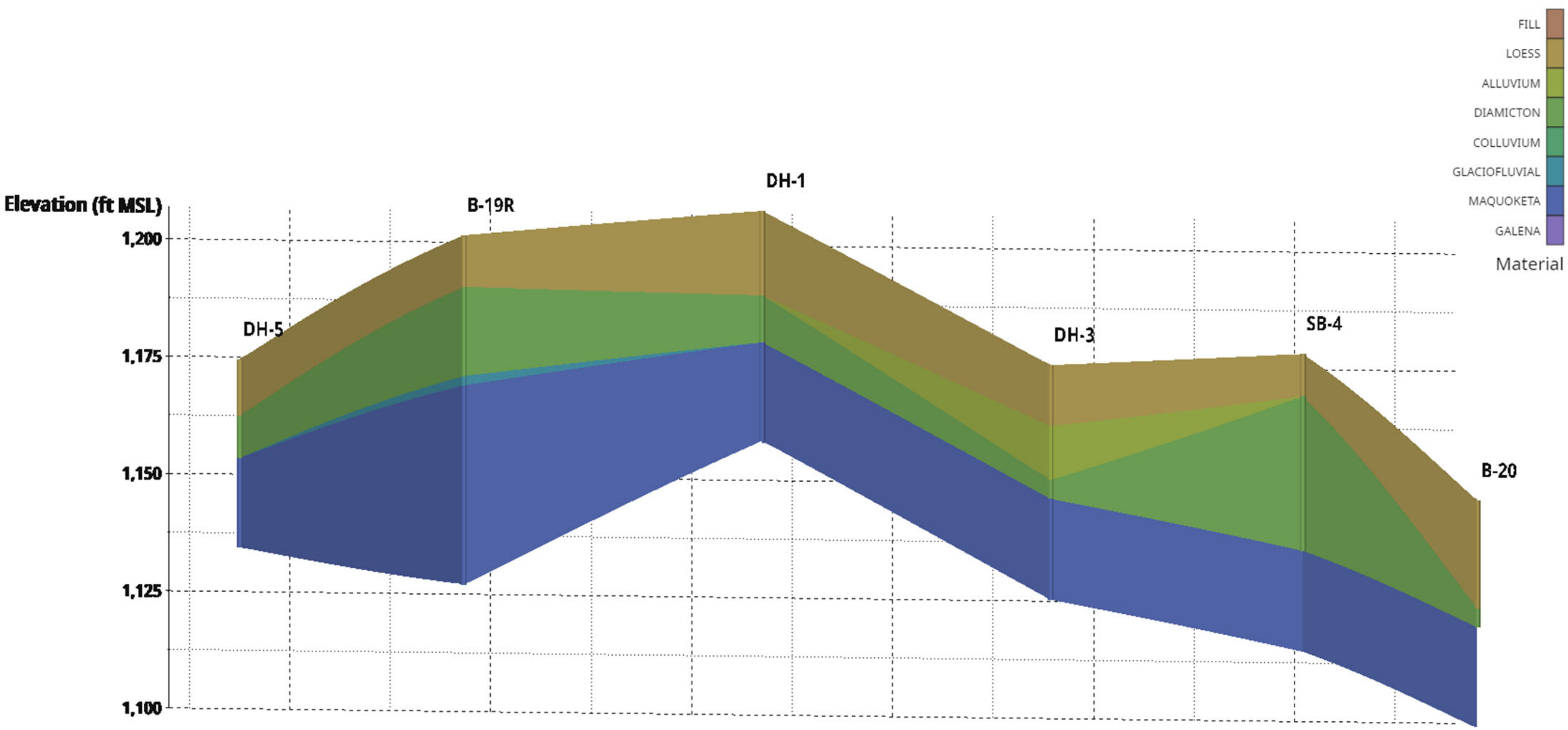


Vertical Exaggeration = 10X

AECOM

FIGURE 14
Geologic Cross-Section I-I'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359

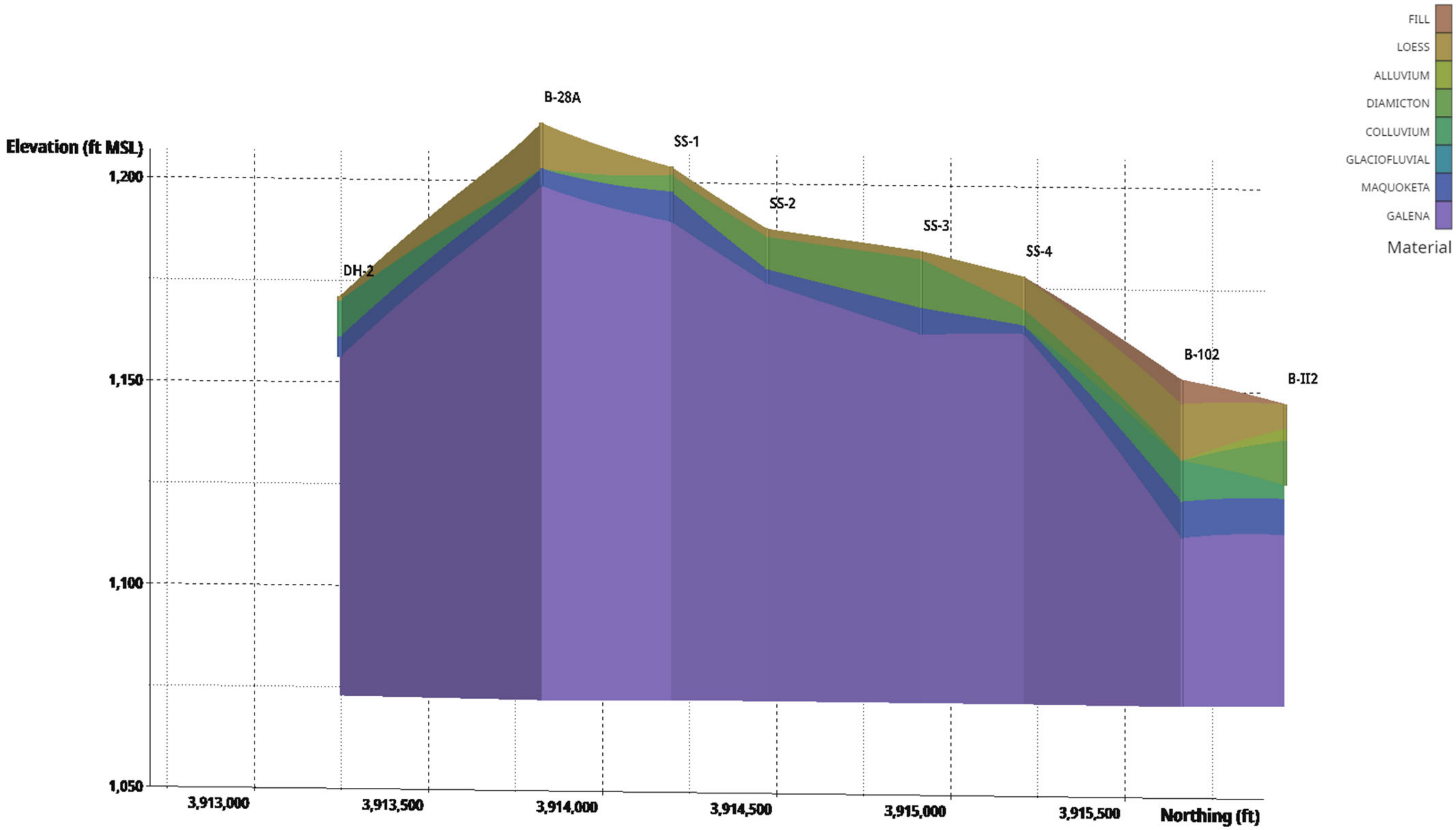


Vertical Exaggeration = 10X

AECOM

FIGURE 15
Geologic Cross-Section J-J'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359

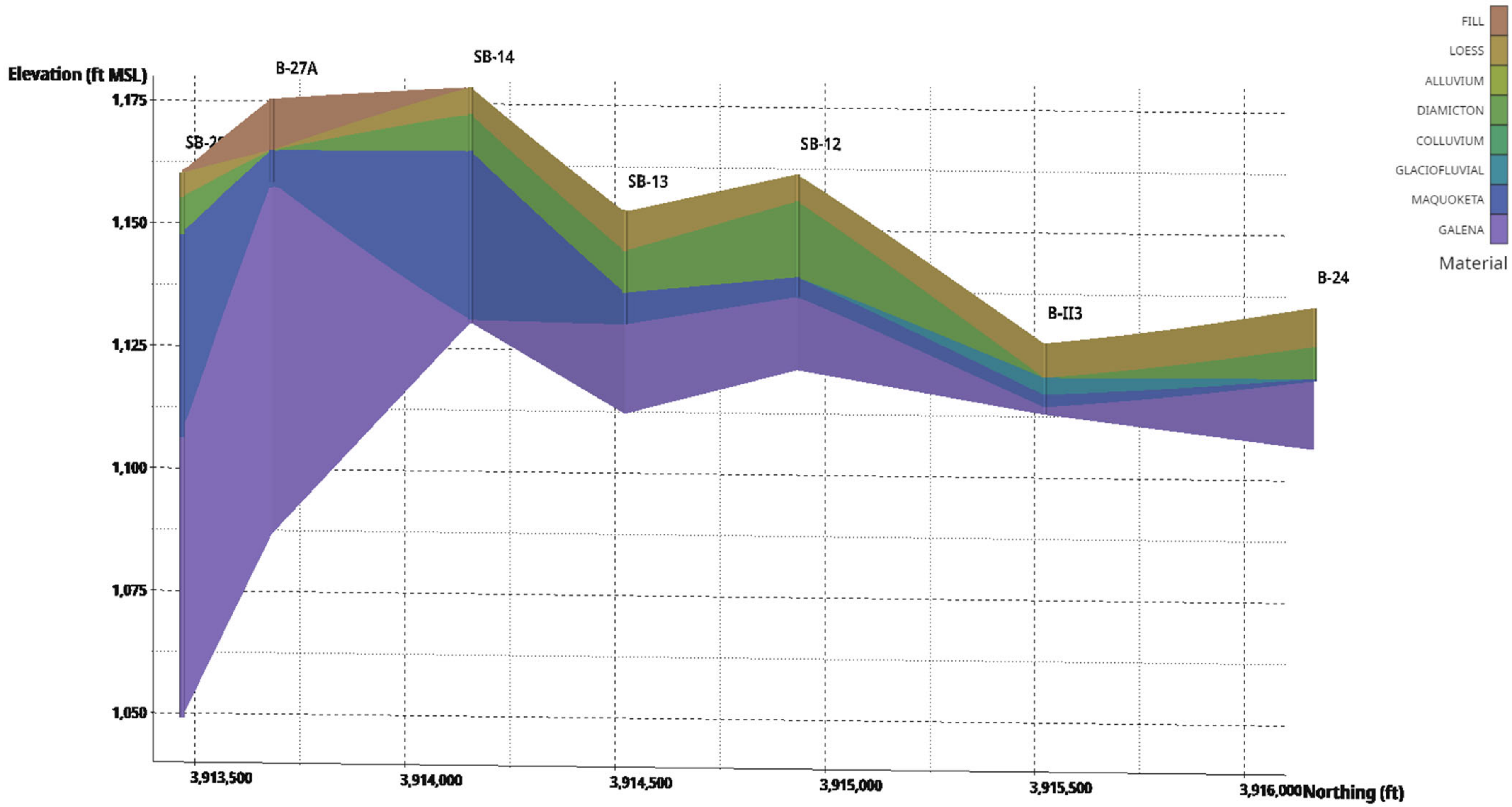


Vertical Exaggeration = 10X

AECOM

FIGURE 16
Geologic Cross-Section K-K'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359

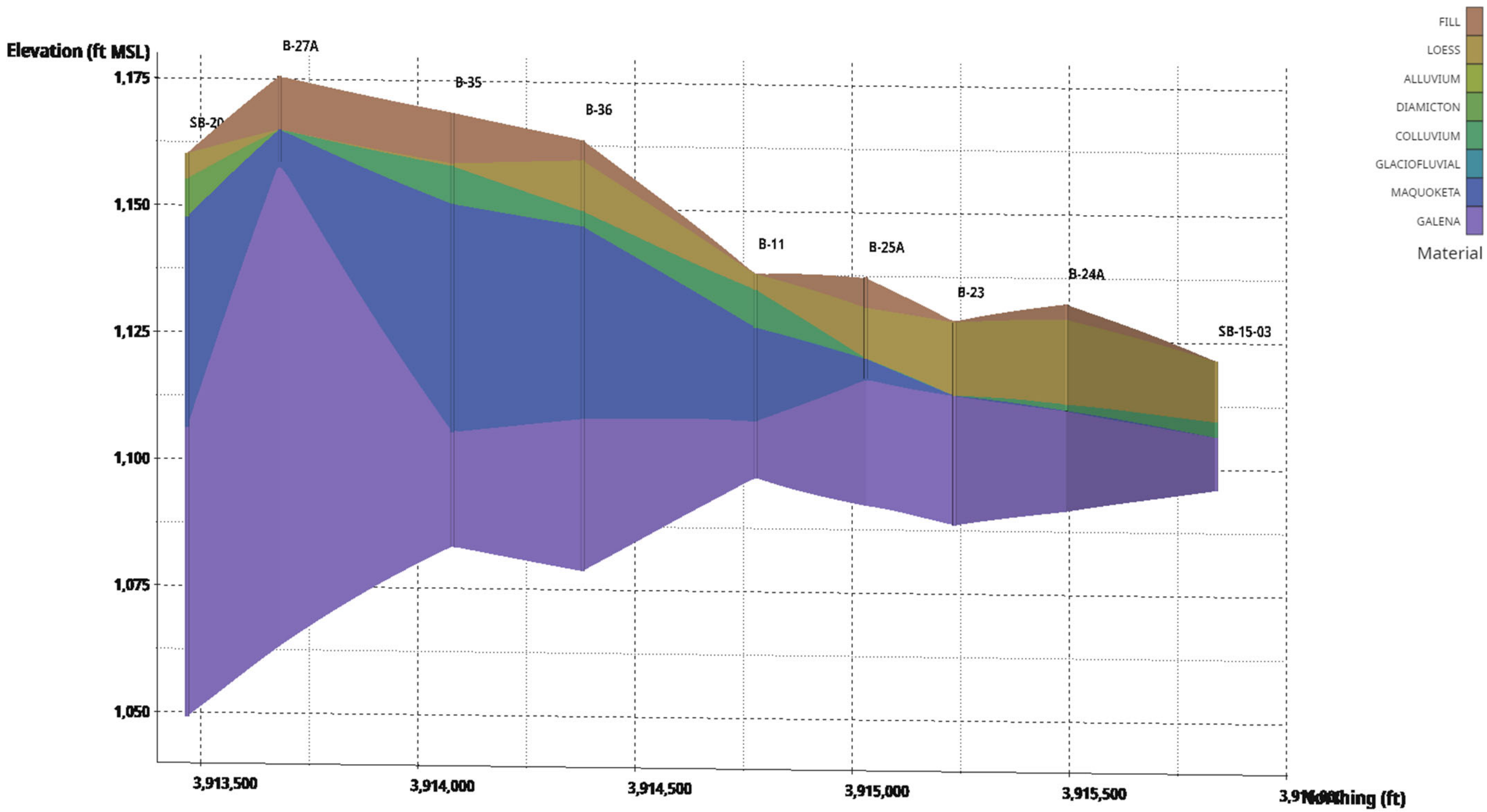


Vertical Exaggeration = 10X

AECOM

FIGURE 17
Geologic Cross-Section L-L'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359

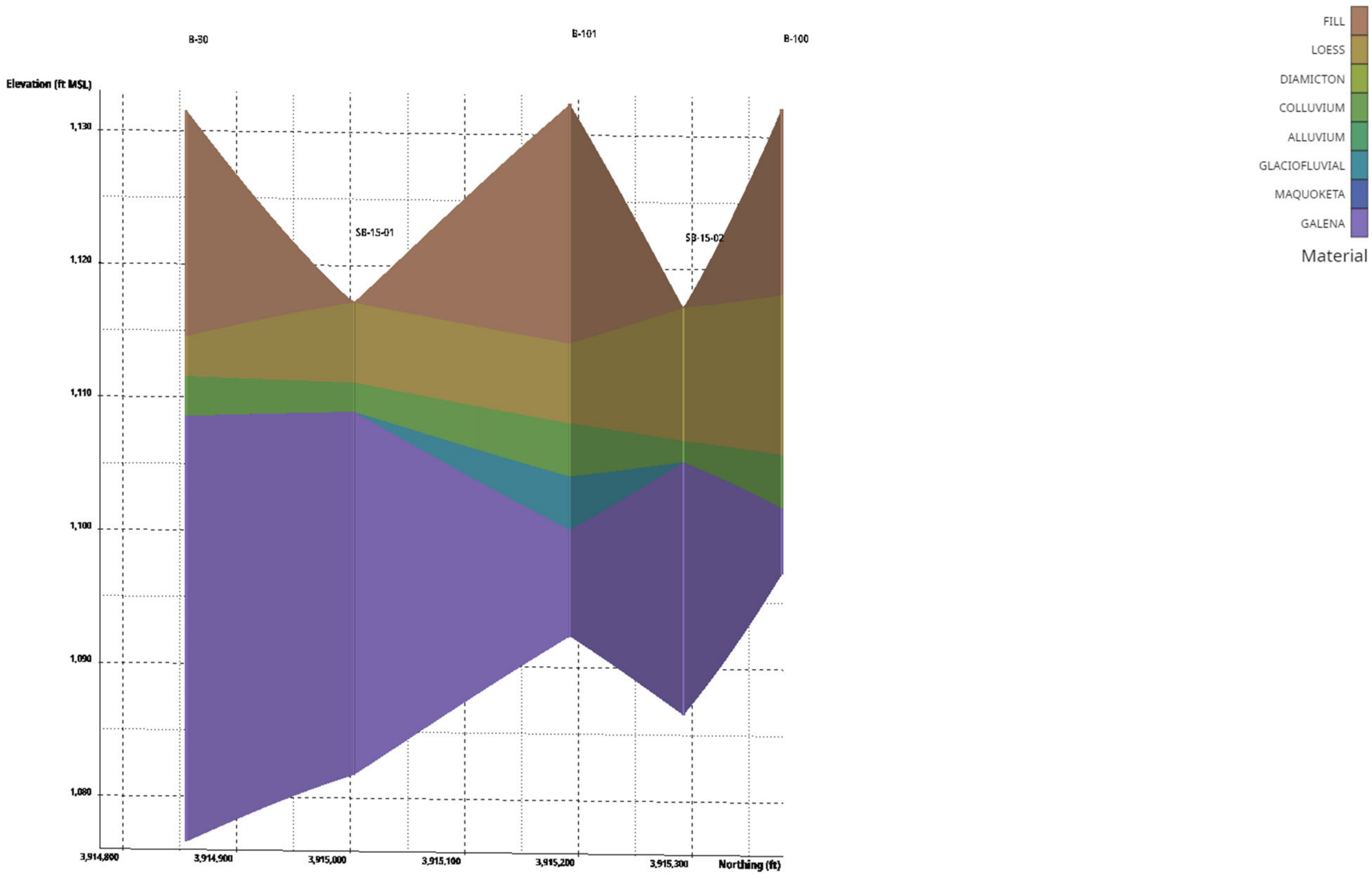


Vertical Exaggeration = 10X

AECOM

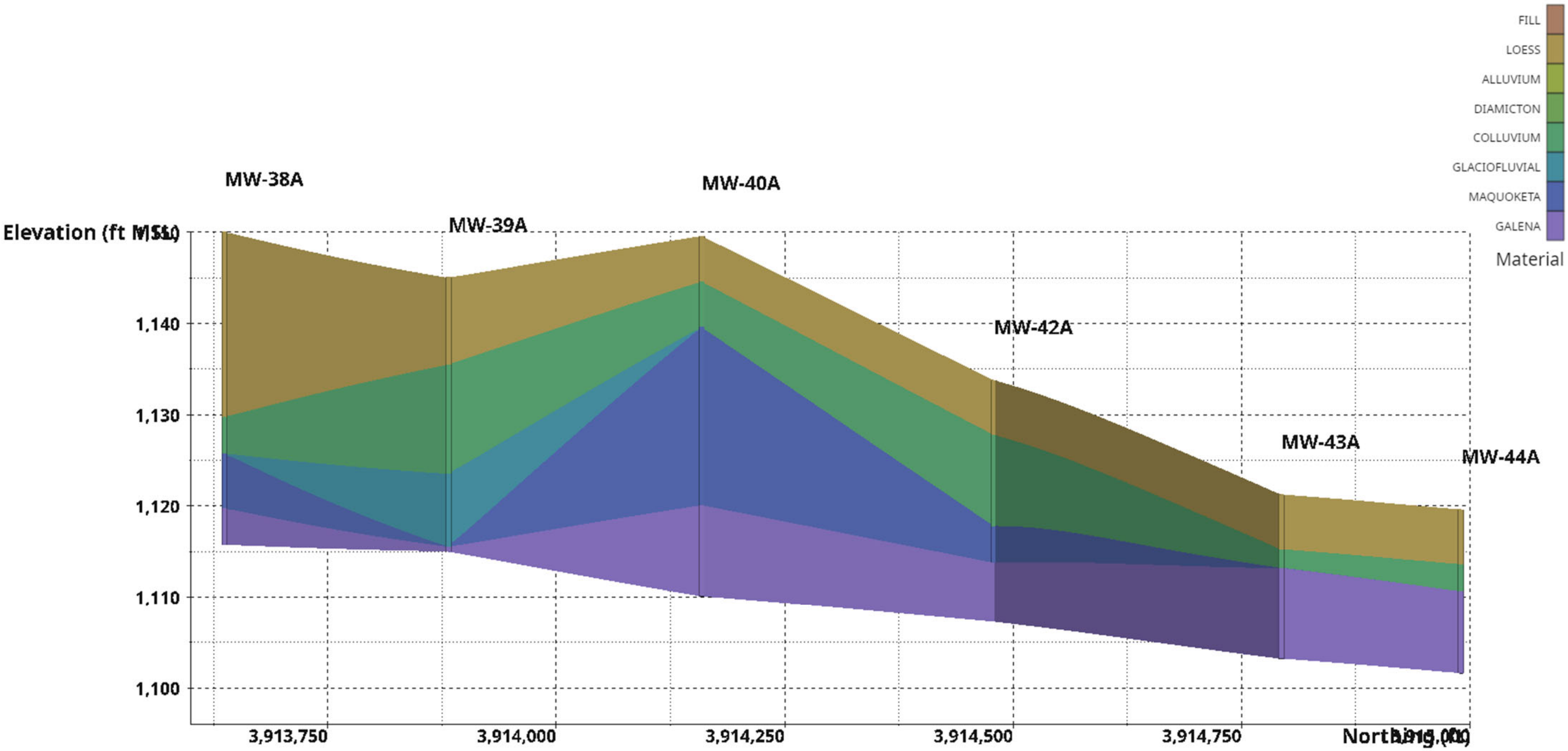
FIGURE 18
Geologic Cross-Section M-M'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



Vertical Exaggeration = 10X

AECOM	FIGURE 19 Geologic Cross-Section N-N'	WINNESHIEK COUNTY LANDFILL 2024 HMSP SEPTEMBER 2024 60711359

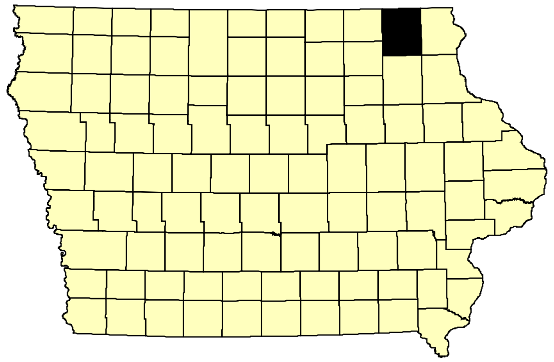


Vertical Exaggeration = 10X

AECOM

FIGURE 20
Geologic Cross-Section O-O'

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



Water Table Contour

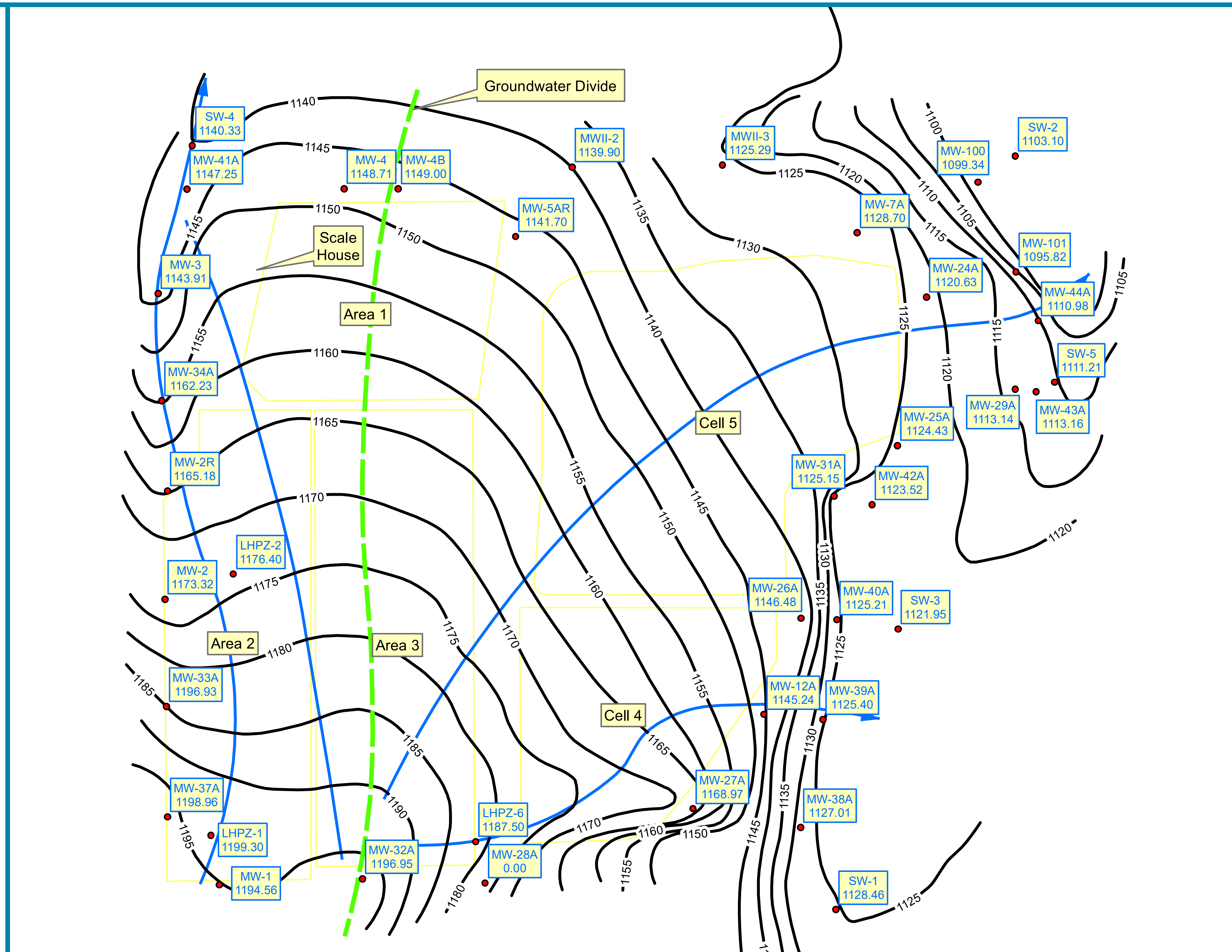
Flow Line

MW-1 919.08 Monitoring Point with Water Elevation AMSL

0 150 300 450 600
Feet

Based on May 2023 water elevations.
NM = Not Measured

Aerial Photography Source: USDA National Agriculture Imagery Program, 2021

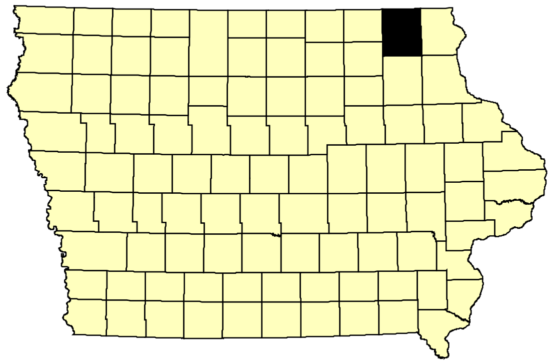


[redacted]

Figure 21
Shallow Water Table Contour Map

Hydrologic Monitoring System Plan
Winneshiek County Solid Waste Agency
Decorah, Iowa

March 2024 60711359



Potentiometric Contour

Flow Line

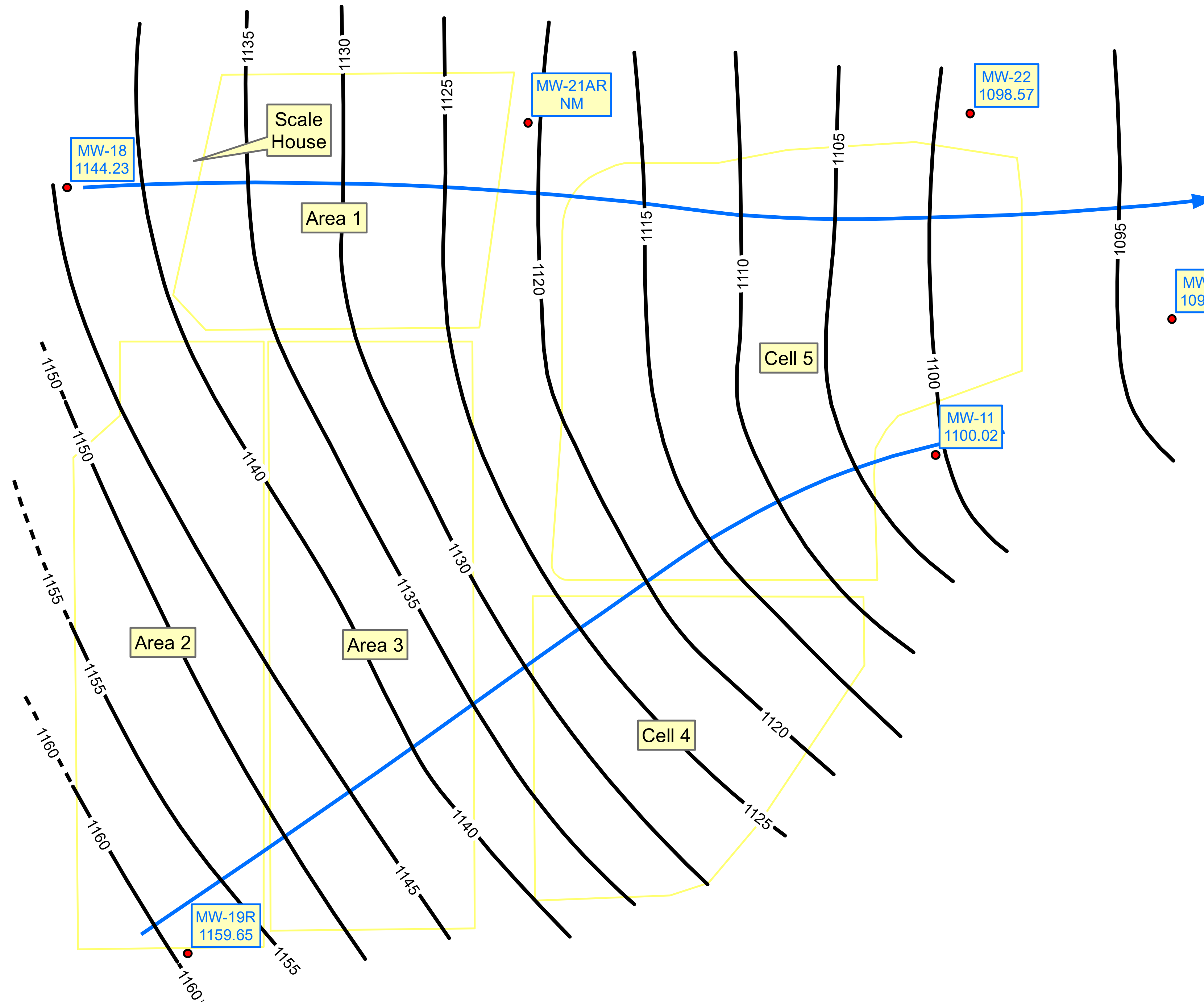
MW-19 919.08 Monitoring Point with Water Elevation AMSL

0 150 300 450 600

Feet

NM = Not measured
Based on May 2023 water elevations.

Aerial Photography Source: USDA National Agriculture Imagery Program, 2021



[redacted]

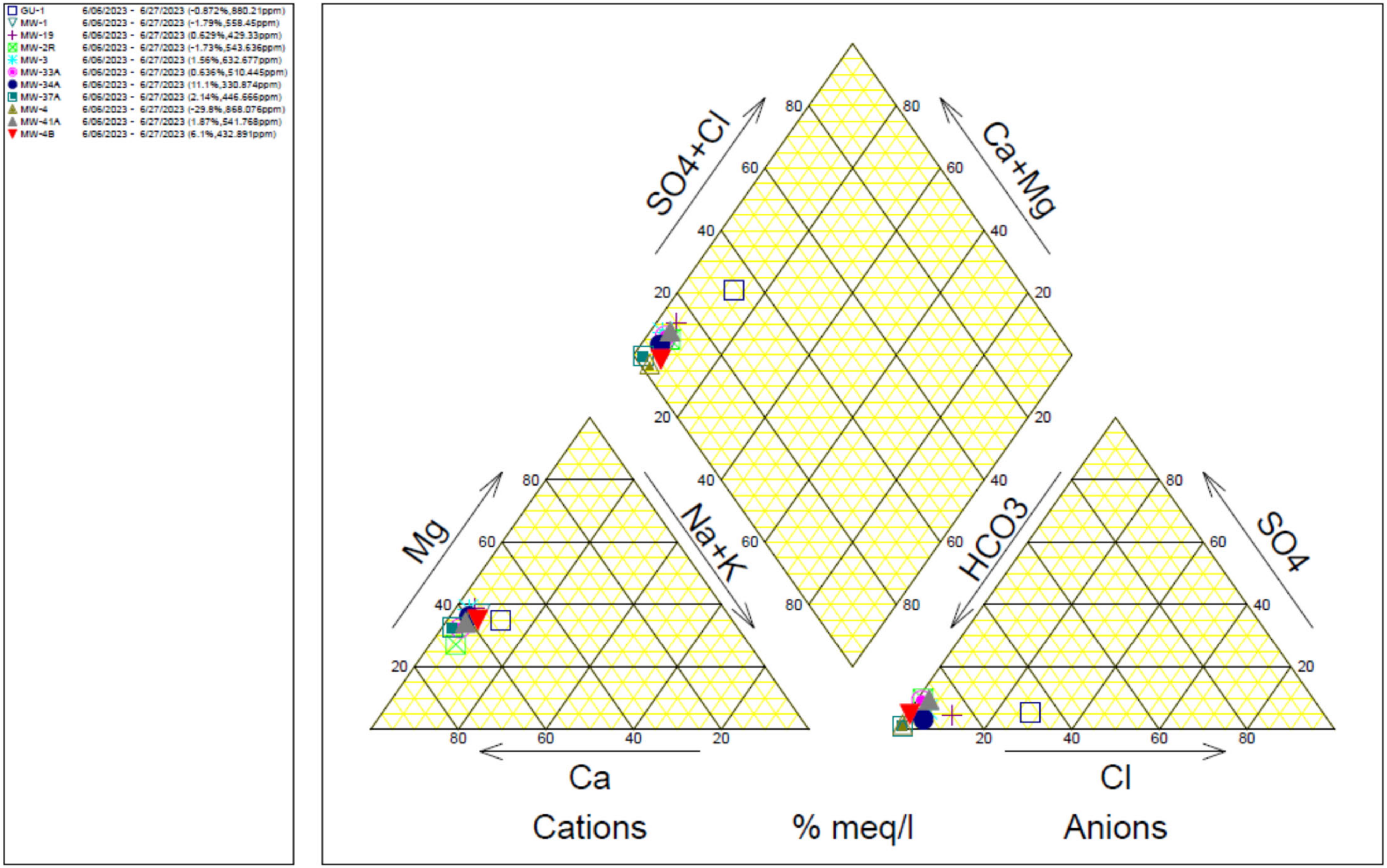
Figure 22
Deep Well Water Elevations

Hydrologic Monitoring System Plan
Winneshiek County Solid Waste Agency
Decorah, Iowa

March 2024

60711359

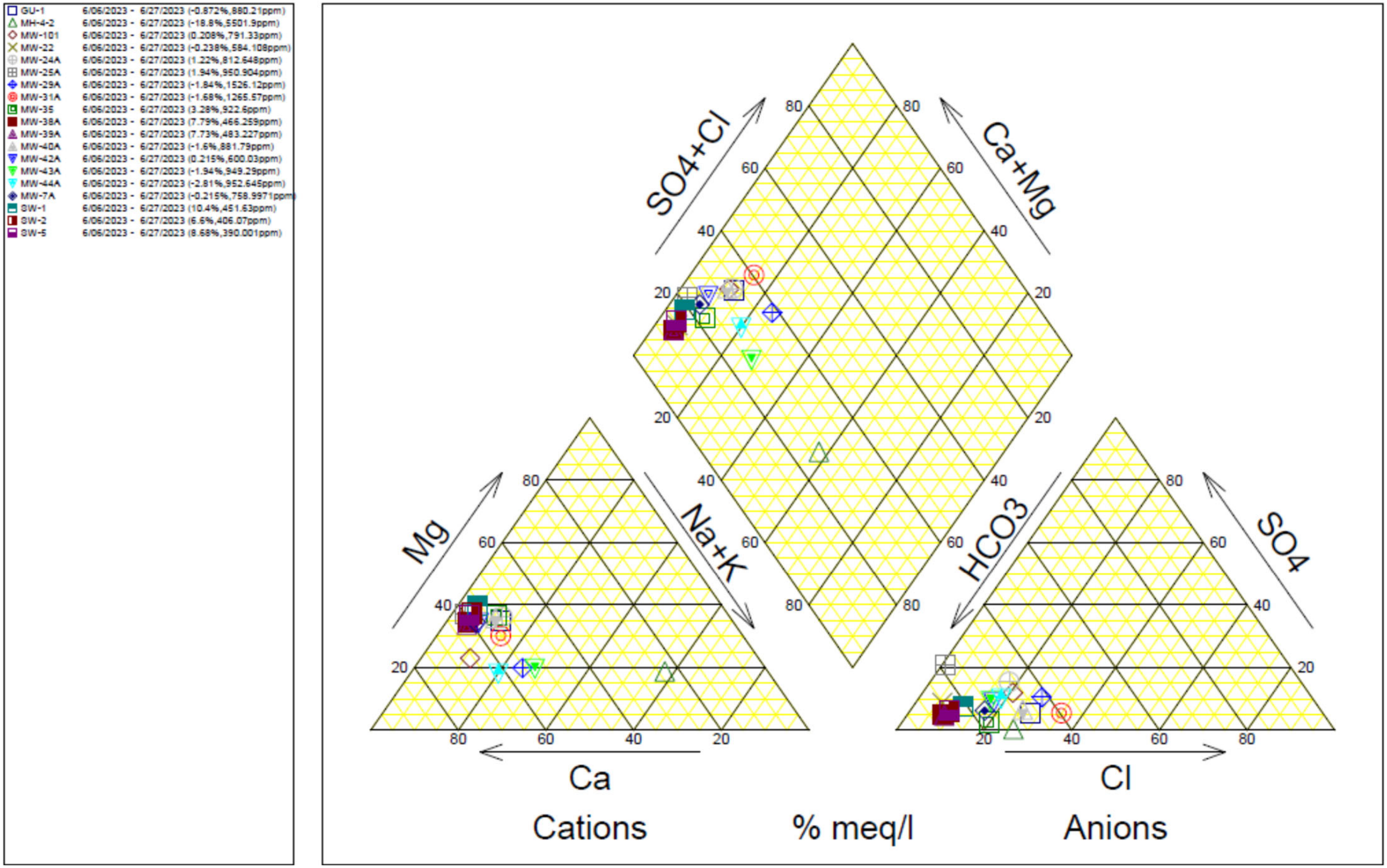
\\na.aecomnet.com\LFS\AMER\Waterloo-USWAT1\DCS\Projects\TRN\60711359_Winn_FY_24-26_Engineering\400_Technical\406 HMSP\2024 HMSP Update\03-GIS FIGURES\Fig22_Deep_Water_Elevation_



AECOM

FIGURE 23
Piper Diagram – West Side

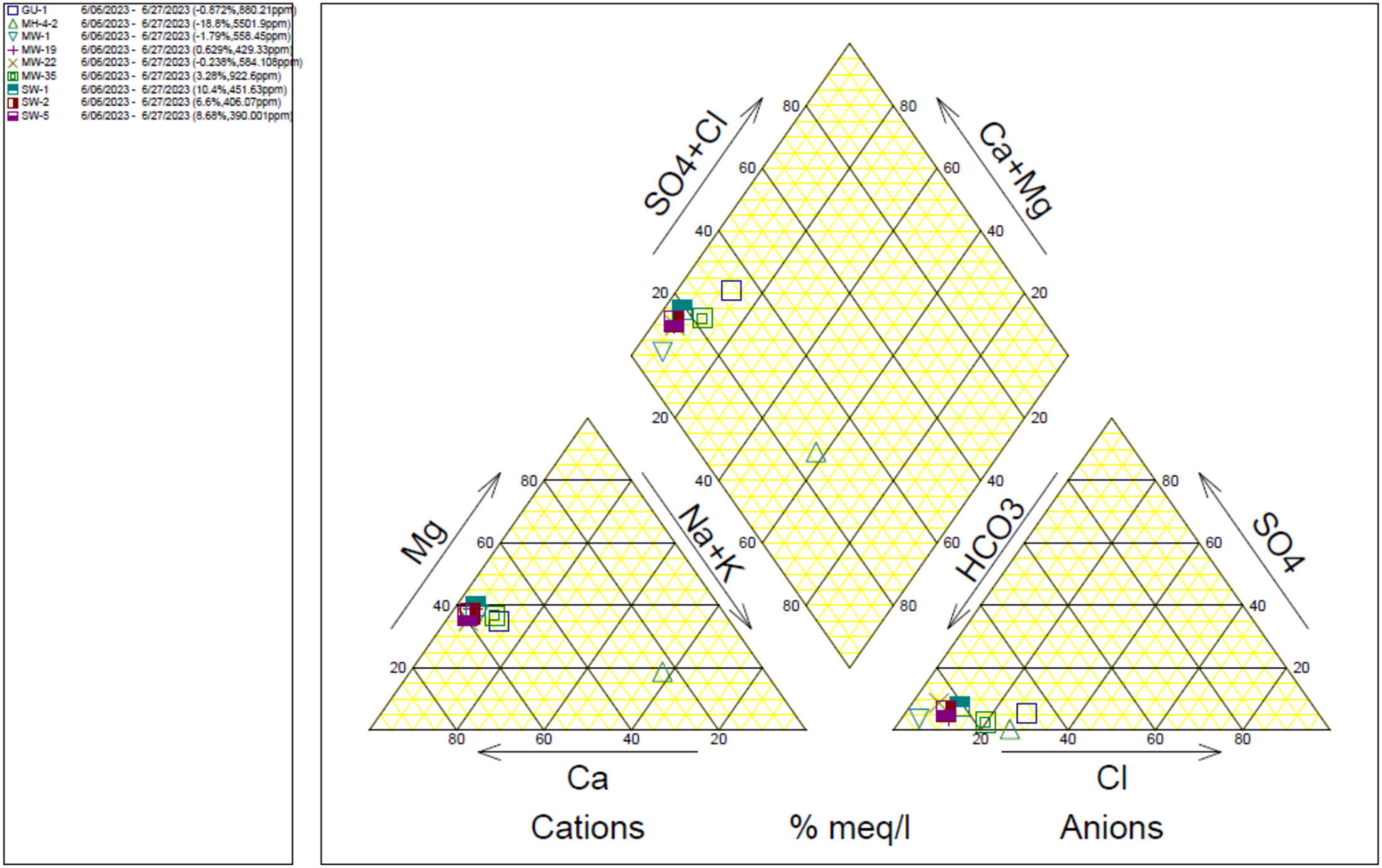
WINNESHIEK COUNTY LANDFILL
2024 HMSP REVISION
SEP 2024 60711359



AECOM

FIGURE 24
Piper Diagram – East Side

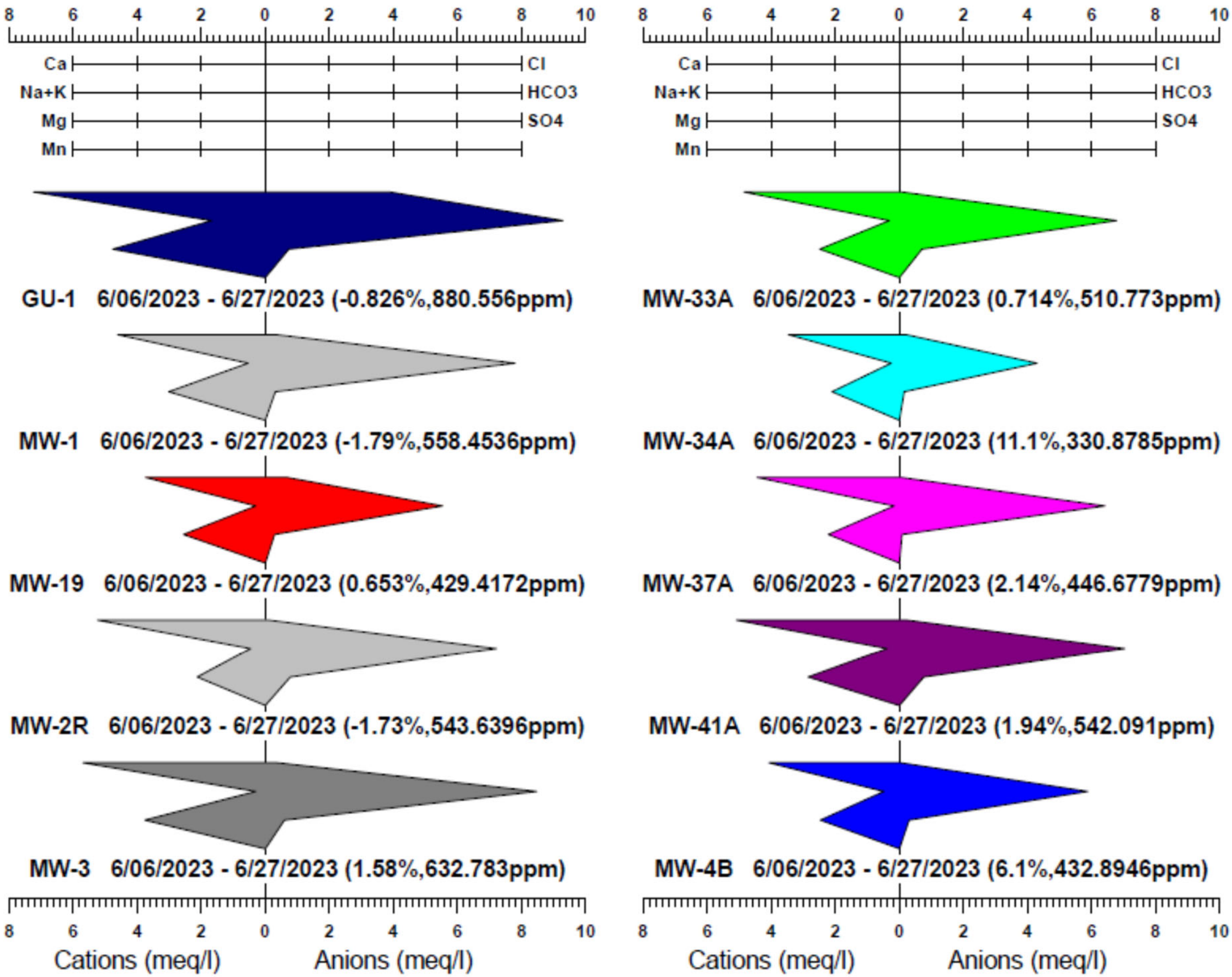
WINNESHIEK COUNTY LANDFILL
2024 HMSP REVISION
SEP 2024 60711359



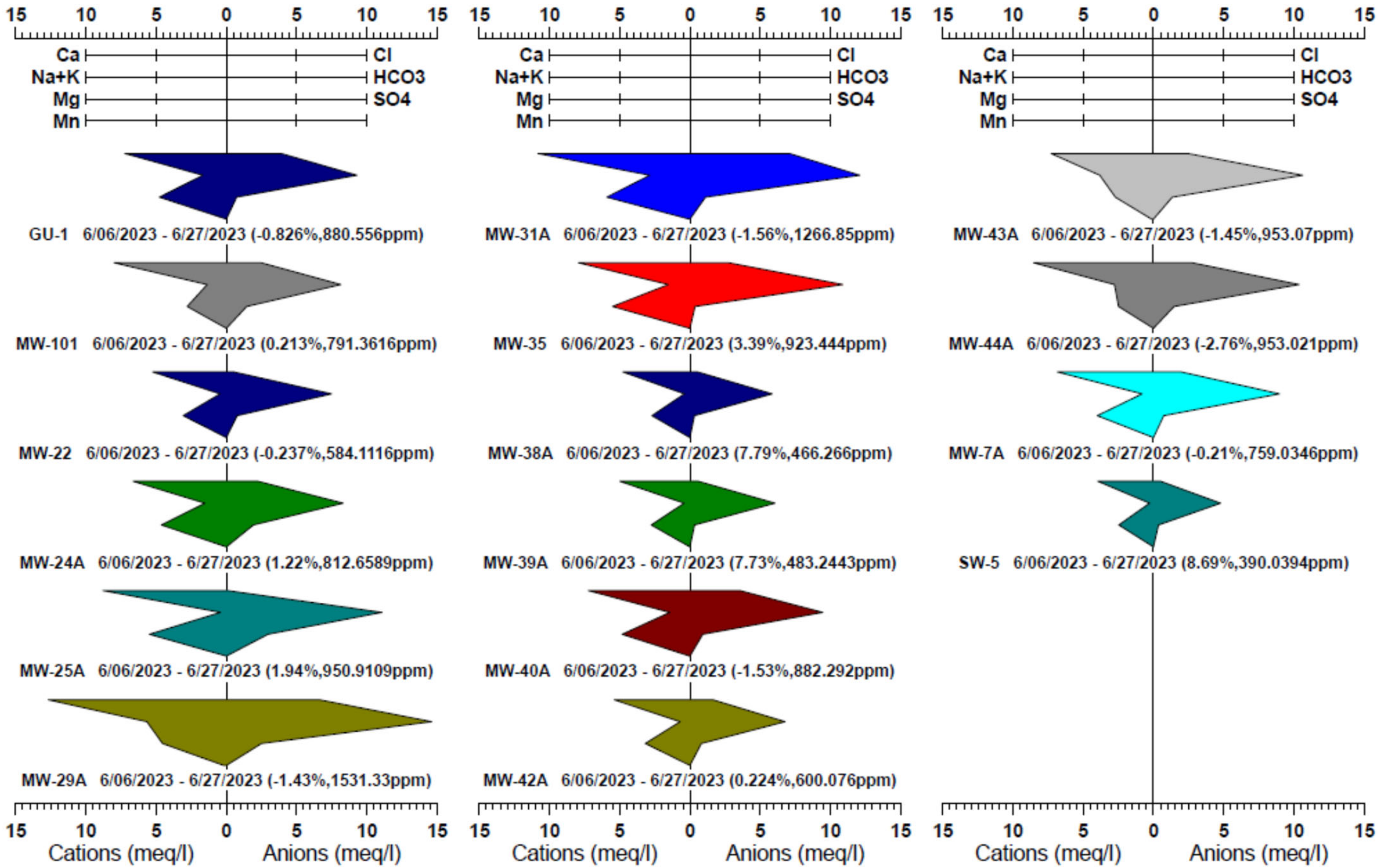
AECOM

FIGURE 25
Piper Diagram – Bedrock and Surface Water

WINNESHIEK COUNTY LANDFILL
2024 HMSP REVISION
SEP 2024 60711359



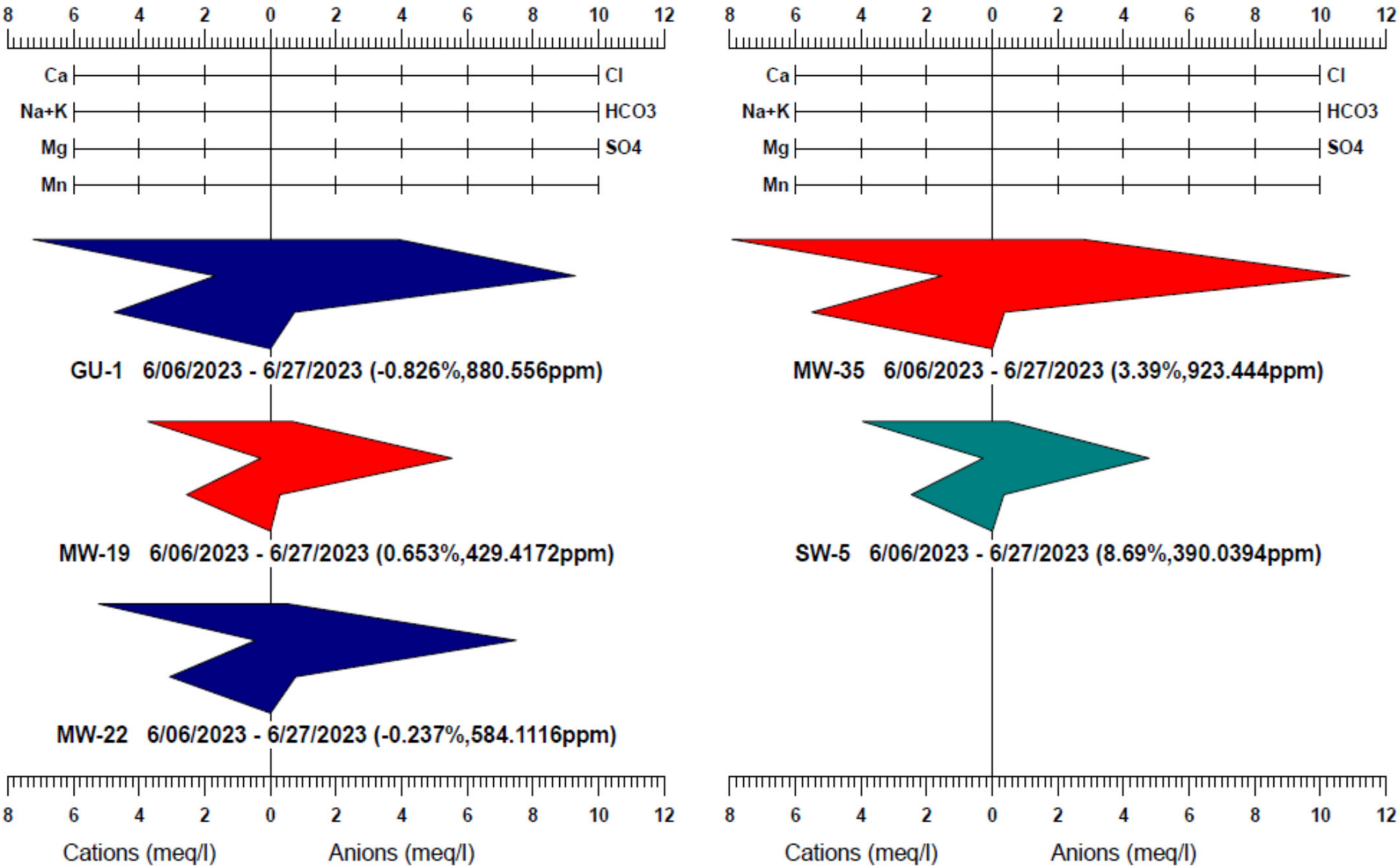
AECOM	FIGURE 26 Stiff Diagram – West Side	WINNESHIEK COUNTY LANDFILL 2024 HMSP REVISION SEP 2024 60711359



AECOM

FIGURE 27
Stiff Diagram – East Side

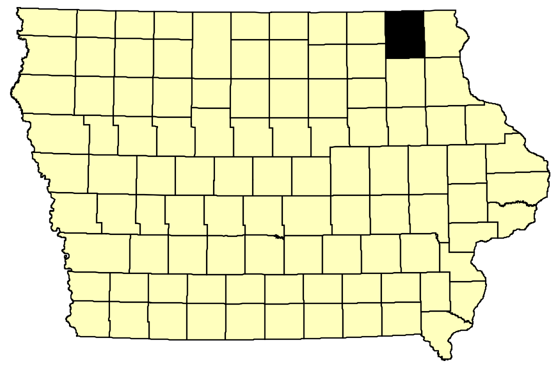
WINNESHIEK COUNTY LANDFILL
2024 HMSP REVISION
SEP 2024 60711359

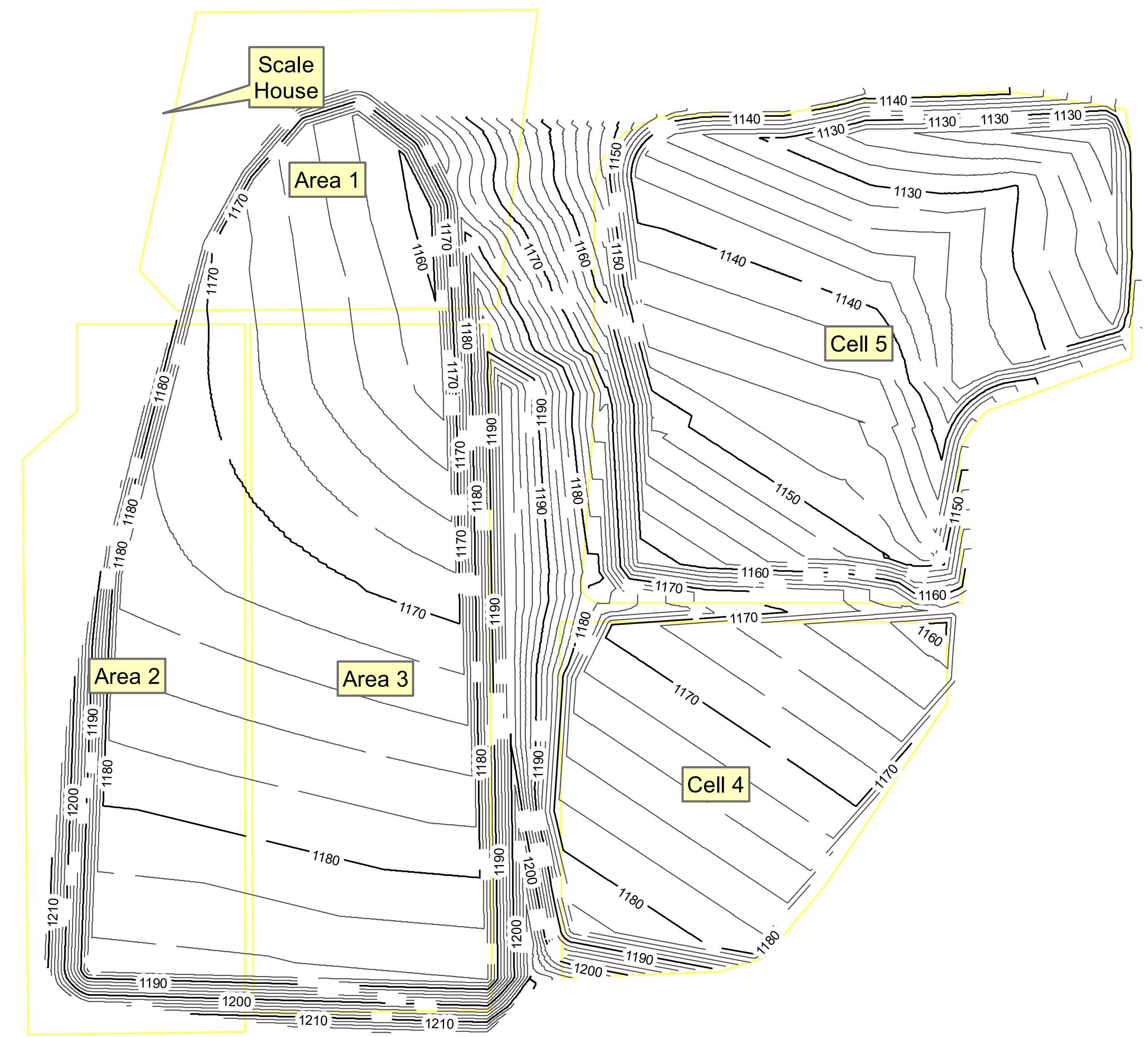


AECOM

FIGURE 28
Stiff Diagram – Bedrock and Surface Water

WINNESHIEK COUNTY LANDFILL
2024 HMSP REVISION
SEP 2024 60711359





0 150 300 450 600

Feet

N
W E
S

Aerial Photography Source: USDA National Agriculture Imagery Program, 2021

[redacted]

Figure 29
Landfill Base Grades

Hydrologic Monitoring System Plan
Winneshiek County Solid Waste Agency
Decorah, Iowa

March 2024

60711359

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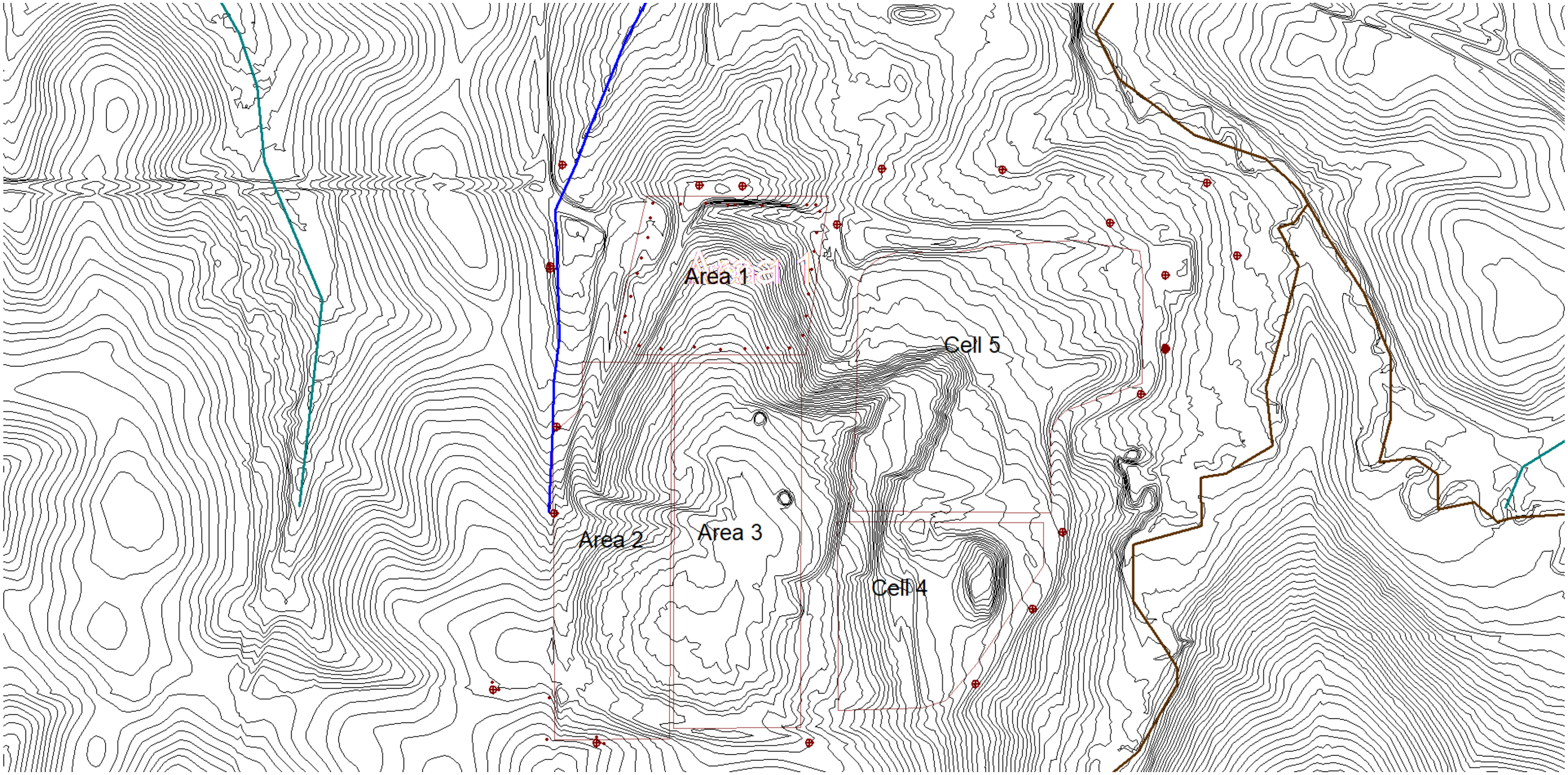
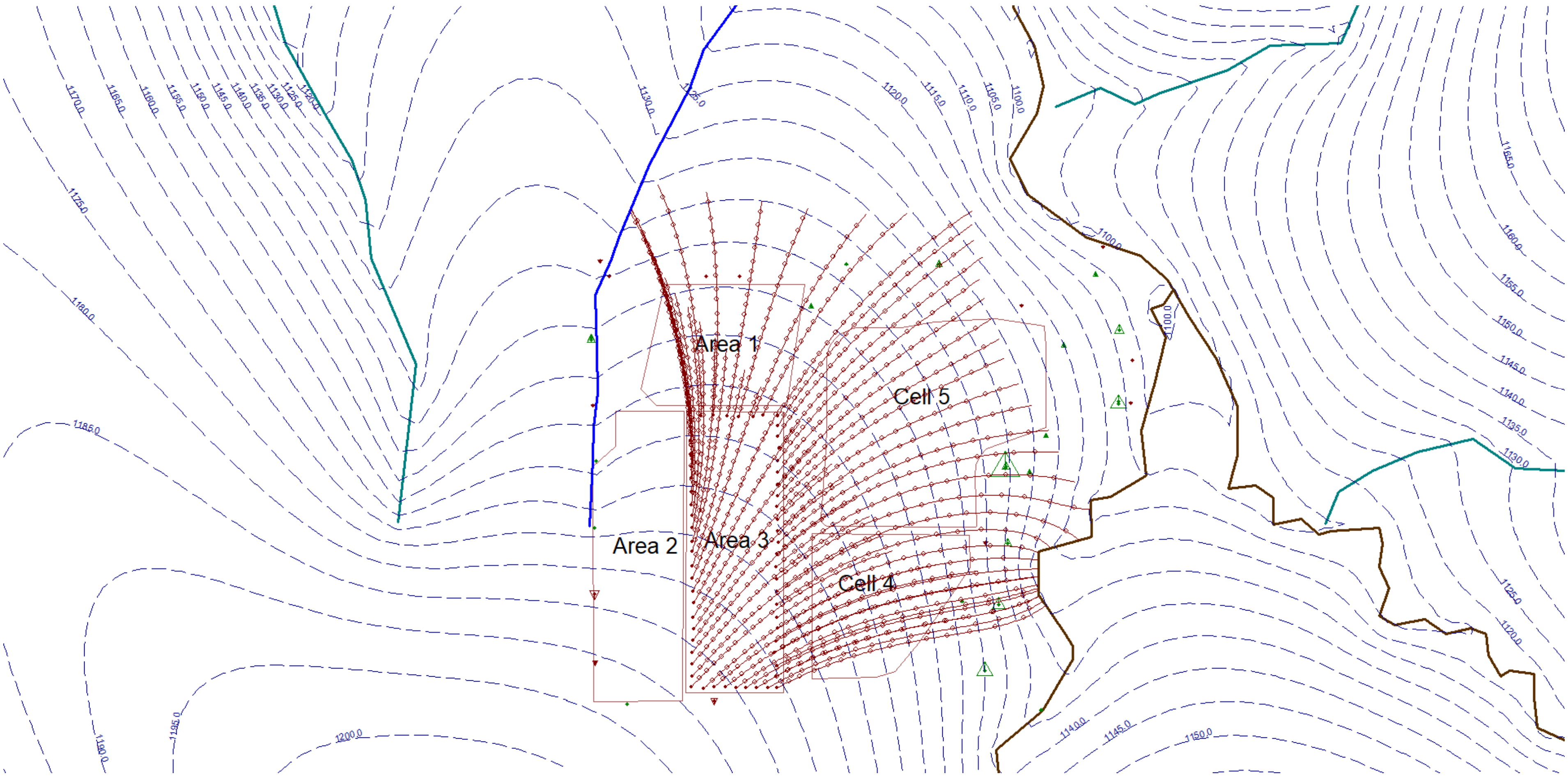


AECOM

FIGURE 30
Theoretical Release Model Domain

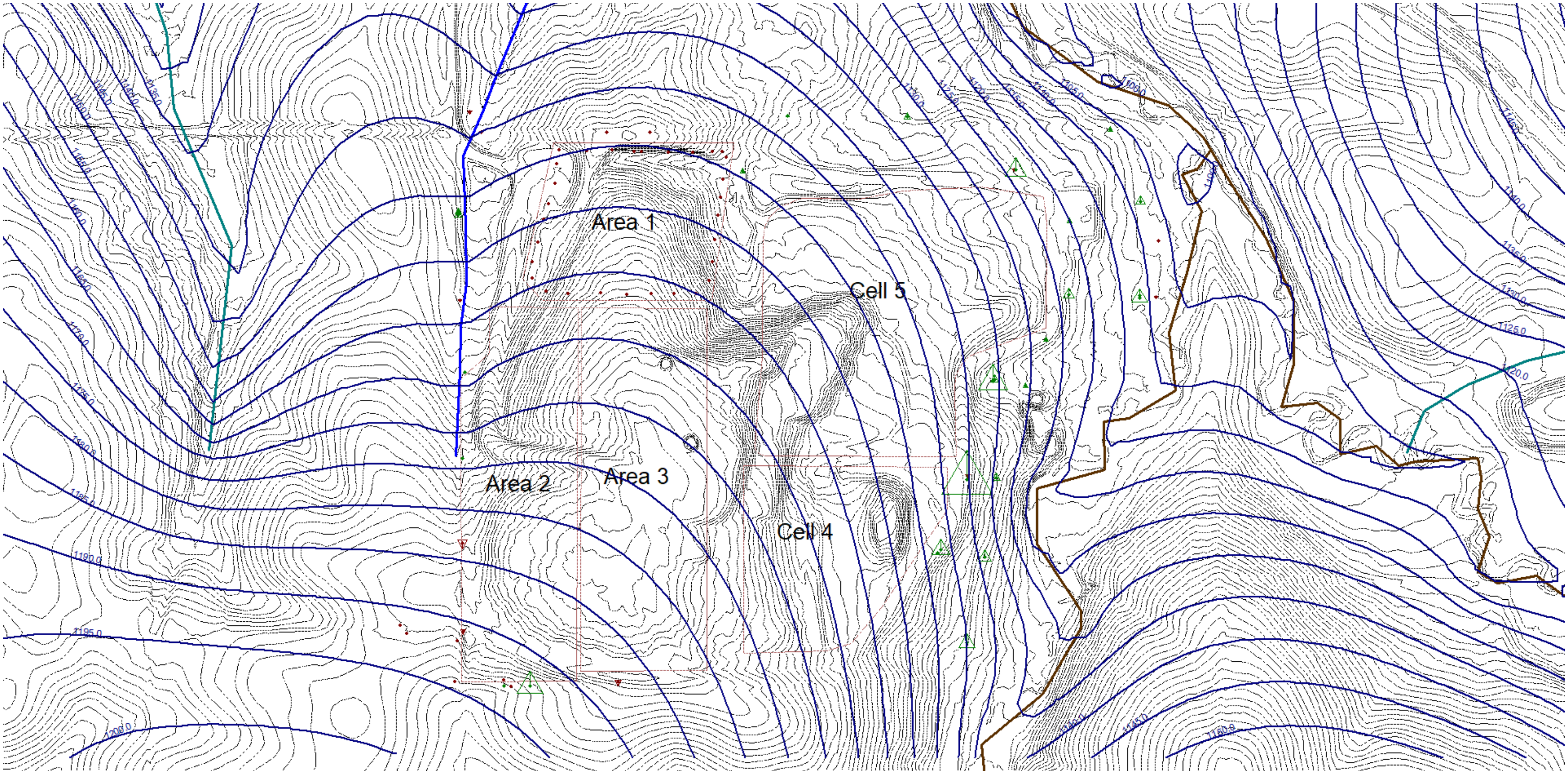
WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



AECOM

FIGURE 31
Theoretical Release: Area 3

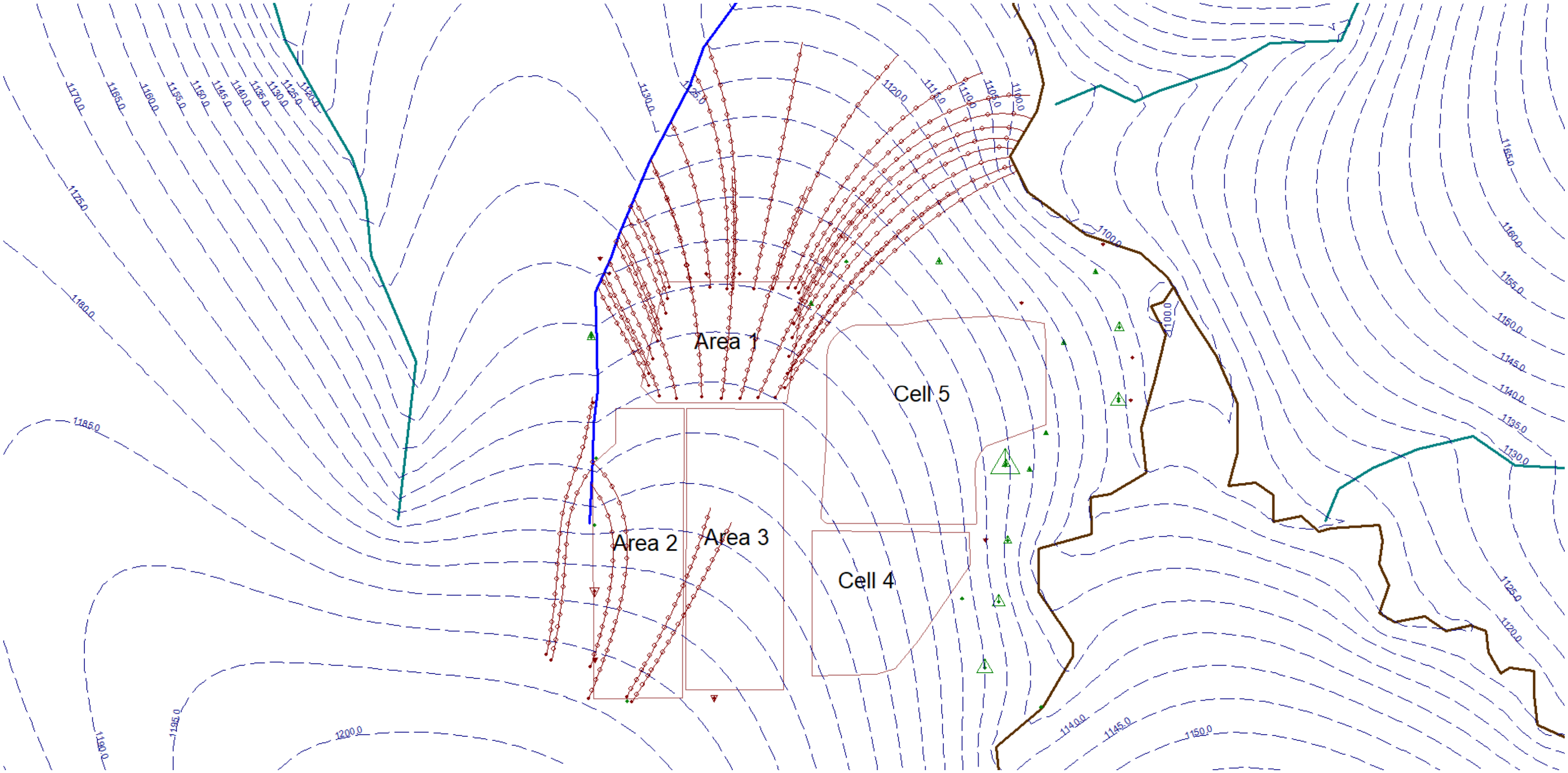
WINNESHIEK COUNTY LANDFILL
2023 HMSP
MAY 2023
60635552



AECOM

FIGURE 32
GFLOW Modeled Groundwater Head

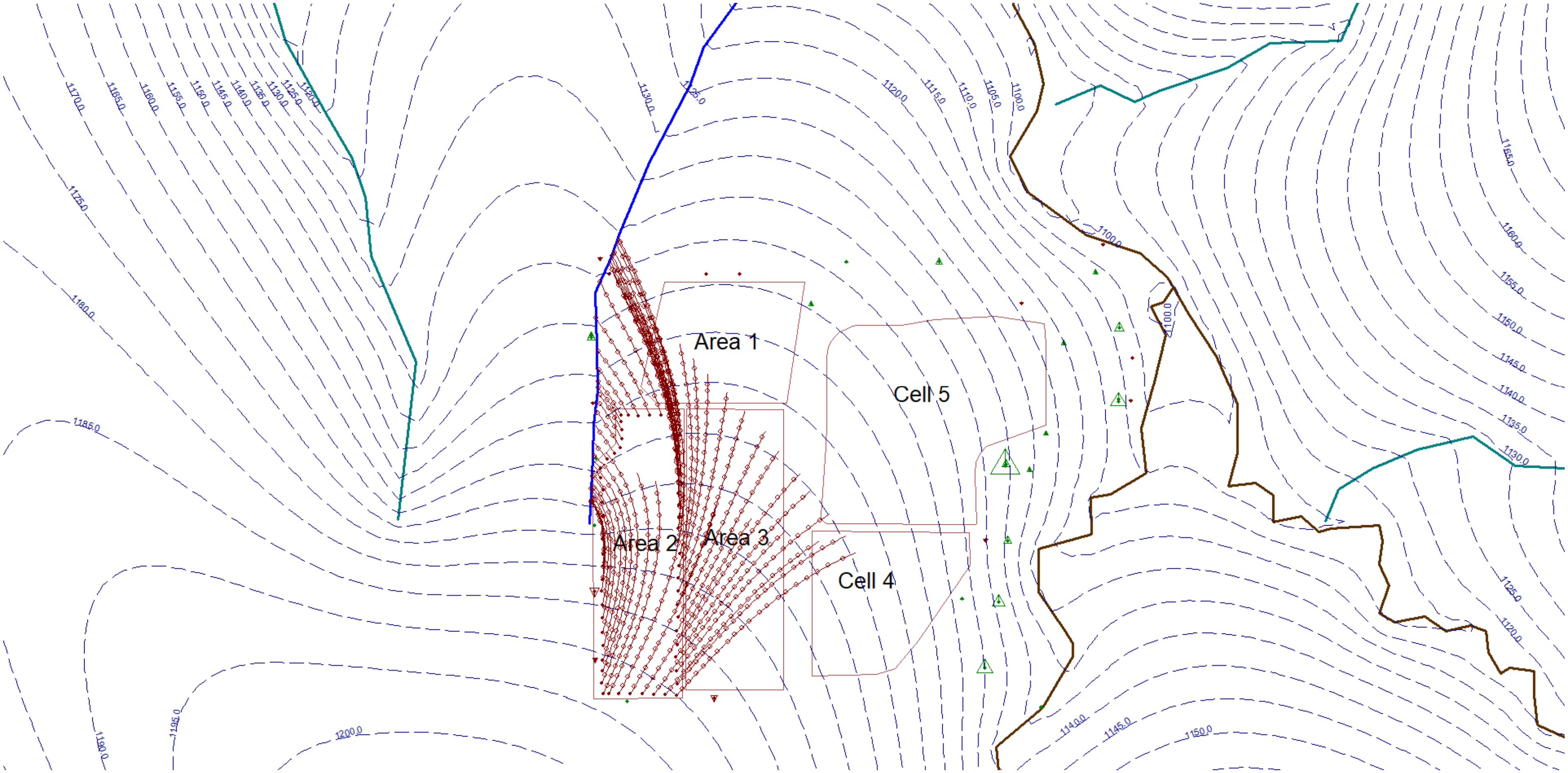
WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



AECOM

FIGURE 33
Theoretical Release: Area 1

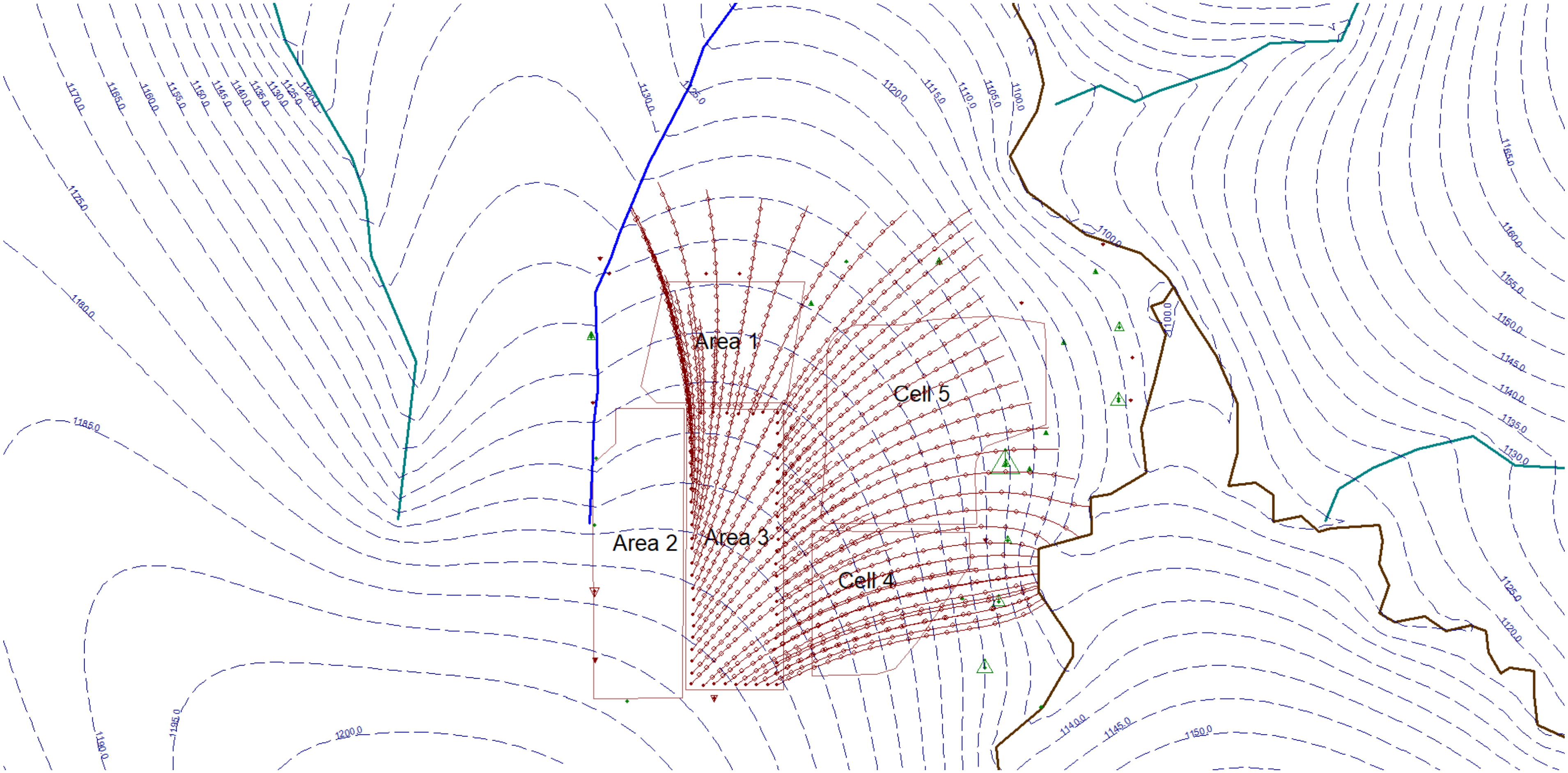
WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



AECOM

FIGURE 34
Theoretical Release: Area 2

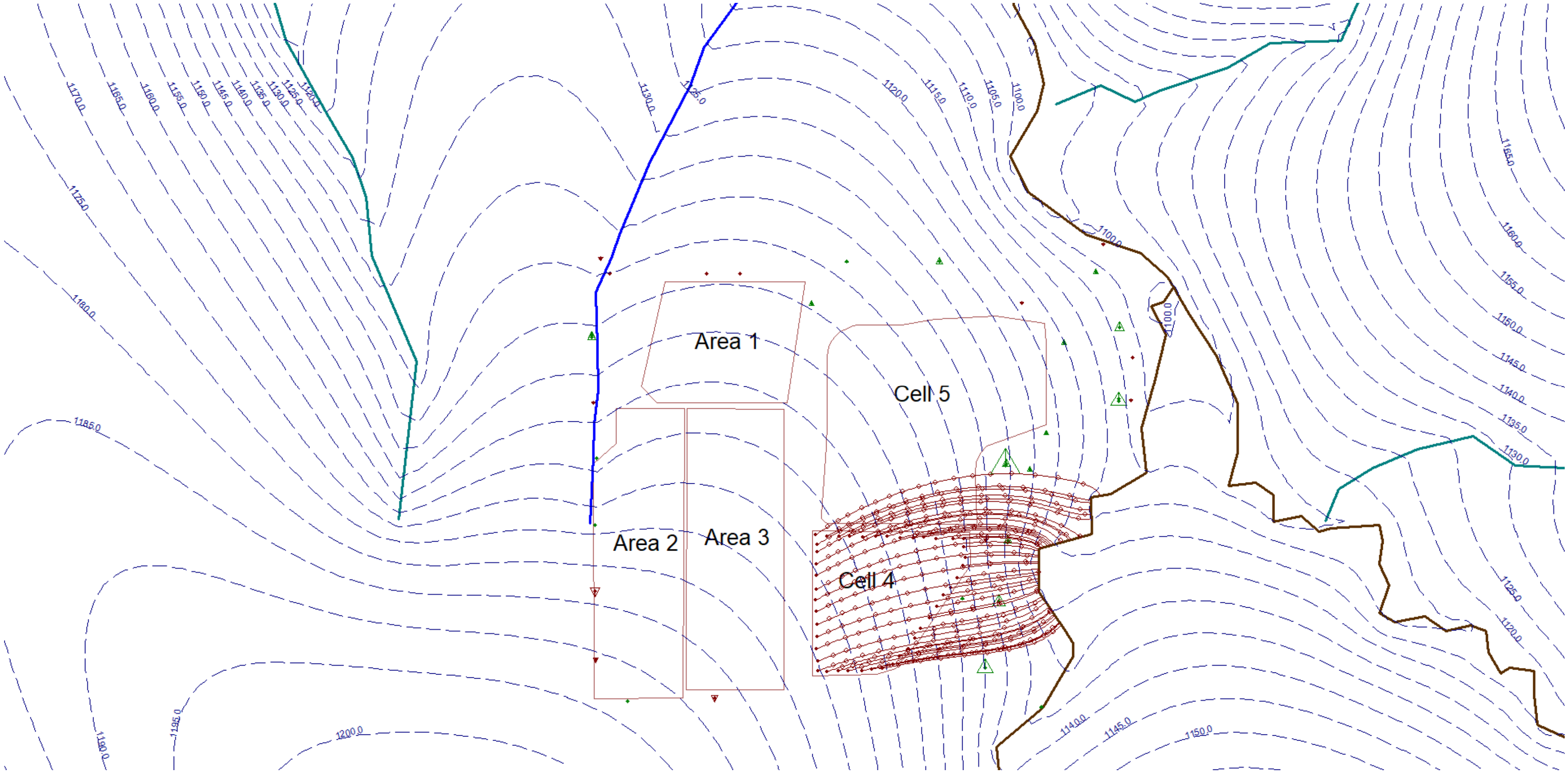
WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



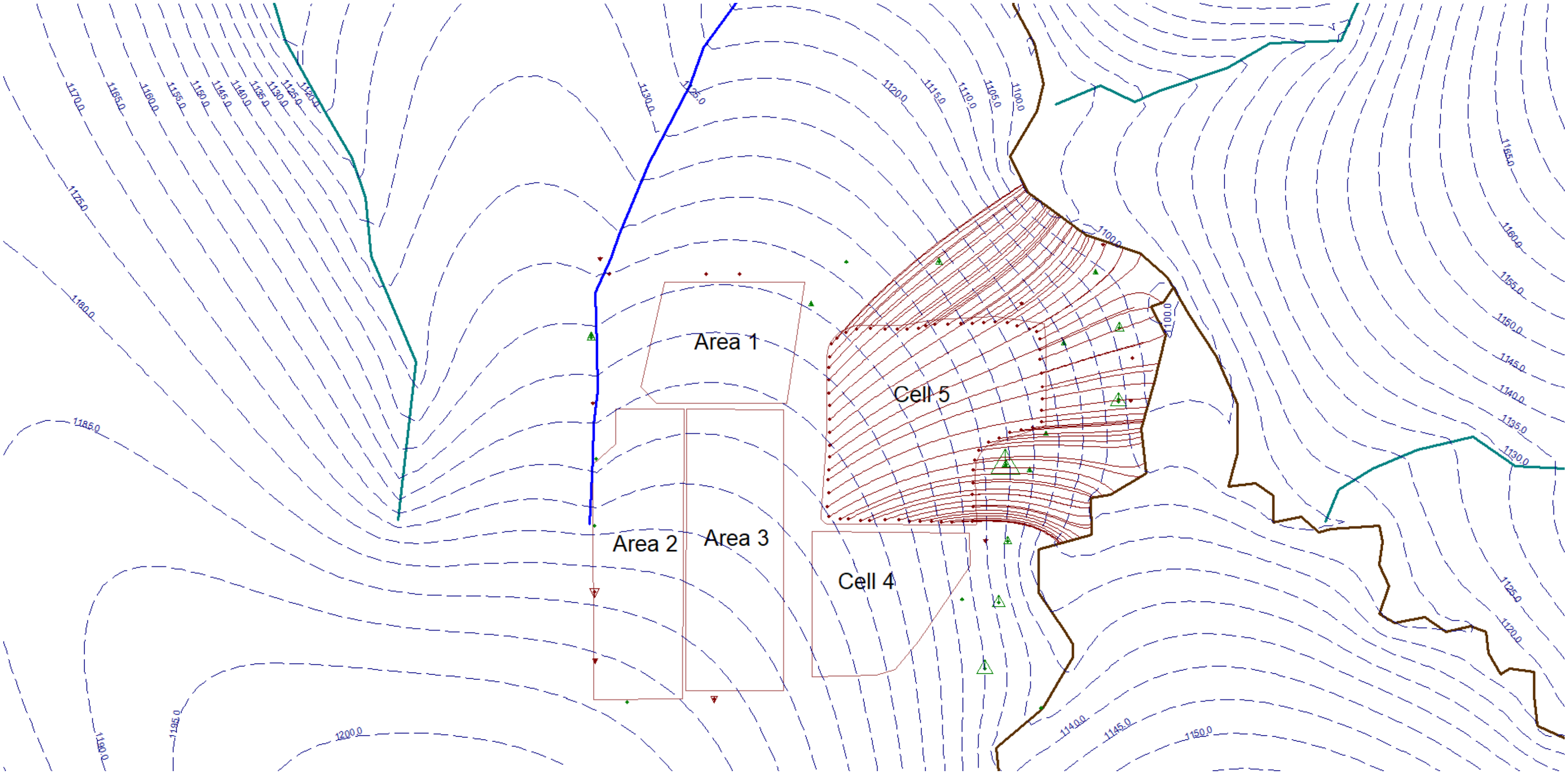
AECOM

FIGURE 35
Theoretical Release: Area 3

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



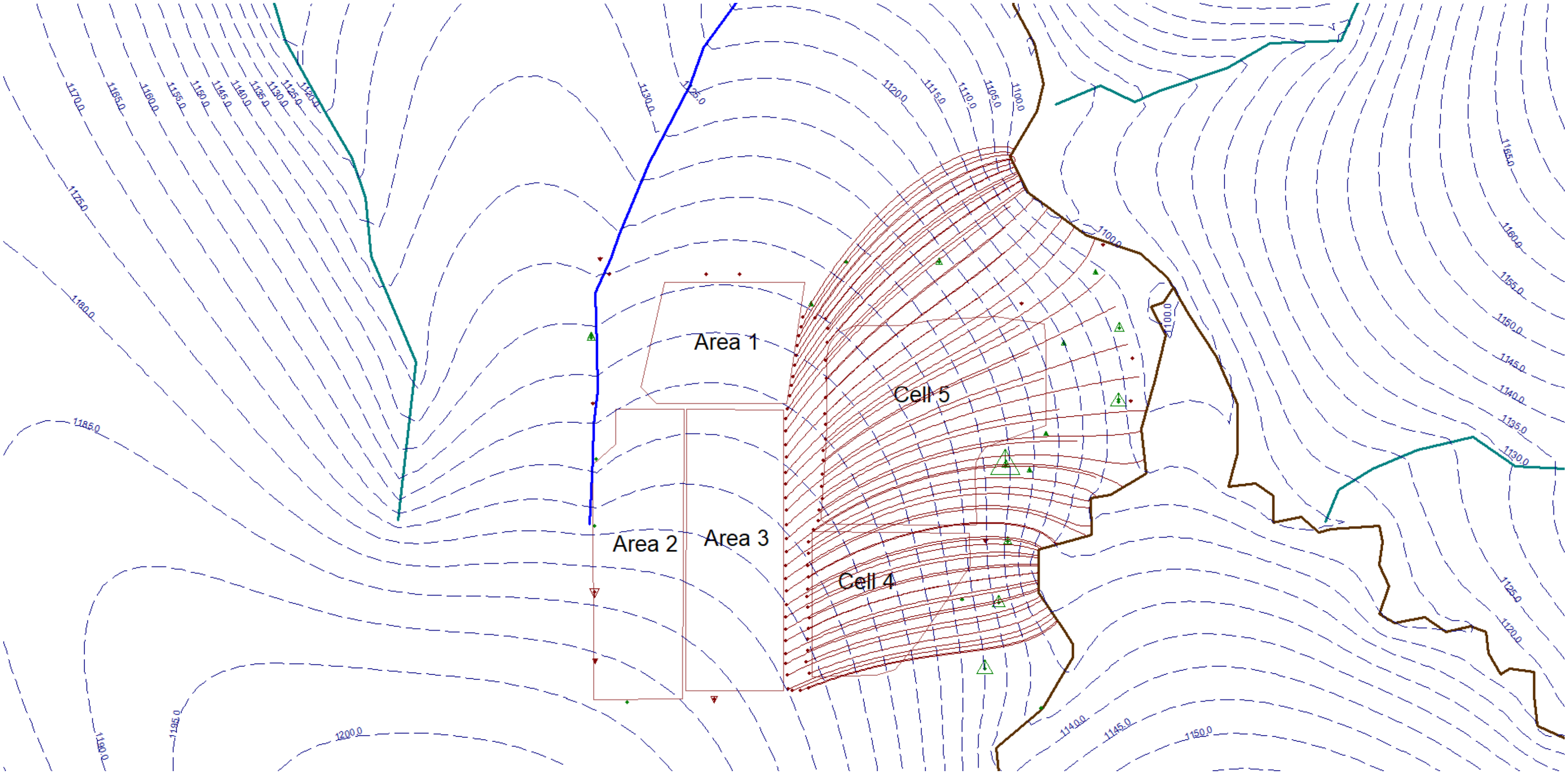
AECOM	FIGURE 36 Theoretical Release: Cell 4	WINNESHIEK COUNTY LANDFILL 2024 HMSP SEPTEMBER 2024 60711359



AECOM

FIGURE 37
Theoretical Release: Cell 5

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359



AECOM

FIGURE 38
Theoretical Release: Cell 5 EXP

WINNESHIEK COUNTY LANDFILL
2024 HMSP
SEPTEMBER 2024 60711359

TABLES

Table 3

Winneshiek County Landfill
Hydrologic Monitoring System Plan

Detection Monitoring		
Shallow (Water Table) Wells		
Gradient/Landfill Unit	**Well Number**	**Screened Geologic Unit[1]**
Upgradient		
Upgradient of Areas 1 and 2	MW-1	Ql/Qt
Upgradient of Areas 1 and 2	MW-37A	Ql/Qt
Downgradient		
Downgradient Area 2	MW-2R	Oeu
Downgradient Areas 1 and 2	MW-3	Qt
Downgradient Area 1	MW-4	Qt/fluv
Downgradient Area 1	MW-4B	Qt/fluv
Downgradient C 5 EXP	MW-7A	Qt
Downgradient C 5 EXP	MW-24A	Qf/Ql/Oe
Downgradient C 5 EXP	MW-25A	Qf/Ql/Oe
Downgradient C 5 EXP, Leachate Lagoon	MW-29A	Ql/Og
Downgradient C 5 EXP	MW-31A	Ql/Qc
Downgradient Area 2	MW-33A	Ql/Qt
Downgradient Areas 1 and 2	MW-34A	Ql/Qt
Downgradient Cell 4	MW-38A	Qc/Og
Downgradient Cell 4	MW-39A	Qc/Og
Downgradient Cell 4	MW-40A	Qc/Og
Downgradient of Area 1, 2 and 3	MW-41A	Qt/Oeu
Downgradient MW-31A, MW-11, Cell 4	MW-42A	Oeu/Oel
Downgradient MW-29A, C 5 EXP, Leachate Lagoon	MW-43A	Og
Downgradient MW-29A, C 5 EXP, Leachate Lagoon	MW-44A	Og
Downgradient Area 1, Area 3, and C 5 EXP	MW-45A	Ql
Downgradient C 5 EXP	MW-46A	Ql/Qc
Downgradient C 5 EXP, Leachate Lagoon	MW-101	Ql/Og
Deep (Bedrock) Wells		
Upgradient		
Upgradient of Areas 2 and 3, Cell 4	MW-19R	Oel
Downgradient		
Downgradient Areas 2 and 3, Cells 4 and 5 EXP	MW-11	Oeu/Oel
Downgradient Areas 1 and 3, and C 5 EXP	MW-22	Og
Downgradient Areas 2 and 3, and Cell 4	MW-35	Oel
Groundwater Assessment Monitoring Points		
Downgradient C 5 EXP, Leachate Lagoon	MW-29A	Ql/Og
Downgradient C 5 EXP	MW-31A	Ql/Qc
Downgradient Area 2	MW-33A	Ql/Qt
Downgradient Cell 4	MW-11	Oel
Downgradient MW-31A, MW-11, Cell 4	MW-42A	Oel
Downgradient MW-29A, C 5 EXP, Leachate Lagoon	MW-43A	Og
Downgradient MW-43A, C 5 EXP, Leachate Lagoon	MW-44A	Og
Leachate Manhole Monitoring Points		
Areas 1, 2, 3; C 5 EXP	MH-1AA	NA

Detection Monitoring		
Shallow (Water Table) Wells		
Gradient/Landfill Unit	**Well Number**	**Screened Geologic Unit[1]**
Cell 4	MH-4-2	NA
Groundwater Level Measurement Only		
Shallow (Water Table) Wells		
Downgradient Area 1 and C 5 EXP	MWII-2	Qt
Downgradient Area 2	MW-2	Qt/Oeu
Downgradient Area Cell 4	MW-12A	Qf/Oe
Downgradient Cell 4	MW-26A	Qf/Qc/Oe
Downgradient Cell 4	MW-27A	Qf/Oe
Upgradient Cells 4 and C 5 EXP	MW-32A	Ql/Oe
Downgradient C 5 EXP, Leachate Lagoon	MW-100	Ql/Og
Deep (Bedrock) Wells		
Upgradient Areas 1 and C 5 EXP	MW-18	Oeu
Downgradient Areas 1 and 3, C 5 EXP, Leachate Lagoon	MW-30	Og
Downgradient Areas 2 and 3, and Cell 4	MW-36	Og
Surface Water		
Upstream	SW-1	Og
Downstream	SW-2	Og
Downstream	SW-3	Og
Downstream	SW-4	Qt/Oeu
Downstream	SW-5	Og
Landfill Cell Groundwater Underdrains		
C 5 EXP	GU-1	Cell underdrain head
C 5 EXP	GU-2	Cell underdrain head
Leachate Head Measurement		
Area 2	LHPZ-1	Leachate Level
Area 2	LHPZ-2	Leachate Level
Area 1	LHPZ-3	Leachate Level
Area 1	LHPZ-4	Leachate Level
Area 3	LHPZ-6	Leachate Level
Cell 4	LHPZ-4-1	Leachate Level
C 5 EXP	LHPZ-5-1	Leachate Level
C 5 EXP	LHPZ-5-2	Leachate Level
C 5 EXP	LHPZ-5E-1	Leachate Level
C 5 EXP	LHPZ-5E-2	Leachate Level

Notes:

[1] Screened geologic unit symbols:
- Qf = Quaternary soil fill placed during landfill construction
- Ql = Quaternary loess
- Qc = Quaternary, pre-Wisconsin Episode colluvium
- Qt = Quaternary pre-Illinoian-age diamicton (“till”)
- fluv = Quaternary fluvioglacial material
- Oeu = Ordovician Maquoketa Formation, Upper Elgin Member (interbedded limestone and shale)
- Oel = Ordovician Maquoketa Formation, Lower Elgin Member (shale)
- Og = Ordovician Galena Group Decorah Formation (limestone)
- NA = not applicable

Table 4

Locations Included in Semi-Annual Groundwater, Surface Water, and Leachate Head Elevation Measurements
Winneshiek County Landfill

GROUNDWATER			
SHALLOW			
Well Number	**Gradient Position**	**Groundwater Monitoring Zone**	**Screened Geologic Unit[1]**
MW-1	Upgradient	Water table	Qt/fluv
MW-2R	Downgradient//Sidegradient Area 2	Water table	Oeu
MW-2	Downgradient/Sidegradient Area 2	Water table	Qt/Oeu
MW-3	Sidegradient/Downgradient Area 1 Downgradient Area 2	Water table	Qt
MW-4	Downgradient Area 1	Water table	Qt/fluv
MW-4B	Downgradient Area 1	Water table	Qt/fluv
MW-7A	Downgradient Areas 1, 2, and 3, Cell 5 EXP	Water table	Qt
MW-12A	Downgradient Areas 2 and 3, Cell 4	Water table	Qf,Oe
MW-24A	Downgradient Areas 1, 2, and 3, Cells 4 and 5 EXP	Water table	Qf,Ql,Oe
MW-25A	Downgradient Areas 2 and 3, Cells 4 and 5 EXP	Water table	Qf,Ql,Oe
MW-26A	Downgradient Areas 2 and 3, Cell 4	Water table	Qf,Qc,Oe
MW-27A	Downgradient/Sidegradient Areas 2 and 3, Cell 4	Water table	Qf,Oe
MW-29A	Downgradient Cell 5 EXP and Leachate Lagoon	Water table	Qf,Ql,Og
MW-31A	Downgradient Cell 5 EXP	Water table	Qf,Ql
MW-32A	Sidegradient Areas 2 and 3 Upgradient Cell 4	Water table	Ql,Oe
MW-33A	Downgradient Cells 2 and 3	Water table	Ql,Qt
MW-34A	Sidegradient/Downgradient Area 1 Downgradient Area 2	Water table	Ql,Qt
MW-37A	Upgradient Areas 1 and 2	Water Table	Qt/fluv
MW-38A	Downgradient Area 3, Cell 4	Water table	Qc,Oe
MW-39A	Downgradient Area 3, Cell 4	Water table	Qc,Oe
MW-40A	Downgradient Area 3, Cell 4	Water table	Qc,Oe

Table 4

Locations Included in Semi-Annual Groundwater, Surface Water, and Leachate Head Elevation Measurements
Winneshiek County Landfill

MW-41A	Sidegradient Area 1	Water table	Qt/Oeu
MW-42A	Downgradient Area 3, Cell 4	Water table	Qc,Oe
MW-43A	Downgradient Area 3, Cell 4	Water table	Og
GROUNDWATER			
Well Number	**Gradient Position**	**Groundwater Monitoring Zone**	**Screened Geologic Unit[1]**
MW-44A	Downgradient Area 3, Cell 4	Water table	Og
MW-45A	Downgradient Area 1 Sidegradient Cell 5 EXP	Water table	Ql
MW-46A	Downgradient Area 1 Sidegradient Cell 5 EXP	Water table	Ql/Og
MWII-2	Downgradient Area 1 Sidegradient Cell 5 EXP	Water table	Qt
MW-100	Downgradient Leachate Lagoon	Water Table	Qf,Ql,Og
MW-101	Downgradient Leachate Lagoon	Water table	Qf,Ql,Og
BEDROCK			
MW-11	Downgradient Areas 2 and 3, Cells 4 and 5	Uppermost bedrock	Oeu/Oel
MW-18	Upgradient Areas 1, 2, and 3 and Cell 5 EXP	Uppermost bedrock	Oeu
MW-19R	Upgradient Cell 4 and 5 EXP	Uppermost bedrock	Oel
MW-22	Downgradient Areas 1, 2, and 3, Cell 5 EXP	Uppermost bedrock	Og
MW-30	Downgradient Cell 5 EXP	Uppermost bedrock	Og
MW-35	Downgradient Cell 4	Uppermost bedrock	Oel
MW-36	Downgradient Cell 4	Uppermost bedrock	Og
SURFACE WATER			
Location	**Gradient Position**	**Surface Water Monitoring Zone**	**Geologic Unit[1]**
SW-1	Upstream	Tributary of Trout River	Qal/Og
SW-2	Downstream	Trout River	Qal/Og
SW-3	Downstream	Tributary of Trout River	Qal/Og
SW-4	Downstream	Tributary of Trout River	Qal
SW-5	Downstream	Tributary of Trout River	Qal/Og
LEACHATE PIEZOMETERS			

Table 4

Locations Included in Semi-Annual Groundwater, Surface Water, and Leachate Head Elevation Measurements
Winneshiek County Landfill

Location	Gradient Position	Leachate Monitoring Zone	Geologic Unit[1]
LHPZ-1	NA	Area 2	NA
LHPZ-2	NA	Area 2	NA
LHPZ-3	NA	Area 1	NA
LHPZ-4	NA	Area 1	NA
LHPZ-6	NA	Area 3	NA
LHPZ-4-1	NA	Cell 4	NA
LHPZ-5-1	NA	Cell 5 EXP	NA
LHPZ-5-2	NA	Cell 5 EXP	NA
LHPZ-5E-1	NA	Cell 5 EXP	NA
LEACHATE PIEZOMETERS			
Location	**Gradient Position**	**Leachate Monitoring Zone**	**Geologic Unit[1]**
LHPZ-5E-2	NA	Cell 5 EXP	NA

LANDFILL CELL GROUNDWATER UNDERDRAINS			
GU-1	NA	Cell 5 EXP	NA
GU-2	NA	Cell 5 EXP	NA

LANDFILL CELL LEACHATE MANHOLES			
MH-1AA	NA	Areas 1, 2, and 3; Cell 5 EXP	NA
MH-4-2	NA	Cell 4	NA

Notes:

[1] Screened geologic unit symbols:
Qal = Quaternary alluvium
Qf = Quaternary soil fill placed during landfill construction

Table 4

Locations Included in Semi-Annual Groundwater, Surface Water, and Leachate Head Elevation Measurements
Winneshiek County Landfill

Ql = Quaternary loess
Qc = Quaternary, pre-Wisconsin Episode colluvium
Qt = Quaternary pre-Illinoian-age diamicton (“Till”)
fluv = Quaternary fluvioglacial material
Oeu = Ordovician Maquoketa Formation, Upper Elgin Member (interbedded limestone and shale)
Oel = Ordovician Maquoketa Formation, Lower Elgin Member (shale)
Og = Ordovician Galena Group Decorah Formation (limestone)
NA = not applicable

Table 7
List of Appendix I Analytical Parameters and Detection Limits

Compound	MDL (µg/L)	RL (µg/L)	GPS (µg/L)
Metals			
Antimony	0.185	1	6
Arsenic	0.505	2	10
Barium	1.04	2	2000
Beryllium	0.125	1	4
Cadmium	0.0441	0.5	5
Chromium	0.729	5	100
Cobalt	0.0453	0.5	2.1
Copper	2.19	5	1300
Lead	0.324	0.5	15
Nickel	0.929	5	100
Selenium	0.928	5	50
Silver	0.14	1	100
Thallium	0.0644	1	2
Vanadium	0.84	5	35
Zinc	11.5	20	2000
Volatile Organic Compounds			
1,1,1,2-Tetrachloroethane	0.21	1	70
1,1,1-Trichloroethane	0.12	1	200
1,1,2,2-Tetrachloroethane	0.10	1	0.3
1,1,2-Trichloroethane	0.12	1	5
1,1-Dichloroethane	0.21	1	140
1,1-Dichloroethylene	0.15	2	7
1,2,3-Trichloropropane	0.19	1	0.0058
1,2-Dibromo-3-Chloropropane	0.50	5	0.2
1,2-Dibromoethane	0.13	1	0.05
1,2-Dichlorobenzene	0.14	1	600
1,2-Dichloroethane	0.18	1	5
1,2-Dichloropropane	0.87	1	5
1,4-Dichlorobenzene	0.20	1	75
2-Butanone	1.04	10	4000
2-Hexanone	0.20	10	NS
4-Methyl-2-Pentanone	0.22	10	560
Acetone	1.79	10	6300
Acrylonitrile	0.53	5	0.32
Benzene	0.11	0.5	5
Bromochloromethane	0.12	5	90
Bromodichloromethane	0.12	1	80
Bromomethane	0.22	4	10
Carbon Disulfide	0.15	1	700
Carbon Tetrachloride	0.24	2	5
Chlorobenzene	0.19	1	100
Chloroethane	0.15	4	2800
Chloromethane	0.31	3	0
cis-1,2-Dichloroethylene	0.13	1	70
cis-1,3-Dichloropropene	0.15	5	NS

Table 7
List of Appendix I Analytical Parameters and Detention Limits
(Continued)

Compound	MDL (µg/L)	RL (µg/L)	GPS (µg/L)
Dibromochloromethane	0.20	5	80
Dibromomethane	0.18	1	70
Dichloromethane	0.17	5	5
Ethylbenzene	0.21	1	700
Iodomethane	0.80	10	NS
Styrene	0.10	1	100
Tetrachloroethylene	0.18	1	5
Toluene	0.15	1	1000
Trans-1,2-Dichloroethylene	0.21	1	100
Trans-1,3-Dichloropropene	0.22	5	NS
Trans-1,4-Dichloro-2-butene	0.13	10	1.8
Tribromomethane	0.14	5	80
Trichloroethylene	0.19	1	5
Trichlorofluoromethane	0.17	4	2000
Trichloromethane	0.28	1	80
Vinyl Acetate	0.74	10	NS
Vinyl Chloride	0.10	1	2
Xylenes	0.13	3	10000

Notes:

NS = No standard

MDL = Method Detection Limit

RL = Reporting Limit

GPS = Groundwater Protection Standard

Appendix A – Boring Logs and Iowa DNR Monitoring Well / Piezometer Construction Documentation Forms (Form 542-1277)

Appendix

Appendix A-1 – 1973 – Boring Logs and Monitoring Well Construction Documentation

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site					Arch/Engr: H. Gene McKeown & Assoc.	
Location: Section 16-97-7 Winneshiek County, Iowa					Owner: Nishna Sanitary Services, Inc.	
Drill Hole #1	Job No. 30-73-4	Date 11/15/73	Elevation 1207	Datum	Location of Drill Hole Near ER Sta 1	Total Depth 49.0'
Water Level Observation None Encountered		Drill Rig CME 45B	Drilling Method Continuous Flight Augers		Driller D. Kahler	Engineer M. Cerny

Depth, Ft.	Sample Data: Type & No.	N Value Blows/Ft.	Recovery %	I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	Laboratory Data: Water Content, %	Dry Density, pcf	qu tsf	Class. Data
0					Brown, Damp, Clayey Silt, Loess				
6	1207 −29 = 1178				Light Brown, Moist, Clayey Silt, Loess				
18					Rust Brown, Damp, Clayey Sand				
23					Light Brown, Moist, Remolded Clay w/Nodules				
28	28 − 1179				Light Yellow Brown, Dry, Weathered Shale				
31					Light Brown, Dry, Shale w/Intermittant				

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site					Arch/Engr: H. Gene McKeown & Assoc.	
Location: Section 16-97-7 Winneshiek County, Iowa					Owner: Nishna Sanitary Services, Inc.	
Drill Hole #1	Job No. 30-73-4	Date 11/15/73	Elevation	Datum	Location of Drill Hole Near ER Sta 1	Total Depth 49.0'
Water Level Observation None Encountered		Drill Rig CME 45B	Drilling Method Continuous Flight Augers		Driller D. Kahler	Engineer M. Cerny

Depth, ft.	SAMPLE DATA Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	LABORATORY DATA Water Content,%	Dry Density,pcf	qu tsf	Class. Data
40	Sack #1				Light Brown, Dry, Shale w/Intermittant Seams of Limestone (Thin)				
45	Sack #2				Gray, Dry, Shale				
50					AUGER REFUSAL w/FINGER BIT AT 49.0'				
55									
60									

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site					Arch/Engr: H. Gene McKeown & Assoc.	
Location: Section 16-97-7 Winneshiek County, Iowa					Owner: Mishna Sanitary Services, Inc.	
Drill Hole #1A	Job No. 30-73-4	Date 11/16/73	Elevation 1207±	Datum	Location of Drill Hole Near ER Sta 1	Total Depth 30.0'
Water Level Observation None Encountered		Drill Rig CME 45B	Drilling Method Continuous Flight Augers		Driller D. Kahler	Engineer M. Cerny

Depth, ft.	Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	Soil Description and Special Notes	Water Content, %	Dry Density, pcf	qu tsf	Class. Data
0					Brown, Damp, Clayey Silt, Loess				
5	U-1		100	2.87		21.5			
					Moist				
10	U-2		100	2.87		25.3			LL-29 PI-4 A-4(…
15	U-3		100	2.87	Gray, Very Moist, Clayey Silt, Loess	22.7			
20	U-4		100	2.87	Rust Brown, Damp, Gravelly Sand	7.3			Non-Plas… A-1-…
25	U-5		100	2.87	Gray, Moist, Remolded Clay w/Nodules	19.4			LL-29 PI-1… A-6(…
30	U-6		100	2.87	Light Yellow Brown, Dry, Shale	15.0			
					BOTTOM OF HOLE AT 30.0'				

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site					Arch/Engr: H. Gene McKeown & Assoc.		
Location: Section 16-97-7 Winneshiek County, Iowa					Owner: Nishna Sanitary Services, Inc.		
Drill Hole #2	Job No. 30-73-4	Date 11/16/73	Elevation 1160±	Datum	Location of Drill Hole Near ER Sta 1		Total Depth 30.0'
Water Level Observation None Encountered		Drill Rig CME 45B	Drilling Method Continuous Flight Augers			Driller D. Kahler	Engineer M. Cerny

Depth, ft.	Sample Data: Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	Soil Description and Special Notes	Laboratory Data: Water Content, %	Dry Density, pcf	qu tsf	Class.
0					Dark Gray, Silty Clay, Topsoil				
					Light Brown, Silty Clay w/Nodules Colluvium				
10				115'					
10–15	Sack #1				Shale & Limestone Seams (Large)				
15					BOTTOM OF HOLE AT 15.0'				
20									
25									
30									

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site	Arch/Engr: H. Gene McKeown & Assoc.
Location: Section 16-97-7 Winneshiek County, Iowa	Owner: Nishna Sanitary Services, Inc.

Drill Hole #3	Job No. 30-73-4	Date 11/16/73	Elevation 1175±	Datum	Location of Drill Hole Near ER Sta 3	Total Depth 50.0'

Water Level Observation	Drill Rig	Drilling Method	Driller	Engineer
24.5' (Perched Table	CME 45B	Continuous Flight Augers	D. Kahler	M. Carny

Depth, ft.	SAMPLE DATA: Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	LABORATORY DATA: Water Content, %	Dry Density, pcf	qu tsf	Class. Data
					Brown, Damp to Moist, Clayey Silt, Loess				
5	U-1		100	2.87		21.1			LL-2[illegible] PI-[illegible] A-4([illegible]
10	U-2		100	2.87	1175.0 / 24.5 / 1150.5	22.9			
					Reddish Brown, Damp, Sand-Gravel				
15	U-3	Disturbed	100	2.87		2.3			Non-Plast. A-1-[illegible]
					Rust Brown, Damp, Sand				
20	U-4		100	2.87		12.1			Non-Plast. A-2-[illegible]
					Perched Water Table @ 24.5' 1151'				
25	U-5		100	2.87	Gray to Light Yellow Brown, Remolded Clay	26.6			LL-3[illegible] PI-1[illegible] A-6([illegible]
					1146±				
30	U-6		100	2.87	Light Yellow Brown, Dry, Weathered Shale	15.3			

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site				Arch/Engr: H. Gene McKeown & Assoc.		
Location: Section 16-97-7 Winneshiek County, Iowa				Owner: Nishna Sanitary Services, Inc.		
Drill Hole #3	Job No. 30-73-4	Date 11/16/73	Elevation	Datum	Location of Drill Hole Near ER Sta 3	Total Depth 50.0'
Water Level Observation 24.5' (Perched Table)	Drill Rig CME 45B	Drilling Method Continuous Flight Augers			Driller D. Kahler	Engineer M. Cerny

Depth, ft.	SAMPLE DATA Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	LABORATORY DATA Water Content, %	Dry Density, pcf	qu tsf	Class. Data
36–40	Sack #1				Gray, Dry, Shale, Weathered				
40–45					Dense				
45–50	Sack #2				Very Dense				
50					AUGER REFUSAL w/FINGER BIT AT 50.0'				
55									
60									
65									

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site					Arch/Engr: H. Gene McKeown & Assoc		
Location: Section 16-97-7 Winneshiek County, Iowa					Owner: Nishna Sanitary Services, Inc		
Drill Hole #4	Job No. 30-73-4	Date 11/15/73	Elevation 1210	Datum	Location of Drill Hole 250' SW of ER Sta 1		Total Depth 42.5'
Water Level Observation None Encountered		Drill Rig CME 45B 1190		Drilling Method Continuous Flight Augers, "N" Rod & Drilling Mud		Driller D. Kahler	Engineer M. Cerny

Depth, ft.	SAMPLE DATA: Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	LABORATORY DATA: Water Content, %	Dry Density, pcf	qu tsf	Class.
					Brown, Moist, Clayey Silt, Loess				
5	U-1		100	2.87		23.4			
10	U-2		100	2.87		24.2			
					Gray				
15	U-3		100	2.87		21.4			
20	Sack #1				Light Yellow Brown, Dry, Shale				
25	Sack #2								
30	Sack #3								

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

...: Proposed Sanitary Landfill Site	Arch/Engr: H. Gene McKeown & Assoc.
...tion: Section 16-97-7 Winneshiek County, Iowa	Owner: Nishna Sanitary Services, Inc.

...	Job No.	Date	Elevation	Datum	Location of Drill Hole	Total Depth
#4	30-73-4	11/15/73			250' SW of ER Sta 1	42.5'

...r Level Observation	Drill Rig	Drilling Method	Driller	Engineer
None Encountered	CME 45B	Continuous Flight Augers, "N" Rod & Drilling Mud	D. Kahler	M. Cerny

SAMPLE DATA					LABORATORY DATA			
Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	Water Content, %	Dry Density, pcf	qu tsf	Class. Data
Sack #4				Gray, Shale, Very Dense				
Run #1		50		Limestone & Shale				
				BOTTOM OF HOLE AT 42.5'				

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site	Arch/Engr: H. Gene McKeown & Assoc.
Location: Section 16-97-7 Winneshiek County, Iowa	Owner: Nishna Sanitary Services, Inc.

Drill Hole #	Job No.	Date	Elevation	Datum	Location of Drill Hole	Total Depth
5	30-73-4	11/15/73			300'S of ER Sta 1	40.0'

Water Level Observation	Drill Rig	Drilling Method	Driller	Engineer
None Encountered	CME 45B	Continuous Flight Augers	D. Kahler	M. Cerny

Depth, ft.	SAMPLE DATA: Type & No.	SAMPLE DATA: N Value Blows/ft.	SAMPLE DATA: Recovery %	SAMPLE DATA: I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	LABORATORY DATA: Water Content, %	LABORATORY DATA: Dry Density, pcf	LABORATORY DATA: qu tsf	LABORATORY DATA: Class. Data
					Gray, Dry, Shale (Very Dense)				
40					AUGER REFUSAL w/FINGER BIT AT 40.0'				
45									
50									
55									
60									
65									

GEOTECHNICAL SERVICES, INC.
OMAHA, NEBRASKA

Project: Proposed Sanitary Landfill Site	Arch/Engr: H. Gene McKeown & Assoc.
Location: Section 16-97-7 Winneshiek County, Iowa	Owner: Nishna Sanitary Services, Inc

Drill Hole #5	Job No. 30-73-4	Date 11/15/73	Elevation	Datum	Location of Drill Hole 1300'S of ER Sta 1	Total Dep 40.0'

Water Level Observation	Drill Rig	Drilling Method	Driller	Engineer
None Encountered	CME 45B	Continuous Flight Augers	D. Kahler	M. Cerny

	SAMPLE DATA					LABORATORY DATA			
Depth, ft.	Type & No.	N Value Blows/ft.	Recovery %	I. D. Sampler, In	SOIL DESCRIPTION AND SPECIAL NOTES	Water Content, %	Dry Density, pcf	qu tsf	Class.
0					Dark Gray, Moist, Topsoil				
					Light Brown, Damp to Moist, Clayey Silt, Loess				
5									
10									
					Brown, Moist, Remolded Clay				
15									
20									
					Light Brown, Moist, Weathered Shale				
25									
					Light Brown, Dry, Weathered Shale w/Intermittant Seams of Limestone (thin)				
30									
					Gray, Dry, Shale				

Appendix A-2 – 1984 – Boring Logs and Monitoring Well Construction Documentation

GEOTECHNICAL SERVICES, INC.

CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

SALINA, KANSAS; AMES, IOWA;
OMAHA, LINCOLN & GRAND ISLAND, NEBRASKA

PROJECT
Winneshiek County Landfill
LOCATION
Decorah, Iowa
LOCATION OF DRILL HOLE
N. End of Landfill, Approx. 79' E of Pole 5' S of Fence

DRILL HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
1	241CA12	10/4/84			D. Freeman	D. Miller

WATER LEVEL OBSERVATIONS: WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	____ HOURS	TYPE OF SURFACE	DRILL RIG
7'				Corn Field	Mobile B-47

DRILLING METHOD	TOTAL DEPTH
4" Continuous Flight Auger	12.0'

DEPTH, ft	SAMPLE NO. & TYPE	N VALVE BLOWS/ft	RECOVERY, %	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	WATER CONTENT, %	DRY DENSITY, pcf	qu, tsf	CLASSIFICATION SYMBOL
				Black	Dry	Soft	Silty Clay	DEVELOPED ZONE				
				Black/ Brown	Damp	Soft	Silty Clay	TRANSITION ZONE				
				Brown	Damp	Medium Soft	Silty Clay	LOESS				
5				Very Reddish Brown	Damp / Moist	Medium Stiff	Clayey Sand	GLACIAL TILL				
				Reddish Brown	Wet							
10							Sandy Clay					

BOTTOM OF HOLE @ 12.0'

NOTE: Installed groundwater observation Well No. 1 in bore hole. See Groundwater Observation Well Schematic drawing.

GEOTECHNICAL SERVICES, INC.
CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

SALINA, KANSAS; AMES, IOWA;
OMAHA, LINCOLN & GRAND ISLAND, NEBRASKA

PROJECT
Winneshiek County Landfill
LOCATION
Decorah, Iowa
LOCATION OF DRILL HOLE
285'± South of Landfill Entrance

DRILL HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
2	241CA12	10/4/84			D. Freeman	D. Miller

WATER LEVEL OBSERVATIONS: WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	____ HOURS	TYPE OF SURFACE	DRILL RIG
NE	15'			Tall Grass	Mobile B-47

DRILLING METHOD	TOTAL DEPTH
4" Continuous Flight Auger	16.0'

SAMPLE NO. & TYPE	N VALVE BLOWS/ft	RECOVERY, %	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	WATER CONTENT, %	DRY DENSITY, pcf	qu, tsf	CLASSIFICATION SYMBOL
			Brown-Gray	Dry	Hard	Gravel	ROADBED				
			Dark Brown	Damp	Soft	Sandy Silt	TRANSITION ZONE				
			Brown	Damp Moist	Medium Soft	Silty Clay	LOESS				
			Gray with Deep Red Mottles	Moist Wet	Medium Stiff	Silty Clay with Sparse Small Gravel	GLACIAL TILL				

BOTTOM OF HOLE @ 16.0'

NOTE: Installed groundwater observation Well No. 2 in bore hole. See Groundwater Observation Well Schematic drawing.

Appendix A-3 – 1989 – Boring Logs and Monitoring Well Construction Documentation

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-1	2365.0070	7-18-89	1198.8	1158.8	J&R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__ HOURS	Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPT
				Continuous Flight Auger	25'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess		
5		Moist			Glacial Till Increasing clay content with depth		
10					Limestone and shale pebbles throughout Rust staining throughout		
	Rust colored		Loose	Sandy Clay	Heavy Rust Staining		
15	Brown	Wet					
		Moist					
20	Light Brown		Tight	Clay	Sand & Gravel seams throughout Heavy rust staining'		
25	Light Yellow	Dry					

Bottom of Boring at 25'

X

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-1 Date started 7-18-89 Date completed 7 18-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NW S.W?
Distance and direction along boundary

Distance and direction from boundary to well 50' North and 125' E of corner

Elevations (± 0.01 ft. MSL):
Ground surface 1198.87
Top of protective casing 1201.37
Top of well casing 1200.87
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at N.W. corner of site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, Iowa 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 22'
Outside casing diameter 2¼"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 22'

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume

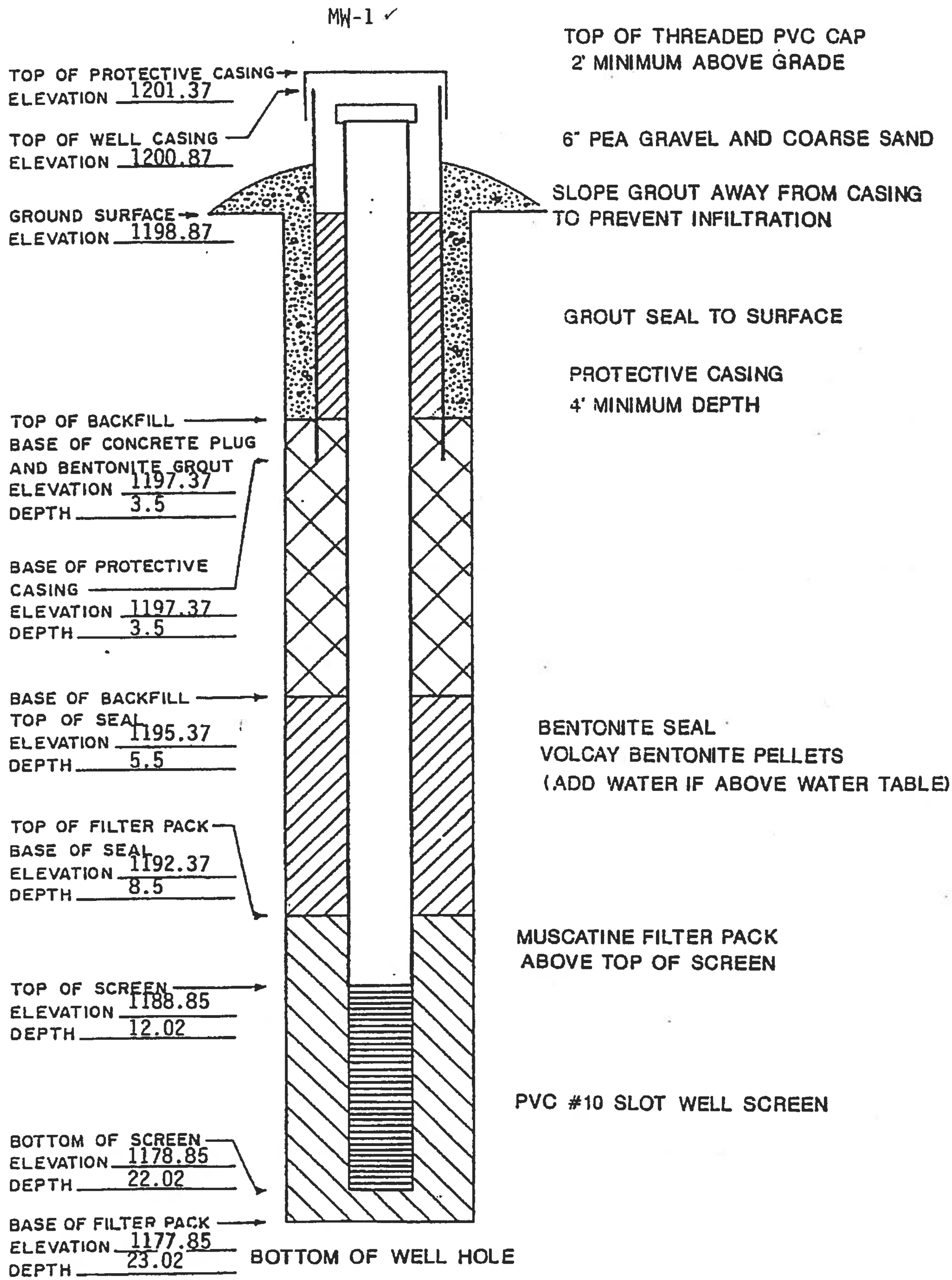
Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume

Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 1180.27
Stabilization time
Well development method Air Jetting

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study)
Average depth of frostline 3'



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-1	
Dates Started 7-18-89	**Date Completed** 7-18-89

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site S.W.	J&R Drilling
Distance & direction along boundary	7922 N.W. 114th
Distance & direction from boundary to well 50' N & 125' E of corner	Grimes, Iowa 50011
Elevations (± 0.01 ft. MSL):	**Name of driller** R. Coons
Ground Surface 1198.87	**Drilling method** Continuous Flight Auger
Top of protective casing 1201.37	**Drilling fluid**
Top of well casing 1200.87	**Bore Hole diameter** 6.00 inches
Benchmark elevation 1158.80	**Soil sampling method** Split Spoon
Benchmark description Second spike in power pole at N.W. corner of site	**Depth of boring** 25 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	**Placement method** Tremie Tube
Length of casing 14 feet	**Volume**
Outside casing diameter 2.5 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	**Material** Neat Cement
Casing joint type Threaded	**Placement method** Tremie Tube
Casing/screen joint type Threaded	**Volume**
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	**Material of protective casing:** Steel
Screen length 10 feet	**Material of grout between protective casing and well casing:** Kwikcrete
Depth of Well 22 feet BGS	**Protective cap:**
Filter Pack:	**Material** Steel
Material Muscatine Sand	**Vented?: Y/N** Y **Locking?: Y/N** Y
Grain Size #1	**Well cap:**
Volume	**Material** PVC
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N** Y
Material Bentonite Pellets	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level 1180.27	**Stabilization time**
Well development method Air Jetting	
Average depth of frostline 3 feet BGS	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

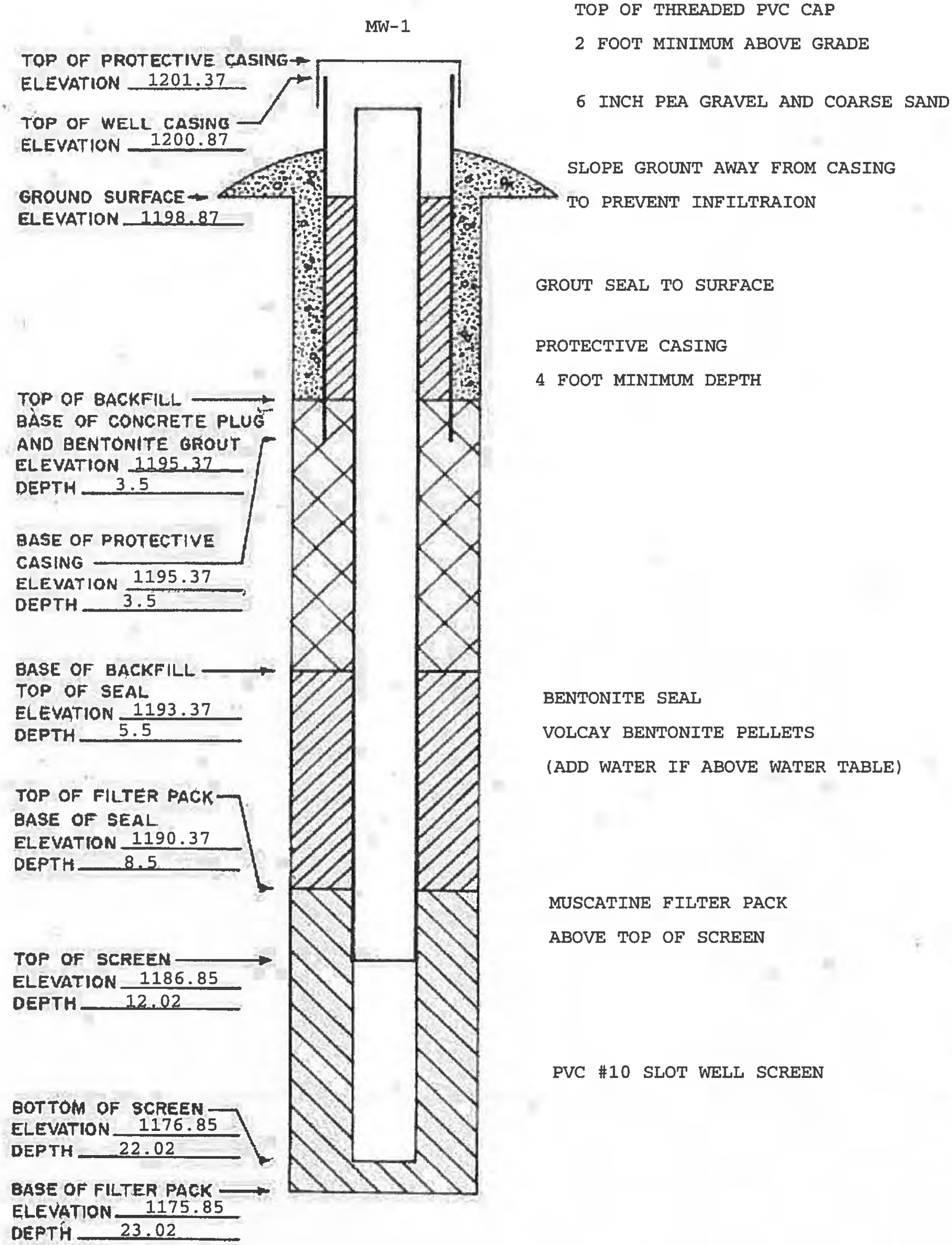
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

Revised 9/05 Form # 542-1277

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Center of West side of Landfill

MW-2

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-2	2365.0070	7-20-89	1186.6	1158.8	J & R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__HOURS	Field	Diedrich D-50
				DRILLING METHOD	**TOTAL DEPTH**
13'	13'			Continuous Flight Auger	15.5'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess		
5		Moist			Glacial Till		
			Tight		Fractured- Moisture in Fractures		
10							
					Limestone Seam at 13.0'		
	Yellow	Wet		Clay			
15							
	Bottom of Boring at 15.5'						

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LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Center of West side of Landfill

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-2	2365.0070	7-20-89	1186.6	1158.8	J & R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS	Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPTH
13'	13'			Continuous Flight Auger	15.5'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0–5	Brown	Dry	Loose	Silty Clay	Loess		
5		Moist			Glacial Till		
			Tight		Fractured-Moisture in Fractures		
10							
	Yellow	Wet		Clay	Limestone Seam at 13.0'		
15							
	Bottom of Boring at 15.5'						

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Center of West Side of Landfill

MW-2

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-17	2365.0070	12-14-89			J&R Drilling	S.L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__HOURS	Field	CME
				DRILLING METHOD	TOTAL DEPTH
				Continuous Flight Auger & Air Rotary	45'

DEPTH (ft.)	SAMPLE DESCRIPTION					SAMPLE DATA	
	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	REMARKS
				Refer to Log of Soil Boring SB-2			
15	Yellow Brown	Moist	Tight	Clay	Sand Seams Throughout		
20	Gray				Fractures in Till		
25							
30		Wet					
35	Gray	Dry	Hard	Shale			

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-17	2365.0070	12-14-89			J&R Drilling	S.L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION: COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	SAMPLE DATA: NUMBER & TYPE	OVA/H•NU READING (ppm) 0 500 1000	DEPTH (ft.)
	Gray	Dry	Hard	Shale				
							Bottom of Boring at 45'	

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-2 Date started 7-20-89 Date completed 7-20-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site SW
Distance and direction along boundary

Distance and direction from boundary to well 630' East and 12' North of Corner

Elevations (± 0.01 ft. MSL):
Ground surface 1186.57
Top of protective casing 1189.07
Top of well casing 1188.57
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at N.W. Corner of site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 18.7'
Outside casing diameter 2½"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 18.7'

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume

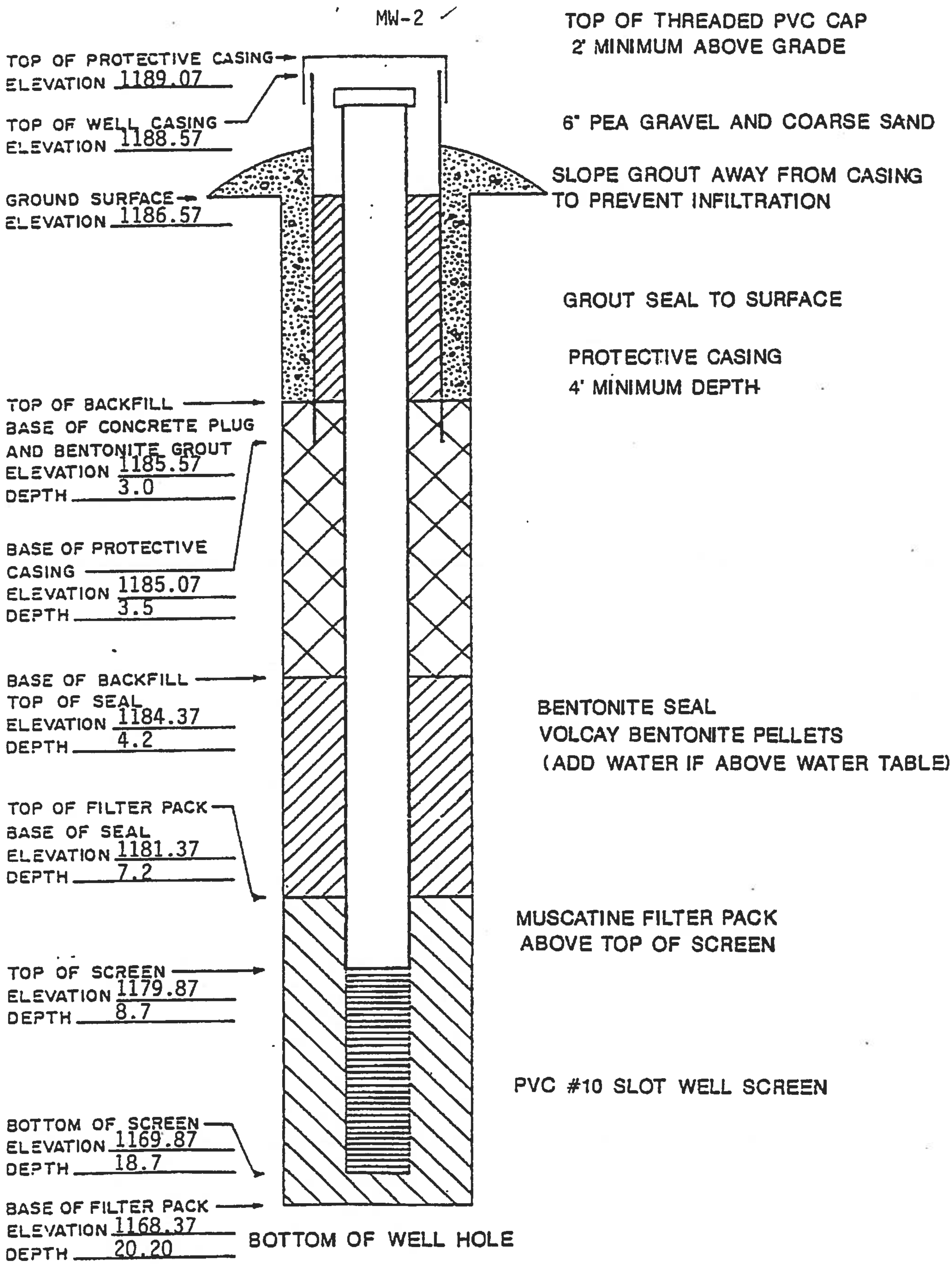
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) DRY
Stabilization time
Well development method

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) Downgradient
Average depth of frostline 3'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-2	
Dates Started 7-20-89	**Date Completed** 7-20-89

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site S.W.	J&R Drilling
Distance & direction along boundary	7922 N.W. 114th
Distance & direction from boundary to well 630' E & 12' N of corner	Grimes, Iowa 50011
Elevations (± 0.01 ft. MSL):	**Name of driller** R. Coons
Ground Surface 1186.57	**Drilling method** Continuous Flight Auger
Top of protective casing 1189.07	**Drilling fluid**
Top of well casing 1188.57	**Bore Hole diameter** 6.00 inches
Benchmark elevation 1158.80	**Soil sampling method** Split Spoon
Benchmark description Second spike in power pole at N.W. corner of site	**Depth of boring** 25 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	**Placement method** Tremie Tube
Length of casing 10.7 feet	**Volume**
Outside casing diameter 2.5 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	**Material** Neat Cement
Casing joint type Threaded	**Placement method** Tremie Tube
Casing/screen joint type Threaded	**Volume**
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	**Material of protective casing:** Steel
Screen length 10 feet	**Material of grout between protective casing and well casing:** Kwikcrete
Depth of Well 18.7 feet BGS	**Protective cap:**
Filter Pack:	**Material** Steel
Material Muscatine Sand	**Vented?: Y/N** Y **Locking?: Y/N** Y
Grain Size #1	**Well cap:**
Volume	**Material** PVC
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N** Y
Material Bentonite Pellets	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level DRY	**Stabilization time**
Well development method	
Average depth of frostline 3 feet BGS	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

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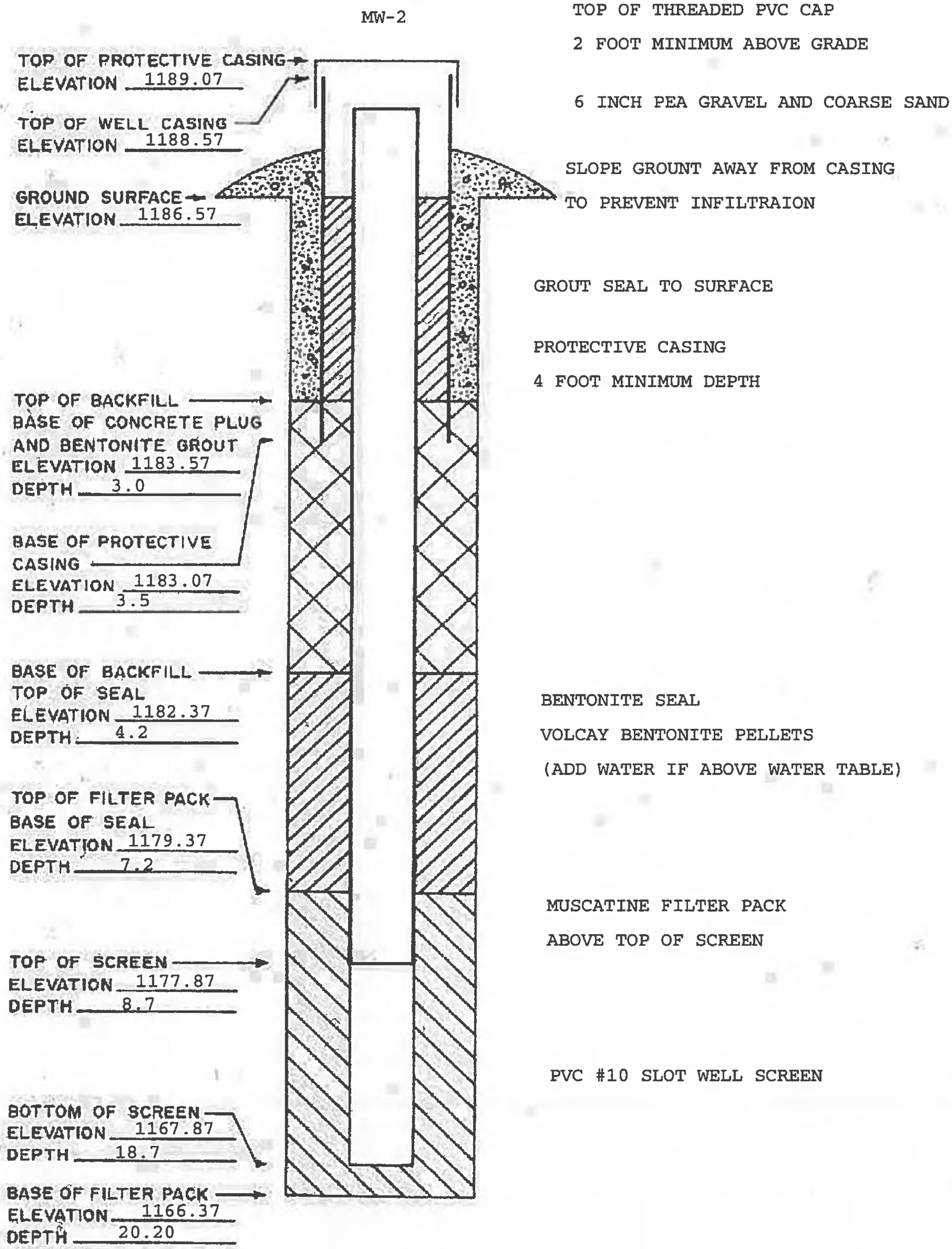
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL
DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Northwest Corner of Landfill

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-3	2365.0070	7-20-89	1160.8	1158.8	J & R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__HOURS	Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPTH
28'	28'			Continuous Flight	34

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess		
5							
		Moist	Tight	Silty Clay	Glacial Till		
10							
					Limestone Seam at 12.5'		
15							
		Wet	Loose	Sandy Clay	Heavy Rust Staining		
20							
	Gray	Moist		Clay	Pebbles throughout		
25							

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-3	2365.0070	7-20-89			J & R Drilling	S.L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION: COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	SAMPLE DATA: NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Gray	Moist		Clay			
					Wet at 28'		
30							
35				Bottom of Boring 34'			

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-3 Date started 7-21-89 Date completed 7-21-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NW
Distance and direction along boundary ______

Distance and direction from boundary to well 8' East and 330' south of NW Corner

Elevations (± 0.01 ft. MSL):
Ground surface 1160.84
Top of protective casing 1163.34
Top of well casing 1162.84
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW Corner of Site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 36.9'
Outside casing diameter 2⅛"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 36.9

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume ______

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume ______

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume ______

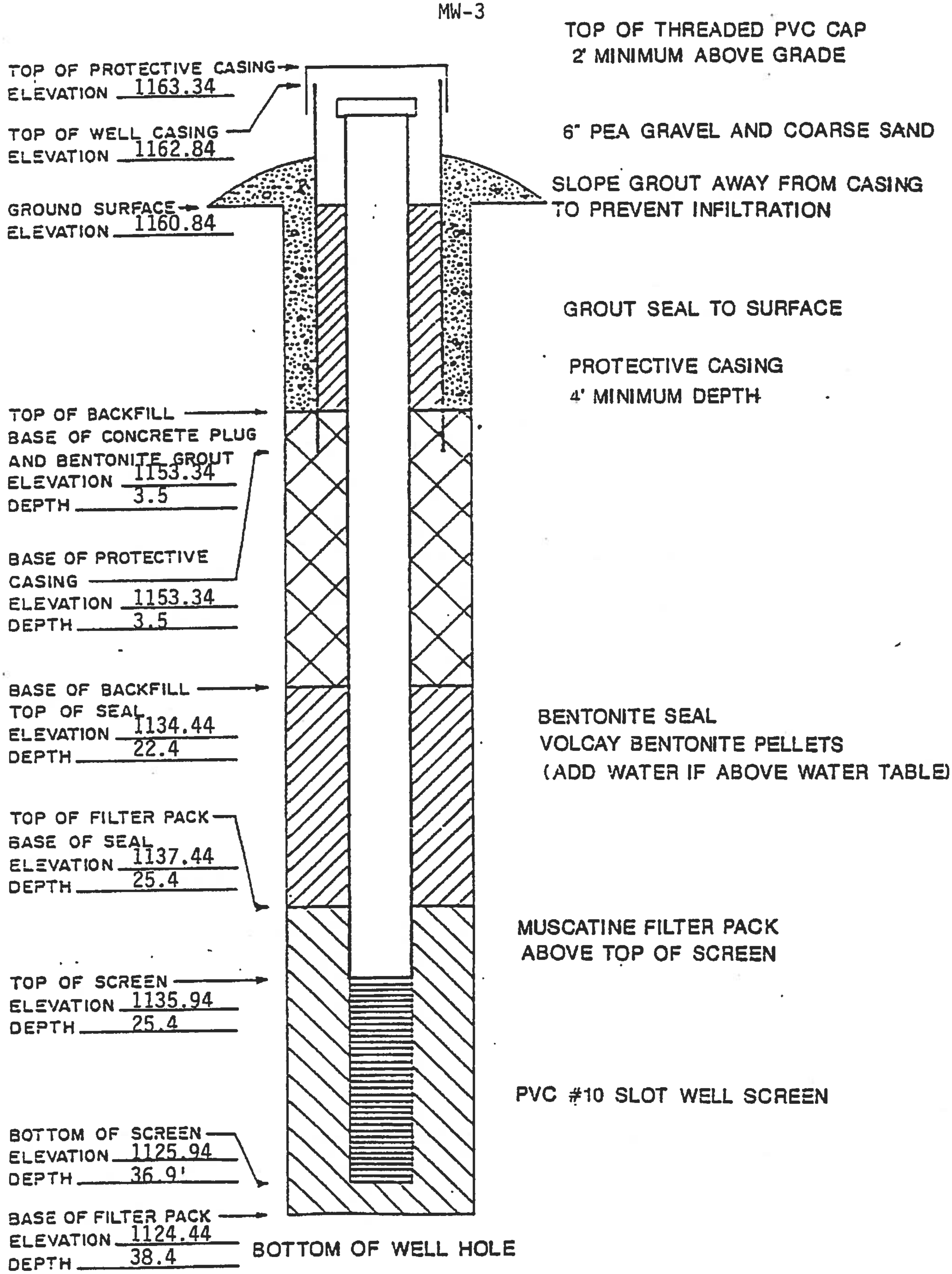
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 1137.49
Stabilization time ______
Well development method Air Jetting

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) ______
Average depth of frostline 3.0'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-3	
Dates Started 7-21-89	**Date Completed** 7-21-89

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site N.W.	J&R Drilling
Distance & direction along boundary	7922 N.W. 114th
Distance & direction from boundary to well 8'E & 330'S of NW corner	Grimes, Iowa 50011
Elevations (± 0.01 ft. MSL):	Name of driller R. Coons
Ground Surface 1160.84	Drilling method Continuous Flight Auger
Top of protective casing 1163.34	Drilling fluid
Top of well casing 1162.84	Bore Hole diameter 6.00 inches
Benchmark elevation 1158.80	Soil sampling method Split Spoon
Benchmark description Second spike in power pole at N.W. corner of site	Depth of boring 38.4 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	Placement method Tremie Tube
Length of casing 27.4 feet	Volume
Outside casing diameter 2.5 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	Material Neat Cement
Casing joint type Threaded	Placement method Tremie Tube
Casing/screen joint type Threaded	Volume
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	Material of protective casing: Steel
Screen length 10 feet	Material of grout between protective casing and well casing: Kwikcrete
Depth of Well 36.9 feet BGS	**Protective cap:**
Filter Pack:	Material Steel
Material Muscatine Sand	Vented?: Y/N Y Locking?: Y/N Y
Grain Size #1	**Well cap:**
Volume	Material PVC
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N Y
Material Bentonite Pellets	

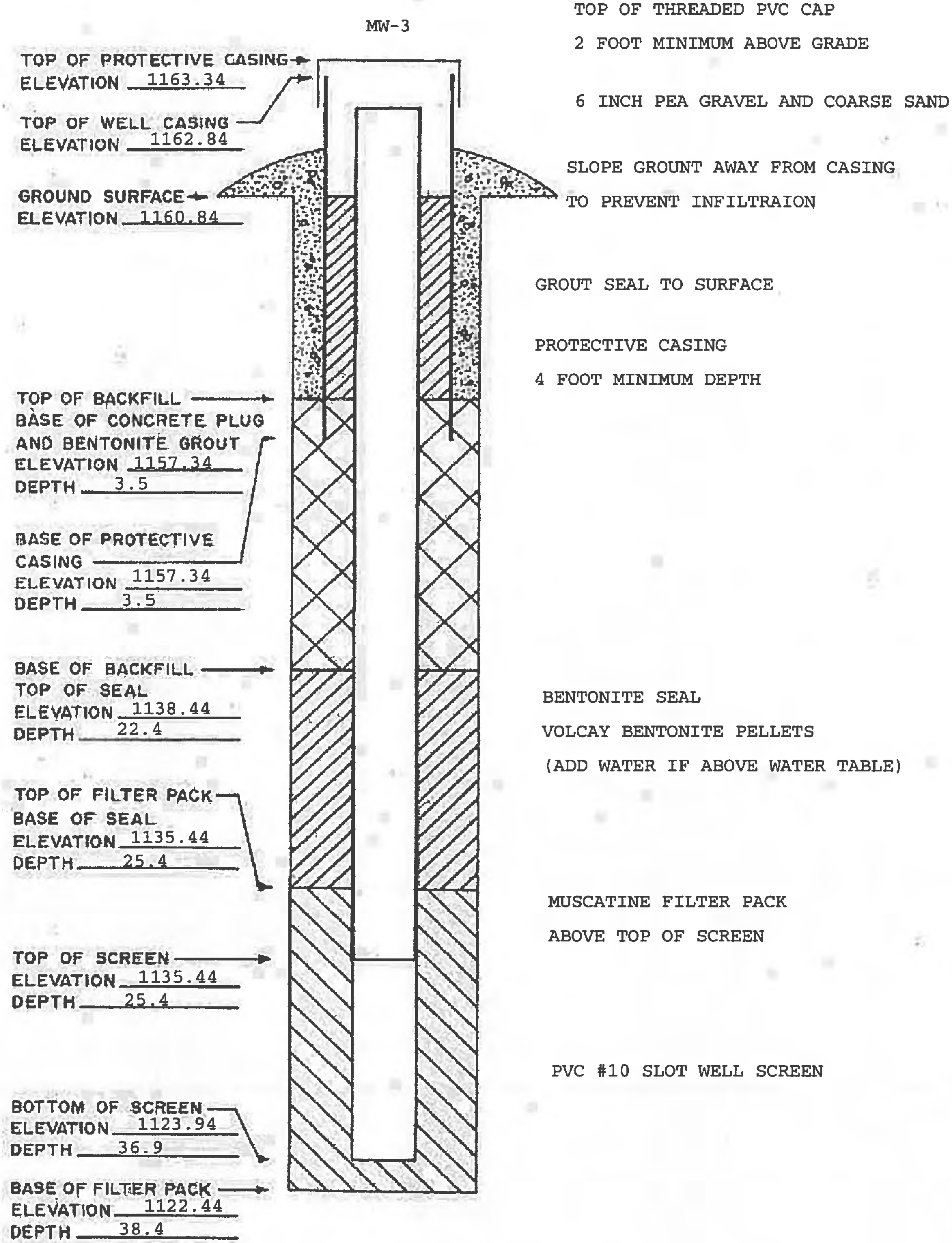
D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level 1137.49	Stabilization time
Well development method Air Jetting	
Average depth of frostline 3 feet BGS	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL
DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Center of North Side of Landfill

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-4	2365.0070	7-19-89	1178.5	1158.8	J & R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__HOURS	Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPTH
30'	30'	26'		Continuous Flight Auger	42'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0	Brown	Dry	Loose	Silty Clay	Loess Root Hairs		
5							
9		Moist	Tight	Silty Clay	Glacial Till		
10							
14.5			Loose	Sandy Clay	Rust staining throughout Sand seams throughout Thin limestone layers		
15							
20							
25							

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-4	2365.0070	7-19			J&R Drilling	S.L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION: COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	SAMPLE DATA: NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Moist	Loose	Sandy Clay	Rust staining throughout Sand seams throughout Limestone fragments		
30							
35		Wet					
40							
	Bottom of Boring 42.0'						

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-4 Date started 7-20-89 Date completed 7-21-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NW
Distance and direction along boundary

Distance and direction from boundary to well 7' south and 563' east of NW corner

Elevations (± 0.01 ft. MSL):
Ground surface 1178.52
Top of protective casing 1181.02
Top of well casing 1180.52
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 44.7'
Outside casing diameter 2½"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 44.7'

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume

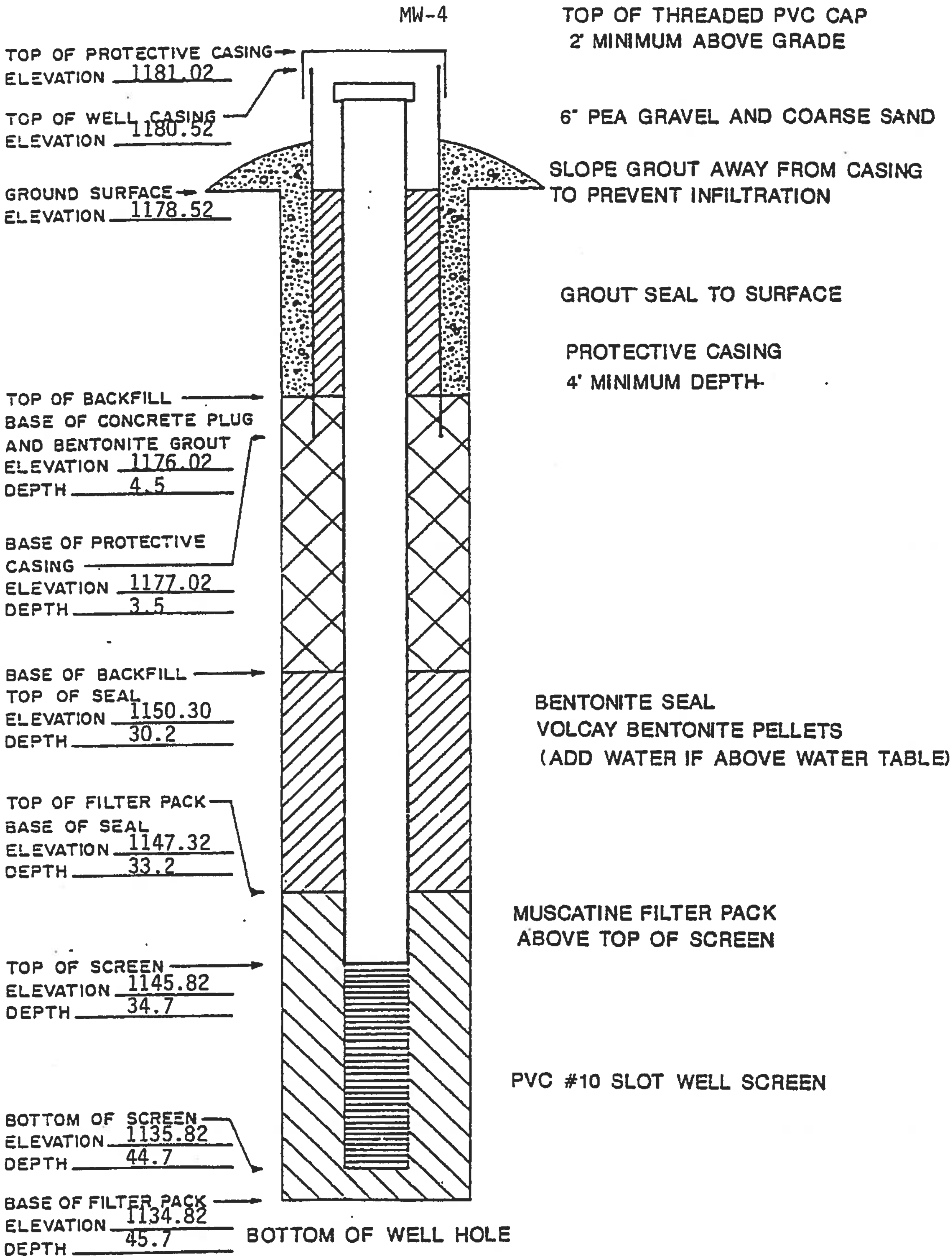
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 1141.13'
Stabilization time
Well development method Air Jetting

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study)
Average depth of frostline 3.0'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-4	
Dates Started 7-20-89	**Date Completed** 7-21-89

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site N.W.	J&R Drilling
Distance & direction along boundary	7922 N.W. 114th
Distance & direction from boundary to well 7'S & 563'E of NW corner	Grimes, Iowa 50011
Elevations (± 0.01 ft. MSL):	**Name of driller** R. Coons
Ground Surface 1178.52	**Drilling method** Continuous Flight Auger
Top of protective casing 1181.02	**Drilling fluid**
Top of well casing 1180.52	**Bore Hole diameter** 6.00 inches
Benchmark elevation 1158.80	**Soil sampling method** Split Spoon
Benchmark description Second spike in power pole at N.W. corner of site	**Depth of boring** 45.7 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	Placement method Tremie Tube
Length of casing 36.7 feet	Volume
Outside casing diameter 2.5 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	Material Neat Cement
Casing joint type Threaded	Placement method Tremie Tube
Casing/screen joint type Threaded	Volume
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	Material of protective casing: Steel
Screen length 10 feet	Material of grout between protective casing and well casing: Kwikcrete
Depth of Well 44.7 feet BGS	**Protective cap:**
Filter Pack:	Material Steel
Material Muscatine Sand	Vented?: Y/N Y Locking?: Y/N Y
Grain Size #1	**Well cap:**
Volume	Material PVC
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N Y
Material Bentonite Pellets	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level 1141.13	**Stabilization time**
Well development method Air Jetting	
Average depth of frostline 3 feet BGS	

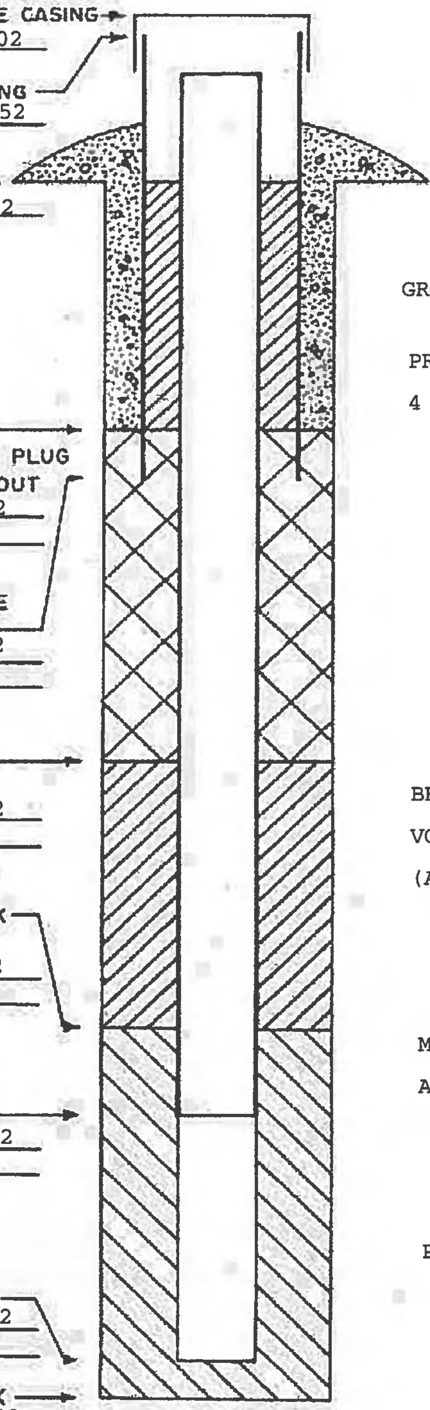
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL
DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-4



TOP OF PROTECTIVE CASING
ELEVATION 1181.02

TOP OF WELL CASING
ELEVATION 1180.52

GROUND SURFACE
ELEVATION 1178.52

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1174.02
DEPTH 4.5

BASE OF PROTECTIVE CASING
ELEVATION 1175.02
DEPTH 3.5

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1148.32
DEPTH 30.2

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1145.32
DEPTH 33.2

TOP OF SCREEN
ELEVATION 1143.82
DEPTH 34.7

BOTTOM OF SCREEN
ELEVATION 1133.82
DEPTH 44.7

BASE OF FILTER PACK
ELEVATION 1132.82
DEPTH 45.7

TOP OF THREADED PVC CAP
2 FOOT MINIMUM ABOVE GRADE

6 INCH PEA GRAVEL AND COARSE SAND

SLOPE GROUNT AWAY FROM CASING
TO PREVENT INFILTRAION

GROUT SEAL TO SURFACE

PROTECTIVE CASING
4 FOOT MINIMUM DEPTH

BENTONITE SEAL
VOLCAY BENTONITE PELLETS
(ADD WATER IF ABOVE WATER TABLE)

MUSCATINE FILTER PACK
ABOVE TOP OF SCREEN

PVC #10 SLOT WELL SCREEN

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Northeast Boundary of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-5	2365.0070	7-19-89	1155.9	1158.8	J&R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__HOURS	Corn Field	Diedrich D-50
				DRILLING METHOD	**TOTAL DEPTH**
				Continuous Flight Auger	16'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess		
5		Moist		Silty Clay	Glacial Till Rust Staining		
10			Loose	Sandy Clay	Sand Seams throughout Heavy rust staining		
15	Yellow			Clay			
	Bottom of Boring 16.0'						

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-5 Date started 7-20-89 Date completed 7-20-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NE
Distance and direction along boundary

Distance and direction from boundary to well 398 Feet West and 335 feet south of NE corner

Elevations (± 0.01 ft. MSL):
Ground surface 1155.93
Top of protective casing 1158.43
Top of well casing 1157.93
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 19.9
Outside casing diameter 2½"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 19.9

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume

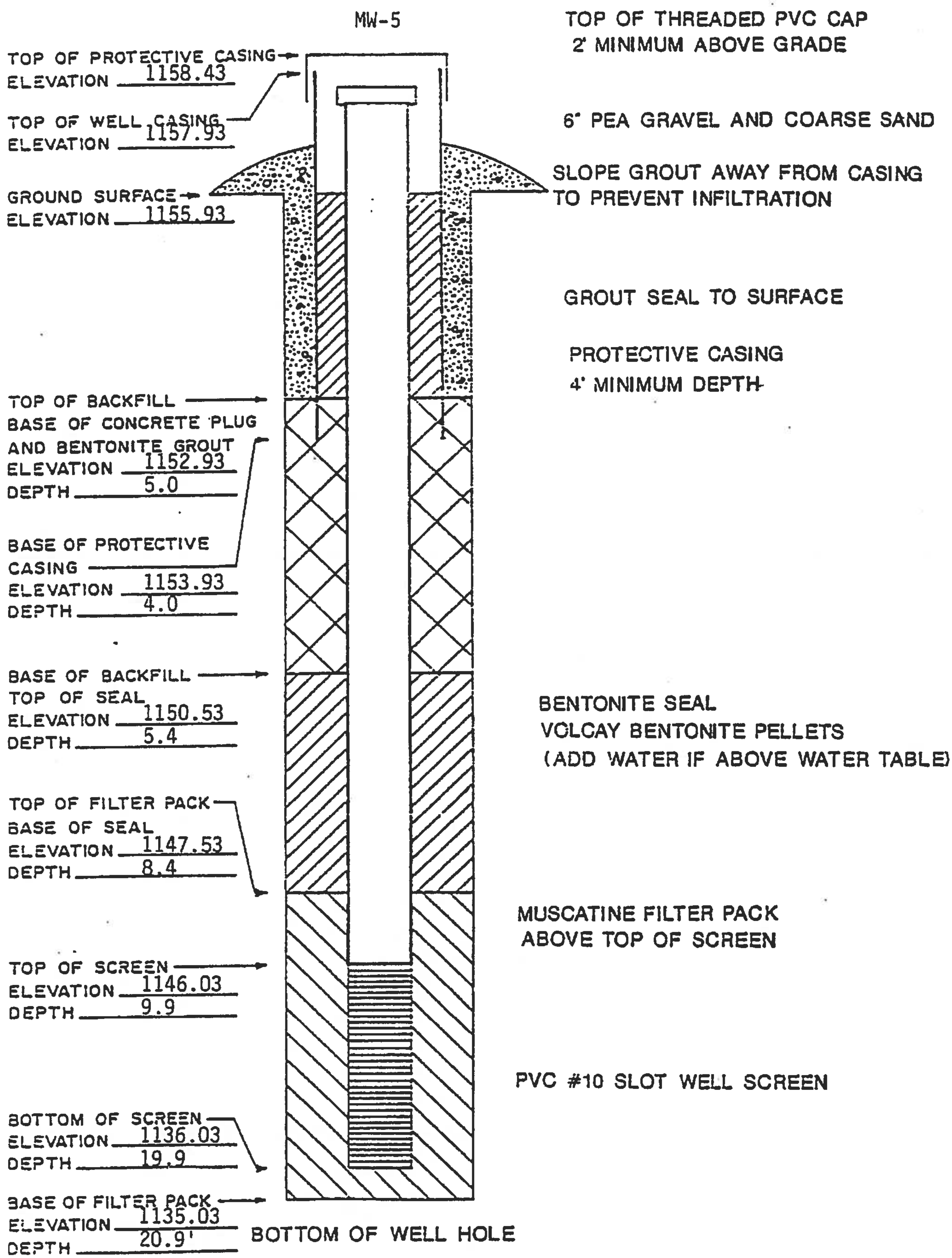
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) Dry
Stabilization time
Well development method

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study)
Average depth of frostline 3.0'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
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DES MOINES, IOWA

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11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Northeast Boundary of fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-6	2365.0070	7-19-89	1156.0	1158.8	J&R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS	Corn Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPTH
		34.5'		Continuous Flight Auger	39'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess Rust staining		
5		Moist			Glacial till Rust staining		
10			Loose	Sandy Clay	Heavy rust staining Sand & gravel throughout		
	Yellow		Tight	Clay	Slight Rust staining Limestone and weathered shale seam at 13.5'		
15							
	Gray	Dry	Dense	Shale			
20							
25							

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-6	2365.0070	7-19=89			J&R Drilling	S.L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION					SAMPLE DATA	
	COLOR	MOIS-TURE	CONSIS-TENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Gray	Dry	Dense	Shale			
30							
35							
				Limestone			
40							

Bottom of Boring at 39.0'

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-6 Date started 7-20-89 Date completed 7-20-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NE
Distance and direction along boundary ___

Distance and direction from boundary to well 400 feet and 335 feet south of NE corner

Elevations (± 0.01 ft. MSL):
Ground surface 1156.04
Top of protective casing 1158.54
Top of well casing 1158.04
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 36.5''
Outside casing diameter 2¼"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 36.5'

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume ___

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume ___

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume ___

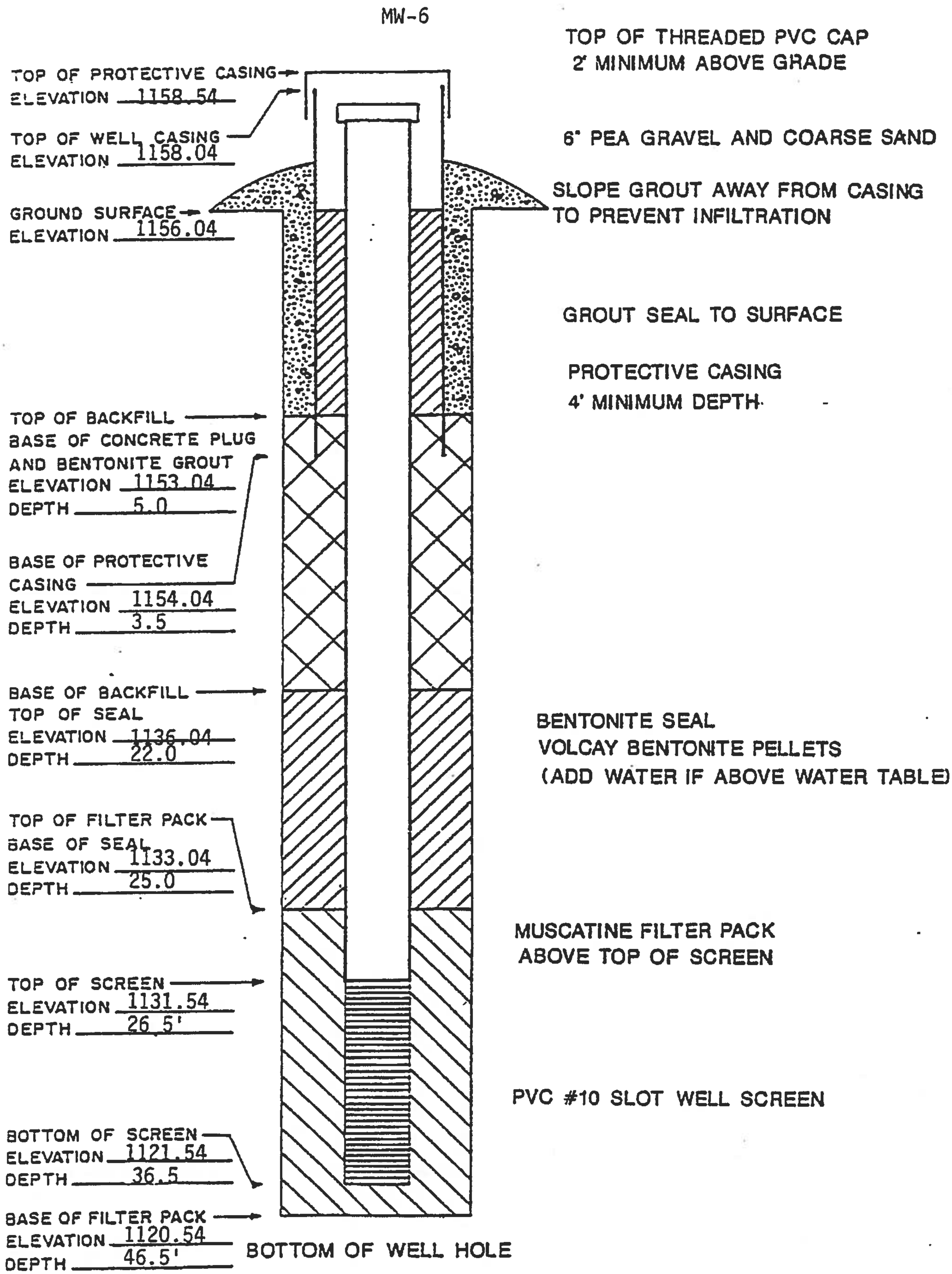
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 1129.16
Stabilization time ___
Well development method Air Jetting

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) ___
Average depth of frostline 3.0'

MW-6



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
East Central Boundary of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-7	2365.0070	7-19-89	1177.2	1158.8	J&R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS	Corn Field	Diedrich D-50
				DRILLING METHOD	**TOTAL DEPT**
				Continuous Flight Auger	45.5'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess		
5		Moist		Silty Clay	Glacial Till Bands of Rust Staining		
10	Yellow		Tight	Clay	Glacial Till		
		Dry		Shale with weathered limestone seams			
15							
20							
	Gray	Dry	Dense	Shale			
25							

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-7	2365.0070	7-19-89			J&R Drilling	Sheryl L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION: COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	SAMPLE DATA: NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Gray	Dry	Dense	Shale			
30							
35							
40							
45				Limestone			
			Bottom of Boring 45.5				

MONITORING WELL / PIEZOMETER CONSTRUCTION
DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-7 Date started 7-19-89 Date completed 7-20-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NE
Distance and direction along boundary

Distance and direction from boundary to well 398 feet west and 880 feet south of NE corner

Elevations (± 0.01 ft. MSL):
Ground surface 1177.18
Top of protective casing 1179.68
Top of well casing 1179.18
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 25.5'
Outside casing diameter 2¼"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 25.5

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume

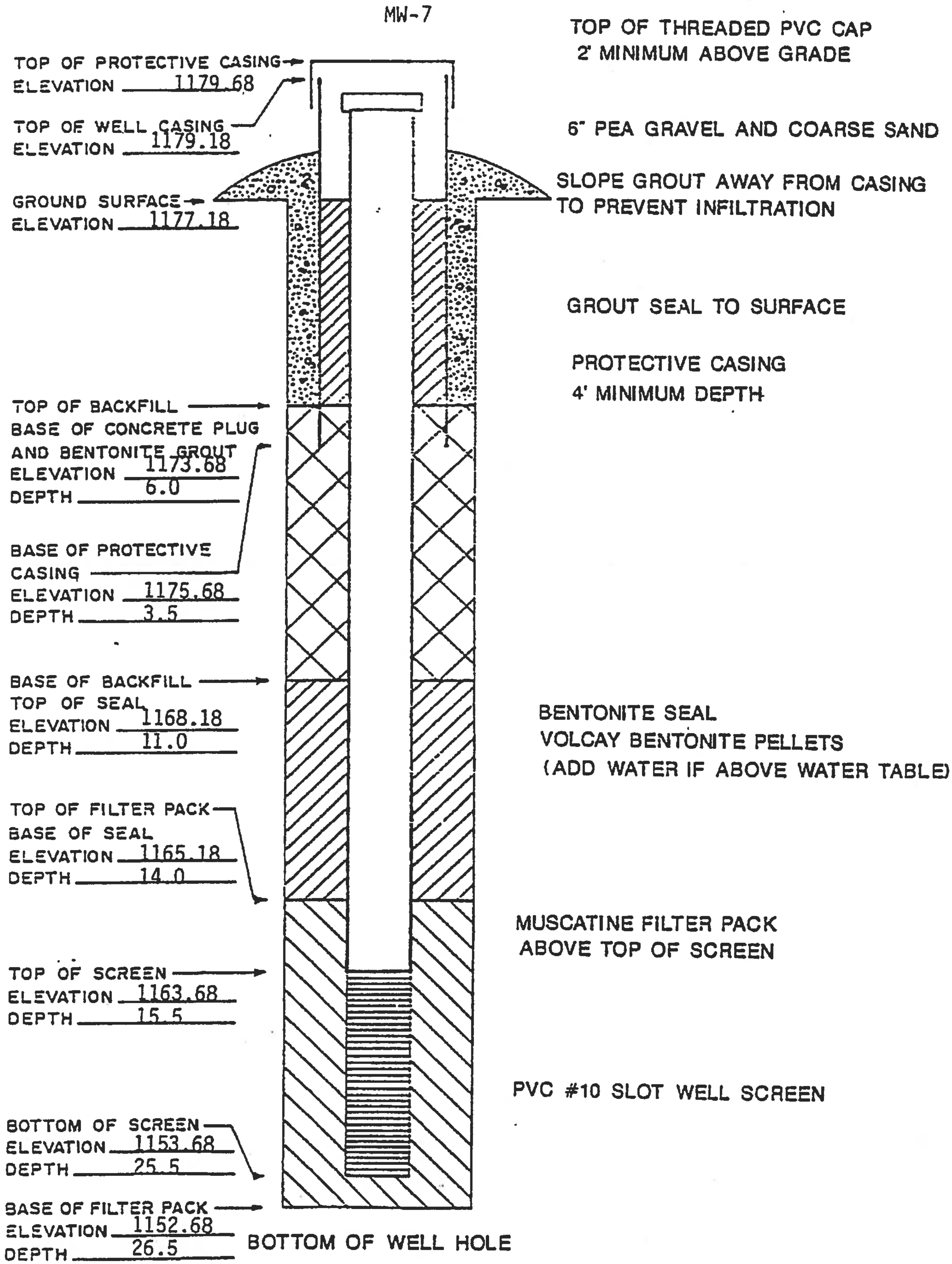
Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume

Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) Dry
Stabilization time
Well development method

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study)
Average depth of frostline 3.0'



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Along East Central Boundary of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-8	2365.0070	7-19-89	1162.5	1158.8	J&R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS	Corn Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPTH
				Continuous Flight Auger	40'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess		
		Moist		Slightly Silty Clay	Glacial Till Slight Rust Staining Limestone Pebbles at 7.5'		
5							
10	Light Yellow						
15							
20	Gray		Dense	Shale			
25							

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-8	2365.0070	7-19-89			J&R Drilling	Sheryl L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION					SAMPLE DATA	
	COLOR	MOIS-TURE	CONSIS-TENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Gray		Dense	Shale			
30							
35							
40				Limestone			
			Bottom of Boring 40'				
45							

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-8 Date started 7-20-89 Date completed 7-20-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NE
Distance and direction along boundary ______
Distance and direction from boundary to well 398 feet west and 1115 feet south of NE corner

Elevations (± 0.01 ft. MSL):
Ground surface 1162.52
Top of protective casing 1165.02
Top of well casing 1164.52
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 28.0'
Outside casing diameter 2¼"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 28.0'

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume ______

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume ______

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume ______

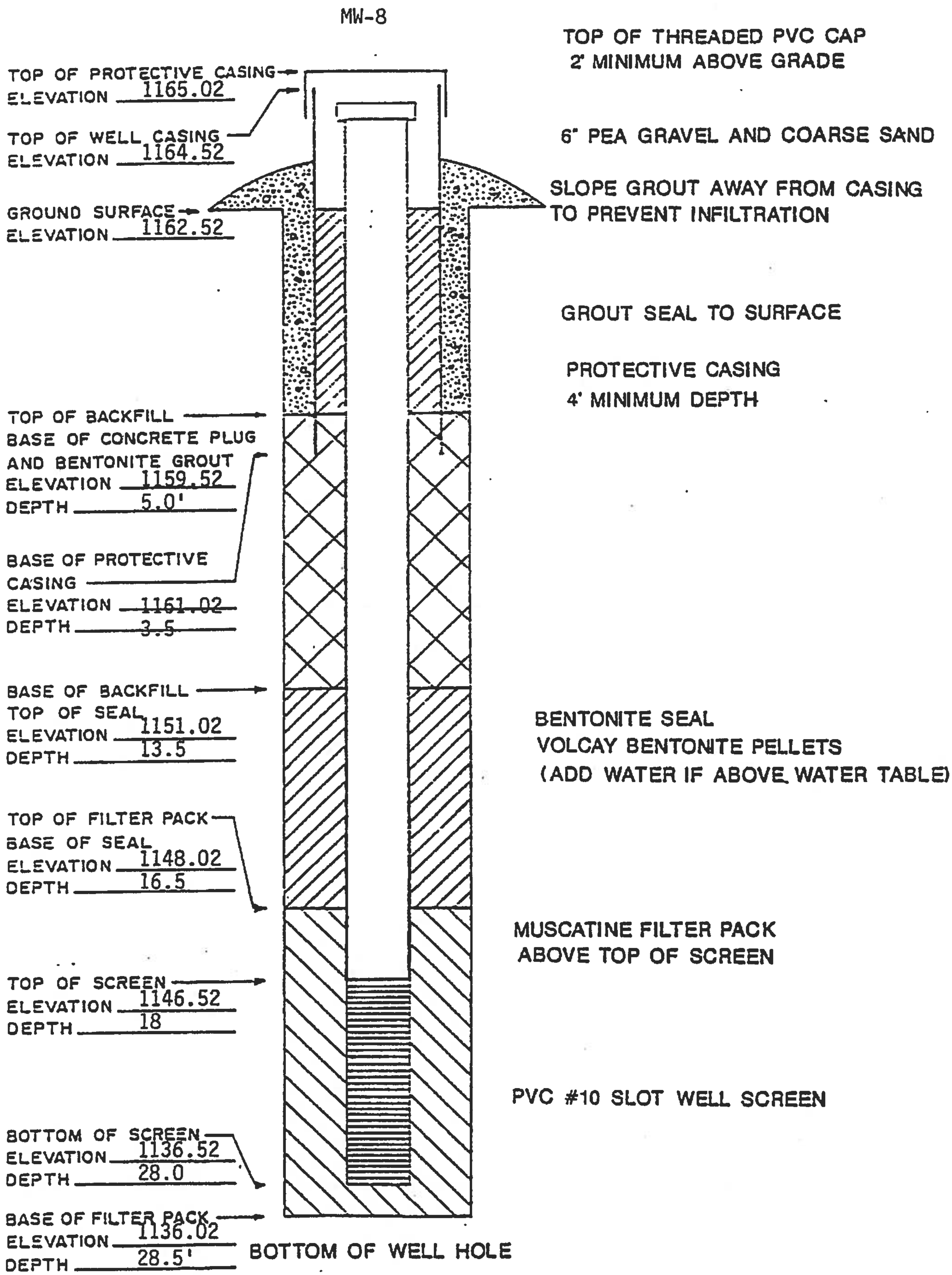
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 1151.18
Stabilization time ______
Well development method Air Jetting

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) ______
Average depth of frostline 3.0'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Southeast Corner of fill area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-9	2365.0070	7-17-89	1186.2	1158.8	J&R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS	Field	Diedrich D-5
				DRILLING METHOD	**TOTAL DEP**
				Hollow Stem Auger	28'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0–5	Brown	Dry	Loose	Silty Clay	Loess Root Hairs Lower 4" has increasing clay		
5	White			Limestone	Weathered		
	Yellow		Tight	Silty Clay	Shale partings Rust staining Limestone pebbles throughout Glacial Till		
10		Moist					
		Dry		Shale	Weathered limestone seams throughout		

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-9	2365.0070	7-17-89			J&R Drilling	Sheryl L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION					SAMPLE DATA	
	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
28	Yellow	Dry		Shale	Weathered limestone seams		

Bottom of Boring at 28.0'

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-9 Date started 7/17/89 Date completed 7/17/89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site SE
Distance and direction along boundary ____

Distance and direction from boundary to well 85' East and 9' north of SE corner

Elevations (± 0.01 ft. MSL):
Ground surface 1186.19
Top of protective casing 1188.69
Top of well casing 1188.19
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site.

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 26.6
Outside casing diameter 2¼"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 26.6'

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume ____

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume ____

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume ____

Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) Dry
Stabilization time ____
Well development method ____

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) ____
Average depth of frostline 3.0'

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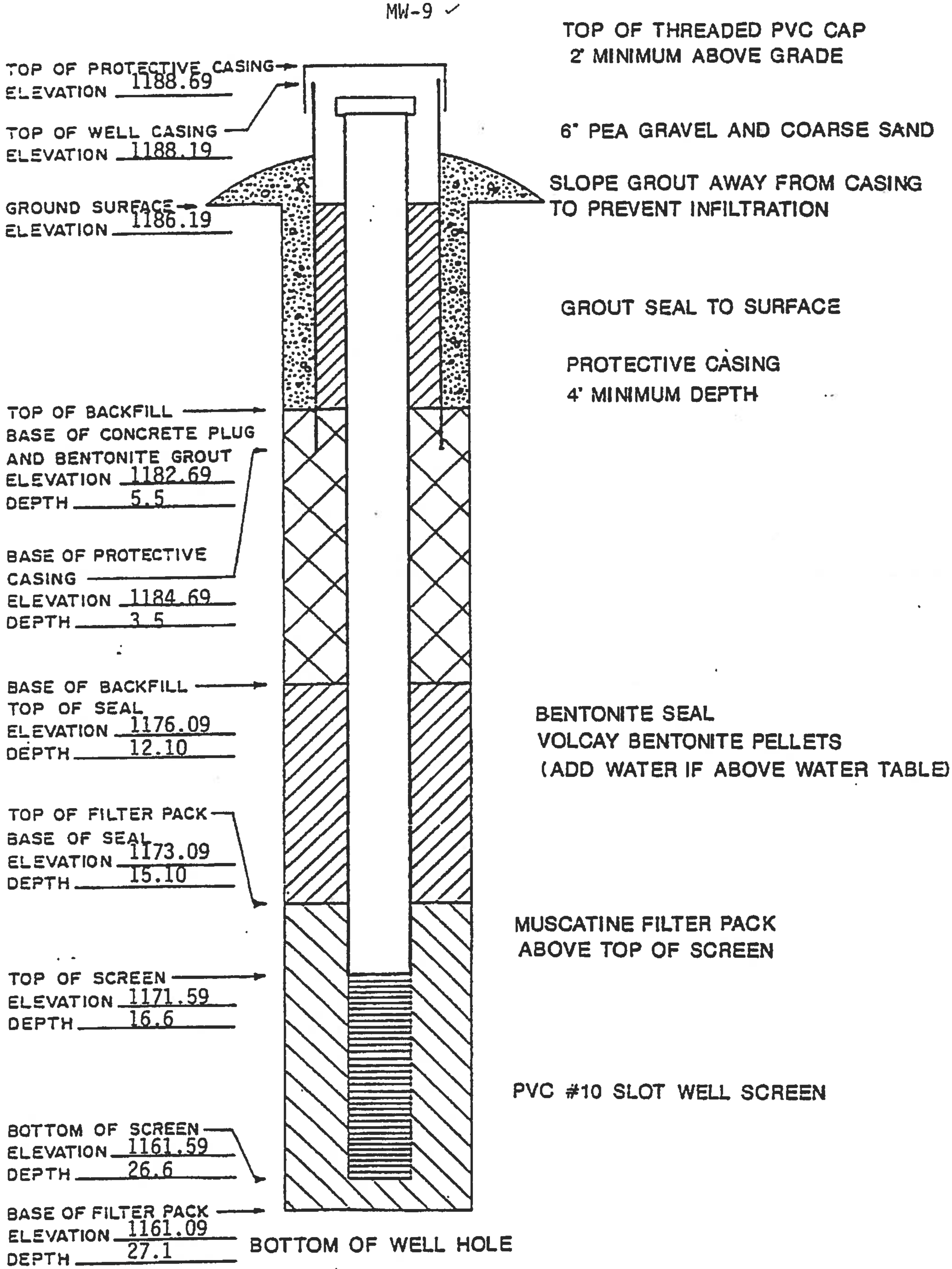
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

MW-9 ✓



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Center of Southern Boundary of fill ar

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-10	2365.0070	7-18-89	1215.7	1158.8	J&R Drilling	Sheryl L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__ HOURS	Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPT
				Continuous Flight Auger	17'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0–6.5	Light Brown	Dry	Loose	Silty Clay	Loess Slight rust Staining		
6.5–15.5		Dry (Moist from 9.5)		Silty Clay	Glacial Till Increasing clay clay content with depth		
15.5–16.5	Brown	Moist		Clay	Limestone Pebbles throughout		
16.5–17.0	Yellow	Dry		Shale and weathered limestone seams	Heavy Rust staining along interface of limestone & clay		

Bottom of Boring at 17.0'

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-10 Date started 7-18-89 Date completed 7-18-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site SW
Distance and direction along boundary ____

Distance and direction from boundary to well 630 feet East and 11 feet north of SW corner

Elevations (± 0.01 ft. MSL):
Ground surface 1215.70
Top of protective casing 1218.20
Top of well casing 1217.70
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site.

B. Soil Boring Information

Name and address of construction company J&R Drilling
7922 N.W. 114th
Grimes, IA 50011
Name of driller R. Coons
Drilling method Continuous Flight Auger
Drilling fluid --
Bore hole diameter 6.00"
Soil sampling method Split Spoon
Depth of boring 25'

C. Monitoring Well Installation

Casing material PVC
Length of casing 16.0'
Outside casing diameter 2¼"
Inside casing diameter 2"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10'
Depth of well 16.0'

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume ____

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Pellets
Placement method Tremie Tube
Volume ____

Backfill (if different from seal):
Material Neat Cement
Placement Method Tremie Tube
Volume ____

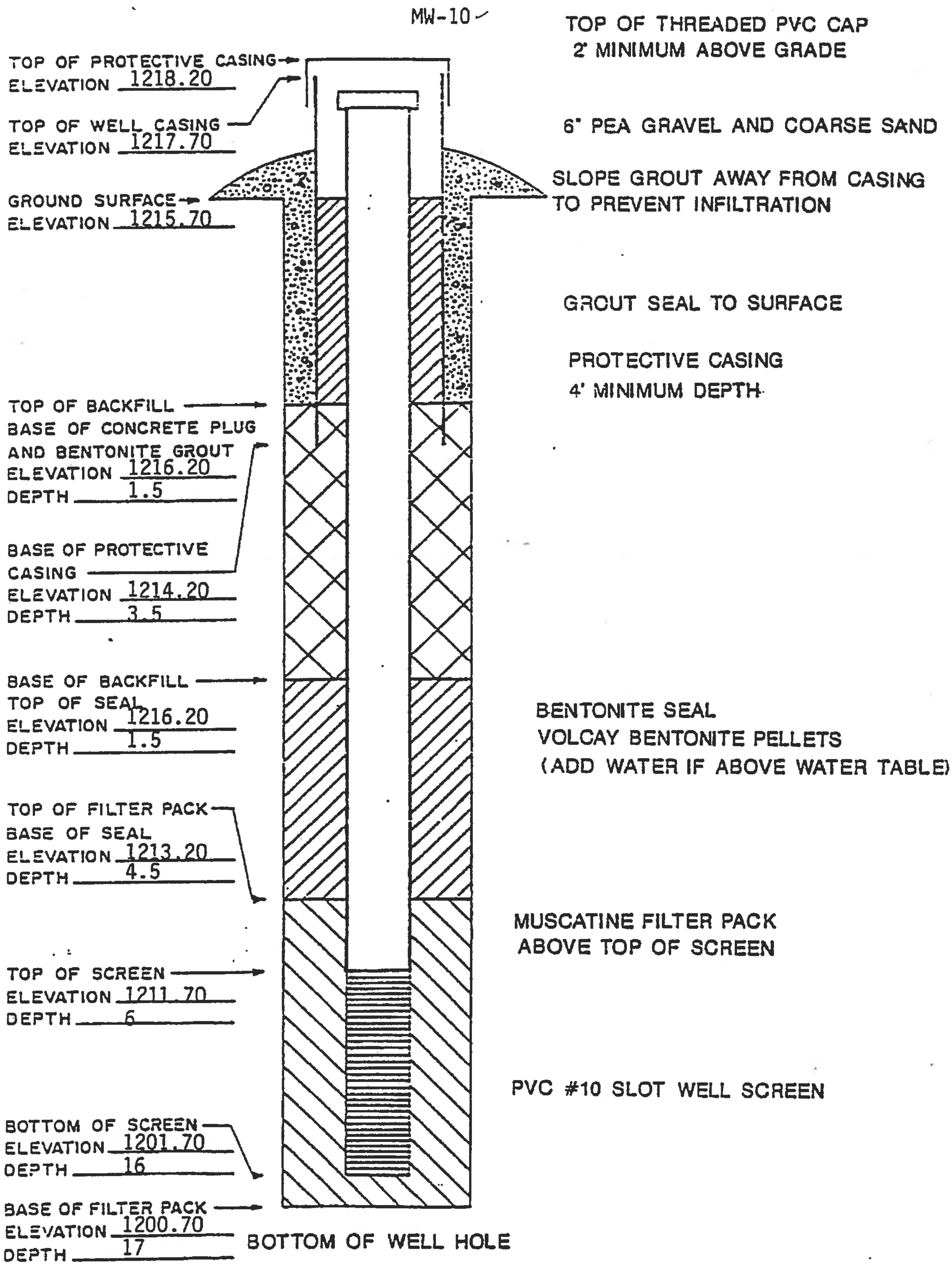
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) Dry
Stabilization time ____
Well development method ____

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) ____
Average depth of frostline 3.0'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA



MONITORING WELL CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Center of Southern Boundary of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-11	2365.0070	7-18 '89	1215.6	1158.8	J&R Drilling	Shery L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__ HOURS	Field	Diedrich D-50
				DRILLING METHOD	**TOTAL DEPTH**
				Continuous Flight Auger	33'

DEPTH (ft.)	SAMPLE DESCRIPTION: COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	SAMPLE DATA: NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0–7	Light Brown	Dry	Loose	Silty Clay	Loess Slight Rust Staining		
7–15.5		Moist (from 10)		Silty Clay	Glacial Till Increasing clay content with depth		
15.5–16.5	Brown		Tight	Clay	Limestone pebbles throughout		
16.5–	Yellow	Dry		Shale and weathered limestone seams/	Heavy Rust staining along interface of limestone & Clay		

Depth scale: 5, 10, 15, 20, 25

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB_11	2365.0070	7-18-89			J&R Drilling	Sheryl L. Howe

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000	DEPTH (ft.)
	Yellow	Dry		Shale and weathered limstone seams				
30								
		moist			Increasing clay content			
				Limestone				
	Bottom of Boring at 33.0'							

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Eastern Boundary of Fill

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-12	2365.0070	7-21-89	1161		J&R Drilling	Sheryl Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__HOURS	Corn Field	Diedrich D-5
				DRILLING METHOD	TOTAL DEPT
				Continuous Flight Auger	25'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
	Brown	Dry	Loose	Silty Clay	Loess		
5		Moist		Silty Clay	Till		
10					Seams of Blue Clay		
15							
20	Gray	Dry		Shale			
25							

Bottom of Boring at 25.0'

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DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Eastern Boundary of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-13	2365.0070	7-21-89	1152		J&R Drilling	Sheryl Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___ HOURS	Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPTH
				Continuous Flight Auger	23'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0–7.5	Brown	Dry	Loose	Silty Clay	Loess Root Hairs Slight Rust Staining		
7.5–17	Yellow	Moist	Tight	Clay	Thin layer of L.S. Pebbles at 7.5' Pebbles and Rust Staining throughout		
17–20		Dry		Shale and Limestone Seams			
20–23	Gray		Dense	Shale			

Bottom of Boring at 23'

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DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Eastern Boundary of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-14	2365.0070	8-4-89	1178		J&R Drilling	Sheryl Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	__HOURS	Corn Field	Diedrich D-50
				DRILLING METHOD	**TOTAL DEPTH**
				Continuous Flight Auger	48'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0–5.5	Brown	Dry	Loose	Silty Clay	Loess		
5.5–13		Damp		Silty Clay	Glacial Till		
13–23	Yellow	Dry		Shale	Thin Limestone Seams Present		
23–	Gray	Dry	Dense	Shale			

Depth scale: 5, 10, 15, 20, 25

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-14	2365.0070	8-4-89	1178		J&P Drilling	Sheryl Howe

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000	DEPTH (ft.)
	Gray	Dry	Dense	Shale				
30								
35								
40								
45								
				Limestone				
				Bottom of Boring at 48.0'				
50								

JAMES M. MONTGOMERY
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DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Eastern Boundary of Fill

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-15	2365.0070	8-4-89	1189		J&R Drilling	Sheryl Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS	Field	Diedrich D-50
				DRILLING METHOD	TOTAL DEPTH
				Continuous Flight Auger	50'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000
0–6	Brown	Dry	Loose	Silty Clay	Loess		
6–14	Light Brown	Damp		Silty Clay	Glacial Till		
14–26	Yellow	Dry		Shale	Weathered Limstone Seams throughout		

Depth scale: 5, 10, 15, 20, 25

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-15	2365.0070	8-4-89	1189		J&R Drilling	Sheryl Howe

DEPTH (ft.)	SAMPLE DESCRIPTION					SAMPLE DATA		DEPTH (ft.)
	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/TIP READING (ppm) 0 500 1000	
	Yellow	Dry		Shale	Weathered Limestone Seams Throughout			
30								
	Gray	Dry	Dense	Shale				
35								
40								
45								
50								
				Bottom of Boring at 50.0'				

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DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfil
LOCATION OF DRILL HOLE
Southwest Corner of Permitted Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-16	2365.0070	12-28-89			J&R Drilling	S.L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS	Field	CME
				DRILLING METHOD	**TOTAL DEPT**
				Continuous Flight Auger & Air Rotary	50'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	REMARKS
				Refer to Log of Soil Boring SB-1			
25	Light Yellow	Dry	Tight	Silty Clay	Sand Seams Throughout Limestone and Weathered Shale Seams Throughout Increasing CLay Content with Depth		
30							
35							
	Gray	Dry	Dense	Shale			
40							
45							

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-16	2365.0070	12-28-89			J&R Drilling	S.L. Howe

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/H•NU READING (ppm) 0 500 1000	DEPTH (ft.)
	Gray	Dry	Dense	Shale				
50							Bottom of Boring at 50'	

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11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Center of West Side of Landfill

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-17	2365.0070	12-14-89			J&R Drilling	S.L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___ HOURS	Field	CME
				DRILLING METHOD	**TOTAL DEPTH**
				Continuous Flight Auger & Air Rotary	45'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	REMARKS
				Refer to Log of Soil Boring SB-2			
15	Yellow Brown	Moist	Tight	Clay	Sand Seams Throughout		
20	Gray				Fractures in Till		
25							
30		Wet					
35	Gray	Dry	Hard	Shale			

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-17	2365.0070	12-14-89			J&R Drilling	S.L. Howe

DEPTH (ft.)	SAMPLE DESCRIPTION					SAMPLE DATA		DEPTH (ft.)
	COLOR	MOIS-TURE	CONSIS-TENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	OVA/H•NU READING (ppm) 0 500 1000	
	Gray	Dry	Hard	Shale				
							Bottom of Boring at 45'	

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11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Northwest Corner of Landfill Adjacent to

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-18	2365.0070	12-29-89			J&R Drilling	S.L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS		
				DRILLING METHOD	**TOTAL DEPTH**
				Continuous Flight Auger & Air Rotary	45'

DEPTH (ft.)	COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	NUMBER & TYPE	REMARKS
				Refer to Log of Soil Boring SB-3			
35	Light Yellow	Wet	Hard	Weathered Limestone	Rock is Fractured		
40							
45							Bottom of Boring at 45'

MONITORING WELL / PIEZOMETER CONSTRUCTION
DOCUMENTATION FORM

Disposal site name Winneshiek County S.L.F. Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-18 Date started 12-29-89 Date completed 12-29-89

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
- Specify corner of site NW
- Distance and direction along boundary 342' South
- Distance and direction from boundary to well 7.5' East

Elevations (± 0.01 ft. MSL):
- Ground surface 1161.32
- Top of protective casing 1163.83
- Top of well casing 1163.65
- Benchmark elevation 1158.80
- Benchmark description Second spike in power pole at NW corner of site.

B. Soil Boring Information

Name and address of construction company J&R Drilling Services
7922 NW 114th
Grimes, IA 50011

- Name of driller J. Stoy
- Drilling method Air Rotary
- Drilling fluid Air
- Bore hole diameter 4"
- Soil sampling method Cuttings
- Depth of boring 45'

C. Monitoring Well Installation

- Casing material PVC
- Length of casing 45'
- Outside casing diameter 2.5"
- Inside casing diameter 2"
- Casing joint type Threaded
- Casing/screen joint type Threaded
- Screen material PVC
- Screen opening size .010
- Screen length 5'
- Depth of well 45'

Well Installation, continued:

Filter pack:
- Material Muscatine Sand
- Grain size #1
- Volume 100 Lbs.

Seal (minimum 3 ft. length above filter pack):
- Material Bentonite Pellets
- Placement method Hand Poured
- Volume 50 Lbs.

Backfill (if different from seal):
- Material Neat Cement
- Placement Method Tremie Tube
- Volume

Surface seal design:
- Material of protective casing: Steel
- Material of grout between protective casing and well casing: Kwikcrete
- Protective cap:
  - Material Steel
  - Vented? Y/N Y Locking? Y/N Y
- Well cap:
  - Material PVC
  - Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) Dry
Stabilization time
Well development method Air Jetting

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) Downgradient
Average depth of frostline 3'

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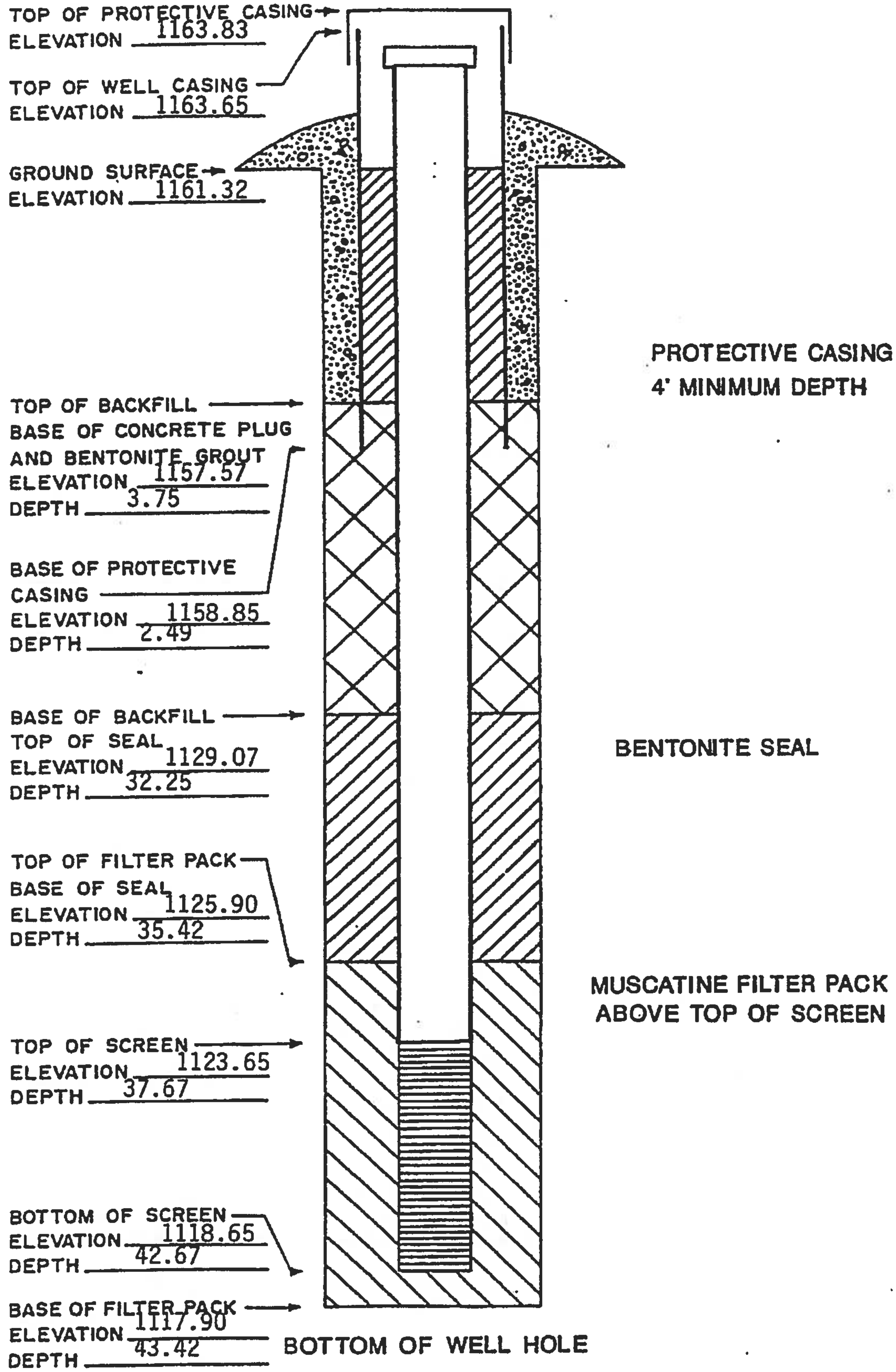
DES MOINES, IOWA

MW-18



PIEZOMETER CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

MARCH, 199

APPENDIX E

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-18	
Dates Started 12-29-89	**Date Completed** 12-29-89

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site N.W.	J&R Drilling
Distance & direction along boundary 342' SOUTH	7922 N.W. 114th
Distance & direction from boundary to well 7.5' EAST	Grimes, Iowa 50011
Elevations (± 0.01 ft. MSL):	**Name of driller** J. Stoy
Ground Surface 1161.32	**Drilling method** Air Rotory
Top of protective casing 1163.83	**Drilling fluid** Air
Top of well casing 1163.65	**Bore Hole diameter** 4.00 inches
Benchmark elevation 1158.80	**Soil sampling method** Cuttings
Benchmark description Second spike in power pole at N.W. corner of site	**Depth of boring** 45 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	**Placement method** Hand Poured
Length of casing 40 feet	**Volume** 50 Lbs.
Outside casing diameter 2.5 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	**Material** Neat Cement
Casing joint type Threaded	**Placement method** Tremie Tube
Casing/screen joint type Threaded	**Volume**
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	**Material of protective casing:** Steel
Screen length 5 feet	**Material of grout between protective casing and well casing:** Kwikcrete
Depth of Well 42.67 feet BGS	**Protective cap:**
Filter Pack:	**Material** Steel
Material Muscatine Sand	**Vented?: Y/N** Y **Locking?: Y/N** Y
Grain Size #1	**Well cap:**
Volume 100 Lbs.	**Material** PVC
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N** Y
Material Bentonite Pellets	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level Dry	**Stabilization time**
Well development method Air Jetting	
Average depth of frostline 3 feet BGS	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

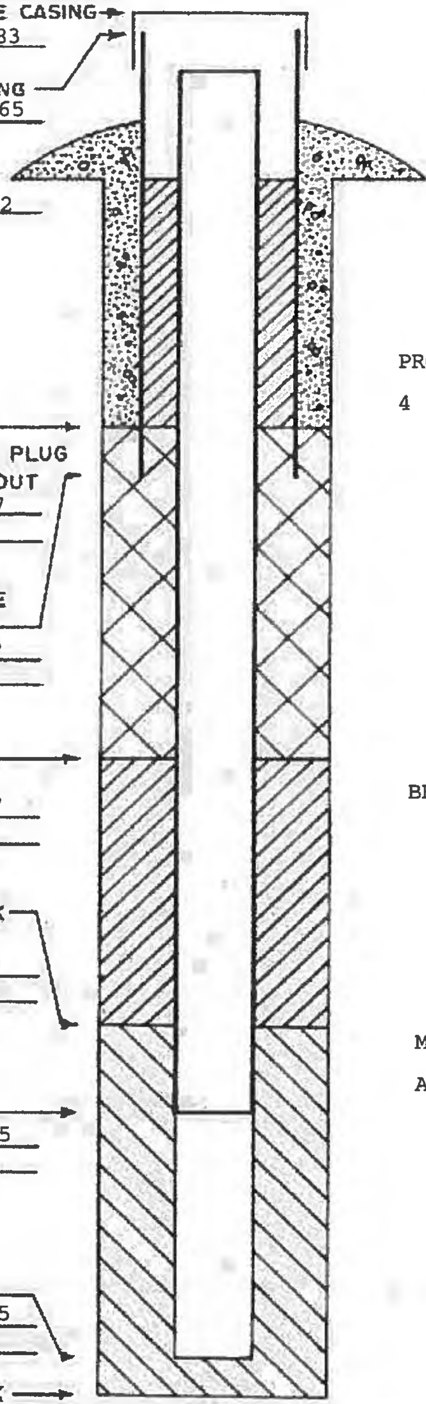
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM
GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-18



TOP OF PROTECTIVE CASING
ELEVATION 1163.83

TOP OF WELL CASING
ELEVATION 1163.65

GROUND SURFACE
ELEVATION 1161.32

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1157.57
DEPTH 3.75

BASE OF PROTECTIVE
CASING
ELEVATION 1158.83
DEPTH 2.49

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1129.07
DEPTH 32.25

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1125.90
DEPTH 35.42

TOP OF SCREEN
ELEVATION 1123.65
DEPTH 37.67

BOTTOM OF SCREEN
ELEVATION 1118.65
DEPTH 42.67

BASE OF FILTER PACK
ELEVATION 1117.90
DEPTH 43.42

PROTECTIVE CASING

4 foot MINIMUM DEPTH

BENTONITE SEAL

MUSCATINE FILTER PACK

ABOVE TOP OF SCREEN

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Northeast Corner of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-19	2365.0070	12-15-89			J&R Drilling	S.L. Howe

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___HOURS		CME
				DRILLING METHOD	TOTAL DEPTH
				Continuous Flight Auger & Air Rotary	55'

DEPTH (ft.)	SAMPLE DESCRIPTION: COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	SAMPLE DATA: NUMBER & TYPE	REMARKS
				See Log of Soil Boring SB-6			
40	Light Yellow to White	Dry	Hard	Limestone	Top 2.5' is Weathered		
45							
50							
55							Bottom of Boring at 55'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
11107 AURORA AVENUE
DES MOINES, IOWA 50322

LOCATION
Winneshiek County Sanitary Landfill
LOCATION OF DRILL HOLE
Southeast Corner of Fill Area

HOLE NO.	JOB NO.	DATE	ELEVATION	DATUM	DRILLER	INSPECTOR
SB-20	2365.0070	12-12-89			J&R Drilling	S.L. Howe

WATER LEVEL OBSERVATIONS			
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER	___ HOURS

TYPE OF SURFACE	DRILL RIG

DRILLING METHOD	TOTAL DEPTH
Continuous Flight Auger & Air Rotary	45'

DEPTH (ft.)	SAMPLE DESCRIPTION: COLOR	MOISTURE	CONSISTENCY	BASIC SOIL TYPE	GEOLOGIC DESCRIPTION & OTHER REMARKS	SAMPLE DATA: NUMBER & TYPE	REMARKS
				See Log of Soil Boring SB-9			
30	Light Yellow to White	Dry	Hard	Limestone	Top 6' is Weathered		
5							
40							
5					Bottom of Boring at 45'		

Appendix A-4 – 1990 – Boring Logs and Monitoring Well Construction Documentation

DATE: 8-16--90

TOTAL DEPTH: 173 FEET

DEPTH (FEET)	GRAPHIC LOG	SAMPLE TYPE	LITHOLOGIC LOG	MONITORING WELL	ELEVATION (FEET)
0–34		LOGGED FROM THE CUTTINGS	UNCONSOLIDATED DEPOSITS		
34–108			GRAY SHALE WITH LIMESTONE SEAMS		
108–173			BEIGE LIMESTONE (GALENA FORMATION) FRACTURED		

Depth scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170

PROJECT NO. 2125.0090

JMM James M. Montgomery
Consulting Engineers Inc.

WINNESHIEK COUNTY SANITARY LANDFILL

SB-19

SITE: **WINNESHIEK COUNTY SANITARY LANDFILL
DECORAH, IOWA**

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-19	
Dates Started 8-16-90	**Date Completed** 8-22-90

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site S.W.	Shawver Well Co.
Distance & direction along boundary 259.4' East	Box 266
Distance & direction from boundary to well 11.6' North	Fredericksburg, IA 50630
Elevations (± 0.01 ft. MSL):	**Name of driller** Jim Bunting
Ground Surface 1203.61	**Drilling method** Air Rotary
Top of protective casing 1205.90	**Drilling fluid** Air
Top of well casing 1205.65	**Bore Hole diameter** 7 7/8 inches
Benchmark elevation 1158.80	**Soil sampling method** Recirculated Cuttings
Benchmark description Second spike in power pole at N.W. corner of site	**Depth of boring** 173 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	**Placement method** Tremie Tube
Length of casing 53.82 feet	**Volume** 11.44 cubic feet
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter 5.00 inches	**Material** As Above
Casing joint type Threaded	**Placement method**
Casing/screen joint type Threaded	**Volume**
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	**Material of protective casing:** Steel
Screen length 20 feet	**Material of grout between protective casing and well casing:** Kwikcrete
Depth of Well 71.78 feet BGS	**Protective cap:**
Filter Pack:	**Material** Steel
Material Muscatine Sand	**Vented?: Y/N** Y **Locking?: Y/N** Y
Grain Size #1	**Well cap:**
Volume 5.98 cubic feet	**Material** PVC
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N** Y
Material Bentonite Grout	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level 49.63	**Stabilization time** 24 Hours
Well development method Bailing	
Average depth of frostline 3 feet BGS	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

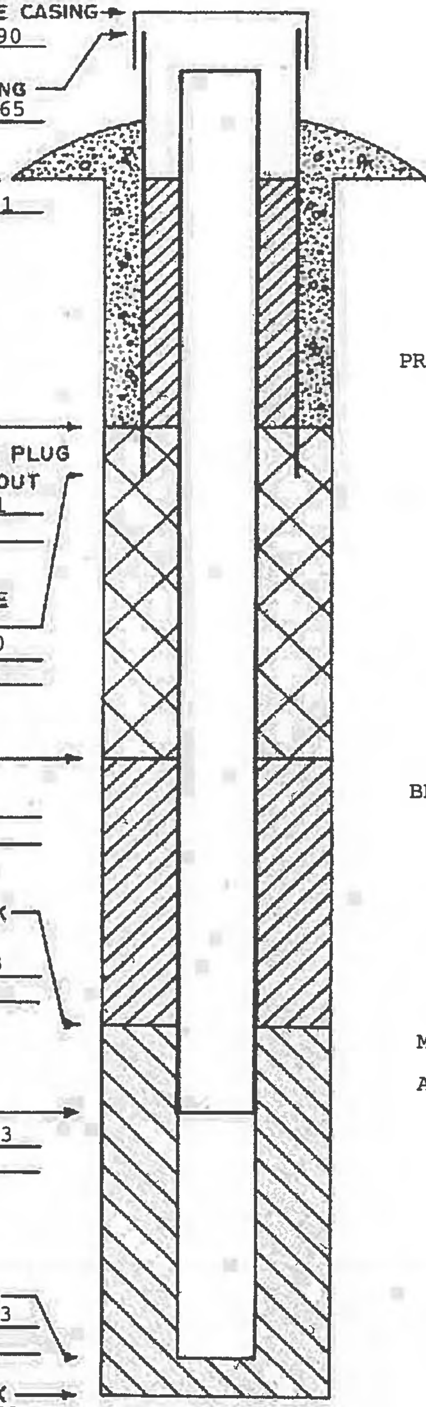
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM
GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-19



TOP OF PROTECTIVE CASING
ELEVATION 1205.90

TOP OF WELL CASING
ELEVATION 1205.65

GROUND SURFACE
ELEVATION 1203.61

PROTECTIVE CASING

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1199.11
DEPTH 4.5

BASE OF PROTECTIVE
CASING
ELEVATION 1199.90
DEPTH 3.71

BASE OF BACKFILL
TOP OF SEAL
ELEVATION
DEPTH

BENTONITE SEAL

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1154.83
DEPTH 48.78

MUSCATINE FILTER PACK
ABOVE TOP OF SCREEN

TOP OF SCREEN
ELEVATION 1151.83
DEPTH 51.78

BOTTOM OF SCREEN
ELEVATION 1131.83
DEPTH 71.78

BASE OF FILTER PACK
ELEVATION 1130.83
DEPTH 72.78

DATE: 8-28-90

TOTAL DEPTH: 111 FEET

DEPTH (FEET)	GRAPHIC LOG	SAMPLE TYPE	LITHOLOGIC LOG	MONITORING WELL	ELEVATION (FEET)
0–34		LOGGED FROM THE CUTTINGS	UNCONSOLIDATED DEPOSITS		
34–54			GRAY SHALE WITH LIMESTONE SEAMS		
54–111			BEIGE LIMESTONE (GALENA FORMATION) FRACTURED		

Depth scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110

PROJECT NO. 2125.0090

JMM James M. Montgomery
Consulting Engineers Inc.

WINNESHIEK COUNTY SANITARY LANDFILL

SB-20

SITE: **WINNESHIEK COUNTY SANITARY LANDFILL
DECORAH, IOWA**

DATE: 8-27-90

TOTAL DEPTH: 109 FEET

DEPTH (FEET)	GRAPHIC LOG	SAMPLE TYPE	LITHOLOGIC LOG	MONITORING WELL	ELEVATION (FEET)
0–18		LOGGED FROM THE CUTTINGS	UNCONSOLIDATED DEPOSITS		
18–63			GRAY SHALE WITH LIMESTONE SEAMS		
63–109			BEIGE LIMESTONE (GALENA FORMATION) FRACTURED		

Depth scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110

PROJECT NO. 2125.0090

JMM James M. Montgomery
Consulting Engineers Inc.

WINNESHIEK COUNTY SANITARY LANDFILL

SB-21

SITE: WINNESHIEK COUNTY SANITARY LANDFILL
DECORAH, IOWA

DATE: 8-7-90 TOTAL DEPTH: 13.5 FEET

DEPTH (FEET)	GRAPHIC LOG	SAMPLE TYPE	LITHOLOGIC LOG	ELEVATION (FEET)
0		CONTINUOUS SPLIT-SPOON SAMPLE NO.1	DARK BROWN, CLAYEY SILT WITH ORGANICS	
		CONTINUOUS SPLIT-SPOON SAMPLE NO. 2	INCREASE IN CLAY CONTENT. RUST STAINING PRESENT	
5		CONTINUOUS SPLIT-SPOON SAMPLE NO. 3		
		CONTINUOUS SPLIT-SPOON SAMPLE NO. 4	YELLOW SILTY CLAY. MORE SAND AND ROCK FRAGMENTS.	
		CONTINUOUS SPLIT-SPOON SAMPLE NO. 5	YELLOW, HIGHLY WEATHERED LIMESTONE SHALE PARTINGS	
10		CONTINUOUS SPLIT-SPOON SAMPLE NO. 6		
			SPOON REFUSAL AT 13.5 FEET - END OF BORING	
15				
20				
25				
30				

PROJECT NO. 2125.0090

JMM James M. Montgomery
Consulting Engineers Inc.

WINNESHIEK COUNTY SANITARY LANDFILL

SS-1

DATE: 8-7-90

TOTAL DEPTH: 13.5 FEET

DEPTH (FEET)	GRAPHIC LOG	SAMPLE TYPE	LITHOLOGIC LOG	ELEVATION (FEET)
0		CONTINUOUS SPLIT-SPOON SAMPLE NO.1	DARK BROWN, ORGANIC CLAYEY SILT.	1187
		CONTINUOUS SPLIT-SPOON SAMPLE NO. 2	INCREASE IN CLAY CONTENT	
5		CONTINUOUS SPLIT-SPOON SAMPLE NO. 3		
		CONTINUOUS SPLIT-SPOON SAMPLE NO. 4		
		CONTINUOUS SPLIT-SPOON SAMPLE NO. 5		
10		CONTINUOUS SPLIT-SPOON SAMPLE NO. 6	YELLOW SILTY CLAY WITH SAND SEAMS AND ROCK FRAGMENTS. RUST STAINING PRESENT	
		CONTINUOUS SPLIT-SPOON SAMPLE NO. 7	HIGHLY WEATHERED LIMESTONE	
			SPOON REFUSAL AT 13.5 FEET - END OF BORING	
15				
20				
25				
30				

PROJECT NO. 2125.0090

JMM James M. Montgomery
Consulting Engineers Inc.

WINNESHIEK COUNTY SANITARY LANDFILL

SS-2

DATE: 8-7-90

TOTAL DEPTH: 20.5 FEET

DEPTH (FEET)	SAMPLE TYPE	LITHOLOGIC LOG
0	CONTINUOUS SPLIT-SPOON SAMPLE NO.1	DARK BROWN, CLAYEY SILT WITH ORGANICS.
	CONTINUOUS SPLIT-SPOON SAMPLE NO.2	YELLOW BROWN SILTY CLAY TO CLAYEY SILT.
5	CONTINUOUS SPLIT-SPOON SAMPLE NO.3	
	CONTINUOUS SPLIT-SPOON SAMPLE NO.4	
	CONTINUOUS SPLIT-SPOON SAMPLE NO.5	MOIST TO WET AT 8-9 FEET. SHALE FRAGMENTS, RUST STAINING.
10	CONTINUOUS SPLIT-SPOON SAMPLE NO.6	
	CONTINUOUS SPLIT-SPOON SAMPLE NO.7	GRAY BROWN, CLAYEY SILT WITH SAND. SAND AND SILT SEAMS RUST STAINED.
15	CONTINUOUS SPLIT-SPOON SAMPLE NO.8	YELLOW, SILTY SANDY CLAY. LOTS OF ROCK FRAGMENTS.
	CONTINUOUS SPLIT-SPOON SAMPLE NO.9	MOIST TO WET.
20	CONTINUOUS SPLIT-SPOON SAMPLE NO.10	WET, RUST-STAINED SAND. ROCK FRAGMENTS.
		AUGER REFUSAL AT 20.5 FEET - END OF BORING
25		
30		

GRAPHIC LOG

ELEVATION (FEET)

PROJECT NO. 2125.0090

JMM James M. Montgomery
Consulting Engineers Inc.

WINNESHIEK COUNTY SANITARY LANDFILL

SS-3

DATE: 8-7-90

TOTAL DEPTH: 14.0 FEET

DEPTH (FEET)	GRAPHIC LOG	SAMPLE TYPE	LITHOLOGIC LOG	ELEVATION (FEET)
0		CONTINUOUS SPLIT-SPOON SAMPLE NO.1	DARK BROWN, CLAYEY SILT WITH ORGANICS	
		CONTINUOUS SPLIT-SPOON SAMPLE NO.2		
5		CONTINUOUS SPLIT-SPOON SAMPLE NO.3		
		CONTINUOUS SPLIT-SPOON SAMPLE NO.4		
		CONTINUOUS SPLIT-SPOON SAMPLE NO.5	YELLOW BROWN, SILTY CLAY WITH SAND SEAMS.	
10		CONTINUOUS SPLIT-SPOON SAMPLE NO.6		
		CONTINUOUS SPLIT-SPOON SAMPLE NO.7	YELLOW HIGHLY WEATHERED LIIMESTONE ROCK DOUGH.	
15			SPOON REFUSAL AT 12.0 FEET - END OF BORING AT 14.0 FEET	
20				
25				
30				

JMM JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.

WINNESHIEK COUNTY SANITARY LANDFILL

SS-4

MONITORING WELL / PIEZOMETER CONSTRUCTION
DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP-1 - 74 P
Well or Piezometer # MW-19 Date started 8-16-90 Date completed 8-22-90

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site SW
Distance and direction along boundary 259.4' East

Distance and direction from boundary to well 11.6 Feet North

Elevations (± 0.01 ft. MSL):
Ground surface 1203.61
Top of protective casing 1205.90
Top of well casing 1205.65
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company Shawver Well Co.
Box 266
Fredericksburg, IA 50630
Name of driller Jim Bunting
Drilling method Air Rotary
Drilling fluid Air
Bore hole diameter 7 7/8"
Soil sampling method Recirculated Cuttings
Depth of boring 173'

C. Monitoring Well Installation

Casing material PVC
Length of casing 53.82
Outside casing diameter
Inside casing diameter 5.00"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 20'
Depth of well 73.82

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume 5.98 cubic feet

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Grout
Placement method Tremie Tube
Volume 11.44 cubic feet

Backfill (if different from seal):
Material As Above
Placement Method
Volume

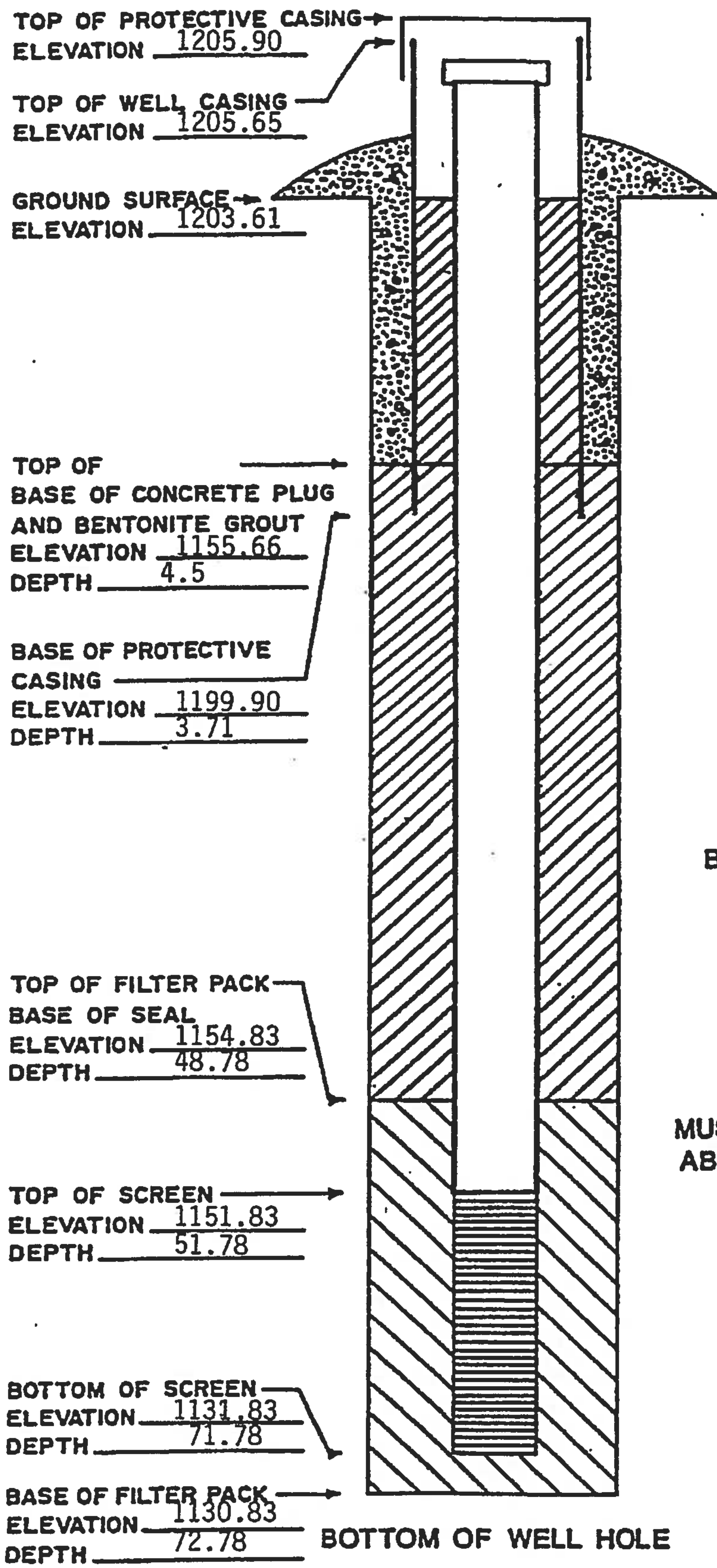
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 49.63
Stabilization time 24 Hours
Well development method Bailing

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) Upgradient
Average depth of frostline 3.0'

MW-19 ✓



PIEZOMETER
CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

APPENDIX I

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP-1 - 74 P
Well or Piezometer # MW-20 Date started 8-28-90 Date completed 8-28-90

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NW
Distance and direction along boundary 294.5 Feet South
Distance and direction from boundary to well 7.5 Feet East

Elevations (± 0.01 ft. MSL):
Ground surface 1160.16
Top of protective casing 1162.24
Top of well casing 1161.99
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company Shawver Well Co.
Box 266
Fredericksburg, IA 50630
Name of driller Jim Bunting
Drilling method Air Rotary
Drilling fluid Air
Bore hole diameter 7 7/8"
Soil sampling method Recirculated Cuttings
Depth of boring 111 Feet

C. Monitoring Well Installation

Casing material PVC
Length of casing 63.45
Outside casing diameter
Inside casing diameter 5.00"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10.0
Depth of well 73.45

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume 3.25 Cubic Feet

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Grout
Placement method Tremie Tube
Volume 14.30 Cubic Feet

Backfill (if different from seal):
Material
Placement Method
Volume

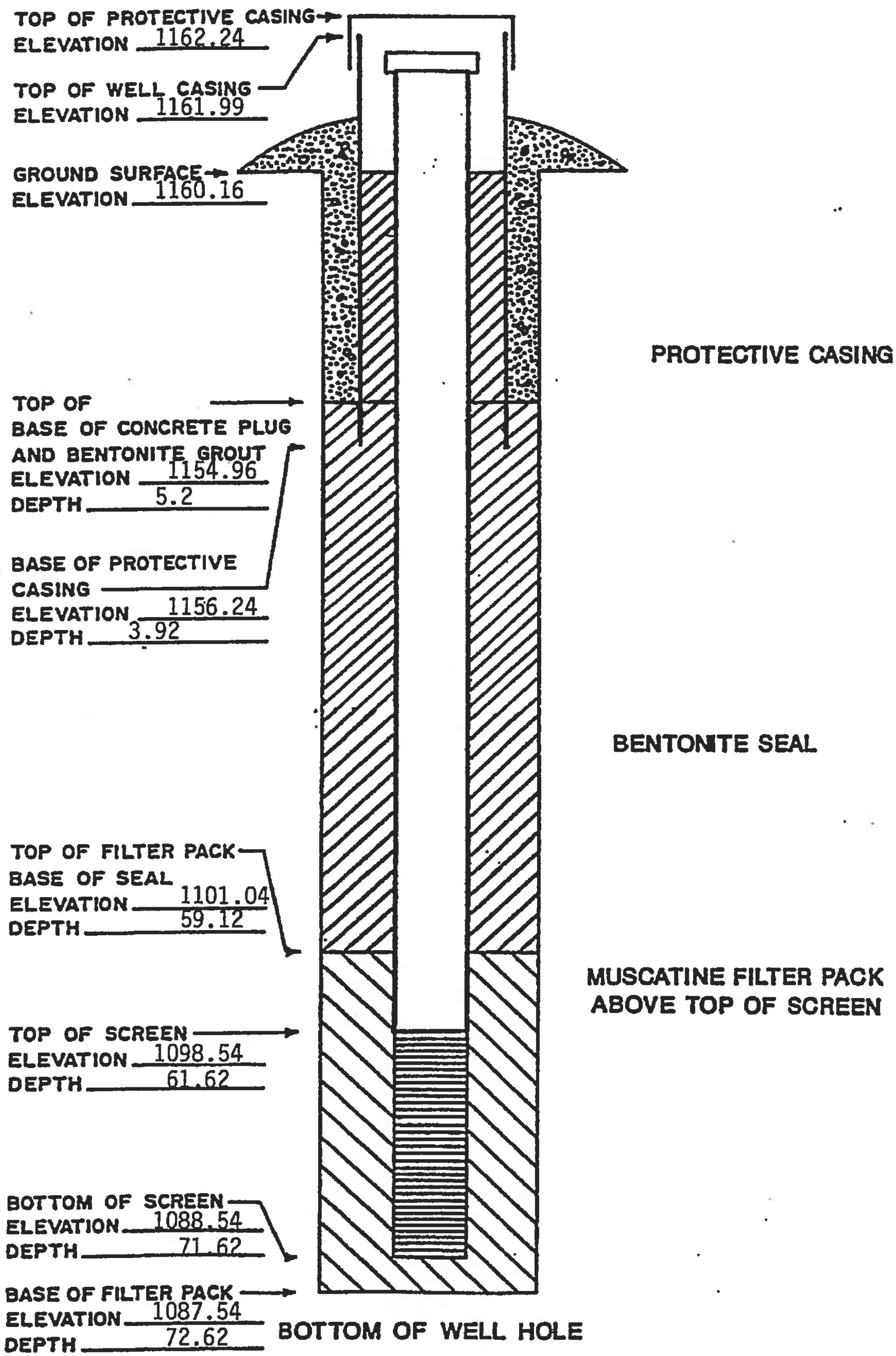
Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 70.39
Stabilization time 24 Hours
Well development method Bailing

Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) Downgradient
Average depth of frostline 3.0'

MW-20



PIEZOMETER
CONSTRUCTION DETAILS

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

APPENDIX

MONITORING WELL / PIEZOMETER CONSTRUCTION
DOCUMENTATION FORM

Disposal site name Winneshiek County Permit # 96 -SDP- 1 - 74 P
Well or Piezometer # MW-21 Date started 8-23-90 Date completed 8-27-90

A. Surveyed Locations and Elevations

Locations (± 0.5 ft.):
Specify corner of site NE
Distance and direction along boundary 381.4 Feet West

Distance and direction from boundary to well 335 Feet South

Elevations (± 0.01 ft. MSL):
Ground surface 1156.56
Top of protective casing 1158.48
Top of well casing 1158.23
Benchmark elevation 1158.80
Benchmark description Second spike in power pole at NW corner of site

B. Soil Boring Information

Name and address of construction company Shawver Well Co.
Box 266
Fredericksburg, IA 50630
Name of driller Jim Bunting
Drilling method Air Rotary
Drilling fluid Air
Bore hole diameter 7 7/8"
Soil sampling method Recirculated Cuttings
Depth of boring 109'

C. Monitoring Well Installation

Casing material PVC
Length of casing 55.61
Outside casing diameter
Inside casing diameter 5.00"
Casing joint type Threaded
Casing/screen joint type Threaded
Screen material PVC
Screen opening size .010
Screen length 10.0
Depth of well 65.61

Well Installation, continued:

Filter pack:
Material Muscatine Sand
Grain size #1
Volume 3.90 Cubic Feet

Seal (minimum 3 ft. length above filter pack):
Material Bentonite Grout
Placement method Tremie Tube
Volume 12.48 Cubic Feet

Backfill (if different from seal):
Material
Placement Method
Volume

Surface seal design:
Material of protective casing: Steel
Material of grout between protective casing and well casing: Kwikcrete
Protective cap:
Material Steel
Vented? Y/N Y Locking? Y/N Y
Well cap:
Material PVC
Vented? Y/N Y

D. Groundwater Measurement

Water level (± 0.01 ft. below top of inner well casing) 56.42
Stabilization time 24 Hours
Well development method Bailing

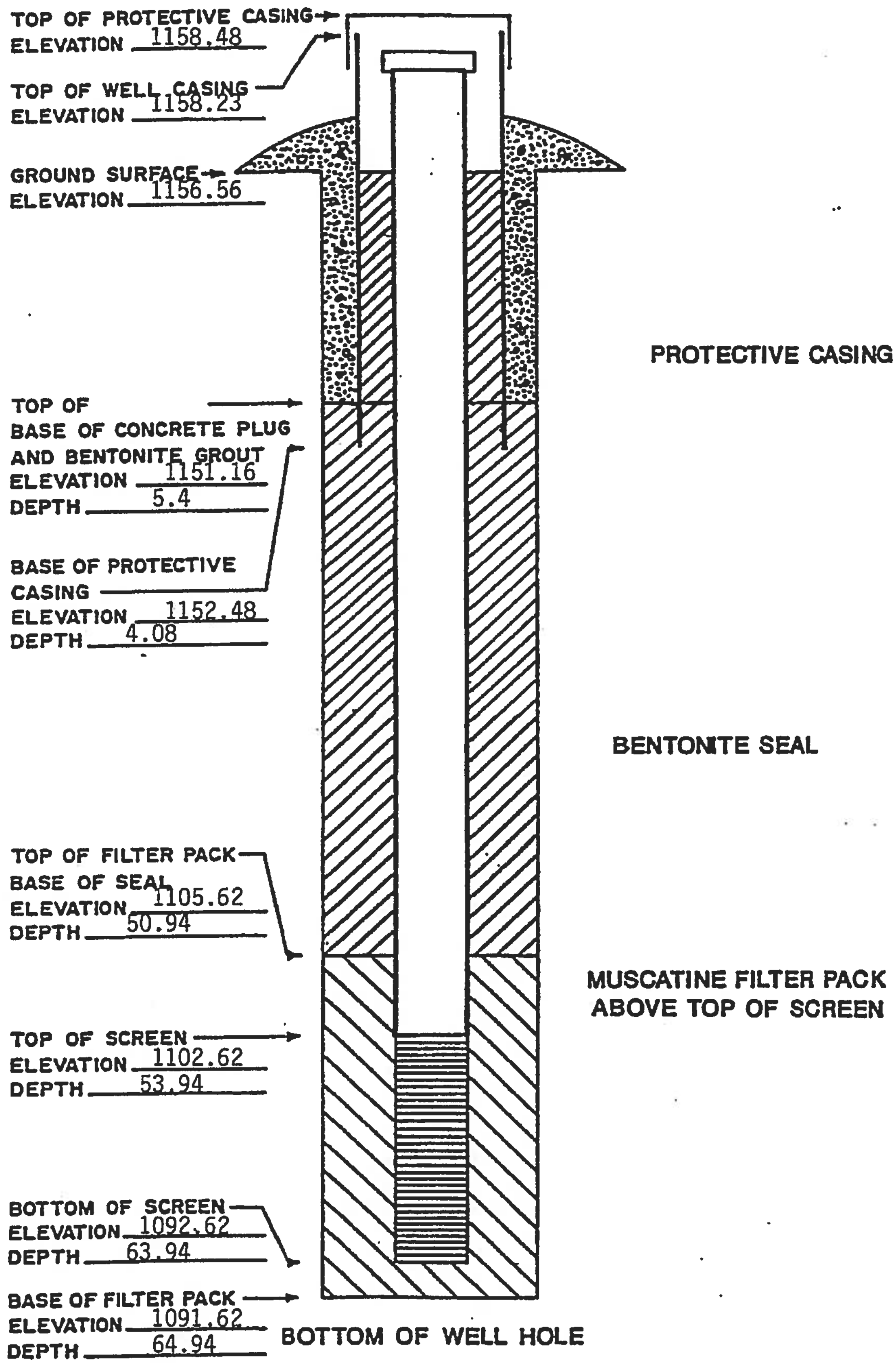
Upgradient or downgradient well? (see piezometric map from Hydrogeologic study) Downgradient
Average depth of frostline 3.0'

JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
DES MOINES, IOWA

APPENDIX B

500921

MW 21



PIEZOMETER CONSTRUCTION DETAILS	JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC. DES MOINES, IOWA	APPENDIX

TABLE 3-3

LEACHATE HEAD ELEVATIONS

Piezometer	Basal Elevation	08-28-90	09-05-90
PZ-1	1,185.05	1,199.12	1,199.28
PZ-2	1,172.69	1,174.67	1,174.62
PZ-3	1,170.09	Dry	Dry
PZ-4	1,159.39	1,159.51	Dry
PZ-5	1,161.00	Dry	Dry
PZ-6	1,184.80	Dry	Dry

Appendix A-5 – 1993 – Boring Logs and Monitoring Well Construction Documentation

APPENDIX A

field boring log

Project Winneshiek Co SLF

Boring No. 92MW4B Date Started 1 20 92 Date Complete 1 20 92

Drilled by Noel Rob Logged by Scott Rig McBride B 57

subsurface stratigraphy

☐ 4" Flight Augers ☑ 4¼" ID H.S. ☐ 6¼" ID H.S.

From	To	Description
0.0	1.5	Frost
1.5	2.5	Brown Sandy Silty Clay
2.5	9.0	Yellow Brown Clayey Silt
9.0	13.0	Grey Brown Clayey Silt w/Sand Seam
13.0	17.5	Yellow Brown Med - Coarse Sand
17.5	18.5	Grey Brown Fine - Med Sand
18.5	36.0±	Rust Brown Med Coarse Sand
36.0±		yellow - Brown Silt
	*	Benseal Grout

Bottom of Boring 38'

water levels

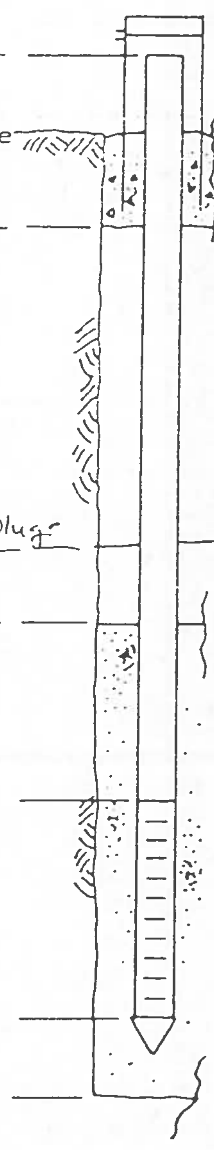
@ 27± While Drilling

___ 0 Hours A.B.

___ ___ Hr. A.B.

well details

☑ Stick-up Cover
☐ Flush Cover



2.5

0 Grade

5.0

Benseal Grout

220 Holeplug

25.5

27.5

37.5

38.0

sample data

Depth	Number/Type	Depth	Number/Type
1.5 4.0	1CS		
4.0 9.0	2CS		
9.0 14.0	3CS		
14.0 - 19.0	4CS		
19.0 - 24.0	5CS		
24.0 - 29.0	6CS		
29.0 - 34.0	7CS		
34.0 - 39.0	8CS		

CS = Continuous Sampler AS = Auger Sample

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** 96-SDP-1-74P
Well or Piezometer No. MW-4B	
Dates Started 1-21-92	**Date Completed** 1-21-92

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	AQUADRILL
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller** JOEL-ROB
Ground Surface	**Drilling method**
Top of protective casing + 2.5 feet	**Drilling fluid**
Top of well casing	**Bore Hole diameter** 4 1/4 inch I.D. HSA
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 38 feet BGS

C. MONITORING WELL INSTALLATION

Casing material	Placement method
Length of casing 30 feet	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter	Material
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material	**Surface seal design:**
Screen opening size	Material of protective casing:
Screen length 10 feet	Material of grout between protective casing and well casing:
Depth of Well 37.5 feet BGS	**Protective cap:**
Filter Pack:	Material
Material	Vented?: Y/N Locking?: Y/N
Grain Size	**Well cap:**
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)

Water level 27+/- WHILE DRILLING	Stabilization time
Well development method	
Average depth of frostline	

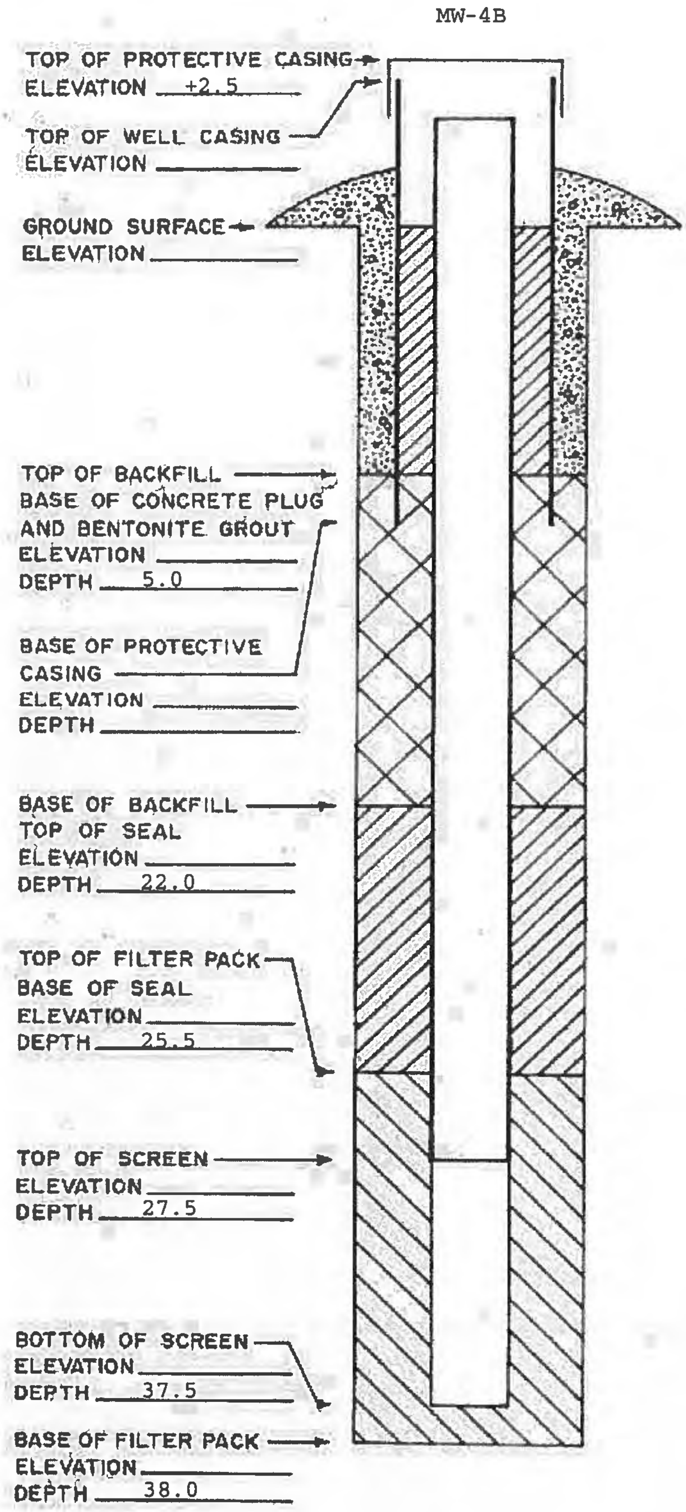
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



450' FROM MW4

field boring log

Project: Winneshiek County Landfill (Rust E&I)

Boring No. MW11-1 Date Started 5/12/93 Date Complete 5/12/93

Drilled by Jeff Logged by Scott Rig ORV

subsurface stratigraphy

☐ 4" Flight Augers ☒ 4¼" ID H.S. ☐ 6¼" ID H.S.

From	To	Description
0	2	Dk. brown silty clay t/organics
2	6.5	Yell brn gray mott si cl and cl silt
6.5	8	Gray rust brown mottled clayey silt
8	12.5	Lt. gray brown mottled clayey silt
12.5	16	Yellowbrown sand (fine to coarse)
16	17	Rust brown clayey silt
17	20.5	Gray clayey silt w/ fine sand
20.5	BOB	Gray fat clay

Bottom of Boring 25

water levels

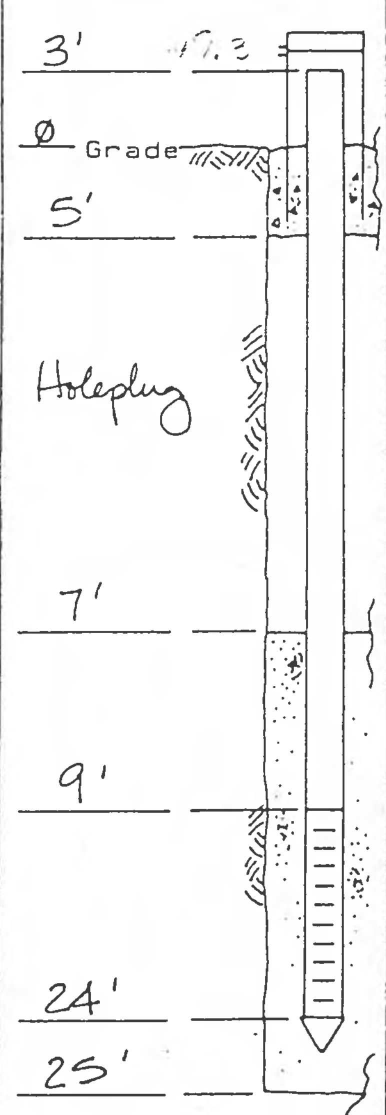
10' While Drilling

___ 0 Hours A.B.

___ ___ Hr. A.B.

well details

☒ Stick-up Cover
☐ Flush Cover



sample data

Depth	Number/Type	Depth	Number/Type
0 - 5	1-CS		
5-10	2-CS		
10-15	3-CS		
15-20	4-CS		
20-25	5-CS		

CS - Continuous Sample AS - Auger Sample

aquadrill

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHEIK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW II-1	
Dates Started 5-12-93	**Date Completed** 5-12-93

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	AQUADRILL
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller** JEFF
Ground Surface	**Drilling method** 4-1/4 inch I.D. HSA
Top of protective casing	**Drilling fluid**
Top of well casing	**Bore Hole diameter**
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 25 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material	Placement method
Length of casing 12 feet	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter	Material
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material	**Surface seal design:**
Screen opening size	Material of protective casing:
Screen length 15 feet	Material of grout between protective casing and well casing:
Depth of Well 24 feet BGS	**Protective cap:**
Filter Pack:	Material
Material	Vented?: Y/N Locking?: Y/N
Grain Size	**Well cap:**
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level 10 feet while drilling	**Stabilization time**
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

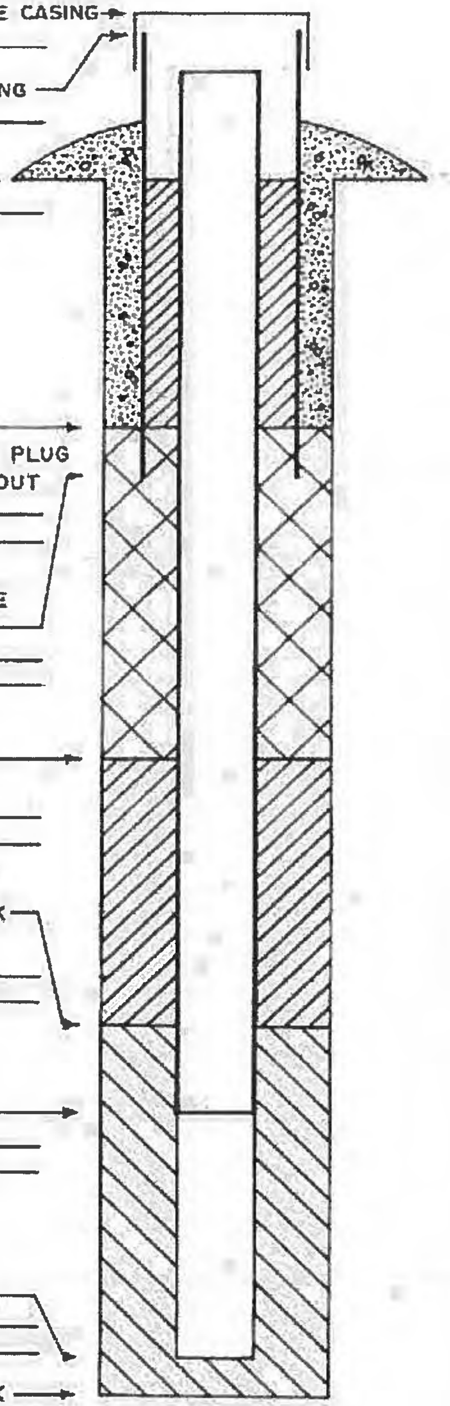
SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW II-1

TOP OF PROTECTIVE CASING
ELEVATION ______

TOP OF WELL CASING
ELEVATION ______

GROUND SURFACE
ELEVATION ______



TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION ______
DEPTH 5.0

BASE OF PROTECTIVE
CASING
ELEVATION ______
DEPTH ______

BASE OF BACKFILL
TOP OF SEAL
ELEVATION ______
DEPTH 5.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION ______
DEPTH 7.0

TOP OF SCREEN
ELEVATION ______
DEPTH 9.0

BOTTOM OF SCREEN
ELEVATION ______
DEPTH 24.0

BASE OF FILTER PACK
ELEVATION ______
DEPTH ______

620' FROM MW4

field boring log

Project WINNESHIEK CO SLF

Boring No. MW 11-2 Date Started 5-11-93 Date Complete 5 12 93

Drilled by JEFF Logged by Scott Rig ORV

subsurface stratigraphy

☐ 4" Flight Augers ☑ 4¼" ID H.S. ☐ 6¼" ID H.S.

From	To	Description
0.0	1.5	DARK BROWN SILTY CLAY w/ ORGANICS
1.5	3.0	YELLOW BROWN GREY MOTTLED SILTY CLAY w/ ORGANICS
3.0	6.0	REDDISH BROWN SILTY SAND FINE-COARSE
6.0	7.0	Lt BROWN GREY MOTTLED SILTY CLAY
7.0	7.5	Lt YELLOW BROWN CLAYEY SILT w/ FINE SAND
7.5	8.0	GREY CLAYEY SILT w/ SAND
8.0	8.5	GREY FINE SILTY SAND
8.5		DARK GREY SILTY CLAY (HIGHLY FRIABLE)

Bottom of Boring 20.0

water levels

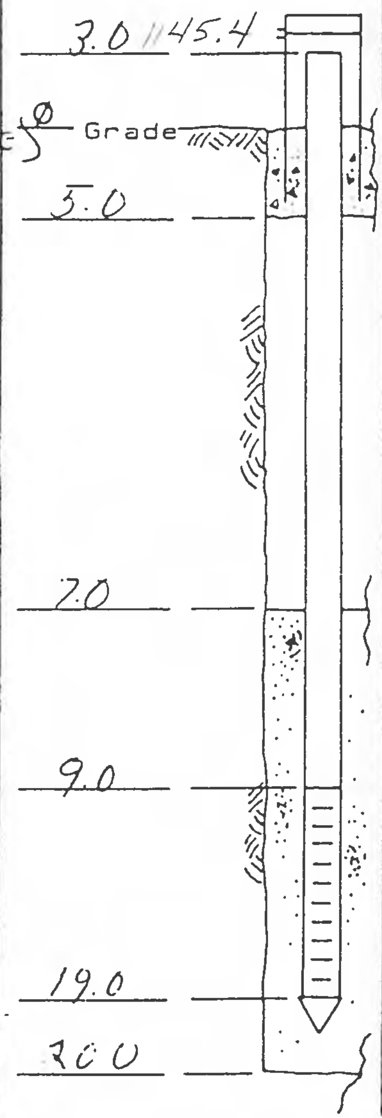
3.0 While Drilling

___ 0 Hours A.B.

___ Hr. A.B.

well details

☑ Stick-up Cover
☐ Flush Cover



sample data

Depth	Number/Type	Depth	Number/Type
0.0-5.0	1CS		
5.0-10.0	2CS		
10.0-15.0	3CS		
15.0-20.0	4CS		

CS - Continuous Sampler AS Auger Sample

aquadrill

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHEIK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW II-2	
Dates Started 5-11-93	**Date Completed** 5-12-93

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	AQUADRILL
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller** JEFF
Ground Surface 1142.4	**Drilling method** 4-1/4 inch I.D. HSA
Top of protective casing	**Drilling fluid**
Top of well casing 1145.4	**Bore Hole diameter**
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 20 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material	Placement method
Length of casing 12 feet	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter	Material
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material	**Surface seal design:**
Screen opening size	Material of protective casing:
Screen length 10 feet	Material of grout between protective casing and well casing:
Depth of Well 19 feet BGS	**Protective cap:**
Filter Pack:	Material
Material	Vented?: Y/N Locking?: Y/N
Grain Size	**Well cap:**
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level 3 FEET WHILE DRILLING	Stabilization time
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

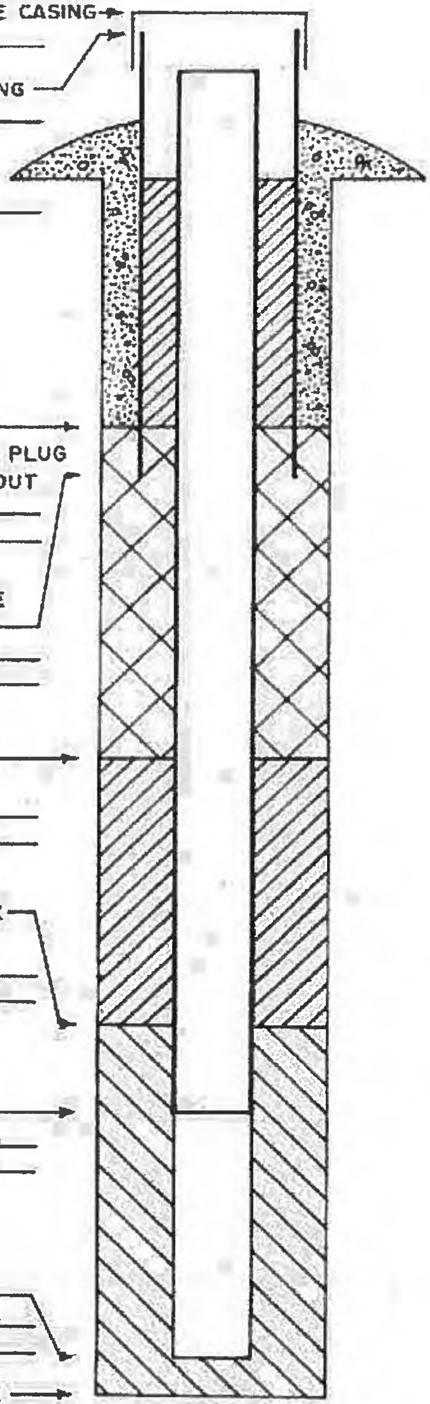
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM
GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW II-2



TOP OF PROTECTIVE CASING
ELEVATION ______

TOP OF WELL CASING
ELEVATION 1145.4

GROUND SURFACE
ELEVATION 1143.4
2

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1137.4
DEPTH 5.0

BASE OF PROTECTIVE
CASING
ELEVATION ______
DEPTH ______

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1137.4
DEPTH 5.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1135.4
DEPTH 7.0

TOP OF SCREEN
ELEVATION 1133.4
DEPTH 9.0

BOTTOM OF SCREEN
ELEVATION 1123.4
DEPTH 19.0

BASE OF FILTER PACK
ELEVATION 1122.4
DEPTH 20.0

1030' FROM MW4 INLINE w/ MW II-2

field boring log

Project WINNESHIEK Co SLF

Boring No. MW II 3 Date Started 5 13 93 Date Complete 5 13 93

Drilled by JEFF Logged by Scott Rig CRV

subsurface stratigraphy

☐ 4" Flight Augers ☒ 4¼" ID H.S. ☐ 6¼" ID H.S.

From	To	Description
0.0	0.5	YELLOW BROWN CLAYEY SILT W/ORGANICS
0.5	3.5	DARK BROWN SILTY CLAY W/ORGANICS
3.5	7.0	Lt GREY BROWN MOTTLED CLAYEY SILT
7.0	10.5	YELLOW BROWN GREY MOTTLED SILTY CLAY W/SAND/GRAVEL
10.5	11.5	YELLOW BROWN SILTSTONE
11.5	13.0	GREENISH GREY SHALE
13.0		YELLOW BROWN WEATHERED LIMESTONE
		* SAMPLER REFUSAL @ 12.5
		* AUGER REFUSAL @ 14.5

Bottom of Boring ~~[illegible]~~ 14.5

water levels

3.0± While Drilling

____ 0 Hours A.B.

____ ____ Hr. A.B.

well details

☒ Stick-up Cover

☐ Flush Cover

3.0 1129.6

Ø Grade

5.0

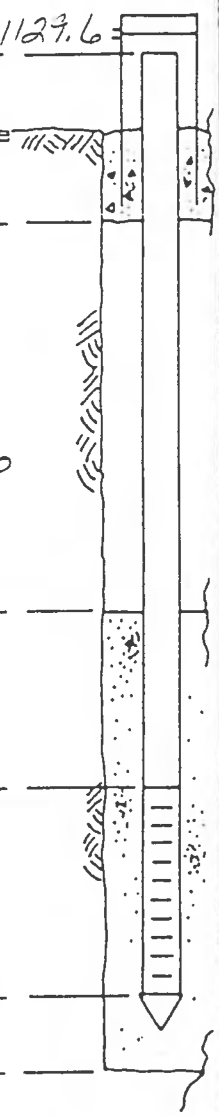
HOLE PLUG

7.0

9.0

14.0

14.5



sample data

Depth	Number/Type	Depth	Number/Type
0.0 5.0	1CS		
5.0 10.0	2CS		
~~[illegible]~~	~~3CS~~		
10.0 12.5	3CS		

CS - Continuous Sampler AS - Auger Sample

aquadrill

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHEIK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW II-3	
Dates Started 5-13-93	**Date Completed** 5-13-93

A. SURVEYED LOCATIONS AND ELEVATIONS	**B. SOIL BORING INFORMATION**
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	AQUADRILL
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller** JEFF
Ground Surface 1126.6	**Drilling method** 4-1/4 inch I.D. HSA
Top of protective casing	**Drilling fluid**
Top of well casing 1129.6	**Bore Hole diameter**
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 14.5 feet BGS

C. MONITORING WELL INSTALLATION

Casing material	Placement method
Length of casing 12 feet	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter	Material
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material	**Surface seal design:**
Screen opening size	Material of protective casing:
Screen length 5 feet	Material of grout between protective casing and well casing:
Depth of Well 14 feet BGS	**Protective cap:**
Filter Pack:	Material
Material	Vented?: Y/N Locking?: Y/N
Grain Size	**Well cap:**
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)

Water level 3 feet while drilling	Stabilization time
Well development method	
Average depth of frostline	

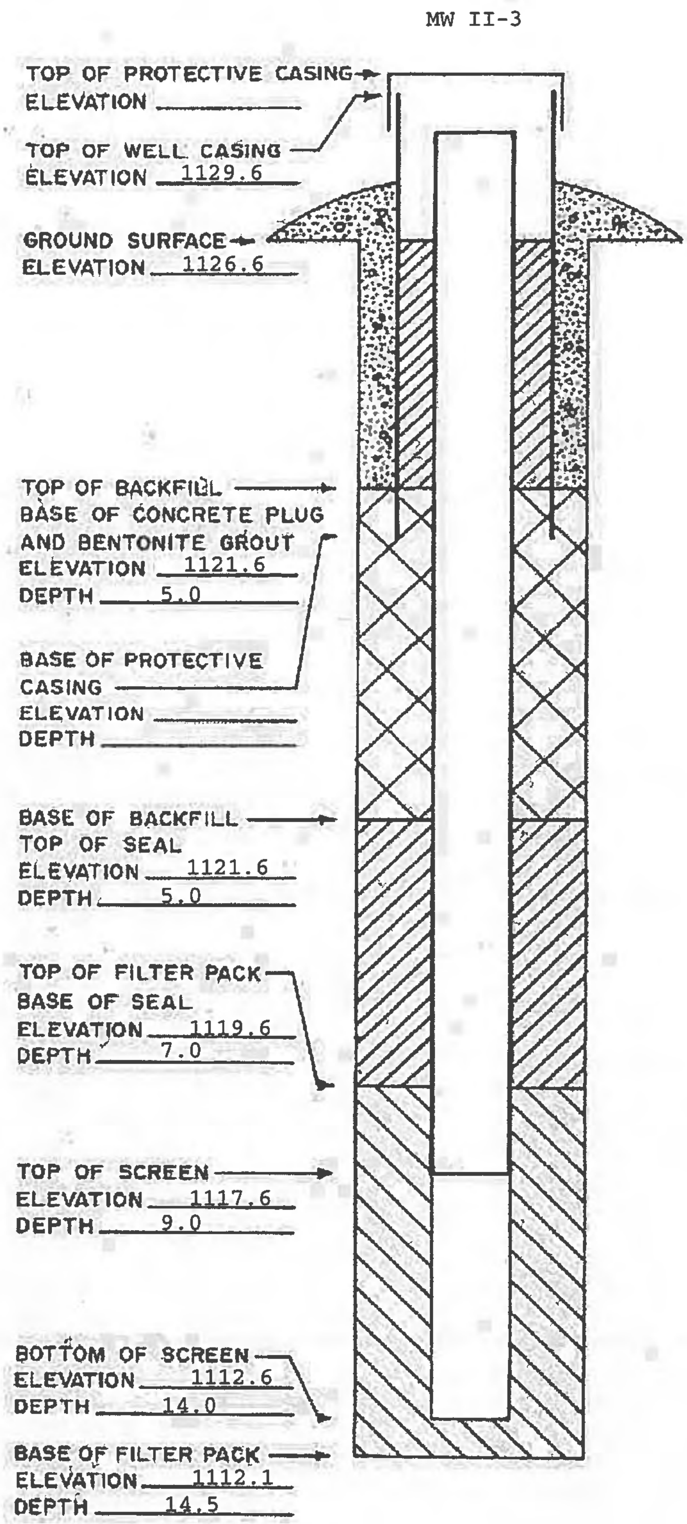
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM
GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



520' FROM MW4

field boring log

Project: Winneshiek County Landfill (Rust E & I)

Boring No. MW11-4 Date Started 12 May 93 Date Complete 13 May 93

Drilled by Jeff Logged by Scott Rig ORV

subsurface stratigraphy

☐ 4" Flight Augers ☒ 4¼" ID H.S. ☐ 6¼" ID H.S.

From	To	Description
0	2	Dark brown silty clay w/ organics
2	5	Yell brn - Lt. gray mottled silty clay
5	13.5	Lt. gray/rust brown mottled clayey silt
13.5	16.5	Yellow brown silty fine - med. sand
16.5	BoB	Yellow brown grey mottled si clay w/ sand seams

Bottom of Boring 20'

water levels

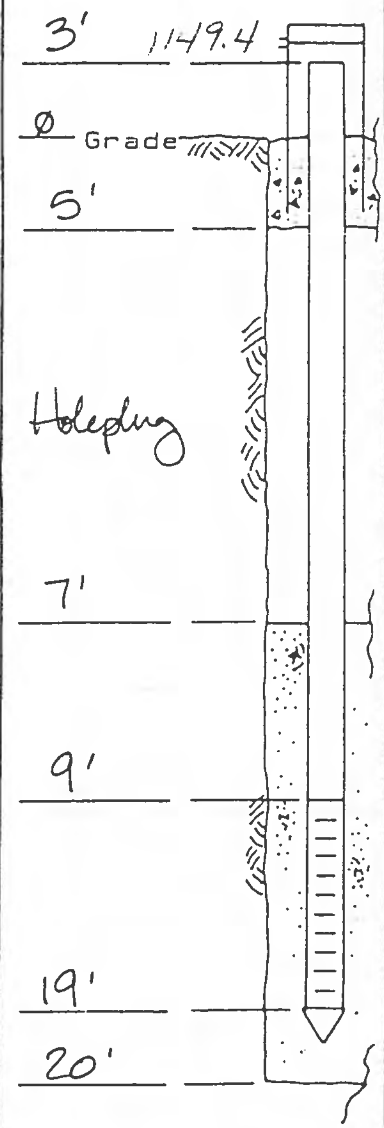
___ While Drilling

___ 0 Hours A.B.

___ ___ Hr. A.B.

well details

☐ Stick-up Cover
☐ Flush Cover



sample data

Depth	Number/Type	Depth	Number/Type
0 - 5	1 - CS		
5 - 10	2 - CS		
10 - 15	3 - CS		
15 - 20	4 - CS		

CS - Continuous Sampler AS - Auger Sample

aquadrill

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHEIK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW II-4	
Dates Started 5-12-93	**Date Completed** 5-13-93

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	AQUADRILL
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller** JEFF
Ground Surface 1146.4	**Drilling method** 4-1/4 inches I.D. HSA
Top of protective casing	**Drilling fluid**
Top of well casing 1149.4	**Bore Hole diameter**
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 20 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material	**Placement method**
Length of casing 12 feet	**Volume**
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter	**Material**
Casing joint type	**Placement method**
Casing/screen joint type	**Volume**
Screen material	**Surface seal design:**
Screen opening size	**Material of protective casing:**
Screen length 10 feet	**Material of grout between protective casing and well casing:**
Depth of Well 19 feet BGS	**Protective cap:**
Filter Pack:	**Material**
Material	**Vented?: Y/N** **Locking?: Y/N**
Grain Size	**Well cap:**
Volume	**Material**
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N**
Material	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

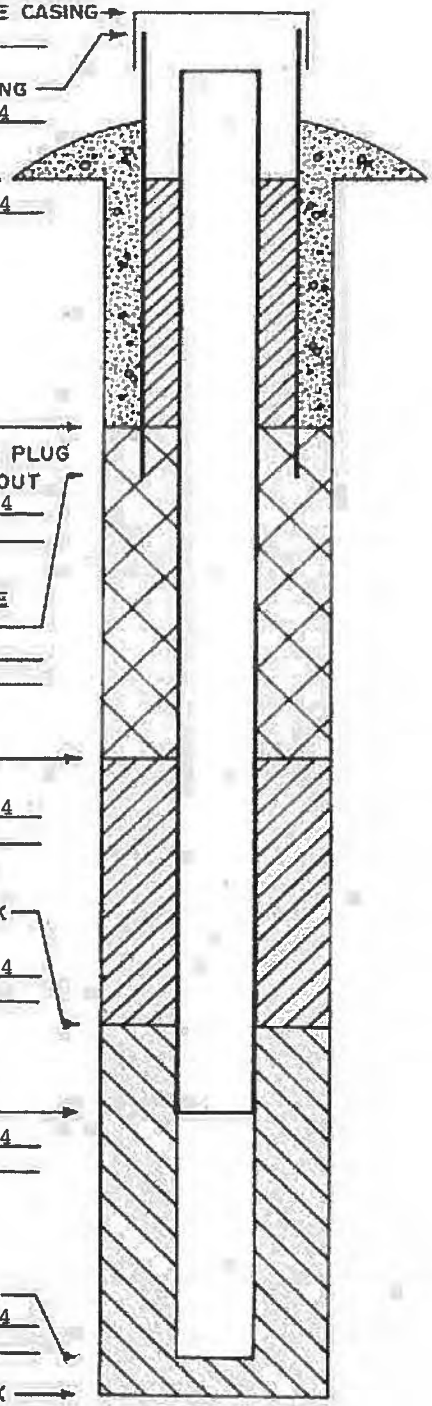
Revised 9/05 Form # 542-1277

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW II-4



TOP OF PROTECTIVE CASING
ELEVATION ________

TOP OF WELL CASING
ELEVATION 1149.4

GROUND SURFACE
ELEVATION 1146.4

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1141.4
DEPTH 5.0

BASE OF PROTECTIVE CASING
ELEVATION ________
DEPTH ________

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1141.4
DEPTH 5.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1139.4
DEPTH 7.0

TOP OF SCREEN
ELEVATION 1137.4
DEPTH 9.0

BOTTOM OF SCREEN
ELEVATION 1127.4
DEPTH 19.0

BASE OF FILTER PACK
ELEVATION 1126.4
DEPTH 20.0

320' FROM MW4

field boring log

Project WINNESHIEK Co SLF

Boring No. MW4S Date Started 5 11 93 Date Complete 5 11 93

Drilled by JEFF Logged by SCOTT Rig ORV

subsurface stratigraphy

☐ 4" Flight Augers ☒ 4¼" ID H.S. ☐ 6¼" ID H.S.

From	To	Description
0.0	1.0	MED BROWN SILTY CLAY w/ORGANICS
1.0	4.0	Lt BROWN SILTY CLAY T/ORGANICS
4.0	11.5	YELLOW BROWN GREY MOTTLED CLAYEY SILT (VERY WET)
11.5	13.0	GREY BROWN MOTTLED CLAYEY SILT
13.0	16.0	YELLOW BROWN GREY SANDY SILTY CLAY w/SAND SEAMS
16.0	17.0	YELLOW BROWN FINE-MED SAND
17.0	22.0	YELLOW BROWN FINE SILTY SAND
22.0		YELLOW BROWN RUST CLAYEY SILT T/SAND

Bottom of Boring 27.5

water levels

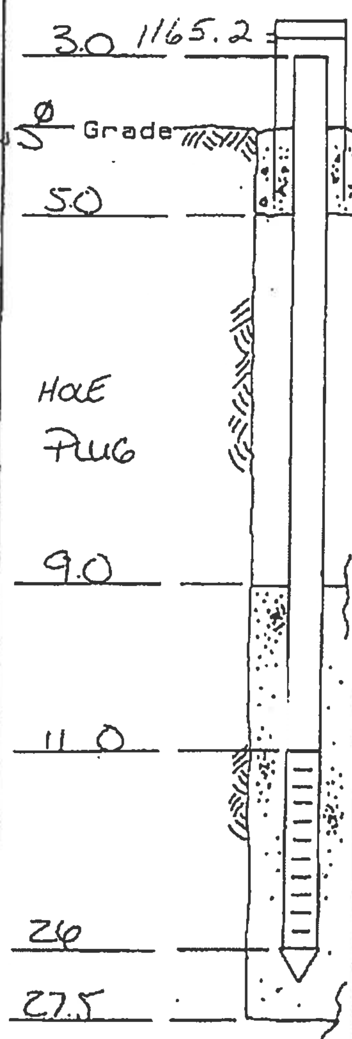
14.0 While Drilling

16.5 0 Hours A.B.

__ __ Hr. A.B.

well details

☒ Stick-up Cover
☐ Flush Cover



sample data

Depth	Number/Type	Depth	Number/Type
0.0-5.0	1CS		
5.0-10.0	2CS		
10.0-15.0	3CS		
15.0-20.0	4CS		
20.0-25.0	5CS		
25.0-27.0	6CS		

CS : Continuous Sampler AS Auger Sample

aquadrill

LOG OF BORING NO. MW-II-5

CLIENT Winneshiek Co. Landfill	ENGINEER Rust Environment and Infrastructure, Inc.
SITE Near Decorah, Iowa	PROJECT Hydrologic Monitoring System Update

BOREHOLE DIA.: 10 in
WELL DIA.: 2 in
TOP OF CASING: +3 ft

Depth (ft)	Description	USCS Symbol	Number	Type	Recovery, in.	SPT - N Blows / ft.	Moisture, %	Dry Density PCF
1	12" Topsoil			HS				
4	SILTY CLAY, TRACE ORGANICS Light Brown							
11.5	CLAYEY SILT (MOTTLED) VERY WET Gray Brown							
13	CLAYEY SILT Yellow Gray Brown							
16	SANDY SILTY CLAY WITH SAND SEAMS Yellow Gray Brown							
22	Fine to Medium Sand from 16' to 17' SILTY FINE SAND Yellow Brown							
25	CLAYEY SILT WITH SAND SEAMS Yellow Brown							
	BOTTOM OF BORING							

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS

WL	∇	▼
WL	∇	∇
WL	NONE	

Terracon

BORING STARTED	4-30-97		
BORING COMPLETED	4-30-97		
RIG	#6	FOREMAN	SAZ
APPROVED	TAS	JOB #	06978506

6/17/97
N3WLLE

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHEIK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW II-5A	
Dates Started	**Date Completed** 4-30-97

A. SURVEYED LOCATIONS AND ELEVATIONS	**B. SOIL BORING INFORMATION**
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	TERRACON INC.
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	Name of driller
Ground Surface 1162.15	Drilling method
Top of protective casing	Drilling fluid
Top of well casing 1164.98	Bore Hole diameter 10 inches
Benchmark elevation	Soil sampling method
Benchmark description	Depth of boring 25 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	Placement method
Length of casing 17.83 feet	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter 2 inches	Material ENVIRO-GEL GROUT
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	Material of protective casing: CADIUM PLATED STEEL
Screen length 10 feet	Material of grout between protective casing and well casing: CONCRETE
Depth of Well 25 feet BGS	**Protective cap:**
Filter Pack:	Material CADIUM PLATED STEEL
Material #0 MORIE SILICA	Vented?: Y/N Y Locking?: Y/N Y
Grain Size	**Well cap:** LOCKING EXPANSION
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material BENTONITE PELLETS	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	Stabilization time
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

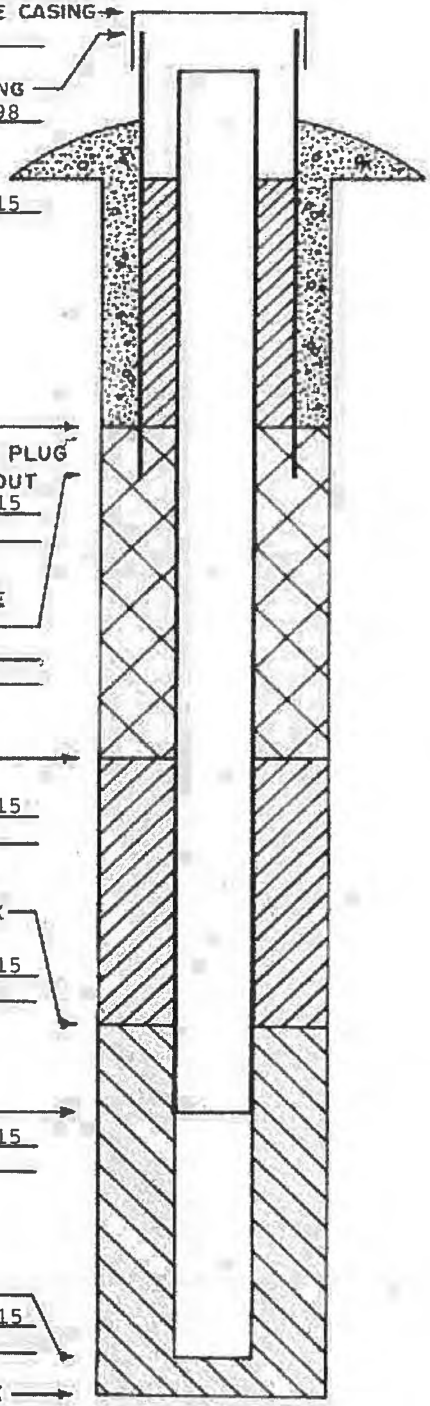
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW II-5A



TOP OF PROTECTIVE CASING
ELEVATION ________

TOP OF WELL CASING
ELEVATION 1164.98

GROUND SURFACE
ELEVATION 1162.15

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1159.15
DEPTH 3.0

BASE OF PROTECTIVE
CASING
ELEVATION ________
DEPTH ________

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1154.15
DEPTH 8.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1149.15
DEPTH 13.0

TOP OF SCREEN
ELEVATION 1147.15
DEPTH 15.0

BOTTOM OF SCREEN
ELEVATION 1137.15
DEPTH 25.0

BASE OF FILTER PACK
ELEVATION 1137.15
DEPTH 25.0

780' FROM MW 4

field boring log

Project Winneshiek Co SLF

Boring No. MW11-6 Date Started 5 11 93 Date Complete 5 11 93

Drilled by Jeff Logged by Scott Rig ORV

subsurface stratigraphy

☐ 4" Flight Augers ☒ 4¼" ID.H.S. ☐ 6¼" ID H.S.

From	To	Description
0.0	1.0	MED BROWN SILTY CLAY W/ ORGANICS
1.0	4.5±	BROWN SILTY CLAY ~ ORGANICS
4.5±	14.5	Lt GREY BROWN MOTTLED CLAYEY SILT T/FINE SAND
14.5	16.0	YELLOW BROWN SILTY SAND FINE - MED
16.0	17.5	GREY & GREEN MOTTLED CLAYEY SILT T/SAND
17.5	18.0	GREY FINE SILTY SAND
18.0		DARK GREY SILTY CLAY (HIGHLY FRIABLE)
		DARK GREY SHALE

Bottom of Boring 25.0

water levels

9.0 While Drilling

4.0± 0 Hours A.B.

__ __ Hr. A.B.

well details

☒ Stick-up Cover
☐ Flush Cover

3.0 1152.9

Ø Grade

5.0

HOLE PLUG

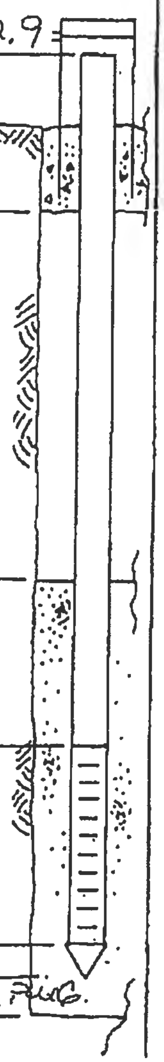
7.0

9.0

19.0

20.0

25.0 HOLE PLUG



sample data

Depth	Number/Type	Depth	Number/Type
0.0-5.0	1CS		
5.0-10.0	2CS		
10.0-15.0	3CS		
15.0-20.0	4CS		
20.0-25.0	5CS		

CS - Continuous Sampler AS - Auger Sample

aquadrill

Appendix A-6 – 1995 – Boring Logs and Monitoring Well Construction Documentation

LOG OF TEST BORING

JOB NO. 7700 95-278 VERTICAL SCALE 1" = 5' BORING NO. 5A

PROJECT WINNESHIEK COUNTY LANDFILL, IOWA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1148.9)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	W	D	LL	PL	Qu or RQD
	CLAYEY SILT, brown (ML-CL)	GLACIAL TILL				SS					
	With sand, grayish brown, from 5' to 7'					SS					
	Light yellowish brown from 7'										
						SS					
14.0	SHALE, gray, hard	BEDROCK				SS					
						SS					
20.0	END OF BORING										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
7-10-95	1145					Dry
7-10-95	---					Dry

START 7-6-95 COMPLETE 7-6-95 @ 1730

METHOD 3 1/4" HSA 0' TO 20'

EAST: NORTH:

CREW CHIEF Gary Studer

twin city testing corporation

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-5A	
Dates Started	**Date Completed** 7-11-95

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller**
Ground Surface 1148.88	**Drilling method**
Top of protective casing 1151.38	**Drilling fluid**
Top of well casing 1151.08	**Bore Hole diameter** 8.00 inches
Benchmark elevation 1158.80	**Soil sampling method**
Benchmark description Second spike in power pole at N.W. corner of site	**Depth of boring** 20 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	**Placement method**
Length of casing 11.6 feet	**Volume**
Outside casing diameter 2.5 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	**Material** Volclay Grout
Casing joint type	**Placement method**
Casing/screen joint type	**Volume**
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inch	**Material of protective casing:** Steel
Screen length 10.5 feet	**Material of grout between protective casing and well casing:** Concrete
Depth of Well 17.7 feet BGS	**Protective cap:**
Filter Pack:	**Material** Steel
Material Silica Sand	**Vented?: Y/N** **Locking?: Y/N**
Grain Size	**Well cap:**
Volume	**Material** PVC
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N** Y
Material Bentonite	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

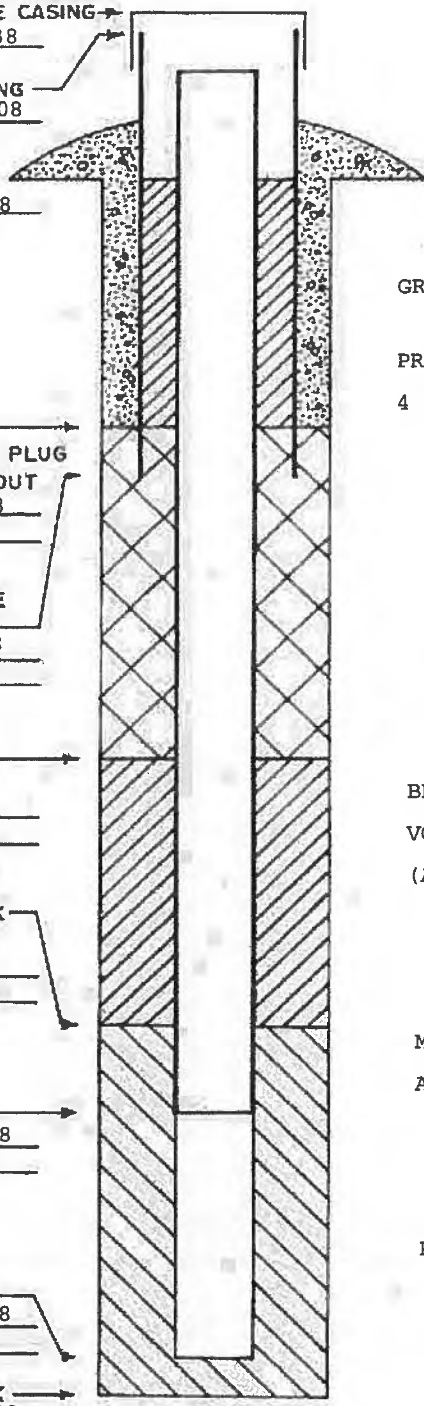
Revised 9/05 Form # 542-1277

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-5A



TOP OF PROTECTIVE CASING
ELEVATION 1151.38

TOP OF WELL CASING
ELEVATION 1151.08

GROUND SURFACE
ELEVATION 1148.88

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1146.88
DEPTH 2.0

BASE OF PROTECTIVE CASING
ELEVATION 1146.38
DEPTH 2.5

BASE OF BACKFILL
TOP OF SEAL
ELEVATION
DEPTH

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1141.68
DEPTH 7.2

TOP OF SCREEN
ELEVATION 1139.48
DEPTH 9.4

BOTTOM OF SCREEN
ELEVATION 1131.18
DEPTH 17.7

BASE OF FILTER PACK
ELEVATION 1128.88
DEPTH 20

TOP OF THREADED PVC CAP

2 FOOT MINIMUM ABOVE GRADE

6 INCH PEA GRAVEL AND COARSE SAND

SLOPE GROUNT AWAY FROM CASING TO PREVENT INFILTRAION

GROUT SEAL TO SURFACE

PROTECTIVE CASING

4 FOOT MINIMUM DEPTH

BENTONITE SEAL

VOLCAY BENTONITE PELLETS

(ADD WATER IF ABOVE WATER TABLE)

MUSCATINE FILTER PACK

ABOVE TOP OF SCREEN

PVC #10 SLOT WELL SCREEN

LOG OF TEST BORING

JOB NO. 7700 95-278 VERTICAL SCALE 1" = 5' BORING NO. 5B

PROJECT WINNESHIEK COUNTY LANDFILL, IOWA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1162.8)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	W	D	LL	PL	Qu or RQD
2.0	CLAYEY SILT, light yellowish brown, moist (ML-CL)	LOESS				SS					
7.0	CLAYEY SILT, brown, moist (ML-CL)	GLACIAL TILL				SS SS					
22.0	CLAYEY SILT WITH WEATHERED LIMESTONE, yellow to yellowish brown, moist	BEDROCK				SS SS SS					
25.1	SHALE, dark gray, moist					SS					
	END OF BORING										

WATER LEVEL MEASUREMENTS						
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
7-17-95	---					Dry

START 7-11-95 COMPLETE 7-11-95 @ 1500

METHOD 3 1/4" HSA 0' TO 25.1'

EAST: NORTH:

CREW CHIEF Alfred Harris

twin city testing corporation

LOG OF TEST BORING

JOB NO. 7700 95-278 VERTICAL SCALE 1" = 5' BORING NO. 6A ~~5B~~

PROJECT WINNESHIEK COUNTY LANDFILL, IOWA

SURFACE ELEVATION 1162.8

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	W	D	LL	PL	Qu or RQD
2.0	CLAYEY SILT, light yellowish brown, moist (ML-CL)	LOESS				SS					
7.0	CLAYEY SILT, brown, moist (ML-CL)	GLACIAL TILL				SS, SS					
22.0	CLAYEY SILT WITH WEATHERED LIMESTONE, yellow to yellowish brown, moist	BEDROCK				SS, SS, SS					
25.1	SHALE, dark gray, moist					SS					
	END OF BORING										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
7-17-95	---					Dry

START 7-11-95 COMPLETE 7-11-95 @ 1500

METHOD 3 1/4" HSA 0' TO 25.1'

EAST: NORTH:

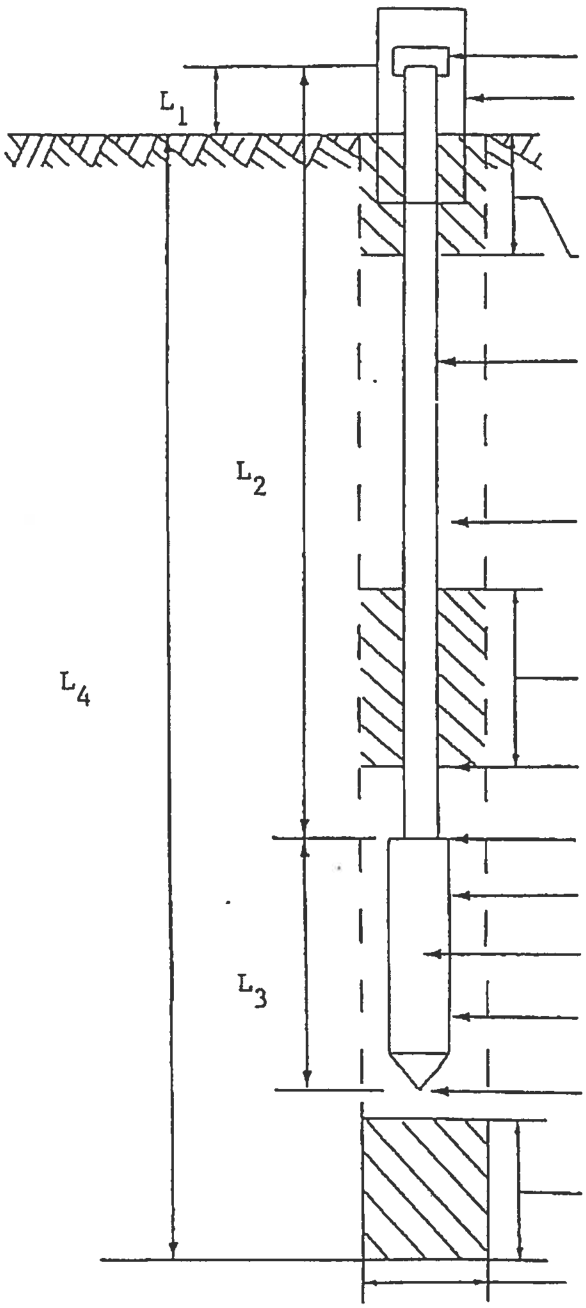
CREW CHIEF Alfred Harris

twin city testing corporation

INSTALLATION OF MONITORING WELL

JOB NO. 7700-95-278 MONITORING WELL NO. ~~5B~~ 6A WINNESHIEK COUNTY LANDFILL

GROUND SURFACE ELEVATION 1162.81 TOP OF RISER PIPE ELEVATION (with cap removed) 1165.73



VENTED CAP	EXPANDABLE PLUG
PROTECTIVE CASING	
Diameter and Type	4" SQUARE STEEL
Total Length	5 FOOT
Length Above Ground	
THICKNESS AND TYPE OF SEAL	2' CONCRETE
DIAMETER AND TYPE OF RISER PIPE	2" SCH 40 PVC
TYPE OF BACKFILL AROUND RISER	VOLCLAY GROUT
THICKNESS AND TYPE OF SEAL	2' BENTONITE HOLEP
DEPTH TO TOP OF FILTER SAND	10' BELOW GRADE
TYPE OF FILTER AROUND SCREEN	SILICA SAND
TYPE OF MONITORING WELL	2" SCH 40 PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" X 10.5'
DEPTH TO BOTTOM OF MONITORING WELL	25' BELOW GRADE
DEPTH TO BOTTOM OF FILTER SAND	25' BELOW GRADE
THICKNESS AND TYPE OF SEAL	NATURAL (SHALE)
DIAMETER OF BOREHOLE	8

L_1 = 2.92 FT

L_2 = 14.4 FT

L_3 = 10.5 FT

L_4 = 25 FT

INSTALLATION COMPLETED:

Date 7/11/95 Time 15:00

MONITORING WELL WATER LEVELS

DATE	TIME	WATER LEVEL
7/17/95	–	DRY

LOG OF TEST BORING

JOB NO. 7700 95-278 VERTICAL SCALE 1" = 5' BORING NO. 21A

PROJECT WINNESHIEK COUNTY LANDFILL, IOWA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1151.5)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	W	D	LL	PL	Qu or RQD
	CLAYEY SILT, brown (ML-CL)	GLACIAL TILL				SS					
	With sand, mottled grayish brown, from 5' to 7'					SS					
7.0	SILTY SAND, fine grained, yellowish brown (SM)					SS					
15.0	SHALE, gray, hard	BEDROCK				SS					
						SS					
						SS					
						SS					
	SHALE, gray, hard										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
7-10-95	1130					1104.43
7-17-95	---					1090.94

START 6-28-95 COMPLETE 6-28-95 @ 1600

METHOD 3 1/4" HSA 0' TO 65'

EAST: NORTH:

CREW CHIEF Gary Studer

twin city testing corporation

LOG OF TEST BORING

JOB NO. 7700 95-278 VERTICAL SCALE 1" = 5' BORING NO. 21A CONTINUED

PROJECT WINNESHIEK COUNTY LANDFILL, IOWA

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	W	D	LL	PL	Qu or RQD
						SS					
45.0	LIMESTONE WITH SOME SHALE, gray, hard					SS					
						SS					
				▼		SS					
65.0	END OF BORING										

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHIEK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-21A	
Dates Started	**Date Completed** 7-6-95

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller**
Ground Surface 1151.54	**Drilling method**
Top of protective casing 1155.14	**Drilling fluid**
Top of well casing 1154.98	**Bore Hole diameter** 8 inch(0-15 feet BGS) 4 inch(15-65 feet BGS)
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 65 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	**Placement method**
Length of casing 57.94 feet	**Volume**
Outside casing diameter 2.5 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	**Material** VOLCLAY GROUT
Casing joint type	**Placement method**
Casing/screen joint type	**Volume**
Screen material VOLCLAY GROUT	**Surface seal design:**
Screen opening size 0.010 inches	**Material of protective casing:** STEEL
Screen length 10.5 feet	**Material of grout between protective casing and well casing:** CONCRETE
Depth of Well 65 feet BGS	**Protective cap:**
Filter Pack:	**Material** STEEL
Material SILICA SAND	**Vented?: Y/N** Y **Locking?: Y/N**
Grain Size	**Well cap:**
Volume	**Material** PVC
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N** Y
Material VOLCLAY GROUT	

D. GROUNDWATER MEASUREMENT ($\pm$ 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

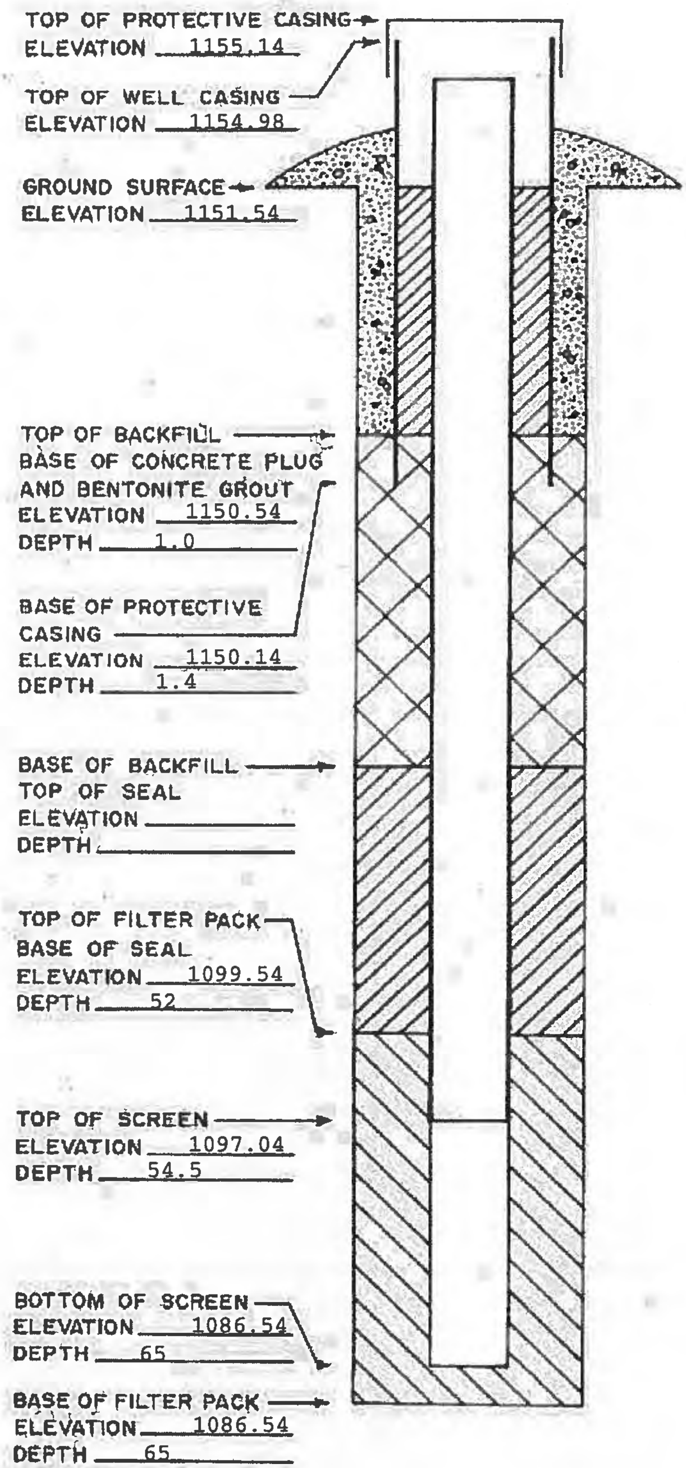
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM
GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-21A



LOG OF TEST BORING

JOB NO. 7700 95-278 VERTICAL SCALE 1" = 5' BORING NO. 21B

PROJECT WINNESHIEK COUNTY LANDFILL, IOWA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 1165.2)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	W	D	LL	PL	Qu or RQD
	CLAYEY SILT, yellowish brown, with trace of rock (ML-CL)	LOESS				SS					
3.0						SS					
	CLAYEY SILT, light brown, moist (ML-CL)	GLACIAL TILL				SS					
7.0											
	CLAYEY SILT WITH WEATHERED LIMESTONE, yellow to yellowish brown, moist, soft	BEDROCK				SS					
22.0											
	SHALE, gray										

START 6-29-95 COMPLETE 7-5-95 @ 1630

METHOD 3 1/4" HSA 0' TO 9'; AIR ROTARY TO 66'

EAST: NORTH:

CREW CHIEF Alfred Harris

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
7-10-95	1400					1156.68
7-17-95	---					1101.24

LOG OF TEST BORING

JOB NO. 7700 95-278 VERTICAL SCALE 1" = 5' BORING NO. 21B CONTINUED

PROJECT WINNESHIEK COUNTY LANDFILL, IOWA

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	W	D	LL	PL	Qu or RQD
	SHALE, gray										
53.0	LIMESTONE, light brown, hard										
66.0	END OF BORING										

Appendix A-7 – 1997 – Boring Logs and Monitoring Well Construction Documentation

LOG OF BORING NO. 7A

CLIENT	ENGINEER
Winneshiek Co. Landfill	Rust Environment and Infrastructure, Inc.
SITE	**PROJECT**
Near Decorah, Iowa	Hydrologic Monitoring System Update

DESCRIPTION

BOREHOLE DIA.: 10 in
WELL DIA.: 2 in
TOP OF CASING: +3 ft

Graphic Log depth	Description	Depth (ft.)	USCS Symbol	Number	Type	Recovery, in.	SPT-N Blows / ft.	Moisture, %	Dry Density PCF
0.7	8" TOPSOIL				HS				
9.5	LEAN CLAY, TRACE SAND Gray Brown	5							
12	SILTY CLAY, TRACE SAND Light Brown	10							
17	LEAN TO FAT CLAY, TRACE SAND Gray Brown		CL/CH	1	3"ST	14			
		15			HS				
	BOTTOM OF BORING								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS		
WL	NONE	
WL		
WL		

Terracon

BORING STARTED	4-29-97
BORING COMPLETED	4-29-97
RIG #6	FOREMAN SAZ
APPROVED TAS	JOB # 06978506

N3WLLE 7. 6/10/97

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHIEK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-7A	
Dates Started	**Date Completed** 4-29-97

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	TERRACON INC.
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller**
Ground Surface 1132.9	**Drilling method**
Top of protective casing	**Drilling fluid**
Top of well casing 1135.9	**Bore Hole diameter** 10 inches
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 17 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	**Placement method**
Length of casing 13 feet	**Volume**
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter 2 inches	**Material** BENTONITE PELLETS
Casing joint type	**Placement method**
Casing/screen joint type	**Volume**
Screen material	**Surface seal design:**
Screen opening size 0.010 inches	**Material of protective casing:** CADIUM PLATED STEEL
Screen length 10 feet	**Material of grout between protective casing and well casing:**
Depth of Well 17 feet BGS	**Protective cap:**
Filter Pack:	**Material** CADIUM PLATED STEEL
Material #0 MORIE SILICA	**Vented?: Y/N** Y **Locking?: Y/N** Y
Grain Size	**Well cap:**
Volume	**Material** LOCKING EXPANSION
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N**
Material CONCRETE	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

Revised 9/05

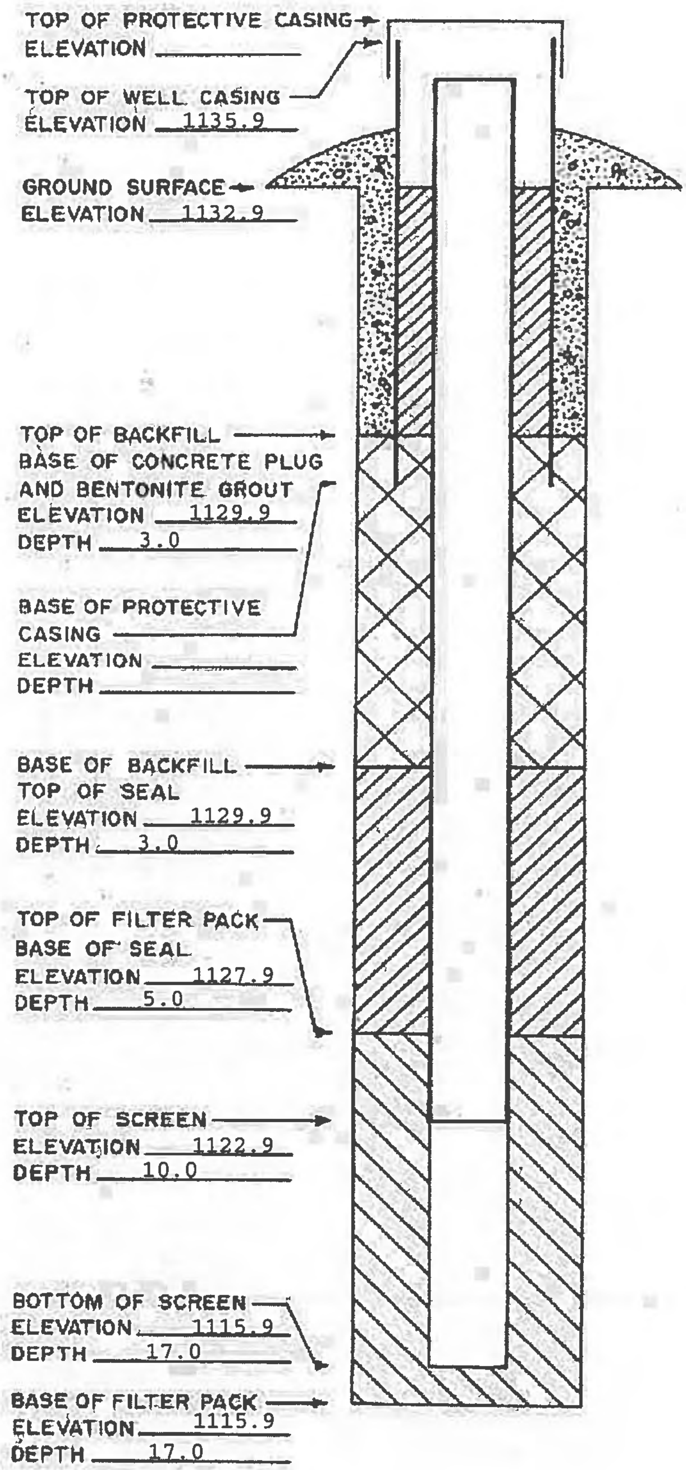
Form # 542-1277

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM
GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-7A



LOG OF BORING NO. 8A

CLIENT	ENGINEER
Winneshiek Co. Landfill	Rust Environment and Infrastructure, Inc.
SITE	PROJECT
Near Decorah, Iowa	Hydrologic Monitoring System Update

BOREHOLE DIA.: 10 in
WELL DIA.: 2 in
TOP OF CASING: +3 ft

Depth of stratum (ft)	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY, IN.	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF
0.5	6" TOPSOIL				HS				
	LEAN CLAY, TRACE SAND Gray Brown, Soft to Medium Dense	5	CL	1	SS	18	3		
					HS				
10.5	Moist Organic seam at 10'	10	CL/ML	2	SS	12	4		
	CLAYEY SILT, TRACE SAND Gray Brown, Dense, Non Plastic		ML	3	SS	18	4		
					HS				
14	Wet at 11' ▽		ML	4	SS	16	3 3		
17	HIGHLY WEATHERED LIMESTONE Light Gray Brown	15			HS		50/5		
	BOTTOM OF BORING								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS		
WL	▽ 14	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	4-28-97
BORING COMPLETED	4-28-97
RIG #6	FOREMAN SAZ
APPROVED TAS	JOB # 06978506

N3WLLE 7 6/10/97

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHIEK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-8A	
Dates Started	**Date Completed** 4-28-97

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	TERRACON INC.
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller**
Ground Surface 1126.5	**Drilling method**
Top of protective casing	**Drilling fluid**
Top of well casing	**Bore Hole diameter** 10 feet
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 17 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	Placement method
Length of casing 13.13 feet	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter 2 inches	Material BENTONITE PELLTS
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material	**Surface seal design:**
Screen opening size 0.010 inches	Material of protective casing: CADIUM PLATED STEEL
Screen length 10 feet	Material of grout between protective casing and well casing:
Depth of Well 17 feet BGS	**Protective cap:**
Filter Pack:	Material CADIUM PLATED STEEL
Material #0 MORIE SILICA	Vented?: Y/N Y Locking?: Y/N Y
Grain Size	**Well cap:** LOCKING EXPANSION
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material CONCRETE	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

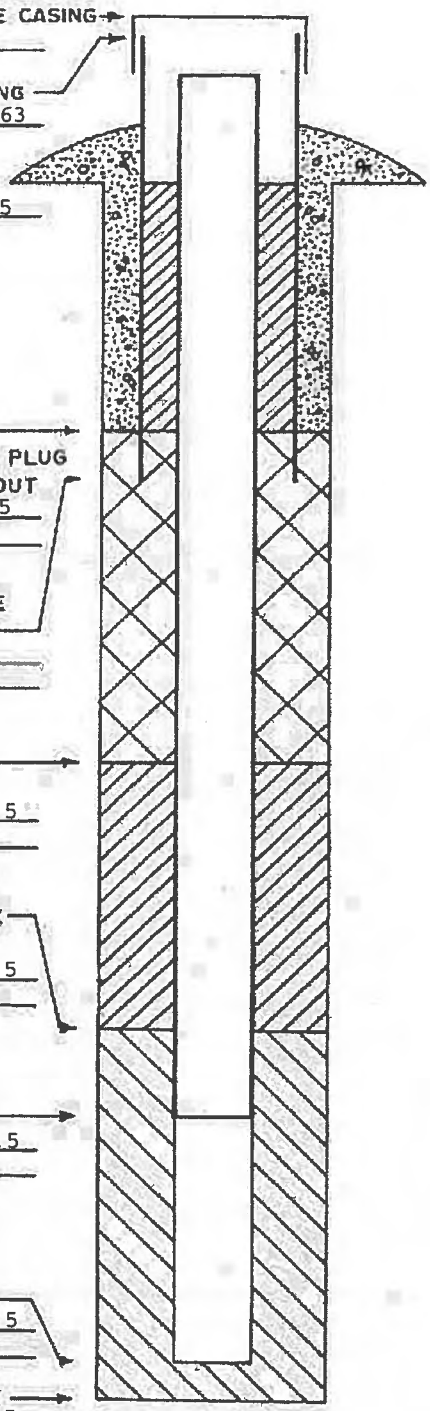
Revised 9/05 Form # 542-1277

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-8A



TOP OF PROTECTIVE CASING
ELEVATION ______

TOP OF WELL CASING
ELEVATION 1129.63

GROUND SURFACE
ELEVATION 1126.5

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1123.5
DEPTH 3.0

BASE OF PROTECTIVE CASING
ELEVATION ______
DEPTH ______

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1123.5
DEPTH 3.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1121.5
DEPTH 5.0

TOP OF SCREEN
ELEVATION 1116.5
DEPTH 10.0

BOTTOM OF SCREEN
ELEVATION 1109.5
DEPTH 17.0

BASE OF FILTER PACK
ELEVATION 1109.5
DEPTH 17.0

LOG OF BORING NO. 22

CLIENT	ENGINEER
Winneshiek Co. Landfill	Rust Environment and Infrastructure, Inc.
SITE	PROJECT
Near Decorah, Iowa	Hydrologic Monitoring System Update

BOREHOLE DIA.: 10 in
WELL DIA.: 2 in
TOP OF CASING: +3 ft

Depth (ft)	Description	USCS Symbol	Number	Type	Recovery, in.	SPT - N Blows / ft.	Moisture, %	Dry Density PCF	
0.7	8" TOPSOIL			HS					
0.7–9.5	LEAN CLAY, TRACE SAND Gray Brown	CL	1	SS	12	4			gr sz
				HS					
9.5–12	SILTY CLAY, TRACE SAND Light Brown	ML/CL	2	SS	18	7			
				HS					
12–18.5	LEAN TO FAT CLAY (Gray Brown), TRACE LIMESTONE GRAVEL (Light Brown) Sand Seams (Red Brown)	CL/CH	3	SS	18	12			gr sz
				HS					
18.5–26	HIGHLY WEATHERED LIMESTONE INTERBEDDED WITH SHALE Light Brown to White		4	SS	0	50/0			
				RB					
26–	WEATHERED LIMESTONE, WITH OCCASIONAL CLAY AND SHALE SEAMS Light Brown to White								

Water level ▽ at 18.5 ft.

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS		
WL	▽ 18.5	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	4-29-97
BORING COMPLETED	4-29-97
RIG #6	FOREMAN SAZ
APPROVED TAS	JOB # 06978506

LOG OF BORING NO. 22

CLIENT	ENGINEER
Winneshiek Co. Landfill	Rust Environment and Infrastructure, Inc.
SITE	**PROJECT**
Near Decorah, Iowa	Hydrologic Monitoring System Update

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, IN.	TESTS: SPT - N BLOWS / FT.	TESTS: MOISTURE, %	TESTS: DRY DENSITY PCF
			35							
	40		40							
	BOTTOM OF BORING									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS		
WL	▽ 18.5	▼
WL	▽	▼
WL		

Terracon

BORING STARTED			4-29-97
BORING COMPLETED			4-29-97
RIG	#6	FOREMAN	SAZ
APPROVED	TAS	JOB #	06978506

N3WLLE 3/10/97

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHEIK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-22	
Dates Started	**Date Completed** 4-29-97

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	TERRACON INC.
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller**
Ground Surface 1132.7	**Drilling method**
Top of protective casing	**Drilling fluid**
Top of well casing 1135.47	**Bore Hole diameter** 10 1/4 inches
Benchmark elevation	**Soil sampling method**
Benchmark description	**Depth of boring** 40 feet BGS

C. MONITORING WELL INSTALLATION	
Casing material PVC	Placement method
Length of casing 32.77 feet	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter 2 inches	Material ENVIRO-GEL GROUT
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material	**Surface seal design:**
Screen opening size 0.010 inches	Material of protective casing: CADIUM PLATED STEEL
Screen length 10 feet	Material of grout between protective casing and well casing: CONCRETE
Depth of Well 40 feet BGS	**Protective cap:**
Filter Pack:	Material CADIUM PLATED STEEL
Material #0 MORIE SILICA	Vented?: Y/N Y Locking?: Y/N Y
Grain Size	**Well cap:** LOCKING EXPANSION
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material BENTONITE SLURRY AND PELLETS	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

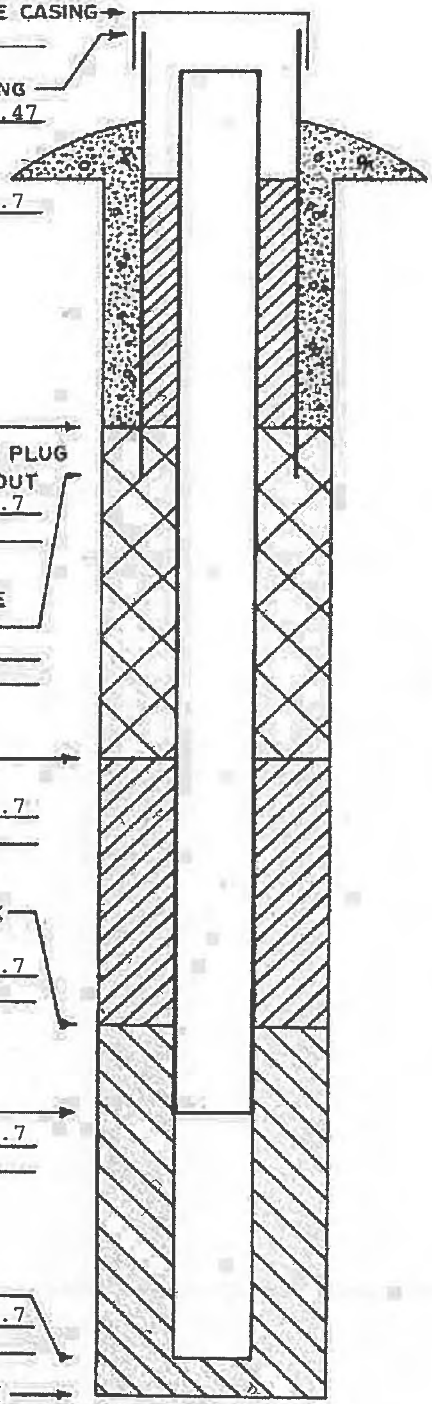
Revised 9/05 Form # 542-1277

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-22



TOP OF PROTECTIVE CASING ELEVATION ____

TOP OF WELL CASING ELEVATION 1135.47

GROUND SURFACE ELEVATION 1132.7

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1129.7
DEPTH 3.0

BASE OF PROTECTIVE CASING
ELEVATION ____
DEPTH ____

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1118.7
DEPTH 14.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1104.7
DEPTH 28.0

TOP OF SCREEN
ELEVATION 1102.7
DEPTH 30.0

BOTTOM OF SCREEN
ELEVATION 1092.7
DEPTH 40.0

BASE OF FILTER PACK
ELEVATION 1092.7
DEPTH 40.0

LOG OF BORING NO. 23

CLIENT	ENGINEER
Winneshiek Co. Landfill	Rust Environment and Infrastructure, Inc.
SITE	PROJECT
Near Decorah, Iowa	Hydrologic Monitoring System Update

BOREHOLE DIA.: 10 in
WELL DIA.: 2 in
TOP OF CASING: +3 ft

Depth (ft)	DESCRIPTION	USCS SYMBOL	NUMBER	TYPE	RECOVERY, IN.	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF
0.5	6" TOPSOIL			HS				
10.5	LEAN CLAY, TRACE SAND Gray Brown	CL	1	3"ST	20			
14.5	CLAYEY SILT, TRACE SAND Gray Brown			HS				
26	WEATHERED LIMESTONE Light Brown to White			RB				
	WEATHERED LIMESTONE WITH CLAY AND SHALE SEAMS Light Brown to White							

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS		
WL	NONE	
WL		
WL		

Terracon

BORING STARTED	4-30-97
BORING COMPLETED	4-30-97
RIG #6	FOREMAN SAZ
APPROVED TAS	JOB # 06978506

6/10/97 N3WLLE

LOG OF BORING NO. 23

CLIENT Winneshiek Co. Landfill	ENGINEER Rust Environment and Infrastructure, Inc.
SITE Near Decorah, Iowa	PROJECT Hydrologic Monitoring System Update

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES: USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, IN.	TESTS: SPT - N BLOWS / FT.	TESTS: MOISTURE, %	TESTS: DRY DENSITY PCF	
			35								
	40		40								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS		
WL	▽ NONE	▼
WL	▼	▼
WL		

Terracon

BORING STARTED	4-30-97		
BORING COMPLETED	4-30-97		
RIG	#6	FOREMAN	SAZ
APPROVED	TAS	JOB #	06978506

N3WLLE 6/10/97

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHEIK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-23	
Dates Started	**Date Completed** 4-30-97

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	TERRACON INC.
Distance & direction along boundary	660 SW 7TH ST. SUITE M
Distance & direction from boundary to well	DES MOINES, IOWA
Elevations (± 0.01 ft. MSL):	Name of driller
Ground Surface 1126.50	Drilling method
Top of protective casing	Drilling fluid
Top of well casing 1129.53	Bore Hole diameter 10.0 inches
Benchmark elevation	Soil sampling method
Benchmark description	Depth of boring 40 feet

C. MONITORING WELL INSTALLATION	
Casing material PVC	Placement method
Length of casing	Volume
Outside casing diameter	**Backfill (if different from seal):**
Inside casing diameter 2.0 inches	Material ENVIRO-GEL GROUT
Casing joint type	Placement method
Casing/screen joint type	Volume
Screen material	**Surface seal design:**
Screen opening size 0.010 inches	Material of protective casing: STEEL
Screen length 10 feet	Material of grout between protective casing and well casing:
Depth of Well 40 feet BGS	**Protective cap:**
Filter Pack:	Material STEEL
Material #0 MORIE SILICA	Vented?: Y/N Y Locking?: Y/N Y
Grain Size	**Well cap:**
Volume	Material
Seal (minimum 3 ft. length above filter pack):	Vented?: Y/N
Material BENTONITE PELLETS AND SLURRY	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	Stabilization time
Well development method	
Average depth of frostline	

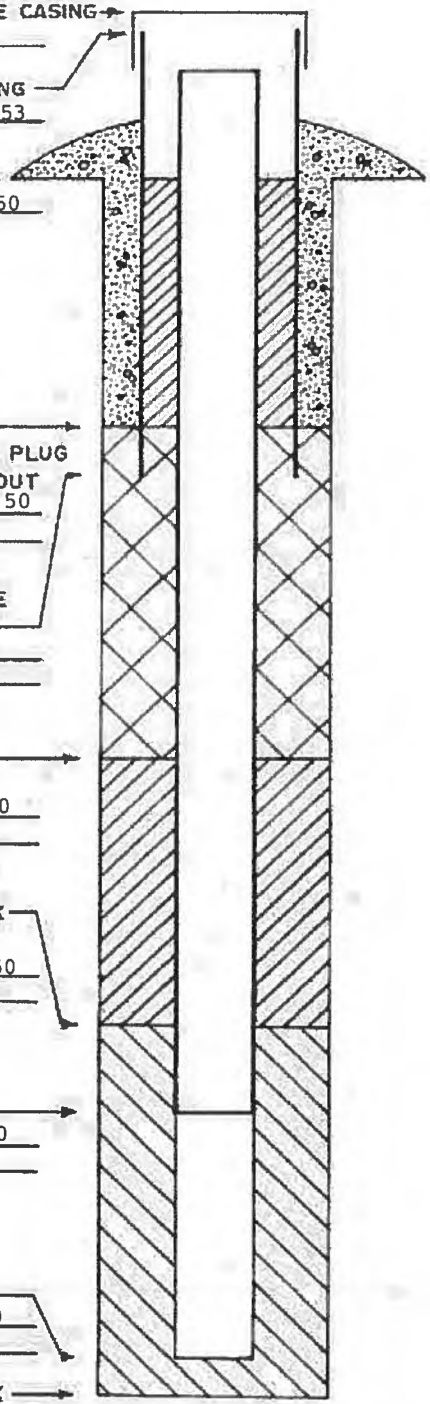
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



TOP OF PROTECTIVE CASING
ELEVATION ________

TOP OF WELL CASING
ELEVATION 1129.53

GROUND SURFACE
ELEVATION 1126.50

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1123.50
DEPTH 3.0

BASE OF PROTECTIVE CASING
ELEVATION ________
DEPTH ________

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1108.50
DEPTH 18.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1098.50
DEPTH 28.0

TOP OF SCREEN
ELEVATION 1096.50
DEPTH 30

BOTTOM OF SCREEN
ELEVATION 1086.50
DEPTH 40.0

BASE OF FILTER PACK
ELEVATION 1086.50
DEPTH 40.0

Appendix A-8 – 2001 – Boring Logs and Monitoring Well Construction Documentation

EARTH TECH

A tyco INTERNATIONAL LTD COMPANY

FIELD BORING LOG

SHEET 1 OF 1

BORING NO. MW-2R

SITE: Winneshiek County Landfill

PROJECT NO. 37655.1050

WATER LEVEL READINGS

DRILLING METHOD: HSA w/ No Sampling to 15.0 feet; Tricone Roller Bit from 15.0 ft to ft; 5 7/8" DIA Bit Air Rotary Rig No. 37 CME 850 ATV

LOG BY: D. Kellehek

FIRM/DRILLER: Terracon Inc. / S. Zeier

PHYSICAL SETTING: Paleozoic Plateau

DATE/TIME	WATER DEPTH	HOLE DEPTH	CASING DEPTH

ABANDONMENT DATE:

ABANDONMENT METHOD:

GROUND SURFACE ELEV.:

COORDINATE TYPE:

NORTH:

EAST:

DATE/TIME START:

DATE/TIME COMPLETE:

WELL INSTALLATION DATE:

DEPTH IN FEET	B	N	A	R	NO.	T	GRAPHIC LOG	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
									Moist at 5.0 ft? Gray Cohesive Deposits
							13.5	CL Gray Yellow	
15							15.0		Broken Limestone Rubble from 13.5 to 15.0; Wet; Lt. Brown.
									Limestone Based on Gamma log and drillers observations
27							27.0		Approximate Contact at 27.0 feet
									Shale
50							50.0		End of Boring at 50.0 feet.

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHIEK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-2R	
Dates Started 10-15-01	**Date Completed** 10-16-01

A. SURVEYED LOCATIONS AND ELEVATIONS		B. SOIL BORING INFORMATION	
Locations (± 0.5 ft.):		**Name & address of construction company**	
Specify corner of site		TERRACON INC.	
Distance & direction along boundary			
Distance & direction from boundary to well			
Elevations (± 0.01 ft. MSL):		Name of driller	S. ZEIER
Ground Surface	1172.80	Drilling method	6.25 inches I.D. HSA
Top of protective casing	1175.70	Drilling fluid	WATER
Top of well casing	1175.34	Bore Hole diameter	
Benchmark elevation		Soil sampling method	
Benchmark description		Depth of boring	50 feet BGS

C. MONITORING WELL INSTALLATION			
Casing material	PVC	Placement method	
Length of casing	18.5 feet	Volume	20 gallons
Outside casing diameter	2.18 inches	**Backfill (if different from seal):**	
Inside casing diameter	2.00 inches	Material	none
Casing joint type	FLUSH THREADED, O-RING	Placement method	
Casing/screen joint type	FLUSH THREADED, O-RING	Volume	
Screen material	PVC	**Surface seal design:**	
Screen opening size	0.010 inches	Material of protective casing:	ANODIZED ALUMINUM
Screen length	10.0 feet	Material of grout between protective casing and well casing:	QUIKCRETE
Depth of Well	26 feet BGS	**Protective cap:**	
Filter Pack:		Material	ANODIZED ALUMINUM
Material	#30 QUARTZ SAND	Vented?: Y/N Y	Locking?: Y/N Y
Grain Size		**Well cap:**	
Volume	5 BAGS	Material	PVC
Seal (minimum 3 ft. length above filter pack):		Vented?: Y/N	N
Material	3/8 inch BENTONITE CHIPS		

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)			
Water level		Stabilization time	
Well development method			
Average depth of frostline	3 feet BGS		

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

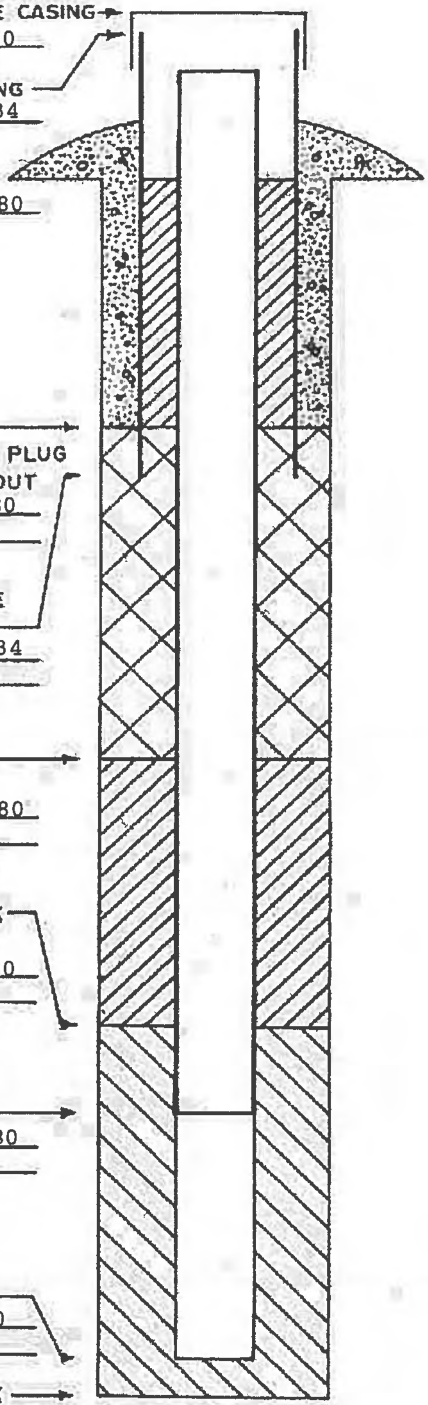
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).

MW-2R



TOP OF PROTECTIVE CASING
ELEVATION 1175.70

TOP OF WELL CASING
ELEVATION 1175.34

GROUND SURFACE
ELEVATION 1172.80

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1169.80
DEPTH 3.0

BASE OF PROTECTIVE CASING
ELEVATION 1170.34
DEPTH 2.46

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1169.80
DEPTH 3.0

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1158.80
DEPTH 14.0

TOP OF SCREEN
ELEVATION 1156.80
DEPTH 16.0

BOTTOM OF SCREEN
ELEVATION 1146.80
DEPTH 26.0

BASE OF FILTER PACK
ELEVATION 1144.80
DEPTH 28.0

EARTH TECH

FINAL SOIL BORING LOG

BORING NO. MW-2R

SHEET 1 OF 2

SITE: Winnesheik Co. Landfill PROJECT NO. 37655

SITE #:

WATER LEVEL READINGS DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV:

LOCAL COORDINATES:

NORTHING:

EASTING:

PHYSICAL SETTING: Palezoil Plateau

LOG BY: D. Kelleher

FIRM/DRILLER: Terracon Inc./S. Zeier

DRILLING METHOD: HSA w/no sampling to 15.0 feet; tricone roller bit from 15.0 to 50.0 feet; 5 7/8 inch dia. bit air rotary

DATE/TIME STARTED: 10/15/01 ;

DATE/TIME COMPLETED: ;

ABANDONMENT DATE:

ABANDONMENT METHOD:

WELL INSTALLATION:

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0								CL	Moist at 5.0 feet. Gray cohesive deposits.
								CL	Broken LIMESTONE rubble from 13.5 to 15.0 feet; wet; light brown.
15								LS	LIMESTONE Based on gamma log and drillers observation.

Tracking Code: 37655/IN.GPJ, ETSOIL, 1/16/02, 13:00

Continued Next Page

EARTH TECH

FINAL SOIL BORING LOG

BORING NO. MW-2R

SITE: Winnesheik Co. Landfill PROJECT NO. 37655 SHEET 2 OF 2

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
25									
								SH	SHALE
30									
35									
40									
45									
50									END OF BORING AT 50.0 FEET.

Tracking Code: 37655YDLGPJ, ETSOIL, 1/16/02, 13:00

EARTH TECH

FINAL ROCK CORE LOG

BORING NO. MW-11

SITE: Winnesheik Co. Landfill PROJECT NO. 37655 SHEET 1 OF 2

WATER LEVEL READINGS

DATE	TIME	DEPTH	CASING

DRILLING METHOD: HSA to 10.5 ft.; air rotary to 40.0 feet.

LOG BY: D. Kelleher

FIRM/DRILLER: Terracon Inc./S. Zeier / G. Everman

PHYSICAL SETTING: Palezoic Plateau

ABANDONMENT DATE: NA

ABANDONMENT METHOD: NA

GROUND SURFACE ELEV: 1136.5

COORDINATES:

NORTHING: 9114.2

EASTING: 12270.2

DATE STARTED: 10/18/01

DATE COMPLETED: 10/18/01

WELL INSTALLATION: 10/18/01

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION	Comment
0		1	5.0							CL	Dark brown LEAN CLAY (CL) cuttings.	
										CL	SANDY LEAN CLAY WITH GRAVEL (CL) cuttings.	
5		2	5.0									
10		3	10.0									
										SH	SHALE cuttings.	
15												
20		4	10.0									
25												

Tracking Codes: 37655WIN.GPJ, ETROCK, 6/14/02, 12:12

EARTH TECH

FINAL ROCK CORE LOG

BORING NO. MW-11

SITE: Winnesheik Co. Landfill PROJECT NO. 37655 SHEET 2 OF 2

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION	Comment
25												
30		5	10.0									
35												
40											END OF BORING AT 40.0 FEET.	
55												

Tracking Codes: 37655WIN.GPJ, ETROCK, 6/14/02, 12:12

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek County Landfill	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-11	
Dates Started 10-18-01	**Date Completed** 10-18-01

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site	TERRACON INC.
Distance & direction along boundary	
Distance & direction from boundary to well	
Elevations (± 0.01 ft. MSL):	**Name of driller** S. ZEIER/ G. EVERMAN
Ground Surface 1136.50	**Drilling method** AIR ROTARY
Top of protective casing 1139.10	**Drilling fluid** AIR
Top of well casing 1138.82	**Bore Hole diameter** 6.00 inches
Benchmark elevation	**Soil sampling method** CUTTINGS
Benchmark description	**Depth of boring** 40.00 ft BGS

C. MONITORING WELL INSTALLATION

Casing material PVC	**Placement method**
Length of casing 32.32 feet	**Volume** 2 bags
Outside casing diameter 2.18 inches	**Backfill (if different from seal):**
Inside casing diameter 2 inches	**Material** Enviroplug Bentonite Powder & 3/8 inch bentonite chips
Casing joint type Flush Threaded, O-Ring	**Placement method**
Casing/screen joint type Flush Threaded, O-Ring	**Volume** 50 Gal. & 2 Bags(Chips)
Screen material PVC	**Surface seal design:**
Screen opening size 0.010 inches	**Material of protective casing:** Anodized Aluminum
Screen length 10.0 feet	**Material of grout between protective casing and well casing:** QUIKCRETE
Depth of Well 40.00 feet BGS	**Protective cap:**
Filter Pack:	**Material** Anodized Aluminum
Material #30 Quartz sand	**Vented?: Y/N** Y **Locking?: Y/N** Y
Grain Size	**Well cap:**
Volume 4 Bags	**Material** PVC
Seal (minimum 3 ft. length above filter pack):	**Vented?: Y/N** Y
Material 3/8" Bentonite Chips	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)

Water level	**Stabilization time**
Well development method	
Average depth of frostline 3 feet BGS	

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

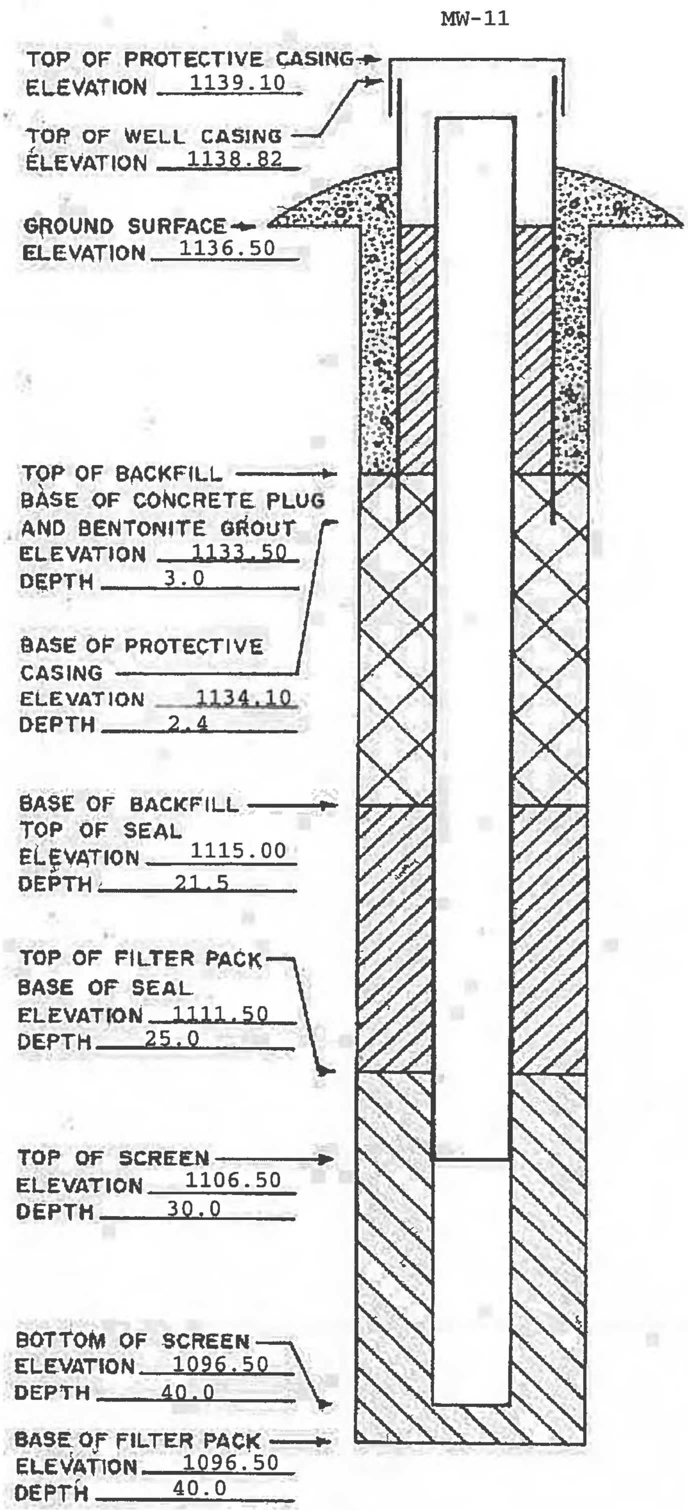
Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

Revised 9/05 Form # 542-1277

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



FIELD ROCK CORE LOG

EARTH TECH — A tyco INTERNATIONAL LTD. COMPANY

BORING NO. B-12

SITE: Winneshiek County Landfill
PROJECT NO. 37655.1050

DRILLING RIG: CME 850 - ATV
CORE BARREL / BIT: NQ Wireline / NQ Diamond Bit
CASING USED: 6.25" ID HSA
LOGGED BY: D. Kelleher
FIRM/DRILLER: Terracon Inc. / S. Zeier
PHYSICAL SETTING: Paleozoic Plateau

WATER LEVEL READINGS

DATE	TIME	DEPTH	CASING

ABANDONMENT DATE: NONE
ABANDONMENT METHOD: NA

GROUND SURFACE ELEV:
COORDINATE/TYPE:
NORTH:
EAST:
DATE/TIME START: 10.16.01 1415
DATE/TIME COMPLETE: 10.17.01 1130
WELL INSTALLATION DATE: 10.17.01

Depth in Feet	METHOD	RUN NO	LENGTH	% RECOVERY	MPF	% WATER GAIN/LOSS (GAL.)	% RQD	FRAC./FT	GRAPHICS	ROCK TYPE CODE	ROCK DESCRIPTION	COMMENTS
0 – 19	HSA	1		Ø (0%)							No sampling from 0.0 to 19.0 feet.	Modified Core Piece Recovery
19 – 21	NQ	2		(50%)		100 gal loss	(50%)		19.0 / 20.5	ML	QUATERNARY DEPOSITS. Hard, Yellowish Brown (10YR 5/8) SILT (ML); Moist; Non Plastic; Cohesive; Laminated; Horizontal Undulatory Laminae; OU; Glaciolacustrine Facies.	Run 2: 4" (3) / 12"
21 – 22	NQ	3		(70%)		100 gal loss	(70%)				TOP OF BEDROCK AT 20.5 FEET	
22 – 25.5	NQ	4		(80%)		200 gal loss	(60%)		24.0	SH	ORDOVICIAN MAQUOKETA FORMATION, Elgin Member. Soft, Yellowish Brown (10YR 5/8) SHALE, Moist; Slightly Weathered to Fresh; Aphanitic; Laminated; Low-Angle Undulatory Laminae; Strongly Effervescent; Trace Subvertical Joints. RQD: 12"/24" = 50% (Run 2) RQD: 18"/24" = 70% (Run 3)	Run 3: 6" (1), 4" (3) / 18"
25.5 – 30	NQ	6		(99%)	2	320 GALLONS LOSS	(63%)			SH / LS	Gradational Contact (24.0 Feet). Elgin Member. Medium Hard, Dark Yellowish Brown (10YR 4/6) SHALE with alternating Gray (10YR 5/1) LIMESTONE; Moist, Slightly Weathered to Fresh; Aphanitic; Laminated; Horizontal Laminae to Thinly Bedded; Strongly Effervescent; Trace Subvertical to Horizontal Joints; Horizontal Joints filled with Silt and Manganese Staining on Joint Faces. RQD = 25" / 42" = 60% (Run 4)	Run 4: 6" (1), (5") (3), 4" (1) / 25". Run 6: 16" (1), 8" (1), 6" (1), 4" (2) / 38"

#27 (at approx. 27 ft)

&cont&

* line represents fracture/joint orientation; dot represents vug or solution feature

Tracking Codes: 6prj.id8, F_ROCKP1, 3/22/94

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

FIELD ROCK CORE LOG

BORING NO. B-12

SITE: WINNESHEIK COUNTY LANDFILL PROJECT NO. 37655.1050

Depth in Feet	METHOD	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS (GAL.)	% RQD	FRAC./FT	GRAPHICS	ROCK TYPE CODE	ROCK DESCRIPTION	COMMENTS
30	NQ	7			2.5	300 GALLONS LOSS				SH	As Above From 24.0 to 30.0 Feet.	MODIFIED CORE RECOVERY
31									31.0	LS	GRADATIONAL CONTACT 31.0 FT	
32										SH	ELGIN MEMBER. Medium Hard, Alternating beds of Dark Yellowish Brown (10YR 4/6) SHALE AND Grayish Brown (10YR 5/2)	7" (1) 6" (2) 4" (1)
33										LS	and Gray (10YR 5/1) LIMESTONE; Moist, Mostly fresh with thin	
34											beds and joint faces of highly weathered alterations; Laminated to	23"
35											thinly Bedded; Horizont Laminae and Beds up to 2 cm; Alternating	
36			72"	72" (100%)			(32%)				variations of SHALE AND LIMESTONE	5" (1)
36	NQ	8			2.0	DRILLED W/ AIR					Beds up to 7 cm; Few Subvertical	28" (1)
37										SH LL	Joints, most filled with silt and clay; Common Manganese Staining on joint	16" (1) 4" (1)
38											faces; Trace Manganese Staining in rock matrix; Vugs ocurring along	53"
39											horizontal joint faces up to 3 cm in diameter commonly with	
40			60"/60"	(100%)			(88%)				plately rock fragments containeo within vugs; Solution cavity across bedding	plane at 34.5 feet.
41	NQ	9		(80%)		AIR	–				RQD: 23"/72" = 32% (Run 7) RQD: 53"/60" = 88% (Run 8)	
42	NQ	10				150 GAL LOSS					Note: At 35.0 Feet, Limestone beds decrease in frequency; becoming	21" (1) 8" (1)
43										SH	mostly dark gray shale below 35.0 Feet.	6" (1) 5" (1)
44												40"
45			45"/45"	100%			(88%)					
46											RQD 40"/45" = 88% (Run 10)	

#2 →

&cont&

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

FIELD ROCK CORE LOG

Sheet 3 of 7

BORING NO. MW-12

SITE: Winneshiek County Landfill PROJECT NO. 37655.1050

Depth in Feet	Method	Run No	Length	% Recovery	MPF	% Water Gain/Loss (Gal.)	% RQD	Frac./Ft	Graphics	Rock Type Code	Rock Description	Comments
												Modified Core Recovery
46	NQ	(11)			2.25					SH	As Above From 35.0 To 46.0 Feet SHARP CONTACT 47.0 FEET	
47–56			115"/120" (96%)			APPROXIMATELY 2.50 GALLONS LOSS	(91%)			LS	GALENA-PLATTEVILLE DOLOMITE FORMATION. Hard, Light Gray (10YR 7/1) DOLOMITIC LIMESTONE with Few Alternating Beds (3 to 5 inches thick) of Dark Gray (10YR 4/1) SHALE; Moist to Dry Rock Matrix; Fresh; Microcrystalline; Medium to Thick Bedded with Horizontal to Low-Angle Undulatory Beds; Fossiliferous with common fragmented Brachiopods concentrated in areas of SHALE Beds; Trace Horizontal to Low-Angle Joints filled with fines; Joint faces fresh with Trace Very Dark Gray (10YR 3/1) to Black (10YR 2/1) Joint Faces; Trace Vugs up to 0.5 cm diameter filled with calcite crystals; Trace Secondary Pyrite Nodules; Upper Stratigraphic Contact includes 2 inches of ~~competent, lit~~ fragmented dolomite lithified in contact with overlying shale; no open fractures or joints at contact. RQD = 109" / 120" = 91% Run 11	28" (1) 22" (1) 16" (2) 11" (1) 8" (1) 109"

&cont&

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

FIELD ROCK CORE LOG

BORING NO. MW-12

SITE: Winneshiek County Landfill PROJECT NO. 37655.1050

Depth in Feet	METHOD	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS (GAL.)	% RQD	FRAC./FT	GRAPHICS	ROCK TYPE CODE	ROCK DESCRIPTION	COMMENTS
												Modified Core Recovery
56	NQ	(12)			2.25 min					LS	As Above From 47.0 to 56.0 feet GALENA PLATTEVILL DOLOMITE FORMATION.	
57–66			120"/120" (100%)			APPROXIMATELY 100 GALLONS WATER LOSS	(97%)		65.0	SH, LS	Hard, Light Gray (10YR 7/1) DOLOMITIC LIMESTONE with Few Alternating Beds of Dark Gray (10YR 4/1) SHALE; Moist to Dry Rock Matrix; Fresh; Microcrystalline; Medium to Thickly Bedded with Low-Angle, Undulatory Beds, Fossiliferous with Brachiopods concentrated in areas of SHALE Beds; Trace Horizontal to Low-Angle Joints Filled with Fines; Trace Vugs up to 0.5 cm diameter filled with calcite crystals; Trace secondary pyrite nodules; Shale bed 11 inches thick from 57.0 to 57.8 feet. RQD: 116"/120" = 97% (Run 12)	27" (1) 21" (1) 18" (1) 14" (2) 11" (1) 6" (1) 5" (1) 116"

Sharp Contact 65.0 feet.

- Stratigraphic Unit / Rock Core Description on next page

→ Transitional contact within GALENA PLATTEVILLE DOLOMITE FORMATION -

- From 47.0 to 65.0; Dolomitic Limestone w/ Beds of Shale
- From 65.0 to 101.0; Dolomitic Limestone Only (no shale beds)

&cont&

1.98, F_ROCKP2, 3/8/04

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

FIELD ROCK CORE LOG

BORING NO. MW-12

SITE: Winneshiek County Landfill PROJECT NO. 37655.1050

Depth in Feet	Method	Run No	Length	% Recovery	MPF	% Water Gain/Loss (Gal.)	% RQD	Frac./Ft	Graphics	Rock Type Code	Rock Description	Comments
66	NQ	13	66–76 (arrow)	120"/120" (100%)	2.25; 22.5 MINUTES PER 10 FT RUN	APPROXIMATELY 100 GAL WATER LOSS	(97%)			LS	As Above From 65.25 Feet to 66.0 Feet. GALENA - PLATTEVILLE (Dolomite) FORMATION. Hard, White (7.5YR 8/1) DOLOMITIC LIMESTONE, Moist to Dry Rock Matrix; Fresh; Microcrystalline; Interclastic; Medium to Thick Bedded; Horizontal Undulatory Beds; Trace Horizontal Joints (Micro); Trace Secondary Pyrite Nodules; Trace Vugs up to 1.5 cm diameter filled with calcite crystals. Interclasts consist of Light Trace Gray (7.5YR 7/1) Medium Grained Dolomitic Limestone	
67												
68												
69												
70												
71												
72												
73												
74												
75												
76											RQD = 116"/120" = 97% Run 13	

&cont&

Tracking, MS_F_ROCKP2, 2/8/04

EARTH TECH — A tyco INTERNATIONAL LTD. COMPANY

FIELD ROCK CORE LOG

BORING NO. MW-12

SITE: Winneshiek County Landfill PROJECT NO. 37655.1050

Depth in Feet	Method	Run No	Length	% Recovery	MPF	% Water Gain/Loss (Gal.)	% RQD	Frac./Ft	Graphics	Rock Type Code	Rock Description	Comments
												Modified Core Recovery
76 – 85	NQ	14	76–85	106"/106" (100%)	2.25; Approximately 20 minutes per 106 in.	Approximately 100 gal water loss	(93%)			LS	As Above from 65.20 Feet to 76.0 Feet. GALENA-PLATTEVILLE (DOLOMITE) FORMATION Hard, White (7.5YR 8/1) DOLOMITIC LIMESTONE, Moist to Dry Rock Matrix; Fresh, Microcrystalline; Interclastic; Medium to Thick Bedded; Horizontal Undulatory Beds; Trace Horizontal Microjoints; Trace Secondary Pyrite Nodules; Trace Vugs up to 1.5 cm diameter filled with calcite crystals; Interclasts consist of Light Gray (7.5YR 7/1) Medium-Grained Dolomitic Limestone. Note: Soft Shale in bottom of core barrel and bit.	24"(1) 18"(1) 13"(2) 10"(2) 5"(2) 98"
85										SH	RQD = 98" / 106" = 93% (Run 14)	
85 – 91	NQ	15	85–91	72"/72" (100%)	2.25; Approx. 13 min per 6 ft	Approx. 60 gal water loss	(94%)			LS	As Above From 65.25 to 85.0 Feet	21"(1) 17"(1) 14"(1) 10"(1) 6"(1) 68"
91											RQD: 68" / 72" = 94% (Run 15)	

&cont&

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

FIELD ROCK CORE LOG

BORING NO. MW-12

SITE: Winneshiek Co. Landfill PROJECT NO. 37655.1050

Depth in Feet	METHOD	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS (GAL.)	% RQD	FRAC./FT	GRAPHICS	ROCK TYPE CODE	ROCK DESCRIPTION	COMMENTS
												Modified Core Recovery
91	NQ	(15)	↓		2.25	APPROXIMATELY 100 GALLONS WATER LOSS				LS	As Above From 65.0 To 91.0 Feet Galena-Platteville Formation. Hard, White (7.5YR 8/1) Dolomitic LIMESTONE, Moist to Dry Rock Matrix; Fresh; Microcrystalline; Interclastic, Medium to Thick Bedded; Horizontal Undulatory Beds; Trace Horizontal Microjoints; Trace Secondary Pyrite Nodules; Trace Vugs up to 1.5 cm diameter; Interclasts consist of medium-grained, Light Gray (7.5YR 7/1) Dolomitic Limestone.	26" (1) 24" (1) 21" (1) 17" (1) 12" (1) 16" (1) 116"
92–99											RQD: 116"/120" = 97% (Run 15)	
100				120"/120" (100%)			(97%)					
101											END OF BORING AT 100.9 FEET See Well Construction Summary MW-12 for Well Details.	

&cont&

MS. F_ROCKP2, 3/8/94

Tracking #

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name WINNESHIEK COUNTY LANDFILL	**Permit No.** #96-SDP-1-74P
Well or Piezometer No. MW-12	
Dates Started 10-16-01	**Date Completed** 10-18-01

A. SURVEYED LOCATIONS AND ELEVATIONS		B. SOIL BORING INFORMATION	
Locations (± 0.5 ft.):		**Name & address of construction company**	
Specify corner of site		TERRACON INC.	
Distance & direction along boundary			
Distance & direction from boundary to well			
Elevations (± 0.01 ft. MSL):		Name of driller	S. ZEIER/ G. EVERMAN
Ground Surface	1150.90	Drilling method	
Top of protective casing	1153.90	Drilling fluid	WATER/AIR
Top of well casing	1153.51	Bore Hole diameter	6.0 inches
Benchmark elevation		Soil sampling method	
Benchmark description		Depth of boring	100.0 feet BGS

C. MONITORING WELL INSTALLATION

Casing material	PVC	Placement method	
Length of casing	60.61 feet	Volume	50lbs.
Outside casing diameter	2.18 inches	**Backfill (if different from seal):**	
Inside casing diameter	2.00 inches	Material	ENVIROPLUG BENTONITE POWDER & 3/8 inch BENTONITE CHIPS
Casing joint type	FLUSH THREADED/ O-RING	Placement method	
Casing/screen joint type	FLUSH THREADED/ O-RING	Volume	120 GAL. & 2 Bags(Chips)
Screen material	PVC	**Surface seal design:**	
Screen opening size	0.010 inches	Material of protective casing:	ANODIZED ALUMINUM
Screen length	10.0 feet	Material of grout between protective casing and well casing:	QUIKCRETE
Depth of Well	68 feet BGS	**Protective cap:**	
Filter Pack:		Material	ANODIZED ALUMINUN
Material	#30 QUARTZ SAND	Vented?: Y/N Y	Locking?: Y/N Y
Grain Size		**Well cap:**	
Volume	5 BAGS	Material	PVC
Seal (minimum 3 ft. length above filter pack):		Vented?: Y/N	N
Material	3/8 BENTONITE CHIPS		

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)

Water level		Stabilization time	
Well development method	WATER/AIR		
Average depth of frostline	3.0 feet BGS		

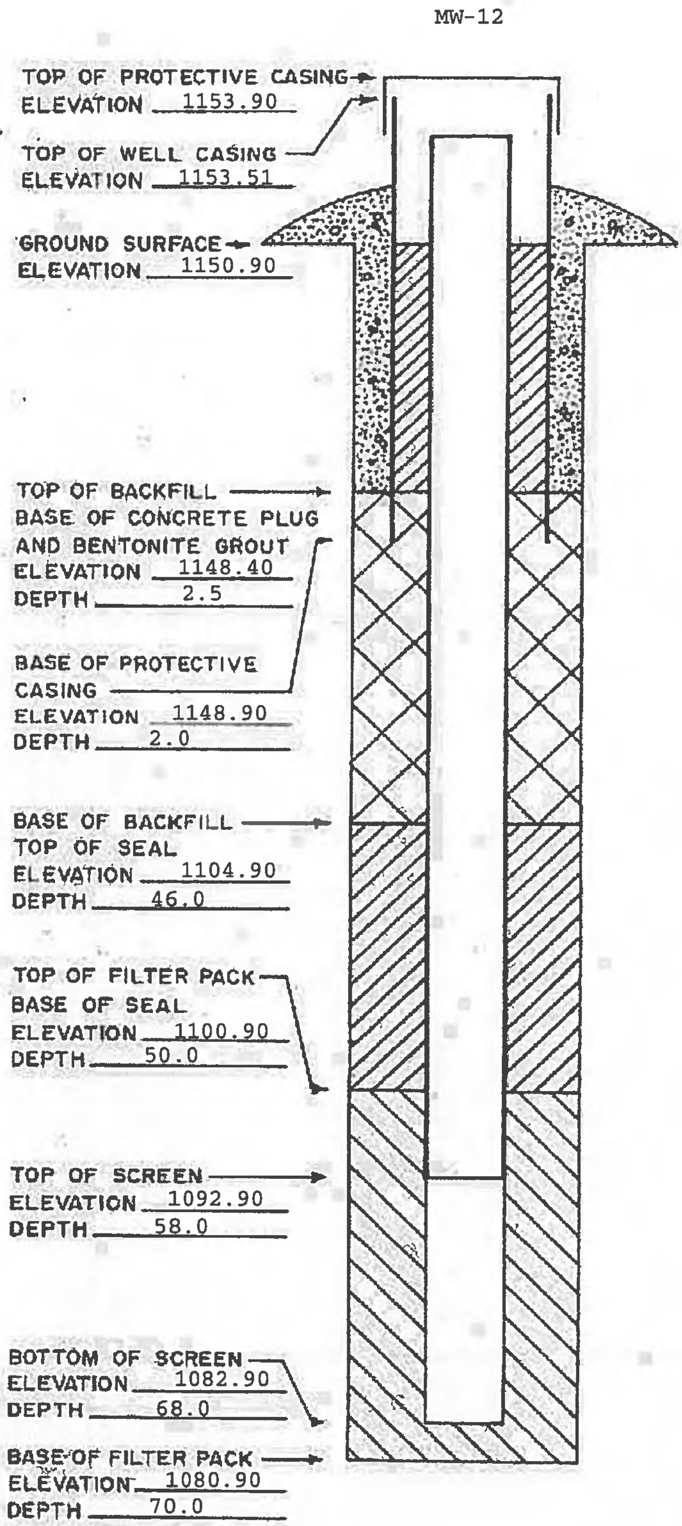
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Energy and Waste Management Bureau, 502 E. 9th Street, Des Moines, IA 50319-0034.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-281-8986, nina.koger@dnr.state.ia.us

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM
GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



LOG OF BORING NO. 20

OWNER/CLIENT: **Winneshiek County Solid Waste Agency**	ARCHITECT/ENGINEER: **Earth Tech**
SITE: **Winneshiek County Landfill, Decorah, Iowa**	PROJECT: **Borrow Site Investigation**

Boring Location: N: 10438 E: 10972

Approx. Surface Elevation.: 1147 ft

DESCRIPTION	Layer bottom depth, ft	Elev., ft	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	
LEAN CLAY, TRACE SAND & ORGANICS, Dark Brown	2	1145			PA						
LEAN CLAY, TRACE SAND, Brown, Medium to Stiff	6	1141	CL	1	ST	7		26		*2000	
					PA						
LEAN CLAY TO SILTY CLAY, TRACE SAND, Gray Brown, Soft to Medium	9	1138	CL/ML	2	ST	19		26		*1000	
Soft clay layer in bottom of Sample 2.			CL					16		*1000	
FINE TO MEDIUM SAND WITH SILT & CLAY, Brown	13.5	1133.5			PA						
SILTY CLAY TO CLAYEY SILT, TRACE SAND, Brown, Stiff	18	1129	ML/CL	3	SS	13	9	23		*3500	
					PA						
SILT, TRACE SAND & SAND SEAMS, Gray, Medium Dense	23	1124	ML	4	SS	14	15	30		*4000	
					PA						
LEAN CLAY WITH SAND, Gray, Medium to Stiff	27	1120	CL	5	SS	8	9	31		*2000	LL=34 PI=18
					PA						
BOTTOM OF BORING											

The stratification lines represent the approximate boundary lines between soil and rock types: In-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 5	WS ▼ 4	(2/5/01)
WL	▽	▽	
WL			

Terracon

BORING STARTED	1-23-01		
BORING COMPLETED	1-23-01		
RIG	#5	FOREMAN	QW
APPROVED	JLM	JOB #	13005099

DTB 27' DTW 4' DTB-DTW= 23' > 10 ft below water table

LOG OF BORING NO. 21

OWNER/CLIENT Winneshiek County Solid Waste Agency	ARCHITECT/ENGINEER Earth Tech
SITE Winneshiek County Landfill Decorah, Iowa	PROJECT Borrow Site Investigation

Boring Location: N: 10783 E: 10972

Approx. Surface Elevation.: 1141 ft

Depth (ft)	DESCRIPTION	Elev.
1.5	LEAN CLAY, TRACE SAND & ORGANICS, Dark Brown	1139.5
5	LEAN CLAY, TRACE SAND, Gray Brown, Stiff	1136
12	LEAN CLAY TO SILTY CLAY, TRACE SAND, Gray Brown, Stiff	1129
13	CLAYEY SAND, Reddish Brown	1128
18	LEAN TO FAT CLAY, TRACE SAND, Gray Brown, Medium to Stiff	1123
21	FAT CLAY WITH SAND, Gray, Hard	1120
	BOTTOM OF BORING	

USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	
		PA						
CL	1	ST	8		28	92	*3000	LL=39 PI=18
		PA						LL=33 PI=12
CL/ML	2	ST	15		22	97	*3500	
		PA						
CL/CH	3	SS	10	8	35		*1500	
		PA						
CH	4	ST	12		22	98	*8500	LL=56 PI=38

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ 14.5	WS ▼ 8.5	(2/5/01)
WL	∇	▼	
WL			

Terracon

BORING STARTED			1-23-01
BORING COMPLETED			1-23-01
RIG	#5	FOREMAN	QW
APPROVED	JLM	JOB #	13005099

BOREHOLE 5099.GPJ TERRACON.GDT 2/21/01

DTB 21' DTW 8.5' DTB-DTW = 12 ft > 10 ft below water table

LOG OF BORING NO. 22

OWNER/CLIENT: Winneshiek County Solid Waste Agency	ARCHITECT/ENGINEER: Earth Tech
SITE: Winneshiek County Landfill, Decorah, Iowa	PROJECT: Borrow Site Investigation

Boring Location: N: 10538 E: 11372

Approx. Surface Elevation.: 1145 ft

GRAPHIC LOG / DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, in.	SAMPLES: SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	TESTS: DRY UNIT WT pcf	TESTS: UNCONFINED STRENGTH, psf	
LEAN CLAY, TRACE SAND & ORGANICS, Dark Brown (2.5 — 1142.5)				PA						
LEAN CLAY, TRACE SAND, Gray Brown, Stiff		CL	1	ST	9		30	85	*3000	LL=42 PI=24
	5			PA						
(8 — 1137)										
LEAN CLAY WITH SAND, TRACE GRAVEL, Brown, Stiff		CL	2	ST	10		22		*2500	
(10.5 — ∇ 1134.5)	10			PA						
FINE TO MEDIUM SAND WITH CLAY, Brown (13.5 — 1131.5)										
FAT CLAY WITH SAND, Gray, Medium to Very Stiff		CH	3	SS	10	7	38		*1500	
	15			PA						
Clayey sand seam in Sample 4.		SC	4	ST	22		23			
		CH					32	80	*3000	LL=69 PI=41
	20			PA						
		CH	5	ST	16		22	101	*6000	
(25 — 1120)	25									
BOTTOM OF BORING										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ 10.5	WD	∇
WL	∇		∇
WL	WCI @ 12' AB		

Terracon

BORING STARTED	1-23-01		
BORING COMPLETED	1-23-01		
RIG	#5	FOREMAN	QW
APPROVED	JLM	JOB #	13005099

BOREHOLE 13C GPJ TERRACON.GDT 2/21/01

LOG OF BORING NO. 23

OWNER/CLIENT: Winneshiek County Solid Waste Agency	ARCHITECT/ENGINEER: Earth Tech
SITE: Winneshiek County Landfill, Decorah, Iowa	PROJECT: Borrow Site Investigation

Boring Location: N: 10988 E: 11372

Approx. Surface Elevation.: 1139.5 ft

Depth (ft)	Description	Elev.
1	LEAN CLAY, TRACE SAND & ORGANICS, Dark Brown	1138.5
12	LEAN CLAY, TRACE SAND, Brown, Medium to Stiff	1127.5
19	LEAN CLAY TO SILTY CLAY, TRACE SAND, Gray Brown, Medium	1120.5
22	FAT CLAY, TRACE SAND (Residual Limestone), Gray Brown, Very Stiff	1117.5
22.5	*** HIGHLY WEATHERED LIMESTONE, Brown	1117

Auger Refusal @ about 22.5 feet.
BOTTOM OF BORING

*** Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

DEPTH, ft.	USCS SYMBOL	NUMBER	TYPE	RECOVERY, in.	SPT - N BLOWS / ft.	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	
0–1.5			PA						
3–5	CL	1	ST	8		25	96	*2000	
5–8			PA						
8–10	CL	2	ST	13		28	93	*1500	
10–13			PA						
13–15	CL/ML	3	ST	15		25	96	*1500	LL=29 PI=7
15–18			PA						LL=30 PI=12
18–20	CL/ML	4	ST					*1500	
	CH							*7500	
20–22.5			PA						

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft		
WL	NONE	WD 17.5 (2/5/01)
WL		
WL		

Terracon

BORING STARTED	1-23-01		
BORING COMPLETED	1-23-01		
RIG	#5	FOREMAN	QW
APPROVED	JLM	JOB #	13005099

BOREHOLE 5099.GPJ TERRACON.GDT 2/21/01

LOG OF BORING NO. 24

OWNER/CLIENT Winneshiek County Solid Waste Agency	ARCHITECT/ENGINEER Earth Tech
SITE Winneshiek County Landfill Decorah, Iowa	PROJECT Borrow Site Investigation

Boring Location: N: 10647 E: 11981

Approx. Surface Elevation.: 1135 ft

Depth (top)	DESCRIPTION	Elev.	DEPTH, ft.	USCS SYMBOL	SAMPLES: NUMBER	TYPE	RECOVERY, in.	SPT - N BLOWS / ft.	TESTS: WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	
0.5	LEAN CLAY, TRACE SAND & ORGANICS, Dark Brown	1134.5				PA						
	LEAN CLAY, TRACE SAND, Brown, Medium to Stiff			CL	1	ST	10		26	89	*2000	LL=36 PI=17
			5			PA						
8		1127										
	LEAN CLAY TO SILTY CLAY, TRACE SAND, Gray Brown, Medium to Stiff			CL/ML	2	ST	10		23	99	*3000	
			10			PA						
14		1121		CL/ML CL/CH	3	ST	10		24 16		*1500 *2000	
14.5	LEAN TO FAT CLAY WITH LIMESTONE FRAGMENTS, Brown, Medium to Stiff	1120.5										
15	*** HIGHLY WEATHERED LIMESTONE, Brown	1120	15									
	BOTTOM OF BORING											

*** Classification estimated from disturbed samples. Core samples and petrographic analysis may reveal other rock types.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NONE	WD ▼
WL	▼	▼
WL		

Terracon

BORING STARTED	1-23-01
BORING COMPLETED	1-23-01
RIG #5	FOREMAN QW
APPROVED JLM	JOB # 13005099

BOREHOLE 1300 .GPJ TERRACON.GDT 2/21/01

LOG OF BORING NO. 25

OWNER/CLIENT: Winneshiek County Solid Waste Agency	ARCHITECT/ENGINEER: Earth Tech
SITE: Winneshiek County Landfill, Decorah, Iowa	PROJECT: Borrow Site Investigation

Boring Location: N: 11698 E: 10809

Approx. Surface Elevation.: 1146 ft

Depth (layer bottom), ft	DESCRIPTION	Elev.	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY, in.	SPT - N BLOWS / ft.	WATER CONTENT, %	DRY UNIT WT pcf	UNCONFINED STRENGTH, psf	
1	LEAN CLAY, TRACE SAND & ORGANICS, Dark Brown	1145				PA						
6	LEAN CLAY, TRACE SAND, Gray Brown, Stiff	1140		CL	1	ST	10		27	91	*2500	LL=41 PI=19
			5			PA						
13	LEAN CLAY TO SILTY CLAY, TRACE SAND, Gray Brown, Stiff	1133		CL/ML	2	ST	20		22	97	*2500	
			10			PA						
15	LEAN CLAY WITH SAND, Gray Brown, Stiff	1131		CL	3	ST	14		17	106	*3000	
16	CLAYEY SAND, Brown	1130	15			PA						
	FAT CLAY WITH SAND, TRACE SAND SEAMS, Gray Brown, Stiff			CH	4	ST	16		26	94	*3500	
			20			PA						
26	With gravel in Sample 5.	1120	25	CH	5	ST	14		27		*2500	
	BOTTOM OF BORING											

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	▽ 16	WD ▼ 12	(2/5/01)
WL	▽	▼	
WL			

Terracon

BORING STARTED	1-23-01		
BORING COMPLETED	1-23-01		
RIG	#5	FOREMAN	QW
APPROVED	JLM	JOB #	13005099

BOREHOLE 13 .GPJ TERRACON.GDT 2/21/01

Appendix A-9 – 2010 – Boring Logs and Monitoring Well Construction Documentation

MW-12A

LOG OF BORING NO. MW-12A

CLIENT Winneshiek County Solid Waste Agency

ENGINEER AECOM

SITE Winneshiek County, Iowa

PROJECT Winneshiek County Sanitary Landfill

DESCRIPTION

BOREHOLE DIA.: 7.25 in
WELL DIA.: 2 in
TOP OF PROTECTOR PIPE: ft
TOP OF CASING: ft
GROUND SURFACE ELEV.:

Depth to bottom of layer, ft	Description	USCS Symbol	Sample Number	Type	Recovery, in.	SPT - N** Blows / ft	Water Content, %	Dry Unit Wt pcf
4.25	**SANDY LEAN CLAY, TRACE GRAVEL**, Light Brown and Yellow	CL	1	SS	13	13 16		
		CL	2	SS	10	34 21		
8.75	**SANDY LEAN CLAY, TRACE GRAVEL & COBBLES**, Light Brown and Yellow	CL	3	SS	14	15 27		
		CL	4	SS	15	14 19		
12.5	**SANDY LEAN CLAY WITH HIGHLY WEATHERED LIMESTONE**, Light Brown	CL	5	SS	16	6 7		
		CL	6	SS	18	9 12		
28	**HIGHLY WEATHERED LIMESTONE WITH GRAVEL, TRACE LEAN CLAY**, Light Brown	CL	7	SS	8	22 11		
			8	SS	8	45 44		
			9	SS	10	19 14		
			10	SS	15	13 21		
			11	SS	24	18 26		
			12	SS	20	10 31		
			13	SS	22	14 27		
			14	SS	24	21 36		

BOTTOM OF BORING

The well consists of 2" diameter 0.010" PVC screen with a bottom point and solid PVC riser pipe to the surface. The annulus was filled with sand to about 1' above the screen and the remainder with bentonite to the surface.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft		
WL	▽ NONE	WD ▽
WL	▽	▽
WL		

Terracon

BORING STARTED	4-22-10		
BORING COMPLETED	4-22-10		
RIG	83E	FOREMAN	MW
APPROVED	DCC	JOB #	13107005

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-26A**

SITE: Winneshiek Co. Landfill   PROJECT NO. 60130759   SHEET 1 OF 1

SITE #: ____

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: ____

PHYSICAL SETTING: Edge of road berm on hilslope

LOCAL COORDINATES:

LOG BY: T. Kemmis   NORTHING: ____

FIRM/DRILLER: Terracon/M. White   EASTING: ____

DRILLING METHOD: 4 1/4 in. ID HSA with 2 in. dia. by 2 ft long split spoon sampler, 140 lb hammer

DATE/TIME STARTED: 4/23/10 ; 09:20

ABANDONMENT DATE: NA   DATE/TIME COMPLETED: 4/23/10 ; 10:05

ABANDONMENT METHOD: NA   WELL INSTALLATION: 4/23/10

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	5 5 8 7	13		65	1	SS		CL	**QUATERNARY, FILL.** Stiff, brown (10YR 4/3) SANDY LEAN CLAY WITH GRAVEL (CL); moist; medium plasticity; cohesive; massive; some sand, few to little gravel; fill.
								ML	Stiff, brownish yellow (10YR 6/6) SILT WITH GRAVEL (ML); moist; low plasticity; cohesive; massive; few to little aggregate gravel; fill.
	8 9 2 2	11		60	2	SS			As above from 1.0 to 2.0 feet.
5	2 3 4 2	7		65	3	SS		CL	**LOESS.** Medium, black (10YR 2/1) LEAN CLAY (CL); moist; low plasticity; cohesive; massive; buried A horizon of modern soil profile; loess.
	2 2 2 2	4		65	4	SS		CL	Soft, brown (10YR 4/3) LEAN CLAY (CL); moist; medium plasticity; cohesive; massive; buried B horizon of modern soil profile; loess.
	2 2 2 1	4		75	5	SS			As above from 6.0 to 8.0 feet.
10	0 1 1 1	2		70	6	SS			As above from 6.0 to 10.0 feet, but consistency changes to very soft.
	6 10 5 2	15		50	7	SS		CL	**PRE-WISCONSIN EPISOPE COLLUVIUM.** Stiff, yellowish brown (10YR 5/6) LEAN CLAY WITH GRAVEL (CL); moist; medium plasticity; cohesive; faintly stratified; little gravel; MOU; colluvium.
								CS	**ORDOVICIAN, MAQUOKETA FORMATION.** CLAYSTONE; weak to moderate; thinly to medium bedded brownish yellow (10YR 6/6) and very pale brown (10YR 7/3); aphanitic; thinly to medium bedded, some beds are laminated; slightly decomposed; competent to slightly disintegrated; slightly fractured; oxidized claystone.
15	4 4 4 1	8		65	8	SS			As above from 13.0 to 14.0 feet.
	3 6 6 5	12		95	9	SS			As above from 13.0 to 16.0 feet.
	3			100	10	SS			As above from 13.0 to 18.0 feet.
									END OF BORING AT 18.5 FEET.
20									

Tracking Codes: 60130759 WINNESHICK LDF 2010 GPJ, ETSOIL, 8/2/10, 18:41

AECOM

PIEZOMETER INSTALLATION DIAGRAM

Site Name: Winneshiek Co LF　Project No. 60130759.11.070　Well No. MW-26A

Northing: ______　Easting: ______　Surf.Elev. ______　Ref. Boring No. B-26A

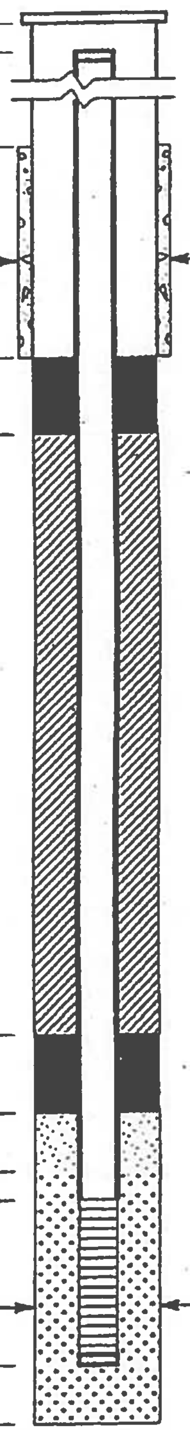
Drilling Contractor: Terracon　Drilling Dates: 4/23/2010

Driller: Matt White/Bob Bergman　Inspected By: Jeff Maletzke　Well Completion Date: 4/23/2010

Drilling Method: 4 1/4-inch HSA w/CME-55 ATV rig　Drilling Fluids (type): None

Depth / Elev.

- Top of Protective Casing: 31.5"
- Top of Riser Pipe: 2.5'
- Ground Surface: 0.00'
- Concrete Thickness: ______
- Concrete Diameter: 8 (Pellet)
- Top of Seal: ______
- Seal Thickness: ______
- Top of Grout: ______
- Grout Thickness: ______
- Well Length: 17.5
- Top of Seal: 0.0
- Seal Thickness: 6
- Top of Fine Sand: N/A
- Fine Sand Thickness: ______
- Top of Filter Pack: 6.0
- Top of Screen: 7.5
- Screen Length: 10'
- Filter Pack Thickness: 12.5
- Borehole Diameter: 8"
- Bottom of Screen: 17.5
- Mat'l. Thickness: 1
- Bottom of Borehole: 18.5



Protective Casing
Type: Steel　Vented (Y/N): Y
Dia.(in): 4" square　Locked (Y/N): Y
Length: 5'　Key No.: CAT

Cap or Plug Type: Pro top　Vented (Y/N): ______

Concrete Collar
Manufacturer: N/A
Volumes: ______ Lbs. of Cement
+ ______ Gal. of Water
= ______ Gal. total Volume

Upper Seal Type: ______
Manufacturer: ______
Volume (Gal.) ______
Hydration: Volume Water: ______　Time: ______

Well Casing Type: PVC
Manufacturer: Johnson Screens
Schedule: 40
Length per Section: 10'　Casing O.D./I.D. 2.375/2.067
No. of Sections: 1　Total Length: 10'

Joints Flush Threaded [X]　Taped [ ]　Welded [ ]　O-Ring [ ]
Manufacturer: ______

Grout Type: ______
Manufacturer: ______
Final Volumes: ______ Lbs. of ______
+ ______ Lbs. of ______
+ ______ Gal. of Water
= ______ Gal. total Volume

Lower Seal Type: 3/8" Sodium Bentonite Hole Plug
Manufacturer: Baroid
Volume (Gal.) 3 - 50 lb bags
Hydration: Volume Water 6.5 gal　Time: 1046

Fine Sand Type: N/A
Manufacturer: ______
Volume (Gal.) ______

Filter Pack Type: Coarse Sand
Manufacturer: BMC Aggregate, Elk Run, IA
Volume (Gal.) 7 3/4 - 50 lb bags

Screen Type: PVC　Sch: 40
Manufacturer: Johnson Screens
Length/Sec. 10'　No of Sec. 1
O.D. 2.375　I.D. 2.067
Slot Size: 0.010　No. Slots/ft. ______
Slotted Length: 10'

Bottom Cap or Plug Type: PVC-Point　Length: 4"

Water Source Terracon shop

NOTES: Water in loess above claystone/shale

Tracking Codes: fpo|id8, PIEZOFF, 12/15/97, 16:42

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-28A**

SITE: Winneshiek Co. Landfill — PROJECT NO. 60130759 — SHEET 1 OF 1

SITE #: ______

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: ______

PHYSICAL SETTING: Summit near sideslope

LOG BY: T. Kemmis

FIRM/DRILLER: Terracon/M. White

DRILLING METHOD: 4 1/4 in. ID HSA with 2 in. dia. by 2 ft long split spoon sampler, 140 lb hammer

ABANDONMENT DATE: NA

ABANDONMENT METHOD: NA

LOCAL COORDINATES

NORTHING: ______

EASTING: ______

DATE/TIME STARTED: 4/22/10 ; 12:05

DATE/TIME COMPLETED: 4/22/10 ; 13:00

WELL INSTALLATION: 4/22/10

Depth in Feet	B	N	A	% Recovery	No.	T	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	3 2 2 2	4		75	1	SS	CL	**QUATERNARY, LOESS.** Soft, dark brown (10YR 3/3) LEAN CLAY (CL); moist; medium plasticity; cohesive; massive; A horizon of modern soil profile; loess.
							CL	Soft, yellowish brown (10YR 5/6) LEAN CLAY (CL); moist; medium plasticity; cohesive; massive; B horizon of modern soil profile; loess.
	2 2 2 2	4		50	2	SS		As above from 1.3 to 2.0 feet.
5	2 2 2 2	4		0	3	SS		
	0 1 1 1	2		50	4	SS	CL	Very soft, yellowish brown (10YR 5/4) LEAN CLAY (CL); moist to wet; medium plasticity; cohesive; massive; OL; loess.
	0 2 1 1	3		60	5	SS		As above from 6.0 to 8.0 feet, but consistency changes to soft.
							CL	Soft, gray (10YR 6/1) mottled with light olive brown (2.5Y 5/6) LEAN CLAY (CL); moist to wet; low to medium plasticity; cohesive; massive; MDU; loess.
10	1 1 3 4	4		70	6	SS		As above from 8.6 to 10.0 feet.
							CS	**ORDOVICIAN, MAQUOKETA FORMATION.** CLAYSTONE; weak; brownish yellow (10YR 6/6); aphanitic; thinly to medium bedded; moderately decomposed; competent to slightly disintegrated; moderately fractured; slightly moist; oxidized, weathered claystone.
	5 11 7 8	18		80	7	SS		As above from 11.3 to 12.0 feet.
	4 8 50/5"	>50		100	8	SS		As above from 11.3 to 14.0 feet.
15								Auger and split spoon refusal at 15.5 feet.
								END OF BORING AT 15.5 FEET.
20								

Tracking Codes: 60130759 WINNESHICK LDF 2010 GPJ, ETSOIL, 8/2/10, 18:41

MW-26A

LOG OF BORING NO. MW-26A

CLIENT: Winneshiek County Solid Waste Agency

ENGINEER: AECOM

SITE: Winneshiek County, Iowa

PROJECT: Winneshiek County Sanitary Landfill

BOREHOLE DIA.: 7.25 in
WELL DIA.: 2 in
TOP OF PROTECTOR PIPE: ft
TOP OF CASING: ft
GROUND SURFACE ELEV.:

Depth to, ft	Description
2.5	SANDY LEAN CLAY WITH GRAVEL, Dark Brown
2.75	COBBLES
4.25	SANDY LEAN CLAY, TRACE GRAVEL, Light Brown
5.5	LEAN CLAY WITH SILT, Dark Gray
8.75	LEAN CLAY, TRACE SILT, Light Brown
14	LEAN TO FAT CLAY, Dark Brown and Brown
18.5	SANDY LEAN CLAY WITH SHALE, Light Brown
	BOTTOM OF BORING

Samples and tests:

USCS SYMBOL	NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft	WATER CONTENT, %	DRY UNIT WT pcf
CL	1	SS	17	10 15		
CL	2	SS	17	17 4		
CL	3	SS	18	5 6		
CL	4	SS	16	4 4		
CL	5	SS	21	4 3		
CL/CH	6	SS	19	2 2		
CL/CH	7	SS	16	16 7		
CL	8	SS	20	8 5		
CL	9	SS	17	6 9		
~~CL~~	~~10~~	~~SS~~	~~6~~	~~3~~		

The well consists of 2" diameter 0.010" PVC screen with a bottom point and solid PVC riser pipe to the surface. The annulus was filled with sand to about 1' above the screen and the remainder with bentonite to the surface.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ 9	WS	
WL			
WL			

Terracon

BORING STARTED	4-23-10
BORING COMPLETED	4-23-10
RIG 83E	FOREMAN MW
APPROVED DCC	JOB # 13107005

WELL 13107005.GPJ TERRACON.GDT 5/26/10

MW-12A

LOG OF BORING NO. MW-12A

CLIENT: Winneshiek County Solid Waste Agency

ENGINEER: AECOM

SITE: Winneshiek County, Iowa

PROJECT: Winneshiek County Sanitary Landfill

DESCRIPTION

BOREHOLE DIA.: 7.25 in
WELL DIA.: 2 in
TOP OF PROTECTOR PIPE: ft
TOP OF CASING: ft
GROUND SURFACE ELEV.:

Depth to base, ft	Description
4.25	**SANDY LEAN CLAY, TRACE GRAVEL**, Light Brown and Yellow
8.75	**SANDY LEAN CLAY, TRACE GRAVEL & COBBLES**, Light Brown and Yellow
12.5	**SANDY LEAN CLAY WITH HIGHLY WEATHERED LIMESTONE**, Light Brown
28	**HIGHLY WEATHERED LIMESTONE WITH GRAVEL, TRACE LEAN CLAY**, Light Brown

BOTTOM OF BORING

The well consists of 2" diameter 0.010" PVC screen with a bottom point and solid PVC riser pipe to the surface. The annulus was filled with sand to about 1' above the screen and the remainder with bentonite to the surface.

USCS SYMBOL	NUMBER	TYPE	RECOVERY, in.	SPT - N** BLOWS / ft	WATER CONTENT, %	DRY UNIT WT pcf
CL	1	SS	13	13 16		
CL	2	SS	10	34 21		
CL	3	SS	14	15 27		
CL	4	SS	15	14 19		
CL	5	SS	16	6 7		
CL	6	SS	18	9 12		
CL	7	SS	8	22 11		
	8	SS	8	45 44		
	9	SS	10	19 14		
	10	SS	15	13 21		
	11	SS	24	18 26		
	12	SS	20	10 31		
	13	SS	22	14 27		
	14	SS	24	21 36		

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	NONE	WD	
WL			
WL			

Terracon

BORING STARTED	4-22-10		
BORING COMPLETED	4-22-10		
RIG	83E	FOREMAN	MW
APPROVED	DCC	JOB #	13107005

MW-1R

LOG OF BORING NO. MW-1R

CLIENT Winneshiek County Solid Waste Agency	ENGINEER AECOM
SITE Winneshiek County, Iowa	PROJECT Winneshiek County Sanitary Landfill

BOREHOLE DIA.: 7.25 in
WELL DIA.: 2 in
TOP OF PROTECTOR PIPE: ft
TOP OF CASING: ft
GROUND SURFACE ELEV.:

Depth to base, ft	DESCRIPTION	USCS SYMBOL	NUMBER	TYPE	RECOVERY, in.	SPT - N ** BLOWS / ft	WATER CONTENT, %	DRY UNIT WT pcf
2	**SANDY LEAN CLAY,** Dark Brown	CL	1	SS	15	4 3		
5.5	**LEAN CLAY, TRACE SAND,** Light Brown	CL	2	SS	20	4 4		
		CL	3	SS	12	4 5		
16	**LEAN TO FAT CLAY, TRACE SAND,** Brown to Brown Gray	CL/CH	4	SS	19	2 3		
		CL/CH	5	SS	16	3 4		
		CL/CH	6	SS	18	3 3		
		CL/CH	7	SS	19	2 3		
		CL/CH	8	SS	21	3 6		
18.5	**SANDY LEAN CLAY, TRACE GRAVEL,** Brown	CL	9	SS	23	9 11		
	BOTTOM OF BORING	~~CL~~	~~10~~	~~SS~~	~~8~~	~~4~~		

The well consists of 2" diameter 0.010" PVC screen with a bottom point and solid PVC riser pipe to the surface. The annulus was filled with sand to about 1' above the screen and the remainder with bentonite to the surface.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	∇ NONE	WD	▼
WL	▼		▼
WL			

Terracon

BORING STARTED	4-22-10		
BORING COMPLETED	4-22-10		
RIG	83E	FOREMAN	MW
APPROVED	DCC	JOB #	13107005

Sheet 1 Of 2

AECOM

FIELD BORING LOG

BORING NO B-28A

SITE: Winneshiek Co. Landfill

PROJECT NO: 60130759

DRILLING METHOD: 4-1/4 in. ID HSA with 2-in. dia. by 2-ft. long split spoon sampler, 140-lb. hammer

LOG BY: T. Klemmer

FIRM/DRILLER: Terracon/M. White

PHYSICAL SETTING: Summit near sideslope

WATER LEVEL READINGS

DATE/ TIME	WATER DEPTH	HOLE DEPTH	CASING DEPTH

ABANDONMENT DATE: NA

ABANDONMENT METHOD: NA

GROUND SURFACE ELEV:

COORDINATE TYPE:

NORTH:

EAST:

DATE/TIME START: 4/22/10; 12:05

DATE/TIME COMPLETE: 4/22/10; 13:00

WELL INSTALLATION DATE: 4/22/2010

DEPTH IN FEET	B	N	A	R	NO	T	GRAPHIC LOG	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	3	4			(1)	SS		CL	QUATERNARY, LOESS, Soft, dark brown (10YR 3/3) LEAN CLAY (CL); moist; medium plasticity; cohesive; massive; A horizon of modern soil profile; loess.
1	2				1.5 of 2.0" 75%				
	2						1.3	CL	Soft, yellowish brown (10YR 5/6) LEAN CLAY (CL); moist; medium plasticity; cohesive; massive; B horizon of modern soil profile; loess.
2	2						[redacted]		
	2	4			(2) [illegible]	SS		CL	As above from 1.3 to 2.0 feet.
3	2				[illegible]				
	2								
4	2								
	2	4			(3)	SS			
5	2			0.0 of 2.0"	0%				
	2								
6	2						6.0		
	0	2			(4)	SS		CL	Very soft, yellowish brown (10YR 5/4) LEAN CLAY (CL); moist to wet; medium plasticity; cohesive; massive; OL; loess.
7	1				1.0 of 2.0" 50%				
	1								
8	1								
	0	3			(5)	SS	8.6		
9	2				1.2 of 2.0" 60%			CL	Soft, gray (10YR 6/1) mottled with light olive brown (2.5Y 5/6) LEAN CLAY (CL); moist to wet; low to medium plasticity; cohesive; massive; MDU; loess.
	1								
10	1								

AECOM

FIELD BORING LOG

Sheet 2 Of 2

BORING NO B-28A

SITE: Winneshiek Co. Landfill

PROJECT NO: 60130759

DRILLING METHOD: See page 1

LOG BY:

FIRM/DRILLER:

PHYSICAL SETTING:

WATER LEVEL READINGS

DATE/ TIME	WATER DEPTH	HOLE DEPTH	CASING DEPTH

ABANDONMENT DATE:

ABANDONMENT METHOD:

GROUND SURFACE ELEV:

COORDINATE TYPE:

NORTH:

EAST:

DATE/TIME START:

DATE/TIME COMPLETE:

WELL INSTALLATION DATE:

DEPTH IN FEET	B	N	A	R	NO	T	GRAPHIC LOG	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
10			↓	↓	6	SS		CL	As above from 8.6 to 10.0 feet.
	1	4							
11	1				1.7" / 2.0"				
	3						11.3		
								CS	ORDOVICIAN, MAQUOKETA FORMATION, ELGIN MEMBER. CLAYSTONE; weak; brownish yellow (10YR 6/6); aphanitic; thinly to medium bedded; moderately decomposed; competent to slightly disintegrated; moderately fractured; slightly moist; oxidized, weathered claystone
12	4			↓	7	SS			
	5	18							
13	11				1.6" / 2.0"				As above from 11.3 to 12.0 feet.
	7								
14	8			↓	8	SS			As above from 11.3 to 14.0 feet.
	4								
15	8				1.5" / 1.5"				
	30/.5"						15.5		Auger and split spoon refusal at 15.5 feet. END OF BORING AT 15.5 FEET.

C:\Data\Projects\Iowa\April 2010\Field Forms\FIELD BORING LOG.xls

AECOM

PIEZOMETER INSTALLATION DIAGRAM

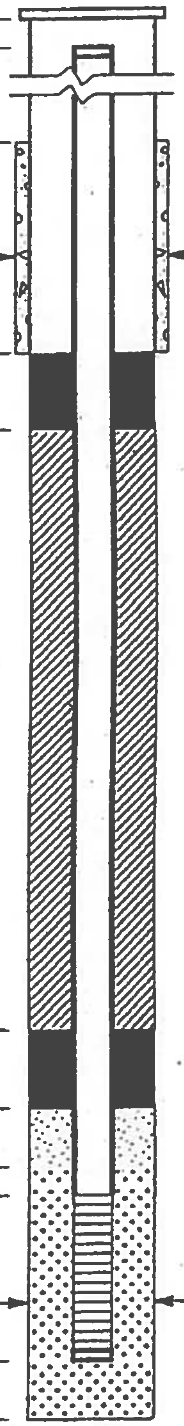
Site Name: Winneshiek Co Landfill Project No. 60130759.11.070 Well No. MW-28A

Northing: ____ Easting: ____ Surf.Elev. ____ Ref. Boring No. B-28A

Drilling Contractor: Terracon Drilling Dates: 4/22/2010

Driller: Matt White/Bob Bergman Inspected By: Jeff Maletzke Well Completion Date: 4/22/2010

Drilling Method: 4¼-inch HSA w/CME-55 ATV rig Drilling Fluids (type): None



	Depth / Elev.
Top of Protective Casing:	34.5"
Top of Riser Pipe:	34"
Ground Surface:	0.00'
Concrete Thickness	
Concrete Diameter	
Top of Seal:	
Seal Thickness	
Top of Grout:	
Grout Thickness	
Well Length	7.2
Top of Seal:	0.0
Seal Thickness	6.0
Top of Fine Sand:	N/A
Fine Sand Thickness	N/A
Top of Filter Pack:	6.0
Top of Screen:	7.3
Screen Length	7
Filter Pack Thickness	9.5
Borehole Diameter	8"
Bottom of Screen:	14.3
Mat'l. Thickness	1.2
Bottom of Borehole:	15.5

Protective Casing
Type: Steel Vented (Y/N): Y
Dia.(in): 4" square Locked (Y/N): Y
Length: 5' Key No.: CAT

Cap or Plug Type: Pintop Vented (Y/N): ____

Concrete Collar
Manufacturer: N/A
Volumes: ____ Lbs. of Cement
+ ____ Gal. of Water
= ____ Gal. total Volume

Upper Seal Type: ____
Manufacturer: ____
Volume (Gal.) ____
Hydration: Volume Water: ____ Time: ____

Well Casing Type: PVC
Manufacturer: Johnson Screens
Schedule: 40
Length per Section: 10 Casing O.D./I.D. 2.375/2.067
No. of Sections: 1 Total Length: 10

Joints Flush Threaded ☒ Taped ☐ Welded ☐ O-Ring ☐
Manufacturer: ____

Grout Type: ____
Manufacturer: ____
Final Volumes: ____ Lbs. of ____
+ ____ Lbs. of ____
+ ____ Gal. of Water
= ____ Gal. total Volume

Lower Seal Type: 3/8" Sodium Bentonite Hole Plug
Manufacturer: Baroid
Volume (Gal.) 3¾ - 50 lb bags
Hydration: Volume Water 7 gal. Time: 1343

Fine Sand Type: ____
Manufacturer: ____
Volume (Gal.) ____

Filter Pack Type: Coarse Sand
Manufacturer: BMC Aggregate, Elk Run, IA
Volume (Gal.) 6½ - 50 lb bags

Screen Type: PVC Sch: 40
Manufacturer: Johnson Screens
Length/Sec. 7 No of Sec. 1
O.D. 2.375 I.D. 2.067
Slot Size: 0.010 No. Slots/ft. ____
Slotted Length: 7'

Bottom Cap or Plug Type: PVC slip Length: 2"

Water Source Terracon shop

NOTES: ____

Tracking Codes: 8pl.idd, PIEZOFF, 12/15/97, 18:42

MW-28A

LOG OF BORING NO. MW-28A

CLIENT: Winneshiek County Solid Waste Agency

ENGINEER: AECOM

SITE: Winneshiek County, Iowa

PROJECT: Winneshiek County Sanitary Landfill

BOREHOLE DIA.: 7.25 in
WELL DIA.: 2 in
TOP OF PROTECTOR PIPE: ft
TOP OF CASING: ft
GROUND SURFACE ELEV.:

Depth to base (ft)	Description	USCS Symbol	Sample Number	Type	Recovery, in.	SPT - N** Blows / ft	Water Content, %	Dry Unit Wt pcf
2	**SANDY LEAN CLAY,** Dark Brown	CL	1	SS	17	5 4		
4.5	**LEAN CLAY,** Brown		2	SS	0	4 4		
10.5	**LEAN TO FAT CLAY,** Brown Gray	CL	3	SS	19	4 4		
		CL/CH	4	SS	18	2 2		
		CL/CH	5	SS	17	3 2		
14	**SANDY LEAN CLAY, TRACE GRAVEL,** Brownish Yellow	CL/CH CL	6	SS	20	2 7		
		CL	7	SS	20	16 15		
15.5	**HIGHLY WEATHERED SHALE,** Yellow and Light Brown		8	SS	18	12 50/5"		

BOTTOM OF BORING

The well consists of 2" diameter 0.010" PVC screen with a bottom point and solid PVC riser pipe to the surface. The annulus was filled with sand to about 1' above the screen and the remainder with bentonite to the surface.

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer
**CME 140 lb. SPT automatic hammer

WATER LEVEL OBSERVATIONS, ft			
WL	NONE	WD	
WL			
WL			

Terracon

BORING STARTED	4-22-10
BORING COMPLETED	4-22-10
RIG 83E	FOREMAN MW
APPROVED DCC	JOB # 13107005

Appendix A-10 – 2015 – Boring Logs and Monitoring Well Construction Documentation

AECOM

FINAL SOIL BORING LOG

BORING NO. **SB-15-01**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851.18** SHEET **1** OF **1**

SITE #: **Lagoon Borings**

PHYSICAL SETTING: **Grassy hillslope, east of Cell 5**
LOG BY: **R. Henning**
FIRM/DRILLER: **Terracon/Scott**
DRILLING METHOD: **3 1/4 HSA, 2-in x 2-ft SS to top of rock; NQ Core to EOB**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
6/4/2015	11.7	35	8.2

ABANDONMENT DATE: **6/4/2015**
ABANDONMENT METHOD: **Quick Grout**

GROUND SURFACE ELEV: **1117.00**
Iowa State Plane LOCAL COORDINATES:
NORTHING: **3914944.7**
EASTING: **5410397.22**
DATE/TIME STARTED: **6/4/15 ; 09:50**
DATE/TIME COMPLETED: **6/4/15 ; 11:30**
WELL INSTALLATION: **NA**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 2 2 3	4		70	1	SS		ML	QUATERNARY LOESS soft, black (10 YR 2/1) SILT (ML), moist, low plasticity, cohesive, massive, A horizon
	2 2 3 2	5		65	2	SS		ML	As above from 2 - 4 feet
	2 3 2 3	4		75	3	SS		CL	medium, dark yellowish brown (10 YR 4/4), LEAN CLAY (CL), moist to wet, medium plasticity, cohesive, massive, OL, loess
5									
	2 3 4 20	7		35	4	SS		CL	WISCONSIN EPISODE COLLUVIUM medium, dark brown (10YR 4/3), LEAN CLAY with GRAVEL (CL), moist to wet, cohesive, low plasticity, massive, colluvium
	50/2	50		9	5	SS		SH	refusal on bedrock; Top of bedrock at 8.2 ft; change to rock coring with NQ core bit; continues on SB-15-01 Rock Core Log
10									
15									

AECOM

FINAL ROCK CORE LOG

BORING NO. **SB-15-01 (CORE)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851.18**

WATER LEVEL READINGS

DATE	TIME	DEPTH	CASING
6/4/2015		11.7	8.2

DRILLING METHOD: 3 1/4 HSA, 2-in x 2-ft SS to top of rock; NQ Core to EOB

LOG BY: R. Henning

FIRM/DRILLER: Terracon/Scott

PHYSICAL SETTING: Grassy hillslope, east of Cell 5

ABANDONMENT DATE: 6/4/2015

ABANDONMENT METHOD: Quick Grout

GROUND SURFACE ELEV: 1117.0

Iowa State Plane COORDINATES:

NORTHING: 3914944.7

EASTING: 5410397.2

DATE STARTED: 6/4/15

DATE COMPLETED: 6/4/15

INSTALLATION: NA

Depth in Feet	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE CODE	ROCK DESCRIPTION
8.2								DL	ORDOVICIAN GALENA GROUP DECORAH FM.
	1	1.5	73			0		DL	very poor, DOLOMITE (DL), strong, pale yellowish brown (10 YR 6/2), medium grained, medium bedded, slightly decomposed, moderately disintegrated, w/ vugs filled with quartz crystals, moderately fractured
10	2	5.0	98			45			interbedded shale and dolomite, poor, DOLOMITE (DL) and SHALE (SH), yellowish brown (10 YR 6/2) dolomite to pale brown (5 YR 5/2) shale, strong on dolomite to weak on shale, medium grained dolomite, fine grained shale, medium bedded, moderately decomposed, slightly disintegrated, moderately fractured
15	3	5.0	95			67			DOLOMITE (DL) with SHALE (SH) seams, moderate to strong, pale yellowish brown (10 YR 6/2), fine to medium grained, massive, slightly decomposed, moderately disintegrated, w/ some quartz filled vugs; moderately fractured, conformable, breaks along shale seams and bedding plane, no vertical fractures; fractures healed
20	4	5.0	100			85		DL	DOLOMITE (DL), strong, pale yellowish brown (10 YR 6/2), fine to medium grained, massive, slightly decomposed, slightly disintegrated, moderately fractured, breaks along bedding plane, some quartz filled vugs.
25	5	5.0	100			78		DL	As above from 25.5 - 30.5 feet;
28.2									

Continued Next Page

Tracking Codes: 60322851.GPJ, ETROCK, 10/23/19, 15:33

AECOM

FINAL ROCK CORE LOG

BORING NO. **SB-15-01 (CORE)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851.18** SHEET **2** OF **2**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
28.2 – 30											
30.5 – 35		6	5.0	94			68			DL	As above from 30.5 - 35.5 feet;
52.2											EOB at 35.5 ft bgs; borehole abandoned with Quick Grout using tremie pipe to ground surface

AECOM

FINAL SOIL BORING LOG

BORING NO. **SB-15-02**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851.18** SHEET **1** OF **1**

SITE #: **Lagoon Borings**

	WATER LEVEL READINGS DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
PHYSICAL SETTING: Grassy hillslope, east of Cell 5	6/4/2015	17.09	30.41	11.6
LOG BY: R. Henning				
FIRM/DRILLER: Terracon/Scott				
DRILLING METHOD: 3 1/4 HSA, 2-in x 2-ft SS to top of rock; NQ Core to EOB				

ABANDONMENT DATE: **6/4/2015**
ABANDONMENT METHOD: **Quick Grout**

GROUND SURFACE ELEV: **1117.00**
Iowa State Plane LOCAL COORDINATES:
NORTHING: **3915258.5**
EASTING: **5410356.20**
DATE/TIME STARTED: **6/4/15 ; 12:10**
DATE/TIME COMPLETED: **6/4/15 ; 13:45**
WELL INSTALLATION: **NA**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 2 2 3	4		90	1	SS		CL	QUATERNARY LOESS soft, yellowish brown (10 YR 5/4), LEAN CLAY (CL), dry to moist, low to medium plasticity, cohesive, medium bedded, A horizon, rooted, OL, loess
	2 2 3 3	5		90	2	SS		CL	medium, moist, as above from 2 - 4 feet
5	1 2 3 4	5		90	3	SS		CL	As above from 4 - 6 feet
	--	--		90	4	SS		CL	wet, as above from 6 - 8 feet
	2 3 6 10	9		100	5	SS		CL	stiff, as above from 8 - 9.5 feet; buried soil horizon top at 9.5 feet; yellowish brown (10 YR 5/6), LEAN CLAY (CL), wet, medium plasticity, medium bedded, buried A horizon, rooted, OL, loess
10	16 7 28 50/1	35		85	6	SS		CL	WISCONSIN EPISODE COLLUVIUM hard, yellowish brown (10 YR 5/6), LEAN CLAY (CL), wet, medium plasticity, medium bedded, colluvium; weathered brown shale from 11 - 11.6 feet,
									Top of bedrock at 11.6 ft; change to rock coring with NQ core bit; continues on SB-15-02 Rock Core Log
15									

Tracking Codes: 60322851.GPJ, ETSOIL, 10/23/19, 15:24

AECOM

FINAL ROCK CORE LOG

BORING NO. **SB-15-02 (CORE)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851.18** SHEET **1** OF **1**

DRILLING METHOD	WATER LEVEL READINGS DATE	TIME	DEPTH	CASING	
3 1/4 HSA, 2-in x 2-ft SS to top of rock; NQ Core to EOB	6/4/2015		17.09	11.6	

GROUND SURFACE ELEV: 1117.0

Iowa State Plane COORDINATES: NORTHING: 3915258.5 EASTING: 5410356.2

LOG BY: R. Henning

FIRM/DRILLER: Terracon/Scott

PHYSICAL SETTING: Grassy hillslope, east of Cell 5

ABANDONMENT DATE: 6/4/2015

ABANDONMENT METHOD: Quick Grout

DATE STARTED: 6/4/15

DATE COMPLETED: 6/4/15

INSTALLATION: NA

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
11.6		1	4.0	95			35				ORDOVICIAN GALENA GROUP DECORAH FM.
15		2	5.0	96			74				DOLOMITE (DL) with SHALE (SH) partings, moderate to strong, pale yellowish brown (10 YR 6/2), fine to medium grained, medium bedded, moderately decomposed, slightly disintegrated, moderately fractured, bedding plane fractures
20		3	5.0	96			77			DL	DOLOMITE (DL), pale yellowish brown (10 YR 6/2), fine to medium grained, massive, slightly decomposed, moderately fractured, bedding plane fractures, conformable, some solutioning between 24.6 and 25.6 feet.
25		4	5.0	100			89			DL	As above from 25.6 to 30.6 feet;
30											EOB at 30.6 ft bgs; borehole abandoned with Quick Grout using tremie pipe to ground surface
31.6											

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **SB-15-03**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851.18** SHEET **1** OF **1**

SITE #: **Lagoon Borings**

	DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
WATER LEVEL READINGS	6/4/2015	12.8	25.6	15

PHYSICAL SETTING: **Grassy hillslope, north of Cell 5**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/Scott**

DRILLING METHOD: **3 1/4 HSA, 2-in x 2-ft SS to top of rock; NQ Core to EOB**

ABANDONMENT DATE: **6/4/2015**

ABANDONMENT METHOD: **Quick Grout**

GROUND SURFACE ELEV: **1120.00**

Iowa State Plane LOCAL COORDINATES

NORTHING: **3915465.9**

EASTING: **5410053.06**

DATE/TIME STARTED: **6/4/15 ; 14:00**

DATE/TIME COMPLETED: **6/4/15 ; 15:30**

WELL INSTALLATION: **NA**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	1 2 2 2	4		34	1	SS		CL	QUATERNARY LOESS soft, yellowish brown (10 YR 5/4), LEAN CLAY (CL), moist, medium plasticity, cohesive, bedded, OL, plant roots, loess
	2 2 2 2	4		46	2	SS		CL	As above from 2 to 4 feet
5	1 2 2 2	4		75	3	SS		CL	As above from 4 to 6 feet; moist to wet
	WOH 1 1 2	2		71	4	SS		CL	very soft, wet, as above from 6 to 8 feet
	2 3 3 3	6		84	5	SS		CL	medium, as above from 8 to 10 feet; sand seam at bottom
10	1 2 2 2	4		63	6	SS		CL	soft, yellowish brown (10 YR 5/4), LEAN CLAY (CL), wet, medium plasticity, cohesive, bedded, OL, plant roots, loess
	6 9 9 14	18		34	7	SS		CL	WISCONSIN EPISODE COLLUVIUM very stiff, dark yellowish brown (10 YR 4/2), GRAVELY LEAN CLAY with SAND (CL), wet, nonplastic, noncohesive, bedded, colluvium
	9 50/6	50		42	8	SS		CL	hard, as above from 14 to 15 feet, colluvium;
15									Top of bedrock at 15.0 ft; change to rock coring with NQ core bit; continues on SB-15-03 Rock Core Log

Tracking Codes: 60322851.GPJ, ETSOIL, 10/23/19, 15:25

AECOM

FINAL ROCK CORE LOG

BORING NO. **SB-15-03 (CORE)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851.18** SHEET **1** OF **1**

WATER LEVEL READINGS

	DATE	TIME	DEPTH	CASING
DRILLING METHOD: **3 1/4 HSA, 2-in x 2-ft SS to top of rock; NQ Core to EOB**	6/4/2015		12.8	15

GROUND SURFACE ELEV: **1120.0**

Iowa State Plane COORDINATES:

NORTHING: **3915465.9**

EASTING: **5410053.1**

LOG BY: **R. Henning**

DATE STARTED: **6/4/15**

FIRM/DRILLER: **Terracon/Scott**

ABANDONMENT DATE: **6/4/2015**

DATE COMPLETED: **6/4/15**

PHYSICAL SETTING: **Grassy hillslope, north of Cell 5**

ABANDONMENT METHOD: **Quick Grout**

INSTALLATION: **NA**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
15		1	0.5	100			0			DL	ORDOVICIAN GALENA GROUP DECORAH FM.
		2	1.0	80			0			DL	DOLOMITE (DL), moderate to strong, pale yellowish brown (10 YR 6/2), medium grained, massive, slightly decomposed, slightly disintegrated, moderately fractured with bedding plane fractures, some solutioning along bedding plane fractures, conformable
		3	4.0	93			33			DL	DOLOMITE (DL), moderate to strong, pale yellowish brown (10 YR 6/2), medium grained, massive, slightly decomposed, slightly disintegrated, moderately fractured with bedding plane fractures, some solutioning along bedding plane fractures, conformable
20											
		4	5.0	100			64			DL	As above from 20.5 to 25.5 feet;
25											
											EOB at 25.5 ft bgs; borehole abandoned with Quick Grout using tremie pipe to ground surface
35											

Continued Next Page

NQ2

LOG OF BORING NO. SB15-01

Job No. 13157016 Client ______

ENGINEER DC
DRILLER SZ
HELPER JS
RIG NO. 977

SURFACE ELEV. ______
BORING STARTED 6-4-15
BORING COMPLETED 6-4-15
STATION [illegible]
OFFSET ______

Sheet 1 of ______
WEATHER 70°
ST SIZE — SS SIZE 2"
CASING USED ______ SIZE ______
HSA USED 10' SIZE 3 1/4

Start Coring @ 9'
Added water @ 9'

Sample No.	Depth or Elevation: From	Depth or Elevation: To	Sampling Method	Penetration Record – Split Spoon Blows 6"	6"	6"	6" (2 Feet)	R: Length Recovered in Inches	Qp: Penetrometer Test in TSF	Sample Description
	0	10	HS							0 - 0.3' Br Sa Ln CL
1	0	2	SS	2	2	2	3	18	1.0	0.3' - 3' Dk Br SiCL -
2	2	4	SS	2	2	3	2	18	.75	3-6 Gr Sa Ln Cl
3	4	6	SS	2	2	2	3	18	.75	6-8 - Dr Br Sa Ln Cl tra LS
4	6	8	SS	2	3	2	0	9	.25	8-9 LS w/ shale
5	9	9+2"	SS	50/2				2	N/A	9-10.2 LS
			DB		RR		RQD			10.2 - 10.5 Br Shale
R1	9	10.5	DB		13/18		0/18			10.5 - 11 LS
R2	10.5	15.5	DB		59/60		30/60			11 - 11.5 Shale
R3	15.5	20.5	DB		55/60		48/60			11.5 - 12 LS
R4	20.5	25.5	DB		60/60		58/60			12 - 12.5 Shale
R5	25.5	30.5	DB		60/60		45/60			12.5 - 13.5 LS
R6	30.5	35.5	DB		60/60		48/60			13.5 - 14.5 Shale
										14 - 35.5 LS
										EOB - [illegible]

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS

WL: ______ WS OR WD
WL: ______ BCR ______ ACR
WL: ______ AB ______ Hr. AB
WL: ______ 24 Hr. AB

TOPSOIL THICKNESS —
FILL THICKNESS —
BORING BACK FILLED X YES ___ NO

CAVE IN LEVEL:
While Drilling and Sampling ______
After Boring Completion ______

WATER LOSS:
At ______ To ______
Percent Loss ______
At ______ To ______
Percent Loss ______

BOULDERS OR OBSTRUCTIONS:
At ______ To ______
At ______ To ______

ARTESIAN PRESSURE:
Depth ______
Height of Soil Rise In Casting ______

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

Terracon

Form 130

LOG OF BORING NO. SB15.02 Job No. 1315?3?6 Client

ENGINEER DC
DRILLER SZ
HELPER 35
RIG NO. 477

SURFACE ELEV.
BORING STARTED 6-4-15
BORING COMPLETED 6-4-15
STATION [illegible]
OFFSET

Sheet 1 of 1
WEATHER 75° Sunny
ST SIZE — SS SIZE 2"
CASING USED — SIZE —
HSA USED 10' SIZE 3¼

Sample No.	Depth or Elevation: From	Depth or Elevation: To	Sampling Method	Penetration Record – Split Spoon Blows 6"	6"	6"	6"	R – Length Recovered In Inches	Qp – Penetrometer Test In TSF	Sample Description
										Started coring 11.6 Added water @ 11.6
	0	10	HS							0-3 [illegible]
1	0	2	SS	2	2	2	3	18	1.5	?-3 Br [illegible]
2	2	4	SS	2	2	3	3	18	.75	?-10.6 Br [illegible]
3	4	6	SS	1	2	3	4	15	1.5	10.6-11.6 Br [illegible] w/ L.S. Layers
4	6	8	SS					18	1.0	11.6-12 L.S
5	8	10	SS	2	3	6	10	20	1.25	12-12.5 Shale
6	10	11.6	SS	16	7	29	50/1	17	NA	12.5-12.8 - L.S
			DB		RR		RQD			12.8-13.5 - Shale
R1	11.6	15.6	DB		48/48		13/48			13.5-14 L.S
R2	15.6	20.6	DB		60/60		46/60			14-14.5 Shale
R3	20.6	25.6	DB		58/60		49/60			14.5-30.6 L.S
R4	25.6	30.6	DB		59/60		51/60			

Form 130

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS
WL: ______ WS OR WD
WL: ______ BCR ______ ACR
WL: — AB — Hr. AB
WL: ______ 24 Hr. AB
TOPSOIL THICKNESS —
FILL THICKNESS —
BORING BACK FILLED X YES ___ NO
CAVE IN LEVEL:
While Drilling and Sampling ______
After Boring Completion ______

WATER LOSS:
At ______ To ______
Percent Loss ______
At ______ To ______
Percent Loss ______

BOULDERS OR OBSTRUCTIONS:
At ______ To ______
At ______ To ______

ARTESIAN PRESSURE:
Depth ______
Height of Soil Rise In Casing ______

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

Terracon

LOG OF BORING NO. [illegible]3

Job No. [illegible] Client

ENGINEER DC
DRILLER [illegible]
HELPER [illegible]
RIG NO. [illegible]

SURFACE ELEV.
BORING STARTED [illegible]
BORING COMPLETED [illegible]
STATION Staked
OFFSET

Sheet 1 of 1
WEATHER
ST SIZE – SS SIZE [illegible]
CASING USED – SIZE –
HSA USED SIZE 3 1/4

[illegible] @ 15
added water @ 15

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	Penetration Record – Split Spoon Blows 6"	6"	6"	6"	R Length Recovered In Inches	Qp Penetrometer Test In TSF	Sample Description
	0	15	HA							0-[illegible] Cl [illegible]
	0	2	[illegible]	1	2	2	2	9	1.0	2-[illegible] Fr [illegible]
[illegible]	2	4	[illegible]	2	2	2	[illegible]	11	[illegible]	[illegible]-10 Br Sa Silt
[illegible]	4	6	[illegible]	1	[illegible]	[illegible]	[illegible]	18	.5	11.5-11.9 Br Fmed [illegible] Cl
[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	2.2	11.9-15 Ls [illegible] Br Sa Ln Cl
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	3	3	20	2.0	15-25.5 Ls
6	[illegible]	12	[illegible]	[illegible]	2	2	2	15	[illegible]	
7	[illegible]	[illegible]	[illegible]	[illegible]	9	9	14	8	NA	EOB - 25.5
8	14	15	SS	9	50/6			10	NA	
				RR		RQD				
R1	15	15.5	DB	[illegible]		0/6				
R2	15.5	16.5	DB	12/12		6/12				
R3	16.5	20.5	DB	48/48		15/45				
R4	20.5	25.5	DB	60/60		35/60				

DRILL CREW CHECK LIST
WATER LEVEL OBSERVATIONS

WL: – WS OR WD
WL: ____ BCR ____ ACR
WL: – AB – Hr. AB
WL: ____ 24 Hr. AB
TOPSOIL THICKNESS –
FILL THICKNESS –
BORING BACK FILLED X YES ___ NO

CAVE IN LEVEL:
While Drilling and Sampling ____
After Boring Completion ____

WATER LOSS:
At ____ To ____
Percent Loss ____
At ____ To ____
Percent Loss ____

BOULDERS OR OBSTRUCTIONS:
At ____ To ____
At ____ To ____

ARTESIAN PRESSURE:
Depth ____
Height of Soil Rise In Casting ____

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

Terracon

Form 130

Appendix A-11 – 2016 – Boring Logs and Monitoring Well Construction Documentation

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-100**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

PHYSICAL SETTING: **North end of lagoon**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/Scott Z.**

DRILLING METHOD: **4 1/4-in HSA; 2-in x 2-ft SS**

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1132.16**

Iowa State Plane LOCAL COORDINATES

NORTHING: **3915375.5**

EASTING: **5410304.42**

DATE/TIME STARTED: **7/25/16 ; 15:30**

DATE/TIME COMPLETED: **7/25/16 ; 17:30**

WELL INSTALLATION: **7/25/16**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	1 2 2 3	4		40	1	SS		FILL	QUATERNARY FILL; soft; dark brown (10YR 3/3); LEAN CLAY (CL); dry; non-plastic; cohesive; massive; FILL
	2 3 3 4	6		100	2	SS			as above from 2 to 6 feet.
5	3 5 3 8	11		90	3	SS			
	3 6 6 4	12		80	4	SS		FILL	Stiff; yellow (2.5 Y 7/6); LEAN CLAY (CL); dry; non-plastic, cohesive; massive; FILL.
	8 10 10 12	20		80	5	SS			as above from 8 to 14 feet.
10	8 10 10 11	20		70	6	SS			
	10 10 11 12	21		75	7	SS			
15	6 8 7 8	15		75	8	SS		CL	Stiff; brown (7.5 YR 4/3) mottled with strong brown (7.5 YR 5/8); LEAN CLAY WITH SILT (CL); dry; non-plastic; cohesive; bedded; topsoil with roots; LOESS.
	6 8 7 6	15		75	9	SS			topsoil
	2 3 3 5	6		100	10	SS		ML	Medium; light brown (7.5 YR 6/6); SILT (ML); wet; non-plastic; cohesive; bedded; LOESS.

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. B-100

SITE: Winneshiek Co. LF PROJECT NO. 60322851

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	2 3 3 3	6		70	11	SS			As above from 20 to 25.5 feet.
	2 3 3 4	6		80	12	SS			Saturated SILT (ML).
25	2 3 3 5	6		65	13	SS			
								SM	Medium dense; brownish yellow (10 YR 6/6); SILTY SAND (SM); wet; non-plastic; non-cohesive; bedded; LOESS.
	11 6 6 6	12		45	14	SS		GC	QUATERNARY WISCONSIN EPISODE COLLUVIUM. Medium dense; yellowish brown (10 YR 5/8); CLAYEY GRAVEL (GC); wet; non-plastic; non-cohesive; gravel composed of weathered dolomite; bedded; colluvium.
	2 8 8 46	16		50	15	SS		CL	very stiff; yellowish brown (10 YR 5/6); LEAN CLAY (CL); wet; low plasticity; cohesive; bedded; colluvium.
30						NS		DL	pale brown (10 YR 6/3); DOLOMITIC LIMESTONE (DL); dry; non-plastic; non-cohesive; bedded; ORDOVICIAN GALENA FORMATION. Auger thru weathered dolomite from 30 - 35 feet; no rock core collected.
35									EOB @ 35 feet bgs; install monitoring well MW-100 in borehole.
40									

Tracking Codes: 60322851_43.GPJ, ETSOIL, 10/23/19, 16:18

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek Co. LF	**Permit No.** 96-SDP-1-74P
Well or Piezometer No. MW-100	
Dates Started 7/25/2016	**Date Completed** 7/25/2016

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site North end; lagoon berm	Terracon
Distance & direction along boundary	3105 Capital Way #5
Distance & direction from boundary to well	Cedar Falls, IA 50613
Elevations (± 0.01 ft. MSL):	**Name of driller** Scott Z.
Ground Surface 1132.16	**Drilling method** 4 1/4-in HSA
Top of protective casing 1135.71	**Drilling fluid** none
Top of well casing 1135.14	**Bore Hole diameter** 8-in
Benchmark elevation	**Soil sampling method** 2-in x 2-ft SS
Benchmark description	**Depth of boring** 35

C. MONITORING WELL INSTALLATION	
Casing material SCH 40 PVC	**Placement method** gravity
Length of casing 23.45-ft	**Volume** 187.5-lbs
Outside casing diameter 2.375-in	**Backfill (if different from seal):** Baroid
Inside casing diameter 2.067-in	**Material** Quik-Grout
Casing joint type flush threaded; o-ring	**Placement method** tremie
Casing/screen joint type flush threaded; o-ring	**Volume** 40-gal
Screen material SCH 40 PVC	**Surface seal design:** Holeplug
Screen opening size 0.010-in	**Material of protective casing:** 4-in sq. x 7-ft steel
Screen length 10-ft	**Material of grout between protective casing and well casing:** 3/8-in Holeplug
Depth of Well 32.0-ft bgs	**Protective cap:**
Filter Pack:	**Material** 4-in sq. x 7-ft steel
Material BMC Aggregates Filter Sand	**Vented?:** ☒ Y ☐ N **Locking?:** ☒ Y ☐ N
Grain Size	**Well cap:** T-Cap
Volume 500-lbs	**Material** 2-in PVC compression T-Cap
Seal (minimum 3 ft. length above filter pack): Baroid	**Vented?:** ☐ Y ☒ N
Material 3/8-in Holeplug	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

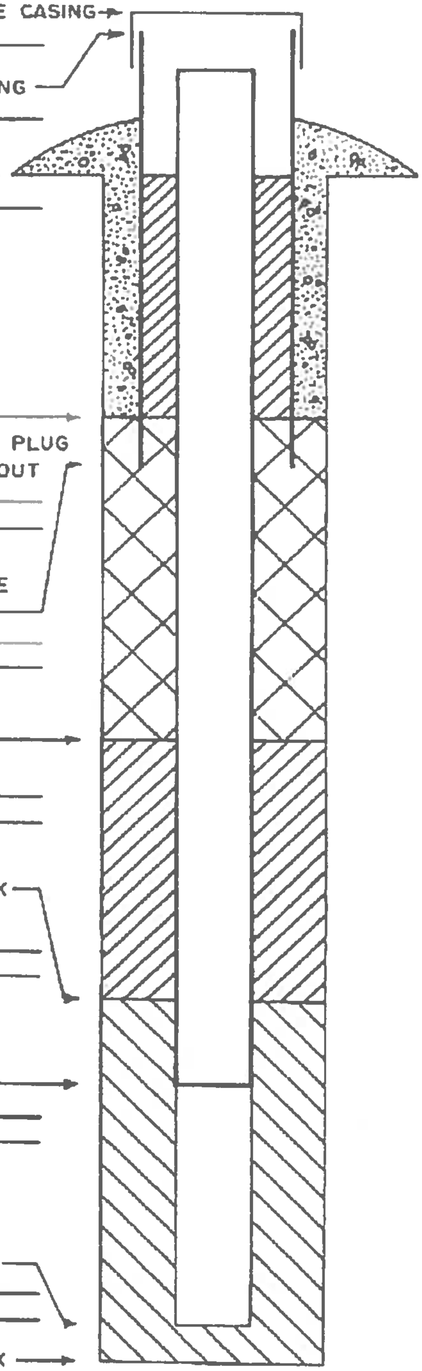
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



TOP OF PROTECTIVE CASING
ELEVATION 1135.71

TOP OF WELL CASING
ELEVATION 1135.14

GROUND SURFACE
ELEVATION 1132.16

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1128.16
DEPTH 4

BASE OF PROTECTIVE CASING
ELEVATION 1128.71
DEPTH 3.45

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1119.66
DEPTH 12.5

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1112.16
DEPTH 20

TOP OF SCREEN
ELEVATION 1110.16
DEPTH 22

BOTTOM OF SCREEN
ELEVATION 1100.16
DEPTH 32

BASE OF FILTER PACK
ELEVATION 1097.16
DEPTH 35

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-101**

SITE: Winneshiek Co. LF | PROJECT NO. 60322851 | SHEET 1 OF 2

SITE #: 96-SDP-1-74P

	WATER LEVEL READINGS			
	DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

PHYSICAL SETTING: East side of lagoon

LOG BY: R. Henning

FIRM/DRILLER: Terracon/Scott Z.

DRILLING METHOD: 4 1/4-in HSA; 2-in x 2-ft SS

ABANDONMENT DATE: NA

ABANDONMENT METHOD: NA

GROUND SURFACE ELEV: 1132.08

Iowa State Plane LOCAL COORDINATES:

NORTHING: 3915126.5

EASTING: 5410410.39

DATE/TIME STARTED: 7/25/16 ; 11:35

DATE/TIME COMPLETED: 7/25/16 ; 15:00

WELL INSTALLATION: 7/25/16

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	1 1 1 2	2		20	1	SS		FILL	QUATERNARY FILL; very soft; reddish brown (5 YR 4/3); LEAN CLAY (CL); dry; non-plastic; cohesive; massive; FILL.
	7 8 6 7	14		80	2	SS			As above from 2 to 10 ft; color change to brownish yellow (10 YR 6/6).
5	6 11 11 10	22		50	3	SS			
	13 14 9 11	23		65	4	SS			
	8 12 11 12	23		70	5	SS			
10	11 11 11 9	22		60	6	SS		FILL	Very stiff; yellowish brown (10 YR 6/6); LEAN CLAY WITH GRAVEL (CL); dry, non-plastic; cohesive, massive; FILL.
	5 5 6 7	11		45	7	SS			As above from 12 to 18 feet.
15	3 4 7 11	11		60	8	SS			
	6 6 7 8	13		75	9	SS			
	5 6 7 11	13		80	10	SS		CL	Stiff; dark grayish brown (10 YR 4/2); LEAN CLAY (CL); moist; low plasticity; cohesive; bedded; topsoil; LOESS.

Continued Next Page

FINAL SOIL BORING LOG

AECOM

BORING NO. **B-101**

SITE: Winneshiek Co. LF PROJECT NO. 60322851 SHEET 2 OF 2

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	4 5 5 7	10		70	11	SS		CL	Stiff; brown (7.5 YR 5/4); LEAN CLAY (CL); wet; low plasticity; cohesive; massive; LOESS.
	3 4 3 5	7		70	12	SS			As above from 22 to 24 feet.
25	9 12 12 10	24		45	13	SS		CL	QUATERNARY WISCONSIN EPISODE COLLUVIUM. Very stiff; strong brown (7.5 YR 4/6); LEAN CLAY WITH SAND AND GRAVEL (CL); wet; non-plastic; non-cohesive; bedded; colluvium.
	3 4 4 7	8		0	14	SS			no recovery; rock lodged in split spoon tip.
	2 2 2 2	4		100	15	SS		SC	Very loose; strong brown (7.5 YR 4/6); CLAYEY SAND (SC); wet; low plasticity; cohesive; colluvium.
30	2 8 7 10	15		75	16	SS			As above from 28 to 32 feet; with dolomitic limestone at bottom of split spoon sample.
	50/4			0	17	SS		DL	ORDOVICIAN GALENA GROUP DECORAH FORMATION; DOLOMITIC LIMESTONE (DL); no recovery due to top of bedrock.
35						NS			Auger thru dolomitic limestone from 34 to 40 ft bgs; no rock core.
40									EOB @ 40-ft bgs; Install monitoring well MW-101 in borehole.

Tracking Codes: 60322851_43 GPJ, ETSOIL, 10/23/19, 16:18

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek Co. LF	**Permit No.** 96-SDP-1-74P
Well or Piezometer No. MW-101	
Dates Started 7/25/2016	**Date Completed** 7/25/2016

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site East side; lagoon berm	Terracon
Distance & direction along boundary	3105 Capital Way #5
Distance & direction from boundary to well	Cedar Falls, IA 50613
Elevations (± 0.01 ft. MSL):	**Name of driller** Scott Z.
Ground Surface 1132.1	**Drilling method** 4 1/4-in HSA
Top of protective casing 1134.95	**Drilling fluid** none
Top of well casing 1134.55	**Bore Hole diameter** 8-in
Benchmark elevation	**Soil sampling method** 2-in x 2-ft SS
Benchmark description	**Depth of boring** 40

C. MONITORING WELL INSTALLATION	
Casing material SCH 40 PVC	**Placement method** gravity
Length of casing 30.4-ft	**Volume** 150-lbs
Outside casing diameter 2.375-in	**Backfill (if different from seal):** Baroid
Inside casing diameter 2.067-in	**Material** Quik-Grout
Casing joint type flush threaded; o-ring	**Placement method** tremie
Casing/screen joint type flush threaded; o-ring	**Volume** 40-gal
Screen material SCH 40 PVC	**Surface seal design:** Holeplug
Screen opening size 0.010-in	**Material of protective casing:** 4-in sq. x 7-ft steel
Screen length 10-ft	**Material of grout between protective casing and well casing:** 3/8-in Holeplug
Depth of Well 38.0-ft bgs	**Protective cap:**
Filter Pack:	**Material** 4-in sq. x 7-ft steel
Material BMC Aggregates Filter Sand	**Vented?:** ☒ Y ☐ N **Locking?:** ☒ Y ☐ N
Grain Size	**Well cap:** T-Cap
Volume 450-lbs	**Material** 2-in PVC compression T-Cap
Seal (minimum 3 ft. length above filter pack): Baroid	**Vented?:** ☐ Y ☒ N
Material 3/8-in Holeplug	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

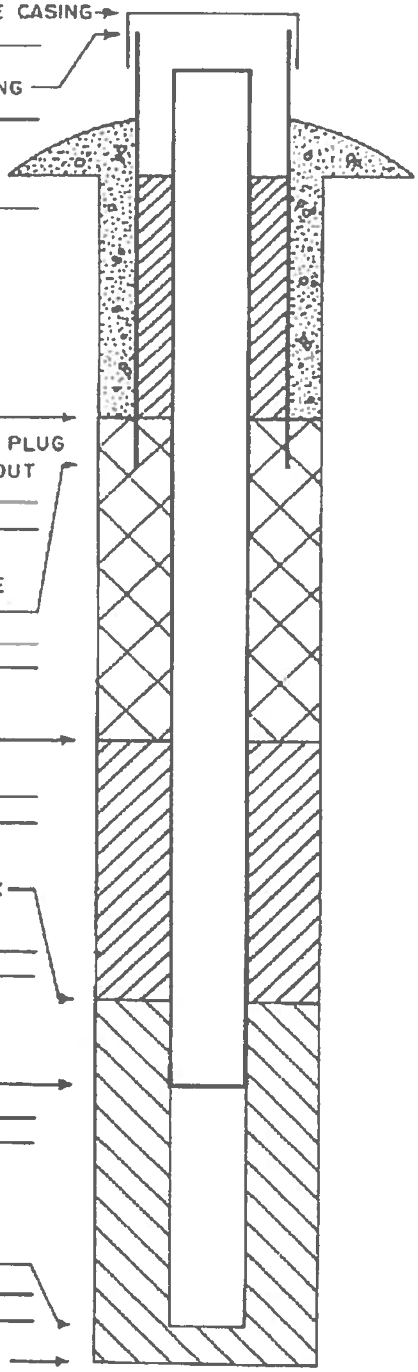
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



TOP OF PROTECTIVE CASING
ELEVATION 1134.95

TOP OF WELL CASING
ELEVATION 1134.55

GROUND SURFACE
ELEVATION 1132.1

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1128.1
DEPTH 4

BASE OF PROTECTIVE CASING
ELEVATION 1127.57
DEPTH 4.53

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1117.6
DEPTH 14.5

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1106.1
DEPTH 26

TOP OF SCREEN
ELEVATION 1104.1
DEPTH 28

BOTTOM OF SCREEN
ELEVATION 1094.1
DEPTH 38

BASE OF FILTER PACK
ELEVATION 1092.1
DEPTH 40

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-102**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING: **North side of Cell 5 EXP**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/Scott Z.**

DRILLING METHOD: **4 1/4-in HSA from 0-36 ft, 2-in x 2-ft SS; 36 to 80.5 ft NQ2 rock core bit**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1151.24**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3915214.3**

EASTING: **5409020.46**

DATE/TIME STARTED: **7/26/16 ; 08:00**

DATE/TIME COMPLETED: **7/27/16 ; 14:30**

WELL INSTALLATION: **7/27/16**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0						NS		FILL	0 - 2 ft; auger thru gravel fill; no sample.
	7 6 5 5	11		50	1	SS		FILL	QUATERNARY FILL. Stiff; gray (10 YR 5/1); LEAN CLAY WITH GRAVEL (CL); dry; non-plastic; cohesive; massive; FILL.
5	3 4 3 5	7		55	2	SS			As above from 4 to 6 feet.
	4 10 9 11	19		90	3	SS		CL	QUATERNARY WISCONSIN EPISODE LOESS. Very stiff; dark yellowish brown (10 YR 4/4); SANDY LEAN CLAY (CL); dry; non-plastic; cohesive; bedded; LOESS.
	7 7 5 6	12		100	4	SS		CL	Stiff; brownish yellow (10 YR 6/8); SANDY LEAN CLAY (CL); dry; non-plastic; cohesive; massive; LOESS.
10	2 2 2 2	4		75	5	SS		ML	Soft; light yellowish brown (10 YR 6/4); SILT (ML); wet; low plasticity; cohesive; massive; silt with very fine sand; LOESS.
	2 3 4 3	7		90	6	SS		ML	Medium; gray (10 YR 5/1) mottled with dark yellowish brown (10 YR 4/6); SILT (ML); wet; low plasticity, cohesive; massive; silt with very fine sand; LOESS.
15	1 2 2 3	4		70	7	SS			
	2 4 3 5	7		80	8	SS		SM	Medium; dark gray (10 YR 4/1); SITLY SAND (SM); wet; non-plastic; non-cohesive; bedded; LOESS.
								ML	Medium; dark gray (10 YR 4/1); SILT (ML); wet; low plasticity; cohesive; bedded; laminated; LOESS.
								SM	Loose; dark gray (10 YR 4/1); SITLY SAND (SM); wet; non-plastic; non-cohesive; bedded; LOESS.
	2 4 4 5	8		100	9	SS		ML	Medium; dark gray (10 YR 4/1); SILT (ML); wet; low plasticity; cohesive; bedded; laminated; LOESS.

Continued Next Page

Tracking Codes: 60322851_43.GPJ, ETSOIL, 10/23/19, 16:28

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-102**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	3 5 5 6	10		100	10	SS		CL	QUATERNARY WISCONSIN EPISODE COLLUVIUM. Stiff; dark gray (10 YR 4/1); SILTY LEAN CLAY (CL); wet; low plasticity; cohesive; bedded; colluvium.
	3 4 5 6	9		95	11	SS		SM	Loose; dark gray (10 YR 4/1); SILTY SAND (SM); wet; non-plastic; non-cohesive; bedded; colluvium.
								CL	Stiff; dark gray (10 YR 4/1); LEAN CLAY (CL); wet; low plasticity; cohesive; massive; colluvium.
25	2 4 4 4	8		95	12	SS			
	5 7 8 13	15		85	13	SS		CL	WISCONSIN EPISODE COLLUVIUM. Stiff; dark gray (10 YR 4/1); LEAN CLAY WITH GRAVEL (CL); moist; low plasticity; cohesive; massive; gravel composed of dolomite and shale; COLLUVIUM.
	18 17 19 19	36		50	14	SS			
30	9 9 9 16	18		95	15	SS		GC	Medium dense; gray (10 YR 6/1); GRAVEL WITH CLAY (GC); wet; overlying ORDOVICIAN MAQUOKETA FM., ELGIN MBR.; dark gray (10 YR 4/1); SHALE (SH); dry to moist; low plasticity; cohesive; massive; laminated; weathered; SHALE.
								SH	ORDOVICIAN MAQUOKETA FM., ELGIN MBR.; hard; dark gray (10 YR 4/1); SHALE (SH); dry to moist; low plasticity; cohesive; massive; laminated; weathered; SHALE.
	10 24 17 19	41		65	16	SS			
35	50/6			25	17	SS			
									End of soil boring @ 36 ft bgs; switch to NQ2 rock core.
40									

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-102 (Rock Core)**

SITE: Winneshiek Co. LF PROJECT NO. 60322851 SHEET 1 OF 3

WATER LEVEL READINGS

	DATE	TIME	DEPTH	CASING
DRILLING METHOD: 4 1/4-in HSA from 0-36 ft, 2-in x 2-ft SS; 36 to 80.5 ft NQ2 rock core bit	7/26/16 15:15		16.6	36
	7/26/16 16:25		25.48	36

GROUND SURFACE ELEV: 1151.2

Iowa State Plane COORDINATES:
NORTHING: 3915214.3
EASTING: 5409020.5

LOG BY: R. Henning
FIRM/DRILLER: Terracon/Scott Z.
PHYSICAL SETTING: North side of Cell 5 EXP

ABANDONMENT DATE: NA
ABANDONMENT METHOD: NA

DATE STARTED: 7/26/16
DATE COMPLETED: 7/207/16
INSTALLATION: 7/27/16

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
36		1	7.3	98	0.19		90			SH	ORDOVICIAN MAQUOKETA FM., Elgin Mbr.; very strong; medium gray (N5/0); SHALE (SH) grading to DOLOMITIC LIMESTONE (DL); medium light gray (N 6/0); microcrystalline; massive; slightly weathered to fresh; competent; moderately fractured; conformable; laminated shale; dry with staining and leaching.
40											ORDOVICIAN GALENA GROUP DECORAH FM.; very strong; DOLOMITIC LIMESTONE (DL) and SHALE (SH); pale yellowish brown (10YR 6/2); microcrystalline; massive; slightly weathered to fresh; competent; moderately fractured; conformable; dry with staining and leaching; erosional break between Maquoketa FM. and Galena Group Decorah FM.
45		2	7.3	98	0.19		90				ORDOVICIAN GALENA GROUP DECORAH FM.; very strong; DOLOMITIC LIMESTONE (DL) and SHALE (SH); pale yellowish brown (10YR 6/2); microcrystalline; massive; slightly weathered to fresh; competent; moderately fractured; conformable; dry with staining and leaching; vugs filled with calcite crystals at 45 ft; few brachiopods in shale beds
50		3	10.0	96	0.21		96			DL	ORDOVICIAN GALENA GROUP DECORAH FM.; very strong; DOLOMITIC LIMESTONE (DL); light brownish gray (5 YR 6/1); microcrystalline; massive; slightly weathered to fresh; competent; moderately fractured; conformable; dry with staining and leaching; vugs filled with calcite crystals; horizontal (micro-joint) fractures; openings extremely narrow.
55											
56											

Continued Next Page

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-102 (Rock Core)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60322851** SHEET **2** OF **3**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
56 – 60.5											
60.5 – 70.5		4	10.0	97	0.17		95			DL	ORDOVICIAN GALENA GROUP DECORAH FM.; very strong; DOLOMITIC LIMESTONE (DL); light brownish gray (5 YR 6/1); microcrystalline; massive; slightly weathered to fresh; competent; moderately fractured; conformable; dry with staining and leaching; vugs filled with calcite crystals; horizontal (micro-joint) fractures; openings extremely narrow; partially healed.
70.5 – 80		5	10.0	100	0.17		100			DL	as above from 70.5 - 80.5 ft

Depth scale: 56, 60, 65, 70, 75, 80

Continued Next Page

Tracking Codes: 60322851_43.GPJ, ETROCK, 10/23/19, 16:17

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-102 (Rock Core)**

SITE: Winneshiek Co. LF PROJECT NO. 60322851 SHEET 3 OF 3

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
80											
											EOB @ 80.5 ft bgs; ream borehole to 6-in diameter and install bedrock piezometer.
104											

Tracking Codes: 60322851 43.GPJ, ETROCK, 10/23/19, 16:17

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek Co. LF	**Permit No.** 96-SDP-1-74P
Well or Piezometer No. MW-5AR	
Dates Started 7/27/2016	**Date Completed** 7/27/2016

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site North side of Cell 5 EXP	Terracon
Distance & direction along boundary	3105 Capital Way #5
Distance & direction from boundary to well	Cedar Falls, IA 50613
Elevations (± 0.01 ft. MSL):	**Name of driller** Scott Z.
Ground Surface 1151.0	**Drilling method** 4 1/4-in HSA
Top of protective casing 1154.21	**Drilling fluid** none
Top of well casing 1153.90	**Bore Hole diameter** 8-in
Benchmark elevation	**Soil sampling method** 2-in x 2-ft SS
Benchmark description	**Depth of boring** 23-ft

C. MONITORING WELL INSTALLATION	
Casing material SCH 40 PVC	**Placement method** gravity
Length of casing 15.18-ft	**Volume** 300-lbs
Outside casing diameter 2.375-in	**Backfill (if different from seal):**
Inside casing diameter 2.067-in	**Material**
Casing joint type flush threaded; o-ring	**Placement method**
Casing/screen joint type flush threaded; o-ring	**Volume**
Screen material SCH 40 PVC	**Surface seal design:** Holeplug
Screen opening size 0.010-in	**Material of protective casing:** 4-in sq. x 7-ft steel
Screen length 10-ft	**Material of grout between protective casing and well casing:** 3/8-in Holeplug
Depth of Well 23.0-ft bgs	**Protective cap:**
Filter Pack:	**Material** 4-in sq. x 7-ft steel
Material BMC Aggregates Filter Sand	**Vented?:** ☒ Y ☐ N **Locking?:** ☒ Y ☐ N
Grain Size	**Well cap:** T-Cap
Volume 450-lbs	**Material** 2-in PVC compression T-Cap
Seal (minimum 3 ft. length above filter pack): Baroid	**Vented?:** ☐ Y ☒ N
Material 3/8-in Holeplug	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

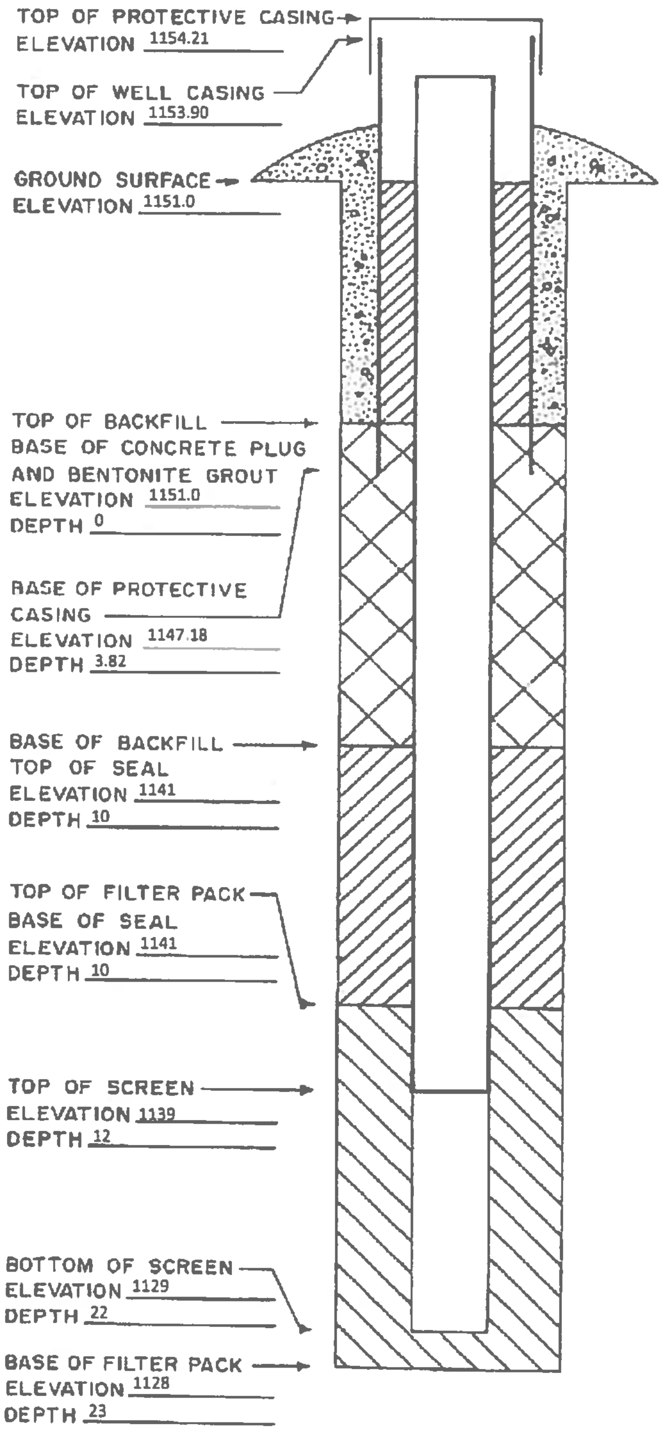
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



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Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name Winneshiek Co. LF	**Permit No.** 96-SDP-1-74P
Well or Piezometer No. MW-21AR	
Dates Started 7/26/2016	**Date Completed** 7/27/2016

A. SURVEYED LOCATIONS AND ELEVATIONS	B. SOIL BORING INFORMATION
Locations (± 0.5 ft.):	**Name & address of construction company**
Specify corner of site North side Cell 5 EXP	Terracon
Distance & direction along boundary	3105 Capital Way #5
Distance & direction from boundary to well	Cedar Falls, IA 50613
Elevations (± 0.01 ft. MSL):	**Name of driller** Scott Z.
Ground Surface 1151.2	**Drilling method** 6 1/4-in HSA; 6-in Tri-cone wash rotary
Top of protective casing 1154.0	**Drilling fluid** City of Decorah water
Top of well casing 1153.61	**Bore Hole diameter** 6-in
Benchmark elevation	**Soil sampling method** 2-in x 2-ft SS
Benchmark description	**Depth of boring** 80.5

C. MONITORING WELL INSTALLATION	
Casing material SCH 40 PVC	**Placement method** gravity
Length of casing 72.37-ft	**Volume** 200-lbs
Outside casing diameter 2.375-in	**Backfill (if different from seal):** Baroid
Inside casing diameter 2.067-in	**Material** Quik-Grout
Casing joint type flush threaded; o-ring	**Placement method** tremie
Casing/screen joint type flush threaded; o-ring	**Volume** 79-gal
Screen material SCH 40 PVC	**Surface seal design:** Holeplug
Screen opening size 0.010-in	**Material of protective casing:** 4-in sq. x 7-ft steel
Screen length 10-ft	**Material of grout between protective casing and well casing:** 3/8-in Holeplug
Depth of Well 77.0-ft bgs	**Protective cap:**
Filter Pack:	**Material** 4-in sq. x 7-ft steel
Material BMC Aggregates Filter Sand	**Vented?:** ☒ Y ☐ N **Locking?:** ☒ Y ☐ N
Grain Size	**Well cap:** T-Cap
Volume 100-lbs	**Material** 2-in PVC compression T-Cap
Seal (minimum 3 ft. length above filter pack): Baroid	**Vented?:** ☐ Y ☒ N
Material 3/8-in Holeplug	

D. GROUNDWATER MEASUREMENT (± 0.01 foot below top of inner well casing)	
Water level	**Stabilization time**
Well development method	
Average depth of frostline	

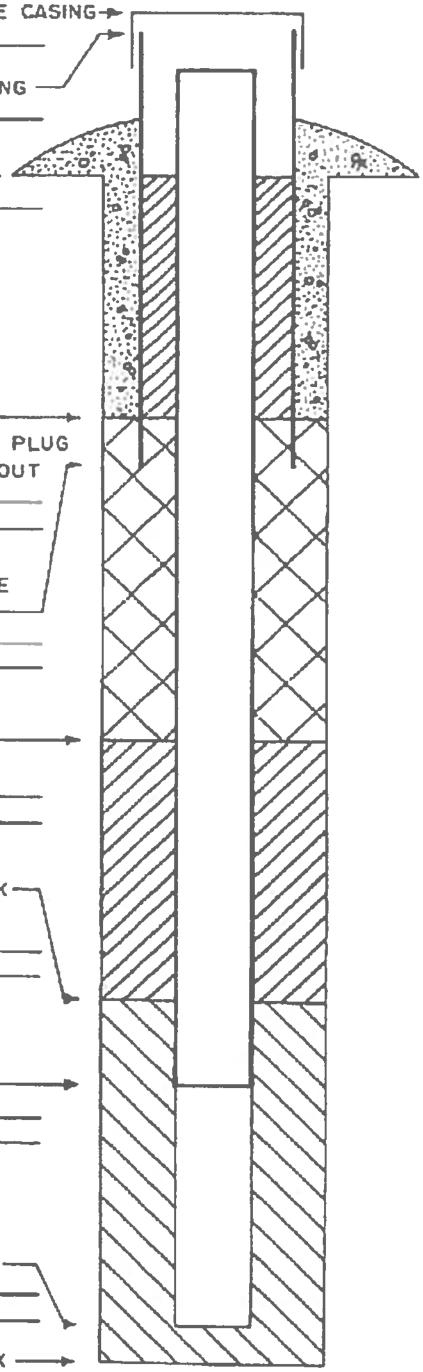
Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½ inch x 11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 FT. MSL

DEPTHS: ± 0.1 FT. FROM GROUND SERFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG (SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL).



TOP OF PROTECTIVE CASING
ELEVATION 1154.0

TOP OF WELL CASING
ELEVATION 1153.61

GROUND SURFACE
ELEVATION 1151.2

TOP OF BACKFILL
BASE OF CONCRETE PLUG AND BENTONITE GROUT
ELEVATION 1147.2
DEPTH 4

BASE OF PROTECTIVE CASING
ELEVATION 1146.96
DEPTH 4.24

BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1090.2
DEPTH 61

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1081.2
DEPTH 70

TOP OF SCREEN
ELEVATION 1079.2
DEPTH 72

BOTTOM OF SCREEN
ELEVATION 1074.2
DEPTH 77

BASE OF FILTER PACK
ELEVATION 1070.7
DEPTH 80.5

Please mail completed form to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E. 9th St, Des Moines, IA 50319.
Questions? Call or Email: Nina Koger Environmental Engineer Sr., 515-725-8309, nina.koger@dnr.iowa.gov

Appendix A-12 – 2019 – Boring Logs and Monitoring Well Construction Documentation

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-30 (Rock)**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

WATER LEVEL READINGS

	DATE	TIME	DEPTH	CASING
DRILLING METHOD: 4 1/4-in HSA from 0-22.9 ft, 2-in x 2-ft SS; 23 to 55 ft NQ2 rock core bit	8/5/2019		12.0	22
	8/6/2019		40	22
	8/6/2019		25	22

GROUND SURFACE ELEV: 1131.3

Iowa State Plane COORDINATES:

NORTHING: 3914791.0

EASTING: 5410408.5

LOG BY: R. Henning

DATE STARTED: 8/5/19

FIRM/DRILLER: Terracon/Ron Faulk

ABANDONMENT DATE: NA

DATE COMPLETED: 8/6/19

PHYSICAL SETTING: Top of leachate lagoon; east side

ABANDONMENT METHOD: NA

INSTALLATION: 8/6/2019

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
22.9		1	2.0	100	2.4	-100	0%			DL	ORDOVICIAN GALENA GROUP DECORAH FM.; strong; pale yellowish brown (10 YR 6/2); DOLOMITE (DL) with some brownish gray (5 YR 4/1) argillaceous layers; fine grained; fossiliferous with gastropods; massive; slightly to moderately decomposed; slightly disintegrated; massively fractured; unconformable.
25		2	5.0	100	2.4	-100	28%				
										CS	CLAYSTONE (CS); strong; brownish gray (5 YR 4/1); aphanitic; massive; slightly decomposed; slightly disintegrated; intensely fractured; conformable.
30		3	5.0	88	2.4	-100	80%			DL	ORDOVICIAN GALENA GROUP DECORAH FM.; strong; light brownish gray (5 YR 6/1); DOLOMITE (DL); aphanitic; slightly decomposed; slightly disintegrated; intensely fractured; conformable.
35		4	5.0	96	2.4	-100	90%				
40		5	5.0	100	2.4	-100	98%			DL	as above from 40 - 45'; many shale partings; possible solutioning; few infilled vugs with calcite
42.9											

Continued Next Page

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-30 (Rock)**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
42.9											
45		6	5.0	90	2.4	-100	90%			DL	ORDOVICIAN GALENA GROUP DECORAH FM.; strong; light brownish gray (5 YR 6/1); DOLOMITE (DL); aphanitic; slightly decomposed; slightly disintegrated; intensely fractured; conformable.
50		7	5.0	100	2.4	-100	100%				
55											EOB at 55-ft bgs. Install monitoring well MW-30 in borehole.
66.9											

Tracking Codes: 60540571.GPJ, ETROCK, 10/4/19, 10:21

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-30**

SHEET 1 OF 2

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: **1131.32**

PHYSICAL SETTING: **Top of leachate lagoon; East side**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/Ron Faulk**

DRILLING METHOD: **4 1/4 HSA; 2-in x 3-ft split spoon to EOB**

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3914791.0**

EASTING: **5410408.52**

DATE/TIME STARTED: **8/5/19 ; 13:00**

DATE/TIME COMPLETED: **8/6/19 ; 10:00**

WELL INSTALLATION: **8/6/2019**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	5 6 8 6	14		60	1	SS		FILL	QUATERNARY HOLOCENE FILL; stiff; olive yellow (2.5 Y 6/8); LEAN CLAY (CL) W/SAND AND GRAVEL; dry; non-plastic; cohesive; fill of constructed leachate lagoon berm.
	4 6 7 11	13		78	2	SS			
5	4 8 6 7	14		88	3	SS			
	0 8 10 10	18		75	4	SS		FILL	as above from 6 - 8 ft; very stiff
	3 4 5 6	9		90	5	SS			
10	5 5 10 11	15		90	6	SS			
	4 7 7 9	14		95	7	SS			
15	4 7 8 8	15		95	8	SS			
	P 5 8 9	13		83	9	SS		ML	QUATERNARY LOESS; stiff; very dark grayish brown (10 YR 3/2); SILT(ML); moist; low plasticity; cohesive; TOP SOIL; under leachate lagoon berm
	2 3 2 3	5		80	10	SS		ML	QUATERNARY LOESS; stiff; black (10 YR 2/1); SILT(ML); wet; low plasticity; cohesive; TOP SOIL; top of water table; under leachate lagoon berm

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-30**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	2 3 4 4	7		50	11	SS		CL	WISCONSIN EPISODE COLLUVIUM; medium; mottled light yellowish brown (2.5 YR 6/3) to gray (2.5 YR 6/1); LEAN CLAY W/SAND and GRAVEL (CL); wet; low plasticity; cohesive; massive; colluvium.
	22 50/4.5"	>50		50	12	SS		GC	hard; yellow (2.5 Y 7/6); CLAYEY GRAVEL (GC); wet; non-plastic; non-cohesive; bedded; weathered dolomitic bedrock; colluvium
									EOB soil boring at 22.9-ft bgs; top of bedrock; change over to NQ rock core.
25									
30									
35									
40									

Tracking Codes: 60540571.GPJ, ETSOIL, 10/4/19, 10:20

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-31**

SHEET 1 OF 2

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING: **Adjacent to MW-11; east side of landfill Cell 5**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/Ron Faulk**

DRILLING METHOD: **4 1/4 HSA; 2-in x 3-ft split spoon to EOB**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
8/7/2019	18.6		
8/7/2019	18.0		
8/8/2019	17		

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1136.17**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3914503.2**

EASTING: **5409904.69**

DATE/TIME STARTED: **8/6/19 ; 15:50**

DATE/TIME COMPLETED: **8/8/19 ; 08:00**

WELL INSTALLATION: **8/8/2019**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	1 2 4 5	6		55	1	SS		FILL	QUATERNARY HOLOCENE FILL; medium; light olive brown (2.5 Y 5/4); LEAN CLAY (CL); dry to moist; low plasticity; cohesive; fill.
	3 5 6 6	11		80	2	SS		ML	QUATERNARY LOESS; stiff; very dark gray (5 YR 3/1); SILT (ML); moist; low plasticity; cohesive; loeww with some reddish brown (5 YR 4/4) staining on partings
5	2 3 4 4	7		75	3	SS		ML	medium; black (5 YR 2.5/1); SILT (ML); moist; low plasticity; cohesive; loess
	P 3 3 4	6		75	4	SS			as above from 6 - 8 ft; moist to wet
	2 4 5 5	9		75	5	SS		CL	WISCONSIN EPISODE COLLUVIUM. stiff; olive yellow (2.5 Y 6/6); LEAN CLAY (CL); moist to wet; low plasticity; cohesive; colluvium
10	2 3 10 14	13		65	6	SS		CS	ORDOVICIAN MAQUOKETA FM; ELGIN Member; CLAYSTONE; brownish yellow to very pale brown (10 YR 6/6 to 7/3); CLAYSTONE (CS); moist; aphanitic; weak to moderate; thinly to medium bedded; slightly decomposed; competent to slightly disintegrated; slightly fractured; oxidized claystone.
	20 19 50/5.5"	>50		70	7	SS			
15	50/1"	>50		5	8	SS		CS	strong; weathered claystone bedrock as above from 14 - 22 ft; weathered claystone bedrock.
	50/2"	>50		5	9	SS			
	50/1"	>50		5	10	SS			

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-31**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	50/0.5"	>50		5	11	SS			
									EOB at 22 ft bgs; borehole reamed to 21.5 ft bgs for installing monitoring well MW-31A
25									
30									
35									
40									

Tracking Codes: 60540571.GPJ, ETSOIL, 10/4/19, 15:38

FINAL SOIL BORING LOG

AECOM

BORING NO. **B-32**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS			
DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: **1216.84**

PHYSICAL SETTING: **South end of Landfill Cell 2**

Iowa State Plane LOCAL COORDINATES:

LOG BY: **R. Henning** NORTHING: **3913439.5**

FIRM/DRILLER: **Terracon/Ron Faulk** EASTING: **5408593.17**

DRILLING METHOD: **4 1/4 HSA; 2-in x 3-ft split spoon to EOB** DATE/TIME STARTED: **8/7/19 ; 14:50**

ABANDONMENT DATE: **NA** DATE/TIME COMPLETED: **8/7/19 ; 16:00**

ABANDONMENT METHOD: **NA** WELL INSTALLATION: **8/7/2019**

Depth in Feet	B	N	A	% Recovery	No.	T	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 3 4 3	7		65	1	SS	ML	QUATERNARY LOESS; medium; dark brown (10 YR 3/3); SILT (ML); dry; non-plastic; cohesive; massive; Ahorizon of modern soil profile; loess
	2 3 3 4	6		65	2	SS		as above from 2 - 4 ft.
5	2 3 3 4	6		50	3	SS	CL	medium; dark yellowish brown (10 YR 4/4); LEAN CLAY (CL); moist; low plasticity; cohesive; massive; B horizon of modern soil profile
	1 2 2 2	4		55	4	SS	CL	soft; yellowish brown (10 YR 5/8); LEAN CLAY WITH SILT AND SAND (CL); moist to wet; low plasticity; cohesive; massive;
	WOH 1 1 1	2		75	5	SS	CL	very soft; yellowish brown (10 YR 5/6); SANDY LEAN CLAY (CL); wet; low plasticity; cohesive; massive
10	1 1 2 2	3		65	6	SS	ML	soft; light yellowish brown (10 YR 6/4); SILT (ML); wet low plasticity; cohesive; massive; loess
	1 1 2 3	3		80	7	SS		as above from 12 - 14 ft.
15	1 3 3 5	6		90	8	SS	SM	medium; pale brown (10 YR 6/3); SILTY SAND (SM); wet; low plasticity; cohesive; massive; loess
	1 4 4 5	8		70	9	SS	ML	medium; mottled light brownish gray to brownish yellow (10 YR 6/2 to 6/8); SILT (ML); wet; low plasticity; cohesive; massive; with sand seams; few pebbles; loess
	2 4 6 6	10		95	10	SS	CL	PRE-ILLINOIAN GLACIAL DIAMICTON. stiff; brownish yellow (10 YR 6/8); LEAN CLAY WITH SAND AND GRAVEL (CL); wet; low plasticity; massive; cohesive; diamicton.

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. B-32

SITE: Winneshiek County Landfill PROJECT NO. 60540571 SHEET 2 OF 2

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	3 3 6 13	9		75	11	SS		CL	stiff; mottled pale brown to brownish yellow (10 YR 6/3 to 6/8); LEAN CLAY WITH GRAVEL (CL); wet low plasticity; cohesive; massive; diamicton with weathered claystone
	15 15 11 13	26		75	12	SS		CS	ORDOVICIAN MAQUOKETA FM, ELGIN Member; CLAYSTONE; very stiff; yellow (2.5 Y 7/6); DOLOMITIC CLAYSTONE (CS); moist; non-plastic; cohesive; massive; weathered claystone
25	15 51 25/0.5"	>50		75	13	SS			as above from 24 - 26 ft.
									EOB at 26 ft; install monitoring well MW-32A in borehole
30									
35									
40									

Tracking Codes: 60540571.GPJ, ETSOIL, 10/4/19, 15:39

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-33**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

	WATER LEVEL READINGS			
	DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

PHYSICAL SETTING: **West of Landfill Cell 2**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/Ron Faulk**

DRILLING METHOD: **4 1/4 HSA; 2-in x 3-ft split spoon to EOB**

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1203.33**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3913918.3**

EASTING: **5408048.70**

DATE/TIME STARTED: **8/7/19 ; 07:45**

DATE/TIME COMPLETED: **8/7/19 ; 09:00**

WELL INSTALLATION: **8/7/2019**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 2 4 5	6		60	1	SS		ML	QUATERNARY LOESS; medium; dark brown (7.5 YR 3/3); SILT (ML); moist; low plasticity; cohesive; massive; top soil; rooted with grass roots; loess
	2 2 3 3	5		55	2	SS		CL	medium; dark yellowish brown (10 YR 4/6); LEAN CLAY (CL); moist; medium plasticity; cohesive; bedded
5	1 2 2 2	4		70	3	SS		CL	soft; yellowish brown (10 YR 5/6); LEAN CLAY WITH SAND (CL); moist to wet; medium plasticity; cohesive; massive; wet at bottom of interval
	1 2 2 2	4		70	4	SS			as above from 6 - 8 ft; wet
	1 1 1 1	2		85	5	SS		SC	very soft; mottled grayish brown (10 YR 5/2) to yellowish brown (10 YR 5/6); CLAYEY SAND (SC); wet; low plasticity; cohesive; massive; loess
10	WOH 1 1 2	2		65	6	SS		ML	very soft; gray (10 YR 6/1); SILT (ML); wet; low plasticity; cohesive; massive; with very fine sand; loess
	1 2 4 6	6		100	7	SS			as above from 12 - 12.7 ft;
								CL	PRE-ILLINOIAN GLACIAL DIAMICTON. medium; mottled yellowish brown to gray (10 YR 5/6 to 6/1); LEAN CLAY WITH SAND (CL); wet; medium plasticity; cohesive; bedded; rooted; some sand and gravel; diammicton
15	3 6 7 9	13		80	8	SS			as above from 14 - 16 ft; weathered bedrock (shale) at bottom of interval
	5 9 18 16	27		80	9	SS		CL	very stiff; olive yellow (2.5 Y 6/6); LEAN CLAY (CL); wet; low plasticity; cohesive; massive; weathered shale; diamicton
	5 9 19 19	28		75	10	SS		SH	ORDOVICIAN MAQUOKETA FM., ELGIN Member, SHALE; very stiff; olive yellow (2.5 Y 6/6); SHALE (SH); wet; low plasticity; cohesive; massive; weathered shale

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AECOM

FINAL SOIL BORING LOG

BORING NO. **B-33**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **2** OF **2**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	13 25 35 50/4.5"	>50		75	11	SS		SH	ORDOVICIAN MAQUOKETA FM., ELGIN Member, SHALE; hard; olive yellow (2.5 Y 6/8); SHALE (SH); wet; low plasticity; cohesive; massive; weathered shale to LEAN CLAY (CL)
									EOB at 22 ft bgs; install monitoring well MW-33A in borehole
25									
30									
35									
40									

FINAL SOIL BORING LOG

AECOM

BORING NO. **B-34**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: **1164.20**

PHYSICAL SETTING: **Adjacent to storm water pond**

Iowa State Plane LOCAL COORDINATES:

LOG BY: **R. Henning**

NORTHING: **3914768.3**

FIRM/DRILLER: **Terracon/Ron Faulk**

EASTING: **5408035.12**

DRILLING METHOD: **4 1/4 HSA; 2-in x 3-ft split spoon to EOB**

DATE/TIME STARTED: **8/7/19 ; 11:20**

ABANDONMENT DATE: **NA**

DATE/TIME COMPLETED: **8/7/19 ; 12:30**

ABANDONMENT METHOD: **NA**

WELL INSTALLATION: **8/7/2019**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 3 3 3	6		65	1	SS		ML	QUATERNARY LOESS; medium; dark brown (7.5 YR 3/2); SILT (ML); moist; low plasticity; cohesive; massive; top soil.
	1 2 3 4	5		55	2	SS			as above from 2 - 4 ft
5	1 1 2 2	3		70	3	SS			as above from 4 - 6 ft; soft; wet at 5.5 ft; approximately pond water level
	WOH 1 2 3	3		100	4	SS			as above from 6 - 8 ft; moist to wet.
	WOH 2 2 3	4		88	5	SS		CL	soft; mottled dark gray to strong brown (7.5 YR 4/1 to 5/8); SILTY LEAN CLAY (CL); moist to wet; low plasticity; cohesive; massive; rooted.
10	WOH WOH WOH 4	0		75	6	SS		ML	very soft; grayish brown (2.5 Y 5/2); SILT (ML); wet; medium plasticity; cohesive; massive; with strong brown (7.5 YR 5/8) iron stained roots
	2 3 3 4	6		88	7	SS		SM	medium; greenish gray (5 GY 5/1); SILTY SAND (SM); wet; low plasticity; cohesive; massive; with few sand and gravel seams
15	4 3 5 6	8		75	8	SS		ML	medium; light yellowish brown (10 YR 6/4); SILT (ML); wet; low plasticity; cohesive; massive; with sand and gravel seams
	2 5 6 11	11		50	9	SS		ML	stiff; mottled light yellowish brown to brownish yellow (10 YR 6/4 to 6/8); SILT (ML); wet; low plasticity; cohesive; massive; with few sand and gravel
	2 4 7 7	11		85	10	SS		CL	PRE-ILLINOIAN GLACIAL DIAMICTON. stiff; mottled light yellowish brown to brownish yellow (10 YR 6/4 to 6/8); LEAN CLAY WITH SAND AND GRAVEL (CL); wet; low plasticity; cohesive; till with weathered dolomite

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AECOM

FINAL SOIL BORING LOG

BORING NO. **B-34**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **2** OF **2**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	4 6 8 16	14		75	11	SS			as above from 20 -22 ft; weathered dolomite; diamicton
	6 14 26 37	40		90	12	SS		SH	ORDOVICIAN MAQUOKETA FM., ELGIN Member, SHALE. hard; gray (10 YR 5/1); SHALE (SH); moist to wet; weathered gray shale; very weak; aphanitic; massive; moderately decomposed; slightly disintegrated; slightly fractured; conformable
25	13 18 30 40	48		80	13	SS			as above from 24 - 26 ft.
									EOB at 26 ft bgs; install monitoring well MW-34A in borehole.
30									
35									
40									

Tracking Codes: 60540571.GPJ, ETSOIL, 10/4/19, 15:40

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-35 (Rock)**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

WATER LEVEL READINGS

	DATE	TIME	DEPTH	CASING
	8/13/2019		44.5	30.5
	8/13/2019		44.3	30.5
	8/13/2019		44.8	30.5
	8/13/19 16:53		44.65	30

GROUND SURFACE ELEV: **1168.1**

Iowa State Plane COORDINATES:

NORTHING: **3913907.2**

EASTING: **5409718.4**

DRILLING METHOD: **4 1/4-in HSA from 0-30 ft, 2-in x 2-ft SS; 30.5 to 85.5 ft NQ2 rock core bit**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/Ron Faulk**

PHYSICAL SETTING: **Adjacent to LF road and MW-12A**

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

DATE STARTED: **8/12/19**

DATE COMPLETED: **8/13/19**

INSTALLATION: **8/12/2019**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
30		1	0.5	100	3.0		100%			SH	ORDOVICIAN MAQUOKETA FM., ELGIN Member. SHALE. weak; grayish orange (10 YR 7/4) to medium gray (N 5/0); aphanitic; thinly bedded; slightly decomposed; slightly disintegrated; slightly fractured; weathered bedrock
		2	5.0	70	3.0	-20%	69%				
35		3	5.0	82	2.4		82%				as above from 35.5 - 40.5 ft.
40		4	5.0	94	2.6		93%			SH	medium; dark gray (N 4/0); moderate; aphanitic; medium bedded; slightly decomposed; slightly disintegrated; sllightly fractured; with some clay filled fractures at bottom of core at approximately 45 ft.
45		5	5.0	92	2.6		92%				as above from 45.5 - 50.5 ft.
50											

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FINAL ROCK CORE LOG

AECOM

BORING NO. **B-35 (Rock)**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

Depth in Feet	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE CODE	ROCK DESCRIPTION
50	6	5.0	90	3.6	-100%	89%			as above from 50.5 - 55.5 ft.; fracture at 52.5 ft; fracture at 53.5 ft
55	7	5.0	72	3.6	-100%	70%			as above from 55.5 - 60.5 ft.
60	8	5.0	82	3.2	-100%	80%			as above from 60.5 - 63 ft.; sharp lithologic contact at 63 ft.
								DL	ORDOVICIAN GALENA GROUP DECORAH FM.; strong; light brownish gray (5 YR 6/1); microcrystalline; medium bedded; slightly decomposed; moderately distintegrated; moderately fractured; fossiliferous with brachiopods and gastropods; few pyrite infillings; fossils along argillaceous layrs within the interval
65	9	5.0	90	2.0	-100%	90%			as above from 65.5 - 70.5 ft.
70	10	5.0	92	2.4	-100%	92%		DL	ORDOVICIAN GALENA GROUP DECORAH FM.; strong; light brownish gray (5 YR 6/1); microcrystalline; medium bedded; slightly decomposed; moderately distintegrated; moderately fractured; fossils along argillaceous layrs within the interval; vug infilled with quartz at 72.5 ft.
								SH	SHALE, browish gray (5 YR 4/1)
74									

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AECOM

FINAL ROCK CORE LOG

BORING NO. **B-35 (Rock)**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
74										DL	DOLOMITE (DL); strong; light brownish gray (5 YR 6/1); microcrystalline; medium bedded; slightly decomposed; slightly disintegrated; slightly fractured; fossiliferous within argillaceous layers; bioturbated with infilled burrows; few pyrite infilling or replacement of brachiopods; fractures from 75.5 - 75.6 ft.
75		11	5.0	100	2.0	-100%	100%				
80		12	5.0	92	2.4	-100%	92%			DL	DOLOMITE (DL); strong; ;ight brownish gray (5 YR 6/1); microcrystalline; medium bedded; slightly decomposed; slightly disintegrated; slightly fractured; predominantly dolomite with less argillaceous and bio turbated layers from 77 - 85.5 ft.
85											EOB rock core ate 85.5 ft bgs; air rotary overdrill borehole for monitoring well MW-35 installation
98											

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-35**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: **1168.10**

PHYSICAL SETTING: **Adjacent to LF road and MW-12A**

Iowa State Plane LOCAL COORDINATES:

LOG BY: **R. Henning**

NORTHING: **3913907.2**

FIRM/DRILLER: **Terracon/Ron Faulk**

EASTING: **5409718.44**

DRILLING METHOD: **4 1/4 HSA; 2-in x 3-ft split spoon to EOB**

DATE/TIME STARTED: **8/12/19 ; 13:45**

ABANDONMENT DATE: **NA**

DATE/TIME COMPLETED: **8/13/19 ; 12:18**

ABANDONMENT METHOD: **NA**

WELL INSTALLATION: **8/12/2019**

Depth in Feet	B	N	A	% Recovery	No.	T	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	9 12 17 14	29		75	1	SS	FILL	QUATERNARY HOLOCENE FILL; very stiff; yellow (10 YR 7/8); LEAN CLAY WITH GRAVEL (CL); dry; non-plastic; cohesive; massive; coarse gravel; fill
	7 9 10 14	19		63	2	SS		as above from 2 - 10 ft.
5	9 13 17 31	30		58	3	SS		
	5 8 36 19	44		65	4	SS		
	10 9 5 4	14		15	5	SS		
10	2 3 5 6	8		95	6	SS	ML	QUATERNARY LOESS; medium; very dark gray (10 YR 3/1); SILT (ML); moist; low plasticity; cohesive; thin bedded; topsoil; A horizon of soil profile
							CL	WISCONSIN EPISODE COLLUVIUM. stiff; yellowish brown (10 YR 5/8); LEAN CLAY (CL); moist; medium plasticity, cohesive; bedded loess; few sand and gravel clasts
	4 7 8 7	15		80	7	SS		as above from 12 - 14 ft.
15	9 10 7 11	17		20	8	SS	CL	very stiff; yellow (10 YR 7/6); LEAN CLAY WITH SAND AND GRAVEL (CL); moist; low plasticity; cohesive; massive; weathered claystone; colluvium
	6 12 12 11	24		50	9	SS		as above from 16 - 18 ft.
	13 11 11 13	22		75	10	SS	CS	ORDOVICIAN MAQUOKETA FM., ELGIN Member, CLAYSTONE; very stiff; yellow (2.5 Y 7/6); CLAYSTONE (CS); dry to moist; non-plastic; cohesive; massive; weathered claystone

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-35**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	11 7 12 4	19		100	11	SS			
	8 12 22 22	34		100	12	SS			as above from 22 - 24 ft.; very stiff
25	12 22 30 32	>50		100	13	SS			as above from 24 - 29.5 ft; hard
	8 15 22 21	37		100	14	SS			
	21 23 46 50	>50		100	15	SS		SH	hard; grayish brown (10 YR 5/2); SHALE (SH); dry; non-plastic; cohesive; bedded; weathered gray shale
30									EOB at 30 ft bgs; set-up for NQ rock coring
35									
40									

Tracking Codes: 60540571.GPJ, ETSOIL, 10/4/19, 15:41

WATER LEVEL READINGS

	DATE	TIME	DEPTH	CASING
DRILLING METHOD: **4 1/4-in HSA from 0-23 ft,**	8/8/2019		38.9	25
2-in x 2-ft SS; 23 to 85 ft NQ2 rock core bit	8/8/2019		38.3	25
	8/8/2019		38.7	25
LOG BY: **R. Henning**	8/8/2019		39.3	25

FIRM/DRILLER: **Terracon/Ron Faulk**

PHYSICAL SETTING: **Adjacent to MW-26A; off landfill road**

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1162.8**

Iowa State Plane COORDINATES:

NORTHING: **3914152.7**

EASTING: **5409809.5**

DATE STARTED: **8/8/19**

DATE COMPLETED: **8/9/19**

INSTALLATION: **8/12/2019**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
23		1	2.0	100			95%			CS	ORDOVICIAN MAQUOKETA FM., ELGIN Member, CLAYSTONE (CS); weak to moderate; pale yellowish brown (10 YR 6/2) to dark yellowish orange (10 YR 6/6); aphanitic; massive; slightly decomposed; slightly disintegrated; slightly fractured; unconformable
25		2	5.0	100			72%				
										SH	ORDOVICIAN MAQUOKETA FM., ELGIN Member; SHALE (SH); medium gray (N 5/0); aphanitic; massive; slightly decomposed; slightly disintegrated; slightly fractured; conformable.
30		3	5.0	100	3		93%			SH	ORDOVICIAN MAQUOKETA FM., ELGIN Member; interbedded SHALE (SH) and DOLOMITE (DL); medium gray (N 5/0) with dark yellowish orange (10 YR 6/6); aphanitic; massive; slightly decomposed; slightly disintegrated; slightly fractured; conformable.
35		4	5.0	100	3		100%				as above from 35 - 40 ft.; large fracture at 37.4 ft bgs.
40		5	5.0	100	3	- 100%	94%			DL	ORDOVICIAN MAQUOKETA FM., ELGIN Member; DOLOMITE (DL); grayish brown (5 YR 3/2); aphanitic; massive; slightly decomposed; slightly disintegrated; slightly fractured; conformable.
43											

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AECOM

FINAL ROCK CORE LOG

BORING NO. **B-36 (Rock)**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

Depth in Feet	CORING DATA: GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	GRAPHIC LOG: ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
43											
45		6	5.0	100	3 -	100%	92%				as above from 45 - 50 ft.
50		7	5.0	100	3 -	100%	88%			DL	ORDOVICIAN MAQUOKETA FM., ELGIN Member; Interbedded SHALE and DOLOMITE; medium dark gray (N 4/0) to olive gray (5Y 4/1); aphanitic; medium bedded; weak to moderate; slightly decomposed; slightly disintegrated; slightly fractured along bedding planes; conformable.
55		8	5.0	100	3 -	100%	72%				ORDOVICIAN GALENA GROUP DECORAH FM.; sharp contact at 55-ft bgs; DOLOMITIC LIMESTONE (LS) with few 1 -3 inch beds of SHALE (SH); light brownish gray (5 YR 6/1) dolomitic limestone and brownish black (5 YR 2/1) shale; dry; moderate to strong; microcrystalline; medium bedded; slightly decomposed; slightly disintegrated; slightly fractured; fossiliferous with brachiopod shells and gastropods; erosional contact with overlying MAQUOKETA FM.; unconformable; fossils concentrated in shale layers
60		9	5.0	100	3 -	100%	100%				as above from 60 - 65 ft bgs; with few infilled vugs; infilled with quartz crystals
65		10	5.0	98	3 -	100%	98%				as above from 65 - 66 ft; transition to dolomitic limestone with few shale beds at 66 ft bgs
										DL	ORDOVICIAN GALENA GROUP DECORAH FM.; DOLOMITE (DL); light brownish gray (5 YR 6/1); moderate to strong; microcrystalline; medium bedded;
67											

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Tracking Codes: 60540571.GPJ, ETROCK, 10/4/19, 15:43

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-36 (Rock)**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
67											slightly decomposed; slightly disintegrated; slightly to moderately fractured; conformable; with few pyrite infilled vugs
70		11	5.0	100	3	- 100%	83%				as above from 70 - 75 ft bgs.
75		12	5.0	100	3	- 100%	73%			DL	ORDOVICIAN GALENA GROUP DECORAH FM.; DOLOMITE (DL); light brownish gray (5 YR 6/1) to bluish gray (5B 5/1); weak to moderate; microcrystalline; medium bedded; moderately tp highly decomposed; moderately to intensely disintegrated; moderately to intensely fractured; conformable; numerous solution fractures; some infilled with clay
80		13	5.0	100	3	- 100%	65%				as above from 80 - 85 ft bgs.
85											EOB at 85 ft bgs.; air rotary overdill borehole and install monitoring well MW-36.
91											

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-36**

SHEET 1 OF 2

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING:	Adjacent to MW-26A; off landfill road
LOG BY:	R. Henning
FIRM/DRILLER:	Terracon/Ron Faulk
DRILLING METHOD:	4 1/4 HSA; 2-in x 3-ft split spoon to EOB

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

ABANDONMENT DATE: NA

ABANDONMENT METHOD: NA

GROUND SURFACE ELEV:	1162.80
Iowa State Plane LOCAL COORDINATES:	
NORTHING:	3914152.7
EASTING:	5409809.52
DATE/TIME STARTED:	8/8/19 ; 09:40
DATE/TIME COMPLETED:	8/9/19 ; 09:20
WELL INSTALLATION:	8/8/2019

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	5 11 22 28	33		75	1	SS		GC	QUATERNARY HOLOCENE FILL; hard; yellow (10 yr 7/6); CLAYEY GRAVEL (GC); non-plastic; non-cohesive; massive; dry; fill.
	15 13 14 11	27		65	2	SS			as above from 2 - 4 ft.; very stiff
5	2 3 4 5	7		75	3	SS		ML	QUATERNARY LOESS; medium; very dark grayish brown (10 YR 3/2); SILT (ML); dry; low plasticity; cohesive; massive; buried A horizon of modern soil profile; loess.
	P 2 3 4	5		65	4	SS			as above from 6 - 8 ft.; moist
	1 2 2 3	4		75	5	SS		CL	medium; dark yellowish brown (10 YR 4/6); LEAN CLAY WITH SAND (CL); moist; low plasticity; cohesive; massive; loess; buried B horizon of modern soil profile.
10	1 1 1 1	2		73	6	SS		CL	very soft; dark yellowish brown (10 YR 4/6); SANDY LEAN CLAY (CL); moist to wet; low plasticity; cohesive; massive; loess.
	WOH 1 1 4	2		75	7	SS			as above from 12 - 13 ft.;
								ML	very soft; yellowish brown (10 YR 5/6); SILT (ML); wet; low plasticity; cohesive; massive; loess.
15	2 4 4 5	8		45	8	SS		GC	WISCONSIN EPISODE COLLUVIUM. medium; yellow (10 YR 7/6); CLAYEY GRAVEL (GC); wet; non-plastic; cohesive; massive; colluvium of weathered Maquoketa Fm. dolomite; dolomite clasts in the interval.
	3 4 5 8	9		75	9	SS			
								CS	ORDOVICIAN MAQUOKETA FM., ELGIN Member, CLAYSTONE. stiff, yellow (10 YR 7/6); CLAYSTONE (CS); weak to moderate; thin to medium bedded; aphannitic; some laminated beds; slightly decomposed; slightly disintegrated; slightly fractured; oxidized claystone.
	5 8 11 15	19		80	10	SS			as above from 18 - 20 ft.

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-36**

SITE: **Winneshiek County Landfill** PROJECT NO. **60540571**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	13 14 20 19	34		85	11	SS			as above from 20 - 23 ft., hard.
	36 60	>50		50	12	SS			
									refusal at 23 ft bgs; switch over to NQ rock core.
25									
30									
35									
40									

Tracking Codes: 60540571.GPJ, ETSOIL, 10/4/19, 15:41

Appendix A-13 – 2021 – Boring Logs and Monitoring Well Construction Documentation

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-19R**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING: **Adjacent to MW-1; SW corner of site**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/S. Zeien**

DRILLING METHOD: **4 1/4-in HSA to top of rock; 2-in x 5-ft CT; 2-in x 2-ft SS; NQ2 rock core**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1201.45**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3913422.7**

EASTING: **5408286.04**

DATE/TIME STARTED: **09/09/21 ; 0800**

DATE/TIME COMPLETED: **09/09/21 ; 1200**

WELL INSTALLATION: **9/9/2021**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0		23		57	1	CT		ML	QUATERNARY, WISCONSINAN EPISODE, PEORIA LOESS. very stiff; very dark grayish brown (10 YR 3/2); SILT (ML); dry; non-plastic; noncohesive; thickly bedded; LOESS (top soil);
								CL	dark yellowish brown (10 YR 4/4); LEAN CLAY (CL); moist; low plasticity; cohesive; thickly bedded; LOESS
5		3		98	2	CT		CL	very soft; mottled dark yellowish brown (10 YR 4/4) to light brownish gray (10 YR 6/2); LEAN CLAY WITH SAND (CL); moist to wet; low plasticity; cohesive; thickly bedded; LOESS.
10		13		45	3	CT		CL	stiff; mottled gray (10 YR 6/1) to strong brown (7.5 YR 5/8); LEAN CLAY (CL); moist to wet; low plasticity; cohesive; thickly bedded; LOESS; buried paleosol
								GC	PRE-ILLINOIAN GLACIAL DIAMICTON. mottled gray (10 YR 6/1) to strong brown; (7.5 YR 5/8); CLAYEY GRAVEL (GC); moist to wet; low plasticity; cohesive; DIAMICTON; clasts of granite pebbles in clay matrix;
								CL	mottled gray (10 YR 6/1) to strong brown; (7.5 YR 5/8); LEAN CLAY (CL); moist to wet; low plasticity; cohesive; DIAMICTON;
15		12		100	4	CT		CL	stiff; yellowish brown (10 YR 5/6); LEAN CLAY (CL); moist to wet; low plasticity; cohesive; massive; with pebbles of quartz and granite in clay matrix; DIAMICTON

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 10/20/21, 13:29

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FINAL SOIL BORING LOG

AECOM

BORING NO. **B-19R**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20		23		100	5	CT		CL	very stiff; light brownish gray (10 YR 6/2) with intervals of yellowish red (5 YR 5/8) paleosols; LEAN CLAY (CL); mosit to wet; low plasticity; cohesive; massive; DIAMICTON
									paleosol
									paleosol
25		>30		90	6	CT		CL	hard; light brownish gray (10 YR 6/2) with intervals (layers) of yellowish red (5 YR 5/8) paleosols; moist to wet; low plasticity; cohesive; massive; DIAMICTON
									paleosol
									paleosol
									paleosol
30	7 14 50/2	>50		54	7	SS		SW	hard; light brownish gray (10 YR 6/2); WELL GRADED SAND (SW); wet, non-plastic; noncohesive; bedded; GLACIOFLUVIAL (paleosol)
	50/1	>50		9	8	SS		CS	ORDOVICIAN, MAQUOKETA FM., ELGIN MEMBER SHALE. hard; very pale brown (10 YR 7/3); CLAYSTONE (CS); wet; nonplastic; cohesive; bedded; weathered claystone (COLLUVIUM).
	50/1	>50		9	9	SS		CS	hard; as above from 34 - 34.5 ft bgs
									EOB soil sampling. Switch to rock core at 34.5 ft bgs
35									
40									

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-19R (Rock)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

WATER LEVEL READINGS

DATE	TIME	DEPTH	CASING

GROUND SURFACE ELEV: **1201.5**

Iowa State Plane COORDINATES:

NORTHING: **3913422.7**

EASTING: **5408286.0**

DRILLING METHOD: **4 1/4-in HSA to top of rock; 2-in x 5-ft CT; 2-in x 2-ft SS; NQ2 rock core**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/S. Zeien**

PHYSICAL SETTING: **Adjacent to MW-1; SW corner of site**

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

DATE STARTED: **09/09/21**

DATE COMPLETED: **09/09/21**

INSTALLATION: **9/9/2021**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
34.5		1	5.0	100			53	3		CS	ORDOVICIAN MAQUOKETA FM., ELGIN MEMBER, CLAYSTONE (CS). strong, oxidized pale yellowish orange (10 YR 8/6) to fresh pale yellowish brown (10 YR 6/2); microcrystalline; massive; moderately decomposed; slightly disintegrated; intensely fractured; unconformable with overlying diamicton; many bedding plane joints; very narrow; horizontal
39.5		2	10.0	90			74	2.5			pale yellowish brown (10 YR 6/2) to grayish orange (10 YR 7/4); LIMESTONE (LS) AND SHALE (SH); interbedded; microcrystalline; massive; moderately decomposed; slightly distintegrated; intensely fractured; many bedding plane joints; very narrow; horizontal; moderate; fossiliferous limestone with brachiopods and shell fragments.
49.5		3	10.0	90			86	2.3			light gray (N 7/0) to light brownish gray (5 YR 6/1), LIMESTONE (LS) with few SHALE (SH) interbeds or argillaceous layers; microcrystalline; massive; moderately decomposed; slightly disintegrated; intensely fractured; many bedding plane fractures; very narrow; horizontal; moderate; trace vugs infilled with calcite crystals
54.5											

Depth scale: 35, 40, 45, 50

Continued Next Page

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-19R (Rock)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
54.5											
59.5		4	10.0	83			76	2			interbedded LIMESTONE (LS) and SHALE (SH); medium light gray (N 6/0); microcrystalline; massive; moderately decomposed; slightly disintegrated; intensely fractured; bedding plane breaks; very narrow; horizontal; moderate
69.5		5	5.0	100			55	3		SH	SHALE (SH); medium light gray (N 6/0); microcrystalline; massive; moderately decomposed; slightly disintegrated; moderately fractured; bedding plane breaks; very narrow; horizontal; moderate
74.5											EOB at 74.5 ft bgs. Ream borehole with 4 1/4-in HSA to set monitoring well MW-19R
78.5											

Depth scale: 55, 60, 65, 70

Tracking Codes: 60635552 MW.GPJ, ETROCK, 10/20/21, 13:33

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-37A**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS	DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

PHYSICAL SETTING: **SW Corner of LF by fence and gate**
LOG BY: **R. Henning**
FIRM/DRILLER: **Terracon/S. Zeien**
DRILLING METHOD: **4 1/4-in HSA to EOB; 2-in x 5-ft CT**

ABANDONMENT DATE: **NA**
ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1207.50**
Iowa State Plane LOCAL COORDINATES:
NORTHING: **3913611.6**
EASTING: **5408051.74**
DATE/TIME STARTED: **09/07/21 ; 1510**
DATE/TIME COMPLETED: **09/07/21 ; 1600**
WELL INSTALLATION: **9/7/2021**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0		15		38	1	CT		ML	QUATERNARY WISCONSINAN EPISODE PEORIA LOESS. stiff; dark brown (10YR 3/3); SILT (ML); dry; non-plastic; noncohesive; bedded; OU; LOESS (top soil)
5		3		77	2	CT		CL	soft; yellowish brown (10 YR 5/6); LEAN CLAY WITH SAND (CL); wet; low plasticity; cohesive; bedded; OU; LOESS
10		8		58	3	CT		ML	medium; mottled brownish yellow (10 YR 6/8) to light brownish gray (10 YR 6/2); SANDY SILT (ML); wet (saturated); low plasticity; cohesive; bedded; OU; LOESS.
								CL	PRE-ILLINOIAN GLACIAL DIAMICTON. medium; grayish brown (10 YR 5/2); LEAN CLAY WITH SAND (CL); wet; low plasticity; cohesive; bedded; DIAMICTON; limestone pebbles
15		18		100	4	CT		CL	very stiff; brownish yellow (10 YR 6/8); LEAN CLAY WITH SAND and GRAVEL (CL); wet; low plasticity; cohesive; bedded; OU; DIAMICTON

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AECOM

FINAL SOIL BORING LOG

BORING NO. **B-37A**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20		15		52	5	CT		SW	stiff; gray (10 YR 6/1); WELL GRADED SAND WITH GRAVEL (SW), wet, non-plastic; non-cohesive; bedded; GLACIOFLUVIAL
									EOB soil boring at 24-ft bgs. Install monitoring well MW-37A in borehole.
25									
30									
35									
40									

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 10/20/21, 13:29

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-38A**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

SITE #: **96-SDP-1-74P**

	WATER LEVEL READINGS DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
PHYSICAL SETTING: **Downslope and east of MW-27A**	9/7/2021	dry	30	27

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/S. Zeien**

DRILLING METHOD: **4 1/4-in HSA to EOB; 2-in x 5-ft CT**

ABANDONMENT DATE: **9/8/2021**

ABANDONMENT METHOD: **Tremie grout and 3/8-in Holeplug**

GROUND SURFACE ELEV: **1150.00**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3913637.0**

EASTING: **5409726.06**

DATE/TIME STARTED: **09/07/21 ; 1000**

DATE/TIME COMPLETED: **09/08/21 ; 0800**

WELL INSTALLATION: **9/7/2021**

Depth in Feet	B	N	A	% Recovery	No.	T	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0		15		87	1	CT	CL	QUATERNARY, WISCONSIN EPISODE, PEORIA LOESS. stiff; dark brown (10 YR 3/3); LEAN CLAY (CL); dry; low plasticity; noncohesive; bedded; OU; top soil.
							CL	QUATERNARY, WISCONSIN EPISODE ,COLLUVIUM. stiff; reddish brown (10 YR 4/4); LEAN CLAY (CL); dry; low plasticity; cohesive; bedded; OL.
							CL	as above from 3 - 5 ft.; moist; medium plasticity.
5		>30		99	2	CT	CL	hard; yellow (10 YR 7/8); LEAN CLAY (CL); moist to wet; low to medium plasticity; cohesive; bedded; weathered claystone COLLUVIUM.
10		>30		100	3	CT	CL	hard; mottled olive yellow (2.5 Y 6/6) to light gray (2.5 Y 7/2); LEAN CLAY (CL); moist; low plasticity; cohesive; massive; OL; weathered claystone with some limestone gravel; COLLUVIUM
15		>30		93	4	CT	CS	ORDOVICIAN MAQUOKETA FM., ELGIN MEMBER, CLAYSTONE. hard; mottled olive yellow (2.5 Y 6/6) to light gray (2.5 Y 7/2); dry to moist; low plasticity; cohesive; massive; water table (?)

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FINAL SOIL BORING LOG

AECOM

BORING NO. **B-38A**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20		>30		92	5	CT		SH	hard; gray (10 YR 5/1); SHALE (SH); dry; microcrystalline; massive; highly decomposed; slightly disintegrated; slightly fractured; fissil
								CS	grading to brownish yellow (10 YR 6/6); CLAYSTONE (CS); dry
		>50		38	6	SS		CS	hard; as above from 24 - 30 ft.
25									
		>50		17	7	SS			
		>50		13	8	SS			
30									EOB at 30-ft bgs. Let borehole sit overnight to check groundwater levels. Abandon borehole 9/8/2021 since borehole was dry. Move location downslope, east of landfill fence; downgradient of Cell 4.

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-38B**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS			
DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: **1145.47**

PHYSICAL SETTING: **Downslope and east of MW-27A**

Iowa State Plane LOCAL COORDINATES:

LOG BY: **R. Henning**

NORTHING: **3913581.8**

FIRM/DRILLER: **Terracon/S. Zeien**

EASTING: **5409812.01**

DRILLING METHOD: **4 1/4-in HSA to EOB; 2-in x 5-ft CT**

DATE/TIME STARTED: **09/08/21 ; 1500**

ABANDONMENT DATE: **NA**

DATE/TIME COMPLETED: **09/08/21 ; 1600**

ABANDONMENT METHOD: **NA**

WELL INSTALLATION: **9/8/2021**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	1 2 2 2	4		35	1	SS		ML	QUATERNARY, WISCONSINAN EPISODE, PEORIA LOESS. soft; very dark grayish brown (10 YR 3/2); SILT (ML); dry; non-plastic; noncohesive; bedded; UU; LOESS (top soil)
	1 2 2 5	4		45	2	SS		ML	soft; yellowish brown (10 YR 5/8); SILT (ML); moist; low plasticity; cohesive; bedded; UU; LOESS.
5	2 3 3 3	6		45	3	SS		ML	medium; as above from 4 - 6 ft.
	1 2 2 2	4		65	4	SS		ML	soft; yellowish brown (10 YR 5/8); SILT (ML); moist to wet; low plasticity; cohesive; bedded; OU; LOESS
	1 1 1 2	2		65	5	SS		ML	very soft; wet (saturated); water table; from 8 - 10 ft.
10	WOH WOH 1 3	1		71	6	SS		ML	very soft; olive yellow (2.5 Y 6/6); SILT (ML); wet; low plasticity; cohesive; bedded; OU; LOESS
	1 2 3 3	5		63	7	SS		ML	medium; mottled brownish yellow (10 YR 6/8) to light olive brown (3.5 Y 5/6); SILT (ML); wet; low plasticity; cohesive; bedded; OU; LOESS.
15	2 3 3 3	6		67	8	SS		ML	medium; strong brown (7.5 YR 5/8); SILT (ML); wet; low plasticity; cohesive; bedded; OU; LOESS.
	2 5 6 9	11		54	9	SS		CL	QUATERNARY, WISCONSIN EPISODE, COLLUVIUM. stiff; mottled light brown (7.5 YR 6/3) to strong brown (7.5 YR 5/8); moist; LEAN CLAY WITH GRAVEL (CL); low plasticity; cohesive; bedded; OU; weathered claystone COLLUVIUM.
	3 7 9 12	16		50	10	SS		CL	very stiff; as above from 18 - 20 ft.

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-38B**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery		No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	6 9 12 14	21			59	11	SS		CS	ORDOVICIAN MAQUOKETA FM., ELGIN MEMEBER. vey stiff; very pale brown (10 YR 8/4); weathered CLAYSTONE (CS); moist; non-plastic; cohesive; thickly bedded; OL; little gravel pebbles.
	6 9 17 25	26			92	12	SS		CS	very stiff; as above from 22 - 24 ft.
25	50/6	>50			21	13	SS		CS	hard; as above from 24 - 26 ft.
	20 50/5	>50			38	14	SS		LS/SH	ORDOVICIAN GALENA GROUP, DUBUQUE FM. hard; brown (10 YR 5/3); weathered LIMESTONE (LS) and SHALE (SH); wet; non-plastic; noncohesive; thickly bedded; UU; limestone and shale gravel.
	50/2	>50			9	15	SS		LS/SH	hard; as above from 28 - 30 ft.
30										EOB at 30-ft bgs. Install monitoring well MW-38A in borehole.
35										
40										

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 10/20/21, 13:29

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-39A**

SHEET **1** OF **2**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: **1150.00**

PHYSICAL SETTING: **Downslope and east of MW-12A**

Iowa State Plane LOCAL COORDINATES:

LOG BY: **R. Henning**

NORTHING: **3913907.2**

FIRM/DRILLER: **Terracon/S. Zeien**

EASTING: **5409818.43**

DRILLING METHOD: **4 1/4-in HSA to EOB; 2-in x 5-ft CT**

DATE/TIME STARTED: **09/07/21 ; 1200**

ABANDONMENT DATE: **9/8/2021**

DATE/TIME COMPLETED: **09/08/21 ; 0800**

ABANDONMENT METHOD: **Tremie grout and 3/8-in Holeplug**

WELL INSTALLATION: **9/7/2021**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0		8		63	1	CT		ML	QUATERNARY, WISCONSIN EPISODE, PEORIA LOESS. medium; very dark brown (10 YR 2/2); SILT (ML); dry; non-plastic; noncohesive; thickly bedded; UU; LOESS; top soil
5		3		83	2	CT		CL	very soft; yellowish brown (10 YR 5/8); LEAN CLAY (CL); moist to wet; low plasticity; cohesive; thickly bedded; OU; LOESS; water table(?)
10		18		58	3	CT		CL	QUATERNARY, WISCONSIN EPISODE, COLLUVIUM. very stiff; yellow (10 YR 7/6); LEAN CLAY (CL); dry to moist; low plasticity; cohesive; massive; OU; COLLUVIUM with some gravel sized clasts; weathered claystone
15		>30		88	4	CT		CS	ORDOVICIAN, MAQUOKETA FM., ELGIN MEMBER CLAYSTONE. hard; mottled olive yellow (2.5 Y 6/6) to light gray (2.5 Y 7/2); LEAN CLAY (CL) to weathered CLAYSTONE (CS); dry; low plasticity; cohesive; massive; OU.

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-39A**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20		>30		80	5	CT		CS	hard; as above from 20 - 25 ft.
25									EOB at 25-ft bgs. Let borehole sit overnight to check groundwater levels. Abandon borehole 9/8/2021 since borehole was dry. Move location downslope, east of landfill fence; downgradient of Cell 4.
30									
35									
40									

FINAL SOIL BORING LOG

AECOM

BORING NO. **B-39B**

SHEET 1 OF 2

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

SITE #: **96-SDP-1-74P**

WATER LEVEL READINGS			
DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH

GROUND SURFACE ELEV: **1143.99**

PHYSICAL SETTING: **Downslope and east of MW-12A**

Iowa State Plane LOCAL COORDINATES:

LOG BY: **R. Henning**

NORTHING: **3913882.3**

FIRM/DRILLER: **Terracon/S. Zeien**

EASTING: **5409873.50**

DRILLING METHOD: **4 1/4-in HSA to EOB; 2-in x 5-ft CT**

DATE/TIME STARTED: **09/08/21 ; 1215**

ABANDONMENT DATE: **NA**

DATE/TIME COMPLETED: **09/08/21 ; 1315**

ABANDONMENT METHOD: **NA**

WELL INSTALLATION: **9/8/2021**

Depth in Feet	SAMPLING DATA: B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0		12		40	1	CT		ML	QUATERNARY, WISCONSINAN EPISODE, PEORIA LOESS. stiff; dark brown (10 YR 3/3); SILT (ML); dry; non-plastic; noncohesive; bedded; UU; LOESS (top soil).
								CL	yellowish brown (10 YR 6/8); LEAN CLAY (CL); moist; low plasticity; cohesive; bedded; OU; LOESS.
5		8		47	2	CT		CL	medium; yellowish brown (10 YR 6/8); LEAN CLAY (CL); moist to wet; low plasticity; cohesive; OU; LOESS.
10	1 1 5 8	6		50	3	SS		CL	QUATERNARY, WISCONSINAN EPISODE, COLLUVIUM. medium; olive yellow (2.5 Y 6/6); LEAN CLAY WITH GRAVEL (CL); moist to wet; low plasticity; cohesive; OU.
	6 5 6 6	11		54	4	SS		GC	stiff; olive yellow (2.5 Y 6/8); CLAYEY GRAVEL (GC); wet; non-plastic; cohesive; OU; COLLUVIUM (weathered claysone and limestone); water table.
	3 4 5 9	9		88	5	SS		CL	stiff; yellow (2.5 Y 7/6) GRAVELLY LEAN CLAY (CL); wet; low plasticity; cohesive; OU; COLLUVIUM.
15	4 6 7 10	13		100	6	SS		CL	siff; as above from 15.5 - 19.5 ft.
	6 9 6 10	15		100	7	SS		CL	
	8	23		50	8	SS		CL	very stiff; as above from 19.5 - 21.5 ft.

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-39B**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	13 10 19								
	14 42 44 24	>50		63	9	SS		GC	hard; brown (10 YR 5/3); CLAYEY GRAVEL (GC); wet, non-plastic; non-cohesive; thickly bedded; OU; GLACIOFLUVIAL; erosional sequence on top of GALENA GROUP.
25	29 17 39 50/2	>50		67	10	SS		GC	hard; as above from 23.5 - 29.5 ft.
	58 50/2	>50		50	11	SS		GC	
	50/1	>50		13	12	SS		GC	
30	48 14 50/3	>50		54	13	SS		SH	ORDOVICIAN, GALENA GROUP, DUBUQUE FM.; hard; grayish brown (10 YR 5/2); SHALE (SH); wet; non-plastic; cohesive; bedded; top of GALENA GROUP.
									EOB at 30-ft bgs; install monitoring well MW-39A in borehole.
35									
40									

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-40A**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

		WATER LEVEL READINGS				
		DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH	GROUND SURFACE ELEV: **1148.32**
PHYSICAL SETTING:	**Downslope and east of MW-26A**	**9/8/2021**	**28.7**	**28**	**30.7**	Iowa State Plane LOCAL COORDINATES:
LOG BY:	**R. Henning**					NORTHING: **3914159.1**
FIRM/DRILLER:	**Terracon/S. Zeien**					EASTING: **5409912.45**
DRILLING METHOD:	**4 1/4-in HSA to EOB; 2-in x 5-ft CT**					DATE/TIME STARTED: **09/07/21 ; 1315**
		ABANDONMENT DATE: **NA**				DATE/TIME COMPLETED: **09/08/21 ; 1045**
		ABANDONMENT METHOD: **NA**				WELL INSTALLATION: **9/8/2021**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0				75	1	CT		CL	QUATERNARY, WISCONSINAN EPISODE, PEORIA LOESS. stiff; brown (10 YR 4/3); LEAN CLAY WITH SILT (CL); dry to moist; low plasticity; cohesive; LOESS (top soil).
								CL	stiff; yellowish brown (10 YR 5/6); LEAN CLAY WITH SAND (CL); dry; non-plastic; cohesive; LOESS.
5				92	2	CT		CL	QUATERNARY, WISCONSINAN EPISODE, COLLUVIUM. very pale brown (10 YR 7/4); LEAN CLAY (CL); dry to moist; low plasticity; cohesive; massive; OU; COLLUVIUM (claystone and limestone pebbles).
10				100	3	CT		CS	ORDOVICIAN, MAQUOKETA FM., ELGIN MEMBER, CLAYSTONE. hard; yellow (2.5 Y 7/6); CLAYSTONE (CS); dry; non-plastic; cohesive; massive; OU.
15				27	4	CT		CS	hard; as above from 15 - 29.5 ft.
	39 47 50/5	>50		75	5	SS			
	50/6	>50		25	6	SS			

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-40A**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20									
	32 50/3	>50		19	7	SS			
	50/3	>50		17	8	SS			
25	50/2	>50		13	9	SS			
	50/0	>50		0	10	SS			
	50/2	>50		8	11	SS			
	50/2	>50		8	12	SS			EOB soil boring at 29.5-ft bgs. Switch to NQ2 rock core.
30									
35									
40									

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 10/20/21, 13:29

AECOM

FINAL ROCK CORE LOG

BORING NO. **B-40A (Rock)**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **1** OF **1**

DRILLING METHOD:	4 1/4-in HSA to top of rock; 2-in x 5-ft CT; 2-in x 2-ft SS; NQ2 rock core
LOG BY:	R. Henning
FIRM/DRILLER:	Terracon/S. Zeien
PHYSICAL SETTING:	Downslope and east of MW-26A

WATER LEVEL READINGS

DATE	TIME	DEPTH	CASING

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV:	1148.3
Iowa State Plane COORDINATES:	
NORTHING:	3914159.1
EASTING:	5409912.5
DATE STARTED:	09/08/21
DATE COMPLETED:	09/08/21
INSTALLATION:	9/8/2021

Depth in Feet	GRAPHICS	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS	% RQD	FRACTURES	ROCK TYPE	ROCK TYPE CODE	ROCK DESCRIPTION
29.5		1	10.0	90			81	1		LS	ORDOVICIAN GALENA GROUP DUBUQUE FM.; light brownish gray (5 YR 6/1) with light brown staining (5YR 5/6) on fractures; LIMESTONE (LS) with SHALE (SH) interbeds pale yellowish orange (10 YR 8/6); microcrystalline; massive; moderately decomposed; slightly disintegrated; moderately fractured; unconformable; numerous bedding plane fractures; narrow not healed; clay infilling in some; wet with minor seepage.
30											
35											
											EOB rock core at 39.5 ft bgs; ream borehole with 4 1/4-in HSA to 40 ft bgs for monitoring well MW-40A installation.
49.5											

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Appendix A-14 – 2022 – Boring Logs and Monitoring Well Construction Documentation

3105 Capital Way
Cedar Falls, IA 50613
P (319) 277-4016
F (319) 277-4320
Terracon.com

Date: August 18, 2022

Winneshiek County Solid Waste Agency
201 West Main Street
Decorah, Iowa 52101

Attention: TJ Schissel

Re: Winneshiek County Landfill

Job No.: 13227047

We are transmitting ☒ herewith ☐ under separate cover

Item	Date	Description
1	8/8/2022	Monitoring Well Abandonment Form (MW-1R, MW-8A and MW-23)
2		AECOM 2022 Monitoring Well Location Map

Remarks:

If you have any questions regarding this information, please contact our office.

Yours truly,

Terracon Consultants, Inc.

By: Dave Cleary

Dave Cleary

Copies to: Address (email)
Russ Henning, AECOM, (email)
Chris Oelkers, AECOM, (email)

IOWA DEPARTMENT OF NATURAL RESOURCES

Abandoned Water Well Plugging Record

1. **Owner:**

Name: Winneshiek County Solid Waste Agency Phone: 563-381-4073

Address: 201 West Main Street

City: Decorah State: Iowa **Zip:** 52101

If this was a Public Water Supply Well, please provide:

PWSID Name: ______ PWSID Number: ______

2. **Location of Well (Cistern):**

SW ¼ of, SW ¼ of, SE ¼ of, Section 9, T 97 N, R 7 ☐ East ☒ West

County: Winneshiek Describe well location on property: MW-1R on attached Monitoring Well Map

GPS Well Location: Latitude: 43.226835 Longitude: -91.673444

3. **Well Description:**

Well depth: 25 ft

Depth to water 0.0 ft.

Casing depth: 25 ft. Casing Material: ☐ Steel ☒ Plastic ☐ Concrete ☐ Clay ☐ Brick ☐ Stone

Casing diameter: 2 in.

Year or decade constructed: unknown Type of Construction: ☐ Drilled ☐ Driven ☐ Bored ☒ Augured ☐ Dug

Is this a Monitoring Well? ☒ Yes ☐ No Well ID: MW-1R

Check if Cistern ☐ Depth: ______ ft. Diameter: ______ ft.

I certify this well has been plugged as required by rule 567-39.8 of the Iowa Administrative Code (IAC). I agree to provide any additional information the county or department may need concerning this well.

Signature of Owner ______ Date Plugged: 8/8/2022

If plugged by certified well contractor, complete this box:
I have plugged this well as required by rule 567-39.8 of the Iowa Administrative Code (IAC).

Signature of Contractor: Dave [signature] Cert No: 9351

OR, If plugged by well owner, complete this box:
The property owner has plugged this well following requirements in rule 567-39.8 of the Iowa Administrative Code (IAC) with the oversight and assistance of the designated county agent.

Signature of County Agent: ______ Date Approved: ______

Eligible for Grants-to-Counties cost share: ☐ Yes ☐ No (Determined by County Agent)

Complete one form for each well plugged and submit within 30 days to the local county agent:

OR, only if no county agent is available, to:

	Water Supply Section **Iowa Department of Natural Resources** **502 E 9th St** **Des Moines IA 50319-0034**

IOWA DEPARTMENT OF NATURAL RESOURCES

Abandoned Water Well
Plugging Record

1. **Owner:**

Name: Winneshiek County Solid Waste Agency Phone: 563-381-4073

Address: 201 West Main Street

City: Decorah State: Iowa **Zip:** 52101

If this was a Public Water Supply Well, please provide:

PWSID Name: ______ PWSID Number: ______

2. **Location of Well (Cistern):**

SW ¼ of, NE ¼ of, NE ¼ of, Section 16, T 97 N, R 7 ☐ East ☒ West

County: Winneshiek Describe well location on property: MW-8A on attached Monitoring Well Map

GPS Well Location: Latitude: 43.225221 Longitude: -91.665662

3. **Well Description:**

Well depth: 17.5 ft

Depth to water: blocked ft.

Casing depth: 17.5 ft. Casing Material: ☐ Steel ☒ Plastic ☐ Concrete ☐ Clay ☐ Brick ☐ Stone

Casing diameter: 2 in.

Year or decade constructed: unknown Type of Construction: ☐ Drilled ☐ Driven ☐ Bored ☒ Augured ☐ Dug

Is this a Monitoring Well? ☒ Yes ☐ No Well ID: MW-8A

Check if Cistern ☐ Depth: ______ ft. Diameter: ______ ft.

I certify this well has been plugged as required by rule 567-39.8 of the Iowa Administrative Code (IAC). I agree to provide any additional information the county or department may need concerning this well.

Signature of Owner ______ Date Plugged: 8/8/2022

If plugged by certified well contractor, complete this box:

I have plugged this well as required by rule 567-39.8 of the Iowa Administrative Code (IAC).

Signature of Contractor: Dave [signature] Cert No: 9351

OR, If plugged by well owner, complete this box:

The property owner has plugged this well following requirements in rule 567-39.8 of the Iowa Administrative Code (IAC) with the oversight and assistance of the designated county agent.

Signature of County Agent: ______ Date Approved: ______

Eligible for Grants-to-Counties cost share: ☐ Yes ☐ No (Determined by County Agent)

Complete one form for each well plugged and submit within 30 days to the local county agent:	OR, only if no county agent is available, to:
	Water Supply Section **Iowa Department of Natural Resources** **502 E 9th St** **Des Moines IA 50319-0034**

IOWA DEPARTMENT OF NATURAL RESOURCES

Abandoned Water Well Plugging Record

1. **Owner:**

Name: Winneshiek County Solid Waste Agency Phone: 563-381-4073

Address: 201 West Main Street

City: Decorah State: Iowa Zip: 52101

If this was a Public Water Supply Well, please provide:

PWSID Name: ______ PWSID Number: ______

2. **Location of Well (Cistern):**

SW ¼ of, NE ¼ of, NE ¼ of, Section 16 , T 97 N, R 7 ☐ East ☒ West

County: Winneshiek Describe well location on property: MW-23 on attached Monitoring Well Map

GPS Well Location: Latitude: 43.225221 Longitude: -91.665662

3. **Well Description:**

Well depth: 40.5 ft

Depth to water blocked ft.

Casing depth: 18.92 ft. Casing Material: ☐ Steel ☒ Plastic ☐ Concrete ☐ Clay ☐ Brick ☐ Stone

Casing diameter: 2 in.

Year or decade constructed: unknown Type of Construction: ☐ Drilled ☐ Driven ☐ Bored ☒ Augured ☐ Dug

Is this a Monitoring Well? ☒ Yes ☐ No Well ID: MW-23

Check if Cistern ☐ Depth: ______ ft. Diameter: ______ ft.

I certify this well has been plugged as required by rule 567-39.8 of the Iowa Administrative Code (IAC). I agree to provide any additional information the county or department may need concerning this well.

Signature of Owner ______ Date Plugged: 8/8/2022

If plugged by certified well contractor, complete this box:
I have plugged this well as required by rule 567-39.8 of the Iowa Administrative Code (IAC).

Signature of Contractor: [signature] Cert No: 9351

OR, If plugged by well owner, complete this box:
The property owner has plugged this well following requirements in rule 567-39.8 of the Iowa Administrative Code (IAC) with the oversight and assistance of the designated county agent.

Signature of County Agent: ______ Date Approved: ______

Eligible for Grants-to-Counties cost share: ☐ Yes ☐ No (Determined by County Agent)

Complete one form for each well plugged and submit within 30 days to the local county agent:

OR, only if no county agent is available, to:

Water Supply Section
Iowa Department of Natural Resources
502 E 9th St
Des Moines IA 50319-0034

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-41**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING:	NW corner adjacent to LF entrance	WATER LEVEL READINGS DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH	GROUND SURFACE ELEV:	1146.63
						Iowa State Plane LOCAL COORDINATES:	
LOG BY:	R. Henning					NORTHING:	3915356.5
FIRM/DRILLER:	Terracon/D. List					EASTING:	5408105.55
DRILLING METHOD:	4 1/4-in. HSA to EOB; 2-in x 2-ft SS					DATE/TIME STARTED:	08/08/22 ; 0945
		ABANDONMENT DATE:	NA			DATE/TIME COMPLETED:	08/08/22 ; 1031
		ABANDONMENT METHOD:	NA			WELL INSTALLATION:	8/8/2022

Depth in Feet	B	N	A	% Recovery	No.	T	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	1 2 2 3	4		60	1	SS	CL	QUATERNARY ANTHROPOCENE FILL. soft; mottled dark yellowish brown to gray (10YR 4/4 to 6/1); moist; LEAN CLAY (CL); low plasticity; cohesive; massive; MUU; with plant roots; top soil
	1 1 1 1	2		83	2	SS	ML	QUATERNARY WISCONSINAN EPISODE PEORIA LOESS. very soft; black (10YR 2/1); SILT (ML); moist; low plasticity; cohesive; massive; OU; LOESS (top soil)
5	1 WOH 1 1	1		55	3	SS	ML	very soft; as above from 4 - 10 ft.
	1 1 1 1	1		60	4	SS	ML	
	1 WOH 1 WOH	1		100	5	SS	ML	
10	WOH WOH WOH WOH	0		50	6	SS	CL	very soft; gray (10 YR 5/1); wet; LEAN CLAY (CL); low plasticity; cohesive; bedded; UU;
	1 WOH WOH 1	0		30	7	SS	SM	very soft; yellowish brown (10 YR 5/8); wet; SILTY SAND (SM); non-plastic; non-cohesive; bedded; glaciofluvial
15	WOH WOH 4 3	4		40	8	SS		
	3 6 4 3	10		75	9	SS	SM	stiff; yellowish brown (10 YR 5/8); SILTY SAND (SM) grading to gray (10 YR 5/1) SILT (ML); non-plastic; non-cohesive; bedded; glaciofluvial
							ML	
	1 1 2 3	3		65	10	SS	CL	PRE-ILLINOIAN GLACIAL DIAMICTON. soft; gray (10 YR 5/1); LEAN CLAY (CL); wet; low plasticity; cohesive; massive; DIAMICTON;

Continued Next Page

FINAL SOIL BORING LOG

BORING NO. **B-41**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **2** OF **2**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery		No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20										EOB at 20-ft BGS; INSTALL monitoring well MW-41A
25										
30										
35										
40										

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-42**

SHEET **1** OF **2**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING: **East side adjacent to LF fence and MW-31A**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/D. List**

DRILLING METHOD: **4 1/4-in. HSA to EOB; 2-in x 2-ft SS**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
8/8/2022	14	20	18
8/8/2022	14	20	NA

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1131.86**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3914479.1**

EASTING: **5410010.99**

DATE/TIME STARTED: **08/08/22 ; 1300**

DATE/TIME COMPLETED: **08/08/22 ; 1400**

WELL INSTALLATION: **8/8/2022**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	1 1 1 3	2		50	1	SS		ML	QUATERNARY WISCONSINAN EPISODE PEORIA LOESS. very soft; dark brown (10YR 3/3); SILT (ML); moist; non-plastic; cohesive; massive; OU; LOESS (top soil)
	2 2 3 3	5		70	2	SS		ML	medium; brown (10YR 4/3); moist; SILT (ML); non-plastic; cohesive; massive; loess.
5	1 2 2 3	4		70	3	SS		ML	soft; very dark grayish brown (10 YR 3/2); SILT (ML); moist (water coated grains); non-plastic; cohesive; massive; loess.
	2 2 5 5	7		70	4	SS		CL	QUATERNARY, WISCONSINAN EPISODE, COLLUVIUM. medium; light yellowish brown (10 YR 6/4); LEAN CLAY (CL); moist to wet; low plasticity; cohesive; massive; weathered claystone;
	9 8 16 15	24		55	5	SS		CL	very stiff; as above from 8 - 10 ft.
10	5 10 26 50/4	36		65	6	SS		CL	hard; as above; wet in colluvium at 10 ft.
	50/3	>50		15	7	SS		CL	hard; as above from 12 - 14 ft.
15	15 50/5	>50		15	8	SS		CL	hard; as above from 14 - 16 ft.
	45 50/3	>50		15	9	SS		CS	ORDOVICIAN, MAQUOKETA FM., ELGIN MEMBER, CLAYSTONE. hard; gray (10 YR 6/1); CLAYSTONE (CS); moist; aphanitic; weak to moderate; thinly to medium bedded; slightly decomposed; competent to slightly distintegrated; slightly fractured.
	30 50/3	>50		15	10	SS		CS	hard; as above, weathered claystone from 18 - 20 ft.

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 12/23/22, 10:19

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-42**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **2** OF **2**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery		No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20										EOB at 20 ft. BGS; install monitoring well MW-42A.
25										
30										
35										
40										

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 12/23/22, 10:19

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-43**

SHEET **1** OF **1**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING: **East side adjacent to Leachate Lagoon**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/D. List**

DRILLING METHOD: **3 1/4-in. HSA to EOB; 2-in x 2-ft SS**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
8/9/2022	7	8	8

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1116.31**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3914793.5**

EASTING: **5410466.60**

DATE/TIME STARTED: **08/09/22 ; 0950**

DATE/TIME COMPLETED: **08/09/22 ; 1100**

WELL INSTALLATION: **8/9/2022**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 2 3 3	5		100	1	SS		ML	QUATERNARY WISCONSINAN EPISODE PEORIA LOESS. medium; brown (10 YR 4/3); moist to wet; SILT with SAND (ML); non-plastic; cohesive; massive; plant roots; topsoil.
	1 3 2 3	5		75	2	SS		ML	medium; very dark brown (10 YR 2/2); SILT (ML); moist to wet; non-plastic; cohesive; massive; roots; loess.
5	1 1 3 2	4		55	3	SS		ML	soft; mottled olive brown (2.5 Y 4/3) to black (2.5 Y 2.5/1); SILT with SAND (ML); wet; non-plastic; cohesive; bedded; loess.
	2 44 37 50/3	>50		25	4	SS		GC	QUATERNARY, WISCONSINAN EPISODE, COLLUVIUM. hard; very pale brown (10 YR 7/4); CLAYEY GRAVEL (GC); wet; non-plastic; noncohesive; bedded; weathered GALENA FM. dolomite colluvium;
				0	5	NR		LS/SH	ORDOVICIAN GALENA GROUP, DUBUQUE FM. top of bedrock at 8 ft. BGS. hard; brown (10 YR 5/3); weathered LIMESTONE (LS) and SHALE (SH); wet; non-plastic; noncohesive; thickly bedded; UU;
10								LS/SH	ream borehole to 18 ft BGS; set monitoring well MW-43A.
15									
									EOB at 18 ft. BGS

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-44**

SITE: **Winneshiek Co. LF** PROJECT NO. **60635552** SHEET **1** OF **1**

SITE #: **96-SDP-1-74P**

PHYSICAL SETTING: **East side adjacent to Leachate Lagoon**

LOG BY: **R. Henning**

FIRM/DRILLER: **Terracon/D. List**

DRILLING METHOD: **3 1/4-in. HSA to EOB; 2-in x 2-ft SS**

WATER LEVEL READINGS

DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
8/9/2022	6	10	10

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1114.67**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3914990.3**

EASTING: **5410472.94**

DATE/TIME STARTED: **08/09/22 ; 0750**

DATE/TIME COMPLETED: **08/09/22 ; 0930**

WELL INSTALLATION: **8/9/2022**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 2 4 5	6		50	1	SS		CL	QUATERNARY WISCONSINAN EPISODE PEORIA LOESS. medium; motled brown to brownish yellow (10 YR 4/3 to 6/6); SILTY CLAY (CL); moist; non-plastic; cohesive; bedded; top soil with plant roots;
	2 2 2 3	4		50	2	SS		ML	soft; very dark grayish brown (10 YR 3/2); SILT (ML); moist to wet; non-plastic; cohesive; bedded; loess
5	1 1 2 2	3		70	3	SS		ML	soft; black (10 YR 2/1); SILT (ML); wet; non-plastic; cohesive; bedded; loess.
	2 50/5	>50		15	4	SS		GC	QUATERNARY, WISCONSINAN EPISODE, COLLUVIUM. hard; very pale brown (10 YR 7/3); CLAYEY GRAVEL (GC); wet; non-plastic; noncohesive; bedded; colluvium composed of weathered GALENA GROUP limestone; saturated.
	50/5	>50		15	5	SS		GC	hard; as above; refusal at top of bedrock approximately 9 ft BGS.
10								LS/SH	ORDOVICIAN GALENA GROUP, DUBUQUE FM. top of bedrock at 9 ft. BGS. hard; brown (10 YR 5/3); weathered LIMESTONE (LS) and SHALE (SH); wet; non-plastic; noncohesive; thickly bedded; UU; ream borehole from 9 - 18 ft BGS.
15									
									EOB at 18 ft BGS. Install monitoring well MW-44A.

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 12/23/22, 10:19

Print Form

IOWA DEPARTMENT OF NATURAL RESOURCES

MONITORING WELL/PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: WINNESHIEK COUNTY LANDFILL　Permit No.: 96-SDP-1-74P

Well or Piezometer No: MW-41A

Dates Started: 08/08/2022　Date Completed: 08/08/2022

A. SURVEYED LOCATIONS AND ELEVATIONS

Locations (± 0.5 ft): N 3915356.48 E 5408105.55

Specify corner of site: IA State Plane

Distance & direction along boundary:

Distance & direction from boundary to wall:

Elevations (± 0.01 ft MSL):

Ground Surface: 1146.63

Top of protective casing: 1149.68

Top of well casing: 1149.75

Benchmark elevation:

Benchmark description:

B. SOIL BORING INFORMATION

Name & Address of Construction Company:

Terracon

6612 Chancellor Drive Suite 102

Cedar Falls IA 50613

Name of Driller: Duncan List

Drilling Method: 4 1/4" HSA

Drilling Fluid: NA

Bore Hole Diameter: 8.25"

Soil Sampling Method: 2' by 2" continuous sampler

Depth of Boring: 20'

C. MONITORING WELL INSTALLATION

Casing material: SCH 40 PVC

Length of casing: 13.1'

Outside casing diameter: 2.375"

Inside casing diameter: 2.067"

Casing joint type: flush threaded

Casing/screen joint type: flush threaded

Screen material: SCH 40 PVC

Screen opening size: 0.010"

Screen length: 10'

Depth of well: 20'

Filter Pack:

Material: Filter Pack Sand

Grain size: 0.007-0.250"

Volume: 32 gal.

Seal (minimum 3 ft length above filter pack):

Material: Bentonite Chips 3/8" hole plug

Placement method: direct pour

Volume: 24 gal.

Backfill (if different from seal):

Material: NA

Placement method: NA

Volume: NA

Surface seal design:

Material of protective casing: 4" by 4" by 7' Steel

Material of grout between protective casing and well casing: 3/8" hole plug

Protective cap:

Material: Steel

Vented: ☐ Yes ☐ No　Locking: ☒ Yes ☐ No

Well Cap:

Material: PVC J-Plug

Vented: ☐ Yes ☒ No

D. GROUNDWATER MEASURMENT (± 0.01 ft below top of inner well casing)

Water level: 1.58 ft　Stabilization Time: 24-hr

Well development method: Bailed and Pumped

Average depth of frostline:

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½x11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed for to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E 9th St, Des Moines IA 50319-0034.

Questions? Call or Email: Nina Koger, Environmental Engineer Sr., 515-281-8986, Nina.Koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 ft MSL
DEPTHS: ± 0.1 ft FROM GROUND SURFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL.)

TOP OF PROTECTIVE CASING
ELEVATION 1149.68

TOP OF WELL CASING
ELEVATION 1149.75

GROUND SURFACE
ELEVATION 1146.63

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1146.63
DEPTH 0.0'

BASE OF PROTECTIVE CASING
ELEVATION 1142.68
DEPTH 3.95'

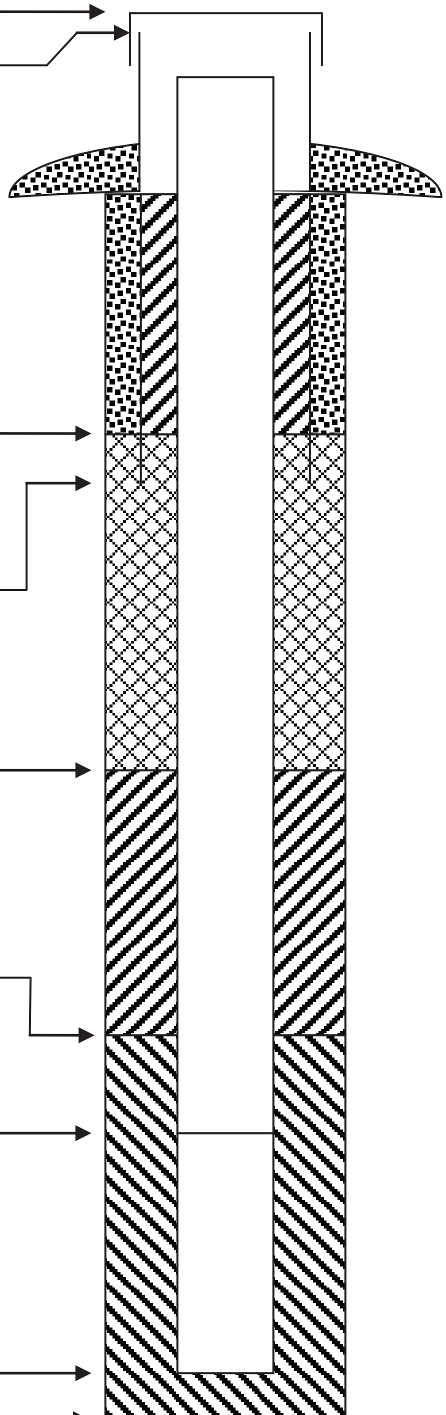
BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1138.13
DEPTH 8.5'

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1138.13
DEPTH 8.5'

TOP OF SCREEN
ELEVATION 1136.63
DEPTH 10'

BOTTOM OF SCREEN
ELEVATION 1126.63
DEPTH 20.0'

BASE OF FILTER PACK
ELEVATION 1126.63
DEPTH 20.0'



Print Form

IOWA DEPARTMENT OF NATURAL RESOURCES

MONITORING WELL/PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: WINNESHIEK COUNTY LANDFILL   Permit No.: 96-SDP-1-74P

Well or Piezometer No: MW-42A

Dates Started: 08/08/2022   Date Completed: 08/08/2022

A. SURVEYED LOCATIONS AND ELEVATIONS

Locations (± 0.5 ft): N 3914479.14 E 5410010.99

Specify corner of site: IA State Plane

Distance & direction along boundary:

Distance & direction from boundary to wall:

Elevations (± 0.01 ft MSL):

Ground Surface: 1131.86

Top of protective casing: 1135.41

Top of well casing: 1135.43

Benchmark elevation:

Benchmark description:

B. SOIL BORING INFORMATION

Name & Address of Construction Company:
Terracon
6612 Chancellor Drive Suite 102
Cedar Falls IA 50613

Name of Driller: Duncan List

Drilling Method: 4 1/4" HSA

Drilling Fluid: NA

Bore Hole Diameter: 8.25"

Soil Sampling Method: 2' by 2" continuous sampler

Depth of Boring: 20'

C. MONITORING WELL INSTALLATION

Casing material: SCH 40 PVC

Length of casing: 13.6'

Outside casing diameter: 2.375"

Inside casing diameter: 2.067"

Casing joint type: flush threaded

Casing/screen joint type: flush threaded

Screen material: SCH 40 PVC

Screen opening size: 0.010"

Screen length: 10'

Depth of well: 20'

Filter Pack:

Material: Filter Pack Sand

Grain size: 0.007-0.250"

Volume: 32 gal.

Seal (minimum 3 ft length above filter pack):

Material: Bentonite Chips 3/8" hole plug

Placement method: direct pour

Volume: 24 gal.

Backfill (if different from seal):

Material: NA

Placement method: NA

Volume: NA

Surface seal design:

Material of protective casing: 4" by 4" by 7' Steel

Material of grout between protective casing and well casing: 3/8" hole plug

Protective cap:

Material: Steel

Vented: ☐ Yes ☐ No   Locking: ☒ Yes ☐ No

Well Cap:

Material: PVC J-Plug

Vented: ☐ Yes ☒ No

D. GROUNDWATER MEASURMENT (± 0.01 ft below top of inner well casing)

Water level: 11.86 ft   Stabilization Time: 24-hr

Well development method: Bailed and Pumped

Average depth of frostline:

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½x11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed for to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E 9th St, Des Moines IA 50319-0034.

Questions? Call or Email: Nina Koger, Environmental Engineer Sr., 515-281-8986, Nina.Koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 ft MSL
DEPTHS: ± 0.1 ft FROM GROUND SURFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL.)

TOP OF PROTECTIVE CASING
ELEVATION 1135.41

TOP OF WELL CASING
ELEVATION 1135.43

GROUND SURFACE
ELEVATION 1131.86

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1131.86
DEPTH 0.0'

BASE OF PROTECTIVE CASING
ELEVATION 1128.41
DEPTH 3.45'

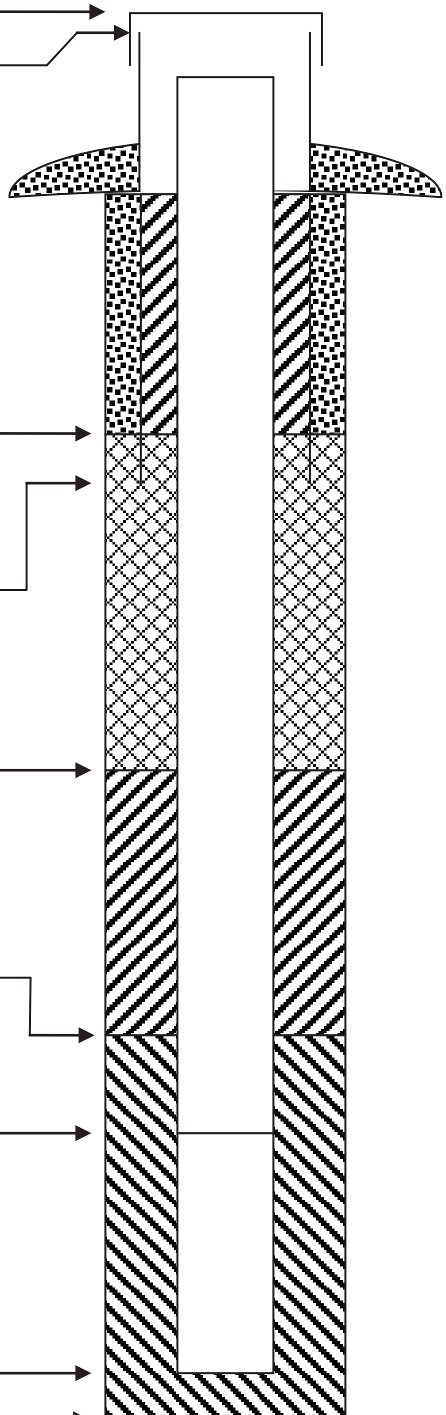
BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1123.36
DEPTH 8.5'

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1123.36
DEPTH 8.5'

TOP OF SCREEN
ELEVATION 1121.86
DEPTH 10'

BOTTOM OF SCREEN
ELEVATION 1111.86
DEPTH 20.0'

BASE OF FILTER PACK
ELEVATION 1111.86
DEPTH 20.0'



Print Form

IOWA DEPARTMENT OF NATURAL RESOURCES

MONITORING WELL/PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: WINNESHIEK COUNTY LANDFILL Permit No.: 96-SDP-1-74P

Well or Piezometer No: MW-43A

Dates Started: 08/09/2022 Date Completed: 08/09/2022

A. SURVEYED LOCATIONS AND ELEVATIONS

Locations (± 0.5 ft): N 3914793.51 E 5410466.60

Specify corner of site: IA State Plane

Distance & direction along boundary:

Distance & direction from boundary to wall:

Elevations (± 0.01 ft MSL):

Ground Surface: 1116.31

Top of protective casing: 1119.13

Top of well casing: 1119.21

Benchmark elevation:

Benchmark description:

B. SOIL BORING INFORMATION

Name & Address of Construction Company:
Terracon
6612 Chancellor Drive Suite 102
Cedar Falls IA 50613

Name of Driller: Duncan List

Drilling Method: 4 1/4" HSA

Drilling Fluid: NA

Bore Hole Diameter: 8.25"

Soil Sampling Method: 2' by 2" continuous sampler

Depth of Boring: 17.5'

C. MONITORING WELL INSTALLATION

Casing material: SCH 40 PVC

Length of casing: 9.90'

Outside casing diameter: 2.375"

Inside casing diameter: 2.067"

Casing joint type: flush threaded

Casing/screen joint type: flush threaded

Screen material: SCH 40 PVC

Screen opening size: 0.010"

Screen length: 10'

Depth of well: 17.5'

Filter Pack:

Material: Filter Pack Sand

Grain size: 0.007-0.250"

Volume: 35 gal.

Seal (minimum 3 ft length above filter pack):

Material: Bentonite Chips 3/8" hole plug

Placement method: direct pour

Volume: 14 gal.

Backfill (if different from seal):

Material: NA

Placement method: NA

Volume: NA

Surface seal design:

Material of protective casing: 4" by 4" by 7' Steel

Material of grout between protective casing and well casing: 3/8" hole plug

Protective cap:

Material: Steel

Vented: ☐ Yes ☐ No Locking: ☒ Yes ☐ No

Well Cap:

Material: PVC J-Plug

Vented: ☐ Yes ☒ No

D. GROUNDWATER MEASURMENT (± 0.01 ft below top of inner well casing)

Water level: 7.62 ft Stabilization Time: 24-hr

Well development method: Bailed and Pumped

Average depth of frostline:

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½x11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed for to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E 9th St, Des Moines IA 50319-0034.

Questions? Call or Email: Nina Koger, Environmental Engineer Sr., 515-281-8986, Nina.Koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 ft MSL
DEPTHS: ± 0.1 ft FROM GROUND SURFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL.)

TOP OF PROTECTIVE CASING
ELEVATION 1119.13

TOP OF WELL CASING
ELEVATION 1119.21

GROUND SURFACE
ELEVATION 1116.31

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1116.31
DEPTH 0.0'

BASE OF PROTECTIVE CASING
ELEVATION 1112.13
DEPTH 4.18'

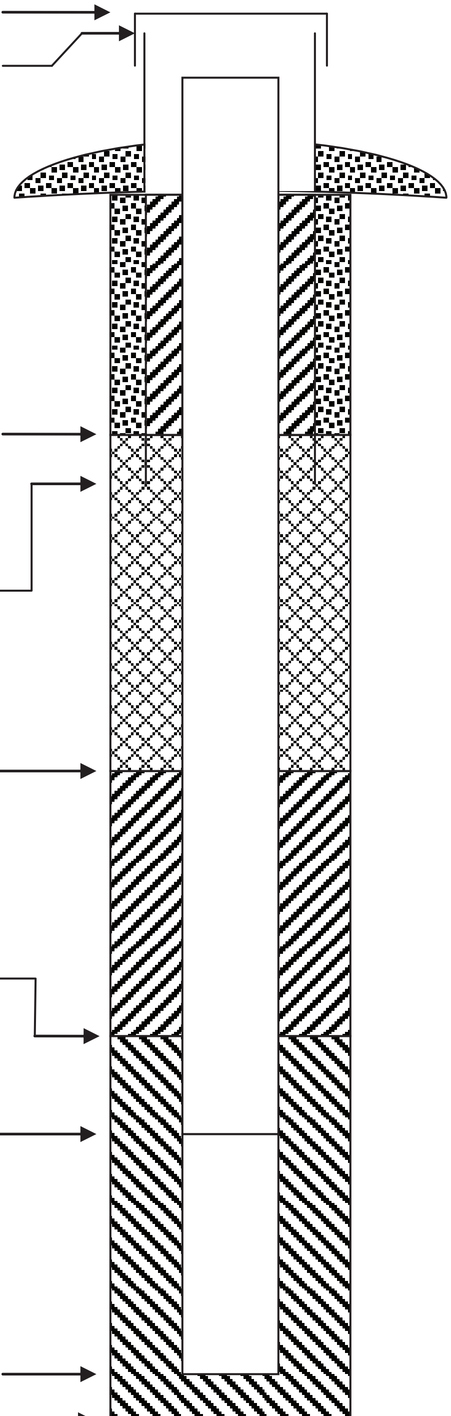
BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1111.31
DEPTH 5.0'

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1110.31
DEPTH 5.0'

TOP OF SCREEN
ELEVATION 1109.31
DEPTH 7'

BOTTOM OF SCREEN
ELEVATION 1099.31
DEPTH 17.0'

BASE OF FILTER PACK
ELEVATION 1098.81
DEPTH 17.5'



Print Form

IOWA DEPARTMENT OF NATURAL RESOURCES

MONITORING WELL/PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: WINNESHIEK COUNTY LANDFILL Permit No.: 96-SDP-1-74P

Well or Piezometer No: MW-44A

Dates Started: 08/09/2022 Date Completed: 08/09/2022

A. SURVEYED LOCATIONS AND ELEVATIONS

Locations (± 0.5 ft): N 3914990.26 E 5410472.94

Specify corner of site: IA State Plane

Distance & direction along boundary:

Distance & direction from boundary to wall:

Elevations (± 0.01 ft MSL):

Ground Surface: 1114.67

Top of protective casing: 1117.86

Top of well casing: 1117.88

Benchmark elevation:

Benchmark description:

B. SOIL BORING INFORMATION

Name & Address of Construction Company:
Terracon
6612 Chancellor Drive Suite 102
Cedar Falls IA 50613

Name of Driller: Duncan List

Drilling Method: 4 1/4" HSA

Drilling Fluid: NA

Bore Hole Diameter: 8.25"

Soil Sampling Method: 2' by 2" continuous sampler

Depth of Boring: 17.0'

C. MONITORING WELL INSTALLATION

Casing material: SCH 40 PVC

Length of casing: 10.2'

Outside casing diameter: 2.375"

Inside casing diameter: 2.067"

Casing joint type: flush threaded

Casing/screen joint type: flush threaded

Screen material: SCH 40 PVC

Screen opening size: 0.010"

Screen length: 10'

Depth of well: 17.0'

Filter Pack:

Material: Filter Pack Sand

Grain size: 0.007-0.250"

Volume: 33 gal.

Seal (minimum 3 ft length above filter pack):

Material: Bentonite Chips 3/8" hole plug

Placement method: direct pour

Volume: 14 gal.

Backfill (if different from seal):

Material: NA

Placement method: NA

Volume: NA

Surface seal design:

Material of protective casing: 4" by 4" by 7' Steel

Material of grout between protective casing and well casing: 3/8" hole plug

Protective cap:

Material: Steel

Vented: ☐ Yes ☐ No Locking: ☒ Yes ☐ No

Well Cap:

Material: PVC J-Plug

Vented: ☐ Yes ☒ No

D. GROUNDWATER MEASURMENT (± 0.01 ft below top of inner well casing)

Water level: 8.63 ft Stabilization Time: 24-hr

Well development method: Bailed and Pumped

Average depth of frostline:

Attachments: Driller's log. Pipe schedules and grouting schedules. 8 ½x11 inch map showing locations of all monitoring wells and piezometers.

Please mail completed for to: Iowa Department of Natural Resources, Land Quality Bureau, 502 E 9th St, Des Moines IA 50319-0034.

Questions? Call or Email: Nina Koger, Environmental Engineer Sr., 515-281-8986, Nina.Koger@dnr.iowa.gov

ELEVATIONS: ± 0.01 ft MSL
DEPTHS: ± 0.1 ft FROM GROUND SURFACE

SPACE TO ATTACH ENTIRE SOIL BORING LOG
(SHOW SCREENED INTERVAL AND FILTER PACK INTERVAL.)

TOP OF PROTECTIVE CASING
ELEVATION 1117.86

TOP OF WELL CASING
ELEVATION 1117.88

GROUND SURFACE
ELEVATION 1114.67

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION 1114.67
DEPTH 0.0'

BASE OF PROTECTIVE CASING
ELEVATION 1112.13
DEPTH 3.81'

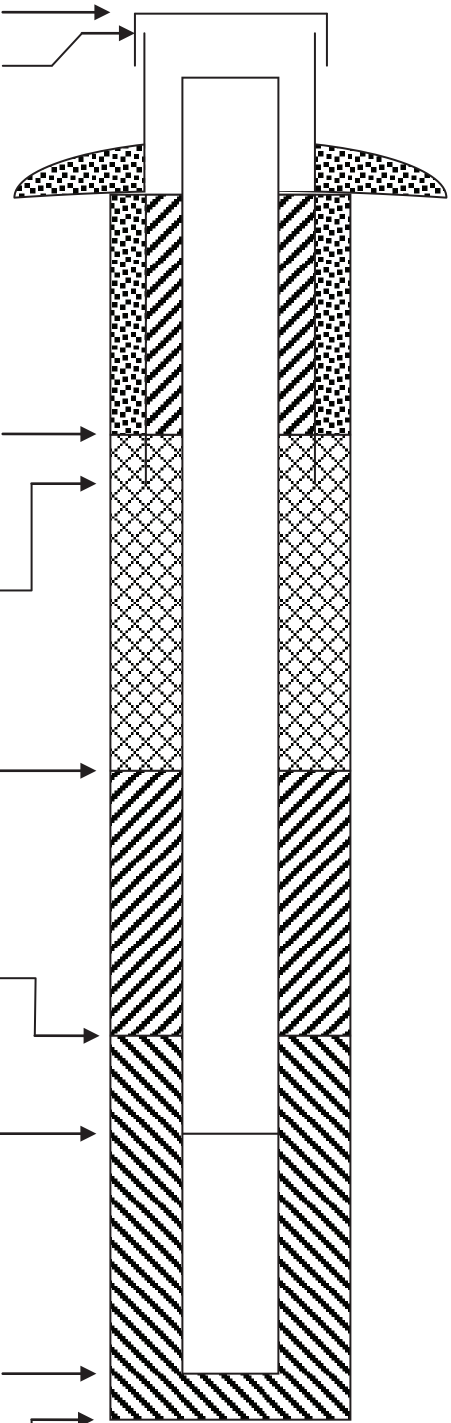
BASE OF BACKFILL
TOP OF SEAL
ELEVATION 1109.67
DEPTH 5.0'

TOP OF FILTER PACK
BASE OF SEAL
ELEVATION 1109.67
DEPTH 5.0'

TOP OF SCREEN
ELEVATION 1107.67
DEPTH 7'

BOTTOM OF SCREEN
ELEVATION 1097.67
DEPTH 17.0'

BASE OF FILTER PACK
ELEVATION 1097.67
DEPTH 17.0'



Appendix A-15 – 2023 – Boring Logs and Monitoring Well Construction Documentation

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-45**

SITE: **Winneshiek Co. LF** PROJECT NO. **60711359** SHEET **1** OF **2**

SITE #: **96-SDP-1-74P**

		WATER LEVEL READINGS		
	DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
PHYSICAL SETTING: **North of Cell 5EXP**	11/7/2023	9.17	20	16
LOG BY: **R. Henning**				
FIRM/DRILLER: **Terracon/D. Cleary**				
DRILLING METHOD: **3 1/4-in. HSA to EOB; 2-in x 2-ft SS**				

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1145.13**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3915302.2**

EASTING: **5409077.77**

DATE/TIME STARTED: **11/06/23 ; 1440**

DATE/TIME COMPLETED: **11/06/23 ; 1524**

WELL INSTALLATION: **11/6/2023**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 3 3 4	6		40	1	SS		FILL	QUATERNARY ANTHROPOCENE FILL. medium; dark brown (10YR 3/3); dry to moist; LEAN CLAY (CL); nonplastic; noncohesive; bedded; with plant roots; top soil
	1 2 3 4	5		60	2	SS		FILL	medium, mottled light brownish gray to brownish yellow (10 YR 6/2 to 6/8); LEAN CLAY (CL); moist, low plasticity; cohesive, bedded, FILL.
5	WH 1 2 2	3		45	3	SS		ML	QUATERNARY WISCONSINAN EPISODE PEORIA LOESS. soft; mottled light brownish gray to brownish yellow (10 YR 6/2 to 6/6); SILT (ML); wet; nonplastic; noncohesive; bedded, LOESS; top of water table.
	WH 1 1 2	2		85	4	SS		ML	very soft; as above; rooted.
	1 1 2 2	3		75	5	SS		ML	soft; as above; saturated.
10	2 4 4 5	8		65	6	SS		ML	medium; gray (10 YR 6/1); SILT (ML); wet; nonplastic; noncohesive; bedded; LOESS.
	2 3 4 5	7		80	7	SS		ML	as above 12 - 12.5 ft.
								CL	QUATERNARY, WISCONSINAN EPISODE, COLLUVIUM. medium; gray (10 YR 6/1); LEAN CLAY (CL); wet; low plasticity; cohesive; massive; weathered ; Maquoketa Shale.
15	2 3 4 4	7		100	8	SS		CL	medium; as above 14 - 16 ft.
	2 3 4 4	7		100	9	SS		CL	medium; as above 16 -18 ft.
	1 3 5 6	8		100	10	SS		CL	medium; as above 18 - 20 ft.

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 03/26/24, 09:11

Continued Next Page

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-45**

SITE: **Winneshiek Co. LF** PROJECT NO. **60711359** SHEET **2** OF **2**

Depth in Feet	B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
20	1 3 4 7	7		100	11	SS		CL	medium; as above 20 - 22 ft.
									EOB at 22 ft BGS for split spoon; 20 ft for bottom of auger. Install monitoring well MW-45A.
25									
30									
35									
40									

Tracking Codes: 60635552_MW.GPJ, ETSOIL, 03/26/24, 09:11

AECOM

FINAL SOIL BORING LOG

BORING NO. **B-46**

SITE: **Winneshiek Co. LF** PROJECT NO. **60711359** SHEET **1** OF **1**

SITE #: **96-SDP-1-74P**

	WATER LEVEL READINGS			
	DATE	WATER DEPTH	HOLE DEPTH	CASING DEPTH
PHYSICAL SETTING: **North of Cell 5EXP**	11/7/2023	9.22	15.5	15.5
LOG BY: **R. Henning**				
FIRM/DRILLER: **Terracon/D. Cleary**				
DRILLING METHOD: **3 1/4-in. HSA to EOB; 2-in x 2-ft SS**				

ABANDONMENT DATE: **NA**

ABANDONMENT METHOD: **NA**

GROUND SURFACE ELEV: **1128.04**

Iowa State Plane LOCAL COORDINATES:

NORTHING: **3915412.4**

EASTING: **5409593.45**

DATE/TIME STARTED: **11/06/23 ; 1440**

DATE/TIME COMPLETED: **11/06/23 ; 1215**

WELL INSTALLATION: **11/6/2023**

Depth in Feet	SAMPLING DATA B	N	A	% Recovery	No.	T	Graphic Log	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS
0	2 3 3 6	6		50	1	SS		FILL	QUATERNARY ANTHROPOCENE FILL. medium; very pale brown (10 YR 7/4); LEAN CLay (CL); dry; nonplastic; noncohesive; bedded; OU; mottles. FILL.
	3 4 3 3	7		20	2	SS		FILL	medium; dark brown (10 YR 3/3); LEAN CLAY (CL); dry; nonplastic; noncohesive; bedded; mottles; FILL.
5	2 2 2 3	4		40	3	SS		ML	QUATERNARY WISCONSINAN EPISODE PEORIA LOESS. soft; very dark grayish brown (10 YR 3/2); SILT (ML); dry; nonplastic; noncohesive; bedded; UU; topsoil; LOESS.
	1 1 1 2	2		60	4	SS		ML	very soft; mottled brownish yellow to light brownish gray (10 YR 6/8 to 6/2); SILT (ML); wet; nonplastic; cohesive; bedded; UU; water table; LOESS.
	1 1 4 2	5		75	5	SS		CL	medium; mottled brownish yellow to light brownish gray (10 YR 6/8 to 6/2); LEAN CLAY (CL); wet; low plasticity; cohesive; bedded; UU; LOESS.
10	2 3 4 5	7		45	6	SS		CL	QUATERNARY, WISCONSINAN EPISODE, COLLUVIUM. medium; light yellowish brown (10 YR 6/4); LEAN CLAY with GRAVEL (CL); wet; low plasticity; cohesive; bedded; colluvium of weathered Maquoketa claystone.
	4 5 5 50/4"	10		25	7	SS		CL	stiff; light olive brown (2.5 Y 5/3) to dark olive brown (2.5 Y 3/3); LEAN CLAY with GRAVEL (CL); wet; low plasticity; cohesive; bedded; Galena Limestone colluvium.
15	18 50/1"	>50		25	8	SS		SW	QUATERNARY, WISCONSINAN EPISODE, ALLUVIUM. very dense; pale brown (10 YR 6/3); WELL GRADED SAND (SW); wet; nonplastic; noncohesie; bedded; coarse grained sand; well rounded; grains shale; granite; quartz; GLACIOFLUVIAL.
									EOB; auger refusal at 15.5 ft.; Install well MW-46A.

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: Winneshiek Co. Landfill   Permit No.: 96-SDP-1-74P

Well/Piezometer No.: MW-45A   Date Started: 11/6/2023   Date Completed: 11/6/2023

Applicable Requirements[1]: ☒ 567 IAC 113 ☐ 567 IAC 115 ☐ Site Permit ☐ 567 IAC 114 ☐ 567 IAC 139 ☐ Other:

A. SURVEYED LOCATION[2] AND ELEVATION OF POINT

Elevations (MSL): Ground Surface: 1145.13   Top of Protective Casing: 1148.03

Top of Well Casing: 1147.69

Site Coordinates: Northing: 3915302.200   Easting: 5409077.770

World Coordinates: Latitude: 43.2264740458   Longitude: -91.6696046387

Elevation and Coordinate Systems: IA State Plane

B. SOIL BORING INFORMATION

Certified Well Contractor: Terracon

Address: 3105 Capital Way, Suite 5   City, State, Zip Code: Cedar Falls, IA 50613

Name of driller: Dave Cleary   Cert No. 9351

Drilling method: 3 1/4 HSA   Drilling fluid: none   Bore hole diameter: 7 1/4-in

Soil sampling method: 2-in x 2-ft split spoon   Depth of boring: 22 feet

C. MONITORING WELL INSTALLATION

Casing material: SCH 40 PVC

Length of casing: 9.13

Casing diameter: 2.375-in O.D.; 2.067-in I.D.

Casing joint type: flush, o-ring

Casing/screen joint type: flush, o-ring

Screen material: SCH 40 PVC

Screen opening size: No. 10 slot

Screen length: 10-ft

Depth of Well: 19.13 feet

Filter Pack: Industrial Sand Coarse Grain

Material: BMC Aggregates L.C.

Grain Size: 0.3 - 0.6 mm

Quantity: 29 gal (4 cu. ft.)

Seal (minimum 3 ft. length above filter pack): 5 feet

Material: Baroid 3/8-in Holeplug

Placement method: gravity

Quantity: 9.6 gal (1.3 cu. ft.)

Backfill (if different from seal): none

Material:

Placement method:

Quantity:

Surface seal design: 3/8-in Holeplug

Material of protective casing: 7-ft x 4-in sq. steel

Material of grout between protective casing and well casing: 3/8-in Holeplug

Protective cap: Torquer 2-in PVC plug

Material: Koby Environmental

Vented?: ☐ Y ☒ N   Locking?: ☐ Y ☐ N

Well cap: PVC

Material: Johnson Screens

Vented?: ☐ Y ☒ N

D. GROUNDWATER MEASUREMENT (±0.01 foot below top of inner well casing)

Water level: 9.17 feet   Stabilization time: 24-hr

Well development method: 3-ft stainless steel bailer; Proactive PVC Monsoon Pump

Average depth of frost line: 5-ft

[1] Refer to the site's permit to determine applicable requirements. Note that some sites may only be regulated by their permit versus current landfill chapters. If the permit and rule are silent regarding applicable requirements, then 567 IAC Chapter 39 shall apply, which requires use of the Well Log (Well Record) Form, not this form. If the applicable requirements have been modified and approved by the DNR, then note under Other.

[2] The location does not need to be surveyed by a licensed surveyor. A handheld GPS reading accurate to +/- 30 feet is acceptable when an aerial photograph showing the location (pin) is included with this form. The site coordinates should be the same coordinate system currently used for survey control and mapping of the site.

DRILLER'S CERTIFICATION

I certify under penalty of law I believe the information reported above is true, accurate, and complete.

Signature ______________________ **Certification #** ____________ **Date** __________

Note: Attach well log, boring log, and map showing new monitoring well/piezometer location in relation to existing wells or piezometers.

Complete one form for each well plugged and submit within 30 days to the local county agent, DNR project officer, and Erik Day with the DNR's Water Supply Section at erik.day@dnr.iowa.gov. DNR prefers that the forms be completed and submitted electronically.

Well and Boring Logs

Elevations: ±0.01 ft. MSL

Depths: ±0.1 ft from Ground Surface

Top of protective casing (TOP)
Elevation C 1148.03

Top of Well Casing (TOC)
Elevation B 1147.69

Ground surface (GS)
Elevation A 1145.13

Depth Use 0

Top of backfill
Base of concrete plug and bentonite grout
Elevation A-W 1145.13
Depth W 0

Base of Protective Casing
Elevation C-A = 1141.03
Depth PC-C-A = 4.1

Base of Backfill, Top of Seal
Elevation A-X = 1145.13
Depth X 0

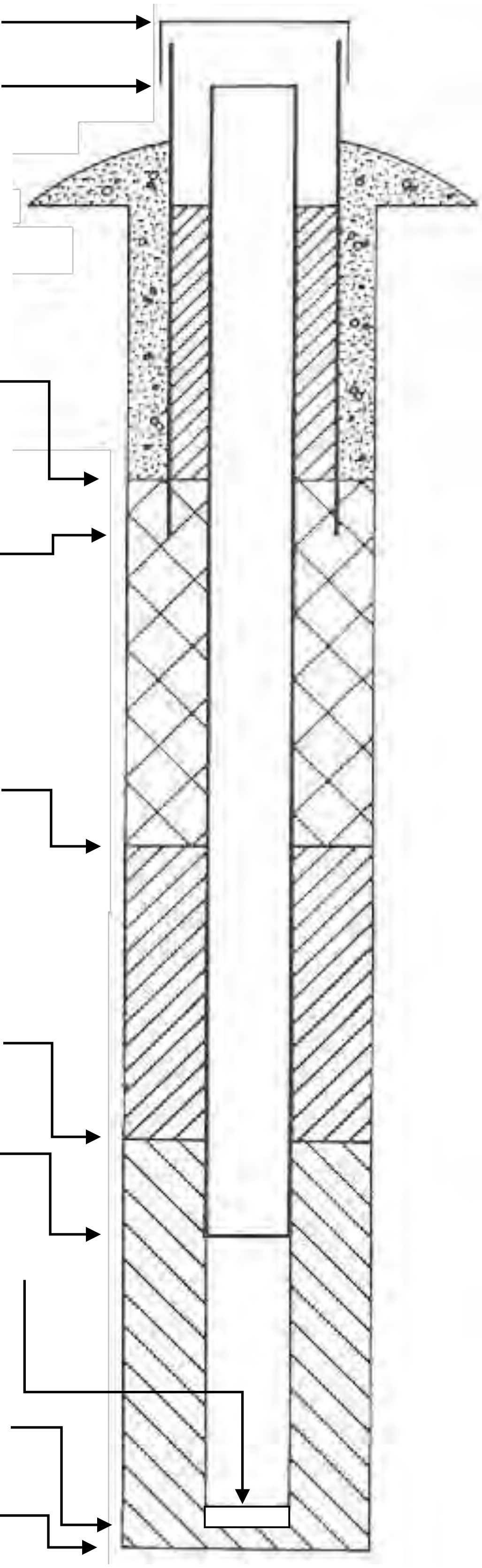
Top of Filter Pack, Base of Seal
Elevation A-Y = 1140.13
Depth Y 5

Top of Screen (TOS)
Elevation B-TD-S-WP = 1139.1
Depth A-TOS^{elev} = 6

Bottom of Screen (BOS)
Elevation B-TD-WP = 1129.13
Depth A-BOS^{elev} = 16

Bottom of Well
Elevation 1128.56
Depth 16.57

Bottom of Filter Pack
Elevation A-Z = 1125.13
Depth Z 20.0



Required Data:

- Elevations for A, B, and C shall be surveyed.
- Depths for W, X, Y, and Z shall be field measured following completion of each item.
- Lengths of the Protective Casing (PC), Screen (S), and Well Point (WP) shall be field measured prior to installation of each item.
- The total Depth (TD) from the Top of Well Casing to the Bottom of Well Point shall be field measured following installation.

PC: 7 S: 10
WP: 0.3 TD: 19.13

MONITORING WELL / PIEZOMETER CONSTRUCTION DOCUMENTATION FORM

Disposal Site Name: Winneshiek Co. Landfill
Permit No.: 96-SDP-1-74P
Well/Piezometer No.: MW-45A
Date Started: 11/6/2023
Date Completed: 11/6/2023
Applicable Requirements[1]: ☒ 567 IAC 113 ☐ 567 IAC 115 ☐ Site Permit ☐ 567 IAC 114 ☐ 567 IAC 139 ☐ Other:

A. SURVEYED LOCATION[2] AND ELEVATION OF POINT

Elevations (MSL): Ground Surface: 1145.13
Top of Protective Casing: 1148.03
Top of Well Casing: 1147.69
Site Coordinates: Northing: 3915302.200 Easting: 5409077.770
World Coordinates: Latitude: 43.2264740458 Longitude: -91.6696046387
Elevation and Coordinate Systems: IA State Plane

B. SOIL BORING INFORMATION

Certified Well Contractor: Terracon
Address: 3105 Capital Way, Suite 5
City, State, Zip Code: Cedar Falls, IA 50613
Name of driller: Dave Cleary
Cert No.: 9351
Drilling method: 3 1/4 HSA
Drilling fluid: none
Bore hole diameter: 7 1/4-in
Soil sampling method: 2-in x 2-ft split spoon
Depth of boring: 22 feet

C. MONITORING WELL INSTALLATION

Casing material: SCH 40 PVC
Length of casing: 9.13
Casing diameter: 2.375-in O.D.; 2.067-in I.D.
Casing joint type: flush, o-ring
Casing/screen joint type: flush, o-ring
Screen material: SCH 40 PVC
Screen opening size: No. 10 slot
Screen length: 10-ft
Depth of Well: 19.13 feet
Filter Pack: Industrial Sand Coarse Grain
Material: BMC Aggregates L.C.
Grain Size: 0.3 - 0.6 mm
Quantity: 29 gal (4 cu. ft.)
Seal (minimum 3 ft. length above filter pack): 5 feet
Material: Baroid 3/8-in Holeplug

Placement method: gravity
Quantity: 9.6 gal (1.3 cu. ft.)
Backfill (if different from seal): none
Material:
Placement method:
Quantity:
Surface seal design: 3/8-in Holeplug
Material of protective casing: 7-ft x 4-in sq. steel
Material of grout between protective casing and well casing: 3/8-in Holeplug
Protective cap: Torquer 2-in PVC plug
Material: Koby Environmental
Vented?: ☐ Y ☒ N Locking?: ☐ Y ☐ N
Well cap: PVC
Material: Johnson Screens
Vented?: ☐ Y ☒ N

D. GROUNDWATER MEASUREMENT (±0.01 foot below top of inner well casing)

Water level: 9.17 feet
Stabilization time: 24-hr
Well development method: 3-ft stainless steel bailer; Proactive PVC Monsoon Pump
Average depth of frost line: 5-ft

---

[1] Refer to the site's permit to determine applicable requirements. Note that some sites may only be regulated by their permit versus current landfill chapters. If the permit and rule are silent regarding applicable requirements, then 567 IAC Chapter 39 shall apply, which requires use of the Well Log (Well Record) Form, not this form. If the applicable requirements have been modified and approved by the DNR, then note under Other.

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I certify under penalty of law I believe the information reported above is true, accurate, and complete.

Signature ____________________ **Certification #** ____________ **Date** __________

Note: Attach well log, boring log, and map showing new monitoring well/piezometer location in relation to existing wells or piezometers.

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Ground surface (GS)
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Depth Use 0

Top of backfill
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Elevation A-W 1145.13
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Depth X 0

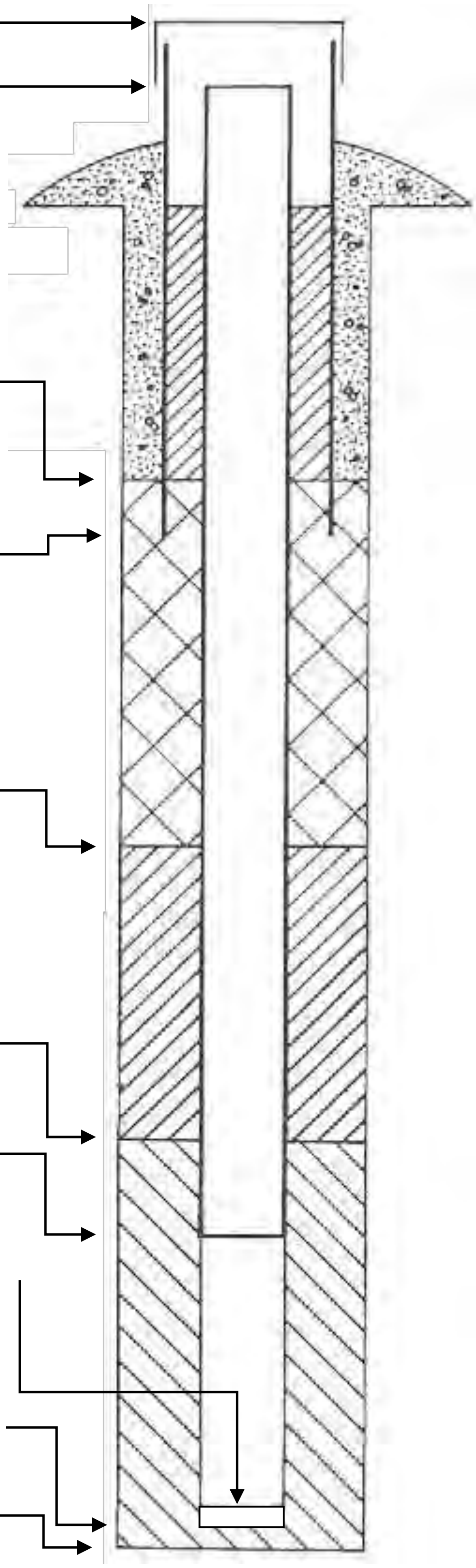
Top of Filter Pack, Base of Seal
Elevation A-Y = 1140.13
Depth Y 5

Top of Screen (TOS)
Elevation B-TD-S-WP = 1139.1
Depth $A\text{-}TOS^{elev}$ = 6

Bottom of Screen (BOS)
Elevation B-TD-WP = 1129.13
Depth $A\text{-}BOS^{elev}$ = 16

Bottom of Well
Elevation 1128.56
Depth 16.57

Bottom of Filter Pack
Elevation A-Z = 1125.13
Depth Z 20.0



Required Data:

- Elevations for A, B, and C shall be surveyed.
- Depths for W, X, Y, and Z shall be field measured following completion of each item.
- Lengths of the Protective Casing (PC), Screen (S), and Well Point (WP) shall be field measured prior to installation of each item.
- The total Depth (TD) from the Top of Well Casing to the Bottom of Well Point shall be field measured following installation.

PC: 7
S: 10
WP: 0.3
TD: 19.13

3105 Capital Way
Cedar Falls, IA 50613
P (319) 277-4016
F (319) 277-4320
Terracon.com

Date: November 13, 2023

Winneshiek County Solid Waste Agency
201 West Main Street
Decorah, Iowa 52101

Attention: TJ Schissel

Re: Winneshiek County Landfill

Project No. 13237075

We are transmitting ☒ herewith ☐ under separate cover

Item	Date	Description
1		Monitoring Well Abandonment Forms (MW-21AR, MW-5AR, MW-II-3, MW-28A)
2		2023 Monitoring Well Location Map for Winneshiek County Landfill provided by AECOM

Remarks:

If you have any questions regarding this information, please contact Dave Cleary at 319-277-4016. Thank you

Yours truly,
Terracon Consultants, Inc.

By:
Dave Cleary

Dave Cleary

Copies to: Address (email)
Mr. Russ Henning, AECOM (email)

IOWA DEPARTMENT OF NATURAL RESOURCES

Abandoned Water Well
Plugging Record

1. **Owner:**

Name: Winneshiek County Solid Waste Agency Phone: 563-381-4073

Address: 201 West Main Street

City: Decorah State: Iowa Zip: 52101

If this was a Public Water Supply Well, please provide:

PWSID Name: ______ PWSID Number: ______

2. **Location of Well (Cistern):**

NE ¼ of, NW ¼ of, NE ¼ of, Section 16 , T 97 N, R 07 ☐ East ☒ West

County: Winneshiek Describe well location on property: See attached Monitoring Well Location Map

GPS Well Location: Latitude: 43.2262142 Longitude: -91.6698493

3. **Well Description:**

Well depth: 79.7 ft

Depth to water none ft.

Casing depth: 79.7 ft. Casing Material: ☐ Steel ☒ Plastic ☐ Concrete ☐ Clay ☐ Brick ☐ Stone

Casing diameter: 2 in.

Year or decade constructed: 1990's Type of Construction: ☒ Drilled ☐ Driven ☐ Bored ☐ Augured ☐ Dug

Is this a Monitoring Well? ☒ Yes ☐ No Well ID: MW-21AR

Check if Cistern ☐ Depth: ______ ft. Diameter: ______ ft.

I certify this well has been plugged as required by rule 567-39.8 of the Iowa Administrative Code (IAC). I agree to provide any additional information the county or department may need concerning this well.

Signature of Owner ______ Date Plugged: 11/7/2023

If plugged by certified well contractor, complete this box:

I have plugged this well as required by rule 567-39.8 of the Iowa Administrative Code (IAC).

Signature of Contractor: Dave Ely Cert No: 9351

OR, If plugged by well owner, complete this box:

The property owner has plugged this well following requirements in rule 567-39.8 of the Iowa Administrative Code (IAC) with the oversight and assistance of the designated county agent.

Signature of County Agent: ______ Date Approved: ______

Eligible for Grants-to-Counties cost share: ☐ Yes ☐ No (Determined by County Agent)

Complete one form for each well plugged and submit within 30 days to the local county agent:

OR, only if no county agent is available, to:

	Water Supply Section **Iowa Department of Natural Resources** **502 E 9th St** **Des Moines IA 50319-0034**

IOWA DEPARTMENT OF NATURAL RESOURCES

Abandoned Water Well
Plugging Record

1. **Owner:**

Name: Winneshiek County Solid Waste Agency Phone: 563-381-4073

Address: 201 West Main Street

City: Decorah State: Iowa Zip: 52101

If this was a Public Water Supply Well, please provide:

PWSID Name: ____________ PWSID Number: ____________

2. **Location of Well (Cistern):**

NE ¼ of, NW ¼ of, NE ¼ of, Section 16 , T 97 N, R 07 ☐ East ☒ West

County: Winneshiek Describe well location on property: See attached Monitoring Well Location Map

GPS Well Location: Latitude: 43.2262142 Longitude: -91.6698493

3. **Well Description:**

Well depth: 23.85 ft

Depth to water 13.77 ft.

Casing depth: 23.85 ft. Casing Material: ☐ Steel ☒ Plastic ☐ Concrete ☐ Clay ☐ Brick ☐ Stone

Casing diameter: 2 in.

Year or decade constructed: 1990's Type of Construction: ☒ Drilled ☐ Driven ☐ Bored ☐ Augured ☐ Dug

Is this a Monitoring Well? ☒ Yes ☐ No Well ID: MW-5AR

Check if Cistern ☐ Depth: ______ ft. Diameter: ______ ft.

I certify this well has been plugged as required by rule 567-39.8 of the Iowa Administrative Code (IAC). I agree to provide any additional information the county or department may need concerning this well.

Signature of Owner ____________ Date Plugged: 11/6/2023

If plugged by certified well contractor, complete this box:

I have plugged this well as required by rule 567-39.8 of the Iowa Administrative Code (IAC).

Signature of Contractor: Dave Ey Cert No: 9351

OR, If plugged by well owner, complete this box:

The property owner has plugged this well following requirements in rule 567-39.8 of the Iowa Administrative Code (IAC) with the oversight and assistance of the designated county agent.

Signature of County Agent: ____________ Date Approved: ____________

Eligible for Grants-to-Counties cost share: ☐ Yes ☐ No (Determined by County Agent)

Complete one form for each well plugged and submit within 30 days to the local county agent:

OR, only if no county agent is available, to:

	Water Supply Section **Iowa Department of Natural Resources** **502 E 9th St** **Des Moines IA 50319-0034**

IOWA DEPARTMENT OF NATURAL RESOURCES

Abandoned Water Well Plugging Record

1. Owner:

Name: Winneshiek County Solid Waste Agency   Phone: 563-381-4073

Address: 201 West Main Street

City: Decorah   State: Iowa   Zip: 52101

If this was a Public Water Supply Well, please provide:

PWSID Name: ____   PWSID Number: ____

2. Location of Well (Cistern):

NW ¼ of, SW ¼ of, NE ¼ of, Section 16 , T 97 N, R 07 ☐ East ☒ West

County: Winneshiek   Describe well location on property: See attached Monitoring Well Location Map

GPS Well Location: Latitude: 43.2213378   Longitude: -91.6699178

3. Well Description:

Well depth: 17 ft

Depth to water none ft.

Casing depth: 17 ft.   Casing Material: ☐ Steel ☒ Plastic ☐ Concrete ☐ Clay ☐ Brick ☐ Stone

Casing diameter: 2 in.

Year or decade constructed: 1990's   Type of Construction: ☒ Drilled ☐ Driven ☐ Bored ☐ Augured ☐ Dug

Is this a Monitoring Well? ☒ Yes ☐ No   Well ID: MW-28A

Check if Cistern ☐   Depth: ____ ft.   Diameter: ____ ft.

I certify this well has been plugged as required by rule 567-39.8 of the Iowa Administrative Code (IAC). I agree to provide any additional information the county or department may need concerning this well.

Signature of Owner ____   Date Plugged: 11/7/2023

If plugged by certified well contractor, complete this box:

I have plugged this well as required by rule 567-39.8 of the Iowa Administrative Code (IAC).

Signature of Contractor: Dave Cy   Cert No: 9351

OR, If plugged by well owner, complete this box:

The property owner has plugged this well following requirements in rule 567-39.8 of the Iowa Administrative Code (IAC) with the oversight and assistance of the designated county agent.

Signature of County Agent: ____   Date Approved: ____

Eligible for Grants-to-Counties cost share: ☐ Yes ☐ No (Determined by County Agent)

Complete one form for each well plugged and submit within 30 days to the local county agent: OR, only if no county agent is available, to:

	Water Supply Section **Iowa Department of Natural Resources** **502 E 9th St** **Des Moines IA 50319-0034**

IOWA DEPARTMENT OF NATURAL RESOURCES

Abandoned Water Well
Plugging Record

1. **Owner:**

Name: Winneshiek County Solid Waste Agency Phone: 563-381-4073

Address: 201 West Main Street

City: Decorah State: Iowa Zip: 52101

If this was a Public Water Supply Well, please provide:

PWSID Name: ______ PWSID Number: ______

2. **Location of Well (Cistern):**

SW ¼ of, SE ¼ of, SE ¼ of, Section 9, T 97 N, R 07 ☐ East ☒ West

County: Winneshiek Describe well location on property: See attached Monitoring Well Location Map

GPS Well Location: Latitude: 43.2267806 Longitude: -91.6676864

3. **Well Description:**

Well depth: 16.55 ft

Depth to water 8.73 ft.

Casing depth: 16.55 ft. Casing Material: ☐ Steel ☒ Plastic ☐ Concrete ☐ Clay ☐ Brick ☐ Stone

Casing diameter: 2 in.

Year or decade constructed: 1990's Type of Construction: ☒ Drilled ☐ Driven ☐ Bored ☐ Augured ☐ Dug

Is this a Monitoring Well? ☒ Yes ☐ No Well ID: MW-II-3

Check if Cistern ☐ Depth: ______ ft. Diameter: ______ ft.

I certify this well has been plugged as required by rule 567-39.8 of the Iowa Administrative Code (IAC). I agree to provide any additional information the county or department may need concerning this well.

Signature of Owner ______ Date Plugged: 11/6/2023

If plugged by certified well contractor, complete this box:

I have plugged this well as required by rule 567-39.8 of the Iowa Administrative Code (IAC).

Signature of Contractor: [signature] Cert No: 9351

OR, If plugged by well owner, complete this box:

The property owner has plugged this well following requirements in rule 567-39.8 of the Iowa Administrative Code (IAC) with the oversight and assistance of the designated county agent.

Signature of County Agent: ______ Date Approved: ______

Eligible for Grants-to-Counties cost share: ☐ Yes ☐ No (Determined by County Agent)

Complete one form for each well plugged and submit within 30 days to the local county agent:

OR, only if no county agent is available, to:

Water Supply Section
Iowa Department of Natural Resources
502 E 9th St
Des Moines IA 50319-0034

Appendix B – Example Field Water Elevation Form

AECOM

Water Elevation

Project No.: ____ Site: ____

Well Number	Elevation of Top of Pipe	Depth to Water	Water Elevation	Depth to Bottom	Well Integrity				Comments
					Locked	Capped	Cracked	Obstruct	

Description of Site: ____

Soil Conditions: ____

Weather: ____ Temperature: ______________________________

Entered on Computer: ___________ Signature: ____ Date: ________________

AECOM

Daily Time Log

Date: ___________/_________/_____

Sat. Sun. Mon. Tues. Weds. Thurs. Fri.

Site: ________________________________ Project No.: __________

Weather: ____

Task/Equipment: ____

Firm/Contractor's Personnel: ________________________________ Hrs On-Site: __________

AECOM Personnel: ________________________________ Hrs On-Site: __________

Site Visitor: ____

Time Log indicating work in progress, remarks:

0600-0630 ____

0630-0700 ____

0700-0730 ____

0730-0800 ____

0800-0830 ____

0830-0900 ____

0900-0930 ____

0930-1000 ____

1000-1030 ____

1030-1100 ____

1100-1130 ____

1130-1200 ____

1200-1230 ____

1230-1300 ____

1300-1330 ____

1330-1400 ____

1400-1430 ____

1430-1500 ____

1500-1530 ____

1530-1600 ____

1600-1630 ____

1630-1700 ____

1700-1730 ____

1730-1800 ____

Items requiring follow up: ____

____

____

Appendix C – Example Well Purging Form

AECOM

Field Meter Instrument Calibration Log

Project No.: ________________________________ Site: _________________________ Date: ________________

Name / Signature of personnel conducting calibration: ____

INSTRUMENT	BRAND	MODEL #	SERIAL #	LAST SERVICED
Water Level Indicator				

INSTRUMENT	BRAND	MODEL #	SERIAL #	CALIBRATED
DO Meter	In-Situ	Aqua Troll 500		

Air Temperature ° C	Calibrated Air (mg/L)	Reading Air (mg/L)

INSTRUMENT	BRAND	MODEL #	SERIAL #	CALIBRATED
Turbidity Meter	In-Situ	Aqua Troll 500		

True Value of Standard:	Actual Reading:	Corrected to:

INSTRUMENT	BRAND	MODEL #	SERIAL #	CALIBRATED
pH/Cond./ORP Meter	In-Situ	Aqua Troll 500		

CONDUCTIVITY (μs)		
True Value of Standard:	Actual Reading:	Corrected to:

pH		
True Value of Standard:	Actual Reading:	Corrected to:
7		
4		

INSTRUMENT	BRAND	MODEL #	SERIAL #	CALIBRATED

True Value of Gas	Actual Reading:	Corrected to:
Open Air		
Isobutylene 100 PPM		

Comments: ____

____

____

____

____

Well Purging and Sampling Collection

Site: ______________________ Well ID: ______________________

Weather Conditions: ______________________ Project No.:______________________

Sample Method (circle one): Pumped Other: _____________ Bailed

Pump Type: (circle one) 0.85" dia. SS Bladder SS Mega-Monsoon 0.675" dia. SS Bladder Other:_______________

Day 1 Date:_________________

Pre-Purge Depth to Water: ____________feet Time: _______

Post-Purge Depth to Water: ___________feet Time: _______

Pump Dial Setting: ______________ Flow Rate: ____________

Total Purge Volume (actual): ____________________ gallons
(At least 1x the total purge volume calculated below needs to be removed prior to sampling)

Day 2 (for wells pumped/bailed dry) Date:_____________

Pre-Purge Depth to Water: ____________feet Time: ________

Post-Purge Depth to Water: ___________ feet Time:________

Total Purge Volume: _____________________ gallons

Total Purge Volume Calculation:

$\mathbf{h_s}$ = Stabilized/Max Drawdown Height = ___________feet

$\mathbf{h_t}$ = Length of Tubing in Well = __________feet

S = Drawdown Volume (2" diameter well) = 0.163 gallons/ft x $\mathbf{h_s}$ = ___________ gallons

P = Bladder Pump (3/16" diameter) Tubing Volume (Gallons) = 0.0014 gallons/ft x $\mathbf{h_t}$ = ____________gallons
Or
P = SS Submersible Pump (3/8" diameter) Tubing Volume (Gallons) = 0.006 gallons/ft x $\mathbf{h_t}$ = ____________gallons

T = Total Purge Volume (Gallons) = **S** + **P** = ________________ gallons

Depth to Bottom: ________________ feet Time: ________ (measure after sample has been collected)

Field parameters will also be recorded with the low flow sampling system.

Date	Time	Depth to Water (D.T.W.)	Volume Removed (Gal.)	pH	Cond.	Temp.	Color	Turbidity	Dissolved Oxygen	Oxidation-Reduction Potential

Comments:

Duplicate - Sample ID.:____________ Time: ___________

Field Blank - Sample ID.:___________ Time: __________

(If no quality control samples were collected cross-out, initial, and date)

Signature:

Date:

Observe Conditions at the Well

Well ID: ____________________ Date: ________________

The following checklist should be used to assess well integrity. A checkmark for each item signifies completion; comments should be added if appropriate.

- ☐ Physical surroundings (e.g. high vegetation, standing water, nearby activities, etc.):
  ____
- ☐ Condition of guard posts: ____
- ☐ Condition of surface seal, if visible. (e.g. concrete cracked, raised, , loose, etc.): ___________________________
- ☐ Condition of protective casing (e.g. extensive rust, broken hinge, loose): ______________________________
- ☐ Well Security (locked/unlocked, lock broken, etc.): ____________________________________
- ☐ Evidence of contamination (e.g., animal or insect parts, recently painted, etc.):
  ____
- ☐ Any obstruction or kinks in the well casing (observed while lowering pump): ________________________
- ☐ Condition of well casing (e.g. intact, cracked, split, etc.): ________________________________
- ☐ Observation or evidence from bailing/pumping of sediment in well: ______________________

Other Notes:

Appendix D – Example Chain of Custody Form

Eurofins TestAmerica, Cedar Falls
704 Enterprise Drive

Cedar Falls, IA 50613
phone 319.277.2401 fax 319.277.2425

Chain of Custody Record

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☑ Other: **Iowa DNR**

TestAmerica Laboratories, Inc. d/b/a Eurofins TestAmerica

Client Contact	Project Manager: Christopher Oelkers	Site Contact:	Date:	COC No:
AECOM	Email: Christopher.Oelkers@aecom.com	Lab Contact:	Carrier:	______ of ______ COCs
501 Sycamore St., Suite 222	Tel/Fax: (319)232-6531/(319)232-0271			Sampler:
Waterloo, IA 50703	**Analysis Turnaround Time**			**For Lab Use Only:**
(319)232-6531 Phone	☑ CALENDAR DAYS ☐ WORKING DAYS			Walk-in Client:
(319)232-0271 FAX	TAT if different from Below ______			Lab Sampling:
Project Name: Groundwater Monitoring	☑ 2 weeks			
Site: Winneshiek County Landfill	☐ 1 week			Job / SDG No.:
P O #	☐ 2 days			
	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	TSS, Lab Turbidity	Appendix I Metals and VOCs	Sample Specific Notes:
MWII-1			G	GW		N		X	X	
MW-1R			G	GW		N		X	X	
MW-1			G	GW		N		X	X	
MW-2R			G	GW		N		X	X	
MW-3			G	GW		N		X	X	
MW-4			G	GW		N		X	X	
MW-4B			G	GW		N		X	X	
MW-5AR			G	GW		N		X	X	
MW-7A			G	GW		N		X	X	
MW-8A			G	GW		N		X	X	

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ______________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for__________ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (°C): Obs'd:_________ Corr'd:__________ Therm ID No.:____________

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time: