Gude Landfill Remediation Design
Basis of Design
Montgomery County, Maryland

100% Submission

Prepared for

Northeast Maryland Waste Disposal Authority and
Montgomery County Department of Environmental Protection
Recycling and Resource Management Division
Montgomery County, Maryland

Prepared by

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December 2020
EA Project No. 15646.01

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LIST OF ACRONYMS AND ABBREVIATIONS

ACM	Assessment of Corrective Measures
the Authority	Northeast Maryland Waste Disposal Authority
Balter	The Robert B. Balter Company
cfm	Cubic feet per minute
CMA	Corrective Measure Alternative
COMAR	Code of Maryland Regulations
the County	Montgomery County Department of Environmental Protection, Recycling and Resource Management Division
DPS	Montgomery County Department of Permitting Services
EA	EA Engineering, Science, and Technology, Inc., PBC
EPA	U.S. Environmental Protection Agency
Floura Teeter	Floura Teeter Landscape Architects
ft	Foot (feet)
in.	Inch(es)
the Landfill	Gude Landfill
LFG	Landfill gas
LFGE	Landfill gas-to-energy
MDE	Maryland Department of the Environment
M-NCPPC	Maryland-National Capital Park and Planning Commission
PVC	Polyvinyl chloride
RAOs	Remedial Action Objectives
scfm	Standard cubic feet per minute
TGOS	Temporary gabion outlet structures
TIS	Traffic Impact Study

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EXECUTIVE SUMMARY

This report constitutes the basis of design for the Gude Landfill Remediation Design project. The report documents the project objectives, assumptions, requirements, technical determinations, and overall decisions made or to be made in the development of the final design.

The project includes engineering, permitting, and support services for addressing the Remedial Action Objectives at the Gude Landfill (the Landfill) in order to achieve compliance with the consent order for the Landfill (Maryland Department of the Environment [MDE] Case Number CO-11-SW-036) (MDE and Montgomery County 2013). The Landfill is owned and managed by the Montgomery County Department of Environmental Protection, Recycling and Resource Management Division (the County).

The EA Engineering, Science, and Technology, Inc., PBC team performed survey, utility location, geotechnical investigation, natural resource fieldwork, a traffic impact study, and a landfill gas (LFG) investigation to gather information to be used in the design.

The proposed design includes capping of the upper surface and portions of the side slopes of the Landfill, to address maximum contaminant level exceedances in groundwater, as well as leachate seeps and LFG lower explosive limit exceedances. The LFG collection system will be reconstructed in phases to ensure continuous LFG collection across the site. The LFG collection system will include modifications to existing extraction wells and the installation of new extraction wells to provide additional control over gas migration along the property boundary to prevent lower explosive limit exceedances for methane gas.

Waste relocated from the northwest slope will be placed on top of the Landfill to increase the slope of the ground surface to promote positive drainage. The relocated waste will be used for regrading activities to achieve subgrade elevations. The waste material will be compacted and any protruding objects that could damage the closure cap will be removed. Areas with waste placement will be compacted and covered with a minimum of 1 foot (ft) of soil, prior to placement of the closure cap.

The closure cap section will consist of an 8-ounce nonwoven needle-punched geotextile, a 40-mil textured linear low-density polyethylene geomembrane, and a 300-mil geocomposite. An alternate closure cap section may be selected by the County. The alternate closure cap section uses a material that combines the geomembrane and geocomposite drainage layer instead of using two separate materials. The closure cap will be overlain by a 1-ft 8-inch (in.) vegetative support soil and 4 in. of topsoil.

The Landfill grading will improve drainage on top of the Landfill by increasing the slopes from the existing condition to the final condition. Drainage on the upper surface of the Landfill is conveyed primarily by a network of open channel swales. The swales convey drainage to existing stormdrain networks along the perimeter of the Landfill. Stormwater runoff on the west and northwest slope will be conveyed by benches and downchutes to a swale at the base of the slope.

A facility has been designed at the low point of the swale to discharge stormwater as sheet flow offsite to match existing conditions.

The design includes a phased construction approach. Two series of phases have been developed for construction. Subgrade construction has been divided into seven phases (S-I through S-VII). Closure cap construction has been divided into six phases (F-I through F-VI).

The proposed LFG collection system will consist of extraction wells (existing and proposed) with well heads for monitoring and control, new below-grade collection system piping (including laterals and header piping, and isolation valves), new condensate drains, and the existing blower-flare facility with enclosed flares, blowers, and condensate knockout. A phased approach to the LFG collection system construction is also proposed.

Future land uses at the Landfill will include passive recreational facilities and may include renewable energy development. The future land uses were selected based on the Authority/County's goals and input from stakeholders. The passive recreation land use design has been incorporated into the Contract Documents.

1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA) has been contracted to provide engineering, permitting, and support services for addressing the Remedial Action Objectives (RAOs) at the Gude Landfill (the Landfill) in order to achieve compliance with the consent order for the Landfill (MDE Case Number CO-11-SW-036) (Maryland Department of the Environment [MDE] and Montgomery County 2013). This design report serves as the basis of design and documents the project objectives, assumptions, requirements, technical determinations, and overall decisions made or to be made in the development of the final design.

1.1 PROJECT OBJECTIVES

The consent order for the Landfill establishes the following RAOs:

- No exceedances of maximum contaminant levels, established by the U.S. Environmental Protection Agency (EPA) as limits for drinking water, in the groundwater at the Landfill property boundary or between the Landfill and adjacent streams;

- No lower explosive limit exceedances for methane gas at the Landfill property boundary; and

- No non-stormwater discharges to the waters of the State.

EA developed an Assessment of Corrective Measures (ACM) Report (EA 2016) to identify a recommended Corrective Measure Alternative (CMA) for the Montgomery County Department of Environmental Protection, Recycling and Resource Management Division (the County) to meet regulatory compliance requirements at the Landfill. Based on the results of the evaluation presented in the ACM Report, MDE approved the recommended CMA, toupee capping and additional landfill gas (LFG) collection. This CMA includes the following components:

- Construction of a toupee closure cap over the top of the Landfill (inclusive of the Northwest, West, Southwest, South, and Southeast Areas), as well as the Landfill side-slopes in the Northwest and West Areas; and

- Construction/installation of additional LFG Collection in the Northwest, West, and Southwest Areas.

Landfill capping was selected as a corrective measure for the Landfill upper surface, as well as portions of the side-slopes of the Landfill, to address maximum contaminant level exceedances in groundwater, as well as leachate seeps and LFG lower explosive limit exceedances in the Northwest and West Areas. The LFG collection system will be reconstructed in phases to ensure continuous LFG collection across the site. Existing monitoring points for the landfill, such as groundwater monitoring wells and LFG perimeter probes, along the limits of disturbance will be protected and maintained. The LFG collection system will include modifications to existing extraction wells and the installation of new extraction wells to provide additional control over gas migration along the property boundary to prevent lower explosive limit exceedances for methane gas.

1.2 BACKGROUND

1.2.1 Site Location and Overview

The Landfill is located at 600 East Gude Drive, Rockville, Maryland 20850. The site is accessed at two locations: East Gude Drive from the south-southwest and Southlawn Lane via Incinerator Lane from the east-southeast.

The Landfill is currently owned and maintained by the County Department of Environmental Protection. The Landfill was used for the disposal of municipal solid waste and incinerator residues from 1964 to 1982. The Landfill property encompasses approximately 162 acres, of which approximately 140 acres were used for waste disposal. An additional 17 acres of waste disposal area were delineated in 2009 on Maryland-National Capital Park and Planning Commission (M-NCPPC) property, beyond the northeastern property boundary of the Landfill. A land exchange between the County and M-NCPPC on October 21, 2014, transferred ownership of this additional waste disposal area to the County in exchange for a similar area of land without waste, which was transferred to M-NCPPC.

1.2.2 Site and Surrounding Area Land Use

The typical ground cover across the Landfill site is open grassy fields with patches of brushy vegetation and trees on most side slopes and along the perimeter borders of the Landfill. The existing LFG collection and conveyance system, including the flare station, gas extraction wells and wellheads, and gas conveyance piping, is situated above grade on the Landfill's ground surface. Six perched liquid dewatering sumps are located below grade on the northwest portion of the upper surface of the Landfill. The site also has a limited area on the top of the Landfill that was designated for flying model airplanes and a concrete pad near the Southlawn Lane facility entrance road that is used for managing storm-related debris.

The surrounding area and properties adjacent to the Landfill have mixed uses including parkland, industrial property, and residential development. Specifically, the adjacent land areas consist of:

- M-NCPPC land and Crabbs Branch Stream (north and northeast);
- Asphalt and cement production facilities, equipment storage yards, scrap metal recycling facilities, and Southlawn Lane (east and southeast);
- East Gude Drive, the 600 East Gude Drive campus (formerly occupied by County Coalition for the Homeless shelter and Community Ministries of Rockville men's shelter), WSSC Water property and Southlawn Branch Stream (southwest and south and southeast); and

- Transcontinental (Williams Gas)/Columbia Gas natural gas pipeline right-of-way and the community of Derwood Station residential development (west and northwest).

1.2.3 Site History

The Landfill was constructed and operated prior to current solid waste management disposal and facility design and closure standards that were implemented by EPA, under the Resource Conservation and Recovery Act. Therefore, the Landfill was not originally constructed with a geosynthetic liner or compacted clay bottom liner, a leachate collection system, an LFG collection system, or a stormwater management system. Reportedly, soil was used as daily cover during waste filling, and a 2-foot (ft) (minimum) final layer of soil was reportedly placed over the waste mass during closure of the Landfill (in 1982) to support the vegetative cover.

Since 1982, the County has voluntarily, or through regulatory mandates, implemented and maintained Best Management Practices for pre-regulatory era landfills to ensure compliance with Code of Maryland Regulations (COMAR) requirements. These Best Management Practices include: soil and vegetative cover system installation, cover system maintenance, leachate seep repairs, LFG collection system installation and maintenance, water quality and LFG monitoring, and stormwater infrastructure. The County currently maintains an active LFG collection and conveyance system including: flares, over 100 gas extraction wells, and horizontal gas conveyance piping. A network of onsite and offsite groundwater monitoring wells; a network of onsite LFG monitoring wells; environmental monitoring programs for groundwater, surface water, and LFG; and stormwater are also maintained for the Landfill site.

1.3 ENVIRONMENTAL INFORMATION

1.3.1 Topography

The site topography of the Landfill is plateau-like and consists of gentle relief (i.e., slope) along the top of the waste-mass and sharp relief along the perimeter property boundary. The elevation along the top of the plateau gently slopes to the south, with localized mounds and depressions throughout. The side-slope falls sharply from the top of the waste-mass to elevations ranging from 55 to 90 ft below the plateau.

1.3.2 Geology

The Landfill is located in central Montgomery County, Maryland, within the upland section of the Piedmont Plateau physiographic province (Maryland Geological Survey 1968; Trapp and Horn 1997). The geology in the upland section of the Piedmont Plateau physiographic province primarily consists of metamorphic and igneous rock formations of Paleozoic and Precambrian age. The Piedmont Plateau is underlain by an assortment of phyllite, slate, marble, schist, gneiss, and gabbro formations. Unconsolidated material overlying bedrock is present at the surface in the vicinity of the Landfill site and extends 20 to 60 ft below ground surface. Based on available groundwater monitoring well construction logs from ATEC Associates Inc. (1988) and more recent boring logs (EA 2010 and 2011), the unconsolidated material consists primarily of silt and clay.

1.3.3 Hydrogeologic Setting

The uplands section of the Piedmont is underlain by three principle types of bedrock aquifers: crystalline-rock and undifferentiated sedimentary-rock aquifers, aquifers in early Mesozoic basins, and carbonate-rock aquifers (Trapp and Horn 1997). The Landfill is underlain by the crystalline rock aquifer that extends over approximately 86 percent of the Piedmont Plateau Physiographic Province. At the Landfill, the crystalline rock that comprises the regional aquifer is overlain by unconsolidated material consisting of interbedded silts and clays and saprolite. Recorded logs from onsite and offsite borings for the groundwater monitoring wells correlated well with these general geological descriptions.

Based on information from site boring logs and well gauging, groundwater is present in the unconsolidated material, as well as the bedrock at the Landfill site. The groundwater table is typically present in the unconsolidated material along the perimeter of the Landfill and under the Derwood Station development, at depths ranging from approximately 3 to 60 ft below ground surface. Groundwater recharge at the Landfill is variable and is primarily determined by precipitation and runoff. Topographic relief, unconsolidated material, and surface recharge variations created by the Landfill may significantly affect the groundwater flow.

Groundwater flow is highly dependent on the composition and grain size of the sediments, and therefore water likely moves more readily in the unconsolidated material than in the underlying bedrock. Groundwater in the bedrock (typically 20 to 60 ft below grade) is stored in, and moves through, fractures. No documentation of the degree of fracturing or orientation of bedrock fractures at the Landfill is available.

The site topography and the natural cover system (grassy surface and soil layer) of the Landfill may allow surface water infiltration. Some of the infiltrating water likely moves vertically into the bedrock, while a portion also moves laterally along the boundary between the unconsolidated material and the surface of the bedrock and discharges to nearby streams and surface depressions.

1.3.4 Groundwater Flow

Based on the data collected from new and existing groundwater monitoring wells, including temporary groundwater monitoring wells, the groundwater flow direction was inferred. The data indicated that groundwater flows in an easterly flow direction across the Landfill site, with minor northerly, northeasterly, and southeasterly flow components.

1.4 DESIGN CONTRACT REQUIREMENTS

As part of EA's design contract, EA has developed quality and communication plans to document the approach to different aspects of the project.

EA developed a project-specific Quality Management Plan based on its Corporate Quality Management Plan. This plan includes detailed roles and responsibilities for all levels of staff.

A project-specific Communication Plan has been developed to identify communications pathways throughout the project. This Plan will be updated as necessary through the life of the project.

EA has developed a Stakeholder Engagement Plan that includes a list of stakeholders from the County, the Northeast Maryland Waste Disposal Authority (the Authority), Gude Landfill Concerned Citizens, Derwood community, neighboring businesses, and regulatory personnel from MDE, M-NCPPC, and the Montgomery County Department of Permitting Services (DPS). The plan also includes a communication framework that is designed to continue to build community, share information, develop a framework of understanding, and obtain input on the project.

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2. PRE-DESIGN INVESTIGATION

2.1 SITE SPECIFIC HEALTH AND SAFETY PLAN

EA developed a site-specific Health and Safety Plan to address worker safety associated with planned field activities. A Site Safety Officer will be provided during all fieldwork performed during the course of the project. The Health and Safety Plan was prepared with the oversight by a Certified Industrial Hygienist and is in compliance with the Occupational Safety and Health Administration and EA's Corporate Health and Safety Plan. All field personnel are required to review the document and sign the review record located within the plan. The Site Safety Officer will also highlight the contents of the plan with field staff prior to beginning fieldwork as has historically been performed with work at the Landfill. The plan includes site communications, confined space avoidance, site hazards, personal protective equipment, and vehicle safety information, as required by the Occupational Safety and Health Administration.

2.2 SURVEY

EA's subcontractor, Wallace Montgomery, performed an aerial flyover and field-run topographic survey of the site in May/June 2018. This work is an update to the survey performed by Wallace Montgomery in 2015, and focuses on providing the most accurate existing conditions, for use as the base mapping in the design documents and estimating material quantities. The aerial survey provided updated mapping for identifiable physical and topographic features, while the field-run survey supplemented items not completely captured by the aerial survey. The horizontal control for the project is relative to the North American Datum of 1983 and the vertical control is relative to the North American Vertical Datum of 1988. A copy of the sealed survey drawings is included in **Attachment A**.

Wallace Montgomery also field surveyed 17 locations across the upper surface of the Landfill in December 2020 to support EA's evaluation of settlement. Wallace Montgomery will survey the elevations at the same locations prior to construction. Discussion of EA's settlement analysis is included in Section 4.2.1.

2.3 UTILITY LOCATION

EA subcontracted Master Locators of Baltimore to provide utility designation and mapping services. Master Locators performed utility designation and mapping using electromagnetic and ground-penetrating radar. Master Locators identified natural gas, electric, communications, sanitary sewer, storm drainage, and water lines within the scope of work boundaries and approximate Landfill property line. A copy of the utility locating report is included in **Attachment B**.

2.4 GEOTECHNICAL INVESTIGATIONS

EA installed four temporary piezometers in 2015 to verify the depth of waste and groundwater within the Landfill footprint in order to determine potential performance of toupee capping as the approved CMA. Cover soil ranged from 5 to 10 ft in depth, with the majority consisting of brown, silty, median grain sandy fill. The more recent LFG extraction well logs also document varying depths of cover soil along the northwest slope, ranging from 2 ft in some locations to greater than 10 ft in areas closer to the access road.

As part of the design of the toupee cap for the Landfill, a geotechnical investigation was required to obtain additional information to characterize the existing cover system, waste mass location (depth to waste), and subsurface conditions across the Landfill site.

The Robert B. Balter Company (Balter) performed test pits across the Landfill to identify the thickness and properties of the existing cover soil in July 2018. Bulk samples of representative soils were recovered for laboratory evaluation. Laboratory analysis included soil classification according to the Unified Soils Classification System, moisture content analysis, sieve gradation analysis, Atterberg limits determination, and modified Proctor tests. Existing cover soil thicknesses ranged from 1.5 to 8 ft. The existing cover soils were found to consist of sand and silt mixtures, sand and clay mixtures, and clays. Discussion on how the results of the test pitting investigation were used in the design is included in Section 4.5.1.1. A copy of the geotechnical evaluation report is included in **Attachment C**.

A second geotechnical evaluation was performed in October 2020 by Balter to further characterize the existing soils at the site. Three Standard Penetration Test borings were performed along the northwest slope of the Landfill to support the global slope stability analysis. The global slope stability analysis is discussed in Section 4.2.3. A copy of the geotechnical evaluation report is included in **Attachment C**.

Six bulk soil samples from the existing Purple Line stockpile were also collected and tested to compare material properties with the specified material properties for the closure. The test results generally met the specifications and indicate the soil can likely be used for the project. Additional soil testing will be performed during construction to verify the soil meets the specification for its intended use. Based on the test results, use of the soil has been incorporated in the cost estimate.

2.5 NATIONAL RESOURCE INVENTORY/FOREST STAND DELINEATION/ FOREST CONSERVATION PLAN

EA conducted a Natural Resource Inventory including a full Forest Stand Delineation and a Wetland Delineation to identify the existing resources at the project site and within the first 200 ft of adjoining land. Narratives were prepared to include discussion on the site conditions, methodology, site photographs, data forms, figures, and agency correspondence. The Forest Stand Delineation and Wetland Delineation were approved by M-NCPPC in August 2019. The Forest Stand Delineation Report and the Wetland Delineation Report are included in **Attachment D**.

A Forest Conservation Plan was developed to support the permitting and project review process following the guidelines provided by Montgomery County and the State of Maryland. The Forest Conservation Plan addresses the forest resources within the project area to remain undisturbed and the mechanisms for their protection. The Forest Conservation Plan also includes details on the reforestation and/or afforestation requirements that may be associated with the proposed design. The Forest Conservation Plan is currently under review by M-NCPPC.

2.6 TRAFFIC IMPACT STUDY

EA's subcontractor T3 Design was contracted to perform a Traffic Impact Study (TIS) for the project. This study includes data collection, analysis, and preparation of a TIS. The TIS documents existing traffic conditions along Southlawn Lane and East Gude Drive near the Landfill. The TIS also evaluates projected future traffic conditions and models the traffic impacts based on volume of construction vehicles for the remediation project activities. The TIS is included as **Attachment E**. Requirements for a traffic control plan were developed and included in the Contract Documents, as part of the Project Manual.

2.7 LANDFILL GAS INVESTIGATION

The MDE-Approved CMA is for toupee capping and additional LFG collection, specifically identified for the Northwest, West, and Southwest Areas of the Landfill. In addition to areas identified for proposed LFG extraction wells, existing LFG extraction wells needed to be evaluated. The original LFG collection system and landfill gas-to-energy (LFGE) facility at the Gude Landfill became operational in 1985, with the enclosed flare installed in 2005, and expansion of the collection system occurring through 2008. The current LFGE system was connected to the grid in 2009, and subsequently ceased operations on June 1, 2017. Since 2008, an additional 27 LFG extraction wells were installed, mainly to assist with LFG migration in the Northwest, West, and Southwest Areas. EA reviewed the operational history, data, and issues with the system as part of the Nature and Extent Study. An LFG technical memorandum is included in **Attachment F**.

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3. APPLICABLE REGULATIONS

A Permit Compliance Report has been prepared to present the permits and approvals that are required for the project, the reviewing agencies for each permit, and a description of the permit application process with anticipated timelines. The Permit Compliance Report is included in **Attachment H**.

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4. DESIGN ELEMENTS

The following section details the assumptions, design considerations, and determinations associated with the Landfill remediation design.

4.1 STAGING AND STOCKPILE AREAS

Staging areas will be required to accommodate the contactor's office trailers, the owner and construction management engineer's trailer, employee parking, and equipment and non-soil material storage. Stockpile areas will be required for soil and aggregate storage. There is not enough area for staging and stockpiling at the site outside of the limit of disturbance; therefore, these areas will be located on the Landfill. An administration area is proposed for the location of the existing LFGE facility. Activities for this area will be limited to contactor's, and the owner and construction management engineer's office trailers and employee parking. No earthmoving equipment will be stored at the administration area. The existing concrete pad on the east side of Incinerator Lane on the upper surface of the Landfill has been identified as an initial staging area for equipment and non-soil material storage. The Contractor will need to perform improvements to the area to remove low spots where water currently ponds and provide necessary erosion and sediment controls for the area. The location of the initial staging area is identified on Contract Drawing C-122. This area may be used for staging for the majority of the project but will eventually be removed to accommodate closure cap construction in that area. Stockpile areas have not been identified on the Contract Drawings because the Contractor will have the flexibility to choose temporary stockpile locations for each phase of work. Locations of the staging and stockpile areas may change as the construction progresses. Re-locating staging and stockpile areas will increase the cost of the project, so the design is intended to minimize the need to re-locate them.

4.2 GRADING AND DRAINAGE

Based on the results of the evaluation presented in the ACM Report, the approved CMA is toupee capping and additional LFG collection. Toupee capping would decrease the volume of leachate generated due to the reduction of infiltration on the top of the Landfill.

To meet the RAOs for LFG migration and leachate seep control, the capping system will extend along the northwest and west slopes of the Landfill. The Landfill waste currently extends to the property boundary on the northwest and west sides; therefore, to accommodate the Landfill cap and to provide for vehicular access, drainage control, and tree planting along the northwest and west slopes, waste relocation and regrading will be required in this area.

The remaining perimeter of the Landfill, on the north, east, and south sides, consists of steep slopes with dense tree cover, both of which significantly reduce rainwater infiltration potential, thus reducing potential leachate generation. These slopes will not be disturbed during construction. This is consistent with the approved CMA presented in the ACM Report.

Waste relocated from the northwest slope will be placed on top of the Landfill to increase the slope of the ground surface to promote positive drainage. The relocated waste will be used for regrading activities to achieve subgrade elevations. The waste material will be compacted and any protruding objects that could damage the closure cap will be removed. Areas with waste placement will be compacted and covered with a minimum of 1 ft of soil, prior to placement of the closure cap.

MDE has previously indicated verbally that reconfiguration of waste onsite is acceptable as part of this project. During the 30 percent design meeting with MDE in November 2018, waste relocation was discussed and documented in the presentation and meeting minutes. Additional grading and relocation of waste will be required to meet the proposed grades and promote adequate drainage.

The proposed grading plan requires both excavation and fill. A primary consideration in developing the grading was balancing the cut and fill to minimize the need to bring soil from offsite to meet the proposed grades. Regrading onsite material is more sustainable and less costly than hauling in soil from offsite. The grading plan has been optimized to balance the excavation and fill quantities below the cap geosynthetics to the greatest extent practicable.

4.2.1 Settlement

The surface of the Landfill continues to settle as pockets of waste decompose and the waste above it ravels and shifts, adjusting to constantly changing pressures. Settlement of a waste mass like the Landfill cannot be predicted with typical geotechnical investigation and analysis techniques because the waste mass is heterogeneous and its properties cannot be sufficiently measured to accurately estimate the varying settlement across the Landfill. Settlement during construction may impact the material quantities so it is critical that it is considered in developing the measurement and payment items for the construction contract.

4.2.1.1 Historic Settlement

EA evaluated historic settlement by analyzing aerial surveys of the Landfill from 2009, 2015, and 2018 to estimate the magnitude of settlement that has occurred at the Landfill during that time. It was estimated that ongoing settlement of the landfill is approximately 30,000 cubic yards per year.

EA identified 17 locations across the upper surface of the Landfill that historically had higher rates of settlement. EA's subcontractor, Wallace Montgomery, field surveyed these locations in December 2020. EA compared the elevations of the surveyed points to the elevations of the same locations in the 2009, 2015, and 2018 surveys. The elevations indicate that the Landfill continues to settle. The ground surface elevation only increased in the area of the Purple Line stockpile where material had been stockpiled between the surveys (2018 and 2020). The rate of settlement from 2018 to 2020 ranges from 40 to 90 percent of the rate of settlement from 2009 to 2018. There are too few data points to draw definitive conclusions, but this likely indicates a reduction in the rate of settlement over time. The historic settlement analysis is included in **Attachment I**.

Wallace Montgomery will survey the same locations in the Spring/Summer of 2021 prior to construction to evaluate elevation changes.

The rate of historic settlement was considered in developing the grading plans for the project. The grading plans account for the potential future settlement before and during construction and roughly balance the cut and fill during waste excavation and relocation activities. Some common borrow soil may be required to meet the regraded waste elevations before the closure cap subgrade is constructed.

4.2.1.2 Landfill Settlement Due to Cap Construction

The project includes areas of waste excavation and waste placement, which will result in increased Landfill surface slopes and promote better drainage from the Landfill surface after capping. The thickness of waste excavation and waste placement will vary across the site and will result in differential settlement of the Landfill.

Settlement of the Landfill was estimated using the methodology from “Settlement of Waste Disposal Fills” by George Sowers (1973). Settlement was estimated at locations that would result in the most significant differential settlement that would reduce Landfill surface slopes and potentially impact drainage. The calculations are included in **Attachment I** and show that the Landfill slopes may be reduced by approximately 0.3 percent in the most critical condition. Based on the available information, the long-term settlement of the Landfill is not anticipated to adversely affect drainage of surface water from the Landfill.

4.2.1.3 Future Settlement Monitoring

The Contractor will install settlement plates to document the settlement of the Landfill during the post-closure period. The plan includes the placement of settlement plates at key locations across the top of the Landfill. The locations were chosen to monitor potential changes to drainage patterns and potential stresses in the Landfill capping system components.

4.2.2 Drainage

The Landfill grading will improve drainage on top of the Landfill by increasing the slopes from the existing condition to the final condition. Analysis of the existing and proposed grades is shown in attached figures, **Figure 1** and **Figure 2**, respectively. **Table 1** presents the reduction of flatter slope areas from the existing condition to the final condition.

Table 1 Slope Areas

Slope Range	Existing (square feet)	Proposed (square feet)	Reduction in Area (percent)
Slope Area Between 0% and 1%	452,444	53,972	88
Slope Area Between 1% and 2%	901,909	258,835	71
Slope Area Between 2% and 3%	1,089,640	656,271	49
Slope Area Between 3% and 4%	1,058,397	558,996	47
Total			
Slope Area Between 0% and 4%	3,502,390	1,528,074	56

The grading approach considers existing drainage patterns. The grading has been developed such that the pre-development runoff characteristics are maintained to the greatest extent practicable after development.

Drainage on the upper surface of the Landfill is conveyed primarily by a network of open channel swales. The swales convey drainage to existing stormdrain networks along the perimeter of the Landfill. Stormwater runoff on the west and northwest slope will be conveyed by benches and downchutes to a swale at the base of the slope. A facility has been designed at the low point of the swale to discharge stormwater as sheet flow offsite.

Downchutes will be constructed with gabion baskets. EA evaluated using gabion baskets compared to alternative lining methods such as concrete-lined channels. It was determined that the construction costs and performance of both materials were similar. EA is proposing gabion downchutes since they have often been constructed on other Montgomery County sites and maintenance staff will be familiar with maintenance procedures.

4.2.3 Global Slope Stability

A global slope stability analysis was performed to ensure the regraded west and northwest slope will be stable during and after construction. The global factor of safety was calculated using Bishop's Modified Method. The computer program PC STABL (Purdue University 1988) was used to perform the multiple runs necessary to search for and analyze the critical surfaces. Results from the global stability analysis indicate that slope stability is not a concern, and results are included in **Attachment J**. The proposed grading and cap construction included in the current design will not have an impact on the stability of slopes around the remaining perimeter of the Landfill since the slopes will remain undisturbed and increases in Landfill elevation are primarily in the middle of the Landfill and not near the tops of the slopes.

4.3 CONSTRUCTION PHASING

The design includes a phased construction approach. Grading will be limited to 20-acre areas based on the limit imposed by the *2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control*. Two series of phases have been developed for construction. Subgrade construction has been divided into seven phases (S-I through S-VII). Closure cap construction has been divided into six phases (F-I through F-VI). The proposed phases have been defined based on balancing cut and fill of onsite material and based on erosion and sediment control measures as described in Section 4.13. The phases have been defined such that the Contractor must complete the closure cap construction of the west and northwest slope prior to construction on the upper surface and eastern portion of the Landfill.

A phased approach to the LFG collection system construction is also proposed. Additional description about the LFG collection system phasing is included in the sequence of construction on the Contract Drawings.

4.4 WASTE EXCAVATION AND HANDLING

Care must be taken during waste handling to identify any potentially unsafe or hazardous conditions, minimize the migration and infiltration of stormwater into areas of disturbance, prevent migration of non-stormwater discharges (e.g., leachate), prevent oxygen intrusion into the waste mass in areas where the gas system remains active, and minimize odors, dust, and vectors. Specification Section 02 61 13.13 provides detailed requirements for waste excavation and handling, which includes daily covering of waste with tarps or a minimum of 6 inches (in.) of soil, management of any leachate encountered, management of odors and dust, and waste grading and compaction requirements. The specifications include the identification of cover soil, waste, and unusual waste materials.

4.5 CLOSURE CAP

The objective of the Landfill closure cap design is to minimize the impact of the Landfill on the surrounding environment to the greatest extent possible. Landfill capping will minimize the infiltration of stormwater through the waste and the potential migration of LFG and the potential migration and/or discharge of Landfill non-stormwater discharges (e.g., leachate). Several closure cap types are proposed. The type of closure cap proposed varies depending on the location on the Landfill. The cross-sections for the different closure cap types are depicted on the Contract Drawings.

4.5.1 Geosynthetic Closure Cap

The majority of the Landfill will be covered with a geosynthetic closure cap. The components, building up from the subgrade, are described in the following sections.

4.5.1.1 Subgrade

The existing ground will be cleared and grubbed before grading commences. The Contractor will be required to excavate existing cover soil in areas where waste excavation and placement will occur and stockpile that soil to re-cover the waste after it is graded and compacted.

Based on the July 2018 geotechnical evaluation performed by the Robert B. Balter Company, existing cover soil thicknesses at the test pit locations ranged from 1.5 to 8 ft. The test pits indicated cover soil thickness averaged 2 ft and the design requires the Contractor to excavate and segregate 1 ft of existing soil cover. The excavated cover soil will be stockpiled for use as fill material.

One foot of subgrade will be provided over all areas of regraded waste before the cap geosynthetics are placed. The subgrade will be compacted to serve as a stable base for the cap section. The construction documents include quality control provisions to eliminate waste protrusions into the subgrade soil. Specification Section 02 61 13.13, Waste Excavation and Material Handling, includes requirements for compaction of the waste and requirements for any protruding waste to be removed before beginning subgrade construction. Specification Section 31 05 15, Earthwork, includes requirements for closure cap subgrade preparation, including compaction and elimination of any protrusions.

4.5.1.2 Geotextile

An 8-ounce nonwoven needle-punched geotextile will be placed between the subgrade and geomembrane. While not required by COMAR, this layer provides a higher interface friction angle with the subgrade and serves to protect the geomembrane from puncture. A calculation to verify that the proposed geotextile provides adequate puncture resistance is included in the geosynthetics calculations in **Attachment L**.

4.5.1.3 Geomembrane

The geomembrane serves as the impermeable barrier of the cap to prevent transfer of materials both into and out of the closed Landfill. COMAR 26.04.07.21 requires a low-permeability layer within the closure cap and specifies that when using a synthetic material as the cap's low-permeability layer, the material must have a minimum thickness of 20 mil and a maximum permeability of 1×10^{-10} centimeters per second. A 40-mil textured linear low-density polyethylene geomembrane is specified in the design to satisfy this requirement due to its thickness, low permeability, high friction angle, interface cohesion, and durability.

It is imperative that the geomembrane not be punctured when installing the closure cap as this will cause unacceptable material transfer between the Landfill and the exterior environment. Procedures for care during the installation of closure cap materials during construction and minimum puncture strength requirements will be specified in the Technical Specifications.

4.5.1.4 Geocomposite Drainage Layer

A drainage layer is required in a closure cap to provide a means for water that infiltrates through the cover soil to be conveyed to an outlet to prevent an unacceptable buildup of pore pressure within the cover soil. Increased pore pressure can create instability between cap components and cover soil and lead to sloughing. COMAR 26.14.07.21 requires that a drainage layer be installed immediately above the low-permeability layer and allows for filter fabrics and drainage blankets to be used for this purpose.

Calculations were prepared to evaluate the capacity of the proposed geocomposite at multiple locations on the Landfill. It was determined that a 300-mil geocomposite drainage layer is adequate for conveying drainage. These calculations are included in the geosynthetics calculations in **Attachment L**.

4.5.1.5 Vegetative Support Soil

COMAR 26.04.07.21 states that a minimum of 2 ft of earthen cover shall be placed over the drainage layer with a minimum cover slope of 4 percent. The material is required to contain sufficient organic material and nutrients to sustain a vegetative cover over time. A vegetative support soil layer of thickness 1 ft 8 in. with a 4-in. layer of topsoil is specified in the design.

To ensure that the geocomposite drainage layer does not become clogged by the vegetative support soil, the vegetative support soil grain size must be specified based on the apparent opening size of the geocomposite. A calculation for the vegetative support soil grain size is included in the geosynthetics calculations in **Attachment L**.

4.5.1.6 Alternate Geosynthetic Closure Cap Section

An alternate closure cap section is included on the design drawings. The County may elect to have the Contractor use a material that combines the geomembrane and geocomposite drainage layer instead of using two separate materials. EA determined that the 50-mil linear low-density polyethylene Agru MicroDrain product will provide an equivalent drainage capacity and permeability as the standard closure cap section. The drainage layers of both closure cap sections are specified to provide a transmissivity of 7.5×10^{-4} square meters per second. The use of this alternate material has saved construction costs for several landfill sites in Maryland.

4.5.1.7 Geosynthetic Closure Cap Stability

Capping materials were selected to ensure the long-term stability of the cap between the interfaces of the various cap components. A veneer slope stability analysis was performed to confirm an adequate factor of safety using infinite slope and finite slope theory for the closure cap configuration. The critical interfaces were evaluated on the longest slopes of the Landfill.

EA has designed the capping system with a minimum factor of safety of 1.5 for slope stability for each interface as is typical for projects of this nature and magnitude. A calculation for the stability of the Landfill cap is included in the geosynthetics calculations in **Attachment L**.

4.5.2 Vegetative Stabilization

COMAR 26.04.07.21 requires that within 30 days after the final earthen cover has been installed, the area shall be vegetatively stabilized using a perennial cover species recommended by the Soil Conservation District. Seed mixes for permanent vegetative stabilization include native meadow and wildflower species over most of the Landfill area.

4.6 ACCESS ROADS

A network of gravel access roads is proposed for the upper surface of the Landfill. Gravel access roads will either be crowned or superelevated for drainage. Details for the gravel access road sections are included on Contract Drawing C-503.

4.7 LANDFILL GAS MANAGEMENT

4.7.1 Existing System Description

The existing LFG collection and conveyance system at the Landfill consists of a network of vertical LFG extraction wells, with mainly above-grade polyvinyl chloride (PVC) conveyance piping. There are three known sumps within the system for the collection of condensate, which are periodically pumped out, as necessary. The original LFG collection and conveyance system and LFGE facility at the Landfill became operational in 1985, with the enclosed flare installed in 2005, and expansion of the collection system occurring through 2008. The current LFGE system was installed and connected to the grid in 2009, and subsequently ceased operations on June 1, 2017. Since 2008, an additional 27 LFG extraction wells were installed, mainly to assist with LFG migration in the Northwest, West, and Southwest Areas. LFG is currently managed by the two enclosed flares installed in 2005. Details regarding the existing LFG collection system are presented in **Attachment F**.

4.7.2 Anticipated LFG Production

EA used the EPA Landfill Gas Emissions Model (LandGEM) to estimate LFG production to be used as the design basis. This information was used as the basis for determining the required well spacing and the locations for proposed LFG extraction wells. Based on the historical waste disposal records and estimates provided by the County during the preparation of the ACM, the anticipated LFG production was determined. Records indicate that the Landfill received an estimated volume of 5.16 million tons of waste throughout its operational years (1965 to 1982). A conservative capture efficiency of 75 percent was assumed for the EPA LandGEM analysis, which is included in **Attachment F**. The existing capture efficiency was not further evaluated since it is anticipated to vary from the existing due to the installation of a new gas collection and conveyance system and toupee cap. The quality of the gas was utilized as 50 percent methane in the model, although it is anticipated that the captured methane may range from 30 to 50 percent.

In the analysis, projected future LFG flow rates range from 60 to 475 standard cubic feet per minute (scfm) from calendar year 2018 to 2070, with an approximate mean value of 201 scfm (**Figure 3**).

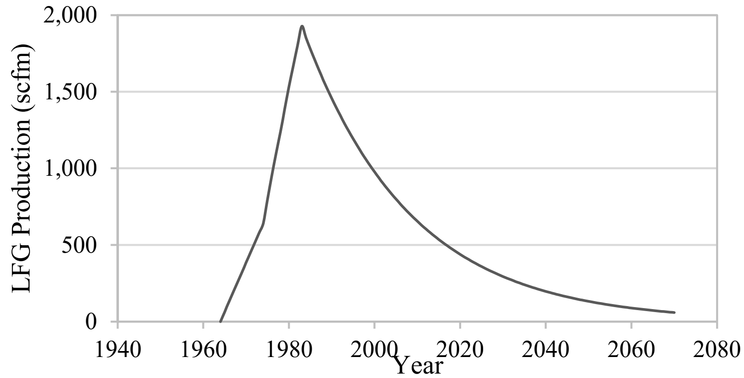

Figure 3 Projected LFG Production from LandGEM Model

Based on the LandGEM results, peak LFG production (1,925 scfm) occurred in 1983, approximately a year after the Landfill stopped accepting waste. The average LFG collection observed from November 2017 to April 2018 was 507 scfm. Due to the general agreement in observed LFG flow with the LandGEM model, an LFG production value of 507 scfm was utilized for the design basis. Based on 2019 monitoring data (January through November) collected by APTIM, the current LFG flow rate as measured at the flare station ranged from 354 to 734 scfm, with an average of 458 scfm. Therefore, 507 scfm is still considered conservative, but within the operational range currently observed.

4.7.3 System Design Details

The proposed LFG collection system will consist of the following primary components:

- Extraction wells (existing and proposed) with well heads for monitoring and control;
- New below-grade collection system piping (including laterals and header piping, and isolation valves);
- New condensate drains; and
- Existing blower-flare facility with:
  - Enclosed flares,
  - Blowers (primary and standby), and
  - Condensate knockout.

The existing LFG collection and conveyance system at the Landfill consists of a network of vertical LFG extraction wells, with mainly above-grade PVC conveyance piping. A substantial portion of the existing extraction well network and collection system of Landfill has been impacted due to the infrastructure age, waste settlement, and above-grade piping, which has been exposed to weather throughout the years. The existing collection system header and lateral piping will be demolished as the collection system will be re-designed and replaced with below-grade collection system piping to be connected with the existing enclosed flare system. Construction is to be phased to allow for the continual operation of the landfill gas collection and conveyance system in a manner that minimizes odors, LFG migration, and oxygen intrusion. The existing condensate sumps, traps, and drains within the Landfill will be disconnected and abandoned; however, a condensate sump located outside of the proposed cap prior to the LFG blower skid will remain. Based on the slope of the finished grade, condensate drains are proposed to be installed at the potential low points of the proposed LFG collection system to manage the condensate generated within the landfill. Additional evaluation of the proposed condensate management within the Landfill and at the blower-flare station is included in **Attachment M**.

4.7.4 Landfill Gas Extraction Well Network

There is currently a total of 116 LFG extraction wells located at the Landfill, 104 of which are operable and are monitored monthly for LFG quality. As of April 2020, 35 of the LFG extraction wells are currently operating in the fully closed position (i.e., no flow). Based on the existing well locations, available methane content, and radius of influence calculation, 72 wells were identified to be utilized after modification and 44 existing extraction wells are scheduled for abandonment, as shown on the Contract Drawings.

Details of existing extraction wells to be abandoned and modified are provided in **Attachment F**. Abandonment of existing extraction wells was based primarily on poor well performance, not on an anticipated reduction in LFG generation.

Twenty wells were investigated to determine their potential to be reused in the proposed LFG collection system. Based on the available methane content in these wells, four wells—EW-4, EW-16, EW-100, and EW-157—were selected to be utilized; the remaining 16 wells were selected to be abandoned (**Attachment F**, Table 7). The existing and proposed LFG extraction wells will have flow control valves and will be connected to a common collection system header.

The placement of the existing extraction wells typically ranges from every 200 to 500 ft in triangular orientation. Well spacing was compared to a calculated radius of influence. Utilizing the current LFG production rate, total waste placement, and average well depth, the approximate radius of influence was calculated (**Attachment N**). The radius of influence was calculated utilizing an EPA method based on the New Source Performance Standard Background Information Document, Appendix E, dated 1991, which takes the depth of the well into account. Additionally, a LFG production of 507 scfm was utilized in the calculation to provide an estimated flow per well. The calculated radius of influence was then used to calculate the well spacing. This calculation yielded a spacing range of 246 ft to 972 ft. Based on the calculated radius of influence range and considering the LFG extraction capacity of the existing system, a conservative typical radius of influence of approximately 150 ft was chosen. New extraction wells will be placed so that the radius of influence is tangential to the perimeter to control any LFG migration off of the waste boundary and also in the interior of the Landfill to control LFG emissions and promote cap stability. Additional wells are proposed along the northwest slope, to the west, and to the northeast to address areas where historical LFG migration has been a concern. Existing wells EW-50, EW-70, EW-105, EW-114, EW-128, and EW-129 were previously selected to be abandoned based on their poor methane content and limited well construction data. Since additional coverage is needed in the areas where these wells are located, these wells are proposed to be modified and reused. Based on the calculated spacing requirement and historical LFG concerns, a total of 33 new extraction wells along with 72 existing wells are required as identified on the Contract Drawings. **Figure 4** (attached) depicts the LFG system layout with an estimated radius of influence for each well.

The vertical extraction wells will be constructed of high-density polyethylene. The bottom portion of the wells will be placed in the waste and is perforated to provide a preferential pathway for the LFG. The upper portion, minimum 20 ft, of the well will be constructed of solid pipe casing to prevent non-LFG intrusion. The perforated interval will be surrounded in the boring with a filter pack or non-calcareous (i.e., non-chemically reactive) aggregate. A bentonite seal will be placed just above the filter pack, native soil or common borrow will be placed and compacted above the filter pack seal, and a membrane boot seal will be created around the geomembrane.

A wellhead will be used to connect the extraction well to the below grade collection system. The wellhead provides flow adjustment, gas monitoring, flow measurement, and leachate extraction, if needed.

Details of the extraction wells and well heads are provided on the Contract Drawings.

4.7.5 Landfill Gas Collection System Piping

The existing LFG collection system is currently positioned on the surface of the Landfill and has been susceptible to damage caused by weather and waste settlement. Buried collection system piping within the Landfill closure cap will provide a better solution to the prevailing issues, given that the Landfill settlement and appropriate slope will be considered in the design for the collection system. The buried LFG collection system will be placed just above the closure cap drainage layer to allow for maintenance without impacting the cap geosynthetics. Trenching details for both inside and outside of the Landfill cap are provided on the Contract Drawings.

The layout of the collection piping is designed to target a minimum 3 percent slope throughout the system to allow for effective condensate drainage; however, the Landfill slopes are flatter than 3 percent in some areas, so there were several isolated areas where 3 percent slope could not be achieved. Based on investigating the historical settlement between 2009 and 2018, the areas of pipe layout less than 3 percent slope are not anticipated to experience significant differential settlement. In areas where settlement has been observed, the slopes were adjusted to be greater than 3 percent when possible. The designed LFG layout consists of approximately 21 percent of the LFG header collection piping at less than 3 percent slope; 8 percent of the header piping is less than 2 percent slope; and the remaining 71 percent header piping is above 3 percent slope. This minimum slope range is based on the final grades and the desire to keep LFG collection piping above the geosynthetic liner. All extraction wells will be connected by lateral pipes and a perimeter looped header pipe. The looped header provides the advantage of self-equalizing or balancing of the vacuum and flow as well as allowing operating personnel to pull LFG from either direction, thus providing flexibility in situations of blockages or header repair. The LFG wells that are located downhill of the header pipe or outside of the Landfill cap are on an extended lateral from the looped header. A modified wellhead is proposed for these remote wells as depicted on the Drawings. The LFG piping will be constructed of SDR 17 high-density polyethylene for its durability and agility in underground installations.

Pipe sizing and pressure drop calculations are provided in **Attachment N**.

4.7.6 Landfill Gas Condensate Collection

As LFG is extracted from the Landfill and transported through the LFG collection system, it gradually cools and a liquid (condensate) is formed. The LFG condensate is primarily made up of water and typically contains minimal quantities of volatile and miscible compounds and can have similar composition to leachate. The layout of the LFG piping is designed to maintain positive drainage to condensate drains in low-lying areas. Where possible, the pipe network is designed so the condensate drainage is oriented with the flow direction of the LFG to minimize pipe surging.

As presented in the Condensate Quantity and Quality Evaluation technical memorandum (**Attachment M**), condensate generated at the Landfill is currently managed with the use of three sumps, several condensate traps, and at least one self-draining condensate trap that currently drains back to the Landfill. Additionally, there is a condensate knockout located at the blower skid that drains to a below-grade condensate sump within the fenced area for the enclosed flares.

As part of the improvements to the LFG collection and conveyance system, the existing condensate sumps, traps, and drains are to be disconnected and abandoned along with the existing above-grade LFG collection system; however, the condensate sumps located outside of the proposed cap located at the inlet to the LFG blower skid will remain. There is a total of 51 condensate drains proposed to be installed at the potential low points of the proposed LFG collection system, based on the slope of the finished grade. The number of condensate drains are to minimize operational issues such as accumulation and blockage of the header pipe due to condensate in areas where the grade of the landfill is less than 3 percent.

A list of proposed condensate drains is provided on the Contract Drawings. The volume of condensate generated can be appropriately managed by the proposed condensate drains and the sump located at the inlet to the blower skid (**Attachment M**).

EA reviewed the existing LFG extraction wells and proposed condensate drain locations to determine potential dry areas where introduction of condensate may generate additional LFG. Dry areas were identified where the drains are in close proximity to the extraction wells that currently contain no water. Since condensate generated from the LFG are proposed to drain back to the landfill, additional LFG generation may occur in these dry areas. Based on the review, 29 condensate drains are located in potential dry areas (**Table 2**).

EA also conducted a sensitivity analysis for the potential production of LFG for the scenario where the waste is either wet or dry; the LFG production rate modeled varied between 356 scfm (wet condition methane generation rate, k=0.05) and 508 scfm (dry condition methane generation rate, k=0.03) in year 2020 (**Figure 5**). For the purposes of the basis of design, EA utilized k = 0.04

based on the Inventory Conventional method since it aligned with the actual LFG production rates at the landfill more closely than other methods. It can be assumed that the differences in moisture content of the waste due to pre- and-post capping conditions, as well as the reintroduction of condensate are not significant enough to impact the overall design and the performance of the landfill gas collection and conveyance system proposed.

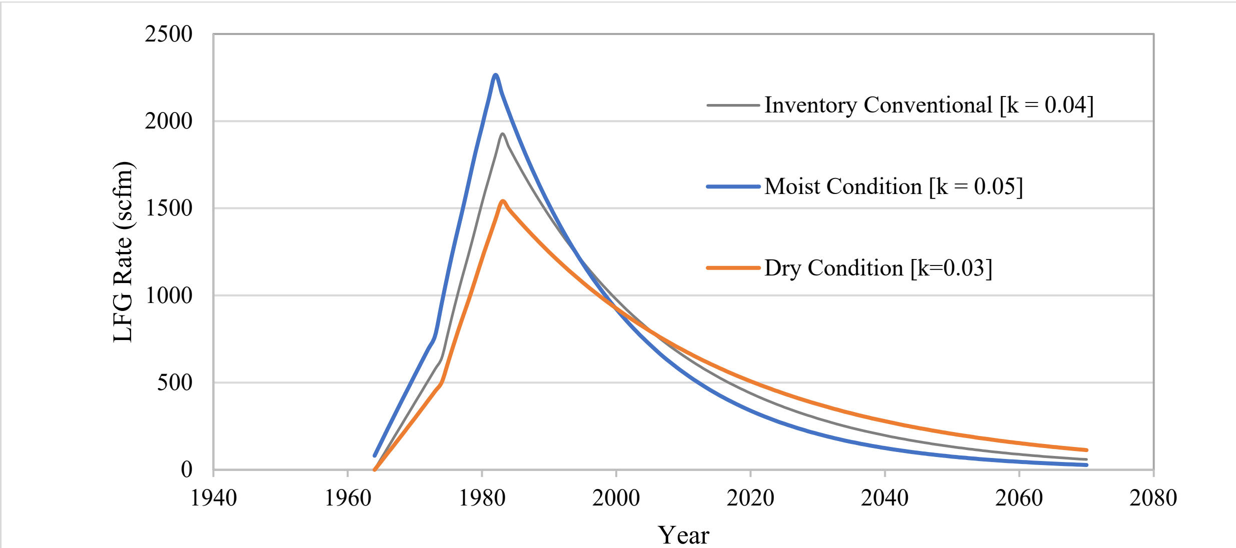

Figure 5 Projected LFG Production Comparison.

Based on overall LFG collection and conveyance system design, it can be concluded that the LFG system is adequately designed and robust enough to handle the additional LFG generation from condensate. Identified potential dry locations are presented in **Figure 6** (attached).

Table 2 Condensate Drain Summary

Condensate Drain No.	Nearest LFG Extraction Wells (square feet)		Additional LFG Generation Anticipated (Yes/No)
	Well ID	Well Condition*	
CD-1	EW-101	High Methane and No Water	Yes
CD-2	EW-101	High Methane and No Water	Yes
CD-3	EW-104	High Methane and Water	No
CD-4	EW-126	High Methane and Water	No
CD-5	EW-14	Low Methane and Water	No
CD-6	EW-129	Low Methane and Water	No
CD-7	EW-110	High Methane and Water	No
CD-8	EW-111	High Methane and Water	No
CD-9	EW-113	High Methane and Water	No
CD-10	EW-114	Low Methane and No Water	Yes
CD-11	EW-12	Abandoned	Yes
CD-12	EW-14	Abandoned	Yes
CD-13	EW-13	Abandoned	Yes
CD-14	EW-13	Abandoned	Yes
CD-15	EW-7	Low Methane and Water	No

Table 2 Condensate Drain Summary

Condensate Drain No.	Nearest LFG Extraction Wells (square feet)		Additional LFG Generation Anticipated (Yes/No)
	Well ID	Well Condition*	
CD-16	EW-15	High Methane and No Water	Yes
CD-17	EW-15	High Methane and No Water	Yes
CD-18	EW-17	High Methane and Water	No
CD-19	EW-20	Abandoned	Yes
CD-20	EW-43	Abandoned	Yes
CD-21	EW-40	Abandoned	Yes
CD-22	EW-40	Abandoned	Yes
CD-23	EW-40	Abandoned	Yes
CD-24	EW-38	High Methane and Water	No
CD-25	EW-35	High Methane and Water	No
CD-26	EW-35	High Methane and Water	No
CD-27	EW-35	High Methane and Water	No
CD-28	EW-35	High Methane and Water	No
CD-29	EW-31	High Methane and No Water	Yes
CD-30	EW-149	High Methane and No Water	Yes
CD-31	EW-149	High Methane and No Water	Yes
CD-32	EW-149	High Methane and No Water	Yes
CD-33	EW-148	Abandoned	Yes
CD-34	EW-145	High Methane and Water	No
CD-35	EW-145	High Methane and Water	No
CD-36	EW-22	High Methane and Water	No
CD-37	EW-21	High Methane and No Water	Yes
CD-38	EW-5	High Methane and No Water	Yes
CD-39	EW-152	High Methane and Water	No
CD-40	EW-36	High Methane and Water	No
CD-41	EW-37	High Methane and No Water	Yes
CD-42	EW-76	High Methane and No Water	Yes
CD-43	EW-37	High Methane and No Water	Yes
CD-44	EW-15	High Methane and No Water	Yes
CD-45	EW-102	High Methane and Water	No
CD-46	EW-36	High Methane and Water	No
CD-47	EW-7	Abandoned	Yes
CD-48	EW-76	High Methane and No Water	Yes
CD-49	EW-43	Abandoned	Yes
CD-50	EW-43	Abandoned	Yes
CD-51	EW-143	High Methane and Water	No

Notes:
* Refer to Figure-1 included in the LFG Investigation Technical Memorandum (**Attachment F**).
Location of Condensate Drains presented on **Figure 6.

4.7.7 Blower-Flare Facility

A blower applies the required vacuum on the LFG collection system and supplies the required discharge pressure for the flare. The amount of vacuum required depends on the size of the LFG collection system and typically varies from 40 to 80 in. of water column (the existing system

currently operates at 82 in. of water column). The amount of pressure required is governed by the flare burner configuration and typically varies from 10 to 20 in. of water column.
As presented in the LFG Investigation technical memorandum, the existing facility has three 20-horsepower blowers in operation, each rated for 600 scfm at 60 in. of water column that are utilized to convey LFG from the collection system to two enclosed flares. The County is currently in the process of installing new variable frequency drives to allow for improving control of the vacuum on the Landfill in the future. The enclosed flares are each rated for 600 scfm at 50 percent methane. EA verified with the flare manufacturer that the existing flares are operational with 30 to 50 percent methane. If the methane volume falls below 25 percent, the LFG needs to be supplemented with methane to maintain combustion and stable operation. Additionally, potential adjustment to the flare components such as adjustments to the thermocouple, flare plate, and dampers may be needed. The existing permit to construct and the as-built drawings for the enclosed flares are included in **Attachment F**. As part of the LFGE project, a butterfly valve and line were installed to direct LFG to the pretreatment skid associated with the LFGE system. It is EA's understanding that this valve was closed June 1, 2017, as part of the LFGE plant shutdown that occurred.

The existing blower/flare station is located at the Gude Drive entrance of the Landfill, adjacent to the LFGE facility that is no longer in use. The blowers were designed to function under a range of conditions that may result due to changes in LFG composition and flow rate. Based on the existing blower/flare facility's capacity (1,200 scfm), location, and current LFG production rate (507 scfm), it is assumed that the existing facility is capable of managing LFG from the new LFG collection system. The existing facility has three blowers each rated for at 600 scfm with a turndown percentage of 73 percent; therefore, each blower can operate at collected LFG flow rate as low as 162 scfm. The existing facility has two flares each rated for at 600 scfm with a turndown ratio of 6:1; therefore, each flare can operate at a LFG flow as low as 100 scfm at 50 percent methane or 167 scfm at 30 percent methane. The LFG flow rate is predicted to be 168 scfm in 2044 (assuming a significant increase in LFG production does not occur due to capping) according to the LandGEM analysis (**Figure 3**). Based on the modeled LFG production and projected collection rate and the turndown of the blowers, the existing facility is anticipated to be able to collect and convey the LFG until 2044. This evaluation only accounts for the capacity of the equipment and does not take into other considerations such as useful life of the equipment or maintenance of the facility.

4.8 DEWATERING SUMPS

There are currently six, 12-inch-diameter high-density polyethylene dewatering sumps located on top of the landfill. These sumps have historically been utilized to dewater the site, specifically in areas along the northwest slope where leachate seeps have historically occurred. The Contractor is to utilize these sumps for dewatering of the northwest slope prior to waste excavation and extend them for future use, if needed. It is anticipated that the leachate or condensate generated during the construction can be transported to the Oaks Landfill on a daily basis up to a volume of 20,000 gallons per day. To verify the compatibility of the existing dewatering sump water quality with the daily maximum discharge limits permitted for the Oaks Landfill in accordance with a Discharge Authorization Permit, dewatering sumps were sampled by EA in October 2020.

Ammonia, biochemical oxygen demand, chemical oxygen demand, total phosphorus, and nickel were detected in all the dewatering samples below the daily maximum limits in the permit. Copper and lead in DS-5 and zinc in DS-4 were detected at concentrations well below their respective discharge limits. One of the polychlorinated biphenyls, Aroclor 1232, was detected above the daily maximum limit (0.001 milligram per liter) at a concentration of 0.0013 milligram per liter. All other required parameters were detected below the laboratory reporting limits. Based on the analytical results, it is anticipated that leachate can be accepted at the Oaks Landfill. Analytical results and field logs for the dewatering samples are included in **Attachment G**.

4.9 GROUNDWATER MONITORING WELLS

The existing groundwater monitoring network for the Landfill consists of 51 groundwater monitoring wells. The project specifications will require the Contractor to protect the existing groundwater monitoring wells within the limit of work during construction. The Gude Landfill ACM, dated April 2016 (EA 2016), included a Work Plan for the Recommended CMA—toupee capping and additional LFG collection. As part of the Work Plan, a total of 9 groundwater monitoring well shallow and deep pairs (18 total groundwater monitoring wells) was proposed. In 2017, 12 of these wells were installed (MW-16A/B, MW-19A/B, MW-21A/B, MW-22A/B, MW-23A/B, MW-24A/B), per the updated Groundwater and Surface Water Monitoring Plan. MW-17A/B and MW-18A/B (along the west/northwestern property boundary) are in an area that will be impacted by the capping project; therefore, the County plans to install these well pairs following construction under a separate contract.

4.10 PIEZOMETERS

As part of the ACM (EA 2016), EA installed four piezometers into waste to evaluate groundwater elevations within the landfill. As part of the capping project these piezometers are to be made permanent and extended with the capping of the landfill. It is anticipated that the County will continue to utilize these piezometers to monitor groundwater elevations and mounding within the landfill following the capping of the landfill.

4.11 LANDFILL GAS MONITORING WELLS

The existing LFG monitoring network for the Landfill consists of 24 permanent LFG compliance monitoring wells along the southern and northwestern property boundaries of the site. Ten of the 24 LFG monitoring wells were installed in June 2010 and seven were installed in December 2016. The project specifications will require the Contractor to protect the existing LFG monitoring wells within the limit of work during construction.

4.12 ENVIRONMENTAL ASSESSMENT REPORT

An Environmental Assessment Report was developed to describe potential construction phase and long-term environmental effects resulting from construction activities. Potential effects of construction include changes to traffic, dust, noise, odor, LFG migration, non-stormwater discharges (e.g., leachate), stormwater runoff, fuel storage, site access, security, and safety, habitat and natural resources, recreation, and site aesthetics. The environmental assessment identifies potential measures to minimize, mitigate, and eliminate the potential effects. Relevant resources, current and potential land uses, and potential positive and negative effects are described. The Environmental Assessment Report is included in **Attachment O**.

4.13 EROSION AND SEDIMENT CONTROL

Erosion on construction sites can be a significant source of sediment pollution to nearby bodies of water. As a result, there are regulations that require construction activities to employ adequate controls to limit the amount of sediment traveling offsite through runoff. This is accomplished through conveying sediment-laden runoff through filtering or sediment-trapping practices prior to discharge offsite. All erosion and sediment control facilities are required to meet design and maintenance criteria as outlined in the *2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control*.

The construction phases have been developed to promote positive drainage from the current phase to the greatest extent possible. Super silt fence is proposed along the phase boundaries to ensure that runoff is filtered prior to leaving the work area. Localized sump areas may develop during grading activities, and the Contract Documents require that the Contractor pump and filter runoff in those areas after storm events.

The progression of grading on the west and northwest slope is shown on the Contract Drawings. The excavation will begin at the top of the slope and work downward in stages. Super silt fence will be placed downgradient of the excavation area to provide sediment filtering as construction progresses downslope. The construction of the northwest slope will occur in specified progressions as detailed on the Contract Documents. Once a subsequent progression has been completed, the downslope super silt fence will be removed so that construction may progress further downslope.

Temporary gabion outlet structures (TGOS) will be installed at the top of the northwest slope to provide sediment filtering for the flatter graded area atop of subgrade phases S-I through S-III. Along with the TGOS, earth dikes will be installed to direct sediment-laden water to the TGOS for treatment and pipe slope drains will be installed to convey treated water to the bottom of slope, bypassing the slope construction. The swales and benches on the northwest slope will be stabilized utilizing same day stabilization as a result of the limited physical space to install sediment capturing and filtering devices for the concentrated flows. Construction of benches, temporary gabion outlet structures, temporary stone outlet structures, pipe slope drains, mountable berms, earth dikes, clean water diversions, and other controls are detailed on the Contract Drawings.

Existing Pond 3 will be converted and expanded to become Sediment Basin No. 1 during construction to manage sediment-laden water from the east side of the site. The sediment basin has been designed in accordance with MDE and DPS requirements and can treat approximately 45 acres of drainage area. Low-permeability soil will be installed in the bottom of Sediment Basin No. 1 during construction to limit stormwater infiltration through the waste.

While there is approximately 74 acres of existing drainage area that is directed towards Sediment Basin No. 1, the construction phasing and clear water bypass diversions have been designed to limit the drainage area to the basin to less than 45 acres in all phases of construction. The design incorporates an 8-ft-wide swale as a part of the required land grading bench. The swale, in coordination with clear water diversion piping, is utilized to bypass flow around the sediment basin for areas that have been vegetatively stabilized. Each phase is individually designed to provide this necessary bypass flow of clean water in order to maintain a smaller sediment basin footprint along with not overloading the system.

After construction is complete, the basin will be decommissioned, and it will not be restored to a pond. A Floodplain Study has been performed and indicates the pond will not be needed in the final condition to control stormwater runoff. The location of Incinerator Lane will not be impacted. The reports documenting the detailed design of the stormwater, drainage, and sediment control elements are included in **Attachment K.**

Previous versions of the erosion and sediment control plans and design report have been submitted to DPS and comments have been received and addressed. Additional review and comment cycles will be performed to obtain DPS approval of the plans.

4.14 STORMWATER MANAGEMENT

Stormwater management is necessary to mitigate the effects of development on the receiving stream system. A stormwater management design must ensure mitigation through practices described in the *2000 Maryland Stormwater Design Manual* as amended and with Montgomery County design requirements based on Chapter 19 of the Montgomery County Code.

A Stormwater Concept Report was initially submitted to DPS in May 2019, and after two review-and-comment cycles, was approved on March 10, 2020. DPS noted that "the proposed grading associated with the capping of the existing landfill is considered to be a 'maintenance activity' and therefore stormwater management is not required." DPS also noted that "safe and non-erosive conveyance of stormwater runoff must be provided to all of the proposed discharge points surrounding the site."

EA analyzed existing and proposed drainage conditions and used this information to develop a stormwater management and drainage design. The approved Stormwater Concept Report and the Stormwater Management Report documenting the design are included in **Attachment K**.

4.15 FUTURE LAND USE EVALUATION

Future land uses at the Landfill will include passive recreational facilities and may include renewable energy development. EA's subcontractor, Floura Teeter Landscape Architects (Floura Teeter), developed a Comparative Analysis of potential land use activities. Floura Teeter researched the allowed land use and permitting requirements which could potentially create barriers or conflicts. The results of this research were incorporated into the Comparative Analysis.

The Comparative Analysis of activities includes a ranking system and focuses on passive recreational, renewable energy, and operational activities.

The future land uses were selected based on the Authority/County's goals and input from stakeholders. Floura Teeter advanced the design of the approved preliminary plan for the passive recreational land uses, selected materials, and developed details that are consistent with the Authority/County's goals and design intent for use in the preparation of a Summary Report. The Summary Report provided conceptual layout drawings, graphics, details, and preliminary construction cost estimates for the selected land use activities. The passive recreation land use design has been incorporated into the Contract Documents. The Basis of Design report prepared by Floura Teeter is included as **Attachment R**.

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5. POST-CLOSURE CARE PLAN

A Post Closure Care Plan was developed to ensure the facility is maintained in compliance with COMAR 26.04.07.22 and 40 Code of Federal Regulations Subpart 258.61(a). The Post-Closure Care Plan includes LFG collection and monitoring, groundwater monitoring, required maintenance, recordkeeping, and operations activities. Maintenance and operational activities include the maintenance of security, cover system, stormwater management structures, and LFG collection system. Monitoring activities include the monitoring of the groundwater monitoring well network, LFG monitoring probe network, surface water, and an inspection plan for the Landfill cover system.

The plan also includes standard monitoring forms and associated training to assist in ensuring the appropriate records for the Landfill post-closure maintenance and monitoring are kept per COMAR 26.04.07.22. The Post-Closure Care Plan is included in **Attachment P**.

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6. REQUEST FOR QUALIFICATION/ REQUEST FOR PROPOSAL FORMAT

6.1 CONTRACTOR PROCUREMENT

The Authority and County have undertaken a two-step procurement process that includes selection of a short-list of contractors based on qualifications, experience, and similar factors. Those selected contractors will be requested to provide a price proposal to perform the remediation as defined in the Contract Documents.

6.2 PRICE PROPOSAL ITEMS

A list of price proposal items has been developed based on the County's preference for unit price items. The items are shown in the Price Proposal Schedule and described in the Measurement and Payment specification.

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7. ANTICIPATED CONSTRUCTION SCHEDULE

An estimated construction schedule has been developed and is intended to provide an overall estimate of the construction duration. Actual detailed workflows may vary from this generalized schedule and actual production rates will vary based on the resources the Contractor applies to the project.

The items presented in the schedule are based on construction phasing as described in Section 4. The schedule anticipates that the Contractor will proactively and aggressively schedule tasks to minimize idle time and move smoothly from one phase to another in accordance with the grading unit requirements.

The schedule is based on experience with similar projects and production rates have been assumed for major schedule items. Major schedule assumptions include:

- Installing erosion and sediment controls will require 2 days per acre of each phase;
- Clearing and grubbing will require 1 day per acre of each phase;
- Subgrade preparation, waste relocation, and LFG adjustments will require 1 day per 1,500 cubic yards of waste cut/fill plus 1 day per acre of each phase;
- Temporary vegetative stabilization will require 1 day per 2 acres of each phase; and
- Closure cap construction with LFG system and access roads will require 5 days per acre of each phase.

An experienced contractor could exceed some of these assumed production rates. The schedule assumes weather impacts will be average for Montgomery County. The schedule does not explicitly show winter shutdown periods, but some work will be difficult during winter months and the Contractor may shut down depending on the weather conditions. No contingency for force majeure events or change orders is included in the schedule.

The construction schedule is included in **Attachment Q**.

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8. REFERENCES

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Figures

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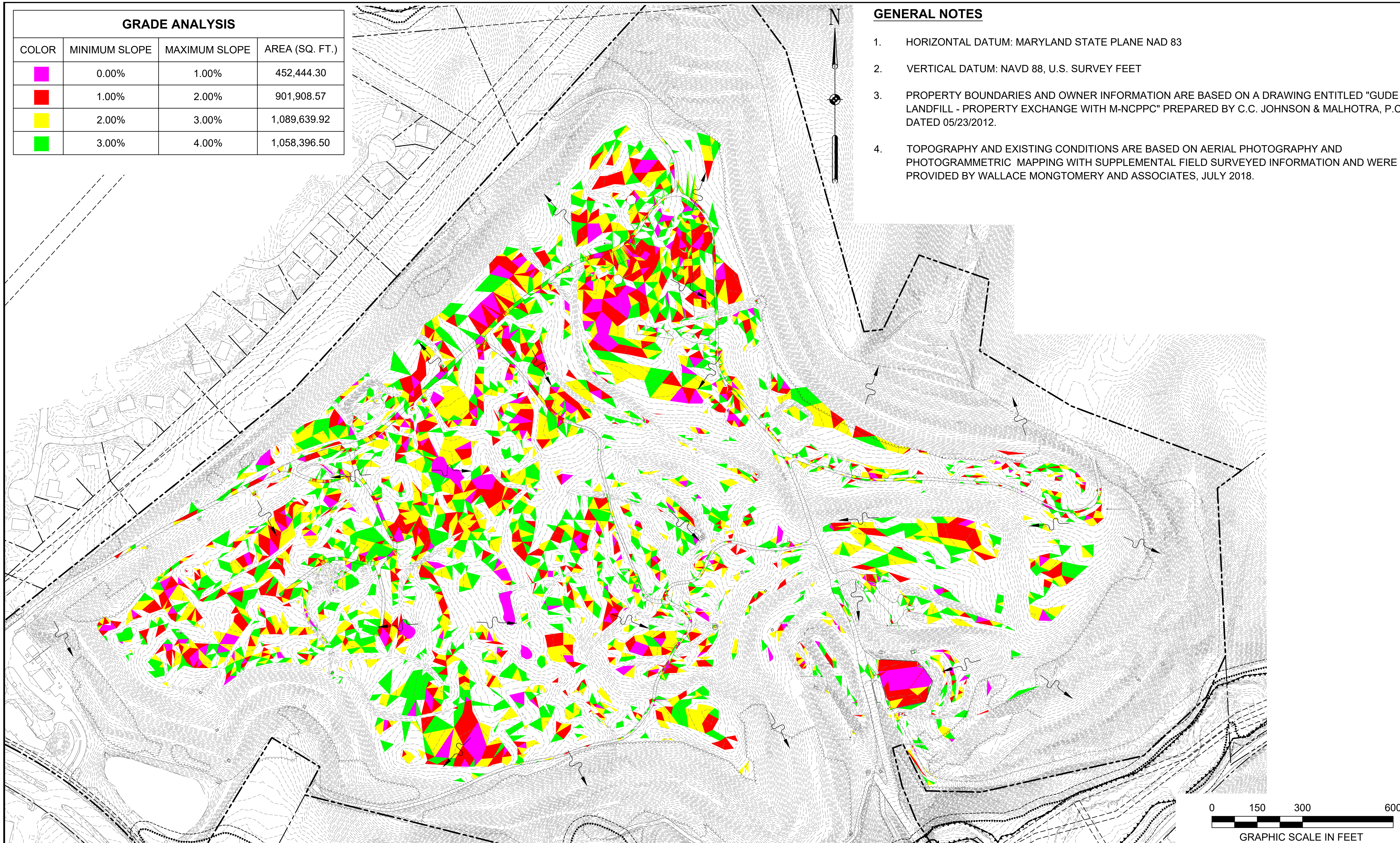
GRADE ANALYSIS

COLOR	MINIMUM SLOPE	MAXIMUM SLOPE	AREA (SQ. FT.)
(magenta)	0.00%	1.00%	452,444.30
(red)	1.00%	2.00%	901,908.57
(yellow)	2.00%	3.00%	1,089,639.92
(green)	3.00%	4.00%	1,058,396.50



GENERAL NOTES

1. HORIZONTAL DATUM: MARYLAND STATE PLANE NAD 83
2. VERTICAL DATUM: NAVD 88, U.S. SURVEY FEET
3. PROPERTY BOUNDARIES AND OWNER INFORMATION ARE BASED ON A DRAWING ENTITLED "GUDE LANDFILL - PROPERTY EXCHANGE WITH M-NCPPC" PREPARED BY C.C. JOHNSON & MALHOTRA, P.C., DATED 05/23/2012.
4. TOPOGRAPHY AND EXISTING CONDITIONS ARE BASED ON AERIAL PHOTOGRAPHY AND PHOTOGRAMMETRIC MAPPING WITH SUPPLEMENTAL FIELD SURVEYED INFORMATION AND WERE PROVIDED BY WALLACE MONGTOMERY AND ASSOCIATES, JULY 2018.

FILE PATH: Q:\PROJECTS\1564601 - GUDE LF DESIGN\CAD\PRODUCTION\FIGURES\1564601 - FIGURE 1.DWG [01] 11/6/18

EA Engineering, Science, and Technology, Inc., PBC
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225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031
(410) 584-7000

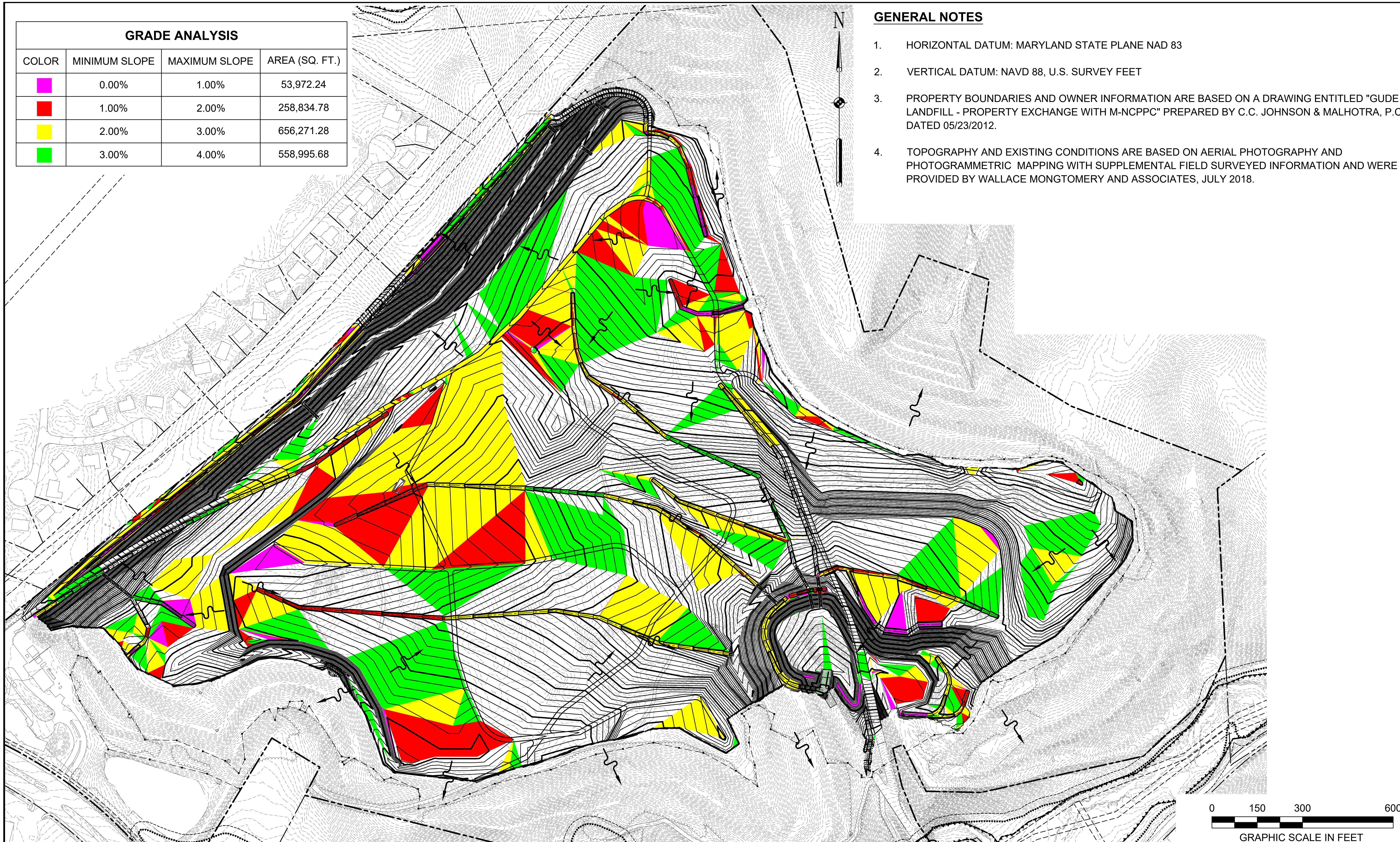
PROJECT NUMBER:	DESIGNED BY:	DRAWN BY:	FIGURE:
1564601	KEF / SMB	SMB	1
DATE:	CHECKED BY:	PROJECT MGR.:	SHEET NUMBER:
DECEMBER 2020	LJO	MJG	-

GUDE LANDFILL REMEDIATION DESIGN
NORTHEAST MARYLAND WASTE DISPOSAL AUTHORITY
BASIS OF DESIGN REPORT
MONTGOMERY COUNTY, MARYLAND

FIGURE 1: EXISTING GRADES ANALYSIS

GRADE ANALYSIS

COLOR	MINIMUM SLOPE	MAXIMUM SLOPE	AREA (SQ. FT.)
Magenta	0.00%	1.00%	53,972.24
Red	1.00%	2.00%	258,834.78
Yellow	2.00%	3.00%	656,271.28
Green	3.00%	4.00%	558,995.68



GENERAL NOTES

1. HORIZONTAL DATUM: MARYLAND STATE PLANE NAD 83
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PROJECT NUMBER:	DESIGNED BY:	DRAWN BY:	FIGURE:
1564601	KEF / SMB	SMB	2
DATE:	CHECKED BY:	PROJECT MGR.:	SHEET NUMBER:
DECEMBER 2020	LJO	MJG	-

GUDE LANDFILL REMEDIATION DESIGN
NORTHEAST MARYLAND WASTE DISPOSAL AUTHORITY
BASIS OF DESIGN REPORT
MONTGOMERY COUNTY, MARYLAND

FIGURE 2: PROPOSED GRADES ANALYSIS

NOTE:
RADIUS OF INFLUENCE FOR INDIVIDUAL WELL VARIES FROM 142 FT TO 561 FT. HOWEVER, A CONSERVATIVE RADIUS OF INFLUENCE OF 150 FT IS SHOWN FOR ALL EXTRACTION WELLS.

GUDE LANDFILL REMEDIATION DESIGN
NORTHEAST MARYLAND WASTE DISPOSAL AUTHORITY

MONTGOMERY COUNTY, MARYLAND

FIGURE 4: LANDFILL GAS RADIUS OF INFLUENCE

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FIGURE 4

SHEET: 1 OF 1

0 100 200 400
GRAPHIC SCALE IN FEET

GUDE LANDFILL REMEDIATION DESIGN
NORTHEAST MARYLAND WASTE DISPOSAL AUTHORITY

MONTGOMERY COUNTY, MARYLAND

FIGURE 6: POTENTIAL DRY LOCATIONS IN LANDFILL GAS COLLECTION SYSTEM

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FIGURE 6

SHEET: 1 OF 1

FILE PATH: G:\PROJECTS\1564601 - GUDE LF DESIGN\CAD\PRODUCTION\FIGURES\1564601 - FIGURE 6 CONDENSATE DRAIN DRY AREA.DWG (FIGURE 6) SULTANA, SHARMIN 12/10/2020 7:59 PM