PART III, ATTACHMENT 2

FACILITY SURFACE WATER DRAINAGE REPORT

Hawthorn Park Recycling and Disposal Facility

Houston, Harris County, Texas

TCEQ Permit MSW-2185A

Owner/Site Operator/Permittee:

WASTE MANAGEMENT

USA Waste of Texas Landfills, Inc.
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INTENDED FOR PERMITTING PURPOSES ONLY

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Project No. 1894269

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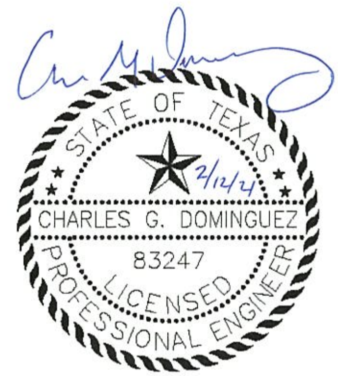

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1.0 INTRODUCTION

This report provides a detailed description of the hydrologic and hydraulic analyses performed for the Hawthorn Park Recycling and Disposal Facility (RDF) Permit Amendment Application (PAA) for Permit No. MSW-2185A. Detailed design calculations and operational considerations for the collection, control, detention, and discharge of stormwater run-off are presented in the appendices of this attachment.

In accordance with the requirements of 30 Texas Administrative Code (TAC) §330.303(a), the proposed facility surface water management system will be constructed, maintained, and operated to manage run-on and run-off during the peak discharge of a 25-year rainfall event, and will prevent the off-site discharge of waste and feedstock material, including, but not limited to, in-process and/or processed materials. In accordance with 30 TAC §330.303(b), surface water drainage in and around the facility will be controlled to minimize surface water running onto, into, and off the treatment area.

As demonstrated in this report, the proposed facility design complies with the requirements of 30 TAC §330.63(c) and Chapter 330, Subchapter G, and the Texas Commission on Environmental Quality's (TCEQ's) *Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill* (RG-417, revised May 2018) (hereinafter "TCEQ's *Surface Water Drainage and Erosional Stability Guidelines*"). The proposed facility design will not adversely alter existing drainage patterns, as demonstrated herein.

1.1 Surface Water Design Overview

The design overview of the facility surface water drainage structures is shown in Figure III-2-1. The Facility Storm Water Management Plan is an overview layout of the proposed drainage control structures and locations. For the proposed landfill development, the landfill final cover slopes at 4% across the crown, or top slope, towards the 4H:1V final cover side slopes. Add-on berms are proposed along the side slopes at a maximum 24-ft vertical spacing (or 96-ft horizontal spacing). The add-on berms, which are sloped at 2% longitudinally along the side slopes, direct run-off to downchutes that travel down the 4H:1V side slopes. Downchutes discharge across concrete-surfaced access road crossings into perimeter ditches armored with riprap, which then convey flow to the detention pond east of the site. The design of the perimeter ditches varies, including by slope, size, shape, and material lining.

The surface water design addresses flow from on-site and off-site areas contributing to the project site. While the site receives some run-on from the surrounding area, the Hawthorn Park RDF generally captures and conveys run-off from within the proposed permit boundary. The Pre-Development Overall Drainage Conditions and Post-Development Overall Drainage Conditions are presented in Figures III-2-2 and III-2-3, respectively. Minimal run-on from outside of the proposed permit boundary enters the site at control points CP-3 through CP-9. In the pre-development condition, stormwater discharges at control points CP-2, CP-10, and CP-11. In the post-development condition, stormwater discharges at control points CP-10, CP-11, and CP-12 into an off-site detention pond facility that is owned, operated, and maintained by the Hawthorn Park RDF permittee (USA Waste of Texas Landfills, Inc.) and permitted by the Harris County Flood Control District (HCFCD). The outfall for this detention pond is designated as control point CP-1.

The design of drainage control structures for the Hawthorn Park RDF ensures that discharges at the permit boundary, and the discharge at CP-1, will not result in an adverse alteration of existing drainage patterns for the 25-year and 100-year storm events. Discharges at the permit boundary are to the detention pond, which is designed to accommodate the discharges, and will not adversely alter the design or function of the detention pond, or overtop the pond in the 25-year and 100-year storm events. The detention pond is designed to detain and attenuate the discharges from the permit boundary, and to discharge at CP-1 at peak flow rates, volumes, and velocities that will not adversely alter existing downstream drainage patterns.

Off-site run-off at CP-2 ceases in the post-development condition, as the proposed expanded waste footprint and associated drainage features capture the run-off in that area. The long flow paths created by add-on berms, downchutes, and perimeter ditches, and the detention provided by the pond, reduce the peak flow rates and velocities of the flows discharging at control point CP-1.

The detailed drainage calculations for pre- and post-development drainage conditions, drainage control structure design and sizing, and models are provided in Appendix III-2A of this report. The perimeter ditches are sized to convey the flow from a 100-year, 24-hour storm with no freeboard, and the 25-year, 24-hour storm with a minimum of 0.5-ft freeboard. The 25-year frequency storm is the design storm for the add-on berms and downchutes.

Figure III-2-4 shows the perimeter ditch layout. Figures III-2-5 through III-2-7 depict flowline elevations, water surface elevations, and top of channel elevations along the entire length of the drainage structures. Figures III-2-8 through III-2-11 contain the details for the drainage controls, such as the perimeter ditches, add-on berms, culverts, and downchutes. Figures III-2-12 and III-2-13 show details for erosion and sedimentation control.

This report includes the following hydrologic and hydraulic analyses:

1. Estimation of pre-development run-on and run-off peak flows, volumes, and detention pond water surface elevation using the Natural Resources Conservation Service (NRCS) Technical Release Number 55 (TR-55), Rational Method, Clark Unit Hydrograph Model, and Soil Conservation Service (SCS) curve number loss methodology with the U.S. Army Corps of Engineers' (USACE's) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) software.

2. Similar estimation of post-development peak flows, volumes, and detention pond water surface elevation using the same methodologies.

3. Design and analysis of perimeter ditches using peak discharge rates from post-development peak flows using USACE's Hydrologic Engineering Center River Analysis Center (HEC-RAS) to obtain flow depth, velocity, and freeboard.

4. Design and analysis of final cover phase and interim phase add-on berms and downchute conveyance structures using the Manning's Equation assuming normal depth using the modeling software HydraFlow Express

5. Estimation of soil loss and presentation of erosion control measures for interim and final cover phases.

6. Design of run-on and run-off control berms for active disposal areas.

2.0 PRE-DEVELOPMENT DRAINAGE CONDITIONS

Under the Hawthorn Park RDF's existing permit, Permit No. MSW-2185, stormwater is controlled by a variety of structures including add-on berms, stormwater flumes (downchutes), perimeter drainage ditches, culverts, and a detention pond. Analysis points were located for the pre-development conditions to represent locations where run-on enters the site and where run-off exits the site and the detention pond. Figure III-2-2 presents the pre-development drainage basin delineations and locations of the control points (CP).

In pre-development conditions, most run-off from the site is captured by the stormwater conveyance structures. The add-on berms and stormwater flumes (downchutes) capture water from the face of the landfill cover and convey that stormwater run-off into the perimeter ditch systems. The perimeter ditches carry runoff around waste areas and generally flow eastward towards the stormwater detention pond. At points on-site where the perimeter ditches cross roadways, the run-off is conveyed under the roads through culverts. The perimeter ditch system combines into two points of discharge, at the north and east, into the detention pond at control points CP-10 and CP-11. All run-off captured by the perimeter ditches outfalls into the detention pond. The water exits the pond at the outfall structure denoted by CP-1. A small portion of the run-off that is not captured by the internal site drainage system is labeled OFF1 and discharge is calculated at CP-2. Run-on contributing areas are labeled as ON1 through ON7 and are calculated at CP-3 through CP-9.

The pre-development and post-development contributing areas for each analysis point are summarized in Table III-2-1 below.

Table III-2-1: Summary of Contributing Areas

Analysis/Control Point		Contributing Area (acre)	
		Pre-Development	Post-Development
Run-off	CP-1 (includes CP-10, CP-11, CP-12)	248.0	253.4
	CP-2	5.4	0.0
Run-on	CP-3	1.0	1.0
	CP-4	0.2	0.2
	CP-5	0.8	0.8
	CP-6	1.1	1.1
	CP-7	3.5	3.5
	CP-8	1.2	1.2
	CP-9	0.8	0.8
Total		262.0	262.0

Figures III-2-2 and III-2-3 depict the pre- and post-development overall drainage condition maps and show all contributing areas and peak flow rates.

The Rational Method and HEC-HMS computer software were used to analyze the pre-development peak flows and volumes resulting from the design storm. Per the Harris County Flood Control District (HCFCD) Policy, Criteria, and Procedure Manual, and considering the size of the watershed is between 50 and 640 acres, the Clark Unit Hydrograph transformation methodology was used for all pre-development drainage basins. Rainfall data for Harris County local to the site was obtained from the National Oceanic and Atmospheric Administration's Atlas 14 Point Precipitation Frequency Server (NOAA PFDS). Times of concentrations for the pre-development condition were calculated using the NRCS TR-55 methodology. Detailed drainage calculations using the above-mentioned methodologies for pre-development conditions are included in Appendix III-2A.

3.0 POST-DEVELOPMENT DRAINAGE CONDITIONS AND DESIGN

The calculated post-development hydrologic conditions define the hydraulic design requirements for the final landfill development. The analysis points are used as the control points for comparison between the pre- and post-development discharges. The facility stormwater control features are designed so that the post-development peak discharges calculated at the run-off control points are equal to or less than the pre-development peak discharges. The post-development design also accounts for the pre-development run-on entering the site from adjacent properties.

Figure III-2-3 depicts the final cover and post-development drainage plan, and shows all drainage areas that were used to determine the post-development discharges. The control points shown on Figure III-2-3 are compared to Figure III-2-2, the Pre-Development Overall Drainage Conditions.

3.1 Post-Development Peak Discharge

Using the same procedures as those used for the pre-development conditions, a surface water model of the expanded facility was constructed using the HEC-HMS software for the post-development conditions. The peak flows were computed with the surface water model using hydrographs for each basin generated from the Clark Unit Hydrograph transformation methodology. These flows were then routed through the surface water conveyance system part of the model (add-on berms, downchutes, perimeter channels, culverts, ponds, etc.) to the defined control points. Details for these calculations are presented in Appendix III-2A.

In accordance with TCEQ regulations, the 25-year, 24-hour storm event was used to compute the peak flow rates, discharge volumes, velocities, and water surface elevations. To comply with the HCFCD's design criteria, the 100-year, 24-hour major storm event was also used to analyze the detention pond and outfall structure. The perimeter ditches were sized to convey the 100-year design storm with no freeboard and to convey the 25-year design storm with a minimum of 0.5 feet of freeboard. These design factors result in a conservative design for these drainage features when considering the TCEQ-specified 25-year and 24-hour design storm.

Table III-2-2 compares the pre- and post-development peak flow rates, discharge volumes, and velocities at control points CP-1 through CP-12. CP-10 through CP-12 represent the control points at the permit boundary, where the perimeter ditches discharge into the detention pond facility on property adjacent to the Hawthorn Park RDF that is owned, operated, and maintained by the landfill permittee (USA Waste of Texas Landfills, Inc.). This existing detention pond facility is permitted by the HCFCD.

Table III-2-2: Summary of Peak Flows and Discharge Volumes

		25-year, 24-hour Storm Event					
		Peak Flow Rate (cfs)		**Discharge Volume (ac-ft)**		**Velocity (fps)**	
Control Point		**Pre-Development**	**Post-Development**	**Pre-Development**	**Post-Development**	**Pre-Development**	**Post-Development**
Run-off	CP-1	151.2	141.8	159.4	138.9	5.0	4.7
	CP-2	30.7	*Routed to CP-1*	4.6	*Routed to CP-1*	2.3	*Routed to CP-1*
	North Ditch CP-10	402.6	262.5	146.9	74.5	2.0	4.4
	East Ditch CP-11	60.1	126.2	22.0	21.7	2.7	4.7
	South Ditch CP-12	--	282.1	--	76.8	--	3.5
Run-on	CP-3	1.8	1.8	0.8	0.8	0.1	0.1
	CP-4	1.1	1.1	0.2	0.2	0.2	0.2
	CP-5	1.8	1.8	0.7	0.7	0.2	0.2
	CP-6	6.3	6.3	1.0	1.0	0.1	0.1
	CP-7	8.6	8.6	2.8	2.8	0.2	0.2
	CP-8	6.8	6.8	1.0	1.0	2.9	2.9
	CP-9	4.5	4.5	0.7	0.7	2.8	2.8

Notes:

cfs = cubic feet per second
ac-ft = acre-feet
fps = feet per second

As shown in the table above for CP-11 and CP-12, there is an increase in peak discharge flow rates for CP-11 and CP-12, an increase in discharge volume for CP-12, and increases in velocities for CP-11 and CP-12. The increases at CP-11 are due to increases in the steepness of the side slopes (6% in pre-development to 25% in post-development) and increases in the slope of the perimeter channels contributing to this control point. Control point CP-12 did not exist in the pre-development condition, so all increases are due to the presence of a new outfall location. For CP-10, there is an increase in velocity from the pre-development to the post-development drainage conditions due to the use of concrete lining in the final 100-feet of the North perimeter ditch. However, the flows at these three control points (CP-10 to CP-12), and all flows from the site, are routed to the detention pond before discharging through control point CP-1 at the pond outfall structure. The post-development peak flowrates, volumes, and velocities are less than those in the pre-development condition at CP-1. This is achieved by increasing the attenuation of the detention pond by increasing the pond's storage capacity. In both the pre-development and post-development conditions, run-off discharges at CP-1 through an existing culvert structure into the HCFCD-controlled White Oak Bayou watershed (E100-00-00).

By comparing the pre-development and post-development peak flow rates, discharge volumes, and velocities at CP-1 and CP-2, it is demonstrated that the surface water discharge from the facility is attenuated such that the proposed expansion of the Hawthorn Park RDF will not adversely alter existing drainage patterns nor adversely impact downstream properties or structures.

3.2 Stormwater Pond Analyses

There is an existing detention pond which is and will continue to be used for detention and sediment control. The pond is located immediately east and off-site of, and adjacent to, the proposed Hawthorn Park RDF permit boundary, as shown on Figures III-2-2 and III-2-3. The detention pond facility is located on property owned and controlled by the Hawthorn Park RDF permittee (USA Waste of Texas Landfills, Inc.) and is permitted by the HCFCD. In September 2020, Jones and Carter, Inc. submitted a revised drainage and detention analysis to HCFCD for the proposed expansion of the Hawthorn Park RDF. This submittal is included as Appendix III-2F-1.

The detention pond facility will be expanded and regraded as discussed in Appendix III-2F-1 and as shown on Figure III-2-3. The expanded detention pond will attenuate the stormwater discharges that will result from the proposed expansion of the Hawthorn Park RDF. The table below provides the estimated maximum water surface elevation during the 25-year, 24-hour storm and 100-year, 24-hour storm events for both the pre- and post-development drainage conditions. The water surface elevations and peak storage are from the HEC-HMS pre-development and post-development model results. The full HEC-HMS results are in Appendix III-2A-1.

Consistent with the guidance in TCEQ's Surface Water Drainage and Erosional Stability Guidelines concerning an off-site drainage structure that is a component part of a facility's surface water drainage system, USA Waste will grant TCEQ an access easement allowing TCEQ to access and inspect the off-site detention pond facility during the active life and post-closure care period of the Hawthorn Park RDF. The proposed access easement is included as Appendix III-2G.

Table III-2-3: Summary of Stormwater Pond

	Pre-Development		**Post-Development**	
	25-Year	**100-Year**	**25-Year**	**100-Year**
Water Surface Elevation (ft)	93.7	95.8	92.9	95.3
Peak Storage (ac-ft)	95.3	158.8	125.2	200.7

3.3 Discharge Structure Analysis for Stormwater Detention Pond

The detention pond's existing hydraulic discharge structure will remain and was modeled for the post-development conditions. The existing structure provides adequate capacity; therefore, no changes are required to the design of this structure.

3.4 Stormwater Conveyance Structures

3.4.1 Perimeter Ditches

All perimeter ditches were designed for the 25-year storm with a minimum of 0.5-ft of freeboard and for containment and conveyance of the 100-year storm using HEC-RAS steady state flow analysis. Calculations for peak discharge rates for the 25-year and 100-year storms are included in Appendix III-2A, Table III-2A-3.

Perimeter channels are typically grass-lined, except for portions of the North and South perimeter ditches which are concrete-lined. Perimeter ditches discharging into the detention pond, upstream/downstream of culverts, and at downchute crossings will be lined with riprap for erosion protection and velocity reduction. For areas where the velocity exceeds 5 ft/sec, the perimeter channel will also be lined with riprap. Riprap sizing calculations using the Federal Highway Administration's (FHWA's) Hydraulic Toolbox program are provided in Appendix III-2A-4.

The perimeter channels are trapezoidal in shape, with variable flowline slopes, bottom widths, depths, and side slopes. The perimeter ditch plan, which shows the overall layout of the North, East, and South perimeter ditches and stationing, are shown on Figure III-2-4. Stations of interest, such as locations of transitions in material, depth, or width, are labeled in the figure. The perimeter ditch profiles are displayed on Figures III-2-5 and III-2-6. The typical perimeter ditch details are shown on Figure III-2-8 along with a ditch schedule that tabulates the ditch geometry, slope, flowline elevation, channel lining, and stationing. The input and output to the HEC-RAS model used to size the perimeter ditches are included in Appendix III-2A-3.

3.4.2 Downchutes and Add-On Berms

Add-on berms and downchutes were designed for the 25-year storm, allowing a minimum of 0.5-ft of freeboard using normal depths. Flow depths for add-on berms and downchutes channels were modeled using the HydraFlow Express software, which applies Manning's Equation to calculate normal depth and velocity given inputs such as channel geometry, slope, roughness coefficient n, and peak discharge Q (cfs). Peak discharges for the 25-year storm are calculated in Appendix III-2A, Tables III-2A-4 and III-2A-5. HydraFlow Express modeling for the worst-case scenario of the downchutes and add-on berms are shown in Appendix III-2A-3.

Add-on berms were designed at a 2 percent slope, with 4H:1V and 2H:1V side slopes and a height of 2 feet. A uniform slope of 2% was selected to ensure positive drainage during smaller storm events while keeping flow velocities below 5 ft/sec for the 25-year design storm. Add-on berm locations are shown on Figures III-2-1 and III-2-3. The add-on berm channel details are presented on Figure III-2-9.

Downchutes along the 4H:1V side slopes of the landfill were designed to be lined with geomembrane (plastic) or an equivalent. A suitable alternative to the geomembrane lining may be used, provided that the design is verified by a professional engineer. The downchute locations are shown on Figures III-2-1 and III-2-3. Downchute profiles are displayed on Figure III-2-7. Downchute cross-sections and details are presented on Figure III-2-9.

4.0 EROSION AND SEDIMENTATION CONTROL PLAN

This Erosion and Sedimentation Control Plan describes the design and operational considerations for controlling erosion along landfill embankments and sedimentation in stormwater collection and storage facilities, and for providing effective erosional stability to top dome surfaces and external embankment side slopes during all phases of facility operation, closure, and post-closure care in accordance with 30 TAC §330.305(d).

In accordance with TCEQ's *Surface Water Drainage and Erosional Stability Guidelines*, the landfill cover phases are defined as daily cover, intermediate cover, and final cover. Top dome surfaces and external embankment side slopes are defined as:

- Those above-grade slopes that directly drain to the perimeter stormwater management system (i.e., directly to a perimeter channel or the detention pond).
- Those above-grade slopes that have received intermediate or final cover.
- Those above-grade slopes that have either reached their permitted elevation or will subsequently remain inactive for longer than 180 days.

Slopes are not considered external embankment side slopes if they drain to:

- Areas with ongoing waste placement.
- Areas excavated for future operations.
- Areas that have received one daily cover.
- Areas under construction that have not received waste.

Areas not considered external embankment side slopes are not required to maintain the erosion management practices outlined in this plan. An area under daily cover that remains inactive for longer than 180 days will be converted to intermediate cover and those applicable erosion controls, as discussed in the following sections, will be required.

This plan is organized to present the erosion and sediment control design and best management practices (BMPs) for all three landfill conditions: active disposal areas, intermediate cover areas, and final cover areas. The erosion and sedimentation controls were developed to provide low run-off velocities, to provide adequate storage detention, and to limit sediment and soil loss impacts to stormwater discharge quality. Soil erosion loss was estimated utilizing the NRCS's Revised Universal Soil Loss Equation. The selection of erosion and sediment control structures will be a continual evolution of temporary and permanent control devices. The facility fill sequence plans will be used to manage the proper selection of both temporary and permanent erosion and sediment controls to ensure stormwater quality standards as presented in the facility's stormwater discharge permit. Temporary (short-term) erosion controls will typically be used during landfill operations, and permanent (long-term) controls will be used for final cover conditions.

Temporary erosion controls are defined as:

- Controls that are installed or constructed within 180 days from when the intermediate cover is constructed and in place until permanent controls are constructed for the final cover or additional placement of waste is resumed on the intermediate cover area.

4.1 General Erosion and Sedimentation Assessment

In assessing the landfill construction and operational practices for potential erosion and sedimentation, the site will consider impacts to sensitive areas, such as steep slopes, surface waters, areas with erodible soils, and existing discharge channels. Also, the facility will disturb the smallest vegetated area possible, keep the amount of cut and fill to a minimum, and maintain the aforementioned sensitive areas. During the construction of landfill cells, it will be necessary to disturb the soil by clearing and grubbing, excavating and stockpiling, rough and final grading, constructing perimeter channel(s), and seeding and/or planting. The BMPs described in the following sections will be utilized to ensure minimal impacts to water quality during these phases of construction and stockpiling activities. Standard TxDOT, TCEQ, and other agency specifications of these BMPs are included in Appendix III-2D.

To guard against soil loss, the phased development plan for landfill cell construction and solid waste placement will be followed. The figures in Part I and Part II of this PAA describe in detail the required fill sequence planning, including sequencing of drainage and run-off controls, to ensure adequate slope stability and limited erosion and soil loss.

4.2 Run-on and Run-off Control for Active Disposal Areas

Run-on and run-off controls for active disposal areas will be utilized to minimize the potential for stormwater contamination. Per §330.305(g), the permittee shall handle, store, treat, and dispose of surface or groundwater that has become contaminated by contact with the working face of the landfill or with leachate in accordance with §330.207 (relating to Contaminated Water Management). Storage areas for this contaminated water must be designed with regard to size, locations, and methods.

The working face of the active disposal area will be encompassed by a run-on berm (top berm) and a run-off berm (toe berm) for the purpose of segregating potentially contaminated and non-contact stormwater. The containment berms are designed to accommodate the 25-year, 24-hour storm, the equivalent of a 11.3-inch rainfall event for the Hawthorn Park RDF site location with 1-ft of freeboard. The top run-on berm is designed to accommodate upstream watersheds that may flow towards the working face and divert the collected uncontaminated stormwater around the working face area for discharge through a permitted stormwater outfall. The toe run-off berm is designed to accommodate storage of stormwater that has potentially contacted the open working face. The berm height requirements and design configurations are detailed in Appendix III-2B.

As a result of progressive disposal and filling operations, ongoing berm extensions/construction will be required to accommodate adequate stormwater run-on diversion (top berm) and proper storage of run-off contact waters (toe berm). The daily operations will include an evaluation of the existing containment berms' capability to manage stormwater run-on and run-off.

4.3 Erosion and Sediment Control for Intermediate Cover Areas

This sub-section describes the interim controls that may be used during phased landfill development to minimize erosion of top dome surfaces and external embankment side slopes with intermediate cover. Based on velocity and soil erosion analyses, a selection of BMPs is identified and general installation guidance is provided. Examples of standard published specifications are also provided. Standard published specifications, which are discussed in the following sections, are provided in Appendix III-2D. In accordance with 30 TAC §330.165(c) and TCEQ guidelines, temporary erosion and sedimentation controls will be implemented on intermediate cover areas within 180 days after placing intermediate cover, including a vegetative cover of at least 60% or mulch cover. Depending on the weather conditions and the season of the year when the intermediate cover is placed, methods of temporary control, as discussed in the following sections, will be implemented to provide for erosion protection. Pursuant to TCEQ guidelines, all calculations in support of this erosion and sedimentation control plan are based on 60% cover.

4.3.1 Erosion and Sedimentation Control Design – Intermediate Cover Areas

In accordance with 30 TAC §330.305(d), the erosional stability of top dome surface and external embankment side slopes was analyzed based on the following criteria:

- The estimated peak velocity should be less than the permissible non-erodible velocities under similar conditions. The applicable non-erodible velocities are 3.75 feet per second for bare soil (loam) slopes and 5.0 feet per second for grassed (60% vegetation) slopes, considering the soil types, grass types, grass conditions, and slope angles at the facility (refer to Appendix III-2C).
- The potential soil erosion loss should not exceed the permissible soil loss for comparable soil-slope lengths and soil-cover conditions. TCEQ's *Surface Water Drainage and Erosional Stability Guidelines* specify that permissible soil loss should not exceed 50 tons/acre/year and recommend a vegetative cover of at least 60%.

Since the exact conditions of the various interim conditions are impossible to predict due to daily changes in fill patterns, a conservative approach is taken to determine the worst-case slope conditions. The built-out condition of the final cover scenario is used and the worst-case slopes are determined from this scenario. Even though interim conditions this extreme are unlikely, this is a conservative assumption so that any possible interim slope conditions or lengths are covered by this extreme case.

The top dome surface is sloped at 4% with a maximum length of approximately 300 feet. The external embankment side slopes are 4H:1V slopes. Analysis indicates that the stormwater velocity on the top surfaces will not exceed the permissible non-erodible velocity in the worst-case conditions, and the length of the 4H:1V slope will be limited to 300 feet to satisfy the flow velocity criteria. Over the length of 300 feet, the shallow concentrated flow method of velocity calculation for the 4H:1V side slope exceeds the permissible non-erodible velocity. The velocity analyses are included in Appendix III-2C-1 and are summarized in Table III-2-4.

Table III-2-4: Summary of Interim Slope Velocities

Cover Slope	Slope Segment	Sheet Flow Method Velocity (fps)	Slope Segment	Shallow Concentrated Flow Method Velocity (fps)
4% slope	Segment 1 0–300 ft	0.73	Segment 2 300+ ft	3.23
4H:1V slope	Segment 1 0–300 ft	1.51	Segment 2 300+ ft	8.07

If an intermediate 4H:1V slope in excess of 300 feet is constructed, then a portion of the slope must be converted to final cover with permanent erosion controls, or temporary add-on soil berms can be installed at 75-foot vertical intervals (i.e. 300 feet along the slope) along the intermediate cover slopes.

The potential soil erosion loss was calculated using the NRCS's Revised Universal Soil Loss Equation. In accordance with TCEQ's *Surface Water Drainage and Erosional Stability Guidelines*, a permissible soil loss of 50 tons/acre/year and a cover of 60% are selected as the design criteria for interim erosion and sediment controls. Results of the soil erosion analyses demonstrate that both the top surfaces and the external embankment side slopes can achieve effective erosional stability without any stormwater diversion structures provided that the soil surfaces are stabilized with at least 60% ground cover. Furthermore, since the flow velocities are the governing parameter for the maximum length of the 4H:1V slopes between the soil berms, the actual amount of soil loss will be reduced. Limiting the uninterrupted length of 4H:1V slopes to a maximum of 300 feet will reduce the maximum soil loss on the intermediate slopes to approximately 43.49 tons/acre/year.

The analyses for interim erosion and sediment controls are included in Appendix III-2C. Appendix III-2C-1 contains the Intermediate Cover Erosion Soil Loss Calculations.

4.3.2 Erosion and Sedimentation Control BMPs – Intermediate Cover Areas

There are numerous BMPs that can be implemented during landfill operations to meet the soil stabilization and stormwater diversion requirements. These BMPs can be used prior to establishing vegetation or in conjunction with vegetation or mulch. The selected BMPs for this site are commonly used and are discussed below. The common BMPs discussed below include a specification and/or detail for reference. The controls discussed below are available from several manufacturers. The site has the flexibility to purchase a control similar to that specified from any manufacturer based on local availability and/or cost. Any other BMPs that may not be commonly used today, such as new technologies as they become available, may be implemented if they are proven to provide satisfactory ground cover and effective erosion control. The evaluation for effectiveness and the demonstration of equivalency of erosion and sediment control BMPs that are not included in this plan will be maintained within the facility's site operating record, furnished upon request to TCEQ, and made available for inspection by TCEQ personnel, as necessary. Furthermore, any control measures and practices used to keep soil loss and flow velocity within permissible limits prior to establishing vegetation or in conjunction with vegetation not approved with this plan, must be approved by TCEQ prior to implementation.

4.3.2.1 Soil Surface Stabilization

Intermediate cover will be temporarily stabilized during installation and maintained throughout facility operations. Erosion and sedimentation controls will be implemented on intermediate covers within 180 days after placing intermediate cover, in accordance with 30 TAC §330.165(c). The soil surface stabilization BMPs that may be implemented at the site are listed below. Vegetation and/or mulch are the most effective erosion control, but until this is achieved, geosynthetics may be used to stabilize the surface of the soil until vegetation can root, spread, and properly grow. If used, these stabilization materials will be removed once the required 60% cover is established.

- Vegetation – Vegetative cover reduces erosion potential by shielding the soil surface from the direct erosive impact of raindrops, improving the soil's porosity and water storage capacity so more water can infiltrate, slowing the run-off, allowing the sediment to drop out, and physically holding the soil in place with plant roots. Grass types that are suitable for the area will be selected in accordance with guidelines published by the State or local agency or other similar sources. The standard seeding specification published by TxDOT is provided in Appendix III-2D.

- Mulch – Mulching is the application of a layer of organic, biodegradable material that is spread over areas where vegetation is not yet established. Types of mulch include compost, straw, wood chips, or manufactured products. Mulch application can be in dry or hydraulic forms. When applied dry, the thickness of the mulch will vary depending on the type of mulch applied. Primary-grind mulch (e.g., wood shreds that form a mass of intertwined fragments), used primarily for erosion control, will be applied using spreading equipment, such as a bulldozer, at a minimum thickness of 2 inches. Compost material, which may consist of more finely ground mulch, will be applied using mechanical spreaders or sprayers. A tackifier or binder may be used to increase the strength and durability of the mulch. Hydraulic mulch includes hydromulch, bonded fiber matrix, flexible growth medium (FGM), and other commercially available products. Hydraulic mulch includes a tackifier or binder that increases the strength and durability of the mulch. Seeds can be applied to the soil first or mixed into the hydraulic mulch. The application method and application rate of hydraulic mulch will be based on manufacturers' recommendations to ensure a uniform and complete coverage. The application method and rate of mulch for other products will be in accordance with that particular product's specifications and recommendations.

- Geosynthetics – Geosynthetic products available for soil erosion controls include geotextile, geomembrane, rolled-erosion control products (RECPs), etc. Erosion control blankets and turf reinforcement mats are examples of RECPs. Erosion control blankets include straw or other mulch material stitched with degradable thread to a photodegradable polypropylene netting structure. The standard specification for RECPs published by the Erosion Control Technology Council is provided in Appendix III-2D. There are numerous products available on the market that can be used. Any material specifically chosen by the site based on cost or local availability will be installed in accordance with that particular manufacturer's specifications and recommendations.

4.3.2.2 Temporary Stormwater Diversions and Sediment Control Structures

Examples of the temporary stormwater diversion and sediment control structures that will be used on the intermediate cover areas are presented below. These structures can be used both prior to and after establishing cover.

- Soil Berms – Soil diversion berms (i.e., temporary add-on berms) are constructed with compacted on-site soils to intercept the flow on the slope and convey the flow laterally to a downchute. The berm design will be minimum 2-feet high, as measured from the invert of the channel to the top of berm, with the invert sloped at 2% in the direction of flow. The slopes of the soil berms will be stabilized with vegetation, mulch, or geosynthetics. The maximum berm length will be controlled to limit the drainage area to less than 4.84 acres, as demonstrated in the calculation included in Appendix III-2C-2. This limit is based on the channel flow capacity, including a maximum flow velocity of 5.0 feet per second, and the rainfall intensity for Harris County local to the Hawthorn Park RDF. These temporary soil berms will be constructed in the same manner as the permanent soil berms on the final cover. A detail of the temporary soil berms (add-on berms) is shown on Figure III-2-11.

- Silt Fences – Silt fences (also known as sediment control fences or fabric filter fences) may be used along the slope to intercept the flow and capture the sediment. The maximum drainage area captured by the silt fence should not exceed the manufacturer's specification but should also be limited to 0.5 acre per 100 feet of fence. The standard specification and detail drawing published by TxDOT is provided on Figure III-2-11.

- Biodegradable Logs or Organic Berms – These types of diversion structures are alternatives to traditional silt fences and hay bales. The biodegradable logs or organic berms are placed along the slope contours to catch the sediment from sheet flow and allow the stormwater to flow through at a reduced speed. A biodegradable log consists of mulch contained in a synthetic mesh sock or tube. The logs are installed on the slope with stake anchors. Organic berms are constructed of compost/mulch. A specification for the compost/mulch filter berm published by TxDOT is included in Appendix III-2D. Any type of biodegradable log or organic berm may be used as long as it is installed in accordance with the manufacturer's specifications and recommendations.

4.3.2.3 Additional Erosion and Sedimentation Control BMPs

In addition to the soil stabilization and stormwater diversion BMPs listed above, the detention pond adjacent to the permit boundary will be used for stormwater detention as well as sediment control.

Temporary stormwater downchutes will be required when soil diversion add-on berms are installed. Based on the calculations included in Appendix III-2C-2, the maximum allowable drainage area for soil diversion berms is 4.84 acres. For the maximum allowable drainage area, the maximum berm length is 702 feet when the temporary add-on berms are spaced at the maximum horizontal distance of 300 feet apart (75 vertical feet). When the temporary add-on berms are spaced at the final cover design of 96 horizontal feet (24 vertical feet), the maximum berm length is 2,196 feet (corresponding to the maximum drainage area of 4.84 acres).

The maximum length of the add-on diversion berms for the final cover design is approximately 1,850 feet, so the temporary stormwater downchutes can be installed in the same location as the permanent final cover stormwater downchutes if the intermediate slope is in the vicinity of a permanent stormwater downchute. Otherwise, a temporary stormwater downchute will be installed at the termination of the temporary add-on soil diversion berm, as necessary to collect run-off from the intermediate slope surface. The recommended minimum temporary downchutes are 2-feet deep and 5-feet wide, with 2H:1V side slopes per Appendix III-2C-3.

A geosynthetic lining material (e.g., geomembrane sheet) will be used to line the temporary downchutes. Other lining materials, such as reno mattresses, gabion baskets, or interlocking concrete blocks, may also be used at the site's discretion if adequate hydraulic capacities are provided. The hydraulic design of the temporary downchutes is included in Appendix III-2C-3.

A detail of a temporary downchute is shown in Figure III-2-11. In lieu of temporary downchutes, corrugated plastic pipes or metal pipes with equivalent flow capacity may be used. If pipes are used to convey run-off from the diversion berms, a demonstration of the downchute pipes' equivalency will be maintained within the site operating record, furnished upon request to TCEQ, and made available for inspection by TCEQ personnel, if necessary.

For on-site stockpiles, the BMPs discussed previously, such as silt fences, rock, or organic berms, may be used at the site's discretion to control erosion and run-off around the stockpile areas. Details of these BMPs are shown on Figures III-2-11 and III-2-12.

4.3.3 Placing and Removing Temporary BMPs

The BMPs discussed in the previous sections will be placed in accordance with the specifications included in Appendix III-2D or in accordance with the manufacturers' guidelines for that particular material. Since these BMPs are only temporary, they will be removed at the site's discretion when the specific situation warrants that the control is no longer needed or if a different control is implemented. Examples of when a control will be removed or replaced are as follows:

- 60% cover has been established.

- The BMP has been destroyed or damaged beyond repair.
- The BMP is not functioning efficiently.
- The intermediate cover area will become part of the active disposal area again.
- The intermediate cover area will receive final cover and permanent erosion controls.
- The BMP becomes a hindrance to daily site operations.

At other times, if deemed necessary by the site, the control may be removed to aid in the daily ongoing waste fill and construction activities that may not specifically be itemized in the above list. The placement and removal of temporary BMPs should not hinder site operations but should be considered by the site as an effective tool to minimize future maintenance or repairs. BMPs will be removed or replaced as part of the site's daily operations. Removed BMPs that have been destroyed or damaged will be disposed of at the working face of the facility. The site will determine a location to store reusable BMPs, so they are easily accessible for future construction.

4.4 Erosion and Sedimentation Control for Final Cover Areas

4.4.1 Erosion and Sedimentation Control Design – Final Cover Areas

The final cover stormwater system design includes side slope add-on berms spaced at maximum 24-foot vertical intervals along the 4H:1V final cover slopes. The selection of stormwater management control structures will be a continual evolution of temporary and permanent control devices. The facility fill sequence plans included in Part II will be used to properly select both temporary and permanent stormwater structural controls.

The stormwater management structural controls were developed to provide low run-off velocities, to provide adequate storage and detention, and to limit sediment and soil loss impacts on stormwater discharge quality. Soil erosion loss and control was estimated using the Universal Soil Loss Equation in the USDA Agriculture Handbook No. 703 - "Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE)," 1997.

The proposed design results in a maximum estimated soil loss of 3.0 tons/acre/year for the 4H:1V side slopes of the landfill final cover. This estimate is equal to approximately 0.02 inches per year eroded from the final cover for this worst-case scenario. Soil loss calculations for final cover areas are presented in Appendix III-2E.

4.4.2 Erosion and Sedimentation Control BMPs – Final Cover Areas

Permanent stormwater management controls include seeding, add-on berms, downchute channels, slope contours, perimeter ditches and berms, final cap design, detention pond, and discharge control structures.

To stabilize the final cover soil, a 6-inch thick topsoil layer that can support native vegetation growth will be installed on the final cover surfaces. Maintenance and inspection, as addressed in Section 5.0 below, will be implemented to ensure a minimum 90% ground cover on the final cover and to ensure that the diversion structures, including the detention ponds, function as designed.

4.5 Minimizing Off-site Vehicular Tracking of Sediments

To minimize the off-site vehicular tracking of sediments onto public roadways, traffic routing and site operation practices will be developed. The following preventative measures will be utilized to control sediment tracking:

- Maintain the site entrance to minimize the accumulation of excessive mud, dirt, dust, and rocks.
- Schedule maintenance and construction of paved and temporary roads to limit disruption of traffic flow patterns or create vehicular safety problems.
- Control traffic routing during wet weather conditions to limit the impact of sediment tracking.

4.6 Maintenance and Inspection

The maintenance and inspection of erosion and sedimentation controls at the facility will be promulgated through continued compliance with the Clean Water Act, the Texas Water Code, and the facility's state stormwater permit.

In compliance with the Texas Pollution Discharge Elimination System (TPDES) requirements for industrial activities with stormwater discharges, a Notice of Intent (NOI) was filed with the TCEQ. The facility is operating under the TCEQ Multi-Sector General Stormwater Permit No. TXR05T969.

Upon approval of this PAA, the facility will update its existing Storm Water Pollution Prevention Plan (SWPPP) to address the new design of the facility surface water management system, and will submit a Notice of Change (NOC) to address any changes required by the new design. The SWPPP will describe the site drainage system, discharges from the site's outfalls, and procedures and controls used to minimize the discharge of pollutants from the site. A copy of the SWPPP is maintained at the facility. Annual audits, employee training, periodic inspections, and implementation of the BMPs outlined in the SWPPP will be conducted as required or otherwise needed.

5.0 INSPECTION, MAINTENANCE, AND RESTORATION PLAN

In addition to the design and operational considerations previously described in the Erosion and Sedimentation Control Plan, it is necessary to inspect and maintain the stormwater management system and erosion control measures to maintain the required effectiveness of the system components. The inspection, maintenance, and repair guidelines discussed in the following sections will be part of the employee training program, as outlined in the Site Operating Plan (SOP) in Part IV. Documentation of the inspections and repairs, as outlined below, will be recorded in the Cover Application Log, and will be maintained as part of the site operating record, in accordance with the SOP.

5.1 Stormwater Management System

The site will be monitored to ensure the integrity and adequate operation of the stormwater collection, drainage, and storage facilities. On a weekly basis, all temporary and permanent drainage facilities will be inspected. Following a significant rainfall event (greater than 0.5 inches within 24 hours), all temporary and permanent drainage facilities will be inspected within 48 hours after the rain event, as ground conditions allow. In the event of a washout or failure, the drainage system will be restored and repaired pursuant to 30 TAC §330.305(e)(1). Plans and actions will be developed to address and remediate the problem to ensure protection of ground and surface waters. Erosion of intermediate and final cover will be repaired pursuant to 30 TAC §330.165(g). Sediment and debris will be removed from channels, ponds, and from around outfall structures, as needed, to maintain the effectiveness of the stormwater management system. The outfall structures will be inspected to ensure their proper operation. Minor maintenance, such as removing excessive sediment and vegetation, will be undertaken as required.

5.2 Landfill Cover Materials

Landfill cover soils are inspected on a regular basis. Daily cover soils are inspected and applied in accordance with the SOP requirements. In addition, during the active life of the site, inspection and documentation of intermediate and final cover will be performed at least once every seven (7) days, as specified by the TCEQ Multi-Sector General Stormwater Permit. During the active life of the site, inspections of intermediate and final cover also will be performed within 48 hours after a significant rain event (greater than 0.5 inches within 24 hours) in which run-off occurs, as ground conditions allow. During the post-closure maintenance period of the site, the final cover will be inspected quarterly. The inspections will include any temporary or permanent erosion measures that are in place at the time of the inspection. Reports of these inspections will be documented in the Cover Application Log and will be maintained in the facility's site operating record, in accordance with the SOP.

In accordance with 30 TAC §330.165(9), erosion gullies or washed-out areas deep enough to jeopardize the intermediate or final cover must be repaired within five (5) days of detection. An eroded area is considered to be deep enough to jeopardize the intermediate or final cover if it exceeds four (4) inches in depth, as measured from the vertical plane from the erosion feature and the 90-degree intersection of this plane with the horizontal slope face or surface. Damage to any temporary or permanent erosion measures noted during the inspections will be repaired or replaced within fourteen (14) days of detection. The repair schedule, as outlined for the cover or the erosion measures, may be extended due to inclement weather conditions or the severity of the condition requiring an extended repair schedule. TCEQ's Region 12 office will be notified to coordinate a revised schedule in case an extended repair schedule is required.

6.0 FLOODPLAIN EVALUATION

Consistent with 30 TAC §§330.61(m)(1), 330.63(c)(2), and 330.547, an evaluation of the 100-year floodplain has been prepared. The Hawthorn Park RDF's proposed improvements, including drainage structures and waste footprint, are located outside of the defined 100-year floodplain. The floodplain is defined by the Federal Emergency Management Agency's (FEMA's) Flood Insurance Rate Map (FIRM) Map Panel No. 48201C0635M dated June 9, 2014.

The proposed permit boundary contains a small portion (less than a one-tenth of an acre) of currently regulated 100-year FEMA floodplain as shown on the FEMA FIRM. The Special Flood Hazard designation for this area was removed by a FEMA-approved Letter of Map Amendment (LOMA), which was submitted by Jones and Carter, Inc., on behalf of the Hawthorn Park RDF permittee (USA Waste of Texas Landfills, Inc.). Per the FEMA approval letter, dated July 17, 2020, the area within the permit boundary that was previously within the 100-year floodplain has been reclassified as a 500-year flood zone. The FIRM Map Panel, LOMA, and FEMA approval letter are included in this report as Appendix III-2F-2.

No portion of the existing or proposed waste disposal footprint is located within the 100-year floodplain. Further in accordance with 30 TAC §330.547:

- No solid waste disposal operations will be conducted in areas that are located in a 100-year floodway as defined by FEMA;
- The facility will not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment; and
- All waste storage and processing facilities will be located outside of the 100-year floodplain.