Gainesville Regional Utilities

Deerhaven Generating Station

Coal Combustion Residuals Landfill Closure and Post-Closure Care Plan (Version 1.0)

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1.0 Introduction

1.1 Overview

Gainesville Regional Utilities (GRU) owns and operates the Deerhaven Generating Station (site) located in Gainesville, Florida. Unit #2 at GRU is a coal-fired power generation unit and the coal combustion residuals (CCR) resulting from the combustion process are either placed directly in the onsite CCR landfill or are transferred to the landfill after being excavated from the CCR surface impoundment system. Figure 1-1 presents the location of the CCR landfill with respect to other site features.

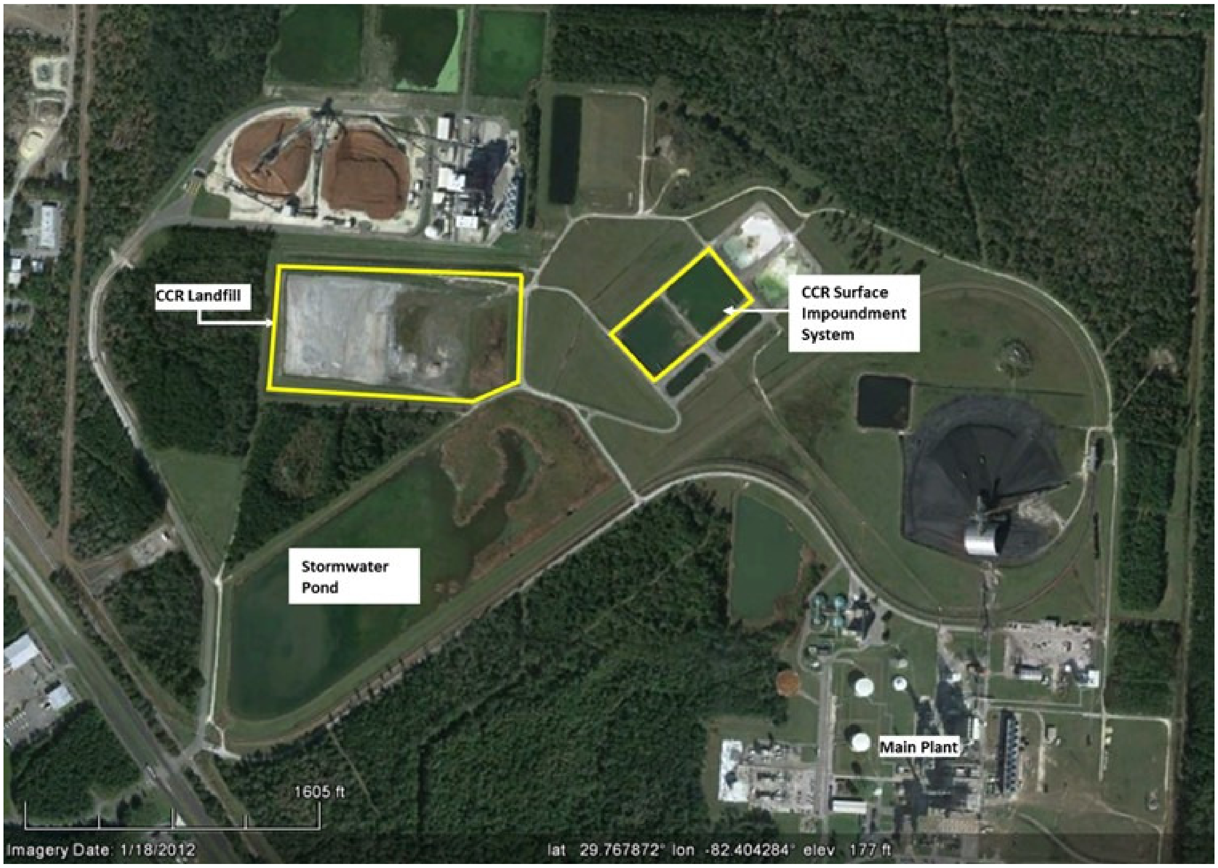


Figure 1-1. Deerhaven Generating Station (image from Google Earth, 01/20/2016)

The site includes the following power generation units: Unit 1 (i.e., natural gas-fired steam turbine), Unit 2 (coal-fired steam turbine), and three natural gas turbines (i.e., GT01-GT03). Current (GRU 2016) projections suggest that the final power generation unit at the site (i.e., GT03) will be retired in 2046. It is assumed that the plant will continue producing CCRs and/or non-CCRs streams that will require disposal at the on-site CCR landfill until 2046.

The Code of Federal Regulations (CFR), specifically 40 CFR 257 (CCR rule), requires the preparation of a CCR unit closure plan (§257.102(b)) that can be implemented at any point during the active life of the CCR unit consistent with recognized and generally accepted good engineering practices. Additionally, §257.104(d) requires the preparation of a post-closure care (PCC) plan. GRU contracted with Innovative Waste Consulting Services, LLC to develop these plans for the CCR landfill in accordance with the CCR rule.

1.2 Report Organization

This closure and PCC plan report is organized into eight sections. Section 1 presents an overview of the report and report organization. Section 2 details background information and includes a description of the site. Section 3 discusses a number of closure-related tasks that will be conducted prior to closure. Section 4 introduces the detailed closure plan including a description of the final cover system design; a description of stormwater and contact water management infrastructure; a detailed description of the closure process; and recordkeeping, notification, and monitoring requirements. Section 5 presents a detailed PCC plan. Section 6 describes limitations associated with this closure and PCC plan. Section 7 lists the references used in the development of this report. Section 8 includes a certification from a qualified professional engineer that this closure and PCC plan meets the requirements of the CCR rule.

Closure plan drawings, calculation packages, and other details related to the closure design are presented in a series of appendices.

2.0 Site Description

2.1 Overview

The CCR Landfill encompasses an approximate 23-acre area located nearly three-quarters of a mile to the northwest of GRU's main plant infrastructure. Available site records indicate that construction of the base of the CCR landfill was completed in 1981. Based on a drawing set conforming to construction records (B&M 1981), the elevation of the landfill base ranges from approximately 180 feet to 185 feet, referenced to the National Geodetic Vertical Datum of 1929 (NGVD29). Following closure, the CCR landfill will reach a maximum height of approximately 266 feet NGVD29.

Construction records indicate that a slurry wall containment system was constructed around the periphery of the CCR landfill and was keyed into an existent underlying natural clay layer; the landfill does not have an engineered bottom liner system. Details on the thickness of the existing natural clay layer and its location relative to landfill surface are not presented in construction drawings. However, a number of boreholes advanced in the general area of the landfill by B&M (1978) suggest that various types of clay (i.e., sandy clay, silty clay, calcareous clay) were encountered from 8 to 18 feet below the ground surface. The top of the slurry wall is not visible from the landfill surface; however, its location is marked on the southern and western external landfill slopes by a series of yellow stakes.

2.2 Waste Filling and Capacity

The landfill has four cells (approximately 5.5 acres each), sequenced from Cell 1 (west) to Cell 4 (east). At the time of the development of this closure plan, Cell 1 and 2 are predominantly receiving flue gas desulfurization (FGD) byproduct. Bottom ash is dredged from GRU's surface impoundments approximately once every 5 years; this dredged bottom ash has historically been placed in Cell 3. The vast majority of fly ash produced at GRU is currently beneficially used offsite for cement production. CCR is currently not being placed in Cell 4.

IWCS developed the proposed final grading plan (included in the Appendix A drawing set) based on the following assumptions:

1. Except for a couple of areas near the toe of the western and southern side slopes, the general side slope configuration of the landfill is 4:1 (horizontal:vertical). The top deck of the landfill is sloped 4% to drain towards the south.
2. The top deck width was assumed to be 50 feet; the 50-foot wide north-south dimension of the top deck was selected to promote maneuverability of closure cap construction and cover maintenance equipment.
3. The top deck will be accessed using a 25-foot wide access ramp with a grade of 10% which is located on the southern slope of the landfill. The access ramp will be sloped inward at 5% to promote stormwater run-off drainage to the swale proposed along the interior edge of the access ramp.

The landfill capacity and the closure surface area were estimated using the proposed final grading plan and AutoCAD Civil 3D 2012. With the exception of the proposed access ramp and adjacent swale, it is estimated that the final cover will be installed over the entire area of approximately 23.1 acres within the extents of the slurry wall containment system.

The landfill started accepting CCR in 1982 and has a total capacity of approximately 1.26 million yd^3; this quantity of material is the maximum inventory of CCR ever expected to be placed in the landfill over its active life. The current CCR acceptance rate at the landfill is approximately 45,000 yd^3 per year (GRU 2015). As of January 2016, CCR was estimated to occupy approximately 307,000 yd^3 of landfill airspace.

The remaining capacity is approximately 953,000 yd^3. Assuming a constant annual generation rate of 45,000 yd^3, which represents the current CCR generation rate, the landfill is expected to reach its capacity in or near 2037. While the retirement of Unit 2 (i.e., the coal-fired unit) in 2031 represents the end of the active CCR generation, it is likely that the landfill will still be necessary for the disposal of additional CCR excavated from the site's CCR surface impoundment system; the surface impoundment system is necessary for the management of the plant's process water (e.g., from plant drains) until plant retirement in 2046.

GRU will fill in the northern drainage ditch with CCR once the final grades of the landfill mound have been achieved. The northern drainage ditch will provide approximately 40,000 yd^3 of CCR capacity; the use of the northern drainage ditch for CCR placement provides a little less than a year of landfill life.

Due to uncertainties such as the future beneficial use market for the CCR and non-CCR currently disposed of in the landfill and the annual generation rate of these materials following retirement of the coal-fired unit, it is assumed that the landfill capacity will be adequate to dispose of these materials until plant retirement in 2046. It is also assumed that the landfill has sufficient capacity to accept CCR and non-CCR resulting from decommissioning and dismantling of the plant's air pollution control devices. It is assumed that landfill closure will be initiated in 2046/2047 after the conclusion of the plant decommissioning and dismantling process.

2.3 Liquids Management

The landfill has a network of 6-inch underdrains that provide gravity discharge of CCR contact water to the drainage ditch located just inside the northern extent of the CCR landfill slurry wall containment system. The northern drainage ditch is approximately 1,300 feet long, 8 feet deep and has side slopes with a 4:1 (horizontal to vertical) configuration, as presented in drawings Y65-3 and Y67-3 of B&M (1981). At the time of landfill construction, a total of four underdrains consisting of perforated polyvinyl chloride (PVC), surrounded by gravel, and wrapped in geofabric were installed to promote gravity drainage of CCR contact water to the northern drainage ditch. Each underdrain is sloped to drain from south to north through the middle of each of the four cells. In 2009, three additional high density polyethylene (HDPE) underdrain pipes were installed between each of the PVC drains and were also sloped to drain from south to north. An east-west oriented pipe was installed at the northern extent of the new underdrains which allowed them to tie in with the existing four underdrain pipes. Three window drains were installed at the intersection of the three new underdrains and the east-west oriented pipe and were extended to stick up a few feet above the landfill surface. The window drains allow the entry of CCR contact surface water into the underdrain system. The window drains were constructed from cylindrical wire cages wrapped with geotextile and filled with gravel. Figure 2-1 shows a layout of the major leachate containment and collection piping features.

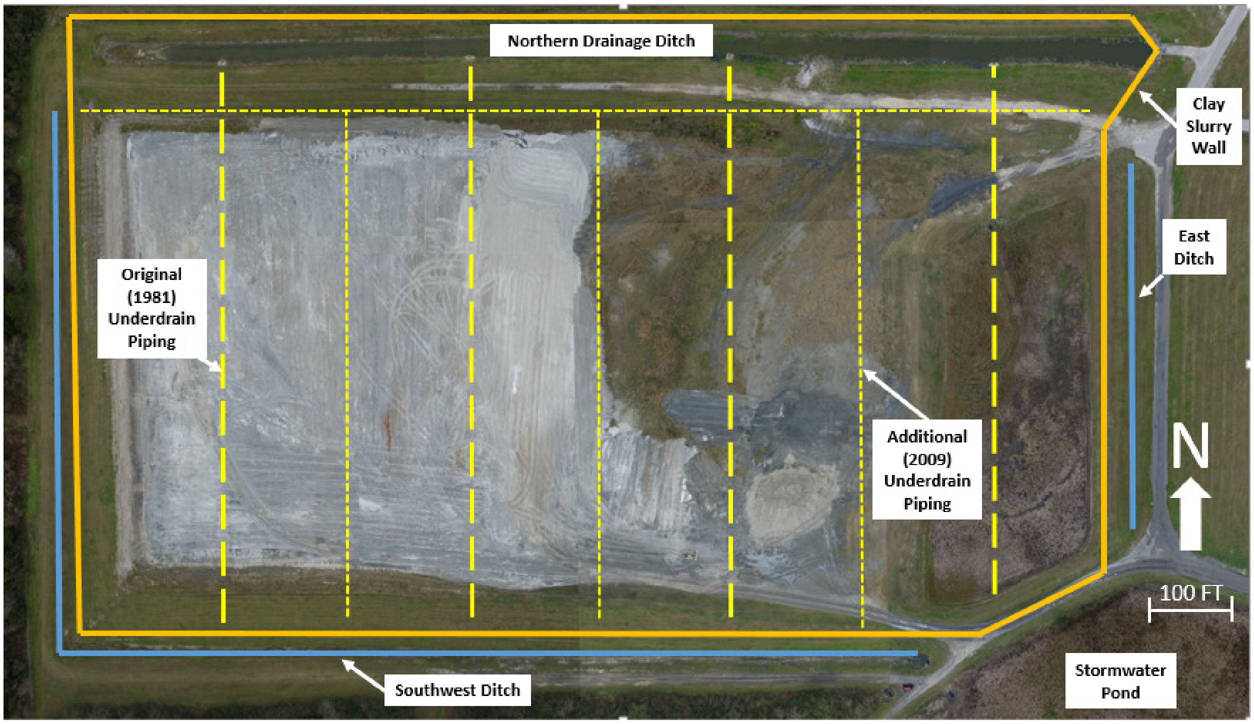


Figure 2-1. CCR Landfill with Stormwater and CCR Contact Water Collection and Containment Features (Image from IWCS (2016))

Ditches located at the western, southern and eastern landfill boundaries collect and divert stormwater to the stormwater pond located to the southeast of the landfill.

3.0 Before Closure

As discussed in Section 2.2, landfill closure activities are expected to be initiated in 2046/2047. At the time of the development of this plan, the Florida Department of Environmental Protection (FDEP) does not appear to have any permit requirements with respect to CCR landfill closure. However, prior to closure initiation, GRU will reevaluate whether any closure-related, FDEP-issued permits must be obtained. GRU will apply for FDEP permits, if any, 2 years before the anticipated landfill closure date. GRU estimates that all necessary permits will be obtained at least 12 months prior to the anticipated landfill closure date. GRU will prepare an Invitation-to-Bid or a Request-for-Proposal for seeking bids from qualified contractors to conduct the construction work needed to close the landfill at least 12 months before the estimated landfill closure date. The contractor selection process is expected to take approximately 6 months.

4.0 Closure Plan

4.1 Overview

This section describes GRU's plan for closure of the CCR landfill in accordance with the CCR rule. It specifically includes details on the design of the final cover system; stormwater management system design; and a description of closure processes including a closure implementation schedule, provisions for amendment of the closure plan and for extension of the closure timeframe. This section also lists the requirements for notices, record keeping and certifications associated with site closure and PCC.

4.2 Final Cover System Design

The final cover system of the landfill is designed to meet the closure performance standards presented in CCR rule section §257.102(d)(1). These require that the design:

1. Control, minimize or eliminate, to the maximum extent feasible, post closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;
2. Preclude the probability of future impoundment of water, sediment, or slurry;
3. Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;
4. Minimize the need for further maintenance of the CCR unit; and
5. Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.

The CCR rule requires that the final cover system must have a permeability less than or equal to the permeability of its bottom liner or natural subsoils present, or have a permeability no greater than $1x10^{-5}$ cm/s, whichever is less. Additionally, the final cover must have a minimum of an 18-inch thick earthen material barrier layer to minimize infiltration and a minimum 6-inch thick earthen material layer capable of sustaining native vegetation. Based on a review of landfill construction documentation, a constructed bottom liner system was not installed beneath the landfill. However, as described previously, the landfill is contained within a slurry wall that is keyed into an existing clay layer underlying the landfill.

While it does not appear that the permeability of the existing clay layer beneath the landfill has been rigorously evaluated, several site subsurface studies (i.e., B&M 1978, JEA 1979, JEA 1980) have tested the permeability of clay layers in the general depth range of the clay layer underneath the landfill. The majority of these measurements have estimated a permeability of $1x10^{-8}$ to $1x10^{-7}$ cm/s. Therefore, the current closure design includes the installation of a covered geomembrane cap to achieve a permeability equal to or less than that of the underlying natural (clay) subsoils. From top to bottom, the final cover system will include the following components:

- 6-inch topsoil layer (capable of supporting native vegetation)
- 18-inch protective soil layer
- 300-mil geocomposite drainage layer (i.e., a geonet sandwiched between two geotextile layers)
- 40-mil textured linear low-density polyethylene (LLDPE) geomembrane
- 12-inch intermediate cover soil layer

In the future, GRU may elect to conduct an additional subsurface investigation to sample and analyze the permeability of the existing clay layer directly outside the CCR landfill slurry wall. If the results from this investigation show a permeability less than the one reported in previous investigations, GRU may update this closure plan in accordance with §257.102(b)(3).

The entire final cover system will be graded to promote drainage to the existing stormwater pond located to the southeast of the CCR landfill; impoundment or accumulation of stormwater within the landfill area is not expected. The stormwater downchute pipes will be covered with soil to assist in minimizing periodic maintenance requirements; buried pipes will preclude photodegradation as well as reduce the incidence of damage resulting from maintenance equipment operation (e.g., mowing, final cover repair). Vegetation native to North Central Florida, such as Bahia and Rye grass, will be used to stabilize the final cover. Furthermore, the placement of stormwater diversion berms at approximately 145-foot (maximum) intervals was selected to mitigate cover soil erosion, as detailed in Appendix E.

Due to the absence of readily biodegradable organic matter in landfilled CCR, GRU does not anticipate significant landfill differential settlement or subsidence. However, in the event that cracks or other indications of final cover damage are observed, GRU will repair the damage to maintain the integrity of the final cover system. The final cover system will be installed in the shortest amount of time possible in general accordance with the schedule detailed in Section 4.5.1.

4.3 Stormwater Management System

4.3.1 Existing Infrastructure

Stormwater run-off from the intermediate soil-covered (i.e., covered with approximately 12 inches of soil and vegetation) western and southern side slopes of the landfill is collected by a stormwater diversion ditch which discharges through a culvert to the stormwater pond located to the southeast of the landfill. The current layout of the southern and western stormwater ditches was developed prior to the promulgation of the CCR rule; the layout of these ditches will need to be adjusted to incorporate the existing southern and western side slope grades into the final cover system design required by the CCR rule.

At the time of the development of this initial closure plan, an approximately 3-foot wide terrace exists on the western and southern external slopes of the landfill over the location of the slurry wall. To install a 2-foot thick final cap over the entire extents of the CCR within the slurry wall requires that an additional 1-foot thick soil layer be placed on the slopes outside of the terrace. With 3:1 (H:V) sideslopes, the toe of the existing western and southern external slopes will need to be extended 3 feet outward from its current position. Therefore, the outside slope of the stormwater drainage ditches at these locations will also need to be moved 3 feet outward; the closure grade topographic layout presented in the Appendix A drawing set includes this modification to these stormwater drainage ditches. An August 2016 topographic evaluation of the southern drainage ditch suggests that some reaches may be 2.5-feet deep. During the relocation process, the ditch will be reconstructed to achieve a minimum 2.75-foot depth (see Appendix C for calculation details).

A stormwater diversion ditch is currently located just outside the eastern section of the slurry wall. Per the results of the berm and swale sizing and pipe capacity calculations presented in Appendix C and Appendix D, this ditch will need to be expanded to include a 2-foot depth and two 24-inch diameter culverts will be installed at its south-most extent to allow stormwater runoff to discharge to the adjacent stormwater pond located to the southeast of the landfill.

4.3.2 Additional Infrastructure

The entire stormwater management system is designed to handle the run-off generated from a 24-hour, 25-year storm. Stormwater on the side slopes of the landfill will be captured and routed via a system of tack-on diversion berms which will be constructed with a longitudinal slope of 2%. The diversion berms are positioned at the approximate mid-elevation of each slope.

All soil-lined stormwater control devices (e.g., diversion berms, swales), final cover soil, and other disturbed soil areas will be seeded/sodded following installation, placement, or grading to promote vegetation establishment and minimize erosion. Appendix B and C respectively present the calculations for estimating peak flow and for sizing stormwater diversion features.

Stormwater which infiltrates through the upper soil layers of the final cover system will be intercepted by a 300-mil geocomposite drainage layer (GDL) overlaying a 40-mil LLDPE geomembrane and routed to a diversion ditch or swale. The Hydrological Evaluation of Landfill Performance model and a series of equations presented by Giroud et al. (2004) were used to evaluate the GDL and demonstrate that the maximum head expected on the geomembrane is less than the thickness of the GDL. The evaluation of the GDL is included in Appendix F.

4.4 Contact Water Management

Once the landfill is completely filled according to the final grading plan presented in Appendix A, GRU will verify that the northern drainage ditch bottom is graded to promote the drainage of liquid towards the existing pump station located at the east-most extent of the ditch. GRU will then install a 12-inch HDPE pipe along the bottom of the ditch and tie in the existing underdrain outlets to this pipe according to the drawing set presented in Appendix A. This pipe will daylight as a cleanout at its western end and will terminate at a sump at its eastern end. Cleanouts for each underdrain outlet tie in will daylight on the northern side slope of filled-in northern drainage ditch. The northern drainage ditch will be filled from west to east in a manner that ensures contact water will drain to the existing pump station. Once the northern drainage ditch is completely filled to the closure grading plan presented in Appendix A, GRU will install the final cover system over this portion of the site as well. Filling and installing the final cover system over the northern drainage ditch allows GRU to minimize contact water generation and the associated treatment costs over the PCC period.

4.5 Closure Process and Closure Plan Updates

4.5.1 Overview and Schedule for Closure Plan Implementation

Landfill closure will be performed by leaving the CCR in place and installing a final cover system over the CCR. The sequential steps involved in closing the CCR landfill generally include sending a notification of intent to close, closure initiation, installation of final cover, notification of completion of closure, and deed notations.

Final cover installation will be performed in the shortest possible time duration using recognized and generally accepted good engineering practices. A schedule of final cover installation activities was developed in accordance with §257.102(b)(vi). The timeframe for each activity was developed based on currently-available information and professional experience with similar projects. The primary tasks associated with closure include earthwork and subgrade preparation prior to geomembrane deployment (including stormwater management system construction), geomembrane and geocomposite drainage layer deployment, 18-inch protection cover soil placement, 6-inch topsoil placement, and sodding. The estimated landfill closure plan implementation schedule is provided in Figure 4-1.

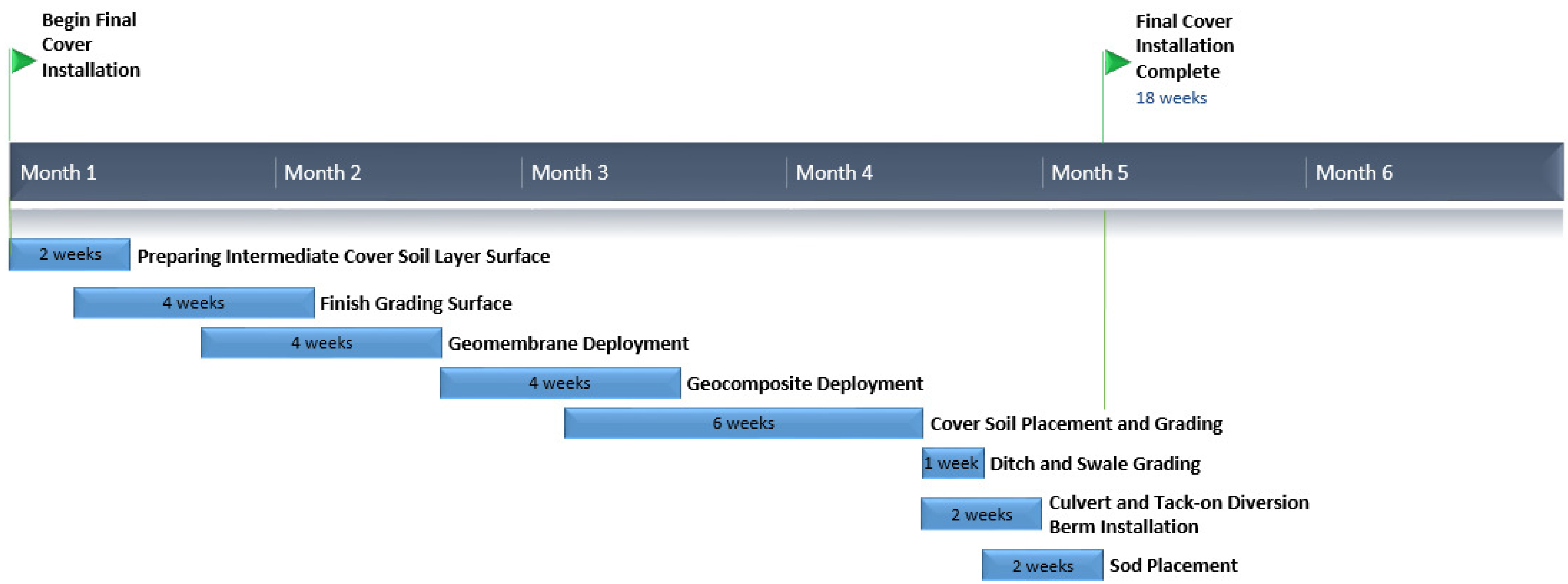


Figure 4-1. Timeline for Closure Construction Activities

The CCR rule (§257.102(b)(3)(ii-iii)) requires GRU to amend the closure plan if any circumstance may necessitate amendment of the closure plan. GRU will amend this closure plan:

1. At least 60 days prior to a planned change in the operation of the facility that substantially affects this closure plan;
2. No later than 60 days following an unanticipated event that requires a revision of the closure plan (before closure activities have started);
3. Within 30 days following an unanticipated event that requires a revision of the closure plan after closure activities have started.

During the active life of landfill, if circumstances require landfill closure before it reaches full capacity, the closure plan will be reevaluated and amended considering the existing landfill grades. If necessary, the PCC plan will also be amended. GRU will notify FDEP of the closure and PCC plan amendments and will place the amended documents in the GRU's operating record and on its publicly-accessible website (§257.105(i)(4) and (12); §257.106(i)(4) and (12); §257.107(i)(4) and (12)). GRU will obtain a certification from a qualified professional engineer on each amended closure and PCC plan verifying that the amended plan meets the requirements of CCR rule (§257.102(b)(4)).

This closure plan was developed assuming that GRU will pursue landfill closure by installing a final cover system. However, if future CCR beneficial use opportunities arise which would allow the use of in-place landfilled CCR, and if CCR is excavated and exported for beneficial use, GRU may amend the closure plan according to the requirements listed for closure by removal of CCR as presented in §257.102(c).

The closure steps for the CCR landfill are explained in detail in the following sections. Table 4-1 shows timeframes for important activities involved in the landfill closure process.

Table 4-1. Deadlines for Important Closure Activities

Closure Activity	Deadline
Closure Initiation §257.102(e)	No later than the 30 days since the final known receipt of any waste or removal of CCR for beneficial use. Within two years of the last receipt of any waste or removal of CCR waste for beneficial use if GRU cannot document the likelihood of additional waste reception at the landfill or CCR beneficial use diversion from the landfill. Closure initiation extensions may be requested. It does not appear that there is a limit on closure initiation extension requests (§257.102(e)(2)(iii)).
Completion of Closure §257.102(f)	Within six months of commencing closure activities, unless additional one-year extension(s) demonstrations are made. A maximum of two one-year extension demonstrations can be made.
Deed Notation §257.102(h)(i)	Following closure completion (assuming CCR is left in place)

During the landfill closure process, GRU will place various documents in the operating record. A list of these documents, their deadline for placement in the operating record, and certification requirements are presented in Table 4-2.

Please note that a copy of each of these documents must be placed in the operating record, and within 30 days of placement in the operating record (§257.106(d), §257.107(d)) must be posted to GRU's publicly-accessible website, and a notification that each of these documents has been placed in the operating record and on the website must be sent to FDEP.

Table 4-2. Operating Record Deadlines and Certification Requirements

Name of Document	**Deadline to be Placed in Operating Record**	**Certification/Statement Requirements**
Initial Closure Plan	October 17, 2016 (§257.102(b)(2))	Professional Engineer Certification §257.102(b)(4)
Amended Closure Plan	When completed; See deadline details in beginning of Section 4.5.	Professional Engineer Certification §257.102(b)(4)
*Closure Initiation Extension Demonstration(s)	Prior to deadline to initiate closure; See deadline discussion in Section 4.5.3	Signed Statement by GRU's Representative §257.102(e)(2)(iii)
Notification of Intent to Close	No later than the date any closure activity is initiated.	Professional Engineer Certification §257.102(g)
*Closure Completion Extension Demonstration(s)	Prior to end of 6 month closure timeframe; See details in Section 4.5.5	Signed Statement by GRU's Representative §257.102(f)(2)(iii)
Notification of Closure Completion	Within 30 days of closure completion.	Professional Engineer Certification §257.102(f)(3)
Notification of deed notation	Within 30 days of deed notation	--

*Recommended deadline – no explicit deadline appears to be included in the rule for closure initiation or completion time extension demonstrations to be placed in the operating record

4.5.2 Notification of Intent to Close

GRU will prepare a notification of intent to close the landfill and place it in GRU's operating record no later than the date on which any closure activity is initiated (§257.102(g), §257.105(i)(7)). The notification will include a certification from a qualified professional engineer verifying that the design of final cover system is in accordance with the requirements of the CCR rule (§257.102(g)). GRU will notify FDEP that the notification has been placed in the operating record and will post a copy of it on its publicly-accessible internet site (§257.106(i)(7), §257.107(i)(7)).

4.5.3 *Closure Initiation*

As required by the CCR rule (§257.102(e)), closure of the landfill will be initiated no later than 30 days following the final known waste deposition or removal (i.e., for the purpose of beneficial use) of CCR or non-CCR waste including wastes from the plant decommissioning and dismantling process. Unless GRU provides written documentation demonstrating that there is a reasonable likelihood that the landfill will continue to remove CCR for the purpose of beneficial use, GRU will initiate closure within two years of the last waste deposit or last CCR removal for beneficial use. However, GRU may secure 2-year closure time extensions by documenting the likelihood of additional CCR removal for beneficial use from the landfill in the foreseeable future. Supporting material for the demonstration will include the following:

1. Information documenting that the landfill can have CCR removed for the beneficial use.

2. Information demonstrating a reasonable likelihood of additional CCR removal for purposes of beneficial use. This information would include an estimate of when additional waste streams will be received at the landfill. Several examples relevant to coal-fired utilities are provided in §257.102(e)(2)(ii)(B)(2-4).

The documentation demonstrating a need for additional 2-year time extensions for landfill closure initiation will include the supporting documents along with the following statement signed by GRU's representative (§257.102(e)(2)(iii)):

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

4.5.4 Final Cover System Installation

The final cover, stormwater management systems, and contact water management system will be installed in accordance with the design details presented in Section 4.2, 4.3, and 4.4, respectively. Unless extenuating circumstances necessitate an earlier closure date, the final cover system will be installed when the CCR landfill reaches its capacity.

Final cover installation will begin with clearing and grubbing of vegetation on the existent 1-foot thick intermediate cover soil layer. The surface will then be graded, smoothed, and compacted to conform to the final grading plan topography included in Appendix A. With the exception of the access ramp and adjacent swale, a 40-mil textured LLDPE geomembrane will be deployed over the entire landfill surface and will be anchored just outside the extent of the slurry wall. A geocomposite drainage layer will then be placed over the geomembrane. The geocomposite will generally terminate upgradient of stormwater collection swales or ditches.

An 18-inch protective soil layer will be placed over the geocomposite – the thickness of this soil layer will be adjusted to install the tack-on diversion berms and to provide a cover for the stormwater downcomer pipes, as detailed in the Appendix A drawing set. Filter point concrete will then be installed to line several stormwater diversion features – other portions of the protective soil layer will be covered with a 6-inch topsoil layer.

The western and southern stormwater ditches will be relocated 3 feet outward from their current position to accommodate the expanded landfill toe as a result of the required cover system. Sod will be placed over all bare-earth areas as soon as feasible to minimize cover soil loss due to erosion. In the event that vegetation cannot be sufficiently established over sections of final cover system prior to the rainy season or significant storm events, temporary erosion control devices such as erosion control mats or tarpaulins will be temporarily placed over the topsoil layer to promote sod retention.

4.5.5 Completion of Closure Activities

Closure of the landfill will be completed within six months of commencing closure activities. If GRU cannot complete closure activities within this timeframe due to reasons beyond GRU's control, GRU will document the need for a one-year time extension (for a maximum of two years) to finish closure activities.

The document will include a narrative discussion of the factors that necessitate an extension of the closure time. These factors may include, but are not limited to:

- Bad weather conditions (e.g., excessive and/or prolonged precipitation)
- Delays caused by the need to coordinate with and obtain necessary approvals and permits from FDEP.

The documentation demonstrating a need for additional 1-year time extensions for landfill closure completion will include the supporting documents along with the following statement signed by GRU's representative (§257.102(f)(2)(iii)):

> *"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."*

GRU will place each of the completed demonstrations in GRU's operating record prior to end of the two-year period. For each extension, GRU will provide factual circumstances demonstrating the need for the extension.

4.5.6 Notification of Closure Completion

Within 30 days of landfill closure completion, a notification of landfill closure will be prepared and certified by a qualified professional engineer verifying that the closure has been completed in accordance with the most recent version of the landfill closure plan (§257.102(f)(3), §257.102(h)). GRU will place the notification in the operating record (§257.105(i)(8)), notify FDEP (§257.106(i)(8)), and post the notification on its publicly-accessible website (§257.107(i)(8)).

4.5.7 Deed Notations

GRU will record a notation on the deed to the property and any other instrument that is normally examined during a title search to notify any potential purchaser that the property has been used as a CCR landfill and its use is restricted under the PCC requirements described in §257.104(d)(1)(iii). A notification stating that the notation has been recorded will be placed in the operation record (§257.105(i)(9)). GRU will notify FDEP regarding inclusion of this notation in the operating record (§257.106(i)(9)) and post a copy of the notification on its publicly-accessible website (§257.107(i)(9)).

4.6 Recordkeeping, Notification, and Publicly-Accessible Website Requirements

GRU will retain a copy of the most current version of the closure plan, all closure-related notifications, and any applicable time extensions in its operating record. The records will be posted on GRU's publicly-accessible website within 30 days of inclusion in the operating record. A notification will be provided to FDEP when any closure-related document, amended document or notification is placed in GRU's operating record and on its publicly-accessible website. Deadlines for placing documents and notifications in the operating record, and details on professional engineer certifications that must be included with the documents and notifications were presented in Table 3-2.

5.0 Post-Closure Care Plan

5.1 Overview

The CCR rule requires a PCC period of 30 years (§257.104(c)(1)). However, this PCC period will be extended if, at the end of the 30-year period, GRU is conducting assessment monitoring of the CCR landfill groundwater monitoring wells. In this event, GRU will continue PCC until GRU returns to detection monitoring of the CCR landfill groundwater monitoring wells (§257.104(c)(2)).

This section describes GRU's plan for PCC of the CCR landfill in accordance with the CCR rule. Specifically, it details the PCC monitoring and maintenance requirements, point of contact, site access control, planned property use, and amendment provisions.

5.2 Monitoring and Maintenance (§257.104(d)(1)(i))

5.2.1 Overview

GRU will monitor and maintain the landfill's final cover system, contact water collection system, stormwater management system, and monitor CCR landfill area groundwater quality for a period of 30 years. During the PCC period, the final cover and other containment and monitoring systems will be inspected at the intervals presented below in Table 5-1. Specific PCC final cover inspection items are included in the CCR landfill PCC monitoring checklist provided in Appendix G.

Table 5-1. Frequency of Monitoring and Maintenance of Various Locations during PCC

Monitoring and Maintenance Location	Monitoring and Maintenance Frequency
Final cover	Quarterly
Contact water collection system	Quarterly
Stormwater management system	Quarterly
Groundwater monitoring wells	See Groundwater Monitoring Plan

5.2.2 Final Cover (§257.104(b)(1))

Final cover monitoring inspections will be conducted on a quarterly basis, but may occur more frequently if necessary (e.g., following major storm events). The final cover will be inspected for signs of contact water seepage, depressions, sloughing, erosion, distressed/excessive vegetation, and impaired stormwater management infrastructure. Any observed deficiency or concern noted during PCC inspections will be documented and addressed as soon as feasible. GRU will maintain the integrity and effectiveness of the final cover system by repairing any observed deficiency (e.g., erosion, damage or obstruction of stormwater infrastructure).

Vegetation across the entire final cover system will be assessed during quarterly inspections. The external slope will be mowed prior to the inspection so that the slope can be clearly observed for signs of erosion, animal burrows, seepage, or any other deficiency. Any areas where grass cover is not observed to be adequate will be sodded or re-seeded. Fertilizers may be applied, as needed, to maintain the vegetative cover. Adequately established vegetation minimizes erosion and important for effective performance of the stormwater management system and the final cover. However, excessive vegetation with larger and deeper roots can potentially create precipitation and stormwater infiltration pathways through the drainage layer of the final cover.

5.2.3 Liquid Collection Systems

The stormwater management devices (e.g., ditches, swales, diversion berms, culverts) and contact water management infrastructure will also be inspected on a quarterly basis to identify issues such as obstructions and damage that may impact their functionality. In the event of significant rainfall or a major storm (e.g., tropical storm, hurricane, tornado), GRU will conduct an immediate follow-up inspection to verify the integrity of the liquid management systems. GRU will initiate repairs in the event of any observed abnormality. Repairs will include the periodic removal of accumulated sediments from liquid management features.

During PCC, the CCR landfill will generate both stormwater and may continue to generate CCR contact water. The landfill does not have a constructed bottom liner system, but contact water is collected through a network of underdrain pipes located at the base of deposited CCR material. Four (4) underdrains will discharge to a common 12-inch pipe located in the northern extent of the landfill. As described in Section 4.4, this pipe will be graded so that all contact water collected by these pipes drains to a sump located towards the eastern side of the drainage ditch. This sump will be equipped with a float-activated pump for automated pumping of the contact water from the sump to a storage tank or directly to offsite treatment (depending on the plant's operational status following landfill closure). Sump pump functionality and the condition of the sump will be inspected during PCC period monitoring events for timely identification of the issues such as sediment accumulation in the sump.

Any necessary repair or maintenance activity will be scheduled and performed as soon as feasible if any unacceptable condition is observed. The PCC inspection checklist (included in Appendix G) shows a list of liquid collection system components that will be monitored during the PCC period.

5.2.4 Groundwater Monitoring (§257.104(b)(3))

Groundwater monitoring during PCC will be conducted in accordance with the CCR rule sections §257.90 through §257.98. Details of the groundwater monitoring program during the active and PCC life of the landfill will be included in the site's groundwater monitoring plan.

5.2.5 Personnel Responsibilities

Personnel responsible for the operation and maintenance of the landfill during PCC will be completely acquainted with the requirements of the CCR rule pertaining to PCC. The personnel will be qualified to assess the condition of final cover and identify deficiencies related to the structural integrity and the effectiveness of the final cover. Additional responsibilities will include scheduling any necessary maintenance and repair work for the final cover and liquids systems.

5.3 Point of Contact (§257.104(d)(1)(ii))

The point of contact for the PCC period is currently the following:

Joey Fowler
Material Handling Supervisor
Deerhaven Generating Station
10001 NW 13Th Street
Gainesville, Florida 32653
(352) 393-6123
FowlerJN@gru.com

Please note that the point of contact is expected to change as the landfill will not be under PCC until 2047. GRU will update the point of contact before the start of the PCC period.

5.4 Planned Property Use (§257.104(d)(1)(iii))

Currently, GRU does not have any plan for post-closure use of the landfill site that will negatively affect the integrity of the final cover or any other component of the landfill containment system. The property will be a private open space with access to only authorized personnel. The PCC plan will be amended in the event that the intended post-closure use of the landfill changes.

In the event GRU decides to conduct post-closure landfill mining (e.g., for the beneficial use of CCR or non-CCR material), GRU will develop a demonstration that the disturbance of the final cover, liner or other component of the containment system will not increase the potential threat to human health or the environment. This demonstration will be certified by a qualified professional engineer and a notification of the demonstration will be sent to FDEP and placed on its publicly-accessible internet site.

5.5 PCC Plan Amendment (§257.104(d)(3))

GRU will amend the PCC plan:

1. At least 60 days prior to a significant, planned change in landfill operations that substantially affect the PCC plan in effect; or
2. Within 60 days following an unanticipated event that requires a revision of the PCC plan before PCC activities have started or within 30 days following an unanticipated event that requires a revision of the PCC plan after PCC activities have started.

GRU will obtain a certification from a qualified professional engineer on all amended PCC plans verifying that the PCC plan meets the requirements of CCR rule. GRU will include this PCC plan and any subsequent amendment of this plan in the operating record, notify FDEP, and post the notification on its publicly-available website per §257.105(i)(12), §257.106(i)(12), §257.107(i)(12), respectively.

5.6 Notification of Completion of PCC (§257.104(e))

Within 60 days of completion of PCC, GRU will prepare a notification of PCC completion which will be certified by a qualified professional engineer verifying that the PCC has been completed in accordance with the closure plan that meets the requirements of §257.104. The notice will be placed in GRU's operating record, FDEP will be notified of PCC completion, and the notice will be placed on its publicly accessible internet site per §257.105(i)(13), §257.106(i)(13), §257.107(i)(14), respectively.

6.0 Limitations

This Closure and PCC Plan has the following limitations:

1. **Slope Stability** - A landfill slope stability analysis was not conducted as part of the development of this closure and PCC plan. The properties of the different CCR placed in the landfill are subject to change (e.g., based on the properties of the combusted coal, operation of the flue gas scrubber system) and the final stability will depend on the location and/or mix of CCR and non-CCR material. In addition, the source and geotechnical properties of the soil that will be used in the intermediate cover and the final cover system are unknown. These geotechnical properties are necessary for a meaningful slope stability analysis. In the absence of this information, the geomembrane and geosynthetic drainage layer are not proposed for placement under the access ramp and the adjacent concrete-lined swale due to potential stability concerns.
2. **Contact Water Management System** – This plan proposes pumping CCR contact water collected from the landfill underdrains to offsite treatment. GRU may consider alternative treatment approaches depending on the availability/viability of offsite treatment. The contact water generation rate at the time of closure is unknown – contact water sump and pump specifications will be selected as part of the future construction-level closure design.
3. **Closure Prior to Final Buildout** – The CCR rule requires a closure plan that describes the steps necessary to close the CCR unit at any point during its active life. The final grades, final in-place volume of CCR, and corresponding design presented in these plans are based on the continued placement of CCR at the landfill until 2046. Unforeseen circumstances such as a change in the beneficial use of CCR or the CCR generation rate may result in landfill grades that are significantly different than those used for closure plan development; as needed, the proposed closure plan will be reevaluated and modified at least two years prior to the anticipated closure date.
4. **Additional Capacit**y – The current design includes CCR fill of the existing northern drainage ditch to promote stormwater drainage. The proposed final grading plan does not use the entire disposal airspace available on the north side of the current landfill footprint. GRU may consider using this airspace in the future before closure, if necessary.

7.0 References

B&M (1978). Subsurface Information for the Deerhaven Generating Station Site Near Hague, Florida for the City of Gainesville, Florida, Deerhaven Unit 2. 76-077-1. Prepared for the Gainesville Alachua County Regional Electric Water & Sewer Utilities Board by Burns and McDonnell.

B&M (1981). Construction Drawings. Deerhaven Generating Station Unit 2. City of Gainesville/Gainesville-Alachua County Regional Utilities Board. Prepared by Burns & McDonnell, Kansas City, Missouri.

Google, Inc. (2012). Google Earth (Version 6.2.1.6014) [Software]. Accessed 20 January 2016.

GRU (2015). Best Management Practices Guide for Managing Coal Combustion Residuals at the Deerhaven Generating Station. Version 3.0. Report prepared by Innovative Waste Consulting Services, LLC, Gainesville, Florida for Gainesville Regional Utilities, Gainesville, Florida.

GRU (2016). Gainesville Regional Utilities 2016 Ten-Year Site Plan. Submitted to the Florida Public Service Commission, 1 April 2016.

IWCS (2016). CCR Landfill. Aerial Imagery. Deerhaven Generating Station, Gainesville, Florida. Photograph taken 14 January 2016.

JEA (1979). Coal Storage Lining Investigation, Deerhaven Unit 2, City of Gainesville/Alachua County Regional Utilities Board, JEA Project No. 77-054-003. Prepared by Jones Edmunds and Associates, Inc. 28 March 1979.

JEA (1980). Proposed Facilities for Coal Storage, Ash Disposal and Evaporator Residue Disposal – Deerhaven Generating Station, JEA Project No. 76-054-003. Prepared by Jones Edmunds and Associates, Inc. March 1980.

8.0 Professional Engineer Certification

This plan was prepared under the supervision, direction and control of the undersigned, registered professional engineer (PE). The undersigned PE is familiar with the requirements of 40 CFR 257.101, 40 CFR 257.102 and 40 CFR 257.104. The undersigned PE certifies that this CCR unit closure plan and PCC plan meets the requirements of 40 CFR 257.102(b) and 40 CFR 257.104(d), respectively.

Name of Professional Engineer: Justin Lamar Smith

Company: Innovative Waste Consulting Services, LLC

Signature:

Date: 10/14/16

PE Registration State: Florida

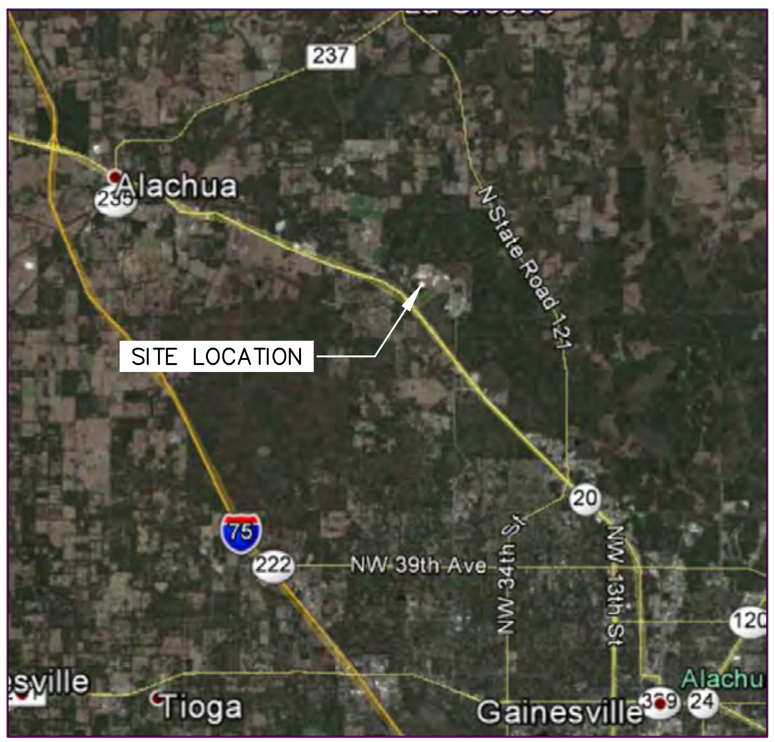
PE License No.: 80463

JUSTIN L. SMITH
LICENSE
No. 80463
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

COAL COMBUSTION RESIDUALS LANDFILL

CLOSURE DESIGN PLAN

APPENDIX A: DRAWING SET



AREA LOCATION MAP

PREPARED FOR:

GAINESVILLE REGIONAL UTILITIES

DEERHAVEN GENERATING STATION
10001 NW 13TH ST.
GAINESVILLE, FL 32653

PREPARED BY:

innovative waste consulting services, llc

6628 NW 9th BLVD. SUITE 3
GAINESVILLE, FL 32605-4282

DATE: OCTOBER 2016

NOT FOR CONSTRUCTION

DRAWING INDEX	
SHEET No	TITLE
1	COVER PAGE
2	GENERAL NOTES
3	CCR LANDFILL LOCATION
4	EXISTING GRADES
5	PROPOSED FINAL GRADES
6	PROPOSED CLOSURE GRADES
7	STORMWATER CONTROL SYSTEM
8	STORMWATER DRAINAGE BASINS
9	STORMWATER MANAGEMENT DETAIL LAYOUT
10	CONTACT WATER MANAGEMENT DETAIL LAYOUT
11	DETAILS 1–4
12	DETAILS 5–7
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16	DETAILS 17–19
17	DETAILS 20–22
18	DETAILS 23–25
19	DETAILS 26–27
20	DETAIL 28

GENERAL NOTES

1. THE EXISTING TOPOGRAPHY PRESENTED IN THIS CLOSURE PLAN IS PRIMARILY DERIVED FROM A IN-HOUSE TOPOGRAPHIC EVALUATION CONDUCTED IN JANUARY 2016 TO ESTIMATE THE EXISTING IN-PLACE QUANTITY OF COAL COMBUSTION RESIDUALS (CCR). ADDITIONAL TOPOGRAPHIC INFORMATION WAS DERIVED FROM AN AS-BUILT SURVEY PROVIDED BY CAUSSEAUX, HEWETT AND WALPOLE, INC. CONDUCTED ON 2 NOVEMBER 2012.
2. THE HORIZONTAL DATUM USED IN THIS DRAWING SET IS BASED ON THE FLORIDA STATE PLANE COORDINATE SYSTEM NORTH (NAD 83). ELEVATIONS ARE REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).
3. FIELD CONDITIONS MAY REQUIRE MODERATE GRADE DEVIATIONS COMPARED TO THOSE SHOWN IN THE DRAWING SET; THE PROPOSED FEATURES SHOWN IN THE DRAWINGS SHALL BE CONSTRUCTED TO WITHIN REASONABLE DEVIATIONS.
4. ALL CLEARANCES AND PROPERTY BOUNDARIES SHALL BE VERIFIED PRIOR TO CONSTRUCTION.
5. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN TO THE BEST INFORMATION AVAILABLE AT THE TIME OF PREPARATION OF THESE DRAWINGS, BUT THERE MAY BE OTHER FEATURES (OR SLIGHT DEVIATIONS FROM THE FEATURES SHOWN) WITHIN THE PROJECT AREA. THE LOCATIONS, ELEVATIONS AND DIMENSIONS OF ALL EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES (WHETHER OR NOT SHOWN ON THE PLANS) AFFECTING THE WORK SHALL BE VERIFIED PRIOR TO CONSTRUCTION.
6. WHATEVER MEANS NECESSARY SHALL BE TAKEN TO PROTECT ALL EXISTING UTILITIES, STRUCTURES, MONITORING WELLS/PIEZOMETERS, AND ALL OTHER CRITICAL SITE INFRASTRUCTURE FROM DAMAGE DURING CONSTRUCTION. ALL MONITORING WELLS/PIEZOMETERS AND OTHER CRITICAL SITE INFRASTRUCTURE DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED OR REPLACED WITH EQUIVALENT MATERIALS AND CONSTRUCTION METHODS. ALL WORK TO REPAIR, MODIFY, REPLACE, OR ABANDON MONITORING WELLS/PIEZOMETERS SHALL BE PERFORMED WITH THE APPROVAL OF AND TO THE SATISFACTION OF THE OWNER, IN ACCORDANCE WITH APPLICABLE FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION (FDEP) RULES, AND BY A LICENSED WELL CONSTRUCTION CONTRACTOR.
7. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH EXISTING APPLICABLE DESIGN AND CONSTRUCTION STANDARDS.
8. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH PREVAILING FEDERAL, STATE, LOCAL, AND OTHER APPLICABLE REGULATIONS.
9. EXISTING LANDFILL SLOPE DIMENSIONS AND TOPOGRAPHY MAY DIFFER FROM THAT SHOWN IN THE DRAWINGS AND ARE SUBJECT TO CHANGE BECAUSE OF WASTE FILLING, EROSION, RE-GRADING, OR EARTHWORK BY THE OWNER.
10. PRIOR TO BEGINNING EARTHWORK, STORMWATER AND EROSION CONTROL PLANS SHALL BE DEVELOPED AND IMPLEMENTED TO PREVENT PONDING AND CONTROL EROSION AND RUNOFF. A CLEAR PATH FOR ALL SURFACE WATER DRAINAGE STRUCTURES AND DITCHES SHALL BE MAINTAINED DURING ALL PHASES OF CONSTRUCTION. WHATEVER MEANS NECESSARY SHALL BE USED TO PREVENT EROSION AND TO MANAGE STORMWATER SUCH THAT THE IMPACT TO CONSTRUCTION IS MINIMIZED. EROSION AND SEDIMENT CONTROLS SHALL BE MAINTAINED UNTIL PERMANENT GROUND COVER HAS BEEN ESTABLISHED.
11. ALL WARNING SIGNALS, SIGNS, LIGHTS, AND FLAG PERSONS WILL BE USED AS REQUIRED BY APPLICABLE FLORIDA DEPARTMENT OF TRANSPORTATION STANDARDS.
12. STORMWATER CONTAMINATED BY CONTACT WITH CCR, DEWATERING DISCHARGE, SOILS CONTAMINATED BY CCR OR CCR CONTACT WATER, AND EXCAVATED CCR SHALL BE CONTAINED AND PROPERLY DISPOSED OF PER THE PREVAILING LOCAL, STATE AND FEDERAL REGULATIONS. DISTURBANCE TO AND UNDERMINING OF ADJACENT STRUCTURES, SLABS, PIPING, AND OTHER UTILITIES/FACILITIES DURING CONSTRUCTION WILL BE PREVENTED.
13. DEWATERING ACTIVITIES WILL BE PERFORMED AS REQUIRED TO ACHIEVE THE GRADES PRESENTED IN THIS DRAWING SET.
14. NO DISTURBANCE SHALL BE ALLOWED OUTSIDE OF THE LIMITS OF CONSTRUCTION, UNLESS APPROVED BY THE OWNER.
15. ENVIRONMENTAL PROTECTION SHALL BE MAINTAINED THROUGHOUT CONSTRUCTION. CONSTRUCTION ACTIVITIES SHALL COMPLY WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS PERTAINING TO WATER, AIR, SOLID WASTE, HAZARDOUS WASTE MATERIALS, OILY SUBSTANCES, AND NOISE POLLUTION. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE IMPLEMENTED AS NECESSARY TO COMPLY WITH THESE REGULATIONS FOR BOTH TEMPORARY AND PERMANENT CONSTRUCTION.
16. ALL TERMS, CONDITIONS, AND REQUIREMENTS OF ALL APPLICABLE PERMITS, INCLUDING (BUT NOT LIMITED TO) US EPA AND FDEP PERMITS FOR THE SITE SHALL BE COMPLIED WITH.
17. ALL EXISTING PAVEMENT, STABILIZED EARTH, FENCES, SIGNS, UTILITIES AND OTHER IMPROVEMENTS SHALL BE REPLACED WITH THE SAME TYPE OF MATERIAL THAT WAS REMOVED OR DAMAGED DURING CONSTRUCTION OR AS A RESULT OF CONSTRUCTION,
18. ALL REQUIRED LICENSES AND PERMITS ASSOCIATED WITH THE CONSTRUCTION OF THIS PROJECT SHALL BE OBTAINED.
19. THE LOCATION OF STORMWATER CONTROL AND CONVEYANCE FEATURES SHOWN IS APPROXIMATE AND MAY BE ADJUSTED DURING CONSTRUCTION TO ACCOMMODATE FIELD CONDITIONS. ACTUAL LOCATIONS AND SLOPES MUST BE FIELD VERIFIED AND DOCUMENTED TO INDICATE THAT APPROPRIATE STORMWATER CONVEYANCE IS ACHIEVED.
20. ALL UNITS SHOWN ARE IN FEET UNLESS NOTED OTHERWISE.
21. ALL STORMWATER CONVEYANCE PIPING SHALL BE DUAL-WALL, SMOOTH-INTERIOR CORRUGATED HDPE.
22. ADJUSTMENTS TO THE CONSTRUCTED COMPONENTS MAY BE REQUIRED AS A RESULT OF SUPPLIER DELIVERY TIMES, CONSTRUCTION SCHEDULING, AND THE REGULATORY APPROVAL PROCESS.
23. SEVERAL SITE ACCESS ROADS RUN ADJACENT TO THE CCR LANDFILL. THESE ROADS SHALL NOT BE OBSTRUCTED DURING CONSTRUCTION ACTIVITIES.
24. TEMPORARY EROSION CONTROL MEASURES TO PREVENT COVER SOIL WASHOUT INTO TOE DRAINS, SWALES/DITCHES, AND OTHER STORMWATER MANAGEMENT STRUCTURES SHALL BE IMPLEMENTED UNTIL COVER VEGETATION IS FULLY ESTABLISHED.
25. TACK-ON DIVERSION BERMS SHALL NOT HAVE AN OUTER SLOPE CONFIGURATION THAT IS STEEPER THAN 2:1 H:V (HORIZONTAL TO VERTICAL).

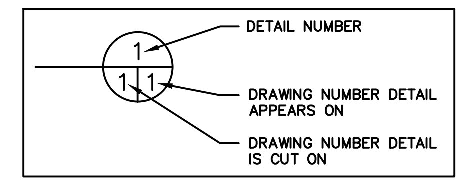
SITE HEALTH AND SAFETY

1. THIS PROJECT INVOLVES WORK IN AND AROUND A CCR LANDFILL. ALL CONSTRUCTION PERSONNEL SHALL BE PROTECTED FROM ALL HAZARDS ASSOCIATED WITH WORKING AT A LANDFILL, INCLUDING CONTACT WITH CCR CONTACT WATER. OSHA CHAPTERS 1910 AND 1926, OSHA EXCAVATION SAFETY STANDARDS, CCR REGULATIONS, AND OTHER APPLICABLE REGULATIONS SHALL BE COMPLIED WITH.

AS-BUILT SURVEY REQUIREMENTS

1. ALL SURVEY WORK REQUIRED AS SHOWN ON THE PLANS AS WELL AS IN THE SPECIFICATIONS SHALL BE CONDUCTED BY A PROFESSIONAL SURVEYOR WITH A VALID LICENSE IN FLORIDA.
2. INTERIM SURVEYS SHALL BE CONDUCTED AS REQUIRED AS CONSTRUCTION PROGRESSES TO ENSURE CONFORMANCE WITH THE DESIGN DOCUMENTS. ANY FIELD CHANGES MADE AS A RESULT OF CONDITIONS ENCOUNTERED DURING CONSTRUCTION MUST BE APPROVED PRIOR TO EXECUTION.
3. UPON COMPLETION OF CONSTRUCTION, A FINAL TOPOGRAPHIC SURVEY SHALL BE PERFORMED TO PROVIDE THE REQUIRED RECORD DRAWING INFORMATION AND TO VERIFY THAT THE FINAL CONTOURS, ELEVATIONS, CLOSURE CAP PLACEMENT AND STORMWATER MANAGMENT SYSTEM COMPONENTS WERE CONSTRUCTED IN ACCORDANCE WITH THE DRAWINGS AND SPECIFICATIONS.

DETAIL DESIGNATION



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LTR	DATE	REVISIONS	BY	APPRD.

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INNOVATIVE WASTE CONSULTING SERVICES, LLC
6628 NW 9th BLVD. SUITE 3
GAINESVILLE, FL 32605-4282
PHONE: (352) 331-4828
FAX: (352) 331-4842

GAINESVILLE REGIONAL UTILITIES
DEERHAVEN GENERATING STATION
10001 NW 13TH ST.
GAINESVILLE, FL 32653

CCR LANDFILL CLOSURE PLAN

GENERAL NOTES

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 2 OF 20

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N

NOTES:

1. SCALE IS APPROXIMATE AND BASED ON THE SCALE INCLUDED IN NOVEMBER 2015 GOOGLE EARTH IMAGERY.

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GRAPHIC SCALE (FEET)

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INNOVATIVE WASTE CONSULTING SERVICES, LLC

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DEERHAVEN GENERATING STATION
10001 NW 13TH ST.
GAINESVILLE, FL 32653

CCR LANDFILL CLOSURE PLAN

CCR LANDFILL LOCATION

DATE: 8 SEPTEMBER 2016

PRJ No:

SCALE: AS SHOWN

DWG No: 3 OF 20

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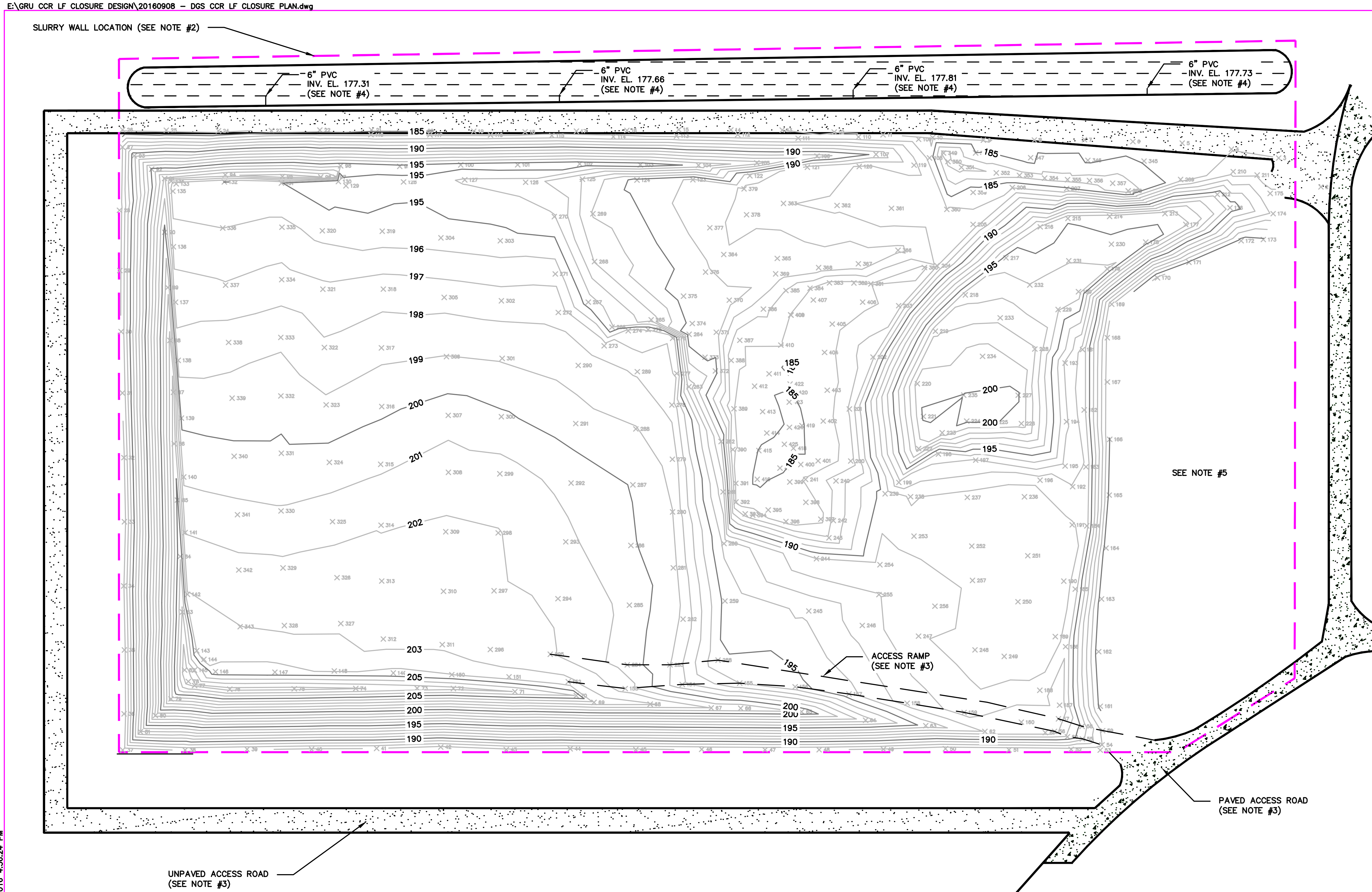

NOTES:

1. THE EXISTING TOPOGRAPHY PRESENTED IS PRIMARILY DERIVED FROM A IN-HOUSE TOPOGRAPHIC EVALUATION CONDUCTED IN JANUARY 2016 TO ESTIMATE THE EXISTING IN-PLACE QUANTITY OF CCR. ADDITIONAL TOPOGRAPHIC INFORMATION USED IN THE DEVELOPMENT OF THE FINAL GRADING PLAN WAS DERIVED FROM AN AS-BUILT SURVEY PROVIDED BY CAUSSEAUX, HEWETT AND WALPOLE, INC. CONDUCTED ON 2 NOVEMBER 2012. ALL ELEVATIONS ARE PRESENTED WITH RESPECT TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).
2. THE NORTHERN AND EASTERN EXTENT OF THE SLURRY WALL IS APPROXIMATE AND BASED ON A 1981 DRAWING SET FROM BURNS AND MCDONNELL CONFORMING TO CONSTRUCTION RECORDS.
3. THE LOCATION OF THE ACCESS RAMP AND ACCESS ROADS IS APPROXIMATE.
4. THESE PIPE INVERTS REPRESENT THE OUTLETS OF AN EXISTING UNDERDRAIN SYSTEM FOR CCR CONTACT WATER.
5. CCR WAS NOT IDENTIFIED IN THIS AREA AS OF JANUARY 2016; TOPOGRAPHY IN THIS AREA WAS NOT EVALUATED.

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GRAPHIC SCALE
(FEET)

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LTR	DATE	REVISIONS	BY	APPRD.

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INNOVATIVE WASTE CONSULTING SERVICES, LLC
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DEERHAVEN GENERATING STATION
10001 NW 13TH ST.
GAINESVILLE, FL 32653

CCR LANDFILL CLOSURE PLAN

EXISTING GRADES (JANUARY 2016)

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 4 OF 20

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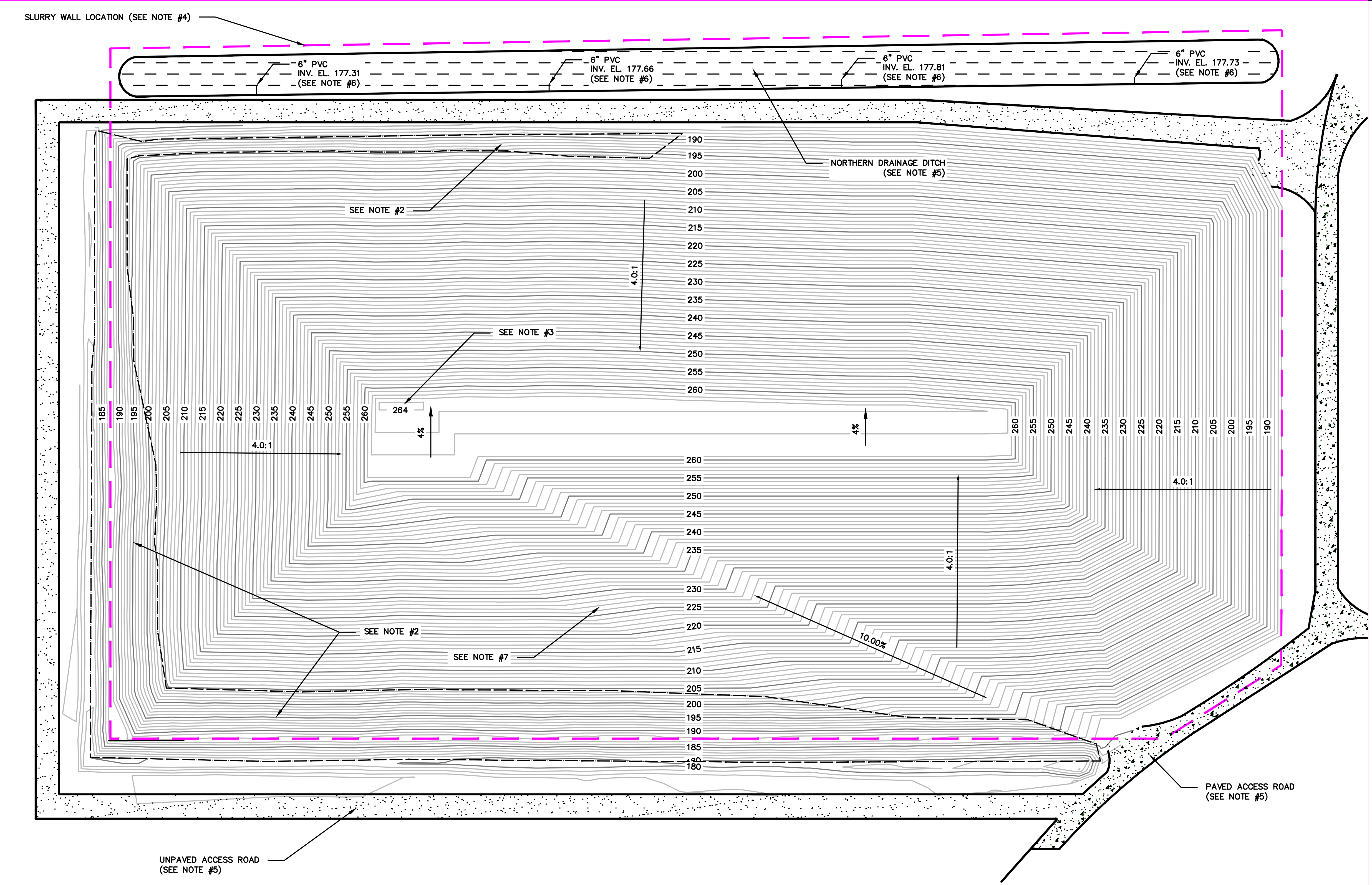

NOTES:

1. FINAL GRADES REPRESENT THE PROPOSED CCR LANDFILL SURFACE AT FINAL BUILD OUT, INCLUDING A 1-FOOT INTERMEDIATE SOIL COVER CAP. THE PRECISE LOCATION OF GRADE BREAKS AND ELEVATIONS WILL DEPEND ON THE FIELD CONDITIONS AT THE TIME OF CLOSURE.
2. AREAS NEAR THE TOE OF THE NORTHERN, WESTERN AND SOUTHERN SIDE SLOPES WILL BE STEEPER THAN 4:1 (H:V) BASED ON EXISTING CONDITIONS. THE APPROXIMATE EXTENTS OF THESE AREAS ARE DELINEATED.
3. THE MAXIMUM ELEVATION OF THE CCR LANDFILL WITH THE INTERMEDIATE COVER SOIL LAYER IS DESIGNED TO BE APPROXIMATELY 264 FT.
4. THE NORTHERN AND EASTERN EXTENT OF THE SLURRY WALL IS APPROXIMATE AND BASED ON A 1981 DRAWING SET FROM BURNS AND MCDONNELL CONFORMING TO CONSTRUCTION RECORDS.
5. THE LOCATION OF THE NORTHERN DRAINAGE DITCH AND ACCESS ROADS IS APPROXIMATE.
6. THESE PIPE INVERTS REPRESENT THE OUTLETS OF AN EXISTING UNDERDRAIN SYSTEM FOR CCR CONTACT WATER.
7. AS NECESSARY, SLOPES MILDER THAN 4:1 MAY BE USED TO TIE-IN PROPOSED FINAL GRADES WITH EXISTING GRADES.

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CCR LANDFILL CLOSURE PLAN

PROPOSED FINAL GRADES

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 5 OF 20

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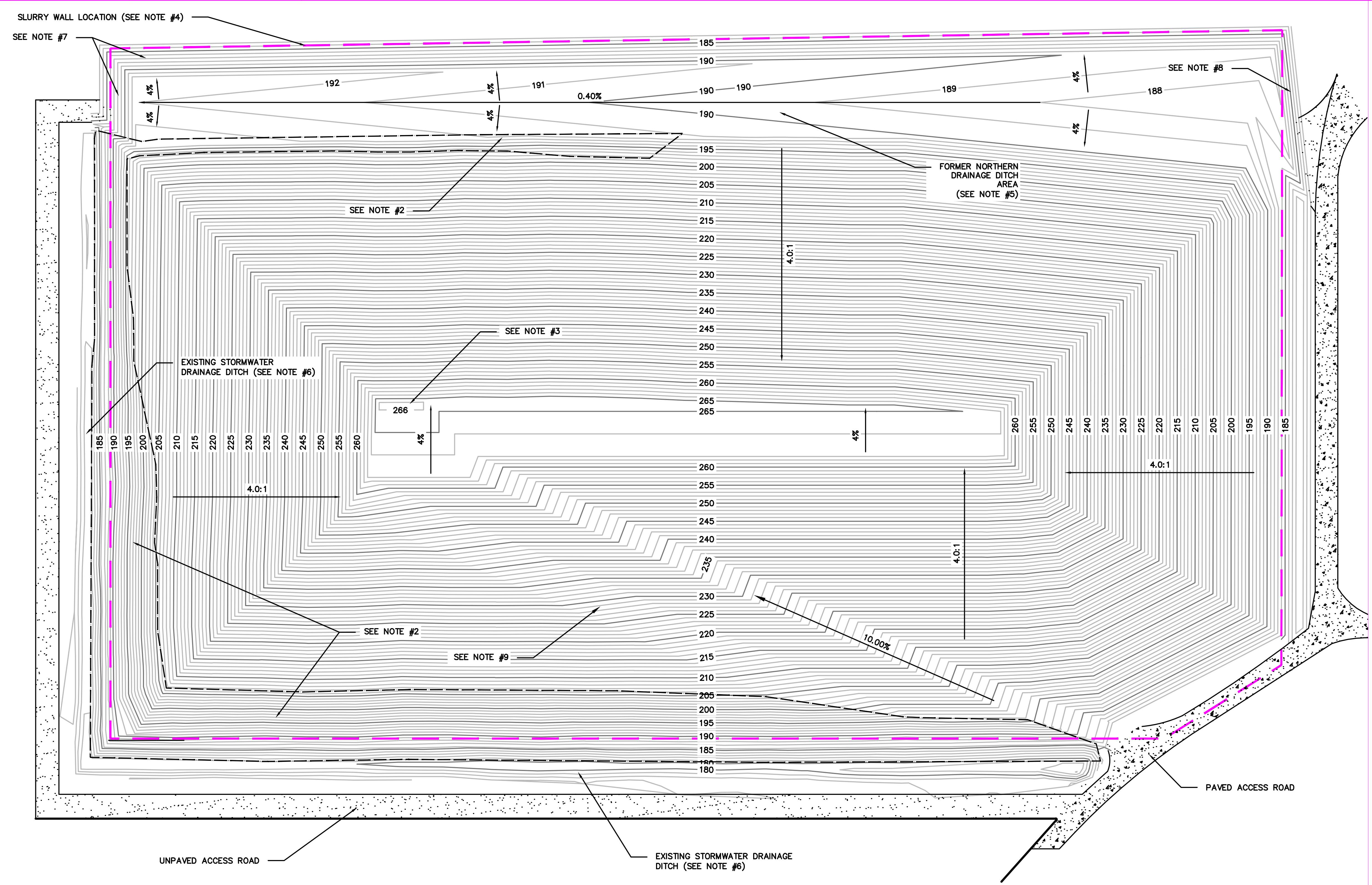

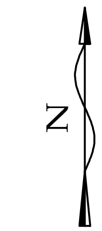

NOTES:

1. THE CLOSURE GRADES REPRESENT THE PROPOSED LANDFILL SURFACE FOLLOWING INSTALLATION OF THE FINAL CLOSURE CAP SYSTEM. EXCEPT FOR THE ACCESS RAMP AND ADJACENT SWALE, THE GEOMEMBRANE WILL BE INSTALLED OVER THE ENTIRE EXTENTS OF THE AREA WITHIN THE SLURRY WALL CONTAINMENT SYSTEM. THE PRECISE LOCATION OF GRADE BREAKS AND ELEVATIONS WILL DEPEND ON THE FIELD CONDITIONS AT THE TIME OF CLOSURE.
2. AREAS NEAR THE BOTTOM OF THE NORTHERN, WESTERN AND SOUTHERN SIDE SLOPES WILL BE STEEPER THAN 4:1 (H:V) BASED ON EXISTING CONDITIONS. THE APPROXIMATE EXTENTS OF THESE AREAS ARE DELINEATED.
3. THE MAXIMUM ELEVATION OF THE CCR LANDFILL WITH THE FINAL COVER SYSTEM IS DESIGNED TO BE APPROXIMATELY 266 FT.
4. THE NORTHERN AND EASTERN EXTENT OF THE SLURRY WALL IS APPROXIMATE AND BASED ON A 1981 DRAWING SET FROM BURNS AND MCDONNELL CONFORMING TO CONSTRUCTION RECORDS.
5. THE NORTHERN DRAINAGE DITCH WILL BE FILLED WITH EITHER CCR OR SOIL. THIS AREA WILL BE BROUGHT TO THE PROPOSED CLOSURE GRADES WITH INSTALLATION OF THE FINAL COVER SYSTEM. PRIOR TO FINAL COVER SYSTEM PLACEMENT, THE CCR CONTACT WATER UNDERDRAINS WILL BE TIED INTO A COMMON HEADER ACCORDING TO THE DETAILS INCLUDED IN THIS DRAWING SET.
6. THE EXISTING STORMWATER DRAINAGE DITCHES LOCATED AT THE WESTERN AND SOUTHERN TOE OF THE LANDFILL WILL BE MOVED 3 FEET OUTWARDS FROM THE LANDFILL TOE AS PART OF CLOSURE ACTIVITIES.
7. THE CONFIGURATION OF THE WESTERN AND NORTHERN SLOPES OF THE NORTHERN DITCH FILL AREA SHALL BE 4:1 (H:V).
8. THE CONFIGURATION OF THE EASTERN SLOPE OF THE NORTHERN DITCH FILL AREA SHALL BE 3:1 (H:V).
9. AS NECESSARY, SLOPES MILDER THAN 4:1 MAY BE USED TO TIE-IN PROPOSED FINAL GRADES WITH EXISTING GRADES.

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CCR LANDFILL CLOSURE PLAN

PROPOSED CLOSURE GRADES

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 6 OF 20

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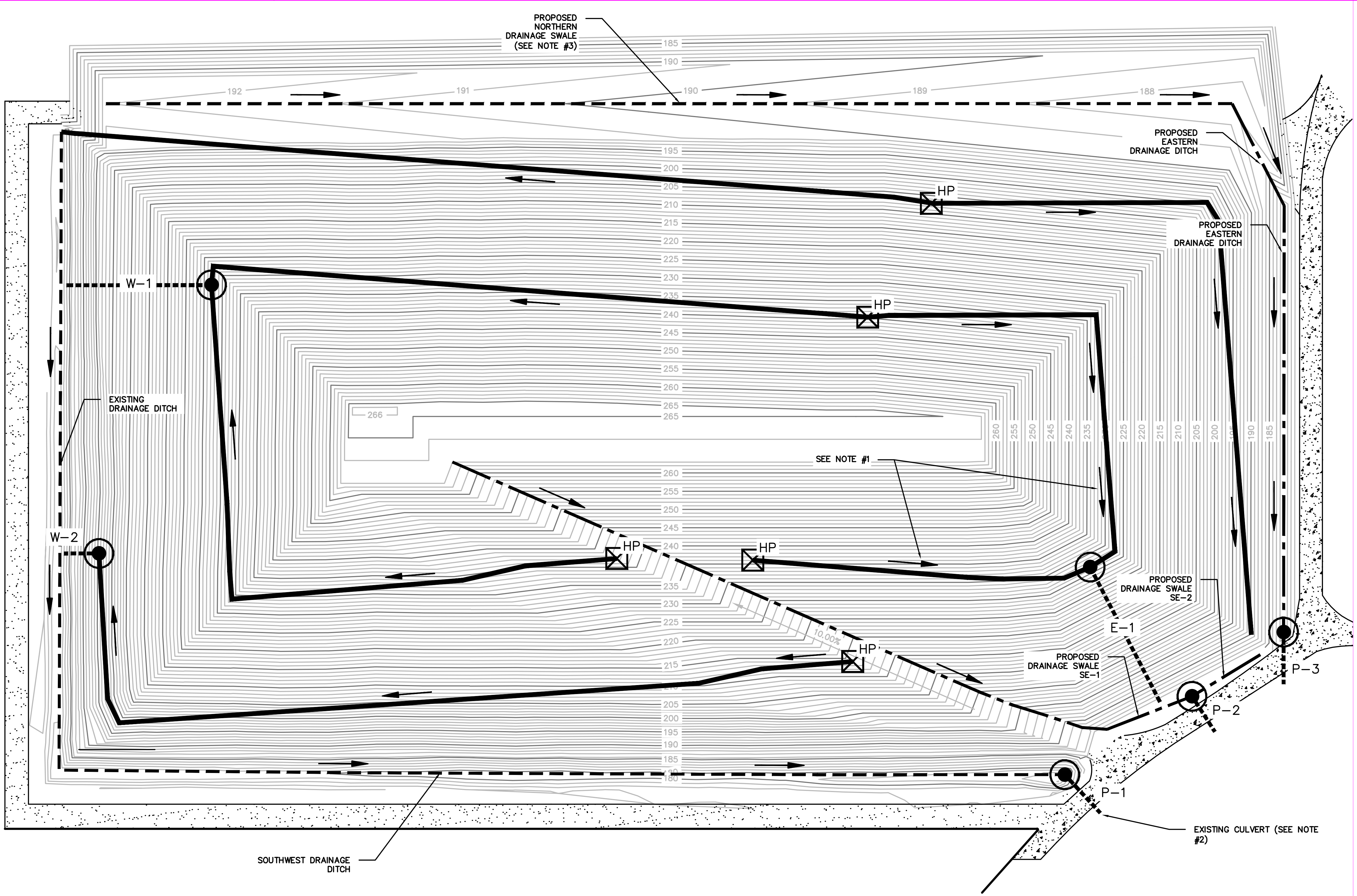

N

NOTES:

1. DIVERSION BERMS SHALL HAVE A MINIMUM LONGITUDINAL SLOPE OF 2%.
2. LOCATION OF THE P-1 CULVERT INLET/OUTLET IS APPROXIMATE. ALL CULVERTS DISCHARGE TO AN EXISTING STORMWATER POND.
3. DRAINAGE SWALE BOTTOM SLOPE OF 0.4%.

LEGEND	
E-1	DOWNCOMER/ CULVERT PIPES
	STORMWATER FLOW DIRECTION
	DITCH/SWALE CENTER LINE (FILTER POINT CONCRETE LINING)
	DITCH/SWALE CENTER LINE (VEGETATED LINING)
	DOWNCOMER/CULVERT PIPE INLET
	DIVERSION BERM
HP	DIVERSION BERM HIGH POINT

0 50 100 200

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CCR LANDFILL CLOSURE PLAN

STORMWATER CONTROL SYSTEM

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 7 OF 20

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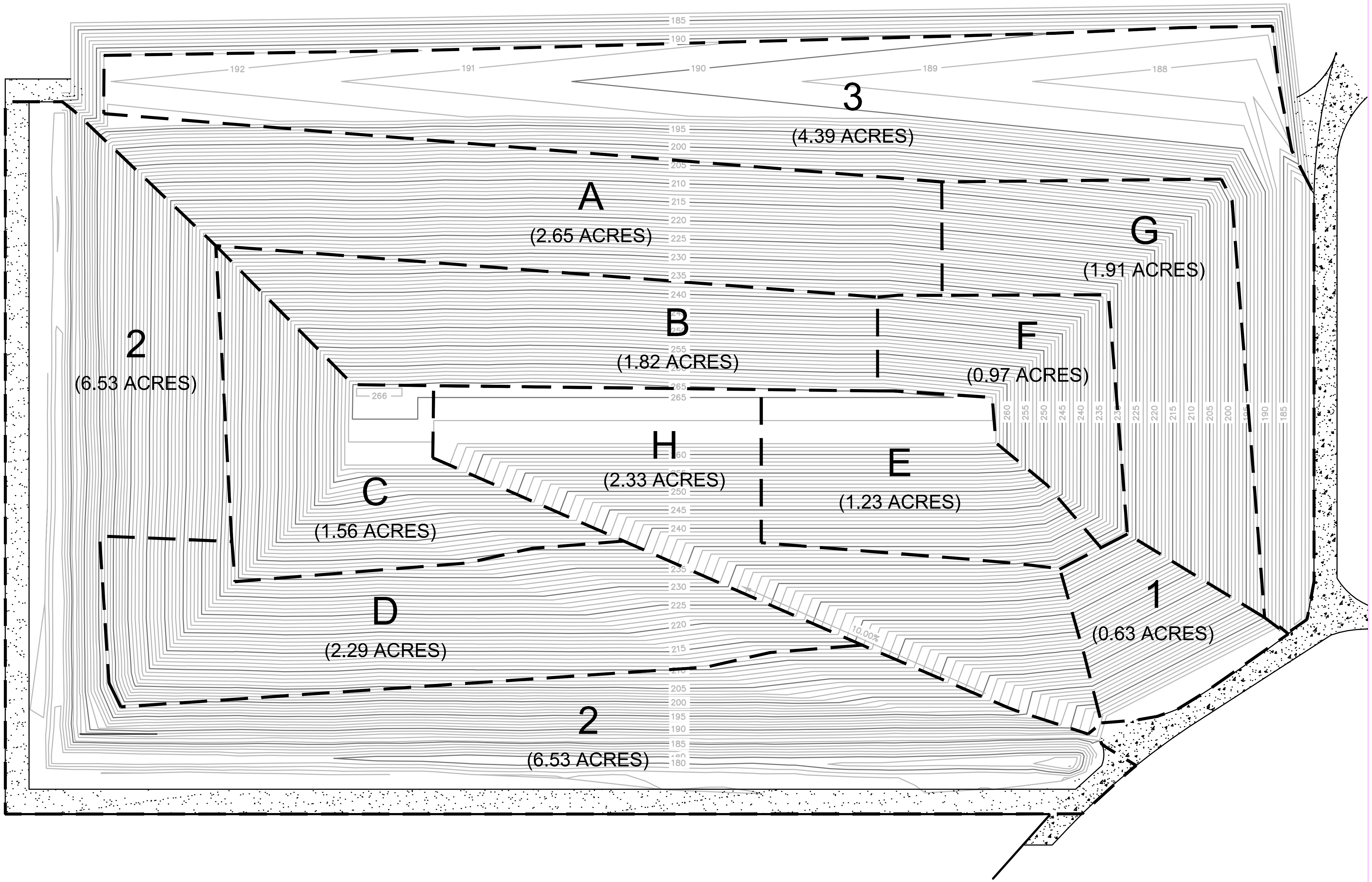

LEGEND

(line symbol)	DRAINAGE BASIN EXTENT
1	DITCH/SWALE BASIN LABEL
A	DIVERSION BERM BASIN LABEL

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CCR LANDFILL CLOSURE PLAN

STORMWATER DRAINAGE BASINS

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 8 OF 20

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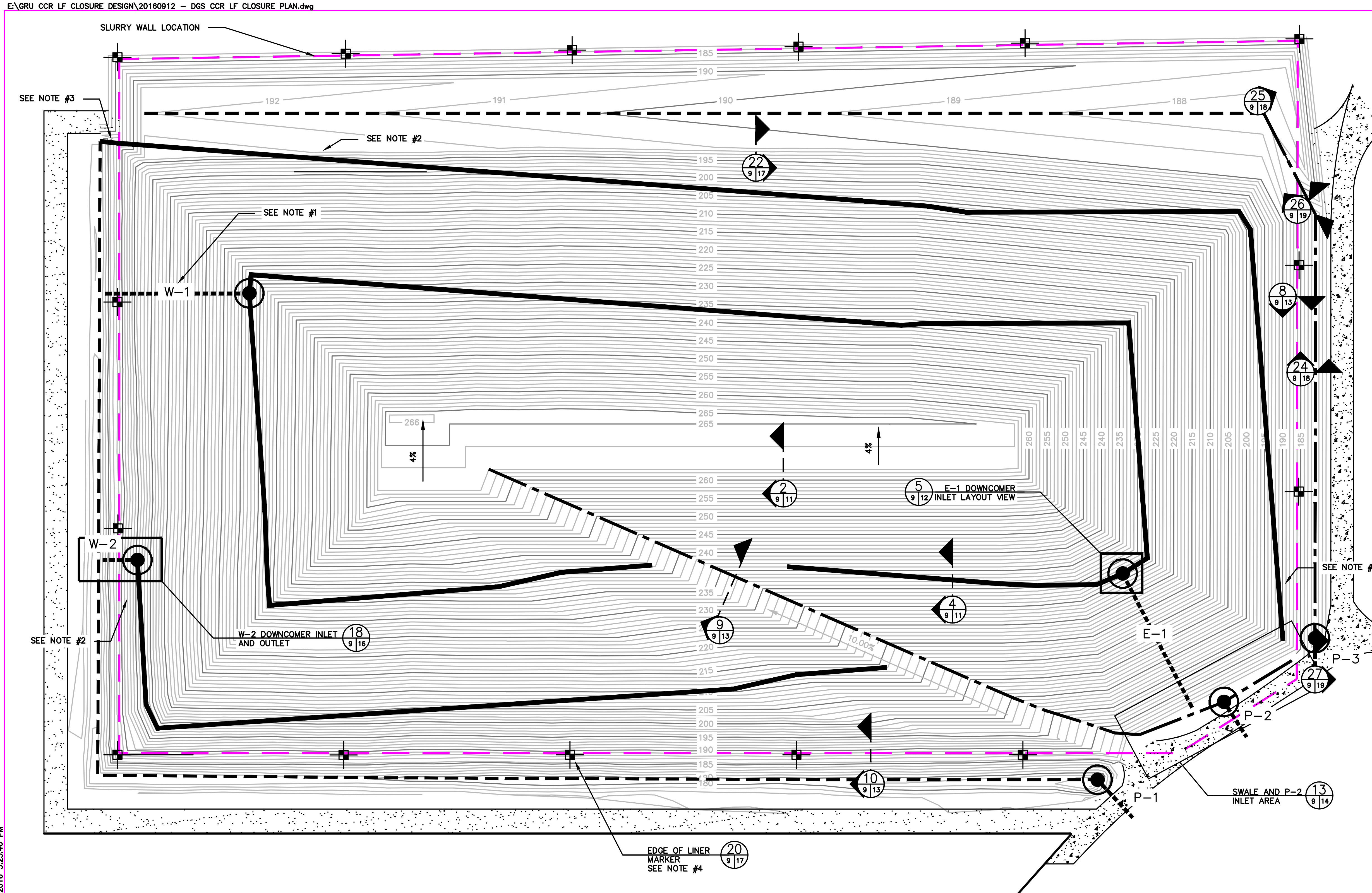

NOTES:

1. THE CONFIGURATION OF THE W-1 DOWNCOMER OUTLET SHALL BE THE SAME AS THAT SHOWN IN THE DETAIL FOR THE W-2 DOWNCOMER OUTLET. THE INLET CONFIGURATION SHALL BE THE SAME ACCEPT THAT THE W-1 INLET SHALL ACCEPT STORMWATER FLOW FROM DIVERSION BERMS LOCATED TO BOTH THE NORTH AND SOUTH.
2. THE GEOSYNTHETIC DRAINAGE LAYER SHALL NOT BE INSTALLED WHERE THE DIVERSION BERM EXTENDS OUTSIDE OF THE SLURRY WALL.
3. THE DIVERSION BERM SHALL BE TIED IN WITH THE START OF THE WESTERN DRAINAGE DITCH. THE SWALE TRANSITION SHALL BE CONSTRUCTED TO MAINTAIN A MINIMUM SWALE DEPTH OF 2 FEET AND SHALL BE LINED WITH 12-INCH RIPRAP PLACED OVER GEOTEXTILE FOR ALL DRAINAGE SLOPES EXCEEDING 5%.
4. EDGE-OF-LINER MARKERS SHALL BE INSTALLED AT LINER CORNER LOCATIONS AND AT APPROXIMATE 250-FOOT INTERVALS. MARKERS SHALL NOT BE PLACED IN ROAD AREAS.

LEGEND	
E-1	PROPOSED DOWNCOMER/ CULVERT PIPE
	DITCH/SWALE CENTER LINE (FILTER POINT CONCRETE LINING)
	DITCH/SWALE CENTER LINE (VEGETATED LINING)
	DOWNCOMER/CULVERT PIPE INLET
	DIVERSION BERM
	EDGE OF LINER MARKER LOCATION

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CCR LANDFILL CLOSURE PLAN

STORMWATER MANAGEMENT DETAIL LAYOUT

DATE: 8 SEPTEMBER 2016

PRJ No:

SCALE: AS SHOWN

DWG No: 9 OF 20

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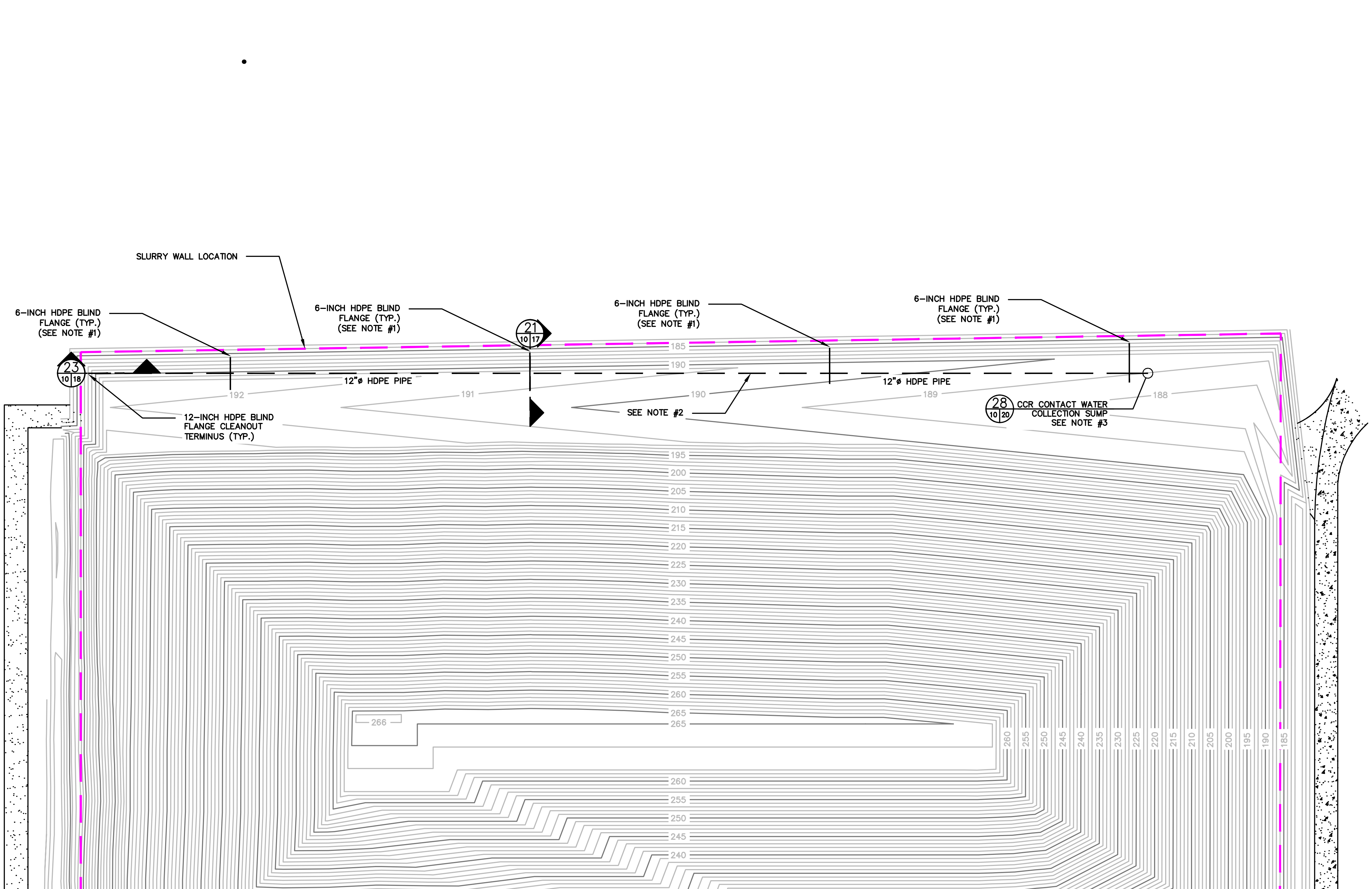

NOTES:

1. ALL 6-INCH HDPE CLEANOUTS SHALL DAYLIGHT AT EL. 185 FT. THE ARRANGEMENT OF ALL 6-INCH CLEANOUTS AND PIPE TIE-INS SHALL CONFORM TO DETAIL 21 ON DRAWING 17.
2. THE 12-INCH HDPE PIPE SHALL BE SLOPED AT 0.4% (MIN) TO PROVIDE DRAINAGE TO A COLLECTION SUMP LOCATED AT THE PIPE'S EASTERN TERMINUS.
3. INCLUDED DETAIL IS A VERTICAL RISER TYPICAL INSTALLATION, © EPG COMPANIES, INC.

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CCR LANDFILL CLOSURE PLAN

CONTACT WATER MANAGEMENT DETAIL LAYOUT

DATE: 8 SEPTEMBER 2016
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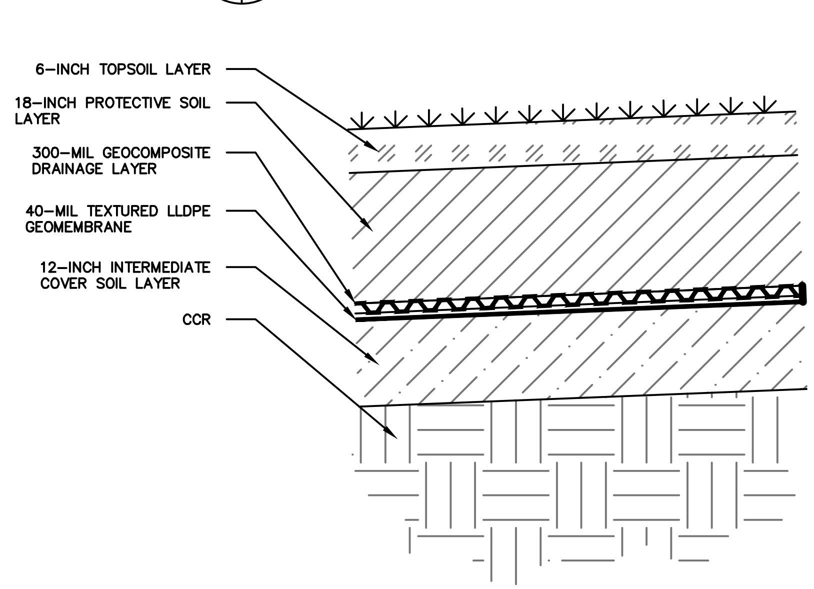
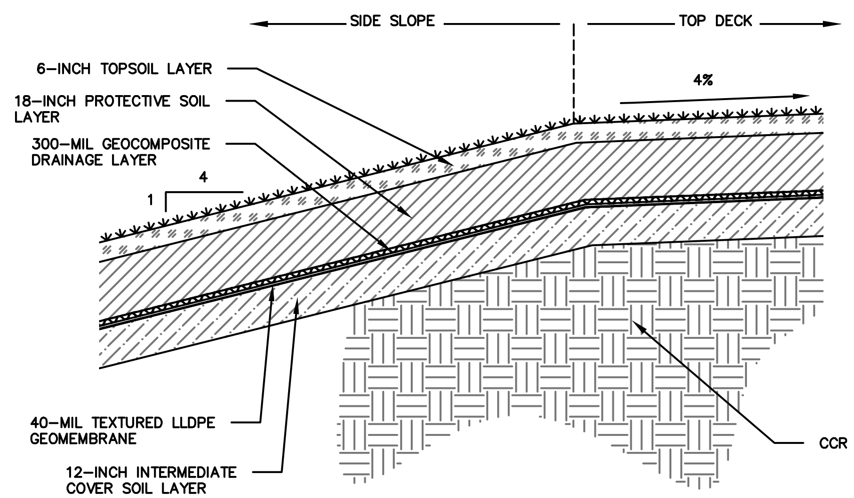
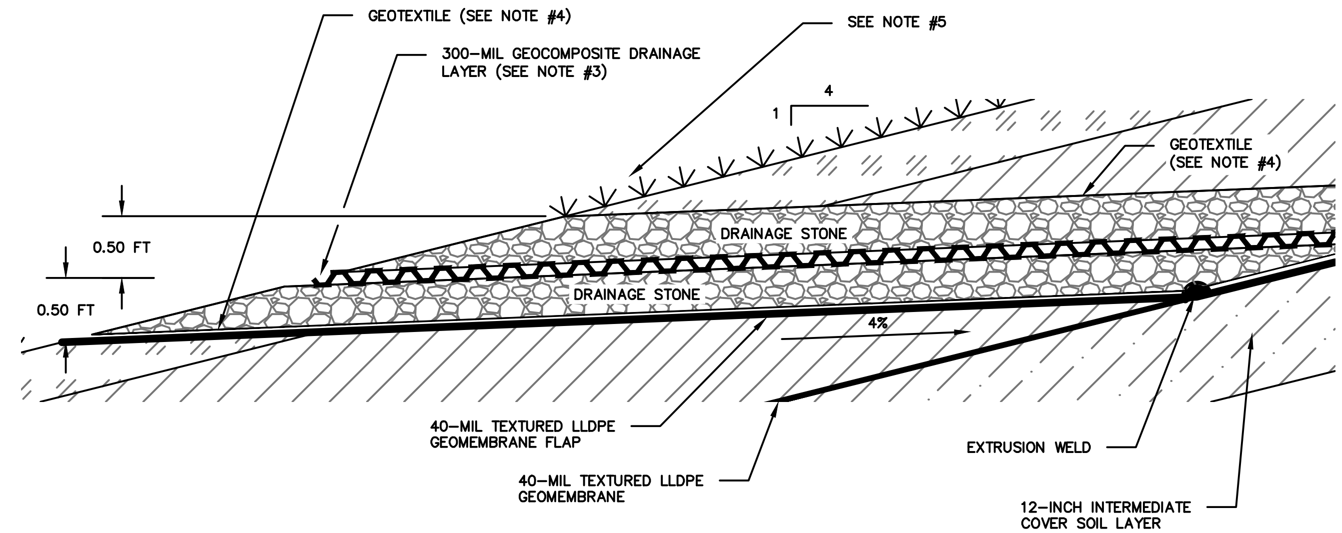
1 FINAL COVER SYSTEM (– / 11)



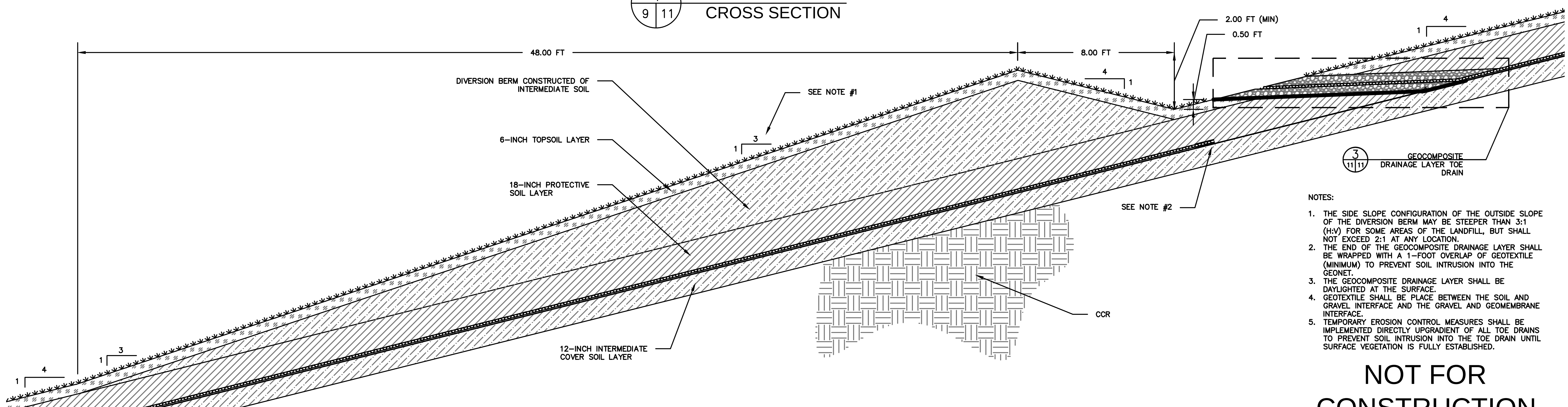
2 FINAL COVER - TOP DECK AND SIDE SLOPE CROSS SECTION (9 / 11)



3 GEOCOMPOSITE DRAINAGE LAYER TOE DRAIN (11-13,17 / 11)



4 DIVERSION BERM CROSS SECTION (9 / 11)



NOTES:

1. THE SIDE SLOPE CONFIGURATION OF THE OUTSIDE SLOPE OF THE DIVERSION BERM MAY BE STEEPER THAN 3:1 (H:V) FOR SOME AREAS OF THE LANDFILL, BUT SHALL NOT EXCEED 2:1 AT ANY LOCATION.
2. THE END OF THE GEOCOMPOSITE DRAINAGE LAYER SHALL BE WRAPPED WITH A 1-FOOT OVERLAP OF GEOTEXTILE (MINIMUM) TO PREVENT SOIL INTRUSION INTO THE GEONET.
3. THE GEOCOMPOSITE DRAINAGE LAYER SHALL BE DAYLIGHTED AT THE SURFACE.
4. GEOTEXTILE SHALL BE PLACE BETWEEN THE SOIL AND GRAVEL INTERFACE AND THE GRAVEL AND GEOMEMBRANE INTERFACE.
5. TEMPORARY EROSION CONTROL MEASURES SHALL BE IMPLEMENTED DIRECTLY UPGRADIENT OF ALL TOE DRAINS TO PREVENT SOIL INTRUSION INTO THE TOE DRAIN UNTIL SURFACE VEGETATION IS FULLY ESTABLISHED.

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CCR LANDFILL CLOSURE PLAN

DETAILS 1-4

DATE: 8 SEPTEMBER 2016
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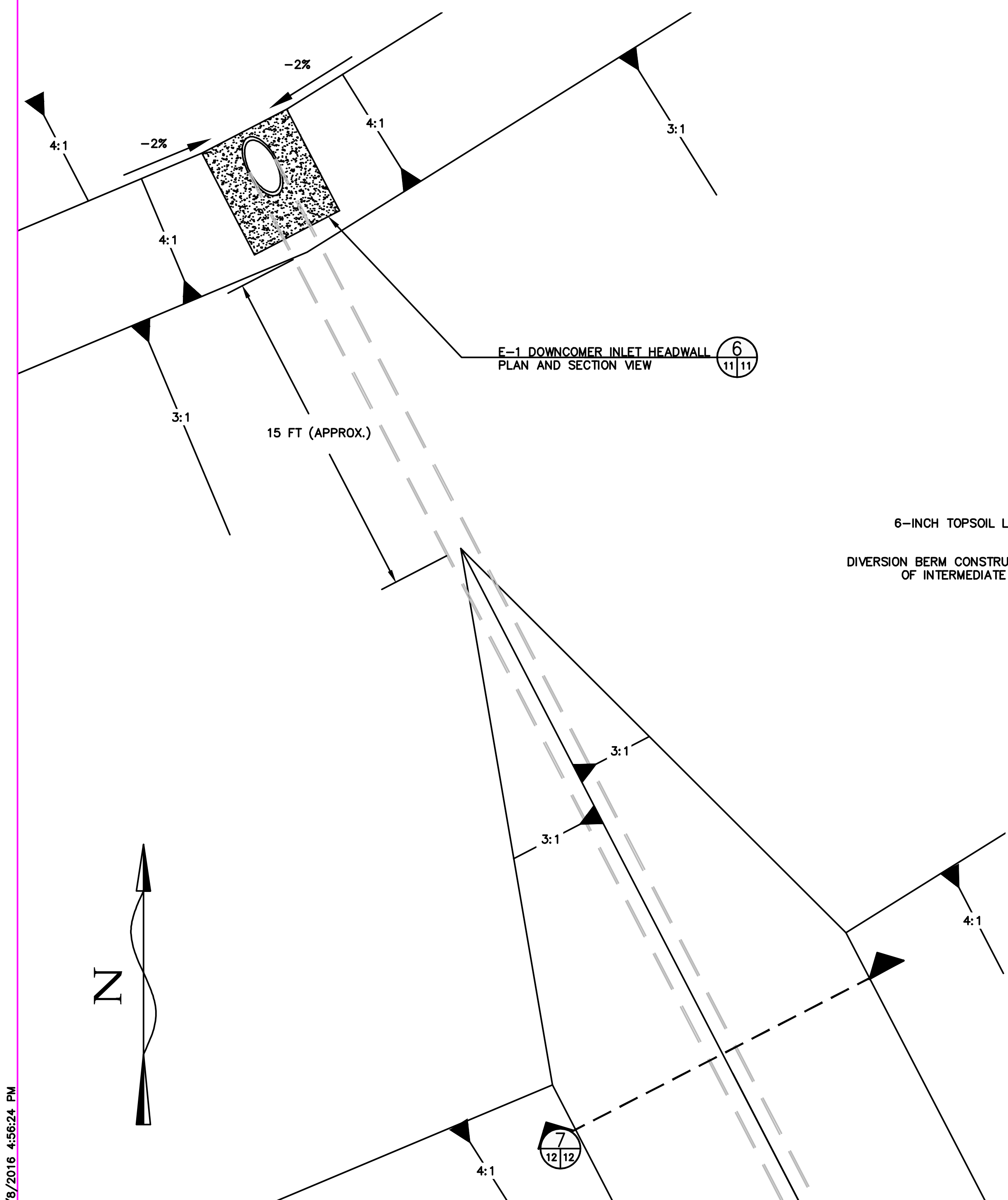
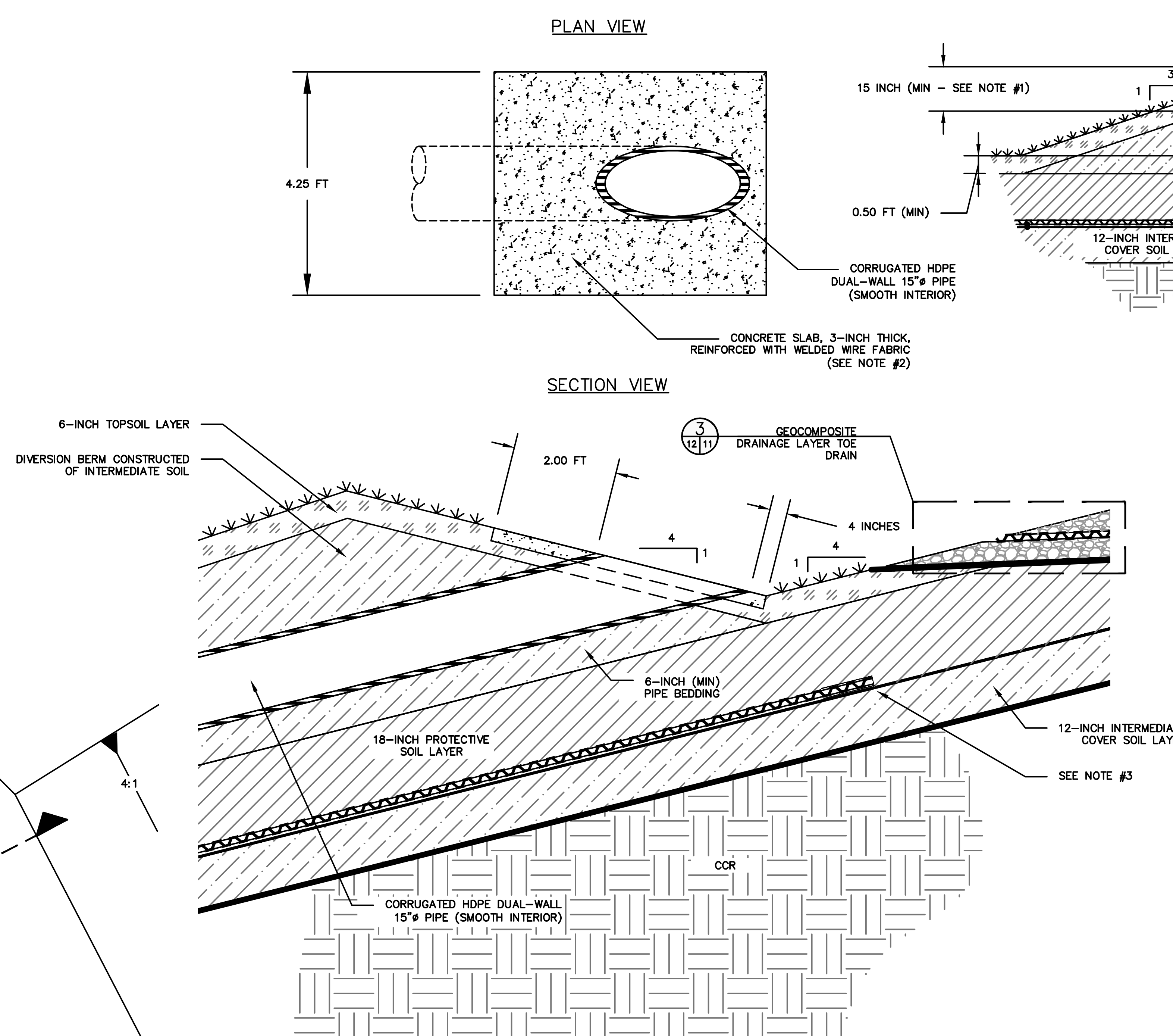
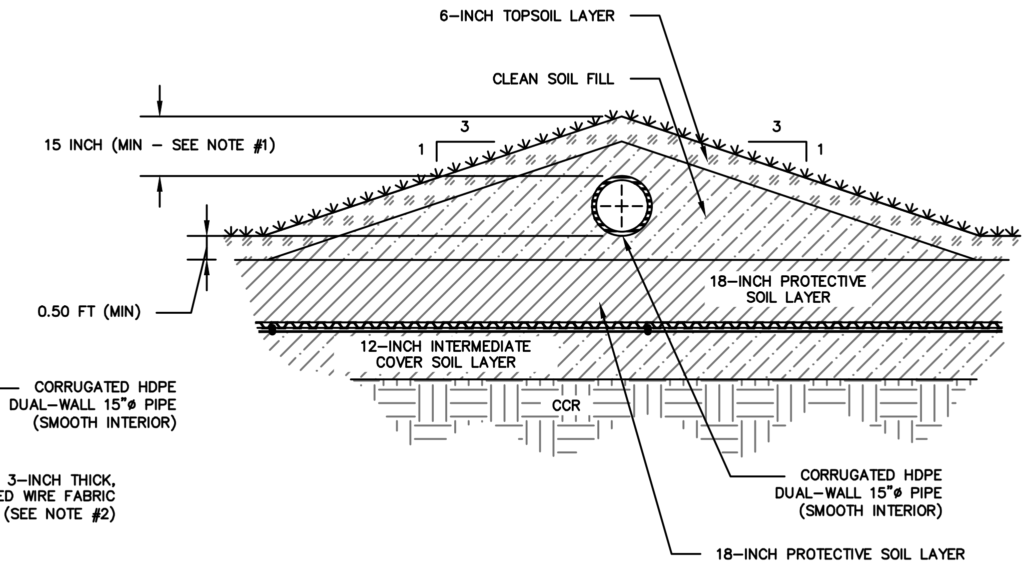
5 (9 | 12) E-1 DOWNCOMER INLET LAYOUT VIEW



6 (12 | 12) E-1 DOWNCOMER INLET HEADWALL



7 (12 | 12) DOWNCOMER PROTECTION CROSS SECTION



NOTES:
1. A MINIMUM OF 15 INCHES OF SOIL SHALL BE PLACED OVER ALL DOWNCOMER PIPES.
2. THE CONCRETE SLAB INLET STRUCTURE DESIGN FOR ALL DOWNCOMER PIPE INLETS IS THE SAME.
3. THE END OF GEOCOMPOSITE DRAINAGE LAYER SHALL BE WRAPPED WITH A 1-FOOT OVERLAP OF GEOTEXTILE (MINIMUM) TO PREVENT SOIL INTRUSION INTO THE GEONET.

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CCR LANDFILL CLOSURE PLAN

DETAILS 5-7

DATE: 8 SEPTEMBER 2016
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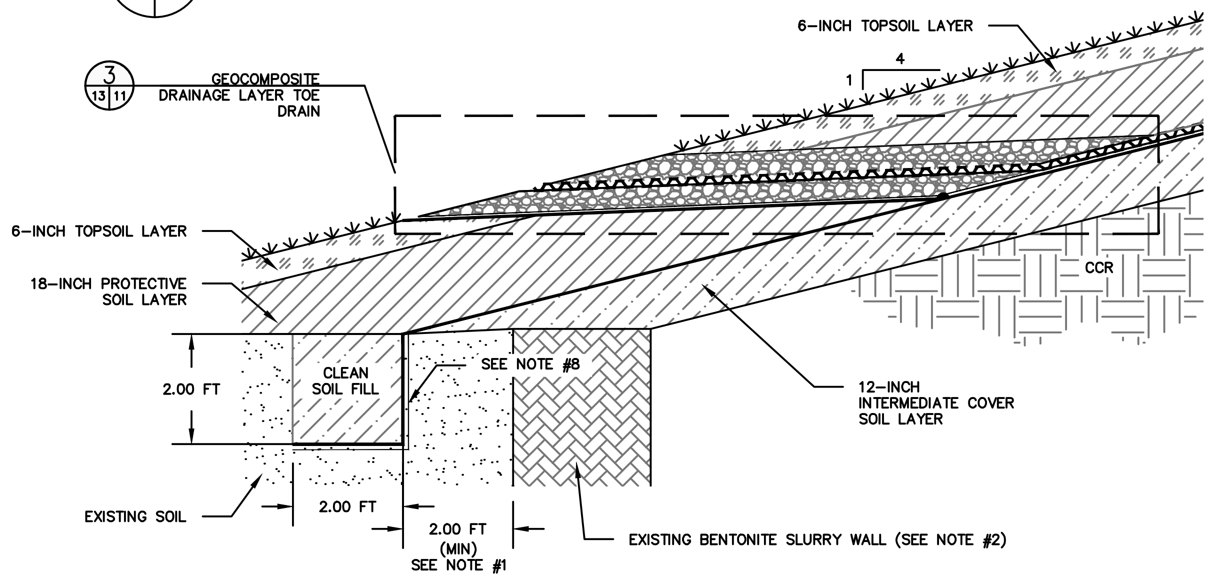
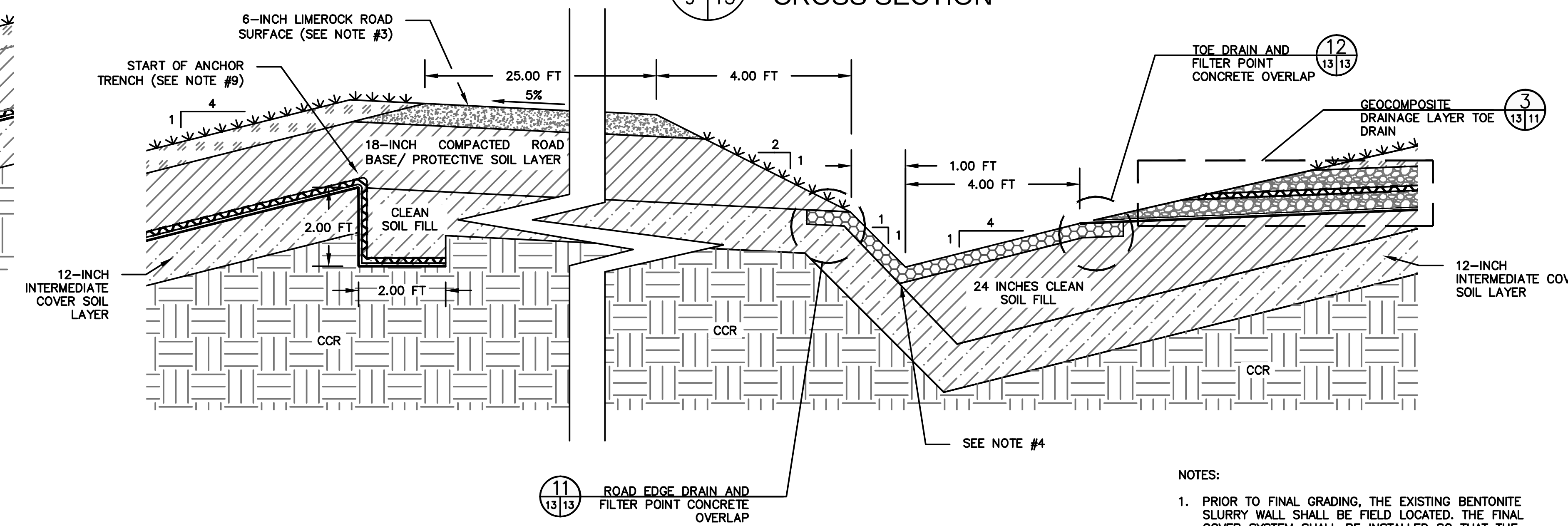
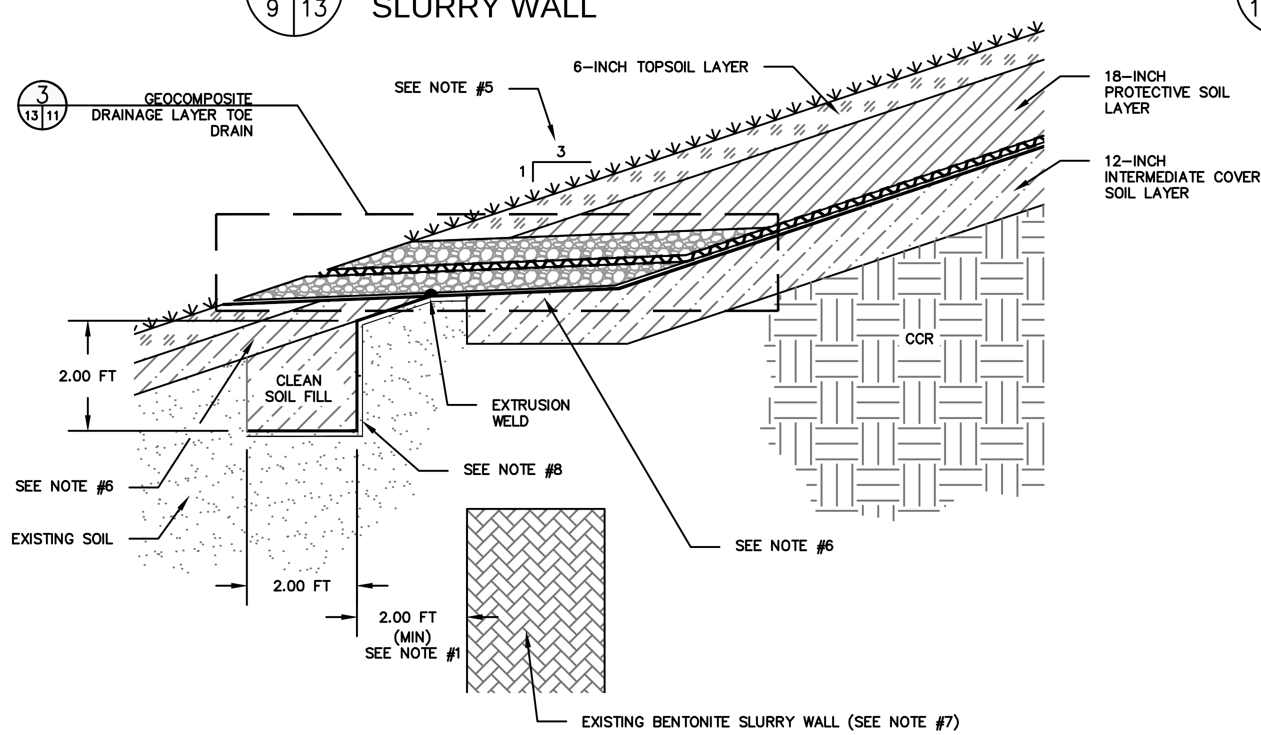
8 (9 | 13) FINAL COVER TIE IN WITH SLURRY WALL



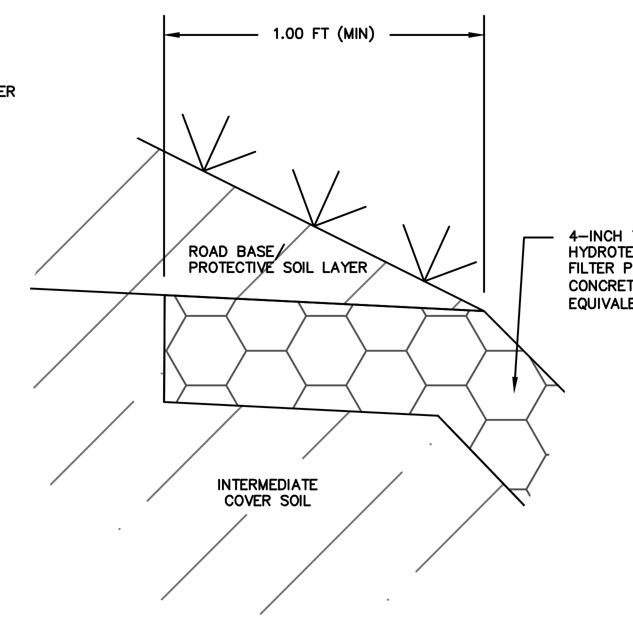
9 (9 | 13) ACCESS RAMP AND SWALE CROSS SECTION



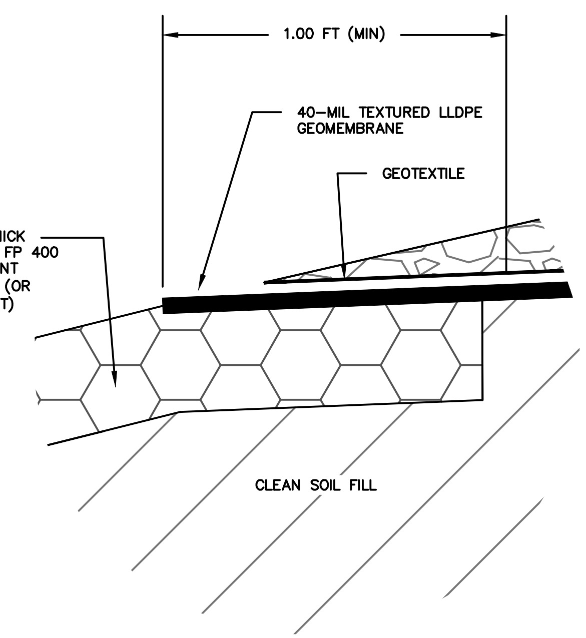
10 (9 | 13) FINAL COVER PLACEMENT OVER SLURRY WALL



11 (13 | 13) ROAD EDGE DRAIN AND FILTER POINT CONCRETE OVERLAP



12 (13 | 13) TOE DRAIN AND FILTER POINT CONCRETE OVERLAP



NOTES:

1. PRIOR TO FINAL GRADING, THE EXISTING BENTONITE SLURRY WALL SHALL BE FIELD LOCATED. THE FINAL COVER SYSTEM SHALL BE INSTALLED SO THAT THE GEOMEMBRANE IS ANCHORED AT LEAST 2 FEET BEYOND THE OUTSIDE EDGE OF THE SLURRY WALL.
2. AS PRESENTED IN A 1981 DRAWING SET FROM BURNS AND MCDONNELL, THE SLURRY WALL IS A MINIMUM OF 2.5 FEET THICK AND THE TOP OF THE WALL IS LOCATED AT AN ELEVATION OF APPROXIMATELY 184 FT AT THIS LOCATION.
3. THE ACCESS RAMP IS SLOPED UPWARD AT 10% AND OUTWARD AT 5% TO PROMOTE STORMWATER COLLECTION FROM THE ACCESS RAMP. THE GEOMEMBRANE AND GEOSYNTHETIC DRAINAGE LAYER WILL NOT BE PLACED UNDER THE ACCESS RAMP.
4. A RADIUS OF CURVATURE FOR FILTER POINT CONCRETE INSTALLATION SHALL BE SELECTED PER MANUFACTURER SPECIFICATIONS. A 1-FOOT SWALE DEPTH (MIN) SHALL BE ENSURED. THE GEOSYNTHETIC DRAINAGE LAYER AND GEOMEMBRANE SHALL NOT BE PLACED UNDERNEATH THE ACCESS RAMP SWALE.
5. THE CONFIGURATION OF THE SIDE SLOPE OVER THE SLURRY WALL IN THE SOUTH VARIES, BUT IS GENERALLY AROUND 3:1 (H:V).
6. AN APPROXIMATELY 3-FOOT WIDE TERRACE EXISTS OVER THE SLURRY WALL ON THE SOUTHERN AND WESTERN SLOPES OF THE LANDFILL. THE COVER SYSTEM SHALL BE INSTALLED AND THE THICKNESS OF THE PROTECTIVE SOIL LAYER SHALL BE ADJUSTED SO THAT THE FINAL SLOPE OVER THE TERRACE IS UNIFORM, AS DEPICTED.
7. BASED ON A 1981 DRAWING SET FROM BURNS AND MCDONNELL, THE TOP OF THE WALL IS LOCATED AT AN ELEVATION OF APPROXIMATELY 183 FT AT THIS LOCATION.
8. A GEOTEXTILE CUSHION LAYER SHALL BE INSTALLED BETWEEN THE GEOMEMBRANE AND THE GROUND SURFACE FOR ALL AREAS WITHOUT A 12-INCH INTERMEDIATE COVER SOIL LAYER AND IN ALL ANCHOR TRENCHES.
9. THE ANCHOR TRENCH WILL BEGIN BELOW THE ANTICIPATED OUTSIDE EDGE OF THE FINAL ACCESS RAMP ROAD.

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CCR LANDFILL CLOSURE PLAN

DETAILS 8-12

DATE: 8 SEPTEMBER 2016
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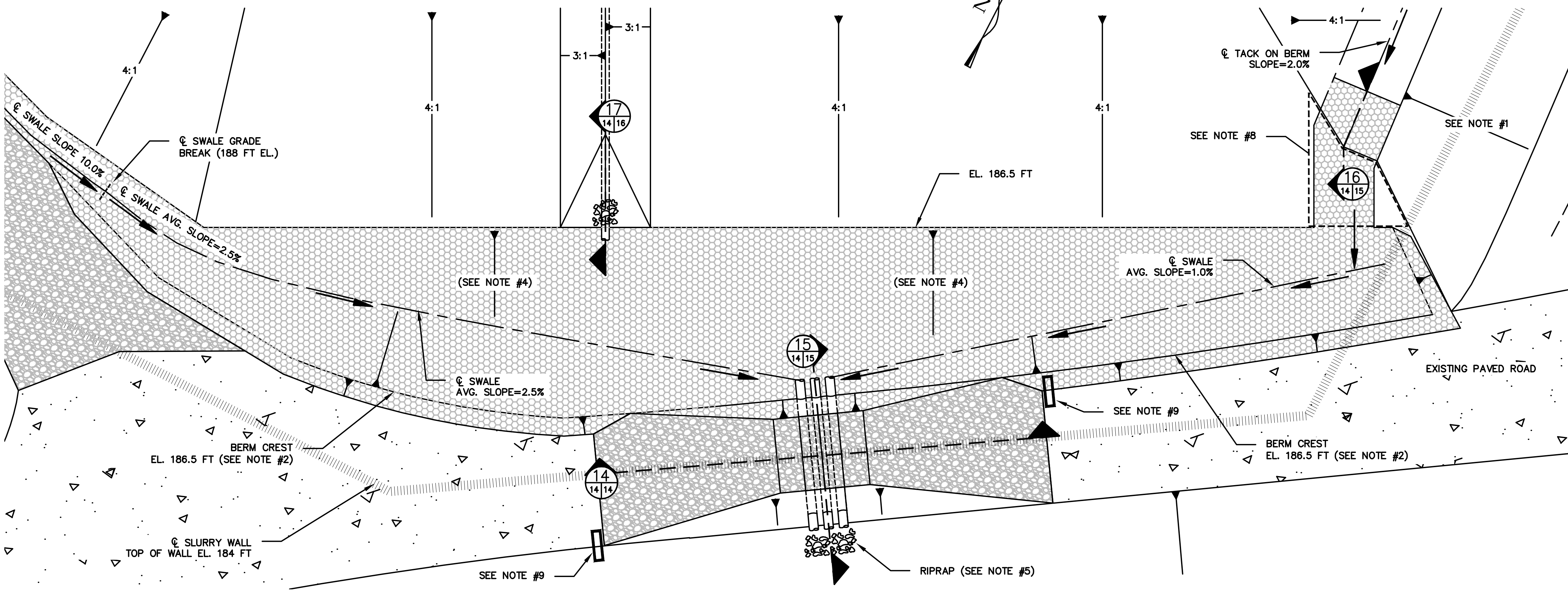
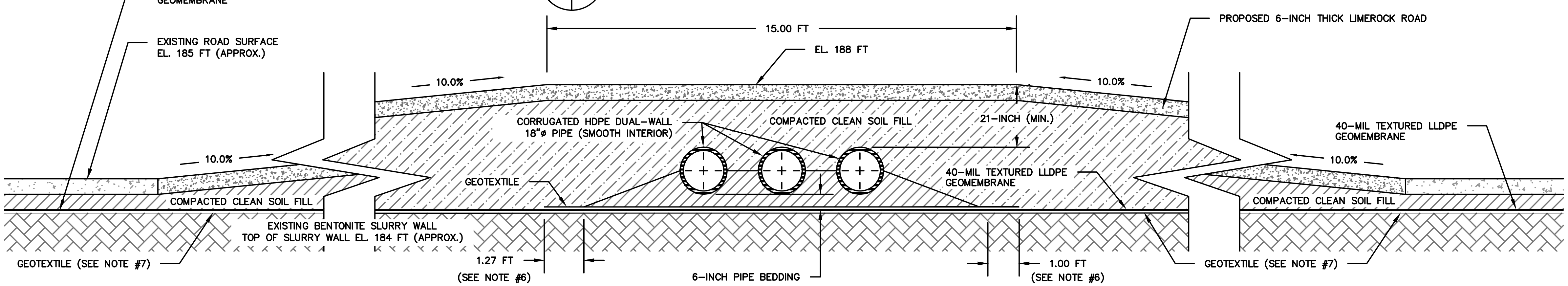
13 (9 | 14) SWALE AND P-2 INLET AREA



NOTES:

1. THE OUTER SLOPE OF THE TACK–ON DIVERSION BERM SHALL BE CONFIGURED TO PREVENT OBSTRUCTION OF THE STORMWATER SWALE LOCATED AT ITS TOE. THE OUTER TACK–ON BERM SLOPE SHALL NOT BE STEEPER THAN 2:1 (H:V) AT ANY LOCATION.
2. PRIOR TO INSTALLATION OF FILTER POINT CONCRETE SWALE LINING, A SOIL BERM SHALL BE CONSTRUCTED ALONG THE EDGE OF THE ROAD TO MAINTAIN A MINIMUM SWALE RIM ELEVATION OF 186.5 FT. FILTER POINT CONCRETE SHALL BE INSTALLED OVER THE BERM. THE BERM SHALL HAVE SIDE SLOPES WITH A 2:1 (H:V) SLOPE CONFIGURATION. THE CREST OF THE BERM SHALL BE CONSTRUCTED WITH A RADIUS OF CURVATURE THAT SUPPORTS INSTALLATION OF THE FILTER POINT CONCRETE PER MANUFACTURER SPECIFICATIONS.
3. THE PROPOSED DRAINAGE DITCH AND APPURTENANT CULVERT AND ROAD CROSSING NOT SHOWN IN THIS DETAIL FOR CLARITY.
4. UNLABELED SWALE SLOPES SHALL BE SELECTED TO ACHIEVE THE INDICATED ELEVATIONS AND CENTERLINE SLOPES.
5. A 12–INCH THICK (MIN.) LAYER OF RIPRAP SHALL BE PLACED OVER THE GEOTEXTILE AT THE OUTLET OF ALL CULVERTS. THE TOP OF THE RIPRAP LAYER SHALL BE AT THE SAME APPROXIMATE ELEVATION AS THE EXISTING SIDE SLOPE GRADES.
6. A GEOTEXTILE CUSHION SHALL BE PLACED BETWEEN THE PIPE BEDDING LAYER AND THE GEOMEMBRANE. THE GEOTEXTILE SHALL EXTEND OUT A MINIMUM OF 1 FOOT BEYOND THE TOE OF THE PIPE BEDDING LAYER.
7. A GEOTEXTILE CUSHION LAYER SHALL BE PLACED UNDER THE GEOMEMBRANE IN ALL AREAS THAT DO NOT HAVE A 12–INCH INTERMEDIATE COVER SOIL LAYER.
8. THE GEOCOMPOSITE DRAINAGE LAYER SHALL NOT BE INSTALLED IN THE INDICATED SLOPE AREA.
9. SIGNS WARNING OF ROAD NARROWING SHALL BE INSTALLED ON EITHER SIDE OF THE CULVERT CROSSING AT THESE APPROXIMATE LOCATIONS.

14 (14 | 14) P-2 CULVERT ROAD CROSSING CROSS SECTION ALONG SLURRY WALL



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CCR LANDFILL CLOSURE PLAN

DETAILS 13–14

DATE: 8 SEPTEMBER 2016
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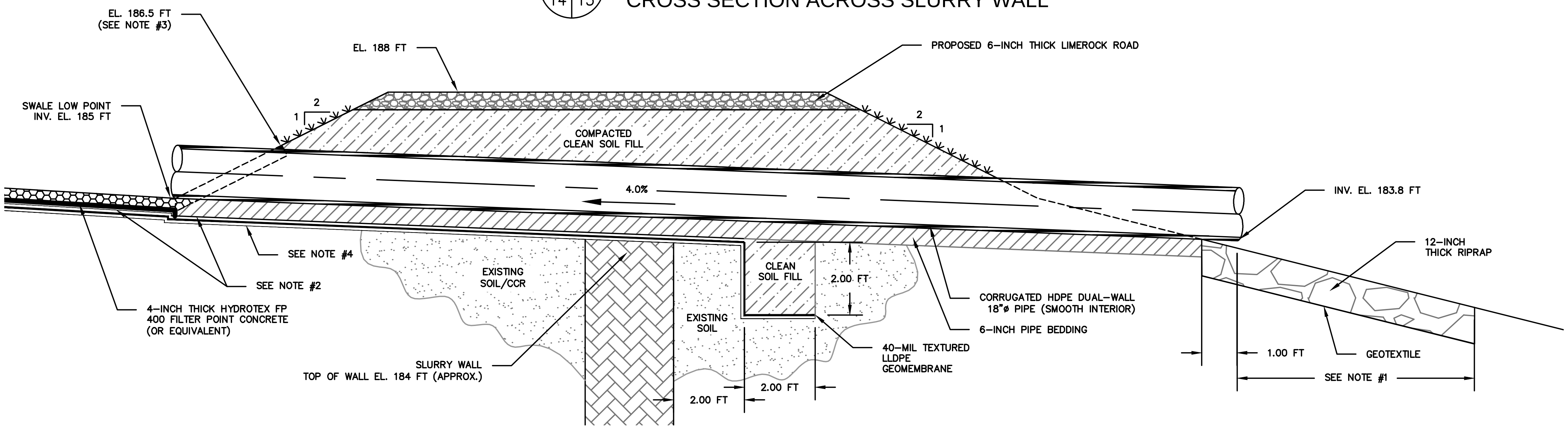
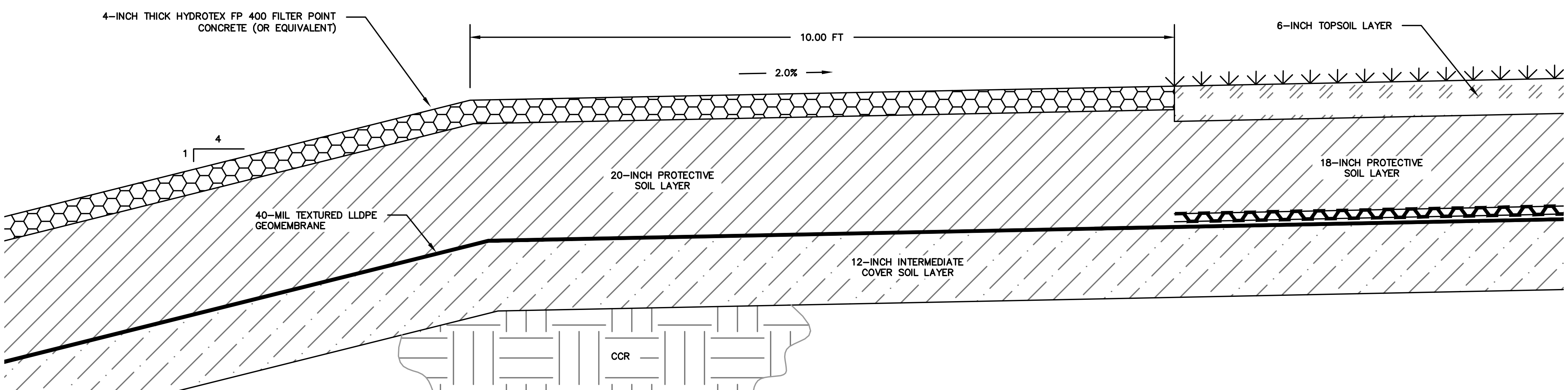
15 (14 | 15) P-2 CULVERT ROAD CROSSING CROSS SECTION ACROSS SLURRY WALL



NOTES:

1. THE RIPRAP APRON SHALL BE EXTENDED DOWN TO THE WATER'S EDGE.
2. A GEOTEXTILE CUSHION SHALL BE PLACED BETWEEN THE INTERFACE OF THE GEOMEMBRANE AND FILTER POINT CONCRETE OR PIPE BEDDING MATERIAL.
3. THE FILTER POINT CONCRETE PIPE PENETRATIONS SHALL BE GROUTED TO PREVENT STORMWATER INFILTRATION AROUND THE PIPE.
4. A GEOTEXTILE CUSHION LAYER SHALL BE PLACED UNDER THE GEOMEMBRANE FOR ALL AREAS THAT DO NOT HAVE A 12-INCH INTERMEDIATE COVER SOIL LAYER.

16 (14 | 15) FILTER POINT CONCRETE LINING OF DIVERSION BERM



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CCR LANDFILL CLOSURE PLAN

DETAILS 15-16

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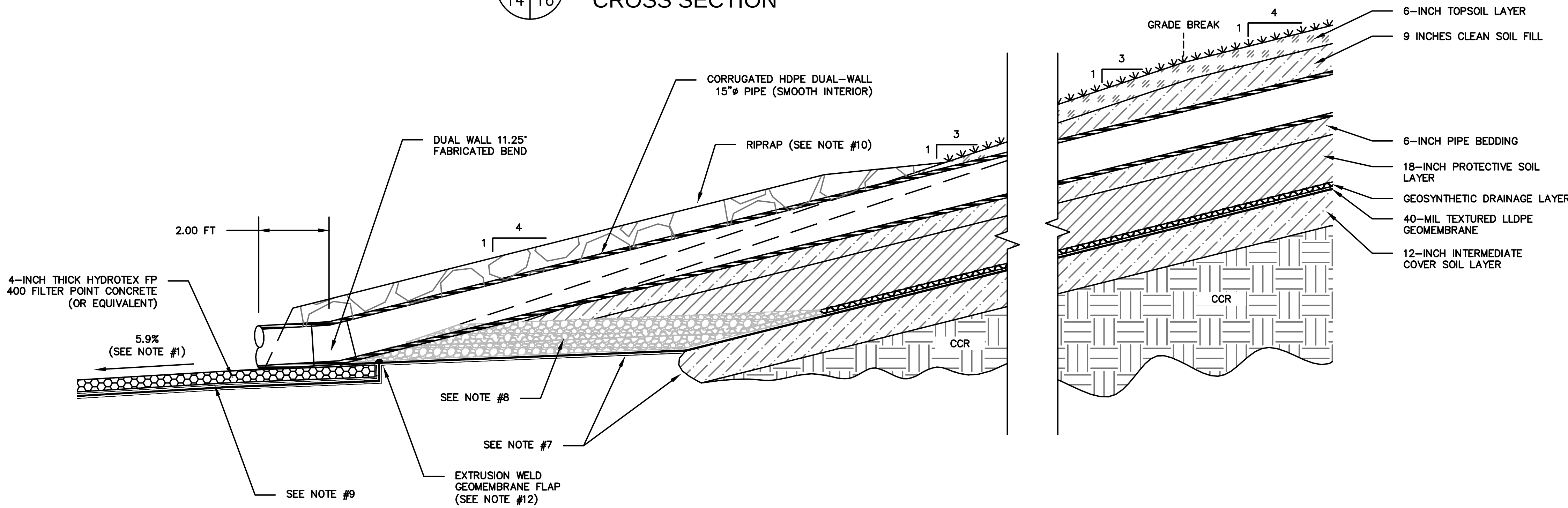
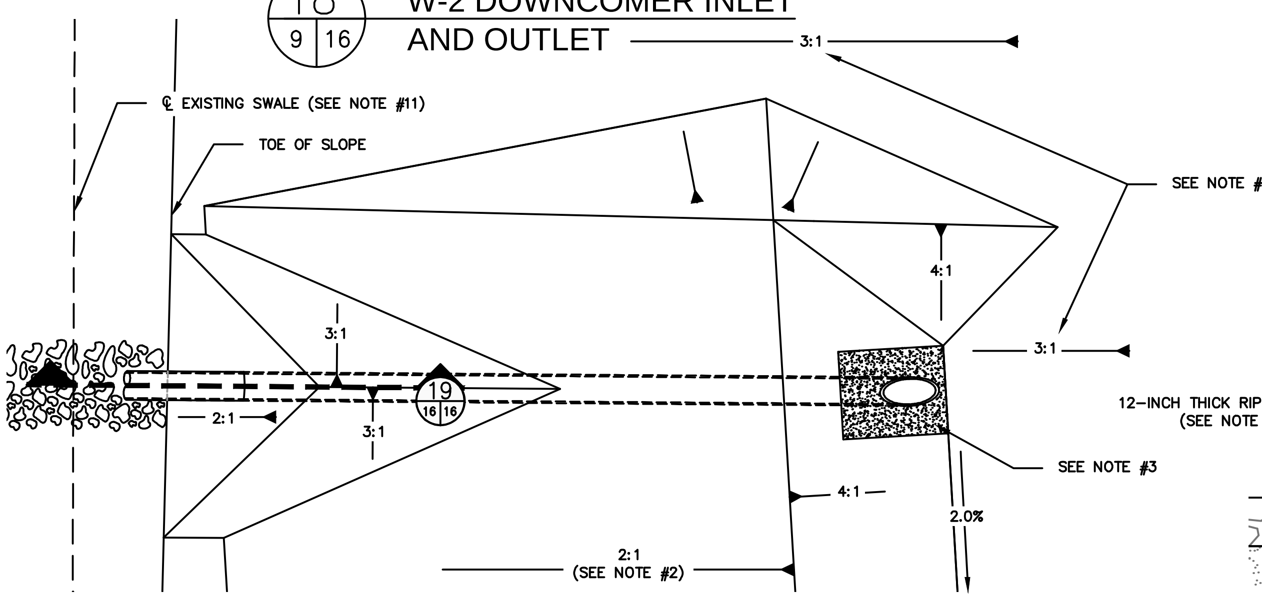
17 (14 | 16) E-1 DOWNCOMER OUTLET CROSS SECTION



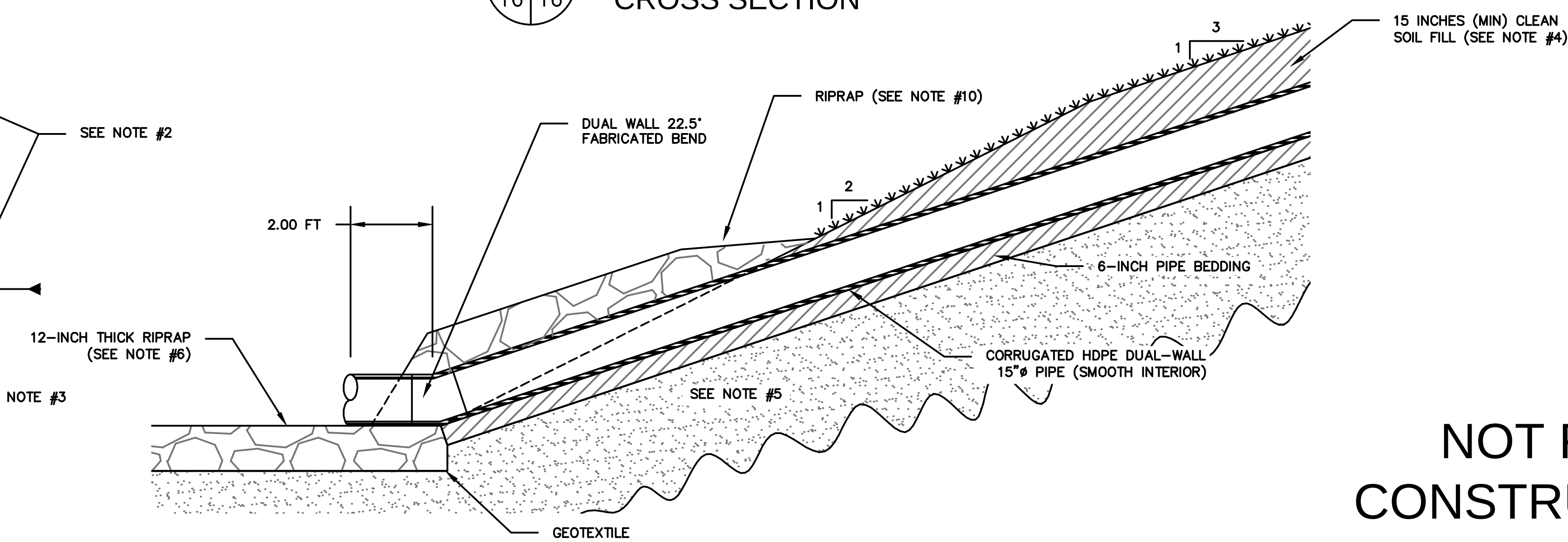
NOTES:

1. THE DRAINAGE SLOPE AT THIS LOCATION IS APPROXIMATE. GRADES SHALL BE SELECTED TO ACHIEVE THE ELEVATIONS AND CENTER LINE DRAINAGE SLOPES AS INDICATED IN DETAIL 13.
2. THE EXISTING SIDE SLOPE CONFIGURATION IN THIS AREA IS APPROXIMATELY 3:1. THE OUTER SLOPE OF THE DIVERSION BERM SHALL BE CONFIGURED WITH A MAXIMUM SLOPE OF 2:1.
3. SLAB CONFIGURATION ACCORDING TO DETAIL 6 AS SHOWN IN DRAWING 12.
4. A MINIMUM OF 15 INCHES OF COVER SOIL SHALL BE INSTALLED OVER ALL DOWNCOMER PIPES.
5. EXISTING SOIL SHALL BE ADJUSTED TO ACHIEVE FINAL GRADES.
6. A 12-INCH LAYER OF RIPRAP SHALL BE PLACED FROM THE TOE OF THE LANDFILL SLOPE TO THE TOE OF THE OPPOSITE SWALE BANK. THE TOP OF THE RIPRAP LAYER SHALL BE AT THE SAME APPROXIMATE ELEVATION AS THE EXISTING SWALE BOTTOM.
7. THE EXACT EXTENTS OF THE INTERMEDIATE COVER SOIL LAYER AND CCR PLACEMENT AREA ARE UNKNOWN. A GEOTEXTILE CUSHION LAYER SHALL BE PLACED UNDER THE GEOMEMBRANE FOR ALL AREAS THAT DO NOT HAVE A 12-INCH INTERMEDIATE COVER SOIL LAYER.
8. TOE DRAIN GREYED OUT FOR CLARITY. SEE DETAIL 3 FOR MORE INFORMATION ON TOE DRAIN ARRANGEMENT.
9. A GEOTEXTILE CUSHION SHALL BE PLACED BETWEEN THE GEOMEMBRANE AND THE FILTER POINT CONCRETE FOR ALL FILTER POINT CONCRETE AREAS EXCEPT THE ACCESS RAMP DRAINAGE SWALE.
10. RIPRAP SHALL BE PLACED OVER ALL EXPOSED DOWNCOMER PIPES, PIPE OUTLETS SHALL REMAIN UNOBSTRUCTED.
11. THE EXISTING DRAINAGE DITCH SLOPE SHALL BE MAINTAINED.
12. THE TOE DRAIN AND UNDERLYING GEOMEMBRANE FLAP SHALL EXTEND OUT A MINIMUM OF 1 FOOT OVER THE FILTER POINT CONCRETE.

18 (9 | 16) W-2 DOWNCOMER INLET AND OUTLET



19 (16 | 16) W-2 DOWNCOMER OUTLET CROSS SECTION



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CCR LANDFILL CLOSURE PLAN

DETAILS 17-19

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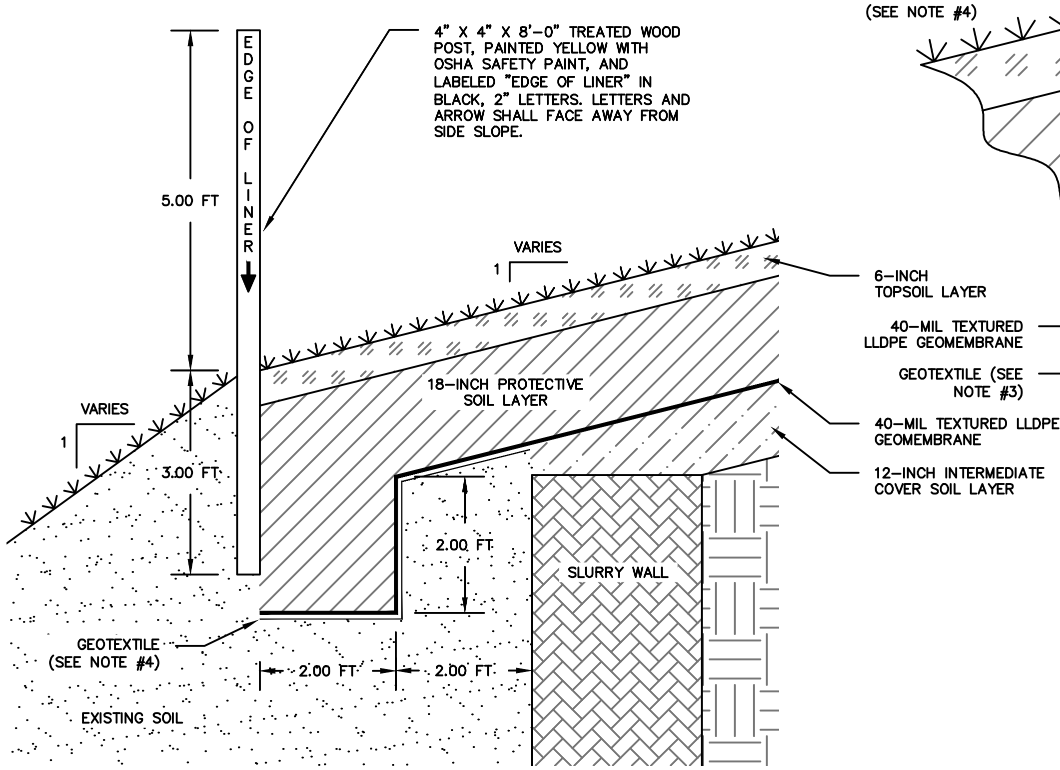
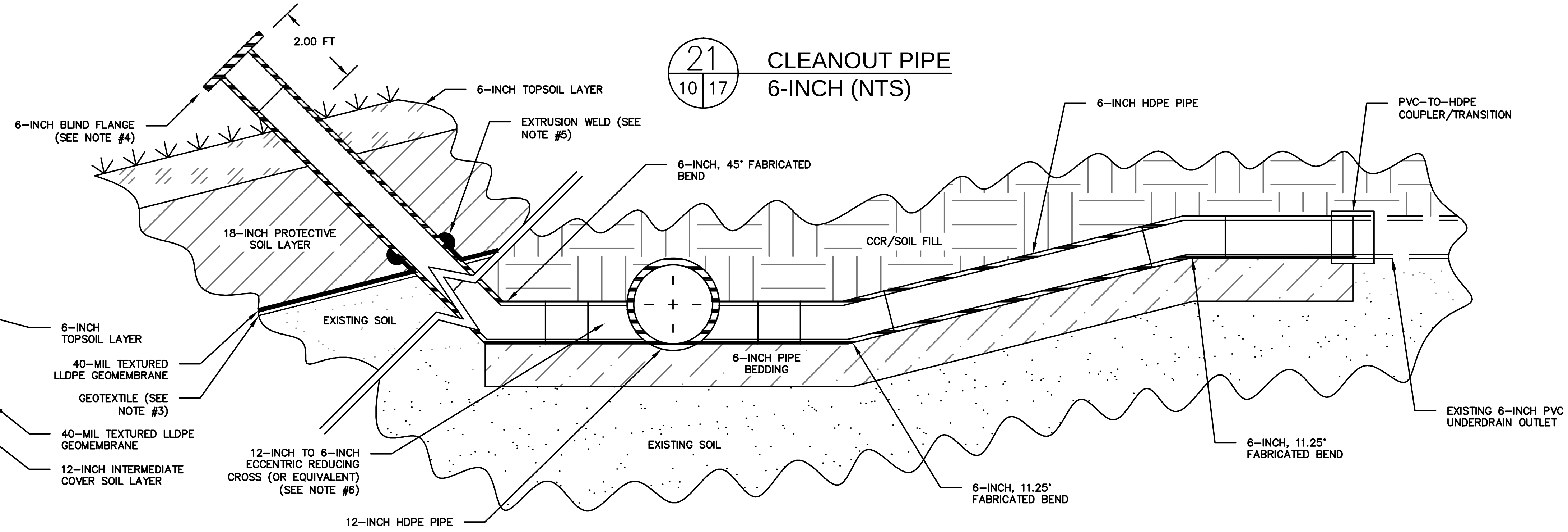
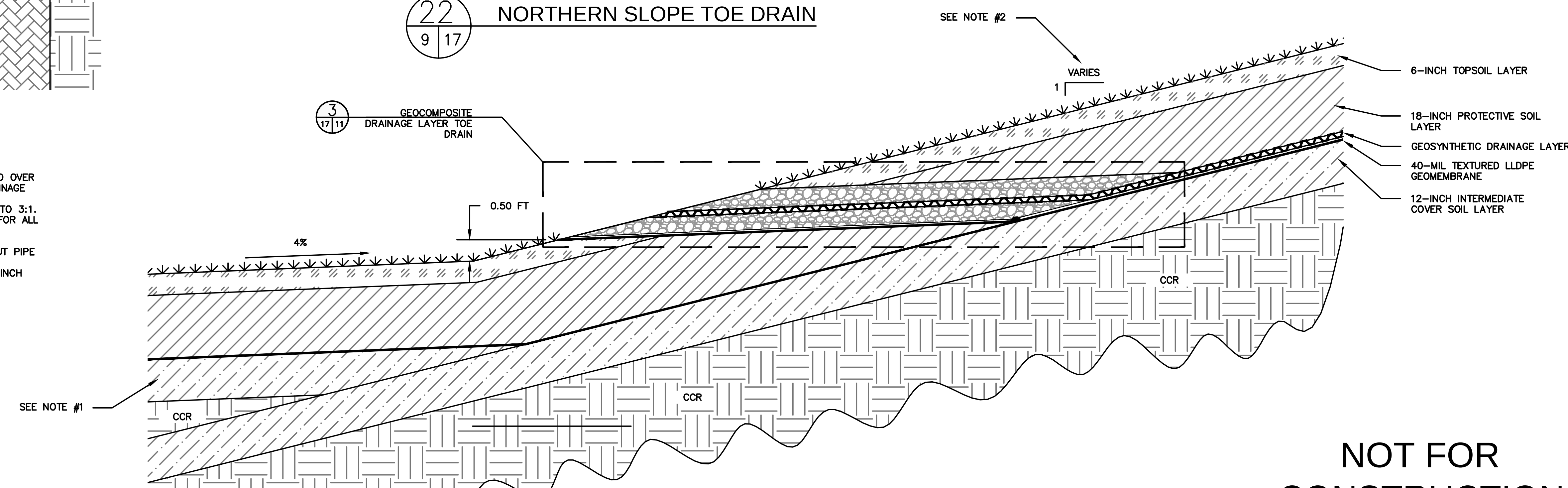
20 (9 | 17) EDGE OF LINER MARKER (NTS)



21 (10 | 17) CLEANOUT PIPE 6-INCH (NTS)



22 (9 | 17) NORTHERN SLOPE TOE DRAIN



NOTES:

1. AN INTERMEDIATE COVER SOIL LAYER OR A GEOTEXTILE WILL BE PLACED OVER THE SURFACE OF THE ADDITIONAL CCR PLACED IN THE NORTHERN DRAINAGE DTICH AS A CUSHION LAYER FOR THE OVERLYING GEOMEMBRANE.
2. THE EXISTING SIDE SLOPE IN THIS AREA GENERALLY VARIES FROM 4:1 TO 3:1.
3. A GEOTEXTILE CUSHION SHALL BE PLACED BELOW THE GEOMEMBRANE FOR ALL AREAS WITHOUT AN INTERMEDIATE COVER SOIL LAYER.
4. CLEANOUTS SHALL DAYLIGHT AT 185 FT EL.
5. A GEOMEMBRANE BOOT SHALL BE EXTRUSION WELDED TO THE CLEANOUT PIPE FOR ALL GEOMEMBRANE PIPE PENETRATIONS.
6. ELEVATIONS OF PIPE CROSSES SHALL BE SELECTED TO ACHIEVE A 12-INCH HDPE PIPE SLOPE OF 0.4% WITH DRAINAGE TOWARDS THE EAST.

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CCR LANDFILL CLOSURE PLAN

DETAILS 20-22

DATE: 8 SEPTEMBER 2016
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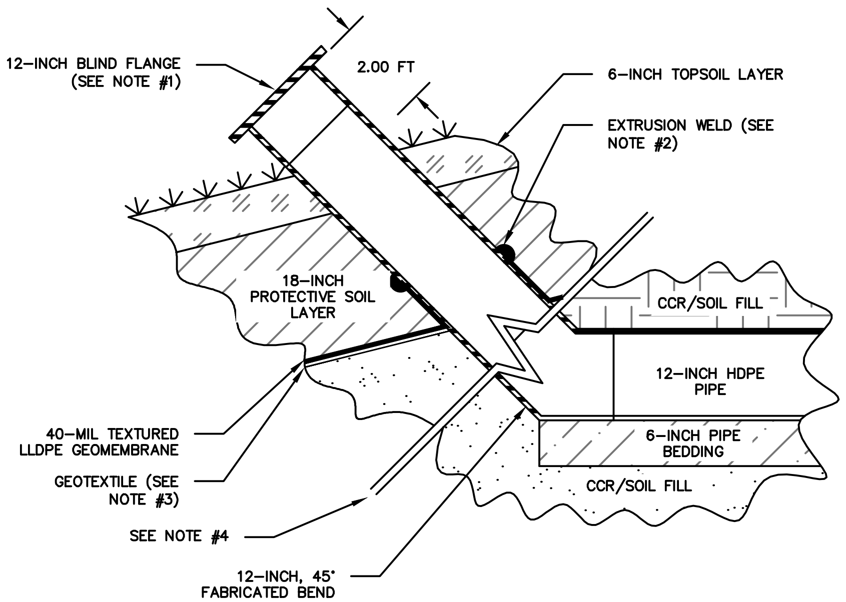
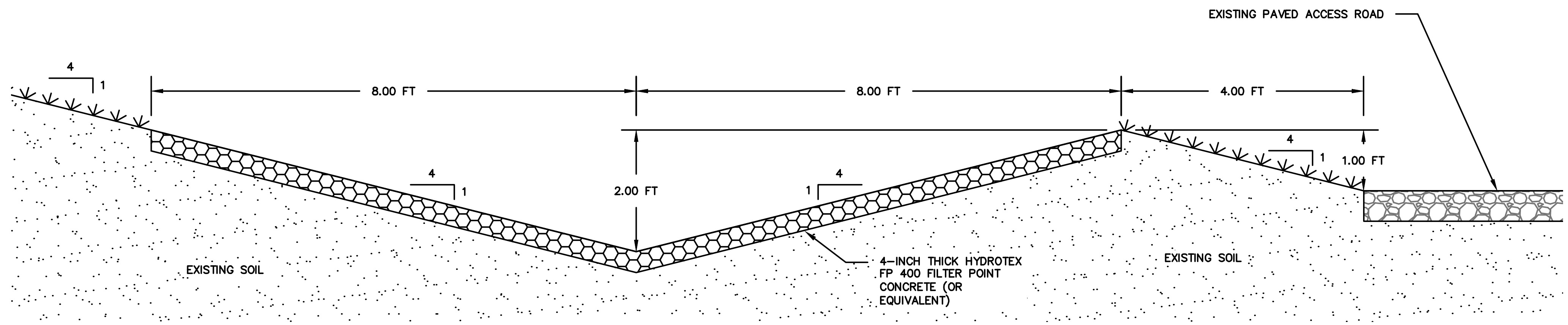
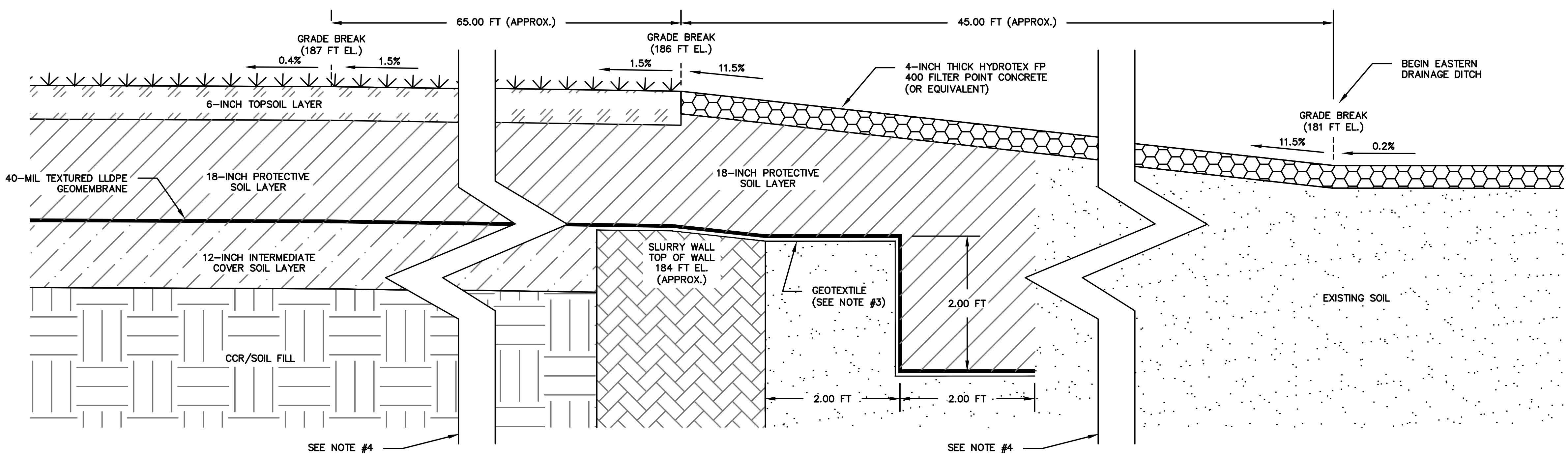
23 (10 | 18) CLEANOUT PIPE 12-INCH (NTS)



24 (9 | 18) EASTERN DITCH CROSS SECTION



25 (9 | 18) NORTHEAST DITCH LONGITUDINAL SECTION



NOTES:

1. CLEANOUTS SHALL DAYLIGHT AT 185 FT EL.
2. A GEOMEMBRANE BOOT SHALL BE EXTRUSION WELDED TO THE CLEANOUT PIPE FOR ALL GEOMEMBRANE PIPE PENETRATIONS.
3. A GEOTEXTILE CUSHION SHALL BE PLACED BELOW THE GEOMEMBRANE FOR ALL AREAS WITHOUT AN INTERMEDIATE COVER SOIL LAYER.
4. SECTION BREAKS SHOWN FOR CLARITY.

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CCR LANDFILL CLOSURE PLAN

DETAILS 23-25

DATE: 8 SEPTEMBER 2016
PRJ No:
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DWG No: 18 OF 20

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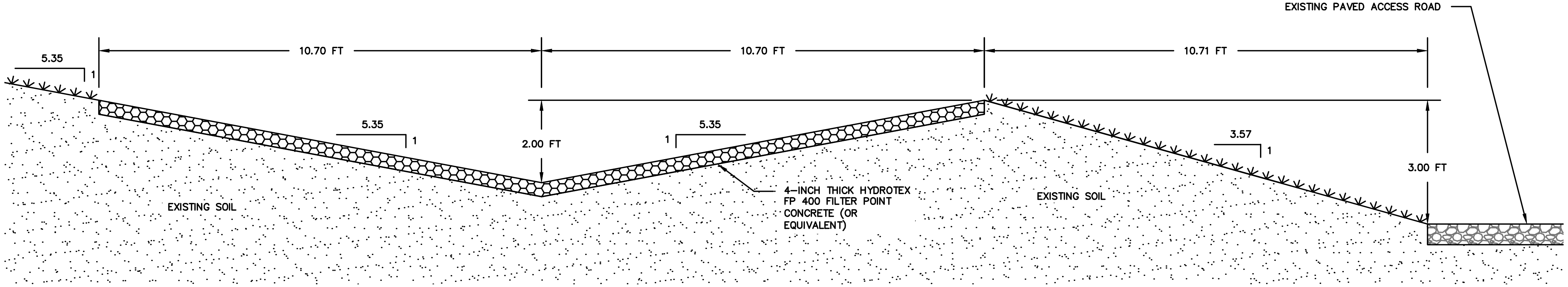
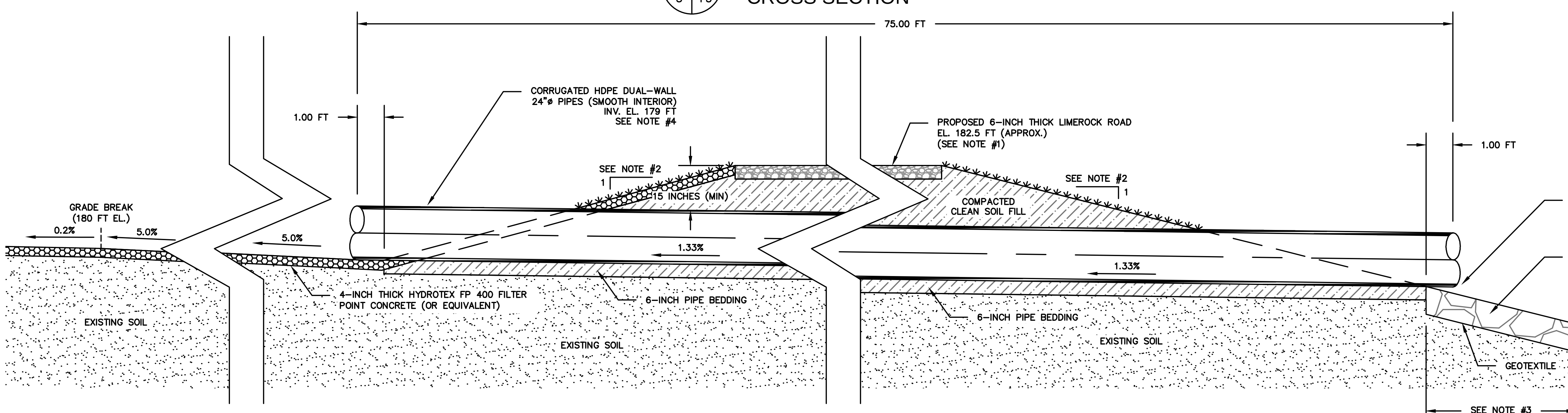
26 (9 | 19) NORTHEAST DITCH CROSS SECTION



NOTES:

1. WIDTH OF PROPOSED LIMEROCK ROAD WILL MATCH EXISTING ROAD PAVEMENT WIDTH.
2. SIDE SLOPE CONFIGURATION WILL MATCH EXISTING SLOPE CONFIGURATION.
3. THE RIPRAP APRON SHALL BE EXTENDED DOWN TO THE WATER'S EDGE.
4. TWO 24"ø CULVERT PIPES SHALL BE PLACED SIDE-BY-SIDE. PIPE FILTER POINT CONCRETE PENETRATION SHALL BE GROUTED TO PREVENT STORMWATER INTRUSION AROUND PIPES.

27 (9 | 19) P-3 CULVERT ROAD CROSSING CROSS SECTION



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CCR LANDFILL CLOSURE PLAN

DETAILS 26-27

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 19 OF 20

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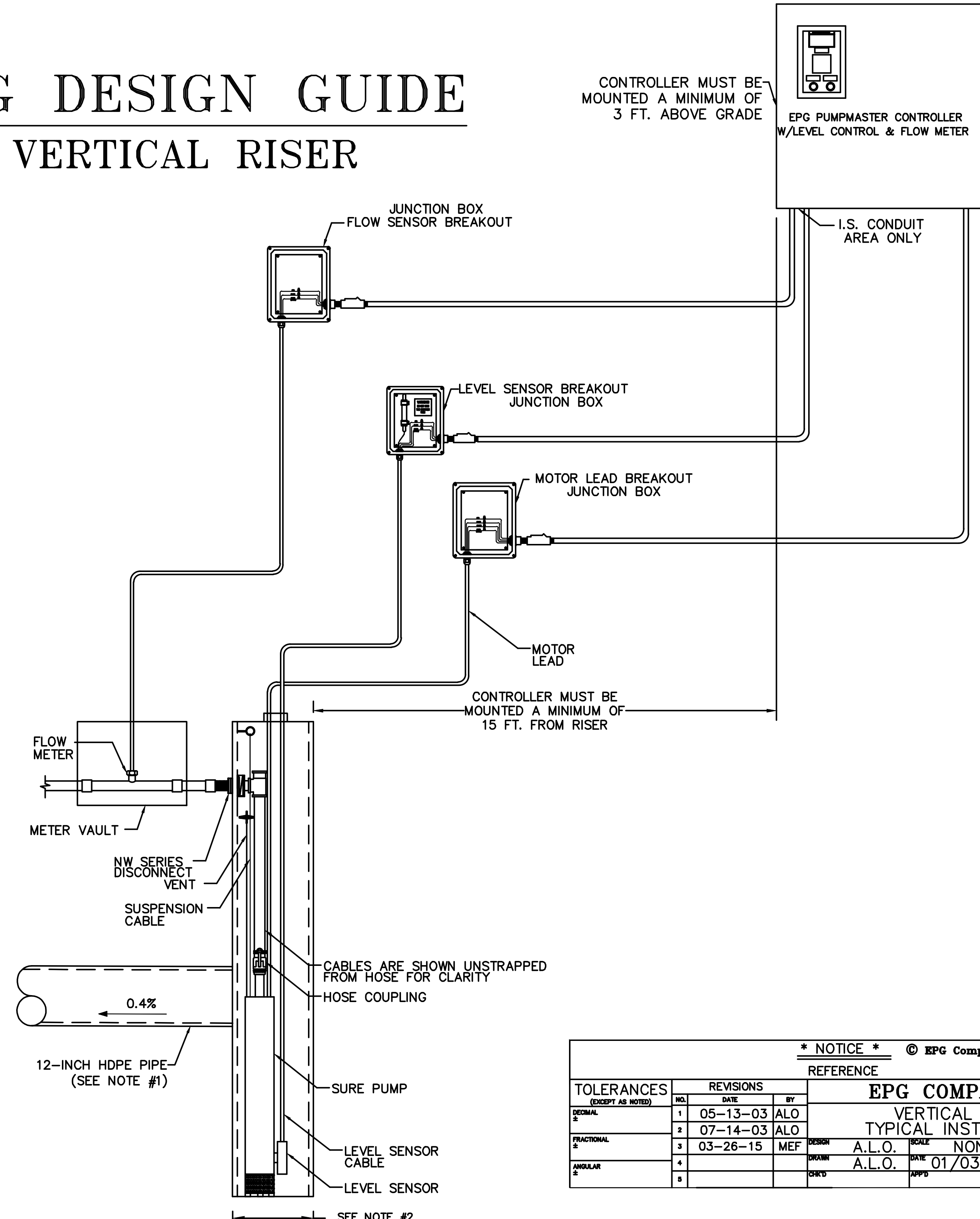
EPG DESIGN GUIDE

VERTICAL RISER



NOTES:

1. ELEVATION OF PIPE BOTTOM SHALL BE SELECTED TO ACHIEVE A MINIMUM PIPE SLOPE OF 0.4% WITH DRAINAGE TO THE EAST.
2. THE CCR CONTACT WATER SUMP DIAMETER, ELEVATIONS AND CONNECTION DETAILS WILL BE SELECTED BASED ON CONDITIONS AT THE TIME OF CLOSURE.

* NOTICE * REFERENCE

TOLERANCES (EXCEPT AS NOTED)	NO.	DATE	BY	EPG COMPANIES		
DECIMAL ±	1	05–13–03	ALO	VERTICAL RISER TYPICAL INSTALLATION		
FRACTIONAL ±	2	07–14–03	ALO	DESIGN A.L.O.	SCALE NONE	MATERIAL
ANGULAR ±	3	03–26–15	MEF	DRAWN A.L.O.	DATE 01/03/03	DRAWING NO. 05814–0000
	4			CHK'D	APP'D	
	5					

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iwcs innovative waste consulting services, llc

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CCR LANDFILL CLOSURE PLAN

DETAIL 28

DATE: 8 SEPTEMBER 2016
PRJ No:
SCALE: AS SHOWN
DWG No: 20 OF 20

APPENDIX B. STORMWATER PEAK DISCHARGE RATE CALCULATIONS

B STORMWATER PEAK DISCHARGE RATE FOR THE FINAL COVER SYSTEM

The stormwater control system for the site is designed to handle the flows from a 24-hour, 25-year design storm. Based on the geographic location of the site and the National Weather Service Hydrometeorological Design Studies Center website, the site-specific rainfall from a 24-hour, 25-year storm was estimated to be 7.27 inches (NOAA 2015).

The final cover area is divided into multiple drainage basins, each of which contributes a fraction of the total stormwater runoff. The peak discharge for each basin is found according to the following (USDA 1986) Equation (1):

$$q_p = q_u * A_m * Q_r * F_p \qquad (1)$$

Where,

q_p = peak discharge (cfs)

q_u = unit peak discharge (csm/in)

A_m = drainage area (mi^2)

Q_r = runoff (in)

F_p = pond and swamp adjustment factor (= 1.00 for 0% pond and swamp area)

The critical (or greatest) q_u is found by determining the critical (or shortest) time of concentration, T_c, by using the plot in Exhibit 4-II from USDA (1986). The appropriate curve used in this plot is found by solving the ratio of initial abstraction to precipitation, where the equation for initial abstraction has been generalized for agricultural watersheds and is represented as (USDA 1986) Equation (2):

$$I_a = 0.2 \times S \qquad (2)$$

Where,

I_a = Initial abstraction, or runoff loss (in)

S = Potential maximum retention after runoff begins (in)

S can be found by determining the curve number for the runoff area, as presented in the following (USDA 1986) Equation (3):

$$S = \frac{1000}{CN} - 10 \qquad (3)$$

Where,

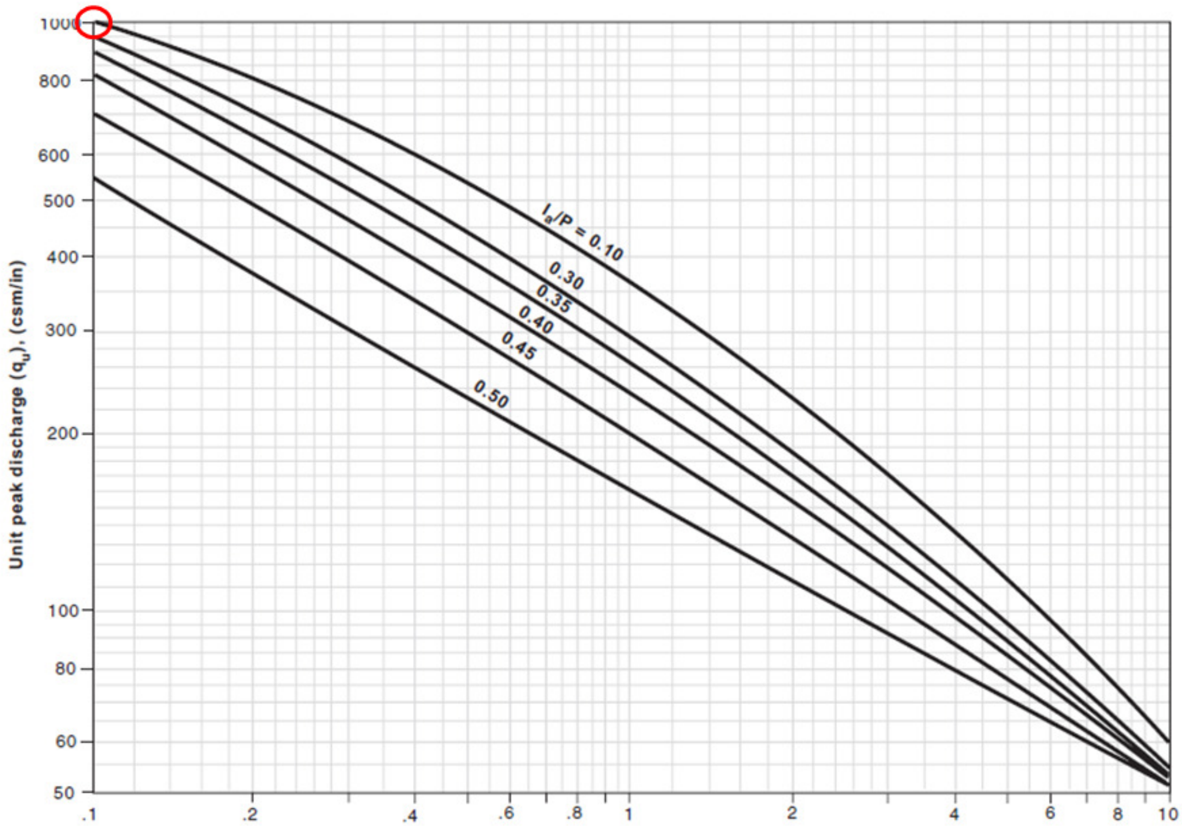
CN = curve number based on site surface soil conditions.

Based on a review of Appendix A of Technical Release 55 (USDA 1986), hydrologic soil group D (representing clay loam, silty clay loam, sandy clay, silty clay or clay) would be most representative of expected site surface cover soil conditions, and also provides the most conservative runoff curve estimate. Table 2-2a (USDA 1986), for an open space with grass cover in excess of 75%, provides a runoff curve number estimate of 80. This gives a potential maximum retention of 2.5 inches before runoff begins. Therefore, the initial abstraction is estimated as 0.5 inches.

As estimated based on location and NOAA (2015), the P_2 (i.e., two-year frequency, 24-hour rainfall) for the site is 4.20 inches and the value for I_a/P_2 (i.e., 0.069) is below the range of values listed in Exhibit 4-II. Per USDA (1986), an I_a/P_2 value of 0.10 was used. Please see the copy of Exhibit 4-11 below.

Because I_a/P_2 is outside the curve range provided for a Type II rainfall distribution, the maximum unit peak discharge (q_u) of 1000 csm/in was assumed for all drainage basins (the maximum y-intercept of I_a/P_2 = 0.10 in USDA (1986) Exhibit 4-II) for a conservative estimate.

Exhibit 4-II Unit peal discharge (q_u) for NRCS (SCS) type II rainfall distribution



Tables 1, 2, 3, 4, and 5 present the estimated peak discharge rates from/for the proposed side slope diversion berms, access ramp swale, ditch basins, culvert/downcomer pipes, and ditches, respectively. Layouts showing the locations of the stormwater diversion features and associated drainage basins are presented in Appendix A.

Table 1. Estimate Peak Discharge Rate for Proposed Side Slope Diversion Berms

Basin	Contributing Area (ft^2)	Area (mi^2)	Unit Peak Discharge, q_u (csm/in)	Peak Discharge, q_p (cfs)
A	115,413	0.00414	1000	20.5
B	79,092	0.00284	1000	14.0
C	67,826	0.00243	1000	12.0
D	99,837	0.00358	1000	17.7
E	53,427	0.00192	1000	9.4
F	42,212	0.00151	1000	7.6
G	82,998	0.00298	1000	14.7

Table 2. Estimated Peak Discharge Rate for Proposed Access Ramp Swale

Basin	Contributing Area (ft^2)	Area (mi^2)	Unit Peak Discharge, q_u (csm/in)	Peak Discharge, q_p (cfs)
H	101,419	0.00364	1000	18.0

Table 3. Estimated Peak Discharge Rate for Ditch Basins

Basin	Contributing Area (ft^2)	Area (mi^2)	Unit Peak Discharge, q_u (csm/in)	Peak Discharge, q_p (cfs)
1	27,441	0.00098	1000	4.9
2	284,381	0.01020	1000	50.4
3	191,237	0.00686	1000	33.9

Table 4. Estimated Maximum Peak Discharge Rate for Culvert/Downcomer Pipes

Pipe	Contributing Basins	Total Flow (cfs)
W-1	B, C	26.1
W-2	D	17.7
E-1	E, F	17.0
P-1	A, B, C, D, 2	114.7
P-2	E, F, G, H, 1	54.5
P-3	3	33.9

Table 5. Estimated Maximum Peak Discharge Rate for Ditches/Swales

Ditch/Swale Flows	Contributing Basins	Total Flow (cfs)
SW	A, B, C, D, 2	114.7
SE-1	E, F, H, (1/2) 1	37.4
SE-2	G, (1/2) 1	17.2
N	3	33.9
E	3	33.9

References

NOAA (2016). NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: FL. http://bit.ly/1Lji8tK accessed 23 August 2016. Data found for site coordinates using the National Oceanic and Atmospheric Administration National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server.

USDA (1986). Urban Hydrology for Small Watersheds. Technical Release – 55. Published by the United States Department of Agriculture Natural Resources Conservation Service and Conservation Engineering Division, June 1986.

APPENDIX C. STORMWATER BERM AND SWALE SIZING CALCULATIONS

C.1 SIDE SLOPE DIVERSION BERM AND V-SHAPED STORMWATER DIVERSION FEATURE CAPACITY CALCULATIONS

The diversion berm swales were designed to convey the stormwater flow associated with a 24-hour, 25-year storm. The erosion potential of the vegetative channel lining was evaluated considering velocity and tractive stress. The maximum diversion berm design flow of 20.5 ft^3/s (i.e., the peak discharge from diversion berm basin A) was used to size all diversion berms, as this represents the maximum flow anticipated for an individual diversion berm, as presented in Appendix B.

The following additional design assumptions were used in order to size the diversion berms:

- The diversion berms, when considered with respect to the final cover side slope, form a v-shaped channel.
- The inside slope of the diversion berms are sloped at 4 horizontal to 1 vertical (4:1).
- The berms are longitudinally sloped at 2% (along the landfill face) towards a downcomer pipe drain inlet.
- Berms are approximately spaced at 35-foot vertical elevation intervals (or 140 feet apart horizontally).

Based on these assumptions, Manning's and the continuity equation were rearranged to determine the minimum diversion berm height required to handle the maximum anticipated flow for the different diversion berm locations. Manning's equation is presented below:

$$V = \frac{1.486}{n} R^{2/3} s^{1/2}$$

Where,

V = velocity (ft/s)

n = Manning's roughness coefficient (0.08 for excavated or dredged channel, channel not maintained, with weeds and brush uncut including dense weeds as high as the flow depth, normal value (Chow 1959))

s = longitudinal slope of channel (ft/ft)

R = hydraulic radius (ft),

$$R = \frac{A}{W_P}$$

Where,

A = cross-sectional flow area (ft^2)

W_P = wetted perimeter (ft)

Manning's equation as rearranged to solve for flow depth is presented below as Equation (1):

$$D = \left(\frac{2Qn(A+B)^{-5/3}\left(\frac{0.5}{\sqrt{A^2+1}+\sqrt{B^2+1}}\right)^{-2/3} s^{-1/2}}{1.486} \right)^{3/8} \quad (1)$$

Where,

Q = maximum diversion berm design flow (ft^3/s)

A = the horizontal distance associated with each foot of vertical rise of the outside of the v-shaped diversion berm channel side slopes (ft) – please see Figure 1 for a depiction of this dimension

B = the horizontal distance associated with each foot of vertical rise of the outside of the v-shaped diversion berm channel side slopes, or the landfill side slope (ft) – please see Figure 1 for a depiction of this dimension

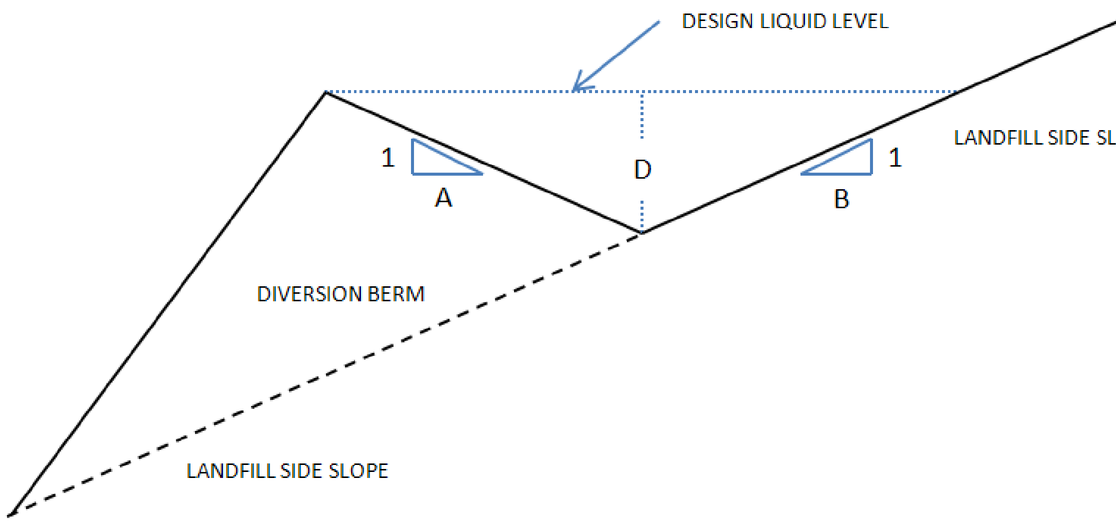


Figure 1. Diversion Berm Swale Cross Section showing variables in Equation (1)

Based on a maximum diversion berm design flow of 20.5 ft^3/s and the assumptions made above, the minimum diversion berm depth necessary to handle the peak flow associated with a 24-hour, 25-year storm is:

1.54 ft

Therefore, the proposed design depth for the side slope diversion berms is:

2.0 ft

Based on the proposed berm dimensions, both the flow velocity and the tractive stress induced on the berm channel lining during the maximum diversion berm design flow of 20.5 ft^3/s need to be within an acceptable range to minimize erosion potential.

The flow velocity (ft/s) can be calculated from the Continuity Equation (2):

$$V = \frac{Q}{A} \quad (2)$$

Where,

A = Cross-sectional area of the flow (ft^2)

The velocity for the maximum diversion berm design flow is:

2.16 ft/s

This estimated maximum velocity is less than the maximum allowable velocity range given for long native grasses (4-6 ft/s) as presented in Fischenich (2001) and therefore grass lining is acceptable for the design.

The tractive stress (psf) induced on the diversion berm sides can be found using the Hassanzadeh (2012) Equation (3):

$$\tau = \rho g R_h S \quad (3)$$

Where,

τ = tractive stress (psf)

ρ = fluid unit weight ($slugs/ft^3$)

g = the gravitational constant (ft/s^2)

R_h = hydraulic radius (ft)

S = channel bed slope

The tractive stress for the maximum diversion berm design flow is:

0.93 psf

The estimated tractive stress is below the permissible shear stress for long native grasses (1.2 – 1.7 psf) as presented in Fischenich (2001) and therefore grass lining is acceptable for the design.

The capacity of additional v-shaped stormwater diversion features was calculated in the same manner using the equations presented above. Table 1 below presents the design values used in the calculations as well as the resulting flow depth, velocity and tractive stress calculated for each stormwater design feature. The selected design depth is also presented and was selected based on the required flow depth.

Table 1. Inputs and Outputs for Additional V-Shaped Stormwater Diversion Feature Capacity Calculations

	Ditch/Swale Locations				
Inputs	**Access Ramp Swale**	**N Drainage Swale**	**E Drainage Ditch**	**SE-1**	**SE-2**
Lining Type	filter point concrete	grass	filter point concrete	filter point concrete	filter point concrete
Permissible Shear Stress (psf)	12.5	1.2-1.7	12.5	12.5	12.5
Permissible Velocity (ft/s)	>18	4-6	>18	>18	>18
Q (cfs)	18	33.9	33.9	37.4	17.2
n	0.02	0.08	0.02	0.02	0.02
Drainage Slope (ft/ft)	0.1	0.004	0.002	0.025	0.005
A	1	25	4	4	12
B	4	25	4	2	1
Outputs	**Access Ramp Swale**	**N Drainage Swale**	**E Drainage Ditch**	**SE-1**	**SE-2**
Flow Depth (ft)	0.78	1.26	1.7	1.23	0.93
Velocity (fps)	11.75	0.86	2.92	8.19	3.08
Tractive Stress (psf)	2.21	0.16	0.1	0.91	0.14
Design Depth Selected (ft)	**1**	**2**	**2**	**1.5**	**1**

The calculated velocity and tractive stress for the grass-lined Northern Drainage Swale is acceptable per the allowable limits presented above. For concrete lining, Fischenich (2001) presents a permissible velocity in excess of 18 ft/s and a permissible shear stress of 12.5 psf; the calculated values for all the filter point concrete-lined diversion features fall below these limits. Please refer to Drawing 6 of Appendix A for the locations of these drainage features.

The n value used for filter point concrete lining is based on personal communication with Scales (2001), a vendor of filter point concrete products. For the purpose of a conservative design, the same total flow rate (i.e., the flow rate from all the basins which drain to the P-3 culvert pipes) was used to estimate the flow depth in both the Northern Drainage Swale and Eastern Drainage Ditch.

SE-1 and SE-2 refer to the filter point concrete-lined drainage swales located at the inlets of the P-2 culvert pipes. SE-1 is the portion of the swale located to the southwest of the pipe inlets and SE-2 represents the portion of the swale located to the northeast of the inlets. The input values used for the capacity calculations presented above were selected to represent the most critical cross section (i.e., the cross section with the steepest side slopes and shallowest depth) of these swale sections.

C.2 SOUTHWEST DRAINAGE DITCH CALCULATIONS

As estimated in Appendix B, the maximum flow (from a 24-hour, 25-year design storm) that must be handled by the grass-lined Southwest (SW) Ditch is 114.7 ft^3/s. The maximum flow that the ditch can handle can be estimated by combining Manning's Equation and the Continuity Equation (presented previously) into Equation (4):

$$Q_{max} = A * \frac{1.486}{n} (\frac{A}{WP})^{2/3} S^{1/2} \quad (4)$$

A representative cross section of the proposed ditch is presented in Figure 2.

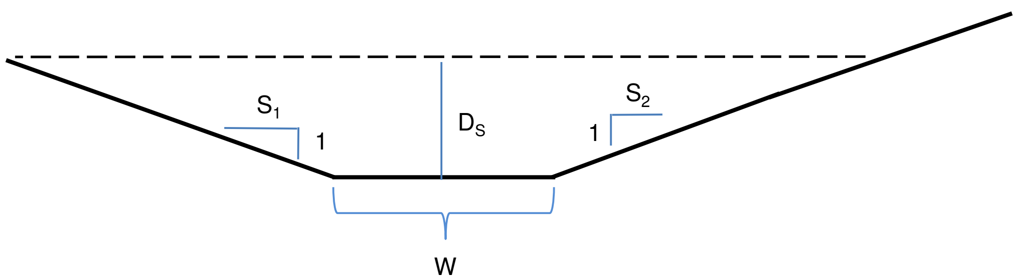


Figure 2. SW Drainage Ditch Cross Section Showing Variables in Equation (5) and Equation (6)

To estimate the maximum flow that can be handled by the ditch, it is necessary to calculate the maximum flow cross-sectional area and hydraulic radius, presented in Equations (5) and (6), respectively:

$$A = \frac{1}{2} S_2 (D_S)^2 + D_S W + \frac{1}{2} S_1 (D_S)^2 \quad (5)$$

$$W_P = \sqrt{(D_S)^2 + (S_2 D_S)^2} + W + \sqrt{(D_S)^2 + (S_1 D_S)^2} \quad (6)$$

Where,

D_S = the depth of the swale (ft)

W = the width of the bottom of the swale (ft)

S_1 = the incremental horizontal distance for each vertical foot of the outside (i.e., with respect to the landfill) slope of the swale

S_2 = the incremental horizontal distance for each vertical foot of the inside (i.e., with respect to the landfill) slope of the swale

Please see Figure 2 for a definition sketch of these variables. Table 2 presents a summary of the inputs used in the calculations and the resulting flow depth, velocity, and tractive stress. A Manning's roughness coefficient of 0.05 was selected as the minimum value of the range presented by Chow (1959) for excavated or dredged channels, channels not maintained, weeds and brush uncut, dense weeds, high as flow depth. The minimum value of the range was selected because it is not anticipated that the entire 2.75-foot deep ditch will be completely filled with vegetation as high as the flow depth. With the exception of the ditch depth, the values presented in Table 2 were estimated from an IWCS topographic evaluation of the drainage ditch based on existing conditions as of August 2016.

Table 2. Inputs and Outputs for the Southwest Drainage Ditch Capacity Calculations

Inputs	
n	0.05
swale slope	0.0034
Ds	2.75
S1	4.0
S2	2.6
W	8.2
Outputs	
Velocity (fps)	2.5
Tractive Stress (psf)	0.37
Flow Capacity (cfs)	119.4

As shown in Table 2, the velocity and tractive stress associated with the maximum design flow fall within the acceptable limits presented by Fischenich (2001) for long native grass lining. The 119.4 ft^3/s flow capacity of the proposed design exceeds the anticipated 114.7 ft^3/s design flow associated with a 24-hour, 25-year storm.

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APPENDIX D. DOWNCOMER AND CULVERT PIPE CAPACITY CALCULATIONS

D PIPE FLOW CALCULATIONS

Determine the minimum downcomer/culvert pipe inner diameter necessary to handle the peak stormwater discharge rates as determined in Appendix B.

Manning's equation gives the pipe flow velocity (m/s) as Equation (1):

$$V = \frac{R^{2/3} i^{1/2}}{n} \qquad (1)$$

Where,

i = slope of the pipe (m/m)

n = Manning's roughness coefficient

R = hydraulic radius (m)

For a full-flowing pipe, R is given by the following Equation (2):

$$R = \frac{A_w}{P_w} = \frac{D}{4} \qquad (2)$$

Where,

D = the inner diameter of the pipe (m)

A_w = cross-sectional area of flow (m^2) = $\frac{\pi}{4} D^2$

P_w = perimeter of the flow area = πD

The continuity equation gives the flow rate (m^3/s) as Equation (3):

$$Q = V A_w$$

Or can be solved for pipe flow velocity (m/s) by rearranging terms,

$$V = \frac{4Q}{\pi D^2} \qquad (3)$$

Equation (1) can be rearranged to solve for R so that:

$$R = \left(\frac{Vn}{i^{1/2}}\right)^{\frac{3}{2}}$$

From equation (2), D = 4R

Therefore, the necessary inner diameter of a pipe can be found as Equation (4):

$$D = 4\left(\frac{Vn}{i^{1/2}}\right)^{\frac{3}{2}} \qquad (4)$$

Substituting equation (3) into (4)

$$D = 4\left(\frac{4Qn}{\pi D^2 i^{1/2}}\right)^{\frac{3}{2}}$$

Or by factoring out D,

$$D = 4^{\frac{1}{4}}\left(\frac{4Qn}{\pi i^{1/2}}\right)^{\frac{3}{8}} \qquad (5)$$

Therefore, the minimum inner pipe diameter for each of the pipes can be found using the flows determined in Appendix B, the gradient of each of the downcomer/culvert pipes from the Appendix A drawing set (or from the known geometry of the existing P-1 culvert pipe), and using a Manning's roughness coefficient of 0.012 for smooth-walled plastic pipe. Table 1 presents a summary of the input variables used to estimate the required pipe diameter while Table 2 presents the calculation results for each downcomer/culvert pipe. Table 2 also presents the selected pipe size for each pipe location.

Table 1. Inputs for Pipe Diameter Calculations

Pipe Location	W-1	W-2	E-1	P-1	P-2	P-3
Total Flow	26.1	17.7	17.0	114.7	54.5	33.9
Number of Pipes	1	1	1	1	3	2
Flow per Pipe (cfs)	26.1	17.7	17.0	114.7	18.2	17.0
n (for HDPE)	0.012	0.012	0.012	0.012	0.012	0.012
i (ft/ft)	0.25	0.25	0.25	0.022	0.04	0.0133

Table 2. Pipe Diameter Calculation Results

Pipe Location	W-1	W-2	E-1	P-1	P-2	P-3
ID (inches)	13.44	11.62	11.44	36.93	16.54	19.81
Pipe Diameter Selected (inches)	15	15	15	36	18	24

A 15-inch pipe was selected for use at all downcomer pipe locations.

It should be noted that the existing 36-inch culvert pipe located at P-1 is mildly sloped (i.e., <1%). Therefore, the headspace above this pipe was accounted for in the pipe gradient estimate. With the headspace contribution, the pipe is still slightly undersized (i.e., less than an inch) to handle the maximum anticipated flow associated with the design storm. However, even if stormwater in the outlet area of the southern drainage ditch overtopped the adjacent unpaved access road, it would discharge into the adjacent stormwater pond.

APPENDIX E. FINAL COVER EROSION RESISTANCE

E Erosion Resistance of the Final Cover System

This calculation package estimates the cover soil loss rate for the landfill final cover system using the Revised Universal Soil Loss Equation (RUSLE). The soil loss rate is calculated for the critical (i.e., steepest) drainage slope.

The RUSLE (Renard et al., 1997) is presented as Equation (1):

$$A = R \times K \times L \times S \times C \times P \quad (1)$$

Where,

A = Average annual soil loss (ton·acre^{-1}·year^{-1})

R = Average annual erosivity factor (hundreds of feet·tonf·inch acre^{-1}·yr^{-1})

K = Soil erodibility factor (ton·acre·h·[hundreds of acre-ft·tonf·in]$^{-1}$)

L = Slope length factor (-)

S = Slope steepness factor (-)

C = Cover-management factor (-)

P = Support practice factor (-)

The site-specific R value can be interpolated using an isoerodent map of the eastern United States (Renard et al, 1997) as shown in shown in Attachment E-1. Based on the location of the site, the R value was interpolated as:

R = 425 hundreds of feet·tonf·inch acre^{-1}·yr^{-1}

The K value was estimated from Table 1 of the Texas Natural Resource Conservation Commission (1993) as shown in Attachment E-2, assuming a top cover of sandy loam with <0.5% organic matter:

K = 0.27 ton·acre·h·[hundreds of acre-ft·tonf·in]$^{-1}$

The critical slope length parallel to the soil surface at the landfill is 145 ft. At a 3:1 (Horizontal: Vertical (H: V)) slope, the slope length (i.e., the horizontal projection of the start of the overland flow to the end of slope gradient where deposition begins) is 137 feet. The slope length factor (L) can be found from Equation (2) (Renard et al, 1997):

$$L = \left(\frac{\lambda}{72.6}\right)^m \quad (2)$$

Where,

λ = slope length (ft)

m = slope length exponent $= \frac{\beta}{1+\beta}$

β = rill to interrill ratio $= \frac{\frac{\sin\theta}{0.0896}}{3.0\times\sin\theta^{0.8}+0.56}$

Θ = angle of the side slope = 18.43 degrees

At a 3:1 (H:V) slope, the ratio of rill to interrill erosion (β) = 2.01

For a freshly-prepared construction slope, the ratio of rill to interrill erosion is assumed to be twice that of an established slope (Renard et al, 1997). Assuming it takes the vegetation of the slope one year to become established, β was estimated as 4.12 for the first year and 2.06 for the remaining years of the post closure care (PCC) period. Therefore;

β_1 = 4.02 (Year 1)

$\beta_{2\text{-}30}$ = 2.01 (Year 2-30)

The slope length exponent (m) was calculated as;

m_1 = 0.80 (Year 1)

$m_{2\text{-}30}$ = 0.67 (Year 2-30)

Therefore, the slope length factor was calculated as

L_1 = 1.66 (Year 1)

$L_{2\text{-}30}$ = 1.53 (Year 2-30)

The slope gradient factor, S, for θ ≥ 9%, was calculated by the following Equation (3):

$$S = 16.8\sin\theta - 0.50 \quad (3)$$

Therefore,

S = 4.81 and

LS was calculated as

LS_1 = 8.03

$LS_{2\text{-}30}$ = 7.37

Assuming the landfill is covered with sod immediately, a single C value is assumed for the entire 30-year post closure care period from Wischmeier and Smith (1978) (shown in Attachment E-3); it is assumed that there is greater than 95% ground cover and no canopy. Therefore,

C_{95} = 0.003

The support practice factor (P) was assumed to be equivalent to pasture land (from Table 17.21 of Mays (2001), as shown in Attachment E-4). Therefore,

P = 1.0

The soil loss for the first year (A_1), for the second through the thirtieth year ($A_{2\text{-}30}$), and the weighted average (A_{avg}) annual soil loss was calculated using Equation 1.

A_1 = 2.76 tons/acre/yr

$A_{2\text{-}30}$ = 2.54 tons/acre/yr

A_{avg} = 2.55 tons/acre/yr

Considering a soil unit weight of 103 pounds/cubic foot (i.e., the midpoint unit weight of a sandy loam as presented in (UF 2015)), the

Rate of soil loss = 0.014 inches/year

The total depth of soil loss during 30-year PCC = 0.41 inches or 1.7% of the 24-inch total thickness of the final cover

Park (1997) suggested an acceptable soil loss rate of 0 to 5 tons/acre/year in a presentation on landfill cover design. Koerner and Daniel (1977) suggested an upper limit of acceptable of soil erosion from a landfill final cover as 2 tons/acre/year. The calculated average soil loss from the GRU Deerhaven CCR landfill during the PCC period is 2.55 tons/acre/year, which is within the acceptable limit as described by Park and slightly above the upper limit proposed by Koerner and Daniel (1977). The rate of soil loss from final cover was calculated as 0.014 inches/year, which corresponds to 0.41 inches or 1.7% of the total 24-inch final cover thickness over the 30-year PCC period. Therefore, based on the estimated rate of soil loss, the integrity of the designed final cover system should be sufficient over the PCC period.

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APPENDIX E	**Final Cover Erosion Resistance**	**CHECKED BY: Pradeep Jain**
PROJECT: GRU DGS CCR LF Final Cover Design	**Date: 8/25/2016**	**DATE: 9/8/2016**

ATTACHMENT E-1: ISOERODENT MAP OF EASTERN UNITED STATES

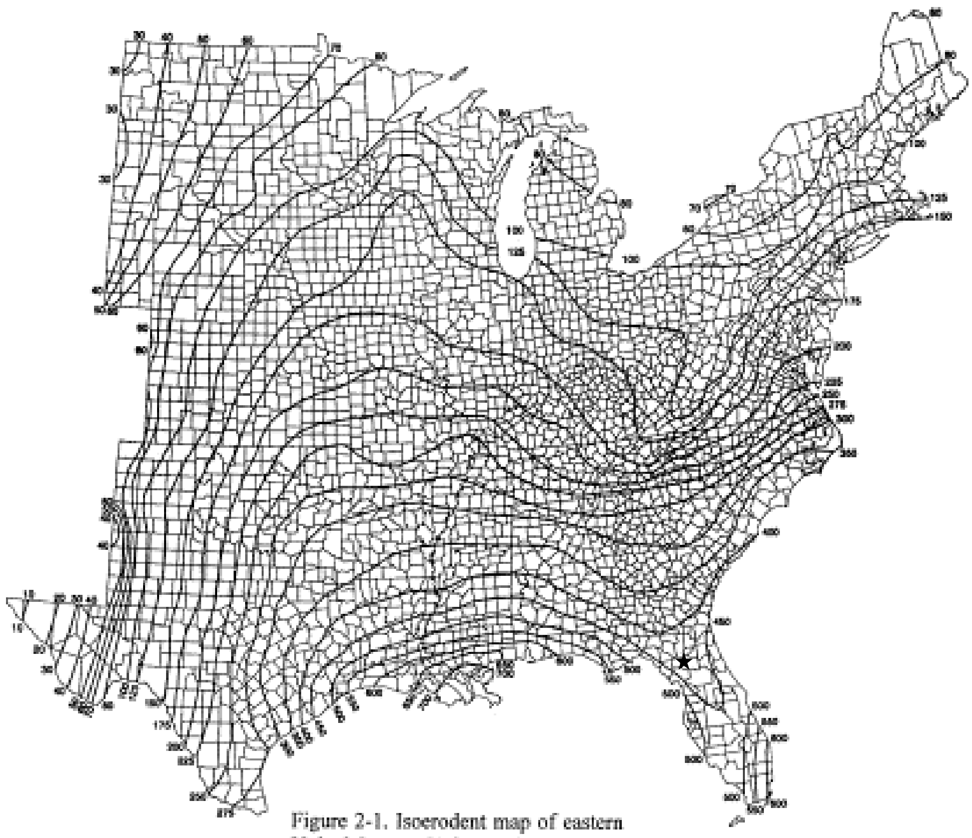

Figure 2-1. Isoerodent map of eastern United States. Units are hundreds ft·tonf·in(ac·h·yr)$^{-1}$.

Rainfall-Runoff Erosivity Factor (R)

ATTACHMENT E-2: APPROXIMATE VALUE OF FACTOR K FOR USDA TEXTURAL CLASSES

Table 1 Approximate Values of Factor K for USDA Textural Classes

TABLE 1

Texture Class	Organic Matter Content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine Sand	0.16	0.14	0.10
Very Fine Sand	0.42	0.36	0.28
Loamy Sand	0.12	0.10	0.08
Loamy Fine Sand	0.24	0.20	0.16
Loamy Very Fine Sand	0.44	0.38	0.30
Sandy Loam	0.27	0.24	0.19
Fine Sandy Loam	0.35	0.30	0.24
Very Fine Sandy Loam	0.47	0.41	0.33
Loam	0.38	0.32	0.29
Silt Loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy Clay Loam	0.27	0.25	0.21
Clay Loam	0.28	0.25	0.21
Silty Clay Loam	0.37	0.32	0.26
Sandy Clay	0.14	0.13	0.12
Silty Clay	0.25	0.23	0.19
Clay	0.13 - 0.29		

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

ATTACHMENT E-3: CROP MANAGEMENT FACTOR

Wischmeier and Smith (1978) Predicting Rainfall Erosion Losses

tion and developmental areas can be obtained from table 5 if good judgment is exercised in comparing the surface conditions with those of agricultural conditions specified in lines of the table. Time intervals analogous to cropstage periods will be defined to begin and end with successive construction or management activities that appreciably change the surface conditions. The procedure is then similar to that described for cropland.

Establishing vegetation on the denuded areas as quickly as possible is highly important. A good sod has a **C** value of 0.01 or less (table 5-B), but such a low **C** value can be obtained quickly only by laying sod on the area, at a substantial cost. When grass or small grain is started from seed, the probable soil loss for the period while cover is developing can be computed by the procedure outlined for estimating cropstage-period soil losses. If the seeding is on topsoil, without a mulch, the soil loss ratios given in line 141 of table 5 are appropriate for cropstage **C** values. If the seeding is on a desurfaced area, where residual effects of prior vegetation are no longer significant, the ratios for periods SB, 1 and 2 are 1.0, 0.75 and 0.50, respectively, and line 141 applies for cropstage 3. When the seedbed is protected by a mulch, the pertinent mulch factor from the upper curve of figure 6 or table 9 is applicable until good canopy cover is attained. The combined effects of vegetative mulch and low-growing canopy are given in figure 7. When grass is established in small grain, it can usually be evaluated as established meadow about 2 mo after the grain is cut.

C Values for Pasture, Range, and Idle Land

Factor **C** for a specific combination of cover conditions on these types of land may be obtained from table 10 (57). The cover characteristics that must be appraised before consulting this table are defined in the table and its footnotes. Cropstage periods and **EI** monthly distribution data are generally not necessary where perennial vegetation has become established and there is no mechanical disturbance of the soil.

Available soil loss data from undisturbed land were not sufficient to derive table 10 by direct comparison of measured soil loss rates, as was done for development of table 5. However, analyses of the assembled erosion data showed that the research information on values of **C** can be extended to completely different situations by combining subfactors that evaluate three separate and distinct, but interrelated, zones of influence: (a) vegetative cover in direct contact with the soil surface, (b) canopy cover, and (c) residual and tillage effects.

Subfactors for various percentages of surface cover by mulch are given by the upper curve of

TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
			Percent ground cover					
Type and height[2]	Percent cover[3]	Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

ATTACHMENT E-4: EROSION CONTROL PRACTICE FACTOR (P)

Mays, L. (2001). Stormwater Collection Systems Design Handbook. Chapter 17-Table 17-21.

TABLE 17.21 Recommended Erosion Control Factor for General Land Use

General land use	*P*
Crop land	0.5
Pasture land	1.0
Forest land	1.0
Urban land	1.0
Other	1.3

Source: From Wanielista (1978).

APPENDIX F. HELP EVALUATION OF THE GEOSYNTHETIC DRAINAGE LAYER

HELP Simulations and Methodology

Objective and Modeling Approach

This appendix describes the use of the Hydrologic Evaluation of Landfill Performance (HELP), developed by Schroeder et al. (1994), to assess the suitability of the final cover system geocomposite drainage layer (GDL) to handle and route the stormwater which infiltrates through the overlying soil layers.

The critical flow path for the GDL is a route which includes the landfill topdeck (i.e., a 50-foot drainage path at a 4% slope) followed by a side slope (i.e., a 145-foot drainage path at a 25% slope). Because the HELP model cannot simultaneously analyze the hydrology associated with multiple slope configurations, two HELP simulations were conducted to analyze the ability of the GDL to handle the maximum flows associated with this critical flow path.

HELP allows the specification of a subsurface inflow for different material layers. Therefore, the HELP-estimated maximum daily flow of liquid collected from the geocomposite drainage layer of the 4% slope, 50-foot section from the first HELP simulation was input as a subsurface inflow for the geocomposite drainage layer in the HELP modeling run conducted to analyze the stormwater elevation head for the geocomposite of the 25% slope, 145-foot section in the second simulation.

The stormwater elevation head on the geomembrane cap is a driving force behind final cover system veneer slope stability, since liquid heads greater than the thickness of the GDL would decrease the amount of friction in overlying soil cap components. The purpose of this calculation package is to verify a maximum head on the geomembrane of less than 0.3 inches under conservative operating conditions; 0.3 inches is a common geocomposite thickness available on the market at the time this calculation package was developed.

HELP Inputs

HELP inputs can be broadly broken down into climatic and design data. Climatic data includes entering representative values for precipitation, temperature, humidity, wind speed and solar radiation, while design data includes inputting information on layer arrangement and properties such as saturated hydraulic conductivity, layer thicknesses and initial moisture content. The HELP model includes a number of default layers with default properties, but allows the user to modify this properties, if desired. A detailed summary of the HELP inputs and modeling results for the 4% slope section and 25% slope section is included in Attachment F-1 and F-2, respectively.

Climate Data

Climatic HELP input data for the site was downloaded from the National Oceanic and Atmosphere Administration (NOAA) National Centers for Environmental Information Climate Data Online tool (NOAA 2016). Thirty (30) years of mean monthly temperature and cumulative monthly rainfall data were downloaded for the period from 1 January 1986 to 31 December 2015 and were averaged by month. These monthly average values were manually entered into HELP and modeling values were then synthetically generated by HELP based on the stochastic statistical distribution of these parameters in Jacksonville, Florida. Solar radiation values were also synthetically generated using the previously entered rainfall data along with the latitude of the site. In the absence of site specific information, model-default average humidity and wind speed information from Jacksonville was selected and used to approximate these conditions for the site.

HELP requires the user to select evapotranspiration data including the evaporative zone depth, the maximum leaf area index, and the growing season period; a (conservative) evaporative zone depth of 10 inches, a good stand of grass (i.e., leaf area index of 3.5), and a growing season spanning the entire year were selected for each of these values, respectively. All climatic data for use by HELP was generated for a 30-year period.

Design Data

Design data assumed the following layers of the final cover system for HELP modeling, from top to bottom:

- 6-inch topsoil layer (capable of supporting native vegetation)
- 18-inch protective soil layer
- 300-mil geocomposite drainage layer (i.e., a geonet sandwiched between two geotextile layers)
- 40-mil textured linear low-density polyethylene (LLDPE) geomembrane

Soil Layers

The hydraulic conductivity of the soil layers was estimated based on Alachua County soil survey information provided in USDA (1985). The surface soils of the County are predominantly sandy, and based on USDA (1985), it appears that the majority of these soils have a hydraulic conductivity less than 15 cm/hr, or approximately 0.017 cm/s. Therefore, for a conservative analysis, this hydraulic conductivity was selected for both the 6-inch and 18-inch soil layers. The other properties for the soil layers were selected and maintained from the model default values provided for soil texture #1, which represents a poorly-graded clean sand, sand-gravel mix.

Lateral Drainage Layer

Layer default properties associated with soil texture #12 (i.e., a model default geonet) were maintained for the lateral drainage layer, except for the hydraulic conductivity, which was selected based on transmissivity data for a currently-available geocomposite product (i.e., GSE

Fabrinet UF). Narejo et al. (2007) provides 100-hour transmissivity data for a number of geocomposite products under three loading conditions: 1,000 psf, 5,000 psf and 10,000 psf. The transmissivity values associated with the 1,000 psf curve were selected for this analysis. Please note that under the two feet of cover soil, the geocomposite would only experience a load of approximately 220 psf (assuming the upper limit of soil density values for Alachua County soils as described in USDA (1985)); the 1,000 psf transmissivity values should provide a conservative estimate.

The specific transmissivity of a geocomposite is dependent on its gradient, assumed as the gradient of the slope on which it is placed. Transmissivity values were estimated from Figure 1 for both 0.04 and 0.25 gradient conditions (i.e., the gradients along the critical flow path), as 1.5E-3 and 3.5E-3 m^2/s, respectively.

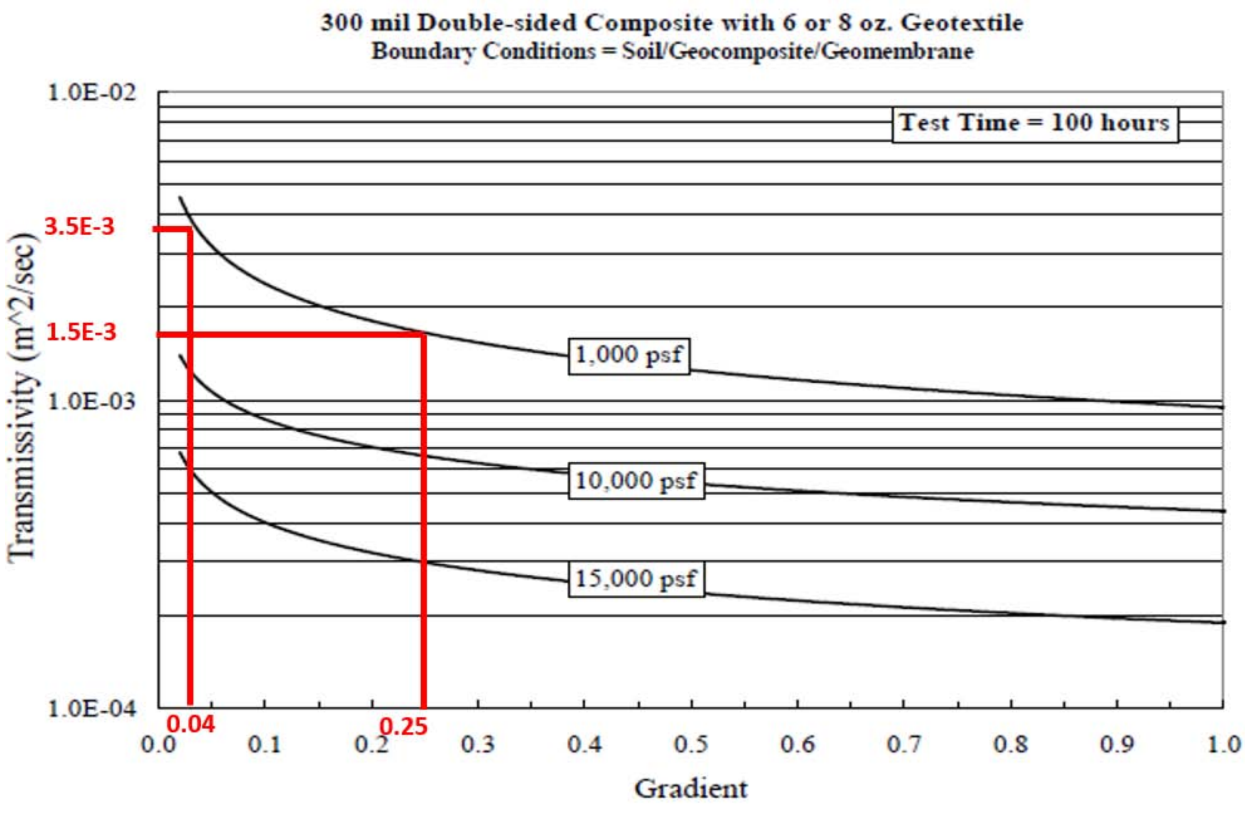

Figure 1. 100-hour Transmissivity Values for 300-mil GSE Fabrinet UF Gecomposite Under Different Loading Conditions (Narejo et al. 2007)

HELP requires specification of effective saturated hydraulic conductivity; the following equation was used to find hydraulic conductivity (K) values based on the transmissivity values estimated from Figure 1:

$$K = \frac{T_i}{B} \quad (1)$$

Where,

T_i = transmissivity of the geocomposite at the ith gradient (m^2/s)

B = the thickness of the geocomposite (m)

The resulting hydraulic conductivities at 4% and 25% slopes were estimated as 45.9 and 19.7 cm/s, respectively. Unless otherwise specified, default HELP inputs were used for the different media layers. Tables summarizing the non-default inputs are presented in Table 1.

Table 1. HELP Soil Layer Properties (Non-default Inputs in Blue)

Layer	Thickness (in)	Effective Saturated Hydraulic Conductivity (cm/s)	Default Values From
Topsoil	6	1.7E-02	HELP Soil Texture #1
Protective Soil	18	1.7E-02	HELP Soil Texture #1
Geocomposite	0.3	45.9 (4% slope) 19.7 (25% slope)	HELP Soil Texture #12
Geomembrane	0.04	0.04E-12	HELP Soil Texture #36

Runoff Curve Number

The runoff curve number was computed by the HELP model for each simulation based on the slope configuration (i.e., 4% or 25%), slope length (i.e., 50 feet or 145 feet), soil texture (i.e., soil texture #1), and vegetation rating (i.e., 3). The curve numbers estimated for the 4% and 25% slope conditions were 38.6 and 50.5, respectively.

HELP Modeling Results and Discussion

The maximum daily heads on the geomembrane over both portions of the critical drainage path are summarized from Attachment F-2 and F-3 in Table 2, below.

Table 2. Maximum Head Estimated in Geocomposite Drainage Layer

Section	Slope Configuration (ft/ft)	Slope Length (ft)	Max Head on Liner Estimated From HELP (inches)	Max Head on Liner Estimated From Giroud et al. 2004 (inches)
Top Deck	0.04	50	0.017	0.0172
Side Slope	0.25	145	0.031	0.0306

Please recall that the maximum daily liquid flow collected from the lateral drainage layer of the top deck (from the first HELP simulation) was included as a subsurface inflow into the lateral drainage layer of the side slope (in the second HELP simulation). Because HELP distributes the subsurface inflow across the entire modeled area, the subsurface inflow was multiplied by the ratio of the 4% slope length to the 25% slope length (i.e., 50/145) to account for the difference in slope modeling areas. The maximum head values for each section of the critical drainage path are noticeably lower than the 0.3-inch thickness provided by a 300-mil geocomposite; the design is considered acceptable.

As a check of the HELP output values, the maximum head for each portion of the critical drainage path was re-calculated using the methodology presented by Giroud et al. (2004), which presents equations for estimating maximum head for two-layer drainage systems including a geocomposite. The maximum daily drainage collected from the lateral drainage layer from each HELP simulation was used as the rate of liquid supply in the Giroud et al. (2004) equations. As a point of reference, the maximum head values calculated for the critical drainage path using Giroud et al. (2004) are also summarized in Table 2. Please note that the HELP simulation and Giroud et al. (2004) head results are essentially identical. A summary of the values used in the Giroud et al. (2004) equations is included in Table 3.

Table 3. Summary of Input Values Used in Supplemental Giroud et al. (2004) Equations

Parameter	Value - Top Deck	Value - Side Slope	Unit	Description
qh	1.795	3.031	in/day	Rate of Liquid Supply
ø1	3.5E-03	1.5E-03	m2/s	Transmissivity of Geocomposite
K2	1.70E-02	1.70E-02	cm/s	Hydraulic Conductivity of Overlying Drainage Layer
tanβ	0.04	0.25	-	Slope Gradient
t1	300	300	mil	Thickness of Geocomposite
Lpath	50	145	ft	Length of Drainage Slope Along Drainage Path

As estimated using HELP and the equations presented by Giroud et al. (2004), the analyzed GDL appears to be sufficient to handle and route the stormwater which infiltrates through the overlying soil layers.

References

Giroud, J.P.; Zhao, A.; Tomlinson, H.M.; Zornberg, J.G. (2004). Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite. *Geosynthetics International*. 11(1): 43-58.

Narejo, D.; Bachus, R.; Thiel, R.; Soong, T.; Li, M. (2007). Drainage Design Manual, 2nd Ed. Developed for GSE Environmental, June 2007.

NOAA (2016). Climate Data Online. National Centers for Environmental Information, National Oceanic and Atmospheric Administration. http://bit.ly/2akw9fx accessed 8 July 2016.

Schroeder, P. R., Aziz, N. M., Lloyd, C. M. and Zappi, P. A. (1994). The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's Guide for Version 3," EPA/600/R-94/168a, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.

USDA (1985). Soil Survey of Alachua County Florida. Report published by the United States Department of Agriculture, Soil Conservation Service, in cooperation with the University of Florida Institute of Food and Agricultural Sciences, Agricultural Experiment Stations and Soil Science Department, and the Florida Department of Agriculture and Consumer Services, August 1985.

ATTACHMENT F-1. HELP MODEL RESULTS FOR CRITICAL DRAINAGE PATH, 4% SLOPE

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
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PRECIPITATION DATA FILE:    C:\HELP4\DHPREC.D4
TEMPERATURE DATA FILE:      C:\HELP4\DHTEMP.D7
SOLAR RADIATION DATA FILE:  C:\HELP4\DHSOL.D13
EVAPOTRANSPIRATION DATA:    C:\HELP4\DHET.D11
SOIL AND DESIGN DATA FILE:  C:\HELP4\DH300_04.D10
OUTPUT DATA FILE:           C:\HELP4\dh300_04.OUT


TIME:  11: 6     DATE:   9/12/2016


******************************************************************************

     TITLE:  GRU DGS CCR Landfill Closure System

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
                                 --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
```

MATERIAL TEXTURE NUMBER 53

```
THICKNESS                  =      6.00   INCHES
POROSITY                   =      0.4170 VOL/VOL
FIELD CAPACITY             =      0.0450 VOL/VOL
WILTING POINT              =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0180 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000009000E-01 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 53

```
THICKNESS                  =     18.00   INCHES
POROSITY                   =      0.4170 VOL/VOL
FIELD CAPACITY             =      0.0450 VOL/VOL
WILTING POINT              =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0899 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000009000E-01 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                  =      0.30   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0108 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   45.9000015000     CM/SEC
SLOPE                      =      4.00   PERCENT
DRAINAGE LENGTH            =     50.0    FEET
```

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

```
THICKNESS                    =      0.04   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY          =      0.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      0.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  1 - PERFECT
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

```
SCS RUNOFF CURVE NUMBER              =     38.60
FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      0.180  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      4.170  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.180  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =      1.730  INCHES
TOTAL INITIAL WATER                  =      1.730  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
JACKSONVILLE   FLORIDA

```
STATION LATITUDE                        =  29.70 DEGREES
MAXIMUM LEAF AREA INDEX                 =   3.50
START OF GROWING SEASON (JULIAN DATE)   =      0
END OF GROWING SEASON (JULIAN DATE)     =    367
EVAPORATIVE ZONE DEPTH                  =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED               =   8.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  73.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  72.00 %
```

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 79.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 78.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSONVILLE FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.40	3.10	4.00	2.40	2.60	6.90
6.30	6.30	4.80	2.70	2.00	2.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSONVILLE FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
55.00	57.80	62.60	68.10	74.90	79.80
81.30	81.20	78.50	70.70	62.90	57.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSONVILLE FLORIDA
AND STATION LATITUDE = 29.70 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.25	3.24	3.57	2.22	2.42	6.87

	6.60	6.16	4.49	2.80	1.85	2.44
STD. DEVIATIONS	1.31	1.60	2.32	1.34	1.45	3.13
	1.86	2.39	1.79	1.22	1.46	1.66

RUNOFF

TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	1.225	1.420	1.378	0.983	1.231	3.140
	3.340	2.706	2.168	1.267	0.617	0.712
STD. DEVIATIONS	0.567	0.723	0.950	0.697	0.793	1.278
	0.992	1.133	1.008	0.501	0.482	0.525

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	1.8766	2.0323	2.1858	1.2688	1.2874	3.4043
	3.1989	3.3683	2.5049	1.7103	1.2758	1.6312
STD. DEVIATIONS	0.7118	0.8998	1.1656	0.8068	0.7690	2.1812
	1.1206	1.6624	0.9963	0.6499	0.8133	1.1224

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0003	0.0004	0.0003	0.0002	0.0002	0.0006
	0.0005	0.0005	0.0004	0.0003	0.0002	0.0003

STD. DEVIATIONS	0.0001	0.0002	0.0002	0.0001	0.0001	0.0004
	0.0002	0.0003	0.0002	0.0001	0.0001	0.0002

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	45.92 (5.558)	166704.1	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	20.186 (2.6120)	73274.94	43.955
LATERAL DRAINAGE COLLECTED FROM LAYER 3	25.74455 (3.75845)	93452.711	56.05903
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000 (0.00000)	0.015	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
CHANGE IN WATER STORAGE	-0.006 (0.6089)	-23.53	-0.014

****

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.05	14701.501
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	1.79491	6515.52148
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00005

AVERAGE HEAD ON TOP OF LAYER 4	0.009	
MAXIMUM HEAD ON TOP OF LAYER 4	0.017	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.7 FEET	
SNOW WATER	0.28	1017.5434
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.2021
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0180

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.1080	0.0180
2	1.4248	0.0792
3	0.0031	0.0103
4	0.0000	0.0000
SNOW WATER	0.000	

****
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ATTACHMENT F-2. HELP MODEL RESULTS FOR CRITICAL DRAINAGE PATH, 25% SLOPE

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\HELP4\DHPREC.D4
TEMPERATURE DATA FILE:      C:\HELP4\DHTEMP.D7
SOLAR RADIATION DATA FILE:  C:\HELP4\DHSOL.D13
EVAPOTRANSPIRATION DATA:    C:\HELP4\DHET.D11
SOIL AND DESIGN DATA FILE:  C:\HELP4\DH300425.D10
OUTPUT DATA FILE:           C:\HELP4\DH300425.OUT


TIME:  13:29     DATE:   9/12/2016


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     TITLE:  GRU DGS CCR Landfill Closure System

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
```

MATERIAL TEXTURE NUMBER 53

```
THICKNESS                  =      6.00   INCHES
POROSITY                   =      0.4170 VOL/VOL
FIELD CAPACITY             =      0.0450 VOL/VOL
WILTING POINT              =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0180 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000009000E-01 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 53

```
THICKNESS                  =     18.00   INCHES
POROSITY                   =      0.4170 VOL/VOL
FIELD CAPACITY             =      0.0450 VOL/VOL
WILTING POINT              =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0899 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000009000E-01 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 0

```
THICKNESS                  =      0.30   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0301 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   19.7000008000     CM/SEC
SLOPE                      =     25.00   PERCENT
DRAINAGE LENGTH            =    145.0    FEET
SUBSURFACE INFLOW          =    225.91   INCHES/YR
```

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER

DH300425

MATERIAL TEXTURE NUMBER 36

THICKNESS	=	0.04 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY	=	0.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	0.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	1 - PERFECT

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	50.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	10.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.180	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.170	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.180	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	1.736	INCHES
TOTAL INITIAL WATER	=	1.736	INCHES
TOTAL SUBSURFACE INFLOW	=	225.91	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
JACKSONVILLE FLORIDA

STATION LATITUDE	=	29.70 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	0
END OF GROWING SEASON (JULIAN DATE)	=	367
EVAPORATIVE ZONE DEPTH	=	10.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00 %

AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 79.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 78.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSONVILLE FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.40	3.10	4.00	2.40	2.60	6.90
6.30	6.30	4.80	2.70	2.00	2.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSONVILLE FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
55.00	57.80	62.60	68.10	74.90	79.80
81.30	81.20	78.50	70.70	62.90	57.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSONVILLE FLORIDA
AND STATION LATITUDE = 29.70 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						

TOTALS	3.25	3.24	3.57	2.22	2.42	6.87
	6.60	6.16	4.49	2.80	1.85	2.44
STD. DEVIATIONS	1.31	1.60	2.32	1.34	1.45	3.13
	1.86	2.39	1.79	1.22	1.46	1.66

RUNOFF

TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	1.225	1.420	1.378	0.983	1.231	3.140
	3.340	2.706	2.168	1.267	0.617	0.712
STD. DEVIATIONS	0.567	0.723	0.950	0.697	0.793	1.278
	0.992	1.133	1.008	0.501	0.482	0.525

SUBSURFACE INFLOW INTO LAYER 3

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	40.2504	36.9813	40.5595	38.4047	39.6611	40.5402
	41.5726	41.7420	39.6408	40.0840	38.4116	40.0050
STD. DEVIATIONS	0.7121	1.1219	1.1656	0.8066	0.7686	2.1813
	1.1208	1.6626	0.9963	0.6500	0.8136	1.1224

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0072	0.0072	0.0072	0.0071	0.0071	0.0075
	0.0074	0.0074	0.0073	0.0071	0.0071	0.0071
STD. DEVIATIONS	0.0001	0.0002	0.0002	0.0001	0.0001	0.0004
	0.0002	0.0003	0.0002	0.0001	0.0001	0.0002

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	45.92	(5.558)	166704.1	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	20.186	(2.6120)	73274.94	43.955
SUBSURFACE INFLOW INTO LAYER 3	0.00000		0.000	0.00000
LATERAL DRAINAGE COLLECTED FROM LAYER 3	477.85339	(3.70583)	1734607.870	1040.53088
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.007	(0.000)		
CHANGE IN WATER STORAGE	-0.006	(0.6089)	-23.53	-0.014

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.05	14701.501
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	3.03117	11003.12990
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.017	
MAXIMUM HEAD ON TOP OF LAYER 4	0.031	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.28	1017.5434

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2021
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0180

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.1080	0.0180
2	1.4248	0.0792

3	0.0088	0.0294
4	0.0000	0.0000
SNOW WATER	0.000	

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APPENDIX G. GAINESVILLE REGIONAL UTILITIES DEERHAVEN GENERATING STATION CCR LANDFILL - POST CLOSURE CARE FIELD INSPECTION CHECKLIST

GRU Deerhaven Generating Station CCR Landfill
Post-Closure Field Inspection Checklist

Inspector Name:	**Date:**		
	Time:		
	No (Acceptable)	(Unacceptable)	**N/A**
Access Control			
Access Roads and Ramps Damaged/Not Navigable			
Structures and Restricted Access Areas Unsecured			
Signs Damaged/Illegible			
Final Cover			
Distressed Vegetation or Cracks in Cover			
Visible Contact Water Seeps or Ponded Contact Water			
Channeling or Evidence of Cover Erosion			
Low Points/Depressions or Ponded Stormwater			
Visible Cover Soil Sloughing			
Shrubs/Trees Present			
Stormwater Management System			
Downcomer/Culvert Inlets Obstructed/Damaged			
Evidence of Erosion at Downcomer Oulets			
Sediment Blockage, Washout, Vegetation Build Up or Damage to Swales, Ditches or Diversion Berms			
Evidence of Contact Water in Stormwater Drainage Features			
Contact Water Collection System			
Liquid Level Above Pump Activation Level			
Pump is Non-functional or Not Receiving Power			
Sediment Accumulated in Sump			

Please document the location and explain all unacceptable observations below and provide the steps taken to remedy the problem) - use back of page for additional space

Observation and Location	Remedy	Estimated Date of Repair

Signature of Inspector ______________________ **Date** ______________________