COAL COMBUSTION RESIDUALS LANDFILL RUN-ON & RUN-OFF CONTROL SYSTEM PLAN

NRG WESTLAND COAL ASH MANAGEMENT SITE

Prepared for

NRG MD Ash Management LLC
25100 Chalk Point Road
Aquasco, MD. 20608

October 17, 2016

12420 Milestone Center Drive, Suite 150
Germantown, MD 20876
Job No: 60429240

NRG Westland Ash Management Site
Coal Combustion Residuals (CCR) Landfill
Run-on & Run-off Control System Plan

Revision Register

CCR Landfill Run-on & Run-off Control System Plan Revision Cycle	Date	Revision No.
Initial CCR Landfill Run-on & Run-off Control System Plan	October 17, 2016	Rev 0

Professional Engineering Certification

I have visited the NRG Westland Ash Management Site located in Dickerson, Maryland, and I hereby certify that this initial CCR Landfill Run-on and Run-off Control System Plan meets the requirements of the Code of Federal Regulations (CFR), 40 CFR Part 257 (Subpart D—Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments) §257.81 Run-on and run-off controls for CCR landfills. Any subsequent amendments to this Plan will be reviewed by a Professional Engineer to ensure that it meets the requirements of 40 CFR §257.81.

Name of Registered Professional Engineer: Jeffrey Hutchins

Registration Number: MD PE 13186

Expiration Date: October 10, 2016

Signature and Seal:

Date: 9/30/16

9/30/16

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

This *Run-on and Run-off Control System Plan* is prepared for the Westland Ash Management Site (Westland Ash Site), owned and operated by NRG MD Ash Management LLC (NRG), as required under the Code of Federal Regulations (CFR) under 40 CFR §257 Subpart D – Standards for Disposal of Coal Combustion Residuals (CCR) in Landfills and Surface Impoundments, §257.81 for run-on and run-off controls.

The Westland Ash Site is operated as a management facility for CCRs (also referred to as coal fly ash and bottom ash), produced at NRG's Dickerson Generating Station. The Westland Ash Site is located on Martinsburg Road adjacent to and south of the NRG Dickerson Generating Station in the town of Dickerson in Montgomery County, Maryland. The street address for the Westland Facility is:

NRG MD Ash Management LLC
Westland Ash Management Site
21200 Martinsburg Road
Dickerson, MD. 20842

Maps showing the location of the Westland Ash Site and NRG's Dickerson Generating Station are presented in Figures 1, 2, and 3.

1.1 REGULATORY BASIS

Since December 1, 2008 the Westland Ash Site has been regulated for CCRs by the Maryland Department of the Environment (MDE) under the Code of Maryland (COMAR) §26.04.10 (Management of Coal Combustion Byproducts) and §26.04.07 (Solid Waste Management), and related sections.

As of April 17, 2015, the Westland Ash Site has also been regulated by 40 CFR Part 257, and more specifically, by §257.81 that requires owners and operators of CCR units to prepare a written *Run-on and Run-off Control System Plan* for entry into NRG's operating record for the Westland Ash Site. 40 CFR §257.81(c) requires these plans to be completed and placed in the facility's operating record by October 17, 2016.

40 CFR §257.81(b) requires runoff from the active portion of the CCR unit to be controlled in accordance with the surface water requirements of §257.3-3 (Surface Water).

Additionally, §257.81(d) makes reference to requirements for recordkeeping, notification, and public accessibility to this Plan via the internet as established in §257.105(g), §257.106(g), and §257.107(g) respectively. See Section 6.0 for additional details.

1.2 DOCUMENT INFORMATION

This *Run-on and Run-off Control System Plan* provides the required information for run-on and run-off control for the Westland Ash Site under §257.81. This *Run-on and Run-off Control*

System Plan was prepared on behalf of NRG and will be accepted into the NRG operating record in accordance with 40 CFR §257.105(g)(3) by October 17, 2016.

A Register of Revisions and Amendments to this *Run-on and Run-off Control System Plan* is presented on Page i of the Plan. Any Revisions or Amendments to the Plan are included in Appendix C with a statement of certification by a licensed professional engineer and placed into the NRG operating record in accordance with 40 CFR §257.105(g)(3). A plan update or revision is required every five years subsequent to completion of the initial plan in accordance with §257.81(c)(4).

1.3 REGULATORY CROSSWALK TABLE

A regulatory crosswalk table mapping the required plan elements under 40 CFR §257.81 against the elements of this Plan is presented in Table 1 below.

Table 1 Regulatory Crosswalk Table

40 CFR 257 Citation	Description of Rule	Run-on & Run-off Control System Plan Section
81(a)(1)	Run-on control for the 24-hour, 25-year storm for the active portion of the CCR unit	3.0
81(a)(2)	Run-off control for the 24-hour, 25-year storm for the active portion of the CCR unit	4.0
81(b)	Compliance with 40 CFR §257.3-3 (Surface Water), and §402 and §4004 of the Clean Water Act regarding the National Pollutant Discharge Elimination System (NPDES)	4.0
81(c)(1)	Documentation of design and construction of run-on and run-off controls	2.2, 3.0, 4.0
81(c)(2)	Amendment of the Plan	1.2
81(c)(3)	Timeframe for preparing the initial Plan	1.2
81(c)(4)	Frequency for revising the Plan	1.2
81(c)(5)	Engineer's certification	1.4
81(d)	Recordkeeping, notification, and internet availability requirements	6.0

1.4 CERTIFICATION

A statement of certification by a licensed professional engineer that this initial *Run-on and Run-off Control System Plan* meets the requirements of 40 CFR §257.81 is presented on Page ii of this Plan.

2.0 BACKGROUND

The Westland Ash Storage Site is located on Martinsburg Road adjacent to and south of the NRG Dickerson Generating Station in the town of Dickerson in Montgomery County, Maryland. The facility receives and stores CCRs produced at NRG's Dickerson Generating Station. The facility and access road connecting the facility to the Dickerson Generating Station were initially designed by D'Appolonia for Potomac Electric Power Co. (PEPCO) in 1977. The facility design received regulatory authorization and construction began in 1979 by PEPCO. The site is composed of three disposal cells, Cells A, B and C, with Cell B being the only operating cell at the site.

- Cell C, which encompasses approximately 18.5 acres, was completed and closed. Cell C is located at the northwest corner of the site, separated from Cell B by PEPCO's 250-foot transmission line right-of-way which runs along the eastern edge of Cell C. On September 9, 2016, NRG completed construction of an engineered, low-permeability capping system on Cell C under a Consent Decree with MDE.
- Cell B, which is the current operational cell, contains a total of approximately 64.4 acres over the center of the site. The access road from the Dickerson Generating Station enters the facility at the northwest corner of Cell B. Approximately 24 acres of Cell B along the northern, western, and southern perimeter slopes are currently complete and closed leaving approximately 40.4 acres as the active, operating portion of the site. The active portion of Cell B is divided into (1) the northern CCR fill area (23.4 acres) and (2) the southern portion consisting of Cell B1-A and Cell B1-B comprising 17 acres. Cell B1-A is currently active while Cell B1-B is not currently operational.
- Cell A, the largest planned cell (approximately 96.6 acres), is situated directly east of Cell B, and divided from Cell B by an approximately 400 ft. wide strip of land denoted as "Preservation Area D." The Cell A area is vegetated and undeveloped, and there are no current plans to construct Cell A.

Maps showing the site layout and the boundary of each of these cells are presented in Figures 2 and 3.

2.1 CELL B AREA AND CAPACITY

Because Cell B is the only operational cell at the site, this Plan specifically addresses run-on and run-off management for Cell B. The stormwater controls described in this Plan have been designed and constructed to be consistent with recognized and accepted good engineering practices and with the requirements for CCR landfills under 40 CFR §257.81.

Although Cell B totals approximately 64.4 acres, the operational portion of the cell consists of only about 40.4 areas, the other 24 acres being currently complete and closed. The cell is surrounded by access roads to the north, south and east, and by an access road and the 250-foot wide PEPCO transmission right-of-way to the west. All surface runoff from the operational portion of Cell B drains to the Westland site's leachate storage Pond 3 by way of leachate underdrain pipes and a leachate transmission main.

Based on the original 1979 design documents for Cell B, it has an estimated CCR capacity of approximately 5.6 million cubic yards. Based on annual aerial photography of the site, Cell B has an estimated in-place volume of CCR of approximately 3.97 million cubic yards. A rough estimate of the remaining air space in Cell B would be approximately 1.63 million cubic yards based on those two estimates, and Cell B could operate for over 16 additional years based on the current annual fill estimates.

2.2 STORMWATER MANAGEMENT ANALYSIS AND DESIGN

In May 2014 the Westland site experienced an extreme rainfall event – comprised of two extreme events over the course of approximately 48 hours – which caused some damage to the existing stormwater management systems on the site. Although these rainfall events appear to have been far in excess of the stormwater management standards required in §257.81 (24-hour, 25-year storm) – some analyses estimate that the events may have equaled or exceeded a 100-year return frequency – out of an abundance of caution NRG retained Geosyntec Consultants (Geosyntec) to prepare a stormwater analysis and design to mitigate against the possibility of similar damage in the future.

The Geosyntec Stormwater Management Plan (SWMP) analyzed and modeled stormwater falling on the inactive portions of the cell (which is referred to as "non-contact water") under conditions of the 24-hour, 25-year design storm in accordance with §257.81(a)(1) for run-on control. However, in consideration of the severity of the event in May 2014, the plan modeled stormwater from the active portions of the cell (which is referred to as "contact water") under conditions of two back-to-back (separated by 24 hours) 6-hour, 100-year design storms. This frequency and intensity was selected because it is similar to the May 2014 event, and is more conservative than the 24-hour, 25-year storm required by §257.81(a)(2) for run-off control.

The Geosyntec SWMP was completed in July 2014, and approved by MDE in December 2014. In January 2015, the SWMP was submitted on behalf of NRG by URS (now AECOM) to the Montgomery County Department of Permitting Services (MC DPS) for revision to the site's approved Erosion and Sediment Control Permit (SC # 203375). The drawings from the approved MC DPS permit package are presented in Appendix A of this Plan; the supporting stormwater calculations and modeling outputs from the SWMP are presented in Appendix B.

As stated above, and as illustrated in Figure 3 and Sheet No. 2 of the SWMP drawings in Appendix A, Cell B is divided into three segments: (1) Closed Cell B, (2) the northern currently active portion of Cell B, and (3) the southern portion of the site. The southern portion is further divided into Cell B1-A which is currently active and Cell B1-B which is not currently operational.

The SWMP makes use of grading and diversion structures to keep stormwater from the active portions of the cell (contact water) separate from stormwater falling on the inactive portions of the cell (non-contact water). Non-contact water is handled as normal stormwater while contact water is handled as leachate. The SWMP further divides the northern and southern areas into drainage sub-areas (Sheet No. 3 in Appendix A) by means of a series of diversion structures,

chimney drain structures, leachate sumps, and sequenced CCR filling and grading that considers the size of each active CCR management sub-area and the capacity of the leachate sumps and chimney drains to effectively manage the runoff within the active cell boundary.

Construction of the various elements that comprise the Cell B SWMP commenced in the spring/summer of 2015 and was substantially completed during 2016. The newly installed run-on and run-off control measures have functioned without incident since their installation.

3.0 CELL B RUN-ON CONTROL SYSTEM

The objective of the Cell B run-on control plan is to divert stormwater from inactive areas of Cell B (non-contact water) away from the active areas and exposed CCRs. These areas are currently (typically) covered with soil and vegetation, though some portions are being used as a soil stockpile area, and other portions that have reached their full capacity are scheduled for installation of an engineered closure cap by the end of 2017.

Cell B is typical of many municipal and CCR landfills in that it is an artificially constructed local topographic high, with its highest elevation approximately 100 feet higher than the surrounding elevations. Additionally, the cell is completely encircled by a perimeter channel and road. Parts of the currently active portion of Cell B and Cell B1-A, and the non-operational Cell B1-B are lower than the adjacent road grade at the present time, but in these places the cell is separated from the perimeter channel by a berm that is an additional 2 to 5 feet higher than the channel. This topographic position determines that the only potential source of non-contact run-on into the active areas of the cell would be from the inactive areas within Cell B.

The SWMP analyzed and designed stormwater features to prevent non-contact water from inactive areas of Cell B from becoming run-on into the active portions of the cell. The design storm used in the modeling was a 24-hour, 25-year Storm (i.e., 5.75 inches of precipitation). This design basis is consistent with typical landfill stormwater design and with the requirements of §257.81(a)(1). Documentation of the analysis, modeling, and design computations is presented in Appendix B.

To separate non-contact and contact water flows the design uses a combination of earth dikes, diversion structures, pipe slope drains, new and existing channels, and a yard inlet with a culvert. Diversion structures that are used to separate contact from non-contact waters are constructed of gabion baskets wrapped with an impermeable geomembrane. In addition, erosion and sediment controls are installed down gradient of the existing borrow area. The erosion and sediment controls include placement of silt fence, construction of a temporary sediment trap and elimination of the existing depression that currently detains runoff from the soil stockpile area.

The locations and details for construction of stormwater features for management of non-contact stormwater runoff are presented in Sheet Nos. 3 to 7 of the SWMP Drawings in Appendix A. Details for implementation of the erosion and sediment control features are based on the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control.

The non-contact stormwater from the inactive portions of Cell B is diverted to exit the cell and discharge into the existing fabric-formed concrete lined perimeter channel around Cell B, thus preventing it from becoming run-on into the active area of the cell. This channel eventually conveys stormwater to one of two discharge points – existing Pond 2 northwest of Cell B, and Culvert No. 7, on the southwestern edge of Cell B. Both of these stormwater conveyances will be included in the site's Stormwater Pollution Prevention Plan (SWPPP).

3.1 CONCLUSION

Based on the design and implementation of the run-on controls presented in this Plan, stormwater runoff should not be able to discharge onto any of the operational areas of Cell B and Cell B1 during a 24-hour, 25-year storm event.

4.0 CELL B RUN-OFF CONTROL SYSTEM

The objective of the Cell B run-off control plan is to ensure that stormwater from active areas of Cell B (contact water) is contained within the active areas and directed into the leachate collection system, and does not become run-off into non-active areas of the site. The active areas of Cell B (Cell B and Cell B1-A) are in various states of use and CCR filling, while the non-operational Cell B1-B has been constructed with a gravel drainage base for future CCR filling. Eventually, as these areas become filled to their design capacity, they will be closed and covered with an engineered, low permeability closure cap.

Currently the outer west, north, and east edges of the active areas of Cell B are surrounded by a system of berms that prevent run-off from these areas from entering the perimeter ditch; however, along some portions of the interior southern border between the active and inactive portions of Cell B, it is necessary to improve the separation between the active and inactive areas, partly because of the constant changes in grade that result from CCR filling activities. The SWMP design addresses this need through the diversion methods described in Section 3.0 above. The SWMP also analyzed, modeled, and designed features to enhance the capacity of the leachate collection system in the active areas to collect stormwater that contacts CCR (i.e., leachate or contact stormwater).

The SWMP analyzed and designed stormwater features to prevent contact water from active areas of Cell B from becoming run-off into the inactive portions of the cell. The hydrologic basis used in the modeling was back-to-back (24-hour separation) 6-hour, 100-year design storms (i.e., 5.15 inches of precipitation). This design basis was selected following preliminary analyses that indicated the design features, as proposed, could manage single event precipitation depths associated with recurrence intervals ranging from 25 to 200 years. However, a multi-day scenario including rainfall amounts similar to volumes observed during the May 2014 rainfall event was selected as a more conservative design scenario for contact water management. This design basis is more conservative, and exceeds the standards of typical landfill stormwater design and the requirements of §257.81(a)(2), which would only require a 24-hour, 25-year

storm. Documentation of the analysis, modeling, and design computations is presented in Appendix B.

The contact water stormwater management design uses a system of diversion structures, chimney drains connected to the existing leachate collection system, and leachate collection sumps. The chimney drains, as shown on Sheet No. 9 in Appendix A, consist of an inner perforated collection pipe, surrounded by an envelope of washed gravel, inside of a larger geotextile-wrapped perforated infiltration pipe, which is surrounded by a mound of bottom ash (which is coarser than fly ash). The inner collection pipe is directly connected to the existing leachate collection and transmission pipe network. During periods of low to moderate rainfall, stormwater infiltrates into the chimney drain through the layers of porous media. However, the top of the collection pipe is open above the infiltration media, so that in periods of high flow, or when the porous media is already saturated (as in the back-to-back storm model), contact water can directly enter the top of the collection pipe. The chimney drains are designed to be extended upward as necessitated by ongoing CCR filling operations.

In the upper elevation areas of the active portions of the cell, contact water is directed into the chimney drains by means of diversion structures consisting of gabion baskets wrapped with permeable geotextile. These diversions also include a weir, allowing stormwater to pass the diversion and flow to a downgradient chimney drain if the upper drain is overwhelmed by high flows. In the lower reaches of the system, the chimney drains are placed in leachate collection sumps that are contained at their lower ends by diversion structures built of gabions wrapped with impermeable geomembrane. Each of the chimney drains is connected to existing leachate pipes within Cell B1-A and B1-B, which discharge to the respective leachate collection sump in each cell. The active Cell B1-A discharges to the leachate collection Pond 3 while the currently non-operational Cell B1-B discharges to the stormwater system.

The locations and details for construction of stormwater features for management of contact stormwater are presented in Sheet Nos. 3 to 10 in the SWMP Drawings in Appendix A.

CCR material filling and cover soil placement will continue according to the grading sequence provided in Sheet Nos. 11 and 12 in Appendix A. The goal of the grading sequence is to maintain flow toward the chimney drains and away from the perimeter of the cell. To accomplish this goal, the plan maintains the active filling area at an elevation lower than the active filling area perimeter. When CCR filling in a particular chimney drain catchment area achieves the proposed final grade, the chimney drain will be decommissioned by: (i) cutting the riser pipe off to at least two feet below the bottom of the final cover soils; (ii) completely backfilling the chimney drain with aggregate; (iii) covering the filled pipe with two layers of geotextile filter fabric; and (iv) constructing the final cover system over the decommissioned pipe.

4.1 CONCLUSION

Based on the design and implementation of the run-off controls presented in this Plan, stormwater run-off should not be able to discharge outside of any of the operational areas of Cell B during a 24-hour, 25-year storm event. By constructing and implementing the run off control

measures within the active portions of Cell B, stormwater runoff is controlled in accordance with §257.81 and the surface water requirements of §257.3-3.

5.0 FUTURE OPERATIONS OF THE RUN-ON AND RUN-OFF CONTROLS

As CCR filling progresses incrementally to the final design grades, portions of the currently active cell areas will be capped and covered, necessitating relocation of the boundary between the active and inactive areas, and of the stormwater run-on and run-off separation controls. Eventually the entire Cell B will be capped with an engineered low permeability closure cap. At that time there will no longer be a need to distinguish active area contact water run-off protection from inactive area non-contact run-on protection, because the entire cell will be an inactive area, and there will be no opportunity for stormwater to contact exposed CCR. However, it will still be necessary to operate and maintain the surface water control system.

During the post-closure period, the stormwater management system will be inspected regularly. During these inspections the drainage channels, earth dikes, let-downs, culverts, and other drainage structures will be examined to assess their condition. Vegetation in the surrounding areas of the stormwater management systems will be mowed and/or controlled using a lawn mower or weed eater equipment. Riprap and velocity control devices will be inspected to ensure their operability. Any necessary repairs or maintenance needs will be addressed by NRG.

6.0 RECORDS, NOTIFICATIONS, AND INTERNET ACCESS

6.1 RECORDKEEPING REQUIREMENTS

In accordance with 40 CFR §257.105, a written operating record will be maintained for the Westland Ash Site CCR facility. As specified in §257.105(g)(3) this operating record will include the most recent version of this *Run-on and Run-off Control System Plan* and any subsequent revisions or amendments.

Each file will be retained for at least five years following the date of each occurrence, maintenance, report, record, or study. The written record will also be maintained as computer files.

6.2 NOTIFICATION REQUIREMENTS

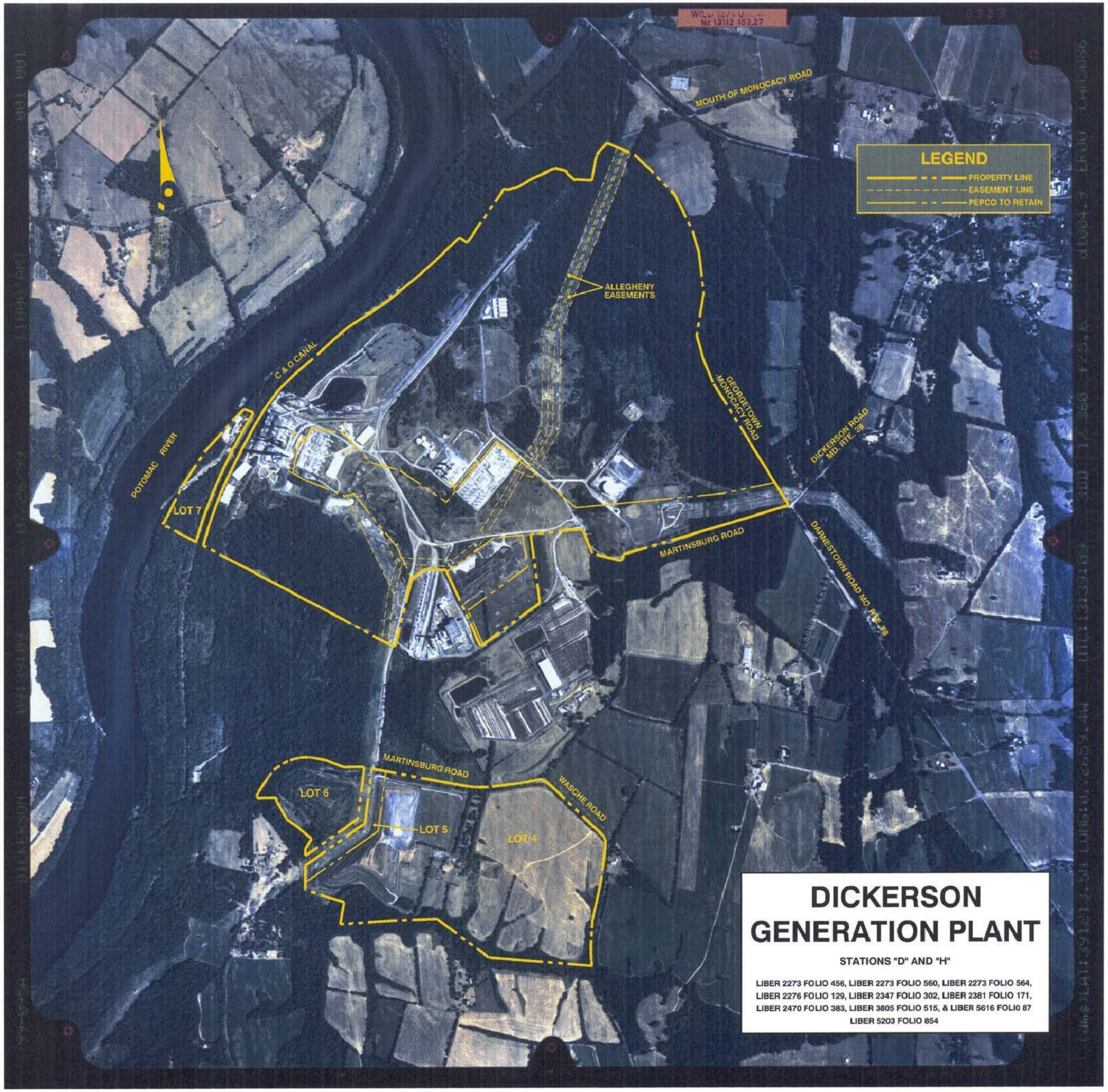
In accordance with 40 CFR §257.106 NRG will notify the Director of the MDE Solid Waste Program whenever information has been placed in the facility's operating record and/or posted to the CCR website. Copies of such information will be provided to MDE as required. As specified in §257.106(g)(3), NRG will provide notification to MDE of the availability of the initial *Run-on and Run-off Control System Plan* and any subsequent revisions or amendments.

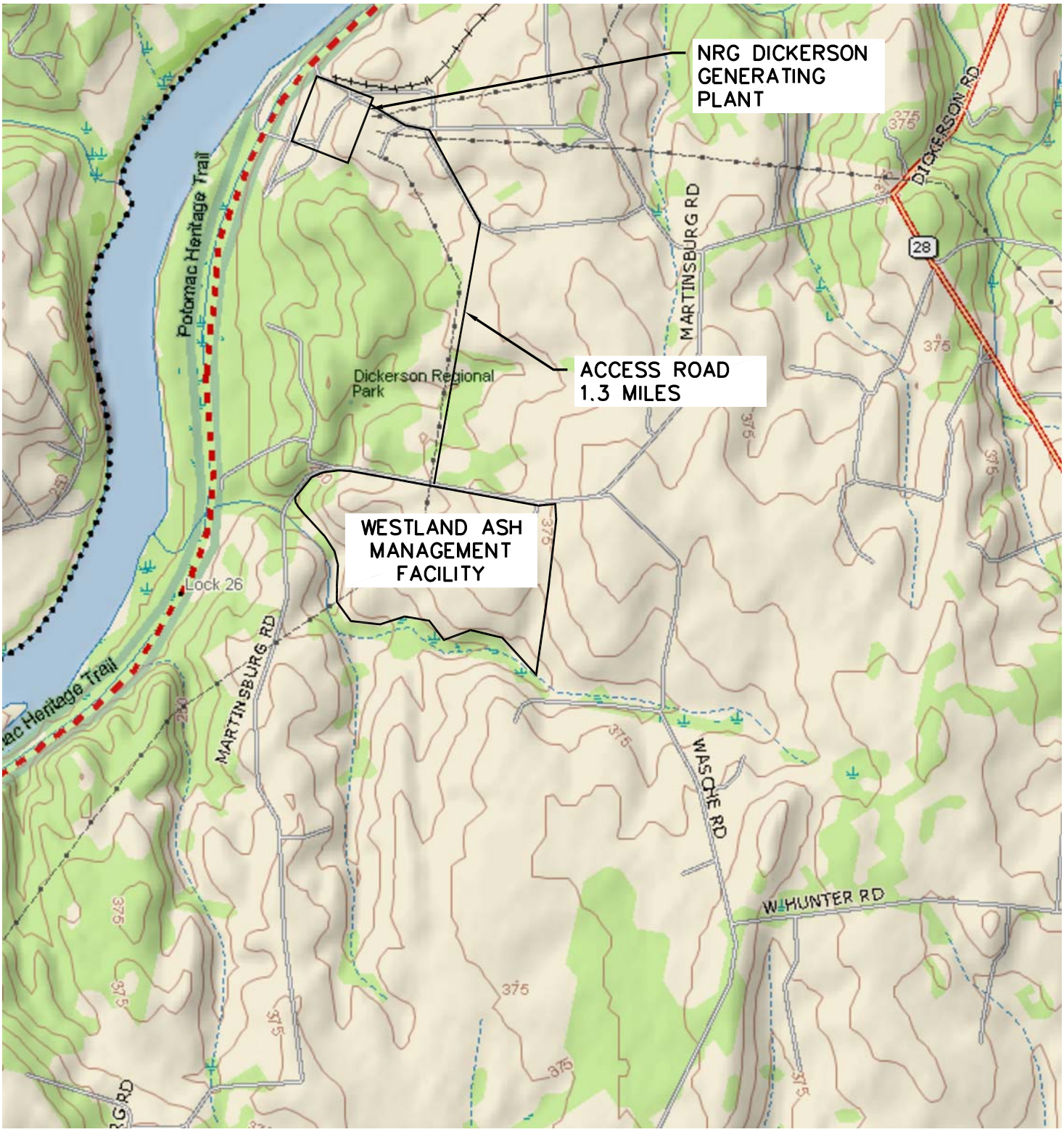
6.3 PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS

In accordance with 40 CFR §257.107, NRG will maintain a publicly accessible internet website entitled "CCR Rule Compliance Data and Information". The most recent version of the *Run-on and Run-off Control System Plan*, along with any revisions or amendments will be maintained on this website in accordance with §257.107(g)(3).

Required information must be posted to the CCR website within 30 days of being entered into the facility's operating record, and must be available to the public for a minimum of five years.

FIGURES


MOUTH OF MONOCACY ROAD
LEGEND
PROPERTY LINE
EASEMENT LINE
PEPCO TO RETAIN
ALLEGHENY EASEMENTS
C & O CANAL
POTOMAC RIVER
LOT 7
GEORGETOWN MONOCACY ROAD
DICKERSON ROAD MD. RTE. 28
MARTINSBURG ROAD
DARNESTOWN ROAD MD. RTE. 28
MARTINSBURG ROAD
WASCHE ROAD
LOT 6
LOT 5
LOT 4
DICKERSON GENERATION PLANT
STATIONS "D" AND "H"
LIBER 2273 FOLIO 456, LIBER 2273 FOLIO 560, LIBER 2273 FOLIO 564, LIBER 2276 FOLIO 129, LIBER 2347 FOLIO 302, LIBER 2381 FOLIO 171, LIBER 2470 FOLIO 383, LIBER 3805 FOLIO 515, & LIBER 5616 FOLIO 87 LIBER 5203 FOLIO 854



N

0 1000' 2000'

SCALE: 1"= 2000'

OWNER: nrg

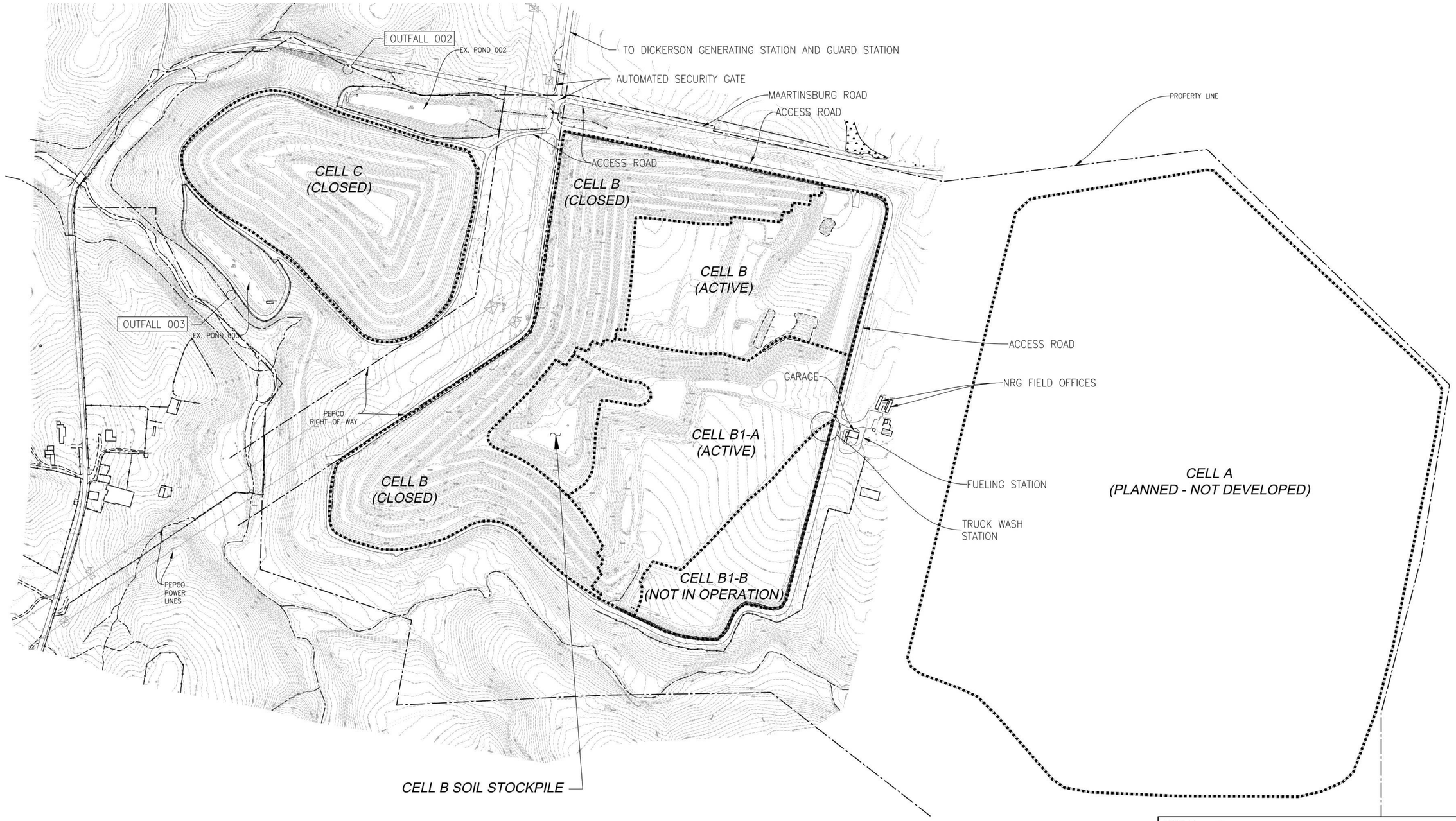
WESTLAND ASH MANAGEMENT FACILITY

SITE LOCATION MAP

PREPARED BY: AECOM

12420 MILESTONE CENTER DRIVE, SUITE 150
GERMANTOWN, MD 20876
TEL: 301.820.3000 FAX: 301.820.3009

	CHECKED BY:	PROJECT No.:	DATE:	FIGURE No.:
	JRH	60429235	09/2016	2



N

0 200' 400'

SCALE: 1"= 200'

O:\Projects\ENV\SEM\Wrant\2013 Westland O&M Plan\O&M Manual\Figures\Drawings\Figure 3 - 22x34_09272016.dwg User:linda.moody Sep 27, 2016 - 12:03pm

OWNER: nrg

WESTLAND ASH MANAGEMENT FACILITY

WESTLAND FACILITY
SITE MAP

PREPARED BY: URS
12420 MILESTONE CENTER DRIVE, SUITE 150
GERMANTOWN, MD 20876
TEL: 301.820.3000 FAX: 301.820.3009

DRAWN BY:	CHECKED BY:	PROJECT No.:	DATE:	FIGURE No.:
LGM	JRH	60429235	09/2016	3

Appendix A

Stormwater Management Plan Drawings

WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION

MONTGOMERY COUNTY, MARYLAND
JANUARY 2015

MARYLAND DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard • Baltimore MD 21230
410-537-3000 • 1-800-633-6101 • www.mde.maryland.gov

Martin O'Malley
Governor

Anthony G. Brown
Lieutenant Governor

Robert M. Summers, Ph.D.
Secretary

December 12, 2014

Mr. Walter Johnson
NRG MD Ash Management LLC
25100 Chalk Point Road
Aquasco MD 20608

Dear Mr. Johnson:

The Maryland Department of the Environment's Solid Waste Program (the "SWP") has received the Release Response and Rectification Plan and the Stormwater Management Plan submitted for the Westland Ash Management Facility located in Dickerson, Maryland. These documents were prepared by Geosyntec Consultants in response to a release of coal combustion byproducts (CCBs) from the site in May 2014.

The SWP has reviewed the Stormwater Management Plan which includes proposed enhancements and upgrades planned at the facility to manage the storm water within Cell B, Cell B-1A, and Cell B-1B and mitigate the potential for future berm failures and washout of CCBs. The Plan proposes the construction of stormwater diversions and chimney drain features within the active area of Cell B to enhance the capacity of the leachate collection system to collect contact storm water, the diversion of clean storm water from inactive and vegetative areas of the cell through the installation of earth dikes, pipe slope drains, culverts, and channels, and the implementation of a sequence of CCB filing to effectively manage the runoff within the cell boundary.

The SWP hereby approves the proposed enhancements and upgrades included in the Stormwater Management Plan dated July 2014. If you have any questions concerning this matter, please contact Mr. Kassa Kebede, Head of the Construction & Maintenance Section, at (410) 537-3315.

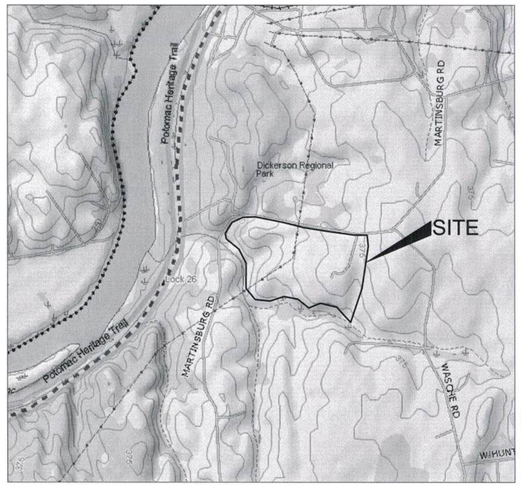
Sincerely,

Martha Hynson

Martha Hynson, Chief
Solid Waste Operations Division

MH:KK:kk
cc: Mr. Horacio Tablada
Mr. Brian Coblentz
Ms. Sharon Talley

Recycled Paper www.mde.maryland.gov TTY Users 1-800-735-2258



SITE VICINITY MAP
0 2000
SCALE 1" = 2000'

INDEX OF DRAWINGS

NOTE:
THIS PLAN SET IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.

MONTGOMERY COUNTY DEPARTMENT OF PERMITTING SERVICES APPROVED FOR:

Stormwater Management:	Sediment Control Technical Requirements:	Administrative Requirements:
NA	Thomas Weeden 2/25/15	Thomas Weeden 2/25/15
Reviewed Date	Reviewed Date	Reviewed Date
Approved Date	Approved 2/27/2015 Date	
231273 S.M. FILE #		203375 SEDIMENT CONTROL PERMIT NO.

NOTE: MCDPS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT

MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

OWNER:

nrg®

NRG MD ASH MANAGEMENT LLC

WESTLAND ASH STORAGE SITE ADDRESS:
21200 MARTINSBURG ROAD
DICKERSON MD, 20842

ISSUED FOR BIDDING DATE BY

ADDENDUM REVISIONS

ADDENDUM NO	ADDENDUM DATE	BY

ISSUED FOR CONSTRUCTION DATE BY

CONSTRUCTION REVISIONS

NO.	DESCRIPTION	DATE	BY

RECORD DRAWINGS DATE BY

STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

ISSUED FOR CONSTRUCTION

PREPARED BY:

URS

12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

GRAPHIC SCALE

NRG MD ASH MANAGEMENT LLC WESTLAND ASH STORAGE FACILITY CELL B1 REMEDIATION MEASURES CONSTRUCTION

TITLE SHEET

DRAWING SHEET No.:	MCDPS SHEET No.:
1	SHEET 73 OF 84
	MDE SHEET No.: SHEET 1 OF 12

LEGEND

- APPROXIMATE CELL LIMIT
- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- FABRICFORM-LINED PERIMETER DITCH
- LEACHATE PIPE (NOTE 3)
- CONTACT WATER / NON-CONTACT WATER DIVISION LINE (NOTE 4)

GENERAL NOTES:

1. TOPOGRAPHIC MAPPING COMPILED BY PHOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 28 DECEMBER 2013.
2. HORIZONTAL CONTROL IS NORTH AMERICAN DATUM OF 1983 (NAD 83, MARYLAND), VERTICAL CONTROL IS NORTH AMERICAN DATUM OF 1988 (NAVD 88).
3. EXISTING LEACHATE PIPES OBTAINED FROM FLORA SURVEYING ASSOCIATES, INC. BASED ON FIELD-RUN SURVEY, DATED 2010.
4. DIVISION LINE WILL VARY DEPENDING UPON FILLING SEQUENCE (SEE DRAWING 11-12).
5. PRIOR TO ASH PLACEMENT ON THIS CELL, SURFACE WATER RUNOFF COLLECTED IN CELL B1-B MAY BE MANAGED AS NON-CONTACT WATER PROVIDED THAT AGGREGATE IS NOT CONTAMINATED WITH CCBs.

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

**THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.**

0 120' 240'
SCALE IN FT

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE

MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

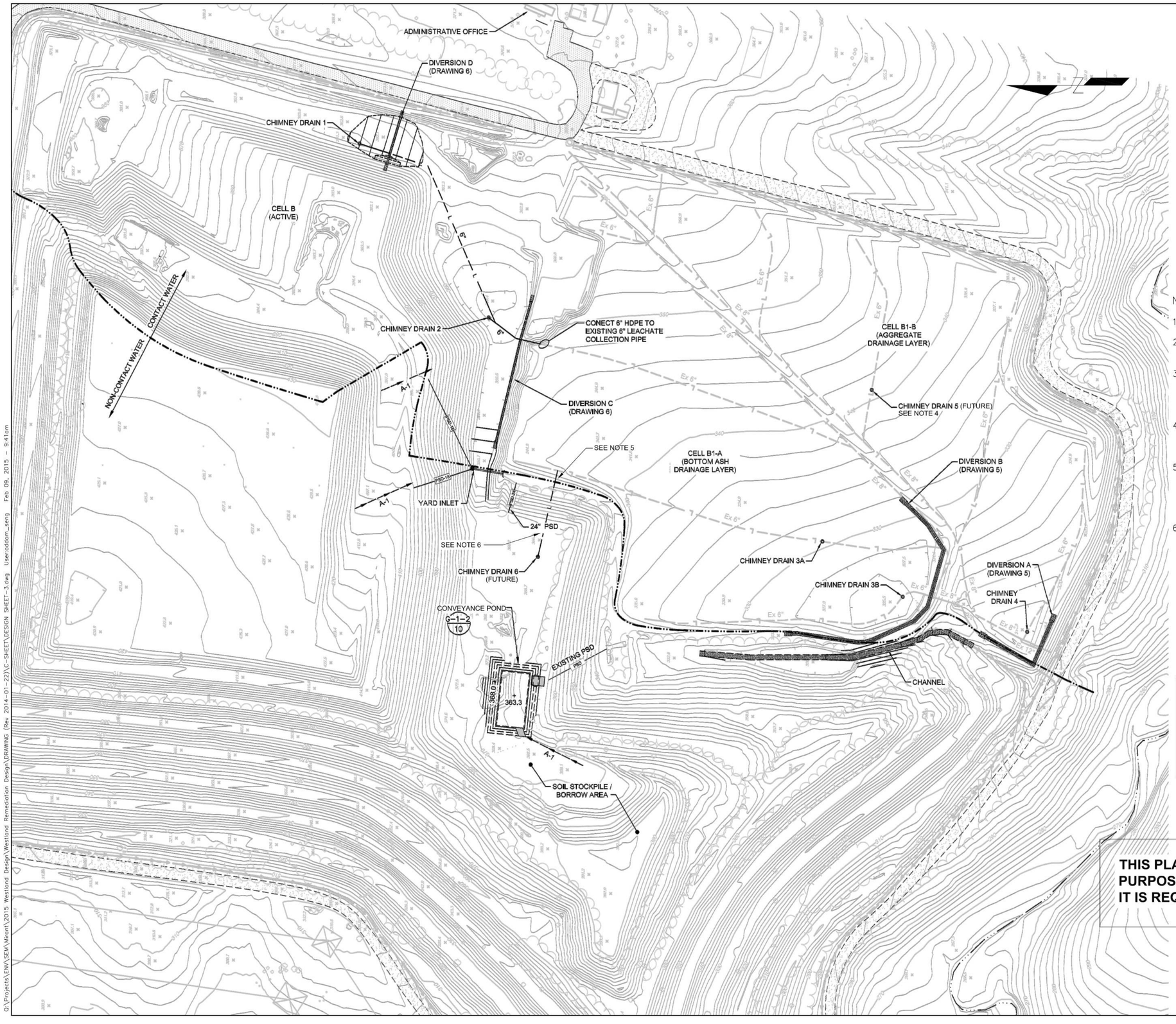
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED
PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

**NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION**

EXISTING CONDITIONS

DRAWING SHEET No.: 2	MCDPS SHEET No.: SHEET 74 OF 84
	MDE SHEET No.: SHEET 2 OF 12



LEGEND

- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- CHIMNEY DRAIN (CD) INLET (1/9)
- GABION WEIR
- DIVERSION
- PIPE SLOPE DRAIN (NOTE 2) (D-1/10)
- EARTH DIKE (C-1/10)
- EXISTING LEACHATE LINE
- CONTACT WATER / NON-CONTACT WATER DIVISION LINE (NOTE 3)

NOTES:

1. SEE DRAWING 2 FOR GENERAL NOTES.
2. NUMBER REFERS TO THE PIPE DIAMETER IN INCHES.
3. NON-CONTACT WATER (SURFACE WATER RUNOFF) WILL BE MANAGED BY EXISTING AND NEW EROSION AND SEDIMENT CONTROL FEATURES.
4. CHIMNEY DRAIN SHALL BE CONSTRUCTED BETWEEN FILLING SEQUENCE 3 AND FILLING SEQUENCE 4 (FUTURE).
5. PRIOR TO BURYING EXISTING LEACHATE COLLECTION DRAIN DURING FILLING SEQUENCE 1, EXTEND FUTURE CHIMNEY DRAIN 6 LEACHATE COLLECTION LINE TO THE CREST OF THE EXISTING CELL B1-A BERM AND CAP THE PIPE.
6. CONSTRUCT CHIMNEY DRAIN 6 AND THE REMAINDER OF THE LEACHATE LINE BETWEEN FILLING SEQUENCE 2 AND FILLING SEQUENCE 3 (FUTURE).

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.

0 80' 160'
SCALE IN FT

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE
MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

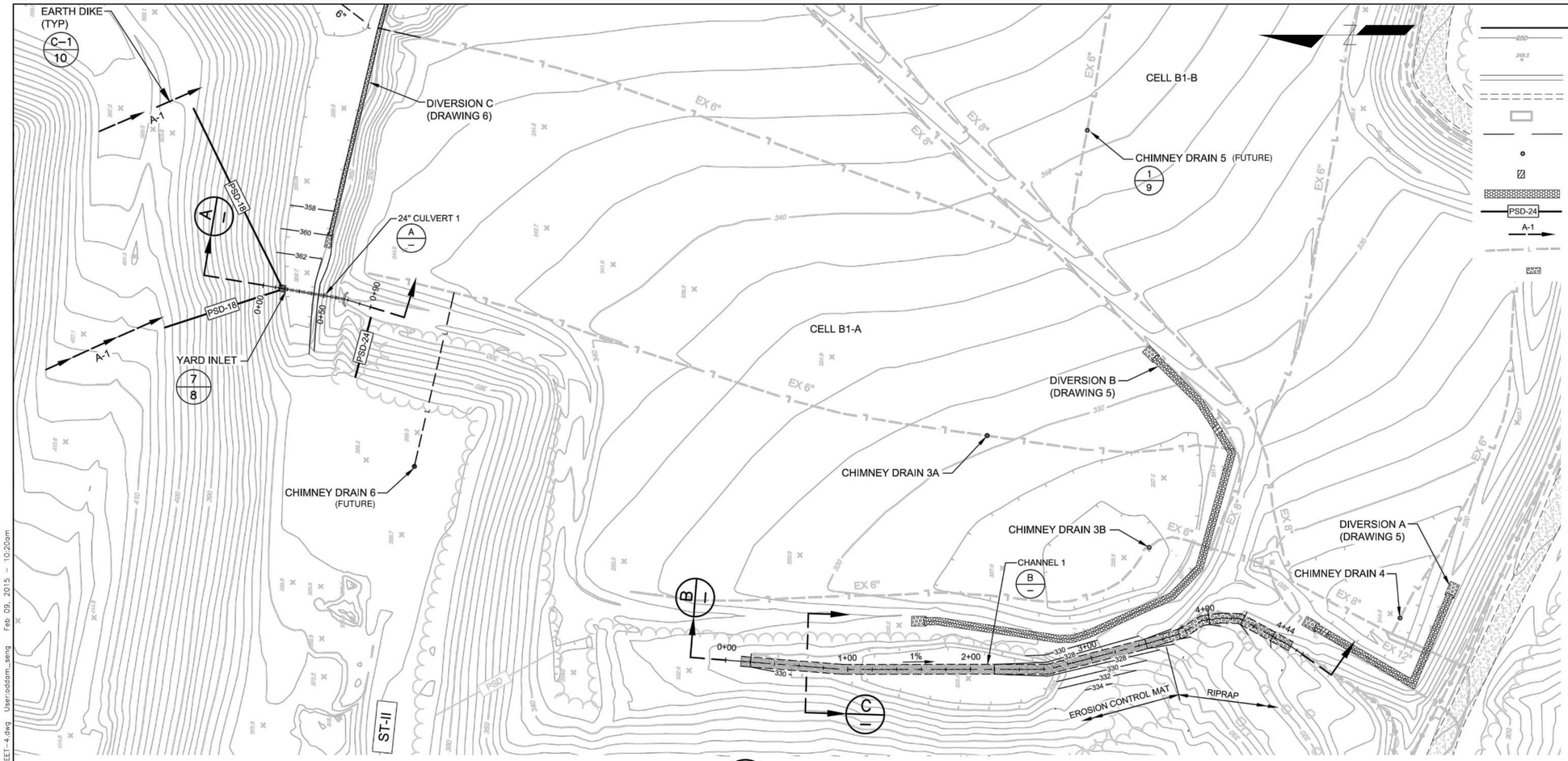
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION

STORMWATER MANAGEMEN PLAN

DRAWING SHEET No.:	MCDPS SHEET No.:
3	SHEET 75 OF 84
	MDE SHEET No.: SHEET 3 OF 12



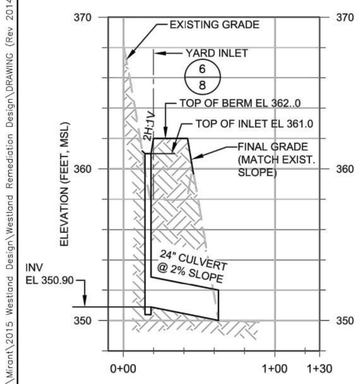
1 / – PLAN
CHANNEL 1 AND CULVERT 1
SCALE: 1" = 50'

LEGEND

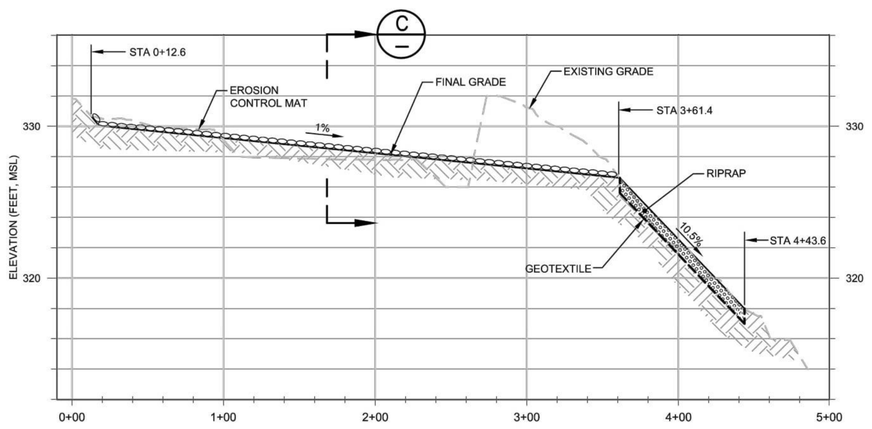
- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- CHIMNEY DRAIN (CD) INLET (1/9, 3/9)
- GABION WEIR
- DIVERSION
- PIPE SLOPE DRAIN PSD-24 (D-1 / 10)
- EARTH DIKE A-1 (C-1 / 10)
- EXISTING LEACHATE LINE
- RIPRAP

GENERAL NOTES:

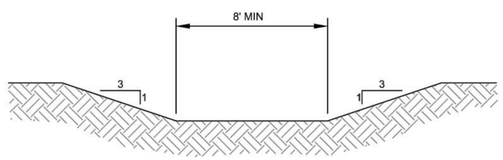
1. SEE DRAWING 2 FOR GENERAL NOTES.
2. 2010 AS-BUILT SUBBASE GRADE FROM FIELD-RUN SURVEY BY FLORA ASSOCIATES, INC.



A / – PROFILE
CULVERT 1
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION = 10x



B / – PROFILE
CHANNEL 1
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION = 10x



C / – SECTION
CHANNEL
HORIZONTAL SCALE: 1" = 4'

THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SM FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE
MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL, IF THE PROJECT HAS NOT STARTED, UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

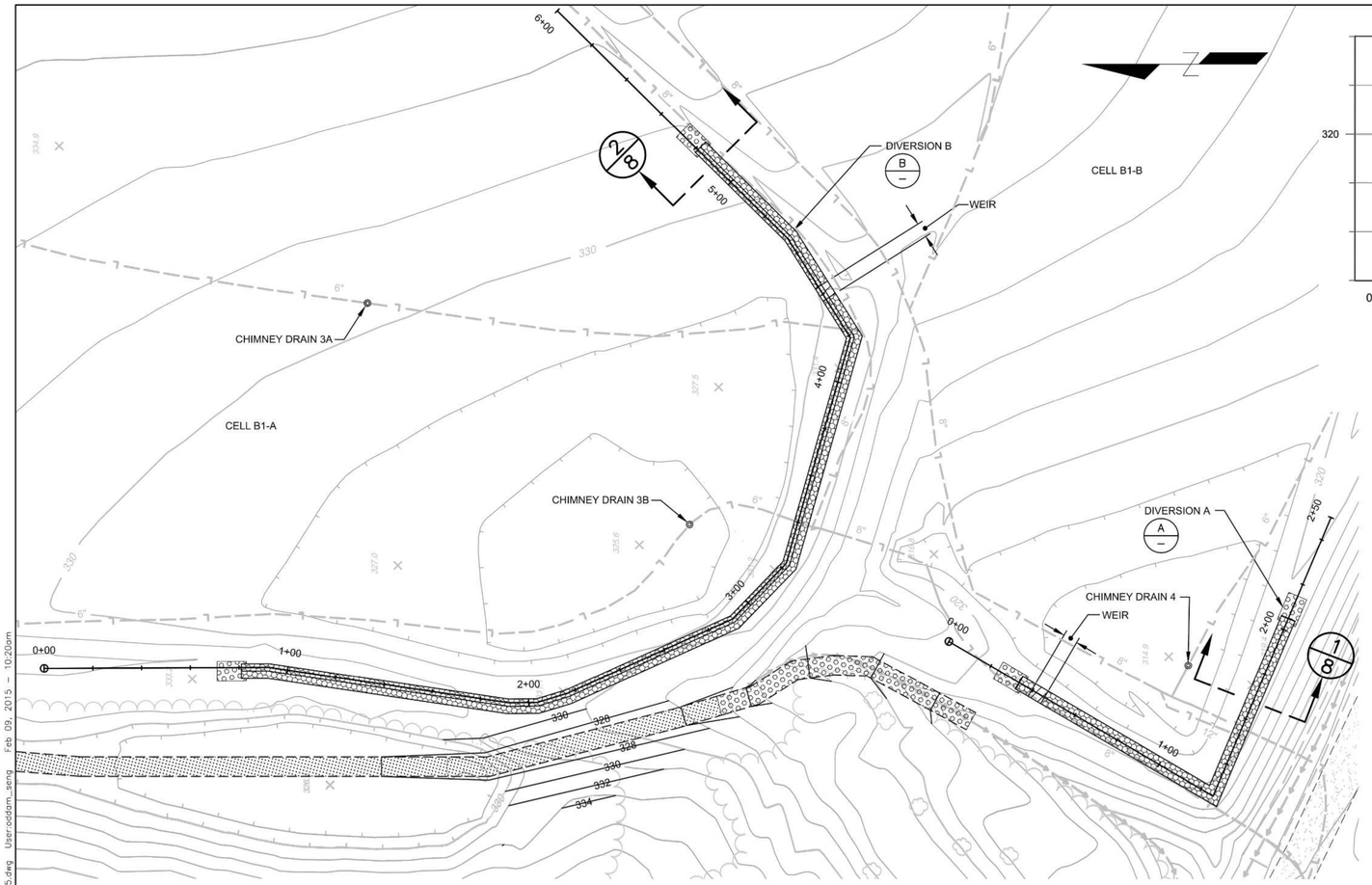
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

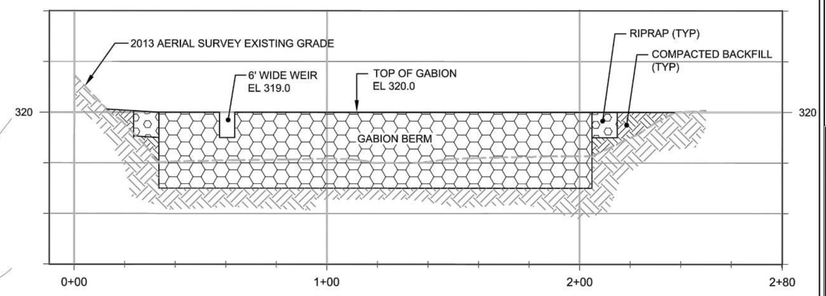
NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION

CHANNEL 1 AND CULVERT 1 PLAN & PROFILES

DRAWING SHEET No.: 4	MCDPS SHEET No.: SHEET 76 OF 84
	MDE SHEET No.: SHEET 4 OF 12



1/3 PLAN
DIVERSION A AND DIVERSION B
SCALE: 1" = 30'



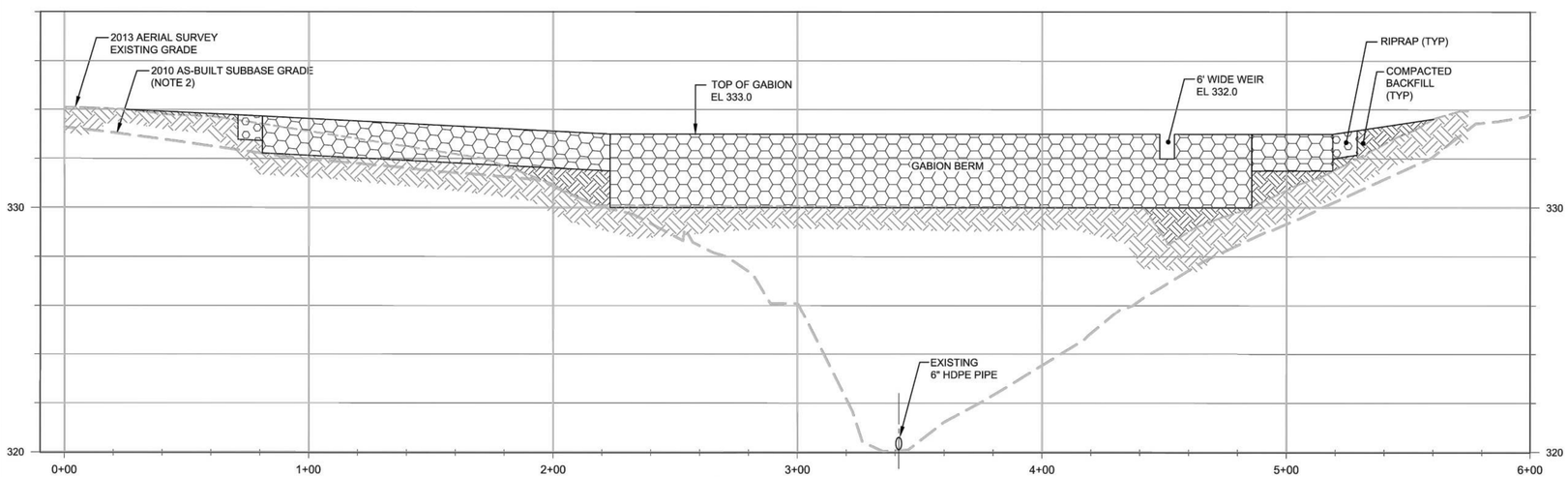
A/– PROFILE
DIVERSION A
SCALE: 1" = 30'

LEGEND

- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- CHIMNEY DRAIN (CD) INLET (1/9)
- GABION WEIR
- DIVERSION
- PIPE SLOPE DRAIN PSD-24 (D-1/10)
- EARTH DIKE A-1 (C-1/10)
- EXISTING LEACHATE LINE

NOTE:

1. SEE DRAWING 2 FOR GENERAL NOTES.
2. 2010 AS-BUILT SUBBASE GRADE FROM FIELD-RUN SURVEY BY FLORA ASSOCIATES, INC.



B/– PROFILE
DIVERSION B
SCALE: 1" = 30'

0 30' 60'
HORIZONTAL SCALE IN FT
0 3' 6'
VERTICAL SCALE IN FT

**THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.**

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SM FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE
MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL, IF THE PROJECT HAS NOT STARTED, UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

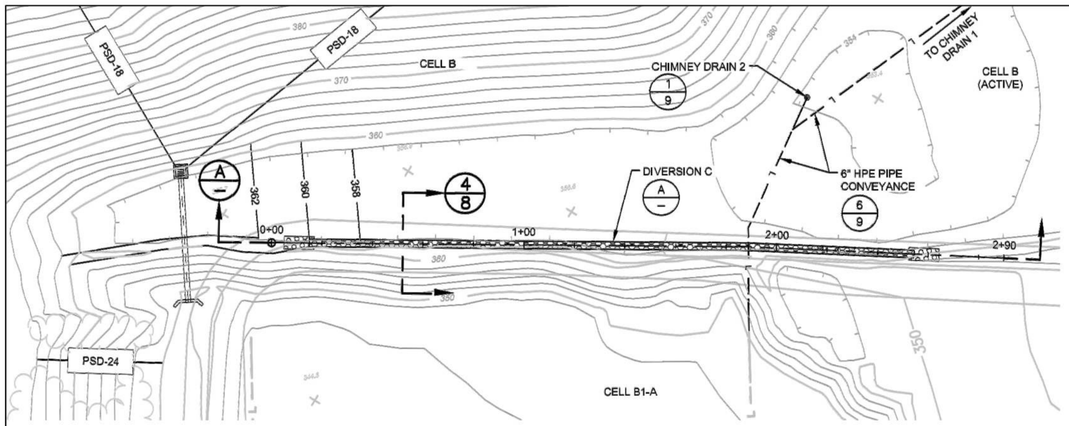
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

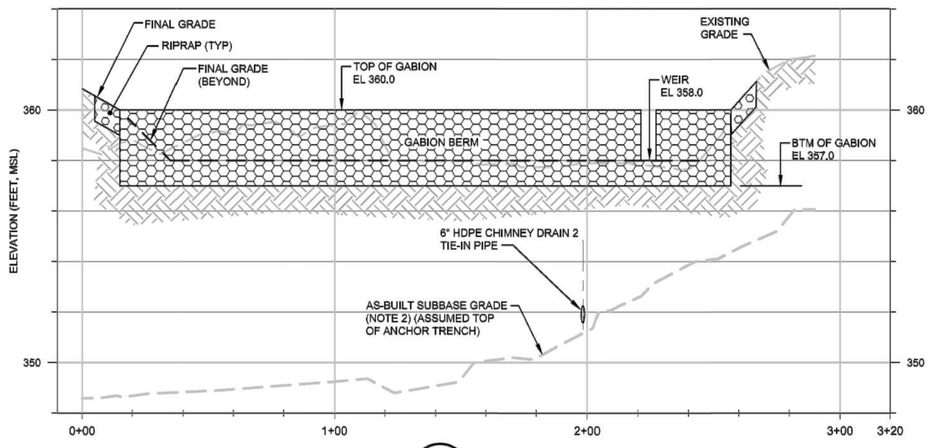
**NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION**

DIVERSIONS A AND B PLAN & PROFILES

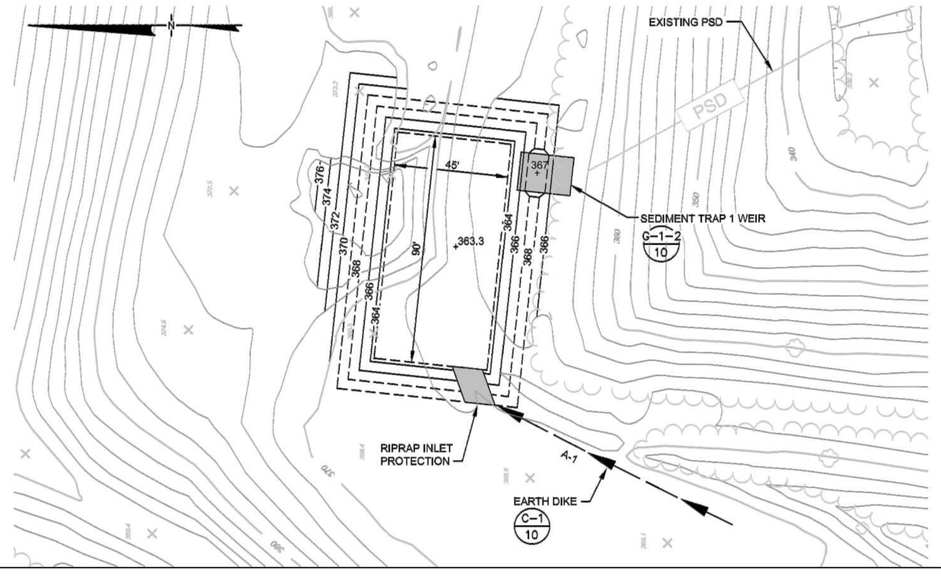
DRAWING SHEET No.: 5	MCDPS SHEET No.: SHEET 77 OF 84
	MDE SHEET No.: SHEET 5 OF 12



1/3 PLAN
DIVERSION C
SCALE: 1" = 30'

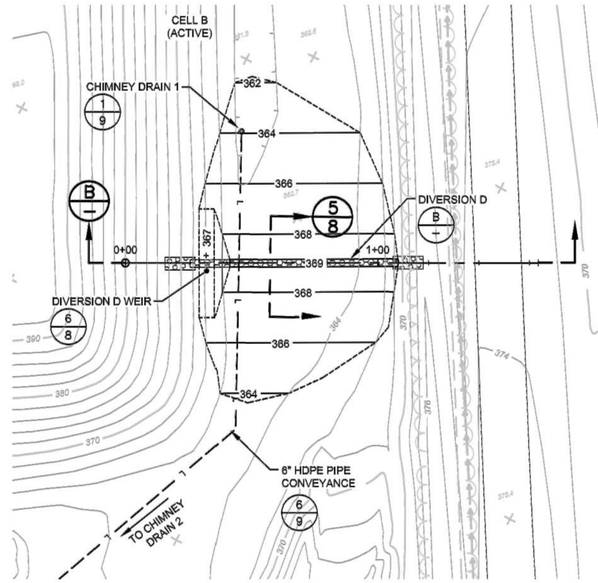


A/3 PROFILE
DIVERSION C
SCALE: 1" = 30'

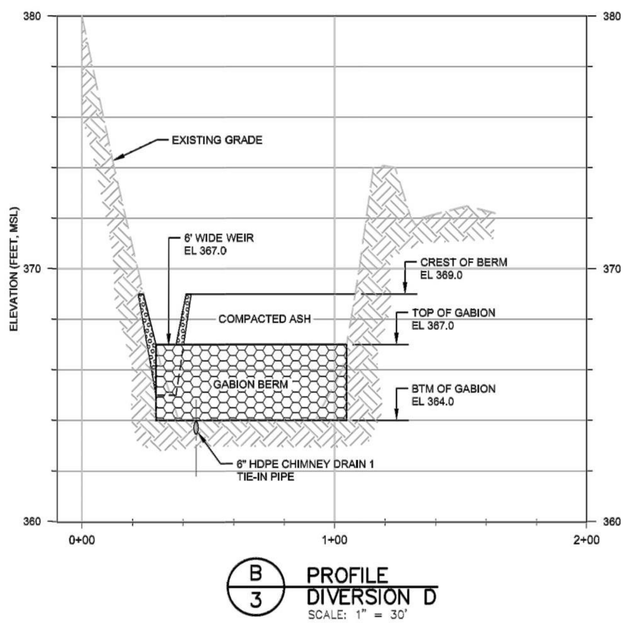


0 30' 60'
HORIZONTAL SCALE IN FT

0 3' 6'
VERTICAL SCALE IN FT



2/3 PLAN
DIVERSION D
SCALE: 1" = 30'



B/3 PROFILE
DIVERSION D
SCALE: 1" = 30'

LEGEND

- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- CHIMNEY DRAIN (CD) INLET
- GABION WEIR
- DIVERSION
- PSD-24 — PIPE SLOPE DRAIN (D-1/10)
- A-1 — EARTH DIKE (C-1/10)
- EXISTING LEACHATE LINE

NOTE:

1. SEE DRAWING 2 FOR GENERAL NOTES.
2. 2010 AS-BUILT SUBBASE GRADE FROM FIELD-RUN SURVEY BY FLORA ASSOCIATES, INC.

**THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.**

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE
MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

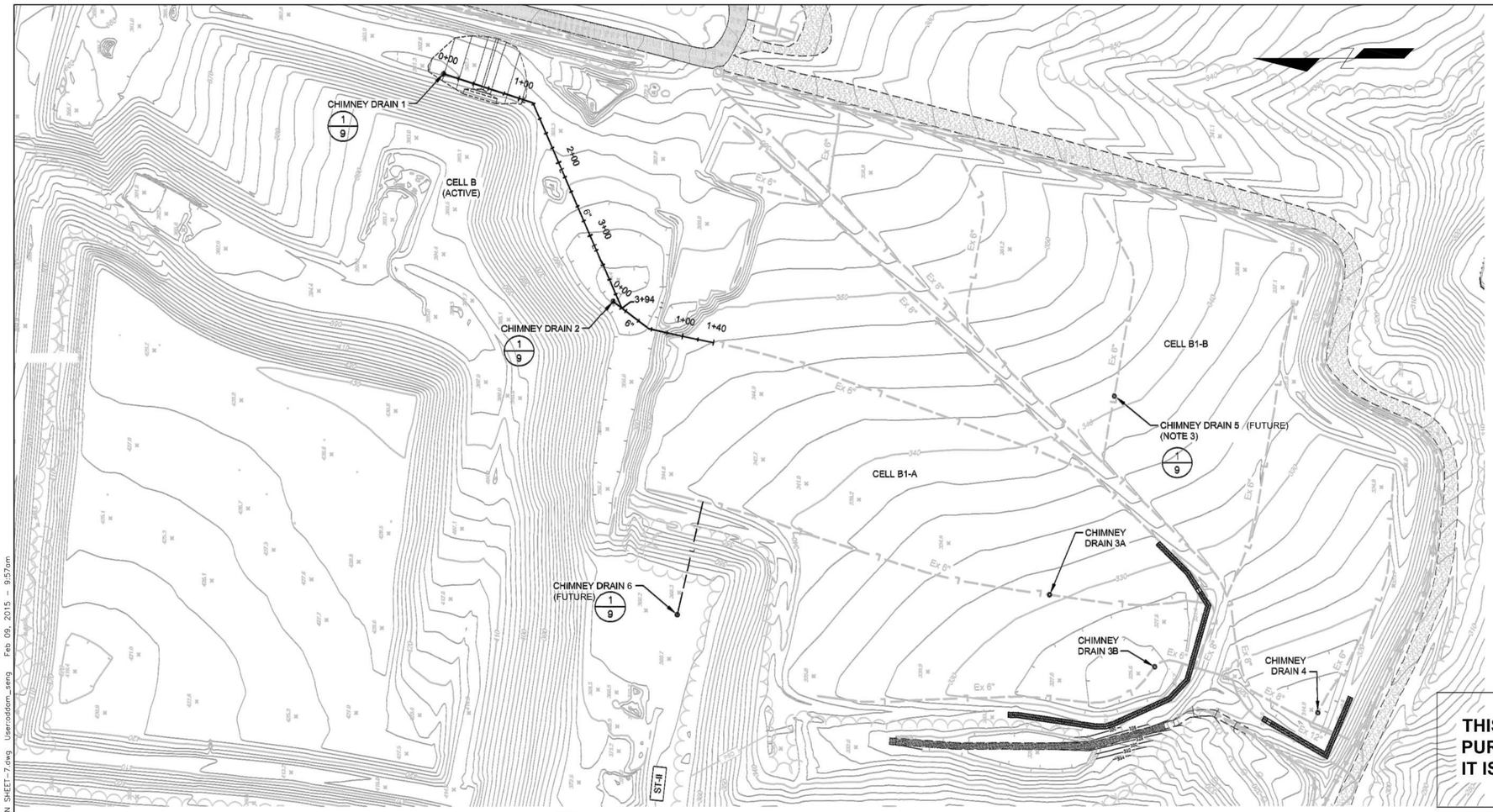
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

**NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION**

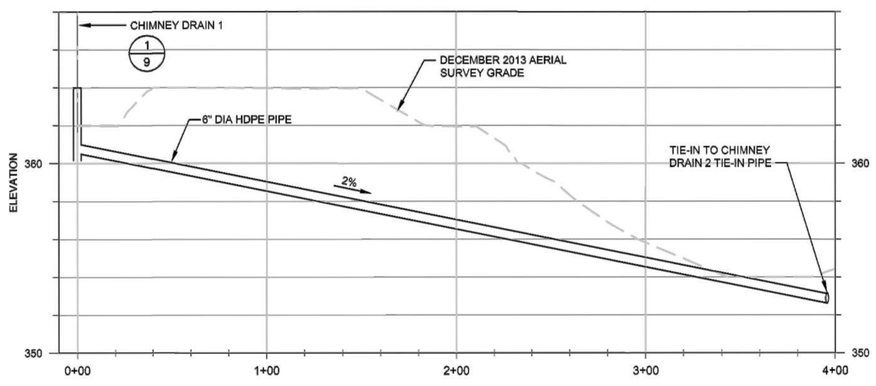
**DIVERSIONS C AND D
PLAN & PROFILES
AND SEDIMENT TRAP 1 PLAN**

DRAWING SHEET No.: 6	MCDPS SHEET No.: SHEET 78 OF 84
	MDE SHEET No.: SHEET 6 OF 12



1/3 PLAN
CHIMNEY DRAIN TIE-IN PIPES
SCALE: 1" = 80'

0 80' 160'
SCALE IN FEET

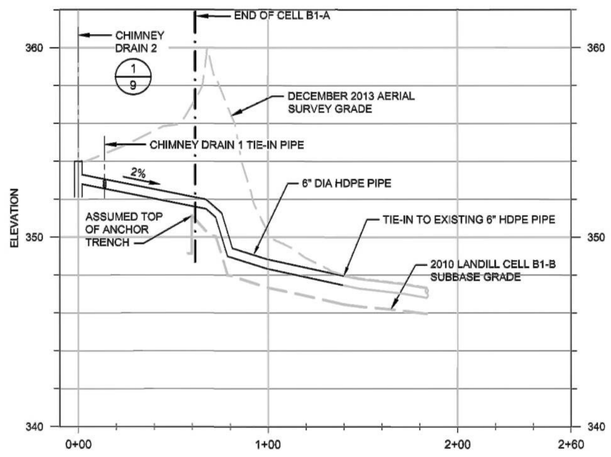


A/- PROFILE
CHIMNEY DRAIN 1 TIE-IN
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 4'

0 40' 80'
HORIZONTAL SCALE IN FEET

0 4' 8'
VERTICAL SCALE IN FEET

VERTICAL EXAGGERATION: 10x



B/- PROFILE
CHIMNEY DRAIN 2 TIE-IN
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 4'

LEGEND

- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- CHIMNEY DRAIN (CD) INLET (1/9)
- GABION WEIR
- DIVERSION
- PSD-24 PIPE SLOPE DRAIN (D-1/10)
- A-1 EARTH DIKE (C-1/10)
- EXISTING LEACHATE LINE

NOTE:

1. SEE DRAWING 2 FOR GENERAL NOTES.
2. 2010 AS-BUILT SUBBASE GRADE FROM FIELD-RUN SURVEY BY FLORA ASSOCIATES, INC.
3. CHIMNEY DRAIN CD-5 (FUTURE) TO BE INSTALLED AS NEEDED.

**THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.**

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE
MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

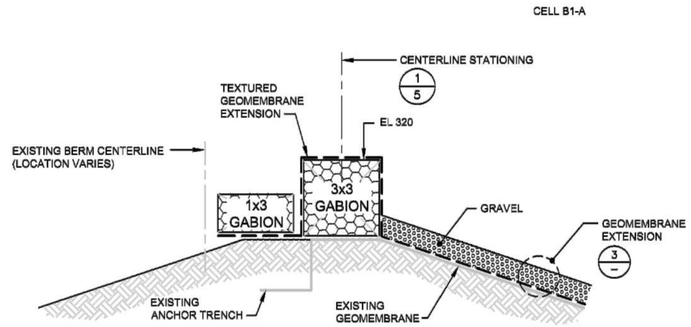
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

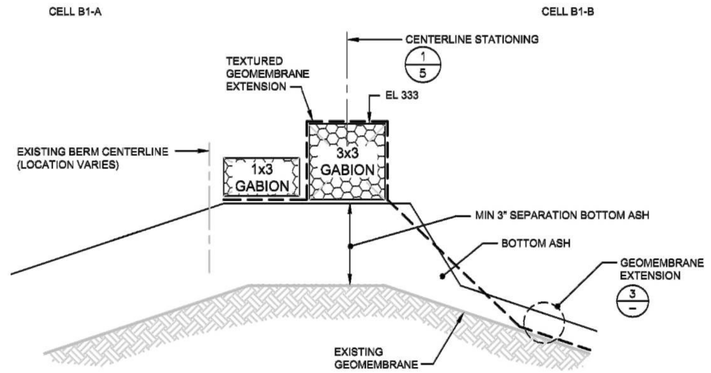
**NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION**

CHIMNEY DRAIN TIE-INS PLAN & PROFILES

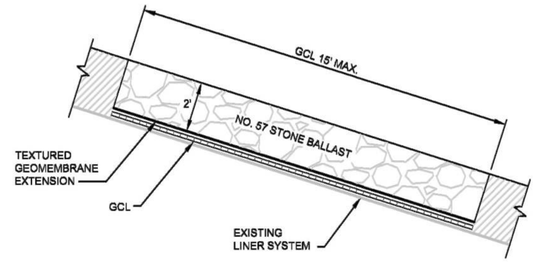
DRAWING SHEET No.:	MCDPS SHEET No.:
7	SHEET 79 OF 84
	MDE SHEET No.: SHEET 7 OF 12



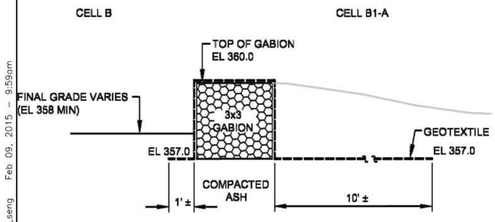
1/4 DETAIL
DIVERSION A
SCALE: 1" = 3'



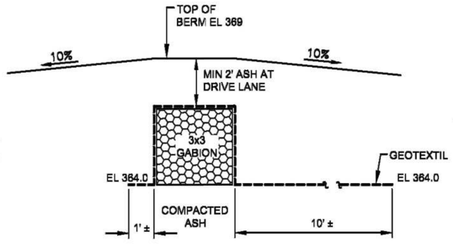
2/4 DETAIL
DIVERSION B
SCALE: 1" = 3'



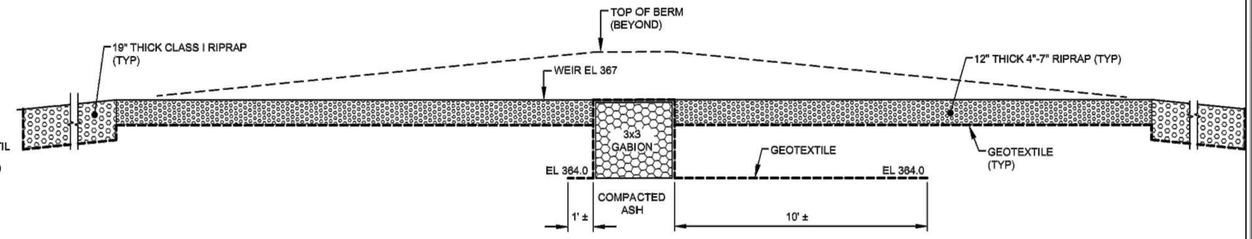
3/– DETAIL
GEOMEMBRANE EXTENSION
SCALE: 1" = 3'



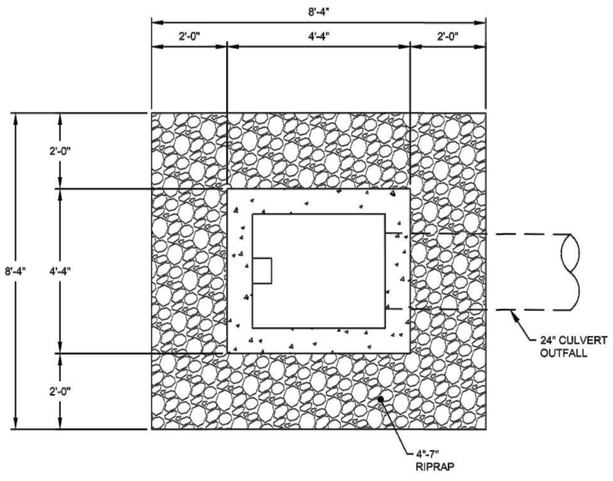
4/4 DETAIL
DIVERSION C
SCALE: 1" = 3'



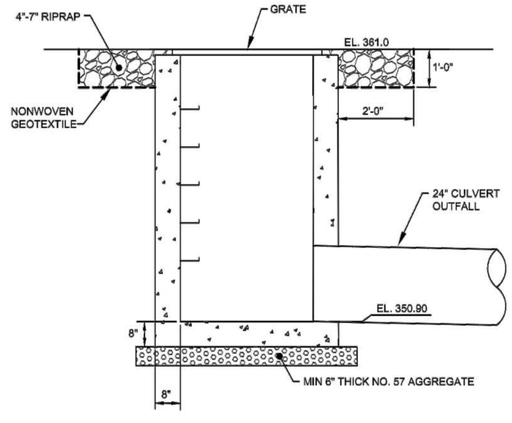
5/6 DETAIL
DIVERSION D
SCALE: 1" = 3'



6/6 DETAIL
DIVERSION D WEIR
SCALE: 1" = 3'



PLAN



SECTION

7/4 DETAIL
MD SHA YARD INLET
(DETAIL MD 381.02)
SCALE: 1" = 3'

**THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.**

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE

MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

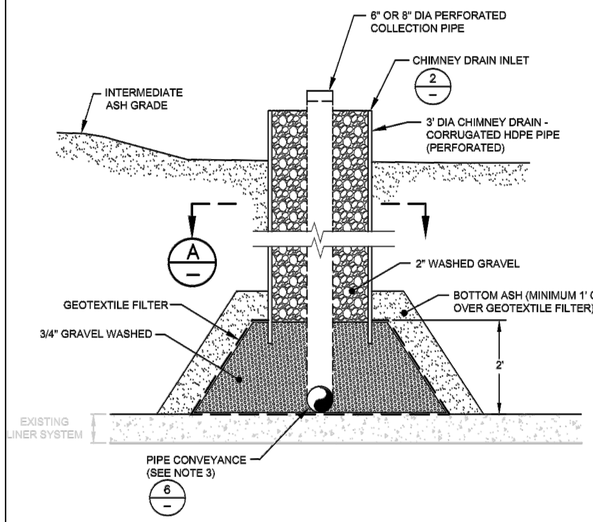
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

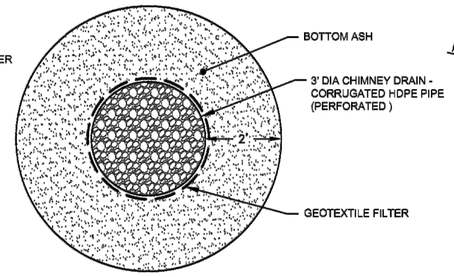
**NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION**

SITE DETAILS 1

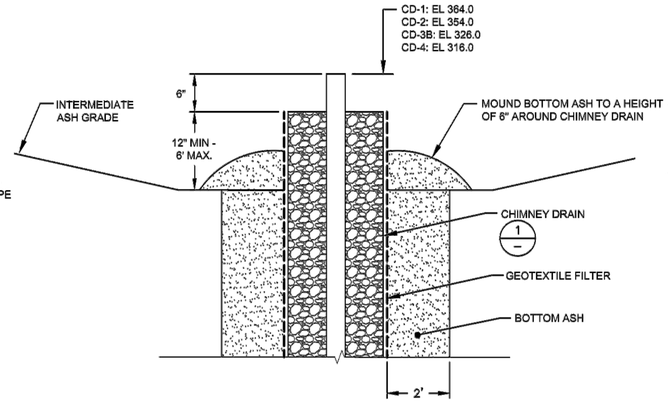
DRAWING SHEET No.: 8	MCDPS SHEET No.: SHEET 80 OF 84
	MDE SHEET No.: SHEET 8 OF 12



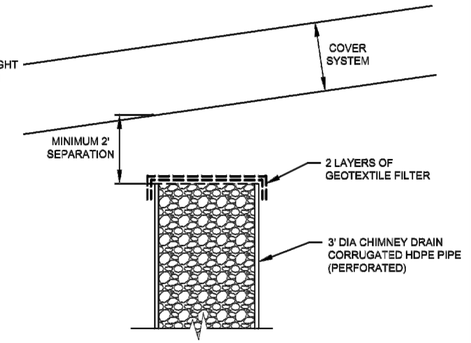
1/4 SECTION
CHIMNEY DRAIN
SCALE: NTS
(NOTE 1)



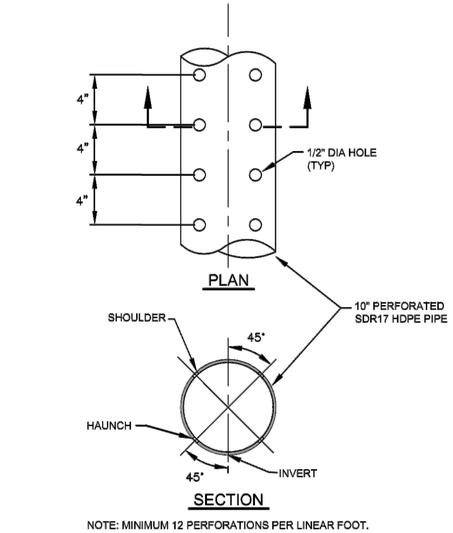
A SECTION
CHIMNEY DRAIN
SCALE: NTS



2 DETAIL (TYP)
CHIMNEY DRAIN INLET
SCALE: NTS

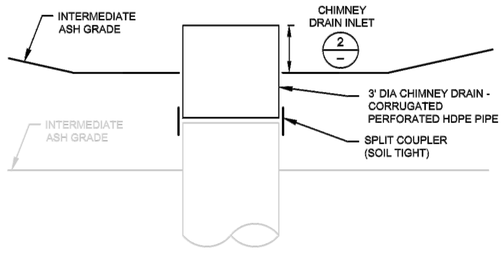


3 DETAIL (TYP)
CHIMNEY DRAIN ABANDONMENT
SCALE: NTS
(NOTE 2)

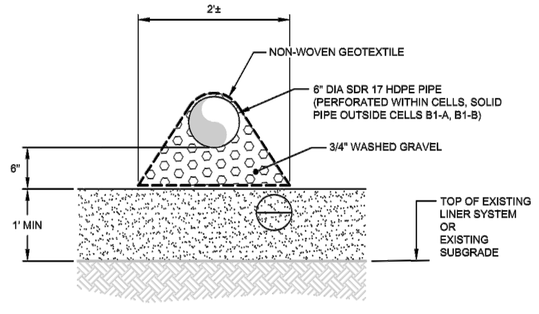


NOTE: MINIMUM 12 PERFORATIONS PER LINEAR FOOT.

4 DETAIL
COLLECTION PIPE PERFORATIONS
SCALE: NTS



5 DETAIL
CHIMNEY DRAIN EXTENSION
SCALE: NTS
(NOTE 1)



6 DETAIL
6 PIPE CONVEYANCE
SCALE: 1" = 1'

NOTE:

1. CHIMNEY DRAIN WILL BE CONTINUOSLY EXTENDED BY THE CCB MANAGEMENT CONTRACTOR AS PART OF THE FILLING OPERATIONS ON AN AS-NEEDED BASIS (DETAIL 5, THIS SHEET).
2. CHIMNEY DRAIN WILL BE DECOMMISSIONED WHEN GRADES REACH PROPOSED FINAL.
3. CHIMNEY DRAINS 1,2, AND 6 (FUTURE) WILL CONNECT TO NEW LEACHATE LINES, REMAINING CHIMNEY DRAINS WILL CONNECT TO EXISTING LEACHATE LINE EMBEDDED IN THE LINER SYSTEM.

THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date
231273
SM FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE
MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL, IF THE PROJECT HAS NOT STARTED, UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

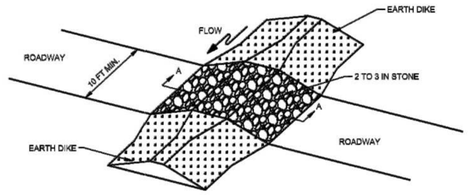
NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION

SITE DETAILS 2

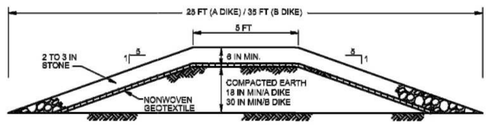
DRAWING SHEET No.: 9	MCDPS SHEET No.: SHEET 81 OF 84
	MDE SHEET No.: SHEET 9 OF 12

DETAIL C-8 MOUNTABLE BERM

STANDARD SYMBOL: MB



ISOMETRIC VIEW



SECTION A-A

CONSTRUCTION SPECIFICATIONS

1. USE MINIMUM WIDTH OF 10 FEET TO ALLOW FOR VEHICULAR PASSAGE.
2. PLACE NONWOVEN GEOTEXTILE, AS SPECIFIED IN SECTION H-1 MATERIALS, OVER THE EARTH MOUND PRIOR TO PLACING STONE.
3. PLACE 2 TO 3 INCH STONE OR EQUIVALENT RECYCLED CONCRETE AT LEAST 6 INCHES DEEP OVER THE LENGTH AND WIDTH OF THE MOUNTABLE BERM.
4. MAINTAIN LINE, GRADE, AND CROSS SECTION. ADD STONE OR MAKE OTHER REPAIRS AS CONDITIONS DEMAND TO MAINTAIN SPECIFIED DIMENSIONS. REMOVE ACCUMULATED SEDIMENT AND DEBRIS. MAINTAIN POSITIVE DRAINAGE.

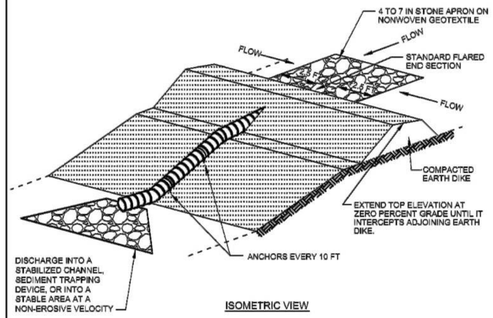
MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	201 1	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

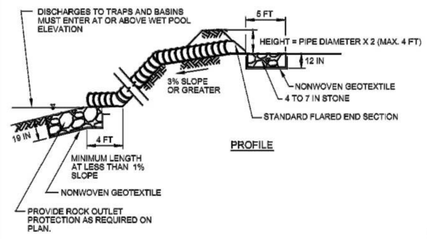
DETAIL D-1 PIPE SLOPE DRAIN

STANDARD SYMBOL: PSD - 12

DESIGNATION PSD-12 REFERS TO 12 IN PIPE SLOPE DRAIN.



ISOMETRIC VIEW



PROFILE

1 OF 2

MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	201 1	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

DETAIL D-1 PIPE SLOPE DRAIN

STANDARD SYMBOL: PSD - 12

DESIGNATION PSD-12 REFERS TO 12 IN PIPE SLOPE DRAIN.

CONSTRUCTION SPECIFICATIONS

1. THE HEIGHT OF THE EARTH DIKE MUST BE AT LEAST 2 TIMES THE PIPE DIAMETER MEASURED FROM THE INVERT OF THE PIPE. EXTEND THE TOP ELEVATION OF DIKE AT ZERO PERCENT GRADE UNTIL IT INTERCEPTS THE TOP OF THE ADJOINING EARTH DIKE.
2. FLEXIBLE PIPE IS PREFERRED. HOWEVER, CORRUGATED METAL PIPE OR EQUIVALENT PVC PIPE CAN BE USED. ALL CONNECTIONS MUST BE WATERTIGHT.
3. ATTACH A FLARED END SECTION TO THE INLET END OF PIPE WITH A WATERTIGHT CONNECTION. AT THE INLET OF THE PIPE SLOPE DRAIN, INSTALL 4 TO 7 INCH STONE OR EQUIVALENT RECYCLED CONCRETE PLACED 12 INCHES IN DEPTH ON NONWOVEN GEOTEXTILE AND EXTEND OUT 5 FEET FROM THE INLET IN ALL DIRECTIONS.
4. PROVIDE NONWOVEN GEOTEXTILE, AS SPECIFIED IN SECTION H-1 MATERIALS, UNDER THE BOTTOM AND ALONG SIDES OF ALL RIPRAP.
5. SECURELY ANCHOR THE PIPE SLOPE DRAIN (PSD) TO THE SLOPE. SPACE THE ANCHORS EVERY 10 FEET.
6. HAND TAMP THE SOIL AROUND AND UNDER THE PIPE AND END SECTION IN 4 INCH LIFTS TO THE TOP OF THE EARTH DIKE.
7. UPON COMPLETING INSTALLATION OF THE PSD, STABILIZE ASSOCIATED DISTURBANCES WITH SEED, MULCH, AND TACK.
8. INSTALL OUTLET PROTECTION AS SPECIFIED ON APPROVED PLAN.
9. KEEP POINTS OF INFLOW AND OUTFLOW FREE OF EROSION. MAINTAIN WATER TIGHT CONNECTIONS AND POSITIVE DRAINAGE. REMOVE ACCUMULATED SEDIMENT AND DEBRIS.

2 OF 2

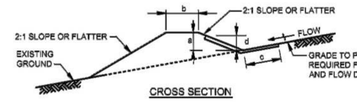
MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	201 1	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

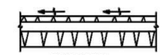
DETAIL C-1 EARTH DIKE

STANDARD SYMBOL: A-1

PLACE DESIGNATION (LIKE A-1) ON FLOW CHANNEL SIDE OF DIKE.



CROSS SECTION



PLAN VIEW

DIKE TYPE	A	B
a - DIKE HEIGHT	18 IN MIN.	30 IN MIN.
b - DIKE WIDTH	24 IN MIN.	36 IN MIN.
c - FLOW WIDTH	4 FT MIN.	6 FT MIN.
d - FLOW DEPTH	12 IN MIN.	24 IN MIN.

FLOW CHANNEL STABILIZATION

A-1	SEED WITH STRAW MULCH AND TACK. (NOT ALLOWED FOR CLEAR WATER DIVERSION.)
A-2/B-2	SEED WITH SOIL STABILIZATION MATTING OR LINE WITH SOD.
A-3/B-3	4 TO 7 INCH STONE OR EQUIVALENT RECYCLED CONCRETE PRESSED INTO SOIL A MINIMUM OF 7 INCHES AND FLUSH WITH GROUND.

CONSTRUCTION SPECIFICATIONS

1. REMOVE AND DISPOSE OF ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SO AS NOT TO INTERFERE WITH PROPER FUNCTION OF EARTHDIKE.
2. EXCAVATE OR SHAPE EARTH DIKE TO LINE, GRADE, AND CROSS SECTION AS SPECIFIED. BANK PROJECTIONS OR OTHER IRREGULARITIES ARE NOT ALLOWED.
3. COMPACT FILL.
4. CONSTRUCT FLOW CHANNEL ON AN UNINTERRUPTED, CONTINUOUS GRADE, ADJUSTING THE LOCATION DUE TO FIELD CONDITIONS AS NECESSARY TO MAINTAIN POSITIVE DRAINAGE.
5. PROVIDE OUTLET PROTECTION AS REQUIRED ON APPROVED PLAN.
6. STABILIZE EARTH DIKE WITHIN THREE DAYS OF INSTALLATION. STABILIZE FLOW CHANNEL FOR CLEAR WATER DIVERSION WITHIN 24 HOURS OF INSTALLATION.
7. MAINTAIN LINE, GRADE, AND CROSS SECTION. REMOVE ACCUMULATED SEDIMENT AND DEBRIS, AND MAINTAIN POSITIVE DRAINAGE. KEEP EARTH DIKE AND POINT OF DISCHARGE FREE OF EROSION, AND CONTINUOUSLY MEET REQUIREMENTS FOR ADEQUATE VEGETATIVE ESTABLISHMENT IN ACCORDANCE WITH SECTION B-4 VEGETATIVE STABILIZATION.
8. UPON REMOVAL OF EARTH DIKE, GRADE AREA FLUSH WITH EXISTING GROUND. WITHIN 24 HOURS OF REMOVAL STABILIZE DISTURBED AREA WITH TOPSOIL, SEED, AND MULCH, OR AS SPECIFIED ON APPROVED PLAN.

MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

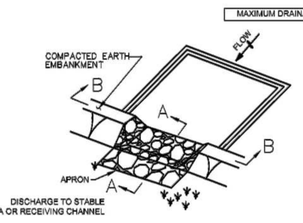
U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	201 1	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

NOTE: MDE CONVEYANCE POND CONSTRUCTED TO DETAIL G-1-2 REQUIREMENTS.

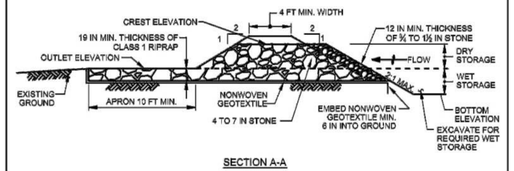
DETAIL G-1-2 STONE/RIPRAP OUTLET SEDIMENT TRAP ST-II

STANDARD SYMBOL: ST-II

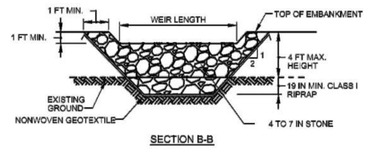
MAXIMUM DRAINAGE AREA = 10 ACRES



ISOMETRIC VIEW



SECTION A-A



SECTION B-B

1 OF 3

MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	201 1	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

DETAIL G-1-2 STONE/RIPRAP OUTLET SEDIMENT TRAP ST-II

STANDARD SYMBOL: ST-II

CONSTRUCTION SPECIFICATIONS

1. CONSTRUCT TRAP IN SUCH A MANNER THAT EROSION AND WATER POLLUTION ARE AVOIDED.
2. CLEAR, GRUB, AND STRIP ANY VEGETATION AND ROOT MAT FROM THE AREA UNDER THE EMBANKMENT AND TRAP BOTTOM.
3. USE FILL MATERIAL FREE OF ROOTS, WOODY VEGETATION, OVERSIZED STONES, ROCKS, ORGANIC MATERIAL, OR OTHER OBJECTIONABLE MATERIAL FOR THE EMBANKMENT.
4. CONSTRUCT TOP OF EMBANKMENT 1 FOOT MINIMUM ABOVE WEIR CREST. COMPACT THE EMBANKMENT BY TRAVERSING WITH EQUIPMENT WHILE IT IS BEING CONSTRUCTED.
5. MAKE ALL CUT AND FILL SLOPES 2:1 OR FLATTER.
6. PLACE NONWOVEN GEOTEXTILE, AS SPECIFIED IN SECTION H-1 MATERIALS, OVER THE BOTTOM AND SIDES OF OUTLET AND APRON PRIOR TO PLACEMENT OF RIPRAP. OVERLAP SECTIONS OF GEOTEXTILE AT LEAST 1 FOOT WITH THE SECTION NEARER TO THE TRAP PLACED ON TOP. EMBED GEOTEXTILE AT LEAST 6 INCHES INTO EXISTING GROUND AT ENTRANCE OF OUTLET CHANNEL.
7. USE CLEAN 4 TO 7 INCH RIPRAP TO CONSTRUCT THE WEIR. USE CLASS I RIPRAP FOR THE APRON. USE OF RECYCLED CONCRETE EQUIVALENT IS ACCEPTABLE.
8. PLACE 1 FOOT OF CLEAN ¾ TO 1½ INCH STONE OR EQUIVALENT RECYCLED CONCRETE ON THE UPSTREAM FACE OF THE WEIR.
9. CONSTRUCT AND MAINTAIN THE OUTLET ACCORDING TO APPROVED PLAN, AND IN SUCH A MANNER THAT EROSION AT OR BELOW THE OUTLET DOES NOT OCCUR.
10. STABILIZE THE EMBANKMENT AND INTERIOR SLOPES WITH SEED AND MULCH. STABILIZE POINTS OF CONCENTRATED INFLOW AS SHOWN ON APPROVED PLAN.
11. REMOVE SEDIMENT AND RESTORE TRAP TO ORIGINAL DIMENSIONS WHEN SEDIMENT HAS ACCUMULATED TO CLEANOUT ELEVATION (50% OF WET STORAGE DEPTH). DEPOSIT REMOVED SEDIMENT IN AN APPROVED AREA AND IN SUCH A MANNER THAT IT WILL NOT ERODE. KEEP POINTS OF INFLOW AND OUTFLOW AS WELL AS INTERIOR OF THE TRAP FREE FROM EROSION, AND REMOVE ACCUMULATED DEBRIS, MAINTAIN EMBANKMENTS TO CONTINUOUSLY MEET REQUIREMENTS FOR ADEQUATE VEGETATIVE ESTABLISHMENT IN ACCORDANCE WITH SECTION B-4 VEGETATIVE STABILIZATION. REMOVE ANY TREES, BRUSH, OR OTHER WOODY VEGETATION GROWING ON EMBANKMENT OR NEAR PRINCIPAL SPILLWAY. MAINTAIN LINE, GRADE, AND CROSS SECTION.
12. WHEN DEWATERING TRAP, PASS REMOVED WATER THROUGH AN APPROVED SEDIMENT CONTROL PRACTICE.
13. UPON REMOVAL, GRADE AND STABILIZE THE AREA OCCUPIED BY TRAP.

2 OF 3

MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	201 1	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

DETAIL G-1-2 STONE/RIPRAP OUTLET SEDIMENT TRAP ST-II

STANDARD SYMBOL: ST-II

STONE/RIPRAP OUTLET SEDIMENT TRAP ST-II, TRAP NO. 1		
DRAINAGE AREA - INITIAL	–	ACRES
DRAINAGE AREA - INTERIM	–	ACRES
DRAINAGE AREA - FINAL	3.71	ACRES
TOTAL STORAGE REQUIRED	14,400	CF
TOTAL STORAGE PROVIDED	14,985	CF
WET STORAGE REQUIRED	7,200	CF
WET STORAGE PROVIDED	7,290	CF
DRY STORAGE REQUIRED	7,200	CF
DRY STORAGE PROVIDED	8,100	CF
EXISTING GROUND ELEVATION AT OUTLET (WET STORAGE ELEVATION)	365	FT
TRAP BOTTOM ELEVATION	363.3	FT
TRAP BOTTOM DIMENSIONS	45 X 90	FT x FT
WEIR LENGTH	15	FT
WEIR CREST (DRY STORAGE) ELEVATION	367.0	FT
CLEANOUT ELEVATION	364.1	FT
TOP OF EMBANKMENT ELEVATION	368.0	FT
SIDE SLOPE	2:1	H:V RATIO
EMBANKMENT TOP WIDTH	4	FT
OUTLET PROTECTION - LENGTH	10	FT
OUTLET PROTECTION - DEPTH	19	IN

3 OF 3

MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	201 1	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE

MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13196
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION

EROSION AND SEDIMENT CONTROL DETAILS

DRAWING SHEET No.:	MCDPS SHEET No.:
10	SHEET 82 OF 84
	MDE SHEET No.: SHEET 10 OF 12

LEGEND

- APPROXIMATE CELL LIMIT
- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- FABRICFORM-LINED PERIMETER DITCH
- LEACHATE PIPE (NOTE 3)
- PROPOSED GRADE CONTOUR (FEET-MSL)
- CHIMNEY DRAIN (CD) INLET (1/9)
- INTERMEDIATE GRADE RUNOFF DIRECTION
- DIVERSION BETWEEN CONTACT AND NON-CONTACT WATER

GENERAL NOTES:

1. TOPOGRAPHIC MAPPING COMPILED BY PHOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 28 DECEMBER 2013.
2. HORIZONTAL CONTROL IS NORTH AMERICAN DATUM OF 1983 (NAD 83, MARYLAND), VERTICAL CONTROL IS NORTH AMERICAN DATUM OF 1988 (NAVD 88).
3. EXISTING LEACHATE PIPES OBTAINED FROM FLORA SURVEYING ASSOCIATES, INC. BASED ON FIELD-RUN SURVEY, DATED 2010.

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.

0 100' 200'
SCALE IN FT

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE

MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

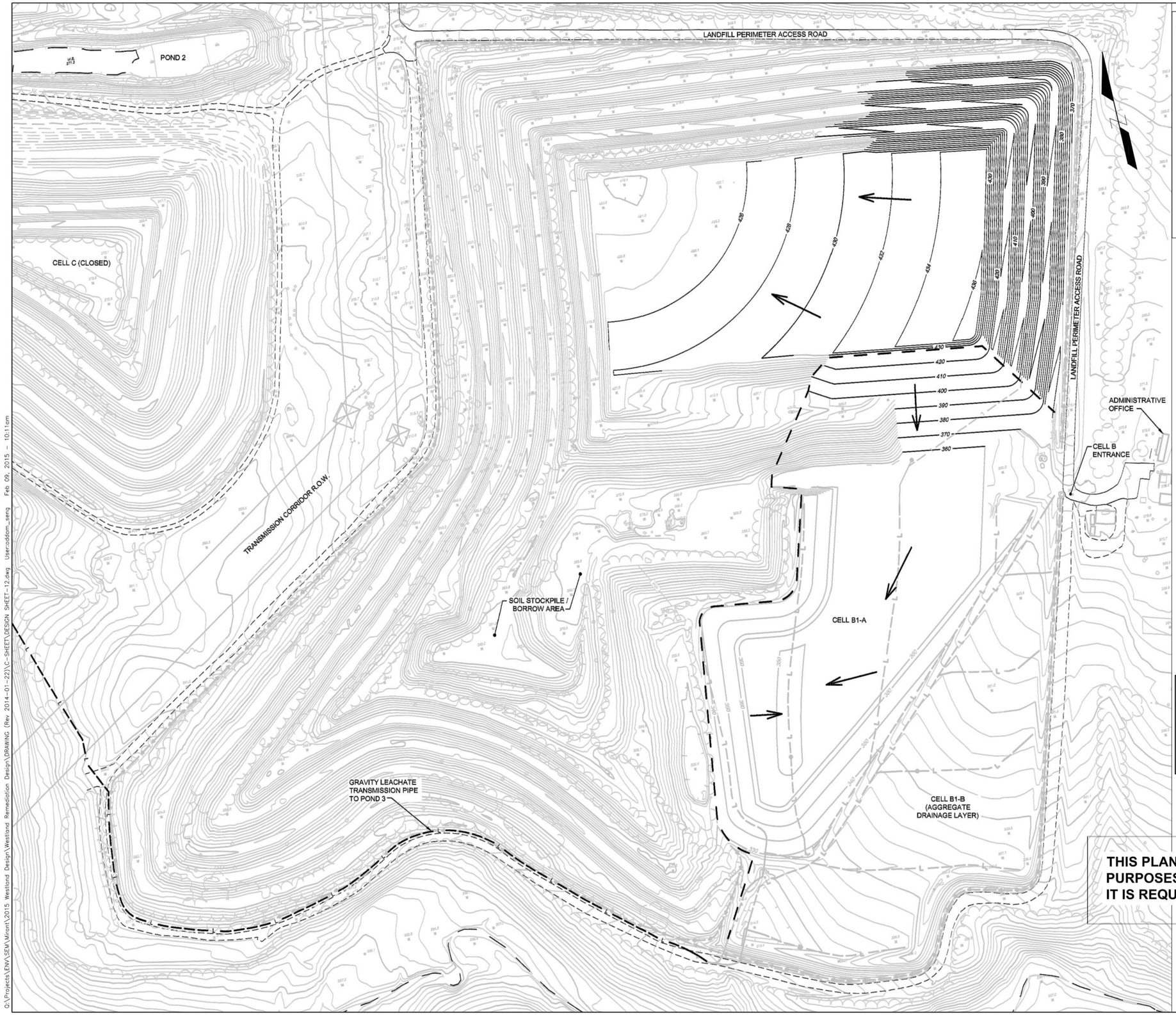
STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION

FILLING SEQUENCING PLAN 1

DRAWING SHEET No.:	MCDPS SHEET No.:
11	SHEET 83 OF 84
	MDE SHEET No.: SHEET 11 OF 12



LEGEND

- APPROXIMATE CELL LIMIT
- EXISTING GRADE CONTOUR (FEET-MSL)
- SPOT ELEVATION
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STRUCTURE
- STREAM
- FABRIFORM-LINED PERIMETER DITCH
- LEACHATE PIPE (NOTE 3)
- PROPOSED GRADE CONTOUR (FEET-MSL)
- CHIMNEY DRAIN (CD) INLET
- INTERMEDIATE GRADE RUNOFF DIRECTION
- DIVERSION BETWEEN CONTACT AND NON-CONTACT WATER

GENERAL NOTES:

1. TOPOGRAPHIC MAPPING COMPILED BY PHOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 28 DECEMBER 2013.
2. HORIZONTAL CONTROL IS NORTH AMERICAN DATUM OF 1983 (NAD 83, MARYLAND), VERTICAL CONTROL IS NORTH AMERICAN DATUM OF 1988 (NAVD 88).
3. EXISTING LEACHATE PIPES OBTAINED FROM FLORA SURVEYING ASSOCIATES, INC. BASED ON FIELD-RUN SURVEY, DATED 2010.

NOTE:
PLANS AND DETAILS ON THIS SHEET PROVIDED BY GEOSYNTEC CONSULTANTS, COLUMBIA, MD., DATED JULY 2014. USED WITH PERMISSION FROM NRG MD ASH MANAGEMENT LLC., SITE OWNER.

THIS PLAN IS FOR INFORMATIONAL PURPOSES ONLY.
IT IS REQUIRED & APPROVED BY MDE.

URS
12420 MILESTONE CENTER DRIVE
SUITE 150
GERMANTOWN, MD 20882
301-820-3000

MCDPS APPROVED FOR:

Stormwater Management:

Reviewed Date

Approved Date

231273
SW FILE #

Sediment Control Technical Requirements:

Reviewed Date

Approved Date

Administrative Requirements:

Reviewed Date

SEDIMENT CONTROL PERMIT #
203375

NOTE
MCDPS APPROVAL OF THIS PLAN WILL EXPIRE ONE YEAR FROM THE DATE OF APPROVAL IF THE PROJECT HAS NOT STARTED UNLESS THE PERMIT HAS BEEN EXTENDED.

THIS APPROVAL DOES NOT NEGATE THE NEED OF A MCDPS ACCESS PERMIT.

STATE OF MARYLAND
JEFFREY R. HUTCHINS
No. 13186
REGISTERED PROFESSIONAL ENGINEER
2/6/15

DRAWN BY: OS	DATE JAN-2015
CHECKED BY: JRH	JOB # 15303902
APPROVED BY: JRH	SCALE:

NRG MD ASH MANAGEMENT LLC
WESTLAND ASH STORAGE FACILITY
CELL B1 REMEDIATION MEASURES CONSTRUCTION

FILLING SEQUENCING PLAN 2

DRAWING SHEET No.:	MCDPS SHEET No.:
12	SHEET 84 OF 84
	MDE SHEET No.: SHEET 12 OF 12

Appendix B

Stormwater Management Plan Supporting Calculations

Prepared for

NRG MD Ash Management, LLC
25100 Chalk Point Road
Aquasco, Maryland 20608

STORMWATER MANAGEMENT PLAN

Westland Ash Management Facility
Dickerson, Montgomery County, Maryland

Prepared by:

Geosyntec consultants

engineers | scientists | innovators

10220 Old Columbia Road, Suite A
Columbia, Maryland 21046

Project Number: MEM1106
July 2014

Geosyntec
consultants

COMPUTATION COVER SHEET

Client: MD Ash **Project:** Westland Ash Mgmt. Facility **Project #:** MEM1106 **Task #:** 02

TITLE OF COMPUTATIONS **STORMWATER MANAGEMENT ANALYSIS**

COMPUTATIONS BY:
Signature For
Printed Name William M. Steier, P.E.
and Title Senior Engineer
05/26/2014
DATE

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature
Printed Name Meredith E. Neely, P.E.
and Title Engineer
05/26/2014
DATE

COMPUTATIONS CHECKED BY:
Signature
Printed Name Meredith E. Neely, P.E.
and Title Engineer
05/26/2014
DATE

COMPUTATIONS BACKCHECKED BY: (Originator)
Signature For
Printed Name William M. Steier, P.E.
and Title Senior Engineer
05/26/2014
DATE

APPROVED BY:
(PM or Designate)
Signature
Printed Name R. David Espinoza, P.E.
and Title Principal
07/21/2014
DATE

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

STORMWATER MANAGEMENT ANALYSIS

INTRODUCTION

The purpose of this calculation package is to evaluate the performance of contact and non-contact stormwater management features proposed for installation at the Westland Ash Management Facility, in Dickerson, Montgomery County, Maryland. This calculation package includes discussion of the parameters used for hydrologi c analyses and hydraulic performance, as well as a summary of the model outputs.

For this analysis, two design storm scenarios are evaluated: one for design of non-contact stormwater runoff from soil and vegetated areas of the site; and one for design of stormwater that contacts exposed ash. For non-contact stormwater, the design basis for which each proposed feature is analyzed is 25-yr. 24-hr. precipitation (5.75 inches). The design basis for features that control contact stormwater is selected as a combination of two 100-yr. 6-hr. design storms that occur 24-hours apart (each storm produces a precipitation depth of 5.15 inches).

ANALYSIS

Watershed analysis is performed using procedures described in the documents, "Urban Hydrology for Small Watersheds, Technical Release 55", (USDA-SCS, 1986) and "Computer Program for Project Formulation Hydrology, Technical Release 20", (USDA –SCS, 1982). The computer program HydroCAD 10.0 (Applied Micro-Computer Systems, 2012) was used to perform the analysis.

The site plan with the proposed locations of new stormwater management features is provided on the Stormwater Management Plan Drawings. Stormwater runoff from the site is conveyed by various stormwater drainage features including: (i) earth berms; (ii) pipe slope drains; (iii) drainage channels and culverts; (iv) stone filled gabion basket diversions; (v) vertical chimney drains; and (vi) horizontal pipes leachate collection pipes.

The site is divided into various subcatchment watersheds and stormwater features, which are analyzed by defining the specific characteristics of the feature using one of three general node types defined by the HydroCAD modeling software. The model node types include: (i) subcatchment nodes, which model runoff from defined drainage areas; (ii) reach nodes, which model flow though channels; and (iii) pond nodes, which for this calculation, model flow at culverts, pipe slope drains, and chimney drain inlets.

PARAMETERS USED IN ANALYSIS

The following describes the selection of the various hydrologic parameters used for the stormwater analysis.

- **Rainfall Distribution and Depth**: Based on data from the National Oceanographic Atmosphere Administration (NOAA) precipitation frequency server [http://dipper.nws.noaa.gov/hdsc/pfds/] ; the 24-hour 25-year return period storm depth is 5.75 inches, and the 6 hour 100-yr design storm is 5.15 inches. Precipitation reference documentation is provided in Attachment 1.
- **Hydrologic Soil Group**: The soil conditions include cover soils that are assumed to exhibit similar characteristics as Hydrologic Soils Group (HSG) C; exposed ash that are assumed to exhibit characteristics similar to HSG B; and an exposed aggregate drainage layer this is assumed to exhibit characteristics similar to HSG A.
- **Curve Number (CN):**

  Runoff curve numbers used in the calculation are selected based on current surface characteristics. The following describes the curve numbers selected for this calculation.

  - For subcatchments that represent areas having a layer of cover soil and vegetation, a curve number (CN) of 74 is selected. This value represents the soil conservation service (SCS) suggested CN for "Open spaces in good condition (grass cover > 75%)" for hydrologic soil group C. A CN of 79 and 91 are used for the borrow pit area, which represents the SCS suggested CN for "Open spaces in fair condition (50-75% grass cover) and newly graded areas, respectively.
  - For Cell B-1A which has an exposed aggregate drainage layers at the surface, a CN of 77 is used, the value recommended by SCS for HSG A for "newly graded areas." For Cell B-1B, which has an exposed bottom ash drainage layer at the surface, a CN of 86 is used, the value recommended for newly graded areas with HSG B. For open ash in the active filling area, a CN of 91 is used, the value recommended by SCS for HSG C for newly graded areas.
- **Subcatchment Drainage Areas**:

  The drainage areas modeled using HydroCAD are shown and summarized in Attachments 2.1 and 2.2.
- **Time of Concentration (T_c):** The T_c value represents the total time for stormwater runoff to travel from the hydraulically most distant point of a watershed or drainage area to a point of interest. Factors affecting T_c include surface roughness, channel shape, flow patterns, and slope. For this analysis the value of T_c is chosen to be 6 minutes (i.e., 0.1 hours) for all

subcatchment, except CW-4, associated with Cell B-1A. An extended T_c is assumed for this area based on the gravel surface associate with the newly constructed cell.

- **Drainage Features:**

  Drainage features are used to convey stormwater away from the contact areas and into the existing stormwater perimeter channel. A general description of the physical characteristics of each feature type is provided below.

  - **Culverts and Pipe Slope Drains:** Culverts and PSD's are modeled using pond nodes, which account for head losses at the inlet entrance.
  - **Channel 1**: Channel 1 that directs non-contact stormwater around Cell B-1B has a trapezoidal geometry. The lining of the channel is dense grass and weeds, with a Manning's N value of 0.40.
  - **Chimney Drains and Diversions**: Stone filled gabion diversions set within the Cell B are used to divert runoff towards chimney drains that will convey contact stormwater runoff into the leachate collection system. The combined diversion and chimney drain inlets are modeled as pond nodes in HydroCAD to allow for step-wise analysis of inflow to the diversion and corresponding outflow thought the proposed chimney drains. In addition to the outflow through the chimney drain, each diversion also includes a weir outlet that passes water not entering the chimney safely around the diversion. The outflow rate through each chimney drain inlet is conservatively estimated to be 0.5 cfs which is approximately 1/5 of the total capacity of the leachate collection system and less than the maximum flow rate into the 6-inch open pipe entrance of each chimney drain.

RESULTS AND CONCLUSIONS

The HydroCAD model output for the non-contact stormwater design analysis is provided in Attachment 2.1 and a summary of the contact water design analysis is presented in Attachment 2.2.

REFERENCES

Applied Microcomputer Systems, "*HydroCAD® Stormwater Modeling System*", Version 10, Chocorua, New Hampshire, 2012.

Federal Highway Administration, Hydraulics Engineering. "*Urban Drainage Design Manual – Storm Drains*" Updated 07 September 2011.

United States Department of Agriculture, Soil Conservation Service (USDA-SCS), "*Computer Program for Project Formulation Hydrology, Technical Release 20*", Washington D.C., 1982.

United States Department of Agriculture, Soil Conservation Service (USDA-SCS), "*Urban Hydrology for Small Watersheds, Technical Release 55*", 2nd ed., Washington, D.C., 1986.

ATTACHMENT 1

PRECIPITATION DATA

NOAA Atlas 14, Volume 2, Version 3
Location name: Dickerson, Maryland, US*
Latitude: 39.2084°, Longitude: -77.4605°
Elevation: 314 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.336** (0.302-0.374)	**0.401** (0.360-0.446)	**0.479** (0.429-0.532)	**0.537** (0.480-0.595)	**0.611** (0.543-0.677)	**0.671** (0.593-0.741)	**0.728** (0.641-0.805)	**0.785** (0.686-0.869)	**0.861** (0.745-0.955)	**0.921** (0.791-1.02)
10-min	**0.534** (0.480-0.594)	**0.639** (0.574-0.710)	**0.765** (0.686-0.851)	**0.857** (0.766-0.950)	**0.972** (0.864-1.08)	**1.06** (0.939-1.17)	**1.15** (1.01-1.27)	**1.24** (1.08-1.37)	**1.35** (1.17-1.50)	**1.44** (1.24-1.60)
15-min	**0.667** (0.599-0.742)	**0.803** (0.721-0.891)	**0.964** (0.865-1.07)	**1.08** (0.965-1.20)	**1.23** (1.09-1.36)	**1.34** (1.19-1.48)	**1.45** (1.28-1.60)	**1.56** (1.36-1.72)	**1.70** (1.47-1.89)	**1.81** (1.55-2.01)
30-min	**0.912** (0.819-1.01)	**1.11** (0.993-1.23)	**1.37** (1.23-1.52)	**1.56** (1.39-1.73)	**1.81** (1.61-2.01)	**2.01** (1.78-2.22)	**2.21** (1.94-2.44)	**2.41** (2.10-2.67)	**2.69** (2.33-2.98)	**2.90** (2.49-3.23)
60-min	**1.13** (1.02-1.26)	**1.38** (1.24-1.54)	**1.75** (1.57-1.94)	**2.02** (1.81-2.25)	**2.41** (2.14-2.66)	**2.71** (2.40-3.00)	**3.04** (2.67-3.36)	**3.37** (2.94-3.73)	**3.84** (3.33-4.26)	**4.22** (3.63-4.70)
2-hr	**1.34** (1.21-1.50)	**1.64** (1.47-1.82)	**2.08** (1.87-2.31)	**2.43** (2.17-2.70)	**2.94** (2.62-3.26)	**3.36** (2.97-3.72)	**3.81** (3.35-4.22)	**4.30** (3.75-4.76)	**5.02** (4.32-5.56)	**5.61** (4.79-6.24)
3-hr	**1.45** (1.30-1.63)	**1.76** (1.58-1.97)	**2.23** (2.00-2.50)	**2.61** (2.34-2.91)	**3.17** (2.81-3.52)	**3.63** (3.20-4.03)	**4.13** (3.61-4.59)	**4.67** (4.05-5.19)	**5.47** (4.69-6.09)	**6.15** (5.21-6.86)
6-hr	**1.80** (1.62-2.02)	**2.18** (1.96-2.44)	**2.75** (2.46-3.07)	**3.21** (2.87-3.59)	**3.91** (3.46-4.35)	**4.50** (3.96-5.01)	**5.15** (4.49-5.72)	**5.87** (5.07-6.52)	**6.93** (5.91-7.72)	**7.84** (6.60-8.75)
12-hr	**2.20** (1.98-2.48)	**2.65** (2.38-2.99)	**3.35** (3.00-3.76)	**3.95** (3.51-4.42)	**4.85** (4.28-5.41)	**5.63** (4.92-6.29)	**6.52** (5.64-7.26)	**7.50** (6.42-8.37)	**9.01** (7.57-10.1)	**10.3** (8.54-11.6)
24-hr	**2.51** (2.30-2.77)	**3.03** (2.78-3.35)	**3.88** (3.55-4.28)	**4.62** (4.21-5.08)	**5.75** (5.20-6.29)	**6.74** (6.05-7.36)	**7.86** (6.99-8.55)	**9.12** (8.01-9.90)	**11.1** (9.56-12.0)	**12.7** (10.9-13.8)
2-day	**2.92** (2.68-3.21)	**3.52** (3.23-3.88)	**4.49** (4.11-4.94)	**5.32** (4.85-5.85)	**6.55** (5.94-7.19)	**7.63** (6.86-8.36)	**8.81** (7.87-9.65)	**10.1** (8.95-11.1)	**12.1** (10.5-13.3)	**13.8** (11.9-15.1)
3-day	**3.09** (2.84-3.39)	**3.73** (3.43-4.10)	**4.75** (4.36-5.22)	**5.62** (5.14-6.17)	**6.92** (6.29-7.57)	**8.05** (7.26-8.79)	**9.29** (8.31-10.1)	**10.7** (9.45-11.6)	**12.7** (11.1-13.9)	**14.5** (12.5-15.9)
4-day	**3.27** (3.00-3.58)	**3.94** (3.63-4.32)	**5.01** (4.60-5.49)	**5.93** (5.42-6.48)	**7.29** (6.63-7.95)	**8.47** (7.65-9.22)	**9.77** (8.75-10.6)	**11.2** (9.95-12.2)	**13.4** (11.7-14.5)	**15.2** (13.2-16.6)
7-day	**3.79** (3.50-4.12)	**4.56** (4.21-4.95)	**5.73** (5.29-6.22)	**6.73** (6.19-7.29)	**8.20** (7.50-8.87)	**9.46** (8.61-10.2)	**10.8** (9.78-11.7)	**12.4** (11.1-13.3)	**14.6** (12.9-15.8)	**16.5** (14.4-17.9)
10-day	**4.33** (4.02-4.69)	**5.20** (4.82-5.63)	**6.45** (5.98-6.98)	**7.50** (6.92-8.10)	**9.00** (8.28-9.71)	**10.3** (9.39-11.1)	**11.6** (10.5-12.5)	**13.0** (11.8-14.1)	**15.1** (13.5-16.3)	**16.9** (14.9-18.3)
20-day	**5.86** (5.48-6.28)	**6.96** (6.51-7.46)	**8.37** (7.83-8.97)	**9.50** (8.87-10.2)	**11.1** (10.3-11.8)	**12.3** (11.4-13.2)	**13.6** (12.6-14.6)	**15.0** (13.7-16.0)	**16.8** (15.3-18.0)	**18.3** (16.5-19.6)
30-day	**7.21** (6.81-7.67)	**8.52** (8.04-9.06)	**10.1** (9.50-10.7)	**11.3** (10.7-12.0)	**13.0** (12.2-13.8)	**14.4** (13.4-15.3)	**15.7** (14.7-16.7)	**17.1** (15.9-18.2)	**19.0** (17.5-20.2)	**20.4** (18.7-21.8)
45-day	**9.05** (8.57-9.56)	**10.7** (10.1-11.3)	**12.4** (11.7-13.1)	**13.7** (13.0-14.5)	**15.5** (14.6-16.3)	**16.8** (15.8-17.7)	**18.1** (17.0-19.1)	**19.3** (18.1-20.4)	**20.9** (19.5-22.2)	**22.1** (20.6-23.5)
60-day	**10.8** (10.3-11.4)	**12.7** (12.0-13.3)	**14.6** (13.8-15.3)	**16.0** (15.2-16.9)	**17.9** (16.9-18.8)	**19.2** (18.1-20.2)	**20.5** (19.3-21.6)	**21.7** (20.4-22.9)	**23.3** (21.8-24.5)	**24.4** (22.7-25.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

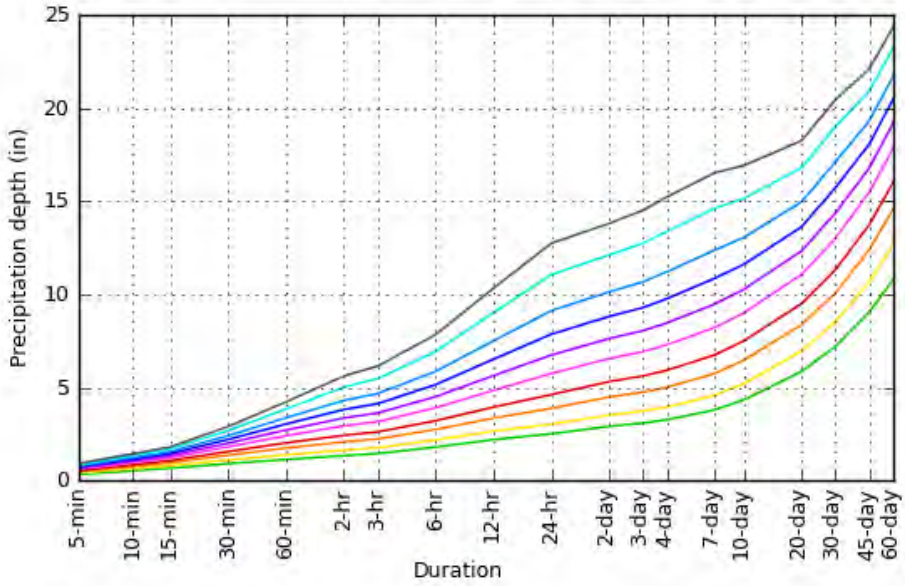
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

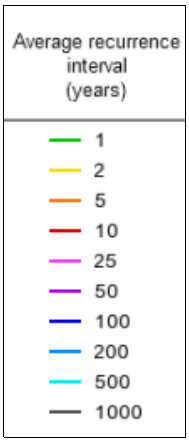
Please refer to NOAA Atlas 14 document for more information.

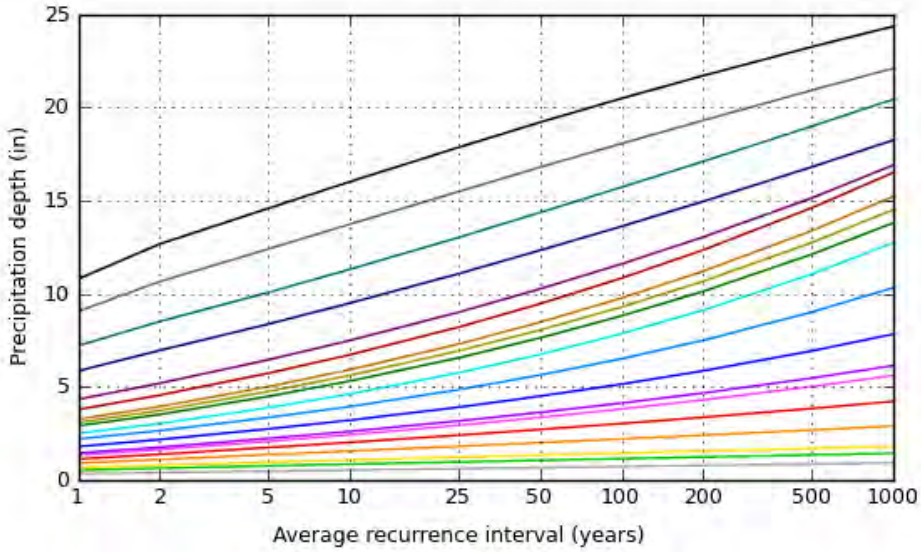
Back to Top

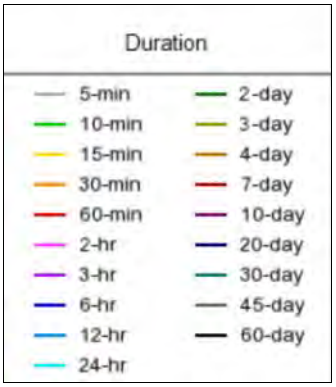
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 39.2084°, Longitude: -77.4605°









NOAA Atlas 14, Volume 2, Version 3 Created (GMT): Sun May 25 13:29:58 2014

Back to Top

Maps & aerials

Small scale terrain

Large scale terrain

Large scale map

Large scale aerial

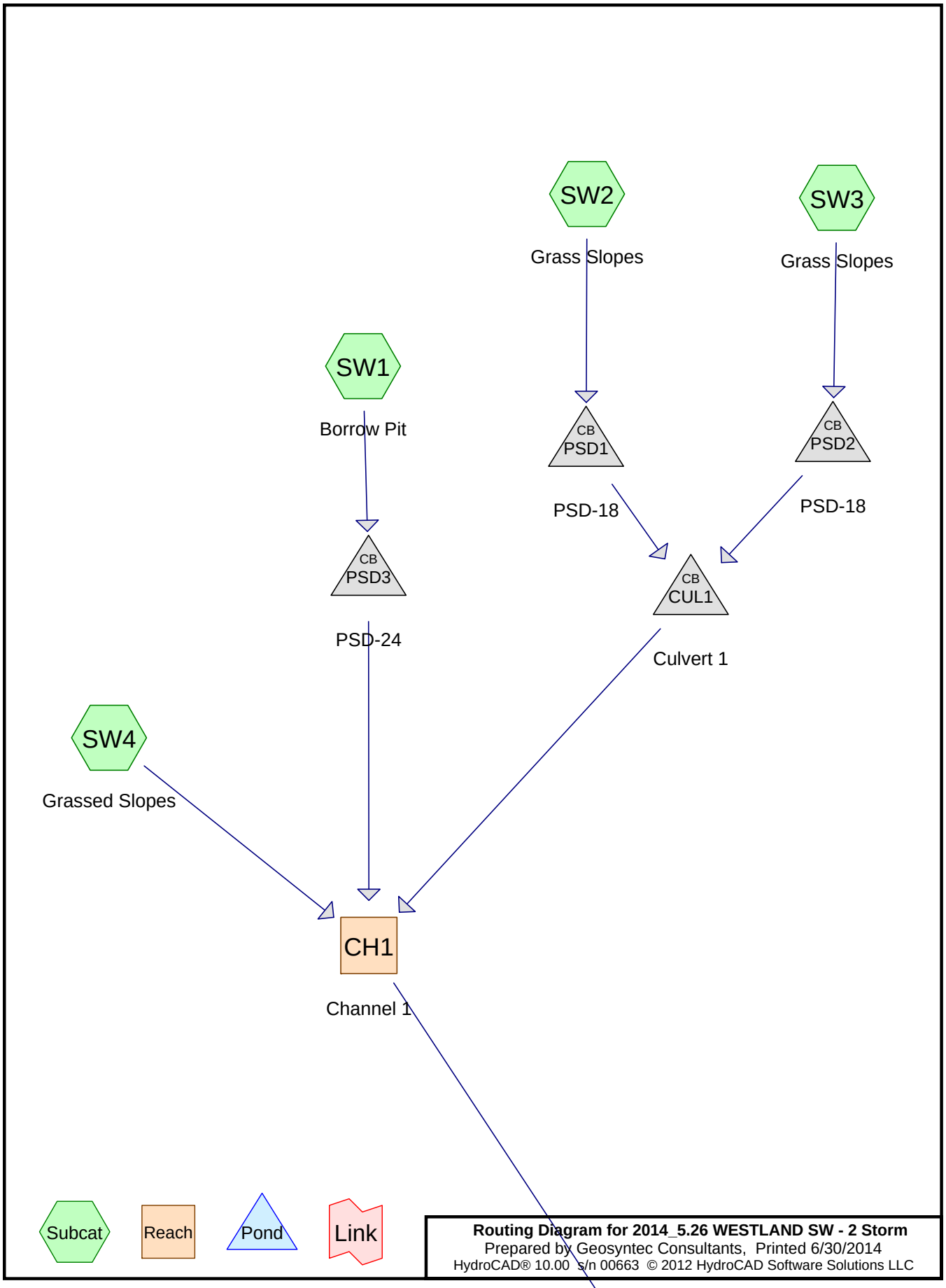
Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

ATTACHMENT 2.1

NON-CONTACT WATER DESIGN ANALYSIS OUTPUT


SW2
Grass Slopes
SW3
Grass Slopes
SW1
Borrow Pit
CB
PSD1
CB
PSD2
PSD-18
PSD-18
CB
PSD3
CB
CUL1
PSD-24
Culvert 1
SW4
Grassed Slopes
CH1
Channel 1
Subcat
Reach
Pond
Link
Routing Diagram for 2014_5.26 WESTLAND SW - 2 Storm
Prepared by Geosyntec Consultants, Printed 6/30/2014
HydroCAD® 10.00 s/n 00663 © 2012 HydroCAD Software Solutions LLC

Time span=1.00-96.00 hrs, dt=0.05 hrs, 1901 points x 2
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SW1: Borrow Pit Runoff Area=151,635 sf 0.00% Impervious Runoff Depth=4.28"
Tc=6.0 min CN=87 Runoff=24.34 cfs 1.241 af

Subcatchment SW2: Grass Slopes Runoff Area=0.634 ac 0.00% Impervious Runoff Depth=2.98"
Tc=6.0 min CN=74 Runoff=3.24 cfs 0.157 af

Subcatchment SW3: Grass Slopes Runoff Area=0.522 ac 0.00% Impervious Runoff Depth=2.98"
Tc=6.0 min CN=74 Runoff=2.67 cfs 0.129 af

Subcatchment SW4: Grassed Slopes Runoff Area=3.364 ac 0.00% Impervious Runoff Depth=2.98"
Tc=6.0 min CN=74 Runoff=17.21 cfs 0.834 af

Reach CH1: Channel 1 Avg. Flow Depth=1.15' Max Vel=3.36 fps Inflow=47.11 cfs 2.361 af
n=0.040 L=625.0' S=0.0100 '/' Capacity=127.43 cfs Outflow=44.26 cfs 2.361 af

Pond CUL1: Culvert 1 Peak Elev=359.14' Inflow=5.91 cfs 0.287 af
24.0" Round Culvert n=0.015 L=50.0' S=0.2000 '/' Outflow=5.91 cfs 0.287 af

Pond PSD1: PSD-18 Peak Elev=403.92' Inflow=3.24 cfs 0.157 af
18.0" Round Culvert n=0.020 L=100.0' S=0.4300 '/' Outflow=3.24 cfs 0.157 af

Pond PSD2: PSD-18 Peak Elev=400.82' Inflow=2.67 cfs 0.129 af
18.0" Round Culvert n=0.020 L=160.0' S=0.2500 '/' Outflow=2.67 cfs 0.129 af

Pond PSD3: PSD-24 Peak Elev=350.21' Inflow=24.34 cfs 1.241 af
24.0" Round Culvert x 2.00 n=0.020 L=100.0' S=0.2500 '/' Outflow=23.99 cfs 1.240 af

Summary for Subcatchment SW1: Borrow Pit

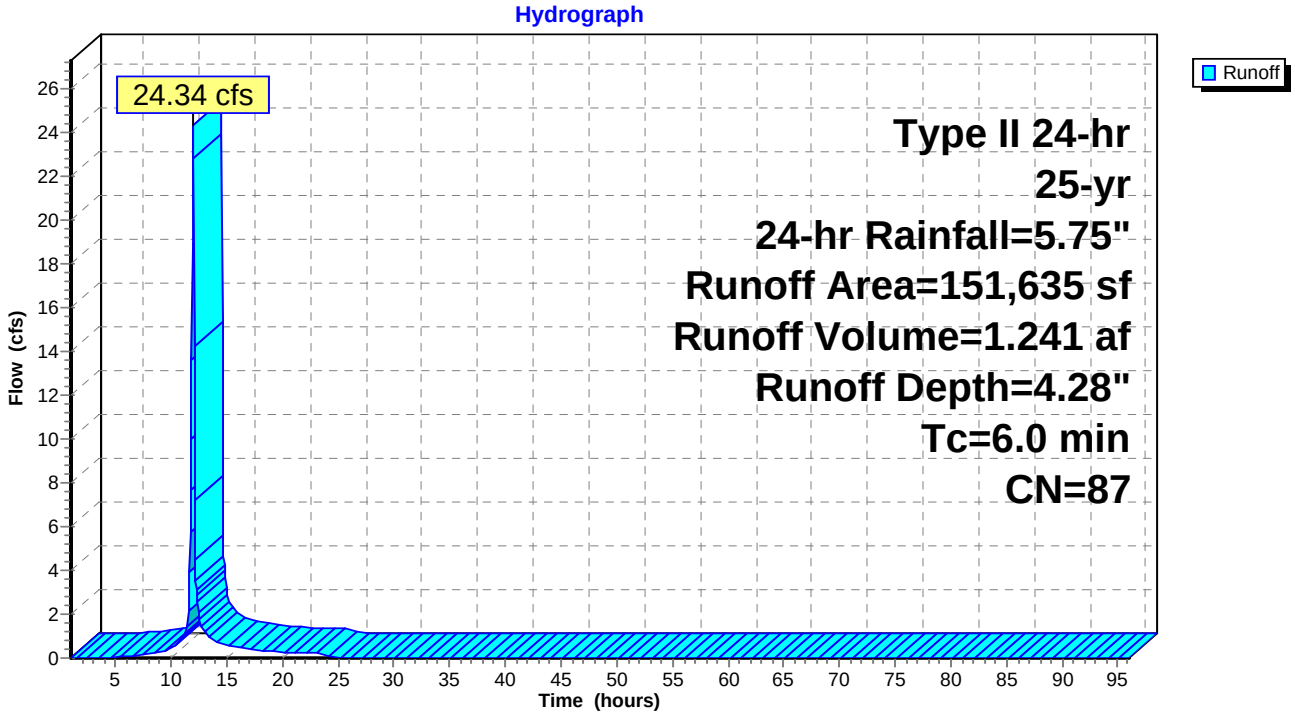
Runoff = 24.34 cfs @ 11.97 hrs, Volume= 1.241 af, Depth= 4.28"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.75"

Area (sf)	CN	Description
53,893	79	50-75% Grass cover, Fair, HSG C
97,742	91	Newly graded area, HSG C
151,635	87	Weighted Average
151,635		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment SW1: Borrow Pit



Summary for Subcatchment SW2: Grass Slopes

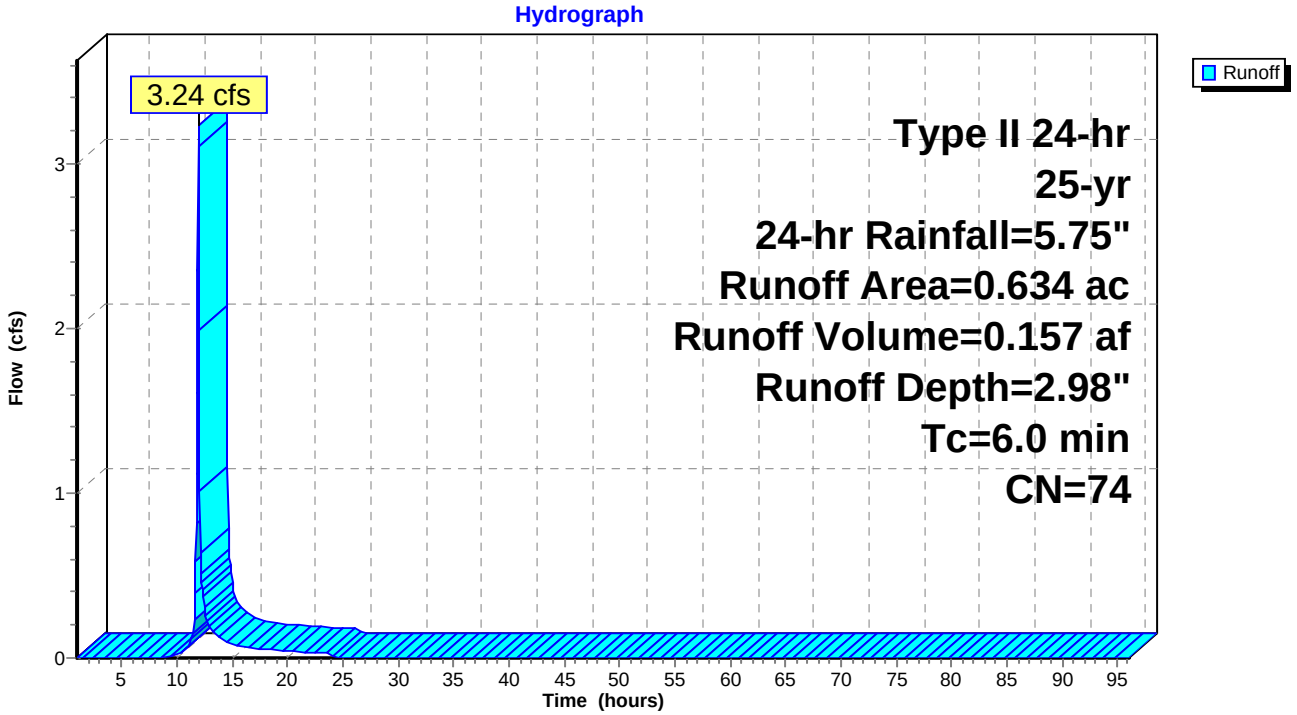
Runoff = 3.24 cfs @ 11.97 hrs, Volume= 0.157 af, Depth= 2.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.75"

Area (ac)	CN	Description
0.634	74	>75% Grass cover, Good, HSG C
0.634		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment SW2: Grass Slopes



Summary for Subcatchment SW3: Grass Slopes

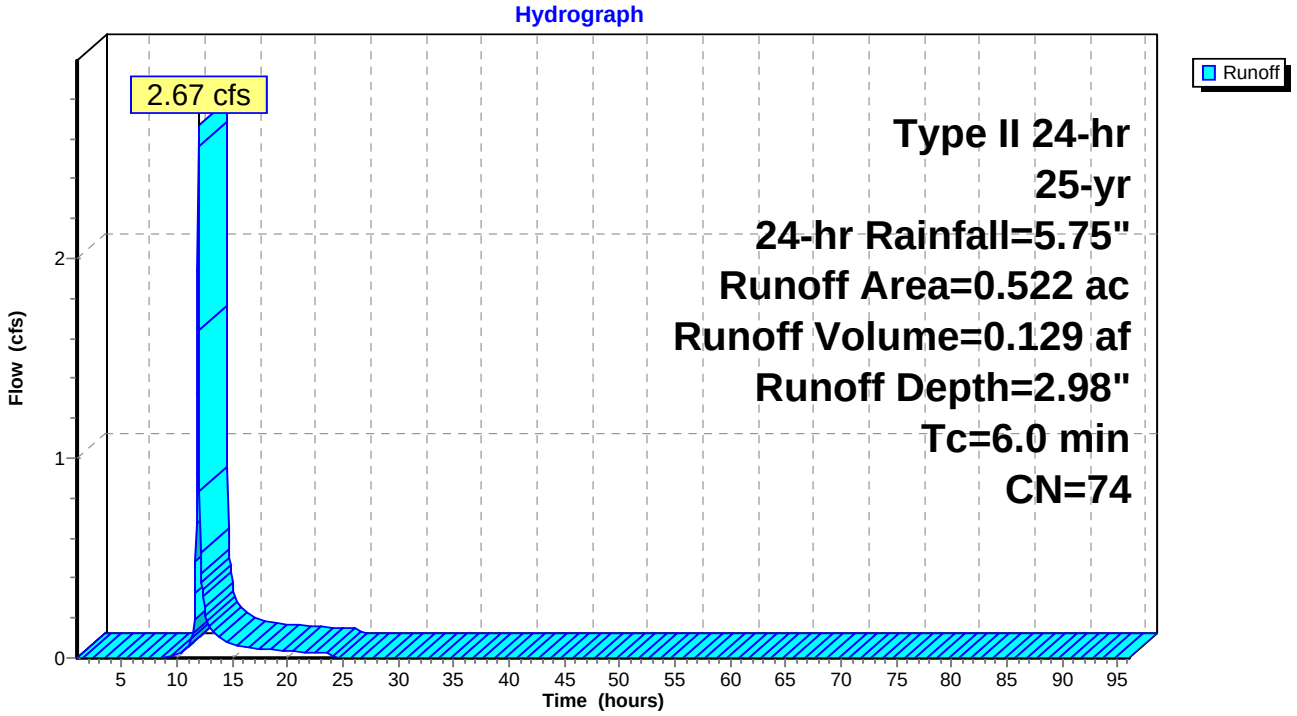
Runoff = 2.67 cfs @ 11.97 hrs, Volume= 0.129 af, Depth= 2.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.75"

Area (ac)	CN	Description
0.522	74	>75% Grass cover, Good, HSG C
0.522		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment SW3: Grass Slopes



Summary for Subcatchment SW4: Grassed Slopes

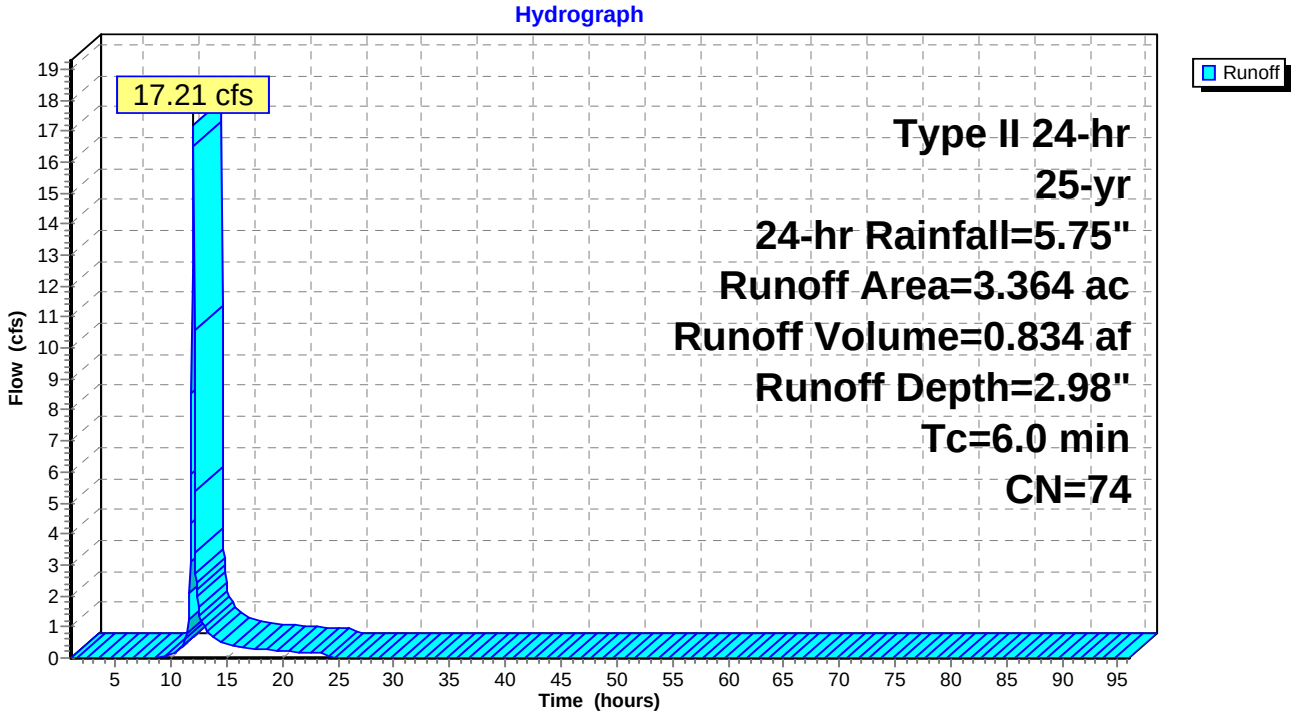
Runoff = 17.21 cfs @ 11.97 hrs, Volume= 0.834 af, Depth= 2.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.75"

Area (ac)	CN	Description
3.364	74	>75% Grass cover, Good, HSG C
3.364		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment SW4: Grassed Slopes



Summary for Reach CH1: Channel 1

Inflow Area = 8.001 ac, 0.00% Impervious, Inflow Depth = 3.54" for 25-yr, 24-hr event
Inflow = 47.11 cfs @ 11.97 hrs, Volume= 2.361 af
Outflow = 44.26 cfs @ 12.00 hrs, Volume= 2.361 af, Atten= 6%, Lag= 1.7 min

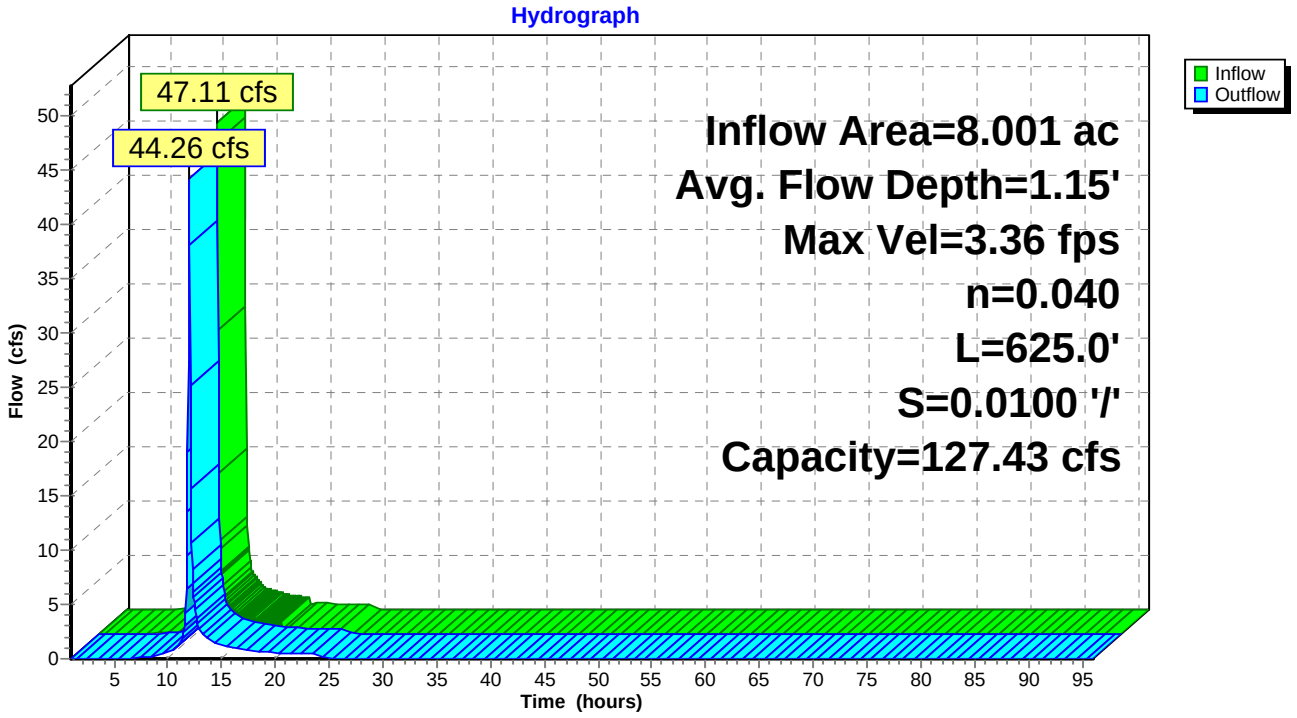
Routing by Dyn-Stor-Ind method, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs / 2
Max. Velocity= 3.36 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 14.8 min

Peak Storage= 8,223 cf @ 12.00 hrs
Average Depth at Peak Storage= 1.15'
Bank-Full Depth= 2.00' Flow Area= 28.0 sf, Capacity= 127.43 cfs

8.00' x 2.00' deep channel, n= 0.040 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 20.00'
Length= 625.0' Slope= 0.0100 '/'
Inlet Invert= 348.00', Outlet Invert= 341.75'

‡

Reach CH1: Channel 1



Summary for Pond CUL1: Culvert 1

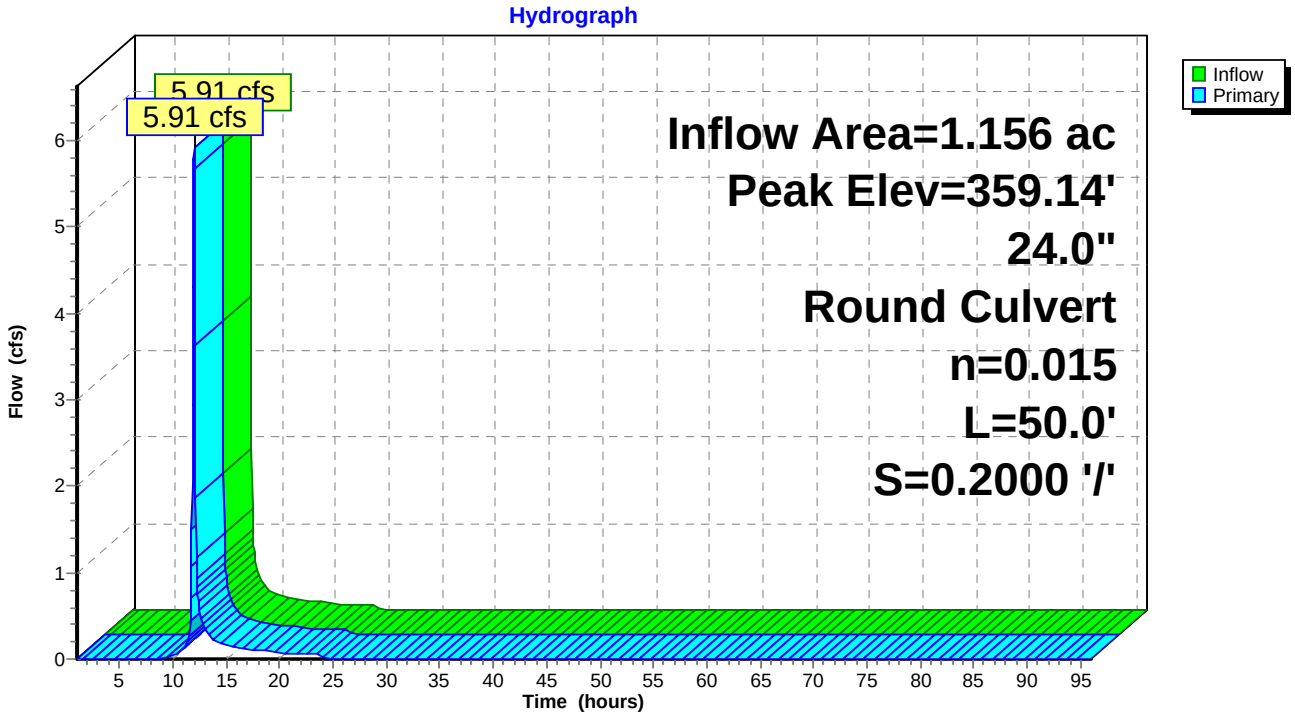
Inflow Area = 1.156 ac, 0.00% Impervious, Inflow Depth = 2.98" for 25-yr, 24-hr event
Inflow = 5.91 cfs @ 11.97 hrs, Volume= 0.287 af
Outflow = 5.91 cfs @ 11.97 hrs, Volume= 0.287 af, Atten= 0%, Lag= 0.0 min
Primary = 5.91 cfs @ 11.97 hrs, Volume= 0.287 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 359.14' @ 11.97 hrs
Flood Elev= 362.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	358.00'	**24.0" Round Culvert** L= 50.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 358.00' / 348.00' S= 0.2000 '/' Cc= 0.900 n= 0.015 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=5.72 cfs @ 11.97 hrs HW=359.12' TW=349.10' (Dynamic Tailwater)
1=Culvert (Inlet Controls 5.72 cfs @ 3.17 fps)

Pond CUL1: Culvert 1



Summary for Pond PSD1: PSD-18

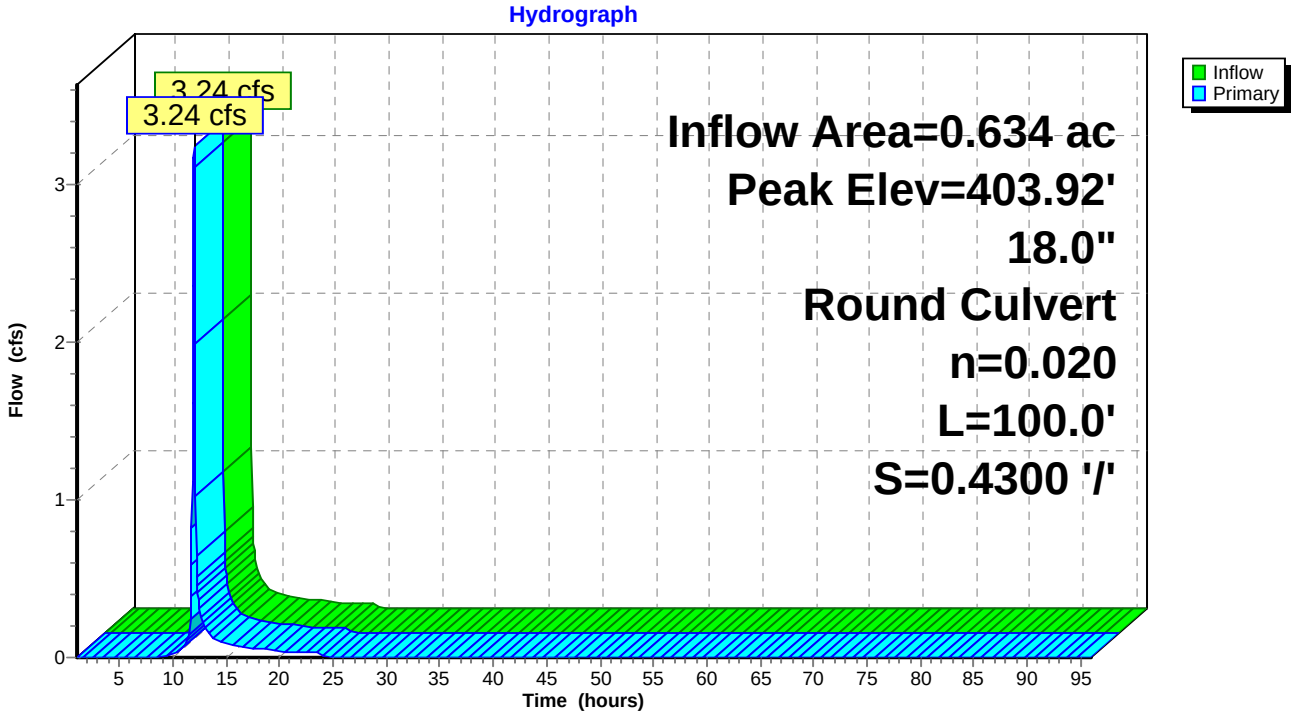
Inflow Area = 0.634 ac, 0.00% Impervious, Inflow Depth = 2.98" for 25-yr, 24-hr event
Inflow = 3.24 cfs @ 11.97 hrs, Volume= 0.157 af
Outflow = 3.24 cfs @ 11.97 hrs, Volume= 0.157 af, Atten= 0%, Lag= 0.0 min
Primary = 3.24 cfs @ 11.97 hrs, Volume= 0.157 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 403.92' @ 11.97 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	403.00'	**18.0" Round Culvert** L= 100.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 403.00' / 360.00' S= 0.4300 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.77 sf

Primary OutFlow Max=3.14 cfs @ 11.97 hrs HW=403.90' TW=359.12' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 3.14 cfs @ 2.85 fps)

Pond PSD1: PSD-18



Summary for Pond PSD2: PSD-18

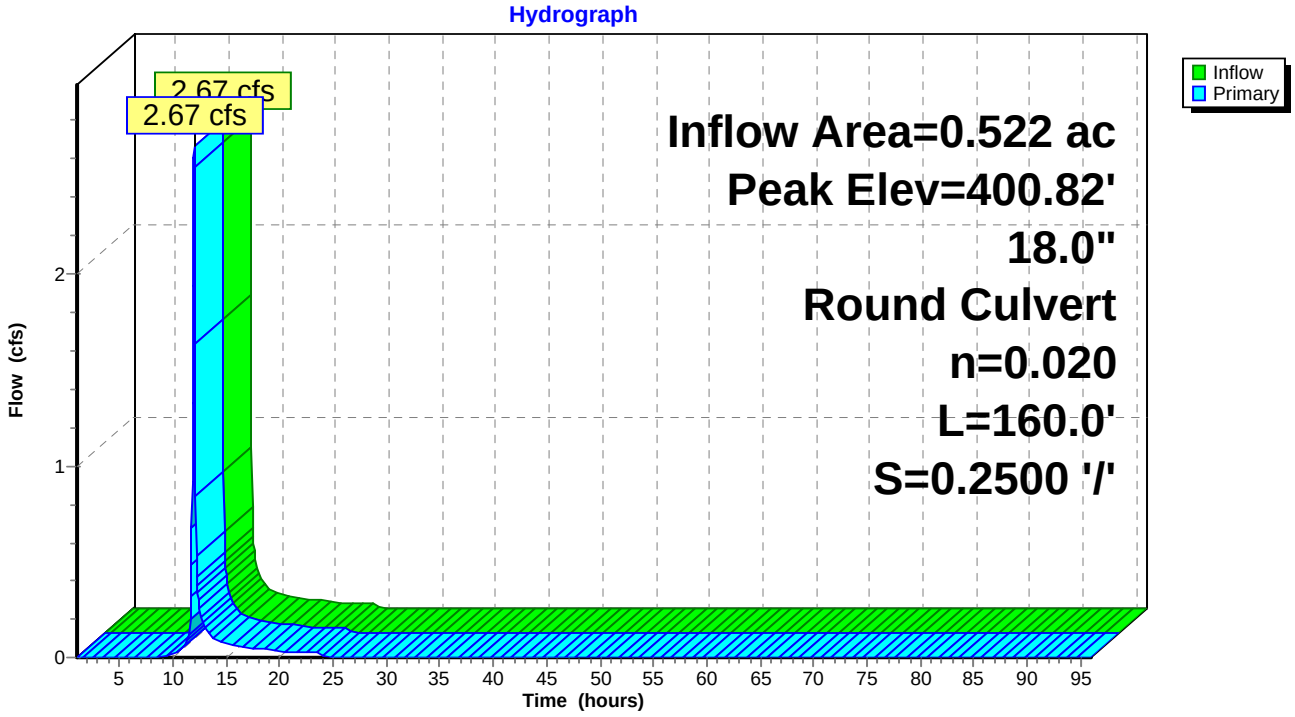
Inflow Area = 0.522 ac, 0.00% Impervious, Inflow Depth = 2.98" for 25-yr, 24-hr event
Inflow = 2.67 cfs @ 11.97 hrs, Volume= 0.129 af
Outflow = 2.67 cfs @ 11.97 hrs, Volume= 0.129 af, Atten= 0%, Lag= 0.0 min
Primary = 2.67 cfs @ 11.97 hrs, Volume= 0.129 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 400.82' @ 11.97 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	400.00'	**18.0" Round Culvert** L= 160.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 400.00' / 360.00' S= 0.2500 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.77 sf

Primary OutFlow Max=2.58 cfs @ 11.97 hrs HW=400.80' TW=359.12' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.58 cfs @ 2.69 fps)

Pond PSD2: PSD-18



Summary for Pond PSD3: PSD-24

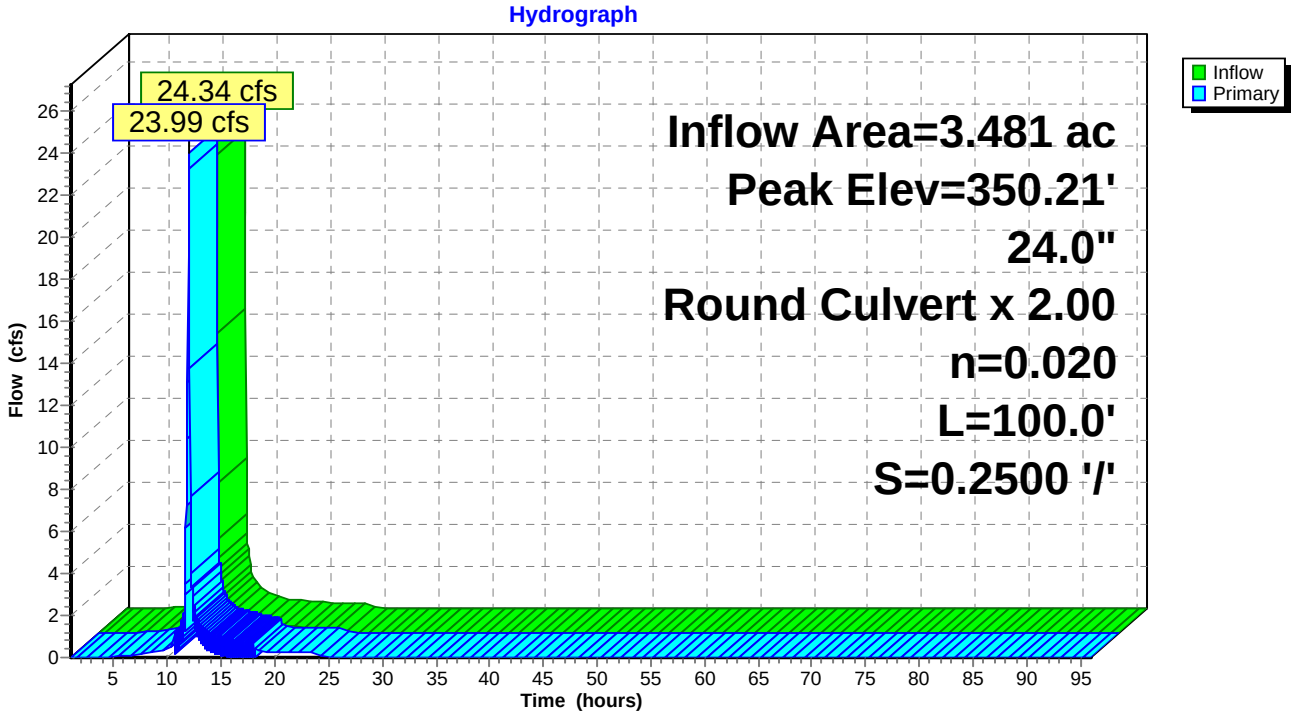
Inflow Area = 3.481 ac, 0.00% Impervious, Inflow Depth = 4.28" for 25-yr, 24-hr event
Inflow = 24.34 cfs @ 11.97 hrs, Volume= 1.241 af
Outflow = 23.99 cfs @ 11.97 hrs, Volume= 1.240 af, Atten= 1%, Lag= 0.4 min
Primary = 23.99 cfs @ 11.97 hrs, Volume= 1.240 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-96.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 350.21' @ 11.98 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**24.0" Round Culvert X 2.00** L= 100.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 0.00' / -25.00' S= 0.2500 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 3.14 sf

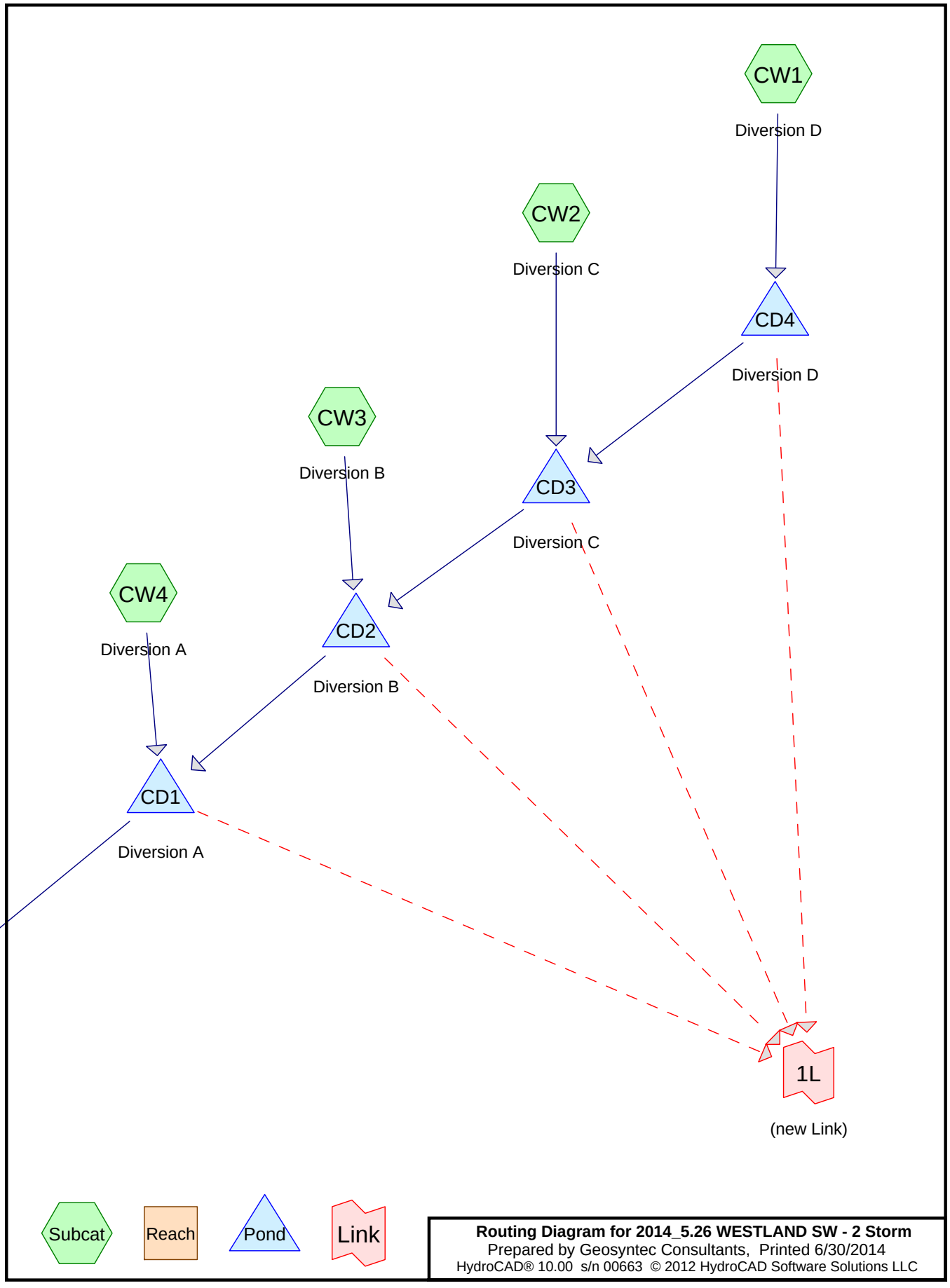
Primary OutFlow Max=23.43 cfs @ 11.97 hrs HW=350.10' TW=349.10' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 23.43 cfs @ 3.73 fps)

Pond PSD3: PSD-24



ATTACHMENT 2.2

CONTACT WATER DESIGN ANALYSIS OUTPUT



Routing Diagram for 2014_5.26 WESTLAND SW - 2 Storm
Prepared by Geosyntec Consultants, Printed 6/30/2014

Comparison Report

Node	Inflow (cfs)	Primary (cfs)	Secondary (cfs)	Total (cfs)	Elevation (feet)	Storage (acre-feet)
Pond CD1	28.69	0.00	**0.50**	0.50	320.58	1.161
Pond CD2	54.26	0.00	0.50	0.50	331.81	**4.003**
Pond CD3	33.59	9.10	0.50	9.60	358.69	1.363
Pond CD4	**57.36**	**13.80**	0.50	**14.30**	**367.91**	2.060

Time span=1.00-112.00 hrs, dt=0.05 hrs, 2221 points x 2
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment CW1: Diversion D Runoff Area=267,531 sf 0.00% Impervious Runoff Depth>4.13"
Tc=6.0 min CN=91 Runoff=57.36 cfs 2.112 af

Subcatchment CW2: Diversion C Runoff Area=3.065 ac 0.00% Impervious Runoff Depth>4.13"
Tc=6.0 min CN=91 Runoff=28.63 cfs 1.054 af

Subcatchment CW3: Diversion B Runoff Area=6.384 ac 0.00% Impervious Runoff Depth=3.61"
Tc=6.0 min CN=86 Runoff=54.26 cfs 1.919 af

Subcatchment CW4: Diversion A Runoff Area=5.791 ac 0.00% Impervious Runoff Depth=2.75"
Tc=15.0 min CN=77 Runoff=28.69 cfs 1.327 af

Pond CD1: Diversion A Peak Elev=320.58' Storage=50,571 cf Inflow=28.69 cfs 1.327 af
Primary=0.00 cfs 0.000 af Secondary=0.50 cfs 1.327 af Outflow=0.50 cfs 1.327 af

Pond CD2: Diversion B Peak Elev=331.81' Storage=174,365 cf Inflow=54.26 cfs 3.176 af
Primary=0.00 cfs 0.000 af Secondary=0.50 cfs 4.260 af Outflow=0.50 cfs 4.260 af

Pond CD3: Diversion C Peak Elev=358.69' Storage=59,366 cf Inflow=33.59 cfs 2.213 af
Primary=9.10 cfs 1.257 af Secondary=0.50 cfs 1.305 af Outflow=9.60 cfs 2.562 af

Pond CD4: Diversion D Peak Elev=367.91' Storage=89,750 cf Inflow=57.36 cfs 2.112 af
Primary=13.80 cfs 1.159 af Secondary=0.50 cfs 1.806 af Outflow=14.30 cfs 2.965 af

Link 1L: (new Link) Inflow=2.00 cfs 8.698 af
Primary=2.00 cfs 8.698 af

Summary for Subcatchment CW1: Diversion D

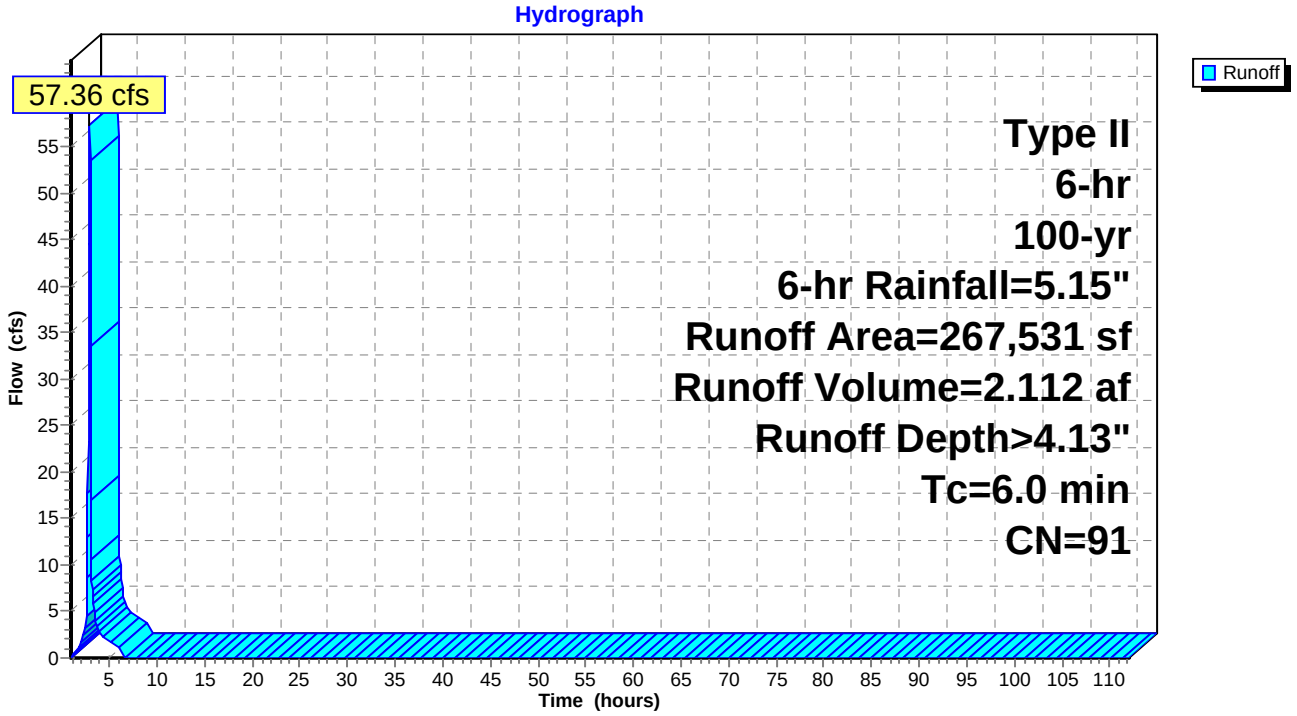
Runoff = 57.36 cfs @ 2.96 hrs, Volume= 2.112 af, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-yr, 6-hr Rainfall=5.15"

Area (sf)	CN	Description
267,531	91	Newly graded area, HSG C
267,531		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment CW1: Diversion D



Summary for Subcatchment CW2: Diversion C

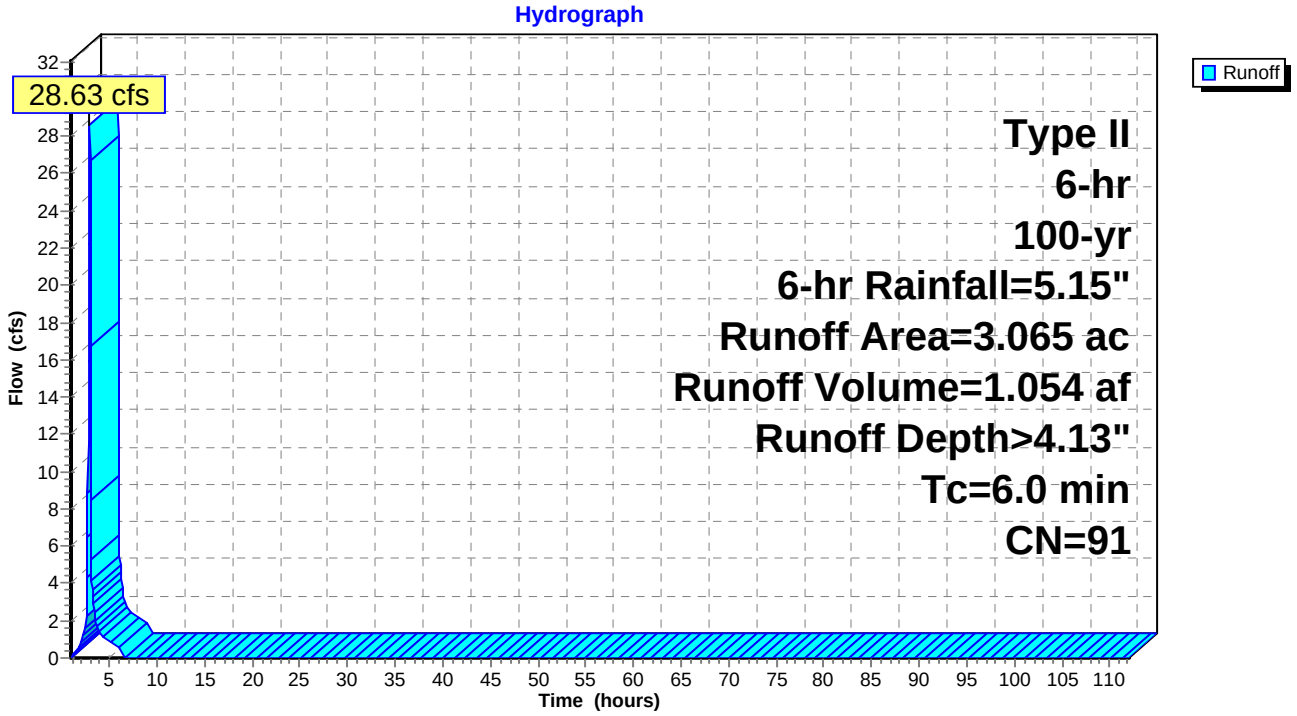
Runoff = 28.63 cfs @ 2.96 hrs, Volume= 1.054 af, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-yr, 6-hr Rainfall=5.15"

Area (ac)	CN	Description
3.065	91	Newly graded area, HSG C
3.065		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment CW2: Diversion C



Summary for Subcatchment CW3: Diversion B

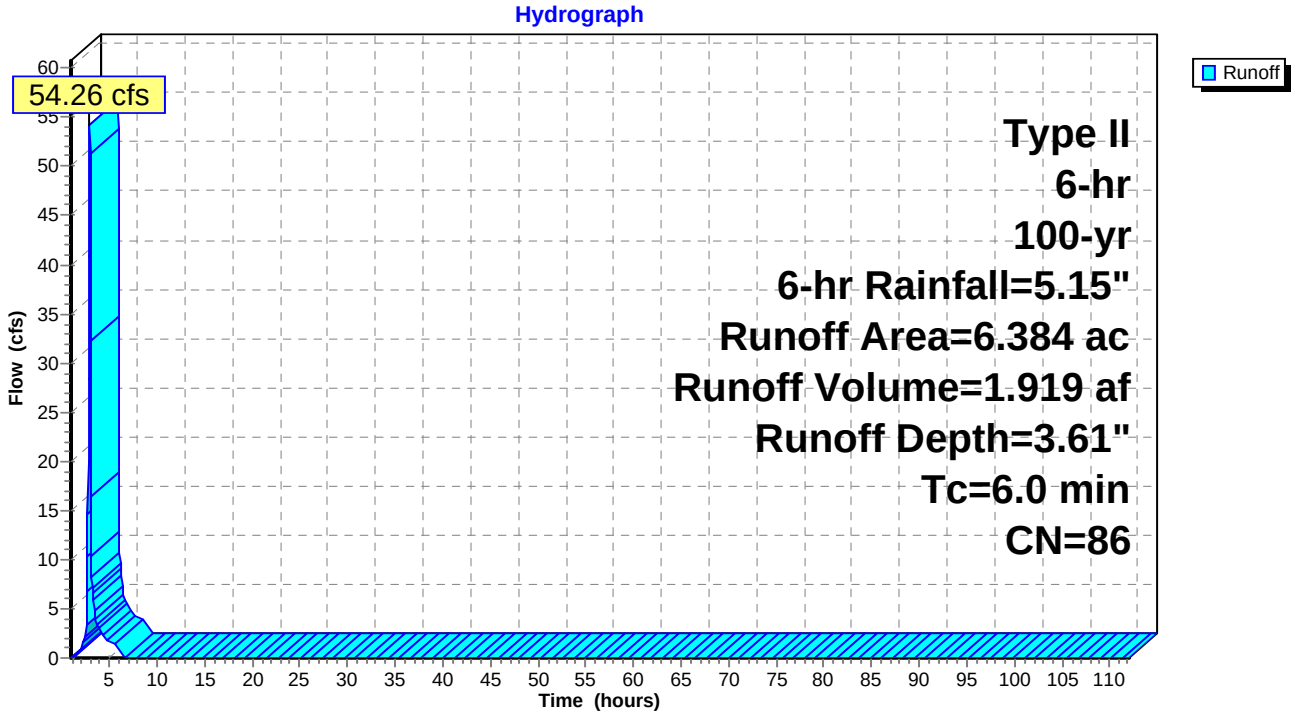
Runoff = 54.26 cfs @ 2.97 hrs, Volume= 1.919 af, Depth= 3.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-yr, 6-hr Rainfall=5.15"

Area (ac)	CN	Description
6.384	86	Newly graded area, HSG B
6.384		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment CW3: Diversion B



Summary for Subcatchment CW4: Diversion A

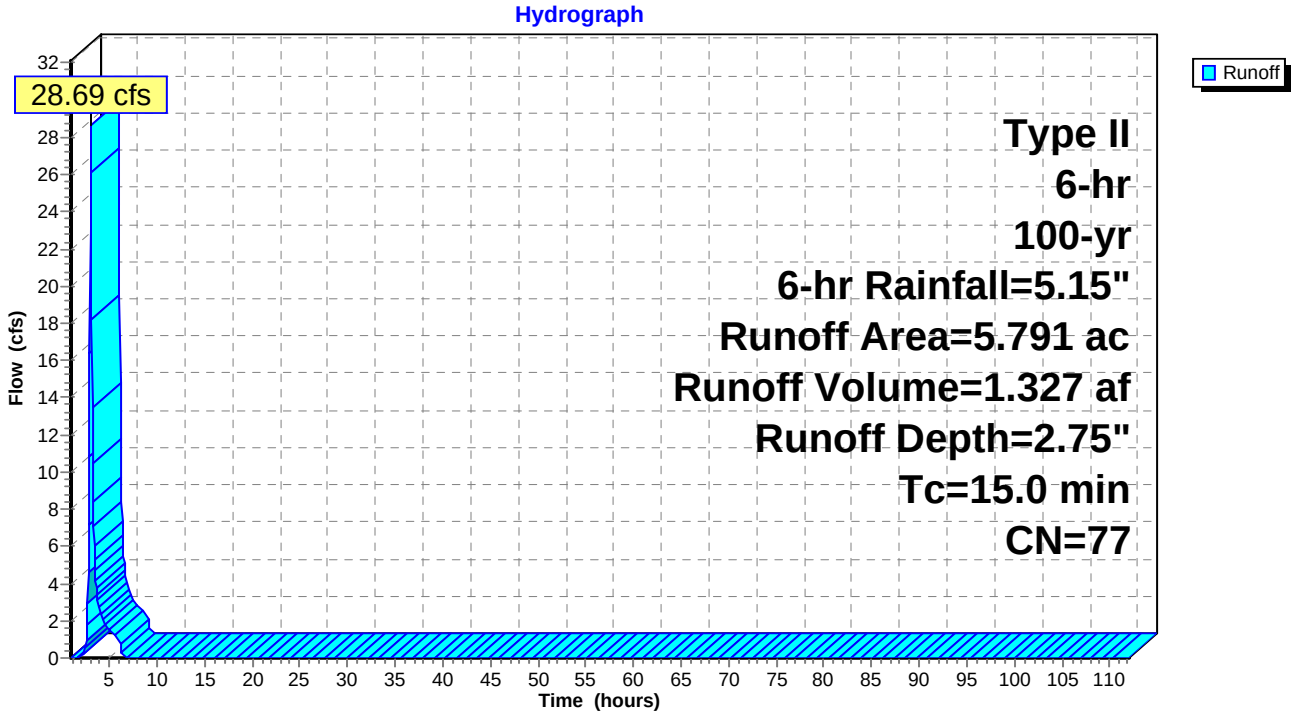
Runoff = 28.69 cfs @ 3.08 hrs, Volume= 1.327 af, Depth= 2.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs
Type II 6-hr 100-yr, 6-hr Rainfall=5.15"

Area (ac)	CN	Description
5.791	77	Newly graded area, HSG A
5.791		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry,**

Subcatchment CW4: Diversion A



Summary for Pond CD1: Diversion A

Inflow Area = 21.382 ac, 0.00% Impervious, Inflow Depth = 0.74" for 100-yr, 6-hr event
Inflow = 28.69 cfs @ 3.08 hrs, Volume= 1.327 af
Outflow = 0.50 cfs @ 2.70 hrs, Volume= 1.327 af, Atten= 98%, Lag= 0.0 min
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Secondary = 0.50 cfs @ 2.70 hrs, Volume= 1.327 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 320.58' @ 6.22 hrs Surf.Area= 17,096 sf Storage= 50,571 cf
Flood Elev= 321.00' Surf.Area= 17,096 sf Storage= 57,700 cf

Plug-Flow detention time= 888.4 min calculated for 1.326 af (100% of inflow)
Center-of-Mass det. time= 888.7 min (1,102.2 - 213.5)

Volume	Invert	Avail.Storage	Storage Description
#1	316.00'	57,700 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

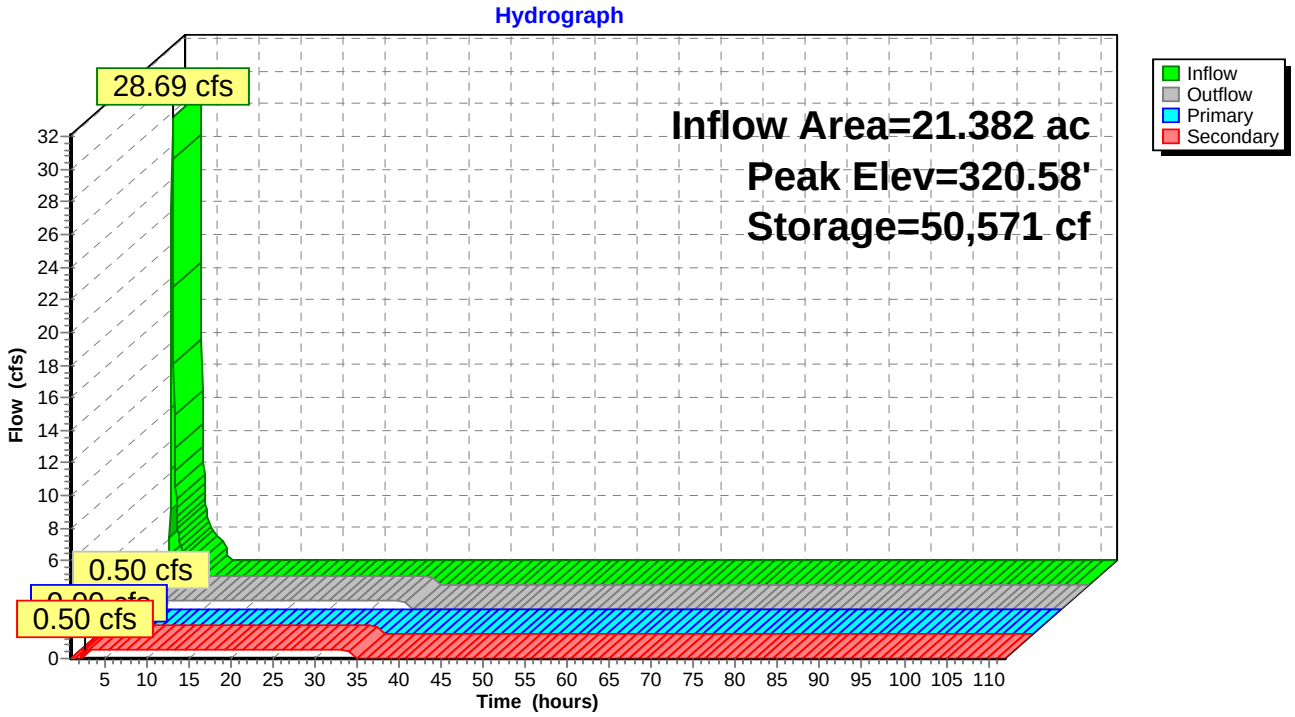
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
316.00	4,008	0	0
318.00	9,750	13,758	13,758
320.00	17,096	26,846	40,604
321.00	17,096	17,096	57,700

Device	Routing	Invert	Outlet Devices
#1	Secondary	316.00'	**0.50 cfs Exfiltration when above 316.00'**
#2	Primary	320.75'	**6.0' long (Profile 18) Broad-Crested Rectangular Weir**
			Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 3.94
			Coef. (English) 2.61 2.64 2.81 2.83 3.06 3.19 3.33

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=316.00' TW=300.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.50 cfs @ 2.70 hrs HW=316.08' TW=0.00' (Dynamic Tailwater)
↑—**1=Exfiltration** (Exfiltration Controls 0.50 cfs)

Pond CD1: Diversion A



Summary for Pond CD2: Diversion B

Inflow Area = 15.591 ac, 0.00% Impervious, Inflow Depth = 2.44" for 100-yr, 6-hr event
Inflow = 54.26 cfs @ 2.97 hrs, Volume= 3.176 af
Outflow = 0.50 cfs @ 1.00 hrs, Volume= 4.260 af, Atten= 99%, Lag= 0.0 min
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Secondary = 0.50 cfs @ 1.00 hrs, Volume= 4.260 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs / 2
Starting Elev= 328.87' Surf.Area= 28,226 sf Storage= 47,166 cf
Peak Elev= 331.81' @ 6.86 hrs Surf.Area= 59,645 sf Storage= 174,365 cf (127,199 cf above start)
Flood Elev= 333.00' Surf.Area= 72,254 sf Storage= 252,655 cf (205,489 cf above start)

Plug-Flow detention time= 3,711.3 min calculated for 3.175 af (100% of inflow)
Center-of-Mass det. time= 2,927.2 min (3,151.5 - 224.3)

Volume	Invert	Avail.Storage	Storage Description
#1	326.00'	330,147 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

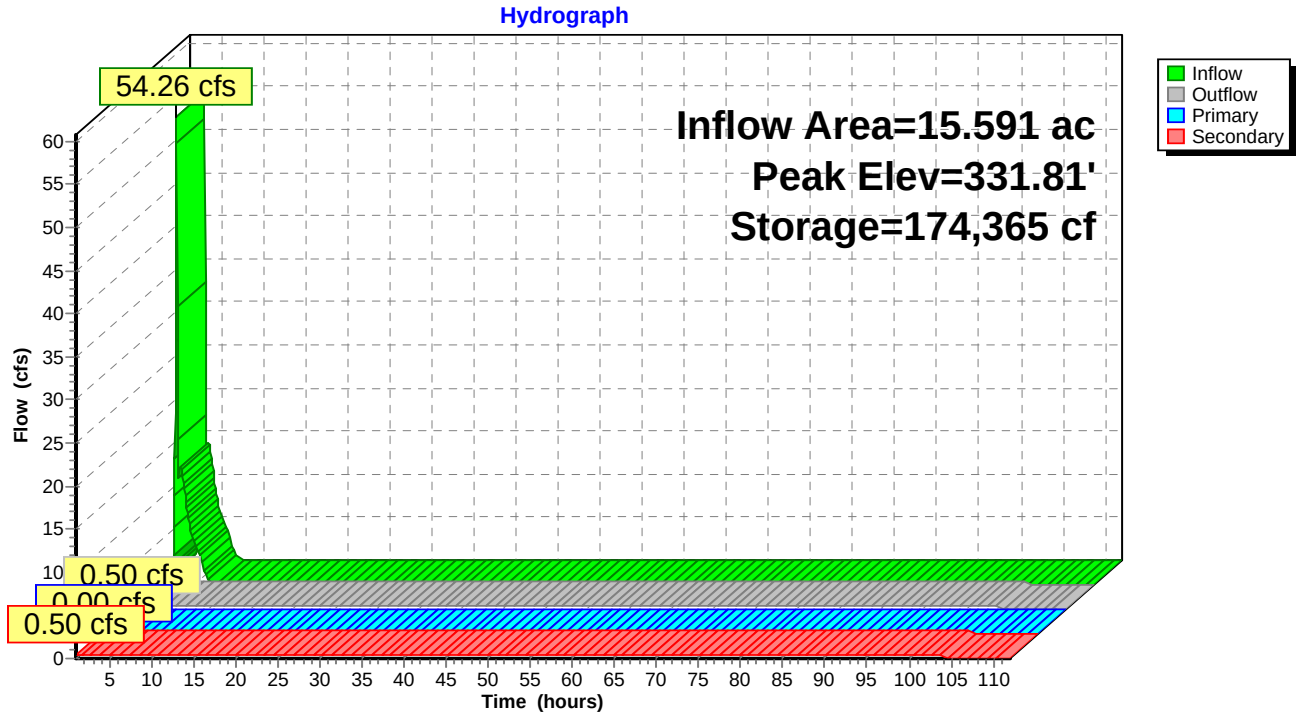
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
326.00	6,084	0	0
328.00	20,072	26,156	26,156
330.00	38,817	58,889	85,045
332.00	61,777	100,594	185,639
334.00	82,731	144,508	330,147

Device	Routing	Invert	Outlet Devices
#1	Secondary	326.00'	**0.50 cfs Exfiltration when above 326.00'**
#2	Primary	332.00'	**6.0' long (Profile 18) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 3.94 Coef. (English) 2.61 2.64 2.81 2.83 3.06 3.19 3.33

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=328.87' TW=316.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.50 cfs @ 1.00 hrs HW=328.87' TW=0.00' (Dynamic Tailwater)
↑—**1=Exfiltration** (Exfiltration Controls 0.50 cfs)

Pond CD2: Diversion B



Summary for Pond CD3: Diversion C

Inflow Area = 9.207 ac, 0.00% Impervious, Inflow Depth > 2.88" for 100-yr, 6-hr event
Inflow = 33.59 cfs @ 3.00 hrs, Volume= 2.213 af
Outflow = 9.60 cfs @ 3.58 hrs, Volume= 2.562 af, Atten= 71%, Lag= 35.1 min
Primary = 9.10 cfs @ 3.58 hrs, Volume= 1.257 af
Secondary = 0.50 cfs @ 1.00 hrs, Volume= 1.305 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs / 2
Starting Elev= 356.16' Surf.Area= 11,846 sf Storage= 15,116 cf
Peak Elev= 358.69' @ 3.58 hrs Surf.Area= 22,471 sf Storage= 59,366 cf (44,250 cf above start)
Flood Elev= 360.00' Surf.Area= 26,804 sf Storage= 91,539 cf (76,423 cf above start)

Plug-Flow detention time= 495.1 min calculated for 2.212 af (100% of inflow)
Center-of-Mass det. time= 424.2 min (641.4 - 217.2)

Volume	Invert	Avail.Storage	Storage Description
#1	354.00'	91,539 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

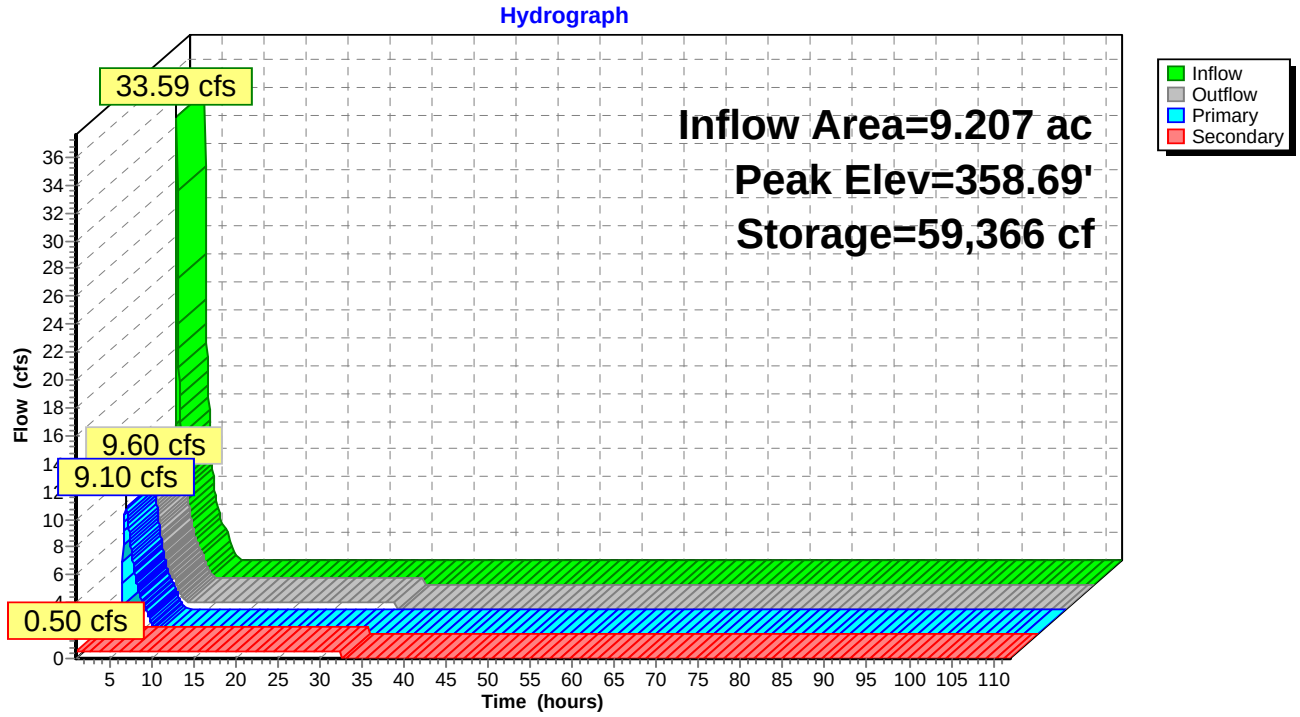
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
354.00	2,157	0	0
356.00	11,122	13,279	13,279
358.00	20,167	31,289	44,568
360.00	26,804	46,971	91,539

Device	Routing	Invert	Outlet Devices
#1	Secondary	354.00'	**0.50 cfs Exfiltration at all elevations**
#2	Primary	358.00'	**6.0' long (Profile 18) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 3.94 Coef. (English) 2.61 2.64 2.81 2.83 3.06 3.19 3.33

Primary OutFlow Max=9.09 cfs @ 3.58 hrs HW=358.69' TW=330.77' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Weir Controls 9.09 cfs @ 2.18 fps)

Secondary OutFlow Max=0.50 cfs @ 1.00 hrs HW=356.16' TW=0.00' (Dynamic Tailwater)
↑—**1=Exfiltration** (Exfiltration Controls 0.50 cfs)

Pond CD3: Diversion C



Summary for Pond CD4: Diversion D

Inflow Area = 6.142 ac, 0.00% Impervious, Inflow Depth > 4.13" for 100-yr, 6-hr event
Inflow = 57.36 cfs @ 2.96 hrs, Volume= 2.112 af
Outflow = 14.30 cfs @ 3.12 hrs, Volume= 2.965 af, Atten= 75%, Lag= 9.5 min
Primary = 13.80 cfs @ 3.12 hrs, Volume= 1.159 af
Secondary = 0.50 cfs @ 1.00 hrs, Volume= 1.806 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs / 2
Starting Elev= 365.81' Surf.Area= 24,237 sf Storage= 37,083 cf
Peak Elev= 367.91' @ 3.12 hrs Surf.Area= 25,077 sf Storage= 89,750 cf (52,667 cf above start)
Flood Elev= 369.00' Surf.Area= 25,077 sf Storage= 116,999 cf (79,916 cf above start)

Plug-Flow detention time= 1,026.7 min calculated for 2.112 af (100% of inflow)
Center-of-Mass det. time= 733.1 min (927.4 - 194.3)

Volume	Invert	Avail.Storage	Storage Description
#1	364.00'	142,076 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

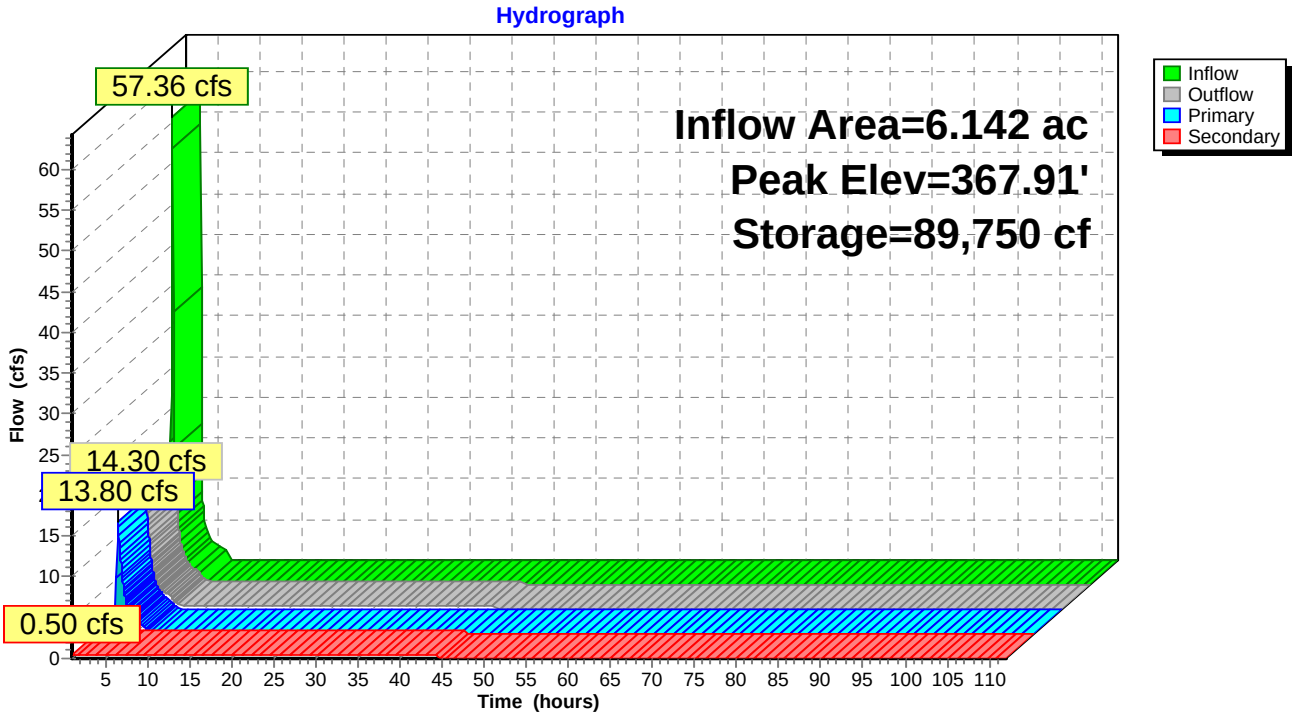
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
364.00	16,955	0	0	16,955
366.00	25,077	41,768	41,768	25,141
367.00	25,077	25,077	66,845	25,703
370.00	25,077	75,231	142,076	27,387

Device	Routing	Invert	Outlet Devices
#1	Primary	367.00'	**6.0' long (Profile 18) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 3.94 Coef. (English) 2.61 2.64 2.81 2.83 3.06 3.19 3.33
#2	Secondary	364.00'	**0.50 cfs Exfiltration when above 364.00'**

Primary OutFlow Max=13.55 cfs @ 3.12 hrs HW=367.90' TW=358.17' (Dynamic Tailwater)
↑└**1=Broad-Crested Rectangular Weir** (Weir Controls 13.55 cfs @ 2.50 fps)

Secondary OutFlow Max=0.50 cfs @ 1.00 hrs HW=365.81' TW=0.00' (Dynamic Tailwater)
↑└**2=Exfiltration** (Exfiltration Controls 0.50 cfs)

Pond CD4: Diversion D

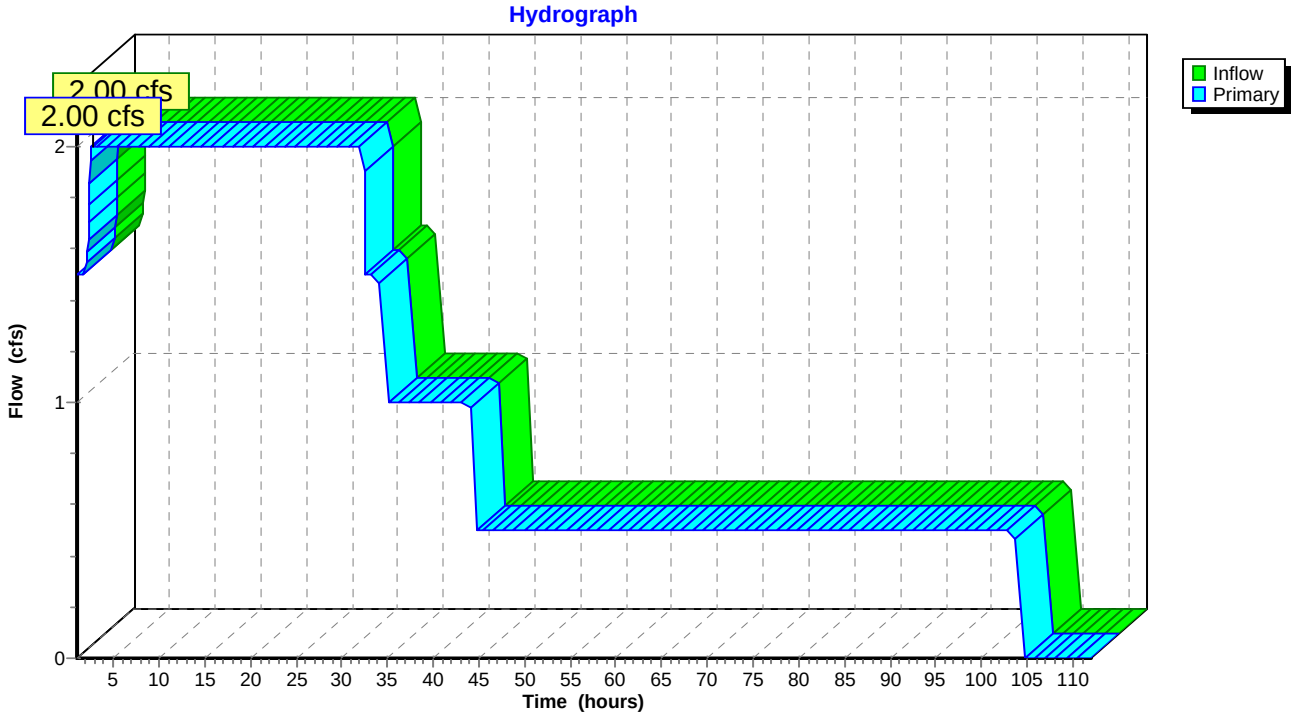


Summary for Link 1L: (new Link)

Inflow = 2.00 cfs @ 2.70 hrs, Volume= 8.698 af
Primary = 2.00 cfs @ 2.70 hrs, Volume= 8.698 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-112.00 hrs, dt= 0.05 hrs

Link 1L: (new Link)



Geosyntec
consultants

COMPUTATION COVER SHEET

Client: MD Ash **Project:** Westland **Project #:** MEM1106 **Task #:** 02

TITLE OF COMPUTATIONS **PIPE FLOW ANALYSIS**

COMPUTATIONS BY:
Signature
6/30/2014 DATE
Printed Name Richard Erb
and Title Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature for
6/30/2014 DATE
Printed Name William M. Steier, P.E.
and Title Senior Engineer

COMPUTATIONS CHECKED BY:
Signature For
6/30/2014 DATE
Printed Name Amar Wadhawan
and Title Senior Staff Engineer

COMPUTATIONS BACKCHECKED BY: (Originator)
Signature
6/30/2014 DATE
Printed Name Richard Erb
and Title Staff Engineer

APPROVED BY:
(PM or Designate)
Signature
6/30/2014 DATE
Printed Name R. David Espinoza, P.E.
and Title Principal

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

PIPE FLOW ANALYSIS

PURPOSE

A design is proposed to direct surface water runoff down into existing leachate collection pipes at the Westland Ash Storage Facility. The purpose of this package is to (1) estimate the flow through the existing 8 in. and 6 in. high density polyurethane (HDPE) leachate collection pipes, and (2) estimate the flow in the Chimney Drains into the HDPE pipe.

PROCEDURE

Flow in the pipe is governed by the gravity forces causing water to flow down gradient and the friction forces between the water and inner pipe surface. For the subject analysis, head loss in the pipe will be determined from the change in elevation. Subsequently, the velocity in the pipe will be calculated and finally, the flow.

PARAMETERS USED

The energy gradient for the 8 in. HDPE pipe is taken from its change in elevation from Cell B to the the leachate collection pond normalized by the distance of the pipe,

$$\frac{initial\ grade - final\ grade}{Length} = Energy\ gradient$$

See Figures 1, 2 and Table 1 for locations of pipes, and gradient values. For the 6 in. HDPE pipe, the energy gradient is taken from its change in elevation from the end of the pipe to the connection to the 8 in. HDPE pipe at the bottom of Cell B.

The surface roughness,e, for PE pipes is taken to be 0.000005 feet (See Attachment 1).

The inner pipe diameter is obtained using the table in Attachment 2 and assuming an SDR of 17.

The kinematic viscosity of water is assumed to be 1.407×10^{-5} ft^2/s corresponding to a temperature of 50^{o}F

PIPE FLOW EQUATIONS

The Darcy-Weisbach equation is used to relate head loss and velocity in pipe flow:

$$h_L = f\frac{L}{D}\frac{V^2}{2g}$$

Where h_L = head loss (feet)
f = friction factor (from Moody diagram)
L = Length of pipe (feet)
D = Inner diameter of pipe (feet)
V = flow velocity (fps)
g = acceleration due to gravity (32.2ft/s^2)

The friction factor is determined from the Moody Diagram (see Attachment 3) and is related to the Reynolds number, Re, and the relative roughness, $\frac{e}{D}$. In this procedure, an assumed friction factor is chosen, and then the velocity is calculated from the Darcy-Weisbach equation, then the Reynolds number and relative roughness are determined and a new friction factor is determined from the Moody diagram. The calculation is repeated until the new Reynolds number calculated is the same as the one predicted by the Moody diagram.

In the case of the 6 in. pipe, an 8 in. pipe from a Chimney Drain will connect into an existing 6 in. pipe. The additional losses calculated from this sudden contraction are calculated by the following equation:

$$h'_c = k_c\frac{V_2^2}{2g}$$

Where h'_c = head loss (feet)
k_c = a constant dependent on the ratio of the pipe diameters[1]
V_2 = Velocity after transition (ft/sec)
g = acceleration due to gravity (32.2ft/s^2)

Once this additional head loss is calculated using the velocity originally determined, the velocity is then calculated again using the combined losses. This correction in velocity is small, as expected because the losses from the pipe transition is minor.

Once the velocity is determined for the correct friction factor using the above procedure, the flow in the pipe is calculated as

$$Q = V\,A$$

Where Q = flow in cubic feet per second
V = Velocity in feet per second
A = cross sectional area of the pipe, $\frac{\pi D^2}{4}$, for circular pipes.

The results for the flow an 8" pipe and a 6" pipe are presented in Table 1

FLOW CAPACITY OF VERTICAL PIPES

The flow capacity through the 8 in. vertical HDPE pipes located inside the Chimney Drains that will direct stormwater down into the existing network of horizontal leachate collection pipes is calculated based on the following equation:

$$Q = CA\sqrt{2gh}$$

Where:
Q = flow rate (cfs)
C = Coefficient of discharge
A = gross cross sectional flow area (ft^2)
g = acceleration due to gravity (32.2 ft/s^2)
h = head above the orifice (ft.)

The vertical pipes are circular in cross section and have a diameter of 8 inches and 6 inches, giving an area of 0.35 ft. and 0.196 ft. respectively. The assumed head is 2 feet above the orifice, and the coefficient of discharge is assumed to be 0.6 for a sharp orifice.[1]

Insterting the values described above into the above equation results in the following.

$$Q_{8"\,pipe} = (0.6)(0.35)\sqrt{(2)(32.2)(2)} = \mathbf{2.38\ cfs}$$

$$Q_{6"\,pipe} = (0.6)(0.196)\sqrt{(2)(32.2)(2)} = \mathbf{1.33\ cfs}$$

RESULTS AND CONCLUSIONS

From this calculation it can be seen that the limiting flow of the system through the 8 in. HDPE pipe is 2.5 cfs. The flow through a single, existing 6 in. HDPE pipe is calculated to be 1.3 cfs including losses from the 8 in. to 6 in. transition. The flow capacity down the vertical pipes in the Chimney Drain is calculated to be 2.38 cfs for an 8 inch pipe and 1.33 cfs for a 6 inch pipe.

REFERENCES

[1] Daugherty, Robert L., Joseph B. Franzini, and E. J. Finnemore. *Fluid Mechanics, with Engineering Applications*. 8th ed. New York: McGraw-Hill, 1985. Print.

FIGURE 1

8" HDPE Pipe from Cell B to Pond 3

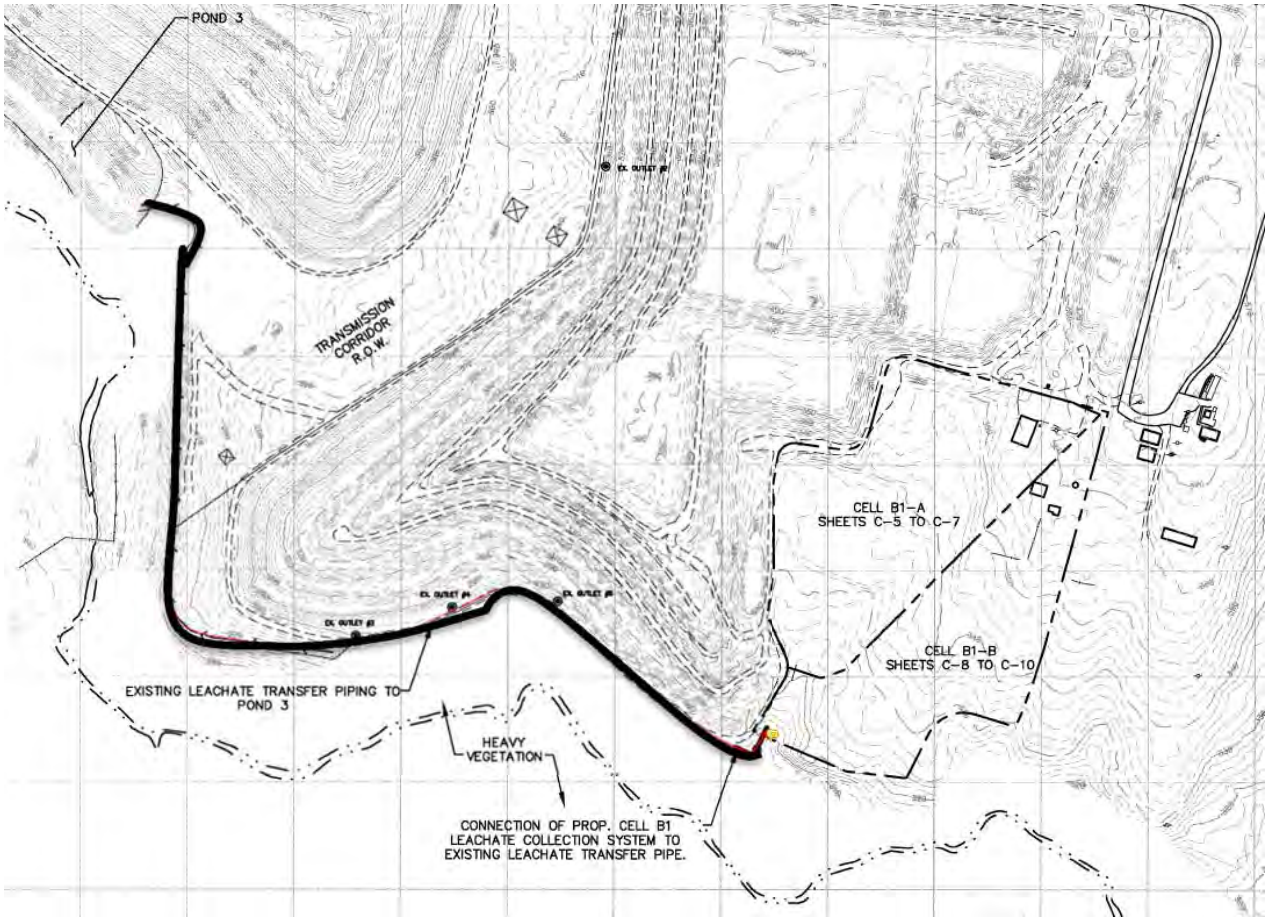
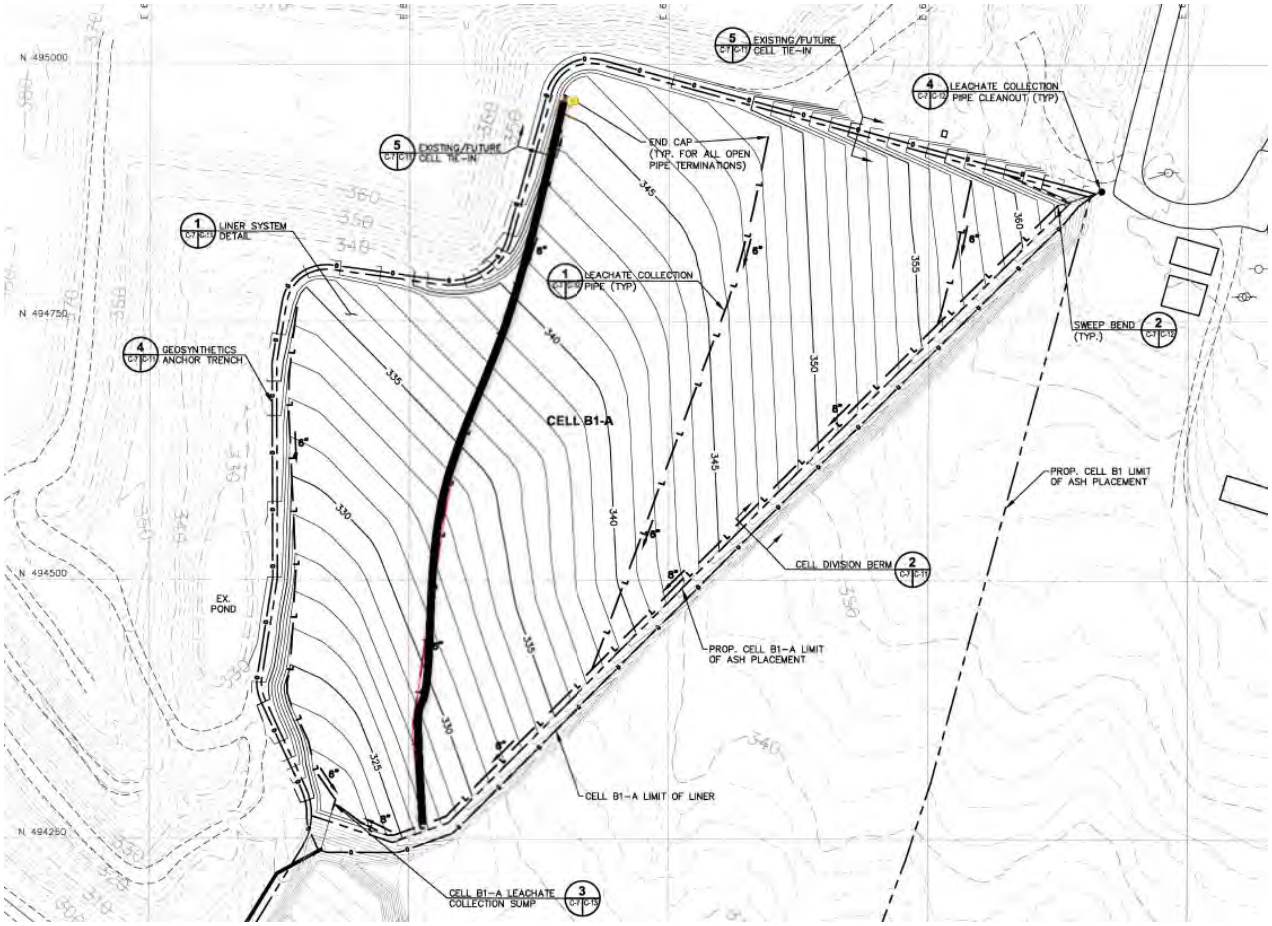


FIGURE 2

6" HDPE Pipe in Cell B



Geosyntec consultants

Written by: Richard Erb **Date:** 6/27/2014

Reviewed by: Amar Wadhawan **Date:** 6/30/2014

Client: MD Ash **Project**: Westland **Project No.**: MEM1106 **Task No.**:

TABLE 1

Summary of Pipe Flow Calculation
Westland Ash Storage Facility
Westland, Maryland

Pipe	Initial grade (ft)	Final grade (ft)	Length (ft)	Energy gradient	e	Inner Diameter (ft)	e/D	f	Velocity (ft/s)	Re	Flow (cfs)
8" HDPE	318	260	2600	0.022	0.000005	0.629	7.95E-06	0.014	8.0	358,000	2.5
6" HDPE	345.5	326.5	725	0.026	0.000005	0.483	1.04E-05	0.015	7.4	253,000	1.4

TABLE 2

Summary of Velocity Correction in 6 in. HDPE Pipe
Westland Ash Storage Facility
Westland, Maryland

Ratio of pip diameter, D_1/D_2	K_c*	Contraction Loss, h'_c (ft)	Corrected Velocity (ft/sec)	Corrected Flow (cfs)
0.77	0.17	0.15	7.35	1.3

*Value is based on a linear interpolation between 0.22 and 0.15 in Table 3

TABLE 3

Table 8.2 Loss coefficients for sudden contraction

D_2/D_1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
k_c	0.50	0.45	0.42	0.39	0.36	0.33	0.28	0.22	0.15	0.06	0.00

(From Daugherty 1985)

ATTACHMENT 1

TABLE 2-1
Surface Roughness for Various New Pipes

Type of Pipe	'ε' Absolute Roughness of Surface, ft		
	Values for New Pipe Reported by Reference[18]	Values for New Pipe and Recommended Design Values Reported by Reference[19]	
		Mean Value	Recommended Design Value
Riveted steel	0.03 - 0.003	–	–
Concrete	0.01 – 0.001	–	–
Wood stave	0.0003 – 0.0006	–	–
Cast Iron – Uncoated	0.00085	0.00074	0.00083
Cast Iron – Coated	–	0.00033	0.00042
Galvanized Iron	0.00050	0.00033	0.00042
Cast Iron – Asphalt Dipped	0.0004	–	–
Commercial Steel or Wrought Iron	0.00015	–	–
Drawn Tubing	0.000005 corresponds to "smooth pipe"	–	–
Uncoated Stee	–	0.00009	0.00013
Coated Steel	–	0.00018	0.00018
Uncoated Asbestos – Cement	–		
Cement Mortar Relined Pipes (Tate Process)	–	0.00167	0.00167
Smooth Pipes (PE and other thermoplastics, Brass, Glass and Lead)	–	"smooth pipe" (0.000005 feet) (See Note)	"smooth pipe" (0.000005) (See Note)

Note: Pipes that have absolute roughness equal to or less than 0.000005 feet are considered to exhibit "smooth pipe" characteristics.

Geosyntec consultants

Written by: Richard Erb **Date**: 6/27/2014

Reviewed by: Amar Wadhawan **Date**: 6/30/2014

Client: MD Ash **Project**: Westland **Project No.**: MEM1106 **Task No.**:

ATTACHMENT 2

PIPE WEIGHTS AND DIMENSIONS (IPS)

OD			Pipe inside diameter (d)	Minimum Wall Thickness (t)	Weight (w)
Nominal in.	Actual in.	DR	in.	in.	lb. per foot
		7	6.01	1.232	12.433
		7.3	6.12	1.182	12.010
		9	6.59	0.958	10.054
		9.3	6.66	0.927	9.771
		11	6.96	0.784	8.425
8	8.625	11.5	7.04	0.750	8.096
		13.5	7.27	0.639	7.001
		15.5	7.45	0.556	6.164
		17	7.55	0.507	5.657
		21	7.75	0.411	4.637
		26	7.92	0.332	3.784

		7	4.62	0.946	7.336
		7.3	4.70	0.908	7.086
		9	5.06	0.736	5.932
		9.3	5.11	0.712	5.765
		11	5.35	0.602	4.971
6	6.625	11.5	5.40	0.576	4.777
		13.5	5.58	0.491	4.130
		15.5	5.72	0.427	3.637
		17	5.80	0.390	3.338
		21	5.96	0.315	2.736
		26	6.08	0.255	2.233
		32.5	6.19	0.204	1.801

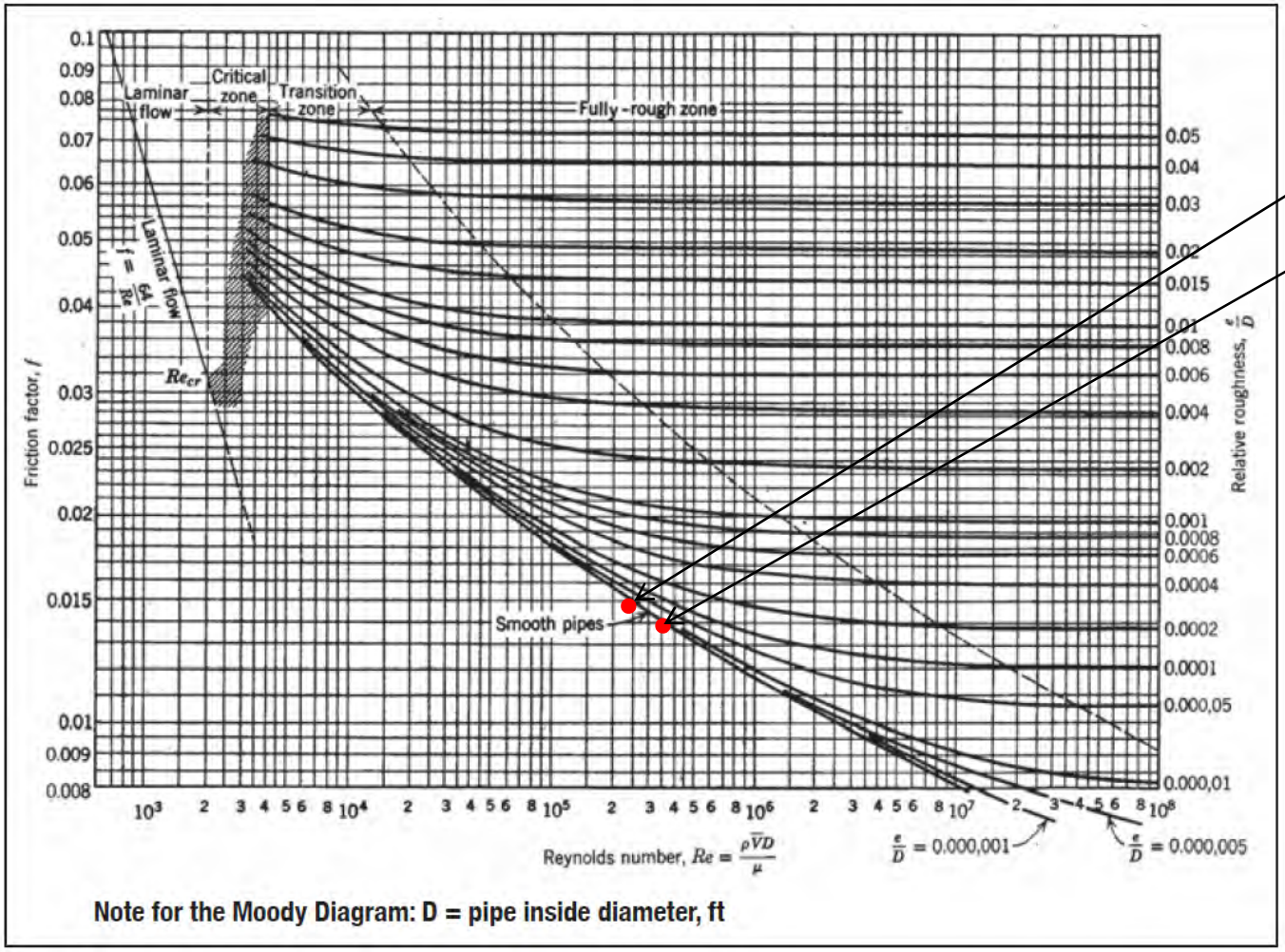
Geosyntec consultants

Written by: Richard Erb **Date:** 6/27/2014

Reviewed by: Amar Wadhawan **Date:** 6/30/2014

Client: MD Ash **Project**: Westland **Project No.**: MEM1106 **Task No.**:

ATTACHMENT 3



Appendix C

Run-on & Run-off Control System Plan Revisions and Amendments