Run-on and Run-off Control System Plan

Rockport Restricted Waste Landfill
Rockport, Spencer County, Indiana
Updated: September 29, 2021
Terracon Project Number: N1215154

Prepared for:
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Columbus, Ohio

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AEP Unique Document ID: GEVR-21-001

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RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN
ROCKPORT RESTRICTED WASTE LANDFILL

Updated: September 29, 2021

1.0 - Introduction

Federal Regulation Title 40, Part 257.81 require the owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must comply with the following:

1. Design, construct, operate, and maintain:
   a. A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm.
   b. A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.
2. Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under §257.3-3
3. Prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the following timeframes:
   a. For existing CCR landfills, the owner or operator of the CCR unit must prepare the initial run-on and run-off control system plan no later than October 17, 2016.
   b. The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans every five (5) years.
4. Obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.
5. Comply with the recordkeeping requirements specified in §257.105(g), the notification requirements specified in §257.106(g), and the internet requirements specified in §257.107(g).

This Run-on and Run-off Control System Plan presents the regulatory-required materials as noted above. This document is the 5-year update to the initial document that was prepared and certified on September 13, 2016. It is prepared for the existing American Electric Power Rockport Restricted Waste Landfill, Rockport, Spencer County, Indiana. The design of run-on and run-off control measures were completed as part of previous landfill permit modifications:

- An IDEM minor modification approval in October 2009 redesigned about 180 acres (East half of the permitted landfill, Storage Area 1A) resulting in reduced landfill footprint with revised final grade configuration incorporating final cap and perimeter drainage channels.

- An IDEM minor modification approval in August 2012 redesigned about 100 acres of the Storage Area 1A landfill upgrading the area to accept Type 1 ash incorporating composite liner with leachate collection system. This redesign did not change the previous redesigned final grade configuration with final cap and perimeter drainage channels.

The landfill operation has installed and is maintaining many of the planned storm water control measures discussed in this plan. Attached Figure 1 - *Erosion and Sediment Control Details* in Appendix 1 illustrates the landfill complex showing the storm water drainage systems as of November 2015 along with erosion and sediment control measures.

2.0 - Run-on Controls

The run-on control system to prevent flow onto the active portion of the landfill during the peak discharge from a 24-hour, 25-year storm must consider site conditions around the landfill outside of the landfill footprint as well as site conditions with-in the landfill footprint.

2.1 Run-On Control Outside the Landfill Footprint

Perimeter drainage channels around the landfill provide controls to handle run-on from outside the landfill footprint. Because the area around the landfill is flat, there is limited potential storm water drainage directed toward the landfill. The series of perimeter drainage channels were designed to handle the run-off from closed landfill areas as their primary purpose. These perimeter channels are constructed along with perimeter containment berms that define the limits of the landfill ash disposal area/footprint. The perimeter channels, see Figure 1 for locations, direct flow to the north to Shaffer Drain and to the south to the Southwest Ditch. Both of these channel systems flow to the west and south to tributaries of Honey Creek which flows to the Ohio River.

Surface water drainage calculations were performed to size the side slope benches and down slope channels incorporated in the final grade and the perimeter channel around the Storage 1A landfill footprint. Storm water drainage calculations used a 25-year, 24-hour storm event to generate storm water runoff from a vegetated final grade surface. See Storm Water Management System in Appendix 2 for further details and design calculations.

The side slope channels were designed to be 20 feet wide and have an irregular "V" shape, having one side slope at 3H:1V and the other side slope at 10H:1V to provide a semi-level surface that can be used for appropriate vehicles to travel. The benches slope at a 0.5% grade to down-slope channels that have a trapezoidal shape with a 6-ft-wide bottom, 3H:1V side slopes, and will be approximately 1-ft-deep.

A perimeter drainage channel system handles storm water runoff flow from the down slope channels and the final cover cap. The perimeter channels have a trapezoidal shape with a 6-ft-wide bottom, 3H:1V side slopes, and are 2 to 2.5 feet deep. The channel are sloped at 0.25% to 0.3%.

2.2 Run-On Control Inside the Landfill Footprint

Within the landfill footprint, limited run-on controls are planned through a site-filling phasing plan that consists of five development and filling phases. This phasing plan results in constructing specific areas to accept ash waste disposal operations while other areas are either un-constructed, being prepared for waste acceptance, have ash waste disposal and are in temporary closed condition, or are filled and in final closed condition. All phases incorporate perimeter containment berms that are either permanent berms or temporary internal berms to control run-on. Run-on controls are planned specific to each phase condition as detailed below and as presented on attached Figures 2 through 5 in Appendix 1 - *Phases 1, 2, 3, 4 & 5 Active Ash Filling Sequence*.

2.2.1 Phase 1 Active Filling

Phase 1 active filling occurs in the southwest corner of the Storage 1A area and consists of previously constructed cells 1B, 2, and 3. Run-on controls within the landfill are provided by Cell 1B having a divider to Cell 1A; Cell 1A grades slope to the north away from the Phase 1 filling area. The south and west sides of the phase have permanent containment berm with perimeter drainage channels construction along the outboard side of the berm. Along the north side of Phase 1 is a temporary access road with drainage channel adjacent to the temporary containment berm; the channel directs stormwater flow to the west to a perimeter drainage channel.

Run-on controls for the Phase 1 Closure are presented on the attached Figure 8 – *Phase 1 Closure Final Grading Plan*, and include diversion channels installed on the side slope benches on the west and south sides, on the plateau at the east boundary with Phase 2, and along the toe of slope along the north boundary. The south and east diversion channels will be routed to a downslope channel on the south slope that will discharge to the south perimeter channel. The west and north diversion channel, along with a diversion channel installed along the inside edge of the Phase 1 access road, will be routed to a channel at the toe of slope at the northwest corner that will discharge to the west perimeter channel.

2.2.2 Phase 2 Active Filling

Phase 2 active filling occurs in the eastern part of the Storage 1A area and consists of previously constructed Cells 1A, part of 4A, and 5. This phase extends north-south across the entire landfill footprint. The east side of this phase is previously closed landfill area that is graded away from the Phase 2 area radially to the north, east, and south. The north side has a permanent containment berm and perimeter channel while the south side is closed landfill slope that incorporates final graded drainage channel benches. Along the west side is a temporary containment berm and the area to the west is graded-landfill areas with temporary cover that slope to the north and west away from the Phase 2 area. The east diversion channel for the Phase 1 Closure will provide for run-on control from that phase adjoining on the west side.

2.2.3 Phase 3 Active Filling

Phase 3 active filling occurs in the northwest corner of the Storage 1A area and consists of previously constructed cells 4A and 4B. Run-on controls for this phase are provided by permanent containment berms with perimeter drainage channels construction along the outboard side of the berm to the north and west. Along the south side is a temporary containment berm and the area to the south is graded-landfill areas with temporary cover that slopes to the west away from the Phase 3 area. This phase will fill against temporary slope of Phase 2 along the east side and will manage runoff from this area as run-off control within the phase. Phase 2 top plateau finish grade will slope away from the Phase 3 filling area.

2.2.4 Phase 4 Active Filling

Phase 4 active filling occurs in the west-central portion of the Storage 1A area and consists of previously constructed cells 6 and 7. Run-on controls for this phase are provided by permanent containment berm with perimeter drainage channel construction along the outboard side of the berm to the west. This phase will fill against temporary slopes of Phases 1, 2, and 3 to the south, east, and north and will manage runoff from these slopes as run-off control within the phase. The top plateau finish grade of Phase 2 and temporary top plateau of Phases 1 and 3 will slope away from the Phase 4 filling area.

2.2.5 Phase 5 Active Filling

Phase 5 active filling area is the final active filling area for the Storage 1A area and will occur over the Phases 1, 3 and 4 areas completing these areas from the temporary top plateau level to finish landfill grade. Run-on will come from along the east side where Phase 2 consists of temporary and finish grades. The finished and closed top plateau will slope away from Phase 5. The active Phase 5 filling will be against the temporary slope of Phase 2 and run-off from this slope will be handled within the phase.

3.0 - Run-off Controls

The run-off control system to prevent flow (contact water) from leaving the active portion of the landfill during the peak discharge from a 24-hour, 25-year storm considers site conditions within active filling areas. Run-off control consists of the following aspects:

- Perimeter containment berms
- Leachate collection system
- Leachate treatment system
- Ash filling operation

Perimeter containment berms that are either permanent or temporary are provided around the active filling area to control run-on as discussed above, but also serve to control run-off. The landfill includes a collection system for contact water (referred to as leachate collection system) that encompasses a drainage layer and perforated collection pipe which are part of the landfill basil liner system. Collected contact water is managed by a series of chimney drains, the leachate collection pipes, conveyance pipes, leachate treatment ponds, and final regulated discharge outlet. Ash filling operation is managed such that contact water is directed to the collection system features. The run-off control features are presented on the attached, Figure 7 - *Leachate Collection System*, in Appendix 1, that is part of from the Minor Modification plan set. The following further describes the run-off control components.

3.1 Perimeter Containment Berms

The perimeter containment berms are constructed around the active-phase filling areas and are either permanent or temporary features. These berms serve to contain the limits of active ash filling and provide a barrier and collection point for run-off control. The leachate collection system and ash filling operation use the berms as part of their control systems as described below.

3.2 Leachate Collection System

The leachate collection system consists of 2-ft-thick drainage layer over the landfill composite liner system and a network of 12-inch-diameter perforated collection pipes. The composite liner system and leachate collection pipe network slope to low points located at the containment berms where the collected run-off flows into conveyance pipes for the leachate treatment system. The leachate collection pipe network spacing is a function of the base grade liner slope, drainage layer permeability, and flow distance to collection pipes. The Hydraulic Evaluation of Landfill Performance (HELP) model was used in evaluating the pipe spacing with respect to contact water percolation to the leachate collection drainage layer, the minimum liner slope and a selected pipe spacing or flow distance to a collection pipe. See Appendix 2 for design calculations.

Design of the chimney drains considered a 25-year, 24-hour storm event and a drainage area of approximately 4 acres. This resulted in a controlled discharge of storm water into the chimney drain and down to the leachate collection pipes. Where possible, the chimney drains are positioned above the perforated leachate collection pipe.

3.3 Conveyance Piping to Treatment Ponds

The leachate collection systems drain toward the western and northern perimeter of the landfill area where the pipes penetrate the landfill liner and continue to drain in conveyance piping toward the leachate treatment ponds. The pipes outside the limits of the landfill liner are contained within an outer containment pipe. The leachate pipes exiting the landfill are 12-inch-diameter HDPE SDR 17 pipe with an outer containment pipe being 18-inch-diameter HDPE SDR 17 pipe. The conveyance pipe slope at minimum 0.25% slope or greater toward the leachate treatment ponds. Manholes are provided at pipe connections and bends.

3.4 Leachate Treatment Ponds

Two leachate treatment ponds serve the landfill operation; one to the west of the landfill (west pond) and one to the north of the landfill (north pond). The ponds were sized to handle the runoff from the landfill base on a 25-year, 24-hour storm for a maximum 50 acres of open exposed waste. Hydrologic runoff analysis using Haestad Method's PondPack software program estimated a runoff rate and volume for this condition. The ponds are approximately 8 feet deep to provide storage of the total storm event runoff with an approximate 2-ft free board. Leachate drains from the pond through a valve vault into a pumping manhole where it is pumped into the existing 002 treatment pond that has an approved NPDES discharge. See Appendix 2 for design calculations.

3.5 Ash Filling Operation

The ash filling operation must be performed in a manner to provide run-off control within the disposal cell such that the contact surface water reaches the leachate collection system. This involves grading the placed ash in a controlled manner to direct contact surface water flow toward the chimney drain structures in the interior portions of the disposal area. Ash grading must be directed away from the outboard slopes. On the outboard slopes the contact surface water must be provided a collection point at the bottom of the slope where the drainage layer is placed up the inboard side of the containment berm; in these situations the ash placement must be kept back away from the drainage layer to not cover it. In situations where the outboard slope is ready for closure, a drainage channel must be provided at the top level of the placed closure cap to collect contact surface water and direct that flow to a location where it can enter the leachate collection system.

4.0 - Plan Review and Changes in Facility Configuration

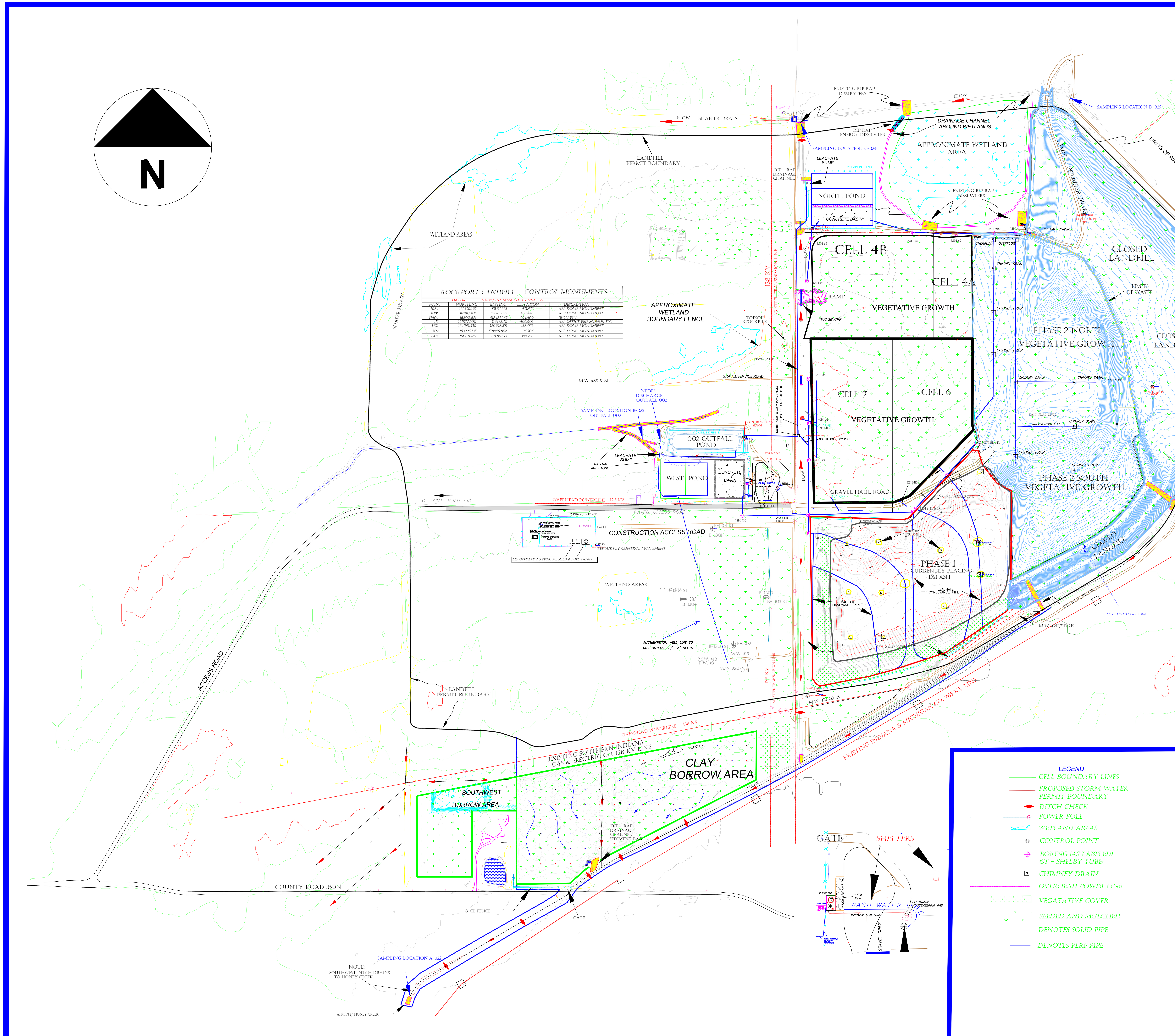
Landfill Owner and/or Operator will review and evaluate this Plan every five (5) years from initial plan preparation and when there are changes in the facility design, construction, operation, or maintenance that materially affect the facility's potential for run-on and run-off control: Amendments to the Plan must be certified by a P.E. Non-technical amendments can be performed by the facility owner and/or operator and may not need P.E. certification.

Owner/Operator will make the necessary revisions to the Plan as soon as possible, but no later than six months after the change occurs. The Plan must be implemented as soon as possible following a technical amendment, but no later than six months from the date of the amendment. All scheduled reviews and Plan amendments will be recorded in the Plan Review Log provided in Appendix 3. The log will be completed even if no amendment is made to the Plan as a result of the review.

5.0 - Professional Engineer Certification

The original plan and all reviews and amended plans must obtain certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements 40 CFR 257. This certification in no way relieves the owner or operator of the facility of his/her duty to fully implement this Plan. The Profession Engineer Certification page is provided in Appendix 4.

APPENDIX 1: FIGURES



ROCKPORT LANDFILL CONTROL MONUMENTS

DATUM: NAD27 INDIANA WEST / NGVD29

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
1084	162530.176	521551.663	431.935	AEP DOME MONUMENT
1085	162917.105	521261.699	438.448	AEP DOME MONUMENT
17404	162563.621	518481.267	404.409	IRON PIN
415	161837.200	517472.40	402.603	AEP OFFICE PED MONUMENT
1501	164091.320	520798.371	438.033	AEP DOME MONUMENT
1502	163996.135	518946.806	396.506	AEP DOME MONUMENT
1504	160811.169	518915.674	399.238	AEP DOME MONUMENT

INDIANA-MICHIGAN POWER CO.

ROCKPORT PLANT

ROCKPORT INDIANA

ROCKPORT LANDFILL
EROSION AND SEDIMENT
CONTROL DETAILS

NAD 27/NGVD 29 INDIANA WEST

SCALE: 1" = 150'

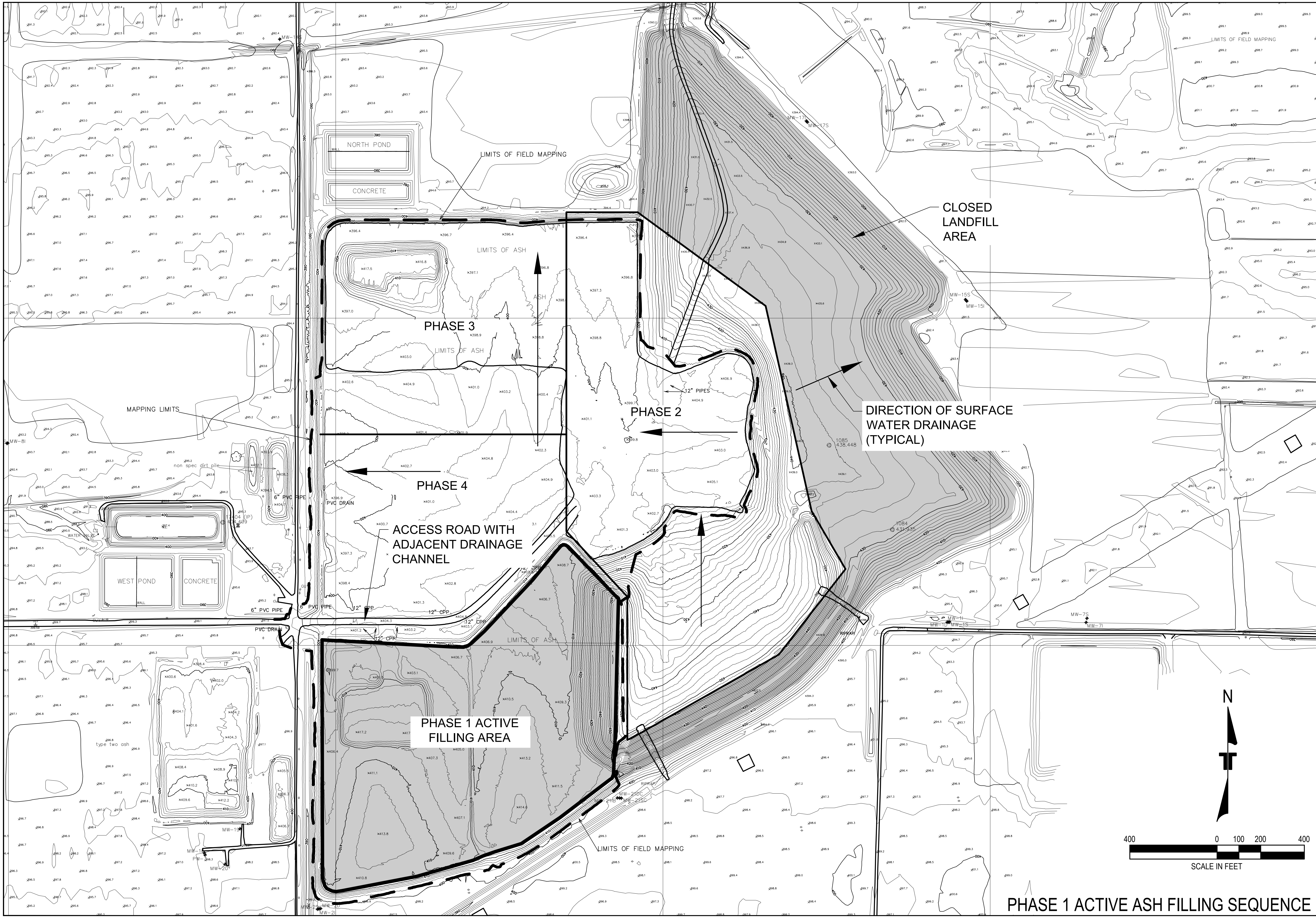
Revisions By: L. HOFIUS

Revision Date: 27, JUNE 2020

Drawn By: LARRY HOFIUS

AMERICAN ELECTRIC POWER
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

FIGURE 1



REV	DATE	BY	DESCRIPTION

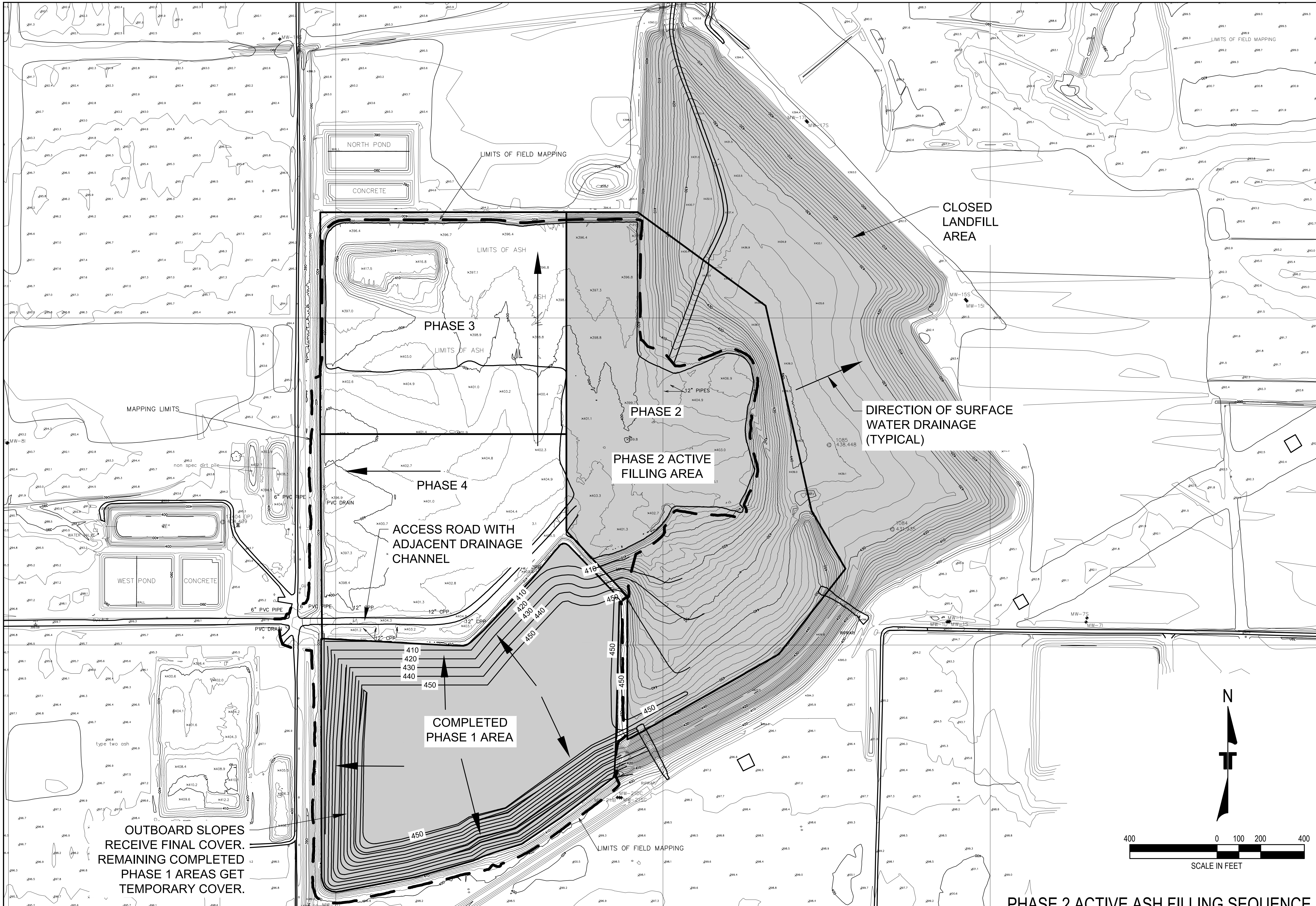
PHASE 1 ACTIVE ASH FILLING SEQUENCE

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN
AMERICAN ELECTRIC POWER
ROCKPORT RESTRICTED WASTE LANDFILL
ROCKPORT, SPENCER COUNTY, INDIANA

Terracon
Consulting Engineers and Scientists
611 LUNKEN PARK DRIVE, CINCINNATI, OHIO 45226
PH. (513) 321-5816, FAX (513) 321-4540

FIGURE 2

DESIGNED BY:	BER
DRAWN BY:	KM
APPVD. BY:	BER
SCALE:	1"=400'
DATE:	12/18/2015
JOB NO.	N1115277
ACAD NO.	FIGURE 2.DWG
SHEET NO.:	2



PHASE 2 ACTIVE ASH FILLING SEQUENCE

REV	DATE	BY	DESCRIPTION

PHASE 2 ACTIVE ASH FILLING SEQUENCE

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

AMERICAN ELECTRIC POWER

ROCKPORT RESTRICTED WASTE LANDFILL

ROCKPORT, SPENCER COUNTY, INDIANA

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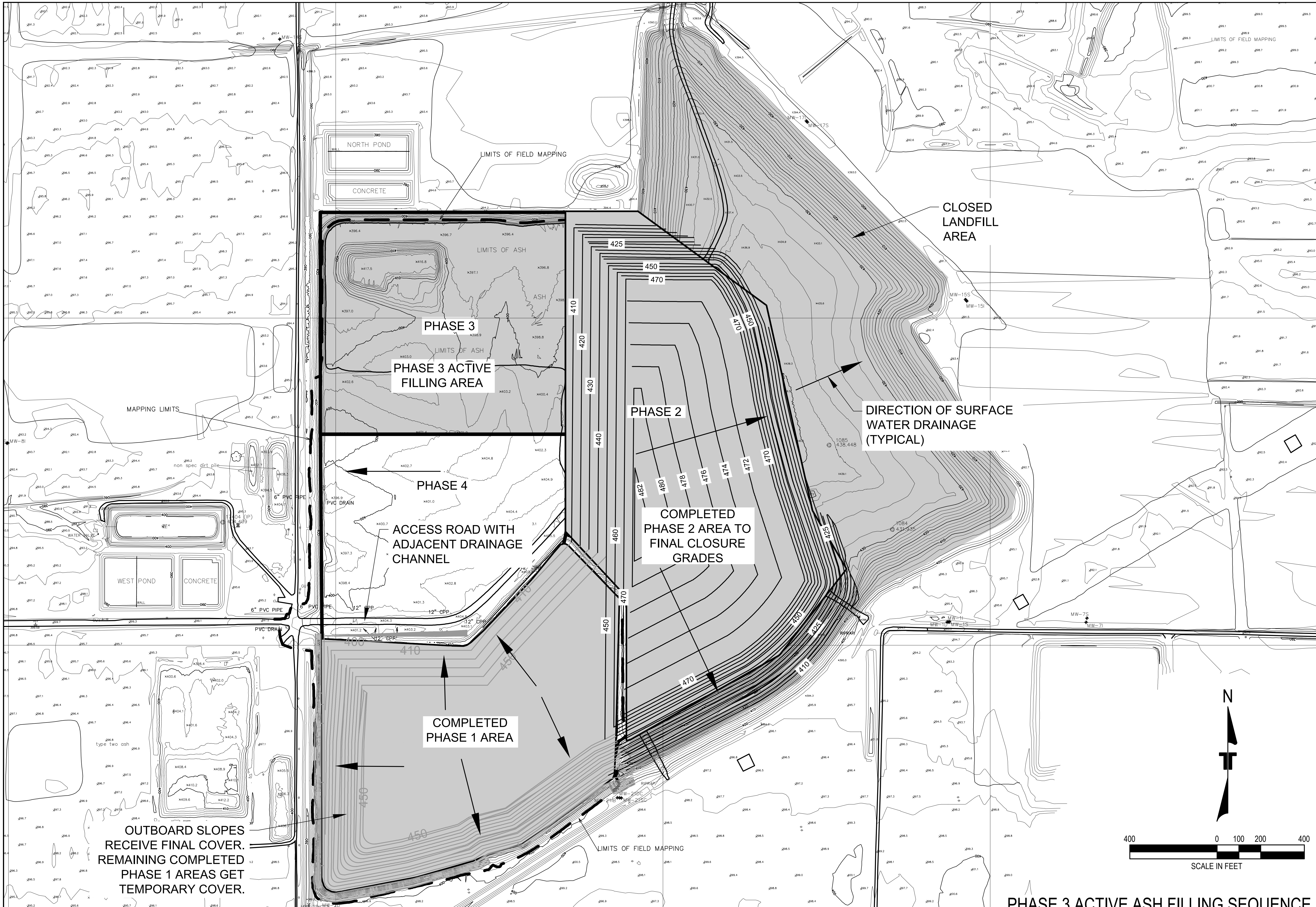
FIGURE 3

DESIGNED BY:	BER
DRAWN BY:	KM
APPVD BY:	BER
SCALE:	1"=400'
DATE:	12/18/2015
JOB NO.	N1115277
ACAD NO.	FIGURE 3.DWG
SHEET NO.:	3



PHASE 3 ACTIVE ASH FILLING SEQUENCE

REV	DATE	BY	DESCRIPTION

PHASE 3 ACTIVE ASH FILLING SEQUENCE

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

AMERICAN ELECTRIC POWER

ROCKPORT RESTRICTED WASTE LANDFILL

ROCKPORT, SPENCER COUNTY, INDIANA

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FIGURE 4

DESIGNED BY:	BER
DRAWN BY:	KM
APPVD BY:	BER
SCALE:	1"=400'
DATE:	12/18/2015
JOB NO.	N1115277
ACAD NO.	FIGURE 3.DWG
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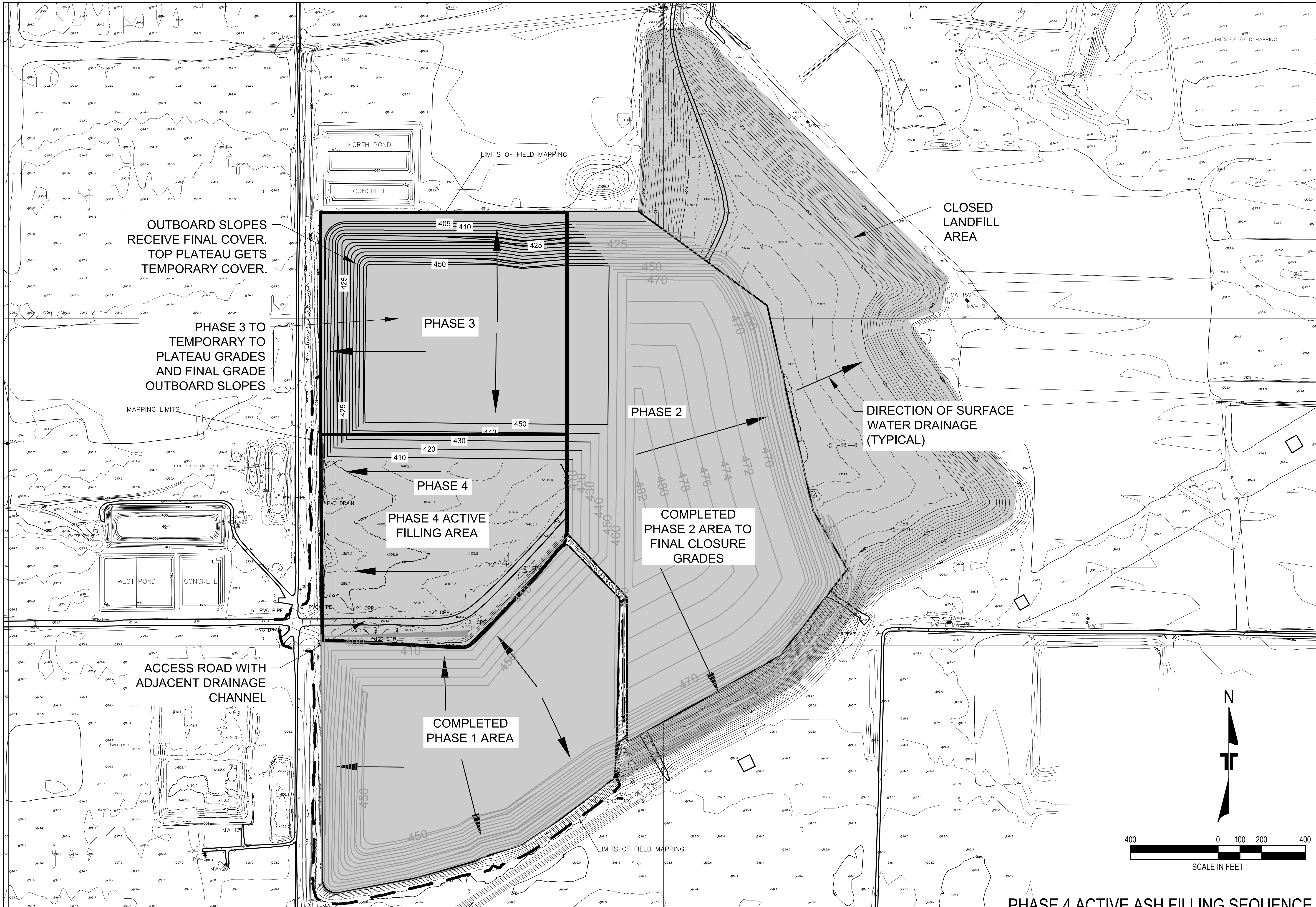

PHASE 4 ACTIVE ASH FILLING SEQUENCE

REV	DATE	BY	DESCRIPTION

PHASE 4 ACTIVE ASH FILLING SEQUENCE

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN
AMERICAN ELECTED POWER
ROCKPORT RESTRICTED WASTE LANDFILL
ROCKPORT, SPENCER COUNTY, INDIANA

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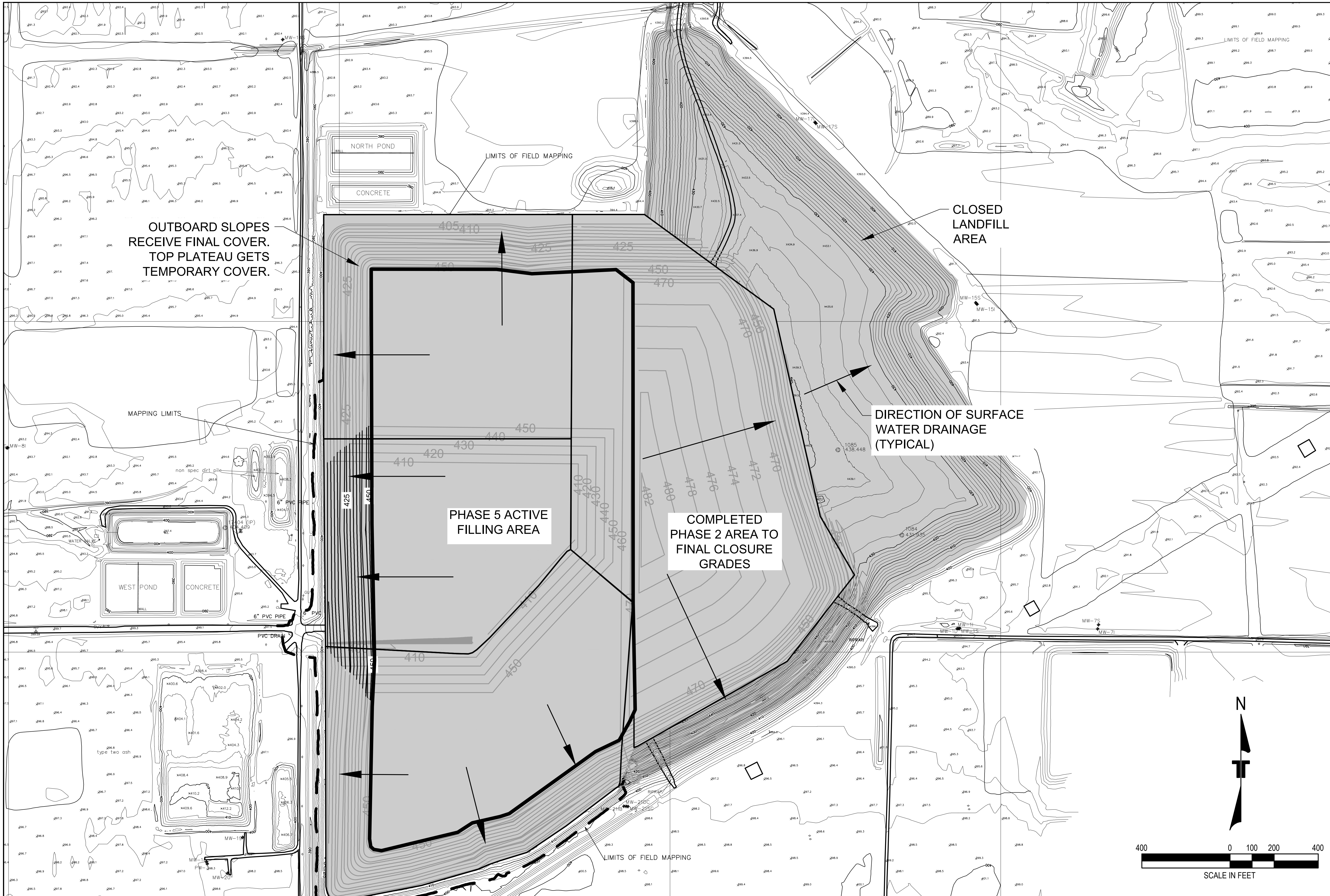
FIGURE 5

DESIGNED BY:	BER
DRAWN BY:	KM
APPVD. BY:	BER
SCALE:	1"=400'
DATE:	12/18/2015
JOB NO.	N1115277
ACAD NO.	FIGURE 3.DWG
SHEET NO.:	5



PHASE 5 ACTIVE ASH FILLING SEQUENCE

REV	DATE	BY	DESCRIPTION

PHASE 5 ACTIVE ASH FILLING SEQUENCE

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

AMERICAN ELECTRIC POWER

ROCKPORT RESTRICTED WASTE LANDFILL

ROCKPORT, SPENCER COUNTY, INDIANA

Terracon

Consulting Engineers and Scientists

611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226

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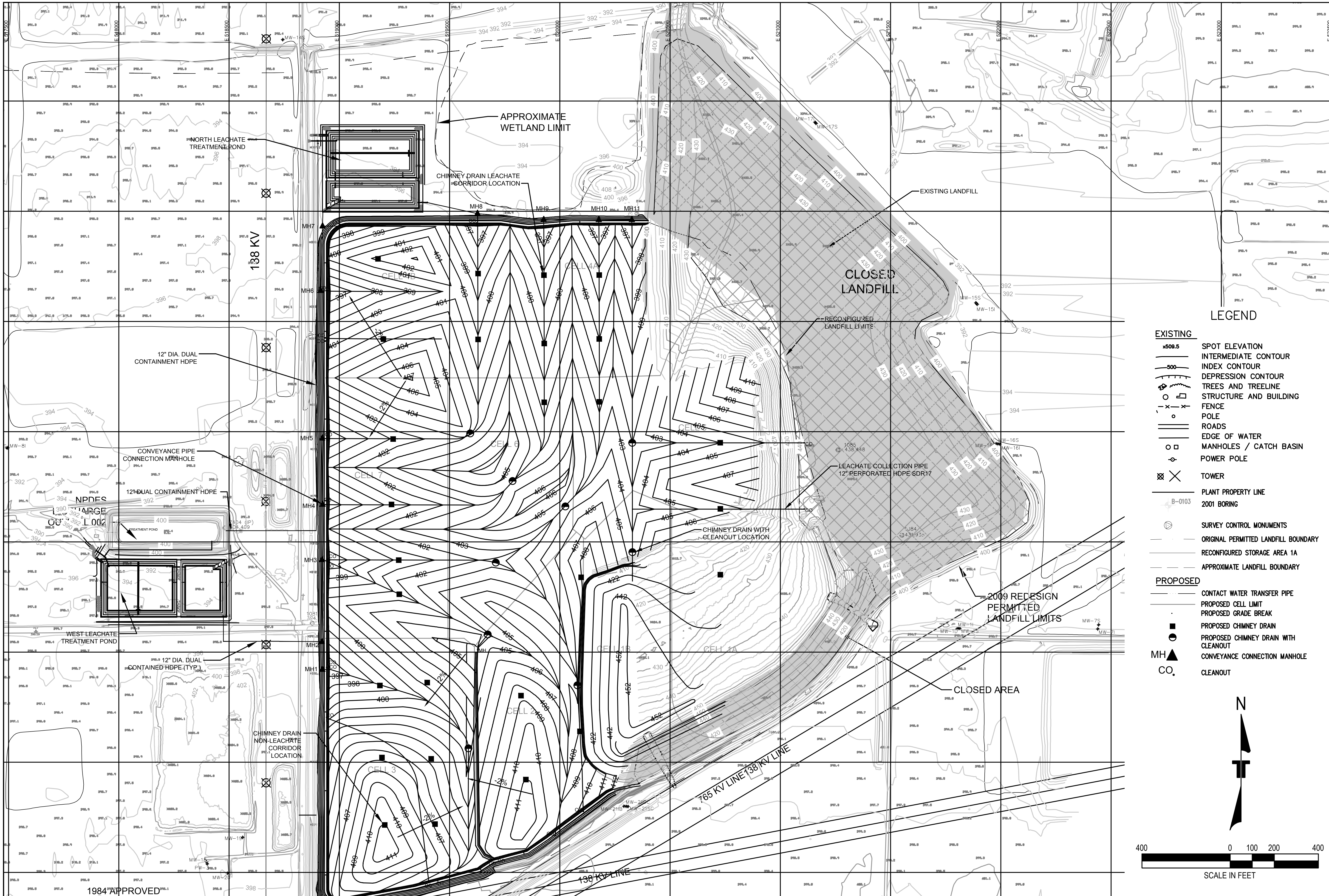
FIGURE 6

DESIGNED BY:	BER
DRAWN BY:	KM
APPVD. BY:	BER
SCALE:	1"=400'
DATE:	12/18/2015
JOB NO.	N1115277
ACAD NO.	FIGURE 3.DWG
SHEET NO.:	6



LEACHATE COLLECTION SYSTEM

REV	DATE	BY	DESCRIPTION

LEACHATE COLLECTION SYSTEM

RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

AMERICAN ELECTRIC POWER

ROCKPORT RESTRICTED WASTE LANDFILL

ROCKPORT, SPENCER COUNTY, INDIANA

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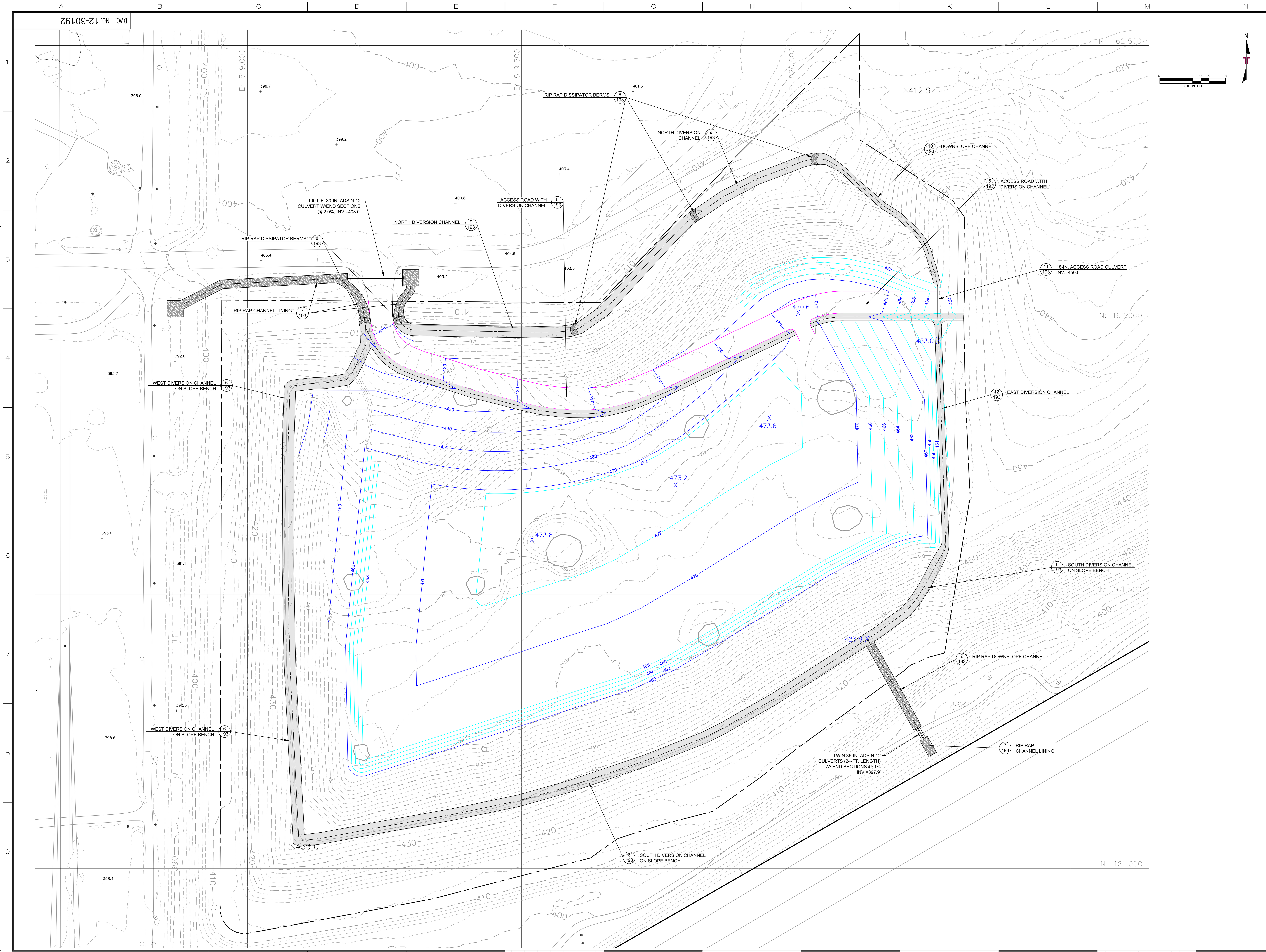
FIGURE 7

DESIGNED BY:	BER
DRAWN BY:	KM
APPVD BY:	BER
SCALE:	1"=400'
DATE:	12/18/2015
JOB NO.	N1115277
ACAD NO.	FIGURE 2.DWG
SHEET NO.:	7



GENERAL NOTES

LEGEND

- WELL
- DRAIN
- EDGE OF ASH
- CULVERT
- TRANSMISSION TOWER
- HORIZONTAL AND VERTICAL CONTROL
- TREE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- SPOT ELEVATION
- 739.6 SPOT TEXT
- WATER LINE
- ASH BOUNDARY (PHASE I)
- 460 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- X 472.3 SPOT ELEVATION
- ACCESS ROAD
- DIVERSION CHANNEL

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA MICHIGAN POWER CO

ROCKPORT PLANT

FLY ASH LANDFILL STORAGE AREA 1A

ROCKPORT INDIANA

PHASE I CLOSURE TOP OF ASH WITH CCR GRADES

DWG. NO. 12-30192

SCALE: 1"=60' | CIVIL ENGINEERING

DR:
CH:
ENGR:
PROJ ENGR:
DATE: 1/21/21
APPROVED BY

FIGURE 8

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

IGS0694

SYSTEM DATE- DD-MMM-YYYY WHERES ARCH

APPENDIX 2:
STORM WATER MANAGEMENT SYSTEM

MEMORANDUM

SUMMARY OF CONTACT WATER MANAGEMENT SYSTEM DESIGN
ROCKPORT PLANT RESTRICTED TYPE I WASTE LANDFILL
ROCKPORT, SPENCER COUNTY, INDIANA

Prepared by: Bruce E. Rome, P.E.
Senior Engineer/Project Manager
Terracon Consultants, Inc.

Introduction

This Memorandum Summary provides an explanation of the design for managing storm water runoff which results in contact water needing to be contained and discharged through the on-site permitted NPDES outlet. Generation of contact water comes from active-open waste disposal areas. The landfill was designed to consist of five (5) phases where there would be active-open waste disposal. During active-open conditions, storm water runoff over placed-ash on the plateau surfaces is collected at chimney drains which are connected to the contact water collection system positioned on the Type I liner. Storm water runoff on the outboard perimeter slope is collected by perimeter containment berms where the runoff drains into liner drainage layer.

Other forms of contact water drainage may occur which include percolation through the place-ash during open cell active operations or in closed/covered areas. Contact water drainage will have limited infiltration into the placed-ash with percolation down through the ash to the basal contact water collection system. During closed/covered conditions, storm water will result in limited infiltration through the cover soil and then through the placed-ash to the basal contact water collection system. Because this volume is expected to be minimal, it has not be considered in the overall performance of the drainage system.

Designing the system is primarily a storm water drainage analysis since the majority of the contact-water generation is by runoff from the placed ash surface. A water balance analysis (HELP model) was completed to check the performance of the liner drainage system for handling contact water that percolates through the in-placed ash to confirm compliance with the regulations of a less than or equal to 12-inch-head on the liner. The HELP model analysis determined the required drainage layer hydraulic conductivity needed to comply with the regulations.

To handle contact water runoff from the active landfill areas, two treatment ponds were planned; one to the west of the landfill located just south of the existing contact water treatment pond (002 Pond) and one to the north of the proposed landfill. Both treatment ponds are sized to hold the runoff from a 25-year, 24-hour storm event for an approximate 50-acre open waste disposal area. Runoff curve number of 90 was used in the analysis to simulate a bare nearly impermeable surface with some shallow depressions that slow surface runoff. These ponds are lined with the Type I composite liner system consisting of 2 feet of $1x10^{-7}$ cm/sec compacted clay and 30-mil geomembrane layer. They each have three interconnected basins that have controlled discharge standpipes to allow ash particles to settle out before the contact water is pumped to the 002 pond for final treatment and discharge through the permitted NPDES outlet.

The design of the chimney drains and sizing the two treatment ponds are explained below.

Chimney Drains

Managing storm water runoff will consist of directing surface contact water toward a series of chimney drains to located in the active cells. The chimney drains are planned to provide a means for storm water runoff to drain down to the contact water collection pipe system. Waste disposal operations must place the fly ash in an active disposal cell such that they maintain a slope toward the chimney drains. The chimney drains were designed to be first level of storm water runoff and sediment control with the intent that some short-term storage/detention will occur around the chimney drain. This allows time for fly ash to settle out before draining through the system. It also is intended to delay the peak runoff entering the conveyance system that drains to the treatment pond. Design of the chimney drains considered a 25-year, 24-hour storm event and a drainage area of approximately 4 acres.

The chimney drains nominally consist of a 3 foot or 4 foot diameter perforated standpipe filled with No. 57 non-calcareous aggregate and are set just above the composite liner and connect to the contact water drainage layer and collection piping. The outside of the perforated pipe is wrapped with a geotextile filter fabric and then bottom ash is placed around the outside perimeter of the chimney drain to at least a 2-ft.-thickness horizontally from the pipe. Perforations in the chimney drain consist of approximately six 2-inch-diameter holes per foot around the chimney drain pipe. Silt fencing may also be placed around the chimney drains to be the first control measure for sediment runoff control.

Hydrographic and hydraulic calculations for the chimney drains are provided below as Figure 1.

Treatment Ponds

The two treatment ponds, as previously mentioned, were designed to handle a 25-year, 24-hour storm event. Estimation of runoff was completed based on SCS Unit Hydrograph analysis using an SCS Curve Number = 90. The holding capacity of each pond was checked based on the Normal Water Level which is set by the shut-off elevation in the pump stations.

Storage capacities for each pond from the Normal Water Level up to the Emergency Spillway are:

West Pond Storage: 3,423,160 Gallons - [457,642 cubic feet or 10.5 acre-feet]
North Pond Storage: 4,602,986 Gallons - [615,360 cubic feet or 14.1 acre-feet]

See Figure 2 for calculation of pond capacities.

The following table lists the projected runoff per phase and status of pond capacity

Phase	Runoff Volume	To Pond	Results
1	3,909,946 Gallons	West	Have capacity[1]
2	5,148,095 Gallons	North	Have capacity[1]
3	2,736,962 Gallons	North	Have capacity
4	2,541,465 Gallons	West	Have capacity
5	3,975,111 Gallons	Each	Combined the two ponds have capacity

1 The pond pumping stations are equipped with automated float switches to turn the pumps on and off as necessary based on the water levels. During a storm event as runoff fills the ponds the pumps will turn on and continue to operate. Pumping at 200 gpm for 24 hours = 288,000 gallons pumped out of the pond. Pumping at 400 gpm for 24 hours = 576,000 gallons pumped out of the pond. With active pumping the ponds have capacity to handle runoff from a 25-year, 24-hour storm.

See Figure 3 for Hydrologic Storm Water Runoff Analysis results.

Flow through the treatment pond basins consists of standpipes for drainage to the next adjoining basin and into the final pump station manhole. An orifice analysis was completed to estimate the flow capacity of the standpipes. The final standpipe was designed to have sufficient flow to the pump station for a minimum 200 gpm pumping rate. The analysis determined the number of drain holes per row and the drain-hole diameter. The final outlet standpipes were constructed using 1.5-inch-diameter drain holes. Figure 4 provides the standpipe flow rate review.

Contact water is pumped to the on-site 002 Pond located north of the West Pond. Contact water discharges through a permitted outlet to local stream channel. If necessary, the 002 Pond is equipped with a pumping station and force main to pump water to the North Stormwater Pond, see discussion below.

Each treatment pond includes an emergency spillway. The spillways were designed based on the difference between a 25-year storm runoff flow rate and a 100-year storm runoff rate. The spillway was designed based on the largest runoff condition which is Phase 2 when there is the largest drainage area flowing to a single treatment pond; the North Pond. Both pond spillways were sized based on this calculation. The calculations first determined the runoff flows for each of the storm events. The SCS method was used to estimate the runoff. The pond was planned to hold the 25-year event, therefore the resulting difference between the flows (100 year minus 25-year runoff), was then used to size the emergency spillway using the Manning's formula with riprap lining. The spillway shape was set such that vehicles can cross over the spillway. Figure 5 provides calculation detail for runoff determination and sizing the trapezoidal-shaped spillway with riprap lining.

Leachate Force Main System

In 2020, a leachate force main system was installed to allow the facility to pump from the contact water pond (002 Pond adjoining the West Pond) to the North Stormwater Pond at the Rockport Plant. The use of this force main system will serve to both significantly increase the pumping capacity for the West and North Ponds, and to overall improve the facility's capability to manage the 25-year, 24-hour design storm flow.

The force main consists of approximately 7,250 linear feet of 6-inch diameter HDPE pipe, with two 250-gpm (each) pumps installed in a sump pit located near the 002 Pond augmentation building. The force main pipe runs mostly along the southern edge of the landfill haul road, and then crosses under both County Road 350 and Honey Creek to connect to an inlet structure at the North Stormwater Pond. The sump pit is connected to the primary discharge pipe for the 002 Pond, such that the discharge can be routed to either: 1) the augmentation building and then to Outfall 002 (Honey Creek) or, 2) to the sump pit for the leachate force main system to pump the discharge to the North Stormwater Pond. The West Stormwater Pond receives the flow from the North Stormwater Pond. The West Stormwater Pond in turn discharges to the West Bottom Ash Pond, which ultimately discharges to Outfall 001 (Ohio River).

Closing Remarks

This summary of the contact water management system has explained the overall approach with details for the chimney drains and treatment ponds. Figures 1 through 5 provide details on specific calculations.

FIGURES

Figure 1 – Chimney Drain Hydraulic Analysis

```
RUNOFF HYDROGRAPHS BASED ON 4 ACRES

              HYG Tag  = 5 YR
              ----------------------------------
              Peak Discharge =         8.66 cfs
              Time to Peak   =      12.0000 hrs
              HYG Volume     =         .764 ac-ft
              ----------------------------------

              HYG Tag  = 10 YR
              ----------------------------------
              Peak Discharge =        10.56 cfs
              Time to Peak   =      12.0000 hrs
              HYG Volume     =         .939 ac-ft
              ----------------------------------

              HYG Tag  = 25 YR
              ----------------------------------
              Peak Discharge =        12.80 cfs
              Time to Peak   =      12.0000 hrs
              HYG Volume     =        1.148 ac-ft
              ----------------------------------

              HYG Tag  = 50 YR
              ----------------------------------
              Peak Discharge =        14.73 cfs
              Time to Peak   =      12.0000 hrs
              HYG Volume     =        1.331 ac-ft
              ----------------------------------

              HYG Tag  = 100 YR
              ----------------------------------
              Peak Discharge =        16.34 cfs
              Time to Peak   =      12.0000 hrs
              HYG Volume     =        1.485 ac-ft

CHIMINEY DRAIN UNIT
         Structure        No.        Outfall    E1, ft     E2, ft
      ----------------    ----       -------  ---------  ---------
      Stand Pipe          SP    --->    LP      20.000     20.000
      Orifice-Circular    H1    --->    LP      19.000     20.000
      Orifice-Circular    H2    --->    LP      18.000     20.000
      Orifice-Circular    H3    --->    LP      17.000     20.000
      Orifice-Circular    H4    --->    LP      16.000     20.000
      Culvert-Circular    LP    --->    TW       1.000     20.000
```

```
Structure ID      = SP
Structure Type    = Stand Pipe
------------------------------------
# of Openings     =         1
Invert Elev.      =     20.00 ft
Diameter          =    3.0000 ft
Orifice Area      =    7.0686 sq.ft
Orifice Coeff.    =      .600
Weir Length       =      9.42 ft
Weir Coeff.       =      .950
K, Submerged      =      .000
K, Reverse        =     1.000


Structure Type    = Orifice-Circular
------------------------------------
# of Openings     =         6
Diameter          =     .1667 ft (2 inches)
Orifice Coeff.    =      .600

Structure ID      = H1  Invert Elev.      =     19.00 ft
Structure ID      = H2  Invert Elev.      =     18.00 ft
Structure ID      = H3  Invert Elev.      =     17.00 ft
Structure ID      = H4  Invert Elev.      =     16.00 ft

Structure ID      = LP
Structure Type    = Culvert-Circular
------------------------------------
No. Barrels       =         1
Barrel Diameter   =    1.0000 ft
Upstream Invert   =      1.00 ft
Dnstream Invert   =       .00 ft
Horiz. Length     =    200.00 ft
Barrel Length     =    200.00 ft
Barrel Slope      =    .00500 ft/ft
```

***** COMPOSITE OUTFLOW SUMMARY ****

WS Elev, Total Q		Converge		Notes
Elev. ft	Q cfs	TW Elev ft	Error +/-ft	Contributing Structures
16.00	.00	Free Outfall		(no Q: H3,H2,H1,SP,H4,LP)
16.50	.41	Free Outfall		H4,LP (no Q: H3,H2,H1,SP)
17.00	.60	Free Outfall		H4,LP (no Q: H3,H2,H1,SP)
17.50	1.16	Free Outfall		H3,H4,LP (no Q: H2,H1,SP)
18.00	1.48	Free Outfall		H3,H4,LP (no Q: H2,H1,SP)
18.50	2.14	Free Outfall		H3,H2,H4,LP (no Q: H1,SP)
19.00	2.55	Free Outfall		H3,H2,H4,LP (no Q: H1,SP)
19.50	3.30	Free Outfall		H3,H2,H1,H4,LP (no Q: SP)
20.00	3.80	Free Outfall		H3,H2,H1,H4,LP (no Q: SP)

```
INFLOW/OUTFLOW HYDROGRAPH SUMMARY Event: 5 Yr
======================================================
Peak Inflow      =     8.66 cfs    at   12.0000 hrs
Peak Outflow     =      .51 cfs    at   13.7500 hrs
======================================================

INFLOW/OUTFLOW HYDROGRAPH SUMMARY Event: 10 Yr
======================================================
Peak Inflow      =    10.56 cfs    at   12.0000 hrs
Peak Outflow     =      .58 cfs    at   14.0000 hrs
======================================================

INFLOW/OUTFLOW HYDROGRAPH SUMMARY Event: 25 Yr
======================================================
Peak Inflow      =    12.80 cfs    at   12.0000 hrs
Peak Outflow     =      .73 cfs    at   14.2500 hrs
======================================================

INFLOW/OUTFLOW HYDROGRAPH SUMMARY Event: 50 YR
======================================================
Peak Inflow      =    14.73 cfs    at   12.0000 hrs
Peak Outflow     =      .88 cfs    at   13.7500 hrs
======================================================

INFLOW/OUTFLOW HYDROGRAPH SUMMARY Event: 100 Yr
======================================================
Peak Inflow      =    16.34 cfs    at   12.0000 hrs
Peak Outflow     =     1.01 cfs    at   13.7500 hrs
======================================================
```

Figure 2 – West Pond Capacity Calculation

West Pond		Concrete-Lined Basin						Basins Two and Three						
Elevation	Distance	Width	Length	Area	Vol. Gal.	Cum.	Distance	Width	Length	Area	Vol. Gal.	Cum.	Total	
388.00														Bottom At Outlet
388.50								196	293	57,428	0			
389.00		156	200	31,200	0		0.50	200	297	59,400	218,468			Pipe Invert
391.00	2.0	172	216	37,152	511,273		2.0	216	313	67,608	950,020			
391.25	0.25	174	218	37,932	70,204		0.25	218	315	68,670	127,420			Normal Water Level
391.50	0.25	176	220	38,720	71,670	71,670	0.25	220	317	69,740	129,413	129,413	201,083	
391.75	0.25	178	222	39,516	73,151	144,820	0.25	222	319	70,818	131,422	260,835	405,655	
392.00	0.25	180	224	40,320	74,647	219,467	0.25	224	321	71,904	133,445	394,280	613,747	
392.25	0.25	182	226	41,132	76,158	295,625	0.25	226	323	72,998	135,483	529,764	825,388	
392.50	0.25	184	228	41,952	77,684	373,308	0.25	228	325	74,100	137,537	667,300	1,040,608	
392.75	0.25	186	230	42,780	79,224	452,533	0.25	230	327	75,210	139,605	806,905	1,259,438	
393.00	0.25	188	232	43,616	80,780	533,313	0.25	232	329	76,328	141,688	948,593	1,481,906	
393.25	0.25	190	234	44,460	82,351	615,664	0.25	234	331	77,454	143,786	1,092,379	1,708,043	
393.50	0.25	192	236	45,312	83,937	699,601	0.25	236	333	78,588	145,899	1,238,278	1,937,879	
393.75	0.25	194	238	46,172	85,538	785,138	0.25	238	335	79,730	148,027	1,386,306	2,171,444	
394.00	0.25	196	240	47,040	87,153	872,291	0.25	240	337	80,880	150,170	1,536,476	2,408,768	
394.00	0.00	206	240	49,440	0	872,291	0.00	240	347	83,280	0	1,536,476	2,408,768	
394.25	0.25	207	242	50,094	90,820	963,112	0.25	242	348	84,216	156,609	1,693,085	2,656,197	
394.50	0.25	208	244	50,752	94,291	1,057,403	0.25	244	349	85,156	158,363	1,851,448	2,908,850	
394.75	0.25	209	246	51,414	95,525	1,152,928	0.25	246	350	86,100	160,124	2,011,572	3,164,500	
395.00	0.25	210	248	52,080	96,767	1,249,695	0.25	248	351	87,048	161,893	2,173,465	3,423,160	Emergency Spillway
					1,831,171						3,469,374		5,300,545	

Figure 2 – North Pond Capacity Calculation

North Pond		Concrete-Lined Basin						Basins Two and Three						
Elevation	Distance	Width	Length	Area	Vol. Gal.	Cum.	Distance	Width	Length	Area	Vol. Gal.	Cum.	Total	
386.50														Bottom at Outlet
387.00							0.5	146	345	50,370	0			
387.50	0.5	58	345	20,010	37,419		0.5	150	349	52,350	192,086			Pipe Invert
389.50	2.0	74	361	26,714	349,496		2.0	166	365	60,590	844,791			
389.75	0.25	76	363	27,588	50,772		0.25	168	367	61,656	114,300			Normal Water
390.00	0.25	78	365	28,470	52,414	52,414	0.25	170	369	62,730	116,301	116,301	168,715	
390.25	0.25	80	367	29,360	54,071	106,485	0.25	172	371	63,812	118,317	234,618	341,103	
390.50	0.25	82	369	30,258	55,743	162,228	0.25	174	373	64,902	120,348	354,965	517,193	
390.75	0.25	84	371	31,164	57,430	219,658	0.25	176	375	66,000	122,393	477,359	697,016	
391.00	0.25	86	373	32,078	59,131	278,789	0.25	178	377	67,106	124,454	601,813	880,602	
391.25	0.25	88	375	33,000	60,848	339,637	0.25	180	379	68,220	126,530	728,343	1,067,979	
391.50	0.25	90	377	33,930	62,580	402,216	0.25	182	381	69,342	128,620	856,963	1,259,179	
391.75	0.25	92	379	34,868	64,326	466,543	0.25	184	383	70,472	130,726	987,689	1,454,232	
392.00	0.25	94	381	35,814	66,088	532,630	0.25	186	385	71,610	132,847	1,120,536	1,653,166	
392.25	0.25	96	383	36,768	67,864	600,494	0.25	188	387	72,756	134,982	1,255,518	1,856,012	
392.50	0.25	98	385	37,730	69,656	670,150	0.25	190	389	73,910	137,133	1,392,651	2,062,801	
392.75	0.25	100	387	38,700	71,462	741,612	0.25	192	391	75,072	139,298	1,531,949	2,273,561	
393.00	0.25	102	389	39,678	73,283	814,896	0.25	194	393	76,242	141,479	1,673,427	2,488,323	
393.25	0.25	104	391	40,664	75,120	890,015	0.25	196	395	77,420	143,674	1,817,101	2,707,117	
393.50	0.25	106	393	41,658	76,971	966,986	0.25	198	397	78,606	145,884	1,962,986	2,929,972	
393.75	0.25	108	395	42,660	78,837	1,045,824	0.25	200	399	79,800	148,110	2,111,095	3,156,919	
394.00	0.25	110	397	43,670	80,719	1,126,542	0.25	202	401	81,002	150,350	2,261,445	3,387,987	
394.00	0.00	120	397	47,640	0	1,126,542	0.00	212	401	85,012	0	2,261,445	3,387,987	
394.25	0.25	121	399	48,279	85,972	1,212,515	0.25	213	403	85,839	155,996	2,417,442	3,629,956	
394.50	0.25	122	401	48,922	90,883	1,303,397	0.25	214	405	86,670	161,296	2,578,737	3,882,135	
394.75	0.25	123	403	49,569	92,089	1,395,487	0.25	215	407	87,505	162,854	2,741,591	4,137,078	
395.00	0.25	124	405	50,220	93,303	1,488,789	0.25	216	409	88,344	164,419	2,906,010	4,394,799	
395.10	0.10	124.4	405.8	50,482	37,662	1,526,452	0.10	216.4	409.8	88,681	66,207	2,972,217	4,498,669	
395.20	0.10	124.8	406.6	50,744	37,858	1,564,310	0.10	216.8	410.6	89,018	66,459	3,038,677	4,602,986	Emergency Spillway
					1,964,138						4,123,395		6,087,533	

Figure 3 – Hydrologic Storm Water Runoff Analysis

Hydrographs based on Phases 1 through 5 projected open areas				
Phase 1 - 34 Acres to West Pond (Tc = 30 minutes)				
24- hour Storm Event	Hydrograph Volume (Acre- Feet)	Peak Runoff, (CFS)	Hydrograph Volume (Gallons)	Peak Runoff, (gpm)
1 Year	5.1	52.1	1,661,727	23,382
2 Year	6.6	67.6	2,150,470	30,339
5 Year	8.5	85.8	2,769,545	38,507
10 Year	10.1	101.4	3,290,871	45,508
25 Year	12.0	119.5	3,909,946	53,632
Phase 2 - 45 Acres to North Pond (Tc = 1 hour)				
24- hour Storm Event	Hydrograph Volume (Acre- Feet)	Peak Runoff, (CFS)	Hydrograph Volume (Gallons)	Peak Runoff, (gpm)
1 Year	6.7	42.8	2,183,053	19,209
2 Year	8.7	55.8	2,834,711	25,043
5 Year	11.2	71.0	3,649,283	31,865
10 Year	13.3	84.1	4,333,523	37,744
25 Year	15.8	99.5	5,148,095	44,656
Phase 3 - 24 Acres to North Pond (Tc = 30 minutes)				
24- hour Storm Event	Hydrograph Volume (Acre- Feet)	Peak Runoff, (CFS)	Hydrograph Volume (Gallons)	Peak Runoff, (gpm)
1 Year	3.6	36.8	1,172,984	16,516
2 Year	4.7	47.8	1,531,395	21,453
5 Year	6.0	60.6	1,954,973	27,197
10 Year	7.1	71.6	2,313,384	32,134
25 Year	8.4	84.4	2,736,962	37,879

Figure 3 – Hydrologic Storm Water Runoff Analysis, Continued

Phase 4 - 22 Acres to West Pond (Tc = 30 minutes)				
24- hour Storm Event	Hydrograph Volume (Acre- Feet)	Peak Runoff, (CFS)	Hydrograph Volume (Gallons)	Peak Runoff, (gpm)
1 Year	3.3	33.7	1,075,235	15,125
2 Year	4.3	43.8	1,401,064	19,657
5 Year	5.5	55.6	1,792,058	24,953
10 Year	6.5	65.6	2,117,887	29,441
25 Year	7.8	77.4	2,541,465	34,737

Phase 5 - 69 Acres to North and West Ponds [34.5 Acres to each] (Tc = 30 minutes)				
24- hour Storm Event	Hydrograph Volume (Acre- Feet)	Peak Runoff, (CFS)	Hydrograph Volume (Gallons)	Peak Runoff, (gpm)
1 Year	5.1	52.9	1,661,727	23,742
2 Year	6.7	68.6	2,183,053	30,788
5 Year	8.6	87.1	2,802,128	39,090
10 Year	10.3	102.9	3,356,037	46,182
25 Year	12.2	121.3	3,975,111	54,439

Rainfall Amounts, Inches	
1 Year	2.8
2 Year	3.4
5 Year	4.1
10 Year	4.7
25 Year	5.4

Figure 4 – Standpipe Flow Rates

West Leachate Pond				
Concrete-Lined Basin	1-inch holes		3/4-inch holes	
Water Elevation	4-inch spacing	6-inch spacing	4-inch spacing	6-inch spacing
391.25	276	177	155	99
391.50	330	203	186	114
391.75	384	246	216	139
392.00	437	276	246	155
392.25	501	324	282	183
392.50	566	357	318	201
392.75	630	408	354	229
393.00	693	445	390	250
393.25	767	499	431	280
393.50	824	538	464	303

North Leachate Pond				
Concrete-Lined Basin	1-inch holes		3/4-inch holes	
Water Elevation	4-inch spacing	6-inch spacing	4-inch spacing	6-inch spacing
389.75	183	26	103	15
390.00	224	35	126	20
390.50	330	81	186	45
391.00	437	105	246	59
391.50	566	203	318	114
392.00	693	230	390	130
392.50	824	357	464	201
393.00	923	388	519	218

West Leachate Pond				
Middle Basin	1-inch holes		3/4-inch holes	
Water Elevation	4-inch spacing	6-inch spacing	4-inch spacing	6-inch spacing
391.25	199	115	112	65
391.50	248	137	139	77
391.75	287	177	161	99
392.00	319	203	176	114

North Leachate Pond				
Middle Basin	1-inch holes		3/4-inch holes	
Water Elevation	4-inch spacing	6-inch spacing	4-inch spacing	6-inch spacing
389.75	80	64	45	36
390.00	11	81	62	45
390.25	132	110	74	62
390.50				

West Leachate Pond				
Middle Basin	1-inch holes		3/4-inch holes	
Water Elevation	4-inch spacing	6-inch spacing	4-inch spacing	6-inch spacing
391.25	128	64	72	36
391.50	171	81	96	45
391.75	214	115	120	65
392.00	257	137	144	77
392.25	311	177	175	99
392.50	367	203	207	114
392.75	423	246	238	139
393.00	478	276	269	155
393.25	543	324	306	182
393.50	610	357	343	201
393.75	666	408	375	229
394.00	714	445	402	250

North Leachate Pond				
Middle Basin	1-inch holes		3/4-inch holes	
Water Elevation	4-inch spacing	6-inch spacing	4-inch spacing	6-inch spacing
389.75	114	100	64	56
390.00	149	121	84	68
390.25	196	159	110	89
390.50	245	184	138	104
390.75	294	227	165	128
391.00	342	256	192	144
391.25	402	303	226	170
391.50	445	335	251	189
391.75	523	385	294	217
392.00	581	421	327	237
392.25	651	474	366	267
392.50	705	514	396	289

Figure 4 - Standpipe Flow Rates Continued

Standpipe Discharge Rate Summary

West Leachate Pond Outlet Standpipe (18" Dia. HDPE)			1.0-Inch-Diameter Drain Holes		1.5-Inch-Diameter Drain Holes	
Description	Elevation	No. Holes	Water Levels	Discharge Rate, gpm	Water Levels	Discharge Rate, gpm
Pond Bottom	388.0					
8" Dia. Outlet Pipe	398.0		389.0	0	389.0	0
1st Row Perfs.	389.0	3	389.5	24	389.5	54
2nd Row Perfs.	389.5	5	390.0	74	390.0	167
3rd Row Perfs.	390.0	5	390.5	140	**390.1**	**200**
4th Row Perfs.	390.5	6	**390.8**	**200**	390.5	315
5th Row Perfs.	391.0	6	391.0	226	391.0	509
6th Row Perfs.	391.5	6	391.5	326	391.5	733
7th Row Perfs.	392.0	6	392.0	438	392.0	985
Standpipe Top	394.0		392.5	560	392.5	1,261
			393.0	645	393.0	1,452
			393.5	718	393.5	1,615
			394.0	783	394.0	1,761

North Leachate Pond Outlet Standpipe (18" Dia. HDPE)			1.0-Inch-Diameter Drain Holes		1.5-Inch-Diameter Drain Holes	
Description	Elevation	No. Holes	Water Levels	Discharge Rate, gpm	Water Levels	Discharge Rate, gpm
Pond Bottom	386.5					
8" Dia. Outlet Pipe	387.5		387.5	0	387.5	0
1st Row Perfs.	387.5	3	388.0	24	388.0	54
2nd Row Perfs.	388.0	5	388.5	74	388.5	167
3rd Row Perfs.	388.5	5	389.0	140	**388.6**	**200**
4th Row Perfs.	389.0	6	**389.3**	**200**	389.0	315
5th Row Perfs.	389.5	6	389.5	226	389.5	509
6th Row Perfs.	390.0	6	390.0	326	390.0	733
7th Row Perfs.	390.5	6	390.5	438	390.5	985
8th Row Perfs.	391.0	6	391.0	560	391.0	1,261
9th Row Perfs.	391.5	6	391.5	693	391.5	1,559
10th Row Perfs.	392.0	6	392.0	835	392.0	1,878
Standpipe Top	394.0		392.5	985	392.5	2,216
			393.0	1,096	393.0	2,465
			393.5	1,193	393.5	2,683
			394.0	1,281	394.0	2,882

Figure 5 - Surface Water Drainage Calculations For Leachate Pond Emergency Spillway

100 Year - 24 Hour storm event, Type II Storm, Flat Slope Condition

Rainfall is 6.5 inches for Rockport Area

Runoff Curve Number is 90 for exposed ash

Runoff Depth from Table 1 interpolation:

6.0 inch rain, CN = 90, Runoff is:	4.85	
	6.5 inch rain, CN=90, Runoff is:	5.34
7.0 inch rain, CN = 90, Runoff is:	5.82	

Determine Runoff Quantity, Q Drainage Area = 45 Acres (based on Phase 2)

Obtain Peak Rate of Discharge from Figure D-2 (Attachment)

Peak Rate of Discharge is: 30 cfs/inch of runoff

Determine Runoff Quantity:

Q = 30 cfs / inch of runoff x 5.34 inches of runoff

Q = 160.1 cfs

25 Year – 24 Hour storm event, Type II Storm, Flat Slope Condition

Rainfall is 5.4 inches for Rockport Area

Runoff Curve Number is 90 for exposed ash

Runoff Depth from Table 1 interpolation:

5.0 inch rain, CN = 90, Runoff is:	3.88	
	5.4 inch rain, CN=90, Runoff is:	4.27
6.0 inch rain, CN = 90, Runoff is:	4.85	

Determine Runoff Quantity, Q Drainage Area = 45 Acres (based on Phase 2)

Obtain Peak Rate of Discharge from Figure D-2 (Attachment)

Peak Rate of Discharge is: 30 cfs/inch of runoff

Determine Runoff Quantity:

Q = 30 cfs / inch of runoff x 4.27 inches of runoff

Q = 128.0 cfs

Leachate Treatment Pond captures the 25-year runoff with the difference going through the emergency spillway

Q difference = $Q_{100} - Q_{25}$ [160.1 cfs – 128.0 cfs]

Q difference = 32.1 cfs Use this to size emergency spillway

Table 1 - Runoff Depth in Inches for Selected CN's and Rainfall Amounts

Rainfall	Curve Numbers (CN)								
(inches)	60	65	70	75	80	85	**90**	95	98
5.0	1.30	1.65	2.04	2.45	2.89	3.37	**3.88**	4.42	4.76
6.0	1.92	2.35	2.80	3.28	3.78	4.31	**4.85**	5.41	5.76
7.0	2.60	3.10	3.62	4.15	4.69	5.26	**5.82**	6.41	6.76

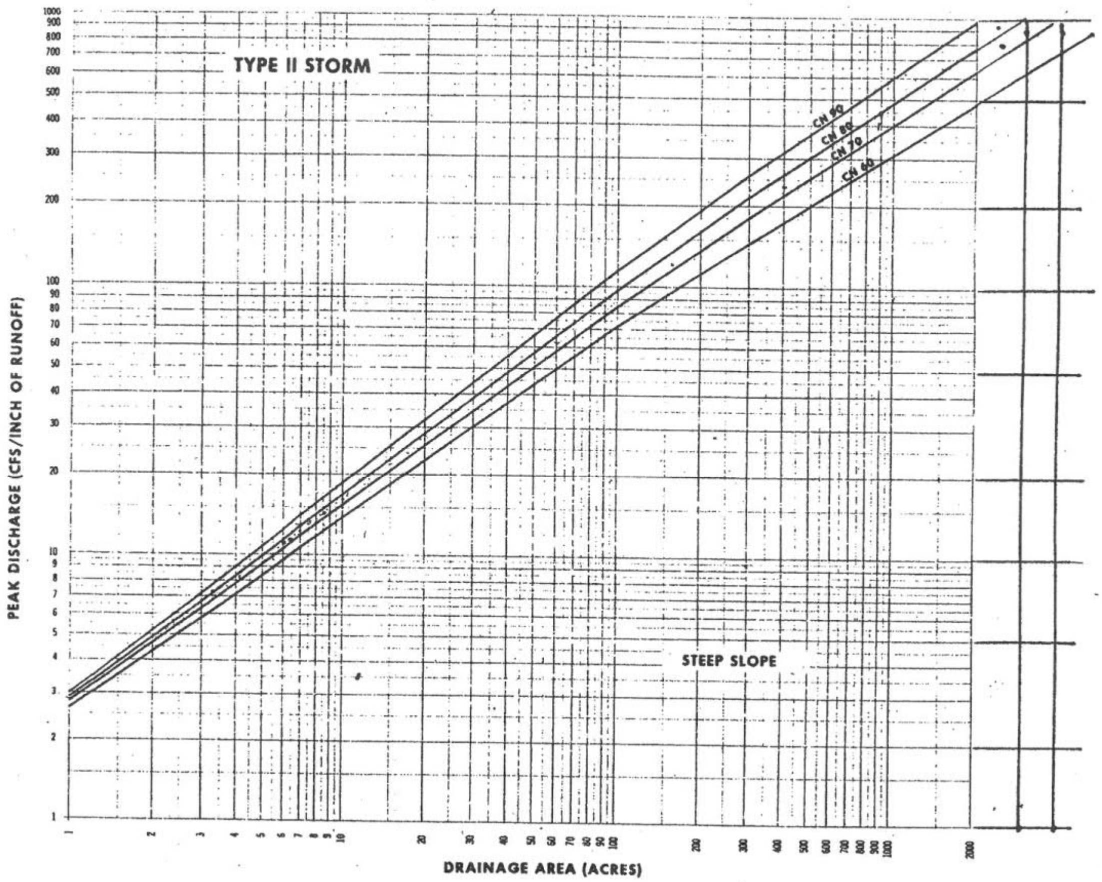


Figure D-2.--Peak rates of discharge for small watersheds (24-hour, type-II storm distribution). Sheet 3 of 3

Calculation of Flow in a Trapezoidal Channel using Manning's Formula

Velocity (V) =	(1.486/n)(R^2/3)(S^1/2)
Flow (Q) =	Velocity x Area (VA)
n =	Manning's Friction Factor
R =	Hydraulic Radius (Area/Wetted Perimeter)
S =	Channel Slope
A =	Area

Design Parameters

Bottom Width, B	8.0	feet		
Sideslope Left, X_L	5	z : 1		
Sideslope Right, X_R	5	z : 1		
Channel Slope, S	1.00%			
Channel Depth, D	0.85	feet	10.2	inches
Manning's "n"	0.035	riprap		

Results

Flow (Q) =	32.3	cu. ft. per sec.
Velocity (V) =	3.1	feet per second

Rip Rap Selection

d(50) = 64.2lbs/cu. ft * D * S/4

d(50) = **0.1** feet

Type	Min. (ft)	D(50), (ft)	Max. (ft)	
A	1.5	2.0	2.5	
B	1.0	1.5	2.0	
C	0.5	1.0	1.5	
D	0.25	0.5	1.0	

Shear Stress, t

w, unit weight of water, (lbs/ft^3)	62.4	
D, flow depth*, (ft)	0.85	
R, hydraulic radius*, (ft)	0.62	* for wide channels use flow depth
Channel wide (1) or narrow (2)	2	
S, channel slope (ft/ft)	0.010	
Shear stress, t =	**0.39**	(lbs/ft^2)

APPENDIX 2
SURFACE WATER DRAINAGE CALCULATIONS – FINAL GRADE

Landfill Redesign
Storage Area 1A
Rockport Plant Fly Ash Landfill

H. C. NUTTING | A TERRACON COMPANY

APPENDIX 2
SURFACE WATER DRAINAGE CALCULATIONS – FINAL GRADE

The following includes calculations for design of:

Landfill Redesign
Storage Area 1A
Rockport Plant Fly Ash Landfill

APPENDIX 2
SURFACE WATER DRAINAGE CALCULATIONS – FINAL GRADE

BENCHES AND DOWN-SLOPE CHANNELS

Landfill Redesign
Storage Area 1A
Rockport Plant Fly Ash Landfill

H. C. NUTTING | A TERRACON COMPANY

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT:	American Electric Power	Prepared By	BER	Date	3/13/2009
PROJECT:	Rockport Fly Ash Landfill	Reviewed By	RSE	Date	3/27/09
W.O. #	N1087247				

OBJECTIVE
Estimate the runoff quantities for the proposed final grade layout and size the planned drainage control structures (swales and flumes).

PLAN LAYOUT
See the attached Figure 1 for layout of the drainage control structures.

BASIS FOR RUNOFF CALCULATIONS
Use 25 Yr/24 Hr storm event, Type II Storm, Flat Slope Condition for 2% Grade
TR55 Method

Rainfall is 5.4 inches for Rockport Area

Runoff Curve Number is 71 for Meadow Condition, Soil Group "C"

Runoff Depth from Table 1 is interpolated to be 2.43 inches as shown below

5.0 inch rain, CN = 70, Runoff is: 2.04
5.0 inch rain, CN=71, Runoff is: 2.12
5.0 inch rain, CN = 75, Runoff is: 2.45
5.4 inch rain, CN=71, Runoff is: 2.43
6.0 inch rain, CN = 70, Runoff is: 2.80
6.0 inch rain, CN=71, Runoff is: 2.90
6.0 inch rain, CN = 75, Runoff is: 3.28

Table 1 - Runoff Depth in Inches for Selected CN's and Rainfall Amounts

Rainfall (inches)	Curve Numbers (CN) 60	65	70	75	80	85	90	95	98
1.0	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	0.00	0.00	0.03	0.07	0.15	0.28	0.46	0.74	0.99
1.4	0.00	0.02	0.06	0.13	0.24	0.39	0.61	0.92	1.18
1.6	0.01	0.05	0.11	0.02	0.34	0.52	0.76	1.11	1.38
1.8	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.29	1.58
2.0	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48	1.77
2.5	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
3.0	0.33	0.51	0.72	0.96	1.25	1.59	1.98	2.45	2.78
4.0	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
5.0	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	1.92	2.35	2.80	3.28	3.78	4.31	4.85	5.41	5.76
7.0	2.60	3.10	3.62	4.15	4.69	5.26	5.82	6.41	6.76
8.0	3.33	3.90	4.47	5.04	5.62	6.22	6.81	7.40	7.76
9.0	4.10	4.72	5.34	5.95	6.57	7.19	7.79	8.40	8.76
10.0	4.90	5.57	6.23	6.88	7.52	8.16	8.78	9.40	9.76

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT:	American Electric Power	Prepared By	BER	Date	3/13/2009
PROJECT:	Rockport Fly Ash Landfill	Reviewed By	RGE	Date	3/21/09
W.O. #	N1087247				

DRAINAGE AREAS

Top Plateau to Top Bench

Area 1a	3.0	Acres	Area 1b	5.8	Acres	Area 1	8.8	Acres
Area 2a	12.1	Acres	Area 2b	6.2	Acres	Area 2	18.3	Acres
Area 3a	16.0	Acres	Area 3b	3.7	Acres	Area 3	19.7	Acres
Area 4a	10.1	Acres	Area 4b	10.3	Acres	Area 4	20.4	Acres
Area 5a	3.9	Acres	Area 5b	5.3	Acres	Area 5	9.2	Acres
Area 6a	12.4	Acres	Area 6b	13.4	Acres	Area 6	25.8	Acres

Mid-Slope Bench Areas (Acres)

Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
2.9	1.6	1.2	2.9	3.4	3.2

DETERMINE PEAK RUNOFF FLOW, Q

Consider runoff from the top plateau to the top bench (flat slope)

Equation: Q = cfs/inch of runoff x inches of runoff

Example Calculation using Drainage Area 1a

Size of Drainage Area 1a: 3.0 Acres

Obtain Peak Rate of Discharge from Figure D-2 (Attachment) with CN of 71

Peak Rate of Discharge, Area 1a: 3.1 cfs/inch of runoff

Determine Runoff Quantity:

Q = 3.1 cfs/inch of runoff x 2.43 inches of runoff

Q = 7.5 cfs

Determine Runoff Flow for All Top Plateau Areas

Area No.	Water Shed Acreage	Peak Discharge, Figure D-2 (Sht 1)	Runoff Flow, (cfs)
1a	3.0	3.1	7.5
2a	12.1	8.2	19.9
3a	16.0	10.0	24.3
4a	10.1	7.1	17.3
5a	3.9	3.7	9.0
6a	12.4	8.4	20.4

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT: American Electric Power — Prepared By BER — Date 3/13/2009
PROJECT: Rockport Fly Ash Landfill — Reviewed By RGT — Date 3/27/09
W.O. # N1087247

Area No.	Water Shed Acreage	Peak Discharge, Figure D-2 (Sht 1)	Runoff Flow, (cfs)
1b	5.8	5.0	12.2
2b	6.2	5.3	12.9
3b	3.7	3.6	8.8
4b	10.3	7.1	17.3
5b	5.3	4.6	11.2
6b	13.4	8.7	21.2

Area No.	Water Shed Acreage	Peak Discharge, Figure D-2 (Sht 1)	Runoff Flow, (cfs)
1	8.8	6.6	16.0
2	18.3	11.0	26.7
3	19.7	11.5	28.0
4	20.4	12.0	29.2
5	9.2	6.6	16.0
6	25.8	13.0	31.6

Determine runoff from the side slope to the mid-slope bench (steep slope)

Area No.	Water Shed Acreage	Peak Discharge, Figure D-2 (Sht 3)	Runoff Flow, (cfs)
1	2.9	6.4	15.6
2	1.6	4.0	9.7
3	1.2	3.2	7.8
4	2.9	6.2	15.1
5	3.4	7.0	17.0
6	3.2	6.6	16.0

Assuming mid-slope bench drains before top plateau, what is higher of the runoffs

Area No.	Top Plateau	Mid-Slope Bench	Larger Flow
1	16.0	15.6	16.0
2	26.7	9.7	26.7
3	28.0	7.8	28.0
4	29.2	15.1	19.2
5	16.0	17.0	17.0
6	31.6	16.0	31.6

SIZING OF THE DRAINAGE CHANNELS - TOP BENCH CHANNEL

Consider the Top Bench with runoff flow from Areas 1a through 6b
Runoff flow reaching the benches vary from 7.5 cfs to 24.3 cfs
Look at the largest flow - 24.3 cfs. Size benches to fit this flow
Size Channel using Manning's Equation with variable vegetative retardance
Ref. Open Channel Hydraulics, Chow, 1959
Solve for Flow Depth (Y) (ft) based on a given shape

Channel Components:

Shape	Irregular Vee		
Vegetative Retardance	C - Moderate		
Channel Slope	0.5% (0.005 ft/ft)		
Side Slopes	3H:1V & 10H:1V		
Sideslope (Left) (Z1:1)		3	(Landfill slope)
Sideslope (Right) (Z2:1)		10	(Bench slope)
Bottom Width (ft)	0.0		

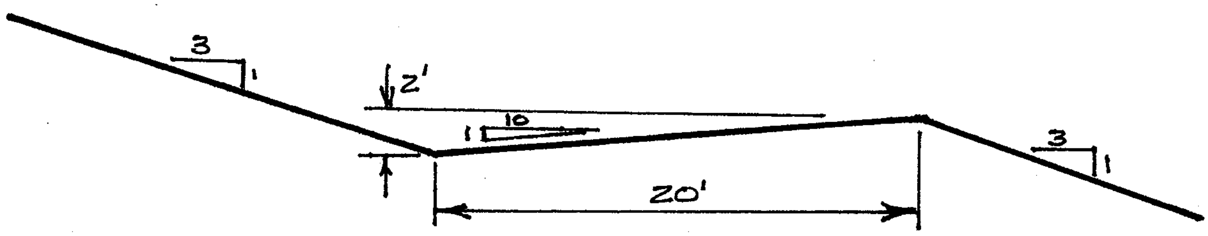
Determined Flow Depth (Y) (ft) **1.8**

Results:

Area (sq ft)	21.1	
Hydraulic Radius	0.89	
Velocity (fps)	1.16	
VR	1.08	
Manning's N	0.08	(From Vegetal Retardance Curve, attached)
Top Width (ft)	23.40	

Retardance	Cover	Conditions
A - Very High	Weeping Love Grass	Excellent Stand, Tall (av 30 in.)
B - High	Bermuda Grass	Good Stand, Tall (av 12 in.)
	Native Grass Mixture	Good Stand, Unmowed
	Weeping Love Grass	Good Stand, Tall (av 24 in.)
	Weeping Love Grass	Good Stand, Mowed, (av 13 in.)
C - Moderate	Crab Grass	Fair Stand, Uncut (10 to 48 in.)
	Bermuda Grass	Good Stand, Mowed (av 6 in.)
	Grass - Legume Mixture	Good Stand, Uncut (6 to 8 in.)
	Kentucky Bluegrass	Good Stand, Headed (6 to 12 in.)
D - Low	Bermuda Grass	Good Stand, Cut to 2.5 in. height
	Grass - Legume Mixture	Good Stand, Uncut (4 to 5 in.)
E - Very Low	Bermuda Grass	Good Stand, Cut to 1.5 in. height

ILLUSTRATION OF PROPOSED BENCH CHANNEL



Mid-Slope Bench will be the same size and shape for consistency.

SIZING OF THE DOWN-SLOPE CHANNELS

Size the down-slope channel based on the peak flow from the drainage areas
Can consider mid-slope bench peak flow will occur before the top bench peak

Maximum peak flow is from Area 6 at 31.6 cfs

Size for 31.6 cfs

Use Critical Flow Equation

V = Sqrt (g x D)

V = Velocity of Flow
g = Gravity = 32.174 ft/s2
D = Flow Depth

V = Q/A A = Area of Flow
A = Q/V = Q/Sqrt (g x D)

Using a trapezodial swale shape, solve for channel bottom width setting the flow depth

Area = 2((Zd)/2) + bd = (Zd) + (bd) = (Z+b)d
b = (Area/d)-Zd Z = channel side slopes

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT:	American Electric Power	Prepared By	BER	Date	3/13/2009
PROJECT:	Rockport Fly Ash Landfill	Reviewed By	[signature]	Date	3/22/09
W.O. #	N1087247				

Try flow depth at 0.5 ft (6 inches) and channel side slopes at 3:1

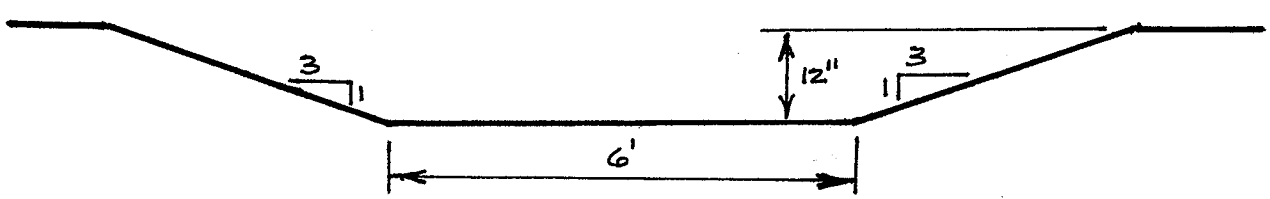
$V = \text{Sqrt}(32.174\ ft/s^2 * 0.5\ ft) =$	4.0	ft/s
Area = 31.6 cfs / 4.0 fps =	7.9	ft^2
$b = (7.9\ ft^2/0.5\ ft) - 3*0.5=$	14.3	ft

Try flow depth at 0.75 ft (9 inches) and channel side slopes at 3:1

$V = \text{Sqrt}(32.174\ ft/s^2 * 0.75\ ft)$	4.9	ft/s	
Area = 31.6 cfs / 4.9 fps =	6.4	ft^2	
$b = (6.4\ ft^2/0.75\ ft) - 3*0.75 =$	6.3	ft	OK

Conclusion: Peak flow will be at approximately 9 inches deep with 6-ft bottom width
Shape down slope channel to be 12 inches deep with 6-ft wide bottom

ILLUSTRATION OF PROPOSED DOWN-SLOPE CHANNEL



Attachments:

Figure 1 - Site Map with drainage areas and channels
25-Year 24-Hour Rainfall Map
Runoff Curve numbers
Figure D-2 Peak rates of discharge for small watersheds (Sheets 1 and 3)
Degrees of Vegetal Retardance for graphical solutions of Manning formula

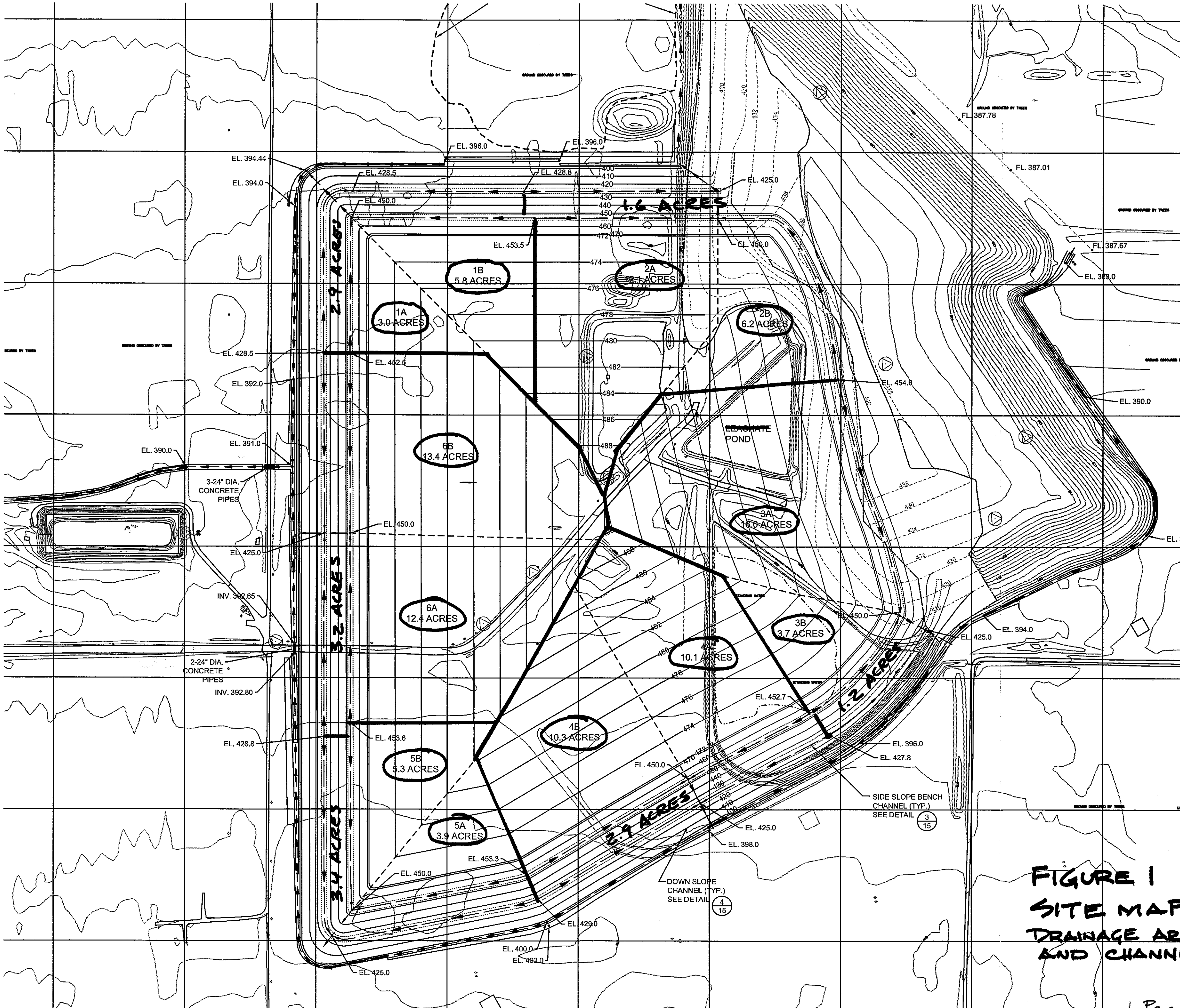
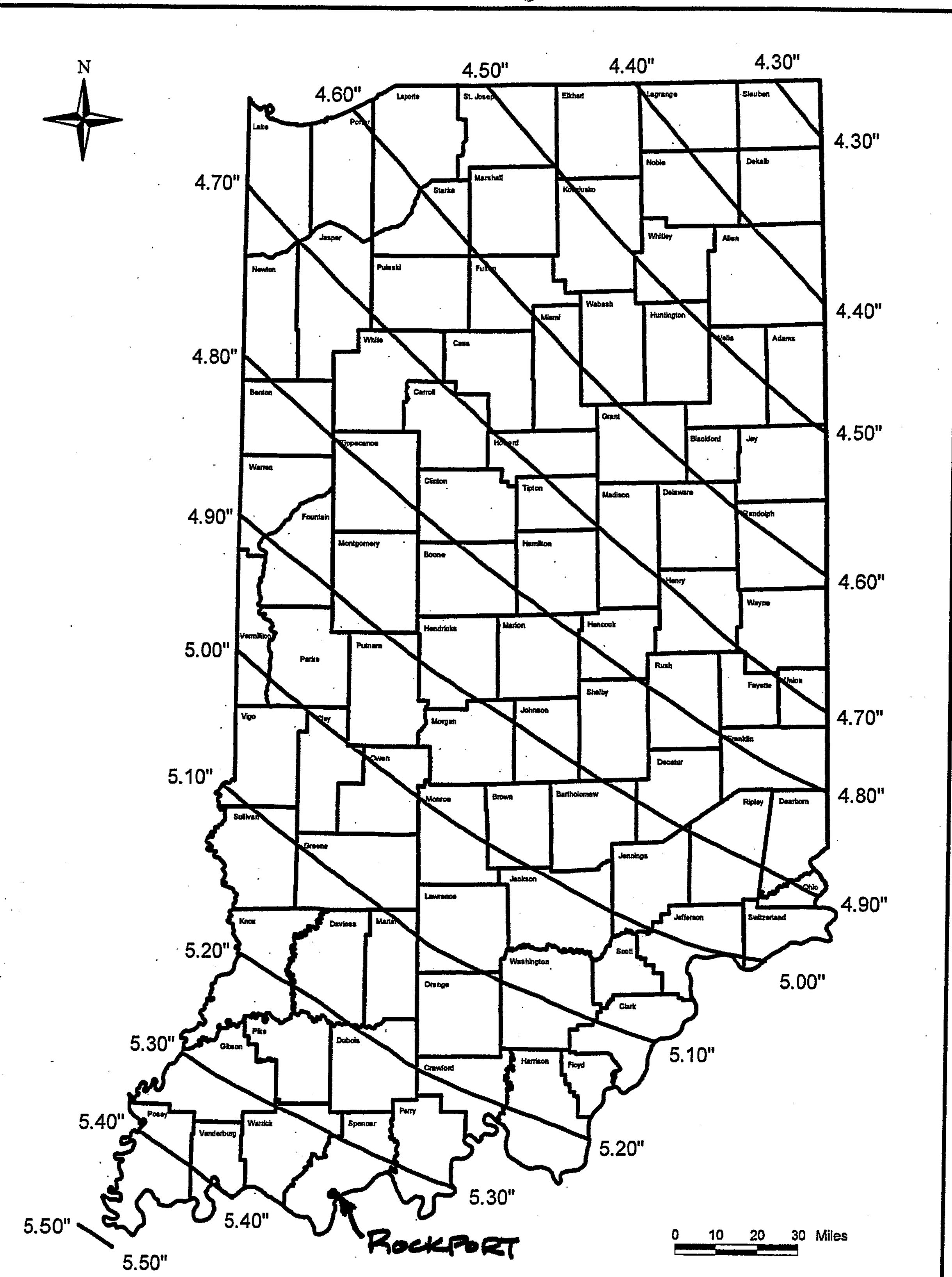


FIGURE 1
SITE MAP
DRAINAGE AREAS AND CHANNELS

RAINFALL - 25 YEAR FREQUENCY - 24 HOUR DURATION



REFERENCE
TECHNICAL PAPER NO. 40
NATIONAL WEATHER SERVICE

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

INDIANA DEPARTMENT OF NATURAL RESOURCES

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

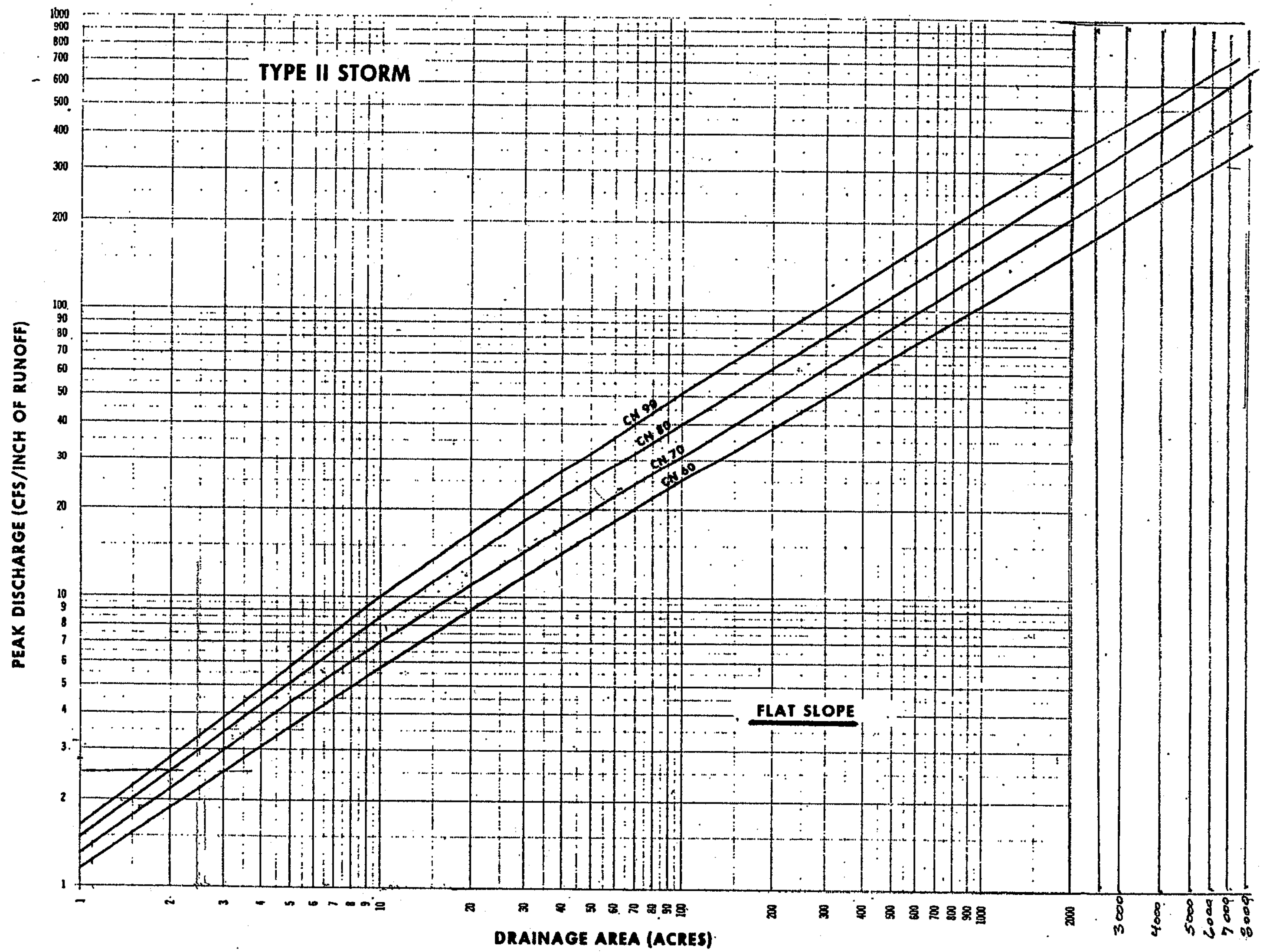


Figure D-2.--Peak rates of discharge for small watersheds (24-hour, type-II storm distribution). Sheet 1 of 3

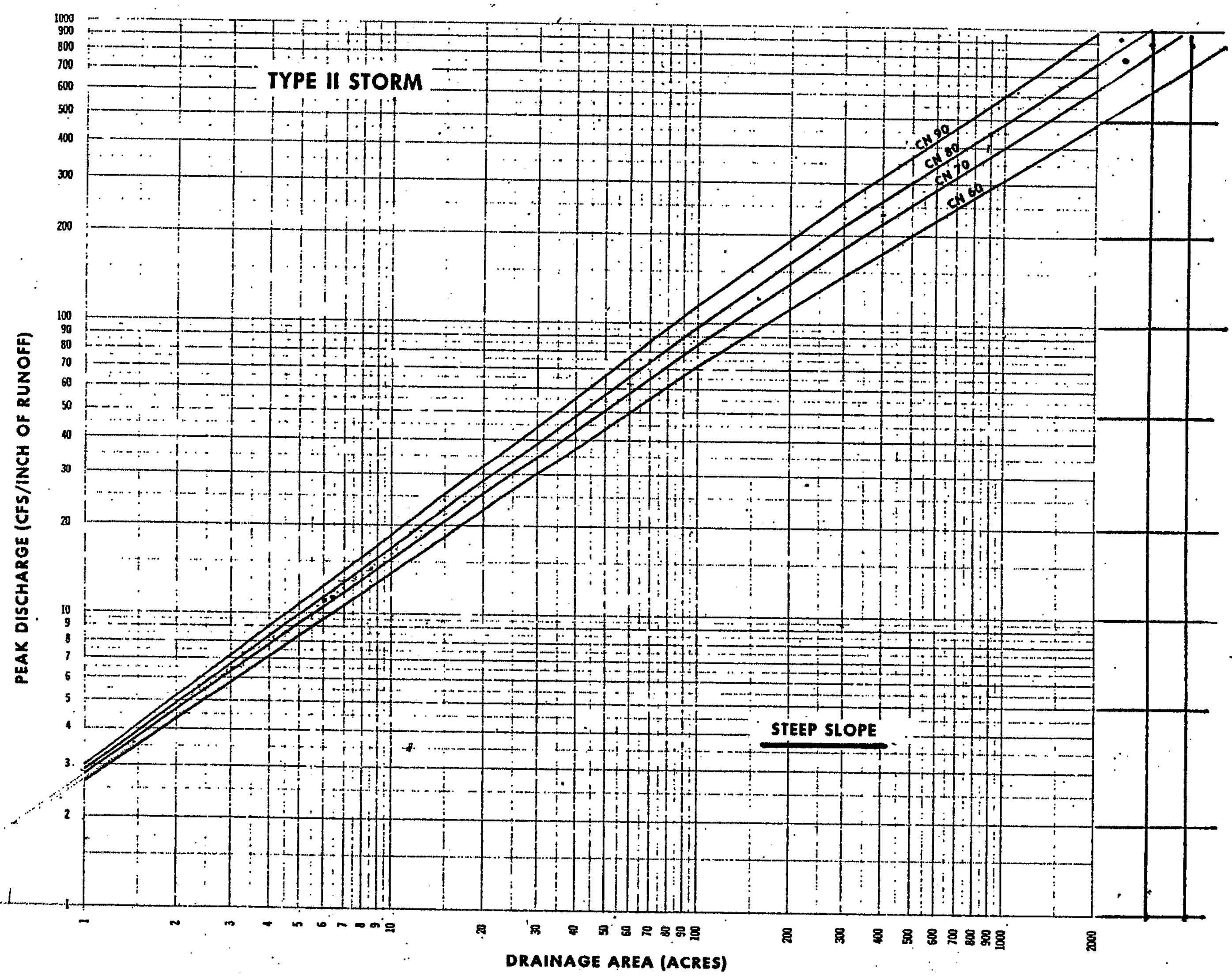
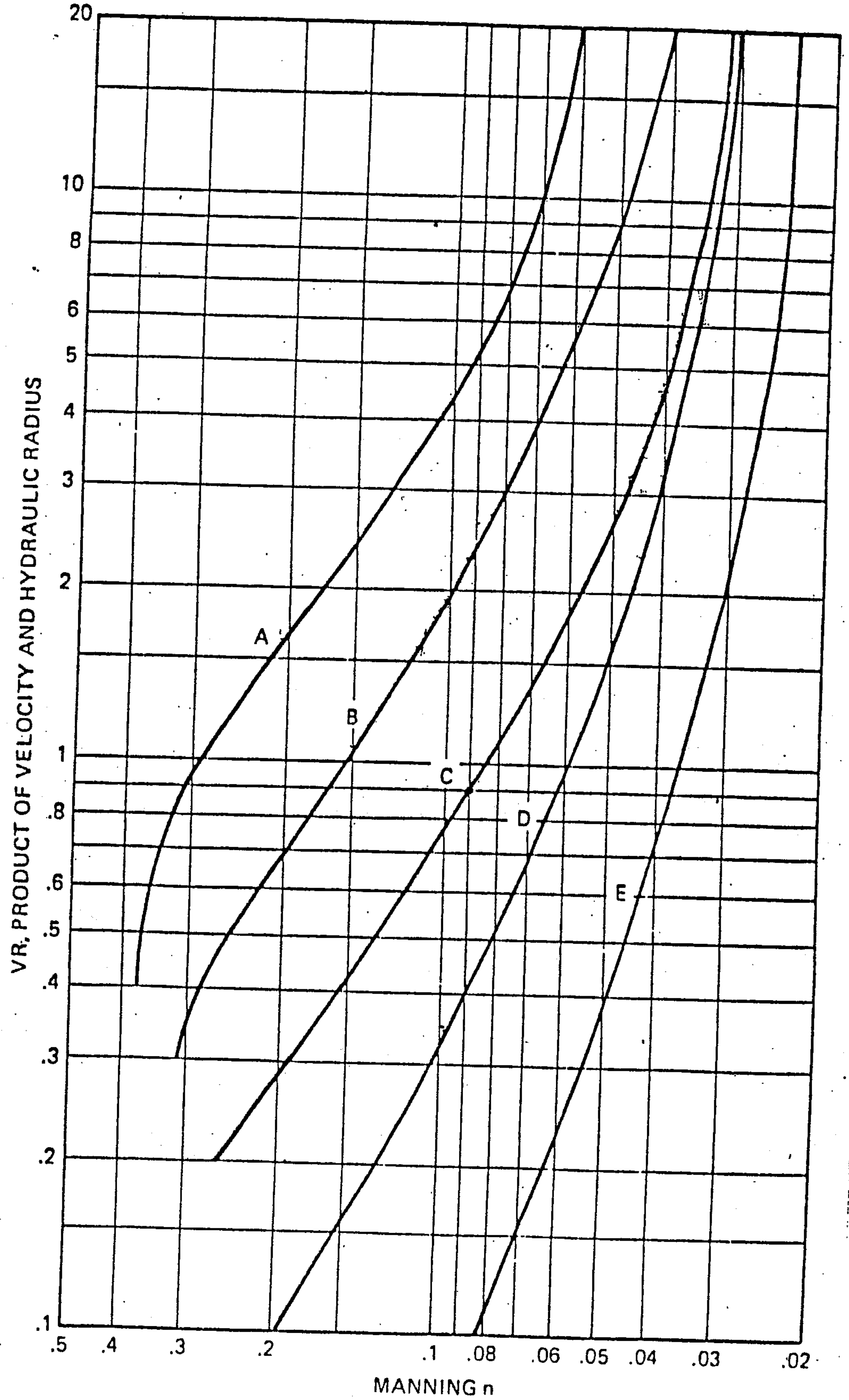


Figure D-2.--Peak rates of discharge for small watersheds (24-hour, type-II storm distribution). Sheet 3 of 3

DEGREES OF VEGETAL RETARDANCE FOR WHICH GRAPHICAL SOLUTIONS OF THE MANNING FORMULA HAVE BEEN PREPARED



FROM SCS "HANDBOOK OF CHANNEL DESIGN FOR SOIL AND WATER CONSERVATION"

APPENDIX 2
SURFACE WATER DRAINAGE CALCULATIONS – FINAL GRADE

UNIVERSAL SOIL LOSS EQUATION CALCULATION

Landfill Redesign
Storage Area 1A
Rockport Plant Fly Ash Landfill

UNIVERSAL SOIL LOSS EQUATION CALCULATION
ROCKPORT FLY ASH LANDFILL REDESIGN

BY: BRUCE ROME
DATE: 1/20/09

INTRODUCTION:
COMPLETE SOIL LOSS EQUATION CALCULATIONS TO DETERMINE EROSION IMPACTS ON THE 3H:1V SLOPE

EQUATION: A=R*K*LS*C*P

A = AVERAGE SOIL LOSS IN TONS PER ACRE FOR THE TIME PERIOD USED FOR FACTOR "R", (i.e. ANNUAL)
R = RAINFALL AND RUNOFF EROSIVITY INDEX
K = SOIL ERODIBILITY FACTOR
LS = SLOPE LENGTH FACTOR
L = LENGTH FACTOR
S = STEEPNESS FACTOR
C = COVER//MANAGEMENT FACTOR
P = PRACTICE FACTOR

SELECTION/DETERMINATION OF EQUATION VALUES:

R= 200 — FROM FIGURE 59, AVERAGE ANNUAL VALUES OF RAINFALL-EROSIVITY FACTOR FOR SOUTHERN INDIANA

K = 0.26 — FROM TABLE 27, APPROPRIATE VALUES OF FACTOR "K" FOR USDA TEXTURAL CLASSES. ASSUMED MATERIAL IS A SILTY CLAY LOAM WITH 4% ORGANIC MATTER CONTENT

LS = 8.6 — FROM TABLE 28, VALUES OF THE FACTOR "LS" FOR SPECIFIC COMBINATIONS OF SLOPE LENGTH AND STEEPNESS. MAXIMUM CONDITIONS ARE SLOPE OF 33% AND LENGTH OF 79 FT.

	75	79	100
30	6.9		8.0
33	8.13	**8.6**	9.5
40	11.0		13.0

C = 0.004 — FROM TABLE 29, GENERALIZED VALUES OF FACTOR "C" FOR STATES EAST OF THE ROCKY MOUNTAINS. ASSUMED CROP TO BE MEADOW, GRASS & LEGUME MIX AT MODERATE PRODUCTIVITY.

P = 1.0 — FROM TABLE 30, VALUES OF FACTOR "P". ASSUMED PRACTICE IS NO SUPPORT PRACTICE.

CALCULATION:
A = 200 x 0.26 x 8.6 x 0.004 x 1.0
A = 1.7888 TONS PER ACRE PER YEAR

CONCLUSION: **The soil loss is below 5 tons per acre per year.**

REFERENCE: Lutton, R.J., et al, "Design and Construction of Covers for Solid Waste Landfills", EPA Report 600/2-79-165, August 1979

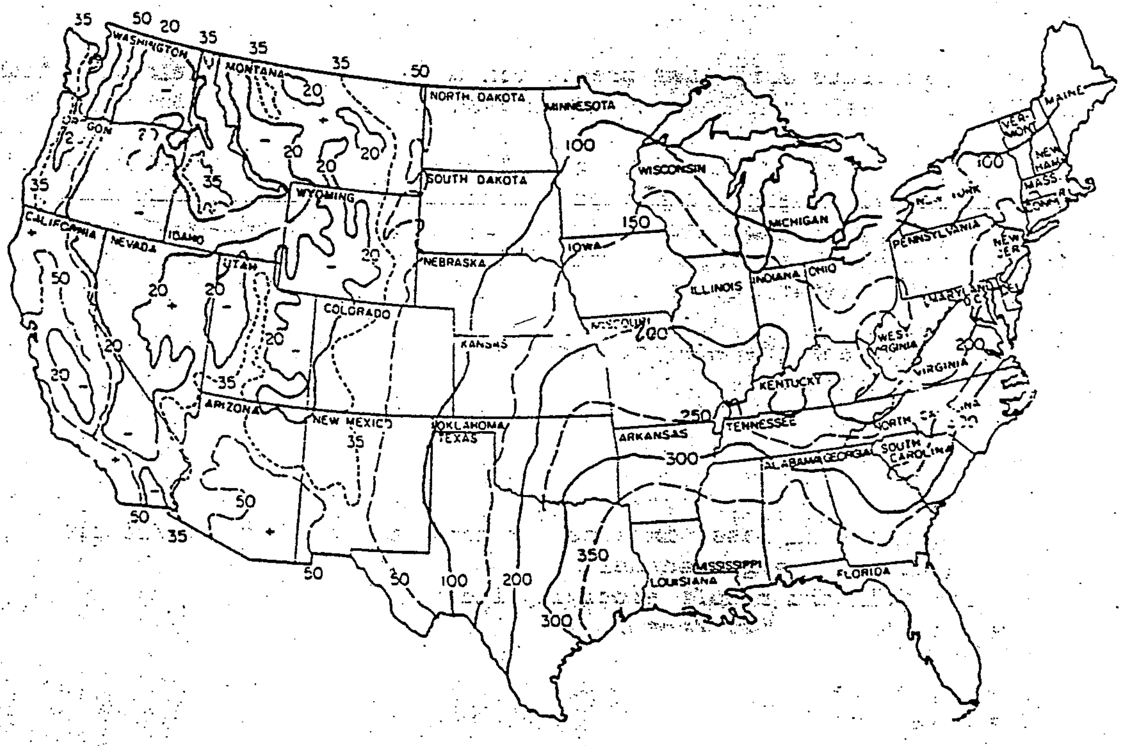


Figure 59. Average annual values of rainfall-erosivity factor R.[79]

TABLE 27. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[79]

Texture class	Organic matter content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

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

TABLE 28. VALUES OF THE FACTOR LS FOR SPECIFIC COMBINATIONS OF SLOPE LENGTH AND STEEPNESS[79]

% Slope	Slope length (feet)											
	25	50	75	100	150	200	300	400	500	600	800	1000
0.5	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
1	0.09	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.21	0.22	0.24	0.26
2	0.13	0.16	0.19	0.20	0.23	0.25	0.28	0.31	0.33	0.34	0.38	0.40
3	0.19	0.23	0.26	0.29	0.33	0.35	0.40	0.44	0.47	0.49	0.54	0.57
4	0.23	0.30	0.36	0.40	0.47	0.53	0.62	0.70	0.76	0.82	0.92	1.0
5	0.27	0.38	0.46	0.54	0.66	0.76	0.93	1.1	1.2	1.3	1.5	1.7
6	0.34	0.48	0.58	0.67	0.82	0.95	1.2	1.4	1.5	1.7	1.9	2.1
8	0.50	0.70	0.86	0.99	1.2	1.4	1.7	2.0	2.2	2.4	2.8	3.1
10	0.69	0.97	1.2	1.4	1.7	1.9	2.4	2.7	3.1	3.4	3.9	4.3
12	0.90	1.3	1.6	1.8	2.2	2.6	3.1	3.6	4.0	4.4	5.1	5.7
14	1.2	1.6	2.0	2.3	2.8	3.3	4.0	4.6	5.1	5.6	6.5	7.3
16	1.4	2.0	2.5	2.8	3.5	4.0	4.9	5.7	6.4	7.0	8.0	9.0
18	1.7	2.4	3.0	3.4	4.2	4.9	6.0	6.9	7.7	8.4	9.7	11.0
20	2.0	2.9	3.5	4.1	5.0	5.8	7.1	8.2	9.1	10.0	12.0	13.0
25	3.0	4.2	5.1	5.9	7.2	8.3	10.0	12.0	13.0	14.0	17.0	19.0
30	4.0	5.6	6.9	8.0	9.7	11.0	14.0	16.0	18.0	20.0	23.0	25.0
40	6.3	9.0	11.0	13.0	16.0	18.0	22.0	25.0	28.0	31.0	--	--
50	8.9	13.0	15.0	18.0	22.0	25.0	31.0	--	--	--	--	--
60	12.0	16.0	20.0	23.0	28.0	--	--	--	--	--	--	--

Values given for slopes longer than 300 feet or steeper than 18% are extrapolations beyond the range of the research data and, therefore, less certain than the others.

TABLE 30. VALUES OF FACTOR P[79]

Practice	Land slope (percent)				
	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{cl})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3] $0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

TABLE 29. GENERALIZED VALUES OF FACTOR C FOR STATES EAST OF THE ROCKY MOUNTAINS [79]

Crop, rotation, and management	Productivity level High	Productivity level Mod.
	C value	
Base value. continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, RdR, fall TP, conv	0.54	0.62
C, RdR, spring TP, conv	.50	.59
C, RdL, fall TP, conv	.42	.52
C, RdR, wc seeding, spring TP, conv	.40	.49
C, RdL, standing, spring TP, conv	.38	.48
C-W-M-M, RdL, TP for C, disk for W	.039	.074
C-W-M-M-M, RdL, TP for C, disk for W	.032	.061
C, no-till pl in c-k sod, 95-80% rc	.017	.053
COTTON		
Cot. conv (Western Plains)	0.42	0.49
Cot. conv (South)	.34	.40
MEADOW		
Grass & Legume mix	0.004	0.01
Alfalfa, lespedeza or Sericia	.020	
Sweet clover	.025	
SORGHUM, GRAIN (Western Plains)		
RdL, spring TP, conv	0.43	0.53
No-till pl in shredded 70-50% rc	.11	.18
SOYBEANS		
B, RdL, spring TP, conv	0.48	0.54
C-B, TP annually, conv	.43	.51
B, no-till pl	.22	.28
C-B, no-till pl, fall shred C stalks	.18	.22
WHEAT		
W-F, fall TP after W	0.38	
W-F, stubble mulch, 500 lbs rc	.32	
W-F, stubble mulch, 1000 lbs rc	.21	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding
% rc - percentage of soil surface covered by residue mulch after new crop seeding
70-50% rc - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

APPENDIX 2
SURFACE WATER DRAINAGE CALCULATIONS – FINAL GRADE

PERIMETER CHANNELS

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT: American Electric Power — Prepared By: BER — Date: 3/15/2009

PROJECT: Rockport Fly Ash Landfill — Reviewed By: [signature] — Date: 3/27/09

W.O. #: N1087247

OBJECTIVE

Estimate the runoff quantities for the proposed perimeter channels and size the planned drainage control structure.

PLAN LAYOUT

See the attached Figure 1 for layout of the drainage control structures.

BASIS FOR RUNOFF CALCULATIONS

Use 25 Yr/24 Hr storm event, Type II Storm, Flat Slope Condition for 2% Grade

Rainfall is 5.4 inches for Rockport Area

Runoff Curve Number is 71 for Meadow Condition, Soil Group "C"

Runoff Depth from Table 1 is interpolated to be 2.43 inches as shown below

5.0 inch rain, CN = 70, Runoff is: 2.04

5.0 inch rain, CN=71, Runoff is: 2.12

5.0 inch rain, CN = 75, Runoff is: 2.45

5.4 inch rain, CN=71, Runoff is: 2.43

6.0 inch rain, CN = 70, Runoff is: 2.80

6.0 inch rain, CN=71, Runoff is: 2.90

6.0 inch rain, CN = 75, Runoff is: 3.28

Table 1 - Runoff Depth in Inches for Selected CN's and Rainfall Amounts

Rainfall	Curve Numbers (CN)								
(inches)	60	65	70	75	80	85	90	95	98
1.0	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	0.00	0.00	0.03	0.07	0.15	0.28	0.46	0.74	0.99
1.4	0.00	0.02	0.06	0.13	0.24	0.39	0.61	0.92	1.18
1.6	0.01	0.05	0.11	0.02	0.34	0.52	0.76	1.11	1.38
1.8	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.29	1.58
2.0	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48	1.77
2.5	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
3.0	0.33	0.51	0.72	0.96	1.25	1.59	1.98	2.45	2.78
4.0	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
5.0	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	1.92	2.35	2.80	3.28	3.78	4.31	4.85	5.41	5.76
7.0	2.60	3.10	3.62	4.15	4.69	5.26	5.82	6.41	6.76
8.0	3.33	3.90	4.47	5.04	5.62	6.22	6.81	7.40	7.76
9.0	4.10	4.72	5.34	5.95	6.57	7.19	7.79	8.40	8.76
10.0	4.90	5.57	6.23	6.88	7.52	8.16	8.78	9.40	9.76

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT: American Electric Power — Prepared By BER — Date 3/15/2009
PROJECT: Rockport Fly Ash Landfill — Reviewed By TBE — Date 3/21/09
W.O. # N1087247

DRAINAGE AREAS

Channel 1	15.9	Acres
Channel 2	47.8	Acres
Channel 3	63.7	Acres
Channel 4	27.5	Acres
Channel 5	75.4	Acres
Channel 6	29.9	Acres

DETERMINE PEAK RUNOFF FLOW, Q

Consider runoff from the top plateau to the top bench (flat slope)

Equation: Q = cfs/inch of runoff x inches of runoff

Example Calculation using Channel 1 Area

Size of Channel 1 Drainage Area: 15.9 Acres

Obtain Peak Rate of Discharge from Figure D-2 (Attachment) with CN of 71

Peak Rate of Discharge 9.5 cfs/inch of runoff

Determine Runoff Quantity:

Q = 9.5 cfs/inch of runoff x 2.43 inches of runoff

Q = 23.1 cfs

Determine Runoff Flow for All Perimeter Channels

Channel	Water Shed Acreage	Peak Discharge, Figure D-2 (Sht	Runoff Flow, (cfs)
1	15.9	9.5	23.1
2a	2.0	4.7	11.4
2b	18.8	11.0	26.7
2c	47.8	20.0	48.6
3	63.7	24.0	58.4
4a	1.6	3.8	9.2
4b	27.5	13.0	31.6
5	75.4	26.0	63.2
6	29.9	14.5	35.3

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT: American Electric Power — Prepared By BER — Date 3/15/2009
PROJECT: Rockport Fly Ash Landfill — Reviewed By [handwritten initials] — Date 3/27/09
W.O. # N1087247

SIZING OF THE PERIMETER DRAINAGE CHANNELS

Channel 1 has peak flow estimate of 23.1 cfs

Size Channels using Manning's Equation with variable vegetative retardance
Solve for Flow Depth (Y) (ft) based on a given shape

Channel Components:

Shape	Trapezoidal
Vegetative Retardance	C - Moderate
Channel Slope	0.3% (0.003 ft/ft)
Side Slopes	3H:1V
Bottom Width (ft)	6.0

Determined Flow Depth (Y) (ft) **1.7**

Results:

Area (sq ft)	18.2	
Hydraulic Radius	1.10	
Velocity (fps)	1.28	
VR	1.46	
Manning's N	0.068	(From Vegetal Retardance Curve, attached)
Top Width (ft)	15.96	

Retardance	Cover	Conditions
A - Very High	Weeping Love Grass	Excellent Stand, Tall (av 30 in.)
B - High	Bermuda Grass	Good Stand, Tall (av 12 in.)
	Native Grass Mixture	Good Stand, Unmowed
	Weeping Love Grass	Good Stand, Tall (av 24 in.)
	Weeping Love Grass	Good Stand, Mowed, (av 13 in.)
C - Moderate	Crab Grass	Fair Stand, Uncut (10 to 48 in.)
	Bermuda Grass	Good Stand, Mowed (av 6 in.)
	Grass - Legume Mixture	Good Stand, Uncut (6 to 8 in.)
	Kentucky Bluegrass	Good Stand, Headed (6 to 12 in.)
D - Low	Bermuda Grass	Good Stand, Cut to 2.5 in. height
	Grass - Legume Mixture	Good Stand, Uncut (4 to 5 in.)
E - Very Low	Bermuda Grass	Good Stand, Cut to 1.5 in. height

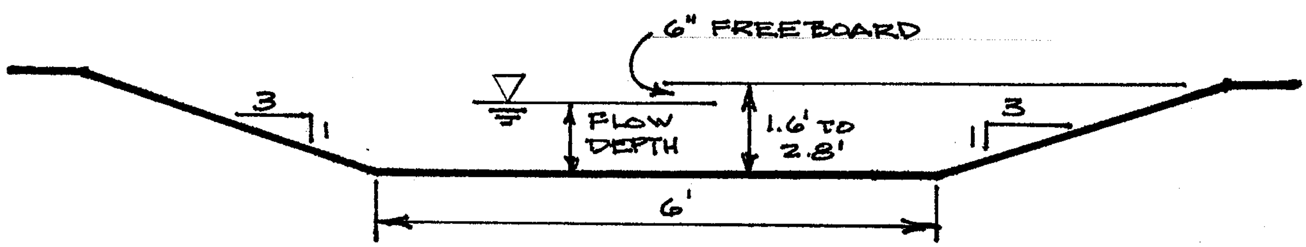
SURFACE WATER DRAINAGE CALCULATIONS

CLIENT: American Electric Power — Prepared By BER — Date 3/15/2009
PROJECT: Rockport Fly Ash Landfill — Reviewed By TGE — Date 3/27/09
W.O. # N1087247

TABLE FOR DESIGN OF PERIMETER DRAINAGE CHANNELS

Channel	1	2a	2b	2c	3	4a	4b	5	6
Flow, cfs	23.1	11.4	26.7	48.6	58.4	9.2	31.6	63.2	35.3
Bottom Width (ft)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Flow Depth, ft	1.66	1.12	1.85	2.24	2.30	1.32	1.85	2.26	1.89
Channel Slope	0.30%	0.30%	0.25%	0.25%	0.25%	0.30%	0.30%	0.30%	0.30%
Side Slopes	3H:1V	3H:1V	3H:1V	3H:1V	3H:1V	3H:1V	3H:1V	3H:1V	3H:1V
Area (sq ft)	18.23	10.48	21.37	28.49	29.67	13.15	21.37	28.88	22.06
Hydraulic Radius	1.10	0.80	1.21	1.41	1.44	0.92	1.21	1.42	1.23
Velocity (fps)	1.28	1.10	1.26	1.88	1.98	0.70	1.49	2.20	1.61
VR	1.41	0.88	1.52	2.65	2.85	0.64	1.80	3.12	1.98
Manning's N	0.068	0.064	0.067	0.050	0.048	0.110	0.062	0.047	0.058
Top Width (ft)	15.96	12.72	17.10	19.44	19.80	13.92	17.10	19.56	17.34

ILLUSTRATION OF PROPOSED PERIMETER CHANNEL



Attachments:

Figure 1 - Site Map with drainage areas and channels
25-Year 24-Hour Rainfall Map
Runoff Curve numbers
Figure D-2 Peak rates of discharge for small watersheds (Sheets 1 and 3)
Degrees of Vegetal Retardance for graphical solutions of Manning formula

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT:	American Electric Power	Prepared By	BER	Date	3/15/2009
PROJECT:	Rockport Fly Ash Landfill	Reviewed By	RGS	Date	3/27/09
W.O. #	N1087247				

SIZING OF THE INTERIOR DRAINAGE CHANNEL ALONG CELLS 2 & 3

Determine Peak Storm Water Runoff

Equation: Q = cfs/inch of runoff x inches of runoff

Size of Drainage Area: 3.0 Acres

Obtain Peak Rate of Discharge from Figure D-2 for Steep Slope with CN of 71

Peak Rate of Discharge 7.0 cfs/inch of runoff

Determine Runoff Quantity:

Q = 7.0 cfs/inch of runoff x 2.43 inches of runoff

Q = 17.0 cfs

Size Channel using Manning's Equation with variable vegetative retardance

Solve for Flow Depth (Y) (ft) based on a given shape

Channel Components:

Shape	Trapezoidal
Vegetative Retardance	C - Moderate
Channel Slope	0.3% (0.003 ft/ft)
Side Slopes	2H:1V
Bottom Width (ft)	**4.0**

Determined Flow Depth (Y) (ft) 1.87

Results:			
	Area (sq ft)	14.47	
	Hydraulic Radius	1.17	
	Velocity (fps)	1.18	
	VR	1.43	
	Manning's N	0.070	(From Vegetal Retardance Curve, attached)
	Top Width (ft)	11.48	

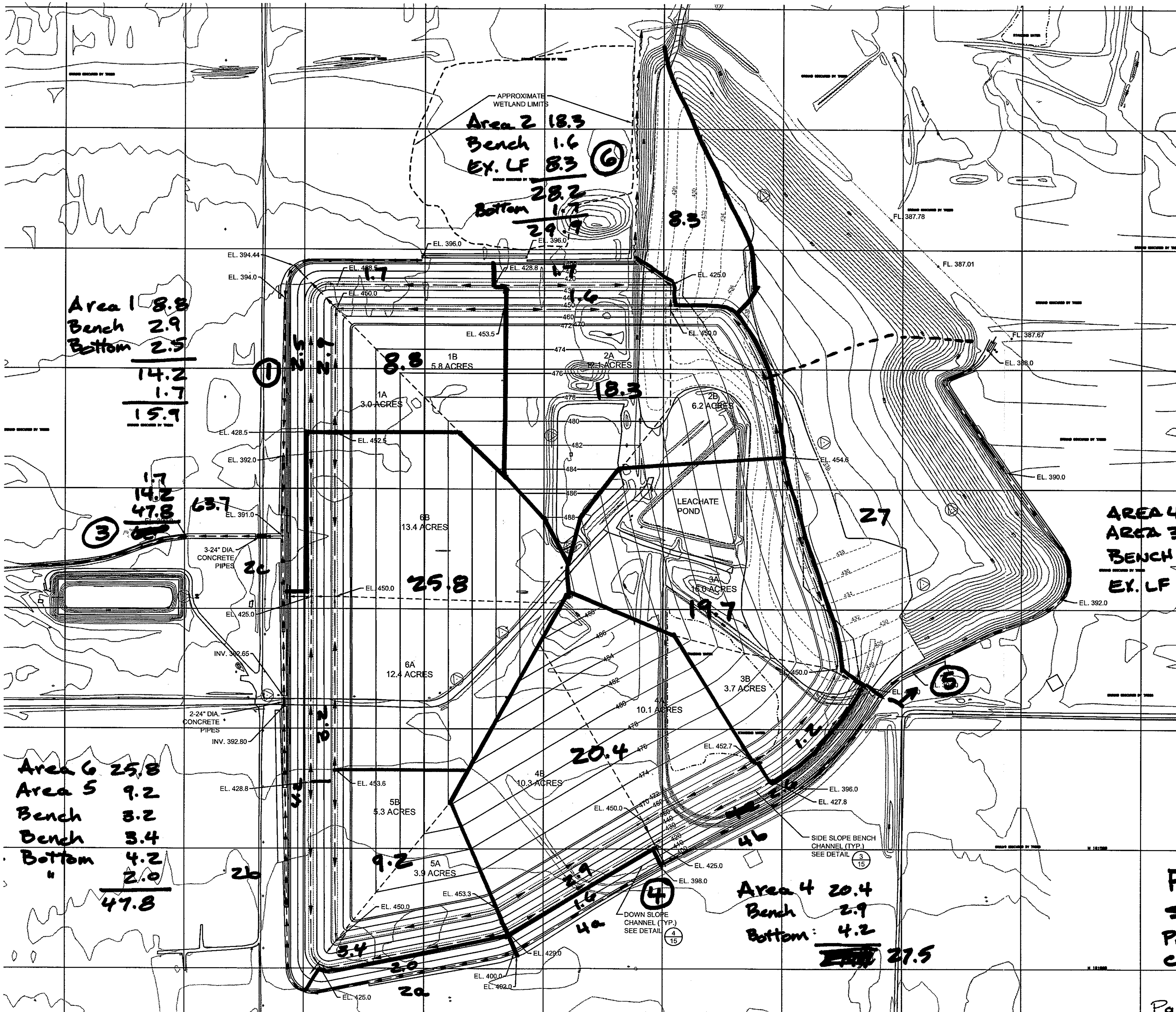
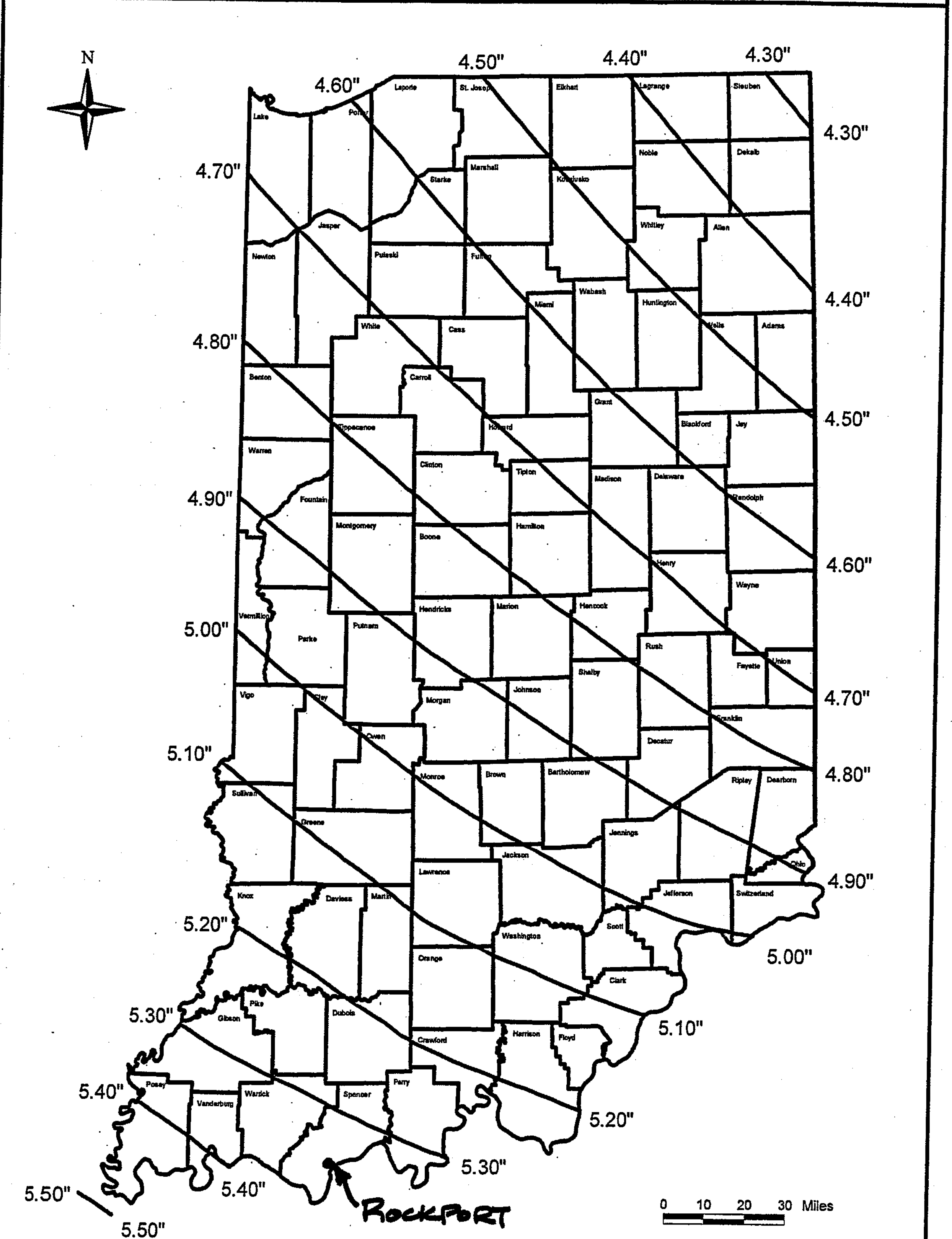


FIGURE 1
SITE MAP
PERIMETER CHANNEL

RAINFALL - 25 YEAR FREQUENCY - 24 HOUR DURATION



REFERENCE
TECHNICAL PAPER NO. 40
NATIONAL WEATHER SERVICE

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

INDIANA DEPARTMENT OF NATURAL RESOURCES

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

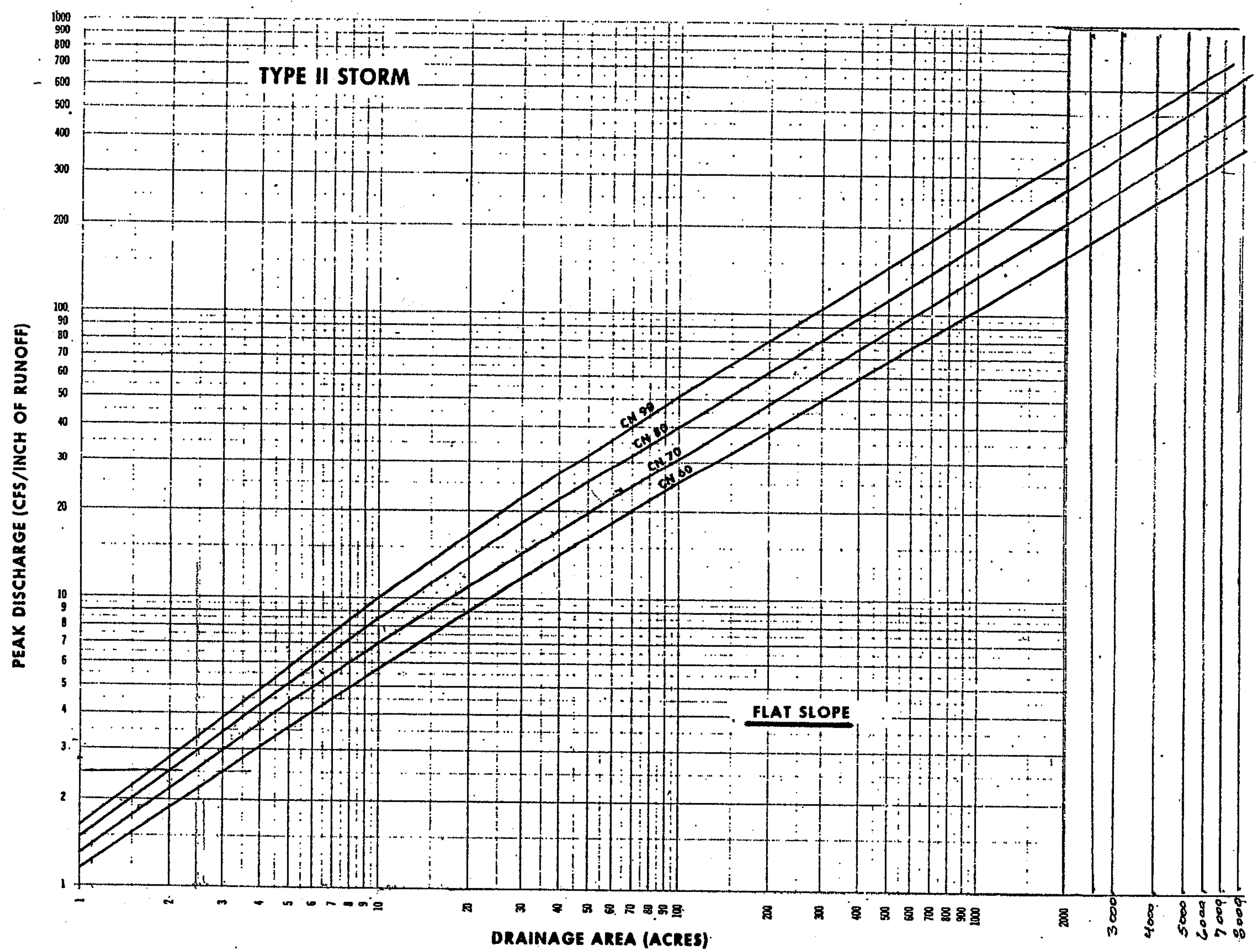


Figure D-2.--Peak rates of discharge for small watersheds (24-hour, type-II storm distribution). Sheet 1 of 3

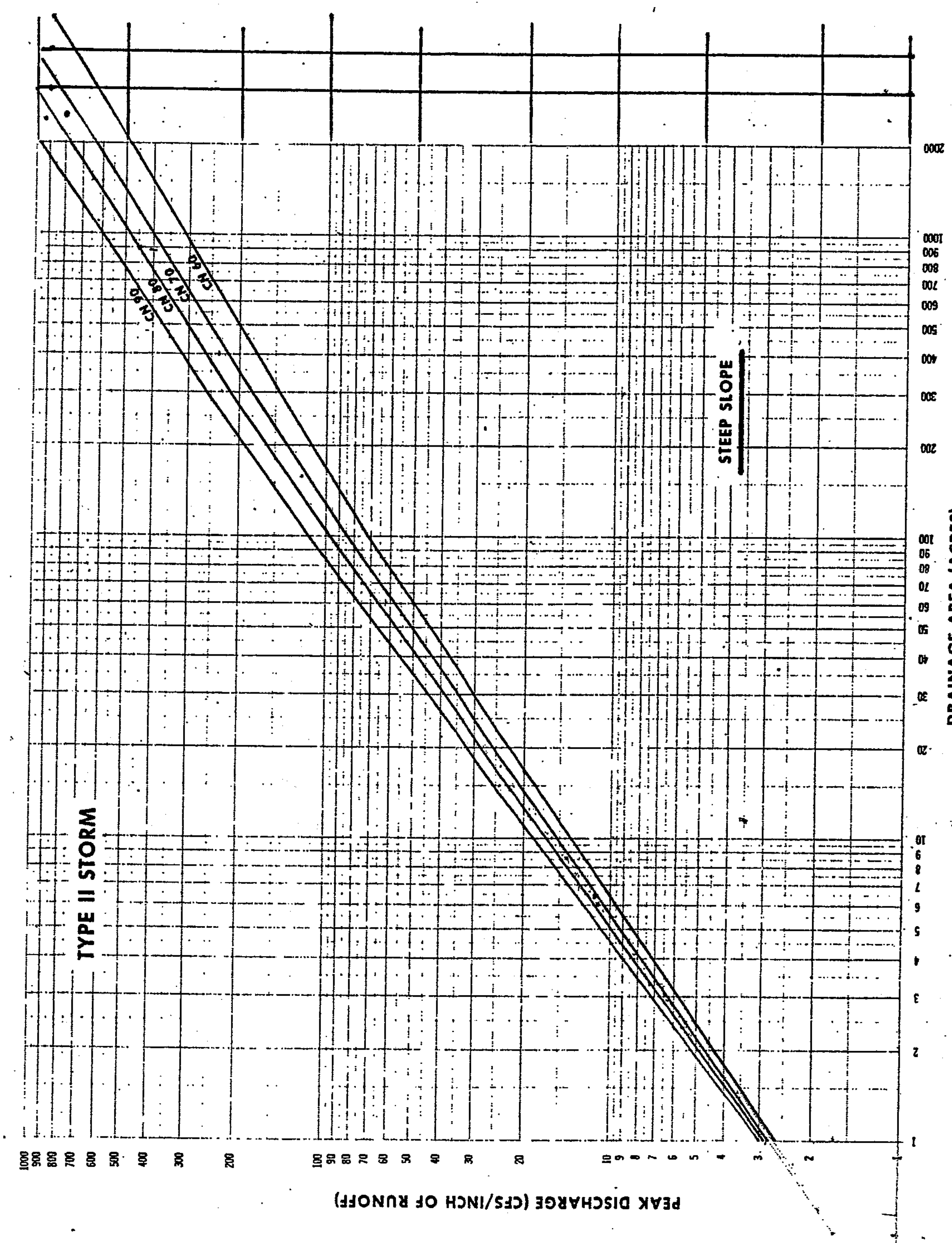
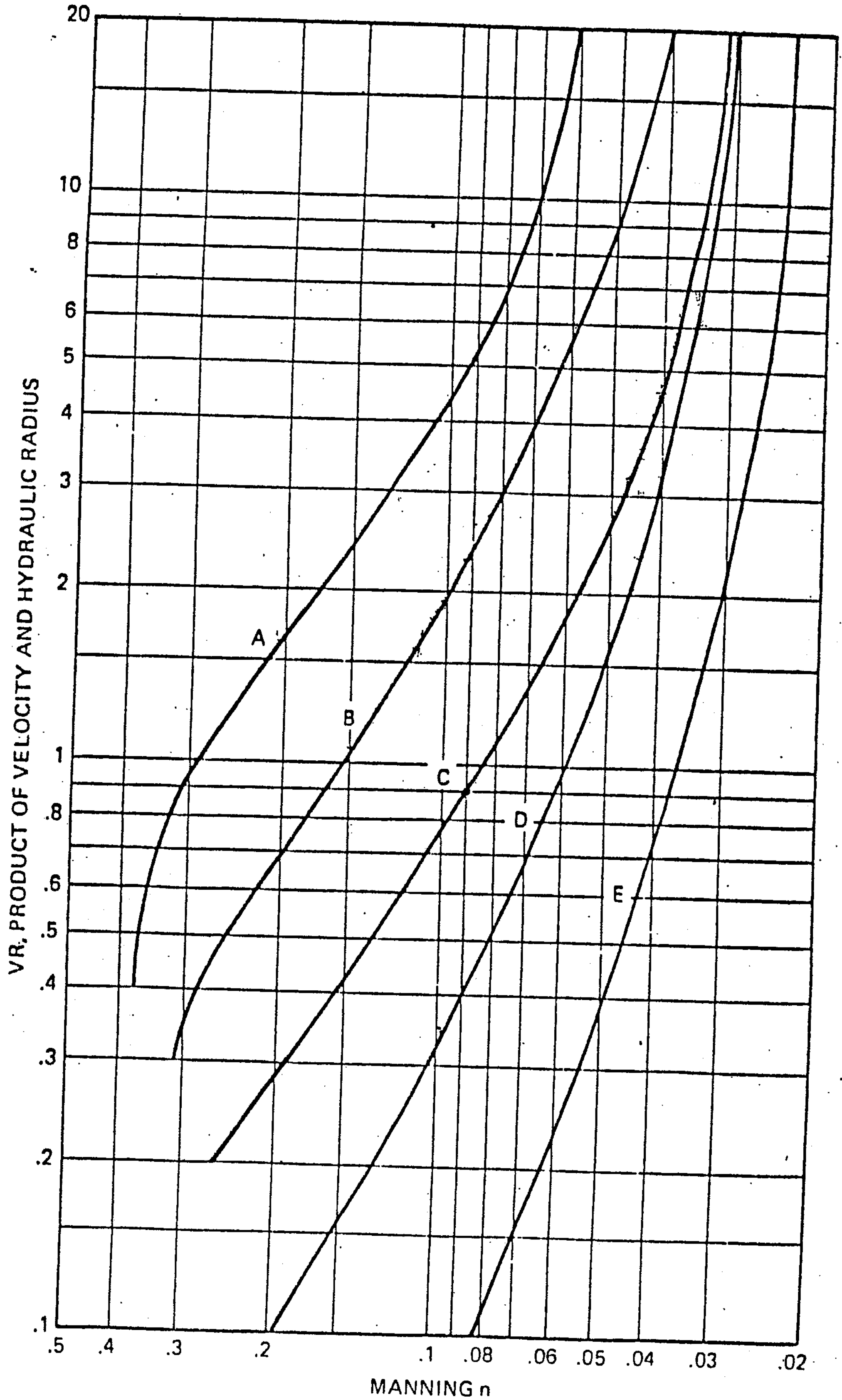


Figure D-2.--Peak rates of discharge for small watersheds (24-hour, type-II storm distribution). Sheet 3 of 3

DEGREES OF VEGETAL RETARDANCE FOR WHICH GRAPHICAL SOLUTIONS OF THE MANNING FORMULA HAVE BEEN PREPARED



FROM SCS "HANDBOOK OF CHANNEL DESIGN FOR SOIL AND WATER CONSERVATION"

APPENDIX 2
SURFACE WATER DRAINAGE CALCULATIONS – FINAL GRADE

CULVERT PIPES

Landfill Redesign
Storage Area 1A
Rockport Plant Fly Ash Landfill

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT: American Electric Power | Prepared By BER | Date 3/15/2009
PROJECT: Rockport Ash Landfill | Reviewed By ~~3/27/09~~ [signature] | Date 3/27/09
W.O. # N1087247

OBJECTIVE
Size culvert in Drainage Channel 3 for under site access road along side AK Steel line.

GIVEN
Due to roadway elevations and channel depth, limited to using 2-ft-diameter pipe
Use concrete pipe with headwalls

Check Inlet Control
From Exhibit 3-9, select HW/D value for 24-inch Culvert Diameter
HW/D = Headwater Depth in Diameters
Determine HW depth and see if applicable to site condition.
If condition is OK, then use selected culvert size or try smaller or larger diameters
For multiple culvert pipes at one location, divide total flow by the number of culverts

CMP with diameter of: 24 inches
Headwater condition is square edge with headwall, (Condition 1)
Peak Flow: 55.9 cfs
Consider installing **three** pipes; so flow per pipe is down to 13.9 cfs
HW/D = 1.05
HW = 25.2 inches Under the 3-ft, so should not overtop the road.
This condition is OK

Check Outlet Control

Ke, entrance loss coefficient = 0.5, headwalls (Table 1)
Head, H from Exhibit 3-11 = 0.55
critical depth, dc = 1.3 for 2-ft-dia. Pipe
(dc + D)/2 = 1.65
tailwater = 2.29 ft, depth of flow in the channel
ho, larger of the two (dc+D)/2 or tailwater = 2.29
LoS = Pipe length of 50 ft and slope of 0.0025 ft/ft = 0.125
HW = H + ho - LoS = 2.715 ft.
Under the 3-ft, so should not overtop the road.

Conclusion
Use three 24-inch-diameter concrete pipes

SURFACE WATER DRAINAGE CALCULATIONS

CLIENT: American Electric Power — Prepared By BER — Date 3/15/2009
PROJECT: Rockport Ash Landfill — Reviewed By RGE — Date 3/27/09
W.O. # N1087247

OBJECTIVE
Size culvert in Drainage Channel 2b for under entrance road.

GIVEN
Due to roadway elevations and channel depth, limited to using 2-ft-diameter pipe
Use concrete pipe with headwalls

Check Inlet Control
From Exhibit 3-9, select HW/D value for 24-inch Culvert Diameter
HW/D = Headwater Depth in Diameters
Determine HW depth and see if applicable to site condition.
If condition is OK, then use selected culvert size or try smaller or larger diameters
For multiple culvert pipes at one location, divide total flow by the number of culverts

CMP with diameter of: 24 inches
Headwater condition is square edge with headwall, (Condition 1)
Peak Flow: 26.7 cfs
Consider installing **two** pipes; so flow per pipe is down to 13.4 cfs
HW/D = 1.05
HW = 25.2 inches Under the 3-ft, so should not overtop the road.
This condition is OK

Check Outlet Control

Ke, entrance loss coefficient = 0.5, headwalls (Table 1)
Head, H from Exhibit 3-11 = 0.5
critical depth, dc = 1.3 for 2-ft-dia. Pipe
(dc + D)/2 = 1.65
tailwater = 1.85 ft, depth of flow in the channel
ho, larger of the two (dc+D)/2 or tailwater = 1.85
LoS = Pipe length of 50 ft and slope of 0.0025 ft/ft = 0.125
HW = H + ho - LoS = 2.225 ft.
Under the 3-ft, so should not overtop the road.

Conclusion
Use two 24-inch-diameter concrete pipes

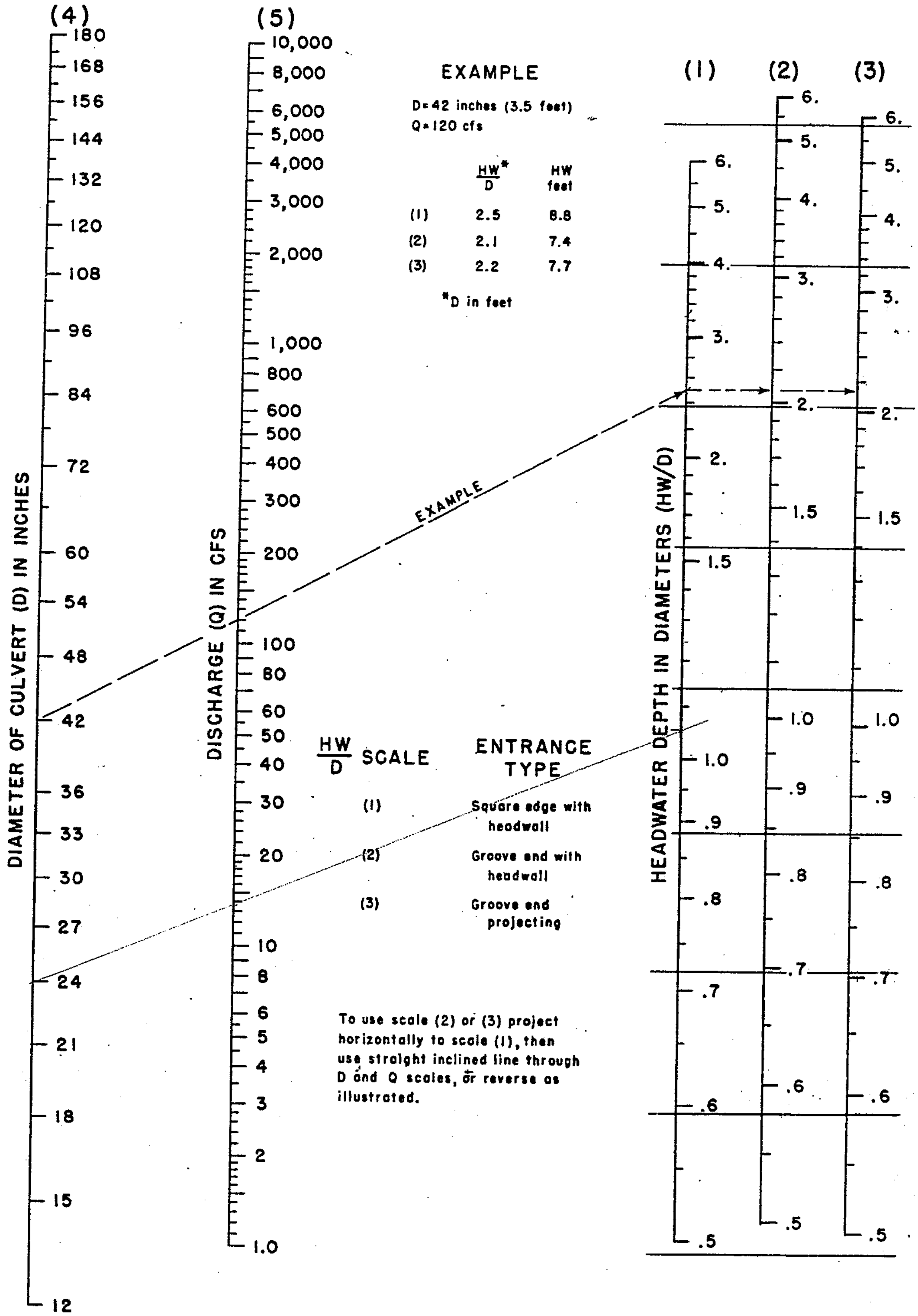


Exhibit 3-9 Headwater depth for concrete pipe culverts with inlet control (Ref. Hyd. Eng. Cir. No. 5, USBPR, 1965)

TABLE 1 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full

Entrance head loss $H_e = k_e \frac{V^2}{2g}$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end) . . .	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge . .	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides . . .	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the beveled inlet, p. 5-13.

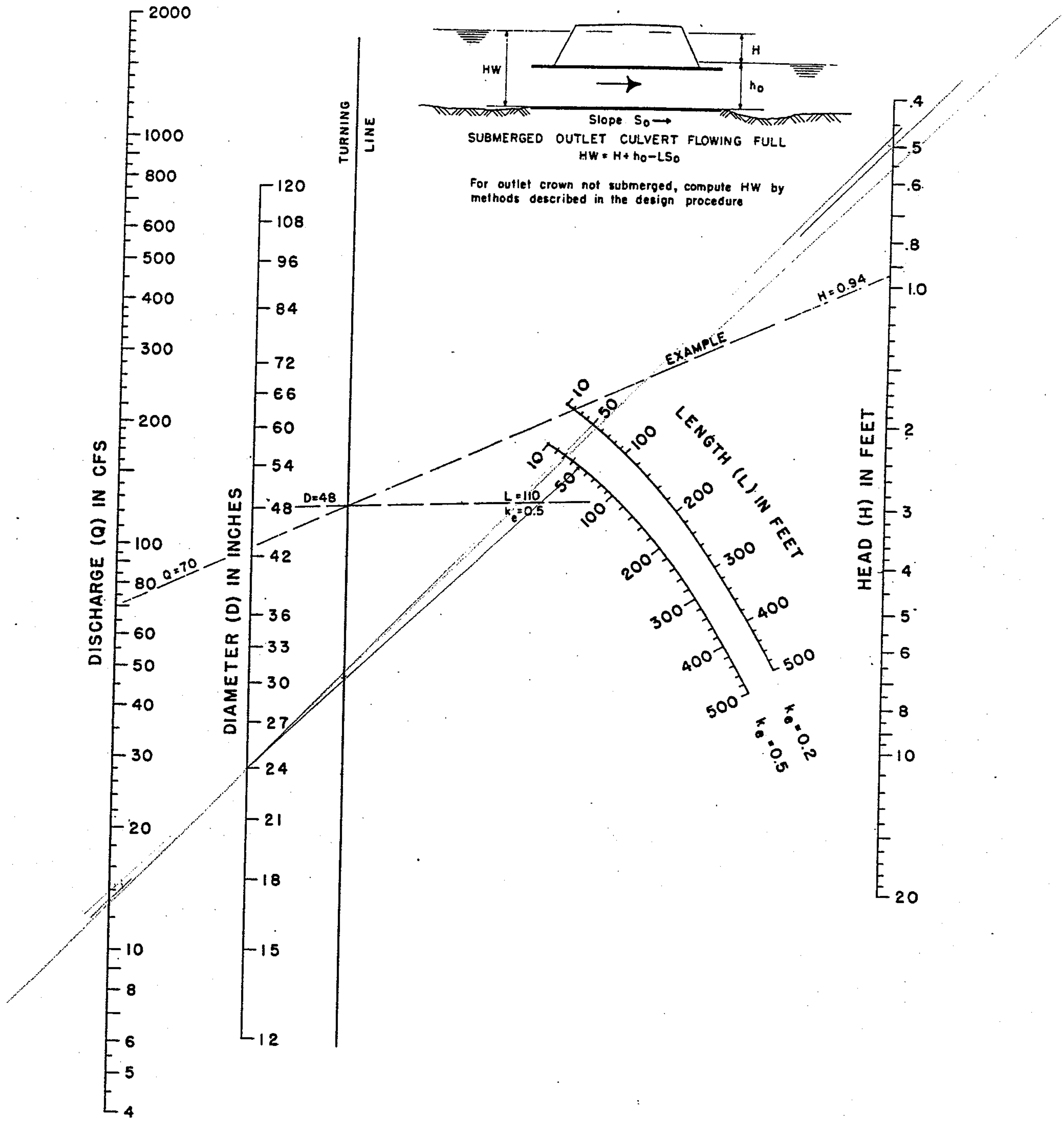
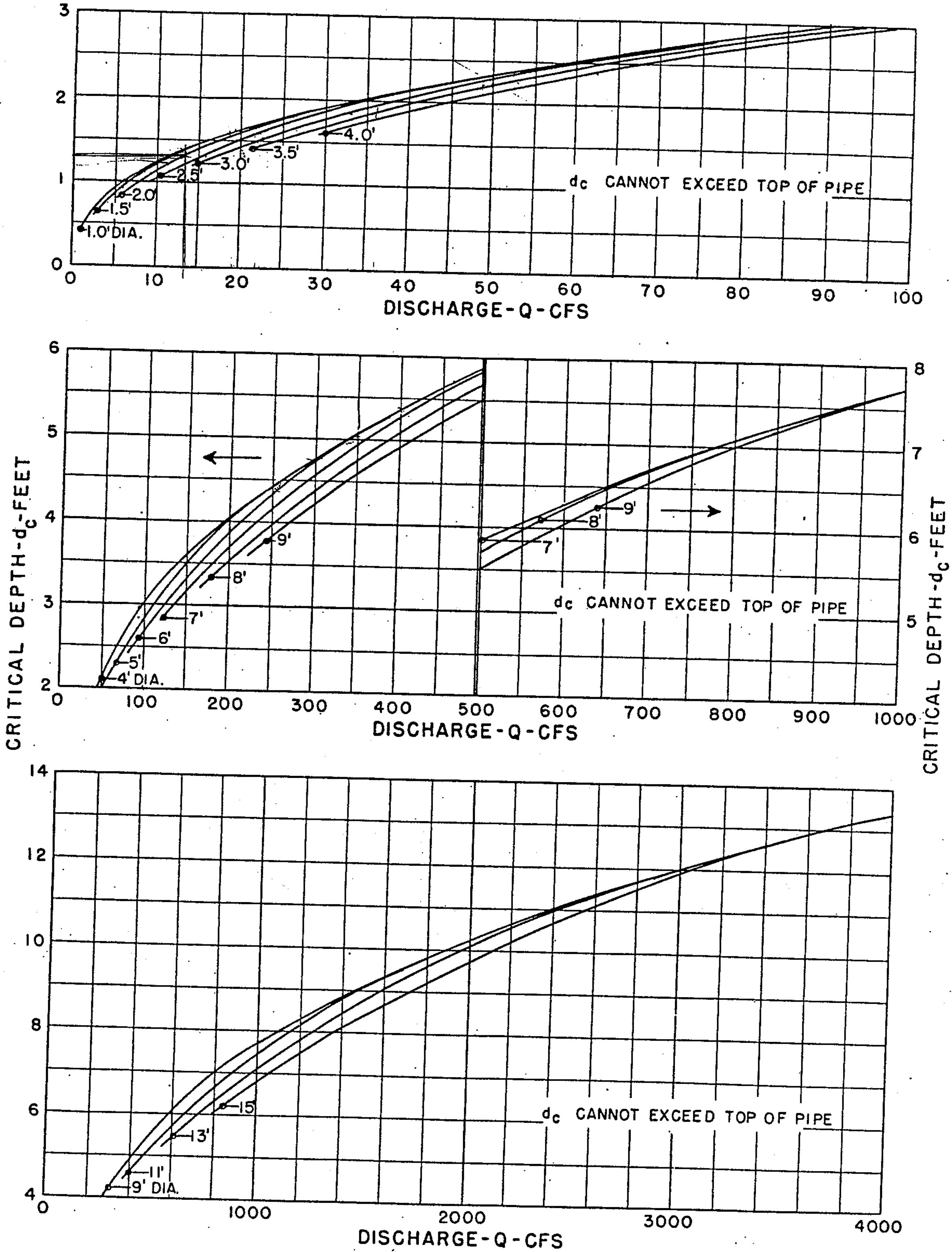


Exhibit 3-11 Head for concrete pipe culverts flowing full with outlet control n = 0.012 (Ref. Hyd. Eng. Cir. No. 5, USBPR, 1965)

CHART 16



BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

STORM WATER DRAINAGE ANALYSIS
PROPOSED SOUTHWEST (SW) DITCH FOR ROCKPORT PLANT FLY ASH LANDFILL
ROCKPORT, INDIANA

INTRODUCTION

This analysis evaluates the storm water runoff from the existing farm land and the proposed landfill development that is routed to this drainage way with construction of the SW Ditch. The existing watershed is approximately 72 acres. The proposed landfill development contributing runoff to the SW Ditch is approximately 54 acres. The total water shed handled by the SW Ditch is approximately 126 acres.

STORM WATER HYDROGRAPH SUMMARY

10 YEAR STORM EVENT	Peak Inflow = 135.70 cfs at 12.5000 hrs
25 YEAR STORM EVENT	Peak Inflow = 171.53 cfs at 12.5000 hrs
50 YEAR STORM EVENT	Peak Inflow = 203.03 cfs at 12.5000 hrs
100 YEAR STORM EVENT	Peak Inflow = 229.70 cfs at 12.5000 hrs

DESIGN STORMS

Storm Frequency	Total Rainfall Depth
10 Year	4.7 inches
25 Year	5.4 inches
50 Year	6.0 inches
100 Year	6.5 inches

CUMULATIVE RAINFALL FRACTIONS (SCS Type II Storm)

Output Time increment = .5000 hrs
Time on left represents time for first value in each row.

Time hrs					
.0000	.000	.005	.010	.016	.022
2.5000	.028	.034	.041	.048	.055
5.0000	.063	.071	.080	.089	.099
7.5000	.109	.120	.132	.147	.163
10.0000	.185	.204	.235	.283	.663
12.5000	.734	.772	.799	.820	.838
15.0000	.854	.868	.880	.891	.902
17.5000	.912	.921	.930	.938	.945
20.0000	.952	.958	.965	.971	.977
22.5000	.983	.989	.994	1.000	

CUMULATIVE RAINFALL DEPTHS (in) 10 YR

Output Time increment = .5000 hrs
Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0235	.0470	.0752	.1034
2.5000	.1316	.1598	.1927	.2256	.2585
5.0000	.2961	.3337	.3760	.4183	.4653
7.5000	.5123	.5640	.6204	.6909	.7661
10.0000	.8695	.9588	1.1045	1.3301	3.1161
12.5000	3.4498	3.6284	3.7553	3.8540	3.9386
15.0000	4.0138	4.0796	4.1360	4.1877	4.2394
17.5000	4.2864	4.3287	4.3710	4.4086	4.4415
20.0000	4.4744	4.5026	4.5355	4.5637	4.5919
22.5000	4.6201	4.6483	4.6718	4.7000	

CUMULATIVE RAINFALL DEPTHS (in) 25 YR

Output Time increment = .5000 hrs

Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0270	.0540	.0864	.1188
2.5000	.1512	.1836	.2214	.2592	.2970
5.0000	.3402	.3834	.4320	.4806	.5346
7.5000	.5886	.6480	.7128	.7938	.8802
10.0000	.9990	1.1016	1.2690	1.5282	3.5802
12.5000	3.9636	4.1688	4.3146	4.4280	4.5252
15.0000	4.6116	4.6872	4.7520	4.8114	4.8708
17.5000	4.9248	4.9734	5.0220	5.0652	5.1030
20.0000	5.1408	5.1732	5.2110	5.2434	5.2758
22.5000	5.3082	5.3406	5.3676	5.4000	

CUMULATIVE RAINFALL DEPTHS (in) 50 YR

Output Time increment = .5000 hrs

Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0300	.0600	.0960	.1320
2.5000	.1680	.2040	.2460	.2880	.3300
5.0000	.3780	.4260	.4800	.5340	.5940
7.5000	.6540	.7200	.7920	.8820	.9780
10.0000	1.1100	1.2240	1.4100	1.6980	3.9780
12.5000	4.4040	4.6320	4.7940	4.9200	5.0280
15.0000	5.1240	5.2080	5.2800	5.3460	5.4120
17.5000	5.4720	5.5260	5.5800	5.6280	5.6700
20.0000	5.7120	5.7480	5.7900	5.8260	5.8620
22.5000	5.8980	5.9340	5.9640	6.0000	

CUMULATIVE RAINFALL DEPTHS (in) 100 YR

Output Time increment = .5000 hrs

Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0325	.0650	.1040	.1430
2.5000	.1820	.2210	.2665	.3120	.3575
5.0000	.4095	.4615	.5200	.5785	.6435
7.5000	.7085	.7800	.8580	.9555	1.0595
10.0000	1.2025	1.3260	1.5275	1.8395	4.3095
12.5000	4.7710	5.0180	5.1935	5.3300	5.4470
15.0000	5.5510	5.6420	5.7200	5.7915	5.8630
17.5000	5.9280	5.9865	6.0450	6.0970	6.1425
20.0000	6.1880	6.2270	6.2725	6.3115	6.3505
22.5000	6.3895	6.4285	6.4610	6.5000	

TIME OF CONCENTRATION - Existing Watershed

Segment #1: Tc: TR-55 Sheet
Description: Farm Field
Manning’s n .0600
Hydraulic Length 300.00 ft
2yr, 24hr P 3.2500 in
Slope .005000 ft/ft
Avg. Velocity .26 ft/sec

Segment #1 Time: .3264 hrs

Segment #2: Tc: TR-55 Shallow
Description: Farm Field
Hydraulic Length 2200.00 ft
Slope .005000 ft/ft
Unpaved
Avg. Velocity 1.14 ft/sec

Segment #2 Time: .5356 hrs
Total Tc: .8621 hrs

TIME OF CONCENTRATION - New Watershed for SW Ditch

Segment #1: Tc: TR-55 Sheet
Description: Top of Landfill
Manning's n .2400
Hydraulic Length 300.00 ft
2yr, 24hr P 3.2500 in
Slope .020000 ft/ft
Avg. Velocity .15 ft/sec

Segment #1 Time: .5683 hrs

Segment #2: Tc: TR-55 Shallow
Description: top of the landfill
Hydraulic Length 600.00 ft
Slope .020000 ft/ft
Unpaved
Avg. Velocity 2.28 ft/sec

Segment #2 Time: .0730 hrs

Segment #3: Tc: TR-55 Shallow
Description: 3:1 slope
Hydraulic Length 75.00 ft
Slope .333000 ft/ft
Unpaved
Avg. Velocity 9.31 ft/sec

Segment #3 Time: .0022 hrs

Segment #4: Tc: TR-55 Channel
Description: 450 bench
Flow Area 10.1600 sq. ft
Wetted Perimeter 16.50 ft
Hydraulic Radius .62 ft
Slope .005000 ft/ft
Manning's n .0300
Hydraulic Length 250.00 ft
Avg. Velocity 2.54 ft/sec

Segment #4 Time: .0273 hrs

Segment #5: Tc: TR-55 Sheet
Description: Sideslope flume
Manning's n .0300
Hydraulic Length 150.00 ft
2yr, 24hr P 3.2500 in
Slope .333000 ft/ft
Avg. Velocity 2.08 ft/sec

Segment #5 Time: .0201 hrs

Segment #6: Tc: TR-55 Channel
Description: SW Ditch
Flow Area 16.6000 sq. ft

Wetted Perimeter	13.80 ft
Hydraulic Radius	1.20 ft
Slope	.002500 ft/ft
Manning’s n	.0300
Hydraulic Length	3800.00 ft
Avg. Velocity	2.81 ft/sec

Segment #6 Time: .3758 hrs

Total Tc: 1.0668 hrs

RUNOFF CURVE NUMBER DATA - SW Ditch Watershed

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
Landfill surface	74	54.000			74.00
Farm Field	78	72.000			78.00
COMPOSITE AREA & WEIGHTED CN --->		126.000			76.29 (76)

STORM WATER RUNOFF UNIT HYDROGRAPHS

SCS UNIT HYDROGRAPH METHOD
Duration = 24 hrs
Tc = 1.0668 hrs
Drainage Area = 126 acres
Runoff CN = 76

10 YEAR STORM EVENT

Peak Discharge = 135.70 cfs
Time to Peak = 12.5000 hrs
HYG Volume = 24.049 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
8.7000	.00	.01	.02	.04	.07
9.2000	.12	.19	.27	.37	.49
9.7000	.63	.79	.99	1.21	1.45
10.2000	1.70	1.94	2.19	2.42	2.66
10.7000	2.93	3.24	3.65	4.14	4.70
11.2000	5.41	6.26	7.26	8.61	11.67
11.7000	16.93	25.23	40.86	59.93	81.75
12.2000	103.32	120.03	131.78	135.70	132.13
12.7000	124.89	114.55	102.26	90.58	79.73
13.2000	70.83	63.18	56.38	50.43	45.55
13.7000	41.27	37.54	34.46	31.72	29.29
14.2000	27.27	25.52	23.96	22.59	21.46
14.7000	20.45	19.54	18.74	18.00	17.31
15.2000	16.70	16.15	15.65	15.20	14.79
15.7000	14.40	14.02	13.63	13.26	12.89
16.2000	12.55	12.23	11.93	11.64	11.40

16.7000	11.18	10.99	10.84	10.71	10.60
17.2000	10.50	10.40	10.29	10.18	10.05
17.7000	9.92	9.77	9.62	9.45	9.30
18.2000	9.15	9.03	8.91	8.82	8.74
18.7000	8.66	8.58	8.48	8.37	8.24
19.2000	8.11	7.96	7.81	7.65	7.49
19.7000	7.35	7.22	7.10	7.01	6.92
20.2000	6.84	6.75	6.65	6.54	6.43
20.7000	6.35	6.28	6.24	6.25	6.27
21.2000	6.30	6.31	6.30	6.27	6.22
21.7000	6.15	6.08	6.02	5.96	5.92
22.2000	5.88	5.85	5.83	5.82	5.80
22.7000	5.80	5.79	5.78	5.78	5.76
23.2000	5.74	5.70	5.63	5.55	5.47
23.7000	5.39	5.34	5.31	5.31	5.29
24.2000	5.21	5.03	4.68	4.24	3.71
24.7000	3.14	2.60	2.08	1.66	1.31
25.2000	1.03	.82	.66	.52	.41
25.7000	.33	.26	.20	.16	.13
26.2000	.10	.08	.06	.05	.04
26.7000	.03	.02	.01	.01	.01
27.2000	.00				

25 YEAR STORM EVENT

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-----------------------------------
Peak Discharge =      171.53 cfs
Time to Peak   =       12.5000 hrs
HYG Volume     =       30.118 ac-ft
-----------------------------------
```

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
7.9000	.00	.00	.00	.02	.03
8.4000	.06	.10	.16	.23	.32
8.9000	.43	.56	.70	.86	1.03
9.4000	1.21	1.40	1.61	1.84	2.09
9.9000	2.39	2.72	3.06	3.42	3.76
10.4000	4.09	4.39	4.70	5.05	5.45
10.9000	6.00	6.65	7.42	8.39	9.53
11.4000	10.89	12.70	16.75	23.63	34.41
11.9000	54.41	78.60	106.08	132.82	153.26
12.4000	167.34	171.53	166.37	156.68	143.21
12.9000	127.52	112.68	98.95	87.72	78.08
13.4000	69.53	62.08	55.98	50.63	45.97
13.9000	42.14	38.73	35.71	33.21	31.05
14.4000	29.12	27.42	26.03	24.78	23.67
14.9000	22.68	21.76	20.91	20.16	19.50
15.4000	18.89	18.33	17.84	17.36	16.89
15.9000	16.43	15.97	15.53	15.11	14.73
16.4000	14.36	14.01	13.71	13.45	13.22
16.9000	13.04	12.88	12.75	12.63	12.50
17.4000	12.37	12.24	12.08	11.92	11.74

17.9000	11.55	11.36	11.17	10.99	10.84
18.4000	10.70	10.58	10.49	10.39	10.29
18.9000	10.17	10.04	9.89	9.73	9.55
19.4000	9.36	9.17	8.98	8.81	8.65
19.9000	8.51	8.40	8.29	8.19	8.09
20.4000	7.97	7.84	7.71	7.60	7.52
20.9000	7.48	7.48	7.51	7.54	7.56
21.4000	7.54	7.51	7.44	7.36	7.28
21.9000	7.20	7.13	7.08	7.04	7.00
22.4000	6.98	6.96	6.94	6.93	6.92
22.9000	6.92	6.91	6.89	6.87	6.81
23.4000	6.74	6.64	6.54	6.45	6.38
23.9000	6.35	6.35	6.32	6.23	6.01
24.4000	5.60	5.07	4.43	3.75	3.10
24.9000	2.49	1.98	1.57	1.23	.98
25.4000	.78	.62	.49	.39	.31
25.9000	.24	.19	.15	.12	.09
26.4000	.07	.06	.04	.03	.02
26.9000	.02	.01	.01	.00	.00
27.4000	.00				

50 YEAR STORM EVENT

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-----------------------------------
Peak Discharge =      203.03 cfs
Time to Peak   =       12.5000 hrs
HYG Volume     =       35.488 ac-ft
-----------------------------------
```

HYDROGRAPH ORDINATES (cfs)

Time hrs	Output Time increment = .1000 hrs Time on left represents time for first value in each row.				
7.4000	.00	.00	.01	.02	.04
7.9000	.08	.13	.19	.27	.36
8.4000	.46	.58	.71	.85	1.00
8.9000	1.18	1.37	1.58	1.80	2.03
9.4000	2.27	2.52	2.79	3.08	3.40
9.9000	3.79	4.20	4.65	5.10	5.52
10.4000	5.93	6.28	6.65	7.06	7.55
10.9000	8.21	9.02	9.97	11.17	12.59
11.4000	14.27	16.49	21.43	29.75	42.73
11.9000	66.60	95.30	127.73	158.96	182.60
12.4000	198.67	203.03	196.42	184.53	168.27
12.9000	149.57	131.95	115.69	102.42	91.04
13.4000	80.97	72.20	65.02	58.73	53.27
13.9000	48.78	44.79	41.26	38.34	35.82
14.4000	33.56	31.58	29.96	28.51	27.22
14.9000	26.07	25.00	24.01	23.15	22.37
15.4000	21.67	21.03	20.46	19.90	19.37
15.9000	18.83	18.31	17.80	17.32	16.87
16.4000	16.45	16.05	15.71	15.41	15.14
16.9000	14.93	14.75	14.59	14.45	14.31
17.4000	14.16	14.00	13.82	13.63	13.43
17.9000	13.21	12.99	12.77	12.57	12.39

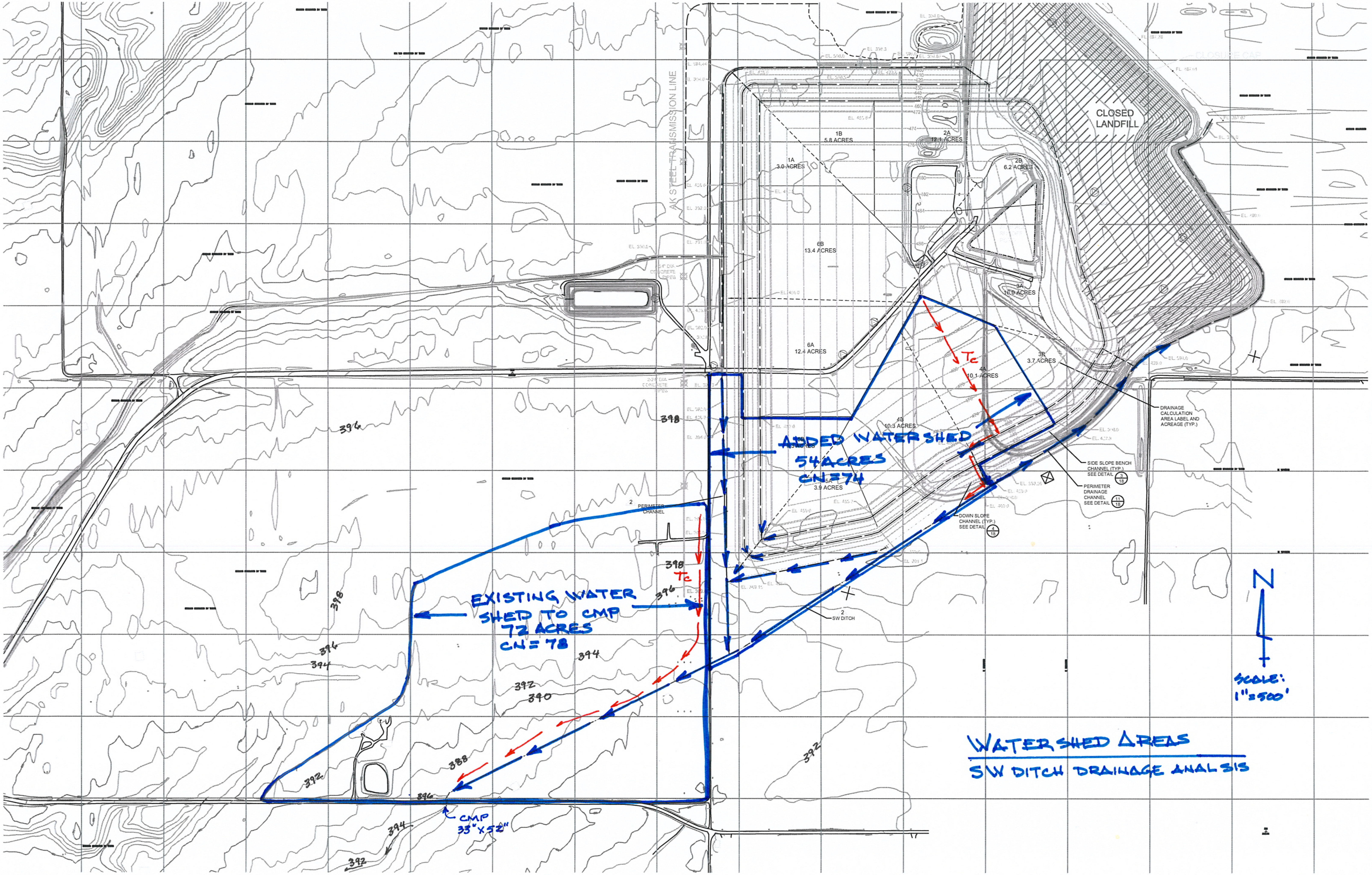
18.4000	12.23	12.10	11.99	11.88	11.76
18.9000	11.63	11.47	11.30	11.12	10.91
19.4000	10.70	10.47	10.26	10.06	9.88
19.9000	9.72	9.59	9.47	9.36	9.24
20.4000	9.10	8.95	8.80	8.68	8.58
20.9000	8.53	8.54	8.57	8.61	8.62
21.4000	8.61	8.57	8.49	8.40	8.31
21.9000	8.21	8.14	8.08	8.03	7.99
22.4000	7.96	7.94	7.92	7.91	7.90
22.9000	7.89	7.88	7.86	7.83	7.77
23.4000	7.68	7.57	7.45	7.35	7.28
23.9000	7.24	7.24	7.20	7.10	6.85
24.4000	6.38	5.78	5.05	4.28	3.54
24.9000	2.84	2.26	1.79	1.41	1.12
25.4000	.89	.71	.55	.44	.35
25.9000	.27	.22	.17	.13	.10
26.4000	.08	.06	.05	.04	.03
26.9000	.02	.01	.01	.00	.00
27.4000	.00				

```
100 YEAR STORM EVENT
-----------------------------------
Peak Discharge =      229.70 cfs
Time to Peak   =       12.5000 hrs
HYG Volume     =       40.058 ac-ft
-----------------------------------
```

HYDROGRAPH ORDINATES (cfs)

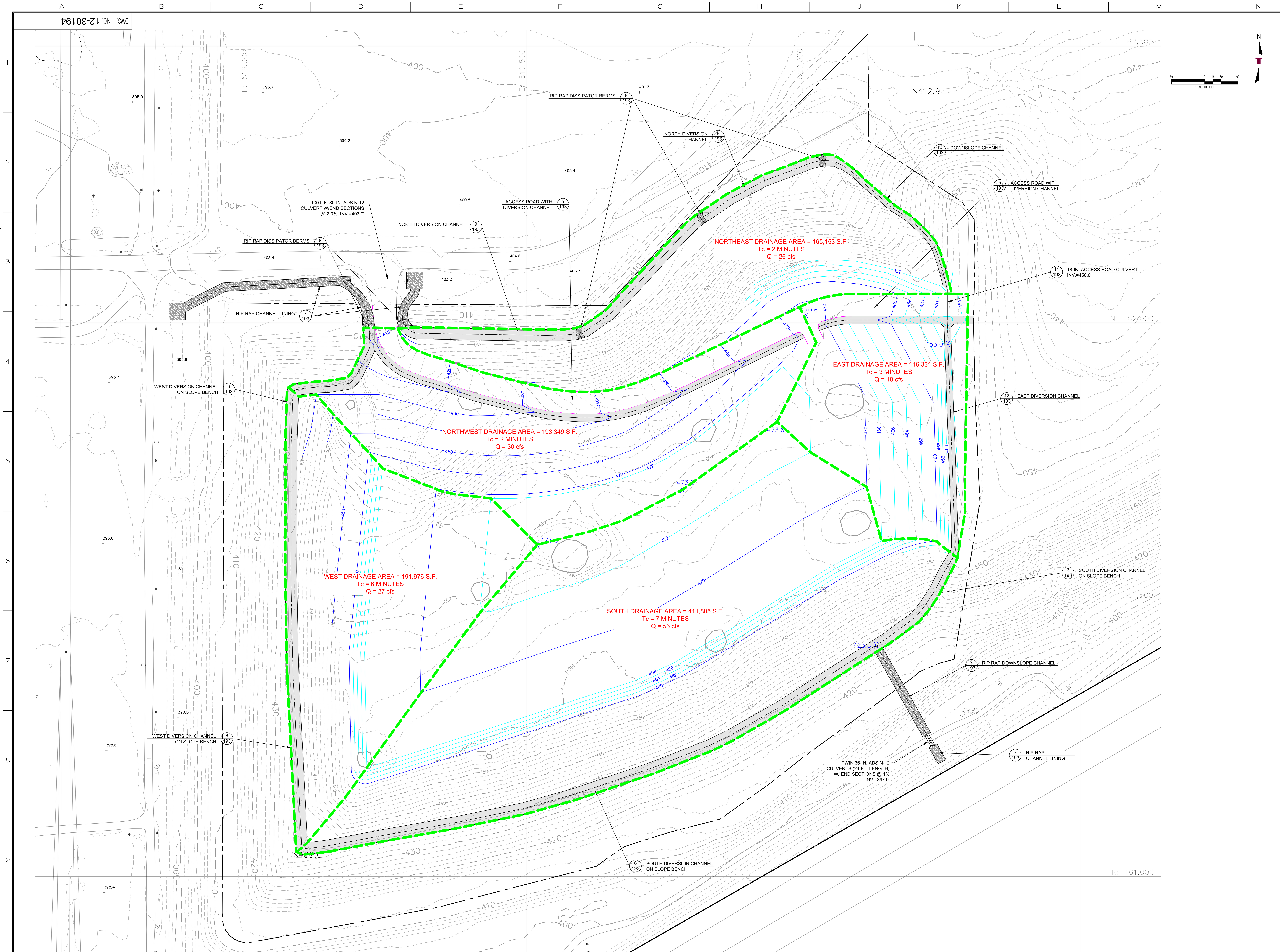
Time hrs	Output Time increment = .1000 hrs Time on left represents time for first value in each row.				
7.0000	.00	.00	.01	.03	.05
7.5000	.09	.14	.20	.28	.38
8.0000	.48	.60	.73	.86	1.01
8.5000	1.17	1.33	1.51	1.71	1.93
9.0000	2.16	2.42	2.69	2.97	3.25
9.5000	3.55	3.87	4.21	4.60	5.06
10.0000	5.55	6.08	6.61	7.11	7.57
10.5000	7.98	8.40	8.86	9.41	10.18
11.0000	11.12	12.23	13.63	15.28	17.23
11.5000	19.82	25.51	35.07	49.92	77.08
12.0000	109.59	146.20	181.20	207.52	225.22
12.5000	229.70	221.81	208.04	189.41	168.16
13.0000	148.18	129.78	114.78	101.93	90.56
13.5000	80.68	72.60	65.52	59.39	54.34
14.0000	49.86	45.91	42.63	39.80	37.28
14.5000	35.06	33.25	31.63	30.18	28.90
15.0000	27.70	26.60	25.63	24.77	23.98
15.5000	23.27	22.64	22.03	21.43	20.83
16.0000	20.25	19.69	19.15	18.66	18.19
16.5000	17.74	17.37	17.03	16.74	16.50
17.0000	16.30	16.12	15.97	15.81	15.65
17.5000	15.47	15.27	15.06	14.84	14.59
18.0000	14.35	14.10	13.88	13.68	13.51

18.5000	|	13.36	13.23	13.11	12.99	12.84
19.0000	|	12.66	12.47	12.27	12.04	11.81
19.5000	|	11.56	11.32	11.11	10.90	10.73
20.0000	|	10.58	10.45	10.33	10.19	10.04
20.5000	|	9.88	9.71	9.57	9.47	9.42
21.0000	|	9.42	9.45	9.49	9.51	9.50
21.5000	|	9.45	9.37	9.27	9.16	9.06
22.0000	|	8.98	8.91	8.85	8.81	8.78
22.5000	|	8.75	8.73	8.72	8.71	8.70
23.0000	|	8.69	8.67	8.63	8.57	8.47
23.5000	|	8.35	8.21	8.10	8.02	7.98
24.0000	|	7.98	7.94	7.83	7.55	7.03
24.5000	|	6.37	5.56	4.71	3.90	3.12
25.0000	|	2.49	1.97	1.55	1.23	.99
25.5000	|	.78	.61	.49	.39	.30
26.0000	|	.24	.19	.15	.12	.09
26.5000	|	.07	.05	.04	.03	.02
27.0000	|	.02	.01	.01	.00	.00



CLOSED LANDFILL
AK STEEL TRANSMISSION LINE
1A 3.0 ACRES
1B 5.8 ACRES
2A 12.1 ACRES
2B 6.2 ACRES
3A 10.0 ACRES
3B 3.7 ACRES
4A 10.1 ACRES
4B 10.3 ACRES
5A 3.9 ACRES
6A 12.4 ACRES
6B 13.4 ACRES
DRAINAGE CALCULATION AREA LABEL AND ACREAGE (TYP.)
SIDE SLOPE BENCH CHANNEL (TYP.) SEE DETAIL 3 18
PERIMETER DRAINAGE CHANNEL SEE DETAIL 11 18
DOWN SLOPE CHANNEL (TYP.) SEE DETAIL 4 18
PERIMETER CHANNEL
SW DITCH
ADDED WATERSHED
54 ACRES
CN=74
EXISTING WATER SHED TO CMP
72 ACRES
CN=78
Tc
CMP 33"x52"
398
396
394
392
390
388
N
SCALE: 1"=500'
WATERSHED AREAS
SW DITCH DRAINAGE ANALSIS

APPENDIX 2
SURFACE WATER DRAINAGE CALCULATIONS – PHASE 1 CLOSURE



GENERAL NOTES

LEGEND

- WELL
- DRAIN
- EDGE OF ASH
- CULVERT
- TRANSMISSION TOWER
- HORIZONTAL AND VERTICAL CONTROL
- TREE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- SPOT ELEVATION
- SPOT TEXT
- WATER LINE
- ASH BOUNDARY (PHASE I)
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- SPOT ELEVATION
- ACCESS ROAD
- DIVERSION CHANNEL

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA MICHIGAN POWER CO

ROCKPORT PLANT

FLY ASH LANDFILL STORAGE AREA 1A

ROCKPORT INDIANA

PHASE I CLOSURE TOP OF ASH WITH CCR GRADES AND DRAINAGE BOUNDARIES

DWG. NO. 12-30194

SCALE: 1"=60' | CIVIL ENGINEERING

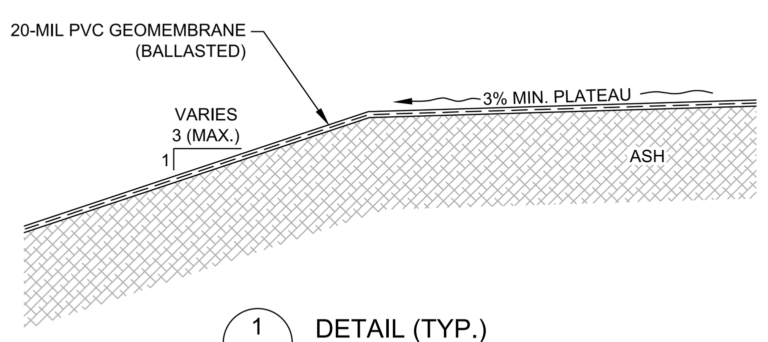
DR:
CH:
ENGR:
PROJ ENGR:
DATE: 1/21/21
APPROVED BY

AEP AMERICAN ELECTRIC POWER

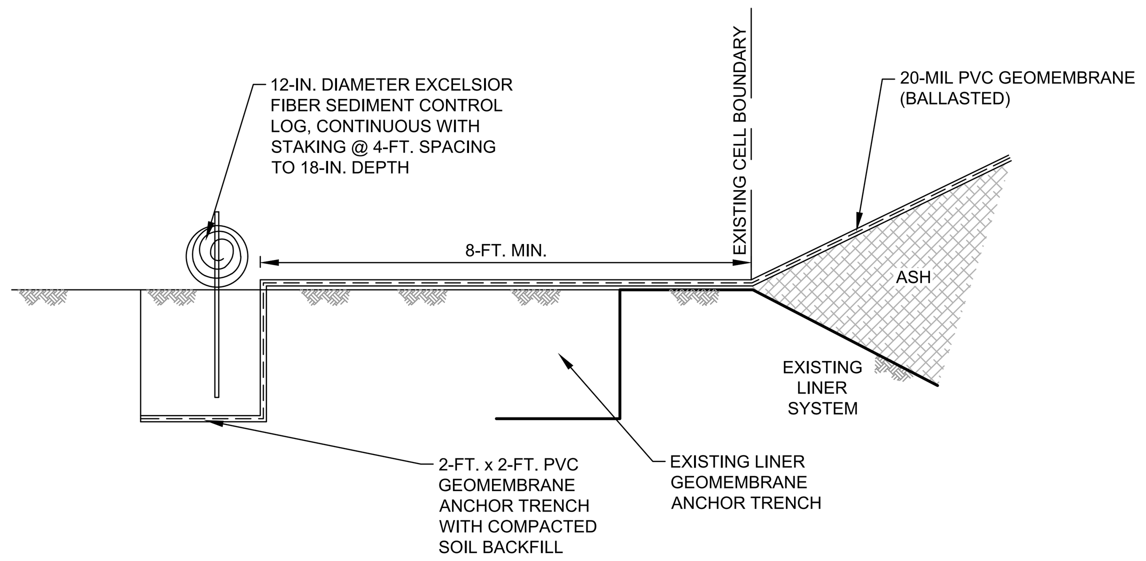
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

SYSTEM DATE- DD-MMM-YYYY WHERES ARCH

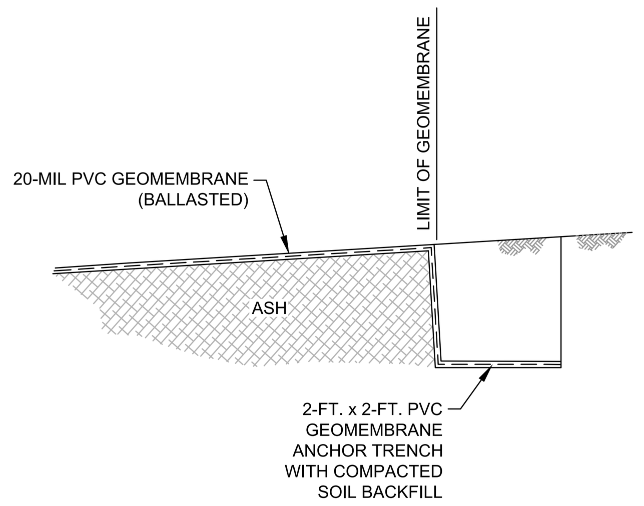
DWG. NO. 12-30193



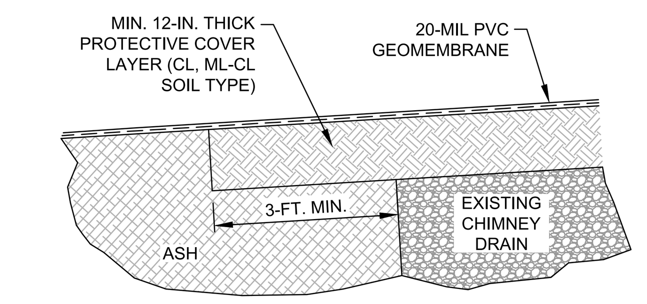
1 / 193 DETAIL (TYP.)
GEOMEMBRANE ON SIDESLOPE
SCALE: 1"=2'



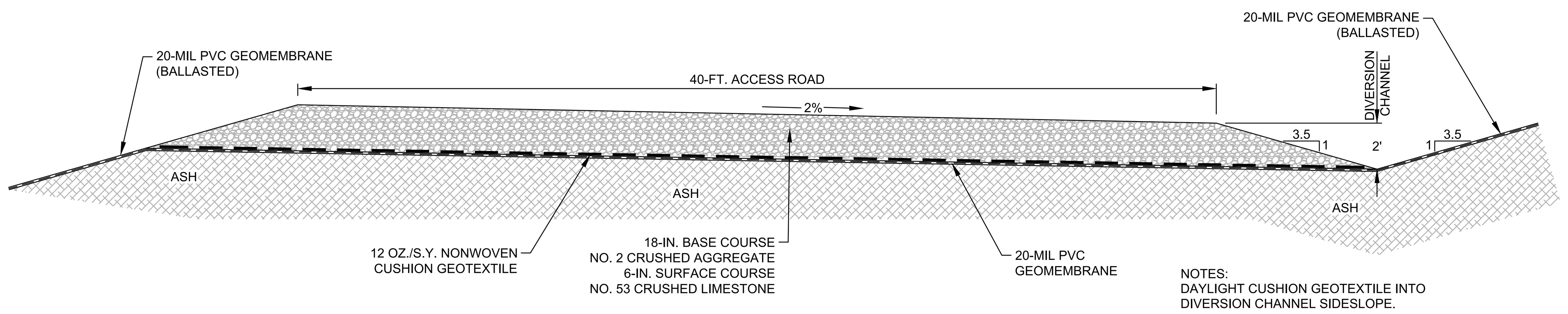
2 / 193 DETAIL (TYP.)
GEOMEMBRANE AT TOE OF SLOPE
SCALE: 1"=2'



3 / 193 DETAIL (TYP.)
GEOMEMBRANE SLOPE ANCHOR TRENCH
SCALE: 1"=2'



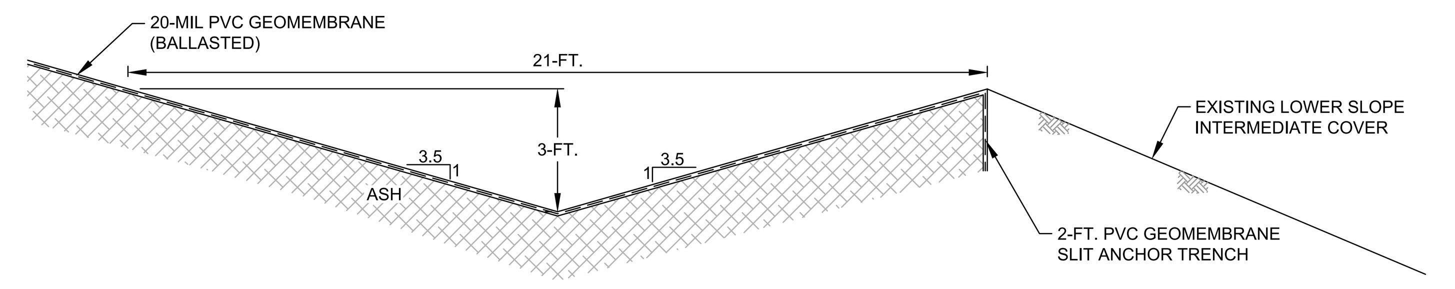
4 / 193 DETAIL (TYP.)
GEOMEMBRANE AT CHIMNEY DRAIN
SCALE: 1"=2'



NOTES:
DAYLIGHT CUSHION GEOTEXTILE INTO DIVERSION CHANNEL SIDESLOPE.

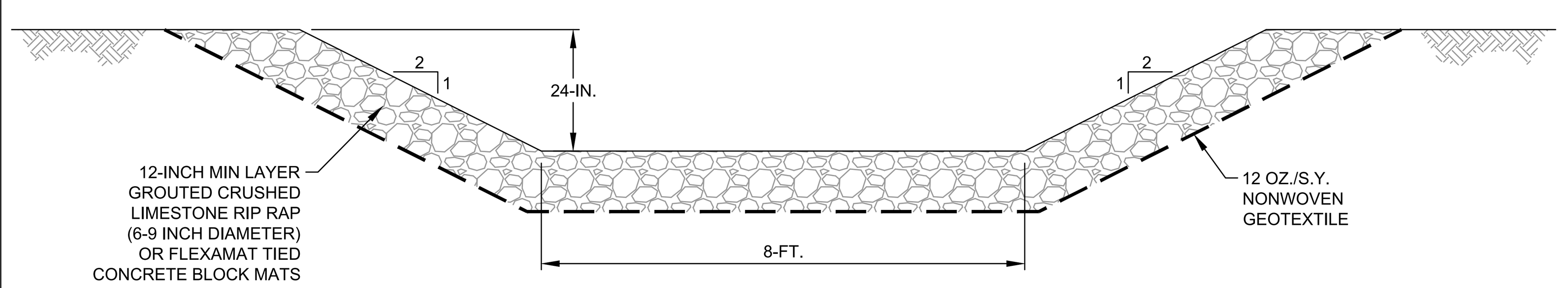
INSTALL ADDITIONAL BALLAST FOR GEOMEMBRANE ALONG CHANNEL BOTTOM AND SIDESLOPES AS NEEDED.

5 / 193 DETAIL (TYP.)
ACCESS ROAD WITH GEOMEMBRANE
SCALE: 1"=4'

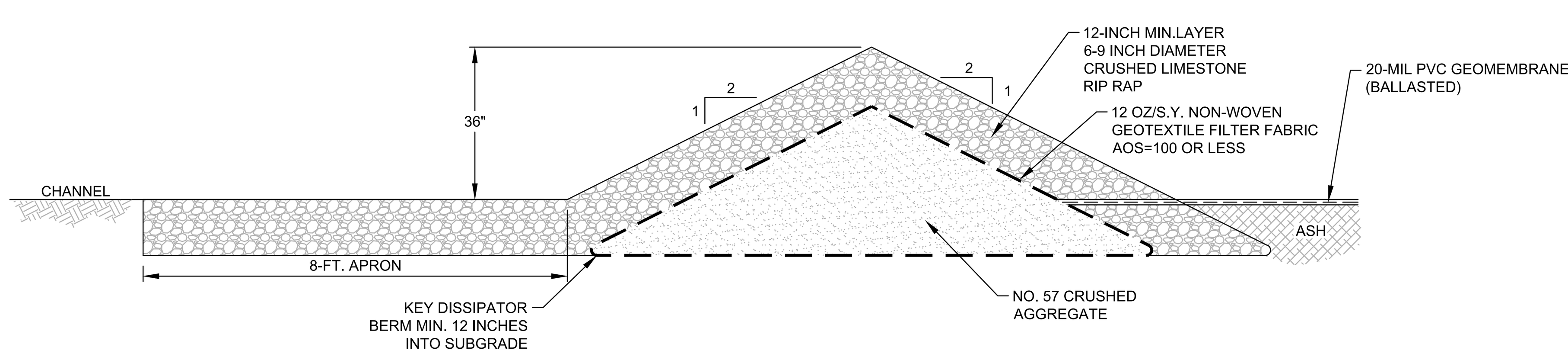


6 / 193 DETAIL (TYP.)
SOUTH/WEST UPPER BENCH DIVERSION CHANNEL
SCALE: 1"=3'

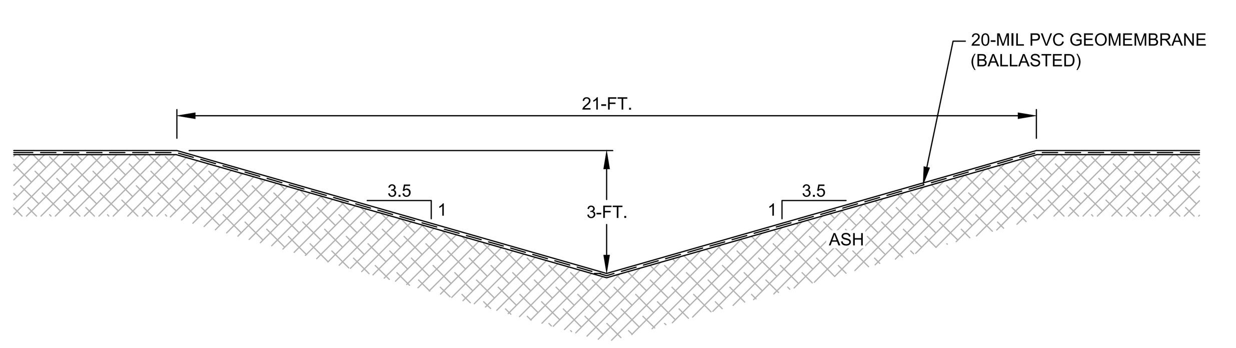
NOTE:
INSTALL ADDITIONAL BALLAST FOR GEOMEMBRANE ALONG CHANNEL BOTTOM AND SIDESLOPES AS NEEDED.



7 / 193 DETAIL (TYP.)
RIP RAP DOWNSLOPE CHANNEL
SCALE: 1"=2'

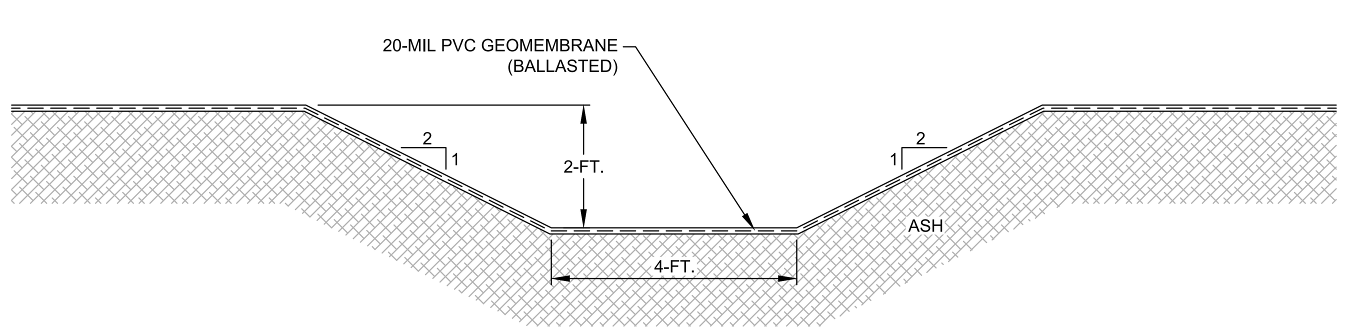


8 / 193 DETAIL (TYP.)
RIP RAP DISSIPATOR BERM
SCALE: 1"=2'



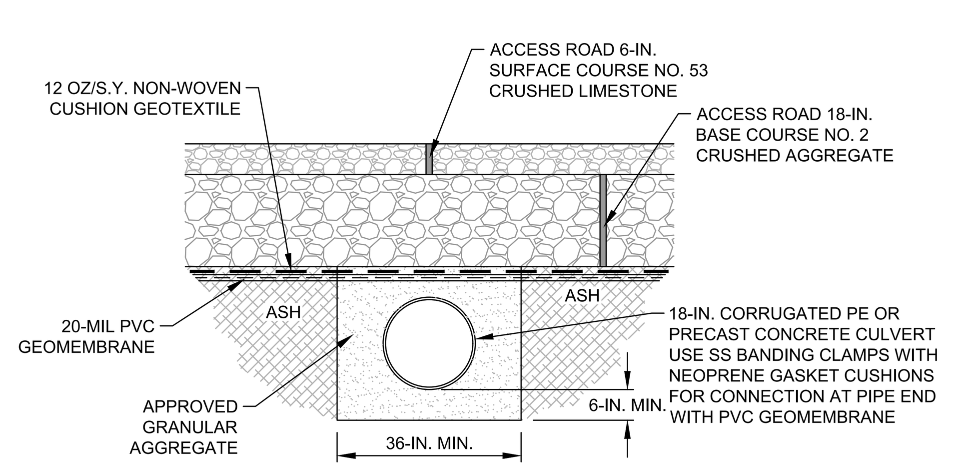
9 / 193 DETAIL (TYP.)
NORTH DIVERSION CHANNEL
SCALE: 1"=3'

NOTE:
INSTALL ADDITIONAL BALLAST FOR GEOMEMBRANE ALONG CHANNEL BOTTOM AND SIDESLOPES AS NEEDED.

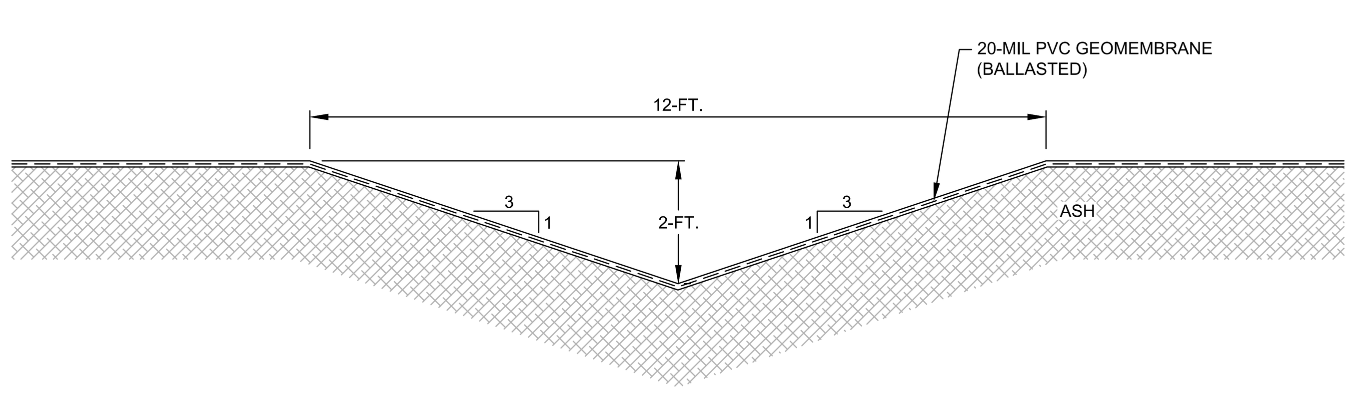


10 / 193 DETAIL (TYP.)
DOWNSLOPE CHANNEL
SCALE: 1"=2'

NOTE:
INSTALL ADDITIONAL BALLAST FOR GEOMEMBRANE ALONG CHANNEL BOTTOM AND SIDESLOPES AS NEEDED.



11 / 193 DETAIL (TYP.)
ACCESS ROAD CULVERT
SCALE: 1"=2'



12 / 193 DETAIL (TYP.)
EAST DIVERSION CHANNEL
SCALE: 1"=2'

NOTE:
INSTALL ADDITIONAL BALLAST FOR GEOMEMBRANE ALONG CHANNEL BOTTOM AND SIDESLOPES AS NEEDED.

GENERAL NOTES

LEGEND

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA MICHIGAN POWER CO
ROCKPORT PLANT
FLY ASH LANDFILL STORAGE AREA 1A
ROCKPORT INDIANA

PHASE I CLOSURE DETAILS

DWG. NO. 12-30193

SCALE: 1"=40' | CIVIL ENGINEERING
DR:
CH:
ENGR:
PROJ ENGR:
DATE: 1/21/21
APPROVED BY

AEP AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

IGS0694

SYSTEM DATE- DD-MMM-YYYY
SYSTEM TIME- HOUR:MINUTE

WHERES ARCH

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP
Project: Rockport Phase I Closure
Project No.: N1215154
By: JLH Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

RUNOFF CALCULATIONS East Drainage Area

Stormwater Flow using Rational Method, Q = C I A

Check 5-YR to 100-Yr storm event, Type II Storm

Runoff Coefficient, C	0.95	Roofs	
Rainfall Intensity (I), based on Time of Concentration (Tc)			
Time of Concentration	3	Minutes	Seelye Chart
Drainage Area:	2.67	Acres	Grading Plan

Storm Frequency	Tc, Minutes	Intensity, (I) = In/Hr	Runoff Coefficient	Area (Acres)	Q, Runoff Flow (CFS)	Intensity, (I) = In/Hr Calculation
5-Yr	3	5.95	0.95	2.67	15	131/(Tc+19)
10-Yr	3	6.54	0.95	2.67	17	170/(Tc+23)
25-Yr	3	6.97	0.95	2.67	18	230/(Tc+30)
50-Yr	3	8.33	0.95	2.67	21	250/(Tc+27)
100-Yr	3	8.53	0.95	2.67	22	290/(Tc+31)

CHANNEL FLOW ANALYSIS

Calculation of Flow in a Trapezoidal Channel using Manning's Formula

Velocity (V) = (1.486/n)(R^2/3)(S^1/2)
Flow (Q) = Velocity x Area (VA)
n = Manning's Friction Factor
R = Hydraulic Radius (Area/Wetted Perimeter)
S = Channel Slope
A = Area

Design Parameters	East Channel			East Channel	
100 Yr Storm Runoff	22	cfs	25 Yr Storm Runoff	18	cfs
Bottom Width, B	0.0	feet		0.0	feet
Sideslope Left, X_L	3.0	z : 1		3.0	z : 1
Sideslope Right, X_R	3.0	z : 1		3.0	z : 1
Channel Slope, S	0.50%			0.50%	
Channel Depth, D	2.00	feet		2.00	feet
Manning's "n"	0.013	concrete		0.013	concrete
top width =	12.00	feet		12.00	feet
Results					
Flow (Q) =	93.6	cu. ft. per sec.		93.6	cu. ft. per sec.
Velocity (V) =	7.8	feet per second		7.8	feet per second

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP
Project: Rockport Phase I Closure
Project No.: N1215154
By: JLH Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

Calculations			
Wetted Perimeter	$WP = H_L+H_R+B$		
$H_L = SQRT((X_L*D)(X_L*D)+(D*D))$ =>		6.32	6.32
$H_R = SQRT((X_R*D)(X_R*D)+(D*D))$ =>		6.32	6.32
	Bottom = B =>	0.00	0.00
	$WP = H_L+H_R+B$ =>	12.65	12.65
	A = [(Top+B)/2]*D =>	12.00	12.00
	Top = $[(X_L*D)+B+(X_R*D)]$ =>	12.00	12.00
	R = Area/Wetted Perimeter =>	0.95	0.95
	R^2/3 =	0.97	0.97
	S^1/2 =	0.07	0.07
	V =	7.8	7.8
	Q = V * A =>	93.6	93.6

Culvert Pipes

Orifice Flow - Round Hole

Orifice Equation: Q = C x A x Sqrt(2gH)

Q = flow (cfs)
C = discharge coefficient
A = area of the orifice opening (sf)
g = gravitational acceleration (ft/s^2)
H = effective head (ft)

Calculations

C =	0.6	
hole diameter =	**18**	**inch**
A =	1.76625	sf
g =	32.174	ft/s^2
H =	Varies	ft
Head, ft	Q, cfs	
0.8	7.4	Top of Culvert Pipe
1.3	9.5	
1.8	11.2	
2.3	12.8	
2.8	14.1	

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP

Project: Rockport Phase I Closure

Project No.: N1215154

By: JLH   Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

Pipe Flow Capacity using Manning's Formula

Velocity (V) =	$(1.49/n)(R^{2/3})(S^{1/2})$
Flow (Q) =	Velocity times Area (VA)

Design Parameters

Pipe Diameter	**18**	**inches**
Pipe Slope	1.00%	
Manning's "n"	0.012	RCP

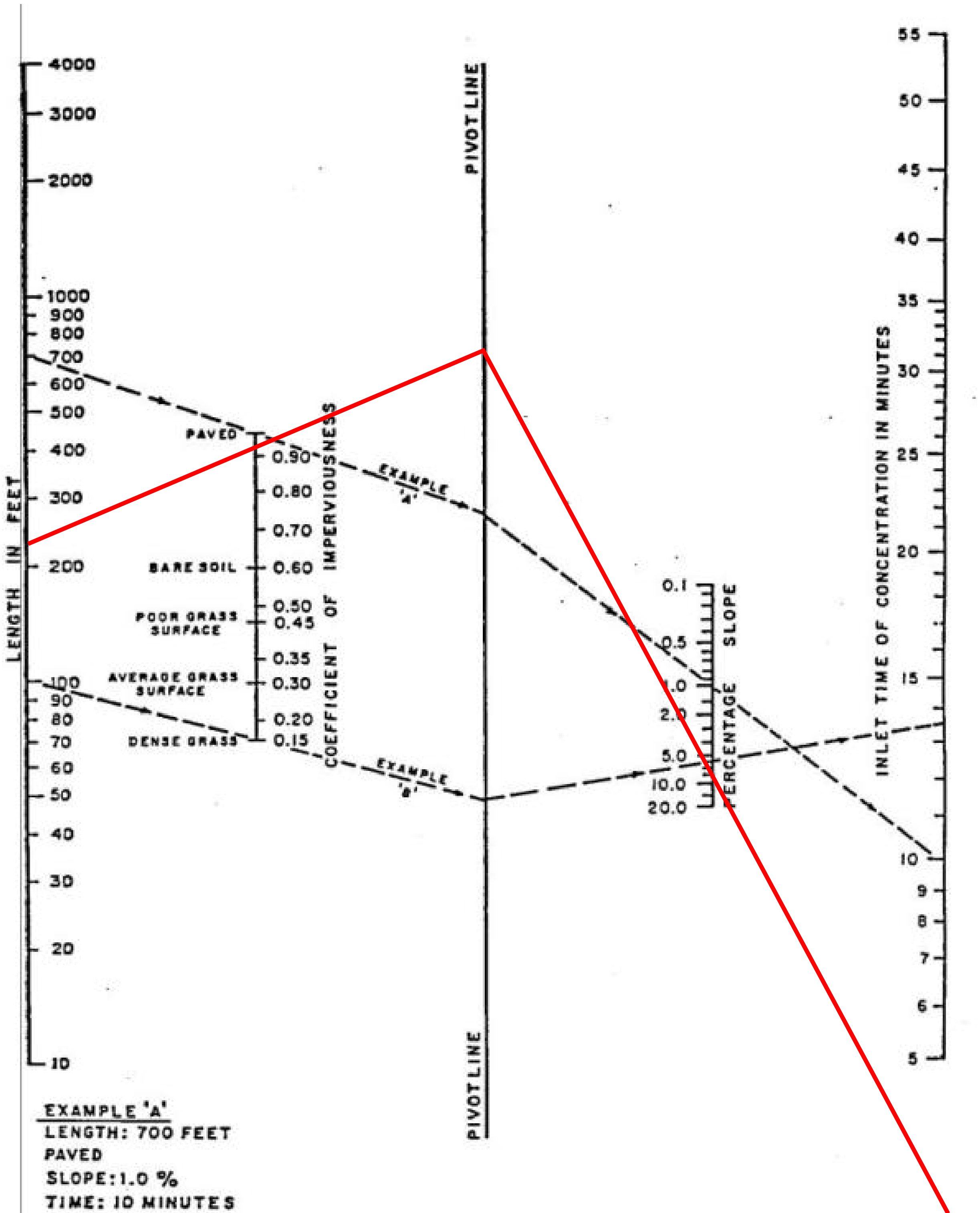
Results

Velocity (V) =	6.5	fps
Flow (Q) =	11.41	cfs

Calculations

Hydraulic Radius	Area/Wetted Perimeter =	Area/Wetted Perimeter = Diameter/4	
Diameter =	1.5	ft	
R=	0.375		
R^2/3 =	0.520021		
S^1/2 =	0.1000		
V =	6.4569		
Q =	VA		
Area =	1.76715	Sq Ft	
Wetted Perimeter	4.7124		
R=	0.375		

Rockport Phase I Closure
East Drainage Area



EXAMPLE 'A'
LENGTH: 700 FEET
PAVED
SLOPE: 1.0 %
TIME: 10 MINUTES

EXAMPLE 'B'
LENGTH: 100 FEET
DENSE GRASS
SLOPE: 6.0 %
TIME: 13 ½ MINUTES

SEELYE CHART

TIME OF CONCENTRATION

Tc = 3 min

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP
Project: Rockport Phase I Closure
Project No.: N1215154
By: JLH Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

RUNOFF CALCULATIONS — Northeast Drainage Area

Stormwater Flow using Rational Method, Q = C I A
Check 5-YR to 100-Yr storm event, Type II Storm

Runoff Coefficient, C	0.95		Roofs
Rainfall Intensity (I), based on Time of Concentration (Tc)			
Time of Concentration	2	Minutes	Seelye Chart
Drainage Area:	3.79	Acres	Grading Plan

Storm Frequency	Tc, Minutes	Intensity, (I) = In/Hr	Runoff Coefficient	Area (Acres)	Q, Runoff Flow (CFS)	Intensity, (I) = In/Hr Calculation
5-Yr	2	6.24	0.95	3.79	22	131/(Tc+19)
10-Yr	2	6.80	0.95	3.79	24	170/(Tc+23)
25-Yr	2	7.19	0.95	3.79	26	230/(Tc+30)
50-Yr	2	8.62	0.95	3.79	31	250/(Tc+27)
100-Yr	2	8.79	0.95	3.79	32	290/(Tc+31)

CHANNEL FLOW ANALYSIS

Calculation of Flow in a Trapezoidal Channel using Manning's Formula

Velocity (V) = (1.486/n)(R^2/3)(S^1/2)
Flow (Q) = Velocity x Area (VA)
n = Manning's Friction Factor
R = Hydraulic Radius (Area/Wetted Perimeter)
S = Channel Slope
A = Area

Design Parameters	Flume			Channel	
100 Yr Storm Runoff	32	cfs	25 Yr Storm Runoff	26	cfs
Bottom Width, B	4.0	feet		0.0	feet
Sideslope Left, X_L	2.0	z : 1		3.5	z : 1
Sideslope Right, X_R	2.0	z : 1		3.5	z : 1
Channel Slope, S	25.00%			2.00%	
Channel Depth, D	2.00	feet		3.00	feet
Manning's "n"	0.013	concrete		0.013	concrete
top width =	12.00	feet		21.00	feet

Results					
Flow (Q) =	1053.2	cu. ft. per sec.		650.0	cu. ft. per sec.
Velocity (V) =	65.8	feet per second		20.6	feet per second

SURFACE WATER DRAINAGE CALCULATIONS

Client:	AEP	**Terracon Consultants, Inc.**
Project:	Rockport Phase I Closure	611 LUNKEN PARK DRIVE
Project No.:	N1215154	CINCINNATI, OHIO 45266
By:	JLH	Date: 8/23/2021

Calculations			
Wetted Perimeter	$WP = H_L+H_R+B$		
	H_L = SQRT((X_L*D)(X_L*D)+(D*D)) =>	4.47	10.92
	H_R = SQRT((X_R*D)(X_R*D)+(D*D)) =>	4.47	10.92
	Bottom = B =>	4.00	0.00
	$WP = H_L+H_R+B$ =>	12.94	21.84
	A = [(Top+B)/2]*D =>	16.00	31.50
	Top = [(X_L*D)+B+(X_R*D)] =>	12.00	21.00
	R = Area/Wetted Perimeter =>	1.24	1.44
	R^2/3 =	1.15	1.28
	S^1/2 =	0.50	0.14
	V =	65.8	20.6
	Q = V * A =>	1053.2	650.0

Culvert Pipes

Orifice Flow - Round Hole

Orifice Equation: Q = C x A x Sqrt(2gH)

Q = flow (cfs)
C = discharge coefficient
A = area of the orifice opening (sf)
g = gravitational acceleration (ft/s^2)
H = effective head (ft)

Calculations

C =	0.6	
hole diameter =	**30**	**inch**
A =	4.90625	sf
g =	32.174	ft/s^2
H =	Varies	ft
Head, ft	Q, cfs	
1.3	26.4	Top of Culvert Pipe
1.8	31.2	
2.3	35.4	
2.8	39.2	
3.3	42.6	

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP

Project: Rockport Phase I Closure

Project No.: N1215154

By: JLH   Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

Pipe Flow Capacity using Manning's Formula

Velocity (V) =	$(1.49/n)(R^{2/3})(S^{1/2})$	
Flow (Q) =	Velocity times Area (VA)	

Design Parameters

Pipe Diameter	**30**	**inches**
Pipe Slope	2.00%	
Manning's "n"	0.012	RCP

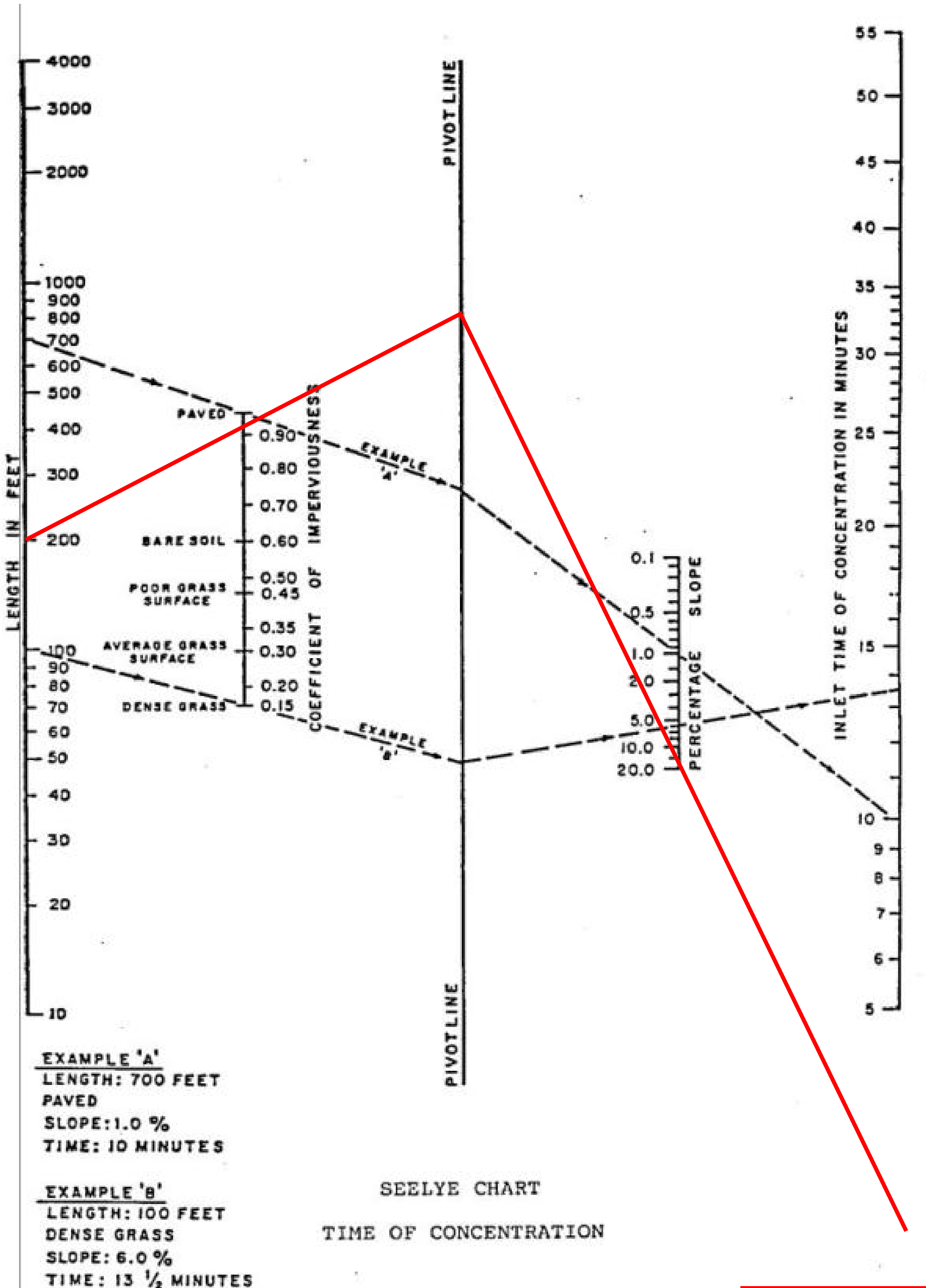
Results

Velocity (V) =	12.8	fps
Flow (Q) =	63.01	cfs

Calculations

Hydraulic Radius	Area/Wetted Perimeter =	Area/Wetted Perimeter = Diameter/4	
Diameter =	2.5	ft	
R=	0.625		
R^2/3 =	0.7310044		
S^1/2 =	0.1414		
V =	12.8363		
Q =	VA		
Area =	4.90875	Sq Ft	
Wetted Perimeter	7.854		
R=	0.625		

Rockport Phase I Closure
Northeast Drainage Area



SEELYE CHART

TIME OF CONCENTRATION

Tc = 2 min

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP
Project: Rockport Phase I Closure
Project No.: N1215154
By: JLH Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

RUNOFF CALCULATIONS

Northwest Drainage Area

Stormwater Flow using Rational Method, Q = C I A
Check 5-YR to 100-Yr storm event, Type II Storm

Runoff Coefficient, C	0.95		Roofs
Rainfall Intensity (I), based on Time of Concentration (Tc)			
Time of Concentration	2	Minutes	Seelye Chart
Drainage Area:	4.4	Acres	Grading Plan

Storm Frequency	Tc, Minutes	Intensity, (I) = In/Hr	Runoff Coefficient	Area (Acres)	Q, Runoff Flow (CFS)	Intensity, (I) = In/Hr Calculation
5-Yr	2	6.24	0.95	4.4	26	131/(Tc+19)
10-Yr	2	6.80	0.95	4.4	28	170/(Tc+23)
25-Yr	2	7.19	0.95	4.4	30	230/(Tc+30)
50-Yr	2	8.62	0.95	4.4	36	250/(Tc+27)
100-Yr	2	8.79	0.95	4.4	37	290/(Tc+31)

CHANNEL FLOW ANALYSIS

Calculation of Flow in a Trapezoidal Channel using Manning's Formula

Velocity (V) = (1.486/n)(R^2/3)(S^1/2)
Flow (Q) = Velocity x Area (VA)
n = Manning's Friction Factor
R = Hydraulic Radius (Area/Wetted Perimeter)
S = Channel Slope
A = Area

Design Parameters	Channel			Flume for NW + W	
25 Yr Storm Runoff	30	cfs	25 Yr Storm Runoff	57	cfs
Bottom Width, B	0.0	feet		8.0	feet
Sideslope Left, X_L	3.5	z : 1		2.0	z : 1
Sideslope Right, X_R	3.5	z : 1		2.0	z : 1
Channel Slope, S	8.00%			25.00%	
Channel Depth, D	2.00	feet		2.00	feet
Manning's "n"	0.013	concrete		0.035	concrete
top width =	14.00	feet		16.00	feet
Results					
Flow (Q) =	440.9	cu. ft. per sec.		642.6	cu. ft. per sec.
Velocity (V) =	31.5	feet per second		26.8	feet per second

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP

Project: Rockport Phase I Closure

Project No.: N1215154

By: JLH   Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

Calculations			
Wetted Perimeter	$WP = H_L+H_R+B$		
$H_L = SQRT((X_L*D)(X_L*D)+(D*D))$ =>		7.28	4.47
$H_R = SQRT((X_R*D)(X_R*D)+(D*D))$ =>		7.28	4.47
	Bottom = B =>	0.00	8.00
	$WP = H_L+H_R+B$ =>	14.56	16.94
	A = [(Top+B)/2]*D =>	14.00	24.00
	$Top = [(X_L*D)+B+(X_R*D)]$ =>	14.00	16.00
	R = Area/Wetted Perimeter =>	0.96	1.42
	R^2/3 =	0.97	1.26
	S^1/2 =	0.28	0.50
	V =	31.5	26.8
	Q = V * A =>	440.9	642.6

Culvert Pipes

Orifice Flow - Round Hole

Orifice Equation: Q = C x A x Sqrt(2gH)

Q = flow (cfs)

C = discharge coefficient

A = area of the orifice opening (sf)

g = gravitational acceleration (ft/s^2)

H = effective head (ft)

Calculations

C =	0.6	
hole diameter =	**0**	**inch**
A =	0	sf
g =	32.174	ft/s^2
H =	Varies	ft
Head, ft	Q, cfs	
0.0	0.0	Top of Culvert Pipe
0.5	0.0	
1.0	0.0	
1.5	0.0	
2.0	0.0	

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP
Project: Rockport Phase I Closure
Project No.: N1215154
By: JLH Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

Pipe Flow Capacity using Manning's Formula

Velocity (V) =	$(1.49/n)(R^{2/3})(S^{1/2})$	
Flow (Q) =	Velocity times Area (VA)	

Design Parameters

Pipe Diameter	**0**	**inches**
Pipe Slope	1.00%	
Manning's "n"	0.012	RCP

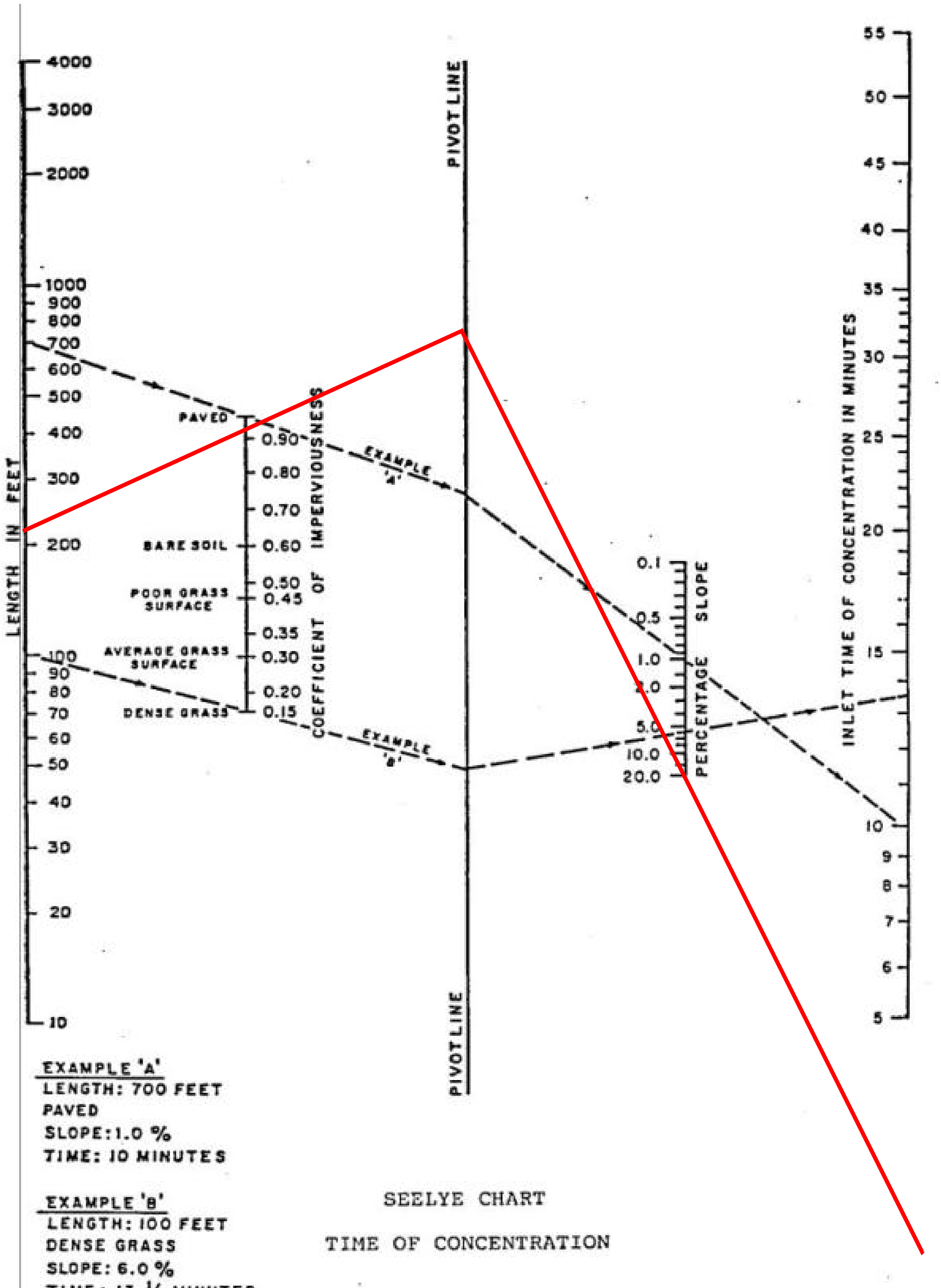
Results

Velocity (V) =	0.0	fps
Flow (Q) =	0.00	cfs

Calculations

Hydraulic Radius	Area/Wetted Perimeter =	Area/Wetted Perimeter = Diameter/4	
Diameter =	0	ft	
R=	0		
R^2/3 =	0		
S^1/2 =	0.1000		
V =	0.0000		
Q =	VA		
Area =	0	Sq Ft	
Wetted Perimeter	0		
R=	#DIV/0!		

Rockport Phase I Closure
Northwest Drainage Area



SEELYE CHART

TIME OF CONCENTRATION

Tc = 2 min

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP	**Terracon Consultants, Inc.**
Project: Rockport Phase I Closure	611 LUNKEN PARK DRIVE
Project No.: N1215154	CINCINNATI, OHIO 45266
By: JLH Date: 8/23/2021	

RUNOFF CALCULATIONS					West Drainage Area		
Stormwater Flow using Rational Method, Q = C I A							
Check 5-YR to 100-Yr storm event, Type II Storm							
Runoff Coefficient, C		0.95	Roofs				
Rainfall Intensity (I), based on Time of Concentration (Tc)							
Time of Concentration	6	Minutes	Seelye Chart				
Drainage Area:	4.4	Acres	Grading Plan				

Storm Frequency	Tc, Minutes	Intensity, (I) = In/Hr	Runoff Coefficient	Area (Acres)	Q, Runoff Flow (CFS)		Intensity, (I) = In/Hr Calculation
5-Yr	6	5.24	0.95	4.4	22		131/(Tc+19)
10-Yr	6	5.86	0.95	4.4	25		170/(Tc+23)
25-Yr	6	6.39	0.95	4.4	27		230/(Tc+30)
50-Yr	6	7.58	0.95	4.4	32		250/(Tc+27)
100-Yr	6	7.84	0.95	4.4	33		290/(Tc+31)

CHANNEL FLOW ANALYSIS

Calculation of Flow in a Trapezoidal Channel using Manning's Formula

Velocity (V) =	(1.486/n)(R^2/3)(S^1/2)
Flow (Q) =	Velocity x Area (VA)
n =	Manning's Friction Factor
R =	Hydraulic Radius (Area/Wetted Perimeter)
S =	Channel Slope
A =	Area

Design Parameters	West Channel on Bench			West Channel on Bench	
100 Yr Storm Runoff	33	cfs	25 Yr Storm Runoff	27	cfs
Bottom Width, B	0.0	feet		0.0	feet
Sideslope Left, X_L	3.5	z : 1		3.5	z : 1
Sideslope Right, X_R	3.5	z : 1		3.5	z : 1
Channel Slope, S	0.50%			0.50%	
Channel Depth, D	3.00	feet		3.00	feet
Manning's "n"	0.013	concrete (geomembrane)		0.013	concrete (geomem
top width =	21.00	feet		21.00	feet
Results					
Flow (Q) =	325.0	cu. ft. per sec.		325.0	cu. ft. per sec.
Velocity (V) =	10.3	feet per second		10.3	feet per second

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP	**Terracon Consultants, Inc.**
Project: Rockport Phase I Closure	611 LUNKEN PARK DRIVE
Project No.: N1215154	CINCINNATI, OHIO 45266
By: JLH Date: 8/23/2021	

Calculations					
Wetted Perimeter	WP = H_L+H_R+B				
	H_L = SQRT((X_L*D)(X_L*D)+(D*D)) =>	10.92			10.92
	H_R = SQRT((X_R*D)(X_R*D)+(D*D)) =>	10.92			10.92
	Bottom = B =>	0.00			0.00
	WP = H_L+H_R+B =>	21.84			21.84
	A = [(Top+B)/2]*D =>	31.50			31.50
	Top = [(X_L*D)+B+(X_R*D)] =>	21.00			21.00
	R = Area/Wetted Perimeter =>	1.44			1.44
	R^2/3 =	1.28			1.28
	S^1/2 =	0.07			0.07
	V =	10.3			10.3
	Q = V * A =>	325.0			325.0

Culvert Pipes

Orifice Flow - Round Hole

Orifice Equation: Q = C x A x Sqrt(2gH)

Q = flow (cfs)
C = discharge coefficient
A = area of the orifice opening (sf)
g = gravitational acceleration (ft/s^2)
H = effective head (ft)

Calculations

C =	0.6	
hole diameter =	**0**	**inch**
A =	0	sf
g =	32.174	ft/s^2
H =	Varies	ft
Head, ft	Q, cfs	
0.0	0.0	Top of Culvert Pipe
0.5	0.0	
1.0	0.0	
1.5	0.0	
2.0	0.0	

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP

Project: Rockport Phase I Closure

Project No.: N1215154

By: JLH Date: 8/23/2021

Terracon Consultants, Inc.

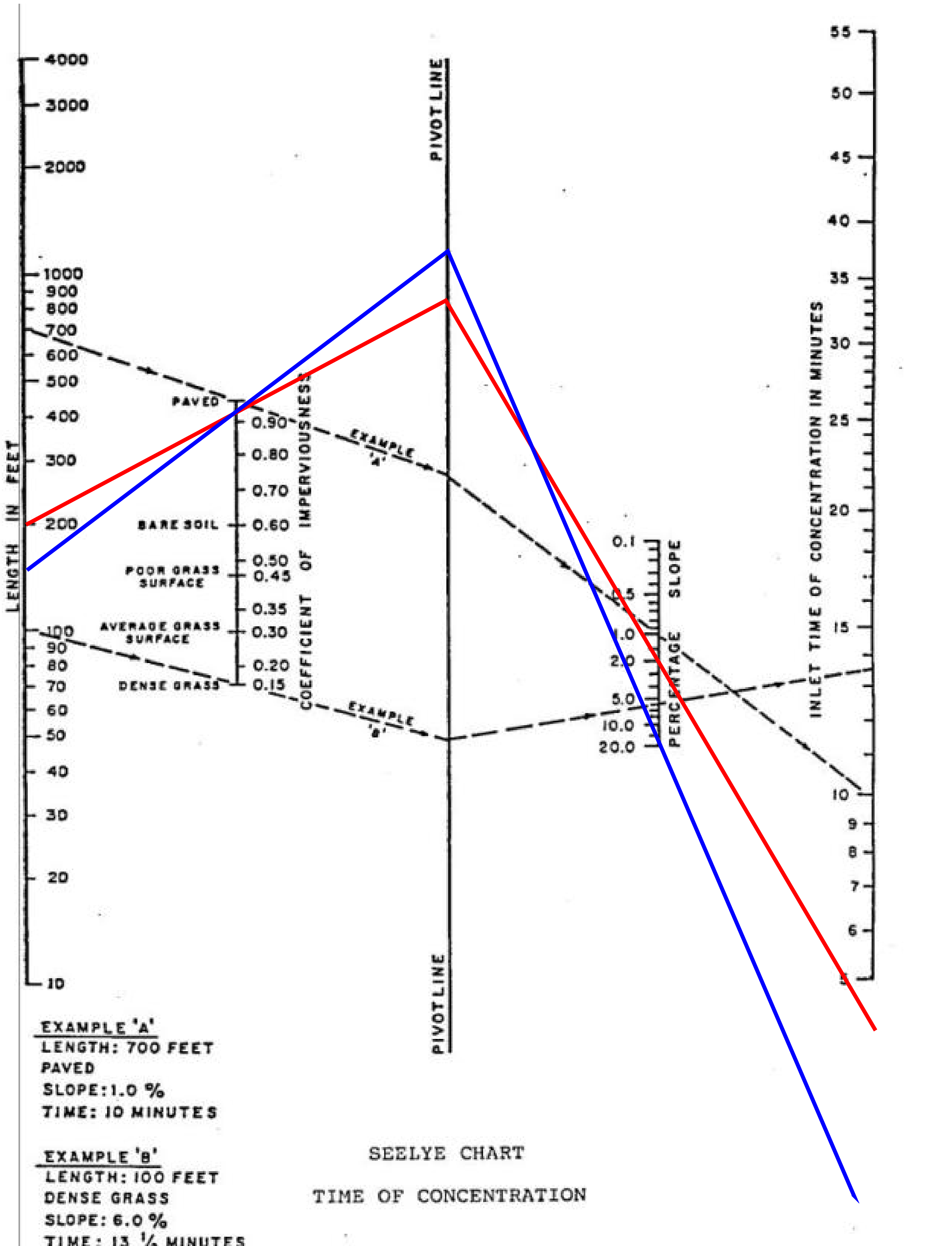
611 LUNKEN PARK DRIVE

CINCINNATI, OHIO 45266

Pipe Flow Capacity using Manning's Formula

Velocity (V) =	$(1.49/n)(R^{2/3})(S^{1/2})$	
Flow (Q) =	Velocity times Area (VA)	
Design Parameters		
Pipe Diameter	**0**	**inches**
Pipe Slope	1.00%	
Manning's "n"	0.012	RCP
Results		
Velocity (V) =	0.0	fps
Flow (Q) =	0.00	cfs
Calculations		
Hydraulic Radius	Area/Wetted Perimeter =	Area/Wetted Perimeter = Diameter/4
Diameter =	0	ft
R=	0	
R^2/3 =	0	
S^1/2 =	0.1000	
V =	0.0000	
Q =	VA	
Area =	0	Sq Ft
Wetted Perimeter	0	
R=	#DIV/0!	

Rockport Phase I Closure
West Drainage Area



SEELYE CHART

TIME OF CONCENTRATION

Plateau: Tc = 4 min

Sideslope: Tc = 2 min

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP	**Terracon Consultants, Inc.**
Project: Rockport Phase I Closure	611 LUNKEN PARK DRIVE
Project No.: N1215154	CINCINNATI, OHIO 45266
By: JLH Date: 8/23/2021	

RUNOFF CALCULATIONS — South Drainage Area

Stormwater Flow using Rational Method, Q = C I A

Check 5-YR to 100-Yr storm event, Type II Storm

Runoff Coefficient, C	0.95		Roofs
Rainfall Intensity (I), based on Time of Concentration (Tc)			
Time of Concentration	7	Minutes	Seelye Chart
Drainage Area:	9.5	Acres	Grading Plan

Storm Frequency	Tc, Minutes	Intensity, (I) = In/Hr	Runoff Coefficient	Area (Acres)	Q, Runoff Flow (CFS)	Intensity, (I) = In/Hr Calculation
5-Yr	7	5.04	0.95	9.5	45	131/(Tc+19)
10-Yr	7	5.67	0.95	9.5	51	170/(Tc+23)
25-Yr	7	6.22	0.95	9.5	56	230/(Tc+30)
50-Yr	7	7.35	0.95	9.5	66	250/(Tc+27)
100-Yr	7	7.63	0.95	9.5	69	290/(Tc+31)

CHANNEL FLOW ANALYSIS

Calculation of Flow in a Trapezoidal Channel using Manning's Formula

Velocity (V) = (1.486/n)(R^2/3)(S^1/2)

Flow (Q) = Velocity x Area (VA)

n = Manning's Friction Factor

R = Hydraulic Radius (Area/Wetted Perimeter)

S = Channel Slope

A = Area

Design Parameters	South Channel on Bench		Flume for S + E	
25 Yr Storm Runoff	56	cfs	74	cfs
Bottom Width, B	0.0	feet	8.0	feet
Sideslope Left, X_L	3.5	z : 1	2.0	z : 1
Sideslope Right, X_R	3.5	z : 1	2.0	z : 1
Channel Slope, S	0.50%		5.00%	
Channel Depth, D	3.00	feet	2.00	feet
Manning's "n"	0.013	concrete	0.013	concrete
top width =	21.00	feet	16.00	feet
Results				
Flow (Q) =	325.0	cu. ft. per sec.	773.7	cu. ft. per sec.
Velocity (V) =	10.3	feet per second	32.2	feet per second

SURFACE WATER DRAINAGE CALCULATIONS

Client:	AEP	**Terracon Consultants, Inc.**
Project:	Rockport Phase I Closure	611 LUNKEN PARK DRIVE
Project No.:	N1215154	CINCINNATI, OHIO 45266
By:	JLH Date: 8/23/2021	

Calculations				
Wetted Perimeter	$WP = H_L+H_R+B$			
	H_L = SQRT((X_L*D)(X_L*D)+(D*D)) =>	10.92		4.47
	H_R = SQRT((X_R*D)(X_R*D)+(D*D)) =>	10.92		4.47
	Bottom = B =>	0.00		8.00
	$WP = H_L+H_R+B$ =>	21.84		16.94
	A = [(Top+B)/2]*D =>	31.50		24.00
	Top = [(X_L*D)+B+(X_R*D)] =>	21.00		16.00
	R = Area/Wetted Perimeter =>	1.44		1.42
	R^2/3 =	1.28		1.26
	S^1/2 =	0.07		0.22
	V =	10.3		32.2
	Q = V * A =>	325.0		773.7

Culvert Pipes

Orifice Flow - Round Hole

Orifice Equation:	Q = C x A x Sqrt(2gH)		
	Q = flow (cfs)		
	C = discharge coefficient		
	A = area of the orifice opening (sf)		
	g = gravitational acceleration (ft/s^2)		
	H = effective head (ft)		
Calculations			
C =	0.6		
hole diameter =	**36**	**inch**	Twin pipes
A =	7.065	sf	
g =	32.174	ft/s^2	
H =	Varies	ft	
Head, ft	Q, cfs		
1.5	41.6	Top of Culvert Pipe	
2.0	48.1		
2.5	53.8		
3.0	58.9		
3.5	63.6		

SURFACE WATER DRAINAGE CALCULATIONS

Client: AEP

Project: Rockport Phase I Closure

Project No.: N1215154

By: JLH Date: 8/23/2021

Terracon Consultants, Inc.
611 LUNKEN PARK DRIVE
CINCINNATI, OHIO 45266

Pipe Flow Capacity using Manning's Formula

Velocity (V) = $(1.49/n)(R^{2/3})(S^{1/2})$

Flow (Q) = Velocity times Area (VA)

Design Parameters

Pipe Diameter	**36**	**inches**
Pipe Slope	1.00%	
Manning's "n"	0.012	RCP

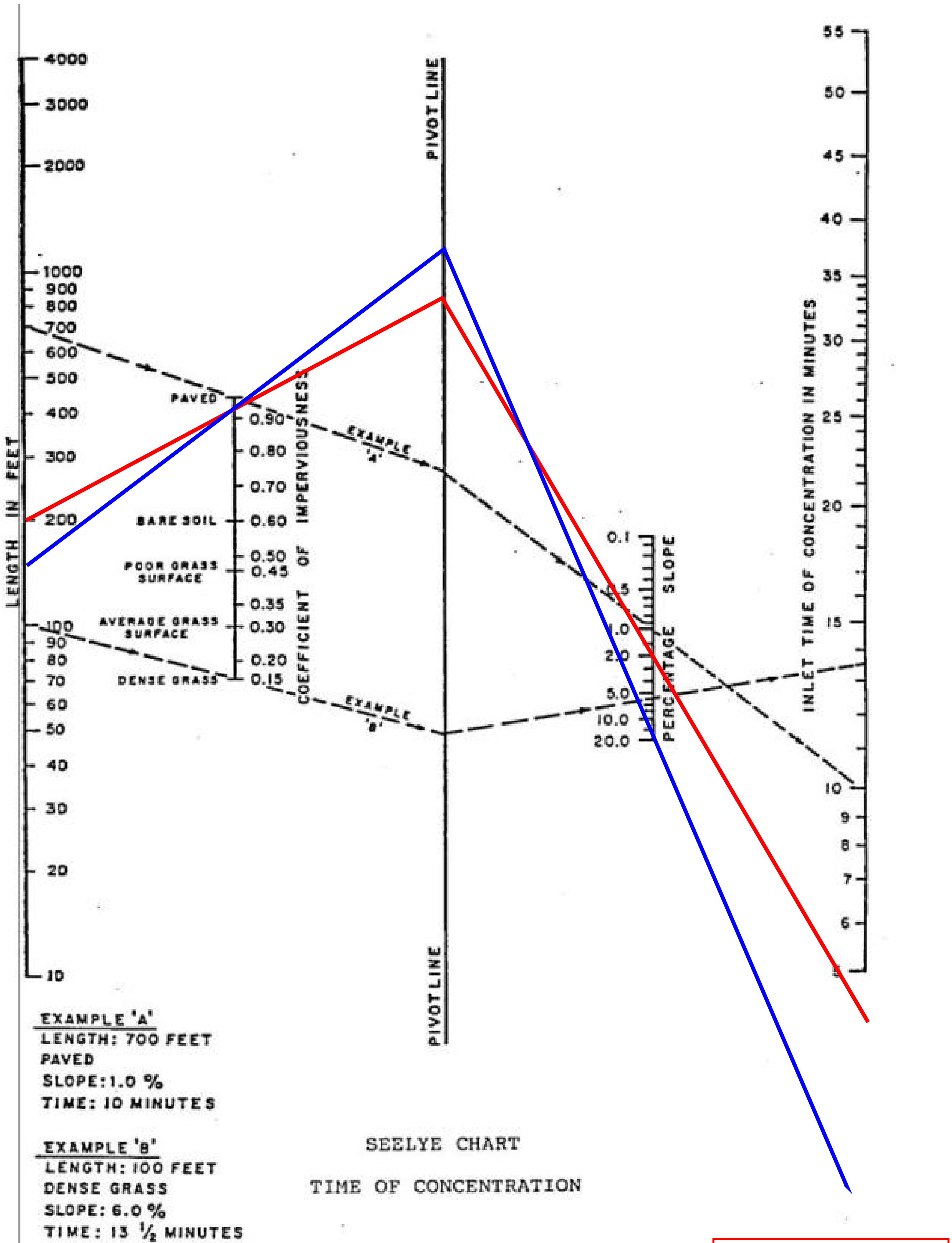
Results

Velocity (V) =	10.2	fps
Flow (Q) =	72.45	cfs

Calculations

Hydraulic Radius	Area/Wetted Perimeter =	Area/Wetted Perimeter = Diameter/4
Diameter =	3	ft
R=	0.75	
R^2/3 =	0.8254818	
S^1/2 =	0.1000	
V =	10.2497	
Q =	VA	
Area =	7.0686	Sq Ft
Wetted Perimeter	9.4248	
R=	0.75	

Rockport Phase I Closure
West Drainage Area



SEELYE CHART

TIME OF CONCENTRATION

Plateau: Tc = 4 min

Sideslope: Tc = 2 min

APPENDIX 3: PLAN REVIEW LOG

Plan Review and Changes in Facility Configuration

Scheduled reviews and Plan amendments shall be recorded in the Plan Review Log below. This log must be completed even if no amendment is made to the Plan as a result of the review.

By	Date	Amendment Description	P.E. certification required?	P.E. Name	Licensing State: Registration No.
Terracon Consultants, Inc.	9/13/2016	Initial Plan	Yes	Bruce Rome	Indiana PE60910201
Terracon Consultants, Inc.	9/29/2021	5-Year Update	Yes	John Hattersley	Indiana PE19700207

APPENDIX 4: PROFESSIONAL ENGINEER CERTIFICATION PAGE

Professional Engineer Certification Page

The undersigned licensed Professional Engineer (P.E.) attests that this Run-on and Run-off Control Plan has been prepared, reviewed, and/or revised in accordance with good engineering practice, including consideration of applicable industry standards and the requirements of 40 CFR 257. This certification in no way relieves the owner or operator of the facility of his/her duty to fully implement this Plan.

Engineer:	John L. Hattersley
Registration Number:	PE19700207
State:	Indiana
Date:	September 29, 2021

P.E. certification is required for the original Plan and Plan reviews and amendments.