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PennEast PIPELINE

Erosion and Sediment Control Plan for the Kidder Compressor Station

PennEast Pipeline Project

October 2019

353754-MM-EN-CO-083 RevB

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Contents

Executive Summary 1

1 Introduction and Overview 2

2 Existing Site Conditions 3
- 2.1 Soil Characteristics 3
- 2.2 Existing Land Use and Land Cover 3
- 2.3 Receiving Waters 3
- 2.4 Existing Riparian Forest Buffers 4
- 2.5 Naturally Occurring Geologic Formations 4

3 Proposed Conditions 6
- 3.1 Proposed Land Use and Land Cover 6
- 3.2 Proposed Site Drainage Characteristics 6

4 Description of Erosion & Sediment Control BMP's 7
- 4.1 Minimize Earth Disturbance 8
- 4.2 General Erosion and Sediment Control Plan Requirements 8

5 BMP Installation Sequence 10

6 Description of Project Site Runoff 11

7 Erosion & Sediment Control BMP Maintenance Plan 12
- 7.1 Inspections 12
- 7.2 General Maintenance 12
- 7.3 Specific Maintenance 12
  - 7.3.1 Rock Construction Entrance 12
  - 7.3.2 Erosion Control Blankets 13
  - 7.3.3 Compost Filter Sock 13
  - 7.3.4 Rock Filters and Weighted Sediment Filter Tubes 13
  - 7.3.5 Filter Bag Inlet Protection 13
  - 7.3.6 Channels 14
  - 7.3.7 Barrel/Riser Sediment Trap 14
- 7.4 E&S Control BMP Removal 14

8 Recycling and Disposal of Materials 15

9 Thermal Impact Analysis 16

10 Anti-degradation Analysis 17

10.1 Non-discharge Alternatives 17
10.2 Alternative Siting 17
10.3 Limited Disturbed Area 17
10.4 Limiting Extent and Duration of Disturbance 18

Appendices 19

A. Soils Report 20

B. Drainage Area Maps 21

C. E&SCP Design Calculations 22

D. Standard E&S Worksheet #22 23

E. E&SCP Drawings 24

Tables

Table 1: Thermal Impact Benefits of Oil and Gas Facility Selection Criteria 16

Executive Summary

PennEast proposes to construct a compressor station facility in Kidder Township, Carbon County, PA as part of the PennEast Mainline Project. The proposed compressor facility will include three gas turbine driven Solar Mars 100 units rated at 15,900 hp each with space for a future compressor. The project site will be accessed by means of a permanent access road that will connect to State Route 940 to the north. The equipment pad area will consist primarily of gravel with a paved circulation road along its perimeter.

Two infiltration basins are proposed to capture and attenuate peak runoff from the equipment pad and the access road. The total site area including the permanent easement and offsite drainage is approximately 43.7 acres, of which, approximately 18.5 acres will be routed through the proposed infiltration basins. A series of infield swales, inlets and piping will convey the runoff to these basins under proposed conditions.

This report summarizes the erosion and sediment control design for this site, proposed to meet the regulatory requirements for this type of development.

1 Introduction and Overview

This Erosion and Sediment Control Plan (E&SCP) has been developed to address control of accelerated erosion and sedimentation resulting from earth disturbances associated with the proposed Kidder Compressor Station site. It was developed in accordance with the requirements of 25 PA Administrative Code Chapters 78 and 102, as well as the Clean Streams Law (35 P. S. §§ 691.1001), as amended, utilizing guidelines and Best Management Practice (BMP) information provided in the Erosion and Sediment Control BMP Manual. This plan complements the PennEast Post Construction Stormwater Management Plan (PCSM Plan) prepared for this project, and was planned and designed to be consistent with that Plan under PA Code §102.8. An up to date copy of this plan, and any subsequently granted variances to the E&SCP, shall be available at the project field site during all stages of earth disturbance activities. This plan was prepared under the supervision of a Professional Engineer licensed in the state of Pennsylvania, who is trained and experienced in erosion and sediment control methods and techniques applicable to the size and scope of the proposed project (see Appendix D for Standard E&S Worksheet #22 - Plan Preparer Record of Training and Experience in Erosion and Sediment Pollution Control Methods and Techniques).

2 Existing Site Conditions

The Existing Conditions Plans (Drawings 023-03-03-001 through 023-03-03-003.1), included in Appendix E, depict all relevant existing site features, including the topography of the project site and the surrounding area, municipal and county boundaries, known property boundaries, roadways, streams, wetlands, and other important features.

2.1 Soil Characteristics

The location of mapped soil types and the attributes of the soils map units crossed by the facility site are provided in Appendix A. These soil boundaries and associated information were obtained from the United States Department of Agriculture (USDA) SSURGO database. Additionally, the Natural Resource Conservation Service (USDA-NRCS) "Web Soil Survey" website (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) was used to generate an "NRCS Custom Soils Resources Report" for this project. The methods that will be utilized to minimize impacts on soils during construction include, but are not limited to:

- Minimizing the area and duration of soil exposure
- Protecting critical areas by reducing the velocity of and control of runoff
- Installing and maintaining the erosion and sediment control measures
- Segregating and stockpiling topsoil
- Reestablishing vegetation following final grading
- Inspecting the area of disturbance and maintaining the erosion and sediment controls as necessary until final stabilization is achieved

The soil report in Appendix A contains the types, depth, slope, and limitations of the soils within the facility construction limits. Additional information in the soil report includes data on the physical characteristics of the soils, such as texture, erosion resistance, and suitability for the intended use.

2.2 Existing Land Use and Land Cover

Land use data is based on information obtained through field surveys, review of aerial photography, and USDA National Agricultural Statistics Service (NASS) Cropland Data Layer (USDA-NASS, 2014). The land use characteristics are classified by primary vegetation cover type and/or predominant land use. The facility site is almost entirely located on a forested/woodland land use area, with about 0.1 acres of the workspace on open land.

2.3 Receiving Waters

The site falls outside of the Tobyhanna Creek Watershed as depicted on Chapter 148 Attachment 2. Surface water resources located within the limits of the compressor station site were identified and delineated during field surveys conducted on October 21, 2014, November 25, 2014, August 25, 2015, and February 10, 2016. The proposed access road to the compressor station crosses an unnamed tributary (UNT) to Black Creek, which is also the receiving stream for the site. The Black Creek system ultimately discharges to the Lehigh River at the County boundary, approximately 5.3 miles southwest of the project site. The tributary within the project site is designated as a High Quality (HQ) waterbody per the PA Chapter 93 Water Quality Standards. A concrete box culvert has been designed to pass the tributary under the proposed access road. The box culvert has been sized to have a natural channel bottom per PennDOT Bridge Design (BD) – 632M standards, while passing the computed 100-year discharge without overtopping the access road.

The FEMA flood insurance maps currently available for the project area are dated June 2002. Per the FEMA FIS maps, no flood hazard information is available for the tributary, although, Black Creek is studied and the limit of FEMA study is approximately 1400 feet downstream of the proposed culvert crossing. The culvert analysis report is submitted separately for reference.

2.4 Existing Riparian Forest Buffers

Riparian buffers are areas of permanent vegetation situated along any surface water(s). When this vegetation is predominantly native trees, shrubs, and forbs that are maintained in a natural state or sustainably managed to protect and enhance water quality, it is considered a riparian forest buffer. There is a 150-foot riparian buffer surrounding a perennial unnamed tributary to Black Creek that flows under the proposed Kidder Compressor Station access road. There are also two intermittent streams just outside the northern corner of the site, and a portion of each stream's 150-foot riparian buffer overlaps a small portion of the workspace. The proposed impacts within the riparian buffers are further discussed and quantified in the riparian buffer waiver request in ESCGP-3 Section 1-7. The riparian buffers are shown on the Erosion and Sediment Control Plan Drawings.

2.5 Naturally Occurring Geologic Formations

General Geology:

The Kidder Compressor Station lies within the Spechty Kopf Formation, according to the Pennsylvania Department of Conservations and Natural Resources (PADCNR). The Spechty Kopf Formation is Mississippian and Devonian age, light to olive gray, fine to medium grained, crossbedded sandstone, siltstone, and polymictic diamicite, and pebbly mudstone with a maximum thickness of 575 feet thick. The formation is arranged in crude fining-upward cycles locally.

Although the proposed Compressor Station site falls within the approximate outlines of the Spechty Kopf Formation, it is possible that other formations or rock types could occur near the proposed Compressor Station, due to the approximate nature of USGS maps.

Surficial Geology:

Based on the Natural Resources Conservation Service (NRCS) Web Soil Survey, the surficial geology within the area of interest consists heavily of the Morris very stony silt loam. The Morris very stony silt loam is generally mapped as 38 percent sand, 46 percent silt, and 16 percent clay.

The Morris very stony silt loam has 0 to 8 percent slopes, is somewhat poorly drained, has a very high runoff class, and has a very low to moderately high rate of water transmission.

Mapped wetlands and existing streams surround the proposed Compressor Station site.

Corrosion of Concrete:

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer.

Based on NRCS Web Soil Survey, the existing soils have a moderate risk of corrosion for concrete buried in the ground. Concrete structures and pipes placed in the proposed infiltration basin may be susceptible to corrosion based on this assessment.

Corrosion of Steel:

"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer.

Based on NRCS Web Soil Survey, the existing soils have a moderate to high risk of corrosion for steel buried in the ground. Steel pipes or exposed steel members may be subjected to corrosion if installed within the proposed site.

Coal Mining:

No abandoned mines have been mapped by PADCNR in the vicinity of the proposed Compressor Station.

Landslide Susceptibility:

"Landslide" is a general term for downslope mass movement of soil, rock, or a combination of materials on an unstable slope. Landslides can vary greatly in their rate of movement, area affected, and volume of material. The principal types of movement are falling, sliding, and flowing, but combinations of these are common. The primary cause of landslides is when colluvial (loose) soil and old landslide debris on steep slopes give way.

The geologic instabilities that cause landslides are often exacerbated by highway projects during which the earth is cut and soil is loosened. Other primary causes of landslides are rainfall or rain-on-snow events that can weaken debris on steep mountain slopes (McCormick Taylor, 2009).

According to the USGS landslide susceptibility map, the facility site is not located within the vicinity of an area with high susceptibility to landsliding.

Earthquake Probability:

A seismic disturbance is any earth movement (natural or manmade) that is caused by a momentary disturbance of the elastic equilibrium of a portion of the earth. PennEast conducted a seismic hazard evaluation to evaluate the potential seismic hazard of the entire PennEast Project area. The purpose of the study was to estimate the levels of ground motions that will be exceeded at specified annual frequencies (or return periods) by performing a probabilistic seismic hazard analysis (PSHA). Based on the results of the PSHA, design ground motions in terms of peak horizontal ground acceleration (PGA) and peak horizontal ground velocity (PGV) were estimated and provided as input for the seismic design of the pipeline.

In summary, seismic hazard due to wave propagation effects should not pose a significant threat to the PennEast Project, and there is no conclusive evidence of Quaternary fault displacement. Therefore, the PGD hazard due to fault offset is considered insignificant.

Potential Geologic Hazard:

No Karst features have been mapped by PADCNR in the vicinity of the proposed Compressor Station.

Faults:

Based on the United States Geological Survey (USGS) mapping, there are no known faults within the vicinity of the proposed Compressor Station site.

3 Proposed Conditions

Earth disturbance shall be minimized to the extent practicable. Planning of the construction sequencing is required to limit the amount and duration of open trench sections, as necessary, to prevent excessive erosion or sediment flow into environmental resource areas. Approximately 37.37 acres will be disturbed at the facility site (25.81 acres for the permanent facility and 11.56 acres for temporary staging).

Earth disturbance shall be restricted to the Limit of Disturbance (LOD) delineated on the Erosion and Sediment Control Plan Drawings 023-03-03-004 through 023-03-03-006.1. These drawings contain the "Plan View", which depicts the proposed facility and site features. This includes the limits of earth disturbance and the locations of proposed BMPs.

3.1 Proposed Land Use and Land Cover

The proposed land cover will change throughout the duration of the proposed project. During the initial construction phase, much of the area will be bare earth. Upon completion of the construction, the site will be stabilized with vegetative cover, an impervious gravel pad, and access road, as indicated on the Plan drawings. Land surfaces will be stabilized and restored as construction activities are completed.

3.2 Proposed Site Drainage Characteristics

An assessment of the site's natural features was completed during the initial stage of project planning. The proposed facility has been sited to protect sensitive natural resources by avoiding these areas whenever possible. The site has also been planned and designed to maintain pre-development drainage patterns to the maximum extent practicable. A conscious effort has been made to maintain existing vegetation where possible, and limit the extents of earth disturbance to the absolute minimum area necessary to construct the proposed facility.

Under proposed conditions, two infiltration basins are proposed to attenuate peak stormwater runoff and provide water quality for this project site. The basins are not expected to alter the general drainage pattern, all stormwater runoff from the project site will continue to ultimately outfall to the unnamed tributary. Since stormwater management facilities must be designed to account for offsite flows (if any), all stormwater management calculations in the PCSM Report are based on the total site area of 43.659 acres.

The north-basin is an infiltration basin with extended detention that will be located adjacent to the site access road near a roadway low point. This basin will strategically capture and treat roadway runoff. Two roadside swales adjacent to and immediately south of the access road will convey roadway runoff to this basin. During construction, the excavated basin will serve as a temporary sediment trap with a bottom elevation of 1736.0', twelve (12) inches above the final basin bottom elevation. Following construction and site stabilization, accumulated sediment and debris will be removed and final grades established.

Two additional swales are proposed north of the access road. The swale further north is a temporary swale that will divert offsite runoff from the temporary work areas during construction. This swale will be filled in at the completion of all construction activities. A second swale is proposed immediately north and adjacent to the access road. This swale will capture and bypass offsite flows through twin 48" culverts under the access road and away from the north-basin. The purpose is to not increase the hydraulic load on the basin by adding stormwater runoff from the offsite and temporary work areas to be vegetated that do not require water quality or quantity treatment. Portions of these offsite areas are zoned as commercial and/or industrial per the Township's current zoning ordinance. As such, the hydraulic analyses for these swales included in the PCSM Report have been performed for "full buildout" conditions.

The south-basin is an infiltration basin with extended detention that will be located adjacent to the proposed equipment pad. A series of swales, inlets and pipes will capture runoff from the pad area and convey it to the basin. It is noted that swales are proposed on all downstream sides of the equipment pad to maximize the capture of stormwater runoff from the pad area and route it through the south-basin for treatment. The south-basin is designed to capture and treat all stormwater runoff from the equipment pad.

4 Description of Erosion & Sediment Control BMP's

The erosion and sediment control BMPs for this earth disturbance activity have been planned to minimize the extent and duration of the proposed earth disturbance, to protect existing drainage features and vegetation, minimize soil compaction, and employ measures and controls that minimize the generation of increased runoff. Specific BMPs have been selected for this site to achieve these broad goals. The location of each proposed BMP is shown on Erosion and Sediment Control Plan Drawings 023-03-03-004 through 023-03-03-006.1.

- **Rock Construction Entrance:**

  A rock construction entrance will be installed at the end of the proposed access to control sediment tracking from the construction site onto PA Route 940. The proposed rock construction entrance location is shown on the E&SCP drawing 023-03-03-006. The rock construction entrance detail is presented on Drawing 023-03-04-001 (Figure 2).

- **Erosion Control Blankets:**

  In accordance with the notes listed on Drawing 023-03-04-002 (Figures 23 and 24), erosion control blankets are to be placed on disturbed slopes 3H:1V and steeper. Areas to be blanketed are indicated on the Erosion and Sediment Control Plan Drawings 023-03-03-004 through 023-03-03-006.1.

- **Compost Filter Sock:**

  Compost filter sock on the E&SCP Drawings 023-03-03-004 through 023-03-03-006.1 is presented as a perimeter control for disturbed areas, and protection from sediment pollution during construction. The compost filter sock detail and specifications are presented on Drawing 023-03-04-001 (Figures 4, 4A & 4B).

- **Rock Filters:**

  Rock filters are proposed to protect against sediment pollution within the proposed channels, as depicted on the E&SCP Drawings 023-03-03-004 through 023-03-03-006. The rock filter detail is presented on Drawing 023-03-04-001 (Figure 12).

- **Weighted Sediment Filter Tubes:**

  Weighted sediment filter tubes are proposed to protect against sediment pollution within the proposed channels with depths less than 2 feet, as depicted on the E&SCP Drawing 023-03-03-004. The weighted sediment filter tube detail is presented on Drawing 023-03-04-001 (Figure 12A).

- **Inlet Filter Bags:**

  In the locations shown on the E&SCP Drawings 023-03-03-004 through 023-03-03-006, filter bags should be installed according to the manufacturer's specifications to provide inlet protection, and be capable of trapping all particles not passing through a No. 40 Sieve. The inlet filter bag detail is presented on Drawing 023-03-04-002 (Figure 14).

- **Channels:**

  Vegetated and riprap-lined channels are proposed throughout the facility site to divert upland runoff entering the site, collect site runoff, and convey the water to the two proposed infiltration basins.

  The locations of the channels are depicted on the E&SCP 023-03-03-004 through 023-03-03-006.1. Runoff and sizing calculations for all swales are included in Appendix C. The vegetated and riprap channel details are presented on Drawing 023-03-04-003 (Figures 49 and 50).

- **Pumped Water Filter Bag**

  Filter bags may be used to filter water pumped from the disturbed areas at the facility site prior to discharging to surface waters. The pumped water filter bag detail is presented on Drawing 023-03-04-002 (Figure 36).

- **Barrel/Riser Sediment Trap**

  As mentioned in Section 3.2, the north basin will serve as a temporary sediment trap during construction. The runoff and sizing calculations for the proposed trap are located in Appendix C. The location of the proposed trap is shown on the E&SCP Drawing 023-03-03-006. The barrel/riser sediment trap and temporary riser details are presented on Drawing 023-03-04-003 (Figures 51 and 52).

4.1 Minimize Earth Disturbance

Limiting the extent and duration of earth disturbance to that which is absolutely necessary to construct the proposed facility is the most simple and effective BMP available. The LOD delineated on E&SCP Drawings 023-03-03-004 through 023-03-03-006.1 has been established to restrict construction activities to the minimum area needed to effectively and efficiently construct the proposed facilities. In addition to limiting the extents of the proposed earth disturbance, construction activities have been planned to limit the duration of earth disturbance. Construction activities shall be sequenced to prevent, to the extent possible, excessive erosion or sediment flow into environmental resource areas.

4.2 General Erosion and Sediment Control Plan Requirements

The BMPs listed in this E&SCP shall be installed and maintained in accordance with FERC requirements, and the PADEP Erosion and Sediment Pollution Control Program Manual, March 2012. These BMPs shall be installed as shown prior to earth disturbance (including clearing and grubbing) within the drainage area of the BMP in question. Appropriate BMPs shall be provided for each stage of activity. Each BMP shall be kept functional until all earth disturbances within the drainage area are completed and a minimum vegetative cover (uniform 70% coverage of perennial vegetation over the entire disturbed area) has been achieved or other suitable permanent erosion protection has been installed.

At least 7 days prior to starting any earth disturbance activities (including clearing and grubbing), the owner and/or operator shall invite all contractors, the landowner, appropriate municipal officials, the E&S Plan preparer, the PCSM Plan preparer, the licensed professional responsible for oversight of critical stages of implementation of the post construction stormwater management plan and a representative from the local conservation district to an on-site preconstruction meeting.

Prior to commencement of any earth disturbance activity, including clearing and grubbing, the owner and/or operator shall clearly delineate sensitive areas, riparian forest buffer boundaries, areas proposed for infiltration practices, the limits of clearing, and trees that are to be conserved within the project site. These parties shall also install appropriate barriers where equipment may not be parked, staged, operated, or located for any purpose.

E&SC measures and facilities shall be installed and operational as indicated in the construction schedule prior to any earth moving activities. See the “BMP Installation Sequence” in Section 5.0 of this E&SCP. Control measures must be in place and operational at the beginning and end of each workday. Wherever possible, the disturbed area shall be permanently stabilized immediately after the final earthmoving has been completed. For disturbed areas that cannot be permanently stabilized, interim stabilization in the form of temporary seeding and mulching shall be implemented. Until the site is permanently stabilized, all E&SC measures shall be properly maintained by the Contractor.

Only after permanent stabilization is achieved, will the temporary E&SC measures be removed. Areas disturbed during removal of the controls must be stabilized immediately. For vegetated areas, permanent stabilization is defined as a uniform 70% perennial vegetative cover.

Minor modification to the approved E&SCP shall be noted on the E&SCP that is available at the site and initialed by the appropriate reviewing entity staff from PADEP and/or the County Conservation District.

Minor changes to the E&SCP may include adjustments to BMPs and locations within the permitted boundary to improve environmental performance, prevent potential pollution, changes in ownership or address, typographical errors, and on-site field adjustments such as the addition or deletion of BMPs, or alteration of earth disturbance activities to address unforeseen circumstances.

Major modifications to the approved E&SCP involving new or additional earth disturbance activity other than those described as minor modifications above, and/or the addition of a discharge will require prior approval by the reviewing entity and may require the submittal of a new E&SCP.

5 BMP Installation Sequence

The entire construction sequence listing all steps to be taken from initial site clearing through final stabilization is included on general notes sheet 023-03-02-002 of the Plan drawings. Refer to the Plan drawings for the site-specific installation information.

At least seven (7) days before starting any earth disturbance activities, the owner and/or operator shall notify the PADEP and Carbon County Conservation District by either telephone or certified mail of the intent to commence earth disturbance activities. Attendance at a pre-construction conference is required upon request of the PADEP.

At least three (3) days before starting any earth disturbance activities, all contractors involved in those activities shall notify the Pennsylvania One Call system at 1-800-242-1776 to determine the location of existing underground utilities.

Once activities are completed and all contributing areas are stabilized, install PCSM BMPs detailed by proposed grading, notes, and details shown on the E&S and PCSM Plan Drawings. Return topsoil to disturbed areas and seed and mulch according to the specifications herein.

6 Description of Project Site Runoff

A primary component of this E&SCP was the design of erosion and sediment control BMPs to minimize and control accelerated erosion and the generation of increased runoff. All proposed E&SC facilities have been designed per design guidance provided in the Erosion and Sediment Pollution Control Program Manual (PADEP, 2012).

Proposed facilities were sized based on the maximum tributary drainage area anticipated during construction. Runoff volumes and rates for specific BMPs were calculated utilizing the methods recommended in the Manual for that type of facility. BMP sizing calculations are provided in Appendix C.

7 Erosion & Sediment Control BMP Maintenance Plan

A maintenance program that provides for routine inspection, as well as repair and replacement as necessary, is essential to effective and efficient operation of the proposed erosion and sediment control BMPs. Implementation of the following maintenance plan is a key component in achieving the intent of this Plan and minimizing accelerated erosion and sedimentation from the proposed earth disturbance. The permittee and any co-permittees shall be responsible for implementing the following maintenance program:

7.1 Inspections

To effectively mitigate project-related impacts, the E&SCP must be properly implemented in the field. Quick and appropriate decisions in the field regarding critical issues such as stream and wetland crossings, placement of erosion controls, trench dewatering, spoil containment, and other construction related items are essential. The Contractor shall inspect all erosion and sediment BMPs after each runoff event and on a weekly basis, at a minimum. This inspection shall include a general review of the performance of all erosion and sediment control facilities, as well as an examination of each individual BMP, noting when maintenance (e.g., cleanout, repair, replacement, regrading, restabilizing, etc.) is required, when specific deficiencies exist, and/or signs of potential future problems are present. The progress of vegetation cover shall also be included in this inspection. All inspections shall be documented in a written report summarizing each inspection and shall include a schedule for repair of all noted deficiencies. All preventive and remedial maintenance work, including clean out, repair, replacement, regrading, reseeding, remulching, and renetting must be scheduled for immediate corrective action. If any installed BMPs are identified as failing to perform as expected, corrective modifications or replacement BMPs shall be scheduled for installation.

An erosion and sediment BMP inspection log shall be maintained on site and be made available to regulatory agency officials and project personnel at the time of inspection. The log shall contain inspection dates, observed deficiencies, and remediation dates.

7.2 General Maintenance

The Contractor shall be responsible for the continuous maintenance of all measures and devices for the duration of the project, until such time the area is stabilized with a minimum uniform perennial 70% vegetative cover or other permanent non-vegetative cover with a density sufficient to resist accelerated erosion and received a written approval of Notice of Termination.

Vegetation voided areas shall promptly be reseeded and mulched to establish protection. Any device found to be clogged, damaged, half-full of silt, or not fully operational will be cleaned of all debris. BMPs will be repaired or replaced (as necessary) to ensure effective and efficient operation. The solid waste disposal is the responsibility of the Contractor. All necessary repairs will be made immediately after any deficiencies are observed.

7.3 Specific Maintenance

The Contractor shall be responsible for the specific maintenance activities throughout the duration of the project as follows:

7.3.1 Rock Construction Entrance

Rock Construction Entrance thickness shall be constantly maintained to the specified dimensions by adding the required aggregate. A stockpile of aggregate shall be maintained on site for this purpose. Aggregate shall also be added to the rock construction entrance to maintain the capacity to remove sediment from tires. In the event the entrance becomes too clogged with sediment and debris to remain effective, the rock construction entrance shall be removed and replaced.

At the end of each construction day, all sediment deposited on paved roadways shall be removed and returned immediately to the construction site upslope of appropriate BMPs. Washing the roadway or sweeping the deposits into roadway ditches, sewer, culverts, or other drainage courses is not acceptable.

If excessive amounts of sediment are being deposited on roadways, the length of the rock construction entrance shall be extended by 50 foot increments until the condition is alleviated. Alternatively, a wash rack shall be installed.

7.3.2 Erosion Control Blankets

Inspect erosion control matting for good continuous contact with underlying soil throughout the entire length. Erosion control matting shall be checked for loose stapled areas and repaired as necessary.

Inspect for erosion and undermining beneath all erosion control matting. Immediately re-grade and repair any undermined or washed out areas.

Check vegetation growth during inspections. Reseed areas as necessary to ensure uniform vegetative cover.

Inspect erosion control matting for displaced, torn, or otherwise damaged matting and restore or replace within four (4) calendar days.

7.3.3 Compost Filter Sock

Check compost filter sock for areas of concentrated discharge. When identified, concentrated discharge locations shall be remediated by adjusting sock alignment to restore level grade and encourage even distribution of discharge.

Check compost filter sock for torn or otherwise damaged sections allowing water to flow under or around the barrier. Damaged socks shall be repaired according to the manufacturer's specification or replaced within 24 hours of identification.

Any section of the barrier which has been undermined or topped shall be immediately repaired with a rock filter outlet, or other acceptable repair as detailed on the Plan drawings.

Sediment shall be removed when accumulations reach ½ the above ground height of the barrier. Removed sediment shall be disposed of in the manner described in this Plan.

Maintain the additional blown/placed mulch on the upslope side of the compost filter sock. Replace biodegradable compost filter socks 6 months after installation and replace photodegradable compost filter socks 12 months after installation.

7.3.4 Rock Filters and Weighted Sediment Filter Tubes

Inspect rock filters and weighted sediment filter tubes weekly and after each runoff event. If repairs are needed, initiate them immediately after the inspection.

Replace any clogged filter stone (AASHTO #57) or damaged weighted sediment filter tubes.

Remove sediment when accumulations reach 1/2 the height of the rock filter or weighted sediment filter tube.

Immediately upon stabilization of each channel, the installer shall remove accumulated sediment, remove the rock filter, and stabilize disturbed areas.

7.3.5 Filter Bag Inlet Protection

Inspect filter bags on a weekly basis and after each runoff event. Clean and/or replace filter bag when the bag is half full, or when flow capacity has been reduced to the point that is causes flooding or bypassing of the inlet.

Dispose of accumulated sediment in the approved manner. Rinse bags that will be reused at a location where the rinse water will enter a sediment trap or sediment basin.

Replace damaged filter bags. Needed repairs shall be initiated immediately after the inspection.

7.3.6 Channels

Channels shall be inspected to ensure that the specified design dimensions and protective linings are maintained at all times.

Inspect channels for channelized flow lines within the channel, unstable side slopes, wash outs, bulges, or slumps in the ditch line. Repair as necessary to correct the issue.

Damaged lining shall be repaired or replaced within 48 hours of discovery.

Channels shall be cleaned whenever total channel depth is reduced by 25% at any location and shall be maintained free of any sediment/debris blocking the normal flow of water. Sediment deposits shall be removed within 24 hours of discovery or as soon as soil conditions permit access to the channel without causing further damage. Removed sediment shall be disposed of in the manner described in this Plan.

7.3.7 Barrel/Riser Sediment Trap

All sediment traps shall be inspected at least weekly and after each runoff event.

A cleanout stake shall be placed near the center of each trap. Accumulated sediment shall be removed when it has reached the clean out elevation on the stake and the trap restored to its original dimensions. Dispose of materials removed from the trap in the manner described in the E&S plan.

Check embankments, spillways, and outlets for erosion, piping and settlement. Clogged or damaged spillways and/or embankments shall be immediately restored to the design specifications.

Displaced riprap within the outlet protection shall be replaced immediately.

7.4 E&S Control BMP Removal

Upon completion of earth disturbance described in this plan, the rock construction entrance shall be removed and the areas stabilized in a manner similar to the remainder of the access road. All other Erosion and Sediment Control BMPs shall remain functional until implementation of the PCSM Plan. At no time shall any BMPs be removed prior to all areas tributary to them achieving permanent stabilization, except when replaced by another state-approved BMP.

After final stabilization has been achieved, temporary erosion and sediment BMPs may be removed if they are not necessary for implementation of the PCSM Plan. Areas disturbed during removal or conversion of the BMPs to PCSM BMPs must be stabilized immediately. To ensure rapid revegetation of disturbed areas, such removal\conversions are to be done only during the germinating season.

8 Recycling and Disposal of Materials

Building materials and other construction site waste must be properly managed and disposed of to reduce the potential for pollution to surface and ground waters, as per 25 PA Code § 102.4(b)(5)(xi). All building materials and waste shall be removed from the site and recycled or disposed of in accordance with PADEP Solid Waste Management Regulations per 25 PA Code 260.1 et seq., 271.1 and 287.1 et. seq. No building materials or waste shall be burned, buried, dumped, or discharged at the site. No off-site disposal area has been identified as part of this E&SCP. Construction waste shall be disposed of properly by the Contractor only at a state-approved disposal or recycling facility.

The Contractor will develop and implement procedures which will detail the proper measures for disposal and recycling of materials associated with or from the project site in accordance with PADEP regulations. Construction waste include, but are not limited to, excess soil materials, building materials, concrete wash water, and sanitary waste that could adversely impact water quality. The Contractor shall inspect the project area weekly and properly dispose of all construction waste. Measures shall be planned and implemented for housekeeping, materials management, and litter control. Wherever possible, re-useable waste shall be segregated from other waste and stored separately for recycling.

The Contractor shall be responsible for submitting an E&SCP for any borrow or waste areas required for completing the work. Disposal locations for excess soil/rock waste shall have appropriate BMPs implemented at the waste site. The disposal locations must be verified with the applicable state agency to show compliance with wetland and floodplain regulations. If an off-site location is used for borrow or disposal, the contractor shall be responsible for developing and implementing an adequate E&SCP for each location, and submitting it to the applicable state agency for review and approval. The Contractor shall immediately stabilize the waste site upon completion of any stage or phase of earth disturbance activity at the waste site.

9 Thermal Impact Analysis

The proposed project was analyzed for potential thermal impacts associated with the planned activities and how potential impacts could be avoided, minimized, or mitigated. Thermal impacts resulting from activities similar to the proposed project are primarily due to the negative impacts of increased impervious area. The following opportunities for negative thermal impacts exist for projects similar to the proposed one:

- Heat transfer from impervious cover to surface runoff
- Solar heat gain in ponded surface water.
- Increased surface temperatures caused by removal of vegetation
- Reduced thermal buffering of stormwater due to reduction in site's infiltration capacity
- Increased stream temperatures due to reduced base flow caused by reduction in site's infiltration capacity

Siting of oil and gas facilities is constrained by the location of the geologic formation planned for extraction and transmission, surface restrictions such as regulatory setbacks from building and waterways, and existing property boundaries. From this perspective, the potential to limit thermal impacts by altering the location of the project is limited. Table 1 below shows the site selection criteria used for the proposed project and how they help to prevent or minimize thermal impacts to receiving waters:

Table 1: Thermal Impact Benefits of Oil and Gas Facility Selection Criteria

Siting Restrictions	Thermal Impact Benefits
Locate proposed construction activities at least 100' from all blue-line surface waterfeatures	Maintain riparian buffers and canopy cover over surface waters to the maximum extent practicable
Avoid impacts to all surface waters and wetlands to the maximum extent possible	Maintain existing hydrology and encourage natural thermal buffering
Locate proposed facilities as close as possible to existing roads	Minimize proposed impervious cover
Choose sites with minimal existing tree cover	Reduce removal of existing tree canopy

In addition to the above site selection criteria, several BMPs will be used to help mitigate negative thermal impacts from the proposed project. Minimizing the LOD to the absolute minimum area necessary to construct the necessary facilities will maintain existing vegetative cover and the infiltration capacity of undisturbed areas to the maximum extent practicable. Also, disturbed areas will be immediately re-vegetated to help cool runoff prior to discharge.

10 Anti-degradation Analysis

The compressor station site is located in the Lehigh River watershed and surface flows currently drain to a UNT to Black Creek, which in turn drains to the Lehigh River. Chapter 93.9d from PADEP Code indicates that UNTs to Black Creek are identified as "HQ-CWF, MF" and there are no exceptions to special criteria. HQ indicates that this is a High Quality Water thus falls under Special Protection, and CWF (cold-water fishes) indicates the maintenance or propagation, or both, of fish species and additional flora and fauna which are indigenous to a cold water habitat. MF (migratory fishes) indicates the passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which move to or from flowing waters to complete their life cycle in other waters.

10.1 Non-discharge Alternatives

The proposed project has been evaluated for nondischarge alternatives for compliance with state regulatory agency antidegradation requirements. Nondischarge alternatives are defined as environmentally sound and cost effective BMPs that individually or collectively eliminate the net change in stormwater volume, rate and quality for storm events up to and including the 2-year design storm when compared to the stormwater rate, volume and quality prior to the earth disturbance activities.

Stormwater basins will be utilized to provide storage attenuation to prevent any increases in the rate of stormwater runoff, thus meeting the PADEP requirements.

Under existing conditions, offsite stormwater runoff flows across the site towards the UNT to Black Creek. Runoff from the site will mainly be diverted to the infiltration basins prior to discharge to the site's receiving stream, thus allowing for settling of solids. Following containment of stormwater and the settling of solids, discharge will be released overland to vegetated locations to allow for additional pollutant removal. Runoff that is not diverted through the basins (small portion of the road) will drain to the receiving water via overland flow across vegetated areas. Offside drainage areas will be bypassed via swales and discharged overland. Riprap will be placed at the end of the swales to dissipate energy. As such, the physical, biological, and chemical qualities of the UNT to Black Creek will be preserved.

10.2 Alternative Siting

Siting of pipelines and facilities is constrained by the location of leased property boundaries, regulatory setbacks, and many other factors. PennEast's facility site selection process incorporates all of these constraints into a desktop analysis for selection of potential sites. This analysis is followed by a detailed field review of potential sites by a site staking committee. During the field review, an engineer, land agent, and biologist coordinate to conduct a facility site review and identify a pad location and proposed facility configuration that provides maximum possible protection of all identified natural resources given the site-specific constraints.

10.3 Limited Disturbed Area

The LOD delineated on the E&SCP drawings has been established to restrict construction activities to the minimum area needed to effectively and efficiently construct the proposed facilities. This BMP is very effective at reducing the runoff volume rate, volume and concentration of pollutants in stormwater runoff. This BMP is "self-crediting" in that it automatically reduces the area to be treated and provides a corresponding reduction in stormwater impacts. However, it is not capable of addressing the impacts of the change in land cover associated with the proposed earth disturbance.

Kidder Compressor Station site is located on a wooded parcel and is surrounded by numerous wetland areas. The exact location and design of the station within the property has been selected to minimize impacts to woodlands, wetlands and streams.

10.4 Limiting Extent and Duration of Disturbance

As described in the Construction Sequence, and throughout this E&SCP, the duration and extent of earth disturbances will be limited to the current stage of work to be completed. Temporary or permanent stabilization is to occur as soon as possible upon completion of each stage. This BMP is very effective at reducing the concentration of pollutants in stormwater runoff and reducing the impact of bare earth on runoff volume and rate. However, it is not capable of addressing the impacts of the long-term change in land cover associated with the proposed earth disturbance.

The proposed site has been designed to minimize the area of disturbance, which minimizes the introduction of impervious areas. Gravel is proposed in lieu of asphalt along the perimeter of the compressor station, and areas within the foot print of the facility that are not graveled will be vegetated. The compressor station will be constructed with a total impervious area of approximately 8.8 acres.

Existing vegetation of the site will be preserved and protected to the greatest extent practicable, through minimizing the extents of the proposed disturbed area to the minimum to accomplish the Project objectives. Approximately 51.2 acres (over 69 percent of the entire 77-acre parcel) will remain undisturbed throughout the construction and operation of the compressor station. The acreage of the site that will be permanently disturbed, but not converted to impervious surfaces (approximately 17 acres) will be restored to a vegetated cover type.

Appendices

A. Soils Report

United States Department of Agriculture

NRCS

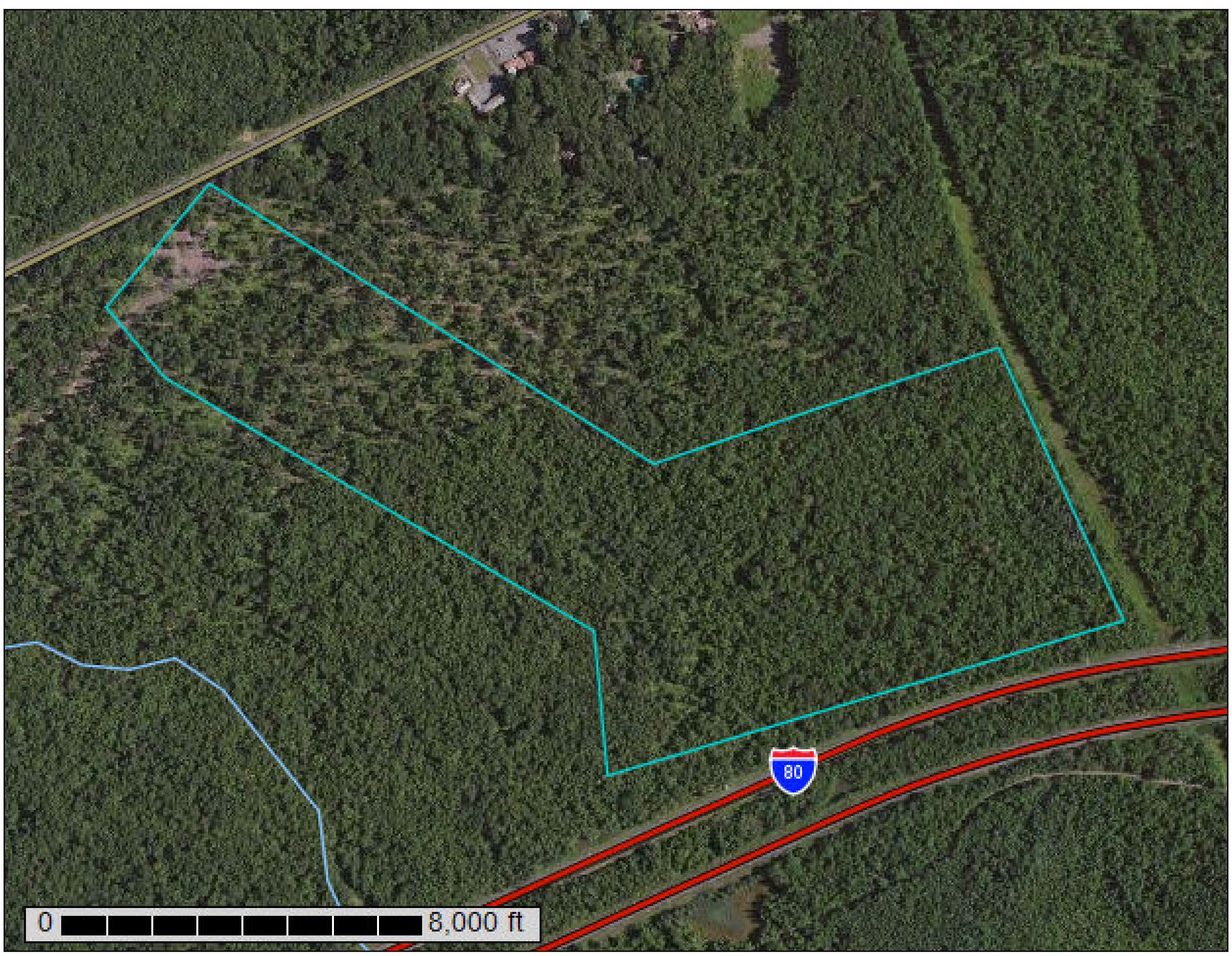
Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Carbon County, Pennsylvania

PennEast: Kidder Compressor Station



June 22, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

Preface............ 2
How Soil Surveys Are Made............ 5
Soil Map............ 8
Soil Map............ 9
Legend............ 10
Map Unit Legend............ 11
Map Unit Descriptions............ 11
Carbon County, Pennsylvania............ 13
AcB—Albrights very stony loam, 0 to 8 percent slopes............ 13
MrB—Morris channery silt loam, 0 to 8 percent slopes, extremely stony............ 14
NvB—Norwich soils, 0 to 8 percent slopes, extremely stony............ 15
Soil Information for All Uses............ 17
Soil Properties and Qualities............ 17
Soil Qualities and Features............ 17
Hydrologic Soil Group ((PennEast: Kidder Compressor Station))............ 17
Soil Reports............ 22
Soil Physical Properties............ 22
Engineering Properties ((PennEast: Kidder Compressor Station))............ 22
References............ 29

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

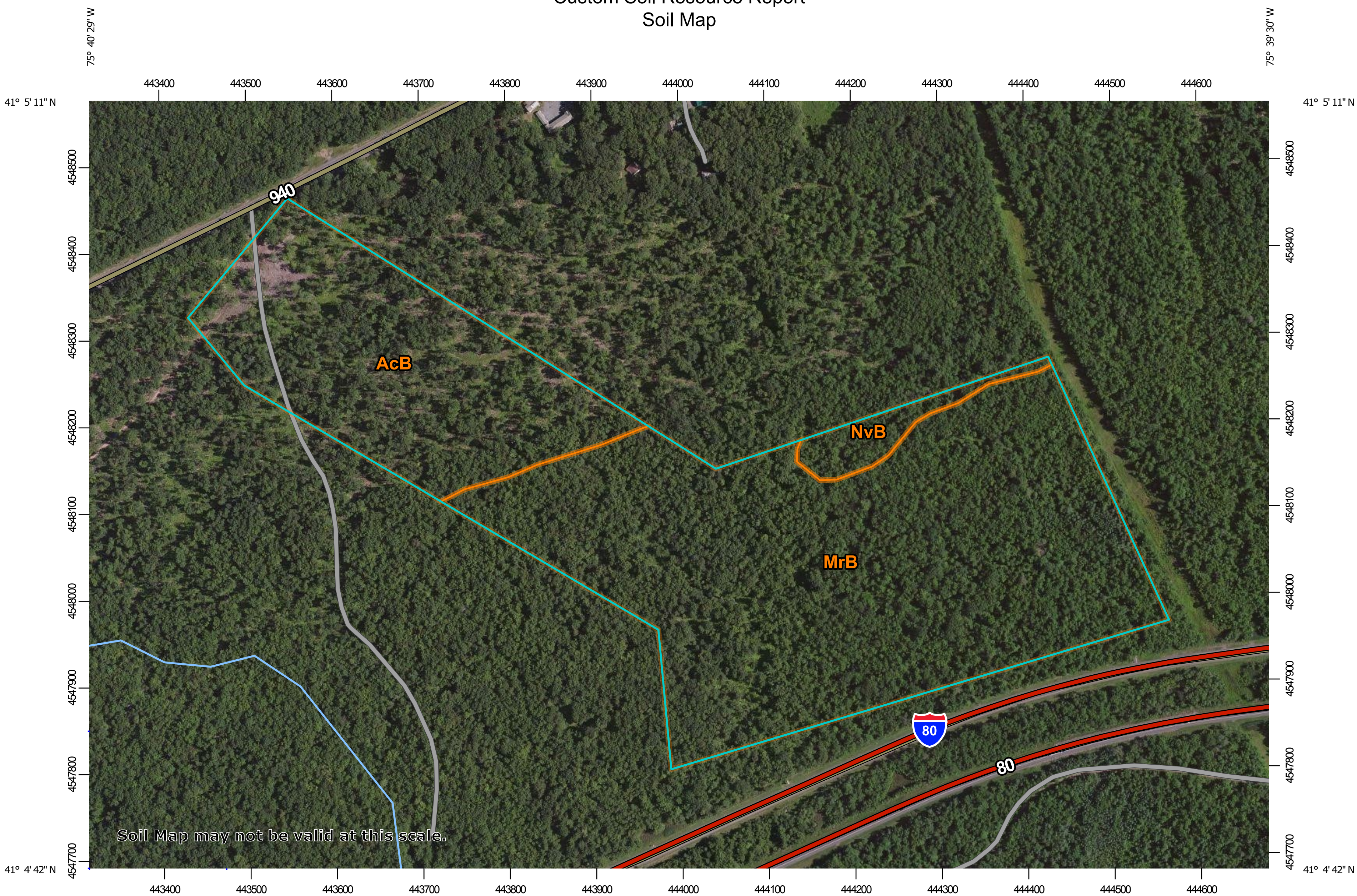
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:6,240 if printed on A landscape (11" x 8.5") sheet.

N

0 50 100 200 300 Meters

0 300 600 1200 1800 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Carbon County, Pennsylvania
Survey Area Data: Version 14, Sep 19, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 20, 2011—Jul 5, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Carbon County, Pennsylvania (PA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AcB	Albrights very stony loam, 0 to 8 percent slopes	21.4	29.4%
MrB	Morris channery silt loam, 0 to 8 percent slopes, extremely stony	49.2	67.5%
NvB	Norwich soils, 0 to 8 percent slopes, extremely stony	2.2	3.1%
Totals for Area of Interest		**72.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Carbon County, Pennsylvania

AcB—Albrights very stony loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: l356
Elevation: 800 to 1,500 feet
Mean annual precipitation: 36 to 46 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 140 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Albrights and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Albrights

Setting

Landform: Ridges
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave
Across-slope shape: Concave, convex
Parent material: Colluvium derived from acid, red sandstone, siltstone, and shale

Typical profile

H1 - 0 to 9 inches: very stony loam
H2 - 9 to 30 inches: channery loam
H3 - 30 to 60 inches: gravelly loam

Properties and qualities

Slope: 0 to 8 percent
Percent of area covered with surface fragments: 1.6 percent
Depth to restrictive feature: 18 to 32 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 16 to 28 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: C/D
Hydric soil rating: No

Minor Components

Shelmadine

Percent of map unit: 20 percent
Landform: Depressions

Hydric soil rating: Yes

MrB—Morris channery silt loam, 0 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2vxct
Elevation: 330 to 2,460 feet
Mean annual precipitation: 31 to 70 inches
Mean annual air temperature: 39 to 52 degrees F
Frost-free period: 105 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Morris, extremely stony, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Morris, Extremely Stony

Setting

Landform: Mountains, hills
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Interfluve, base slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loamy till from reddish sandstone, siltstone, and shale

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 5 inches: channery silt loam
Bw - 5 to 12 inches: channery silt loam
Eg - 12 to 16 inches: channery silt loam
Bx - 16 to 60 inches: channery silt loam
C - 60 to 72 inches: channery loam

Properties and qualities

Slope: 0 to 8 percent
Percent of area covered with surface fragments: 7.0 percent
Depth to restrictive feature: 10 to 22 inches to fragipan
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D

Hydric soil rating: No

Minor Components

Norwich, extremely stony

Percent of map unit: 5 percent
Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Wellsboro, extremely stony

Percent of map unit: 5 percent
Landform: Hills, mountains
Landform position (two-dimensional): Backslope, shoulder
Landform position (three-dimensional): Interfluve, side slope, head slope
Down-slope shape: Convex, concave
Across-slope shape: Convex, linear
Hydric soil rating: No

NvB—Norwich soils, 0 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2vcjx
Elevation: 330 to 2,460 feet
Mean annual precipitation: 31 to 70 inches
Mean annual air temperature: 39 to 52 degrees F
Frost-free period: 105 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Norwich, extremely stony, very poorly drained, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Norwich, Extremely Stony, Very Poorly Drained

Setting

Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Loamy till dominated by reddish sandstone, siltstone and shale fragments

Typical profile

A - 0 to 6 inches: mucky silt loam
Eg - 6 to 10 inches: channery silt loam

Bg - 10 to 16 inches: channery silt loam
Bgx - 16 to 46 inches: channery silt loam
C - 46 to 72 inches: channery silt loam

Properties and qualities

Slope: 0 to 8 percent
Percent of area covered with surface fragments: 7.0 percent
Depth to restrictive feature: 10 to 24 inches to fragipan
Natural drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Hydric soil rating: Yes

Minor Components

Norwich, extremely stony

Percent of map unit: 10 percent
Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Morris, extremely stony

Percent of map unit: 5 percent
Landform: Mountains, hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group ((PennEast: Kidder Compressor Station))

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

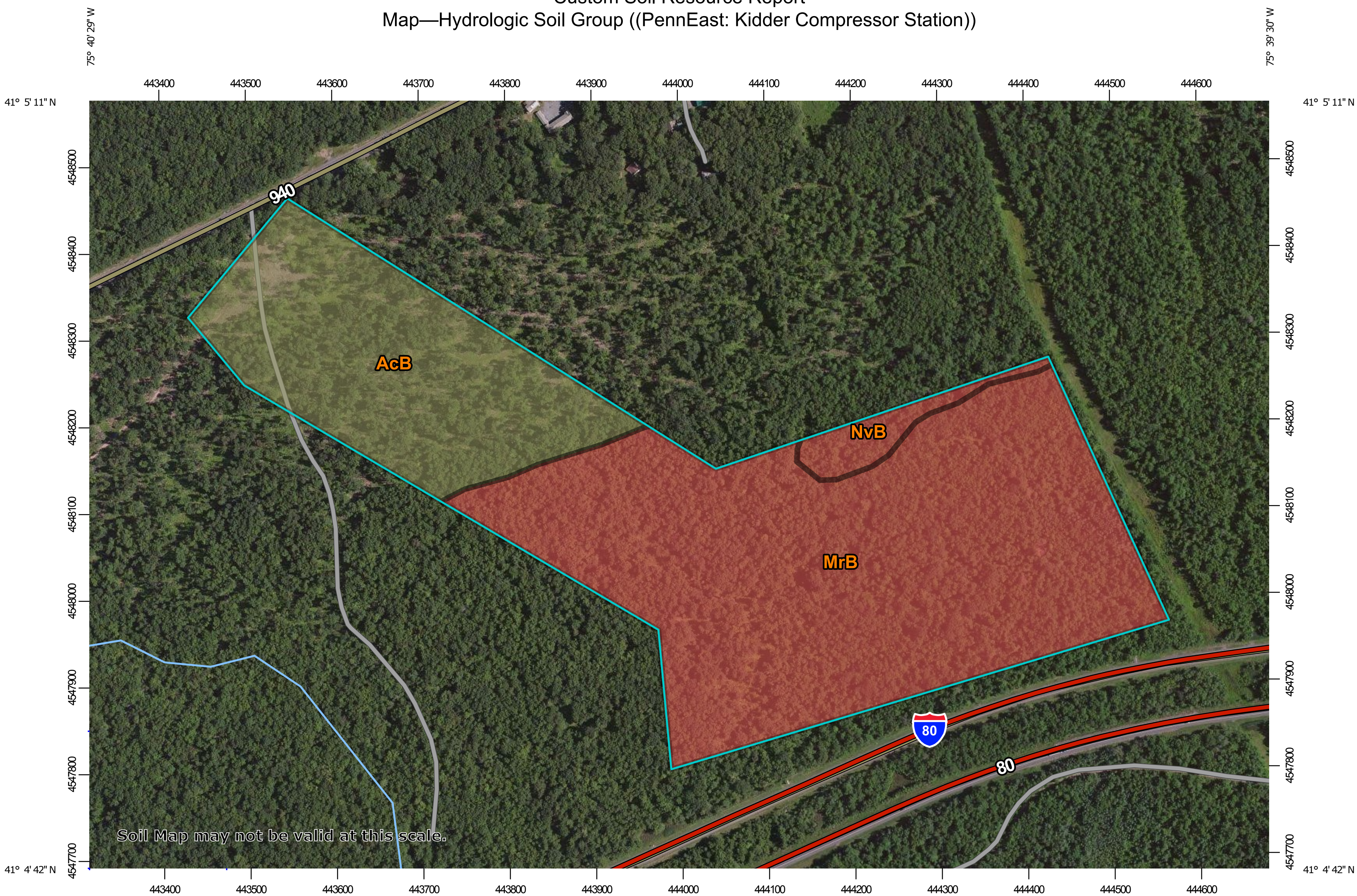
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

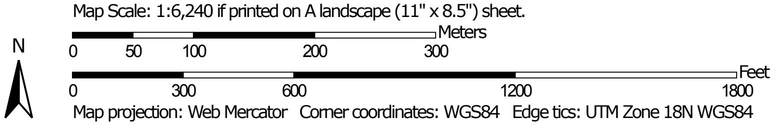
Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Map—Hydrologic Soil Group ((PennEast: Kidder Compressor Station))



Map Scale: 1:6,240 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Carbon County, Pennsylvania
Survey Area Data: Version 14, Sep 19, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 20, 2011—Jul 5, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group ((PennEast: Kidder Compressor Station))

Hydrologic Soil Group— Summary by Map Unit — Carbon County, Pennsylvania (PA025)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
AcB	Albrights very stony loam, 0 to 8 percent slopes	C/D	21.4	29.4%
MrB	Morris channery silt loam, 0 to 8 percent slopes, extremely stony	D	49.2	67.5%
NvB	Norwich soils, 0 to 8 percent slopes, extremely stony	D	2.2	3.1%
Totals for Area of Interest			**72.9**	**100.0%**

Rating Options—Hydrologic Soil Group ((PennEast: Kidder Compressor Station))

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties ((PennEast: Kidder Compressor Station))

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Carbon County, Pennsylvania														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
AcB—Albrights very stony loam, 0 to 8 percent slopes														
Albrights	80	C/D	0-9	Very stony loam	ML, SM	A-4	6-16- 26	0-10- 20	70-85-100	60-73-95	55-73-90	40-60-80	22-31-39	6-9 -13
			9-30	Silty clay loam, gravelly silt loam, channery clay loam, channery loam	CL, ML, SC, SM	A-4, A-6	0- 0- 0	0- 8- 15	80-90-100	65-80-95	60-75-90	40-63-85	25-33-40	3-9 -15
			30-60	Channery clay loam, gravelly silty clay loam, silt loam, gravelly loam	CL, ML, SC, SC-SM	A-2, A-4, A-6	0- 0- 0	0- 8- 15	65-83-100	45-70-95	40-65-90	25-53-80	20-30-40	3-9 -15

Engineering Properties–Carbon County, Pennsylvania														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
MrB—Morris channery silt loam, 0 to 8 percent slopes, extremely stony														
Morris, extremely stony	90	D	0-1	Moderately decomposed plant material	PT	A-8	0-15- 20	—	—	—	—	—	—	—
			1-5	Channery silt loam, silt loam, channery loam, very channery silt loam, very channery loam	GM, OL, OH	A-4, A-7-5, A-5	0- 1- 3	9-17- 33	58-81-89	58-80-89	49-76-89	37-62-77	29-49 -77	3-8 -16
			5-12	Flaggy silt loam, very channery silt loam, very channery loam, channery silt loam, channery loam, silt loam, loam	GM, CL	A-4, A-6	0- 1- 3	10-19-37	65-84-92	64-84-91	52-78-91	39-62-78	19-29 -38	3-10-15
			12-16	Very channery silt loam, channery silt loam, channery loam, silt loam, loam, very channery loam, flaggy silt loam	GM, CL	A-4, A-6	0- 1- 3	10-19-37	65-84-92	64-84-91	52-77-91	38-60-76	18-26 -36	3-9 -15

Engineering Properties–Carbon County, Pennsylvania														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			16-60	Very channery loam, channery sandy loam, very channery sandy loam, channery clay loam, very flaggy silt loam, channery silt loam, very channery silt loam, very flaggy loam, channery loam	GM, CL	A-6, A-4	0- 4- 18	10-16-42	58-84-88	57-84-88	47-78-88	36-62-76	18-26-39	3-10-20
			60-72	Very channery sandy loam, channery silt loam, very flaggy loam, very channery loam, channery loam, channery sandy loam, very flaggy silt loam, very channery silt loam	CL, GM	A-2-4, A-6, A-4	0- 4- 18	11-19-43	56-78-88	55-78-88	43-68-88	30-51-73	18-25-38	3-9 -19

Engineering Properties–Carbon County, Pennsylvania														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
NvB—Norwich soils, 0 to 8 percent slopes, extremely stony														
Norwich, extremely stony, very poorly drained	85	D	0-6	Channery silt loam, channery loam, mucky silt loam	GM, OH	A-7-5, A-4	0- 1- 6	0- 9- 27	52-85-100	50-84-100	40-78-100	32-69-95	32-64-78	2-15-17
			6-10	Loam, channery loam, channery silt loam, silt loam	GM, CL, MH	A-6, A-4, A-7-5	0- 1- 14	0-12- 25	63-80-100	62-80-100	50-72-100	40-63-93	17-36-53	2-13-18
			10-16	Channery silt loam, channery loam, silt loam, loam	ML, CL, GM	A-6, A-4, A-7-6	0- 1- 14	0-12- 25	63-80-100	62-80-100	50-72-100	40-63-93	17-32-47	2-13-18
			16-46	Channery loam, channery silt loam, channery sandy loam, very channery silt loam, very channery loam, very channery sandy loam, gravelly silt loam, very gravelly loam	CL, GM	A-2-4, A-6	0- 2- 24	0-13- 33	58-79-88	56-78-87	44-72-87	35-63-83	16-31-37	2-15-18
			46-72	Channery loam, very channery silt loam, very channery loam, channery silt loam, channery sandy loam, very channery sandy loam, gravelly silt loam, very gravelly loam	GM, CL	A-6, A-2-4	0- 4- 24	0-15- 33	57-76-88	56-75-88	43-68-88	33-60-81	16-30-38	2-13-19

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

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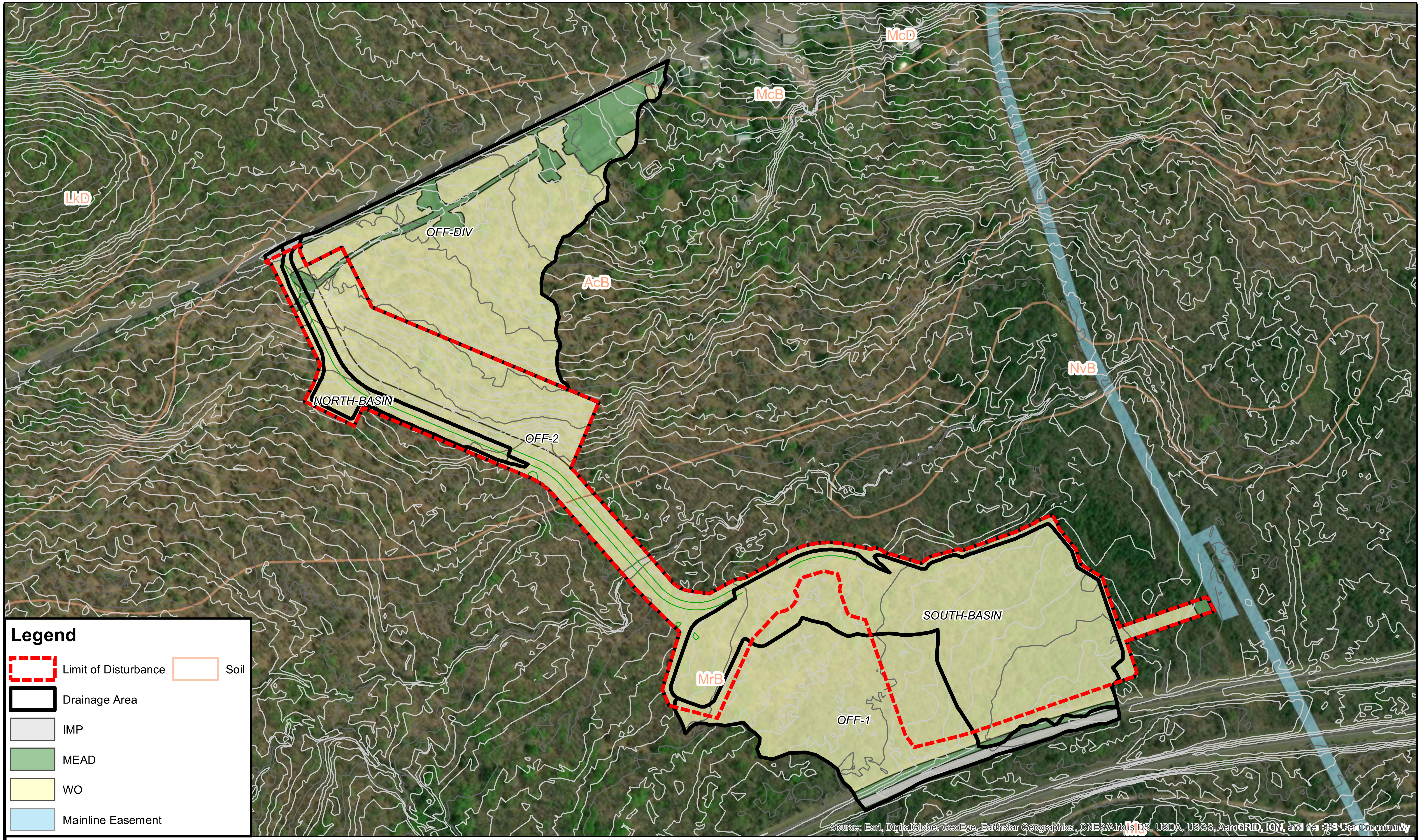
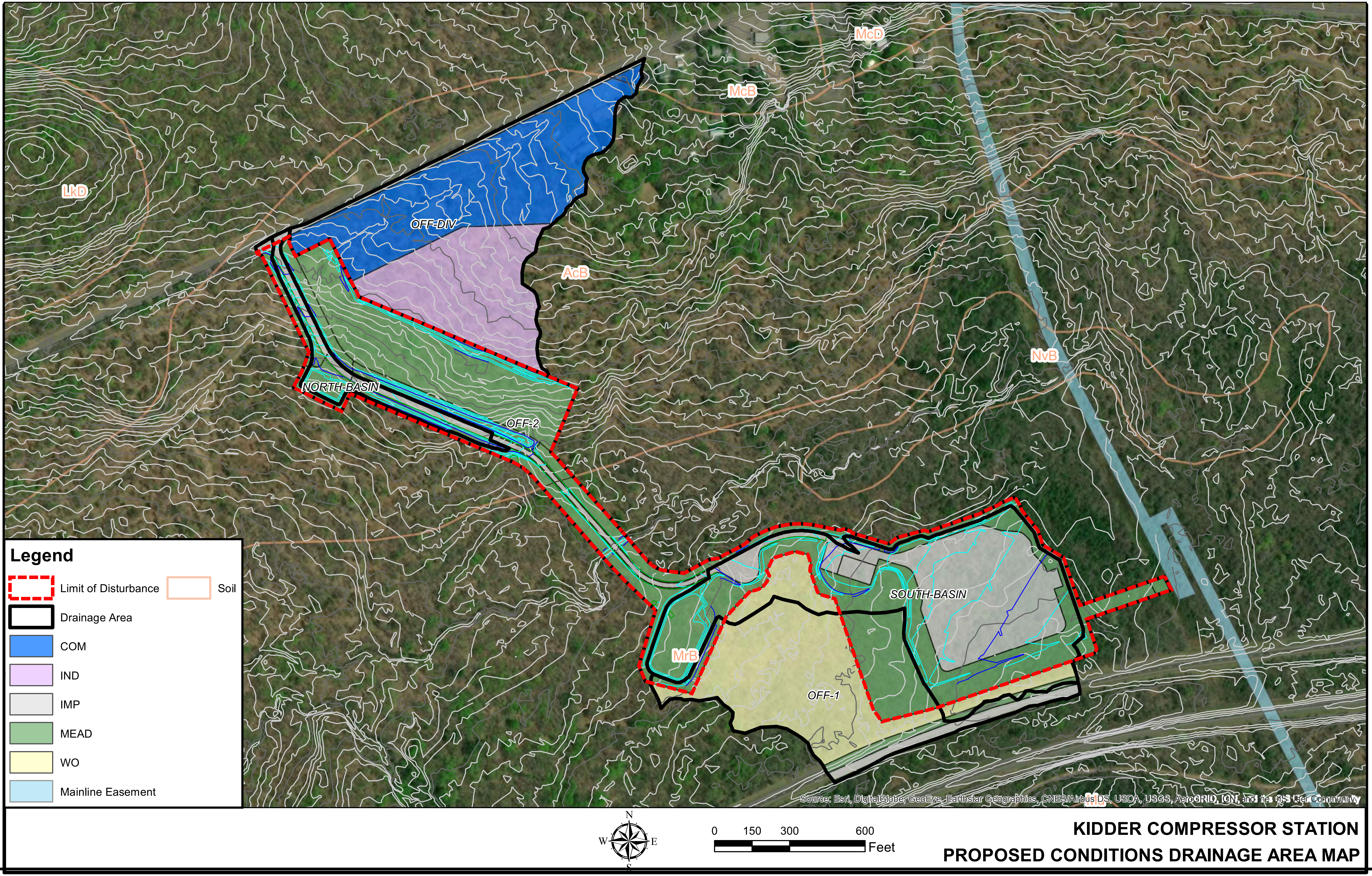
United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

B. Drainage Area Maps



KIDDER COMPRESSOR STATION
EXISTING CONDITIONS DRAINAGE AREA MAP

Map Document: (P:\353754 PennEast\Stormwater\Kidder Compressor\GIS\Projects\EX_DA_Map.mxd) 12/14/2018 7:01:44 PM zhi76919



KIDDER COMPRESSOR STATION

PROPOSED CONDITIONS DRAINAGE AREA MAP

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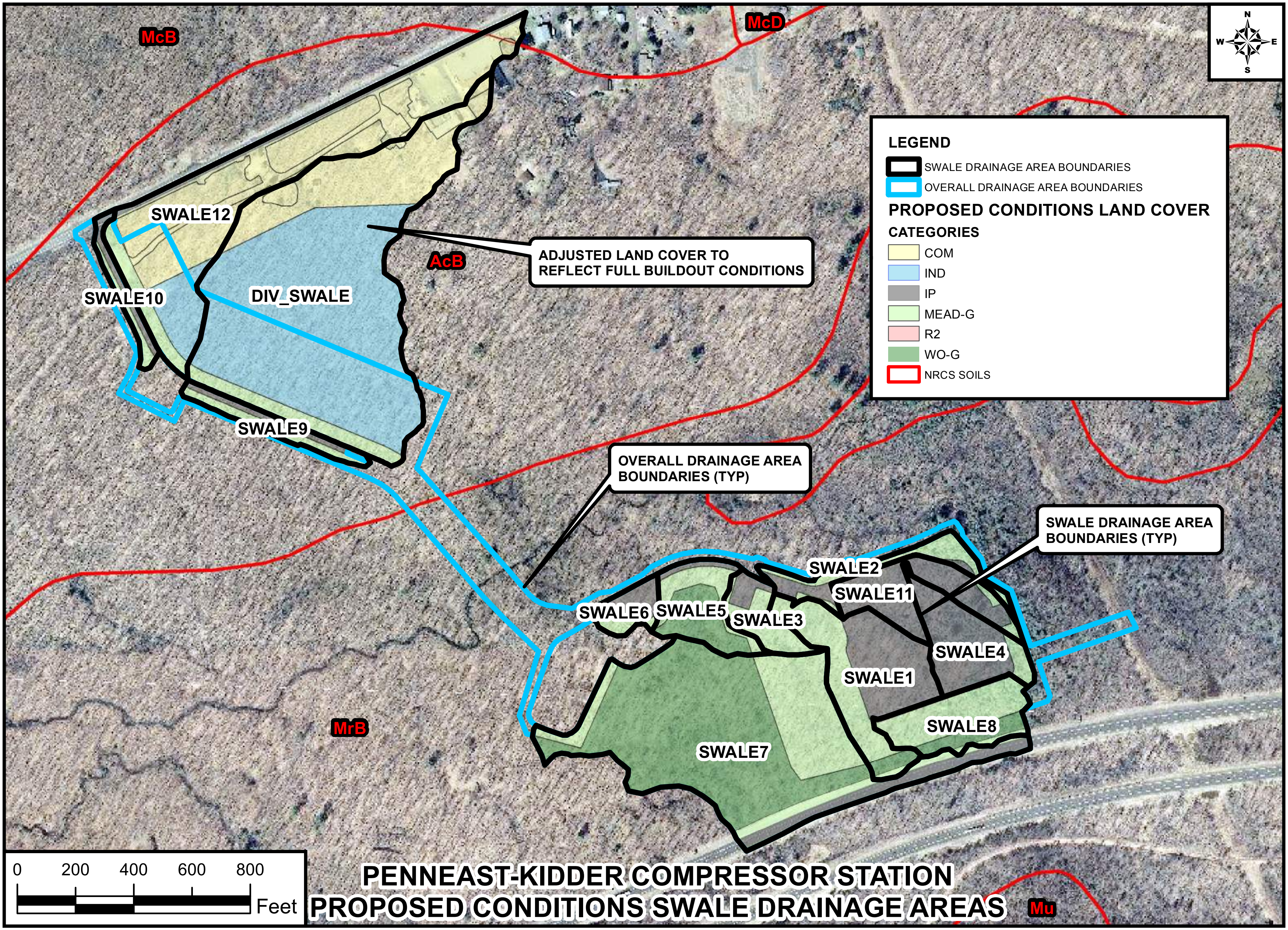
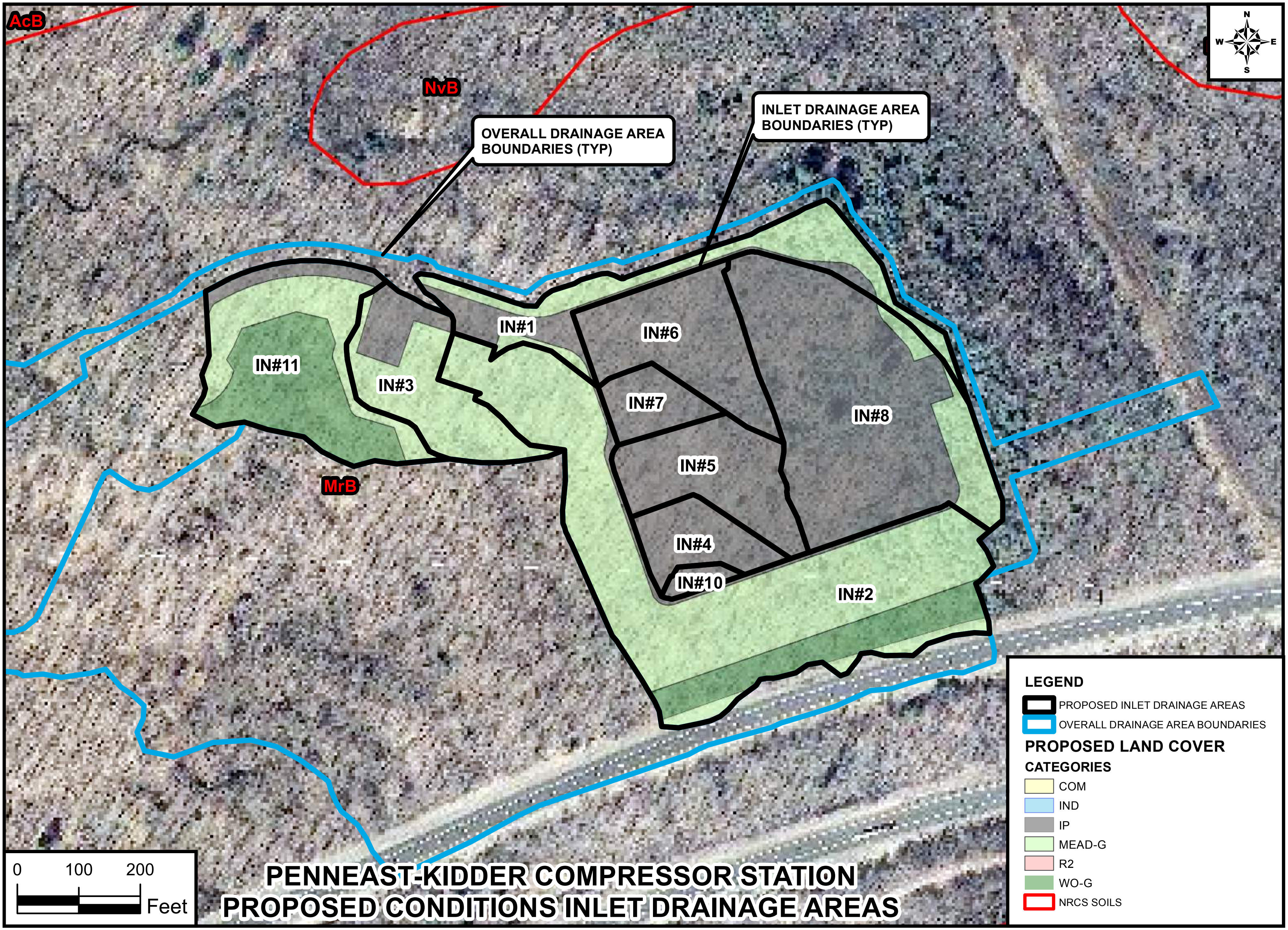
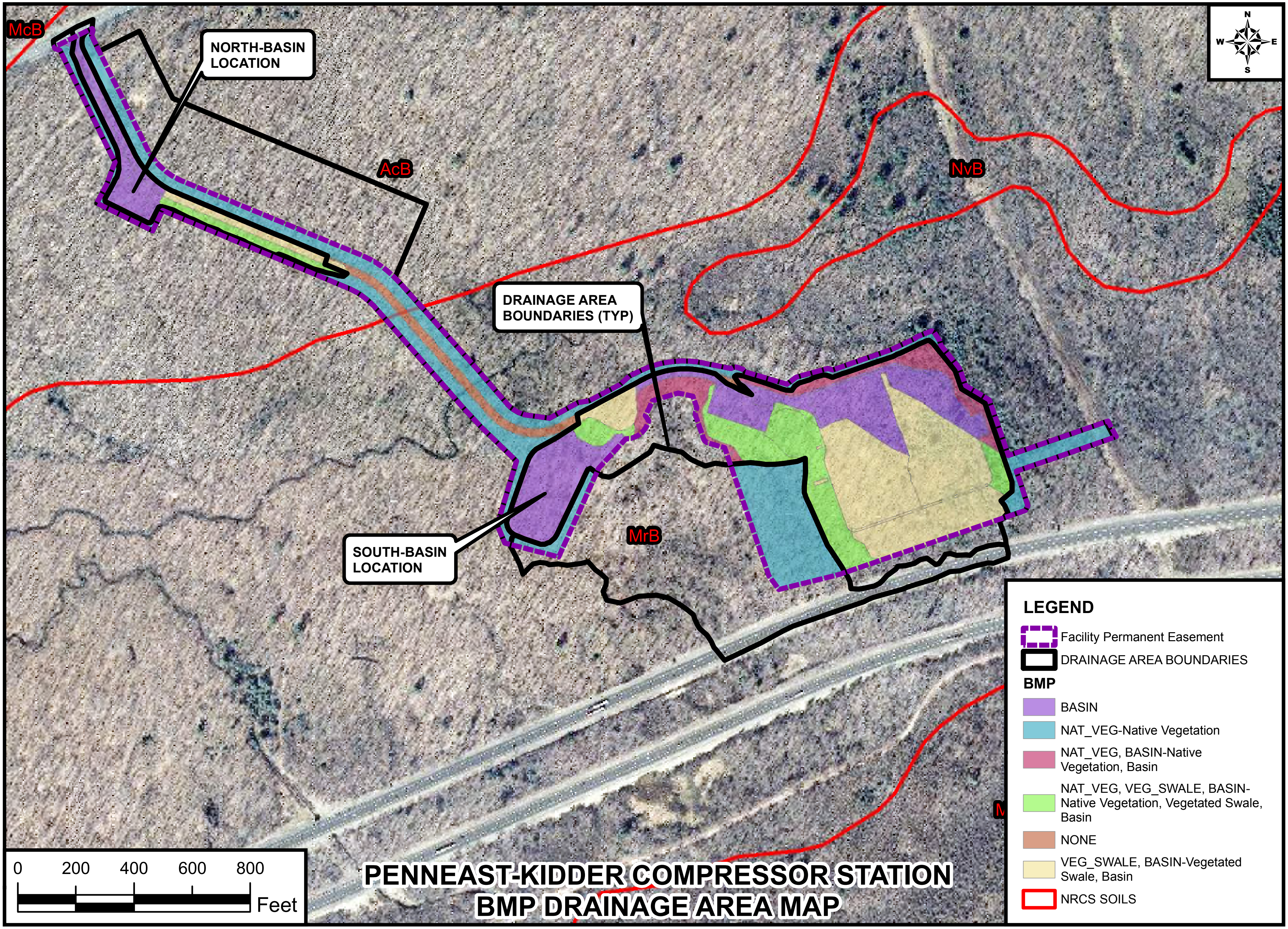


PENNEAST-KIDDER COMPRESSOR STATION
PROPOSED CONDITIONS SWALE DRAINAGE AREAS



PENNEAST-KIDDER COMPRESSOR STATION
PROPOSED CONDITIONS INLET DRAINAGE AREAS

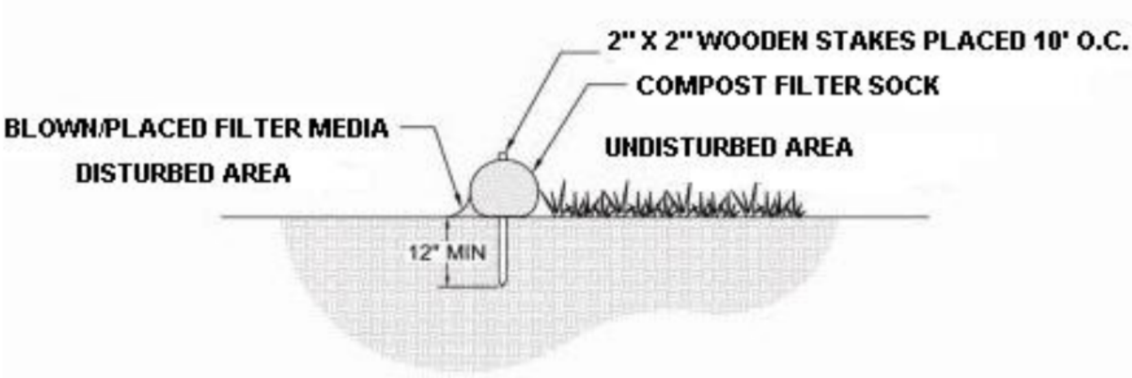


PENNEAST-KIDDER COMPRESSOR STATION BMP DRAINAGE AREA MAP

C. E&SCP Design Calculations

STANDARD E&S WORKSHEET #1
Compost Filter Socks

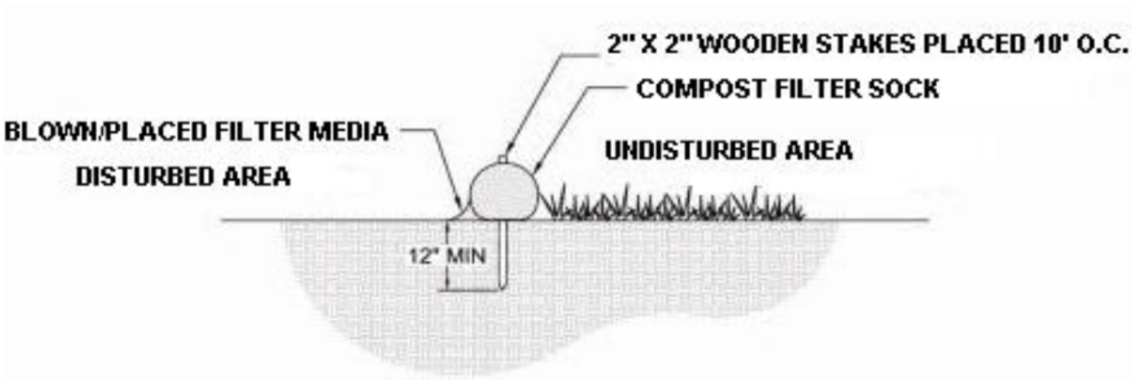
PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK DATE: 10/2019
CHECKED BY: MDN DATE: 10/2019



Sock No.	Dia. (in)	Location	Slope Percent	Slope Length Above Barrier (ft)
1	12	East side of proposed pad area	1	145
2	12	East side of proposed pad area	1	150
3	12	East side of proposed pad area	2	220
4	12	East side of proposed pad area	2	255
5	12	East side of proposed pad area	8	60
6	12	East side of proposed pad area	4	45
7	12	East side of proposed pad area	3	80
8	12	East side of proposed pad area	2	170
9	12	Northeast corner of proposed pad area	2	215
10	12	Northeast corner of proposed pad area	3	220
11	12	West side of proposed pad area	2	245
12	18	West side of proposed pad area	2	270
13	18	West side of proposed pad area	2	335
14	24	West side of proposed pad area	2	435
15	24	West side of proposed pad area	2	460
16	18	West side of proposed pad area	2	280
17	18	West side of proposed pad area	2	320
18	12	North side of proposed office/parking area	2	135
19	12	North side of proposed office/parking area	2	160
20	12	North side of proposed office/parking area	2	175
21	12	North side of proposed office/parking area	3	195
22	12	North side of proposed office/parking area	3	220
23	12	North side of proposed office/parking area	4	115
24	12	North side of proposed office/parking area	5	100
25	12	East side of proposed cul-de-sac	2	26
26	12	East side of proposed cul-de-sac	2	10
27	12	East side of proposed cul-de-sac	2	75
28	12	North side of proposed cul-de-sac	2	30

STANDARD E&S WORKSHEET #1
Compost Filter Socks

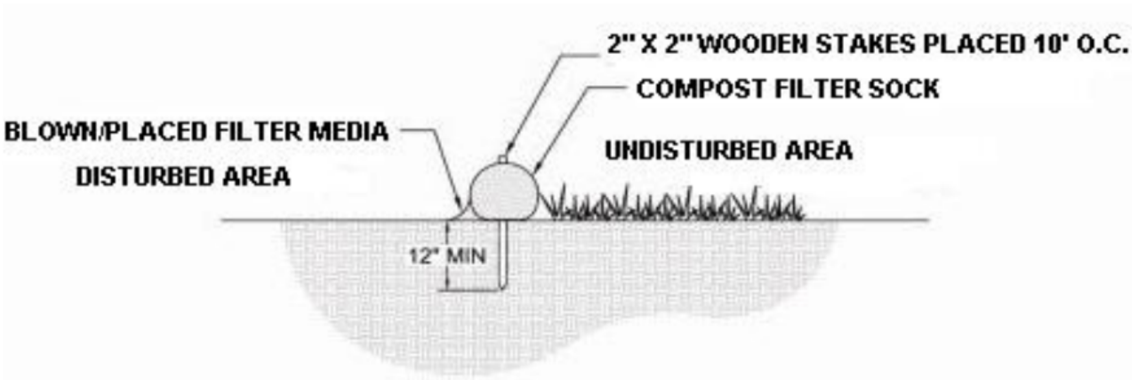
PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK DATE: 10/2019
CHECKED BY: MDN DATE: 10/2019



Sock No.	Dia. (in)	Location	Slope Percent	Slope Length Above Barrier (ft)
29	12	North side of proposed cul-de-sac	2	30
30	12	North side of proposed cul-de-sac	2	90
31	12	North side of proposed cul-de-sac	3	40
32	12	North side of proposed cul-de-sac	3	20
33	18	West side of proposed stormwater retention basin south	4	275
34	24	West side of proposed stormwater retention basin south	3	390
35	24	South side of proposed Industrial Drive station 21+00	3	445
36	24	South side of proposed Industrial Drive station 20+00	3	375
37	12	South side of proposed Industrial Drive station 19+00	2	90
38	12	East side of proposed box culvert, proposed Industrial Drive station 19+00	2	90
39	12	East side of proposed box culvert, proposed Industrial Drive station 19+00	2	30
40	12	West side of proposed box culvert, proposed Industrial Drive station 19+00	3	220
41	12	West side of proposed box culvert, proposed Industrial Drive station 19+00	3	160
42	12	South side of proposed Industrial Drive station 18+00	3	225
43	12	South side of proposed Industrial Drive station 17+00	4	120
44	18	South side of proposed Industrial Drive station 16+00	4	300
45	12	South side of proposed Industrial Drive station 15+00	3	230
46	32	South side of proposed Industrial Drive station 14+00	7	360
47	32	South side of proposed Industrial Drive station 13+00	7	375
48	12	East edge of proposed staging area (south of Temp-Swale)	8	35
49	12	East edge of proposed staging area (south of Temp-Swale)	8	50
50	12	East edge of proposed staging area (south of Temp-Swale)	8	70
51	12	East edge of proposed staging area (south of Temp-Swale)	8	90
52	12	East edge of proposed staging area (south of Temp-Swale)	8	65
53	12	East edge of proposed staging area (south of Temp-Swale)	8	90

STANDARD E&S WORKSHEET #1
Compost Filter Socks

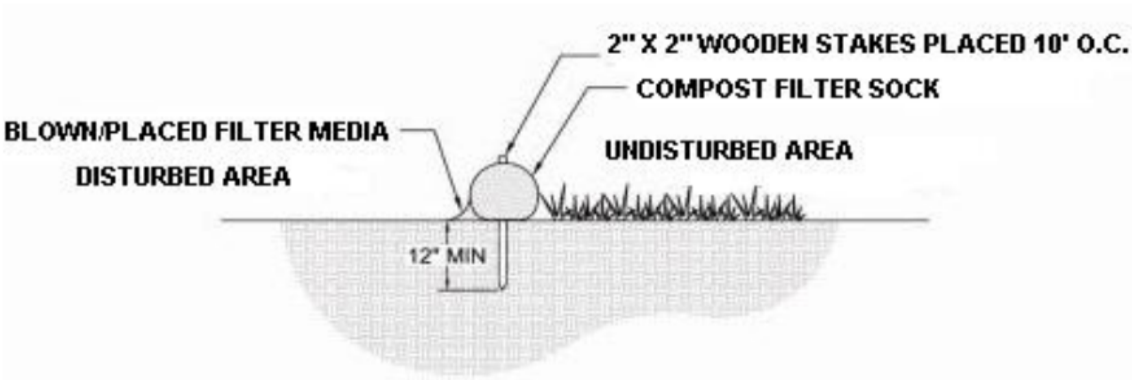
PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK DATE: 10/2019
CHECKED BY: MDN DATE: 10/2019



Sock No.	Dia. (in)	Location	Slope Percent	Slope Length Above Barrier (ft)
54	12	East edge of proposed staging area (south of Temp-Swale)	8	85
55	18	North side of proposed Industrial Drive station 14+00	8	240
56	18	North side of proposed Industrial Drive station 14+00	7	165
57	12	North side of proposed Industrial Drive station 14+00	7	95
58	18	North side of proposed Industrial Drive station 14+00	9	185
59	18	North side of proposed Industrial Drive station 13+00	10	230
60	18	North side of proposed Industrial Drive station 13+00	10	250
61	18	North side of proposed Industrial Drive station 13+00	10	240
62	18	North side of proposed Industrial Drive station 12+00	10	225
63	18	North side of proposed Industrial Drive station 12+00	10	215
64	18	North side of proposed Industrial Drive station 12+00	10	205
65	18	North side of proposed Industrial Drive station 11+00	8	190
66	12	North side of proposed Industrial Drive station 10+00	5	225
67	12	North side of proposed Industrial Drive station 8+00	5	215
68	12	North side of proposed Industrial Drive station 7+00	5	225
69	12	North side of proposed Industrial Drive station 7+00	5	230
70	12	North side of proposed Industrial Drive station 6+00	5	230
71	12	North side of proposed Industrial Drive station 5+00	5	205
72	18	North side of proposed Industrial Drive station 5+00	5	185
73	12	North side of proposed Industrial Drive station 4+00	5	190
74	12	North side of proposed Industrial Drive station 4+00	5	170
75	12	North side of proposed Industrial Drive station 3+00	5	160
76	12	North side of proposed Industrial Drive station 3+00	8	85
77	12	North side of proposed Industrial Drive station 2+00	8	85
78	12	North side of proposed Industrial Drive station 2+00	5	230
79	12	North side of proposed Industrial Drive station 2+00	4	205
80	12	North side of proposed Industrial Drive station 1+00	3	155
81	32	South side of proposed Industrial Drive station 12+00	7	355

STANDARD E&S WORKSHEET #1
Compost Filter Socks

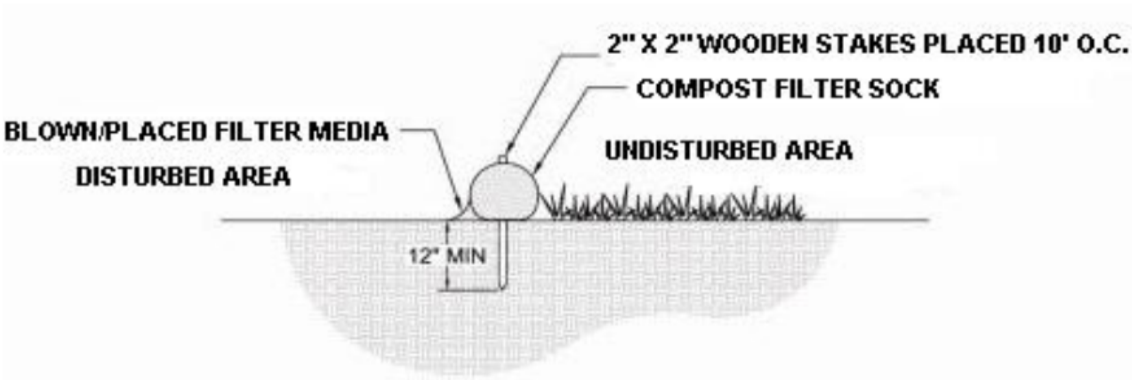
PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK DATE: 10/2019
CHECKED BY: MDN DATE: 10/2019



Sock No.	Dia. (in)	Location	Slope Percent	Slope Length Above Barrier (ft)
82	32	South side of proposed Industrial Drive station 11+00	7	325
83	18	South side of proposed Industrial Drive station 9+00	5	305
84	18	South side of proposed Industrial Drive station 7+00	5	345
85	18	South side of proposed Industrial Drive station 7+00	5	350
86	18	South side of proposed Industrial Drive station 6+00	5	315
87	24	South side of stormwater retention basin north	5	420
88	12	West side of stormwater retention basin north	3	20
89	24	North side of stormwater retention basin north	7	265
90	24	Northwest corner of stormwater retention basin north	5	370
91	18	South side of proposed Industrial Drive station 4+00	5	275
92	12	South side of proposed Industrial Drive station 4+00	4	45
93	12	South side of proposed Industrial Drive station 3+00	4	55
94	18	South side of proposed Industrial Drive station 3+00	6	175
95	12	South side of proposed Industrial Drive station 2+00	6	140
96	12	South side of proposed Industrial Drive station 2+00	5	230
97	12	South side of proposed Industrial Drive station 1+00	4	210
98	12	South side of proposed Industrial Drive station 1+00	7	110
99	32	North side of Temp-Swale	4	574
100	24	North side of Temp-Swale	4	445
101	32	North side of Temp-Swale	4	583
102	32	North side of Temp-Swale	4	563
103	24	North side of Temp-Swale	4	434
104	32	North side of Temp-Swale	4	580
105	32	North side of Temp-Swale	4	515
106	32	North side of Temp-Swale	4	600
107	12	North side of Temp-Swale	4	147
108	12	North side of Temp-Swale	4	70
109	32	North side of Temp-Swale	4	519

STANDARD E&S WORKSHEET #1
Compost Filter Socks

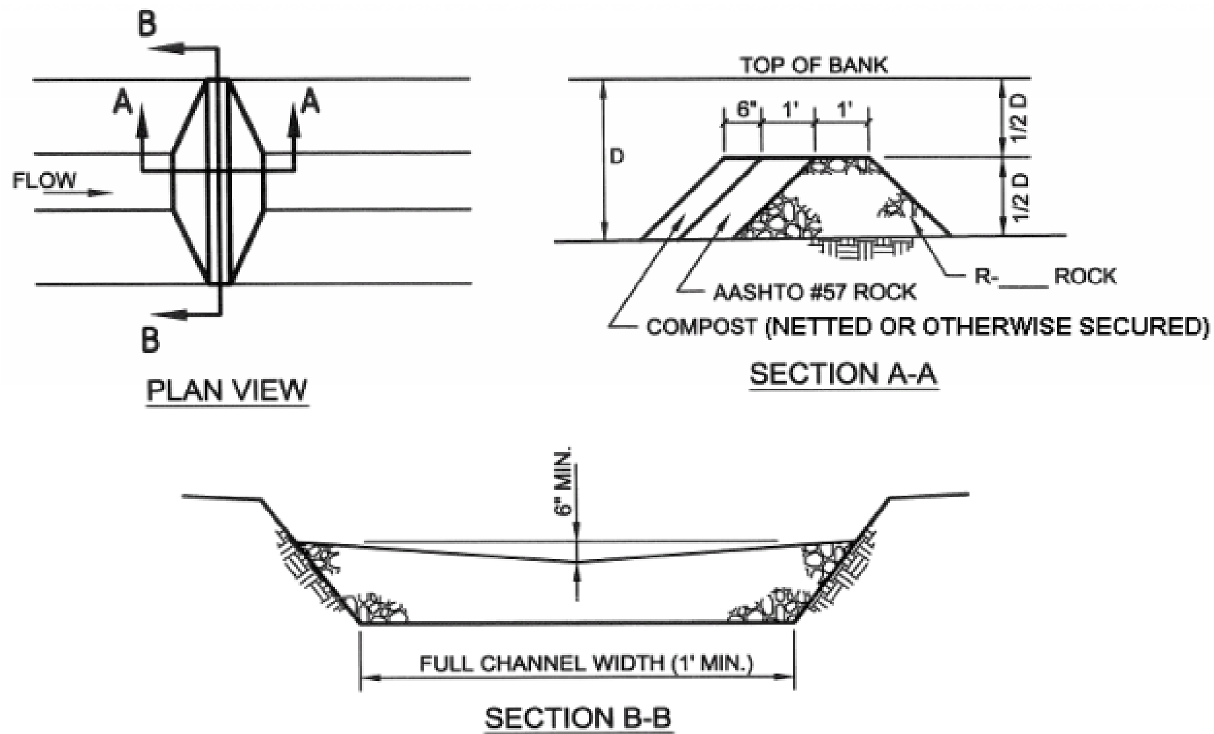
PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK DATE: 10/2019
CHECKED BY: MDN DATE: 10/2019



Sock No.	Dia. (in)	Location	Slope Percent	Slope Length Above Barrier (ft)
110	32	East edge of proposed staging area (north of Temp-Swale)	5	650
111	12	East edge of proposed staging area (north of Temp-Swale)	5	157
112	12	East edge of proposed staging area (north of Temp-Swale)	5	19
113	12	East edge of proposed staging area (north of Temp-Swale)	5	134
114	12	East edge of proposed staging area (north of Temp-Swale)	5	144
115	12	East edge of proposed staging area (north of Temp-Swale)	5	155
116	12	East edge of proposed staging area (north of Temp-Swale)	6	57
117	12	East edge of proposed staging area (north of Temp-Swale)	6	50
118	32	East edge of proposed staging area (north of Temp-Swale)	6	400
119	32	East edge of proposed staging area (north of Temp-Swale)	6	317
120	18	East edge of proposed staging area (north of Temp-Swale)	6	203
121	24	East edge of proposed staging area (north of Temp-Swale)	7	274
122	18	East edge of proposed staging area (north of Temp-Swale)	7	164
123	12	East edge of proposed staging area (north of Temp-Swale)	8	138

STANDARD E&S WORKSHEET #8
Rock Filters

PROJECT NAME:	PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION:	CARBON COUNTY
PREPARED BY:	KEK — DATE: 10/15/2018
CHECKED BY:	MDN — DATE: 10/15/2018



Note: Not Suitable for Channels less than two feet total depth

ROCK FILTER NO.	LOCATION	D (FT)	RIPRAP SIZE
RF-1	Downstream end of SWALE-1	2	R-3
RF-7	Southeast corner of SWALE-7	2	R-3
RF-7A	Downstream end of SWALE-7	2	R-3
RF-9	Downstream end of SWALE-9	2	R-3
RF-10	Downstream end of SWALE-10	2	R-3
RF-12	Downstream end of SWALE-12	2	R-3
RF-DIV1	Middle of DIV-SWALE	4	R-4
RF-DIV2	Downstream end of DIV-SWALE	4	R-4
RF-TEMP	Downstream end of TEMP-SWALE	2	R-3

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: MDN DATE: 10/15/18
CHECKED BY: KEK DATE: 10/15/18

CHANNEL OR CHANNEL SECTION		DIV-SWALE	SWALE-1
TEMPORARY OR PERMANENT?	(T OR P)	P	P
DESIGN STORM	(2, 5, OR 10 YR)	100-year	100-year
ACRES	(AC)	14.95	3.78
MULTIPLIER	(1.6, 2.25, OR 2.75) [1]	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)
Q_r (REQUIRED CAPACITY)	(CFS)	121.6	34.8
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	121.6	34.8
PROTECTIVE LINING[2]		R-3 Riprap	TRM-435
n (MANNING'S COEFFICIENT)[2]		0.03	0.06
V_a (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A
V (CALCUALTED AT FLOW DEPTH d)	(FPS)	3.58	2.42
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	1.00	8.00
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.43	0.88
CHANNEL BOTTOM WIDTH	(FT)	6.00	6.00
CHANNEL SIDE SLOPES	(H:V)	LEFT 2.5:1 RIGHT 2:1	3:1
D (TOTAL DEPTH)	(FT)	4	2
CHANNEL TOP WIDTH @ D	(FT)	30	18
d (CALCULATED FLOW DEPTH)	(FT)	2.78	1.41
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	22.68	14.46
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	2.16	4.26
d_{50} STONE SIZE	(IN)	3	N/A
A (CROSS-SECTIONAL AREA)	(SQ. FT)	39.87	14.42
R (HYDRAULIC RADIUS)		1.73	0.96
S (BED SLOPE)[3]	(FT/FT)	0.00	0.01
S_C (CRITICAL SLOPE)	(FT/FT)	0.010	0.050
$.7S_c$	(FT/FT)	0.007	0.035
$1.3S_c$	(FT/FT)	0.013	0.065
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	1.22	0.59
MINIMUM REQUIRED FREEBOARD[4]	(FT)	1.00	0.50
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in seperate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: MDN DATE: 10/15/18
CHECKED BY: KEK DATE: 10/15/18

CHANNEL OR CHANNEL SECTION		SWALE-2	SWALE-3
TEMPORARY OR PERMANENT?	(T OR P)	P	P
DESIGN STORM	(2, 5, OR 10 YR)	100-year	100-year
ACRES	(AC)	1.18	1.01
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)
Q_r (REQUIRED CAPACITY)	(CFS)	38.6	6.0
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	38.6	6.0
PROTECTIVE LINING[2]		R-4 Riprap	TRM-435
n (MANNING'S COEFFICIENT)[2]		0.05	0.06
V_a (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A
V (CALCUALTED AT FLOW DEPTH d)	(FPS)	4.10	2.36
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.00	2.00
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	1.67	1.02
CHANNEL BOTTOM WIDTH	(FT)	3.00	4.00
CHANNEL SIDE SLOPES	(H:V)	3:1	3:1
D (TOTAL DEPTH)	(FT)	2	1
CHANNEL TOP WIDTH @ D	(FT)	15	10
d (CALCULATED FLOW DEPTH)	(FT)	1.34	0.47
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	11.04	6.82
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	2.24	8.51
d_{50} STONE SIZE	(IN)	6	N/A
A (CROSS-SECTIONAL AREA)	(SQ. FT)	9.41	2.54
R (HYDRAULIC RADIUS)		0.82	0.36
S (BED SLOPE)[3]	(FT/FT)	0.020	0.03
S_C (CRITICAL SLOPE)	(FT/FT)	0.030	0.060
$.7S_c$	(FT/FT)	0.021	0.042
$1.3S_c$	(FT/FT)	0.039	0.078
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	0.66	0.53
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in seperate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: MDN DATE: 10/15/18
CHECKED BY: KEK DATE: 10/15/18

CHANNEL OR CHANNEL SECTION		SWALE-4	SWALE-5
TEMPORARY OR PERMANENT?	(T OR P)	P	P
DESIGN STORM	(2, 5, OR 10 YR)	100-year	100-year
ACRES	(AC)	2.05	1.77
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)
Q_r (REQUIRED CAPACITY)	(CFS)	15.8	6.1
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	15.8	6.1
PROTECTIVE LINING[2]		TRM-435	R-3 Riprap
n (MANNING'S COEFFICIENT)[2]		0.06	0.04
V_a (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A
V (CALCUALTED AT FLOW DEPTH d)	(FPS)	2.30	2.54
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.00	2.00
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	0.79	0.53
CHANNEL BOTTOM WIDTH	(FT)	8.00	4.00
CHANNEL SIDE SLOPES	(H:V)	3:1	3:1
D (TOTAL DEPTH)	(FT)	1	2
CHANNEL TOP WIDTH @ D	(FT)	14	16
d (CALCULATED FLOW DEPTH)	(FT)	0.68	0.45
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	12.08	6.70
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	11.76	8.89
d_{50} STONE SIZE	(IN)	N/A	3
A (CROSS-SECTIONAL AREA)	(SQ. FT)	6.83	2.41
R (HYDRAULIC RADIUS)		0.56	0.35
S (BED SLOPE)[3]	(FT/FT)	0.019	0.02
S_C (CRITICAL SLOPE)	(FT/FT)	0.060	0.040
$.7S_c$	(FT/FT)	0.042	0.028
$1.3S_c$	(FT/FT)	0.078	0.052
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	0.32	1.55
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A' and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufacture linings without vegetation and with vegetation in seperate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: MDN DATE: 10/15/18
CHECKED BY: KEK DATE: 10/15/18

CHANNEL OR CHANNEL SECTION		SWALE-6	SWALE-7
TEMPORARY OR PERMANENT?	(T OR P)	P	P
DESIGN STORM	(2, 5, OR 10 YR)	100-year	100-year
ACRES	(AC)	0.66	11.69
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)
Q_r (REQUIRED CAPACITY)	(CFS)	4.6	22.4
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	4.6	22.4
PROTECTIVE LINING[2]		TRM-435	R-4 Riprap
n (MANNING'S COEFFICIENT)[2]		0.07	0.05
V_a (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A
V (CALCUALTED AT FLOW DEPTH d)	(FPS)	1.53	3.79
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.00	2.00
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT	0.57	1.72
CHANNEL BOTTOM WIDTH	(FT)	4.00	4.00
CHANNEL SIDE SLOPES	(H:V)	3:1	3:1
D (TOTAL DEPTH)	(FT)	2	2
CHANNEL TOP WIDTH @ D	(FT)	16	16
d (CALCULATED FLOW DEPTH)	(FT)	0.53	0.89
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	7.18	9.34
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	7.55	4.49
d_{50} STONE SIZE	(IN)	N/A	6
A (CROSS-SECTIONAL AREA)	(SQ. FT)	2.96	5.94
R (HYDRAULIC RADIUS)		0.40	0.61
S (BED SLOPE)[3]	(FT/FT)	0.017	0.03
S_C (CRITICAL SLOPE)	(FT/FT)	0.090	0.050
$.7S_c$	(FT/FT)	0.063	0.035
$1.3S_c$	(FT/FT)	0.117	0.065
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	1.47	1.11
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufacture linings without vegetation and with vegetation in seperate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: MDN DATE: 10/15/18
CHECKED BY: KEK DATE: 10/15/18

CHANNEL OR CHANNEL SECTION		SWALE-8	SWALE-9
TEMPORARY OR PERMANENT?	(T OR P)	P	P
DESIGN STORM	(2, 5, OR 10 YR)	100-year	100-year
ACRES	(AC)	2.07	0.88
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)
Q_r (REQUIRED CAPACITY)	(CFS)	9.7	5.7
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	9.7	5.7
PROTECTIVE LINING[2]		R-3 Riprap	TRM-435
n (MANNING'S COEFFICIENT)[2]		0.04	0.08
V_a (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A
V (CALCUALTED AT FLOW DEPTH d)	(FPS)	2.44	1.10
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.00	2.00
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT	0.54	39.31
CHANNEL BOTTOM WIDTH	(FT)	2.00	3.00
CHANNEL SIDE SLOPES	(H:V)	3:1	3:1
D (TOTAL DEPTH)	(FT)	1	2
CHANNEL TOP WIDTH @ D	(FT)	8	15
d (CALCULATED FLOW DEPTH)	(FT)	0.86	0.9
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	7.16	8.40
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	2.33	3.33
d_{50} STONE SIZE	(IN)	3	N/A
A (CROSS-SECTIONAL AREA)	(SQ. FT)	3.94	5.13
R (HYDRAULIC RADIUS)		0.53	0.59
S (BED SLOPE)[3]	(FT/FT)	0.010	0.70
S_C (CRITICAL SLOPE)	(FT/FT)	0.030	0.120
$.7S_c$	(FT/FT)	0.021	0.084
$1.3S_c$	(FT/FT)	0.039	0.156
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	0.14	1.10
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A' and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufacture linings without vegetation and with vegetation in seperate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: MDN DATE: 10/15/18
CHECKED BY: KEK DATE: 10/15/18

CHANNEL OR CHANNEL SECTION		SWALE-10	SWALE-11
TEMPORARY OR PERMANENT?	(T OR P)	P	P
DESIGN STORM	(2, 5, OR 10 YR)	100-year	100-year
ACRES	(AC)	0.58	1.98
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)
Q_r (REQUIRED CAPACITY)	(CFS)	4.0	15.5
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	4.0	15.5
PROTECTIVE LINING[2]		R-4 Riprap	R-3 Riprap
n (MANNING'S COEFFICIENT)[2]		0.07	0.04
V_a (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A
V (CALCUALTED AT FLOW DEPTH d)	(FPS)	2.35	2.91
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.00	2.00
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	1.48	0.65
CHANNEL BOTTOM WIDTH	(FT)	3.00	4.00
CHANNEL SIDE SLOPES	(H:V)	3:1	3:1
D (TOTAL DEPTH)	(FT)	2	1
CHANNEL TOP WIDTH @ D	(FT)	15	10
d (CALCULATED FLOW DEPTH)	(FT)	0.4	0.82
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	5.4	8.92
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	7.50	4.88
d_{50} STONE SIZE	(IN)	6	3
A (CROSS-SECTIONAL AREA)	(SQ. FT)	1.68	5.30
R (HYDRAULIC RADIUS)		0.30	0.58
S (BED SLOPE)[3]	(FT/FT)	0.059	0.01
S_C (CRITICAL SLOPE)	(FT/FT)	0.110	0.160
$.7S_c$	(FT/FT)	0.077	0.112
$1.3S_c$	(FT/FT)	0.143	0.208
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	1.60	0.18
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.50
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in seperate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD E&S WORKSHEET #11
Channel Design Data

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: MDN DATE: 10/2019
CHECKED BY: KEK DATE: 10/2019

CHANNEL OR CHANNEL SECTION		SWALE-12	TEMP - SWALE
TEMPORARY OR PERMANENT?	(T OR P)	P	T
DESIGN STORM	(2, 5, OR 10 YR)	100-year	5-year
ACRES	(AC)	8.48	16.69
MULTIPLIER	(1.6, 2.25, OR 2.75)[1]	N/A (CALCULATIONS INCLUDED AT END OF APPENDIX C)	2.25
Q_r (REQUIRED CAPACITY)	(CFS)	64.2	37.6
Q (CALCULATED AT FLOW DEPTH d)	(CFS)	64.2	37.6
PROTECTIVE LINING[2]		R-8 Riprap	Jute Net
n (MANNING'S COEFFICIENT)[2]		0.08	0.022
V_a (ALLOWABLE VELOCITY)	(FPS)	N/A	N/A
V (CALCUALTED AT FLOW DEPTH d)	(FPS)	4.11	3.45
τ_a (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	2.00	2.00
τ_d (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	3.32	0.30
CHANNEL BOTTOM WIDTH	(FT)	2.00	2.00
CHANNEL SIDE SLOPES	(H:V)	3:1	3:1
D (TOTAL DEPTH)	(FT)	2	2.5
CHANNEL TOP WIDTH @ D	(FT)	14	26
d (CALCULATED FLOW DEPTH)	(FT)	1.97	1.6
CHANNEL TOP WIDTH @ FLOW DEPTH d	(FT)	13.82	11.62
BOTTOM WIDTH: FLOW DEPTH RATIO	(12:1 MAX)	1.02	1.25
d_{50} STONE SIZE	(IN)	24	N/A
A (CROSS-SECTIONAL AREA)	(SQ. FT)	15.6	10.9
R (HYDRAULIC RADIUS)		1.1	10.8
S (BED SLOPE)[3]	(FT/FT)	0.027	0.003
S_C (CRITICAL SLOPE)	(FT/FT)	0.100	0.008
$.7S_c$	(FT/FT)	0.070	0.006
$1.3S_c$	(FT/FT)	0.130	0.010
STABLE FLOW?	(Y/N)	Y	Y
FREEBOARD BASED ON UNSTABLE FLOW	(FT)	N/A	N/A
FREEBOARD BASED ON STABLE FLOW	(FT)	0.03	0.90
MINIMUM REQUIRED FREEBOARD[4]	(FT)	0.50	0.63
DESIGN METHOD FOR PROTECTIVE LINING[5] PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S

1. Use 1.6 for Temporary Channels; 2.25 for Temporary Channels in Special Protection (HQ or EV) Watersheds; 2.75 for Permanent Channels. For Rational Method, enter "N/A" and attach E&S Worksheets 9 and 10. For TR-55 enter "N/A" and attach appropriate Worksheets.
2. Adjust "n" value for changes in channel liner and flow depth. For vegetated channels, provide data for manufactured linings without vegetation and with vegetation in seperate columns.
3. Slopes may not be averaged.
4. Minimum Freeboard is 0.5 ft. or 1/4 Total Channel Depth, whichever is greater.
5. Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is required for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

STANDARD E&S WORKSHEET #14
Sediment Basin/Sediment Trap Storage Data

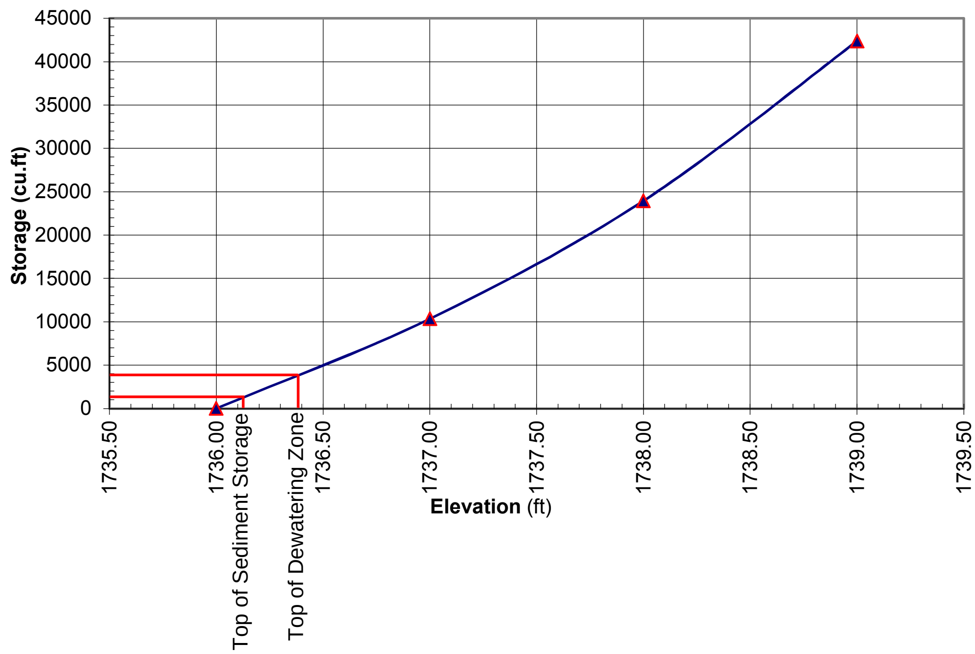
PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK DATE: 10/15/2018
CHECKED BY: MDN DATE: 10/15/2018

BASIN STAGE STORAGE TABLE-NORTH BASIN

Infiltration Runoff Volume:
Target Runoff Elevation: **1736.0** **(Primary orifice will be set at this elevation)**

ELEVATION ft	AREA sq.ft	AVG AREA sq.ft	ELEV DIFF ft	INCR VOL cu.ft	CUM VOL cu.ft
1736.00	9285.97				0
1737.00	11422.9	10354	1.0	10354	10354
1738.00	15776.78	13600	1.0	13600	23954
1739.00	21068.35	18423	1.0	18423	42377
		0	0.0	0	
		0	0.0	0	

STAGE-STORAGE



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Stage.xls

STANDARD E&S WORKSHEET #15
Sediment Basin/Sediment Trap Dewatering Discharge Data

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK / JMB DATE: 10/15/2018
CHECKED BY: MDN DATE: 10/15/2018

PERFORATION DISCHARGE (TOP OF RISER TO SEDIMENT CLEAN-OUT ELEVATION)

WATER SURFACE ELEVATION[1]	RISER PERFORATION DISCHARGE RATES									TOTAL DISCHARGE (CFS)
	ROW ELEVATION[2]									
	ROW 1	ROW 2	ROW 3	ROW 4	ROW 5	ROW 6	ROW 7	ROW 8	ROW 9	
	1736.25	1737.25	-	-	-	-	-	-	-	
1738.000	0.034	0.022	-	-	-	-	-	-	-	0.056
1737.750	0.032	0.018	-	-	-	-	-	-	-	0.049
1737.500	0.029	0.012	-	-	-	-	-	-	-	0.041
1737.250	0.026	0.000	-	-	-	-	-	-	-	0.026
1737.000	0.022	0.000	-	-	-	-	-	-	-	0.022

Notes:
1. From E&S Worksheet #14: Top elevation is Top of Dewatering Zone, and bottom elevation is Top of Sediment Storage Zone.
2. All perforations should be the same size. One-inch diameter perforations are preferred. Specify size of perforations 1 inch diameter. Each orifice row should have approximately the same number of perforations and the orifice rows should be equally spaced vertically. Specify the number of perforations in each orifice row 1 .

STANDARD E&S WORKSHEET #19
Sediment Trap Design Data

PROJECT NAME:	PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION:	CARBON COUNTY
PREPARED BY:	KEK	DATE:	10/15/2018
CHECKED BY:	MDN	DATE:	10/15/2018

TRAP NUMBER		NORTH BASIN	
DRAINAGE AREA (5 ACRES MAX)	(AC)	1.95	
REQUIRED CAPACITY (2,000 CF/AC)	(CF)	3900	
CAPACITY PROVIDED AT ELEVATION h	(CF)	23954	
SOIL TYPES IN DRAINAGE AREA		AcB	
REQUIRED SURFACE AREA (5,300 x AC)[1]	(SQ. FT)	10335	
* AVERAGE BOTTOM LENGTH	(FT)	145	
* AVERAGE BOTTOM WIDTH	(FT)	65	
* AVERAGE TRAP LENGTH AT ELEVATION h	(FT)	160	
* AVERAGE TRAP WIDTH AT ELEVATION h	(FT)	75	
SURFACE AREA AT ELEVATION h	(SQ. FT)	15777	
BOTTOM ELEVATION	(FT)	1736.00	
CLEAN-OUT ELEVATION (@700 CF/AC)[2]	(FT)	1736.25	
TOP OF EMBANKMENT ELEVATION[3]	(FT)	1739.00	
EMBANKMENT HEIGHT	(FT)	3	
CREST OF SPILLWAY ELEVATION[4]	(FT)	1738.00	
FLOW LENGTH AT ELEVATION h	(FT)	165	
FLOW LENGTH/WIDTH RATIO AT ELEV h[5]	(2:1 MIN)	2	

Notes:

1. If sandy clays, silty clays, silty clay loams, clay loams, or clays predominate soil types.
2. Minimum 12" above bottom of trap.
3. Minimum 12" above elevation at which 1.5 cfs/acre discharge capacity is provided.
4. Minimum 24" above bottom of trap.
5. 4:1 Flow Length:Width ratio required for HQ and EV watersheds.

EMBANKMENT SPILLWAYS

OUTLET WIDTH (2 x # ACRES MIN.)[1]	(FT)	N/A	
SPILLWAY HEIGHT h	(FT)	N/A	
OUTLET SIDE SLOPES	(2H:1V MAX)	N/A	
SPILLWAY OUTSIDE SLOPE Z1	(2 MIN.)	N/A	
SPILLWAY INSIDE SLOPE Z2	(2 MIN.)	N/A	

Notes:

1. 6 x # Acres Min. if not discharging directly to a waterway.

RISER PIPE SPILLWAYS

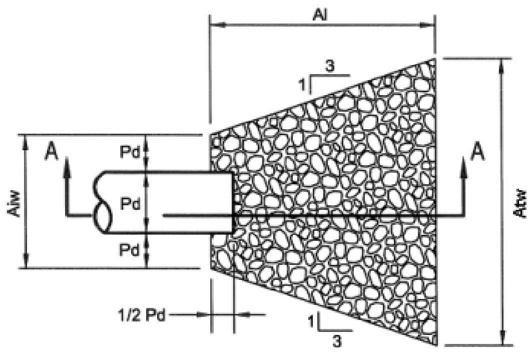
Dr (RISER DIAMETER, 8" MIN.)	(IN)	18	
Db (BARREL DIAMETER, 6" MIN.)	(IN)	14	
SPILLWAY CAPACITY WITH 12" FREEBOARD	(CFS)	4.94	
BARREL OUTLET ELEVATION	(FT)	1735.00	
MAX WATER SURFACE ELEVATION (@ 1.5 CFS/AC DISCHARGE)	(FT)	2.93	

OUTLET BASIN

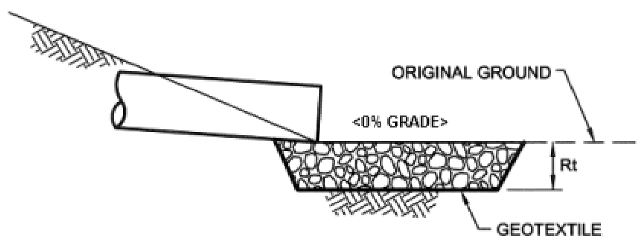
LENGTH (6 Db)	(FT)	7.00	
WIDTH (3 Db)	(FT)	3.50	
DEPTH (Db)	(FT)	1.17	
RIPRAP PROTECTION	(R-SIZE, R-3 MIN)	R-3	

STANDARD E&S WORKSHEET #20
Riprap Apron Outlet Protection

PROJECT NAME: PENNEAST PIPELINE PROJECT - KIDDER COMPRESSOR STATION
LOCATION: CARBON COUNTY
PREPARED BY: KEK DATE: 10/15/2018
CHECKED BY: MDN DATE: 10/15/2018



PLAN VIEW



SECTION A - A

NO.	Location	PIPE DIA. Pd (in)	TAIL WATER COND. (Max or Min)	MAN. "n" FOR PIPE	PIPE SLOPE (ft/ft)	Q (cfs)	V* (fps)	RIPRAP SIZE	Rt (in)	Al (ft)	Aiw (ft)	Atw (ft)
HW-3	BASIN SOUTH	48	Min	0.024	0.010	144.03	16.40	R-6	36	30	12	42
HW-2	ACCESS ROAD STA. 13+40	48	Min	0.024	0.028	121.59	13.79	R-5	27	30	24	54

***: The anticipated velocity (V) should not exceed the maximum permissible shown in Table 6.6 for the proposed riprap protection. Adjust for less than full pipe flow. Use Manning's equation to calculate velocity for pipe slopes $\geq$ 0.05 ft/ft.**

Kidder Compressor Station - Sediment Trap - Riser Pipe Spillway

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.010	
Channel Slope	0.00500	ft/ft
Normal Depth	1.17	ft
Diameter	1.17	ft
Discharge	4.94	ft³/s

Results

Discharge	4.94	ft³/s
Normal Depth	1.17	ft
Flow Area	1.07	ft²
Wetted Perimeter	3.67	ft
Hydraulic Radius	0.29	ft
Top Width	0.00	ft
Critical Depth	0.92	ft
Percent Full	100.0	%
Critical Slope	0.00545	ft/ft
Velocity	4.62	ft/s
Velocity Head	0.33	ft
Specific Energy	1.50	ft
Froude Number	0.00	
Maximum Discharge	5.32	ft³/s
Discharge Full	4.94	ft³/s
Slope Full	0.00500	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Kidder Compressor Station - Sediment Trap - Riser Pipe Spillway

GVF Output Data

Normal Depth Over Rise	100.00	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.17	ft
Critical Depth	0.92	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00545	ft/ft

Post Construction Stormwater
Management Facility Calculations

NOAA Atlas 14, Volume 2, Version 3
Location name: Kidder Twp, Pennsylvania, USA*
Latitude: 41.0816°, Longitude: -75.6658°
Elevation: 1744.44 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.330 (0.296-0.367)	0.394 (0.355-0.440)	0.474 (0.425-0.529)	0.541 (0.484-0.603)	0.632 (0.560-0.704)	0.713 (0.626-0.796)	0.800 (0.696-0.894)	0.897 (0.771-1.00)	1.05 (0.886-1.18)	1.18 (0.980-1.34)
10-min	0.515 (0.462-0.572)	0.617 (0.555-0.689)	0.741 (0.664-0.827)	0.841 (0.752-0.936)	0.977 (0.865-1.09)	1.09 (0.958-1.22)	1.22 (1.06-1.36)	1.35 (1.16-1.52)	1.56 (1.32-1.76)	1.74 (1.44-1.97)
15-min	0.633 (0.568-0.703)	0.759 (0.683-0.848)	0.915 (0.819-1.02)	1.04 (0.930-1.16)	1.21 (1.07-1.35)	1.36 (1.19-1.51)	1.51 (1.32-1.69)	1.69 (1.45-1.90)	1.95 (1.65-2.20)	2.18 (1.81-2.47)
30-min	0.844 (0.757-0.938)	1.02 (0.919-1.14)	1.26 (1.13-1.41)	1.46 (1.30-1.62)	1.73 (1.53-1.92)	1.96 (1.72-2.19)	2.21 (1.93-2.47)	2.50 (2.15-2.80)	2.93 (2.48-3.31)	3.31 (2.75-3.76)
60-min	1.03 (0.928-1.15)	1.26 (1.13-1.41)	1.59 (1.43-1.77)	1.86 (1.66-2.07)	2.25 (1.99-2.51)	2.59 (2.28-2.90)	2.98 (2.59-3.33)	3.41 (2.93-3.82)	4.08 (3.45-4.61)	4.68 (3.89-5.32)
2-hr	1.24 (1.12-1.39)	1.51 (1.36-1.69)	1.90 (1.71-2.14)	2.24 (2.01-2.52)	2.77 (2.46-3.11)	3.25 (2.87-3.65)	3.83 (3.34-4.30)	4.50 (3.88-5.06)	5.58 (4.74-6.33)	6.59 (5.50-7.53)
3-hr	1.36 (1.23-1.52)	1.65 (1.49-1.83)	2.06 (1.85-2.29)	2.41 (2.16-2.67)	2.96 (2.64-3.29)	3.48 (3.07-3.86)	4.08 (3.56-4.54)	4.79 (4.13-5.34)	5.94 (5.03-6.67)	7.01 (5.83-7.92)
6-hr	1.75 (1.57-1.97)	2.10 (1.89-2.35)	2.58 (2.32-2.90)	3.01 (2.69-3.38)	3.70 (3.28-4.14)	4.34 (3.81-4.86)	5.10 (4.43-5.72)	6.01 (5.15-6.76)	7.49 (6.30-8.49)	8.88 (7.34-10.1)
12-hr	2.18 (1.95-2.47)	2.62 (2.35-2.96)	3.24 (2.90-3.66)	3.80 (3.38-4.29)	4.69 (4.13-5.30)	5.53 (4.82-6.25)	6.53 (5.63-7.38)	7.73 (6.57-8.76)	9.69 (8.08-11.0)	11.5 (9.44-13.2)
24-hr	2.64 (2.40-2.97)	3.17 (2.88-3.57)	3.94 (3.57-4.43)	4.62 (4.17-5.18)	5.71 (5.11-6.37)	6.73 (5.97-7.46)	7.95 (6.99-8.77)	9.40 (8.19-10.3)	11.8 (10.1-12.9)	14.0 (11.9-15.2)
2-day	3.10 (2.81-3.46)	3.72 (3.38-4.16)	4.60 (4.17-5.15)	5.39 (4.87-6.01)	6.65 (5.96-7.39)	7.83 (6.96-8.66)	9.24 (8.14-10.2)	10.9 (9.52-12.0)	13.7 (11.8-14.9)	16.3 (13.8-17.7)
3-day	3.28 (2.99-3.66)	3.93 (3.58-4.39)	4.84 (4.40-5.41)	5.64 (5.12-6.29)	6.93 (6.24-7.69)	8.14 (7.27-8.99)	9.56 (8.47-10.5)	11.3 (9.88-12.3)	14.1 (12.1-15.3)	16.7 (14.2-18.1)
4-day	3.46 (3.16-3.86)	4.14 (3.78-4.62)	5.08 (4.63-5.67)	5.90 (5.37-6.57)	7.22 (6.53-7.99)	8.44 (7.58-9.31)	9.88 (8.80-10.9)	11.6 (10.2-12.7)	14.4 (12.5-15.7)	17.0 (14.6-18.6)
7-day	4.12 (3.77-4.56)	4.91 (4.49-5.45)	5.98 (5.46-6.63)	6.92 (6.29-7.65)	8.40 (7.59-9.25)	9.76 (8.76-10.7)	11.3 (10.1-12.4)	13.2 (11.7-14.4)	16.2 (14.1-17.7)	19.0 (16.3-20.6)
10-day	4.77 (4.38-5.26)	5.67 (5.20-6.25)	6.83 (6.25-7.52)	7.83 (7.14-8.61)	9.38 (8.52-10.3)	10.8 (9.74-11.8)	12.4 (11.1-13.5)	14.3 (12.7-15.6)	17.2 (15.2-18.8)	19.9 (17.3-21.6)
20-day	6.44 (5.99-7.03)	7.60 (7.05-8.28)	8.90 (8.24-9.68)	10.0 (9.25-10.9)	11.7 (10.8-12.7)	13.2 (12.1-14.3)	14.8 (13.5-16.0)	16.7 (15.2-18.1)	19.6 (17.7-21.2)	22.2 (19.8-23.9)
30-day	8.04 (7.54-8.65)	9.44 (8.84-10.1)	10.9 (10.2-11.7)	12.1 (11.3-13.0)	13.9 (12.9-14.9)	15.5 (14.3-16.5)	17.2 (15.9-18.3)	19.1 (17.6-20.4)	22.0 (20.1-23.5)	24.5 (22.2-26.2)
45-day	10.2 (9.60-10.8)	11.9 (11.2-12.6)	13.4 (12.7-14.3)	14.8 (13.9-15.7)	16.7 (15.7-17.8)	18.4 (17.2-19.5)	20.2 (18.8-21.4)	22.1 (20.6-23.5)	25.0 (23.2-26.6)	27.5 (25.3-29.2)
60-day	12.3 (11.6-13.0)	14.3 (13.5-15.1)	16.0 (15.2-17.0)	17.5 (16.6-18.6)	19.7 (18.6-20.8)	21.6 (20.3-22.8)	23.6 (22.1-24.9)	25.7 (24.1-27.2)	28.9 (26.9-30.5)	31.6 (29.2-33.4)

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

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

Please refer to NOAA Atlas 14 document for more information.

Back to Top

DIV_SWALE-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.4
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	2.67
Sheet flow time, min	**26.60**
SHALLOW CONC. FLOW	
Flow length, ft	1225.88
Watercourse slope, %	4.00
Surface Description	unpaved
Velocity, ft/s	3.23
Sh. Conc. Flow time, min	**6.33**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	1
channel flow depth, ft	3.00
Channel flow length, ft	434.72
channel bed slope, %	0.69
Mannings N	0.024
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	0
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.007
top width at flow depth, ft	19.00
top width including freeboard, ft	19.00
wetted area, sq. ft	30.00
wetted peri, ft	19.97
hyd. Radius, ft	1.50
velocity, ft/s	6.76
Discharge, cfs	202.92
Theta, rad	0.01
Froudes Number	0.69
Flow Type	**subcritical**
Channel flow time, mins	**1.07**
TIME OF CONC., mins	**34.00**

SWALE 1/ IN#2-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	2.00
Sheet flow time, min	**2.72**
SHALLOW CONC. FLOW	
Flow length, ft	69
Watercourse slope, %	0.58
Surface Description	unpaved
Velocity, ft/s	1.23
Sh. Conc. Flow time, min	**0.94**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	6
channel flow depth, ft	2.00
Channel flow length, ft	483.35
channel bed slope, %	2.00
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.020
top width at flow depth, ft	18.00
top width including freeboard, ft	24.24
wetted area, sq. ft	24.00
wetted peri, ft	18.65
hyd. Radius, ft	1.29
velocity, ft/s	8.31
Discharge, cfs	199.45
Theta, rad	0.02
Froudes Number	1.04
Flow Type	**supercritical**
Channel flow time, mins	**0.97**
TIME OF CONC., mins	**4.62**

SWALE 2/ IN#1-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.011
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	1.20
Sheet flow time, min	**2.07**
SHALLOW CONC. FLOW	
Flow length, ft	311
Watercourse slope, %	2.12
Surface Description	paved
Velocity, ft/s	2.96
Sh. Conc. Flow time, min	**1.75**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	3
channel flow depth, ft	2.00
Channel flow length, ft	560.00
channel bed slope, %	2.00
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.02
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.020
top width at flow depth, ft	15.00
top width including freeboard, ft	21.12
wetted area, sq. ft	18.00
wetted peri, ft	15.65
hyd. Radius, ft	1.15
velocity, ft/s	7.71
Discharge, cfs	138.80
Theta, rad	0.02
Froudes Number	0.96
Flow Type	**subcritical**
Channel flow time, mins	**1.21**
TIME OF CONC., mins	**5.03**

SWALE 3/ IN#3-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	1.65
Sheet flow time, min	**2.93**
SHALLOW CONC. FLOW	
Flow length, ft	34.57
Watercourse slope, %	15.97
Surface Description	unpaved
Velocity, ft/s	6.45
Sh. Conc. Flow time, min	**0.09**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	4
channel flow depth, ft	1.00
Channel flow length, ft	283.78
channel bed slope, %	3.47
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.035
top width at flow depth, ft	10.00
top width including freeboard, ft	16.24
wetted area, sq. ft	7.00
wetted peri, ft	10.32
hyd. Radius, ft	0.68
velocity, ft/s	7.14
Discharge, cfs	49.98
Theta, rad	0.03
Froudes Number	1.26
Flow Type	**supercritical**
Channel flow time, mins	**0.66**
TIME OF CONC., mins	**3.68**

SWALE 4/ IN#8-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	1.33
Sheet flow time, min	**3.19**
SHALLOW CONC. FLOW	
Flow length, ft	328
Watercourse slope, %	1.46
Surface Description	paved
Velocity, ft/s	2.46
Sh. Conc. Flow time, min	**2.22**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	8
channel flow depth, ft	1.00
Channel flow length, ft	11.00
channel bed slope, %	2.00
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.020
top width at flow depth, ft	14.00
top width including freeboard, ft	20.24
wetted area, sq. ft	11.00
wetted peri, ft	14.32
hyd. Radius, ft	0.77
velocity, ft/s	5.89
Discharge, cfs	64.79
Theta, rad	0.02
Froudes Number	1.04
Flow Type	**supercritical**
Channel flow time, mins	**0.03**
TIME OF CONC., mins	**5.45**

SWALE 5/ IN#11-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.15
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	1.33
Sheet flow time, min	**16.01**
SHALLOW CONC. FLOW	
Flow length, ft	296.35
Watercourse slope, %	3.21
Surface Description	unpaved
Velocity, ft/s	2.89
Sh. Conc. Flow time, min	**1.71**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	4
channel flow depth, ft	2.00
Channel flow length, ft	0.00
channel bed slope, %	#DIV/0!
Mannings N	0.024
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	0
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	#DIV/0!
top width at flow depth, ft	16.00
top width including freeboard, ft	16.00
wetted area, sq. ft	20.00
wetted peri, ft	16.65
hyd. Radius, ft	1.20
velocity, ft/s	#DIV/0!
Discharge, cfs	#DIV/0!
Theta, rad	#DIV/0!
Froudes Number	#DIV/0!
Flow Type	**#DIV/0!**
Channel flow time, mins	**#DIV/0!**
TIME OF CONC., mins	**17.72**

SWALE 7-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.05
Flow length, ft	77.63
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	1.29
Sheet flow time, min	**3.98**
SHALLOW CONC. FLOW	
Flow length, ft	34.86
Watercourse slope, %	30.12
Surface Description	unpaved
Velocity, ft/s	8.85
Sh. Conc. Flow time, min	**0.07**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	4
channel flow depth, ft	2.00
Channel flow length, ft	297.21
channel bed slope, %	0.50
Mannings N	0.024
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	0
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.005
top width at flow depth, ft	16.00
top width including freeboard, ft	16.00
wetted area, sq. ft	20.00
wetted peri, ft	16.65
hyd. Radius, ft	1.20
velocity, ft/s	4.98
Discharge, cfs	99.68
Theta, rad	0.01
Froudes Number	0.62
Flow Type	**subcritical**
Channel flow time, mins	**0.99**
TIME OF CONC., mins	**5.04**

SWALE 7-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.4
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	0.67
Sheet flow time, min	**46.31**
SHALLOW CONC. FLOW	
Flow length, ft	601.74
Watercourse slope, %	1.74
Surface Description	unpaved
Velocity, ft/s	2.13
Sh. Conc. Flow time, min	**4.71**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	4
channel flow depth, ft	2.00
Channel flow length, ft	297.21
channel bed slope, %	0.50
Mannings N	0.024
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	0
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.005
top width at flow depth, ft	16.00
top width including freeboard, ft	16.00
wetted area, sq. ft	20.00
wetted peri, ft	16.65
hyd. Radius, ft	1.20
velocity, ft/s	4.98
Discharge, cfs	99.68
Theta, rad	0.01
Froudes Number	0.62
Flow Type	**subcritical**
Channel flow time, mins	**0.99**
TIME OF CONC., mins	**52.01**

SWALE 8/ IN#9 -Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.05
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	1.33
Sheet flow time, min	**6.65**
SHALLOW CONC. FLOW	
Flow length, ft	32.77
Watercourse slope, %	42.77
Surface Description	unpaved
Velocity, ft/s	10.55
Sh. Conc. Flow time, min	**0.05**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	2
channel flow depth, ft	1.00
Channel flow length, ft	212.17
channel bed slope, %	1.89
Mannings N	0.024
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	0
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.019
top width at flow depth, ft	8.00
top width including freeboard, ft	8.00
wetted area, sq. ft	5.00
wetted peri, ft	8.32
hyd. Radius, ft	0.60
velocity, ft/s	6.07
Discharge, cfs	30.34
Theta, rad	0.02
Froudes Number	1.07
Flow Type	**supercritical**
Channel flow time, mins	**0.58**
TIME OF CONC., mins	**7.28**

SWALE 9-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.15
Flow length, ft	10.13
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	9.87
Sheet flow time, min	**0.83**
SHALLOW CONC. FLOW	
Flow length, ft	0
Watercourse slope, %	#DIV/0!
Surface Description	unpaved
Velocity, ft/s	#DIV/0!
Sh. Conc. Flow time, min	**#DIV/0!**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	8
channel flow depth, ft	0.48
Channel flow length, ft	679.80
channel bed slope, %	0.70
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.007
top width at flow depth, ft	10.88
top width including freeboard, ft	17.12
wetted area, sq. ft	4.53
wetted peri, ft	11.04
hyd. Radius, ft	0.41
velocity, ft/s	2.30
Discharge, cfs	10.40
Theta, rad	0.01
Froudes Number	0.58
Flow Type	**subcritical**
Channel flow time, mins	**4.94**
TIME OF CONC., mins	**5.77**

SWALE 10-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	7.59
2-Yr 24-Hr rainfall, in	3.18
Land slope, %	28.33
Sheet flow time, min	**0.09**
SHALLOW CONC. FLOW	
Flow length, ft	0.01
Watercourse slope, %	19500.00
Surface Description	unpaved
Velocity, ft/s	225.31
Sh. Conc. Flow time, min	**0.00**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	5
channel flow depth, ft	0.96
Channel flow length, ft	463.42
channel bed slope, %	0.45
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.005
top width at flow depth, ft	10.76
top width including freeboard, ft	17.00
wetted area, sq. ft	7.56
wetted peri, ft	11.07
hyd. Radius, ft	0.68
velocity, ft/s	2.59
Discharge, cfs	19.62
Theta, rad	0.00
Froudes Number	0.47
Flow Type	**subcritical**
Channel flow time, mins	**2.98**
TIME OF CONC., mins	**3.06**

SWALE 11-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.18
Land slope, %	1.43
Sheet flow time, min	**3.10**
SHALLOW CONC. FLOW	
Flow length, ft	109
Watercourse slope, %	1.79
Surface Description	unpaved
Velocity, ft/s	2.16
Sh. Conc. Flow time, min	**0.84**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	5
channel flow depth, ft	0.96
Channel flow length, ft	119.00
channel bed slope, %	1.76
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.018
top width at flow depth, ft	10.76
top width including freeboard, ft	17.00
wetted area, sq. ft	7.56
wetted peri, ft	11.07
hyd. Radius, ft	0.68
velocity, ft/s	5.12
Discharge, cfs	38.72
Theta, rad	0.02
Froudes Number	0.92
Flow Type	**subcritical**
Channel flow time, mins	**0.39**
TIME OF CONC., mins	**4.33**

SWALE 12-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.011
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	4.67
Sheet flow time, min	**1.20**
SHALLOW CONC. FLOW	
Flow length, ft	139.43
Watercourse slope, %	2.15
Surface Description	unpaved
Velocity, ft/s	2.37
Sh. Conc. Flow time, min	**0.98**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	2
channel flow depth, ft	2.00
Channel flow length, ft	1130.21
channel bed slope, %	3.27
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.033
top width at flow depth, ft	14.00
top width including freeboard, ft	20.24
wetted area, sq. ft	16.00
wetted peri, ft	14.65
hyd. Radius, ft	1.09
velocity, ft/s	9.53
Discharge, cfs	152.49
Theta, rad	0.03
Froudes Number	1.19
Flow Type	**supercritical**
Channel flow time, mins	**1.98**
TIME OF CONC., mins	**4.16**

IN#4-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.011
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.17
Land slope, %	1.47
Sheet flow time, min	**1.91**
SHALLOW CONC. FLOW	
Flow length, ft	58.44
Watercourse slope, %	2.57
Surface Description	paved
Velocity, ft/s	3.26
Sh. Conc. Flow time, min	**0.30**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	2
channel flow depth, ft	1.00
Channel flow length, ft	89.30
channel bed slope, %	0.56
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.006
top width at flow depth, ft	8.00
top width including freeboard, ft	14.24
wetted area, sq. ft	5.00
wetted peri, ft	8.32
hyd. Radius, ft	0.60
velocity, ft/s	2.65
Discharge, cfs	13.23
Theta, rad	0.01
Froudes Number	0.47
Flow Type	**subcritical**
Channel flow time, mins	**0.56**
TIME OF CONC., mins	**2.77**

IN#5-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.011
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.18
Land slope, %	1.43
Sheet flow time, min	**1.92**
SHALLOW CONC. FLOW	
Flow length, ft	108
Watercourse slope, %	1.67
Surface Description	paved
Velocity, ft/s	2.62
Sh. Conc. Flow time, min	**0.69**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	5
channel flow depth, ft	0.96
Channel flow length, ft	78.00
channel bed slope, %	0.45
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.004
top width at flow depth, ft	10.76
top width including freeboard, ft	17.00
wetted area, sq. ft	7.56
wetted peri, ft	11.07
hyd. Radius, ft	0.68
velocity, ft/s	2.58
Discharge, cfs	19.52
Theta, rad	0.00
Froudes Number	0.46
Flow Type	**subcritical**
Channel flow time, mins	**0.50**
TIME OF CONC., mins	**3.11**

IN#6-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.18
Land slope, %	1.43
Sheet flow time, min	**3.10**
SHALLOW CONC. FLOW	
Flow length, ft	109
Watercourse slope, %	1.79
Surface Description	unpaved
Velocity, ft/s	2.16
Sh. Conc. Flow time, min	**0.84**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	5
channel flow depth, ft	0.96
Channel flow length, ft	119.00
channel bed slope, %	1.76
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.018
top width at flow depth, ft	10.76
top width including freeboard, ft	17.00
wetted area, sq. ft	7.56
wetted peri, ft	11.07
hyd. Radius, ft	0.68
velocity, ft/s	5.12
Discharge, cfs	38.72
Theta, rad	0.02
Froudes Number	0.92
Flow Type	**subcritical**
Channel flow time, mins	**0.39**
TIME OF CONC., mins	**4.33**

IN#7-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.18
Land slope, %	2.00
Sheet flow time, min	**2.71**
SHALLOW CONC. FLOW	
Flow length, ft	125
Watercourse slope, %	1.60
Surface Description	unpaved
Velocity, ft/s	2.04
Sh. Conc. Flow time, min	**1.02**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	5
channel flow depth, ft	0.96
Channel flow length, ft	65.00
channel bed slope, %	0.38
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.004
top width at flow depth, ft	10.76
top width including freeboard, ft	17.00
wetted area, sq. ft	7.56
wetted peri, ft	11.07
hyd. Radius, ft	0.68
velocity, ft/s	2.39
Discharge, cfs	18.08
Theta, rad	0.00
Froudes Number	0.43
Flow Type	**subcritical**
Channel flow time, mins	**0.45**
TIME OF CONC., mins	**4.19**

IN#10-Tc CALCULATIONS

SHEET FLOW	
Manning's n	0.02
Flow length, ft	150
2-Yr 24-Hr rainfall, in	3.18
Land slope, %	2.00
Sheet flow time, min	**2.71**
SHALLOW CONC. FLOW	
Flow length, ft	125
Watercourse slope, %	1.60
Surface Description	unpaved
Velocity, ft/s	2.04
Sh. Conc. Flow time, min	**1.02**
CHANNEL FLOW	
Left side slope, %	33.3333
Right side slope, %	33.3333
bottom width, ft	5
channel flow depth, ft	0.96
Channel flow length, ft	65.00
channel bed slope, %	0.38
Mannings N	0.03
Accn. Due to gravity, ft/sec2	32.2
Freeboard, ft	1.04
H:V, left	3.00
H:V, right	3.00
bed slope, ft/ft	0.004
top width at flow depth, ft	10.76
top width including freeboard, ft	17.00
wetted area, sq. ft	7.56
wetted peri, ft	11.07
hyd. Radius, ft	0.68
velocity, ft/s	2.39
Discharge, cfs	18.08
Theta, rad	0.00
Froudes Number	0.43
Flow Type	**subcritical**
Channel flow time, mins	**0.45**
TIME OF CONC., mins	**4.19**

Figure 2.10.4.2(E)
Storm Intensity - Duration - Frequency
Curves for Region 5

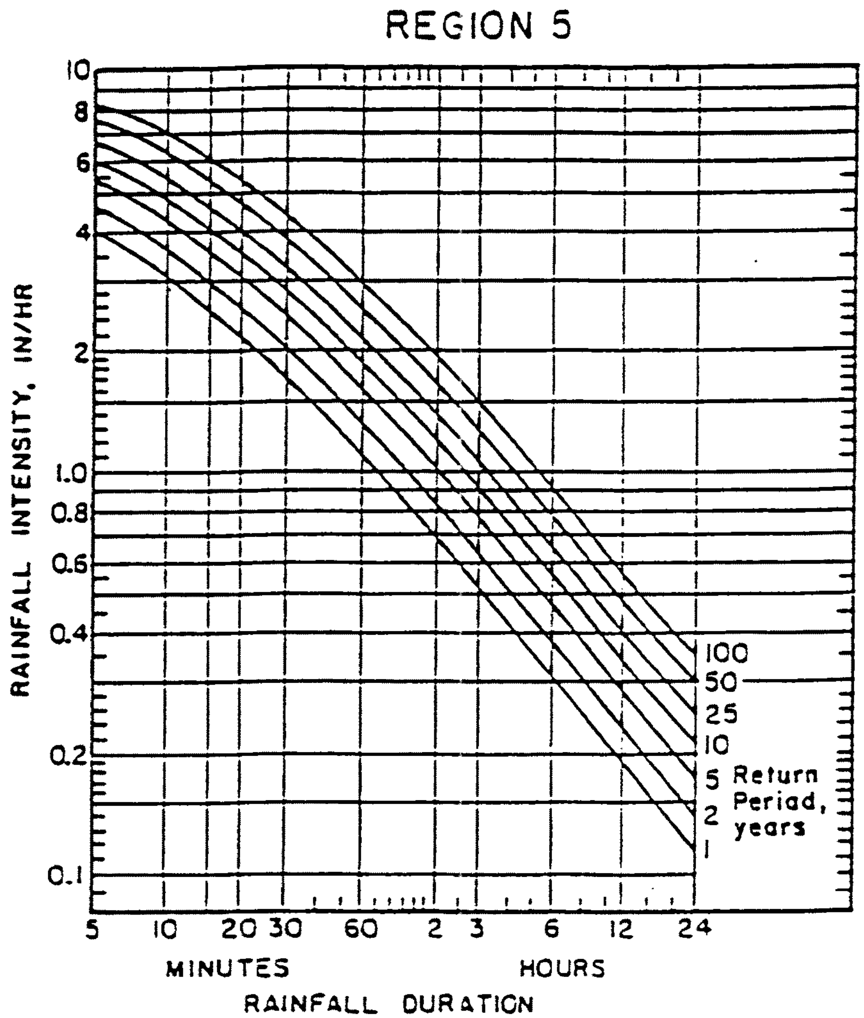


Table B-3
Runoff Coefficients

		Hydrologic Soil Group			
Land Use Description		**A**	**B**	**C**	**D**
Cultivated land					
without conservation treatment		.49	.67	.81	.88
with conservation treatment		.27	.43	.61	.67
Pasture or range land					
poor condition		.38	.63	.78	.84
good condition		.14	.25	.51	.65
Wood or forest land					
thin stand, poor cover, no mulch		.17	.34	.59	.70
good cover		.13	.22	.45	.59
Open spaces, lawns, parks, golf courses, cemeteries					
good conditions: grass cover on 75% or more of the area		.14	.25	.51	.65
fair conditions: grass cover on 50% to 75% of the area		.20	.45	.63	.74
Commercial and business areas (85% impervious)		.84	.90	.93	.96
Industrial districts (72% impervious)		.67	.81	.88	.92
Residential					
Average Lot Size	**Average % Impervious**				
1/8 acre or less	65	.59	.76	.86	.90
1/4 acre	38	.45	.55	.70	.80
1/3 acre	30	.30	.49	.67	.78
1/2 acre	25	.22	.45	.63	.74
1 acre	20	.20	.41	.63	.74
Paved parking lots, roofs, driveways, etc.		.99	.99	.99	.99
Streets and roads:					
Paved with curbs and storm sewers		.99	.99	.99	.99
Gravel		.57	.76	.84	.88
Dirt		.49	.69	.80	.84

NOTE: Values are based on SCS definitions and are average values derived by an advisory committee for this Manual.

SOURCE: New Jersey Department of Environmental Protection, Division of Water Resources - "Technical Manual for Stream Encroachment," August, 1984.

Existing site conditions of bare earth or fallow shall be considered as meadow when choosing a C value.

Editor's Note: Table B-4, Manning roughness coefficients, is on file in the Township offices.

PENNEAST-KIDDER COMPRESSOR STATION
LAND USE/LAND COVER CONDITIONS RUNOFF COEFFICIENTS INDEX
RATIONAL METHOD

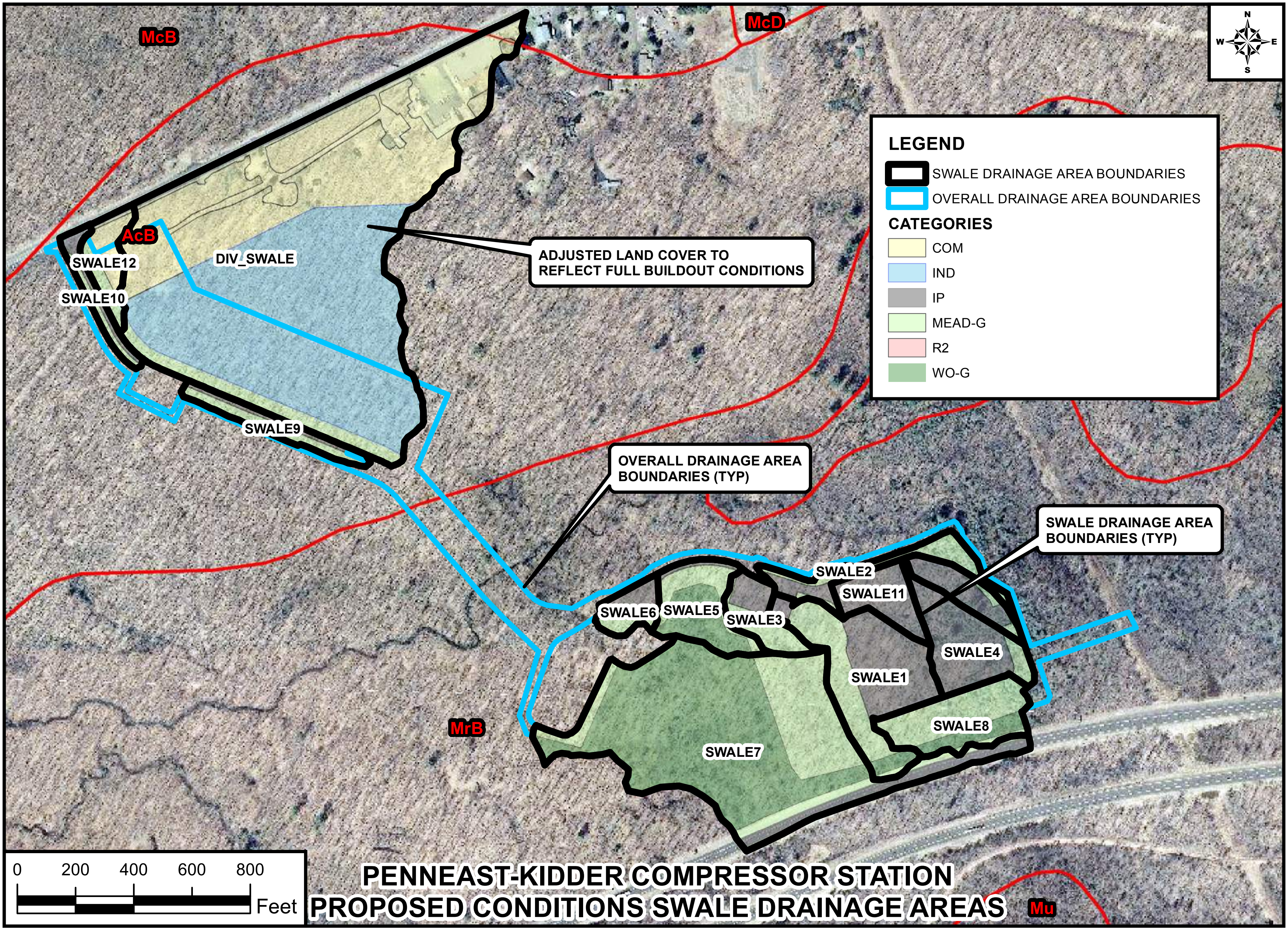
LU Index	Land Cover Description	LU Symbol	Hydrologic Soil Group (HSG)				KIDDER CODE APP. B TABLE B-3 CLASSIFICATION
			A	B	C	D	
1	WOODS-GOOD CONDITION	WO-G	0	0	0	0.59	WOOD OR FOREST LAND - GOOD CONDITION
2	MEADOW-GOOD CONDITION	MEAD-G	0.14	0.25	0.51	0.65	PASTURE - GOOD CONDITION
3	IMPERVIOUS	IP	0.99	0.99	0.99	0.99	STREETS AND ROADS: PAVED
4	OPEN SPACE-GOOD CONDITION (GRASS COVER >75%)	OS-G	0.14	0.25	0.51	0.65	OPEN SPACE GOOD CONDITION (LAWN, PARK, GOLF COURSE)
5	H-C HIGHWAY COMMERCIAL (PER ZONING MAP)	COM	0.84	0.9	0.93	0.96	COMMERCIAL (85% IMPERVIOUS)
6	L-I LIGHT INDUSTRIAL (PER ZONING MAP)	IND	0.67	0.81	0.88	0.92	INDUSTRIAL (72% IMPERVIOUS)
7	R-2 RESIDENTIAL MEDIUM DENSITY (PER ZONING MAP)	R2	0.22	0.45	0.63	0.74	RESIDENTIAL - 1/2 ACRE

PENNEAST-KIDDER COMPRESSOR STATION
EXISTING SOIL TYPES INDEX

Source: NRCS Web Soil Survey

Soil Symbol	Soil Description	HSG for Rational Method
AcB	Albrights very stony loam, 0 to 8 percent slopes	D
LkD	Leck kill very stony loam, 8 to 25 percent slopes	B
MbB2	Meckesville channery loam, 3 to 8 percent slopes, moderately eroded	C
McB	Meckesville very stony loam, 0 to 8 percent slopes	C
McD	Meckesville very stony loam, 8 to 25 percent slopes	C
MrB	Morris channery silt loam, 0 to 8 percent slopes, extremely stony	D
Mu	Muck and Peat	D
NvB	Norwich soils, 0 to 8 percent slopes, extremely stony	D
TuB	Tunkhannock gravelly loam, 3 to 8 percent slopes	A
TuC	Tunkhannock gravelly loam, 8 to 15 percent slopes	A
TuD	Tunkhannock gravelly loam, 15 to 25 percent slopes	A
W	Water	D

Notes:
1.NRCS HSG rating for AcB is C/D. A HSG of D used for calculation purposes.
2.NRCS HSG rating for Mu is A/D. A HSG of D used for calculation purposes.
3. A HSG rating of D used for Water.



PENNEAST-KIDDER COMPRESSOR STATION
PROPOSED CONDITIONS SWALE DRAINAGE AREAS
LEGEND
SWALE DRAINAGE AREA BOUNDARIES
OVERALL DRAINAGE AREA BOUNDARIES
CATEGORIES
COM
IND
IP
MEAD-G
R2
WO-G
ADJUSTED LAND COVER TO REFLECT FULL BUILDOUT CONDITIONS
OVERALL DRAINAGE AREA BOUNDARIES (TYP)
SWALE DRAINAGE AREA BOUNDARIES (TYP)
DIV_SWALE
SWALE1
SWALE2
SWALE3
SWALE4
SWALE5
SWALE6
SWALE7
SWALE8
SWALE9
SWALE10
SWALE11
SWALE12
McB
McD
AcB
MrB
Mu
N
S
E
W
0
200
400
600
800
Feet

PENNEAST-KIDDER COMPRESSOR STATION									
PROPOSED CONDITIONS RUNOFF COEFFICIENT CALCULATIONS FOR PROPOSED SWALES									
ID	**DA**	**Cover**	**Soils**	**HSG**	**Area**	**Area (Acres)**	**C**	**CN*A**	**RC**
46	DIV_SWALE	COM	AcB	D	23251.413	0.534	0.96	0.512	0.96
48	DIV_SWALE	COM	AcB	D	129483.183	2.973	0.96	2.854	0.96
45	DIV_SWALE	IND	AcB	D	457745.707	10.508	0.92	9.668	0.92
47	DIV_SWALE	IP	AcB	D	3097.839	0.071	0.99	0.070	0.99
49	DIV_SWALE	MEAD-G	AcB	D	37441.162	0.860	0.65	0.559	0.65
	DIV_SWALE Total					**14.945**		**13.663**	**0.91**
13	SWALE1	IP	MrB	D	137.124	0.003	0.99	0.003	0.99
14	SWALE1	IP	MrB	D	83918.062	1.926	0.99	1.907	0.99
12	SWALE1	MEAD-G	MrB	D	2940.407	0.068	0.65	0.044	0.65
16	SWALE1	MEAD-G	MrB	D	69375.835	1.593	0.65	1.035	0.65
15	SWALE1	WO-G	MrB	D	8169.411	0.188	0.59	0.111	0.59
	SWALE1 Total					**3.777**		**3.100**	**0.82**
30	SWALE10	COM	AcB	D	403.792	0.009	0.96	0.009	0.96
31	SWALE10	IP	AcB	D	1690.943	0.039	0.99	0.038	0.99
32	SWALE10	IP	AcB	D	12176.616	0.280	0.99	0.277	0.99
33	SWALE10	MEAD-G	AcB	D	11105.278	0.255	0.65	0.166	0.65
	SWALE10 Total					**0.583**		**0.490**	**0.84**
17	SWALE11	IP	MrB	D	79941.979	1.835	0.99	1.817	0.99
18	SWALE11	MEAD-G	MrB	D	6409.719	0.147	0.65	0.096	0.65
	SWALE11 Total					**1.982**		**1.913**	**0.96**
35	SWALE12	COM	AcB	D	37886.895	0.870	0.96	0.835	0.96
36	SWALE12	COM	AcB	D	53797.814	1.235	0.96	1.186	0.96
38	SWALE12	COM	AcB	D	100314.797	2.303	0.96	2.211	0.96
43	SWALE12	COM	AcB	D	79366.053	1.822	0.96	1.749	0.96
50	SWALE12	COM	AcB	D	707.744	0.016	0.96	0.016	0.96
37	SWALE12	COM	McB	C	4938.127	0.113	0.93	0.105	0.93
42	SWALE12	COM	McB	C	382.895	0.009	0.93	0.008	0.93
34	SWALE12	IND	AcB	D	41348.951	0.949	0.92	0.873	0.92
40	SWALE12	IP	AcB	D	19751.828	0.453	0.99	0.449	0.99
41	SWALE12	IP	AcB	D	2360.037	0.054	0.99	0.054	0.99
39	SWALE12	IP	McB	C	2013.575	0.046	0.99	0.046	0.99
44	SWALE12	MEAD-G	AcB	D	26500.052	0.608	0.65	0.395	0.65
	SWALE12 Total					**8.480**		**7.927**	**0.93**
4	SWALE2	IP	MrB	D	17511.083	0.402	0.99	0.398	0.99
5	SWALE2	MEAD-G	MrB	D	33758.022	0.775	0.65	0.504	0.65
	SWALE2 Total					**1.177**		**0.902**	**0.77**
2	SWALE3	IP	MrB	D	10357.240	0.238	0.99	0.235	0.99
3	SWALE3	MEAD-G	MrB	D	33808.746	0.776	0.65	0.504	0.65
	SWALE3 Total					**1.014**		**0.740**	**0.73**
0	SWALE4	IP	MrB	D	79121.232	1.816	0.99	1.798	0.99
1	SWALE4	MEAD-G	MrB	D	10167.745	0.233	0.65	0.152	0.65
	SWALE4 Total					**2.050**		**1.950**	**0.95**
6	SWALE5	IP	MrB	D	7315.615	0.168	0.99	0.166	0.99
8	SWALE5	MEAD-G	MrB	D	27677.521	0.635	0.65	0.413	0.65
7	SWALE5	WO-G	MrB	D	42039.335	0.965	0.59	0.569	0.59

PENNEAST-KIDDER COMPRESSOR STATION									
PROPOSED CONDITIONS RUNOFF COEFFICIENT CALCULATIONS FOR PROPOSED SWALES									
ID	**DA**	**Cover**	**Soils**	**HSG**	**Area**	**Area (Acres)**	**C**	**CN*A**	**RC**
	SWALE5 Total					**1.768**		**1.149**	**0.65**
9	SWALE6	IP	MrB	D	17398.276	0.399	0.99	0.395	0.99
11	SWALE6	MEAD-G	MrB	D	11108.573	0.255	0.65	0.166	0.65
10	SWALE6	WO-G	MrB	D	71.358	0.002	0.59	0.001	0.59
	SWALE6 Total					**0.656**		**0.562**	**0.86**
21	SWALE7	IP	MrB	D	39472.060	0.906	0.99	0.897	0.99
19	SWALE7	MEAD-G	MrB	D	24346.769	0.559	0.65	0.363	0.65
20	SWALE7	MEAD-G	MrB	D	4092.896	0.094	0.65	0.061	0.65
23	SWALE7	MEAD-G	MrB	D	113986.806	2.617	0.65	1.701	0.65
22	SWALE7	WO-G	MrB	D	327314.174	7.514	0.59	4.433	0.59
	SWALE7 Total					**11.690**		**7.456**	**0.64**
25	SWALE8	IP	MrB	D	3832.513	0.088	0.99	0.087	0.99
24	SWALE8	MEAD-G	MrB	D	5067.017	0.116	0.65	0.076	0.65
27	SWALE8	MEAD-G	MrB	D	61265.835	1.406	0.65	0.914	0.65
26	SWALE8	WO-G	MrB	D	19785.088	0.454	0.59	0.268	0.59
	SWALE8 Total					**2.065**		**1.345**	**0.65**
28	SWALE9	IP	AcB	D	16253.591	0.373	0.99	0.369	0.99
29	SWALE9	MEAD-G	AcB	D	22173.531	0.509	0.65	0.331	0.65
	SWALE9 Total					**0.882**		**0.700**	**0.79**
	Grand Total					**51.069**		**41.895**	**0.82**

The "RC" value is an area averaged runoff coefficient value (arithmatic mean) calculated as:

$$RC=\frac{\sum_{i=1}^{n} C_i \ x \ Area_i}{\sum_{i=1}^{n} Area_i}$$

PENNEAST-KIDDER COMPRESSOR STATION
RATIONAL METHOD PEAK FLOW CALCULATIONS FOR PROPOSED SWALES

Return Period (Yrs) 100

Min. Time of Concentration (mins) 5 **(Unless otherwise noted below)**

DA	Area (Acres)	RC	Tc (mins)	Rainfall Intensity (in/hr)	Q (cfs)
DIV_SWALE	14.945	0.91	34.00	4.2	57.384
SWALE1	3.777	0.82	5.00	8.1	25.111
SWALE10	0.583	0.84	5.00	8.1	3.967
SWALE11	1.982	0.96	5.00	8.1	15.491
SWALE12	8.480	0.93	5.00	8.1	64.207
SWALE2	1.177	0.77	5.00	8.1	7.304
SWALE3	1.014	0.73	5.00	8.1	5.993
SWALE4	2.050	0.95	5.00	8.1	15.794
SWALE5	1.768	0.65	17.72	5.3	6.088
SWALE6	0.656	0.86	5.00	8.1	4.553
SWALE7	11.690	0.64	52.10	3.0	22.367
SWALE8	2.065	0.65	7.30	7.2	9.683
SWALE9	0.882	0.79	5.00	8.1	5.672

Note: Peak Flow calculations for SWALE12 account for full buildout conditions

TOTAL FLOW FOR SWALE1	ADD
SWALE1	25.111
SWALE8	9.683
TOTAL	**34.794**

TOTAL FLOW FOR SWALE2	ADD
SWALE2	7.304
SWALE4	15.794
SWALE11	15.491
TOTAL	**38.590**

TOTAL FLOW FOR DIV_SWALE	ADD
DIV_SWALE	57.384
SWALE12	64.207
TOTAL	**121.591**

Calculated based on full buildout conditions.
Note that this flow passes through the twin 48" cross culverts

PENNEAST-KIDDER COMPRESSOR STATION							
PROPOSED SWALE SCHEDULE							
SWALE #	BOTTOM WIDTH (FT)	LEFT SIDE SLOPE (H:V)	RIGHT SIDE SLOPE (H:V)	DEPTH (FT)	LINING MATERIAL	D_{50} (IN)	PLACEMENT THICKNESS (IN)
DIV_SWALE	6.0	2.5	2.0	4.0	R-3	3	9
SWALE1	6.0	3.0	3.0	2.0	TRM-435		
SWALE10	3.0	3.0	3.0	2.0	R-4	6	18
SWALE11	4.0	3.0	3.0	1.0	R-3	3	9
SWALE12	2.0	3.0	3.0	2.0	R-8	24	63
SWALE2	3.0	3.0	3.0	2.0	R-4	6	18
SWALE3	4.0	3.0	3.0	1.0	TRM-435		
SWALE4	8.0	3.0	3.0	1.0	TRM-435		
SWALE5	4.0	3.0	3.0	2.0	R-3	3	9
SWALE6	4.0	3.0	3.0	2.0	TRM-435		
SWALE7	4.0	3.0	3.0	2.0	R-4	6	18
SWALE8	2.0	3.0	3.0	1.0	R-3	3	9
SWALE9	3.0	3.0	3.0	2.0	TRM-435		

***Note: Refer to Site Plans for location of proposed swales**

PROJECT NAME:	**DIV_SWALE**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	121.59	**See attached Rational Peak Flow Calculations (Assumes Full Buildout)**
Left side slope, %	40.00	
Right side slope, %	50.00	
Bottom width, ft	6	
Channel Depth provided, ft	4	
Channel bed slope, %	0.25	
Mannings N	0.03	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	2.50	
H:V, right	2.00	
bed slope, ft/ft	0.0025	
Calculated channel flow depth, ft	2.78	
top width at flow depth, ft	18.50	
Bottom Width:Flow Depth Ratio	2.16	**Ratio Ok**
wetted area, sq. ft	34.01	
wetted peri, ft	19.69	
hyd. Radius, ft	1.73	
velocity, ft/s	3.58	
Discharge, cfs	121.59	
Theta, rad	0.002	
Froudes Number	0.38	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.43	
Protective Lining	**Riprap**	
Lining required	**R-3**	
D_{50}, inches	3	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	9	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.03	
Calculated Critical Slope,Sc ft/ft	0.01	
0.7 Sc, ft/ft	0.01	
1.3 Sc, ft/ft	0.02	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.69	
Freeboard Provided, ft	1.22	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE1**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	34.79	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	6	
Channel Depth provided, ft	2	
Channel bed slope, %	1	
Mannings N	0.06	
Accn. Due to gravity, ft/sec2	32.2	
DESIGN METHOD FOR LINING - SHEAR STRESS		
CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.01	
Calculated channel flow depth, ft	1.41	
top width at flow depth, ft	14.43	
Bottom Width:Flow Depth Ratio	4.27	**Ratio Ok**
wetted area, sq. ft	14.36	
wetted peri, ft	14.89	
hyd. Radius, ft	0.96	
velocity, ft/s	2.42	
Discharge, cfs	34.79	
Theta, rad	0.010	
Froudes Number	0.36	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.88	
Protective Lining	**Vegetated**	
Lining required	**TRM-435**	
D_{50}, inches		
Placement Thickness, inches		
Adjusted Mannings N	0.06	
Calculated Critical Slope,Sc ft/ft	0.05	
0.7 Sc, ft/ft	0.04	
1.3 Sc, ft/ft	0.07	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	0.59	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE2**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	38.59	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	3	
Channel Depth provided, ft	2	
Channel bed slope, %	2	
Mannings N	0.05	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.02	
Calculated channel flow depth, ft	1.34	
top width at flow depth, ft	11.04	
Bottom Width:Flow Depth Ratio	2.24	**Ratio Ok**
wetted area, sq. ft	9.41	
wetted peri, ft	11.48	
hyd. Radius, ft	0.82	
velocity, ft/s	4.10	
Discharge, cfs	38.59	
Theta, rad	0.020	
Froudes Number	0.62	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	1.67	
Protective Lining	**Riprap**	
Lining required	**R-4**	
D_{50}, inches	6	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	18	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.05	
Calculated Critical Slope,Sc ft/ft	0.03	
0.7 Sc, ft/ft	0.02	
1.3 Sc, ft/ft	0.04	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	0.66	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE3**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	5.99	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	4	
Channel Depth provided, ft	1	
Channel bed slope, %	3.47	
Mannings N	0.06	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.0347	
Calculated channel flow depth, ft	0.47	
top width at flow depth, ft	6.82	
Bottom Width:Flow Depth Ratio	8.52	**Ratio Ok**
wetted area, sq. ft	2.54	
wetted peri, ft	6.97	
hyd. Radius, ft	0.36	
velocity, ft/s	2.36	
Discharge, cfs	5.99	
Theta, rad	0.035	
Froudes Number	0.61	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	1.02	
Protective Lining	**Vegetated**	
Lining required	**TRM-435**	
D_{50}, inches		
Placement Thickness, inches		
Adjusted Mannings N	0.05	
Calculated Critical Slope,Sc ft/ft	0.06	
0.7 Sc, ft/ft	0.04	
1.3 Sc, ft/ft	0.07	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	0.53	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE4**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	15.79	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	8	
Channel Depth provided, ft	1	
Channel bed slope, %	1.87	
Mannings N	0.06	
Accn. Due to gravity, ft/sec2	32.2	
DESIGN METHOD FOR LINING - SHEAR STRESS		
CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.0187	
Calculated channel flow depth, ft	0.68	
top width at flow depth, ft	12.10	
Bottom Width:Flow Depth Ratio	11.71	**Ratio Ok**
wetted area, sq. ft	6.87	
wetted peri, ft	12.32	
hyd. Radius, ft	0.56	
velocity, ft/s	2.30	
Discharge, cfs	15.79	
Theta, rad	0.019	
Froudes Number	0.49	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.80	
Protective Lining	**Vegetated**	
Lining required	**TRM-435**	
D_{50}, inches		
Placement Thickness, inches		
Adjusted Mannings N	0.06	
Calculated Critical Slope,Sc ft/ft	0.06	
0.7 Sc, ft/ft	0.04	
1.3 Sc, ft/ft	0.07	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	0.32	**Check Freeboard**

PROJECT NAME:	**SWALE5**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	6.09	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	4	
Channel Depth provided, ft	2	
Channel bed slope, %	1.87	
Mannings N	0.04	
Accn. Due to gravity, ft/sec2	32.2	
DESIGN METHOD FOR LINING - SHEAR STRESS		
CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.0187	
Calculated channel flow depth, ft	0.45	
top width at flow depth, ft	6.69	
Bottom Width:Flow Depth Ratio	8.91	**Ratio Ok**
wetted area, sq. ft	2.40	
wetted peri, ft	6.84	
hyd. Radius, ft	0.35	
velocity, ft/s	2.54	
Discharge, cfs	6.09	
Theta, rad	0.019	
Froudes Number	0.67	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.52	
Protective Lining	**Riprap**	
Lining required	**R-3**	
D_{50}, inches	3	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	9	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.04	
Calculated Critical Slope,Sc ft/ft	0.04	
0.7 Sc, ft/ft	0.03	
1.3 Sc, ft/ft	0.06	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	1.55	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE6**	
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**	
PREPARED BY:	**DATE:**	**3/1/2017**
CHECKED BY:	**DATE:**	**3/1/2017**

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	4.55	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	4	
Channel Depth provided, ft	2	
Channel bed slope, %	1.73	
Mannings N	0.07	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.0173	
Calculated channel flow depth, ft	0.53	
top width at flow depth, ft	7.19	
Bottom Width:Flow Depth Ratio	7.52	**Ratio Ok**
wetted area, sq. ft	2.98	
wetted peri, ft	7.36	
hyd. Radius, ft	0.40	
velocity, ft/s	1.53	
Discharge, cfs	4.55	
Theta, rad	0.017	
Froudes Number	0.37	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.57	
Protective Lining	**Vegetated**	
Lining required	**TRM-435**	
D_{50}, inches		
Placement Thickness, inches		
Adjusted Mannings N	0.07	
Calculated Critical Slope,Sc ft/ft	0.09	
0.7 Sc, ft/ft	0.06	
1.3 Sc, ft/ft	0.11	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	1.47	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE7**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	22.37	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	4	
Channel Depth provided, ft	2	
Channel bed slope, %	3.09	
Mannings N	0.05	
Accn. Due to gravity, ft/sec2	32.2	
DESIGN METHOD FOR LINING - SHEAR STRESS		
CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.0309	
Calculated channel flow depth, ft	0.89	
top width at flow depth, ft	9.32	
Bottom Width:Flow Depth Ratio	4.51	**Ratio Ok**
wetted area, sq. ft	5.91	
wetted peri, ft	9.61	
hyd. Radius, ft	0.61	
velocity, ft/s	3.79	
Discharge, cfs	22.37	
Theta, rad	0.031	
Froudes Number	0.71	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	1.71	
Protective Lining	**Riprap**	
Lining required	**R-4**	
D_{50}, inches	6	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	18	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.05	
Calculated Critical Slope,Sc ft/ft	0.05	
0.7 Sc, ft/ft	0.03	
1.3 Sc, ft/ft	0.06	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	1.11	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE8**	
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**	
PREPARED BY:	**DATE:**	**3/1/2017**
CHECKED BY:	**DATE:**	**3/1/2017**

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	9.68	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	2	
Channel Depth provided, ft	1	
Channel bed slope, %	1	
Mannings N	0.04	
Accn. Due to gravity, ft/sec2	32.2	
DESIGN METHOD FOR LINING - SHEAR STRESS		
CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.01	
Calculated channel flow depth, ft	0.86	
top width at flow depth, ft	7.18	
Bottom Width:Flow Depth Ratio	2.32	**Ratio Ok**
wetted area, sq. ft	3.96	
wetted peri, ft	7.46	
hyd. Radius, ft	0.53	
velocity, ft/s	2.44	
Discharge, cfs	9.68	
Theta, rad	0.010	
Froudes Number	0.46	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.54	
Protective Lining	**Riprap**	
Lining required	**R-3**	
D_{50}, inches	3	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	9	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.04	
Calculated Critical Slope,Sc ft/ft	0.03	
0.7 Sc, ft/ft	0.02	
1.3 Sc, ft/ft	0.04	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	0.14	**Check Freeboard**

PROJECT NAME:	**SWALE9**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	5.67	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	3	
Channel Depth provided, ft	2	
Channel bed slope, %	0.7	
Mannings N	0.08	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.007	
Calculated channel flow depth, ft	0.90	
top width at flow depth, ft	8.42	
Bottom Width:Flow Depth Ratio	3.32	**Ratio Ok**
wetted area, sq. ft	5.16	
wetted peri, ft	8.72	
hyd. Radius, ft	0.59	
velocity, ft/s	1.10	
Discharge, cfs	5.67	
Theta, rad	0.007	
Froudes Number	0.20	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.39	
Protective Lining	**Vegetated**	
Lining required	**TRM-435**	
D_{50}, inches		
Placement Thickness, inches		
Adjusted Mannings N	0.08	
Calculated Critical Slope,Sc ft/ft	0.12	
0.7 Sc, ft/ft	0.08	
1.3 Sc, ft/ft	0.15	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	1.10	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE10**	
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**	
PREPARED BY:	**DATE:**	**3/1/2017**
CHECKED BY:	**DATE:**	**3/1/2017**

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	3.97	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	3	
Channel Depth provided, ft	2	
Channel bed slope, %	5.93	
Mannings N	0.07	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.0593	
Calculated channel flow depth, ft	0.40	
top width at flow depth, ft	5.41	
Bottom Width:Flow Depth Ratio	7.47	**Ratio Ok**
wetted area, sq. ft	1.69	
wetted peri, ft	5.54	
hyd. Radius, ft	0.30	
velocity, ft/s	2.35	
Discharge, cfs	3.97	
Theta, rad	0.059	
Froudes Number	0.65	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	1.49	
Protective Lining	**Riprap**	
Lining required	**R-4**	
D_{50}, inches	6	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	18	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.07	
Calculated Critical Slope,Sc ft/ft	0.11	
0.7 Sc, ft/ft	0.08	
1.3 Sc, ft/ft	0.15	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	1.60	**Freeboard Ok, Calculated<Provided**

PROJECT NAME:	**SWALE11**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	15.49	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	4	
Channel Depth provided, ft	1	
Channel bed slope, %	1.27	
Mannings N	0.04	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

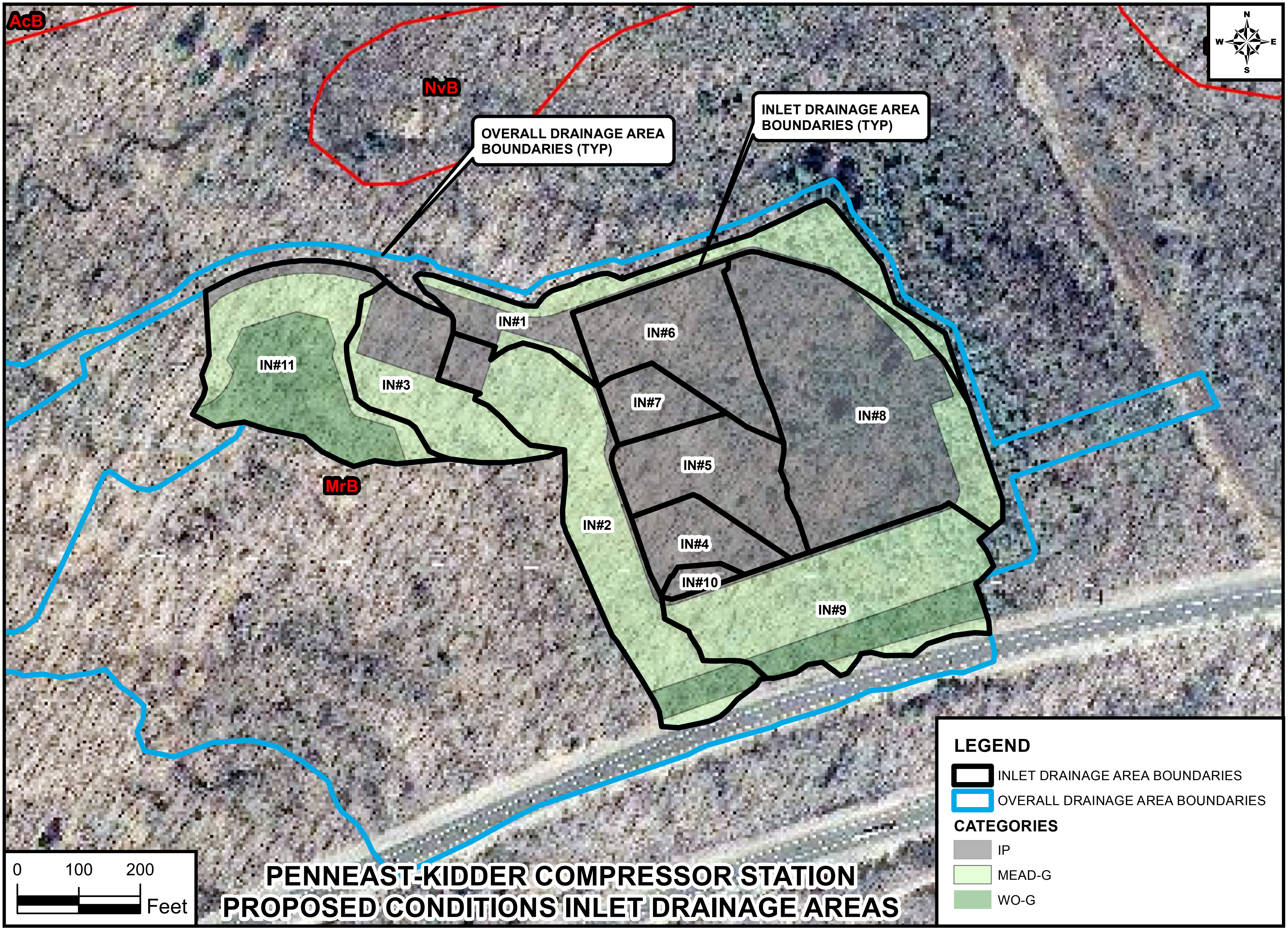
CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.0127	
Calculated channel flow depth, ft	0.82	
top width at flow depth, ft	8.93	
Bottom Width:Flow Depth Ratio	4.86	**Ratio Ok**
wetted area, sq. ft	5.32	
wetted peri, ft	9.20	
hyd. Radius, ft	0.58	
velocity, ft/s	2.91	
Discharge, cfs	15.49	
Theta, rad	0.013	
Froudes Number	0.57	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	0.65	
Protective Lining	**Riprap**	
Lining required	**R-3**	
D_{50}, inches	3	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	9	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.04	
Calculated Critical Slope,Sc ft/ft	0.03	
0.7 Sc, ft/ft	0.02	
1.3 Sc, ft/ft	0.03	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	0.18	**Check Freeboard**

PROJECT NAME:	**SWALE12**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/1/2017**	
CHECKED BY:	**DATE:**	**3/1/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	64.21	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	2	
Channel Depth provided, ft	2	
Channel bed slope, %	4.4	
Mannings N	0.08	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.044	
Calculated channel flow depth, ft	1.97	
top width at flow depth, ft	13.84	
Bottom Width:Flow Depth Ratio	1.01	**Ratio Ok**
wetted area, sq. ft	15.62	
wetted peri, ft	14.48	
hyd. Radius, ft	1.08	
velocity, ft/s	4.11	
Discharge, cfs	64.21	
Theta, rad	0.044	
Froudes Number	0.52	
Flow type	subcritical	
Shear Stress, Lb/Sq.Ft	5.42	
Protective Lining	**Riprap**	
Lining required	**R-8**	
D_{50}, inches	24	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	63	**Per PA E&S Manual Chapter 6**
Adjusted Mannings N	0.08	
Calculated Critical Slope,Sc ft/ft	0.10	
0.7 Sc, ft/ft	0.07	
1.3 Sc, ft/ft	0.13	
Stable Flow?	Stable	
Calculated Freeboard, ft	0.50	
Freeboard Provided, ft	0.03	**Check Freeboard**



PENNEAST-KIDDER COMPRESSOR STATION
PROPOSED CONDITIONS INLET DRAINAGE AREAS

PENNEAST-KIDDER COMPRESSOR STATION									
PROPOSED CONDITIONS RUNOFF COEFFICIENT CALCULATIONS FOR PIPE CAPACITY ANALYSIS									
ID	**DA**	**Cover**	**Soils**	**HSG**	**Area**	**Area (Acres)**	**CN**	**CN*A**	**Weighted CN**
12	IN#1	IP	MrB	D	17511.086	0.402	0.99	0.398	0.99
13	IN#1	MEAD-G	MrB	D	33758.022	0.775	0.65	0.504	0.65
	IN#1 Total					**1.177**		**0.902**	**0.77**
5	IN#10	IP	MrB	D	4220.211	0.097	0.99	0.096	0.99
	IN#10 Total					**0.097**		**0.096**	**0.99**
16	IN#11	IP	MrB	D	7315.615	0.168	0.99	0.166	0.99
18	IN#11	MEAD-G	MrB	D	27677.521	0.635	0.65	0.413	0.65
17	IN#11	WO-G	MrB	D	42039.335	0.965	0.59	0.569	0.59
	IN#11 Total					**1.768**		**1.149**	**0.65**
8	IN#2	IP	MrB	D	137.124	0.003	0.99	0.003	0.99
9	IN#2	IP	MrB	D	7101.989	0.163	0.99	0.161	0.99
7	IN#2	MEAD-G	MrB	D	8007.424	0.184	0.65	0.119	0.65
11	IN#2	MEAD-G	MrB	D	130641.659	2.999	0.65	1.949	0.65
10	IN#2	WO-G	MrB	D	27954.510	0.642	0.59	0.379	0.59
	IN#2 Total					**3.991**		**2.612**	**0.65**
14	IN#3	IP	MrB	D	10357.240	0.238	0.99	0.235	0.99
15	IN#3	MEAD-G	MrB	D	33808.746	0.776	0.65	0.504	0.65
	IN#3 Total					**1.014**		**0.740**	**0.73**
6	IN#4	IP	MrB	D	20663.003	0.474	0.99	0.470	0.99
	IN#4 Total					**0.474**		**0.470**	**0.99**
4	IN#5	IP	MrB	D	40448.814	0.929	0.99	0.919	0.99
	IN#5 Total					**0.929**		**0.919**	**0.99**
2	IN#6	IP	MrB	D	47316.124	1.086	0.99	1.075	0.99
	IN#6 Total					**1.086**		**1.075**	**0.99**
3	IN#7	IP	MrB	D	15316.563	0.352	0.99	0.348	0.99
	IN#7 Total					**0.352**		**0.348**	**0.99**
0	IN#8	IP	MrB	D	111747.081	2.565	0.99	2.540	0.99
1	IN#8	MEAD-G	MrB	D	16577.462	0.381	0.65	0.247	0.65
	IN#8 Total					**2.946**		**2.787**	**0.95**
	Grand Total					**13.834**		**11.098**	**0.80**

The "RC" value is an area averaged runoff coefficient value (arithmatic mean) calculated as:

$$RC=\frac{\sum_{i=1}^{n} C_i \ x \ Area_i}{\sum_{i=1}^{n} Area_i}$$

PENNEAST-KIDDER COMPRESSOR STATION
RATIONAL METHOD PEAK FLOW CALCULATIONS FOR PIPE CAPACITY ANALYSIS

Return Period (Yrs) 100
Min. Time of Concentration (mins) 5 **(Unless otherwise noted below)**

DA	Area (Acres)	RC	Tc (mins)	Rainfall Intensity (in/hr)	Q (cfs)
IN#1	1.177	0.77	5.00	8.1	7.304
IN#10	0.097	0.99	5.00	8.1	0.777
IN#11	1.768	0.65	17.72	5.3	6.088
IN#2	3.991	0.65	5.00	8.1	21.158
IN#3	1.014	0.73	5.00	8.1	5.993
IN#4	0.474	0.99	5.00	8.1	3.804
IN#5	0.929	0.99	5.00	8.1	7.446
IN#6	1.086	0.99	5.00	8.1	8.710
IN#7	0.352	0.99	5.00	8.1	2.820
IN#8	2.946	0.95	5.00	8.1	22.575

TOTAL FLOW FOR IN#2	ADD
IN#2	21.158
IN#7	2.820
IN#5	7.446
IN#4	3.804
IN#10	0.777
TOTAL	**36.004**

TOTAL FLOW FOR MH#1	ADD
IN#6	8.710
IN#2	21.158
IN#7	2.820
IN#5	7.446
IN#4	3.804
IN#10	0.777
TOTAL	**44.715**

TOTAL FLOW FOR IN#1	ADD
IN#1	7.304
IN#8	22.575
TOTAL	**29.879**

TOTAL FLOW FOR MH#6	ADD
IN#6	8.710
IN#2	21.158
IN#7	2.820
IN#5	7.446
IN#4	3.804
IN#10	0.777
IN#1	7.304
IN#8	22.575
TOTAL	**74.594**

TOTAL FLOW FOR MH#3	ADD
IN#6	8.710
IN#2	21.158
IN#7	2.820
IN#5	7.446
IN#4	3.804
IN#10	0.777
IN#1	7.304
IN#8	22.575
IN#3	5.993
TOTAL	**80.587**

***Note: Total flows at MH#4 and MH#2 are same as MH#3 as there are no flow inputs at these locations**

TOTAL FLOW FOR MH#5	ADD
IN#6	8.710
IN#2	21.158
IN#7	2.820
IN#5	7.446
IN#4	3.804
IN#10	0.777
IN#1	7.304
IN#8	22.575
IN#3	5.993
IN#11	6.088
TOTAL	**86.675**

PENNEAST-KIDDER COMPRESSOR STATION
PROPOSED DRAINAGE PIPES CAPACITY ANALYSIS

Pipe ID	P#16
Upstream Str	IN#10
Downstream Str	FA#4
peak Discharge, cfs	0.78
Pipe Diamater, in	15.00
Manning's N	0.013
% Slope	0.50
diameter of pipe, d, ft	1.25
wetted area, sf =	1.23
wetted perimeter, P, ft =	3.93
R =	0.31
Slope, ft/ft =	0.005
Full Flow Velocity, ft/s =	**3.73**
Full Flow Q, cfs =	**4.58**

Capacity Ok

Pipe ID	P#26
Upstream Str	MH#6
Downstream Str	MH#3
peak Discharge, cfs	74.59
Pipe Diamater, in	33.00
Manning's N	0.013
% Slope	2.50
diameter of pipe, d, ft	2.75
wetted area, sf =	5.94
wetted perimeter, P, ft =	8.64
R =	0.69
Slope, ft/ft =	0.025
Full Flow Velocity, ft/s =	**14.12**
Full Flow Q, cfs =	**83.85**

Capacity Ok

Pipe ID	P#9
Upstream Str	IN#5
Downstream Str	FA#2
peak Discharge, cfs	7.45
Pipe Diamater, in	18.00
Manning's N	0.013
% Slope	0.50
diameter of pipe, d, ft	1.5
wetted area, sf =	1.77
wetted perimeter, P, ft =	4.71
R =	0.38
Slope, ft/ft =	0.005
Full Flow Velocity, ft/s =	**4.21**
Full Flow Q, cfs =	**7.45**

Capacity Ok

Pipe ID	P#3
Upstream Str	IN#4
Downstream Str	FA#1
peak Discharge, cfs	3.80
Pipe Diamater, in	15.00
Manning's N	0.013
% Slope	0.50
diameter of pipe, d, ft	1.25
wetted area, sf =	1.23
wetted perimeter, P, ft =	3.93
R =	0.31
Slope, ft/ft =	0.005
Full Flow Velocity, ft/s =	**3.73**
Full Flow Q, cfs =	**4.58**

Capacity Ok

Pipe ID	P#11
Upstream Str	IN#7
Downstream Str	FA#3
peak Discharge, cfs	2.82
Pipe Diamater, in	15.00
Manning's N	0.013
% Slope	0.50
diameter of pipe, d, ft	1.25
wetted area, sf =	1.23
wetted perimeter, P, ft =	3.93
R =	0.31
Slope, ft/ft =	0.005
Full Flow Velocity, ft/s =	**3.73**
Full Flow Q, cfs =	**4.58**

Capacity Ok

Pipe ID	P#10
Upstream Str	IN#6
Downstream Str	MH#1
peak Discharge, cfs	8.71
Pipe Diamater, in	18.00
Manning's N	0.013
% Slope	1.25
diameter of pipe, d, ft	1.5
wetted area, sf =	1.77
wetted perimeter, P, ft =	4.71
R =	0.38
Slope, ft/ft =	0.0125
Full Flow Velocity, ft/s =	**6.66**
Full Flow Q, cfs =	**11.78** Capacity Ok

Pipe ID	P#5
Upstream Str	IN#2
Downstream Str	MH#1
peak Discharge, cfs	36.00
Pipe Diamater, in	30.00
Manning's N	0.013
% Slope	0.89
diameter of pipe, d, ft	2.5
wetted area, sf =	4.91
wetted perimeter, P, ft =	7.85
R =	0.63
Slope, ft/ft =	0.0089
Full Flow Velocity, ft/s =	**7.90**
Full Flow Q, cfs =	**38.80** Capacity Ok

Pipe ID	P#4
Upstream Str	MH#1
Downstream Str	MH#3
peak Discharge, cfs	44.72
Pipe Diamater, in	30.00
Manning's N	0.013
% Slope	1.27
diameter of pipe, d, ft	2.5
wetted area, sf =	4.91
wetted perimeter, P, ft =	7.85
R =	0.63
Slope, ft/ft =	0.0127
Full Flow Velocity, ft/s =	**9.44**
Full Flow Q, cfs =	**46.35** Capacity Ok

Pipe ID	P#15
Upstream Str	IN#3
Downstream Str	MH#3
peak Discharge, cfs	5.99
Pipe Diamater, in	18.00
Manning's N	0.013
% Slope	0.50
diameter of pipe, d, ft	1.5
wetted area, sf =	1.77
wetted perimeter, P, ft =	4.71
R =	0.38
Slope, ft/ft =	0.005
Full Flow Velocity, ft/s =	**4.21**
Full Flow Q, cfs =	**7.45** Capacity Ok

Pipe ID	P#6
Upstream Str	IN#1
Downstream Str	MH#3
peak Discharge, cfs	29.88
Pipe Diamater, in	27.00
Manning's N	0.013
% Slope	1.50
diameter of pipe, d, ft	2.25
wetted area, sf =	3.98
wetted perimeter, P, ft =	7.07
R =	0.56
Slope, ft/ft =	0.015
Full Flow Velocity, ft/s =	**9.57**
Full Flow Q, cfs =	**38.03**

Capacity Ok

Pipe ID	P#7
Upstream Str	MH#3
Downstream Str	MH#4
peak Discharge, cfs	80.59
Pipe Diamater, in	48.00
Manning's N	0.013
% Slope	1.00
diameter of pipe, d, ft	4
wetted area, sf =	12.57
wetted perimeter, P, ft =	12.57
R =	1.00
Slope, ft/ft =	0.01
Full Flow Velocity, ft/s =	**11.46**
Full Flow Q, cfs =	**144.03**

Capacity Ok

Pipe ID	P#17
Upstream Str	IN#11
Downstream Str	MH#5
peak Discharge, cfs	6.09
Pipe Diamater, in	24.00
Manning's N	0.013
% Slope	0.50
diameter of pipe, d, ft	2
wetted area, sf =	3.14
wetted perimeter, P, ft =	6.28
R =	0.50
Slope, ft/ft =	0.005
Full Flow Velocity, ft/s =	**5.11**
Full Flow Q, cfs =	**16.04**

Capacity Ok

OUTFALLS TO SOUTH-BASIN

Pipe ID	P#18
Upstream Str	MH#5
Downstream Str	HW#3
peak Discharge, cfs	86.68
Pipe Diamater, in	48.00
Manning's N	0.013
% Slope	1.00
diameter of pipe, d, ft	4
wetted area, sf =	12.57
wetted perimeter, P, ft =	12.57
R =	1.00
Slope, ft/ft =	0.01
Full Flow Velocity, ft/s =	**11.46**
Full Flow Q, cfs =	**144.03**

Capacity Ok

PROJECT NAME:	**EMERGENCY SPILLWAY NORTH**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/2/2017**	
CHECKED BY:	**DATE:**	**3/2/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	18.25	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	25	
Channel Depth provided, ft	1	
Channel bed slope, %	33.33	
Mannings N	0.04	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.3333	
Calculated channel flow depth, ft	0.13	
top width at flow depth, ft	25.79	
Bottom Width:Flow Depth Ratio	190.80	
wetted area, sq. ft	3.33	
wetted peri, ft	25.83	
hyd. Radius, ft	0.13	
velocity, ft/s	5.49	
Discharge, cfs	18.25	
Theta, rad	0.322	
Froudes Number	2.67	
Flow type	supercritical	
Shear Stress, Lb/Sq.Ft	2.73	
Protective Lining	**Riprap**	
Lining required	**R-5**	
D_{50}, inches	9	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	27	**Per PA E&S Manual Chapter 6**

PROJECT NAME:	**EMERGENCY SPILLWAY SOUTH**		
LOCATION:	**KIDDER TOWNSHIP, CARBON COUNTY PA**		
PREPARED BY:	**DATE:**	**3/2/2017**	
CHECKED BY:	**DATE:**	**3/2/2017**	

CHANNEL OR CHANNEL SECTION		
Temporary or Permanent (T or P)	P	
Required Capacity, Qr (cfs)	64.00	**See attached Rational Peak Flow Calculations**
Left side slope, %	33.33	
Right side slope, %	33.33	
Bottom width, ft	35	
Channel Depth provided, ft	1	
Channel bed slope, %	33.33	
Mannings N	0.04	
Accn. Due to gravity, ft/sec2	32.2	

DESIGN METHOD FOR LINING - SHEAR STRESS

CHECK FOR SHEAR STRESS		
H:V, left	3.00	
H:V, right	3.00	
bed slope, ft/ft	0.3333	
Calculated channel flow depth, ft	0.23	
top width at flow depth, ft	36.36	
Bottom Width:Flow Depth Ratio	154.07	
wetted area, sq. ft	8.11	
wetted peri, ft	36.44	
hyd. Radius, ft	0.22	
velocity, ft/s	7.90	
Discharge, cfs	64.00	
Theta, rad	0.322	
Froudes Number	2.92	
Flow type	supercritical	
Shear Stress, Lb/Sq.Ft	4.72	
Protective Lining	**Riprap**	
Lining required	**R-7**	
D_{50}, inches	18	**Per PA E&S Manual Chapter 6**
Placement Thickness, inches	45	**Per PA E&S Manual Chapter 6**

ANTI SEEP COLLAR CALCULATIONS

BASIN ID	PIPE SIZE (IN)	SPILLWAY INV ELEV. (FT)	MAX WATER SURFACE ELEV. (FT)	DELTA FT	EMBANKMENT ANGLE Z COMPONENT	PIPE SLOPE (FT/FT)	SATURATED ZONE PIPE LENGTH, Ls (FT)	INCREASE IN FLOW PATH, Lf (FT)	MINIMUM COLLAR PROJECTION, V min (FT)	NUMBER OF COLLARS, N	COLLAR SIDE WIDTH, S (IN)
NORTH	18	1738.00	1737.07	0.93	3	0.005	6.64	7.64	1.00	1	42
SOUTH	24	1737.25	1736.75	0.5	3	0.005	3.57	4.11	0.54	1	37

Culvert Calculator Report
TWIN_48in

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	1,742.52 ft	Headwater Depth/Height	0.84
Computed Headwater Elevation	1,737.34 ft	Discharge	97.33 cfs
Inlet Control HW Elev.	1,737.01 ft	Tailwater Elevation	1,732.00 ft
Outlet Control HW Elev.	1,737.34 ft	Control Type	Entrance Control

Grades

Upstream Invert	1,734.00 ft	Downstream Invert	1,732.00 ft
Length	65.00 ft	Constructed Slope	0.030769 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	1.34 ft
Slope Type	Steep	Normal Depth	1.19 ft
Flow Regime	Supercritical	Critical Depth	2.09 ft
Velocity Downstream	13.20 ft/s	Critical Slope	0.003949 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	2		

Outlet Control Properties

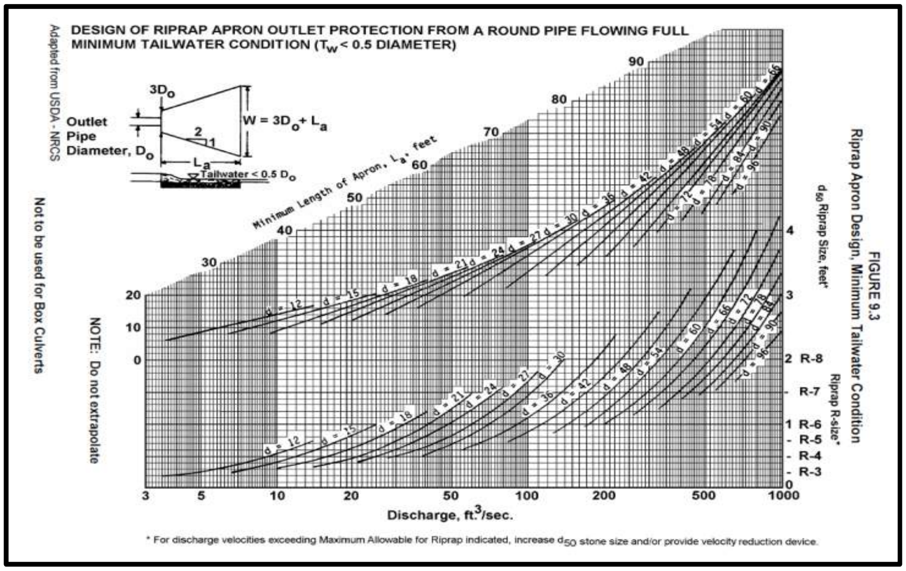
Outlet Control HW Elev.	1,737.34 ft	Upstream Velocity Head	0.83 ft
Ke	0.50	Entrance Loss	0.42 ft

Inlet Control Properties

Inlet Control HW Elev.	1,737.01 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	25.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

RIPRAP APRON
SOUTH-BASIN 48" INCOMING PIPE

Q, cfs	144.03	**(Based on 48" pipe flowing full as the 100-year discharge is a lower value)**
Inside diameter of pipe, D ft	4	



From graph above:

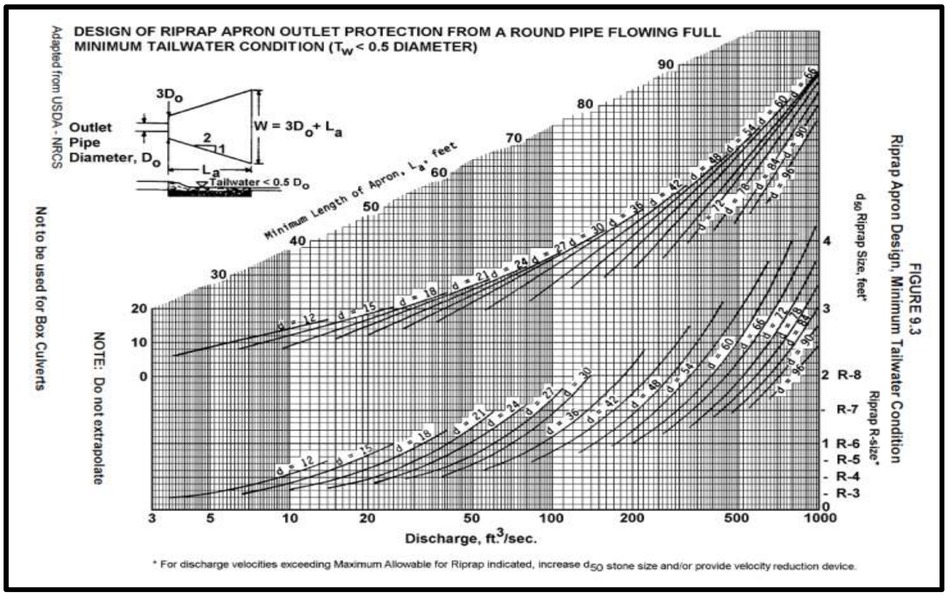
Riprap Size	R-6
D_{50}, inches	12
Apron Length, ft	30
Apron Width at pipe end, ft	12
Apron Width at downstream end, W ft	42

SIZING SUMMARY:

La, ft	**30**
W, ft	**42**
D_{50}, inches	**12**
Riprap Size	**R-6**
Placement Thickness, ft	**3**

RIPRAP APRON
TWIN 48" CROSS CULVERTS

Q, cfs	121.59	**(Refer to twin 48" headwater calculations)**
Inside diameter of pipe, D ft	4	



From graph above:

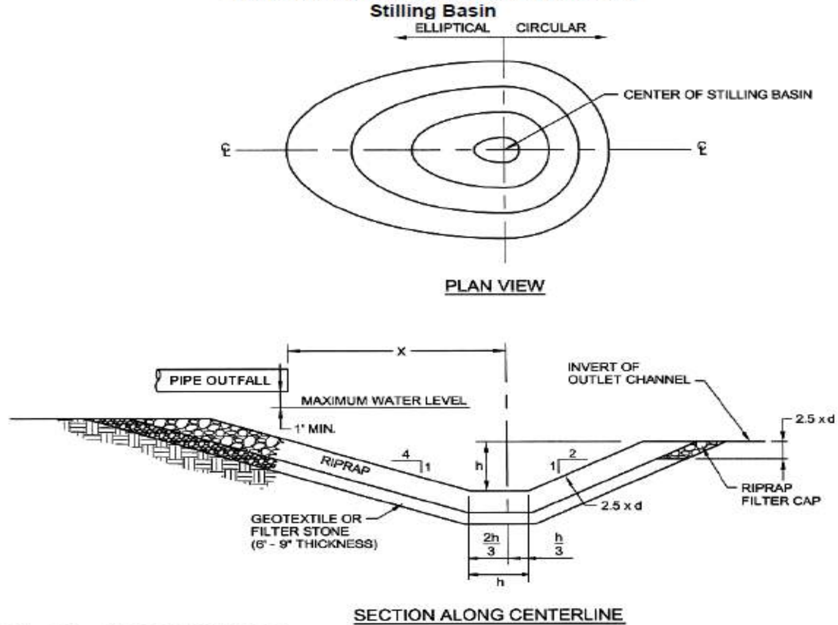
Riprap Size	R-5	
D_{50}, inches	9	
Apron Length, ft	30	
Apron Width at pipe end, ft	24	**Twin 48" pipes**
Apron Width at downstream end, W ft	54	

SIZING SUMMARY:

La, ft	**30**
W, ft	**54**
D_{50}, inches	**9**
Riprap Size	**R-5**
Placement Thickness, ft	**2.25**

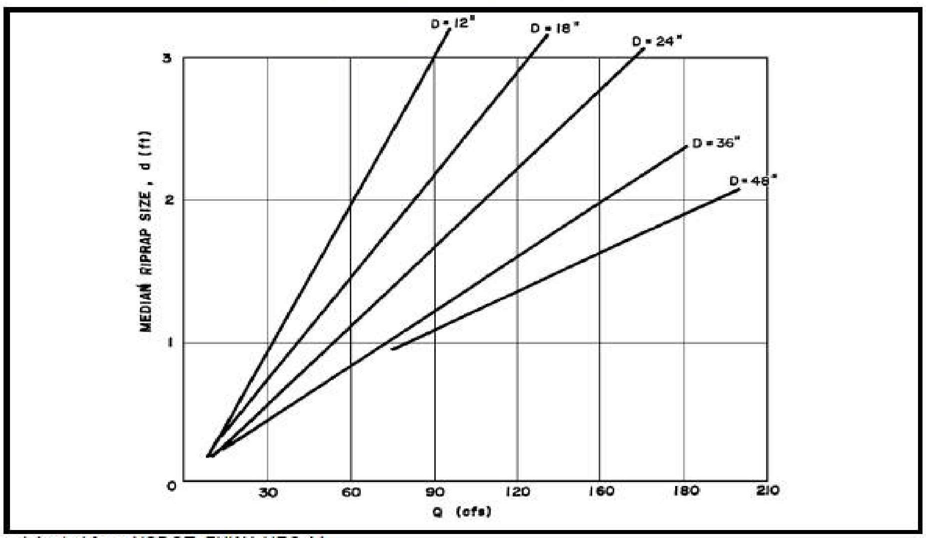
STILLING BASIN DESIGN
NORTH-BASIN OUTFALL (SB-2)

STANDARD CONSTRUCTION DETAIL # 9-4
Stilling Basin



Adapted from USDOT, FHWA HEC 14

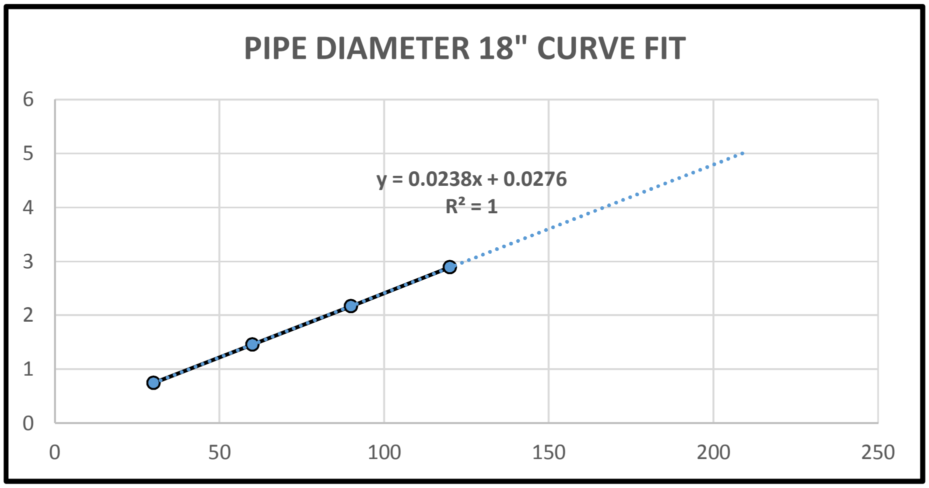
FIGURE 9.7
d_{50} Stone Size for Stilling Basins



Adapted from USDOT, FHWA HEC 14

From the Riprap Size Graph Above:

D (in)	Q (cfs)						
	30	60	90	120	160	180	210
12	0.9152	1.9724	2.973				
18	0.7436	1.4576	2.1668	2.8896			
24	0.5577	1.1144	1.6864	2.2224	2.7645		
36	0.4433	0.8294	1.2145	1.6006	1.9867	2.3753	
48			1.0858	1.3575	1.6292	1.9009	



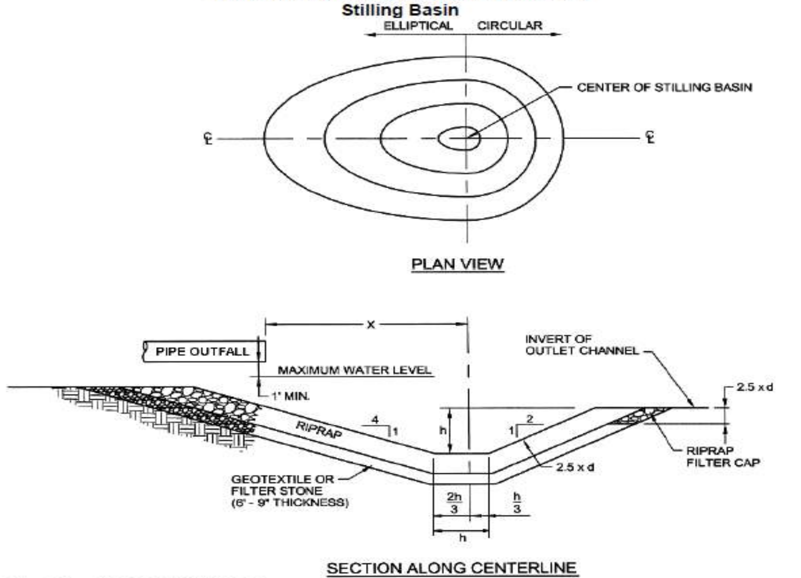
Q, cfs	6.358	**(Refer to Hydraflow Reports for 100-year basin discharge)**
Inside diameter of pipe, D ft	1.5	
D_{50}, ft	0.18	2.15 **inches**
	3	**inches**
Use Riprap size of	**0.25**	**ft**
Required basin depth, H ft	**0.99**	
Pipe Diamater, in	18.00	
Manning's N	0.013	
% Slope	0.50	
wetted area, sf =	1.77	
wetted perimeter, P, ft =	4.71	
R =	0.38	
Slope, ft/ft =	0.005	
Full Flow Velocity, ft/s =	4.21	
Depth of Water in basin, m ft	0.99	
g, ft/sec^2	32.2	
Distance between pipe crown and WS, P ft	2.5	
X, ft	**2.35**	

SIZING SUMMARY:

X, ft	**3**
H, ft	**1**
D_{50}, inches	**3**
Riprap Size	**R-3**
Placement Thickness, ft	**1**
Major Axis, Ft	**5**
Minor Axis, Ft	**2**

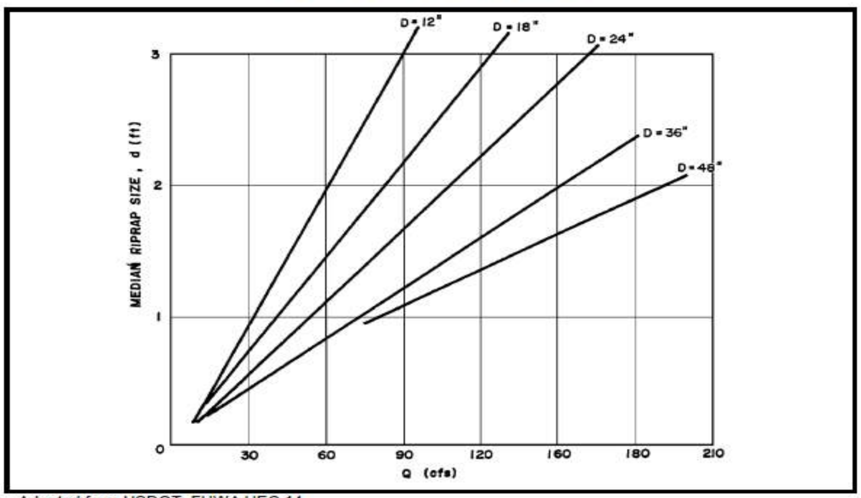
STILLING BASIN DESIGN
SOUTH-BASIN OUTFALL (SB-1)

STANDARD CONSTRUCTION DETAIL # 9-4
Stilling Basin



Adapted from USDOT, FHWA HEC 14

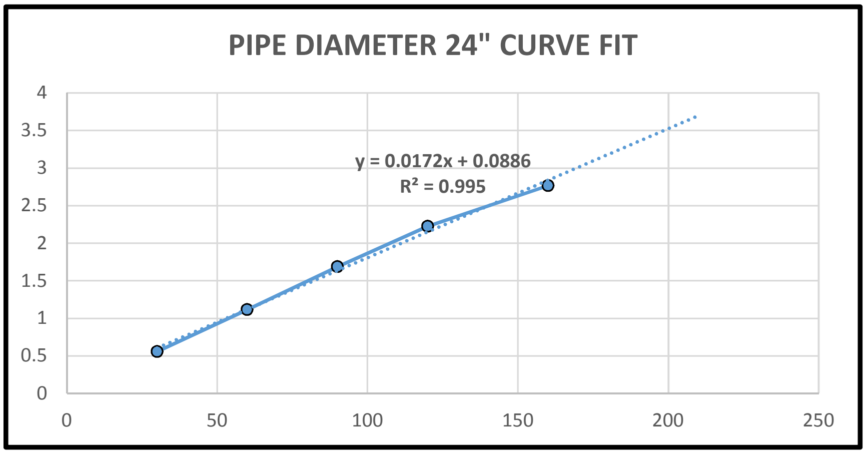
FIGURE 9.7
d_{50} Stone Size for Stilling Basins



Adapted from USDOT, FHWA HEC 14

From the Riprap Size Graph Above:

D (in)	Q (cfs)						
	30	**60**	**90**	**120**	**160**	**180**	**210**
12	0.9152	1.9724	2.973				
18	0.7436	1.4576	2.1668	2.8896			
24	0.5577	1.1144	1.6864	2.2224	2.7645		
36	0.4433	0.8294	1.2145	1.6006	1.9867	2.3753	
48			1.0858	1.3575	1.6292	1.9009	



Q, cfs	73.89	**(Refer to Hydraflow Reports for 100-year basin discharge)**
Inside diameter of pipe, D ft	2	
D_{50}, ft	1.36	16.31 **inches**
	18	**inches**
Use Riprap size of	**1.50**	**ft**
Required basin depth, H ft	**1.82**	
Pipe Diamater, in	24.00	
Manning's N	0.013	
% Slope	0.50	
wetted area, sf =	3.14	
wetted perimeter, P, ft =	6.28	
R =	0.50	
Slope, ft/ft =	0.005	
Full Flow Velocity, ft/s =	5.11	
Depth of Water in basin, m ft	1.82	
g, ft/sec^2	32.2	
Distance between pipe crown and WS, P ft	2.5	
X, ft	**3.24**	

SIZING SUMMARY:

X, ft	**4**
H, ft	**2**
D_{50}, inches	**18**
Riprap Size	**R-7**
Placement Thickness, ft	**4**
Major Axis, Ft	**10**
Minor Axis, Ft	**5**

***Note: Outfall for South-Basin consists of three 24" barrels. Outfall protection will require three stilling basins. As such, the width has to be adjusted as below.**

Revised Major Axis, Ft	**10**
Revised Minor Axis, Ft	**15**

Swale ID	Outfall Discharge Q cuft/sec	Swale Depth D ft	TW Depth TW ft	D_{50} Calculated in	D_{50} Accepted in	Riprap Size	Apron Length L ft	Apron Depth H in
Swale 6	4.46	2.2	0.1	0.51	3.00	R-3	9	9
Swale 9	5.5	3.1	0.1	0.42	3.00	R-3	13	9

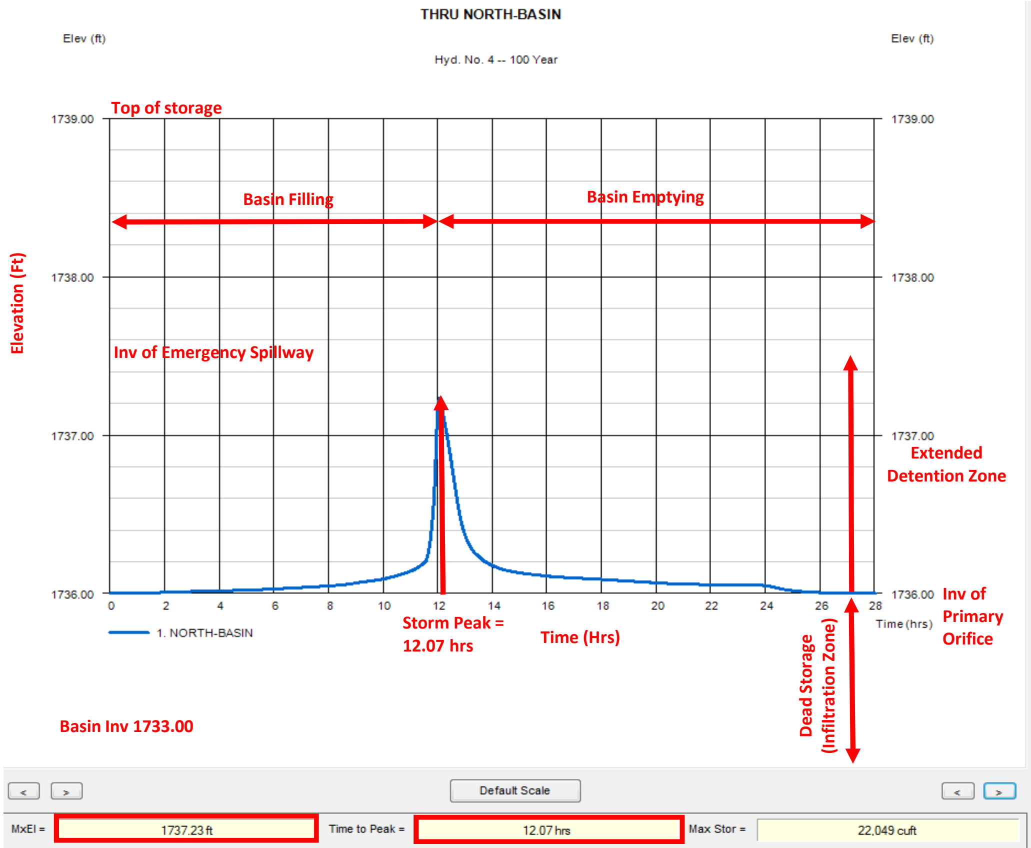
BASIN DEWATERING TIME CALCULATIONS
INFILTRATION BASIN NORTH

BASIN NAME	BASIN	
KTP-1	0.88	
KTP-2	1.6	
AVERAGE, IN/HR	1.24	
FOS	**3.00**	***BASIN FLOOD TEST HAS SAFETY FACTOR BUILT IN*
DESIGN RATE, IN/HR	**0.41**	

INFILTRATION OF STORAGE VOLUME BELOW PRIMARY ORIFICE

Basin Bottom Elevation, ft	1735.00	
Primary Orifice Elevation, ft	1736.00	
Depth Below Primary Orifice, ft	1.00	
DRAIN TIME (1)	**2.42**	***DRAIN TIME FOR DEAD STORAGE BELOW PRIMARY ORIFICE***

INFILTRATION OF STORAGE VOLUME ABOVE PRIMARY ORIFICE (THROUGH OUTLET STR)



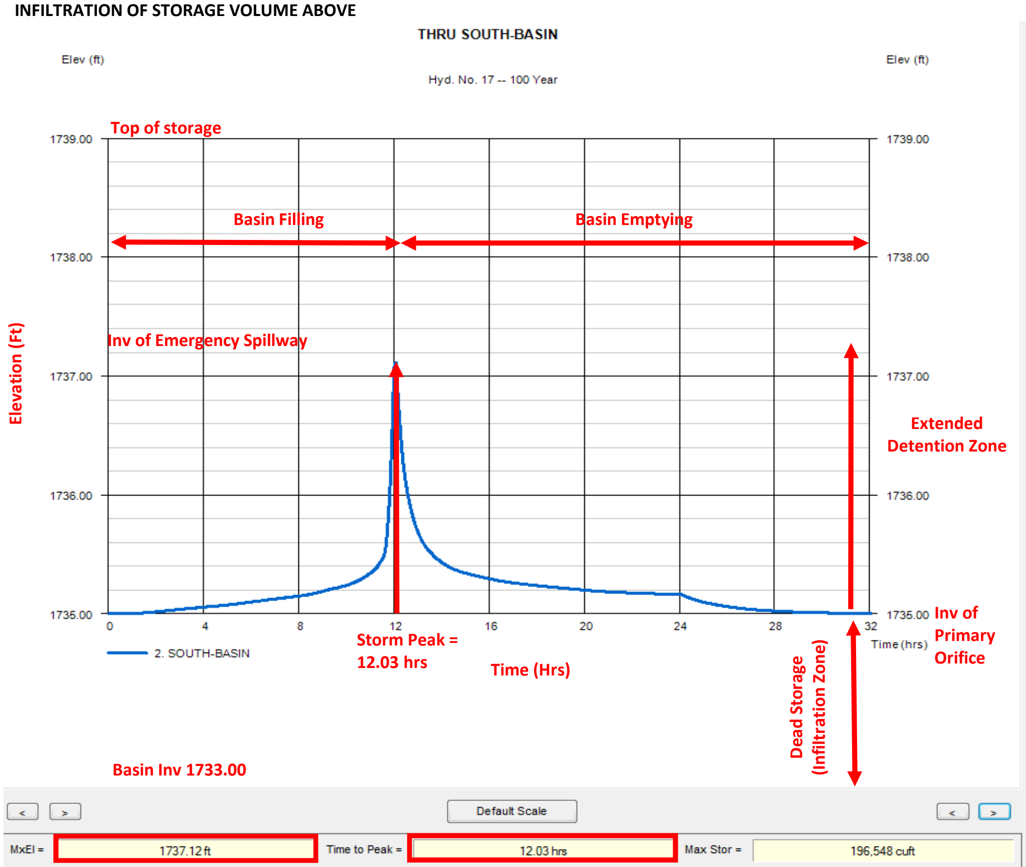
Time (hrs)	Elev (ft)
25.77	1736.01
25.80	1736.01
25.83	1736.01
25.87	1736.01
25.90	1736.01
25.93	1736.01
25.97	1736.01
26.00	1736.01
26.03	1736.01
26.07	1736.01
26.10	1736.01
26.13	1736.00
26.17	1736.00
26.20	1736.00
26.23	1736.00
26.27	1736.00
26.30	1736.00
26.33	1736.00
26.37	1736.00
26.40	1736.00
26.43	1736.00
26.47	1736.00
26.50	1736.00
26.53	1736.00
26.57	1736.00
26.60	1736.00
26.63	1736.00
26.67	1736.00

DRAIN TIME (2)	**14.06**	***DRAIN TIME FROM 100-YEAR STORM PEAK TO DEAD STORAGE ELEVATION***
TOTAL DRAIN TIME	**16.48**	

DEWATERING TIME CALCULATIONS
INFILTRATION BASIN SOUTH

BASIN NAME	**BASIN**	
KTP-3	1.25	
KTP-4	1	
KTP-5	3.12	
KTP-6	1.40	***BASIN FLOOD TEST HAS SAFETY FACTOR BUILT IN**
KTP-7	1.25	
KTP-8	1.50	
AVERAGE, IN/HR	1.59	
FOS	**3.00**	***DRAIN TIME FOR DEAD STORAGE BELOW PRIMARY ORIFICE***

DESIGN RATE, IN/HR	**0.53**
INFILTRATION OF STORAGE VOLUME BELOW	
Basin Bottom Elevation, ft	1733.00
Primary Orifice Elevation, ft	1735.00
Depth Below Primary Orifice, ft	2.00
DRAIN TIME (1)	**3.78**
INFILTRATION OF STORAGE VOLUME ABOVE	



Time (hrs)	Elev (ft)
30.73	1735.01
30.77	1735.01
30.80	1735.01
30.83	1735.01
30.87	1735.01
30.90	1735.01
30.93	1735.01
30.97	1735.01
31.00	1735.01
31.03	1735.01
31.07	1735.01
31.10	1735.01
31.13	1735.01
31.17	1735.01
31.20	1735.01
31.23	1735.01
31.27	1735.01
31.30	1735.00
31.33	1735.00
31.37	1735.00
31.40	1735.00
31.43	1735.00
31.47	1735.00
31.50	1735.00
31.53	1735.00
31.57	1735.00
31.60	1735.00
31.63	1735.00

DRAIN TIME (2)	**19.27**
TOTAL DRAIN TIME	**23.05**

D. Standard E&S Worksheet #22

STANDARD E&S WORKSHEET # 22
PLAN PREPARER RECORD OF TRAINING AND EXPERIENCE IN EROSION AND SEDIMENT POLLUTION CONTROL METHODS AND TECHNIQUES

NAME OF PLAN PREPARER: MICHAEL DENICHILO

FORMAL EDUCATION:

Name of College or Technical Institute: VILLANOVA UNIVERSITY

Curriculum or Program: CIVIL AND ENVIRONMENTAL ENGINEERING (BS)
WATER RESOURCES AND ENVIRONMENTAL ENGINEERING (MS)

Dates of Attendance: **From:** 2004 / 2009 **To:** 2008 / 2011

Degree Received BACHELOR OF SCIENCE / MASTER OF SCIENCE

OTHER TRAINING:

Name of Training:	FEDERAL ENERGY REGULATORY COMMISSION (FERC) - ENVIRONMENTAL REVIEW AND COMPLIANCE FOR NATURAL GAS FACILITIES	GAS TECHNOLOGY INSTITUTE (GTI) - TRANSMISSION PIPELINE DESIGN & CONSTRUCTION PRACTICES
Presented By:	DAVID HANOBIC / DANNY LAFFOON / MAGGIE SUTER / LARRY BROWN / TIM DRAKE / JENNIFER LEE / MIKE TIMPSON / JANELLE RIELAND / JOE HOLLER	GUS / BILL
Date:	MARCH 7-9, 2017	NOVEMBER 6-10, 2017

EMPLOYMENT HISTORY:

Current Employer: MOTT MACDONALD

Telephone: (973) 379-3400

Former Employer: N/A

Telephone: N/A

RECENT E&S PLANS PREPARED:

Name of Project:	Rahway River Pipe Replacement	Rivervale to Market Project	
County:	Union County, NJ	Bergen County, NJ	
Municipality:	Linden	Carlstadt / River Vale / Emerson / Paramus	
Permit Number:	2017-2960	18-1148	
Approving Agency:	Somerset - Union Soil Conservation District	Bergen County Soil Conservation District	

E. E&SCP Drawings

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