Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance

Dominion Transmission, Inc.

Engineering Services Reference Manual
Revised 12/1/2016

Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance

Table of Contents

Figures

Tables

ACRONYM LIST

BMP – Best management practice
CLSM – Controlled low strength material
DCNR – (Pennsylvania) Department of Conservation and Natural Resources
DTI – Dominion Transmission, Inc.
DTM – Digital terrain model
E&S – Erosion and Sediment
E&SC – Erosion and sediment control
ECC – Environmental Compliance Coordinator
EI – Environmental Inspector
EIES – Energy Infrastructure Environmental Services
FERC – Federal Energy Regulatory Commission
GIS – Geographic information system
GPS – Global positioning system
HDD – Horizontal Directional Drill
LiDAR – Light Detection and Ranging
LMS – Learning management system
LOD – Limit of disturbance
MD - Maryland
MSE – Mechanically stabilized earth
NOT – Notice of Termination
NRCS – National Cooperative Soil Survey
NRI – Natural Resource Inventory
OEPA – Ohio Environmental Protection Agency
OGRIP – Ohio Geographically Referenced Information Program
PAMAP – Pennsylvania Map
ROW – Right of way
RSS – Reinforced Soil Slope
SWPPP – Stormwater Pollution Prevention Plan
TWS – Temporary work space
USDA – United States Department of Agriculture
USGS – United States Geological Survey

VESCP – Virginia Erosion and Sediment Control Program
WSS – Web Soil Survey
WV – West Virginia
WVDEP – West Virginia Department of Environmental Protection
WVDOH – West Virginia Department of Highways
WVGES – West Virginia Geological and Economic Survey

Slope Stability Policy and Procedure for Pipeline Design, Construction and Right of Way Maintenance

POLICY:

The following slope stability procedure must be utilized as part of the development and execution of any Dominion Transmission, Inc. (DTI) pipeline project. The possibility of slope failures including landslides, will be considered during the routing, design, construction, restoration and post-construction phases of a pipeline project to avoid, reduce, or mitigate the incidence of slope failures on DTI pipeline projects. Specifically, DTI personnel and contractors engaged in pipeline projects must be trained to understand this policy and conform to the following procedure.

PROCEDURE:

1.0 Applicability

This policy and procedure will become effective on September 30, 2016. The applicability table shown below provides the details of which sections of the procedure are applicable for new pipeline projects, active pipeline projects and pipeline replacement projects.

Table 1: Applicability Sections for New Pipeline Projects, Pipeline Replacement Projects, and Existing ROW.

Applicable Sections	New pipeline projects that begin permitting after 9/30/2016	Pipeline Replacement Projects in Existing ROW	Slope Failures on Existing ROW
2.0 Introduction	X	X	
2.1 Slope Failure Susceptibility	X	X	
2.2 Types of Slope Failures	X	X	
2.3 Slope Failure Causes	X	X	
3.0 Pipeline Route Selection	X		
3.1 Preliminary Route Selection	X		
3.2 Desktop Study	X		
3.2.1 Existing Landslide Maps and Data	X		
3.2.2 Define Slopes of Greater than 30 Degrees	X	X	
3.2.3 USDA Natural Resources Conservation Service Soil Surveys	X	X	
3.2.4 Light Detection and Ranging (LiDAR)	X		

Table 1: Applicability Sections for New Pipeline Projects, Pipeline Replacement Projects, and Existing ROW, Continued.

Applicable Sections	New pipeline projects that begin permitting after 9/30/2016	Pipeline Replacement Projects in Existing ROW	Slope Failures on Existing ROW
3.2.5 Mine Study	X		
3.2.6 Desktop Study Mapping	X		
3.3 Field Reconnaissance	X	X	
3.4 Desktop Slope Failure Risk Assessment	X		
3.5 Selection of Preventative Measures for Identified High Risk Slope Failure Locations	X		
3.5.1 Selection of Preventative Measures for Pipeline Replacement Projects		X	
4.0 Pipeline Design and Engineering	X	X	
4.1 Excavation Minimization	X	X	X
4.2 Document Slope Failure Areas on Project Plans	X	X	
4.3 Temporary Work Space (TWS)	X	X	X
4.4 Include Additional Drainage	X	X	X
4.5 Engineered Details	X	X	X
4.6 Construction Stormwater Permit	X	X	
4.7 Stormwater Pollution Prevention Plan	X	X	
4.8 Documentation of Design Information	X		
5.0 Pipeline Preconstruction Planning	X	X	

Table 1: Applicability Sections for New Pipeline Projects, Pipeline Replacement Projects, and Existing ROW, Continued.

Applicable Sections	**New pipeline projects that begin permitting after 9/30/2016**	**Pipeline Replacement Projects in Existing ROW**	**Slope Failures on Existing ROW**
5.1 Slope Failure Training	X	X	X
5.1.1 Training	X	X	X
5.1.2 Environmental Permit Transition	X	X	X
5.2 Slope Failure Mitigation and Response Materials	X	X	
6.0 Addressing Slope failures during Construction	X	X	
6.1 Inspections	X	X	
6.2 Responding to Slope Failures	X	X	X
6.2.1 Evaluate Priority	X	X	X
6.2.2 Install Temporary BMPs	X	X	X
6.2.3 Gather Data	X	X	X
6.2.4 Select Slope Failure Repair Approach	X	X	X
6.2.5 Install Short Term Stabilizing Measures	X	X	X
6.2.6 Implement and Document Slope Failure Repair	X	X	X
6.2.7 Documentation of Repairs	X	X	X
7.0 Addressing Slope Failures after Construction	X	X	X
8.0 Slope Failures Caused by a Third Party	X	X	X

2.0 Introduction

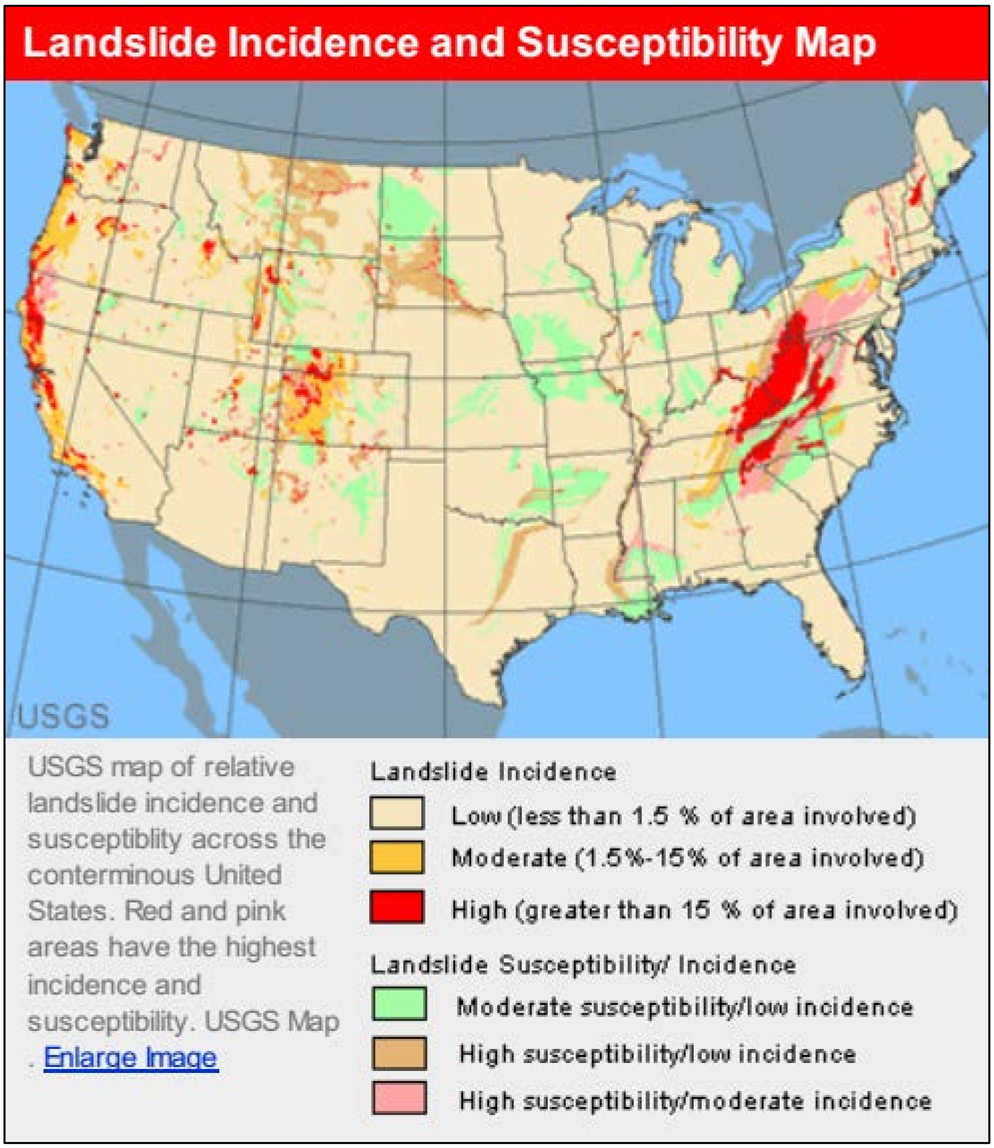
Slope failures, also referred to as landslides or slips on pipeline right-of-ways (ROW) can create adverse erosion control conditions, result in sediment deposits in adjacent waterways, cause landowner complaints, and/or damage the pipeline or other infrastructure. Additionally, slope failures can be costly to repair. Recognizing that the location of slope failures can be challenging to predict, the purpose of this procedure is to avoid and/or reduce the number and severity of slope failures that occur on new Dominion pipeline ROW, and planned expansion of existing Dominion ROW. Every pipeline project and slope failure is unique. Therefore, the specific requirements during project planning and implementation are dependent upon the site-specific conditions. The procedure provides the following:

- A method of identifying potential slope failures;
- Preventative measures;
- A method of protecting waterbodies from slope failure material runoff;
- Containment procedures for slope failure material;
- Remediation procedures; and,
- Training requirements.

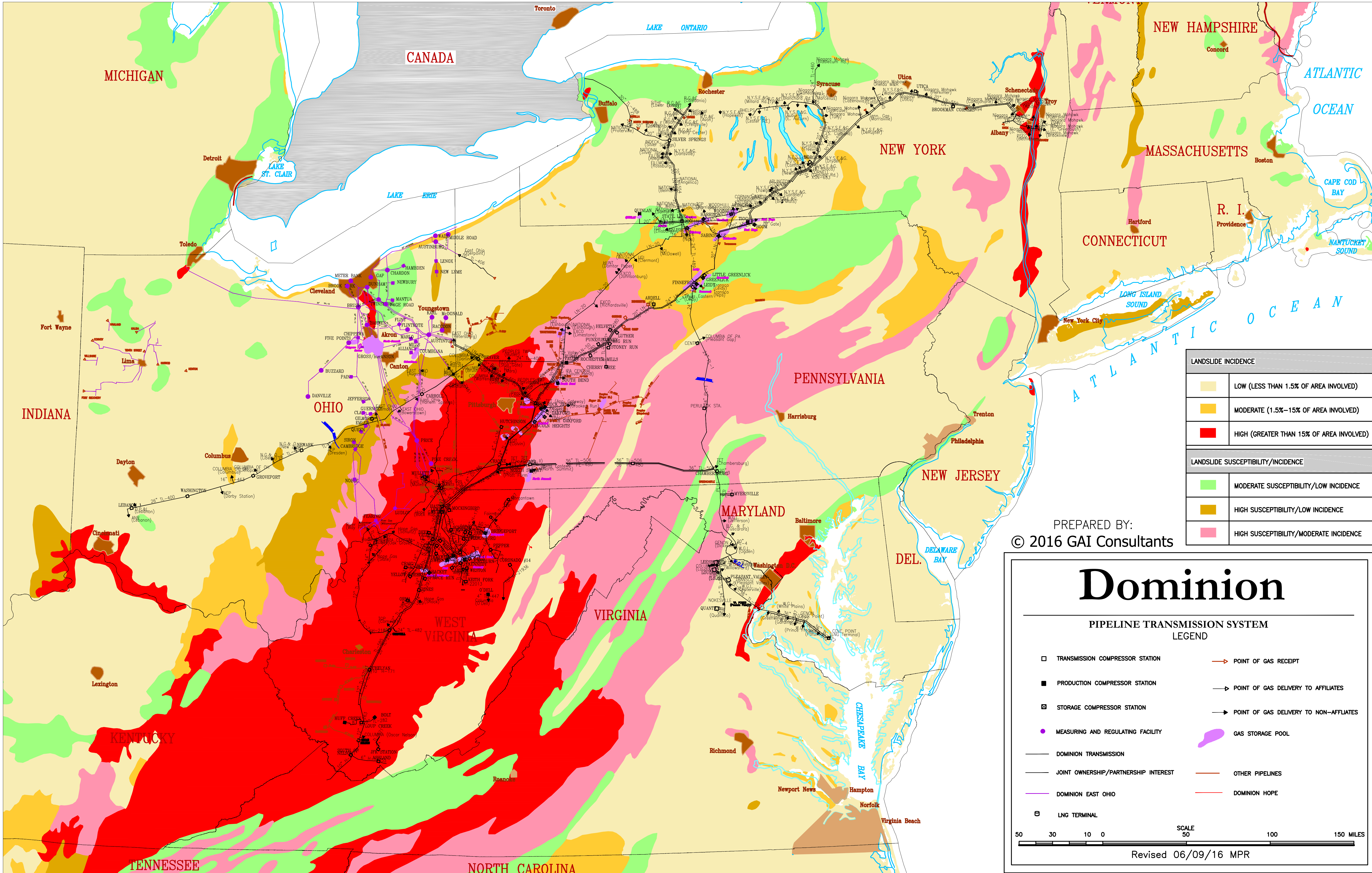
2.1 Slope Failure Susceptibility

Slope failures are plentiful and occur naturally in a large portion of the DTI operating area, and in particular the Appalachian Plateau and Valley and Ridge Provinces. Susceptibility is generally associated with cohesive soils (Silts and Clays) formed on steeper slopes that are triggered by precipitation, gravity and human activities. This region has some of the highest landslide or slope failure susceptibility in the United States, as indicated in Figure 1, which shows a USGS landslide map of the conterminous United States, and Figure 2, which shows a smaller scale map of DTI's operating area, with the locations having the highest risk of landslides shown in red.

Figure 1 – Landslide Susceptibility Map of the United States[1]



[1] USGS - Landslide Overview Map of the Conterminous United States


Dominion
PIPELINE TRANSMISSION SYSTEM
LEGEND
TRANSMISSION COMPRESSOR STATION
PRODUCTION COMPRESSOR STATION
STORAGE COMPRESSOR STATION
MEASURING AND REGULATING FACILITY
DOMINION TRANSMISSION
JOINT OWNERSHIP/PARTNERSHIP INTEREST
DOMINION EAST OHIO
LNG TERMINAL
POINT OF GAS RECEIPT
POINT OF GAS DELIVERY TO AFFILIATES
POINT OF GAS DELIVERY TO NON-AFFLIATES
GAS STORAGE POOL
OTHER PIPELINES
DOMINION HOPE
SCALE
50 30 10 0 50 100 150 MILES
Revised 06/09/16 MPR
LANDSLIDE INCIDENCE
LOW (LESS THAN 1.5% OF AREA INVOLVED)
MODERATE (1.5%-15% OF AREA INVOLVED)
HIGH (GREATER THAN 15% OF AREA INVOLVED)
LANDSLIDE SUSCEPTIBILITY/INCIDENCE
MODERATE SUSCEPTIBILITY/LOW INCIDENCE
HIGH SUSCEPTIBILITY/LOW INCIDENCE
HIGH SUSCEPTIBILITY/MODERATE INCIDENCE
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PENNSYLVANIA
NEW YORK
NEW JERSEY
DEL.
CONNECTICUT
R. I.
MASSACHUSETTS
NEW HAMPSHIRE
ATLANTIC OCEAN
LAKE ONTARIO
LAKE ERIE
LAKE ST. CLAIR
LONG ISLAND SOUND
CAPE COD BAY
NANTUCKET SOUND
DELAWARE BAY
CHESAPEAKE BAY
Toronto
Buffalo
Rochester
Syracuse
Utica
Schenectady
Troy
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Elizabeth City
Roanoke
Charleston
Pittsburgh
Youngstown
Akron
Canton
Cleveland
Toledo
Detroit
Fort Wayne
Lima
Dayton
Columbus
Cincinnati
Lexington

Landslides are common in the mountainous terrain of Virginia due to the presence of steep slopes and highly fractured bedrock overlain by shallow soils. The greatest landslide hazards are present in western and southwestern Virginia. Areas of low-relief such as the Piedmont and Coastal Plain also have landslides but these are generally smaller and generated by human disturbance.

Landslides have occurred throughout the majority of Pennsylvania. However, most landslides occur in southwestern Pennsylvania in areas where shallow soils are developed on steep slopes that have clay-rich bedrock. Areas such as this include the Waynesburg Hills and Pittsburgh Low Plateau sections of the Appalachian Plateaus province.

Landslides are rare or nonexistent throughout much of Ohio due to a lack of steep slopes and/or lack of geologic units prone to failure. However, there are a few areas of Ohio that experience frequent landslides. Portions of eastern and southern Ohio are characterized by steep slopes and several hundred feet of local relief. Bedrock of Mississippian, Pennsylvanian, and Permian ages, thick colluvium, and thick lake silts and outwash formed in association with Pleistocene glaciers make these areas particularly prone to slope failures. Red mudstones lose strength when they become wet and are the most slide-prone rocks in eastern Ohio. The state has experienced slope failures in areas where thick colluvium has developed, such as in Hamilton and Clermont County and the Scioto River Valley. The north-eastern half of Ohio along the Lake Erie shoreline experiences continual erosion, preventing the natural achievement of slope stability.

New York is not categorized as a state with a serious landslide threat as most of the state's soil consists of dense glacial till comprised mostly of granular material that is not prone to landsliding. However, landslides have occurred across all of New York State, from the Adirondacks to Long Island where soft cohesive soils exist. The most common type of landslides that occur in New York are due to the combination of New York's physiography and glacial history with most landslides occurring along major rivers and lake valleys were there were previously glacial lakes. These lakes result in glacial lake deposits (silts and clays) and are generally associated with steeper slopes.

2.1.1 Appalachian Highlands Region

The geology of the Appalachian Highlands is a primary contributor to the high incidence of slope failures. The Appalachian Plateau Province in West Virginia and Pennsylvania occurs west of the Appalachian Front, and coincides with the highest incidence of slope failures. This region contains narrow valleys and steep sided slopes with some deeper valleys. Overburden soils generally consist of colluvium overlying shallow bedrock. Colluvium is soil and debris (rock, tree material, etc.) that accumulate at the base of a slope or along the side slope by mass wasting or sheet erosion. It generally includes angular rock fragments, not sorted according to size, and could contain larger portions of bedrock. The sedimentary bedrock is mostly of the Permian-Pennsylvanian age that is relatively flat-lying and consists of cyclic sequence of sandstone, red beds, shale, limestone, and coal from the Dunkard and Monongahela Groups. Bedrock from the underlying Conemaugh Group is present in the deeper valleys. Because of the region's steep topography, abundant rainfall, low shear strength rocks, and soils with low residual strength, landslides have resulted in major infrastructure and property damage. In addition, large portions of West Virginia are extensively underlain by deep mining operations and strip mines that can also be associated with ground movements.

Southeast of the Appalachian Plateau, the flanks of the Appalachian Ridges and the Blue Ridge are covered by colluvium that is highly susceptible to sliding. Because the colluvium covers many types of bedrock, the map designations of landslide incidence and susceptibility cross formational boundaries. The designations do not correspond so closely in these areas to the units on the geologic map of the United States as they do in most areas west of the Mississippi. Most slope movements in the colluvium consist of slowly moving debris slides although many debris avalanches and debris flows can occur. Rainfall and the subsequent increase in groundwater conditions is a common trigger for landslides in this region, with the factors being the soil types and shape of the land surface, all of which relate to the underlying bedrock geology, and in many cases to slope modifications by human activity. Widespread occurrences of landslides coincide with major rainfall events, especially when the remnants of large storms track over the mountains.

In the Great Valley of Pennsylvania, Maryland, West Virginia and Virginia, east of the Appalachian Ridges, broad areas of Cambrian and Ordovician limestone contain pockets of thick residual clay that is moderately susceptible to sliding. This clay forms many small earth flows and slumps, especially along highway cuts.

<u>2.1.2 Piedmont Region</u>

East of the Appalachian Mountains, is the Piedmont Province of Maryland, Pennsylvania and Virginia. The province is a dissected rolling plain formed on residual soil from deeply weathered metamorphic rocks, and is bordered on the east by a dissected terraced plain on thick deposits of sand, gravel, and clay. Most of the region is free of landslides, except in the Lower Cretaceous clays of Maryland and Virginia, where the incidence of slumps and earth flows is high.

2.1.3 Atlantic Coastal Plain Region

The low dissected Atlantic Coastal plain of Maryland and Virginia is generally free of slope instability due to the moderate terrain in the majority of the area. However, there are localized areas in eastern Maryland with relatively steep slopes that have a high incidence of slope failures. In addition, a majority of Southern Maryland is highly susceptible to slope failure where the Marlboro Clay is exposed. A poorly exposed outcropping of Marlboro Clay begins in Prince Georges County and continues southwest for approximately 20 miles reaching into Charles County. Slope failures are particularly numerous in the east-central and south-western portions of Prince Georges County. Also, in the valleys of Piscataway and Mattawoman Creeks, the clay is mostly buried beneath Holocene alluvium.

2.2 Types of Slope Failures

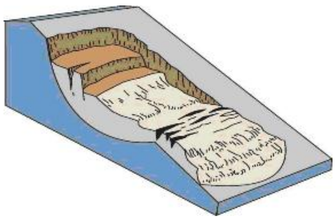
The term landslide or slip as it pertains to geologic reference can be defined as[2]: 1. the downward falling or sliding of a mass of soil, detritus, or rock, on or from a steep slope; 2. the mass itself. Other terms used to describe slips include landslides, land slips, land movements, slumps, slides, etc. The term "head scarp" refers to the tear in the ground surface located at the top of a slip. The term "toe bulge" refers to the mound of failed soil at the base of the slip.

The most common types of slips are described below[3], and a representation of some typical slips observed on pipeline ROW are presented in Figure 3.

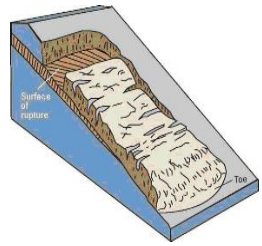
[2] http://dictionary.reference.com/browse/landslide

[3] FEMA Landslide Loss Reduction: A Guide for State and Local Government Planning

Figure 3 – Types of Slope Failures



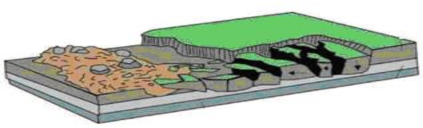
Rotational Slide



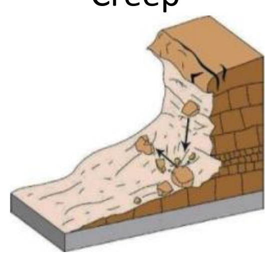
Translational Slide

Earthflow

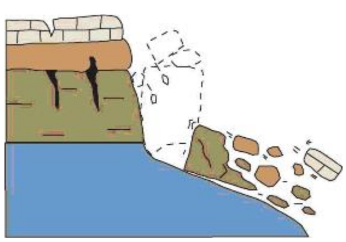
Creep



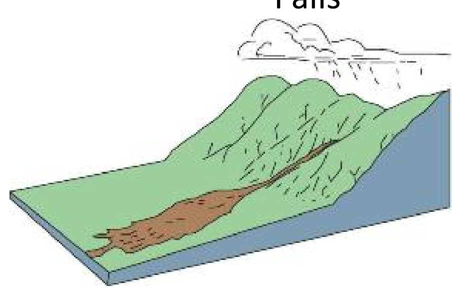
Lateral Spread



Falls



Topple



Debris Flow

Source: USGS

- *Rotational Slides* – Movement of soil and debris downslope in a distinctive rotational motion. A "slump" is an example of a small rotational slide.
- *Translational Slide* – Down slope movement of soil and/or rock on a relatively planar surface and has little rotational movement or backward tilting. The mass commonly slides out on top of the original ground surface.
- *Earthflow* – Unchannelized flow of water, soil, rock, and vegetation that moves downslope.
- *Creep* – Imperceptibly slow, steady downward movement of a slope. Evidence of creep can be indicated by curved tree trunks, bent or tilted fences or retaining walls, and hummocky ground surface.
- *Lateral Spread* – Nearly horizontal movement of geologic materials; usually occurs on very gentle slopes.
- *Falls* – Abrupt movement of masses of soil or rock that becomes detached from steep slopes or cliffs. Movement generally occurs by free-fall, bouncing, and rolling. These movements are promoted by undercutting, differential weathering, excavation, or erosion.
- *Topple* – A block of rock that tilts or rotates forward on a pivot point and then separates from the main mass, falling to the slope below.
- *Debris Flow* – A moving mass of loose mud, sand, soil, rock, water and air that travels down a slope under the influence of gravity. To be considered a debris flow, the moving material must be loose and capable of "flow" and at least 50% of the material must be sand-size particles or larger.

2.3 Causes of Slope Failures

Slope Failures can be caused by nature, by man, or a combination of both. A listing of common contributing factors to slips is below.

Human Activities

- Removal of shallow bedrock on steep slopes and replacement with a weaker backfill material, such as soil fill;
- Removal of vegetation and trees;
- Changes in slope configuration, such as additional load placed on the top of the soil mass, or removal of material near the bottom of the soil mass (such as trenching for pipeline construction); and,
- Changes to the surface water or groundwater regime, such as the addition of water to a slope.

Natural Factors

- Weather;
- Erosion of toe support;
- Weathering of bedrock can produce weak, slope failure-prone materials;
- Earthquakes; and,
- Rapid lowering or rising of water level.

3.0 Pipeline Route Selection

Pipeline route selection is an important component of avoiding or minimizing the impacts of slope failures for new natural gas pipelines. The route selection process described in this document must be used for all DTI projects that include the construction of new natural gas pipelines or re-alignment of existing pipelines. DTI will avoid or mitigate the adverse effects of slope failures by following a route selection process that incorporates identification, avoidance, and/or mitigation. This process is an iterative process, and it includes preliminary route selection, desktop studies, field reconnaissance, landowner discussions and landowner considerations, temporary and permanent access road identification, and environmental factors as inputs to developing a final route. Multiple iterations of each step in the process may be necessary to develop a route that avoids or reduces the risk of slope failures.

3.1 Preliminary Route Selection

Preliminary routing includes establishing a preliminary route that serves as a starting point for the project team, and the final route will likely vary from this preliminary route. A preliminary route can be established using tools such as topographic maps, Google Earth™, available light detection and ranging (LiDAR) data, and other computer mapping software. Considerations during preliminary routing include slope failure-prone areas and construction techniques. Preliminary routing will avoid or minimize routing parallel to slopes, also known as "side hilling", as this construction technique requires excessive excavation of material, increases the construction limits of disturbance, and results in a right-of-way that is difficult to restore and to stabilize. During preliminary route layout, care must be taken to traverse slopes perpendicular to topographic contours, and to avoid traversing slopes greater than 30 degrees (58 percent) to the maximum extent practicable. If traversing slopes of greater than 30 degrees (58 percent) cannot be avoided, it must be minimized, and these areas will be a focus of the desktop study and further evaluation during the field reconnaissance process discussed below in Section 3.3.

3.2 Desktop Study

The purpose of the desktop study is to further evaluate the preliminary route and make route adjustments prior to conducting the field reconnaissance. The DTI Project Team/field engineer, in consultation with DTI Engineering Management must decide at the beginning of a project the appropriate data to be considered during the desktop study. For small projects, the desktop study may only consist of a review of the route, and identification of steep slope areas that can be avoided. For longer projects, the desktop study should be more extensive and can include all of the items discussed below. The desktop study includes a review of existing data on slope failures and slope failure-prone areas, to allow the DTI Project Team/field engineer to make corresponding alterations in the route to avoid or minimize routing across existing slope failures and slope failure-prone areas, and to identify areas that must be crossed that will require additional review during field reconnaissance and project design.

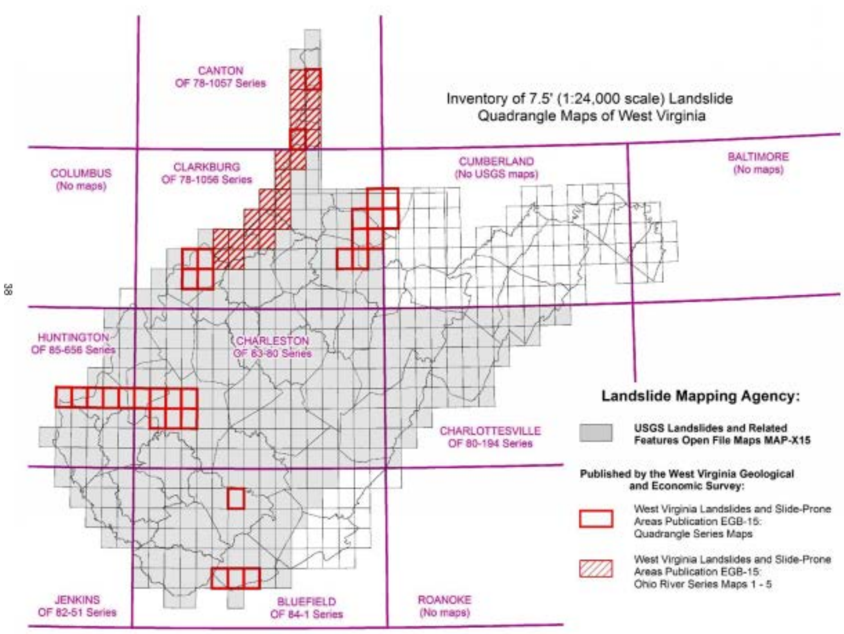
The DTI Project Team/field engineer must define the study corridor at the beginning of the study to provide ample coverage for route alterations either during the desktop study or the field reconnaissance study. Because the potential for route adjustments is greater for longer pipelines, the desktop study corridor must be wider than for shorter pipelines. The minimum width of a study corridor during the desktop review phase is 1000 feet, but may be expanded if necessary based on the project specifics. Geographic information system (GIS) is the most efficient method to conduct the desktop study. A project-specific GIS database can be developed using various information sources including, but not limited to those listed below. Additional information in the GIS includes topography, residential and commercial structures, land use, geology, streams, wetlands, cultural resource sites, cultural features such as roads, railroads, public lands and cemeteries to be used during the desktop study to refine the pipeline route prior to beginning the field reconnaissance. Potential access roads must be identified during the desktop study for further evaluation during the field reconnaissance.

3.2.1 Existing Landslide Maps and Data

The United States Geological Survey (USGS) maintains publically available GIS data for a digital compilation of landslide overview mapping of the conterminous United States at http://pubs.usgs.gov/of/1997/ofr-97-0289/ . This dataset consists of polygons enclosing areas of landslide incidence and susceptibility for the conterminous United States. The purpose of this dataset is to give the user a general indication of areas that may be susceptible to landslides, and is not suitable for local planning or site selection without further investigation on the ground.

For a portion of West Virginia, maps of old landslides and slide-prone areas were compiled in 1976 by the West Virginia Geological and Economic Survey (WVGES) in WVGES Publication EGB-15a, West Virginia Landslides and Slide-Prone Areas, P. Lessing, et. al, 1976. Landslides and slide-prone areas were mapped on USGS 7.5 minute quadrangles. Thirty-six 7.5 minute quadrangles are available as georeferenced images from the WV GIS Technical Center. The GIS data can be accessed here WVGISTC: GIS Data Clearinghouse, and areas covered by the data are shown in Figure 4 below. Non-georeferenced maps are available for the remaining USGS quadrangles shown in gray in Figure 4. These maps are available for download and can be georeferenced for projects that occur in areas where the georeferenced data are not directly available from the WV GIS Tech Center. State-specific information other than from USGS as discussed above are not available for Maryland, Ohio, New York, Pennsylvania or Virginia.

Figure 4 – Landslide Mapping in West Virginia



The maps must be used in the desktop study to identify areas of past slope failures, the slopes at the highest risk for slope failures, and the route adjusted to the extent practicable to avoid the highest hazard areas.

3.2.2 Define Slopes of Greater than 30 Degrees.

The desktop study must identify the degree of slope for the entire route. There are several methods to identify and define the degree of slope, either by direct measurement from topographic maps or using various computer programs. The DTI Project Team/field engineer will select an appropriate method based on the size of the project. The DTI Project Team/field engineer may select a slope angle that is shallower than 30 degrees on a project-specific bases.

3.2.3 USDA Natural Resources Conservation Service Soil Surveys

The United States Department of Agriculture (USDA) National Cooperative Soil Survey (NRCS) web-based Web Soil Survey (WSS) (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) provides georeferenced soil maps. The DTI Project Team/field engineer will review the soil survey information related to soil landscapes, soil formation, soil limitations for various land uses, and properties of the soils in the survey areas. In particular, information related to soil origin, slope steepness, drainage characteristics, typical soil profile with layer thickness, approximate depth to bedrock, and slope failure-prone soils can be obtained from the soil survey. Additionally, archived soil surveys are available for selected portions of West Virginia (http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=WV), and may provide additional interpretation of soil conditions, land use applications, and soil hazards.

The objective of soil surveys is to separate major landforms that have similar land use, and not to delineate exact boundaries of soil type. Therefore, soil surveys provide a broad overview of soil conditions but are not designed for site-specific evaluations.

3.2.4 Light Detection and Ranging (LiDAR)

LiDAR is a remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. LiDAR is capable of producing high resolution mapping of the earth's surface including very subtle topographic features such as headscarps, lobate features, and hummocky topography indicative of past or active slope failures.

For projects that include construction of new pipelines, the DTI Project Team/field engineer may use publicly available LiDAR data in the desk top study. If publicly available LiDAR data is not available, the project specific LiDAR data may be obtained if the DTI Project Team/field engineer and Engineering Management decides it is necessary. LiDAR data is available for purchase from select vendors for portions of the DTI system. Where LiDAR data is unavailable for purchase, it may be deemed necessary to obtain project-specific LiDAR data by flying the route. The DTI Project Team/field engineer and Engineering Management must determine if the route should be flown to obtain LiDAR data. If the DTI Project Team/field engineer determines that project specific LiDAR is not necessary, that decision must be documented in the Desktop study documentation. Typical LiDAR coverage ranges from 1000 feet to 4000 feet in width.

LiDAR data is analyzed by developing a digital terrain model (DTM) that can be imported to various computer aided drafting software suites. The DTM can be imported into the project GIS during the desktop study and used to identify past slope failures, steep slopes and other terrain features useful in routing the pipeline.

Publically available LiDAR data are available to varying degrees for each state as shown below;

Maryland: LiDAR data and other mapping data are available from the Maryland iMAP program located at http://imap.maryland.gov/Pages/lidar-topography-server.aspx

New York: LiDAR is available for portions of New York from the New York State Elevation Data site (http://gis.ny.gov/elevation/).

Ohio: LiDAR data for Ohio are available through the Ohio Geographically Referenced Information Program at http://ogrip.oit.ohio.gov/)

Pennsylvania: LiDAR data for Pennsylvania are available at the PAMAP website athttp://www.pamap.dcnr.state.pa.us/

Virginia: LiDAR is available for portions of Virginia from the Virginia LiDAR Database at http://www.virginialidar.com/index-3.html#.V3Qtw032apo

West Virginia: As of July 2015, LiDAR data is available from the WV GIS Tech Center for all or portions of Berkley, Gilmer, Jackson, Jefferson, Morgan, Webster, and Wyoming counties of West Virginia.

3.2.5 Mine Study

A mining study should occur in areas of suspected resource mining. Underground and surface coal mining is extensive throughout West Virginia, southwestern Pennsylvania, western Virginia, and southeastern Ohio. A study of state agency data bases should be checked for potential impacts to the pipeline route. Depending on the type of mining, the impacts could range from ground subsidence or ground movement from uncontrolled backfilling of strip mines or auger mining to longwall mine panel subsidence. Publically available mine mapping from state agencies are shown below:

New York
Department of Environmental Conservation - Mining & Reclamation
http://www.dec.ny.gov/cfmx/extapps/MinedLand/search/mines/
Information on the mines can be found by location, permit information or mine identification

Ohio
Division of Geological Survey - Division of Mineral Resources
https://gis.ohiodnr.gov/MapViewer/?config=OhioMines
Information for the coal seam and mine names are given

Pennsylvania
Pennsylvania Mine Map Atlas - Pennsylvania State University
http://www.minemaps.psu.edu/
Information on the Mine Map and the coal seam and mine names are given

Virginia
Virginia Department of Mines, Minerals and Energy
https://www.dmme.virginia.gov/DM/DMMappingCenter.shtml
Maps and Resource Center for mapping with mining status and coal mine outlines

West Virginia
West Virginia Geological & Economic Survey
http://ims.wvgs.wvnet.edu/index.html
All Mining Map - Information on the seam and mine names are given

3.2.6 Desktop Study Mapping

At the conclusion of the desktop study, a map will be generated that shows a composite of the desktop study results identifying the areas of high risk for slope failures including; slopes greater than 30 degrees (58 percent), past slope failures, slope failure-prone areas based on USGS mapping and/or LiDAR data, surface or near-surface mine areas that could impact stability and areas where shallow bedrock exists.

The purpose of the mapping is to document and locate areas where further evaluation during the field reconnaissance is necessary. The information from the desktop study must be used in conjunction with other desktop data (streams, wetlands, residences, roads, cultural features, etc.) to revise the preliminary route to avoid as many high hazard areas as practicable. Slope failure-prone areas that cannot be avoided, must be identified for further evaluation during the field reconnaissance.

3.3 Field Reconnaissance

Field reconnaissance must be performed by individuals experienced in the identification and assessment of slope failures, other geohazards, and pipeline constructability to enhance the data obtained during the desktop study. This geohazard field reconnaissance can be performed in conjunction with identification of environmental features (i.e., streams, wetlands), but must include an emphasis on risk indicators for future slope failures. In particular, the following information are to be recorded with a hand-held GPS unit or other suitable mapping device, field notes, and photographs: existing slope failures, hummocky topography, head scarps, toe bulges, seeps and springs, tilted utility poles and fence posts, misaligned fences or guardrails, tilted trees, curved tree trunks, bedrock outcrops, sink holes, and mine spoil.

Based on the project conditions, the field reconnaissance can be limited to those areas identified during the desktop study as having increased risk of slope failures and potentially other impacts. The DTI Project Team/field engineer in consultation with DTI Engineering Management must determine if the field reconnaissance is to be performed on the entire pipeline alignment. The study corridor for field reconnaissance must be no less than the planned LOD, but may be up to 600 feet or greater in width.

3.4 Desktop Slope Failure Risk Assessment

Following data collection through the desktop study and field reconnaissance, a desktop slope failure risk assessment will be performed using the Desktop Slope Failure Risk Assessment Matrix included in Appendix A for new pipeline projects. For pipeline replacement projects, the DTI Project Team/field engineer will use the results of the field reconnaissance discussed in Section 3.3 to identify existing and previous slope failures and designate those areas as High Risk.

Using the guidance information included in Appendix A, each potential slope failure area identified in the desktop study and field reconnaissance will be assigned a numerical value for the following:

- Low, Moderate, or High probability of additional slope movement; and,
- Low, Moderate, or High probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features.

Multiplying these two numerical values provides a risk score, as shown in the Slope Failure Risk Matrix in Figure 5 (included in Appendix A). The resulting risk score will be tabulated to prioritize the slope failures based on risk of future movement and degree of impact. This prioritization will allow for selection of 1) risks which can be avoided through a reroute or special construction design; 2) risks which are feasible to address as part of construction; 3) risks which cannot be avoided and will be handled as a future maintenance repair, if necessary.

Figure 5 – Desktop Slope Failure Risk Assessment Matrix

Probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features	Probability of additional slope movement		
	High Probability (3)	Moderate Probability (2)	Low Probability (1)
High Probability (3)	High Risk (9)	High Risk (6)	Moderate Risk (3)
Moderate Probability (2)	High Risk (6)	Moderate Risk (4)	Low Risk (2)
Low Probability (1)	Moderate Risk (3)	Low Risk (2)	Low Risk (1)

3.5 Selection of Preventative Measures for Identified High Risk Slope Failure Locations

Following risk prioritization as outlined in Section 3.4 above, those areas along the preliminary route that have a risk score of "High" will be assigned a preventative measure. The DTI Project Team/field engineer and DTI Engineering Management must select preventative measures appropriate for each high risk location identified during the slope failure risk assessment. The DTI Project Team/field engineer also will determine if preventative measures are necessary for any of the moderate risk locations. This determination can be based on landowner concerns, highly sensitive resources in the area (trout streams, freshwater mussel streams, residential areas, transportation corridors, other utilities or other considerations. Potential preventative measures are listed below:

- Reroute around the slope failure hazard.
- Adjust the pipeline route through the slope failure hazard to minimize the consequence if slope failure were to occur. For instance, if a cross slope cannot be avoided, route the pipeline on the upslope side of the ROW and/or bury the pipe within bedrock to minimize risk to the pipeline integrity if a slope failure were to occur.
- Define locations that require engineered details, such as specialized backfill. This will include areas with slopes steeper than 30 degrees (58 percent).
- Define locations to perform a preemptive repair of an existing slope failure through which the pipeline passes.
- Adjust Temporary Work Space (TWS) limits such that soil stockpiling is not permitted along ridgelines where known slope failures are present immediately downslope of the LOD.
- In rare cases, Horizontal Directional Drill (HDD) under the hazard. However, it is not expected that HDD will be a viable options in most cases due to site constraints, such as steep terrain, that make HDD infeasible. Additionally, the increased impacts resulting from larger ground disturbance associated with HDD may increase the risk of slope failures.
- Identify and provide sufficient permanent access roads to facilitate inspection and repair in high risk slope failure locations after restoration.

3.5.1 Selection of Preventive Measures for Pipeline Replacement Projects

A Desktop Slope Failure Risk Assessment is not required for pipeline replacement projects. Therefore, the selection of preventive measures for pipeline replacement projects must be done using information gathered during the field reconnaissance. Any existing slope failure will be considered a high risk, and the project team should select an appropriate preventative measure to address that slope failure. Potential preventative measures are listed below:

- Reroute around the slope failure hazard.
- Adjust the pipeline route through the slope failure hazard to minimize the consequence if slope failure were to occur. For instance, if a cross slope cannot be avoided, route the pipeline on the upslope side of the ROW and/or bury the pipe within bedrock to minimize risk to the pipeline integrity if a slope failure were to occur.

- Define locations that require engineered details, such as specialized backfill. This will include areas with slopes steeper than 30 degrees (58 percent).
- Define locations to perform a preemptive repair of an existing slope failure through which the pipeline passes.
- Adjust Temporary Work Space (TWS) limits such that soil stockpiling is not permitted along ridgelines where known slope failures are present immediately downslope of the LOD.
- In rare cases, Horizontal Directional Drill (HDD) under the hazard. However, it is not expected that HDD will be a viable options in most cases due to site constraints, such as steep terrain, that make HDD infeasible. Additionally, the increased impacts resulting from larger ground disturbance associated with HDD may increase the risk of slope failures.
- Identify and provide sufficient permanent access roads to facilitate inspection and repair in high risk slope failure locations after restoration.

4.0 Pipeline Design and Engineering

Slope failure-prone areas that were identified through the desktop study and field reconnaissance during the pipeline route selection phase must be properly engineered if avoidance is not an option. Additionally, preventative measures for high-risk slope failure areas were assigned to prioritize the work. Some of the selected preventative measures will be implemented during the engineering and design phase, as described in this section.

4.1 Excavation Minimization

Pipeline construction activities can result in conditions that can cause slope failures including removal of shallow bedrock on steep slopes and replacement with a weaker backfill material, removal of vegetation and trees, changes in slope configuration, and changes to the surface water or groundwater regime. Therefore, care must be taken to minimize excavation to that necessary to safely install the pipeline in areas prone to slope failures. The pipeline trench should be excavated to minimize the volume of material excavated and requiring subsequent restoration. The prepared pipe should be welded and or bent to match the trench profile rather than expanding the trench profile to accommodate the pipeline. Road crossings and bore pits are to be designed to minimize excavation through the use of shoring. Adequate extra work space is to be determined during project design, to prevent storing excavated material on steep slopes.

4.2 Document Slope Failure Areas on Project Plans

Slope failures and slope failure-prone areas must be included in the project plans. The following items must be included on the Stormwater Pollution Prevention Plans (SWPPP) and the Erosion and Sediment (E&S) control plans:

- Slope failure areas having high risk, as determined in Section 3.4 (not applicable for pipeline replacement projects);
- Existing slope failures; and,
- Slopes steeper than 30 degrees (58 percent).

The above items will be clearly identified on the plans using legend items, shading, or call outs such that the information is conveyed to the construction personnel and that awareness of the hazard is communicated.

4.3 Temporary Work Space (TWS)

As discussed in Section 3.5, TWS limits must be identified during the route selection phase so that soil stockpiling is not permitted along ridgelines in high risk areas, or where known slope failures are present immediately downslope of the LOD. Similarly, the limits of TWS must be adjusted to avoid placement over existing slope failures.

4.4 Include Additional Drainage

The project plans and specifications must include provisions for additional subsurface drainage on slopes greater than 30 degrees (58 percent). Include callouts and details in the E&S plans for location and type of drainage.

4.5 Engineered Details

Project-specific engineered details and specifications must be developed for those slope failure-prone areas requiring engineered preventative measures, as identified in Section 3.5. These locations will likely include areas with slopes steeper than 30 degrees (58 percent), or locations requiring pre-emptive repair of an existing slope failure in the proposed pipeline corridor.

It is important to understand that there is no one particular type of repair approach that works for all slope failures. Selection of the most cost effective preventative measure generally requires the following steps:

1. Detailed subsurface exploration to determine the condition of existing materials, depth of failure surface, depth to bedrock or stable soils, and groundwater conditions.
2. Slope stability modeling of the existing slope and the proposed preventative measure(s). This is done to verify that the repair will provide sufficient improvement in the stability of the final slope. Surface topography, laboratory strength testing, and groundwater information are necessary to perform this type of analysis.
3. Perform an Alternatives Feasibility Study to assess suitability of possible preventative and/or repair measures. Associated construction costs of each alternative can be evaluated as well.

Given difficult site access and time constraints for most pipeline projects in this region, some of these steps may not be feasible. Absent this information, conservative assumptions can be made as to the soil strength parameters, and the depth and type of failure surface for design based on good engineering principles and best professional judgment.

In general, the following engineered design methods apply to slope failure prevention and correction, and are presented in general order of increasing cost. Selection of the most appropriate engineered prevention measure or combination thereof, is dependent on individual site conditions and constraints. The DTI Project Team/field engineer and Engineering Management must also consider input from landowners, permitting agencies, and the Federal Energy Regulatory Commission (FERC) as applicable to evaluate all the factors that influence the design and construction of engineered design methods. Example typicals are shown in Appendix B. These typicals are provided as potential examples, and must be tailored to meet the site-specific requirements for each slope failure location.

- Drainage Improvement:
  - Provide subsurface drainage at seep locations through granular fill and outlet pipes.
  - Incorporate drainage into trench breakers using granular fill.
  - Intercepting groundwater seeps and diverting off ROW.
- Buttressing slopes with Sakrete trench breakers.
- Change Slope Geometry:
  - Reduce the slope by cutting at the top, or incorporating a toe buttress.
  - On many overly steepened slopes the depth to bedrock is relatively shallow and slope failures often occur at the interface between the overburden soil and the bedrock. By removing the overburden soil and leaving the bedrock exposed, this could eliminate these types of slope failures. Continued erosion of the soft exposed bedrock should be anticipated.

  - Modifications to E&S BMPs may be required to manage stormwater runoff between the final ROW slope configuration and existing grades beyond the ROW. One alternative approach to manage stormwater is to direct runoff to a defined channel within the ROW to carry surface water downslope. The channel must be stabilized with rip rap or by other means and be directed to an appropriately-sized stabilized outlet.
- Bench and Regrade with Controlled Backfill:
  - A common slope failure repair approach for slopes up to 30 degrees (58 percent) includes removal of the failed soil mass and reconstruction of the slope by cutting level benches into competent soil or rock beneath the failure plane, installing subsurface drainage, and placing compacted soil or other material as backfill.
- Use Alternate Backfill:
  - Removal of the existing fill soil and replacement with rock fill, such as shot rock (WVDOH Item 704.8 or equivalent) can be beneficial in slope failure repair because it improves drainage, provides a higher friction strength, and generally weighs less than a compacted soil backfill. This method is effective on slopes as steep as 38 degrees (78 percent), but should not be expected to vegetate.
  - The potential use of controlled low strength material (CLSM), such as cementitious flowable fill, as backfill within the pipeline trench could be considered as a method to reduce the pipeline trench from collecting and transporting water. The challenge is placing this material incrementally up the slope and containing it long enough for the flowable fill to harden and gain strength. **Note: Dominion policy does not allow the use of CLSM containing fly ash as filler. Therefore a flowable fill using fine aggregates or sand must be used.**
- Chemical Stabilization of Backfill:
  - Chemical modifiers, such as cement and lime, have successfully been used to dry cohesive soils that are saturated beyond the optimum moisture content, and are often used to extend the construction season. When used at higher concentrations, these modified soils can exhibit increased strength properties that can benefit slope failure stabilization projects on slopes up to 30 degrees (58 percent) or greater.
- Geogrid Reinforced Slope:
  - For slopes steeper than 30 degrees (58 percent), construction of a reinforced soil slope (RSS) may be necessary to match existing grades. A RSS consists of benching into the existing slope, installing subsurface drains, and incorporating geogrid reinforcement into compacted backfill.

- Retaining Structures:
    - Numerous types of retaining structures can be effective for slope failure prevention and repair, and are often used in combination with the repair approaches discussed previously. However, structural approaches are generally expensive since they require specialized equipment for installation on remote sites with challenging access. From the standpoint of protecting the pipeline, the most economical solution in certain cases may be to install a retaining wall and then regrade the slope below. In some cases, the slope below the retaining structure may continue to move.
    - One structural approach includes installation of soil nails with surface mesh to anchor the surficial soils to the underlying competent soil or rock. The soil nail spacing and length are designed based on the soil/rock conditions and the depth of sliding. If desired, the surface mesh can be sized to permit vegetation growth through the mesh.
    - Another alternative is the proprietary Geopier SRT system, which utilizes patented plate pile steel reinforcing elements to stabilize slopes. This system is advertised for use on slope failures less than 15 feet in depth where the soil conditions consist of an upper zone of unstable soil over stable soil or soft rock, since the pile elements must penetrate below the sliding surface into stable material. If shallow bedrock is present, predrilling of each plate pile could be required.
    - Other structural retaining wall options include gabion baskets, modular blocks, geocells, H-pile and lagging, drilled shafts, tieback walls, sheet piles, and mechanically stabilized earth (MSE).

4.6 Construction Stormwater Permit

State agency construction stormwater permits and the Federal Energy Regulatory Commission (FERC) require that restoration of the ROW be performed to match preconstruction grade. These requirements sometimes can be problematic on slopes steeper than 30 degrees (58 percent) where pipeline construction activities remove the shallow bedrock and replace it with weaker soil fill. The soil fill has lower internal shear strength than the natural rock and is unstable on these steep slopes, thus increasing the risk of slope failures. To prevent this known slope failure root cause, slopes could be reconstructed to a shallower grade than the existing slope. If the final restored slope is 30 degrees (58 percent) or less, this approach would allow restoration of the ROW using fill materials comprised of natural soil and rock fragments without engineering design. If adjustments to the final grade are implemented, then the pipeline embedment must be increased sufficiently to maintain adequate cover depth. Additionally, modifications to stormwater Best Management Practices (BMPs) will be required since the ROW will likely be at lower elevation than the surrounding hillside, which could preclude installation of waterbars to divert water off ROW. An option to manage this stormwater effort is to direct the runoff to a defined channel within the ROW to convey surface water downslope. Any change in topography may require an individual construction stormwater permit rather than the general permit, which could add significant time to the permitting timeline and require additional review by permitting agencies along with the potential for a public comment period. This approach would require landowner approval and FERC approval if on a FERC project.

4.7 Stormwater Pollution Prevention Plan (SWPPP)

The SWPPP must include a discussion of the methods implemented to avoid slope failures and a plan of action should slope failures occur. The below paragraph provides a template that can be modified with specific measures to be used on a project.

> *Potential erosion problem areas, including but not limited to areas with 30^0 slopes or greater, will be protected by silt fence and permanent slope breakers. Slope breakers will be placed a minimum of 75 feet apart in areas with greater than 25^0 slopes. Care has been taken to avoid areas of steep slopes as much as practical; however, areas which could not be avoided will be addressed with (INSERT ENGINEERING MEASURES, e.g. waterbars, Rolled Erosion Control Product). In the event that subsurface flow is encountered, an under drain will be utilized, as necessary, to divert water outside of the LOD. If encountered, seeps can be mitigated by using seep collectors placed downslope of areas showing seepage. Armored fill placed at the toe of the slope may be used in areas of steep slopes in addition to a perforated drain pipe to divert subsurface water away from the cut slope. If a slope failure occurs Dominion will (INSERT CONTAINMENT MEASURES, e.g. install super silt fence, gabion baskets, jersey barriers or other portable containment devices) to keep the slope failure from impacting areas outside the LOD or waters of the state. Steep slopes have been avoided to the maximum extent practicable. Steep slopes will be restored with erosion control blanket and Dominion will implement the slope failure prevention items mentioned above as needed.*

Maryland: Slopes equal to, or greater than, 15 percent are classified as “steep slopes” and must be shown on the NRI plan. The standard symbol for steep slopes must be used on the plan and included in the legend.

New York: The New York State Standards for Erosion and Sediment Control Manual requests site plans which delineate and avoid disturbing wetlands, stream corridors and, to the extent practicable, wood lots, steep slopes and other environmentally sensitive areas. The plans should also minimize impacts by maintaining vegetative buffer strips between disturbed area and water resources. Additionally, an E&SC plan should be prepared for all land development and construction activity when uncontrolled erosion and sedimentation is anticipated and should, at a minimum, include sites on slopes that exceed 15%, sites in areas of severe erosion potential, sites within 100 feet and draining to wetland, sites within 100 feet draining to a watercourse, and/or sites with a high percentage of colloidal solids.

Ohio: Oil and gas pipeline construction activities are conditionally exempt from stormwater discharge permitting in Ohio. However, the Ohio Rainwater and Land Development Manual provides limited best practices for steep slopes. Additionally, the Ohio Environmental Protection Agency (OEPA) defines steep slopes as those that are 15 percent or greater.

Pennsylvania: According to the Erosion and Sediment Pollution Control Program Manual, critical areas should be covered with erosion control fabric. Critical areas are defined as part of a disturbed area which poses the greatest threat of sediment pollution to a receiving water. Any slope 3H:1V or steeper directly above a surface water is considered a steep slope and a critical area.

Virginia: According to the General VPDES Permit for Discharge of Stormwater from Construction Activities, a legible site plan must be submitted that identifies the limits of land disturbance including steep slopes and natural buffers around surface waters that will not be disturbed, as well as minimize(s) the disturbance of steep slopes is required as part of the permitting process.

West Virginia: WVDEP requires that the SWPPP include information on slide prone areas and the methods to be implemented to both avoid slope failures and a plan of action should slope failures occur.

4.8 Documentation of Design Information

The following documentation must be developed and filed in the DTI Engineering Documentum filing system.

- Desktop Study mapping and documentation of route adjustments to avoid slope failures and slope failure-prone areas;
- Slope failure Risk Assessment and identification of high risk areas; and
- Selected avoidance or mitigation method for each high risk slope failure location identified in the slope failure risk assessment

5.0 Pipeline Preconstruction Planning

5.1 Slope Failure Training

Training in this procedure consists of annual training on the ~~e~~ procedure, and project-specific review at the Environmental Permit Transition meeting.

5.1.1 Training

DTI personnel with responsibility for pipeline routing, construction, or operation must be trained in this procedure on an annual basis. The training may be completed by an online learning management system (LMS) module or may be conducted by Energy Infrastructure Environmental Services (EIES) personnel, or DTI Engineering Management. At a minimum, the following personnel will be trained;

- Engineering Directors and Managers;
- Design and construction engineers;
- Operations Directors, Managers and Supervisors;
- Construction supervisors; and
- Construction and operations Environmental Compliance Coordinators (ECC).

The training must include the following;

- types and causes of slope failures;
- routing avoidance and desktop methods;
- field reconnaissance;
- risk prioritization;
- pipeline design and engineering to prevent slope failures;
- addressing slope failures during construction;
- addressing slope failures post construction; and,
- reporting requirements.

5.1.2 Environmental Permit Transition

Prior to beginning construction, DTI and contractor personnel with responsibility for the pipeline construction must attend the Permit Transition with EIES. The EIES Permitting Lead will schedule the Permit Transition meeting to rollout the permits and clearances. The meeting will include a review of all environmental permits. At a minimum, the following personnel must attend the Environmental Permit Transition meeting;

- Permit Lead
- Project supervisor;
- Operations Supervisor/Manager (if available);
- ECC; and
- Environmental Inspector (EI) (if identified).

Recommended attendees at the Permit Transition meeting include the following;

- Construction engineer;
- Contractor supervisors, superintendents, and foreman - Policy can be reviewed with contractor at separate pre-construction meeting if cannot attend permit transition meeting;
- DTI inspectors; and

If the contractor cannot attend the environmental permit transition meeting, this policy will be reviewed with the contractor at a separate preconstruction meeting. The Environmental Permit Transition meeting will review the environmental permit conditions, training requirements, inspection requirements, and reference to this policy and procedure.

5.2 Slope Failure Mitigation and Response Materials

The DTI Construction Supervisor must identify during the preconstruction phase, the materials to be maintained onsite during construction to address a slope failure and to prevent slope failures from impacting waters of the state. These materials may include belted silt retention fence, super silt fence, jersey barriers, sakrete bags, gabion baskets, soil additives, drain pipe, stone, geotextile, or portable containment structures.

6.0 Addressing Slope Failures During Construction

6.1 Inspections

For projects with a construction stormwater permit or other E&S plan approved by a regulatory agency, inspection and maintenance of all E&S control structures shall be completed and documented. The ROW and E&S control devices will be inspected by the EI or person designated by the DTI Construction Supervisor. A record of weekly and storm event inspections will be maintained onsite for the duration of the project by the Project EI or Project Supervisor. Inspection forms will include the date(s) and names(s) of personnel making the inspection and results (including any major observations and corrective actions taken or needed). Any major observation and corrective action needed will be carried over to subsequent inspection reports until completely resolved. The inspection records must be maintained onsite during construction and retained by DTI Engineering for a minimum period of three (3) years after final stabilization. Completed inspection reports must be provided to the Construction ECC on a routine basis during construction, and the Construction ECC will conduct periodic site visits to review inspection records and to complete environmental self-assessments on select projects. Construction stormwater inspection requirements vary by state. The below table summarizes these requirements which are further detailed in the subsequent sections.

Table 2. Construction Stormwater Inspection Requirements by State.

State	Inspection Frequency	Rainfall Inspection	Inspection Records	Sign Posting
Maryland	Weekly	The following day after rainfall event resulting in runoff.	Inspection records maintained for three (3) years from the date that permit terminated.	NA
New York	< 5 acres – every 7 days > 5 acres disturbed at one time – at least 2 times every 7 calendar days separated by 2 full calendar days	NA	Inspection reports retained for 5 years following submittal of the NOT.	NA
Ohio	Every 7 calendar days	Within 24 hours of a 0.5" storm event that occurs within a 24 hour period.	Inspection reports retained for 3 years following the submittal of the NOT.	NA

Pennsylvania	Weekly	Within 24 hours after a measurable rainfall event	Inspection reports retained for 3 years from the date of the termination of coverage.	NA
Virginia	Every 5 business days or at least every 10 business days and →	Within 48 hours following any runoff producing measurable storm event.	Inspection report retained for 3 years from the expiration or termination of the permit.	Post copy of notice of coverage letter.
West Virginia	Every 7 calendar days for actively disturbed areas and Every 14 calendar days for restored areas	Within 24 hours after a storm event > 0.5" of rain in a 24 hour period.	Inspection reports retained for 2 years.	Sign posted within 24 hrs. of submitting NOI.

6.1.1 FERC Requirements

For FERC projects, inspections are required in accordance with the FERC Plan. FERC inspections are required on a daily basis in areas of active construction or equipment operation, on a weekly basis in areas with no construction or equipment operation, and within 24 hours of each 0.5 inch of rainfall. All grade surfaces, walls, dams and structures, vegetation, E&SC measures and other protective devices must be maintained in good and effective condition and promptly repaired or restored, even if damaged by a third party.

6.1.2 Maryland

The December 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control can be found at the following site:

http://www.mde.state.md.us/programs/water/stormwatermanagementprogram/soilerosionandsedimentcontrol/pages/programs/waterprograms/sedimentandstormwater/erosionsedimentcontrol/esc_standards.aspx

According to the Maryland Soil Erosion and Sediment Control Manual SECTION A-3 SEDIMENT CONTROL PRINCIPLES, the owner is responsible for conducting routine inspections and required maintenance. At a minimum, the site and all controls should be inspected weekly and the next day after each rain event. However, the approval authority may require more frequent inspections, especially adjacent to sensitive areas or in impaired watersheds. A written inspection report is part of every inspection. In addition, Maryland requires a "Responsible Person" to act as an inspector. The responsible personnel involved in the construction project shall have a Certificate of Training at a Maryland Department of the Environment (MDE) approved training program for the control of erosion and sediment prior to beginning the project. Additionally, the owner or developer shall certify right of entry for periodic on-site evaluation by the appropriate enforcement authority and/or MDE.

6.1.3 New York

The following excerpts are from *Part IV. Inspection and Maintenance Requirements of the New York, Department of Environmental Conservation, SPDES General Permit for Stormwater Discharges from Construction Activity*. A copy of the entire document and appendices can be found at the following location**:**

http://www.dec.ny.gov/docs/water_pdf/gp015002.pdf

A qualified inspector must conduct site inspections. The qualified inspector qualifications are a: - licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided they have received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity.

The qualified inspector shall conduct site inspections where soil disturbance activities are on-going at least once every seven (7) calendar days. In areas where disturbance is greater than five (5) acres of soil at any one time or in sensitive areas, the inspector shall conduct at least two (2) site inspections every seven (7) calendar days. The two (2) inspections shall be separated by a minimum of two (2) full calendar days. During temporarily suspended work (e.g. winter shutdown) and when *temporary stabilization* measures have been applied to all disturbed areas, a site inspection should be completed at least once every thirty (30) calendar days.

6.1.4 Ohio

The following excerpt is from the *Ohio Environmental Protection Agency, General Permit Authorization for Stormwater Discharges Associated with Construction Activity under the National Pollutant Discharge Elimination System.* A copy of the entire document can be found at the following location**:**

http://www.epa.ohio.gov/Portals/35/permits/OHC000004_GP_Final.pdf

At a minimum, procedures in an SWPPP shall provide that all controls on the site are inspected at least once every seven calendar days and within 24 hours after any storm event greater than one-half inch of rain per 24 hour period. The inspection frequency may be reduced to at least once every month if the entire site is temporarily stabilized or runoff is unlikely due to weather conditions. The permittee shall assign "qualified inspection personnel" to conduct these inspections to ensure that the control practices are functional and to evaluate whether the SWPPP is adequate and properly implemented.

6.1.5 Pennsylvania

The following excerpt is from the *March 2012 Pennsylvania Department of Environmental Protection (PADEP) Erosion and Sediment Pollution Control Program Manual.* A copy of the entire document can be found at the following location**:**

http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-88925/363-2134-008.pdf

PADEP requires a maintenance program that provides for the operation and maintenance of BMPs and the inspection of BMPs on a weekly basis and after each stormwater event, including the repair or replacement of BMPs to ensure effective and efficient operation. The program must provide the completion of a written report documenting each inspection and all BMP repair or replacement and maintenance activities.

Pennsylvania has no certification requirement for E&SC inspectors.

6.1.6 Virginia

The following excerpt is from the *Virginia Department of Environmental Quality, General VPDES Permit for Discharges of Stormwater from Construction Activity.* A copy of the entire document can be found at the following location**:**

http://www.deq.virginia.gov/Portals/0/DEQ/Water/Regulations/9VAC25-880-VPDESConstructionSWGPRegulation.pdf

Virginia requires Inspections to be conducted at a frequency of at least once every five business days and no later than 48 hours following a measurable storm event. In the event that a measurable storm event occurs when there are more than 48 hours between business days, the inspection shall be conducted on the next business day; and representative inspections used by utility line installation, pipeline construction, or other similar linear construction activities shall inspect all outfalls discharging to surface waters identified as impaired or for which a TMDL wasteload allocation has been established and approved prior to the term of this general permit.

Virginia requires a "Certified Inspector" to complete all E&SC inspections. Certified Inspector means an employee or agent of a VESCP authority who holds a certificate of competence from the Board in the area of project inspection or is enrolled in the Board's training program for project inspection and successfully completes such program within one year after enrollment. The Virginia Regulation can be found at the following site:

http://register.dls.virginia.gov/details.aspx?id=3945

6.1.7 West Virginia

The following is summarized from *Section G. Other Requirements of the West Virginia Department of Environmental Protection, Division of Water and Waste Management, General Water Pollution Control Permit* for Stormwater Associated with Oil and Gas Related Construction Activities. A copy of the entire document can be found at the following location**:**

http://www.dep.wv.gov/WWE/Programs/stormwater/csw/Documents/OG%20stormwater%20GP%203_10_15.pdf

Inspections must be completed by individuals experienced and trained in E&S control inspections. Inspections must be completed and documented at least once every ***seven (7) calendar days*** for actively disturbed areas, *14 calendar days* for restored areas (restored areas includes pavement, buildings, stable waterways, a healthy, vigorous stand of perennial grass that uniformly covers at least 70 percent of the ground) and *within 24 hours* after any storm event greater than one-half (0.5) inch of rain per 24-hour period. The Project area will continue to follow the preceding schedule until a Notice of Termination (NOT) has been submitted and is approved by WVDEP. Slope failure repairs, soil conditioning, fertilization, reseeding, and mulching will be performed as required.

6.2 Responding to Slope Failures

In the event a slope failure is documented during an inspection, the following steps must be followed. Each step is discussed in detail in the following subsections and summarized in Table 2.

1. Contact the ECC immediately and they will notify EIES who will help evaluate the priority of the slope failure based on the document "Slope Failure Priority Guidance" in Appendix D. The ECC will complete any required reporting to regulatory agencies.
2. Install temporary BMPs to contain slope failure material and to prevent the slope failure from impacting waters of the state.
3. Gather data on slope failure and submit to Dominion Engineering and EIES.
4. Determine repair method and whether the repair is field-directed or engineering-directed.
5. Install short term field stabilizing measures, if applicable.
6. Implement and document slope failure repair.

Table 3. Slope failure Reporting and Repair Responsibility Matrix.

Responsible Party	Action	Time Frame
Construction Supervisor	Report Slope failures to the ECC upon discovery, who will work with EIES to evaluate slope failure using Slope Failure Priority Guidance (Appendix D)	Immediately upon discovery
Construction Supervisor	Install temporary BMPs to contain slope failure material/prevent slope failure from impacting waters of the state	As soon as practicable
ECC	Notify state environmental agency if required	Immediately
Construction Supervisor	Complete Slope Failure Information and Reporting Form (Appendix C)	Within 5 business days of discovery of slope failure
Engineering Team	Complete Slope Failure Repair Assessment Form (Appendix C) and determine if slope failure repair will be field-directed or engineering-directed.	Within 10 business days of receipt of Slope failure Evaluation Reporting Form
Engineering Team	Design repair of Engineering-directed repairs	As soon as practicable
Construction Supervisor	Install short term stabilizing measures for Priority 1 and 2 slope failures that will not be repaired within 60 days of discovery	As soon as practicable
Construction Supervisor	Implement slope failure repair	As soon as practicable
Construction Supervisor	Document slope failure repair	Upon completion of repair

6.2.1 Evaluate Priority

Upon observation of a slope failure, the ECC must be contacted to assist in the Slope Failure Priority determination using the Slope Failure Priority Guidance in Appendix D. The ECC will contact the appropriate entity for all Priority 1 and 2 Slope failures, as specified in Appendix D.

6.2.2 Install Temporary BMPs

DTI's Construction Supervisor or the EI must direct the contractor to install temporary BMPs for containment of slope failure material to protect waterbodies from slope failure material and runoff. Typical details for temporary containment measures, including silt fence, silt sock, super silt fence, and jersey barriers, are included in the SWPPP. Selection of the appropriate BMPs must be determined by the EI in consultation with the DTI Construction Supervisor so that runoff from the slope failure material is contained and waterbodies, if present, are protected. It is noted that temporary BMPs will not arrest future slope movements, and follow up actions to remediate the slope failure must be implemented as soon as practicable.

6.2.3 Gather Data

The Construction Supervisor will obtain site data of the slope failure by completing the Slope failure Information and Reporting Form provided in Appendix C, and will submit this information to DTI Engineering and EIES within five (5) business days of discovering the slope failure. The slope failure information and reporting form included in Appendix C may be used to document slope failure information. In particular, the following minimum information will be obtained and communicated:

- Name of observer;
- Date;
- Slope failure location, including latitude and longitude;
- Slope failure dimensions;
- Site photographs;
- Site sketch;
- Evidence of preexisting slope failures;
- Presence of surface water or groundwater;
- Estimate of slope steepness;
- Estimate of slope failure type (i.e., rotational, translational, earthflow, etc.); and
- Slope failure priority based on Slope Failure Priority Guidance (Appendix D).

6.2.4 Select Slope Failure Repair Approach

Within ten (10) business days of receiving the slope failure data form, DTI Engineering will evaluate whether the slope failure repair is to be field-directed or engineering-directed, and whether to engage a specialist in slope failure evaluation and repair (i.e., geotechnical engineer). The attached score sheet has been developed to assist in determining the appropriate direction of the repair and whether to engage a specialist. In general, field-directed repairs are to be limited to slope failures that are on slopes flatter than 30 degrees (58 percent), can be repaired by installation of drainage measures and earthwork, and have low consequence of future failure. Slope failures that occur on steep slopes, extend outside the ROW, pose increased consequence of future failure, or require construction techniques outside the pipeline contractor's typical construction methods are to be directed by DTI Engineering.

Selection of the most appropriate slope failure repair method is dependent on individual site conditions and constraints. Section 3.5 above provides a discussion on typical repair approaches.

- If the slope failure repair will be field-directed, then the EI and Construction Supervisor will determine the most appropriate repair approach. In general, this will involve installation of drainage, minor slope regrading, and replacement of the failed soil on benches.
- If the slope failure repair will be engineering-directed, then the Project Engineer will lead development of the slope failure repair plan.
- If a geotechnical engineer is engaged, then the Project Engineer will coordinate with the specialist to select and design the repair. This may require field exploration, stability modeling, alternatives feasibility study, and preparation of construction plans.

6.2.5 Install Short Term Stabilizing Measures

In addition to installation of temporary BMPs per Section 5.2, Priority 1 and 2 slope failures that will not be repaired within 60 days of discovery, and other slope failures that will not be repaired within 120 days of discovery will have short term stabilizing measures applied. The following is a list of possible short term stabilizing measures that can be considered:

- Remove soil at the top of the slope failure to unload the slope;
- Install a toe buttress using soil or rock fill, gabion baskets or similar devices;
- If possible, perform minor regrading of the slope with some level of compaction to smooth out the existing scarps and reduce the number of pockets in which water can collect;

- Direct drainage away from the slope failure through waterbars, diversion ditches, or temporary drains;
- Place plastic on the failed slope to protect the soils from rainfall and surface runoff; and
- Monitor the slope failure for signs of slope movement, especially after periods of heavy rain fall. If additional movement is detected or visible (i.e. cracks or scarps), notify Dominion Engineering for assistance.

Even with temporary measures, there is still a risk of additional slope movement. Therefore, long term slope failure repair measures must be implemented.

6.2.6 Implement Slope Failure Repair The slope failure repair must be completed in an efficient and timely manner, and implemented in accordance with the slope failure repair approach selected following this procedure.

<u>6.2.7 Document Repair</u>

The slope failure repair must be documented by the Construction Supervisor, and documentation stored in the DTI Engineering Documentum filing system. Documentation must include the following;

- Name of person completing documentation;
- Date repair was completed;
- Repair location, including latitude and longitude;
- As-built of repair showing locations of installed devices including, subsurface drainage devices, ditching, water bars, buttressing, etc.;
- Method of repair; and
- Photos of repair.

<u>7.0 Addressing Slope Failures After Construction</u>

In the event of a slope failure occurring after construction and prior to regulatory agency approval of a Notice of Termination (NOT) the stormwater permit, the DTI Project Team/field engineer must follow the procedures described in Section 6.0. DTI financial policies provide an out-of-cycle budget request mechanism to reopen a project budget with the proper justification to address slope failures that are a result of construction after the project budget has been closed. The out of cycle budget request can be used to address slope failures that occur in the time period between NOT submittal and regulatory agency approval of the NOT, and to ensure inspections continue until the NOT is approved.

In the event that a slope failure is discovered after approval of the NOT through routine pipeline patrols or other methods of inspection, DTI Operations must report the slope failure to the ECC who will assist EIES in the determination of the slope failure priority classification as a Priority 1 (immediate danger to environment or human health), Priority 2 (sediment laden run-off has entered a water body, Priority 3 (sediment has not reached water body, but appears imminent), or Priority 4 (poses little or no threat to the environment). In addition, DTI Operations must contact DTI Field Engineering for assistance to review the condition and develop a repair plan in accordance with this Policy and Procedure for Slope failure Avoidance, Identification, Prevention, and Remediation.

8.0 Slope Failures Caused by a Third Party

If it is determined that a slope failure is caused by the actions of a third party and not related to pipeline construction or activities by DTI, the DTI Engineering Team or Operations will contact the DTI Land, Lease, and ROW group to make notification to the third party of the slope failure.

APPENDIX A

Desktop Slope Failure Risk Assessment

Desktop Slope Failure Risk Assessment Matrix

Probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features	Probability of additional slope movement		
	High Probability (3)	**Moderate Probability (2)**	**Low Probability (1)**
High Probability (3)	High Risk (9)	High Risk (6)	Moderate Risk (3)
Moderate Probability (2)	High Risk (6)	Moderate Risk (4)	Low Risk (2)
Low Probability (1)	Moderate Risk (3)	Low Risk (2)	Low Risk (1)

Probability of additional slope movement

- Low
  - Slope 22° (40%) or flatter
  - No bedrock outcrops visible
  - No evidence of previous slope movement (bent trees, fence posts, utility poles)
  - No mapped landslide is present
- Moderate
  - Slope 22° to 30° (40% to 58%)
  - Bedrock outcrops possible or limited to small portion of the slope
  - Possible evidence of previous slope movement (bent trees, fence posts, utility poles)
  - Mapped landslides present in the area, but not within the LOD
- High
  - Slope steeper than 30° (58%)
  - Bedrock outcrops prevalent or cover a sizeable portion of the slope
  - Evidence of previous slope movement (bent trees, fence posts, utility poles)
  - Mapped landslide is present within the LOD
  - Existing landslide is present based on field observations

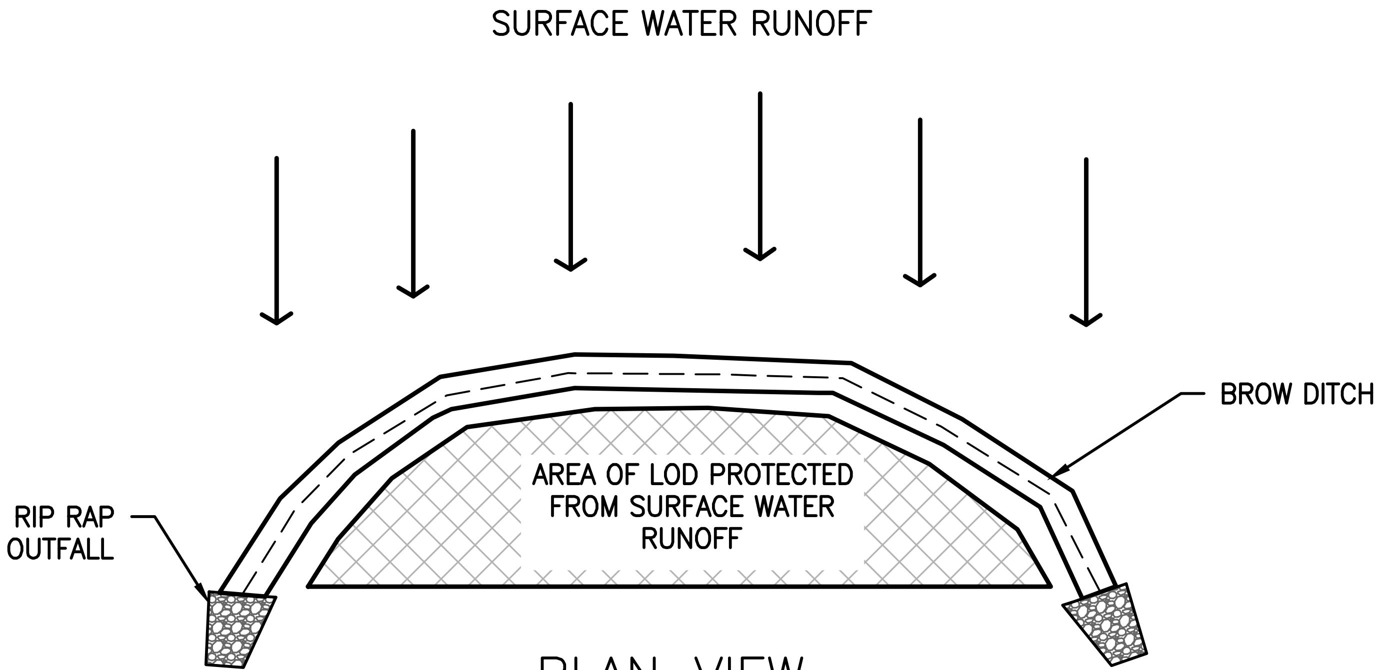
Probability of significant impact to pipeline, waterbodies, roadways, adjacent property, or other features

- Low
  - Pipeline traveling directly up and down the slope
  - Waterbodies or roadways are located 50 feet or more from toe of slope
- Moderate

    - Pipeline traveling directly up and down the slope and slope is 30° (58%) or steeper
    - Pipeline crossing the slope (sidehilling), but will likely be installed below top of bedrock surface
    - Waterbodies or roadways are located 20 to 50 feet or more from toe of slope
- High
    - Pipeline crossing the slope (sidehilling), but will not be installed below top of bedrock surface, or top of bedrock surface is unknown
    - Waterbodies or roadways are located less than 20 feet from toe of slope

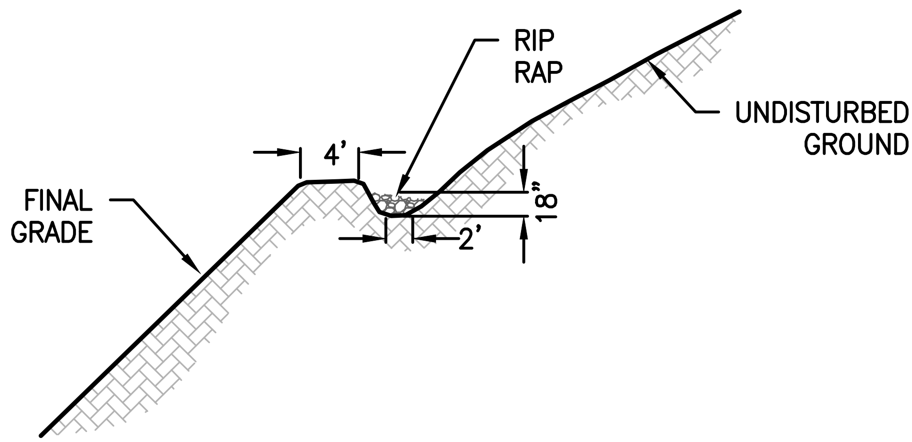
APPENDIX B

Select Typicals



PLAN VIEW

N.T.S.



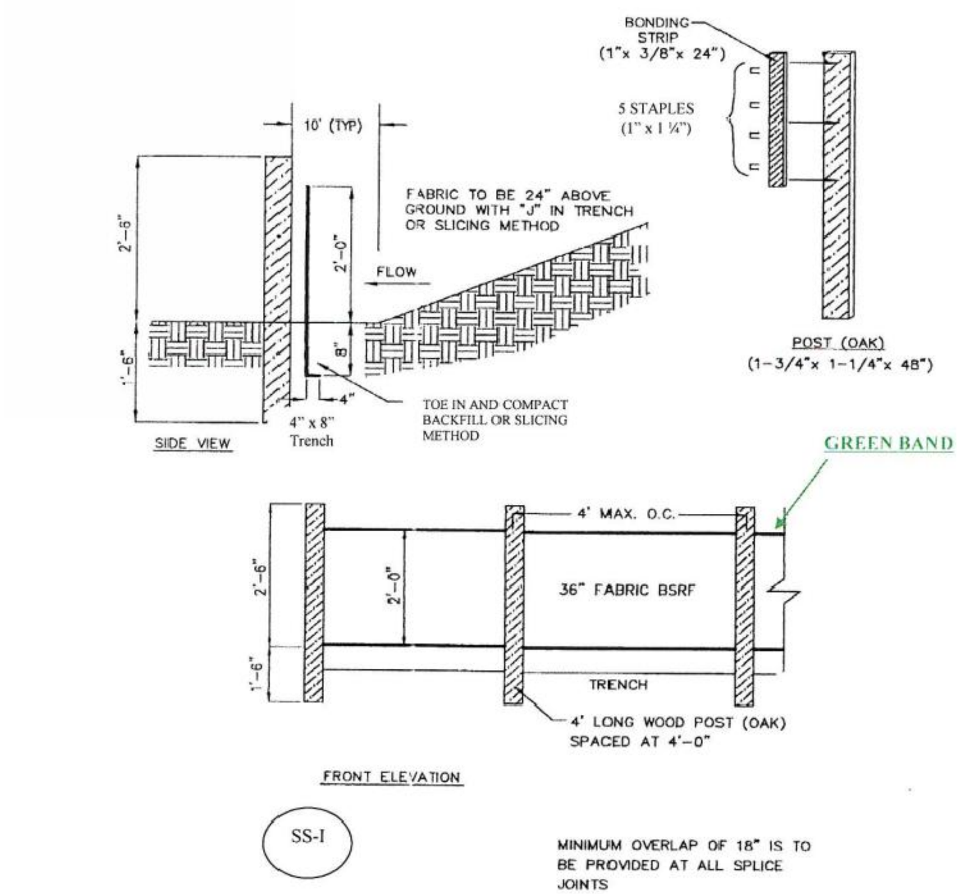
SECTION

N.T.S.

BROW DITCH DETAIL

BELTED SILT RETENTION FENCE
INSTALLATION DETAIL
PRIORITY I – GREEN BAND

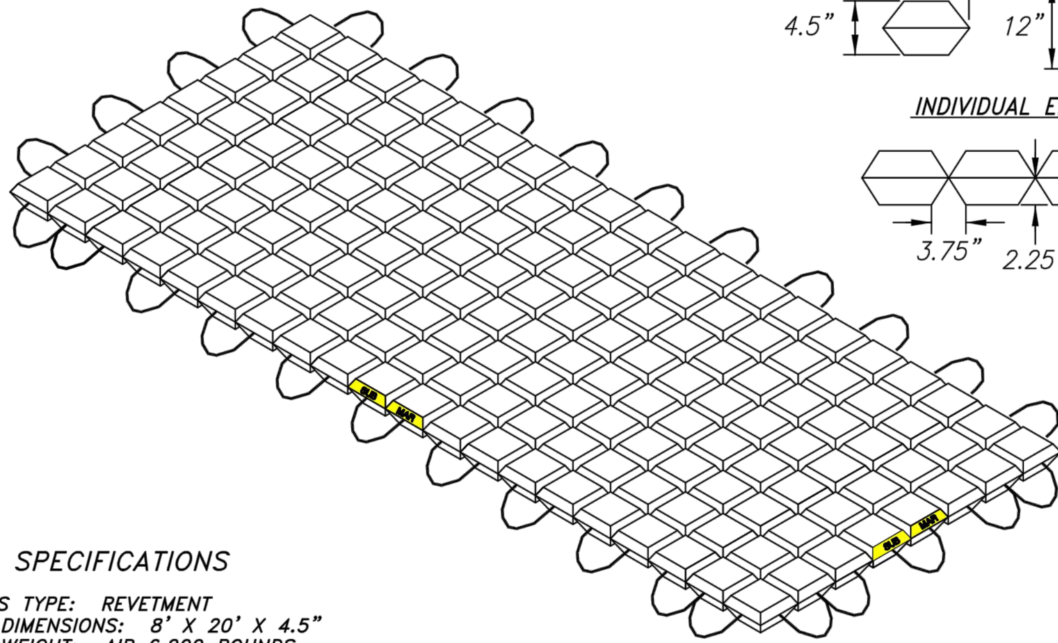
SILT-SAVER, INC.

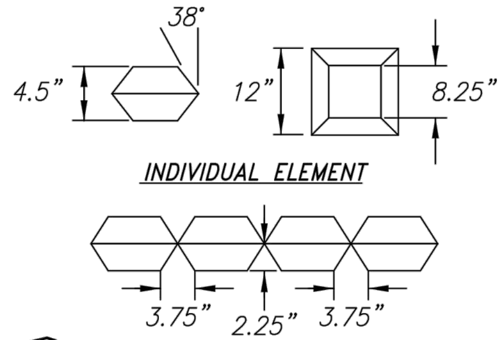


BELTED SILT RETENTION FENCE (BSRF)

SILT-SAVER, INC.
• 1094 Culpepper Drive • Conyers, GA 30094 •
Office 770-388-7818 • Fax 770-388-7640 • Toll Free 1-888-382-SILT (7458) • Website www.siltsaver.com •

BELTED SILT RETENTION FENCE





SPECIFICATIONS

MATTRESS TYPE: REVETMENT
MATTRESS DIMENSIONS: 8' X 20' X 4.5"
MATTRESS WEIGHT: AIR 6,200 POUNDS
MATTRESS WEIGHT SUBMERGED: 3,600 POUNDS (APPROX.)
CONCRETE DENSITY: 145 LBS. PER CU. FT., 4,000 PSI
160 ELEMENTS: 5/8" ULTRA VIOLET STABILIZED COPOLYMER
EXTRUDED FIBER ROPE, MINIMUM TENSILE STRENGTH 9,500 POUNDS

805 Dunn Street
Houma, LA 70360
Ph. 985-868-0001
Fax 985-851-0108
Email: submar@submar.com
Website: www.submar.com

SUBMAR
Synergy with Nature

SUBMAR
STANDARD 8.00'x20.00'
MAT DETAIL

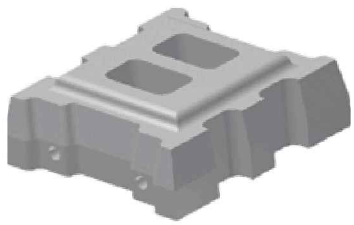
4.5" CONCRETE MATTRESS

DATE:	CHECKED BY:	DRAWN BY:	SCALE:	CONTACT:	PHONE #:
01/03/13	DWD	KPF	N.T.S.		

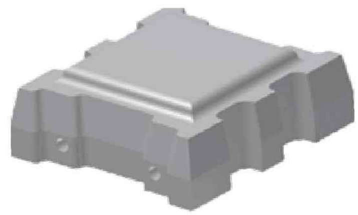
SUBMAR MATTRESS DETAIL

CONTECH® ENGINEERED SOLUTIONS

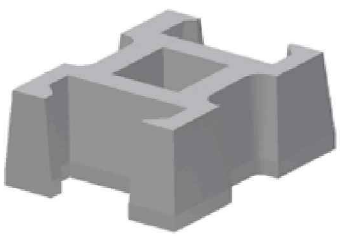
ARMORTEC® Product Details



ArmorFlex® - Open Cell

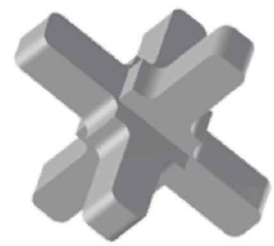


ArmorFlex® - Close Cell

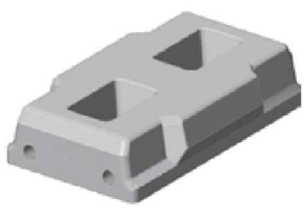


ArmorLoc®

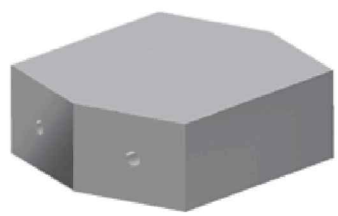
ArmorWedge®



A-Jacks®



ArmorStone®

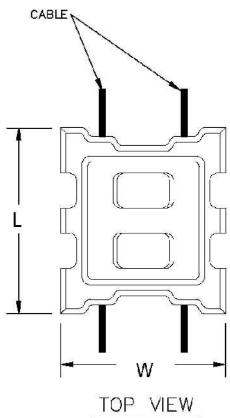


ArmorRoad®

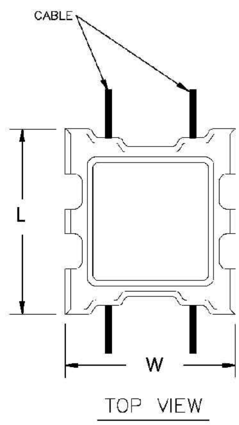
MANUFACTURING SPECIFICATION
ASTM D6684-04

ARMORTEC® Erosion Control Solutions

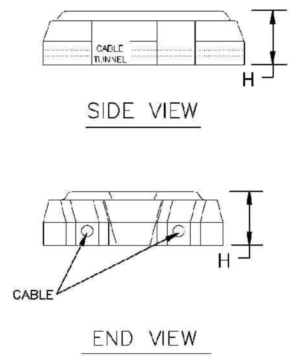
ArmorFlex® (not to scale)

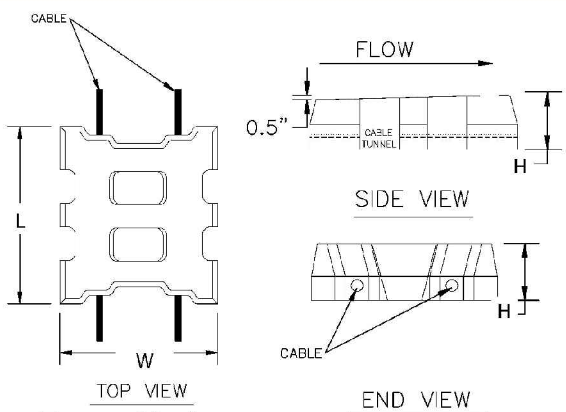


Open Cell Block

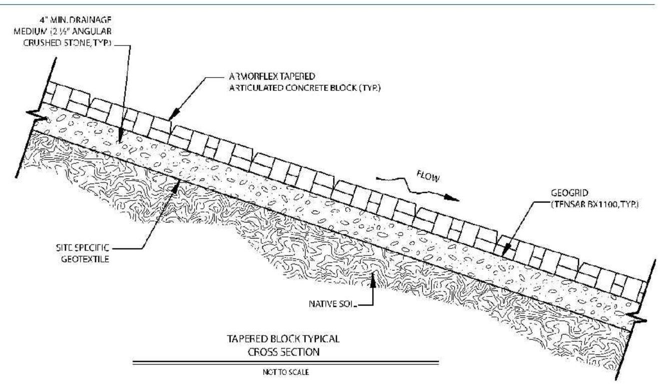


Close Cell Block

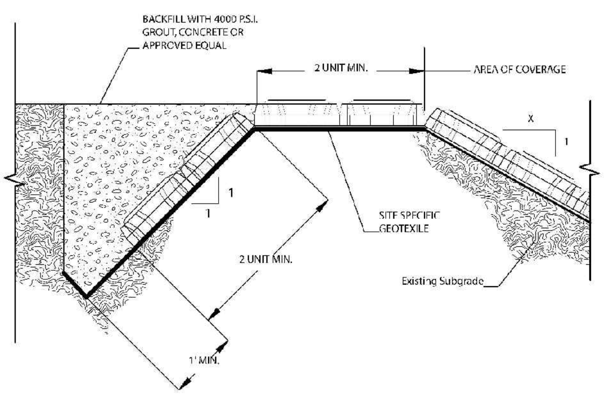




Tapered Series



Tapered Series - Cross Section

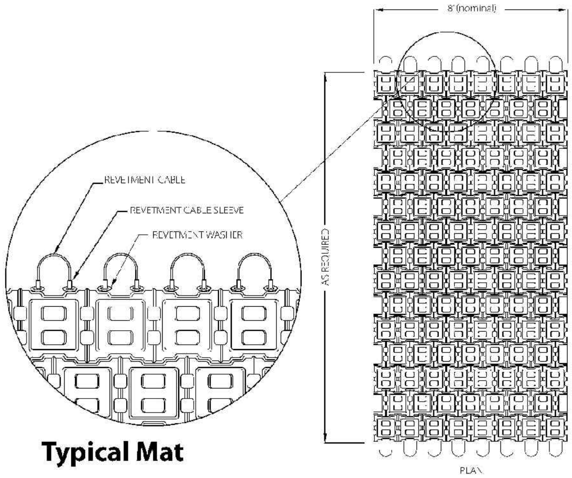


Top of Slope - Standard Detail

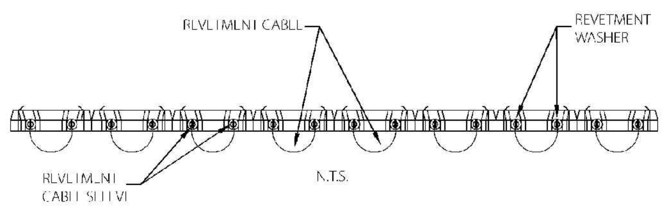
ArmorFlex Unit Specification

Concrete Block Class	Open/Closed Cell	Nominal Dimensions			Gross Area/ (sq. ft.)	Block Weight		Open Area %
		L	W	H		lbs	lbs/sq. ft.	
30s	Open	13.0	11.6	4.75	0.98	33-35	34-36	20
50s	Open	13.0	11.6	6.00	0.98	42-45	43-46	20
40	Open	17.4	15.5	4.75	1.77	59-64	33-36	20
50	Open	17.4	15.5	6.00	1.77	76-82	43-46	20
70	Open	17.4	15.5	8.50	1.77	108-117	61-66	20
40L	Open	17.4	23.6	4.75	2.58	97-105	38-41	20
70L	Open	17.4	23.6	8.50	2.58	174-188	68-73	20
45s	Closed	13.0	11.6	4.75	0.98	39-42	38-43	10
55s	Closed	13.0	11.6	6.00	0.98	50-54	49-55	10
45	Closed	17.4	15.5	4.75	1.77	71-77	40-43	10
55	Closed	17.4	15.5	6.00	1.77	91-98	52-56	10
85	Closed	17.4	15.5	8.50	1.77	136-146	77-83	10
45L	Closed	17.4	23.6	4.75	2.58	109-118	42-46	10
85L	Closed	17.4	23.6	8.50	2.58	207-223	80-87	10
High Velocity Application Block Classes								
40-T	Open	17.4	15.5	4.75	1.77	58-63	33-35	20
50-T	Open	17.4	15.5	6.00	1.77	75-81	43-46	20
70-T	Open	17.4	15.5	8.50	1.77	116-124	65-70	20

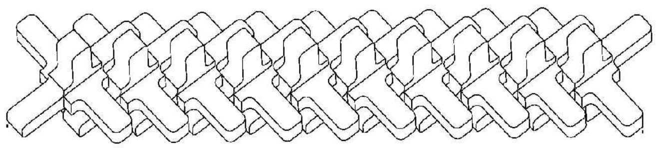
ArmorFlex® cont. (not to scale)



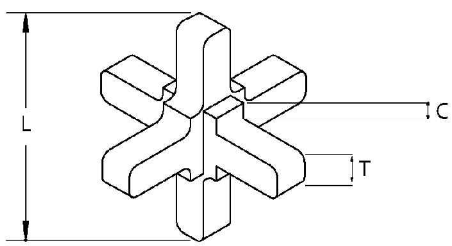
Typical Mat



A-Jacks® (not to scale)



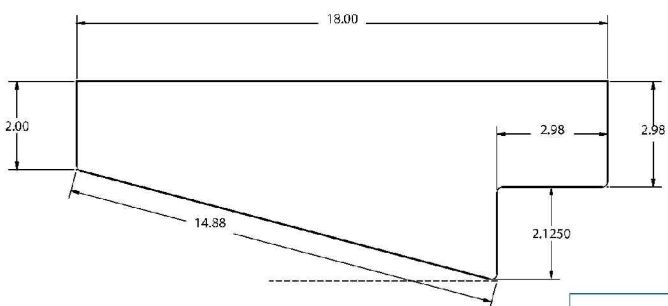
A-Jacks Placement Profile



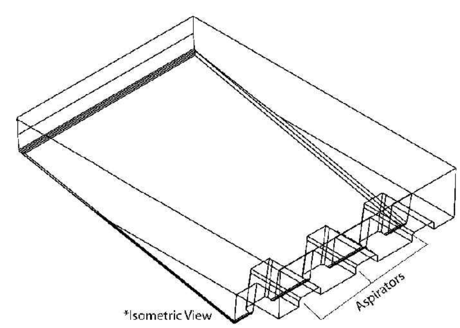
A-Jacks Unit

A-Jacks Unit Specification					
A-JACKS	L(IN)	T(IN)/H(IN)	C(IN)	VOL(FT³)	WT (LBS)
AJ-24	24	4	1.84	0.56	78
AJ-48	48	7.36	3.68	4.49	629
AJ-72	72	11.04	5.52	15.14	2.120
AJ-96	96	14.72	7.396	35.87	5.022
AJ-120	120	18.40	9.20	70.69	9.699

ArmorWedge® (not to scale)

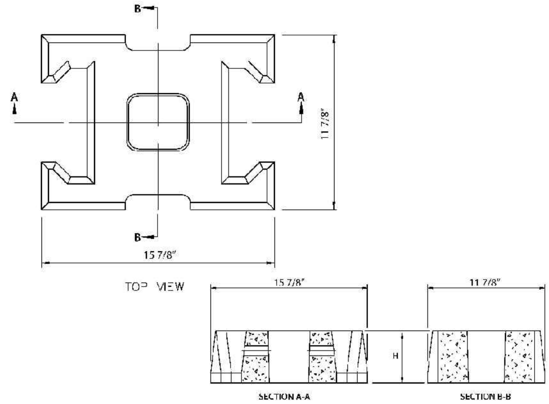


Side View - Typical Block



ArmorWedge Unit Specification					
UNIT DIMENSION	UNIT WEIGHT (LBS/ FT³)	SYSTEM WEIGHT (LBS/ FT³)	UNIT COVERAGE (SF)	COMPRESSIVE STRENGTH (PSI)	MAXIMUM ABSORPTION (LBS/FT³)
12x18	130-140	54-59	1.1875	4000	12

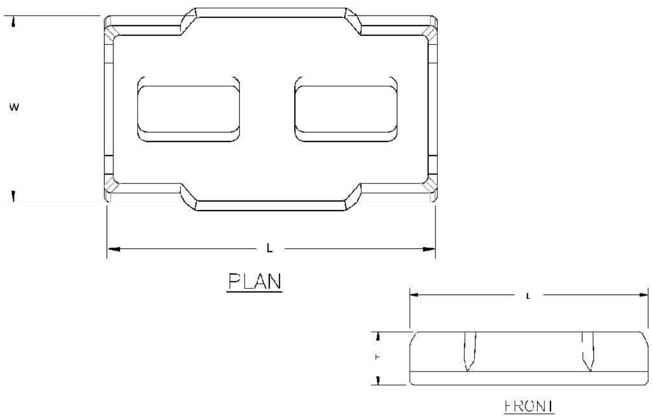
ArmorLoc® (not to scale)



ArmorLoc Unit Specification								
	TECHNICAL DATA			DIMENSIONS AND WEIGHTS				
BLOCK	Specific Weight lbs/ft³	Compressive Strength psi	Max Absorption, Avg. of 3 units 10 lbs/ft³	Thickness Inches (H)	Gross Area/ Grid ft²	Weights/ Grid lbs	Weights/ Area lbs/ft²	Open Area %
3510	130-140	4000 min	10	4	1.0	30-35	30-35	25
4511	130-140	4000 min	10	5.25	1.1	44-50	40-45	20
5011	130-140	4000 min	10	6	1.1	50-54	40-45	20

*Open-cell block shown. Closed-cell block also available.

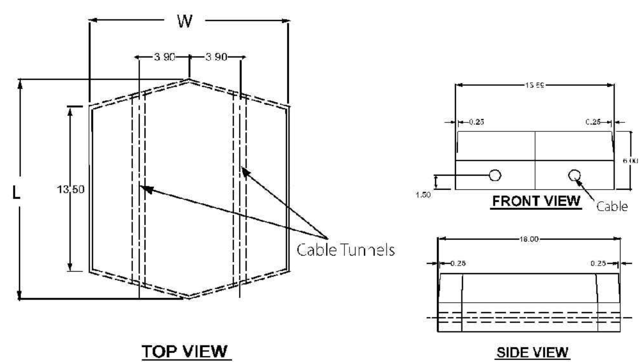
ArmorStone® (not to scale)



ArmorStone Unit Specification								
CONCRETE BLOCK CLASS		NOMINAL DIMENSIONS (IN.)			UNIT COVERAGE (SF)	BLOCK		OPEN AREA %
		L	W	H		UNIT WEIGHT LBS.	SYSTEMS WEIGHTS LBS./SF	
AS 40	Open	18.00	10.00	4.50	1.25	50-54	40-44	25
AS 55	Closed	18.00	10.00	4.50	1.25	61-66	49-53	5

ArmorRoad® (not to scale)

ArmorRoad Unit Specification							
BLOCK	TYPE	L	W	H	SF COVERAGE PER UNIT	WEIGHT LBS PER UNIT	SF PER TRUCK LOAD
Mat	Closed	18.00	15.60	6.00	1.74	105-109	750
Individual	Closed	18.00	15.60	6.00	1.74	100-104	750



ARMORTEC Minimum Physical Requirements per ASTM 06684-04					
MIN. DENSITY (IN AIR) LBS/FT³		MIN. COMPRESSIVE STRENGTH PSI		MAX WATER ABSORPTION LBS/FT³	
Ave. of 3 Units	Individual Unit	Ave. of 3 Units	Individual Unit	Ave. of 3 Units	Individual Unit
130	125	4,000	3,500	9.1	11.7

ARMORTEC PRODUCT DETAILS (4 OF 4)

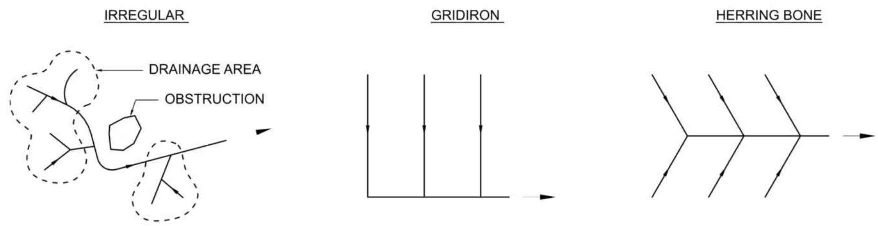
French Drains

Subsurface drainage systems have been in common use for centuries. They take many forms, but are all similar in design and function to the traditional French drain. French drains are excavated trenches filled with aggregate surrounding a slotted or perforated pipe that conveys excess surface and groundwater to a discharge point away from the drainage area. **EZ***flow* drainage products can be used as a substitution for conventional aggregate in French drain systems.

PLACEMENT

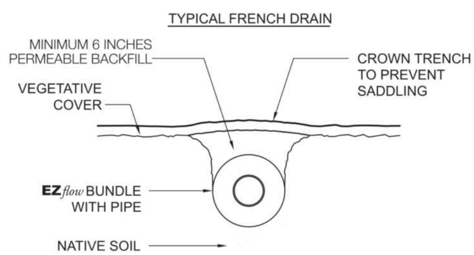
EZ*flow* drainage French drains should be laid out strategically to dewater irregular, poorly drained areas. A defined pattern such as a herring bone and gridiron should be used to drain complete areas including lawns, athletic fields, golf course greens and sand traps. These patterns include laterals that drain to collectors that discharge to an outfall. In general, laterals should not be longer than 50 feet and collectors no longer than 100 feet without increasing the pipe diameter downstream. In addition, the slope of each downgradient run should increase throughout the length of the system.

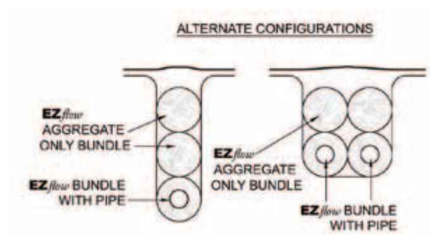
Trench depth and spacing will vary depending on soil texture of the area being drained. Trench depth can also be limited by outlet conditions in flatter areas. Lines may be spaced widely and deeply in sandy soils, and are generally placed shallower and closer together in clay soils.

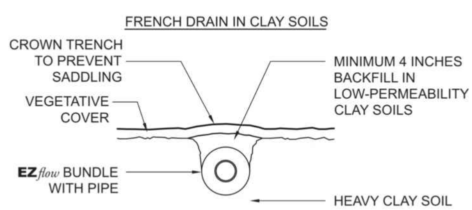


PRODUCT

The 7-inch **EZ***flow* drainage bundles with integrated 3-inch pipe are appropriate for small area residential subsurface drainage systems. 10-inch bundles with 4-inch pipe can be used to drain areas of up to two acres in poorly drained organic soils. In larger areas or if there is over 200 feet of pipe upstream, the 15-inch bundles with 6-inch pipe are recommended.





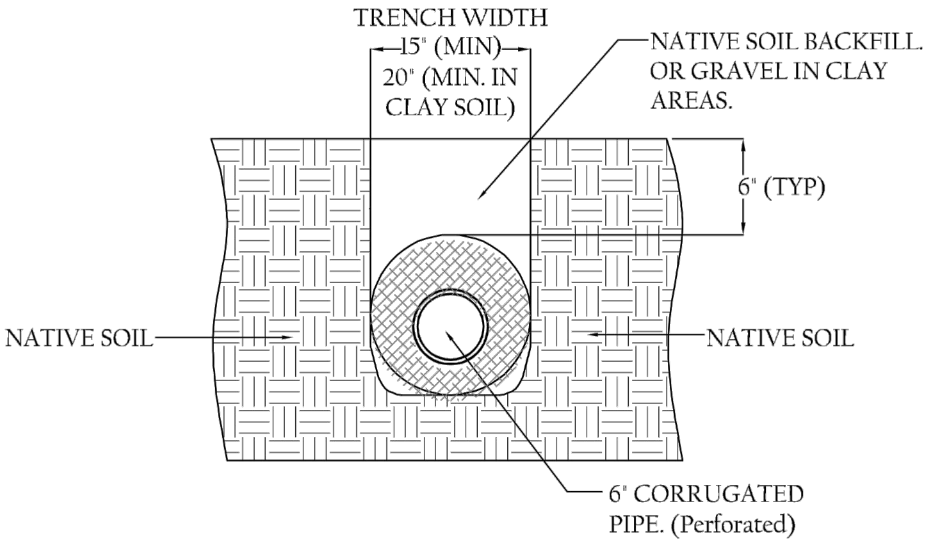


Minimum Recommended Depth of Cover*

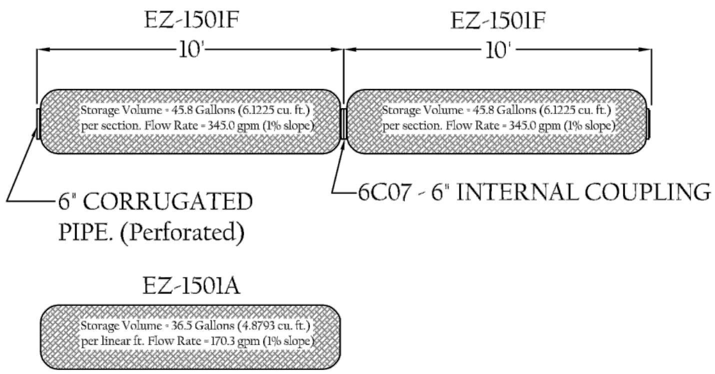
Condition	Depth (in.)
Residential area, commercial lawn mowers	6**
Athletic fields with consistent activity	8
Areas with occasional light vehicular traffic	12

* It is recommended that **EZ***flow* drainage systems be installed a minimum of 6 inches below existing or planned subsurface irrigation lines.
** In low-permeability clay soils, trenches can be placed with a minimum 4 inches of permeable backfill.

TRENCH DRAIN DETAIL



SECTION



PLAN VIEW

ADDITIONAL COVER MAY BE REQUIRED BASED ON SITE CONDITIONS. 12" COVER REQUIRED TO OBTAIN AN H-10 LOAD RATING. CONSULT WITH A LOCAL ENGINEER FOR SITE SPECIFIC REQUIREMENTS.

NDS

TECHNICAL SERVICES
1-888-825-4716
techservice@ndspro.com

EZflow™
AGGREGATE DRAINAGE SYSTEM

N. T. S.

TRENCH DRAIN DETAIL

French Drain Installation Instructions

The steps below offer typical installation practices for French drains and will vary based on site conditions. These practices are also applicable to landscape plant bed drains and for wet areas on golf courses.

1. Identify the area to be drained and mark off lateral and collector lines before digging beginning trench excavation.

2. Start excavating the trench at the discharge point or where connections to downstream piping will be made. Trench width should be equal to the diameter of the bundle being used. Trench depth will reflect existing terrain, desired drainage line slope and length, height of bundles(s) and required cover thickness. Ensure proper slopes by using a transit or builder's level and grade the trench bottom evenly for proper flow.

3. Place the **EZ***flow* drainage bundle with pipe end to end along the edge of the trench. Use an end cap at the system high point and fully insert the proper couplings at all bundle-to-bundle connections. Lay the connected bundles with pipe in trench, stacking aggregate-only bundles above these bundles as needed.

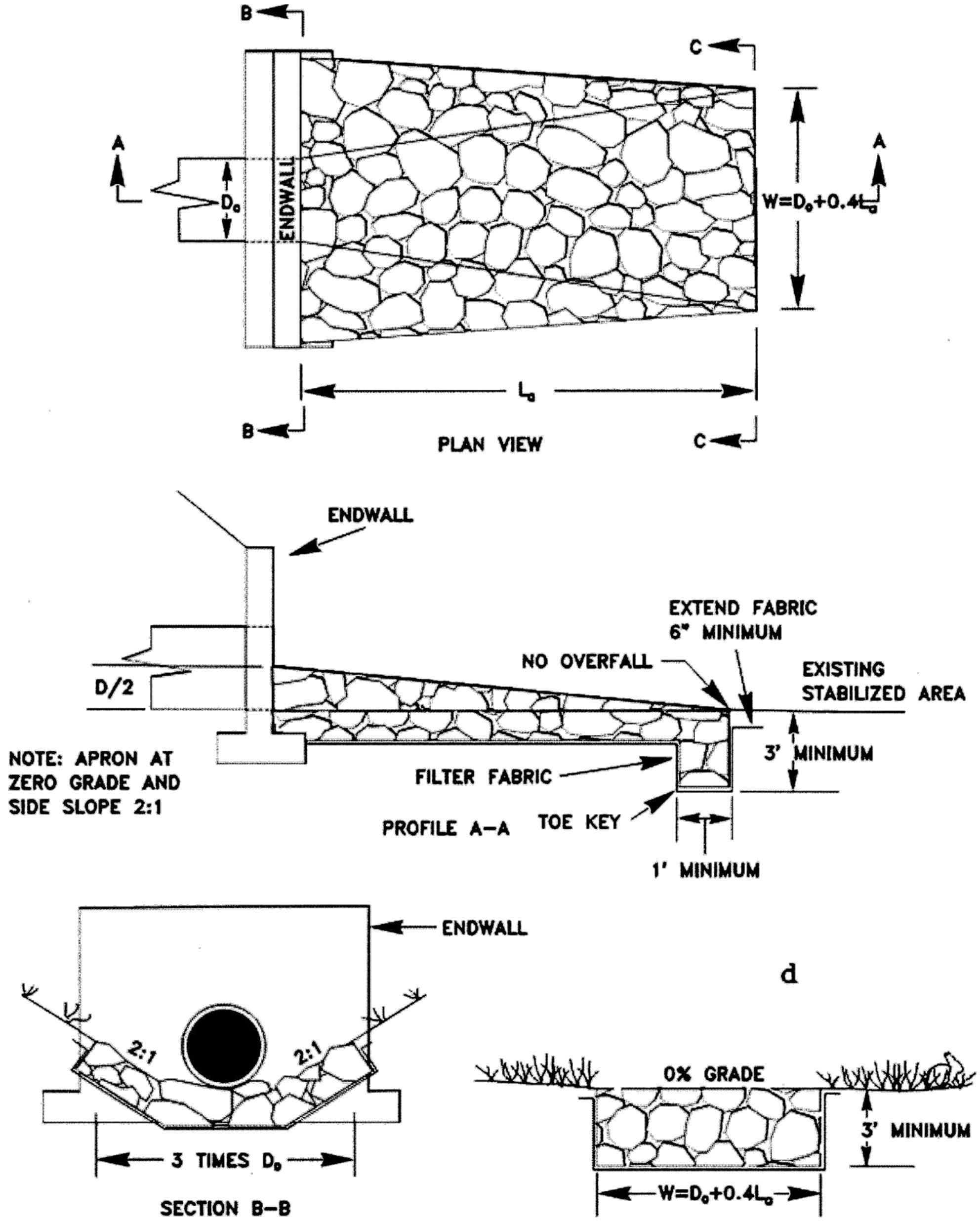
4. Place a minimum of 4-inches permeable backfill (see recommended depths of cover on page 6) over the bundles without compaction. Additional sand/backfill can be placed and compacted normally above the loose fill to prevent trench saddling. Cover trench with sod or topsoil and seed to finish installation.

TRENCH DRAIN DETAIL

FIGURE 3.17.3

OUTLET PROTECTION

DISCHARGE TO UNCONFINED SECTION
(MINIMUM TAILWATER)

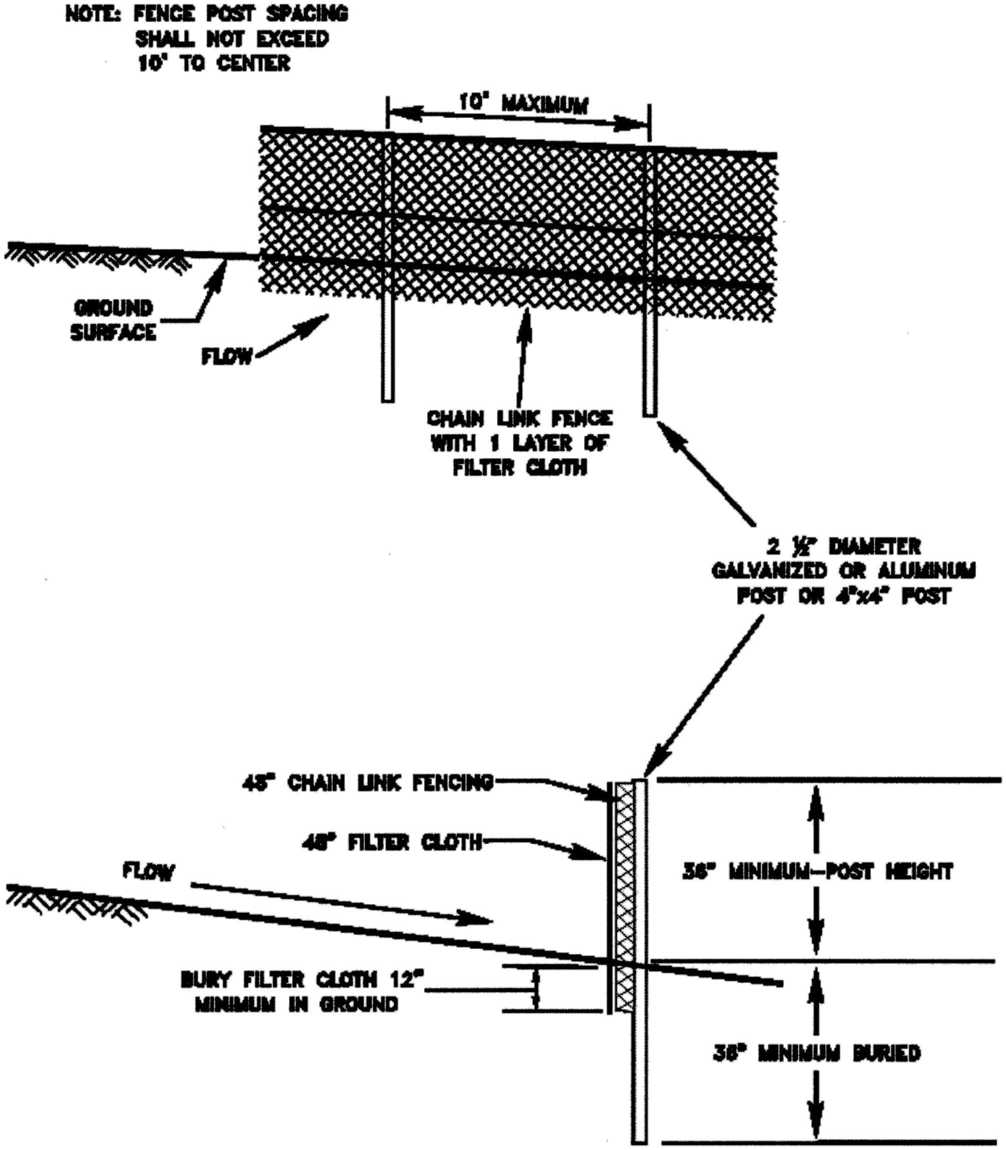


FROM NEW YORK STANDARDS AND SPECIFICATIONS
FOR EROSION AND SEDIMENT CONTROL

OUTLET PROTECTION DETAIL

FIGURE 3.28.1

SUPER SILT FENCE



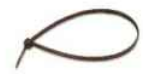
SUPER SILT FENCE DETAIL

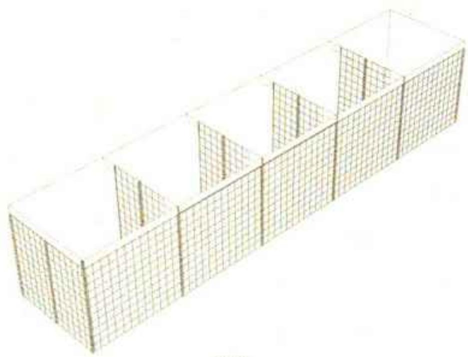
BARRICAGE ™ FLOOD

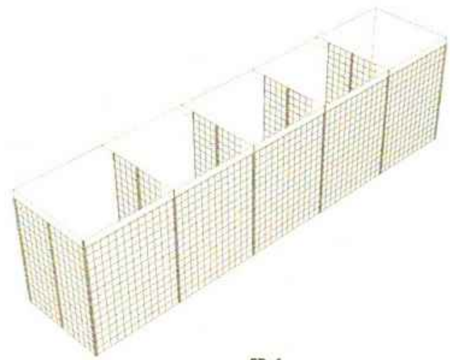
SHIELD | FLOOD | EARTH | ROCK

BarriCage™ geotextile-lined civil system for flood-defense applications. Interior grids free of geotextile fabric allow the fill to compact between cells. Easily fillable with dirt, sand, or gravel. Spiral corners join to other units with included connecting pins. Plastic ties are provided to secure geotextile lining and prevent fill from falling between system joints.


Connecting Pin


Plastic Tie


FD-3
H-3' W-3' L-15' (5 cages)


FD-4
H-4' W-3' L-15' (5 cages)

GENERAL SPECIFICATIONS:
Galvanized welded wire system to ASTM A 974-97 standards with geotextile lining. Lining is high-quality, nonwoven geotextile made of polypropylene fibers designed to form a high-strength fabric. Geotextile liner is available in tan color.

WELDED WIRE GRID CONTAINER	
Wire	
Wire Guage	8.5 American SWG, steel
Wire Diameter	0.155"/3.937mm
Wire Tensile Strength	80-110 ksi 550-760 kPa
Corrosion Protection	Zn-5Al-MM to ASTM A 856A/A 856M-03 minimum coating weight 0.8oz/Ft²/240g/m²
Grid	
Wire Spacing	3" x 3"
Tolerance on Line Wire Spacing	+/ - 1/8"
Cross Wire Straightness Across Test Panel	Limit of deviation 1/4" in 72"
Mesh Strength	70% of wire tensile strength
Panels	
Squareness	In 4' diagonals shall not vary by more than 5/8"
Flatness	In 6' not more than 2" from plane

GEOTEXTILE	STANDARD	VALUE
Mechanical Properties		
Grab Tensile Strength (Machine Direction)	ASTM D 4632	170lbs.
Grab Tensile Strength (Cross Direction)	ASTM D 4632	170lbs.
Grab Elongation (Machine Direction)	ASTM D 4632	50%
CBR Puncture	ASTM D 6241	450lbs.
Endurance Resistance		
Trapezoidal Tear (Machine Direction)	ASTM D 4533	70lbs.
Trapezoidal Tear (Cross Direction)	ASTM D 4533	70lbs.
UV Resistance (% retained after 500 hrs)	ASTM D 4355	90%
Hydraulic Properties		
Apparent Opening Size*	ASTM D 4751	70 US Std. Sieve
Permittivity*	ASTM D 4491	1.50sec⁻¹
Permeability*	ASTM D 4491	.38 cm/sec
Water Flow*	ASTM D 4491	110 gpm/ft²

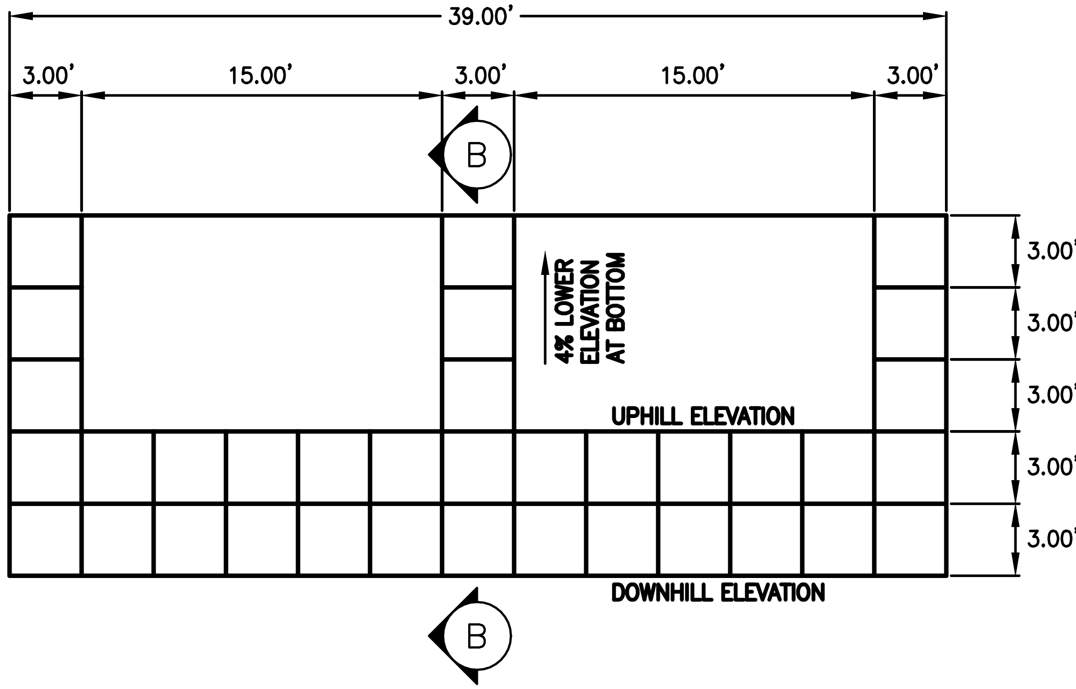
*At time of manufacturing. Handling may change these properties.

a product of landmark EARTH SOLUTIONS, INC.

The given values were obtained through a series of testing performed by our suppliers and other outside testing facilities. The information included herein is subject to change at any time without notice from Landmark Earth Solutions™, Inc.

barricage

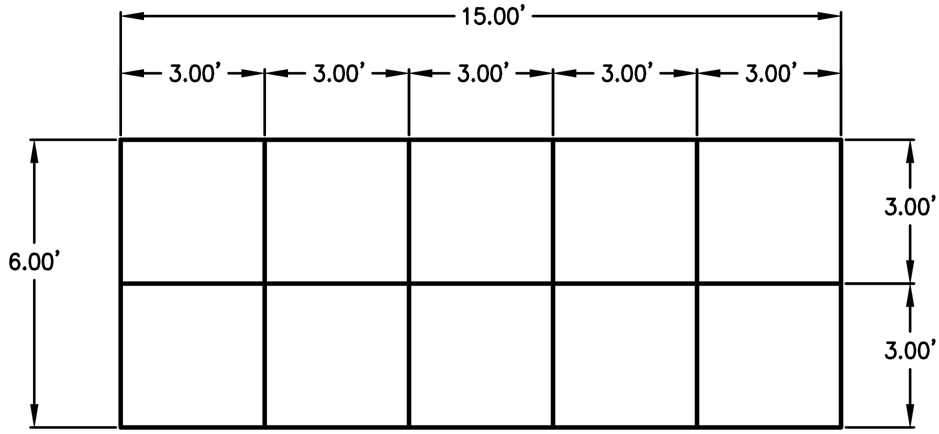
BARRICAGE CONTAINMENT DETAIL



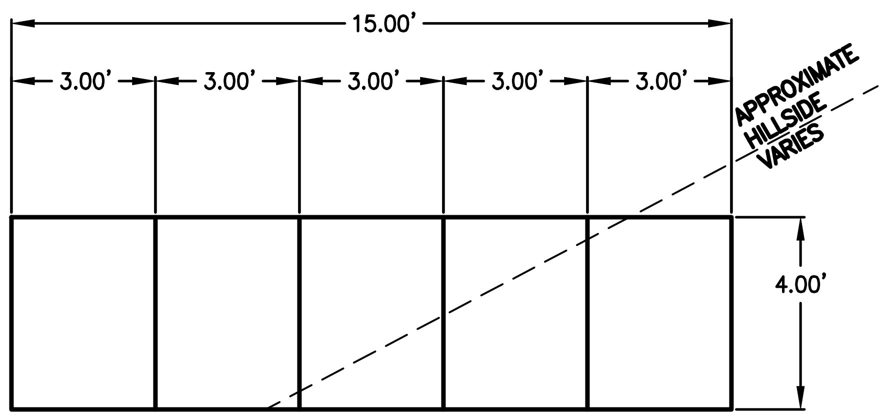
PLAN VIEW
N.T.S.

NOTE:
THIS PRODUCT FOR USE AS A TEMPORARY BUTTRESS OR CONTAINMENT. NOT FOR PERMANENT USE.

BARRICAGE CONTAINMENT DETAIL



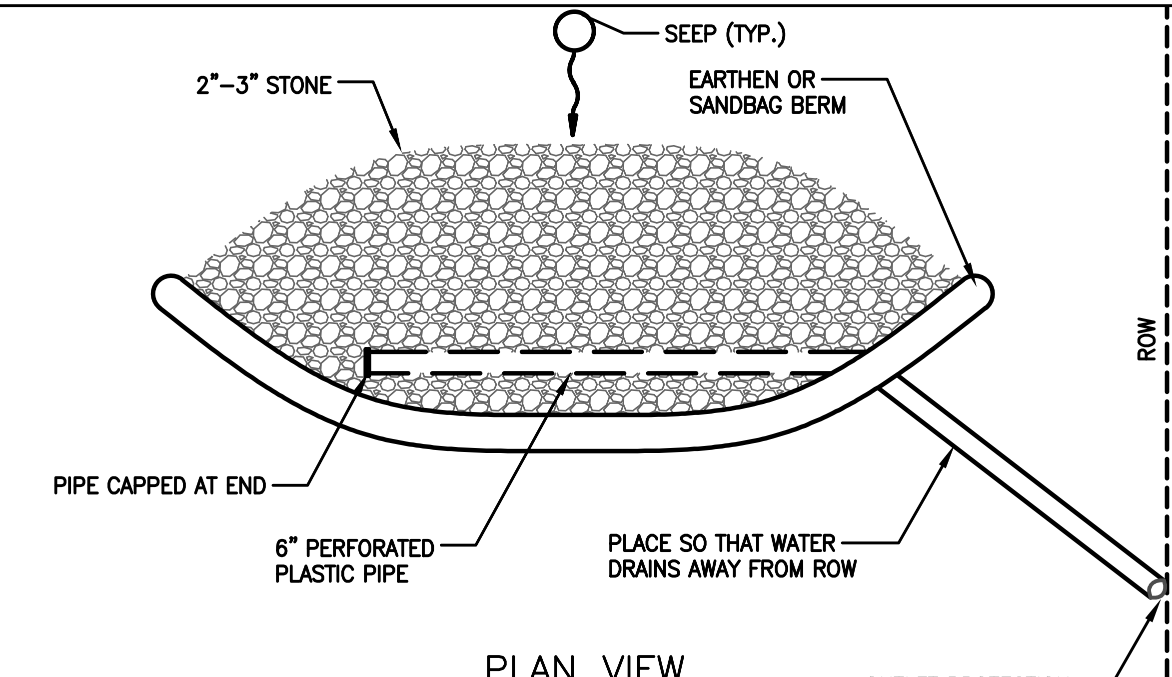
AERIAL VIEW
N.T.S.



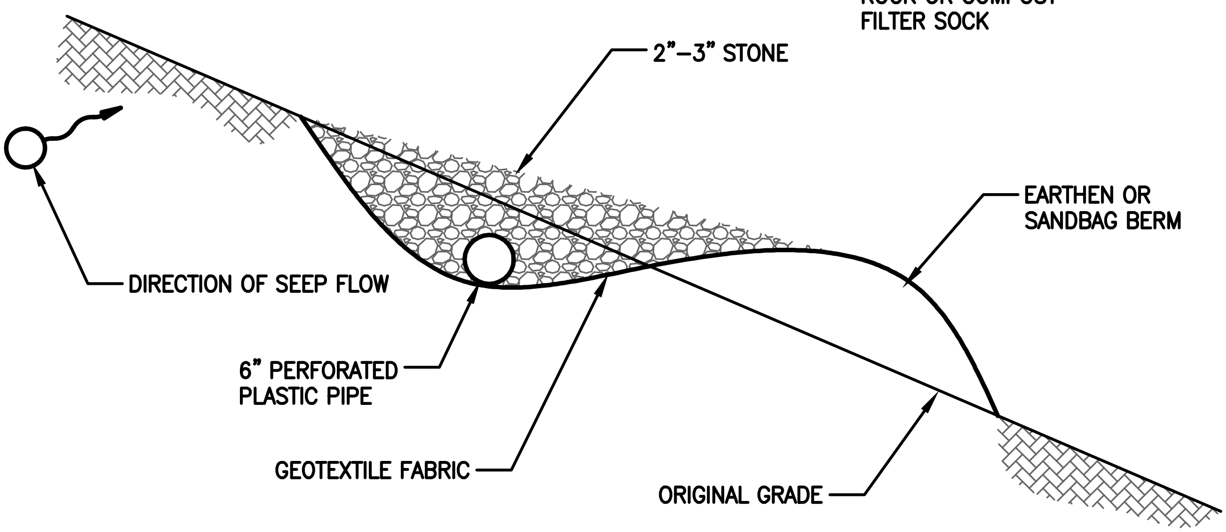
SECTION B
N.T.S.

NOTE:
THIS PRODUCT FOR USE AS A TEMPORARY BUTTRESS
OR CONTAINMENT. NOT FOR PERMANENT USE.

BARRICAGE CONTAINMENT DETAIL



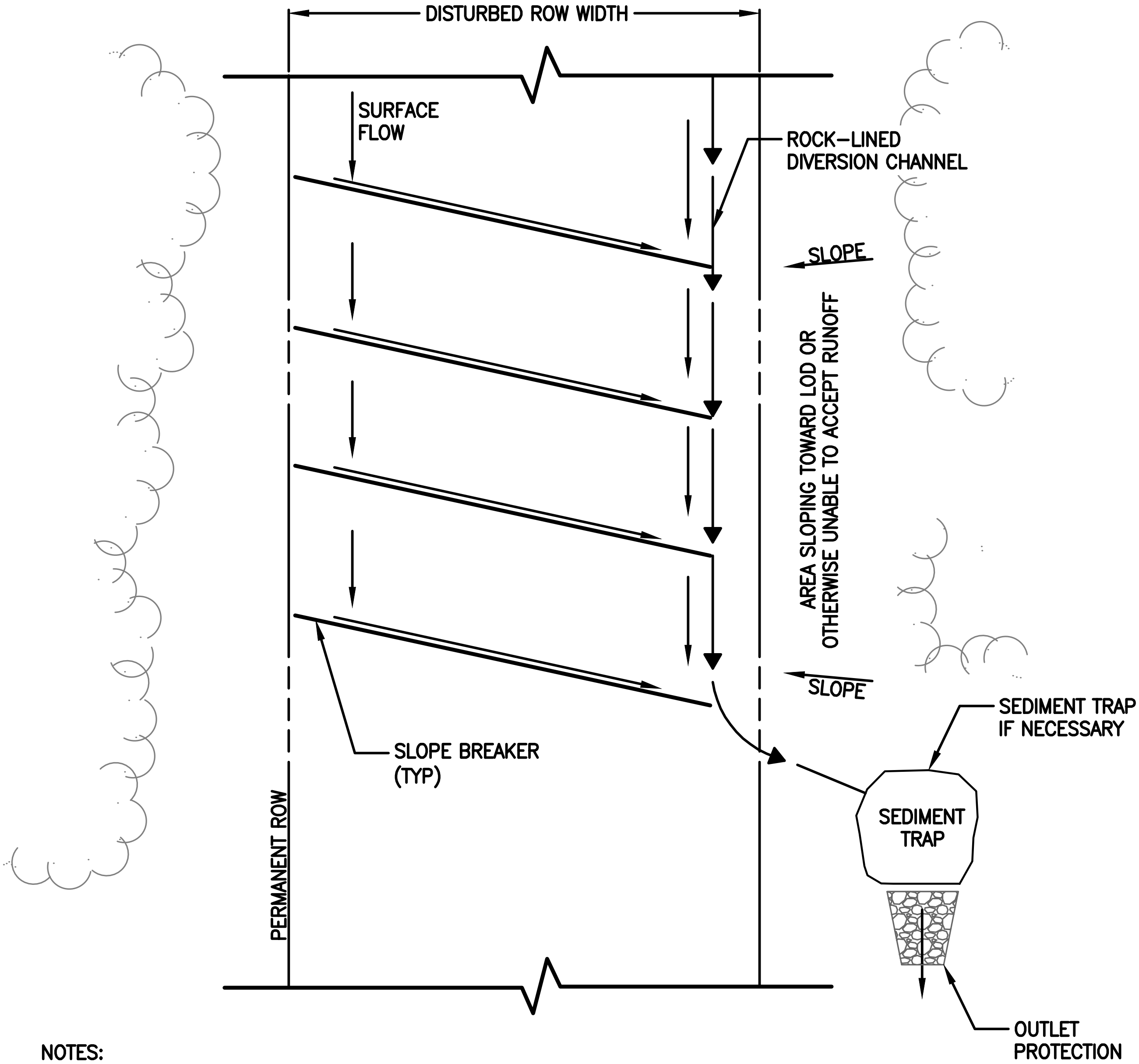
PLAN VIEW
N.T.S.



SECTION
N.T.S.

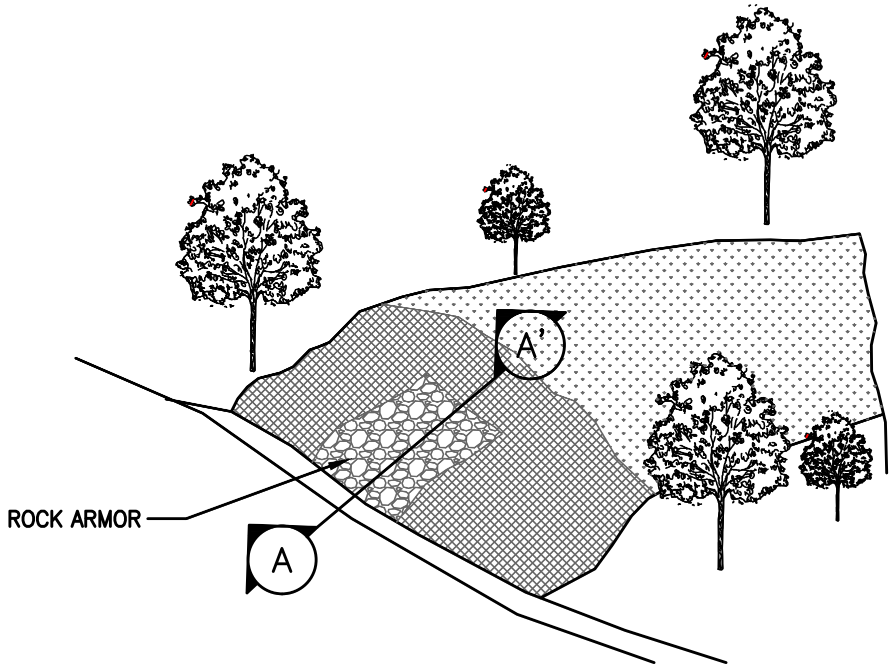
NOTE:
BERMS MAY BE CONSTRUCTED USING SANDBAGS TEMPORARILY DURING CONSTRUCTION. PERMANENT BERMS TO BE CONSTRUCTED USING COMPACTED EARTH.

SEEP COLLECTOR DETAIL

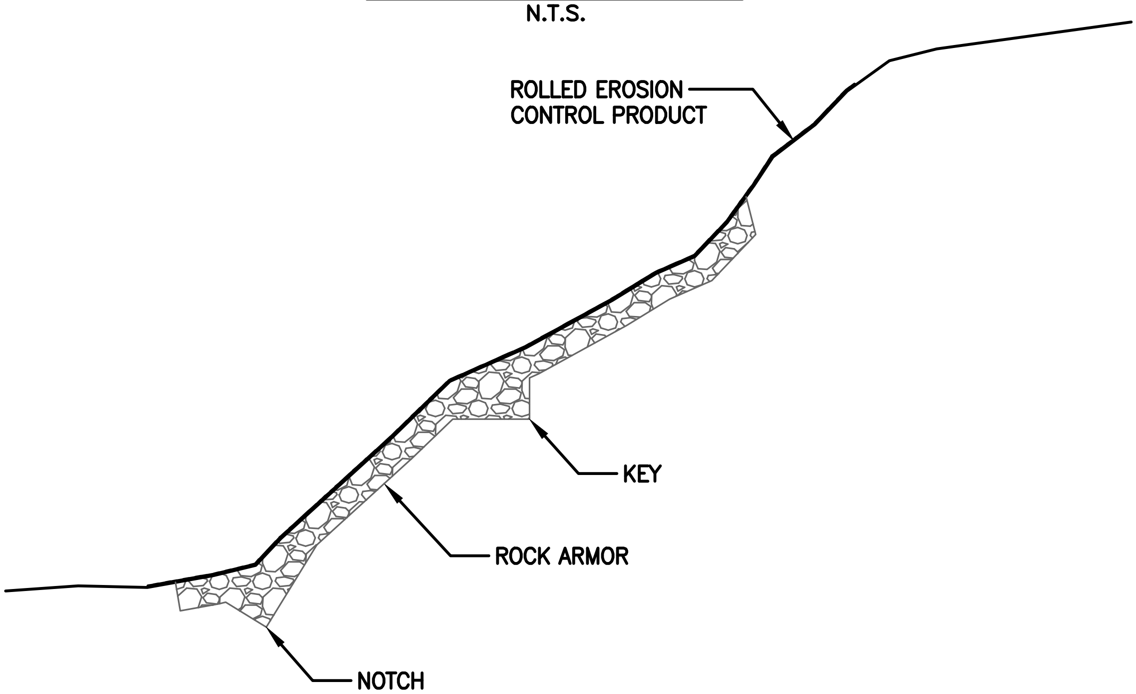


NOTES:
1. CHANNEL AND SLOPE BREAKER LAYOUT WILL NEED TO BE FIELD ADJUSTED TO CONFORM TO SITE CONDITIONS
2. CHANNEL MAY REQUIRE STONE CHECK DAMS, ROLLED EROSION CONTROL PRODUCTS AND OTHER SITE SPECIFIC EROSION AND SEDIMENT CONTROL MEASURES AS NECESSARY
3. SEDIMENT TRAP MAY BE REQUIRED WHERE SUFFICIENT VEGETATIVE COVER EXISTS DOWNSLOPE OF DIVERSION CHANNEL
4. SEDIMENT TRAP WILL REQUIRE SIZING BY AN ENGINEER

CROSS DRAIN DETAIL

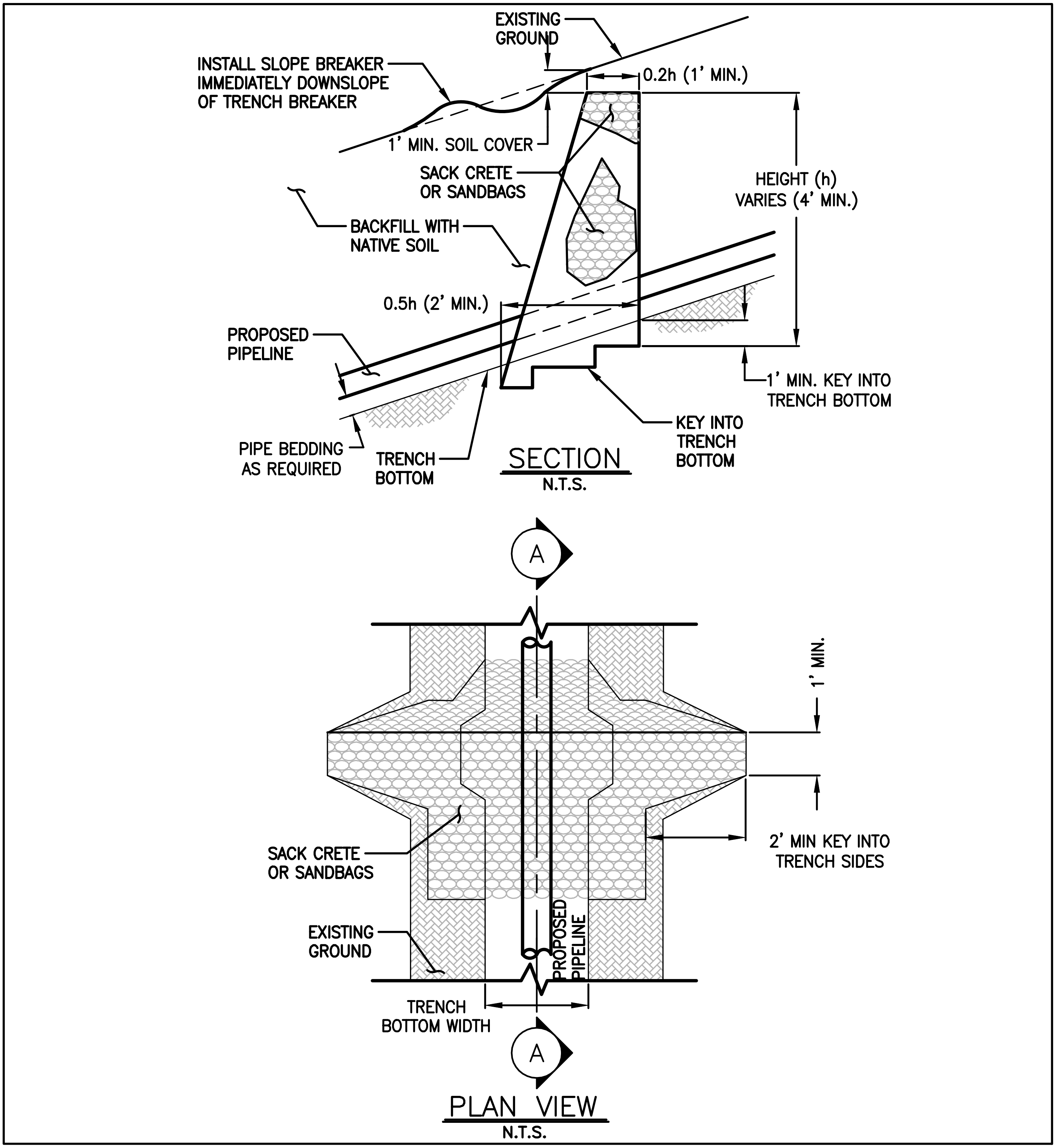


PERSPECTIVE VIEW
N.T.S.

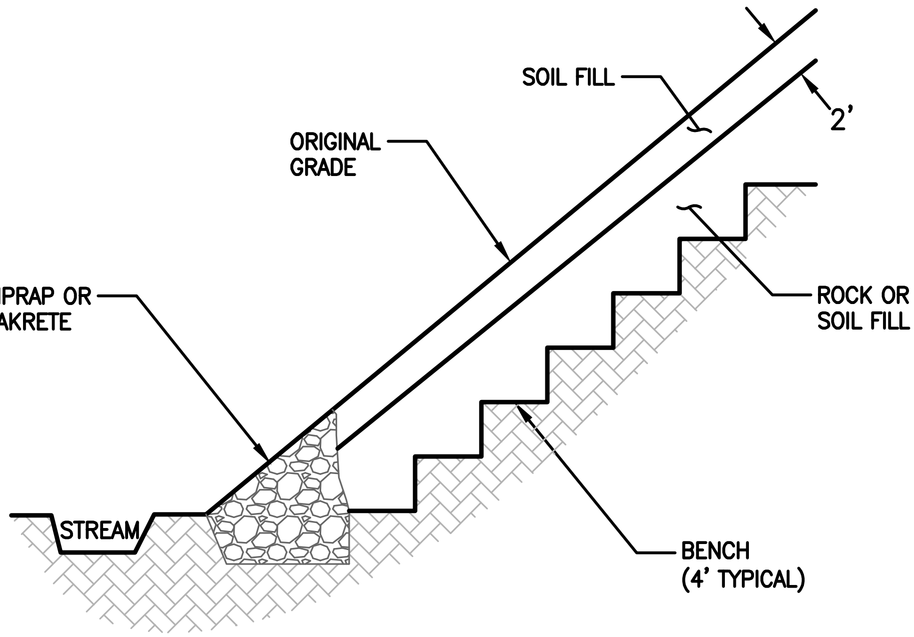


A–A' ROCK ARMOR ON STEEP SLOPE
N.T.S.

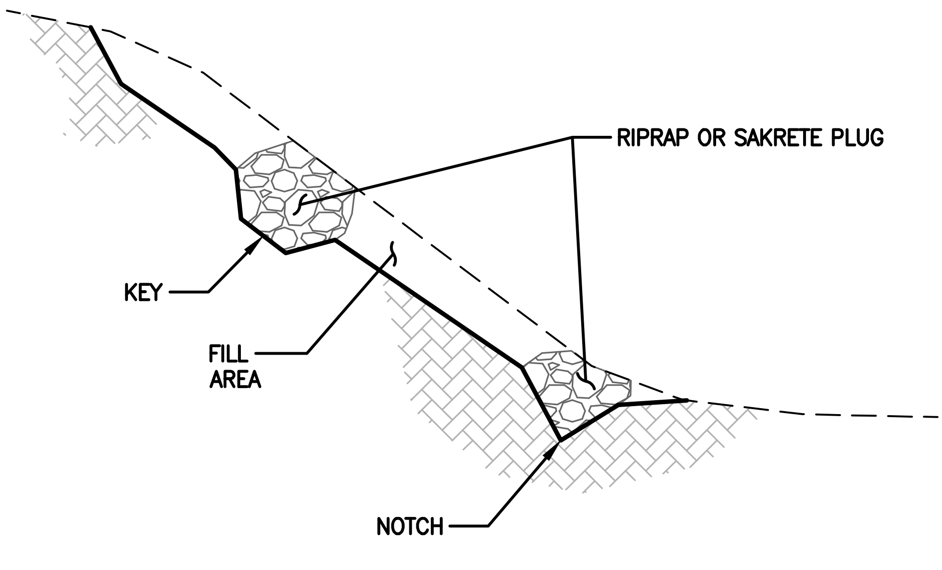
ROCK FILTER BLANKET DETAIL



TRENCH PLUG AND WATERBAR DETAIL

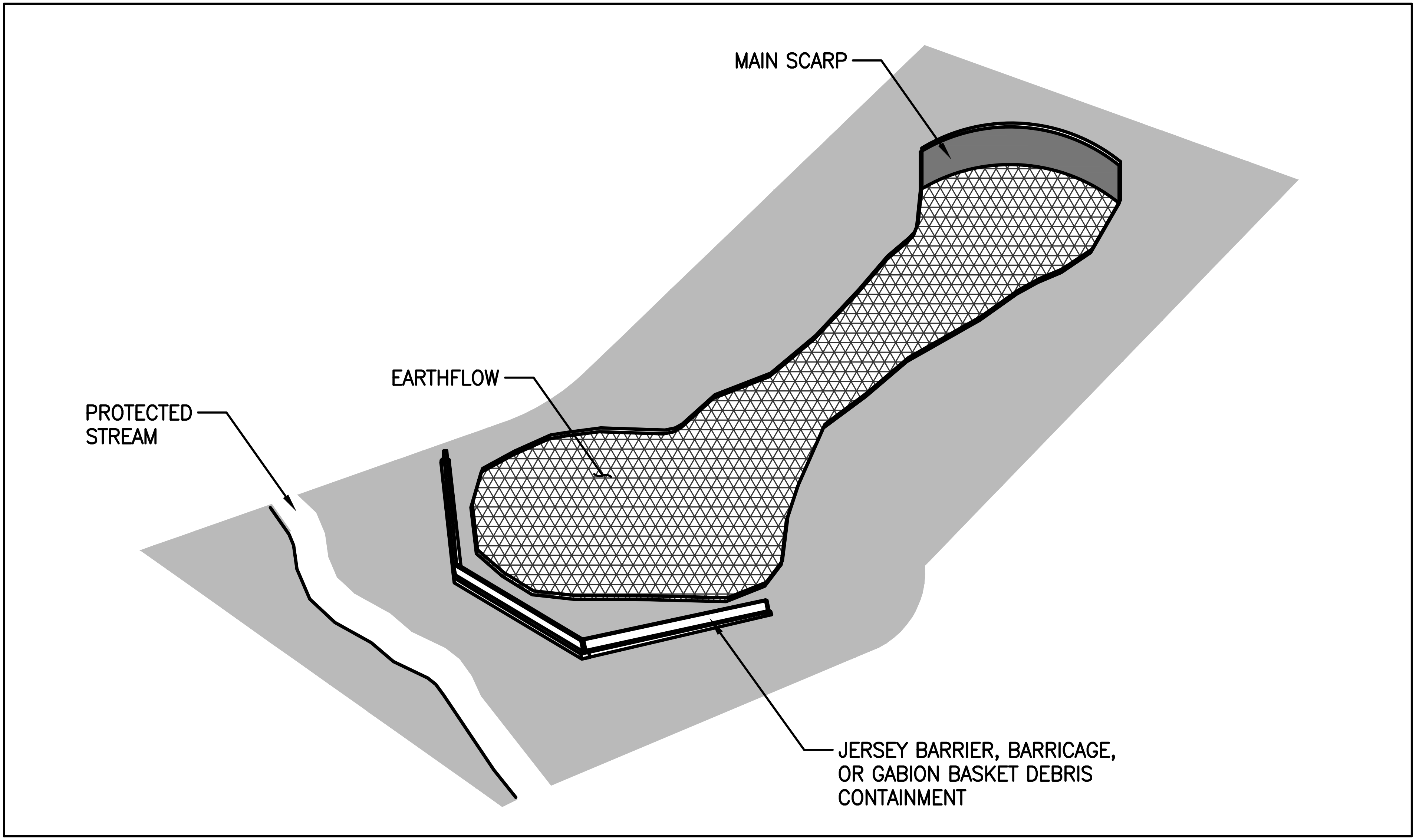


BENCH AND REGRADE TYPICAL
N.T.S.

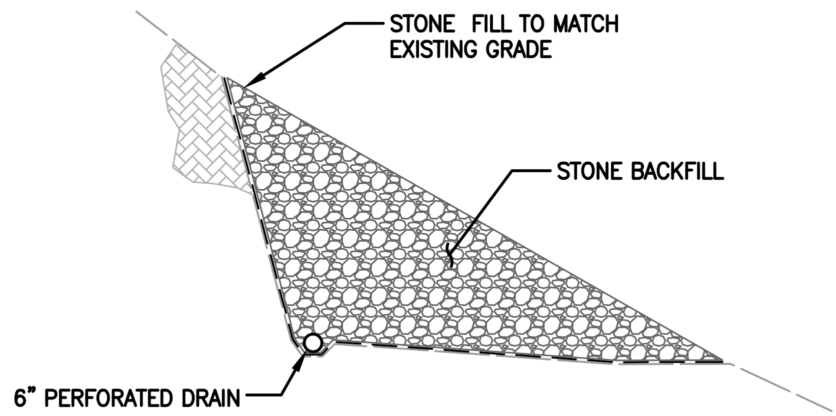


KEYING TYPICAL
N.T.S.

BENCH AND REGRADE WITH CONTROLLED BACKFILL DETAIL

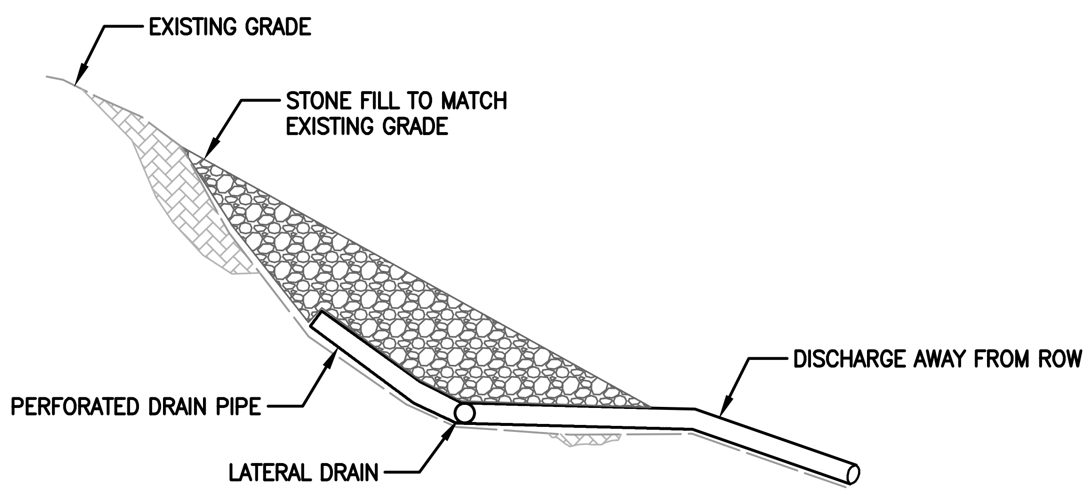


GABION BASKET/JERSEY BARRIER CONTAINMENT DETAIL



STONE WITH DRAIN TO RESTORE FAILING SLOPE

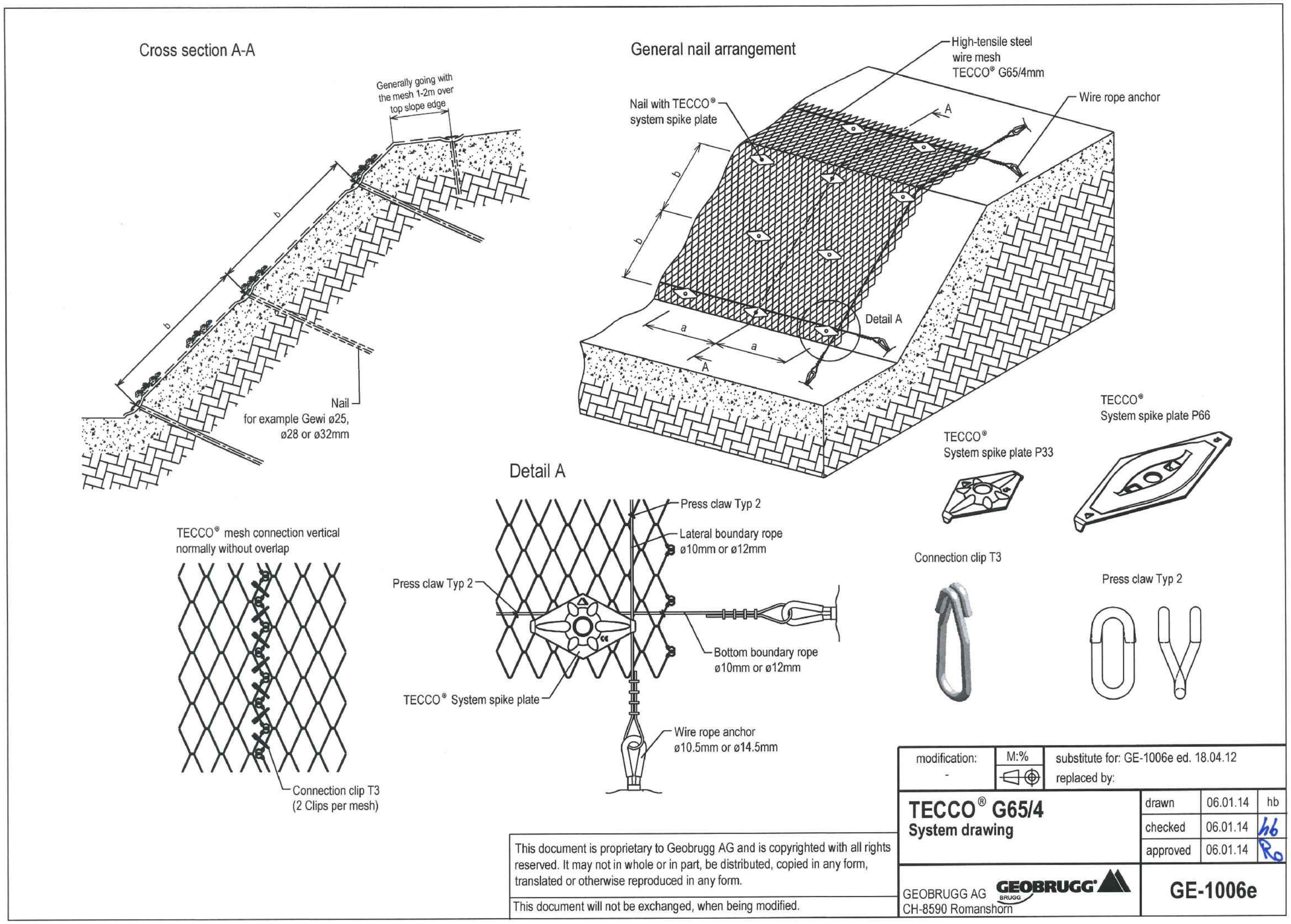
N.T.S.



SMALL SLIP REPAIR WITH LATERAL

N.T.S.

ROCK FILL ON SLOPES BETWEEN 30–38 DEGREES DETAIL



GEOBRUGG–TECCO SYSTEM – WIRE MESH STABILIZATION

APPENDIX C

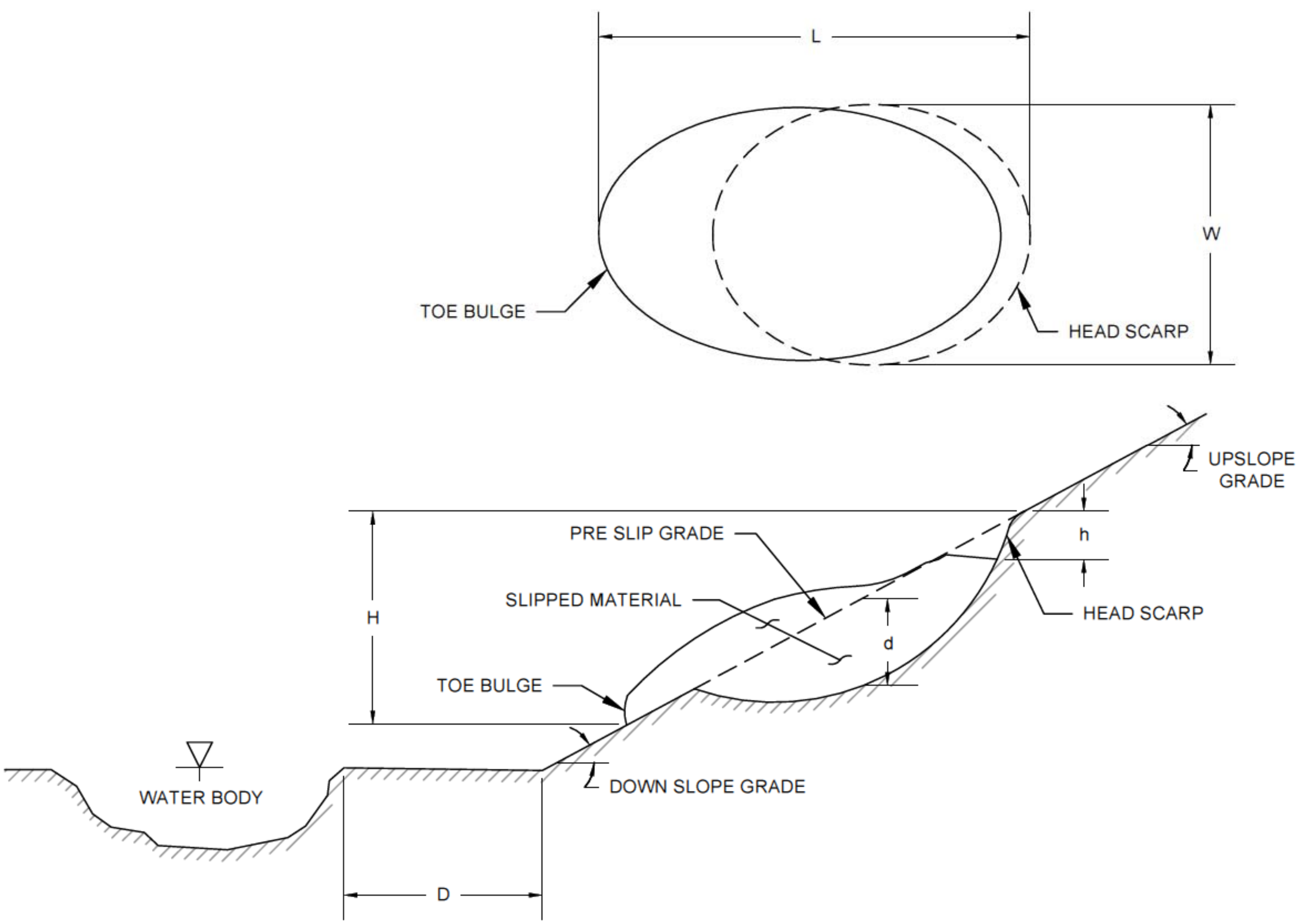
Forms

SLOPE FAILURE INFORMATION AND REPORTING FORM

Pipeline Name	
Slope Failure Station	GPS Coordinates Latitude ____________________ Longitude ____________________

Name of Observer	
Date	

Slope Failure Priority per Guidance in Appendix D Policy	◯ **1**	◯ **2**	◯ **3**	◯ **4**



Slope Characteristics

General dimensions (Rough estimate) *See above sketch for dimension key	Length, ***L*** (ft): ______________________ Width, ***W*** (ft): ______________________ Head Scarp Height, ***H*** (ft):_______________________ Height of total slope failure area, ***h*** (ft):______________________ Distance from base of slope to waterbody, ***D*** (ft)______________________ Estimated maximum depth of failure surface, ***d*** (ft)______________________
Slope Angle	At failure ◯ 20° or flatter ◯ 22° to 30° ◯ 30° to 38° ◯ Steeper than 38°
	Upslope ◯ 20° or flatter ◯ 22° to 30° ◯ 30° to 38° ◯ Steeper than 38°
	Downslope ◯ 20° or flatter ◯ 22° to 30° ◯ 30° to 38° ◯ Steeper than 38°
Slope direction relative to pipeline	◯ Pipeline is parallel to slope (up and down slope) ◯ Some amount of cross slope ◯ Pipeline is perpendicular to slope (cross slope, or sidehilling)
Slope type	◯ Natural ◯ Cut ◯ Fill ◯ Cut and fill
Presence of surface water	◯ Yes ◯ No ◯ Unknown Describe: ______________________
Presence of groundwater	◯ Yes ◯ No ◯ Unknown Describe: ______________________
Rock outcrops	◯ Yes ◯ No ◯ Possible Describe location:
Rock type	☐ Shale ☐ Mudstone /Claystone ☐ Siltstone ☐ Sandstone ☐ Limestone ☐ Coal ☐ Interbedded ☐ Others ______________________
Is there evidence of tree movement? **Look at trunks**	Perpendicular or leaning tree trunks is evidence of recent movement Describe: ______________________
	Tree trunk bending and going vertical is evidence of previous slide movement Describe: ______________________

Slope Failure Characteristics

Failure surface appearance	○ Circular ○ Hummocky ○ Terraced
Type of movement	○ Rotational slide ○ Translational block slide ○ Debris slide ○ Complex
Failure material(s)	○ Soil ○ Rock ○ Both Describe:
Head scarp	Describe:
Secondary scarps	Describe:
Evidence of toe bulge	○ Yes ○ No ○ Possible
Evidence of erosion	☐ Head ☐ Toe ☐ Flank ☐ Body ☐ None
Is failure within pipeline ROW	○ Permanent ○ Temporary ○ Outside LOD
Current impact to adjacent structures or properties	☐ Waterbody ☐ Pipeline/Utilities ☐ Roads ☐ Railroad ☐ Residential ☐ Buildings ☐ Bridge ☐ None ☐ Others______________________________ Distance from toe of slope (ft): ______________________________
Potential impact to adjacent structures or properties	☐ Waterbody ☐ Pipeline/Utilities ☐ Roads ☐ Railroad ☐ Residential ☐ Buildings ☐ Bridge ☐ None ☐ Others ______________________________ Horizontal distance from toe of slope (ft): ______________________________

Existing remediation	☐ Drainage ☐ Bio-stabilization ☐ Slope geometry correction ☐ Retaining structures ☐ Internal slope reinforcement ☐ Erosion control ☐ Chemical stabilization ☐ None ☐ Others ____________________ Describe:

Other

Site access	☐ Site is accessible by permanent road, or active temporary access road ☐ Site access requires traversing steep slopes or long distance along ROW
Contractor availability	☐ Pipeline contractor still on site ☐ Pipeline contractor no longer on site, but still responsible for ROW restoration ☐ Pipeline contractor not contractually obligated for ROW restoration ☐ Specialty contractor required for anticipated repair method

Comments	

Photo Log

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SLOPE FAILURE SKETCH

Plan View and Cross-Section

Pipeline Name	Slope Failure Station

SLOPE FAILURE REPAIR ASSESSMENT FORM

Use this form to evaluate whether repair of an existing slope failure will be field-directed or engineering-directed, and whether to engage a specialist in slope failure evaluation and repair (i.e., geotechnical engineer).

PIPELINE NAME: ____________________ **SLOPE FAILURE STATION:** __________________ **DATE:** ______________

FILLED OUT BY: ____________________ **PROJECT MANAGER:** __________________

Criteria	Value	Selected Score
Slope Steepness		
Flatter than 20 degrees	1	
20 degrees to 30 degrees	5	
30 degrees to 38 degrees	10	
Steeper than 38 degrees	20	
Slope Direction Relative to Pipeline		
Pipeline is parallel to slope (i.e., up and down the slope)	1	
Some amount of cross slope	5	
Pipeline is perpendicular to slope (i.e., cross slope, or sidehilling)	10	
Evidence of Pre-existing Slope Failures		
None	1	
Mapped slope failures are present at the site, or pipeline plans indicate this location is a slope failure-prone hazard	5	
Tree trunks in the vicinity bend and go vertical	10	
Slope Failure Location		
Slope failure and material is fully within ROW	1	
Slope failure or material extends beyond ROW	10	
Consequence of Future Movement		
No Potential for Impact to pipeline, water bodies, roadways or private property	1	
Slope failure has potential to cause danger to human health and the environment (compromises other utilities, pipeline rupture, blocked public roadway(s), fish kill, release of pipeline fluids, sediment/debris in stream)	3	
Slope failure has caused an immediate danger to human health and the environment (compromises other utilities, pipeline rupture, blocked public roadway(s), fish kill, release of pipeline fluids, sediment/debris in stream)	5	
Site Access		
Site is accessible by permanent road or active temp. access road	1	
Site access requires traversing steep slopes or long distance along ROW	5	
Contractor Availability		
Pipeline contractor still on site	1	
Pipeline contractor no longer on site, but still responsible for ROW restoration	3	
Pipeline contractor not contractually obligated for ROW restoration	5	
Specialty contractor required for anticipated slope failure repair method	10	
	TOTAL	**0**

	Score
Field-directed repair	7-25
Engineering-directed repair	20-35
Engage third party specialist (i.e., geotechnical engineer)	30-70

APPENDIX D
Slope Failure Priority Guidance

Slope Failure Priority Guidance

- If you identify a slope failure on an *actively permitted construction project*, you must immediately notify the Environmental Compliance Coordinator (ECC). The ECC will coordinate with Energy Environmental Infrastructure Services (EIES) to determine the slope failure priority and the regulatory agency notification requirements. The ECC will notify the appropriate regulatory agencies as applicable.
- The ECC and EIES will work with you to identify the slope failure priority (see below).
- The ECC will provide immediate notification to the appropriate regulatory agency as required. **NOTE**: most regulatory agencies define immediate as "upon awareness and knowledge," and generally expects this to occur within 2 hours.
- If the ECC cannot be reached, contact the permitting lead in EIES. If neither the ECC nor the EIES permitting lead can be reached, please review the Slope Failure Priority Guidance below and prioritize the slope failure. For all priority 1 and 2 slope failures, immediate notification must be made to the appropriate regulatory agency. In most states this is the state emergency Spill Line, but not the National Response Center.

Slope Failure Priority Guidance

Priority 1 Slope Failure:

Definition: A slope failure which has caused an immediate danger to human health and/or the environment. This type of slope failure requires an emergency response.

Criteria: If any one of the following criteria exists, it is a Priority 1 slope failure.

- Compromises or threatens other utilities.
- Active and/or functional pipeline is broken or detached.
- A public roadway which may be used for emergency vehicles is blocked.
- A fish kill has been observed and/or reported in the general vicinity.
- Release of aqueous phase hydrocarbons (i.e. condensate). If aqueous phase hydrocarbons have been released to surface water additional notification to the National Response Center may be required.

Required Actions: Depending on the criteria met above, at least one or more of the following actions must be taken for a Priority 1 slope failure.

- Contact 811 or the appropriate one call for utilities.
- Notify the appropriate state Spill Line.
- Contact responsible party if not Dominion and potential to impact our right of way.
- Contact any other outside agencies for emergency purposes as necessary.

Priority 2 Slope Failure:

Definition: A slope failure or associated migration of sediment and/or debris, which has reached a waterway causing Conditions Not Allowable in state waters.

Criteria: If any one of the following criteria exists, it is a Priority 2 slope failure.

- Slope failure material or sediment laden runoff has entered water body.
- A pipeline is exposed but not broken.

Required Actions: At least one of the following actions must be taken for a Priority 2 slope failure.

- Contact 811 or the appropriate one call for utilities.
- Notify the appropriate state Spill Line.
- Contact responsible party if not Dominion and potential to impact our right of way.
- Contact any other outside agencies for emergency purposes as necessary.

Priority 3 Slope Failure:

Definition: A slope failure, slide or associated migration of sediment and/or debris that has not yet reached state waters.

Criteria: If any one of the following criteria exists, it is a Priority 3 slope failure.

- Impact to the water body is imminent.

Required Actions:

- Notify responsible party if not Dominion and potential to impact our right of way.

Priority 4 Slope Failure:

Definition: A slope failure that poses little or no environmental threat.

Criteria:

- No water body in the immediate area.
- Low/no probability of Conditions Not Allowable (Sediment in water body, E&S controls not maintained).
- Pipeline is not in danger of exposure, severing, detaching or rupture.

Required Action:

- Notify responsible party if not Dominion and potential to impact our right of way.