

Dirt Gravel and Low
Volume Road Program
January 26, 2023
9am

Small Slip and Slide Repair

CDGRS

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Thanks to Sullivan and Cameron County
for example projects

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Small Slip and Slide Repair

- The Basics
- A Plan of Attack
- Example 1: Sizer Run Rd & Hunts Run Rd, Cameron County
- Example 2: Lick Creek Rd, Schrader Creek Rd, South Black Creek Rd Sullivan County



Credit: Cameron County CD

Diagnosing types and causes of roadside slope instability and simple, cost-effective techniques for road bank repair



Credit: Pike County CD

Don't let your most valuable assets slip away from you!



A User Guide to Diagnosing and Repairing Failing Road Banks

This guide describes common slope failures, the conditions that contribute to the failures and stabilization techniques that can be used to repair damaged slopes.

The guide reviews common causes of slope failure and methods of stabilizing slopes based on local site conditions, such as type of slope failure, type of soil, and drainage.

Scenarios for eight common slope failures are presented based on combinations of the site conditions.

As you will see, the recommended remedy for most all small slope failures is the same or similar in all the scenarios.



Authors: David Saftner, Carlos Carranza-Torres and Mitchell Nelson

Report Number: MN/RC 2017-17G

Date Published: June 2017

A User Guide to Diagnosing and Repairing Failing Road Banks

Slopes can be stabilized by adding a surface cover to the slope, excavating, and changing (or regrading) the slope geometry, adding support structures to reinforce the slope, or using drainage to control the groundwater in slope material.

Three site conditions should be considered when choosing an appropriate method for stabilizing a slope:

- Type of slope failure
- Type of soil
- Presence of groundwater (poor drainage)

Type of Slope Failure:

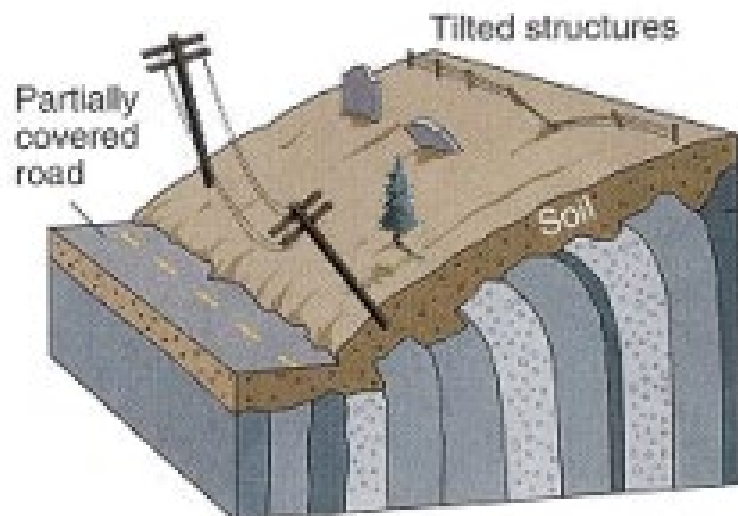
Slope failure is generally classified as either a rotational slide or a surficial soil creep.

- Rotational slide failures
 - circular pattern
 - leave behind exposed soil
- Creep failures
 - slow-moving
 - material gradually moves downhill

Surface cracking can indicate the slope is nearing a rotational slide failure.

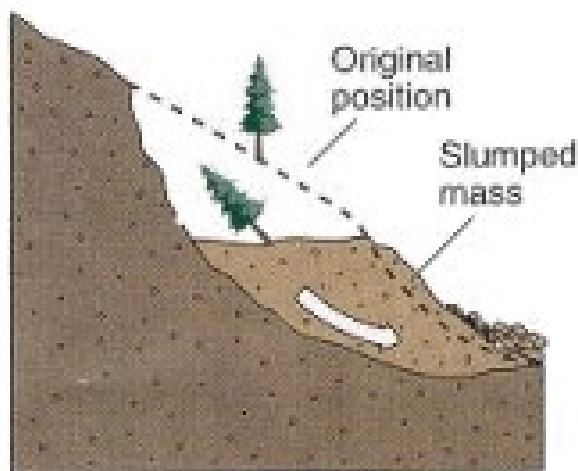
Common causes of creep failure are seasonal freeze-thaw cycles and inadequate shear strength properties in soil. Bent trees or signs can indicate creep failure.

Type of Slope Failure:



CREEP

Creep is the slow downslope movement of soil and loose rock fragments. Features on the surface will be tilted. Trees may show bent "pistol-butt" trunks.



SLUMP (Rotational Slide)

Slump is the slow to moderate movement of materials on a slope. In most cases the materials are unconsolidated or poorly consolidated. The motion is rotational, and the plane of movement is curved.

Type of Soil:

Two soil types to consider:

- Cohesive soils (such as silt and clay)
- Granular soils (sand)

Soil types can often be distinguished by a visual inspection, but sometimes laboratory testing is required.

Slopes made of granular or sandy soil are less likely to experience deep rotational slides.

Slopes made of cohesive soils like clay and silt usually have more drainage concerns and are more susceptible to seasonal frost heave.



Presence of Groundwater (poor drainage):

The third major site condition that affects a slope is poor drainage. Drainage is considered poor if groundwater lowers soil shear strength and leads to failure.

Groundwater has a significant effect on shear strength. **In the research study, removing groundwater provided the greatest difference in the output factor of safety.**



Diagnosing the Cure:

Determining the site conditions that most closely match the type of slope failure, type of soil, and presence of groundwater will guide you to one of eight practical repair methods to use.

	Failure Type	Soil Type	Groundwater Concerns?
Scenario 1	Rotational Slide	Cohesive	Yes
Scenario 2	Rotational Slide	Cohesive	No
Scenario 3	Rotational Slide	Granular	Yes
Scenario 4	Rotational Slide	Granular	No
Scenario 5	Surficial Creep	Cohesive	Yes
Scenario 6	Surficial Creep	Cohesive	No
Scenario 7	Surficial Creep	Granular	Yes
Scenario 8	Surficial Creep	Granular	No

Diagnosing the Cure:

To determine the appropriate scenario:

- First, determine the failure type (rotational or creep).
- Next, choose the soil type of the slope material (cohesive or granular).
- Then determine whether groundwater is present at the site.

*Note: “Poor drainage” is interchangeable with “groundwater concerns.”



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Plan of Attack:

Scenarios 1 through 4-

Site Conditions:

- **Rotational failure**
- Cohesive or sandy soil
- With or without groundwater concerns

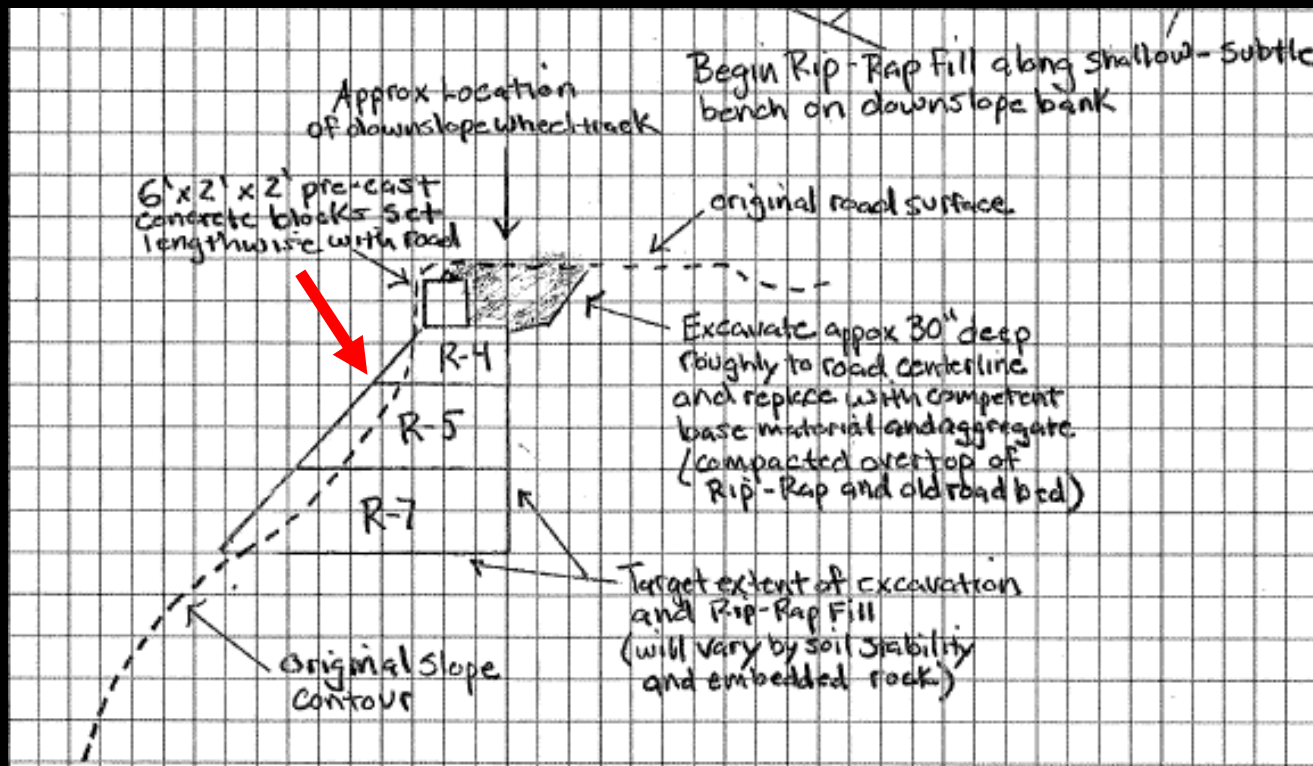
Recommended Stabilization Approach for all small rotational failures:

- Remove and replace poor soils
- Add drainage features
- Add vegetative cover, hard armoring or both (hard armor sandy soils to prevent erosion)



Plan of Attack:

- Drainage features remove groundwater
- Fill-and-regrade work adds stability
- Place drains near the toe of the slope
- If significant rotational failure has already occurred, rebuild the slope with as low of a slope angle as possible.



Plan of Attack:

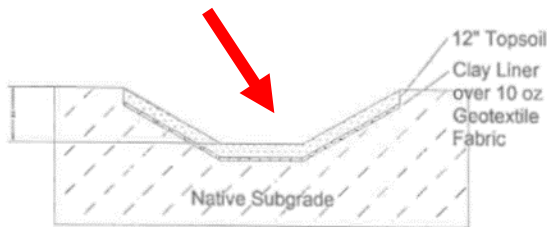
Specific to Sandy Soils:

Surface cover is very important for slopes with granular soil because erosion is a concern. Surface erosion can cause geometric inconsistencies that lead to failure. Erosion can often cause washout failure. Use a hard armor surface cover (riprap or coarse gravel).

Concrete Barrier Backed with Rip Rap Detail
N.T.S.



Clay Lined Swale Detail



*Clay Liner to be Bentomat SDN
N.T.S.



Plan of Attack:

Scenarios 5 through 8-

Site Conditions:

- **Creep failure**
- Cohesive or sandy soil
- With or without groundwater concerns

Recommended Stabilization Approach for all small creep failures:

- Remove and replace poor soils
- Add drainage features
- Add vegetative cover, hard armoring or both (hard armor sandy soils to prevent erosion)

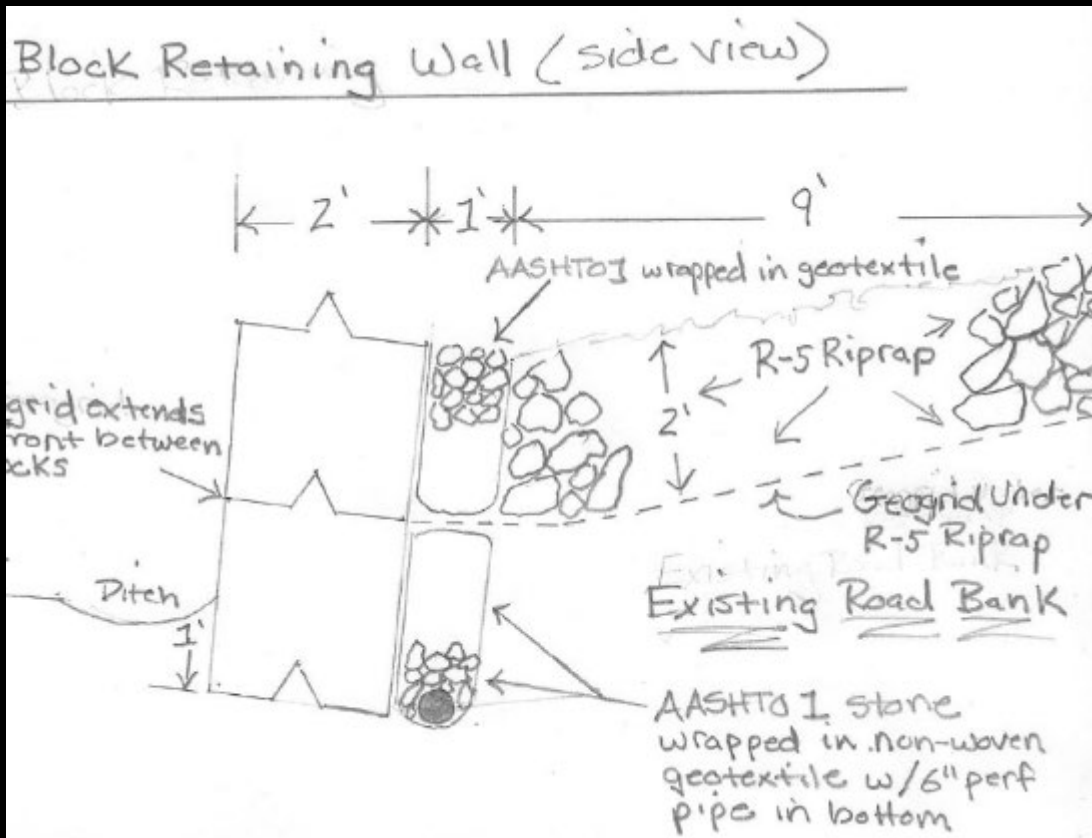


Credit: Wayne County CD



Plan of Attack:

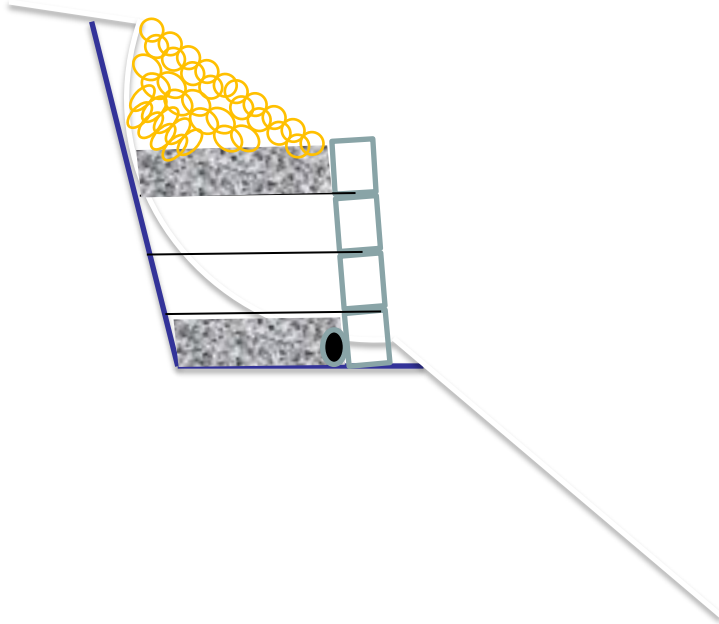
- Drainage features remove groundwater
- Fill-and-regrade work adds stability
- Place drains near the toe of the slope
- For creep failures, if soil cannot be removed and replaced, use a buttress at toe of the slope to stabilize the bank.



Plan of Attack:

Repair for Rotational Failures (Slumps)

With blocks, geosynthetics,
competent fill, drainage, and cover
(to control erosion)



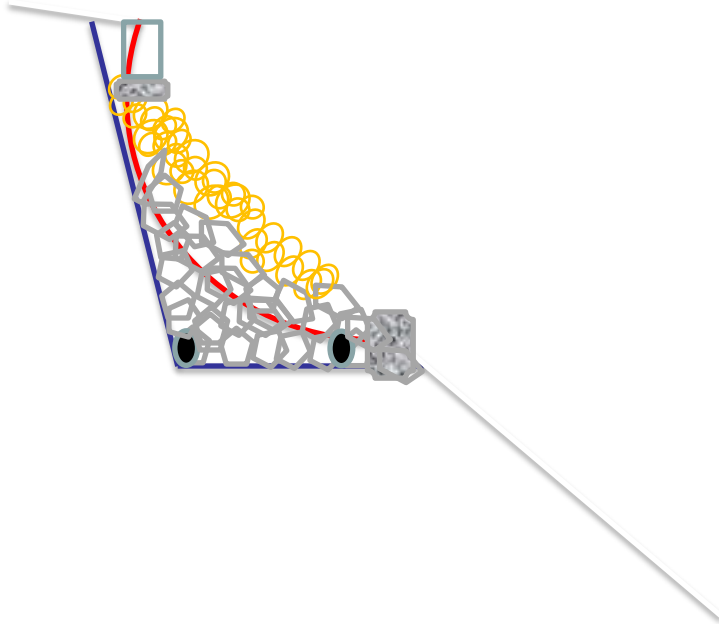
Must excavate below slip



Plan of Attack:

Repair for Rotational Failures (Slumps)

With Riprap, geosynthetics, drainage



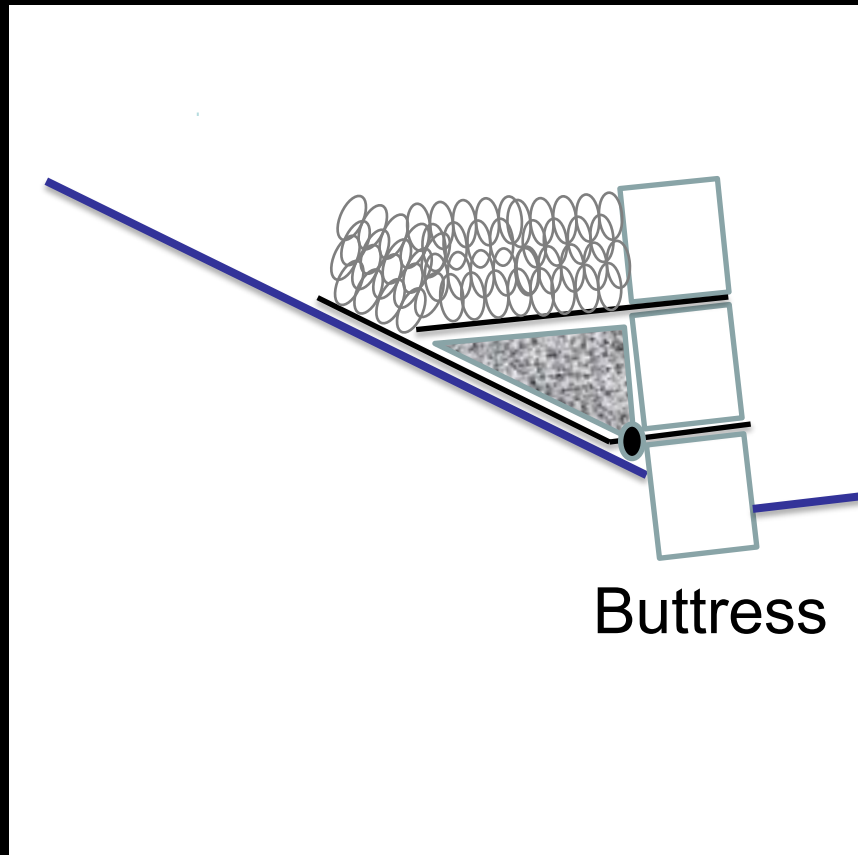
Must excavate below slip plane



Plan of Attack:

Repair for Creep Failures (Ooze)

With block, riprap, geosynthetics, drainage



Plan of Attack:

Repair concerns for all slope failures:

- Bank instability caused by over-steepening can often be corrected by “laying the bank back” (shaping to a lesser grade). Most common on upslope road banks.
- Loss of a stable toe from aggressive ditch cleaning, streambank erosion, etc. can trigger slope failure.
- Adding drainage features to your stabilization plan is cheap insurance against unforeseen problems.
- Don't underestimate the value of vegetation (or lack of) in maintaining bank stability, especially woody vegetation.
- Don't forget the benefits of fill to address bank instability.....

Fall Brook Road Fill Slope Stabilization Project



Fall Brook Road Fill Slope Stabilization Project



Fall Brook Road Fill Slope Stabilization Project



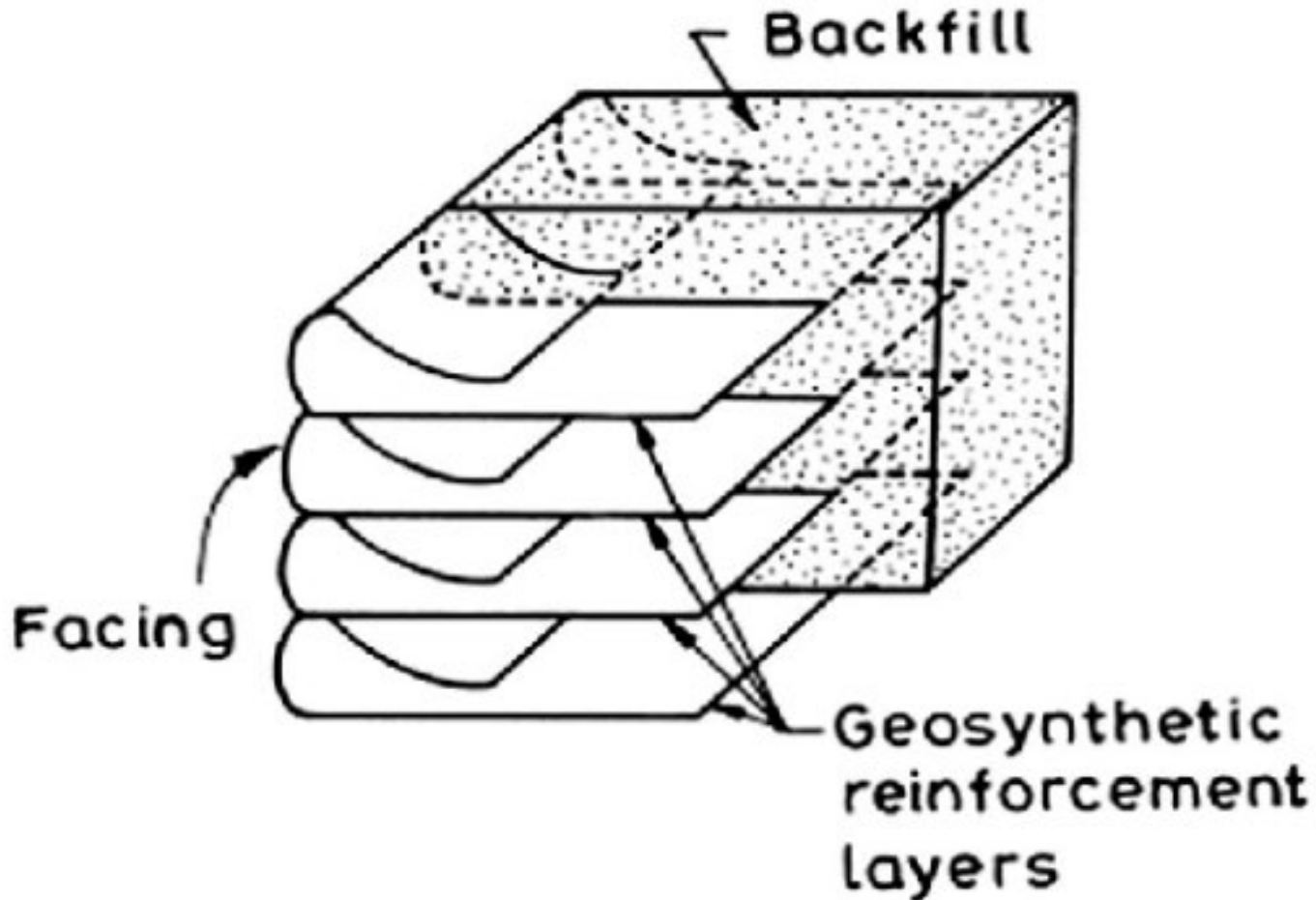
Knee replacement, hip replacement, toe replacement...

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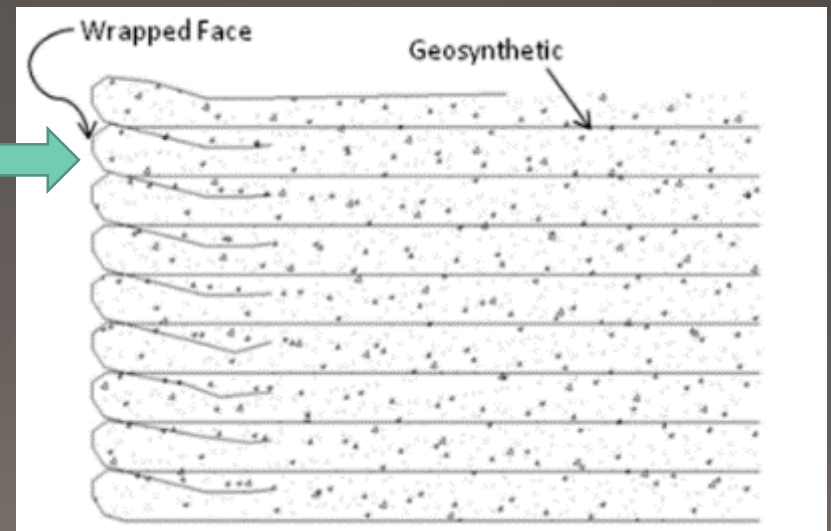


Geosynthetic Reinforced Soil (GRS) Slide Repair





Geosynthetic can be wrapped or pinched between facing block/rock



Benefits of GRS

- Cost \$\$\$
 - Traditional fixes are pricey
 - Significant resources
 - Specialized equipment
 - Done with readily available materials
- Can typically be done with township labor
- Can be completed in few days
- GRS repairs are not applicable to all sites



Sizer Run – Shippen Township



- 200' long 8' high
- Used Contractor for implementation
- 90 concrete blocks
- 2 new pipes
- 24 loads of 2RC
- 4 Days to complete
- \$23,200.00

Sizer Run



GRS stabilization method used
block wall extends to slip plane

Hunts Run Road – Lumber Township

- 2 different slides along road
- Hunts Run Class A Wild Trout
- Completed with Township Labor
- Both approximately 140' x 6'
- 100 mafia block
- 30 loads of 2RC
- Approximately \$29,000.00



Hunts Run Road



Stabilized both upslope
and downslope banks

Hunts Run Road



Lower bank repair used GRS
method with block wall

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AVOID THIS....



AND MAKE A PLAN

Lick Creek Road Sullivan County, PA

Lick Creek Road Dirt and Gravel Road Project Cherry Township, Sullivan County June 16, 2021

This road cuts across a side hill adjacent to Lick Creek. The road is down to bedrock in many places. Ditches are at road elevation and do not function. Areas of saturated unstable soils above the road slough into the road ditch and this is exaggerated when it is graded and cleaned in an attempt to get the ditch to function. To shape the road and aid pipe installations, fill is needed to elevate the road above the ditch and to cover bedrock with gradable material. Areas of bank stabilization are required. To avoid digging in bedrock or further bank destabilization, underdrain in ditches will not be used.

Stationing layout is oriented from the southwest to the northeast. I failed identify the starting point (station 00+00) in my field notes and will need to confirm the location before the start of the project.

00+00 –Begin project. Begin 12" of compacted road fill.

01+25 to 04+00 – elevate road with 18" of compacted road fill.

01+67 – Replace existing crosspipe with 15" x 20' HDPE pipe.

02+00 to 02+60 – Install concrete block retaining wall per project sketch #1 along north road bank.

02+11 – Leave existing 15" crosspipe.

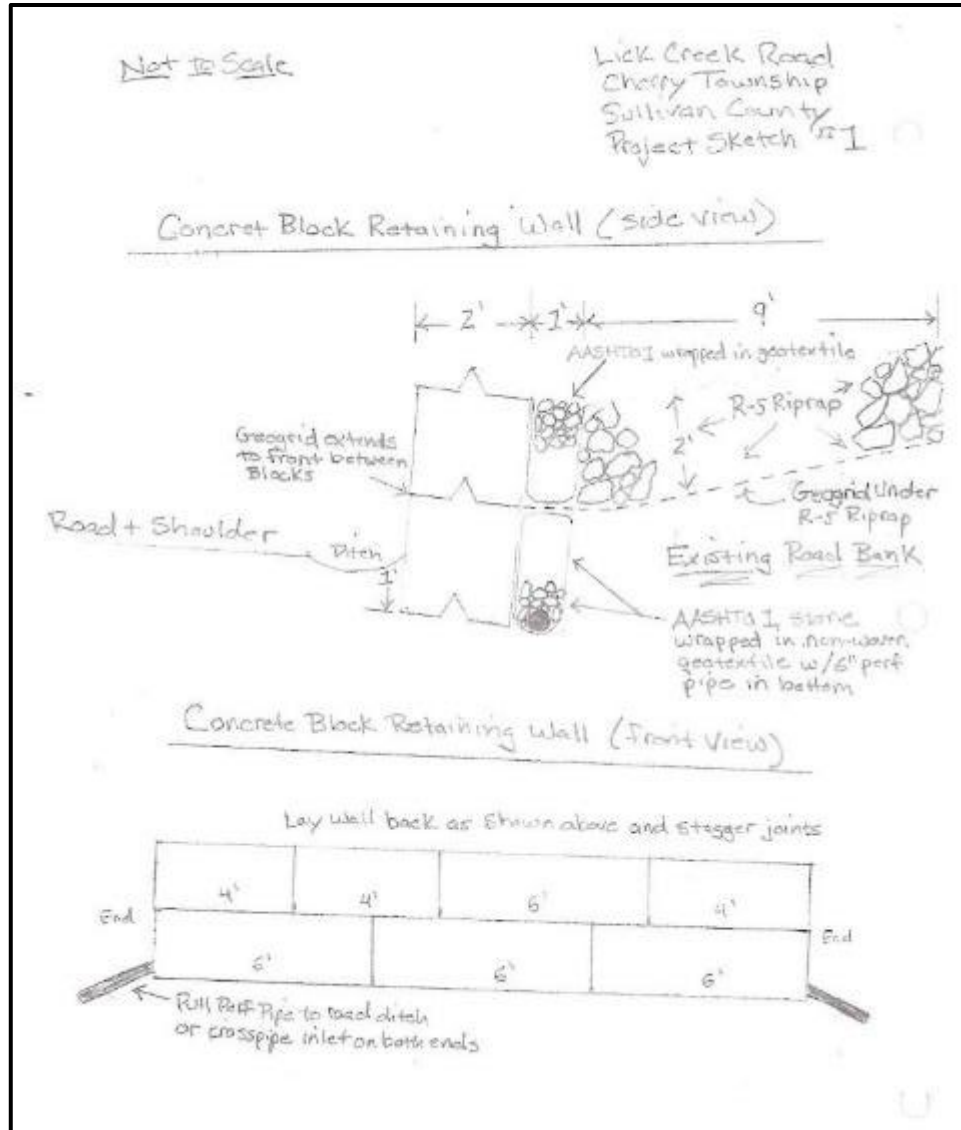
03+20 – Install new 15" x 20' HDPE crosspipe.

04+30 to 05+90 – Install concrete block retaining wall per project sketch RW1 along north road bank.

04+43 – Replace existing crosspipe with 15" x 20' HDPE pipe.

06+63 – Install new 15" x 20' HDPE crosspipe.

Lick Creek Road Bank Stabilization Plan



Lick Creek Road Before Stacked Concrete Wall



Bank sloughing onto roadway



Excavating for drain and rock overlay



Lick Creek Road

Stacked Concrete Wall #1 Completed



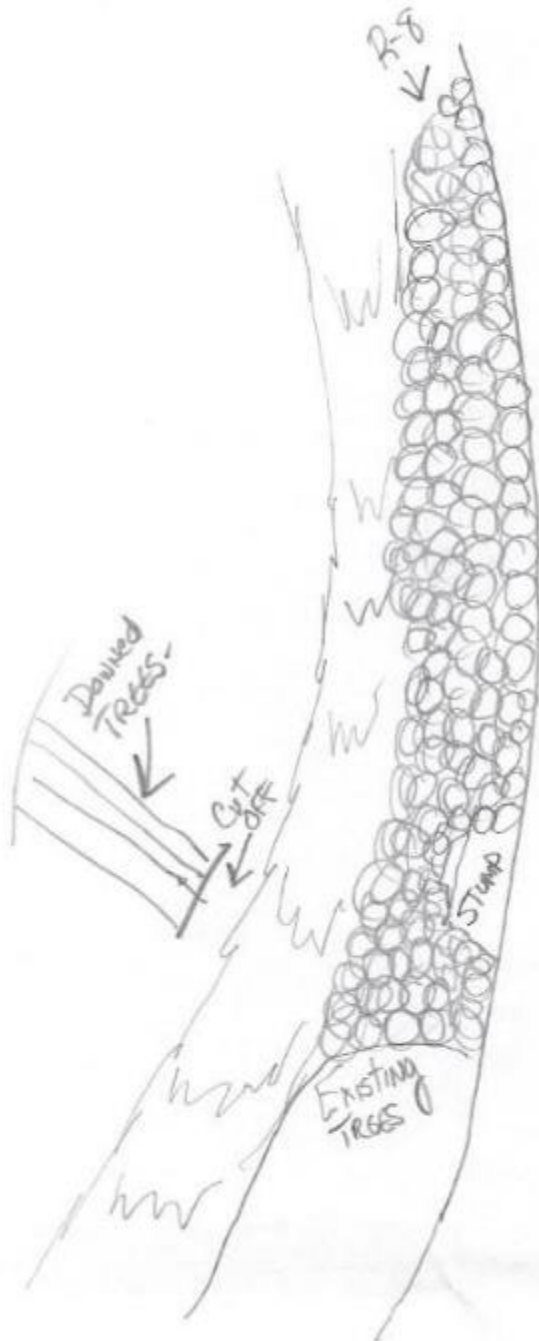
Lick Creek Road Stacked Concrete Wall #2 Completed



**Rock overlay
replaces poor soils**



**Footer drain and
pipe remove water**



R-8'S
 100' x 12' x 6'

Cut TREES FROM STUMP - CLEAR STREAM CHANNEL OF TREES - FULL STUMP AGAINST Embankment OR Remove FROM site if possible.

Two - TO REMOVE BANK ON OPPOSITE SIDE OF ROAD - SHIFT LANE 2-4'

R-STONE
 100
 x 12

 1200
 x 6

 7200 FT³
 x 27

 266400
 x 1.6

 372288 TONS
 x 1.5 = 277716 TONS

Schrader Creek Road Sullivan County, PA

Schrader Creek Road Before Stacked Rock Wall



**Slip Encroaching
on Road**

**Road Bank / Stream
Bank Failing**



Schrader Creek Road Completed Stacked Rock Wall



**Large Rock embedded
into channel make
stable toe**



**Road shifted for stable
bank angle without
stream encroachment**

Attachment A
To Contact SECTION 9106 OF THE PENNSYLVANIA VEHICLE CODE
DIRT, GRAVEL AND LOW VOLUME ROAD MAINTENANCE
GRANT APPLICATION

5790727

Sullivan County Forks Township Project Location: County Project Location: Municipality		District Use Only	
Carl Vough Supervisor/ Roadmaster 2591 ISM Certified Person Position Certification Date		Application Type: <input checked="" type="checkbox"/> DOR <input type="checkbox"/> LVR	
Forks Township Official Name of Applying Agency		Work Site ID: 5790727	
627 Malynena Hill Road Dushore Pa 18614 Mailing Address		Date Received: 9/30/22	
Carl Vough 570 794 3166 570 794 3847 Contact Person Phone Fax		E-Mail: chad@equi.com.NET	
South Blackcreek T 622 Road Name / ID Number		Blackcreek Affected Stream or Tributary	
Aug 2022 Proposed Project Start Date		Aug 2022 Proposed Project Completion Date	
		Existing Road Surface Type: <input checked="" type="checkbox"/> Unpaved <input type="checkbox"/> Paved Is project considered an emergency? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	

- The applicant is required to identify and obtain all necessary permits before starting the project.
- Identify the proposed work elements: Ditches Improved E ditch Outlets Added Ditch Right-of-Way Improvements
 Road Banks Improve Road Bank Improved Road Surface Stabilized
 Stream Crossings Improved Storm Water Improvements Vegetative Management Other: large culvert
 - The applicant is required to obtain the DSA Specification and Certification fees prior to DSA placement.
 - Complete Attachment B "Project Work Plan" including a sketch of proposed project. Attach a locational map with the project highlighted.
 - Project cost estimate: summarize costs here and attach detailed documentation if needed.

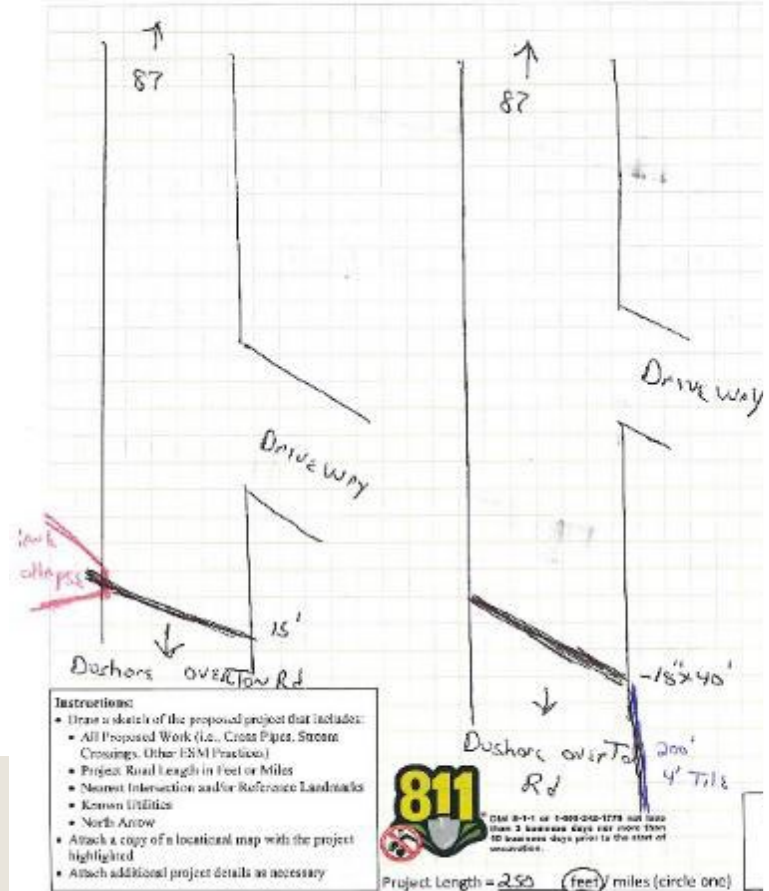
Grant Requested Funds			In-Kind Contributions		
Materials	Equipment	Labor	Materials	Equipment	Labor
Pipe Stone 4850.82	Trucking 2400.00		Soil/Gravel Pickup 1272.25		948.00

Grant Requested.....	\$ 7250.82
In-Kind Contributions.....	\$ 2220.25
Total Project Value.....	\$ 9471.07

Carl Vough
Applicant Signature Date: 9/26/2022

Attachment B
To Contact SECTION 9106 OF THE PENNSYLVANIA VEHICLE CODE
DIRT, GRAVEL AND LOW VOLUME ROAD MAINTENANCE
PROJECT WORK PLAN

Forks Township Applicant SOUTH Blackcreek T 622 Road Name / ID Number



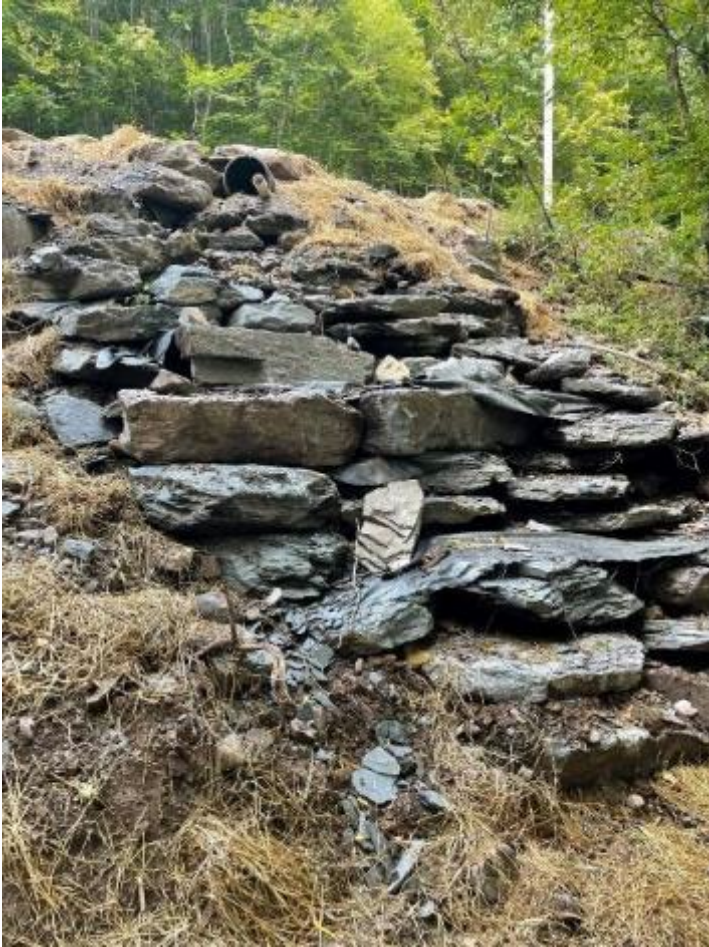
South Black Creek Road Sullivan County, PA

South Black Creek Road

Bank Failure Due To Surface Erosion Before Outfall Pipe Stabilization



South Black Creek Road Outfall Pipe Stabilization



**Reconstructed bank
at pipe outfall**



**Rock at stable angle
with large rock at toe**

Questions?

Or let us know your experiences.



CDGRS

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tmz115@psu.edu

Thanks to Sullivan and Cameron County
for example projects