Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

LAND RECLAMATION, LANDSLIDE TREATMENT

CODE 453

(ac)

DEFINITION

Stabilize in-place natural materials, mine spoil, waste, or overburden to prevent downslope movement.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Repair unstable natural or altered slopes to prevent slope failure
- Protect public health and safety
- Decrease erosion and sedimentation
- Improve offsite water quality, including downstream drinking water and landscape resource quality
- Create a condition conducive to establishing surface protection and beneficial land use

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where in-place material, mine spoil, waste, overburden, or altered natural slopes are unstable, moving, or have the potential of moving downslope in a manner that will cause damage to life, property, or the environment.

This practice does not apply to engineered or constructed embankments such as dams, dikes, levees, terraces, and road fills.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct the land reclamation, landslide treatment system to meet all Federal, Tribal, State, and local regulations.

Develop a site plan that is consistent with the site conditions, planned land use, landowner's conservation objectives, and sound engineering practice and judgement. The geologic investigation must be performed by an experienced or licensed geologist or geotechnical engineer.

When there is a risk for damage to private and public infrastructure or potential for loss of life, include controls to ensure safety. This may include the complete removal of the material subject to sliding or the removal of individuals occupying an affected area to the extent and duration deemed necessary.

Site investigations

The area of investigations must encompass the entire landslide and both surface and subsurface features that may have an influence on the landslide to determine the following:

- Surface profiles, cross sections, and topographic features

- Geologic profiles and cross sections showing attitude and conditions of strata and details of the slip zone
- Depth to a stable foundation
- Soil classification and engineering properties, including gradation, density, strength, and chemical characteristics for each stratum
- Ground water levels for all seasonal conditions
- Depth, extent, and volume of material involved
- Estimated preslide profile and subsurface conditions
- Conditions where slopes are stable in similar materials
- Extrinsic factors (e.g., land use activities and/or precipitation events) that triggered or remobilized the failure

The requirements contained in the NRCS National Engineering Manual (NEM) (Title 210), Part 531, "Geology" apply for the geologic investigations and seismic assessments.

Exercise extreme caution and carefully plan activities before permitting any personnel, drilling equipment, or construction machinery in the slide area. A slide is often active during wet periods and may be comparatively stable during dry periods.

Slope stability
Design measures to prevent or stabilize the slide area based on geotechnical engineering analysis and judgment of an engineer trained and experienced in soil and rock mechanics. The slope stability analysis must account for all site-specific critical soil and loading conditions and strengths. Use long-term strength parameters (c=0 and internal friction based on residual shear).

Select methods of slope stability analysis that are appropriate for the loading conditions and for the location and shape of sliding or potential failure surfaces. Provide appropriate safety factors based on the degree of uncertainty in the soil strength values used, the soil and water conditions assumed, and the detail of the analysis used.

Criteria for minimum seismic coefficients and recurrence interval must meet the most stringent of local, State, or Federal requirements.

Water control
Control sources of water entering the landslide area to the extent possible in accordance with the following:

Surface runoff water
Intercept runoff water entering the landslide area and divert to a stable outlet.

Water from direct precipitation
To the extent possible, limit infiltration by providing positive surface drainage and sealing surface cracks within the area. Grading and shaping may be required to provide positive surface drainage.

Install terraces, diversion structures, and waterways as needed to provide safe water disposal without erosion and with positive grade to reduce seepage. Protect the surface of the treated area from erosion as appropriate.

Ground water
Incorporate measures, including vegetative treatment where appropriate, to intercept ground water that contributes to instability of the area. Design drainage systems in accordance with NRCS National Engineering Handbook (NEH) (Title 210), Part 633, Chapter 26, "Gradation Design of Sand and Gravel Filters." Design for the system to remain operational in the event of limited movement of the landslide area after construction.

Earth material control
For the design, evaluate the impacts of the internal water and the earth and rock material on loading, strength, or counter-buttressing, as appropriate.

Loading control
Where appropriate, evaluate alternatives for loading control, including removing excess material from the upper portions of the slide mass; removing the entire slide mass; dewatering at least the upper portion of the slide; and removing excess weight associated with development. Identify sites for safe disposal of excavated slide material as part of planning and design.

Slope reduction
When practical, reduce critical slopes within the slide area by grading.

Increasing internal strength
Where appropriate, analyze the potential of removing and recompacting soil material at designed levels of moisture and compactive effort. Include in the analysis the impact of biotechnical slope stabilization practices.

External restraints
Use external restraints where slope movements must be limited due to high-valued improvements and where manipulation of the earthen material may not achieve the desired results. Design external restraints to withstand overturning, sliding at or below the base, and bearing failure of the foundation. All measures must include provisions for proper drainage.

Vegetative treatment
If vegetative treatment is part of the landslide treatment design, plant vegetation using selected soil bioengineering or biotechnical slope stabilization techniques appropriate to the site. Use deep-rooted grasses and shrubs with proven performance in soil bioengineering. Analysis and selection of site vegetative treatment must account for transpiration potential, rooting depth, soil pH, particle size, and nutrient content.

Component practices
Design and install all individual practices included as a main or supporting component to the landslide treatment in accordance with applicable NRCS conservation practice standards and specifications. If NRCS standards are not available, design and install the features using current engineering technology.

Environmental
Provide all disturbed areas with adequate water disposal systems, and establish vegetative cover, or otherwise protect the disturbed area to control erosion and sediment as soon as practicable. Include temporary protective measures if a long delay is anticipated in establishing permanent cover. Control human, animal, and vehicular traffic to protect the area.

Responsibilities
The landowner and/or contractor is the responsible party required to locate all buried utilities in the project area, including drainage tile and other structural measures. The landowner is also responsible for obtaining all necessary permits for project installation prior to construction.

CONSIDERATIONS

Consider installing instrumentation such as inclinometers, survey markers, piezometers, or flow measurement devices to monitor slope movement, pore water pressures, water levels, and seepage from the slope to ensure the repair is functioning as intended.

Consider the visual appearance of the completed site to ensure compatibility with nearby land uses.

Consider offsite water quality effects such as acid mine drainage.

When designing drainage systems to remain operative after limited land movement, use pipes with caution because of the potential of breaking and/or misalignment with further movement. Flat or nearly flat gradients should be avoided for the same reasons.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying this practice to achieve the intended purpose or purposes.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the site and review it with the landowner prior to construction. At a minimum, include—

- Periodically checking the site for areas where settlement may adversely affect drainage and land use. Perform needed repairs promptly
- Periodically checking the site for bare spots, eroded areas, areas of excessive settlement, and other areas where initial attempts to establish vegetation were not successful. Use soil testing to identify soil amendments needed to facilitate revegetation
- Maintaining access roads
- Maintaining drainage structures and channels
- Periodically checking the site for noxious weeds and invasive species. Treat, as appropriate
- Controlling vehicular traffic to minimize disturbance to reclaimed areas
- Periodically checking structural measures and fencing. Repair or replace, as needed
- Keeping regular records of site conditions using monitoring instrumentation, if applicable

REFERENCES

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USDA NRCS. Rural Abandoned Mine Program Handbook (Title 300). Washington, D.C.