U. S. Geological Survey.

REPORTS-OPEN FILE SERIES, no. 76-661: 1976.

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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Open-File Report 76-661

1976

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LANDSLIDE PROBLEMS AT WEST VALLEY NUCLEAR SERVICE CENTER, NEW YORK

--An Assessment and Recommendations for Study

By ROBERT W. FLEMING

Problems due to landslides prompted a visit to the West Valley Nuclear Service Center (WVNSC) near Springville, New York, on March 15 and 16, 1976. From this visit a report was prepared and contains the following:

1. An assessment of the landslide conditions.
2. An assessment of the immediacy of the landslide problems.
3. A suggested study program for reducing the landslide hazard to an acceptable level. It is apparently necessary that the integrity of the site be maintained for a very long period of time, perhaps 1,000 years.

I. Landslide Conditions. The surficial geology of the WVNSC and surrounding areas has been mapped by Robert Lafluer, Department of Geology, Rensselaer Polytechnical Institute. Landslide problems in the area appear to be confined to a glacial till, described by Lafluer as an olive-gray silt. At present, there are no measurements of the engineering or mineralogical characteristics of this silt.

The WVNSC is underlain by about 100 feet of the till. The area occupied by the large WVNSC buildings and adjacent flatlands is comprised of alluvial fan deposits as much as a few feet thick overlying the till. There seemingly was a significant amount of grading associated with construction of the center and the distributions of cut and fill are unknown;

however, the large landslides near the storage lagoons, about 1,000 feet east-northeast of the main buildings, are apparently related to grading for construction of the center. A preconstruction grading plan and map would be very useful background information.

The depth to the failure surface in the till is apparently less than 10 feet for slides on natural slopes, but may be significantly deeper for slopes that have been modified by cutting or filling. In the case of natural slopes, the depth to failure may be influenced by the depth of leaching or oxidation of the till. Very shallow landslides may be influenced by the depth of frost penetration.

A range in age of sliding is implied by the forms of hillside slopes. Relatively old failures are characterized by hummocky topography and subtle, lobate masses along valley floors. Active slides have scarps and cracks at the crowns, and bulging, lobate masses at the toes typical of a slump.

Current landslide problems are most severe in areas modified by cuts or fills and on slopes lacking vegetation. These areas extend well beyond the boundaries of the WVNSC. At the WVNSC, small slides are abundant in poorly compacted, sidehill fills of access roads, particularly near the underground disposal sites. Cuts that are only 4 or 5 feet high commonly contain several small slides. In natural slopes, sliding appears to be a dominant process in gully widening.

A research program for the landslide problem should attempt to evaluate: (a) the frequency of landsliding in the past, (b) the critical times of sliding during the year, (c) the characteristic dimensions of the slides and rates of movement, (d) the mechanics of landsliding, and (e) the potential corrective measures.

II. Assessment of Immediacy of the Problem. At present there is not enough information available to evaluate the seriousness of the problem. Most of the landslides at the WVNSC are small, but they pose a threat to the integrity of the disposal areas. Considering the requirements for stability of this site, studies are necessary to evaluate the long-term slope behavior and establish a course of remedial action.

Landslides near the lagoons pose a short-term problem. I have no reliable information on construction of the lagoons, history of the sliding, or on operating water levels in the lagoons. The existing landslides appear to pose a short-term and potentially dangerous threat to the easternmost lagoon. Continued slide movement could rupture the drain line or even encroach on the lagoon itself. I consider this to be the most serious immediate problem and recommend that it receive special attention.

III. Suggested Study Program. The suggested study program is divided into five parts. The first three are studies intended to develop an understanding of the areal distribution of landslides, history, and the mechanics of landsliding in the till. The fourth part is a recommendation for study of two large slides near the lagoons. The last suggests a program to test the possibility of using vegetation to control slope movements.

1. Prepare transverse and longitudinal profiles of first- and second-order stream valleys in the till and relate them to valley size. This should be a comprehensive study of slope forms both within and outside the boundaries of the West Valley Nuclear Service Center. The study should include observations of slope failures as they relate to slope height, slope inclination, valley shape, and vegetation.

2. Map the distribution of landslides in the West Valley Nuclear Service Center on the existing 1" = 400' site map, and determine the relative ages of sliding. If possible, determine the absolute time of failure for individual slides. Prepare planetable maps at about 1" = 20' of the large slides near the lagoons and record all cracks and other landslide features on the map.

3. On the basis of the mapping, select a representative sample of slides for more detailed study.

a. On one group of about five slides, excavate backhoe trenches through the slides to get an accurate location of the failure surface. Take a series of samples from the slide material and from the till below the failure plane. Obtain gradation, water content, Atterberg limits, and density measurements on all samples. Clay mineralogy should be determined on a few selected samples. Obtain the strength of three undisturbed samples from each slide: one in the landslide material, one from the failure plane, and one from the intact material below the slide. The methods of strength testing should be decided on the basis of preliminary studies, but residual direct shear tests probably would be best. (Assume 40 index tests and 15 strength tests.)

b. In a second representative group of about five slides, monitor the rates of movement of the slide materials. This could be done by surveying markers or continuously recording movements with extensometers. The frequency of monitoring should be determined from results of the initial series of measurements of rates of movement.

c. In two apparently stable slopes, dig trenches to obtain samples for testing, and, in two other locations, set reference markers for creep measurements. It would also be useful to set markers to measure soil removed by sheetwash. This is commonly done by placing washers around circular rods driven into the soil and marking the precise level of the washer on the rod. As soil is removed, the washer slips down the rod to record the amount of loss. The method could be modified to measure aggradation as well as soil loss.

d. Photography. One of the best methods of overall monitoring of landslide problems is by means of photography. Photography could also be useful in the analysis of the erosion-sedimentation problems. Because the area has low relief, low-altitude stereo photographs at a scale as large as

1:1,200 could be feasible. If funds permit, color photography is preferred. It is important to establish an accurate base map quickly and, if good ground control is established at the same time, detailed measurements can be made directly from the photographs. The area should be photographed twice each year, and more frequently if unusual climatic events occur. Also, photographs should be taken from specific points on the ground for a record of movements. Ideally, the photography should be from established bench marks along a specific bearing. The photographs would be most useful if a pair of large-format stereo cameras were used. It is possible to accurately resolve small movements with this technique.

4. Two lagoons located about 1,000 feet east-northeast of the main buildings have been excavated to a depth of about 30 feet in the till. The materials that were removed during excavation and placed nearby apparently have caused failure of the slope to Erdman Brook. The morphology of the slides along Erdman Brook near the lagoons suggests that the failure surfaces are deeper than those in the natural slopes. If so, they threaten the integrity of one of the lagoons.

I recommend that a geotechnical consultant examine the slope near the lagoon and make recommendations for stabilization of that slope.

5. Based on observations made during my reconnaissance, it appears that vegetation might effectively control slope failures. Slopes covered with large trees are much less prone to slide than slopes that are covered with grass or small bushes. I suggest that test areas be established to study the effectiveness of vegetation in controlling movements. A variety of trees and phreatophytes should be evaluated. In general, plants with deep and widespread roots, plants that require large amounts of water, and perhaps trees that tend to bloom early and to start using water early in the spring would be most useful.

Trees should be planted with minimal ground disturbance and should be of a size that their control effectiveness at maturity can be evaluated. The development of and changes in experimental control plots should be monitored regularly.

IV. Estimated Schedule of Study. The landslide study at the WVNSC should include a large initial effort directed toward a basic understanding of the problem. The scope of followup studies would be determined by the results of the basic program. For example, it is possible that the experimental vegetation study would reveal that the landslides can be controlled by a program of planting. If so, it would not be necessary to develop more than a rudimentary understanding of the landslide processes in the area.

Studies should begin as soon as possible. It is likely that the movements are greatest during the spring, and delay would cause loss of about a year's data. Ground control should be established and photography completed before the vegetation has blossomed. Instrumentation should be next in priority when enough is known to select the best slides for monitoring rates of movement. Ideally, the reconnaissance and mapping of the area should be completed before particular slides are selected for detailed study. However, if sliding is most active in the spring, it will be necessary to arbitrarily select a few slides for monitoring in order to obtain important data this year.

It is not appropriate to recommend a specific program for study of the slides before the slope measurements and mapping have been completed. However, regardless of the results of preliminary studies, it is likely that the study of the slides should include photography, trenching, laboratory testing, and measurement of surface displacements. I assume that drilling will not be a necessary part of most studies because the failures are apparently not deep. If the preliminary studies reveal that movements could be deeper than 10 to 15 feet, drilling would be required.