GEOTECHNICAL APPRAISAL - SLOPE STABILITY

Project: BERKELY/RIVERSIDE AREA STUDY

Location: North Vancouver, B.C.

Client: The Corporation of the District of North Vancouver

Our File: VA 2670 November 3, 1980

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1. INTRODUCTION

This report presents the results of a general geotechnical appraisal of the potential for slide activity along a section of the east bank of the Seymour River. The area studied was site of serious slide activity during a severe rainstorm in December, 1979. The section of slope in question is approximately one mile long, and extends from 2438 Carnation Street to 2425 Berkley Avenue, east of the Seymour River, in the District of North Vancouver.

Within the limits of the study area (Drawing D-2670-1), 68 residential properties are located along the crest and 56 along the base of the slope. The overall slope in the study area is about 250 feet high.

On December 17, 1979 after a period of several days of heavy rainfall, sliding occurred at three different locations along the slope. These slides appear to have originated in the over-steepened fill portions at the top of the slope and developed into flow slides which reached the base of the slope. One of the flow slides demolished two houses at the base of the slope. Also, some cracking and slumps were observed at other locations along the crest of the slope.

Klohn Leonoff Ltd. was retained by the District of North Vancouver to prepare a general geotechnical appraisal of the study area. The objectives of the investigation were to identify site conditions relevant to potential slope instability, and prepare recommendations for necessary remedial work to minimize the risk of future slope failures similar to those of 1979. The approach to the study was discussed in our letter of proposal dated May 12, 1980. Authorization to proceed with the work was received from the District of North Vancouver in a letter dated May 23, 1980. A copy of this letter and the terms of reference agreed to for this study are attached in

Appendix I. Within the terms of reference for this study we have attempted to identify areas of hazard from future slides. Due to the general, reconnaissance type, nature of this investigation, we cannot give assurance however, that all possible areas of hazard have been identified. Also, we wish to point out that while the remedial work is proposed to reduce the risk of serious sliding, some degree of risk will always exist even after remedial treatments are undertaken

2. SUMMARY OF OBSERVATIONS AND COMMENTS

- The overall slope in the study area is about 250 feet high with residential development both at the top and the bottom of the slope. Most of the slope is in its natural state with heavy vegetation typical of the slopes in the Coastal Range. Generally, the topography at the bottom and the top of the slope has been altered by the residential development, with the extent of alteration varying from property to property. At the top of the slope, fill has been placed to extend some of the lots, resulting in an artificially steepened slope; at the bottom of the slope, in some places, the slope has been cut back to a steeper configuration, again to extend the level lot area.

- There is no history of deep-seated sliding in the study area. The 1979 slides were all surface slides originating in the loose fill at the crest of the slope. At least one similar slide also occurred in 1972 following a period of heavy precipitation. The geology of the soils in the slope are such that a deep-seated slope failure is not considered a hazard in the slide area.

- Conditions exist at some locations along the crest of the slope such that there is danger of future surface slides during periods of heavy rainfall. The greatest danger of future sliding is at locations where slumping and cracking has occurred during previous storms and where over-steepened fill soils and debris have been placed at the crest of the natural slope, as discussed in the report.

- The greatest danger from future sliding is to the properties at the base of the slope. With one exception, houses at the crest of the slope are founded in dense natural soils and are not endangered by surface sliding of the outer portions of the fill slopes. The house at 2175 Berkley Avenue is founded on fill. However, it is located well back from the crest of the slope and outside any potentially unstable zone.

- The only possible danger to houses at the crest of the slope is in areas of previous sliding. The upper portions of the slope in the slide areas are quite steep and could ravel back, resulting in loss of support under some of the houses.

- To minimize the risk of future sliding, remedial work is recommended at locations of known slides as well as at other areas at the crest of the slope having moderate to high potential for future sliding. The recommendations for remedial measures are presented in Section 5 of the report.

- Some localized instabilities are noted at the back of about half of the properties at the base of the slope. These instabilities are localized in nature and are not likely to be a cause of any major sliding of the river bank slope. No remedial work is recommended at this time. Ravelling of slopes will continue, however, at some locations and will require periodic clean up and maintenance.

- Storm runoff is handled by open ditches along Lennox Street and Hayseed Close. Consideration should be given to elimination of these ditches and installation of a storm drainage system.

3. SCOPE OF GEOTECHNICAL EVALUATIONS UNDERTAKEN

Within the terms of reference for this study, as attached in Appendix I, general on-site inspections of the study area were undertaken by the professional staff of Klohn Leonoff Ltd. during the course of this assignment from June to October, 1980. The study area as shown on Drawing D-2670-1, extends from 2438 Carnation

Street to 2425 Berkley Avenue along the hillside slope west of Lennox Street - Layton Drive - Carman Place - Hayseed Close and Berkeley Avenue. The purpose of the above inspections was to identify site conditions relevant to potential slope instability in the study area, specifically, the following items of work were included in the on-site evaluations.

(a) Logging of soil exposures - this was only possible at a few locations such as slide areas. The slopes are generally covered with heavy growth. No deep investigations were undertaken.

(b) Examination of gradients of both natural and man-made slopes - gradients were determined with a hand held inclinometer; no detailed survey was done.

(c) Examination of degree and condition of vegetative cover on slopes.

(d) Identification of modifications to the topography both at the top and bottom of the slope due to residential development - The vegetative growth since residential development, which occurred as far back as 20 years ago, obscured any topographic changes and made their identification difficult.

(e) Logging of apparent spring and seepage activity - since much of this phase of on-site investigations was done during the relatively dry months of June and July, the seepages observed were quite low as compared to those which may occur during the wet winter months.

(f) Identification of changes in drainage patterns resulting from residential development - as in item (d), the extended period since construction and subsequent growth on slopes hindered this identification.

(g) Examination of any other factors the study identifies as being related to slope stability - existing conditions of settled or sloughed ground and/or the state of any retaining structures placed by home owners were noted at individual properties both at the top and the bottom of the slope. Discussions were held with most of the property owners as to their recollections of any events related to slope instability before, during and after heavy rainstorms, particularly those of 1972 and 1979.

The observations from the on-site inspections were recorded for each property in the form of detailed inspection reports with accompanying photographs in some cases. Summaries of our observations are given in Appendices II to IV. Because conditions at the base of the slope are not expected to cause major instability of the overall slope (see Section 6. of this report) summaries of our observations at the base of the slope are not included in this report.

The above on-site evaluations were supplemented with an examination of a series of air photographs of the site taken at various times over approximately the last 30 years, a review of published geological reports of the area, and information from our files from the last 30 years of practice in the Vancouver region. A previous geotechnical report pertaining to the study area prepared by Golder Associates dated January 8, 1980 was made available to us by the District of North Vancouver for review in connection with this study. A list of the published reports reviewed in this study is attached in Appendix V.

Recent known cases of slope instability in the study area have been associated with major rainstorms, both in 1972 and 1979. Data from these rainstorms have been analyzed, within the terms of reference for this study, to establish a probable frequency of occurrence of a rainstorm of similar pattern and severity to the 1979 storm which could be expected to trigger slope instability in local areas with high potential for failure.

4. GENERAL DISCUSSION OF FACTORS RELEVANT TO THE STUDY

Before discussing the types of remedial action required at specific locations along the hillside in the study area, it is pertinent to present a general discussion of factors affecting slope stability and other items included in the terms of reference for this study. Some of the more relevant factors are discussed below.

4.1 Subsoils, Seepage and Slope Gradients

The study area is anticipated to be underlain by bedrock of the Burrard Formation, consisting of sandstone and shale (including siltstone) with some conglomerate. The Seymour River Valley has cut into glacial and interglacial deposits placed during previous stages of ice advance and retreat. The soils in the hillside slope are dense glacial drift and interglacial deposits of dense sand and silt. At the surface, to a depth of five to ten feet, these deposits have been weathered and broken up into loose soil. Generally, on the upper area behind the crest of the slope, a five to ten foot thick deposit of medium to coarse gravel and interbedded sand is encountered.

Minor groundwater seepage zones were noted from place to place at various elevations along the slope. Also, more severe seepage or intermittent springs could be seen near the toe of the slope in various areas. In addition, a number of minor surface flow paths

for water are evident down the slope, some carrying surface runoff from uplands and some carrying water originating from groundwater seepage within the more pervious surface soils. The number of these seepage zones and the quantity of seepage will vary with variations in precipitation levels at different times of the year.

The gradient of the natural river bank slope in the study area shows local variations depending upon the underlying conditions. The steeper overall gradients are generally of the order of 30 to 35 degrees. At the crest of the river bank at numerous locations, the slope has been over-steepened by placement of fills for the purpose of extending the upland for residential development. Also, in some locations, the slope has been over-steepened at the base by cutting into the hillside for the same purpose.

4.2 History of Instability in the Study Area

The terms of reference for this study included an examination of air photographs of the site. A series of air photographs including years 1952, 1957-58, 1968, 1971, 1976 and 1979 was obtained. Unfortunately the scale of the photographs is too small to obtain any detailed information. Based on an examination of the above photographs, a review of the available published geotechnical information and general information from our files from the last thirty years of practice the following observations are indicated:

(a) There is no apparent history of deep-seated movement in the hillside slope at the study area.

(b) In addition to the slides that occurred in December 1979, there is evidence from 1976 air photographs that sliding may have occurred below Lennox Street during the previous major rainstorm of 1972. One of the slides occurred behind the property at 1425 Lennox Street. The evidence of 1972 sliding was noted during our on-site inspection of the study area. Discussions with the home owner at 1425 Lennox Street

confirmed that a major slope movement occurred affecting the property at the crest of the slope and was similar in nature to the 1979 slides. However, there were no buildings immediately at the base of the slope, so no damage occurred. A complete description of the details of this slide area is summarized in Appendix IV.

(c) There is evidence that sliding of any consequence in the study area has always been associated with periods of heavy rainfall.

(d) While there is moderate risk of seismic activity in the Vancouver area, there is no record of any sliding of consequence ever being triggered in the study area by a seismic shock. While there is always some risk that a seismic shock may trigger a failure at local areas with high potential for failure, the risk is relatively low. A seismic shock would have to coincide with a prolonged period of heavy rainfall for the highest risk, and the probability of two such events coinciding is very low.

(e) Generally speaking the steep natural slopes along the Seymour River Valley, even when totally unaffected by man's activity, are subject to surface sliding and slumping from time to time. The occasional natural slide movements occur when near surface subsoils weather and soften sufficiently, in some local very steep area, and the vegetative growth is unable to hold the soils in place. The process of weathering and gradual weakening of the near surface natural soils is very slow, taking decades or even centuries in many areas. The sliding on natural slopes almost never occurs during the drier season of the year, but takes place during wet periods when large quantities of water saturate the surface soils and increase seepage forces tending to move the surface soils down the slope.

(f) When generally loose fill soils and debris are placed on the steep natural slopes, the added weight of the man made fill increases the downward acting forces on the underlying natural soils, and lowers the factor of safety. The force increase is greatest where relatively large quantities of oversteep* man made fill are placed on the slope. In most instances the fill materails will sit safely on the slopes during drier weather conditions. However, the softening of the fill and underlying natural soils during periods of heavy prolonged rainfall, and the increase in activating forces, can result in a further reduction of the factor of safety and a surficial slope failure. If a failure occurs it may be within the fill alone, or within the natural soils underlying the fill. The occurrence of a failure in natural soils below a man made fill perched on a steep slope may be associated with the presence of the fill, and the failure may not have occurred if the fill was not present. The frequency of the occurrence of slides in the study area has increased with the increase of residential construction near the slope, and the major slides during the past 8 years have occurred in locations where relatively large quantities of fill and/or debris were placed on the slope, near the crest. If a zone of fill material, or a zone of fill and underlying natural soils, moves on the slope the movements may induce sliding in otherwise stable materials further down the slope. Also, if a slope failure originates part way down a steep slope the soils above the initial failure may lose some support and may subsequently fail.

(g) Water from the upland areas flowed over the natural slopes at various locations prior to any human alteration of the area. As indicated above, the temporary lowering of the factor of safety against sliding during heavy rainfall is generally the trigger for slide activity in any local area where the factor of safety is

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* the term oversteep is intended to indicate fill materials placed at a very steep angle at or close to the maximum angle of repose for the fill material, and sometimes steeper than the natural slope angle.

relatively low but not critical during drier periods. When storm drains and ditches on streets adjacent to the crest of the slope are installed and remove water from the area, the total volume of water flowing over the slope is decreased. A reduction in total volume of water flowing over the slopes is beneficial. When paved drive ways and roof drains collect water and discharge it on the upper portion of the slope the total volume of storm runoff over the slope is not increased from the natural condition, however, the distribution of discharge and the time rate may be changed from the natural condition.

(h) Potentially unstable conditions in man made fills and the surficial natural soils are aggravated if drain pipes are poorly maintained or designed (if they are broken, if the ends are covered, or if perforated drain pipe was used as the discharge line) and if they discharge concentrated flows of water into the soils, or directly onto fill soils or onto exceptionally steep weathered natural soils. Conversely, the least aggravation of potentially unstable conditions will occur if the drain pipes are properly maintained on a regular basis to ensure that:

- they are not broken nor the outlets covered.
- they have an energy dissipator box at the outlet end.
- the outlet end (energy dissipator) is located on the most stable available natural ground in an area that appears to have a low potential for sliding, beyond any fill soils.
- the drainage pipes are protected against blockage by ice during freezing weather.

Qualitatively, a small reduction in risk of failure of the natural slope soils would result if all water from drainage pipes was discharged beyond the base of the slope. However, this is costly and may be impractical. The damage to slope vegetation during installation may outweigh the benefit. As indicated above the most practical solution may be to locate the discharge and energy dissipators for each drain on the most stable nearby natural ground below any man made fill soils.

4.3 Stability of Natural Slopes

The steeper portions of the natural slope in the study area are at inclinations of 30° to 35°. The slopes are underlain by dense glacial drift and inter-glacial deposits of dense sand and silt. At the surface, to a depth of five to ten feet, these deposits have been weathered and loosened somewhat by frost and plant action.

In its geological development, the hillside slope in question has been subject to sliding due to the under cutting by the Seymour River. This slope is no longer subject to this natural process of erosion as it is now outside the influence area of the River. Nevertheless, local, weaker areas of the weathered surface material on the steeper portions of the slope will slump occasionally during periods of intense rainfall due to a temporary rise in the water table. This action will occur from time to time even in areas unaffected by man's activity. The vegetative cover on the slope in general is in fairly good condition, and it appears that slumping in the weathered zone has not been too serious in the immediate past.

4.4 Effects of Residential Development on Slope Stability

The slope conditions have been altered by the residential development at the top and the bottom of the slope in the following four ways with respect to stability considerations:

(a) Fills have been pushed over the crest of the natural slope to extend the upland area. The extent of fill placed varies from property to property. In many cases this fill is standing at slope angles much steeper than those of the natural slope below. The man made fills are primarily made up of native materials, perhaps from excavations made on each property during the course of property development. In some cases, large amounts of local debris such as trees, etc. have been incorporated in the fill.

The outer portions of the man made fills extending beyond the crest of the natural slope are potentially unstable and are subject to sliding, particularly during periods of heavy rainfall.

(b) At the bottom of the slope, the lot areas have been extended in some locations by cutting into the natural slope at the back of the properties. While these oversteepened portions of the slope are a source of continuing minor localized soil movement, they are not a serious concern with respect to major slope failures of the type that took place in 1979.

(c) Due to the general development behind the crest of the slope, surface runoff water which would have previously drained over the slope has now been directed into the storm sewer system. This is definitely an improvement in the slope conditions as far as general stability aspects are concerned.

(d) Due to residential development, some of the surface runoff is now collected and discharged over the hillside slope in concentrated flows from roof and driveway drains. If blocked or broken, these drains can also discharge concentrated flows directly into the relatively loose man made fills at the crest of the slope. Many of the drain pipe outlets were not evident at the properties examined and the disposition of water flow from these drains is unknown. Uncontrolled concentrated drainage into the fill or on the slope is generally not desirable from the viewpoint of slope stability.

The major hazard of potential slope instability is in the loose and over-steepened fill deposited at the crest of the natural slope at some locations. If this material slides, it may induce sliding in the weathered natural soils on the slope below. The over-steepened loose fill zones have a low risk of failure during dry weather conditions with an increasing risk during wet weather. As discussed below, water is the additional "triggering" factor for a major flow slide.

4.5 Role of Water in Slope Stability

Excessive water is the major "triggering" factor in most cases of slope instability. In slope instabilities such as those of 1979 in the study area, water, generally from prolonged and heavy rainfall is necessary to trigger the failure of the loose and overly steep fill zones with high potential for failure. In a recent paper (Eisbacher and Clague, 1980) 27 cases of landslides have been associated with rainstorms in the Vancouver region in this century alone.

The most common of slides triggered by water are slippages in the loose surface material on the slopes and are generally referred to as flow slides, mud flows, debris flows or surface slides. The main cause of these slides is the temporary rise in the water table in the surface soils. Also, downslope forces on the soil are increased due to an increase in the weight of soil through increase in water content. If surface runoff flows into cracks in the potentially unstable fill zones, the water pressure in the cracks can lead to further widening of cracks and thus, initiation of movement.

Once an initial failure occurs, the failed soil can block drainage; a second more severe failure may follow the initial small failure when blocked water and soil break free. When drainage is blocked by the first failure, the second failure is often larger and more damaging.

On December 17, 1979, we believe the outer portion of the fill material at the crest of the slope most likely failed first. The failed material then moved down the slope scouring and gouging surface debris and weathered soils on the lower portions of the slopes.

4.6 Analysis of Storm Data

Since sliding in the study area has in the past been associated with heavy rainstorms, we have evaluated the return periods of the 1979 and 1972 rainstorms that have been related to known cases of instability at the site. In local areas of potentially unstable fill or weathered natural soils, the likelihood of future slide activity is primarily related to the probability of occurrence of storms with the same order, or greater intensity and duration than those of the previous storms when sliding occurred. It should be noted, however, that some portions of the slope where cracking

occurred during the 1979 storm have been weakened and could be susceptible to failure under conditions less severe than those of the 1979 storm. Data analyses for the above two storms in question are presented below.

General Method of Analysis. The procedure followed was to select nearby stations that bracketed the site in elevation, and use this data to estimate the rainfall at the site for the storm period. Rainfall intensity-duration-frequency (I-D-F) curves available from the Atmospheric Environment Service were used to estimate I-D-F curves for the site. These curves were used to predict the return period of storms of various durations at the site.

1979 Storm

Precipitation at Site - December 12 to 18, 1979. A typical elevation for the study area (mid-slope) is 300 feet. The following stations were selected to provide data for the estimate of precipitation at the site:

STATION	ELEVATION (FT.)	START OF RECORD
1. North Vancouver Second Narrows	12	1957
2. Seymour Boulevard	28	1968
3. North Vancouver Municipal Hall	475	1964
4. Seymour Falls	800	1927

Other stations further from the study area were not considered because physiographic influences would make these records less representative of the site. Even though the Ioco Refinery station is located on the North Shore at a similar elevation as the study site, it was not included in the analysis as its December 1979 pattern of rainfall differed significantly from that of the above four stations.

Mass curves of accumulated rainfall during the 7-day period of December 12-18, 1979 were plotted for the above four stations, from which the rainfall rate at the study site was estimated. These precipitation data are shown on Drawing D-2670-3 and are summarized as follows:

Precipitation at Site

Date - December, 1979	12	13	14	15	16	*17	18
Daily Precipitation (mm)	35	90	20	0	95	70	15
Accumulated Precipitation (mm)	35	125	145	145	240	310	325

It should be noted that the daily totals for the stations (and therefore for the site) are based on a climate day, usually taken from 0800 PST on the date given to 0800 PST on the following day.

Based on the estimated daily precipitation, the rainfall extremes for the 7-day period at the site were as follows:

Duration (consecutive days)	1	2	3	4	5	*6	7
Rainfall extreme (mm)	95	165	180	205	275	310	325

* Large slides occurred on this day.

Return Periods* for the December 12-18, 1979 Rainfall Extremes at Site

Rainfall intensity-duration-frequency (I-D-F) curves were available from Atmospheric Environment Service for 1 to 10 day storms at North Vancouver Second Narrows and Seymour Falls, and from the Greater Vancouver Regional District for 1 day storms at North Vancouver Municipal Hall. Elevation-precipitation curves were plotted for a range of durations and return periods from the available I-D-F curves. An I-D-F curve was generated for the site (see Drawing D-2670-4) from reading the elevation precipitation curves at elevation 300 feet. Using the I-D-F curves, return periods for the December 12-18, 1979 rainfall extremes were estimated as follows:

Return Period for Extreme Rainfalls (Years)

Duration of Extreme (days)	Elev.	1	2	3	4	5	6	7
N. Vancouver 2nd Narrows	(12 ft.)	3	6	5	4	21	21	16
Estimate at Study Site	(300 ft.)	3	6	4	4	9	12	12
Seymour Falls	(800 ft.)	3	4	4	3	8	9	7

North Vancouver Municipal Hall

(daily rainfall)

- maximum in 24 hours 12 years
- maximum calendar day 8 years
- maximum climatic day 3 years

* The return period for a storm is the average time interval for recurrence, however, equivlent storms may occur at shorter time intervals than the average. A better way to consider the probability of occurrence of an event is to consider that the fraction 1/Return period is the probability of occurrence in any one year.

As can be seen for the records for the Municipal Hall station, the choice of day can significantly affect the return period for a 1-day extreme rainfall. However, for longer duration storms the effect becomes much smaller. Since the slides occurred on December 17, the duration of the storm is 6 days and the estimated return period is 12 years or less.

1972 Storm

A comparison was made between the storms of 1972 and 1979. The return periods for storms of various durations were estimated for two stations for which I-D-F curves were available from Atmospheric Environment Service for durations greater than one day:

Return Periods

Station	Storm	Duration (days) 1	3	5	10	Max. 24 hours
North Van. 2nd Narrows	Dec. 1972	13	5	15	20	24
	Dec. 1979	3	5	21	8	
Seymour Falls	Dec. 1972	2	3	5	10	13
	Dec. 1979	3	4	8	5	

As can be seen, the 3-day extremes were similar for both storms, while 1-day and 10-day extremes were generally greater in 1972, and the 5-day extreme was greater in 1979 than in 1972. It is not possible to say in advance what period of storm will be most critical for any given slope. An estimate of the return period for a 5-day extreme at the site for the 1972 storm is 6 years compared with 9 years for the 1979 storm.

In a technical paper by Eddy (1980) which investigated the Christmas day 1972 storm, he estimated that the return period for the maximum 24 hour rainfall at the study site is 5 years, and at the North Vancouver Municipal Hall is 9 years.

4.7 Rainfall Intensity and Pattern

The pattern of the rainfall as well as the total precipitation will affect the stability of some slopes. However, the studies have shown that storm rainfall associated with instability of portions of a slope with a high potential for failure is not uncommon. Rainfall similar to the December 1972 and the December 1979 storms probably reoccurs 10 to 20 times per century at the study area.

From the rainfall records for the North Vancouver Municipal Hall station (November 1963-December 1977), the eight largest 5-day extreme rainfalls were obtained and cumulative rainfall curves have been plotted on Drawing A-2670-5. The 5-day totals ranged from 56% to 85% of that for the December 1979 storm. As noted by Schaefer (1980) the December 1979 storm was slightly unusual in that the storm consisted of two distinct periods of rainfall separated by a dry spell. However, it is not obvious that this pattern would be more severe than, for example, the January 1968 storm during which over 80% of the five day total fell on two consecutive days. Slope instability occurred somewhere in the Greater Vancouver area for six of the eight storms plotted, according to Eisbacher and Clague (1980).

4.8 Discussion of Rainfall Analysis

A number of points should be kept in mind in regard to the rainfall analysis. First the exact pattern of each storm is unique and will not be repeated. Secondly, there is not a recording station on the site so that information had to be extrapolated to the site, giving an estimate of the pattern of the storm at the site. Thirdly, the

periods of record for the precipitation stations are of relatively short duration, so the return period estimates are more approximate than those that could be computed for other long-term stations. Fourthly, the nature of rainfall extremes is logarithmic so that a relatively small percentage increase in rainfall can produce a large change in the estimated return period. For example, on Drawing A-2670-4, an increase in rainfall of 7-day duration from 320 mm to 380 mm (less than 20%), changes the estimated return period from 10 years to 25 years (250%).

In summary the analysis of the available storm data indicates the return period for a storm likely to cause instability of fills or natural soils with a high potential for sliding is less than 12 years. That is, the probability of occurrence of a storm of equal or greater intensity, for the same duration, is 1/12 (8%) or greater in any one year. The fact that sliding at areas with a high potential for sliding occurred in both 1972 and 1979 confirms that the relevant return period is relatively short.

4.9 Comments on Golder Associates Report

Golder Associates prepared a report dated January 8, 1980 concerning the "Mudslides - December 17, 1979 - Riverside Drive - North Vancouver, B.C." The report briefly outlined their involvement immediately following the slides, discussed the causes and nature of the slides, commented on the potential for future slides, and included general recommendations regarding remedial measures. The Golder report was not a general study and only dealt with the need for remedial works at the three existing slide areas and near 1305 Lennox and 2217 Berkley where a potential for future sliding was considered to exist.

Within the terms of reference for this report we are obliged to comment on the findings and recommendations of the Golder Associates

report. We are generally in agreement with their findings and recommendations. The following are some of the most note-worthy comments in their report.

(a) "...the slides were caused primarily by the heavy precipitation conditions but the slides were initiated by failure of loose fill materials at the crest of the slope." (p.5)

(b) "The sites where slides have occurred... are now more stable than they were before the slides took place... however, minor sloughing and ravelling will occur near the crest of the slide scarps. With time... back to a slope of the order of 30 to 35 degrees." (p.5 & 6)

(c) "Where slides did not occur, but where surface cracking and settlement of filled ground took place, there is a potential for future slides. However, these potential slides would not likely develop unless precipitation and groundwater conditions worse than those of December 17th, (1979), were to occur." (p.6)

(d) "Wherever there is fill at the crest of the slope and wherever groundwater drainage is toward or into these fills, there is a greater potential for instabilities to develop as compared to areas where these conditions do not exist." (p.6)

(e) "It is recommended that remedial treatments be carried out in the three existing slide areas to prevent further ravelling... and to control erosion... Consideration should also be given to stabilization of locally oversteepened slopes along the slide path." (p.6)

(f) "...remedial treatments should also be carried out near 1305 Lennox and 2217 Berkley..." (p.7)

(g) "Wherever there is fill at the crest of the slope and wherever groundwater drainage is toward or into these fills... (the) potential (for instability) can be relieved if suitable remedial treatments are carried out." (p.6)

We are in general agreement with the above seven comments. With reference to comment (b), we agree, that at the site of the slides, the potential for mudslides is reduced and that sloughing and ravelling will occur. It is noted that ravelling back to slopes of 35° or flatter will undermine the houses at 2360 and 2379 Carman Place. In addition, the oversteepened fill slopes left in place at the sides of the slides will be more exposed to weathering, and could tend to slide sideways into the existing slide depression.

With reference to comment (c), we agree that, where slides did not occur, but where surface cracking and settlement of filled ground took place, there is a potential for future slides. However, the presence of cracks slightly lessens the contact area for shear resistance, and allows faster inflow of water to the slide surface. Generally cracking will lessen the stability of a slope compared to previous conditions.

5. RECOMMENDATIONS FOR REMEDIAL WORK AT TOP OF SLOPE

As discussed earlier in the report, this study has identified that there is a risk of future slides at the valley slope in question during periods of severe rainstorms. The risk varies from quite low to quite high, depending on the extent and volume of overly steep loose fill and debris at the top of the slope and on the quality of the water drainage system at the top of the slope. We have also indicated that there is no risk to the houses at the crest of the slope from future slides, since these houses are founded on dense natural ground or well back from the crest of the slope. The greatest risk from future slides is to the houses at the base of the slope. The major thrust of the remedial work, therefore, is to minimize the risk to the properties at the base of the slope from future slides.

There are varying amounts of risk of future slides all along the full length of the hillside slope. However, not all of the potential sliding activity that could take place along the slope will pose serious risk to the properties at the base of the slope. Remedial work is recommended at this time only at properties where we believe that there is moderate to high risk of major slides at this time similar to those which occurred in 1979. At other properties along the crest of the slope, we believe that there is a low risk of major slides and only a limited amount of remedial work is recommended. It is possible, however, that in future changes may occur that will warrant additional remedial work.

The details of the recommended remedial work at each property at the crest of the slope are presented below. It should be emphasized that the remedial work recommended is the minimum we feel that should be undertaken at each property at this time and within the limited scope of this study we feel that the recommended remedial work for each property is likely to be the most economical. While the remedies indicated are proposed to reduce the risk of future serious slides, like those of 1979, some degree of risk will always exist on the valley slopes and we do not give assurance that slope failure or sliding will not occur after remedial treatment. The home owners may wish to undertake additional remedial work. Also, the details presented for the remedial work are conceptual in nature. The home owners are advised to seek additional assistance from their own qualified geotechnical engineer to establish the details of work required on their property before actual construction is undertaken and to assess possible remedial alternatives.

The sixty-nine properties examined at the crest of the slope can be grouped into three broad categories with respect to the potential risk of sliding and the remedial work recommended as shown on Drawing D-2670-1. They are described below.

5.1 Properties With Very Low Risk of Major Instability

At the following 33 properties, the risk of major instability is quite low. The general geotechnical conditions are fairly good. Little or no fill has been pushed over the crest of the slope. General maintenance of slope and existing drainage systems is, however, essential to keeping the risk of future slides to a minimum. The properties are listed below.

1231 Lennox Street	1775 Layton Drive	2474 Hayseed Close
1369 Lennox Street	2372 Carman Place	2486 Hayseed Close
1383 Lennox Street	2386 Carman Place	2125 Berkley Avenue
1439 Lennox Street	1839 Layton Drive	2265 Berkley Avenue
1451 Lennox Street	1847 Layton Drive	2293 Berkley Avenue
1475 Lennox Street	1855 Layton Drive	2321 Berkley Avenue
1485 Lennox Street	2439 Hayseed Close	2335 Berkley Avenue
1499 Lennox Street	2442 Hayseed Close	2349 Berkley Avenue
1575 Lennox Street	2448 Hayseed Close	2363 Berkley Avenue
2410 Swinburne Ave.	2454 Hayseed Close	2409 Berkley Avenue
1731 Layton Drive	2468 Hayseed Close	2425 Berkley Avenue

For all the properties in the very low risk classification, the following minimal remedial work is recommended.

Standard Recommendations

(a) Existing debris should be removed and no new debris should be placed at or over the crest of the slope.

(b) Vegetative growth should be controlled to allow the home owner to carry out periodic examinations of drainage outlets, and inspection of the slopes for any signs of distress (cracks, slumps, etc.)

(c) If at any future time an inspection shows any signs of slope distress, the owner should have a further stability assessment made.

(d) For those properties not connected to storm sewers, existing drain outlets should be found and checked to see if they are operational (e.g. during or immediately following a storm). If there is any sign of erosion, energy dissipators should be placed to disperse the flow. If the drains are not operational, they should be replaced, preferably with a connection to the storm sewer if possible. Drainage which exists in fill should be extended down the slope to natural ground and energy dissipators installed.

(e) Any existing abandoned septic tanks should be removed or filled with compacted soil.

(f) The home owner should inspect the drain pipes at least 2 times each year, in spring and fall, during rainfall and should maintain the pipes in good working order at all times.

(g) Additional comments on each property, if required, are included in Appendix II.

Much, if not all, of this work could be carried out by home owners, so no estimate of costs has been provided. In the attached summaries and recommendations (Appendix II), the above measures have been referred to as standard recommendations.

5.2 Properties With Low Risk of Major Instability

Twenty-four properties have been identified to have a low risk of major instability, as shown on Drawing D-2670-1. Considerable amounts of fill has been placed over the crest of the natural slope at some of these properties, which have potential for sliding. There are also signs of at least limited instability in the fill in some cases. With an improved drainage system, however, we feel that the stability at these properties can be maintained at a acceptable level and the risk of major instability can be minimized.

The standard recommendations given for properties with very low risk (Section 5.1) also apply to all properties in this classification. In addition, further measures to improve drainage are specifically recommended. A three-fold system of drainage improvements has been developed to allow brevity in describing the recommendations for each property. In order of increasing cost and difficulty of installation, the drainage improvements are:

Drainage Improvement - Class 1

Downspouts for roof drainage should be connected to a closed conduit that is carried over the slope to a point below any fill which has been placed on the lot, and connected to an energy dissipator (concrete box that slows flow, and discharges water by overflow). The conduit should be secured to the slope to prevent parting of the conduit. A recommended type of conduit is asphalt-coated galvanized corrugated metal pipe with double-length couplings. The diameter of the pipe should be adequate to handle the flow; a 6-inch diameter should be adequate for most properties.

Drainage Improvement - Class 2

As well as downspouts, foundation and driveway (if present) drainage should be connected to a new conduit as given in Class 1. This will require excavation to connect with the foundation drains.

Drainage Improvements - Class 3

As well as new connections for the roof, foundation and driveway drains, an interceptor drain is recommended. (We have been told that the drainage of some of the properties is already to storm sewers (see Drawing D-2670-2), and, if it is confirmed that this is the case, these properties will not require

new connections for the existing drains). Generally the drain should be placed across the backyard, in natural soils upslope of any fill material that has been placed at the slope crest. A trench excavated 1 1/2 feet into hardpan or at least five feet deep should be excavated across the yard. Excavated material should be disposed of away from the property. The base of the trench should have a slight slope to one side of the yard. A six inch perforated pipe (perforations down) should be placed in the middle of the trench, and the trench backfilled with free-draining material (for example, pea gravel). The low end of the perforated pipe should be connected to a closed conduit directed over the slope as in Class 1. It is desirable that the surface of the yard area be sloped slightly towards the drain, both from the house and from the slope crest.

The costs of the drainage measures will vary considerably. Because of difficult access for equipment and/or a desire to reduce the effect of construction on the balance of the yard, many owners may elect to carry out the work manually, in some cases doing the work themselves. Excavation costs will therefore vary considerably. Material costs will be fairly nominal.

Properties in this classification along with the level of drainage control recommended are listed below.

Property	Class of Drainage Recommended
1275 Lennox Street	1
1491 Lennox Street	2
1535 Lennox Street	2
1557 Lennox Street	2
1593 Lennox Street	2
2402 Swinburne Avenue	2
2414 Swinburne Avenue	3
1677 Layton Drive	3
1797 Layton Drive	3
1815 Layton Drive	3
1863 Layton Drive	3

Property	Class of Drainage Recommended
District Land between 1863 Layton Drive and 2462 Hayseed Close	3
2462 Hayseed Close	3
2480 Hayseed Close	1
2141 Berkley Avenue	2
2157 Berkley Avenue	3
2175 Berkley Avenue	3
2191 Berkley Avenue	3
2249 Berkley Avenue	3
2251 Berkley Avenue	3
2279 Berkley Avenue	3
2307 Berkley Avenue	1
2377 Berkley Avenue	3
2391 Berkley Avenue	3

Additional comments on each property, if required, are given in Appendix III.

5.3 Properties With Moderate to High Risk of Instability

As shown on Drawing D-2670-1, twelve properties have been identified to have moderate to high risk of serious instability similar to those which occurred in 1979. A considerable amount of loose fill has been pushed over the crest of the natural slope at these properties to oversteepen slopes. Six of these properties have already been affected by previous slides in 1972 and 1979 and will require a significant amount of remedial work to rehabilitate these areas to a stable condition. The outer portions of the fill at the remaining properties have also been cracked and weakened and will require stabilization. Specific recommendations for each property are described below.

The standard recommendations given for properties with very low risk apply to all properties in this classification. As well drainage improvement of category 2 given for properties with low risk are recommended for all of these properties. In the discussion of each property below, a specific recommendation for each property is given, but it is recognized that other measures (such as retaining walls) could be considered for each case. A more detailed investigation for design, or the home owner's wishes, could indicate that alternate remedial measures may be preferable.

We recognize that the 1972 slide below 1425 Lennox Street did not cause damage at the bottom of the slope, because of a lack of development immediately at the toe of the slope. This fact suggests that slides from properties along Lennox Street may not cause extensive damage. However, future slides might be more mobile and flow further beyond the toe of the slope, and even if damage is minimal, the slides would extend onto properties belonging to others.

The two basic additional recommendations are to remove fill that has been placed at the crest, and to protect the more serious existing slide areas from future ravelling by placement of free draining, fine, very angular rockfill. In all areas of removal of potentially unstable fill, the exposed surface should be protected from erosion by immediate revegetation (for example, hydroseeding) or covered with a blanket of very angular free-draining rockfill. In areas of rockfill placement, the existing surfaces should be stripped of all loose and softened material. A heavy gauge perforated drain should be installed securely to the slope down the thalweg (low point) of the slide, and covered with free-draining, well-graded granular material to prevent piping of the underlying soil. An energy dissipator should be provided at the outlet of the pipe.

The rockfill should consist of crushed pieces of a durable rock without excessive sand sizes. The rockfill should contain some clean sand, but only enough to provide filtering action for water. The sand content must be low to maintain the high angle of friction between angular rock particles. This will give the highest strength to the fill. The exact slope of the fill will depend on the material obtained, and the surface should be graded to a slope a few degrees flatter than the maximum angle at which the material will stand. To define the toe of the fill a single layer of gabions may be required, depending on details of the slope.

It is recognized that removal of the fill will, in some cases, cause a reduction in the yard area. To increase the yard area it would be possible to add a deck extension over the slope. The deck supports should be founded a minimum of three feet into the dense natural soil, to reduce the possibility of undermining of the footings by erosion.

A list of the properties in this classification and remedial measures recommended for each property are listed below.

Property	Additional Remedial Measures Recommended (Ref. Drawings B-2670-6 to -21)
1305 Lennox Street	Removal of fill
1345 Lennox Street	Removal of fill
*1425 Lennox Street	Removal of fill

* No remedial work is recommended at this time in the slide path of 1972. Only removal of unstable fill soils in adjoining areas is recommended. Conditions may change in future and indicate additional remedial work at that time.

Property	Additional Remedial Measures Recommended
1691 Layton Drive	Removal of fill
1709 Layton Drive	Removal of fill
1753 Layton Drive	Removal of fill
2391 Carman Place	Removal of fill
2379 Carman Place	Removal of soft disturbed soils and Placement of rockfill
2360 Carman Place	Removal of soft disturbed soils and Placement of rockfill
2205 Berkley Avenue	Removal of fill
2217 Berkley Avenue	Removal of fill
2223 Berkley Avenue	Removal of fill

See Appendix IV for a description of existing conditions at each property in their category and cost "guesstimate" for the recommended remedial action.

6. PROPERTIES AT BASE OF SLOPE

The visual inspection of the properties at the base of the slope indicated that conditions at the bottom of the slope are not likely to cause large-scale instability of the slope such as occurred in 1979. Therefore, summaries of the inspection reports have not been included in this report. However, localized instability is present on approximately one-half of the properties at the base of the slope. This is generally caused by cutting at the toe of the slope to extend the yard area. Ravelling of the slope can be expected to continue at these locations, and will require clean-up and maintenance. A number of the properties have drainage problems at the rear of the lots and consideration should be given to drainage improvement. These drainage problems are not expected to cause major instability of the slope. Another hazard noted during the inspection was the presence of large trees relatively close to several of the houses.

In the areas where slides have occurred in 1979, the slide debris should be removed, natural drainage channels should be re-established, and vegetation should be encouraged.

7. RECOMMENDATIONS FOR IMPROVEMENTS ON DISTRICT LAND

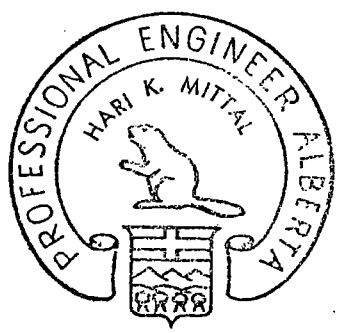
Storm runoff is handled by open ditches along Lennox Street and Hayseed Close. We recommend that consideration be given to elimination of these ditches and installation of a storm drainage system. A storm drain system would control the flow of surface water and reduce the infiltration of water into the ground behind the crest of the slope within the study area. As noted in Section 5.3 of this report drainage improvements are recommended for the land between 1863 Layton Drive and 2462 Hayseed Close.

KLOHN LEONOFF LTD.

W. PATRICK STEWART, P.Eng.

HARI K. MITTAL, PH.D, P.Eng. (Alberta)

WPS/HKM/ktt



APPENDIX I

LETTER OF AUTHORIZATION

AND

TERMS OF REFERENCE

VA2670

THE CORPORATION OF THE DISTRICT OF NORTH VANCOUVER

DISTRICT MUNICIPAL HALL
P.O. BOX 86218, NORTH VANCOUVER, B.C.
V7L 4K1
TELEPHONE 987-7131

May 23, 1980

Mr. K.I. Morrison, P.Eng.
Geotechnical Division
Klohn Leonoff Consultants Ltd.
10180 Shellbridge Way
Richmond B.C.
V6X 2W7

Dear Sir:

Re: Berkley/Riverside Slide Area

On May 20th Council in an IN CAMERA Policy and Planning Committee meeting considered the contents of the terms of reference for the Berkley/Riverside slide area geotechnical study.

After discussion the following resolution was adopted:

> THAT the terms of reference for the Berkley/Riverside slide area contained in the submission by Klohn Leonoff Consultants Ltd. be approved as amended by the Municipal Engineer in memo dated May 20th, subject to the approval of Mr. David Stuart, Solicitor for our insurers.

A copy of these terms of reference have been sent to Mr. Stuart and when his reply is received we will advise of his position.

Yours truly,

J.F. Sigurjonsson,
Deputy Municipal Clerk

JFS:afh

Enc: 1 copy terms of reference

VA2670

Terms of reference for the geotechnical appraisal of the Berkley/Riverside slide area approved by Council on May 20, 1980

1. The Consultant will first carry out a general geotechnical appraisal of the entire area from 2425 Berkley on the north to 2438 Carnation on the south and west to Riverside Drive in order to determine the nature and location of the hazards to existing properties at the top and bottom of the bank. The study will involve:

   - A reconnaissance survey to log soil exposures. No deep investigations are visualized.
   - Examination of natural slope gradients.
   - Examination of vegetative cover on the slopes, and examination of air photographs to evaluate relative slope stability over the years.
   - Identification of modifications to topography at the top and bottom of the slope as a result of residential development.
   - Logging of apparent spring and seepage activity.
   - Identification of changes in drainage pattern resulting from residential development.
   - Examination of any other factor the study identifies as related to slope stability.

2. The Consultant will examine rainfall records for several North Shore stations to establish a return period for the type of storm activity that is most likely to produce instability in "weaker" areas. The storm activity envisaged is equivalent or more severe than the December 1979 storm.

3. The Consultant's report will include a comparison between his findings and those of the Golder Report of January 8, 1980 (recognizing that the latter confined the need for remedial works to the three existing slides of those properties near 1305 Lennox and 2217 Berkley where moderate to severe cracking and ground settlement had occurred at the crest of the slope and where a potential for future slides was considered to exist).

4. In examining potential causal factors for future slides or other damage in each area, the consultant will identify the factors that have a significant influence on stability.

Without limiting the foregoing, the consultant will clearly identify those factors which are peculiar to specific properties within the study areas as contrasted to those which are likely to exist on other properties which were unaffected within the study area or elsewhere in the municipality. These factors will be evaluated in terms of their relative importance to the possibility of future slides. Emphasis will be placed on the locations at which the causal factors by degree or combination appear to be more severe, and most likely to give rise to future problems, along with suggestions as to whether remedial action is warranted.

As previously indicated, the Consultant will attempt to identify all significant causal factors and areas of severe hazard. However, the consultant is not required to give assurance that all factors or hazard areas are identified.

5. Each suggested remedy to improve resistance to slide activity will be described in detail for each property where remedial action is required including a "guesstimate" of the cost. In all cases, the cost of such remedies must be such that it would be considered reasonable for an owner to undertake in terms of cost/benefit. While remedies will be suggested to reduce risk, some degree of risk will always exist and the Consultant will not be required to provide assurance that slope failure or sliding will not occur after remedial treatment.

   If remedial action is too costly for an owner to undertake the general remedial measure should be mentioned including a "guesstimate" of the cost, but with no details.

6. The Consultant will, in composing his report, recognize that it may be made available to the public and particularly to the owners of the specific properties concerned and will therefore employ a language which will be readily understood.

APPENDIX II

SUMMARIES AND RECOMMENDATIONS FOR PROPERTIES WITH VERY LOW RISK OF MAJOR INSTABILITY

APPENDIX II

SUMMARIES AND RECOMMENDATIONS FOR PROPERTIES WITH VERY LOW RISK OF MAJOR INSTABILITY

(Ref. Drawing D-2670-1)

SEE SECTION 5.2 OF REPORT.

For all the properties in this classification, the following minimal remedial work is recommended:

a) Existing debris should be removed and no new debris should be placed at or over the crest of the slope.

b) Vegetative growth should be controlled to allow the homeowner to carry out examination of drainage outlets, and inspection of the slopes for any signs of distress (cracks, slumps, etc.).

c) If at any future time an inspection shows any signs of slope distress, further investigation should be carried out.

d) For those properties not connected to storm sewers, existing drain outlets should be found and checked to see if they are operational (e.g. during or immediately following a storm). If there is any sign of erosion, energy dissipators should be placed to disperse the flow. If the drains are not operational, they should be replaced, preferably with a connection to the storm sewer if possible. Drainage which exits in fill should be extended down the slope to natural ground and energy dissipators installed.

e) Any existing abandoned septic tanks should be removed or filled with lightly compacted sand.

1231 LENNOX STREET

SUMMARY

- Natural slopes at 30° to 32°.
- Steepened by fill immediately behind house to 35°. Fill extended horizontally 5 feet past original slope crest. Fill slope grassed and landscaped with small shrubs.
- Fill appears to be of good quality, no stumps, spread thinly and uniformly.
- Roof and foundation drains lead to rockpits more than 40 feet downslope.
- Site previously serviced by septic tank.
- Natural drainage is away from fill to gullies at either side of property.
- Street runoff is directed to open ditches on either side of Lennox Street. No curbs or storm sewer system.
- Ditches outflow in undeveloped land to south of property.
- Most slopes within property appear stable.
- Possible failure scarp exists below rockpit in the north gully.

RECOMMENDATIONS

- Standard
- drainage appears adequate.

1369 LENNOX STREET

SUMMARY

- Property does not reach to edge of slope.
- According to owner, no history of slumping.
- Assume roof and foundation drains extend over slope or unconnected since no visible outlets in shallow road ditch.
- Site never serviced by septic tank.
- Natural drainage runs to southwest, towards 1345 Lennox.
- Street runoff directed to open ditches on either side of Lennox Street. No curbs or storm sewers.

RECOMMENDATIONS

- Standard.

1383 LENNOX STREET

SUMMARY

- House constructed well back from slope.
- Yard grassed to edge of slope, appears well-drained.
- Slopes below crest, 37° on average.
- Evergreens cleared or stripped of branches for view on southern slope.
- Compost dumped over slope crest.
- Roof drains appear to be disconnected.
- Foundation drains assumed to extend over bank, but no outlets were visible.
- Street runoff directed to open ditches on either side of Lennox Street, no curbs or storm sewers.
- Site previously serviced by septic tank.
- Slopes appear stable.
- Possible old failure surface down southwest gully. Slopes increase from 30° to 40° downslope.

RECOMMENDATIONS

- Standard.

1439 LENNOX STREET and 1451 LENNOX STREET

SUMMARY

- Properties do not reach to slope.
- According to owners, no history of slumping.
- Roof and foundation drains collected, lead to 1425 Lennox driveway drain then outlet over bank near south property line of 1425 Lennox.
- Street runoff directed to open ditches on either side of Lennox Street. No curbs or storm sewer.
- Sites never serviced by septic tanks.

RECOMMENDATIONS

- Standard.

1475 LENNOX STREET

SUMMARY

- House constructed well back from slope crest.
- Backyard averages 20° slope.
- Backyard and slope crest overgrown, ground surface uneven.
- Crest is rounded except for short oversteepened section at 45° for 5 vertical feet. Possibly landscaping fill.
- Natural slopes below crest are at 37°.
- No visible evidence of slumping.
- Some evidence of surface erosion on slope.
- Roof and foundation drains in poor condition. Probably extend over bank but outlets were not visible.
- Site previously serviced by septic tank.
- New pool installation at 1485 Lennox drains down onto unpaved driveway.
- Street runoff directed to open ditches on either side of Lennox Street. No curbs or storm sewer system.

RECOMMENDATIONS

- Standard.

1485 LENNOX STREET

SUMMARY

- Property does not extend to slope.
- Southern edge of property drops at 30° towards 1475 Lennox.
- According to owner, no history of slumping.
- Roof and foundation drains extend over slope, but outlets were not visible.
- Unfinished pool drains towards 1475 Lennox.
- Street runoff directed to open ditches on either side of Lennox Street. No curbs or storm sewer.
- Recently constructed house, site never serviced by septic tank.

RECOMMENDATIONS

- Standard.
- Pool drain to be extended below fill on adjacent property.

1499 LENNOX STREET

SUMMARY

- Property does not reach to slope.
- According to owner, no history of slumping.
- Roof and foundation drains probably extend over bank but no outlets were visible.
- Street runoff directed to open ditches on Lennox Street. No curbs or storm sewer system.

RECOMMENDATIONS

- Standard.

1575 LENNOX STREET

SUMMARY

- Sundeck footings lie approximately 5 feet behind slope crest.
- Slope below crest slightly oversteepened with fill, compost and timber debris for 10 vertical feet.
- Natural slope at 33° to 36°.
- Southern slope area stripped of surface vegetation by foot traffic. Soil has been further eroded by runoff water.
- According to owner, no history of slumping.
- Roof and foundation drains extend over bank, but outlets were not visible.
- Street runoff directed to open ditches on Lennox Street. No curbs or storm sewer sytem.

RECOMMENDATIONS

- Standard.

2410 SWINBURNE AVENUE

SUMMARY

- Level yard, property line extends just to crest of slope.
- Slope naturally vegetated, average, 30° to 35°. Steepens slightly to west.
- No history of slumping.
- No visible fill. Some debris, including compost, thrown over edge.
- Roof and foundation drains connected to storm sewer system on Swinburne.
- House probably originally serviced by septic tanks.

RECOMMENDATIONS

- Standard
- Drainage appears adequate.

1731 LAYTON DRIVE

SUMMARY

- House constructed well back from slope crest.
- Pool constructed 11 feet from slope crest.
- Roof, foundation and pool drains connected to storm sewer.
- House never serviced by septic tank.
- Slope side of concrete pool deck drains onto slope crest. Remainder of deck drains to storm sewer.
- Wooden deck extends to slope crest.
- Slope crest rounded, steepening to 37° for approximately 10 vertical feet, then decreasing to 34°.
- No visible fill except small amounts associated with properties to north and south.
- Slope below crest is overgrown, very little debris. Exposed soil is sand with trace silt, loose on surface.
- Slope has been cleared of many large evergreens. Stumps remain in ground.
- Some evidence of soil erosion due to runoff.
- Slope appears stable. Some instability at property lines associated with slumping at adjacent properties during December 1979 rainstorm.

RECOMMENDATIONS

- Standard
- Drainage appears adequate.

1775 LAYTON DRIVE

SUMMARY

- House constructed 25 feet from slope crest.
- Roof and foundation drains connected to storm sewer system.
- House never serviced by septic tank.
- Backyard level and grassed.
- Slopes below crest average 33°. Slightly oversteepened by fill compost and stump debris to 35° at south property line increasing to 47° at north.
- Natural drainage to small gully at centre of property, average 37°
- No evidence of seepage or runoff erosion.
- Some minor settlement at slope crest occurred near north property line in association with December 1979 rainstorm. Crest settlement continues across property to north.

RECOMMENDATIONS

- Standard.
- Drainage appears adequate.

2372 CARMAN PLACE

SUMMARY

- House constructed on relatively flat ground.
- Backyard gently slopes towards northwest corner.
- Rounded crest, lower slopes average 35°.
- No evidence of fill or debris on crest or slope.
- No evidence of seepage or erosion.
- Crest and slope vegetation appears natural, mature evergreens at crest.
- Roof and foundation drains connected to storm sewer.
- House never serviced by septic tank.
- According to owner, No history or evidence of instability.

RECOMMENDATIONS

- Standard.
- Drainage appears adequate.

2386 CARMAN PLACE

SUMMARY

- House constructed well back from slope crest.
- Backyard fairly level, covered in mulch.
- Slopes angle at 45° for 10 vertical feet, then decrease to approximately 35°.
- Large established evergreens on crest and slope. Occasional stumps indicate some clearing.
- No evidence of erosion gullies or seepage on slope.
- Natural drainage path runs east at base of 45° slope.
- Roof and foundation drains connected to storm sewer.
- House never serviced by septic tank.
- According to owner, no history of slumping.
- Slopes appear stable.

RECOMMENDATIONS

- Standard
- Drainage appears adequate.

1839 LAYTON DRIVE

SUMMARY

- Only 9 feet of lot extend to slope crest.
- Level backyard increases to 30° below slope crest.
- No visible fill.
- Compost thrown over bank.
- Large 3 foot diameter evergreen established at crest.
- No visible seepage or eroded gullies.
- Roof and foundation drains connected to storm sewer.
- House never serviced by septic tank.
- Slopes appear stable.
- According to owner, no history of slumping.

RECOMMENDATIONS

- Standard
- Drainage appears adequate.

1847 LAYTON DRIVE

SUMMARY

- Owner refused permission to inspect backyard and slope. Yard viewed from adjoining properties.
- House constructed approximately 30 feet from slope crest.
- Level backyard, may be some fill.
- Slope estimated at 30° to 35°.
- Backyard, crest and slope vegetated by 8 inch diameter evergreens. Appears to be minimal disturbance.
- Roof and foundation drains connected to storm sewer.
- House never serviced by septic tank.
- Slopes appear stable from superficial appraisal.

RECOMMENDATIONS

- Standard (but not allowed on property)
- Drainage may be adequate.

1855 LAYTON DRIVE

SUMMARY

- House constructed approximately 30 feet from slope crest.
- Backyard slopes southwest at 20° to 25°.
- Slope below rounded crest averages 35°. Slope angles west.
- Most of backyard and slope left in natural state. Some trees cleared.
- May be some oversteepening of crest where level grass has been extended to crest near southwest property line. Slope at 37° to 40°.
- No visible seepage on slope.
- Roof and foundation drains connect to storm sewer.
- House never serviced by septic tank.
- Slopes appear stable.
- According to owner, no history of slumping.

RECOMMENDATIONS

- Standard
- Drainage appears adequate.

2439 HAYSEED CLOSE

SUMMARY

- Property does not extend to slope crest.
- Roof and foundation drains open to ground or extend over bank. Outlets were not visible.
- House formerly serviced by septic tank.
- Street drainage directed to shallow ditches on Hayseed. No curbs or storm sewer system.

RECOMMENDATIONS

- Standard.

2442 HAYSEED CLOSE

SUMMARY

- House constructed well back from slope crest.
- Relatively level backyard extends 35 feet, then slopes steeply at 45° to 60° for 10 vertical feet to former gravel pit.
- Gravel pit fairly level with uneven ground surface. May indicate settlement. Area vegetated with grass, weeds and small deciduous trees.
- Pit extends to slope crest. Some sand and gravel fill pushed over crest. Lower slopes average 30°, vegetated with evergreens.
- No visible seepage on slopes.
- Natural drainage path runs northwest along toe of steep upper slope.
- Roof and foundation drains extend over bank but outlets were not visible.
- House previously serviced by septic tank.
- Street drainage directed to shallow ditches on Hayseed Close. No curbs or storm sewer system.

RECOMMDATIONS

- Standard.

2448 HAYSEED CLOSE

SUMMARY

- House constructed well back from slope crest.
- Backyard slopes gently for 35 feet, then steepens to 40° for approximately 10 vertical feet. Lower slopes continue fairly steeply at 35°.
- Upper slopes are vegetated with dense bush and appear to have been cleared for evergreens.
- No visible fill.
- Compost thrown over bank.
- No evidence of seepage or surface erosion.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House previously serviced by septic tank.
- Street runoff directed to shallow ditches on Hayseed Close. No curbs or storm sewer system.
- No evidence of previous slumping.

RECOMMDATIONS

- Standard.

2454 HAYSEED CLOSE

SUMMARY

- House constructed on level ground.
- Fairly level backyard extends 25 feet from house.
- Backyard retained at slope crest by well built 4 1/2 foot cribwall in good condition.
- Slopes below cribwall at 35° to 40°.
- Slopes vegetated with large evergreens, little ground cover.
- Probably some fill behind cribwall.
- No visible seepage or surface erosion on slope.
- Roof and foundation drain extend over bank, but outlets were not visible.
- House previously serviced by septic tank.
- Street runoff directed to shallow ditches on Hayseed Close. No curbs or storm sewer system.

RECOMMENDATIONS

- Standard.

2468 HAYSEED CLOSE

SUMMARY

- House constructed to within 15 feet of slope crest.
- Sundeck extends over slope crest but sundeck foundations angle back to 5 feet behind crest.
- Rounded crest steepens to 33° slope.
- Minor quantity of fill pushed out over slope.
- Slope vegetated with large evergreens and minimal ground cover.
- Sand and gravel exposed between trees, possibly washed by surface runoff.
- Roof and foundation drains extend over bank. Outlets were visible immediately below crest.
- No visible seepage.
- House never serviced by septic tank.
- Street runoff directed to open ditches on Hayseed Close. No curbs or storm sewer system.
- According to owner, no history of slumping, however, one sundeck footing at slope crest failed, possibly due to shallow sliding or erosion.

RECOMMENDATIONS

- Standard.

2474 HAYSEED CLOSE

SUMMARY

- House constructed to within 15 feet of slope crest.
- Slopes below crest at 30° to 35°.
- Slopes maintained in natural state. Some additional ground cover has been planted.
- No visible fill, seepage or erosion.
- Roof and foundation drain extend over bank but outlets were not visible.
- House previously serviced by septic tank.
- Street drainage directed to open ditches on Hayseed Close. No curbs or storm sewer system.
- According to owner, no history of slumping.
- Slopes appear stable.

RECOMMENDATIONS

- Standard.

2486 HAYSEED CLOSE

SUMMARY

- House constructed on level ground behind slope crest.
- Backyard built up with fill retained by a 6 foot high wall of tree trunks.
- Slopes below wall average 30° to 35°.
- Large quantities of compost thrown down slope.
- No visible seepage or surface erosion on property. However, on adjacent district pipeline right-of-way, foot traffic and surface runoff have combined to undermine the pipeline and erode the slope below the retaining wall.
- Roof and foundation drains extend over bank but outlets were not visible.
- House previously serviced by septic tank.
- Street runoff directed to open ditches on Hayseed Close. No curbs or storm sewer system.
- According to owner, no history of slumping.

RECOMMENDATIONS

- Standard.
- Path (along pipeline) should be gravelled to reduce erosion.

2125 BERKLEY AVENUE

SUMMARY

- House constructed 15 to 35 feet behind slope crest.
- Below rounded crest, slopes average 20° to 30°, steepening off ridge to north.
- Level backyard contains occasional uneven surface where fill has settled over buried stumps.
- Minimal fill added to garden at slope crest.
- Slope below crest naturally vegetated except near property line where trees have been cleared for fence.
- Compost thrown over fence to 1 1/2 foot depth.
- Driveway drain connected to roof and foundation drains which extend over bank. Outlets were visible just below fence, but partially covered by thick mat of compost. North outlet has eroded a 1 foot deep trench. Ground beyond fence seems damp.
- According to owner, no history of slumping.
- Slopes appear stable.

RECOMMENDATIONS

- Standard.

2265 BERKLEY AVENUE

SUMMARY

- House constructed on gentle slope above crest.
- Backyard contained by 12 foot high reinforced concrete retaining wall founded on piles. Wall appears to be in good condition.
- Below wall, slope is benched by 2-4 foot high cribwalls composed of stumps and planks.
- Fill pushed over bank has increased slope angle to average of 43° for approximately 50 feet downslope.
- Lower slopes at 30° to 33°.
- No evidence of seepage on slope.
- Several drain outlets extend over bank, including roof and foundation drains. Outlets have been designed to minimize erosion, incorporating concrete linings or a series of stilling basins.
- House has never been serviced by septic tank.
- Street runoff is directed to storm sewer system.
- Retaining wall contains two vertical cracks.
- Owner commented that retaining wall moved slightly after completion and continues to settle. No problems were encounterd during December 1979 rainstorm.

RECOMMENDATIONS

- Standard.
- Drainage appears adequate.

2293 BERKLEY AVENUE

SUMMARY

- Slopes average 35°.
- Fill has been pushed over bank and extends approximately 30 feet downslope.
- Slope is strewn with stumps, cuttings and debris. Some stumps are buried under fill.
- Southern part of slope may be old failure surface as tree trunks are curved.
- Several large original trees are established in the backyard.
- No evidence of seepage on slope.
- Above ground swimming pool near slope crest drains by 1 inch diameter PVC pipe over bank. Erosion at pipe outlet is minimal.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- According to owner, no history of slumping. No problems during December 1979 rainstorm.

RECOMMENDATIONS

- Standard.

2321 BERKLEY AVENUE

SUMMARY

- Property viewed from adjacent lot because of dog.
- Half of backyard sloping towards crest was reworked and re-seeded. Apparently some trees in yard had been removed.
- Slopes below crest were estimated at 40° for 30 feet down-slope. Lower slopes averaged 30° to 35°.
- Roof and foundation drains apparently extend over bank.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- No settlement or slumping was visible.

RECOMMENDATIONS

- Standard.

2335 BERKLEY AVENUE

SUMMARY

- Slopes steepened by fill to 40° for 30 feet downslope.
- Lower slopes at approximately 30°.
- Fill consists of stumps and trees overlain by sandy soil. Debris often supported by tree trunks and rooted stumps.
- Above ground swimming pool near crest drains over bank at northwest corner of property. Drain outlet not visible due to surface planks and debris.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- No seepage or surface erosion evident on slope.
- Southern portion of slope crest appears to have settled slightly.
- Owner commented than some soil at crest is lost every year.

RECOMMENDATIONS

- Standard.

2349 BERKLEY AVENUE

SUMMARY

- Slope below crest lies at 40° for 30 feet downslope.
- Lower slopes at 30° to 35°.
- Vegetation close to crest mostly brush. Lower slopes vegetated with mature growth of evergreens and ferns.
- Slope reasonably clear of debris.
- Roof and foundation drains extend over bank but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- No history of slumping.

RECOMMENDATIONS

- Standard.

2363 BERKELY AVENUE

SUMMARY

- Very steep slope at property boundary averages 50° for 25 feet downslope, then abruptly decreases to 15° and angles north towards creek.
- Slopes appear to be natural except for some fill extending 5 to 10 feet downslope of crest.
- No debris or stumps on slope.
- No evidence of seepage or surface erosion.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- According to owner, no history of slumping.

RECOMMENDATIONS

- Standard.

2409 and 2425 BERKLEY AVENUE

SUMMARY

- Houses constructed approximately 40 feet from slope crest.
- Small quantities of fill extend 5 to 10 feet downslope of crest.
- Some debris and compost thrown over bank.
- Large evergreens established in backyard indicate minimal fill.
- No evidence of seepage or surface erosion on slopes.
- Small creek runs southwest at toe of slope.
- Roof and foundation drains extend over bank, but outlets were not visible.
- Houses never serviced by septic tank.
- Street runoff directed to storm sewer.
- According to owner, no history of slumping.

RECOMMENDATIONS

- Standard.

APPENDIX III

SUMMARIES AND RECOMMENDATIONS FOR PROPERTIES WITH LOW RISK OF MAJOR INSTABILITY

APPENDIX III

SUMMARIES AND RECOMMENDATIONS FOR PROPERTIES WITH LOW RISK OF MAJOR INSTABILITY

(Ref. Drawing D-2670-1)

SEE SECTION 5.2 OF REPORT

The standard recommendations given for properties with very low risk apply to all properties in this classification. In addition, further measures to improve drainage are specifically recommended. In order of increasing cost and difficulty of installation, the drainage improvements are:

Drainage Improvement - Class 1

Downspouts for roof drainage should be connected to a closed conduit that is carried over the slope to a point below any fill which has been placed on the lot, and connected to an energy dissipator (concrete box that slows flow, and discharges water by overflow). The conduit should be secured to the slope to prevent parting of the conduit. A recommended type of conduit is asphalt-coated galvanized corrugated metal pipe with double-length couplings. The diameter of the pipe should be adequate to handle the flow; a 6-inch diameter should be adequate for most properties.

Drainage Improvement - Class 2

As well as downspouts, foundation and driveway (if present) drainage should be connected to a new conduit as given in Class 1. This will require excavation of the foundation drains.

Drainage Improvements - Class 3

As well as new connections for the roof, foundation and driveway drains, an interceptor drain is recommended. (We have been told that the drainage of some of the properties is already to storm sewers (see Drawing D-2670-2), and, if it is confirmed that this is the case, these properties will not require new connections for the existing drains). Generally

the drain should be placed across the backyard, in natural soils upslope of any fill material that has been placed at the slope crest. A trench excavated 1 1/2 feet into hardpan or at least five feet deep should be excavated across the yard. Excavated material should be disposed of away from the property. The base of the trench should have a slight slope to one side of the yard. A six inch perforated pipe (perforations down) should be placed in the middle of the trench, and the trench backfilled with free-draining material (for example, pea gravel). The low end of the perforated pipe should be connected to a closed conduit directed over the slope as in Class 1. It is desirable that the surface of the yard area be sloped slightly towards the drain, both from the house and from the slope crest.

1275 LENNOX STREET

SUMMARY

- Patio and deck attached to house, constructed to within 5 feet of slope crest.
- Slopes immediately below crest are steep (40° to 45°) and continue well downslope.
- Additional oversteepening caused by accumulation of compost, timber and construction debris at crest and on slope.
- Very little visible fill.
- Grassed to edge of slope.
- Roof and foundation drains extend over bank, but outlets are not visible.
- Patio drains through retaining wall onto slope crest.
- Slope shows evidence of surface runoff, some erosion.
- Street runoff directed to open ditches on either side of Lennox Street. No curbs or storm sewer system.
- Site may have previously been serviced by septic tank.
- Small slump near north property line occurred in December, 1979, in association with larger slump at 1305 Lennox.
- Possible slump scarp below deck. Crest is slightly undercut, steep (45°) and vegetated with small deciduous shrubs and trees.

RECOMMENDATIONS

- Standard.
- Drainage - 1.

1491 LENNOX STREET

SUMMARY

- House construction at crest of 35° slope.
- Slopes in northern corner and at end of road to south have been oversteepened by accumulations of compost, timber debris and loose fill. Slopes are up to 45° for 15 vertical feet.
- Southern part of slope has been cleared of large trees.
- No history of slumping.
- Slopes appear stable, but have recently been disturbed due to construction of houses at 1485 and 1499 Lennox Street.
- Patio tiles have settled at downslope angle.
- Roof drains are open to ground.
- Drains from 1485 and 1499 Lennox probably outlet over bank, but outlets were not visible.
- House probably originally serviced by septic tank.
- Street runoff directed to open ditches on either side of Lennox Street. No curbs or storm sewer system.

RECOMMENDATIONS

- Standard.
- Drainage - 2

1535 LENNOX STREET

SUMMARY

- House and small concrete patio constructed close to slope crest.
- Crest recently landscaped with sloping fill held by cribwork 4 1/2 feet high below house and patio, decreasing to 2 feet at property lines.
- Slopes below cribwork from 35° to 38° for 10 vertical feet then decreasing to 32°.
- Possible movement indicated by crack in concrete patio, recent landscaping and buttressing of cribwork.
- Driveway drains, roof and foundation drains probably extend over bank but outlets were not visible.
- Patio drains onto fill.
- House originally serviced by septic tank.
- Street runoff directed to open ditches on Lennox. No curbs or storm sewer system.

RECOMMENDATIONS

- Standard.
- Drainage - 2

1557 LENNOX STREET

SUMMARY

- 6 foot rockwall topped by a 4 foot fence built at slope crest to contain backyard. Fill added to 4 foot height and landscaped with concrete tile and gardens.
- Slope immediately below wall at 35° to 40°.
- Some debris accumulated below wall.
- Slope decreases to 32° approximately 30 feet downslope.
- Small gully on south portion of property collects runoff. Wet and heavily vegetated.
- Two rows of draintile extend through rockwall.
- Bottom tiles partially plugged by debris.
- Roof and foundation drains probably extend over bank but outlets were not visible. May be connected to wall drains.
- House never serviced by septic tank.
- Street runoff directed to open ditches on Lennox Street. No curbs or storm sewer systems.

RECOMMENDATIONS

- Standard.
- Drainage - 2.

1593 LENNOX STREET

SUMMARY

- Level backyard formed on steep slope by placing fill behind 15 foot cribwall of heavy creosoted timbers.
- Additional cribwork creates small terraces above main level.
- Tiebacks run back into fill at intervals.
- Cribwall is butted up against live trees at highest section in northwest corner.
- Slopes immediately below and beside cribwall are 37° and naturally vegetated.
- Slopes decrease to 32° 20 feet downslope of wall except for small wet gully at 35° directly below centre of cribwall.
- Ridge extends at 34° from northwest corner of wall, flattening to 20° 150 feet downslope.
- Steep narrow gully parallels north edge of ridge, beginning 20 feet from house at 40° angle.
- Runoff from roof, foundation and driveway drains directed over bank. Visible outlet at northwest gully has caused wide erosion 25 feet from house and has steepened gully walls to 50°.
- Street runoff is directed to open ditches on Lennox Street. No curbs or storm sewer system.
- Sandy fill inside cribwall settled around tree roots during December, 1979 rainstorm. Apparently there was no visible movement of any cribwork.

RECOMMENDATIONS

- Standard.
- Drainage - 2.

2402 SWINBURNE AVENUE

SUMMARY

- Cribwork, maximum 6 feet high, creates a level garden at back of house, just over slope crest. Additional cribwork creates small terraces close to house.
- Built by contractor in 1976 on fairly gentle slopes (25° to 30°).
- Split cedar cribwall creosoted on fill side - with tiebacks.
- Slopes below cribwork steepened to 35° or 38°.
- Gully (40°) south of property line in district right of way.
- Slump occurred in northeast corner of terraced fill during December, 1979, rainstorm. Narrow but visible crack 15 feet long.
- Settling of small cribwork (tilt to northeast).
- No obvious movement of main cribwork, possible tilt to northeast.
- Apparently sandy fill behind cribwork.
- Timber and debris below cribwork.
- Draintiles and roof drains on streetside of house collected and run to storm sewer on Swinburne.
- No draintile on sides or back of house.
- Possibly some runoff may be directed over slope.
- Overflow drainpipe on south side of house. Owner commented no flow during December, 1979, rainstorm.
- Evidence of runoff erosion on north side of house below low cribwork.

RECOMMENDATIONS

- Standard.
- Drainage - 2 - some of drainage presently to storm sewer.

2414 SWINBURNE AVENUE

SUMMARY

- Sundeck footings built on slope crest.
- No visible fill.
- Slopes are uneven, irregular, varying from 25° to 45° in steps, averaging 37°.
- Slope immediately below crest oversteepened with strumps, timber and compost accumulating behind live trees. Noticeable particularly along north fence and extreme south corner of lot.
- Roof and foundation drains connected to storm sewer on Swinburne.
- Natural drainage away from house towards street or slope.
- Possible drain outlet over bank at northwest corner of lot. Evidence of surface runoff.
- Some patio footings appear tilted. Noticed after December, 1979 rainstorm, but may not be attributable to rainstorm.
- Possible narrow steep slide paths and scarps below crest. Well overgrown with deciduous vegetation.

RECOMMENDATIONS

- Standard.
- Drainage - 3 - even with drains to storm sever there is some evidence of instability.

1863 LAYTON DRIVE

SUMMARY

- House constructed on gentle east-west slope approximately 50 feet from existing slope crest.
- Backyard levelled by cutting into eastern bank. Grass extends to crest.
- Backyard has settled unevenly, particularly in area within 15 feet of crest.
- Crest area oversteepened to 50° for 15 vertical feet. Appears to be thin layer of fill over logs, timber and general debris. Debris has jammed up against tall stumps and trees.
- Site was apparently a former gravel pit mined to a depth of about 20 feet. This suggests extensive fill.
- Natural slope below debris averages 33°. Vegetated with tall, small diameter evergreens. Many stumps indicate some recent clearing.
- No visible seepage or eroded gullies on slope. Evidence of some runoff on footpaths over crest.
- Roof and foundation drains connected to storm sewer.
- Never serviced by septic tank.
- No known history of slumping.
- No visible cracks but settlement may indicate a large quantity of unstable material including some fill.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

1677 LAYTON DRIVE

SUMMARY

- Roof and foundation drains connected to storm sewer.
- Slope 40° below crest for 10 vertical feet, then averaging 36° over uneven ground.
- Material at top of crest appears unstable. Loose sandy soil, stumps and debris extend from 5 feet behind crest, down the steep slope. May be associated with unstable conditions to the north during December 1979 rainstorm.
- No visible cracks.
- Unstable material may be fill.
- Some evidence of erosion caused by surface runoff.

RECOMMENDATIONS

- Standard
- Drainage - 3 - even with drain to storm sewer, there is some evidence of instability.

1815 LAYTON DRIVE

SUMMARY

- House constructed well back from slope.
- Slope angle approximately 45° for 10 to 15 vertical feet, then 30° to 35°.
- Fill including sand, gravel, boulders and stumps, pushed over bank across entire lot in a thin layer.
- Backfill placed behind 8 foot high cribwall built on steep slope. Constructed of 1 1/4 inch x 20 inch timber boards and posts.
- Roof and foundation drains connected to storm sewer system.
- House never serviced by septic tank.
- Above ground pool at crest may be drained over bank.
- No visible surface erosion but toe of oversteepened slope moist. No signs of seeapge.
- Additional trees planted on slope.
- Some settlement has occurred in a 2 foot wide strip along crest. No visible cracks. Owner indicated settlement had existed unchanged for 8 years.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

ADJACENT DISTRICT LAND (Between 1863 Layton and 2442 Hayseed)

SUMMARY

- Land between 1863 Layton and 2442 Hayseed borders slope crest.
- Land has been levelled, but ground surface is uneven. Vegetated with high grass, weeds and small deciduous trees.
- Slope crest oversteepened to 50° for 10 vertical feet by fill overlying large quantity of stumps and timber debris.
- Debris rests against stumps and tree trunks.
- Slope below debris averages 33°, vegetated with evergreens.
- Area was apparently a former gravel pit. Extensive fill is likely present.

RECOMMENDATIONS

- Standard.
- Drainage - 3 - only interceptor drain recommended.

2462 HAYSEED CLOSE

SUMMARY

- House constructed near original slope crest.
- Level backyard created by backfilling behind 5 foot high rock-and-mortar retaining wall.
- Wall constructed in semi-circle across property. Approximately 1 foot thick. Apparently built in 6 inch deep trench. No cantilever supports or draintiles.
- Slopes below rockwall fairly steep, averaging 35°.
- Some oversteepening exists immediately below wall. Probably due to fill dumped after excavation of wall trench. Some timber debris below fill.
- Slopes are vegetated with 1 to 6 inch diameter evergreens. Generally lower trunks are curved and ground cover is minimal.
- Seepage and surface erosion is visible across property below rockwall.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House previously serviced by septic tank.
- Street runoff directed to open ditches on Hayseed Close. No curbs or storm sewer system.
- During December 1979 rainstorm, fill settled an average of 6 inches within 8 feet of retaining wall. Fill has continued to settle and had reached a maximum of 10 inches by June, 1980 when inspected.
- Wall has cracked at either end of semi-circle. Problem may have been initiated by December, 1979, rainstorm.

RECOMMENDATIONS

- Standard
- Drainage - 3
- Drains recommended through retaining wall.

2480 HAYSEED CLOSE

SUMMARY

- House constructed near slope crest.
- Slopes average 30° to 35°.
- Minor amount of fill pushed over slope.
- Crest generally rounded, but partially supported at western edge by 5 foot high weak retaining wall of planks.
- Slopes densely vegetated by ground cover and evergreens. Evidence of clearing at and immediately below crest.
- No visible seepage or surface erosion.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House previously serviced by septic tank.
- Street runoff directed to open ditches on Hayseed Close. No curbs or storm sewer system.
- According to owner, no history of slumping.

RECOMMENDATIONS

- Standard.
- Drainage - 1.

2141 BERKLEY AVENUE

SUMMARY

- House constructed more than 20 feet from slope crest.
- Level backyard fill is supported by apparently competent 4 foot high cribwall of 8 inch square timber posts and 2 inch thick lagging. Gaps have been left in lagging for drainage.
- Slopes below cribwall lie consistently at 33° for 15 vertical feet then become irregular and uneven, varying from 10° to 38° in steps.
- Roof and foundation drains are assumed to extend over bank, but tiles were not found during cribwall construction and outlets were not visible.
- House previously serviced by septic tank.
- Seepage and wet pockets of ground were observed at base of steep uneven slopes.
- Some surface erosion was evident, originating from broken rock-wall near north property line and possibly from buried draintile.
- Water ponds at base of paved north driveway immediately above cribwall.
- Some settlement (1 to 2 inches) has occurred in fill within 6 feet of cribwall and may be associated with December 1979, rainstorm.

RECOMMENDATIONS

- Standard
- Drainage - 2.

2157 BERKLEY AVENUE

SUMMARY

- House constructed 25 feet from existing slope crest.
- Level backyard paved with flagstones and bordered with sloping rockwall. Large level terrace on southern portion of lot supported by rock and cement walls in poor condition.
- Slopes below terrace average 30° to 35° and are thickly covered with compost and debris.
- Slopes steepen to 40° in northwest corner where gully falls away to southwest.
- Possible slide scar at head of gully north of property.
- Natural drainage towards gully interrupted by rockwalls.
- Two seepage points observed on slope. One at southwest corner below cracked rockwall and concrete tank. Other at corner of mortar block wall.
- Ground generally damp and uneven.
- Roof and foundation extend over bank, but outlets were not visible. Outlets may be associated with seepage points.
- Some surface erosion visible on slope.
- House previously serviced by septic tank.
- Street runoff directed to storm sewers.
- Settlement has occurred across backyard above sloped rockwall, causing minor cracking of flagstones. Settlement most significant in northwest corner above steeper slopes. Owners commented that settlement has been gradual and not specifically associated with December 1979, rainstorm.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

2175 BERKLEY AVENUE

SUMMARY

- House partially founded on fill but reasonably well back from present crest.
- Level backyard constructed of deep fill supported by concrete cantilever retaining wall.
- Wall constructed before house, apparently on advice of building inspector. Wall apparently designed by engineer and founded on fill.
- Property lies at head of natural steep gully. Slopes below retaining wall are 38° to 40°, and partially oversteepened by fill and compost.
- Possible slide scar near south property line, tree trunks are bent.
- Roof and foundation drains extend over bank but no outlets were visible.
- Retaining wall drained by gravel backfill and through tiles.
- House previously serviced by septic tank. Outlines of tank and field visible in backyard.
- Street and driveway runoff directed to storm sewers.
- No seepage or surface erosion observed on slope.
- House shows evidence of gradual settlement.
- Some evidence of partial instability of fill.
- Retaining wall settled 8 inches in last 1 1/2 years.
- Backyard fill has settled up to 8 inches at retaining wall since fall of 1979. Slump most noticeable in southwest corner of yard near septic tank.
- Rockwalls at property lines have cracked 6 feet behind retaining wall. South wall cracked during December 1979 rainstorm.
- Southern portion of concrete wall tilts slightly downhill.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

2191 BERKLEY AVENUE

SUMMARY

- Backyard constructed of fill supported by 3 foot high retaining wall.
- Fill evident up to 50 feet below slope crest. Slopes steepened to 40°. Fill in loose condition overlying stumps and debris.
- Lower slopes average 35°.
- Roof and foundation drains extend over bank but appear to be blocked. Visible outlets were dry.
- House previously serviced by septic tank. Location visible in backyard. Distribution box collapsed in fall of 1979.
- Street and driveway runoff directed to storm sewers.
- No seepage or surface erosion visible on slope.
- Southern portion of backyard, near septic tank location, has settled. Owners indicate that settlement has been gradual and is not associated with December 1979 rainstorm.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

2249 BERKLEY AVENUE

SUMMARY

- House constructed approximately 35 feet from existing slope crest.
- Level backyard apparently extended by dumping fill over slope.
- Slopes in the northwest corner are oversteepened to 40° for 30 vertical feet in two rough benches.
- Other slopes average 33° to 35°.
- Fill appears to be in loose condition overlying stumps and debris. Thick surface debris extends well down slope.
- No evidence of seepage or surface erosion on slope.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House previously serviced by septic tank.
- Street runoff directed to storm sewer.
- A closed crack extends into southern portion of backyard in association with cracking, settlement and sliding of properties to the south during December 1979 rainstorm.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

2251 BERKLEY AVENUE

SUMMARY

- Backyard apparently extended by dumping fill over slope.
- Slopes oversteepened to 40° for approximately 30 feet downslope.
- Lower slopes at 30° to 32°.
- Fill appears to be in loose condition, overlying stumps and debris.
- Frontyard drains towards house and slope.
- Street runoff directed to storm sewer.
- Ground is continuously moist, particularly at toe of frontyard slope.
- Roof and foundation drains extend over bank near northwest corner of yard. Water seems to flow continuously from drain outlet although quantity of flow varies.
- An erosion gully has formed below the drain outlet. No other evidence of seepage or surface erosion.
- House previously serviced by septic tank.
- Owners commented that localized slumping at southwest corner of backyard had occurred prior to December 1979.
- No other evidence of settlement was observed.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

2279 BERKLEY AVENUE

SUMMARY

- Natural slopes of 33° have been slightly oversteepened by fill to 38° for 20 vertical feet below crest.
- Deciduous vegetation and curved tree trunks may indicate old gully or failure scar on slope near northwest corner of property.
- Small 3 foot high concrete retaining wall holds back fill in northwest corner.
- No seepage or surface erosion visible on slope.
- Exposed soil appears to be dense silt with some gravel.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- Ground has settled approximately 2 inches in central portion of backyard within 7 feet of slope crest. Debris and compost have been thrown on slope in this area.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

2307 BERKLEY AVENUE

SUMMARY

- Slopes below crest average 43°.
- Fill extends approximately 40 feet below crest. Debris on slope is limited.
- Upper slope vegetated predominantly with grass and brush, few trees.
- No seepage points observed on slope.
- Concrete swimming pool near crest drains over slope near northern property line. Slope has been severely eroded below outlet.
- Roof and foundation drains extend over bank but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- Swimming pool patio slab in northwest corner settled after December 1979 rainstorm. Adjacent slab had apparently settled slightly prior to 1979.

RECOMMENDATIONS

- Standard.
- Drainage - 1.

2377 BERKLEY AVENUE

SUMMARY

- Backyard consists of 30 foot wide lawn contained by 6 foot fence.
- Outside fence, a 15 foot wide vegetable garden has been created by backfilling a 4 foot high mortar block wall and a wood cribwall.
- Wall appears to be in good condition, but is partially braced by decomposing tree stumps.
- Slopes below wall are steep (40°) and vegetated by brambles rather than evergreens of adjacent slopes.
- Lower slopes average 30°.
- Seepage was observed adjacent to a large tree stump below the mortar block wall.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- Settlement has occurred in the backyard in a large semicircle within 10 feet of the fence. Settlement has caused distortion of the fence but has not visibly disturbed the garden or the mortar block wall. Settlement may or may not be associated with December 1979 rainstorm.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

2391 BERKLEY AVENUE

SUMMARY

- House constructed approximately 50 feet from slope crest.
- Level backyard extends to natural slope averaging 35° to 40°.
- Fill at crest extends 10 to 15 feet downslope. Fill is more extensive near small gully at southwest corner of property.
- Many evergreens have been cleared off slope leaving large stumps which act as retaining elements for fill near crest.
- No evidence of seepage or surface erosion on slope.
- Roof and foundation drains extend over bank, but outlets were not visible.
- House never serviced by septic tank.
- Street runoff directed to storm sewer.
- Small creek runs southwest at toe of slope.
- During December 1979 rainstorm, a part of the slope crest closest to the gully at the southwest corner of the property settled. The ground in this area, was and continues to be soggy and soft.

RECOMMENDATIONS

- Standard.
- Drainage - 3.

APPENDIX IV

SUMMARIES AND RECOMMENDATIONS FOR PROPERTIES WITH MODERATE TO HIGH RISK OF MAJOR INSTABILITY

APPENDIX IV

SUMMARIES AND RECOMMENDATIONS FOR PROPERTIES WITH MODERATE TO HIGH RISK OF MAJOR INSTABILITY

(Ref. Drawing D-2670-1)

SEE SECTION 5.3 OF REPORT

The standard recommendations given for properties with very low risk apply to all properties in this classification. As well drainage improvement of Class 2 given for properties with low risk are recommended for all of these properties.

Two basic additional recommendations are to remove fill that has been placed at the crest, and to protect the more serious existing slide areas from future ravelling by placement of free draining, fine, very angular rockfill. In all areas of removal of potentially unstable fill, the exposed surface should be protected from erosion by immediate revegetation (for example, hydroseeding), or covered with a blanket of very angular, free-draining rockfill. In areas of rockfill placement, the existing surfaces should be stripped of all loose and softened material. A heavy gauge perforated drain should be installed securely to the slope down the thalweg (low point) of the slide, and covered with free-draining, well-graded granular material to prevent piping of the underlying soil. An energy dissipator should be provided at the outlet of the pipe.

The rockfill should consist of crushed pieces of a durable rock without excessive sand sizes. The rockfill should contain some clean sand, but only enough to provide filtering action for water. The sand content must be low to maintain the high angle of friction between angular rock particles. This will give the highest

strength to the fill. The exact slope of the fill will depend on the material obtained, and the surface should be graded to a slope a few degrees flatter than the maximum angle at which the material will stand. To define the toe of the fill a single layer of glabions may be required, depending on details of the slope.

It is recognized that removal of the fill will, in some cases, cause a reduction in the yard area. To increase the yard area it would be possible to add a deck extension over the slope. The deck supports should be founded a minimum of three feet into the dense natural soil, to reduce the possibility of undermining of the footings by erosion.

1305 LENNOX STREET - refer to Drawings B-2670-6 & 7

SUMMARY

- Steep slopes, approximately 45°. Oversteepened in areas by a series of surface planks, rockwalls and cribwork. All onslope construction in poor condition. Construction extends well down bank.
- Natural slope below construction at 33° to 35°.
- Level backyard contains a lined pool. In December, 1979, yard was grassed and landscaped to slope crest.
- Serious cracking and slumping occurred adjacent to pool in December, 1979.
- Cracks indicate a large quantity of unstable material including some fill.
- Roof, foundation and pool drains extend a short distance over bank.
- Small waterline carried over bank to greenhouse.
- Slope cut by erosion gullies below crest, particularly near south property line.
- Street runoff directed to open ditches on either side of Lennox Street. No curbs or storm sewer sytem.
- Site was perviously serviced by septic tank.
- Additional draintile, pool supports and a sundeck have been installed on the slopeside of pool since December, 1979.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Removal of fill.
- "Guesstimate" of cost $8,000.00.

1345 LENNOX STREET - refer to Drawings B-2670-6 & 8

SUMMARY

- Backyard level to slope crest where fill is retained by 3 foot high cribwall.
- Yard is grassed, landscaped with garden at crest.
- Steep slopes (45° to 47°) decrease to 37° approximately 30 feet downslope.
- Steep gullies follow north and south property lines.
- Gullies are lightly vegetated and may be old failure surfaces.
- Slumping occurred in December, 1979, indicating a quantity of unstable material.
- No obvious fill except immediately behind cribwall.
- Roof and foundation drains extend over bank, outlets are not visible.
- Some evidence of runoff erosion downhill.
- Site was formerly serviced by septic tank.
- Base of small slope at north property line lined with recently cleaned draintile.
- Street runoff directed to open ditches on either Lennox Street. No curbs or storm sewer sytem.

RECOMMENDATIONS

- Standard.
- Drainage inprovement 2
- Removal of fill.
- "Guesstimate" of cost $3,000.00.

1425 LENNOX STREET - refer to Drawings B-2670-9 & 10

SUMMARY

- Slopes on north section of property, are 35° to 37°. Relatively stable, vegetated with mature timber.
- Steep slopes (to 46°) to centre and south below pool, concrete patio and wood sundecks. Vegetated with brambles and small deciduous trees.
- Slide occurred in December, 1972, taking out southern sundeck and fill. Rebuilt with moderately sound cribwork. Backfilled with sand, overlain with plastic and a light wooden deck.
- December, 1979, rainstorm caused settlement of sundecks, fill and concrete patio. Patio also cracked slightly.
- Pool has never cracked.
- Site never serviced by septic tank.
- Roof and foundation drains open to ground, according to owner.
- Drains from 1439 and 1451 Lennox collected and directed over bank below south sundeck at location of 1972 slide. 1425 Lennox driveway drain included in collection. Drainpipe extended at least 20 feet over bank.
- Erosion evident well down 1972 slide path.
- Pool drain outlets approximately 50 feet down northern slope. Riprap has been washed downhill and a 3 foot deep gully eroded.
- Street runoff is directed to open ditches to either side of Lennox Street. No curbs or storm sewer.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2
- Removal of fill.
- "Guesstimate" of cost $3,000.00.

1691 LAYTON DRIVE - refer to Drawings B-2670-11 & 12

SUMMARY

- Grassed backyard slopes gently towards bank but developed property does not extend to slope crest.
- Roof and foundation drains connected to storm sewer system.
- House never serviced by septic tank.
- Settlement occurred at extreme northwest corner of developed lot during December, 1979 rainstorm. Slumping occurred beyond fence line at slope crest.
- Steep slopes below crest, 42° for 20 vertical feet. Slopes decrease to an average 36° below.
- Crest consists of loose sandy soil with little surface vegetation. Shrubs and timber litter slope. Compost dumped at crest.
- Small gully to north at 45°.
- Slump scarp at crest, 2 feet high and 25 feet long, associated with December, 1979 rainstorm. Northern portion of crest settled slightly.
- Gully to north appears to be an old failure scar.
- Appears to be a large quantity of unstable material at crest. Monitoring since winter rainstorm has indicated no further movement, according to owner.

RECOMMENATIONS

- Standard.
- Drainage improvement 2
- Removal of fill.
- "Guesstimate" of cost $5,000.00.

1709 LAYTON DRIVE - refer to Drawings B-2670-11 & 13

SUMMARY

- Slopes below crest average 42° for 15 vertical feet. Grades to uneven slopes of approximately 33°.
- Small gully at south property line at 45°. Possible old failure surface.
- Backyard grassed and landscaped to slope crest.
- House constructed well back from slope.
- Roof and foundation drains connected to storm sewer system.
- House never serviced by septic tank.
- Fill near slope crest of poor quality, stumps covered by loose sand fill. Yard has settled unevenly.
- Slope noticeably lacking in large evergreens as compared to adjacent properties. Several 6 inch diameter trees at crest.
- Extensive slumping at crest during December 1979 rainstorm. Slump scarp in two steps each 2 feet high extending across property. Slope below scarps at 50° for 5 vertical feet then 44° for 20 vertical feet. Steep slopes (40°) continue downhill.
- Cracking extended in a broken line across yard approximately 7 feet behind crest.
- Some evidence of runoff erosion in southern gully.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Removal of fill.
- "Guesstimate" of cost $5,000.00.

1753 LAYTON DRIVE - refer to Drawings B-2670-11 & 14

SUMMARY

- House constructed well back from slope.
- Pool built to within 9 feet of slope crest.
- Slopes at 40° to 45° for 10 vertical feet, levelling to 5 foot wide path then continuing at 37° to 40°.
- Yard extended approximately 10 feet at crest presumably by fill excavated during pool construction. Sandy soil thrown over some stumps and timber debris visible from path. Overgrown with brambles. Additional debris oversteepens slope below path to 55° for 5 vertical feet.
- Roof, foundation and pool drains connected to storm sewer. Driveway drains to street.
- House never serviced by septic tank.
- Pool overflow drain on patio may lead over bank.
- Steady seepage flowing from hole at toe of fill near path. May be due to pool overflow drains.
- Some evidence of runoff erosion on slope below path.
- Slopes cleared of trees by previous owners. Recent growth topped only.
- According to owner, considerable settlement on slope side of pool occurred in assication with December 1979 rainstorm. Patio slabs tilted, separating from pool. Cracks widen in rockwalls 8 feet from crest. Crest slumped across property disturbing chain link fence and surface concrete slabs. Previous settlement had been minor. Pool has not cracked.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Removal of fill.
- "Guesstimate" of cost $5,000.00.

2391 CARMAN PLACE - refer to Drawings B-2670-15 & 16

SUMMARY

- House constructed on gentle slope near crest.
- Backyard slopes more steeply, benched in 3 steps.
- Slope continues at angles up to 45° for 20 feet below crest, then decreases to 35° on maturely vegetated slope.
- Minor quantities of fill and debris observed on slope.
- Lined swimming pool constructed on eastern portion of backyard at slope crest.
- Roof, foundation and pool drains extend over slope to toe of terraces below pool. Drains may be partially inoperative as very small quantities of water were observed at outlets.
- Minor gullying and erosion on slopes below outlets. Vegetation consists of small deciduous trees and bush.
- Owner has observed seepage on slope approximately 10 feet below crest.
- According to owner, serious slumping and some sliding occurred in December 1979 on western portion of yard in conjunction with large slide in adjacent property.
- Exposed slopes have oversteepened to 55°.
- Exposed soil is very dense cemented silt with some sand and gravel overlain with weathered loose silt.
- Seepage is evident on exposed slopes, generally running over the surface of dense silt. Weathered surface material is saturated near seeps.
- Owner has retained services of an independent professional geotechnical engineer to appraise his property.
- Owner has initiated remedial action by planting exposed slopes with a recommended grass seed. Further steps are contemplated.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Removal of fill.
- "Guesstimate" cost $5000.00.

2379 CARMAN PLACE - refer to Drawings B-2670-15 & -17

SUMMARY

- Concrete pool built on bench cut into slope on northern portion of backyard.
- Most of backyard below pool and house slid during December 1979 rainstorm. Cement patio tiles were undermined.
- Exposed slopes are very steep, up to 55°, composed of very dense cemented silt with varying amounts of sand and gravel overlain with loose weathered silt.
- Sand fill, underlying stumps and original top soil are evident at edges and top of failure surface.
- Seepage is visible across slope, most noticeably 20 feet below crest at boundary between yellow and grey silts. Seepage runs over surface of dense silts, saturating and eroding the loose overlying material.
- Grass has naturally re-established itself over approximately 1/2 of the slope.
- Prior to slide, fill apparently extended 4 to 5 horizontal feet beyond slide scarp and sloped steeply down bank.
- Fill was landscaped with small shrubs and trees and a chain link fence. A small vegetable garden stood near eastern property line.
- Slope immediately below house was sparsely vegetated with mature evergreens as compared to adjacent slopes.
- Roof and foundation drains extended over bank near eastern property line, approximate centre of slide area.
- Pool drain extended over bank, probably near middle of property (western edge of slide).
- House was never serviced by septic tank.
- No remedial action has been initiated by owners except for replacing drain pipe extensions downslope.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2
- Placement of rockfill is slide area and removal of fill left in place after slide.
- "Guesstimate" of cost $50,000.00.

2360 CARMAN PLACE - refer to Drawings B-2670-15 & 18

SUMMARY

- House built on gently sloping ground (10°) near top of slope.
- Length of level backyard varies from 5 to 20 feet.
- Slopes below crest angle at approximately 45° for 20 vertical feet then decrease to an average of 37°.
- Slopes are heavily vegetated. Crest contains young deciduous trees and brambles. Lower slopes contain mature evergreens.
- Slide occurred during December 1979 rainstorm below northwest corner of house. 33 foot wide scarp begins within 5 feet of sundeck foundations and patio.
- Exposed face roughly indicates strata. 2 1/2 feet of sandy fill overlying 5 inches of former topsoil overlying approximately 2 feet of sand, gravel and cobbles. Below lies very dense cemented silt containing trace to little sand and gravel. Loose weathered silts lie over most of the failure surface.
- Visible seepage across failure surface, particularly 15 feet below scarp. Seepage runs along surface of dense silts, saturating and eroding the overlying weathered material.
- Roof and foundation drains extend over bank along nothern edge of slide.
- House never serviced by septic tank.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Placement of rockfill in slide area and removal of fill left in place after slide.
- "Guesstimate" of cost $20,000.00.

2205 BERKLEY AVENUE - refer to Drawings B-2670-19 & 20

SUMMARY

- House constructed a minimum of 15 feet from slope crest.
- Level backyard created by dumping fill over slope. Fill partially supported by 2 foot high wooden cribwall in poor condition. Fill steepens upper slopes to 36°.
- Fill consists of loose excavated material overlying stumps and debris. Debris often braced against tree trunks and stumps. Fill most extensive in gully near north property line.
- Lower slopes at 32°.
- Some evidence of surface erosion on slope.
- Roof and foundation drains extend over bank near south property line. Drains have been disconnected since December 1979 rainstorm.
- House previously serviced by septic tank. Location is visible near north property line. Septic tank distribution box extends toward slope crest.
- Street and driveway runoff directed to storm sewers.
- Owner indicated that minor settlement had been occurring at the slope crest over the last 10 years as underlying stumps decomposed.
- During December 1979 rainstorm, extensive cracking occurred across property and the northern portion of the yard slid, along with part of the adjoining property. Septic tank distribution box was exposed by slide. Slide debris continued downslope to end up behind 2318 Treetop Lane.
- Remaining slide scarps lie at 45° in sandy fill and at 50° to 65° in stump debris.
- Exposed soil on slide path appears to be very dense bedded silt with some gravel overlain by loose saturated weathered silt. Seepage over the surface of the dense silt causes rapid weathering.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Removal of fill.
- "Guesstimate" of cost $4,000.00.

2217 BERKLEY AVENUE - refer to Drawings B-2670-19 & 20

SUMMARY

- House constructed well back from slope crest.
- Level backyard created by dumping fill over slope crest. Fill steepens slopes to an average of 42° for 25 vertical feet. Fill is most extensive in gully near south property line, and consists of loose excavated material overlying decomposing stumps and debris.
- Roof and foundation drains extend over bank near south property line.
- House previously serviced by septic tank located near south property line. Septic tank distribution box is located near the slope crest and had settled before December 1979.
- During the December 1979 rainstorm, extensive cracking occurred in the southern portion of the property and the slope crest settled across the entire width of the property. Part of the yard slid, along with a portion of the adjoining property, exposing both the septic tank distribution box and the roof and foundation drain outlet. Slide debris continued downslope to end up behind 2318 Treetop Lane.
- Remaining slide scarp lies to 50°, but flattens rapidly to 36° in the slide path.
- Exposed soil on the slide path appears to be very dense silt with some sand and gravel overlain by loose saturated weathered silt. Seepage over the surface of the dense silt causes rapid weathering.
- The slide scar has partially revegetated by natural means.
- Seepage from the drain tiles at the scarp has eroded a channel through the surface material.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Removal of fill.
- "Guesstimate" of cost $4,000.00.

2223 BERKLEY AVENUE - refer to Drawings B-2670-19 & 21

SUMMARY

- Level backyard apparently been extended by dumping fill over slope crest. Slopes are oversteepened to approximately 40° for 40 vertical feet.
- Lower slopes at 30° to 33°.
- Fill appears to be in loose condition, overlying stumps and debris. Debris extend well down slope.
- Upper slopes vegetated by young deciduous growth.
- Roof and foundation drains extend over the bank and outlet about 30 feet below the crest near the south property line. Drains do not appear to be operational as there is no evidence of erosion below the outlet.
- No evidence of seepage or surface erosion on slope.
- House previously serviced by septic tank. Septic tank distribution box located near slope crest.
- Street and driveway runoff directed to storm sewer.
- During the December 1979 rainstorm, settlements of up to 4 inches occurred at the slope crest across the entire width of the backyard. The most severe settlements occurred near the south property line and the septic tank distribution box. Subsequent settlement has occurred.
- Edge of settled ground showed as a distinct slope break. No open cracks.

RECOMMENDATIONS

- Standard.
- Drainage improvement 2.
- Removal of fill.
- "Guesstimate" of cost $4,000.00.

APPENDIX V

REFERENCES

APPENDIX V

REFERENCES

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