

THE COMMUNITY PLAN
A PORTION OF
**GLENBROOKE
SOUTH
NEIGHBOURHOOD**

THE CORPORATION OF THE
CITY OF NEW WESTMINSTER
BYLAW NO. 5629, 1986

A bylaw to designate a certain community plan
as part of the Official Community Plan of the
City

WHEREAS Section 944 of the "Municipal Act, R.S.B.C. 1979, c. 290" empowers Council to have a community plan prepared;

AND WHEREAS Section 947 of the Municipal Act requires that an official community plan be designated by bylaw;

AND WHEREAS Council on 1983 December 19 adopted the Community Plan for New Westminster with the intention of preparing detailed neighbourhood plans;

NOW THEREFORE the City Council of The Corporation of the City of New Westminster ENACTS AS FOLLOWS:

1. This bylaw shall be cited for all purposes as "Official Community Plan Designation Bylaw No. 5629, 1986".
2. That certain community plan prepared under Section 944 of the Municipal Act as a community plan, a copy of which is attached to this bylaw, is hereby designated as part of the official community plan of the City of New Westminster.

GIVEN FIRST READING this 6th day of October A.D. 1986.

GIVEN SECOND READING this 27th day of October A.D. 1986.

PUBLIC HEARING held this 27th day of October A.D. 1986.

GIVEN THIRD READING this 27th day of October A.D. 1986.

RECONSIDERED and FINALLY PASSED and ADOPTED and the Seal of The Corporation of the City of New Westminster affixed this 3rd day of November A.D. 1986.

I hereby certify the foregoing By-Law to be a True and Correct copy of the Corporation of The City of New Westminister

Official Community Plan
Designation

By-Law No. 5629 1986 as adopted by the Council of the City of New Westminister in accordance with the provisions of the Municipal Act on the 03 day of November 1986
Date of Certification November 04, 1986

P. J. Larkin
CITY CLERK
Corporation of The City of New Westminister

Tom Buhac
MAYOR

P. J. Larkin
CITY CLERK

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INTRODUCTION

The Community Plan for The City of New Westminster

The Community Plan for the City of New Westminster 1982, states that areas having a unique character and site development difficulties should be designated as "special planning areas" so that detailed neighbourhood plans or development policies can be prepared and approved by Council.

In accordance with this approach a detailed "community plan" for the undeveloped portion of the Glenbrooke South neighbourhood has been undertaken. The plan will serve as a guide to development in the neighbourhood.

It proposes to designate the Plan Area as a "Development Permit Area" where a development permit would be mandatory prior to the start of construction for all developments except for those with three or less housing units.

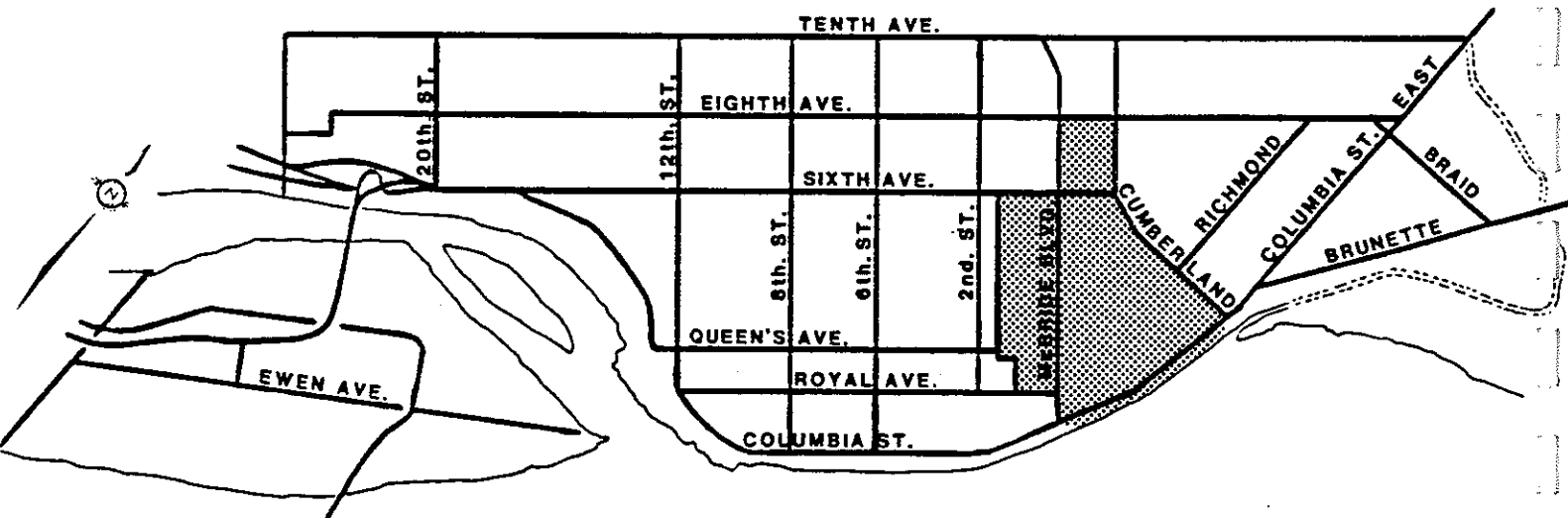
The Neighbourhood

The "neighbourhood" concept has generally been accepted by the public as the basis for community development. It is the area within which residents may share common services, social activities and community facilities. This concept is important for residential developments because it encourages individual projects to be integrated within the entire neighbourhood and not looked upon as a single entity.

Earlier planning studies of the City have determined some fifteen neighbourhoods or character areas with homogeneous socio-economic characteristics. For convenience, planning and administrative purposes, these areas were considered as the minimum planning units of the community. The Glenbrooke South Area is one of these fifteen areas (see Map 1, Neighbourhoods of New Westminster).

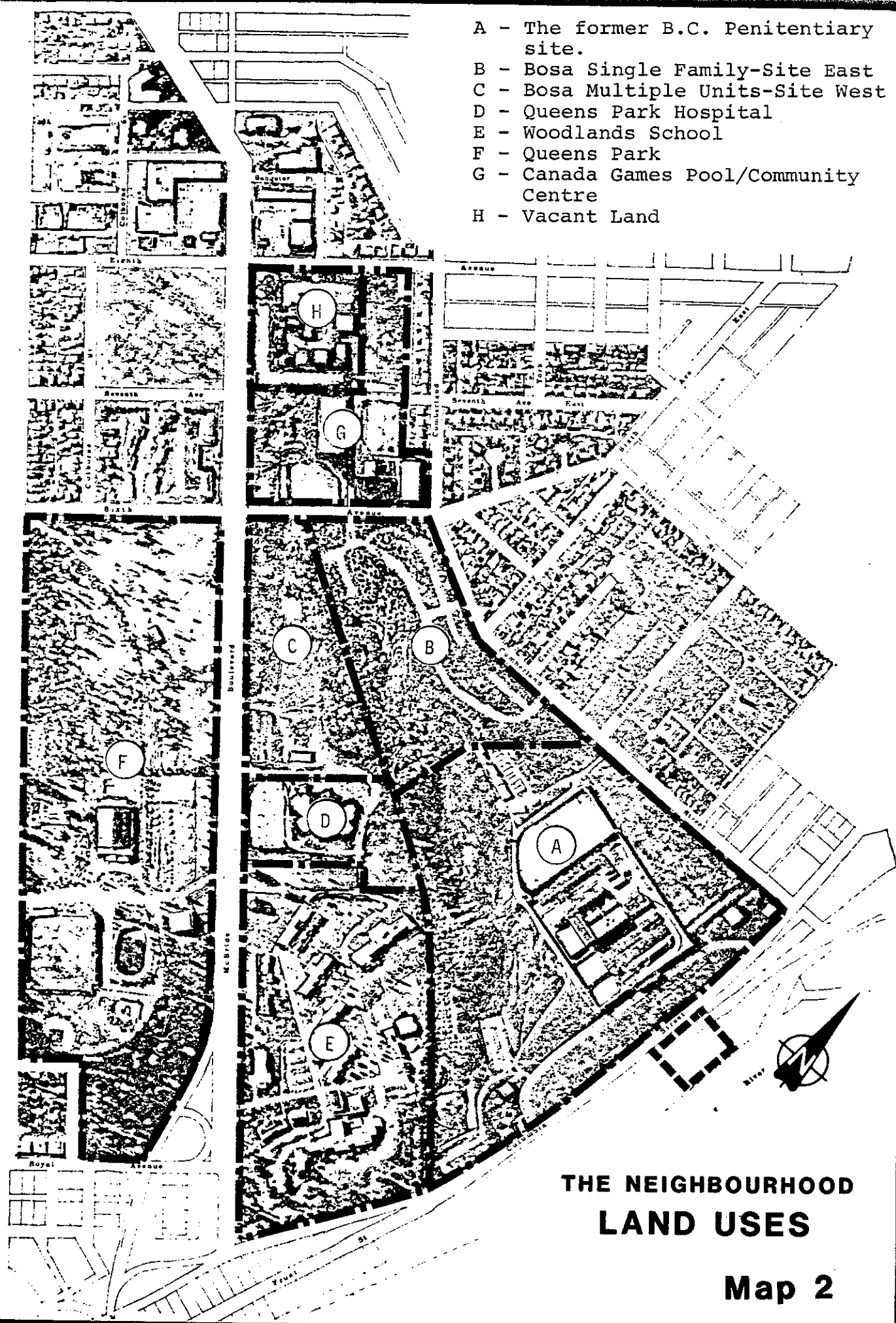
It can be seen from Map 2 that the neighbourhood has a definite institutional character as evidenced by such uses as the Canada Games Pool/Community Centre complex; Woodlands

GLENBROOKE SOUTH



**THE
NEIGHBOURHOOD**
Map 1

- A - The former B.C. Penitentiary site.
- B - Bosa Single Family-Site East
- C - Bosa Multiple Units-Site West
- D - Queens Park Hospital
- E - Woodlands School
- F - Queens Park
- G - Canada Games Pool/Community Centre
- H - Vacant Land



**THE NEIGHBOURHOOD
LAND USES**

Map 2

School, Queens Park Hospital, and Queens Park. Their concentration in this area occupies more than half of the Glenbrooke South neighbourhood.

Map 3 shows the current zoning in the neighbourhood.

Historical Background

The Glenbrooke South neighbourhood is the location where much of the early history of the City took place. Here, the major Indian village of Skiaimetl was located on the banks of the Glen River, now known as the Glenbrooke Ravine. Also, the historic landing of the Royal Engineers occurred on the south shoreline of the neighbourhood along the Fraser River. At this site, Royal Engineer surveyors of the Columbia Detachment determined an absolute value of longitude for New Westminster. Today the spot is marked with the Royal Engineers' Base Observatory 1859-60. What is now known as the BC Penitentiary lands was the site for the Provincial capital buildings, including Government House.

With the entry of British Columbia into Confederation, the Federal Government promised the construction of a penitentiary and a mental hospital. The Glenbrooke South lands were chosen for both these facilities--the former on the east side of the ravine, the latter on the west side.

In 1914, the City initiated a sewer program which required the location and construction of a very large diameter trunk sewer in the bed of the Glen River. Today, this facility is located within the Glenbrooke Ravine and has become an integral part of the Greater Vancouver regional sewer network which serves the surrounding municipalities as well as the City.

Beginning in 1945, the periphery of the neighbourhood was developed, as well as portions of the Glenbrooke North neighbourhood, with one-family dwellings. In that year, the Glenbrooke Apartments were constructed at Sixth Avenue just west of McBride Boulevard. In the 1950s, commercial buildings were erected at the north-east corner of Eighth Avenue and McBride Boulevard. In the 1960s, when the City

10th Ave.

- (AG-1) Limited Agricultural Districts
- (RS-1) One Family Dwelling Districts
- (RT-2) Townhouse Districts
- (RM-1) Multiple Dwelling Districts (Garden Apts.)
- (RM-2) Multiple Dwelling Districts (Low Rise)
- (P-1) Public and Institutional Districts (Low Rise)
- (P-3) Public and Institutional Districts (High Rise)

8th Ave.

P-1

13 RS-1

6th Ave.

RT-2

RM-1

RM-2

RS-1

GP. 1. Lot 115

RS-1

P-3

Columbia St.

Royal Ave.

AG-1



THE NEIGHBOURHOOD ZONING

faced a period of rapid growth, a small portion of the Glenbrooke South neighbourhood was developed for one-family houses. However, most of the area still remained in institutional uses. To the north, the Victory Heights area developed as a one-family residential area, with some apartments adjacent to the commercial area. It was also during the period between 1960 and 1969 that commercial uses were introduced at what is now known as the Royal Square shopping centre.

As the City grew, the BC Penitentiary property took on more importance and became more valuable and the location of a penal institution in the City was questioned. In the 1960s, the Penitentiary lands diminished when the City acquired a large amount of property on the north side of Sixth Avenue East to develop a community centre. Successive additions enlarged the community centre--the greatest increase in floor space coming with the Canada Games Pool in 1973.

In 1970, Douglas College opened, occupying temporary buildings at Eighth Avenue and McBride Boulevard. More buildings were gradually added to the site until the College moved to a permanent campus on Royal Avenue in 1982.

During the 1970s, it was the consensus of many that Douglas College would be located on the large site at the south-west corner of Sixth Avenue East and Cumberland Street. However, the development of the Downtown Regional Town Centre plan, containing a central site for Douglas College, made the aforementioned Sixth Avenue site available for other uses.

In the early 1980s, this site was subdivided into 82 one-family lots and construction began.

The phase-out of the BC Penitentiary in 1981 opened the way for its possible redevelopment.

In 1981, the Province announced its intention of closing Woodlands School in the 1990s or later. Therefore, this large piece of property may also become available for redevelopment.

In 1983, the large Provincial parcel at the south-east corner of Sixth Avenue East and McBride Boulevard was purchased by Bosa Construction Ltd. Subsequently, a development plan and

rezoning were approved by the City which allowed 346 units of various types of multiple accommodation. Construction of the project began in late 1983 and is now complete.

It has long been rumoured that the Glenbrooke Apartments at McBride Boulevard and Sixth Avenue will be redeveloped to a higher density by the Federal Government. Built immediately after the war (1945), these low-rise units have a high potential for redevelopment.

AREA OF THIS COMMUNITY PLAN

The area of this Community Plan is shown screened on the attached Map 4. It is bounded on the north by Cumberland Street, which abuts an area of single family residential and cemetery uses; on the east by Columbia Street, on the south by Woodlands School, Queens Park Hospital and a 346 unit multiple dwelling development, and on the west by Sixth Avenue.

The Plan Area consists of approximately 90 acres. Roughly 18 percent of this property is build on with single family residences and about 27 percent is in the form of a ravine. As shown on Map 5 this ravine, containing the Glen Creek, is the most dominant topographic feature in this area.

The steep sloping sides of the ravine have a depth of about 50 feet, making the ravine unsuitable for development. Located at the bottom of the ravine is the Glenbrooke Trunk sewer. The remainder of the site is fairly level and slopes eastwards at about a 10 to 15 percent grade towards the Fraser River. It is considered excellent for building purposes.

Because of the steep ravine, the net buildable land is approximately:

TOTAL PROPERTY	90	acres
DEVELOPED AREA	16.3	acres
RAVINE	24.7	acres
BUILDABLE LAND	49	acres

A frontage road with two connections to Columbia Street provides the main access to the undeveloped portion of the property at the present time. Since Columbia Street is a major arterial street, giving direct access to the Patullo Bridge and the Trans-Canada Highway (via Brunette Avenue), traffic volumes are high and are likely to remain so, or increase in the future.



10th Ave.

8th Ave.

6th Ave.

First St.

Royal Ave.

Cumberland St.

Columbia St.



THE PLAN AREA
Map 4

PURPOSE OF THE COMMUNITY PLAN

The purpose of this Community Plan is to:

- 1) Provide direction for public and private investment.
- 2) Provide guidelines for development.
- 3) Establish development objectives.
- 4) Provide a mechanism to achieve the stated objectives.

OBJECTIVES OF THE COMMUNITY PLAN

The objectives of this plan are:

- 1) To develop the site as a unique area by taking advantage of its location, physical attributes environmental and heritage resources.
- 2) To enhance the area as a place to live and spend leisure time, thus improving the image of the neighbourhood.
- 3) To encourage development on a human scale with proper pedestrian circulation and a focus for social activity.
- 4) To maintain, and where possible, raise land value in the area.
- 5) To maintain a balance between private investment in the area and the resultant public costs and benefits.
- 6) To protect development from hazardous conditions.
- 7) To provide guidelines for the form and character of development.

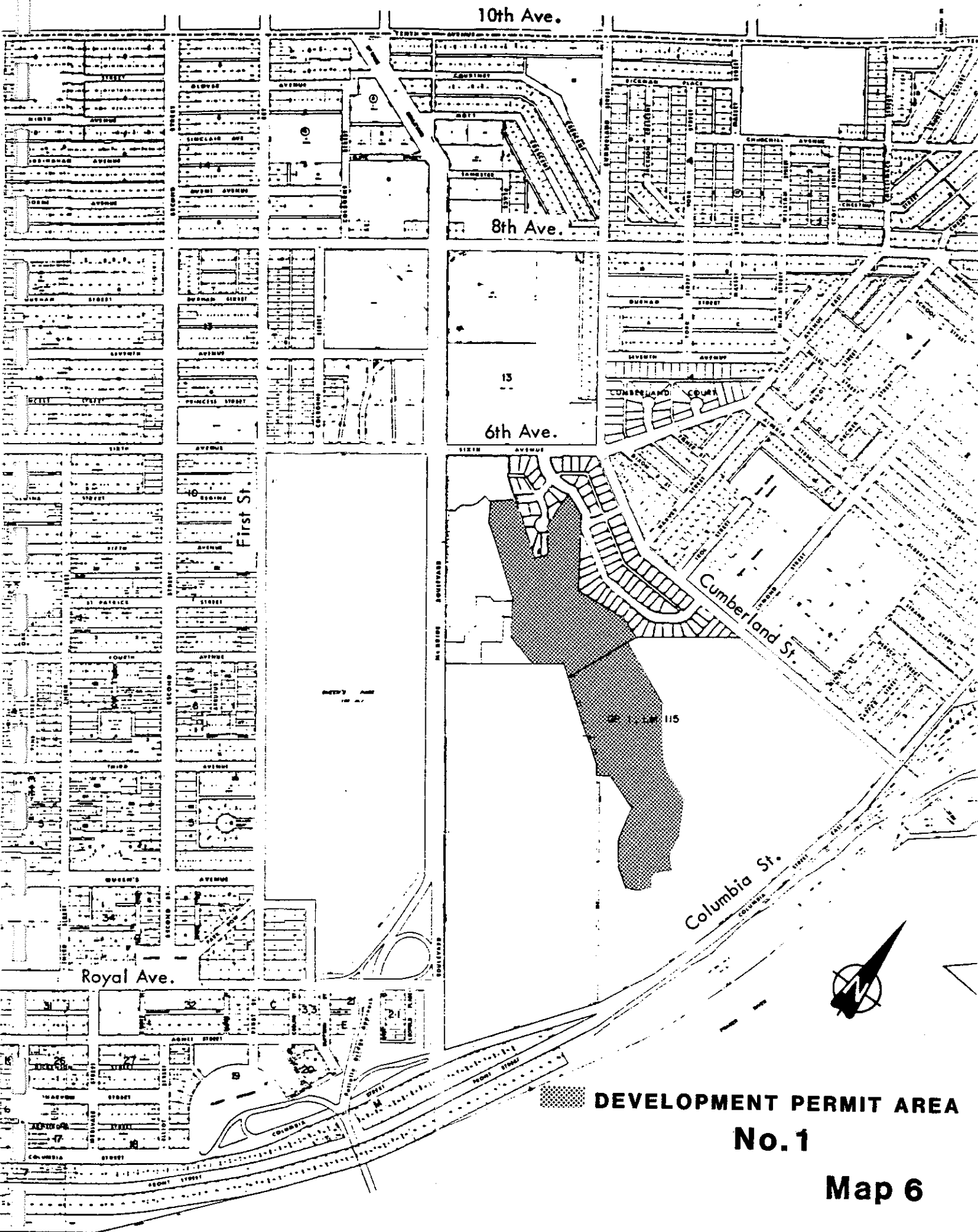
DEVELOPMENT PERMIT AREA DESIGNATIONS

- a) The area shown screened on Map 6 is Development Permit Area No. 1. This area is so designated because of the steep slopes of the Glen Creek on which it is essential to protect and enhance the indigenous or natural plant material to prevent slope failure.

A detailed site inspection was undertaken by Took Structural Laboratory Inc. and a copy of their report is attached as Appendix A.

Development permits issued in this area shall be in accordance with the following:

- 1) No permanent structures shall be permitted in the areas subject to slope failure or damage from slope failure.
 - 2) No septic disposal system involving general discharge or irrigation system shall be permitted in the hazard area.
 - 3) Notwithstanding the uses permitted in the zoning bylaw, no land use involving significant general water discharge shall be permitted.
 - 4) Notwithstanding the bylaw provisions or requirements, drainage facilities shall be required to divert drainage away from the area subject to slope failure.
 - 5) The indigenous plant material shall be maintained and enhanced on the areas subject to failure.
 - 6) All new building sites shall be in areas not subject to slope failure.
- b) The area shown screened on Map 7 is the Development Permit Area No. 2. One of the objectives of declaring this parcel a development permit area is to ensure that the form and character of development on this site is in keeping with the adjacent areas.



10th Ave.

8th Ave.

6th Ave.

First St.

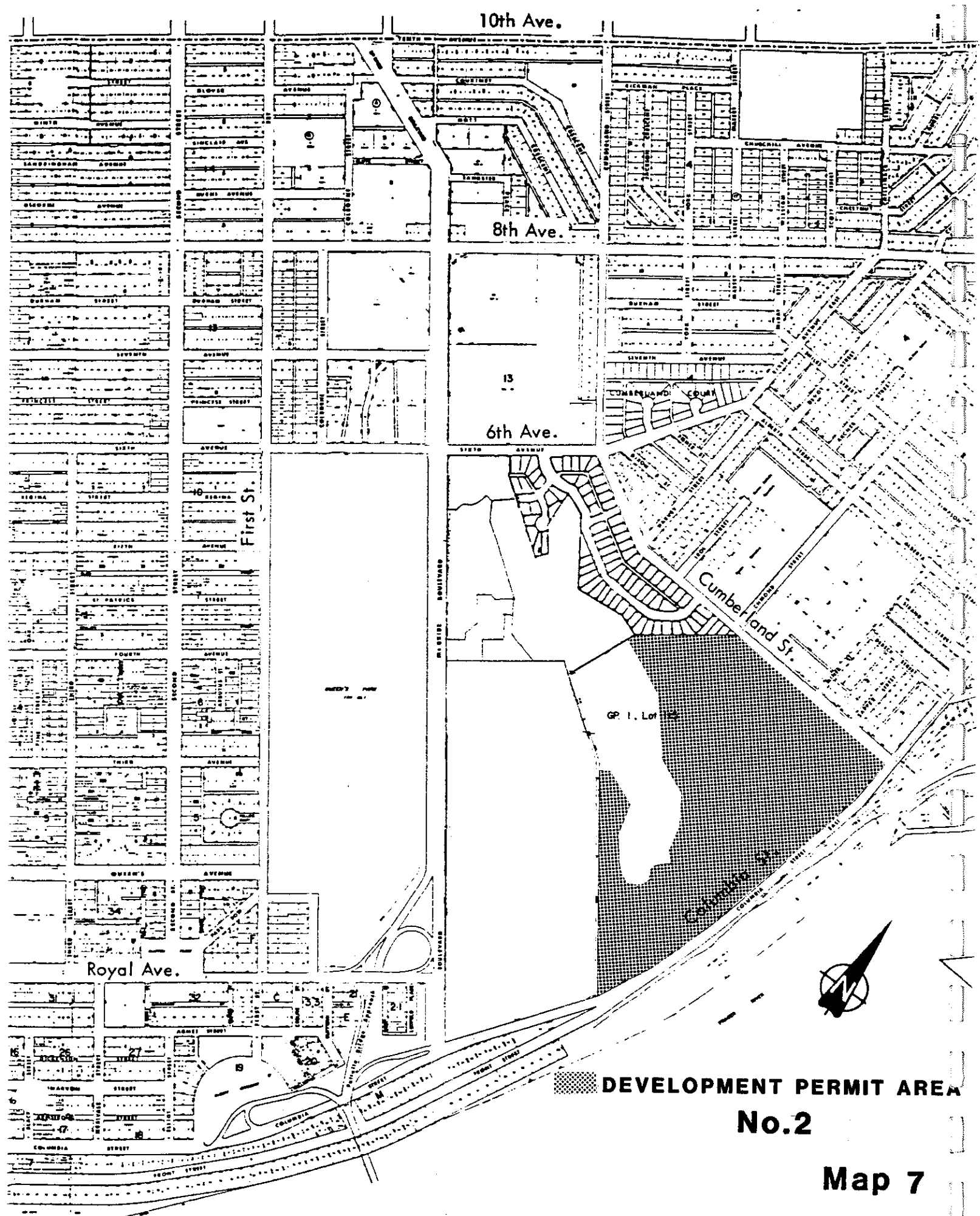
Cumberland St.

Columbia St.

Royal Ave.

**DEVELOPMENT PERMIT AREA
No. 1**

Map 6



10th Ave.

8th Ave.

6th Ave.

First St.

Royal Ave.

Cumberland St.

GP 1. Lot 12



**DEVELOPMENT PERMIT AREA
No.2**

Map 7

Development permits issued in this area shall be in accordance with the following guidelines:

- 1) The scale and massing of buildings should relate to adjacent developments and provide an easy transition to development to the north and east.
- 2) The shape, siting, roof lines and exterior finishes of buildings should be sufficiently varied to avoid a monotonous appearance.
- 3) View corridors to the Fraser River and the adjacent shore should be preserved.
- 4) The development should have a sense of unity but should not be made monotonous through repetition of building form.
- 5) Exterior lighting and signs should be unobstructive, be in scale with their surroundings, and be used to unify the development.
- 6) The location, height and form of buildings should be in keeping with the topography.

ELEMENTS OF THE PLAN

Housing

One of the major policies contained in the Community Plan for New Westminster is to encourage residential development where adequate community services and facilities already exist or where they can be easily provided. It calls for housing to be located close to work and leisure opportunities with transit and throughfares nearby to provide easy access, and with density standards set to ensure adequate space, light, air and safety.

Because of the location of the Plan Area in relation to existing services and facilities it meets most of these criteria. Thus the opportunity exists for the creation of an exciting new living environment.

Map 8 shows the approximate location and form of residential development anticipated in the undeveloped portion of the Plan Area, while Map 9 shows the associated types and densities. As indicated on the preceding maps, there exists, in the Plan Area, the opportunity for the private market to provide a wide range of housing types at affordable prices.

The flexibility needed to produce an innovative and exciting development will be achieved through the Development Permit System while densities and uses will be controlled through the Zoning Bylaw.

Commercial Development

New Westminster is well endowed with commercial facilities. The plan area is within a short distance of both the Downtown and Sapperton commercial area. For this reason, there is little need to set aside extensive areas for commercial uses within the plan area. However, a small convenience shopping complex should be provided, preferably in a central location, to meet local needs. The areas designated (C-2) on Map 10 are the ones suggested for this use.

Cultural Facilities

It has been estimated that the plan area can accommodate about 900 housing units of varying forms. Based on this estimate one can expect about 2,000 new residents in the neighbourhood when the development is completed. Although the neighbourhood is well endowed with recreation facilities, these may not be capable of handling comfortably a population increase of the magnitude anticipated. Thus a small recreation complex capable of meeting the less exotic needs of the residents of the Plan Area should be provided. A quality recreation facility would, not only meet a need in close proximity to home, but it would also act as a cohesive element to the plan area. The area designated (P-1) on Map 11 is the suggested location for this facility.

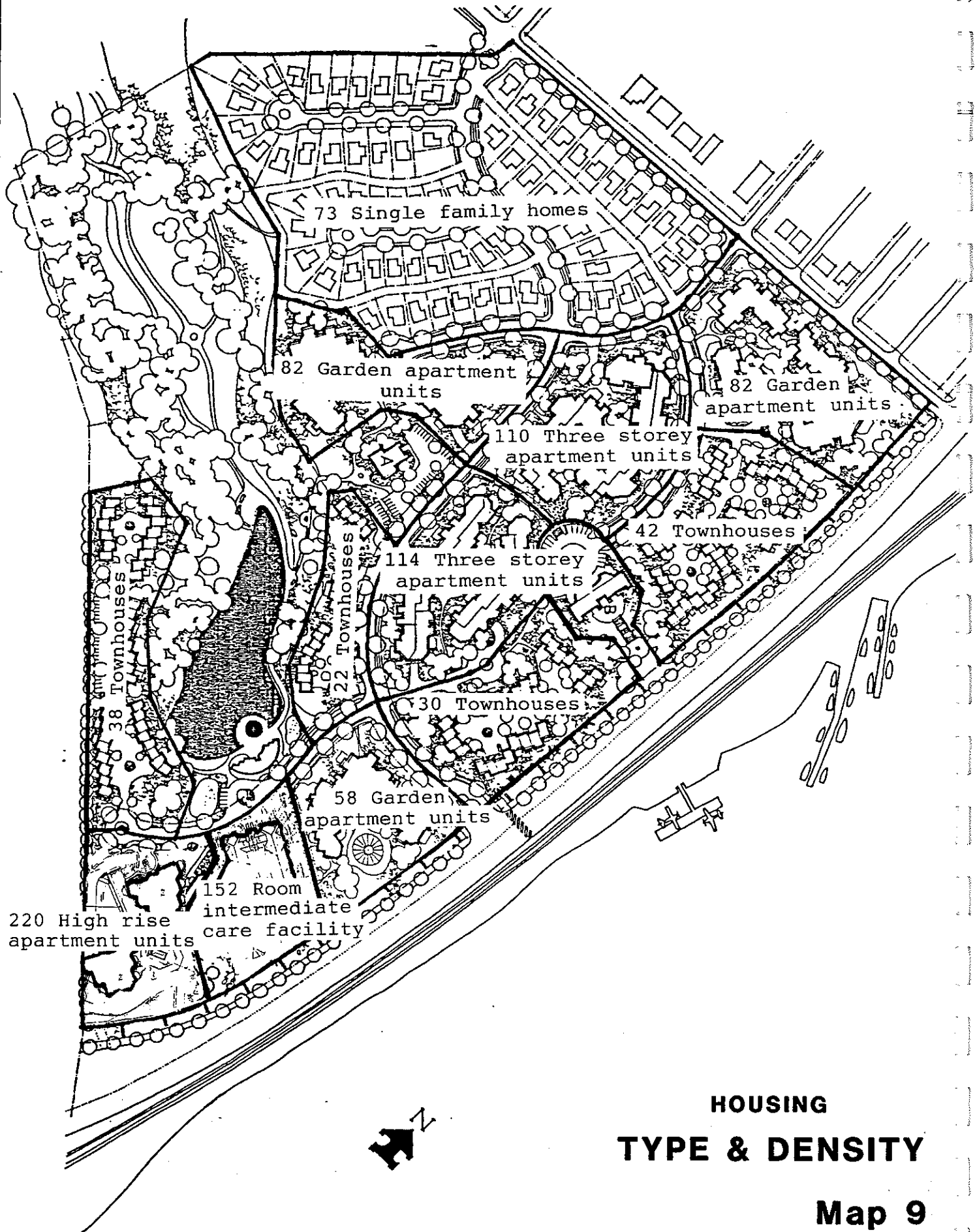
Open Space

The depression formed by the Glenbrooke Ravine affords an excellent opportunity to provide recreational open space of a



**HOUSING
LOCATION & FORM**

Map 8





**COMMERCIAL AREAS
LOCATION**

Map 10



**RECREATION FACILITIES
LOCATION**

Map 11

passive nature. This area should be maintained in almost its natural state along the slopes with minimal disruption of the natural growth.

In the past the Glen River gave to the site the added attraction of moving water, however, urban growth has diminished this feature. Therefore, a man made water element along the river bed should be encouraged. Trails, with rest areas, enhanced by flowering plants and shrubs would benefit the adjoining development and should form part of the open space development.

Traffic

The street system to serve the plan area should be designed to discourage non-destination traffic and respect the topography of the site. Access to the Plan Area from Columbia Street East should be restricted to one entrance and exit point. Map 12 shows how this can be achieved.

Parking

Development in the Plan Area shall provide adequate off-street parking on the same site as the building it serves or on a nearby site. If provided on a separate site it shall be secured by a covenant. All parking shall be paved, well drained and, if provided on grade, protected from streets and residential views by landscaping or fences.

Sound Protection

Columbia Street East which traverses the eastern boundary of the Plan Area carries a significant Volume of traffic, for it is a feeder route to Highway No. 1. Running parallel to Columbia Street East, in the vicinity of the Plan Area, is the main line of the Burlington Northern Railway. Because of these features the site is exposed to a high level of noise.

The proposed SkyTrain link to Coquitlam may have to be accommodated within this corridor, and would increase the ambient noise level. Therefore, developers building in this area must pay particular attention to the provision of sound protection through the use of berms, fences, landscaping, double glazed windows or other measures.



STREETS

Map 12

Landmarks and Monuments

Because the Plan Area is the location where much of the early history of the City took place it is important that some legacies of the past be preserved. Five items have been identified as worthy of preservation. These are:

- 1) The Original Gaol Block Building;
- 2) The Gatehouse Administration Building;
- 3) The south-western Guard Tower;
- 4) The Royal Engineer's Base Observatory;
- 5) The Westminster Commemorative Cairn.

The objects identified above must be retained. However, the Original Gaol Block Building and the Gatehouse Administration Building may be adapted for reuse in a modern development. Because of the necessity to modify the site for development, it may be necessary to relocate the Westminster Commemorative Cairn. Should this be necessary it should be relocated to public property, but if relocated to private property it must be protected.

It may be necessary to raise or lower the Royal Engineer's Base Observatory, but the present location must be retained.

IMPLEMENTATION

This Community Plan shall apply to all development within the Plan Area.

Environmental Constraints

- a) Demolition - Prior to the commencement of development the walls of the penitentiary shall be removed in an orderly staged manner.
- b) Sound Protection - Because the Plan Area is exposed to a high level of noise, extensive measures will be required to protect perspective residents.

- c) Staging of Growth - Expansion of services should not take place until an agreed subdivision plan is in place for the intended benefiting properties.
- d) Ravine Area - The slopes of the Glen Ravine are regarded as unbuildable and shall be kept free of structures. The river bed should be developed for passive recreation including a water feature.

Regulatory Systems

- a) Zoning Bylaw - Land uses shall be regulated by the New Westminster Zoning Bylaw.
- b) Development Permits - Development Permits will be required for all projects except those containing three or fewer one-family residences.

APPENDIX

Took Structural Laboratory Inc.

5485 - 180th STREET, SURREY, B.C. V3S 5R9

Telephone 576-8561

June 25, 1986

File: 63402

City of New Westminster
511 Royal Avenue
New Westminster, B.C. V3L 1H9

Attention: Mr. Percy Perry, Planning Dept.

Re: Proposed Residential Subdivision of Old B.C.
Penitentiary Lands Adjacent Brunette Avenue
just east of McBride Boulevard

Dear Sir:

As per the request of the developer, Mr. Roger Schlosser, please find attached the general information we use as addendum to our formal reports covering slope failure investigations and development near slopes.

We are of the opinion, drawn from observing hundreds of failures concerning slopes, that a very desirable prevention is protection and enhancement of the indigenous or natural plant growth already in residence. One exception is the deciduous trees that reach their prime and present the possibility of toppling over, thereby pulling their root bowl out of the soil face. We believe these trees must have proper care and cutting before this happens.

The natural ground cover is generally a mix of different plant species thereby reducing the chance of a single infection through diseases or animal attack denuding the slope.

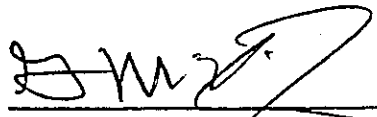
If further questions are raised please contact the writer.

Yours truly,

TOOK STRUCTURAL LABORATORY INC.

/jr

cc. - Mr. R. Schlosser ✓
- file



G. McKinney, P. Eng.

from the ground up

Took Structural Laboratory Inc.

5485 - 180th STREET, SURREY, B.C. V3S 5R9

Telephone 576-8561

A P P E N D I X - - - - -

from the ground up

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Geological Hazards And Constraints

Geological hazards are naturally occurring geological and geomorphological processes and unstable conditions that present a risk to life and property. Hazards are a consequence of gravity induced downslope movement, processes induced with water, wind, erosion and deposition. They vary from catastrophic and dramatic effects, such as avalanches and rock-slides, to barely perceptible but persistent processes such as slow earthflows. (Geological hazards related to volcanic and seismic activity are not considered here.)

Certain additional site conditions may present problems dangerous to development. These include poor drainage, steep slopes, and soft compressible substrate. These are constraints. They are not hazards if they can be overcome through economically appropriate technological means. Hazards are potentially occurring, re-occurring, or continuous geological processes that are commonly impossible or unfeasible to control or prevent.

Nature Of Surficial Slope Failures

LANDSLIDES

The term landslide describes the failure of a slope through downward and outward movement of surficial and/or subsoil materials. These failures may occur in deposited soils or natural soils seemingly stable from their presence historically.

The sketch on Sheet No. 2 illustrates the main features of a landslide. A very definite surface of rupture forms during the failure process along which the soil moves over underlying undisturbed material. Note that the diagram indicates that the surface of rupture may extend to a considerable depth so that a landslide cannot be considered as always just a surface phenomenon.

from the ground up

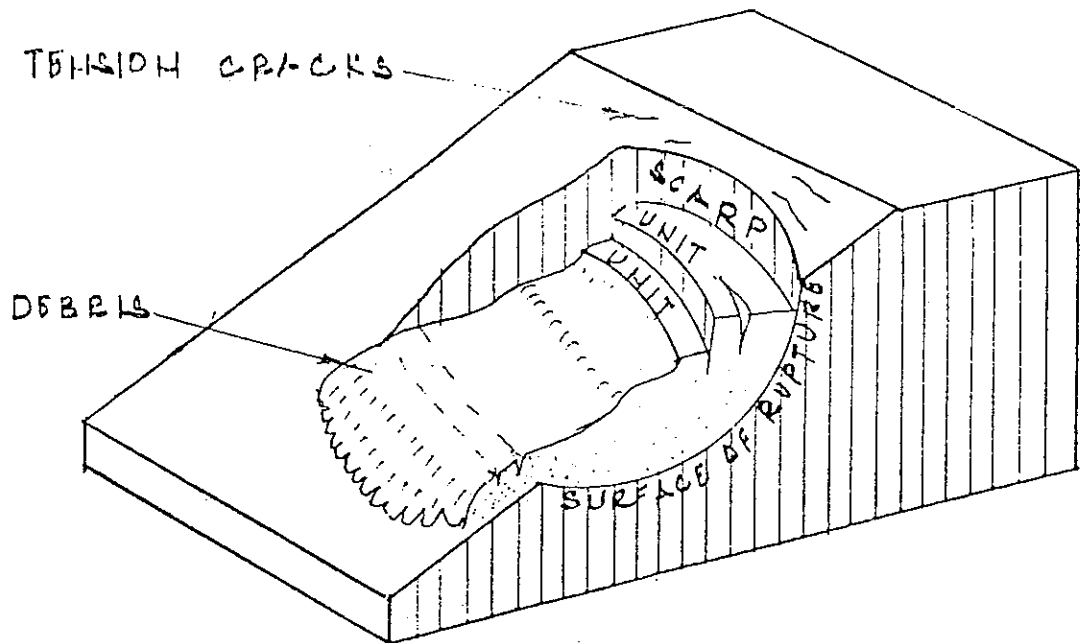
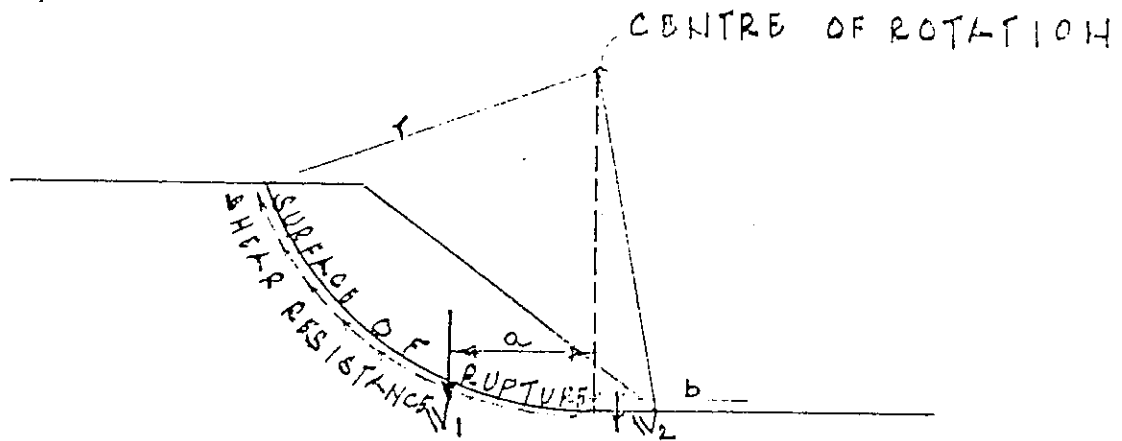


Illustration Of A Landslide

$$\begin{aligned} \text{FACTOR OF SAFETY} &= \frac{\text{SHEAR RESISTANCE}}{\text{SHEAR FORCE}} \\ &= \frac{\text{SHEAR STRENGTH} \times l}{W_1 b - W_2 \times b} \end{aligned}$$



Simplified Stability Analysis Of Slopes

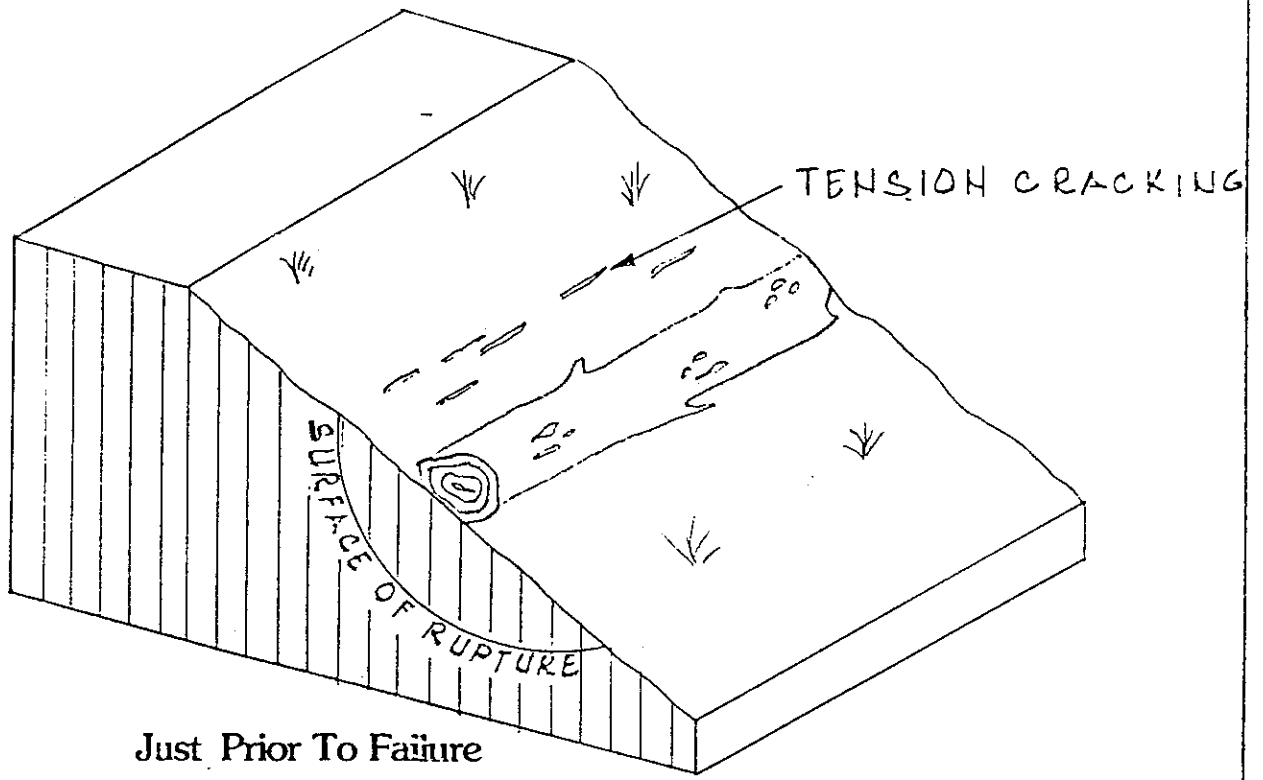
Factors influencing the stability of a slope are the inclination, the over-all height, the character of the soil, position of ground water table, insulative support of topsoil mantle and plant growth, and its structural geology. The structural geology may be determined as to its sequence of strata, slope of beds and faults or imperfections through constructing bore holes and/or seismic resistivity testing.

Information required for stability analysis, as shown simplified on Sheet No. 2, encompasses three physical descriptions, i.e. topography of the slope, structural geology and ground water conditions. Of these, only the topography can be relatively inexpensively determined from site surveying or aerial photogrammetry. In fact, access to desired locations of bore holes, which are expensive, often leads to such disturbance of the slope as to introduce weakness and storm runoff erosion. However, a stability analysis will provide a rational method from which future risk of a slope failure may be eliminated or at least reduced to an acceptable minimum.

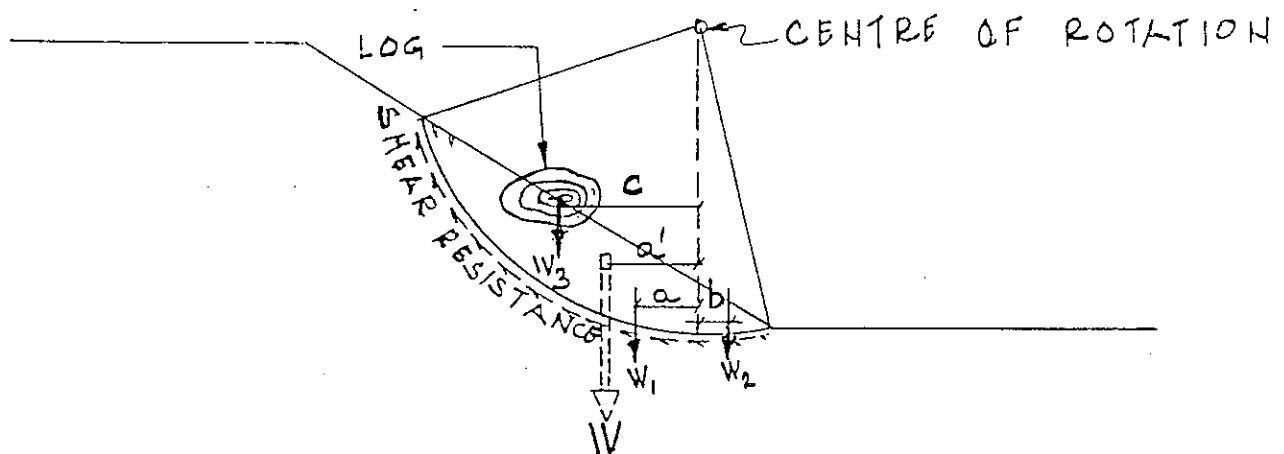
Throughout the Lower Mainland the forested slopes have been logged several times. Quite often the logging operations left logs lying on the slopes. Sheet No. 3 is presented to demonstrate how such logs can become a trigger mechanism for precipitating future slides. The weight of the log and damming of ground water movement increases the weight of the mass to the left side of the centre of rotation as shown. The counter balancing soil mass on the right side and the available shear resistance may then be overpowered. All of these Logs, even if they angle down the slope should be removed. Removal has to be in a careful manner so as not to scrape off the topsoil mantle. The best approach is to cut the logs and split them into firewood pieces and hand carry them off the slope.

In the event the logs are drug off the slope then much effort will be required to re-seed and cut terrace the scarred runs with regular attention given through the rain seasons to ensure small slope failures do not begin.

As to soil conditions influencing landslides the most critical slope stability problems usually occur with fine grained soils, particularly clays. The erosive efforts of rain and wind bring many slopes to the point of failure. Most important, these soils are difficult to drain and, with the added weight of water, thereby overpower the balancing weight of the soil mass at the toe of the slope.



CUT SECTION THROUGH SLOPE
SHOWING OVERLOADING OF SLOPE
FROM WEIGHT OF OLD LOG



Simplified Stability Analysis Of Heavy Log On Slope

TOOK STRUCTURAL LABORATORY

Sheet No. 3

Of further importance is that through movement, although minute, the fine grained soils can lose a significant portion of their strength upon remoulding. The degree of loss is called sensitivity. A highly sensitive soil mass usually identifies itself by the debris in the landslide not remaining at the foot of the failure but spreading out and moving away from the slope. Often failures occur but the evidence is not there through water courses below removing the debris. Therefore, the stability of the slope, in general, may be roughly estimated by discovering past slip circles and noting the bulking behavior or non-existence of the debris at the base of the failure.

Improvement of the stability of slopes may be obtained through control of ground water, over-all flattening of the slope, no undercutting at the foot of the slope, and encouragement of good plant growth and maintenance of the topsoil mantel.

Means Of Prevention By The Homeowner

If work must be done near a slope it must always be conducted in a manner so as to improve the stability moments shown on Sheet No.2. Weight added to the foot of the slope increases the balancing forces as does material removed from the crest reduces the need for the balancing forces. In working a natural bank it is important not to excavate soil from the toe of the slope and in placing fills or berms at the toe, the materials used should be free draining so that the level of ground water does not rise in the slope.

Identification Of Incipient Failure

Both man-made and natural slopes, have in the past, and undoubtedly in the future will fail with catastrophic consequences either from pure blundering on man's part or, equally effective, the result of slow environmental changes. The owner's ability to identify these changes and his awareness of how to head them off, can easily be dealt with by him and he can then virtually eliminate them through the period of his occupancy. Perhaps the historical behavior of the hillside itself and its plant cover provide the most important information towards maintaining stability. The information herein and his living with the land can be easiest noted and best utilized by the land occupant himself in preventing slope failures.

Trigger Mechanisms Leading To Immediate Potential Failure

TOPSOIL MANTLE FORMATION AND AFFECTS

Movement of water from the surface of the soil downward leaches inorganic colloids and soluble material from the upper portion which creates a distinct soil profile. The depth of leaching action depends on the amount of water, the permeability of the soil and the length of time involved.

The surface layer is lacking in the fines which the subsurface layer has accumulated in addition to its original fines. The soil beneath the subsurface layer has been little affected by water and remains essentially unchanged. These layers, designated downward, are the A, B, and C Horizons. In Agricultural Engineering they may be further subdivided.

When living matter, such as animal life, micro-organisms, plant life, etc. dies, decomposition or mineralization takes place. This process takes time.

Complete mineralization may take several years in the Lower Mainland climate.

The original dead matter, which may be deposited on or within or be introduced into the soil, is known as soil organic matter and consists of carbohydrates, pectins, proteins, lignins, waxes, fats, resins, and ash, etc.; the final products of mineralization include water, carbon dioxide, nitrogen, ammonia, methane, and mineral salts. In the interim period of decomposition the partly decomposed organic matter is more complex and is known as humus, which consists of proteins, celluloses, hemicelluloses, sugars, starches, lignins, fats, waxes, resins, mineral salts, and others. Humus is therefore an unstable product and varies in strength as the period of decomposition progresses.

Of the products of decomposition, sugars, starches, proteins, celluloses, and hemicelluloses are rapidly decomposed, where the lignins, fats, resins, and waxes are much more resistant.

The process of decomposition is accomplished by animals, bacteria, and fungi, where microbial activity is usually most pronounced in calcium soils. It is assumed that forest residues are mainly broken down by fungi and grassland residues by bacteria.

In general, as a young soil-matures so the amount of humus increases until at maturity a condition of equilibrium is reached between mineralization and the amount of humus returned to the soil provided no change occurs in natural conditions. The quantity and quality of humus in any profile is determined largely by the plant life and hence by the local climate which, in turn, has a controlling influence over micro-organic activity. The amount of humus does not necessarily increase with the amount of deposited organic matter, but depends on the intensity of biological activity. Thus, tropical forest soils are relatively low in humus whilst in grassland areas, where bacterial activity is moderate, there may be considerable humus.

The distribution of humus, on formation, will vary with the vegetation cover under which it is formed. Under grassland cover the humus will be deposited within the upper foot or so of the profile. Under forest conditions the humus mainly exists in a layer which is really superimposed over the profile, the remainder will occur dispersed within the area of root penetration. Under open grass cover, where roots may extend to considerable depths in search of water, decomposition is rapid. The humus or humic residue content is low and more or less uniformly distributed through the profile.

In Delta, roots have been found to reach six foot depths in the Fraser River deposits of silty sand. Also earth worms have been found at these depths. However, the root margin in the dense surficial soil of the White Rock bluffs is quite shallow.

Humus is not very soluble in water, and translocation into the profile is mainly mechanical or by suspension in the water. The dispersion of humus products from the surface layers into the profile will therefore depend on the permeability of the soil.

To assess the effect of humus on the soil properties it may be considered to be composed of a number of, say, polar and apolar compounds. Humus is generally considered to take the form of a compound of humic acid, in the sense that many clays are considered to be compounds of silicic acid, and to possess considerable base-exchange capacity. Some of the compounds in humus are thought to take the form of apolar colloids of low base exchange capacity. These apolar constituents are considered to orientate themselves around electro-negative soil colloids forming a dense layer which is thought to reduce not only their already low exchange capacity but also that of the system as a whole. The effect is one of self-protection.

Since these organic apolar colloids are but very slowly reversible they act, on drying, as a soil stabilizer by preventing individual clay particles from absorbing moisture and by binding a number of soil particles together to form, on dehydration, stable water resisting aggregates.

This aggregation by colloidal organic matter has been found to be more pronounced the lower the percentage of clay, and even more effective with sand than with clay. It is more permanent in hydrogen systems than in calcium systems.

Clearly the effect of organisms, inseparable from organic matter, is of more importance than the presence of hydrophilic organic matter. It is thought that, in the case of clay, the organic matter lies almost entirely within the active clay fraction. The organic matter content based on the whole soil does not give a true picture of the importance of the organic matter content. Therefore, the soil properties may be drastically changed through the introduction of organic matter even though it does not appear gross in the soil mass. Though the percentage of organic matter and the percentage of clay may be low. The percentage of organic matter in the clay fraction may be very high leading to failure.

Soils in which organic matter is accumulated under conditions of low bacterial activity, stymied by lack of mineral activators, contain a relatively large proportion of cellulose and hemicellulose. This type of organic matter is almost always objectionable. Inorganic stabilizers containing lime, may, if added to such soils in amounts insufficient to kill the microbial organisms, result in their activation by the calcium ion and, through a connected chain of events, may weaken rather than improve a subgrade soil.

Studies have been conducted which offer stabilization treatments for various pedological soil types based on the type of organic matter to be found in such soils. For example the cutting off of air and possible moisture accumulation may change normal bacterial oxidation of organic matter into anaerobic fermentation with the formation of slimy decomposition products and a loss of carrying capacity. This decomposition, if it could not be removed, might be stayed by use of germicides.

Anaerobic fermentation may cause the reduction of ferric to ferrous compounds during oxidation of the organic matter. This is believed to be the cause of certain earth fill failures composed of compacted surface soil.

The air content of the topsoil mantle is an elusive clue as to the triggering mechanism of a slide. There are three distinct phases generally noted during permeability testing:

- (i) An initial period in which the permeability decreases.
- (ii) A second period during which the permeability increases to as much or more than thirty times the previous minimum rate.
- (iii) A final period during which the permeability gradually decreases.

Air entrapped during the wetting of soil lowers the permeability. The air is dissolved by percolating water and the permeability then increases. A maximum is reached when air is no longer present, or hardly any. An increase in temperature, resulting in an increase in the volume of entrapped air causes a relative decrease in permeability. A snow cover will insulate the soil mantle and raise the temperature thereby decreasing the permeability.

It must also be noted that water without dissolved air has lower viscosity and therefore a higher permeability is measured.

Contained air lies within the fine material making it impossible for all the air to escape as the soil is wetted. Swelling of these fines, which are contained in the non-swelling coarse aggregate mixture, can occur only at the expense of the air voids existing in the soil. Otherwise the whole soil mass would swell and upon drying would not return to its volume but gain additional volume of air voids. The contact zone upon which the topsoil mantle rests would then be slowly incorporated into the mantle-like material. The air entrapped at saturation will, in a way, act as a factor of safety by preventing complete saturation. It is when wetting occurs over a sufficient time to allow percolating water to remove the air, the permeability to increase, and subsequent loading of water on the soil mass to increase that sliding can be triggered.

In Summary, to obtain the best possible chance of introducing a slide, conditions should be:

1. Have many days of constant wetting which will allow percolating water to remove most of the minute entrapped air bubbles.
2. Removal of the air allows the permeability to rise such that water movement through the soil grains is as high as possible.
3. Snow falls and blankets the surficial soil whose temperature warms from the insulative effect. The remaining air bubbles increase in volume from warming, and reduce the permeability thereby loading up the soil with slower moving water.
4. Further rain on the snow weighs the surface even more.
5. With falling permeability the pore water pressure increases and the holding afforded by cohesion and intergranular support is overcome.

Any steps taken to ensure that each of the above mechanisms are available to occur in proper sequence will best produce a slide. Conversely, any interruption of the sequence or reduction of the mechanisms will inhibit a slide.

