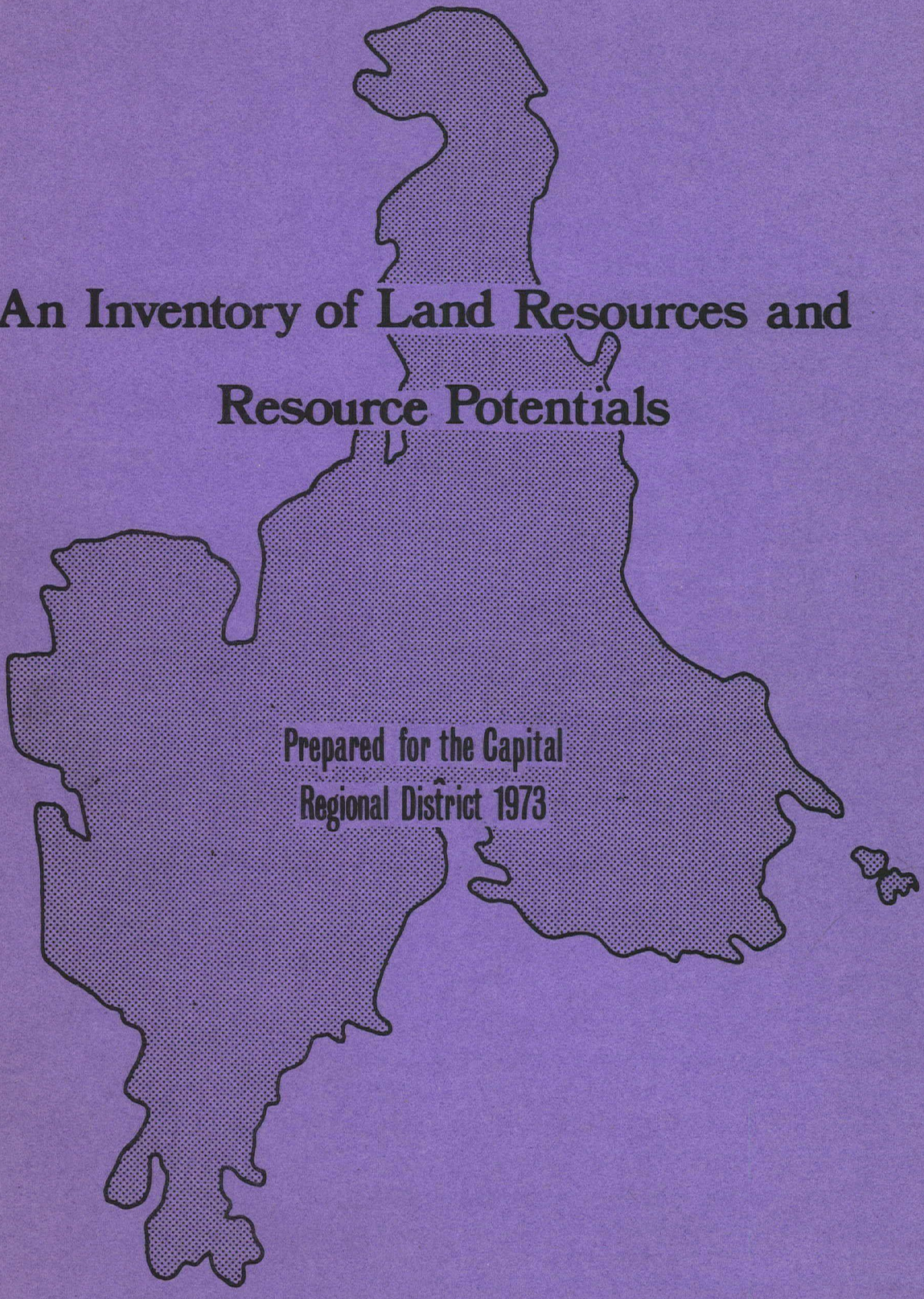
An Inventory of Land Resources and Resource Potentials



Prepared for the Capital Regional District 1973

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An inventory of land resources and resource potentials : a report to the capital region district.

AN INVENTORY OF LAND RESOURCES AND RESOURCE POTENTIALS IN THE CAPITAL REGIONAL DISTRICT

A REPORT TO THE CAPITAL REGIONAL DISTRICT

A Co-operative Report Comprising Narratives and Maps
by

British Columbia Land Inventory (C.L.I.)
Pacific Forestry Research Centre, Canadian Forestry Service
Soil Survey Section, Canada Department of Agriculture

Edited by
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W. Arthur Benson

May 1973

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PREFACE

W. Arthur Benson

The Planning Department of the Capital Regional District requested this comprehensive study from the British Columbia Land Inventory. The request was accepted on two conditions: 1) that other cooperating agencies of the Canada Land Inventory were willing to be involved since the British Columbia Land Inventory did not cover all sectors in this particular Region, and 2) that the inputs would be restricted mainly to information already at hand and would be basic information which may or may not support the existing five alternatives previously proposed by the Planning Department.

As a result three agencies are involved in the study: The British Columbia Land Inventory of the B.C. Department of Agriculture; Pacific Forestry Research Centre (The Canadian Forestry Service) of the Department of the Environment; and The Soil Survey Section of the Canada Department of Agriculture. All three agencies must give thanks to the Lands Directorate of the Department of the Environment which partially finances some of their programs.

While this study is comprehensive, it involved only minimal field work during the difficult winter season. As a result it can be used in planning at the regional level but cannot be used for management of individual parcels of land. The Canadian Forestry Service will publish their contributions separately and in a slightly different form in the near future. Other more detailed work will be available in map form in the near future and will show: annual precipitation; climate capability for agriculture; growing season temperatures; evapotranspiration; water deficit; agricultural capability; and forest capability. These additional maps will be produced as a part of existing department programs and not published as a supplement to this report. Other detailed aspects which may occur to interested citizens can often be handled by questioning individual authors. As examples, citizens could raise questions about management or preservation of flowering dogwood or engineers could request environmental impact and soil mechanics information for a particular

head or pipeline location. In all examples the authors of particular sections of the study could rapidly supply a great many answers. Similarly an environmentally sound subdivision might be considered by someone in the enlightened future and the authors could be very helpful. To date no environmentally planned subdivisions have occurred in the area.

Some of the maps utilize facts related to currently accepted technology but other maps can easily be made to relate to some new technology. For example interpretations are given for subsurface sewage disposal from flush toilet systems because it is a prominent technology. It is not the best technology and in fact many partial water or waterless systems are available. Authorities seldom recognize such systems which could allow many new alternatives for urban development.

None of the authors are completely satisfied with their work because of the short time they were able to spend and because the winter season was a very poor time for even rudimentary field work. Nonetheless, I feel they should be conguatulated for doing their best in the time allowed and for giving the people of the Region a very large amount of useful data never available before.

These data are not plans nor are the participants in the study planners in the traditional sense. Planning is what one does with the data to relate them to life styles and what one considers to be a viable community. In this study a great many basic physical facts are presented mainly in map form. These maps can be compared and overlain and a great many alternatives for development will emerge based on the physical response of the land. These will have to be held up to the standards of life styles, economics, service feasibility, and legislation such as the Land Commission Act, etc. The Planning Department of the Capital Regional District has a great deal of planning expertise. Members of the study team feel confident that the Planning Department can utilize this data in conjunction with the responses of the community to formulate a Regional plan. I am happy to submit this report to them. Copies of this report are available from the Planning Department, Capital Regional District. Maps in the report are available for viewing at full size in the Planning

Department offices, 524 Yates Street, Victoria; the Pacific Forestry Research Centre, 506 West Burnside Road, Victoria; the Canada Department of Agriculture Research Station (Soils Section), 6660 N.W. Marine Drive, Vancouver; and the British Columbia Land Inventory, 321 Menzies Street, Victoria, B.C.

I wish to thank Mr. F.B. Armitage, Program Manager, Pacific Forestry Research Centre, Canadian Forestry Service and Mr. L. Farstad, Head, Soil Survey Section, Canada Department of Agriculture for authorizing participation of their staff and very often for direction. I also thank Mr. D. Blower for doing most of the coordination and meeting arrangements. Mr. R. Reid did a phenomenal job in coordination of mapping and reproduction.

Following is a list of active participants, some of whom were also authors and appear elsewhere.

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CLIMATIC SUMMARY FOR GREATER VICTORIA REGION

R.R. Chilton

The following climatological summary, when combined with other data inputs will facilitate land use planning. From a climatic viewpoint, lowland areas are the least suitable lands because of lack of ventilation. Stagnation of air may result in greater air pollution potential, shorter frost free period and fewer sunshine hours. The highlands to the west are less favourable primarily because of more precipitation and less hours of sunshine. North slopes are less appealing for settlement as substantially lower amounts of sunshine are received. The remainder of the region is climatically well endowed to provide a favourable climate for human activity.

GENERAL CLIMATIC REGIME

The general climatic regime of the Greater Victoria area is one of mild, wet winters and sunny, cool, dry summers. Although the climate of the region is similar throughout, distinct differences do occur. It is advantageous from an urban planning viewpoint to encourage settlement in areas where humans are most comfortable. Within the Study Area, climate is everywhere favourable to human comfort. However, the Highlands, which are wetter, snowier and duller may provide a less desirable climate to some. This can be seen from the information presented in Table 1.

PRECIPITATION* AND SUNSHINE AMOUNTS (TABLE 1)

	Annual Rain	Annual Snow	Annual Total Precipitation	Annual Hours of Sunshine
Victoria Highlands	42.76	33.6	46.12	1800-1900 (approx)
Victoria Gonzales	24.60	12.9	25.87	2216
Victoria Int. Airport	31.93	17.9	33.72	2064

(Precipitation values are in inches)

Secondly, land capability for agriculture, recreation, forestry, wildlife, industrial and urban development should be considered, as well as air pollution potential.

It is important to emphasize at the outset that the climatic maps and narratives produced in this report are to be considered a general interpretation of Victoria's climate. More specific studies are possible and necessary in relation to land uses on particular land parcels. Much of the material in this report is presented in the accompanying maps, while a list of definitions is given in the Definition of Terms, this section.

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* See also Figure 1

Potential Evapotranspiration and Moisture Deficit Regime*

The calculation of potential evapotranspiration using Penman's formula for a short grass surface is a useful index to indicate the moisture regime.[2] The moisture deficits calculated aid in delineating the areal variation in moisture requirements. Thus it is possible to determine something about the irrigation needs of the region. Increases of potential evapotranspiration (P.E.) occur towards the east and inland from coastal locations, so that maximum P.E. takes place in the mid-peninsula area. Moisture deficits which accommodate actual evapotranspiration, precipitation, soil moisture storage, and runoff increase fairly rapidly from west to east and decrease slightly in the higher rainfall areas of the peninsula. The climatically better agricultural lands tend to have the higher moisture deficits, hence higher irrigation requirements. Irrigation water is supplied primarily from reservoirs and local streams. Before agricultural uses are undertaken, the irrigation needs must be known. The map presented indicates the areal variation which would occur if the surface were completely homogeneous and climatic parameters were the only varying factors. However, substantial variations do occur as soil and vegetation types differ. Also, a prime cause of micro-climatic evapotranspiration differences are aspect and exposure. To determine these variations more precise measurements and calculations are necessary. The mapped values depict the average deficit for the map area.

Climate Capability for Agriculture[3]

The climate capability for agriculture classification when used in conjunction with other resource base information will aid in land use planning. The climate classification used, considers the range of crops which can be grown in the vicinity, frost free period, growing degree days, and the water balance. An important factor in the climate classification is frost free period. This is a parameter varying substantially over the region, primarily as a result of differences in exposure and elevation. Exposed coastal locations for example, have frost free periods in excess of 230 days. An increase occurs towards the south part of the region with Gonzales having the longest frost free period of 283 days.[4]

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* See Figure 2

A N N U A L P R E C I P I T A T I O N A N D R U N - O F F

~~~ Mean annual precipitation in inches (1941 - 1970 mean)
----- Mean annual potential runoff in inches (sum of monthly precipitation minus monthly evapotranspiration)

Runoff is water available for runoff. It does not take into account losses due to soil moisture water recharge, or interception by vegetation. These combined with differences in soil moisture capacity, reduce the actual amount of runoff by varying amounts.

All the isolines are approximations only, as a result of the methods used in calculating the totals.

Prepared by: Climatology Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.
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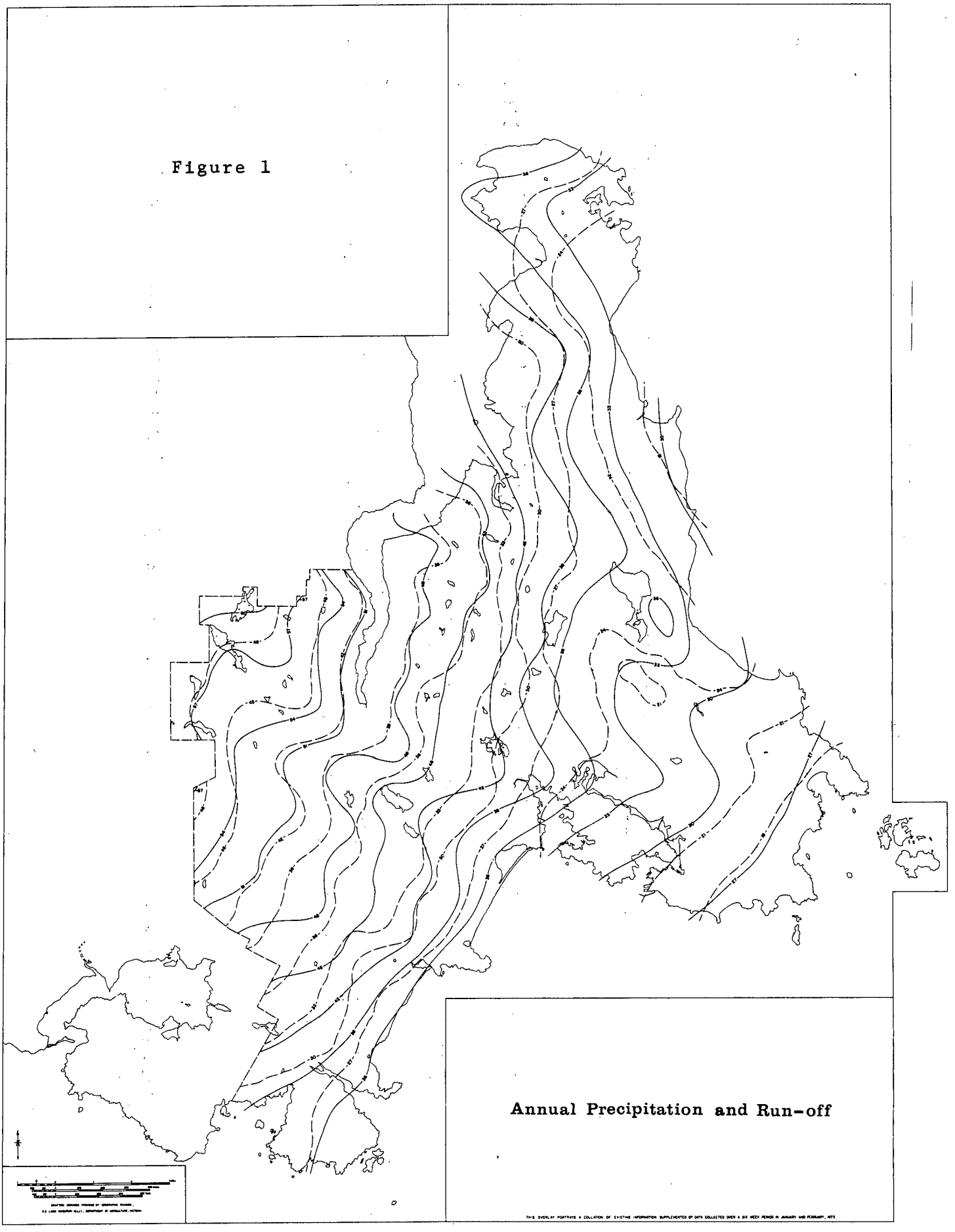
Figure 1



E V A P O T R A N S P I R A T I O N A N D W A T E R D E F I C I T

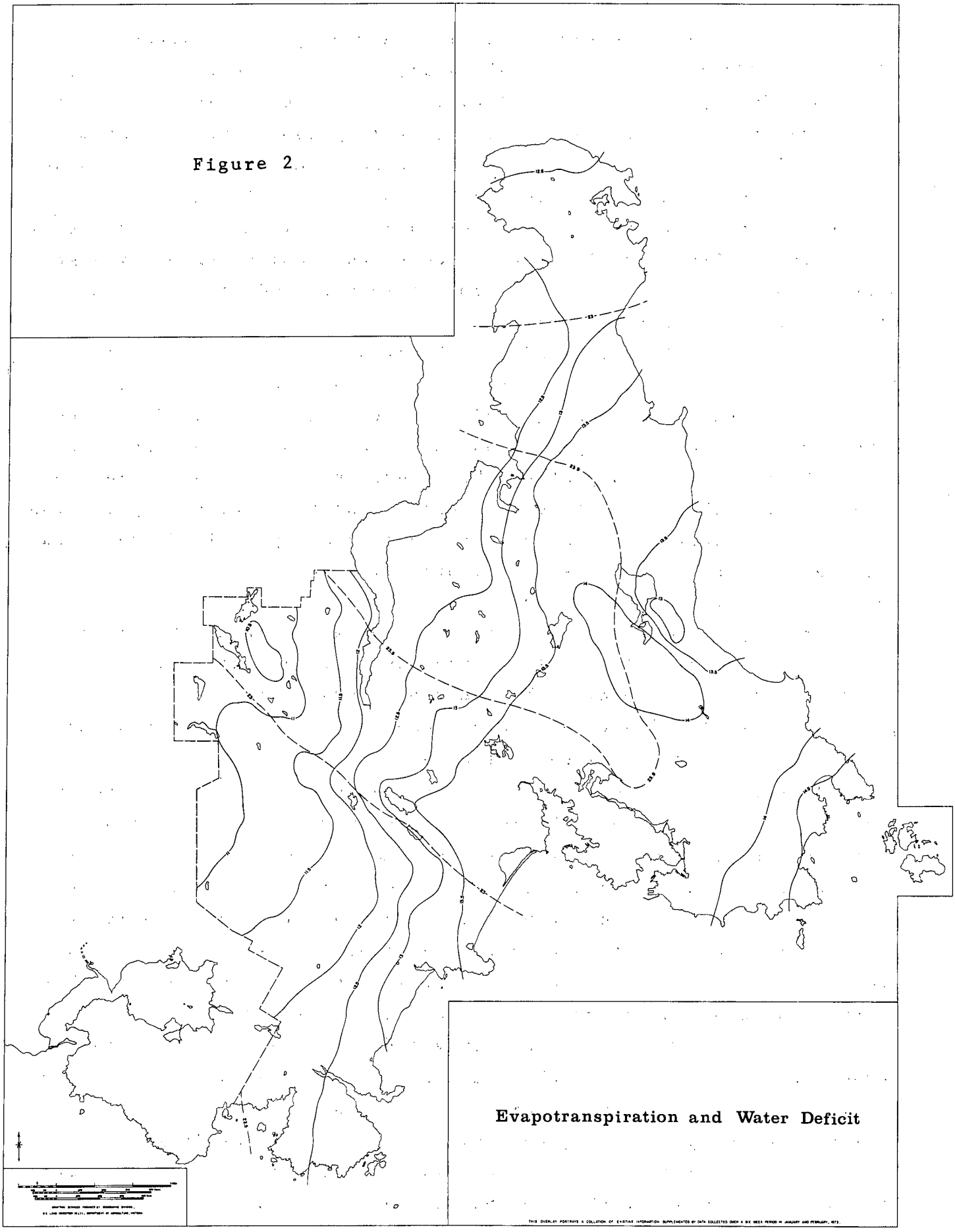
~~~~ Mean annual potential evapotranspiration (Penmans) over short grass (measured in inches)
~~~~ Mean annual water deficit in inches (sum of monthly precipitation minus monthly evapotranspiration)

The location of the isolines on this map is approximate due to the paucity of the data and the map scale. The trend in the pattern of lines is more notable.

Water deficit is calculated as the total excess of potential evapotranspiration over precipitation during the months in which it is greater than the precipitation. Local differences in evapotranspiration rates due to slope, aspect, and vegetation are not considered. Differences in soil moisutre capacity are not considered in calculating the deficit.

Prepared by: Climatology Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 2



Lower lying areas experience far shorter periods without frost (less than 200 days). Tod Creek Valley north of Prospect Lake, and the Happy Valley - Glen Lake Valley vicinity have a relatively short frost free period as low as 150 days. Valley lands such as these are more likely to have frost, as lack of turbulence permits the accumulation of radiationally cooled air. Secondly, low lying lands may be subject to a variable flow of cold air from higher lands surrounding the valleys. Frost problems can be compounded unless proper management is undertaken. Shielding from previaling winds for example, will decrease frost free period.[5]

The construction of roads, if built across avenues of cold air flow, may redirect flow to another land unit and hence change the land's capability. Changes of vegetation cover will effect the length of the frost free period as well. Changes in the landscape should be considered only after the repercussions of the change are studied. Finally, it must be emphasized that the variability of frost free periods negates generalizations as they apply to land use planning. For example, exotic varities of plants suitable to one area cannot be grown in certain other areas.

Growing degree days are also an important part of the Climate Capability for Agriculture Classification. The growing degree day concept aids in determining the range of crops it is possible to grow in the region. A very general comment will be included so as to indicate trends throughout the area.

A decrease in the number of growing degree days occurs to the west in response to generally lower summer maximum temperatures. Secondly, in close proximity to the ocean, a decrease in mean temperature lowers the number of growing degree days. The decrease is not critical to plant growth. Finally, an increase in elevation lowers the number of heat units substantially at an approximate rate of 500 growing degree days per 1000 feet. Primarily, this decrease may be attributed to a shorter growing season at the higher elevations. Agricultural crops requiring a fairly long growing season may therefore not be suited to regions such as the Highlands. The areas which have the limitation G, have had their climate class lowered as a result of insufficient growing degree days. It is noted that large moisture deficits occur in the Greater Victoria region. If an irrigated rating is considered, most of the area has a class 1a or better climate.

On the average, if ten inches of water is the assumed moisture content within the soil profile, the marjority of the region has a non-irrigated rating of climatic class 2A, with a deficit from 1.5 to 4.5 inches during the growing season. In extreme western regions a climatic moisture deficit of 0 to 1.5 inches occurs during the growing season which results in a climatic class 1A. The ten inches of available water is the assumed maximum quantity of water which can occur within a four foot soil profile.*

Growing Season Temperatures (March to October) See Figure 3

The highest growing season temperatures are evident in the inland regions of the Saanich peninsula, away from the cooling marine influence. Secondly, a slight decrease in growing season temperatures is evident at the higher elevations. The Highlands have, for example, slightly lower growing season temperatures, as do higher areas west of Metchosin and Finlayson Arm. A slight decrease in growing season temperture is also noted in the cloudier climes to the west.

Hours of Sunshine[6]

The number of hours of sunshine is an important parameter when considering human comfort, recreation potential, and possible settlement pattersn. Generally a decrease in hours of sunshine occurs from the south to the north end of the peninsula. For example, Victoria Gonzales has about 200 more sunshine hours than does the Saanich Canada Department of Agriculture station. Secondly, a decrease in the number of hours of sunshine is evident towards the west as a more cloudy climate is approached. A decrease of 200-300 in sunshine hours takes place as one progresses from Gonzales to the Sooke region. The Highlands and upland areas have a decrease of about 200-300 sunshine hours as compared to the hours recorded at Victoria International Airport. Clouds tend to linger on highland regions, particularly when a moist south-west air flow is occurring.[7] The surrounding uplands decrease the number of hours of sunshine in the lowlands by shading in the early morning and late afternoon hours. Secondly, it might be advantageous to avoid northerly slopes as significantly

*Further clarification of climatic classes and limitations can be found in footnote 3.

less sunshine is received here. For example, a north slope having a fifteen degree slope has approximately 62% of the solar radiation that is received on an east or west slope.[8] This is an important consideration when planning urban development and building design.

January Mean Temperatures

Decreasing temperatures generally correspond to an increase in elevation. Secondly, temperatures tend to decrease away from the Strait of Juan de Fuca. The extreme south coast has an average temperature of 39.0° F., whereas the Highlands and water supply areas to the west experience temperatures of 35.0 to 36.0[9] Fahrenheit. Greater snowfalls are therefore possible in these colder locales.

Air Mixing Potential

The air pollution potential and wind rose map (Figure 4) indicates regions where ventilation is usually light in relation to exposed lands. The shaded areas on the map represent those sites which are frequently poorly ventilated. One such area of minimal ventilation is represented by the Gorge Road wind station. Gonzales, conversely, is an exposed site having much higher wind velocities on the average. Also, Victoria International Airport is indicative of a fairly exposed site. North of Gonzales, wind velocities tend to decrease until the airport is approached. Here, a natural east to west corridor permits winds to move air back and forth over the northern peninsula. The more exposed regions generally have much better pollution dispersal potential than do protected lowlands. Exposed coastal locations generally have greater winds particularly in summer when sea breezes effect the region. Prolonged temperature inversions (Table 2) are casued by subsidence of air affecting coastal British Columbia particularly in the autumn. If at all possible, activities such as burning (slash burning included) should be kept to a minimum during these prolonged inversion periods. Corresponding to the peak in prolonged autumn inversions, is the frequent persistence of periods of light winds (less than or equal to seven miles per hour). A second type of temperature inversion is that which occurs on clear calm nights. Radiational, cooling results in surface air becoming colder than warmer air above. This represents a stable situation whereby vertical mixing of air is lacking. These relatively shallow inversions are most often quickly dispersed by

the sun's heating and secondly by daytime winds. The areas where the deepest and most prolonged inversions most frequently occur are the protected lowlands. Two areas where inversions appear to occur most frequently are the Happy Valley - Glen Lake - Langford Lake lowlands and secondly, the Tod Creek valley. An indication of the inversion frequency in Greater Victoria is given in the following table. The inversions occurring overnight are primarily the far less important temporary radiational inversion, whereas those occurring during the day are prolonged subsidence type.

INVERSION FREQUENCY IN COASTAL BRITISH COLUMBIA[9] (TABLE 2)

Spring		Summer		Autumn		Winter	
Day	Night	Day	Night	Day	Night	Day	Night
3%	40%	5%	50%	10%	50%	-	40%

As urbanization of the region increases, higher amounts of pollution are likely. It is with this in mind that planning should be undertaken so as to minimize the effects of airborne pollutants. Greenbelt areas for example, aid in freshening urban air by decreasing dust content.[10]

Exposed coastal locations have greater wind flow and more frequent wind shift, thereby having greater pollution dispersal potential. Highrise buildings or other extensive obstructions if built in close proximity to the sea may retard movement of air and hence pollution dispersal. Extensive urban development, including housing, services and major roadways should be avoided in the poorly ventilated regions. The areas where air mixing potential problems are fewest appear to be upland regions in the west, the Highlands, the west part of the peninsula out of the lowlands, and exposed sites fairly close to the coast.

ACKNOWLEDGEMENTS

I am indebted to the following people who made the narrative portion of the paper a possibility: A.E. Littler, Tom Muirhead, Peter Sagert, Dr. Stanton Tuller, and J.V. Zacharias.

C L I M A T E C A P A B I L I T Y F O R A G R I C U L T U R E A N D G R O W I N G S E A S O N T E M P E R A T U R E (APRIL - OCTOBER)

CLIMATIC CLASS — CHARACTERISTICS (Based on the range of crops that can be grown)

($1b_3G$)

- the frost free period is greater than 150 days.
- the range of growing degree days greater than $42^{\circ}F$ is 3000 to 3500.
- full capability can only be achieved if supplemental water is supplied.
- there are cool winter temperatures suitable for wintering cabbage and lettuce.
- a thirty inch maximum annual precipitation limit occurs for tree fruits.
- the probability of extreme winter temperatures exceeding $-10^{\circ}F$ is nil. Snow cover is discontinuous.

The G designation after the $1b_3$ indicates insufficient heat units (growing degree days) during the growing season. A greater number (i.e. values over 3500) would result in a higher climatic class.

Range of crops possible:

a) Key crops - wide range of cool season crops such as canning peas, cole crops, potatoes, raspberries, small fruits, sugar beet seed, lettuce and bulbs.
b) A limited range of heat loving crops such as - beans, corn, cucurbits, narrow range of grapes, tomatoes, hardy tree fruits, onions and pumpkins.
c) Cereal grains.

($1a_1G$) The range of growing degree days above $42^{\circ}F$ is 2500 - 3000. Despite frost free period of greater than 150 days the climatic class has been dropped from a $1b_3$ because of lack of growing degree days. If there was a number of growing degree days greater than 3000, this would be a class $1b_3$. Winter climate in this class is the same. Range of crops generally same as $1b_31$

($1a_1F$) The frost free period is from 120 to 150 days. The F denotes that a slightly lower frost free period has decreased the climatic class from a $1b_3$. The growing degree days are over 3000 however. Range of crops generally same as $1b_3$.

(1G) The range of growing degree days greater than $42^{\circ}F$ is 2150 to 2600. All other climatic factors correspond to a $1a_1$ class. The G denotes insufficient heat units. This eliminates the possiblity of consistently producing tree fruits.

(2G) The range of growing degree days greater than $42^{\circ}F$ is 1900 to 2150. Insufficient heat units (G) further limit the production of the crops listed for 1G.

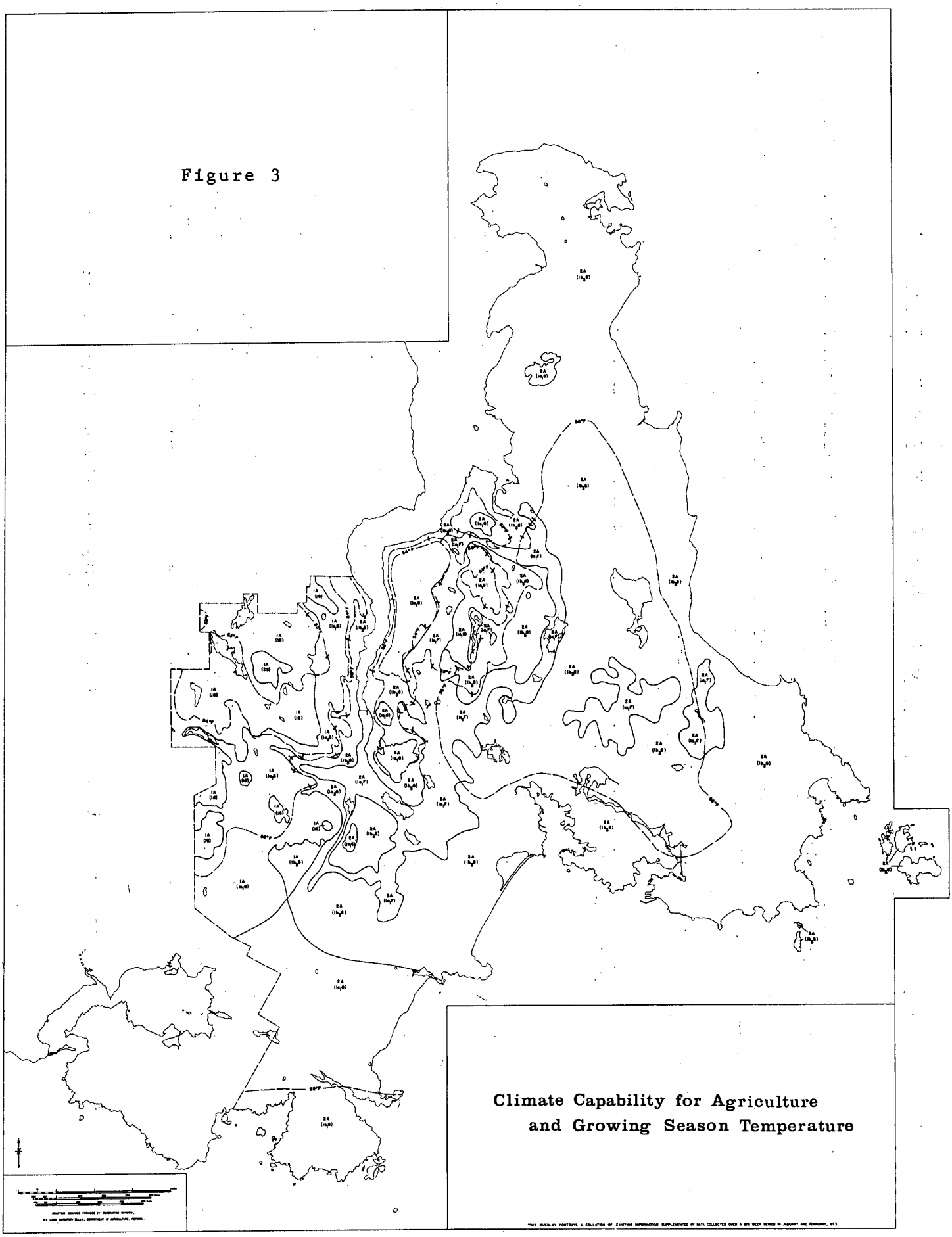
Note: Class symbols indicated in parentheses assume irrigation is provided.

2A The climate classification which would occur if irrigation water is not provided. There is a moisture deficit in these areas of from 1.5 to 4.5 inches during the growing season. This climatic moisture deficit is derived by subtracting an assumed 10.0 inches of available water, (which is provided by the soil profile) from the overall moisture deficit (Precipitation - Potential Evapotranspiration).

1A The climate classification which would occur if irrigation water is not provided. There is a moisture deficit of from 0 to 1.5 inches during the growing season. Calculated in the same manner as 2A.

Prepared by: Climatology Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 3


Climate Capability for Agriculture
and Growing Season Temperature

A I R P O L L U T I O N A N D W I N D R O S E S

M - Areas where air circulation is minimal, and radiation induced local inversions are likely. These same areas are more susceptible to frosts.

L - Areas where light air circulation is suspected and radiation induced local inversions possible. Frost is more likely to occur here.

← Movement of air is likely on calm, clear nights.

Radiation inversions are those which occur in the clear overnight hours as a result of radiational cooling with cold air accumulating beneath warmer air.

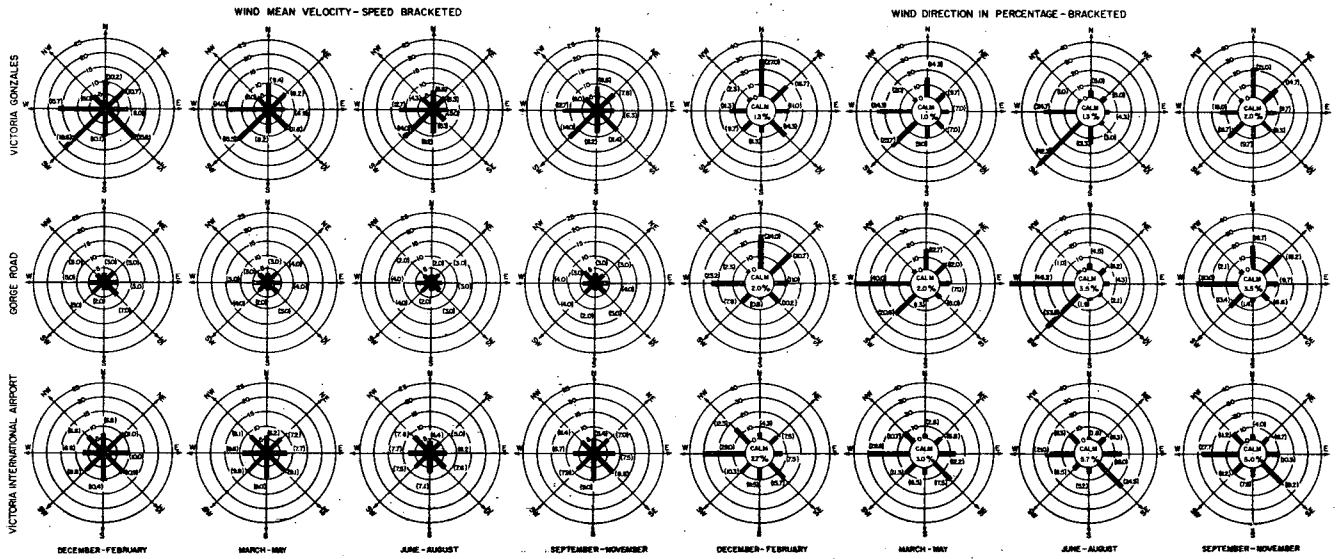


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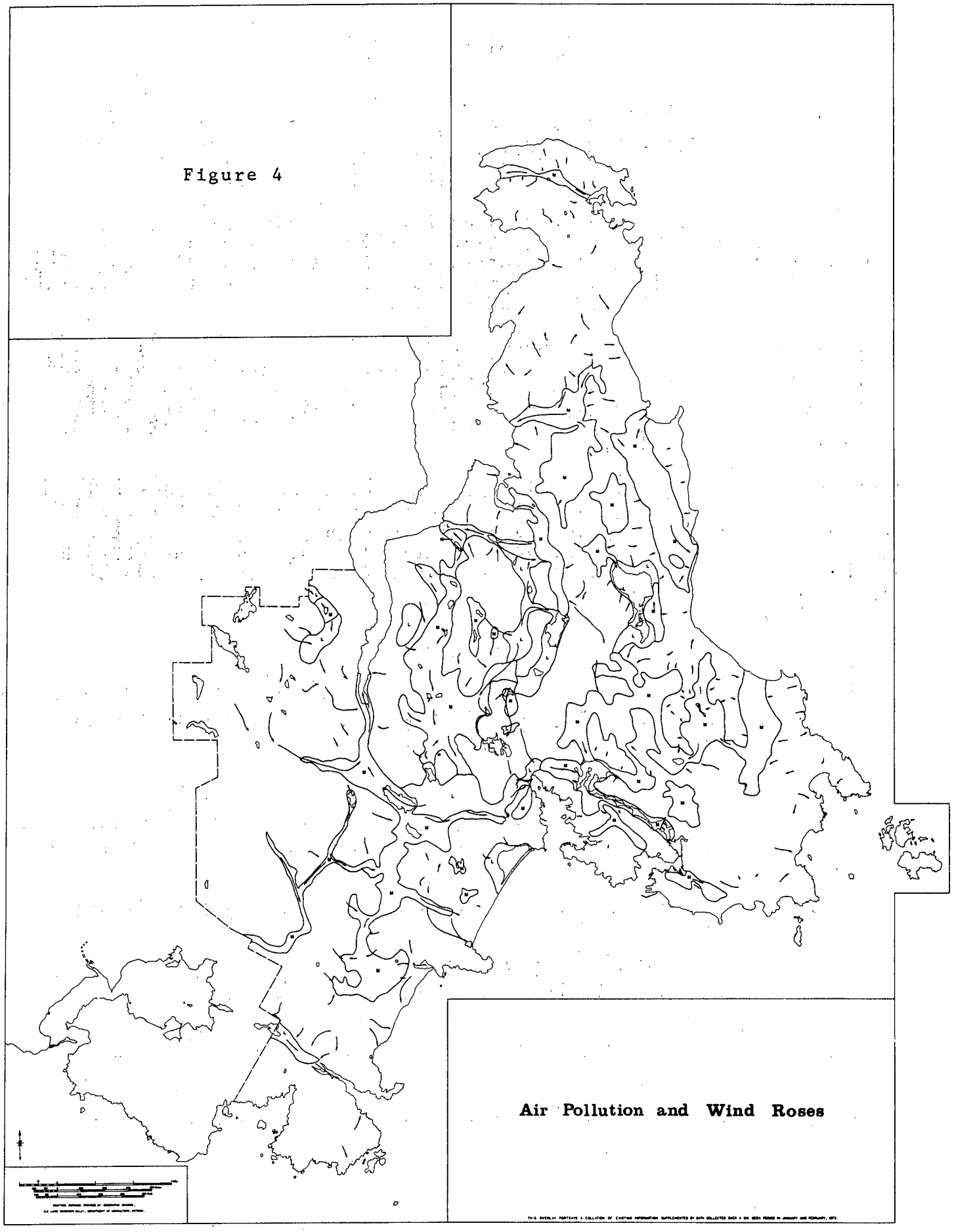
Figure 4



DEFINITION OF TERMS

Potential Evapotranspiration (P.E.) is defined as the amount of water lost from a given area by evaporation from the soil surface and by transpiration from plants if moisture is not limiting. In this report P.E. is estimated for a short grass surface.

Moisture Deficit is the amount Potential Evapotranspiration exceeds precipitation assuming there is three inches of moisture stored within the soil. This refers to the moisture deficit as given on the moisture deficit map and not that considered in the agriculture climate capability classification system.

Growing Degree Days is the number of degrees assimilated over a mean temperature of 42.0° during the growing season. Decisions as to the crops planted are to some extent based upon the number of growing degree days. This temperature represents the start and end of the growing season, and is a fairly good indicator of the initiation of plant growth in the spring.

Temperature Inversion is an increase of temperature with height above the earth's surface. This is the reverse of the normal characteristics in which the temperature decreases with height. Inversions may occur from near ground level to altitudes far above the earth's surface. Under such conditions very little turbulent exchange of air is permitted to occur.

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REGIONAL HYDROLOGY AND FISH POTENTIAL

Eero J. Karanka

Rainfall, streamflow, and fish potential are components of an interrelated environmental system. Rainfall is transformed into streamflow and streamflow is an important parameter of potential for supporting fish populations.

RAINFALL

Rainfall occurs as discrete events in time, varying in amount over space. When summed, rainfall has a seasonal time distribution, varying in total accumulation as trends over space. There are no definable boundaries in mapping the accumulation totals; maps present the average trends over many years of observation.

The rainfall pattern in the study areas is highly seasonal with pronounced dry and wet seasons. The percentage of winter rainfall from October to April is a measure of seasonality. Within the area, this varies from 81 to 88 percent. The most highly seasonal pattern, 86 percent or over, is found in a broad belt extending from Gonzales Heights, along the southern coast, and through the Highlands as far north as Shawnigan Lake. The remainder of the area, including most of Saanich Peninsula, has a somewhat higher summer rainfall in relation to the annual rainfall.

Summer rainfall, reflected in May to September mean rainfall, increases to the west and to the north within the study area. The lowest summer rainfall is found in the extreme southeast, where Gonzales Hill averages a little over 3 inches. This increase north to about 5.5 inches at the north end of Saanich Peninsula, and west to about 7.5 inches at Goldstream Lake. The winter pattern, on the other hand, has mainly a westerly increasing trend. The driest area, with rainfall ranging from less that 25 inches, extends along the eastern coast of the Saanich Peninsula. The remainder of the relatively low lying flat terrain of the Saanich Peninsula receives from 25 to 30 inches. There is a sharp increase along the highland front. This wet belt in the Highland and Malahat Districts receives in excess of 40 inches during the winter.

STREAMFLOW

Rainfall is translated into streamflow through the action of the land. Two major transformations occur (1) loss of water from the system and (2) a time lag of rainfall before the water is released as streamflow. Some of the rainfall is intercepted before it can be converted into streamflow. Losses occur because of interception in the canopy of vegetation, through evaporation and transpiration, and through recharge of soil moisture. All of these processes reduce the total volume of water available as streamflow. The timing of the release of water as streamflow is mainly a function of the amount and kind of storage available on and within the land. This storage capacity must be filled before streamflow occurs.

LOSSES OF WATER

Evapotranspiration

The availability of water for runoff is dependent on the excess of rainfall over interception losses, evapotranspiration and recharge of soil moisture. Interception losses are important in forests, being highest during light showers and warm temperatures of summer and lowest in the winter. Most of the winter rainfall reaches the ground. No usable estimates of interception losses are available for the study area.

Evapotranspiration losses are also highest in summer resulting in an annual drought throughout the study area. Excess of evapotranspiration over rainfall begins in April along the south coast and through the lowlands of the eastern Saanich Peninsula. The excess continues until October, over a period of 5 1/2 months. Generally, water deficits of 12 to 14 inches are built up during this period.*

In the highland areas, the period of water deficit is about a month shorter. The onset of deficit is delayed until May and ends in mid-September. The excess of water over evapotranspiration losses defines surplus periods, the time during which water is available for runoff. In highland areas, this period begins in mid-September and lasts until the end of April. There is a steep gradient along the highland front (transition zone) in water surplus. The lowland areas to the south and east of the front have a period of surplus

*Water deficit and surplus figures indicated in this section should be regarded an order of magnitude estimates since they are based upon approximations of potential evapotranspiration.

about a month shorter. Total surplus water available for runoff varies from about 17 inches in the extreme southeast to almost 30 inches along the highland front.

Total water deficits vary from about 10.5 inches in the Watershed to about 13 inches in the Highland District. Surpluses range from 35 inches in the Highland District to almost 50 inches in the Watershed. The increase to the west reflects the steady increase of winter rainfall in that direction.

Soil Moisture Storage

Soil moisture storage further reduces the amount of runoff. This storage, varying from 2 to 5 inches, reduces vertical runoff by an equivalent amount. In the study area, the recharge period extends into late October or early November. During this period, there is little increase in runoff. The reduction of runoff is most important in the lowlands area as soil moisture storage is highest here.

Soil moisture storage is distinct from storage in groundwater reservoirs. The soil moisture acts as storage for release through evapotranspiration during the summer whereas groundwater storage is eventually released as streamflow.

HYDROLOGIC SIGNIFICANCE OF LAND UNITS*

The transformation of rainfall into runoff is made through the movement of rainfall upon and through the land. The amount of storage within or on a land unit is one important criterion in defining the hydrological significance of a land unit. The effect of storage is to delay the occurrence of runoff and of lowering the peak flow in relation to the amount of rainfall. This stabilizing effect maintains streamflow between storm events and after the winter rain season.

A second criterion for defining the hydrologic significance is the mode of runoff. Runoff occurs in modes of occurrence and the relative importance of each mode influences the time lag (delay) in streamflow after rainfall. Runoff can occur in one of three modes, surface flow, as seepage or as groundwater flow. The delay in streamflow is least when the proportion of surface flow is greatest. These modes are closely related to the structure of the underlying materials.

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*See Figure 5

H Y D R O L O G I C S I G N I F I C A N C E O F L A N D F O R M U N I T S

HYDROLOGIC RELATIONSHIP OF LANDFORM UNITS

1. Steeplands - rock at or near surface with steep slopes and high relief. These are major sources of storm runoff, with some seepage.

2. Rocky hills and depressions - rock at or near surface with rocky knobs, and marshy depressions. These are storm runoff sources, but higher seepage and storage components delay the peaks of runoff.

3. Alluvium - sand and gravel valley bottom units which receive runoff from up channel and surrounding hills. These act as groundwater storage to maintain stream flows.

4. Surface sand and gravel - glacial sand and gravel units exposed at the surface. These are mainly a groundwater reservoir discharging into surrounding water bodies and have little surface runoff.

5. Depressional clays - these units, predominantly marine clays in depressions, are generally poorly drained and impermeable. They act as storage units for surface runoff and seepage from surrounding hills.

6a. Upland clays - marine clays on upland which are generally impermeable. These contribute both runoff and seepage to depressions.

6b. Upland tills - coarse tills on uplands which are more permeable than clay units. These contribute both runoff and seepage to depressions, and to groundwater where they overlie sands and gravels.

7. Permanent lakes - these units are open water all year round, and are streamflow regulators.

8. Permanent marshes - these units are wetlands during all or part of the year, and act as streamflow regulators.

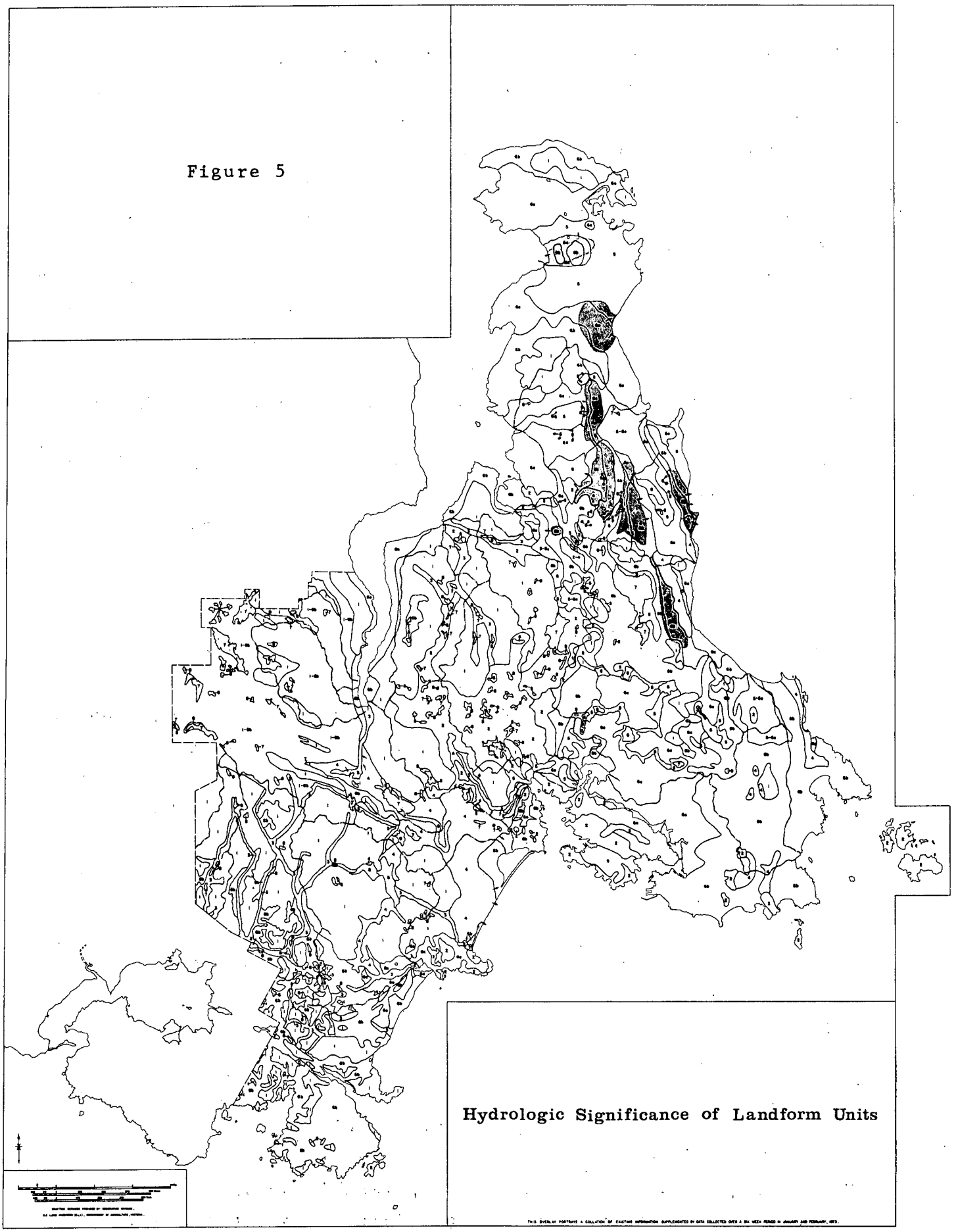
main groundwater reservoirs with recharge possible from a number of sources. These contribute to streamflow and depressional moisture where exposed at surface.

direction of groundwater seepage and springs.

watershed boundaries.

Prepared by: Climatology Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 5



The amount and type of storage within the land unit and the relative importance of the three modes are the main criteria used for defining the significance of land units. These characteristics of the soil and sub-surface materials, combined with different cover types, produce distinct local water balances. The following nine units cover the major differences in the soil and sub-surface materials within the study area.

1) Steep upland surfaces - rock and thinly mantled rock outcrops with steep slopes and high local relief. These areas are the sources of the most intense storm runoff. They are characterized by a dense network of small intermittent channels. Most of the bedrock in the study area is fractured and faulted. Losses to the groundwater system may occur in the fracture zones. There is little surface storage. As a result, these units are subject to extreme drought in the dry season.
2) Hilly surfaces - rock and thinly mantled rock outcrops on low, knobby hills. Slopes can be steep but relief is low. The hills alternate with pockets of clay or muck in hollows. These units are sources of delayed runoff and the runoff from these units is much slower than from the upland units. Much of the water seeps through the soil and collects in depressions between the low hills. The depressions delay and lower the peak storm runoff from these units. The rocky areas are subject to summer drought.
3) Valley bottom alluvium - silt, sand and gravel deposits along stream channels. These units receive and store runoff. They have a high percolation rate, absorbing water from the stream channel and seepage from surrounding uplands. Alluvial areas are susceptible to flooding during intense storm runoff.
4) Gravel and sand terraces - glaciofluvial sand and gravel deposits. These units are generally raised in relation to existing stream channels. Gravel and sand terraces have little direct on surface runoff. Most of the rainfall infiltrates into the ground water system. The groundwater in turn discharges into stream channels. They also receive and discharge seepage from any adjacent upland areas. Local flooding can occur during intense rainstorms if accumulation of water exceeds the percolation rate.
5) Lowland clays - lowland clays are impermeable units in depressions, receiving seepage from surrounding upland areas. Because of the

impermeability of the clay, runoff collects in the depressions forming a swampy area, or a temporary pond.

6a) Upland marine clays - upland marine clays are slowly permeable units which contribute delayed runoff to adjacent low lying channels and depressions. To some extent, they function as sources of runoff in the same way as upland rock areas. However, in the marine clays, the runoff peaks are delayed because of seepage in the soil above the slowly permeable layer. Marine clays generally overlie compact tills; in combination the clay over till is virtually impermeable to water.

6b) Upland tills - upland tills function in the same way as upland marine clays as sources of delayed runoff. These units are more permeable than the clays because of the coarse texture of the tills. Consequently, seepage increases. Where the till overlies gravel deposits, infiltration through the till layer contributes to the groundwater table in the gravel. In these areas, runoff is delayed even more. Dishcarge from the underlying gravel deposit may occur in a different land unit.

7) Permanent lakes - depressions permanently filled by open water. They are the most important surface storage elements in stream basins.

8) Permanent & seasonal marshes - impermeable depressions in clay or bedrock, filled by a pond during all or part of the year. They are important surface storage elements in stream basins.

9) Buried sand and gravel aquifers - several sand and gravel deposits overlain by clays and tills are found within the Saanich Peninsula, chiefly in Central and Northern Saanich. These deposits function as a groundwater reservoir, contributing to stream flow throughout the dry season. Flow from these deep aquifers is the most uniform of any of the units in which storage occurs. The nature of recharge to the deep aquifers is unclear. Most recharge undoubtedly comes from infiltration through overlying till, or seepage underneath till from nearby rock outcroppings. But there is still doubt whether the recharge from these sources accounts for all the observed discharge. Another possible source of recharge is seepage from fracture and fault zones in bedrock, underlying the aquifer. Source regions for such recharge may be quite distant from the aquifer.

COVER TYPE AND LAND USE CHANGES

Cover type is very important in modifying the local water balance. Each land use type has a different effect. Six broad categories of land use are sufficient to include the range of cover conditions found in the Victoria area. These are shown on the present land use map. The six categories are:

1) Bare surface - rock slopes, quarries and cleared vacant land. Cover type has no influence on the water balance on these units. On units which have been cleared, conditions in the surface material may be altered, increasing impermeability and surface runoff or increasing permeability and surface runoff depending on soil types. Present land use units included are L,E,V.
2) Thin forest - open canopy and shrub cover. This cover type reduces slightly the total amount of runoff from the underlying surface, through interception of rain by the canopy, and evapotranspiration. Present land use units are T_3, U_2.
3) Heavy forest - dense canopy. This cover type greatly reduces the total amount of surface runoff, as well as the speed of transmission through the unit. The amount of loss through interception and evapotranspiration are the highest for any cover type. A duff layer as well as permeable soil structure encourage retention and infiltration of moisture in the underlying materials. Present land use units are: T_1, T_2.
4) Agricultural fields - although a diversity of land use exists in agriculture, most have a similar influence on water balance. The effects of these units are intermediate between forested cover and bare surface. Interception loss and evapotranspiration are not as high as in the heavy forest unit. On the other hand, vegetation encourages infiltration into the soil, reducing the rate of transmission of runoff through these units. Present land use units included are: H_{2-4}, G_2, A_1, P_1, K_1.
5) Low density urban - the amount of impervious area increases in relation to the intensity of urban development. Low density urban areas, in this section of the study, are defined as residential areas with a lot size greater than a third of an acre. Impermeable surface area is about 25% of the lot size. Also included are urban open land and recrational features. Present land use units O_{1-4} and parts of R_{2-3}.

6) High density urban - includes high density residential areas, and areas with large amount of pavement. The amount of impervious surface area varies from 25 to 100%. Land use units included are R_1, parts of R_{2-3}, C,W,J,Z, and Y.

Three main types of land use change occur in urbanization: clearing of cover, construction, and channeling of runoff. Two main effects of these changes are increase in volume of runoff, and increase in the speed of transmission of runoff downstream.

Land clearing usually reduces infiltration loss, evapotranspiration loss, and permeability of the soil. The major effect is an increase in the total volume of runoff. This effect occurs in both conversion of forest to farmland as well as in farmland to urban land.

Construction and drainage channeling increase the speed of runoff. Construction increases the amount of impermeable surface, reducing infiltration. Channeling of the surface runoff eliminates storage and increases the channel, gradually increasing the velocity of transmission downstream. The combined effect is to increase peak flow of runoff by as much as 3 times, and to reduce the stability of the runoff.

The reduction of storage along the stream channel in relation to the amount of runoff is the major impact of urbanization. Urbanization induces a flash flood discharge regime. This effect cannot be entirely alleviated. Lowland areas are usually subject to natural flooding. The flooding hazard continues in spite of improved drainage and channeling, with hazard increasing downstream. Urbanization of upland areas subjects the lowland areas to an increased flooding hazard. Simultaneous urbanization of upland and lowland areas is particularly hazardous. Some of the effects of urbanization can be alleviated by designing storage within the urban drainage network. As much of the natural storage as possible should be retained, especially land units most important to each stream basin.

WATER QUALITY

Water quality differences occur naturally in the surface water of the Capital Region. There is a major difference between highland

and lowland water, in addition to differences between basins and within basins.

Quantified measurement of water quality is confined to studies of the lakes within the region. Observation of water quality in streams is mainly qualitative estimation of turbidity and colour taken during field study in January 1973. These observations permit a relative ordering of the streams at that time.

Lakes

Several parameters of water quality have been measured in lakes within the region. These areas have generally been spot checked rather than continuous checking with only a few lakes having detailed biological or chemical analysis.

Seasonal changes in lake structure and composition affect water quality. Interpretation of water quality is difficult without a series of measurements throughout the year to determine how water quality parameters change with the changes in lake structure.

All the lakes in the region undergo a seasonal change in structure. The change in structure is an annual cycle of temperature stratification in summer and turnover in the fall. Stratification begins in March at lower elevations with the growth of a shallow heated layer at the lake surface. The heated layer grows deeper and warmer through the summer. The upper layer reaches maximum temperatures of 70 to 75 degrees during July and August when this layer extends to a maximum depth of 12 to 18 feet. In the fall, the upper layer cools more rapidly and finally warmer water from below forces its way to the surface. This process is called "turnover" and it is completed around mid-to-late October when a relatively constant temperature occurs at all depths. The temperature at time of turnover varies from 46 to 52^{o} (Hagmeier et al 1969 - 72).

Maximum temperature of the surface layer varies within the region. The Watershed lakes are 5 to 8^{o}F. cooler than the lowland lakes, reaching maximum temperatures of 60 to 70^{o}F. The highland lakes are also a few degrees cooler. Swan Lake and the entire set of lakes from Prospect through Thetis to Langford are a few degrees warmer than Elk-Beaver lakes.

The dissolved oxygen content of the water varies with the stratification. Oxygen levels in the epilimnion are high because of surface mixing and production by algae. The layer below the epilimnion has very little mixing or circulation during stratification. Oxygen levels diminish gradually towards the bottom. The bottom mud itself may be anaerobic during the summer. During fall turnover, oxygen levels are replenished throughout the profile. (Hagmeier, et al).

The other physical factor affecting water quality in the lakes is the annual flushing through winter runoff. Runoff from the catchments occurs mainly from November through April. The runoff coincides with the period when the lake is not thermally stratified. The entire lake is flushed, rather than a surface layer.

The build up of nutrients in the lakes is dependent to some extent on the flushing rate. The lower the flushing rate, the greater is the potential for building up the level of nutrients. Lakes with the lowest flushing rates are most susceptible to degradation of water quality, and are also the most difficult to restore when the quality is degraded.

Flushing rate varies with the volume of the lake and amount of runoff from the catchment. The highest flushing rates are in the small lakes of the Highlands. These lakes hold less than 5" of runoff per year from their catchments; the flushing rates are less than a month, so that complete change of water probably occurs several times every winter. The Watershed lakes and the smaller lowland lakes (Glen, Florence, Durrance) have flushing rates of 2 to 4 months, flushing occurs two or three times every winter. The longest flushing rates are in the large lwoland lakes - Thetis, Langford, Prospect and Elk. Flushing rate varies from a half year to almost three years.

The available chemical data permit tentative division of the lakes into 4 groupings according to the level of nutrients. Total dissolved solids content and Secchi disc readings of the light penetration of the lakes have been taken conveniently only twice in many lakes. Surveys by the Fisheries Branch are usually taken in May, while a survey by E.J. Vuori and Dr. E. Hagmeier at the University of Victoria was made in the winter. A number of individual

lake surveys have also been conducted by students under the direction of Dr. Hagmeier. The readings are not comparable because of seasonal changes. Nevertheless, they both indicate a similar division of the lakes. The following is a tentative grouping of the lakes based on these surveys:

	Fisheries Branch		Hagmeier and Vuori		Hagmeier	
	Secchi(ft)	TDS(ppm)	Secchi(ft)	TDS(ppm)	Secchi(ft)	TDS(ppm)
Watershed	16+	30-50	16-18	100-200		
Highland	10-12	40-70				
Lowlands	10-16	60-120	10-12	400-650	10-16	200-500
Swan Lake					2-5	500+

The Watershed lakes were the least eutrophic in both surveys. The lowland lakes were most eutrophic in both surveys. The small highland lakes seemed to be slightly more eutrophic than the Watershed lakes, according to the Fisheries Branch surveys. Swan is by far the most eutrophic of the lowland lakes.

More detailed ranking of the lakes is being attempted at the Biology Department of the University of Victoria. Methods include lake bottom diatom counts, species and abundance of benthic fauna and algae counts and detailed analysis of chemical constituents. The results of these studies are still too inconclusive to permit finer ranking.

Streams

Water quality in the streams was estimated by appearance during a field survey. This is a quantitative estimate of turbidity and water colouration. The main constituent of turbidity is suspended sediment load; the main colouration within the area is the brown from cedar root. The following is a tentative ordering of water quality based on appearance. These estimates do not take into account any chemical or biological measurements, only estimated light penetration.

Worst

Craigflower
Hagan Creek
Colquitz, Glen
Tod, Metchosin
Millstream, Sandhill

Best Goldstream, Veitch

The upper headwaters of the streams are much clearer than the main branch, to which these estimates are applicable. Hagan Creek is by far the worst; there is at least an order of magnitude difference between this creek and any of the others.

The aesthetic quality of the smaller streams was affected by the use of steep banks as convenient private dumps throughout the area. A few of these partially block creeks. The worst observed during the field survey was Cole Creek, a tributary of the Metchosin.

FISH POTENTIAL*

The lakes and streams of the Capital Regional area have a number of fish species - habitat associations. These associations rather than absolute biological productivity are the basis for the mapping of potential. The associations and productivity seem to coincide, at least quantifiable. The only quanitifiable estimates of fish populations available are for anadromous salmon and steelhead runs. Cutthroat trout, the most important species in many of the streams, has never been studied in much detail. Virtually the only information available about cutthroat is where populations exist.

There are approximately seven species associations within the region, four in streams, three in lakes. Although it is possible to indicate approximate boundaries of habitats, and assign a rating for fish capability, it is not desirable to view fish potential within such fixed boundaries. Most of the fish populations utilize more than one habitat during their life cycle. All the habitats used by the fish during the life cycle are equally important. The identification of fish habitats and potentials on a map should be viewed within the context of individual fish populations and their movements through a stream basin.

The following are tentative associations of species within the area:

Streams

1) Anadromous - steelhead, coho, chum, spring.

   This association is confined to the Goldstream. It is the most productive anadromous association to be found in the area, supporting populations of four different species. The spawning

*See Figure 6

area and fry nursery feeding area is found within the stream, all the species migrate to the sea in their second or third year (chum in the first year). Saanich Inlet is very important as a feeding area for the marine phase of these populations.

2) Anadromous - Cutthroat, coho.
This association is found mainly in lowland streams smaller than the ones in which a steelhead population is maintained. Steelhead and cutthroat trout are competitive to some extent and tend to be dominant in different stream environments. Spawning and first year rearing take place within the stream. Summer streamflow is critical for the first year stage. The cutthroat migrate downstream into estuarine areas, which form the main feeding area. The coho migrate further offshore. There may be a small steelhead run in some of these streams, but it is minor compared to cutthroat.

3) Anadromous - Cutthroat.
This association is found in small stream - estuary systems. Some of the estuaries have turned into landlocked lagoons in the southern part of the area.

4) Resident - Cutthroat, brown trout.
This association is found in streams without lakes or sea access. The population must maintain itself in the stream channel itself, in contrast to migration of other populations to larger water bodies for feeding. These populations tend to be made up of smaller individuals because of the limitation in feeding habitat. Very little is known about the habitats and populations within the study area. Spawning is probably in the same types of loose gravels favoured by the migratory populations, while feeding habitat is in quieter spots of the river, especially in any deeper pools.

Lakes

1) Cutthroat, small mouth bass.
This association is found in many of the larger warm lowland lakes. Small mouth bass and minor populations of sunfish are both introduced species in these lakes. These lakes have a high productivity and are large enough to support both populations of fish. To some extent, these species occur in different habitats within the lake. The cutthroat spawns in small inflow or outflow

streams, while bass spawn along the lake shore. Bass prefer the warm waters of the epilimnion, while cuttroat are found in the deeper, cooler hypolimnion during summer. There is some competition between these two species; bass prey on the young trout. Maintenance of separate rearing areas for the trout aid their survival.

2) Sunfish (Pumpkinseed), Small mouth bass.
The small shallow lowland lakes support introduced sunfish and small mouth bass. Sunfish tolerate higher temperatures than the bass. These lakes are too shallow to develop a good stratification. Consequently the trout population is minor.

3) Cutthroat.
All of the cooler highland lakes support populations of cutthroat trout. The life cycle of these populations is similar to that of lowland lake cutthroat and sea run cutthroat. They require a stream channel for spawning.

STREAM HABITATS

Stream channel structure and materials are very important in influencing the capability of streams to support fish. The materials range from solid rock outcrops to mud. Six size classes of materials are sufficient for differentiating the range of habitats encountered.

1) Rock outcrop - fast moving water usually in rapids and waterfalls of varying height. These are barriers to fish movement when sufficiently high. Fish habitat is confined to the deep pools which are often found below rapids.
2) Rubble, boulders - fast moving water, often in cascades, through a divided channel. These may be barriers to fish movement. Fish habitat is confined to pools between larger boulders.
3) Gravel - varies in size. When loose, forms the main spawning area for all salmon and trout species. These stretches also serve as the first year nursery area for trout and coho. Water is often too shallow to support resident populations of adults.

4) Gravel-silt - often found along smaller streams. These form poorer spawning areas, and are utilized by fry populations. The water is deep enought to support adult fish.
5) Sand - some of the best pools for resident fish are found in stretches having sand banks. These pools are their main feeding habitat.
6) Silt-mud - the water is the slowest moving of all the habitats, usually found near the mouth of streams, either near lakes or the sea. Fish use this habitat mainly for feeding and through-migration.

In general, the potential of the streams and lakes is higher than actual production. Many of the populations have suffered a decline through the various pressures of urbanization. Some of the smaller lakes are also affected. This decline is significant, because the fish population are a very important urban recreation and aesthetic resource. The effect is felt into the coastal zone recreation as well.

The lakes also have a higher potential than current production. Many of the spawning qualities for lake populations of trout have been affected by various developments. A few improvements, such as clearing of minor obstructions in channels could increase the spawning area in many of the lakes. But the biggest obstacle to urban recreational use of the lakes is the lack of access. Very few of the lakes, especially the smaller ones, have good access facilities; then value for urban recreation is restricted.

The information permits a tentative ranking of the streams in terms of their relative importance as fish habitat. The most important lakes are not necessarily within the most important stream basin. The following is a tentative ranking:

	Streams
Best	Goldstream
	Craigflower
	Colquitz
	Sandhill
	Millstream, Metchosin, Veitch
	Todd
	Glen
Worst	Hagan

In general, the ranking also indicates the relative order of suitability for modifying the runoff regime. Goldstream, Craigflower, and Colquitz systems should be protected as much as possible

for their value as fish producers. Such a ranking should not be interpreted as meaning that the lesser fish producing streams need not be protected. Some of these have valuable local populations of fish, such as the cutthroat in Prospect Lake. There is a local recreational and aesthetic value in maintenance of fish populations in the smaller streams. This value is important as life style amenity.

The urban recreation potential of existing and potential augmented fish populations is very high. This potential is one of the most important aesthetic values of the area, contributing to the maintenance of the life style alternatives so important in the Victoria area. In planning within the area, such an amenity resource should not only be protected, but enhanced in keeping with the natural capability of the stream systems to support fish population.

BASIN DESCRIPTIONS

Colquitz Creek

Runoff

The southern portion of the Colquitz basin is completely urbanized. Portions have been severely affected. The rest of the basin is mostly cleared agricultural land, with pockets of forest land in the steeper parts.

A few small rocky hills within the Colquitz basin have concentrated runoff. The rest of the upland portion of the basin is made up of tills and clays. Although these are underlain by an impermeable hardpan layer, runoff is much delayed by seepage through the soil above the layer.

All the upland areas drain into lowland flats, which are underlain by impermeable clay. These flats are flooded annually. Streamflow is maintained in sloughs through the flats almost year round. In addition to the ponds flooded annually by runoff, the Colquitz basin has three lakes. By far the largest lake in the study area, Elk Lake completely stabilizes runoff from the surrounding catchment. It has a volume equivalent to almost three years runoff from its catchment. This is the longest flushing time for any lake in the Victoria area. The other lakes, Swan and Blenkinsop, are much smaller. In spite of their smaller volume, they do regulate and maintain runoff.

The Colquitz basin demonstrates the effects or urbanization in the Swan Lake drainage. Water quality and runoff regime have both degenerated to the point where currently the system is almost

useless as fish habitat.

The rest of the basin is an almost classic example of the problems posed by urban development. It maintains an important fish population which could be improved. Urbanization of the lowlands is completely undersirable because of the depth of flooding it experiences. Urbanization of the highlands makes the stabilization of runoff dependent on storage in the lowland flood plains. It also changes the water quality and runoff regime. Whether the fish production can be maintained in spite or urbanization is difficult to answer. Evidence from elsewhere suggests that it cannot.

Water Quality

Water quality as well as runoff regime have been affected in Swan Lake and Creek. Swan Lake is by far the most turbid lake in the study area. Overall water quality is poor through this drainage, though it improves in the creek below Swan Lake.

Colquitz Creek itself is probably the second most turbid major creek in the study area. Turbidity seems to begin below the first pond along its course, and gradually increases toward the mouth. The turbidity seems to be related to the low areas; the water is relatively clear in upland creeks.

Elk Lake is naturally eutrophic. Water quality is still good, as measured by Secchi disc and dissolved solids content. The lake is sensitve to changes in water quality because of the three year flushing time. Consequently, land use changes in the surrounding watershed should be carefully evaluated.

Fish Potential and Channel Form

The Colquitz supports a substantial population of sea run cutthroat trout, and a small run of coho slamon. Formerly, it also had a steelhead trout population. The main stream is passable to a series of rapids on the outlet from Elk Lake. All the tributaries are passable within the flat lowlands. Only the main spawning areas below the rapids have been identified. Spawning probably occurs along the tributaries as well, but no fry counts have been made to find the areas utilized. The sloughs in which the tributaries flow may be important for maintaining the fry during the summer.

Cutthroat have existed in the Swan Creek drainage in the past, but the water quality has deteriorated to the point where this system is now marginal. The rest of the Colquitz system still maintains

a good run, though even here it is not as good as formerly. Although recent streambank and channel improvements apparently have not damaged the runs, they have not helped either (obstruction of channel, sedimentation, bank clearing).

The run to the Colquitz is the second half of the trout population of the Gorge waterway. This cutthroat trout population is one of the best on Vancouver Island, and forms a unique recreation resource in the middle of a major urban area. Conditions in the Gorge are almost ideal for maintaining a large population, if water quality spawning conditions are maintained. Degrading of the population in Colquitz Creek will degrade the whole Gorge waterway fishery.

Although small, the coho run is also important for maintaining an outer waterfront salmon sports fishery. This population is limited now to from 10 to perhaps 50 spawners, mostly in the main spawning areabelow Highway 17A. Formerly, spawning extended up the tributary that joins the main stream in this area.

Elk Lake maintains a separate cutthroat population. This is one of the largest lake populations in the Victoria area. Lake conditions are ideal. The spawning area is in the creek draining into the Northwest corner of Elk Lake. Conditions in the creek were formerly excellent but agricultural draining operations have apparently degraded the stream. Restoration here would include construction of a spawning channel and possibly a pond for the fry before they are allowed into Elk Lake.

All three lakes in this drainage support bass and sunfish populations. Elk Lake supports a good population of bass. Swan and Blenkinsop are limited to sunfish, and marginal even for these.

Craigflower Creek

Runoff

The importance of Craigflower Creek to the fish population it supports makes it essential to protect this watershed as much as possible.

Two headwaters arise in the steep portion of the Highlands. The rocky, thinly forested slopes are the source of concentrated runoff. The headwater creeks flow through depressions which have a good storage capacity for holding and delaying runoff peaks. The depressions are floored by permeable alluvial materials. In addition they contain several small lakes. The capacity of the lakes is quite

small. Fork Lake for example, has a volume equivalent to 3.5" of runoff from its basin. These tributaries fall steeply into the lower Craigflower basin. They flow through an additional series of marshes, further reducing and delaying runoff peaks.

These delays are important in staggering the period of runoff flow. Runoff on the third headwater originating in the steep highland is delayed only by two swamps. Runoff from this branch should reach Pike Lake earlier than from the other headwaters. Pike Lake acts as the main regulator for flow from the eastern headwater.

Runoff from the southern portion of the basin is quite sluggish. It originates in low hilly areas, and must pass through a network of lakes and swamps before reaching the main channel. Thetis and McKenzie Lakes are the major storage areas. Thetis Lake has a capacity about equal to a full year's runoff. Consequently, runoff should be quite stable.

Nearly all the flow stabilization takes place above the confluence of the creeks from Prior and Pike Lakes. The lower portion of the stream, which has the important spawning areas, has little storage along the channel. There are two or three pockets of alluvium, but for the most part, the channel is either rocky or cut into relatively impermeable marine clays. The latter are subject to high water tables, especially when the creek is high.

Water Quality

Water quality through the Craigflower system is excellent. There is very little turbidity even in the lower part of the basin.

Two portions of the watershed are particularly sensitive to changes in water quality. These are Thetis Lake and the spawning area of the lower basin. Thetis Lake is naturally eutrophic, but a combination of relatively low flushing rate and very low summer inflows make it susceptible to further eutrophication. The spawning area is already partly lined with housing. Some additional clearing has recently taken place adjacent to a smaller spawning area upstream, resulting in a log jam in the creek.

Fish Potential and Channel Structure

Although the lower part of the creek as far as Pike and Prior Lakes has numerous small rapids and falls, all are passable for anadromous fish runs. This entire lower basin supports the second largest anadromous fish population in the study area. A run of

between 100 - 300 coho utilize the spawning area, while Prior and Pike Lakes serve as nursery rearing areas for the fry. A good run of cutthroat trout utilizes the same area of the creek. Both of these runs are important for local sports fishing, the cutthroat in the Gorge waterway and the coho along the outer waterfront. Both of these sports fisheries are dependent on maintenance of the Craigflower Creek spawning area.

The lakes support their own populations of cutthroat trout. Except for minor obstructions, the spawning channels for these appear to be good. There are no major obstructions to movements of fish through the entire lower basin; only the populations of Fizzle and Fork Lake are separated by a major barrier from the rest of the basin.

Glen Creek

Runoff

The Glen Creek drainage includes three blocks of steep upland catchment, and a level lowland receiving area in the Colwood gravel deposit. Within the gravel deposit, Glen Lake and a neighbouring swamp occupy depressions. The creek draining Glen Lake occupies another depression in the gravel deposit.

The runoff regime includes fast runoff from the uplands into the gravel and alluvium at the base of the slopes. In some areas the runoff is so fast that local flooding occurs around the base of the hill. There is very little runoff on the gravel deposit. Instead, rainfall infiltrates and is discharged as groundwater into the Glen Creek channel. The storage in the lake and gravel deposits should maintain streamflow in the channel through the dry season.

Water Quality

Water quality in the drainage has been affected by urbanization. This drainage, along with Swan Creek, Bawker Creek, and Florence Creek, seem to have suffered the most from urbanization. Several sources of contamination occur; the swamp to the west of Glen Lake is contaiminated from cattle. A second source of farm contamination occurs along the drainage channel from Glen Lake. Glen Lake itself is naturally eutrophic but is further enriched by septic tank discharge. The combined effects of urbanization and contamination from stream side sources is evident in the turbid-

ity of the lower stream course.

Fish Potential

Glen Lake maintains a population of sunfish (pumpkinseed) and small mouth bass. There does not appear to be a cutthroat population. Potential for trout is moderate. Spawning facilities in the outlet stream are suitable for cutthroat, but competition with sunfish may affect maintenance of a population in the lake.

The lower part of the creek supports an anadromous cutthroat population. This population utilizes Esquimalt Lagoon as its main feeding habitat. Spawning area in the creek is limited, and may be affected by water quality. This population is cut off from the upper part of the creek by a fall close to the mouth.

Goldstream River

Runoff

The Goldstream River is regulated by a series of dammed lakes. These lakes form part of the Greater Victoria District water supply. Consequently, water may be withdrawn from the lakes for the water supply, rather than allowed to discharge down the Goldstream. The drawdown occurs in the critical summer months when storage water is needed to maintain streamflow.

Rainfall in the Goldstream is considerably heavier than in the rest of the study area. The basin itself consists of an upland plateau, mantled by till and heavily forested. The forest and till cover reduce and slow down the transmission of runoff peaks downstream. Lake storage and depressional topography further reduce the peaks.

The Goldstream flows in a deep trench in the lower part of the basin. The steep walls of the trench produce some of the most concentrated runoff in the basin. Part of the trench floor is covered with the Colwood gravel deposit. The Goldstream is deeply incised into this gravel which collects runoff from surrounding uplands, and discharges it as groundwater into the Goldstream from a perched water table. Discharge from the gravels is an alternative water supply for maintaining summer flow; the volume and effectiveness of the discharge do not appear to be as good as discharge from headwater basin storage.

Langford Lake, a part of the Goldstream basin, collects run-off from the steep uplands to the north and south. Further inflows occur from the Colwood gravel deposit. The lake is large enough to stabilize heavy runoff inflows from the steep upland slope and it has a flushing rate of approximately one year.

Water Quality

Water quality in the main Goldstream system is excellent. Some contamination of the water may occur from groundwater seepage of the Colwood aquifer, as well as septic tank effluent from a number of trailer courts.

The watershed lakes of the Goldstream system are the least eutrophic in the greater Victoria area. Langford Lake, on the other hand, is among the most eutrophic of the lowland lakes. The natural enrichment of this lake has been increased by outflow from septic tanks along the shoreline.

Fisheries

The Goldstream system is the most productive in the whole area in terms of number of species as well as absolute numbers of fish. Coho, Spring, Chum, and Steelhead use the lower Goldstream for spawning and yearling feeding. Over the last 10 years, the spawning populations of these species has averaged:

Coho	300 - 500
Chum	5000 - 10,000
Spring	1 - 50
Steelhead	33 - 269 (5 years) - catch totals which may be about 25-33% of total run.

The production can be severely affected by withdrawals of water from the Goldstream. Steelhead catches reflect a crisis in the late 1960's due to such withdrawls. Catches declined to about 1/8 of the former levels.

The Watershed lakes maintain population of cutthroat. Conditions seem to be excellent, with no major restrictions to spawning or lake production.

Langford Lake appears to be inhabited by small mouth bass and sunfish populations. The potential for trout is good, with some clearing of the main spawning area at the outlet. With initial

stocking, a cutthroat population could be maintained in this lake.

Hagan Creek

Runoff

Much of the flow in Hagan Creek originates in the southern part of the basin. Most of the runoff accumulates through seepage rather than direct overland flow. Nearly all the upland areas are till covered and forested, reducing the runoff volume and creating ideal conditions for seepage. The seepage accumulates in a series of depressions underlain by clay. The volume of flow in the creek flowing through the depressions is quite small, especially in the upper basin. Because of the storage and delay in the soil, the flow is maintained into the summer.

The largest amount of seepage accumulation occurs in a large peat bog (which has been drained). Groundwater seepage from the Keating aquifer adds to the soil seepage. Much of the rainfall in the upland area above the aquifer infiltrates into the aquifer. A larger portion of the runoff from this upland area occurs as groundwater discharge rather than overload flow.

Flow in Hagan Creek is maintained in summer by the slow discharge of groundwater, and the large amount of storage in the peat bog. Additional groundwater discharge from the Hagan aquifer enters the northern bank of Hagan Creek.

Runoff from Mt. Newton collects in another long depression. Volumes should be reduced by the heavy forest cover on Mt. Newton, the south facing aspect of the upland slopes, and by the seepage of much of the runoff through till and clay layers, rather than overland.

Water Quality

Water quality of the southern branch is the worst of any in the study area. The water is absolutely black with sediment from the peat bog. The tributaries draining Mt. Newton are clear in comparison, but their small volume does not change the water quality of the main stream as heavy sediment content is maintained all the way to the sea.

Fish Potential and Stream Materials

The main branch of the stream is useless as trout habitat because of the sediment load. A trout population is maintained

only in the main northern branch of the Hagan where streamflow is maintained by groundwater discharge and trout escaping from farm ponds form the core of the trout population.

No anadromous fishery is possible because of the 80 foot drop directly into the ocean at the mouth of the creek.

Metchosin Creek

Runoff

Almost all the runoff regulation along Metchosin Creek is the result of groundwater storage in stream channel materials. The entire basin contains only a few units of surface storage, mainly in a seasonal marsh on Bilson Creek. The value of alluvial materials in the valley as storage appears to be the most important in the area. An additional factor in reducing runoff peaks is the length of the stream channel.

The valley extends between blocks of upland which vary in cover from exposed bedrock to thick forest. The upland blocks fall steeply into the valley and runoff problems have been associated with clearing and construction on Triangle Mountain. The other upland blocks probably respond in the same manner when cleared.

The lower portion of the Metchosin is incised into a plain underlain by marine deposits and till. Parts of this plain have a few subsurface lenses of gravel, probably forming small local aquifers for groundwater. Runoff from the plain probably enters the main channel as seepage, rather than direct surface runoff.

Water Quality

Water quality in much of the basin appears to be fair. There is a small amount of turbidity in the water from Bilson Creek marsh area and as a result the water at the mouth of the creek is moderately turbid.

Several sources of contamination are known; the Bilson and Cole are contaminated by effluent from chicken farms, while cattle are grazed near the main channel at several places.

Fish Potential

Metchosin Creek has only a stream fishery for cutthroat and brown trout. An 80 foot falls, directly into Woody's Lagoon, prevents anadromous fish runs. Woody's Lagoon itself would form an excellent feeding habitat for coastal cutthroat. There is good potential along

the lower and middle portions of Metchosin Creek for supporting the in-stream fishery. Excellent spawning gravels occur in a stretch running through a new subdivision. Further upstream, there are numerous deep pools where the creek flows through an alluvial sand deposit.

Millstream

Runoff

The most concentrated runoff in the basin originates in the prominent rocky ridges of the upper watershed. These ridges are mostly steep exposed bedrock, with a thin forest cover. This runoff is stored in the depressions separating these ridges. A part of the main valley floor consists of alluvial gravels; the secondary valley is floored by coarse till materials. In addition, a series of lakes and seasonal swamps in both valleys further delay the passage of runoff. All the lakes are shallow (less than 20 feet), with high flushing rates but runoff must pass through them in series.

The middle section of the Millstream basin consists of a wide trough of low hills and hollows. As this section is also more thickly wooded than the upper watershed, runoff amount is reduced, and the basin structure reduces the concentration of runoff. The main stream continues as a series of lake or swamp filled depressions.

The lower basin adds to the stability of the flow. The flood plain of the stream is a narrow series of pockets deeply incised into the Colwood gravel deposit. The flood plain pockets are all susceptible to flooding but alluvial sand desposits function as groundwater storage units, while the Colwood gravels discharge from a perched water table. This discharge helps maintain the flow of the lower Millstream in the dry season.

Florence Lake discharges into the lower reach of the Millstream and concentrated runoff flows into Florence Lake from a steep hill. This runoff is already a fast discharge and flash flooding is increasing with building on thehill slope. Florence Lake itself fluctuates in size and depth. The volume of the lake is equivalent to 10 inches of runoff from the basin, more than half being available for absorbing inflows. Discharge from the lake is further impeded by low gradients in the outflow creek. The higher the level of flooding in the lake, the greater the chance of flooding along this creek.

Water Quality

Water quality in the upper Millstream appears to be excellent. Although the water is discoloured by cedar root, total dissolved solids content of Matson Lake was a low 61 ppm when measured in 1961.

The lower reaches of the stream have been affected by development and there is probably contamination from animal wastes at several large farms located beside the stream. One subdivision discharges secondary effluent and summer flow below this point may be comprised of a large portion of the effluent. Discharge from the Colwood gravels is also suspected of contamination as turbidity of the water increases noticeably through the lower basin. The Florence Lake system probably has the most serious potential problem, as it is poorly drained with a very low rate of flushing in the summer months. This lake is eutrophic in its natural state.

Fish Potential

The Millstream supports a number of separate populations of cutthroat and a population of pumpkinseed. The estuary of the Millstream supports sea run cutthroat trout. The runs are stopped by a series of three 20 foot waterfalls and an impassable culvert at the southern end of Mill Hill. Above these falls, the stream supports a population of trout between Mitchell, and Matson Lakes, a long stretch below Matson Lake. Both stretches have good spawning gravels and moderately good pools. All the lakes of the Millstream system support cutthroat. The spawning areas are for the most part along the inlet stream. Except for Mitchell Lake, the outlets have steep impassable falls.

Florence Lake supports a population of sunfish and is more suitable for this species and small mouth bass than for cutthroat because of the temperature regime. Maximum depth is only 19 feet and temperature is relatively high through the entire profile. In addition, the spawning facilities are poor on the inlet stream. They will undergo further degradation if housing continues upslope.

The overall potential of the Millstream is only moderate relative to other streams in the area, but separate populations existing in the system are all locally important in the lakes.

F I S H C A P A B I L I T Y

STREAMS

1 - Very high capability for supporting fish populations in streams. These units are excellent spawning areas supporting two or more species of anadromous trout and salmon.

2 - High capability for supporting fish populations in streams. These units are good spawning areas supporting two or more species. They are important spawning areas for cutthroat trout and important habitats for local stream cutthroat trout populations.

3 - Moderate capability for supporting fish populations. These are poor spawning areas used by one species and are poor habitats for cutthroat trout populations.

4 - Limited value for supporting fish populations.

LAKES

1 - Deep eutrophic lowland lakes which have very high capability to support populations of several fish species.

2 - Upland mesotrophic lakes which have a high capability to support population of cutthroat trout, and lowland lakes limited by lack of spawning areas for cutthroat trout.

3 - Shallow lowland lakes which are limited in their capability for cutthroat trout populations by warm water temperatures in summer.

COASTAL

1 - Very high capability to support cutthroat trout in shallow estuarine areas.

2 - High capability to support cutthroat trout in estuarine areas.

3 - Moderate capability to support cutthroat trout limited by lack of natural spawning facilities.

2cl - areas supporting high and moderate populations
3cl of clams and crabs.

A - Main salt water salmon feeding areas. No differentiation of species of ability to support salmon is made (based on information from "Where to Find Salmon" by C.R. White and B. Colegrave).

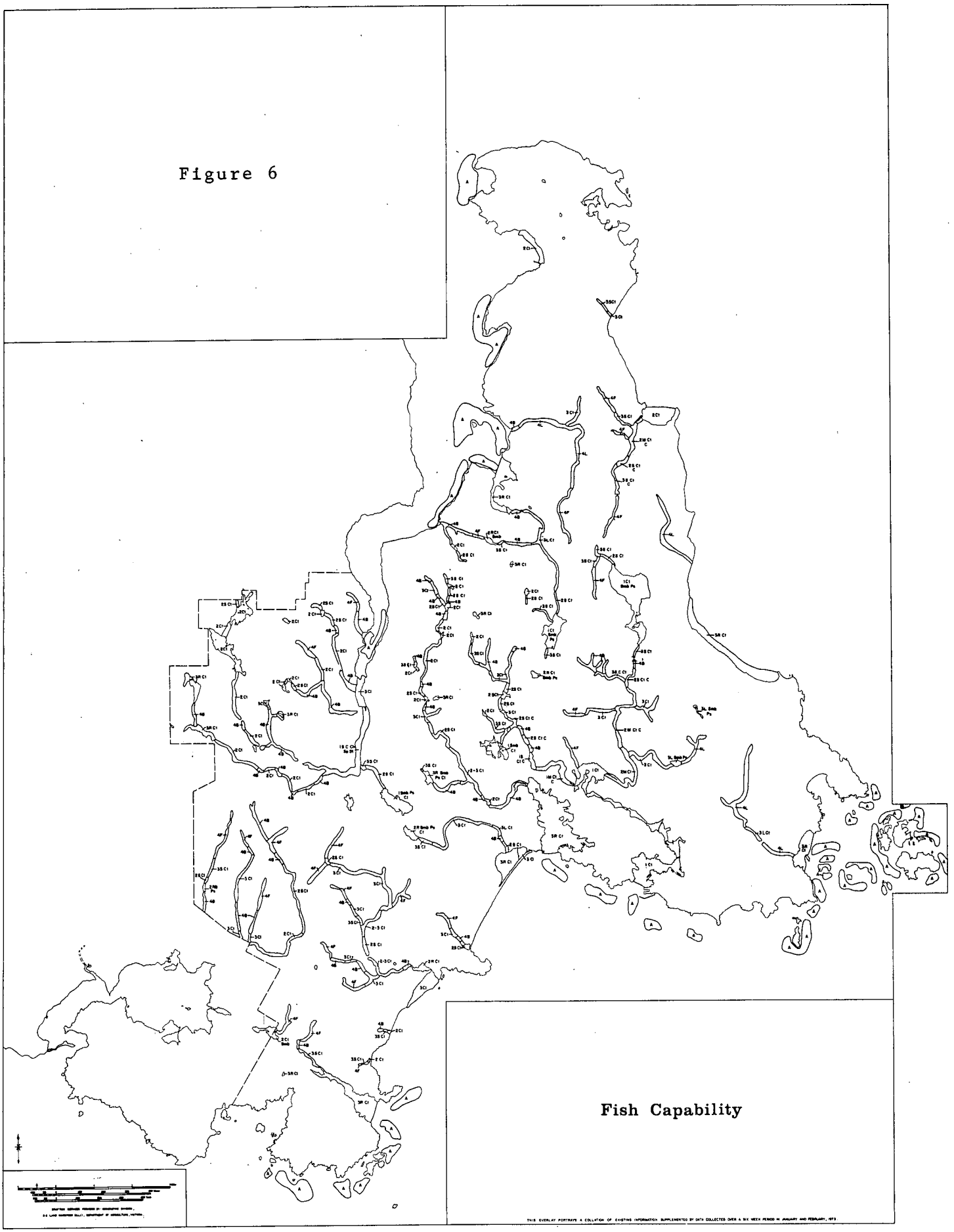
SYMBOLS

S - Spawning area for salmon or trout.
R - Restricted spawning area for supporting trout population.
M - Area important for migration of salmon or trout in streams.
F - Stream limited by lack of water in summer.
B - Stream limited by steep and/or rough channel formation.
L - Limitation due to turbidity and silt content of water.

Ct	- Cutthroat	Rb	- Rainbow (stocked)
C	- Coho	Smb	- Small mouth bass
Sp	- Spring	Ps	- Pumpkin seed (sunfish)
Ch	- Chum	St	- Steelhead

Prepared by: Climatology Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 6



Sandhill (Shady) Creek

Runoff

Much of the upper Sandhill basin is perched on top of marine clay resting over a deep aquifer. Materials in the upper basin are permeable to some extent, so that part of the rainfall is lost to the deep aquifer. This loss is locally important on Bear Hill, one of the few steep areas with concentration of runoff. The remainder of the upland catchment is underlain by tills, sometimes having a veneer of marine clay on top. Runoff is delayed by seepage over impermeable layers.

There is no other substantial storage in the Sandhill basin. The clay over which the stream flows is locally saturated by seepage and the stream channel is incised with no large ponding areas until the lower reach of the stream. Even here, the clay deposits are gently sloping and the channel is incised.

All the above factors result in a shortage of water in the Sandhill. This is alleviated to some extent by the construction of ponds along the stream channel. These are neither deep or extensive in area.

Water Quality

Water quality deteriorates in the ponds along the upper channel. This deterioration is most marked in summer, when the lack of inflow stagnates these water bodies. In addition, an aluminum fabricating plant has discharged effluent containing acid on two occasions into the creek. Both resulted in extensive fish kills. Water quality does not appear to deteriorate any further below the ponds. The stream flows in a wooded valley, protecting the water quality.

Fish Population

The Sandhill at one time supported a larger population of fish. A small cutthroat and coho population continue to survive and the lowest pond is probably used as a nursery by young trout while all the upper ponds are inaccessible. This small population utilizes Saanichton Bay, especially the estuary of the creek, as its feeding area. The coho population survives only as a few individuals, perhaps 10 to 25 spawners.

The fish population of the Sandhill have been affected by lack of flow in summer rather than water quality. The low runoff in the

basin, combined with water licence withdrawals from the creek, result in virtually no summer flow.

Tod Creek

Runoff

Tod Creek basin has a large amount of surface storage. Heavy runoff can occur on much of the upland, forming the western half of the basin. Soil and forest cover are both sparse and much of the runoff flows into a number of lakes, each having a large volume and relatively low flushing rate.

Prospect Lake is the largest storage reservoir in the Tod Creek system. The flushing rate of about a year indicates sufficient volume to hold and stabilize the runoff regime from a normal year. Prospect Lake is fed by two tributaries and direct runoff from the surrounding hills. The hills on the east side are heavily wooded, so reducing runoff.

The Maltby Lake drainage has an additional large storage capacity in both the lake and associated swamps. Maltby Lake is surrounded for the most part by low rocky hills on which drainage is held up by depression.

The Killarney Lake drainage has an additional large storage capacity, in the lake and in valley bottoms alluvium. Killarney Lake itself has a flushing rate of almost a year.

The mainstem Tod Creek flowing out of Prospect Lake is stabilized by a large amount of lake storage. A large seasonal pond forms about a mile downstream from the lake. This ponding results from a combination of restricteddrainage where the valley narrows, and runoff from the surrounding hills as well as the main stream. Runoff from the western side of the valley is direct, though reduced by heavy forest cover. The eastern side of the valley consists of a range of till-covered hills, surrounded by depressions. Runoff, much of it as seepage, collects in the depressions before draining into the main valley. These depressions are particularly well displayed around Observatory Hill.

The Durrance Lake drainage is also well regulated. Durrance Lake has a flushing rate of half a year. Additional storage is available on Heal Lake. Much of the Durrance Lake has a flushing rate of half a year. Additional storage is available on Heal Lake. Much of the Durrance drainage is heavily forested, further reducing

flood runoff.

Water Quality

Water quality is good in the Prospect Lake drainage, and in the mainstem Tod Creek as far as the large ponding area on the flood plain. Below the ponding area, water quality noticeably deteriorates.

Water quality in the lakes is generally good, though all the lakes are naturally eutrophic, partly the result of septic tank effluents from housing along the shore. Killarney and Heal Lakes are probably affected by the Greater Victoria garbage dump.

Fish Population

Each of the lakes supports a cutthroat trout population. Prospect Lake has one of the highest potentials in the Capital Regional area; three spawning areas along the two inflow creeks and the main outflow creek support the population. With improvements to the spawning areas, the lake potential could be used more effectively. The lake supports a large bass population as well.

Durrance Lake also has excellent potential as trout habitat. Unfortunately it has poor spawning facilities, and requires stocking to maintain the population. The lake also supports a bass population.

Killarney and Heal Lakes support cutthroat populations. The effects of seepage from the municipal garbage dump on fish population are unknown.

Maltby Lake supports mainly sunfish. It apparently also has a cutthroat trout population, but the spawning facilities are limited.

The main Tod Creek has a good potential as a trout stream. The upper part is currently used for spawning and rearing by the Prospect Lake population. The lower part undoubtedly supports resident trout which have moved downstream. The creek does not support anadromous fish runs, although at one time it did with the aid of a fish ladder at the mouth. There are no major obstructions in the system, except for the falls at the mouth, and on Durrance Creek.

Veitch Creek

Runoff

Veitch Creek has a different pattern of surface materials

from the other creeks of the Victoria area. It has the more simple pattern of wet coastal streams, with steep upland blocks with heavy runoff draining into the narrow valley. The valley floor is covered with gravel alluvium, which forms the major storage for maintenance of runoff. There are no lakes within the basin, although several marshes form in the valley bottom. If the upper watershed is maintained with adequate forest cover, the runoff regime will be stable.

Water Quality

Water quality is excellent. The only major sources of sediment or contamination within the area are in some of the valley bottom farm units.

Fish Potential

A fall close to the mouth of the creek prevents utilization of the upper channel by anadromous fish. The stretch of the stream within the study area supports a resident cutthroat population. Individuals of this population are small in size, probably due to the limited feeding habitat in the creek. Much of the creek bed appears to be more suitable for spawning than maintenance of an adult population.

The descriptions of river basins cover most of the Capital Regional study area, and all of the major basins. A number of smaller basins deserve brief discussion of their fish potential.

Ayum Creek

This basin contains Glinz Lake, which has a good potential for supporting a rainbow or cutthroat population. It is currently stocked with rainbow. This population utilizes the spawning area on the inlet creek; the outlet has no potential for spawning.

Matheson Creek

Matheson Lake is intensely used by anglers. The population of cutthroat is limited by poor spawning facilities and there is little potential for spawning in the inflow streams which are small and flashy in regime. The outflow creek is also limited with a dam at the outlet while the stream channel has intermittent gravels and discharge. With improvements to the outlet and spawning channel, recruitment should improve. Matheson Lake also supports a small mouth bass population.

Pease Creek

The Pease Creek drainage supports a good cutthroat population in Pease Lake. This population has access to an excellent spawning channel along the inlet creek. Of all the Highland lakes, this one has the best natural cutthroat population habitat.

There are a number of other smaller fish populations within the area. Streams such as the Arbutus and Niagara on the Malahat support resident cutthroat populations and a number of lagoons along the Metchosin - Colwood coastline support small populations of cutthroat. Reay Creek and creeks flowing into Cordova Bay near Sidney support small estuarine populations of cutthroat and they should not be overlooked in planning as they have local recreational and aesthetic values. The local and regional aesthetic values of having fish population in stream systems are important, but are often overlooked. Fish resources are unique urban recreational assets.

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NATIVE VEGETATION*

R.G. McMinn, S. Eis, E. Oswald

FLORA[1]

The cool Mediterranean climate enjoyed by the residents of Victoria endows much of the Capital Regional District with a flora which is unique in Canada. Summer dryness is a major determining factor of the flora. In addition to the North Pacific anticyclone which in summer frequently blocks the western cyclonic systems, the regional climate of the Pacific Northwest is modified by the rain-shadow effect of the Vancouver Island and Olympic Mountain Ranges. The greatest expression of this rainshadow effect occurs in a strip from 47° to 50°N latitude known as the Puget Trough in the south and the Strait of Georgia Depression in the north. This strip includes the southeastern rim of Vancouver Island, the Gulf Islands and the rim along the west coast of the British Columbia mainland southwards through the Puget Sound to the west of Mount Ranier in Washington State. The Saanich Peninsula and adjacent Gulf Islands which are unique in having a lower summer rainfall than most parts of Canada occur in the driest and mildest section of the rainshadow strip and are separated from continental land bodies by oceanic water At higher elevations and to the west of the Saanich Peninsula rainfall is higher with concomittant changes in vegetation to dense forest types which also occur elsewhere on Vancouver Island.

The original vegetation that developed in the Saanich Peninsula consisted of stands of garry oak (Quercus garryana) on dry sites, arbutus (Arbutus menziesii) and Douglas fir (Pseudotsuga menziesii) on moist sites and western red cedar (Thuja plicata), grand fir (Abies grandies), Sitka spruce (Picea sitchensis), red alder (Alnus rubra) and bigleaf maple (Acer macrophyllum) on wet sites. Other species, such as lodgepole pine (Pinus contorta), western white pine (Pinus monticola), western hemlock (Tsuga heterophylla), western yew (Taxus brevifolia), western juniper (Juniperus scopulorum), black cottonwood

*See the summary map, Figure 7.

[1]The contributions of Dr. L.J. Clark and Mr. W.F. Savale Jr., and Dr. A.F. Szczawinski and T.C. Brayshaw of the Provincial Museum, to this section are gratefully acknowledged.

(Populus trichocarpa), flowering dogwood (Cornus nutallii) and Pacific crabapple (Pyrus diversifolia) would have been present to a lesser extent. Various combinations of these tree species occurred along with associated understory species wild onion (Allium geyeri var. tomentosum), wild hyacinth (Brodiaea coronaria), and camass (Camassia leichtlinii), to the Regional District and the absence of other species elsewhere in Canada, wild onion (Allium amplectens) and white meconella (Meconella oregana), exemplifies the uniqueness of the area's flora. Colorful spring flowers such as camass (Camassia quamash), shooting star (Dodecatheon hendersonii), easter lily (Erythronium oreganum), and chocolate lily (Fritillaria lanceolata) provide floristic attractions which are not commonly duplicated in Canada.

Land clearing for agriculture and urban development has irreversibly altered much of the native habitats. Sitka spruce was almost eliminated because the wood was desirable for construction. Lodgepole pine-peatmoss bogs were cleared for vegetable gardens. Oak-grassland and Douglas fir habitats occupied good sites for grazing and farming and many of the original stands were greatly modified or eliminated for agriculture. Unfortunately few studies were conducted before this intensive alteration so that the exact constitution and distribution of these communities is not known.

A few records do exist which give an indication of the disturbance to the native flora. Spleenwort (Asplenium trichnomanes), sunflower (Helianthus maximiliani), meadow foam (Limnanthes macounii), and dwarf blueberry (Vaccinium caespitosum), were collected in the early twentieth century but are no considered extinct in the area. The distribution and abundance of several other species has been reduced to near extinction on the Saanich Peninsula, although they may be found elsewhere. Because the Saanich Peninsula and adjacent areas were possibly their only habitat on Vancouver Island some species such as lace fern (Cheilanthes gracillimi), northern coral root (Coralorrhiza trifida), mountain lady's-slipper (Cypripedium montanum), and large round-leaved orchid (Habenaria orbiculata) are now presumably extinct on the Island.

Some studies have been conducted on bogs, mostly because they were not disturbed as rapidly and extensively as upland areas. The

diversity of the flora supported by the different bogs is amazing at first glance. Each bog however, has a different developmental history, physiography and climate associated with it. Quite conceivably, much the same could have been true for the upland areas since the geological history of the area has left a topography with a wide array of micro-climates and edaphic conditions. Perhaps this is why we find some species restricted to only one or two locations such as sanicle (Sanicula arctopoides) near Cattle Point, balsam root (Balsamorhiza deltoidea) and white meconella (Meconella oregana) only in Thetis Park and gold star (Crocidium multicaule) only on Mt. Finlayson to name a few.

Why should we be concerned about perpetuating a population or a community of plants, especially those with essentially no commercial value? There are several reasons. Most of these communities could be perpetuated within an hours dirve of Victoria making them very useful outdoor classrooms for use at various levels of education from primary school to university. The Provincial Museum conducts guided tours to various natural areas for students and tourists. Such tours are becoming increasingly popular with the recent upsurge of public awareness of natural environments. Victoria is well known as a retirement centre of Canada and many senior citizens derive numerous pleasant hours visiting natural areas, as well as developed parks, either on their own or through membership in natural history societies. Such people enjoy viewingbirds and other animals. Several species are endangered because of their habitats are being destroyed. The restricted distribution of many species or their unique occurrence within certain communities is of particular interest to science.

PARTIAL LIST OF PLANTS OF PARTICULAR INTEREST (TABLE 3)

Adiantum pedatum (Maidenhair fern)
Allium acuminatum (Hooker's onion)
Allium amplectens (Wild onion)
Allotropa virgata (Candy stick)
Arbutus menziessii (Arbutus)
Arctostaphylos columbiana (Manzanita)
Betula glandulosa (Bog birch)
Betula papyrifera (Paper birch)
Botrychium multifidum (Grape fern)
Brodiaea coronaria (Wild hyacinth)
Brodiaea hyacinthina (Fool's onion)
Calypso bulbosa (Fairyslipper)
Collinsia parviflora (Blue-eyed Mary)
Corallorhiza maculata var. flavida (Coral root)
Crocidium multicaule (Gold star)
Cornus nuttallii (Flowering Dogwood)
Cypripedium montanum (Mountain lady's-slipper)
Delphinium menziesii (Larkspur)
Dodecatheon hendersonii (Shooting star)
Drosera rotundifolia (Sundew)
Dryopteris arguta (Coastal shield fern)
Empetrum nigrum (Crowberry)
Erythronium oregonum (Easter lily)
Fritillaria lanceolata (Rice root, chocolate lily)
Kalmia polifolia (Swamp laurel)
Lilium columbianum (Tiger lily)
Lithophragma parviflora (Rock fringecup)
Lomatium utriculatum (Spring gold)
Lupinus densylorus var. scopulorum (Lupin)
Picea sitchensis (Sitka spruce)
Plectritis congesta (Seablush)
Pterospora andromedea (Pinedrops)
Pyrus fusca var. diversifolia (Pacific crabapple)
Quercus garryana (Garry oak)
Saxifraga integrifolia (Saxifrage)
Sisyrinchium douglasii (Satin flower)
Woodwardia fimbriata (Chain fern)

PLANT COMMUNITIES

The native terrestrial plant communities which occupy areas large enough (± 20 ac) to be mapped at the present scale (1:50,000) range from Garry Oak scrub in rock outcrop areas at the dry end of the spectrum to skunk cabbage growing in permanently wet muck soils. Treeless rock outcrop communities and bog and aquatic communities which are not mapped occur at either end of this spectrum. Littoral and marine plant communities are also not included. For the most part, mapping was done by interpretation from aerial photographs with a small amount of ground control to establish which communities could be recognized from aerial photographs. The stratification of types generally follows the classification of plant communities outlined by Szczawinski (1973). Additional types and interpretations have been obtained from Roemer (1972). All mapped units encompass inclusions of other communities. Some are a mosaic but have been mapped according to the dominant type for simplicity. This map must be considered a first approximation in view of the time constraint (less than three weeks) in its preparation.

The scale and detail in which the native plant communities are mapped will, in most cases, be insufficient to answer site-specific planning questions in an ecologically optimum manner. On the Saanich Peninsula, in particular, an advanced state of urban and agricultural development coincides with a high degree of natural diversity. This results in such an intricate pattern for those vegetational habitats remaining that they could only be fully inventoried if mapped more intensively at a larger scale. The more detailed and site-specific interpretations necessary for detailed planning could be obtained from more detailed mapping.

Garry Oak Communities

Garry oak communities once characterized a significant portion of the Capital Regional District. Although more extensive in the Pacific coast States further south, their principal development in British Columbia was in this District where oak together with the associated carpet of flowers in spring formed an essentially unique plant community in British Columbia and Canada. These oak communities provided excellent homesites for the native Indian population, contrasting with the continuous, sombre coniferous forest covering the remainder

of Vancouver Island. The attractions of the oak parkland led to the early establishment of a Hudson's Bay fort and subsequently to a city. Thus the oak communities have special significance both for today's landscape and because of their historical associations.

Two principal subtypes, an Oak-grass parkland restricted to the drier sector and an Oak-shrub community of scrub forest occurring at lower elevations in most parts of the region in rock outcrop situations, are included within the Garry oak map unit. The scrub community in particular, can be especially endowed with a great diversity of spring flowering bulbs. The predominance of oak in the deeper soils of the parklands may well have been due to selective pressure or removal of other species, principally Douglas fir, both pre and post colonial settlement. The occurrence of the oak parkland in the drier portion of the District means that in its native condition it has been largely obliterated by urbanization. Some impression of "oak parkland" remains in moderate density urban developments and golf courses but continued apartment development and landscaping gardens and parks with tall growing exotic conifers could hasten the demise of even this vestigial impression. Origianlly some oak-parkland sites were suitable for agriculture but little if any of this usuage remains.

Arbutus-Douglas fir and Arbutus-lodgepole pine-Douglas fir Communities

Arbutus is nearly as unique as Garry oak in Canada, although its occupancy of somewhat wetter environments gives it a greater distribution along the east coast of Vancouver Island. Arubtus-Douglas fir communities occupy rocky sites in the lower elevation portions of the District. The relative propotion of Douglas fir and arbutus depend largely on the history and stage in development of stands. Selective pressures on Douglas fir may leave a high proportion of arbutus and conversely long periods without disturbance may reduce the frequency of arbutus. Many stands form an attractive parklike mixture with ocean spray, dogtooth lily, polypody fern and stone crop, the characteristic species of the shrub and herb layer.

In drier areas Arbutus-Douglas fir stands include a significant proportion of oak. Intergrades consequently consisting of Garry oak-arbutus and Arbutus-Garry oak communities have been mapped according to the prevalence of each species. Douglas fir is or was present in these transitional communities.

At higher elevations, for example in the Highland District, lodgepole pine occurs together with arbutus and Douglas fir on the shallow rocky soils of hilltops and steep slopes. The dryness of such sites result in the pine as well as the Douglas fir being relatively stunted which may add rather than detract from its aesthetic appeal. Shrubs and attractive flowering plants likewise form components of this community.

Salal-lichen Communities

The uppermost elevations in the Census Area, the exposed hilltops of the Watershed, form the habitat for a community comprising rock outcrops carpeted by lichens and mosses interspersed with low growing salal (Gaultheria shallon) in shallow-to-bedrock soils. The principal trees are Douglas fir and logepole pine which may assume an almost shorepine configuration in such exposed locations.

Salal-Oregon grape Communities

Salal and oregon grape (Mahonia hervosa) constitute the characteristic undergrowth shrubs of the most prevalent forested communities. They are most prevalent both because they occupy sites of intermediate condition and because they have been less disturbed by urbanization and agriculture than other sites. Mapped in this type are both Szczawinski's Gaultheria shallon-Pseudotsuga menziesii and Eurynchium oreganum-Pseudotsuga menziesii (Moss-Douglas fir) communities because they could not be adequately differentiated on aerial photographs. Szczawinski indicates that the Gaultheria-Pseudotsuga community forms a dry, open forest community with Douglas fir the predominant tree and salal, honeysuckle, rattlesnake plantain, lady's-slipper and coral root the most important components of shrub and herb layers. The Eurhynchium-Pseudotsuga community forms a denser Douglas fir forest with Oregon grape in the shrub layer and Eurynchium oreganum and Hylocomium splendeus (feather moss) forming a carpet of mosses on the ground. In wetter areas such as the Watershed, the Salal-Oregon grape community while likewise dominated by Douglas fir may also include some hemlock and cedar and is more appropriately referred to the Douglas fir-salal association investigated by McMinn (1960) on Vancouver Island and Eis (1962) on the north shore mountains on the lower mainland of British Columbia. This map type occurs on a variety of soil types ranging from glacial till on slopes through coarse textured gravels on level terrain.

Swordfern, Swordfern-salal and Swordfern-hemlock-fir Communities

Lush swordfern (Polystechum minitum) grows where permanent seepage keeps soils moist throughout the growing season. Veteran

Douglas fir trees of considerable stature constitute the principal tree cover of some stands of the swordfern community, although western red cedar and grand fir may be common. In poorly drained sites on marine clays, grand fir is the predominant tree and little Douglas fir is present. Red alder may be the dominant tree in early stages of forest growth after disturbance. Undergrowth species include such herbs as may leaves, trillium and foam flower. The duff layer is commonly only sparsely carpeted with mosses except in wet patches.

In drier locations where seepage is only seasonal, the swordfern is not so lush and occurs with an admixture of salal in the shrub layer. Such sites are less productive for forestry but the stature of the Douglas fir is still impressive.

At higher elevations, in the wetter climate of the Greater Victoria Watershed, seepage enriched topographic situations, such as the base of slopes, may be moist to wet throughout the year. Hemlock may occur as commonly as Douglas fir and cedar. Mosses are common. These are productive forest sites, although they may be poorly stocked in the natural state.

Black cottonwood-crab apple-willow Communities

This community occurs in depressions and poorly drained parts of valley floors which flood during the winter. It has been reduced to remnants and disturbed fragments because of agricultural usage.

Wetland Communities

The several wetland communities of the Region were not differentiated at this scale of mapping. They range from Alder-Skunk cabbage communities (Alnus rubra - Lysichetum americanum) in rich muck soils where seepage keep the site moist throughout the year to peatmoss (Sphagnum spp.) communities with stunted lodgepole pine. Also included are shrubby communities of crabapple and willow and open sedge communities.

INTERPRETATIONS[1]

The native plant communities have been interpreted in terms of suitability for residential, recreational and greenbelt use and their need for preservation because of uniqueness, rareness, and cultural significance (scientific and aesthetic values). Forestry and agriculture are mentioned only incidentally because these are the subject of other chapters. The interpretations made must be considered tentative because they have not been the subject of back-

[1]Based on information suppled by Dr. H.L. Roemer, Biology Department, University of Victoria.

ground research. Throughout the Regional District, there are localized occurrences of precious vegetation which have not been included in this inventory. More precise inventories and interpretations could result from more detailed studies.

Garry Oak Communities

Oak Parkland

1. Residential Suitability. While very suitable, further high density development would diminish the parkland impression still remaining. Exotic plantings may likewise detract from the native parkland impression.
2. Suitability for Recreation Use, Carrying Capacity and Management. Very suitable, especially in a semi-natural state e.g. playgrounds and golf courses. Carrying capacity is high in the semi-natural state but only moderate if the natural state is to be maintained. Walking trails are necessary for maintenance of the native ground flora. The difference between Beacon Hill and Uplands Park is indicative of this necessity. Liming and fertilizing should be avoided and mowing delayed until August. While grass fires may enhance most of the spring flowers, especially camas, they also encourage encroachment by broom.
3. Suitability for Greenbelt. Ideal with no buffer zone necessary to maintain the community in a relatively natural state. The overall impression of oak parkland can be retained or reconstructed by the avoidance of tall growing or exotic conifers which exceed the canopy level of the oak.
4. Need for Preservation. The scarcity of this community in its natural states renders consideration of preservation almost academic. Where it is present (e.g. Uplands Park) considerable attention seems warranted.

Oak Scrub Forest

1. Residential Suitability. Suitable but construction and servicing may be impeded by rocky ground. The use of such hilltop sites for residences should be carefully considered from all aspects of development.
2. Suitability for Recreational Use, Carrying Capacity and Management. Good for parks when trails can be maintained. Carrying capacity is low to moderate because visitors should be restricted to trails if the natural state is to be maintained. Rock outcrop vegetation

is easily damaged by trampling and horseback riding. This community is subject to invasion by broom which requires control if the native plant values are not to be reduced.

3. Suitability for Greenbelt. Very suitable for greenbelts of any size, including those of small size. No buffer zone is necessary. Conventional residential landscaping reduces the natural aesthetic appeal.
4. Need for Preservation. Limited examples of this community in a natural condition still exist (e.g. Seymour Hill in Thetis Lake Sanctuary). Protection, including prohibition of grazing, is necessary if wildflower populations are to be maintained.

Arbutus-Douglas fir Communities

1. Residential Suitability. Although this community is considered to be of a high quality for residential use, development may be costly because of the rocky terrain.
2. Suitability for Recreation Use, Carrying Capacity and Management. This type is attractive for hiking and strolling because walking is not impeded by obstructing shrubs. This ease of traverse is however, a liability if the natural state is to be maintained because the wildflowers and moss on the rocks are easily damaged by trampling. Carrying capacity consequently is low unless trails are adhered to. Degraded forms, without abundant wildflowers, resulting from grazing are tolerant of greater use. Grazing and human disturbance may increase the abundance of Garry oak in the long term.
3. Suitability for Greenbelt. Buffer strips are usually unnecessary to provide windfirmness, but the sensitive wildflowers must be protected from excessive access. The overall character of the type can be maintained even with some residential development provided the original trees are preserved.
4. Need for Preservation. A number of extremely attractive wildflowers (e.g. easter lily, shooting star, lady's slipper) are abundant in these communities. While immediate danger of losing these communities is not great, the number of stands in good natural condition is not unlimited.

Salal-lichen Communities

These hilltop communities are currently quite remote and are under no immediate pressure. The mosses and lichens growing on rock outcrops in this community are intolerant of trampling. Should greater access to the Watershed for recreation purpose occur, trails in such communities will eventually be required to preserve them in their natural state.

Salal-Oregon grape Communities

1. Residential Suitability. These communities probably offer the least physical obstruction for residential development. Although retention in their natural state is not compatible with moderate to high density development, loss of these communities probably represents the smallest social cost of any of the mapped types. Like any other closed coniferous community these types are rather unstable after opening up. Wind damage and invasion by weeds and shrubs due to changes in light and microclimate are unavoidable around clearings. Such disturbed forest types may be unsightly and unsafe for several years after partial clearing, so that the alternatives appear to be total clearing or very large lots. Exceptions are young stands or areas which have been grazed for many years and are already parklike.
2. Suitability for Recreational Use, Carrying Capacity, Management. In their natural state these communities are probably less attractive than the preceeding types because of the density of the evergreen shrub layer. A good trail system is necessary for easy traverse. Mature trees can provide an aesthetic background for hiking and horseback trails. Carrying capacity is largely dependent on the provision of trails.
3. Suitability for Greenbelt. A buffer area may be needed because trees may be unstable when these sites are opened up. This type is likely to be sufficiently productive that woodlots could have commercial as well as aesthetic value. Woodlots should be of sufficient size and appropriate shape for windfirmness.
4. Need for Preservation. These communities are less valuable and more common than other types, although a selection of mature stands would be an asset to the District. Rare species do not occur in these units.

N A T I V E P L A N T C O M M U N I T I E S

O - Garry oak on dry rocky hilltops or on deeper soils following selective removal of other trees.

O-A - Garry oak - arbutus transition.

A-O - Arbutus - Garry oak transition.

A - Arbutus - Douglas fir on steep rocky slopes at lower elevations.

L - Salal - lichen at higher elevations on exposed bedrock sites which are dry in summer.

Ap - Arbutus - Lodgepole pine - Douglas fir on hilltops and steep slopes at higher elevations.

S - Salal - Oregon grape on well drained glacial soils on slopes and on level coarse textured soils.

P-S - Swordfern - salal on sites with seepage which may be absent in summer.

P - Swordfern on sites with permanent seepage.

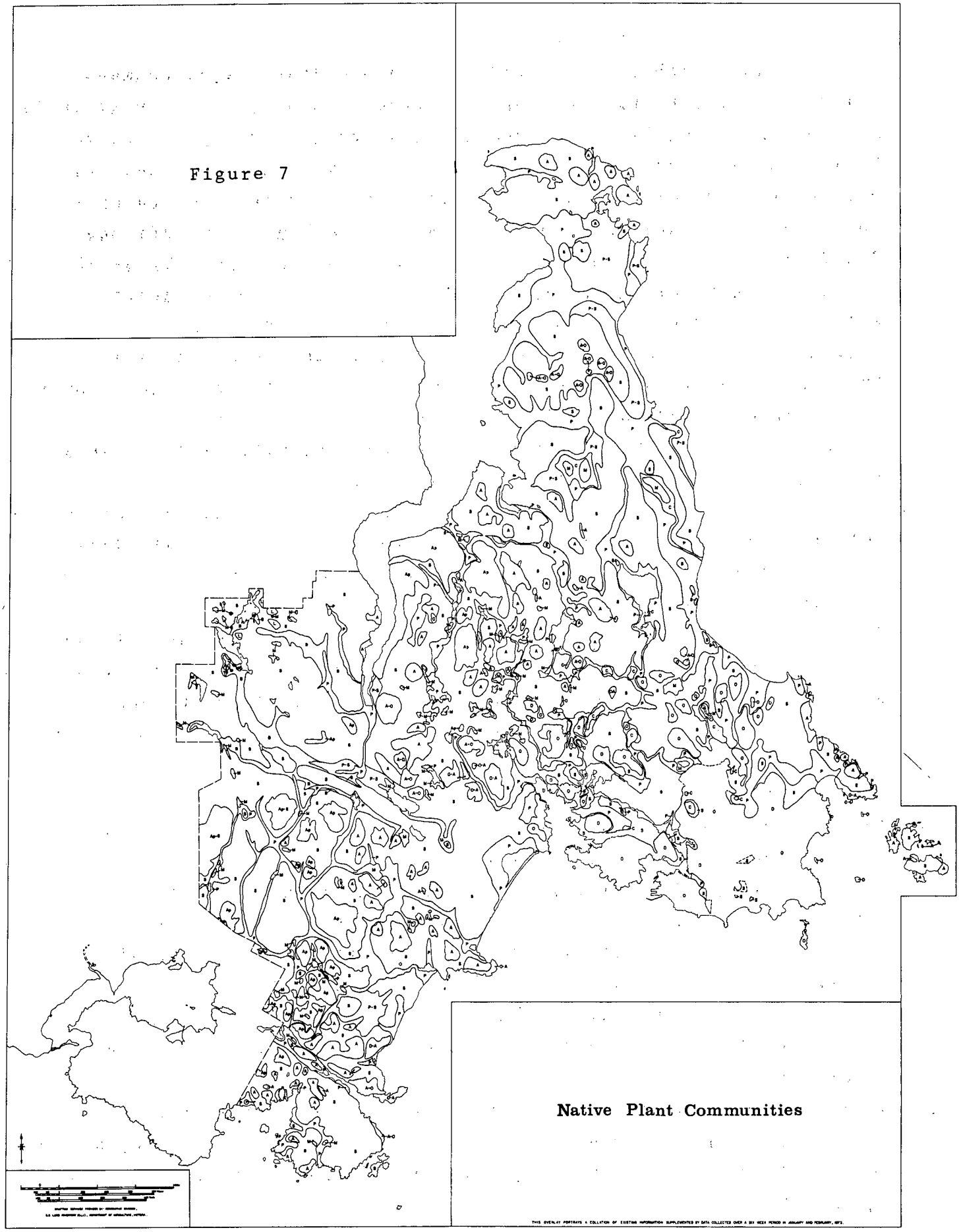
B - Swordfern - hemlock - amabilis fir on higher elevation sites with permanent seepage.

C - Black cottonwood - crab apple - willow on sites which flood in winter.

M - Skunk cabbage - peat moss swamps.

Prepared by: Pacific Forest Research Centre, Canadian Forestry Service, Victoria, B.C.

Figure 7



Native Plant Communities

Swordfern Communities

1. Residential Suitability. Swordfern and Swordfern-salal communities indicate the presence of no appreciable obstacle to residential development. Conflicts because of forestry or farming values may be indicated because these are sites with high forest capability. The understory vegetation is relatively intolerant of disturbance and because of their stature, trees may be lacking in windfirmness. Grand fir in moist sites may be especially vulnerable. Trees in the wet, higher elevation type are also likely to be unstable.
2. Suitability for Recreation, Carrying Capacity and Management. Typically these communities are more traversible than the salal types because of the absence of shrubs layers. Their ferns however are fragile. Carrying capacity consequently is related to trail frequency. Large trees in these types are aesthetically valuable as a backdrop for hiking and horseback trails.
3. Suitability for Greenbelt. A buffer zone is needed if the relatively delicate understory vegetation is to remain in the natural state. Windfirmness may be a problem in small patches and the understory may be invaded by shrubs making access more difficult.
4. Need for Preservation. Although a common type on Vancouver Island and the lower Mainland, logging and agriculture has reduced the area of this type in the virgin state. Their lush growth and spectacular tree sizes indicate that undisturbed stands merit consideration for preservation.

Black Cottonwood-crabapple-willow Community

1. Residential Suitability. Suitability is poor because of seasonal flooding and high agricultural potential.
2. Suitability for Recreational Use. Unsuitable in original form, but when cleared, temporary winter ponds may be valuable for skating. As part of the varied landscape they may be valuable for educational purposes and as wildlife observation sites.
3. Suitability for Greenbelt. Where remaining, examples of this community add to the diversity of landscapes and are of ecological significance.
4. Need for Preservation. One of the rare communities of the Saanich Peninsula. Conservation is of aesthetic and scientific interest. In the cleared state, this type is valuable for waterfowl in winter.

Wetland Communities

Skunk Cabbage Community

1. Residential Suitability. Unsuitable because of wet soils and instability on slopes.
2. Suitability for Recreational Use. Suitable for hiking and nature study if log walks are provided. Carrying capacity is low because of the necessity of maintaining log walks.
3. Suitability for Greenbelt. Suitable where present, but generally of limited extent.
4. Need for Preservation. The lush growth of plants such as skunk cabbage, ladyfern, horsetails, trillium make this an interesting community meriting preservation to maintain the diversity of landscapes. The springs originating in these sites may be of ecological significance.

Lodgepole Pine-Labrador Tea-Peatmoss; Sedge Meadow; and Willow-Hardhack Communities.

Of the seven Lodgepole pine-peatmoss bogs formerly in the Saanich Peninsula, only two remain, Rithet's and Goldstream. These merit protection because of their relict nature and the rare plants they contain. Most of the local bog, marsh and stream communities have features of ecological significance within their drainage systems. For example, conversion of wetlands into agricultural lands can lead to eutrophication of streams. Marshes along the midsection of streams can be effective moderators of floods.

Swamp communities have no forestry or agricultural potential unless drained.

1. Residential Suitability. Unsuitable without complete destruction of the natural environment.
2. Recreation Use. Restricted to viewing from the margins unless some form of walk (e.g. logs) is provided because wetland communities are very susceptible to damage.
3. Suitability for Greenbelt. Bogs and marshes add to the diversity of rural landscapes. In addition, their ecological importance and their poor suitability for other uses makes them desirable for inclusion in greenbelts.
4. Need for Preservation. Most wetland areas have concentrations of botanical rarities. A detailed inventory would be necessary to

pinpoint the most threatened types. However, it appears that in all still intact wetland communities, the benefits from agriculture or other types of development would not outweigh the ecological, hydrological, scientific and aesthetic losses.

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TREE COVER TYPES

(Present and Projected Suitability)

J.P. Senyk

The map (Figure 8) attempts to portray present tree cover types and projects types, based on species suitability to site, defined on the basis of surficial materials (taking into account the range of conditions present, i.e. soil texture, drainage, etc.) and climate.

The range of species incorporated in each cover type does not in most cases define the complete range of species present within a particular map unit but rather includes those species that are most abundant and/or are best suited to the range of site conditions most prevalent in that unit (i.e. it is possible that nearly all of the species listed could occur within same units).

An attempt has been made to show the general transition from dry to wetter climates through changes in species composition.

Historically, fires, logging and agricultural land clearing have affected the natural communities and it must be recognized that present vegetation over a large part of the District is the result of "human conditioning", (i.e. "cultural ecosystems").

Time constraints, imposed on researching background information and field checking, allowed for only a broad overview of the area. Most of the information is of a cursory nature which can only be improved and verified through a much more intensive survey.

RECRATION, RESIDENTIAL AND PROTECTION CONSIDERATION

Prime recreation landscapes from the standpoint of aesthetics and use are considered to be those that contain a varies topography, a variety of landforms and associated wetlands (streams, lakes); support a diversity of tree and lesser species and a wide range of age classes and stocking densities; contain uncommon species, are generally devoid of dense understory vegetation and are able to withstand a variety of recreational pursuits without serious damage to their character.

Severe damage to sensitive (intolerant) landscapes (through recreation use) can be controlled by specifying type of recreational pursuits and directing or channeling use to the more stable parts of these particular landscapes through the use of developed trails, campsites etc.

Prime residential landscapes are considered by the author to be those that contain gently to somewhat rolling topography, deep, well drained, permeable soils, a variety of landforms and diverse tree cover (generally favouring slow growing deciduous species with a minor conifer mix). Positions with views of surrounding area, be it land or water, are highly desirable.

In delicate or sensitive landscapes, widely spaced residential development and associated blocks of greeen space will aid in maintaining their overall quality. Careful consideration must be given when manipulating forest cover, be it through logging or clearing for residential development, particularily in watershed areas where both quantity and quality of water are important. The same is true in areas where soils are highly susceptible to erosion. Maintaining quality wildlife habitat is another factor that must be considered.

TOLERANCE TO USE

Because tree cover types are tied directly to specific surficial materials; together forming the major part of the visual landscape, and knowing the growth characteristics of the species and the range of soil conditions existing within the surficial material units, an interpretation of tolerance touse (or sensitivity) of any particular landscape or (map unit) can be made.

The followinggroups are arranged in order of increasing tolerance (decreasing sensitivity) to use, be it recreation or other development.

1. Cover types occuring on very shallow soils over bedrock (minor areas of deeper till) and steep slope colluvium. These include the oak-fir association part of the fir-arbutus-oak transition zone, fir-arbutus (cedar-grand fir), fir-arbutus-lodgepole pine, and fir-lodgepole pine; (moving from dry to wet environments, towards cooler temperatures and higher elevations).

2. Cover types occurring on organic soils. This is the alder-bog community grouping.
3. Cover types occurring on marine clays and alluvium. These include the grand fir-cedar-alder-black cottonwood group, the fir-grand fir-cedar-alder and alder-cedar-fir-grand fir types.
4. Cover types occurring on till and till with minor rock outcrops. These include fir-grand fir-(cedar-arbutus), fir-cedar(arbutus-grand fir), fir-lodgepole pine-grand fir and fir-cedar-hemlock (listed in order from dry to wetter climates).
5. Cover types occurring on gravels. This is the fir (grand fir-cedar-arbutus) type.

By taking one particular map unit, the one that fits the Highlands areas as an example, certain projections on types of use and problems involved can be made. From the above tolerance groupings, the area fits into group #1 (less tolerant).

The tree cover types characterizing this particular landscape is the fir-arbutus (cedar-grand fir). Minor yew, alder, maple and lodgepole pine (in the north) occur and are worth noting.

This unit consists of broken topography, ridge, slope and depression, the ridges generally very shallow to bedrock with shallow to moderately deep colluvium on side slopes and deep, till on lower slopes and in depressions.

Within this unit, fir occurs on shallow to deep, well drained to moderately well drained soils and the arbutus on very shallow, well to excessively drained soils on bedrock and on deeper soils on exposed slopes. Grand fir occurs in moist depressional areas and is transitional to cedar and alder on the wetter sites. (Cedar occurs over a wide range of sites within this unit, generally associated with seepage water). Yew, though not abundant occurs on sites similar to those of fir. Maple prefers relatively moist, deep soils and is often found on lower slopes and depressions, receiving moisture. Lodgepole pine occupies the arbutus niche at higher elevations in the northern part of the unit.

Except on the deeper soils which are a minor portion of this unit, tree roots are generally restricted by bedrock. In general trees growing on these shallow soils are not vigorous and are likely more susceptible to insect or disease attack, than trees growing on better sites.

TREE COVER TYPE
(PRESENT AND PROJECTED SUITABILITY)

1. Garry oak, Douglas fir.
2. Douglas fir, arbutus, Garry oak.
3. Douglas fir, arbutus, (grand fir, western red cedar).
4. Douglas fir, arbutus, lodgepole pine.
5. Douglas fir, lodgepole pine (arbutus).
6. Douglas fir, (lodgepole pine, grand fir)
7. Douglas fir, grand fir, (western red cedar, arbutus).
8. Douglas fir, western red cedar, arbutus (grand fir).
9. Douglas fir, western red cedar, western hemlock.
10. Douglas fir, grand fir, western red cedar, red alder.
11. Grand fir, western red cedar, red alder, black cottonwood.
12. Red alder, western red cedar, Douglas fir, grand fir.
13. Black cottonwood, alder (bog communities).

Other tree species often found growing in association with the above groups are: big leaf maple, western flowering dogwood, western yew, western white pine, Pacific crab apple and Sitka spruce (now quite rare).

Prepared by: Pacific Forest Research Centre, Canadian Forestry Service, Victoria, B.C.

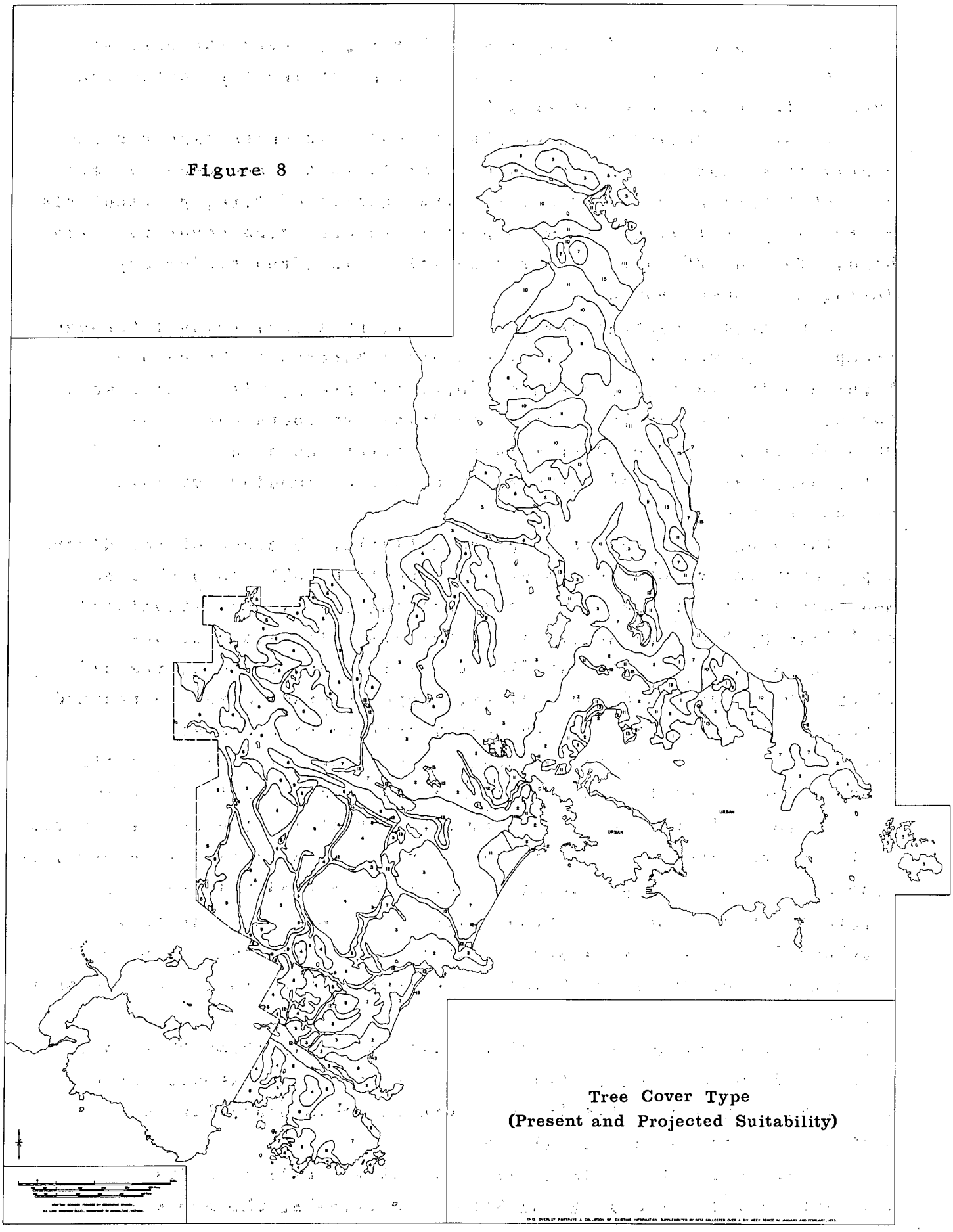


Figure 8
URBAN
URBAN
Tree Cover Type
(Present and Projected Suitability)

Extended period of drought will hit these areas the hardest, either killing individual trees outright or at least predisposing them to insect and disease attack.

Windthrow hazard on these shallow soils is quite high particularly if stands are opened quickly, or if roots have been damaged through trampling or other means. The chances of fire, particularly on the very shallow soils, with associated open tree cover is quite high. The "duff" layer in these positions is often tinder dry during the summer months.

Long term, physical damage to soils, by actual removal through trampling can result if these areas are subjected to heavy use. Trees growing in poorly drained, "wetland" areas, with a high water table, are often shallow rooted and damage to roots can result through trampling. Windthrow in these areas can be a problem if large areas of tree cover are removed in the immediate vicinity of such stands.

The area is quite pleasing aesthetically, because of the diverse topography and vegetative cover. It should be able to withstand moderately heavy recreation use if walking trails are established. By following the more stable landform-vegetation associations (i.e. deep soils, relatively flat terrrain, deeply rooted trees) along lower slopes and depressions, properly brushed and maintained trails will confine most of the heavy traffic to these areas. Tightly controlled passage through the shallow soil - arbutus-fir association and of the wetland communities should do little harm.

In the opinion of the author, residential development is limited by topography and rockiness of the terrain and only extensive development should be contemplated with a minimum of road building and clearing. Manipulation of tree cover, i.e. removing overstory Douglas-fir and promoting arbutus will enhance the quality as well as removing the windthrow hazard that is likely to result when stands are opened.

The above is an example of the type of information that could be derived for each cover type portrayed on the map sheet. Such information is particularily pertinent to areas where land use patterns are not well established.

In areas where the land use patterns are well established, i.e. agricultural lands on the Saanich Peninsula, the map projects

tree cover types based on species suitability to site. The possiblity exists of enhancing the visual and sensory experience associated with pastoral settings by planting green belts and noise and view buffers. Some marginal farmland could be planted to farm woodlots providing recreational areas and wildlife habitat as well as an economic return.

These ideas may soundabstract at present but changing values over time may indeed make them quite meaningful.

FOREST CAPABILITY

H. Hirvonen

INTRODUCTION

All mineral and organic soils are divided into four classes based upon their inherent ability to grow commercial timber (see Figure 9). The important factors basic to this classification are:

- -Known or inferred information about the unit such as soil profile, depth, moisture, parent material, landform, climate and vegetation.
- -Associated with each division is a productivity range based on the mean annual increment of douglas-fir (Black Cottonwood in rare instances) at or near a rotation age of 100 years (50 years for black cottonwood). The productivity rating is for normal, i.e. fully stocked, stands. It may be assumed that only good management would have produced stands of this nature.
- -Forest productivity data were gathered and analyzed utilizing the procedures outlined by R.C. Kowall in "Methodology-Land Capability for Forestry in British Columbia".
- -The following are not considered: location, access, distance to markets, size of units, ownership, present state (large urban areas are not classified) or special crops such as Christmas trees.

Douglas fir was chosen as the main indicator species because under most site conditions within the regional district it out produces the other naturally occurring commercial species. In addition, for units where, for example, western red cedar or western hemlock may outproduce Douglas fir, the lack of suitable stands prevented evaluation of the capability of such units to produce these species.

Black cottonwood is the only other indicator species used. Its use is restricted to the rating of certain units which are characterized by a high water table for much of the year and are subject to periodic flooding. The potential of black cottonwood to attain higher productivities than species such as red alder and

CLZ Class 1a 191 to 170 ft³/acre/year
1c 171 to 190 " "
b 151 to 170
a 131 to 150
1 111 to 130
2 91 to 110
3 71 to 90
4 51 to 70
5 31 to 50
6
7 < 10

F O R E S T C A P A B I L I T Y

CLZ 1b,c,d E - Lands having an excellent capability for forestry - productivities greater than 150 cubic feet per acre per year can be expected.

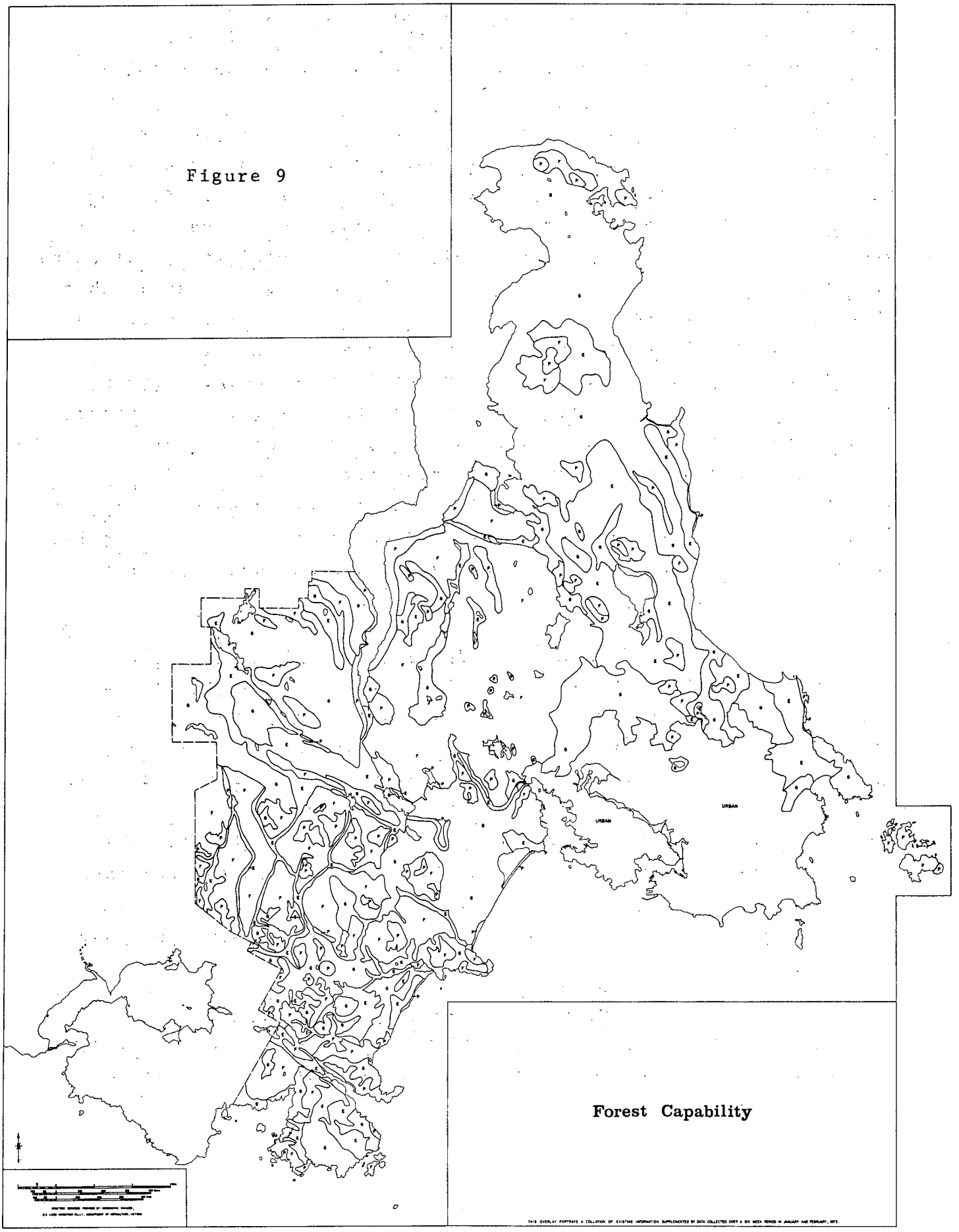
CLZ 1,1a,2G - Lands having a good capability for forestry - productivities between 90 and 150 cubic feet per acre per year can be expected with the medium to coarse textured soils generally faring better than the marine clays.

CLI 3+4 F - Lands having a fair capability for forestry - productivities will usually be from 51 to 90 cubic feet per acre per year on the shallow soils and somewhat higher on the deeper till pockets.

CLI 5,6,7 P - Lands having a poor capability for forestry - generally productivities of no more than 50 cubic feet per acre per year can be expected.

Prepared by: Pacific Forest Research Centre, Canada Forestry Service, Victoria, B.C.

Figure 9



western red cedar on these sites and the inability of Douglas-fir to endure periodic inundations prompted its use as an indicator species.

The very moist organic units are generally unproductive for forestry purposes and are rated as poor sites for forest capability. However, many of the moist but fairly well drained, alluvial bottomlands presently supporting stands of red alder and western red cedar are rated as having high and very high forest capabilities utilizing Douglas-fir as the indicator species. The continuous seepage that these bottomlands receive, coupled with the coarse texture of the soils present, allows for high productivities to occur.

It is recognized that for any specific site, Douglas-fir may be surpassed in productivity by a more suitable species. However, at the scale of this inventory coupled with the lack of suitable stands of other species from which productivity data could be obtained, the choice of Douglas-fir as an indicator species of forest capability should provide a good assessment of the potential productivity that can be found in the Capital Regional District.

DESCRIPTIVE RESUMÉ OF FOREST CAPABILITY CLASSES

Lands Having an Excellent Capability for Forestry (E)

Lands with deep, medium textured (gravelly sandy loam) soils developed from coarse textured glacial tills, alluvium or gravel. They frequently receive seepage and nutrients from adjacent areas and their soils are moderately well-drained to imperfectly drained (on alluvial bottomlands) and have good water-holding capacities. Temperatures and evapotranspiration rates are not extreme. There are no limitations to forest productivity other than the regional climate.

Producitivites greater than 150 cubic feet per acre per year can be expected.

Lands Having Good Capability for Forestry (G)

Lands with either deep soils of medium to fine texture (sandy clay loam to clay loam) developed on marine materials or cappings

of marine clays over coarse-textured glacial tills, or in other areas, soils with sandy loam to loamy sand textures over coarse-textured glacial tills. The medium to fine textured soils are moderately well-drained and have good water-holding capacity. The soils of other areas are associated with minor components of bedrock outcrops.

The most common limitations (all of a relatively slight nature) to forest productivity are restricted rooting depth resulting from dense or consolidated soil layers in the marine areas and soil moisture deficiencies during the May to October growing season.

Productivities from 90 to 150 cubic feet per acre per year can be expected. The medium to coarse textured soils are generally more productive than the marine clays.

Lands Having Fair Capability for Forestry (F)

Soils are generally shallow to bedrock with deeper soils occurring as pockets of coarse textured glacial till interspersed throughout. These deeper till pockets do not constitute more than thirty percent of the area.

The shallow to bedrock soils are generally rapidly drained, coarse-textured with a relatively poor water-holding capacity. The deeper pockets of till receive seepage from the adjacent slopes and are generally moderately-well-drained. Such pockets have a higher potential productivity than adjacent shallow to bedrock units.

The most common limitations are restriction of the rooting zone by bedrock, soil moisture deficiency and exposure on some coastal areas.

Productivities will usually be from 51 to 90 cubic feet per acre per year on the shallow soils with productivities ranging up to 130 cubic feet per acre per year on the pockets of deeper till.

Lands Having Poor Capability for Forestry (P)

Mineral soils are frequently shallow, excessively drained and coarse textured. Organic soils are poorly drained and generally inundated during the winter.

Included in this category are major rock outcrops, areas with very shallow soils, highly exposed units along the coast, coastal

beach deposits, tidal flats and deep organic soils.

The most common limitations (frequently in combination) are shallowness to bedrock, deficiency or excess of soil moisture and inundation.

Moderate to high productivities may occur in receiving pockets between bedrock units. Such sites however, form an inconsequential percentage of the total unit. Generally, productivities of no more than 50 cubic feet per acre per year can be expected.

LANDSCAPE PARAMETERS AND INTERPRETATIONS

E.B. Wiken

SUMMARY OF PROBLEMS RELATED TO SOIL CHARACTERISTICS

This section describes and summarizes the significant soil features and related factors that should aid in the planning of urban and non-urban developments. Since this report provides only general soil information it is particularly important that the maps (See Figures 11 - 16) be correctly interpreted and supplemented with research where necessary to achieve maximum usefulness.

One of the most conspicuous and important factors governing land use suitability is the nature of the landscape. Topography and soil in relation to its physical and chemical composition have an important influence on the cost of installing the necessary services that accompany the change from a rural or wild state to an urban community. In particular, characteristics of soil stability and drainage determine to some extent the type of development most suited to the inherent soil characteristics. A few of the natural limiting factors are indicated below.

Urbanization is accompanied by ground surface changes and increased rates of water runoff. These, in turn greatly intensify the potential for soil erosion, especially in areas that have been stripped of the protective vegetative cover. Even though the erosion of soil material cannot be completely avoided during construction, preventative measures should be considered to reduce or abate erosion losses in susceptible areas. Otherwise, the sedimentation in ditches and drains will cause a needless maintenance expense to municipalities.

The ability to support structures, and the ease and cost of maintaining them, varies according to soil characteristics. Cracking or subsidence of foundations are common occurrences where homesites are located on certain clay deposits which are subject to periods of wetness. Soil stability interpretations cover a broad grouping of soil materials that should aid in illustrating possible problem areas requiring on site investigation and evaluation by planners and engineers.

Ponding and flooding are directly related to soil characteristics and natural drainage systems. Areas subject to ponding are usually natural depressions lacking adequate drainage outlets. They may drain relatively quickly or hold water intermittently depending on the kind of soil and subsoil. Areas adjacent to major streams that periodically overflow their natural channels are subject to flooding. A careful soil evaluation combined with knowledge of the natural drainage systems will reveal sites where water damage is most likely to occur. Development in these susceptible areas should recognize the potential hazards and planning should encourage developments which will result in minimized damage (i.e. agricultural, wetland wildlife habitats, recreational, non-residential).

Much reliance has been placed on percolation tests in estimating the suitability of soil materials for subsurface sewage disposal. These have not proven to be entirely satisfactory. Septic tank effluent disposal fields must be placed in a soil that drains adequately, filters sufficiently and oxidates effectively. The total area of the Capital Regional District has some form of limitation insofar as the safe disposal of effluent is concerned. In areas not subject to ponding and flooding or steep slopes, the main problems are soil materials with high clay content (these types transmit water very slowly when saturated), impermeable subsoil layers, and insufficiency in both the quantity of soil fines (clay, silt) for adequate filtering and the volume of soil material for filter beds. Under these natural landscape limitations, the quality of ground and surface water will deteriorate especially when septic tanks become too numerous. Figure 10 shows textural composition for silts, clays, sands, etc.

Turning to agricultural lands, much of the region includes good to excellent agricultural soils (Canada Land Inventory Classes 1 to 4 including irrigated ratings*). These are predominantly restricted to areas outside the mountainous terrain. Although farmland has and is undergoing a piecemeal depletion due to urban

*See: The Canada Land Inventory, Soil Capability Classification for Agriculture, Report No. 2, Lands Directorate, Dept. of Environment, Ottawa, 1965.
Note also that in British Columbia, both dryland and irrigated ratings are mapped. Similarily, organic soils have been assigned a capability rating for natural conditions and under drainage.

development, the potential for expansion of croplands still exists. Future increases in agricultural productivity could be achieved through more intensive management and increased use of fertilizer and irrigation as well as by increasing the variety of crops.

Too often the natural limiting factors are neglected. A careful evaluation of the natural landscape from a planning and engineering viewpoint will relate topography, drainage systems and kinds of soil, as to its natural suitability for a variety of uses. These features will then determine to an important extent the least cost in terms of development and environmental impact.

SOIL DATA AND LANDSCAPE PARAMETERS

Introduction

The main focus of this study was to present a generalized analysis and correlation of such features as soils, landforms, geology and surface drainage. It does not replace on-site evaluations for intensive land uses, but it gives an indication of the degree of suitability for various land uses.

General Geologic and Landscape Features

The succession of geologic events (especially glaciation) and the nature of the bedrock have markedly influenced the form and location of land features. Although the last glacier receded about 10,000 years ago, the consequent landforms are sufficiently well developed to influence the pattern and type of urban and rural development.

Features such as mountains, hills and depressional wetlands can impose dominating restrictions over the suitability of land for a variety of uses. Outwash gravels have provided stable sites for urban development as well as supplying a valuable source of coarse materials for construction purposes. The marine clay deposits associated with the lowland areas have low permeabilities and poor internal drainage for the practical design of septic tank disposal systems. Additionally, these deposits are often unstable materials for building foundations without proper drainage. Mountainous areas offer attractive views and provide a wide variety of building sites.

The study area can be divided into four broad physiographic regions corresponding to natural surface[1] materials, (exclusive of

[1] Appreciation is extended to C. Halstead, Geological Survey of Canada, Vancouver, for providing an unpublished surficial material map for North and South Saanich.

living plants) and to the relative flatness or steepness of the topography.

1. The largest is the mountainous Highland and Goldstream region. These are composed chiefly of a variety of fractured volcanics[2] (basalts, andesites, etc.) and metamorphics (gneissic diorite). Some minor sedimentary formations occur on the northernmost tip (Cloake Hill) of Saanich Peninsula. The topography is moderately rugged ranging up to 800 feet in the Metchosin area and up to 1300 - 1800 feet in the Highland and Goldstream area. Outcrops of bedrock are common on high peaks and steep slopes.
2. The second largest area is comprised of nearly level to gently rolling marine deposits. These silts and clays are mainly associated with the lowland areas of Saanich, Victoria, and Metchosin.
3. Adjacent to Elk Lake and the central portion of the Goldstream River there occurs gently to strongly rolling till deposits (heterogenous mixtures of sand, silt, clay, and rocks).
4. In the Langford-Colwood and Happy Valley area, relatively level outwash and alluvial deposits occur and coarse sands and gravels are common.

Soil Characteristics In Relation to Surficial Materials

The variable nature of surface materials within these regions, combined with natural drainage, climate and topography give rise to many kinds of soils. For the purpose and constraints of this study, the term surficial materials was used to designate a broad grouping of soils[3] that respond in similar ways to manipulation and development.

Some of the factors used to differentiate these groups are: the relative proportions of sand, silt and clay, and how these particles aggregate; the general acidity level of each area; the arrangement and thickness of different layers in the soil; the presence or absence of bedrock, or restricting substratum materials and the fluctuations of the water table.

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[2] J.E. Muller, 1971, Geological Reconnaissance Map of Vancouver Island and Gulf Islands, Geological Survey of Canada.

[3] Appreciation is extended to T.M. Lord, Canada Department of Agriculture, Vancouver, for field checking in North and South Saanich.

TEXTURAL CLASSIFICATION

Department of Agriculture

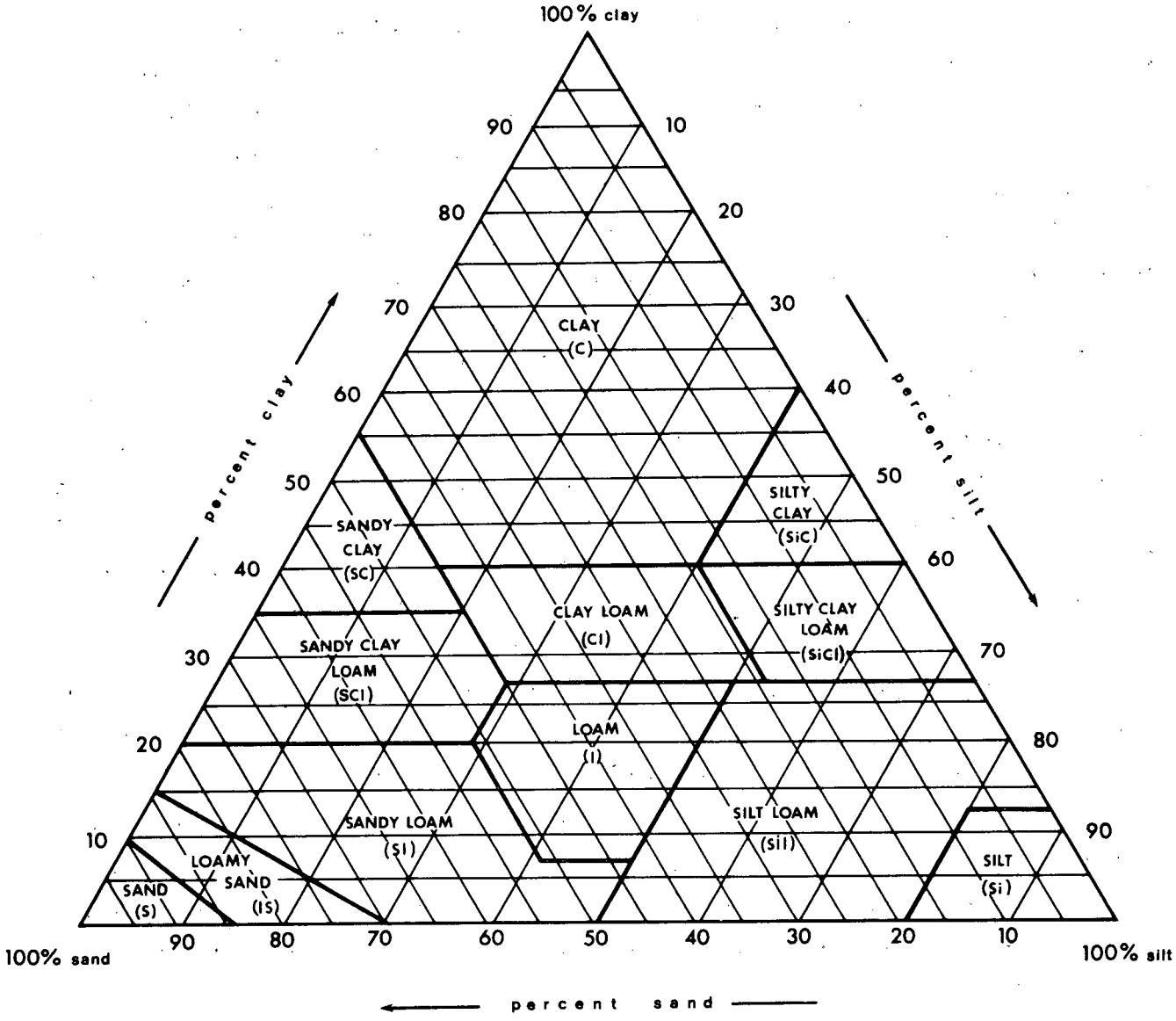

FIGURE 10

The broad material groupings consist of organics, clay, till alluvium, gravels, colluvium (loose and incoherent deposits, usually at the foot of a cliff, brought there chiefly by gravity), rocks and miscellaneous materials (beach deposits, coastal bluff deposits).

The organic soils (swamps, peat bogs, etc.) occupy closed depressions. These areas tend to have high water tables throughout the year. Peat-like soils (1)* are mainly undecomposed plant parts formed from sedges moss and woody vegetation. Muck soils (1a) occur mainly in the lowland marine clay area. These are composed of shallow deposits of unrecognizable plant remains overlying mineral deposits similar in texture to the soils on the adjacent uplands.

The marine clay deposits occupy nearly level plains and slight depressions within the coastal lowlands. Subsoils are generally compact and semi-impervious to water. This condition promotes lateral subsurface flow of water. Many of the poorly drained clay loam soils (2) occupy the lower positions where large amounts of runoff water are received and ponded on the subsoil. The adjacent upland clay soils (2b) tend to be somewhat better drained and often overly till deposits to varying depths. Other poorly drained soils (2a) are developed on medium textured marine materials underlain by semi-impervious marine clay.

The topography of the deep till deposits is undulating to hilly (3), and steep (3a) along some parts of the valley side. These soils are well to moderately well drained coarse textured materials formed in glacial till. They are characterized by 1 1/2 to 2 feet of pervious gravelly sandy loam over a compact semi-impervious gravelly sandy loam till. Lateral movement of water over the semi-impervious subsoil is common during the winter and early spring. Often these soils are associated with areas (4,5) shallow or deep to bedrock.

The alluvial sediments consist of deep, well to poorly drained, coarse (6) to medium (6a) textured soils. They are nearly level areas close to the major streams. The upland areas enclosed by

*Numbers refer to units on the surficial material map, Figure 11

unit (6) have unfortunately been exaggerated area wise and might better be described as an accumulation of coarse textured alluvial and colluvial material often overlying pockets of glacial till or bedrock. When streams emerge into bays or lagoons they often form a mixed deposit (7) of organic and mineral material. These are saline areas which are generally exposed at low tide and flooded during high tide.

Associated with gravel deposits (8) are deep, well to excessively drained, coarse and moderately coarse textured soils developed in sand or interstratified sand and gravel outwash materials. They occupy almost level glacial outwash fans or terraces, and in a few places, steep slopes.

Colluvial deposits occur on or at the foot of strongly sloping rock faces. These materials consist of gravel or coarse rock fragments that have accumulated as a result of the downslope movement of weathered rock.

Shallow soils (2 or 3 feet) over bedrock (10a, 11a, 11b) and those areas with steep slopes and rock outcrops (10, 11) are common in the Highland and Goldstream Mountains. In contrast, the Thetis Lake area has low relief characterized by well drained knolls and wet depressions (11b). The shallow soils common to the well drained positions of both areas are pervious to subsurface overland water flow.

The coastal bluff (12) topography is very steeply sloping and the soil mantle is variable. Coastal beaches (13) are composed of sand and gravel, having variable drainage and gentle slopes.

SOIL INTERPRETATION

Introduction

A comprehensive evaluation of the suitabilities of the landscape for urban, agricultural, and conservational uses must consider the natural limiting factors of the environment. The interpretations included in this section are based on soils and other information obtained about the climate, topography, hydrology and geology of the area. Each interpretation is designed to illustrate the natural degree of limitation a site presents for a given land use. These interpretative guides provide for rating sites according to three

degrees of limitations or suitability. Although the terminology for degrees of limitations is not standardized there is similarity in the following terms:

1. Good is comparable to Slight Susceptibility or Few Limitations.
2. Fair is comparable to Moderate Susceptibility or Moderate Limitations.
3. Poor is comparable to High Susceptibility, Severe or Severe Limitations.

Rating of good, few and slight do not require any special planning or management since the restrictions are fairly easy to overcome. Fair or moderate ratings have restrictions that can be overcome with good management or planning. Poor, high and severe ratings indicate that more extensive and more costly measures are required to overcome the natural limitations. Often it is not economical nor feasible to correct severe limitations. An example of using these ratings is in selecting sites for playgrounds. Marshes or peat bogs have severe natural limitations and somewhat poorly drained soils on hilly landscapes may have moderate limitations, whereas well drained flat lying areas have only slight limitations.

The interpretative guide uses only natural factors as criteria; land values and special construction design are not considered in the rating. In some circumstances the natural limiting factors can be modified or removed so that a site can be used safely for the intended use. Thus, the ultimate decision for specific uses of land should be made by on-site evaluation by planners and developers.

Primary considerations were given to single purpose interpretative maps, each one interpreting the following uses or characteristics: 1) surface erosion potential; 2) soil stability at depths to 6 feet; 3) areas subject to ponding and flooding; 4) suitability for subsurface sewage disposal; and 5) soil capability for agriculture (See List of Figures). Table 4 following, rates each general soil area for the following uses or properties: thickness and source of top soil sand and gravel sources; road fill source; depth to water table; seepage and excavation.

Interpretation For Surface Erosion Potential

Soil materials under a protective vegetative cover experiences very little erosion. Man manipulates and disturbs the vegetative

cover mainly through his urban activities. The most serious are the grading practices of the land for homesites, roads and utilities. The surface erosion rating is intended to predict the relative erodibility of the soil mantle in the absence of vegetative cover.

Erosion is caused by rainfall and runoff water as splashing rain drops or running water moves and displaces soil materials in proportion to the water's volume and velocity. Depositions occur as the water slows down or spreads out. Sediments are often costly to remove from water supplies or storm sewer systems; they can also damage spawning grounds and adversely effect lake oriented developments and recreation.

Evaluations for each degree of limitation must consider soil propertieis, slope length and gradient, seepage characteristics and climate (especially rainfall). Surface erosion potential outlines areas in which sediment abatement practices should be considered during development and construction. Rectifying sediment problems in streams, lakes, rivers and susceptible urban utilities (sewers, reservoirs, etc.) is often an unnecessary and unjustifiable expense to the taxpayer.

Slight Susceptibility

Practically none or very little loss of soil materials is expected. These areas are usually well drained, deep to bedrock, and have only slight erosion potential. These areas occur on level to gently sloping terrain.

Moderate Susceptibility

Soil characteristics make these area relatively more liable to erosion. They are moderately well to well drained soils (M1*, M2) which have some limitation because of moderate slopes and restricting subsurface layers. Maintenance of vegetative cover is relatively important.

High Susceptibility

Soils in this group have a high erosion potential. Conditions such as seepage, texture, and landscape position all contribute to the expected large losses of soil materials (H1). Some areas (H2) have a surface layer which is highly susceptible but the under-

*Refers to symbols on surface erosion potential map, Figure 12.

lying substratum has a moderate erosion potential. These areas require special techniques and practices to prevent erosion and sedimentation.

Soil Stability At Depths to 6 Feet

Proper footing for the construction of buildings, underground utilities or roads is largely dependent on the material upon which the structure is placed. Soils are similar to other materials in that they deform under load. The most susceptible kinds of soils to movement and deformation are the fine grained clay soils that are prone periods of wetness.

Several factors were considered. The shrink-swell potential of soils was examined since certain soils of high clay content can undergo movements resulting in foundation stresses. Bearing capacity was considered, since many soils, like the organic types, are poorly suited to construction because of their poor ability to support loads. Soils susceptible to long periods to wetness were also noted, since good drainage is required to attain maximum bearing capacity. Many of the wet clay soils are subject to landslides if tremors are common, especially when these soils occupy steep slopes.

These ratings are based on the inherent nature of the undisturbed and dominant soil material at depths to 6 feet. Soils with bedrock less than 6 feet below the surface were rated on the underlying hardrock. Except in special cases, bedrock of this area is normally an adequate foundation material. These ratings are not intended to predict stability of heavy structures but rather to predict the suitability for light structures (e.g. homesites). Many of the limitations even in the poor stability category can be overcome with proper foundation design.

Good Stability

Soils in this group consist of deep, well to excessively drained soils that have been formed on or derived from outwash sand and gravel deposits (G2)* or where bedrock occurs at depths less than 6 feet (G1). There are none to slight limitations on

*Refers to symbol on stability map, Figure 13.

these areas for soil stability. They have low shrink-swell and compressibility potentials and the depth to the water table is 6 feet and greater.

Fair Stability

These are deep, moderately well drained soils that have been derived from glacial till (F1) or from well drained marine deposits (F3). The till material below 4 feet usually has both a low shrink-swell potential and a low compressibility potential. These areas of glacial till may have only slight limitations in some areas.

Poor Stability

The soils in this group have one or more of the stability factors which make them poorly suited for many urban purposes. Most of the soils are deep, somewhat poorly or very poorly drained and have formed on marine clay type materials (P1) or organic deposits (P1). Steep eroded or gullied areas (P2) are also included. The soils either have a high shrink-swell potential, a severe compressibility potential, a high water table, or are liable to mass movement. Corrective measures are often impractical.

Interpretation for Areas Subject to Ponding and Flooding

Enclosed drainage basins and flat lying areas usually have limited natural drainage resulting in local ponding and flooding. In these sites, water often approaches or covers the ground surface for extended periods of the year. Flooding or high water tables can impose severe restrictions on the efficiency of septic tank absorption fields, or the suitability for the development of industrial and urban sites.

Areas subject to flooding are usually areas adjacent to major streams that periodically overflow their natural channels. These areas are not always evident and careful evaluation of soil characteristics and local records are needed. Areas prone to ponding are usually depressional areas that are natural collection basins for seepage and runoff waters. It can also include areas with impervious subsoil layers which perches the water table for intermittent periods, especially during the early spring.

These ratings are intended to note the degree to which areas are susceptible to problems closely associated with wetness. In

the more susceptible areas, it is necessary to recognize the potential hazards that could occur with certain kinds of developments. Alternate uses which minimize damage should be encouraged (i.e. wetland wildlife habitats, recreation, non-residential and agricultural).

Slight Susceptibility

These soils areas are not affected by surface ponding or stream flood waters. These are usually coarse textured or upland soils (S)* where water is removed within a short period of time either by downward percolation or surface runoff. There usually is no need for supplemental drainage measures (i.e. drainage tiles, ditches).

Moderate Susceptibility

These are deep, moderately well to well drained soils (M2) or areas with intermittent wet depressions (M1). The areas of deep soils display a seasonal high water table near the surface for short periods of the year especially during the winter and spring period. These areas are considered generally suitable for development subject to certain restrictions. Supplemental drainage is necessary for some structures.

High Susceptibility

These are deep, somewhat poorly to very poorly drained marine clay soils (H2) and poorly to very poorly drained organic soils (H1). Here the major limiting elements are the marine clay subsoil which perches the water table and fosters lateral flow of seepage water. Organic soils tend to be natural catchment basins that have poor natural drainage outlets. Extensive drainage measures are needed to remove the water.

Interpretations For Subsurface Sewage Disposal

Sewage effluent contains substances known to be harmful to humans. The ability of the land to renovate this effluent so that it approaches drinkable water is a very complex and difficult subject. The nature of soil materials is a strong influence, as

*Refers to symbols on the ponding and flooding map, Figure 14.

are growing plants and the local climate. If these are ineffective, a practical goal which would permit reuse and minimize deleterious impact would not be obtained. In the specific case of substances like nitrates, the only opportunities for removal are by plants and microorganisms adjacent to the effluent. Since these organisms are essentially restricted to the upper zone of septic tank tile drains, as well as being dormant in the winter, the water quality goals may be seriously impaired. In the case of heavy metals (e.g. lead) and other inorganics the soil must rely on insitu organics and clay minerals to fix and retain these obnoxious substances. Clean soils such as sands and gravels have little capability to fix or retain these substances, thus we could expect them to pass relatively freely. The ratings to follow are intended to reflect the ability of the soil system to filter and purify septic tank effluent in a manner which will allow uncontaminated water to return to the ground water supplies, streams or lakes.

Although percolation capacity (ability of soil to transmit water) controls whether a site is suitable subsurface sewage disposal systems, it is generally believed to be an inadequate tool. It only demonstrates how a soil can transmit water not its ability to renovate and retain those noxious substances related to health and hygiene. The major focus of the criteria used in these ratings is to evaluate the renovative responses of the land. Considerations were given to percolation rates, permeabilities, depth to water tables or other restricting layers (hardpan, rock, etc.) flooding hazard, slope length and gradient, volume of soil material, soil textures (relative amounts of sand, silt and clay), climate and biotic life.

Severe Limitations

All soils have severe limitations for subsurface sewage disposal: in some places (S3,S4)* water saturation prevents the oxidizing of sewage by-products, it also promotes the formation of substances which clog soil pores; in others (S4) the soil conducts

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*Refers to symbols on subsurface sewage disposal map, Figure 15.

water very slowly when saturated and has the tendency to seal itself with sewage solids; the mountainous regions (S1) generally lack sufficient quanitites of soil material to filter effluent, thus raw effluent tends to reach underground aquifers via crevices or fractures in the bedrock; other areas (S5) have limited filtering depth and its compact subsoil promotes lateral subsurface seepage of effluent; many coarse textured soils (S2) inhibit retention of dissolved substances and groundwater contamination hazard may be high.

Soil Capability for Agriculture

The soil capability classification for agriculture is an interpretative grouping that shows the capability of the soils for growing a range of regionally adapted crops.[1,2] In this classification the mineral soils are grouped into seven classes according to their limitations and potentialities for agricultural use (See Figure 16). Class 1 soils have few limitations, the widest range of use and the least risk of damage when they are used for agriculture. The soils in the other classes have progressively greater natural limitations.

Classes 1, 2, 3, are capable of varying degrees of sustained production of common cultivated crops, the fourth is marginal for permanent pasture, the sixth is capable of use only for native pasture while the seventh class includes soils incapable of arable culture of permanent pasture.

The classes (1 to 7) can further be divided into subclasses. These are groupings that show particular kinds of limitations or hazards within the classes. These are undesirable structure and/or low permeability (D); erosion (E); subject to inundation (I); moisture limitation (M); stoniness (P); consolidated bedrock (R); topography limitation (T); wetness (W); and cumulative minor characteristics (X).

Conventions on maps are noted in the following manner:

a) Capability class and subclass limitation.

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[1] Canada Land Inventory, Report No. 2, 1965, Soil Capability Classification for Agriculture, Lands Directorate, Dept. of Environment, Ottawa.

[2] G.G. Runka, Land Capability For Agriculture, B.C. Land Inventory (C.L.I.), Soil Survey Division, B.C. Dept. of Agriculture, Kelowna, B.C.

i) Mineral soils

The capability class number is followed by the subclass limitation.

e.g. 5P — This symbol indicates a capability class of 5 with a subclass limitation of stoniness (P).

ii) Organic soils

The capability class number is preceded with the capital letter "O" and the subclass limitation is noted after the number.

e.g. O5W — This indicates an organic soil with a capability class of 5 and a subclass limitation of wetness (W).

b) Improved Ratings

i) Mineral soils

The capability of mineral soils can improve under irrigation. This improved rating is shown in rounded brackets.

e.g. 5P Dryland rating

(4P) Irrigated rating

ii) Organic soils

The capability of organic soils can be improved by drainage. This improved rating is shown in square brackets.

e.g. O4W Natural State Rating

[O3W] Drained Rating

c) Proportions of different kinds of soils.

When two or more soils occur within a map unit their relative percentages are noted with a "complex" symbol.

e.g. $5^{7}_{P} - 3^{3}_{D,M}$ This indicates that 70% of the area has a Class 5 capability with the remaining 30% Class 3. The irrigated rating is also indicated.

$(4^{7}_{P} - 2^{3}_{D,M})$

Most areas of till soils (dominantly Classes 2 and 3) have a topographic limitation. Topography increases the costs of cultivation and decreases the uniformity of growth and crop maturity. In areas of more clayey nature (dominantly Classes 2 and 3) the restrictions are related to wetness and subsurface soil layers that inhibit root penetration.

Wetness is also a limitation on the shallow (dominantly Class 2) and deep (dominantly Class 4) organics. Soils developed on gravel and sand deposits (dominantly Classes 4 and 5) and shallow soils overlying bedrock (dominantly Classes 5 and 6) are affected by drouthiness due to low water holding capacity. Mountainous upland areas (dominantly Classes 6 and 7) are restricted by topography and occurrences of consolidated bedrock.

Extensive urban development has occurred in the Capital Regional District (Zone 2). It is estimated that 20,635 acres (32.2 sq. mi.) have already been subdivided in areas of Agriculture Capability Classes 1, 2, 3, and 4.

TABLE 4. INTERPRETATIONS OF ENGINEERING PROPERTIES OF THE SOILS

Surficial Units	*Associated Soils	Thickness of Top Soil (in inches)	Top Soil Quality	Sand Gravel Quality	Road Fill Quality	Depth to Water Table	Seepage	Excavation
Organic								
1	Arrowsmith	40+	Fair	Poor	Poor	2-4 feet	Natural catchments for seepage	Difficult when wet
1a	Metchosin, Tolmie	20-40	Good	Poor	Poor	2-6 feet		
Clay								
2	Cowichan, Saanichton	8-14	Fair	Poor	Poor	4-6 feet except for brief periods of the year.	Seepage and perched water likely at contact with clay material.	Fairly easy, some difficulty with underlying clay or when wet.
2a	Tolmie	8-10	Good	Poor	Fair			
2b	Saanichton, Tolmie	2-4	Fair	Poor	Poor			
Till								
3	Shawnigan, Cadboro	0-2	Fair	Poor	Good	More than 6 feet except for brief periods of the year.	Seepage and perched water likely at contact with hard rock or underlying substratum.	Fairly easy, some difficulty with till substratum. Easy down to about 2 feet with some difficulty with hardrock.
3a	Shawnigan	0-2	Fair	Poor	Good			
3b	Langford, Dashwood	0-8	Poor	Poor	Good			
4	Shawnigan, Cadboro, Volcanic Rocks	0-2	Fair to Poor	Poor	Good			
5	Galiano, Sedimentary Rocks	0-2	Poor	Poor	Poor			
Alluvium								
6	Cassidy, Chemainus, Qualicum	2-4	Poor	Poor	Good	More than 6 feet except for brief periods of the year.	Natural seepage receiving area. Tidal dependent.	Easy
6a	Chemainus, Saanichton, Cowichan	12-20	Good	Poor	Poor			Easy
7	Tidal Flats	nil	Poor	Poor	Poor			Easy
Gravels								
8	Qualicum, Esquimalt	nil	Poor	Good	Good	More than 10 feet.	Not a problem.	Fairly easy, in places stones may interfere.
Colluvium								
9	none	nil	Poor	Poor	Moderate	More than 6 feet.	Seepage at contact with hardrock.	Fairly easy, rock content may hinder
Rock								
10	Sedimentary Rock	nil	Poor	Poor	Poor	More than 6 feet.	Seepage at contact with hardrock.	Difficult
10a	Sedimentary Rock, Galiano		Poor	Poor	Poor			Difficult at rock contact.
11	Volcanic Rock	nil	Poor	Poor	Poor			Difficult
11a	Volcanic Rock, Shawnigan	nil	Poor	Poor	Poor			No difficulty down to rock, will require explosives.
11b	Volcanic Rock, Shawnigan Cadboro	nil	Poor	Poor	Poor			
Miscellaneous								
12	Coastal Bluff	nil	Poor	Poor		4-6 feet	Likely with perched water table.	Fairly easy
13	Coastal Beach	nil	Poor	Poor		More than 6 feet	Tidal dependent	Fairly easy

*Soil Survey of Southeast Vancouver Island and Gulf Islands, British Columbia, Report No. 6, Research Branch, Canada Department of Agriculture, Vancouver, B.C.

S U R F I C I A L M A T E R I A L S

ORGANICS

1 - Deep (greater than 4 feet) semi-decomposed organic material.
1a - Shallow (less than 2 feet) well decomposed organic deposits underlaid by clay.

CLAY

2 - Deep (greater than 6 feet) fine to medium textured marine materials (clay, clay loam).
2a - Medium textured (sandy clay loam, fine sandy loam) marine materials underlaid by clays.
2b - Fine textured (clay) marine material (greater than 4 feet) underlaid by course textured glacial till (gravelly sandy loam). Coarse textured cappings occur as a minor inclusion in this unit.

TILL

3 - Deep (greater than 6 feet) coarse textured glacial till (gravelly sandy loam).
3a - Deep coarse textured glacial till occupying steep-land areas.
3b - Coarse textured (loamy sand, gravelly loamy sand) marine material underlaid by glacial till at depths of less than 3 feet.
4 - Coarse textured glacial till associated with bedrock areas of volcanic origin (rocks less than 40% of area).
5 - Coarse textured glacial till associated with sedimentary (shale) bedrock (rock less than 40% of area).

ALLUVIUM

6 - Coarse textured alluvium (gravelly loamy sand, gravelly sandy loam).
6a - Medium textured alluvium (clay loam, fine sandy loam).
7 - Tidal flats, mixture of organic and mineral material, often saline and stony.

GRAVELS

8 - Deep (greater than 10 feet) interstratafied gravels and gravel sand mixtures, little or no fines.

COLLUVIUM

9 - Shallow (less than 2 feet) gravel or coarse rock fragments occupying steep slopes (35% +).

ROCKS

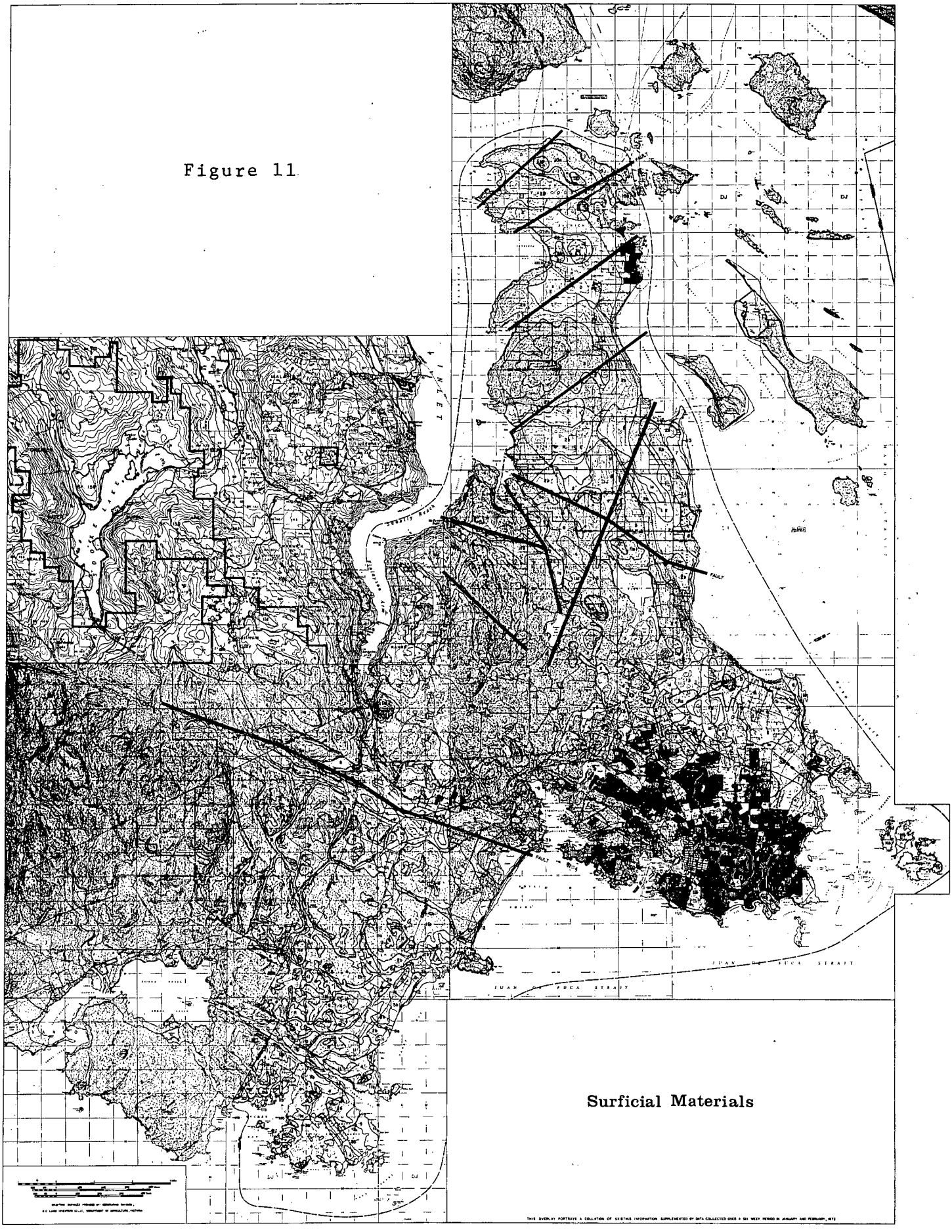
10 - Sedimentary (shale) rock outcrops.
10a- Sedimentary rock outcrops with pockets (less than 30%) of coarse textured glacial till.
11 - Volcanic rock outcrops.
11a- High relief (greater than 250 feet) volcanic rock units with pockets (less than 30%) of coarse textured glacial till.
11b- Low relief (less than 250 feet) volcanic rock units with pockets (less than 30%) of coarse textured glacial till.

MISCELLANEOUS

12 - Steep coastal bluffs
13 - Coastal beach deposits.

Prepared by: Soil Survey Unit, Research Station, Canada Department of Agriculture, Vancouver, B.C.

Figure 11



S U R F A C E E R O S I O N P O T E N T I A L

This single purpose map is based on the soils natural susceptibility to soil erosion once all vegetative cover is removed. The dominant consideration is for surface soil losses incurred by runoff and overland flow.

These ratings are intended to predict susceptibility but they do not replace onsite evaluation. These units may contain areas which have ratings different from those shown on the map.

SLIGHT SUSCEPTIBILITY

S - Soil materials in this group have none to slight limitations for soil loss.

MODERATE SUSCEPTIBILITY

Soils materials in this group have relatively moderate limitations for soil loss.

M1 - Numerous shallow gullies and sheet erosion can be expected. Subsoil potential is slight.

M2 - This broad clay material group was separated from H1 due to better structure, infiltration and drainage. With poor management it could revert to the H1 grouping.

HIGH SUSCEPTIBILITY

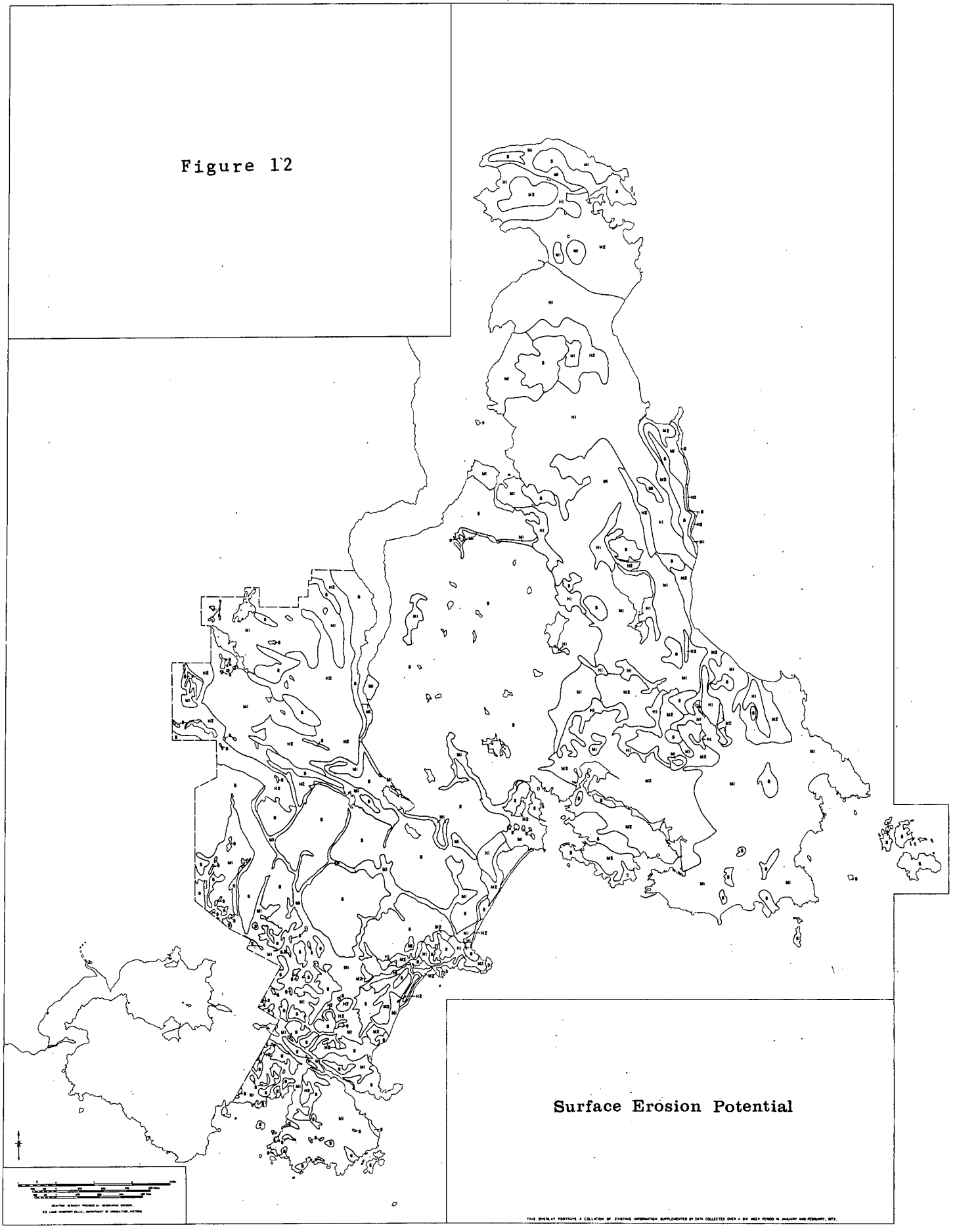
Soil materials in this group have relatively severe limitations for soil loss.

H1 - Large loss of soil material can be expected.

H2 - The surface material of this unit tends to be highly susceptible because of steep slopes, but the subsoil erosion potential is moderate.

Prepared by: Soil Survey Unit, Research Station, Canada Department of Agriculture, Vancouver, B.C.

Figure 12



S O I L S T A B I L I T Y A T D E P T H S

T O S I X F E E T

This single purpose map is based on the inherent nature of the undisturbed and dominant material at depths to 6 feet. Where bedrock occurs at depths less than 6 feet it is assumed that most foundations in the area would be placed on the bedrock. These ratings do not replace onsite evaluation or tests in order to determine feasibility.

GOOD STABILITY

These units consist of well drained soils with none to few limitations for soil stability.

G1 - This group consists of shallow soils overlying local bedrock.

G2 - This unit has been formed on or derived from outwash sands and gravels.

FAIR STABILITY

These moderately well drained units have only slight limitations for soil stability. These have medium to high compressibility potential and fair shear strength.

F1 - Deep semi-pervious glacial till material, it may contain minor inclusions of bedrock.

F2 - Shallow water-worked deposits overlying a compact glacial till or bedrock.

F3 - Dominantly marine materials.

POOR STABILITY

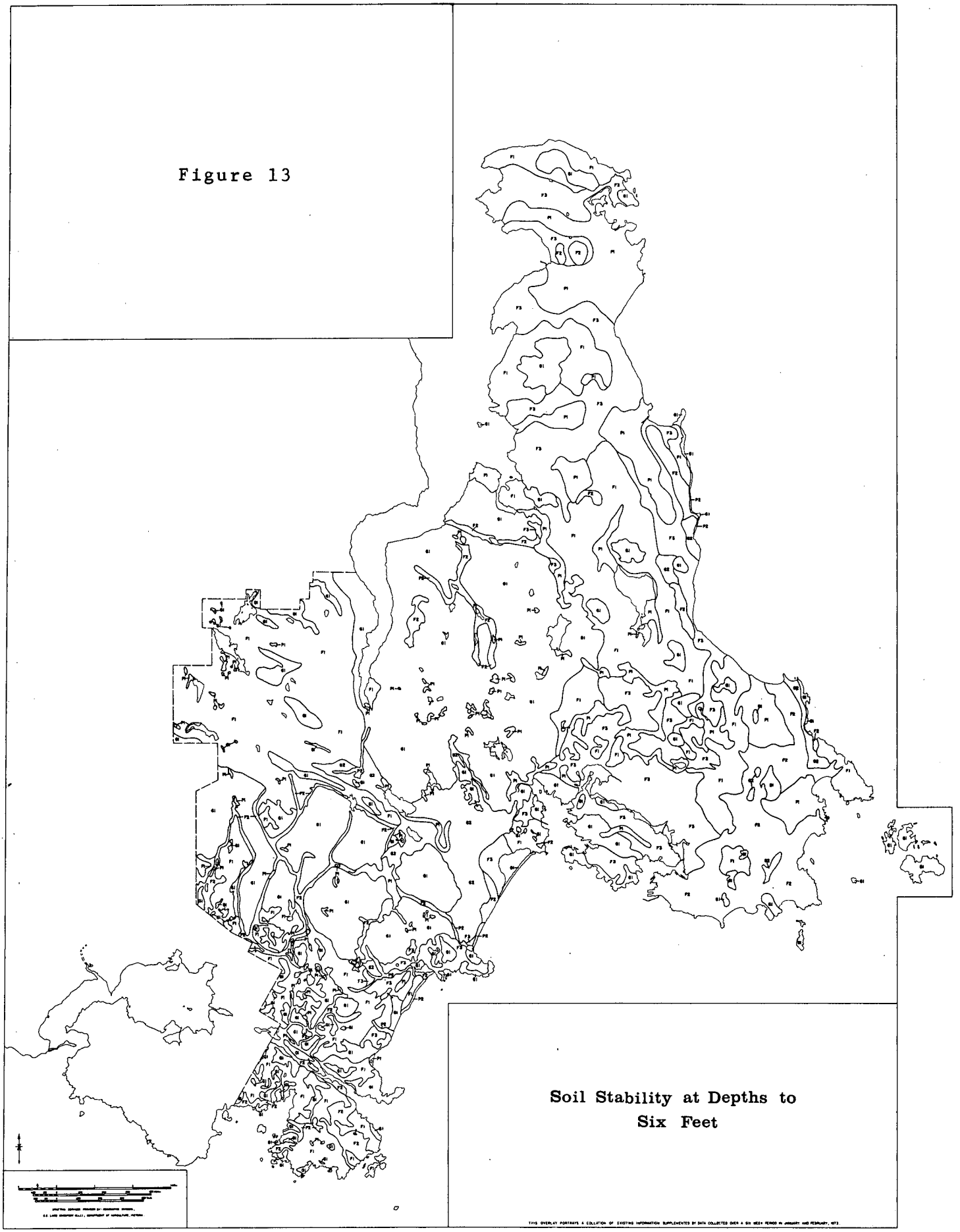
The soils in this group are generally poor sites for many urban purposes. Most of these units are deep impervious to semi-pervious deposits which have severe compressibility potential, high water table or high shrink-swell potential.

P1 - Deposits of silts and clays of marine origin or scattered areas of organic deposits.

P2 - Dominantly steeply eroded or gullied areas.

Prepared by: Soil Survey Unit, Research Station, Canada Department of Agriculture, Vancouver, B.C.

Figure 13



Soil Stability at Depths to Six Feet

SUSCEPTIBILITY TO PONDING AND FLOODING

This single purpose map is based on the soil mapping units susceptibility to ponding and flooding during periods of high runoff or, for surface water to remain ponded or perched on natural impervious to semi-impervious substratum. Each unit is intended to predict the susceptibility of an area, but variations may be contained which have ratings different from those shown on the map.

Detailed soil surveys or specific onsite evaluation may be needed for operational planning.

SLIGHT SUSCEPTIBILITY

S - These soil areas are occupied by mapping units that are not affected by surface ponding or stream flood waters. These are usually coarse textured or upland soils where water is removed within a short period of time either by downward percolation or surface runoff.

MODERATE SUSCEPTIBILITY

These soil areas are occupied by mapping units that usually need supplemental drainage for brief periods of the year.

M1 - These areas contain upland complexes of swales and low relief knolls. The swales foster temporary marshy depressions.

M2 - These areas contain soils that display a seasonal high water table near the surface for short periods of the year.

M3 - These areas contain compact substratum material overlain by pervious deposits of variable depth (1-3 feet).

HIGH SUSCEPTIBILITY

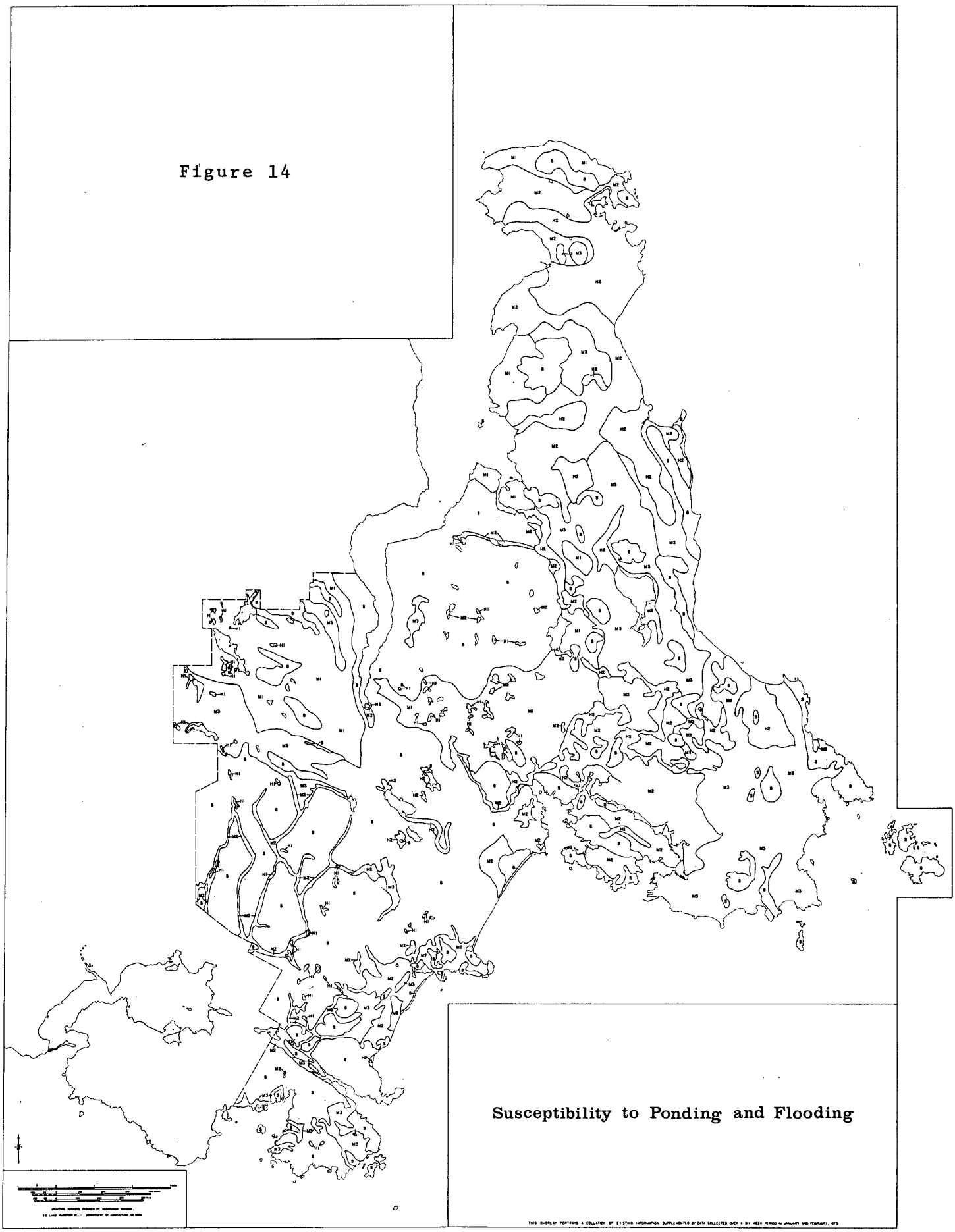
These soil areas are occupied by mapping units that require extensive drainage measures to remove water.

H1 - These are usually poorly drained organic soils that are subject to and may remain ponded or flooded throughout the year.

H2 - These units show evidence of perched water tables near or at the surface for extended periods of the year.

Prepared by: Soil Survey Unit, Research Station, Canada Department of Agriculture, Vancouver, B.C.

Figure 14



Susceptibility to Ponding and Flooding

SUBSURFACE SEPTIC TANK ABSORPTION FIELDS

This single purpose map is based on inherent engineering properties which limits the ability of a soil to absorb effluents. It is intended for general planning. Each unit is designed to predict the general suitability of an area, but variations may be contained which have ratings different from those shown on the map.

Detailed soil surveys of specific onsite evaluation may be needed for operational planning.

SEVERE LIMITATIONS

These soils areas are occupied by soil mapping units with severe limitations which inhibit satisfactory operation of filter fields. Several limiting factors for each unit are listed.

S1 - Slopes in excess of 15%, depth to fractured bedrock less than 4 feet or poor filtering potential for effluent.

S2 - Inadequate occurrence of soil fines to permit proper filtering of sewage.

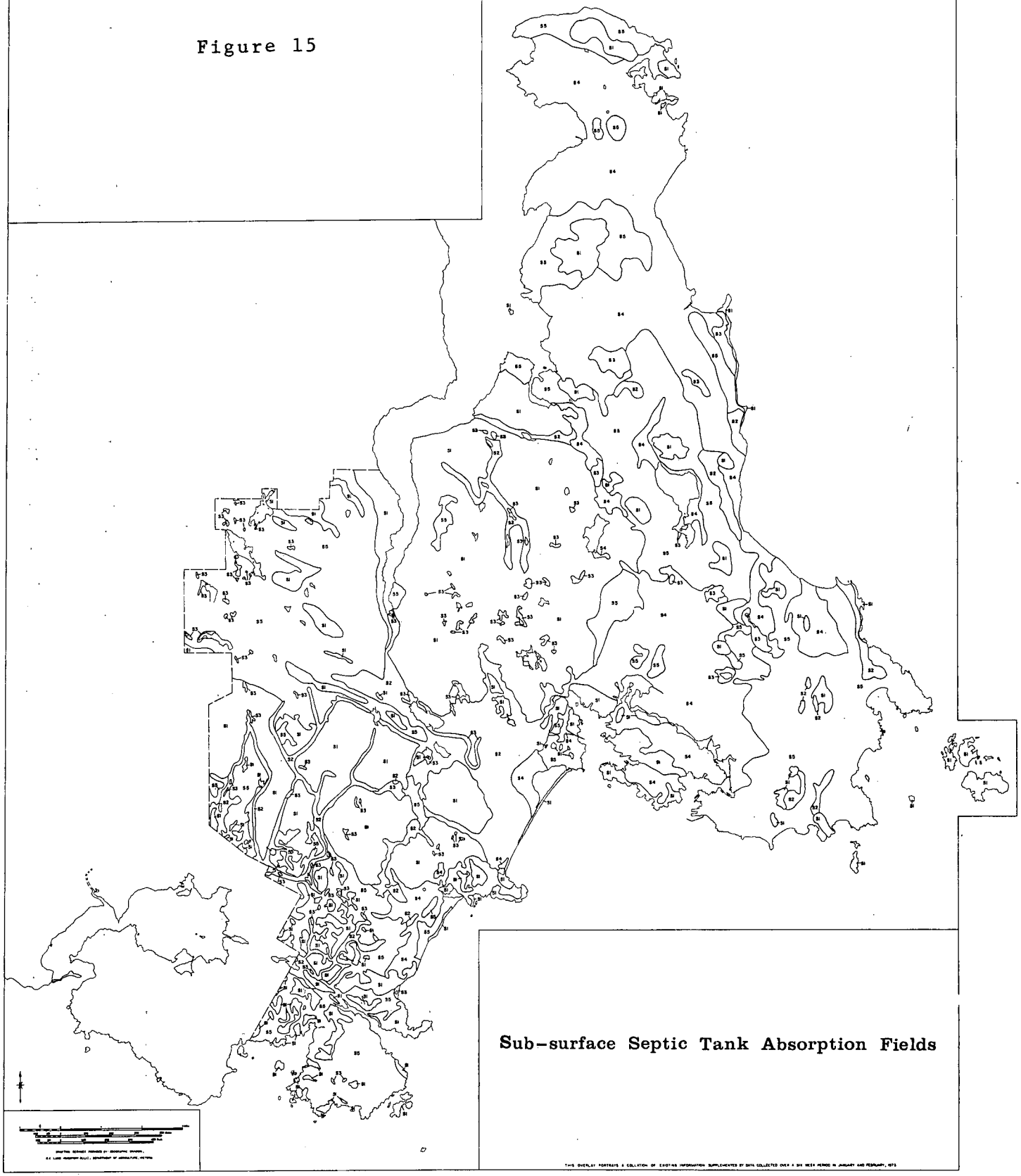
S3 - Subject to frequent ponding and flooding (anaerobic environment).

S4 - Adverse (low) percolation rates, subject to seasonal water tables within 2 feet of the surface.

S5 - Limited filtering area, depth to semi-impervious to impervious substratum less than 3 feet, plus minor occurrences of hard rock.

Prepared by: Soil Survey Unit, Research Station, Canada Department of Agriculture, Vancouver, B.C.

Figure 15



Sub-surface Septic Tank Absorption Fields

A G R I C U L T U R E C A P A B I L I T Y

Class 1 - Soils have no significant limitations for crops.

Class 2 - Soils have moderate limitations restricting range of crops or require moderate conservation practices.

Class 3 - Soils have moderately severe limitations restricting range of crops or require special conservation practices.

Class 4 - Soils have severe limitations restricting range of crops or require special conservation practices, or both.

Class 5 - Soils have very severe limitations restricting capability to producing perennial forage crops and improvement practices are feasible.

Class 6 - Soils are capable only of producing perennial forage crops and improvement practices are not feasible.

Class 7 - Soils have no capability for arable culture or permanent pasture.

O - Organic Soils with same class ratings as above (e.g. O7W - organic soil with no capability for arable culture or permanent pasture due to excess water).

SUBCLASSES

D - Undesirable soil structure and/or low permeability.

E - Past erosion damage limits agricultural use.

I - Inundation - flooding by streams or lakes limits use.

M - Low moisture holding capacity.

N - Salinity - These soils are adversely affected by soluble salts.

P - Stoniness interferes with tillage, planting and harvesting.

R - Shallowness to solid bedrock (less than 3 feet from surface).

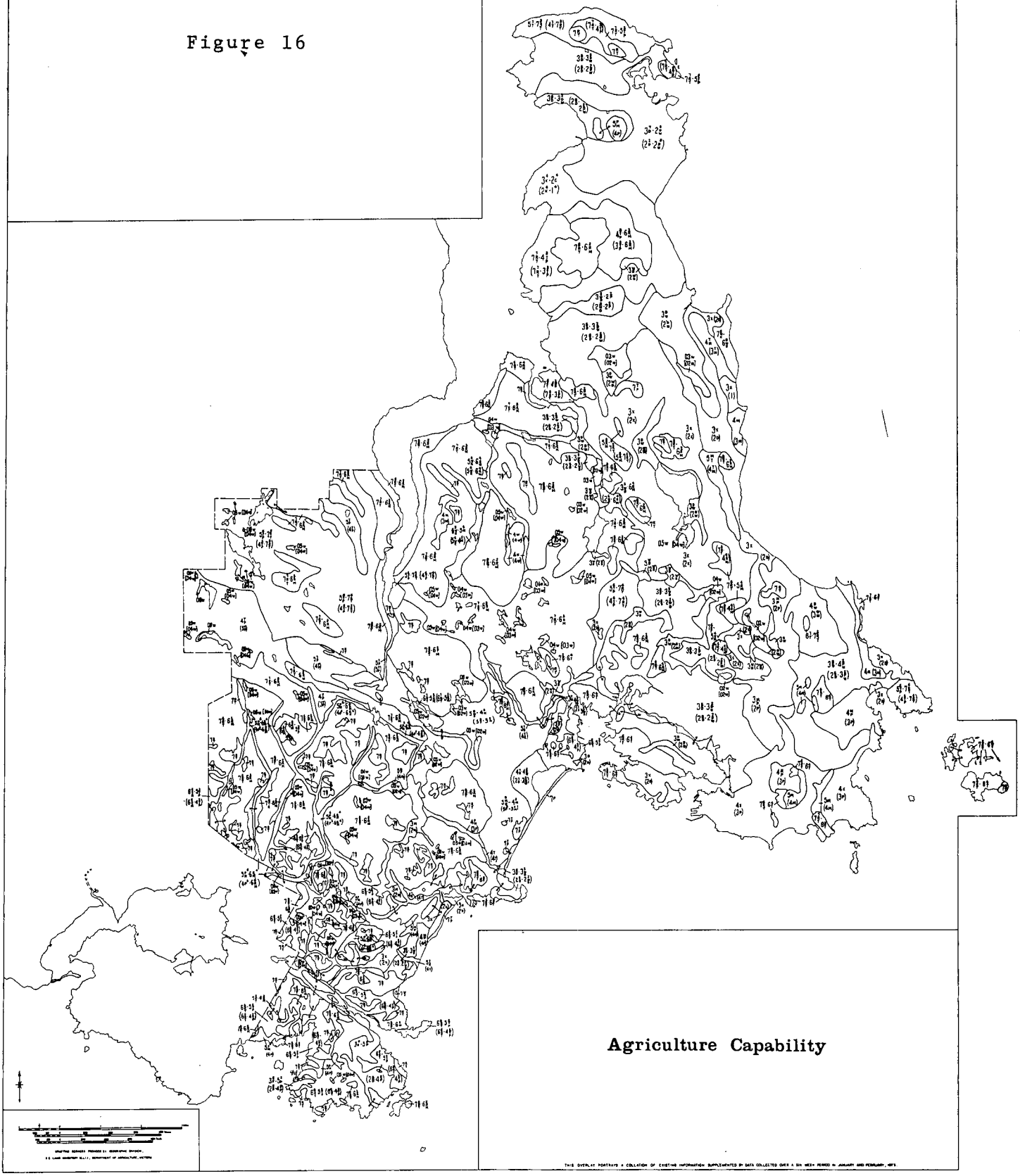
T - Adverse topography - either steepness or the pattern of slopes.

W - Excess water - other than that from flooding.

X - Minor cumulative limitations - two or more adverse characteristics that individually would not affect class rating.

Prepared by: Soil Survey Unit, Research Station, Canada Department of Agriculture, Vancouver, B.C.

Figure 16



Agriculture Capability

LAND SUITABILITY FOR WILDLIFE

A.J. Luckhurst, D. Blower

BACKGROUND AND METHODS

Map Units

The Capital Regional District study area lands were mapped on the basis of landforms, soils, vegetation and climate. Emphasis was placed on those factors which influence the distribution and abundance of wildlife species and natural boundaries were adjusted where the influence of man has materially and, for all practical purposes, permanently altered the natural environment.

Habitat types

Wildlife habitat in the study area was arbitrarily divided into six broad categories. The map units usually include one, but may include more than one habitat type.

Wildlife species

Bird and mammal species characteristically associated with each of the six general habitat types are listed separately in Tables 5 to 7 at the end of this section.

Land Suitability Classification

Each map unit was assessed generally as to its limitations and suitability for wildlife and assigned a rating. Five suitability classes were used ranging from very high (class 1) for units which contain habitat suitable for a very large number and/or variety of wildlife species to low (class 5) for units which contain habitat suitable for a low number and/or variety of wildlife species. In addition, three special class categories were assigned to indicate major concentration areas for nesting, wintering or as a stop-over for migrating birds.

Suitability ratings were based on existing environmental conditions but consideration was given to the degree of effort or expense necessary to maintain or improve the habitat. Existing land uses relative to farming, industrial or urban development and transportation are assumed to be permanent in nature. No attempt was made to extrapolate potential wildlife values as they could exist

under natural conditions on such lands, and it was assumed that opportunities to manage these lands for wildlife while possible is seldom feasible. In most cases habitat on these lands could be improved to some degree for wildlife even though intensive management is not usually possible.

Suitability limitations

Some of the main factors limiting suitability of wildlife habitat are listed in the legend. These permanent limitations are symbolized on the map as suitability subclasses, see Figure 17.

Discussion

The factors used to delimit the map units are not always definitive and rarely is there a sharp separation between habitat types, expecially as broad and inclusive as those used here. By definition, the broad habitat types used include transition areas such as estuaries or lagoons which are transitional between the marine, freshwater and associated terrestrial habitats. The openland habitat includes shrubland which is transitional between open fields and forest habitats. Since the study area as a whole straddles two major Biotic Areas, it is largely transitional between these and this is reflected in the remaining elements of the natural vegetation. Forest habitat in the Gulf Island Biotic Area[1] is mainly open deciduous or mixed forest consisting mainly of Garry Oak (Quercus garryana), arbutus (Arbutus menziesii), and Douglas fir (Psudotosuga menziesii). Forest habitat in the Coast Forest Biotic Area, which experiences higher annual rainfall, is mainly a closed-canopied coniferous forest in which the major tree species are western hemlock (Tsuga heterophylla), western red cedar (Thuja plicata) and grand fir (Abies grandis) in association with Douglas fir. The nature of the forest cover varies widely with edaphic and other site factors however and closed-canopied stands dominated by western red cedar and grand fir occur on wet sites in the Gulf Islands Biotic Area while an open forest of Douglas fir and arbutus is common on dry sites such as shallow rocky soils in the Coast Forest Biotic Area. It is difficult to make a sharp distinction between such transition zones which contain elements common to both of the major biotic areas. Where units contain habitat suitable for wildlife species common to either the open or closed

[1]For a description of Biotic Areas see Munroe and Cowan, 1947 or Cowan and Guiguet, 1965.

forest habitats, both are symbolized on the map. Clearing due to logging and fire in the closed forest, where succession proceeds rapidly, are not delimited on the suitability map. Even though species more characteristic of the open forest or openland may occur here, they are soon eliminated as seral vegetation proceeds quickly back to dense coniferous cover. Often too, the available habitat in such temporary clearings is quickly occupied by an increased number of species common to the closest forest.*

The species lists of birds and mammals by habitat types are not intended to be mutually exclusive or inclusive. In addition to the variability that exists in habitat types, many species can utilize a range of habitats or vary in their habitat preference seasonally. Species are listed under the habitats with which they are most commonly associated. A species associated commonly with, or relatively abundant in, two or more habitats is listed under each. In many cases, the decision to list or not to list a species under a given habitat is arbitrary and would not necessarily agree with the value judgement of other authorities.

The variety of land mammals found in the study area is somewhat limited in comparision to many other parts of the province. Of the large terrestrial mammals occurring in the Gulf Islands Biotic Area, which includes most of the settled portion, only the coast deer is abundant. This species is limited by residential and urban development over much of this area but it occurs through the Saanich Peninsula wherever remnant forests provide adequate cover. Other large mammals include black bear and cougar which though never abundant are not uncommon in the coast forest. Fur bearers such as raccoon, mink and otter are locally common along beaches and stream-side habitat. Most mammals are secretive and are active mainly in the nocturnal or twilight hours so they are not commonly observed. However, the chance sighting, or just the knowledge that a variety of wild mammals are present is a rewarding experience for many. Although hunting is not allowed on municipal lands and is restricted throughout much of the area, it does provide recreation and valued experience for many in outlying areas. Although there is much criticism of

*See Tables 5 to 7 of this section.

L A N D S U I T A B I L I T Y F O R W I L D L I F E

SUITABILITY CLASS	DESCRIPTION
1 (Very high)	These lands contain habitat suitable for a very high number and/or variety of bird and mammal species. Little or no manipulation beyond existing use or management is required to maintain the habitat.
2 (High)	These lands contain habitat suitable for a high number and/or variety of bird and mammal species. Little or no manipulation beyond existing practices is required to maintain the habitat.
3 (Moderate High)	These lands contain habitat suitable for a moderate-high number and/or variety of bird and mammal species. Or these lands would support a high number and/or variety of wildlife but require a moderate outlay of expense or effort to meet this potential.
4 (Moderate Low)	These lands contain habitat suitable for a moderate-low number and/or variety of bird and mammal species. They would support a moderate-high variety and/or abundance only with a major effort or expense.
5 (Low)	These lands contain habitat suitable for a low number and/or variety of bird and mammal species. They are mainly highly urbanized lands on which natural habitat is absent or greatly fragmented. These lands either can not be improved for wildlife, or can only be improved to support a moderate-low number and/or variety of wildlife with major effort or expense.

SPECIAL CLASS DESIGNATIONS	DESCRIPTION
W	Habitat of special importance for wintering.
N	Habitat of special importance for nesting.
M	Habitat of special importance for migration.

INDICATOR HABITAT	WILDLIFE HABITAT*
C_1	Coastal habitat (1) (beaches, tidal mudflats, estuaries, lagoons, shallow coastal waters).
C_2	Coastal habitat (2) (coast littoral marine waters, rocky islets and shoreline).
F_1	Forestland habitat (1) (open coniferous, deciduous or mixed forest).
F_2	Forestland habitat (2) (closed coniferous forest).
O	Openland habitat (fields, farmland, shrubland).
W	Wetland habitat (lakes, ponds, wet or flooded fields, bogs and some stream or streamside habitat).

*Bird and mammal species occurring within each habitat type are listed in accompanying narrative.

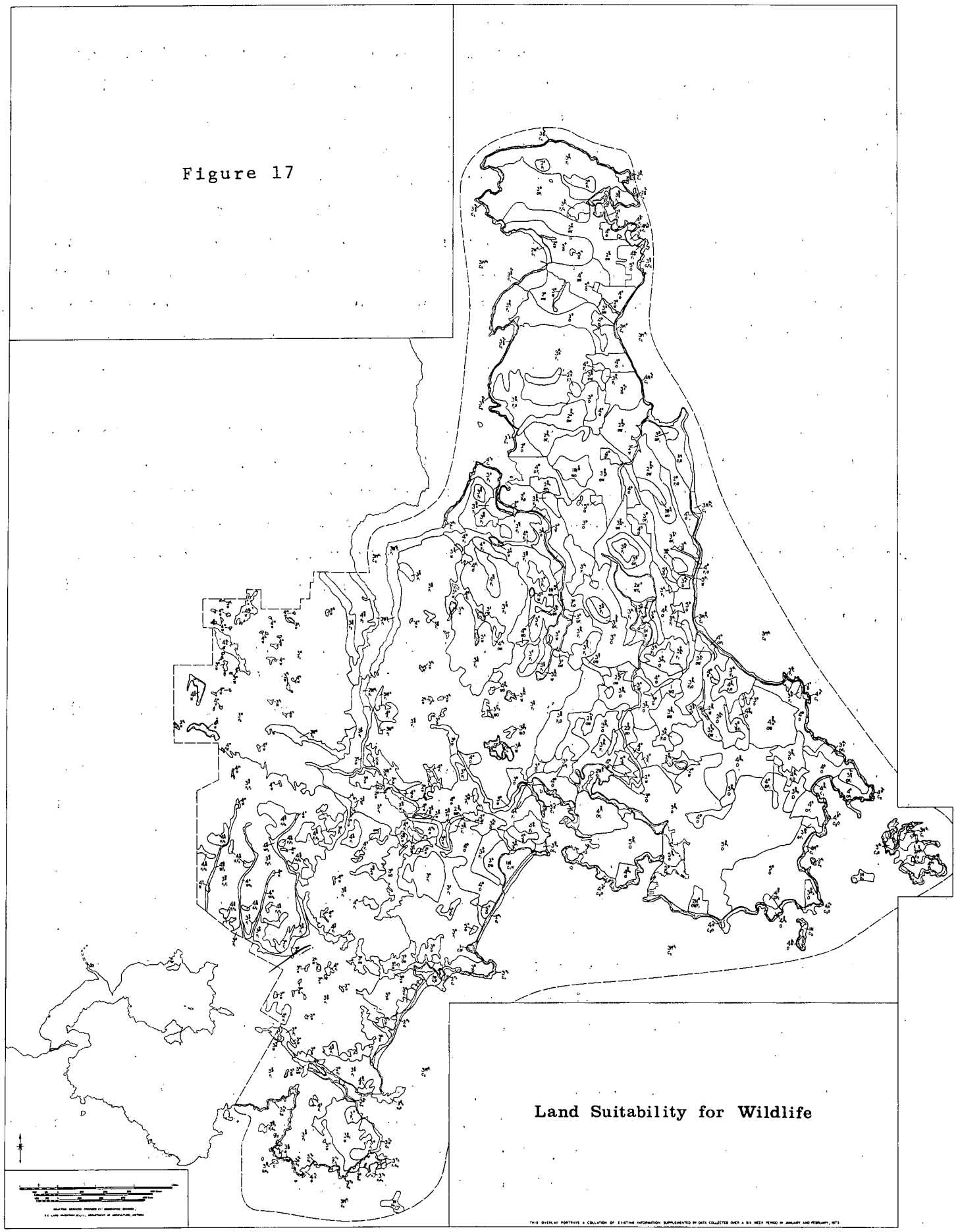
LIMITATIONS	DESCRIPTION
D	Urban development which reduces the amount and/or suitability of habitat either directly by removing it from production or through disturbance.
G_1	Poor distribution or interspersion of habitat components including lands isolated by urban development. This limitation can not usually be reduced or eliminated without major expense or effort.
G_2	Lack of or poor interspersion of cover which reduces the suitability of the habitat. This limitation can often be reduced or eliminated with low or moderate expense or effort.
I	Excessive fluctuation of water level or tidal action which adversely affects the habitat.
M	Soil moisture deficiency or excessiveness which limits the production of favourable vegetation for food and cover.
Q	Snow depth limitations which commonly reduce the availability of winter foods either directly, or by reducing the mobility of species such as deer.
R	Exposed bedrock, unreclaimed quarries and gravel pits, soils shallow to bedrock and subject to erosion.
T_1	Adverse topography due to excessive steepness such as to reduce optimum vegetation or increase susceptibility to erosion.
T_2	Steeply sloping beaches which limit the extent of productive intertidal and shallow coastal waters.
Z	Water depth is too deep or shallow for the development of optimum wetland habitat.

CLASSIFICATION EXAMPLES

$3^{R}_{F_1}$	An area of class 3 land which supports open coniferous, deciduous, or mixed forest wildlife (F1) and which is limited by exposed bedrock (R) and by urban development (D).
$2W^{G_1}_{W}$	An area of class 2 land which is of special importance for wintering (2W) wetland wildlife (W) and which is limited slightly by poor distribution of habitat components (G_1).

Prepared by: Wildlife Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 17



consumptive uses of wildlife such as hunting, wildlife suffers much more from the loss of habitat. While hunting removes replaceable individuals, the loss of habitat is usually irreplaceable and the resulting loss of wildlife is final and absolute.

The great environmental diversity of the study area is reflected in a variety and abundance of bird species. The inherent natural diversity of the landscape has been augmented by agricultural practices which provide an abundant food source and a habitat for many species, some rare or absent under primitive conditions. Two introduced species, the skylark and the mountain quail which occur here and in a few adjacent locations on Southern Vancouver Island, occur nowhere else in Canada.

It is an important wintering area for many species of birds and is also important for many others which migrate along the coast. Spectacular concentrations, especially of seabirds and waterfowl, are common in some locations. Upland game birds and waterfowl provide many residents with a hunting experience, and birdwatching is a popular pastime with a rapidly growing number of organized and amateur participants.

PRESERVING AND MAINTAINING WILDLIFE VALUES

Recently, planners in many parts of North America have come to recognize a value in "backyard" wildlife and are recommending the consideration of wildlife needs in the concept of regional and municipal plans. Even though we know little of the specific requirements of most bird and mammals species, wildlife values can be maintained by protecting critical habitats and observing some very fundamental, general guidelines. Those habitat elements which support or encourage a large variety or number of wildlife are worth special efforts to protect and maintain. Estuaries and lagoons such as Metchosin Lagoon and Goldstream estuary are highly productive transitional environments which contribute in a major way to fish and wildlife populations. They should be protected at all costs. The study area contains a number of very productive wetlands including Elk, Beaver, Blinkhorn and Blenkinsop lakes, Panama flats, Quicks pond, Rithet's bog, and flooded fields in the vicinity of Glen Lake, Happy Valley and Martindale Road. Even wetlands of reduced suitability due to development such as at Swan Lake, are relatively productive and, in some ways their

location in an urban setting adds to their value. Some lands underlain by marine clays have a potential for wetland wildlife and this is indicated on the suitability map although they are not necessarily wetlands at present.

Streams are important elements, especially those capable of supporting significant anadromous or resident fish populations such as Goldstream and Colquitz rivers. Such streams link freshwater, marine and terrestrial environments and serve as corridors for mammals like mink, raccoon and otter. Ensuring viable stream and streamside environments can add considerably to regional and back-yard wildlife values. Beaches also serve as corridors and can sustain a range of high impact uses with little damage. Their viability depends on the protection of some adjacent terrestrial habitat for cover and rich intertidal areas such as Patricia Bay, Tzueum Harbour and Cordova Bay which support a variety of food organisms and wild-life forms.

Other important elements are lands which serve as critical nesting or wintering sites such as: sea bird nesting colonies on islands like Trial, Chain, the Great Chain group and Race Rocks; herronries in McDonald Park and on Chatham Island; and coast deer winter range on the steep west-facing slopes along Finlayson Arm. Such lands serve wildlife and influence suitability of lands for wildlife over a wide surrounding area.

As well as considering lands of high productivity or critical elements, plans should consider the maintenance of a full range of representative habitats to maintain diversity and ensure against the loss of critical elements which are required by wildlife.

It is a fundamental rule that an impact which produces change in one area of an ecological system or relationship tends to induce change through the entire system. Such events and relationships can be extremely complex and experience has shown that our ability to predict consequences, slow deterioration or reverse trends is all too limited. Since we know so little about the requirements of many wildlife species or of man's impact on their habitat, attempts should be made to retain natural systems or at least to maintain systems in as natural a state as possible.

Most forms of land use reduce diversity, eliminate essential habitat elements, and often result in a poor interspersion of habitat elements due to unnecessary draining and clearing. Wildlife values can be largely sustained and even increased by encouraging agricultural users and even urban landowners to leave some undisturbed cover on their land to consider wildlife before draining.

CHARACTERISTIC MAMMALS OF THE STUDY AREA (TABLE 5)

Wetland Habitat (W) (lakes, ponds, wet or flooded fields, bogs and some streamside habitat)

Name	Comments
Wandering shrew (Sorex vagrans vancouverensis)	mainly marshy areas in the Gulf Islands Biotic area. This subspecies confined to Vancouver Island.
Wandering shrew (Sorex vagrans isolatus)	mainly marshy area in the Coast Forest Biotic area.
Navigator shrew (Sorex palustris brooksi)	This subspecies confined to Vancouver Island.
Muskrat (Ondatra zibethica)	common locally
Norway rat (Rattus norvegicus)	common, introduced
Roof rat (Rattus rattus)	common near human habitation.
Short-tailed weasel (Mustela erminea anquinae)	This subspecies confined to Vancouver and adjacent islands. Uncommon and seldom seen.
Mink (Mustela vison evagor)	This subspecies confined to Vancouver and a few adjacent islands. Common but seldom seen.
River otter (Lutra canadensis pacifica)	not uncommon but rarely seen.(streamside and lakes).

Openland Habitat (O) (fields, farmland, shrubland)

Wandering shrew (Sorex vagrans vancouverensis)	most abundant on Gulf Islands Biotic Area.
Little brown bat (Myotis lucifagus alascensis)	varied habitat; widespread throughout B.C.
Yuma bat (Myotis yumanensis saturatus)	common seasonally
Eastern cottontail (Sylvilagus floridanus)	introduced; spreading

Name	Comments
White-footed mouse (Peromyscus maniculatus angustus)	common, widespread.
Townsend Vole (Microtus townsendi tetramerus)	This subspecies confined to South Vancouver Island.
Norway rate (Rattus Norvegicus)	common, introduced
Roof rat (Rattus rattus)	introduced, mainly near dwellings.
House mouse (Mus musculus domesticus)	introduced
Raccoon (Procyon lotor vancouverensis)	common, widespread
Short-tailed weasel (Mustela erminea anquinae)	uncommon, seldom seen
Columbian blacktail deer (Odocoileus hemionus columbianus)	adjacent to forest cover.
Forestland Habitat (F_1) (open coniferous, deciduous or mixed forest - mainly within Gulf Islands Biotic Area)	
Wandering shrew (Sorex vagrans vancouverensis)	this subspecies confined to Vancouver Island.
Western big-eared bat (Corynohinus townsendi townsendi)	this subspecies confined to South Coastal B.C.
Big brown bat (Eptesicus fuscus bernardinis)	inhabits a variety of forests found across southern half of B.C.
Silver haired bat (Lasionycteris noctivagans)	inhabits a variety of forests found across southern half of B.C.
Hoary bat (Lasiurus cinereus)	found only in southern B.C.
California bat (Myotis californicus caurinus)	variable habitat; Southwest B.C.
Long eared bat (Myotis evotis pacificus)	forest broken with rock outcropping. Southwest B.C.
Little brown bat (Myotis lucifagus alascensis)	varied habitat; widespread throughout B.C.

Name	Comments
Yuma bat (Myotis yumanensis suturatus)	common seasonally, favours clearings.
Eastern cottontail (Sylvilagus floridanus)	recent introduction presently expanding its range in this area.
White-footed mouse (Peromyscus maniculatus angustus)	common, widespread.
Townsend vole (Microtus townsendi tetramerus)	confined to southern Vancouver Island. Most abundant in this habitat type.
Norway rat (Rattus Norvegicus)	common, introduced
Roof rat (Rattus rattus)	introduced; usually near human habitation.
Raccoon (Procyon lotor vancouverensis)	especially near streams and beaches.
Short-tailed weasel (Mustela erminea anquinae)	uncommon seldom seen.
Columbian blacktail deer (Odocoileus hemionus columbianus)	where sufficient tree cover
Cougar (Felis concolor vancouverensis)	uncommon now due to human habitation.

Forestland Habitat (F_2) (closed coniferous forest - mainly within Coast Forest Biotic Area)

Wandering shrew (Sorex vagrans isolatus)	this subspecies confined to Vancouver Island.
Big brown bat (Eptesecus fuscus bernardinis)	inhabits a variety of forests found across southern half of B.C.
Silver-haired bat (Lasionycteris noctivagans)	inhabits a variety of forests found across souther half of B.C.
Hoary bat (Lasiurus cinereus)	found only in southern B.C., uncommon
California bat (Myotis calfornicus caurinus)	variable habitat; Southwest B.C.

Name	Comments
Long-eared bat (Myotis evotis pacificus)	forest broken with rock outcropping. Southwest B.C.
Keen bat (Myotis keeni keeni)	dense forest; coastal B.C.
Little brown bat (Myotis lucifagus alascensis)	varied habitat; widespread throughout B.C.
Red squirrel (Tamiasciurus hudsonicus lanuginosus)	coniferous forest; coastal B.C.
White-footed mouse (Peromyscus maniculatus angustus)	variable habitat at low elevations, confined to Vancouver Island.
White-footed mouse (P.m. interdictus)	confined to Vancouver Island; (mainly coastal rain forest at high elevations than above).
Townsend vole (Microtus townsendi tetramerus)	confined to South Vancouver Island.
Norway rat (Rattus Norvegicus)	common; introduced
Roof rat (Rattus rattus)	introduced usually around human inhabitations but occurs ferally.
Black bear (Ursus americanus vancouveri)	this subspecies confined to Vancouver Island.
Raccoon (Procyon lotor vancouverensis)	varied habitat, common in area.
Marten (Martes americana caurina)	mainly coniferous forests. Not uncommon in favourable habitat but rarely seen.
Cougar (Felis concolor vancouverensis)	in association with black-tailed deer, its main prey species, where human disturbance is not too limiting.

Name	Comments
Columbian blacktail deer (Odocoileus hemionus columbianus)	a distinctive subspecies of the coast forest; varies locally and seasonally in abundance. Common.
Coastal Habitat (C_1 and C_2) (beaches, tidal mudflats, estuaries, lagoons, shallow coastal waters, coast littoral marine waters, rocky islets and shoreline)	
White-footed mouse (Peromyscus maniculatus angustus)	common, widespread
Norway rat (Rattus Norvegicus)	common, introduced
Roof rat (Rattus rattus)	common, introduced species especially near human habitations.
Raccoon (Procyon lotor vancouverensis)	common in this habitat
Short-tailed weasel (Mustela erminea anquinae)	uncommon, seldom seen.
Mink (Mustela vison evagor)	common in this habitat but seldom seen.
Canadian river otter (Lutra canadensis pacifica)	not uncommon but seldom seen.
Pacific striped dolpin (Lagenorhynchus obliquidens)	winter visitor
Pacific Killer whale (Grampus rectipinna)	common in inshore waters.
Harbour porpoise (Phocaena vomerina)	common in inshore waters.
Gray whale (Eschrichtius glaucus)	common migrant
Mink whale (Balaenoptera acutorostrata)	sporadic
Humpback whale (Megaptera novaeangliae)	sporadic
Northern sea lion (Eumetopias jubata)	common, haul-outs at Race Rocks.

Name	Comments
California sea lion (Zalophus californianus)	common locally, haul-outs at Race Rocks.
Hair seal (Phoca vitulina richardi)	common, haul-outs on rocky beaches such as Trial and Great Chain Islands.

RARE OR LOCALLY EXTINCT MAMMALS (TABLE 6)

Name	Comments
Baird beaked whale (Berardius bairdi)	rare or accidental
Stejneger beaked whale (Mesoplodon stejnegeri)	rare or accidental
Cuvier whale (Zipius cavirostris)	rare or accidental
Baird dolpin (Delphinus bairdi)	rare or accidental
Scammon blackfish (Globicephala scammoni)	rare or accidental
Dall porpoise (Phocaenoides dall)	rare
Common finback whale (Balaenoptera physalus)	rare in inside waters
Blue whale (Sibbaldus musculus)	extremely rare or accidental in inshore waters. The largest of the whales.
Pacific right whale (Eubalaena sieboldi)	extremely rare due to over-harvesting.
Wolverine (Gulo luscus)	extremely rare or locally extinct. Coast forest habitat.
Wolf (Canis lupus)	extremely rare or locally extinct.
Sea otter (Enhydra lutris lutris)	extremely rare or locally extinct.
Northern fur-seal (Callorhinus ursinus cynocephalus)	occasional
Northern elephant seal (Mirounga angustrostris)	occasional
Roosevelt elk (Cervus canadensis roosevelti)	locally extinct, formerly in coast and Gulf Islands Biotic Area.
Fallow deer (Dama dama)	rare, introduced species; occasional on Saanich Peninsula (from adjacent Gulf Islands).
Beaver (Castor canadensis leucodontus)	rare or locally extinct.

BIRDS OF THE STUDY AREA (TABLE 7)

Wetland Habitat (W) (lakes, ponds, wet or flooded fields, bogs and some stream or streamside habitat)

Abundant or Common Characteristic Species

Name	Main Habitat	Status
Great blue heron (Ardea herodias)	lake & streamside	common resident
Canada goose (Branta canadensis)	lake	common resident and migrant
Mallard (Anas platyrhynchos)	variable	abundant resident
Pintail (Anas acuta)	fields	abundant wintering
Green-winged teal (Anas carolinensis)	variable	abundant wintering resident
American widgeon (Mareca americana)	fields, lakes	abundant wintering
Shoveler (Spatula clypeata)	fields	common wintering
Wood duck (Aix sponsa)	lakes, ponds	uncommon resident
Ring-necked duck (Aythya collaris)	lakes, ponds	common wintering
Lesser scaup (Aythya affinis)	lakes	common wintering
Common Goldeneye (Bucephala clanqula)	lakes	abundant wintering
Canvasback (Aythya valisineria)	fields, lakes	common wintering
Hooded merganser (Lophodytes cucullatus)	lakes, streams	common resident
Common merganser (Mergus merganser)	lakes, streams	abundant wintering uncommon resident
American coot (Fulica americana)	lakes, (low elevation)	common wintering rare resident
Killdeer (Charadrius vociferus)	fields	abundant resident
Common snipe (Capella gallinago)	fields	common wintering rare resident
Greater yellowlegs (Totanus melanoleucus)	variable	common wintering uncommon resident
Dunlin (Erolia alpina)	fields	common wintering common migrant

Name	Habitat	Status
Dowitcher (Limnodromus sp.)	fields	common migrant
Glaucous-winged gull (Larus glaucescens)	lakes, fields	abundant resident
Mew gull (Larus canus)	lakes, fields	abundant wintering uncommon, non-nesting resident
Common nighthawk (Chordeiles minor)	over lakes	common summer visitor
Belted Kingfisher (Megaceryle alcyon)	streamside, lakeside	common resident
Traill's flycatcher (Empidonax traillii)	over lakes, bogs	common summer visitor
Violet-green swallow (Tachycineta thalassina)	over lakes	abundant summer visitor
Barn swallow (Hirundo rustica)	over lakes	abundant summer visitor
Cliff swallow (Petrochelidon pyrrhonota)	over lakes	common summer visitor
Long-billed marsh wren (Telmatodytes palustris)	fields, bogs	common resident
Swainson's thrush (Hylocichla ustulata)	streamsides	common summer visitor
Yellow warbler (Dendroica petechia)	streamsides (residential)	common summer visitor
Yellowthroat (Geothlypis trichas)	bogs, streamsides	common summer visitor
Wilson's warbler (Wilsonia pusilla)	streamsides	common summer visitor
American goldfinch (Spinus tristis)	streamsides	common summer visitor
Uncommon Characteristic Species		
Pied-billed grebe (Podilymbus podiceps)	lakes	uncommon resident
Mute swan (Cygnus olor)	lakes (low elevation)	uncommon resident

Name	Habitat	Status
Whistling swan (Olor columbianus)	lakes	uncommon wintering uncommon migrant
Trumpeter swan (Olor buccinator)	lakes	uncommon wintering
White-fronted goose (Anser albifrons)	lakes	uncommon wintering
Snow goose (Chen hyperborea)	fields	uncommon wintering
Gadwall (Anas streptera)	lakes	uncommon wintering
Blue-winged teal (Anas discors)	lakes, fields	uncommon summer visitor
Cinnamon teal (Anas cyanoptera)	fields	uncommon summer visitor
European widgeon (Mareca penelope)	fields	uncommon wintering
Redhead (Aythya americana)	lakes	uncommon wintering
Rough-legged hawk (Buteu lagopus)	fields	rare winter visitor
Marsh hawk (Circus cyaneus)	fields	uncommon wintering
Osprey* (Pandion haliaetus)	lakes	uncommon summer visitor
Pigeon hawk (Falco columbaius)	fields	uncommon wintering
Sora (Porzona carolina)	fields	uncommon summer visitor
Pectoral sandpiper (Erolia melanotos)	fields	uncommon migrant
Short-eared owl (Asio flammeus)	fields	uncommon wintering
Vaux's swifts (Chaetura vauxi)	over lakes, fields	uncommon summer visitor
Western wood pewee (Contopus sordidulus)	streamsides	uncommon summer visitor
Tree swallow (Iridoprocne bicolor)	over lakes	uncommon summer visitor
Rough-winged swallow (Stelgidopteryx ruficollis)	over lakes	uncommon summer visitor

*Has declined due to loss of habitat.

Name	Habitat	Status
American dipper (Cinclus mexicanus)	streams and streamsides	uncommon resident
Lincoln's sparrow (Melospiza lincolnii)	streamside	uncommon migrant
Open land (O) (fields, farmland, shrubland)		
Abundant or Common Characteristic Species		
Red-tailed hawk (Buteo jamaicensis)	variable	common resident
California quail (Lophortyx californicus)	shrubland	common resident (introduced)
Ring-necked pheasant (Phasianus colchicus)	farmland	common resident (introduced)
Mourning dove (Zenaidura macroura)	shrubland	common summer visitor, uncommon resident
Screech owl (Otus asio)	variable	common resident
Common nighthawk (Chordeiles minor)	variable	common summer visitor
Red-shafted flicker (Colaptes cafer)	variable	common resident
Skylark* (Alauda arvensis)	fields	common resident (introduced)
Violet-green swallow (Tachycineta thalassina)	variable	abundant summer visitor
Barn swallow (Hirundo rustica)	variable	abundant summer visitor
Cliff swallow (Petrochelidon pyrrhonta)	variable	common summer visitor
Northwestern crow (Corvus caurinus)	variable	common summer visitor

*Apparently declining due to loss of habitat.

Name	Habitat	Status
Chestnut-backed chickadee (Parus rufescens)	variable (residential)	abundant resident
Bewick's wren (Thryomahes bewickii)	shrub (residential)	common resident
Robin (Turdus migratorius)	variable (residential)	abundant resident
Water pipit (Anthus spinoletta)	fields	common migrant uncommon wintering
Starling (Sturnus vulgaris)	fields (residential)	abundant resident (introduced)
Orange-crowned warbler (Vermivora celata)	variable	abundant summer visitor; rare nesting resident
House sparrow (Passer domesticus)	shrubland (residential)	abundant resident (introduced)
Western meadowlark (Sturnella neglecta)	fields	common migrant uncommon resident
Red-winged blackbird (Agelaius phoeniceus)	fields	abundant resident abundant migrant
Brewers blackbird (Euphagus cyanocephalus)	fields	abundant resident
Brown-headed cowbird (Molothrus ater)	fields	abundant summer visitor; uncommon resident
Rufous-sided towhee (Pipilo erythrophthalmus)	variable	abundant resident
Savannah sparrow (Passerculus sandwichensis)	fields	common summer visitor; uncommon resident
Oregon junco (Junco oreganus)	shrubland (residential)	abundant resident
Chipping Sparrow (Spizella passerina)	shrubland (residential)	common summer visitor
White-crowned sparrow (Zonotrichia leucophrys)		common summer visitor; uncommon resident

Name	Habitat	Status
Fox sparrow (Passerella iliaca)	shrubland	common wintering
Song sparrow (Melospiza melodia)	variable	abundant resident
Traill's flycatcher (Empidonax traillii)	shrubland	common summer visitor
Western wood pewee (Contopus sordidulus)	shrubland	common summer visitor
Bewick's wren (Thryomanes bewickii)	shrubland	common resident

Uncommon Characteristic Species

Marsh hawk (Circus cyaneus)	fields	uncommon wintering
Pigeon hawk (Falco columbarius)	fields	uncommon wintering
Sparrow hawk (Falco sparverius)	variable	uncommon resident
Short-eared owl (Asio flammeus)	fields	uncommon wintering
Vaux's swift (Chaetura vauxi)	variable	uncommon summer visitor
Yellow-shafted flicker (Colaptes auritis)	variable	uncommon wintering
Tree Swallow (Iridoprocne bicolor)	over fields	uncommon summer visitor
Northern shrike (Lanius excubitor)	variable	uncommon wintering
Lapland Longspur (Calcarius lapponicus)	fields	uncommon migrant
Snow bunting (Plectophenax nivalis)	fields	uncommon wintering uncommon migrant

Forestland (F_1) (open coniferous, deciduous or mixed forest - mainly within Gulf Islands Biotic Area)

Abundant or common characteristic species

Sharp-shinned hawk (Accipiter striatus)	variable	common wintering uncommon resident
Cooper's hawk (Accipiter cooperii)	variable	common resident

Name	Habitat	Status
Red-tailed hawk (Buteo jamaicensis)	variable	common resident
Blue grouse (Dendragapus obscurus)	coniferous	common resident
Ruffed grouse (Bonasa umbellus)	mixed	common resident
Band-tailed pigeon (Columba faciata)	variable	common resident uncommon wintering
Rock dove (Columba livia)	(residential)	abundant resident (introduced)
Screech owl (Otus asio)	variable	commong resident
Common nighthawk (Chordeiles minor)	variable	common summer visitor
Rufous hummingbird (Selasphorus rufus)	variable (residential)	common summer visitor
Red-shafted flicker (Colaptes cafer)	variable	common resident
Pileated woodpecker (Dryocopus pileatus)	coniferous & mixed	common resident
Hairy woodpecker (Dendrocopos villosus)	coniferous & mixed	common resident
Downy woodpecker (Dendrocopos pubescens)	mixed	common resident
Traill's flycatcher (Empidonax traillii)	deciduous	common summer visitor
Western flycatcher (Empidonax difficilis)	deciduous & mixed	common summer visitor
Olive-sided flycatcher (Nuttallornis borealis)	coniferous & mixed	common summer visitor
Steller's jay (Cyanocitta stelleri)	mixed	common resident
Common raven (Corvus corax)	coniferous	common resident
Northwestern crow (Corvus caurinus)	mixed (residential)	abundant resident
Chestnut-backed chickadee (Parus rufescens)	variable	abundant resident
Common bushtit (Psaltriparus minimus)	variable (where ocean spray Holodiscus discolor is abundant)	common resident

Name	Habitat	Status
Brown creeper (Certhia familiaris)	mixed & coniferous	common resident
House wren (Troglodytes aedon)	variable (residential)	common summer visitor
Winter wren (Troglodytes troglodytes)	coniferous & mixed	common summer visitor
Bewick's wren (Thryomanes bewickii)	variable (residential)	common resident
Robin (Turdus migratorius)	variable (residential)	abundant resident
Varied thrush (Ixoreus naevius)	coniferous & mixed	common winter rare nesting resident
Hermit thrush (Hylocichla guttata)	coniferous & mixed	uncommon wintering
Swainson's thrush (Hylocichla ustulata)	mixed	common summer visitor
Golden-crowned kinglet(Regulus satrapa)	coniferous	common resident
Ruby-crowned kinglet (Regulus calendula)	coniferous & mixed	uncommon wintering common migrant
Cedar waxwing (Bombycilla cedrorum)	variable	common summer visitor; uncommon wintering
Solitary vireo (Vireo solitarius)	mixed & coniferous	common summer visitor
Orange-crowned warbler (Vermivora celata)	brushy forest	abundant summer visitor, rare nesting resident
Warbling vireo (Vireo gilvus)	deciduous & mixed	common summer visitor
Yellow warbler (Dendroica petechia)	deciduous (residential)	common summer visitor; common migrant
Audubon's warbler (Dendroica auduboni)	coniferous	common summer visitor

Name	Habitat	Status
Townsend's warbler (Dendroica townsendi)	coniferous	common summer visitor
Macgillivray's warbler (Oporornis tolmiei)	mixed (brushy)	common summer visitor
Wilson's warbler (Wilsonia pusilla)	variable (brushy)	common summer visitor
House sparrow (Passer domesticus)	variable (brushy residential)	common resident
Purple finch (Carpondacus purpureus)	variable	common resident
House finch (Carpondacus mexicanus)	variable (residential)	common resident
Pine siskin (Spinus pinus)	coniferous & mixed	common resident uncommon wintering
American goldfinch (Spinus tristis)	deciduous	common summer visitor, uncommon resident
Rufous-sided towhee (Pipilo erythrophthalmus)	mixed (brushy)	abundant resident
Oregon junco (Junco oreganus)	variable (residential)	abundant resident
Chipping sparrow (Spizella passerina)	variable (residential)	common summer visitor
Fox sparrow (Passerella iliaca)	variable (brushy)	common wintering
Song sparrow (Melospiza melodia)	variable (brushy)	abundant resident
Uncommon Characteristic Species		
Turkey vulture (Cathartes aura)	variable	uncommon summer visitor, abundant fall migrant
Sparrow hawk (Falco sparverius)	open	uncommon resident
Mourning dove (Zenaiduro macraura)	variable	uncommon resident
Saw-whet owl (Aegolius acadius)	variable	uncommon migrant rare nesting resident

Name	Habitat	Status
Pygmy owl (*Glaucidium gnoma*)	coniferous	uncommon resident
Yellow-shafted flicker (*Colaptes auritus*)	variable	uncommon wintering
Purple martin (*Progne subis*)	coniferous	uncommon summer visitor
Western bluebird* (*Sialia mexicana*)	mixed & coniferous	rare nesting resident
Towsend's solitaire (*Myadestes townsendi*)	mixed & coniferous	uncommon wintering uncommon migrant
Northern shrike (*Lanius excubitor*)	variable	uncommon wintering
Hutton's vireo (*Vireo huttoni*)		uncommon resident
Myrtle warbler (*Dendroica coronata*)	coniferous & mixed	uncommon migrant
Black-throated grey warbler (*Dendroica nigrescens*)	mixed	uncommon summer visitor
Western tanager (*Piranga ludoviciana*)	variable	uncommon summer visitor
Black-headed grosbeak (*Pheucticus melanocephalus*)	variable	uncommon summer visitor
Evening grosbeak (*Hesperiphona vespertina*)	coniferous	uncommon resident (eratic)
Red crossbill (*Loxia curvirostra*)	coniferous	uncommon resident (eratic)
Slate-coloured junco (*Junco hyemalis*)	coniferous & mixed	uncommon wintering
Yellow-bellied sapsucker (*Sphyrapicus varius*)	coniferous & mixed	uncommon wintering

Forestland (F_2) (closed coniferous forest - mainly within Coast Forest Biotic Area)

Common Characteristic Species

Sharp-shinned hawk (*Accipiter striatus*)	common wintering uncommon resident
Blue grouse (*Dendragapus obscurus*)	common resident

*Has apparently declined due to loss of habitat and influence of introduced aliens.

Name	Habitat	Status
Common nighthawk (Chordeiles minor)		common summer visitor
Black swift (Cypseloides niger)		common summer visitor
Pileated woodpecker (Dryocopus pileatus)		common resident
Yellow-bellied sapsucker (Sphgrapicus varius)		uncommon wintering
Hairy woodpecked (Dendrocopos villosus)		common resident
Western flycatcher (Empidonax difficilis)		common summer visitor
Western wood pewee (Contopus sordidulus)		common summer visitor
Olive-sided flycatcher (Nuttallornis borealis)		common summer visitor
Steller's Jay (Cyanocitta stelleri)		common resident
Common raven (Corvus corax)		common resident
Chestnut-backed chickadee (Parus rufescens)		abundant resident
Red-brested nuthatch (Sitta canadensis)		common resident
Brown creeper (Certhia familiaris)		common resident
Winter wren (Troglodytes troglodytes)		common resident
Varied thrush (Ixoreus naevius)		common wintering rare nesting resident
Hermit thrush (Hylocichla guttata)		common summer visitor
Golden-crowned kinglet (Regulus satrapa)		common resident
Ruby-crowned kinglet (Regulus calendula)		common wintering
Audubon's warbler (Dendroica townsendi)		common summer visitor rare nesting resident
Townsend's warbler (Dendroica townsendi)		common summer visitor rare nesting resident
Western tanager (Piranga ludoviciana)		uncommon summer visitor

Name	Habitat	Status
Pine siskin (Spinus pinus)		common resident uncommon wintering
Chipping sparrow (Spizella passerina)		common summer visitor
Golden-crowned sparrow (Zonotrichia atricapilla)		common wintering
Fox sparrow (Passerella iliaca)		common wintering rare nesting resident
Uncommon characteristic species		
Grey jay (Pepisoreus canadensis)		uncommon wintering (uncertain)
Short-eared owl (Asio flammeus)		uncommon wintering uncommon migrant
Saw-whet owl (Aegolius acadius)		uncommon migrant rare nesting resident
Black swift (Cypseloides niger)		uncommon summer visitor
Yellow-bellied sapsucker (Sphyrapicus varius)		uncommon wintering
Red-breasted sapsucker (Sphyrapicus varius)		uncommon resident
Western wood pewee (Contopus sordidulus)		abundant summer visitor
Hermit thrush (Hylocichla guttata)		uncommong wintering
Townsend's solitaire (Myadestes townsendi)		uncommon wintering
Myrtle warbler (Dendroica coronata)		uncommon migrant
Evening grosbeak (Hesperiphona vespertina)		uncommon resident
Red crossbill (Loxia curvirostra)		uncommon resident
Slate-coloured junco (Junco hyemalis)		uncommon wintering
Coastal Habitat (C_1)	(Beaches, tidal mudflats, estuaries, lagoons, shallow coastal waters)	
Common or abundant characteristic species		
Common loon (Gavia imma)	lagoons	common wintering uncommon resident

Name	Habitat	Status
Red-throated loon (Gavia stellata)	lagoons	common wintering
Red-necked grebe (Podiceps grisegena)	lagoons	common wintering rare non-nesting resident
Horned grebe (Podiceps auritus)	lagoons	abundant wintering
Eared grebe (Podiceps caspicus)	lagoons	uncommon wintering
Western grebe (Aechmophorus occidentalis)	lagoons	common wintering
Double-crested cormorant (Phalacrocorax auritus)	lagoons	common resident
Great blue heron (Ardea herodias)	tidal flats, estuaries	common resident
Canada goose (Branta canadensis)	estuaries, lagoons	common resident common migrant
Black brant (Branta nigricans)	tidal flats, estuaries	abundant migrant
Mallard (Anas platyrhynchos)	estuaries, lagoons	abundant resident abundant wintering
Pintail (Anas acuta)	estuaries, lagoons	abundant wintering
Green-winged teal (Anas carolinensis)	estuaries, lagoons	abundant wintering rare nesting resident
American widgeon (Mareca americana)	estuaries, lagoons	abundant wintering
Shoveler (Spatual clypeata)	estuaries, lagoons	common wintering
Canvasback (Aythya valisineria)	estuaries, lagoons	common wintering
Lesser scaup (Aythya affinis)	lagoons	abundant wintering
Greater scaup (Aythya marila)	lagoons & shallow coast waters	abundant wintering
Common Goldeneye (Bucephala clangula)	lagoons	non-nesting winter visitor

Name	Habitat	Status
Bufflehead (Bucephela albeola)	lagoons	non-nesting wintering visitor
Ruddy duck (Oxyura jamaicensis)	lagoons	abundant wintering
Black oystercatcher (Haemantopus bachmani)	shore (Trial Island)	common resident
Semipalmated plover (Charadrius semipalmatus)	shore	common migrant
Black-bellied plover (Sqatrarola squatarola)	shore	common wintering
Surfbird (Aphriza virgata)	rocky shore	common wintering
Black turnstone (Arenaria melanocephala)	shore	abundant wintering
Spotted sandpiper (Actitis macularia)	shore	common migrant uncommon non-nesting resident
Rock sandpiper (Erolia ptilocnemis)	shore	common wintering
Least sandpiper (Erolia minutilla)	shore	abundant migrant
Dowitcher (Limnodromus sp.)	shore, mudflats	common migrant
Western sandpiper (Ereunetes mauri)	shore	abundant migrant
Northern phalarope (Lobipes lobatus)	shore	common migrant
Glaucous-winged gull (Larus glaucescens)	variable	abundant resident
Herring gull (Larus argentatus)	variable	common wintering
California gull (Larus californicus)	variable	common migrant
Mew gull (Larus canus)	variable	abundant wintering
Bonaparte's gull (Larus philadelpia)	variable	abundant migrant uncommon summer visitor
Heermann's gull (Larus heermanni)	variable	common migrant
Common tern (Sterna hirundo)	variable	common migrant
Belted kingfisher (Megaceryle alcyon)	shore & lagoon	common resident

Name	Habitat	Status
Trumpeter swan (Olor buccinator)	estuaries	uncommon wintering
White-fronted goose(Anser albifrons)	estuaries & lagoons	uncommon winter visitor; uncommon migrant
Snow goose (Chen hyperborea)	estuaries & lagoons	uncommon winter visitor
Blue-winged teal (Anas discors)	estuaries & lagoons	uncommon winter visitor
Cinnamon teal (Anas cyanoptera)	estuaries & lagoons	uncommon summer visitor
European widgeon (Mareca penelope)	estuaries & lagoons	uncommon winter visitor
Redhead (Aythya americana)	estuaries & lagoons	uncommon winter visitor
Barrow's goldeneye (Bucephala islandica)	estuaries & lagoons	uncommon winter visitor
American Golden plover (Pluvialis dominca)	shore	uncommon migrant
Whimbrel (Numenius phaeopus)	shore	uncommon migrant
Wandering tattler (Heteroscelus incanum)	shore	uncommon migrant
Baird's sandpiper(Erolia bairdii)	shore	uncommon migrant
Sanderling (Crocethia alba)	shore	uncommon winter visitor
Western gull (Larus occidentalis)	variable	uncommon migrant
Franklin's gull (Larus pipixans)	variable	uncommon migrant
Black-legged kittiwake (Rissa tridactyla)	variable	uncommon migrant
Coastal Habitat (C_2) (Coast littoral marine waters, rocky islets and shoreline)		
Common or Abundant Characteristic Species		
Yellow-billed loon (Gavia adamsii)		rare winter visitor
Arctic loon (Gavia arctica)		common winter visitor

Name	Habitat	Status
Red-throated loon (Gavia stellata)		common winter visitor
Red-necked grebe (Podiceps grisegena)		common winter visitor; rare non-nesting visitor
Horned grebe (Podiceps auritus)		abundant winter visitor
Eared grebe (Podicepts caspicus)		common winter visitor
Western grebe (Aechmophorus occidentalis)		abundant winter visitor; uncommon resident
Dougle-crested cormorant (Phalacrocorax auritus)		common resident
Brandt's cormorant (Phalacrocorax penicillatus)		common winter
Pelagic cormorant (Phalacrocorax pelagicus)		abundant resident
Greater scaup (Aythya marila)		abundant winter visitor
Lesser scaup (Aythya affinia)		abundant winter visitor
Common goldeneye (Bucephala clangula)		abundant winter visitor
Bufflehead (Bucephela albeola)		abundant winter visitor
Oldsquaw (Clangula hyemalis)		common winter visitor
Harlequin duck (Histrionicus histrionicus)		common non-nesting resident
White-winged scoter (Melanitta deglandi)		abundant winter visitor
Surf scoter (Melanitta perpicillata)		abundant winter visitor
Parasitic jaeger (Stercorarius parasiticus)		common migrant
Glaucous-winged gull (Larus glaucescens)		abundant resident
Herring gull (Larus argentatus)		common winter visitor
California gull (Larus californicus)		common migrant

Name	Habitat	Status
Mew gull (Larus canus)		abundant winter visitor
Bonaparte's gull (Larus philadelphia)		abundant migrant uncommon summer visitor
Heermann's gull (Larus heermanni)		common migrant
Common tern (Sterna hirundo)		common migrant
Common murre (Uria aalge)		common winter visitor
Pigeon guillemot (Cepphus columba)		common resident
Marbeled murrelet (Brachyramphus marmoratum)		common resident
Rhinoceros auklet (Cerorhinca monocerata)		common summer visitor; uncommon resident
Uncommon Characteristic Species		
Common scoter (Melanitta perspicillata)		uncommon winter visitor
Western gull (Larus occidentalis)		uncommon migrant
Franklin's gull (Larus pipixcan)		uncommon migrant
Black-legged kittiwake (Rissa tridactyla)		uncommon migrant
Ancient murrelet (Synthliboramphus antiquum)		uncommon winter visitor
Tufted Puffin (Lunda cirrhata)		uncommon summer visitor
Rare, or Vagrant Species		
Fulmar (Fulmaris glacialis)	coast littoral	rare migrant
Sooty shearwater (Puffinus griseus)	coast littoral	rare migrant
Slender-billed shearwater (Puffinus tanvirostris)	coast littoral	rare migrant
Fork-tailed petrel (Oceanodroma furcata)	coast littoral	rare migrant
Green heron (Butorides virescens)	wetlands, (Lakes, bogs)	rare nesting resident

Name	Habitat	Status
Goshawk (Accipiter gentilis)	open & closed forest	rare winter visitor; rare nesting resident
Swainson's hawk (Buteo swainsoni)	open forest & fields	rare migrant
Rough-legged hawk (Buteo lagopus)	open lands (wetlands)	rare winter visitor
Golden eagle (Aquila chrysaetos)	variable	rare migrant
Gyrfalcon (Falco rusticolus)		rare winter visitor
Peregrine falcon (Falco pergrinus)	open lands, open forests	rare nesting resident
Mountain quail (Oreortyn pictus)	open forests (brushy)	rare nesting resident (introduced)
Gray partridge (Perdix perdix)	open lands	rare nesting resident
Sandhill crane (Grus canadensis)	open lands	rare migrant
Virginia rail (Rallus limicola)	wetlands (bogs)	uncommon resident
Solitary sandpiper (Tringa solitaria)	wetlands (streamsides)	rare migrant
Lesser yellowlegs (Tatanus flavipes)	wetlands, coastal shore	uncommon migrant
Knot (Calidris canutus)	streamside, shore	uncommon migrant
Sharp-tailed sandpiper (Erolia ocuminata)	wetlands	uncommon
Marbled godwit (Limosa fedoa)	coastal shore	rare migrant
Ring-billed gull (Larus delowarensis)	coastal shore & waters	rare migrant
Sabine's gull (Xema sabina)	coastal shore & waters	rare migrant
Cassin's auklet (Ptychoramphus aleutica)	coastal waters	rare migrant

Name	Habitat	Status
Barn owl (Tyto alba)	open land	rare nesting resident
Great horned owl (Bubo virginanua)	open forests	rare nesting resident
Snowy owl (Nyctea scandiaca)	open land	rare winter visitor
Lewis' woodpecker (Asyndesmus lewis)	open or closed forest	resident
Western kingbird (Tyrranus verticalis)	coastal shore	uncommon
Hammond's flycatcher (Empidonax hammondii)	open forest	rare summer visitor
Horned lark (Eremophila alpestris)	open land	rare nesting resident
Clark's nutcracker (Nucifraga columbiana)	open forest	uncommon
Mountain bluebird (Sialia currucoides)	open land (shrub) open forest	uncommon
Red-eyed vireo (Vireo olivaceus)	open forest	rare summer visitor
Nashville warbler (Vermivora ruficapilla)	open forest	rare migrant
Yellow-headed blackbird (Xanthocephalus xanthocephalus)	wetland, open land	uncommon
Luzuli bunting (Passerina amoena)	open forest	uncommon
Vesper sparrow (Pooecetes gramineus)	open land (shrubs)	uncommon
Harris sparrow (Zonotrichia querula)	open forest	rare winter visitor
White-throated sparrow (Zonotrichia albucollis)	open forest (brushy, residential)	rare winter visitor

Notes

status: refers to status in the Capital Regional District study area.

abundant: easily observable on any day in the appropriate season and habitat.

common: recorded annually by most birdwatchers.

uncommon: recorded annually by at least one birdwatcher but not by most.

rare: not recorded annually by participating birdwatchers of the natural history society.

vagrant: outside the normal range of the species, very few records reported.

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RECREATION

D.R. Benn

INTRODUCTION

The recreation maps (Figures 18 and 19) present information primarily gained by examination of air photographs of the study area augmented by some field checking. Natural features are identified and little attemptwas made to survey present access to beaches or facilities such as boat launching ramps. theatres, parks and commercial recreation features. Some of these facilities are indicated on the Present Land Use map, Figure 20.

The emphasis on natural recreation features is warranted for a number of reasons. The Capital Regional District is primarily interested in obtaining information that will be useful in land use allocation decisions. The identification of natural recreation features, their distribution and extent, may aid in the preservation of these recreation attractions during the anticipated period of urban growth in the greater Victoria area. In addition, although man-made facilities such as swimming pools are a very important aspect of recreation, the main factors affecting their creation is related to the people's willingness to pay for them. On the other hand, natural features such as beaches, vegetation, wildlife and attractive landscapes are often the product of many years of natural processes. Given moderate financial resources, the option to build a swimming pool is always open. Unplanned urbanization of an attractive landscape eliminates the option of recreation and higher quality liveability associated with natural features.

<u>The recreation features map should not be used in isolation</u>. It does not contain all the data pertinent to recreation values. The requirements for intensive use recreation facilities such as campgrounds, parking lots and other structures are similar to those for residential and commercial uses. In this regard, reference should be made to landform, soil, climate and water maps. Close

attention should be paid to other sources of data, particularly the wildlife, fishery and vegetation maps for an appropriate appreciation of greater Victoria's recreation resources (see List of Figures). Keep in mind also that this data is a first approximation only and does not eliminate the need for more detailed inventories in the future.

CONSIDERATION OF DATA

The Recreation Feature map should not be treated as complete information on outdoor recreation. The inventory was done over a short period of time and considerable difficulty was experienced in obtaining certain types of information.

(1) Indications are that considerable information on the history of the area exists. However, this information is scattered between various departments of government (federal, provincial, and local), universities, individuals and various publications. There appears to be no attempt to coordinate or synthesize this data, making it impossible to adquately cover the history of the area in a short time.

(2) Individual studies on water pollution for small areas exist but a comparative summary for the Capital Regional District is difficult to make. Therefore, water pollution was not considered a factor in assessing beach and water-based recreation. Currently, outfalls at Macaulay Point, Clover Point and Cordova Bay etc., pose serious limitations to use of greater Victoria's beaches aesthetically as well as for health reasons. In addition, a number of potential areas are rendered useless for recreational scuba diving. Pollution has resulted in the disturbance of marine life forms and reduced underwater visibility.

(3) A lack of detailed climatic information, particularly in the highlands, makes it difficult to adequately assess winter sport potential. Similarly, generalizations on water temperatures for swimming are based on very limited data.

(4) The short time of the study did not permit an orderly sequence of information gathering. Ideally, base information on landforms, soils, vegetation and climate should be made available

in advance of interpretations for recreation. In addition, the recreation personnel should be permitted to make more of an input into the base information gathering so that it is more meaningful for recreation interpretations.

THE MAPS

Two recreation maps are supplied: 1) The Recreation Features map; and 2) Recreation Significance map, Figures 18 and 19 respectively. The Recreation Feature map describes the occurrence and distribution of recreation features and by inference gives an indication of the types of recreation activities which are suitable for different units of land. The Recreation Significance map gives an indication of the importance of different units of land. The capability of the land to support recreation activities, the uniqueness of natural features, the association of features common to a site and aesthetic attractiveness of an area are the main factors determining the significance of a unit of land for recreation.

Recreation Features

Twenty-three symbols are used to describe the recreation landscape of the study area. Three are used to designate different levels of site capability for intensive use facilities; two designate important beaches; five are used to describe boating and water oriented activities; three for cultural features; two for biotic features; five for site specific upland features; and three symbols are used to designate three distinct broad upland types.

Intensity of Use

The Capital Regional District embraces approximately 250 miles of marine shoreline, 50 miles of fresh water shoreline and about 100 miles of streams. These are the critical areas for many forms of outdoor recreation and attract the greatest number of people seeking recreational enjoyment. The shorelines of the study area vary from gently sloping beaches to rugged steep bedrock exposures. Five categories are used to describe the physical characteristics of the shorelands as they relate to recreation use. Three categories, map symbols "K", "N", and "M" describe intensity of use while two categories, map symbols "B" and "G" designate beach areas.

R E C R E A T I O N F E A T U R E S

INTENSITY OF USE

K - Intensive Use Recreation - shoreland and stream-side sites where soils, landforms and vegetation are well suited to intensive use recreation facilities such as organized camping and cottaging.

N - Moderate Use Recreation - shoreland and stream-site sites with some capability for intensive use facilities but with moderate limitations of slope, soils or landform.

M - Extensive Use Recreation - shoreland and stream-side corridors suited to picnicking, viewing, exploration and photography but where more intensive recreation or facilities are not desirable.

BEACHES

B - Beaches composed mostly of sand to fine gravels offering opportunities for sunbathing and swimming as well as beachcombing.

G - Beaches composed of cobbles or irregular rocks and with good capability for beachcombing, viewing and exploration; sunbathing and swimming opportunities limited.

BOATING AND WATER ACTIVITIES

C - Canoeing

Y - Boating

U - Natural harbour and moorage potential (and/or existing marina facility).

X - Invertebrate area; clam and crab collecting

D - Scuba diving area

CULTURAL FEATURES

Z - Man-made feature

A - Archeaological site

H - Historic site

BIOTIC FEATURES

W - Wildlife observation

E - Unique and attractive vegetation

UPLAND FEATURES

V - Viewpoints and vistas

F - Waterfall

R - Landforms and erosional features with recreational value

J - Rock and fossil collecting areas

S - Winter sport potential

Q - Green Belts - areas of mostly natural landscapes such as forests and seral vegetation with good potential for extensive forms of outdoor recreation such as hiking, riding and nature interpretation.

P - Pastoral land - areas predominately of farmland; or closer to the urban centers playgrounds and vacant land. These are lands partially altered by human activity but offering potential for outdoor recreation.

8 - Urban Land - developed areas with little or no potential for outdoor recreation.

MAP NOTES

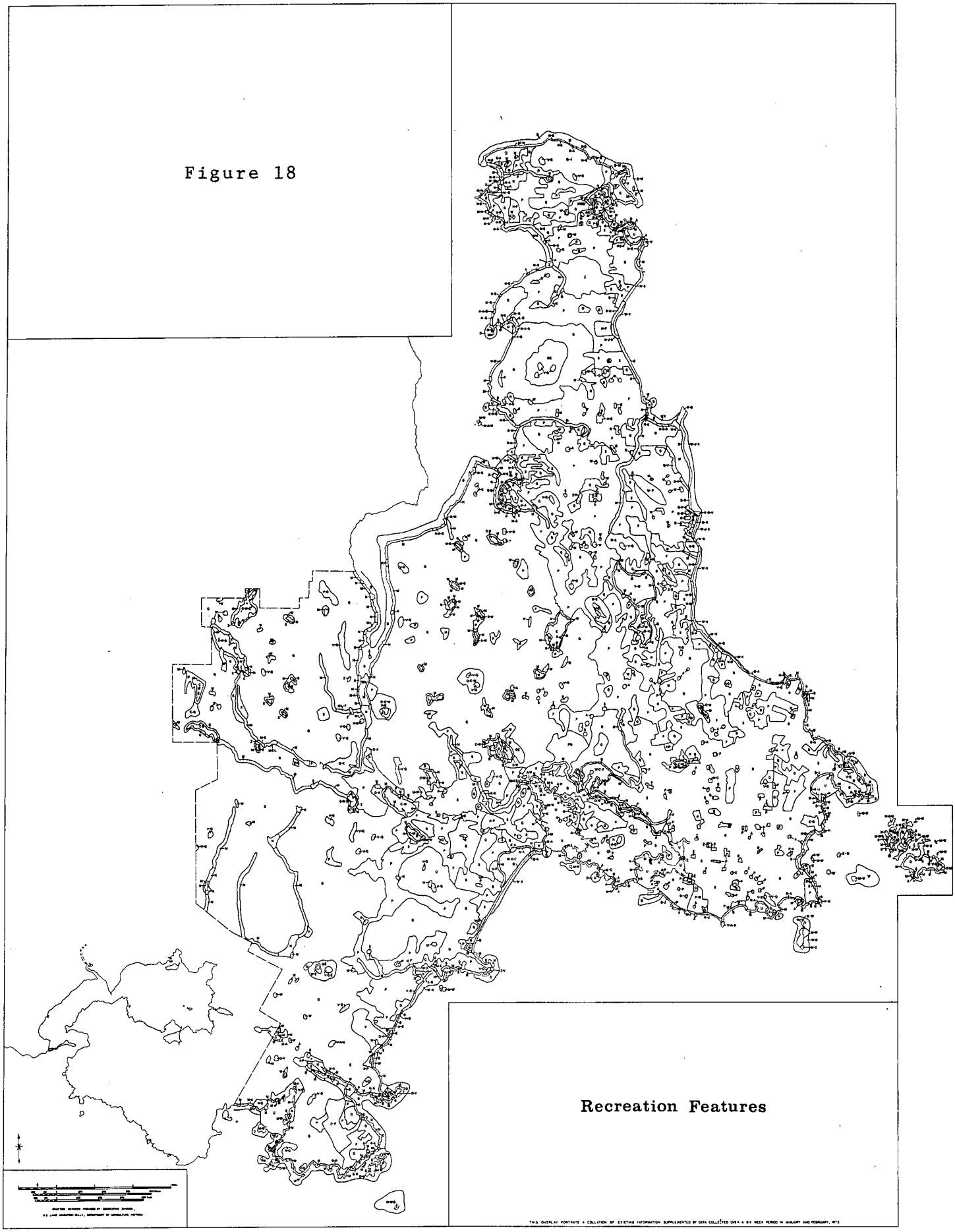
1 - See Fish Capability map for identification of sport fishing and fish run observation areas.
2 - See Natural Plant Communities map for more adequate information on unique and attractive vegetation.
3 - see Wildlife Suitability map for more complete information on wildlife values.
4 - See Present Land Use map for location of present recreation facilities such as parks, marinas, rinks, etc. The Recreation Feature map concerns itself primarily with natural recreation features and land suitability for various types of outdoor recreation activities.

SOURCES OF INFORMATION

The main source of information was from interpretation of 1:16,000 air photos taken July, 1972 supported by interviews with the Victoria City Archivist, Provincial Archeaologist and others, information supplies by the Capital Regional District study team and a limited amount of field checking.

Prepared by: Recreation Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 18



Map Symbol - K Intensive Use Recreation - These are sites ideally suited to intensive recreation use such as organized camping along the shorelands and/or stream corridors. Terrain is flat to gently sloping and materials are coarse textured and deep. There are few limitations for development into campsites, roads, parking lots, buildings, or other facilities normally associated with trailer parks, recreational lodging and campsites. An excellent example of this type of land occurs adjacent to the Goldstream River. On the Surficial Materials map, Figure 11, Intensive Use Recreation correlates with landforms identified as deep gravels.

Map Symbol - N Moderate Use Recreation - These sites have some capability for intensive use recreation but with limitations such as slopes of 10 to 20%. The shores of Prospect Lake are an example of this land type. Surficial materials are predominately volcanic rock units of low relief with pockets of coarse textured glacial till. Dispersed recreational lodging or camping could occur on the pockets of glacial till. Dispersed recreational lodging or camping could occur on the pockets of glacial materials.

Map Symbol - M Extensive Use Recreation - For the most part, the shorelands and stream corridors of the study area are unsuited to intensive recreation use. Areas of bedrock, rugged topography, and thin soils predominate along marine coasts while fine textured alluvial and organic soils are common along many streams and lakeshores. However, these areas are very attractive and offer many opportunities for extensive forms of recreation such as hiking, picnicking, viewing, photography and nature interpretation.

Beaches

For swimming and sunbathing, most of the beaches of the greater Victoria area tend to be too coarse textured (cobbles and boulders) and front on relatively cold water. However, the beaches are important for other activities such as walking, beach combing, exploration and viewing. These latter activities may occur in all seasons of the year.

The beaches of the area tend to fall into two categories: those with potential for swimming and sunbathing in the summer and those with little or no potential for swimming or sunbathing.

Map Symbol - B Indicates the limited amount of beach composed of sand or fine gravel and suitable for sunbathing and swimming. In the Victoria area the swimming season is short due to the relatively short periods of hot weather, frequent cool winds and cool water temperatures. Under ideal conditions, following several days of warm cloudless weather and with the right combination of tides and calm air, marine waters off some of the beaches may have temperatures up 77°F. However, temperatures of 55°F to 65°F are more typical during July and August.

Fresh water temperatures are somewhat higher than those for marine waters during the summer. Temperatures of 68°F to 72°F are typical for many of the numerous small lakes in the study area. However, beaches on lakes are confined to relatively small sites on Elk, Beaver and Thetis Lakes.

Some bathing also takes place in pools of creeks such as on the Goldstream River.

Map Symbol - G Applies to extensively distributed marine beach areas where opportunities for swimming and sunbathing are very restricted. The main limitations to use are cobbles and rough stones, steep offshore gradients and cold water temperatures. These areas offer excellent opportunities for gathering and collecting driftwood, shells, and rocks, for walking, wildlife viewing, photography and other extensive type activities.

Boating and Water Activities

The inventory concerns itself primarily with land resources. This fact, combined with an apparent lack of data and criteria for boating and sailing limits the usefulness of the recreation maps to give information on these activities.

Map Symbol - U Identifies natural harbours. These are bays affording natural protection from winds and waves with potential for harbour facilities, marinas and service centres for sport fishing and pleasure craft.

Map Symbol - Y (Boating) and Map Symbol - C (Canoeing) are used on the lakes and lagoons. Opportunities for power boats are excellent on the marine waters and since most of the lakes are of small size,

power boats should be discouraged on the lakes. The extensive use of the Canoeing feature symbol on the map reflects this bias. Power boats with their attendant noise and hazards are inconsistent with canoeing, row boating, wildlife observation and fishing. Elk Lake is the only body of fresh water with some capability for power boats.

Map Symbol - X Identifies invertebrate areas; beaches and tide flats with opportunities to gather clams and crabs. Amongst the better spots for clamming and crabing are Cordova Bay, Patricia Bay, Bazan Bay, Metchosin Lagoon, Saanichton Bay, Discovery and Chatham Islands and Esquimalt Lagoon. Common species include rock crabs, torge crabs, butter clams and little-neck clams. There doesn't appear to be any good opportunities to collect oysters in the area.

Map Symbol - D Indicates offshore areas suited to scuba diving. One of the most interesting areas for diving is off the shore between Pedder and Becher Bays. Like many other spots, however, divers must be experienced and familiar with local conditions due to hazardous tides. Other sites used by divers include Albert Head, International Boundary Marker off Fort Rodd Hill, Saxe Point, Ogden Point breakwater, Trial Island, Cadboro Point and Turgoose Point. It should be noted that all these areas are fairly dangerous for diving. The safest diving areas are associated with the excellent opportunities for diving in Saanich Inlet and Finlayson Arm. Yarrow and Henderson Points are particularly popular spots. The importance of diving should not be overlooked. It is a fast growing activity and takes place in all seasons of the year. Lack of public access to potential diving areas is currently the most significant problem for divers in the greater Victoria area.

Map Symbol - A Archaeological Sites. Approximately 200 archaeological sites are indicated on the Recreation Feature map. These vary from highly significant Indian encampment areas to sites yielding a limited number of artifacts. Unfortunately many of the sites have been disturbed or completely covered by modern structures. The destruction of archaeological sites could be avoided in the future by closer liaison with the Provincial Archaeologist before construction of roads, buildings and other facilities take place.

Map Symbol - Z Man-made features which have recreation interest for viewing or interpretation. An excellent example of this type of feature is the Dominion Astrophysical Observatory.

Map Symbol - H Historic Feature. Map information on historic features is incomplete. Some major historic sites are indicated but the map should not be considered the only source of historic data. It is strongly urged that a separate, detailed historic study be done by the Capital Regional District.

Biotic Features

Map Symbol - W Indicating wildlife areas and Map Symbol E indicating attractive and unique vegetation describe the location of the most significant biotic features. Reference should be made to the Wildlife Suitability, Tree Species Associations and Natural Plant Communities maps and narratives for more detailed information on biotic communities. See Table of Contents and List of Figures.

Upland Features

Map Symbol - V Viewpoints and vistas such as hilltop vantage points affording viewing opportunities of attractive landscapes. Examples include Mount Douglas and Gonzales Hill.

Map Symbol - F Waterfalls. No large waterfalls are found within the study area but a number of small attractive settings are found at Metchosin Lagoon, Niagara Creek, Goldstream River and near Durrance Lake.

Map Symbol - R Landforms and erosional features with viewing or interpretative value. The most dramatic landforms in the study area are the sea cliffs such as at Cowichan Head.

Map Symbol - J Rock and Fossil collecting. The most significant areas for rock collecting are the marine beaches. Dallasite quartz is common to many areas such as Clover Point, Island View Beach, Bazan Bay and Cadboro Bay. Jasper, Rhodonite and agate are also found. Fossils occur in the vicinity of Cloake and North Hills, while old mammoth bones and shells have been preserved in clays in Central Saanich.

Map Symbol - S Winter sport potential. The mild climate and low amounts of snow in the study area provide very limited opportunities

for skiing and other winter sports. A few hills have some tobogganning potential while higher elevation lakes may permit ice skating during periodic cold spells. These sites of limited winter sport potential are identified on the Recreation Feature map.

The Viewing, Waterfall, Landform, Rock Collecting and Winter Sport features tend to be site specific or occupy reasonably small distinct units of land. The remainder of the study area was broken into three categories which occupy very broad units of upland with no specific recreation attraction or feature.

Map Symbol - 8 Identifies built up areas, residential, commercial or industrial lands with little or no potential for outdoor recreation.

Map Symbol - P Identifies permanently altered landscapes, particularly farmland with some potential for outdoor recreation such as hiking, riding and viewing. Within the urban areas small units of P identify playgrounds and vacant lots.

Map Symbol - Q Identifies those areas with natural vegetation with good opportunities for extensive forms of outdoor recreation.

Recreation Significance

Basis of Recreation Significance

A second map, Recreation Significance, Figure 19, attempts to highlight outstanding and important recreation areas. Measuring the significance of an area for recreation is admittedly somewhat subjective and arbitrary. However, the following guidelines were used as an aid in determining recreation significance classes.

1) Recreation Capability - the ability of a unit of land to accommodate and sustain recreation use. This primarily relates to the intensity of use features.

2) Recreation Attractiveness - the ability of a unit of land to attract recreation use. Beach areas with opportunities for bathing, wildlife observation and clam digging would obviously rate higher than uplands with few attraction features.

3) Uniqueness - certain features are unique or scarce within the study region such as waterfalls, therefore, they receive a relatively high significance class. Similarly, the oak arbutus forests of the region are relatively unique provincially.

Recreation Significance Classes

Class 1 - Very High Recreation Significance. These areas have, for the most part, outstanding opportunities for a full range of outdoor recreation activities. They include the best beaches and harbour areas along the marine shores as well as the excellent upland features associated with some of the lakes and streams of the region such as the Goldstream River drainage. Public ownership and public access should be maintained or established for these highly significant areas; at present public use of many of these areas is restricted.

Class 2 - High Recreation Significance. These are relatively attractive recreation units but offering a more restricted range of recreational opportunities than Class 1 lands. Most often they are associated with the rugged and rocky coastlines or with upland areas with potential for one or few extensive recreation activities.

Class 3 - Moderate Recreation Significance. Class 3 lands are predominately composed of broad areas of forest or farmland with no specific recreation attraction but they are important areas of open space for hiking and viewing.

Class 4 - Low Recreation Significance. These areas are built-up lands or permanently committed to uses not normally compatible with popular forms of outdoor recreation.

R E C R E A T I O N S I G N I F I C A N C E

The significance of recreation features is based on capability, uniqueness and comparative attractiveness.

Class I - Very High Recreation Significance - Equivalent to C.L.I. Recreation Sector Classes 1 and 2.

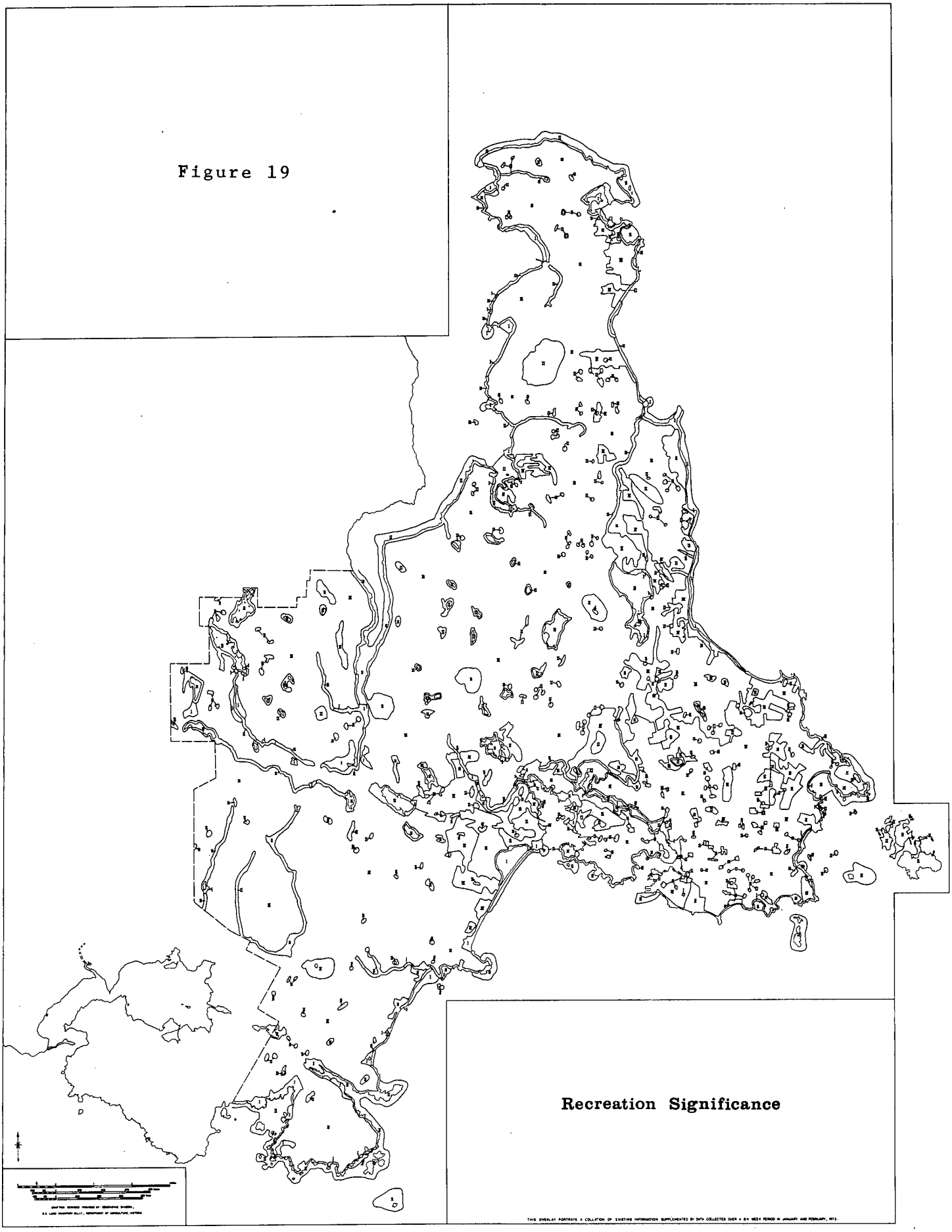
Class II - High Recreation Significance - Equivalent to C.L.I. Recreation Sector Classes 3 and 4.

Class III - Moderate Recreation Significance - Equivalent to C.L.I. Recreation Sector Classes 5 and 6.

Class IV - Low Recreation Significance - Equivalent to C.L.I. Recreation Sector Class 7.

Prepared by: Recreation Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 19



PRESENT LAND USE AND LAND USE CONSTRAINTS

Christopher V. Stanley-Jones

This narrative has been written to accompany the Present Land Use Map (Figure 20) and the Land Use Constraints Map (Figure 21). A more complete description of the legends and how they were applied is presented as well as a discussion of the limitations and qualifications pertaining to each of the maps. The Present Land Use Legend is extracted from a more complete legend and therefore, not all of the categories used in this section follow a complete numerical sequence.

PRESENT LAND USE

Urban Land

R1 Moderate to High Density Residential includes apartments, townhouses, duplexes, trailer parks and any residential complex other than a single family detached house.

R2 Low Density Residential is applied to single family detached housing.

R2(3) Residential Development and Developing Post 1970 is used to distinguish those areas of recent construction. Observations were made from field checking and aerial photographs. This category was only applied to R2 residential areas.

C Commercial includes retail shops, offices, motels, service stations and auto repair or wrecking depots (not scrap metal centres).

W Industrial includes wholesaling, warehousing, manufacturing, service industries and scrap metal centres.

J Institutional includes educational centres, government offices, and legislative buildings, prisons, federal lands (D.N.D.), churches, hospitals, cemetaries, and fire and police stations.

Y Transportation Facilities is used to describe roads, rail, air, and water facilities including port terminals and lands associated with transporation such as parking lots and motor-vehicle testing stations.

Z Utilities include power/transformer stations, communication facilities, rights-of-way and waste facilities.

E Mines, Quarries and Gravel Pits are used to map areas where extraction of earth materials occurred. All E's used in the study pertained to gravel pits.

O1 Parks, public and private facilities, include dedicated parks and dedicated historic sites and show gardens.

O2 Indoor Recreation Facilities include arenas, curling rinks, swimming pools, and theatres.

O3 Outdoor Recreation Facilities include: a) golf courses, racetracks, playing fields (including those associated with other uses particularly schools but not those within parks), horse riding academies, and general outdoor areas such as campgrounds associated with a marina; b) Marine facilities such as public access to water/beach areas and extensive beach areas used for walking, sunning, etc.

O4 Seasonal Residences includes some cottages in the area of Lands End Road and Finlayson Arm Inlet.

V Vacant Land is used to indicate those areas generally surrounded by urban development and not attached to extensive non-urban uses.

Agricultural Land

G2 Apple and Pear Orchards.

H1 Livestock Buildings include poutry, fur and dairy farm buildings and associated yards.

H2 Horticulture includes greenhouses, nurseries and truck farming or market gardening.

H3 Horticulture includes flower, bulb and holly farms.

H4 Berry crops is used to indicate strawberries, raspberries, and loganberries.

A1 Field Vegetables include extensive areas where crops such as beets, turnips, potatoes and cabbages were grown.

P1 Improved Pasture indicates those fields which were recently cropped for hay or used as pasture for livestock.

K1 Unimproved pasture is used to describe former improved pasture which has deteriorated. Frequently, K1 includes old fields

which were partially covered with scrub growth and showed an absence of cultivation. (See also qualifications and limitations section).

--K Forest Range is used in conjunction with another type symbol such as T to indicate range land within a forest area. Fences and use by livestock were the identifying features used to distinguish range land.

Woodland

T1 Mature Productive Forest Land indicates land bearing a productive forest type with at least one tree per acre greater than 11.1 inches in diameter at breast height. Mapping of T1 areas for this study was based upon Forest Cover maps and Present Land Use maps previously compiled by Canada Land Inventory in 1968/69.

T2 Immature Productive Forest Land describes those areas with immature cover. They included areas of recently logged or burnt productive land which had been artificially replanted.

T3 Not Satisfactorily Restocked Forest Land describes those areas recently logged, burnt or diseased. They have not been reforested although regeneration may have begun by natural seeding.

U2 Scrubland, a sub-category of Non Productive Woodland, is used to indicate those areas of sparsely vegetated terrain which do not fit into the Rock category. In addition, U2 indicates areas of scrub cover such as willow and dwarf conifers frequently found in wet areas.

Other

M Swamp, Marsh and Bog are used to indicate wetland areas covered with swamp or marsh type of vegetation such as reeds and other aquatic plants. It did not include areas used for grazing during dry periods.

L Rock and other Unvegetated Surfaces are used to indicate areas of exposed bedrock with virtually no vegetative covering.

S Sandflats, Dunes and Beaches indicate those areas with exposed sand surfaces and virtually no vegetative cover.

P R E S E N T L A N D U S E

A more complete description of the legend may be found in the Present Land Use narrative which describes the component parts of the categories and how they were applied during the land-use study.

Components of the legend below were extracted from a more detailed legend and therefore some of the categories may not complete a numerical sequence.

Some of the categories below may include a secondary use. Such a use, when it occurs, will be indicated by a dotted boundary and a bracketted symbol except where a unit extends into permanent water in which case only a dashed boundary will be shown.

URBAN LAND

R1	Moderate to High Density Residential
R2	Low Density Residential (Single Family Detached)
R2(3)	Residential Development and Developing Post 1970
C	Commercial
W	Industrial
J	Institutional
Y	Transportation Facilities
Z	Utilities
E	Mines, Quarries and Gravel Pits
01	Parks
02	Indoor Recreation Facilities
03	Outdoor Recreation Facilities
04	Seasonal Residences
V	Vacant

AGRICULTURAL LAND

G2	Apples and Pears
H1	Livestock Buildings - Poultry, Fur Farms, and Dairy Barns
H2	Horticulture- Greenhouses, Nurseries, and Tree Farms
H3	Horticulture - Flower, Bulb, Holly, and Xmas Tree Farms
H4	Berry Crops
A1	Field Vegetables
P1	Improved Pasture - Hay, Alfalfa, and Permanent Pasture
K1	Unimproved Pasture
--K	Forest Range (Used in conjunction with another type symbol. e.g. T_2K)

WOODLAND

T1	Mature Productive Forest Land
T2	Immature Productive Forest Land
T3	Not Satisfactorily Restocked Forest Land
U2	Scrubland

OTHER

M	Swamp, Marsh, and Bog
L	Rock and Other Unvegetated Surfaces
S	Sandflats, Dunes, and Beaches
X	Permanent Water Surfaces

Source Material

Forest Cover Map (Goldstream Watershed, Malahat and Goldstream Land District, Greater Victoria Water District. Scale: 4 inches = 1 mile, 1964.

C.L.I. (B.C.), Present Land Use Project, Scale 1:50,000 (92B/5W, 6W, 11W and 12W), 1968 - 1969

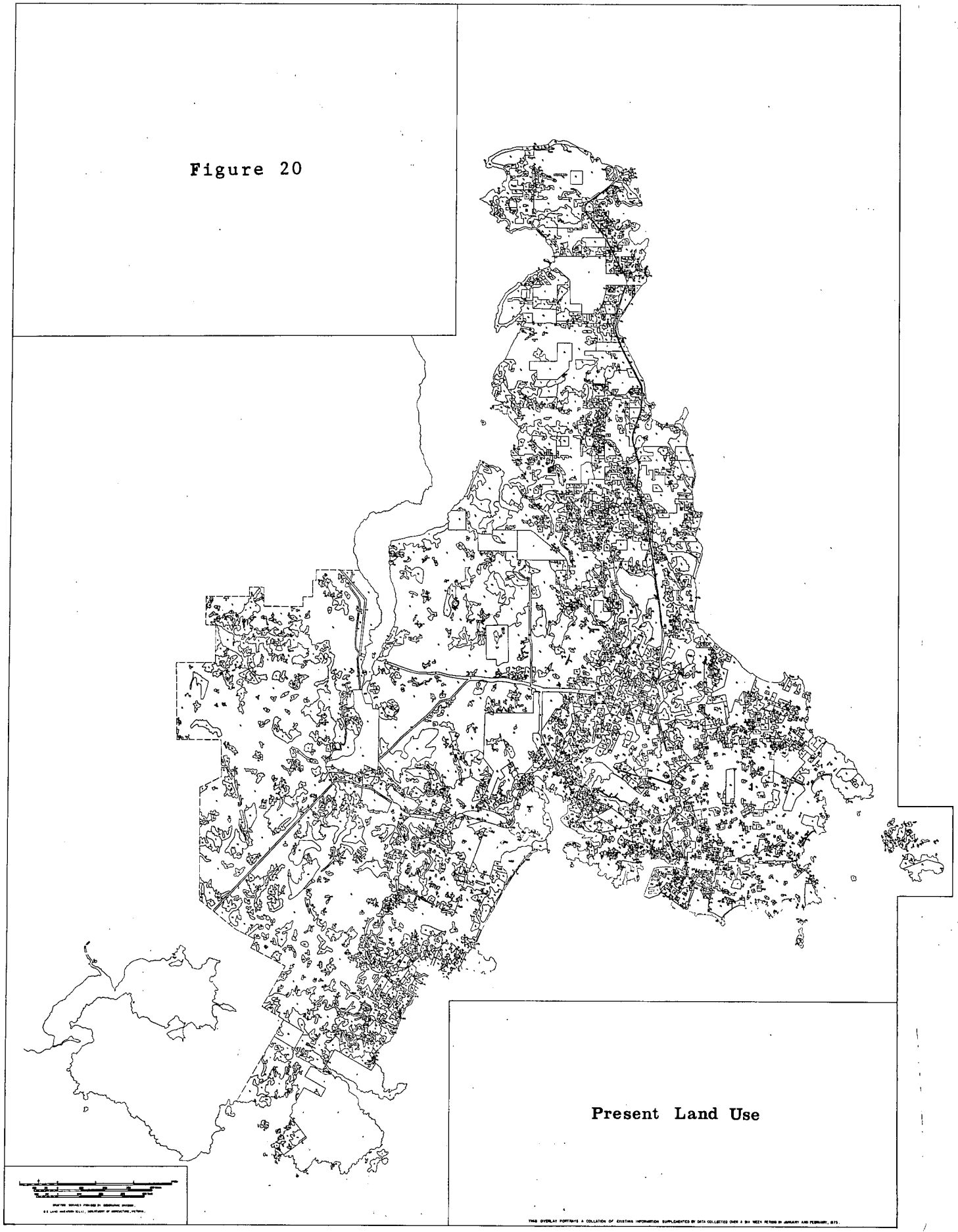
Land Use Maps (Large scale sheets supplied by the Capital Regional District), 1972

Provincial Aerial Photography, 1971 and 1972.

Field Checking, 1973.

Prepared by: Geographic Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 20



Present Land Use

X Permanent Water Surfaces include lakes, ponds, and other permanent water bodies large enough to map. Boundaries for the lakes and streams are based upon the low-water mark whereas the high-water level is used for reservoirs and tidal areas.

Qualifications and Limitations

Duplexes cause some problems in R1 (High Density Residential) and R2 (Low Density Residential). These difficulties are:

1. Duplexes can be scattered through single family dwellings and these are not easily distinguished.
2. Duplexes within the R1 category may be sparsely spaced and result in lower density than some R2, single family areas.

Some of the Apple and Pear Orchards (G2) appeared to be in a state of decline and showed little sign of cultivation or prunning. Unimproved Pasture (K1) was used in a broader sense than literally pasture. It is, at times, used to map clearings in forested regions which may be essentially bedrock covered with short grass or moss.

Under the Woodland category, caution should be used in defining Mature Productive Forest Land (T1), Immature Productive Forest Land (T2) and Not Satisfactorily Restocked Land (T3) boundaries. These categories were defined in past work and the units were identified from forest cover maps which were amended to indicate recently logged regions (T3). There is a fine distinction between T1 and T2 forests - basically age of trees and size. In addition, some T2 areas recently logged but replanted have virtually the same appearance as some of the T3 units.

There is a subtle difference between some of the Marsh (M) and Scrublands (U2) units. The latter may appear to be a swamp and within surface water but the vegetation is generally dense brush whereas M limits the vegetation to aquatic plants and shrubs.

Only a small indication of Sand (S) units occur because many of the sand beaches are mapped as Outdoor Recreation (O3).

LAND USE CONSTRAINTS

Discussion of Legend: Qualifications and Limitations

There are anumber of factors which might restrict the use of land whether they be legal/administrative boundaries or existing

use in a physical sense. As a derivative of the Present Land Use and Agriculture Capability maps and additional available information, a Land Use Constraints Map was compiled*.

Not all of the possible constraints were mapped and of those indicated, only one per unit is assigned. For example, the use of an Indian Reserve (IR) may have an additional constraint such as being within prime agriculture land. In such a case, only the IR category will be shown. It was the intent of the author to indicate only the major constraints to development of the land for alternate uses. Prime agriculture land was considered a restraint at the time of mapping because of a recent land freeze and pending legislation at the provincial level**.

Within the agriculture capability ratings, complexes of capabilities have been used for many units within the study area. As a result, the Land Use Constraint map uses two categories for agriculture land. A1 includes those lands with an agriculture capability class of 1, 2, 3, or 4 and any complex unit with a component of one of these classes which comprises greater than fifty percent of the unit. For example, $3^{6} - 6^{4}$ would be mapped as A1. The second category, A2 is used to show complexes with less than or equal to fifty percent of the unit being class 1, 2, 3 or 4. Both A1 and A2 were defined on the basis of irrigated or drained ratings where applicable.

As such, the agricultural lands (A1 and A2) shown do not include any class 5, 6 or 7 land unless it is a component within a unit with one of the better classes (eg. $6^{6} - 4^{4}$). A more complete description of the units is shown on the Agriculture Capability map, Figure 16. That map, in turn, would need a further separation of units to isolate the components within each unit.

When considering some of the constraints, only major units were mapped. This is particularly true of the urban land which is comprised of the major residential, commercial, and industrial/ wholesale categories shown on the Present Land Use map. Similarily,

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* See Figure 21.

** By Orders-in-Council, No. 4483 (December 21, 1972) and No. 157 (January 18, 1973), the Province of British Columbia suspended all further non-agricultural development of agricultural land with a capability class of 1, 3, 3, or 4 as defined by the Canada Land Inventory. Subsequent developments have resulted in debate of Bill 42 - the Land Commission Act.

L A N D U S E C O N S T R A I N T S

A more complete definition of the categories may be found in the Present Land Use narrative.

Urban Land areas not included with the built-up core are frequently a rural residential use. That is, they are residences located on large lots or small acreages.

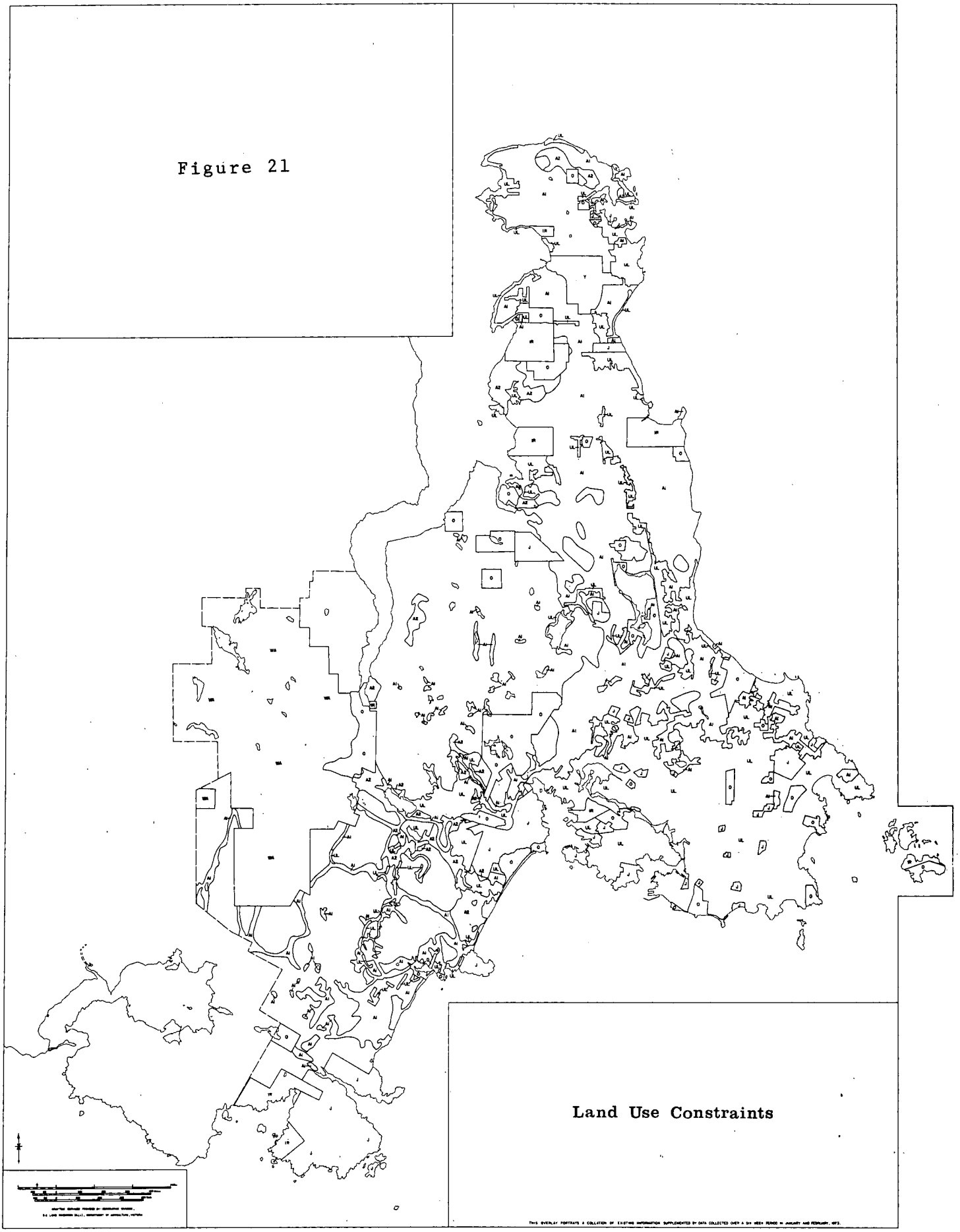
Agricultural Land categories A1 and A2 are shown for only those areas outside of the other land use contraint units.

These capabilities are based upon irrigated ratings when available.

A1	Agricultural Land - Capability Classes 1, 2, 3, or 4 and complexes with greater than 50% of one of these classes (e.g. $3^{6} - 6^{4}$)
A2	Agricultural Land which has a capability complex with less than or equal to 50% class 1, 2, 3, or 4. (e.g. $6^{6} - 4^{4}$)
IR	Indian Reserves
J	Institutional Land (D.N.D., Educational, Government, etc.)
O	Parks and Gold Courses
UL	Urban Land (Residential, Commercial, Industrial/Wholesale)
Y	Transportation Facilities
WA	Watershed Areas

Prepared by: Geographical Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 21



only the major parks and golf courses (O) are shown. The latter, may or may not present a real constraint but they do frequently occupy large areas.

The major Institutional Features (J) such as government reserves indicate the extent of these units within the region. They present a real constraint under existing policies and yet some of the relatively undeveloped areas have a potential for alternate uses.

Both major Transportation Facilities (Y), the Victoria International Airport and the B.C. Ferry terminal at Swartz Bay restrict other uses. Likewise, the Greater Victoria Water Supply Area, indicated as WA, is shown because of the present restrictive policy for other uses within the watershed. Smaller reservoirs and storage areas were not shown although it is recognized that these too present similar restraints.

Greenbelt areas are not indicated nor are foreshore leases. All of the aforementioned constraints curtail other users and likewise physical characteristics must be considered. These constraints and alternate capabilities as indicated by other co-operators in this report can be used collectively to determine the type of use desired and whether it is capable of being developed within reasonable means.

ACKNOWLEDGEMENTS

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Miss C.M. Redmond (Assistance with legend and field work).
Drafting staff

II. Capital Regional District (Supply of large scale land use maps.

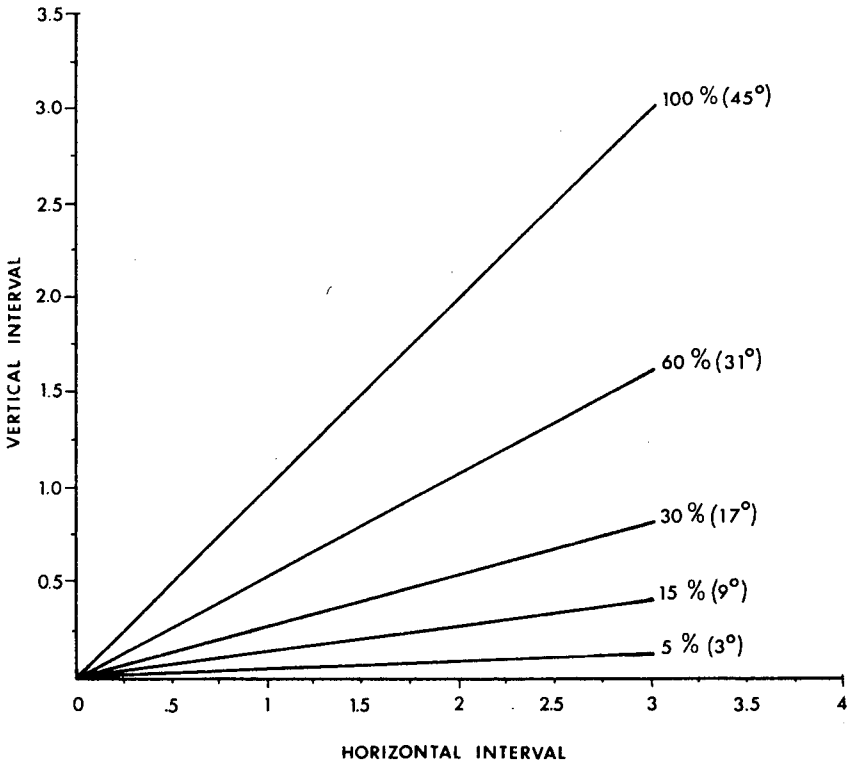
SLOPE CLASSIFICATION

Editors' Note

The Slope Classification Map, Figure 23, was produced from topographic maps and a conversion rule to calculate the percentage slope.* There are two schools of thought regarding expressing slope as a percentage or as an angle in degrees relative to the horizontal. Figure 22, illustrates the comparison between slopes expressed as percentages or degrees and visually shows the angles as used on the Slope Classification Map.

SLOPE CONVERSION

Figure 22



The slope map shows the variety of topographic relief within the study area and gives some indication of those areas where urban development may be more costly because of excessive slope. It is generally felt that any slopes over 30% would require special development practices. Development on these slopes would require careful

*J.I. Sneddon, N. Cukor and L. Farstad, "A technique for Rapidly Determining Topographic Class from Topographic Maps", Canadian Journal of Science, 52:518-519 (October, 1972).

S L O P E C L A S S I F I C A T I O N

* TOPOGRAPHIC CLASS SLOPE DESCRIPTION

1. Flat to Gently Rolling (0 - 5%) - Topography favourable for most uses. Surface drainage may be a problem in some areas.

2. Gently Sloping (5 - 15%) - Topography favourable for most uses. The steeper portions of complex slopes are too steep for most agriculture.

3. Moderately Steep (15 - 30%) - Topography favourable for most urban development, but cost of servicing and maintenance of services noticeably higher than classes 1 and 2 . Too steep for most agriculture.

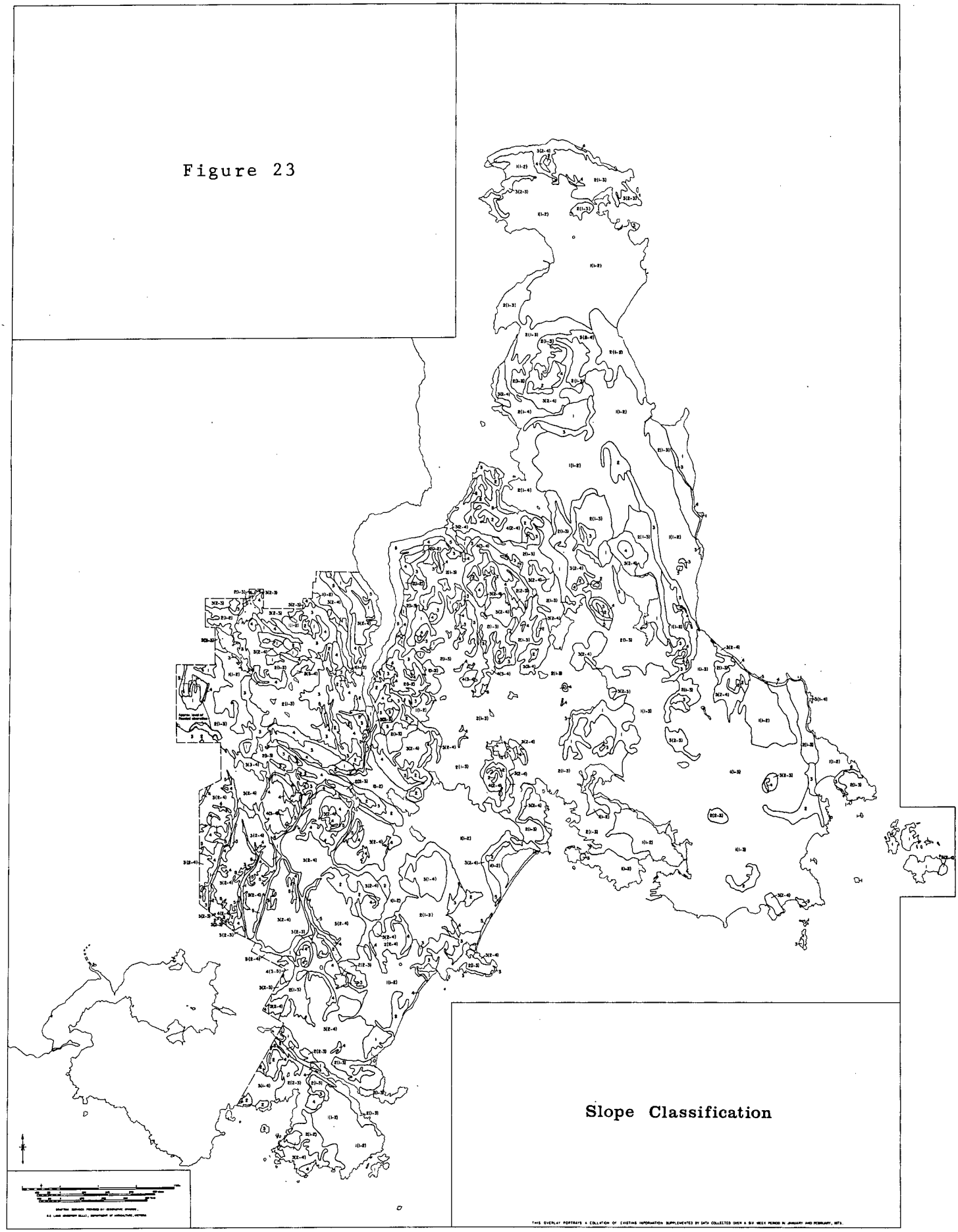
4. Steep (30 - 60%) - Topography unfavourable for most urban development. Cost of servicing and maintenance of services are very high. Too steep for agriculture.

5. Very Steep (60+%) - Topography unfavourable for urban development and agriculture. Exposed bedrock and cliff areas are common.

* Map units which have considerable variability in slopes are termed complex slopes. The range in slope in such units are shown in brackets following the main topographic class designation.

Prepared by: Wildlife Division, B.C. Land Inventory, Department of Agriculture, Victoria, B.C.

Figure 23



consideration of factors such as access position or type, supply of services and construction of building with regards to additional costs and need to determine the stability of the building site.

Within the classification system, complex classes have been used to show the variability of slope within a particular class. For example, a 4 (2-4) unit includes slopes ranging from 5% to as much as 60% but on the average, the unit is a class 4 slope (30-60%). The topographic map used in determining the slope gradient had a 25 foot contour interval and thus it follows that a variety of slopes may occur within such an interval and yet not appear on this map.