Province of British Columbia | Ministry of Environment

MEMORANDUM

To: Mr. A.P. Kohut
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Date: February 25, 1980

File: 92 B 11

Fr: Mr. M. Zubel
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Re: Saanich Peninsula Water Supply
- Groundwater Study

Introduction

At the request of J.D.C. Fuller, Chief of Engineering Division (Water Investigations Branch), in a memorandum dated September 5, 1979 to Mr. H.I. Hunter, Chief of Hydrology Division (Water Investigations Branch), an office study of the groundwater potential in the Saanich peninsula has been made; with particular reference to the maximum probable yields of the various aquifers.

The following report has been prepared from a study of available well log data, surficial and bedrock geologic maps, aerial photographs and previous reports related to groundwater conditions in the Saanich peninsula.

Surficial Geology

The surficial geology of the Saanich peninsula as shown in Figure 1, has been adapted from geologic mapping by Clapp (1915), Halstead (1967), and soils mapping of Day et al, (1959).

According to Halstead (1967), the Saanich peninsula has been subjected to at least three major glaciations. Deposits related to the final (Fraser) glaciation are widespread and well exposed. According to Halstead (1967), the general sequence of depositions of this final stage is as follows:

1) Prior to the final glaciation, outwash from meltwaters of the Cowichan Ice tongue deposited silt, sand and gravel across the Saanich peninsula.

2) The final Vashon ice advance removed some of the earlier deposits; and upon retreat, deposited till across much of the Saanich peninsula. The Vashon till overlies the older unconsolidated deposits or

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bedrock below elevations of about 400 feet.

3) Upon deglaciation, the Saanich peninsula which had been isostatically depressed, was covered by the sea to a depth of approximately 275 feet above present sea levels. Following the retreat of the Vashon ice, marine and glacio-marine deposits (silts and clays) accumulated over the Saanich peninsula, blanketing much of the area.

4) As the land rose, the seas regressed and peat accumulated in undrained depressions.

Groundwater Potential From Surficial Aquifers

Figure 2 has been prepared to show the probable extent and maximum probable well yields of the various major sand and gravel aquifers in the Saanich peninsula; as well as the locations of all known wells completed in the sands and gravels with reported yields in excess of 10 USgpm. Outlines of the aquifer boundaries are based upon the known extent of permeable sand and gravel deposits as determined from the surficial geology, well log data and previous investigations (eg. Halstead, 1967; Callan, 1968; Livingston, 1961; and Forster, 1975). The major groundwater aquifers in the peninsula are as follows:

(a) Cordova Bay Aquifer

This aquifer extends from the north side of Mt. Douglas to the north-east end of Elk Lake. It underlies a terrace ridge averaging 2,500 feet in width and a length of approximately 13,000 feet. Gravel pits within this ridge show 15 feet of sandy Vashon till overlying about 80 feet of poorly sorted horizontally bedded gravels, which in turn overlies white to grey fine sands. Recharge to the aquifer is probably entirely from rainfall. Some runoff from the rock surface of Bear Hill may be feeding the aquifer. The estimated possible annual recharge to the aquifer is 108 million Imperial gallons. Springs at about 100 feet elevation occur along the east side of the ridge.

In 1941, the Municipality of Saanich completed 9 production wells within the aquifer. The wells were pump tested at rates ranging from 185 USgpm to 485 USgpm. The resulting specific capacities ranged between 4 USgpm/ft. to 20 USgpm/ft. of drawdown. A pumping test, carried out on two wells at a combined rate of 950 USgpm, resulted in 2 to 3 feet of interference drawdown in neighbouring wells located a few hundred feet away. It appears that the wells were never put into production due to silting problems, water hardness and iron problems. When piped water from the City of Victoria became available, the wells were abandoned. At present the only major user of the aquifer is the Trio Ready-mix plant, which pumps approximately 100 gpm from the aquifer, for washing gravel.

(b) Keating Aquifer

According to Livingston (1961), this aquifer is a thick terrace-like deposit of gravel and sand, located south and north of Keating Cross Road between Oldfield Road and West Saanich Road. Gravel pits along Keating Cross Road show exposures of medium to fine sands that underlie up to 100 feet of Saanich gravels which in turn are covered by about 20 feet of sandy Vashon till and/or clay. Precipitation is probably the only form of recharge to the aquifer. According to Livingston (1961) and Callan (1968), an estimated 35 million gallons of precipitation per year recharges the aquifer. Springs and flowing artesian conditions exist north of Keating Cross Road. At present, the major user of the Keating aquifer is Butler Brothers. Brentwood Waterworks District, which utilized the aquifer, recently abandoned the use of their wells.

(c) East Saanich Road Aquifer

According to Callan (1969), that portion of the elongated belt of subtill sands and gravels lying south of Hovey Road and east of the Keating aquifer is designated as the East Saanich Road aquifer. The aquifer has a known thickness of up to 150 feet and is capped by till, averaging 15 to 20 feet thick. Springs occur along the east flank of the aquifer, at an elevation of 100 feet. The total areal extent of this aquifer is approximately 1,200 acres and according to Callan (1968), it is estimated that 144 million gallons of precipitation recharges the aquifer annually. According to well log data, the aquifer is being extensively utilized for domestic and irrigation purposes.

(d) Hagan Creek Aquifer

According to Callan (1968), this aquifer is located west of Saanichton, around the head of Hagan Creek, and appears to be isolated from the East Saanich Road aquifer by a bedrock ridge at depth. The aquifer contains Quadra sand of a maximum known thickness of 70 feet and is overlain by up to 30 feet of Vashon till. Flowing artesian conditions are known to exist in the western edge of the aquifer where overflow from the aquifer (ie. springs) enters Hagan Creek. Livingston (1961) noted that extensive pumping near the creek causes a decline in the level of Hagan Creek. Callan (1968) estimates that 55 million gallons of precipitation recharges the aquifer annually. At present, the aquifer is being utilized for domestic and irrigation purposes.

(e) Cowichan Head Aquifer

The ridge along the eastern shore, running from Cowichan Head to the East Saanich Indian Reserve has been labelled as the Cowichan Head aquifer by Livingston (1961). The limited data available indicates that this area contains at least one sand and gravel zone capable of serving as an aquifer. The gravel, exposed at Cowichan Head, is high above sea level, appears dry, and is overlain by stony clay which greatly impedes recharge to the aquifer. Well log data indicates that wells in this area are not very productive.

(f) Sidney Aquifer

This aquifer is located southeast of Sidney. Marine erosion has removed the clay, till and probably much of the sand in certain areas, and produced a number of distinct terraces in the area. Recharge is from precipitation and from the northeast slope of Mt. Newton. The main users of this aquifer until 1979, were the Town of Sidney (which pumped an estimated 30 million gallons per year) and a number of farmers. Presently, various farmers are still utilizing the aquifer for domestic and irrigation purposes.

(g) North Saanich Aquifer

This limited aquifer is located immediately north of the airport. Wells drilled in this area encountered 60 feet of saturated sand and some gravel. The wells reported low to moderate yields. Livingston (1961) estimates this aquifer receives approximately 35 million gallons of recharge yearly. The aquifer is not being extensively utilized and may have good potential for further development.

Bedrock Geology

The bedrock geology of the Saanich peninsula (Figure 3) has been mapped by various geologists including Clapp (1914), Halstead (1967) and Muller (1975). According to Muller (1975), the Saanich peninsula is underlain by a variety of volcanic, intrusive, sedimentary and metamorphic rocks that have undergone deformation and faulting more than once. Various major and minor structural lineaments (eg. faults, fractures, bedding planes) that may be related to areas of moderate to high groundwater potential, are evident on aerial photographs of the region. Traces of the major lineaments have been identified by Halstead (1967) and are shown in Figure 3.

Groundwater Potential From Fractured Bedrock

Figure 3 shows the location of all known wells that have reported yields of at least 10 gpm from fractured bedrock. Out of approximately 2,500 bedrock and surficial wells known to have been constructed in the Saanich peninsula, only 300 bedrock wells (ie. 12 percent) have reported yields in excess of 10 gpm. The majority of these higher capacity wells have reported yields of less than 30 gpm, while only 11 bedrock wells had reported yields between 100 gpm and 300 gpm (max.). These reported yields however were mostly determined from preliminary short-duration tests (eg. bail test) and may be substantially less than the long term capability of the wells (as determined from long duration pumping tests).

It is evident from the above figures that the groundwater potential from the fractured bedrock throughout the Saanich peninsula is extremely variable. The yields from wells constructed in bedrock are generally low and large capacity bedrock wells are exceptions in this area.

Due to the complex nature of the fractured bedrock, it is very difficult to generally outline the areas of exceptional groundwater potential. The amount of groundwater occurring in the fractured bedrock depends upon the number, size and character of open fractures at depth. Consequently the amount of groundwater that may be extracted by a well(s) depends upon the number, size, and degree of interconnection between open water-bearing fractures that are encountered by the well(s). Hence, since the majority of fractures of fracture zones occur at depth, it is generally not possible to determine the heavily fractured zones without some kind of subsurface exploration such as geophysical surveys (ie. resistivity) or test drilling.

Attempts have been made to correlate the locations of the higher yielding wells with major structural lineaments. However, an analysis of the locations of the major lineaments with wells in the immediate vicinity of these lineaments shows that there is no consistent correlation. In fact, the yield from wells in the vicinity of the major lineaments varies from low to high.

It appears that the more productive bedrock wells have been found in areas where there are high densities of intersecting minor lineaments (as observed on aerial photographs). The more productive bedrock wells have also been found in low-areas adjacent to topographic highs, such as Mt. Newton; where the groundwater levels are high, possibly representative of regions of groundwater discharge.

Pumping Interference Effects

Pumping interference effects upon existing wells may be a problem for high producing wells, especially bedrock wells with yields in excess of 100 gpm. According to available pumping test data from specific cases, high yielding bedrock wells in the Saanich peninsula have been known to cause interference drawdowns of as much as 30 feet in wells that were as far away as 3,000 feet. The drawdown effects caused by pumping from wells constructed in surficial deposits have been less dramatic.

Pumping interference effects may also be a problem with regards to licensed watercourses. The surface waters (ie. streams, creeks, etc.) in the Saanich peninsula are presently protected and quite heavily committed under water licenses granted under the B.C. Water Act by the Water Management Branch. Extensive pumping from wells constructed within the range of interference with surface streamflows may affect the surface waters presently protected under water licenses, especially during the critical low precipitation period in the summer.

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Groundwater Quality

Since the principal recharge to aquifers is from precipitation (rain or snow melt), the quality of groundwater in the surficial and bedrock aquifers is generally very good. Various water quality analyses performed on samples of water obtained from bedrock wells indicate that the quality of groundwater in bedrock aquifers is generally good and is classified as a moderately hard calcium bicarbonate type of water. An exception to the above is a zone of brackish groundwaters extending from Patricia Bay to Tsehum Harbour (Figure 3). Deep bedrock wells (400 to 600 feet deep) in the area northeast of the International Airport have reported TDS values in the range of 1,000 to 3,100 mg/L (the maximum recommended B.C. Health standard is 1,000 mg/L). From water quality analyses of samples from these wells, it appears that the principle ion contributing to these high TDS values is chloride.

Conclusions

The foregoing report has been a summary of available data regarding the groundwater potential from surficial aquifers and fractured bedrock in the Saanich peninsula. Estimates of the potential supply of potable groundwater in Central and North Saanich range from 2,500 to 11,000 USgpm (Foweraker, 1975). However, further detailed in-depth studies are needed to obtain a more valid estimate of the potential supply of groundwater. According to Foweraker (1975), a groundwater study involving (among other things) hydrogeologic field studies, test drilling, pumping tests, monitoring, geophysical testing, hydrochemical studies and model studies could take three and one-half years to complete (minimum); at an anticipated cost of $428,000.00 (1975 dollars).

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MZ/dd

Attach.

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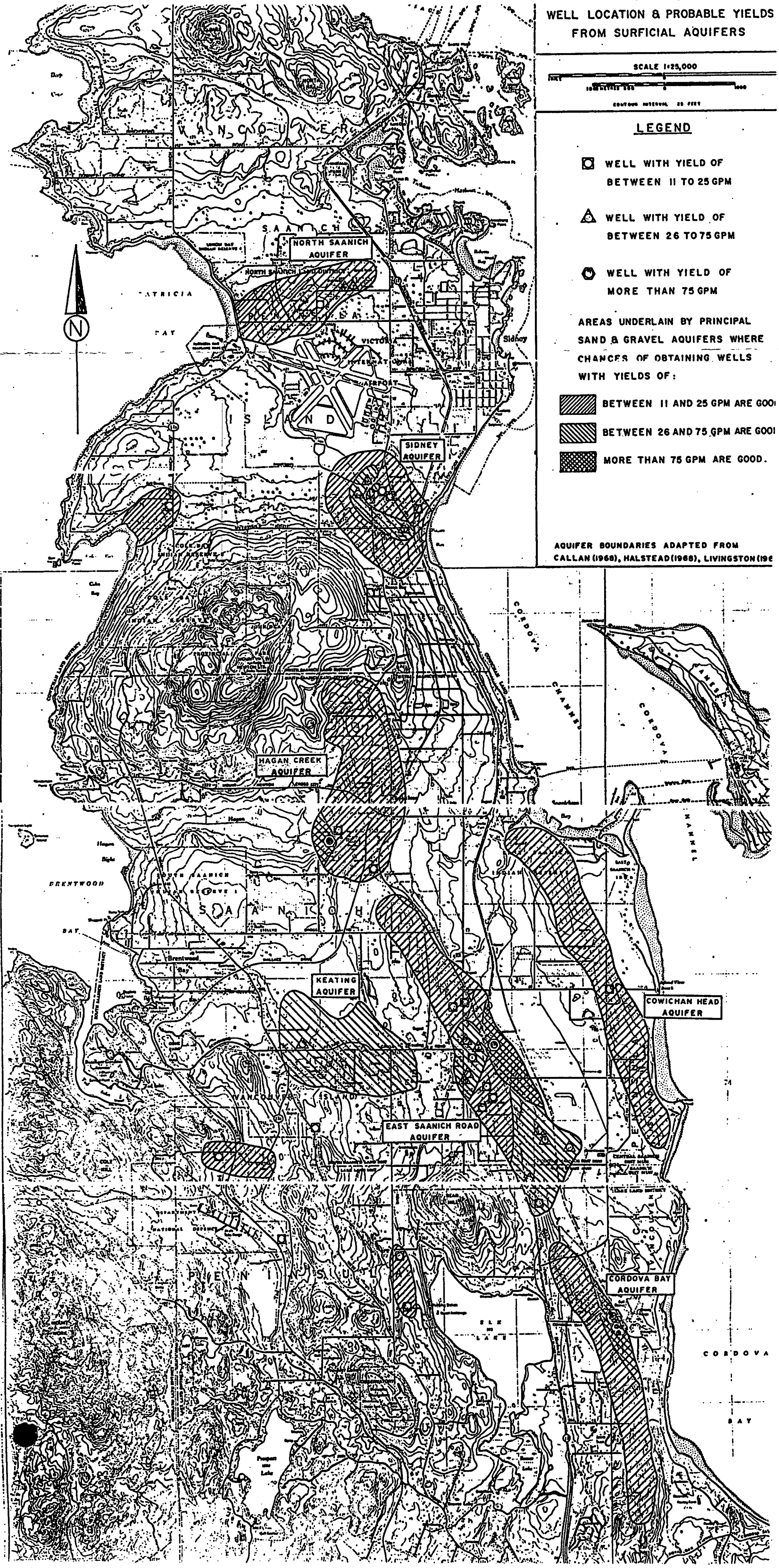
FIG. 2


WELL LOCATION & PROBABLE YIELDS FROM SURFICIAL AQUIFERS
SCALE 1:25,000
LEGEND
WELL WITH YIELD OF BETWEEN 11 TO 25 GPM
WELL WITH YIELD OF BETWEEN 26 TO 75 GPM
WELL WITH YIELD OF MORE THAN 75 GPM
AREAS UNDERLAIN BY PRINCIPAL SAND & GRAVEL AQUIFERS WHERE CHANCES OF OBTAINING WELLS WITH YIELDS OF:
BETWEEN 11 AND 25 GPM ARE GOO
BETWEEN 26 AND 75 GPM ARE GOO
MORE THAN 75 GPM ARE GOOD.
AQUIFER BOUNDARIES ADAPTED FROM CALLAN (1968), HALSTEAD (1968), LIVINGSTON (196
NORTH SAANICH AQUIFER
SIDNEY AQUIFER
HAGAN CREEK AQUIFER
KEATING AQUIFER
EAST SAANICH ROAD AQUIFER
COWICHAN HEAD AQUIFER
CORDOVA BAY AQUIFER
N
VICTORIA
AIRPORT
Sidney
BRENTWOOD
BAY
CORDOVA CHANNEL
CORDOVA BAY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ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH
DWG. No. FIGURE 3
FILE No. 92 B/11
ENGINEER M. ZUBEL
DATE DEC. 1979
BEDROCK GEOLOGY & WELL LOCATIONS
SCALE 1:25,000
CONTOUR INTERVAL 25 FEET
LEGEND
3 NANAIMO GROUP
SANDSTONE, SHALE CONGLOMERATE
2 COAST INTRUSIONS
GRANODIORITE, QUARTZ DIORITE, DIORITE, GABBRO, GRANITE
1 VANCOUVER VOLCANICS
ANDESITE, TUFF, AGGLOMERATE, VOLCANIC BRECCIA, ETC....
FAULT, FRACTURE, LINEAMENT (AFTER HALSTEAD, 1967)
WELL WITH YIELD OF BETWEEN 11 TO 25 GPM
WELL WITH YIELD OF BETWEEN 26 TO 75 GPM
WELL WITH YIELD OF MORE THAN 75 GPM
BRACKISH ZONE CHLORIDE LEVELS >200 mg/L
(BEDROCK GEOLOGY COMPILED AFTER RICE, 1959)
VANCOUVER ISLAND
SAANICH PENINSULA
Sidney
CORDOVA CHANNEL
CORDOVA BAY
BRENTWOOD BAY
ELK LAKE
GOWLAND RANGE


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ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH
DWG. No. FIGURE 1
FILE No. 92B/11
ENGINEER M. ZUBEL
DATE DEC., 1979
SURFICIAL GEOLOGY OF SAANICH PENINSULA
SCALE 1:25,000
1 MILE 0 1
1000 METRES 500 0 1000
CONTOUR INTERVAL 25 FEET
LEGEND
SAND & GRAVEL
CLAY
TILL, Sandy & Gravelly
PEAT, MUCK, Sand & MUCK
BEDROCK, Bare or Thinly Mantled
SURFICIAL GEOLOGY ADAPTED FROM CLAPP (1915), HALSTEAD (1967), DAY ET AL (1959).
VANCOUVER
SAANICH
PENINSULA
ISLAND
VICTORIA INTERNATIONAL AIRPORT
Sidney
PATRICIA BAY
CORDOVA CHANNEL
BRENTWOOD BAY
SAANICH
CORDOVA BAY
ELK LAKE
GOWLAND RANGE