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October 26, 1978.

Department of Fisheries,
Environment Canada,
1090 West Pender Street,
Vancouver, B.C. V6E 2P7.

Attention: Mr. R. Stephenson, P. Eng.

Dear Sir:

Re: Groundwater Investigation,
Mathers Creek Hatchery, Louise Island.

This letter-report describes the test drilling project at Mathers Creek and is further to several telephone discussions while the work was being carried out. A preliminary site investigation was carried out by Hugh Liebscher, hydrogeologist of the Inland Waters Directorate. His work on the geology indicated that it should be possible to obtain supplies of groundwater.

BACKGROUND

The purpose of the test drilling program on Louise Island was to establish the availability of groundwater for a proposed hatchery for enhancement of chum salmon stocks at Mathers Creek. The groundwater requirements for the facility, which vary throughout the year, are as follows:

August and September	200 igpm
October to February (incl.)	600 igpm
March and April	1000 igpm
May to July (incl.)	100 igpm

Because of the maximum water requirement of 1000 igpm, we proposed to construct 8" diameter test-production wells so that if drilling was successful two wells would be capable of yielding a combined capacity of 1000 igpm. Five sites in the Mathers Creek Watershed were designated for drilling and if drilling was not successful at Mathers Creek there was a possibility of test drilling in the alluvial fans of Iron Duke Creek and Clew Creek. As it turned out, the wells at the first two sites were capable of supplying the required amount of water so no further drilling was required.

TEST DRILLING AND WELL CONSTRUCTION

The test drilling project was carried out by Nor-West Water Well Drilling Ltd. A cable tool rig and equipment for drilling and testing were delivered to Louise Island by barge. Drilling of the first test-production well began on September 2nd. Final testing of the second production well was completed on October 14th. The job proceeded with only normal delays in spite of difficult conditions. The drilling crew came out for about a week after drilling of both wells was completed and a decision was being made re screen selection. Access to the second site was bad; a small cat was used to move around. Under difficult conditions Nor-West Water Well Drilling Ltd. have done an outstanding job. Poor air freight service also caused several unnecessary delays.

Well 78-1

The first test-production well was drilled at a site close to the Fisheries cabin on Mathers Creek. The log of the 8" diameter well is as follows:

0 - 4 ft.	stony sand
4 - 7 ft.	gravel and wood
7 - 15 ft.	gravel and boulders
15 - 20 ft.	hard gravel
20 - 25 ft.	hard till and boulders
25 - 40 ft.	cemented gravel
40 - 43 ft.	hard till and stony clay
43 - 45 ft.	cemented gravel
45 - 47 ft.	gravel
47 - 55 ft.	hard till and stones
55 - 66 ft.	gravel, sharp, waterbearing
66 - 68 ft.	sand, dry
68 - 73 ft.	hard sharp gravel
73 - 76 ft.	stony clay and till
76 - 82 ft.	gravel, hard and sharp
82 - 84 ft.	pieces of rock and balls of clay (compact clay containing gravel?)
84 - 123 ft.	gravel
123 - 128 ft.	coarse clayey gravel
128 - 130 ft.	compact gravel; no water

The static level is about 19 ft. but fluctuates with the tide. The well was completed with the following 8" nominal stainless steel well screen assembly:

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Type K packer
20 ft. of .080" slot screen
5 ft. of .100" slot screen
bail bottom set at 124 ft.

The screen assemblies of both wells were designed on the basis of sieve analyses of samples of the aquifer taken by bailer during drilling. Development was carried out by surging and bailing. Drilling was terminated when the bottom of the gravel aquifer from 84 to 123 ft. had been reached. Although the original intention was to continue drilling until bedrock was encountered, when the casing became tight in the compact gravel below the aquifer we decided to terminate drilling. The depth to bedrock at this site is therefore unknown. We think that it is not likely to be much deeper than the 130 ft. depth of the testhole.

To avoid delays while waiting for the screen, the drilling rig was moved to the second site. Drilling of the second test-production well was also successful (see below); because of the difficult access it was decided to install the screen and complete development and pump testing of the second well before moving back to the site of the first well. After Well 78-2 was completed the drilling rig was moved back to the first site and the well completed.

Well 78-2

The second test-production well was drilled at a site several hundred feet from the first well. The log of the 8" diameter well is as follows:

0 - 7 ft.	hard stony gravel
7 - 15 ft.	boulders
15 - 45 ft.	till and boulders
45 - 58 ft.	till and stony clay
58 - 67 ft.	water-bearing gravel
67 - 69 ft.	till with clay balls; water
69 - 85 ft.	gravel, water-bearing
85 - 87 ft.	dirty clay
87 - 136 ft.	gravel, water-bearing
136 - 138 ft.	silty sand with clay

The following assembly of Johnson's stainless steel 8" nominal screen and 7" I.D. pipe blanks was installed:

at top	type K packer
93 to 98 ft.	5 ft. of 0.080" slot screen
98 to 111 ft.	13 ft. of 7" pipe blank
111 to 121 ft.	10 ft. of 0.080" slot screen

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121 to 126 ft.	5 ft. of 7" pipe blank
126 to 136 ft.	10 ft. of 0.080" slot screen
at bottom	bail bottom

The blanks are used to lengthen the screen assembly while avoiding screening less desirable parts of the aquifer.

DISCUSSION

Both wells are constructed in the same non-flow artesian aquifer. The fact that Well 78-2 responded so quickly when Well 78-1 was pump confirms this. In glaciated areas of B.C. aquifers are generally not truly confined but often form part of complex leaky systems characterized by anisotropy.

We have not visited Mathers Creek. Our knowledge of local geology is based on:

1) geological mapping at 1:125,000 scale by A. Sutherland Brown, B.C. Department of Mines and Petroleum Resources, 1968, Bulletin No. 54, "Geology of the Queen Charlotte Islands, British Columbia";
2) study of air photographs;
3) subsurface information provided by drilling of the two production wells;
4) general knowledge of coastal geologic conditions from other projects carried out in the Queen Charlotte Islands, the West Coast of British Columbia and on Vancouver Island.

In both wells the aquifer is located beneath a fairly thick section of glacial, glaciomarine (?) and glaciofluvial sediments. The air photos show that Mathers Creek meanders across a broad flat valley, approximately at sea level; clearly the formation of the U-shaped valley is not related to present day Mathers Creek. The fact that the top of the water-bearing gravel in which the wells are completed is at approximately the same elevation in both wells suggests that the filling of the valley occurred quite rapidly. The thickness of the valley fill is unknown; the two wells do not reach bedrock. The gravel aquifer may be outwash associated with ice which advanced from the mountains into the sea at the time of a lower relative sea level. This, of course, is very speculative. Even with intensive field mapping it may not be possible to describe the geologic history with any certainty. More work aimed at a better understanding of the surficial geology cannot be justified for present purposes.

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An understanding of the geologic setting of the wells, however, is important in discussing the character of the aquifer. This is particularly true here when testing of the wells (see below) has shown a tidal effect.

PUMP TESTING, WELL AND AQUIFER CAPACITY

Equipment necessary for pump testing, except for the pump motor, was mobilized with the drilling equipment. When it came time for testing, the test pump motor was sent up by air freight. The test pump was supplied by a subcontractor, Aqua-Flo Testing and Equipment Ltd. who also sent up a crew to carry out the test. The pump used for testing was a single stage Tait submersible pump with 8" bowls powered by a diesel electric plant. The pumping rate was measured by means of a standard 5" diameter circular orifice on 8" diameter pipe. Drawdowns during pumping and recovery of the water levels after termination of pumping, were measured by means of electric water level indicators. Data collected during testing are appended along with standard plots of the data. During the pump test of Well 78-1 the conductivity of the water was measured during the test with a conductivity meter.

From the pump test data of Well 78-1, drawdown vs. time has been plotted on regular squared paper. This clearly shows the tidal fluctuations which occur in both wells. The maximum fluctuations are approximately the same in spite of the fact that Well 78-2 is further from shore than Well 78-1. As far as we can tell from the plots, the tidal fluctuations of both wells are in phase. We have no sea tide data so we do not know whether they are in phase with the tide. The total amplitude is about 7.3 ft., probably almost half of the tide in that area.

It is difficult to correct the data for tides in such a permeable aquifer to enable us to calculate the transmissivity. We know from the specific capacity of Well 78-1 that the transmissivity is more than 10^5 US gal. per day per ft. width; this is quite high. Well interference is small. Correcting roughly for tidal effects, the interference seems to be less than one foot after one hour of pumping at 600 US gpm. A calculation of transmissivity using corrected observation well data yields a figure of 3.5×10^5 US gal/day/ft. width.

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The conductivity of the water did not change significantly during the test. In this situation the most important constriction to the use of large quantities of groundwater over a prolonged period may be sea water intrusion. The factors which tend to favour sea water intrusion are:

1. Proximity to the sea.
2. Large tidal fluctuations in the sea.
3. Depth of the aquifer below sea level.
4. A constant high rate of pumping over a long period.

Factors which tend to minimize intrusion are:

1. Ample recharge from the land side.
2. Low permeability of material overlying the aquifer and shielding the aquifer from direct contact with the sea.

It is obvious that several of these factors are unknown. We estimate however from what we know of the geology of the area and because of the climate that the recharge from the land side is high. It is not possible to determine this absolutely. The groundwater gradient between the wells and the sea, however, might give an indication of the rate of recharge. By determining the elevation of the well casings relative to a point on the shore it should be possible to determine the seaward gradient of the water table. This would be complicated by the tidal effect.

The glacial material overlying the aquifer probably extends into the sea. It is reasonable to expect that it extends downslope into deep water. If so, this blanket of material of lower permeability will be effective in decreasing sea water intrusion and also in decreasing the thickness of the zone of mixing sea water and fresh water which occurs because of the very high tides in that area.

In our opinion it is not practical to carry out a pump test of sufficient length to find out whether sea water intrusion will occur over months of pumping. If such intrusion occurs it will be quite gradual and it will occur at Well 78-1 before reaching Well 78-2. If over a long period of pumping there is an increase in NaCl in Well 78-1 the main production can be taken from Well 78-2 while another well is constructed further inland. In any case we believe that sea water intrusion is quite unlikely. The testing shows that the capacities of the wells are much higher than the rates at which they were pumped during testing. The capacity will be limited by the size of pumps which can be installed in 8" wells. A practical limit

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is probably about 800 to 900 igpm.

If more water is required in future other wells can be constructed in this aquifer. As discussed above the limitations may be sea water intrusion. It would be wise to use the present installations for at least one year before constructing other wells nearby.

SUMMARY AND RECOMMENDATIONS

In summary:

1. A drilling program at Mathers Creek has been successful in locating an aquifer capable of supplying more than 1000 igpm of fresh water.

2. The testing indicates that the capacities of the wells 78-1 and 78-2 are each considerably more than 600 US gpm.

3. There is a large tidal fluctuation in the aquifer.

4. Sea water intrusion into this aquifer is certainly possible but is unlikely at the anticipated pumping rates.

5. More water can be obtained in future by constructing more wells in the aquifer but this should not be done until the aquifer has been in use for one year.

Yours truly,

PACIFIC HYDROLOGY CONSULTANTS LTD.

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