CANOE CREEK INDIAN BAND

HYDROGEOLOGICAL INVESTIGATION TO ASSESS THE FEASIBILITY OF DEVELOPING AN ALTERNATIVE GROUNDWATER SOURCE FOR DOMESTIC WATER SUPPLY ON DOG CREEK INDIAN RESERVE NO. 1

PACIFIC HYDROLOGY CONSULTANTS LTD.

DECEMBER 9, 1987

ATTACHMENT

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December 9, 1987

Canoe Creek Indian Band
Administration Office
General Delivery
DOG CREEK, B. C. V0L 1J0

Attention: Chief Agnes Jack

Subject: Hydrogeological Investigation to Assess the Feasibility of Developing an Alternative Groundwater Source for Domestic Water Supply on Dog Creek Indian Reserve No. 1

Dear Sirs:

The purpose of this letter is to report on our investigation of the feasibility of developing an alternative groundwater source for domestic water supply on Dog Creek Indian Reserve No. 1. Authorization to proceed with a feasibility study as outlined in our **Proposal to Provide Hydrogeological Consulting Services in Regard to the Possible Construction of a Water Well(s) for Domestic Supply on Dog Creek Indian Reserve No. 1** was received in a telephone call from Chief Agnes Jack on November 4.

1.0 INTRODUCTION

E. Livingston, P. Eng., of Pacific Hydrology Consultants Ltd. visited the Reserve on November 12. He met with Mssrs. David Archie and Earl Boston. From discussions, mostly with Mr. Archie, during our field investigation; from miscellaneous discussions with Mr. John Bolton, P. Eng., DIAND Technical Services, and also with Ms. Heidi Schreiner, Environmental Health Officer, Health and Welfare Canada, we understand that the situation with respect to water supply on Dog Creek I. R. No. 1 is as follows:

1. Dog Creek Village consists of 31 houses along with a school, a fire hall, a community hall, a Band Office and other buildings. The Village is made up of two parts: one part is spread out along the north side of the road along Dog Creek and the other part is a subdivision on the south side of Dog Creek near the eastern edge of the Reserve.

2. The Village is provided with water by a modern, gravity, water distribution system with fire hydrants; the system includes a concrete storage reservoir.

3. The source for the Village Water System is a spring in a small gulley on the north side of Dog Creek near the western edge of the Reserve. Water flows a short distance from the spring to the reservoir. The flow from the spring is not controlled; excess water overflows to the gulley. The flow of the spring is more than sufficient for the needs of the Village and seasonal fluctuations in the flow of the spring are small.

4. Tests of the water in the system have shown the presence of coliform bacteria but there is no particular pattern to the occurrence of such bacteria. The chemical quality of the water is satisfactory.

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5. Future growth of the Village is expected to take place on the southeast part of the Reserve. The projected average day demand is 48 litres per minute (10.6 igpm); the maximum day demand is 144 L/min (31.7 igpm).

In addition to E. Livingston's field visit and to the previously mentioned discussions, the following sources of information have been used in preparation of this letter-report:

1. Geological Survey of Canada Bulletin 196 by H. W. Tipper, 1971, **Glacial Geomorphology and Pleistocene History of Central British Columbia** and, in particular, Geological Survey of Canada Map 1292A, **Surficial Geology Taseko Lakes British Columbia** at a scale of 1:250,000.

2. Geological Survey of Canada Map 1505A, **Tectonic Assemblage Map of the Canadian Cordillera and Adjacent Parts of the United States of America**; scale 1:2,000,000; 1981.

3. 1:500,000 scale topographic map NTS 92O/9, **DOG CREEK.**

4. Vertical air photos, Roll A26009, No.'s 13, 15, 17, 19 and 21; scale 1:10,000; 1982.

5. Chemical and bacteriological analyses of water samples collected from the spring which supplies the Village on Dog Creek I. R. No. 1, and from wells on Dog Creek I. R. No. 2, which were provided by Ms. Heidi Schreiner of Health and Welfare Canada.

6. The log of a water well on Dog Creek I. R. No. 1 and the logs of several water wells on Dog Creek I. R. No. 2 provided by Action Drilling Ltd. who drilled the wells in 1982.

7. The log of a water well at the Dog Creek School which was provided by Groundwater Section, B. C. Ministry of Environment and Parks.

2.0 GEOLOGY

In the subject area, basaltic volcanic flows of the Chilcotin Volcanics of Miocene-Pliocene age overlie sedimentary rocks of the Marble Canyon Formation of Mississipian-Triassic ~~area~~ age. The contact between the volcanic rocks and the underlying sedimentary rocks can be seen on the north side of Dog Creek several kilometres east of Dog Creek I. R. No. 1. At the Reserve, the contact is buried under younger sediments.

Dog Creek Valley is partially filled with sediments of glacial origin. These sediments include ice contact deposits and silt lake beds with varved bedding. The varved lake beds were deposited in large lakes which formed at the end of the last glacial episode in this area about 10,000 years ago. Varves are thin beds consisting of a pair of laminae; each pair of laminae represents a yearly cycle of sedimentation. Ice contact deposits are jumbled mixtures of sand, gravel, silt and till which were deposited against melting ice at the end of glaciation.

There is evidence that the valley of the Fraser River was occupied by a huge lake which formed behind a dam of ice and glacial debris somewhere downstream at the end of the last glacial episode about 10,000 years ago. This lake, with a surface elevation about 790 m (2590 ft), extended into the lower part of Dog Creek. During this time, the Dog Creek Valley was filled with sediment - mostly lake beds - up to the elevation of the high terrace above the Village. When the downstream dam burst and the glacial lake drained down the Fraser River, water rushed out of the Dog Creek Valley and removed much of the fill. The high terraces are remnants of the fill. The log of a drilled well at the Dog Creek School shows that the fill extends below the valley bottom to a depth of at least 59.8 m (196 ft), at which depth the School Well had not encountered bedrock; another well near the eastern boundary of the Reserve was drilled to a total depth of 60.4 m (198 ft) without reaching bedrock.

At some time after the deposition and erosion of the glacial sediments in the Dog Creek Valley, a large landslide occurred on the south side of the Creek. This landslide involves the bedrock as well as the overlying post-glacial sediments. The main body of the slide consists of a hummocky area with several small sloughs on the lower end; the top (south) end is marked by a scarp of volcanic rocks. The landslide extends eastward almost from the west boundary of the Reserve to beyond the east boundary; from the scarp at the south end, it extends north to the Creek and across the Creek in the eastern part of the Reserve. The subdivision on the eastern side of the Reserve is built on the landslide which seems to be stable at the present time except, perhaps, for small areas near springs and sloughs on the lower end where there is local slumping; this opinion about the stability of the landslide is based on our rapid reconnaissance of the subject area as it affects water supply from groundwater.

.../6

3.0 GROUNDWATER HYDROLOGY AND WATER SUPPLY

The source of the water in the spring which supplies the Village on Dog Creek I. R. No. 1 is a bed of coarse gravel in a small gulley. The gravel bed, which seems to be about 0.6 m (2 ft) thick, is underlain by very compact silty lake beds. The material overlying the gravel cannot be seen; however, it is likely that the overlying material, which extends up to the terrace at elevation about 790 m (2590 ft) and about 25 m (80 ft) above the spring, also consists of lake beds. The spring flow seems to be concentrated in the gravel over an horizontal length of 10 to 15 m (33 to 49 ft). Another larger and deeper gulley lies just east of that which contains the Village Spring; however, this larger gulley is dry indicating that the gravel which yields water to the Village Spring is quite local in extent - perhaps a lens of gravel in the lake beds.

Since there is very little area on the terrace above the spring, local recharge from precipitation can be ruled out as the source of water for the spring. North of the spring, the terrace meets the outcrop of volcanic flows. It seems most likely that the source of water in the spring is water which is moving along an interflow zone in the volcanics and into the bed or lens of gravel; the spring is discharge from this gravel lens.

There is also a small spring on the south side of Dog Creek near the top end of the large landslide. The source for this spring also seems to be the volcanic rocks, which outcrop above the spring. At the time of our recent visit of November 12, this spring was flowing less than one litre per second (16 USgpm). It discharges into the western side of the largest of the ponds on the landslide. The pond has no outlet and water probably leaks out of it into the landslide; this water moves through the landslide and discharges in one active spring and several seeps and sloughs on the lower end of the landslide. The spring at the lower end of the landslide also flows at less than one litre per second; however, by constructing a collection system, it may be possible to get more than the observed flow from these springs. The fact that the springs are flowing in November after an extremely dry summer and fall certainly shows that they are permanent water sources.

The small springs on the landslide are clearly not useful for supplying the existing system at the present time. However, if the population of the Reserve increases and more houses are constructed on the south side of the Creek - particularly toward the west end of the Reserve - these springs may be useful in supplying an extended system, especially if such a system included a balancing reservoir on the south side of the Creek. At the time of our field visit of November 12, a field meter showed a conductivity in the range of 420 to 550 microsiemens for water from these springs - much less than the 800 microsiemens obtained for Dog Creek water and the 700 to 750 microsiemens obtained for water from the spring which supplies the Village. These measurements of the conductivity - which is a reflection of the total mineralization in the water - clearly show that the water from the small springs is of better quality than the water in Dog Creek and, also of better quality than that from the Village Spring.

Information on subsurface conditions in the Dog Creek Valley in the vicinity of Dog Creek I. R. No. 1 is known only from two drilled wells: a well at the Dog Creek School, which was constructed by Manville Drilling in March 1971, and a well near Dog Creek below the subdivision on the east side of the Reserve, which was drilled by Action Drilling Ltd. in September 1982. Manville Drilling reported that the well at the Dog Creek School was drilled in gravel and clay to a total depth of 59.8 m (196 ft), that it was completed as an open end pipe and that it yielded 0.8 L/sec (10 i[?]gpm). Action Drilling Ltd. reports that the well on Dog Creek I. R. No. 1 is completed as an open end pipe at a depth of 60.4 m (198 ft) and that it obtained 0.45 L/sec (6 i[?]gpm).

For individual water supply, it should be possible to construct low capacity wells in the landslide deposits and, if no permeable sediments are located in these deposits, a small quantity of water sufficient for one or two households can probably be developed from the bedrock. However, to construct drilled wells on the Reserve which have sufficient capacity to be utilized as sources of community water supply, it is necessary to locate a sufficient thickness of permeable sediment below the water table that can yield water to wells for long term pumping. The lake beds are not sufficiently permeable but there may be permeable sediments below them or within them. The presence of such permeable materials within the valley fill sediments can only be investigated by drilling. Certainly, the two aforementioned wells do not give much encouragement that an aquifer capable of supplying the needs of the Village can be located at an economical cost; however, the information provided by these two wells is not sufficient or complete enough to rule out the development of a satisfactory groundwater source from drilled wells.

4.0 GROUNDWATER QUALITY

Attached to this letter-report is a summary table prepared from chemical analyses which were provided by Ms. Heidi Schreiner, Environmental Health Officer for Health and Welfare Canada. The table includes the following fairly complete chemical analyses:

1. Analyses for water samples which were collected from the Village Spring on September 8, 1986 and March 27, 1987.
2. Analyses for water samples which were collected from drilled wells which we understand are located on Dog Creek I. R. No. 2 upstream in the Dog Creek Valley.

The two water analyses for the Village Spring are included to show seasonal water quality changes. The two analyses for water from the drilled wells are included to show the range of groundwater quality and also to compare the quality of groundwater from drilled wells in the subject area to that of the water from the Spring which presently serves the Village on Dog Creek I. R. No. 1.

The total mineralization (as conductivity) of the four water samples, as represented by the analyses in the table in the attachments, varies significantly. This results in waters of different chemical type and complexity as shown in the table which follows.

Sample Identification	Conductivity (microsiemens)	Water Type
Village Spring - Sept./86	788	magnesium + calcium + sodium/bicarbonate + sulphate
- Mar./87	699	magnesium + calcium + sodium/bicarbonate
E. Sargent Well - Nov./84	540	magnesium + calcium/bicarbonate
L. Harry Well - Jan./87	1092	magnesium + sodium/bicarbonate + sulphate

Because we have been unable to obtain details about the depth of the wells for which analyses are available, and/or about the aquifers which yield water to the wells, it is not possible to comment on the chemical analyses other than in a general way as they relate to the quality of the

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groundwater from the Village Spring. The following can be concluded about the quality of the groundwater in the Dog Creek Valley generally, and about the quality of groundwater from the spring supplying the Village on Dog Creek I. R. No. 1, specifically:

1. The groundwater in the Dog Creek Valley is very hard; this is similar to other groundwater in the Central Interior of B. C. where - for example, at 108 Mile Ranch - the hardness is known to be related to the presence of limestone.

2. The seasonal fluctuation in the quality of water from the Village Spring is relatively insignificant on a broad scale but is sufficient to change the water type.

3. The hardness and total dissolved solids from the Village Spring represent average groundwater quality in the Dog Creek Valley; groundwater of much poorer quality is known in the Valley. From our field measurements of conductivities of the Village Spring, of Dog Creek water and of water from the springs at the base of the land-slide (700 to 750, 800 and 420 to 550 microsiemens, respectively) it seems likely that the Evelyn Sargent Well, like the springs at the base of the landslide, obtains water from a more local groundwater flow system.

4. Positive features of the groundwater from the Village Spring are that it is very low in total manganese and iron which can be serious nuisances in domestic water systems.

The main concerns in regard to the quality of water from the Village Spring are pollution, as shown by the presence of coliform bacteria, and the growth of algae in the intake area. There is virtually no possibility that water from the gravel source of the spring contains coliform bacteria; therefore, the source of pollution must be from surface. An examination of the terrace above the Spring shows that it is intensively grazed by horses and probably also by cattle; old and fresh manure can be seen everywhere. It is also clear that runoff from part of this terrace area goes to the gulley above the spring from where it would join the spring water and enter the intake leading to the reservoir. Algae growth at the intake may be a source of organic carbon which shows in the analyses of water from the Spring.

5.0 COURSE OF ACTION AND ESTIMATED COSTS

Our investigation has shown that it would be difficult to improve on the present Spring water source supplying the Village on Dog Creek I. R. No. 1, providing that the intermittent pollution of the source can be remedied; however, having said this, the following alternatives, for improving the existing groundwater source or for developing an alternative groundwater source, are possible:

1. **Fence off that part of the terrace above the Village Spring to prevent domestic animals from reaching the terrace above the Spring.** Fences can be run up the slope on both sides of the gulley almost to the rock bluff allowing for east-west passage of animals near the bluff.

This would stop deposition of manure and would allow the ground cover of grasses and weeds to increase, thus reducing runoff from the area. Along with this, shallow drainage trenches could be dug near the head of the gulley to direct any runoff away from the gulley. In our opinion, the measures outlined above would completely solve the pollution problem.

2. **Carry out works at the Spring to prevent runoff water from getting into the Spring Intake.** This could be done by putting in drainage trenches as mentioned in 1. and improving the intake works to bring water from the Spring directly into the intake pipe. To achieve this, it will be necessary to excavate into the gravel where it is exposed; such excavation will not be easy to do because of the very steep slope above the gravel. Excavation in the gravel will tend to cause caving of the overlying sediments.

3. **Intercept water in the gravel before it reaches the point of discharge in the Spring.** This may be done either by:

   a. drilling one or more horizontal cased holes directly into the gravel; or

   b. drilling one or more sloping cased holes from a site below the spring to intercept the gravel north of the spring.

   Either alternative a. or b. can be carried out using recently developed equipment designed for this purpose: a machine called an Aardvark drills with casing in any direction and a plastic, partially perforated 38 mm (1½") diameter casing is placed in the hole before the casing used in the drilling is withdrawn. Alternative a. above is more difficult to carry out than alternative b., because it would be necessary to prepare access to the elevation of the gravel on a very steep slope. Alternative b. can be accomplished by setting up near the reservoir and drilling upward to reach the gravel 10 to 20 m (33 to 65½ ft) north of the discharge point of the Spring.

4. **Develop a completely new supply by drilling vertical wells.** This involves the drilling of one or more 150 mm (6") diameter test-production wells in the bottom of the Dog Creek Valley. It may be necessary to drill several holes in order to find enough (say 2½ L/sec or 40 USgpm) water for the Reserve and there is a risk that the groundwater may be of poor quality. Even, if a satisfactory aquifer with good quality water is found, pumping is required to get the water to the reservoir. The intitial cost - involving exploration, well construction, pump and pumphouse, installation of piping and powerline, and installation of controls - is much higher than any of the alternatives for improvement of the spring source. In addition, the operating costs would be higher because of the cost of electric power and maintenance.

The costs of some items of the alternatives outlined above - for example, the costs of fencing and of excavating a drainage trench - are dependent on local costs and are somewhat difficult to estimate. However, we believe that the estimates which follow are realistic:

1. Construct a fence on the terrace above the Spring

a. Material	$ 1,000.
b. Labour	3,000.
c. Dig 100 m of shallow trench	500.
	$ 4,500.

2. Improve the Spring Intake to prevent inflow from the gulley

a. Material	$ 500.
b. Labour	3,000.
c. Dig 100 m of shallow trench	500.
d. Engineering, supervision, reporting, etc.	2,000.
	$ 6,000.

6.0 SUMMARY AND CONCLUSIONS

From our investigation of the water supply situation on Dog Creek I. R. No. 1, as discussed in this report, we summarize the main points and conclude the following:

1. The Village on Dog Creek I. R. No. 1 is provided with water of good chemical quality from a modern gravity water system whose source is a Spring. System sotrage is not sufficient to satisfy insurance underwriters but is otherwise adequate.

2. The main growth of the Village is expected to be in the southeast part of the Reserve which is located on an old landslide. This area is served with water from the Village System.

3. Samples taken for bacteriological testing show that coliform bacteria have occasionally been present in the water from the Village Spring, particularly during times when surface water runoff occurs in fall and spring.

4. There is virtually no possibility that bacteria exist in the source of the Spring, which is a bed or lens of gravel in silty lake beds. The source of bacterial pollution is probably surface runoff from the terrace above the Spring which is a pasture for domestic animals.

5. Springs in the landslide area may be of interest in the future if the main Village growth continues to be on the south side of Dog Creek. The capacity of these springs is not large but the water quality seems to be good.

6. Logs of drilled wells in the Dog Creek Valley show that it is possible to obtain groundwater from the thick valley fill. The information on groundwater availability from the valley fill sediments is not very detailed but indications are that an aquifer is likely to be at a depth about 61 m (200 ft) and that well capacities are not likely to be very high.

7. It is possible to deal with the pollution problem at the Village Spring by:
   a. fencing the area above the Spring to prevent pollution;
   b. improving the Spring Intake;
   c. drilling inclined holes into the gravel lens to intercept water before it reaches the Spring;
   d. developing an entirely new groundwater source by constructing one or more wells in the bottom of the Valley.

   The costs of these alternatives are estimated to be **$4,500.**, **$6,000.**, **$13,500.**, and **$23,500.**, respectively.

8. We conclude that the present water system serving the Village on Dog Creek I. R. No. 1, which uses a Spring above the western end of the Village, is difficult to improve upon and that action should be taken to improve this source to eliminate the intermittent pollution.

7.0 RECOMMENDATIONS

From our investigation of the water supply situation on Dog Creek I. R. No. 1, we recommend the following course of action:

1. Protect the Village Spring from pollution by carrying out alternatives 1. and 2., described on Pages 12 and 13, as follows:
   a. fencing off the area above the Spring;
   b. digging a shallow ditch to catch and divert any runnoff away from the gulley in which the Spring is located;
   c. improving the Spring Intake area.

.../18

2. If, for any reason, the recommendation outlined in 1. is not acceptable, carry out the drilling of inclined holes to intercept water in the gravel lens before it reaches the Spring.

Yours truly,

PACIFIC HYDROLOGY CONSULTANTS LTD.

E. Livingston

E. Livingston, P. Eng.

Attachment

SUMMARY OF GROUNDWATER QUALITY IN THE DOG CREEK VALLEY

Constituent		DOG CREEK I. R. NO. 1 VILLAGE SPRING		WELLS ON DOG CREEK I. R. NO. 2(?)	
		Sept. 8, 1986	Mar. 27, 1987	Evelyn Sargent Nov. 21, 1986	Lilly Harry Jan. 19, 1987
PHYSICAL PARAMETERS					
pH		8.28	8.29	8.10	7.94
Conductivity (micromhos/cm)		788.	699.	540.	1092.
True Color [Pt-Co Scale](Cu)		<5.	<5.	<5.	<5.
Turbidity (NTU)		0.35	0.58	<1.0	3.3
Hardness (mg/L)		336.	208.	339.	435.
DISSOLVED ANIONS (mg/L)					
Alkalinity: Bicarbonate	HCO_3	346.	353.	399.	372.
Carbonate	CO_3	Nil	Nil	–	Nil
Hydroxide	OH	Nil	Nil		Nil
Chlorides	Cl	3.97	1.00	<0.50	1.5
Sulfates	SO_4	96.0	57.5	24.0	230.
Nitrates and Nitrites	N	0.62	0.91	0.13	0.032
Fluorides	F	0.11	0.091	0.18	0.11
Phosphorus	P	<0.02	–		
Ammonia	as N	0.012			
Total Organic Carbon	C	1.8	4.2		
DISSOLVED METALS (mg/L)					
Calcium	Ca	34.6	30.0	52.0	46.5
Magnesium	Mg	59.3	53.2	51.0	75.8
Sodium	Na	36.3	32.1	6.42	61.6
Potassium	K	3.45	3.94	1.83	4.60
Iron	Fe	<0.030	<0.030	<0.03	<0.030
Manganese	Mn	<0.003	<0.003	<0.005	0.14
Silica	SiO_2	22.9	23.6	18.0	12.1
Copper	Cu			0.027	
Lead	Pb			<0.05	
Zinc	Zn			0.051	
Cadmium	Cd			<0.002	
TOTAL METALS (mg/L)					
Iron	Fe	<0.030	<0.030	<0.03	0.31
Manganese	Mn	<0.003	<0.003	<0.005	0.14
Arsenic	As	0.002	0.001		0.003
Barium	Ba	0.010	0.017		0.007
Cadmium	Cd	<0.001	<0.001		<0.001
Chromium	Cr	0.009	<0.010		<0.02
Copper	Cu	<0.001	<0.001		<0.015
Lead	Pb	<0.001	<0.001		0.001
Zinc	Zn	<0.010	<0.010		0.13

Sources of information:

(1) – Can Test Ltd. File No. 13291F; October 7, 1986.
(2) – Can Test Ltd. File No. 2654G; April 23, 1987.
(3) – Analytical Service Laboratories Ltd. File No. 1428A; November 30, 1984.
(4) – Can Test Ltd. File No. 1683G; February 4, 1987.