PROJECT NUMBER W705104

EVALUATION OF FEASIBILITY OF RECONSTRUCTING THE GROUNDWATER INTAKE OF YARROW WATERWORKS DISTRICT

Prepared for

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Attention: Mr. John W. Wedler, P. Eng., President

Subject: **Evaluation of the Feasibility of Reconstructing the Groundwater Intake of Yarrow Waterworks District**

Dear Sirs:

1.0 INTRODUCTION

The purpose of this letter is to report on the results of a preliminary investigation carried out to assess the feasibility of replacing or reconstructing an existing infiltration gallery in the Vedder River with a facility that has higher capacity. It is further to discussions onsite on June 30, 1995 among: Mr. Lazlo Kocsis, Operations Manager of Yarrow Waterworks District; John Wedler, P. Eng., of J.W. Wedler & Associates Ltd. (JWWAL); and, Ed Livingston, P. Eng., Associate Consultant of Pacific Hydrology Consultants Ltd. (PHCL). It is also further to several telephone discussions between Ann Badry, P. Geo., Hydrogeologist/Manager. All of the discussion concerned the present condition of the waterworks intake and pumping facilities and what might be done to improve them.

In preparation of this letter-report, the following documents have been considered:

1. JWWAL Drawing No. C5-1115-1-1, "Site Plan, Intake and Pump Station", of scale 1:1000, dated February 1995.
2. N.T.S. Map 92G/1, **Mission**, of scale 1:50,000, with a contour interval of 20 metres.
3. Geological Survey of Canada Map 1487A, **Surficial Geology Chilliwack (West Half)**, of scale 1:50,000.
4. Records of four drilled water wells obtained from Groundwater Section of B.C. Environment.

From the above-mentioned documents, from the discussions between Wedler and Badry, from the onsite discussions among Wedler, Kosic and Livingston during the site investigation, we understand that the situation concerning the Yarrow Waterworks groundwater intake is as follows:

1. The main source of water for Yarrow Waterworks District is an unnamed perennial creek on the northwest slope of Vedder Mountain. Flow from the Creek feeds storage reservoirs from which water flows to the distribution system by gravity; the water is chlorinated at the reservoir.

2. A buried intake pipe and pump house located at the north end of Wilson Road on the flood plain of Vedder River is used to meet occasional summer peak demands, to provide fire flows and to provide water to the system during emergencies. The facility consists of a two-metre diameter sump located inside the pump house; the sump extends 6.29 metres deep below the pump house floor. From the sump, a 300 mm diameter intake pipe extends about 33 m north under a small pond created by damming an inlet channel that extends about 150 m northeastward to an inlet culvert in the Vedder River. From the end of the intake pipe, three parallel perforated pipes, about 10 metres long extend and are buried under the pond. The dam is constructed of a log and gravel; the pond is about one metre deep. Two Deming turbine pumps deliver water from the sump into the distribution system against system pressure of about 100 psi. The pumps, which can be operated individually or in parallel, are controlled manually during periods of high demand; the two pumps have a combined operating capacity of about 31.8 *l*/sec (420 i(?)gpm). Gaseous chlorine is metered into the sump when the pumps are running.

3. A few drilled wells have been installed on the Vedder River floodplain but they are reported to yield water which is very high in dissolved iron.

   Records show that the well closest to the existing facility is one on the west side of Wilson Road at a distance about 300 m (980 ft) south of the pump house. It was drilled in 1958 by G&G Well Drillers. The record is difficult to read but the "Owners Name" seems to be "Yarrow Test #1"; if so, it may have been a test hole drilled in a search for water for Yarrow Waterworks District. In any case, it was called a dry hole and was abandoned; the drillers litholog of sediments encountered in the test hole is as follows:

0.0 - 3.4 m	(0 - 11 ft)	clay
3.4 - 4.3 m	(11 - 14 ft)	clay, sand, gravel and rotten wood
4.3 - 5.2 m	(14 - 17 ft)	gravel and water
5.2 - 6.1 m	(17 - 20 ft)	fine sand, silt and wood
6.1 - 8.2 m	(20 - 27 ft)	gravel, some silt and clay
8.2 - 8.8 m	(27 - 29 ft)	fine sand, bits of wood
8.8 - 14.9 m	(29 - 49 ft)	blue clay
14.9 - 15.5 m	(49 - 51 ft)	fine sand and water
15.5 - 18.3 m	(51 - 60 ft)	hard clay
18.3 - 22.6 m	(60 - 74 ft)	clay
22.6 - 22.9 m	(74 - 75 ft)	fine sand, little water
22.9 - 25.9 m	(75 - 85 ft)	sandy clay
25.9 - 39.9 m	(85 - 131 ft)	clay; a little water at 39.9 m (131 ft)
39.9 - 40.5 m	(131 - 133 ft)	fine gravel, clayey
40.5 - 43.3 m	(133 - 142 ft)	layer of clay fine sand
43.3 - 49.7 m	(142 - 163 ft)	clay
49.7 - 54.3 m	(163 - 178 ft)	sandy clay; water-bearing
54.3 - 122.0 m	(178 - 400 ft)	clay.

   The litholog shows clearly that the only aquifer, at least to a depth of 122 m (400 ft) is several layers of sand and gravel at less than 15.5 m (51 ft); most of the permeable layers are reported to contain wood.

   Another nearby well was one constructed in 1979 by Pacific Water Wells Ltd. under supervision of B.C. Environment, apparently for Township of Chilliwack. This well, which is located about

430 m (1400 ft) east of the pump house, near the B.C. Hydro Railway track, also encountered a shallow aquifer bottomed at a depth about 23 m (75 ft). The record on file with Groundwater Section shows that the well was constructed with screens and that a pumping test was carried out at a rate of 15.1 *l*/sec (240 USgpm). There is no mention of water quality. The litholog, which is much less detailed than the one given previously and does not mention wood in the aquifer, is as follows:

0.0 - 7.6 m	(0 - 25 ft)	sand, some gravel
7.6 - 13.1 m	(25 - 43 ft)	gravel
13.1 - 22.0 m	(43 - 72 ft)	coarse sand, silt
22.0 - 22.9 m	(72 - 75 ft)	fine sand
22.9 - 23.8 m	(75 - 78 ft)	gray clay
23.8 - 39.6 m	(78 - 130 ft)	silty clay.

Also on hand is a record of another well located about 1006 m (3300 ft) east of the pump house. This well was drilled in 1978 by Linder's Well Drilling and was rated to have a capacity of 3.16 *l*/sec (50 USgpm). The litholog for this well which is reported to be of similar depth extends to 21.6 m (71 ft); the well owner's name on the record is given as Bill Keillor.

2.0 HYDROGEOLOGY

The existing Yarrow Waterworks facilities are located inside the dyke along the Vedder River, which becomes confined as a canal about 1.5 km downstream from the facilities. Before the drainage of Sumas Lake in 1926, the River discharged into Sumas Lake approximately where the canal begins. Before being confined by dykes, the River meandered over a large area depositing sand and gravel on a broad flood plain. The floodplain sediments contain organic material in the form of wood, twigs, leaves and other debris.

Groundwater is flowing through the permeable floodplain deposits, with a gradient similar to that of the River. According to water level elevations taken from the JWWAL plan, the gradient of the River, as it flows past the subject area is 0.0034 (0.34%). Assuming an average horizontal hydraulic conductivity of 10^{-2} cm/sec for the floodplain sand and gravel gives a velocity of groundwater flow of 3.4×10^{-5} cm/sec or 2.97 cm/day. This is obviously only an order of magnitude estimate. However, it does indicate that groundwater moving downstream through the floodplain sediments tends to remain in the ground for a considerable length of time.

Verbal reports that groundwater from wells constructed in the area of the old Sumas Lake contains sufficient dissolved iron to make the water unsuitable for domestic use, can be explained by slow movement of water through sediments containing organic debris. The organic material tends to produce a low pH condition which promotes the dissolution of iron-bearing minerals. However, the actual water quality at any specific site is dependent on local conditions and can only be determined by sampling and testing. One of the records mentioned previously notes the presence of wood in the shallow aquifer.

3.0 YARROW WATERWORKS INTAKE FACILITY

3.1 Existing Facility

The Yarrow Waterworks infiltration gallery facility has clearly been designed to obtain Vedder River water seeping downward from the small pond into the perforated pipes buried under the pond. When the pump(s) in the sump is running, the head in the intake piping is lower than that in the pond so that flow is induced downward out of the pond into the intake pipes. It is doubtful that a significant amount of groundwater flows into the system.

The disadvantages of the present system are:

1. Water in the pond could be polluted due to contact with animals or humans, and filtration through the bottom of the pond may not be effective in removing such pollution.
2. It is not possible to clean out the buried intake system without digging it up; it may contain silt and sand which has come through holes in the intake pipes.
3. The intake pond and channel from the Vedder River require maintenance, especially after high water levels in the River.
4. It would not be easy to increase the capacity of the present system except by digging up the existing pipes in order to extend or replace them.

The advantages of the existing gallery facility are:

1. The chemical quality of the water is good.
2. It can be improved at relatively low cost using much of the existing facilities.
3. It is very accessible.

3.2 Alternatives for Improving the Yarrow Waterworks Source at the Vedder River

The following are possible alternatives for improving the Yarrow Waterworks Source at the Vedder River:

- Reconstruct the intake part of the existing facility by extending the water pipe.
- Construct a new infiltration facility.
- Construct a vertical screened well.

In the previously mentioned onsite discussions of June 30, 1995, Messrs. Kocsis and Wedler suggested reconstructing the intake part of the facility by extending the intake pipe northward past the pond and under the gravelly floodplain, where some type of intake piping or gallery would obtain water under the dry floodplain and where it would be better protected from pollution than it is at the small pond. The idea is certainly sound in principle; however, the proposed facility would pick up groundwater which is likely to be of different quality than the water in the pond. The specific concern is whether the groundwater at the suggested locations would contain enough dissolved iron to make it unsuitable for domestic consumption. If the suggested location is underlain by clean permeable gravel carrying relatively fast-moving river water, iron would probably not be a problem.

The proposed gallery reconstruction requires that some testing be done before proceeding with design and construction. The following investigation is suggested:

1. Using an excavator, dig several test holes along the proposed alignment of an intake pipe, to a depth of at least that of the intake pipe.

2. Carry out a pumping test of each pit using a trash pump with capacity of 20 *l*/sec (260 igpm) or more. The pump should be equipped with sufficient discharge pipe to minimize return of pumped water (short circuiting) and the flow rate should be measured by timing the filling of a container of known volume. A simple staff gauge should be placed in the pit before starting pumping in order to measure the change in water level as pumping proceeds.

3. After pumping until the water is quite clear, or at the end of the test, collect a water sample to be checked for iron. It should be possible to get an approximate idea of iron content by using a field kit (Hach or other). If the iron content is quite high, it is often possible to detect iron by a "jar test". This is done by aerating the water by shaking about an half a jarful and observing it periodically for signs of an iron precipitate.

The procedure outlined above will make it possible to estimate the length of intake pipe which may be required to achieve the capacity required for a new intake facility as well as obtaining an indication of the water quality. Obviously, if the first pit yields water high in iron, there is little point in proceeding further. However, if the capacity of a first test pit, as shown by pumping is rather low, it may be worth excavating additional pits provided that the water quality is satisfactory, as the floodplain gravel can change from place to place.

The second alternative of constructing an infiltration facility similar to the existing one, but with improvements to increase capacity, to reduce the chances of contamination and to facilitate cleaning of the subsurface components could proceed as follows:

1. Construct a fence around the improved pond to keep out animals and humans.

2. Construct the edges of the pond to minimize caving, ravelling, etc. Could the pond be surrounded by lock blocks?

3. Construct the intake parts of the facility out of sections of stainless steel well screens or, perhaps, PVC wire-wound screen (Johnson PVC Vee Wire Screen).

4. Place the screens in artificial beds constructed of rounded gravel and sand of selected size - in other words, a designed filter. A possibility is to bury the screens in pea or birdseye gravel overlain by filter cloth, with a top layer of medium-fine sand to act as a slow sand filter.

5. Arrange all underground piping so that it can be backwashed using water from the reservoir under line pressure, by bringing all intake pipes to surface or into a manhole.

6. Install a simple propeller-type totalizing water meter on the main line leading to the distribution system so that it is possible to determine performance of both pump and intake system during operation.

The third possibility for obtaining additional water is to construct a screened vertical well and equip it with a submersible pump. For a successful screened vertical well, certain conditions must prevail:

1. If the shallow aquifer in the area contains water high in iron, there must be a deeper aquifer containing good quality water - preferably water with a low permeability zone separating the two aquifers.

2. A lower aquifer must have sufficient transmissivity to permit construction of wells of economic capacity, say, 40 *l*/sec (530 igpm).

There is enough information from available water well records, as previously discussed in Section 1.0, to show that conditions are not favourable for construction of a vertical well.

4.0 CONCLUSIONS

All of the information on hand concerning the hydrogeology and the construction of the existing infiltration gallery that serves Vedder Waterworks District seems to favour reconstruction of the existing facility; however, construction of a new infiltration gallery facility has enough advantages so that digging and testing of at least one test pit is justified.

The design of any new subsurface intake (infiltration galley) should be based on groundwater levels at times of low flow of the Vedder River - probably September.

We trust that this letter provides the information you require at this time. However, please do not hesitate to call if you wish to further discuss any aspect of the contents of this letter.

Yours truly,
PACIFIC HYDROLOGY CONSULTANTS LTD.

Ed Livingston

Ed Livingston, P. Eng.
Associate Consultant