



MEMORANDUM

To: M. Wei
Sr. Groundwater Hydrologist
Groundwater Section
Water Management Branch

Date: Feb. 23, 1999
File: 92 F/7

Re: **Completion Report - Installation and Testing of Well 8-97 and Re-evaluation of Groundwater Supply Potential of Quadra Sand Aquifer at Deep Bay.**

1. Introduction

As requested by G. Smail, Land Officer, Land Management Branch, British Columbia Assets and Land Corporation, the November 25, 1997 report entitled *Completion Report - Installation and Testing of Well 8-97 and Re-evaluation of Groundwater Supply Potential of Quadra Sand Aquifer at Deep Bay* prepared by Pacific Hydrology Consultants Ltd. for Deep Bay Waterworks District has been reviewed.

Mr. Smail requested comments by e-mail on February 3, 1999 to A.P. Kohut, Manager, requesting that Groundwater Section staff comment on the safe yield of DB 8-97 at Deep Bay. DB 8-97 was constructed to supplement the Deep Bay Water System and to further evaluate the Quadra sand aquifer for future groundwater development.

Pacific Hydrology has concluded that DB 8-97 can sustain a safe long-term yield of 11.73 L/s (154 Igpm) with simultaneous pumping of existing Deep Bay Waterworks production wells 1-73, 3-69, 4-77, 5-85, and 6-90.

2. Well Location and Construction

DB 8-97 is located between Bowser and Deep Bay on D.L. 86 and approximately 150m (490 ft) southeast of DB 5-85 and adjacent to the Island Highway (Figures 1 and 2).

DB 8-97 is a 203mm (8 in) diameter well drilled in July 1997 by Kalicum Drilling Ltd. using the air rotary method of drilling and completed to a depth of 23.0m (75.4 ft) in fine brown sand (Quadra sand). DB 8-97 is completed in coarse and fine sand from ground surface and the aquifer is unconfined. The well is completed with 250mm (10 in) diameter surface casing. The well is completed with a 6.1m (20 ft) length screen assembly set between 16.9 to 23.0m (55.4 to 75.4 ft). Measurements are from top of the well casing. The 203mm (8 in) diameter screen assembly consists of 3.7m (12 ft) of 15 slot stainless steel screen overlying 1.5m (5 ft) of 10 slot stainless steel screen. Well construction has shown that aquifer thickness increases in a southerly direction and DB 7-96 and DB 8-97 are the most productive of the Deep Bay production wells.

Although the well casing was reported to be out of alignment, a dummy test performed by John Motherwell (JMAEL) showed the well to be straight and able to accommodate a permanent submersible pump without difficulty.

3. Pumping Test Results

A step-drawdown test was carried out on DB 8-97 on October 28, 1997 by Kalicum Drilling Ltd. to determine an optimal pumping rate for the constant rate pumping test. The test consisted of 10 - five minute tests with pumping rates increasing from 6.12 to 17.42 L/s (81 to 230 Igpm).

Based on the step-drawdown data, 15.8 L/s (209 Igpm) was selected as being a suitable pumping rate for the constant rate pumping test.

The hydrogeologic report submitted by Pacific Hydrology Consultants Ltd. is complete and comprehensive and results obtained have shown that DB 8-97 is capable of sustaining a long-term yield of 11.73 L/s (154 Igpm). The report meets all of the criteria defined in the Water Management Branch publication "Guidelines for Minimum Standards in Water Well Construction - Province of B.C." The rating of DB 8-97 at 11.73L/s (154 Igpm) is based on the following results:

- DB 8-97 was pump tested on October 30, 1997 by Kalicum Drilling Ltd. for a period of 1455 minutes (24.2 hours) at a constant pumping rate of 15.4 L/s (203 Igpm).
- Stabilization of water level in DB 8-97 was apparent after 1260 minutes of constant rate pumping at 15.4 L/s (203 Igpm), while simultaneously pumping DB 1-73, 3-69, 4-77, 5-85, and 6-90 at a total combined rate of approximately 47.0 L/s (620 Igpm).
- A total drawdown of 13.1m (43.03 ft) occurred in DB 8-97 representing approximately 79 percent of the available drawdown at the time of testing. Most of the drawdown can be attributed, however, to well loss with little drawdown in the aquifer. Ninety-two percent of the total drawdown occurred within the first two minutes of pumping.
- Based on the available drawdown at the time of testing of 16.5m (54.2 ft), specific capacity of 1.17 L/s (4.72 Igpm/ft) of drawdown and 30 percent factor of safety, DB 8-97 should be capable of sustaining a well capacity of 13.6 L/s (179 Igpm). Badry (1998) has further incorporated additional allowance for a small amount of expected mutual well interference and a higher than normal water level in October 1997 (Figure 3). Badry (1997) has concluded that DB 8-97 has a long-term capacity of 11.73 L/s (154 Igpm) with simultaneous pumping of DB 8-97, 1-73, 3-69, 4-77, 5-85, and 6-90.
- Eighty-nine percent of water level recovery occurred within 2 minutes of shutting the pumps down. Undisturbed water level recovery was monitored for approximately one day. After 1345 minutes, water level was within 0.07m (0.23 ft) of the original static water level. Complete water level recovery can be expected.

- An aquifer transmissivity of $1615\text{m}^2/\text{day}$ (1.3×10^5 USgpd/ft) was determined from the time-drawdown plot. When the transmissivity is $124\text{m}^2/\text{day}$ (1×10^4 gpd/ft) or more, well yields can be adequate for industrial, municipal or irrigation purposes (Driscoll, 1986).

4. Well Interference and Monitoring

As reported by Badry (1997), pumps in DB 1-73, 3-69, 4-77, 5-85, and 6-90 were shut down several hours prior to start of pumping DB 8-97 to allow for water level recovery in the well field. The pumps were turned back on individually between 223 and 270 minutes after the pumping of DB 8-97 was started. There was no interference effect noted in these wells while DB 8-97 was pumped and the other Deep Bay production wells were shut down. Simultaneous pumping of DB 8-97, 1-73, 3-69, 4-77, 5-85 and 6-90 resulted in a total interference drawdown of 0.65m (2.1 ft) in observation well 331 which is not considered excessive. Zero interference drawdown was noted in observation well 310 from the individual pumping of DB 8-97 or the combined pumping of DB 8-97, 1-73, 3-69, 4-77, 5-85, and 6-90. Interference drawdown was not apparent in the monitoring well at Gainsburg Swamp. Interference effect on these wells approximates the zone of influence from the simultaneous pumping of the Deep Bay production wells.

Observation wells 310 and 331 are ideally located to monitor simultaneous pumping interference of the Deep Bay production wells. These observation wells have been designated high priority (Hodge, 1998) for the future installation of data loggers and it is the Groundwater Section's intention to replace the present monitoring equipment (chart recorders) with data loggers when resources become available.

5. Water Quality

Water samples were collected near the end of pumping on October 31, 1997 and submitted to JB Laboratories Ltd. for analysis. DB 8-97 was analyzed for chemical and bacteriological testing.

The groundwater can be classified as low in mineralization (TDS = 65 mg/L), soft (hardness = 35 mg/L) and slightly acidic (pH = 6.9) and considered excellent for domestic purposes without treatment. All parameters checked met federal and provincial drinking water quality guidelines except noncoliform bacteria (2000 CFU/100 ml). This level is, however, apparently not unusual for a new well. It has been recommended by the consultant that before DB 8-97 is placed in production, the coliform and noncoliform bacterial will be rechecked for compliance with B.C. Ministry of Health requirements.

6. Conclusions and Recommendations

6.1. DB 8-97 is 203mm (8-in) diameter and completed in fine sand (Quadra sand) to a depth of 23.0m (75.4 ft). The well is completed with 250mm (10 in) diameter surface casing and screened with a 6.1m (20 ft) length stainless steel screen. DB 8-97 was drilled by Kalicum Drilling Ltd. using the air-rotary method of drilling. Although the well casing was reported to be out of

alignment, a dummy test showed the well to be straight and able to accommodate a permanent submersible pump without difficulty.

6.2. **The long-term well capacity determined by the consultant as 11.73 L/s (154 Igpm) for simultaneous pumping with DB 1-73, 3-69, 4-77, 5-85, and 6-90 is reasonable and should be accepted.** In rating the well, the consultant has incorporated an additional safety allowance for the small amount of mutual well interference anticipated and the higher than normal water level in October 1997. Well construction and testing have shown DB 7-96 and DB 8-97 are the most productive of the Deep Bay production wells.

6.3. Water quality can be described as low in mineralization, soft, and slightly acidic. Water quality is considered excellent for domestic purposes without treatment. As recommended by the consultant, prior to placing DB 8-97 in production, coliform bacteria and noncoliform bacteria should be rechecked for compliance with B.C. Ministry of Health requirements.

6.4. The Groundwater Section is in agreement with the consultant in commending Deep Bay Waterworks District personnel for their long history of stewardship with respect to protection of the Quadra sand aquifer at Deep Bay. The unconfined aquifer is highly vulnerable to contamination from surface sources.

6.5. Observation Wells 310 and 331 have been designated high priority (Hodge, 1998) for the future installation of data loggers. The RST - BH1000 data trapper is now being field tested. When resources are available for purchase of data loggers, it is the Groundwater Section's intention to replace the present chart recorders with data loggers in observation wells 310 and 331 at Deep Bay. Observation wells 310 and 331 provide excellent data for well field management purposes. Observation well 331 is quite centrally located to monitor the simultaneous pumping of the Deep Bay production wells.

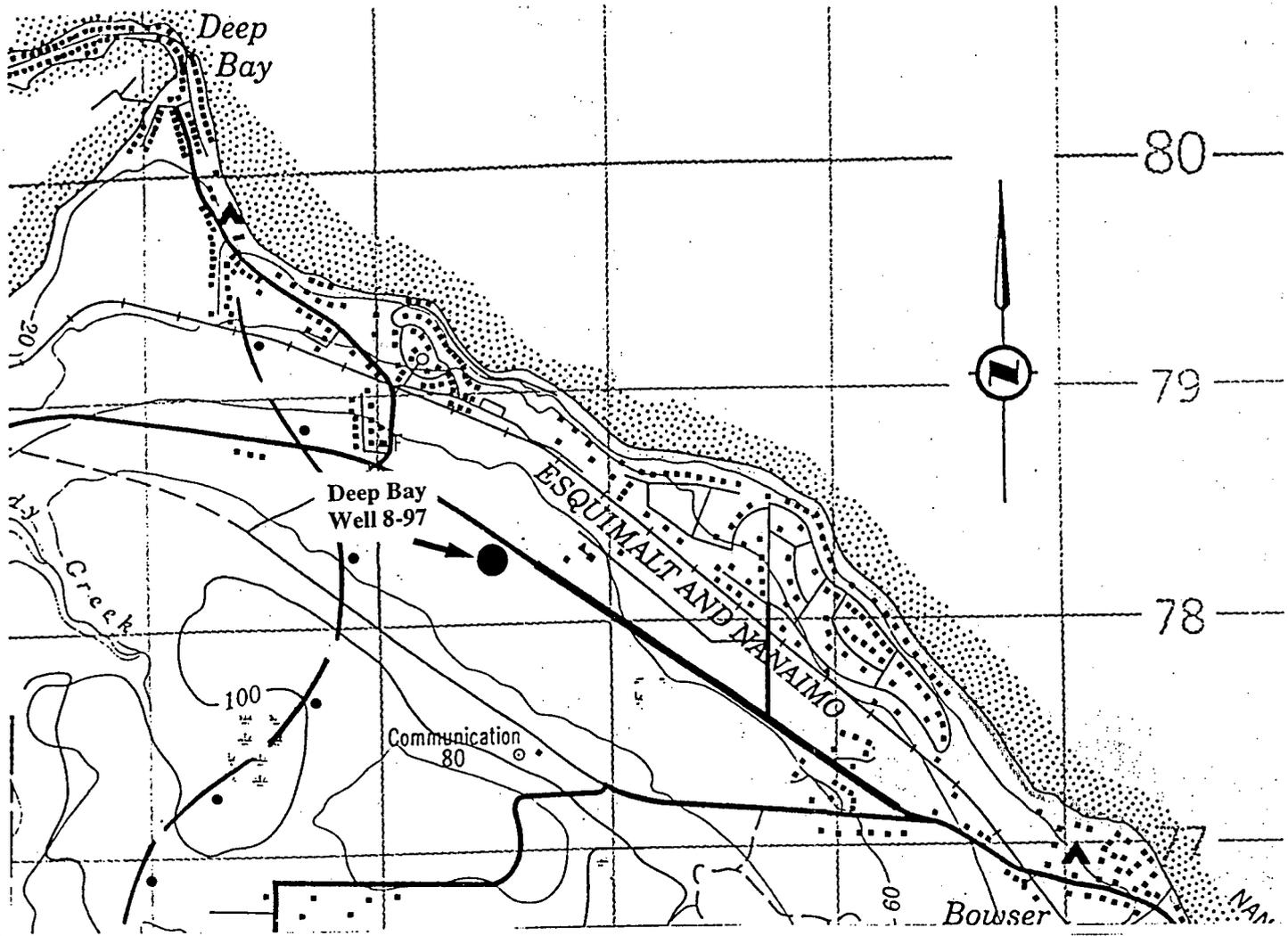
6.6. The well head and aquifer protection measures and groundwater management recommendations by the consultant are supported by the Groundwater Section, Water Management Branch.

7. References

- Badry, A., 1998. *Completion Report - Installation and Testing of Well 8-97 and Re-evaluation of Groundwater Supply Potential of Quadra Sand Aquifer at Deep Bay*. Prepared by Pacific Hydrology Consultants Ltd. for Deep Bay Waterworks District. Project No. D707103.
- Driscoll, F.G., 1986. *Groundwater and Wells*, Second Edition, Published by Johnson Division, St. Paul, Minnesota 55112.
- Hodge, W.S., 1998. *Observation Well Network Evaluation - Groundwater Level Monitoring*. Unpublished memorandum, Ministry of Environment, Water Management Branch. File 38000-30.

W. S. Hodge
W.S. Hodge, P. Geo., Groundwater Section
Water Management Branch





SITE LOCATION MAP



Province of British Columbia
 Ministry of Environment, Lands and Parks
 Water Management Branch
 Groundwater Section

TO ACCOMPANY REPORT ON
**Completion Report - Installation
 and Testing of Deep Bay Well 8-97**

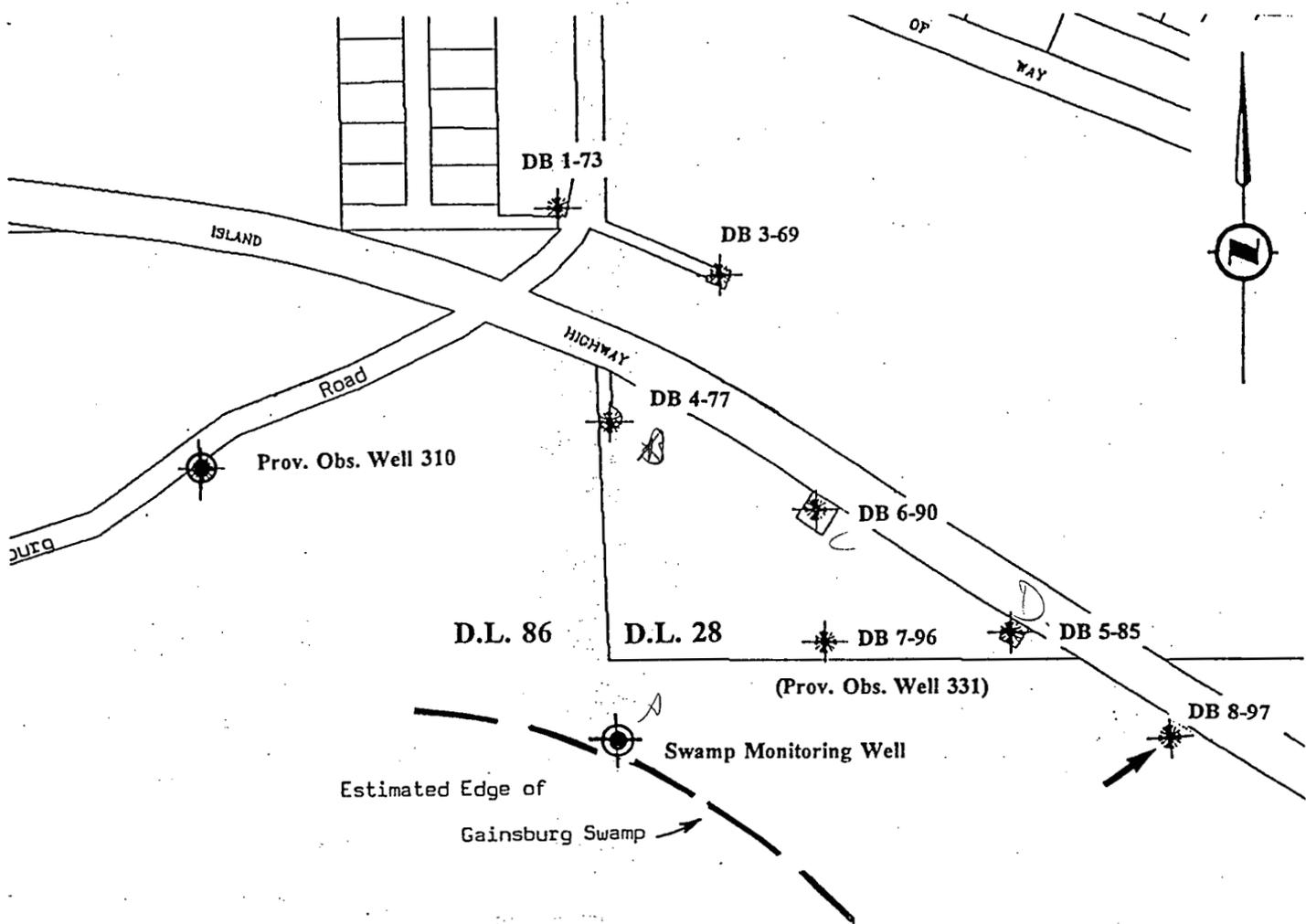
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 Feb. 1999

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FIGURE 1



WELL LOCATION MAP



Province of British Columbia
 Ministry of Environment, Lands and Parks
 Water Management Branch
 Groundwater Section

TO ACCOMPANY REPORT ON
**Completion Report - Installation
 and Testing of Deep Bay Well 8-97**

SCALE: 1" = 500'

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FIGURE 2

Figure 3

Hydrograph of Observation Well No. 310 Deep Bay/Bowser, B.C.

