Province of
British Columbia

Environment, Lands, & Parks
Water Management Division
765 Broughton St.
Victoria, B.C.
V8V 1X4

MEMORANDUM

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

Date: November 27, 1995

File: 92C/13

Re: Village of Ucluelet - Lost Shoe Creek Aquifer

1. Introduction

As requested by G. Buble of the Municipal Engineering Services, a review of the well test report prepared by Pacific Hydrology Consultants Ltd. (Arengi and Badry, 1995) has been carried out. Mr. Buble has requested general comments on the report and specific comments on the aquifer capacity to meet the demand of 150 L/s (2400 USgpm) for the Village of Ucluelet and fish processing industry.

Pacific Hydrology Consultants Ltd. have rated the theoretical capacities of LSC production wells 1-95, 2-95 and 3-95 at 25.2 L/s (400 USgpm), 28.4 L/s (450 USgpm), and 44.2 L/s (700 USgpm) and the practical (maximum) capacity of test well 1-94 at 22.1 L/s (350 USgpm) for a total well field capacity of 120 L/s (1900 USgpm). Theoretical and practical capacities quoted have accounted for interference drawdown caused by simultaneous pumping of the three LSC production wells and test well 1-94. In order to satisfy the total demand of 150 L/s (2400 USgpm), Pacific Hydrology Consultants Ltd. have recommended that another production well capable of yielding 31.5 L/s (500 USgpm) can be constructed 60 metres (197 feet) north of LSC production well 1-95.

Previous comments were provided by Groundwater Section staff (Wei, 1994) on the consultants numerical model and estimates of the aquifer capacity to provide the projected 150 L/s (2400 USgpm) demand.

This memorandum discusses the prospects of these wells meeting the Village of Ucluelet requirements and makes recommendations for water level and water quality monitoring and supports the consultant's recommendation for implementation of a wellhead and aquifer protection and management program.

2. LSC Production Wells and Test Well 1-94 Locations

MW

The Lost Shoe Creek (LSC) Aquifer well field is located in an inactive gravel pit on DL 462 of the Regional District of Alberni-Clayquot opposite the intersection of the Tofino-Ucluelet Highway and the Alberni Highway (Figure 1).

LSC production wells 1-95, 2-95, 3-95 and test well 1-94 are spaced apart a distance of approximately 60 metres (200 feet) as shown in Figure 2. Ground surface elevation is slightly lower in the southeast corner of the well field. Ground surface

apk

elevations for LSC production wells 1-95 and 2-95 are 35.02 metres (114.85 feet) and 34.24 metres (112.31 feet) above mean sea level while the well head elevation for LSC production well 3-95 is 34.92 metres (114.54 feet) above mean sea level. The well head elevation for test well 1-94 was not reported.

Water well records for LSC production wells 1-95, 2-95, 3-95 and test well 1-94 have been designated BCGS map numbers 092C.093.3.3.3. # 5 , 092C.093.3.3.3. # 6 , 092C.093.3.3.3. # 7 and 092C.093.3.3.3. # 8 respectively (Appendix A). The UTM coordinates for LSC production wells 1-95, 2-95, 3-95 and test well 1-94 are CK 2940-1075, CK 2939-1076, CK 2938-1074, and CK 2941-1073 respectively.

3. LSC Aquifer Description and Capacity

The LSC aquifer consists of glacially-derived permeable sand and gravel. According to Arengi and Badry (1995) drilling near the junction of the Alberni-Highway and the Ucluelet-Tofino Highway shows that the sand and gravel may be as thick as 20 metres (65 feet) and is underlain by sandy silt and silty sand which may be glaciomarine sediments. The bottom of the aquifer is an irregular erosion surface which results in local changes in aquifer thickness. There appears to be a local thinning of the aquifer to the southeast of the well field. Although it is apparent that addition of fill material in the vicinity of the Ucluelet well field has created local confining conditions, the regional undisturbed LSC aquifer appears to be unconfined. Thin clay seams may, however, create local confining conditions (refer to Section 4)

The LSC aquifer boundaries (Figure 3) were interpreted by Pacific Hydrology Consultants Ltd. from bedrock outcrop locations, aerial photographs, and test well data. The aquifer area is reportedly 11.5 km^2 in size (Wei, 1994).

Groundwater Section staff (Wei, 1994) reviewed the Pacific Hydrology Report (1994) entitled "Completion Report - Evaluation of Groundwater Potential of Lost Shoe Creek and Albion Aquifers to supply the Village of Ucluelet" and the report entitled "Groundwater Recharge Conditions at Lost Shoe Creek Aquifer at Ucluelet" (Badry, 1994). With respect to the aquifer capacity, Wei (1994) concluded that on the basis of this report, although the water balance method and numerical model suggests that the aquifer may be capable of supplying up to hundreds of litres/second (thousands of USgpm) this method was sufficient only for providing preliminary order of magnitude answers to the aquifer capacity.

According to Arengi and Badry (1995) and using an infiltration rate of 40 percent of precipitation, 1.34 metres or 4.4 feet/year of precipitation is available to recharge the aquifer. (The 30 year average annual precipitation at Ucluelet during the period 1961 to 1990 is 3.36 metres or 11.0 feet). Using the equation: Recharge = Area x Infiltration rate, Arengi and Badry, 1995 have approximated aquifer recharge at 1.7×10^7 m^3/year based on an aquifer area of 1.3×10^7 m^2 or 12.9 km^2 (slightly larger than Wei's aquifer area determination of 11.5 km^2) and infiltration of 40 percent of the annual average precipitation. This approximation appears reasonable. A 40 percent infiltration rate seems realistic as the area around the well field is flat, the runoff factor is likely small and the sands and gravels at surface are highly permeable. Groundwater withdrawal by the Village of Ucluelet well field is

4.8 x 10^6 m^3/year based on 150 L/s (2400 USgpm) for 365 days/year representing only 2.8 percent of the available recharge to the aquifer. It would therefore appear that aquifer depletion would not occur at the proposed withdrawal rate of 150 L/s (2400 USgpm).

4. LSC Production Wells and Test Well 1-94 Construction

LSC production wells 1-95, 2-95, and 3-95 were completed in April and May 1995 by Fred's Drilling of Langley using the cable-tool method. The 300 mm (12-inch) diameter production wells are drilled through unconsolidated material and equipped with Johnson stainless steel screens. The production wells are completed with 400 mm (16-inch) diameter surface casings and the annular space between the well casings has been filled with bentonite grout.

LSC production well 1-95 has been screened with three sections of screen separated by two 200 mm (8-inch) diameter sections of blank pipe (Figure 4). It is of interest to note why blank sections were installed between 12.9 and 16.5 metres (42.1 to 54 feet) when the aquifer lithology and sieve analysis results suggest these zones could have been screened.

LSC production well 2-95 has been screened with two sections of screen separated by one 250 mm (10-inch) diameter section of blank pipe. The well is equipped with a 0.9 metre (3 feet) length of 250 mm (10-inch) diameter tail pipe located below the screen (Figure 5).

LSC production well 3-95 has been screened with four sections of screen separated by one 250 mm (10-inch) diameter section of blank pipe (Figure 6). Test well 1-94 was completed in January 1994 by Anderson Water Wells of Courtenay using the cable tool method. Test well 1-94 is a 200 mm (8-inch) diameter well drilled through unconsolidated material and screened with three sections of screen separated by two 168 mm (6.6-inch) diameter sections of blank pipe (Figure 7).

Lithologic descriptions of the LSC production wells report fill material evident from ground surface to a maximum depth of 4.9 metres (16 feet). The fill material includes wood chunks, plywood and barbed wire and the consultant has reported that compaction of fill material has created local confining conditions.

Further site investigation approximately 20 metres (65 feet) from LSC production well 2-95 revealed large chunks of asphalt and sediments containing tar to a depth of about 2 metres (6.6 feet) below ground level. This material was removed and a monitoring program initiated. A confining layer is also evident at depth in LSC production well 2-95 where clay was encountered at a depth of 10.4 to 10.7 metres (34 to 35 feet).

5. LSC Production Wells and Test Well 1-94 Pumping Test Procedures

LSC production wells 1-95, 2-95, and 3-95 and test well 1-94 were tested by B.C. Aquifer Testing and Equipment Ltd. under the supervision of Pacific Hydrology Consultants Ltd. The wells were pumped using submersible pumps powered by diesel-engine generators and water was discharged through 152mm (6-inch) diameter lay-flat pipe to a northwest-draining slope.

LSC production well 1-95 and test well 1-94 were tested and water levels monitored on April 25-27, 1995 for periods of 2880 minutes (Figures 8 and 9). Prior to conducting the constant rate pumping test, a step-test was performed on LSC production well 1-95 to establish the optimum pumping rate. The testing of test well 1-94 was started 115 minutes after the start of pumping LSC production well 1-95. Water levels were also monitored in observation wells 1-80 and 2-80, and the east and main ponds during the pumping of LSC production well 1-95 and test well 1-94. The location of the observation wells and ponds are shown in Figure 2.

LSC production well 2-95 and 3-95 were tested and water levels monitored on June 1-4, 1995 for periods of 4080 minutes (Figures 10 and 11). Prior to conducting the constant rate pumping test, a step-test was performed on LSC production well 2-95 to establish the optimum pumping rate. The testing of LSC production well 3-95 was started 1200 minutes after the start of pumping of LSC production well 2-95. Water levels were also monitored in LSC production well 1-95, test well 1-94, observation wells 1-80 and 2-80 and the main pond during the pumping of LSC production well 2-95 and 3-95.

Water level recovery was monitored after pumping stopped in the LSC production wells and test well 1-94 and time-recovery plots are shown in Figures 12 and 13.

A total of 89.8 mm (3.53 inches) of precipitation occurred between the period April 20 and June 4, 1995. Of the total precipitation, 4.1mm (0.16 inches) occurred between April 20 and April 30, 52.1 mm (2.05 inches) occurred between May 1 and May 26 and 33.6 mm (1.32 inches) occurred between June 3 and 4. The climate station is located at Ucluelet Kennedy Camp.

6. Well Capacities

Review of the consultant's methodology and calculations in determining individual well capacities has been carried out and are considered accurate and reasonable. The consultant has determined the theoretical long-term capacity of each well taking into consideration seasonal water table fluctuations and interference drawdown due to simultaneous pumping of the three other wells over 100 days of continuous pumping without recharge (an unlikely scenario). These long-term capacities are 25.2 L/s (400 USgpm) for LSC production well 1-95, 28.4 L/s (450 USgpm) for LSC production well 2-95, 44.2 L/s (700 USgpm) for LSC production well 3-95, and 18.9 to 22.1 L/s (300 to 350 USgpm) for LSC test well 1-94. As the estimated seasonal water table fluctuation for each well was deducted before application of the standard 30 percent safety factor, the writer is in agreement with the consultant that the well capacities may be conservative.

Further, the writer is in agreement with the consultant that an appropriate site for construction of an additional well capable of yielding 31.5 L/s (500 USgpm) to meet the total capacity of 150 L/s (2400 USgpm) would be a distance of 60 to 70 metres (200 to 230 feet) north of the LSC well field (Figure 2). The aquifer appears to be thicker in this direction and better wellhead protection is likely provided at this site (as compared to a site nearer to the east of the LSC well field closer to the Ucluelet Highway and the MOTH yard).

Distance drawdown plots (Figure 14) for simultaneous pumping of LSC production wells 2-95 and 3-95 at pumping rates of 33.3 L/s (528 USgpm) and 51.2 L/s (812 USgpm) respectively indicate the radius of influence extends to about 350 metres (1150 feet) from production well 2-95 and about 150 metres (490 feet) from production well 3-95 after 3400 minutes. Figure 14 also shows the cone of depression beginning to stabilize after a relatively short period of time of 3400 minutes. From Arengi and Badry (1995 - Table 3, page D 2) it is evident that 1.019 metres (3.34 feet) of drawdown was observed in LSC production well 1-95 during simultaneous pumping of LSC production wells 2-95 and 3-95 at a combined pumping rate of 84.5 L/s (1340 USgpm) after 3400 minutes. On this basis, the interference drawdown that should occur in a proposed well located 60 metres (200 feet) north of LSC production well 1-95 or 120 metres (400 feet) north of LSC production well 3-95, would be 0.18 metres (0.59 feet). As well yield is directly proportional to drawdown under radial flow conditions, drawdown interference that should occur in a well located at this location, if the pumping rate (simulating the combined pumping rate of the three LSC production wells and test well 1-94) were increased to 120 L/s (1900 USgpm) should be 0.26 metres (0.84 feet). Construction of a production well at this location should therefore be acceptable with respect to interference drawdown. Transmissivities of 2240 m^2/day (1.8×10^5 USgpd/ft and 960 m^2/day (7.7×10^4 USgpd/ft) calculated from the distance drawdown plots (Figure 14) indicate the aquifer has excellent water bearing capability. Corresponding storage coefficients of 0.09 and 0.22 calculated from the distance-drawdown plots typically fall between the normal range of 0.01 and 0.30 for an unconfined aquifer.

The interference drawdown of 1.75 metres (5.74 feet) reported in the main pond during simultaneous pumping of LSC production wells 2-95 and 3-95 may be misinterpreted and could actually be vertical leakage into the permeable strata below. Water levels in the pond were measured through a 0.25 mm (1-inch) diameter PVC pipe.

7. Water Quality Discussion

Water samples were collected for LSC production wells 1-95, 2-95, and 3-95 and test well 1-94 and submitted to Analytical Services Laboratories for chemical and bacteriological analysis. On the basis of the parameters analysed the groundwater from the Lost Shoe Aquifer can be classified as soft, low in mineralization, and slightly acidic. The schoeller plots shown in Appendix A indicate the water is a sodium-chloride-bicarbonate type groundwater. Tabulation of major parameters for all wells sampled have shown negligible charge balance errors. Total iron exceeded the proposed drinking water standard of 0.3 mg/L only in LSC production well 1-95, however manganese content in all wells sampled exceeded the proposed drinking water standard of 0.05 mg/L with the highest manganese level being 1.38 mg/L for LSC production well 1-95. It is evident that manganese levels did reduce with increased pumping. Ryznar Stability Index values of between 11.78 and 12.51 for the wells sampled (Appendix A) indicate the groundwater is corrosive. The corrosive nature of the groundwater could in time enlarge screen slot openings or develop

holes in the casing and pumping of silt or sand could occur. As a precaution the specific capacity of the well should be periodically checked to monitor well performance.

Water samples from the LSC production wells and test well 1-94 were also analysed for sulphate reducing bacteria, iron bacteria, and heterotrophic plate counts by EVS Environment Consulting. The consultant has indicated (per. comm) that the Health Department official on site requested analysis for sulphate-reducing bacteria and heterotrophic plate counts be carried out only because of his previous recent experience with groundwater sampling in the prairies. Although sulphate reducing bacteria was detected in varying concentrations in all the water samples submitted according to the consultant this is not unusual and is not a health concern.

8. Wellhead Protection

Because of the permeable nature of the sand and gravel aquifer, delineation of a well head protection area is an important part of the LSC aquifer management plan. The purpose of delineating wellhead areas is to define the geographic limits most critical to the protection of a wellhead (U.S. Environmental Protection Agency, 1993). Of the six methods commonly used for delineating a well head protection area, the calculated fixed radii method is appropriate at this early stage for application to the LSC aquifer.

The calculated fixed radius approach involves drawing a circular boundary around a well for a specified time of travel. The equation $r = \sqrt{Qt / (\pi n H)}$ calculate the required radius of protection for the well and is based on the volume of water that could be pumped from a well in a specified time period. The time period is chosen by estimating the time necessary to clean up ground water contamination before it reaches a well, or to allow adequate dilution or dispersion of contaminants (U. S. Environmental Protection Agency, 1993).

To determine the wellhead protection areas the following hydrologic information was required:

Q = Pumping rate of well
n = Aquifer porosity (0.25)
H = Aquifer thickness
t = Travel time to well in years (5)
π = 3.1416

Based on the above criteria, well head protection areas have been determined for the LSC production wells and test well 1-94. These are as follows: LSC production well 1-95 (255 metres or 835 feet), LSC production well 2-95 (310 metres or 1020 feet), LSC production well 3-95 (325 metres or 1065 feet) and test well 1-94 (205 metres or 670 feet). Calculations are shown in Appendix B. Aquifer porosity of 0.25 has been used in these calculations. Porosity for sand and gravel is normally in the range of 0.25 to 0.40 (Driscoll, 1986). The contaminant travel time to each well at

this time is specified at 5 years.

Once water level data become available from observation wells and production wells it may be possible to apply a more sophisticated wellhead delineation technique such as the variable shape or analytical method and hydrogeologic mapping to wellhead protection, if desired.

An obvious potential source of contamination to the wellfield is the MOTH yard located directly east of the wellfield and across the Highway where petroleum products may leak or spill presenting a potential hazard to the aquifer. As the wellfield is located near the intersection of two major highways there is always a threat of contamination from road salts and contaminant spills.

The wellhead and aquifer protection and management program outlined by Pacific Hydrology Consultants Ltd. should be implemented as soon as possible.

9. LSC Aquifer Classification

The map-based aquifer classification system developed by Kreye et al, (1994) was used to classify the LSC aquifer. The system classifies aquifers on the basis of their level of development (use) and vulnerability to contamination and provides ranking values for aquifers using hydrogeologic and water use criteria. The ranking component indicates the relative importance of an aquifer and is determined by summing the point values for aquifer productivity, size, vulnerability, demand, type of use, quality concerns and quantity concerns. According to Kreye et al, (1994) possible ranking scores range from a low of 5 to a high of 21. The higher the ranking score the greater the aquifer's priority.

The LSC aquifer has been classified as IIA with a ranking value of 14. The IIA classification indicates the aquifer is moderately developed and highly vulnerable to contamination from surface sources. A ranking value of 14 reflects the relative importance of the aquifer, mainly with respect to vulnerability, demand and water use criteria. The LSC Aquifer has been added to the Provincial aquifer inventory database.

10. Conclusions and Recommendations

10.1. The LSC aquifer is approximately 11.5 km^2 in size (Wei, 1994) and is comprised of highly permeable sand and gravel. The undisturbed LSC aquifer appears to be unconfined, however, dumping and compaction of fill material has locally created confining conditions. The Ucluelet area has a very high annual rainfall and an estimated 40 percent infiltration rate seems reasonable. As the estimated annual aquifer recharge to the aquifer from precipitation alone is 1.7×10^7 m^3/year, it would appear that aquifer depletion would not occur at the proposed withdrawal rate of 150 L/s (2400 USgpm).

10.2. Review of the consultant's methodology in determining well capacities for each well for simultaneous pumping of all wells was carried out and results obtained are considered reasonable. The theoretical long-term well capacities determined are as follows: LSC production well 1-95 (25.2 L/s or 400 USgpm), 2-95

(28.4 L/s or 450 USgpm), 3-95 (44.2 L/s or 700 USgpm) and test well 1-94 (22.1 L/s or 350 USgpm) for a combined well field capacity of 120 L/s (1900 USgpm). In determining theoretical well capacities, the consultant has factored in seasonal water table fluctuation and projected interference drawdown to determine useable drawdown before the standard 30 percent safety factor was applied, giving an additional element of safety in calculating well capacities.

10.3. The consultant's site location for construction of an additional well capable of yielding 31.5 L/s (500 USgpm) to meet the total demand of 150 L/s (2400 USgpm) a distance of 60 to 70 metres (200 to 230 feet) north of the LSC well field is considered appropriate. The LSC aquifer appears to be thicker in this direction and better wellhead protection is likely provided at this site. The consultant's suggestion that aquifer response to the four existing wells under pumping conditions be assessed prior to location and construction of an additional production well is considered prudent.

10.4. As part of the LSC aquifer management plan, LSC test well 1-80 should be established as a long-term provincial observation well to monitor aquifer recharge and future withdrawal effects within the well field area of influence. This well is located about 10 metres (33 feet) northwest of LSC test well 1-94. The well should be equipped with a water level recorder to monitor water levels on a continuous basis. Water levels should also be collected from the LSC production wells and test well 1-94 prior to these wells being put into production. Water levels can be monitored manually (tape read) on a once/month basis. Regular collection of water level data will allow determination of the seasonal water table fluctuation.

10.5. LSC test well 2-80 was established as Provincial Observation Well 329 in September 1995 (Hodge, 1995). The well is equipped with a water level recorder and monitors water levels in the LSC aquifer outside the area of influence of the LSC production wells.

10.6. The LSC aquifer water quality can be classified as slightly acidic, soft, and low in mineralization. All parameters analyzed were within the guidelines for the 1989 Canadian Drinking Water Quality Standards with the exception of manganese (all wells) and total iron (LSC production well 1-95). The highest manganese level occurred in LSC production well 1-95 and manganese levels did reduce with increased pumping. Complete water quality should be monitored at least once a year, preferably during the late summer or early fall when water levels would be at or near seasonal lows. Manganese and iron should initially be monitored more frequently to determine if concentrations continue to reduce through prolonged pumping. If manganese levels do not continue to reduce with prolonged pumping over time, then treatment may be necessary. The corrosive nature of the groundwater could in time enlarge screen slot openings or develop holes in the casing and pumping of silt or sand could occur. As a precaution the specific capacity of the well should be periodically checked to monitor well performance.

10.7. Once the LSC production wells and test well 1-94 are put into production, water levels and flow should be monitored on a regular basis. Flow meters should be installed on the well heads to monitor flow and the wells should be equipped for monitoring water levels. Both pumping and non-pumping water levels should be regularly monitored.

10.8. Preliminary well head protection areas have been determined for the LSC production wells and test well 1-94. The wellhead protection areas are circular areas around each well calculated based on the volume of water pumped over a 5-year period. These radii for wellhead protection areas are as follows: LSC production well 1-95 (255 metres or 835 feet), LSC production well 2-95 (310 metres or 1020 feet), LSC production well 3-95 (325 metres or 1065 feet) and test well 1-94 (205 metres or 670 feet). A potential point source of contamination to the wellfield is the MOTH yard located directly east of the LSC aquifer and located within the designated wellfield protection area.

10.9. The wellhead and aquifer protection and management program outlined by Pacific Hydrology Consultants Ltd. are supported by the Groundwater Section, Water Management Division and should be implemented as soon as possible.

10.10. The Lost Shoe Aquifer has been classified as IIA with a ranking value of 14. The IIA classification indicates the aquifer is moderately developed and highly vulnerable to contamination from surface sources. A ranking of 14 reflects the relative importance of the aquifer, mainly with respect to vulnerability, demand, and water use criteria.

11. References

Arengi and Badry, 1995. *Completion Report Construction and Testing of Lost Shoe Creek Production Wells 1-95, 2-95, 3-95 and evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet.* Pacific Hydrology Consultants Ltd. Unpublished report to Koers and Associates Engineering Ltd.

Badry, A. 1994a. *Groundwater Recharge Conditions at Lost Shoe Creek Aquifer at Ucluelet.* Pacific Hydrology Consultants Ltd. Unpublished letter - report to Ministry of Municipal Affairs.

Driscoll, F.G., 1986. *Groundwater and Wells.* Second Edition. Johnson Division, St. Paul Minnisota 55112.

Hodge, W.S., 1995. *Establishment of Observation Well No. 329 - Ucluelet.* Unpublished memorandum to M. Wei, Sr. Groundwater Hydrologist,

Groundwater Section, Hydrology Branch, Water Management Division, Ministry of Environment Lands and Parks.

Kreye, R., Ronneseth, K., and Wei, M., 1994. *An Aquifer Classification System for Groundwater Management in British Columbia.* Sixth National Drinking Water Conference, BCWWA. Victoria, B.C.

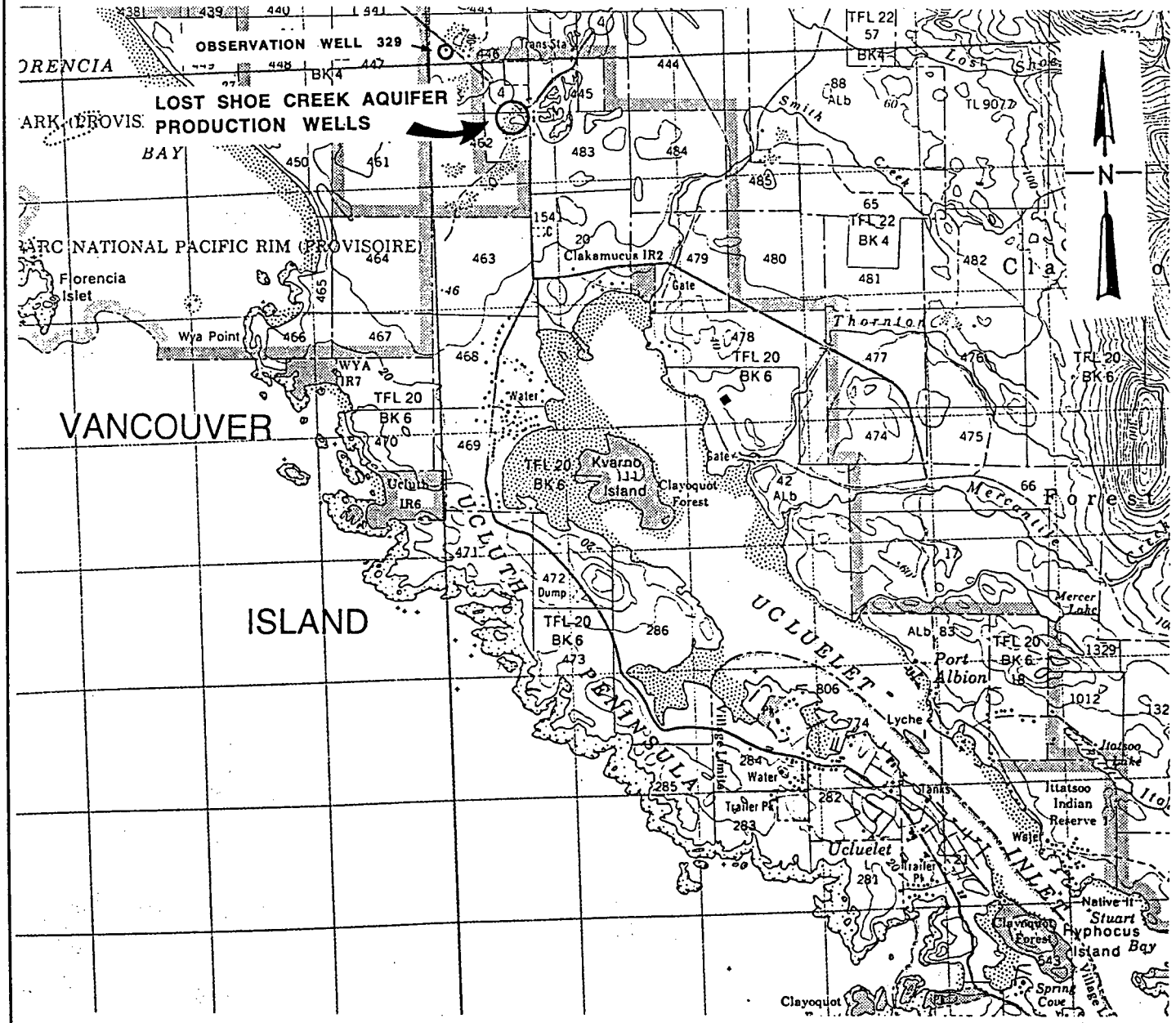
Pacific Hydrology Consultants Ltd., 1994b. *Completion Report Evaluation of Groundwater Potential of Lost Shoe Creek and Albion Aquifers to Supply the Village of Ucluelet.* Unpublished report to Koers and Associates Engineering Ltd.

U.S. Environmental Protection Agency, 1993. *Wellhead Protection: A Guide for Small Communities.* Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC. 144 pp.

Wei, M., 1994. *Lost Shoe Aquifer - Modelling to Estimate Aquifer Capacity.* Unpublished memorandum to A.P. Kohut, Manager, Groundwater Section, Hydrology Branch, Water Management Division, Ministry of Environment Lands and Parks.

W. S. Hodge

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



SITE LOCATION MAP

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

TO ACCOMPANY REPORT ON

Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet

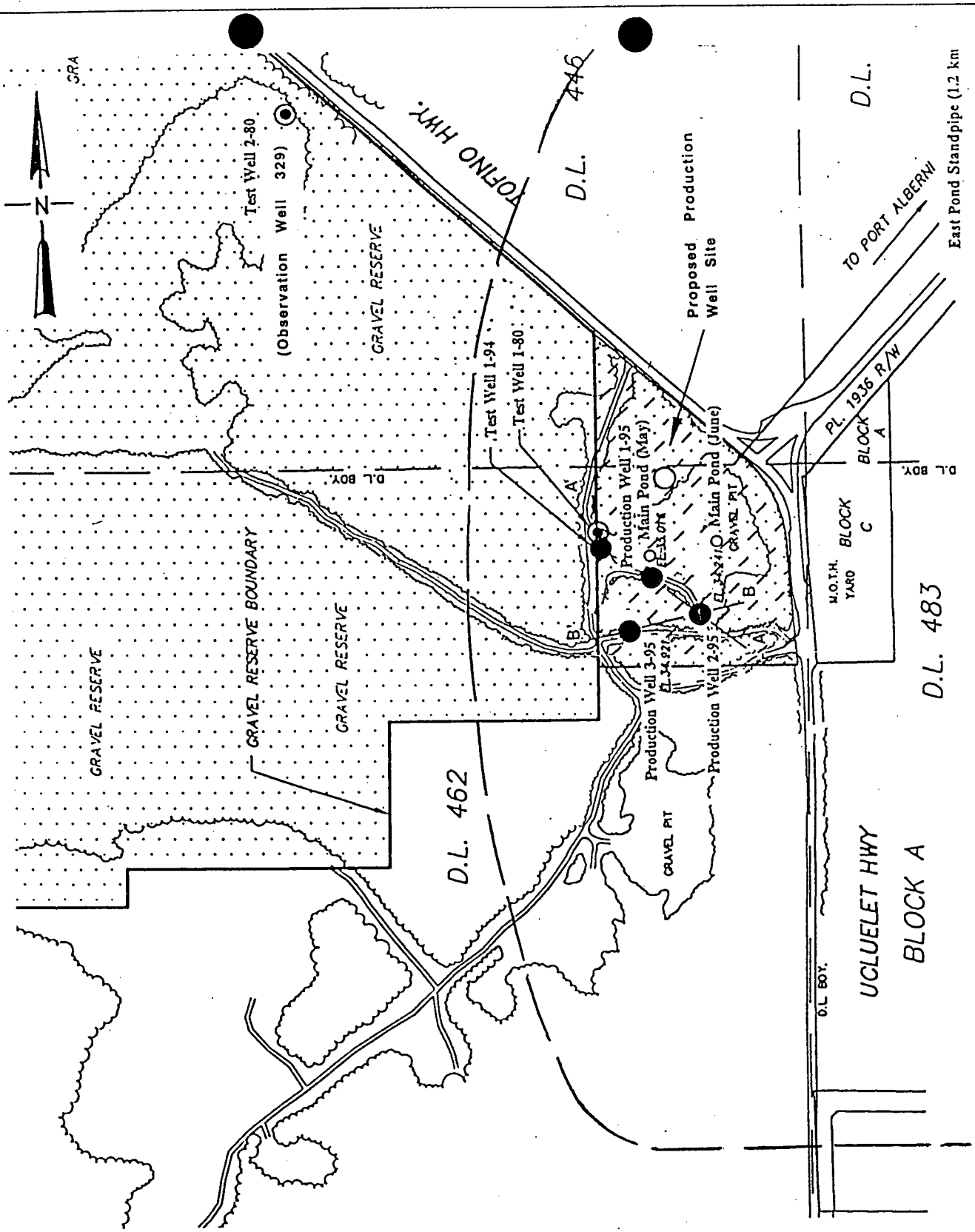
SCALE: 1:50000

DATE: NOV. 1995

PRODUCED BY: W.S. HODGE

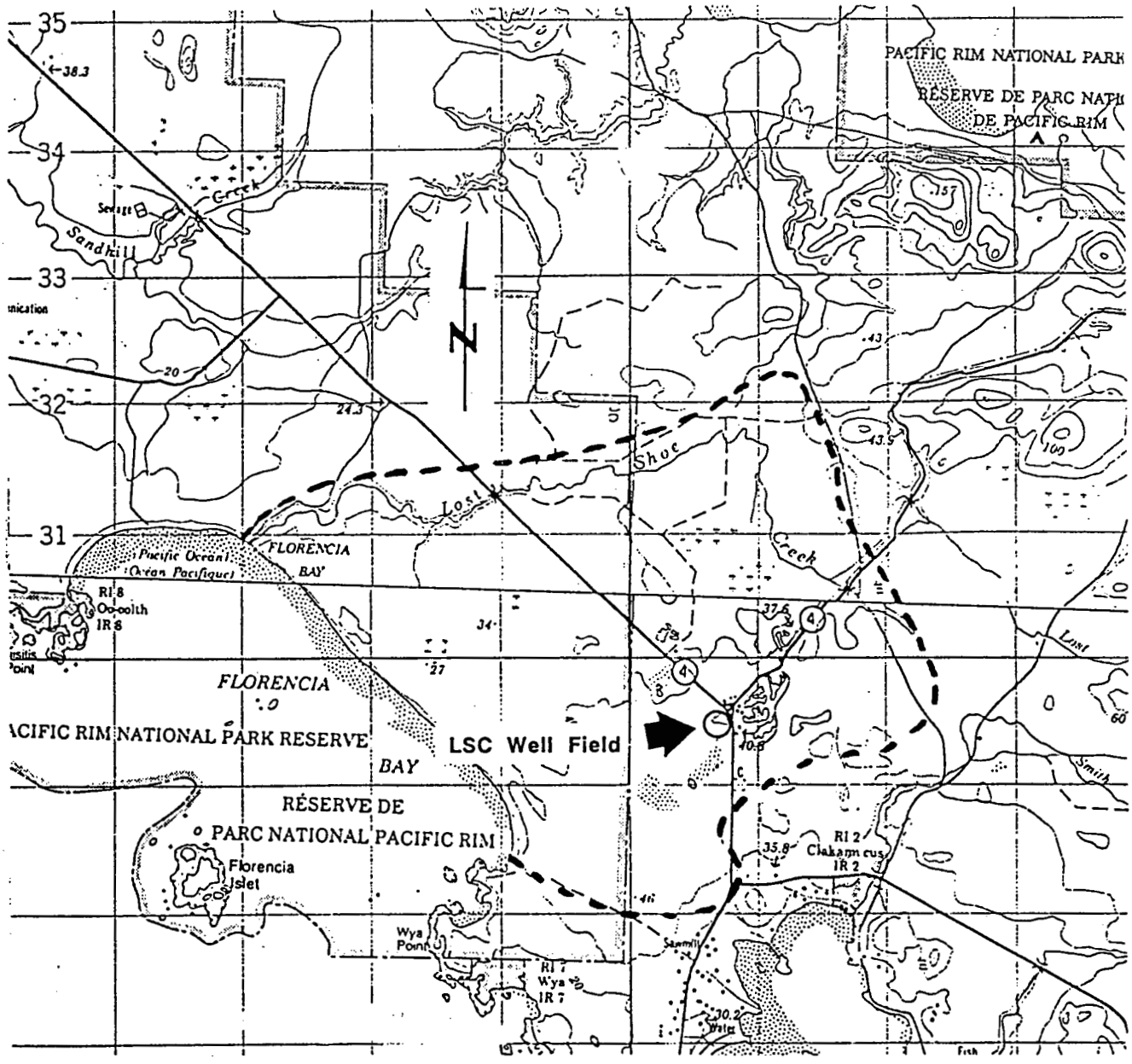
FILE NO. 0317588

FIGURE: 1



(AFTER ARENGI AND BADRY, 1995) **WELL LOCATION PLAN**

Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section		TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE: 1:5600	DATE NOV. 1995	PRODUCED BY: W.S. HODGE FILE NO. 0317588 FIGURE: 2



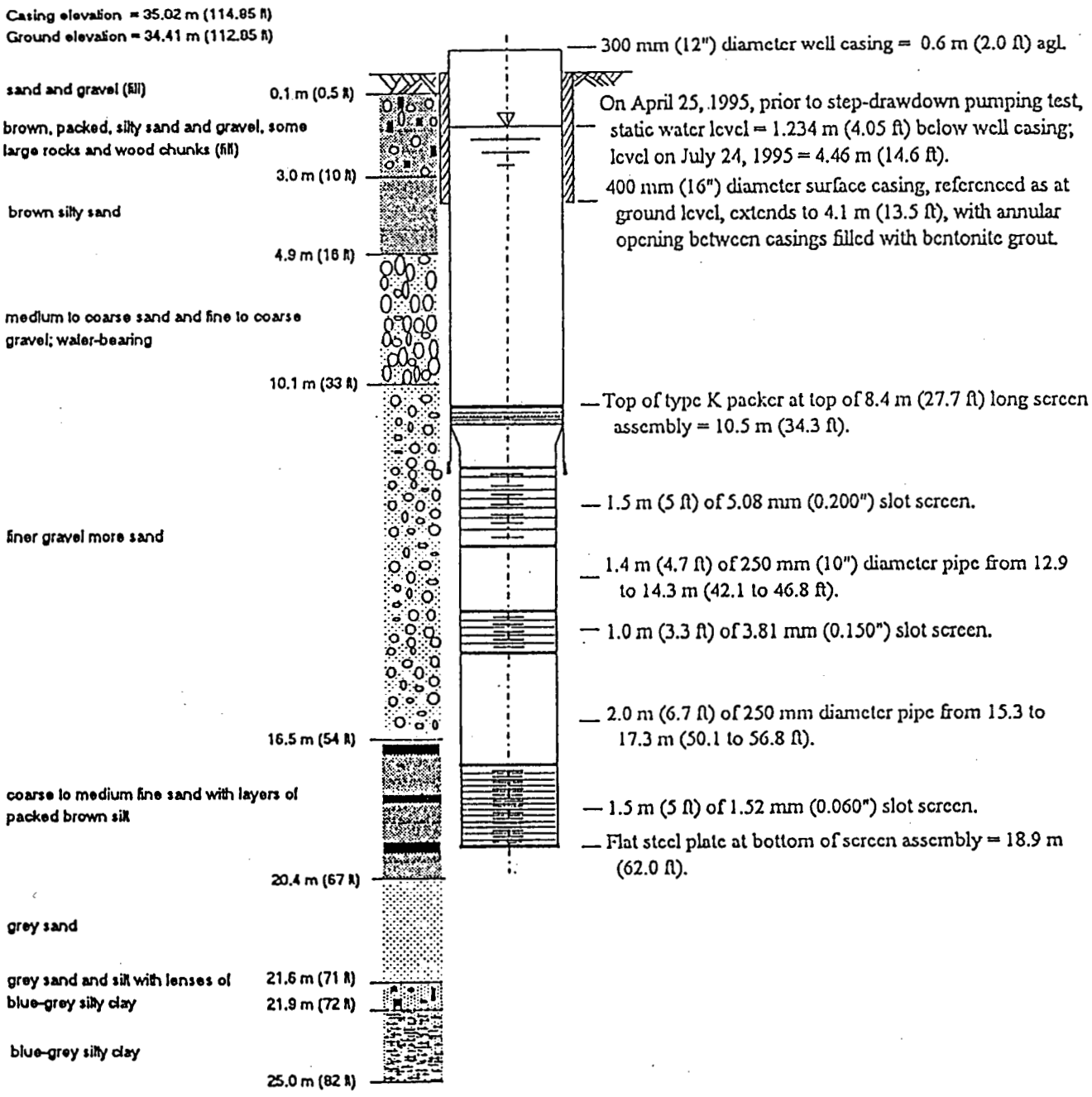
Denotes interpreted boundary of Lost Shoe Creek Aquifer

SITE LOCATION MAP

(AFTER ARENGI AND BADRY, 1995)

Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section	TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE: 1:50000	DATE: NOV. 1995
PRODUCED BY: W.S. HODGE	
FILE NO. 0317588	FIGURE: 3

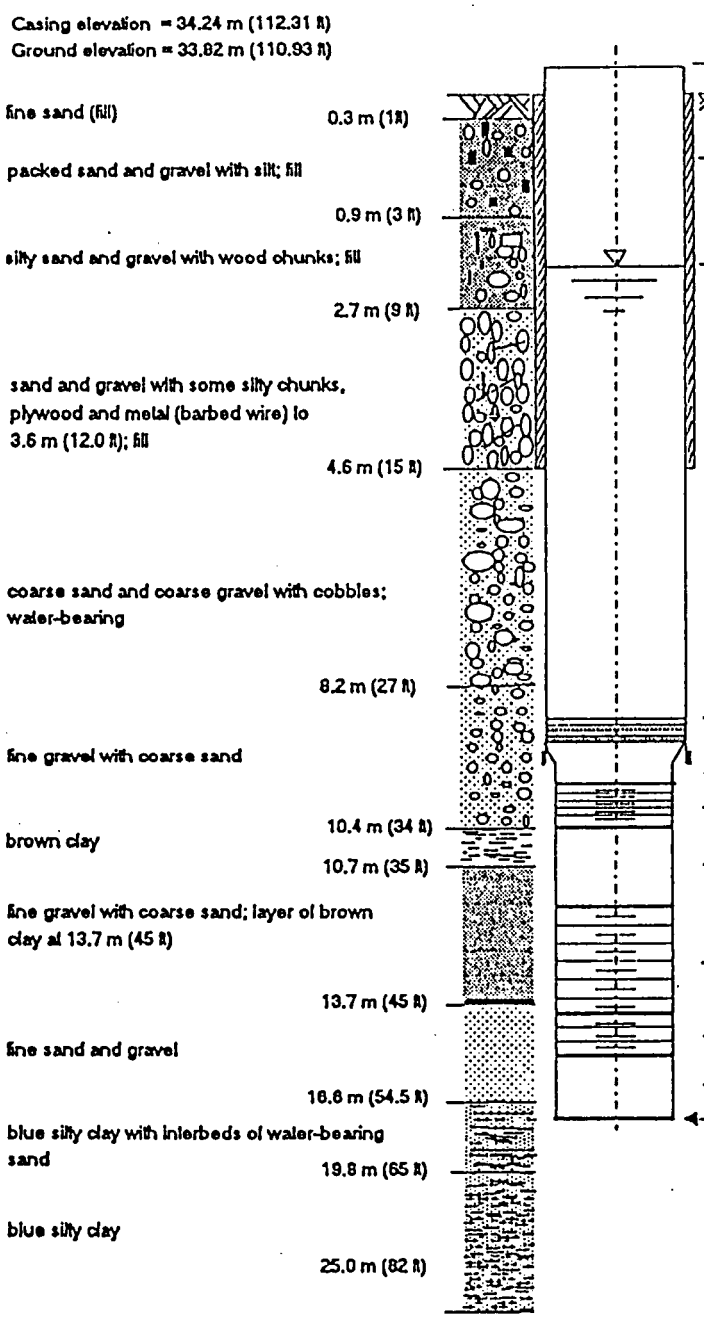
LOST SHOE CREEK PRODUCTION WELL 1-95
CONSTRUCTION DETAILS



(AFTER ARENGI AND BADRY, 1995)

Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section		TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE: As shown	DATE NOV. 1995	PRODUCED BY: W.S. HODGE FILE NO. 0317588 FIGURE: 4

LOST SHOE CREEK PRODUCTION WELL 2-95
CONSTRUCTION DETAILS



300 mm (12") diameter well casing = 0.4 m (1.4 ft) agl.

400 mm (16") diameter surface casing, referenced as at ground level, extends to 4.6 m (15.0 ft), with annular opening between casings filled with bentonite grout.

On June 1, 1995, prior to constant-rate pumping test, static water level = 1.926 m (6.32 ft) below well casing; level on July 24, 1995 = 3.67 m (12.0 ft).

Top of type K packer at top of 7.6 m (24.9 ft) long screen assembly = 9.5 m (31.1 ft).

0.9 m (3 ft) of 1.02 mm (0.040") slot screen.

1.8 m (5.8 ft) of 250 mm (10") diameter pipe from 11.2 to 12.9 m (36.7 to 42.5 ft).

2.4 m (8 ft) of 3.81 mm (0.150") slot screen.

0.6 m (2 ft) of 2.54 mm (0.100") slot screen.

0.9 m (3 ft) of 250 mm diameter pipe from 16.1 to 17.1 m (52.8 to 56.0 ft).

Flat steel plate at bottom of screen assembly = 17.1 m (56.0 ft).

(AFTER ARENGI AND BADRY, 1995)

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

TO ACCOMPANY REPORT ON
Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet

SCALE: As shown

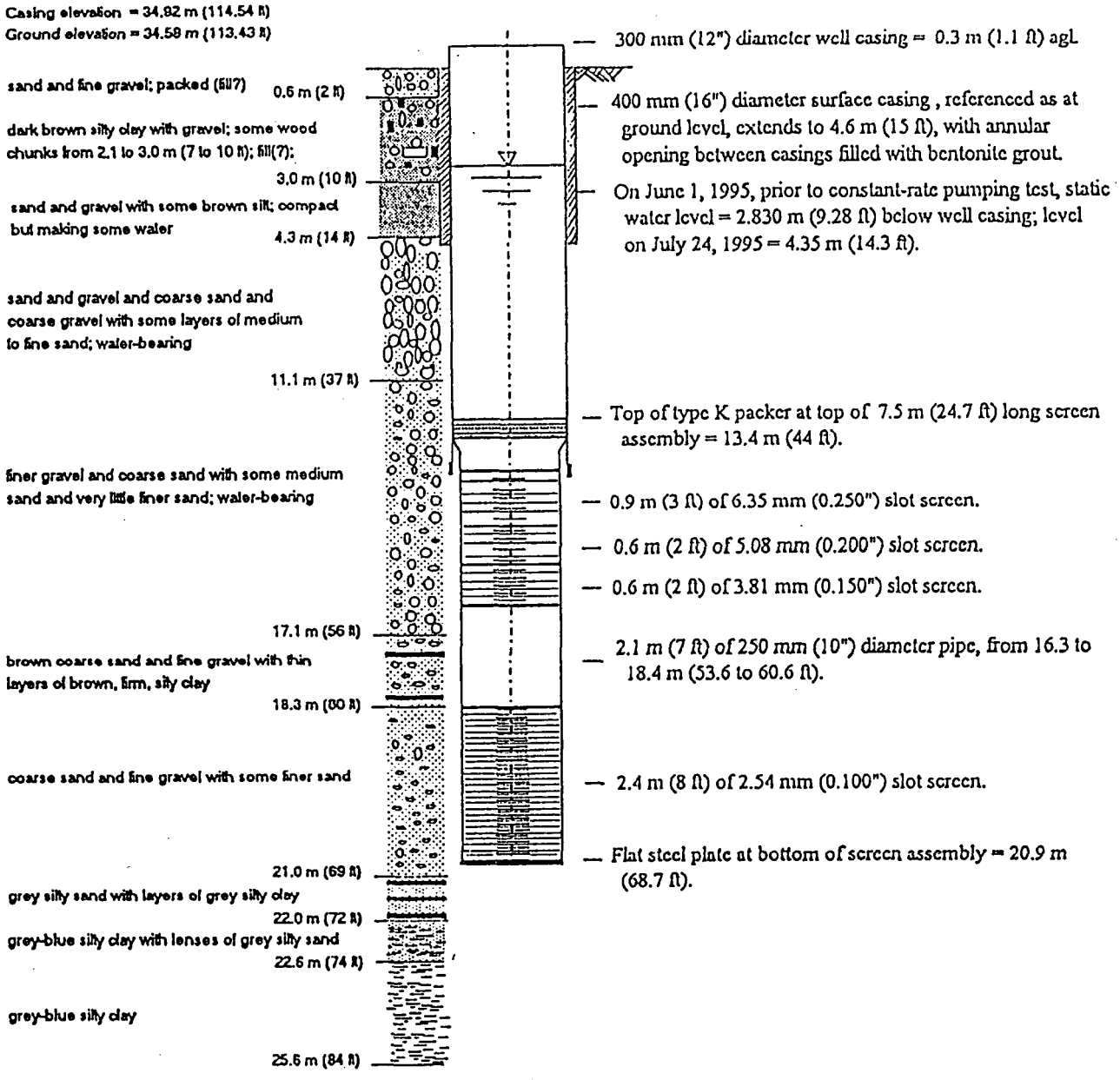
DATE
NOV. 1995

PRODUCED BY: W.S. HODGE

FILE NO. 0317588

FIGURE: 5

LOST SHOE CREEK PRODUCTION WELL 3-95
CONSTRUCTION DETAILS



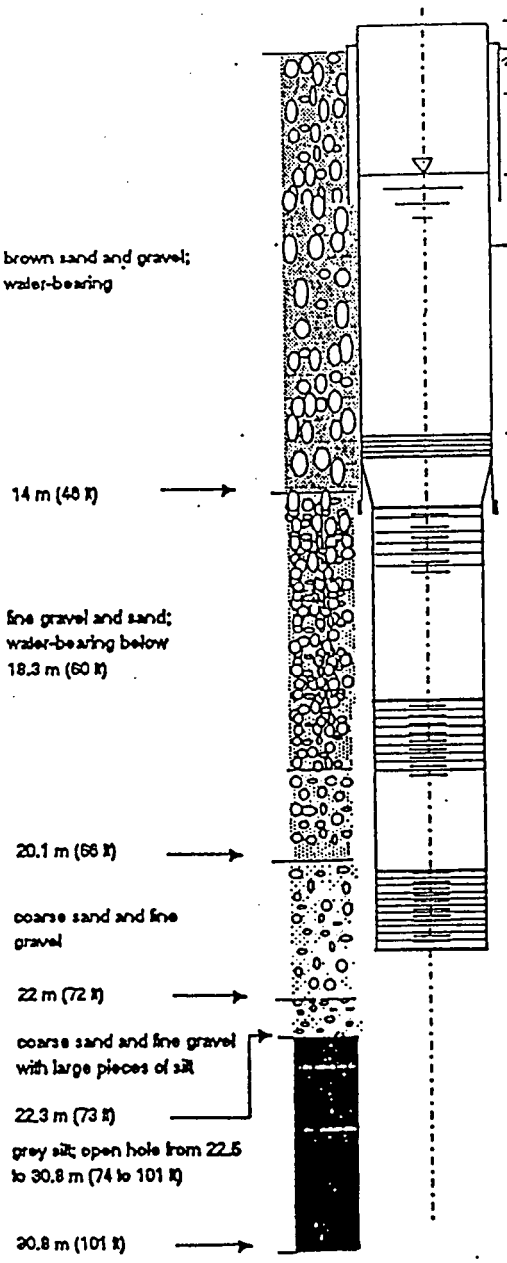
(AFTER ARENGI AND BADRY, 1995)

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

TO ACCOMPANY REPORT ON
Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet

SCALE: As shown	DATE: NOV. 1995	PRODUCED BY: W.S. HODGE
		FILE NO. 0317588 FIGURE: 6

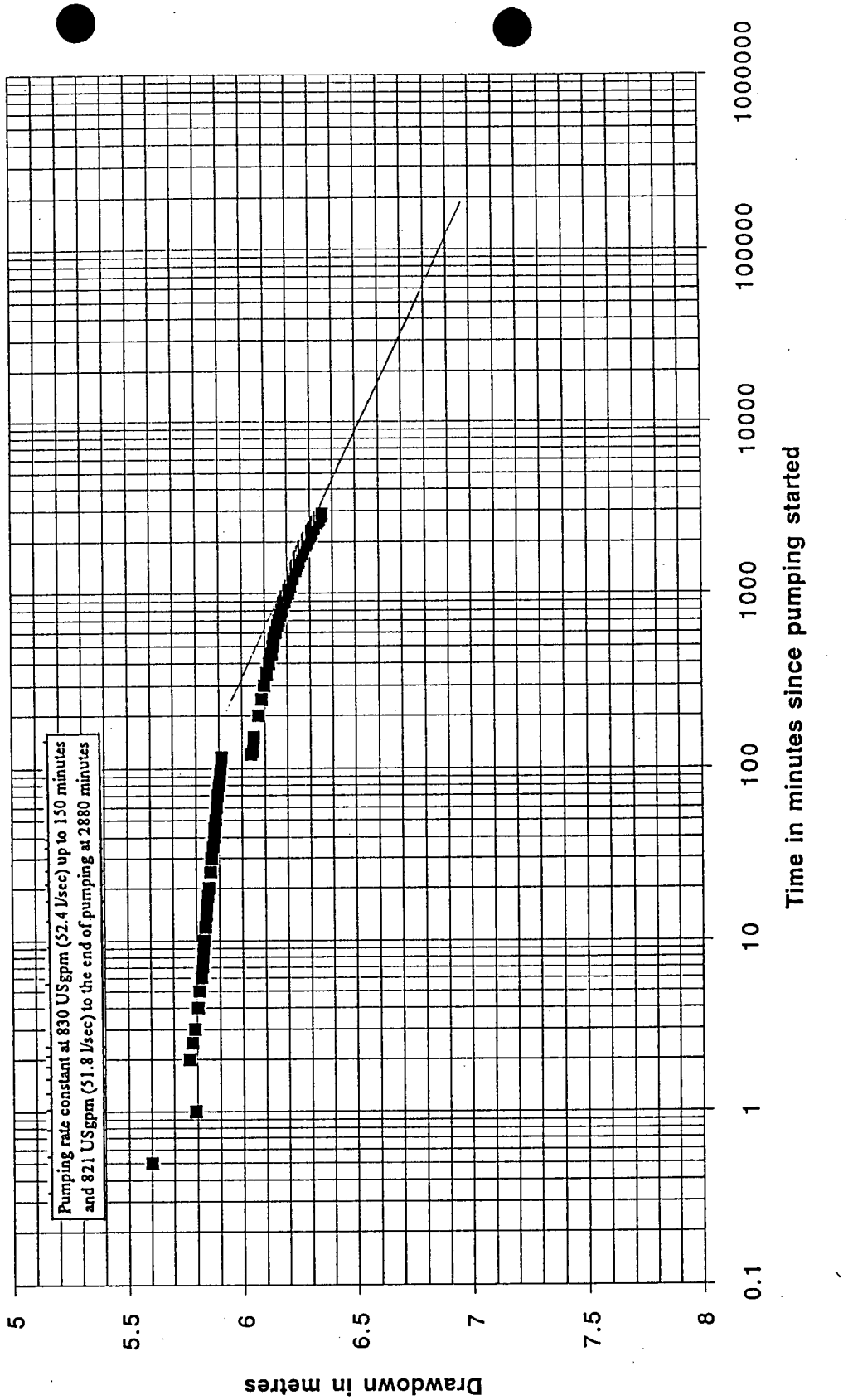
LOST SHOE CREEK TEST WELL NO. 1-94
CONSTRUCTION DETAILS



(AFTER ARENGI AND BADRY, 1995)

Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section		TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE : As shown	DATE NOV. 1995	PRODUCED BY : W.S. HODGE FILE NO. 0317588 FIGURE: 7

LSC PRODUCTION WELL 1-95 - TIME VS DRAWDOWN PLOT

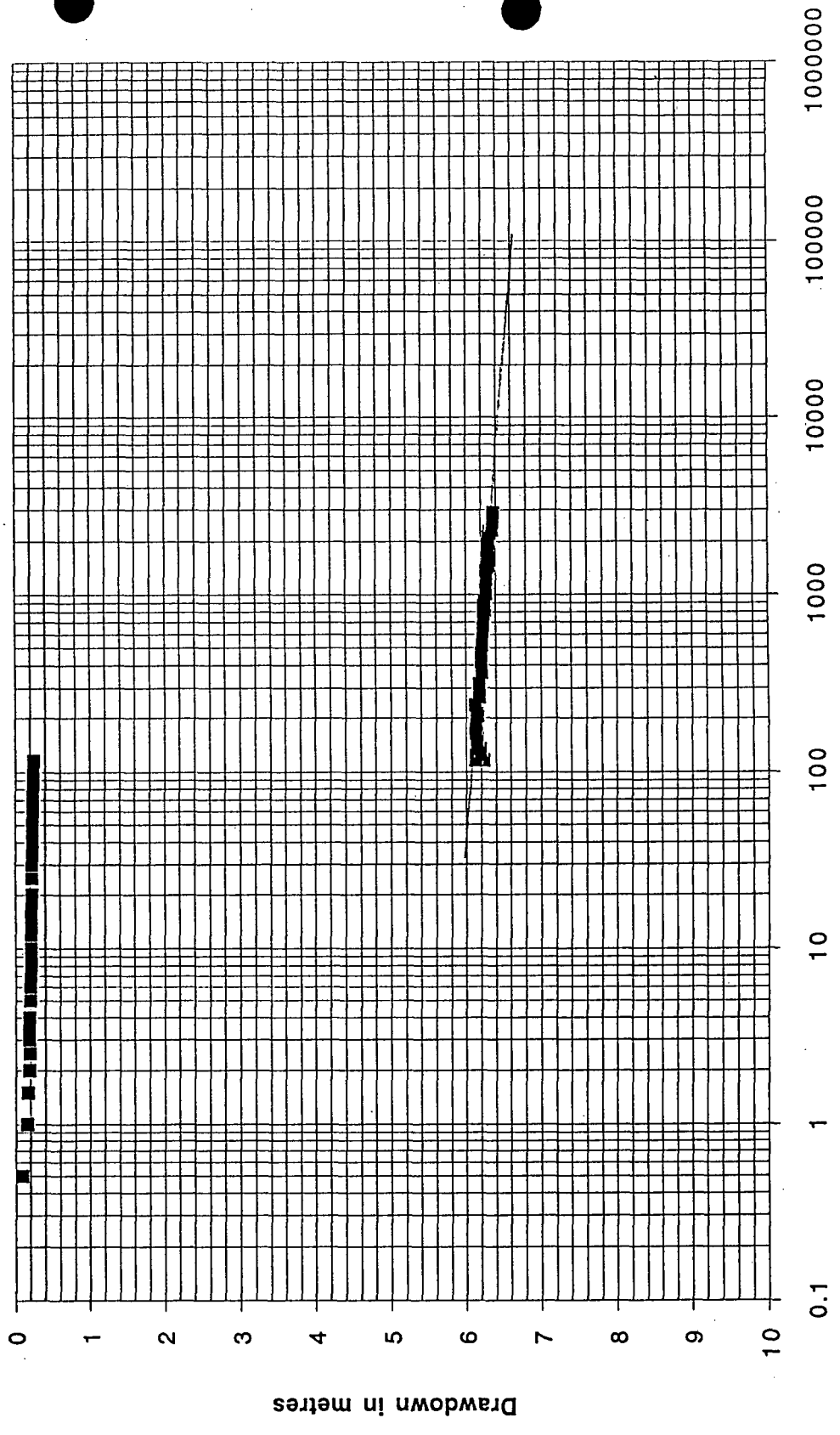


Province of British Columbia
Ministry of Environment, Lands and Parks
Water Management Division
Hydrology Branch
Groundwater Section

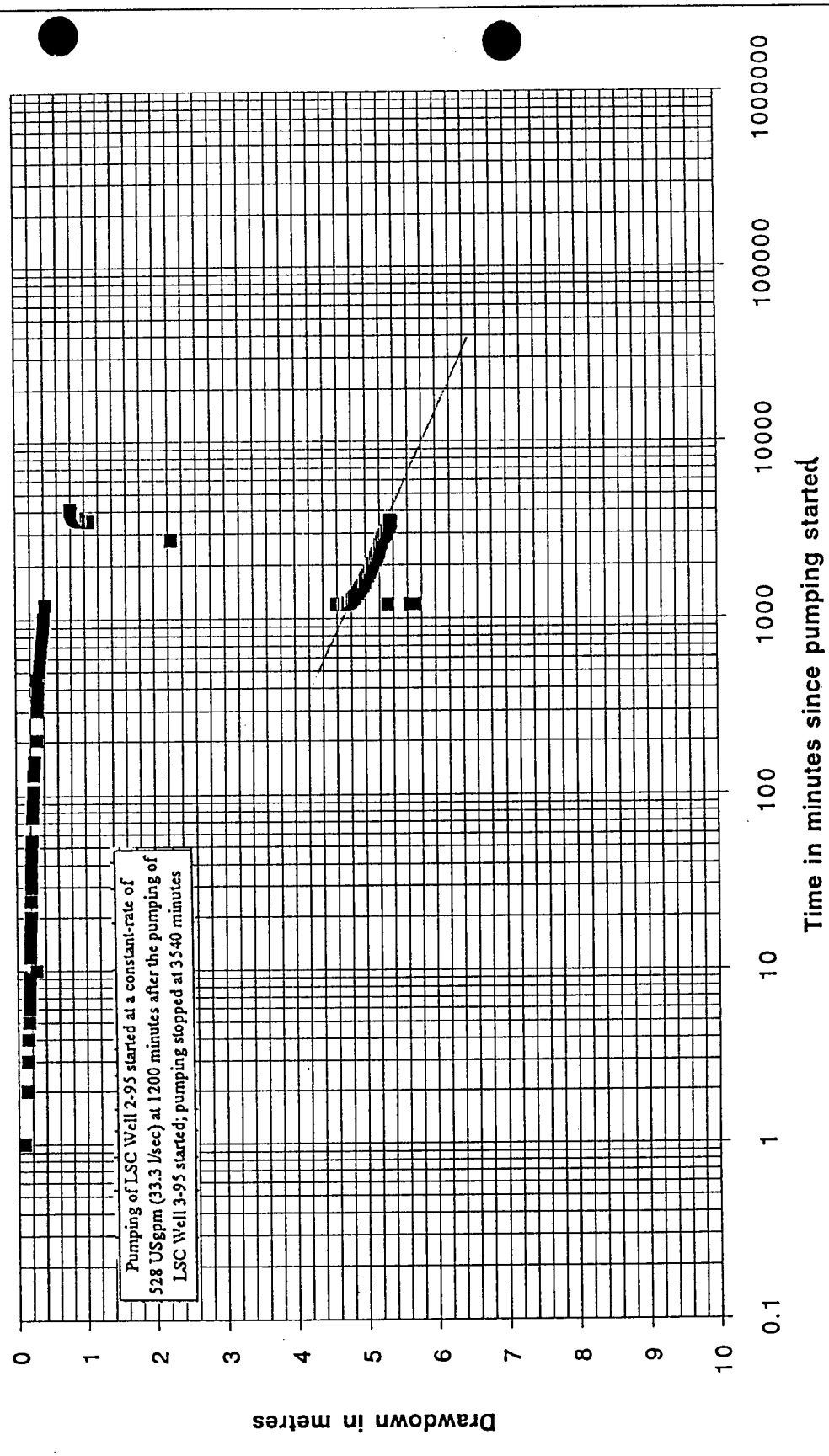
TO ACCOMPANY REPORT ON

Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet

SCALE: As shown	DATE: NOV. 1995	PRODUCED BY: W.S. HODGE
		FILE NO. 0317508 FIGURE: 8



Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section		TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE: As shown	DATE NOV. 1995	PRODUCED BY: W.S. HODGE FILE NO. 0317588 FIGURE: 9



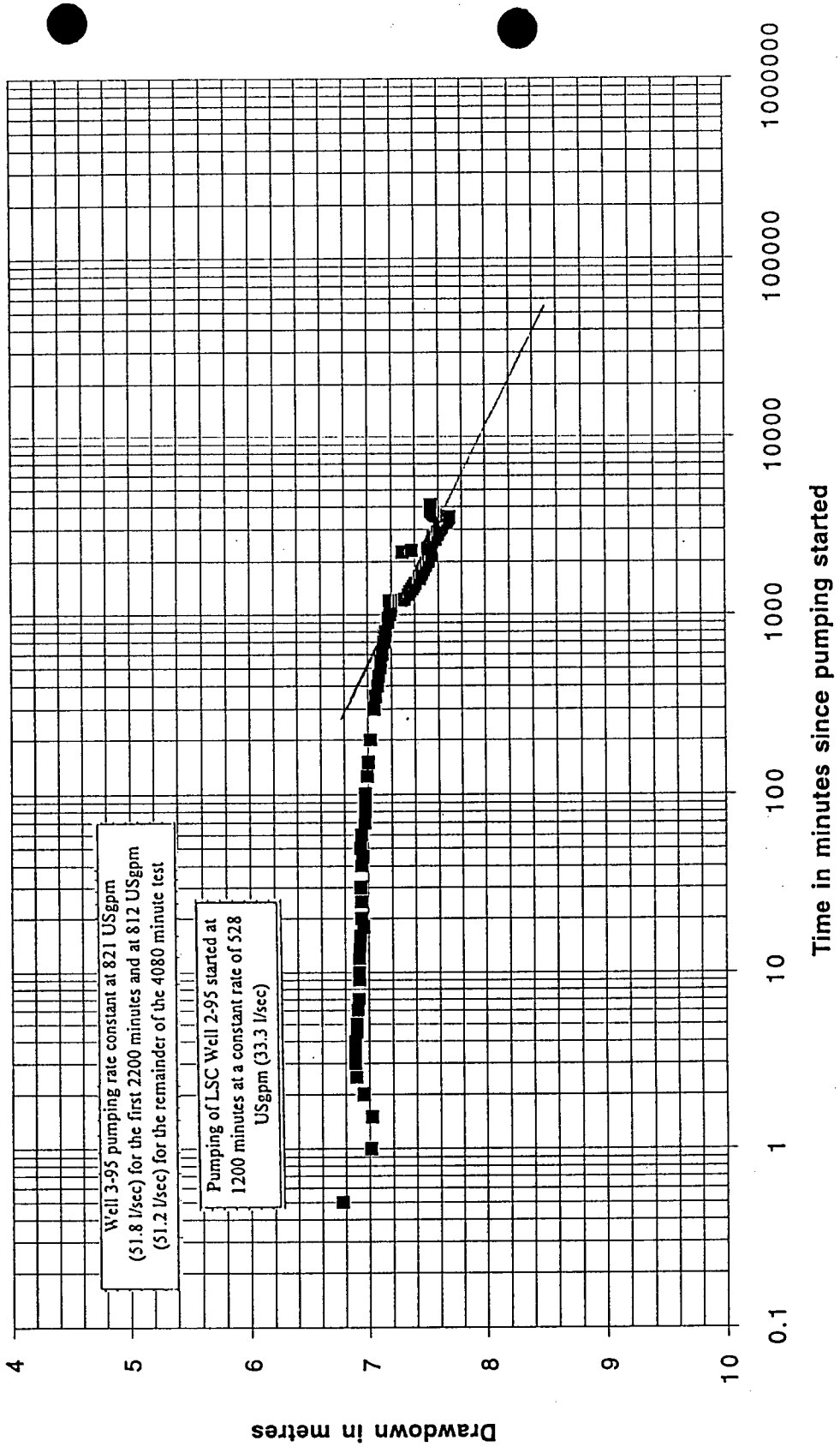
Province of British Columbia
Ministry of Environment, Lands and Parks
Water Management Division
Hydrology Branch
Groundwater Section

TO ACCOMPANY REPORT ON

Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet

SCALE: As shown	DATE NOV. 1995	PRODUCED BY: W.S. HODGE
		FILE NO. 0317588 FIGURE: 10

LSC PRODUCTION WELL 3-95 - TIME VS DRAWDOWN PLOT



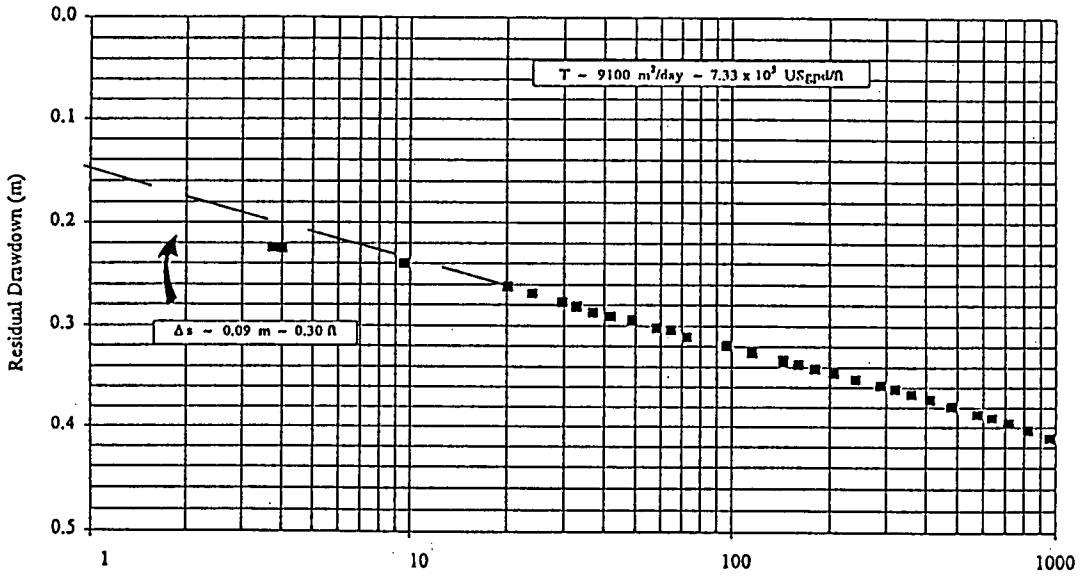
Province of British Columbia
Ministry of Environment, Lands and Parks
Water Management Division
Hydrology Branch
Groundwater Section

TO ACCOMPANY REPORT ON

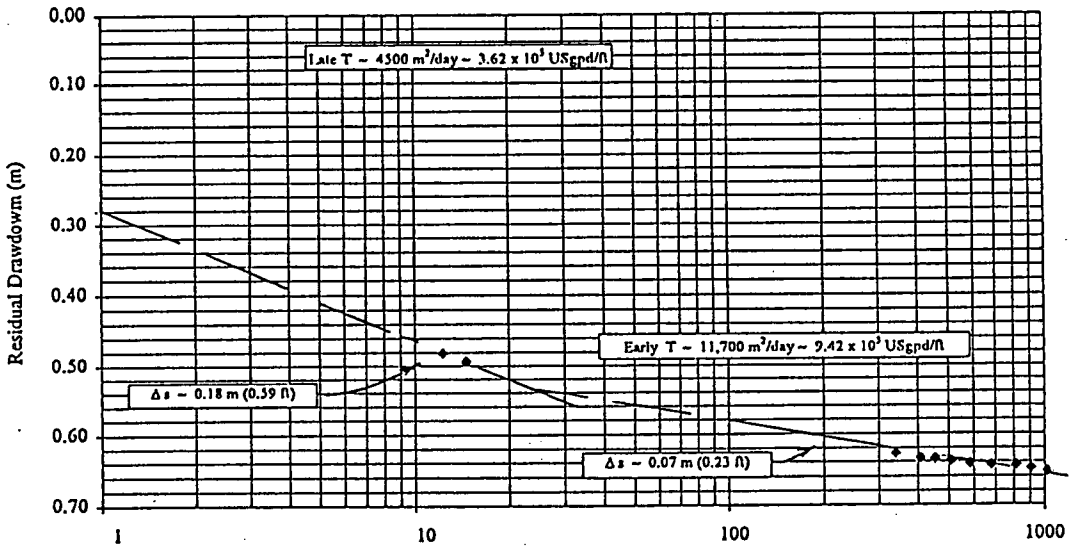
Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet

SCALE: As shown	DATE: NOV. 1995	PRODUCED BY: W.S. HODGE
		FILE NO. 0217588 FIGURE: 11

Time-Recovery Plot for Constant-Rate Pumping Test of
LSC Production Well 1-95



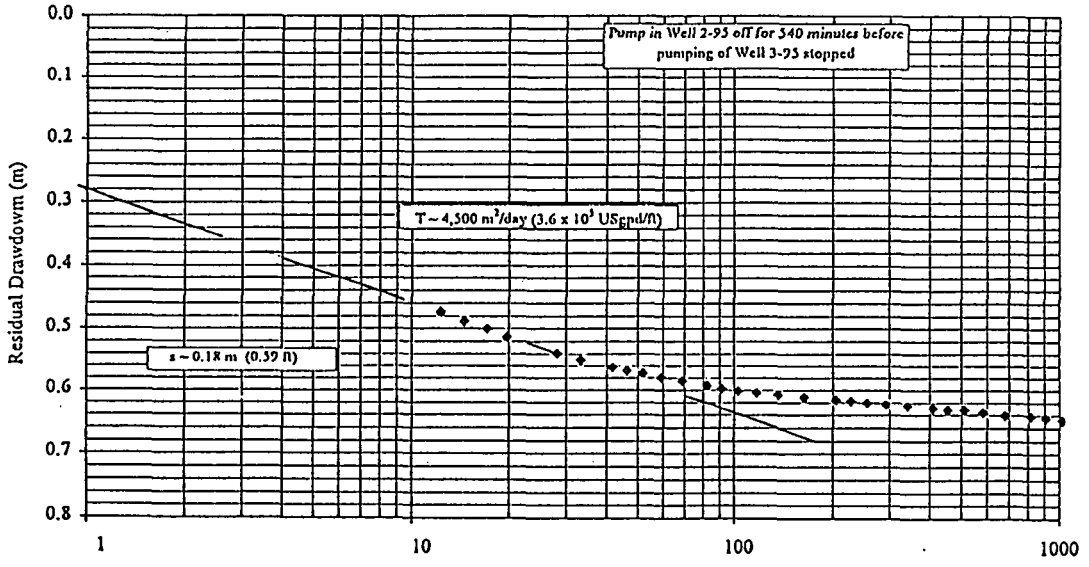
Time-Recovery Plot for Constant-Rate Pumping Test of
LSC Well 2-95



(AFTER ARENGI AND BADRY, 1995)

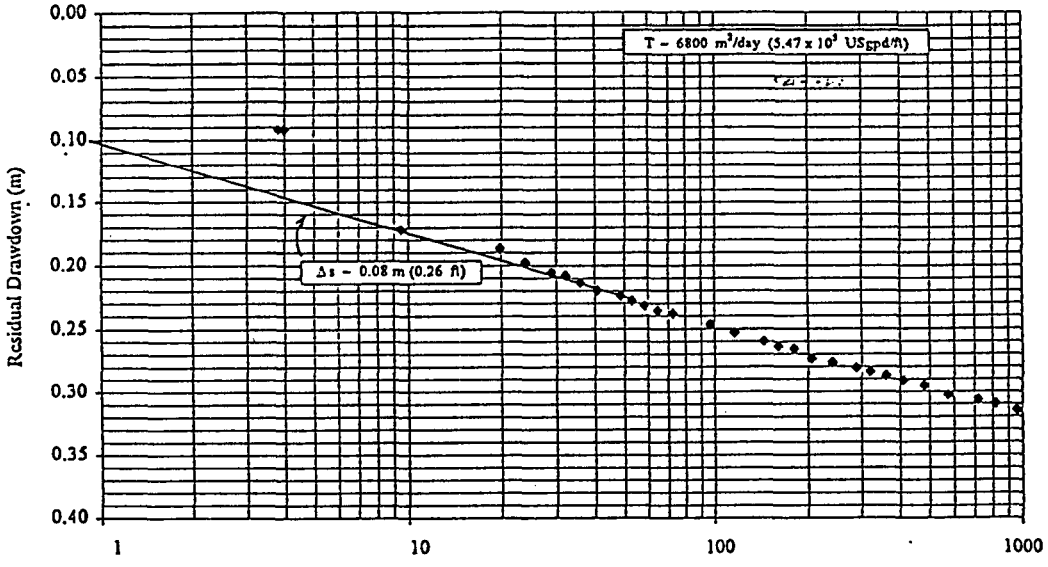
Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section	TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE: As shown DATE: NOV. 1995	PRODUCED BY: W.S. HODGE FILE NO. 0317508 FIGURE: 12

Time-Recovery Plot for Constant-Rate Pumping Test of LSC Well 3-95



Time in Minutes Since Pumping Started/Time in Minues Since Pumping Stopped

Time-Recovery Plot for Constant-Rate Pumping Test of LSC Test Well 1-94

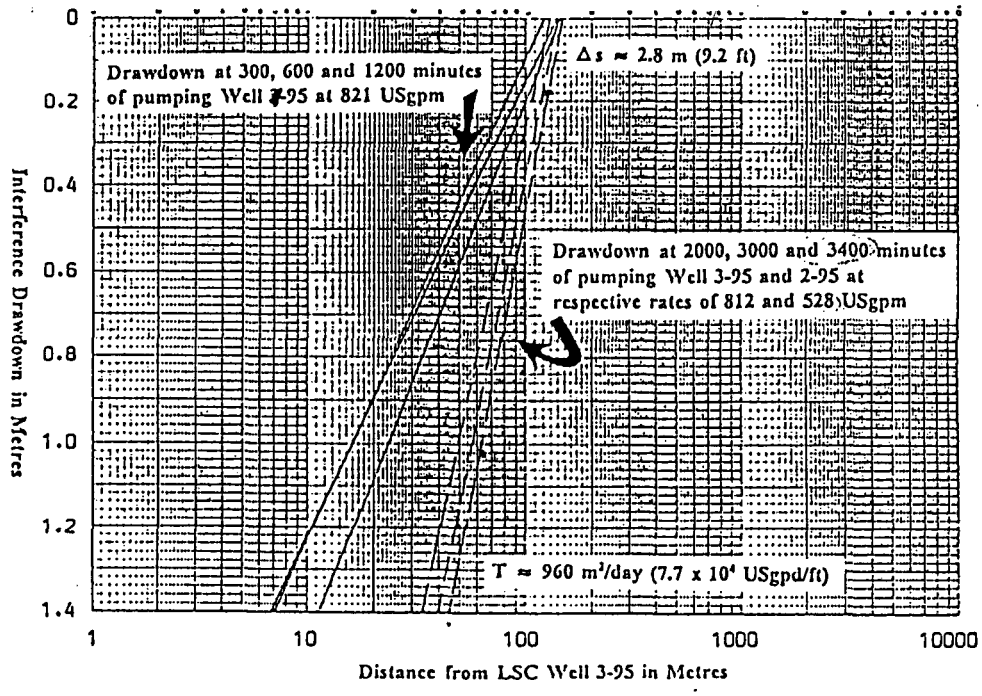


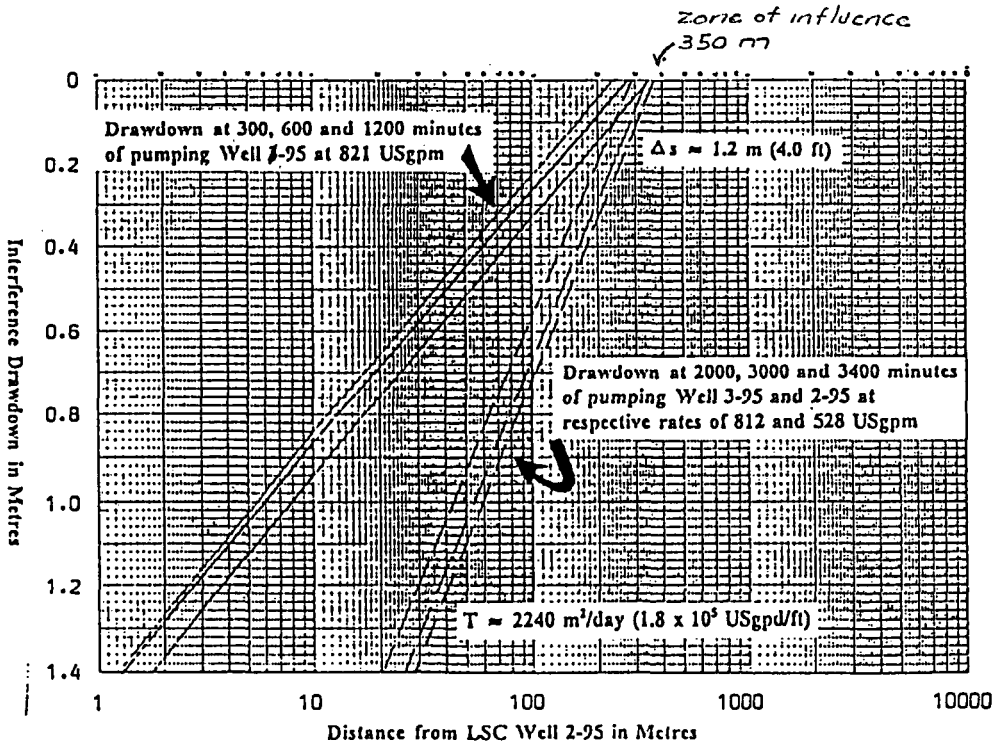
Time in Minutes Since Pumping Started/Time in Minutes Since Pumping Stopped

(AFTER ARENGI AND BADRY, 1995)

Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section		TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE: As shown	DATE NOV. 1995	PRODUCED BY: W.S. HODGE FILE NO. 0317588 FIGURE: 13

DISTANCE-DRAWDOWN ANALYSIS FOR PUMPING TESTS OF LSC PRODUCTION WELLS 2-95 AND 3-95





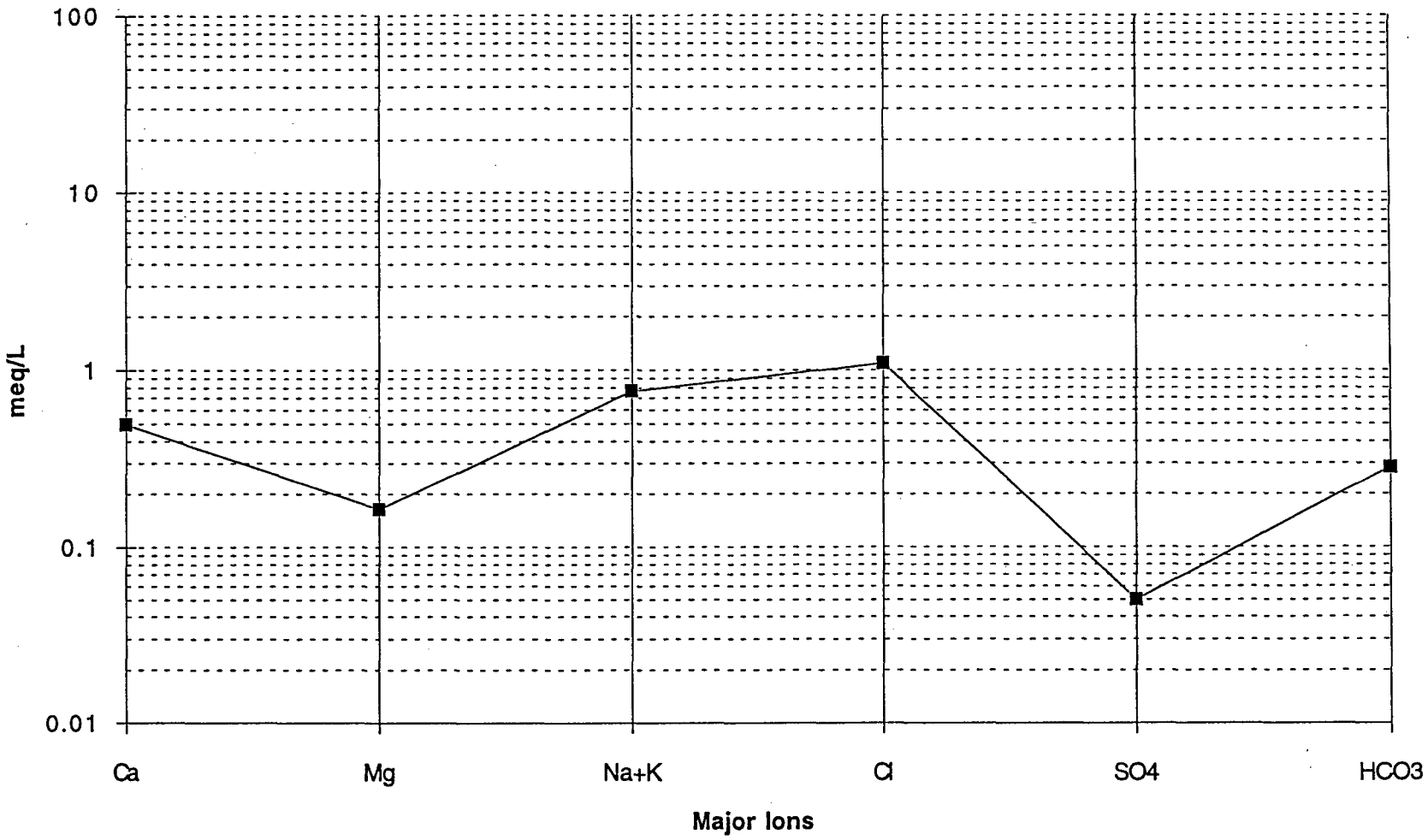
(AFTER ARENGI AND BADRY, 1995)

Province of British Columbia Ministry of Environment, Lands and Parks Water Management Division Hydrology Branch Groundwater Section	TO ACCOMPANY REPORT ON **Evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet**
SCALE: As shown DATE: NOV. 1995	PRODUCED BY: W.S. HODGE FILE NO. 0317588 FIGURE: 14

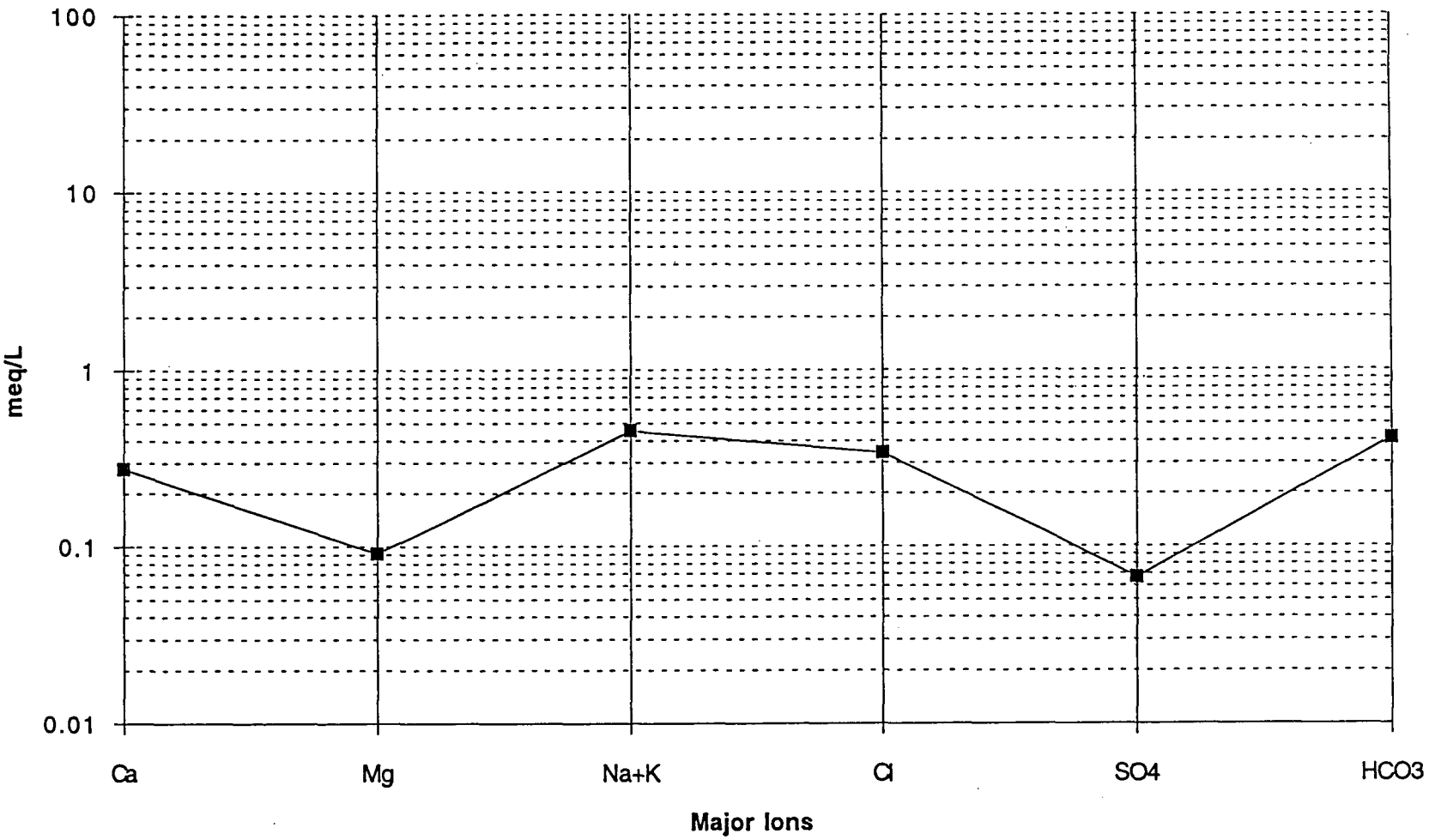
APPENDIX A

Schoeller Plots for LSC Production Wells 1-95, 2-95 and 3-95
Ryzner Stability Index (RSI) calculations for LSC Production Wells 1-95, 2-95 and 3-95 and Test Well 1-94.
Well Records for LSC Production Wells 1-95, 2-95, 3-95 and Test Well 1-94.

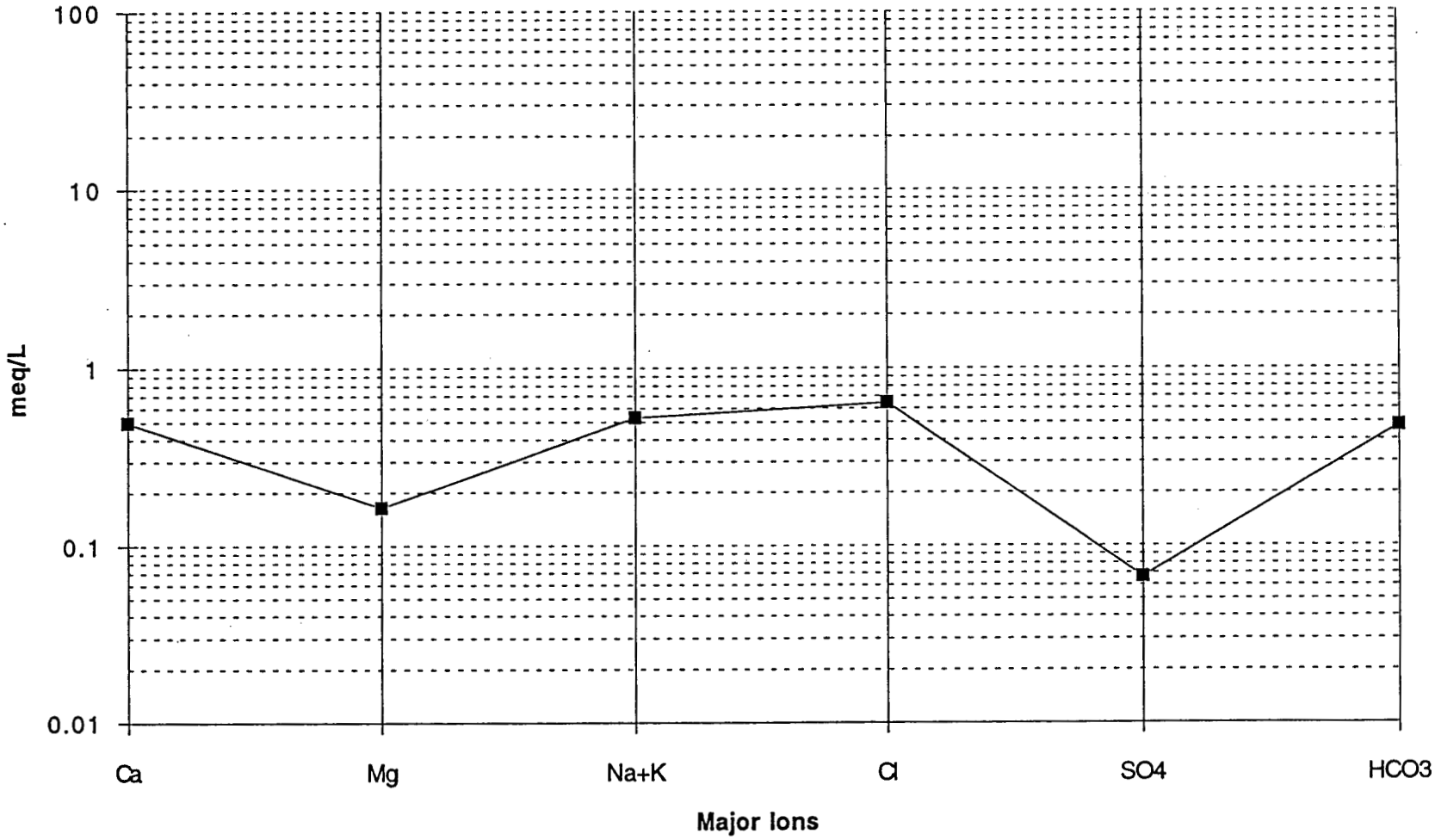
Appendix A Schoeller Plot - Production Well 1-95



Appendix A Schoeller Plot - Production Well 2-95



Appendix A Schoeller Plot - Production Well 3-95



Appendix A

LOST SHOE CREEK AQUIFER -
PRODUCTION WELL LSC 1-95

Calculation of the Ryzner Stability Index.

Sample Date: June 15, 1995

I = S - C - pH

where TDS = 110 mg/L
pH = 6.20
therefore S = 23.01

alkalinity = 14.2 mg/L
calcium = 10 mg/L

therefore C = 4.3

Ryznar Stability Index =

I = 23.01 - 4.3 - 6.20 = 12.51

A RSI of >7.0 indicates that the groundwater is corrosive.

Appendix A

LOST SHOE CREEK AQUIFER -
PRODUCTION WELL LSC 2-95

Calculation of the Ryzner Stability Index.

Sample Date: June 15, 1995

$I = S - C - pH$

where TDS = 55 mg/L
pH = 6.40
therefore S = 22.95

alkalinity = 20.5 mg/L
calcium = 5.53 mg/L

therefore C = 4.4

Ryznar Stability Index =

$I = 22.95 - 4.4 - 6.40 = \underline{12.15}$

A RSI of >7.0 indicates that the groundwater is corrosive.

Appendix A

LOST SHOE CREEK AQUIFER -
PRODUCTION WELL LSC 3-95

Calculation of the Ryzner Stability Index.

Sample Date: June 20, 1995

$I = S - C - pH$

where TDS = 76 mg/L
pH = 6.37
therefore S = 22.98

alkalinity = 23.8 mg/L
calcium = 9.99 mg/L

therefore C = 4.7

Ryznar Stability Index =

$I = 22.98 - 4.7 - 6.37 = \underline{11.91}$

A RSI of >7.0 indicates that the groundwater is corrosive.

Appendix A

LOST SHOE CREEK AQUIFER -
TEST WELL 1-94

Calculation of the Ryzner Stability Index.

Sample Date: February 24, 1994

I = S - C - pH

where TDS = 90 mg/L
pH = 6.51
therefore S = 22.99

alkalinity = 15.6 mg/L
calcium = 7.02 mg/L

therefore C = 4.7

Ryznar Stability Index =

I = 22.99 - 4.7 - 6.51 = 11.78

A RSI of >7.0 indicates that the groundwater is corrosive.

BCGS MAP 092C•093•3•3•3 WELL NO. 005

WATER WELL RECORD

MINISTRY OF ENVIRONMENT WATER MANAGEMENT DIVISION VICTORIA, BRITISH COLUMBIA

Z ___ WELL NO. ___ E ___ N ___

Z X Y NO.

NAT. TOPO. SHEET NO. ___

LEGAL DESCRIPTION: LOT ___ SEC. ___ TP. ___ R. ___ D.L. 462 LAND DISTRICT CLAYQUOT PLAN ___

DESCRIPTIVE LOCATION NE CORNER D.L 462 SW OF INTERSECTION HWY 4 and TOFINO Hwy LICENCE NO. ___ DATE ___

OWNER'S NAME VILLAGE OF UCLUELET ADDRESS UCLUELET

DRILLER'S NAME FREDS DRILLING ADDRESS LANGLEY DATE COMPLETED April 1995

DEPTH 62' ELEVATION OF ___ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 12" LENGTH ___

METHOD OF CONSTRUCTION Cable tool CASING DIAM 16" LENGTH ___

SCREEN LOCATION *See inside SCREEN ☒ SIZE * LENGTH * TYPE JOHNSON

SANITARY SEAL YES ☑ NO ☐ SCREEN ☐ SIZE ___ LENGTH ___ TYPE ___

PERFORATED CASING ☐ LENGTH ___ PERFORATIONS FROM ___ TO ___

GRAVEL PACK ☐ LENGTH ___ DIAM. ___ SIZE GRAVEL, ETC. ___

DISTANCE TO WATER 4.05' ☐ ESTIMATED WATER LEVEL

FROM TOC ☒ MEASURED ELEVATION ___ ARTESIAN PRESSURE ___

DATE OF WATER LEVEL MEASUREMENT Apr 25/95 WATER USE PRODUCTION WELL

PRODUCTION TEST SUMMARY

DATE Apr 25/95

TEST BY Freds Drilling

BAIL TEST ☐ PUMP TEST ☑ DURATION OF TEST 2880 min

RATE 821 USgpm DRAWDOWN 20.8'

WATER LEVEL AT COMPLETION OF TEST 24.9'

AVAILABLE DRAWDOWN ___ SPECIFIC CAPACITY ___

PERMEABILITY ___ STORAGE COEFF. ___

TRANSMISSIVITY ___

ESTIMATED WELL YIELD 400 USgpm

RECOMMENDED PUMPING RATE ___

RECOMMENDED PUMP SETTING ___

CHEMISTRY

TEST BY ___ DATE ___

TOTAL DISSOLVED SOLIDS ___ mg/l TEMPERATURE ___ °C pH ___ SILICA (SiO_2) ___ mg/l

CONDUCTANCE ___ μmhos/cm AT 25°C TOTAL IRON (Fe) ___ mg/l TOTAL HARDNESS ($CaCO_3$) ___ mg/l

TOTAL ALKALINITY ($CaCO_3$) ___ mg/l PHEN. ALKALINITY ($Ca CO_3$) ___ mg/l MANGANESE (Mn) ___ mg/l

COLOUR ___ ODOUR ___ TURBIDITY ___

ANIONS	mg/l	epm	CATIONS	mg/l	epm
CARBONATE (CO_3)			CALCIUM (Ca)		
BICARBONATE (HCO_3)			MAGNESIUM (Mg)		
SULPHATE (SO_4)			SODIUM (Na)		
CHLORIDE (Cl)			POTASSIUM (K)		
NO_2 • NO_3 (NITROGEN)			IRON (DISSOLVED)		
• TKN. (NITROGEN)					
PHOSPHORUS (P)					

• TKN = TOTAL KJELDAHL NITROGEN CHEMISTRY SITE NO. ___

NO_2 = NITRITE NO_3 = NITRATE

CHEMISTRY FIELD TESTS

TEST BY ___ DATE ___ EQUIPMENT USED ___

LITHOLOGY

FROM	TO	DESCRIPTION
0	.5	sand & gravel
.5	10	brown packed silty sand & gravel w/some large rocks and wood chunks; FILL
10	16	BROWN SILTY SAND; FILL ?
16	33	med to coarse sand & fine to coarse gravel, w.b.
33	54	finer gravel w/ more sand
54	67	coarse to med-fine sand w/ layers of packed brown silt
67	71	grey sand
71	72	grey sand & silt w/ lenses of blue-grey silty clay
72	82	blue-grey silty clay.
		Production Well LSC 1-95

CONTENTS OF FOLDER

☒ DRILL LOG ☐ PUMP TEST DATA ☐ CHEMICAL ANALYSIS

☐ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☐ REPORT

OTHER * sketch of construction & lithologic details

SOURCES OF INFORMATION ___

BCGS MAP 092C.093.3.3.3 WELL NO. 006

WATER WELL RECORD

MINISTRY OF ENVIRONMENT WATER MANAGEMENT DIVISION — VICTORIA, BRITISH COLUMBIA

Z ___ WELL NO. ___ E ___ N ___ Z X Y NO.

LEGAL DESCRIPTION: LOT ___ SEC. ___ TP. ___ R. ___ D.L. 462 LAND DISTRICT CLAYOQUOT PLAN ___

DESCRIPTIVE LOCATION NORTH PART OF DL 462 S.W. OF INTERSECTION OF ALBERNI HWY & TOFINO HWY LICENCE NO. ___ DATE ___

OWNER'S NAME VILLAGE OF UCLUELET ADDRESS UCLUELET

DRILLER'S NAME FRED'S DRILLING ADDRESS LANGLEY DATE COMPLETED MAY 1995

NAT. TOPO. SHEET NO. ___

DEPTH 56 ELEVATION OF ___ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 12" LENGTH ___

METHOD OF CONSTRUCTION CABLE TOOL CASING DIAM 16" LENGTH ___

SCREEN LOCATION *SEE INSIDE SCREEN ☒ SIZE * LENGTH ___ TYPE JOHNSON

SANITARY SEAL YES ☐ NO ☐ SCREEN ☐ SIZE ___ LENGTH ___ TYPE ___

PERFORATED CASING ☐ LENGTH ___ PERFORATIONS FROM ___ TO ___

GRAVEL PACK ☐ LENGTH ___ DIAM. ___ SIZE GRAVEL, ETC. ___

DISTANCE TO WATER 5.82 ☐ ESTIMATED WATER LEVEL

FROM TOC ☒ MEASURED ELEVATION ___ ARTESIAN PRESSURE ___

DATE OF WATER LEVEL MEASUREMENT MAY 30/95 WATER USE PRODUCTION WELL

PRODUCTION TEST SUMMARY

DATE MAY 30 1995

TEST BY FRED'S DRILLING

BAIL TEST ☐ PUMP TEST ☒ DURATION OF TEST 4080 min

RATE 528 USgpm DRAWDOWN 17.6'

WATER LEVEL AT COMPLETION OF TEST 23.9'

AVAILABLE DRAWDOWN ___ SPECIFIC CAPACITY ___

PERMEABILITY ___ STORAGE COEFF. ___

TRANSMISSIVITY ___

ESTIMATED WELL YIELD ___

RECOMMENDED PUMPING RATE ___

RECOMMENDED PUMP SETTING ___

CHEMISTRY

TEST BY ___ DATE ___

TOTAL DISSOLVED SOLIDS ___ mg/l TEMPERATURE ___ °C pH ___ SILICA (SiO_2) ___ mg/l

CONDUCTANCE ___ μmhos/cm AT 25°C TOTAL IRON (Fe) ___ mg/l TOTAL HARDNESS ($CaCO_3$) ___ mg/l

TOTAL ALKALINITY ($CaCO_3$) ___ mg/l PHEN. ALKALINITY ($Ca CO_3$) ___ mg/l MANGANESE (Mn) ___ mg/l

COLOUR ___ ODOUR ___ TURBIDITY ___

ANIONS	mg/l	epm	CATIONS	mg/l	epm
CARBONATE (CO_3)			CALCIUM (Ca)		
BICARBONATE (HCO_3)			MAGNESIUM (Mg)		
SULPHATE (SO_4)			SODIUM (Na)		
CHLORIDE (Cl)			POTASSIUM (K)		
$NO_2 + NO_3$ (NITROGEN)			IRON (DISSOLVED)		
* TKN. (NITROGEN)					
PHOSPHORUS (P)					

* TKN = TOTAL KJELDAHL NITROGEN

NO_2 = NITRITE NO_3 = NITRATE

CHEMISTRY SITE NO. ___

CHEMISTRY FIELD TESTS

TEST BY ___ DATE ___ EQUIPMENT USED ___

LITHOLOGY

FROM	TO	DESCRIPTION
0	1.0	fine sand ; fill
1.0	3	packed sand + gravel
3	9	SILTY SAND + GRAVEL + WOOD CHUNKS, FILL
9	15	SAND & GRAVEL W/SOME SILT/ CHUNKS, PLYWOOD & METAL (CABLE?) WIRE) TO 12.0'; FILL
15	27	COARSE SAND & COARSE GRAVEL W/ COBBLES ; W/B
27	34	FINE GRAVEL W/ COARSE SAND
34	35	BROWN CLAY
35	45	FINE GRAVEL W/ COARSE SAND; LAYER OF BROWN CLAY @ 45'
45	54.5	FINE SAND & GRAVEL
54.5	65	BLUE SILTY CLAY W/ INTERBEDS OF W/B. SAND
65	82	BLUE SILTY CLAY
		PRODUCTION WELL LSC 2-95

CONTENTS OF FOLDER

☒ DRILL LOG ☐ PUMP TEST DATA ☐ CHEMICAL ANALYSIS

☐ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☐ REPORT

OTHER * sketch of construction + lithologic details

SOURCES OF INFORMATION ___

BCGS MAP 092C • 093 • 3 • 3 • 3 WELL NO. 007

WATER WELL RECORD

MINISTRY OF ENVIRONMENT WATER MANAGEMENT DIVISION VICTORIA, BRITISH COLUMBIA

Z WELL NO.

E

N

Z X Y NO.

NAT. TOPO. SHEET NO.

LEGAL DESCRIPTION: LOT ____ SEC. ____ TP. ____ R. ____ D.L. 462 LAND DISTRICT CLAYQUOT PLAN ____

DESCRIPTIVE LOCATION north part of DL 462 SW of intersection of Alberni Hwy + Tofino Hwy LICENCE NO. ____ DATE ____

OWNER'S NAME VILLAGE OF UCLUELET ADDRESS UCLUELET

DRILLER'S NAME Fred's Drilling ADDRESS ____ DATE COMPLETED May 1995

DEPTH 68.7' ELEVATION OF ____ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 12" LENGTH ____

METHOD OF CONSTRUCTION CABLE TOOL CASING DIAM 16" LENGTH ____

SCREEN LOCATION * see inside SCREEN ☒ SIZE * LENGTH ____ TYPE ____

SANITARY SEAL YES ☐ NO ☐ SCREEN ☐ SIZE ____ LENGTH ____ TYPE ____

PERFORATED CASING ☐ LENGTH ____ PERFORATIONS FROM ____ TO ____

GRAVEL PACK ☐ LENGTH ____ DIAM. ____ SIZE GRAVEL, ETC. ____

DISTANCE TO WATER 8.81' ☐ ESTIMATED WATER LEVEL

FROM TOC ☒ MEASURED ELEVATION ____ ARTESIAN PRESSURE ____

DATE OF WATER LEVEL MEASUREMENT ____ WATER USE ____

PRODUCTION TEST SUMMARY

DATE ____

TEST BY Fred's Drilling

BAIL TEST ☐ PUMP TEST ☒ DURATION OF TEST 4080 min

RATE 821 USgpm DRAWDOWN 24.1'

WATER LEVEL AT COMPLETION OF TEST ____

AVAILABLE DRAWDOWN ____ SPECIFIC CAPACITY ____

PERMEABILITY ____ STORAGE COEFF. ____

TRANSMISSIVITY ____

ESTIMATED WELL YIELD ____

RECOMMENDED PUMPING RATE ____

RECOMMENDED PUMP SETTING ____

CHEMISTRY

TEST BY ____ DATE ____

TOTAL DISSOLVED SOLIDS ____ mg/l TEMPERATURE ____ °C pH ____ SILICA (SiO_2) ____ mg/l

CONDUCTANCE ____ μmhos/cm AT 25°C TOTAL IRON (Fe) ____ mg/l TOTAL HARDNESS ($CoCO_3$) ____ mg/l

TOTAL ALKALINITY ($CoCO_3$) ____ mg/l PHEN. ALKALINITY ($Co\ CO_3$) ____ mg/l MANGANESE (Mn) ____ mg/l

COLOUR ____ ODOUR ____ TURBIDITY ____

ANIONS	mg/l	epm	CATIONS	mg/l	epm
CARBONATE (CO_3)			CALCIUM (Ca)		
BICARBONATE (HCO_3)			MAGNESIUM (Mg)		
SULPHATE (SO_4)			SODIUM (Na)		
CHLORIDE (Cl)			POTASSIUM (K)		
$NO_2 + NO_3$ (NITROGEN)			IRON (DISSOLVED)		
• TKN. (NITROGEN)					
PHOSPHORUS (P)					

• TKN = TOTAL KJELDAHL NITROGEN CHEMISTRY SITE NO. ____

NO_2 = NITRITE NO_3 = NITRATE

CHEMISTRY FIELD TESTS

TEST BY ____ DATE ____ EQUIPMENT USED ____

CONTENTS OF FOLDER

☐ DRILL LOG ☐ PUMP TEST DATA ☐ CHEMICAL ANALYSIS

☐ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☐ REPORT

OTHER * Sketch of construction + lithologic details

SOURCES OF INFORMATION ____

LITHOLOGY

FROM	TO	DESCRIPTION
0	2	SAND + FINE GRAVEL, PACKED, FILL
2	10	DARK BROWN SILTY CLAY W/ GRAVEL SOME WOOD CHUNKS FROM 7 TO 10 FEET, drilled open hole, fill?
10	14	Sand + gravel w/ some brown silt, compact but making some water.
14	37	Sand + gravel + coarse sand and coarse gravel w/ some
37	56	FINER GRAVEL + COARSE SAND w/ some med. sand and very little finer sand, wb.
56	60	BROWN COARSE SAND + FINE GRAVEL W/ thin layers of brown firm, silty clay
60	69	coarse sand + fine gravel w/ some finer sand
69	72	grey silty sand w/ layers of grey silty clay
72	74	blue-grey silty clay w/ lenses of grey silty sand
74	84	GREY BLUE silty clay
		Production Well LSC 3-95

BCGS MAP 092C.093.3.3.3 WELL NO. 008

WATER WELL RECORD

MINISTRY OF ENVIRONMENT WATER MANAGEMENT DIVISION — VICTORIA, BRITISH COLUMBIA

LEGAL DESCRIPTION: LOT ____ SEC. ____ TP. ____ R. ____ D.L. 462 LAND DISTRICT CLAYQUOT PLAN ____

DESCRIPTIVE LOCATION NE CORNER OF DL 462 LICENCE NO. ____ DATE ____

Z ____ WELL NO. ____ E ____ N ____ Z X Y NO. ____ NAT. TOPO. SHEET NO. ____

OWNER'S NAME VILLAGE OF UCLUELET ADDRESS UCLUELET

DRILLER'S NAME ANDERSON WATER WELLS ADDRESS COURTENAY BC DATE COMPLETED JAN 1994

DEPTH 69.9 ELEVATION OF ____ ☒ ESTIMATED ☐ SURVEYED CASING DIAM. 8" LENGTH ____

METHOD OF CONSTRUCTION CABLE TOOL CASING DIAM 12 LENGTH ____

SCREEN LOCATION * SEE INSIDE SCREEN ☒ SIZE * SEE INSIDE LENGTH ____ TYPE ____

SANITARY SEAL YES ☐ NO ☐ SCREEN ☐ SIZE ____ LENGTH ____ TYPE ____

PERFORATED CASING ☐ LENGTH ____ PERFORATIONS FROM ____ TO ____

GRAVEL PACK ☐ LENGTH ____ DIAM. ____ SIZE GRAVEL, ETC. ____

DISTANCE TO WATER 12.52' ☐ ESTIMATED WATER LEVEL

FROM TOC ☐ MEASURED ELEVATION ____ ARTESIAN PRESSURE ____

DATE OF WATER LEVEL MEASUREMENT FEB 10/94 WATER USE TEST WELL

PRODUCTION TEST SUMMARY

DATE Feb 11/94

TEST BY ____

BAIL TEST ☐ PUMP TEST ☒ DURATION OF TEST 2880 min

RATE 566 USgpm DRAWDOWN 19.9'

WATER LEVEL AT COMPLETION OF TEST 32.4 ft

AVAILABLE DRAWDOWN ____ SPECIFIC CAPACITY 28.4 USgpm/ft

PERMEABILITY ____ STORAGE COEFF. ____

TRANSMISSIVITY ____

ESTIMATED WELL YIELD 300 USgpm

RECOMMENDED PUMPING RATE ____

RECOMMENDED PUMP SETTING ____

CHEMISTRY

TEST BY ____ DATE ____

TOTAL DISSOLVED SOLIDS ____ mg/l TEMPERATURE ____ °C pH ____ SILICA (SiO_2) ____ mg/l

CONDUCTANCE ____ μmhos/cm AT 25°C TOTAL IRON (Fe) ____ mg/l TOTAL HARDNESS ($CoCO_3$) ____ mg/l

TOTAL ALKALINITY ($CoCO_3$) ____ mg/l PHEN. ALKALINITY (Co CO_3) ____ mg/l MANGANESE (Mn) ____ mg/l

COLOUR ____ ODOUR ____ TURBIDITY ____

ANIONS	mg/l	epm	CATIONS	mg/l	epm
CARBONATE (CO_3)			CALCIUM (Ca)		
BICARBONATE (HCO_3)			MAGNESIUM (Mg)		
SULPHATE (SO_4)			SODIUM (Na)		
CHLORIDE (Cl)			POTASSIUM (K)		
NO_2 + NO_3 (NITROGEN)			IRON (DISSOLVED)		
• TKN. (NITROGEN)					
PHOSPHORUS (P)					

• TKN • TOTAL KJELDAHL NITROGEN CHEMISTRY SITE NO. ____

NO_2 • NITRITE NO_3 • NITRATE

CHEMISTRY FIELD TESTS

TEST BY ____ DATE ____ EQUIPMENT USED ____

LITHOLOGY

FROM	TO	DESCRIPTION
0	12.5	BROWN SAND & GRAVEL
12.5	46	BROWN SAND & GRAVEL; WB.
46	60	BROWN FINE GRAVEL & SAND, WB.
60	66	BROWN FINE GRAVEL & SAND MORE SANDY; WB.
66	72	COARSE SAND & FINE GRAVEL, GREY.
72	73	GREY COARSE SAND & SOME FINE GRAVEL & LARGE PIECES OF GREY SILT
73	101	GREY SILT (OPEN HOLE FROM 74-101')
		TEST WELL 1-94

CONTENTS OF FOLDER

☐ DRILL LOG ☐ PUMP TEST DATA ☐ CHEMICAL ANALYSIS

☐ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☐ REPORT

OTHER * SKETCH OF CONSTRUCTION + LITHOLOGIC DETAILS

SOURCES OF INFORMATION ____

APPENDIX B

Wellhead protection area calculations for LSC production wells 1-95, 2-95, 3-95 and test well 1-94.
Aquifer Classification Work Sheet.

Appendix B - Wellhead Protection Area Calculations.

LSC production well 1-95

$Q = (400)(2.23 \times 10^{-3}\ ft^3/sec)(86400\ sec/day)(365\ days/yr)\ ft^3/yr.$
$Q = 281 \times 10^7\ ft^3/yr.$

$$r = \frac{(2.81 \times 10^7\ ft^3/yr)(5)}{\sqrt{(3.1416)(0.25)(51)}}$$

r = 835'

LSC production well 2-95

$Q = (450)(2.23 \times 10^{-3}\ ft^3/sec)(86400\ sec/day)(365\ days/yr)\ ft^3/yr.$
$Q = 3.16 \times 10^7\ ft^3/yr.$

$$r = \frac{3.16 \times 10^7\ ft^3/yr.}{\sqrt{(3.1416)(0.25)(38)}}$$

r = 1020'

LSC production well 3-95

$Q = (700)(2.23 \times 10^{-3}\ ft^3/sec)(86400\ sec/day)(365\ days/yr)\ ft^3/yr.$
$Q = 4.92 \times 10^7\ ft^3/yr.$

$$r = \frac{4.92 \times 10^7\ ft^3/yr.}{(3.1416)(0.25)(55)} =$$

r = 1065'

Test well 1-94

$Q = (350)(2.23 \times 10^{-3}\ ft^3\ /sec)(86400\ sec/day)(365\ days/yr)\ ft^3/yr.$
$Q = 2.46 \times 10^7\ ft^3/yr.$

$$r = \frac{2.46 \times 10^7\ ft^3/yr.}{(3.1416)(0.25)(70)}$$

r = 670'

AQUIFER CLASSIFICATION WORK SHEET - Appendix B

AQUIFER LOCATION: Ucluelet

REFERENCE NUMBER:

DESCRIPTIVE LOCATION: Near intersection of Ucluelet-Tofino Highway and Highway #4.

DESCRIPTIVE NAME: Lost Shoe Aquifer - Ucluelet

NTS MAP SHEET: 92 C/13

WELL RECORD MAP SHEET: Groundwater Location Map: BCGS Number - 092C.093.3.3.3.

CLASSIFICATION: IIA **RANKING VALUE: 14**

Aquifer Size: Approximately 11.5 km^2

Aquifer Boundaries: Geologic features, aerial photographs and test well data

Geologic Formation (overlying): Glacial derived silty sand and gravel deposits.

Geologic Formation (aquifer): Glacial derived sand and gravel deposits, underlain by sandy silt and silty sand possibly glaciomarine sediments. .

Confined/Unconfined/Bedrock: Regionally unconfined but locally confined conditions created by addition of fill material in the vicinity of the Ucluelet well field.

Vulnerability: High - vulnerable to contamination from surface sources. Highly permeable sands and gravels at surface. Aquifer is unconfined except locally around wellfield where addition of compacted fill material has created confined conditions.

Productivity: High yields - range from 22.1 L/s (350 USgpm) to 44.2 L/s (700 USgpm). Transmissivity of 2240 m^2/day - 960 m^2/day at well field

Depth to Aquifer: At ground surface to 4.9 metres (16 feet).

Depth to Water: Approx. 1.2 metres (4 feet) to 2.7 metres (9 feet) below ground level.

Flow Direction: Presently unknown

Recharge: Infiltration of precipitation. Possibly some contribution from Lost Shoe Creek.

Well Density: Lost Shoe Creek production wells (3) and test wells and observation wells - clustered locally.

Users/Level of Use: Community Water Supply - Ucluelet

Reliance on Source:

Conflicts Between Users: None documented

Quantity Concerns: None documented

Quality Concerns: Water quality results indicate locally high iron and manganese levels. Corrosive groundwater.

References:

Arengi and Badry, 1995. Completion Report Construction and Testing of Lost Shoe Creek Production Wells 1-95, 2-95, 3-95 and evaluation of Lost Shoe Creek Aquifer for the Village of Ucluelet.

Wei, M., 1994. Lost Shoe Aquifer - Modelling to Estimate Aquifer Capacity. Unpublished memorandum to A.P. Kohut, Manager, Groundwater Section, Hydrology Branch, Water Management Division, Ministry of Environment Lands and Parks.

AQUIFER CLASSIFICATION AND RANKING

AQUIFER LOCATION: Ucluelet

REFERENCE NUMBER:

CLASSIFICATION: IIA **RANKING VALUE: 14**

Classification Component:

Level of Development: **II** Moderate level of development in relation to aquifer productivity.

Vulnerability: **A** High vulnerability to contamination.

Ranking Component:

	Value	
Productivity:	3	
Vulnerability:	3	
Size:	2	
Demand:	3	
Type of Use:	3	
Quality Concerns:	0	
Quantity Concerns:	0	Total = 14