Province of British Columbia | Ministry of Environment | WATER MANAGEMENT BRANCH

MEMORANDUM

Mr. J. Dick, Manager
Planning & Mine Impact Review
Planning & Assessment Branch
Ministry of Environment
777 Broughton Street
BUILDINGS
V8V 1X5

Date: February 6, 1985

Our File: ~~034669541~~ 92B/12-28

Re: Cowichan-Koksilah Water Management Plan
- Groundwater Input

As requested by L. Hannah and B. Turner, please find enclosed a report prepared by M. Zubel of our Section, regarding the groundwater resource for the above plan. The final maps (Figures 1 and 2) are being prepared by the Draughting Section and as soon as they are completed, copies will be forwarded to you.

Should you have any questions or concerns regarding any aspects of the report, please do not hesitate to call our office.

J C Foweraker

J.C. Foweraker, Head
Groundwater Section
Water Management Branch
387-1115

Encl.

Mr. Zubel Z.
Mr [illegible] for info
file

W-372

FEB/85

COWICHAN-KOKSILAH WATER MANAGEMENT PLAN
GROUNDWATER RESOURCE EVALUATION

INTRODUCTION

The following report is an office evaluation of the groundwater resource within the Cowichan and Koksilah watersheds. It is based upon a review and analysis of available groundwater reports on file, water well record data, geologic reports and maps. This report also addresses the following concerns (terms of reference) as requested by Planning and Assessment Branch:

1. Update well information, and extend information around Cowichan Lake and along the Koksilah River where it exists, using the map and report prepared by K. Ronneseth in 1982, but only within the confines of the study area;

2. Assess available water quality information in the study area;

3. Discuss interrelationship between groundwater and the lower Cowichan River, or in other areas where there may be potential for such conflict;

4. Provide quantitative assessment where possible with respect to large potential groundwater sources, such as might be used for agriculture, domestic or municipal uses;

5. Discuss potential for expanding Duncan's municipal water supply in the future.

GEOLOGY

Much of the study area is underlain by bedrock at surface, or veneer deposits over bedrock (see Figure 1). According to Muller and Jeletzky (1970), the bedrock areas consist predominantly of volcanic, intrusive and sedimentary rocks of Upper Cretaceous to Permian and older ages. Halstead (1966) indicates that during the Pleistocene Epoch, as a result of glaciation and deglaciation, the Cowichan valley was filled with a moderately thick succession of unconsolidated sediments. These glacial sediments consist of till, clay, silty clay, sand and gravel, deposited in continental and marine environments directly by ice or from its meltwaters. Presently, the maximum thickness of the unconsolidated surficial deposits in the valley is not exactly known; however, a well located at the mouth of the Cowichan River was drilled to a depth of 200 feet without encountering bedrock. Flanked by bedrock uplands, the main valley occupied by permeable water-bearing valley fill deposits is considered the most important source of groundwater.

HYDROGEOLOGIC DATA

In the Groundwater Section files, there are over 3,000 records of well data for the study area and various hydrogeological reports. One of these reports deals with the groundwater potential for agricultural capabilities for the eastern part of the study area (Ronneseth, 1982). Additional well information since the Ronneseth report was reviewed, and pertinent data was utilized to update and modify the groundwater capability map for that area. In addition, all available well information for the rest of the study area was reviewed to extend the information on groundwater for the rest of the study area. Figure 1 is the resulting map which shows the areas where groundwater is presently available and being utilized, and where potential groundwater may exist.

GROUNDWATER POTENTIAL ASSESSMENT

Based on available well record data and the surficial geology of the area, Figure 1 shows the general extent of the major groundwater aquifers and the relative degree of groundwater potential within the study area. As shown in Figure 1, the most productive aquifers (presently being used for agricultural, municipal and industrial uses) are those outlined as areas underlain by confined and/or unconfined aquifers with known good groundwater potential. The location of wells with reported yields between 25 gpm and 2,000 gpm are plotted within these outlined areas.

On the southeast side of Duncan, there are presently 8 large diameter wells located along the north and south sides of the Cowichan River (which appears to be the main source of recharge to these wells), supplying up to a total of approximately 12,000 gpm of groundwater during maximum peak withdrawals. These wells supply the District of North Cowichan and City of Duncan sufficient water to meet present municipal needs, and a Provincial fish hatchery. An analysis of water level data (between 1975 and 1982) from Provincial observation wells located in the vicinity of these production wells, indicates that production well pumping has not caused any declining trends in local groundwater levels for the period of record. With the exception of very minor interference drawdown effects between wells, it appears that there is no "mining" of groundwater occurring in this area as a result of production well pumping. This suggests that the aquifer in the vicinity of the lower Cowichan River may be capable of supplying more groundwater to additional production wells. However, before additional production wells for Duncan's future municipal water supply or any other major use, could be considered, a more detailed hydrogeologic investigation of the area immediately around the present production wells is recommended. The objective of this study would be to more fully assess the effects of present withdrawals upon the aquifer, potential pumping interference effects on existing wells by additional well(s), and more importantly, the present and future effects of major groundwater withdrawals upon low flows of the Cowichan River which may lead to conflicts with other water users (such as fisheries). This hydrogeologic investigation could involve an assessment of the actual extent and characteristics (i.e., aquifer transmissivities, storativity, etc.) of the aquifer(s), the amount of recharge and groundwater flow, hydrologic and meteorologic data, the actual amount of groundwater withdrawals, and could involve field inventories, well drilling, pumping tests, possible geophysical testing, and water level monitoring (both surface and groundwater).

Near the mouth of the Cowichan River, there are some very productive large-diameter wells owned by Doman Industries with reported yields between 1500 gpm and 1865 gpm. In the immediate area of these wells there are also several smaller diameter (6-inch) flowing artesian wells with estimated flows up to approximately 400 gpm. It is not known to what extent ground water is being utilized in this area for industrial or other purposes. However, it appears that this area is underlain by a significant confined groundwater reservoir, and that there is good potential for further ground water development. A more detailed site specific hydrogeologic assessment would be required to ascertain the extent of the groundwater potential in this area.

Figure 1 also outlines areas underlain by confined and/or unconfined aquifers with known moderate groundwater potential; (i.e., limited potential for agricultural or municipal use). These areas were identified on the basis of available well record data, i.e., wells completed in sands and/or gravels, having reported yields betweeen 10 gpm and 25 gpm, and surficial geologic considerations. Well record analysis indicates that many wells within these outlined areas, although indicating yields of up to 25 gpm, could have produced higher yields if the wells had penetrated the entire aquifer, and/or larger diameter wells were constructed and larger pumps installed, and/or better screen design was utilized. In other words, the groundwater potential for agricultural, domestic or municipal use could be greater than indicated, (i.e., well yields in the order of hundreds of gallons per minute). The amount of further groundwater withdrawal that may be available from these aquifers is not fully known and may require detailed, costly studies to complete.

The third type of area in Figure 1 is underlain predominantly by sand and/or gravel deposits (as determined from surficial geology only), where there <u>may be</u> potential for groundwater development. Since there is little to no groundwater data available for these areas, it is difficult to ascertain the amount of groundwater that may be available. Further data by way of test wells, pumping tests, etc., would be required to assess the situation. Preliminary indications, however, are favourable for domestic supplies, and for only limited agricultural or municipal supplies (i.e., well yields up to 50 gpm).

The remaining parts of the map area are underlain predominantly by bedrock/veneer over bedrock or shallow morainal deposits in which the groundwater potential is generally low to nil. Wells completed within the bedrock areas have reported yields generally less than 10 gpm. Some higher yielding wells to about 50 gpm have also been reported, however, their sustained long-term yields have not been proven. Groundwater investigations for municipal or agricultural uses within these areas are not recommended.

For domestic purposes, the groundwater potential may be adequate.

GROUNDWATER-SURFACE WATER INTER-RELATIONSHIP

In 1975, the Groundwater Section was involved in a research project regarding the groundwater potential of the lower Cowichan River aquifers, south to south-east of Duncan. One of the objectives of the project was to evaluate the effects of major groundwater withdrawals on the flows in the Cowichan River. According to Foweraker (1976), the project was able to identify:

1) The presence of three distinct aquifers.

2) A similarity in groundwater level and river level hydrograph curves for observation well and Cowichan River water level, suggesting that there is a good hydraulic continuity between the Cowichan River and the "middle aquifer."

3) That groundwater withdrawals are expected to affect river flows to <u>some extent</u>, however, the exact relationship will not be known until production wells are utilized over a long term and the records analyzed.

To date, the effects of major groundwater withdrawals by the City of Duncan's four production wells (estimated maximum withdrawal at 7,000 USgpm) and the District of North Cowichan's four production wells (estimated maximum withdrawals at 5,500 USgpm), on flows of the lower Cowichan River have not been analyzed. In order to ascertain the present effects of groundwater withdrawals on the lower Cowichan River flows, a more detailed assessment of existing data is required. This would include determining the

the amount of groundwater withdrawals in the area, the extent of surface water allocation (i.e., licenses), and additional river and groundwater level data from sources both upstream and downstream of the production well fields.

Due to a lack of data elsewhere along the Cowichan and Koksilah Rivers, it is not known whether groundwater withdrawals from wells located along these rivers is affecting low flows. The amount of groundwater withdrawals from these wells is not as great as in the area south-east of Duncan. Therefore, surface water-groundwater conflicts are not expected to be significant. However, if surface water supplies are fully allocated (i.e., licensed), there may be potential for surface water-groundwater conflicts if aquifers, hydraulically connected to surface waters, are further developed. Collection of groundwater and river level data, groundwater use, and other relevant data regarding the groundwater resource would be required to determine the relationship between surface waters and any underlying aquifers, and to assess the potential for and extent of surface water-groundwater conflicts in these areas.

GROUNDWATER QUALITY ASSESSMENT

Figure 2 shows the locations of wells within the Cowichan-Koksilah plan area for which there is groundwater chemistry data. Table 1 provides a summary of the available groundwater quality data, and the following comments are an assessment of this data.

An analysis of the well type and depths indicates that the majority of wells with groundwater quality data are shallow (less than 200 ft. deep) and are completed in surficial (unconsolidated) deposits within shallow ground water flow systems. There are five bedrock wells completed to depths of between 190 feet and 410 feet. These wells can also be considered completed within relatively shallow groundwater flow systems. The significance of a shallow groundwater flow system is that most natural waters will be relatively low in total dissolved solids (T.D.S.), low in specific conductance and be relatively soft to moderately soft in hardness. This appears to be the case for groundwaters within this study area (see Table 1). Table 1 also indicates that for the parameters tested, most of the groundwaters within the study area have chemical concentrations within acceptable limits for drinking water quality based on the B.C. Drinking Water Quality Standards (1982). The exceptions include the groundwater tested from wells no. 3, 11, 18, 19, 20 and 21 (which have pH values slightly above or below the recommended limits), and those from wells no. 13 and 14 (which have reported Chloride levels over and almost above the recommended limit of 250 mg/L). Regarding the high Chloride concentration and salt water content of these two latter wells, (which are close to the fresh water-salt water interface). Kohut (1981) suggests that the source of the salt water content in the wells (particularly under pumping conditions) is from salt water located in a nearby distributary channel. The low chloride concentrations reported for groundwaters from nearby well no.'s 8, 12, and 15 suggest that the above salt water intrusion problem is localized.

At present, there are no other known contaminated groundwaters within the study area. There have been concerns that some wells operating near the City of Duncan's sewage treatment ponds, located east of Duncan and just north of the lower Cowichan River, may become contaminated by seepage of effluent from the treatment ponds. Further research and investigation of this site specific area, including the possible construction of monitoring wells near the ponds would be required to assess the potential for contamination. Further research would also be required to identify the source(s) and degree of any other potential groundwater contamination throughout the study area; and the vulnerability of producing aquifers to potential contamination.

CONCLUSIONS AND RECOMMENDATIONS

Available data have been reviewed and compiled, and a map prepared showing the groundwater resource potential in the study area. Figure 1 shows the locations of existing known aquifers capable of providing groundwater supplies to agricultural, municipal, industrial and domestic uses. A quantitative assessment of large potential groundwater sources was done utilizing this map.

The amount and extent of potential surface water-groundwater conflicts is not fully known within the study area. Further investigations and analysis of data are required to better assess the potential problem(s).

Analysis of water quality data indicates that for the parameters tested, most groundwaters within the study area are within drinking water quality objectives, and that there are no apparent significant groundwater concerns. Further research is required to identify and analyze the potential for groundwater contamination by man-made activities and the potential for salt water intrusion problems in the Cowichan Bay estuary area.

M Zubel.

M. Zubel
Senior Geological Engineer
Groundwater Section

REFERENCES

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Foweraker, J.C. 1976. Groundwater Research Project, Cowichan River Aquifers near Duncan, B.C. Groundwater Section, Ministry of Environment report, File 92 B/13 #30.

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Muller, J.E. and Jeletzky, J.A. 1970. Geology of the Upper Cretaceous, Nanaimo Group, Vancouver Island and Gulf Islands, British Columbia. Geological Survey Paper 69-25, Department of Energy, Mines and Resources.

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TABLE 1

Cowichan/Koksilah Water Management Plan
Groundwater Quality Data

Well No. (Fig.2)	Well Type and Depth (ft.)	Sample Date	pH	Temp (°C)	T.D.S	Conductivity (mho/cm)	Total Hardness	Alkalinity (HCO_3/CO_3)	Cl	SO_4	NO_2/NO_3	Fe (Diss.)	Fe (Total)	Ca	Mg
1	B-250	02/76	8.0	16	-	300	136	136	15.0	-	-	-	0.4	-	-
2	S- 96	09/78	8.5	15	-	180	85	85	7.6	-	-	-	0.8	-	-
3	S- 27	03/72	6.0	-	-	-	5	-	>5.0	-	-	-	3.0	-	-
4	B-410	08/74	7.5	17	-	435	119	204	15.0	-	-	-	0.4	-	-
5	S- 78	07/78	8.5	14	-	500	102	238	30.0	-	-	-	5.0	-	-
6	S-103	12/65	7.5	14	-	245	120	-	c 22.7	-	-	-	1.0	-	-
7	S- 74	05/73	7.5	14	-	245	120	-	c 15.2	-	-	-	1.0	-	-
8	S- 14	12/80	-	10	-	200	-	-	c 37.9	-	-	-	-	-	-
9	S- 15	05/75	-	16	-	78	-	-	-	-	-	-	1.0	-	-
10	S- 82	06/82	7.6	13	-	195	85	85	7.6	-	-	-	1.6	-	-
11	B-300	11/79	10.0	13	-	1000	290	299	143.0	-	-	-	0.5	-	-
12	S-160	02/76	7.9	15	-	-	86	-	45.0	-	-	-	L0.5	-	-
13	S- 10	12/80	-	15	-	1130	-	-	c393.9	-	-	-	-	-	-
14	S- 15	12/80	-	20	-	800	-	-	c242.4	-	-	-	-	-	-
15	S- 20	05/75	6.5	-	-	-	34	-	15.2	-	-	-	1.2	-	-
16	S-158	06/82	8.5	14	-	275	119	136	7.6	-	-	-	1.3	-	-
17	S- 42	06/82	8.0	20	-	300	119	136	7.6	-	-	-	1.8	-	-
18	S-200	10/75	9.2	12	-	510	45	-	105.0	L5.0	L0.02	-	10.4	5.9	7.4
19	S-160	12/75	9.0	14	210	385	39	-	71.6	L5.0	L0.02	-	0.2	4.2	6.9
20	S-146	03/78	9.1	-	-	-	40	80	75.0	L5.0	2.90	-	0.1	10.0	30.0
21	S- 26	05/75	5.7	16	-	-	20	25	10.0	L5.0	3.00	0.04	-	15.0	35.0
22	S- 36	05/71	8.0	18	-	440	102	-	c 75.8	-	-	-	1.0	-	-
23	S- 47	11/61	7.3	-	40	-	29	25	1.2	8.0	-	-	0.1	9.8	1.0
24	B-210	07/82	7.3	14	-	610	51	238	75.0	-	-	-	2.3	-	-
25	S- 38	07/82	7.8	15	-	400	153	119	22.0	-	-	-	2.0	-	-
26	S- 93	12/74	6.7	18	-	-	40	50	7.5	L5.0	-	-	0.3	30.0	10.0
27	S- 63	08/68	7.1	-	63	-	32	36	6.5	L5.0	-	0.04	L0.1	9.0	1.5
28	S- 79	10/68	7.0	-	-	-	45	46	-	-	6.50	0.06	-	-	-
29	S- 70	11/68	6.9	-	-	-	-	38	-	-	2.50	0.04	L0.1	7.5	5.4
30	S- 82	09/68	7.1	-	61	-	41	44	1.5	-	-	0.02	L0.1	8.5	2.6
31	S- 80	05/75	7.4	9	40	-	33	-	L0.5	L5.0	-	0.04	L0.1	7.7	3.3
32	S- 31	09/75	6.7	18	-	60	24	25	1.8	L5.0	0.08	-	0.1	8.5	0.8
33	S- 20	09/75	6.7	15	-	60	25	25	1.7	L5.0	0.13	-	0.1	8.5	0.8
34	S- 39	09/75	6.7	15	-	62	25	26	1.8	L5.0	0.07	-	0.2	8.8	0.8
35	S- 14	09/75	6.8	19	-	61	25	25	1.7	L5.0	0.09	-	0.3	8.8	0.8
36	S- 35	09/75	6.8	17	-	50	20	20	1.6	L5.0	0.05	-	L0.1	7.0	0.6
37	S- 36	09/75	6.8	18	-	55	22	23	1.6	L5.0	0.09	-	0.2	7.8	0.7
38	S-152	12/75	6.9	11	-	66	29	29	1.8	L5.0	0.09	-	0.1	9.7	1.1
39	S-104	02/84	-	-	-	-	-	-	-	-	-	0.10	0.4	7.6	1.0
40	S- 65	03/76	7.3	-	38	-	25	-	1.5	22.6	-	0.04	L0.1	8.0	1.2
41	S- 73	02/77	7.3	-	44	-	23	31	2.5	L5.0	L0.10	0.04	-	7.3	1.3
42	S- 49	03/77	6.0	-	50	-	26	28	3.0	L5.0	L0.10	0.04	-	7.9	1.6
43	S- 75	04/77	7.1	-	59	-	27	37	6.0	L5.0	L0.10	-	L0.1	9.4	0.9
44	S- 80	06/78	7.4	-	42	49	22	26	L0.5	L5.0	L0.10	0.02	0.5	7.6	1.5
45	S- 70	06/78	7.0	-	48	57	24	29	L0.5	6.8	L0.10	0.02	L0.1	8.3	0.8
46	S- 76	04/82	7.0	-	53	57	25	32	2.5	L5.0	0.15	0.02	L0.1	8.8	0.8
47	S- 49	08/63	7.0	-	45	-	32	29	1.9	L5.0	L0.10	-	L0.1	9.5	1.1
48	S- 53	10/69	6.8	-	74	-	37	36	5.2	6.3	-	0.03	L0.1	9.8	3.1
49	S- 70	07/68	6.9	-	-	-	44	49	-	-	L0.10	0.06	0.1	-	-
50	B-190	07/82	8.0	16	-	395	85	187	15.0	-	-	-	0.6	-	-
51	S- 30	06/75	7.5	14	-	270	120	-	c15.2	-	-	-	2.5	-	-
52	S- 21	02/66	6.0	19	-	115	70	-	c22.7	-	-	-	1.0	-	-
53	S- 80	01/70	7.4	-	86	-	48	62	6.7	13.0	-	0.07	-	8.8	6.3
54	S-130	04/71	-	-	-	-	-	-	-	-	-	0.10	2.1	-	-
55	S- 91	10/70	8.1	-	170	-	88	103	2.0	18.2	-	0.10	0.8	24.2	6.6
56	S- 79	04/71	7.7	-	123	-	56	74	1.0	7.2	0.88	0.10	2.1	20.8	1.0

Well Type* B - Bedrock
S - Surficial

Note: Units in mg/less otherwise noted
L - less than
c - denotes calculated value

FIG 1

GROUNDWATER POTENTIAL
COWICHAN - KOKS
WATER MAN. PLAN

Figure Figure
FIGURE 1

COWICHAN-KOKSILAH WATER MANAGEMENT PLAN GROUNDWATER POTENTIAL