GOVERNMENT OF BRITISH COLUMBIA

MEMORANDUM

TO: Dr. J.C. Foweraker
Head
Groundwater Section

FROM: A.P. Kohut
Geological Engineer
Groundwater Section

February 6, 19 76

SUBJECT: Crooked River Waterworks District - Groundwater Problem

OUR FILE: 0239015

YOUR FILE:

An assessment of the available hydrogeologic data, including a review of geologic literature, well card data, water chemistry and air photograph interpretation has been completed for the Crooked River - Bear Lake area. Pertinent information was also obtained from a preliminary field investigation carried out in 1974 by the Lands Service (Moncur, 1974). The present water supply for the community of Bear Lake comes from two wells which produce water with a relatively high concentration of iron. This report provides some possible explanations for the high iron concentrations in the groundwater at the well sites and gives recommendations on location and testing of alternate well sites.

GENERAL GEOLOGY

Basaltic pillow lavas, andesite and related pyroclastic rocks of the Slide Mountain Group (Muller and Tipper, 1969) are thought on the basis of aeromagnetic interpretation to underlie the region at depth mantled by a thick succession of glacial and post-glacial deposits. The Crooked River Valley occurs within a former large glacial meltwater channel (Tipper, 1971) which formed during deglaciation of the area. Maximum thickness of the valley fill deposits is unknown, but are probably comprised mainly of outwash sands and gravels interbedded with glacial till. Moraine comprised of glacial till with lenses of sand and gravel occurs on the valley upland east of Bear Lake where drumlinoid features, indicating a southwest to northeast direction of ice movement, are prominent.

SURFICIAL GEOLOGY

A preliminary surficial geologic map (Figure 1) was prepared on the basis of air photograph interpretation and earlier investigations (Moncur, 1974). Four surficial units in the area are recognized from oldest to youngest as follows:

Unit 1: Probable Moraine Ridge

Unit 2: Alluvial Terrace and Channel Deposits

Unit 3: River Alluvium

Unit 4: Lacustrine Deposits

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A brief description of these units may be inferred from existing well logs and air photograph interpretation.

Unit 1: Probable Moraine Ridge

Local topographic highs including knobs and ridges occur within the Crooked Creek Valley and probably represent moraine ridges. Glacial till has been reported occurring on the ridge north of Bear Lake (Moncur, 1974). Morphology of the ridges suggest the moraine underlies the valley and has been dissected by outwash channels (Unit 2) infilled with sand.

Unit 2: Alluvial Terrace and Channel Deposits

Fine brown sand occurs along abandoned channels dissecting the moraine deposits and as terrace deposits. Origin of the sand may be in part glacial outwash deposited during deglaciation, river alluvium deposited during the post-glacial regime of the Crooked River and/or eolian deposits. Maximum thickness of the sand is 164 feet at the community of Bear Lake, but may be of variable thickness throughout the area.

Unit 3: River Alluvium

Sand, silt and clay occurs along the channel of the Crooked River related to the present regime of the river.

Unit 4: Lacustrine Deposits

Fine sand, silt, clay and deposits of muck and peat occur along abandoned channels and low-lying areas of the valley floodplain. The deposits are probably thin and overly alluvial sands of unit 2.

WELL INVENTORY

A summary of the four wells completed in the area is given in Table 1. Wells of the Crooked River Waterworks designated 1 and 2 are estimated to be capable of supplying 40 and 90 USgpm respectively. The Department of Recreation and Conservation well at Bear Lake was tested at 65 USgpm while the fourth well located east of the community is rated at 6 USgpm.

Shallow sand point wells from 15 to 18 feet deep have been reported around a small lake southeast of the Bear Lake community (Moncur, 1974).

STRATIGRAPHY

The wells of the Crooked River Waterworks and the Bear Lake park well are located on alluvial sand deposits. Drill logs indicate the general succession

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at the Bear Lake community well sites consists of 145 to 164 feet of fine brown to gray sand underlain by coarse sand and gravel interbedded with glacial till. The park well shows the same general sequence with 91 feet of silty fine sand underlain by sand and gravel. Surface sands are only four feet thick along the moraine ridge at the PGE well which is underlain by sand, gravel and possibly some till.

GROUNDWATER CHEMISTRY

A summary of groundwater analyses conducted on the Bear Lake community and park wells is given in Table 2. Water at both localities is of the calcium bicarbonate type with higher overall mineralization occurring in the area of the community wells. Iron values in the range of 1.5 to 9.2 have been reported for the community wells while the park well is relatively free of iron. Shallow groundwater southeast of the community wells from shallow sand points also has significant iron values up to 2.0 mg/ℓ (Moncur, 1974). Three possible explanations for the variability in iron content of the groundwater may be the following:

(a) Iron content of the groundwater may vary with depth and with a particular aquifer. This is suggested by the two community wells which are screened at different depths. The shallower well at 168-178 feet has a lower iron content from 1.5 to 3.0 mg/ℓ as opposed to the deeper well at 200-210 feet which is reported as 7.5 mg/ℓ. Shallow sand points, however, suggest even at shallow depth the iron content may be high and that areal variations occur.

(b) Mineralogy of the aquifer, for example the natural content of iron minerals, may vary areally and be responsible for anomalous high iron in the groundwater. Original source of the iron minerals may have been from the underlying volcanic rocks.

(c) Isolation of groundwater flow systems as discussed by Moncur (1974) may come about due to the relatively impermeable till ridges separating aquifer sands. Iron content and overall mineralization may therefore concentrate in local areas where groundwaters are discharging or where recharge from surface sources is restricted. The park well for example may be influenced by recharge from Bear Lake and/or the Crooked River, and is subsequently low in iron.

RECOMMENDATIONS

The region underlain by the surficial sands of unit 2 in the vicinity of the Bear Lake park well appears to be the best area for relocating the community wells. A suitable site (Test Site 1) is indicated in Figure 1.

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Since the high iron content in the community wells could be due to local conditions, groundwater exploration north and west of the community may be warranted. Suitable test sites 2 and 3 are indicated in Figure 1.

Drilling should be conducted with a cable-tool rig. Water samples for iron analysis could be taken during the drilling at different levels and should groundwater high in iron be encountered the testhole could be curtailed and the rig moved to another site. Iron introduced during the drilling from the well casing, however, could produce anomalous high results and it may be necessary to screen the aquifer to verify if the iron comes from the aquifer. The drilling program could be conducted in two parts including:

(a) an initial testing program utilizing 6-inch diameter cased testholes, screened and pump tested followed by;

(b) construction of 8-inch diameter production wells based on the initial test drilling and pump testing results.

Alternatively 8-inch diameter wells could be drilled as testholes for subsequent use as production wells where they are successful. Unfortunately limited pump test data is available for existing wells. Based on the existing data, the future community requirements of 300 to 350 USgpm (pers. comm. A. MacTaggart, 1976) should be met by two to three 8-inch diameter production wells. Pump tests of at least a 24-hour duration are recommended to test for boundary conditions.

REFERENCES

Moncur, M.C. (1974) Bear Lake Community Water Supply, Lands Service, Memo report, File: 0232302-3, June 24.

Muller, J.E. and Tipper, H.W. (1969) McLeod Lake Geology, Map 1204A, Geol. Survey of Canada.

Tipper, H.W. (1971) Glacial Geomorphology and Pleistocene History of Central British Columbia, Geol. Survey of Canada, Bulletin 196.

A.P. Kohut

A.P. Kohut
Geological Engineer
Groundwater Section

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Attachs.

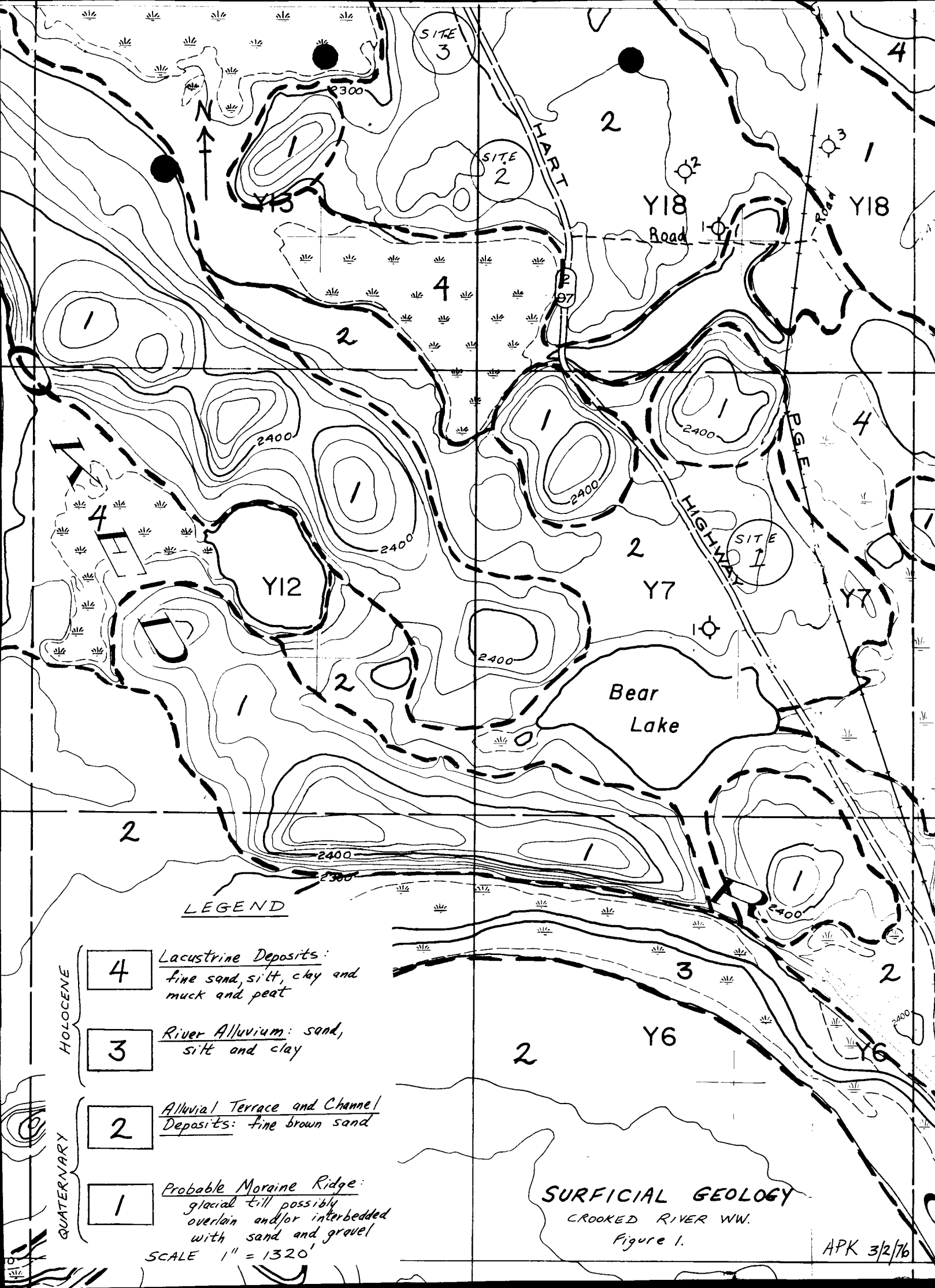
SITE 3
SITE 2
SITE 1
HART Road
Y18
Y18
Road
Y12
Y7
Y7
Y6
Y6
HIGHWAY
P.G.E.
Bear Lake
2400
2300
N
LEGEND
HOLOCENE
4 Lacustrine Deposits: fine sand, silt, clay and muck and peat
3 River Alluvium: sand, silt and clay
QUATERNARY
2 Alluvial Terrace and Channel Deposits: fine brown sand
1 Probable Moraine Ridge: glacial till possibly overlain and/or interbedded with sand and gravel
SCALE 1" = 1320'
SURFICIAL GEOLOGY
CROOKED RIVER WW.
Figure 1.
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Table 1. Summary of wells completed in the Crooked River - Bear Lake area

Well	Date Drilled	Map Number	Depth (feet)	Casing Diameter (inches)	Screen Diameter (inches)	Screen Length (feet)	Screen Slot Size	Screen Setting (feet)	Static Water Level (feet)	Pump Test Rate (USgpm)	Drawdown	Specific Capacity (USgpm/ft)	Remarks
Crooked River Waterworks Well 1	1963	Y18,1	220	6	-	10	30	200-210	36	-	-	-	iron 1.5 to 2 mg/ℓ
Crooked River Waterworks Well 2	Oct. 1969	Y18,2	178.5	8	-	10	100	168-178	44	20	0	-	high iron
Dept. of Recreation and Conservation	Aug. 1962	Y7,1	133	6	6	4 4	30 40	124-128 128-132	83 -	65 -	31 -	2 -	low iron -
Bear Lake PGE	Dec. 1966	Y18,3	116	-	-	5	15	-	-	6	-	-	-

Table 2. Summary of groundwater analyses, Bear Lake area

Well	Date	Na^+	Ca^{2+}	Mg^{2+}	K^+	Cl^-	SO_4^{2-}	Total Alkalinity	Total Hardness	pH	Specific Conductivity (micromhos/cm)	Total Iron	Manganese	Field Iron
Bear Lake Park Well	12/11/75*	2.5	21.9	1.6	0.5	0.7	<5	69.2	61.3	8.0	136	0.2	0.18	-
" "	5/74+	-	-	-	-	-	-	-	-	-	-	-	-	0
Bear Lake Community Well	12/11/75*	1.5	36.6	3.3	0.4	<0.5	<5	110	105	7.3	207	9.2	0.32	-
Bear Lake Community Well 1	5/74+	-	-	-	-	-	-	-	-	-	-	-	-	7.5
Bear Lake Community Well 2	5/74+	-	-	-	-	-	-	-	-	-	-	-	-	3.0

All values reported in mg/ℓ except pH and Conductivity.
*Data from A. McTaggart, WRB, 1976.
+Data from Moncur (1974).