867-873-4453

Att: Eric 27pgs

Prepared for:

CURRAGH RESOURCES INC.

by

E. T. Carefoot, P. Eng.

February 12, 1988

Assessment of the Potential for a Hydraulic Link between Vangorda Creek and the Faro Town Wells

Prepared jointly with Hydrogeological Consultants Ltd.

Prepared by
E. I. Carefoot, P. Eng.

February 26, 1988

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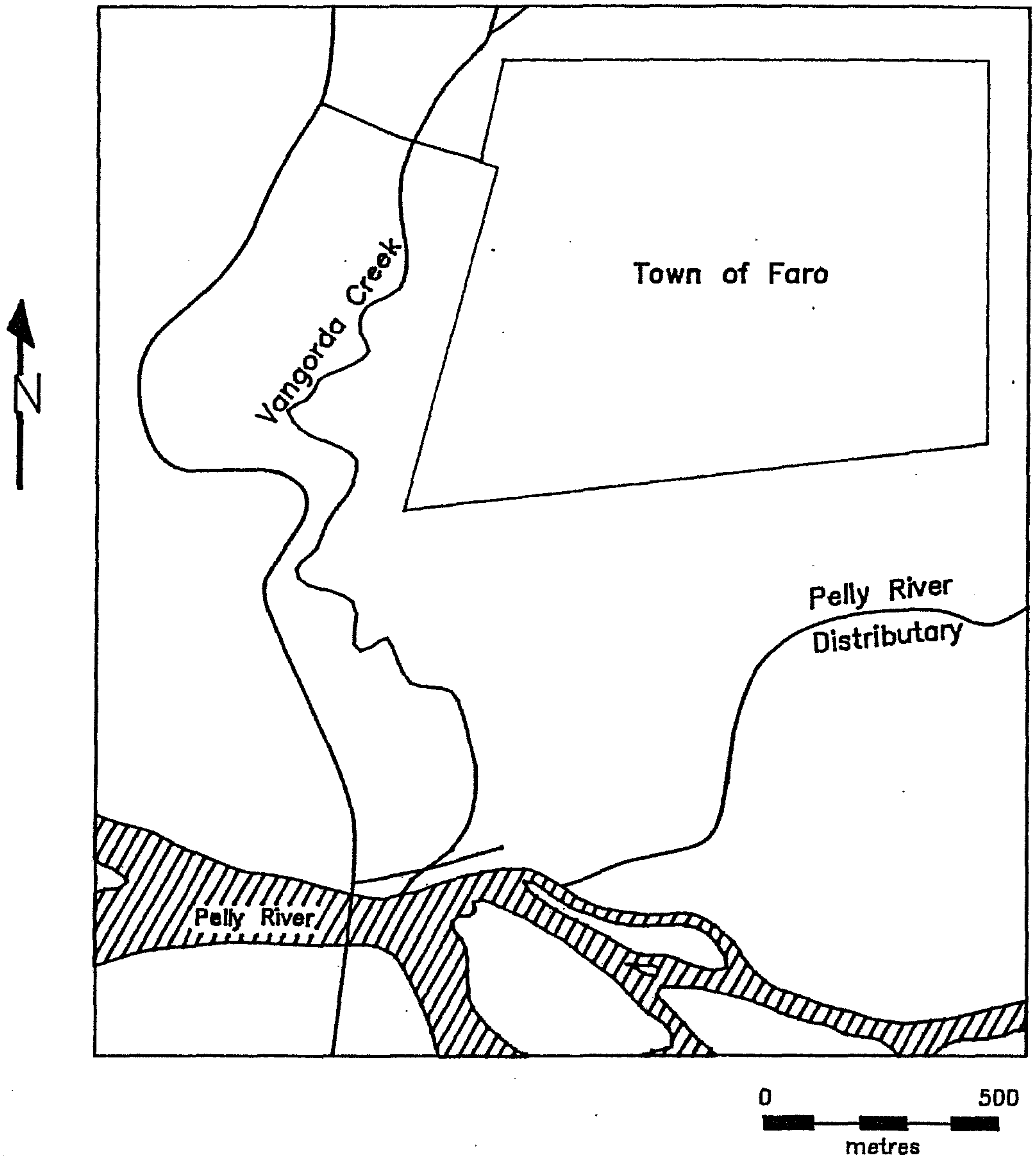
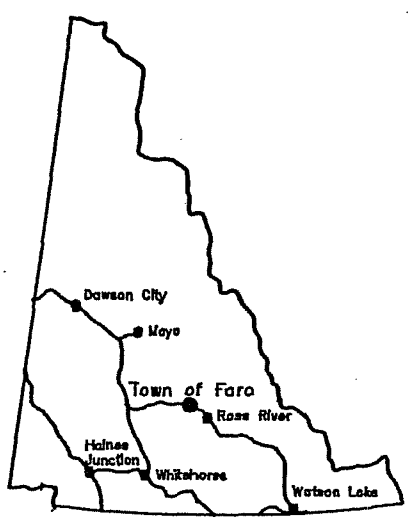
INTRODUCTION

Curragh Resources is developing two open pits on the Vangorda Plateau near the Town of Faro, YT (Figure 1). The development is approximately 10 kilometres upstream of the junction of Vangorda Creek and the Pelly River. The Town of Faro obtains its water supply from water wells completed in a sand and gravel aquifer near the junction of Vangorda Creek and the Pelly River.

Because of the proximity of the water wells to Vangorda Creek, it is necessary to assess the possibility of direct hydraulic continuity between Vangorda Creek and the aquifer(s) in which the Town of Faro's water wells are completed. The assessment is to be made from available published and unpublished data; no field work will be undertaken at this time.

In as much as the available background data from plans, charts and reports are in imperial units, and the data are being used in preparing this report, we have retained Imperial Units for sketches, plans and in some instances in the text. It is neither practical nor correct to interpolate to metric units from imperial units for contouring, without the original mapping being available.





Curragh Resources Inc. Faro, YT Vangorda Creek/Faro Water Well Assessment	
Index Map	
February, 1988	Figure 1.

BACKGROUND

The Town of Faro was created by the Anvil Mining Corporation and the Government of the Yukon in the latter part of the 1960's. Mr. E. Carefoot, working for Associated Engineering Services Ltd., was involved in the planning and design of the townsite, the supervision during the construction, and as a consulting engineer after the townsite was occupied. As part of the development of the townsite, a potable water supply was required. International Water Supply Limited carried out a program, in 1968, to locate and develop a groundwater supply. The program was restricted to the Pelly River Valley, in close proximity to Vangorda Creek[1].

Two water wells were completed by IWS in 1968; in 1980, a third water well was installed by Midnight Sun Drilling Co. Ltd. under the direction of Hydrogeological Consultants Ltd.[2]

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1 International Water Supply Limited (1968). Letter Report dated May 7, 1968 prepared by J. W. Kirk.

2 Hydrogeological Consultants Ltd. (1980). Town of Faro - 1980 Groundwater Program. Unpublished contract report.

PRESENT PROGRAM

The present program has involved the compilation of pertinent field observations made by Mr. E. Carefoot between 1966 and 1985. In some cases, details were recorded in field books while other observations are based on memory.

Copies of both the IWS letter report and attachments and the report prepared by Hydrogeological Consultants Ltd. were available for review. In addition, a geotechnical report by Ripley, Klohn and Leonoff Ltd.[3] associated with the soil conditions in close proximity to the bridge over the Pelly River was available.

[3] Ripley, Klohn and Leonoff Ltd. (1967). Proposed Pelly River Bridge, Foundation Report. Unpublished Contract Report.

RESULTS

Pertinent Field Observations

* Vangorda Creek

Vangorda Creek is normally a relatively small stream, being two to three metres in width. Where the Vangorda Creek enters the Pelly River Valley, the creek flows over a bedrock outcrop. Upstream from this point, the stream has been observed to be intermittently flowing over other bedrock outcrops. Within a kilometre of the Pelly River Valley, Vangorda Creek has also exhibited characteristics of a stream flowing over permafrost. Between the point where Vangorda Creek enters the Pelly River Valley and the point where it joins the Pelly River, Vangorda Creek has an average gradient of 1 in 50.

While the quantity of water flowing in Vangorda Creek was not measured, it is estimated to be in the order of 0.5 m^3/second during at least part of the summer months. Flow has been observed in the creek in the winter months, although the volume is considerably less than 0.5 m^3/second. No change in the volume of flow was noted between where Vangorda Creek enters the Pelly River Valley and where it enters the Pelly River, a distance of approximately 800 metres. This is not to say there is no change; only that if there was a change, it was too small to be noticed by casual observations.

Prior to 1968 the channel occupied by Vangorda Creek in its lower reaches was east of Water Wells No.'s 1 and 2. In late 1968 or early 1969, Vangorda Creek moved to a new channel approximately 100 metres west of the water wells; this is the channel which the creek presently occupies.

The change of Vangorda Creek from one channel to another was brought about by several factors, which are as follows:

- a high-water stage in the Pelly River;
- a weakness in the land surface brought about by the installation of the first water line;
- a high-water stage in Vangorda Creek; and
- a forest fire in 1968 eliminating spruce forest cover, altering the ground thermal regime.

Because of the high-water stage in the Pelly River, water from the distributary overflowed its bank and continued westward to Vangorda Creek. The material around the water line was easily eroded by the flowing water and a new channel for Vangorda Creek was established. When the waters receded, Vangorda Creek remained in the new channel.

From the aerial photographs, it is apparent that at some time in the past, Vangorda Creek has occupied a channel further west of its present location. Presumably, the change from this channel was not aided by man's activities in the area.

The data available for the chemical quality of the water from Vangorda Creek in 1987 is limited to a few major anions and cations and a few heavy metals. The results imply that the water is a calcium-magnesium-bicarbonate-type water with low total dissolved solids. The zinc concentrations in seven samples analysed in 1987 varied between 0.007 and 0.052 mg/l. The water samples from Vangorda Creek analysed in 1975 suggest that there is a significant variation in the total dissolved solids.

* Pelly River

The Pelly River is a misfit stream, occupying a valley which is larger than the present-day river could create. As a result of the changing hydrologic regimes, there have been various stages of down-cutting and aggrading. At the same time tributaries, such as Vangorda Creek, have also been adjusting to different hydrologic regimes.

The Pelly River is presently meandering across its broad valley creating several lateral distributaries. One distributary in particular originates approximately two kilometres upstream from the Town of Faro's water wells and follows close to the toe of the north escarpment, returning to the mainstream within about 100 metres of the Town's water wells; several other distributaries converge at this same location.

The feature occupied by Vangorda Creek is an alluvial fan. It would appear that sediments carried by Vangorda Creek have been deposited in the Pelly River Valley and have been, at least in part, reworked by the Pelly River. The amount of reworking has been limited by the topographic high which is situated less than 0.5 kilometres downstream from where Vangorda Creek enters the Pelly River Valley. While it is not obvious from the surficial materials, the topographic high is most likely underlain by a bedrock high and is the reason the distributaries of the Pelly River come together in close proximity to the point where Vangorda Creek discharges into the Pelly River.

The water in the Pelly River would also be considered a calcium-magnesium-bicarbonate-type water with low total dissolved solids. The conductivity in the 1975 samples varied between 140 and 320 micromohos/cm with zinc concentrations varying between 0.006 and 0.033 mg/l.

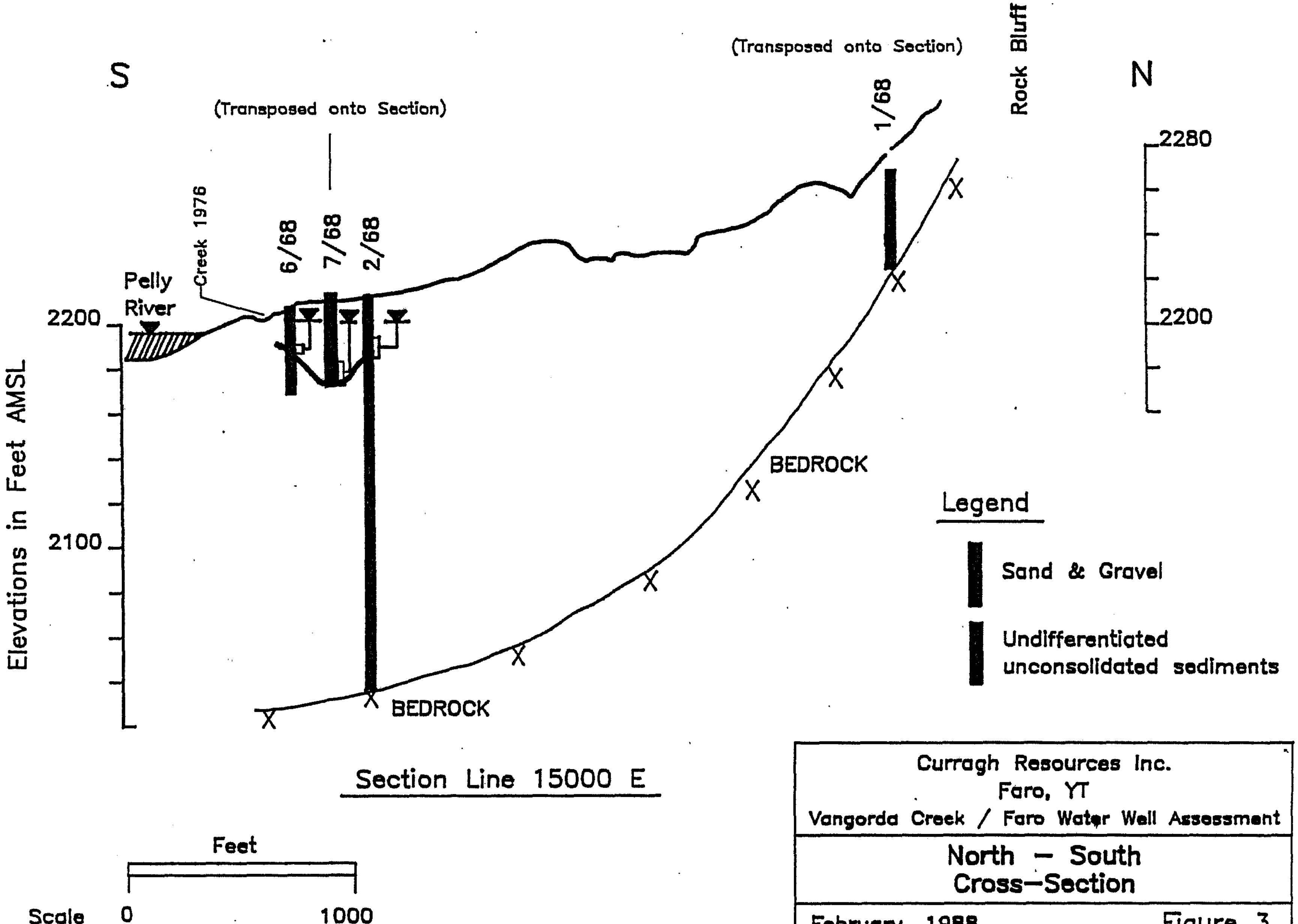
Water Wells

A total of eleven test holes were constructed in 1968 (Figure 2). Of these eleven test holes, 10 were completed such that water levels could be measured at the site; the only location where water levels are not available is Test Hole No. 1/68. Test Holes No.'s 5/68 and 7/68 were completed as Water Wells No.'s 1 and 2, respectively.

A north-south cross-section (Figure 3), parallel to Vangorda Creek, shows that Water Well No. 2 (Test Hole No. 7/68) is completed in what appears to be a channel deposit. The east-west cross-section (Figure 4) shows that the channel deposit extends upstream from the site of WW No. 2 through the WW No. 3 site. The aquifer tests with Water Wells 2 and 3 indicate the sand and gravel aquifer in which the two wells are completed has a transmissivity in the order of 5000 m^2/day; the aquifer test with WW No. 2 indicated that the aquifer had a storativity of 0.2 m^3/m^3 (IWS, 1968).

On April 25, 1968 at 08:00 Hours, the water levels at nine sites were measured. The water levels were measured as a distance below the top of the casing, the elevation of which had been determined by surveying. When the water-level elevation is plotted and contoured (Figure 5), it can be seen that a hydraulic low exists. The lowest water levels occur along an east-west line from WW No.'s 1 and 2 to Test Hole No. 4/68; at the site of Test Hole No. 2/68 to the north and 6/68 to the south, the water level is higher. Test Hole No. 6/68 is located between the hydraulic low and the Pelly River and has the highest water level of all the test hole sites; the water levels at all sites are higher than the elevation of the Pelly River (2196.54 feet AMSL), measured within 100 metres of the Test Hole No. 4/68 site.

Curragh Resources Inc.
February 12, 1988



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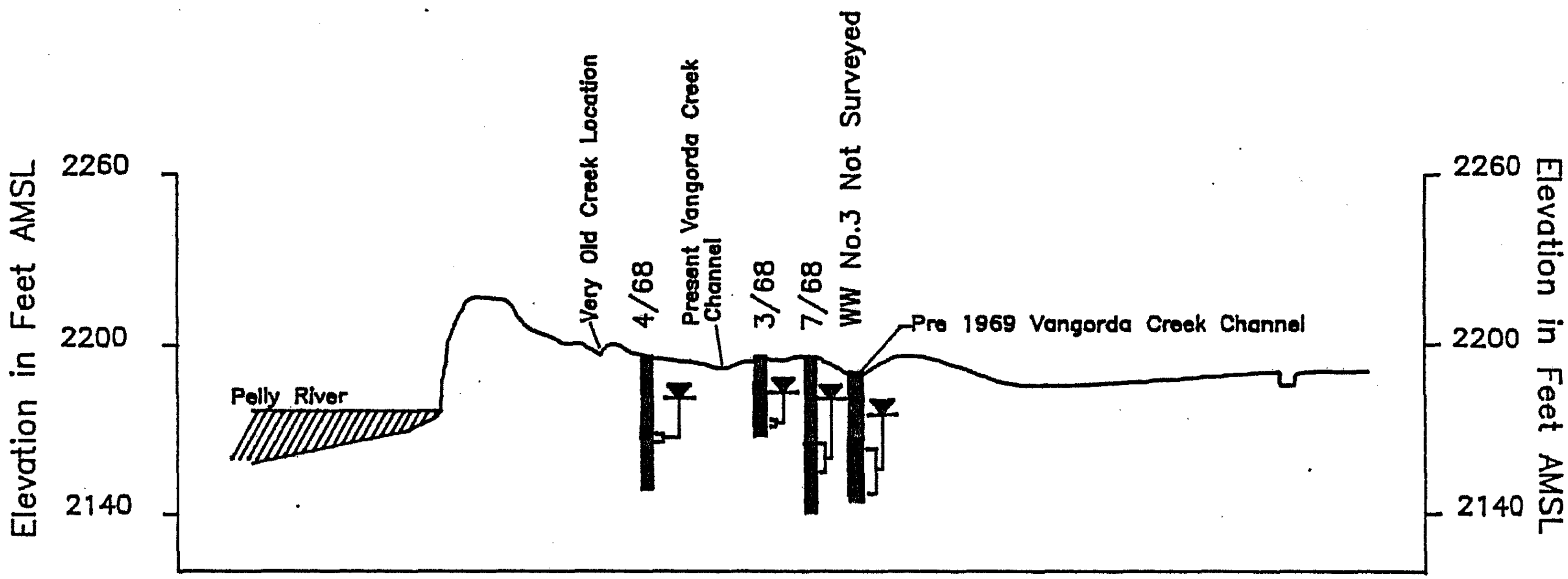
Vangorda Creek / Faro Water Well Assessment

North — South Cross—Section

February, 1988 Figure 3.



Section Line 40500 S

Legend

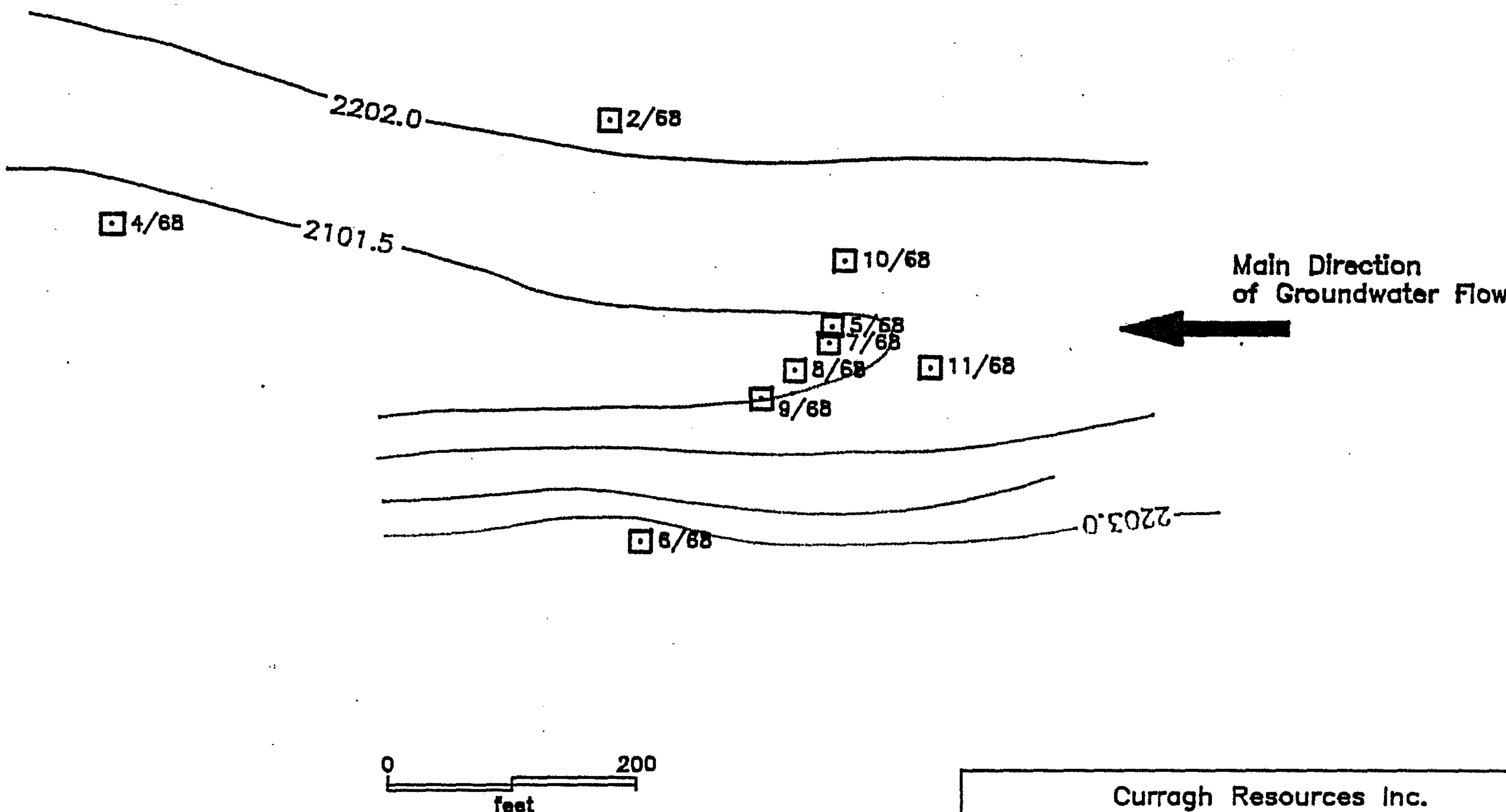
Sand & Gravel

Undifferentiated unconsolidated sediments

Feet

Scale 0 1000

Curragh Resources Inc. Faro, YT Vangorda Creek / Faro Water Well Assessment	
West — East Cross—Section	
February, 1988	Figure 4.



Curragh Resources Inc.
Faro, YT
Vangorda Creek/Faro Water Well Assessment

Water Level Map

February, 1988 — Figure 5.

The water levels at nine sites were measured during the aquifer test with WW No. 2. The water levels at seven sites were drawn down as a result of pumping. At the site of Test Holes No.'s 4/68 and 6/68, the water level rose more than 0.1 feet. The rise in water level at the site of Test Hole No. 6/68 was attributed "to recharge from Vangorda Creek or recirculation of the pumpage", with the pumpage referring to the groundwater being pumped during the aquifer test.

The International Water Supply Limited's letter report provides hydrographs for water levels in Test Hole 2/68 and the Pelly River from April 6 to 29 and in Test Hole 6/68 from April 14 to 29, 1968. The water level at the 2/68 site and in the River generally declined throughout the entire interval. The water level in Test Hole 6/68 generally rose between April 20 and 29, with there being a rise of more than 2.5 feet between April 20 and 25.

Chemical analysis data for the domestic groundwater supply, other than Standard Municipal Analysis, appear to be quite limited. However, testing has been done for reasons other than normal municipal operations and generally has a little broader scope than the normal testing. Two such analyses were conducted in 1974; a third analysis is available for the WW No. 3 groundwater. Copies of the chemical analyses are presented in Appendix A. The results of field tests to determine hardness, iron, chloride and pH were given in the IWS letter report for water samples collected from Test Holes No.'s 2/68, 3/68 and 5/68 and from the Pelly River. A Piper tri-linear plot shows that there was no significant change in the chemical quality of the groundwater between 1974 and 1980.

Three water samples obtained from the Town's water supply in 1975 showed that the zinc concentration in the groundwater from the aquifer in which the Town's water wells are completed varied between 0.03 and 0.134 mg/l.

The temperature was the only physical parameter of the groundwater measured in 1968. The groundwater temperature was measured at three sites and showed lower temperatures closer to the Pelly River.

INTERPRETATION

The water levels measured on April 25, 1968 at 08:00 Hours suggest that the main direction of groundwater flow within the sand and gravel aquifer is from east to west (Figure 5). There is a hydraulic gradient from the north and a steeper gradient from the south. However, there does not appear to be a hydraulic continuity between the Test Holes No.'s 4/68 and 6/68 sites and the aquifer in which the Town of Faro's water wells are completed.

If there is hydraulic continuity between the aquifer and the Pelly River the contact would have to be upstream where the river is at a higher elevation; the most logical location for the contact would be in association with the distributary upstream from the water wells, along the northern edge of the Pelly River Valley.

The rise in water level which was measured in Test Hole No. 6/68 during the aquifer test with WW No. 2 may have been caused by leakage down the annulus between the casing and the wall of the test hole. Apparently the test hole was constructed by drilling and driving either 8", 10" or 12" casing; the final completion of Test Hole No. 6/86 was a 2" screen set at a depth of 18 feet.

For the most part, Vangorda Creek is flowing over materials with a relatively low permeability. If water from the creek is to enter the ground it would be expected to do so in the lower reaches where the stream gradient is lower and where the Pelly River has washed away some of the fines leaving more permeable materials. However, in western Canada, the seemingly never-ending supply of rockflour, created by glacial action, tends to seal the beds of most rivers, regardless of size. Whether or not the beds are always sealed has not been demonstrated at this time. For example, during a high-water stage, most fine-grained sediment could be removed from a stream bed which could then theoretically allow hydraulic continuity between a stream and an aquifer underlying the stream.

The extent of the aquifer in which the Town of Faro's water wells are completed is not known. However, it appears from the cross-sections that the aquifer does not extend a significant distance to the north or south of the water wells. The topographic high to the west of the wells suggests that

the aquifer does not extend downstream in the Pelly River more than a few hundred metres. Since the aquifer does not show signs of being a depletion-type aquifer, the aquifer must either extend a significant distance upstream or be receiving an appreciable quantity of recharge from the Pelly River system.

There is a similarity between the chemical quality of the Vangorda Creek water, the Pelly River water and the groundwater from the aquifer in which the Town of Faro's water wells are completed. All the waters are calcium-magnesium-bicarbonate-type waters with low total dissolved solids. However, the concentration of zinc in the groundwater is five to ten times higher than the concentration in the surface waters.

CONCLUSION

The present data suggest that, under normal conditions, direct hydraulic continuity between Vangorda Creek and the aquifer in which the Town of Faro water wells are completed is unlikely. However, during a high-water stage, the fine-grained material may be removed from the creek bed and water from Vangorda Creek could enter the aquifer. At the present time, the main source of recharge to the aquifer is the Pelly River system.

RECOMMENDATIONS

The conclusions reached during the present study are qualitative rather than quantitative. There is a paucity of data and the situation should be remedied. We are not aware of any testing of the waters of Vangorda Creek in the vicinity of the wells to enable a comparison to be made to the well water. To establish background data, planned and orderly sampling and testing of both the well water and water in the creek should be carried out. It is recommended that sampling and testing of both waters be commenced. Initial testing should be done in March, June, September and December to evaluate the seasonal water fluctuations and quality. The creek should be sampled where it exits from the escarpment below the townsite. Samples of well water should be obtained from No. 1 Well Pumphouse, not from the distribution system in the townsite. Testing should be as done for Standard Municipal Analysis used in Alberta, with the addition of tests for lead and zinc. The program should commence as soon as possible to obtain control data prior to surface work being done in the stream headwater run-off area.

Because of the limited amount of data available and if conditions dictate, it may be necessary to equip one observation water well with a continuous water-level recorder for at least one year, to record the water-level fluctuations in the aquifer. After one year's records are available, the results of the chemical analyses and the water-level fluctuations would be analysed to determine what future action could be taken.

GLOSSARY

AMSL	- above mean sea level
l/min	- litres per minute
lpm	- litres per minute
igpm	- imperial gallons per minute
m^3	- cubic metres
m^2/day	- metres squared per day
BGL	- below ground level
BTOC	- below top of casing
TOC	- top of casing
Transmissivity	- measure of the quantity of groundwater which can flow through the rocks; units are metres squared per day
Storativity	- measure of the quantity of groundwater which can be stored in a rock unit; units are cubic metres per cubic metre
UTM	- Universal Transverse Mercator Grid
GWRIS	- Ground Water Resources Information Service of Alberta Environment

CURRAGH RESOURCES INC.
FARO, YT
VANGORDA CREEK/FARO WATER WELL ASSESSMENT

WATER WELL NO. 1
TW 5/68

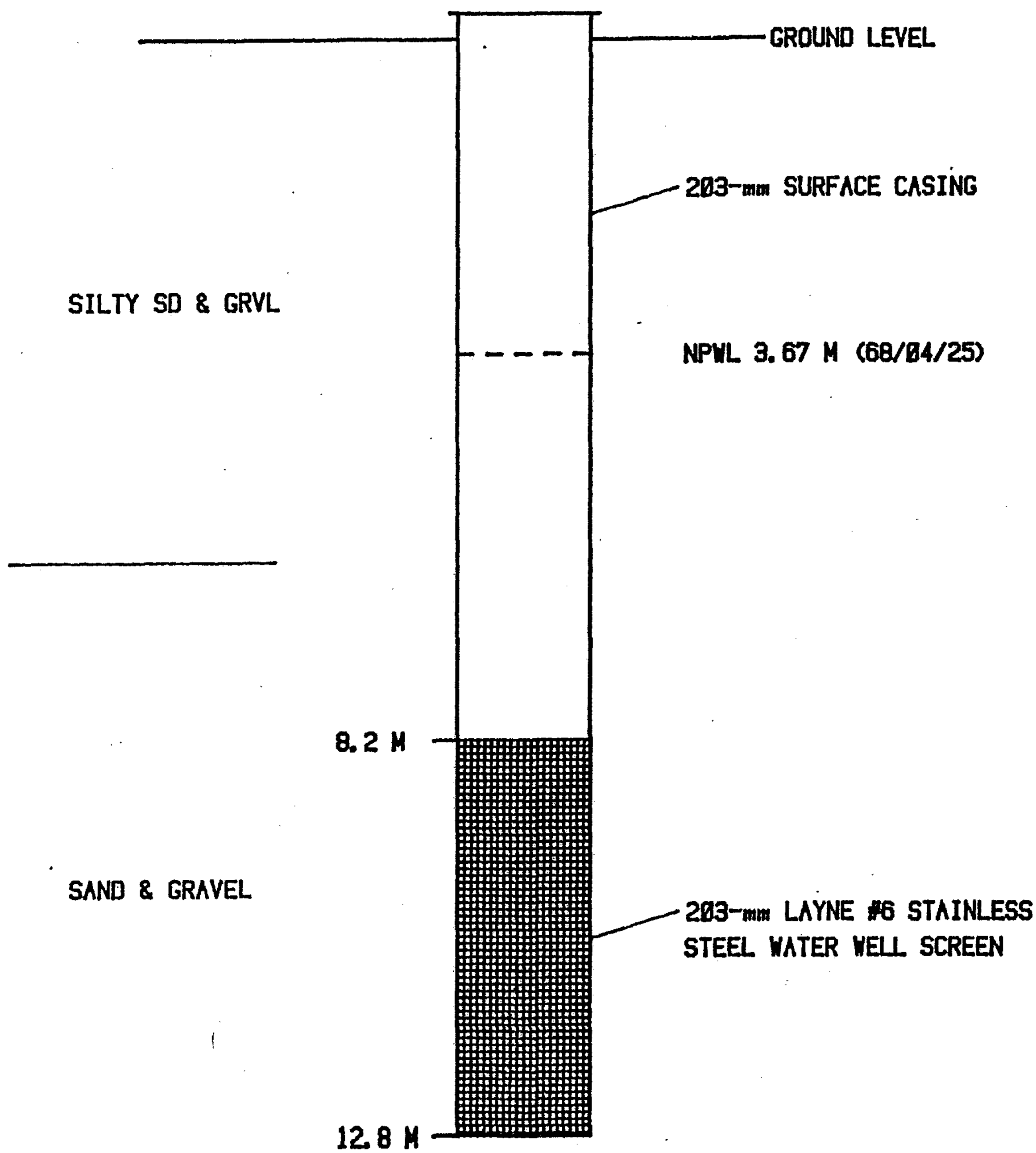


DIAGRAM SHOWING COMPLETION

CURRAGH RESOURCES INC.
FARO, YT
VANGORDA CREEK/FARO WATER WELL ASSESSMENT

WATER WELL NO. 2
TW 7/68

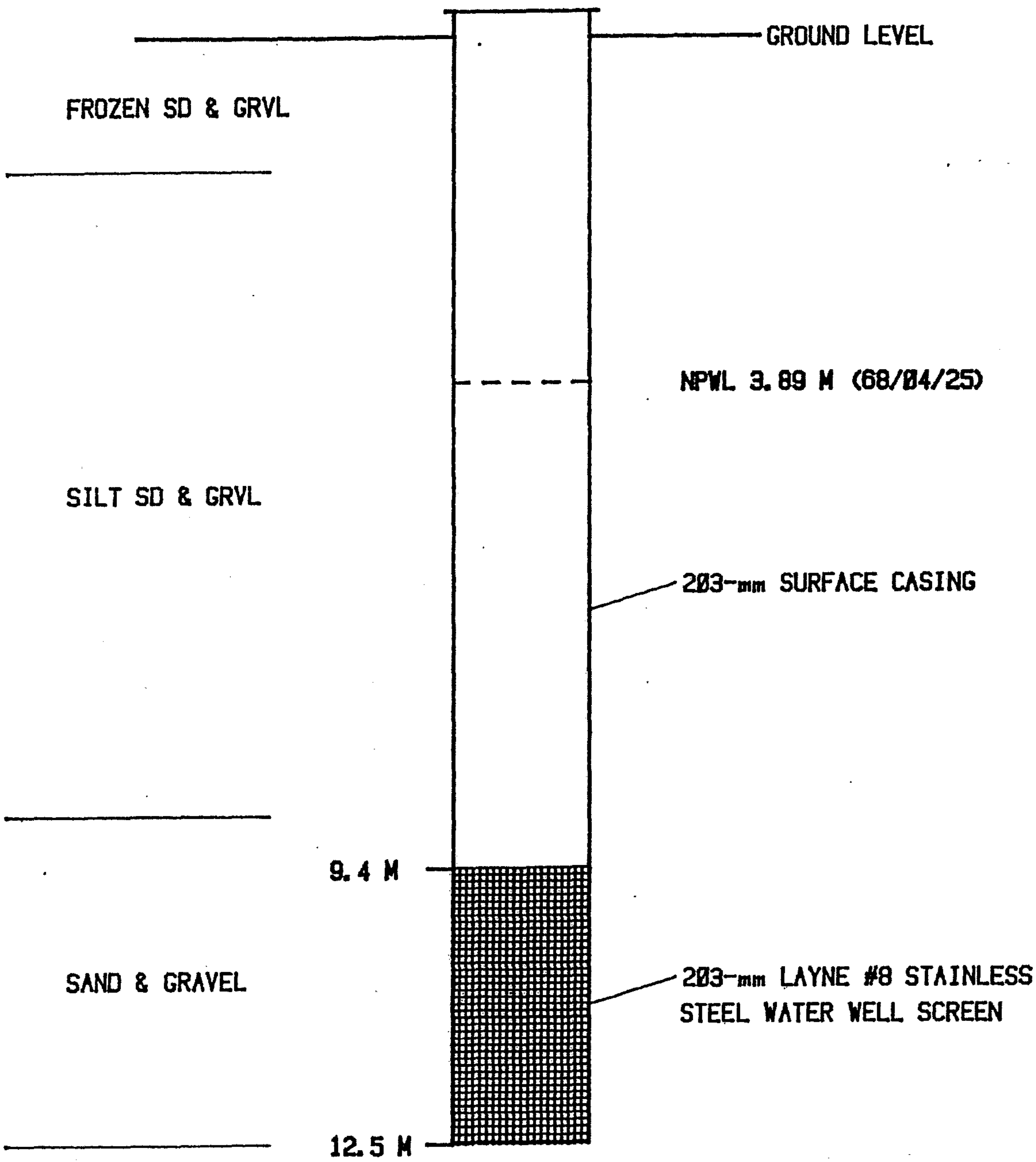


DIAGRAM SHOWING COMPLETION

CURRAGH RESOURCES INC.
FARO, YT
VANGORDA CREEK/FARO WATER WELL ASSESSMENT

WATER WELL NO. 3
WTH NO. 1-80

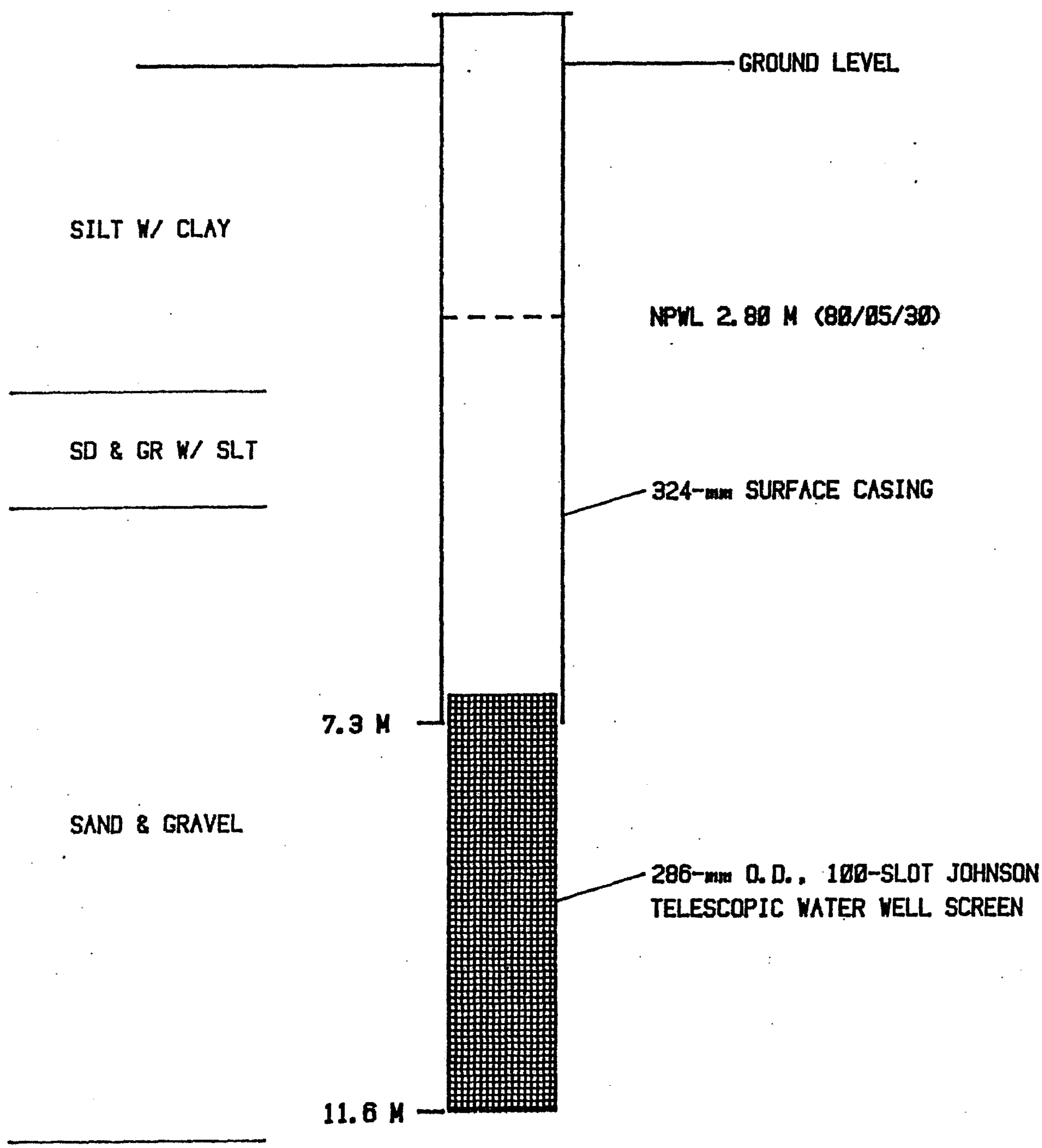


DIAGRAM SHOWING COMPLETION

LAIDLAW, B.Sc., F.C.I.C.
W. POPIEL, B.Sc., M.E., M.E.I.C.

Telephone 786-1340
786-1580

THE NATIONAL TESTING LABORATORIES LIMITED

1045 ARLINGTON ST.
WINNIPEG, MAN. R3E 2G4

Report ON SAMPLE OF WATER

Received from FARO, YUKON TERRITORY — Laboratory No. K-3532

For ANALYSIS — Date MAY 24TH, 1974

Reported to MR. W. D. HURST,
67 KINGWAY AVENUE, WINNIPEG, MANITOBA, R3M 0G2

PH	7.8	
DISSOLVED SOLIDS (BY EVAPORATION)	274	PPM
NITRATE (N)	.21	"
TOTAL IRON (FE)	.03	"
ALKALINITY:		
TO PHENOLPHTHALEIN	0	"
TOTAL	159	"
TOTAL HARDNESS ($CaCO_3$)	205	"
CALCIUM (CA)	49	"
MAGNESIUM (MG)	20	"
SODIUM (NA)	3	"
POTASSIUM (K)	1	"
CARBONATE (CO_3)	0	"
BICARBONATE (HCO_3)	194	"
SULPHATE (SO_4)	44	"
CHLORIDE (CL)	3	"

THIS IS A LOW MINERALIZED WATER, ALMOST CHLORIDE FREE, AND HAVING ITS MAIN MINERALS OF SULPHATE AND CARBONATE HARDNESS.

THE NATIONAL TESTING LABORATORIES LIMITED

G.C.LAIDLAW

GCL/MM

RESULTS OF LABORATORY ANALYSIS

DOMESTIC WATER FARO YUKON

Determination	Amount mg/l
Total dissolved solids, at 105C	346
Phenophthalein alkalinity, as CaO	0
Total alkalinity, as CaCO	180
Carbonatr Alkalinity, as CaCO	0
Bicarbonate alkalinity	180
Cartbonater, as CO	0
Bicarbonates, as HCO	220
Hyrroxides, as OH	0
Carbon dioxide, as CO2	6
Chloride, as Cl	3
Sulfate, as SO	54
Flouride, as F	0.3
Phosphate, as PO4	3.3
pH(laboratory)	7.8
Stability index	6.4
Saturation index	0.7
Total hardness, as CaCO	204
Calcium hardness, as CaCO	174
Magnesium hardness, as CaCO	30
Calcium, Ca	70
Magnesium, as Mg	7.3
Sodium, as Na	4.2
Iron, as Fe	0.1
Manganese, as Mn	0
Coppeń, as Cu	0.5
Silica, as SiO2	9
Color, standard platinum cobalt scale	0
Odor threshold	0
Turbidity, Jackson units	0
Carbon dioxide, free	20
Oxygen, dissolved	6.3

According to Standard Methods for the Examination of Water
Sampled and tested 1974
Journal AWWA 1976

WESTERN INDUSTRIAL LABORATORIES LIMITED

LABORATORY REPORT

Telephone
(403) 439-7969

8109 - 102 Street
Edmonton, Alberta
T6E 4A4

CHEMICAL ANALYSIS OF WATER

Submitted by Hydrogeological Consultants Ltd. Date 5 June 80

Sample Town of Faro W.T.H. #1-80 Report No. 296-710

31 May, 1980. Lab No. 80-1843

Constituent	mg/l	Constituent	mg/l
Total Filtrable Residue	335	Sulfate SO_4	69
Fixed Filtrable Residue	223	Chloride Cl	2
Sodium & Potassium (Calc. as Na)	9	Iron Fe	0.03
Calcium Ca	59	Fluoride F	0.13
Magnesium Mg	20	Nitrate + Nitrite N	0.39
Total Hardness as $CaCO_3$	230		
Carbonate CO_3	NIL		
Bicarbonate HCO_3	212		
Total Alkalinity as $CaCo_3$	175		

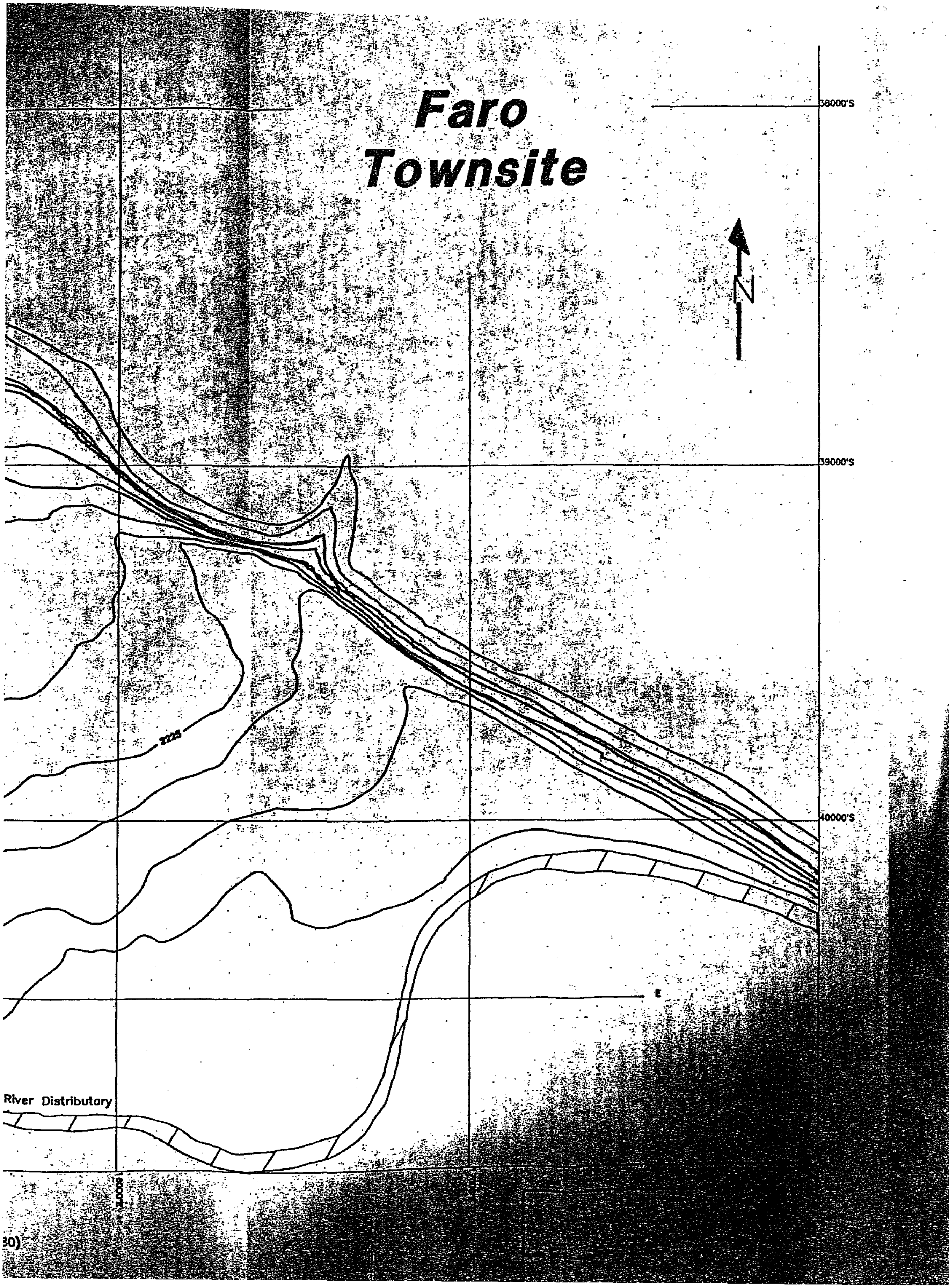
pH 7.75 Conductivity 425 micromhos/cm Turbidity ____ N.T.U.

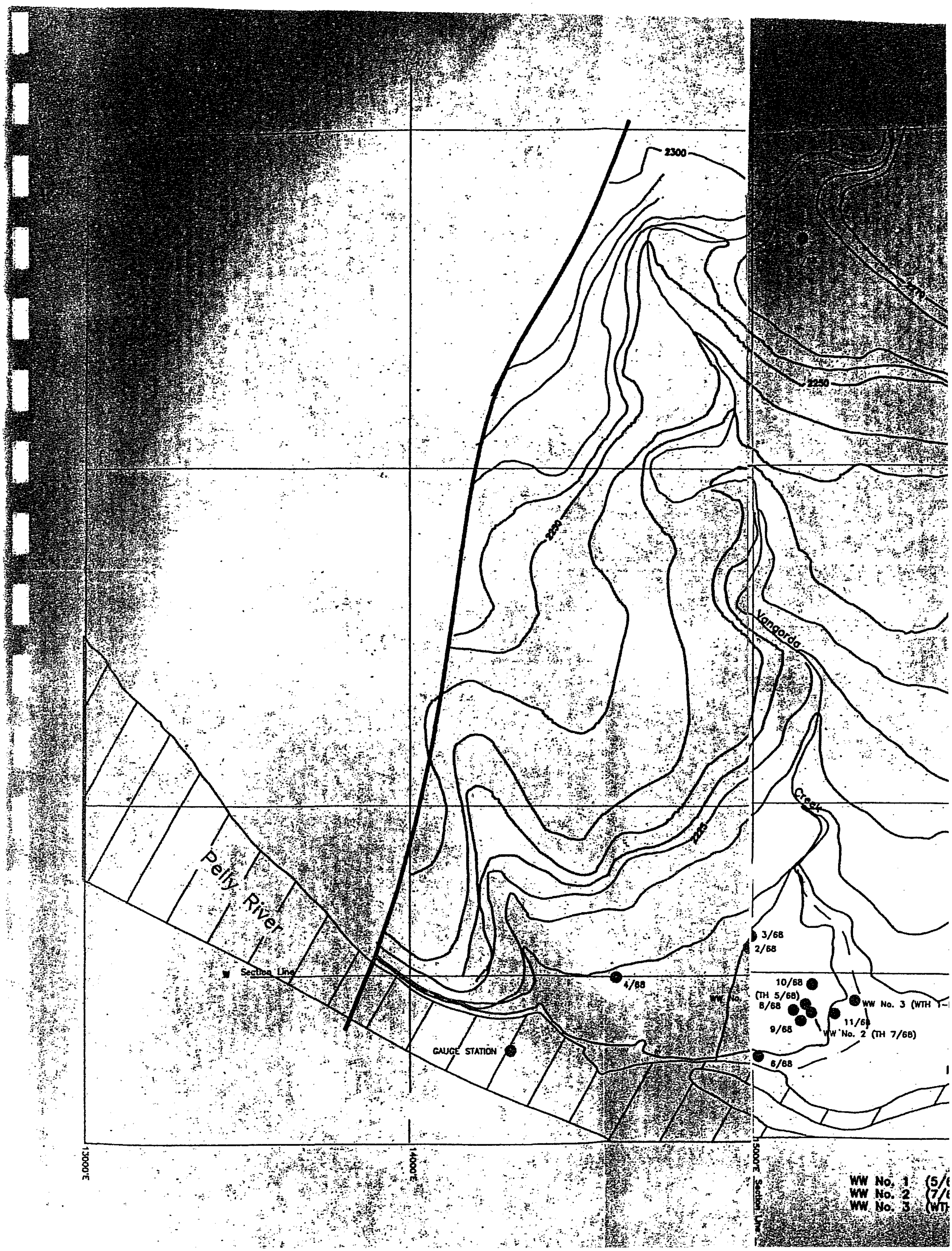
Remarks

WESTERN INDUSTRIAL LABORATORIES LIMITED

Frank Harrison

Frank Harrison


Faro
Townsite
38000'S
39000'S
40000'S
N
3225
River Distributary


2300
2250
2250
2225
Vangorda
Creek
Pelly River
Section Line
4/68
GAUGE STATION
3/68
2/68
10/68
(TH 5/68)
8/68
9/68
11/68
WW No. 3
WW No. 2 (TH 7/68)
6/68
13000'E
14000'E
15000'E Section Line
WW No. 1
WW No. 2
WW No. 3