TITAN STEEL & WIRE CO. LTD.

PROGRESS REPORT
GROUNDWATER INVESTIGATION CARRIED OUT UNDER PURCHASE ORDER NUMBER 21104 IN REGARD TO WASTE MANAGEMENT PERMIT NO. PE-161

PACIFIC HYDROLOGY CONSULTANTS LTD.

APRIL 23, 1985

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April 23, 1985

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Attention: Mr. H. Yianni,
Project Engineer

Subject: Progress Report
Groundwater Investigation Carried Out Under Purchase Order Number 21104 in Regard to Waste Management Permit No. PE-161

Dear Sir:

The purpose of this progress report is to describe the work that we have carried out to investigate groundwater movement and groundwater quality on and around the Titan Steel & Wire Co. Plant site. The main objective is to determine whether a contaminant plume has developed because of the sludge-settling lagoons and, if so, to identify the contaminants in the plume and delineate the path of travel and the rate of travel of the plume.

Background information is contained in our letter of proposal dated December 12, 1984 and in a letter dated December 13, 1984.

1.0 INTRODUCTION

In Section 2.0 (Page 4) of our letter of proposal of December 12, 1984 we proposed to determine the direction of groundwater flow in the vicinity of the Titan Plant by analyzing water samples to detect the presence of a plume of contaminated water, and/or by determining the groundwater gradient using a surveyor's level. Both methods were used.

The observation points that were installed to obtain water table elevations and to obtain water samples are constructed so that any of them can easily be completed as permanent monitoring wells.

2.0 OBSERVATION WELL CONSTRUCTION

Nine observation wells were installed to determine the groundwater gradient under the Titan Plant site. These observation wells consist of 38 mm (1½") i.d. P.V.C. Schedule 80 pipe with 0.254 mm (0.010") slots for a length of about 1 m at the bottom end which is closed with a solid plug. A typical observation well is shown on Figure 2 (Appendix A).

The casings were placed in open holes dug with a 75 mm (3") diameter bucket-type hand auger.

Digging is very easy and rapid in the dry sand but is more difficult and slower in the saturated sand which tends to cave. The sand is quite uniform and loose although it is possible to feel more compact layers in the dry sand. In several places at a depth between 2 and 3 m below surface, there is some wood and organic debris along with a few pebbles. A small amount of bentonite drilling mud was used in several holes to facilitate drilling below the water table.

The locations of the observation wells are shown on Titan Drawing Number D-P95-053 (our Figure 1 in Appendix A); a summary of other data about the observation wells is given in Table 1 in Appendix A.

Each observation well was developed by pumping with a small diaphragm-type hand pump and by back-washing with clear water. The capacities of the wells vary from about 1 litre per minute to about 20 litres per minute. Additional development would probably increase the capacities of most of the wells.

The top of the casing of each observation well was used as a datum for determining the elevation of the water table. The elevations of the tops of the casings were determined by means of a surveyor's level, assuming an elevation of 5 m at a location on the railway track near Door 6 of the Plant. This datum point is marked by aluminum paint on the rail.

A large diameter observation well

was constructed near Observation Well No. 5 by digging with a 159 mm ($6\frac{1}{4}$") diameter bucket-type hand auger. Steel stove-pipe was used as a casing. The temporary well was constructed in order to install an automatic water level recorder to observe whether there is any tidal fluctuation under the Plant site that would affect movement of a contaminant plume. A site near Observation Well No. 5 was selected, as this area on the Titan Property is closest to tide water. A copy of the circular chart from the water level recorder is included in Appendix A as Figure 3. The recorder was left in place for two tidal cycles.

3.0 WATER QUALITY SAMPLING

A water sample was collected from each observation well at the time of completion by using a portable diaphragm hand pump. The samples were sent to Analytical Service Laboratories Ltd. (ASL) in Vancouver for determination of zinc only. Zinc was chosen as an indicator of contamination because it is very mobile and it is known to be present in large amounts in the sludge-settling lagoons.

On March 16 all of the observation wells were pumped and portable field equipment was used to measure conductivity, pH and temperature of the water. Field and laboratory chemical results are included in Table 2 in Appendix B.

4.0 SURFACE DRAINAGE

In this situation, where we are dealing with a water table in permeable sediments, it is important to examine the character of surface water drainage in the Plant area. From our reconnaissance of the area we have observed the directions of surface water flow in ditches and creeks that drain the area and we have also obtained an indication of the extent of tidal movement in the surface drainage.

On the Fraser River Floodplain northwest of the railway track, drainage is mostly northeastward to the un-named creek which drains the upland and crosses the track about 1 km northeast of the Plant. The creek is tidal for about 200 m from its mouth up to where a large water main crosses the creek forming a drop structure. A ditch along the southeast side of the track intercepts runoff from the Surrey Upland. The large paved area of the Harbour Commission Property that is leased by Johnston Terminals & Storage Ltd. is drained by several storm drains that discharge directly to the River.

The Titan Plant area and the Cleanwood Plant area are drained by a ditch along the southeast side of the property; this ditch discharges into the narrow embayment (Gunderson Slough) where the boatyards are located. Part of this ditch is tidal. There is a constant flow of clean cooling water from the Titan Plant to the ditch. This

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ditch has recently been deepened; it has no lining so a small amount of water may leak into the underlying sand. This leakage is likely to decrease as a silty layer of low permeability forms in the bottom of the channel.

5.0 DISCUSSION OF INVESTIGATION RESULTS

5.1 GROUNDWATER GRADIENT

Considering both the water table elevations and the groundwater chemistry, we have interpreted groundwater movement in the Plant areas as shown on Figure 1. The direction of groundwater flow is toward the River as expected. The surprise is how steep the gradient is across the property: for example, between Observation Wells No. 4 and No. 9 along the north Plant Property boundary and also between Wells No. 1 and No. 8. These steep gradients may be caused by an abrupt change from lower permeability sediments of the Fraser River Delta to more permeable fill under the Fraser Dock area.

The drainage ditch from the Plant to Gunderson Slough apparently has no effect on the overall gradient.

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5.2 TIDAL FLUCTUATION

The automatic water level recorder graph (Figure 3 in Appendix A) shows that the tidal influence under the Plant area is insignificant and has no influence on contaminant plume movement.

5.3 GROUNDWATER QUALITY

With the exception of Observation Well No. 3, the amount of zinc in the groundwater under the Plant area is remarkably low. There is no correlation between the amount of zinc and the very high conductivity obtained in several of the wells. The high zinc seems to correlate with a low pH (see Table 2 in Appendix B).

The high conductivity of ground-water from Well No. 7 shows clearly that the origin of the highly conductive water is up-gradient of the Titan Plant area. We understand that an area east of the lagoons was used in the past for dumping chemical waste. This seems most likely to be the source of the contaminant plume.

The data show clearly that the plume of highly conductive water is quite local: for example, Observation Well No. 2 shows a slightly elevated conductivity of 790 microsiemens compared to a conductivity of 5500 micro-siemens in Observation Well No. 3 at a distance about 68½ m

(225 ft). We assume that the conductivity of 370 microsiemens obtained for water from Observation Well No. 5 is typical background quality of water in the Fraser River floodplain sediments.

The preliminary chemical results should not be considered to be precise. No special sample preservation techniques were used. However, the results are sufficiently accurate to show that no significant contaminant plume has been created by the sludge-settling lagoons.

6.0 SUMMARY

The results of the groundwater investigation at the Titan Plant may be summarized as follows:

1. The groundwater gradient under the Titan Plant area is toward the Fraser River.
2. The tidal influence under the Plant area is insignificant.
3. There is no evidence that a contaminant plume is moving from the sludge-settling lagoons.
4. There is a local plume of highly conductive water that originates up-gradient of the lagoons.

7.0 RECOMMENDATIONS

In light of the results of the groundwater investigation, and in consideration of the requirements of Waste Management Permit No. PE-161, we recommend the following:

1. Observation Well No. 5 be completed as a well to monitor background water quality.
2. Observation Wells No. 3, No. 4 and No. 9 be completed as monitoring wells.
3. An additional monitoring well be constructed between Wells No. 3 and No. 9, perhaps at the southeast corner of the Rod Storage Shed.

Yours truly,

PACIFIC HYDROLOGY CONSULTANTS LTD.

A. Badry

A. Badry, Geologist

E. Livingston

E. Livingston, P. Eng.

attachments

APPENDIX A

OBSERVATION WELL LOCATION AND
WATER TABLE CONTOUR MAP
AND
OBSERVATION WELL DETAILS

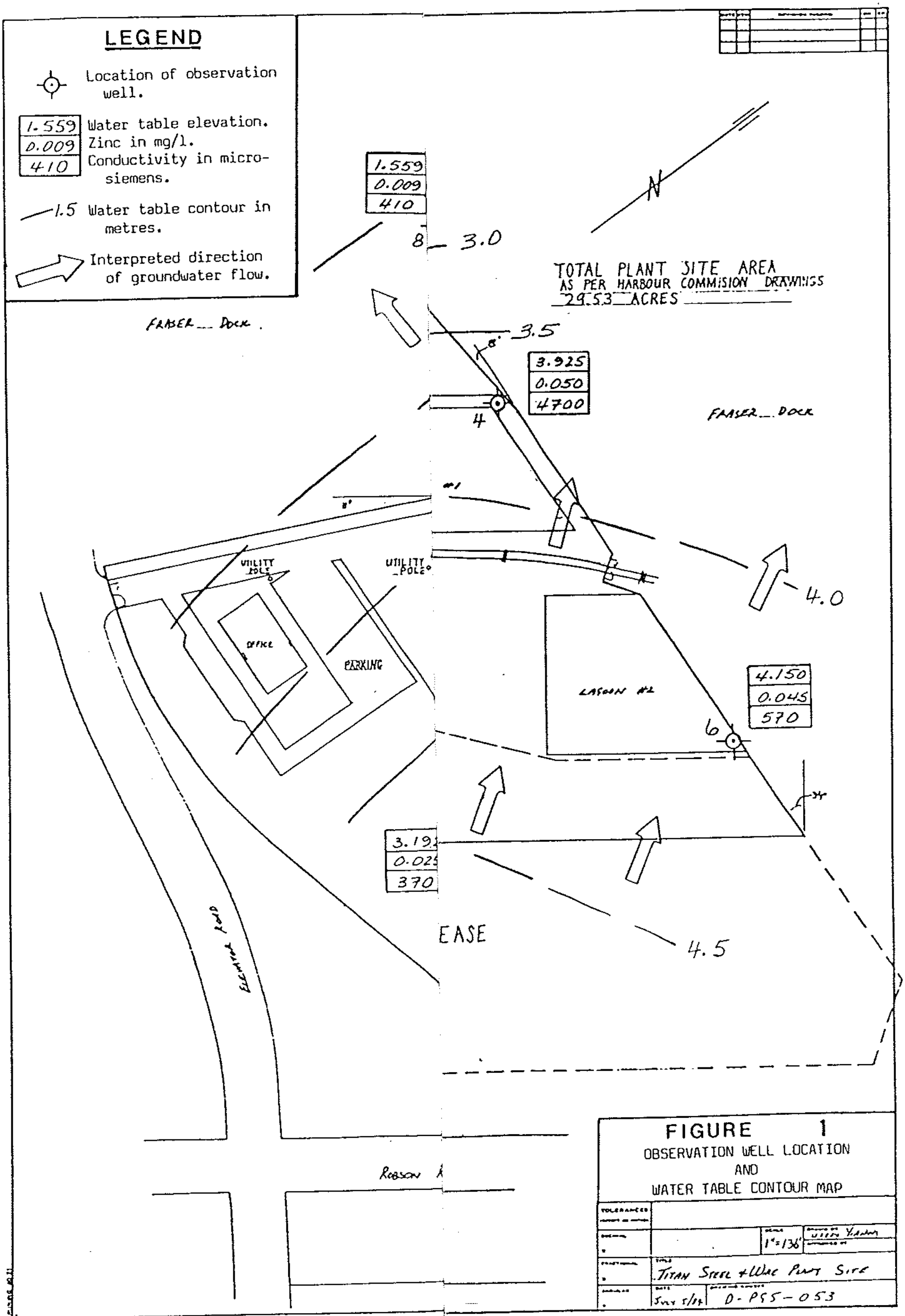

FIGURE 1
OBSERVATION WELL LOCATION
AND
WATER TABLE CONTOUR MAP

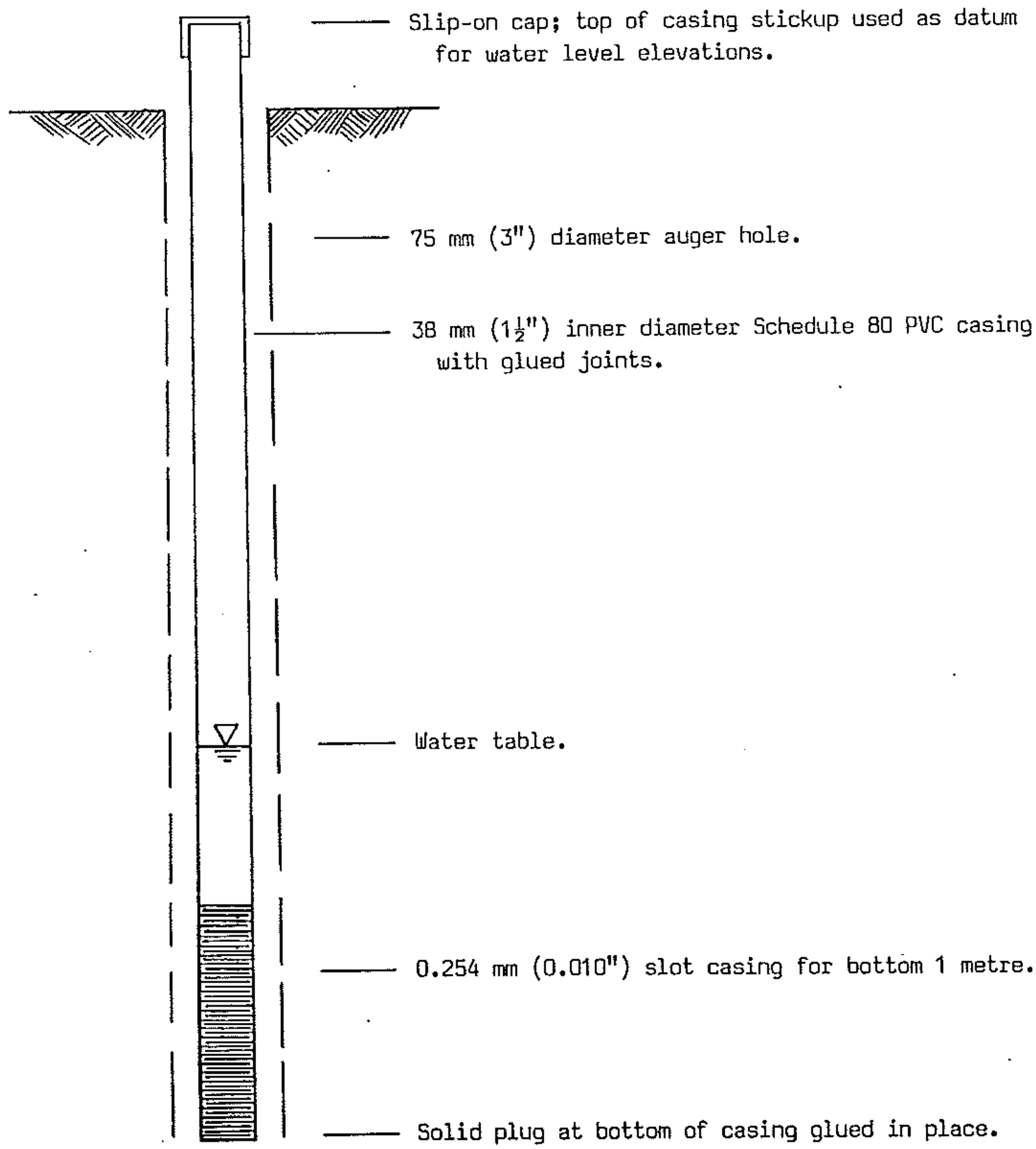

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FIGURE 2

TYPICAL OBSERVATION WELL CONSTRUCTION

Scale: N.T.S.

Table 1. DETAILS OF OBSERVATION WELLS

Well No.	Total Depth Below Top of Well		Stickup		Elevation of Top of Casing		Distance to Water - Mar. 16		Water Table Elevation Mar. 16, 1985		Remarks
	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	
1	3.585	(11.76)	0.229	(0.75)	6.005	(19.70)	2.590	(8.50)	3.415	(11.20)	Hole in sand from surface to total depth; silty interbeds near bottom Drilling mud used to install; calgon used for development.
2	3.104	(10.18)	0.204	(0.67)	5.822	(19.10)	1.864	(6.11)	3.958	(12.98)	Hole in sand from surface; last 0.3 m (1 ft) in silt, peat and wood. Drilling mud used to install.
3	3.119	(10.23)	0.354	(1.16)	6.012	(19.72)	1.833	(6.01)	4.179	(13.71)	Hole in sand from surface; silty interbeds in last 0.15 m ($\frac{1}{2}$ ft). Drilling mud used to install.
4	3.768	(12.36)	0.256	(0.84)	6.480	(21.25)	2.555	(8.38)	3.925	(12.87)	Hole entirely in sand; drilling mud used to install.
5	3.424	(11.23)	0.128	(0.42)	5.910	(19.38)	2.718	(8.92)	3.192	(10.47)	Hole in sand from surface; last 0.3 m (1 ft) in silt with wood.
6	5.152	(16.90)	0.152	(0.50)	5.490	(18.01)	1.340	(4.40)	4.150	(13.61)	Hole in sand from surface.
7	3.430	(11.25)	0.204	(0.67)	6.702	(21.98)	2.148	(7.04)	4.554	(14.94)	Top 0.3 m (1 ft) of hole in gravel fill; sand to total depth.
8	6.170	(20.24)	0.440	(1.44)	6.225	(20.42)	4.666	(15.30)	1.559	(5.11)	Hole in sandy gravelly fill to 1 m (3.3 ft), fine to medium sand to 3 m (9.8 ft), silt from 3 to 3.3 m and sand to bottom.
9	4.380	(14.37)	0.450	(1.48)	6.180	(20.27)	3.847	(12.62)	2.333	(7.65)	Hole in coarse gravel fill containing wire, wood and other debris to 1 m and in fine sand to bottom.

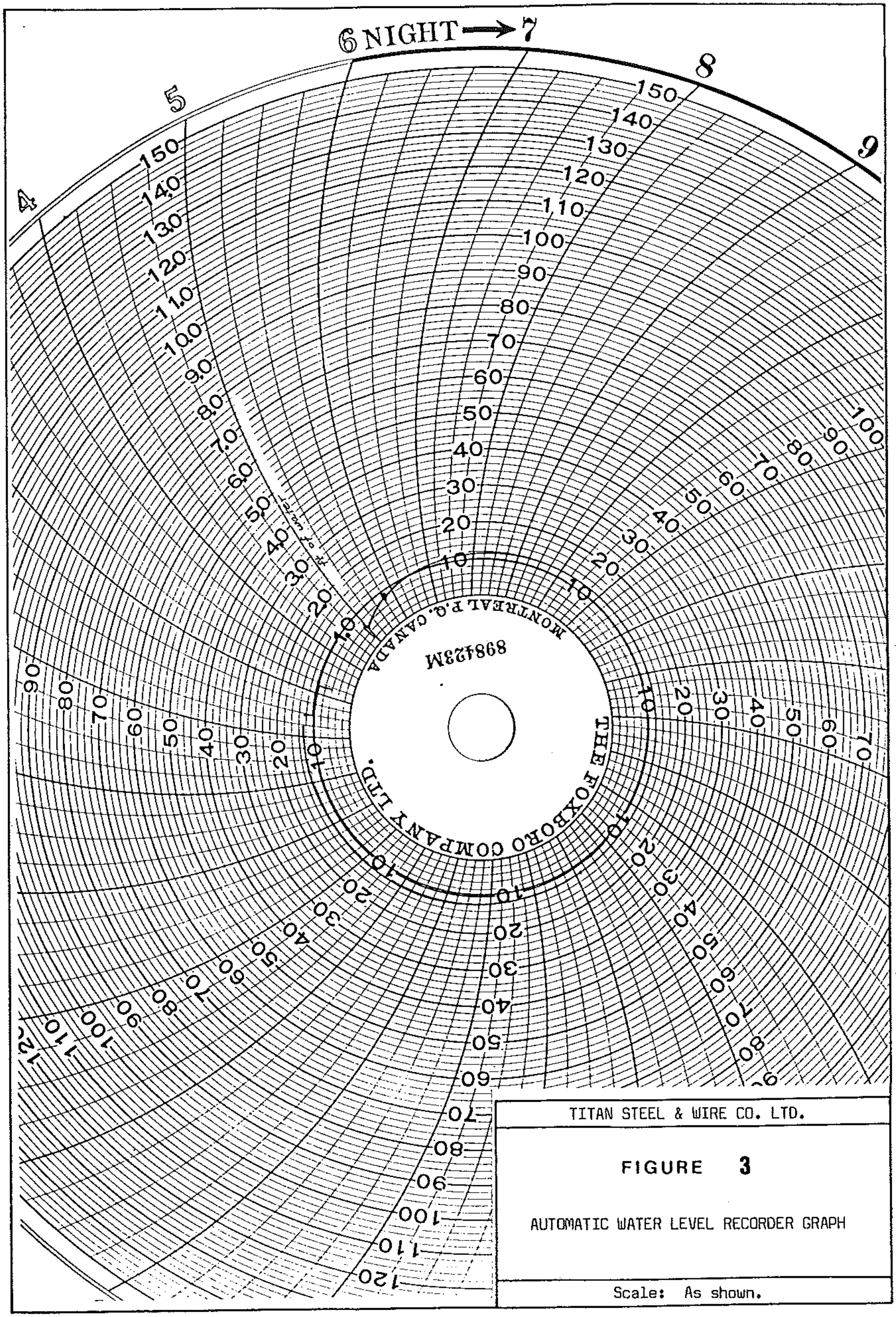

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FIGURE 3

AUTOMATIC WATER LEVEL RECORDER GRAPH

Scale: As shown.

APPENDIX B

GROUNDWATER QUALITY

Table 2. GROUNDWATER QUALITY

Well No.	Conductivity (microsiemens)	pH	Water Temperature °F	Water Temperature °C	Zn	Remarks
1	720	8.8	51	10.5	0.042	
2	790	8.0	50	10	0.008	
3	5500	5.2	49½	9.7	82.0	
4	4700	8.5	49	9.4	0.050	
5	370	7.8	52	11.1	0.025	
6	570	8.5	45	7.2	0.045	Located close to a recently melted pile of snow.
7	5400	7.5	48½	9.2	0.008	
8	410	8.4	-	-	0.009	
9	3900	8.5	48	8.9	0.075	
Drain					0.26	