PROVINCE OF BRITISH COLUMBIA
MINISTRY OF ENVIRONMENT
WATER MANAGEMENT BRANCH

CONTRACT NO. 75

Drilling, Construction and Testing of
Observation Wells at
Coombs and Hornby Island, B.C.

Observation Well No.'s 287 and 288

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Water Management Branch

Victoria, B.C.
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Drilling, Construction and Testing
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CONTRACT NO. 75

1. INTRODUCTION

Establishment of observation wells at Coombs and Hornby Island was recommended by Zubel (1982) and Wei (1983). Coombs and Hornby Island lie along the east coast of Vancouver Island between Courtenay and Nanaimo (Figure 1). Both areas depend on groundwater as the main source of water supply and have a high concentration of wells. Many wells are open holes drilled into bedrock intercepting water-bearing zones. Water quantity and quality are reported problems. Observation wells in these areas would allow collection of groundwater data for assessing aquifer behaviour to local pumping, natural recharge and pollution over a period of time. A field survey by D. Kalyn, groundwater technician, in the winter of 1983 to locate suitable abandoned wells for use as observation wells was unsuccessful. Consequently, drilling was required to establish these observation wells.

2. WELL DRILLING

Well drilling was carried out by Island Well Drilling Ltd. of Ladysmith. In total, two observation wells (152 mm Ø) were established, one each at Coombs and Hornby Island (Appendix A).

The wells were drilled by the air rotary method with a Shram Rotadrill rig. Contract cost totalled $7,996.17 (Appendix B).

2.1 Observation Well No. 287

Work began on March 5, 1984, at Coombs along the Burgoyne Road right-of-way (Figures 2 and 3). An initial hole, Testhole #1, was drilled in the wrong location due to mislocating a survey pin, to a depth of 8.8 m (29 feet) and was subsequently backfilled and abandoned.

The rig was moved 12.1 m (39.7 feet) west of Testhole #1 and a second hole was drilled for completion as an observation well (Picture 1). Surface casing 254 mm (10 inches) in diameter was first installed to 8.8 m (29 feet). Bedrock was encountered at 8.2 m (27 feet). A 152 mm (6-inch) diameter overlap casing was placed inside the surface casing and drilling was then continued with a 152 mm (6-inch) open hole to a depth of 92.4 m (303 feet). Geologic samples collected at regular intervals showed drilling encountered the following:

Depth	Material
0.0 m to 3.0 m (10')	Brown till
3.0 m to 8.2 m (27')	Grey sandy till
8.2 m to 92.4 m (303')	Soft black shale

Water was first detected at about 24 m (80 feet) flowing into the well at a rate of roughly $3(10^{-2})$ L/s (1/2 gpm). No other water-bearing zones were detected below this depth. The static water level upon completion was 2.74 m (9.0 feet) below the top of the 152 mm casing. After drilling, the well was developed by flushing with air. A surface seal was then constructed by filling the annular space between the 254 mm and 152 mm casings with cement and cuttings, and pulling out the 254 mm

casing. A well lid was attached to the well head to complete the well (Figure 4 and Pictures 2, 3, 4, 5, 6 and 7). A pump test was not performed because of the low yield.

2.2 Observation Well No. 288

Work on Hornby Island began March 7, 1984, along the Central Road right-of-way with Testhole #1 at Site #1 (Figure 5 and Picture 8). This 152 mm diameter hole was drilled to 67.1 m (220 feet) and encountered the following geologic materials:

Depth	Material
0.0 m to 0.8 m (2.5')	Topsoil
0.8 m to 1.8 m (6')	Conglomerate
1.8 m to 48.8 m (160')	Grey sandstone with some light grey sandstone
48.8 m to 67.1 m (220')	Black shale

The hole was dry and subsequently backfilled and abandoned (Pictures 9 and 10).

Another hole (Observation Well No. 288) was drilled at Site #2 275 m (900 feet) south of Testhole #1 (Figures 5 and 6 and Picture 11). A 254 mm surface casing was installed to 6.1 m (20 feet). A 152 mm overlap casing was then placed inside the surface hole and drilling continued with a 152 mm open hole to 77.1 m (253 feet). Geologic samples collected showed drilling encountered the following:

Depth	Material
0.0 m to 3.0 m (10')	Conglomerate
3.1 m to 4.6 m (15')	Soft black shale
4.6 m to 5.2 m (17')	Light grey sandstone
5.2 m to 16.8 m (55')	Greenish grey sandstone/ conglomerate
16.8 m to 38.1 m (125')	Black shale
38.1 m to 39.6 m (130')	Grey sandstone
39.6 m to 42.7 m (140')	Black shale
42.7 m to 45.7 m (150')	Light grey sandstone
45.7 m to 51.8 m (170')	Black shale
51.8 m to 62.5 m (205')	Light grey sandstone
62.5 m to 77.1 m (253')	Black siltstone grading down to black shale

Some water was first detected between 4.6 m (15 feet) and 5.2 m (17 feet). No major water-bearing zones were encountered below that, however, small quantities of water were being contributed to the well at depth. Upon completion the total yield was estimated at $6(10^{-3})$ L/s (5 gph) and the static water level was 15.03 m (49.3 feet) below the top of the 152 mm casing. The well was developed by flushing with air. A surface seal was constructed by filling the annular space between the 254 mm and 152 mm casings with cement and cuttings, and pulling out the 254 mm casing. A well lid was attached to the well head to complete the well (Figure 7 and Pictures 12, 13, 14 and 15). A pump test was not performed because of the low yield. A summary of the well drilling is presented in Table 1.

3. WATER CHEMISTRY

Water chemistry was tested in the field with a conductivity meter and Hach Kit from air flushed samples. Following drilling but before recorder installation, a sample was collected from each well with a tube sampler, and

sent to the Environmental Laboratory in Vancouver for chemical analysis. Chemistry results are shown in Figure 8, Table 2 and Appendix C.

Water quality from both observation wells is very soft and relatively high in pH, dissolved mineralization, fluoride, boron and aluminum. PH, TDS and fluoride exceed those limits set in B.C. Drinking Quality Standards, 1982. In addition, water from Observation Well No. 287 appears to contain excessively high amounts of iron (Fe diss. = 0.57 mg/L). The waters can be characterized as Na-HCO_3 type water with corroding tendency (moderately high Ryznar Index) and not ideal for irrigation (high SAR index).

4. DISCUSSION

The Coombs Observation Well No. 287 appears to be completed into shales of the Haslam Formation. The Hornby Island Observation Well No. 288 appears to be completed into conglomerates, sandstones and shales of the Geoffrey Formation. Both formations belong to the Nanaimo Group, a sequence of sedimentary rocks formed during the Mesozoic Era. Most wells in both areas are completed into bedrock. However, overburden in both areas, comprising mostly till up to several metres thick, overlies bedrock and some wells in Coombs are dug into this overburden to tap shallow groundwater. No high capacity wells are known to exist in either area - the bedrock aquifers appear to have very limited yield. Although Observation Well No. 288 penetrated several bedding plane fractures, none proved productive. The water chemistry suggests some salty and/or brackish water may be seeping into the lower portion of both observation wells.

Water quality from both observation wells is similar even though the wells are completed into different flow systems. Hydrologically, Hornby Island can be regarded as a freshwater mound atop a seawater basement with the mound continually being recharged by precipitation and discharging to the sea, and is separate from the flow systems of Vancouver Island. The

relatively high concentrations of boron and flouride may reflect the presence of some brackish groundwater seeping into the wells. The aluminum content may be naturally occurring or may be from contamination during sampling - this is not clear.

A more complete assessment of the hydrogeology can be made through continued monitoring of the bedrock aquifers in both these areas.

5. CONCLUSIONS AND RECOMMENDATIONS

(1) Two 152 mm diameter observation wells were established: one each at Coombs and Hornby Island. Observation Well No. 287 at Coombs was completed to 92 m in soft black shales. Observation Well No. 288 at Hornby Island was completed to 77 m in interlayered conglomerates, sandstones and shales. Both wells have very low capacities. The wells are adequate however to monitor water level response.

(2) Cost for the drilling contract totalled $7,996.17.

(3) Water quality from both wells is similar: very soft and relatively high in pH, dissolved mineralization, fluoride, boron and aluminum. The waters can be characterized as $Na^{-}HCO_3$ type water.

(4) Water samples should be collected at least twice a year.

(5) Water level should be monitored with an automatic recorder for a minimum of 10 years (Pictures 16 and 17 and Appendix D).

6. REFERENCES

Wei, M. 1983. Groundwater Observation Well Network Expansion Program Proposal, 1983-84 Fiscal Year. Ministry of Environment, Groundwater Section, Victoria, B.C., File 0183613-B.

Zubel, M. 1982. Groundwater Observation Well Network Expansion Program Proposal, 1982-83 Fiscal Year. Ministry of Environment, Groundwater Section, Victoria, B.C., File 0183613-B.

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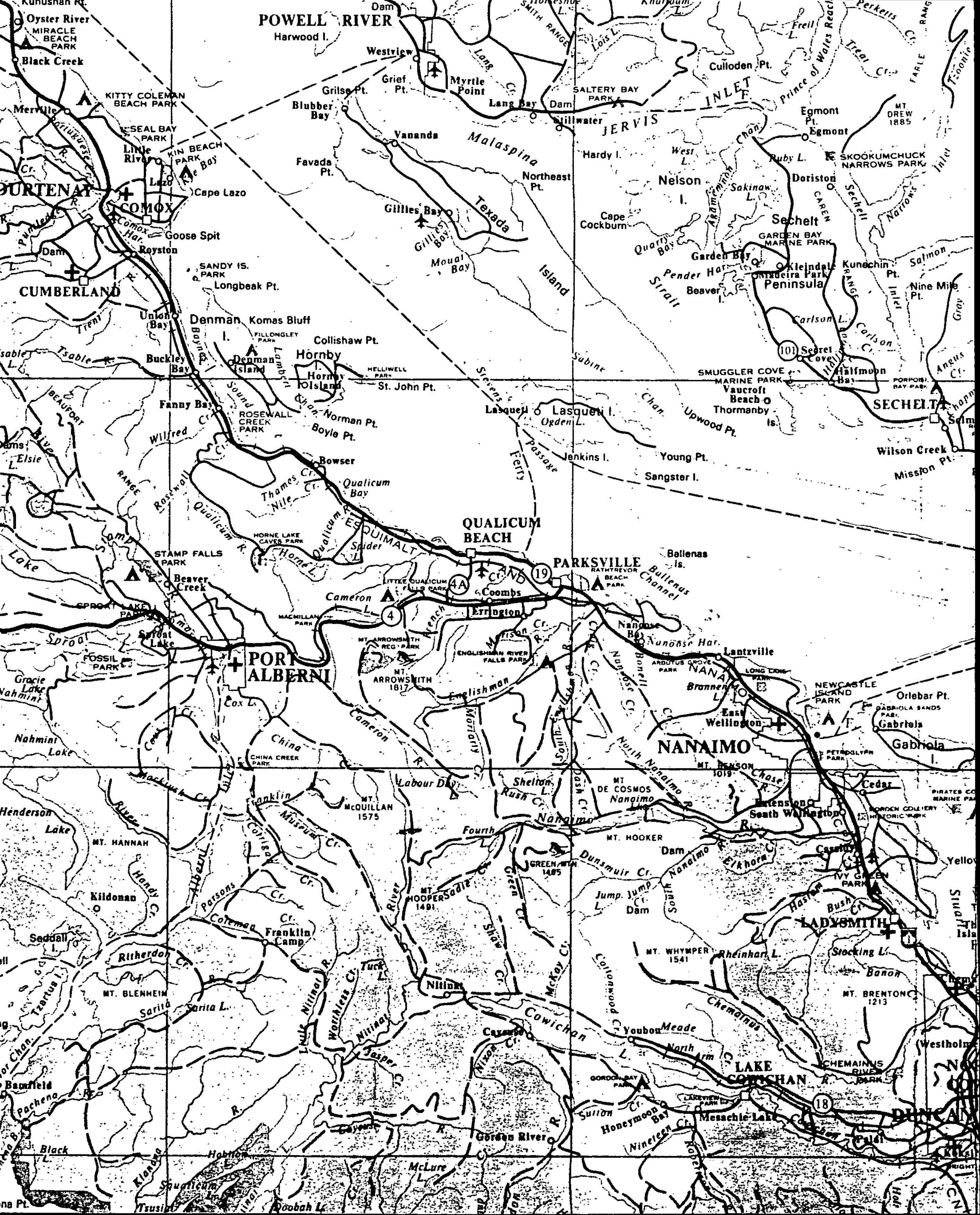
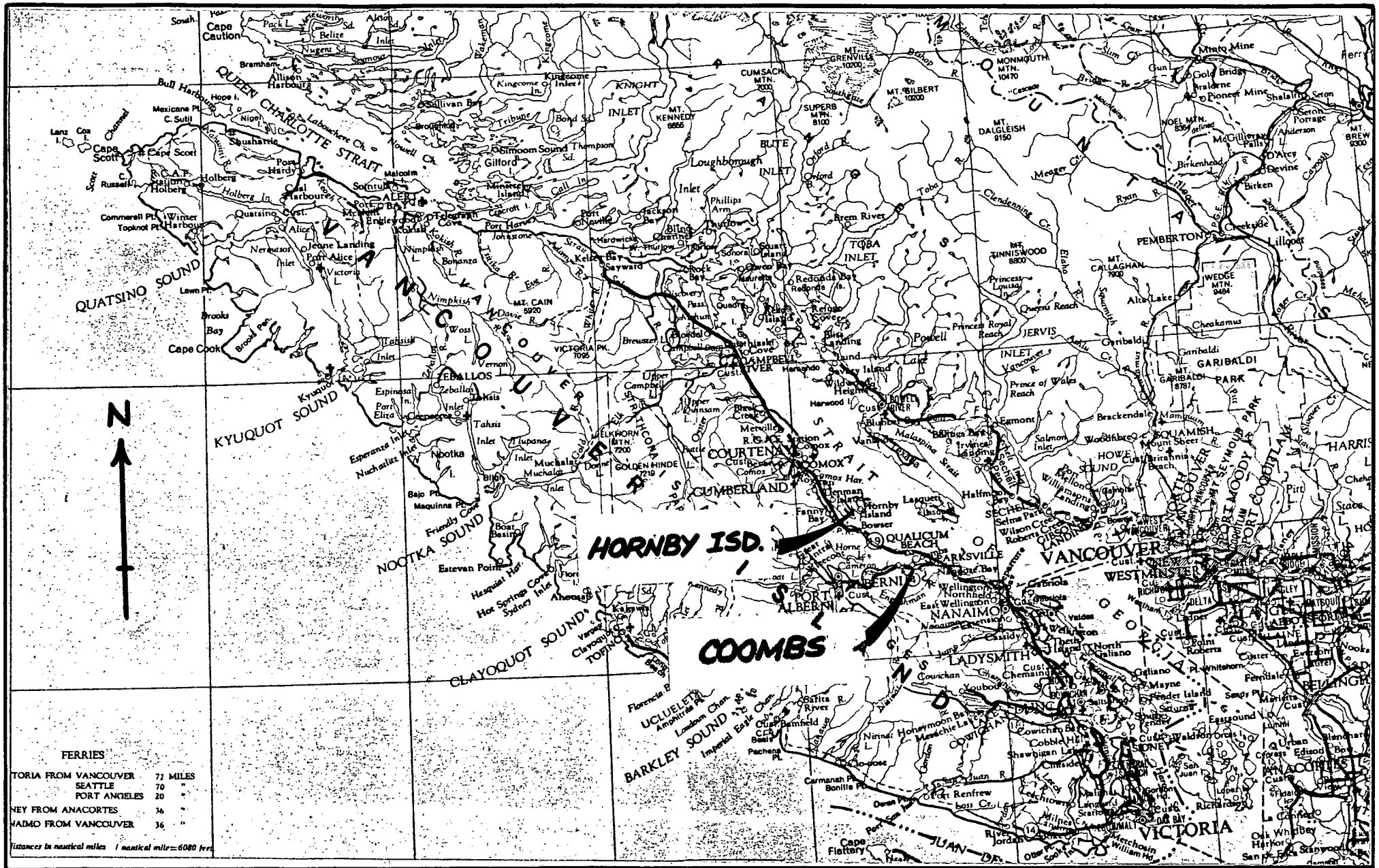
MW/dma



Oyster River
MIRACLE BEACH PARK
Black Creek
KITTY COLEMAN BEACH PARK
Merville
SEAL BAY PARK
Little River
KIN BEACH PARK
Lazo
Cape Lazo
COMOX
Goose Spit
Royston
CUMBERLAND
SANDY IS. PARK
Longbeak Pt.
Union Bay
Denman I.
Komas Bluff
FILLONGLEY PARK
Collishaw Pt.
Hornby Island
Denman Island
Buckley Bay
HELLIWELL PARK
St. John Pt.
Fanny Bay
ROSEWALL CREEK PARK
Norman Pt.
Boyle Pt.
Bowser
Qualicum Bay
HORNE LAKE CAVES PARK
STAMP FALLS PARK
Beaver Creek
SPROAT LAKE PARK
Sproat Lake
FOSSIL PARK
PORT ALBERNI
QUALICUM BEACH
PARKSVILLE
RATHTREVOR BEACH PARK
Ballenas Is.
LITTLE QUALICUM FALLS PARK
Coombs
Errington
Cameron L.
MACMILLAN PARK
MT. ARROWSMITH REG. PARK
MT. ARROWSMITH 1817
ENGLISHMAN RIVER FALLS PARK
Nanoose Bay
Lantzville
NANAIMO
NEWCASTLE ISLAND PARK
Orlebar Pt.
GABRIOLA SANDS PARK
Gabriola I.
East Wellington
CHINA CREEK PARK
MT. McQUILLAN 1575
MT. DE COSMOS
MT. BENSON 1019
PETROGLYPH PARK
Cedar
Extension
South Wellington
MT. HANNAH
MT. HOOKER
GREEN MTN. 1485
MT. HOOPER 1491
Kildonan
Franklin Camp
MT. WHYMPER 1541
IVY GREEN PARK
LADYSMITH
MT. BLENHEIM
Sarita L.
Nitinat
MT. BRENTON 1213
Youbou
LAKE COWICHAN
CHEMAINUS RIVER PARK
GORDON BAY PARK
Honeymoon Bay
Mesachie Lake
DUNCAN
Bamfield
Gordon River
POWELL RIVER
Harwood I.
Westview
Myrtle Point
Grief Pt.
Grilse Pt.
Blubber Bay
Vananda
Favada Pt.
Gillies Bay
Texada Island
Malaspina Strait
Lang Bay
Stillwater
SALTERY BAY PARK
JERVIS INLET
Culloden Pt.
Egmont Pt.
Egmont
MT. DREW 1885
SKOOKUMCHUCK NARROWS PARK
Hardy I.
Nelson I.
Northeast Pt.
Cape Cockburn
Doriston
Sechelt Peninsula
GARDEN BAY MARINE PARK
Garden Bay
Kleindale
Madeira Park
Kunechin Pt.
Nine Mile Pt.
Pender Har.
Beaver I.
Carlson L.
Secret Cove
Halfmoon Bay
SMUGGLER COVE MARINE PARK
Vaucroft Beach
Thormanby Is.
PORPOISE BAY PARK
SECHELT
Lasqueti I.
Jenkins I.
Young Pt.
Upwood Pt.
Sangster I.
Wilson Creek
Mission Pt.
Strait of Georgia



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

~~TO ACCOMPANY REPORT ON~~

LOCATION MAP

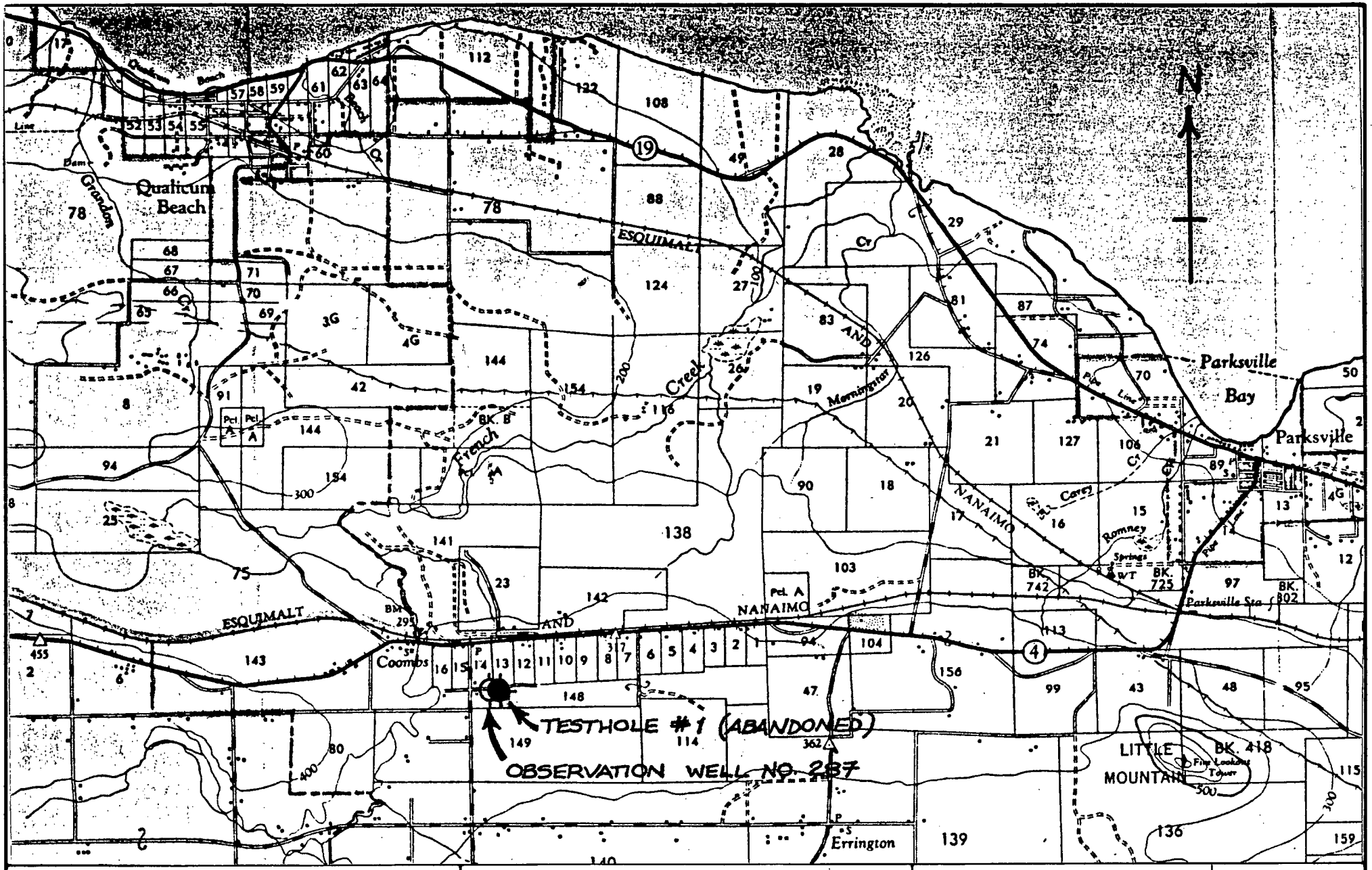
SCALE: VERT. N/A
HOR. 1:1,900,800

DATE NOV. 184

M. WEI ENGINEER

FILE No. 92F/8,10 DWG. No. FIGURE 1

BCIL 7674-M.E.



Province of British Columbia
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~~TO ACCOMPANY REPORT ON~~

LOCATION OF OBSERVATION WELL NO. 287, COOMBS, B.C.

SCALE: VERT. N/A
HOR. 1:50,000

DATE APRIL/84

M. WEI ENGINEER

FILE No. 92F/8,10 DWG. No. FIGURE 2

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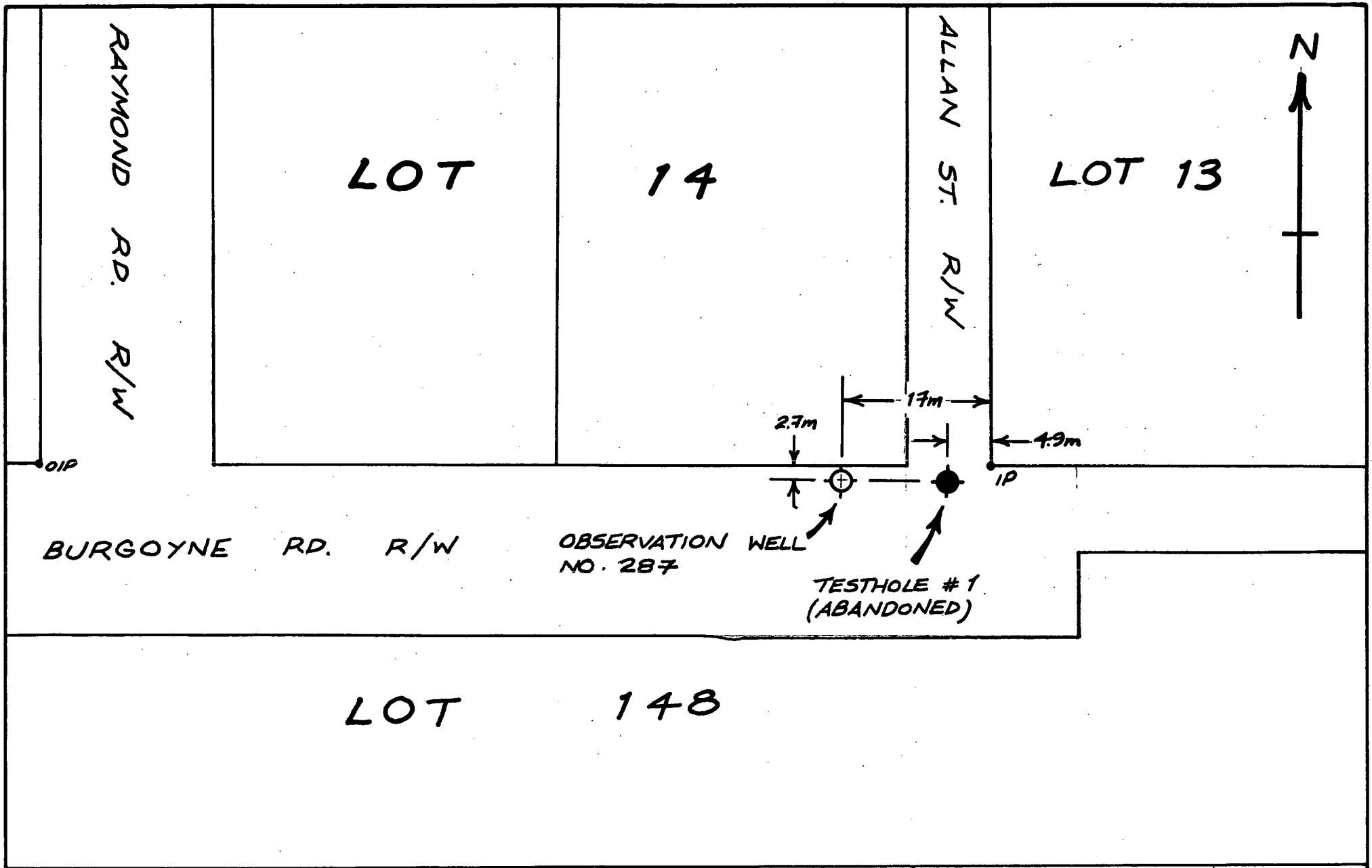

Province of British Columbia
Ministry of Environment
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~~TO ACCOMPANY REPORT ON~~
SITE PLAN,
OBSERVATION WELL NO. 287,
COOMBS, B.C.

SCALE: VERT. N/A
HOR. 1 : 600

DATE APRIL/84

M. WEI ENGINEER

FILE No. 92F/8, 10 DWG. No. FIGURE 3.

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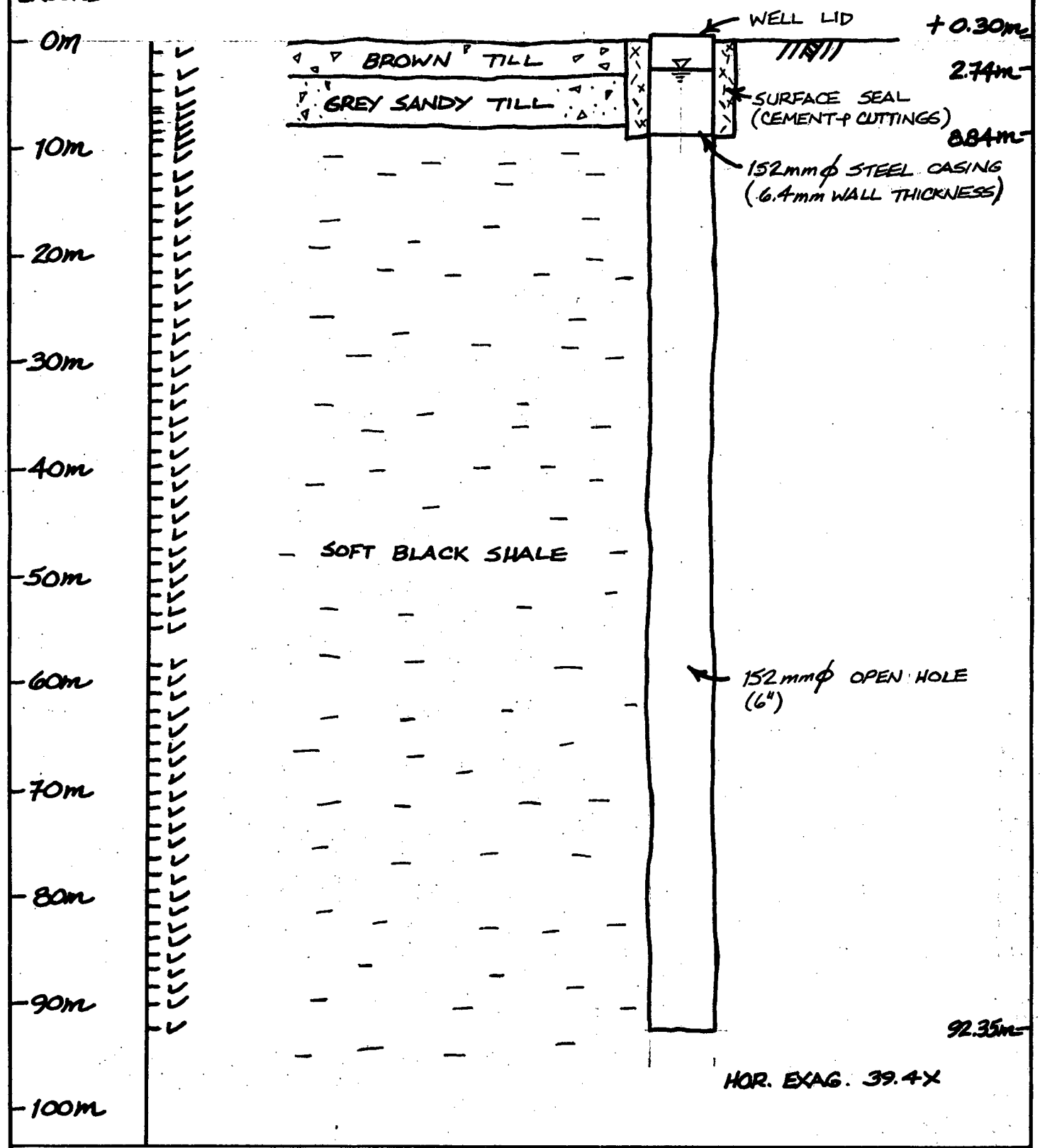

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~~TO ACCOMPANY REPORT ON~~
GEOLOGIC DESCRIPTION & WELL COMPLETION, OBSERVATION WELL NO. 287, COOMBS, B.C.

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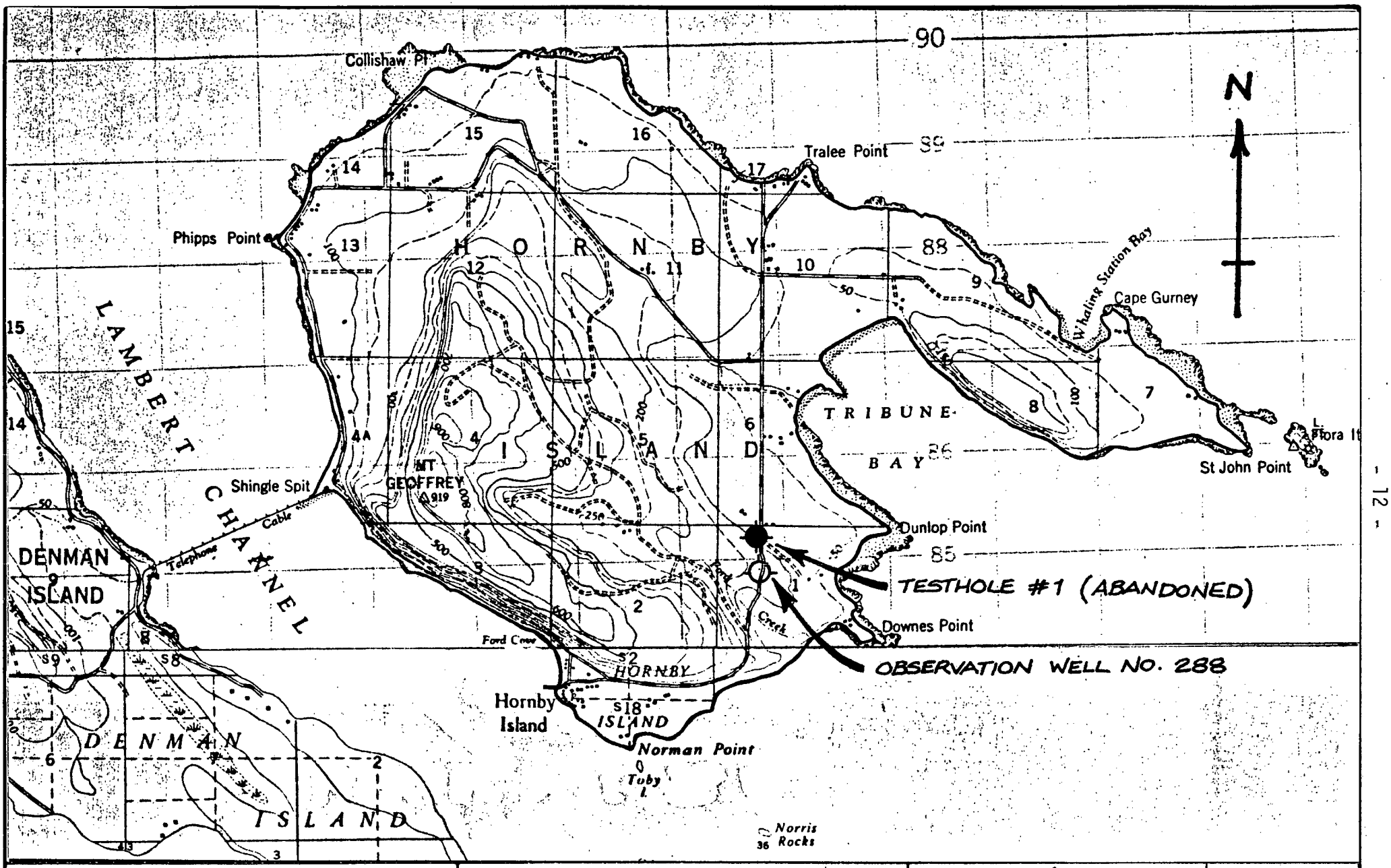
DATE NOV. /84

M. WEI ENGINEER

FILE No. 92F/8,10 DWG. No. FIGURE 4

BCIL 7673-M.E.



Province of British Columbia
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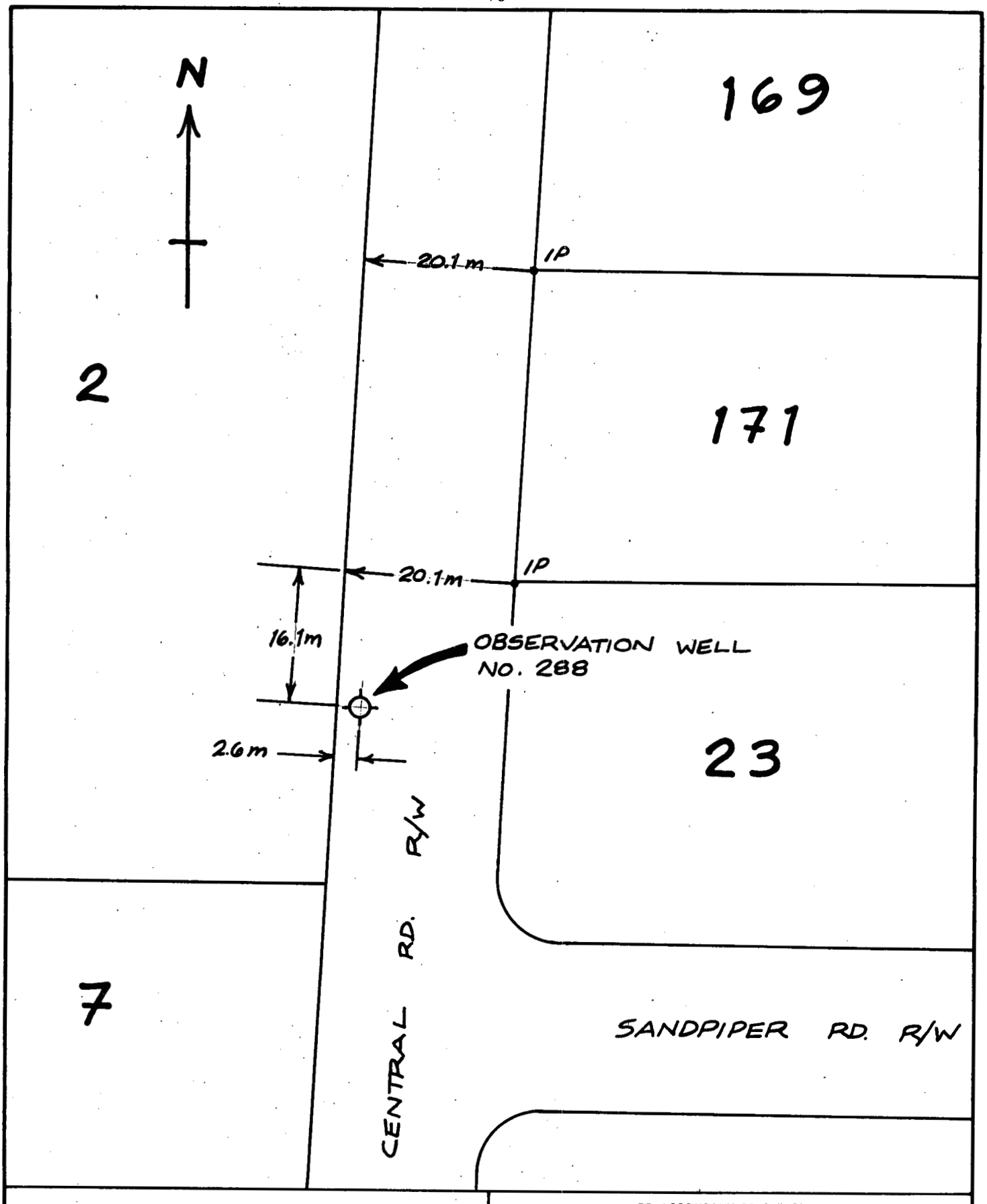
WATER MANAGEMENT BRANCH

~~TO ACCOMPANY REPORT ON~~

LOCATION OF OBSERVATION WELL NO. 288, HORNBY ISLAND, B.C.

SCALE: VERT. N/A	DATE
HOR. 1:50,000	APRIL/84
M. WEI	ENGINEER
FILE No. 92F/8,10	DWG. No. FIGURE 5

VANCAL 8570



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

~~TO ACCOMPANY REPORT ON~~
SITE PLAN,
OBSERVATION WELL NO. 288,
HORNBY ISLAND, B.C.

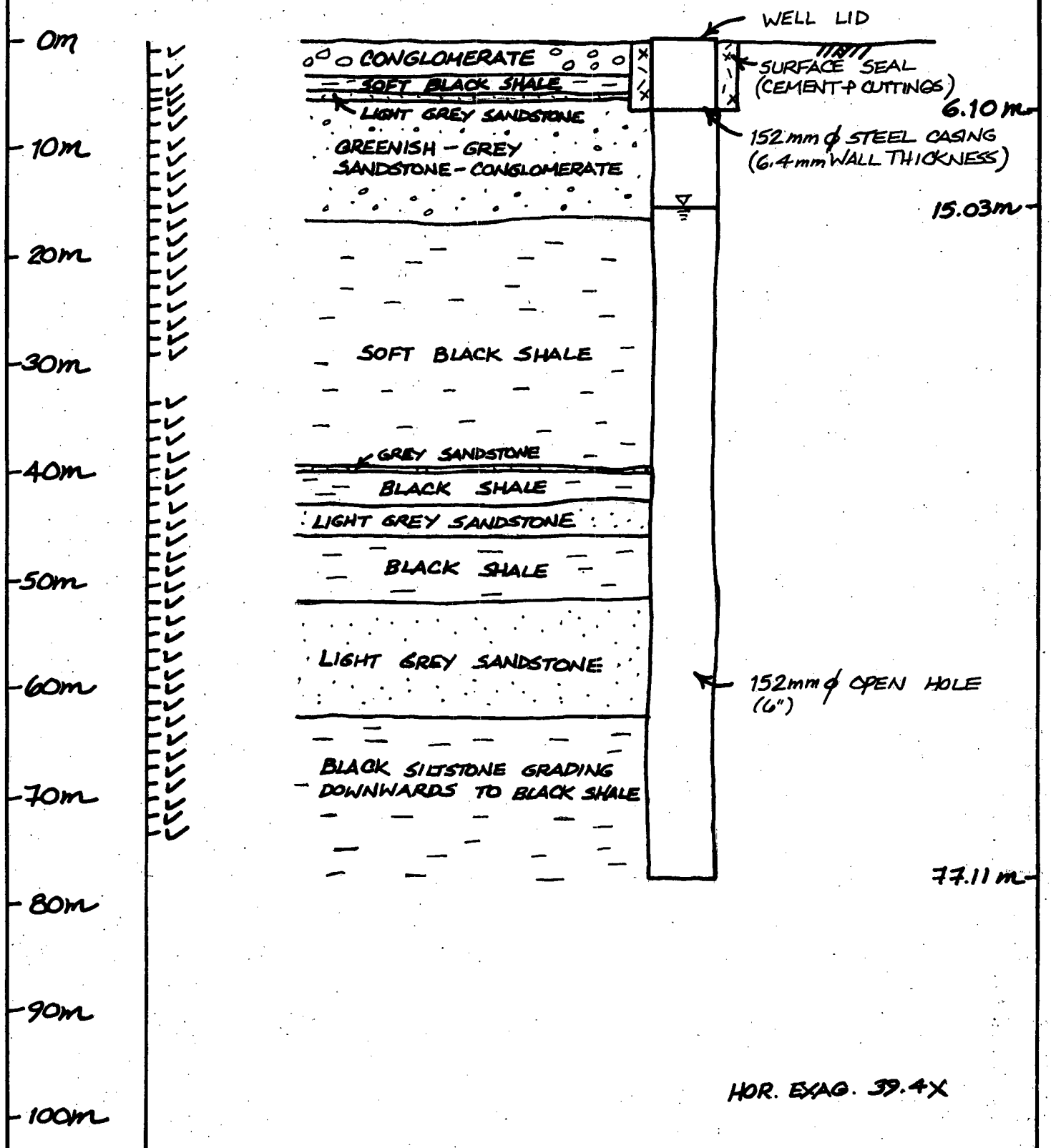
SCALE: VERT. N/A
HOR. 1:600

DATE
APRIL/84

M. WEI
ENGINEER

FILE No. 92F/8,10 DWG. No. FIGURE 6

BCIL 7673-M.E.



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~~TO ACCOMPANY REPORT ON~~
GEOLOGIC DESCRIPTION + WELL COMPLETION, OBSERVATION WELL NO. 288, HORNBY ISLAND, B.C.

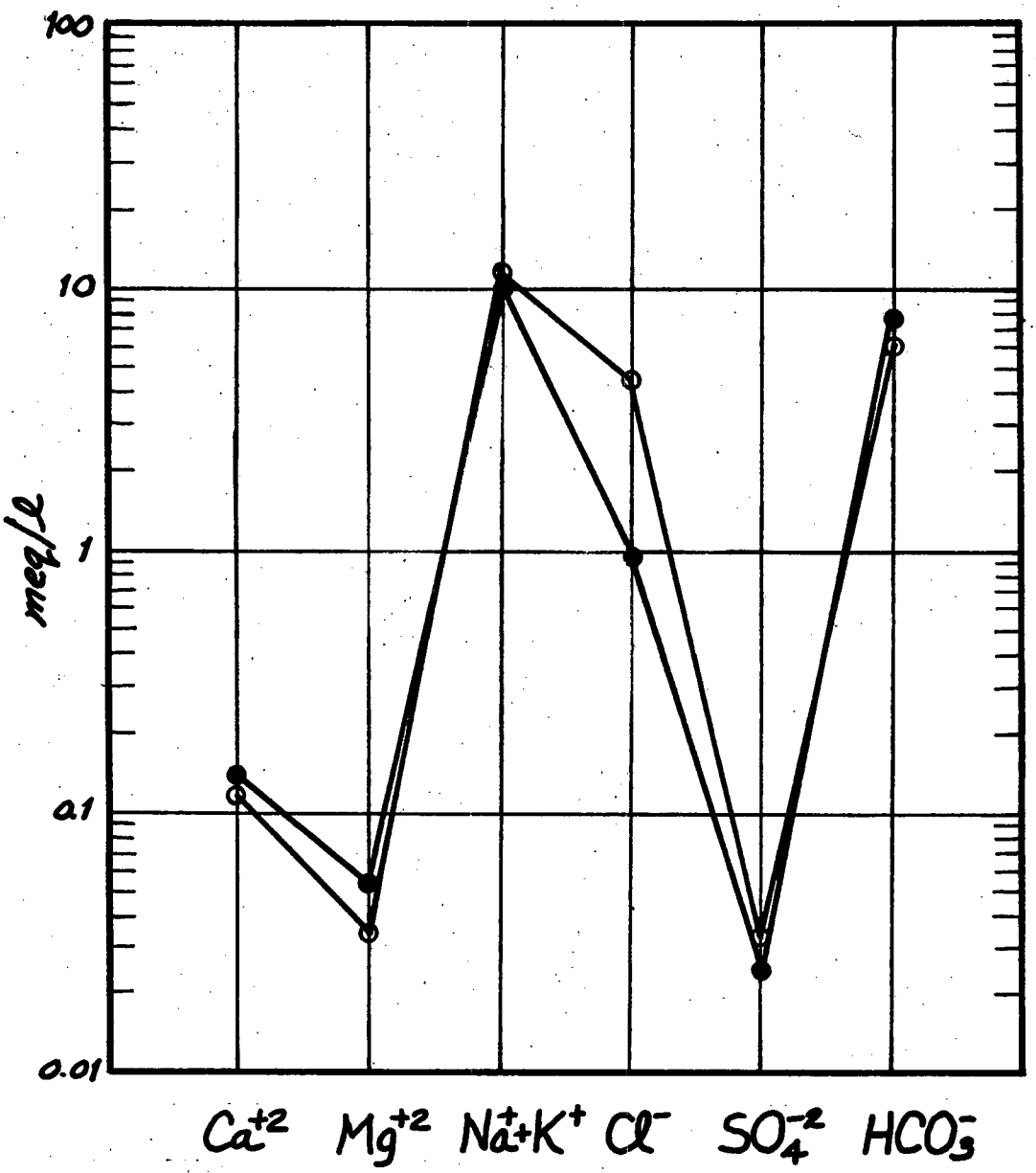
SCALE: VERT. 1:500
HOR. 1:12.7

DATE NOV./84

M. WEI ENGINEER

FILE No. 92F/8,10 DWG. No. FIGURE 7

BCIL 7673-M.E.



● – OBS. WELL NO. 287

⊙ – OBS. WELL NO. 288

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

~~TO ACCOMPANY REPORT ON~~

GENERAL WATER CHEMISTY
PRESENTED ON SCHOELLER DIAGRAM.

SCALE: VERT. N/A
HOR. N/A

DATE NOV./84

M. WEI ENGINEER

FILE No. 92F/8,10 DWG. No. FIGURE 8

BCIL 7673-M.E.

TABLE 1

Well Drilling Summary

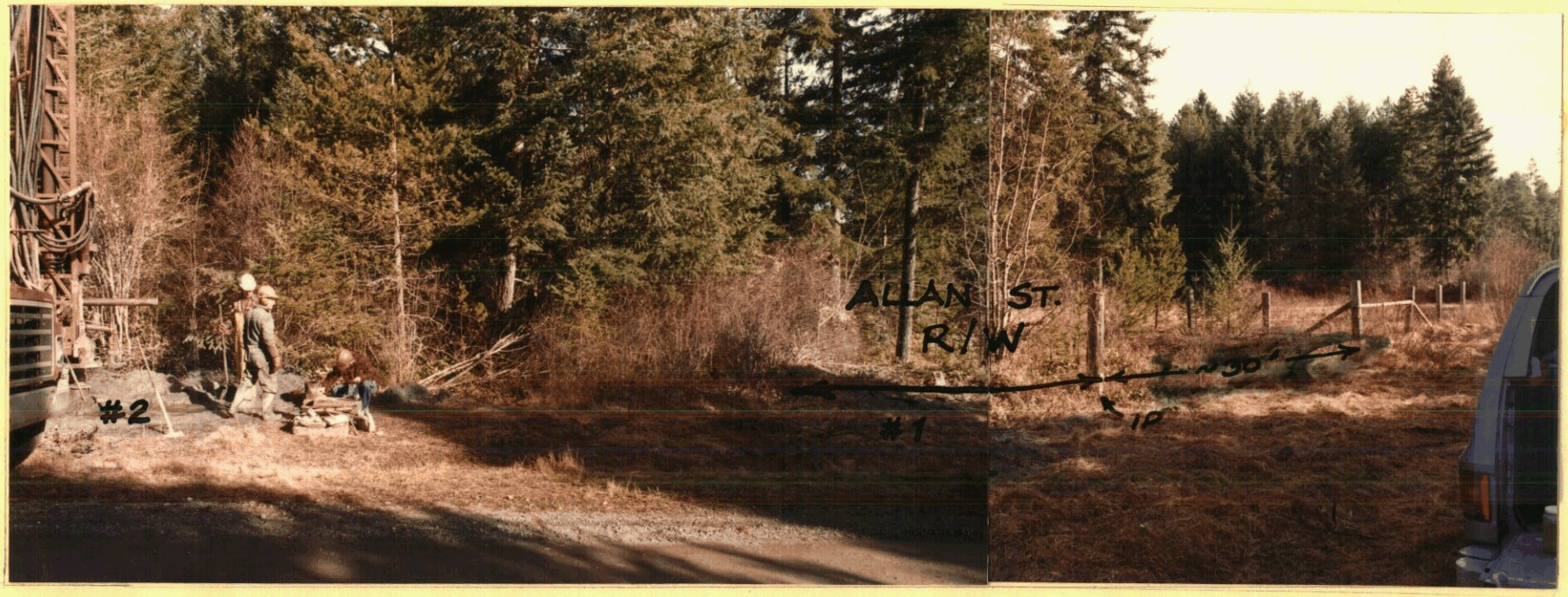
Well	Location	Diameter (mm)	Depth (m)	SWL (m)	Estimated Well Head Elevation (m)	Estimated Yield (L/s)	Status	Estimated Well Bottom Elevation (m)	Estimated Water Level Elevation (m)
Testhole #1	Coombs	254	8.84	-	-	dry	backfilled & abandoned	-	-
Obs. Well No. 287	Coombs	152	92.35	2.74	103	$3(10^{-2})$	in use	11	100
Testhole #1	Hornby Island	152	67.06	-	-	dry	backfilled & abandoned	-	-
Obs. Well No. 288	Hornby Island	152	77.11	15.03	42	$6(10^{-3})$	in use	-35	27

TABLE 2

Water Chemistry Summary

Chemical Parameters	COOMBS		HORNBY ISLAND	
	Observation Well No. 287		Observation Well No. 288	
	Field Analysis	Lab Analysis	Field Analysis	Lab Analysis
Temperature (°C)	9.5		10	
Spec. Conductance (mhos/cm)	710	970	1,600	1,210
pH	10	9.2	10	9.1
TDS		584		710
Hardness	42.8	9.78		7.27
Ca^{+2}		2.83		2.22
Mg^{+2}		0.66		0.42
$Na^{+} + K^{+}$		228 + 1.1		268 + 1.4
Cl^{-}	61	33.7	576	164
SO_4^{-2}		1.2		1.6
HCO_3^{-}		465.8		375.0
Fe	>5.0	0.57	3.5	0.16
Mn		0.02		0.01
F		1.65		1.93
B		0.79		1.46
Ryznar Index		7.7		8.3
SAR Index		32		43

*All parameters are in mg/L except Temperature, Specific Conductance, pH, Ryznar Index and SAR index.



Picture 1. Looking north at site #1 (abandoned TH #1) and 2 (Obs. Well no. 287) with respect to Allan Street right-of-way

Picture 2. Drilling Obs. Well no. 287 at site #2, Coombs

Picture 3. Estimating yield

Picture 4. Grouting the surface seal

Picture 5. Pulling out the 254 mm (10") Ø surface casing

Picture 6. Constructing the well lid

Picture 7. The completed Obs. Well no. 287

Picture 8. Looking south at site #1, Hornby Island

Picture 9. Drilling testhole #1 at site #1

Picture 10. Pulling out 152 mm (6") Ø surface casing and abandoning testhole #1

Picture 11. Looking south at site #2, Hornby Island

Picture 12. Drilling Obs. Well no. 288 at site #2, Hornby Island

Picture 13. Mixing cement for grouting surface seal

Picture 14. Grouting surface seal

Picture 15. Constructing the well lid

Picture 16. Obs. Well no. 287, Coombs

Picture 17. Obs. Well no. 288, Hornby Island

Appendix A

Well Log Files

[redacted] W [redacted] N [redacted] 28 [redacted]

WATER WELL RECORD

DEPT. OF ENVIRONMENT, WATER RESOURCES SERVICE, WATER INVESTIGATIONS BRANCH VICTORIA, BRITISH COLUMBIA

Z [ ] [ ] WELL NO. [ ] [ ]

LEGAL DESCRIPTION: LOT ADJACENT TO 14 SEC. ____ TP. ____ R. ____ D.L. ____ LAND DISTRICT NANOOSE PLAN 1939

DESCRIPTIVE LOCATION BURGOYNE RD. RIGHT-OF-WAY COOMBS, B.C. LICENCE NO. ____ DATE ____

Z ____ X 2 Y 7 NO. 26

OWNER'S NAME MINISTRY OF ENVIRONMENT - GROUNDWATER SECTION ADDRESS 4TH FL - 765 BROUGHTON ST. - VICTORIA, B.C.

DRILLER'S NAME ISLAND WELL DRILLING ADDRESS R.R. 1 LADYSMITH, B.C. DATE COMPLETED MAR 6/84

NAT. TOPO. SHEET NO. 92 F/8

DEPTH 303' ELEVATION OF ____ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 6" LENGTH 29'

METHOD OF CONSTRUCTION AIR-ROTARY CASING DIAM ____ LENGTH ____

SCREEN LOCATION ____ 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 9' ☐ ESTIMATED WATER LEVEL

FROM GROUND LEVEL ☐ MEASURED ELEVATION ____ ARTESIAN PRESSURE ____

DATE OF WATER LEVEL MEASUREMENT MAR. 12/84 WATER USE OBSERVATION WELL (#287)

PRODUCTION TEST SUMMARY

DATE ____

TEST BY ____

BAIL TEST ☐ PUMP TEST ☐ DURATION OF TEST ____

RATE ____ DRAWDOWN ____

WATER LEVEL AT COMPLETION OF TEST ____

AVAILABLE DRAWDOWN ____ SPECIFIC CAPACITY ____

PERMEABILITY ____ STORAGE COEFF. ____

TRANSMISSIVITY ____

RECOMMENDED PUMPING RATE ____

RECOMMENDED PUMP SETTING ____

CHEMISTRY

TEST BY ENVIRONMENTAL LABORATORY - VANCOUVER 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. 1401952

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 ____

LITHOLOGY

FROM	TO	DESCRIPTION
0	10'	BROWN TILL
10	27	GREY TILL
27	303	BLACK SHALE

28

OBS. WELL NO. 288

WATER WELL RECORD

DEPT. OF ENVIRONMENT, WATER RESOURCES SERVICE, WATER INVESTIGATIONS BRANCH VICTORIA, BRITISH COLUMBIA

Z [ ] [ ] WELL NO. [ ] [ ] [ ] [ ] [ ] [ ]

[ ] [ ] [ ] [ ] [ ] [ ] [ ]

Z X Y NO.

LEGAL DESCRIPTION: LOT 2 (ADJACENT TO) SEC. 1 TP. ____ R. ____ D.L. ____ LAND DISTRICT NANAIMO PLAN 26598

DESCRIPTIVE LOCATION CENTRAL RD. R/W - HORNBY ISLAND LICENCE NO. ____ DATE ____

OWNER'S NAME MINISTRY OF ENVIRONMENT - GROUNDWATER SECTION ADDRESS 4TH FL - 765 BROUGHTON ST. - VICTORIA, B.C.

DRILLER'S NAME ISLAND WELL DRILLING ADDRESS R.R. 1 LADYSMITH, B.C. DATE COMPLETED MAR. 9/84

NAT. TOPO. SHEET NO. 92 F/10

NANAIMO SHEET 5 SEC. 1 #6

DEPTH 253' ELEVATION OF ____ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 6" LENGTH 20'

METHOD OF CONSTRUCTION AIR ROTARY CASING DIAM ____ LENGTH ____

SCREEN LOCATION ____ 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 15.03M ☐ ESTIMATED WATER LEVEL

FROM GROUND LEVEL ☐ MEASURED ELEVATION ____ ARTESIAN PRESSURE ____

DATE OF WATER LEVEL MEASUREMENT MAR. 13/84 WATER USE OBSERVATION WELL NO. 288

PRODUCTION TEST SUMMARY

DATE MAR. 8/84

TEST BY AIR - BLOWN

BAIL TEST ☐ PUMP TEST ☐ DURATION OF TEST ____

RATE ~5 G.P.M. DRAWDOWN ____

WATER LEVEL AT COMPLETION OF TEST ____

AVAILABLE DRAWDOWN ____ SPECIFIC CAPACITY ____

PERMEABILITY ____ STORAGE COEFF. ____

TRANSMISSIVITY ____

RECOMMENDED PUMPING RATE ____

RECOMMENDED PUMP SETTING ____

CHEMISTRY

TEST BY ENVIRONMENTAL LABORATORY - VANCOUVER DATE MAR. 13, 1984

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. 1401953

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

LITHOLOGY

FROM	TO	DESCRIPTION
0	10'	CONGLOMERATE
10	15	SOFT BLK SHALE
15	20	LT. GRAY SANDSTONE
20	55	CONGLOMERATE
55	125	BLK. SHALE
125	130	GRAY SANDSTONE & SHALE
130	140	BLK. SHALE
140	150	LT GRAY SANDSTONE
150	170	BLK SHALE
170	205	LT GRAY SANDSTONE
205	253	BLK. SHALE

-20-

Appendix B

Contract Costs

ephone: 245-2078

FREE ESTIMATES

ISLAND WELL DRILLING

Water Well Drilling Contractor

W. J. WILLIAMS, OWNER-OPERATOR — GROUHEL ROAD, R.R. 1, LADYSMITH, B.C.

Province of B.C.,
Water Management Branch,
Ministry of Enviroment,
Parliament Buildings,
Victoria, B.C. V8V IX5

March 14, 1984

Re:Contract No. 75

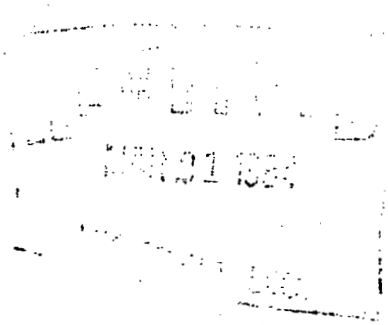
File 92. F/B 10

Item:	Unit Price	Quanity	Cost	
1. Mob.& Demob.	$200.00	1	$ 200.00	✓
2. Move Btwn sites at Coombs	-	1	-	
3. Move Coombs to Hornby Is.	-	1	-	
4. 10" Cased Drilling	30.00/ft.	82'	2460.00	✓
13. 10" refund casing	15.00/ft.	82	-1230.00	✓
6. 6" Overlap easing	7.00/ft.	57.5'	402.50	✓
7. 6" Drilling	8.00/ft.	723'	5784.00	✓
12. Hourly work	80.00/hr.	3.5hrs.	280.00	✓
15. 6" Refundcasing	5.00/ft.	7.5ft.	~~- 38.50~~ → 37.50 mN	✓
16. 6" Cap & Fittings	20.00/cap	2	40.00	✓
17. Standby	50.00/hr.	1.1 hr.	55.00	✓
5Bags Cement	8.00/bag	5	~~40.00~~ → 42.17 mN.	✓

m.N. 3

Total of Items 1,4,6,7,12,16,17 &Cement ---------	$ 9261.50	$9,263.67
Minus Total of Items 13 & 15 ----------	1268.50	$1,267.50
Amount Due	$ 7993.00	$7,996.17 mN

WATER MANAGEMENT BRANCH
GOODS/SERVICES RECEIVED
ON March 9, 1984
CHARGE TO 32-48-214-05431-2001
SIGNATURE Mike Wei
DATE March 27, 1984



Appendix C

Water Chemistry Reports

MAY 3, 1984 ENVIRONMENTAL LABORATORY PAGE 1
MINISTRY OF THE ENVIRONMENT

MAY - 9 1984

WATER QUALITY REPORT FOR SAMPLE 317340W

TO: INVENTORY & ENGIN. BR.
765 BROUGHTON 4TH FLOOR
VICTORIA, B.C.
ATTENTION OF: D KALYN

FOR SITE: 1401952 COOMBS OBS WELL NO.287

SAMPLING DATE(S): MAR 12/84 1600 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 20
SAMPLED BY: GROUNDWATER SECTION
CHARGE TO: WATER PGM (VICTORIA)
DATE PROCESSED TO COMPUTER: MAR 14/84

0040103	PH	9.2 REL UNIT	0071701	RES:FILT.105C	584. MG/L
0110101	SPECIFIC CONDUC	970. UMHO/CM	1010105	ALKALINITY:PHNL	39.1 MG/L
1020106	ALKALINITY:TOT	460. MG/L	1041702	CHLORIDE	33.7 MG/L
1061701	FLUORIDE	1.65 MG/L	1070002	HARDNES,T:CACO3	9.78 MG/L
1091703	NITROGN:NO2 NO3	0.02 MG/L	1130105	NITROGN:KJELDAH	0.85 MG/L
1191703	PHOSPHORUS :TOT DISSOLVED	0.024 MG/L	1201702	SILICA:REACTIVE	5.3 MG/L
1211703	SULPHATE	1.2 MG/L	2641703	POTASSIUM DISSOLVED	1.1 MG/L
2651703	SODIUM DISSOLVED	228. MG/L			

FOLLOWING ARE PACKAGE TESTS:

2510214	ARSENIC TOTAL	L 0.25 MG/L	2511413	ARSENIC DISSOLVED	L 0.25 MG/L
2521413	BORON DISSOLVED	0.79 MG/L	2530214	CADMIUM TOTAL	L 0.01 MG/L
2531413	CADMIUM DISSOLVED	L 0.01 MG/L	2540214	CALCIUM TOTAL	3.78 MG/L
2541413	CALCIUM DISSOLVED	2.83 MG/L	2550214	CHROMIUM TOTAL	0.02 MG/L

SAMPLE NO. 317340W CONTINUED ON NEXT PAGE.

MAY 3, 1984 ENVIRONMENTAL LABORATORY PAGE 1
MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 317338W

TO: INVENTORY & ENGIN. BR.
765 BROUGHTON 4TH FLOOR
VICTORIA, B.C.
ATTENTION OF: D KALYN

FOR SITE: 1401953 HORNBY I. OBS WELL NO.288

SAMPLING DATE(S): MAR 13/84 1400 HRS
SAMPLE TYPE: FRESH WATER
SAMPLING DEPTH: 30
SAMPLED BY: GROUNDWATER SECTION
CHARGE TO: WATER PGM (VICTORIA)
DATE PROCESSED TO COMPUTER: MAR 14/84

0040103	PH	9.1 REL UNIT	0071701	RES:FILT.105C	710. MG/L
0110101	SPECIFIC CONDUC	1210. UMHO/CM	1010105	ALKALINITY:PHNL	27.3 MG/L
1020106	ALKALINITY:TOT	362. MG/L	1041702	CHLORIDE	164. MG/L
1061704	FLUORIDE	1.93 MG/L	1070002	HARDNES.T:CACO3	7.27* MG/L
1091703	NITROGN:NO2 NO3	L 0.02* MG/L	1130105	NITROGN:KJELDAH	0.82 MG/L
1191703	PHOSPHORUS :TOT DISSOLVED	0.219 MG/L	1201702	SILICA:REACTIVE	7.9 MG/L
1211703	SULPHATE	1.6 MG/L	2641703	POTASSIUM DISSOLVED	1.4 MG/L
2651703	SODIUM DISSOLVED	268. MG/L			

FOLLOWING ARE PACKAGE TESTS:

2510214	ARSENIC TOTAL	L 0.25 MG/L	2511413	ARSENIC DISSOLVED	L 0.25 MG/L
2521413	BORON DISSOLVED	1.46 MG/L	2530214	CADMIUM TOTAL	L 0.01 MG/L
2531413	CADMIUM DISSOLVED	L 0.01 MG/L	2540214	CALCIUM TOTAL	6.24 MG/L
2541413	CALCIUM DISSOLVED	2.22* MG/L	2550214	CHROMIUM TOTAL	0.05 MG/L

SAMPLE NO. 317338W CONTINUED ON NEXT PAGE.

MAY 3, 1984 ENVIRONMENTAL LABORATORY PAGE 2
MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 317340W

2551413	CHROMIUM DISSOLVED	L 0.01 MG/L	2560214	COPPER TOTAL	0.03 MG/L
2561413	COPPER DISSOLVED	0.03 MG/L	2570214	IRON TOTAL	10.9 MG/L
2571413	IRON DISSOLVED	0.57 MG/L	2580214	LEAD TOTAL	L 0.1 MG/L
2581413	LEAD DISSOLVED	L 0.1 MG/L	2590214	MAGNESIUM TOTAL	2.03* MG/L
2591413	MAGNESIUM DISSOLVED	0.66 MG/L	2600214	MANGANESE TOTAL	0.17 MG/L
2601413	MANGANESE DISSOLVED	0.02 MG/L	2620214	MOLYBDENUM TOTAL	L 0.01 MG/L
2621413	MOLYBDENUM DISSOLVED	L 0.01 MG/L	2630214	NICKEL TOTAL	L 0.05 MG/L
2631413	NICKEL DISSOLVED	L 0.05 MG/L	2660214	ZINC TOTAL	0.03 MG/L
2661413	ZINC DISSOLVED	L 0.01 MG/L	2670214	ALUMINUM TOTAL	3.33 MG/L
2671413	ALUMINUM DISSOLVED	0.36 MG/L	2680214	COBALT TOTAL	L 0.1 MG/L
2681413	COBALT DISSOLVED	L 0.1 MG/L	2701413	BARIUM DISSOLVED	0.07 MG/L
2720214	VANADIUM TOTAL	0.01 MG/L	2721413	VANADIUM DISSOLVED	L 0.01 MG/L

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 193.20

REMARKS:

FOR ENVIRONMENTAL LABORATORY

MAY 3, 1984 ENVIRONMENTAL LABORATORY PAGE 2
MINISTRY OF THE ENVIRONMENT

WATER QUALITY REPORT FOR SAMPLE 317338W

2551413	CHROMIUM DISSOLVED	L 0.01 MG/L	2560214	COPPER TOTAL	0.05 MG/L
2561413	COPPER DISSOLVED	L 0.01 MG/L	2570214	IRON TOTAL	27.4 MG/L
2571413	IRON DISSOLVED	0.16 MG/L	2580214	LEAD TOTAL	L 0.1 MG/L
2581413	LEAD DISSOLVED	L 0.1 MG/L	2590214	MAGNESIUM TOTAL	8.03* MG/L
2591413	MAGNESIUM DISSOLVED	0.42 MG/L	2600214	MANGANESE TOTAL	0.35 MG/L
2601413	MANGANESE DISSOLVED	0.01 MG/L	2620214	MOLYBDENUM TOTAL	0.02 MG/L
2621413	MOLYBDENUM DISSOLVED	L 0.01 MG/L	2630214	NICKEL TOTAL	L 0.05 MG/L
2631413	NICKEL DISSOLVED	L 0.05 MG/L	2660214	ZINC TOTAL	0.07 MG/L
2661413	ZINC DISSOLVED	0.02 MG/L	2670214	ALUMINUM TOTAL	18.4 MG/L
2671413	ALUMINUM DISSOLVED	0.19 MG/L	2680214	COBALT TOTAL	L 0.1 MG/L
2681413	COBALT DISSOLVED	L 0.1 MG/L	2701413	BARIUM DISSOLVED	0.07 MG/L
2720214	VANADIUM TOTAL	0.07 MG/L	2721413	VANADIUM DISSOLVED	L 0.01 MG/L

THE APPROXIMATE COST OF THE ABOVE TESTS IS $ 187.20

REMARKS:

FOR ENVIRONMENTAL LABORATORY

Appendix D

Water Level Recorder Installation Specifications

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

MEMORANDUM

To: W.S. Hodge
Senior Technician
Groundwater Section
Water Management Branch

Date: April 12, 1984

File: 0183613-B-287

Re: Establishment of Observation Well #287, Coombs

Introduction

On Monday, March 12, 1984 an automatic water level recorder was installed on the recently drilled observation well in Coombs. This well along with another observation well on Hornby Island was drilled under Government Contract No. 75 - "Drilling, Construction and Testing of Groundwater Observation Wells at Coombs and Hornby Island, B.C."

The purpose of establishing this observation well was to monitor long-term water level fluctuations in the aquifer. Most drilled wells in this area report low well yields and poor water quality (mainly hydrogen sulphide problems). Coombs area residents rely solely on groundwater for their water requirements.

Well Location

The well is located within the Burgoyne Road right-of-way adjacent to Lot 14, Block 5, Plan 1939 (Figures 1 and 2). Attached to this memorandum is a copy of "Permission to Construct Works Within Crown Lands" which has been approved by the Ministry of Transportation and Highways.

Well Drilling and Testing Details

Date Drilled	March 5-6, 1984
Depth of Well	92.3 metres (303 feet)
Diameter of Well	152 mm (6-inch)
Aquifer Material	Shale
Static Water Level	2.77 m (March 12, 1984)
Well Yield	Approx. 1/2 gpm
Drilling Contractor	Island Well Drilling - Red Williams

Equipment on Site

1 steel recorder housing
1 152 mm diameter steel casing extension (1.2 m length)
1 101 mm diameter weight drive pipe
1 wood recorder stand with painter
1 8 kg lead clock drive weight
1 127 mm diameter float
1 12 metre graduated float tape

WM
AK
MW

W.S. Hodge April 12, 1984

1 metric Stevens water level recorder (RG 30) with Chelsea clock (C6 59) with 2:1 gage scale
1 6 ounce counterweight
2 clips
1 Viro lock

The recorder housing and standpipes were painted dark green and a Ministry of Environment identification label and number (287) was attached to the housing.

Ground Level Datum Measurements

Static water level to pointer ..... 4.279 metres
Ground level (concrete pad) to pointer ..... 1.510 metres
Tape reading ..... 1.956 metres

The correction factor to be applied to the tape reading is therefore +0.813 metres.

Observer

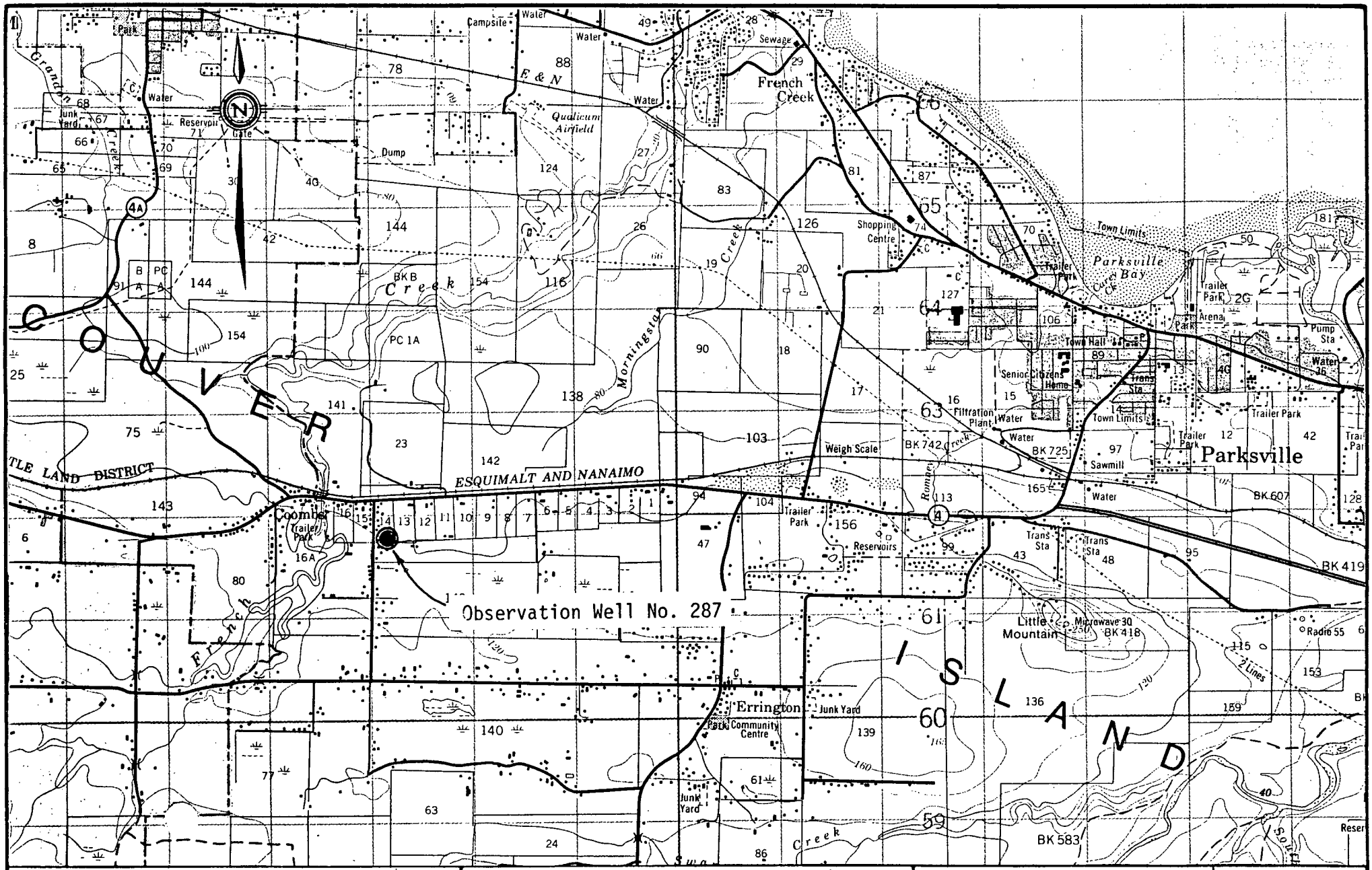
Mrs. Sharon Etty
Highways Maintenance Yard
Box 249
Parksville, B.C.
V0R 2S0 Telephone: 248-6212

Mrs. Etty works for the Ministry of Transportation and Highways in Parksville and has agreed to change the recorder charts monthly and send them directly to the Ministry of Environment regional office in Nanaimo. There will be NO charge for this service.

Dave Kalyn

Dave Kalyn
Technician
Groundwater Section
Water Management Branch
387-1115

DK/dma



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

TO ACCOMPANY REPORT ON

Coombs Observation Well No. 287

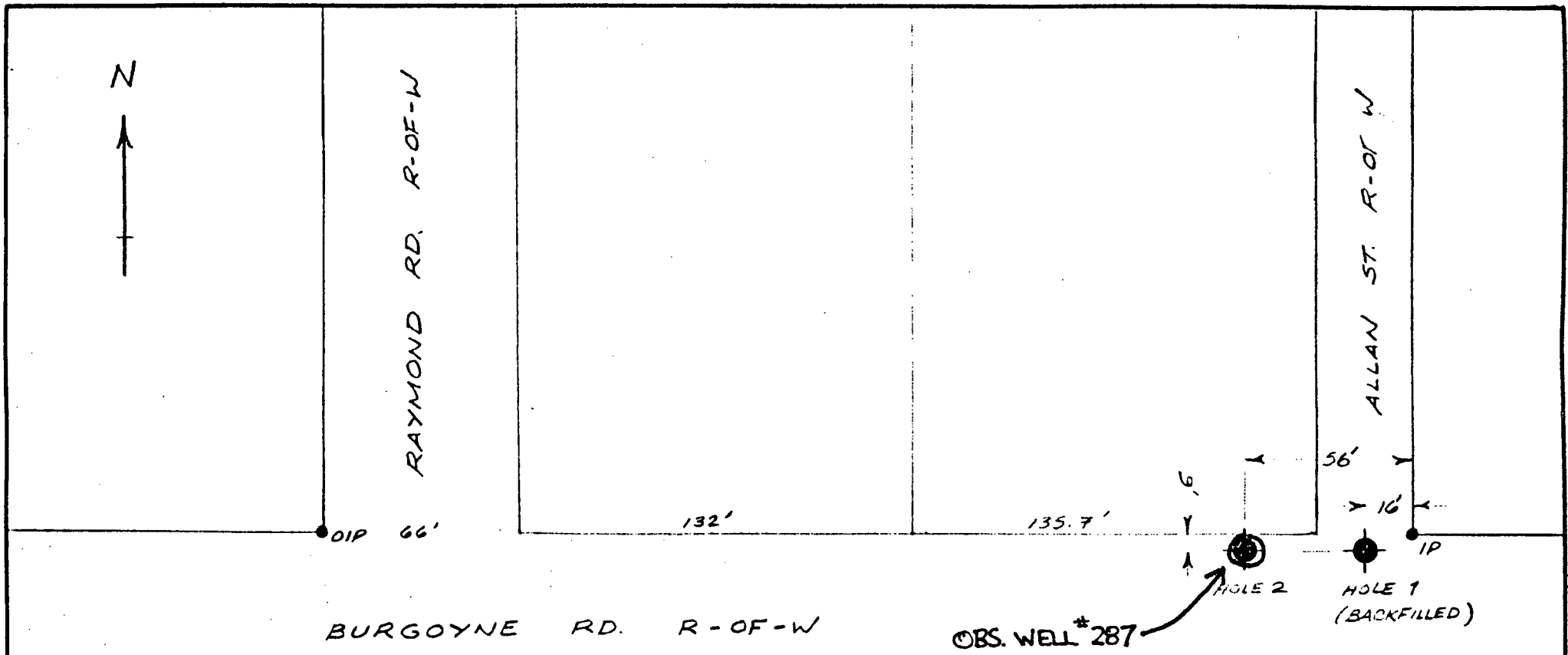
SCALE: ~~VERT.~~ 1:50,000
~~HOR.~~

DATE March, 1984

M. Wei ENGINEER

FILE No. 0183613-B-287 DWG. No. 1

VANCAL 8570



LOCATION OF HOLES 1 + 2, COOMBS, B.C.

Province of British Columbia
Ministry of the Environment
ENVIRONMENTAL AND ENGINEERING SERVICE
WATER INVESTIGATIONS BRANCH

TO ACCOMPANY REPORT ON
COOMBS - OBSERVATION WELL
NO. 287

SCALE: VERT. N/A
HOR. 1" = 50'

DATE
MARCH/84

M. WEI
ENGINEER

FILE No. 92F/8
DWG. No. FIGURE 2

bcil 6661 wrs

Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

MEMORANDUM

To: W.S. Hodge
Senior Technician
Groundwater Section
Water Management Branch

Date: April 12, 1984
File: 0183613-B-288

Re: Establishment of Observation Well #288, Hornby Island

Introduction

On Tuesday, March 13, 1984 an automatic water level recorder was installed on the recently drilled observation well on Hornby Island. This well along with another observation well in Coombs was drilled under Government Contract No. 75 - "Drilling, Construction and Testing of Groundwater Observation Wells at Coombs and Hornby Island, B.C."

The purpose of establishing this observation well is to monitor long-term water level fluctuations in the aquifer. Many of the nearby drilled wells in this area (~~Tribune Bay~~) report poor water quality and low well yields. Some well owners have also reported salt water in their wells. Well density is very high in this area and residents are very concerned about the quality and quantity of groundwater, as it is their sole source of water.

Well Location

Observation well #288 is located within the Central Road right-of-way adjacent to Lot 2, Section 1, Plan 26598, Hornby Island (Figures 1 and 2). Attached to this memorandum is a copy of "Permission to Construct Works Within Crown Lands" which has been approved by the Ministry of Transportation and Highways.

Well Drilling and Testing Details

Date Drilled	March 8-9, 1984
Depth of Well	77.1 metres (253 feet)
Diameter of Well	152 mm (6-inch)
Aquifer Material	Shale
Static Water Level	15.031 m (March 13, 1984)
Well Yield	Approx. 5 gallons per hour
Drilling Contractor	Island Well Drilling - Red Williams

Equipment on Site

1 steel recorder housing
1 152 mm diameter steel casing extension (1.2 m length)
1 101 mm diameter weight drive pipe
1 wood recorder stand with pointer
1 8 kg lead clock drive weight
1 127 mm diameter float
1 12 metre graduated float tape

W-372

W.S. Hodge April 12, 1984

1 metric Stevens water level recorder (RG 38) with Chelsea clock (CG 43) with 2:1 gage scale
1 6 ounce counterweight
2 clips
1 Viro lock

The recorder housing and standpipes were painted dark green and a Ministry of Environment identification label and number (288) was attached to the housing.

Ground Level Datum Measurements

Static water level to pointer ..... 16.681 metres
Ground level* to pointer ..... 1.650 metres
Tape reading ..... 3.229 metres

*Ground level is 0.300 m below bottom of slip-on sleeve.

The correction factor to be applied to the tape reading is therefore +11.802 metres.

Observer

Mr. Gordon Batement
Highways Maintenance Yard
General Delivery
Hornby Island, B.C.
V0R 1Z0

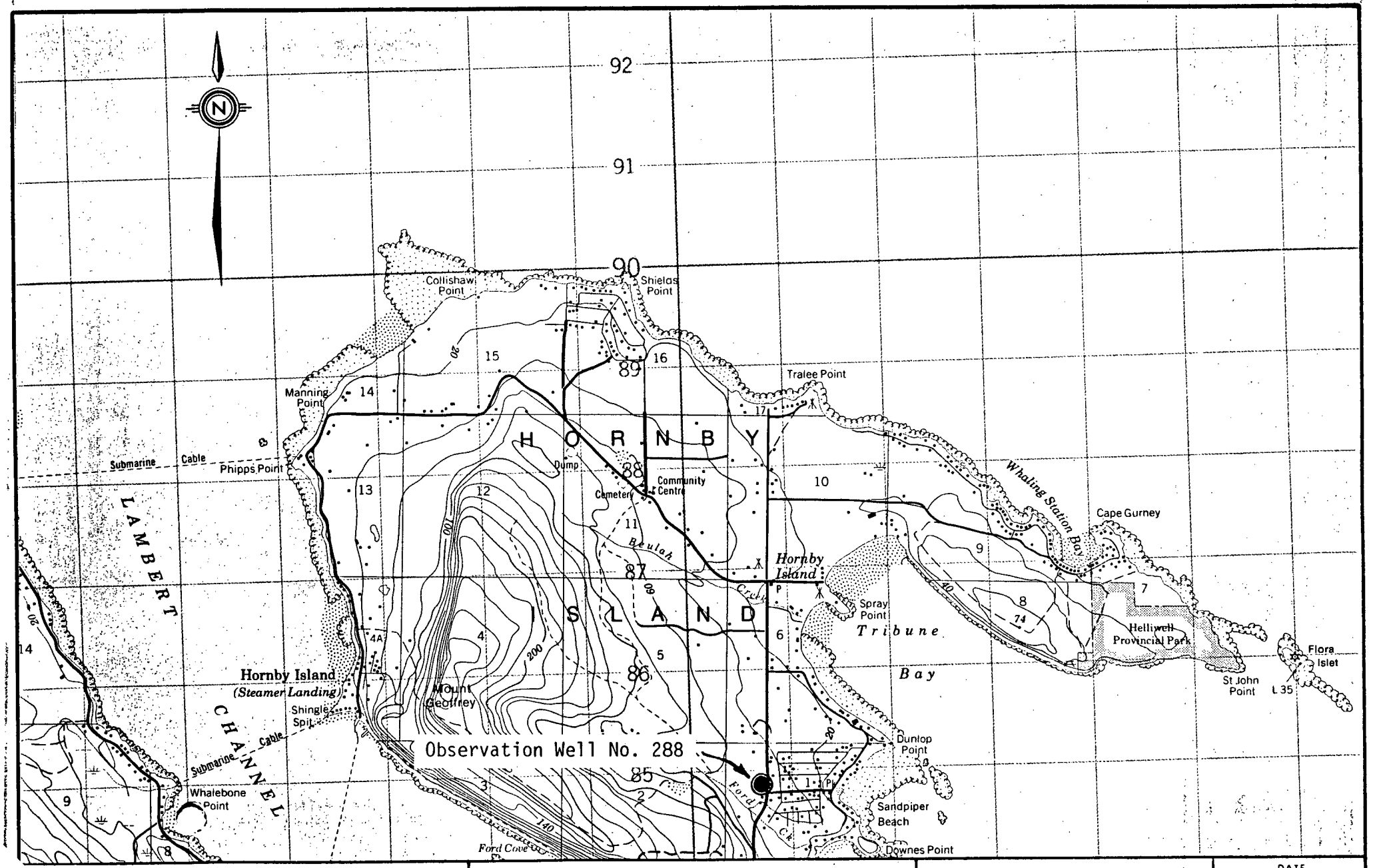
Telephone: 335-2722 (Yard)
335-0227 (Home)

Mr. Bateman works for the Ministry of Transportation and Highways on Hornby Island and has agreed to change the recorder charts on the Denman Island observation well (#268). These charts will be mailed directly to the Ministry of Environment regional office in Nanaimo and there will be NO charge for this service.

Dave Kalyn

Dave Kalyn
Technician
Groundwater Section
Water Management Branch
387-1115

DK/dma



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

~~TO ACCOMPANY REPORT ON~~

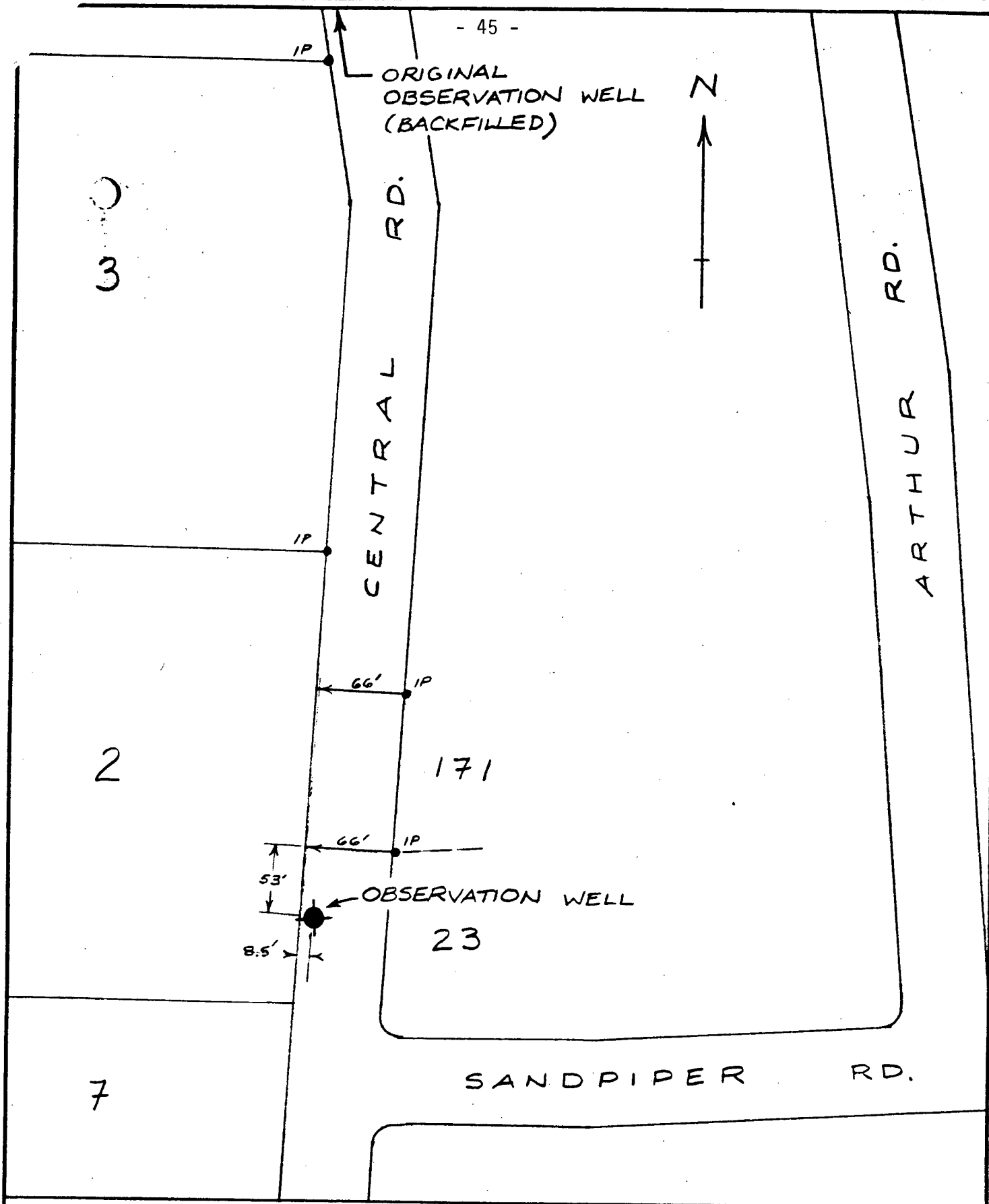
Observation Well No. 288
Hornby Island

SCALE: ~~VERT~~ 1:50,000
~~HOR~~

DATE March 1984

M. Wei ENGINEER

FILE No. 0183613-B-288 DWG. No. 1



Province of British Columbia
Ministry of Environment
WATER MANAGEMENT BRANCH

~~TO ACCOMPANY REPORT ON~~
LOCATION OF HORNBY ISLAND OBSERVATION WELL

SCALE: VERT. N/A
HOR. 1" = 100'

DATE MARCH 12/84

M. WEI ENGINEER

FILE No. 92F/10 DWG. No. FIGURE 2

BCIL 7873-M.E.