No.

Republic of Mauritius
Mauritius Wastewater Management Authority

Republic of Mauritius
Technical Assistance
for
Grand Baie Sewerage Project Phase 1-B

Final Report
Volume3: Report of Geological Survey

March 2011

Japan International Cooperation Agency (JICA)

NIPPON KOEI CO.,LTD. (NK)

AFD
CR (3)
11-004

Republic of Mauritius
Mauritius Wastewater Management Authority

Republic of Mauritius
Technical Assistance
for
Grand Baie Sewerage Project Phase 1-B

Final Report
Volume3: Report of Geological Survey

March 2011

Japan International Cooperation Agency (JICA)

NIPPON KOEI CO.,LTD. (NK)

1. REPORT OF GEOLOGICAL SURVEY

(Pumping Station)

FACTUAL REPORT ON GEOLOGICAL SURVEY OF PUMPING STATIONS AT GRAND BAIE

Prepared for
Nippon Koei Co Ltd

Prepared by
Water Research Co Limited

March 2011
OPG 110056 NIP

Revision	Description	Issued by	Date
0	Issued for comments	CD/ES/ NC	7th March 2011
1	Final Issue	CD/ES/ NC	18th March 2011

Produced	**Nazila Choolun**
	Cecile Dejean
Signature	
Date	**18th March 2011**
Checked	**Emilio Saldivar**
Signature	
Date	**18th March 2011**

Contents

1 Introduction

1.1 Introduction

On 25th January 2011, Water Research Co Limited (Water Research) was instructed by the Japan International Coorperation Agency - JICA (Client) to carry out an Injection Well (Borehole) and Geological (Corehole) Surveys to support the evaluation of the Grand Baie Sewerage Project by the Wastewater Management Authority (WMA). The Study Team appointed by the Client is Nippon Koei Ltd and the local representative is Luxconsult Co. Ltd. The Injection Well Survey is carried out to evaluate the disposal capacity of wells; the Geological Survey is being carried out to support the design of foundations for the pumping stations.

1.2 Scope of works and Report format

The Injection Well Survey works consist of the drilling of 2No boreholes, permeability testing, ground water level measurement as on-site works and water quality testing, geological logging and factual reporting as off-site works. The Geological Survey works consist of the drilling of 8No. coreholes, standard penetration tests (SPT), ground water level measurement as on-site works and water quality, unconfined compressive strength (UCS) tests and factual reporting.

2 Desk study information

2.1 Site location and topography

The locations of the 8No. Coreholes are distributed in the region around the Grand Baie Treatment Plant, namely at Petit Raffray, The Vale, Pereybere, Cap Malheureux and Sottise as follows:

1. Coreholes CH 4 and CH 5 are located at Petit Raffray, along the Union Branch Road with elevations varying between 20m and 40m amsl.
2. Coreholes CH 6 and CH 7 are located at the Vale, along the Vale Road and the Plaines Des Papayes Road with elevations varying between 30m and 40m amsl.
3. Coreholes CH 1 and CH 2 are located at Pereybere. CH 1 is located along the access road from the Vingt Pieds B45 Road to the B38 Pointe aux Piments-Mon Choisy Coast Road and CH 2 is located along the Vingt Pieds Road respectively with elevations varying between 0m and 10m amsl.
4. CH 3 located at Cap Malheureux located about 500m to the west of the Vingt Pieds Road with varying between 0m and 10m amsl.
5. CH 8 is located at Sottise just next to the junction of the A4 Grand Baie, Vingt Pieds and Sottise Roads with elevations varying between 0m to 10m amsl.

The Client cancelled the drilling of CH 5. Figure 2.2 shows the location of the coreholes.

2.2 Geology

The 1:50,000 Geological Map of Mauritius (Figure 2.3, Ref. 1) shows that the sites under investigation are underlain by fresh basalt of the Late Lavas of the Younger Volcanic Series that are characterised by uniform doleritic facies. These late lavas are light greyish in colour and show many phenocrysts (large crystal surrounded by a finer-grained matrix in an igneous rock) of olivine scattered in the doleritic network of feldspars and pyroxenes (silicate minerals). They are often porous and vesicular and show many cracks and fissures, but they are also sometimes compact. Scoriaceous textures are common, mainly at the upper and lower parts of the flows. Weathering is in general not important and is very often in concentric beds production onion-type alteration structures (Ref. 3).

The sites under investigation form part of the Northern Plains which have been constructed by three volcanoes, namely Butte aux Papayes (3.6km to the south of CH 6), Forbach Hill (2.7km to the south east of CH 6) and Mt Virer (3.6km to the south west of CH 8). The Butte aux Papayes – Forbach system dominates the skyline of the areas as seen from Plaines des Papayes and Grand Baie. At many places near the volcanic vents of the North, recent lavas cap earlier ones. The presence of earlier Intermediate Lavas around the Butte aux Papayes and Mt. Virer indicates that the later flows from Forbach and Mt Piton volcanoes have invaded the domains of

the Butte aux Papayes and Mt. Virer and buried the earlier flows before flowing towards Grand Baie and Pointe aux Cannoniers (Ref 2).

According to the Soil Map of Mauritius (Figure 2.4, Ref. 4), all coreholes except CH 1 and CH 2 and the 2No. boreholes are underlain by Latosolic Red Prairie Soils that have developed below the 2,500mm isohyet. The typical profile consists of a dark brown A horizon, rich in organic matter and containing variable but usually high amounts of gravels and stones overlying a reddish brown B horizon (Ref. 3). CH 1 and CH 2 are underlain by lithosols comprising rough broken land of mountains and gorges and rockland made up of almost weathered rocks.

According to the hydrogeological survey (Figure 2.4, Ref. 1); the project site is under the aquifer of the Northern Plains.

3 Geotechnical field and laboratory works

3.1 Geotechnical investigation works

The ground investigation was awarded to Water Research on 25th January 2011 with Geotechnical site works carried between the 10th and 18th February 2011; hydrogeological works are still in progress at the time of producing this Report. The scope of fieldwork, including the number and depth of exploratory holes, was specified by the Study Team and was undertaken in general accordance with BS 5930 (1999) (Ref. 5) and as per the Specifications of the Client. The site works included:

- Rotary drilled coreholes with core recovery to 10m depth below ground level (bgl).
- Standard Penetration Tests (SPTs) in all boreholes.
- Soil sampling for geotechnical laboratory testing (small bulk and U2 undisturbed samples) at regular intervals within all strata. Most of the encountered strata were too hard for collecting U2 samples.

The location of the coreholes is shown in Figure 2.2 and the photographs of site works are presented in Appendix A. The following Sections present a general description of the works carried out.

3.2 Rotary core drilling

7No. coreholes were formed using rotary drilling techniques in order to determine and delimit the ground profile beneath the site and to carry out sampling and in situ testing. The coreholes were situated at the proposed locations of future pumping stations; the locations are shown on Figure 2.2.

The exploratory coreholes, designated CH 1 to CH 4 and CH 6 to CH 8, were drilled to 10.0m depth below ground level using NMLC triple tube core barrel (hole diameter of 76mm and core diameter of 52mm) followed by NW casing (outside diameter of 88.9mm and inside diameter of 76.2mm) in collapsible strata. Water was used as flushing medium. Circulation of water was stopped so as to achieve the maximum recovery when coring of soft and weak materials; the term “dry coring” is used in such cases. Dry cored soft samples are generally 76mm in diameter.

The core samples recovered from the rotary boreholes were photographed, sampled and described by Water Research’s Geologist according to BS5930:1999 (Ref. 5). Details of the strata encountered are given on the borehole logs in Appendix C along with the assessment of Total Core Recovery (TCR), Solid Core Recovery (SCR) and Rock Quality designation (RQD), each expressed as a percentage of the individual core runs. Fracture Index (FI) is also reported. The photographs of the cores are presented in Appendix B2. Standpipes were installed in all coreholes as requested by the Study Team. The standpipe consisted of a 50mm PVC plain pipe installed over a length of 4.0m and slotted as from 4.0m to the bottom of the borehole at 10.0m (see

photograph of installation of standpipe in Appendix A). The bottom end of the standpipe is fitted with a glued type end cap. The top end is fitted with a screw type end cap. Clean Gravels (angular shapes of diameter 3-6mm) filter material was backfilled in the annulus space. A sealing plug material of cement (thickness 0.50m) was placed on the gravel filtered material, to prevent ingress of surface water and to secure the pipe.

3.3 In situ testing

3.3.1 Standard Penetration Test (SPT)

Standard penetration tests (SPT) were carried out in cohesive and granular soils and weathered rocks in accordance with BS5930:1999 (Ref. 5). The test consisted of driving a 50mm split spoon in soils or a cone is rocks by means of a 63.5kg hammer falling a height of 760mm. The SPT blow count N is the number of blows required to drive the spoon by 300mm after initially seating the spoon by 150mm. Tests for which the full penetration of 450mm could not be achieved after 50 blows are termed as "Refusals" (R). SPT test results are shown in Table 3.1.

Table 3.1 Summary of SPT results

CH No.	Test No.	Depth (m)	Strata	N – Value	Recovery (cm)
CH 1	1	1.0 – 1.5	Gravel	1	22
	2	2.5 – 3.0	Gravel	2	25
	3	5.0 – 5.5	MWB	28	18
	4	7.0 – 7.2	MWB	R	0
	5	7.85 – 7.95	MWB	R	0
CH 2	1	1.0 – 1.5	Gravel	18	36
	2	2.5 – 3.0	Gravel	21	18
	3	4.0 – 4.2	MWB	R	0
	4	5.0 – 5.2	MWB	R	0
	5	7.0 – 7.5	MWB	28	0
	6	9.0 – 9.5	Gravel	17	21
CH 3	1	0.9 – 1.1	M to SWB	R	0
	2	2.18 – 2.30	M to SWB	R	0
CH 4	1	1.0 – 1.2	M to SWB	R	0
	2	2.0 – 2.2	SWB	R	0
	3	3.0 – 3.2	SWB	R	0
	4	4.0 – 4.2	Fresh Basalt	R	0
	5	5.0 – 5.2	Fresh Basalt	R	0
	6	6.0 – 6.2	Fresh Basalt	R	0
	7	7.0 – 7.2	MWB	R	0
	8	8.0 – 8.2	MWB	R	0
	9	9.0 – 9.2	MWB	R	0
CH 6	1	1.0 – 1.5	Gravel	10	25

CH No.	Test No.	Depth (m)	Strata	N – Value	Recovery (cm)
	2	2.0 – 2.2	MWB	R	0
	3	3.0 – 3.2	SWB	R	0
	4	4.0 – 4.2	SWB	R	0
	5	5.0 – 5.5	Clay (scoria)	9	27
	6	6.0 – 6.5	Clay (scoria)	25	13
	7	7.0 – 7.5	Clay (scoria)	26	26
	8	8.0 – 8.5	Clay (scoria)	31	20
	9	9.0 – 9.5	Clay (scoria)	35	17
CH 7	1	1.0 – 1.5	C to HWB	10	28
	2	2.0 – 2.5	C to HWB	10	30
	3	3.0 – 3.5	MWB	18	22
	4	4.0 – 4.5	MWB	22	26
	5	5.0 – 5.5	C to HWB	R	38
	6	6.0 – 6.2	MWB	R	0
	7	7.0 – 7.2	MWB	R	0
	8	9.0 – 9.2	MWB	R	0
CH 8	1	1.0 – 1.5	RS to CWB	19	33
	2	2.0 – 2.5	RS to CWB	17	35
	3	3.0 – 3.2	MWB	R	0
	4	4.0 – 4.2	SWB	R	0
	5	5.0 – 5.2	SWB	R	0
	6	6.0 – 6.2	MWB	R	0
	7	7.25 – 7.45	HWB	R	0
	8	9.0 – 9.2	MWB	R	0

3.4 Laboratory testing

12No. Unconfined Compressive Strength Tests on rock core samples from all coreholes except CH 7 were programmed by the Study Team as shown on the schedules presented in Appendix C. The testing was carried out in accordance with the IRSM – Suggested Methods for Determining the Uniaxial Compressive Strength and Deformability of Rock Materials (Ref. 6) at the University of Mauritius. The results are enclosed in Appendix C of this report.

2No. Groundwater samples were taken at coreholes CH 1 and CH 2. The samples were taken on 22nd February 2011 at the end of the drilling activities. Tests were carried out at Chemco and Cernol Laboratories. The results are presented in Appendix C of this report and also in Table 4.3.

4 Geotechnical Results

4.1 Identified soil profile

The coreholes confirmed the geological sequence described in the published records. The depth and thickness of the various strata as interpreted in the exploratory logs are summarised in Table 4.1. The corehole logs and photographs are presented in Appendix B-1 and B-2 respectively.

Table 4.1 Depth intervals for various encountered strata

CH No.	Fill Material	Gravel	Clay to HWB	MWB	MWB to SWB	SWB to Fresh Basalts	Cavities
CH 1	0.0 – 0.5	0.5 – 3.0		3.0 – 8.3	8.3 – 10.0		
CH 2		0.0 – 3.6 8.5 – 10.0		3.6 – 5.66 6.23 – 8.5 (scories)			5.66 – 6.23
CH 3	0.5 – 0.7				0.7 – 2.45 8.25 – 10.0	2.45 – 8.25	
CH 4				6.81 – 10.0	0.0 – 1.55	1.55 – 6.5	6.72 – 6.81
CH 6	0.0 – 0.5 (topsoil)	0.5 – 1.7	4.7 – 9.5	1.7 – 2.3 9.5 – 10.0		2.3 – 4.7	
CH 7	0.0 – 0.45 (topsoil)		0.45 – 3.0 4.5 – 5.5 (CWB to HWB)	3.0 – 4.5 5.5 – 10.0			
CH 8	0.0 – 0.35 (topsoil)		0.35 – 3.0 (RS to CWB) 7.25 – 8.0	3.0 – 4.1 5.4 – 7.25 8.0 – 10.0	4.1 – 5.4		

The following definitions were considered for weathered basalts:

- Residual Soil: No recognisable rock texture. Surface layer contains humus and plant roots.
- Completely Weathered (CW) basalt: Rock completely decomposed by weathering in place but texture still recognisable. Can be excavated by hand.
- Highly Weathered (HW) basalt: Rock so weakened by weathering that fairly large pieces can be broken and crumbled in the hands. Sometimes recovered as core in careful rotary drilling.
- Moderately Weathered (MW) basalt: Considerable weathered throughout. Possessing some strength – large pieces cannot be broken by hand, reasonable core recovery. Often limonite stained. Difficult to rip.

- Slightly Weathered (SW) basalt: Distinctly weathered through much of the rock fabric with slight limonite staining. Strength approaches that of the fresh rock. Requires explosive for excavation. Highly permeable open joints.
- Fresh Basalt may have some limonite stained joints, indicating water percolation.

The following sections summarise the in situ test results for the encountered strata.

4.2 Fill Material and Topsoil

Fill Material was encountered in coreholes CHs 1 and 3 as from the surface and reaching up to a maximum depth of 0.7m in thicknesses varying between 0.2m and 0.5m. The Fill Material was described as dense gravely fine sand.

Topsoil was encountered in CH 6, 7 and 8 as from the surface and reaching up to a maximum depth of 0.5m below ground level, with thicknesses varying between 0.35m and 0.5m. This layer was generally described as firm brown gravelly medium plasticity clay with frequent roots.

4.3 Weathered Basalt soil-like behaviour

Clay, Residual Soil to Completely Weathered Basalt and Completely to Highly Weathered Basalt were encountered in CH 6, 7 and 8 as from 0.35m depth and reaching up to a maximum of 8.0m in thicknesses varying between 0.75m and 4.8m.

4.4 Weathered Basalt rock-like behaviour

Moderately Weathered Basalt was encountered in all coreholes except CH 3 as from 1.7m and reaching up to the maximum explored depth in thicknesses varying between 0.6m and 5.3m. This layer was described as moderately strong grey medium grained vesicular with occasional amygdales basalt with closely to very closely spaced, rough undulating and sub-horizontal joints. Moderately Weathered Basalt was also encountered as non-intact gravel strata in CH 1, 2 and 6 as from the surface and reaching up to a depth of 10.0m, in thicknesses varying between 1.2m and 3.6m. This layer was generally described as medium dense to dense silty coarse subangular to subrounded and vesicular moderately weathered basalt. 4No. unconfined compressive strength tests were carried out on MWB and values varied between 24.7MPa and 65.5MPa.

Moderately to Slightly Weathered Basalt was encountered in CH 1, 3, 4 and 8 as from the surface (in CH 4) and reaching up to the maximum explored depth in thicknesses varying between 1.3m and 1.75m. This layer was described as moderately strong to strong grey fine grained vesicular with rare amygdales basalt with medium to closely spaced, rough undulating and sub-horizontal joints. 3No. unconfined compressive strength tests were carried out on MWB to SWB and values varied between 29.9MPa and 45.9MPa.

Slightly Weathered and Fresh Basalts were encountered in CH 3, 4 and 6 as from a depth of 1.55m and reaching to a maximum of 8.25m in thicknesses varying between 2.4m and 5.8m. These layers were generally described as moderately strong to strong grey medium to fine grained vesicular with occasional or rare amygdales and widely to closely spaced stepped rough sub-horizontal to sub-vertical joints. 5No. unconfined compressive strength tests were carried out on SWB to Fresh Basalts and values varied between 32.6MPa and 72.1MPa. It is worth noting that a low value of 17.9MPa was obtained for a sample of SWB to Fresh Basalt because the sample had an existing crack prior to testing and failure occurred along the crack.

Cavities were identified in CH 2 and CH 4 at depths of 5.66m to 6.23m and 6.72m to 6.81m respectively.

4.5 Groundwater

Groundwater monitoring was carried out at the end of the drilling. The measurements are presented in Table 4.2:

Table 4.2 Measurement of Groundwater level taken on 21.01.11

CH No.	Depth to water (m)
CH 1	0.95
CH 2	4.15
CH 3	N/A
CH 4	N/A
CH 6	N/A
CH 7	N/A
CH 8	N/A

The results from water analyses are presented in Table 4.3 below.

Table 4.3 Summary of chemical test results

Parameter	Units	Test results	
		CH 1	CH 2
Conductivity	µS/cm	825	2200
pH	-	7.73	7.31
TDS	mg/L	422	1190
Turbidity	NTU	29.6	4.26
COD	mg/L	221	153
Nitrate as N	mg/L	0.35	5.24
Chlorides	mg/L	110.3	584
Sulphates	mg/L	37.2	168.4
Nitrate as NO_2^-	mg/L	2	8

5 Closing remarks

On 25th January 2011, Water Research Co Limited (Water Research) was instructed by the Japan International Coorperation Agency - JICA (Client) to carry out an Injection Well (Borehole) and Geological (Corehole) Surveys to support the Technical Assistance for the Grand Baie Sewerage Project which is being carried out for the Wastewater Management Authority (WMA). The Study Team appointed by the Client is Nippon Koei Ltd and the local representative is Luxconsult Co. Ltd.

The Injection Well Survey is the test drilling for the effluent disposal of the Grand Baie Wastewater Treatment Plant. The Geological Survey is being carried out to support the design of foundations for the pumping stations. This Preliminary Factual Report presents brief desk study information for the site (including description of the geology, maps and plans) and the factual information from the Corehole Survey only and will be implemented into the main report of the Technical Assistance for the Grand Baie Sewerage Project as Volume 4. The information presented is as per the Specification provided.

The identified soil profiles in order of vertical sequence consist of

- topsoil or fill material encountered in thicknesses varying between 0.2m and 0.5m
- clay (Residual Soil to Completely and Completely to Highly Weathered Basalts in thicknesses varying between 0.75m and 4.8m categorised as weathered basalt with soil-like behaviour.
- Moderately to Slightly Weathered Basalts encountered in thicknesses varying between 0.6m and 5.3m and Slightly Weathered and Fresh Basalts in thicknesses varying between 2.4m and 5.8m all categorised as weathered basalt with rock-like behaviour.

Rock samples from all coreholes except CH 7 were tested for Unconfined Compressive Strength (UCS) at the University of Mauritius Laboratory. The results are presented in this report.

Groundwater was encountered in CH 1 and CH 2 at 0.95m and 4.15m depth, below ground level, respectively. Water quality analyses were carried on samples from the two coreholes and results are presented in this report.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

6 References

1. L. Giorgi and S Borchiellini (1999), Les aquifères de l'Ile Maurice (Map)
2. Prem Saddul (2002), Mauritius, A geomorphological analysis, Mahatma Gandhi Institute. pp. 31-35.
3. Proag, V. (1995), The geology and water resources of Mauritius, analysis, Mahatma Gandhi Institute.
4. Directorate of overseas surveys (UK) (1962), Soil Map of Mauritius, Public Works and Survey Department, Port Louis Mauritius.
5. British Standards (1999), BS 5930, Code of practice for site investigations.
6. International Society for Rock Mechanics (1979), Suggested Methods for Determining the Uniaxial Compressive Strength and Deformability of Rock Materials.

7 Figures

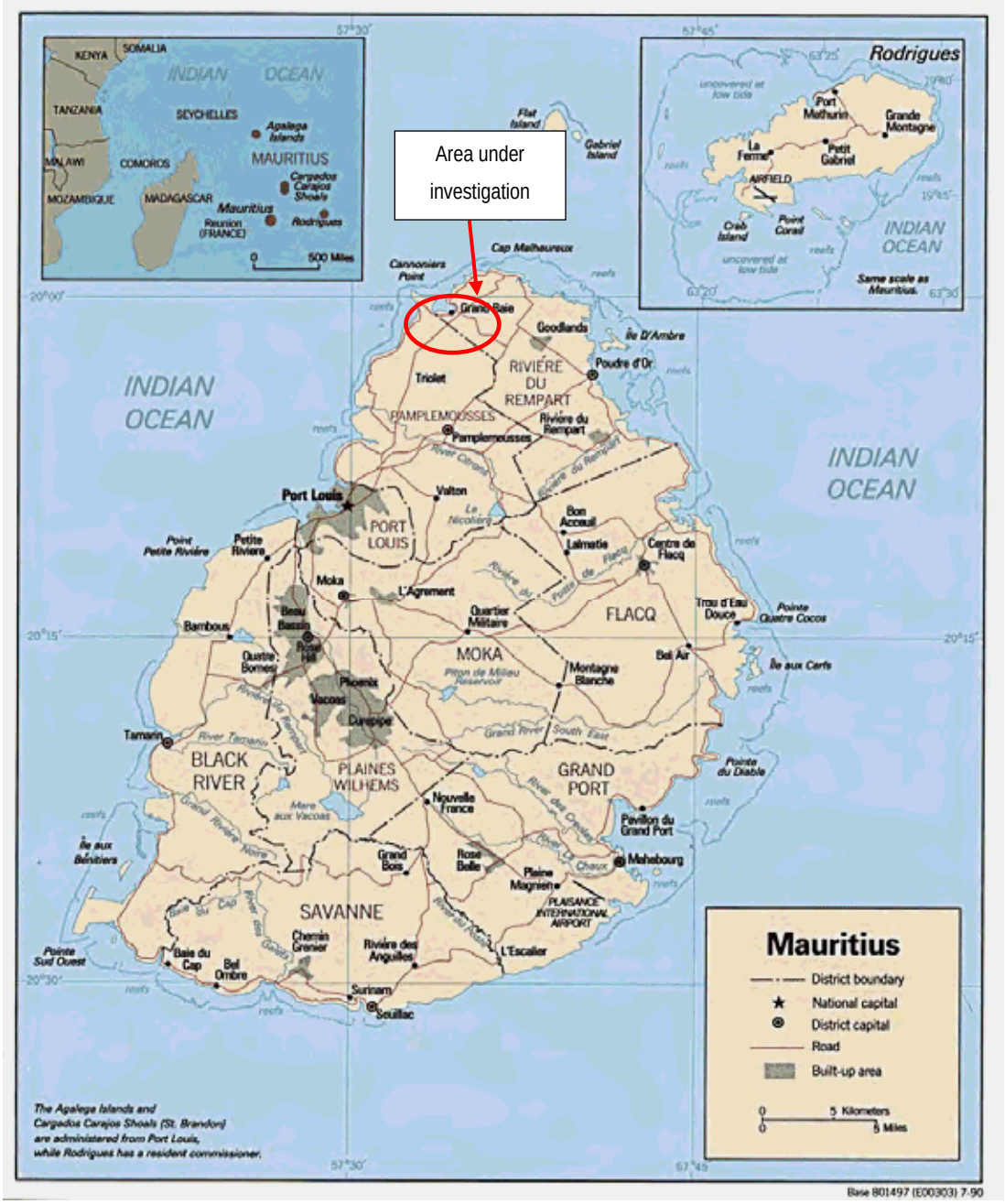


Figure 2.1 General location of the site

Figure 2.2 Site Location

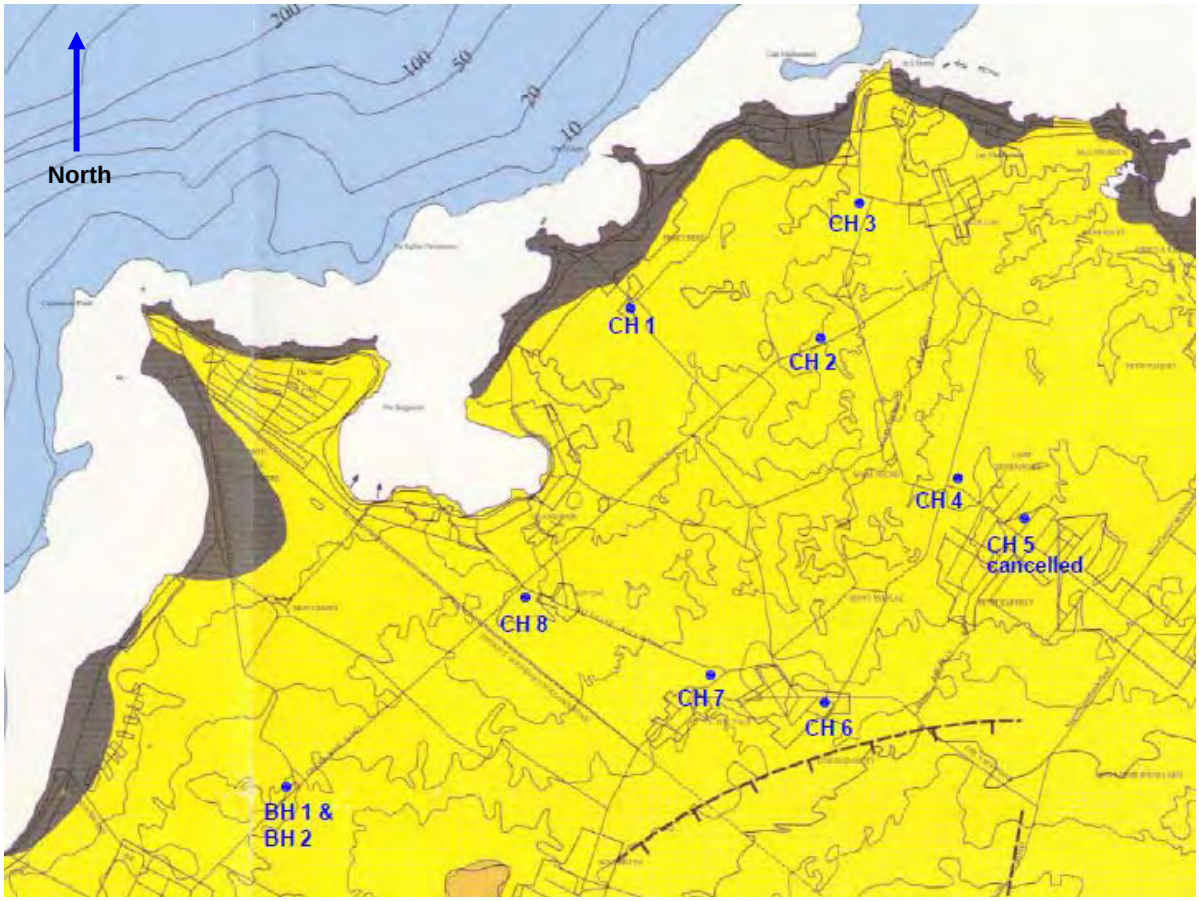


Figure 2.3 Location of the site on geological map

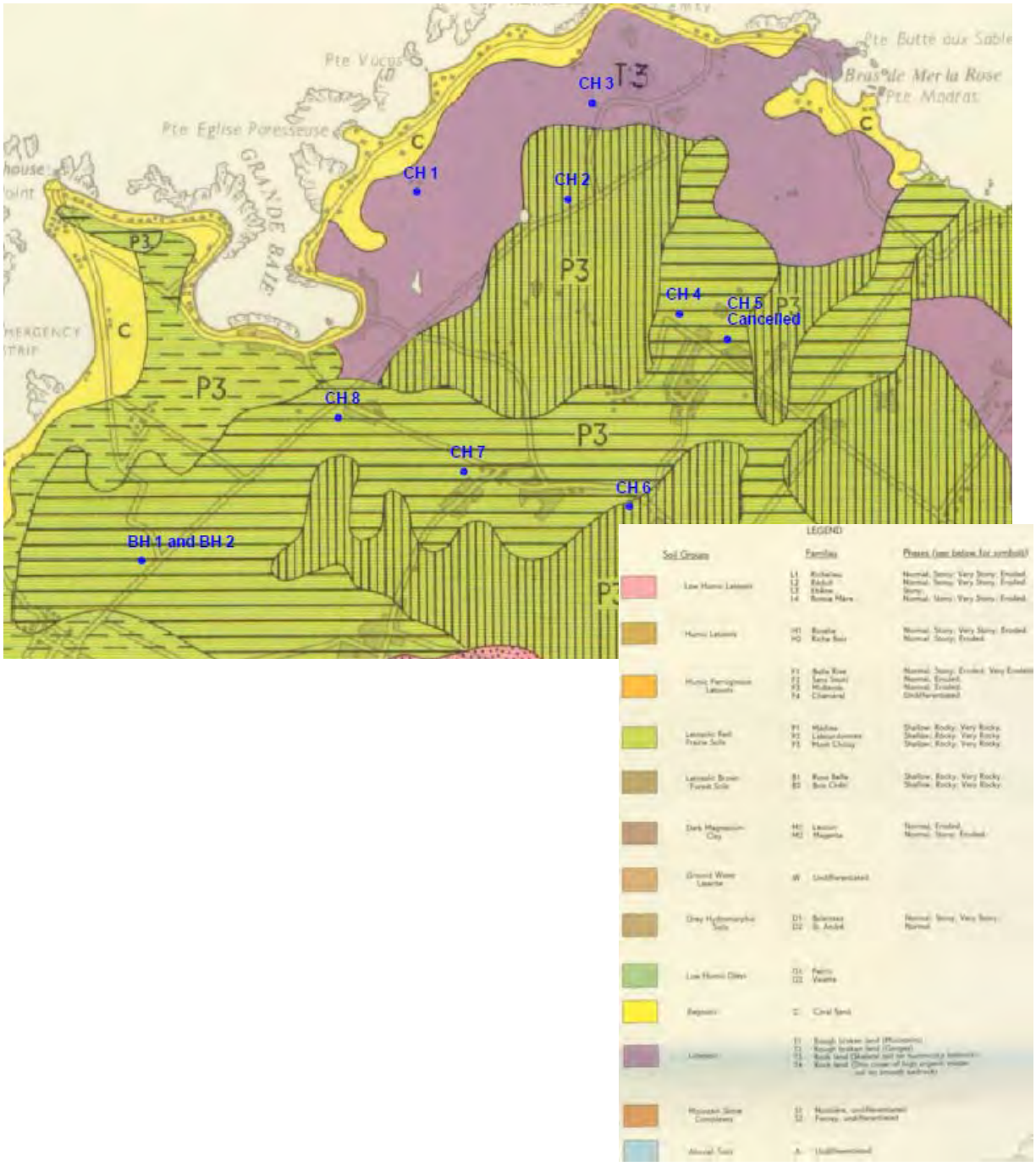


Figure 2.4 Location of the site on soil map

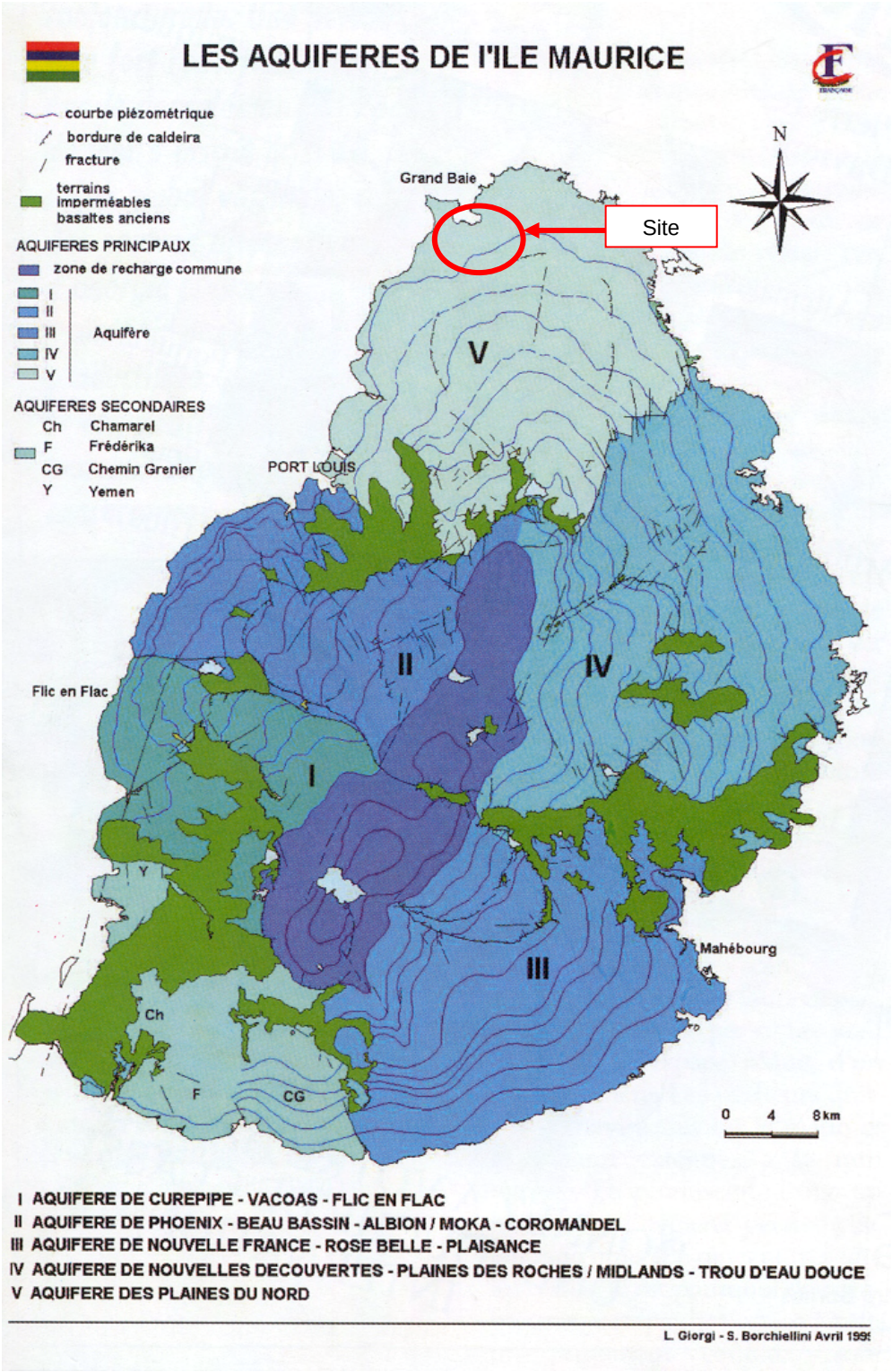


Figure 2.5 Location of the site on the Aquifer map

Appendix A Photographs of site works

Figure B-1 Drilling

Figure B-2 Installation of standpipe

Figure B-3 Slotted tube for standpipe

Appendix B Exploratory Holes

Appendix B-1 Corehole logs

WATER RESEARCH CO. LTD

BOREHOLE No. : CH 1-Piezo

SITE : Grand Baie

Drilling rig : APAFOR	**National Grid Coordinates**	**Start Date :** 14.02.11
Casing Diameter : 88.9mm	**N :** Not Available	**End Date :** 14.02.11
Borehole Diameter : 76mm	**E :** Not Available	**Final Depth :** 10.00m
Core Diameter : 76mm-52mm	**Ground Level :** Not Available	**Water depth :** 0.95m on 21.02.11

Description of strata	Legend	Scale (m)	Elevation/Depth	Sample / In situ Test	N Value / Pocket Pen. kPa	Recovery (cm)	Core run	TCR (%)	SCR (%)	RQD (%)	FI	Casing depth	Drilling
Dense grey sandy coarse subangular GRAVEL of moderately weathered basalt. Sand is grey medium size. MACADAM.			-0.50										
			0.50										
Dense grey silty sandy coarse subangular to subrounded GRAVEL of moderately weathered basalt. Sand is grey medium size and silt is dark brown medium plasticity.			-1.00				1.00	100	0	0			
		1.0	1.00	S	1	22	1.50						DC-76mm
Dense grey with cream mottles silty coarse subangular to subrounded GRAVEL of moderately weathered basalt with rare shell. Silt is brownish cream medium plasticity.							2.00	100	0	0			
		2.0					2.50	100	0	0			
				S	2	25	3.00						
		3.0	-3.00										
Moderately strong grey with orange discolorations at joints medium grained vesicular with occasional amygdales. MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating and subhorizontal.			3.00								NI		
											11		
		4.0					4.00	100	46	33			WD-52mm
							5.00	100	7	0		NW 5.00	
		5.0		S	26	18	5.50				NI		DC-52mm
							6.00	100	0	0			
		6.0					6.34	100	0	0			
							7.00	100	27	15	6		WD
		7.0		S	R	0							DC-52mm
							7.85	100	14	14	NI		
		8.0		S	R	0							
			-8.30										
Moderately strong to strong grey with cream disoclorations at joints fine grained with rare amygdales MODERATELY TO SLIGHTLY WEATHERED BASALT. Joints are medium to closely spaced, rough stepped and subhorizontal.			8.30										
		9.0					9.00	100	38	38	9		WD-52mm
							10.00	100	65	50	NI		
		10.0	-10.00										
			10.00										

Annotations :
U : Undisturbed tube sample
D : Disturbed sample
RU : Refusal at jacking of U sampler
R : (SPT) Refusal
C : (SPT) Solid Cone
S : (SPT) Split Spoon
NI : Non Intact
P : Pressurometer

Logged by : CD
Drillers : MD/RM
Checked by :

Contract No. : OPG 11056 NIP
Project : Grand Baie Sewerage Project
Sheet of : 1 of 1

WATER RESEARCH CO. LTD

BOREHOLE No. : CH 2-Piezo

SITE : Grand Baie

Drilling rig : APAFOR	**National Grid Coordinates**	**Start Date :** 11.02.11
Casing Diameter : 88.9mm	**N :** Not Available	**End Date :** 11.02.11
Borehole Diameter : 76mm	**E :** Not Available	**Final Depth :** 10.00m
Core Diameter : 76mm-52mm	**Ground Level :** Not Available	**Water depth :** 4.15m on 21.02.11

Description of strata	Legend	Scale (m)	Elevation/Depth	Sample / In situ Test	N Value / Pocket Pen. kPa	Recovery (cm)	Core run	TCR (%)	SCR (%)	RQD (%)	FI	Casing depth	Drilling
Moderately weak to moderately strong grey with orangish brown discolorations medium grained MODERATELY WEATHERED BASALT. Joints are infilled by brown medium plasticity clay, are very closely to extremely closely spaced, rough stepped and randomly orientated.		1.0					0.75	100	0	0			DC-76mm
							1.00	100	0	0			
				S	18	36	1.50						
		2.0					2.00	100	0	0	NI		WD
							2.50	100	0	0			DC-52mm
				S	21	18	3.00						
		3.0	-3.60										
Moderately strong grey with occasional yellowish cream discolorations at joints medium grained vesicular with occasional amygdales MODERATELY WEATHERED BASALT. Joints are medium to closely spaced, rough undulating and sub-horizontal to sub-vertical.		4.0	3.60				4.00	100	0	0			
				S	R	0					>20		WD-52mm
							5.00	100	76	69	4		
		5.0	-5.10	S	R	0							
Moderately strong slightly purplish grey medium grained vesicular with frequent amygdales MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating, sun-horizontal to sub-vertical.			5.10								>20		
		6.0	-5.66										
			5.66										
			-6.23									NW	
Cavity.			6.23				6.50	62	38	28	>20	6.50	
Moderately weak to moderately strong slightly purplish grey medium grained vesicular with frequent amygdales MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating, sun-horizontal to sub-vertical. SCORIES??		7.0					7.00	100	0	0			DC-52mm
				S	28	0	7.50				NI		
		8.0	-8.50				8.50	100	4	0			WD-52mm
Medium dense grey silty coarse sub-angular GRAVEL of moderately vesicular basalt. Silt is brown high plasticity.			8.50				9.00	100	0	0			DC-52mm
		9.0		S	17	21	9.50						
			-10.00				10.00	100	0	0			
		10.0	10.00										

Annotations :
U : Undisturbed tube sample
D : Disturbed sample
RU : Refusal at jacking of U sampler
R : (SPT) Refusal
C : (SPT) Solid Cone
S : (SPT) Split Spoon
NI : Non Intact
P : Pressurometer

Logged by : CD
Drillers : MD/RM
Checked by :

Contract No. : OPG 11056 NIP
Project : Grand Baie Sewerage Project
Sheet of : 1 of 1

WATER RESEARCH CO. LTD

BOREHOLE No. : CH 3-Piezo

SITE : Grand Baie

Drilling rig : APAFOR	**National Grid Coordinates**	**Start Date :** 10.02.11
Casing Diameter : 88.9mm	**N :** Not Available	**End Date :** 10.02.11
Borehole Diameter : 76mm	**E :** Not Available	**Final Depth :** 10.00m
Core Diameter : 76mm-52mm	**Ground Level :** Not Available	**Water depth :** Water circulation loss at8.50m

Description of strata	Legend	Scale (m)	Elevation/Depth	Sample / In situ Test	N Value / Pocket Pen. kPa	Recovery (cm)	Core run	TCR (%)	SCR (%)	RQD (%)	FI	Casing depth	Drilling
Dense brown clayey gravelly medium SAND. Clay is brown medium plasticity.Gravels are coarse sub-angular gravel of moderately weathered basalt. FILL MATERIAL.			-0.50				0.50	100	0	0			DC-76mm
			0.50				0.90	100	16	0			
Dense creamish grey gravelly fine SAND. Gravels are coarse sub-angular of moderately weathered basalt. FILL MATERIAL.		1.0		S	R	0					14		
Moderately strong grey with yellow discolorations ay joints medium grained vesicular with frequent amygdales MODERATELY TO SLIGTHLY WEATHERED BASALT. Joints are medium to closely spaced, rough undulating and sub-horizontal.		2.0					2.18	100	83	83		NW 2.18	
			-2.45	S	R	0					5		
Moderately strong to strong grey with occasional cream discolorations fine grained with rare amygdales SLIGHTLY WEATHERED BASALT TO FRESH BASALT. Joints are wide to closely spaced, stepped rough and sub-horizontal.		3.0	2.45				3.75	100	85	81			
		4.0											
		5.0											
		6.0					6.00	100	98	89	3		WD-52mm
		7.0											
		8.0	-8.25										
Moderately strong grey with yellow discolorations ay joints medium grained vesicular with frequent amygdales MODERATELY TO SLIGTHLY WEATHERED BASALT.. Joints are medium to closely spaced, rough undulating and sub-horizontal.			8.25								>20		
		9.0					9.00	100	89	89			
											6		
		10.0	-10.00				10.00	100	65	58			
			10.00										

Annotations :
U : Undisturbed tube sample
D : Disturbed sample
RU : Refusal at jacking of U sampler
R : (SPT) Refusal
C : (SPT) Solid Cone
S : (SPT) Split Spoon
NI : Non Intact
P : Pressurometer

Logged by : CD
Drillers : MD/RM
Checked by :

Contract No. : OPG 11056 NIP
Project : Grand Baie Sewerage Project
Sheet of : 1 of 1

WATER RESEARCH CO. LTD

BOREHOLE No. : CH 4-Piezo

SITE : Grand Baie

Drilling rig : APAFOR	**National Grid Coordinates**	**Start Date :** 15.02.11
Casing Diameter : N/A	**N :** Not Available	**End Date :** 15.02.11
Borehole Diameter : 76mm	**E :** Not Available	**Final Depth :** 10.00m
Core Diameter : 76mm-52mm	**Ground Level :** Not Available	**Water depth :** Water circulation loss at 6.50m

Description of strata	Legend	Scale (m)	Elevation/Depth	Sample / In situ Test	N Value / Pocket Pen. kPa	Recovery (cm)	Core run	TCR (%)	SCR (%)	RQD (%)	FI	Casing depth	Drilling
Moderately strong to strong grey medium grained very vesicular with frequent amygdales MODEATELY TO SLIGHTLY WEATHERED BASALT. Joints are medium to closely spaced, rough undulating, sub-horizontal and sub-horizontal.		1.0		S	R	0	1.00	100	94	90	6		Water Drilling-52mm
			-1.55										
Moderately strong to strong grey with orangish brown discolorations at joints medium grained slightly vesicular with occasional amygdales SLIGHTLY WEATHERED BASALT. Joints are widely to closely spaced, rough stepped, sub-horizontal to sub-vertical.		2.0	1.55	S	R	0	2.00	100	100	100			
		3.0		S	R	0	3.00	100	98	98	4		
				S	R	0	4.00	100	61	53			
		4.0	-4.00										
Strong grey fine grained with rare amygdales FRESH BASALT. Joint are widely spaced, stepped rough and sub-horizontal.			4.00	S	R	0	5.00	100	98	98			
		5.0		S	R	0	6.00	100	100	100	1		
		6.0		S	R	0							
			-6.50										
Moderately strong to strong with orangish brown discolorations at joints medium grained slightly vesicular with occasional amygdales SLIGHTLY WEATHERED BASALT. Joints are widely to closely spaced, rough stepped, sub-horizontal to sub-vertical.			6.50				7.00	91	71	71	>20		
		7.0		S	R	0							
Cavity (between 6.72m and 6.81m).							8.00	100	42	11			
Moderately strong purplish grey medium grained very vesicular MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating, sub-horizontal to sub-vertical.		8.0		S	R	0					8		
			-9.00				9.00	100	61	46			
Moderately strong slightly purplish grey medium grained slightly vesicular MODERATELY WEATHERED BASALT. Joints are medium to closely spaced, rough undulating, sub-horizontal to sub-vertical.		9.0	9.00	S	R	0							
							10.00	100	80	80	5		
		10.0	-10.00										
			10.00										

Annotations :
U : Undisturbed tube sample
D : Disturbed sample
RU : Refusal at jacking of U sampler
R : (SPT) Refusal
C : (SPT) Solid Cone
S : (SPT) Split Spoon
NI : Non Intact
P : Pressurometer

Logged by : CD
Drillers : MD/RM
Checked by :

Contract No. : OPG 11056 NIP
Project : Grand Baie Sewerage Project
Sheet of : 1 of 1

WATER RESEARCH CO. LTD

BOREHOLE No. : CH 6-Piezo

SITE : Grand Baie

Drilling rig : APAFOR	**National Grid Coordinates**	**Start Date :** 16.02.11
Casing Diameter : 88.9mm	**N :** Not Available	**End Date :** 16.02.11
Borehole Diameter : 76mm	**E :** Not Available	**Final Depth :** 10.00m
Core Diameter : 76mm-52mm	**Ground Level :** Not Available	**Water depth :** Water circulation loss at 4.35m

Description of strata	Legend	Scale (m)	Elevation/Depth	Sample / In situ Test	N Value / Pocket Pen. kPa	Recovery (cm)	Core run	TCR (%)	SCR (%)	RQD (%)	FI	Casing depth	Drilling
Firm brown gravelly medium plasticity CLAY with frequent roots. Gravels are coarse coarse subrounded to subangular of moderately vesicular weathered basalt. TOP SOIL.			-0.50				0.60	100	0	0			
			0.50				1.00	100	0	0			
Medium dense grey coarse subrounded to subangular GRAVEL of moderately vesicular weathered basalt. Clay is brown medium plasticity.		1.0		S	10	25	1.50						
			-1.70										
			1.70				2.00	100	16	0	>20	NW 2.00	DC-76mm
Moderately strong grey with brown discolorations at joitns medium grained vesicular MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating and randomly orientated.		2.0	-2.30	S	R	0					NI		
			2.30				2.50	100	30	0	9		
							3.00	100	88	88			
Strong grey with orange discolorations at joints fine graiend SLIGHTLY WEATHERED BASALT. Joints are widely to closely spaced, smooth planar and subhorizontal.		3.0		S	R	0							
							4.00	100	100	100	2		
		4.0		S	R	0							
			-4.70								>20		WD-52mm
			4.70				5.00	100	59	48			
Firm to stiff purplish grey gravelly medium plasticity CLAY (scoria) with occasional cobbles. Gravels are coarse subrounded to subangular and cobbles are of moderately weak vesicular weathered basalt.		5.0		S	9	27	5.50						
							6.00	100	0	0			
		6.0		S	25	13	6.50						
							7.00	100	22	0			
		7.0		S	26	26	7.50						
							8.00	100	0	0			
		8.0		S	31	20	8.50						
							9.00	100	0	0			
		9.0		S	35	17	9.50						DC-52mm
			-9.50										
Moderately strong grey medium grained MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, stepped smooth, subhorizontal to subvertical.			9.50										
			-10.00				10.00	100	44	0	>20		WD-52mm
		10.0	10.00										

Annotations :
U : Undisturbed tube sample
D : Disturbed sample
RU : Refusal at jacking of U sampler
R : (SPT) Refusal
C : (SPT) Solid Cone
S : (SPT) Split Spoon
NI : Non Intact
P : Pressurometer

Logged by : CD
Drillers : MD/RM
Checked by :

Contract No. : OPG 11056 NIP
Project : Grand Baie Sewerage Project
Sheet of : 1 of 1

WATER RESEARCH CO. LTD

BOREHOLE No. : CH 7-Piezo

SITE : Grand Baie

Drilling rig : APAFOR	**National Grid Coordinates**	**Start Date :** 17.02.11
Casing Diameter : 88.9mm	**N :** Not Available	**End Date :** 17.02.11
Borehole Diameter : 76mm	**E :** Not Available	**Final Depth :** 10.00m
Core Diameter : 76mm-52mm	**Ground Level :** Not Available	**Water depth :** Water circulation loss at 5.68m

Description of strata	Legend	Scale (m)	Elevation/Depth	Sample / In situ Test	N Value / Pocket Pen. kPa	Recovery (cm)	Core run	TCR (%)	SCR (%)	RQD (%)	FI	Casing depth	Drilling
Firm brown with yellow dots gravelly medium plasticity CLAY with frequent roots. Gravels are coarse sub-rounded to sub-angular of moderately weathered basalt. TOP SOIL.			-0.45				0.56	100	0	0			
			0.45				1.00	100	0	0			
Firm brown gravelly high plasticity CLAY. Gravels are coarse sub-rounded of moderately weathered basalt. COMPLETELY TO HIGHLY WEATHERED BASALT.		1.0		S	10	28	1.50						
							2.00	100	0	0			DC-76mm
		2.0		S	10	30	2.50						
			-3.00				3.00	100	0	0			
Moderately strong dark grey with orange discolorations at joints medium grained vesicular MODERATELY WEATHERED BASALT. Joints are very closely to extremely closely spaced, rough undulating and randomly orientated.		3.0	3.00	S	18	22	3.50						
							4.00	100	0	0	NI	NW 4.00	DC-52mm
		4.0		S	22	26	4.50						
			-4.50										
Firm brown gravelly high plasticity CLAY with occasional cobbles. Gravels are coarse sub-rounded and cobbles are of moderately weathered basalt. COMPLETELY TO HIGHLY WEATHERED BASALT.			4.50				5.00	100	0	0			
		5.0		S	R	38	5.50						
			-5.50										
Moderately strong slightly purplish grey with orange discolorations at joints MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough stepped, sub-horizontal to sub-vertical.			5.50				6.00	100	32	0			
		6.0		S	R	0					>20		
			-6.55										
Moderately weak to moderately strong dark grey with orange discolorations at joints, medium grained vesicular with frequent amygdales MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating, sub-vertical to sub-horizontal.			6.55				7.00	100	34	0			
		7.0		S	R	0					NI		
											9		
		8.0											
											>20		
		9.0		S	R	0	9.00	22	21	0			
											NI		
		10.0	-10.00				10.00	100	20	0			
			10.00		R								WD-52mm

Annotations :
U : Undisturbed tube sample
D : Disturbed sample
RU : Refusal at jacking of U sampler
R : (SPT) Refusal
C : (SPT) Solid Cone
S : (SPT) Split Spoon
NI : Non Intact
P : Pressurometer

Logged by : CD
Drillers : MD/RM
Checked by :

Contract No. : OPG 11056 NIP
Project : Grand Baie Sewerage Project
Sheet of : 1 of 1

WATER RESEARCH CO. LTD

BOREHOLE No. : CH 8-Piezo

SITE : Grand Baie

Drilling rig : APAFOR	**National Grid Coordinates**	**Start Date :** 18.02.11
Casing Diameter : 88.9mm	**N :** Not Available	**End Date :** 18.02.11
Borehole Diameter : 76mm	**E :** Not Available	**Final Depth :** 10.00m
Core Diameter : 76mm-52mm	**Ground Level :** Not Available	**Water depth :** Water circulation loss at 5.65m

Description of strata	Legend	Scale (m)	Elevation/Depth	Sample / In situ Test	N Value / Pocket Pen. kPa	Recovery (cm)	Core run	TCR (%)	SCR (%)	RQD (%)	FI	Casing depth	Drilling
Firm brown slightly gravelly medium plasticity CLAY with occasional roots. Gravels are coarse sub-angular of moderately weathered basalt. TOP SOIL.			-0.35										
			0.35				1.00	100	0	0			
Stiff brownish brown slightly gravelly high plasticity CLAY. RESIDUAL SOIL TO COMPLETELY WEATHERED BASALT.		1.0		S	19	33							DC-76mm
							1.50						
		2.0					2.00	100	0	0			
				S	17	35							
							2.50						DC-52mm
							3.00	100	0	0		NW 3.00	
		3.0	-3.00										
Moderately strong grey with orangish brown discolorations medium grained very vesicular with frequent amygdales MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating, sub-horizontal to sub-vertical.			3.00	S	R	0					>20		
											NI		
							4.00	100	31	0	18		
		4.0	-4.10	S	R	0							
Moderately strong to strong grey fine grained with rare amygdales SLIGHTLY WEATHERED BASALT. Joints are medium to closely spaced, planar rough and sub-horizontal.			4.10										
							5.00	100	85	53	7		
		5.0		S	R	0							
			-5.40								>20		
Moderately strong grey with orangish brown discolorations medium grained very vesicular with frequent amygdales MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough undulating, sub-horizontal to sub-vertical. From 6.70 to 6.85m Firm medium plasticity silt (Ash).			5.40										
							6.00	100	92	74	4		WD-52mm
		6.0		S	R	0							
							6.50	100	44	26	>20		
													DC-52mm
		7.0											
			-7.25				7.25	100	60	34	15		
Moderately weak to moderately strong brownish grey with yellowish brown discolorations at joints medium grained vesicular HIGHLY WEATHERED BASALT.			7.25	S	R	0							
			-8.00				8.00	100	14	0			
		8.0	8.00										
Moderately strong grey with brown discolorations medium grained vesicular with frequent amygdales MODERATELY WEATHERED BASALT. Joints are very closely to closely spaced, rough undulating, sub-horizontal to sub-vertical.											18		
							9.00	100	68	37			
		9.0		S	R	0							WD-52mm
			-9.30								14		
Moderately strong grey with cream discolorations medium grained with occasional vesicles and amygdales MODERATELY WEATHERED BASALT. Joints are closely to very closely spaced, rough planar and sub-horizontal.			9.30										
			-10.00				10.00	100	84	36			
		10.0	10.00										

Annotations :
U : Undisturbed tube sample
D : Disturbed sample
RU : Refusal at jacking of U sampler
R : (SPT) Refusal
C : (SPT) Solid Cone
S : (SPT) Split Spoon
NI : Non Intact
P : Pressurometer

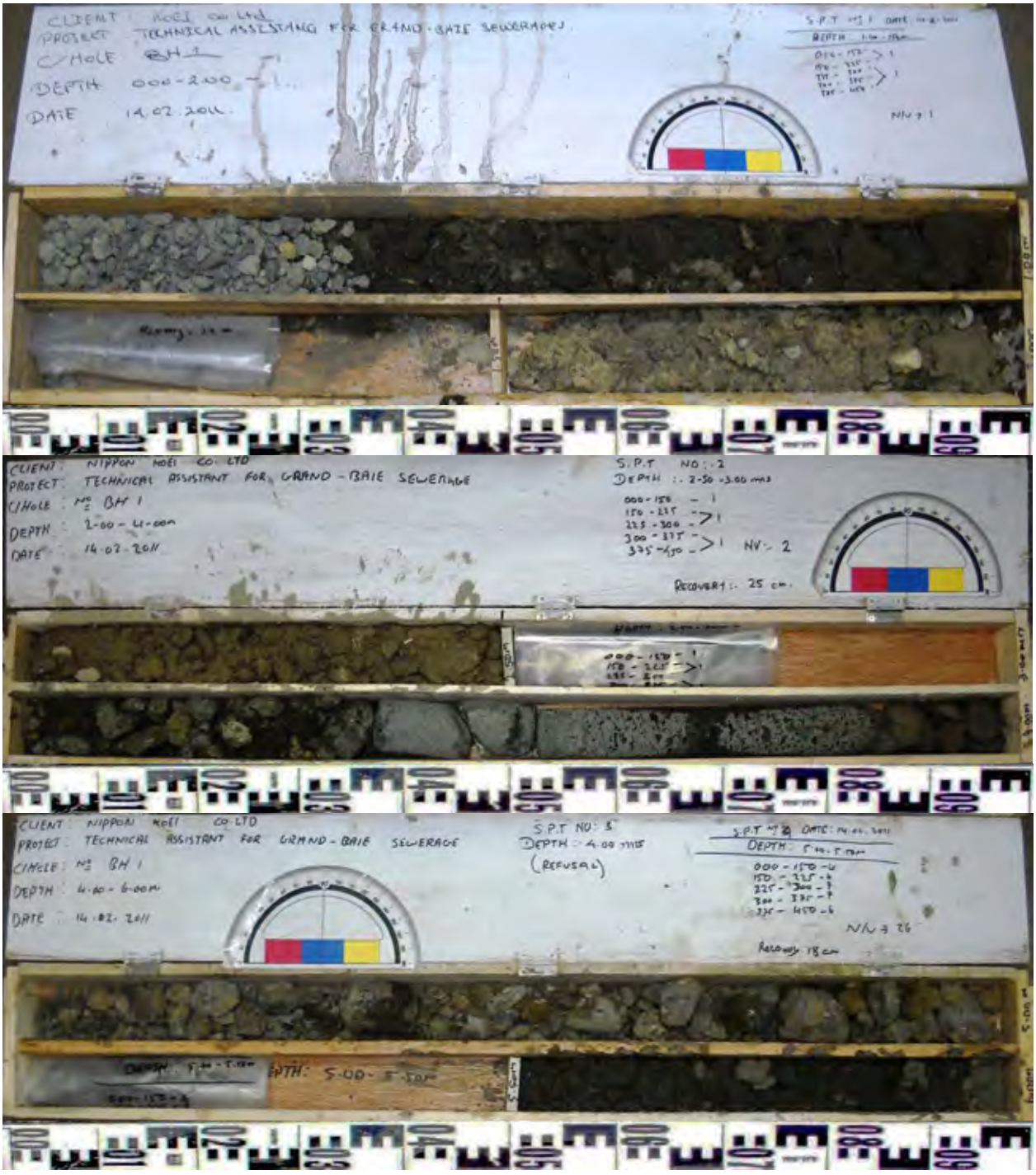
Logged by : CD
Drillers : MD/RM
Checked by :

Contract No. : OPG 11056 NIP
Project : Grand Baie Sewerage Project
Sheet of : 1 of 1

Appendix B-2 Photographs of Cores

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 1 **Page 1 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 1



Depth : 0.00 –6.00 meters

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 1 **Page 2 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 1

Depth : 6.00 –10.00 meters

End of Core Hole at 10.00 meters

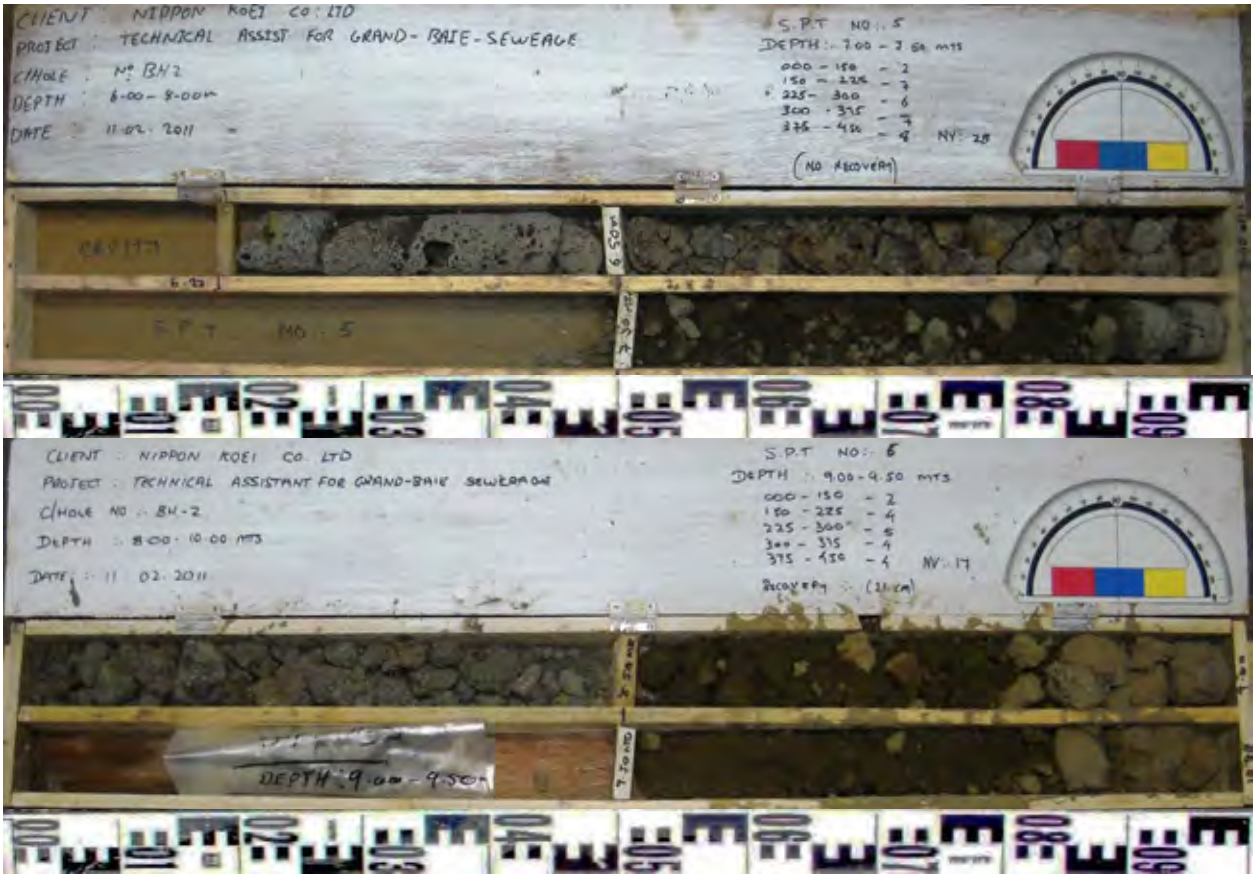
WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 2 **Page 1 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 2

Depth : 0.00 –6.00 meters

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 2 **Page 2 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 2



Depth : 6.00 –10.00 meters

End of Core Hole at 10.00 meters

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 3 **Page 1 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 3

Depth : 0.00 –6.00 meters

COREHOLE BH 3

Depth : 6.00 –10.00 meters

End of Core Hole at 10.00 meters

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 4 Page 1 of 2	CLIENT: NIPPON KOEI CO. LTD CONTRACT No.: OPG 11056 NIP

COREHOLE BH 4

Depth : 0.00 –6.00 meters

COREHOLE BH 4

Depth : 6.00 –10.00 meters

End of Core Hole at 10.00 meters

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 6 **Page 1 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 6

Depth : 0.00 –6.00 meters

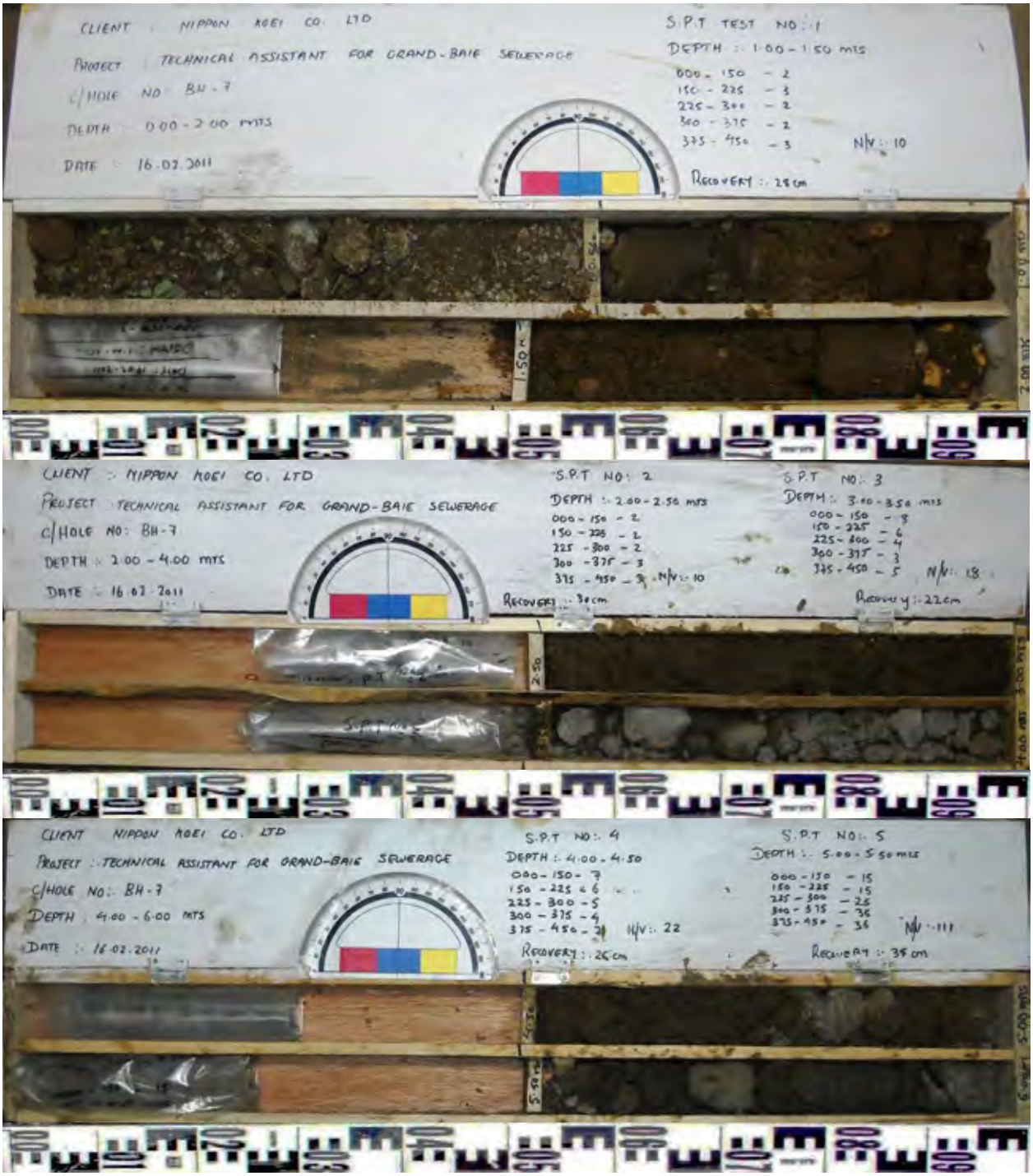
COREHOLE BH 6

Depth : 6.00 –10.00 meters

End of Core Hole at 10.00 meters

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 7 **Page 1 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 7



Depth : 0.00 –6.00 meters

COREHOLE BH 7

Depth : 6.00 –10.00 meters

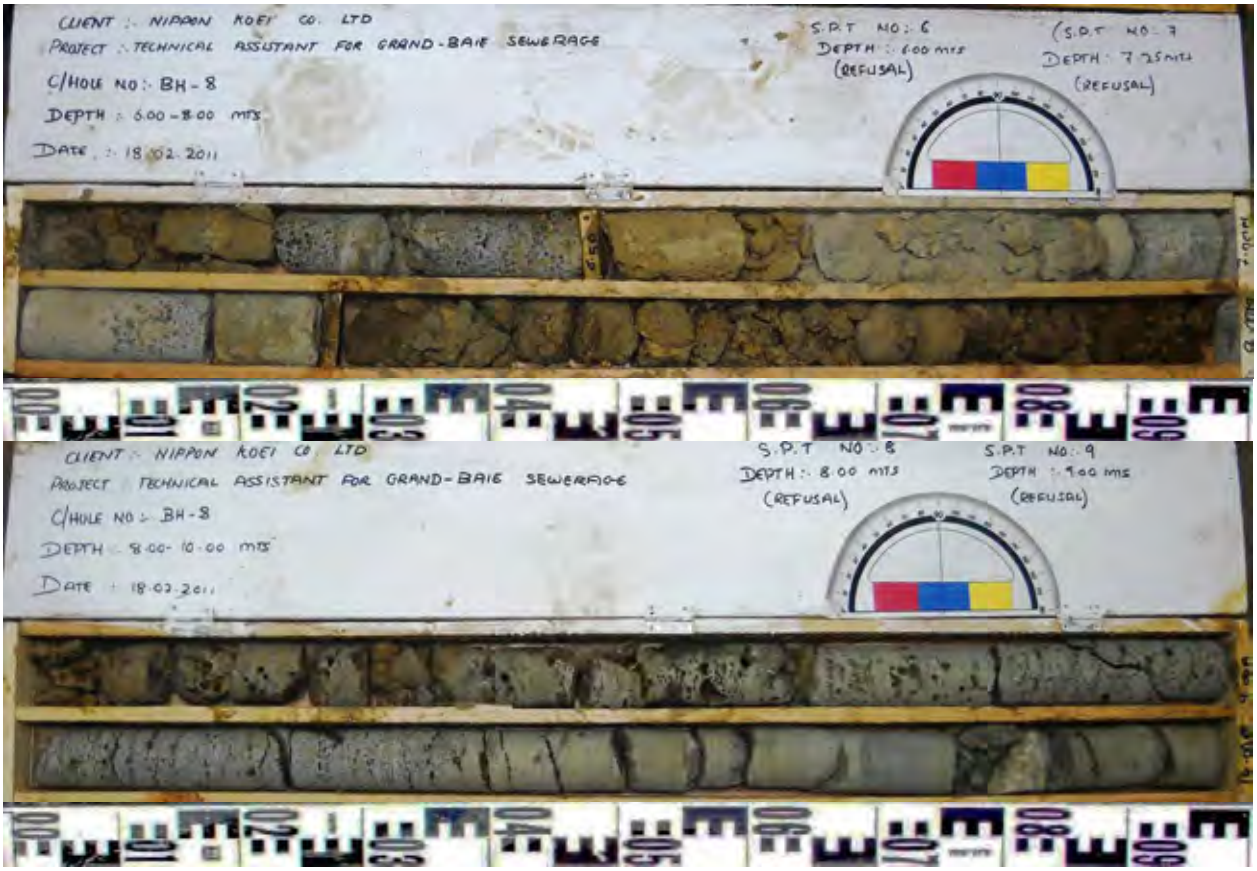
End of Core Hole at 10.00 meters

WATER RESEARCH CO. LTD	SUBSOIL INVESTIGATION AT GRAND BAIE
BH 8 **Page 1 of 2**	**CLIENT: NIPPON KOEI CO. LTD** **CONTRACT No.: OPG 11056 NIP**

COREHOLE BH 8

Depth : 0.00 –6.00 meters

COREHOLE BH 8



Depth : 6.00 –10.00 meters

End of Core Hole at 10.00 meters

Appendix C Laboratory Test Results

CHEMCO

CHEMCO LABORATORY SERVICES

CERTIFICATE OF ANALYSIS

REQUESTED BY Water Research Co Ltd Old Quay Road Port Louis	SAMPLING LOCATION SAMPLING PLAN NO. DATE COLLECTED TIME COLLECTED WEATHER	: N/A : N/A : N/A : N/A : N/A
CONTACT PERSON Mr. Emilio Saldivar	SAMPLE REMITTANCE REF. NO. SAMPLE ID NO. DATE RECEIVED	: SRF/CHEM/LAB/WRC/03 : 2173 : 25 February 2011
DESCRIPTION OF SAMPLE One water sample from NIPPON KOEI COMPANY LTD; TECHNICAL ASSISTANT FOR GRAND BAIE SEWERAGE (CH:2) submitted on 25.02.11.	**OUR REFERENCE** REPORT DATE TEST STARTED ON TEST ENDED ON	**: DB/AE/WR/11/451** : 07 March 2011 : 25 February 2011 : 07 March 2011

PARAMETERS	UNITS	RESULTS	PERMISSIBLE LIMITS	DETECTION LIMITS	REFERENCE METHODS
PHYSICAL TESTS					
Conductivity	µS/cm	2 200	-	-	APHA 2510 B
pH	-	7.31	-	-	APHA 4500-H+
Total Dissolved Solids	mg/L	1 190	-	-	APHA 2540 C
Turbidity	NTU	4.26		-	Nephelometric Method
CHEMICAL TESTS					
Chemical Oxygen Demand	mg/L	153	-	-	APHA 5220 C
Nitrate (as N)	mg/L	5.24	-	-	APHA 4500-NO_3 B
Chlorides	mg/L	584		-	**APHA 4500-Cl B**
Sulphates	mg/L	168.4	-	-	AOAC Official Method 973.57

GENERAL COMMENTS

1. All the tests were carried out at room temperature unless otherwise specified in standard test method.
2. Abbreviations used in this report are: mg/L: milligrams per liter ; µS/cm: micro Siemens per centimeter; ml/ L: milliliter per liter; n/a: Not applicable; D.L: Detection Limit; N.D: Not detected ; MPN/100ml: most probable number per 100 ml

THE ANALYTICAL DATA IN THIS REPORT WERE REVIEWED AND VALIDATED BY THE FOLLOWING PERSON(S):

A. Emritte

AMRINE EMRITTE
LABORATORY ANALYST

CHEMCO LTD P.O. Box 160 Tel: 216-3990 Port Louis

DHIRAJ BOKHOREE
WATER TREATMENT & LABORATORY DIVISION MANAGER

Note: Certificate of analysis shall not be reproduced except in full, without written approval of the laboratory.

-End of Report-

CHEMCO

CHEMCO LABORATORY SERVICES

CERTIFICATE OF ANALYSIS

REQUESTED BY Water Research Co Ltd Old Quay Road Port Louis	SAMPLING LOCATION SAMPLING PLAN NO. DATE COLLECTED TIME COLLECTED WEATHER	: N/A : N/A : N/A : N/A : N/A
CONTACT PERSON Mr. Emilio Saldivar	SAMPLE REMITTANCE REF. NO. SAMPLE ID NO. DATE RECEIVED	: SRF/CHEM/LAB/WRC/03 : 2172 : 25 February 2011
DESCRIPTION OF SAMPLE One water sample from NIPPON KOEI COMPANY LTD; TECHNICAL ASSISTANT FOR GRAND BAIE SEWERAGE (CII:1) submitted on 25.02.11.	**OUR REFERENCE** REPORT DATE TEST STARTED ON TEST ENDED ON	**: DB/AE/WR/11/450** : 07 March 2011 : 25 February 2011 : 07 March 2011

PARAMETERS	UNITS	RESULTS	PERMISSIBLE LIMITS	DETECTION LIMITS	REFERENCE METHODS
PHYSICAL TESTS					
Conductivity	µS/cm	825	-	-	APHA 2510 B
pH	-	7.73	-	-	APHA 4500-H+
Total Dissolved Solids	mg/L	422	-	-	APHA 2540 C
Turbidity	NTU	29.6		-	Nephelometric Method
CHEMICAL TESTS					
Chemical Oxygen Demand	mg/L	221	-	-	APHA 5220 C
Nitrate (as N)	mg/L	0.35	-	-	APHA 4500-NO_3 B
Chlorides	mg/L	110.3		-	**APHA 4500-Cl^- B**
Sulphates	mg/L	37.2	-	-	AOAC Official Method 973.57

GENERAL COMMENTS

1. All the tests were carried out at room temperature unless otherwise specified in standard test method.
2. Abbreviations used in this report are: mg/L: milligrams per liter ; µS/cm: micro Siemens per centimeter; ml/ L: milliliter per liter; n/a: Not applicable; D.L: Detection Limit; N.D: Not detected ; MPN/100ml: most probable number per 100 ml

THE ANALYTICAL DATA IN THIS REPORT WERE REVIEWED AND VALIDATED BY THE FOLLOWING PERSON(S):

AMRINE EMRITTE
LABORATORY ANALYST

DHIRAJ BOKHOREE
WATER TREATMENT & LABORATORY DIVISION MANAGER

Note: Certificate of analysis shall not be reproduced except in full, without written approval of the laboratory.

-End of Report-

Cernol
Water Solutions Ltd

PERSONAL SERVICE REPORT

Company	**: Water Research Co. Ltd.**
Address	**: Old Quay Road, Port Louis**
Date of sample	**: 22/02/11**
Date of Test	**: 22/02/11**
BRN	**: C07013374**

Reference: W 184-185/B/11

Dear Madam,

We are pleased to submit hereunder results of analysis performed on your water samples collected on the 22ND February 2011.

PARAMETERS	UNITS	NIPPON KOE 1 COMPANY TECHNICAL ASSISTANT FOR GRAND BAY SEWERAGE CH 1
Nitrite	(mg/l, NO_2^-)	2

Assuring you of our best services at all times.

Yours faithfully,
For and on behalf of
CERNOL WATER SOLUTIONS LTD

MICHAEL CARVER
ADMINISTRATIVE MANAGER

Cernol
Water Solutions Ltd

PERSONAL SERVICE REPORT

Company	**: Water Research Co. Ltd.**
Address	**: Old Quay Road, Port Louis**
Date of sample	**: 22/02/11**
Date of Test	**: 22/02/11**
BRN	**: C07013374**

Reference: W 182-183/B/11

Dear Madam,

We are pleased to submit hereunder results of analysis performed on your water samples collected on the 22ND February 2011.

PARAMETERS	UNITS	NIPPON KOE 1 COMPANY TECHNICAL ASSISTANT FOR GRAND BAY SEWERAGE CH 2
Nitrite	(mg/l, NO_2^-)	8

Assuring you of our best services at all times.

Yours faithfully,
For and on behalf of
CERNOL WATER SOLUTIONS LTD

MICHAEL CARVER
ADMINISTRATIVE MANAGER

UNIVERSITY OF MAURITIUS
FACULTY OF ENGINEERING
CIVIL ENGINEERING DEPT.

Requestor: ***Water research Co. Ltd.***
Project : ***Subsoil investigation @ Grand Baie***
Site/location: ***Grand Baie***
Date: ***Mar-11***

TEST: UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE

Sample No	Depth (m)	Mean diameter mm	Mean Length mm	Initial Mass g	Bulk density (Kg/m^3)	Failure Load kN	Unconfined Compressive strength MPa	Sample Description	Remarks
BH 1	3.65 - 3.85	51.5	132.0	641.32	2334	64.2	30.8	Moderately strong,light grey, highly vesicular (~20-25%),max. size 11x16x10mm, fine grained Basalt.	
BH 1	8.64 - 8.83	51.6	131.8	708.57	2572	96.0	45.9	Strong,light grey, slightly vesicular(~ 5%) (max. size 15x5x5mm), fine grained Basalt.	
BH 2	4.20 - 4.40	51.6	130.2	724.21	2661	136.9	65.5	Strong,light grey, slightly weatherd with some isolated vesicles (max. size 7x 7x 10 mm). fine grained Basalt.	
BH 2	4.70 - 4.90	51.6	130.6	741.99	2718	129.4	61.9	Strong,light grey, slightly weatherd with some very small isolated vesicles fine grained Basalt.	
BH 3	1.50 -1.70	51.6	130.5	602.45	2209	62.4	29.9	Moderately strong, slightly weathered, highly vesicular (30 -40%),max size:15x5x10 mm, light grey fine grained Basalt.	

UNIVERSITY OF MAURITIUS
FACULTY OF ENGINEERING
CIVIL ENGINEERING DEPT.

Requestor: ***Water research Co. Ltd.***
Project : ***Subsoil investigation @ Grand Baie***
Site/location: ***Grand Baie***
Date: ***Mar-11***

TEST: UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE

Sample No	Depth (m)	Mean diameter mm	Mean Length mm	Initial Mass g	Bulk density (Kg/m^3)	Failure Load kN	Unconfined Compressive strength MPa	Sample Description	Remarks
BH 3	2.50 - 2.70	51.7	131.8	721.48	2609	37.6	17.9	Strong,light grey, fine grained Basalt with much small vesicles throughout the core and one existing hair crack.	Failure occurred along the existing crack.
BH 4	0.00 - 0.20	51.6	132	654.93	2374	78.8	37.7	Moderately strong, light grey,highly vesicular (~ 30%)max. size 20x10x10mmdeep, fine grained Basalt.	
BH 4	4.00 - 4.20	51.8	130	729.16	2663	151.8	72.1	Strong,light grey, slightly weatherd , fine grained Basalt with numerous small vesicles throughout the core	
BH 6	2.53 - 2.73	51.7	133.6	746.19	2662	139.9	66.7	Strong,light grey, slightly weatherd , fine grained Basalt with numerous small vesicles throughout the core	
BH 3	4.05 - 4.25	51.6	129.8	738.31	2721	119.9	57.4	Strong,light grey, slightly weatherd , fine grained Basalt with numerous small vesicles throughout the core	

UNIVERSITY OF MAURITIUS
FACULTY OF ENGINEERING
CIVIL ENGINEERING DEPT.

Requestor: ***Water research Co. Ltd.***
Project : ***Subsoil investigation @ Grand Baie***
Site/location: ***Grand Baie***
Date: ***Mar-11***

TEST: UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE

Sample No	Depth (m)	Mean diameter mm	Mean Length mm	Initial Mass g	Bulk density (Kg/m^3)	Failure Load kN	Unconfined Compressive strength MPa	Sample Description	Remarks
BH 8	4.64 - 4.90	51.6	130.2	727.68	2674	68.1	32.6	Moderately strong,light pinkish grey, fine grained Basalt with numerous small vesicles throughout the core	
BH 8	5.32 - 5.94	51.5	133.3	702.92	2533	51.4	24.7	Moderately strong,light pinkish grey,slightly weathered fine grained Basalt with some isolated small vesicles:max. size 8x6x10 mm	

2. REPORT OF BOREHOLE INJECTION TEST

FACTUAL REPORT ON

INJECTION SURVEY

AT GRAND BAIE

Prepared for

Nippon Koei Co Ltd

Prepared by

Water Research Co Limited

March 2011

OPG 110056 NIP

Revision	Description	Issued by	Date
0	DRAFT - Issued for comments	ES/ NC	16th March 2011
1	FINAL issue	ES/ NC	22nd March 2011

Produced	**Nazila Choolun**
Signature	
Date	**22nd March 2011**
Checked	**Emilio Saldivar**
Signature	
Date	**22nd March 2011**

Contents

1 Introduction

1.1 Introduction

On 25th January 2011, Water Research Co Limited (Water Research) was instructed by the Japan International Coorperation Agency - JICA (Client) to carry out an Injection Well (Borehole) and Geological (Corehole) Surveys to support the evaluation of the Grand Baie Sewerage Project by the Wastewater Management Authority (WMA). The Study Team appointed by the Client is Nippon Koei Ltd and the local representative is Luxconsult Co. Ltd. The Injection Well Survey is carried out to evaluate the disposal capacity of wells; the Geological Survey is being carried out to support the design of foundations for the pumping stations.

1.2 Scope of works and Report format

The Injection Well Survey works consist of the drilling of 2No boreholes, permeability testing, ground water level measurement as on-site works and water quality testing, geological logging and factual reporting as off-site works. The Geological Survey works consist of the drilling of 8No. coreholes, standard penetration tests (SPT), ground water level measurement as on-site works and water quality, unconfined compressive strength (UCS) tests and factual reporting.

The aim of the works executed was to determine the borewell capacity and collect drilling and geological data. The following information is presented in this Factual Report:

- Description of the Works
- Borehole characteristics
- Geological data collected during the drilling process
- Pumping test results to determine the safe yield
- Result of chemical analyses of the borehole water (not available at the time of producing this Report).

2 Desk study information

2.1 Site location and topography

The 2No. boreholes are located within 1km of the Grand Baie Treatment and situated some 250m apart (Figures 2.1 and 2.2). Site elevations vary between 20m and 40m amsl. At the time of the investigation, the site was covered with sugarcane cultivation. The boreholes are situated at approximately 1km from the sea.

2.2 Geology

The 1:50,000 Geological Map of Mauritius (Figure 2.3, Ref. 1) shows that the borehole site is underlain by fresh basalt of the Late Lavas of the Younger Volcanic Series that are characterised by uniform doleritic facies. These late lavas are light greyish in colour and show many phenocrysts (large crystal surrounded by a finer-grained matrix in an igneous rock) of olivine scattered in the doleritic network of feldspars and pyroxenes (silicate minerals). They are often porous and vesicular and show many cracks and fissures, but they are also sometimes compact. Scoriaceous textures are common, mainly at the upper and lower parts of the flows. Weathering is in general not important and is very often in concentric beds production onion-type alteration structures (Ref. 3).

According to the hydrogeological survey (Figure 2.4, Ref. 1); the project site is under the aquifer of the Northern Plains.

3 Geotechnical field and laboratory works

3.1 Geotechnical investigation works

The Works was awarded to Water Research on 25th January 2011 with site works carried out between the 28th February and 17th March 2011. The works comprised 2No. boreholes and included drilling, logging, airlift to develop the borewell and pumping and recovery tests. The location of the coreholes is shown in Figure 2.2 and the photographs of site works are presented in Appendix A. The drilling works were performed in accordance with the "Code of Practice for site Investigation – BS 5930:1999" (Ref. 4). The summary of the works is presented in Appendix B.

The following Sections present a general description of the works carried out.

3.2 Drilling and Well Development

The position of the hole and timing of drilling were agreed between Water Research and the Study Team.

Boring was carried out using a Super Rock rig following Down the Hole Hammer (DTH) technique as best suitable under prevailing conditions. Photos of site works are presented in Appendix A.

BH 1 was completed at 300mm diameter and 52.0m depth. After completion of the drilling and prior to airlift the borehole was lined with 250mm diameter PVC pipe, slotted between 6.0m and 42.0m. During installation of the PVC, the borehole walls collapsed and closed as from 42.0m. The airlift system was then installed to the bottom of the borehole to develop and clean the hole by injecting compressed air. The 1hr long airlift was carried out on the 28th February 2011 producing a yield of 18.0m^3/hr. The well development data is presented on Appendix B.

BH 2 was completed at 375mm diameter from 0.0m to 52.0m and at 250mm diameter from 52.0m to 72.0m depth. After completion of the drilling and prior to airlift the borehole was lined with 300mm diameter PVC pipe from 0.0m to 52.0m depth and with 200mm diameter pipe from 52.0m to 72.0m, slotted between 3.0m and 72.0m. The airlift system was then installed to the bottom of the borehole to develop and clean the hole by injecting compressed air. The 1hr long airlift was carried out on the 08th March 2011 producing a yield of 42.0m^3/hr. The well development data is presented on Appendix B.

3.3 Identified Soil Profile

The DTH technique does not produce rock core samples. The limited description presented below as logging is based on fragmented material resulting from the use of the drilling hammer – the material description is by the driller on site. Photographs of the cuttings are presented in Appendix A of this report.
The soil profiles in BH 1 and BH 2 were identified as comprising:

BH 1		BH 2	
▪ 0.0m to 3.0m (bgl)	Basalt;	▪ 0.0m to 2.0m (bgl)	Clay;
▪ 3.0m to 5.0m bgl	Weathered Basalt;	▪ 2.0m to 4.0m bgl	Fresh Basalt;
▪ 5.0m to 28.0m bgl	Basalt;	▪ 4.0m to 8.0m bgl	Moderately Weathered Basalt;
▪ 28.0m to 30.0m bgl	Weathered Basalt;	▪ 8.0m to 32.0m bgl	Moderately Weathered Basalt;
▪ 30.0m to 38.0m bgl	Basalt;	▪ 32.0m to 36.0m bgl	Weathered Basalt;
▪ 38.0m to 44.0m bgl	Weathered Basalt;	▪ 36.0m to 37.00m bgl	Cavity;
▪ 44.0m to 51.0m bgl	Basalt;	▪ 37.0m to 39.0m bgl	Highly Weathered Basalt;
▪ 51.0m to 52.0m bgl	Weathered Basalt.	▪ 39.0m to 40.0m bgl	Basalt;
		▪ 40.0m to 44.0m bgl	Weathered Basalt;
		▪ 44.0m to 48.0m bgl	Fresh Basalt;
		▪ 48.0m to 52.0m bgl	Highly Weathered Basalt;
		• 52.0m to 61.0m bgl	Highly Weathered Basalt;
		• 61.0m to 66.0m bgl	Clay;
		• 66.0m to 72.0m bgl	Highly Weathered Basalt.

2No. water strikes were recorded in BH 1 at 28.0m bgl (fresh water) and at 38.0m bgl (sea water) respectively with the static water level at 27.25m bgl before the start of the pumping tests.

2No. water strikes were recorded in BH 2 at 31.0m bgl (fresh water) and at 37.0m bgl (sea water) respectively with the static water level at 26.50m bgl before the start of the pumping tests. The geological logs are presented in Appendix C.

3.4 Pumping Tests

The pumping tests were performed in both boreholes to assist on the definition of the performance characteristics of the borehole and the aquifer. The pumping tests in BH 1 were carried out between the 10th and 12th March 2011 by means of a SP95-6 Grundfos submersible pump installed at 39.0m bgl. Pumping Tests in BH 2 were carried out between the 15th and 17th March 2011 by means of a submersible Jet Pump installed at 48.5m bgl. The tests comprised, in sequential order, 4No. consecutive steps and recovery, 1No. 24hrs and 1No. recovery tests. The drawdowns during pumping tests and the recovery tests were recorded in the pumped well using a water level indicator (electric probe).

3.4.1 Step Tests

Step tests assist on the evaluation of the maximum rate of extraction for the well. 4No. step tests were carried out on BH 1 and BH 2 on the 10th March 2011 and on the 15th March 2011 respectively at the yields and

durations presented in Table 3.1. The yield versus draw down data for BH 1 and BH 2 is presented in Appendix C and Figures 3.1 to 3.4.

Table 3.1 Summary of step tests results

No. Step	Duration of Test (mins)	Q (Yield) m^3/h	s (Draw down) m	s/Q h/m^2	Q/s m^2/h
BH 1					
1	30	25.5	0.03	0.00118	850.0
2	30	50.2	0.05	0.00100	1004.0
3	30	75.6	0.10	0.00132	756.0
4	30	106.0	0.16	0.00151	662.5
BH 2					
1	30	69.9	0.03	0.0004	2330.0
2	30	154.0	0.02	0.0001	7700.0
3	30	227.7	0.01	0.0000	22770.0
4	60	363.0	0.09	0.0002	4033.3

3.4.2 Long Term Pumping Tests

The constant yield long term pumping test allows the determination of the hydraulic parameters of the aquifer. The long term test in BH 1 consisted of a constant rate of $106m^3/hr$. The drawdown at the end of the pumping test was 0.32m. The data for the long term pumping test in BH 1 are presented in Appendix C and Figures 3.5 to 3.7.

The long term test in BH 2 consisted of a constant rate of $350m^3/hr$. The drawdown at the end of the pumping test was 0.03m. The data for the long term pumping test in BH 2 are presented in Appendix C and Figures 3.8 to 3.10.

Transmissivity and Coefficient of Storage can be obtained from time-drawdown graphs. Transmissivity (T) is defined as the rate of flow through the vertical section of an aquifer one meter wide and extending the full saturated height of an aquifer under a hydraulic gradient of 1 (100%). Transmissivity can be used to compute the flow through any vertical section of an aquifer using the Darcy equation (Ref. 5 and 6). Coefficient of storage, S, of an aquifer represents the volume of water released from storage, or taken into storage, per unit of aquifer storage area per unit change in head. In unconfined aquifers, S is the same as the specific yield of the aquifer and range from 0.01 to 0.3. In confined aquifers, S ranges from 10^{-5} to 10^{-3}. Coefficient of storage is lower in confined aquifers because they are not drained during pumping, and any water released from storage is obtained primarily by compression of the aquifer and expansion of the confined water when the head (pressure) is reduced during pumping. During pumping the pressure is reduced in the aquifer, but the aquifer is not dewatered.

Transmissivity, measured between 100mins and 1000mins during the 24hr pumping test in BH 1 (Figure 3.5), is 9311m^2/day (1.08x$10^{-1}$$m^2$/s). Transmissivity, measured between 100mins and 1000mins during the 24hr pumping test in BH 2 (Figure 3.8), is 15372m^2/day (1.78x$10^{-1}$$m^2$/s). Values lower than 12.4m^2/day indicate enough water for domestic wells or other low-yield uses; values higher than 124m^2/day indicate flow that can be adequate for industrial, municipal or irrigation purposes (Refs. 6 and 7).

3.5 Conductivity measurements

Conductivity measurements and temperature were taken with Solinst Water Level Meter Model 101. The results obtained in BH 1 and BH 2 are shown in Appendix D of this report.

3.6 Water Quality Tests

The collection of groundwater for physical-chemical analysis is an important part of the groundwater exploitation programme. Water samples were collected from BH 1 and BH 2 towards the end of the 24hrs pumping test on the 12th and 17th March 2011 respectively.

4 Closing remarks

On 25th January 2011, Water Research Co Limited (Water Research) was instructed by the Japan International Coorperation Agency - JICA (Client) to carry out an Injection Well (Borehole) and Geological (Corehole) Surveys to support the Technical Assistance for the Grand Baie Sewerage Project which is being carried out for the Wastewater Management Authority (WMA). The Study Team appointed by the Client is Nippon Koei Ltd and the local representative is Luxconsult Co. Ltd.

This Preliminary Factual Report presents brief desk study information for the site (including description of the geology, maps and plans) and the factual information from the Injection Survey only. The information presented is as per Specification provided and will be used to assess the characteristics of the boreholes for injection of treated wastewater from the Grand Baie WWTP.

The Works was awarded to Water Research on 25th January 2011 with site works carried out between the 28th February and 17th March 2011 and comprised 2No. boreholes and included drilling, logging, airlift to develop the borewell and pumping and recovery tests. The drilling works were performed in accordance with the "Code of Practice for site Investigation – BS 5930:1999".

Borehole BH 1 was drilled at 300mm diameter and 52.0m depth and lined with 250mm PVC which was slotted between 6.0m and 42.0m. A 1hr long airlift was carried out in BH 1 producing a yield of 18.0m^3/hr. BH 2 was completed at 375mm diameter from 0.0m to 52.0m and at 250mm diameter from 52.0m to 72.0m depth. After completion of the drilling and prior to airlift the borehole was lined with 300mm diameter PVC pipe from 0.0m to 52.0m depth and with 200mm diameter pipe from 52.0m to 72.0m, slotted between 3.0m and 72.0m. A 1hr long airlift was carried out in BH 2 producing a yield of 42.0m^3/hr.

4No. step tests were carried out in BH 1 at yields of 25.5m^3/hr, 50.2m^3/hr, 75.6m^3/hr and 106.0m^3/hr respectively. A 24-hours long term test was carried out at 106m^3/h with a drawdown of 0.23m. 4No. step tests were carried out in BH 2 at yields of 69.9m^3/hr, 154m^3/hr, 227.7m^3/hr and 363.0m^3/hr respectively. A 24-hours long term test was carried out at 350m^3/h with a drawdown of 0.03m. Transmissivities, measured between 100mins and 1000mins during the 24hr pumping test on BH 1 and BH 2 were of the order of 9311m^2/day (1.08x10^{-1}m^2/s) and 15372m^2/day (1.78x10^{-1}m^2/s) respectively.

Physico-chemical testing of water samples collected from both boreholes will be carried out and the results will be submitted when available.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

5 References

1. L. Giorgi and S Borchiellini (1999), Les aquifères de l'Ile Maurice (Map)
2. Prem Saddul (2002), Mauritius, A geomorphological analysis, Mahatma Gandhi Institute. pp. 31-35.
3. Proag, V. (1995), The geology and water resources of Mauritius, analysis, Mahatma Gandhi Institute.
4. Directorate of overseas surveys (UK) (1962), Soil Map of Mauritius, Public Works and Survey Department, Port Louis Mauritius.
5. British Standards (1999), BS 5930, Code of practice for site investigations.
6. British Standards (1992), BS 6316, Code of practice for test pumping of water wells.
7. Driscolli, F. G. (1989), Groundwater and wells, Second Edition, Johnson. pp. 76, 210-237.
8. Ministry of Public Utilities (Water Resources Unit) (1992-1995), Hydrology Data Book.

6 Figures

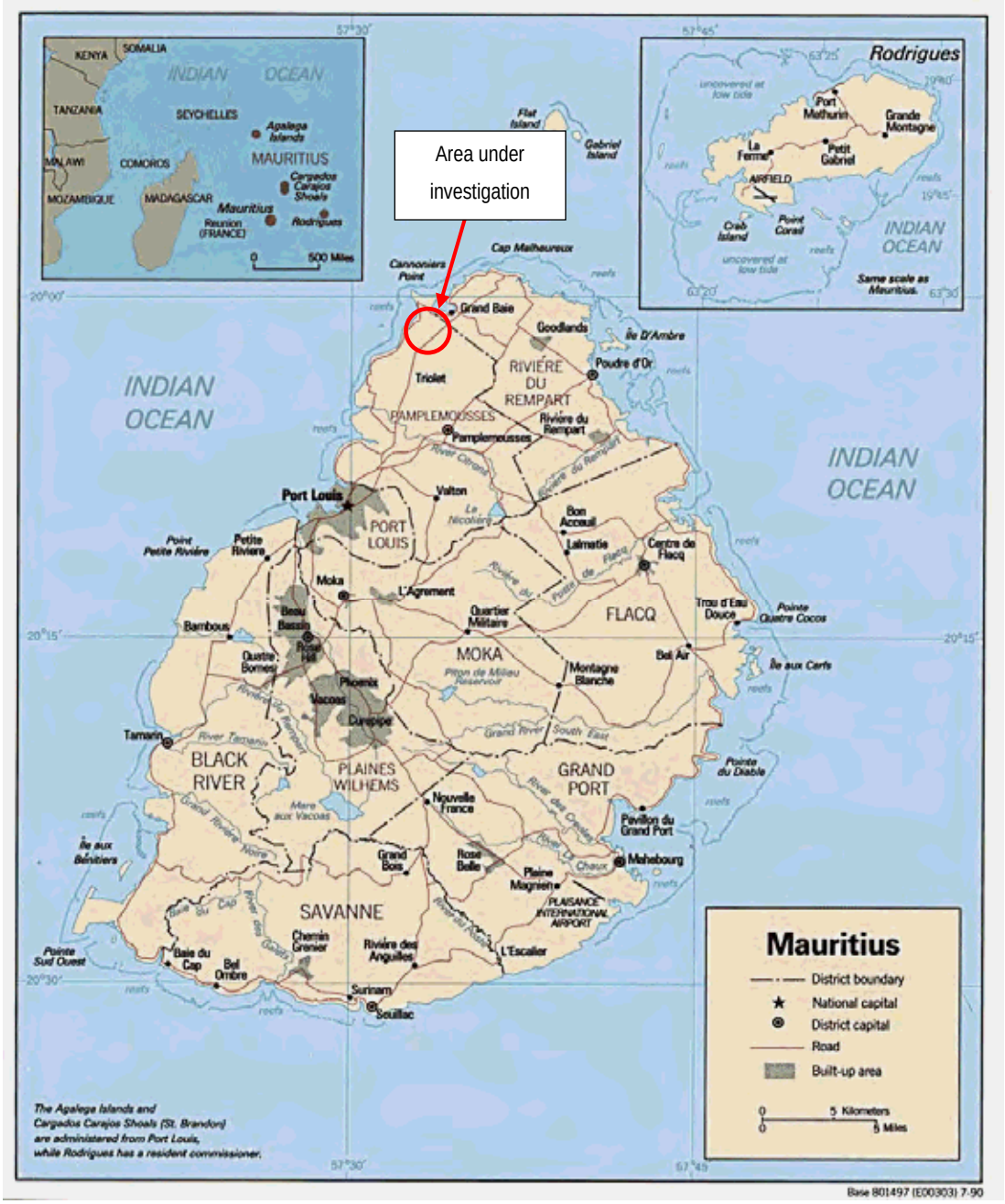


Figure 2.1 General location of the site

Figure 2.2 Site Location

Figure 2.3 Location of the site on geological map

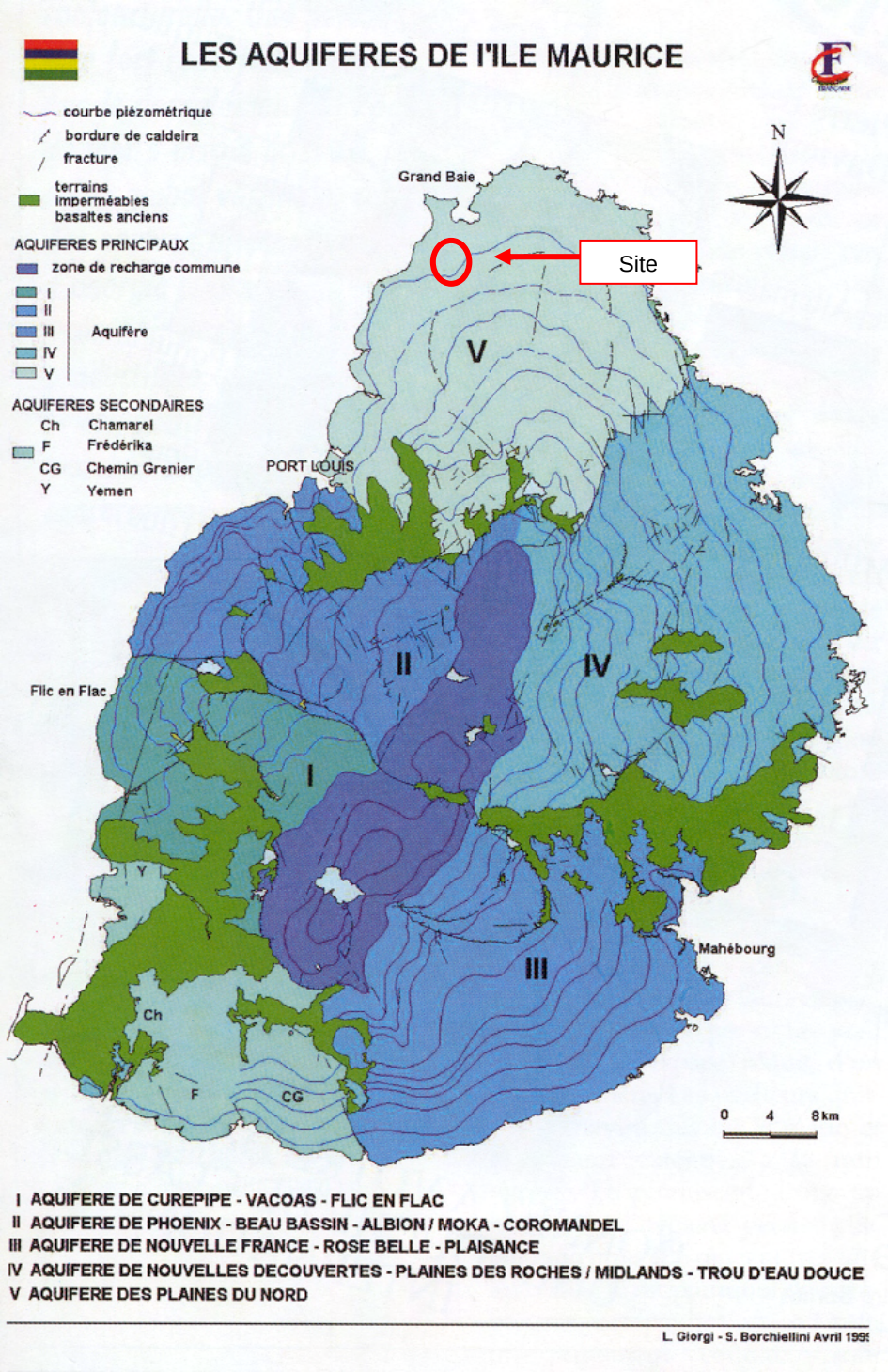


Figure 2.4 Location of the site on the Aquifer map

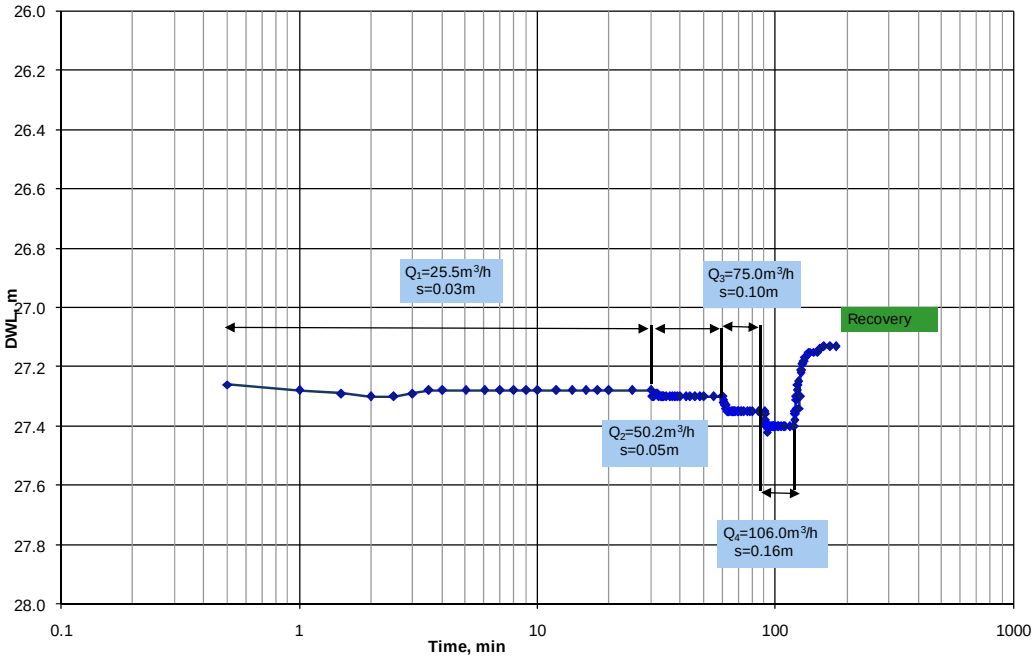


Figure 3.1 Graphs showing pumping steps tests results in BH 1

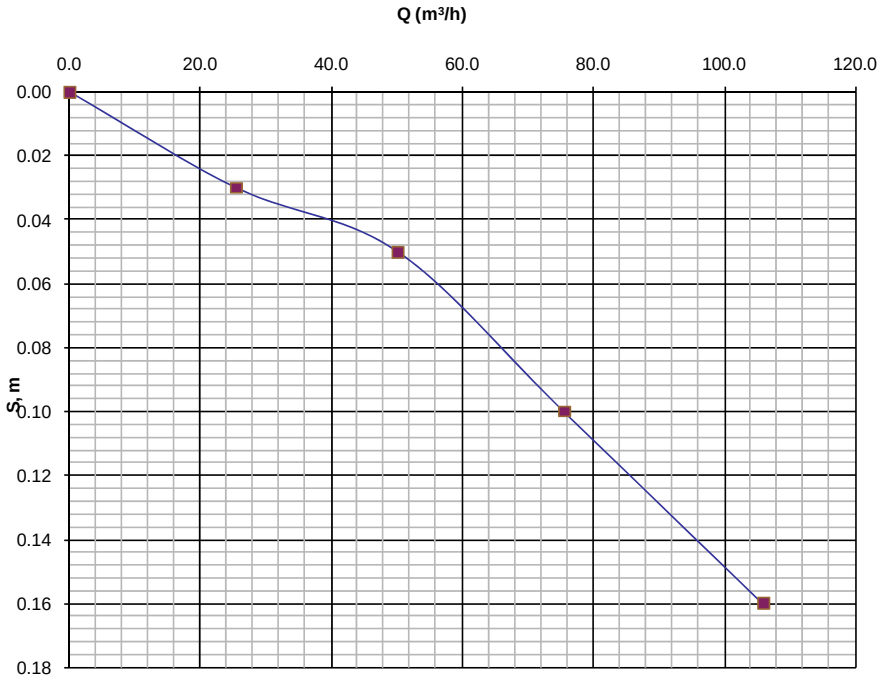


Figure 3.2 Characteristic curve for BH 1

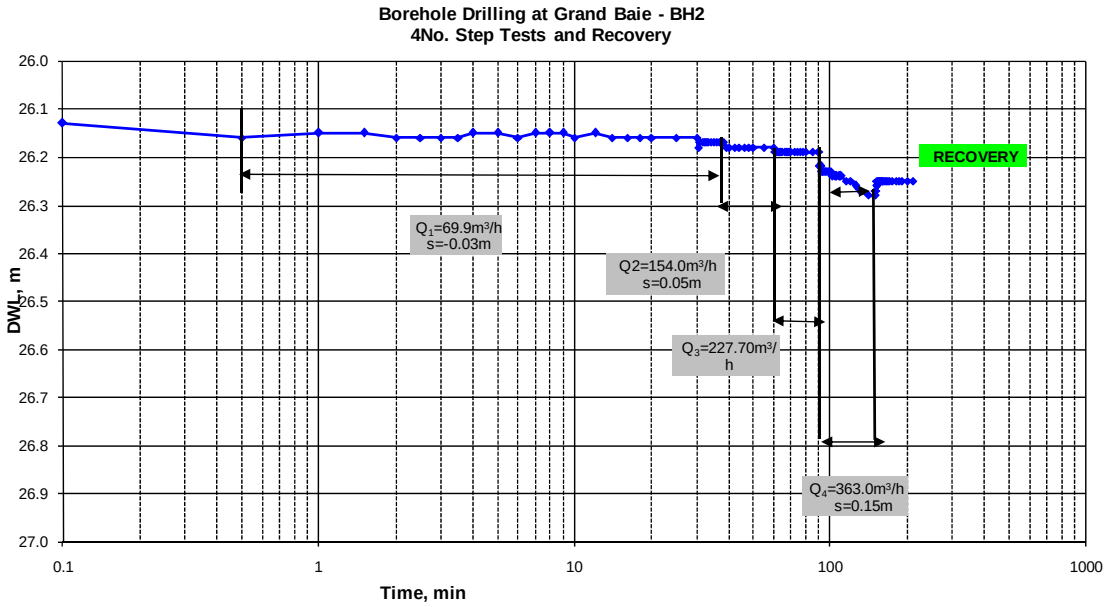


Figure 3.3 Graphs showing pumping steps tests results in BH 2

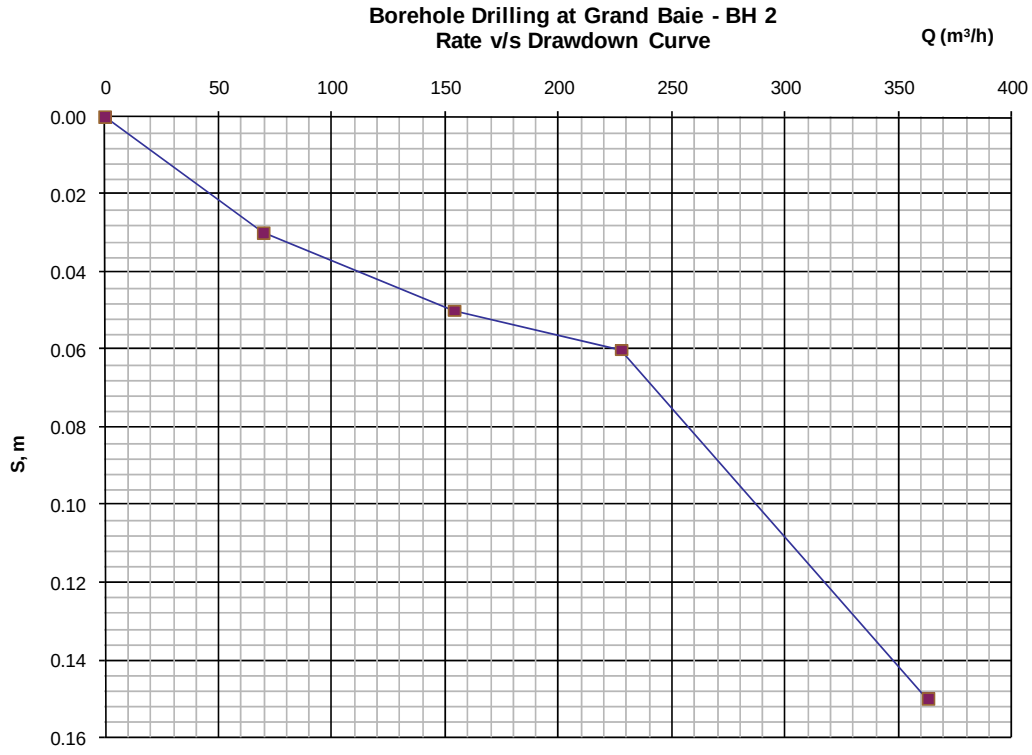


Figure 3.4 Characteristic curve for BH 2

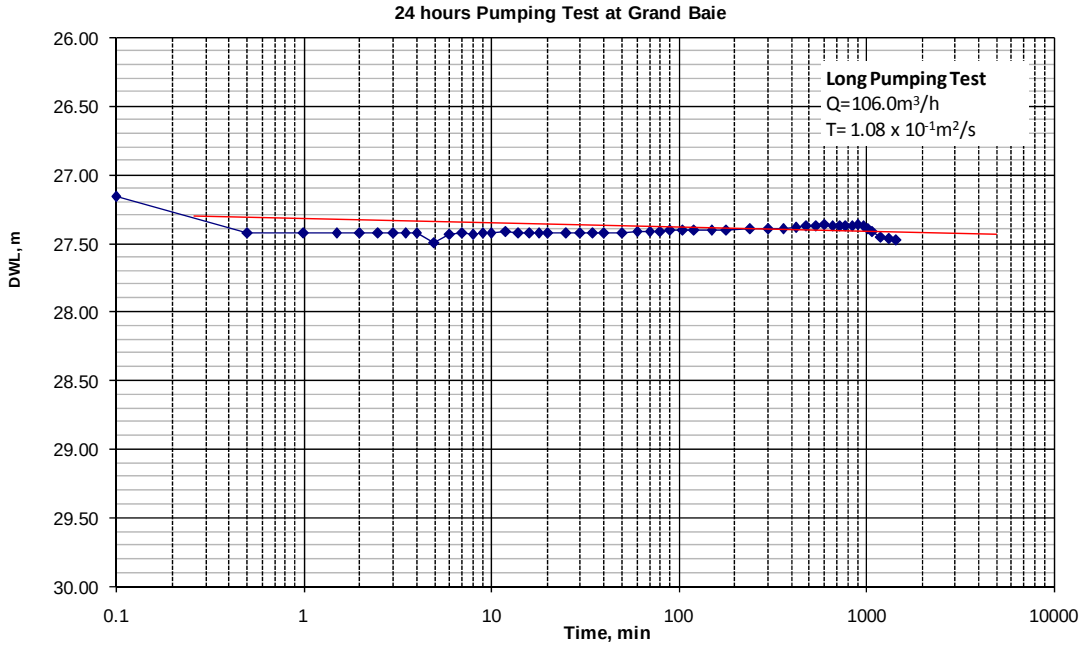


Figure 3.5 24hrs pumping test results for BH 1

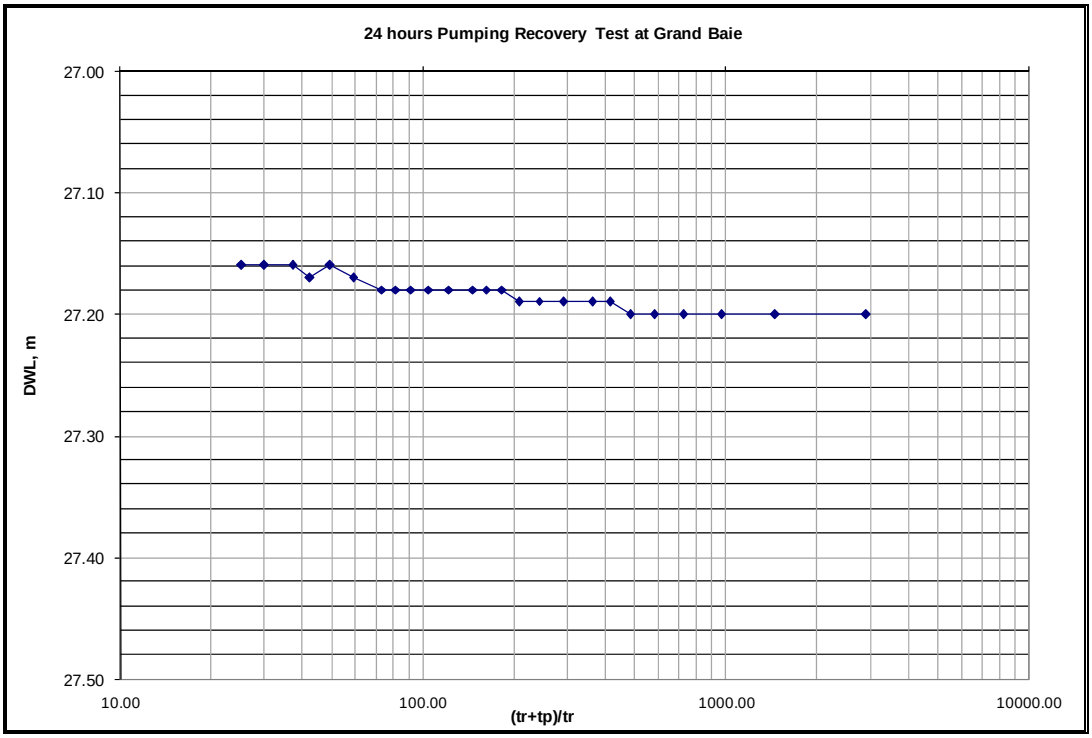


Figure 3.6 Recovery after 24hrs pumping test in BH 1

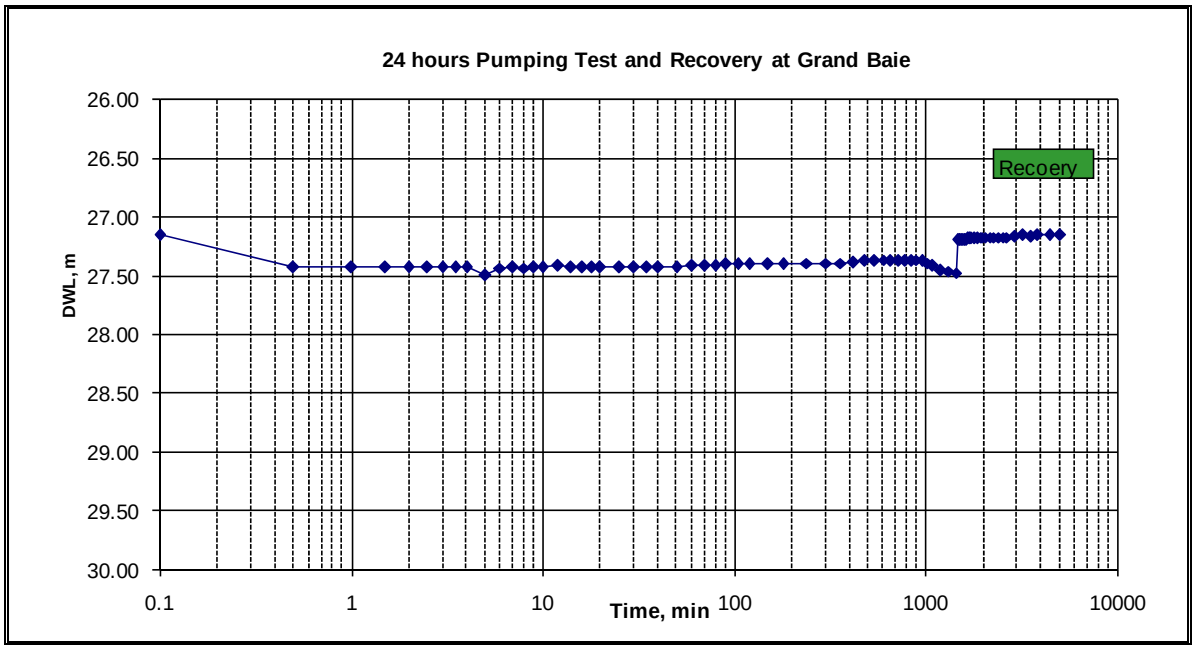


Figure 3.7 24hrs pumping test and recovery in BH 1

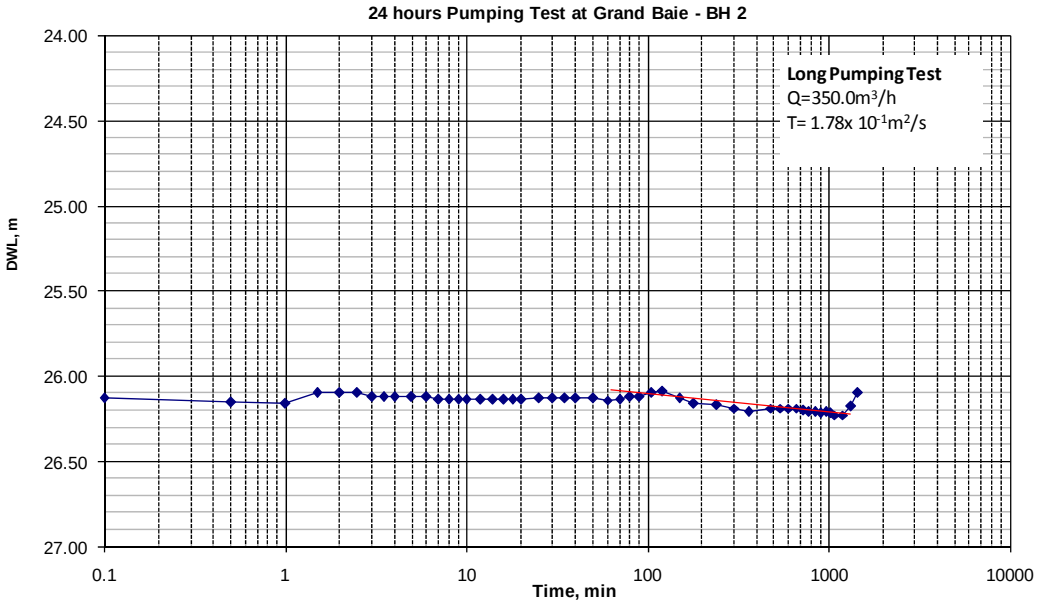


Figure 3.8 24hrs pumping test results for BH 2

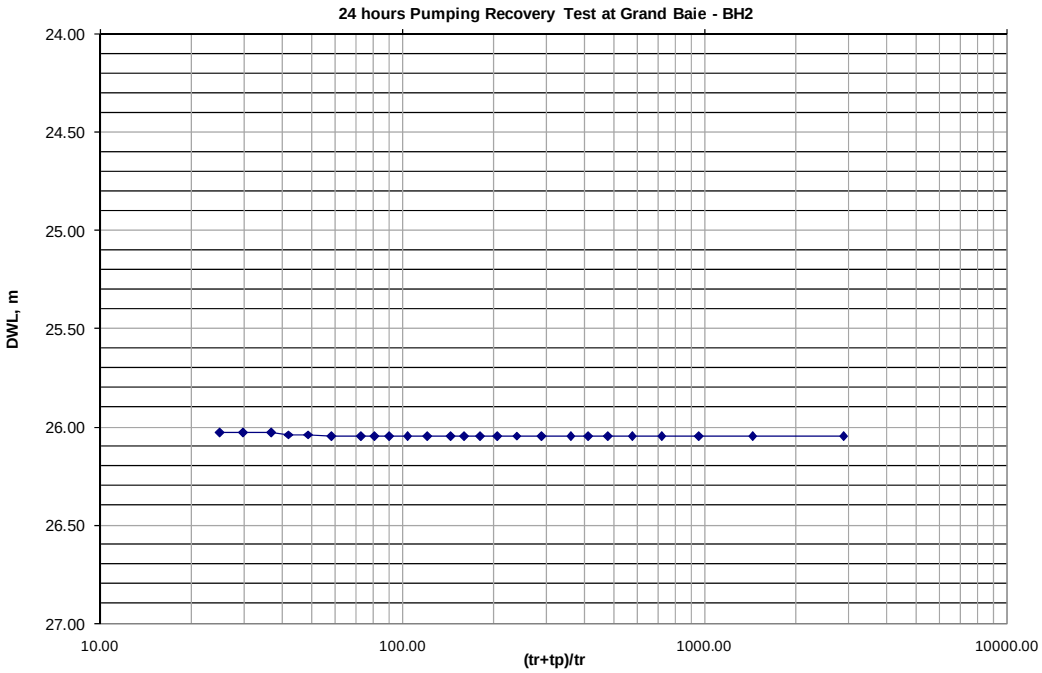


Figure 3.9 Recovery after 24hrs pumping test in BH 2

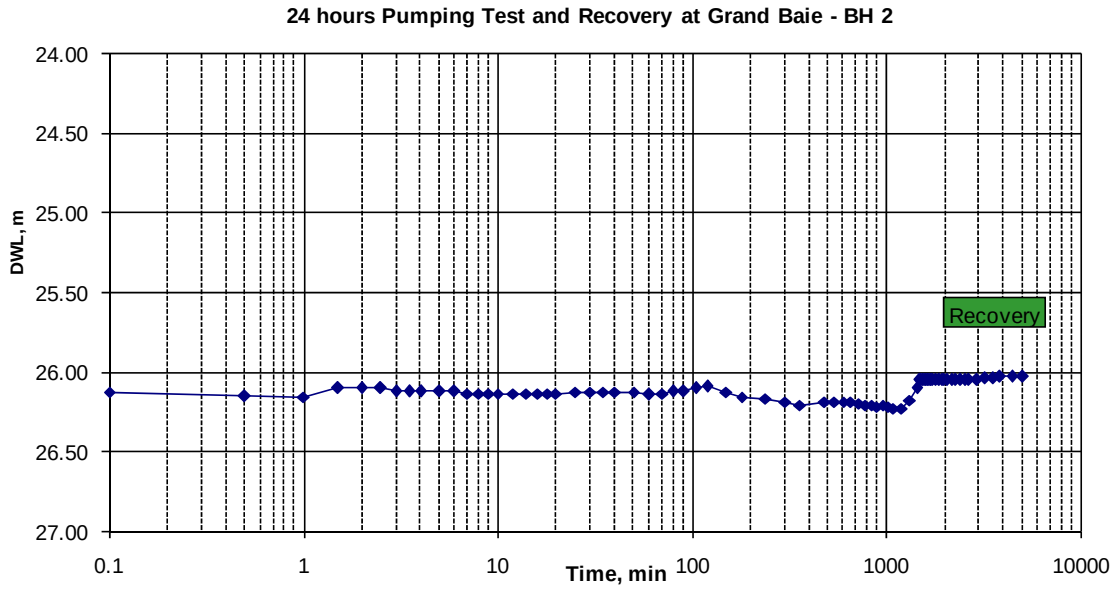


Figure 3.10 24hrs pumping test and recovery in BH 2

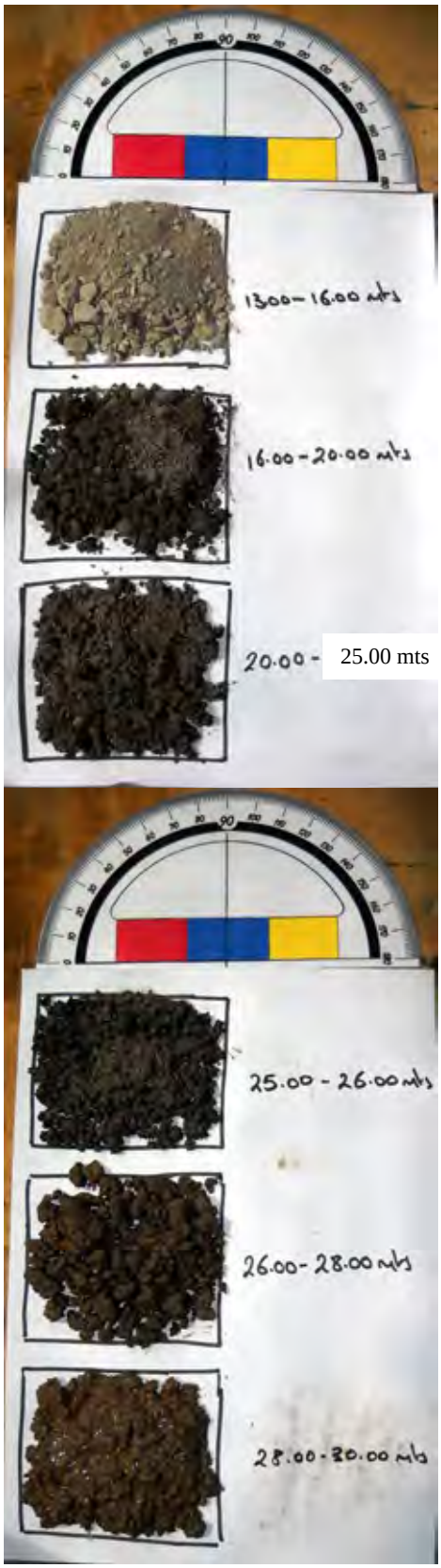
Appendix A Photographs of site works and of Cuttings

B.1 View of the Site – BH 1

B.1 Drilling of BH 1

CUTTINGS BH 1

CUTTINGS BH


13.00-16.00 mts
16.00-20.00 mts
20.00 - 25.00 mts
25.00 - 26.00 mts
26.00 - 28.00 mts
28.00 - 30.00 mts

CUTTINGS BH

WATER RESEARCH CO. LTD	PUMPING TEST GRAND BAIE
BH 2 Page 1 of 2	CLIENT: NIPPON KOEI CO. LTD CONTRACT No.: 110056 NIP

CUTTINGS BH 2

CUTTINGS BH 2

Between 32.00 - 72.00 meters NO RECOVERY

Final Depth: 72.00 meters

Appendix B Summary of Works & Exploratory Borehole Log

BoreHole Drilling & Test Pumping

Summarised Report of Borehole Drilling, Well Construction, Development, Pumping Test, Water Quality Test and Recommendation

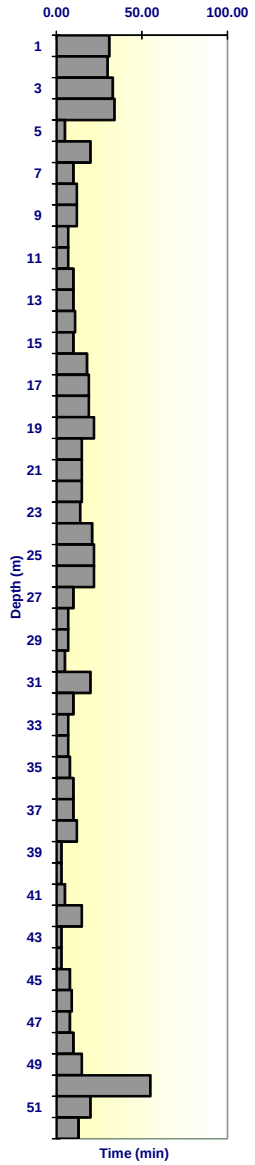
GENERAL	
Project	Bore hole drilling
Contractor	WATER RESEARCH CO. LTD.
Job Reference	ORB 11056 NIP
Consultant	N / A
Client	NIPPON KOEI CO.LTD
Borehole No. / Code (by WRU/CWA)	BH 1
Location - District	Choisy
Plant used for Boring	Super Rock
Boring Type(Overburden/Rock)	DTH
Purpose of Borehole/Water use application	Injection of Treated Wastewater
Date of Commencement - Completion of Boring	23.02.2011
Depth of Borehole	52.00m
Diameter of Borehole	380mm
Type of screen used & Diameter of PVC lining	330mm PVC Lining
Length of Plain PVC	0.00-6.00m
Length of Slotted PVC	6.00-42.00m
AIR LIFT	
Method of yield determination	Volumetric measurement
Airlift yield & Duration	18.00m^3/hr, 1hr
Pumping Test	
Make of pump used during pumping test	Grunfos SP 95 - 6
Duration of Pumping Test (start - complet. date)	10.03.10 -12.03.10
Depth of pump installed during pumping test	39.00m
Water Strikes marks during boring	28.0m (Fresh water) and 47.0m (Salt water)
Static Water Level (SWL)	27.25m
Dynamic Water Level (DWL)	27.48m
Change in Draw Down during Pumping Test	0.23m
Final Yield during Pumping Test = Q	106.0 m^3/h
Step Test Yield	25.5m3/hr - 50.2m3/hr - 75.6m3/hr - 106.0m3/hr
Step Test Drawdown	0.03m - 0.05m - 0.10m - 0.16m
Pump	
Pump Installed in BH for Exploitation Purposes	N / A
Date of Installed	N / A
Model, kw, H, Q, Dia. of Rising Main	N / A
Depth installed	N / A
Water Quality Test	
At the end of pumping test	N / A
Date of results	
Note :	

Groundwater Exploitation	BOREHOLE LOG WITH BASIC DATA

PROJECT	**Bore hole drilling**	**B.H No**	**BH 1002**
		Date started	23-Feb-11
Job No.	ORB 11056 NIP	**Date Completed**	26-Feb-11
Location	Choisy	**Rig Used**	Super Rock
Client	NIPPON KOEI CO.LTD	**Hole Diameter**	380mm
Contractor	Water Research Co.Ltd.	**Depth of Hole**	52.00m
Logged By	JLE	**Lining Type**	330mm PVC Lining

Well Data			Pumping		Strata Encountered				Min	Bar Chart
Date	Hole(381mm) PVC(250mm)Lining Water		Air Lift (m^3/h)	Pump (m^3/h)	Water Intake	Conductivity Profile	Depth (m)	Geological Descriptions of Strata from Cuttings Recovered	Penetration rate	Penetration chart Depth(m) vs Time(min)
23-Feb-11			18.0 m^3/h - 1hr Air-lift test	106.0m^3/hr - 24 hrs pumping test			1		31.00	
							2	0.00-4.00 Basalt	30.00	
							3		33.00	
							4		34.00	
							5	4.00-5.00 Highly Weathered Basalt	5.00	
							6		20.00	
							7		10.00	
							8		12.00	
							9		12.00	
							10		7.00	
							11		7.00	
							12		10.00	
							13		10.00	
							14		11.00	
							15		10.00	
							16		18.00	
							17	5.00-27.00 Basalt	19.00	
							18		19.00	
							19		22.00	
							20		15.00	
							21		15.00	
							22		15.00	
							23		14.00	
							24		21.00	
							25		22.00	
							26		22.00	
							27		10.00	
	SWL 27.25m						28	27.00-30.00	7.00	
							29	Highly Weathered Basalt	7.00	
							30		5.00	
							31	Cavity 31.0 to 31.40m	20.00	
							32		10.00	
							33	Cavity 33.0 to 33.50m	7.00	
							34	30.00-38.00 Basalt	7.00	
							35		8.00	
							36		10.00	
							37		10.00	
							38		12.00	
							39		3.00	
							40		3.00	
							41	38.00-44.00 Highly Weathered Basalt	5.00	
							42		15.00	
							43		3.00	
							44		3.00	
							45	44.00-51.00 Basalt	8.00	
							46		9.00	
							47		8.00	
							48		10.00	
							49		15.00	
							50		55.00	
							51		20.00	
26-Feb-11							52	51.00-52.00 Highly Weathered Basalt	13.00	

Penetration chart
Depth(m) vs Time(min)



Legend

Slotted PVC
Plain PVC

Fresh water
Salt water

WATER RESEARCH CO. LTD

BoreHole Drilling & Test Pumping

Summarised Report of Borehole Drilling, Well Construction, Development, Pumping Test, Water Quality Test and Recommendation

GENERAL	
Project	Bore hole drilling
Contractor	WATER RESEARCH CO. LTD.
Job Reference	ORB 11056 NIP
Consultant	N / A
Client	NIPPON KOEI CO.LTD
Borehole No. / Code (by WRU/CWA)	BH 2
Location - District	Choisy - Grand Baie
Plant used for Boring	Super Rock
Boring Type(Overburden/Rock)	DTH
Purpose of Borehole/Water use application	Injection for treated wastewater
Date of Commencement - Completion of Boring	28.02.11 - 07.03.11
Depth of Borehole	72.00m
Diameter of Borehole	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Type of screen used & Diameter of PVC lining	PVC Lining - 300mm (from 0.0m to 52.0m) & 200mm (52.0m to 72.0m)
Length of Plain PVC	0.00 - 3.00m
Length of Slotted PVC	3.00 - 72.00m
AIR LIFT	
Method of yield determination	Volumetric measurement
Airlift yield & Duration	42.00m^3/hr, 1hr
Pumping Test	
Make of pump used during pumping test	Jet Pump
Duration of Pumping Test (start - complet. date)	15-16.02.11
Depth of pump installed during pumping test	48.50m
Water Strikes marks during boring	31.0m (fresh water) & 37.0m (sea water)
Static Water Level (SWL)	26.13m
Dynamic Water Level (DWL)	26.10m
Change in Draw Down during Pumping Test	0.03m
Final Yield during Pumping Test = Q	350m^3/hr
Step Test Yield	69.9m^3/hr - 154.0m^3/hr - 227.7m^3/hr - 363.0m^3/hr
Step Test Drowdown	0.03m - 0.02m - 0.01m - 0.09m
Pump	
Pump Installed in BH for Exploitation Purposes	N / A
Date of Installed	N / A
Model, kw, H, Q, Dia. of Rising Main	N / A
Depth installed	N / A
Water Quality Test	
At the end of pumping test	16.02.11
Date of results	on going
Note :	

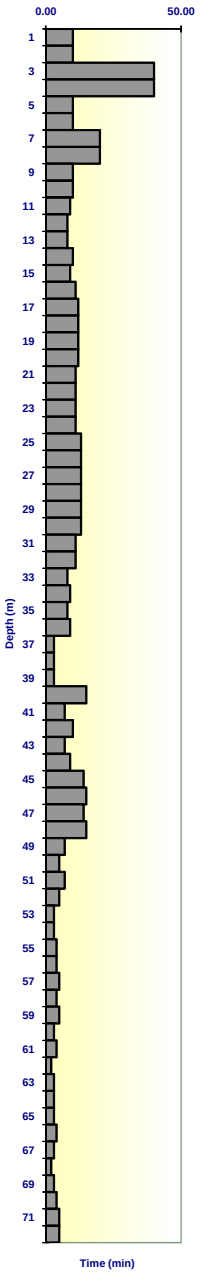
Groundwater Exploitation

BOREHOLE LOG WITH BASIC DATA

PROJECT	**Bore hole drilling**	**B.H No**	**BH 2**
		Date started	28-Feb-11
Job No.	ORB 11056 NIP	**Date Completed**	7-Mar-11
Location	Choisy - Grand Baie	**Rig Used**	Super Rock
Client	NIPPON KOEI CO.LTD	**Hole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Contractor	Water Research Co.Ltd.	**Depth of Hole**	72.00m
Logged By	JLE	**Lining Type**	PVC Lining - 300mm (from 0.0m to 52.0m) & 200mm (52.0m to 72.0m)

Well Data | **Pumping** | **Strata Encountered** | **Min** | **Bar Chart**

Date	Hole(381mm) PVC(250mm)Lining Water	Air Lift (m³/h)	Pump (m³/h)	Water Intake	Conductivity Profile	Depth (m)	Geological Descriptions of Strata from Cuttings Recovered	Penetration rate
28-Feb-11		42.0 m³/h - 1hr Air-lift test				1	0.00-2.00 Clay	10.00
						2		10.00
						3	2.00-4.00 Fresh Basalt	40.00
						4		40.00
						5	4.00-8.00	10.00
						6		10.00
						7	Moderately Weathered Basalt	20.00
						8		20.00
						9	8.00-32.00	10.00
						10		10.00
						11		9.00
						12		8.00
						13		8.00
						14		10.00
						15		9.00
						16		11.00
						17		12.00
						18		12.00
						19	Moderately Weathered Basalt	12.00
						20		12.00
						21		11.00
						22		11.00
						23		11.00
						24		11.00
						25		13.00
	SWL 26.50					26		13.00
						27		13.00
						28		13.00
						29		13.00
						30		13.00
						31		11.00
						32		11.00
						33	32.00-36.00	8.00
						34	Weathered Basalt	9.00
						35		8.00
						36	Between 36.00-37.00 Cavity	9.00
						37	36.00-39.00	3.00
						38	Highly Weathered Basalt	3.00
						39		3.00
						40	9.00-40.00 Basalt	15.00
						41	40.00-44.00	7.00
						42		10.00
						43	Weathered Basalt	7.00
						44		9.00
						45	44.00-48.00	14.00
						46	Fresh Basalt	15.00
						47		14.00
						48		15.00
						49	48.00-52.00	7.00
						50		5.00
						51	Highly Weathered Basalt	7.00
						52		5.00
						53	52.00-61.00	3.00
						54		3.00
						55		4.00
						56	Highly Weathered Basalt	4.00
						57		5.00
						58		4.00
						59		5.00
						60		3.00
						61		4.00
						62	61.00-66.00	2.00
						63		3.00
						64	Clay	3.00
						65		3.00
						66		4.00
						67	66.00-72.00	3.00
						68		2.00
						69	Highly Weathered Basalt	3.00
						70		4.00
						71		5.00
7-Mar-11						72		5.00



Legend

Slotted PVC
Plain PVC

Fresh water
Salt water

Appendix C Results of Pumping Tests

Tables of tests data for BH 1

STEP TEST 1 - 25.5m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 1**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	380mm
Location	Choisy	**Borehole Depth**	52.00m
Date started	10-Mar-11	**Pump Type**	Grunfos SP 95 - 6
Date completed	10-Mar-11	**Pump Installed at**	39.00m
SWL (m)	27.25 m	**Lining PVC (1)**	0.00-6.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	6.00-42.00m (Slotted type)

Date	Duration			Yield		Dynamic Water level(DWL)	**Residual**	**Observation well water level**	
Time	Hours	Minutes	Seconds	m3/h	L/min.	Pumping Well(m)	**Drawn Down(m)**		
10-Mar-11		**0**	0			27.25	**0.00**		
		0.5	30			27.26	**0.01**		
		1	60			27.28	**0.03**		
		1.5	90			27.29	**0.04**		
		2	120			27.30	**0.05**		
		2.5	150			27.30	**0.05**		
		3	180			27.29	**0.04**		
		3.5	210			27.28	**0.03**		
		4	240		**25.5**	27.28	**0.03**		
		5				27.28	**0.03**		
		6				27.28	**0.03**		
		7				27.28	**0.03**		
		8				27.28	**0.03**		
		9				27.28	**0.03**		
		10				27.28	**0.03**		
		12				27.28	**0.03**		
		14			**25.5**	27.28	**0.03**		
		16				27.28	**0.03**		
		18				27.28	**0.03**		
		20				27.28	**0.03**		
		25				27.28	**0.03**		
		30				27.28	**0.03**		
		35							
		40							
		50							
10-Mar-11	1	**60**							

STEP TEST 2 - 50.2m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 1**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	380mm
Location	Choisy	**Borehole Depth**	52.00m
Date started	10-Mar-11	**Pump Type**	Grunfos SP 95 - 6
Date completed	10-Mar-11	**Pump Installed at**	39.00m
SWL (m)	27.25 m	**Lining PVC (1)**	0.00-6.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	6.00-42.00m (Slotted type)

Date / Time	Duration Hours	Minutes	Seconds	Yield m3/h	Yield L/min.	Dynamic Water level(DWL) Pumping Well(m)	**Residual Drawn Down(m)**	**Observation well water level**	
10-Mar-11		**0**	0			27.28	**0.03**		
		0.5	30			27.30	**0.05**		
		1	60			27.30	**0.05**		
		1.5	90			27.29	**0.04**		
		2	120			27.29	**0.04**		
		2.5	150			27.30	**0.05**		
		3	180			27.30	**0.05**		
		3.5	210		**50.2**	27.30	**0.05**		
		4	240			27.30	**0.05**		
		5				27.30	**0.05**		
		6				27.30	**0.05**		
		7				27.30	**0.05**		
		8				27.30	**0.05**		
		9				27.30	**0.05**		
		10				27.30	**0.05**		
		12				27.30	**0.05**		
		14				27.30	**0.05**		
		16				27.30	**0.05**		
		18				27.30	**0.05**		
		20				27.30	**0.05**		
		25				27.30	**0.05**		
		30				27.30	**0.05**		
		35							
		40							
		50							
10-Mar-11	1	**60**							

STEP TEST 3 - 75.6m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 1**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	380mm
Location	Choisy	**Borehole Depth**	52.00m
Date started	10-Mar-11	**Pump Type**	Grunfos SP 95 - 6
Date completed	10-Mar-11	**Pump Installed at**	39.00m
SWL (m)	27.25 m	**Lining PVC (1)**	0.00-6.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	6.00-42.00m (Slotted type)

Date / Time	Duration Hours	Minutes	Seconds	Yield m3/h	Yield L/min.	Dynamic Water level(DWL) Pumping Well(m)	**Residual Drawn Down(m)**	**Observation well water level**	
10-Mar-11		**0**	0			27.30	**0.05**		
		0.5	30			27.31	**0.06**		
		1	60			27.32	**0.07**		
		1.5	90			27.33	**0.08**		
		2	120			27.33	**0.08**		
		2.5	150			27.34	**0.09**		
		3	180			27.35	**0.10**		
		3.5	210			27.35	**0.10**		
		4	240			27.35	**0.10**		
		5				27.35	**0.10**		
		6				27.35	**0.10**		
		7				27.35	**0.10**		
		8			**75.0**	27.35	**0.10**		
		9				27.35	**0.10**		
		10				27.35	**0.10**		
		12				27.35	**0.10**		
		14				27.35	**0.10**		
		16				27.35	**0.10**		
		18				27.35	**0.10**		
		20				27.35	**0.10**		
		25				27.35	**0.10**		
		30				27.35	**0.10**		
		35							
		40							
		50							
10-Mar-11	1	**60**							

STEP TEST 4 - 106.0m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 1**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	380mm
Location	Choisy	**Borehole Depth**	52.00m
Date started	10-Mar-11	**Pump Type**	Grunfos SP 95 - 6
Date completed	10-Mar-11	**Pump Installed at**	39.00m
SWL (m)	27.25 m	**Lining PVC (1)**	0.00-6.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	6.00-42.00m (Slotted type)

Date / Time	Duration: Hours	Minutes	Seconds	Yield: m3/h	L/min.	Dynamic Water level(DWL) Pumping Well(m)	**Residual Drawn Down(m)**	**Observation well water level**	
10-Mar-11		**0**	0			27.35	**0.10**		
		0.5	30			27.36	**0.11**		
		1	60			27.38	**0.13**		
		1.5	90			27.39	**0.14**		
		2	120			27.40	**0.15**		
		2.5	150			27.42	**0.17**		
		3	180			27.40	**0.15**		
		3.5	210			27.40	**0.15**		
		4	240			27.40	**0.15**		
		5				27.40	**0.15**		
		6				27.40	**0.15**		
		7				27.40	**0.15**		
		8				27.40	**0.15**		
		9				27.40	**0.15**		
		10			**106.0**	27.40	**0.15**		
		12				27.40	**0.15**		
		14				27.40	**0.15**		
		16				27.40	**0.15**		
		18				27.40	**0.15**		
		20				27.40	**0.15**		
		25				27.40	**0.15**		
		30			**106.0**	27.40	**0.15**		
		35							
		40							
		50							
10-Mar-11	1	**60**							

RECOVERY TEST AFTER STEP TEST PUMPING

Project	Bore hole drilling	**Borehole No.**	**BH 1**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	380mm
Location	Choisy	**Borehole Depth**	52.00m
Date started	10-Mar-11	**Pump Type**	Grunfos SP 95 - 6
Date completed	10-Mar-11	**Pump Installed at**	39.00m
SWL (m)	27.25 m	**Lining PVC (1)**	0.00-6.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	6.00-42.00m (Slotted type)

Date	**Duration**			**Yield**		Dynamic Water level(DWL)	Draw Down(m)	Remarks	
Time	Hours	Minutes	Seconds	m^3/h		in Pumping Well (m)	(DWL - SWL)		
10-Mar-11		**0**	0			27.41	**0.16**		
		0.5	30			27.38	**0.13**		
		1	60			27.36	**0.11**		
		1.5	90			27.35	**0.10**		
		2	120			27.34	**0.09**		
		2.5	150			27.31	**0.06**		
		3	180			27.30	**0.05**		
		3.5	210			27.28	**0.03**		
		4	240			27.26	**0.01**		
		5				27.25	**0.00**		
		6				27.34	**0.09**		
		7				27.30	**0.05**		
		8				27.22	**-0.03**		
		9				27.21	**-0.04**		
		10				27.19	**-0.06**		
		12				27.18	**-0.07**		
		14				27.17	**-0.08**		
		16				27.16	**-0.09**		
		18				27.15	**-0.10**		
		20				27.15	**-0.10**		
		25				27.15	**-0.10**		
		30				27.15	**-0.10**		
		35				27.14	**-0.11**		
		40				27.13	**-0.12**		
		50				27.13	**-0.12**		
10-Mar-11	1	**60**				27.13	**-0.12**		

24 HOURS TEST PUMPING

Project	Bore hole drilling		**Borehole No.**	**BH 1**	
Client	NIPPON KOEI CO.LTD		**Borehole Diameter**	380mm	
Location	Choisy		**Borehole Depth**	52.00m	
Date started	11-Mar-11		**Pump Type**	Grunfos SP 95 - 6	
Date completed	12-Mar-11		**Pump Installed at**	39.00m	
SWL (m)	27.25	m	**Lining PVC (1)**	0.00-6.00m	(Plain type)
Dia.of PVC Lining	300	mm	**Lining PVC (2)**	6.00-42.00m	(Slotted type)

Date	**Duration**			**Yield**	Dynamic Water level(DWL)	Draw Down(m)	Remarks		
Time	Hours	Minutes	Seconds	m^3/h	in Pumping Well (m)	(DWL - SWL)	Conductivity		BH 2
11-Mar-11		**0**	0		27.16	**-0.09**			26.46
		0.5	30		27.43	**0.18**			
		1	60		27.43	**0.18**			
		1.5	90		27.43	**0.18**			
		2	120		27.43	**0.18**			
		2.5	150		27.43	**0.18**			
		3	180		27.43	**0.18**			
		3.5	210		27.43	**0.18**			
		4	240.0		27.43	**0.18**			
		5	300.0		27.50	**0.25**			
		6	360.0		27.44	**0.19**			
		7	420.0		27.43	**0.18**			
		8	480.0		27.44	**0.19**			
		9	540.0		27.43	**0.18**			
		10	600.0		27.43	**0.18**			
		12	720.0		27.42	**0.17**			
		14	840.0	**106**	27.43	**0.18**			
		16	960.0		27.43	**0.18**			
		18	1080.0		27.43	**0.18**			
		20	1200.0		27.43	**0.18**			
		25	1500.0		27.43	**0.18**			
		30	1800.0		27.43	**0.18**			25.90
		35	2100.0		27.43	**0.18**			
		40	2400.0		27.43	**0.18**			
		50	3000.0		27.43	**0.18**			
	1	**60**	3600.0		27.42	**0.17**			25.89
		70	4200.0		27.42	**0.17**			
		80	4800.0		27.42	**0.17**			
		90	5400.0		27.41	**0.16**			
		105	6300.0		27.41	**0.16**			
	2	**120**	7200.0		27.41	**0.16**			
		150	9000.0		27.41	**0.16**			
	3	**180**	10800.0		27.41	**0.16**			
	4	**240**	14400.0		27.40	**0.15**			
	5	**300**	18000.0		27.40	**0.15**			
	6	**360**	21600.0		27.40	**0.15**			
	7	**420**	25200.0		27.39	**0.14**			
	8	**480**	28800.0		27.38	**0.13**			
	9	**540**	32400.0		27.38	**0.13**			
	10	**600**	36000.0		27.37	**0.12**			
	11	**660**	39600.0		27.38	**0.13**			
	12	**720**	43200.0		27.38	**0.13**			25.31
	13	**780**	46800.0		27.38	**0.13**			
	14	**840**	50400.0		27.38	**0.13**			
	15	**900**	54000.0		27.37	**0.12**			
	16	**960**	57600.0		27.38	**0.13**			26.39
	17	**1020**	61200.0		27.40	**0.15**			
	18	**1080**	64800.0		27.42	**0.17**			26.50
	20	**1200**	72000.0		27.46	**0.21**			
	22	**1320**	79200.0		27.47	**0.22**			26.37
12-Mar-11	24	**1440**	86400.0		27.48	**0.23**			

RECOVERY TEST AFTER 24HOURS TEST PUMPING

Project	BH Drilling for Exploitation of U/G water		**Borehole No.**	**BH 1**	
Client	NIPPON KOEI CO.LTD		**Borehole Diameter**	380mm	
Location	Choisy		**Borehole Depth**	52.00m	
Date started	11-Mar-11	**tr**= time of pumping test (s)	**Pump Type**	Grunfos SP 95 - 6	
Date completed	12-Mar-11	**tr** = **86400** s	**Pump Installed at Depth**	39.00m	
SWL (m)	27.25 **m**		**Lining PVC (1) Length**	0.00-6.00m	(Plain type)
Dia.of PVC Lining	250 **mm**		**Lining PVC (2) Length**	6.00-42.00m	(Slotted type)

Date	Duration **tp**			(tr+tp)/tr	Yield		Dynamic Water level(DWL)	**Residual**	**Observation well water level**	
Time	Hours	Minutes	Seconds		m^3/h	L/min.	Pumping Well(m)	**Drawn Down(m)**		
12-Mar-11		**0**	0				27.48	**0.23**		
		0.5	30	2881.00			27.20	**-0.05**		
		1	60	1441.00			27.20	**-0.05**		
		1.5	90	961.00			27.20	**-0.05**		
		2	120	721.00			27.20	**-0.05**		
		2.5	150	577.00			27.20	**-0.05**		
		3	180	481.00			27.20	**-0.05**		
		3.5	210	412.43			27.19	**-0.06**		
		4	240	361.00			27.19	**-0.06**		
		5	300	289.00			27.19	**-0.06**		
		6	360	241.00			27.19	**-0.06**		
		7	420	206.71			27.19	**-0.06**		
		8	480	181.00			27.18	**-0.07**		
		9	540	161.00			27.18	**-0.07**		
		10	600	145.00			27.18	**-0.07**		
		12	720	121.00			27.18	**-0.07**		
		14	840	103.86			27.18	**-0.07**		
		16	960	91.00			27.18	**-0.07**		
		18	1080	81.00			27.18	**-0.07**		
		20	1200	73.00			27.18	**-0.07**		
		25	1500	58.60			27.17	**-0.08**		
		30	1800	49.00			27.16	**-0.09**		
		35	2100	42.14			27.17	**-0.08**		
		40	2400	37.00			27.16	**-0.09**		
		50	3000	29.80			27.16	**-0.09**		
12-Mar-11		**60**	3600	25.00			27.16	**-0.09**		

Tables of tests data for BH 2

STEP TEST 1 - 69.9m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 2**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Location	Choisy - Grand Baie	**Borehole Depth**	72.00m
Date started	15-Mar-10	**Pump Type**	Jet Pump
Date completed	15-Mar-10	**Pump Installed at**	48.50m
SWL (m)	26.13 m	**Lining PVC (1)**	0.00 - 3.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	3.00 - 72.00m (Slotted type)

Date	Duration			Yield		Dynamic Water level(DWL)	**Residual**	**Observation well water level**	
Time	Hours	Minutes	Seconds	m3/h	L/min.	Pumping Well(m)	**Drawn Down(m)**		
15-Mar-10		**0**	0			26.13	**0.00**		
		0.5	30			26.16	**0.03**		
		1	60			26.15	**0.02**		
		1.5	90			26.15	**0.02**		
		2	120			26.16	**0.03**		
		2.5	150			26.16	**0.03**		
		3	180			26.16	**0.03**		
		3.5	210			26.16	**0.03**		
		4	240			26.15	**0.02**		
		5				26.15	**0.02**		
		6				26.16	**0.03**		
		7			**69.9**	26.15	**0.02**		
		8				26.15	**0.02**		
		9				26.15	**0.02**		
		10				26.16	**0.03**		
		12				26.15	**0.02**		
		14				26.16	**0.03**		
		16				26.16	**0.03**		
		18				26.16	**0.03**		
		20				26.16	**0.03**		
		25				26.16	**0.03**		
15-Mar-10		**30**				26.16	**0.03**		

STEP TEST 2 - 154.0m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 2**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Location	Choisy - Grand Baie	**Borehole Depth**	72.00m
Date started	15-Mar-10	**Pump Type**	Jet Pump
Date completed	15-Mar-10	**Pump Installed at**	48.50m
SWL (m)	26.13 m	**Lining PVC (1)**	0.00 - 3.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	3.00 - 72.00m (Slotted type)

Date	Duration			Yield		Dynamic Water level(DWL)	**Residual**	**Observation well water level**	
Time	Hours	Minutes	Seconds	m3/h	L/min.	Pumping Well(m)	**Drawn Down(m)**		
15-Mar-10		**0**	0			26.16	**0.03**		
		0.5	30			26.18	**0.05**		
		1	60			26.17	**0.04**		
		1.5	90			26.17	**0.04**		
		2	120			26.17	**0.04**		
		2.5	150			26.17	**0.04**		
		3	180			26.17	**0.04**		
		3.5	210		**154.0**	26.17	**0.04**		
		4	240			26.17	**0.04**		
		5				26.17	**0.04**		
		6				26.17	**0.04**		
		7				26.17	**0.04**		
		8				26.17	**0.04**		
		9				26.18	**0.05**		
		10				26.18	**0.05**		
		12				26.18	**0.05**		
		14				26.18	**0.05**		
		16				26.18	**0.05**		
		18				26.18	**0.05**		
		20				26.18	**0.05**		
		25				26.18	**0.05**		
15-Mar-10		**30**				26.18	**0.05**		

STEP TEST 3 - 227.7m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 2**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Location	Choisy - Grand Baie	**Borehole Depth**	72.00m
Date started	15-Mar-10	**Pump Type**	Jet Pump
Date completed	15-Mar-10	**Pump Installed at**	48.50m
SWL (m)	26.13 m	**Lining PVC (1)**	0.00 - 3.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	3.00 - 72.00m (Slotted type)

Date	Duration			Yield		Dynamic Water level(DWL)	**Residual**	**Observation well water level**	
Time	Hours	Minutes	Seconds	m3/h	L/min.	Pumping Well(m)	**Drawn Down(m)**		
15-Mar-10		**0**	0			26.18	**0.05**		
		0.5	30			26.19	**0.06**		
		1	60			26.19	**0.06**		
		1.5	90			26.19	**0.06**		
		2	120			26.19	**0.06**		
		2.5	150			26.19	**0.06**		
		3	180		**227.7**	26.19	**0.06**		
		3.5	210			26.19	**0.06**		
		4	240			26.19	**0.06**		
		5				26.19	**0.06**		
		6				26.19	**0.06**		
		7				26.19	**0.06**		
		8				26.19	**0.06**		
		9				26.19	**0.06**		
		10				26.19	**0.06**		
		12				26.19	**0.06**		
		14				26.19	**0.06**		
		16				26.19	**0.06**		
		18				26.19	**0.06**		
		20				26.19	**0.06**		
		25				26.19	**0.06**		
15-Mar-10		**30**				26.19	**0.06**		

STEP TEST 4 - 363.0m^3/h

Project	Bore hole drilling	**Borehole No.**	**BH 2**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Location	Choisy - Grand Baie	**Borehole Depth**	72.00m
Date started	15-Mar-10	**Pump Type**	Jet Pump
Date completed	15-Mar-10	**Pump Installed at**	48.50m
SWL (m)	26.13 m	**Lining PVC (1)**	0.00 - 3.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	3.00 - 72.00m (Slotted type)

Date	Duration			Yield		Dynamic Water level(DWL)	**Residual**	**Observation well water level**	
Time	Hours	Minutes	Seconds	m3/h	L/min.	Pumping Well(m)	**Drawn Down(m)**		
15-Mar-10		**0**	0			26.19	**0.06**		
		0.5	30			26.22	**0.09**		
		1	60			26.22	**0.09**		
		1.5	90			26.22	**0.09**		
		2	120			26.23	**0.10**		
		2.5	150			26.23	**0.10**		
		3	180			26.23	**0.10**		
		3.5	210			26.23	**0.10**		
		4	240			26.23	**0.10**		
		5				26.23	**0.10**		
		6				26.23	**0.10**		
		7				26.23	**0.10**		
		8				26.23	**0.10**		
		9				26.23	**0.10**		
		10			**363.0**	26.23	**0.10**		
		12				26.24	**0.11**		
		14				26.24	**0.11**		
		16				26.24	**0.11**		
		18				26.24	**0.11**		
		20				26.24	**0.11**		
		25				26.25	**0.12**		
		30				26.25	**0.12**		
		35				26.26	**0.13**		
		40				26.27	**0.14**		
		50			**363.0**	26.28	**0.15**		
15-Mar-10	1	**60**				26.28	**0.15**		

RECOVERY TEST AFTER STEP TEST PUMPING

Project	Bore hole drilling	**Borehole No.**	**BH 2**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Location	Choisy - Grand Baie	**Borehole Depth**	72.00m
Date started	15-Mar-10	**Pump Type**	Jet Pump
Date completed	15-Mar-10	**Pump Installed at**	48.50m
SWL (m)	26.13 m	**Lining PVC (1)**	0.00 - 3.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	3.00 - 72.00m (Slotted type)

Date / Time	Duration			Yield		Dynamic Water level(DWL) in Pumping Well (m)	Draw Down(m)	Remarks	
	Hours	Minutes	Seconds	m^3/h			(DWL - SWL)		
15-Mar-10		**0**	0			26.28	**0.15**		
		0.5	30			26.27	**0.14**		
		1	60			26.26	**0.13**		
		1.5	90			26.26	**0.13**		
		2	120			26.26	**0.13**		
		2.5	150			26.25	**0.12**		
		3	180			26.25	**0.12**		
		3.5	210			26.25	**0.12**		
		4	240			26.25	**0.12**		
		5				26.25	**0.12**		
		6				26.25	**0.12**		
		7				26.25	**0.12**		
		8				26.25	**0.12**		
		9				26.25	**0.12**		
		10				26.25	**0.12**		
		12				26.25	**0.12**		
		14				26.25	**0.12**		
		16				26.25	**0.12**		
		18				26.25	**0.12**		
		20				26.25	**0.12**		
		25				26.25	**0.12**		
		30				26.25	**0.12**		
		35				26.25	**0.12**		
		40				26.25	**0.12**		
		50				26.25	**0.12**		
15-Mar-10		**60**				26.25	**0.12**		

WATER RESEARCH CO. LTD

24 HOURS TEST PUMPING

Project	Bore hole drilling	**Borehole No.**	**BH 2**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Location	Choisy - Grand Baie	**Borehole Depth**	72.00m
Date started	16-Mar-11	**Pump Type**	Jet Pump
Date completed	17-Mar-11	**Pump Installed at**	48.50m
SWL (m)	26.13 m	**Lining PVC (1)**	0.00 - 3.00m (Plain type)
Dia.of PVC Lining	300 mm	**Lining PVC (2)**	3.00 - 72.00m (Slotted type)

Date	Duration			Yield	Dynamic Water level(DWL)	Draw Down(m)	Remarks		
Time	Hours	Minutes	Seconds	m^3/h	in Pumping Well (m)	(DWL - SWL)	Conductivity		**BH 1**
16-Mar-11		**0**	0		26.13	**0.00**			25.24
		0.5	30		26.15	**0.02**			
		1	60		26.16	**0.03**			
		1.5	90		26.10	**-0.03**			
		2	120		26.10	**-0.03**			
		2.5	150		26.10	**-0.03**			
		3	180		26.12	**-0.01**			
		3.5	210		26.12	**-0.01**			
		4	240.0		26.12	**-0.01**			
		5	300.0		26.12	**-0.01**			
		6	360.0		26.12	**-0.01**			
		7	420.0		26.14	**0.01**			
		8	480.0		26.14	**0.01**			
		9	540.0		26.14	**0.01**			
		10	600.0		26.14	**0.01**			
		12	720.0	**350.0**	26.14	**0.01**			
		14	840.0		26.14	**0.01**			
		16	960.0		26.14	**0.01**			
		18	1080.0		26.14	**0.01**			
		20	1200.0		26.14	**0.01**			
		25	1500.0		26.13	**0.00**			
		30	1800.0		26.13	**0.00**			24.45
		35	2100.0		26.13	**0.00**			
		40	2400.0		26.13	**0.00**			
		50	3000.0		26.13	**0.00**			
	1	**60**	3600.0	**350.0**	26.14	**0.01**			23.90
		70	4200.0		26.14	**0.01**			
		80	4800.0		26.12	**-0.01**			
		90	5400.0		26.12	**-0.01**			
		105	6300.0		26.10	**-0.03**			
	2	**120**	7200.0		26.09	**-0.04**			
		150	9000.0		26.13	**0.00**			
	3	**180**	10800.0		26.16	**0.03**			
	4	**240**	14400.0		26.17	**0.04**			
	5	**300**	18000.0		26.19	**0.06**			22.00
	6	**360**	21600.0		26.21	**0.08**			
	8	**480**	28800.0		26.19	**0.06**			23.85
	9	**540**	32400.0		26.19	**0.06**			
	10	**600**	36000.0	**350.0**	26.19	**0.06**			
	11	**660**	39600.0		26.19	**0.06**			
	12	**720**	43200.0		26.20	**0.07**			23.85
	13	**780**	46800.0		26.21	**0.08**			
	14	**840**	50400.0		26.21	**0.08**			
	15	**900**	54000.0		26.22	**0.09**			
	16	**960**	57600.0		26.21	**0.08**			
	17	**1020**	61200.0		26.22	**0.09**			23.85
	18	**1080**	64800.0	**350.0**	26.23	**0.10**			
	20	**1200**	72000.0		26.23	**0.10**			
	22	**1320**	79200.0		26.18	**0.05**			25.85
17-Mar-11	24	**1440**	86400.0		26.10	**-0.03**			25.08

WATER RESEARCH CO. LTD

RECOVERY TEST AFTER 24HOURS TEST PUMPING

Project	BH Drilling for Exploitation of U/G water	**Borehole No.**	**BH 2**
Client	NIPPON KOEI CO.LTD	**Borehole Diameter**	375mm (0.0m to 52.0m) and 250mm (52.0m to 72.0m)
Location	Choisy - Grand Baie	**Borehole Depth**	72.00m
Date started	17-Mar-11	**Pump Type**	Jet Pump
Date completed	17-Mar-11	**Pump Installed at Depth**	48.50m
SWL (m)	26.13 **m**	**Lining PVC (1) Length**	0.00 - 3.00m (Plain type)
Dia.of PVC Lining	250 **mm**	**Lining PVC (2) Length**	3.00 - 72.00m (Slotted type)

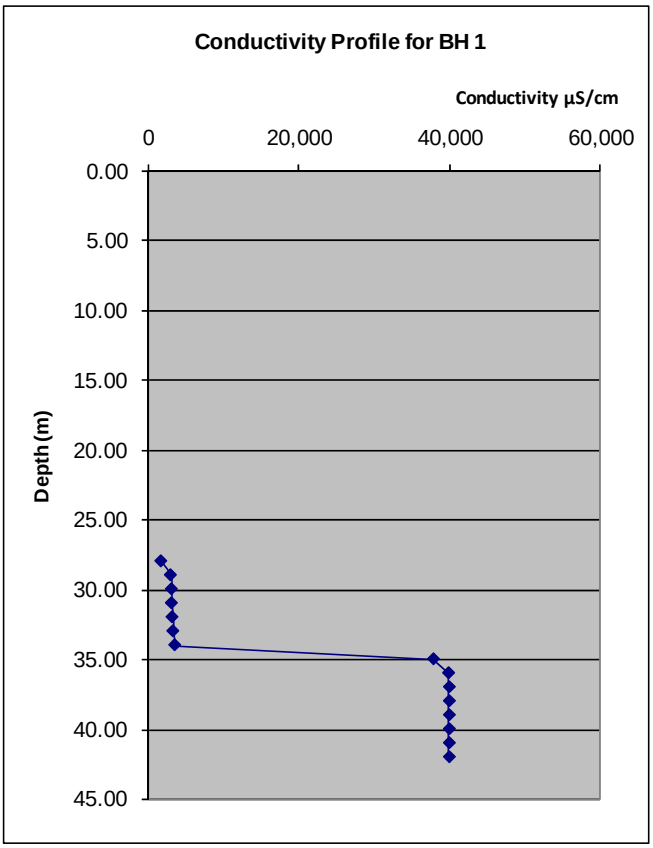
tr= time of pumping test (s)

tr = **86400** s

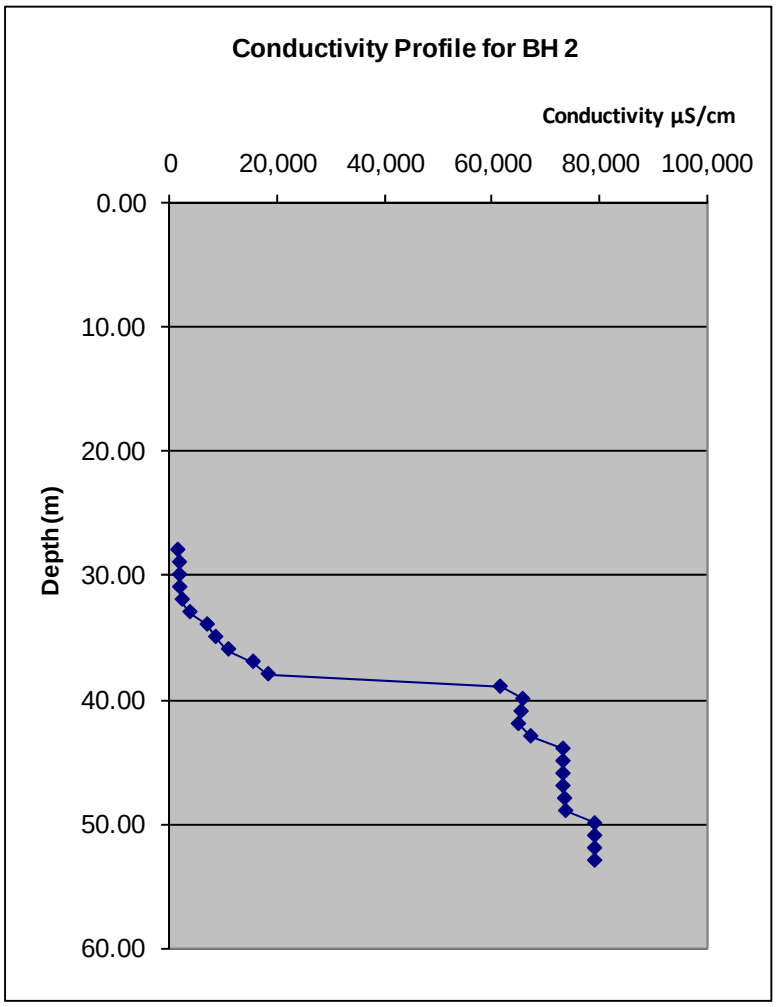
Date	Duration **tp**			(tr+tp)/tr	Yield		Dynamic Water level(DWL)	**Residual**	**Observation well water level**	
Time	Hours	Minutes	Seconds		m^3/h	L/min.	Pumping Well(m)	**Drawn Down(m)**		**BH 1**
17-Mar-11		**0**	0				26.10	**-0.03**		25.08
		0.5	30	2881.00			26.05	**-0.08**		
		1	60	1441.00			26.05	**-0.08**		
		1.5	90	961.00			26.05	**-0.08**		
		2	120	721.00			26.05	**-0.08**		
		2.5	150	577.00			26.05	**-0.08**		
		3	180	481.00			26.05	**-0.08**		
		3.5	210	412.43			26.05	**-0.08**		
		4	240	361.00			26.05	**-0.08**		
		5	300	289.00			26.05	**-0.08**		
		6	360	241.00			26.05	**-0.08**		
		7	420	206.71			26.05	**-0.08**		
		8	480	181.00			26.05	**-0.08**		
		9	540	161.00			26.05	**-0.08**		
		10	600	145.00			26.05	**-0.08**		
		12	720	121.00			26.05	**-0.08**		
		14	840	103.86			26.05	**-0.08**		
		16	960	91.00			26.05	**-0.08**		
		18	1080	81.00			26.05	**-0.08**		
		20	1200	73.00			26.05	**-0.08**		
		25	1500	58.60			26.05	**-0.08**		
		30	1800	49.00			26.04	**-0.09**		27.12
		35	2100	42.14			26.04	**-0.09**		
		40	2400	37.00			26.03	**-0.10**		
		50	3000	29.80			26.03	**-0.10**		
17-Mar-11		**60**	3600	25.00			26.03	**-0.10**		27.10

Appendix D Conductivity Profile

BOREHOLE DEPTH	CONDUCTIVITY	Temperature
meters	microsiemens/cms	°C
28.00	1,765	25.6
29.00	3,032	25.6
30.00	3,156	25.5
31.00	3,164	25.5
32.00	3,242	25.5
33.00	3,356	25.5
34.00	3,596	25.5
35.00	37,800	25.5
36.00	39,800	25.5
37.00	39,900	25.5
38.00	39,900	25.5
39.00	39,900	25.5
40.00	39,900	25.5
41.00	39,900	25.5
42.00	39,900	25.5



BOREHOLE DEPTH	CONDUCTIVITY	Temperature
meters	microsiemens/cms	°C
28.00	1,460	25.6
29.00	1,775	25.5
30.00	1,783	25.5
31.00	1,823	25.5
32.00	2,309	25.5
33.00	3,725	25.5
34.00	6,936	25.5
35.00	8,517	25.5
36.00	10,900	25.5
37.00	15,500	25.5
38.00	18,300	25.5
39.00	61,500	25.7
40.00	65,700	25.7
41.00	65,400	25.7
42.00	64,900	25.7
43.00	67,200	25.7
44.00	73,200	25.7
45.00	73,200	25.7
46.00	73,200	27.7
47.00	73,200	27.7
48.00	73,500	27.7
49.00	73,700	27.7
50.00	79,100	27.7
51.00	79,100	27.7
52.00	79,100	27.7
53.00	79,100	27.7


Conductivity Profile for BH 2
Conductivity µS/cm
0
20,000
40,000
60,000
80,000
100,000
Depth (m)
0.00
10.00
20.00
30.00
40.00
50.00
60.00

Appendix E Water Quality Test Results

Cernol
Water Solutions Ltd

PERSONAL SERVICE REPORT

Company: Water Research Co.Ltd

Address: Old Quay D Road, Port Louis

Attention: Mr. Jean Noel Gourgoirie

Date of sample: 22/03/11

Date of Test: 22/03/11

Project: Water Quality Test for Injection Survey at G. Baie

Client: Nippon Koei Co. Ltd

Job No. OPG 110056 NIP

Reference: W 084-085/C/11

Dear Mr. Gourgoirie

We are pleased to submit nereunder results of analysis performed on your water samples collected on the 22nd March 2011.

PARAMETERS	UNITS	BH 1	BH 2
pH @ 25° C	-	7.88	7.09
Total Dissolved Solids	mg/l	18050	19250
Conductivity	µS/cm	25786	27500
Turbidity	FTU	NIL	NIL
Chloride	mg/l, Cl^-	11457	12462
Nitrite	mg/l, NO_2^-	7	4
Nitrate-N	mg/l, NO_3	45	55
Sulphate	mg/l, SO_4^{2-}	1350	1750
COD	mg/l	1700	1325

Assuring you of our best services at all times.

Yours faithfully
For and on behalf of
CERNOL WATER SOLUTIONS LTD

MICHAEL CARVER
ADMINISTRATIVE MANAGER