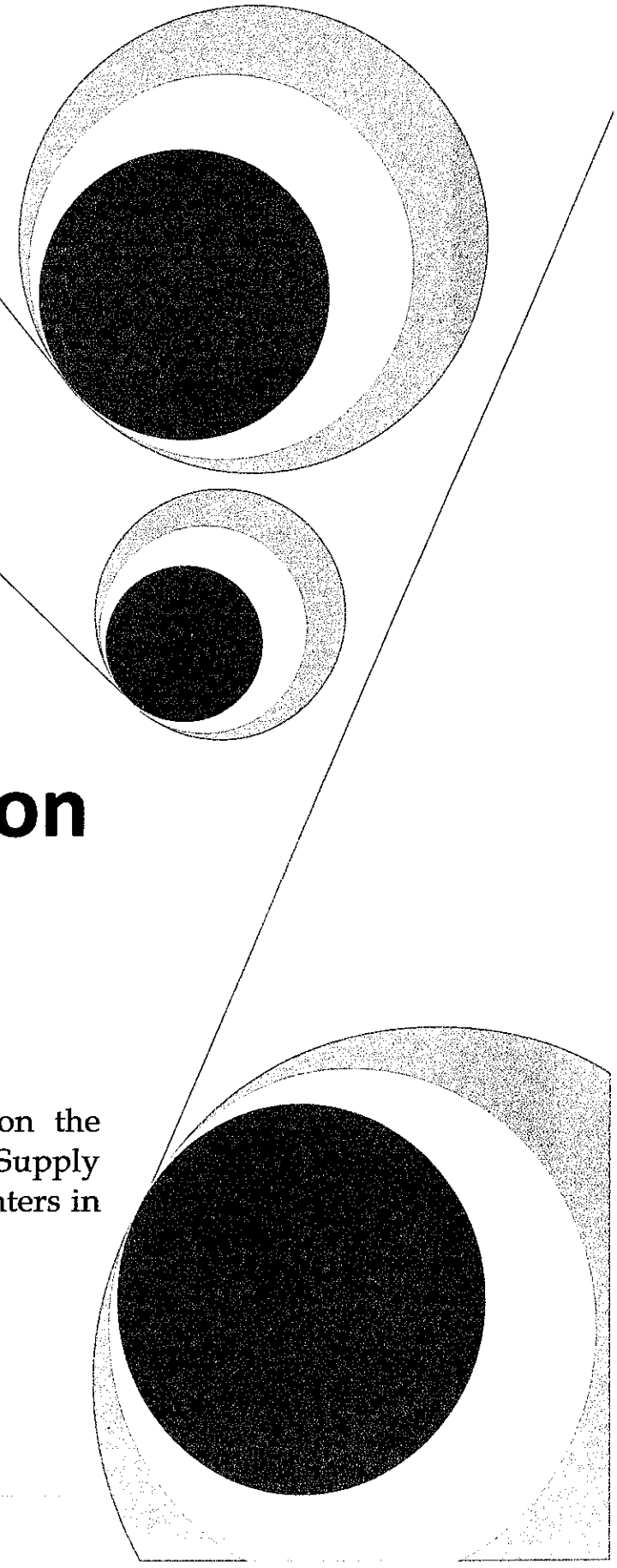
資料-10　　土質調査結果

PS
DL

Pacific Strata Drilling Limited



Soil Investigation Survey Report

For the Basic Design Team Study on the Project for Improvement of Water Supply System in Honiara and Provincial Centers in the Solomon Islands

Kenneth Bulehite
April 2008

DOCUMENT INFORMATION

Project Title

The Project for Improvement of Water Supply System in Honiara and Provincial Centers in the Solomon Islands: Soil Investigation Survey

Client

Organization:	**Yachiyo Engineering Co., Ltd**
Client Contact	Mr. Masatoshi SENO

Document

Prepared by:	**Mr. Kenneth Bulehite.....**
Checked by:	**Mr. Kenneth Bulehite.....**

Distribution List

Organization	**Date**	**Issued To:**
Yachiyo Engineering	**May 2008**	**Mr.** Masatoshi SENO

Table of Contents

1 Introduction

Pacific Strata Drilling Limited has undertaken a soil investigation survey for the Basic Design Study on the Project for the improvement of Water Supply System in Honiara and Provincial Centers in the Solomon Islands.

The survey as detailed in this report, has reviewed the geology information on Honiara areas. The survey considered the detail information provided as part 2 Technical information of the contractual agreement.

The survey involves drilling of 8 boreholes of 10 meters in depth for Service Reservoirs and Water Treatment Facilities and Standard Penetration Tests (SPT) at every meter depth intervals at each borehole. However, due to unavailability of equipment in the country the undisturbed sample from cohesive strata at each borehole could not be obtained.

The report also contains laboratory analysis for each of the sample obtained from the boreholes. The laboratory test will cover the Soil Classification and Soil Strength Tests using British and Australian Standards appropriately.

The Plate Loading Test was also done for all the Service Reservoir s and Water Treatment Facility to determine the ultimate bearing capacity of soil at the bottom. Eight (8) plate loading test were done one at each of the five (5) Services Reservoirs and three (3) Water Treatment Facilities. The plate loading test was done according to ASTM D – 1194 using a diameter of 30 cm circular load plate to determine the ultimate bearing capacity of soil and allowable bearing capacity of soil. The loads of test was done according to step by step test with load of 5 ton/m^2, 10 ton/m^2, 15 ton/m^2, 20 ton/m^2, and 30 ton/m^2.

The expected allowable bearing capacity of soil at the bottom is 10 ton/m^2 and the ultimate bearing capacity of soil is at settlement is 30mm equal to the 10% of a diameter of loading plate.

The results of all the tests were analyzed and presented in a tabular and graph forms. The discussion was also made for each site. The general discussion on the results was also made in chapter 6 of this report.

2 Review of Existing Documentation and Data Collection

2.1 Review of Existing Document

The soil investigation survey in Solomon Islands has been primarily limited to the few large building project and restricted to the low coast region area of Honiara area. It is also limited to the town areas.

2.1.1 Geology of the Honiara Area

Hackman [1979] undertook the study of the Geology of Honiara area and produce a 1:50,000 scale geological sheet GU4 "Honiara". In the Honiara area, a Palaeogene igneous basement is overlain unconformably by not more than about 1400 m of Neogene to Quaternary sedimentary and volcanic rocks, including volcaniclastics and reef limestones. The basement comprises basaltic andesites intruded by predominantly dioritic complex of probable Oligocene age.

The succeeding Miocene to Pleistocene volcanic include the predominantly andesitic Gallego Lavas and the associated Tiaro Tuff-breccias, which provide the source materials for the Plio – Pleistocene Lungga Beds, a variable sequence of volcaniclastic wackes, arenites and rudites with carbonate admixture.

The Lungga Beds comprise a lithesome of three distinct facies: In the south the Plio-Pleistocene Mataniko Sandstones, Tp-Qplm, comprise about 400m of volcanic arenites and wackes with turbidite features. Around Honiara and Mount Austen, the Pleistocene Honiara Beds, Qplh, about 400m thick, form a sequence of calcareours volcanic arenite and rudites: these phase westwards into the Saghalu Conglomerates, Qpls, which form a mantle of volcaniclastic rudites derived from the Gallego Volcanics in the northwest. The Kombito Marls, Qpk, are a lagoonal back – reef facies of the Honiara Beds.

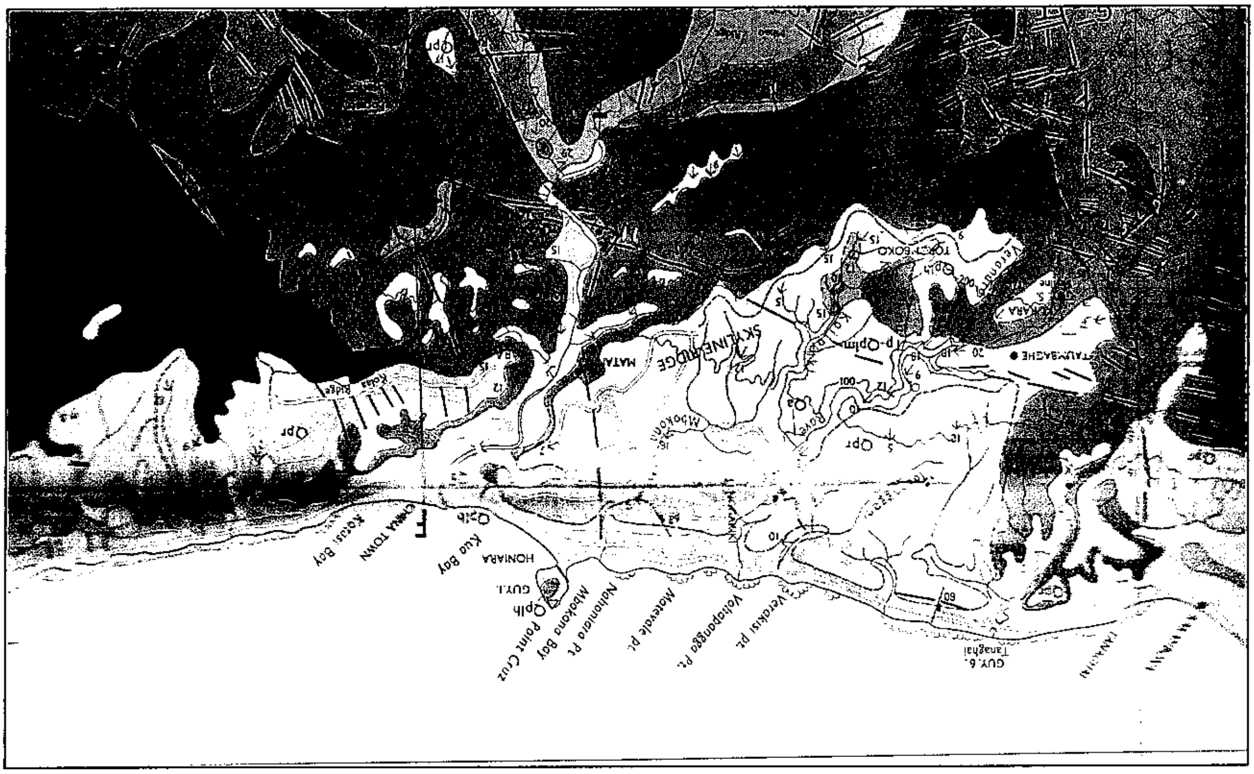


Figure 1: Geology Map of Immediate Honiara

2.1.2 Geology of Immediate Honiara Area

The Honiara Beds are capped by a 60 m of coralgal biolithite and derived debris, the Honiara Reef Limestones (Qpr), which are associated with a magnificent complex sequence of terraces with a height ranging from 700m above to 100m below the sea level.

Most of the coastal are fringed with dead corals (Qr), which is being swamped by alluvium, Qa, derived from the major rivers. Extensive alluvial valleys occur along the courses of the Lungga, Poha and Umasani River.

The structural geology is controlled essentially by faulting. Faults trending NNW – SSE are the

most persistent along their strikes, e.g. the Saghalu Fault, which forms the western "hinge" to the main outcrop of the Poha Diorite: many of these fractures are high-angle reverse fault which have contributed to composite horsting of the pre-Pliocene basement. Figure1 shows the geology map of the immediate Honiara area.

2.1.3 Earthquake

Solomon Islands experience earthquake of magnitude 4.5 and above on average 12 times every month. In recent years, Solomon Islands experience some of the most devastating earth quake in magnitude 7 & 8 in the Richter scale. The latest major earthquake occurs in 2 April 2007 with magnitude 8.1. The Gizo earthquake kills 52 people and cause 15,000 homeless

2.2 Data Collection

Data sampling for the laboratory and in situ testing especially Standard Penetration Test was done using drilling rig with rotary bit.

Plate 1: Drilling Rig G 210B

2.2.1 Drilling Rig

The description of the soil was done through the identification of soil characteristics using the borehole log. The disturbed sample is collected for the soil classification and identification test. Undisturbed sample is not possible due to non availability of sampling tube in the country. The Standard Penetration Test (SPT) shall be done using the drilling rig with a hammer of 63 kg. The SPT is done according to AS 1289

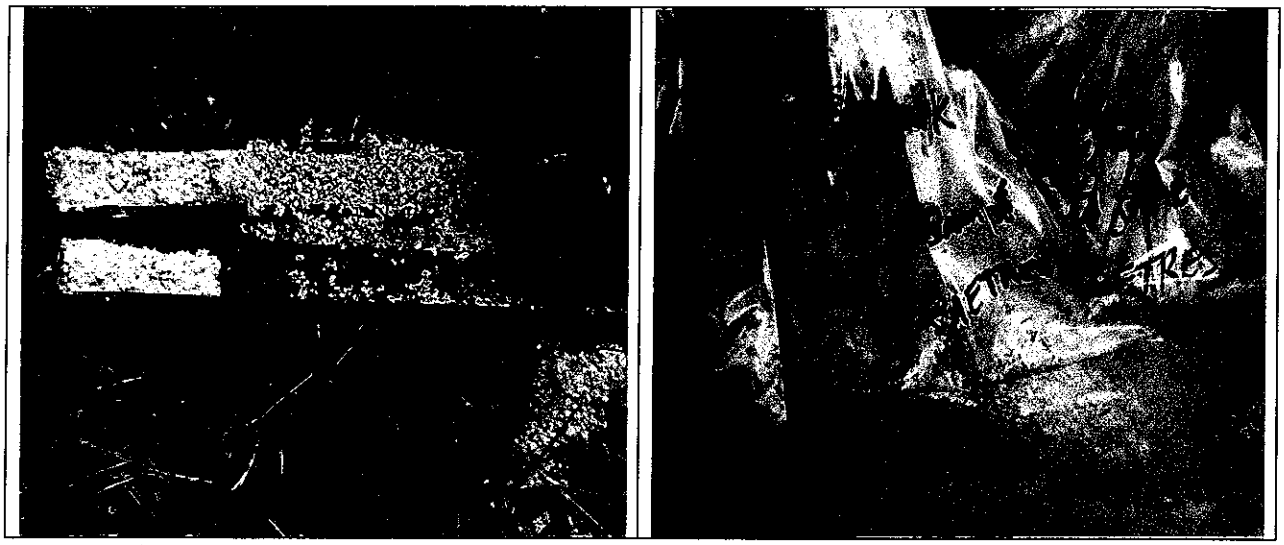


Plate 2: Core sample from SPT Rods & Sample Bag

2.2.2 Laboratory

The laboratory test is done by the Material Laboratory of the Ministry of Infrastructure Development using the British Standards (BS) and Australian Standards (AS) 1289.

2.2.3 Plate Loading

The plate loading test is done according to the ASTM D 1194 using 30 cm diameter plate and hydraulic jack to apply the required step by step reactive loads. The standard had been withdrawn due to its limitation. The geology and soil situation in Honiara, especially in the terraces area is consist of the Honiara Reef Limestone, which is generally uniform thus meet the minimum requirement for the plate loading test for the determination the ultimate bearing capacity and expected bearing capacity.

Plate3: Plate Loading Test and Slab used additional weight

The equipment used as weight for the counter load is:

- Mitchubisu Truck 4 tonne
- 17 Concrete slabs, Size 1200mm x 540 mm x 125 mm
- Hydraulic Jack with gauge in kg/cm^2

3 Survey Works

The survey works covers the following:

- Borehole drilling
- Sampling and In situ Testing
- Laboratory Testing
- Plate Loading Testing

3.1 Timeframe

The survey work was done within two weeks, the mobilization activities take a week and the last week was used to prepare the report.

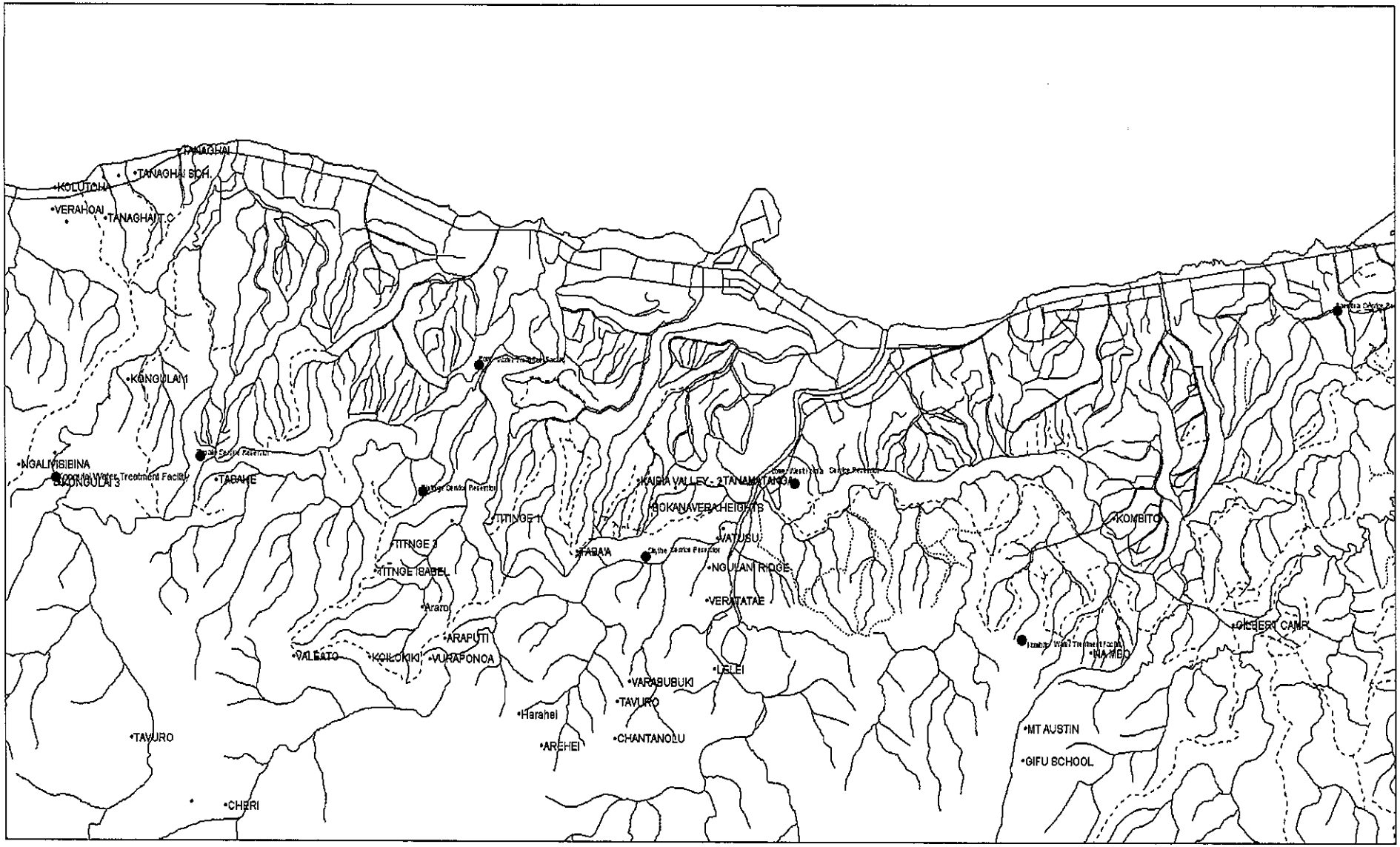


Figure 2: Location of Site Investigation

Soil Investigation Survey

No:	Activities	Number of Days																													T
	Number of Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
		April																		May											
	Date	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	
1.0	Signing of Contract Agreement	#																													
2.0	Mobilization									#																					
3.0	Site Visit and Inspection								#																						
4.0	Drilling of Borehole																														
4.1	Tasahe Reservior																														
4.2	Tintinge Reservior																														
4.3	Skyline Reservior																														
4.4	Lower West Kolaa Reservior																														
4.5	Panatina Reservoir																														
4.6	Kongulai Water Treatment																														
4.7	Rove Water Treatment																														
4.8	Kombito Water Treatment																														
5.0	Sampling and In situ Testing																				#										
6.0	Laboratory Testing																														
7.0	Plate Loading Test																						#								
8.0	Report Writing																														
8.1	Review of documents									#																					
8.2	Draft Report completed																										#				
8.3	Review Report																											#			
8.4	Final Report																												#		
9.0	Report Completion																													##	

Key # **Milestones**

Project completion

A10- 11

4 Service Reservoir & Water Treatment Facility Site

4.1 Panatina Service Reservoir

Panatina Service Reservoir is situated on the eastern part of Honiara. The site is easily accessible by road. Currently it has an existing reservoir tank of 600 m^3, a disinfection house and existing foundation of an old reservoir tank. The project proposed a 2000 m^3 capacity reservoir tank.

4.1.1 Borehole Drilling

The borehole drilling was done using boring rig equipment. The borehole log for each of the borehole is a borehole journal was document in a log sheet of paper to provide the description of strata of the soil.

Plate 4.1: Drilling rig and Operator at Test Site

4.1.2 Sampling and In situ Testing

Borehole log below provides details of the sampling and the in situ testing done

4.1.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.1.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the

number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log Annex 1 below.

4.1.3 Laboratory Testing

The laboratory test was done according to British Standard (BS) by the Material Laboratory, Ministry of Infrastructure Development

4.1.3.1 Soil Classification Tests

Moisture Content

Sample	1- 4 m depth	6 m depth
Moisture Content %	14	14.9

Plasticity Test

Sample	1 –4 m depth	6 m depth
	%	%
Liquid Limit %	43	41
Plastic limit %	27	18
Plasticity Index %	16	23
Linear Shrinkage %	6.4	7.9

From the Plasticity Chart for Soil Classification, the soil sample at Panatina Service Reservoir is medium compressible inorganic clay.

Specific Gravity

Sample	1	2	3
Specific Gravity (G_s)	2.62	2.59	2.63

The average Particle Specific Gravity is 2.61

Grain size distribution analysis

The results of the Particle Size Distribution is tabulated in Table 4.4 and presented in Graph 4.4

Sample	1-4 m depth	6 m depth
D_{10}	0.075	0.075
D_{60}	2.7	5.8
C_u	36	77
	Well graded	Well graded
D_{30}	0.72	1
C_e	3.6	2.3
	Uniform	Medium Graded

4.1.4 Plate Loading Testing

Panatina Service Reservoir was done on the western part, outside of the existing fence. The depth of the trench is about 0.7 m depth. The test was done twice for confirmation of the initial test. The results are clearly detailed below.

4.1.4.1 Soil Condition

The soil condition at Panatina Services Reservoir is brown clayey soil. The soil appears to firm and cohesive. The plate below shows the settlement of the 30 cm diameter plate.

Plate 4.1: Hydraulic Jack and the settlement of the Plate Loading Test

4.1.4.2 Data

The data of the plate loading test results of the two gauges for the reading are tabulated below.

Table 4.1: Tabulated Results

Test Load 1

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0.00	0.00
1.00	2.05	2.53
1.50	3.08	1.36
2.00	2.02	2.12
3.00	7.80	7.70

Test load 2

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0	0.00
0.50	1.03	0.72
1.00	2.45	0.75
1.50	1.91	1.74
2.00	2.30	2.08
2.50	5.70	4.85

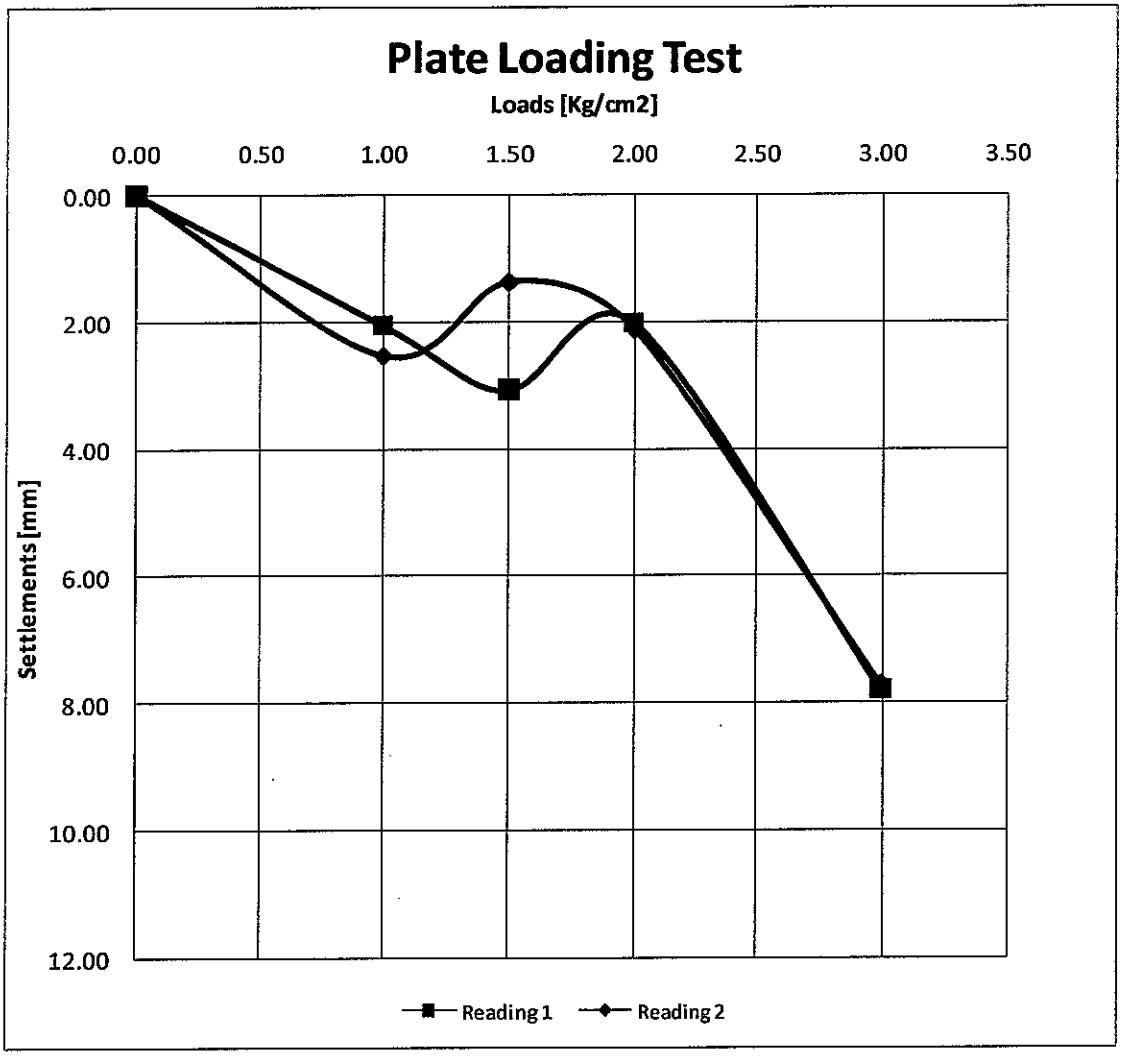


Figure: 4.1a: Plate loading Test for Panatina Service Reservoir

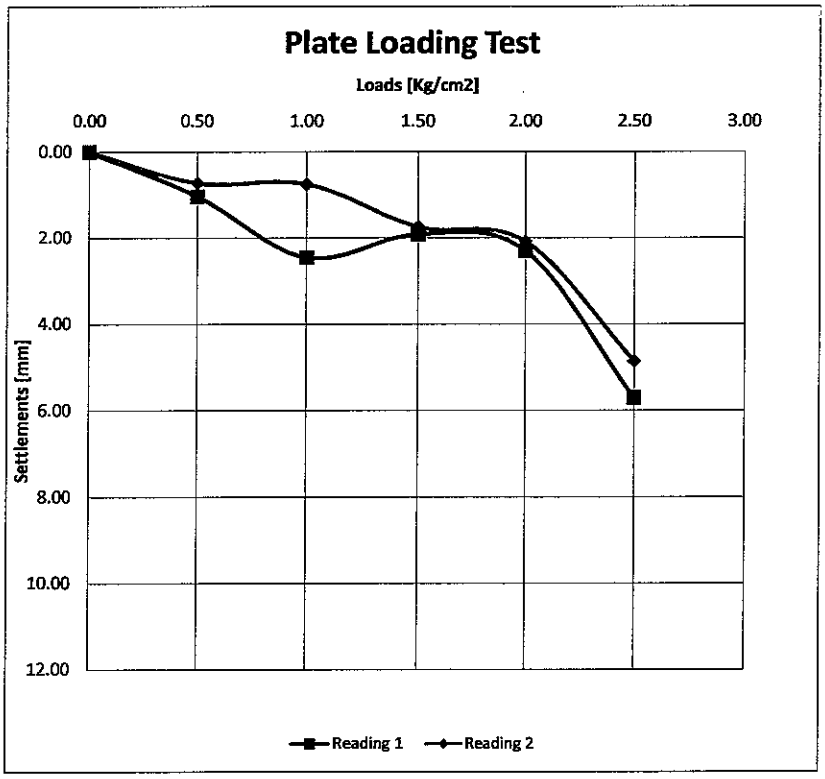


Figure: 4.1b: Plate loading Test for Panatina Service Reservoir

4.1.4.3 Results

The ultimate bearing loading for the soil condition in Panatina is 2.0 kg / cm^2 or 20 ton / m^2. The soil at the test level is mostly clay soil. The tests done shows that soil was moist following the rainfall the day before, which also indicate cohesion type soil.

4.2 Tasahe Service Reservoir

Tasahe is situated in the western end of Honiara City area along the Galloping Horse / Skyline terrace. Currently in the area is a chlorination injection chamber and service reservoir of 12.0m x 21.6m x 4.0m. The proposed service reservoir will be two 8m x 23m x 4.5 m. The existing chlorination house will be removed including existing pipeline system.

4.2.1 Borehole Drilling

The borehole drilling was done using boring rig equipment GEMCO 210B. The borehole log in Annex 1 below shows the descriptive strata of the soil at the interested area.

4.2.2 Sampling and In situ Testing

4.2.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.2.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log in Annex 2 below.

4.2.3 Laboratory Testing

The laboratory test was done according to British Standard (BS)

4.2.3.1 Soil Classification Tests

Moisture Content

Sample	1- 5 m depth	6 – 10 m depth
Moisture Content %	14.3	15.4

Plasticity Test

Sample	2 – 6 m depth	8 m depth	10 m depth
	%	%	%
Liquid Limit %	40	32	35
Plastic limit %	18	19	21
Plasticity Index %	22	13	14
Linear Shrinkage %	8.6	6.3	7.3

From the Plasticity Chart for Soil Classification, the sample for 2 – 6 m depth the soil is medium compressible inorganic clay. The soil sample for 8m depth and 10m depth is low compressible inorganic clay soil.

Specific Gravity

Sample	1	2	3
Specific Gravity (G_s)	2.57	2.52	2.58

The average specific gravity is 2.56

Grain size distribution analysis
The results of the Particle Size Distribution is tabulated in Table 4.1 and presented in Graph 4.1

Sample	1-5 m depth	6 – 10 m depth
D_{10}	0.075	0.075
D_{60}	2.5	3.6
C_u	33	48
	Well graded	Well graded
D_{30}	0.2	0.4
C_e	1	1.48
	Medium Graded	Medium Graded

From the Particle Size Distribution Graph 4.2 the samples of depth 1- 5 m and 6 -10 m are Gravel with Sandy Clay Soils.

4.2.4 Plate Loading Testing

The soil condition at Tasahe is firmly dark brown graded coral gravel and rock. The test had to be done twice due to suspicious of abnormality on the results. Plate 4.2 shows the gravel with clay and coral soil at Tasahe Service Reservoir. The plate loading test was done on the 24 April 2008. Plate 4.1 shows the soil condition of the area.

Plate 4.2: Firmly graded Coral Gravel with Clay at Tasahe Site

4.2.4.1 Results

The result of the plate loading test were tabulated in Table 4.2 and graphed in Figure 4.2. The recommended maximum required load of 30 ton / m^2 applied the soil does not appear to be failed. The ultimate bearing loading for the soil condition in Tasahe is more than 3.5 kg / cm^2 or 35 ton / m^2.

Table 4.1: Tabulated results of two dial gauge for the plate loading test

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0.00	0.00
0.50	0.30	0.10
1.00	0.50	1.15
1.50	0.55	0.30
2.00	1.55	0.60
2.50	0.50	0.90
3.00	0.70	1.10
3.50	0.90	0.21

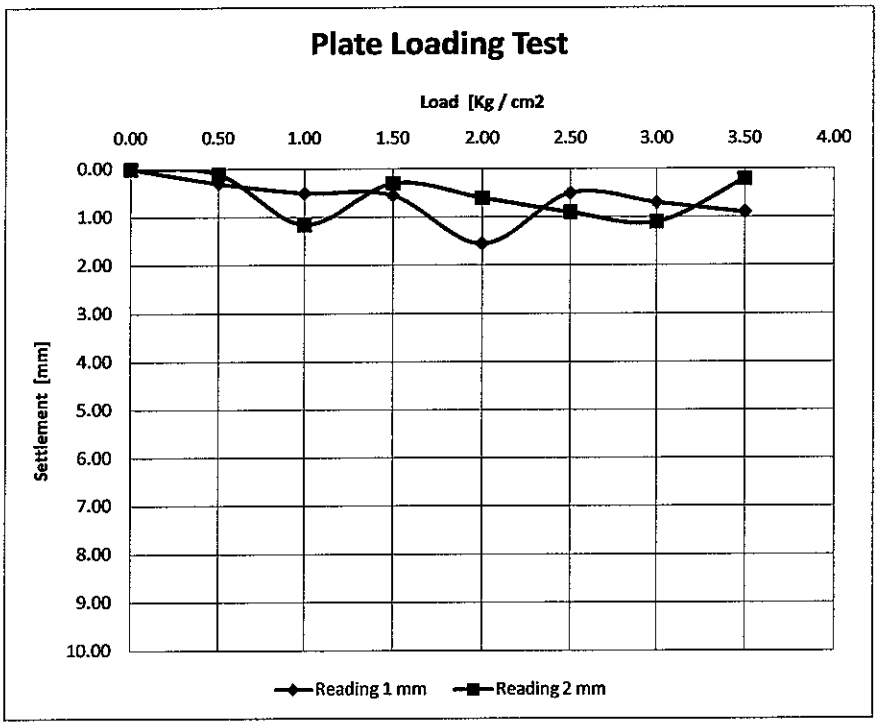


Figure 4.1: Plate loading Test for Tasahe Service Reservoir

4.2.4.2 Discussion

From the result on plate loading test, the recommended load of 30 ton /m^2 is applied and yet there is no indication of settlement occurring above 2 mm. The acceptable allowable capacity of 10 ton / m^2 is within the strength of the soil tested, which is about 50 cm below the ground level.

4.3 Kongulai Purification facility

Kongulai is situated in the western part Honiara. It is the situation of the main water supply system of Honiara, supplying about 50% of Honiara Water Supply. Currently, there is an existing pumping station and a chlorination injection system at Kogulai.

4.3.1 Borehole Drilling

The borehole drilling was done using boring rig equipment. The drilling rig was towed to the site using backhoe due to road condition. The borehole log for each of the borehole is a borehole journal was document in a log sheet of paper to provide the description of strata of the soil.

4.3.2 Sampling and In situ Testing

4.3.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.3.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log in Annex 3 below.

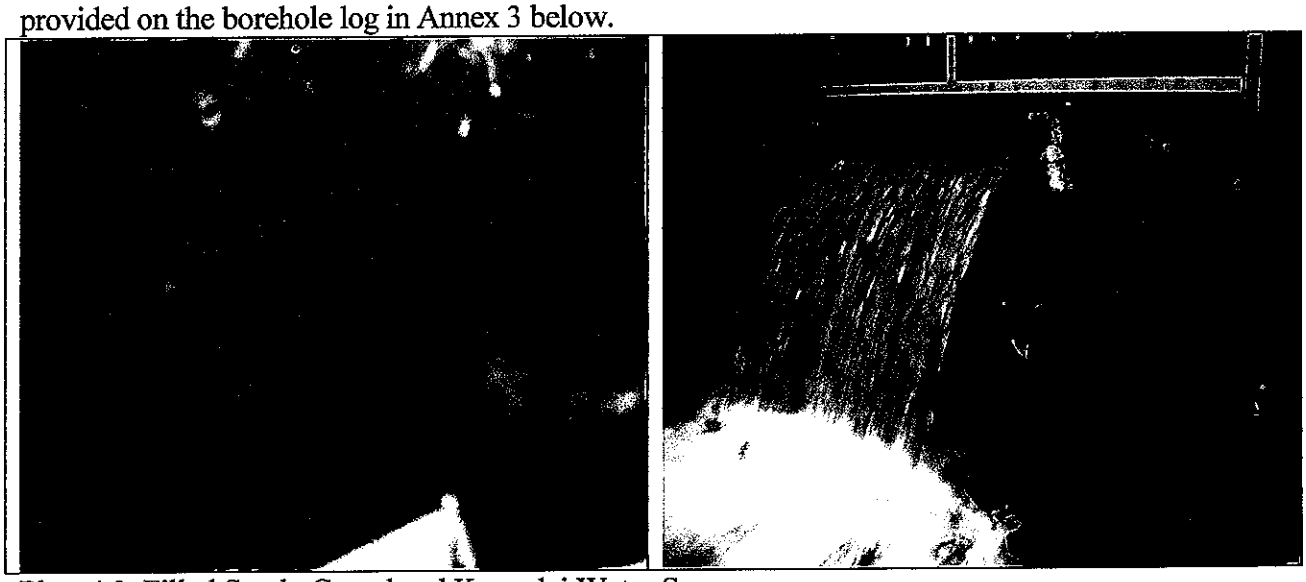


Plate 4.3: Filled Sandy Gravel and Kongulai Water Source

4.3.3 Laboratory Testing

The laboratory test was done according to British Standard (BS) by the Material Laboratory, Ministry of Infrastructure Development

4.3.3.1 Soil Classification Tests

The following were the results of the laboratory classification test.

Moisture Content

Sample	3 - 7 m depth	6 m depth	8 -10 m depth
Moisture Content %	64.1	56.7	20.7

Plasticity Test

Sample	8 - 10 m depth
	%
Liquid Limit %	31
Plastic limit %	23
Plasticity Index %	8
Linear Shrinkage %	5.0

The soil sample is low compressible inorganic clay soil

Specific Gravity

Sample	1	2	3
Specific Gravity (G_s)	2.56	2.51	2.53

Grain size distribution analysis

The results of the Particle Size Distribution is tabulated in Annex 2.1 and presented in Annex 2.2

Sample	3-7 m depth	6 m depth	8 – 10 m depth
D_{10}	0.075	0.075	0.075
D_{60}	0.075	0.26	1.7
C_u	1	3.5	23.3
	Uniform	Uniform	Well graded
D_{30}	0.075	0.084	0.075
C_e	13.3	4.3	0.5
	Uniform	Uniform	Well Graded

From the Particle Size Distribution graph present in Graph 5.1, the sample of depth between 3 -7 indicated high presents of clay (Cu) and sample for 6m depth shows sandy clay (Su) and sample 8 – 10 shows sandy gravel clay (Gc).

4.3.4 Plate Loading Testing

The soil condition at Kongulai proposed water treatment site appears to be filled sandy gravel; it is likely to fill done for the construction of the pumping station. The access to the site was difficult due to road condition.

4.3.4.1 Results

The result of the plate loading test were tabulated in Table 4.3 and graphed in Figure 4.3. The ultimate bearing loading for the soil condition is 3.0 kg / cm^2 or 30 ton / m^2.

4.3.4.2 Discussion

From the test the ultimate bearing capacity is 30 ton / m^2, which the recommended maximum loads applied.

Table 4.3: Tabulated Results of Two Gauge

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0.00	0.00
0.50	0.21	0.17
1.00	0.39	1.22
1.50	0.57	0.27
2.00	1.21	0.87
2.50	1.47	0.97
3.00	3.05	2.20
3.50	5.25	6.90

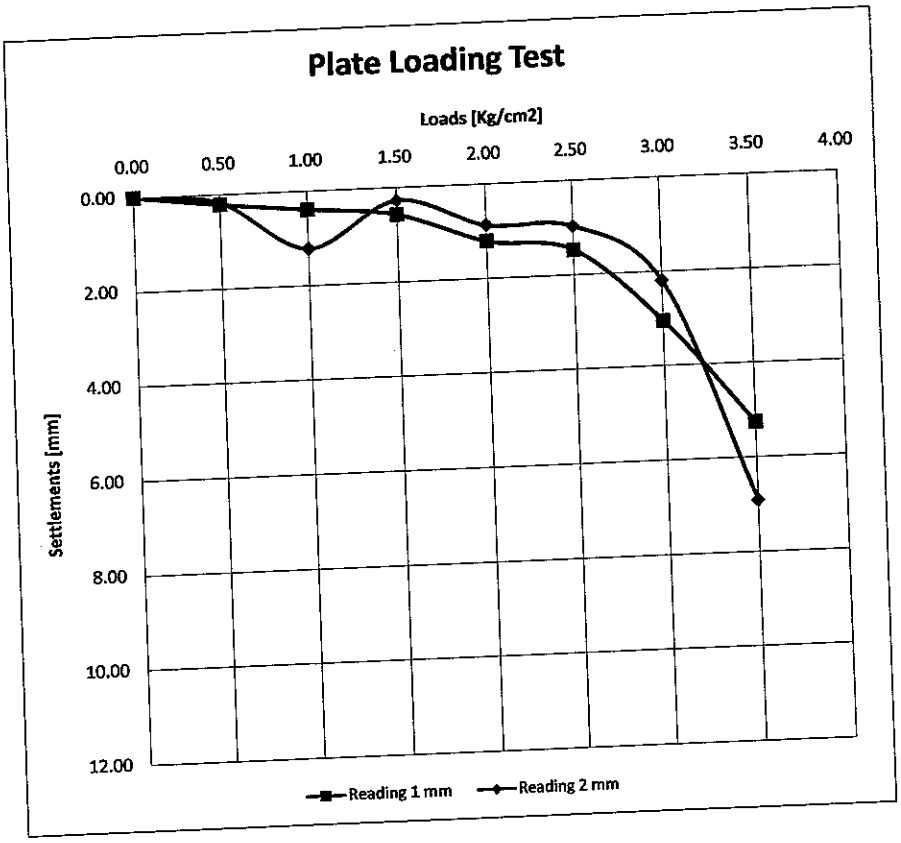


Figure 4.3: Plate loading Test for Kongulai Service Reservoir

4.4 Kombito Purification facility

Kombito is situated south east of Honiara. Currently, there is an existing pumping station at Kombito Borehole. The proposed plan was to develop a water treatment facility, which shall consist of two settling tank

4.4.1 Borehole Drilling

The borehole drilling was done using boring rig equipment. The borehole log annex 4 for each of the borehole is a borehole journal was document in a log sheet of paper to provide the description of strata of the soil.

4.4.2 Sampling and In situ Testing

4.4.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.4.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log in Annex 4 below.

4.4.3 Laboratory Testing

The laboratory test was done according to British Standard (BS) by the Material Laboratory, Ministry of Infrastructure Development

4.4.3.1 Soil Classification Tests

Moisture Content

Sample	1- 4 m depth	2- 10 m depth
Moisture Content %	24	16

Plasticity Test

Sample	1 –4 m depth	5-10 m depth
	%	%
Liquid Limit %	45	43
Plastic limit %	30	25
Plasticity Index %	15	18
Linear Shrinkage %	9.3	9.2

From the Plasticity Chart for Soil Classification, the soil sample at Kombito Water Treatment Facility Service Reservoir is medium compressible inorganic clay.

Specific Gravity

Sample	1 – 4 m	5 – 10 m
Specific Gravity (G_s)	2.55	2.60

Grain size distribution analysis

The results of the Particle Size Distribution is tabulated in annex 4.1 and presented in Annex 4.2

Sample	1-5 m depth	6 - 10 m depth
D_{10}	0.075	0.075
D_{60}	2.5	3.5
C_u	33	47
	Well graded	Well graded
D_{30}	0.075	0.3
C_e	1	4
	Uniform	Uniform Graded

From the Graph the soil is 30 % of gravel, 30 % sand and 30 % clay , therefore the soil can be termed as well graded gravelly sandy clay.

4.4.4 Plate Loading Testing

The plate loading test was done approximately 40m from the existing pumping station. The soil condition is coral gravel. The depth of the test hole is 0.40 m.

4.4.4.1 Results

The results of the plate loading test are presented in table 4.4 and figure 4.4 below. There is no indication of any failure or any major settlements occur when the required maximum load is applied. However, 3.5 kg/cm^2 load is applied. Therefore, there should be no problem, if the ultimate bearing capacity of 30 ton/m^2 is used.

Table 4.4: Tabulated Results of Two Gauge

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0.00	0.00
0.50	0.18	0.30
1.00	0.19	1.46
1.50	0.15	0.37
2.00	0.14	0.34
2.50	0.13	0.27
3.00	0.25	0.47
3.50	0.42	0.83

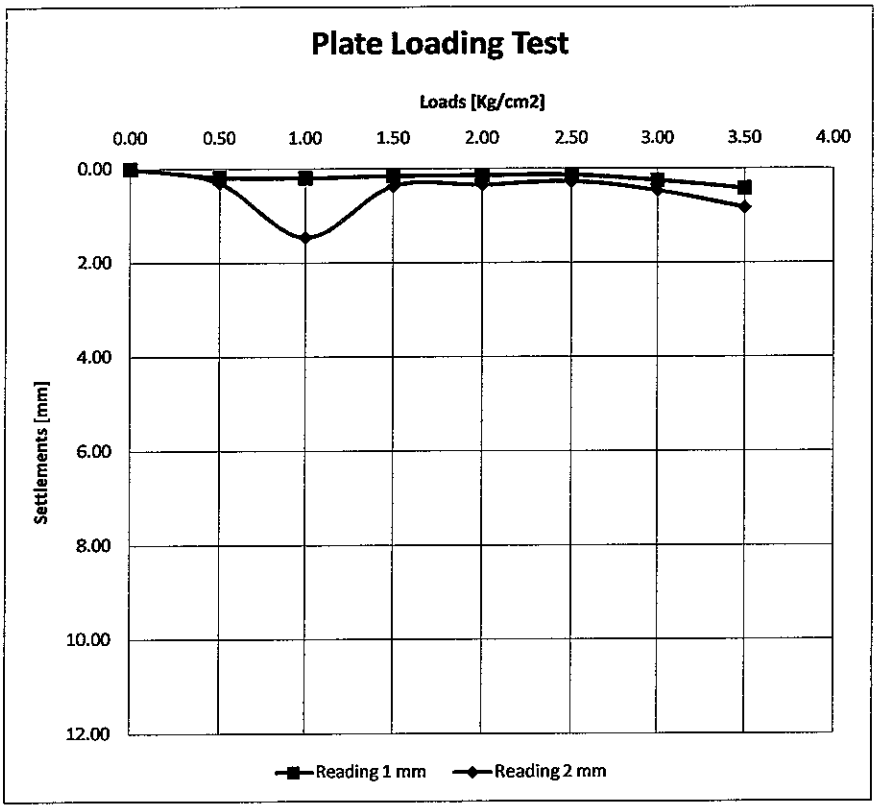


Figure 4.4: Plate loading Test for Kombito Water Treatment Facility

4.4.4.2 Discussion

As mentioned above, there should be no problem with using the ultimate bearing capacity of 30 ton/m^2 and allowable capacity of 10 ton/m^2. Plate 4.4 shows the coral gravel that is presented at Kombito. The soil strength is capable of taking the load for the treatment.

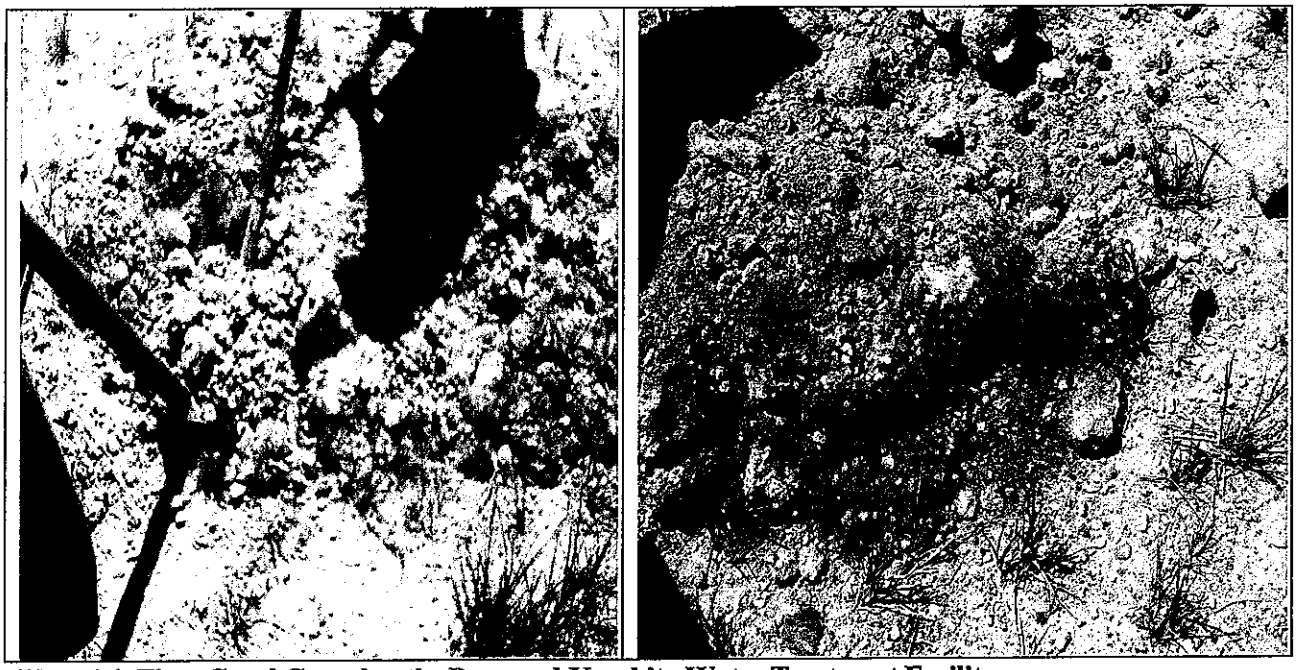


Plate 4.4: Firm Coral Gravel at the Proposed Kombito Water Treatment Facility

4.5 Lower West Kola' a Service Reservoir

Lower west Kola'a Service Reservoir is situated at the central part of Honiara, overlooking Mataniko River. The geology of the lower Kola'a Site is Mataniko Siltsones. The most typical rock occurrence is a dark grey tuffaceous mudstone, with well marked bedding and with abundant crystals of augite and feldspar which appear fresh and unworn. Irregularly interspersed with the typical mass are bands of coarse or finer materials, the latter almost silty.

Currently there are two existing tanks at the site. The proposed site for the new reservoir is situated on the other side of the access road. However due to restriction on the access the test and drilling were done on the access road site of the reservoir. The proposed Service Reservoir is 10m x 12m x 3.8m

4.5.1 Borehole Drilling

The borehole drilling was done using boring rig equipment. The borehole log for each of the borehole is a borehole journal was document in a log sheet of paper to provide the description of strata of the soil.

4.5.2 Sampling and In situ Testing

4.5.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.5.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log in Annex 5 below.

4.5.3 Laboratory Testing

The laboratory test was done according to British Standard (BS) by the Material Laboratory, Ministry of Infrastructure Development

4.5.3.1 Soil Classification Tests

Moisture Content

Sample	1 - 2 m depth	3 - 10 m depth
Moisture Content %	10.5	25.4

Plasticity Test

Sample	1 –4 m depth	6 m depth
	%	%
Liquid Limit %	34	50
Plastic limit %	23	36
Plasticity Index %	11	14
Linear Shrinkage %	5.6	6.1

From the Plasticity Chart for Soil Classification, the soil sample at Panatina Service Reservoir is medium compressible inorganic clay.

Specific Gravity

Sample	1 – 2 m depth	3 – 10 m depth
Specific Gravity (G_s)	2.63	2.52

Grain size distribution analysis

The results of the Particle Size Distribution is tabulated in Annex 5.1 and Graphed in Annex 5.2

Sample	1-2 m depth	3 – 10 m depth
D_{10}	0.075	0.075
D_{60}	15	0.4
C_u	200	5
	Well graded	Uniformly graded
D_{30}	1.3	0.075
C_e	17	1

From the distribution graph, the soil for depth 1 – 2m is 60 % gravel and 20 % sand and the remaining 20 % is clay. Soil in depth 3 – 10 m is 20 % gravel, 45 % sand and the remaining 35 % clay. Therefore the soil can be described as clayey sandy gravel (GW – C) and gravelly clay sand (GS) respectively

4.5.4 Plate Loading Testing

The plate loading test for Lower West Kola'a done on the upper part of the existing tank due to the problem of access of the road Results. The depth of the excavation area is 0.5 m. The soil condition was a mixture of coral gravel, sandstone and top soil possibly from the access road.

4.5.4.1 Results

The result of the plate loading test were tabulated in Table 4.5 and graphed in Figure 4.5. The ultimate bearing loading for the soil condition is 2.0 kg / cm^2 or 20 ton / m^2. However, this was done on the soil that could be transported by water during heavy rainfall. The result is showing us the results of soil but the soil strength at the actual area for the proposed Service Reservoir would be higher than the results of the load test.

Table 4.5: Tabulated Results of Test at Lower West Kola'a

Loads	Settlement 1	Settlement 2
kg/cm2	mm	mm
0.00	0.00	0.00
0.50	1.70	1.28
1.00	2.92	1.51
1.50	1.36	1.92
2.00	6.44	4.57
3.00	13.2	11.40

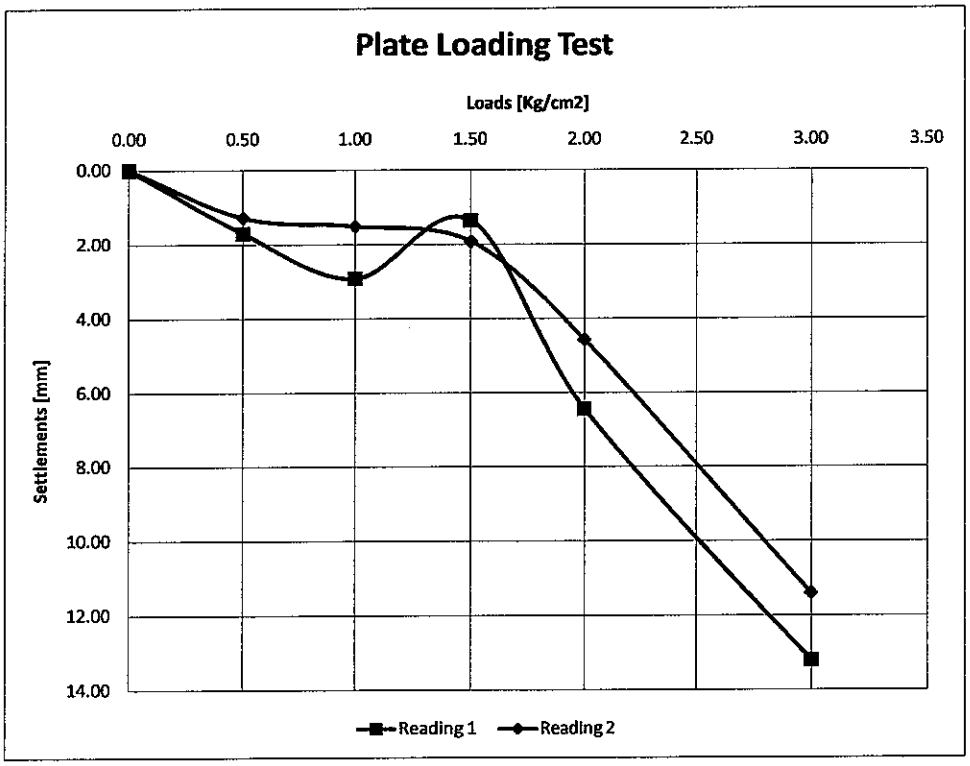


Figure 4.5.: Plate loading Test for Lower West Kola'a Service Reservoir

4.5.4.2 Discussion

The ultimate bearing loading for the soil condition in Lower West Kola'a is 2.0 kg / cm^2 or 20 ton / $m^{2.}$. Anyhow, the ultimate bearing loading of 30 ton / m^2 should be acceptable. The soil strength below, which is sandstone should acceptable.

4.6 Skyline Service Reservoir

Skyline Services Reservoir is situated at the central Honiara. Currently there is two existing tank 12.2 m x 11.0 m x 3.6 m and 15.97 m diameter x 2.4m height. The proposed tank is 20 m x 25 m x 4 m. The geology is coral gravel with clay.

4.6.1 Borehole Drilling

The borehole drilling was done using boring rig equipment. The borehole log for each of the borehole is a borehole journal was document in a log sheet of paper to provide the description of strata of the soil.

4.6.2 Sampling and In situ Testing

4.6.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.6.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log in Annex 6 below.

4.6.3 Laboratory Testing

The laboratory test was done according to British Standard (BS) by the Material Laboratory, Ministry of Infrastructure Development

4.6.3.1 Soil Classification Tests

Moisture Content

Sample	1 - 5 m depth	6 – 10 m depth
Moisture Content %	13.3	13.4

Plasticity Test

Sample	0 – 2 m depth	4 – 10 m depth
	%	%
Liquid Limit %	38	37
Plastic limit %	18	17
Plasticity Index %	20	20
Linear Shrinkage %	11.6	10.7

From the Plasticity Chart for Soil Classification, the soil sample at Panatina Service Reservoir is medium compressible inorganic clay.

Specific Gravity

Sample	1	2
Specific Gravity (G_s)	2.58	2.58

The average Particle Specific Gravity is 2.61

Grain size distribution analysis

The results of the Particle Size Distribution is tabulated in Annex 6.1 and presented in Annex 6.2

Sample	1-5 m depth	6 - 10 m depth
D_{10}	0.075	0.075
D_{60}	6	3
C_u	80	40
	Well graded	Well graded
D_{30}	0.35	0.35
C_e	4.7	4.7
	Uniform	Medium Graded

From the graph the soil for 1-5 m depth is 50% gravel, 25 % sand and for 6 -10 m depth is 30 % gravel and 45% sand and the remaining is mostly clay. Therefore the soil can be term as clay sandy gravel and clay gravelly sand respectively

4.6.4 Plate Loading Testing

The plate loading test for Skyline Service Reservoir was done twice due to the present of clay soil with moist. When the load applied the plate penetrated through the soil easily. There seems to be present of water or moist. The soil condition shows that there is very high presence of clay on the soil. Therefore, in spite of presence of coral gravel, the plate just sinks in. The test was stopped after the sink and the wider plate above the 30 cm diameter plate is also touching the ground. Plate 4.6 shows the soil characteristic and the plate sinks in the soil.

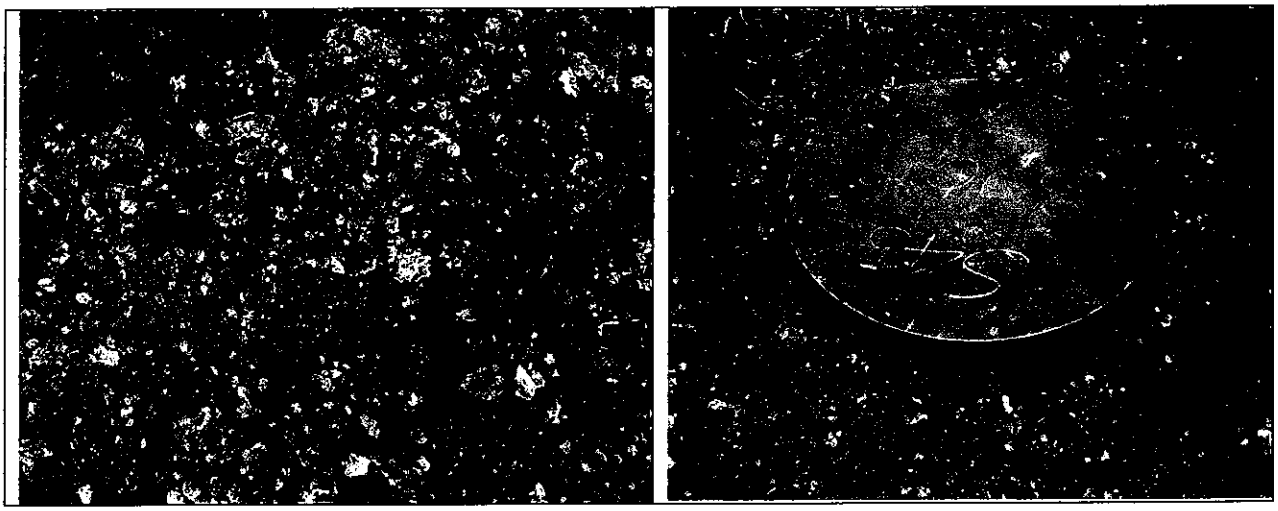


Plate 4.6: Coral gravel soil and Plate in the soil

4.6.4.1 Results

The results of the two plate loading test done at Skyline Service Reservoir were tabulated in Table 4.6a and table 4.6b and graphed in Figure 4.6a and 4.6b. The result consistently shows that the ultimate bearing capacity for the Skyline Service Reservoir is only 1.5 kg / cm^2 or 15 ton / m^2. Therefore, a compaction of sub-base soils needs to be done to improve the soil strength that will be able to take the weight bearing of the proposed Service Reservoir of 20^m x 25^m x 4^m.

Table 4.6a: Tabulated Results of Plate Test in Skyline Service Reservior

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0.09	0.00
1.00	0.86	0.79
1.50	2.83	4.57
2.00	10.23	15.46

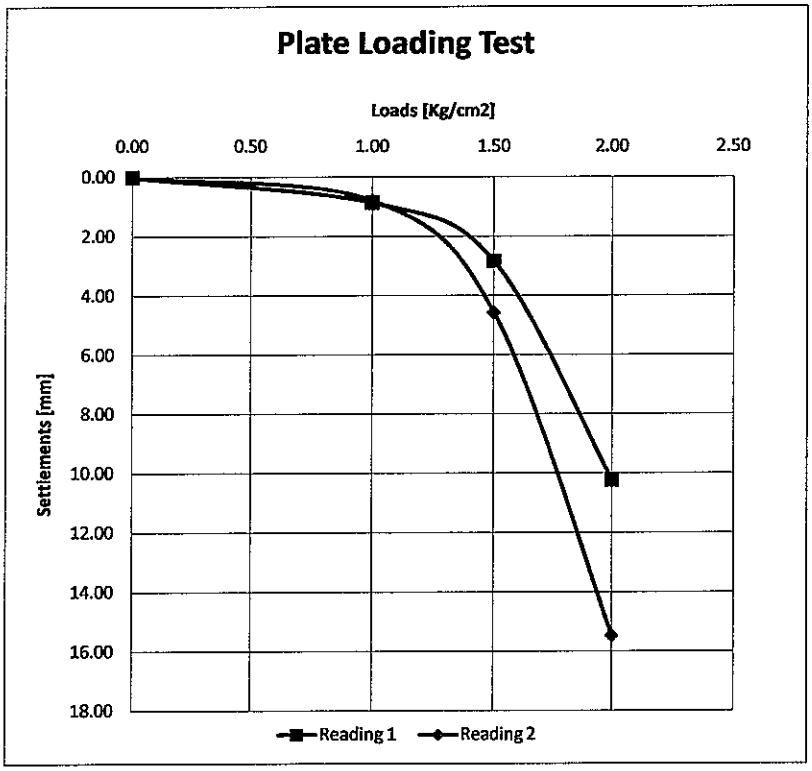


Figure 4.6 a: Plate loading Test for Skyline Service Reservoir

Table 4.6b: Tabulated Results of Plate Test in Skyline Service Reservior

Loads	Settlement 1	Settlement 2
kg/cm2	mm	mm
0.00	0.00	0.00
0.50	0.61	0.44
1.00	2.93	3.33
1.50	5.56	5.85
2.00	13.76	16.18

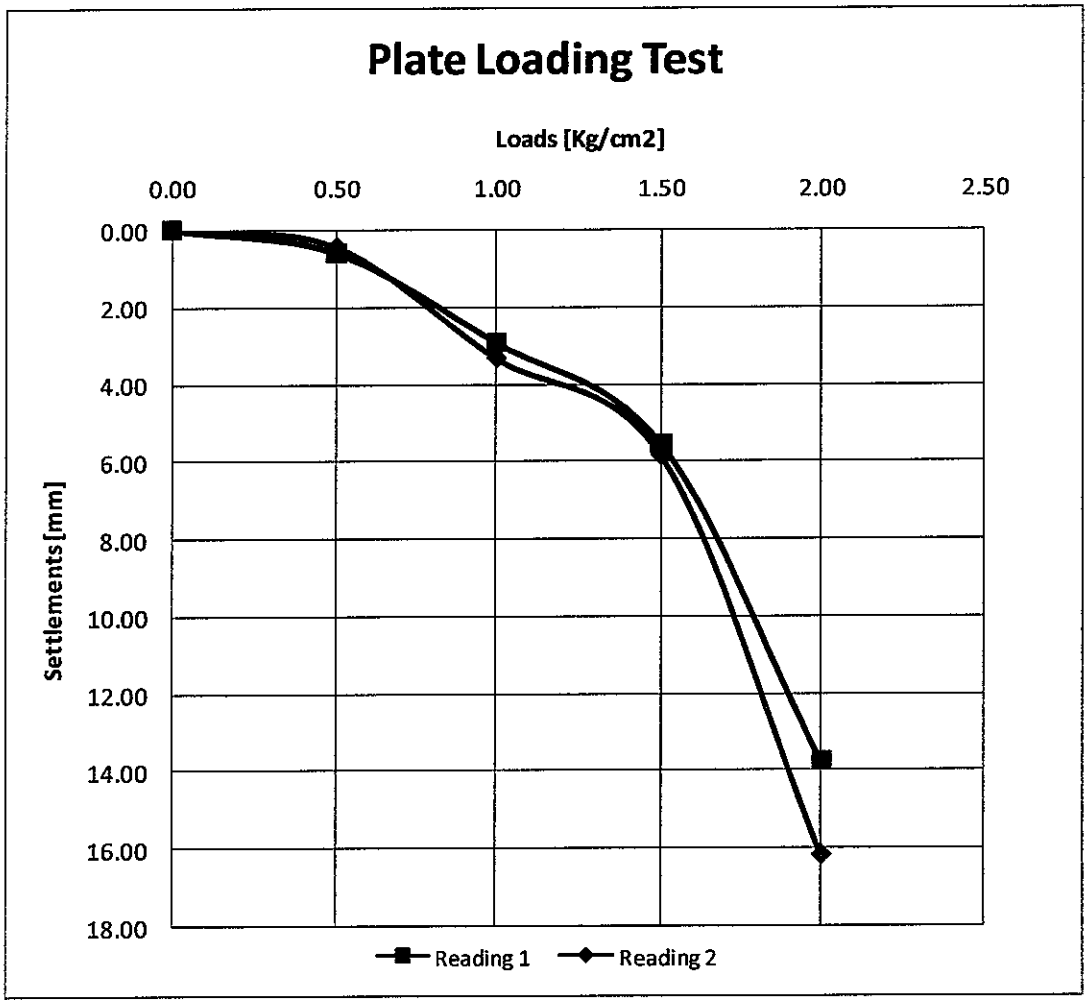


Figure 4.6b: Plate loading Test for Skyline Service Reservoir

4.6.4.2 Discussion

The ultimate bearing loading for the soil condition in Skyline is 1.50 kg / cm^2 or 15 ton / m^2. The skyline site will need to compact to improve the soil strength.

4.7 Tintinge service reservoir

Tintinge Service Reservoir is situated on the upper part of Rove area. There is an existing tank of 12m x 10.8m x 3m. The proposed reservoir of 16m x 18m x 5m, the soil is mostly coral gravel. The existing tank and concrete footing will be removed prior to the construction of the proposed new tank reservoir. Backhoe had been request to level the entrance of the gate in order that work could be done.

4.7.1 Borehole Drilling

The borehole drilling was done using boring rig equipment. The borehole log for each of the borehole is a borehole journal was document in a log sheet of paper to provide the description of strata of the soil.

4.7.2 Sampling and In situ Testing

4.7.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.7.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log in Annex 7 below.

4.7.3 Laboratory Testing

The laboratory test was done according to British Standard (BS) by the Material Laboratory, Ministry of Infrastructure Development

4.7.3.1 Soil Classification Tests

Moisture Content

Sample	3- 5 m depth	6 - 10 m depth
Moisture Content %	10.2	10.8

Plasticity Test

Sample	4 –6 m depth	8 – 10 m depth
	%	%
Liquid Limit %	42	34
Plastic limit %	27	25
Plasticity Index %	15	9
Linear Shrinkage %	11.4	8.6

From the Plasticity Chart for Soil Classification, the soil sample at Tintinge Service Reservoir is medium compressible inorganic clay.

Specific Gravity

Sample	1 – 5 m depth	6 – 10 m depth
Specific Gravity (G_s)	2.62	2.58

The average Particle Specific Gravity is 2.61

Grain size distribution analysis
The results of the Particle Size Distribution is tabulated in Annex 7.1 and presented in Annex 7.2

Sample	1-5 m depth	6 - 10m depth
D_{10}	0.075	0.075
D_{60}	2.7	5.8
C_u	36	77
	Well graded	Well graded
D_{30}	0.72	1
C_e	1.63	0.28
	Uniform	Medium Graded

From the Particle Size Distribution graph in Annex 7.2 the soil between 1 – 5 m is 30 % gravel, 50 % sand and 20 % clay and between 6 – 10 m is 40 % gravel, 40% sand and 20% clay. The soil is Gravelly sand y clay soil.

4.7.4 Plate Loading Testing

The soil condition at Tintinge is firmly dark brown graded coral gravel. Plate 4.7 below shows the soil condition at Tintinge Service Reservoir. The plate loading test was done on the 9 May 2008 and repeated on the 11 May 2008.

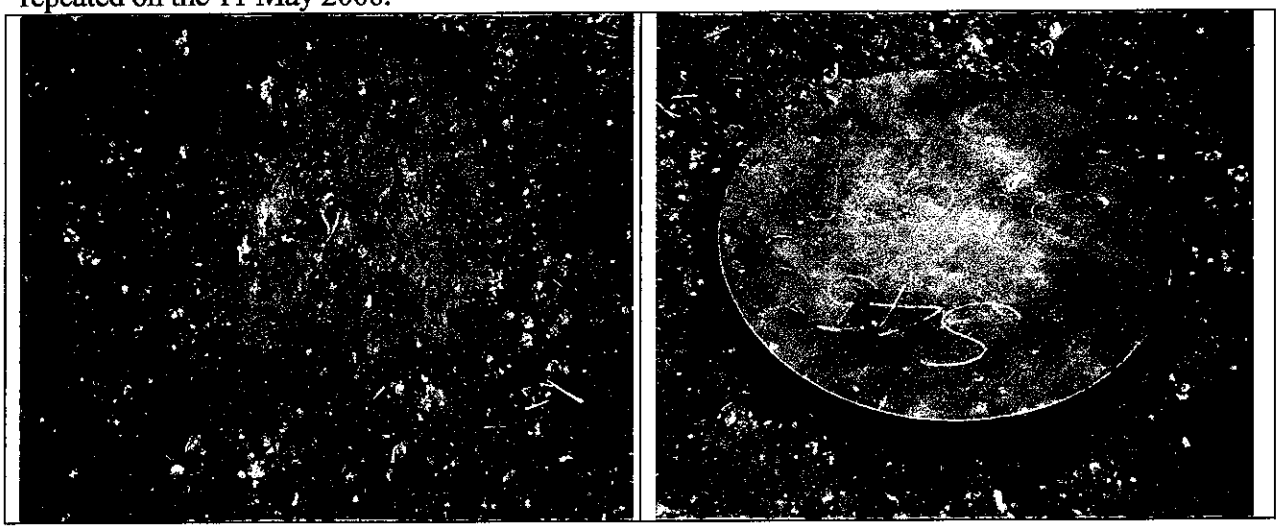


Plate 4.7: Soil Condition at Tintinge Service Reservoir

4.7.4.1 Results

The result of the plate loading test were tabulated in Table 4.7 and graphed in Figure 4.7. The maximum load of 32.5 ton / m^2 applied. However, the ultimate bearing loading for the soil condition in Tintinge is 3.0 kg / cm^2 or 30 ton / m^2.

Table1 4.7: Tabulated Results of Two Gauge

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0.00	0.00
0.50	0.99	0.35
1.00	0.41	0.87
1.50	0.91	0.92
2.00	1.73	1.01
2.50	2.00	1.00
3.00	2.32	0.93
3.25	3.99	4.40

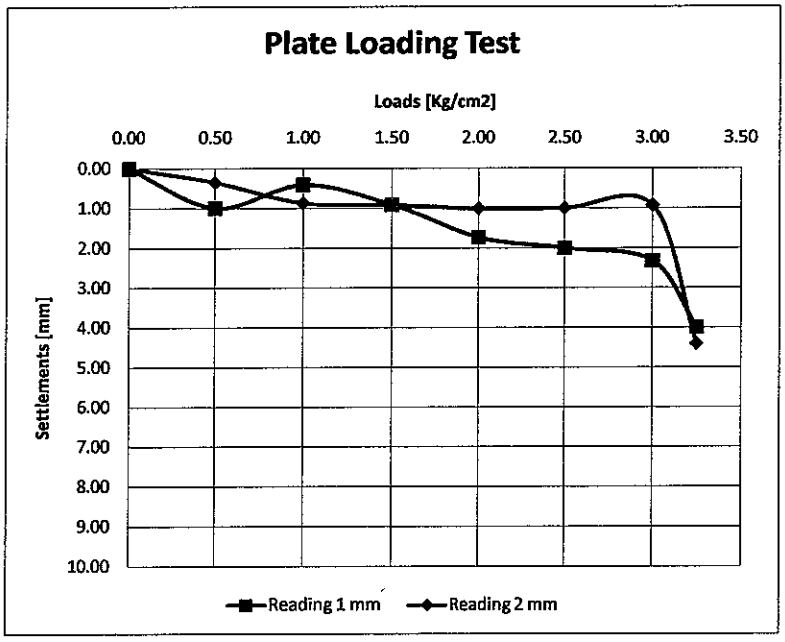


Figure 4.7: Plate loading Test for Tintinge Service Reservoir

4.7.4.2 Discussion

From the result on plate loading test, the maximum load of 32.5 ton /m^2 is applied and there is an indication of settlement occurring about 4 mm. The ultimate bearing capacity is 30 ton / m^2. The soil strength is acceptable with limited compaction.

4.8 Rove Water Treatment facility

The proposed Rove Water Treatment Facility is situated on the upper end of the Botanical Garden. Due to access limitation, the site which was suggested near the stream was not possible. The area which was tested was near the old tank foundation opposite the houses.

4.8.1 Borehole Drilling

The borehole drilling was done using boring rig equipment. The borehole log for each of the borehole is a borehole journal was document in a log sheet of paper to provide the description of strata of the soil.

4.8.2 Sampling and In situ Testing

4.8.2.1 Disturbed Sample

The recovered cutting and the core sample from the drilling and SPT respectively. The sample was group according to the soil properties from the drilling borehole log.

4.8.2.2 Standard Penetration Test

The Standard Penetration Test (SPT) was done according to AS 1289. The N value is the sum of the number of blow between 150 mm – 450mm. The result of the SPT at each depth of 1 m interval is provided on the borehole log in annex 8 below.

4.8.3 Laboratory Testing

The laboratory test was done according to British Standard (BS) by the Material Laboratory, Ministry of Infrastructure Development

4.8.3.1 Soil Classification Tests

Moisture Content

Sample	1-2 m depth	3 - 5 m depth	6 – 10 m depth
Moisture Content %	45.4	19.5	13.5

There is high presence of moisture content at depth 1 -2 m possibly due heavy rainfall and clay soils presence.

Plasticity Test

Sample	1 –2 m depth	6 m depth
	%	%
Liquid Limit %	64	34
Plastic limit %	39	25
Plasticity Index %	25	9
Linear Shrinkage %	19.5	5.0

From the Plasticity Chart for Soil Classification, the soil sample at Rove Water Treatment Facility Service Reservoir is medium compressible inorganic clay.

Specific Gravity

Sample	1 – 2 m depth	3 – 10 m depth
Specific Gravity (G_s)	2.66	2.57

Grain size distribution analysis

The results of the Particle Size Distribution is tabulated in Table 4.4 and presented in Graph 4.4

Sample	1-4 m depth	6 m depth
D_{10}	0.075	0.075
D_{60}	2.7	5.8
C_u	36	77
	Well graded	Well graded
D_{30}	0.72	1
C_c	3.6	2.3
	Uniform	Medium Graded

From the Particle Size Distribution graph in Annex 8.2 the soil between 1 – 2 m is 40 % medium to fine gravel, 40 % sand and 20 % clay, between 3 – 5 m is 52 % gravel, 30% sand and 18% clay. The soil is Gravelly sand y clay soil. The soil between 6 -10 m is 5 % gravel, 50 % sand and 45 % clay, which sandy clay soil.

4.8.4 Plate Loading Testing

As mentioned above, the plate loading test was done near the old reservoir tank foundation. The test was done after a heavy rainfall at night. The soil condition is clay cohesive soil. The test was done in spite of problem experienced during to slight drizzles during the test time.

4.8.4.1 Results

The result of the plate loading test were tabulated in Table 4.8 and graphed in Figure 4.8. The soil shows a steady increase as the load is applied. The Soil strength at the proposed site near the stream could be higher the clay soil tested. However ultimate bearing loading for the soil condition in Rove is 1.5 kg / cm^2 or 15 ton / m^2, the test was done upper part of the proposed site.

Table4.8: Tabulated Results of Plate Loading Test

Loads	Reading 1	Reading 2
kg/cm2	mm	mm
0.00	0.00	0.00
0.50	2.63	3.63
1.00	3.87	3.04
1.50	4.60	6.50
2.00	7.76	8.00
2.50	9.14	11.92

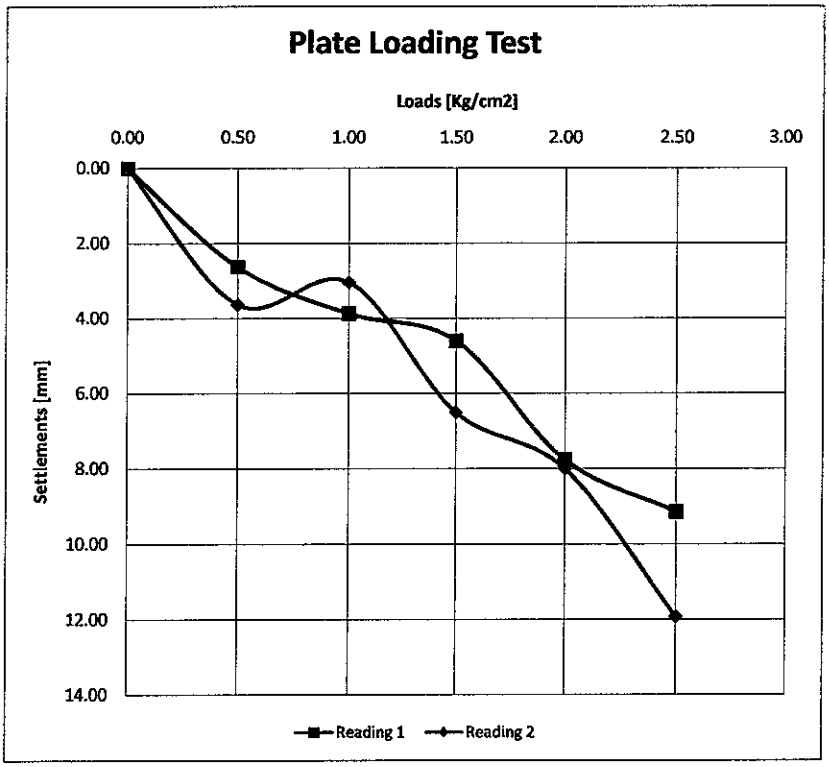


Figure 4.8: Plate loading Test for Proposed Rove Water Treatment Facility

4.8.4.2 Discussion

The test result shows that the ultimate bearing 15 ton / m^2. The site needs to be prepared to compact the soil sub-base level to improve the strength of the soil. The area that was proposed as the site for the proposed rove water treatment site is situated on the lower site from the test site. However, it needs to be compacted to accomplish the required strength.

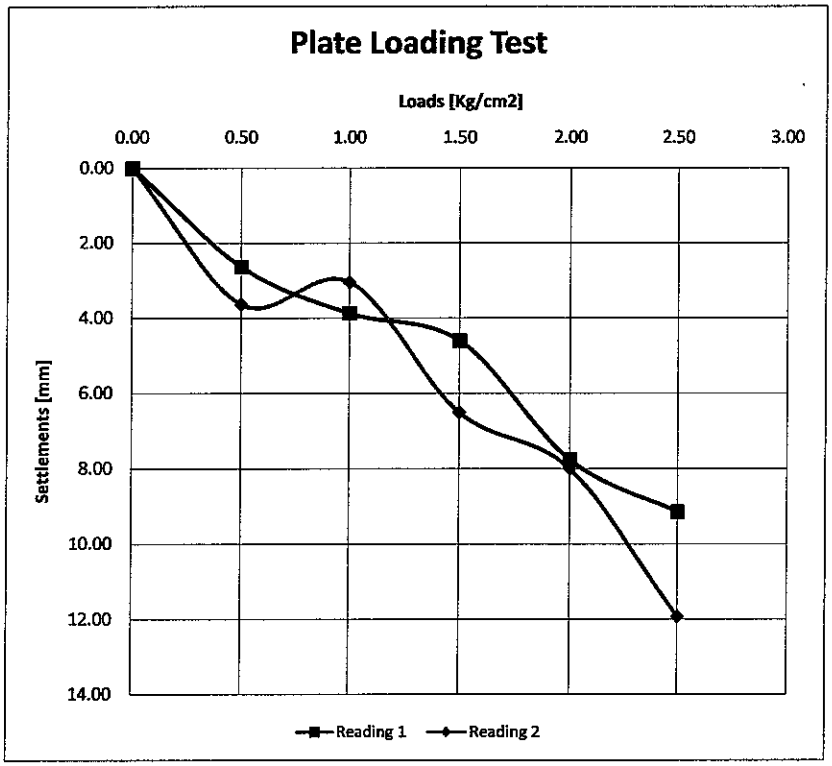


Figure 4.8: Plate loading Test for Proposed Rove Water Treatment Facility

4.8.4.2 Discussion

The test result shows that the ultimate bearing 15 ton / m^2. The site needs to be prepared to compact the soil sub-base level to improve the strength of the soil. The area that was proposed as the site for the proposed rove water treatment site is situated on the lower site from the test site. However, it needs to be compacted to accomplish the required strength.

5 Summary of Discussion

The results for laboratory test, drilling log and SPT were summaries in section 4 of this report.

The geology of immediate Honiara Area is mostly Honiara Reef Limestone. The area was associated with magnificent complex sequence of terraces ranging from 700m above to 100m below the sea level. The Mataniko area is consist of Mataniko Siltstones.

The soil classification for each of the sites shows is mostly coral gravel with various percentage amounts of clay and sand. The top soil mostly had a percentage of clay.

The soil condition at Tasahe, Kombito, Kongulai, and Tintinge can accommodate any footing design with the ultimate bearing capacity of 30 ton /m^2. The rest of the site had a ultimate bearing capacity of between 15 ton/m^2 and 25 ton/m^2 , therefore the compaction needs to be done to soil condition to improve the soil strength to accommodate the weight of the service reservoir.

6 Reference

1. **Hackman, B.D 1979** "Geology of the Honiara Area"
   Libra Press Limited, Hongkong
2. **Smith, G.N 1982** "Elements of Soil Mechanics for Civil and Mining Engineers"
   Collins Professional Books, London
3. **ASTM D 1194 – 1994** "Standard Test Method for Bearing Capacity of Soil for Static Load and Spread Footing"
   SAI Global Limited
4. **Vazirani V.N & Chandola, S.P 2001** "Civil Engineering Handbook"
   Khanna Publishers

5. **SAA 1998** "Australian Standards for Civil Engineering Students, Part 1: Materials and Testing"
   SAI Global Limited

Annex 1

Name of Project	**The improvement of Water Supply System Project**	**Borehole Number :**	**1**
Date Drilled:	26-Apr-08	**Location:**	Panatina Service Reservoir
Rig:	GEMCO 2106	**Elevation:**	70 m asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level [m]	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance "N"	Symbol	Symbol	Soil Description		Water Presents	Moisture Content %	Penetrometer N
				15	30	45				Lithology	Colour		10 30 50 70 90	10 20 30 40
0.0	70.0		S(30)	1	8	10	18	SC		Coral Clay	Black	Moist	⊗	⊗
1.0	69.0	D1	S(30)	11	12	11	23	GC		Well graded Coral Gravel	White	Dry	⊗	⊗
2.0	68.0	D2 B1	S(30)	13	9	8	17	GW		Well graded Coral Gravel	White	Dry	⊗	⊗
3.0	67.0	D3	S(30)	8	10	12	22	GW		Well graded Coral Gravel	White	Dry	⊗	⊗
4.0	66.0	D4 B2	S(30)	9	8	11	19	GW		Well graded Coral Gravel	White	Dry	⊗	⊗
5.0	65.0	D5	S(30)	8	8	8	16	GP		Poorly Graded Soft Coral Gravel	Brown	Moist	⊗	⊗
6.0	64.0	D6 B3	S(30)	9	6	7	13	GP		Poorly Graded Soft Coral Gravel	Brown	Moist	⊗	⊗
7.0	63.0	D7	S(30)	23	30		30	GW		Hard Coral Gravel	Brown	Moist	⊗	⊗
8.0	62.0							GW		Very Hard Coral Gravel	light Brown	Dry	⊗	⊗
9.0	61.0							GW		Very Hard Coral Gravel	light Brown	Dry		⊗
10.0	60.0							GW		Very Hard Coral Gravel	light Brown	Dry		⊗

REMARKS:
Coral started at 0.40 m
SPT at 8 m is bouncing
From 6.40 m good for diamond core drilling only, very hard coral experienced
At 7.00 m SPT hammer started bouncing at 30 cm
From 7.40 m hard drilling (coral) still no water circulation

Key:
D : Disturbed Sample
B : Bulk
W : Water
o : Core Recovery
S(30) : Standard Penetration Test
C(27) : Cone
(27) : No. Blows for 300mm Penetration
v : In-situ Vane Shear Test
U1/70 : Undisturbed Sample 100mm Dia
/70 : No. Of Blows to drive sample 450 mm
u-/70 : Undisturbed Sample - no recovery
S&A : Shell & Auger
DD :Rotary Diamond Drilled

Note:
This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

PS DL

Pacific Strata Drilling Limited

Borehole 1

Particle Size Distribution

Location: Panatina Service Reservior

Date: 30-Apr-08 **Analysed by:** Clifford Betokerah
Ministry of Infrastructure Developent

Method	Wet Seiving							
Total mass (g)	265	380	346	388	355	106	278	289
Depth of sampl	0	1	2	3	4	5	6	7
Seive	**Passing %**	**Passing %**	**Passing %**	**Passing %**	**Passing %**	**Passing %**	**Passing %**	**Passing %**
mm								
0.075	21.8	13.3	13.5	22.6	16.6	18.9	16.2	11.9
0.150	27.5	14.1	15.5	24.4	17.2	19.5	17.6	12.9
0.300	44.5	17.3	19.8	28.8	20.3	22.9	21.2	16.4
0.600	63.4	23.1	27.3	34.5	25.7	29.7	26.6	21.2
1.18	72.1	32.1	39.4	42.5	32.7	40.2	34.5	27.4
2.00	77	41.1	52.4	50.5	40	49.2	42.4	34
5.00	83.8	57.2	75.5	67	54.4	65.9	67.6	48.2
10.00	88.7	72.2	91.7	83.5	70.2	85.4	86.3	62.7
14.00	89.8	76.9	93.7	87.1	78.9	91.3	89.9	68.2
20.00	93.6	90.3	95.7	93	89.3	100	95.7	77.2
28.00	100	93.2	100	100	89.3		100	100
37.50		100			100			
50.00								
63.00								
75.00								
80.00								
90.00								
100.00								
200.00								

Annex 1.2

PARTICLE SIZE DISTRIBUTION

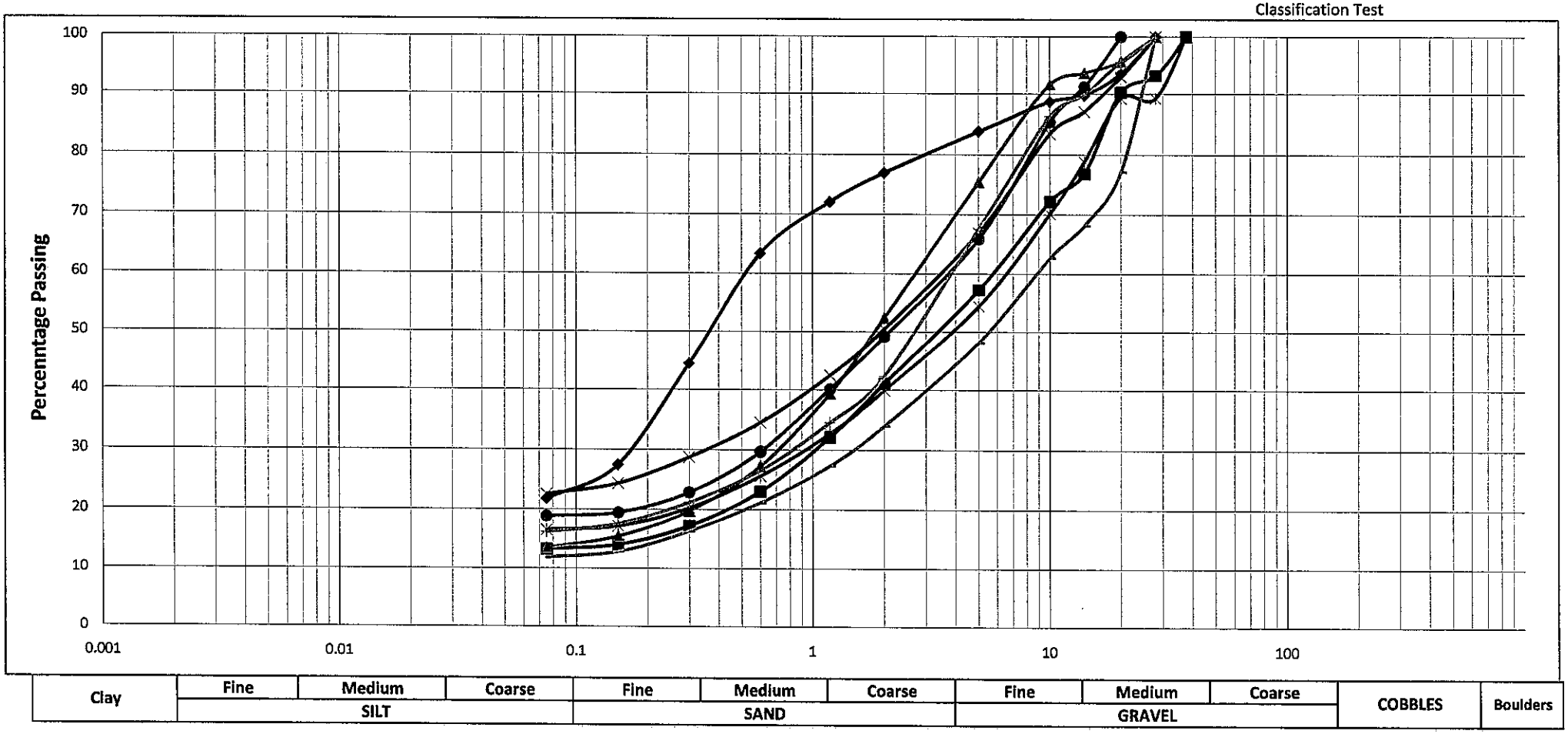
PS DL Pacific Strata Drilling Limited

Location : Panatina Service Reservoir

Date of Test : 20-May-2008

Borehole No: 1

Description : Particle Distribution Classification Test



PS Pacific Strata Drilling Limited

DL

Borehole Log

Annex 2

Name of Project	The improvement of Water Supply System Project	**Borehole Number :**	2
Date Drilled:	29-Apr-08	**Location:**	Tasahe Service Reservoir
Rig:	GEMCO 2106	**Elevation:**	140m asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level (m)	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance N	Group Symbol	Symbol	Soil Description		Water Presents	Moisture Content	Penetrometer N
				15	30	45				Lithology	Colour		10 20 30 50 70 90	10 20 30 40
0.0	140.0							SC		Clay Topsoil	Black	dry		
1.0	139.0	D1	S(30)	4	6	15	21	GC		Clay Coral Gravel	Brown	moist	⊗	⊗
2.0	138.0	D2 B1	S(30)	8	16	11	27	GC		Clay Coral Gravel	Brown	moist	⊗	⊗
3.0	137.0	D3	S(30)	7	8	9	17	GC		Clay Coral Gravel	Brown	moist	⊗	⊗
4.0	136.0	D4 B2	S(30)	5	7	13	20	GC		Clay Coral Gravel	Brown	moist	⊗	⊗
5.0	135.0	D5	S(30)	8	8	13	21	SP		Poorly Granded Sandy Coral Gravel	Brown	moist	⊗	⊗
6.0	134.0	D6 B3	S(30)	8	6	8	14	SP		Poorly Granded Sandy Coral Gravel	Brown	moist		⊗
7.0	133.0	D7	S(30)	8	6	5	11	SP		Poorly Granded Sandy Coral Gravel	Brown	moist		⊗
8.0	132.0	D8 B4	S(30)	4	6	9	15	SP		Poorly Granded Sandy Coral Gravel	Brown	moist		⊗
9.0	131.0	D9	S(30)	6	6	6	12	SP		Poorly Granded Sandy Coral Gravel	Brown	moist		⊗
10.0	130.0	D10 B5	S(30)	10	13	11	24	SW		Firm Sandy Coral Gravel	Brown	moist	⊗	⊗

REMARKS: *Penetration test completed*

Key:
D : Disturbed Sample
B : Bulk
W : Water
o : Core Recovery
S(30) : Standard Penetration Test
C(27) : Cone
(27) : No. Blows for 300mm Penetration
v : In-situ Vane Shear Test
U1/70 : Undisturbed Sample 100mm Dia
/70 : No. Of Blows to drive sample 450 mm
u-/70 : Undisturbed Sample - no recovery
S&A : Shell & Auger
DD : Rotary Diamond Drilled

Note: This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

Annex 2.1

PS DL **Pacific Strata Drilling Limited** **Borehole** **2**

Particle Size Distribution

Location: **Tasahe Service Reservior**

Date: **8-May-08** **Analysed by** **Clifford Betokerah**
Ministry of Infrastructure Developent

Method	Wet Seiving	
Total mass (g)	**1099**	**1010**
Depth of sample (m)	1-5 m	6 -10 m

Seive	Passing %	Passing %
mm		
0.075	23.5	25.4
0.150	24.7	28.2
0.300	28.3	33.5
0.600	33.8	40
1.18	40.8	47.1
2.00	48	54.2
5.00	67.3	79.9
10.00	81.6	91.9
14.00	88.5	97.6
20.00	96.2	98.5
28.00	100	100
37.50		
50.00		
63.00		
75.00		
80.00		
90.00		
100.00		
200.00		

Annex 2.2

PARTICLE SIZE DISTRIBUTION

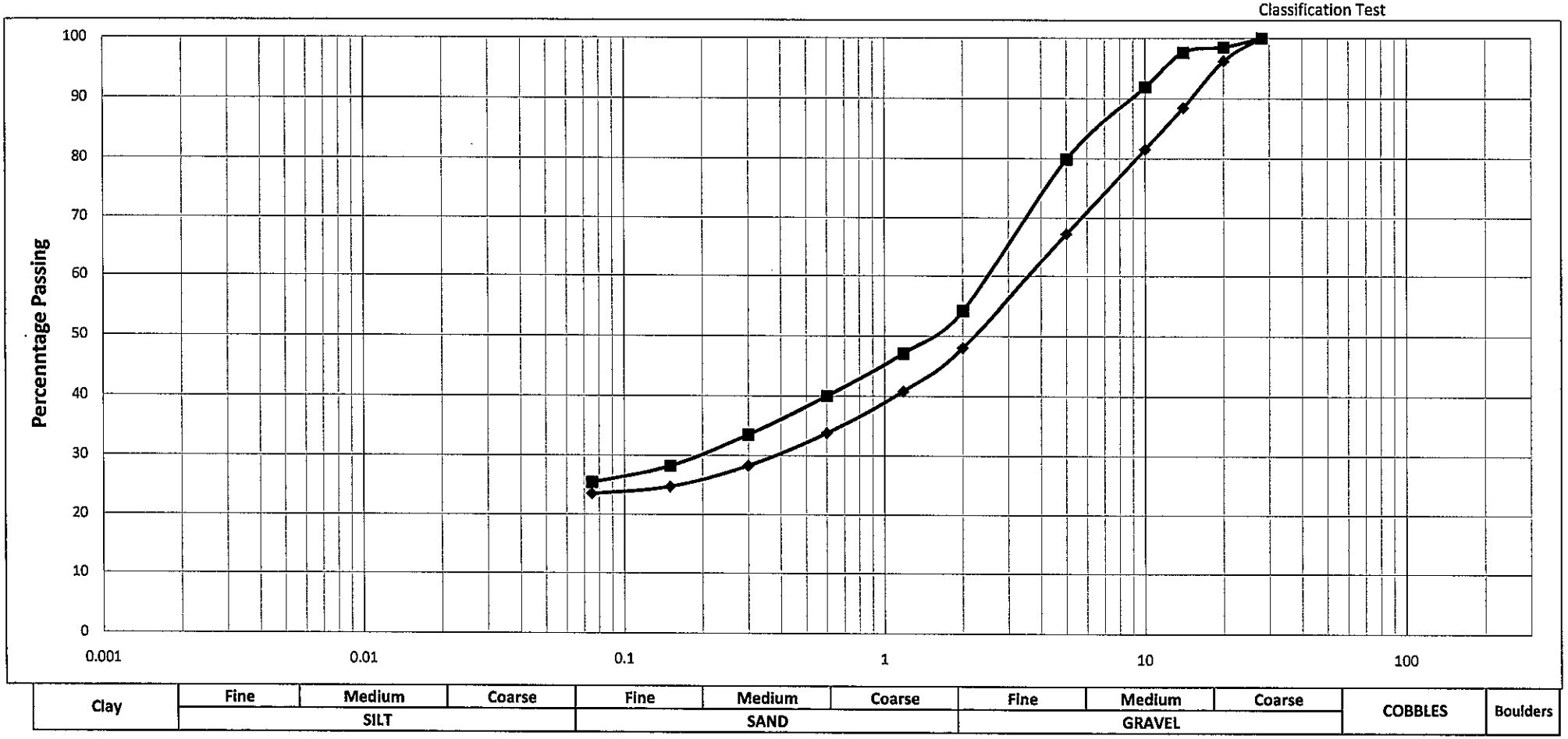
PS DL Pacific Strata Drilling Limited

Location : Tasahe Service Reservior

Date of Test : 30-April-2008

Borehole No: 2

Description : Particle Distribution Classification Test



Annex 3

Name of Project	**The improvement of Water Supply System Project**	**Borehole Number :**	**3**
Date Drilled:	1-May-08	**Location:**	Kogulai Water Treatment Facility
Rig:	GEMCO 2106	**Elevation:**	20m asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level [m]	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance "N"	Group Symbol	Symbol	Soil Description		Water Situation	Moisture Content	Penetrometer N
				15	30	45				Litthology	Colour			10 20 30 40
0.0	20.0							SC		Filled gravel	Gray			
1.0	19.0	D1	S(30)	3	4	3	7	SC		Fine Sandstone & Top soil	Black			⊗
2.0	18.0	D2	S(30)	2	4	7	11	GP		Clay Soil	Brown			⊗
3.0	17.0	D3	S(30)	1	2	4	6	GP		Clay Soil	Brown		⊗	⊗
4.0	16.0	D4	S(30)	6	3	2	5	GP		Clay Soil	Brown		⊗	⊗
5.0	15.0	D5	S(30)	5	5	8	13	GP		Clay Soil	Brown		⊗	⊗
6.0	14.0	D6	S(30)	10	8	20	28			Sandstone	Gray		⊗	⊗
7.0	13.0	D7	S(30)	2	3	6	9	GP		Clay Soil	Brown		⊗	⊗
8.0	12.0	D8	S(30)	9	10	8	18	GM		Coral Gravel	White		⊗	⊗
9.0	11.0	D9	S(30)	21	22	30	52	GM		Coral Gravel	White		⊗	⊗
10.0	10.0	D10	S(30)	27	29	30	59	GM		Coral Gravel	White		⊗	⊗

REMARKS: *Water circulation were lost at level 2 m, no bulk sample collected*

Water circulation started again at 7m but lost it again at 8 m

Key:

D : Disturbed Sample
B : Bulk
W : Water
o : Core Recovery
S(30) : Standard Penetration Test
C(27) : Cone
(27) : No. Blows for 300mm Penetration
v : In-situ Vane Shear Test
U1/70 : Undisturbed Sample 100mm Dia
/70 : No. Of Blows to drive sample 450 mm
u-/70 : Undisturbed Sample - no recovery
S&A : Shell & Auger
DD :Rotary Diamond Drilled

Note: This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

PS DL **Pacific Strata Drilling Limited** **Borehole** 3

Particle Size Distribution

Location: Kongulai Service Reservior

Date: 8-May-08 **Analysed by** Clifford Betokerah

Ministry of Infrastructure Development

Method	Wet Seiving		
Total mass (g)	717	227	694
Depth of sample (m)	3- 5 /7 m	6 m	8 - 10 m
Seive Size	Passing %	Passing %	Passing %
mm			
0.075	65.7	28.2	34.4
0.150	72	41.4	36
0.300	82.2	65.2	40.8
0.600	87.8	89	48.9
1.18	89.9	97.8	57.7
2.00	91.6	99.6	61.7
5.00	94.4	100	71.9
10.00	100		81.8
14.00			84.8
20.00			86.4
28.00			100
37.50			
50.00			
63.00			
75.00			
80.00			
90.00			
100.00			
200.00			

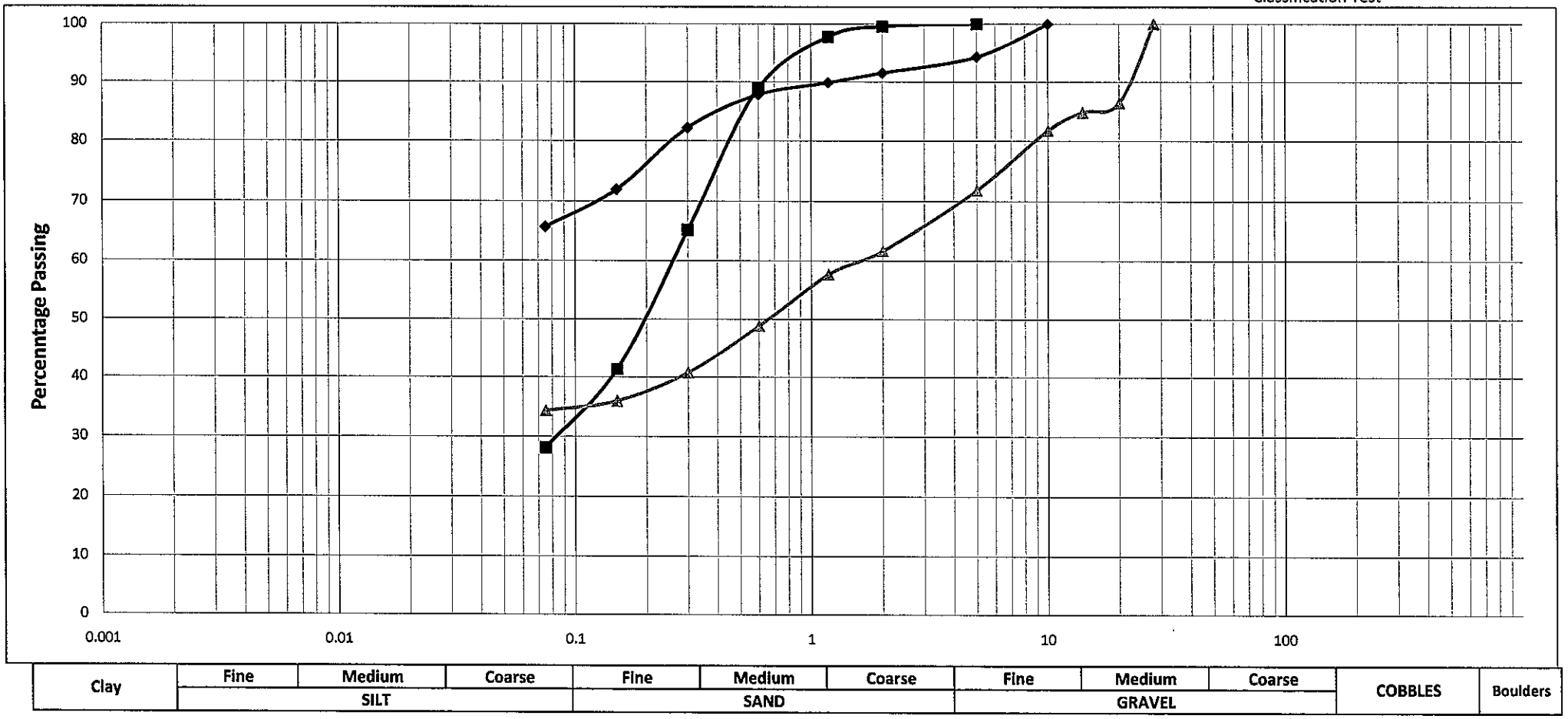
Annex 3.2

PARTICLE SIZE DISTRIBUTION

PS DL Pacific Strata Drilling Limited

Location : Kongulai Water Treatment Facility **Date of Test :** 30-April-2008

Borehole No: 3 **Description :** Particle Distribution Classification Test



Appendix 4

Name of Project	**The improvement of Water Supply System Project**	**Borehole Number :**	4
Date Drilled:	8-May-08	**Location:**	Kombito Water Treatment Facility
Rig:	GEMCO 210B	**Elevation:**	50m asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level [m]	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance "N	Group Symbol	Symbol	Soil Description		Water Presents	Moisture Content	Penetrometer N
				15	30	45				Lithology	Colour		10 30 50 70 90	10 20 30 40
0.0	50.0	PL						GW		Compacted Coral gravel	Light Brown	dry		
1.0	49.0	D1	S(30)	5	7	7	14	GC		Coral Gravel	Light Brown	dry	⊗	⊗
2.0	48.0	D2 B1	S(30)	2	2	2	4	GC		Coral Gravel with Clay	Brown	dry	⊗	⊗
3.0	47.0	D3	S(30)	3	4	6	10	GC		Coral Gravel with Clay	Brown	wet	⊗	⊗
4.0	46.0	D4 B2	S(30)	6	6	25	31	GC		Coral Gravel with Clay	Brown	wet	⊗	⊗
5.0	45.0	D5	S(30)	8	17	30	47	GC		Compacted Coral gravel clay	Light Brown	wet	⊗	⊗
6.0	44.0	D6 B3	S(30)	8	15	30	45	GC		Compacted Coral gravel clay	Light Brown	wet		⊗
7.0	43.0	D7	S(30)	10	6	7	13	GC		Coral Gravel with Clay	Light Brown	wet		⊗
8.0	42.0	D8 B4	S(30)	15	40	40	80	GW		Compacted Coral Gravel	Light Brown	wet		⊗
9.0	41.0	D9	S(30)	16	32	20	52	GW		Compacted Coral Gravel	Light Brown	wet		⊗
10.0	40.0	D10 B5	S(30)	10	9	40	49	GC		Compacted Coral gravel clay	Light Brown	wet	⊗	⊗

REMARKS: *Penetration test completed*

Hammer is bouncing up and down between 30cm - 45 cm at 8 m and 10 m level
Watertable level noted at 3 m level

Key:
D : Disturbed Sample
B : Bulk
W : Water
o : Core Recovery
PL: Plate Loading Test
S(30) : Standard Penetration Test
C(27) : Cone
(27) : No. Blows for 300mm Penetration
v : In-situ Vane Shear Test
U1/70 : Undisturbed Sample 100mm Dia
/70 : No. Of Blows to drive sample 450 mm
u-/70 : Undisturbed Sample - no recovery
S&A : Shell & Auger
DD :Rotary Diamond Drilled

Note:
This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

PS DL **Pacific Strata Drilling Limited** **Borehole** 4

Particle Size Distribution

Location: Kombito Water Treatment Facility

Date: 8-May-08 **Analysed by** Clifford Betokerah
Ministry of Infrastructure Developent

Method	Wet Seiving	
Total mass (g)	846	1460
Depth of sample (m)	1-4 m	5 -10 m
Seive	**Passing %**	**Passing %**
mm		
0.075	30.8	23.7
0.150	31.6	25.3
0.300	35.4	29.6
0.600	41.4	35.5
1.18	48.6	42.3
2.00	55.8	48.8
5.00	73.3	67.9
10.00	87.5	80.2
14.00	91.9	86.2
20.00	98.3	92.5
28.00	100	100
37.50		
50.00		
63.00		
75.00		
80.00		
90.00		
100.00		
200.00		

Annex 4.2

PARTICLE SIZE DISTRIBUTION

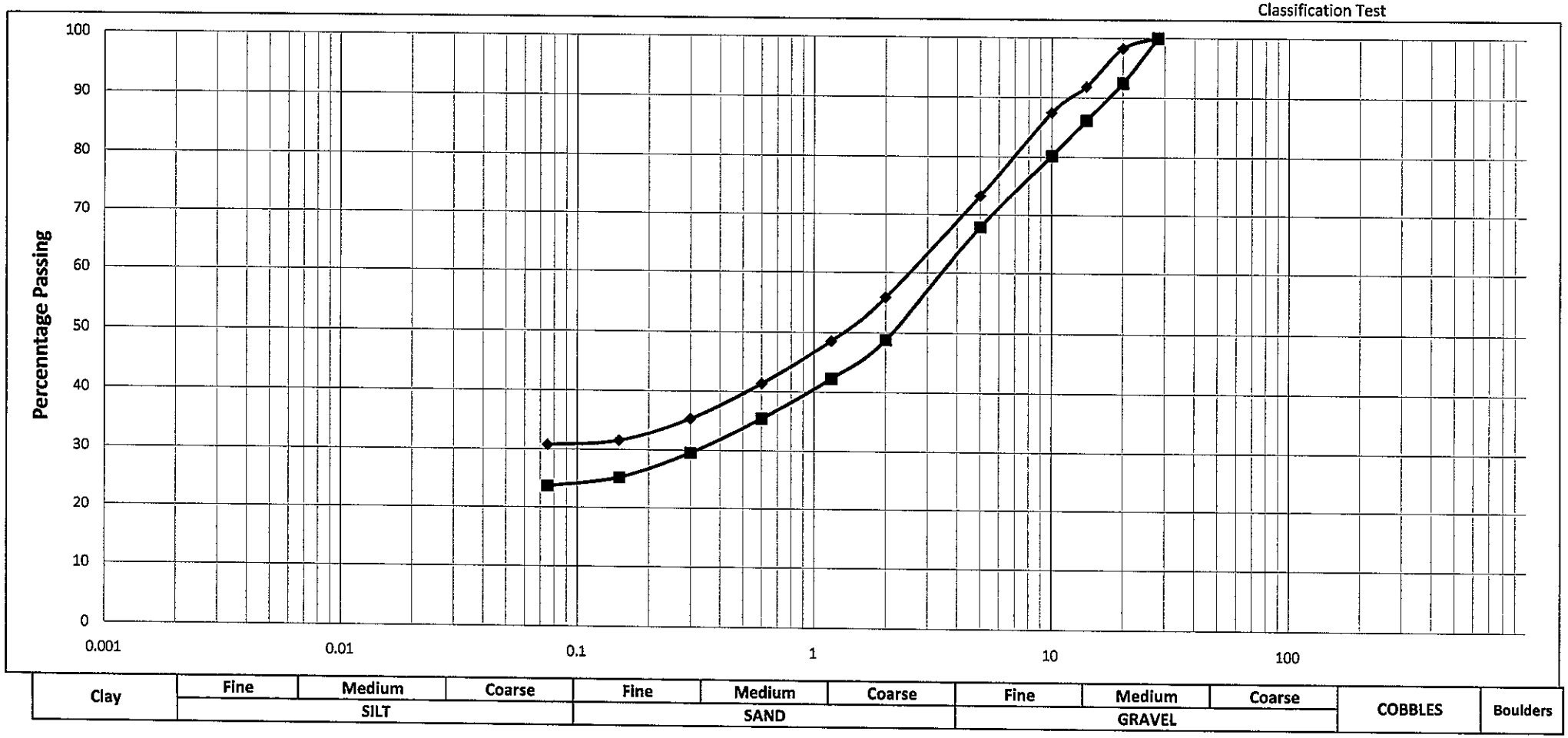
PS DL Pacific Strata Drilling Limited

Location : Kombito Water Treatment Facility

Date of Test : 30-April-2008

Borehole No: 4

Description : Particle Distribution Classification Test



PS Pacific Strata Drilling Limited

DL

Borehole Log

Annex 5

Name of Project	The improvement of Water Supply System Project	**Borehole Number :**	5
Date Drilled:	29-Apr-08	**Location:**	Lower Kola'a Service Reservoir
Rig:	GEMCO 2106	**Elevation:**	50 m asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level (m)	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance "N"	Group Symbol	Symbol	Soil Description		Water Presents	Moisture Content	Penetrometer
				15	30	45				Lithology	Colour		10 30 50 70 90	N 10 20 30 40
0.0	50.0							SC		Coral Gravel Clay	Brown			
1.0	49.0	D1	S(30)	18	22	30	52	GC		Clay Coral Gravel Sandstones	Brown		⊗	⊗
2.0	48.0	D2 B1	S(30)	27	30	30	60	GC		Massive Coral Sandstone	White		⊗	⊗
3.0	47.0	D3	S(30)	28	30	30	60	GC		Sandstone	Brown		⊗	⊗
4.0	46.0	D4 B2	S(30)	28	30	30	60	GC		Sandstone	Brown		⊗	⊗
5.0	45.0	D5	S(30)	20	30	30	60	SP		Sandstone	Brown		⊗	⊗
6.0	44.0	D6 B3	S(30)	30	30	30	60	SP		Sandstone	Brown		⊗	⊗
7.0	43.0	D7	S(30)	30	30	30	60	SP		Sandstone	Brown		⊗	⊗
8.0	42.0	D8 B4	S(30)	30	30	30	60	SP		Sandstone	Brown		⊗	⊗
9.0	41.0	D9	S(30)	30	30	30	60	SP		Sandstone	Brown		⊗	⊗
10.0	40.0	D10 B5	S(30)	30	30	30	60	SW		Sandstone	Brown		⊗	⊗

REMARKS: *Sandstone encountered at 3 m, easy to drill with rock bit, but hard to drive SPT through it*

Hammer bouncing up an down at 3 m - 10 m
SPT 30 means that the hammer is bouncing up and down otherwise specified

Key:
D : Disturbed Sample
B : Bulk
W : Water
o : Core Recovery
S(30) : Standard Penetration Test
C(27) : Cone
(27) : No. Blows for 300mm Penetration
v : In-situ Vane Shear Test
U1/70 : Undisturbed Sample 100mm Dia
/70 : No. Of Blows to drive sample 450 mm
u-/70 : Undisturbed Sample - no recovery
S&A : Shell & Auger
DD : Rotary Diamond Drilled

Note: This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

Annex 5.1

PS DL **Pacific Strata Drilling Limited** **Borehole** 5

Particle Size Distribution

Location: Proposed Lower West Kola'a Service Reservior

Date: 15-May-08 **Analysed by** Clifford Betokerah

Ministry of Infrastructure Development

Method	Wet Seiving	
Total mass (g)	323	1289
Depth of sample (m)	1-2 m	3 -10 m
Seive	**Passing %**	**Passing %**
mm		
0.075	17.7	35.1
0.150	18.6	40.6
0.300	22	55.7
0.600	25.7	65.9
1.18	29.7	71.3
2.00	34.3	75.3
5.00	43.9	82.2
10.00	55.1	88.3
14.00	59.7	92.4
20.00	77.2	96.7
28.00	100	100
37.50		
50.00		
63.00		
75.00		
80.00		
90.00		
100.00		
200.00		

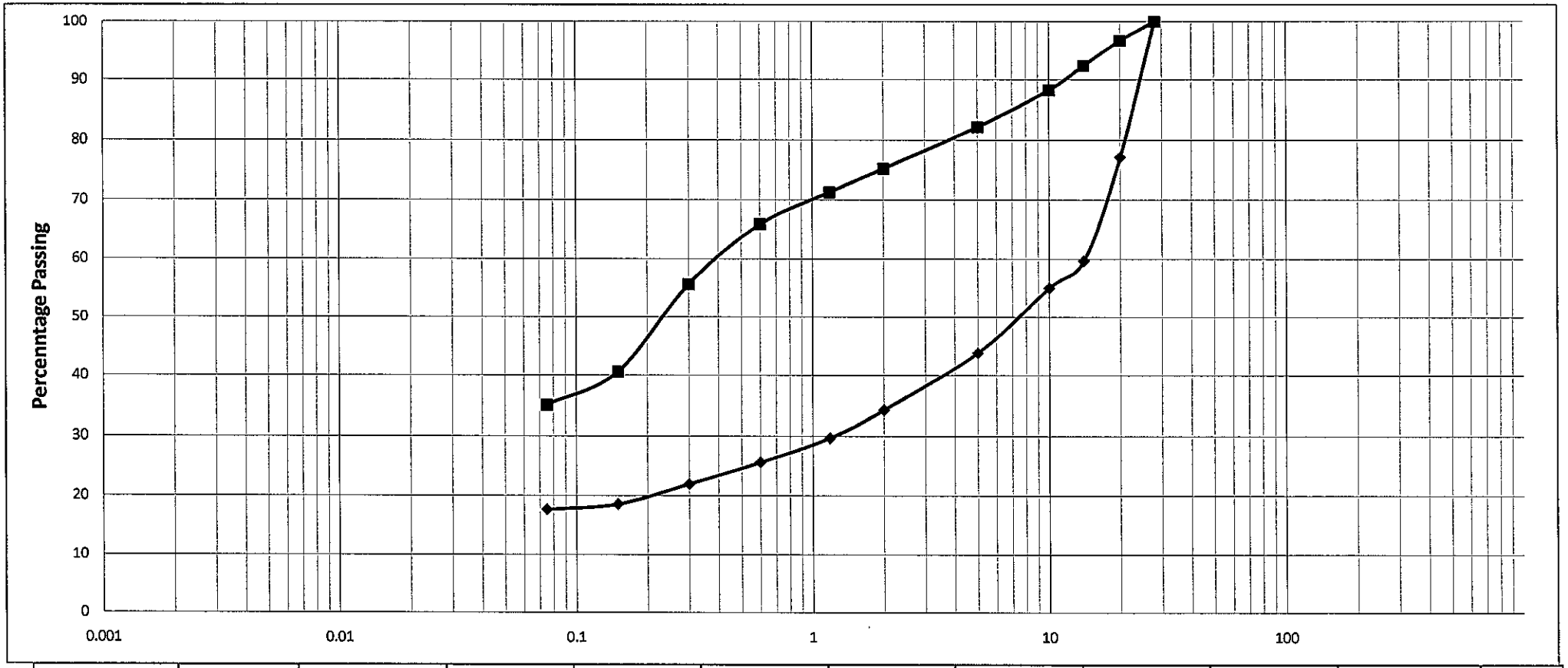
Annex 5.2

PARTICLE SIZE DISTRIBUTION

PS DL Pacific Strata Drilling Limited

Location : Lower West Kola'a Service Reservior **Date of Test :** 20-May-2008

Borehole No: 5 **Description :** Particle Distribution Classification Test



Name of Project	The improvement of Water Supply System Project	**Borehole Number :**	6
Date Drilled:	29-Apr-08	**Location:**	Skyline Service Reservoir
Rig:	GEMCO 210B	**Elevation:**	109.6 **m** asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level [m]	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance "N"	Group Symbol	Symbol	Soil Description: Lithology	Soil Description: Colour	Water Presents	Moisture Content	Penetrometer N
				15	30	45							10 30 50 70 90	10 20 30 40
0.0	109.6							SC		Clay Coral Topsoil	Light Brown	moist		
1.0	108.6	D1	S(30)	7	9	11	20	GC		Clay Coral	Light Brown	Moist	⊗	⊗
2.0	107.6	D2 B1	S(30)	4	6	14	20	GC		Clay Coral	Light Brown	Moist	⊗	⊗
3.0	106.6	D3	S(30)	7	12	13	25	GC		Clay Coral	Light Brown	Moist	⊗	⊗
4.0	105.6	D4 B2	S(30)	7	10	12	22	GC		Clay Coral	Light Brown	Moist	⊗	⊗
5.0	104.6	D5	S(30)	7	7	11	18	GC		Clay Coral	Light Brown	Moist	⊗	⊗
6.0	103.6	D6 B3	S(30)	10	9	12	21	GC		Clay Coral	Light Brown	Moist	⊗	⊗
7.0	102.6	D7	S(30)	15	9	10	19	GC		Loosely graded Clay Coral	Light Brown	Moist	⊗	⊗
8.0	101.6	D8 B4	S(30)	9	8	7	15	GC		Loosely graded Clay Coral	Light Brown	Moist	⊗	⊗
9.0	100.6	D9	S(30)	11	13	14	27	GC		Loosely graded Clay Coral	Light Brown	Moist	⊗	⊗
10.0	99.6	D10 B5	S(30)	9	10	9	19	GC		Loosely graded Clay Coral	Light Brown	Moist	⊗	⊗

REMARKS: *Penetration test completed*

Key:	D : Disturbed Sample	S(30) : Standard Penetration Test	U1/70 : Undisturbed Sample 100mm Dia
	B : Bulk	C(27) : Cone	/70 : No. Of Blows to drive sample 450 mm
	W : Water	(27) : No. Blows for 300mm Penetration	u-/70 : Undisturbed Sample - no recovery
	o : Core Recovery	v : In-situ Vane Shear Test	S&A : Shell & Auger
			DD :Rotary Diamond Drilled

Note: This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

Annex 6.1

PS DL **Pacific Strata Drilling Limited**

Borehole 6

Particle Size Distribution

Location: Skyline Service Reservior

Date: 15-May-08 **Analysed by** Clifford Betokerah

Ministry of Infrastructure Development

Method	Wet Seiving	
Total mass (g)	1091	1414
Depth of sample (m)	1-5m	6 -10 m
Seive	**Passing %**	**Passing %**
mm		
0.075	25.5	24.4
0.150	26.4	25.6
0.300	29.3	28.9
0.600	33.5	34
1.18	38.6	40.6
2.00	44	48
5.00	56.4	78.6
10.00	71.4	93.3
14.00	78.8	96.6
20.00	88.9	100
28.00	95	
37.50	100	
50.00		
63.00		
75.00		
80.00		
90.00		
100.00		
200.00		

Annex 6.2

PARTICLE SIZE DISTRIBUTION

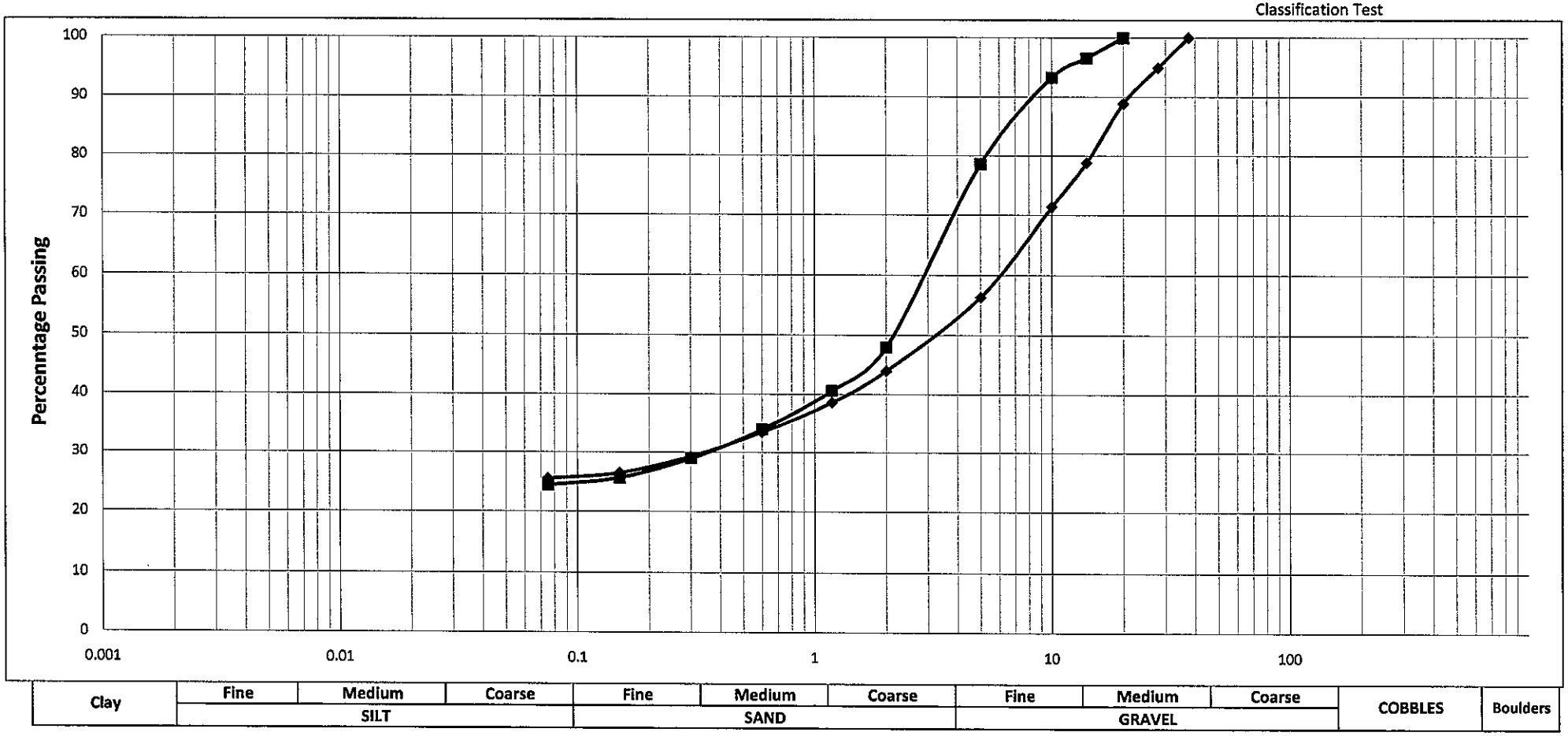
PS DL Pacific Strata Drilling Limited

Location : Skyline Service Reservior

Date of Test : 20-May-2008

Borehole No: 6

Description : Particle Distribution Classification Test



Annex 7

Name of Project	**The improvement of Water Supply System Project**	**Borehole Number :**	**7**
Date Drilled:	15-May-08	**Location:**	Tintinge Service Reservior
Rig:	GEMCO 210B	**Elevation:**	200m asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level [m]	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance "N"	Group Symbol	Symbol	Soil Description		Water present	Moisture Content	Penetrometer N
				15	30	45				Lithology	Colour		10 30 50 70 90	10 20 30 40
0.0	200.0							GW		Coral & Top soil	Black	Dry		
1.0	199.0	D1	S(30)	9	11	11	22	GC		Coral Gravel	Light Brown	Dry	⊗	⊗
2.0	198.0	D2 B1	S(30)	15	17	30	47	GC		Coral Sand	Light Brown	Moist	⊗	⊗
3.0	197.0	D3	S(30)	15	12	13	25	GC		Coral Sand	Light Brown	Moist	⊗	⊗
4.0	196.0	D4 B2	S(30)	11	5	6	11	GC		Coral Gravel with Clay	Light Brown	Moist	⊗	⊗
5.0	195.0	D5	S(30)	2	1	1	2	GC		Loose Coral Sand	Light Brown	Wet	⊗	⊗
6.0	194.0	D6 B3	S(30)	2	1	1	2	GC		Loose Coral Sand	Light Brown	Wet	⊗	⊗
7.0	193.0	D7	S(30)	11	12	13	25	GC		Loose Coral Sand	Light Brown	Wet	⊗	⊗
8.0	192.0	D8 B4	S(30)	14	10	12	22	GW		Coral Sand	Light Brown	Wet	⊗	⊗
9.0	191.0	D9	S(30)	22	14	23	37	GW		Coral Sand	Light Brown	Moist	⊗	⊗
10.0	190.0	D10 B5	S(30)	16	15	22	37	GC		Coral Sand	Light Brown	Moist	⊗	⊗

REMARKS: *Penetration test completed*

Key:
- D : Disturbed Sample
- B : Bulk
- W : Water
- o : Core Recovery
- S(30) : Standard Penetration Test
- C(27) : Cone
- (27) : No. Blows for 300mm Penetration
- v : In-situ Vane Shear Test
- U1/70 : Undisturbed Sample 100mm Dia
- /70 : No. Of Blows to drive sample 450 mm
- u-/70 : Undisturbed Sample - no recovery
- S&A : Shell & Auger
- DD : Rotary Diamond Drilled

Note: This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

Annex 7.1

PS DL **Pacific Strata Drilling Limited** **Borehole** **7**

Particle Size Distribution

Location: **Proposed Tintinge Service Reservior**

Date: **20-May-08** **Analysed by** **Clifford Betokerah**

Ministry of Infrastructure Development

Method	**Wet Seiving**	
Total mass (g)	**1102**	**682**
Depth of sample (m)	1-5m	6 -10 m
Seive	**Passing %**	**Passing %**
mm		
0.075	19.8	21.3
0.150	20.6	23.4
0.300	24	28.8
0.600	29	35.3
1.18	35.1	42.5
2.00	42.2	50.9
5.00	65.9	74.2
10.00	79.8	87.3
14.00	87.7	91.6
20.00	94.8	96.2
28.00	100	100
37.50		
50.00		
63.00		
75.00		
80.00		
90.00		
100.00		
200.00		

Annex 7.2

PARTICLE SIZE DISTRIBUTION

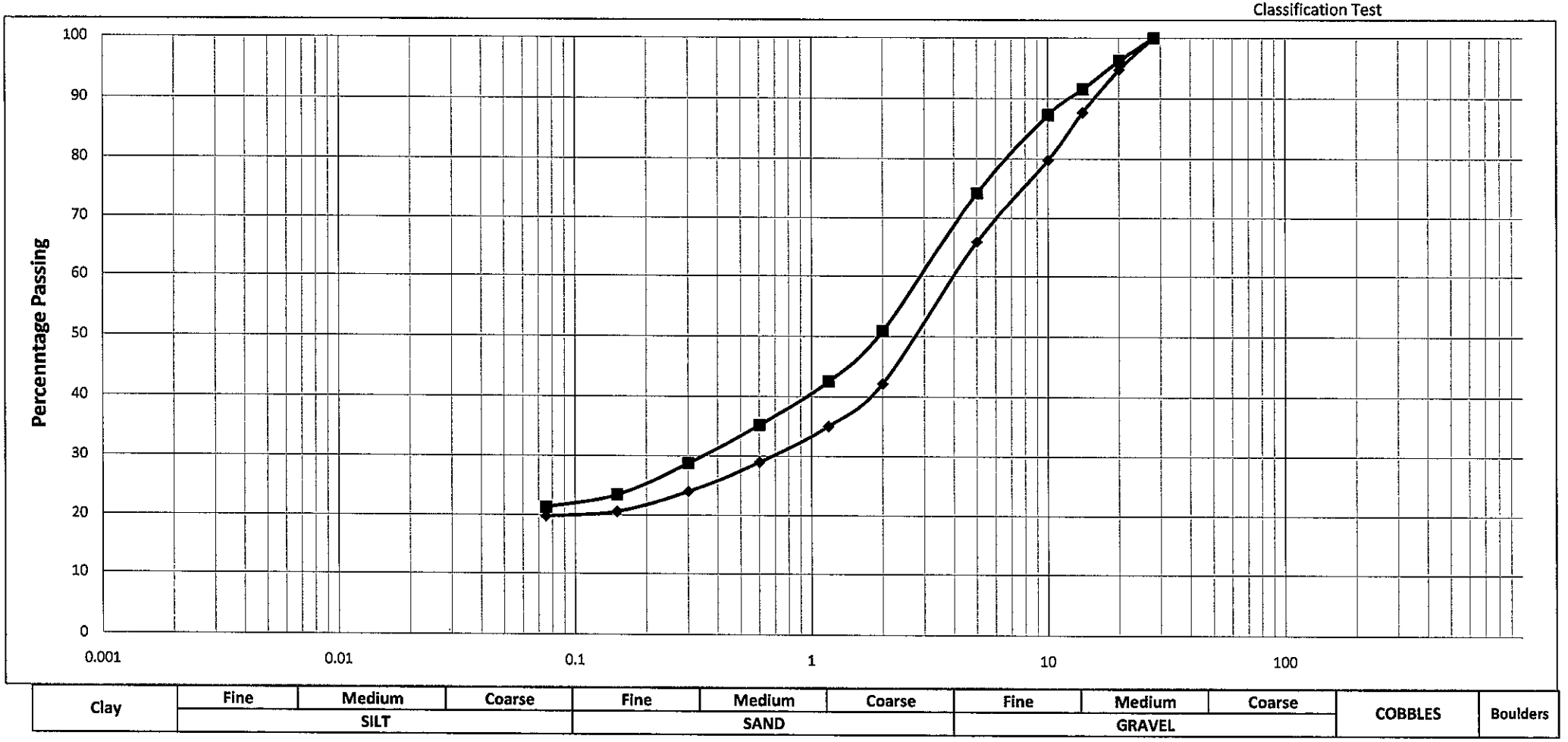
PS DL Pacific Strata Drilling Limited

Location : Tintinge Service Reservior

Date of Test : 20-May-2008

Borehole No: 7

Description : Particle Distribution Classification Test



Name of Project	**The improvement of Water Supply System Project**	**Borehole Number :**	**8**
Date Drilled:	16-May-08	**Location:**	**Rove Water Treatment Facility**
Rig:	GEMCO 210B	**Elevation:**	30 m asl
Contractor:	Pacific Strata Drilling	**Operator:**	John
Bit Type	3.5" Rock Bit	**Ground Level:**	

Depth (m)	Level (m)	Sample Type	Standard Penetration Test	Number of Blows at each 15 cm			Penetration Resistance "N"	Group Symbol	Symbol	Soil Description		Water Presents	Moisture Content %	Penetrometer N
				15	30	45				Lithology	Colour		10 30 50 70 90	10 20 30 40
0.0	30.0							GW		Compacted Coral gravel	Brown	moist		
1.0	29.0	D1	S(30)	2	3	4	7	GC		Coral Gravel	Brown	moist	⊗	⊗
2.0	28.0	D2 B1	S(30)	3	4	6	10	GC		Coral Gravel with Clay	Dark brown	moist	⊗	⊗
3.0	27.0	D3	S(30)	2	3	8	11	GC		Coral Gravel with Clay	Brown	moist	⊗	⊗
4.0	26.0	D4 B2	S(30)	8	9	7	16	GC		Coral Gravel with Clay	Brown	wet	⊗	⊗
5.0	25.0	D5	S(30)	4	9	18	27	GC		Compacted Coral gravel clay	Brown	wet	⊗	⊗
6.0	24.0	D6 B3	S(30)	4	8	10	18	GC		Compacted Coral gravel clay	Light Brown	moist	⊗	⊗
7.0	23.0	D7	S(30)	30				GC		Coral Gravel with Clay	Light Brown	moist	⊗	⊗
8.0	22.0	D8 B4	S(30)	13	26	33	59	GW		Compacted Coral Gravel	Brown	moist	⊗	⊗
9.0	21.0	D9	S(30)	22	4	3	7	GW		Compacted Coral Gravel	Brown	wet	⊗	⊗
10.0	20.0	D10 B5	S(30)	30				GC		Compacted Coral gravel clay	Brown	wet	⊗	⊗

REMARKS: *Rock encountered at 7 m. SPT tube could not be driven further into rock (no SPT core sample collected)*

Hammer is bouncing up and down at 7 m and 10 m

Key:
- D : Disturbed Sample
- B : Bulk
- W : Water
- o : Core Recovery
- S(30) : Standard Penetration Test
- C(27) : Cone
- (27) : No. Blows for 300mm Penetration
- v : In-situ Vane Shear Test
- U1/70 : Undisturbed Sample 100mm Dia
- /70 : No. Of Blows to drive sample 450 mm
- u-/70 : Undisturbed Sample - no recovery
- S&A : Shell & Auger
- DD : Rotary Diamond Drilled

Note: This borehole log has been prepared for the purpose of Geotechnical Purpose and does not neccesarily contain information suitable for an a environmental assessment of the subsurface condition

PS DL **Pacific Strata Drilling Limited**

Particle Size Distribution

Borehole 8

Location: Proposed Rove Water Treatment Facility

Date: 20-May-08 **Analysed by** Clifford Betokerah

Ministry of Infrastructure Developent

Method	**Wet Seiving**		
Total mass (g)	**607**	**524**	**381**
Depth of sample (n	1-2 m	3-5 m	6 - 10 m

Seive	Passing %	Passing %	Passing %
mm			
0.075	21.9	16.6	44.3
0.150	22.7	18.1	48.2
0.300	26.2	22.1	61.6
0.600	31.8	27.4	79.5
1.18	38.6	32.9	89.5
2.00	46.2	38.4	92.4
5.00	64.2	52.1	95.3
10.00	72.6	66.4	98.2
14.00	75.6	75.6	100
20.00	88.3	85.9	
28.00	94.2	96.2	
37.50	100	100	
50.00			
63.00			
75.00			
80.00			
90.00			
100.00			
200.00			

Annex 8.2

PARTICLE SIZE DISTRIBUTION

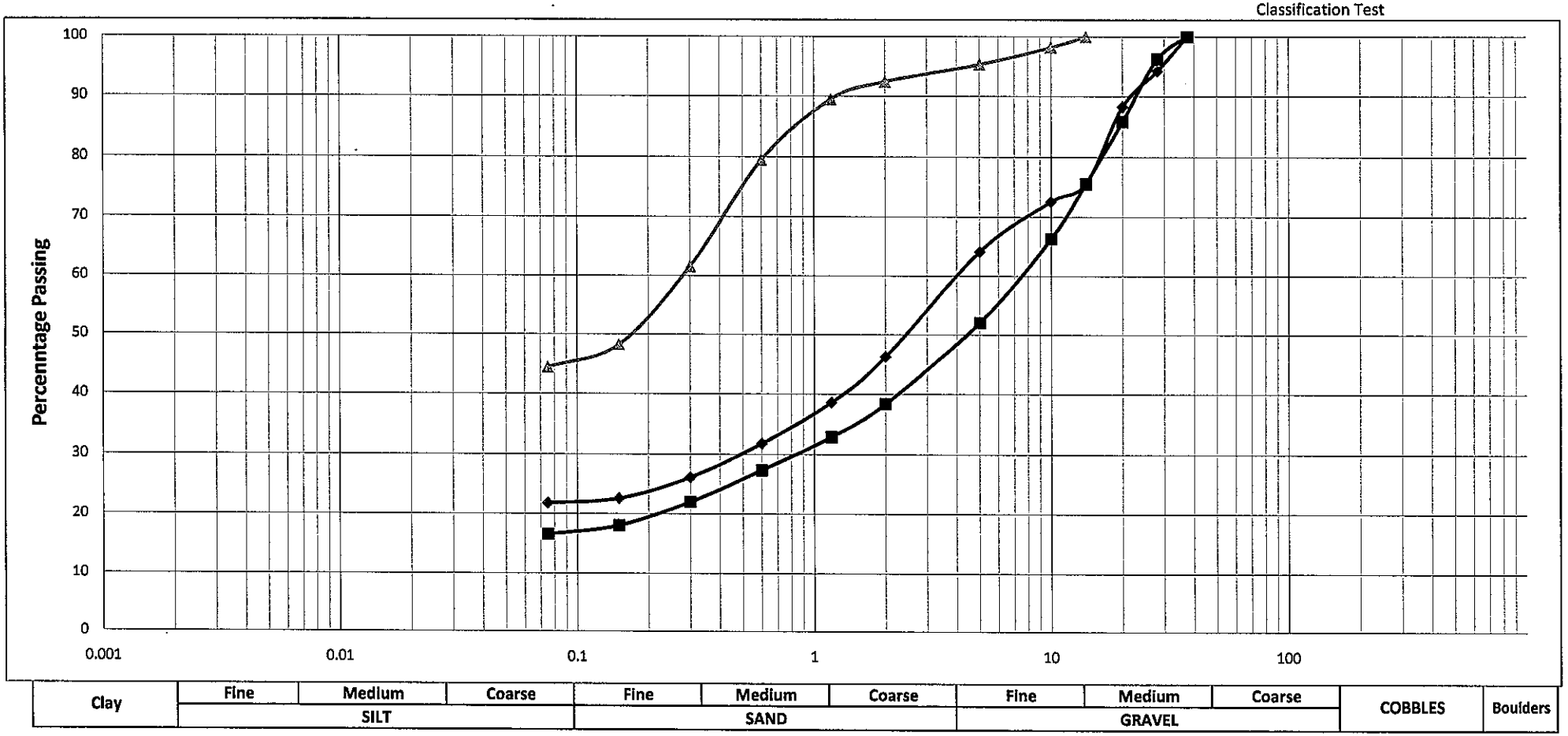
PS DL Pacific Strata Drilling Limited

Location : Rove Water Treatment Facility

Date of Test : 20-May-2008

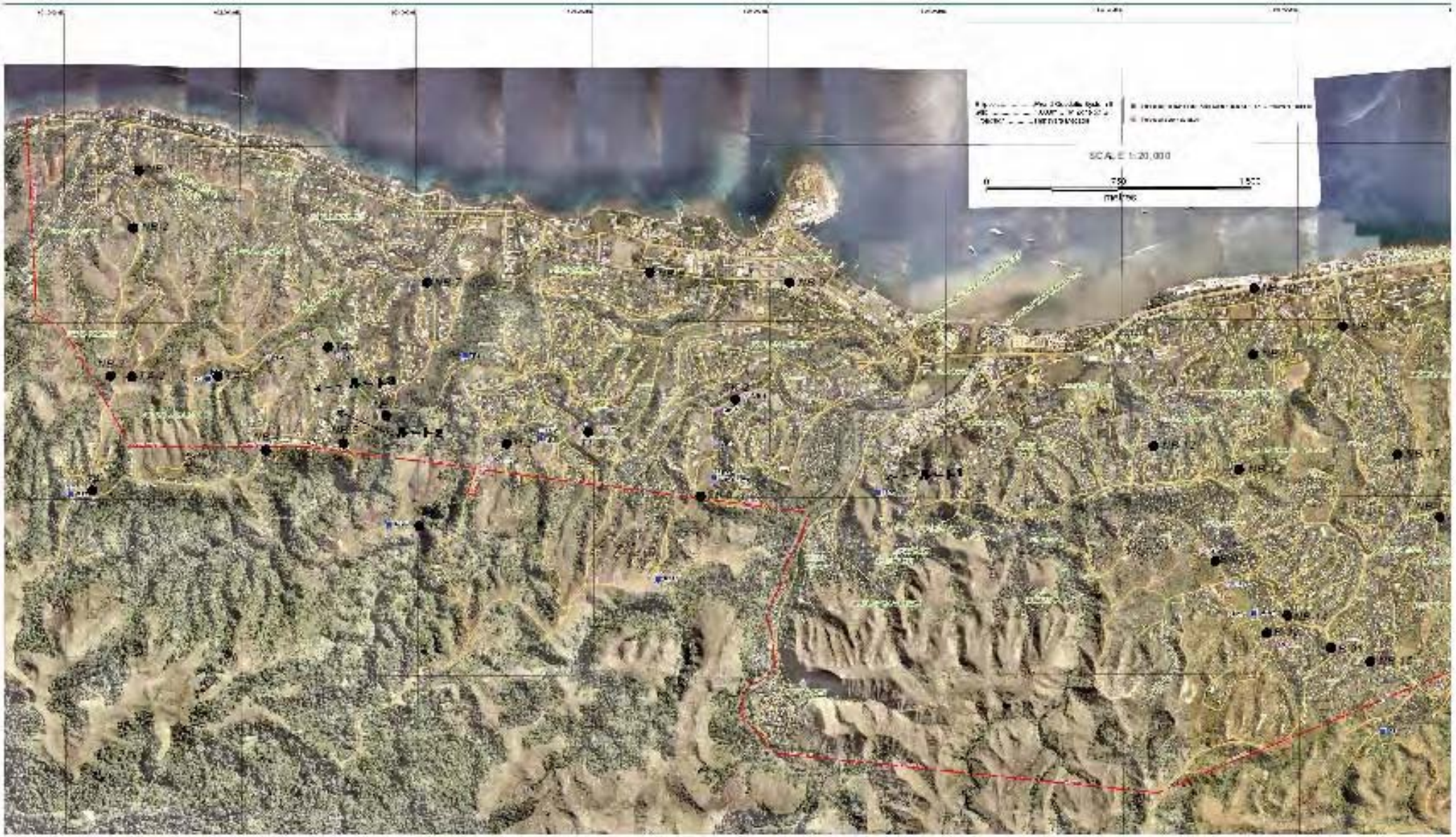
Borehole No: 8

Description : Particle Distribution Classification Test



Clay	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	Boulders
	SILT			SAND			GRAVEL				

資料-11　　管路ルート試掘調査結果



A11--1


NB-21
LEGEND
TA-1 ~ TA-4 : CONVEYANS AND TRANSMISSION PIPELINE (WELLS TO TASAHE RESERVOIR)
TI-1 ~ TI-4 : CONVEYANS AND TRANSMISSION PIPELINE (WELLS TO TITINGE RESERVOIR)
SK-1, SK-2 : CONVEYANS AND TRANSMISSION PIPELINE (WELLS TO SKYLINE RESERVOIR)
B-01 ~ B-03 : CONVEYANS AND TRANSMISSION PIPELINE (WELLS TO BORDERLINE RESERVOIR)
NB-1 ~ NB-21 : DISTRIBUTION MAIN PIPELINE

資料-11

(1) ホニアラ市試掘結果

1）導水管及び送水管路	試掘位置			
井戸～Tasahe配水池	TA-1 粘性土 	TA-2 砂質粘性土 	TA-3 粘性土 	TA-4 粘性土 
井戸～Titnge配水池	TI-1 礫混じり粘性土 	TI-2 粘性土 	TI-3 礫混じり粘性土 	
井戸～Skyline配水池	SK-1 礫混じり砂質土 	SK-2 粘性土 		
井戸～Borderline配水池	BO-1 礫混じり粘性土 	BO-2 礫混じり粘性土 	BO-3 粘性土 	

2）配水管路	試掘位置		
ホニアラ市西部側	NB-1 礫混じり砂質土 	NB-2 砂質土 	NB-3 礫混じり砂質土 
	NB-4 礫混じり粘性土 	NB-5 礫混じり粘性土 	NB-6 粘性土 
	NB-7 礫混じり砂質土 	NB-8 礫混じり粘性土 	NB-9 礫混じり粘性土 

資料-11

2）配水管路	試掘位置		
ホニアラ市中央部	NB-10 粘性土	NB-11 粘性土	NB-12 砂質土
			
	NB-13 礫混じり砂質土	NB-14 砂質土	NB-15 礫混じり砂質土
			
	NB-16 砂質土	NB-17 粘性土	NB-18 砂質土
			
ホニアラ市東部側	NB-19 粘性土	NB-20 粘性土	NB-21 粘性土
			

(2) ホニアラ市岩露出路線

ホニアラ市岩露出路線	ルート-1 ロウワ・コラア配水池へのアクセス付近		ルート-2 配水管路（1）	
				
	ルート-3 配水管路（2）	コングライ調整池へのアクセス		
				

(3) アウキ市試掘結果

1）導水管路	試掘位置	
井戸～高レベル配水池	AB-1（井戸予定位置近辺） 礫混じり粘性土	AB-2（井戸予定位置近辺） 粘性土
		

資料-12　　水質調査結果

1. 水源水質調査方法

各水源よりサンプリングを実施し、数回にわたり公定法（国内再委託）および、簡易分析法による水質分析を実施した。簡易分析による各水質項目の測定方法を表 1 に示す。公定法の測定方法は、2. 水質分析結果（公定法）を参照のこと。

表-1　測定方法（簡易分析）

水質項目	測定法	定量下限値
水温	アルコール温度計による	0.1(℃)
濁度	比濁法	0.5(°)
色度	比色法	2(°)
pH	電極法	0.1(−)
電気伝導率	電極法	10(μs/cm)
硝酸性窒素	還元ナフチルエチレンジアミン比色法(パックテスト)	0.2(mg/l)
アンモニア性窒素	インドフェノール青比色法(パックテスト)	0.1(mg/l)
マンガン	過よう素酸カリウム比色法(パックテスト)	0.5(mg/l)
六価クロム	ジフェニルカルバジド比色法(パックテスト)	0.05(mg/l)
塩素要求量	上水試験方法 2001 による	−
大腸菌群	簡易試験紙	−

計画水源とサンプリング箇所の関係を表−2 に示す。4 つの新規井戸の水質調査に関しては、本調査では各計画井戸の試掘を実施する予定がなかったため、現在稼動中のホワイトリバー１、ホワイトリバー２、コンビト井戸、マタニコ井戸の水質を測定することで対応することとした。

表-資 8-2　計画水源とサンプリング箇所の関係

	計画水源	サンプリング箇所
水源名	コングライ湧水	コングライ湧水
	ロベ湧水	ロベ湧水
	コンビト湧水	コンビト湧水
	タサヘ新井戸群	ホワイトリバー井戸1
	ティティンゲ新井戸群	ホワイトリバー井戸 2
	スカイライン新井戸群	マタニコ井戸
	ボーダーライン新井戸群	コンビト井戸

2. 水源水質分析結果（公定法）

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -1/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月19日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ①KONGLAI	定量下限値	基準値	計量方法
浮遊物質量	mg/L	1.3	0.5	-	上水試験方法VI-1-12
溶解性蒸発残留物	mg/L	200	10	1000	上水試験方法VI-1-13
アルカリ消費量(pH4.8)	mg/L	170	2.5	—	上水試験方法VI-1-14
大腸菌数	MPN/100mL	23	1	-	上水試験方法VII-2.2.2
化学的酸素要求量	mg/L	0.9	0.5	—	上水試験方法VI-1-18
マグネシウム	mg/L	2.3	0.01	—	上水試験方法VI-3-6
カルシウム	mg/L	68	0.01	—	上水試験方法VI-3-9
ふっ素	mg/L	検出せず	0.05	1.5	上水試験方法VI-2-3
塩化物イオン	mg/L	1.5	0.05	250	上水試験方法VI-2-4
硝酸性窒素	mg/L	0.26	0.02	50	上水試験方法VI-2-12
りん酸イオン	mg/L	0.07	0.01	—	上水試験方法VI-2-8
硫酸イオン	mg/L	1.2	0.2	250	上水試験方法VI-2-7
シアン	mg/L	検出せず	0.01	0.07	上水試験方法VI-2-22
アンモニア性窒素	mg/L	検出せず	0.05	—	上水試験方法VI-2-10
マンガン	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-12
モリブデン	mg/L	検出せず	0.005	0.07	上水試験方法VI-3-19

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -2/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月19日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ①KONGLAI	定量下限値	基準値	計量方法
鉄	mg/L	0.11	0.01	0.3	上水試験方法VI-3-13
ニッケル	mg/L	検出せず	0.002	0.02	上水試験方法VI-3-14
亜鉛	mg/L	検出せず	0.001	3	上水試験方法VI-3-16
バリウム	mg/L	検出せず	0.05	0.7	上水試験方法VI-3-24
鉛	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-27
クロム	mg/L	検出せず	0.005	0.05	上水試験方法VI-3-11
銅	mg/L	検出せず	0.01	1	上水試験方法VI-3-15
砒素	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-17
セレン	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-18
カドミウム	mg/L	検出せず	0.0005	0.003	上水試験方法VI-3-21
総水銀	mg/L	検出せず	0.00005	0.001	上水試験方法VI-3-25
ほう素	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-4
以下余白					

備考) 検出せずとは定量下限値未満のことです。
上水試験法(2001) 基準値は飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -3/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月19日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ②ROVE	定量下限値	基準値	計量方法
浮遊物質量	mg/L	検出せず	0.5	－	上水試験方法VI-1-12
溶解性蒸発残留物	mg/L	300	10	1000	上水試験方法VI-1-13
アルカリ消費量(pH4.8)	mg/L	230	2.5	－	上水試験方法VI-1-14
大腸菌数	MPN/100mL	3	1	－	上水試験方法Ⅷ-2.2.2
化学的酸素要求量	mg/L	検出せず	0.5	－	上水試験方法VI-1-18
マグネシウム	mg/L	4.0	0.01	－	上水試験方法VI-3-6
カルシウム	mg/L	96	0.01	－	上水試験方法VI-3-9
ふっ素	mg/L	0.08	0.05	1.5	上水試験方法VI-2-3
塩化物イオン	mg/L	4.0	0.05	250	上水試験方法VI-2-4
硝酸性窒素	mg/L	1.1	0.02	50	上水試験方法VI-2-12
りん酸イオン	mg/L	0.03	0.01	－	上水試験方法VI-2-8
硫酸イオン	mg/L	3.6	0.2	250	上水試験方法VI-2-7
シアン	mg/L	検出せず	0.01	0.07	上水試験方法VI-2-22
アンモニア性窒素	mg/L	検出せず	0.05	－	上水試験方法VI-2-10
マンガン	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-12
モリブデン	mg/L	検出せず	0.005	0.07	上水試験方法VI-3-19

備考)　検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -4/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月19日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号
環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ②ROVE	定量下限値	基準値	計量方法
鉄	mg/L	0.03	0.01	0.3	上水試験方法VI-3-13
ニッケル	mg/L	検出せず	0.002	0.02	上水試験方法VI-3-14
亜鉛	mg/L	0.002	0.001	3	上水試験方法VI-3-16
バリウム	mg/L	検出せず	0.05	0.7	上水試験方法VI-3-24
鉛	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-27
クロム	mg/L	検出せず	0.005	0.05	上水試験方法VI-3-11
銅	mg/L	検出せず	0.01	1	上水試験方法VI-3-15
砒素	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-17
セレン	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-18
カドミウム	mg/L	検出せず	0.0005	0.003	上水試験方法VI-3-21
総水銀	mg/L	検出せず	0.00005	0.001	上水試験方法VI-3-25
ほう素	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-4
以下余白					

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -5/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月19日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295) 1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ③KONBITO	定量下限値	基準値	計量方法
浮遊物質量	mg/L	9.9	0.5	－	上水試験方法VI-1-12
溶解性蒸発残留物	mg/L	220	10	1000	上水試験方法VI-1-13
アルカリ消費量(pH4.8)	mg/L	180	2.5	－	上水試験方法VI-1-14
大腸菌数	MPN/100mL	6	1	－	上水試験方法VIII-2.2.2
化学的酸素要求量	mg/L	1.4	0.5	－	上水試験方法VI-1-18
マグネシウム	mg/L	4.1	0.01	－	上水試験方法VI-3-6
カルシウム	mg/L	69	0.01	－	上水試験方法VI-3-9
ふっ素	mg/L	検出せず	0.05	1.5	上水試験方法VI-2-3
塩化物イオン	mg/L	2.0	0.05	250	上水試験方法VI-2-4
硝酸性窒素	mg/L	0.33	0.02	50	上水試験方法VI-2-12
りん酸イオン	mg/L	0.06	0.01	－	上水試験方法VI-2-8
硫酸イオン	mg/L	0.8	0.2	250	上水試験方法VI-2-7
シアン	mg/L	検出せず	0.01	0.07	上水試験方法VI-2-22
アンモニア性窒素	mg/L	検出せず	0.05	－	上水試験方法VI-2-10
マンガン	mg/L	0.02	0.01	0.5	上水試験方法VI-3-12
モリブデン	mg/L	検出せず	0.005	0.07	上水試験方法VI-3-19

備考)　検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -6/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月19日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043 (295) 1101 (代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ③KONBITO	定量下限値	基準値	計量方法
鉄	mg/L	0.70	0.01	0.3	上水試験方法VI-3-13
ニッケル	mg/L	検出せず	0.002	0.02	上水試験方法VI-3-14
亜鉛	mg/L	0.002	0.001	3	上水試験方法VI-3-16
バリウム	mg/L	検出せず	0.05	0.7	上水試験方法VI-3-24
鉛	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-27
クロム	mg/L	検出せず	0.005	0.05	上水試験方法VI-3-11
銅	mg/L	検出せず	0.01	1	上水試験方法VI-3-15
砒素	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-17
セレン	mg/L	0.002	0.001	0.01	上水試験方法VI-3-18
カドミウム	mg/L	検出せず	0.0005	0.003	上水試験方法VI-3-21
総水銀	mg/L	検出せず	0.00005	0.001	上水試験方法VI-3-25
ほう素	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-4
以下余白					

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値は明日飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -7/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月18日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号
環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ④WHITE RIVER BH1	定量下限値	基準値	計量方法
浮遊物質量	mg/L	検出せず	0.5	-	上水試験方法VI-1-12
溶解性蒸発残留物	mg/L	330	10	1000	上水試験方法VI-1-13
アルカリ消費量(pH4.8)	mg/L	240	2.5	—	上水試験方法VI-1-14
大腸菌数	MPN/100mL	検出せず	1	-	上水試験方法Ⅶ-2.2.2
化学的酸素要求量	mg/L	検出せず	0.5	—	上水試験方法VI-1-18
マグネシウム	mg/L	8.2	0.01	—	上水試験方法VI-3-6
カルシウム	mg/L	87	0.01	—	上水試験方法VI-3-9
ふっ素	mg/L	0.13	0.05	1.5	上水試験方法VI-2-3
塩化物イオン	mg/L	2.7	0.05	250	上水試験方法VI-2-4
硝酸性窒素	mg/L	検出せず	0.02	50	上水試験方法VI-2-12
りん酸イオン	mg/L	検出せず	0.01	—	上水試験方法VI-2-8
硫酸イオン	mg/L	10	0.2	250	上水試験方法VI-2-7
シアン	mg/L	検出せず	0.01	0.07	上水試験方法VI-2-22
アンモニア性窒素	mg/L	検出せず	0.05	—	上水試験方法VI-2-10
マンガン	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-12
モリブデン	mg/L	検出せず	0.005	0.07	上水試験方法VI-3-19

(備考) 検出せずとは定量下限値未満のことです。
上水試験法(2001) 基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -8/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月18日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ④WHITE RIVER BH1	定量下限値	基準値	計量方法
鉄	mg/L	0.12	0.01	0.3	上水試験方法VI-3-13
ニッケル	mg/L	検出せず	0.002	0.02	上水試験方法VI-3-14
亜鉛	mg/L	検出せず	0.001	3	上水試験方法VI-3-16
バリウム	mg/L	検出せず	0.05	0.7	上水試験方法VI-3-24
鉛	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-27
クロム	mg/L	検出せず	0.005	0.05	上水試験方法VI-3-11
銅	mg/L	検出せず	0.01	1	上水試験方法VI-3-15
砒素	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-17
セレン	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-18
カドミウム	mg/L	検出せず	0.0005	0.003	上水試験方法VI-3-21
総水銀	mg/L	検出せず	0.00005	0.001	上水試験方法VI-3-25
ほう素	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-4
以下余白					

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値は飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -9/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

件 名：水質分析

採 取 年 月 日：平成20年4月18日

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ⑤WHITE RIVER BH2	定量下限値	基準値	計量方法
浮遊物質量	mg/L	検出せず	0.5	-	上水試験方法VI-1-12
溶解性蒸発残留物	mg/L	310	10	1000	上水試験方法VI-1-13
アルカリ消費量(pH4.8)	mg/L	250	2.5	—	上水試験方法VI-1-14
大腸菌数	MPN/100mL	検出せず	1	-	上水試験方法Ⅷ-2.2.2
化学的酸素要求量	mg/L	検出せず	0.5	—	上水試験方法VI-1-18
マグネシウム	mg/L	13	0.01	—	上水試験方法VI-3-6
カルシウム	mg/L	74	0.01	—	上水試験方法VI-3-9
ふっ素	mg/L	0.23	0.05	1.5	上水試験方法VI-2-3
塩化物イオン	mg/L	1.6	0.05	250	上水試験方法VI-2-4
硝酸性窒素	mg/L	0.06	0.02	50	上水試験方法VI-2-12
りん酸イオン	mg/L	0.03	0.01	—	上水試験方法VI-2-8
硫酸イオン	mg/L	6.1	0.2	250	上水試験方法VI-2-7
シアン	mg/L	検出せず	0.01	0.07	上水試験方法VI-2-22
アンモニア性窒素	mg/L	検出せず	0.05	—	上水試験方法VI-2-10
マンガン	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-12
モリブデン	mg/L	検出せず	0.005	0.07	上水試験方法VI-3-19

備考) 検出せずとは定量下限値未満のことです。
上水試験法(2001) 基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -10/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

件 名：水質分析

採 取 年 月 日：平成20年4月18日

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ⑤WHITE RIVER BH2	定量下限値	基準値	計量方法
鉄	mg/L	0.12	0.01	0.3	上水試験方法VI-3-13
ニッケル	mg/L	検出せず	0.002	0.02	上水試験方法VI-3-14
亜鉛	mg/L	0.001	0.001	3	上水試験方法VI-3-16
バリウム	mg/L	検出せず	0.05	0.7	上水試験方法VI-3-24
鉛	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-27
クロム	mg/L	検出せず	0.005	0.05	上水試験方法VI-3-11
銅	mg/L	検出せず	0.01	1	上水試験方法VI-3-15
砒素	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-17
セレン	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-18
カドミウム	mg/L	検出せず	0.0005	0.003	上水試験方法VI-3-21
総水銀	mg/L	検出せず	0.00005	0.001	上水試験方法VI-3-25
ほう素	mg/L	0.02	0.01	0.5	上水試験方法VI-3-4
以下余白					

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値は飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -11/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号
環境計量士　赤羽 徹
分析責任者　井上 英徳

件 名：水質分析

採 取 年 月 日：平成20年4月18日

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ⑥KONBITO BH	定量下限値	基準値	計量方法
浮遊物質量	mg/L	検出せず	0.5	-	上水試験方法VI-1-12
溶解性蒸発残留物	mg/L	370	10	1000	上水試験方法VI-1-13
アルカリ消費量(pH4.8)	mg/L	230	2.5	-	上水試験方法VI-1-14
大腸菌数	MPN/100mL	1	1	-	上水試験方法VII-2.2.2
化学的酸素要求量	mg/L	検出せず	0.5	-	上水試験方法VI-1-18
マグネシウム	mg/L	4.3	0.01	-	上水試験方法VI-3-6
カルシウム	mg/L	100	0.01	-	上水試験方法VI-3-9
ふっ素	mg/L	0.09	0.05	1.5	上水試験方法VI-2-3
塩化物イオン	mg/L	13	0.05	250	上水試験方法VI-2-4
硝酸性窒素	mg/L	0.34	0.02	50	上水試験方法VI-2-12
りん酸イオン	mg/L	0.04	0.01	-	上水試験方法VI-2-8
硫酸イオン	mg/L	5.9	0.2	250	上水試験方法VI-2-7
シアン	mg/L	検出せず	0.01	0.07	上水試験方法VI-2-22
アンモニア性窒素	mg/L	検出せず	0.05	-	上水試験方法VI-2-10
マンガン	mg/L	検出せず	0.01	0.5	上水試験方法VI-3-12
モリブデン	mg/L	検出せず	0.005	0.07	上水試験方法VI-3-19

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値は飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -12/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号
環境計量士　赤羽 徹
分析責任者　井上 英徳

件 名：水質分析

採 取 年 月 日：平成20年4月18日

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ⑥KONBITO BH	定量下限値	基準値	計量方法
鉄	mg/L	0.01	0.01	0.3	上水試験方法VI-3-13
ニッケル	mg/L	検出せず	0.002	0.02	上水試験方法VI-3-14
亜鉛	mg/L	0.003	0.001	3	上水試験方法VI-3-16
バリウム	mg/L	検出せず	0.05	0.7	上水試験方法VI-3-24
鉛	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-27
クロム	mg/L	検出せず	0.005	0.05	上水試験方法VI-3-11
銅	mg/L	検出せず	0.01	1	上水試験方法VI-3-15
砒素	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-17
セレン	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-18
カドミウム	mg/L	検出せず	0.0005	0.003	上水試験方法VI-3-21
総水銀	mg/L	検出せず	0.00005	0.001	上水試験方法VI-3-25
ほう素	mg/L	0.01	0.01	0.5	上水試験方法VI-3-4
以下余白					

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)　　資料－8

計 量 証 明 書

証明番号　W080690 -13/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号
環境計量士　赤羽 徹
分析責任者　井上 英徳

件 名：水質分析

採 取 年 月 日：平成20年4月18日

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ⑦MATANIKO BH	定量下限値	基準値	計量方法
浮遊物質量	mg/L	検出せず	0.5	—	上水試験方法VI-1-12
溶解性蒸発残留物	mg/L	290	10	1000	上水試験方法VI-1-13
アルカリ消費量(pH4.8)	mg/L	200	2.5	—	上水試験方法VI-1-14
大腸菌数	MPN/100mL	検出せず	1	—	上水試験方法VII-2.2.2
化学的酸素要求量	mg/L	0.5	0.5	—	上水試験方法VI-1-18
マグネシウム	mg/L	22	0.01	—	上水試験方法VI-3-6
カルシウム	mg/L	53	0.01	—	上水試験方法VI-3-9
ふっ素	mg/L	0.40	0.05	1.5	上水試験方法VI-2-3
塩化物イオン	mg/L	8.3	0.05	250	上水試験方法VI-2-4
硝酸性窒素	mg/L	0.07	0.02	50	上水試験方法VI-2-12
りん酸イオン	mg/L	0.11	0.01	—	上水試験方法VI-2-8
硫酸イオン	mg/L	9.3	0.2	250	上水試験方法VI-2-7
シアン	mg/L	検出せず	0.01	0.07	上水試験方法VI-2-22
アンモニア性窒素	mg/L	検出せず	0.05	—	上水試験方法VI-2-10
マンガン	mg/L	0.02	0.01	0.5	上水試験方法VI-3-12
モリブデン	mg/L	検出せず	0.005	0.07	上水試験方法VI-3-19

備考)　検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

2. 水源水質分析結果(公定法)

計 量 証 明 書

証明番号　W080690 -14/14
受付番号　G08-01459
平成20 年6 月2 日

八千代エンジニヤリング 株式会社　御中

中外テクノス株式会社
広島県広島市西区横川新町9番12号
中外テクノス株式会社
関東環境技術センター
千葉県千葉市緑区大野台2丁目2番16
TEL 043(295)1101(代)
登録番号　第 521 号

環境計量士　赤羽 徹
分析責任者　井上 英徳

件 名：水質分析

採 取 年 月 日：平成20年4月18日

計量結果を次のとおり証明致します。

計量の対象および単位		計量の結果 ⑦MATANIKO BH	定量下限値	基準値	計量方法
鉄	mg/L	0.09	0.01	0.3	上水試験方法VI-3-13
ニッケル	mg/L	検出せず	0.002	0.02	上水試験方法VI-3-14
亜鉛	mg/L	0.003	0.001	3	上水試験方法VI-3-16
バリウム	mg/L	検出せず	0.05	0.7	上水試験方法VI-3-24
鉛	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-27
クロム	mg/L	検出せず	0.005	0.05	上水試験方法VI-3-11
銅	mg/L	検出せず	0.01	1	上水試験方法VI-3-15
硫素	mg/L	0.001	0.001	0.01	上水試験方法VI-3-17
セレン	mg/L	検出せず	0.001	0.01	上水試験方法VI-3-18
カドミウム	mg/L	検出せず	0.0005	0.003	上水試験方法VI-3-21
総水銀	mg/L	検出せず	0.00005	0.001	上水試験方法VI-3-25
ほう素	mg/L	0.02	0.01	0.5	上水試験方法VI-3-4
以下余白					

備考）検出せずとは定量下限値未満のことです。
上水試験法(2001)　基準値はWHO飲料水水質ガイドラインに基づいたものです。
分析は持込試料にて実施しました。

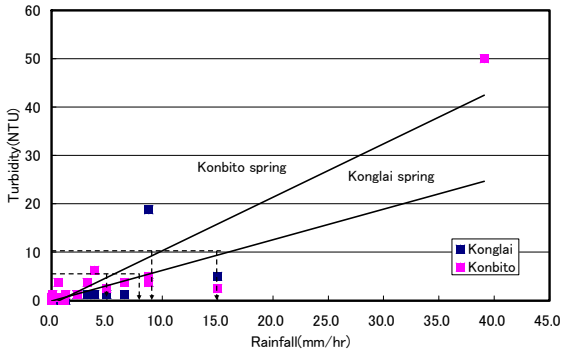
3. 日水質分析結果

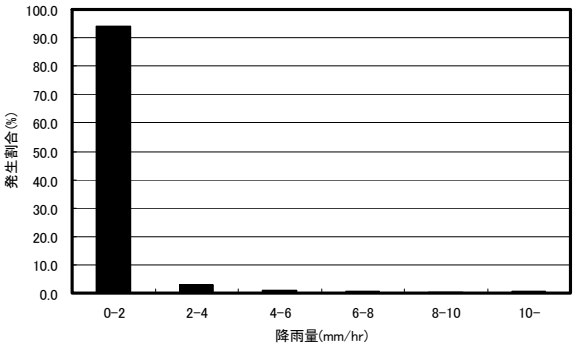
	Date		Meteorology			Konglai						Rove						Kombito					
			Wether	Temp.(℃)	Rainfall(mm/	Time	Temp.(℃)	pH(−)	EC(us/cm	urbidity(°	Color(°)	Time	Temp.(℃)	pH(−)	EC(us/cm	urbidity(°	Color(°)	Time	Temp.(℃)	pH(−)	EC(us/cm	urbidity(°	Color(°)
1	3/24	Mon	FINE	29.3	0.0	11:10	23.6	8.0	290	0	5	10:00	27.0	7.3	450	0	2	12:30	−	7.5	420	0	2
2	3/25	Tue	FINE	28.3	5.2	11:25	23.8	8.0	310	0	2	10:10	26.1	7.6	450	0	2	12:15	25.0	7.5	410	0	0
3	3/26	Wed	CLUDY	27.6	22.0	16:00	23.6	8.0	300	0	0	16:45	28.6	7.6	440	0	2	15:10	25.0	7.5	400	0	0
4	3/27	Thu	FINE	27.0	6.3	10:50	23.9	8.0	320	0	4	10:00	26.7	7.6	480	0	0	12:10	25.0	7.5	400	1	2
5	3/28	Fri	CLUDY	27.4	0.4	10:00	23.5	8.3	340	0	2	9:23	25.5	7.5	460	0	0	10:55	24.6	7.5	390	0	2
6	3/29	Sat	FINE	27.8	9.5	10:56	23.8	8.5	330	0	2	10:23	26.9	7.6	440	0	0	12:00	24.9	7.5	360	0	2
7	3/30	Sun			0.0																		
8	3/31	Mon	FINE	29.2	0.0	10:34	23.8	8.0	340	0	2	9:57	27.3	7.3	480	0	0	9:15	25.9	7.5	360	0	2
9	4/1	Tue	FINE	28.5	0.0	11:28	23.8	8.0	310	0	0	10:48	27.7	7.5	420	0	0	9:46	25.2	8.0	410	0	2
10	4/2	Wed	CLUDY	24.2	88.7	10:14	23.7	8.0	320	4	0	9:35	25.8	7.4	460	3	0	10:57	25.3	8.0	410	2	2
11	4/3	Thu	FINE	30.1	14.8	11:15	24.8	8.2	400	0	0	14:42	23.8	7.6	310	0	0	13:42	28.6	7.6	460	0.5	2
12	4/4	Fri	FINE	26.2	2.7	10:27	23.5	8.0	320	0	0	9:50	26.9	7.5	460	0.5	0	9:15	26.2	7.5	390	0.5	2
13	4/5	Sat	CLUDY	27.2	43.9	9:25	23.6	8.2	340	3	2	10:45	28.6	7.6	470	0.5	0	11:20	25.3	8.0	400	4	2
14			RAIN							15	20					0	2					3	2
15	4/6	Sun	RAIN	23.8	42.0	7:45	23.2	8.0	250	1	2	8:40	25.1	7.6	450	0	2	9:20	24.0	7.6	300	3	2
16	4/7	Mon	RAIN	24.2	17.7	10:37	23.8	8.0	280	1	5	8:40	26.9	7.6	470	1	2	12:10	25.0	7.5	330	3	2
17	4/8	Tue	CLUDY	23.8	11.4	10:16	23.8	−	310	1	2	11:14	26.7	−	470	1	2	9:13	25.0	−	330	1	2
18	4/9	Wed	FINE	26.5	6.2	11:19	24.8	8.0	330	0	2	10:41	26.8	7.6	480	0	2	9:46	25.0	7.6	370	0	2
19	4/10	Thu	FINE	25.4	0.0	9:53	23.8	8.1	340	0	2	9:14	25.9	7.6	480	0	2	10:42	25.0	7.7	380	0.5	2
20	4/11	Fri	FINE	27.8	0.0	11:30	23.6	8.0	330	0	0	10:19	28.0	7.5	450	0	0	9:24	25.2	7.8	390	0.5	2
21	4/12	Sat	FINE	26.3	0.0	11:20	23.8	8.0	320	0	0	9:22	26.0	7.5	470	0	0	10:33	25.3	7.7	380	0	2
22	4/13	Sun			11.5																		
23	4/14	Mon	CLUDY	25.0	2.8	11:23	24.3	8.5	310	0	0	10:50	27.0	7.5	460	0.5	2	10:00	24.9	7.5	360	3	4
24	4/15	Tue	FINE	24.9	10.6	14:50	23.8	8.4	320	0	0	14:10	29.0	7.5	490	0	0	13:32	24.8	7.6	390	0	0
25	4/16	Wed	CLUDY	27.5	195.5	10:30	23.5	7.8	240	2	6	11:17	27.9	7.5	470	0.5	2	9:30	24.2	7.8	200	40	20
26	4/17	Thu	CLUDY	25.5	21.3	11:30	23.8	8.0	310	1	2	12:00	27.8	7.6	480	0.5	2	10:35	24.8	7.8	340	5	10
27	4/18	Fri	CLUDY	24.3	26.8	11:00	24.1	8.4	330	1	2	11:30	26.2	7.6	470	0.5	2	10:11	24.1	7.6	340	2	4
28	4/19	Sat	CLUDY	25.5	0.7	8.55	23.6	8.0	370	0	0	9:30	26.7	7.5	510	0	0	10:26	25.0	7.8	390	1	2
	NUM.			25	27		25	24	25	26	26		25	24	25	26	26		24	24	25	26	26
	AVE.			26.5	20.0		23.8	8.1	318	1	2		26.8	7.5	459	0	1		25.1	7.7	372	3	3
	MAX.			30.1	195.5		24.8	8.5	400	15	20		29.0	7.6	510	3	2		28.6	8.0	460	40	20
	MIN.			23.8	0.0		23.2	7.8	240	0	0		23.8	7.3	310	0	0		24.0	7.5	200	0	0
	DIV.			1.8	39.3		0.4	0.2	32.0	3.0	3.9		1.1	0.1	35.4	0.6	1.0		0.9	0.2	48.7	7.6	3.9

Note: shows the day when it rained heavily at the previous night in honiara.
Less than 0.5° on Turbidity and less than 2° on color are described as 0° here.

4. 高濁度の発生頻度の検討

高濁度対応型調整池の使用頻度を検討するために、高濁度の発生頻度の検討を行った。日水質分析データを用いコングライ湧水およびコンビト湧水における降雨強度と原水濁度の関係を検討した。結果を図-1 に示す。また 2007 年 4 月～2008 年 3 月における各降雨強度の年間発生頻度を図-2 に示す。





※1 濁度 1 度=0.8NTU として換算した。

図-1 降雨強度と原水濁度の関係

図-2 各降雨強度の年間発生頻度
（2007 年 4 月～2008 年 3 月）

図-1 と図-2 を用い、コングライ湧水およびコンビト湧水が濁度 5NTU 以上および濁度 10NTU 以上となる年間発生頻度を検討した。結果を表-1 に示す。

表-1 高濁度の年間予想発生頻度

	5NTU※1 以上		10NTU※2 以上	
	降雨強度	頻度※3	降雨強度	頻度※3
コングライ湧水	8mm/hr 以上	1.2%（18 回）	16mm/hr 以上	0.3%（4 回相当）
コンビト湧水	6mm/hr 以上	1.9%（28 回）	10mm/hr 以上	0.8%（12 回相当）

※ 1 高濁度対応型調整池の目標処理水質

※ 2 8 時間以上継続した場合、高濁度対応型調整池が対応できない原水濁度

※ 3 強降雨が発生する最大の時間を 6 時間とし、従って 4 回/日として検討した。

本検討によれば、濁度低減施設が必要となる原水濁度が 5NTU 以上となる降雨が発生する年間頻度は、コングライ湧水で 18 回、コンビト湧水で 28 回となった。

5. 簡易ジャーテスト試験

(1)方法

コングライ湧水およびコンビト湧水に関し、①沈降試験、②凝集沈殿試験を実施した。

① 沈降試験は、500ml のビーカを用い、目視で濁度粒子の沈降速度、上澄水濁度、上澄水色度の測定を行った。

② 凝集沈殿試験は、図 1 に示す簡易ジャーテスト試験および沈降試験を実施し、各湧水における濁度の沈降性を測定した。コングライ湧水に関しは原水濁度が低かったこともあり、水源周辺から採取した土を添加した試験も実施した。

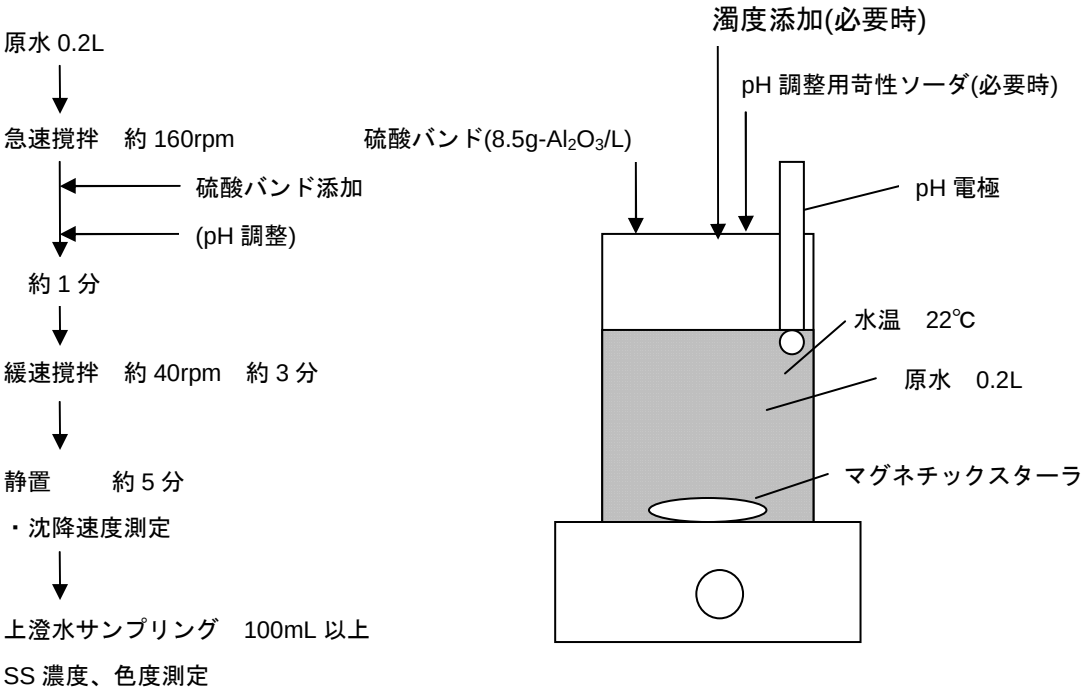


図 1　凝集沈殿試験方法

(2)結果

1) 沈降試験結果

1)-1 原水水質

湧水	コングライ湧水		コンビト湧水
サンプリング月日	4 月 5 日	4 月 6 日(濁度添加)	4 月 16 日
pH	-	8.8(-)	8.3(-)
濁度	15°	20°	40°
色度	20°	20°	20°

1)-2 沈降試験結果

湧水	コングライ湧水		コンビト湧水
サンプリング月日	4 月 5 日	4 月 6 日(濁度添加)	4 月 16 日
上澄水 pH	-	8.8(-)	8.3(-)
上澄水濁度	7°	10°	15°
上澄水色度	20°※2	10°	10°
沈降速度※1	約 30mm/分	約 30mm/分	約 30mm/分

※1 肉眼で検出できる最低粒子径(粒子径約 0.3mm)の沈降速度

※2 原水をろ紙 5C でろ過したろ過水色度は、10°

2) 凝集沈殿試験結果

2)-1 原水水質

湧水	コングライ湧水		コンビト湧水	
原水 No.	1	2	3	4
サンプリング月日	4 月 6 日	4 月 6 日 (濁度添加)	4 月 6 日	4 月 16 日
pH	8.3(-)	8.8(-)	8.3(-)	8.3(-)
濁度	1°	20°	3°	40°
色度	2°	20°	2°	20°

2)-2 凝集沈殿試験結果

①コングライ湧水

原水 No		1	1	1	1	1	1	1	2
硫酸バンド注入率 ($mg\text{-}Al_2O_3/L$)		85	43	43	43	21	10	10	10
硫酸バンド添加後 pH(-)		4.5	6.1	6.2	6.2	6.8	7.5	7.6	7.8
苛性ソーダ注入率(mg/L)		75	無	13	25	無	無	無	無
苛性ソーダ添加後 pH(-)		6.3		6.5	6.8				
処理性能	凝集性	○	△	△	△	△	△	△	○
	沈降速度(mm/分)	-	-	-	-	-	約 30	約 30	約 50
	上澄水濁度(°)	-	-	-	-	-	2	2	3
	上澄水色度(°)	-	-	-	-	-	<2	<2	5
備考								緩撹なし	

②コンビト湧水

原水 No		3	3	3	4
硫酸バンド注入率(mg-Al_2O_3/L)		43	21	10	10
硫酸バンド添加後 pH(-)		7.1	7.3	7.6	7.8
苛性ソーダ注入率(mg/L)		無	無	無	無
苛性ソーダ添加後 pH(-)					
処 理 性能	凝集性	○	△	△	○
	沈降速度(mm/分)	-	-	約 30	約 50
	上澄水濁度(°)	-	-	2	1
	上澄水色度(°)	-	-	<2	2
備考					

資料-13　　入手資料リスト

収集資料リスト

調査名 ソロモン国諸島国ホニアラ市及びアウキ市水供給システム改善計画基本設計調査

番号	名　　称	形態 図書・ビデオ 地図・写真等	ｵﾘｼﾞﾅﾙ･ｺﾋﾟｰ	発行機関	発行年
1	2004 APPROVED ANNUAL BUDGED	図書	コピー	SIWA	2004
2	A PRELIMINARY WATER RESOUCES DEVELOPMENT REPORT	図書	コピー	MINISTRY OF ENERGY, WATER & MINERAL RESOURCES	2001
3	TECHNICAL AND FINANCIAL RECOVERY PROGRAMME DRAFT FINDING REPORT 2003	図書	コピー	EUROPEAN COMMISSION	2003
4	SOLOMON ISLANDS PROJECT REPORT	図書	コピー	HYDOROPLAN	–
6	TECHNICAL AND FINANCIAL RECOVERY PROGRAMME DRAFT FINDING REPORT 2003 APPENDICS	図書	コピー	HYDOROPLAN	2003
6	SOLOMON ISLANDS FINAL REPORT PHASE2 2003	図書	コピー	HYDOROPLAN	2003
7	SOLOMON ISLANDS FINAL REPORT PHASE2 ANNEXES 2003	図書	コピー	HYDOROPLAN	2003
8	SOLOMON ISLANDS PRELIMINARY DESIGNS AND SPECIFICATIONS	図書	コピー	HYDROPLAN	–
9	KOMBITO WATERWORKS SURVEY REPORT	図書	コピー	HYDROPLAN AND SIWA	2001
10	CORPORATE DEVELOPMENT PLAN OF THE SIWA 2001-2002	図書	コピー	HYDROPLAN	2001
11	THE WORLD BANK SOLOMON ISLANDS GOVERNMENT IMPLEMENTATION OF MANAGEMENT	図書	コピー	ALLENS ARTHUR ROBINSON	–

番号	名　　称	形態 図書・ビデオ 地図・写真等	ｵﾘｼﾞﾅﾙ･ｺﾋﾟｰ	発行機関	発行年
	CONTRCT FINAL REPORT				
12	WATER SUPPLY CAPITAL WORKS PLAN 1996-2016	図書	コピー	SIWA	2004
13	DEVELOPMENT OF THE SOLOMON ISLAND URBAN WATER & SEWERAGE INFRASTRUCTURE –PROJECT DESIGN STUDY	図書	コピー	SMEC	2000
14	FLOFIDA ISLANDS	地図	コピー	BRITISH GOVERNMENT'S OVERSEAS DEVELOPMENT	1974
15	NEW GEORGIA	地図	コピー	DIRECTORATE OF OVERSEAS SURVEY	1970
16	TULAGHI NORTH	地図	コピー	LANDS DIVISION, MINISTRY OF AGRICULTURE AND LAND	–
17	TULAGHI SOUTH	地図	コピー	LANDS DIVISION, MINISTRY OF AGRICULTURE AND LAND	–
18	GUADALCANAL	地図	コピー	BRITISH GOVERNMENT'S OVERSEAS DEVELOPMENT	1974
19	AUKI MALAITA	地図	コピー	-	–
20	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
21	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
22	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
23	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
24	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
25	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
26	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
27	NORO	地図	コピー	MINISTRY OF LAND ENERGY AND NATURAL RESOURCES	1983
28	BRITISH SOLOMON ISLANDS	地図	オリジナル	DEPARTMENT OF GEOLOGICAL SURVAY	1969

番号	名　　称	形態 図書・ビデオ 地図・写真等	ｵﾘｼﾞﾅﾙ･ｺﾋﾟｰ	発行機関	発行年
29	HONIARA	地図	オリジナル	DEPARTMENT OF GEOLOGICAL SURVAY	–
30	WEST FLORIDA ISLANDS	地図	オリジナル	DEPARTMENT OF GEOLOGICAL SURVAY	1977
31	NORTH NEW GEOGEA	地図	オリジナル	DEPARTMENT OF GEOLOGICAL SURVAY	1985
32	THE PROJECT FOR IMPROVEMNET OF WATER SUPPLY SYSTEM IN HONIARA AND PROVINCIAL CENTERS IN THE SOLOMON ISLANDS	図書	コピー	MINSTRY OF MINES AND ENERGY THE SOLOMON ISLANDS	2005
33	THE SOLOMON ISLADNS WATER AUTHORITY ACT 1992	図書	コピー	SIWA	1992
34	BJC&ASSOCIATE ENVIRONMENTAL CONSULTS	図書	コピー	BJC&ASSOCIATES ENVIRONMENTAL CONSULTANTS	–
35	PACIFIC STRATA DRILLING LTD	図書	コピー	PACIFIC STRATA DRILLING LTD	2007
36	KRAMER GROUP	図書	コピー	KRAMER GROUP	–