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COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

DETAILED DESIGN OF BISRI DAM PROJECT

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DAM FOOTPRINT

GEOTECHNICAL INVESTIGATION REPORT VII

FACTUAL

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- APPENDIX 1. GEOLOGIE DU SITE (PLAN G-02 / JULY 11, 2014) – ZONE D' EMPRUNT
(PLAN G-16 / SEPTEMBER 22, 2014)

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1. Introduction

One boreholes (BHVR6) was located (Appendix 1) and drilled within the right side valley of the dam in a manner to determine the subsurface soil stratum (multi-layered foundation soil of the dam), underlying bedrock stratigraphy and to compare the results of dynamic cone penetration test (DCPVR4) with standard penetration test values (BHVR6).

BHVR6: 121m

New test pits (15 nos. of NTP, see Figure 1 to 17) were excavated (see Figure 18 to 21) within the areas (R-1/2, S-3, S-4, S-5B, S-6A, S-6B, R-8, N-1, N-2, R-5 and R-6, see Figure 22 and Appendix 1) previously recommended as Sand/Gravel material sources, to a maximum depth of 5.6m from the natural ground level.

In-situ Field Density (Sand-Cone Method, see Figure 23) and Moisture Content (Speedy Moisture Testing Kit, see Figure 24) tests were carried out during the execution of the test pits.

Representative bulk soil samples were taken from the test pits (see Figure 25) and sent to the laboratory for testing (see Figure 26). List of sampling and laboratory testing is presented in Appendix 6 of this factual report.



Figure 1: NTP9, Sand/Gravel material source of R-1, 2.

NTP9 (X: -333650.49, Y: -61727.07, Z: + 405.14, Date: 10.09.2014): 2.6m deep, *groundwater table at a depth of 2.4m.*

As per site description;

0 - 1.8m: Cream to light brown slightly silty fine to medium SAND with some organic matters (*in-situ testing and bulk sampling at 0.7m*).

1.8 – 2.2m: Very gravelly SAND with few cobbles (*in-situ* testing and bulk sampling at 2m).

2.2 – 2.6m: Bluish to greenish grey sandy SILT.



Figure 2: NTP10, Sand/Gravel material source of S-3

NTP10 (X: -333377.65, Y: -61444.44, Z: + 414.91, Date: 10.09.2014): 4.2m deep, groundwater table is deeper than 4.2m.

As per site description;

0 - 0.2m: Agricultural top soil.

0.2 – 3.8m: SAND and GRAVEL with few Cobbles (in-situ testing and bulk sampling at 2m and 3.5m).

3.8 – 4.2m: Bluish to greenish grey slightly clayey sandy SILT.



Figure 3: NTP11, Sand/Gravel material source of S-4

NTP11 (X: -333022.74, Y: -61264.20, Z: + 417.01, Date: 10.09.2014): 5m deep, groundwater table is deeper than 5m.

As per site description;

0 - 0.3m: Agricultural top soil.

0.3 – 5m: SAND and GRAVEL with some Cobbles (in-situ testing and bulk sampling at 1.7m and 4m)



Figure 4: NTP12, Sand/Gravel material source of S-4

NTP12 (X: -333079.71, Y: -61080.69, Z: + 416.7, Date: 11.09.2014): 5.3m deep, groundwater table is deeper than 5.3m.

As per site description:

0 - 0.3m: Agricultural top soil.

0.3 – 1.5m: SAND and GRAVEL with few Cobbles and a thin layer (30cm thick) of medium Sand (in-situ testing and bulk sampling at 1.5m).

1.5 – 3.5m: SAND and GRAVEL with some Cobbles and few Boulders (in-situ testing and bulk sampling at 3m).

3.5 – 4m: Light brown slightly sandy silty CLAY.

4 – 5.3m: Bluish to greenish grey silty CLAY.



Figure 5: NTP13, Sand/Gravel material source of S-5B

NTP13 (X: -332527.44, Y: -60972.44, Z: + 415.81, Date: 11.09.2014): 3.8m deep, groundwater table at a depth of 3.7m.

As per site description;

0 - 0.4m: Medium Sand with some organic matters.

0.4 – 2.6m: SAND and GRAVEL with many Cobbles and some organic matters (in-situ testing and bulk sampling at 1.5m).

2.6 – 3.8m: Very gravelly SAND with few Cobbles (in-situ testing and bulk sampling at 3.5m).

4.2 – 5.2m: Bluish grey silty CLAY



Figure 6: NTP14, Sand/Gravel material source of S-5B

NTP14 (X: -332040.71, Y: -61065.84, Z: + 421.38, Date: 11.09.2014): 5.5m deep,
groundwater table at a depth of 5.5m.

As per site description;

0 - 2m: SAND and GRAVEL with many Cobbles, a thin layer (20cm thick) of medium Sand and few organic matters (in-situ testing and bulk sampling at 1.4m).

2 – 3.4m: SAND and Gravel with many Cobbles and some Boulders (in-situ testing and bulk sampling at 3.4m).

3.4 – 5m: SAND and GRAVEL with many Cobbles 5 – 5.5m: Bluish to greenish grey clayey SILT.



Figure 7: NTP15, Sand/Gravel material source of S-6A

NTP15 (X: -331521.72, Y: -61133.31, Z: + 421.64, Date: 12.09.2014): 2.7m deep, groundwater table at a depth of 2.3m.

As per site description;

0 - 0.2m: Agricultural top soil.

0.2 – 1.5m: SAND and GRAVEL with some Cobbles, few Boulders and organic matters.

1.5 – 2.7m: SAND and GRAVEL with some Cobbles and few Boulders (in-situ testing and bulk sampling at 1.8m).



Figure 8: NTP16, Sand/Gravel material source of S-6B

NTP16 (X: -331098.31, Y: -61078.36, Z: + 425.73, Date: 12.09.2014): 4m deep, *groundwater table at a depth of 3.8m.*

As per site description;

0 - 0.7m: Agricultural top soil.

0.7 – 4m: SAND and GRAVEL with some Cobbles and Boulders (in-situ testing and bulk sampling at 1.7m and 3.5m).



Figure 9: NTP17, Sand/Gravel material source of S-6B

NTP17 (X: -330927.87, Y: -61101.12, Z: + 425.29, Date: 12.09.2014): 2.2m deep, groundwater table at a depth of 2.2m.

As per site description;

0– 2.2m: SAND and GRAVEL with some Cobbles / Boulders and a thin layer (40cm thick) of medium Sand (in-situ testing and bulk sampling at 1.8m).



Figure 10: NTP18, Sand/Gravel material source of R-8

NTP18 (X: -330854.58, Y: -61039.85, Z: + 425.43, Date: 12.09.2014): 3.5m deep, groundwater table at a depth of 1.8m.

As per site description;

0– 2.2m: SAND and GRAVEL with some Cobbles and Boulders (in-situ testing and bulk sampling at 1m).

2.2– 3.5m: Bluish to greenish grey slightly clayey sandy SILT.



Figure 11: NTP19, Sand/Gravel material source of N-1

NTP19 (X: -334021.37, Y: -61669.69, Z: + 412.01, Date: 10.09.2014): 5.6m deep, groundwater table is deeper than 5.6m.

As per site description;

0– 0.7m: SAND and GRAVEL (in-situ testing and bulk sampling at 0.4m).

0.7– 2m: Gravely SAND with some organic matters (in-situ testing and bulk sampling at 1.2m).

2– 5.6m: Bluish to greenish grey SILT and CLAY.



Figure 12: NTP20, Sand/Gravel material source of N-1

NTP20 (X: -333764.77, Y: -61484.72, Z: + 412.88, Date: 10.09.2014): 5.4m deep, groundwater table is deeper than 5.4m.

As per site description;

0– 1.3m: SAND and GRAVEL with few Cobbles and some organic matters (in-situ testing and bulk sampling at 0.8m).

1.3– 4.7m: Brown silty fine SAND and clayey sandy SILT with some organic matters.

4.7– 5.4m: Bluish to greenish grey clayey SILT.



Figure 13: NTP21, Sand/Gravel material source of N-2

NTP21 (X: -333460.07, Y: -61231.17, Z: + 409.61, Date: 10.09.2014): 5.3m deep, groundwater table at a depth of 5m.

As per site description;

0 - 0.3m: Agricultural top soil.

0.3– 4.2m: SAND and GRAVEL with few Cobbles and some organic matters (in-situ testing and bulk sampling at 1.5m and 3.5m).

4.2– 4.9m: Reddish brown slightly silty and gravelly medium SAND.

4.9– 5.3m: Bluish to greenish grey silty CLAY.



Figure 14: NTP22, Sand/Gravel material source of R-5

NTP22 (X: -332262.47, Y: -60882.50, Z: + 415.93, Date: 11.09.2014): 1.8m deep, groundwater table at a depth of 1.4m.

As per site description;

0– 1.8m: SAND and GRAVEL with Cobbles and Boulders (in-situ testing and bulk sampling at 1m).



Figure 15: NTP23, Sand/Gravel material source of R-6

NTP23 (X: -331751.59, Y: -61106.74, Z: + 420.25, Date: 11.09.2014): 2.1m deep, groundwater table at a depth of 1.7m.

As per site description:

0– 2.1m: SAND and GRAVEL with Cobbles and Boulders (in-situ testing and bulk sampling at 1.5m).



Figure 16: SAND and GRAVEL with some Cobbles (NTP11).



Figure 17: SAND and GRAVEL with Cobbles and Boulders (NTP23)



Figure 18: NTP11



Figure 19: NTP22



Figure 20: NTP17

NTP	width (m)	length (m)	depth (m)	volume (m³)
NTP9	2.1	4.3	2.6	23.5
NTP10	3.5	6.1	4.2	89.7
NTP11	2.0	4.5	5.0	45.0
NTP12	3.1	5.4	5.3	88.7
NTP13	5.3	3.3	3.8	66.5
NTP14	3.2	5.9	5.5	103.8
NTP15	3.1	4.8	2.7	40.2
NTP16	3.8	6.3	4.0	95.8
NTP17	2.8	4.9	2.2	30.2
NTP18	3.5	5.9	3.5	72.3
NTP19	2.7	6.0	5.6	90.7
NTP20	3.2	6.1	5.4	105.4
NTP21	3.7	6.0	5.3	117.7
NTP22	3.6	4.9	1.8	31.8
NTP23	3.6	3.7	2.1	28.0
Total Volume				1029.1

Figure 21: Test pit dimensions.

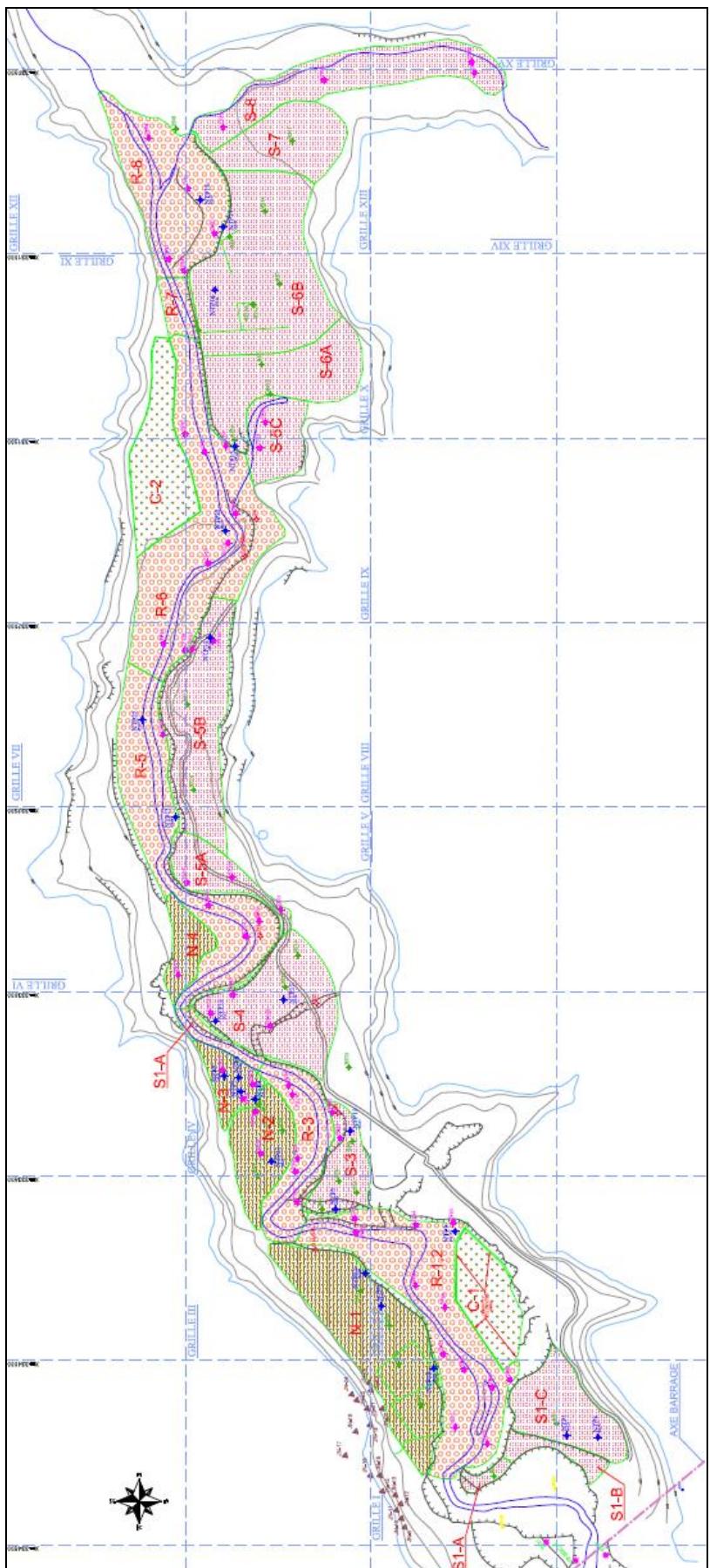


Figure 22: Previously recommended Sand/Gravel material sources.



Figure 23: Sand-cone method (NTP21)



Figure 24: Speedy moisture test kit.



Figure 25: Soil sampling (NTP19)



Figure 26: Bulk samples taken from the new test pits (NTP9-NTP23).

2. Field Investigation

The field investigation was performed between June 19 and July 5, 2014. One borehole (BHVR6) to a depth of 121m was drilled at location shown on Figure 27. Truck mounted rotary drill rig (see Figure 28) was used in field investigation.



Figure 27: Borehole location.

BHVR6 / Piezometer (+414.49 NGL): 121 meters deep.

0-104.5m: Flood-plain and lacustrine soil deposits.

104.5-109.5m: Old colluvial soil deposits.

109.5-121m: Dark grey weathered clayey MARLSTONE (C2b).

Groundwater table was detected in borehole at below given depth (July 18, 2014) from the natural ground level (NGL).

BHVR6 / Piezometer (+414.49 NGL):

Groundwater table at a depth of 9.29m (+405.2)

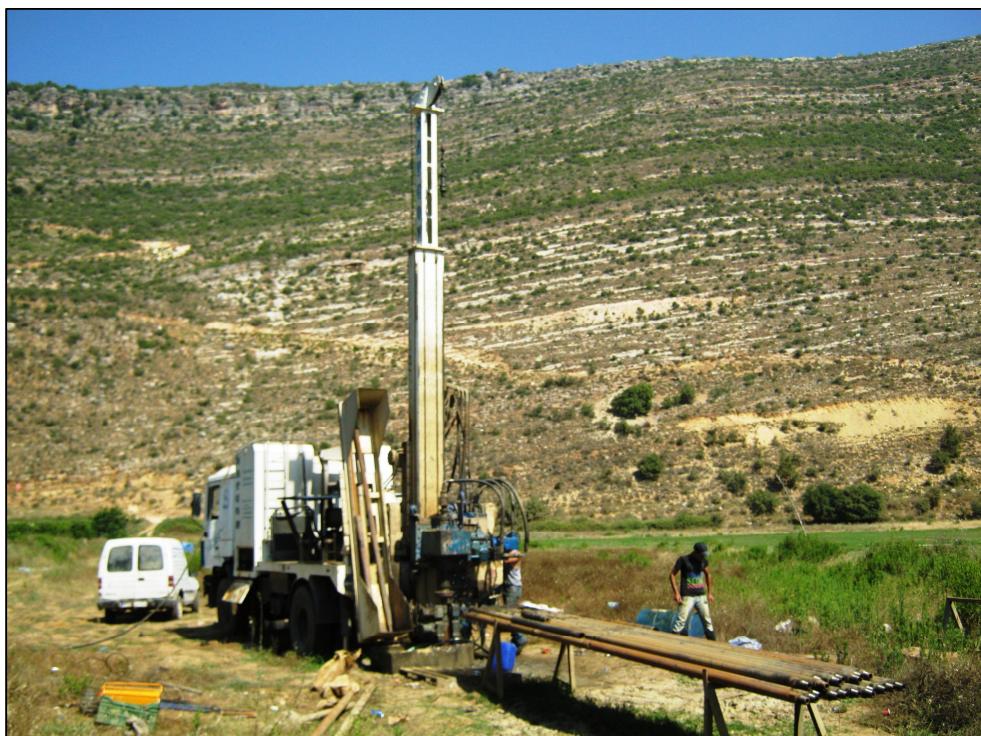


Figure 28: BHVR6

3. Scope of Works

The scope of works of this field investigation consisted of the followings:

- Continuous core drilling in soil and rock.
- Performing Standard Penetration Test in soil and obtaining disturbed (D) samples.
- Undisturbed (UD) soil sampling by using thin wall Shelby tubes.
- Performing borehole water permeability (Falling Head Test) test in soil and highly to completely weathered (disintegrated) rock.
- Installing standpipe open piezometers into the borehole and measuring the depth and fluctuations of the groundwater table including daily (morning and evening) borehole water level measurements.

86mm diameter (OD) double tube core barrel equipped with tungsten carbide core bit was used in continuous core drilling with NW drill rods and HW casings (see Figure 29)

Core drilling was performed by using as minimum as possible amount of circulation water, only clean water was used during the drilling, water losses were recorded on site and indicated in logs of boring.

Cores (soil) taken from the borehole were sealed with waterproof plastic tapes and stored in standard wooden core boxes. All the necessary information related to the runs of coring and borehole was clearly indicated on the boxes. Photos of core boxes are presented in Appendix 3 of this factual report.

In soil strata, Standard Penetration Test (SPT) was performed at 3m intervals (in parallel to undisturbed soil sampling) by using Split-Spoon SPT sampler in 2 inches outside diameter (see Figure 30) with automatic trip SPT hammer used in DCPT probing (see Figure 31). The obtained soil samples (disturbed) were labelled and kept in moisture-proof containers for laboratory testing.



Figure 29: Double tube core barrel



Figure 30: Split-Spoon SPT sampler.

Standard Penetration Test (SPT) was performed to estimate the relative densities of the subsurface soil strata (multi-layered foundation soil of the dam) and to compare the results with dynamic cone penetration test carried out in DCPVR4 (find below the comparison between SPT and DCPT).



Figure 31: Automatic trip SPT hammer.

Undisturbed soil sampling was done at 3m intervals by using thin wall Shelby tubes 3 inches in outside diameter and 50cm long with a check valve at the head of the tube (see Figure 32). Shelby tubes were driven into the soil by pushing them only.

After the sampling, head and bottom end of the tubes were coated with wax and the tubes were sealed with waterproof plastic tape.



Figure 32

In soil and disintegrated rock strata, Falling Head borehole water permeability test was performed at 3m intervals (see Figure 33). The test results are presented in Appendix 4 of this factual report.



Figure 33

Perforated (one third of the standpipe) UPVC pipes, 50mm diameter (OD) and 3.7mm thick, wrapped with geotextile (PP, 150 gr/m²) were installed into the boreholes as open standpipe piezometers with concrete heading and steel pipe protection (see Figure 34), in a manner to measure the depth and fluctuations of the groundwater table (Appendix 5).



Figure 34

Upon the request of the designer (March 17, 2014), Pocket Penetrometer as shown on Figure 35 was used to evaluate consistency and approximate unconfined compressive strength/undrained shear strength of the cohesive soil strata (BHVR1, BHVR2, BHVR4 and BHVR6).



Figure 35

BHVR1 / Piezometer (+413.97 NGL): 115 meters deep, groundwater table at a depth of 9.33m (+404.64)

Pocket Penetrometer Readings (7.5-10m): Olive brown soft silty CLAY

First reading: 0.3 kg/cm^2 (UCS), $Cu = 0.15 \text{ kg/cm}^2$ (Undrained Shear Strength)

Second Reading: 0.3 kg/cm^2 , $Cu = 0.15 \text{ kg/cm}^2$

Pocket Penetrometer Readings (12-23m): Olive brown soft very clayey SILT

First reading: 0.4 kg/cm^2 , $Cu = 0.2 \text{ kg/cm}^2$

Second Reading: 0.2 kg/cm^2 , $Cu = 0.1 \text{ kg/cm}^2$

Third Reading: 0.3 kg/cm^2 , $Cu = 0.15 \text{ kg/cm}^2$

Pocket Penetrometer Readings (33-73m): Olive brown medium stiff silty CLAY

First reading: 0.6 kg/cm^2 , $Cu = 0.3 \text{ kg/cm}^2$

Second Reading: 0.5 kg/cm^2 , $Cu = 0.25 \text{ kg/cm}^2$

Third Reading: 0.7 kg/cm^2 , $Cu = 0.35 \text{ kg/cm}^2$

Fourth Reading: 0.7 kg/cm^2 , $Cu = 0.35 \text{ kg/cm}^2$

Fifth Reading: 0.6 kg/cm^2 , $Cu = 0.3 \text{ kg/cm}^2$

BHVR2 / Piezometer (+414.09 NGL): 111 meters deep, groundwater table at a depth of 9.24m in average (+404.85)

Pocket Penetrometer Readings (0-4.5m): Brown m. stiff to stiff very clayey SILT.

First reading: 0.8 kg/cm^2 , $Cu = 0.4 \text{ kg/cm}^2$

Second Reading: 1 kg/cm^2 , $Cu = 0.5 \text{ kg/cm}^2$

Pocket Penetrometer Readings (4.5-16m): Olive green soft to medium stiff sometimes hard very silty CLAY (loss of water circulation at 6m).

First reading: 0.5 kg/cm^2 , $Cu = 0.25 \text{ kg/cm}^2$

Second Reading: 1.6 kg/cm^2 , $Cu = 0.8 \text{ kg/cm}^2$

Third Reading: 0.4 kg/cm^2 , $Cu = 0.2 \text{ kg/cm}^2$

Pocket Penetrometer Readings (16-26m): Olive green soft to m, stiff very sandy and clayey SILT.

First reading: 0.4 kg/cm^2 , $Cu = 0.2 \text{ kg/cm}^2$

Second Reading: 0.4 kg/cm^2 , $Cu = 0.2 \text{ kg/cm}^2$

BHVR4 / Piezometer (NGL: +398.14): 84 meters deep, groundwater table at a depth of 2.25m (+395.89).

Pocket Penetrometer Readings (3.5-9m): Olive brown soft very clayey SILT.

First reading: 0.3 kg/cm^2 , Cu = 0.15 kg/cm^2

Pocket Penetrometer Readings (17-23m): Olive brown soft to m. stiff very clayey SILT.

First reading: 0.5 kg/cm^2 , Cu = 0.25 kg/cm^2

Second Reading: 0.5 kg/cm^2 , Cu = 0.25 kg/cm^2

Pocket Penetrometer Readings (23-41.5m): Olive brown medium stiff silty CLAY.

First reading: 0.7 kg/cm^2 , Cu = 0.35 kg/cm^2

Second Reading: 0.7 kg/cm^2 , Cu = 0.35 kg/cm^2

BHVR6 / Piezometer (NGL: +414.49): 121 meters deep, groundwater table (GWT) at a depth of 9.29m (GWT: +405.02).

Pocket Penetrometer Reading (0-11.5m): Yellowish brown soft sandy very silty CLAY

Reading: 0.4 kg/cm^2 , Cu = 0.20 kg/cm^2

Pocket Penetrometer Reading (30-57.5m): Olive brown m. stiff sandy very silty CLAY

First reading: 0.7 kg/cm^2 , Cu = 0.35 kg/cm^2

Second Reading: 0.5 kg/cm^2 , Cu = 0.25 kg/cm^2

Third Reading: 0.5 kg/cm^2 , Cu = 0.25 kg/cm^2

Pocket Penetrometer Reading (57.5-68.5m): Olive brown soft silty CLAY

First reading: 0.3 kg/cm^2 , Cu = 0.15 kg/cm^2

Second Reading: 0.2 kg/cm^2 , Cu = 0.10 kg/cm^2

Pocket Penetrometer Reading (68.5-77.5m): Olive brown medium stiff silty CLAY

First Reading: 0.6 kg/cm^2 , Cu = 0.30 kg/cm^2

Second Reading: 0.6 kg/cm^2 , Cu = 0.30 kg/cm^2

Pocket Penetrometer Reading (77.5-104.5m): Olive brown m. stiff to stiff silty CLAY

First reading: 0.9 kg/cm^2 , Cu = 0.45 kg/cm^2

Second Reading: 0.8 kg/cm^2 , Cu = 0.4 kg/cm^2

Third Reading: 1 kg/cm^2 , Cu = 0.5 kg/cm^2

All the field works were performed according to ASTM standards (ASTM D6640: Core drilling in soil and rock, ASTM D1586: Standard Penetration Test, Lambe & Whitman: Falling Head Test, ASTM D4750: Determining Subsurface Liquid Levels in a boreholes, ASTM D1587: Undisturbed soil sampling and ASTM WK27337: New Test Method for Pocket Penetrometer Test) and were supervised by an engineering geologist.



4. Comparison between SPT (BHVR6) & DCPT (DCPVR4)

The Dynamic Cone Penetration Test was performed continuously in a manner, to estimate the relative densities / consistencies of the subsurface soil strata, to determine dam foundation strength and to evaluate the liquefaction potential.

A solid cone having an apex angle of 60 degrees and an end diameter of 62.5mm was used in Dynamic Cone Penetration Test with AW (min. 3 meters long) / BW / HW drill rods and Automatic Trip SPT Hammer.

The Dynamic Cone Penetration Test (DCPT) was performed with full casing (114mm dia.) down to 60m and then with enlarging the hole diameter by the use of tri-cone bit (4 inches dia.) in a manner to minimize the friction losses between the drill rods and wall of the hole. Casing was systematically installed into the hole after each run of penetration of 3 meters without casing.

Total of the recorded numbers of blows (DCPT blows / 10cm run) for each 30cm run, were normalized/corrected for the amount of energy delivered to the drill rods (Energy Ratio) depending on the hammering system (Automatic Trip SPT Hammer), Anvil size (Small, around 2 kg), blow rate (36 blows per minute), rod length (variable) and borehole diameter (62.5 to 114mm).

Correction factors used:

Hammering System (Automatic Trip SPT Hammer): 1.3

Anvil Size (Small around 2 kg): 0.75

Blow Rate (36 bpm): 1

Rod Length: 0.75 (0-3.9m), 0.85 (3.9-6m), 0.95 (6-9.9m) and 1 (>9.9m)

Borehole Diameter: 1 (62.5-114mm)

Then, the normalized DCPT values ($N_{cbr}60$) were converted to SPT values (N60) according to IS: 4968 (Part II)-1976 ($N_{cbr}60 / N60 = 1.5$ up to a depth of 4m and $N_{cbr}60 / N60 = 1.75$ for depths of deeper than 4m).

However, recurrent anomalies due to the skin friction of the driven drill rods were appeared periodically. These anomalies were obtained especially within the deep silty clay and each time, below the casing (between 0.9 and 3m).

Above mentioned anomalies (computed SPT values, SPT_E / N60) shall accordingly be normalized as shown on Figure 36.

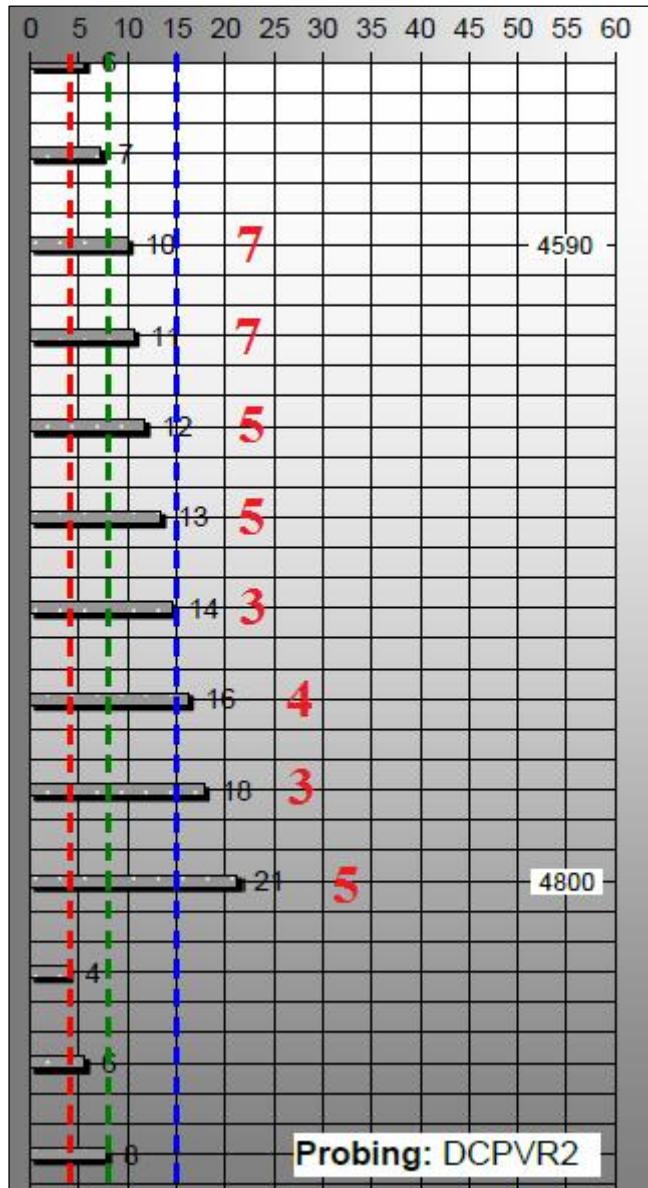


Figure 36

According to the comparison table (see Table 1), the computed SPT values (DCPVR4) independent than the above mentioned anomalies, are almost in harmony with the values taken from the borehole BHVR6 (latter test results).

However and in addition to normalizing the anomalies within the deep silty clay, the computed SPT values ($SPT_E / N60$) shall also be developed for sand by referring to the latter test results of BHVR6 (SPT / N60).

COMPARISON TABLE			
Depth (m)	DCPVR4	BHVR6	Soil Description (In-Situ & Lab.)
	SPT _E / N60	SPT / N60	
2.5	3	5	Yellowish brown sandy very silty CLAY
5.5	2	3	Yellowish brown sandy very silty CLAY
8.5	3	5	Brown sandy very silty CLAY
11.5	4	5	Grey silty very clayey SAND
14.5	30	50	Yellowish brown slightly silty SAND
17.5	13	41	Olive brown SAND
19.5	21	> 50	Yellowish brown silty SAND
22.5	23	> 50	Olive brown silty SAND
24	36	> 50	Olive brown silty SAND
25.5	35	> 50	Olive brown silty SAND
27	31	> 50	Olive brown silty SAND
28.5	38	> 50	Olive brown silty SAND
30	37	> 50	Olive brown silty SAND
32.5	7	7	Brown very silty SAND/CLAY
35.5	7	6	Olive brown sandy very silty CLAY
38.5	8	6	Olive brown sandy very silty CLAY
41.5	8	7	Brown slightly clayey SILT
44.5	14	10	Olive brown sandy very silty CLAY
47.5	9	7	Olive brown very silty CLAY
57.5	9	6	Olive brown very silty CLAY
61.5	6	4	Olive brown silty CLAY
65	5	3	Olive brown silty CLAY
68.5	7	6	Olive brown very silty CLAY
71.5	6	8	Olive brown silty CLAY
74.5	6	8	Olive brown silty CLAY
77.5	7	9	Olive brown silty CLAY
80.5	8	11	Olive brown silty CLAY
83.5	11	11	Olive brown silty CLAY
86.5	12	11	Olive brown silty CLAY
89.5	16 (Anomaly)	6	Olive brown silty CLAY
92.5	-	12	Olive brown silty CLAY
95.5	-	8	Olive brown silty CLAY
98.5	-	12	Olive brown silty CLAY
101.5	-	11	Olive brown silty CLAY
104.5	-	> 50	Old colluvial soil deposits

Table 1

5. Subsurface Strata

According to the core boxes, the following subsurface soil and rock strata were encountered within the borehole BHVR6. The logs of boring are presented in Appendix 2 of this factual report.

BHVR6 / Piezometer (NGL: +414.49): 121 meters deep, groundwater table (GWT) at a depth of 9.29m (GWT: +405.02).

0-104.5m: Flood-plain and lacustrine soil deposits.

0-11.5m: Yellowish brown and brown soft sandy very silty CLAY.

11.5-30m: Yellowish and olive brown dense silty SAND.

30-57.5m: Brown and olive brown medium stiff sandy very silty CLAY.

57.5-68.5m: Olive brown soft silty CLAY.

68.5-77.5m: Olive brown medium stiff silty CLAY.

77.5-104.5m: Olive brown medium stiff to stiff silty CLAY.

104.5-109.5: Old colluvial soil deposits (pervious).

Sub-rounded gravels, cobbles and boulders of Limestone with Marl and Clay

109.5-121m: C2b.

Dark grey highly to completely and completely weathered very weak clayey MARLSTONE

Loss of water circulation, 100% between 115.5 and 121m.

6. Soil Sampling & Laboratory Testing

Package 3/Lebanon:

Representative soil (flood-plain and lacustrine, 27 nos. in total) and rock samples (limestone/J7-J6, 5 nos. in total) from the boreholes (BHVR4, BHVR6, BHLA3 and BHLA4) at different depths, were selected (see Figure 37 and 38) for laboratory testing in Lebanon. List of sampling / laboratory testing program is presented in Appendix 6 of this factual report.

Soil:

Disturbed SPT samples: 23 nos.

Disturbed core sample: 1 no.

Undisturbed (Shelby) samples: 3 nos.

Rock:

Core samples: 5 nos.

Package 2/Morocco:

Representative undisturbed (UD) soil samples (cohesive flood-plain and lacustrine soil deposits, 10 nos. in total) from the boreholes (BHVR1 and BHVR6) at different depths, were selected (see Figure 39) for laboratory testing (Triaxial/CU+U and Odometer) in Morocco. List of sampling / laboratory testing program is presented in Appendix 6 of this factual report.

BHVR1: 4 nos. of UD soil sample.

BHVR6: 6 nos. of UD soil sample.



Figure 37



Figure 38



Figure 39

7. Closure

The findings presented in this factual report are based on the assumption that the subsurface soil and rock strata and their conditions do not deviate appreciably from those disclosed in boreholes. There may be conditions pertaining to the site which were not disclosed by this subsurface soil/rock survey, and thus could not be taken into account. Therefore, the findings are valid under this assumption only.



APPENDICES

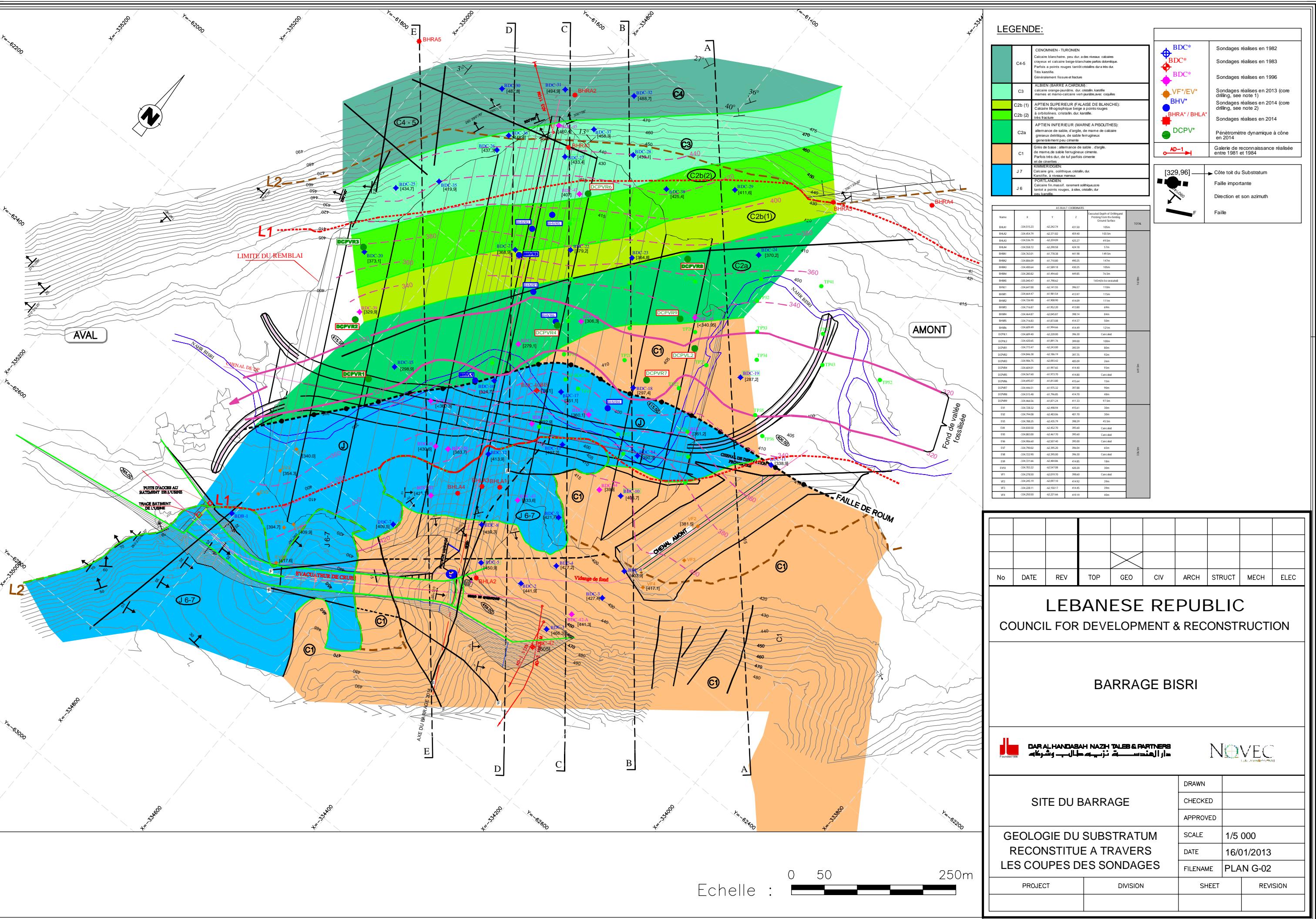
- APPENDIX 1. GEOLOGIE DU SITE (PLAN G-02 / JULY 11, 2014) – ZONE D' EMPRUNT (PLAN G-16 / SEPTEMBER 22, 2014)
- APPENDIX 2. LOGS OF BORINGS
- APPENDIX 3. PHOTOS OF CORE BOXES
- APPENDIX 4. BOREHOLE WATER PERMEABILITY TEST RESULTS
- APPENDIX 5. GROUNDWATER & DAILY BOREHOLE WATER LEVEL MEASUREMENTS
- APPENDIX 6. LIST OF SAMPLING & LABORATORY TESTING PROGRAM - LEBANON: PACKAGE 3 / MOROCCO: PACKAGE 2

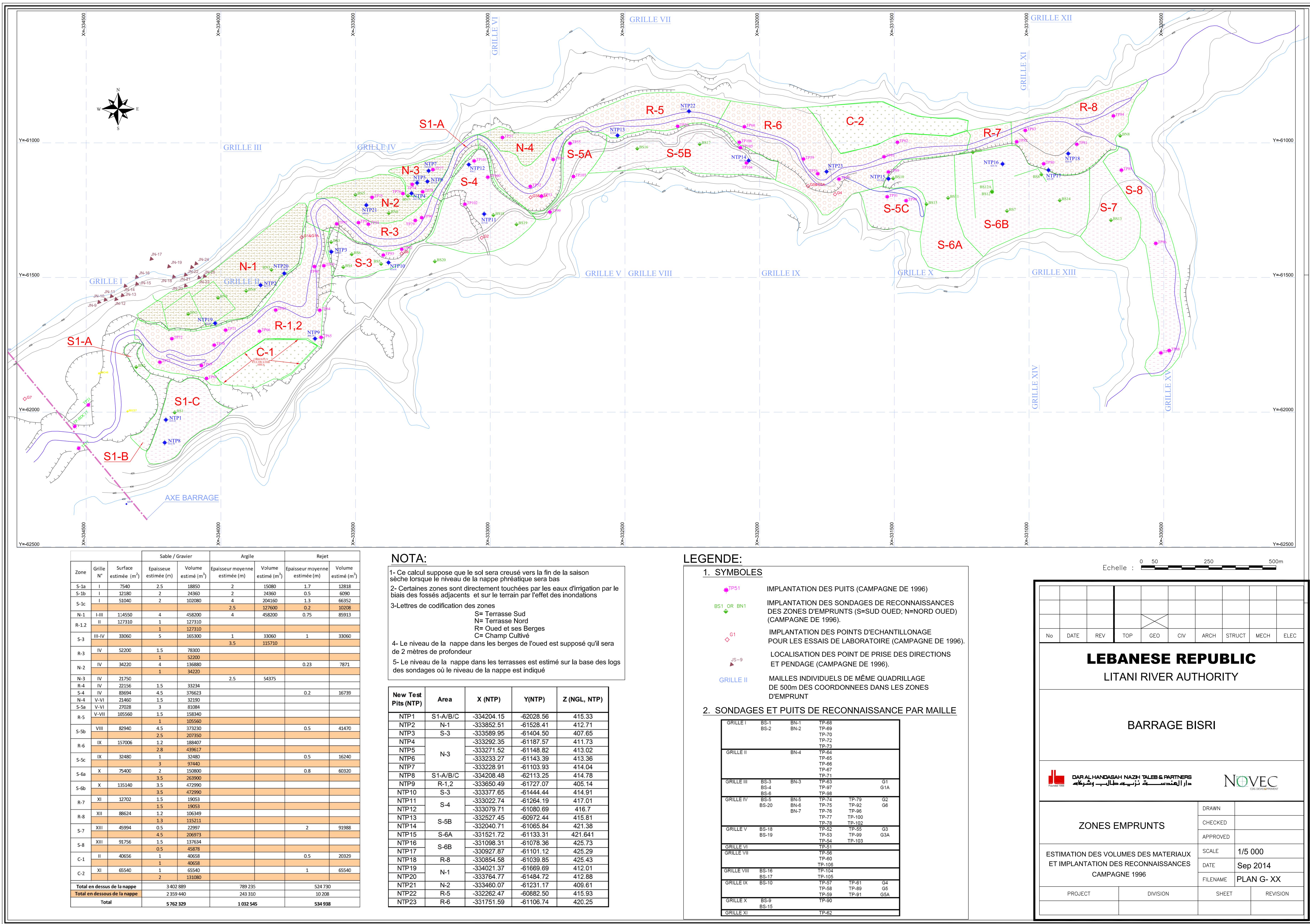
APPENDIX 1. GEOLOGIE DU SITE (PLAN G-02 / JULY 11, 2014) – ZONE D' EMPRUNT (PLAN G-16 / SEPTEMBER 22, 2014)



DAR AL-HANDASAH NAZIH TALEB & PARTNERS
دار الهندسة نزيح طالب وشريك

Founded 1956





APPENDIX 2. LOGS OF BORINGS



DAR AL-HANDASAH NAZIH TALEB & PARTNERS
دَارُ الْمَهَنَّادَةِ نَازِحٌ طَالِبٌ وَشَرَكَةٌ

Founded 1956

BISRI Dam Project: Geo. Inv. Report VII: (Factual) / Dam-Footprint - September 2014

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 1 OF: 13						
EQUIPMENT: CMV 1000			METHOD: Rotary			BOREHOLE DEPTH (m): 121m					
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014					
ENGINEER: K.S.			DRILLER: Nawraz			DATE FINISHED: 05/07/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
1					medium stiff light brown sandy CLAY			20	0	0	
2											Shelby tube (1.5-2m)
3											Shelby tube (2-2.5m)
4											
5											Shelby tube(4.5-5m)
6											Shelby tube(5-5.5m)
7											
8											Shelby tube(7.5-8m)
9											Shelby tube(8-8.5m)
10					medium stiff olive green CLAY			100	0	0	
								57	0	0	

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 2 OF: 13						
EQUIPMENT: CMV 1000			METHOD: Rotary			BOREHOLE DEPTH (m): 121m					
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014					
ENGINEER: K.S.			DRILLER: Nawraz			DATE FINISHED: 05/07/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	Remarks			
11					ditto	57	0	Shelby tube(10.5-11m)			
12								Shelby tube(11-11.5m)			
13											
14								Shelby tube(13.5-14m)			
15					very dense olive green clayey SAND	87	0				
16											
17					dense olive green clayey SAND	33	0	Shelby tube(16.5-17m)			
18								Shelby tube(17-17.5m)			
19					very dense olive green SAND with grounded gravels	72	0				
20											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR06						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m):	414.49	SHEET: 3 OF: 13						
EQUIPMENT: CMV 1000			METHOD:	Rotary	BOREHOLE DEPTH (m): 121m						
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm):	63 to 68	DATE STARTED: 4/26/2014						
ENGINEER: K.S.			DRILLER:	Nawraz	DATE FINISHED: 05/07/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
21	50/12cm Refusal				very dense olive green SAND with grounded gravels	88	0	0			
22	21,35,42 77					36	0	0			
23	28,36,45 N=81					56	0	0			
24	18,26,31 N=57					50	0	0			
25	36,38,50/8cm Refusal					81	0	0			
26						47	0	0			
27						23	0	0			
28	28, 35, 46 81										
29											
30											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 4 OF: 13						
EQUIPMENT: CMV 1000			METHOD: Rotary			BOREHOLE DEPTH (m): 121m					
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014					
ENGINEER: K.S.			DRILLER: Nawraz			DATE FINISHED: 05/07/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
31			17,30,42 72		hard olive green CLAY		62	0	0		
32					ditto, medium stiff					Shelby tube(31.5-32m) (Empty)	
33			3, 3, 4 7							Shelby tube(32-32.5m)	
34							63	0	0		
35										Shelby tube(34.5-35.5m) (Empty)	
36			2,3,3 N=6								
37							57	0	0		
38										Shelby tube(37.5-38.5m)	
39			3, 3, 3 6								
40					soft to medium stiff olive green sandy CLAY		93	0	0		

SPT Standard Penetration Test

UCS Unconfined Compressive Strength

LT Layer Thickness

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

TCR Total Core Recovery

RQD Rock Quality Designation

SCR Solid Core Recovery

ST Sample Type

SYM Symbol

WT Water Table

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 5 OF: 13						
EQUIPMENT: CMV 1000			METHOD: Rotary			BOREHOLE DEPTH (m): 121m					
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014					
ENGINEER: K.S.			DRILLER: Nawraz			DATE FINISHED: 05/07/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
41					ditto	93	0	0			Shelby tube(40.5-41.5)
42					medium stiff olive green sandy CLAY						
43						47	0	0			Shelby tube(43.5-44m)
44											Shelby tube(44-44.5m)
45											
46						77	0	0			Shelby tube(46.5-47.5)
47											
48											
49											
50											Shelby tube(49.5-51m)

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 6 OF: 13						
EQUIPMENT: CMV 1000			METHOD: Rotary			BOREHOLE DEPTH (m): 121m					
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014					
ENGINEER: K.S.			DRILLER: Nawraz			DATE FINISHED: 05/07/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
51					ditto						
52											
53											
54					soft olive green CLAY						
55						77	0	0			
56											Shelby tube(55.5-56.5) (Empty)
57											Shelby tube(56.5-57.5r)
58	2, 3, 3 6										
59					soft olive green slightly sandy CLAY						Shelby tube(59.5-60.5r)
60						90	0	0			

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001			BOREHOLE NO.: BHVR06						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)													
LOCATION: BISRI				Elevation (m): 414.49			SHEET: 7 OF: 13						
EQUIPMENT: CMV 1000				METHOD: Rotary			BOREHOLE DEPTH (m): 121m						
HOLE DAM. (mm): 86 to 114				CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014						
ENGINEER: K.S.				DRILLER: Nawraz			DATE FINISHED: 05/07/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL			% FINES	TCR (%)	Remarks			
-					ditto								
-										Shelby tube(60.5-61.5m)			
-													
61													
-					1,2,2 N=4								
-													
-													
62													
-					2,1,2 N=3								
-													
-													
63													
-					2,2,4 N=6								
-													
-													
64													
-					medium stiff olive green CLAY sometime slightly sandy								
-													
-													
65													
-					Shelby tube(63-64m)								
-													
-													
66													
-					Shelby tube(64-65m)								
-													
-													
67													
-					Shelby tube(66.5-67.5m)								
-													
-													
68													
-					Shelby tube(67.5-68.5m)								
-													
-													
69													
-					Shelby tube(68.5-69.5m)								
-													
-													
70													

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001			BOREHOLE NO.: BHVR06						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)													
LOCATION: BISRI				Elevation (m): 414.49			SHEET: 8 OF: 13						
EQUIPMENT: CMV 1000				METHOD: Rotary			BOREHOLE DEPTH (m): 121m						
HOLE DAM. (mm): 86 to 114				CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014						
ENGINEER: K.S.				DRILLER: Nawraz			DATE FINISHED: 05/07/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL			% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
71					medium stiff olive green CLAY sometime slightly sandy			100	0	0			Shelby tube(70.5-71m)
72													Shelby tube(71-71.5m)
73													
74													Shelby tube(73.5-74m)
75													Shelby tube(74-74.5m)
76													
77													Shelby tube(76.5-77m)
78													Shelby tube(77-77.5m)
79													
80													Shelby tube(79.5-80m)

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001			BOREHOLE NO.: BHVR06						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)													
LOCATION: BISRI				Elevation (m): 414.49			SHEET: 9 OF: 13						
EQUIPMENT: CMV 1000				METHOD: Rotary			BOREHOLE DEPTH (m): 121m						
HOLE DAM. (mm): 86 to 114				CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014						
ENGINEER: K.S.				DRILLER: Nawraz			DATE FINISHED: 05/07/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL			% FINES	TCR (%)	Remarks			
81					stiff olive green CLAY sometime slightly sandy					Shelby tube(80-80.5m)			
82													
83								57	0	Shelby tube(82.5-83m)			
84										Shelby tube(83-83.5m)			
85													
86										Shelby tube(85.5-86m)			
87										Shelby tube(86-86.5m)			
88													
89								100	0	Shelby tube(88.5-89m)			
90										Shelby tube(89-89.5m)			

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 10 OF: 13						
EQUIPMENT: CMV 1000			METHOD: Rotary			BOREHOLE DEPTH (m): 121m					
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014					
ENGINEER: K.S.			DRILLER: Nawraz			DATE FINISHED: 05/07/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
91					stiff olive green CLAY sometimes slightly sandy		87	0	0		
92											Shelby tube(91.5-92m)
93											Shelby tube(92-92.5m)
94							70	0	0		
95											Shelby tube(94.5-95m)
96											Shelby tube(95-95.5m)
97							93	0	0		
98											Shelby tube(97.5-98m)
99											Shelby tube(98-98.5m)
100							93	0	0		

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06					
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 11 OF: 13						
EQUIPMENT: CMV 1000			METHOD: Rotary			BOREHOLE DEPTH (m): 121m					
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68			DATE STARTED: 4/26/2014					
ENGINEER: K.S.			DRILLER: Nawraz			DATE FINISHED: 05/07/2014					
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
101					stiff olive green CLAY sometimes slightly sandy	93	0	0			Shelby tube (100.5-101m)
102											Shelby tube (101-101.5m)
103						87	0	0			Shelby tube (103.5-104m)
104											Shelby tube (104-104.5m)
105						40	8.7	0			
106						30	4.7	0			
107						57	10	0			
108						13	3.3	0			
109											
110											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001		BOREHOLE NO.: BHVR06							
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)													
LOCATION: BISRI			Elevation (m): 414.49		SHEET: 12 OF: 13								
EQUIPMENT: CMV 1000			METHOD: Rotary		BOREHOLE DEPTH (m): 121m								
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm): 63 to 68		DATE STARTED: 4/26/2014								
ENGINEER: K.S.			DRILLER: Nawraz		DATE FINISHED: 05/07/2014								
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL			% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
111			31,50/8cm Refusal					13	3.3	0			
112			22,31,29 N=60					0	0	0			
113			26,38,41 N=79					0	0	0			
114												Casing	
115			31,50/8cm Refusal					14	0	0			down to 114m
116			41,50/3cm Refusal										Flushing water loss
117			50/8cm Refusal										100% between
118								28	0	0			115.5-121m
119													
120								42	0	0			
								77	0	0			

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SATCON

SOIL STUDIES

BORING LOG

CLIENT: DAR-TALEB				FILE NO.: 14-001	BOREHOLE NO.: BHVR06						
PROJECT: BISRI DAM / SECOND PACKAGE (DAM FOOTPRINT)											
LOCATION: BISRI			Elevation (m):	414.49	SHEET: 12 OF: 13						
EQUIPMENT: CMV 1000			METHOD:	Rotary	BOREHOLE DEPTH (m): 121m						
HOLE DAM. (mm): 86 to 114			CORE DIAM. (mm):	63 to 68	DATE STARTED: 4/26/2014						
ENGINEER: K.S.			DRILLER:	Nawraz	DATE FINISHED: 05/07/2014						
DEPTH (m)	SYMBOL	ST	SPT N blows	LT	DESCRIPTION OF MATERIAL	% FINES	TCR (%)	SCR (%)	R.Q.D (%)	UCS N/mm ²	Remarks
121						13	3.3	0			
122											
123											
124											
125											
126											
127											
128											
129											
130											
End of borehole at 121m											

SPT Standard Penetration Test

TCR Total Core Recovery

ST Sample Type

UCS Unconfined Compressive Strength

RQD Rock Quality Designation

SYM Symbol

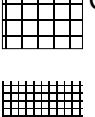
LT Layer Thickness

SCR Solid Core Recovery

WT Water Table

N Number of blows from SPT. Where full 0.3m has not been achieved, the number of blows for the quoted penetration is given

SOIL STUDIES

SOIL SYMBOL	ROCK SYMBOL	SAMPLERS	OTHERS
 GP	 Dolomite		 Water Level
 GP-GM	 Chalky Limestone		
 GM	 Calcarenite		
 GC	 Weak Chalky LIMESTONE		
 SW	 Sandy Limestone		
 SP	 Basalt / volcanics		
 SP - SM	 Chert		
 SM-SC	 CL		
 ML	 Creamy White LIMESTONE		
 CH-MH	 PT		
 OL	 Fill Material		
 OH	 MARL		
 PT	 SANDSTONE		
 CLAY	 CLAYSTONE		
 CLAYwith Sand and Gravel	 Oolitic LIMESTONE		
	 Micritic LIMESTONE		
	 Mudstone		
	 Gypsum		
	 Siltstone		

ROCK CLASSIFICATION

% RQD	Classification
<25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
>90	Excellent

GRANULAR SOILS

N-Value	Relative Density
< 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE SOIL

N-Value	Consistency
< 2	Very Soft
2 - 4	Soft
4 - 8	Medium Stiff
8 - 15	Stiff
15 - 30	Very stiff
> 30	Hard

APPENDIX 3. PHOTOS OF CORE BOXES



DAR AL-HANDASAH NAZIH TALEB & PARTNERS
دارالهندسة نزيح طالب وشريك

Founded 1956























APPENDIX 4. BOREHOLE WATER PERMEABILITY TEST RESULTS



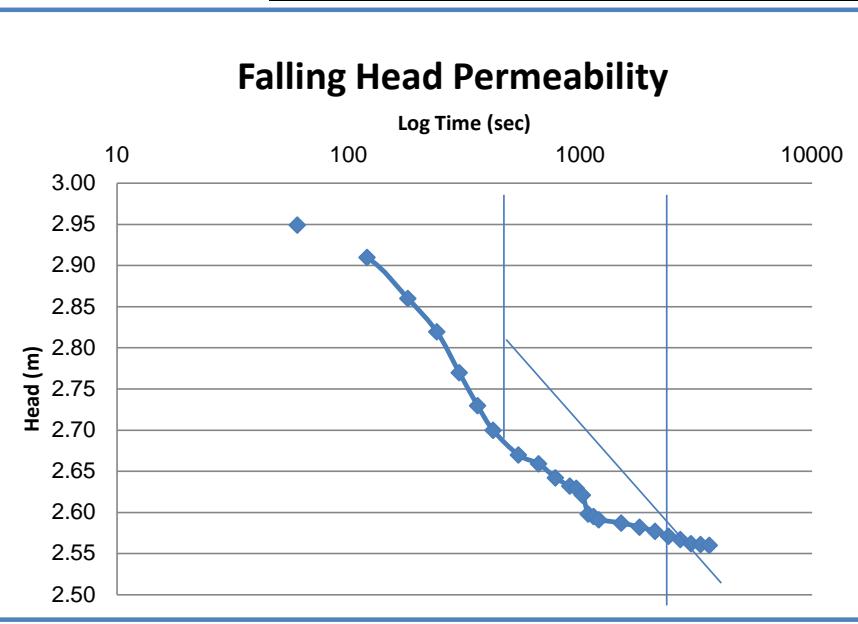
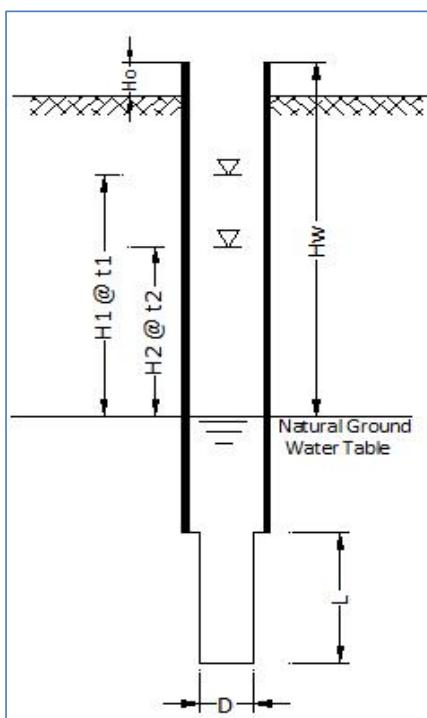
DAR AL-HANDASAH NAZIH TALEB & PARTNERS
دارالهندسة نزيح طالب وشريك

Founded 1956

BISRI Dam Project: Geo. Inv. Report VII: (Factual) / Dam-Footprint - September 2014

PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/26/2014		
Test Location	0 to 3	Y		K(m/sec):	1.8328E-08		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	3.00
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.05	60	2.95
WATER LEVEL BEFORE TEST	W.L.	dry	mAD	2	0.09	120	2.91
HEIGHT OF CASING ABOVE NGL	Ho		m	3	0.14	180	2.86
CASING TOP LEVEL		0	mAD	4	0.18	240	2.82
CASING LENGTH			m	5	0.23	300	2.77
CASING BOTTOM LEVEL		0	mAD	6	0.27	360	2.73
BOREHOLE DEPTH		3	m	7	0.30	420	2.70
BOREHOLE BOTTOM LEVEL		-3	mAD	9	0.33	540	2.67
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	0.34	660	2.66
WATER HEAD	Hw	3	m	13	0.36	780	2.64
				15	0.37	900	2.63
				16	0.37	960	2.63
				17	0.38	1020	2.62
				18	0.40	1080	2.60
				19	0.41	1140	2.60
				20	0.41	1200	2.59
				25	0.41	1500	2.59
				30	0.42	1800	2.58
				35	0.42	2100	2.58
				40	0.43	2400	2.57
				45	0.43	2700	2.57
				50	0.44	3000	2.56
				55	0.44	3300	2.56
				60	0.40	3600	2.56

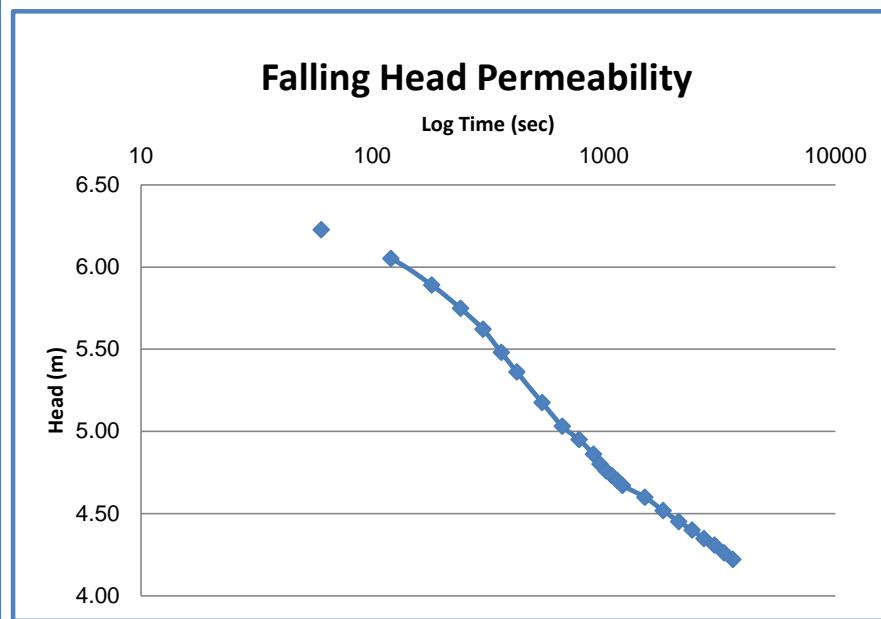
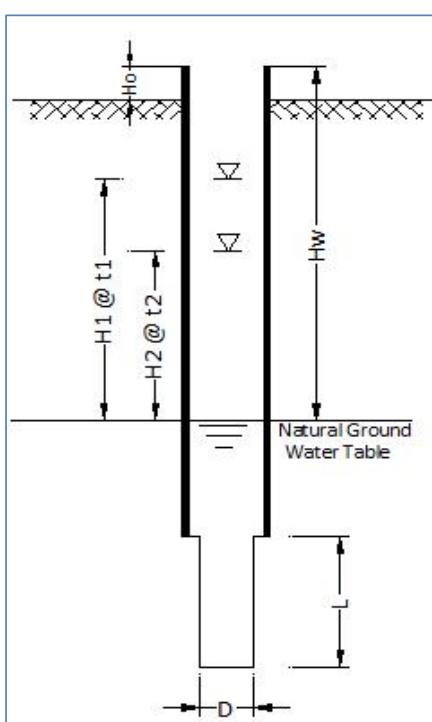
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/26/2014		
Test Location	3 to 6	Y		K(m/sec):	1.1326E-07		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	6.40
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.17	60	6.23
WATER LEVEL BEFORE TEST	W.L	-3	mAD	2	0.35	120	6.05
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.51	180	5.89
CASING TOP LEVEL		0.4	mAD	4	0.65	240	5.75
CASING LENGTH		3.4	m	5	0.78	300	5.62
CASING BOTTOM LEVEL		-3	mAD	6	0.92	360	5.48
BOREHOLE DEPTH		6	m	7	1.04	420	5.36
BOREHOLE BOTTOM LEVEL		-6	mAD	9	1.22	540	5.18
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	1.37	660	5.03
WATER HEAD	Hw	6.4	m	13	1.45	780	4.95

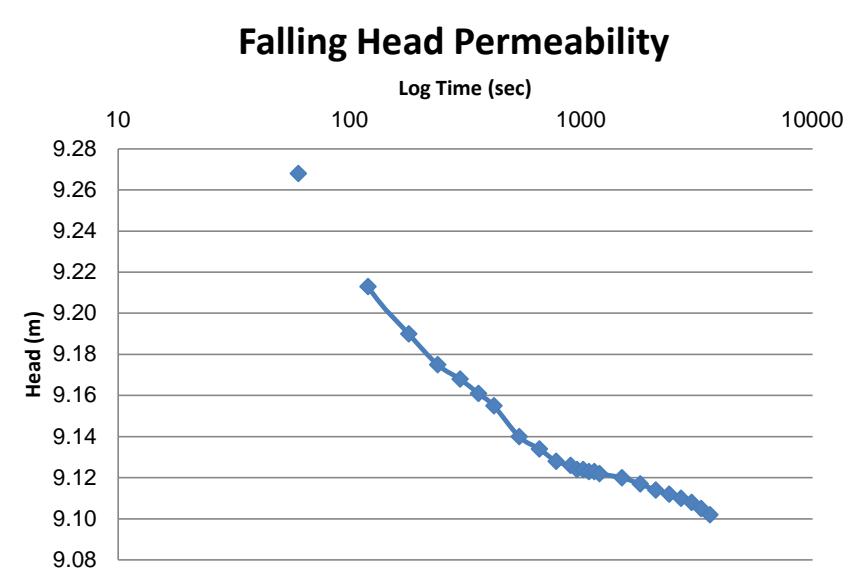
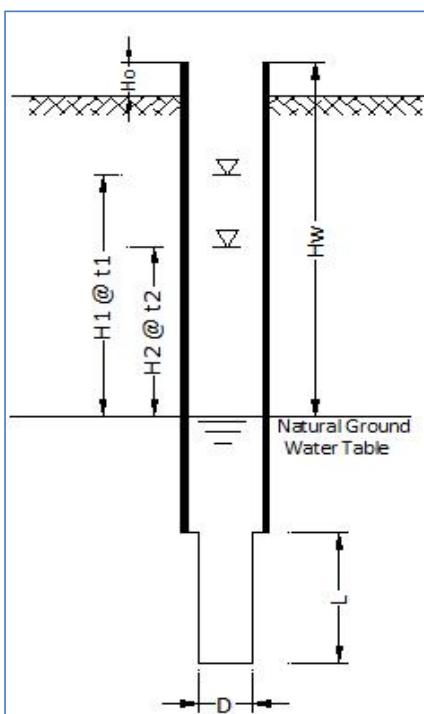
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

15	1.54	900	4.86
16	1.60	960	4.80
17	1.64	1020	4.76
18	1.67	1080	4.73
19	1.70	1140	4.70
20	1.73	1200	4.67
25	1.80	1500	4.60
30	1.88	1800	4.52
35	1.95	2100	4.45
40	2.00	2400	4.40
45	2.05	2700	4.35
50	2.09	3000	4.31
55	2.14	3300	4.26
60	2.18	3600	4.22



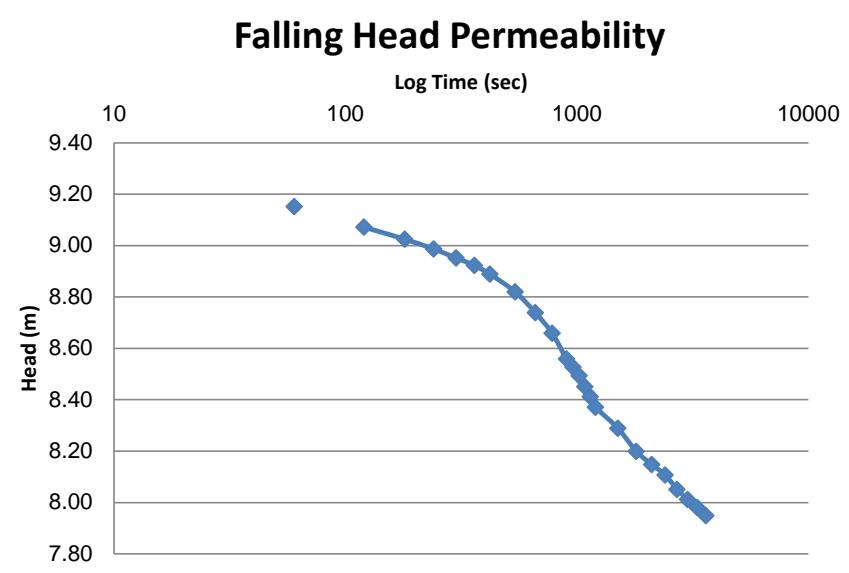
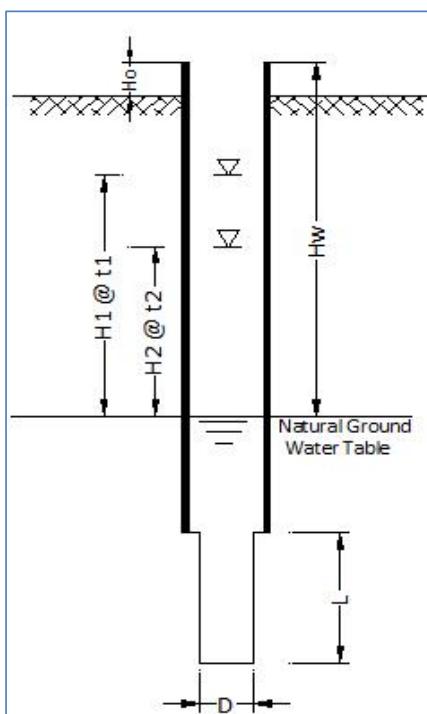
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT							
Borehole	BHVR 06	X		Date:	4/26/2014		
Test Location	6 to 9	Y		K(m/sec):	1.1072E-09		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.40
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.13	60	9.27
WATER LEVEL BEFORE TEST	W.L	-7.5	mAD	2	0.19	120	9.21
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.21	180	9.19
CASING TOP LEVEL		0.4	mAD	4	0.23	240	9.18
CASING LENGTH		6.4	m	5	0.23	300	9.17
CASING BOTTOM LEVEL		-6	mAD	6	0.24	360	9.16
BOREHOLE DEPTH		9	m	7	0.25	420	9.16
BOREHOLE BOTTOM LEVEL		-9	mAD	9	0.26	540	9.14
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	0.27	660	9.13
WATER HEAD	Hw	9.4	m	13	0.27	780	9.13
				15	0.27	900	9.13
				16	0.28	960	9.12
				17	0.28	1020	9.12
				18	0.28	1080	9.12
				19	0.28	1140	9.12
				20	0.28	1200	9.12
				25	0.28	1500	9.12
				30	0.28	1800	9.12
				35	0.29	2100	9.11
				40	0.29	2400	9.11
				45	0.29	2700	9.11
				50	0.29	3000	9.11
				55	0.30	3300	9.11
				60	0.30	3600	9.10

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/26/2014		
Test Location	9 to 12	Y		K(m/sec):	2.3592E-08		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.10	60
WATER LEVEL BEFORE TEST		W.L.	-9.3	mAD	2	0.18	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	0.23	180
CASING TOP LEVEL			0.4	mAD	4	0.26	240
CASING LENGTH			9.4	m	5	0.30	300
CASING BOTTOM LEVEL			-9	mAD	6	0.33	360
BOREHOLE DEPTH			12	m	7	0.36	420
BOREHOLE BOTTOM LEVEL			-12	mAD	9	0.43	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3	m	11	0.51	660
WATER HEAD		Hw	9.25	m	13	0.59	780
					15	0.69	900
					16	0.72	960
					17	0.76	1020
					18	0.80	1080
					19	0.84	1140
					20	0.88	1200
					25	0.96	1500
					30	1.05	1800
					35	1.10	2100
					40	1.14	2400
					45	1.20	2700
					50	1.24	3000
					55	1.27	3300
					60	1.30	3600
							7.95

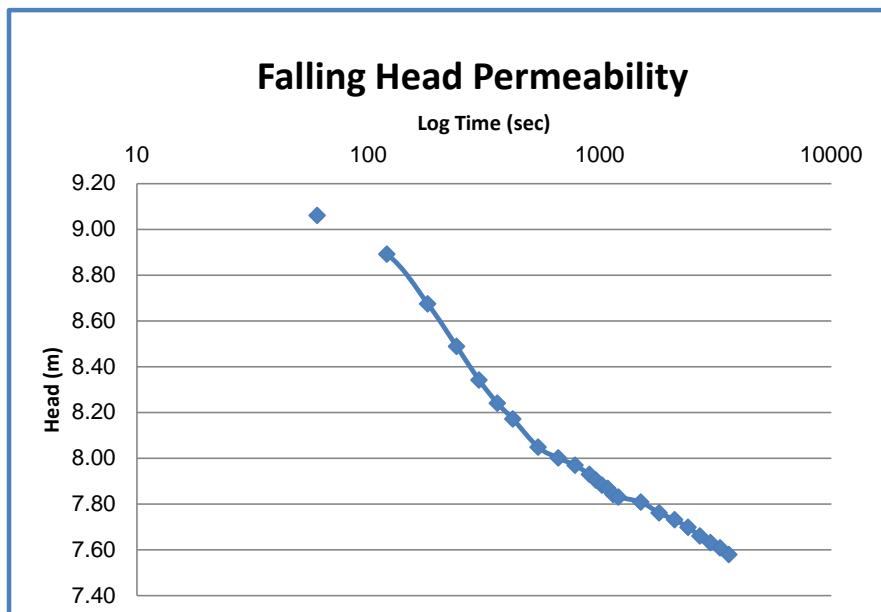
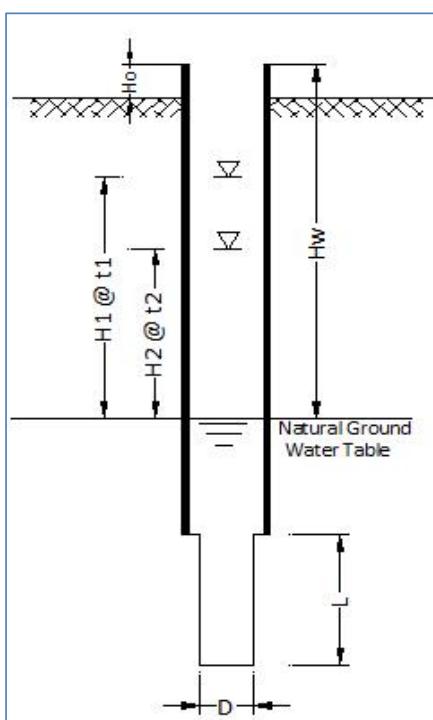
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/28/2014		
Test Location	12 to 15	Y		K(m/sec):	1.1915E-07		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.19	60	9.06
WATER LEVEL BEFORE TEST	W.L	-12	mAD	2	0.36	120	8.89
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.58	180	8.68
CASING TOP LEVEL		0.4	mAD	4	0.76	240	8.49
CASING LENGTH		12.4	m	5	0.91	300	8.34
CASING BOTTOM LEVEL		-12	mAD	6	1.01	360	8.24
BOREHOLE DEPTH		15	m	7	1.08	420	8.17
BOREHOLE BOTTOM LEVEL		-15	mAD	9	1.20	540	8.05
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	1.25	660	8.00
WATER HEAD	Hw	9.25	m	13	1.28	780	7.97

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

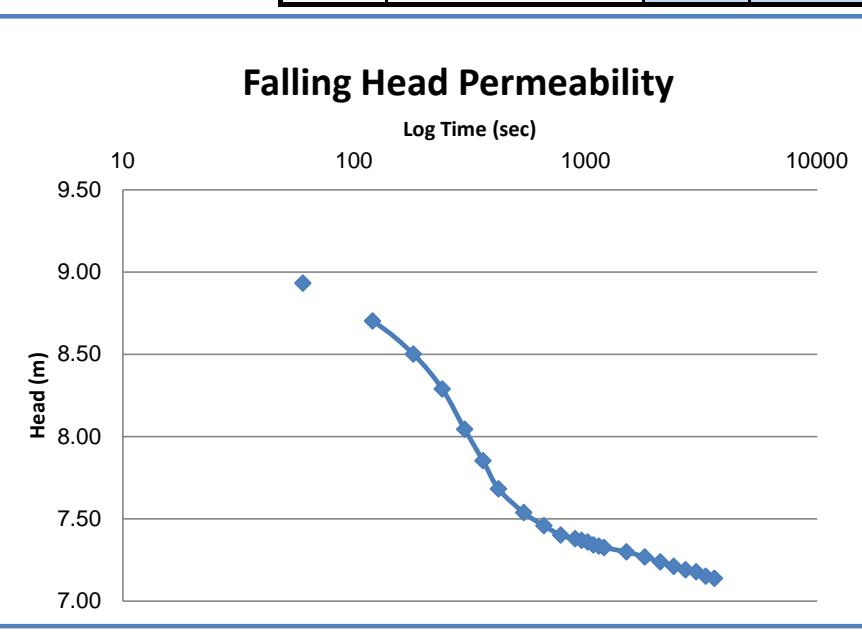
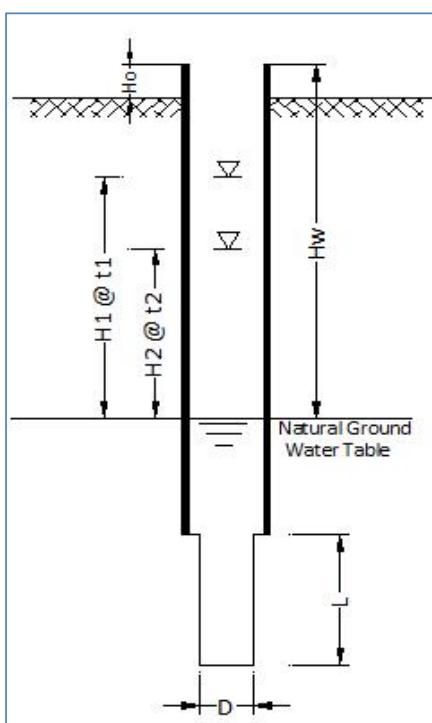
15	1.32	900	7.93
16	1.35	960	7.91
17	1.37	1020	7.88
18	1.38	1080	7.87
19	1.41	1140	7.84
20	1.42	1200	7.83
25	1.44	1500	7.81
30	1.49	1800	7.76
35	1.52	2100	7.73
40	1.55	2400	7.70
45	1.59	2700	7.66
50	1.62	3000	7.63
55	1.64	3300	7.61
60	1.67	3600	7.58



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/28/2014		
Test Location	15 to 18	Y		K(m/sec):	1.8766E-07		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.32	60	8.93
WATER LEVEL BEFORE TEST	W.L	-15	mAD	2	0.55	120	8.70
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.75	180	8.50
CASING TOP LEVEL		0.4	mAD	4	0.96	240	8.29
CASING LENGTH		15.4	m	5	1.21	300	8.05
CASING BOTTOM LEVEL		-15	mAD	6	1.40	360	7.85
BOREHOLE DEPTH		18	m	7	1.57	420	7.68
BOREHOLE BOTTOM LEVEL		-18	mAD	9	1.71	540	7.54
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	1.79	660	7.46
WATER HEAD	Hw	9.25	m	13	1.85	780	7.40

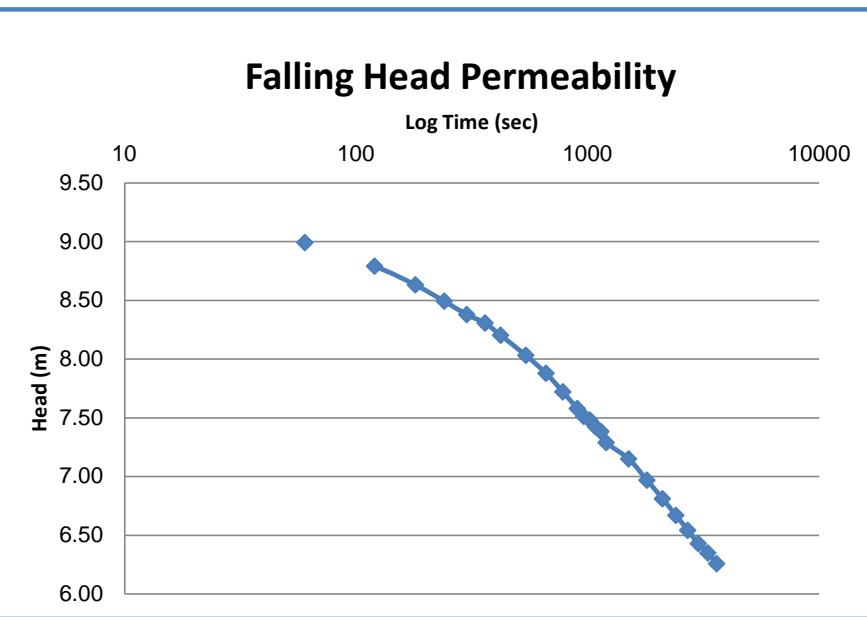
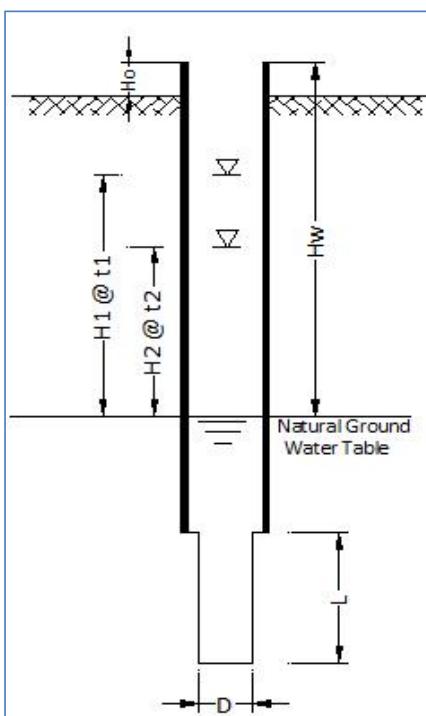
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

15	1.87	900	7.38
16	1.88	960	7.37
17	1.89	1020	7.36
18	1.91	1080	7.34
19	1.92	1140	7.34
20	1.92	1200	7.33
25	1.95	1500	7.30
30	1.98	1800	7.27
35	2.01	2100	7.24
40	2.04	2400	7.21
45	2.06	2700	7.19
50	2.07	3000	7.18
55	2.10	3300	7.15
60	2.11	3600	7.14



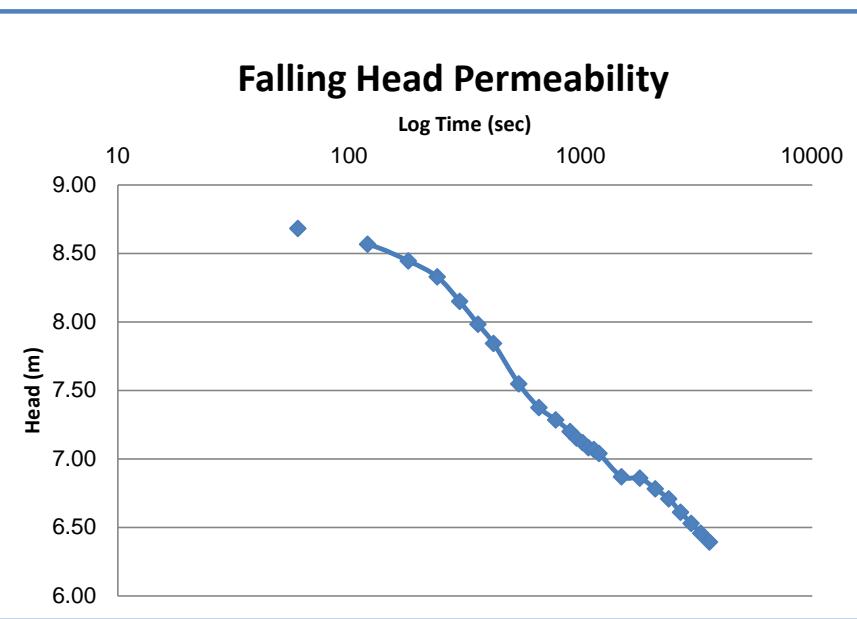
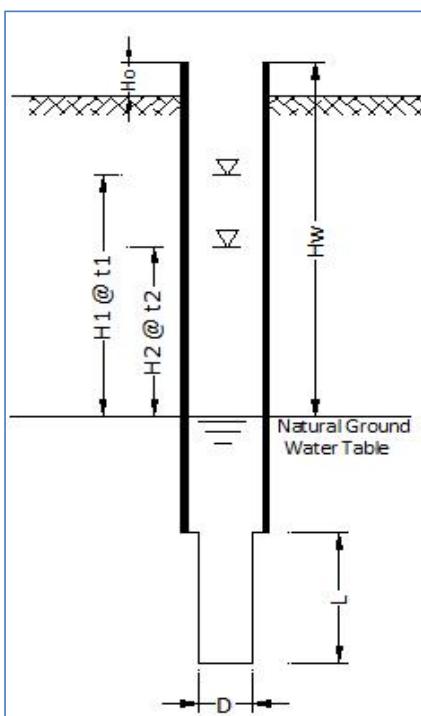
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/28/2014		
Test Location	18 to 21	Y		K(m/sec):	1.6559E-07		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.26	60
WATER LEVEL BEFORE TEST		W.L.	-16	mAD	2	0.46	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	0.62	180
CASING TOP LEVEL			0.4	mAD	4	0.76	240
CASING LENGTH			18.4	m	5	0.87	300
CASING BOTTOM LEVEL			-18	mAD	6	0.94	360
BOREHOLE DEPTH			21	m	7	1.05	420
BOREHOLE BOTTOM LEVEL			-21	mAD	9	1.22	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3	m	11	1.37	660
WATER HEAD		Hw	9.25	m	13	1.53	780
					15	1.67	900
					16	1.74	960
					17	1.77	1020
					18	1.83	1080
					19	1.87	1140
					20	1.96	1200
					25	2.10	1500
					30	2.28	1800
					35	2.44	2100
					40	2.58	2400
					45	2.71	2700
					50	2.82	3000
					55	2.90	3300
					60	2.99	3600
							6.26

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/28/2014		
Test Location	21 to 24	Y		K(m/sec):	2.3204E-07		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.57	60
WATER LEVEL BEFORE TEST		W.L	-20.3	mAD	2	0.68	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	0.81	180
CASING TOP LEVEL			0.4	mAD	4	0.92	240
CASING LENGTH			21.4	m	5	1.10	300
CASING BOTTOM LEVEL			-21	mAD	6	1.27	360
BOREHOLE DEPTH			24	m	7	1.41	420
BOREHOLE BOTTOM LEVEL			-24	mAD	9	1.70	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3	m	11	1.88	660
WATER HEAD		Hw	9.25	m	13	1.97	780
					15	2.05	900
					16	2.10	960
					17	2.13	1020
					18	2.17	1080
					19	2.18	1140
					20	2.21	1200
					25	2.38	1500
					30	2.39	1800
					35	2.47	2100
					40	2.54	2400
					45	2.64	2700
					50	2.72	3000
					55	2.79	3300
					60	2.86	3600
							6.39

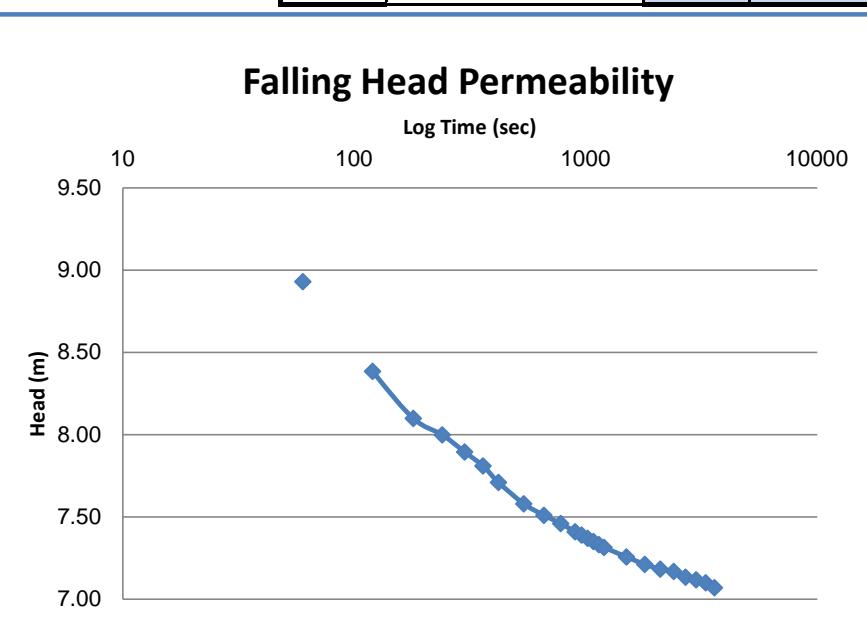
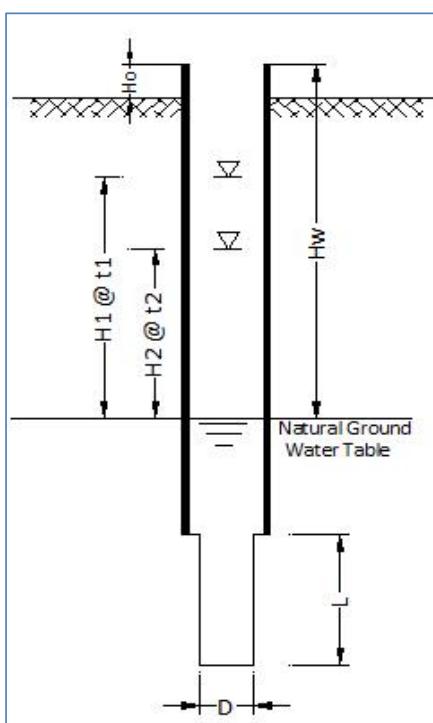
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/29/2014		
Test Location	24 to 27	Y		K(m/sec):	1.4554E-07		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.32	60	8.93
WATER LEVEL BEFORE TEST	W.L	-18	mAD	2	0.87	120	8.39
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	1.15	180	8.10
CASING TOP LEVEL		0.4	mAD	4	1.25	240	8.00
CASING LENGTH		24.4	m	5	1.36	300	7.90
CASING BOTTOM LEVEL		-24	mAD	6	1.44	360	7.81
BOREHOLE DEPTH		27	m	7	1.54	420	7.71
BOREHOLE BOTTOM LEVEL		-27	mAD	9	1.67	540	7.58
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	1.74	660	7.51
WATER HEAD	Hw	9.25	m	13	1.79	780	7.46

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

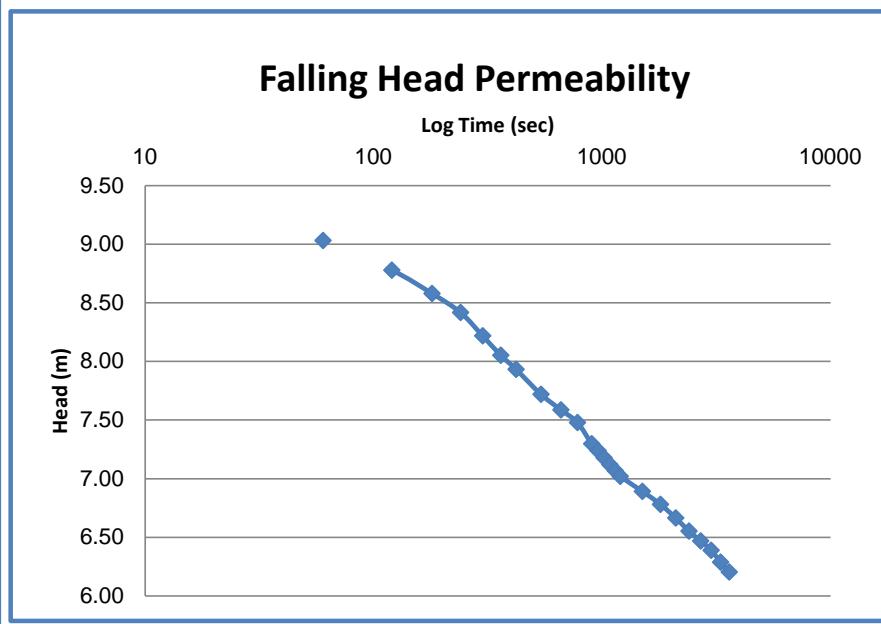
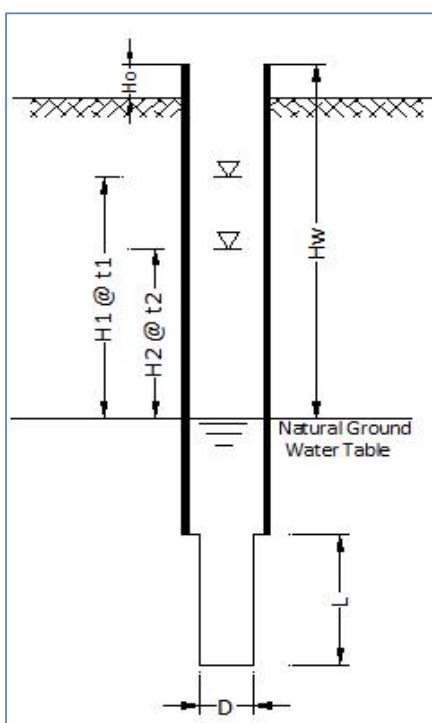
15	1.84	900	7.41
16	1.86	960	7.39
17	1.88	1020	7.37
18	1.90	1080	7.35
19	1.92	1140	7.33
20	1.94	1200	7.32
25	1.99	1500	7.26
30	2.04	1800	7.21
35	2.07	2100	7.18
40	2.08	2400	7.17
45	2.12	2700	7.13
50	2.13	3000	7.12
55	2.15	3300	7.10
60	2.18	3600	7.07



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/29/2014		
Test Location	27 to 30	Y		K(m/sec):	1.0378E-07		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.22	60	9.03
WATER LEVEL BEFORE TEST	W.L	-25	mAD	2	0.47	120	8.78
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.67	180	8.58
CASING TOP LEVEL		0.4	mAD	4	0.83	240	8.42
CASING LENGTH		27.4	m	5	1.03	300	8.22
CASING BOTTOM LEVEL		-27	mAD	6	1.20	360	8.05
BOREHOLE DEPTH		30	m	7	1.32	420	7.93
BOREHOLE BOTTOM LEVEL		-30	mAD	9	1.53	540	7.72
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	1.66	660	7.59
WATER HEAD	Hw	9.25	m	13	1.77	780	7.48

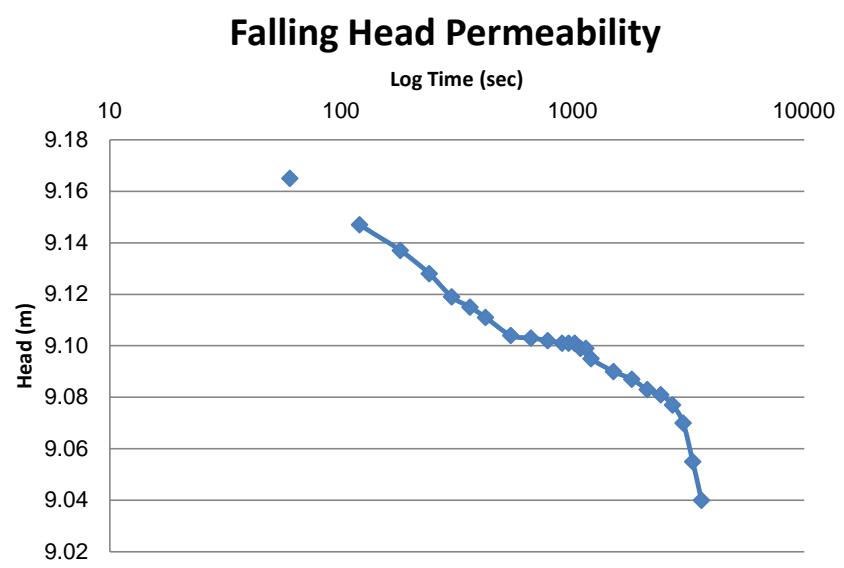
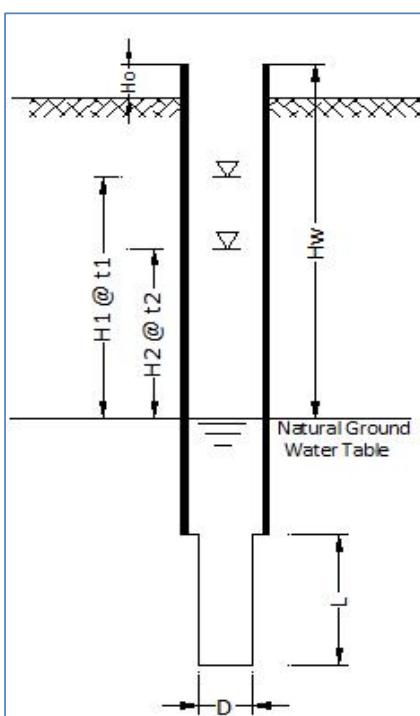
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

15	1.95	900	7.30
16	2.01	960	7.24
17	2.07	1020	7.18
18	2.13	1080	7.12
19	2.18	1140	7.07
20	2.23	1200	7.02
25	2.36	1500	6.89
30	2.47	1800	6.78
35	2.59	2100	6.67
40	2.70	2400	6.55
45	2.78	2700	6.47
50	2.86	3000	6.39
55	2.96	3300	6.29
60	3.05	3600	6.20



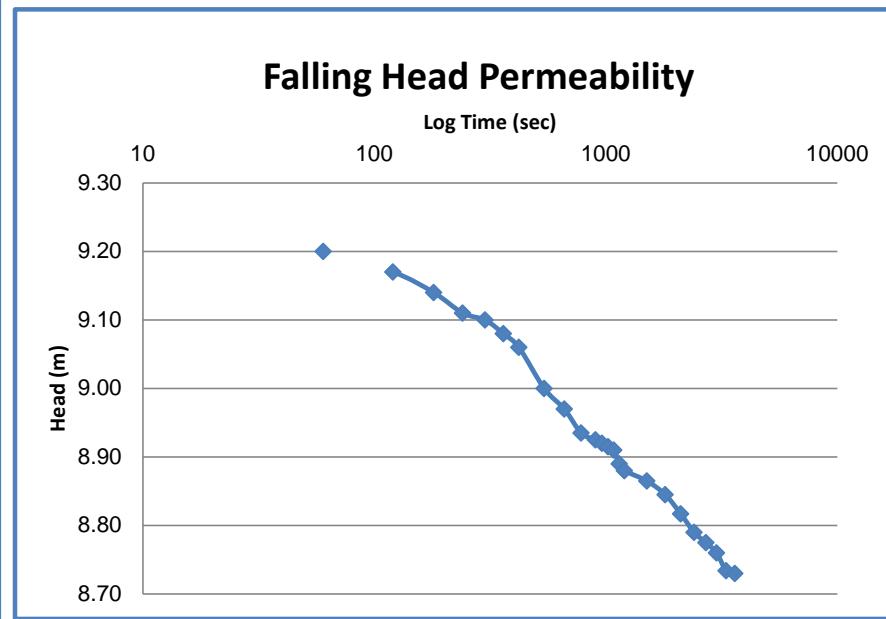
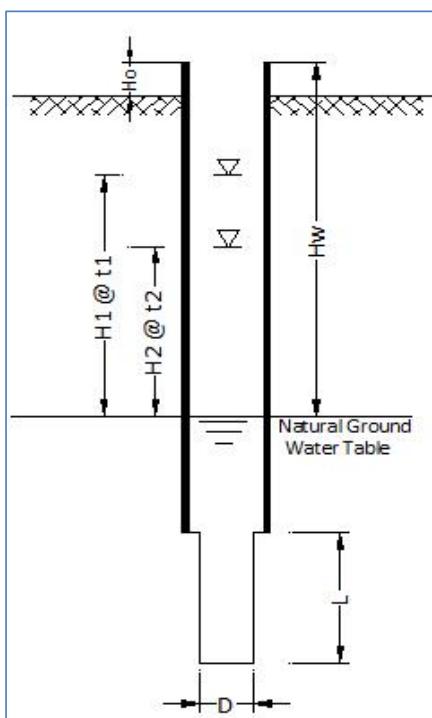
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	4/29/2014		
Test Location	30 to 33	Y		K(m/sec):	1.5052E-09		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.09	60	9.17
WATER LEVEL BEFORE TEST	W.L	-18	mAD	2	0.10	120	9.15
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.11	180	9.14
CASING TOP LEVEL		0.4	mAD	4	0.12	240	9.13
CASING LENGTH		30.4	m	5	0.13	300	9.12
CASING BOTTOM LEVEL		-30	mAD	6	0.14	360	9.12
BOREHOLE DEPTH		33	m	7	0.14	420	9.11
BOREHOLE BOTTOM LEVEL		-33	mAD	9	0.15	540	9.10
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	0.15	660	9.10
WATER HEAD	Hw	9.25	m	13	0.15	780	9.10
				15	0.15	900	9.10
				16	0.15	960	9.10
				17	0.15	1020	9.10
				18	0.15	1080	9.10
				19	0.15	1140	9.10
				20	0.16	1200	9.10
				25	0.16	1500	9.09
				30	0.16	1800	9.09
				35	0.17	2100	9.08
				40	0.17	2400	9.08
				45	0.17	2700	9.08
				50	0.18	3000	9.07
				55	0.20	3300	9.06
				60	0.21	3600	9.04

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



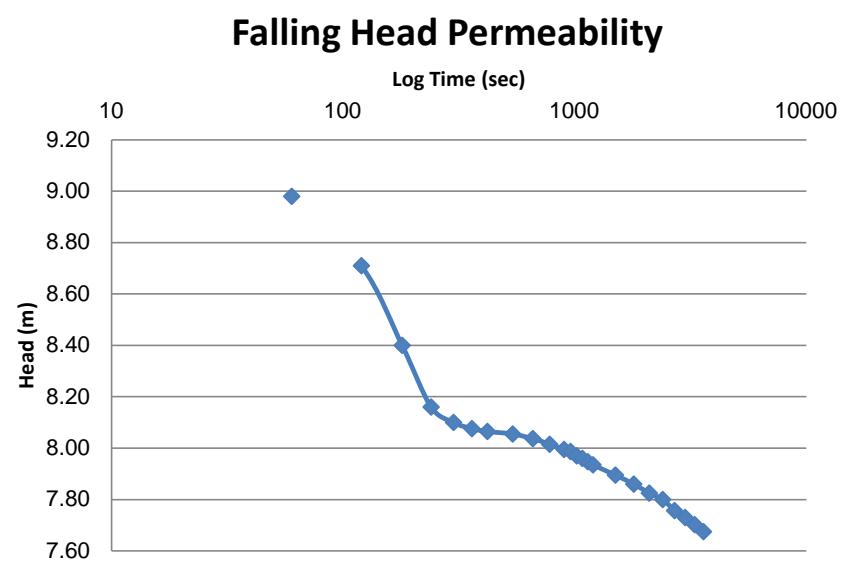
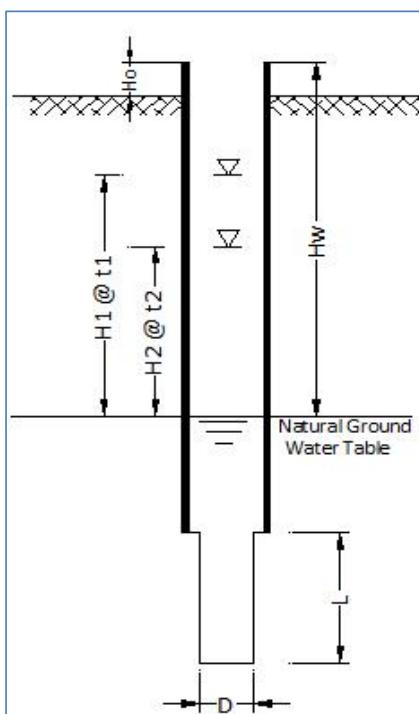
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	5/14/2014		
Test Location	33 to 36	Y		K(m/sec):	1.2066E-08		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.05	60
WATER LEVEL BEFORE TEST		W.L	-13.2	mAD	2	0.08	120
HEIGHT OF CASING ABOVE NGL		Ho	0	m	3	0.11	180
CASING TOP LEVEL			0	mAD	4	0.14	240
CASING LENGTH			33.4	m	5	0.15	300
CASING BOTTOM LEVEL			-33.4	mAD	6	0.17	360
BOREHOLE DEPTH			36	m	7	0.19	420
BOREHOLE BOTTOM LEVEL			-36	mAD	9	0.25	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	2.6	m	11	0.28	660
WATER HEAD		Hw	9.25	m	13	0.32	780
					15	0.33	900
					16	0.33	960
					17	0.34	1020
					18	0.34	1080
					19	0.36	1140
					20	0.37	1200
					25	0.39	1500
					30	0.41	1800
					35	0.43	2100
					40	0.46	2400
					45	0.48	2700
					50	0.49	3000
					55	0.52	3300
					60	0.52	3600
							8.73

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



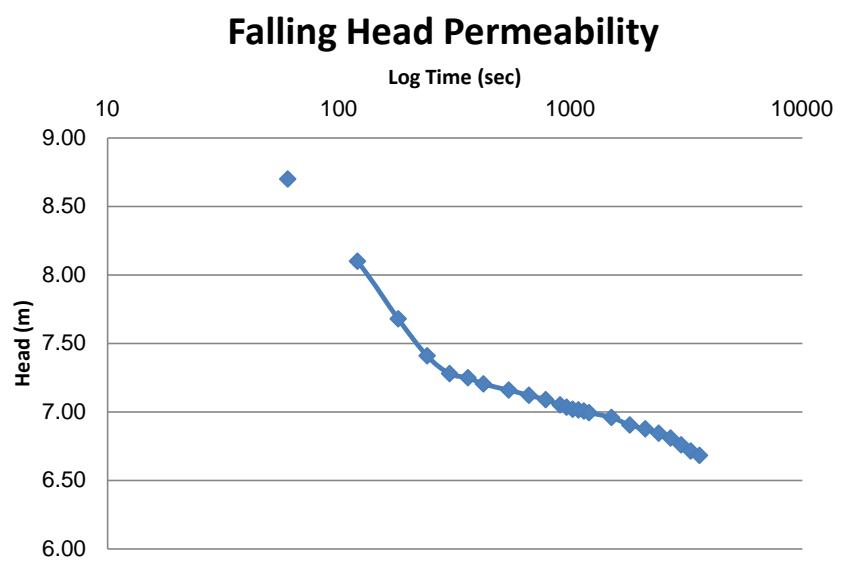
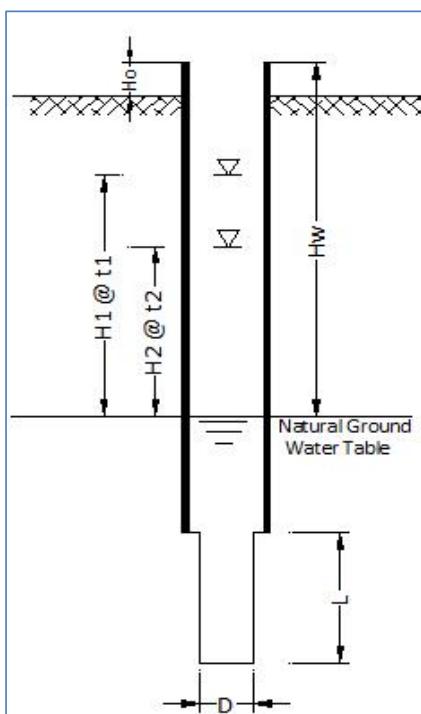
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	5/14/2014		
Test Location	36 to 39	Y		K(m/sec):	1.6244E-08		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.27	60
WATER LEVEL BEFORE TEST		W.L	-10.7	mAD	2	0.54	120
HEIGHT OF CASING ABOVE NGL		Ho	0.55	m	3	0.85	180
CASING TOP LEVEL			0.55	mAD	4	1.09	240
CASING LENGTH			36.4	m	5	1.15	300
CASING BOTTOM LEVEL			-35.85	mAD	6	1.17	360
BOREHOLE DEPTH			39	m	7	1.19	420
BOREHOLE BOTTOM LEVEL			-39	mAD	9	1.20	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3.15	m	11	1.21	660
WATER HEAD		Hw	9.25	m	13	1.24	780
					15	1.26	900
					16	1.26	960
					17	1.28	1020
					18	1.29	1080
					19	1.30	1140
					20	1.32	1200
					25	1.36	1500
					30	1.39	1800
					35	1.43	2100
					40	1.45	2400
					45	1.49	2700
					50	1.52	3000
					55	1.55	3300
					60	1.58	3600
							7.68

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



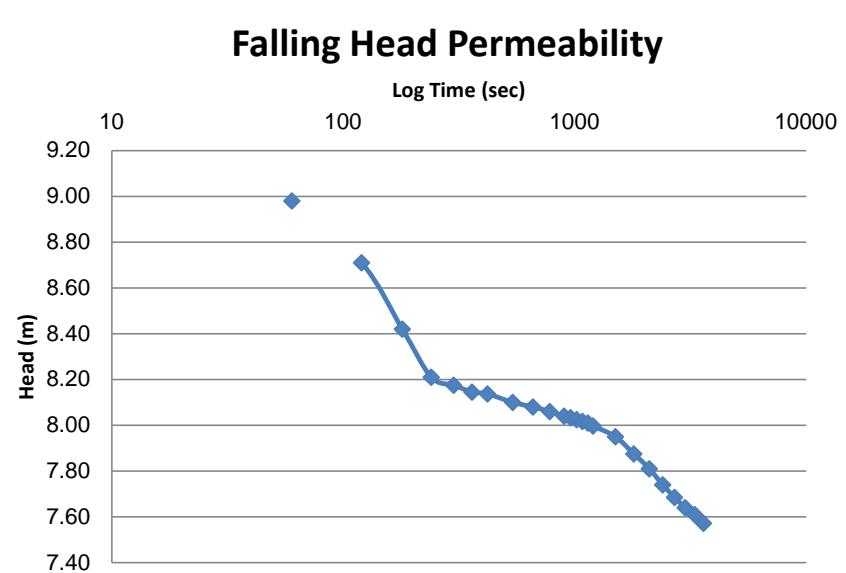
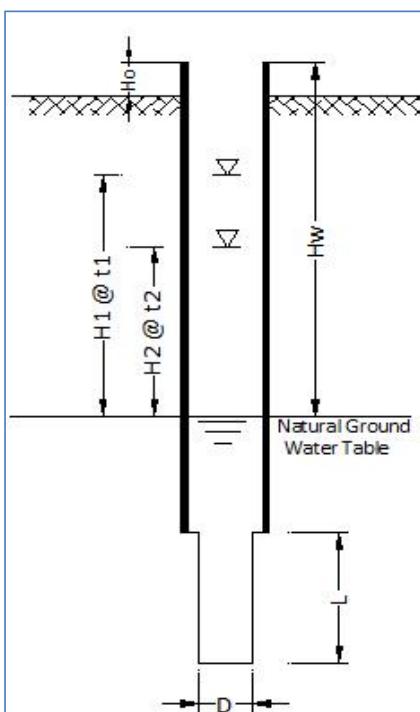
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	5/14/2014		
Test Location	39 to 42	Y		K(m/sec):	2.8382E-08		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.55	60
WATER LEVEL BEFORE TEST		W.L	-13.15	mAD	2	1.15	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	1.57	180
CASING TOP LEVEL			0.4	mAD	4	1.84	240
CASING LENGTH			39.4	m	5	1.97	300
CASING BOTTOM LEVEL			-39	mAD	6	2.00	360
BOREHOLE DEPTH			42	m	7	2.05	420
BOREHOLE BOTTOM LEVEL			-42	mAD	9	2.09	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3	m	11	2.13	660
WATER HEAD		Hw	9.25	m	13	2.16	780
					15	2.20	900
					16	2.22	960
					17	2.23	1020
					18	2.24	1080
					19	2.24	1140
					20	2.26	1200
					25	2.29	1500
					30	2.35	1800
					35	2.37	2100
					40	2.41	2400
					45	2.44	2700
					50	2.49	3000
					55	2.54	3300
					60	2.57	3600
							6.68

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



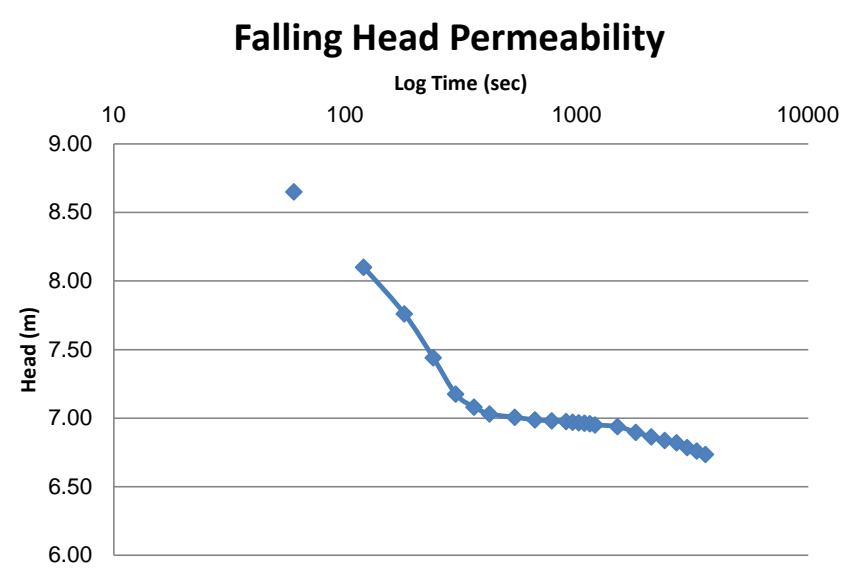
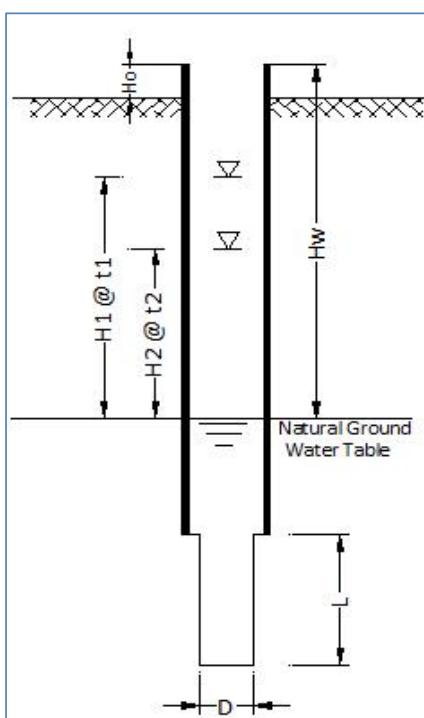
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	5/15/2014		
Test Location	42 to 45	Y		K(m/sec):	2.5392E-08		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.27	60	8.98
WATER LEVEL BEFORE TEST	W.L	-11.3	mAD	2	0.54	120	8.71
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.83	180	8.42
CASING TOP LEVEL		0.4	mAD	4	1.04	240	8.21
CASING LENGTH		42.4	m	5	1.08	300	8.18
CASING BOTTOM LEVEL		-42	mAD	6	1.11	360	8.15
BOREHOLE DEPTH		45	m	7	1.11	420	8.14
BOREHOLE BOTTOM LEVEL		-45	mAD	9	1.15	540	8.10
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	1.17	660	8.08
WATER HEAD	Hw	9.25	m	13	1.19	780	8.06
				15	1.21	900	8.04
				16	1.22	960	8.03
				17	1.23	1020	8.03
				18	1.23	1080	8.02
				19	1.24	1140	8.01
				20	1.25	1200	8.00
				25	1.30	1500	7.95
				30	1.38	1800	7.88
				35	1.44	2100	7.81
				40	1.51	2400	7.74
				45	1.57	2700	7.69
				50	1.61	3000	7.64
				55	1.64	3300	7.61
				60	1.68	3600	7.57

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	5/15/2014		
Test Location	45 to 48	Y		K(m/sec):	1.5479E-08		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.60	60	8.65
WATER LEVEL BEFORE TEST	W.L	-12.55	mAD	2	1.15	120	8.10
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	1.49	180	7.76
CASING TOP LEVEL		0.4	mAD	4	1.81	240	7.44
CASING LENGTH		45.4	m	5	2.08	300	7.18
CASING BOTTOM LEVEL		-45	mAD	6	2.17	360	7.08
BOREHOLE DEPTH		48	m	7	2.22	420	7.03
BOREHOLE BOTTOM LEVEL		-48	mAD	9	2.24	540	7.01
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3	m	11	2.26	660	6.99
WATER HEAD	Hw	9.25	m	13	2.27	780	6.98
				15	2.28	900	6.98
				16	2.28	960	6.97
				17	2.28	1020	6.97
				18	2.29	1080	6.96
				19	2.29	1140	6.96
				20	2.30	1200	6.95
				25	2.31	1500	6.94
				30	2.35	1800	6.90
				35	2.39	2100	6.86
				40	2.41	2400	6.84
				45	2.43	2700	6.82
				50	2.47	3000	6.79
				55	2.49	3300	6.76
				60	2.52	3600	6.74

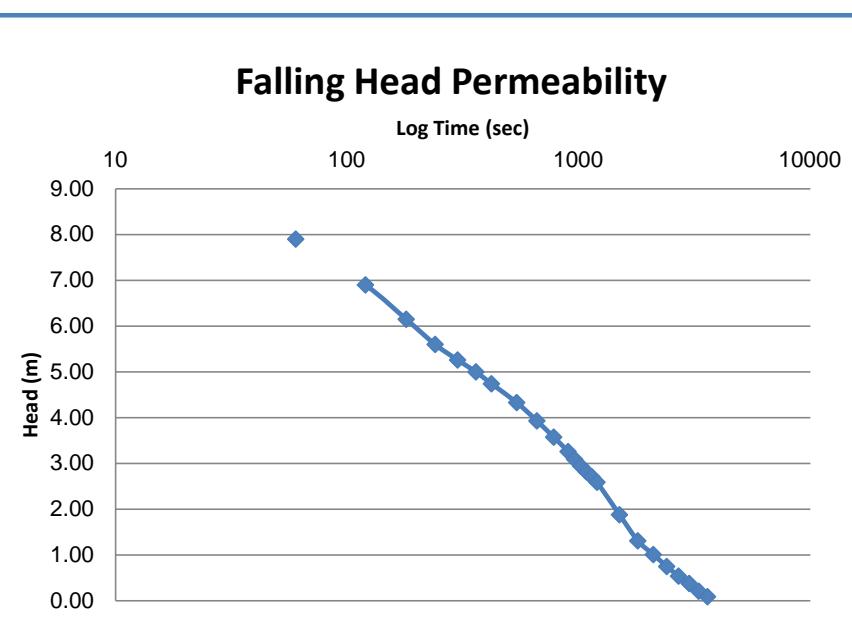
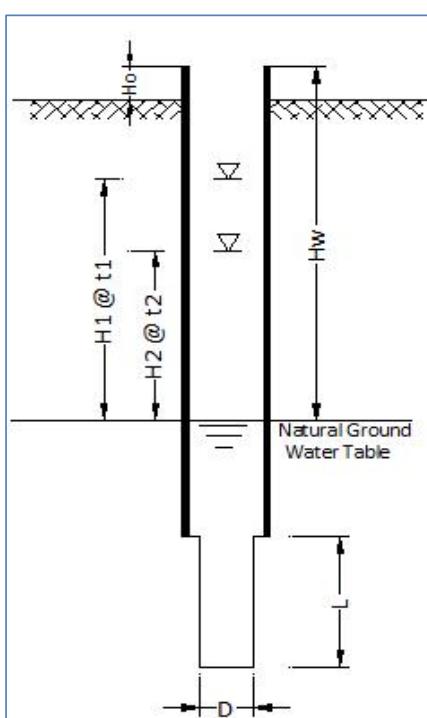
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/4/2014		
Test Location	54 to 56.5	Y		K(m/sec):	1.5539E-06		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	1.35	60	7.90
WATER LEVEL BEFORE TEST	W.L	-11.5	mAD	2	2.35	120	6.90
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	3.10	180	6.15
CASING TOP LEVEL		0.4	mAD	4	3.65	240	5.60
CASING LENGTH		54.4	m	5	3.99	300	5.26
CASING BOTTOM LEVEL		-54	mAD	6	4.25	360	5.00
BOREHOLE DEPTH		56.5	m	7	4.51	420	4.74
BOREHOLE BOTTOM LEVEL		-56.5	mAD	9	4.92	540	4.33
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	2.5	m	11	5.32	660	3.93
WATER HEAD	Hw	9.25	m	13	5.68	780	3.58

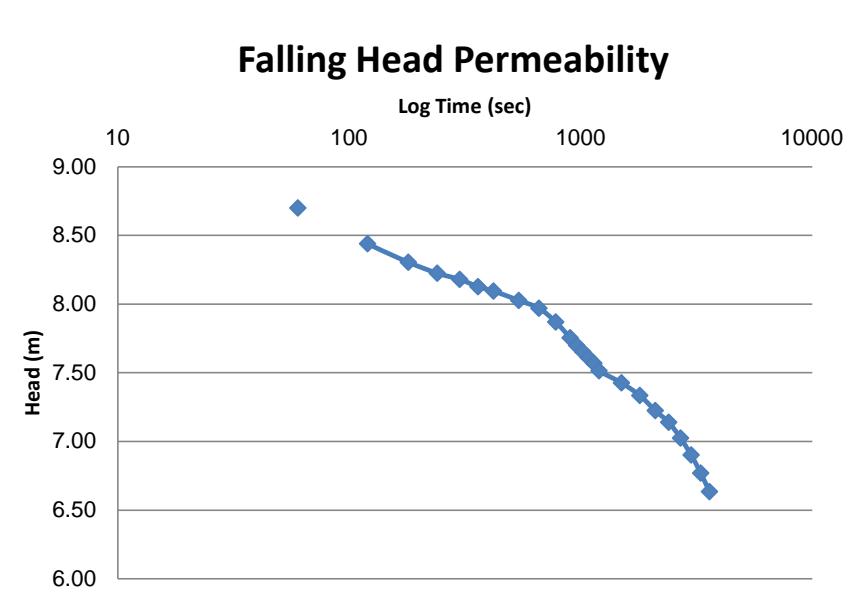
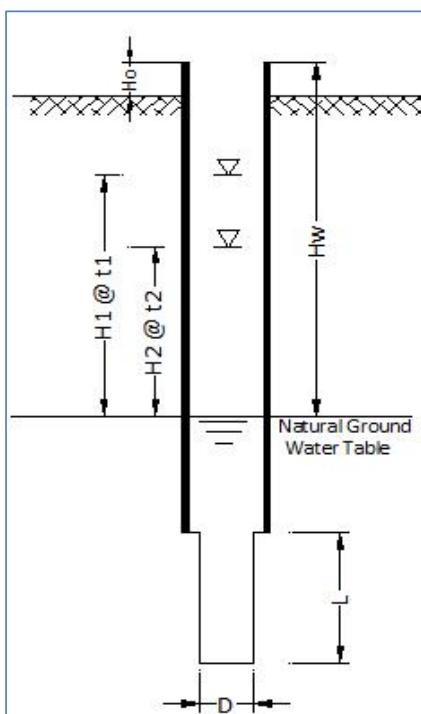
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

15	5.99	900	3.26
16	6.16	960	3.09
17	6.31	1020	2.95
18	6.43	1080	2.82
19	6.54	1140	2.71
20	6.66	1200	2.59
25	7.37	1500	1.88
30	7.94	1800	1.31
35	8.24	2100	1.01
40	8.50	2400	0.75
45	8.71	2700	0.54
50	8.87	3000	0.38
55	9.04	3300	0.21
60	9.16	3600	0.09



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/4/2014		
Test Location	56.5 to 59.5	Y		K(m/sec):	6.0080E-08		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.55	60
WATER LEVEL BEFORE TEST		W.L	-13.1	mAD	2	0.81	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	0.95	180
CASING TOP LEVEL			0.4	mAD	4	1.03	240
CASING LENGTH			56.9	m	5	1.07	300
CASING BOTTOM LEVEL			-56.5	mAD	6	1.12	360
BOREHOLE DEPTH			59.5	m	7	1.16	420
BOREHOLE BOTTOM LEVEL			-59.5	mAD	9	1.22	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3	m	11	1.28	660
WATER HEAD		Hw	9.25	m	13	1.38	780
					15	1.50	900
					16	1.55	960
					17	1.60	1020
					18	1.64	1080
					19	1.68	1140
					20	1.74	1200
					25	1.82	1500
					30	1.92	1800
					35	2.03	2100
					40	2.11	2400
					45	2.23	2700
					50	2.35	3000
					55	2.48	3300
					60	2.62	3600
							6.64

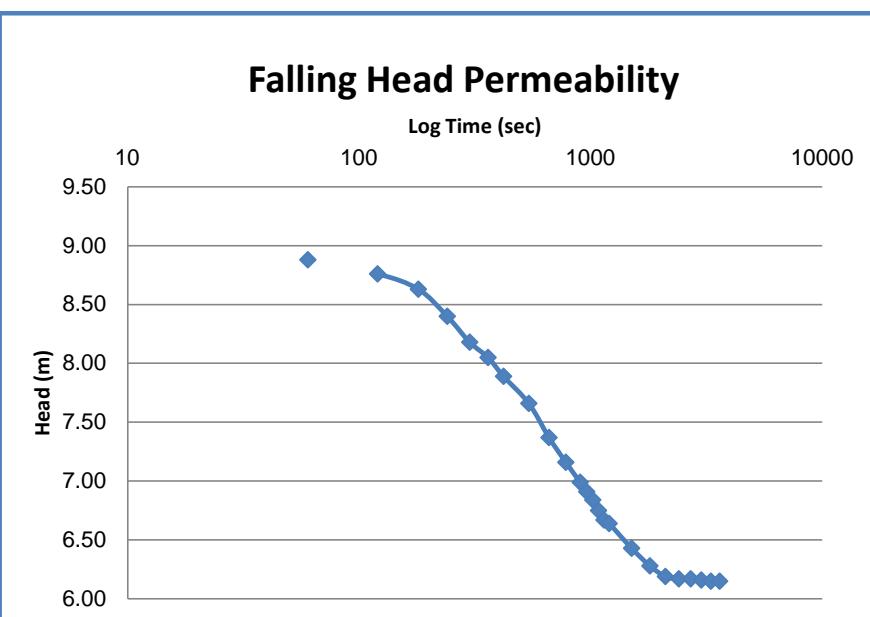
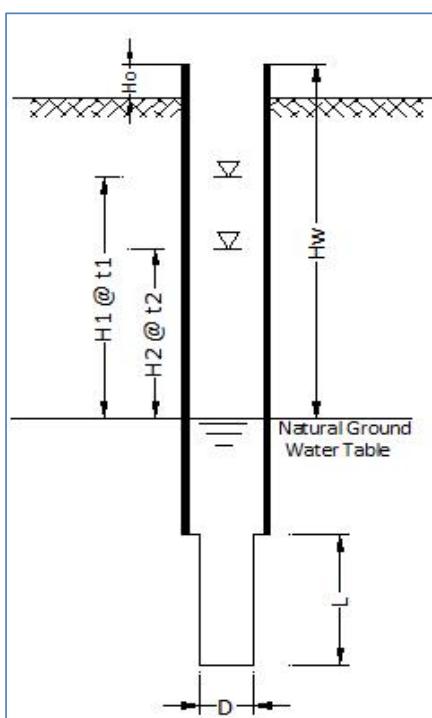
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/23/2014		
Test Location	59.5 to 62.5	Y		K(m/sec):	1.0350E-07		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.37	60	8.88
WATER LEVEL BEFORE TEST	W.L	-10.7	mAD	2	0.49	120	8.76
HEIGHT OF CASING ABOVE NGL	Ho	0.5	m	3	0.62	180	8.63
CASING TOP LEVEL		0.5	mAD	4	0.85	240	8.40
CASING LENGTH		59.8	m	5	1.07	300	8.18
CASING BOTTOM LEVEL		-59.3	mAD	6	1.20	360	8.05
BOREHOLE DEPTH		62.5	m	7	1.36	420	7.89
BOREHOLE BOTTOM LEVEL		-62.5	mAD	9	1.59	540	7.66
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.2	m	11	1.88	660	7.37
WATER HEAD	Hw	9.25	m	13	2.09	780	7.16

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

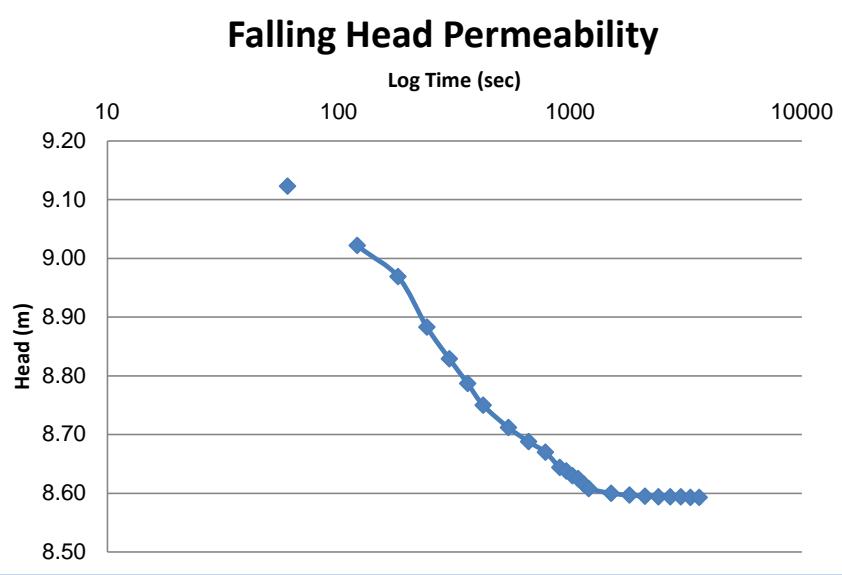
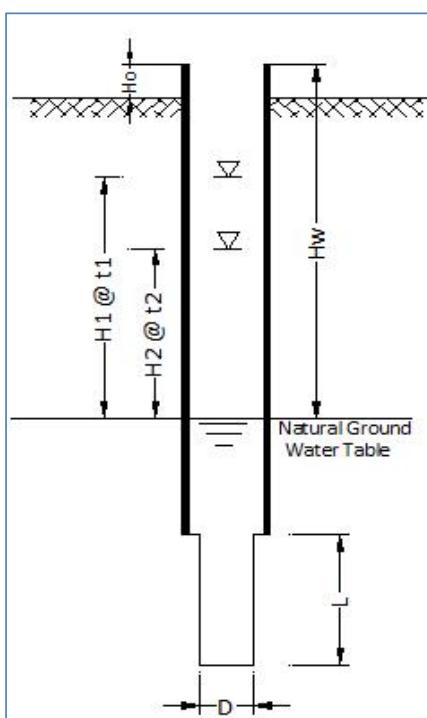
15	2.26	900	6.99
16	2.34	960	6.91
17	2.41	1020	6.84
18	2.50	1080	6.75
19	2.58	1140	6.67
20	2.61	1200	6.64
25	2.82	1500	6.43
30	2.97	1800	6.28
35	3.06	2100	6.19
40	3.08	2400	6.17
45	3.08	2700	6.17
50	3.09	3000	6.16
55	3.10	3300	6.15
60	3.10	3600	6.15



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/23/2014		
Test Location	62.5 to 65.5	Y		K(m/sec):	2.5454E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.13	60	9.12
WATER LEVEL BEFORE TEST	W.L	-17	mAD	2	0.23	120	9.02
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.28	180	8.97
CASING TOP LEVEL		0.4	mAD	4	0.37	240	8.88
CASING LENGTH		62.8	m	5	0.42	300	8.83
CASING BOTTOM LEVEL		-62.4	mAD	6	0.46	360	8.79
BOREHOLE DEPTH		65.5	m	7	0.50	420	8.75
BOREHOLE BOTTOM LEVEL		-65.5	mAD	9	0.54	540	8.71
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.56	660	8.69
WATER HEAD	Hw	9.25	m	13	0.58	780	8.67

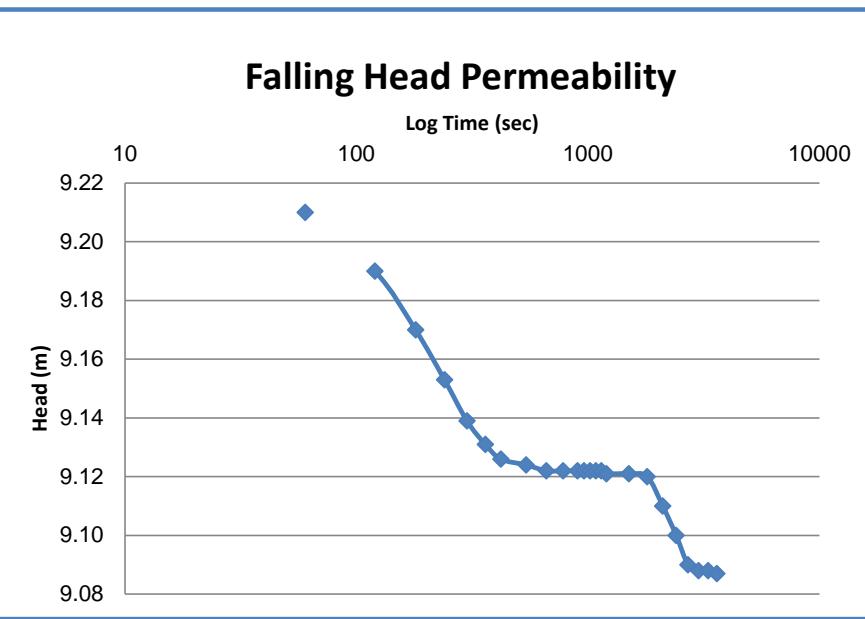
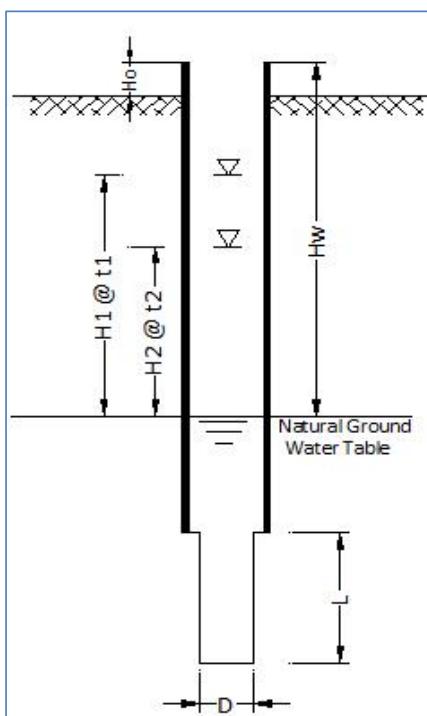
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

15	0.61	900	8.64
16	0.61	960	8.64
17	0.62	1020	8.63
18	0.63	1080	8.63
19	0.63	1140	8.62
20	0.64	1200	8.61
25	0.65	1500	8.60
30	0.65	1800	8.60
35	0.66	2100	8.60
40	0.66	2400	8.59
45	0.66	2700	8.59
50	0.66	3000	8.59
55	0.66	3300	8.59
60	0.66	3600	8.59



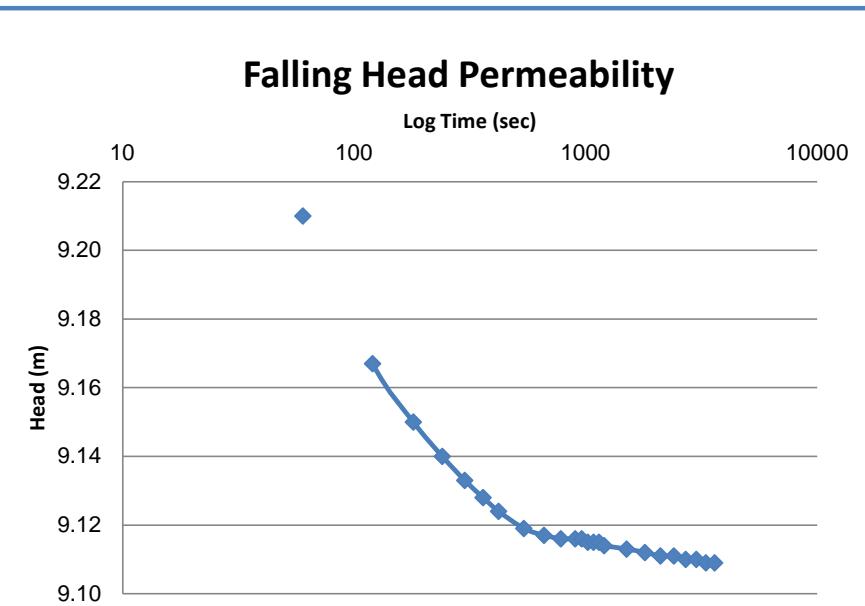
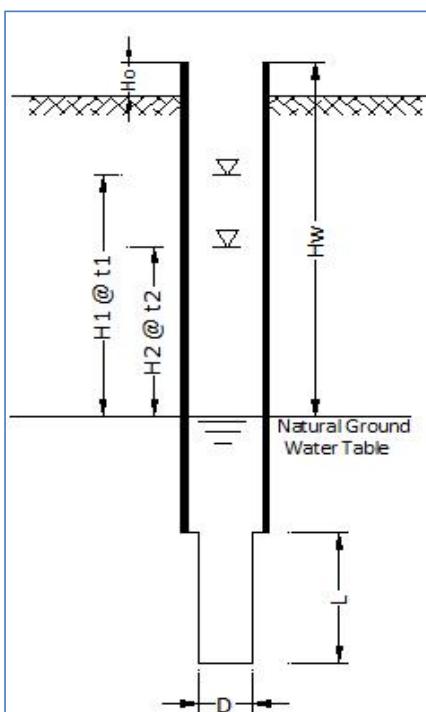
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/23/2014		
Test Location	65.5 to 68.5	Y		K(m/sec):	3.9210E-10		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.04	60
WATER LEVEL BEFORE TEST		W.L.	-21	mAD	2	0.06	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	0.08	180
CASING TOP LEVEL			0.4	mAD	4	0.10	240
CASING LENGTH			65.8	m	5	0.11	300
CASING BOTTOM LEVEL			-65.4	mAD	6	0.12	360
BOREHOLE DEPTH			68.5	m	7	0.12	420
BOREHOLE BOTTOM LEVEL			-68.5	mAD	9	0.13	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3.1	m	11	0.13	660
WATER HEAD		Hw	9.25	m	13	0.13	780
					15	0.13	900
					16	0.13	960
					17	0.13	1020
					18	0.13	1080
					19	0.13	1140
					20	0.13	1200
					25	0.13	1500
					30	0.13	1800
					35	0.14	2100
					40	0.15	2400
					45	0.16	2700
					50	0.16	3000
					55	0.16	3300
					60	0.16	3600
							9.09

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



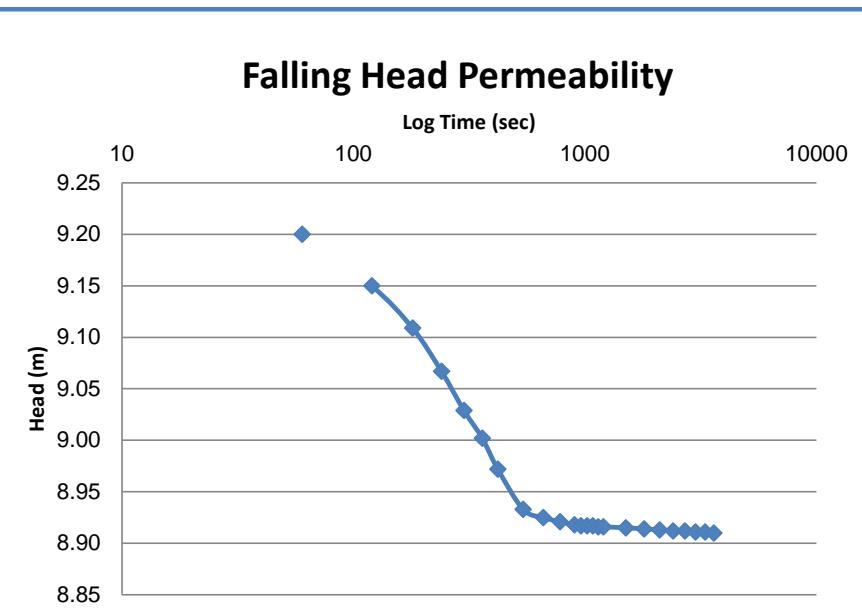
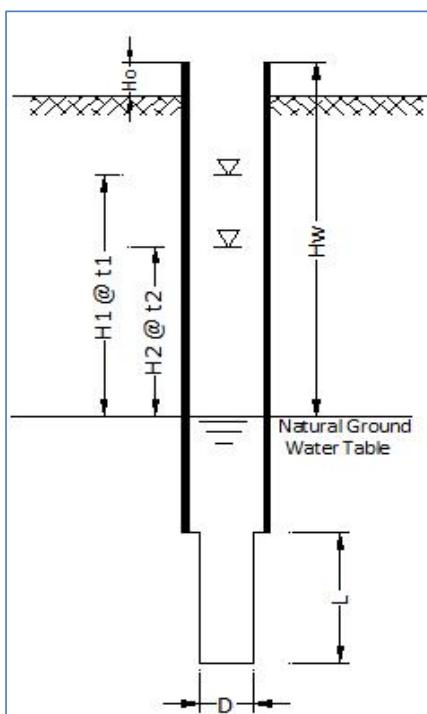
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/24/2014		
Test Location	68.5 to 72	Y		K(m/sec):	3.4387E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.04	60	9.21
WATER LEVEL BEFORE TEST	W.L	-22.3	mAD	2	0.08	120	9.17
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.10	180	9.15
CASING TOP LEVEL		0.4	mAD	4	0.11	240	9.14
CASING LENGTH		68.8	m	5	0.12	300	9.13
CASING BOTTOM LEVEL		-68.4	mAD	6	0.12	360	9.13
BOREHOLE DEPTH		72	m	7	0.13	420	9.12
BOREHOLE BOTTOM LEVEL		-72	mAD	9	0.13	540	9.12
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.6	m	11	0.13	660	9.12
WATER HEAD	Hw	9.25	m	13	0.13	780	9.12
				15	0.13	900	9.12
				16	0.13	960	9.12
				17	0.14	1020	9.12
				18	0.14	1080	9.12
				19	0.14	1140	9.12
				20	0.14	1200	9.11
				25	0.14	1500	9.11
				30	0.14	1800	9.11
				35	0.14	2100	9.11
				40	0.14	2400	9.11
				45	0.14	2700	9.11
				50	0.14	3000	9.11
				55	0.14	3300	9.11
				60	0.14	3600	9.11

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



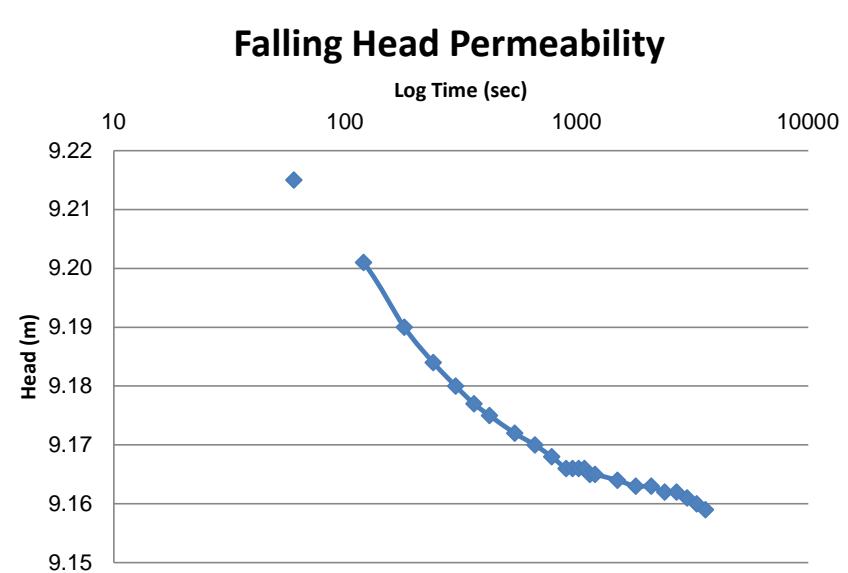
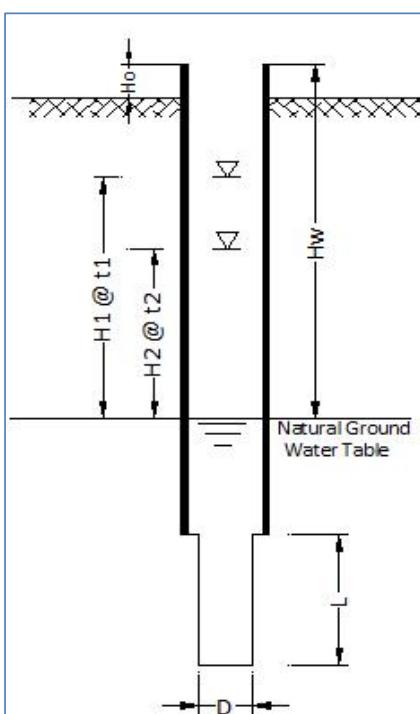
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/24/2014		
Test Location	72 to 75	Y		K(m/sec):	6.1166E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.05	60	9.20
WATER LEVEL BEFORE TEST	W.L	-31	mAD	2	0.10	120	9.15
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.14	180	9.11
CASING TOP LEVEL		0.4	mAD	4	0.18	240	9.07
CASING LENGTH		72.3	m	5	0.22	300	9.03
CASING BOTTOM LEVEL		-71.9	mAD	6	0.25	360	9.00
BOREHOLE DEPTH		75	m	7	0.28	420	8.97
BOREHOLE BOTTOM LEVEL		-75	mAD	9	0.32	540	8.93
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.33	660	8.93
WATER HEAD	Hw	9.25	m	13	0.33	780	8.92
				15	0.33	900	8.92
				16	0.33	960	8.92
				17	0.33	1020	8.92
				18	0.33	1080	8.92
				19	0.33	1140	8.92
				20	0.33	1200	8.92
				25	0.34	1500	8.92
				30	0.34	1800	8.91
				35	0.34	2100	8.91
				40	0.34	2400	8.91
				45	0.34	2700	8.91
				50	0.34	3000	8.91
				55	0.34	3300	8.91
				60	0.40	3600	8.91

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



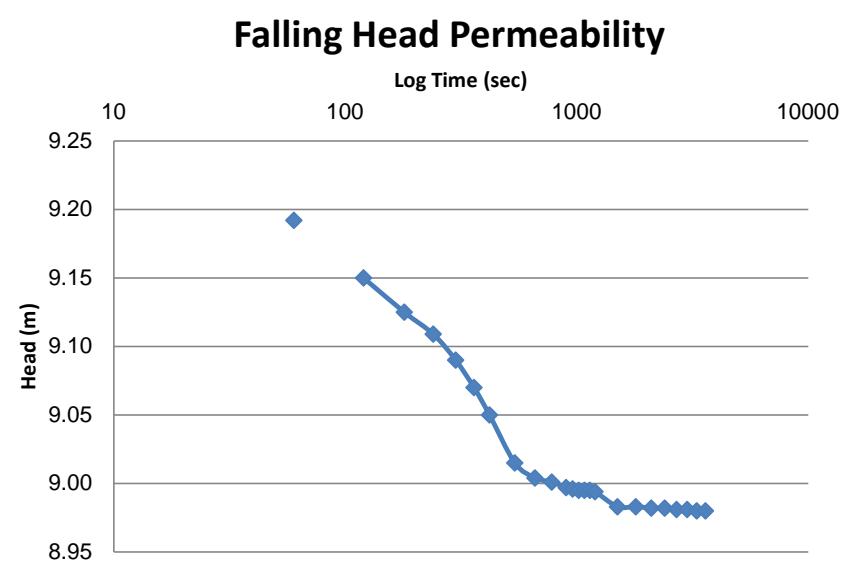
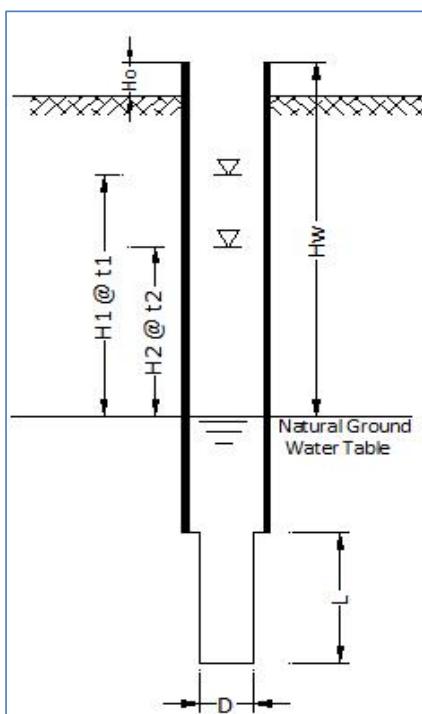
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/24/2014		
Test Location	75 to 78	Y		K(m/sec):	3.0250E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.04	60	9.22
WATER LEVEL BEFORE TEST	W.L	-31	mAD	2	0.05	120	9.20
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.06	180	9.19
CASING TOP LEVEL		0.4	mAD	4	0.07	240	9.18
CASING LENGTH		75.3	m	5	0.07	300	9.18
CASING BOTTOM LEVEL		-74.9	mAD	6	0.07	360	9.18
BOREHOLE DEPTH		78	m	7	0.08	420	9.18
BOREHOLE BOTTOM LEVEL		-78	mAD	9	0.08	540	9.17
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.08	660	9.17
WATER HEAD	Hw	9.25	m	13	0.08	780	9.17
				15	0.08	900	9.17
				16	0.08	960	9.17
				17	0.08	1020	9.17
				18	0.08	1080	9.17
				19	0.09	1140	9.17
				20	0.09	1200	9.17
				25	0.09	1500	9.16
				30	0.09	1800	9.16
				35	0.09	2100	9.16
				40	0.09	2400	9.16
				45	0.09	2700	9.16
				50	0.09	3000	9.16
				55	0.09	3300	9.16
				60	0.09	3600	9.16

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



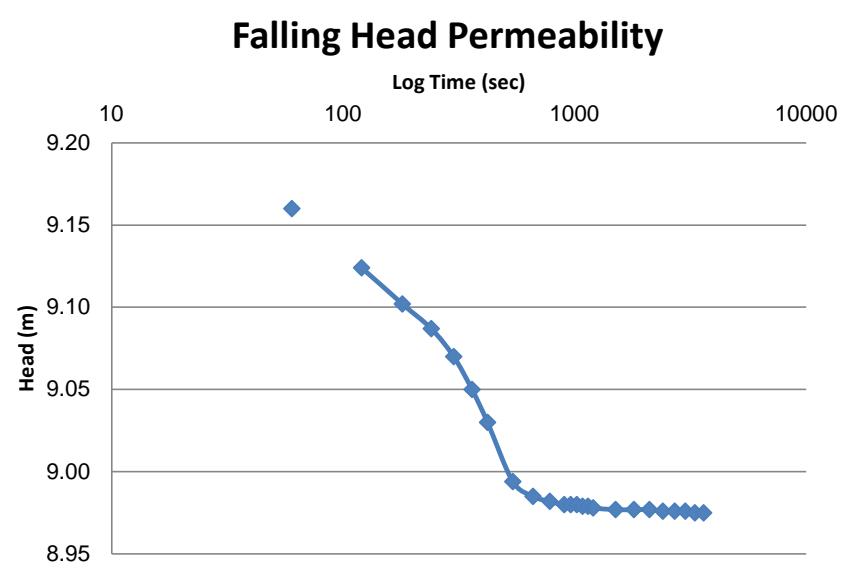
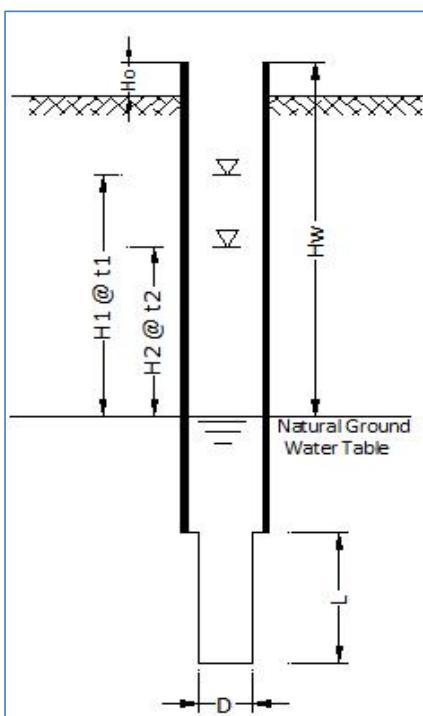
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/25/2014		
Test Location	78 to 81	Y		K(m/sec):	8.8552E-10		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.06	60
WATER LEVEL BEFORE TEST		W.L.	-18	mAD	2	0.10	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	0.13	180
CASING TOP LEVEL			0.4	mAD	4	0.14	240
CASING LENGTH			78.3	m	5	0.16	300
CASING BOTTOM LEVEL			-77.9	mAD	6	0.18	360
BOREHOLE DEPTH			81	m	7	0.20	420
BOREHOLE BOTTOM LEVEL			-81	mAD	9	0.24	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3.1	m	11	0.25	660
WATER HEAD		Hw	9.25	m	13	0.25	780
					15	0.25	900
					16	0.25	960
					17	0.26	1020
					18	0.26	1080
					19	0.26	1140
					20	0.26	1200
					25	0.27	1500
					30	0.27	1800
					35	0.27	2100
					40	0.27	2400
					45	0.27	2700
					50	0.27	3000
					55	0.27	3300
					60	0.27	3600

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



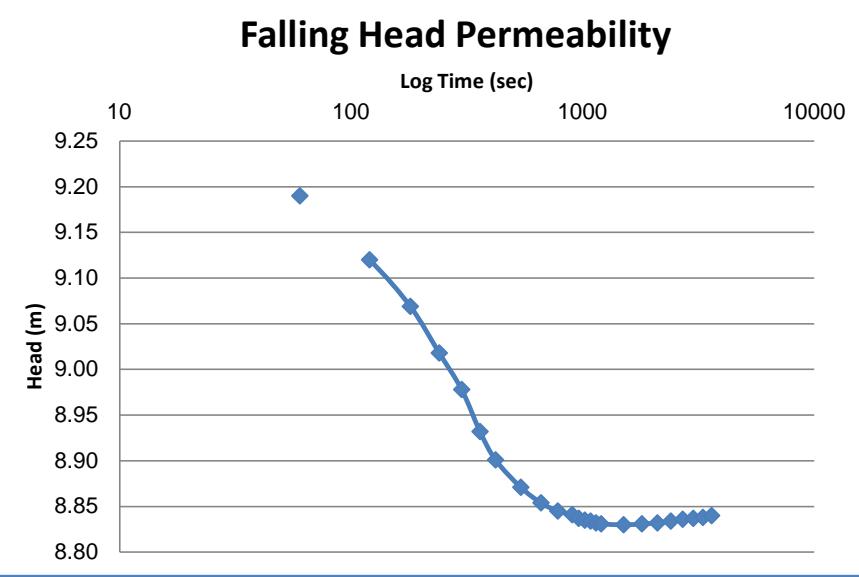
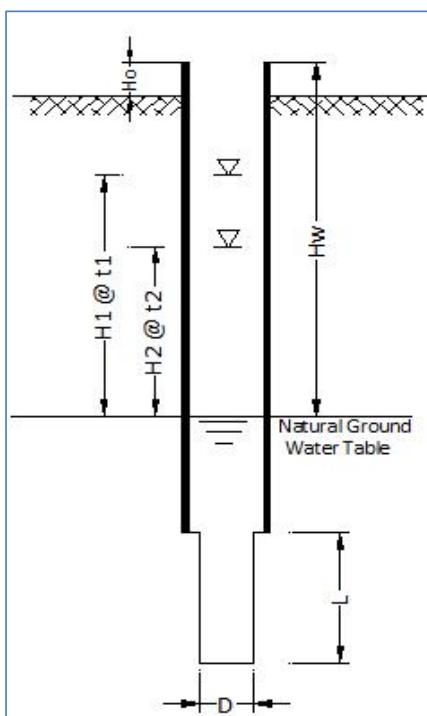
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/25/2014		
Test Location	81 to 84	Y		K(m/sec):	4.0494E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.09	60	9.16
WATER LEVEL BEFORE TEST	W.L	-26.8	mAD	2	0.13	120	9.12
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.15	180	9.10
CASING TOP LEVEL		0.4	mAD	4	0.16	240	9.09
CASING LENGTH		81.3	m	5	0.18	300	9.07
CASING BOTTOM LEVEL		-80.9	mAD	6	0.20	360	9.05
BOREHOLE DEPTH		84	m	7	0.22	420	9.03
BOREHOLE BOTTOM LEVEL		-84	mAD	9	0.26	540	8.99
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.27	660	8.99
WATER HEAD	Hw	9.25	m	13	0.27	780	8.98
				15	0.27	900	8.98
				16	0.27	960	8.98
				17	0.27	1020	8.98
				18	0.27	1080	8.98
				19	0.27	1140	8.98
				20	0.27	1200	8.98
				25	0.27	1500	8.98
				30	0.27	1800	8.98
				35	0.27	2100	8.98
				40	0.27	2400	8.98
				45	0.27	2700	8.98
				50	0.27	3000	8.98
				55	0.28	3300	8.98
				60	0.28	3600	8.98

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



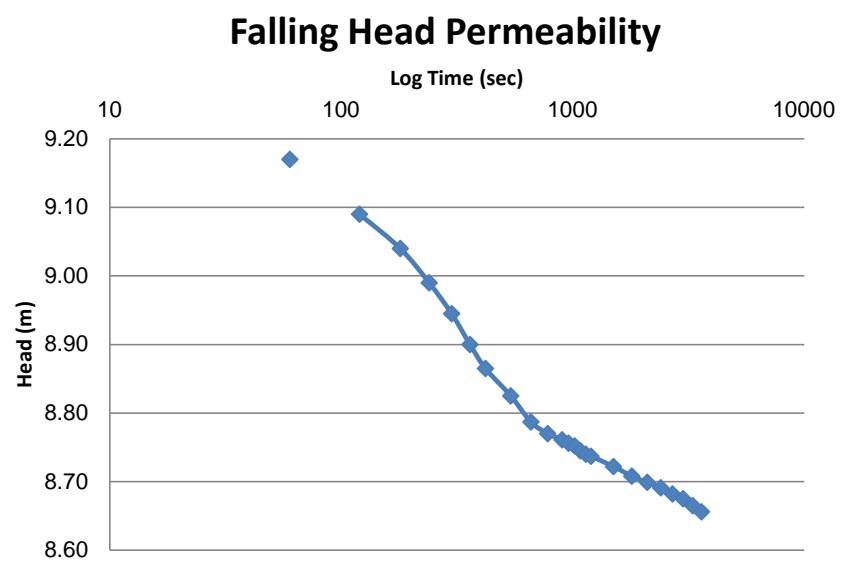
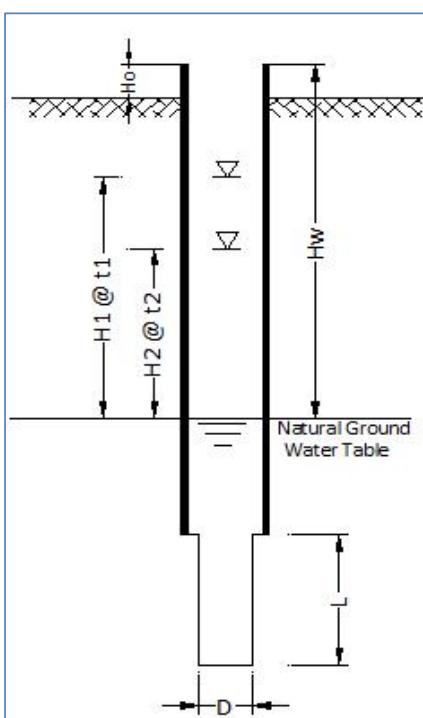
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/25/2014		
Test Location	84 to 87	Y		K(m/sec):	2.1437E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.06	60	9.19
WATER LEVEL BEFORE TEST	W.L	-31.5	mAD	2	0.13	120	9.12
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.18	180	9.07
CASING TOP LEVEL		0.4	mAD	4	0.23	240	9.02
CASING LENGTH		84.3	m	5	0.27	300	8.98
CASING BOTTOM LEVEL		-83.9	mAD	6	0.32	360	8.93
BOREHOLE DEPTH		87	m	7	0.35	420	8.90
BOREHOLE BOTTOM LEVEL		-87	mAD	9	0.38	540	8.87
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.40	660	8.85
WATER HEAD	Hw	9.25	m	13	0.41	780	8.85
				15	0.41	900	8.84
				16	0.41	960	8.84
				17	0.42	1020	8.84
				18	0.42	1080	8.83
				19	0.42	1140	8.83
				20	0.42	1200	8.83
				25	0.42	1500	8.83
				30	0.42	1800	8.83
				35	0.42	2100	8.83
				40	0.42	2400	8.83
				45	0.41	2700	8.84
				50	0.41	3000	8.84
				55	0.41	3300	8.84
				60	0.41	3600	8.84

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



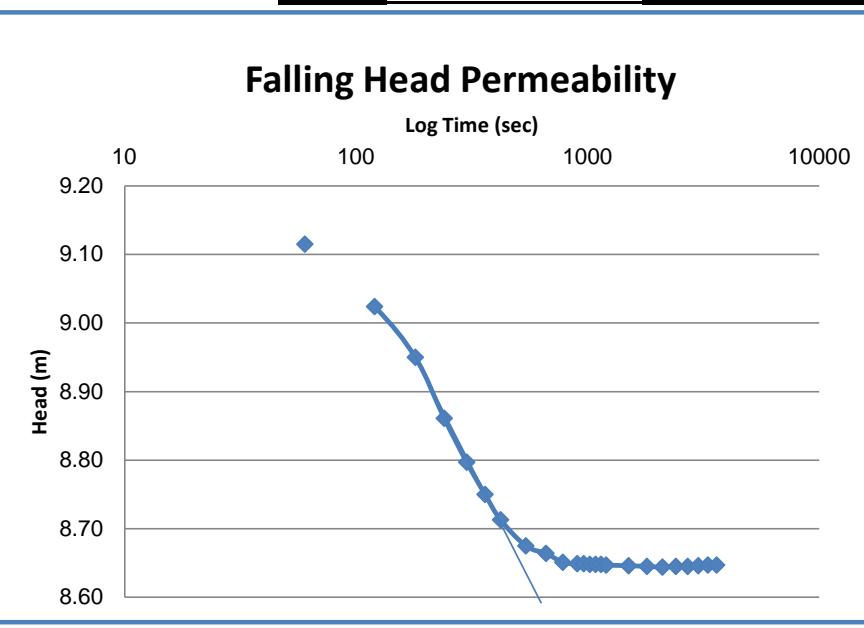
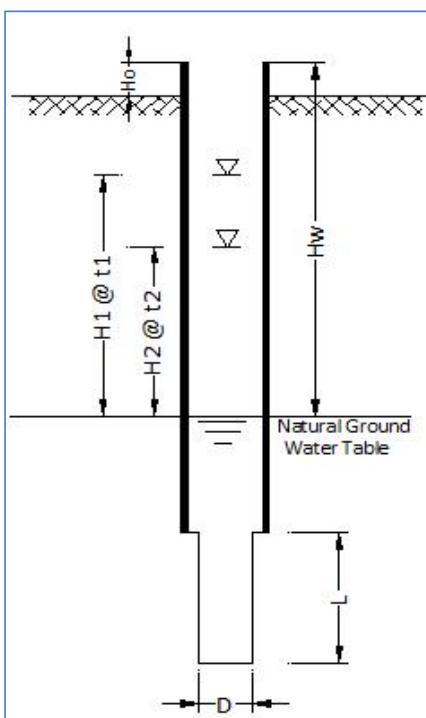
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/26/2014		
Test Location	87 to 90	Y		K(m/sec):	5.4620E-09		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.08	60	9.17
WATER LEVEL BEFORE TEST	W.L	-35	mAD	2	0.16	120	9.09
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.21	180	9.04
CASING TOP LEVEL		0.4	mAD	4	0.26	240	8.99
CASING LENGTH		87.3	m	5	0.31	300	8.95
CASING BOTTOM LEVEL		-86.9	mAD	6	0.35	360	8.90
BOREHOLE DEPTH		90	m	7	0.39	420	8.87
BOREHOLE BOTTOM LEVEL		-90	mAD	9	0.43	540	8.83
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.46	660	8.79
WATER HEAD	Hw	9.25	m	13	0.48	780	8.77
				15	0.49	900	8.76
				16	0.49	960	8.76
				17	0.50	1020	8.75
				18	0.51	1080	8.75
				19	0.51	1140	8.74
				20	0.51	1200	8.74
				25	0.53	1500	8.72
				30	0.54	1800	8.71
				35	0.55	2100	8.70
				40	0.56	2400	8.69
				45	0.57	2700	8.68
				50	0.58	3000	8.68
				55	0.59	3300	8.67
				60	0.59	3600	8.66

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



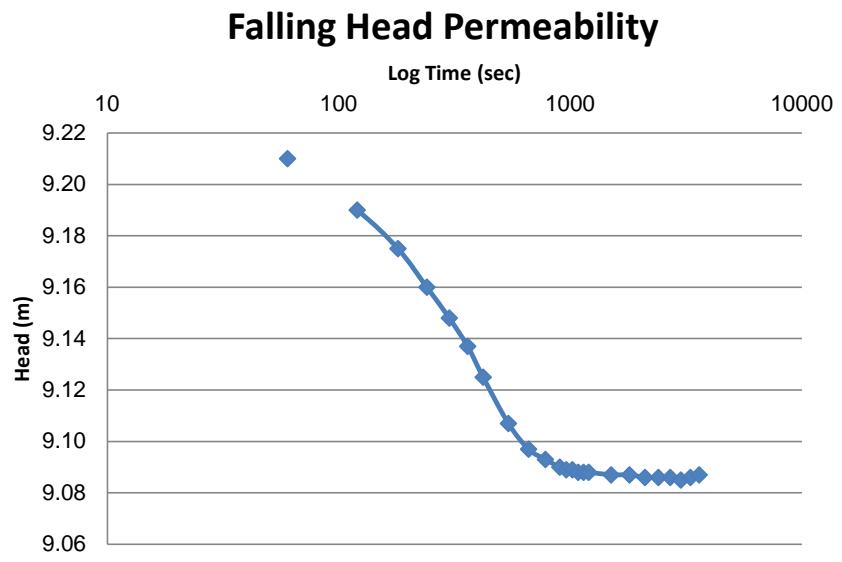
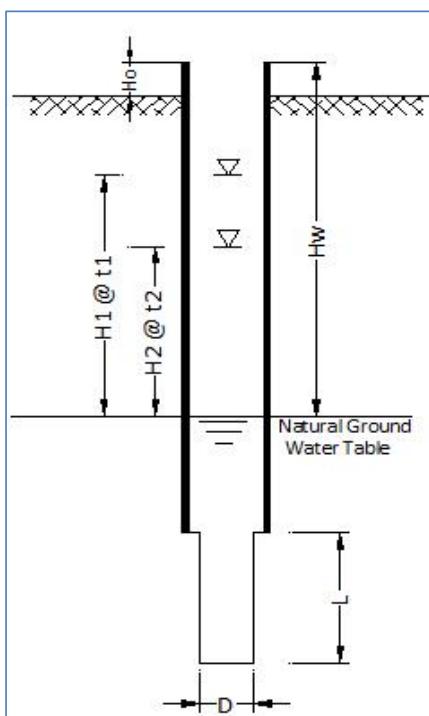
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/26/2014		
Test Location	90 to 93	Y		K(m/sec):	4.1203E-09		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.14	60	9.12
WATER LEVEL BEFORE TEST	W.L	-32	mAD	2	0.23	120	9.02
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.30	180	8.95
CASING TOP LEVEL		0.4	mAD	4	0.39	240	8.86
CASING LENGTH		90.3	m	5	0.45	300	8.80
CASING BOTTOM LEVEL		-89.9	mAD	6	0.50	360	8.75
BOREHOLE DEPTH		93	m	7	0.54	420	8.71
BOREHOLE BOTTOM LEVEL		-93	mAD	9	0.58	540	8.68
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.59	660	8.66
WATER HEAD	Hw	9.25	m	13	0.60	780	8.65
				15	0.60	900	8.65
				16	0.60	960	8.65
				17	0.60	1020	8.65
				18	0.60	1080	8.65
				19	0.60	1140	8.65
				20	0.60	1200	8.65
				25	0.60	1500	8.65
				30	0.61	1800	8.65
				35	0.61	2100	8.64
				40	0.61	2400	8.65
				45	0.61	2700	8.65
				50	0.60	3000	8.65
				55	0.60	3300	8.65
				60	0.60	3600	8.65

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



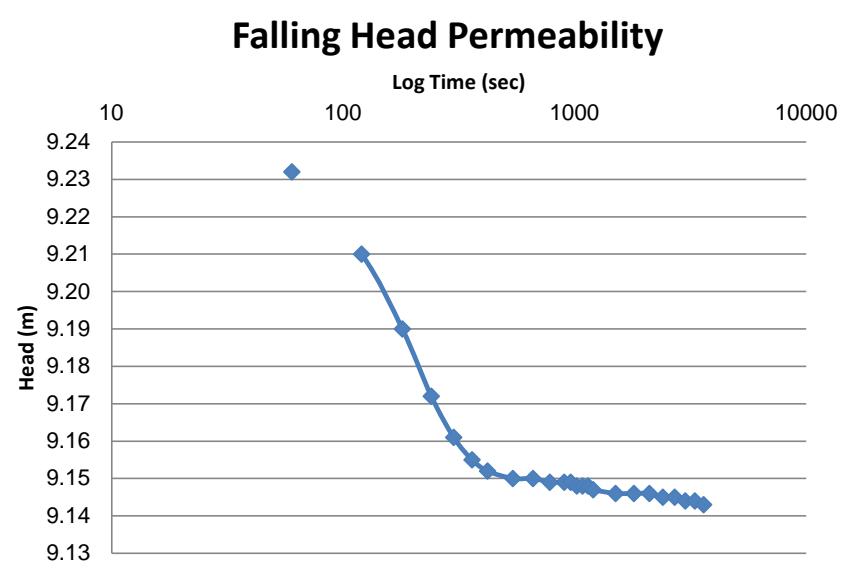
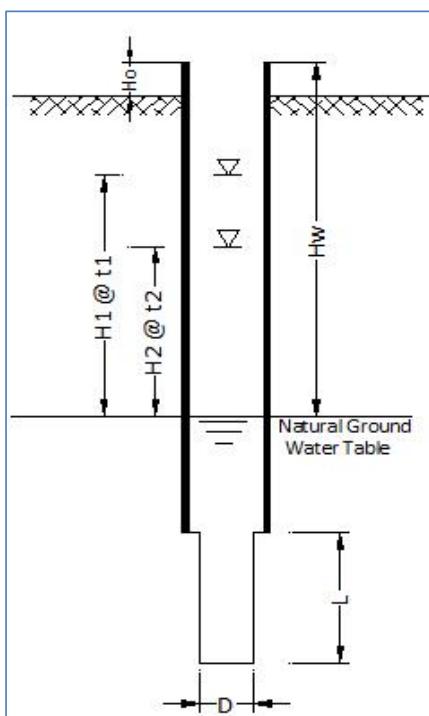
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/26/2014		
Test Location	93 to 96	Y		K(m/sec):	1.3070E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.04	60	9.21
WATER LEVEL BEFORE TEST	W.L	-28.5	mAD	2	0.06	120	9.19
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.08	180	9.18
CASING TOP LEVEL		0.4	mAD	4	0.09	240	9.16
CASING LENGTH		93.3	m	5	0.10	300	9.15
CASING BOTTOM LEVEL		-92.9	mAD	6	0.11	360	9.14
BOREHOLE DEPTH		96	m	7	0.13	420	9.13
BOREHOLE BOTTOM LEVEL		-96	mAD	9	0.14	540	9.11
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.15	660	9.10
WATER HEAD	Hw	9.25	m	13	0.16	780	9.09
				15	0.16	900	9.09
				16	0.16	960	9.09
				17	0.16	1020	9.09
				18	0.16	1080	9.09
				19	0.16	1140	9.09
				20	0.16	1200	9.09
				25	0.16	1500	9.09
				30	0.16	1800	9.09
				35	0.16	2100	9.09
				40	0.16	2400	9.09
				45	0.16	2700	9.09
				50	0.17	3000	9.09
				55	0.16	3300	9.09
				60	0.16	3600	9.09

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



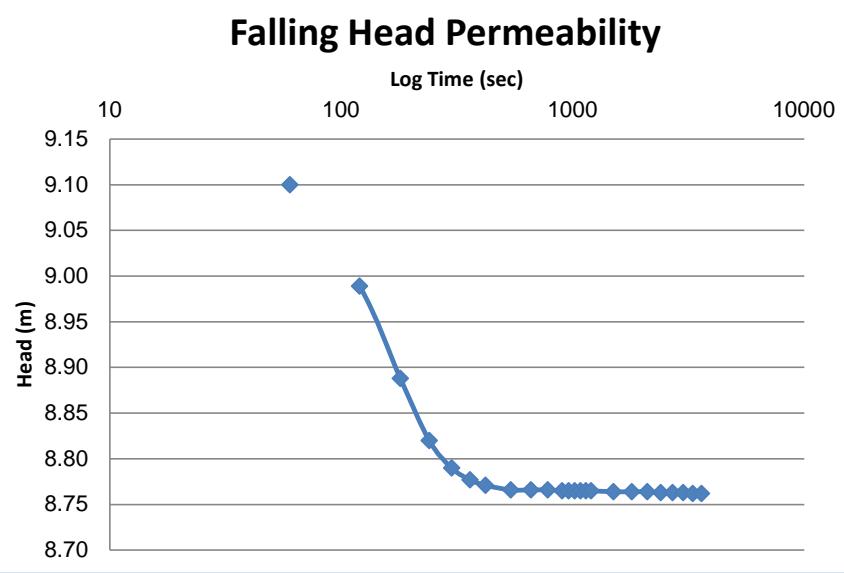
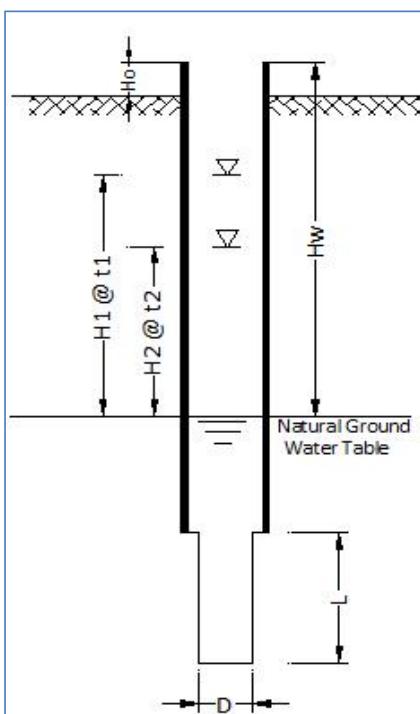
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/26/2014		
Test Location	96 to 99	Y		K(m/sec):	2.6738E-10		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.02	60	9.23
WATER LEVEL BEFORE TEST	W.L	-30.5	mAD	2	0.04	120	9.21
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.06	180	9.19
CASING TOP LEVEL		0.4	mAD	4	0.08	240	9.17
CASING LENGTH		96.3	m	5	0.09	300	9.16
CASING BOTTOM LEVEL		-95.9	mAD	6	0.10	360	9.16
BOREHOLE DEPTH		99	m	7	0.10	420	9.15
BOREHOLE BOTTOM LEVEL		-99	mAD	9	0.10	540	9.15
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.10	660	9.15
WATER HEAD	Hw	9.25	m	13	0.10	780	9.15
				15	0.10	900	9.15
				16	0.10	960	9.15
				17	0.10	1020	9.15
				18	0.10	1080	9.15
				19	0.10	1140	9.15
				20	0.10	1200	9.15
				25	0.10	1500	9.15
				30	0.10	1800	9.15
				35	0.10	2100	9.15
				40	0.11	2400	9.15
				45	0.11	2700	9.15
				50	0.11	3000	9.14
				55	0.11	3300	9.14
				60	0.11	3600	9.14

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



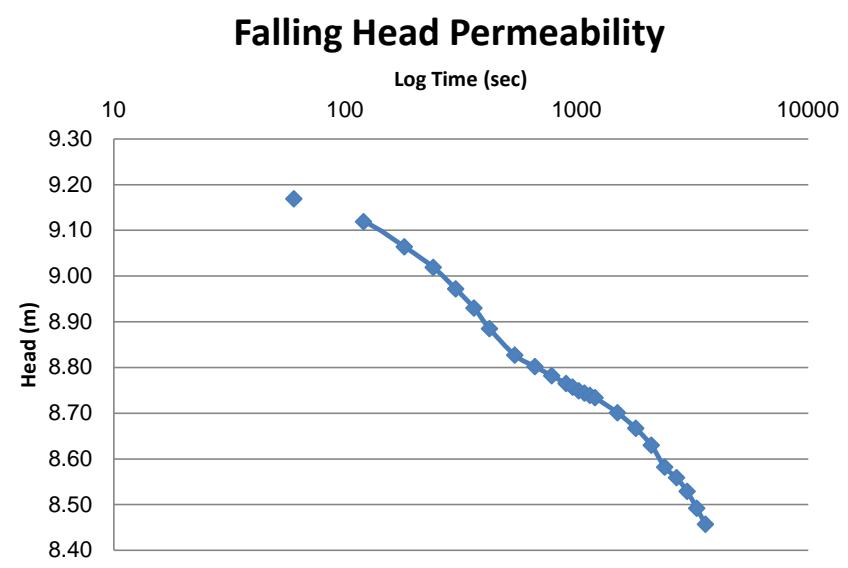
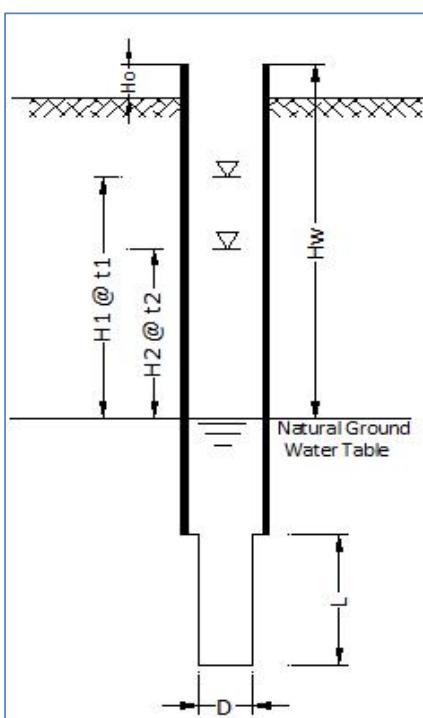
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/27/2014		
Test Location	99 to 102	Y		K(m/sec):	1.5796E-09		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.15	60
WATER LEVEL BEFORE TEST		W.L.	-13	mAD	2	0.26	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	0.36	180
CASING TOP LEVEL			0.4	mAD	4	0.43	240
CASING LENGTH			99.3	m	5	0.46	300
CASING BOTTOM LEVEL			-98.9	mAD	6	0.47	360
BOREHOLE DEPTH			102	m	7	0.48	420
BOREHOLE BOTTOM LEVEL			-102	mAD	9	0.48	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3.1	m	11	0.48	660
WATER HEAD		Hw	9.25	m	13	0.48	780
					15	0.49	900
					16	0.49	960
					17	0.49	1020
					18	0.49	1080
					19	0.49	1140
					20	0.49	1200
					25	0.49	1500
					30	0.49	1800
					35	0.49	2100
					40	0.49	2400
					45	0.49	2700
					50	0.49	3000
					55	0.49	3300
					60	0.49	3600
							8.76

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



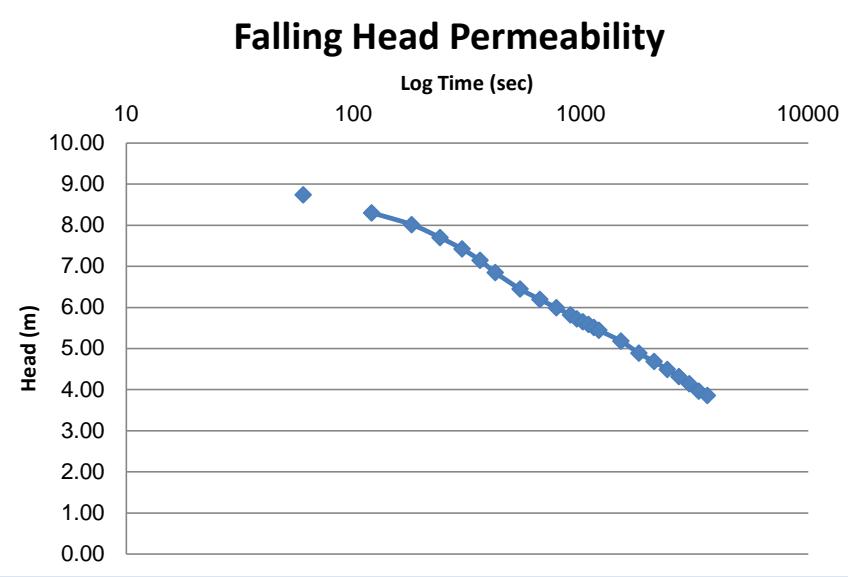
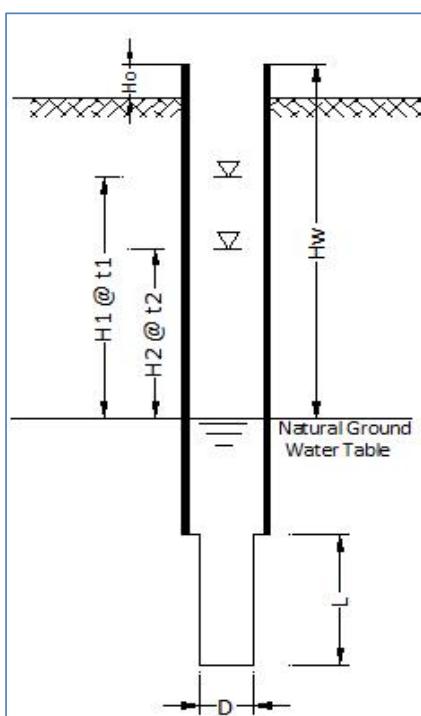
PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/27/2014		
Test Location	102 to 105	Y		K(m/sec):	1.4480E-08		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	1	0.08	60	9.17
WATER LEVEL BEFORE TEST	W.L	-25.5	mAD	2	0.13	120	9.12
HEIGHT OF CASING ABOVE NGL	Ho	0.4	m	3	0.19	180	9.06
CASING TOP LEVEL		0.4	mAD	4	0.23	240	9.02
CASING LENGTH		102.3	m	5	0.28	300	8.97
CASING BOTTOM LEVEL		-101.9	mAD	6	0.32	360	8.93
BOREHOLE DEPTH		105	m	7	0.37	420	8.89
BOREHOLE BOTTOM LEVEL		-105	mAD	9	0.42	540	8.83
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.1	m	11	0.45	660	8.80
WATER HEAD	Hw	9.25	m	13	0.47	780	8.78
				15	0.49	900	8.77
				16	0.49	960	8.76
				17	0.50	1020	8.75
				18	0.51	1080	8.74
				19	0.51	1140	8.74
				20	0.52	1200	8.73
				25	0.55	1500	8.70
				30	0.58	1800	8.67
				35	0.62	2100	8.63
				40	0.67	2400	8.58
				45	0.69	2700	8.56
				50	0.72	3000	8.53
				55	0.76	3300	8.49
				60	0.79	3600	8.46

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/28/2014		
Test Location	105 to 108	Y		K(m/sec):	2.2828E-07		
Inclination	0	Z					
DIAMETER OF CASING		D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)
DIAMETER OF TEST SECTION		D	86	mm	0	0.00	0
NATURAL GROUND LEVEL		NGL	0	mAD	1	0.51	60
WATER LEVEL BEFORE TEST		W.L	-25.5	mAD	2	0.95	120
HEIGHT OF CASING ABOVE NGL		Ho	0.4	m	3	1.24	180
CASING TOP LEVEL			0.4	mAD	4	1.55	240
CASING LENGTH			105.3	m	5	1.83	300
CASING BOTTOM LEVEL			-104.9	mAD	6	2.10	360
BOREHOLE DEPTH			108	m	7	2.40	420
BOREHOLE BOTTOM LEVEL			-108	mAD	9	2.80	540
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE		L	3.1	m	11	3.05	660
WATER HEAD		Hw	9.25	m	13	3.26	780
					15	3.43	900
					16	3.53	960
					17	3.60	1020
					18	3.66	1080
					19	3.74	1140
					20	3.81	1200
					25	4.07	1500
					30	4.36	1800
					35	4.56	2100
					40	4.76	2400
					45	4.93	2700
					50	5.11	3000
					55	5.29	3300
					60	5.39	3600
							3.86

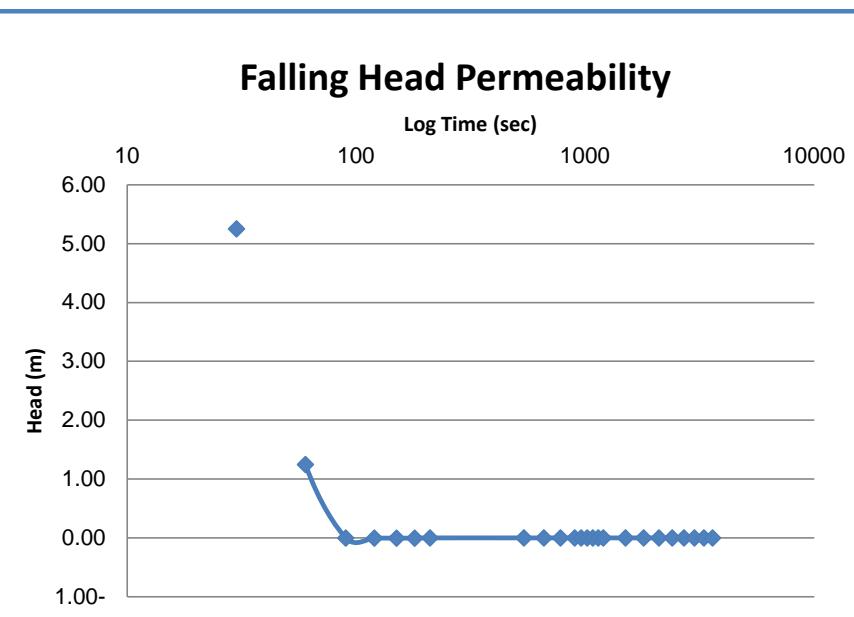
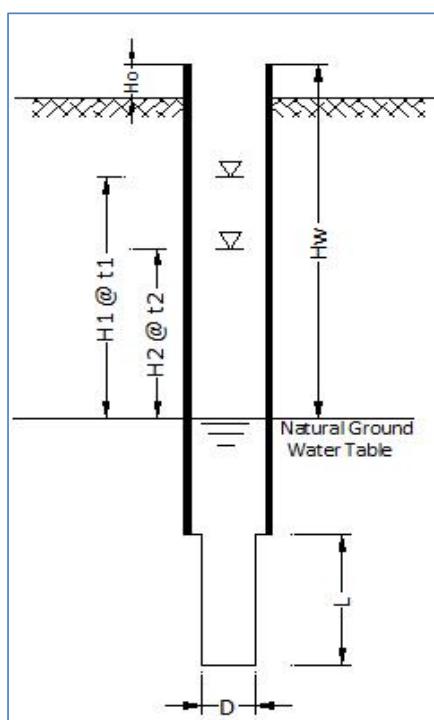
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/28/2014		
Test Location	108 to 111	Y		K(m/sec):	7.0506E-05		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	0.5	4.00	30	5.25
WATER LEVEL BEFORE TEST	W.L	-25.5	mAD	1	8.00	60	1.25
HEIGHT OF CASING ABOVE NGL	Ho	0.45	m	1.5	9.25	90	0.00
CASING TOP LEVEL		0.45	mAD	2	9.25	120	0.00
CASING LENGTH		108.3	m	2.5	9.25	150	0.00
CASING BOTTOM LEVEL		-107.85	mAD	3	9.25	180	0.00
BOREHOLE DEPTH		111	m	3.5	9.25	210	0.00
BOREHOLE BOTTOM LEVEL		-111	mAD	9	9.25	540	0.00
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.15	m	11	9.25	660	0.00
WATER HEAD	Hw	9.25	m	13	9.25	780	0.00

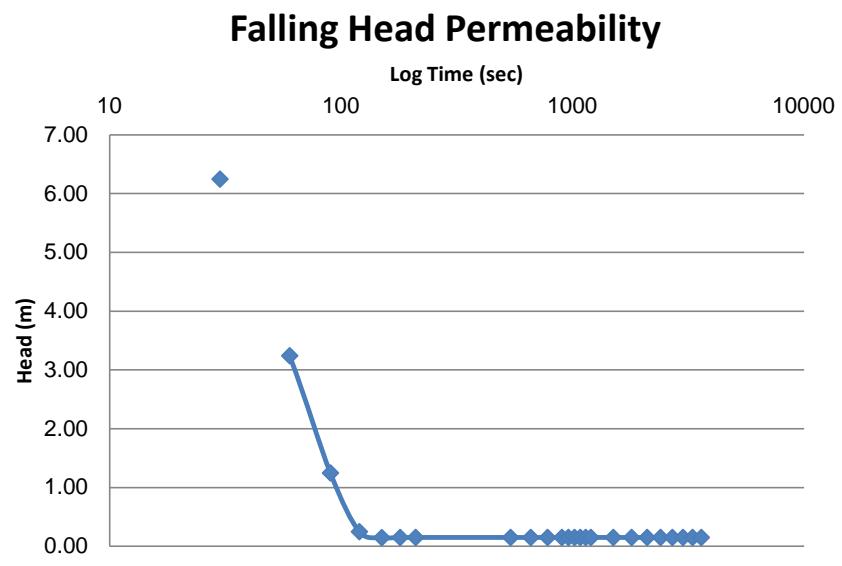
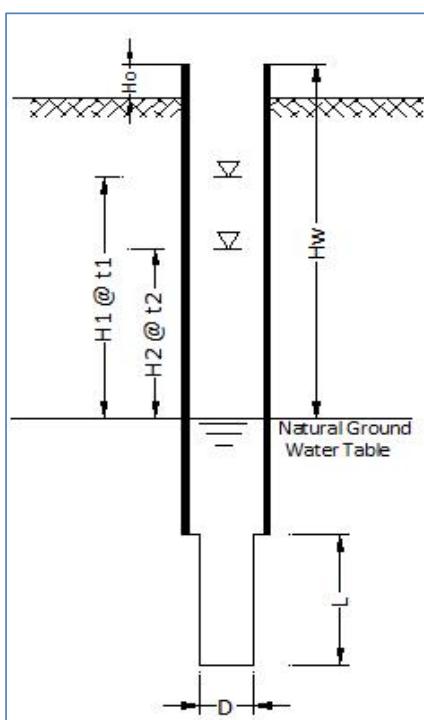
$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$

15	9.25	900	0.00
16	9.25	960	0.00
17	9.25	1020	0.00
18	9.25	1080	0.00
19	9.25	1140	0.00
20	9.25	1200	0.00
25	9.25	1500	0.00
30	9.25	1800	0.00
35	9.25	2100	0.00
40	9.25	2400	0.00
45	9.25	2700	0.00
50	9.25	3000	0.00
55	9.25	3300	0.00
60	9.25	3600	0.00



PROJECT		Besri Dam II			FALLING HEAD PERMEABILITY TEST		
CLIENT		DAHNT					
Borehole	BHVR 06	X		Date:	6/28/2014		
Test Location	111 to 114	Y		K(m/sec):	3.7797E-05		
Inclination	0	Z					
DIAMETER OF CASING	D1	127	mm	Time (min)	Drop Down Below Casing Top Level (m)	Time (sec)	Head (m)
DIAMETER OF TEST SECTION	D	86	mm	0	0.00	0	9.25
NATURAL GROUND LEVEL	NGL	0	mAD	0.5	3.00	30	6.25
WATER LEVEL BEFORE TEST	W.L	-25.5	mAD	1	6.01	60	3.24
HEIGHT OF CASING ABOVE NGL	Ho	0.45	m	1.5	8.00	90	1.25
CASING TOP LEVEL		0.45	mAD	2	9.00	120	0.25
CASING LENGTH		108.3	m	2.5	9.10	150	0.15
CASING BOTTOM LEVEL		-107.85	mAD	3	9.10	180	0.15
BOREHOLE DEPTH		111	m	3.5	9.10	210	0.15
BOREHOLE BOTTOM LEVEL		-111	mAD	9	9.10	540	0.15
LENGTH OF THE UNCASED SECTION IN THE BOREHOLE	L	3.15	m	11	9.10	660	0.15
WATER HEAD	Hw	9.25	m	13	9.10	780	0.15
				15	9.10	900	0.15
				16	9.10	960	0.15
				17	9.10	1020	0.15
				18	9.10	1080	0.15
				19	9.10	1140	0.15
				20	9.10	1200	0.15
				25	9.10	1500	0.15
				30	9.10	1800	0.15
				35	9.10	2100	0.15
				40	9.10	2400	0.15
				45	9.10	2700	0.15
				50	9.10	3000	0.15
				55	9.10	3300	0.15
				60	9.10	3600	0.15

$$K_{(m/sec)} = \frac{D^2}{8L(t_2 - t_1)} \ln \left(\frac{L}{D} \right) \ln \left(\frac{H_1}{H_2} \right)$$



APPENDIX 5. GROUNDWATER & DAILY BOREHOLE WATER LEVEL MEASUREMENTS



DAR AL-HANDASAH NAZIH TALEB & PARTNERS
دارالهندسة نزيح طالب وشريك

Founded 1956

BISRI DAM PIEZOMETRIC SURVEY DATED JULY 10, 2014

Piezometer	Depth of groundwater table (m) from the NGL (July 10, 2014)	NGL (Updated on December 2013)	Depth of groundwater table as project level (July 10, 2014)
BDC-2	26.49	443.16	416.7
BDC-3	12.19	428.353	416.2
BDC-4	16.3	428.585	412.3
BDC-5	45.53	454.435	408.9
BDC-6	21.71	417.86	396.2
BDC-7	7.1	416.33	409.2
BDC-8	41.6	440.584	399.0
BCD-9	26.45	422.417	396.0
BCD-12	17.93	413.74	395.8
BDC-13	15.29	410.7	395.4
BDC-18	2.45	398.35	395.9
BDC-26	73.11	437.8	364.7
BDC-27	50.58	433.202	382.6
BDC-28	36.3	439.6	403.3
BDC-32	59.47	490.22	430.8
EV2	3.79	401.7	397.91
EV3	Artesian flow	398.29	Artesian flow
EV7	Artesian flow	396	Artesian flow
EV10	20.33	420.2	399.87
VF2	6.13	414.92	408.79
VF3	6.11	414.45	408.34
VF4	6.15	419.19	413.04
BHVL1	0.62	396.57	395.95
BHLA1	35.77	431.5	395.73
BHLA2	55.36	459.4	404.04
BHVR3	9.1	413.8	404.7
BHVR5	9.49	414.37	404.88
BHRA3	25.88	430.25	404.37
BHRA1	39.33	441.98	402.65
BHVR2	9.75	414.09	404.34
BHRA2	101.2	490.25	389.05
BHVR1	9.29	413.97	404.68
BHLA3	29.41	425.27	395.86
BHLA4	28.13	424.18	396.05
BHVR4	1.9	398.14	396.24
BHVR6	9.29	414.49	405.2

BISRI DAM PIEZOMETRIC SURVEY DATED JULY 18, 2014

Piezometer	Depth of groundwater table (m) from the NGL (July 18, 2014)	NGL (Updated on December 2013)	Depth of groundwater table as project level (July 18, 2014)
BDC-2	26.54	443.16	416.6
BDC-3	12.21	428.353	416.1
BDC-4	16.3	428.585	412.3
BDC-5	45.51	454.435	408.9
BDC-6	21.83	417.86	396.0
BDC-7	7.07	416.33	409.3
BDC-8	41.72	440.584	398.9
BCD-9	26.42	422.417	396.0
BCD-12	17.9	413.74	395.8
BDC-13	15.3	410.7	395.4
BDC-18	2.47	398.35	395.9
BDC-26	72.33	437.8	365.5
BDC-27	50.61	433.202	382.6
BDC-28	36.61	439.6	403.0
BDC-32	59.2	490.22	431.0
EV2	3.81	401.7	397.89
EV3	Artesian flow	398.29	Artesian flow
EV7	Artesian flow	396	Artesian flow
EV10	20.28	420.2	399.92
VF2	6.33	414.92	408.59
VF3	6.07	414.45	408.38
VF4	6.21	419.19	412.98
BHVL1	0.67	396.57	395.9
BHLA1	35.81	431.5	395.69
BHLA2	55.73	459.4	403.67
BHVR3	8.98	413.8	404.82
BHVR5	9.77	414.37	404.6
BHRA3	25.93	430.25	404.32
BHRA1	39.29	441.98	402.69
BHVR2	9.81	414.09	404.28
BHRA2	100.87	490.25	389.38
BHVR1	9.75	413.97	404.22
BHLA3	29.53	425.27	395.74
BHLA4	27.96	424.18	396.22
BHVR4	2	398.14	396.14
BHVR6	9.68	414.49	404.81

BISRI DAM PIEZOMETRIC SURVEY DATED JULY 31, 2014

Piezometer	Depth of groundwater table (m) from the NGL (July 31, 2014)	NGL (Updated on December 2013)	Depth of groundwater table as project level (July 31, 2014)
BDC-2	26.56	443.16	416.6
BDC-3	12.2	428.353	416.2
BDC-4	16.29	428.585	412.3
BDC-5	45.48	454.435	409.0
BDC-6	21.88	417.86	396.0
BDC-7	7.11	416.33	409.2
BDC-8	41.71	440.584	398.9
BCD-9	26.53	422.417	395.9
BCD-12	17.92	413.74	395.8
BDC-13	15.3	410.7	395.4
BDC-18	2.42	398.35	395.9
BDC-26	71.82	437.8	366.0
BDC-27	50.65	433.202	382.6
BDC-28	36.7	439.6	402.9
BDC-32	59.27	490.22	431.0
EV2	3.8	401.7	397.9
EV3	Artesian flow	398.29	Artesian flow
EV7	Artesian flow	396	Artesian flow
EV10	20.3	420.2	399.9
VF2	6.49	414.92	408.43
VF3	6.04	414.45	408.41
VF4	6.42	419.19	412.77
BHVL1	0.77	396.57	395.8
BHLA1	35.83	431.5	395.67
BHLA2	55.97	459.4	403.43
BHVR3	9.3	413.8	404.5
BHVR5	10.3	414.37	404.07
BHRA3	25.96	430.25	404.29
BHRA1	39.31	441.98	402.67
BHVR2	9.83	414.09	404.26
BHRA2	100.98	490.25	389.27
BHVR1	9.92	413.97	404.05
BHLA3	29.75	425.27	395.52
BHLA4	27.98	424.18	396.2
BHVR4	1.95	398.14	396.19
BHVR6	9.77	414.49	404.72

BISRI DAM PIEZOMETRIC SURVEY DATED AUGUST 11, 2014

Piezometer	Depth of groundwater table (m) from the NGL (August 11, 2014)	NGL (Updated on December 2013)	Depth of groundwater table as project level (August 11, 2014)
BDC-2	26.55	443.16	416.6
BDC-3	12.18	428.353	416.2
BDC-4	16.29	428.585	412.3
BDC-5	45.5	454.435	408.9
BDC-6	21.92	417.86	395.9
BDC-7	7.09	416.33	409.2
BDC-8	41.66	440.584	398.9
BCD-9	26.55	422.417	395.9
BCD-12	17.99	413.74	395.8
BDC-13	15.31	410.7	395.4
BDC-18	2.39	398.35	396.0
BDC-26	71.56	437.8	366.2
BDC-27	50.67	433.202	382.5
BDC-28	36.8	439.6	402.8
BDC-32	59.25	490.22	431.0
EV2	3.78	401.7	397.92
EV3	Artesian flow	398.29	Artesian flow
EV7	Artesian flow	396	Artesian flow
EV10	20.29	420.2	399.91
VF2	6.52	414.92	408.4
VF3	6.01	414.45	408.44
VF4	6.44	419.19	412.75
BHVL1	0.8	396.57	395.77
BHLA1	35.8	431.5	395.7
BHLA2	56.11	459.4	403.29
BHVR3	9.29	413.8	404.51
BHVR5	10.42	414.37	403.95
BHRA3	26	430.25	404.25
BHRA1	39.22	441.98	402.76
BHVR2	9.8	414.09	404.29
BHRA2	101.15	490.25	389.1
BHVR1	10.22	413.97	403.75
BHLA3	29.86	425.27	395.41
BHLA4	27.98	424.18	396.2
BHVR4	2.01	398.14	396.13
BHVR6	10.03	414.49	404.46

BISRI DAM PIEZOMETRIC SURVEY DATED AUGUST 20, 2014

Piezometer	Depth of groundwater table (m) from the NGL (August 20, 2014)	NGL (Updated on December 2013)	Depth of groundwater table as project level (August 20, 2014)
BDC-2	26.61	443.16	416.6
BDC-3	12.21	428.353	416.1
BDC-4	16.35	428.585	412.2
BDC-5	45.52	454.435	408.9
BDC-6	21.98	417.86	395.9
BDC-7	7.19	416.33	409.1
BDC-8	41.86	440.584	398.7
BCD-9	26.57	422.417	395.8
BCD-12	17.97	413.74	395.8
BDC-13	15.27	410.7	395.4
BDC-18	2.31	398.35	396.0
BDC-26	70.83	437.8	367.0
BDC-27	50.72	433.202	382.5
BDC-28	36.96	439.6	402.6
BDC-32	59.33	490.22	430.9
EV2	3.92	401.7	397.78
EV3	Artesian flow	398.29	Artesian flow
EV7	Artesian flow	396	Artesian flow
EV10	20.26	420.2	399.94
VF2	6.87	414.92	408.05
VF3	5.98	414.45	408.47
VF4	6.66	419.19	412.53
BHVL1	0.91	396.57	395.66
BHLA1	35.83	431.5	395.67
BHLA2	56.49	459.4	402.91
BHVR3	9.38	413.8	404.42
BHVR5	10.56	414.37	403.81
BHRA3	26.11	430.25	404.14
BHRA1	39.29	441.98	402.69
BHVR2	9.92	414.09	404.17
BHRA2	101.07	490.25	389.18
BHVR1	10.58	413.97	403.39
BHLA3	29.96	425.27	395.31
BHLA4	28.02	424.18	396.16
BHVR4	2.16	398.14	395.98
BHVR6	10.41	414.49	404.08

BISRI DAM PIEZOMETRIC SURVEY DATED AUGUST 29, 2014

Piezometer	Depth of groundwater table (m) from the NGL (August 29, 2014)	NGL (Updated on December 2013)	Depth of groundwater table as project level (August 29, 2014)
BDC-2	26.65	443.16	416.5
BDC-3	12.15	428.353	416.2
BDC-4	16.36	428.585	412.2
BDC-5	45.59	454.435	408.8
BDC-6	22.08	417.86	395.8
BDC-7	7.31	416.33	409.0
BDC-8	42.12	440.584	398.5
BCD-9	26.64	422.417	395.8
BCD-12	18.11	413.74	395.6
BDC-13	15.35	410.7	395.4
BDC-18	2.31	398.35	396.0
BDC-26	70.24	437.8	367.6
BDC-27	50.79	433.202	382.4
BDC-28	37.41	439.6	402.2
BDC-32	59.5	490.22	430.7
EV2	4.01	401.7	397.69
EV3	Artesian flow	398.29	Artesian flow
EV7	Artesian flow	396	Artesian flow
EV10	20.25	420.2	399.95
VF2	6.94	414.92	407.98
VF3	5.92	414.45	408.53
VF4	6.76	419.19	412.43
BHVL1	1.01	396.57	395.56
BHLA1	35.9	431.5	395.6
BHLA2	56.84	459.4	402.56
BHVR3	9.53	413.8	404.27
BHVR5	10.85	414.37	403.52
BHRA3	26.34	430.25	403.91
BHRA1	39.33	441.98	402.65
BHVR2	10.04	414.09	404.05
BHRA2	101.11	490.25	389.14
BHVR1	10.79	413.97	403.18
BHLA3	30.14	425.27	395.13
BHLA4	28.09	424.18	396.09
BHVR4	2.24	398.14	395.9
BHVR6	10.62	414.49	403.87

BHVR6	DATE	Morning	Evening
	4/26/2014		4.88
	4/28/2014	9.3	4.45
	4/29/2014	8.76	3.2
	5/14/2014	9.37	2.4
	5/15/2014	8.55	4.88
	5/16/2014	9.15	5.55
	6/4/2014	9.28	3.35
	6/23/2014	9.25	8.3
	6/24/2014	9.3	3
	6/25/2014	9.45	1
	6/26/2014	8.99	2
	6/27/2014	9.29	0.5
	6/28/2014	9	1.03
	7/5/2014	9.29	9.82

APPENDIX 6. LIST OF SAMPLING & LABORATORY TESTING
PROGRAM - LEBANON: PACKAGE 3 / MOROCCO:
PACKAGE 2



DAR AL-HANDASAH NAZIH TALEB & PARTNERS
دار الهندسة نزيح طالب وشريك

BISRI Dam Project: Geo. Inv. Report VII: (Factual) / Dam-Footprint - September 2014

Bisri Dam Laboratory Testing Program - Third Package / Lebanon

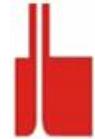


DAR AL HANDASAH NAZIH TALEB & PARTNERS consulting engineers
دار الهندسة نزيه طالب وشركاه للتصميم والاستشارات الفنية

Sampling

Sampling				Testing												
No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)				Soil				Rock			
BHVR6	2.5	SPT	Yellowish brown very clayey SILT	26.04.2014	1	Moisture Content	15		1	Consolidation	0			0		
	5.5		Yellowish brown silty CLAY	26.04.2014	1	Void Ratio	10		1	Atterberg	10			0		1
	8.5		Brown clayey SILT	26.04.2014	1	Sieve	15		1	Organic Content	6			0		
	11.5		Grey slightly clayey SILT	26.04.2014	1	Hydrometer	10		1	Bulk and Saturated Density	12			0		1
	14.5		Yellowish brown silty fine SAND (NP)	28.04.2014	1	UCS	0		1	Uni-axial CS (Saturated)	0			0		
	22.5		Olive brown slightly gravelly coarse to medium SAND	28.04.2014	1	Triaxial (CU+U)	0		1	PLI (Saturated)	0			0		1
	27		Olive brown slightly gravelly coarse to medium SAND	29.04.2014	1	Shear box-0.2 mm/min	0		1	Water Absorption	0			0		
	28.5		Olive brown medium to fine SAND	29.04.2014	1				1	Unit Weight (Saturated)	0			0		1
	30		Olive brown slightly gravelly coarse to medium SAND	29.04.2014	1				1	Soundness ($MgSO_4$)	0			0		
	32.5		Brown slightly clayey SILT	29.04.2014	1				1	Slake Durability	0			0		
	38.5		Olive brown silty CLAY	14.05.2014	1				1	Calcium Carbonate	0			0		
	44.5		Olive brown very clayey SILT	15.05.2014	1				1	Sulfate, Chloride, PH	7					
	47.5		Olive brown silty CLAY	15.05.2014	1				1							
	57.5		Olive brown silty CLAY	04.06.2014	1				1							
	68		Olive brown silty CLAY	23.06.2014	1				1							

Bisri Dam Laboratory Testing Program - Third Package / Lebanon



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Sampling

Bisri Dam Laboratory Testing Program - Third Package / Lebanon



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دار الْهَنْدَسَةِ نَازِحٌ طَالِبٌ وَشَرَكَةٌ لِلْمُهَندَّسَاتِ الْفَنِيَّةِ

Sampling

Testing

No. of BH	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling		Unit (U)	Soil						Rock						General Total	25		
							Moisture Content	Void Ratio	Sieve	Hydrometer	UCS	Triaxial (CU+U)	Shear box-0.2 mm/min	Consolidation	Atterberg	Organic Content	Bulk and Saturated Density	Uni-axial CS (Saturated)	PLI (Saturated)	Water Absorption	Unit Weight (Saturated)	Soundness ($MgSO_4$)
BHLA3	11.5-11.7	Core	Beige slightly dolomitic sandy LIMESTONE	02.06.2014													1	1	1	1	1	1
	46.3-46.5		Light olive brown LIMESTONE	09.06.2014													1	1	1	1	1	1
BHLA4	16.3-16.5	Core	Light olive brown LIMESTONE	13.06.2014													1	1	1	1	1	1
	36.5-36.8		Light olive brown and beige LIMESTONE	16.06.2014													1	1	1	1	1	1
	50.4-50.7		Light olive brown and beige LIMESTONE	17.06.2014													1	1	1	1		

Bisri Dam Laboratory Testing (Morocco) - Undisturbed Soil Samples (Second Package)																																											
Sampling						Testing																																					
No. of BH	Depth of Sampling (m)	Type of Sampling	Sample Description	Date of Sampling	Unit (U)	Moisture Content	10	Void Ratio	0	Sieve	10	Hydrometer	10	UCS	0	Triaxial (CU+U)	5	Triaxial (CD)	0	Consolidation	5	Atterberg	10	Atterberg	10	Uni-axial CS	0	PLI	0	Water Absorption	0	Unit Weight	0	Soundness	0	Slake Durability	0	Calcium Carbonate	0	Sulfate, Chloride, PH	5	General Total	65
BHVR1	61.5-62m	Shelby	Undisturbed	As per ID card		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	62-62.5m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	70.5-71m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	71-71.5m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
BHVR6	79.5-80m	Shelby	Undisturbed	As per ID card		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	80-80.5m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	91.5-92m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	92-92.5m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	100.5-101m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
	101-101.5m					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									

BISRI DAM LABORATORY TESING - NEW TEST PITS / SAND & GRAVEL / LEBANON						Testing																	
Sampling																							
No. of Test Pit	Depth of Sampling (m)	Type of Sample	Sample Description	Date of Sampling	Unit (U)	Sieve (including Cobbles and Boulders)	Sand Equivalent	Clay Content	Atterberg Limits (passing sieve No.40)	Specific Gravity	Bulk (moist) and Saturated Density	Void Ratio	Field Density (Sand-cone method)	In-situ moisture content (Speedy)	Proctor Density	Soaked CBR at 100%	Proctor Density	LA (500 Revolutions)	Soundnes	Organic Content	AAR (Alkali aggregate reactions)	Sulfate, Chloride, PH	General Total
NTP9	0.7	Bulk	Slightly silty SAND.		Sieve (including Cobbles and Boulders)	13				13													
	2		Very gravelly SAND with few Cobbles.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP10	2	Bulk	SAND and GRAVEL with few Cobbles.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	3.5				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP11	1.7	Bulk	SAND and GRAVEL with some Cobbles.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	4				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP12	1.5	Bulk	SAND and GRAVEL with few Cobbles.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	3				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP13	1.5	Bulk	SAND and GRAVEL with many Cobbles.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	3.5				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP14	1.4	Bulk	SAND and GRAVEL with many Cobbles		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	3.4				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP15	1.8	Bulk	SAND and GRAVEL with some Cobbles and few Boulders.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		

BISRI DAM LABORATORY TESING - NEW TEST PITS / SAND & GRAVEL / LEBANON							Testing																			
Sampling																										
No. of Test Pit	Depth of Sampling (m)	Type of Sample	Sample Description			Date of Sampling	Unit (U)		Sieve (including Cobbles and Boulders)	Sand Equivalent	Clay Content	Atterberg (passing sieve No.40)	Specific Gravity	Bulk (moist) and Saturated Density	Void Ratio	Field Density (Sand-cone method)	In-situ moisture content (Speedy)	Proctor Density	Soaked CBR at 100%	Proctor Density	LA (500 Revolutions)	Soundness	Organic Content	AAR (Alkali aggregate reactions)	Sulfate, Chloride, PH	General Total
NTP16	1.7	Bulk	SAND and GRAVEL with some Cobbles and Boulders.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	3.5							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP17	1.8	Bulk	SAND and GRAVEL with some Cobbles and Boulders.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP18	1	Bulk	SAND and GRAVEL with some Cobbles and Boulders.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP19	0.4	Bulk	SAND and GRAVEL.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	1.2		Gravely SAND.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP20	0.8	Bulk	SAND and GRAVEL with few Cobbles.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP21	1.5	Bulk	SAND and GRAVEL with few Cobbles.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	3.5							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
NTP22	1	Bulk	SAND and GRAVEL with Cobbles and Boulders.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
NTP23	1.5	Bulk	SAND and GRAVEL with Cobbles and Boulders.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	