Geological Investigation
for
the Broadlands Hydropower Project

Appendix

CHAPTER 1

CORE DRILLING

1.1 Bore Hole Logs

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- DIVERSION TUNNEL,KEHELGAMU OYA,LEFT BANK | **B.H No.: DT 01**

DRILLING DATA		BOREHOLE DATA
STARTED :	**20/12/02**	X-COORDINATE :164,981.324m
COMPLETED :	**29/12/02**	Y-COORDINATE :198,303.675m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :122.771m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :97.271m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :25.50m
FOREMAN :	**KRNK**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N°VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00															
1					1.00	0.45	31									Brown colour, densed,clayey silty sand with weathered rock particles 1.45m					1
					23 / 12																
					1.40																
2					29 / 12			Joint at 1.91m(45^0) (Partly weathered joint surface)								Fresh to slightly weathered rock of biotite gneiss 2.00m		30	12		2
	20							Vertical joint at 2.26-2.50m (Fresh tight joint surface)								Fresh rock of biotite gneiss			64		
								Joint at 2.50m(65^0) (Smooth joint surface filled with greenish material)			1		Nil								
3											4		0.40								3
											7		0.70								
									1.45	6.45	10		1.90	0	5*10^{-6}						
4											7		1.10								4
											4		0.90								
											1		0.40								
5			Grey																		5
								Joint at 5.43m(55^0) (Weathered rough joint surface)											80		
6								Joint at 5.92m(55^0) (Iron stained joint surface)													6
	21																				
7																7.00m					7
								Sub vertical joint at 7.12-7.50m (Fresh tight joint surface)								Fractured, fresh rock of biotite gneiss			46		
								Joint at7.68m(20^0) (Iron stained, rough joint surface)								(Rock broken into pieces due to joints) 8.00m					
8											1		0.80								8
											4		0.80			Fresh rock of biotite gneiss					
											7		1.20								
									6.45	11.45	10		1.60	0	4*10^{-6}						
9											7		0.90								9
											4		0.60								
	22										1		0.50			9.40m					
10																Fresh rock of garnetiferous quartz rich gneiss					10
11			Greyish white													11.00m					11
																Fresh rock of garnet biotite gneiss Some pyrites available					
12																					12
13																					13

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROUGHNESS, PERSISTENCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
								Foliation joint at13.20m(65^0) (Smooth slickensided joint)			1		Nil			Fresh rock of garnet biotite gneiss Mica rich band from 14.00-14.30m			60		
14	23							Joint at13.33m(58^0) (Fresh joint surface) Joint at13.93m(45^0)(Fresh joint surface)			4 7		0.10 0.40								14
								Foliation joint at14.09m(40^0) (Fresh joint surface)	11.45	16.45	10 7		1.10 0.50	0	3*10^{-5}	14.20m Fresh rock of quartzite Some garnets					
15	27										4 1		Nil Nil								15
16																16.00m					16
	28							Subvertical joint at 16.55-16.75m (Rough, irregular joint filled with thing film of greenish material & this goes along biotite rich band,Mica & pyrites available at the joint) Joint at16.78-16.94m(70^0)(Rough,irregular joint surface)								Fresh rock of quartz rich biotite gneiss			38 65		
17																17.73m					17
								Joints at 17.57(60^0) & 17.77(40^0) (Joints partly filled with calcitic gauge)			1 4		Nil 0.60			Fresh rock of Calc gneiss					
18											7		0.60			18.15m			48		18
								Subvertical joint at 16.55-16.75m (Joint filled with calcitic gauge)	16.45	21.45	10 7		0.90 0.30	0	2*10^{-6}	Fresh rock of biotite gneiss 18.88m					
19											4 1		Nil Nil			Fresh rock of Calc gneiss					19
20			Greyish white													19.94m					20
								Joints at 20.18m(20^0),20.18m(50^0), 20.22m(55^0),20.27m(60^0) Joints at 20.28-20.43m(73^0), 20.50-20.68m(73^0), 20.84-20-21.00m(73^0) (Joints partly filled with calcitic gauge) Joints at 21.10-21.30m(70^0), 20.31-21.49m(70^0), 21.50-22.00m(70^0) (Joint filled with calcitic gauge)								Fresh, fractured rock of quartz rich garnetiferous biotite gneiss					
21																21.50m					21
22																Fresh, fractured rock of quartz rich garnetiferous biotite gneiss					22
											1		Nil			Rock broken into pieces due to major joint pattern					
											4		0.80								
23											7		1.10								23
								Sub vertical joint at 23.30-23.64m (Joint partly filled with calcitic gauge)	21.45	25.50	10 7 4		1.60 0.80 1.10	0	5*10^{-5}	23.20m Fresh, fractured rock of quartz rich garnetiferous biotite gneiss			40		
24											1		0.30								24
25								Foliation joint at24.57m(40^0) (Joint goes along biotite rich layer)													25
	29							Foliation joint at25.32m,25.48, 25.53m(450)(Fresh joint surface)								25.60m			44		
26								**BOREHOLE COMPLETTED AT 25.60M**													26
27																					27
28																					28
29																					29
30																					30

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars) Manometer Reading	WATER LOSS	(total(liters)/time(min)	LUGEON of K(m/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
31																				31
32																				32
33																				33
34																				34
35																				35
36																				36
37																				37
38																				38
39																				39
40																				40
41																				41
42																				42
43																				43
44																				44
45																				45
46																				46
47																				47

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN DAM AXIS,RIGHT BANK — **B.H No.: MB 01**

DRILLING DATA		BOREHOLE DATA
STARTED :	**25/10/02**	X-COORDINATE :164,717.431m
COMPLETED :	**2002/11/4**	Y-COORDINATE :197,640.971m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :122.585m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :81.815m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :40.77m
FOREMAN :	**WLN**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS	JOINT SEPARATION
VR= very rough	V= very tight
R: rough	T= tight
SR: slightly rough	MO= moderately open
S= smotth	O= open
SL=slickensided	

JOINT SPACING	OTHER SYMBOLS
VW= very widely> 2m	SL/CW - Soil & Completely Weathered
W= widely	HW - Highly Weathered
MW= moderately wide	MW - Moderately Weathered
C= Closely	SW - Slightly Weathered
VC= very closely	TCR - Total Core Recovery
	RQD - Rock Quality Designation
	GWL - Ground water Level

LEGEND FOR GRAPHIC LOG

Sand; Clay; Fresh to slightly weathered charnockite; Highly to mod weathered charnockite; Fresh to slightly weathered biotite gneiss; Highly to mod weathered biotite gneiss; Quartzite; Calc gneiss; Boulder

TCR | ROD | WEATHERING: SL/CW, HW, MW, SW

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N° VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
0						0.00									Brown to whitish brown colour					0
						0.45	6								clayey silt with few quartz sand					
1			Light brown												1.00m					1
	25							Joint at 1.40m(30°)(Joint surface weathered into rock & rough joint filled with silty clay)							Highly weathered rock 1.48m					
2			Dark brown to dark grey												Fresh rock of charnockitic gneiss 2.36m					2
					2.25			Joint at 2.41m(60°) & 2.53m(55°)							Highly to mod . weathered rock of acidic charnockite					
					2.60			(Weathered, rough joint surfaces)							Moderately weathered rock of biotite schist 2.95m					
3					27 / 10			Subvertical joint at 3.00m(Highly weathered, rough joint surface filled with clayey material)							Highly weathered rock/Rock in pieces		71			3
								Joint at 3.35m(55°)(Joint surface weathered into rock & rough joint filled with white gauge)							Fresh rock of charnockitic gneiss					
4								Joint at 3.75m(35°)(Fresh tight joint)												4
5								Joint at 5.16m(48°) (partly iron stained smooth joint surface)												5
											1	0.50								
								Joint at 5.85m(48°) (Fresh joint filled with			4	2.10								
6								thing film of brownish material)			7	5.50								6
									4.35	9.08	10	16.00	3	$4*10^{-5}$	Quartz rich band from 6.15m-7.30m					
											7	5.80								
											4	1.90								
7	26										1	0.20								7
								Joint at 7.31m(15°)(Fresh tight joint)												
8			Light grey																	8
9																				9
	27																			
10																				10
											1	Nil								
											4	Nil								
											7	0.02								
11									9.08	14.22	10	0.05	0	$1*10^{-7}$						11
	29										7	0.03								
											4	Nil								
12											1	Nil								12
															Biotite rich band from11.93m to 12.38m					
13																				13

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY							GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N° VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
14																Fresh rock of charnockitic gneiss					14
15																					15
16											1		Nil								16
											4		Nil								
											7		0.02								
17									14.22	19.31	10		0.60	0	$2*10^{-7}$						17
											7		0.03								
											4		Nil								
18											1		Nil								18
19																					19
	30																				
20																Biotite rich band from19.56m to 20.13m					20
21											1		Nil								21
											4		Nil								
								Joint at 21.46m(60^0) (Fresh joint filled with			7		0.02								
								thing film of yellowish material)	19.31	24.17	10		0.50	0	$1*10^{-7}$						
											7		0.20								
22	31		Light brown								4		Nil			Biotite rich band from 21.95m to					22
								Foliation joints at 22.27,22.29 &			1		Nil			22.14m					
								$22.32m(15^0)$ (Rough joint filled with thing													
23								film of greyish material)													23
24																					24
	1																				
25																					25
26											1		Nil								26
											4		0.01								
											7		0.03								
27									24.17	29.74	10		0.06	0	$1*10^{-7}$						27
											7		0.02								
											4		Nil								
28											1		Nil								28
29																					29
30																					30

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N° VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
31															Fresh rock of charnockitic gneiss					31
	2										1		Nil							
											4		Nil							
											7		0.04							
32									29.74	34.27	10		0.08	0	$2*10^{-7}$					32
											7		0.05							
											4		Nil							
33											1		Nil							33
34																				34
35																				35
36			Light brown								1		Nil							36
											4		Nil							
											7		0.30							
37									34.27	40.77	10		0.09	0	$2*10^{-7}$					37
											7		0.04							
											4		0.01							
	3										1		Nil							
38																				38
39																				39
40																				40
	4															40.77m				
41								**BOREHOLE COMPLETTED AT 40.77M**												41
42																				42
43																				43
44																				44
45																				45
46																				46

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-MAIN DAM AXIS,RIGHT BANK — **B.H No.: MB 02**

DRILLING DATA		BOREHOLE DATA
STARTED :	**2002/10/11**	X-COORDINATE :164,701.313m
COMPLETED :	**18/10/02**	Y-COORDINATE :197,626.567m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :109.430m
DRILLING METHOD :	**ROTARY**	ELEVATI ON (BOTTOM) :69.300m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :40.13m
FOREMAN :	**WLN**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | ROD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILL WATER (COLOR, LOSS)	RATE OF DRILLING	WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
1								Joint at 0.30-0.46m(70^0)							Fresh rock of charnockitic gneiss		75	57, 75, 84		1
								Joint at 0.52m(20^0)												
								(partly iron stained rough joint surfaces)												
								Joint at 1.22m(40^0)												
								(Iron stained rough joint surfaces)												
								Joint at 1.42-1.58m(70^0)												
2					1.70			Joint at 1.68-1.76m(70^0)(Iron stained,									37			2
					18 / 10			slightly weathered joint surfaces)												
					2.20															
					2.45						1	0.35								
3					2.60						4	2.02								3
					12 / 10						7	3.80								
					3.10			Parallel joints at 3.64m & 3.67m(5^0)	1.00	5.30	10	6.35	1	2*10^{-5}						
					13,14 /10			(Iron stained, weathered joint surfaces)			7	4.10								
	11										4	1.98								
4											1	0.42								4
5																				5
6																				6
7			Whitish grey								1	0.01								7
											4	0.02								
											7	0.03								
	12								5.30	9.85	10	0.05	0	1*10^{-7}						
8											7	0.04								8
											4	0.01								
											1	Nil								
9																				9
	13																			
10																				10
											1	Nil								
											4	0.01			Biotite rich band at 10.82m-10.92m					
11											7	0.03								11
									9.85	14.80	10	0.05	0	1*10^{-7}						
											7	0.02								
											4	0.01								
12											1	Nil								12
13																				13

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liter)/hme(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14																Fresh rock of charnockitic gneiss					14
15																					15
16	14																				16
17								Joint at 16.37m(45^0) (Smooth mica rich joint surface)	14.80	19.54	1 4 7 10 7		Nil 0.01 0.02 0.04 0.03	0	1*10^{-7}	Biotite rich band at 16.35m-16.55m					17
18											4 1		0.01 Nil			Biotite rich band at 17.35m-17.46m Biotite rich band at 17.89m-18.05m					18
19																					19
20																					20
21								Foliation joints at 20.82 &20.86m (30^0) (Fresh, tight joints)			1 4 7		Nil Nil 0.01								21
22			Whitish grey						19.54	24.05	10 7 4		0.03 0.02 Nil	0	9*10^{-8}						22
23	15										1		Nil			23.22m					23
24																Fresh rock of pegmatite 23.66m Fresh rock of granulitic biotite gneiss					24
25								Foliation joint at 24.72m (30^0) (Fresh, tight joint)													25
26											1 4 7		Nil 0.01 0.02								26
27									24.05	29.93	10 7 4 1		0.04 0.03 Nil Nil	0	9*10^{-8}						27
28																					28
29	16																				29
30																					30

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
31															Fresh rock of granulitic biotite gneiss					31
32											1		Nil							32
											4		0.01							
											7		0.02							
33									29.93	35.25	10		0.04	0	$1*10^{-7}$					33
											7		0.02							
											4		Nil							
34											1		Nil							34
35			Whitish grey																	35
36																				36
37	17										1		Nil							37
											4		0.01							
											7		0.02							
38									35.25	40.13	10		0.04	0	$1*10^{-7}$					38
											7		0.02							
											4		0.01							
39											1		Nil							39
40	18															40.13m				40
41								**BOREHOLE COMPLETTED AT 40.13M**													41
42																				42
43																				43
44																				44
45																				45
46																				46

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-MAIN DAM AXIS,LEFT BANK

B.H No.: MB 03

DRILLING DATA		BOREHOLE DATA
STARTED :	**2002/12/6**	X-COORDINATE :164,673.670m
COMPLETED :	**21/12/02**	Y-COORDINATE :197,602.979m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :107.225m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :57.225m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :50.00m
FOREMAN :	**MRAMHP**	INCLINATION : Inclined (50^0)
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS	JOINT SEPARATION
VR= very rough	V= very tight
R: rough	T= tight
SR: slightly rough	MO= moderately open
S= smotth	O= open
SL=slickensided	
JOINT SPACING	OTHER SYMBOLS
VW= very widely> 2m	SL/CW - Soil & Completely Weathered
W= widely	HW - Highly Weathered
MW= moderately wide	MW - Moderately Weathered
C= Closely	SW - Slightly Weathered
VC= very closely	TCR - Total Core Recovery
	RQD - Rock Quality Designation
	GWL - Ground water Level

LEGEND FOR GRAPHIC LOG

Sand; Clay; Fresh to slightly weathered charnockite; Highly to mod weathered charnockite; Fresh to slightly weathered biotite gneiss; Highly to mod weathered biotite gneiss; Quartzite; Calc gneiss; Boulder

TCR | ROD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILL WATER (COLOR, LOSS)	RATE OF DRILLING	WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
0					0.00										Fresh rock of charnockitic gneiss					0
					From 17^{th}															
1																				1
					1.23															
					7 /12															
2											1	Nil								2
											4	Nil								
					2.38						7	0.03								
	6				2.60			Joint at 3.64m (30^0) (Fresh, tight joint)	0.65	5.00	10	0.05	0	$1*10^{-7}$						
					10 /12						7	0.02								
3											4	Nil								3
											1	Nil								
4																				4
5	7							Joint at 5.03m (60^0) (Partly chloritized, tight joint)													5
6																				6
7			Grey								1	Nil								7
											4	Nil								
											7	0.03								
									5.00	10.00	10	0.05	0	$1*10^{-7}$	Biotite rich band at 7.36m-7.56m					
8	9										7	0.03								8
											4	0.01								
											1	Nil								
9																				9
10																				10
11	10										1	Nil								11
											4	Nil								
											7	0.03								
									10.00	15.00	10	0.05	0	$1*10^{-7}$						
											7	0.04								
12											4	0.01								12
											1	Nil								
13																				13

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY							GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N` VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
14	11															Fresh rock of charnockitic gneiss					14
15																					15
16																					16
											1		Nil								
											4		0.03								
17	12										7		0.10								17
									15.00	20.00	10		0.15	0	$4*10^{-7}$						
											7		0.12								
											4		0.04			Biotite rich band at 17.58m-18.00m					
18								Joint at 18.05m (50^0) (Fresh, tight joint)			1		Nil								18
19																					19
20	13																				20
21																					21
								Foliation joint at 21.88m (30^0)													
			Grey					(Fresh, tight joint)			1		Nil								
22											4		0.06								22
											7		0.12			Biotite rich band at 21.88-22.42m					
									20.00	25.00	10		0.35	0	$9*10^{-7}$						
											7		0.28								
23											4		0.10								23
								Joint at 23.16m (37^0)			1		Nil								
								(Fresh,rough, tight joint)													
24	14							Joint at 24.05m (60^0)													24
								(Fresh,chloritized, tight joint)													
25																					25
26																					26
											1		Nil								
											4		Nil								
27											7		0.04								27
									25.00	30.00	10		0.07	0	$2*10^{-7}$						
											7		0.03								
											4		Nil								
28	16										1		Nil								28
29																					29
30																					30

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(litters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
								Joint at 30.57m (45^0)								Fresh rock of charnockitic gneiss					
								(Fresh,chloritized, tight joint)													
31																					31
											1		Nil								
32	17										4		Nil								32
								Foliation joint at 32.28m (55^0)			7		0.03								
								(Fresh, tight joint) Joint goes along biotite	30.00	35.00	10		0.05	0	$1*10^{-7}$	Biotite rich band at 32.28-32.50m					
								rich layer			7		0.03								
33											4		0.01								33
											1		Nil								
34																					34
35																					35
36	18																				36
											1		Nil								
											4		Nil								
37											7		0.02								37
									35.00	40.00	10		0.04	0	$1*10^{-7}$						
											7		0.03								
											4		Nil								
38											1		Nil								38
39			Grey																		39
40	19																				40
																40.40m					
41																Fresh rock of garnet biotite gneiss					41
											1		Nil								
											4		Nil								
42											7		0.02								42
									40.00	45.00	10		0.04	0	$1*10^{-7}$						
											7		0.02								
											4		Nil								
43											1		Nil								43
44																					44
45	20																				45
46																			83		46
								Joint at 46.46m (60^0)													
								Joint at 46.55m (60^0)													
47								(Fresh,chloritized, tight joints)													47

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOUR)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH FROM TOP	DEPTH TO BOTTOM	PRESSURE (bars)	Manometer Reading	WATER LOSS	(total(liters)/time(min)	LUGEON of K(m/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
48											1		Nil			Fresh rock of garnet biotite gneiss					48
											4		0.02							
											7		0.06							
49			Grey						45.00	50.00	10		0.14	0	$4*10^{-7}$					49
											7		0.07							
											4		0.02							
50	21										1		Nil			50.00m				50
								BOREHOLE COMPLETTED AT 50.00M												
51																				51
52																				52
53																				53
54																				54
55																				55
56																				56
57																				57
58																				58
59																				59
60																				60
61																				61
62																				62
63																				63
64																				64

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT
BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-MAIN DAM AXIS,LEFT BANK

B.H No.: MB 04

DRILLING DATA		BOREHOLE DATA
STARTED :	**26/12/02**	X-COORDINATE :164,658.747m
COMPLETED :	**2003/1/1**	Y-COORDINATE :197,585.707m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :116.814m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :76.814m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :40.00m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS	JOINT SEPARATION
VR= very rough	V= very tight
R: rough	T= tight
SR: slightly rough	MO= moderately open
S= smotth	O= open
SL=slickensided	
JOINT SPACING	OTHER SYMBOLS
VW= very widely> 2m	SL/CW - Soil & Completely Weathered
W= widely	HW - Highly Weathered
MW= moderately wide	MW - Moderately Weathered
C= Closely	SW - Slightly Weathered
VC= very closely	TCR - Total Core Recovery
	RQD - Rock Quality Designation
	GWL - Ground water Level

LEGEND FOR GRAPHIC LOG

Sand; Clay; Fresh to slightly weathered charnockite; Highly to mod weathered charnockite; Fresh to slightly weathered biotite gneiss; Highly to mod weathered biotite gneiss; Quartzite; Calc gneiss; Boulder

TCR | ROD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
0						0.00															0
						0.45	8										Yellowish brown soft silty clay(Top soil) 0.45m					
1																	Yellowish brown soft sandy clay 1.00m					1
					1.68												Boulder of weathered rock (Boulder has crushed into pieces)					
					28 /12	1.55																
2					1.95	2.00	17										2.00m					2
					29 /12												Yellowish brown,soft, silty clay					
3																	Highly to moderately weathered rock of garnet biotite gneiss					3
					3.85																	
					27 /12																	
4			Light brown																			4
								Joint at 4.48m(65^0)(Weathered ,rough, filled with clayey silt)											85			
5	26							100% water loss at 4.48m									4.88m					5
																	Fresh rock of charnockitic gneiss					
6																						6
7											1		Nil									7
											4		0.02									
											7		0.05									
8									5.40	10.00	10		0.08	0	2*10^{-7}							8
											7		0.06									
											4		0.03									
9											1		Nil									9
			Grey														9.28m					
					9.39												Fresh rock of pegmatite					
					31 / 12																	
10																						10
					10.19																	
					1 / 1																	
11											1		Nil				11.10m					11
																	Fresh rock of charnockitic gneiss					
											4		0.04									
											7		0.08									
12	27								5.00	15.00	10		0.13	0	3*10^{-7}							12
											7		0.09									
											4		0.40									
											1		Nil									
13																						13

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
14															Fresh rock of charnockitic gneiss					14
								Joint at 14.20m (60^0) (Fresh, tight joint)												
15								Joint at15.04m(10^0)												15
								(Partly iron stained rough joint surface)												
16																				16
								Foliation joints at 16.50 & 16.53m (60^0)												
								(Fresh, tight joints)												
17											1		Nil							17
					17.23						4		0.03							
					30 / 12			Joint at 17.63m (50^0) (Fresh, tight joint)			7		0.06							
	28								15.00	20.00	10		0.10	0	3*10^{-7}					
18								Joint at 17.92m (45^0) (Fresh, tight joint)			7		0.06							18
								Foliation joints at 18.06,18.15,18.23,			4		0.04			Biotite rich layers appeared & rock		63		
								18.48 &18.93m (60^0)			1		Nil			is jointed along this layers				
								(Fresh, tight joints)												
19																				19
								Foliation joint at 19.25m (50^0)												
								(Fresh, tight joint)												
20																				20
21																				21
								Rock in pieces due to joints										46		
								(Chloritized, tight joint-may be foliation joints)								Rock in pieces(From 21.00-21.56m)				
											1		0.02			Maximum-5cm				
22			Grey					Joint at 22.33-22.52m (75^0)(Chloritized, tight joint)			4		0.16							22
								Foliation joint at 22.68-22.98m (75^0)			7		0.28					30		
								(Chloritized,slickensided, tight joint)	20.00	25.00	10		0.45	0	1*10^{-6}					
								Joint at 22.80m (30^0) (Chloritized, tight joint)			7		0.30							
23								Joints at 22.90 & 22.96m (50^0)			4		0.18							23
								(Chloritized,slickensided, tight joint)			1		0.03					70		
								Vertical joint at 23.00-23.30m (50^0)												
								(Fresh, tight joint)												
24																				24
25	29																			25
26																				26
											1		Nil							
											4		Nil							
27											7		0.04							27
									25.00	30.00	10		0.08	0	3*10^{-7}					
											7		0.05							
											4		0.02							
28											1		Nil							28
29																				29
30																				30

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
31																				31
											1		Nil							
											4		0.03							
32											7		0.18							32
									30.00	35.00	10		0.25	0	$6*10^{-7}$					
											7		0.19							
											4		0.04							
33											1		Nil							33
34	30																			34
35			Grey													Fresh rock of charnockitic gneiss 34.80m					35
																Fresh rock of calc. gneiss Mica rich band at 35.59-35.73m & core is partly washed out at this band					
36																				36
																		85		
								Joints at 36.55 & 36.88m(45^0)												
								(Joint filled with thing film of calcitic gauge)			1		Nil							
37											4		0.03							37
											7		0.18					73		
									35.00	40.00	10		0.25	0	$6*10^{-7}$					
								Vertical joint at 37.65-37.92m			7		0.19							
38								(Joint filled with thing film of calcitic gauge)			4		0.04							38
											1		Nil							
39																39.00m				39
																Fresh rock of charnockitic gneiss				
40	31															40.00m				40
								BOREHOLE COMPLETTED AT 40.00M												
41																				41
42																				42
43																				43
44																				44
45																				45
46																				46

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- CONDUIT TRACE

B.H No.: CT 1

DRILLING DATA		BOREHOLE DATA
STARTED :	**21/11/2002**	X-COORDINATE :164,584.150m
COMPLETED :	**24/11/2002**	Y-COORDINATE :197,638.873m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :121.883m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :101.883m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :20.00m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00									Brown to muddy brown, sandy silty clay.(some weathered rock fragments) 0.45m					
						0.45	4														
1															Yellowish brown colour,loose, clayey silty sand (some weathered rock fragments) 1.55m					1
						1.55															
2						2.00	5								Yellowish brown colour,soft sandy clay 2.00m					2
															Redish yellowish brown, loose,silty clayey sand (Lateritic Soil)					
3																				3
						3.00															
						3.45	7														
4															4.00m					4
															Yellowish brown,soft sandy clay					
						4.55															
5						5.00	4								5.00m					5
															Redish brown to yellowish brown, loose,clayey silty sand					
6																				6
					6.28	6.00															
					24/11	6.45	8														
					6.78																
7					23/11																7
						7.55															
8						8.00	2								8.00m					8
															Whitish brown micacious, very smooth,soft feldspathic inorganic clay (Highly decomposed formation)					
9					9.10																9
					22/11	9.00															
						9.45	4														
10	21																				10
						10.55															
11						11.00	9														11
						11.55															
						11.72	50HB								11.72m					
12															Fresh rock of charnokitic gneiss		78	36		12
			Grey					Joints at 12.00m(50°) &12.33m(30°) (iron stained, rough joint surfaces)													
13																				13

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14											1		Nil			Fresh rock of charnokitic gneiss					14
											4		Nil								
											7		0.05								
									12.50	15.35	10		0.07	0	$3*10^{-7}$						
											7		0.04								
											4		Nil								
15											1		Nil								15
	22															15.35m					
																Fresh rock of charnokitic gneiss					
								Joint at 15.72m(40^{o})								(High content of quartz)					
16								(Iron stained rough surface)								15.88m-16.00m weatheredportion.		81	81		16
								Joint at 16.46m(32^{o}) (tight joint)													
17			Grey								1		Nil								17
											4		0.12								
											7		0.20			Weathered portion from 17.67m to					
									15.35	20.00	10		0.28	0	$7*10^{-7}$	17.80m					
18											7		0.23								18
											4		0.13								
											1		Nil			18.51m					
19																Highly to moderately weathered rock of charnokitic gneiss			71		19
																19.17m					
																Fresh rock of charnokitic gneiss					
20								Joint at 19.85m(60^{o}) (fresh tight joint)											57			20
	23															20.00m					
21								**BOREHOLE COMPLETED AT 20.00M**														21
22																					22
23																					23
24																					24
25																					25
26																					26
27																					27
28																					28
29																					29
30																					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- CONDUIT TRACE — **B.H No.: CT 2**

DRILLING DATA		BOREHOLE DATA
STARTED :	**2002/2/11**	X-COORDINATE :164,321.890m
COMPLETED :	**2002/9/11**	Y-COORDINATE :197,892.802m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :113.713m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :98.213m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :15.50m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N°VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
1			Light brown													Highly to moderately weathered boulder of gneissic rock (Rock in pieces due to weathering and drilled with T/C casing bit)		66			1
					1.52																
					6 / 11																
2					2.10																2
					2.21			Joints at 2.21m(50°) ,2.50m(45°),								Fresh rock of charnockitic gneiss with little amount of garnets (From 1.70m to1.75m rock has slightly weathered)					
					2.29			2.53m(60°) & 2.83m(40°)													
					9 / 11			(Fresh tight joints)													
3	2																				3
								Joint at 3.05m(57°) (Fresh tight joint)													
4	6										1		Nil								4
											4		0.05								
											7		0.08								
									2.50	7.00	10		0.12	0	$3*10^{-7}$	4.17m					
											7		0.07			Fresh rock of garnetiforous biotite gneiss					
5								Sub vertical joint at 5.46-5.73m (weathered			4		0.04								5
								rough joint surface)			1		Nil					44			
								Joint at 5.87m(65°) (Tight, slightly iron stained joint surface)													
6								Sub vertical joint at 5.73-5.92m (Slightly													6
								weathered, rough, iron stained joint surface)											83		
								Joint at 6.65m(50°) (Tight, slightly iron stained joint surface)													
7																7.00m					7
																Fresh rock of garnetiforous biotite gneiss (Biotite% is less Quartz% & garnet% are high)					
8																					8
								Joint at 8.80m(55°) (Fresh tight joint)			1		Nil								
9	7										4		Nil								9
											7		0.02								
									7.00	12.00	10		0.05	0	$1*10^{-7}$	9.56m					
											7		0.03			Fresh rock of charnockitic gneiss					
10											4		0.02								10
											1		Nil								
11																					11
12																					12
13																					13

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY							GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N'VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
14	8		Grey						12.00	15.50	1 4 7 10		Nil Nil 0.02 0.05	0	$2*10^{-7}$	Fresh rock of charnockitic gneiss					14
15	9										7 4 1		0.04 0.02 Nil			15.50m					15
16								**BOREHOLE COMPLETTED AT 15.50M**													16
17																					17
18																					18
19																					19
20																					20
21																					21
22																					22
23																					23
24																					24
25																					25
26																					26
27																					27
28																					28
29																					29
30																					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL — **B.H No.: MT 1**

DRILLING DATA		BOREHOLE DATA
STARTED :	**2002/10/11**	X-COORDINATE :164,028.099m
COMPLETED :	**19/10/02**	Y-COORDINATE :198,008.066m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :124.491m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :88.951m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :35.54m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS
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R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N°VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00															
						0.46	3									Brown to yellowish brown colour, soft, sandy silty clay with pebbles & fine to coarse grained quartzitic sand 1.10m					
1																					1
						1.50										Dark brown colour,soft, silty clay with highly weathered rock fragments					
						1.95	5									Some plant roots 2.43m					
2																					2
																Boulder 2.65m					
3																					3
						3.10										Dark brown colour, silty clay with highly weathered rock fragments 3.10m					
						3.55	11									Whitish brown colour, medium dense, fine to coarse grained silty sandy material (May be completely weathered rock)					
4																					4
						4.50															
						4.95	12									4.95m					
5																					5
																Light brown to yellowish brown colour, medium dense to dense , fine to medium grained, silty sandy material					
6																					6
						6.00															
	11					6.45	14														
7																					7
						7.50															
						7.85	46HB									7.85m					
8																Boulder 8.00m					8
																Whitish brown, colour completely weathere fine grained, silty material 8.47m					
																Boulder 8.66m					
9																					9
						9.00										Whitish brown, colour completely weathered, fine grained, silty material					
						9.45	34									Weathered rock fragments available 9.83m					
10																		53			10
																Highly to moderately weathered biotite shist with garnets Rock in pieces due to weathering (Rock in pieces) 10.70m		50			
11																					11
	12		Light brown													Highly to moderately weathered quartzo feldspathic gneiss with coarse quartz grains & garnets (Rock in pieces)		40			
12																					12
																		43			
13																					13

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14			Light brown									100% W.L. AT 13.85				Highly to moderately weathered quartzo feldspathic gneiss with coarse quartz grains & garnets (Rock in pieces)		26			14
15																		36			15
16																		39			16
17																		27			17
18					17.95													20			18
19	15				16/10											18.88m		45			19
20																Highly to moderately weathered charnockitic gneiss 19.20m		80			20
21																Highly to moderately weathered quartzo feldspathic gneiss with garnets (Rock in pieces)		44			21
22					21.16													24			22
23					19/10													42			23
24					23.32											Highly to moderately weathered quartzo feldspathic gneiss with garnets		37			24
25					23.46													32			25
26					17/10													34			26
27	16															26.00m		65	20		27
28								Sub vertical joints at 28.30mto 28.46m (Weathered,rough, Iron stained joint surface)								Moderately weathered rock of charnockitic gneiss 27.00m		36			28
29								Joint at 28.95m(70^0) (Weathered,rough, Iron stained joint surface)								Highly to moderately weathered quartzo feldspathic gneiss with garnets		84	27		29
30	17															29.48m		71	63		30
																Slightly weathered quartzo feldspathic gneiss with garnets					

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N'VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
31															Same above rock,quartz bands & biotite rich layers available 30.47m		58	41		31
															Highly weathered quartzo feldspathic gneiss with garnets (Rock in pieces)		35			
32											1		0.52							32
											4		1.35				44			
											7		2.06							
33									30.00	35.54	10		2.72	0	$6*10^{-6}$	33.00m				33
											7		2.19							
											4		1.42			Moderately to slightly weathered	58			
34								Sub vertical joint from 33.68m to 33.92m (Weathered joint surface)			1		0.60			quartzo feldspathic gneiss with garnets (Rock in pieces) 34.00m					34
								Foliation joint at 34.52m(15^{0}) (Slightly weathered,rough,brownish joint surface)								Fresh quartzo feldspathic gneiss with garnets 34.48m				
35																Fresh garnetiferous biotite gneiss				35
	18															Fresh to slightly weathered quartzo feldspathic gneiss with garnets 35.54m				
36								**BOREHOLE COMPLETTED AT 35.54M**												36
37																				37
38																				38
39																				39
40																				40
41																				41
42																				42
43																				43
44																				44
45																				45
46																				46
47																				47

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- PENSTOCK — **B.H No.: MT 2**

DRILLING DATA		BOREHOLE DATA
STARTED :	**15/10/2002**	X-COORDINATE :161,508.252m
COMPLETED :	**25/10/2002**	Y-COORDINATE :198,150.331m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :100.007m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :65.007m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :35.00m
FOREMAN :	**KRNK**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N°VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00										Dark brown, silty clay with tree roots (Top soil layer) 0.45m					
						0.45	3									Redish brown, loose, silty fine to coarse sand with rock fragments 1.50m					
1																					1
	15																				
						1.50										Light redish brown dense silty fine to coarse sand with some weathered rock fragments. (high percentage of quartz) 3.45m					
2						1.95	25														2
3																					3
						3.45										Dark brown, medium dense, clayey silt					
4						3.90	17														4
																Dark yellowish brown, clayey fine to coarse moderately dense sand 4.40m					
	16				4.45																
5																Boulder of weathered gneissic rock 5.					5
																Brown completely weathered material(silty sand) 5.45m					
6						5.70										Light reddish brown, dense, silty fine to coarse sand with weathered feldspathic particles. (Insitu formation)					6
						6.15	24														
	17																				
7																					7
																7.75m					
8						7.65															8
						7.75	35HB									Dense completely weathered material (Brown silty sand) 8.25m					
																Weathered rock boulder 8.45m					
9			Yellowish grey													Completely weathered material (sludge sample- is fine to coarse silty sand with weathered feldspar particles)					9
	18																				
10																					10
11																					11
12																					12
13																					13

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14																Completely weathered material (sludge sample-is fine to coarse silty sand with weathered feldspar particles)					14
15	19																				15
16																					16
17	20		Yellowish grey																		17
18																					18
19																					19
20																					20
21																					21
21	21							Vertical joint at 21.80m-21.90m (Tight								21.80m					21
22								and iron stained)								Fresh to slightly weathered rock of biotite gneiss			17		22
23								Vertical joint from 22.05m-23.00m(partly tight fresh joint)			1		0.40			(From 22.05m-22.30m rock is broken into pieces because of vertical joints)					23
											4		0.60			23.35m					
											7		0.90			Fresh rock of biotite gneiss					
24									21.80	26.80	10		1.40	0	$4*10^{-6}$						24
											7		0.60								
	22										4		0.30			24.25m					
											1		0.30			Fresh to slightly weathered rock of biotite gneiss			69		
25								Joint at 25.05m(40^{o})								From 25.05m-25.55m rock is broken					25
								Sub vertical from 25.05m-25.55m(slightly weathered discoloured joint surface)								into pieces and slightly weathered due to joints. In this joited portion quartz content is high.					
26			Grey													26.40m					26
27																Fresh rock of biotite gneiss.					27
											1		Nil								
28											4		Nil								28
	23										7		Nil								
								Joint at 28.51m (37^{o}) (Fresh joint partly	26.45	31.45	10		0.08	0	$2*10^{-7}$						
								filled with whitish guage)			7		Nil								
29											4		Nil								29
											1		Nil								
																29.51m					
30								Fracturing starts at 29.51m								Fractured fresh quartzite					30

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
31															Fractured fresh quartzite 30.25m			85		31
32								Joint at 32.32m(25^0) (Partly iron stained rough joint surface)							Fresh rock of quartzite.					32
33			Grey					Joint at 32.83m(35^0) (partly iron stained			1		Nil							33
34	24							rough joint)	31.45	35.00	4		Nil							34
35	25										10		0.02	0	7*10^{-8}	35.08m				35
											7		Nil							
											4		Nil							
											1		Nil							
36								**BOREHOLE COMPLETED AT 35.08M**												36
37																				37
38																				38
39																				39
40																				40
41																				41
42																				42
43																				43
44																				44
45																				45
46																				46
47																				47

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- PENSTOCK — **B.H No.: MT 3**

DRILLING DATA		BOREHOLE DATA
STARTED :	**28/11/2002**	X-COORDINATE :161,448.998m
COMPLETED :	**05/12/2002**	Y-COORDINATE :198,139.480m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :77.842m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :52.272m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :25.57m
FOREMAN :	**WLN**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILL WATER (COLOR, LOSS)	RATE OF DRILLING	WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N`VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total{litters}/time{min})	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00										Reddish brown, dense, silty fine to coarse sand with some gravels.					
1						0.45	8														1
2						1.95															2
3						2.40	54									3.00m					3
																Reddish brown, dense, silty fine to coarse sand					
4					5.10	3.90										4.15m					4
					29/12	4.15	76HB									Highly to moderately weathered garnet-quartzo feldspathic gneiss.					
	28															5.20m					
5																					5
																Moderately to highly weathered rock of biotite gneiss.(Rock in pieces max.9cm & min.<1cm)		81			
6																6.00m					6
					7.70						1	Nil				Moderately to highly weathered rock of biotite gneiss. Rock in pieces					
											4	0.60									
					3/ 13						7	1.60						75			
7									4.15	9.15	10	4.00	1	$1*10^{-5}$		7.00m					7
											7	1.20				Highly to moderately weathered rock of garnet-quartzo feldspathic gneiss.					
	29										4	0.50									
8											1	Nil									8
																		75			
9			Grey																		9
																		94			
10																					10
											1	1.00									
											4	1.50						80			
11											7	1.60									11
					11.60				9.15	14.15	10	3.00	1	$8*10^{-6}$							
											7	2.10									
					4 / 12						4	1.50						72			
12											1	0.90									12
					13.10													75			
13					5 / 12																13

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASINGICEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14	3															Highly to moderately weathered rock of garnet-quartzo feldspathic gneiss. 14.00m		49			14
15								Joint at 14.80m(40°) (partly weathered joint surface)								Fresh rock of garnet biotite gneiss. 15.60m			80		15
16											1		Nil			Weathered garnet biotite gneiss 15.85m			60		16
											4		1.10			Fresh rock of garnet biotite gneiss.					
											7		1.30								
17								Joints at 16.81m(15°) &16.90m(20°) (weathered rough joint surfaces)	14.15	19.15	10		2.00	0	$5*10^{-6}$						17
											7		1.40								
											4		0.90								
18								Sub vertical joint at 17.95m to 18.29m (Tight joint)			1		0.40								18
19																19.00m			42		19
20			Grey					Vertical joint at 20.09m-20.4m (Partly iron stained) Here the rock is in pieces due to that joint.								Fresh rock of quartz rich garnet biotite gneiss. 20.00m			47		20
21	4															Fresh rock of garnet biotite gneiss.					21
											1		Nil								
											4		Nil								
22								Joint at 21.40m-21.49m(55°) (fresh tight joint)	19.15	24.15	7		Nil						86		22
											10		0.02	0	$5*10^{-6}$						
											7		Nil								
											4		Nil								
											1		Nil								
23																23.00m					23
24																Moderately weathered garnet biotite gneiss 24.00m			68		24
25								Joint at 24.80m(40°) (fresh tight joint) Sub vertical joint at 24.80m- 25.50m (Partly tight joint)	24.15	25.50	10		0.00	0	0	Fresh rock of garnet biotite gneiss.			76		25
	5															25.57m		57			
26								**BOREHOLE COMPLETED AT 25.57M**													26
27																					27
28																					28
29																					29
30																					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- PENSTOCK — **B.H No.: MT- 4**

DRILLING DATA		BOREHOLE DATA
STARTED :	**29/10/2002**	X-COORDINATE :161,468.184m
COMPLETED :	**11/11/2002**	Y-COORDINATE :198,200.832m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :87.558m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :57.008m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :30.55m
FOREMAN :	**KRNK**	INCLINATION : Vertical
LOGGED BY :	**BMAPM**	BEARING : -

KEY

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R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Fresh to slightly weathered charnockite
Highly to mod weathered charnockite
Fresh to slightly weathered biotite gneiss
Highly to mod weathered biotite gneiss
Quartzite
Calc gneiss
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N`VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total{liters}/time{min})	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
1						0.00										Yellowish brown, loose fine to medium silty sand. Some coarse sand also available					1
						0.45	8									1.00m					
2						1.95														2
3						2.40	15									Reddish brown, moderately densed fine to coarse silty sand with some weathered rock fragments					3
4	29					3.90										4.00m					4
						4.35	15									Reddish brown, densed silty,fine to coarse quartzitic sand with some pebbles					
5																5.00m					5
6						5.85										Dark reddish brown, fine sandy clayey,silt					6
						6.30	27									6.00m					
7																Light reddish brown, densed silty,fine to coarse quartzitic sand with some pebbles					7
					7.70																
					3 / 11																
8						7.80															8
						8.25	31									8.25m					
9	2															Highly weathered rock of garnet biotite gneiss Highly weathered rock in pieces		53			9
10			Greyish yellow															68			10
11																		64			11
12																		64			12
13																		68			13

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASINGICEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14																Highly weathered rock of garnet biotite gneiss Highly weathered rock in pieces		60			14
15																		60			15
16	3				15.30 15.60 8 / 11 16.45													70			16
17	4		Greyish yellow		9 ,10,11/ 11											Highly weathered rock of biotite gneiss, Rock in pieces 16.27m		40			17
18								Foliation joints at 17.17,17.21,17.31m(50^0) (Weathered,rough, joint surfaces) Foliation joint at 18.08m(50^0) (Tight,rough, joint)								Moderately weathered rock of biotite gneiss 18.48m		82 70	39		18
19	5										1		Nil			Highly weathered rock of garnet biotite gneiss, Rock in pieces					19
20									18.30	21.90	4 7 10 7		0.40 0.60 1.10 0.60	0	$4*10^{-6}$			54			20
21	8							Foliation joints at 21.08,21.13m(45^0) (Weathered,rough, joint surfaces)			4 1		0.30 0.10			20.92m		82			21
22																Fresh rock of biotite gneiss Few garnets available From 21.00 to 21.70m biotite% is high			78		22
23								Sub vertical joint from 23.20m-23.70m (Tight joint)			1		Nil						25		23
24								Sub vertical joint from 23.79m-23.95m (Tight joint)			4 7		Nil 0.02								24
25	9		Whtiish grey						21.90	27.05	10 7 4 1		0.05 0.02 Nil Nil	0	$2*10^{-7}$						25
26																Biotite rich layer from 25.43-26.60m					26
27																					27
28	10										1		Nil								28
29								Foliation joint at 28.87m(42^0) (Fresh, tight joint)	27.05	30.55	4 7 10 7		Nil 0.03 0.06 0.02	0	$2*10^{-7}$						29
30											4 1		Nil Nil			Fresh,quartz rich, biotite gneiss Few garnets available					30

DEPTH (m)	DRILLING					SPT RESULTS		JOINTS	PERMEABILITY							GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY		WEATHERING	DEPTH (m)
	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR,LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min}	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints		CORE RECOVERY %	R.Q.D. %		
	11		Whitish grey													Fresh,quartz rich, biotite gneiss 30.55m					
								BOREHOLE COMPLETED AT 30.55M													
31																					31
32																					32
33																					33
34																					34
35																					35
36																					36
37																					37
38																					38
39																					39
40																					40
41																					41
42																					42
43																					43
44																					44
45																					45
46																					46
47																					47

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- Divertion Tunnel | **B.H No.:DT 2** |

DRILLING DATA		BOREHOLE DATA
STARTED :	2003/7/7	X-COORDINATE :164,804.155m
COMPLETED :	2003/12/7	Y-COORDINATE :197,605.418m
MACHINE TYPE :	TONE	ELEVATION (COLLAR) :139.440m
DRILLING METHOD :	ROTARY	ELEVATION (BOTTOM) :
CORE BARREL, BIT :	NX	FINAL DEPTH :60.00m
FOREMAN :	MRAMHP	INCLINATION : Angle 45^0
LOGGED BY :	SRMS/RMLKR	BEARING :

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Decomposed mica
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic Gneiss
Quartzite
Calc gneiss/Crystalline Lime stone
Calc gneiss

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOUR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	DRILLING: SPT VALUES DEPTH(m)	DRILLING: SPT VALUES N'VALUE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROUGHNESS, PERSISTENCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (BARS)	PERMEABILITY: MANOMETER READING	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	MOSAIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
0			Brown														Fine to coarse grained,moderate dense,brown,clayey silty sand (Some gravels available) (Top soil layer) 0.52					0
1			Grey														Fresh charnockitic gneiss (Boulder) 1.55		81			1
2																	Fine to medium grained, brown sand (Sludge sample)					2
3																						3
4																						4
5																						5
6																						6
7			Brown																			7
8	7				8.32 08/07																	8
9																						9
10																						10
11																						11
12																						12
13																	13.00					13

FEASIBILITY STUDY OF THE BROADLANDS HYDRO POWER PROJECT
BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERING & MINERAL SERVICES cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- Divertion Tunnel | **B.H No.:DT 2** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	DRILLING: SPT VALUES DEPTH(m)	DRILLING: SPT VALUES N' VALUE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: Manometer Reading	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: ROCK TYPE, COLOUR, GRAIN SIZE, TEXTURE AND STRUCTURE (MASSIVE, CLEAVED, FOLIATED, LINEATED, FLOW BANDED, GNEISSOSE, PORPHYRITIC, ECT: SCALE AS FOR JOINT SPACING), WEATHERING,ALTERATION,MINOR LITHOLOGICAL CHARACTERISTICS, STRENGTH,JOINTS	MOSAIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14			Brown														Fine to medium grained, brown sand (Sludge sample) 13.72					14
15			Greyish brown		15.24 09/07												Fine grained, brown sand (Mica & weathered feldspar available) (Insitu formation) (Sludge sample) (Highly decomposed material)					15
16																						16
17																						17
18			Light brown																			18
19																						19
20	8																					20
21			Greyish brown		20.48 12/07																	21
22																						22
23																						23
24																						24
25																						25
26																						26
27																						27
28																						28
29																						29
30																	30.00					30

FEASIBILITY STUDY OF THE BROADLANDS HYDRO POWER PROJECT
BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- Divertion Tunnel | **B.H No.:DT 2** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	DRILLING: SPT VALUES DEPTH(m)	DRILLING: SPT VALUES N' VALUE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: Manometer Reading	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: ROCK TYPE, COLOUR, GRAIN SIZE, TEXTURE AND STRUCTURE (MASSIVE, CLEAVED, FOLIATED, LINEATED, FLOW BANDED, GNEISSOSE, PORPHYRITIC, ECT: SCALE AS FOR JOINT SPACING), WEATHERING,ALTERATION,MINOR LITHOLOGICAL CHARACTERISTICS, STRENGTH,JOINTS	MOSAIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
31	9	30.12	Greyish brown														Fine grained, brown sand (Mica & weathered feldspar available) (Insitu formation) (Sludge sample) (Highly decomposed material)					31
32																					32
33																					33
34																	34.00				34
35																	Fine grained, brown sand (Mica & weathered feldspar available high % of micas) (Insitu formation) (Sludge sample) (Highly decomposed material)					35
36																					36
37																					37
38																					38
39																					39
40																	40.03				40
41																	Brown mica layer (Flackey grains) (Sludge sample) (Highly decomposed material)				41
42																					42
43																					43
44																					44
45																					45
46	11		Redish brown																		46
47																	47.00				47

FEASIBILITY STUDY OF THE BROADLANDS HYDRO POWER PROJECT
BOREHOLE LOG FOR ENGINEERING PURPOSES

cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- Divertion Tunnel | **B.H No.:DT 2** | **Page 4 of 4**

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR;LOSS)	DRILLING: RATE OF DRILLIN	DRILLING: WATER LEVELS	DRILLING: SPT VALUES DEPTH(m)	DRILLING: SPT VALUES N'VALUE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: Manometer Reading	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: ROCK TYPE, COLOUR, GRAIN SIZE, TEXTURE AND STRUCTURE (MASSIVE, CLEAVED, FOLIATED, LINEATED, FLOW BANDED, GNEISSOSE, PORPHYRITIC, ECT: SCALE AS FOR JOINT SPACING), WEATHERING,ALTERATION,MINOR LITHOLOGICAL CHARACTERISTICS, STRENGTH,JOINTS	MOSAIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
48																	Brown mica layer (Flackey grains) (Sludge sample) (Highly decomposed material)					48
49																						49
50																						50
51																						51
52																						52
53			Redish brown														53.00					53
54																	Reddish brownish mica layer (Flackey grains) (Sludge sample) (Highly decomposed material)					54
55																						55
56																						56
57																						57
58																						58
59																						59
60	12																60.00					60

Bore hole completed at 60.00m

61																						61
62																						62
63																						63
64																						64

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-DAM AXIS,LEFT BANK | **B.H No.: MB5** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**18-09-03**	X-COORDINATE :164,631.381m
COMPLETED :	**26-09-03**	Y-COORDINATE :197,564.127m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :138.601m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :30.15m
FOREMAN :	**UKSJ**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/Crystaline lime stone
Boulder

TCR | ROD | WEATHERING: SL/CW, HW, MW, SW

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
1	18		Brown												Fine to coarse grained brown silty sand with road aggregate 0.20 Fine to coarse grained yellowish brown to reddish brown clayey sand (small amount of gravels & organic material avaliable) 1.75					1
2		2.20			2.20 20/03										Brown fine to coarse grained silty sand (some amount of gravel & pebbles available) 2.20					2
3								Joint at 3.17m (60^0) Joint surface weathered & rough												3
4	19				3.75 23/09 4.35 21/09										Fresh charnocktic gneiss 4.10					4
5								Joint at 4.10m (50^0) & 4.55m(Highly weathered jointed zones)	3.25	8.50	Large amount of water takes through joints Unable to develop pressure				Fresh charnocktic gneiss (Core loss at 4.10-4.55m) 5.00		22	22		5
6	20							Joint at 5.85m (45^0) (Tight smooth joint surface)							Fresh charnockitic gneiss At 6.80m some amount of graphite available			73		6
7					6.35 26/09										7.00					7
8	21		Witish Grey					Joint at 7.37m (35^0) Joint at 7.38m (30^0)and 7.44m (40^0) (Tight fresh joint surfaces, filled with black thin film of secondary materials)			1 4	Nil Nil							8
9	22				8.60 25/09			Joint at 8.00m (Joint surface slightly weathered in to rock & filled with thin film of dark brown secondary materials)	8.50	13.30	7 10 7 4 1	Nil Nil Nil Nil Nil	0	0	Fresh charnocktic gneiss 10.00					9
10																				10
11	23														Fresh charnocktic gneiss (some amount of garnet avaiable) 12.00					11
12																				12
13															Fresh quartz rich charnocktic gneiss (qtz grain size relatively large) 13.00					13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-DAM AXIS,LEFT BANK | **B.H No.:MB5** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14								Joint at 13.78m(40^0) ((Tight joint filled with thin film of grey and black secondary materials)								Fresh quartz rich charnocktic gneiss (qtz grain size relatively large)					14
15											1		Nil								15
											4		Nil								
											7		Nil								
16									13.50	19.20	10		Nil	0	0						16
											7		Nil								
											4		Nil								
17											1		Nil				16.00				17
18	24																Fresh quartz rich garnet biotite gneiss				18
19																					19
20																					20
21											1		3.3								21
											4		5.7								
											7		7.3								
22			Whitish brown						19.50	25.50	10		10.6	2	10^{-5}						22
											7		7.7								
											4		6.1								
23											1		3.4								23
24																	23.84				24
	25																		16		
25																	Fresh garnet biotite gneiss			82	25
26																	26.00				26
27																					27
28																	Fresh quartz rich garnet biotite gneiss (relatively quartz % high)				28
29																					29
30	26																30.15				30

Bore hole completed at 30.15m

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & CONTRACTORS cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- CONDUIT TRACE | **BH No: CT 3** | **Page 1 of 2**

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/9/28**	X-COORDINATE :164,465.645m
COMPLETED :	**2003/10/1**	Y-COORDINATE :197,713.476m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :106.730m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH : 20.35 m
FOREMAN :	**UKSJ**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level HB -Hammer bounced

LEGEND FOR GRAPHIC LOG
Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/ Crystaline lime stone
Boulder

TCR | ROD | WEATHERING: SL/CW, HW, MW, SW

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total{liters}/time{min})	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
1															Fine to medium grained, yewllowish brown,silty sand (Top soil layer) 0.30 Boulder (Fresh gneissic rock) 0.50		75			1
2						1.50 1.95	5								Fine to coarse grained, brown, clayey silty sand (Some large rock fragments avilable, may be broken pieces of boulder)					2
3						3.00 3.15	>5 HB								3.33					3
4	28		Pale brown		3.50 29/9										Boulder (Garnet biotite gneiss) 3.40 Fine to coarse grained, light brown, silty sand (Some gravels and rock fragments avilable) 4.2		95			4
5					4.60 1/10										Fresh to highly weathered garnet biotite gneiss (Boulder) 5.70		50			5
6																				6
7															Fine to medium grained, brown, silty sand (Sludge sample) (Some large rock fragments avilable, may be broken pieces of boulder) (Some weathered micas available) 7.25					7
8															Fine to coarse grained,brown,silty sand (Some gravels and rock fragments avilable) 8.00					8
9															Fine to medium grained, brown, silty sand (Sludge sample) (Some weathered micas available)					9
10																				10
11																				11
12															12.00					12
13															Fine to medium grained, brown,silty sand (Sludge sample) (Some gravels and rock fragments available) 13.00					13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

cecb ENGINEERS & CONTRACTORS — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- CONDUIT TRACE | **B.H No.: CT 3** | **Page 2 of 2**

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14	29															Fine to medium grained, brown,silty sand (Sludge sample) 14.00					14
15			Brown			15.00 15.05	>15 HB									Fine to medium grained, brown,silty sand 15.00					15
16																Fine to medium grained, brown,silty sand (Some gravels and large rock fragments avilable)					16
17		16.95														16.95					17
18	30		Light grey to brown					(Due to joints and weathering rock broken into pieces,could'n determine exact positions of the joints due to core loss)								Slightly to moderately weathered crystaline lime stone (Some hornblende,biotite and diopsite available) 1		50	48		18
19																Fresh to highly weathered crystaline lime stone (Some hornblende and micas available) 19.00		74	35		19
20	1															Moderately to highly weathered crystaline lime stone (Some amount of weathered micas available) 20.35		27			20
																Bore Hole completed at 20.35m					
21																					21
22																					22
23																					23
24																					24
25																					25
26																					26
27																					27
28																					28
29																					29
30																					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & CONSULTANTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-CONDUTE TRACE | **B.H No.: CT4** | **Page 1 of 2**

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/10/7**	X-COORDINATE :164261.681m
COMPLETED :	**2003/10/11**	Y-COORDINATE :197938.506m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :103.040m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :20.00m
FOREMAN :	**UKSJ**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/Crystaline lime stone
Boulder

TCR | ROD | WEATHERING (SL/CW, HW, MW, SW)

DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION		RECOVERY			
DEPTH (m)	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR, LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total{liters}/time{min}	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	CORE RECOVERY %	R.Q.D. %	WEATHERING	DEPTH (m)
1					0.40 7/10											Fine to coarse grained,brown clayey silty sand Some amount of gravels & rock fragments available					1
						1.50										1.50					
2						1.95	1									Fine to coarse grained, yellowish brown clayey silty gravelly sand 2.00					2
3					2.2 10/10	3.00															3
						3.45	7														
4	7																				4
5																Fine to coarse grained, yellowish brown clayey silty sand Some rock fragments & coarse gravels available					5
6						6															6
						6.45	9														
7																					7
	8					7.50															
						7.95	8														
8																8.00					8
9						9.00										Fine to coarse grained, light brown clayey silty sand Weathered feldspars & micas available (Highly decomposed material)					9
						9.45	20									9.50					
10																					10
						10.50															
						10.95	17									Light brown to white clayey sandy silt. Weathered feldspars & micas available (Highly decomposed material)					
11																					11
12						12.00															12
						12.45	23														
	9																				
13																13.00					13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-CONDUTE TRACE | **B.H No.: CT4** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14			Dark brown			14.00 14.45	11									Light brown to white clayey sandy silt. Weathered feldspars & micas available (Highly decomposed material) 14.50					14
15																Light brown clayey silt Weathered feldspars & micas available (Highly decomposed material)					15
16						16.00 16.45	11														16
17			Brown													Brown clayey sandy silt Weathered feldspars & micas available (Highly decomposed material) 18.25					17
18	10	18.3																			18
19			Whitish grey													Fresh rock of crystaline limestone					19
20	11															20.00					20
								Bore Hole Completed at 20.00m													
21																					21
22																					22
23																					23
24																					24
25																					25
26																					26
27																					27
28																					28
29																					29
30																					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & CONTRACTORS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-MAIN TUNNEL | **B.H No.: MT5** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/8/22**	X-COORDINATE :164,050.587m
COMPLETED :	**2003/9/3**	Y-COORDINATE :198,005.489m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :123.838m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :30.25m
FOREMAN :	**WLN**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/Crystaline lime stone
Boulder

TCR | ROD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
0						0.00															0
						0.45	4										Fine to coarse grained,loose,silty sand .Some gravels available 0.45					
1																					1
						1.50											Fine to coarse grained,loose,					
2						1.95	5										gravelly sand					2
																	Some highly weathered rock fragments					
3	22																					3
						3.00																
						3.45	5										3.45					
4																						4
																	Fine to coarse grained, reddish brown silty sand					
5						4.50																5
						4.95	4															
					5.60 24/08																	
						5.50																
6	23					5.95	42										6.30					6
																	Fine to coarse grained, reddish brown silty sand					
7						7.00											Some highly weathered rock fragments					7
						7.45	26										(Highly decomposed material)					
8																	8.25					8
	24																Highly weathered biotite gneiss		20			
9				Light greish brown													(Boulder ?) 9.25					9
						9.25																
						9.70	58										Fine to coarse grained, brown silty sand.Some highly weathered rock fragments					
10																	(Highly decomposed material)					10
						10.80											11.25					
11						11.25	45															11
																	Fresh to slightly weathered garnet biotite gneiss 11.75		32			
12				Complete loss of water															44			12
																	Fresh to moderately weathered garnet biotite gneiss (Rock brocken into pieces) 13.00					
13																						13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-MAIN TUNNEL | **B.H No.: MT5** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
					13.20 26/08											Biotite gneissic rock brocken into pieces 13.25					
14	25															Fresh to highly weathered garnet biotite gneiss (Rock brocken into pieces along the joints) 15.00					14
15																					15
16			Light grey to light brown													Fine to coarse grained, dark brown silty sand (Highly decomposed material) 17.30					16
17																					17
18	26															Slightly to moderately weathered garnet biotite gneiss 19.25		33			18
19			Light cream																		19
20	27															Fresh to moderately weathered garnet biotite gneiss.(Garnet % is high) 20.05		40	53		20
21																Fine to medium grained, brown silty sand (Highly decomposed material Sludge sample) 21.25					21
22																Fresh to moderately weathered , garnet rich quartazo feldspathic gneiss. 22.75			60		22
23																Fine to medium grained, brown silty sand (Highly decomposed material-Sludge sample) 23.60					23
24																Fresh to moderately weathered ,garnet rich quartazo feldspathic gneiss. 24.00			55		24
25			White to light brown													Fine to medium grained, brown silty sand (Highly decomposed material Sludge sample) 25.65					25
26																Fresh to moderately weathered ,garnet biotite gneiss. 25.95		46			26
27																Fine to medium grained, brown silty sand (Highly decomposed material Sludge sample) 27.50					27
28																Mod. to highly weathered ,garnet biotite gneiss/27.6					28
29		28.9														Fine to medium grained, brown silty sand. Some gravels & rock fragments available (Highly decomposed material Sludge sample)					29
30																					30

BOREHOLE COMPLETED AT 30.25M

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & CONSULTANTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-MAIN TUNNEL | **B.H No.: MT 6** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/9/6**	X-COORDINATE :164,015.436m
COMPLETED :	**2003/9/16**	Y-COORDINATE :197,995.307m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :134.126m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH :40.10 m
FOREMAN :	**WLN**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/Crystalline Limestone
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DRILLING					SPT RESULTS		JOINTS	PERMEABILITY						GENERAL DESCRIPTION		RECOVERY			
DEPTH (m)	DAILY ADVANCE	CASING/CEMENT	DRILL WATER (COLOR, LOSS)	RATE OF DRILLING	WATER LEVELS	DEPTH	N' VALUVE	NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	DEPTH (M) FROM TOP	DEPTH (M) TO BOTTOM	PRESSURE (bars)	WATER LOSS	(total(liters)/time(min)	Lugeon Unit (Lu)	Coefficient of Permeability (cm/s)	Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	CORE RECOVERY %	R.Q.D. %	WEATHERING	DEPTH (m)
						0.00														
						0.45	1									Fine to coarse grained,dark brown , loose clayey silty sand (Top soil layer) 0.45					
1																Fine to coarse grained,brown, clayey silty sand with weathered rock fragments 1.00					1
			Light brown													Fine to coarse grained,brown, dense silty sand with weathered rock fragments					
						1.50														
2						1.95	57									2.15					2
	6															Moderate to highly weathered biotite gneiss (may be a boulder)		90			
3																Fine to coarse grained silty sand with highly weathered rock fragments					3
						3.00														
						3.45	61									3.90					
4	7															Fresh to highly weathered garnet biotite gneiss 4.10		80			4
			Dark Brown to gray													Medium to coarse grained brown sand with mica (Sludge sample) (Highly decomposed rock) 5.00					
5																					5
																Fresh to highly weathered garnet biotite gneiss 5.3		77			
6						5.75										Fine to coarse grained,light brown, silty sand with weathered feldspar and mica (Highly decomposed rock)					6
						6.20	16									6.65					
7																Fine to medium grained,brown silty sand with mica (Sludge sample) 7.00					7
																Moderate weathered to highly weathered garnet biotite gneiss 7.20		50			
8																Fine to medium grained,brown silty sand with weathered mica (Sludge sample) 7.70					8
9																Fine to coarse grained,yellowish brown silty sand with weathered feldspar and mica (Highly weathered rock)					9
						9.25															
						9.70	74														
10	8		Light brown													10.20					10
						10.65										Fine to coarse grained,reddish brown clayey silty sand (Weathered rock fragments) 11.00					
11						11.10	33														11
																Fine to medium grained,brown silty sand (Sludge sample) 11.30					
12																Fine to coarse grained,brown, silty sand with mic 12.00					12
						12.40															
						12.60	>50									Fine to coarse grained,light brown, silty sand with weathered feldspar					
13																13.00					13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & CONTRACTORS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL | **B.H No.: MT 6** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14																Fine to coarse grained,light brown, silty sand with weathered feldspar 13.50 Highly weathered biotite gneiss 14.00		40			14
15			Brown to Light gray													Fine to medium grained,brown, silty sand with weathered mica (Sludge sample) (May be decomposed rock) 15.00					15
16	9															Highly weathered biotite gneiss 15 Fine to coarse grained,dark brown, silty sand with mica (Sludge sample) 15.80 Fine brown silt (Sludge sample) 16.00		55			16
17																Fine to coarse grained,dark brown, silty sand with mica (Sludge sample) 17.30					17
18																Fine to coarse grained,light brown, silty sand with weathered feldspar and mica (Sludge sample) 18.30					18
19			Light creamy red													Fine to coarse grained,dark brown, silty sand with weathered feldspar and mica (Sludge sample)					19
20																					20
21	10																				21
22			Whitish brown(at 22.65m Complete water loss)													22.00 Yellowish brown silty sand(Sludge sample) 22					22
23																Fresh to moderately weathered garnet biotite gneiss22.50 Fine to coarsegrained,brown silty sand with weathered mica(Sludge sample) 23.00		64			23
24	12															Fresh to moderately weathered garnetiferrous quartzo feldspathic gneiss 23.35 Fresh to moderately weathered biotite gneiss 24.25		60 27			24
25																Moderate to highly weathered garnet biotite gneiss 25.55		29			25
26			Light to dark brown													Fine to coarse grained,dark brown, silty gravelly sand with weathered mica (Sludge sample)					26
27																					27
28					28.45 16/9											28.20					28
29	13															Fine to coarse grained,dark brown silty gravelly sand with highly weathered rock fragment (May be weathered rock) 29					29
30			Gray to brown													Fine to medium grained,dark brown, silty sand with weathered mica (Sludge sample) 30.00					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & CONTRACTORS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL | **B.H No.: MT 6** | **Page 3 of 3**

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
31																Fine to coarse grained,dark brown, silty gravelly sand with rock fragments					31
																31.20					
32																Fine to coarse grained,dark brown silty gravelly sand					32
																32.70					
33																Fine to coarse grained,dark brown silty sand with weathered mica (Sludge sample)					33
34			Light brown to dark brown																		34
35	14																				35
36																					36
37			Light gray to dark brown																		37
																37.80					
38		38.00														Slight to highly weathered garnet biotite gneiss 38.00		85			38
39			Light gray(38.95m complete water loss)													Fresh garnet biotite gneiss (High % of Quartz)		93	93		39
40	15							Joint at 40.10(sub horizontal) joint surface slightly weathered into rock													40
																40.10					
								BOREHOLE COMPLETED AT 40.10m													
41																					41
42																					42
43																					43
44																					44
45																					45
46																					46
47																					47

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- SURGE TANK | **B.H No.: MT 7** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/9/17**	X-COORDINATE :161,591.171m
COMPLETED :	**2003/10/6**	Y-COORDINATE :198,111.429m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :124.040m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :60.00m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS	JOINT SEPARATION
VR= very rough	V= very tight
R: rough	T= tight
SR: slightly rough	MO= moderately open
S= smotth	O= open
SL=slickensided	
JOINT SPACING	OTHER SYMBOLS
VW= very widely> 2m	SL/CW - Soil & Completely Weathered
W= widely	HW - Highly Weathered
MW= moderately wide	MW - Moderately Weathered
C= Closely	SW - Slightly Weathered
VC= very closely	TCR - Total Core Recovery
	RQD - Rock Quality Designation
	GWL - Ground water Level

LEGEND FOR GRAPHIC LOG

Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/Crystalline Lime Stone
Boulder

TCR | RQD | WEATHERING: SL/CW, HW, MW, SW

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00										Fine to coarse grained,reddish brown,loose					
						0.45	6									clayey,silty sand(Top soil layer) 0.45					
1																Fine to coarse grained,reddish brown,					1
																silty sand (More % of coarse grains available)					
						1.55															
2						2.00	8														2
3						3.00										3.00					3
						3.45	16									Fine to coarse grained,red to pink, clayey					
																silty,sand					
4																(Some gravels available)					4
						4.55															
5	17					5.00	12														5
6						6.00															6
						6.45	7														
7			Brown																		7
						7.55										7.68					
					7.89 18/9	7.68	>50									Fine to medium grained,reddish brown					
8																silty sand					8
																(Some weathered micas available)					
9					9.04 19/9	9.00															9
						9.27	>50														
10																					10
						10.55															
						11.00	42														
11					10.92 21/9											11.00					11
																Fine to coarse grained,reddish brown,dense					
12						12.00										Quartz sand					12
	18					12.38	>50														
13																13.00					13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- SURGE TANK | **B.H No.: MT 7** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	PT RESULT: DEPTH	PT RESULT: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						13.00										Fine to medium grained,brown silty sand (Some weathered micas available)					
14						13.45	16														14
15						15.00															15
						15.45	14														
16																					16
						16.55															
17			Brown			17.00	18														17
																17.50					
18																Fine to medium grained,light brown silty sand (Some weathered micas available) (May be highly decomposed rock)					18
						18.00															
						18.24	>50														
19					18.95 22/9																19
						19.55															
20	19					19.60	>50														20
																20.48					
		20.48														Moderate to highly weathered biotite gneiss		35			
21																					21
																		18			
22																					22
23																23.00					23
																Slightly to moderately weathered biotite gneiss		22			
24																24.00					24
																Moderate to highly weathered biotite gneiss		20			
25	21		Light brown to light grey					(Core loss due to weathered zone								25.00					25
								from 25.0 to 25.45m)								Slightly to moderately weathered biotite gneiss (Pegmatitic feature appeared)		58	44		
								Joint at 25.45(irregular) highly								(Core loss due to weathered zone)					
26								weathered in to rock								26.00					26
								Joint at 25.85m(30^0) joint surface			1		-			Slightly weathered biotite gneiss		25			
								slightly weathered into rock)			4		0.05			(Some garnets available)					
											7		0.25								
27									25.50	29.00	10		0.63	0.1	3x10^{-6}						27
											7		0.30								
								(Joint set has developed from 27.50			4		0.14					80	60		
								to 28.33m along the foliation planes			1		0.03			27.50					
								foliation planes, joint intensity 5/m)								Slightly weathered biotite gneiss (In some places pegmatitic feature appeared)		90	50		
28																28.33					28
																Fresh biotite gneiss (Quartz % is high)		100	100		
29	22		Light grey																		29
30																30.00					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERING & ARCHITECTURE cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- SURGE TANK | **B.H No.: MT 7** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	PT RESULT: DEPTH	PT RESULT: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
											1		-			Fresh biotite gneiss (Quartz % is high)		100	100		
								Joint at 31.48m(25^0) (tight joint)			4		0.08								
31								Joint at 31.63m(35^0) (tight joint-			7		1.30								31
								surface filled with thin film of white material)	29.00	34.36	10		1.56	0.20	3x10^{-6}	31.00 Fresh garnet biotite gneiss			95		
	23							Joints at 32.05 & 32.25m(15^0)			7		1.38								
								Joint at 32.65(50^0)			4		0.42								
32								Joint at 32.90(20^0)(tight joints-			1		0.02								32
								surfaces slightly weathered into rock)											82		
								Joint at 32.94(45^0) (tight joint ,surface													
								filled with white secondary material)													
33								Joint zone from 32.97 to 33.10m													33
								(Joint surfaces slightly weathered into rock)								33.00 Fresh biotite gneiss		90	70		
								Joint from 33.25 to 33.35m(55^0)													
								Suface filled with grey thin film													
34								Joint at 33.50(subvertical) tight joint								(Quartz & garnet rich layer from 33.40 to 33.47m) (Small amount of garnet avilable section from					34
	24							surface slightly weathered into rock								34.00 to 34.36m) 34.36					
								Joint at 34.00(40^0) tight joint			1		-			Fresh biotite gneiss		83	39		
								Foliation joint at 34.36(30^0)			4		0.03			(Biotite % is high)					
35								Highly jointed zone(subvertical &			7		0.16			(Small biotite bands available)					35
								subhorizontal) from 34.36 to 36.40m	34.25	39.00	10		0.25	0.0	6x10^{-7}						
								(joint surfaces filled with black material,			7		0.17								
								Rock has broken into pieces due to joints)			4		0.05								
36								Joint at 34.90(35^0) (surface filled with			1		-								36
								thick white material)													
																36.40					
																Fresh biotite gneiss		100	100		
37	25															(Quartz % is high)					37
																(Small amount of garnet avilable)					
38																					38
39			Light grey					Joint from 39.22 to 39.66m(subvertical)														39
								surface filled with white secondary material			1		-						64		
											4		0.20								
											7		0.10								
40	27								39.00	44.00	10		0.15	0.0	3x10^{-7}	40.00					40
								Joint at 40.98m(30^0) (tight folition joint)			7		0.12			Fresh garnet biotite gneiss			98		
											4		0.40			(Quartz % is high)					
											1		-								
41																					41
																			75		
								Joint from 42.22 to 42.41m(vertical)													
42	28							(surface filled with white secondary material)													42
								Joint at 42.73m(30^0) (tight joint-												100		
								surface filled with grey secondary material)													
43																43.00					43
								Joint at 43.45m(30^0)								Fresh biotite gneiss			90		
								Joint at 43.75m(45^0)								(Small amount of garnet available)					
								(surfaces filled with black secondary material)													
44	29							Joint from 44.0 to44.20m(subvertical)													44
								Joint at 44.80m(30^0)								44.20					
								(surface filled with dark grey material)								Fresh biotite gneiss					
																(Quartz % is high)					
45											1		-								45
											4		0.04						100		
											7		0.15								
									43.90	49.00	10		0.20	0.0	4x10^{-7}						
46											7		0.16			46.00					46
											4		0.04			Fresh biotite gneiss					
											1		-								
47																47.00					47

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT
BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb LABORATORY & SITE INVESTIGATION

LOCATION :- SURGE TANK | **B.H No.: MT 7** | **Page 4 of 4**

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,L	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	PT RESULT: DEPTH	PT RESULT: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH FROM TOP	PERMEABILITY: DEPTH TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
48																Fresh garnet biotite gneiss					48
	30																				
49								Joint from 49.30 to 49.55m(subvertical-tight													49
								joint surface filled with grey material)													
								Joint at 49.78m(30^0)											52		
								(surface filled with dark grey material)													
50								Joints from 49.90 to 50.15 &								Fresh biotite gneiss					50
								50.20 to 50.47m(80^0)													
								(surface filled with dark grey material)			1	-				50.47					
								Joint at 50.53m(subhorizontal-tight joint)			4	0.02				Fresh garnet biotite gneiss					
51											7	0.10				(Quartz % is high)					51
	1								49.00	54.00	10	0.14	0.0		$3x10^{-7}$				100		
											7	0.10									
											4	0.03									
52											1	-									52
								Joints from 52.45 to 52.62 &											74		
								52.72 to 52.80m(80^0)(tight joints)													
53	2																				53
								Joint at 53.52m(30^0)													
								(Trimolite available along the joint)													
			Light grey																100		
54																					54
											1	-									
											4	0.02									
											7	0.08									
55									54.00	59.00	10	0.13	0.0		$3x10^{-7}$						55
											7	0.09									
											4	0.04									
											1	-									
56	4																				56
57																					57
								Joint at 57.61(30^0) (fresh,tight joint)													
											1	-							65		
58											4	-									58
											7	0.05									
									57.50	60.00	10	0.08	0.0		$3x10^{-7}$						
								Joint at 59.53(40^0)(fresh,tight joint-			7	0.06									
59	5							surface filled with grey secondary material)			4	0.02									59
								Joint from 59.88 to 60.00m(subvertical)			1	-									
								(surface filled with light grey material)													
								Joint at 60.00m(20^0)(tight & fresh joint)													
60	6															60.00					60

Bore hole completed at 60.00m

61	61
62	62
63	63
64	64

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL | **B.H No.: MT 8** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/12/8**	X-COORDINATE :161,984.829m
COMPLETED :	**2003/9/9**	Y-COORDINATE :197,955.406m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :154.587m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :80.06m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneis
Quartzite
Calc gneiss/Crystaline lime stone
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
0						0.00									Fine to medium grained,dark brown,					0
						0.45	5								clayey silty sand (Top soil layer) 0.55					
1															Slightly weathered garnet hornblend gneiss		40			1
	12				1.45 12/8										(May be a boulder) 1.60					
2						2.00 to 2.24	>50								Fine to medium grained, brown, dense,silty sand					2
															(Some weathered micas available) 2.24					
3					2.88 19/8										Fine to medium grained, light brown, silty sand (Sludge sample)					3
4															(Some weathered micas available)					4
5																				5
6																				6
7			Brown																	7
8					7.53 13/8															8
9																				9
	13														9.50					
10															Fine to coarse grained, light grey, silty sand (Sludge sample)					10
															(Some weathered micas and feldspars available)					
11															(May be highly decomposed rock)					11
12															12.18					12
					12.84 7/9										Fresh slightly weathered, biotite gneiss (Small amount of garnets available) 13.00		37	21		
13																				13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL | **B.H No.: MT 8** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14																Fresh slightly weathered, biotite gneiss (Small amount of garnets avilable)		24	16		14
																14.38					
15			Brown													Fine to coarse grained, light grey, silty sand (Sludge sample) (Some weathered micas and feldspars available) (May be highly decomposed rock)					15
16		16.0						Joint at 16.18m (sub horizontal)			1		-							16
								(irregular, joint surface weathered			4		0.43			16.00					
	15							into rock)			7		0.85			Fresh garnet biotite gneiss		95	90		
17								Joint at 17.78m (sub horizontal)	16.50	20.00	10		1.28	0.3	$4x10^{-6}$						17
								(irregular joint)			7		0.86								
								Joint at 17.28m (10^0)			4		0.45			17.00					
								(joint surface slightly weathered			1		-			Fresh biotite gneiss		97	85		
18								into rock)								(Small amount of garnets avilable)					18
								Joint from 17.52 to 17.56m													
								(Weathered zone)													
																		71	50		
								Joint at 18.56m(sub vertical)													
19			Light grey					(joint surface weathered into rock)													19
																19.00					
								Joint at 19.06m (subhorizontal)								Fresh Quartz rich garnet biotite		98	86		
								(tight joint,surface filled thin film of								gneiss					
20	19							reddish brown material)													20
																20.00					
								(Highly jionted zone from 20.0 to 21.0m								Fresh to moderately weathered		63	30		
								core loss due to joints)								Quartz richgarnet biotite					
21																21.00					21
											1		-								
											4		0.30			Fresh Quartz rich garnet biotite		100	90		
								Joint at 21.07(sub horizontal)			7		0.87			gneiss					
								(irregular, joint surface slightly weathered	19.50	24.55	10		1.85	0.3	$5x10^{-6}$						
22								into rock)			7		1.37			(Quartz rich bands					22
											4		0.82			from 22.67 to 22.72m			100		
											1		0.15			from 23.83 to 24.24m					
																from 24.36 to 25.00m					
																from 25.35 to 25.55m					
23			Grey													from 26.90 to 27.10m					23
																from 29.00 to 29.20m)					
24																					24
	20																				
25								Joint at 25.26m (35^0)													25
								(joint surface filled thin film of grey													
								secondary material)													
26																					26
											1		-								
											4		-								
											7		0.07								
27									24.60	29.00	10		0.12	0.0	$3x10^{-7}$						27
											7		0.08								
											4		0.03								
28	22		Light grey								1		-								28
29																					29
30	23															30.00					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL | **B.H No.: MT 8** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
																Fresh Quartz rich garnet biotite gneiss		100	100		
											1		-								
											4		-								
31											7		0.04			(Quartz rich bands					31
									29.00	34.00	10		0.06	0.0	$2x10^{-7}$	from 31.40 to 31.52m					
											7		0.05			from 34.92 to 35.04m)					
											4		-								
32											1		-								32
																(Pegmatitic features appaered from					
																36.75 to 37.15m)					
33																					33
34	26																				34
35																					35
											1		-								
36											4		0.03								36
											7		0.05								
									34.00	39.00	10		0.12	0.0	$3x10^{-7}$						
											7		0.06								
37	27							Two parellel joints at 37.36 & 37.93m(45^0)			4		0.05			37.00					37
								(joint surfaces filled with thick film of			1		0.02			Fresh biotite gneiss			91		
								white secondary material)													
								Joint at 37.75m (50^0)													
38								(joint surface filled thin film of black								(Pegmatitic features appaered from					38
								secondary material)								38.16 to 38.86m)					
								Joint at 37.53m (45^0) tight joint													
39	28		Light grey													39.00					39
								Joint at 39.75m (45^0)								Fresh biotite gneiss			68		
								(joint surface filled by thin grey film)								(Biotite % is high)					
								Joint at 40.30m (50^0)													
40								(joint surface filled by thin black material)													40
								Joint at 40.80m (50^0) (slicken sided joint)													
								(joint surfaces filled with thin film of													
								black secondary material)													
41																					41
											1		-						100		
											4		0.06								
											7		0.09								
42									39.15	44.63	10		0.15	0.0	$4x10^{-7}$						42
											7		0.09								
											4		0.05								
43											1		-								43
44																					44
	30																				
											1		-								
45											4		0.02								45
								Joint from 45.70 to 46.30m(vertical)			7		0.06								
									44.50	49.00	10		0.17	0.0	$5x10^{-7}$	(Biotite rich layer from 45.70 to					
											7		0.09			46.95m)			70		
46											4		0.04								46
											1		-								
								Joint at 47.07m (30^0)													
								(joint surfaces filled with thin film of													
47								grey secondary material)								47.00					47

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & SCIENTISTS cecb LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL | **B.H No.: MT 8** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
48																Fresh biotite gneiss (Biotite % is high) (Small amount of garnets available)		100	90		48
49	31		Light grey					Joint at 48.58m (irregular) (joint surface filled with thin film of grey secondary material) Joint at 50.70m (irregular) (joint surface filled with thin film of black secondary material)			1 4	-	-			(Biotite rich layer from 48.05 to 50.30m)					49
50								Joint at 51.18m (60^0) tight joint Joint at 51.40m (30^0) tight joint (joint surface filled with thin film of black secondary material)			1 4 7	- - 0.07									50
51	1								49.00	54.00	10	0.12	0.0	$3x10^{-7}$							51
52			Grey								7 4 1	0.08 0.02 -				(Biotite rich layer from 52.34 to 53.28m)					52
53								Joint at 52.26 & 53.97m (30^0) tight joint (joint surfaces filled with thin film of grey secondary material)											90		53
54																54.00					54
55																Fresh biotite gneiss			100		55
56											1 4 7	- - 0.08									56
57	3								54.00	59.00	10 7 4 1	0.14 0.08 0.03 -	0.0	$4x10^{-7}$							57
58																					58
59																			91		59
60			Light grey					Joint at 59.30m (35^0) tight joint joint surface filled with thin film of black secondary material Joint at 60.95m (40^0) tight fresh joint													60
61																					61
62								Joint at 62.05m (70^0) tight joint	59.00	64.00	1 4 7 10	- 0.03 0.09 0.18	0.0	$5x10^{-7}$					100		62
63								joint surface filled with thin film of dark grey secondary material Joint from 62.30 to 62.47 (60^0) tight joint joint surface filled with thin film of black secondary material			7 4 1	0.10 0.04 -							32	100		63
64	4															64.00					64

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- MAIN TUNNEL | **B.H No.: MT 8** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N'VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min)	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
65																Fresh biotite gneiss		100	100		65
											1		-								
											4		0.04								
66											7		0.09								66
									64.00	69.00	10		0.20	0.0	$5x10^{-7}$						
											7		0.10								
											4		0.05								
67											1		0.02								67
68			Light grey																		68
69	5																				69
											1		74.0								
											4		80.0								
									69.00	74.00	5	100%	95.0	10.8	$2x10^{-4}$						
70								Two parellel joints at 70.80 & 80.86m			4		82.0								70
								(tight,joint surfaces filled with thin film of			1		80.0								
								dark grey secondary material)													
71																			81		71
								Joint zone from 71.55 to 71.70m													
								(irregular joint surfaces filled grey and													
								white secondary material)											66		
72								(pyrite avaslable along the joint surfaces)													72
								Joint at 72.10m (sub horizontal)													
			0% to 100%					(joint surface filled with white thin film)													
								Joint at 72.30m (50^0)													
73								(joint surface filled with grey thin film)													73
			Loss 100%					Joint at 72.52m (40^0)											92		
								(Garnets available along the surface)													
								Two parellel joints at 73.55 & 74.85m(40^0)													
74	6							(joint surface filled with grey thin film)													74
75								Joints from 75.44 to 75.49m(subvertical)			1		-								75
								& at 76.70(45^0) & at 76.90(60^0)			4		0.03						78		
								(joint surfaces filled with grey thin film)			7		0.10								
									73.50	78.46	10		0.17	0.0	$4x10^{-7}$						
76								Joints at 77.0 & 77.13m(40^0)			7		0.13								76
								(joint surfaces filled with grey thin film)			4		0.05								
								Joints at77.30 & 77.50m(50^0) tight joints			1		0.02								
								Joints at78.02 & 78.16m(45^0) tight joints													
77			Light grey					Joints at 78.68m(30^0)													77
								(joint surfaces filled with grey thin film)											89	53	
								Joints at 78.76m(30^0)										77.56			
								(joint surface slightly weathered into rock)								Fresh biotite gneiss		94	83		
78	7							Joints at 78.79,78.85,79.0,79.1,79.18,			1		-			(Small amount of garnets available)					78
								79.25,79.34,79.4,79.55,79.77,79.88m			4		0.04								
								(horizotal) slightly slicken sided joints			7		0.09								
																78.46					
									78.00	80.06	10		0.15	0.1	$7x10^{-7}$	Fresh garnet biotite gneiss		100	100		
79								Joint from 79.10 to 79.61m (subvertical)			7		0.09								79
								(tight joint)			4		0.03								
								(Due to these joints in section from			1		-								
								78.46 to 80.06 rock has broken													
80	8							into pieces)													80
								Bore hole completed at 80.06m													
81																					81

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT
BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- TAILRACE | **B.H No.: TR 1** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/10/10**	X-COORDINATE :161313.227m
COMPLETED :	**2003/10/16**	Y-COORDINATE :198240.940m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :65.845m
DRILLING METHOD	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT	**NX**	FINAL DEPTH : 25.30m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS
VR= very rough
R: rough
SR: slightly rough
S= smotth
SL=slickensided

JOINT SPACING
VW= very widely> 2m
W= widely
MW= moderately wide
C= Closely
VC= very closely

JOINT SEPARATION
V= very tight
T= tight
MO= moderately open
O= open

OTHER SYMBOLS
SL/CW - Soil & Completely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
TCR - Total Core Recovery
RQD - Rock Quality Designation
GWL - Ground water Level

LEGEND FOR GRAPHIC LOG
Sand
Clay
Biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/Crystalline Limestone
Boulder

TCR | **RQD** | **WEATHERING**: SL/CW, HW, MW, SW

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00										Fine to coarse grained,brown,loose,silty					
						0.45	6									sand with some gravels(Top soil layer) 0.45					
1																Fine to coarse grained,brown,silty sand					1
																1.55					
						1.55										Medium to coarse grained brown ,dense,					
2						2.00	48									gravelly sand 2.00					2
																Fine to coarse grained, reddish brown,sand					
																(Some amount of coarse graines & gravels					
																available)					
3			Brown			3.00										3.00					3
						3.27	>50									Highly weathered to highly decomposed rock 3.27					
																Fine to coarse grained,light brown,silty sand					
																(Sludge sample) (Some weathered micas					
4																available)					4
						4.50										4.50					
						4.68	>50									Highly weathered to highly decomposed rock 4.68					
5																Fine to coarse grained,light brown,silty sand					5
					5.38 11/10											(Sludge sample) (Some weathered micas					
																available) (May be highly weathered rock)					
6	10	6.00														5.48					6
																Highly to moderately weathered boitite gneiss		59			
																(High % of Quartz and feldspars) 6.00					
			Light grey													Highly to moderately weathered boitite gneiss		35			
7																					7
								(Rock has broken into pieces and core										27			
								loss observed due to weathered zones													
			Water loss at 7.56m		7.84 14/10			and joints section from 5.48 to 9.00m)													
8																					8
					8.15 17/10													34			
																9.00					
9								Joint from 9.0 to 9.05m(weathererd zone)								Fresh biotite gneiss		##	70		9
								Joint at 9.44m(40^0) (tight foliation joint)								(Quartz % is high)					
	11							Joint at 9.60m(subhorizontal-tight joint)													
								Joints at 9.76 &9.80m(45^0) (tight joint)													
10	12							Joint at 9.95m(45^0) (white patches								10.00					10
								observed along the joint surface)			1	-				Fresh biotite gneiss			95		
											4	0.03									
			Light grey					Joint at 10.79m(30^0) (tight joint)			7	0.08									
11								(joint developed along biotite rich layer)	9.50	14.00	10	0.15	0	4x10^{-7}							11
								Joints at 10.79 & 11.70m(30^0) tight joints			7	0.09									
								(joints developed along biotite rich layer)			4	0.04									
											1	-									
12																			100		12
13																13.00					13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- TAILRACE | **B.H No.: TR 1** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14	14							Joints at 13.54 & 13.90m(25^0)(tight joints)							Fresh biotite gneiss					14
															14.00					
								Joint from 15.0 to 15.08m(70^0) (tight joint)							Fresh biotite gneiss					
								Joints at 15.27m(30^0) (tight foliation joint)							(Quartz % is high)					
15								Two parellel joints at 15.63 & 15.72m(45^0)												15
								(tight joints)							15.00					
											1	-			Fresh biotite gneiss			80		
											4	-								
											7	0.06								
16									14.00	19.00	10	0.13	0	$3x10^{-7}$	16.00					16
											7	0.07			Fresh biotite gneiss			100		
											4	0.02			(Quartz % is high)					
											1	-								
17															17.00					17
								Joint from 17.15 to 17.33m(subvertical-							Fresh biotite gneiss			62		
								tight joint)												
								Joint from 17.73 to 17.89m(80^0) (tight joint)												
18																				18
								Joint at 18.23m(30^0) (tight foliation joint)										100		
19	15																			19
			Light grey																	
20																				20
											1	-								
											4	-								
21											7	0.03								21
								Joint at 21.27m(30^0) (tight foliation joint-	19.50	25.30	10	0.07	0	$2x10^{-7}$				90		
								joints developed along biotite rich layer)			7	0.04								
								Joint at 21.46m(30^0)(tight joint)			4	-								
22											1	-								22
								(Compositional layers have folded										100		
								from 21.53 to 21.73m)												
23																				23
24	16																			24
25																				25
	17														25.30					

Bore hole completed at 25.30m

26																				26
27																				27
28																				28
29																				29
30																				30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- QUARRY | **B.H No.: BQ1** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/7/21**	X-COORDINATE :165,079.076m
COMPLETED :	**2003/7/27**	Y-COORDINATE :198,278.868m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :176.102m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NX**	FINAL DEPTH :25.05m
FOREMAN :	**MRAMHP**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS	JOINT SEPARATION
VR= very rough	V= very tight
R: rough	T= tight
SR: slightly rough	MO= moderately open
S= smotth	O= open
SL=slickensided	
JOINT SPACING	OTHER SYMBOLS
VW= very widely> 2m	SL/CW - Soil & Completely Weathered
W= widely	HW - Highly Weathered
MW= moderately wide	MW - Moderately Weathered
C= Closely	SW - Slightly Weathered
VC= very closely	TCR - Total Core Recovery
	RQD - Rock Quality Designation
	GWL - Ground water Level

LEGEND FOR GRAPHIC LOG

Sand
Clay
Garnet biotite gneiss
Quartzo feldspathic gneiss
Charnockite
Granitic gneiss
Quartzite
Calc gneiss/Crystaline lime stone
Boulder

TCR | RQD | WEATHERING (SL/CW, HW, MW, SW)

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total{liters}/time{min})	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00									Fine to coarse grained brown clayey silty sand (Top soil layer) 0.45					
						0.45	8								Fine to coarse grained brown clayey silty sand 1.50					
1																				1
2						1.50														2
						1.95	11								Fine to coarse grained reddish brown silty quartz sand (High % of coarse grains) (Some quartz gravels available) 4.50					
3																				3
						3.00														
4						3.45	18													4
					4.26 21/07															
						4.50									Fine to coarse grained pinkish brown silty sand (Some quartz gravels available)					
5						4.95	15													5
6																				6
						6.00														
	21					6.45	14													
7			Brown																	7
						7.50														
8						7.95	15								7.95					8
															Fine to coarse grained pinkish brown clayey silty sand (Some gravels and weathered feldspars available)					
9																				9
						9.00														
						9.45	20													
10															10.50					10
						10.50									Fine to coarse grained, brown silty sand (Some weathered feldspars available)					
11						10.95	23													11
12															12.00					12
						12.00									Fine to coarse grained, pink, very dense,silty sand (Some gravels available) 12.45					
						12.45	57													
13																				13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

LABORATORY & SITE INVESTIGATION UNIT

LOCATION :- QUARRY | **B.H No.: BQ1** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS	PERMEABILITY: (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14	23		Brown		13.58 23/07	13.50 to 13.73	>51									Fine to coarse grained ,brown,silty sand (Sludge sample) 13.95					14
15					14.75 26/07											Fresh to slightly weathered ,impure Quartzite (Rock has broken into pieces) 16.00		8			15
16	25																				16
17			Light brown Loss 100%-0%													Fresh ,impure Quartzite (Rock has broken into pieces) 17.05		19			17
18								Sub horizontal joints available inbetween 17.05m to 18.16m,(Couldn't determine exact possition due to core loss) joint surfaces filled with thin film of black secondary material									Fresh, garnety ferrous Quartzo feldspathic gneiss) (Rock has broken into pieces due to sub horizontal joints) 18.16		83	59		18
19								Sub horizontal joints available inbetween 18.16m to 20.60m,(Couldn't determine exact possition due to core loss) joint surfaces filled with thin film of dark brown secondary material									Rock changing zone fresh to slightly weathered, Quartzo feldspathic gneiss to impure Quartzite) 20.60		21	9		19
20																					20
21	26	20.6	Light brown													Fresh to slightly weathered ,impure Quartzite (Small amount of micas available) 22.75		16	9		21
22																					22
23								Sub vertical joints available inbetween 22.75m to 25.05m,(Couldn't determine exact possition due to core loss) joint surfaces filled with thin film of greyish black secondary material									Fresh Quartzite (In some places rock has broken into pieces due to sub vertical joints) 25.05		27	19		23
24																		56			24
25	27																				25
								Bore hole completed at 25.05m													
26																					26
27																					27
28																					28
29																					29
30																					30

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

LOCATION :-QUARRY | **B.H No.: BQ 2'** |

DRILLING DATA		BOREHOLE DATA
STARTED :	**2003/10/2**	X-COORDINATE :164,757.367m
COMPLETED :	**2003/10/5**	Y-COORDINATE :198,200.350m
MACHING TYPE :	**TONE**	ELEVATION (COLLAR) :157.017m
DRILLING METHOD :	**ROTARY**	ELEVATION (BOTTOM) :m
CORE BARREL, BIT :	**NQ**	FINAL DEPTH : 25.10 m
FOREMAN :	**WLN**	INCLINATION : Vertical
LOGGED BY :	**SRMS/RMLKR**	BEARING : -

KEY

JOINT ROUGHNESS	JOINT SEPARATION
VR= very rough	V= very tight
R: rough	T= tight
SR: slightly rough	MO= moderately open
S= smotth	O= open
SL=slickensided	
JOINT SPACING	OTHER SYMBOLS
VW= very widely> 2m	SL/CW - Soil & Completely Weathered
W= widely	HW - Highly Weathered
MW= moderately wide	MW - Moderately Weathered
C= Closely	SW - Slightly Weathered
VC= very closely	TCR - Total Core Recovery
	RQD - Rock Quality Designation
	GWL - Ground water Level

LEGEND FOR GRAPHIC LOG

Sand; Clay; Garnet biotite gneiss; Quartzo feldspathic gneiss; Charnockite; Granitic gneiss; Quartzite; Calc gneiss/Crystalline Lime stone; Boulder

TCR | RQD | WEATHERING: SL/CW, HW, MW, SW

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR, LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: Rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
						0.00														
						0.45	4									Fine to coarse grained, brown,loose clayey silty sand (Top soil layer) 0.45					
1																Fine to coarse grained, reddish brown,clayey silty sand (Some rock fragments available) 1.00					1
2																Fine to coarse grained, yellowish brown,clayey silty sand (Some weathered rock fragments available) 2.00					2
3					2.90 2/10											Fine to coarse grained, light yellow,clayey silty sand (Highly weathered rock) 3.00					3
4			Yellow		3.90 3/10											Medium to coarse grained yellowish brown silty sand (Sludge sample) (Some weatherred feldspars available) 3.65					4
																Highly weathered to highly decomposed granitic gneiss 4.65					
5																Fine to coarse grained, light brown,sandy silty clay					5
6																Fine to coarse grained yellowish brown silty sand (Sludge sample) 6.60					6
7																Highly weathered to highly decomposed granitic gneiss (In some places rock weathered into clay)7.0					7
8			White to light yellow													Fine to coarse grained, light yellow, silty sand (Sludge sample) 8.00					8
																Highly weathered granitic gneiss (Rock has broken into pieces due to weathering)					
9																Fine to medium grained, light yellow, silty sand (Sludge sample) 9.00					9
10	2															Highly weathered to highly decomposed granitic gneiss 10.00					10
																Fine to coarse grained, light yellow, silty sand 10.					
11																Highly weathered to highly decomposed hornblende biotite gneiss(High % of hornblende) 11.00					11
12			Dark grey to white													Highly weathered to highly decomposed granitic gneiss 11.70					12
					12.8 4/10											Fine to coarse grained, light yellow, silty sand (Sludge sample) (Some weathered feldspars available) 12.40					
13		12.4												60		High to moderately weathered granitic gneiss 13.00		80			13

GEOLOGICAL INVESTIGATION FOR THE BROADLANDS HYDROPOWER PROJECT

BOREHOLE LOG FOR ENGINEERING PURPOSES

ENGINEERS & ARCHITECTS cecb — LABORATORY & SITE INVESTIGATION UNIT

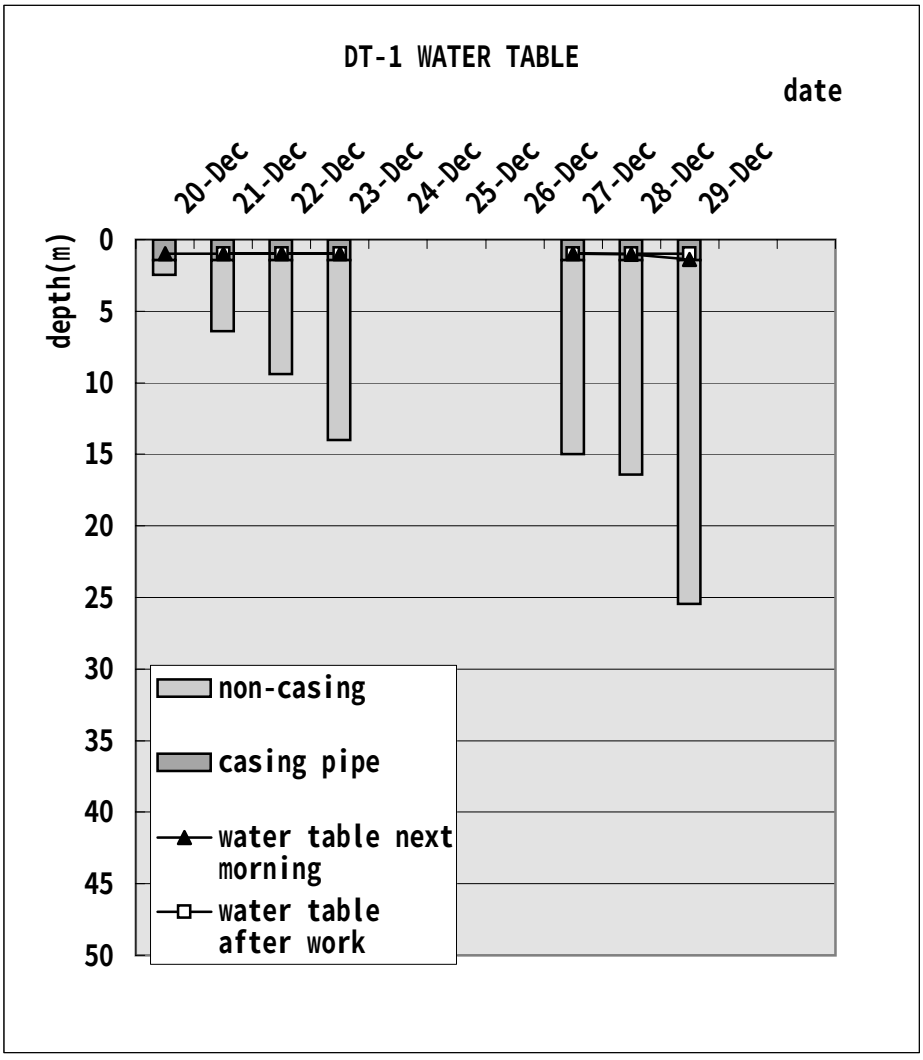
LOCATION :-QUARRY | **B.H No.: BQ 2'** |

DEPTH (m)	DRILLING: DAILY ADVANCE	DRILLING: CASING/CEMENT	DRILLING: DRILL WATER (COLOR,LOSS)	DRILLING: RATE OF DRILLING	DRILLING: WATER LEVELS	SPT RESULTS: DEPTH	SPT RESULTS: N' VALUVE	JOINTS: NO OF JOINTS, SETS, TYPE, SPACING, ORIENTATION, CONNECTIONS, (ROGHNESS, PERSISTANCE, SEPARATION, FILL TYPE, AND THICKNESS SLICKENSIDED)	PERMEABILITY: DEPTH (M) FROM TOP	PERMEABILITY: DEPTH (M) TO BOTTOM	PERMEABILITY: PRESSURE (bars)	PERMEABILITY: WATER LOSS (total(liters)/time(min))	PERMEABILITY: Lugeon Unit (Lu)	PERMEABILITY: Coefficient of Permeability (cm/s)	GENERAL DESCRIPTION: rock type, colour, grain size, texture and structure (massive, cleaved, foliated, lineated, flow banded, gneissose, porphyritlic,etc: scale as for joint spacing), weathering, alteration, minor lithological characteristics, strengths, joints	GRAPHIC LOG	RECOVERY: CORE RECOVERY %	RECOVERY: R.Q.D. %	WEATHERING	DEPTH (m)
14			Light grey to white					Joint 14.00 & 14.32 (subhorizontal) (joint surfaces weathered into rock & filled with black material) Two parellel joints from 14.0 to 14.12 & from14.17 to 14.32m(80^0)(joint surfaces moderately weathered into rock & formed redish brown material)							High to moderately weathered granitic gneiss (Rock broken into pieces due to weathering & joints) (Some hornblende & biotite rich layer observed) 14.00		77	33		14
15								(Rock has broken into pieces due to subhorizontal & sub vertical joints in section from 15.0 to 16.0m, joint intensity 7/m ,joint surfaces weathered into rock)							Fresh to moderately weathered granitic gneiss (Biotite rich layer available along the joint from (vertical)14.38 to 15.00m) 15.00		78	25		15
16			Light brown to white					Joint from 16.13 to 16.28m(60^0) (joint surface weathered into rock & filled with thick black secondary material)							Slight to moderately weathered granitic gneiss		88			16
17								Two parellel joints at 16.70 & 16.73m(55^0) (Surfaces filled by yellowish brown material) Sub vertical joint from 16.32 16.73 (joint surfaces slightly weathered into rock)							17.00					17
18	3							Joint from 16.78 to 16.90m(60^0) (joint surface weathered into rock & filled with black secondary material)							Fesh granitic gneiss		100	100		18
19			Light grey					Joints at 19.0,19.2,19.32,19.55m (subhorizontal) (joint surfaces weathered into rock)									89	89		19
20								Weathered zone from19.62 to 20.0m (Core loss is due to this zone)							19.62 Slight to moderately weathered granitic gneiss		100	53		20
21			Light brown to white												(Inbetween section from 20.06 to20.59m rounded patches formed due to solution activities and due to this rock has moderately weathered)		39			21
22	4							Joints at21.22 & 22.00m(35^0) (tight joints, weathered into rock) Joint at21.45m(70^0) (tight joint, surface filled with yellow material)									100	100		22
23			Light brown to light grey					Joint at22.65m(subhorizontal-irregular joint surface highly weathered into rock)							22.65 Fresh to slightly weathered granitic gneiss (In some places rock has discoloured due to solution activities)			90		23
24								Joints at23.28m(10^0) & 23.72(15^0) (joints weathered into rock) (surfaces filled with dark brown material) Tight joint from23.4 to 23.65(vertical)							24.00			85		24
25	5							(Rock has broken into pieces due to joints & weathering in section from 24.00 to 25.10m, joint intensity 6/m)							Fresh to highly weathered granitic gneiss (In some places rock has discoloured due to solution activities) 25.10		85	62		25
								Bore hole completed at 25.10m												
26																				26
27																				27
28																				28
29																				29
30																				30

1.2 Water tables of Drilling holes

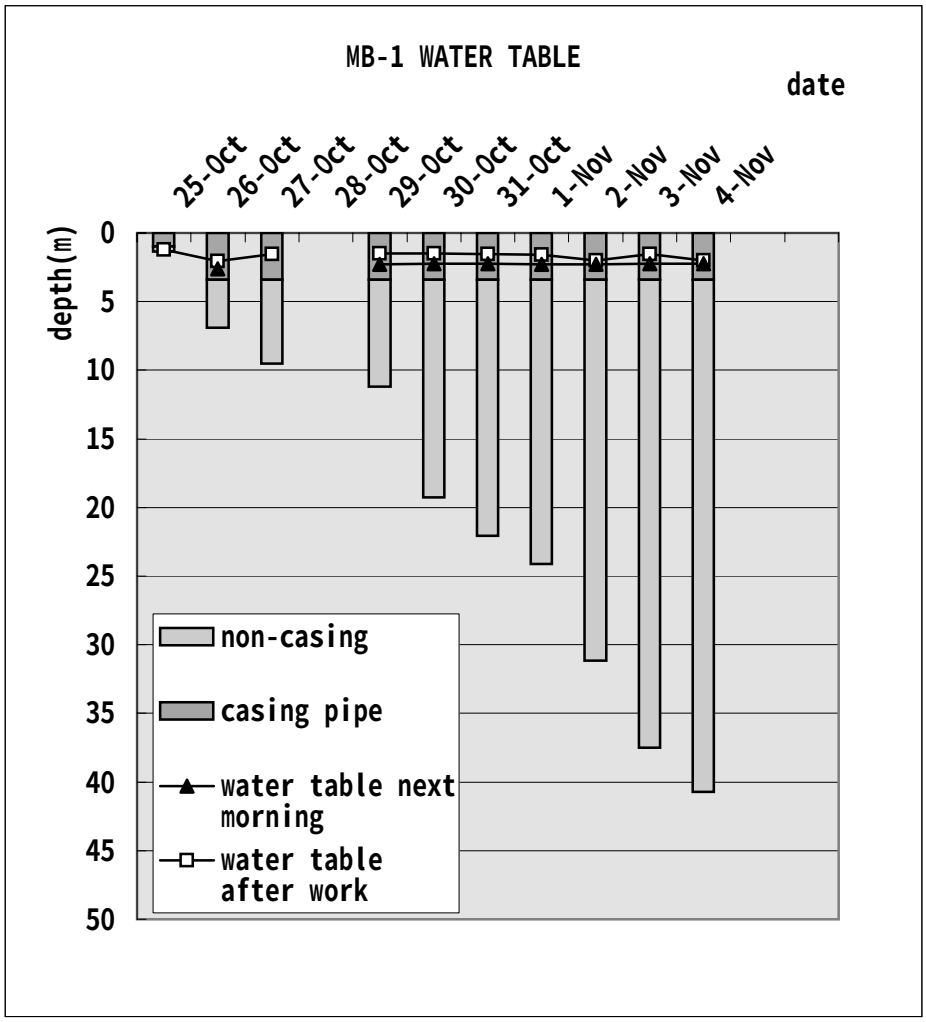
Boring No. DT-1 25m **Diversion tunne**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
20-Dec	2.50		1.00	1.45	1.05	0	0.45	31					
21-Dec	6.45	1.00	1.00	1.45	5.00				1.45	6.45	0		
22-Dec	9.45	1.00	1.00	1.45	8.00				6.45	11.45	0		
23-Dec	14.05	1.00	1.00	1.45	12.60				11.5	16.45	0		
24-Dec													
25-Dec													
26-Dec													
27-Dec	15.04	1.00	1.00	1.45	13.59				16.5	21.45	0		
28-Dec	16.45	1.00	1.04	1.45	15.00				21.5	25.5	0		
29-Dec	25.50	1.00	1.40	1.45	24.05								



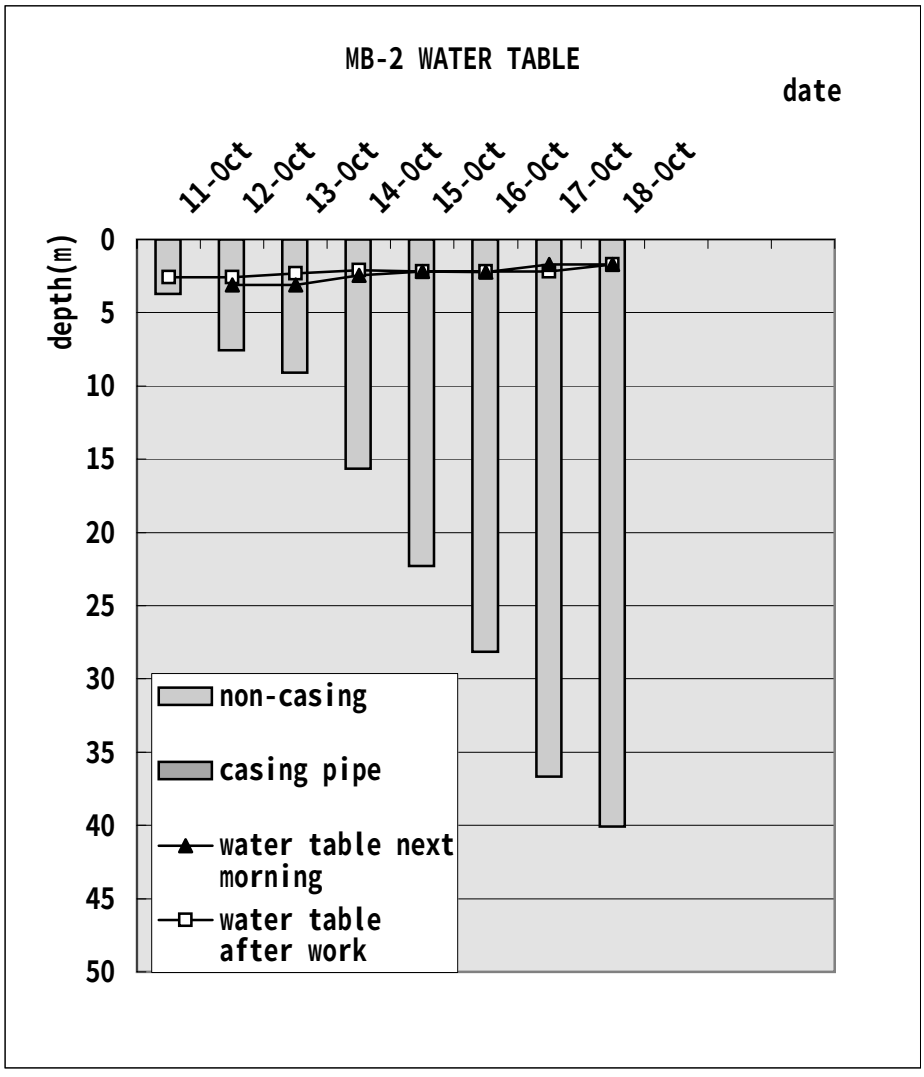
Boring No. MB-1 40m **Main Dam**

Date	daily advance	water table after work	water table next morning	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
25-Oct	1.40	1.20		1.00	0.40	0	0.45	5					
26-Oct	6.95	2.05	2.60	3.40	3.55								
27-Oct	9.58	1.55		3.40	6.18				4.35	9.08	3	$4.37*10^{-5}$	
28-Oct					0.00								
29-Oct	11.24	1.50	2.30	3.40	7.84								
30-Oct	19.31	1.50	2.25	3.40	15.91				9.09	14.22	0		
31-Oct	22.12	1.55	2.25	3.40	18.72				14.22	19.31	0		
1-Nov	24.17	1.60	2.30	3.40	20.77				19.31	24.17	0		
2-Nov	31.20	2.00	2.30	3.40	27.80				24.17	29.74	0		
3-Nov	37.54	1.55	2.25	3.40	34.14				29.74	34.27	0		
4-Nov	40.77	2.00	2.25	3.40	37.37				34.27	40.77	0		
					0.00								



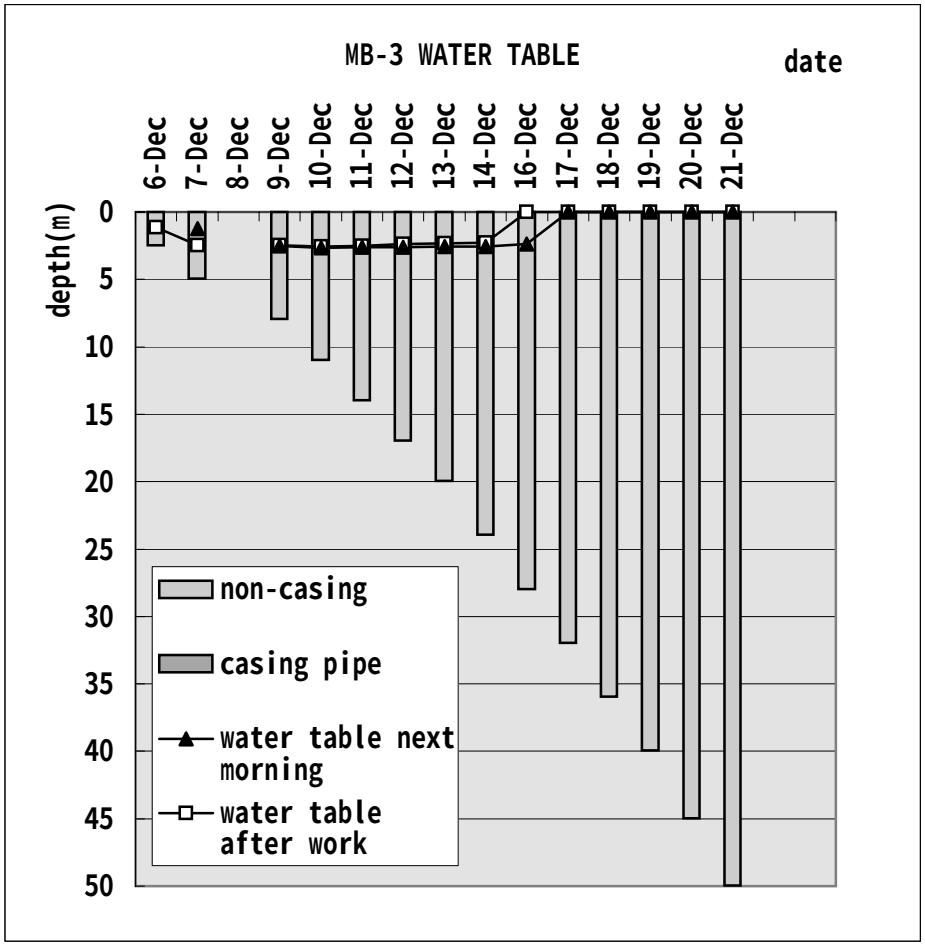
Boring No. MB-2 40m **Main Dam**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
11-Oct	3.76	2.60		0.00	3.76				1.00	5.30	1	$85*10^{-5}$	
12-Oct	7.62	2.60	3.10	0.00	7.62				5.30	9.85	0	$39*10^{-7}$	
13-Oct	9.14	2.30	3.10	0.00	9.14				9.85	14.80	0	$29*10^{-7}$	
14-Oct	15.67	2.10	2.45	0.00	15.67				14.80	19.54	0	$08*10^{-7}$	
15-Oct	22.34	2.20	2.20	0.00	22.34				19.54	24.05	0	$46*10^{-8}$	
16-Oct	28.17	2.20	2.25	0.00	28.17				24.05	29.93	0	$15*10^{-8}$	
17-Oct	36.71	2.20	1.70	0.00	36.71				29.93	35.25	0	$88*10^{-8}$	
18-Oct	40.13	1.70	1.70	0.00	40.13				35.25	40.13	0	$06*10^{-7}$	



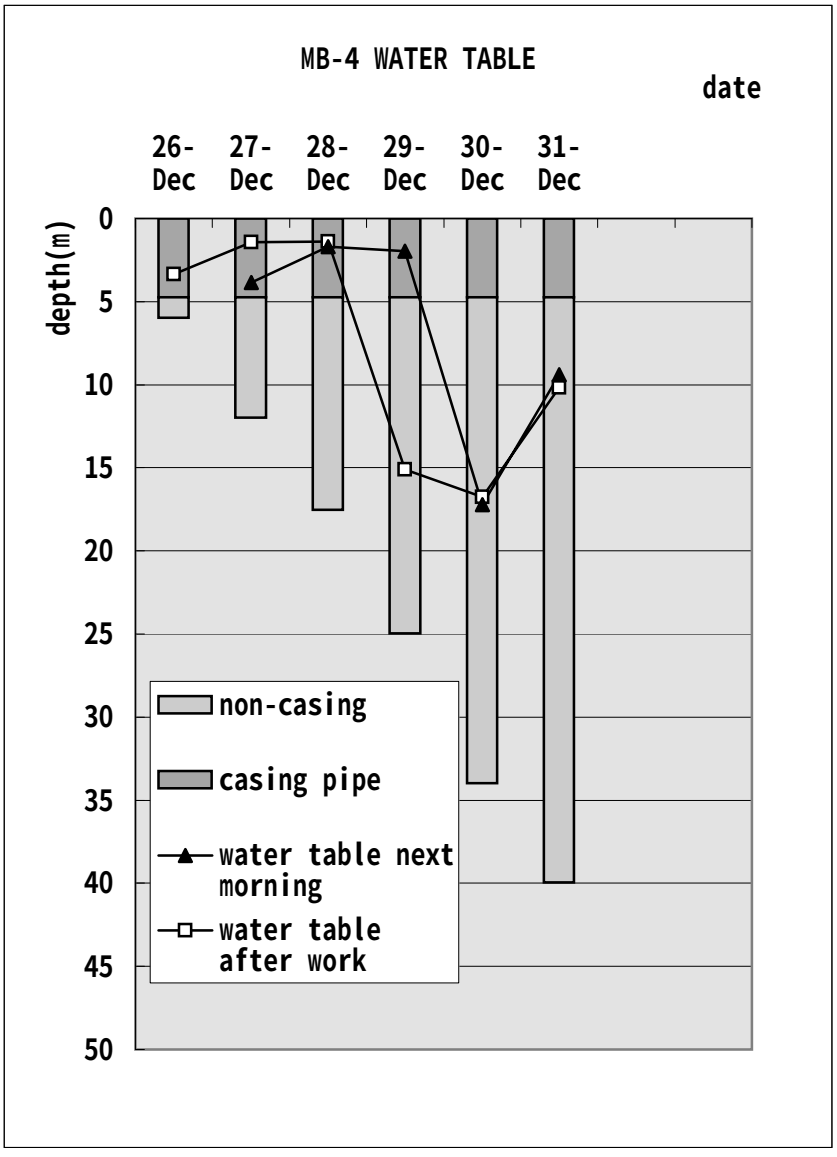
Boring No. MB-3 50m (50 degrees) Main Dam

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
6-Dec	2.50	1.16			2.50				0.65	5	0.00		
7-Dec	5.00	2.45	1.23		5.00				5	10	0.00		
8-Dec					0.00				10	15	0.00		
9-Dec	8.00	2.46	2.53		8.00				15	20	0.00		
10-Dec	11.00	2.56	2.65		11.00				15	20	0.00		
11-Dec	14.00	2.54	2.63		14.00				20	25	0.00		
12-Dec	17.00	2.36	2.60		17.00				25	30	0.00		
13-Dec	20.00	2.35	2.58		20.00				30	35	0.00		
14-Dec	24.00	2.30	2.55		24.00				35	40	0.00		
16-Dec	28.00	0.00	2.38		28.00				40	45	0.00		
17-Dec	32.00	0.00	0.00		32.00				45	50	0.00		
18-Dec	36.00	0.00	0.00		36.00								
19-Dec	40.00	0.00	0.00		40.00								
20-Dec	45.00	0.00	0.00		45.00								
21-Dec	50.00	0.00	0.00		50.00								



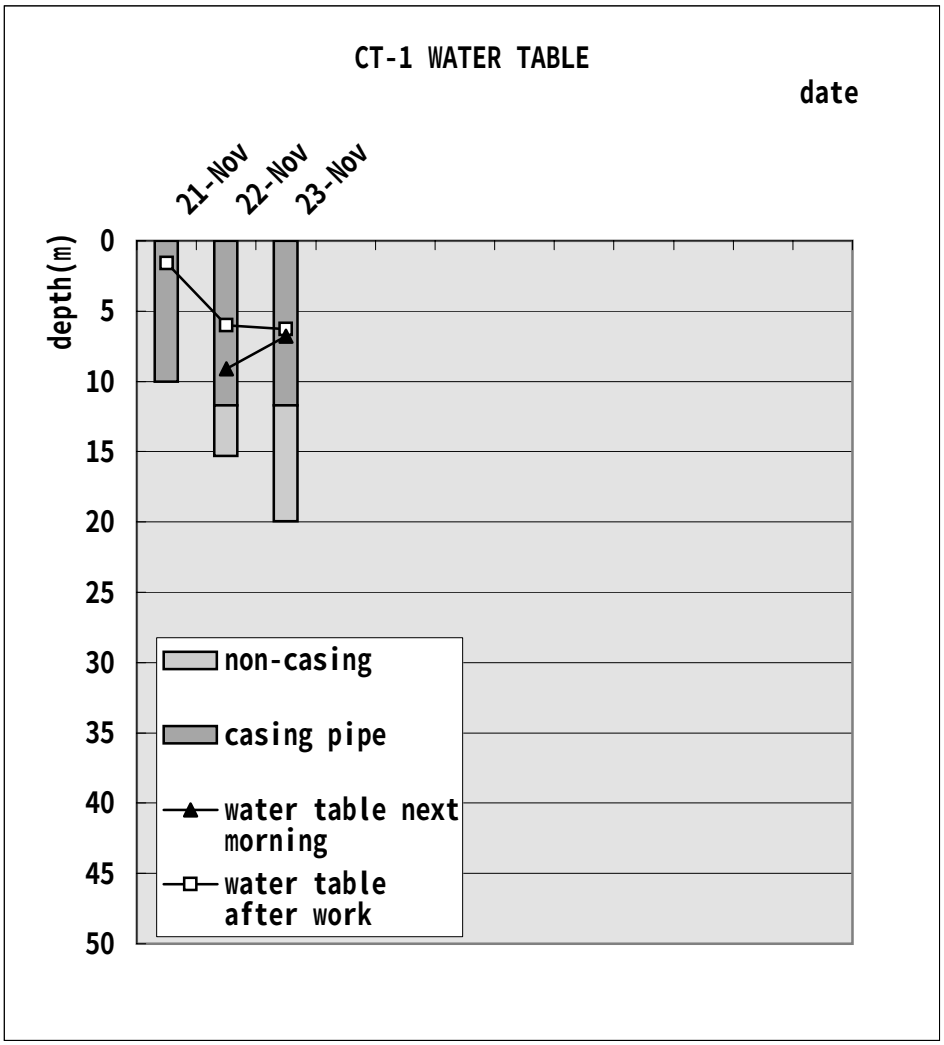
Boring No. MB-4 40m **Main Dam**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
26-Dec	6.00	3.36		4.75	1.25				5	10	0		
27-Dec	12.00	1.42	3.85	4.75	7.25				10	15	0		
28-Dec	17.55	1.40	1.68	4.75	12.80				15	20	0		
29-Dec	25.00	15.10	1.95	4.75	20.25				20	25	0		
30-Dec	34.00	16.74	17.23	4.75	29.25				30	35	0		
31-Dec	40.00	10.16	9.39	4.75	35.25								



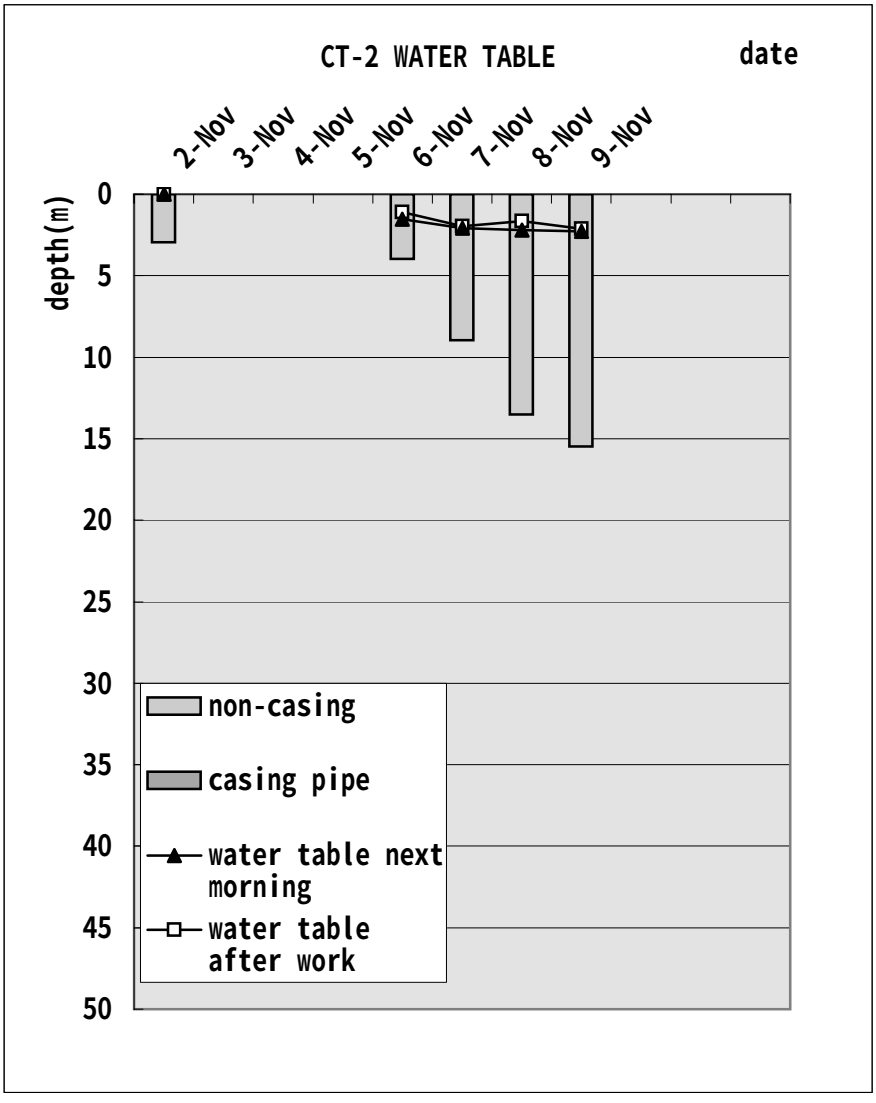
Boring No. CT-1 20m **Conduit Trace**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
21-Nov	10.00	1.60		10.00	0.00	0.00	0.45	4					
22-Nov	15.35	6.00	9.10	11.72	3.63	1.55	2.00	5					
23-Nov	20.00	6.28	6.78	11.72	8.28	3.00	3.45	7					
						4.55	5.00	4					
						6.00	6.45	8					
						7.55	8.00	2					
						9.00	9.45	4					
						10.55	11.00	9					



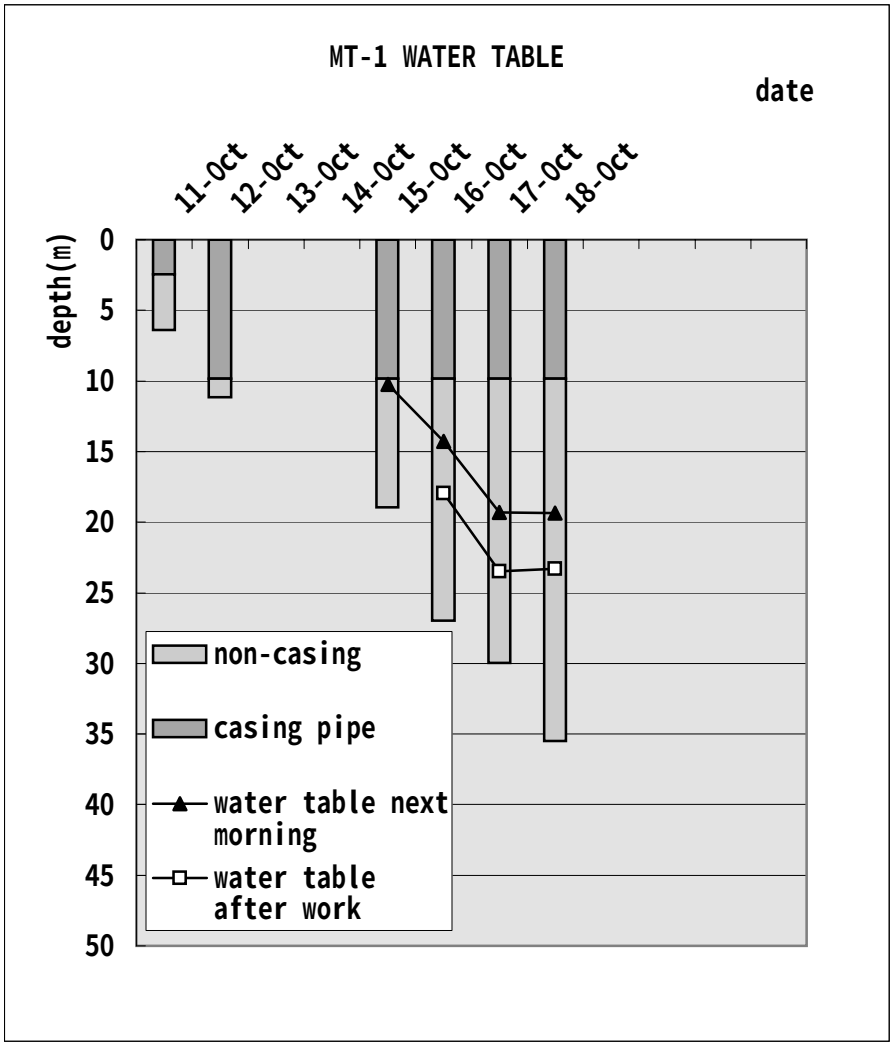
Boring No. CT-2 15m **Conduit Trace**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
2-Nov	3.00	0.00	0.00	0.00	3.00								
3-Nov													
4-Nov													
5-Nov													
6-Nov	4.00	1.10	1.52	0.00	4.00								
7-Nov	9.00	1.96	2.10	0.00	9.00				2.5	7	0		
8-Nov	13.55	1.64	2.21	0.00	13.55				7	12	0		
9-Nov	15.50	2.13	2.29	0.00	15.50				12	15.5	0		



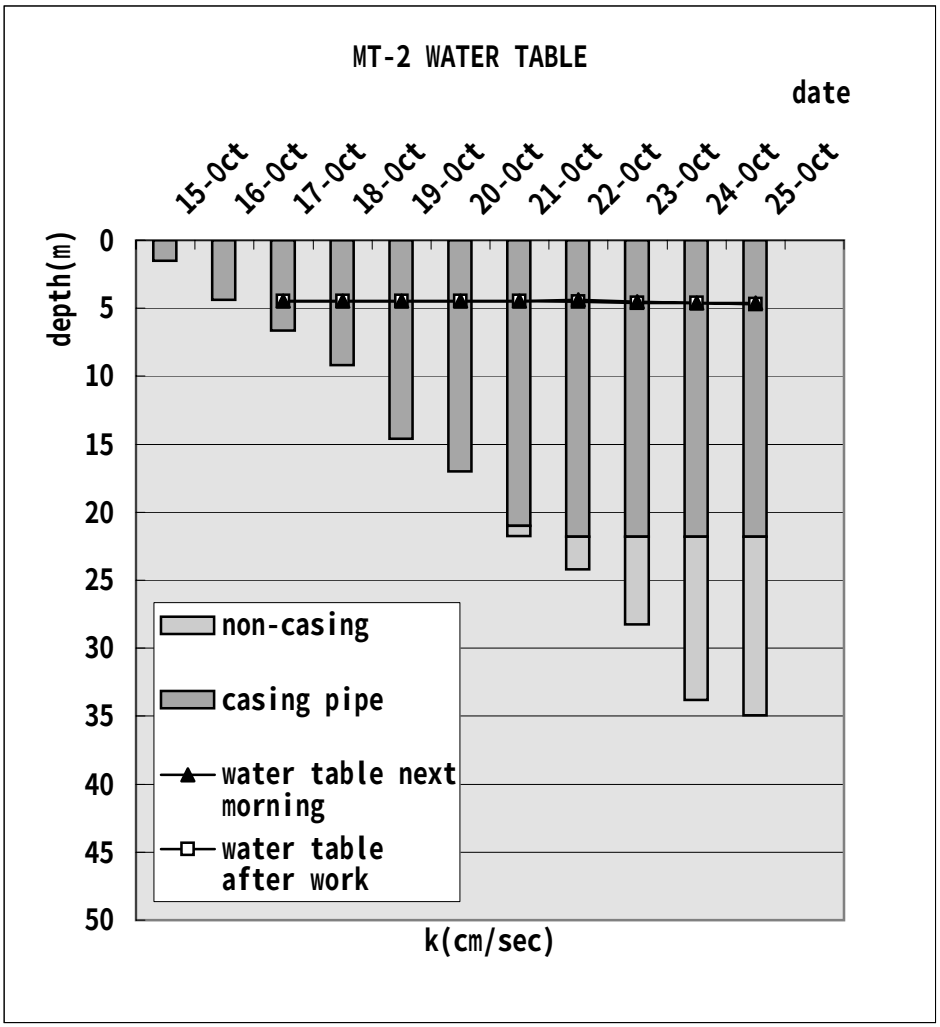
Boring No. MT-1 30m **Main Tunne**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
11-Oct	6.45			2.43	4.02	0.00	0.45	3					
12-Oct	11.20			9.83	1.37	1.50	1.95	5					
13-Oct						3.10	3.55	11					
14-Oct						4.50	4.95	12					
15-Oct	19.00		10.25	9.83	9.17	6.00	6.45	14					
16-Oct	27.00	17.95	14.30	9.83	17.17	7.50	7.85	46					
17-Oct	30.00	23.46	19.33	9.83	20.17	9.00	9.45	34					
18-Oct	35.54	23.32	19.36	9.83	25.71				30.00	35.54	0.4	$5.57*10^{-6}$	



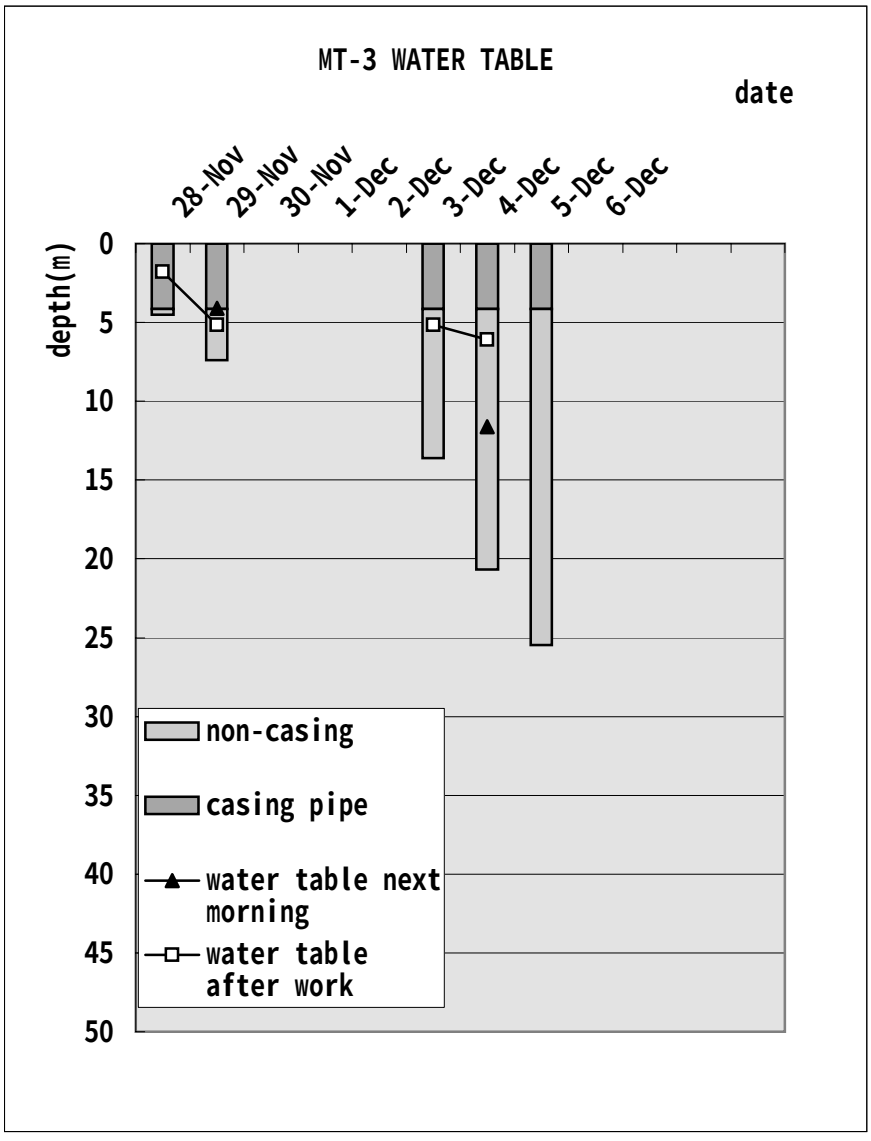
Boring No. MT-2 35m **Penstock**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
15-Oct	1.50			1.50	0.00	0.00	0.45	3					
16-Oct	4.40			4.40	0.00	1.50	1.95	25					
17-Oct	6.65	4.45	4.45	6.65	0.00	3.45	3.90	17					
18-Oct	9.20	4.45	4.45	9.20	0.00	5.70	6.55	24					
19-Oct	14.60	4.45	4.45	14.60	0.00	7.65	8.10	HB					
20-Oct	17.00	4.45	4.45	17.00	0.00								
21-Oct	21.80	4.45	4.45	21.00	0.80								
22-Oct	24.25	4.50	4.40	21.80	2.45								
23-Oct	28.30	4.60	4.50	21.80	6.50				21.8	26.8	0	$1.01*10^{-6}$	
24-Oct	33.85	4.60	4.60	21.80	12.05				26.5	31.5	0	$5.07*10^{-7}$	
25-Oct	35.00	4.70	4.60	21.80	13.20				30	35	0	$5.07*10^{-7}$	



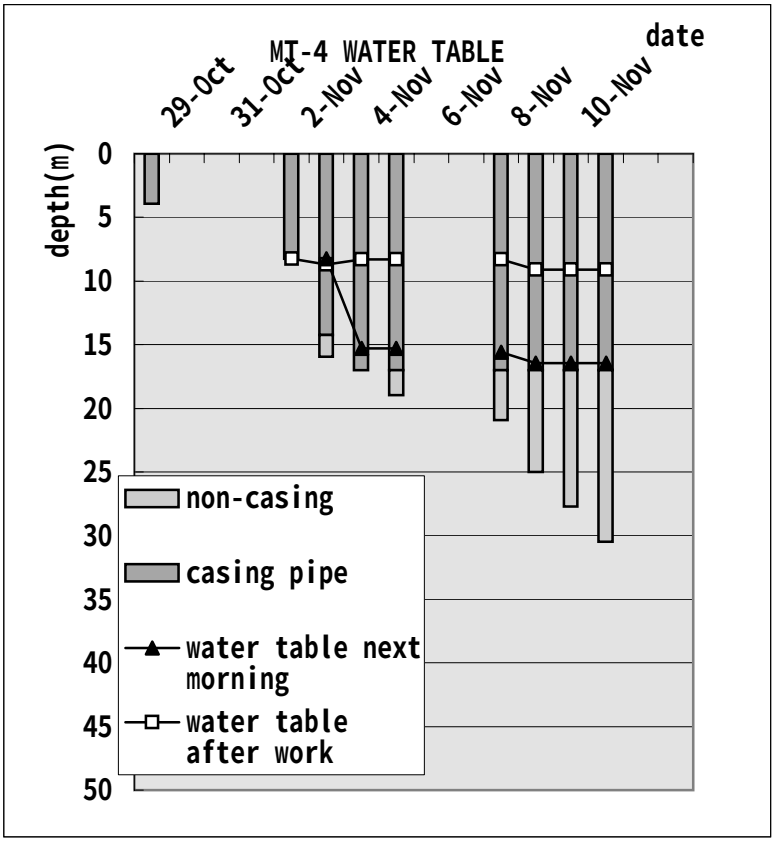
Boring No.　MB-3　25m　　**Penstock**

Date	daily advance	water table after work	water table next morning	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-valu	k cm/se	
28-Nov	4.55	1.80		4.15	0.40	0.00	0.45	8	4.15	9.15	0.8		
29-Nov	7.45	5.15	4.10	4.15	3.30	1.95	2.40	54	9.15	14.15	0.7		
30-Nov													
1-Dec													
2-Dec													
3-Dec	13.65	5.15		4.15	9.50	3.90	4.15	28	14.15	19.15	0.7		
4-Dec	20.70	6.10	11.60	4.15	16.55				19.15	24.15	0		
5-Dec	25.50			4.15	21.35				24.15	25.5	0		
6-Dec													



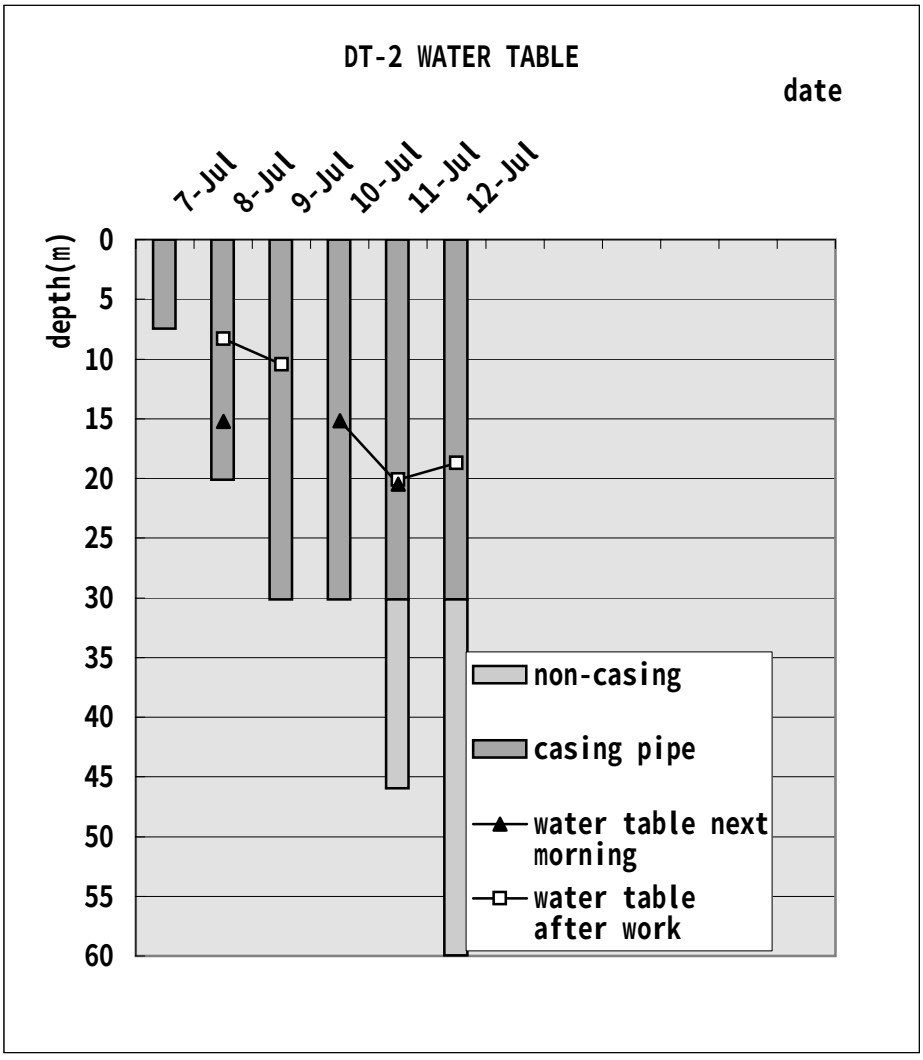
Boring No. MT-4 30m **Penstock**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
29-Oct	3.90			3.90	0.00	0	0.45	8					
30-Oct					0.00	2	2.4	15					
31-Oct					0.00	3.9	4.35	15					
1-Nov					0.00	5.9	6.3	27					
2-Nov	8.25	8.25		8.25	0.00	7.8	8.25	31					
3-Nov	16.00	8.70	8.25	14.25	1.75								
4-Nov	17.00	8.30	15.30	17.00	0.00								
5-Nov	19.00	8.30	15.30	17.00	2.00								
6-Nov					0.00								
7-Nov					0.00								
8-Nov	21.00	8.30	15.60	17.00	4.00								
9-Nov	25.05	9.10	16.45	17.00	8.05				17	21.9	0	$2.7*10^{-6}$	
10-Nov	27.75	9.10	16.45	17.00	10.75				2.19	27.1	0	$3.8*10^{-6}$	
11-Nov	30.55	9.10	16.45	17.00	13.55				27.1	30.6	0	$3.9*10^{-6}$	



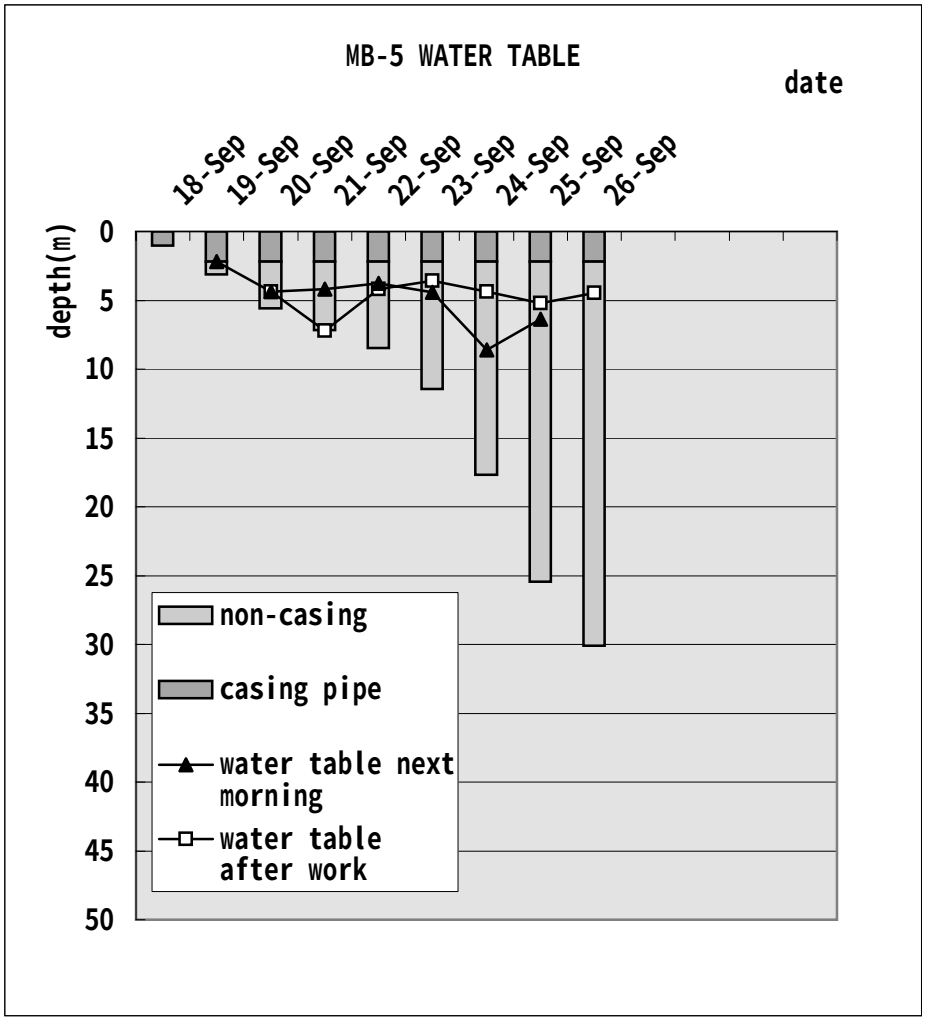
Boring No. DT-2 60m (45 degrees) **Diversion tunne**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
7-Jul	7.45			7.45	0.00								
8-Jul	20.10	8.32	15.24	20.10	0.00								
9-Jul	30.12	10.45		30.12	0.00								
10-Jul	30.12		15.18	30.12	0.00								
11-Jul	46.00	20.13	20.48	30.12	15.88								
12-Jul	60.00	18.73		30.12	29.88								



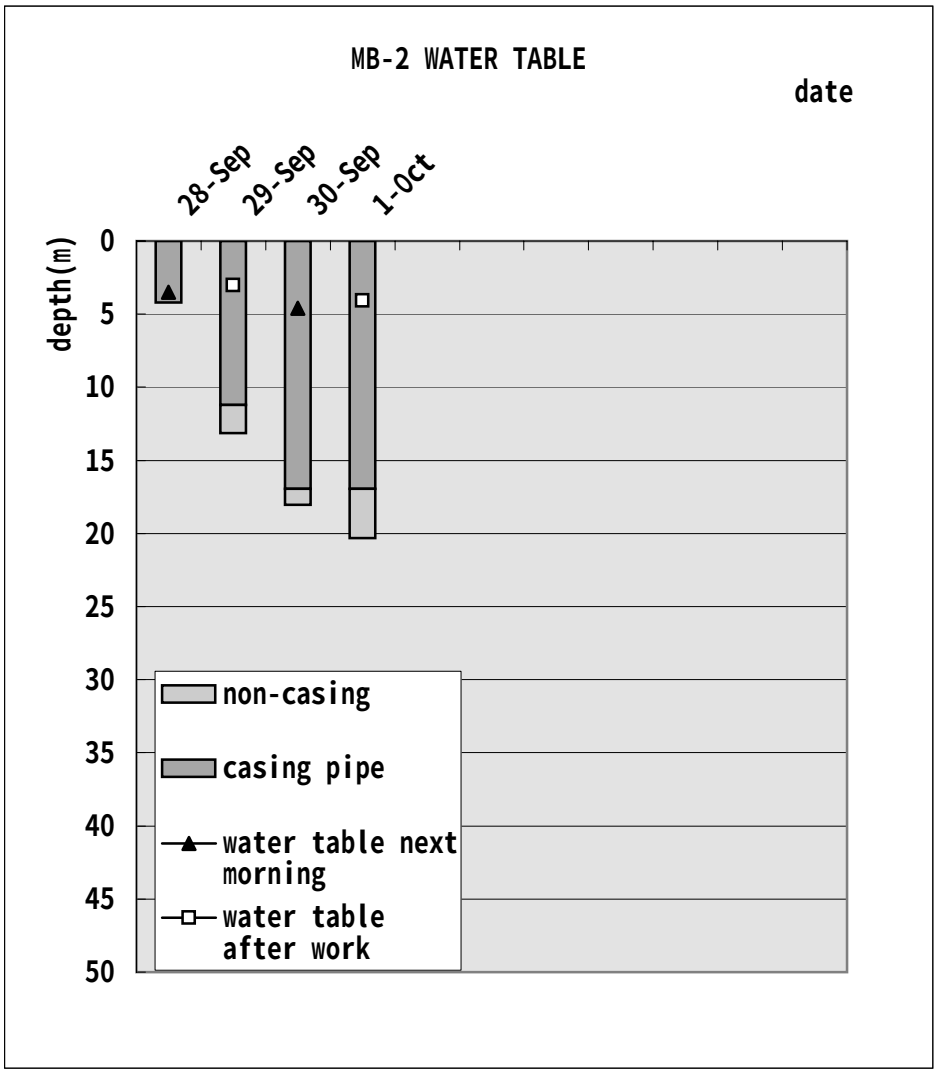
Boring No. MB-5 30m **Main Dam**

Date	daily advance	water table after work	water table next morning	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
18-Sep	1.00			1.00	0.00	1	1.45	1					6.20-7.20
19-Sep	3.15		2.20	2.20	0.95								water loss
20-Sep	5.65	4.35	4.35	2.20	3.45				3.25	8.50	>50		
21-Sep	7.20	7.20	4.20	2.20	5.00				8.50	13.50	0		
22-Sep	8.50	4.20	3.75	2.20	6.30				13.50	19.20	0		
23-Sep	11.50	3.60	4.40	2.20	9.30				19.50	25.50	2.1		
24-Sep	17.70	4.35	8.60	2.20	15.50								
25-Sep	25.50	5.20	6.35	2.20	23.30								
26-Sep	30.15	4.45		2.20	27.95								



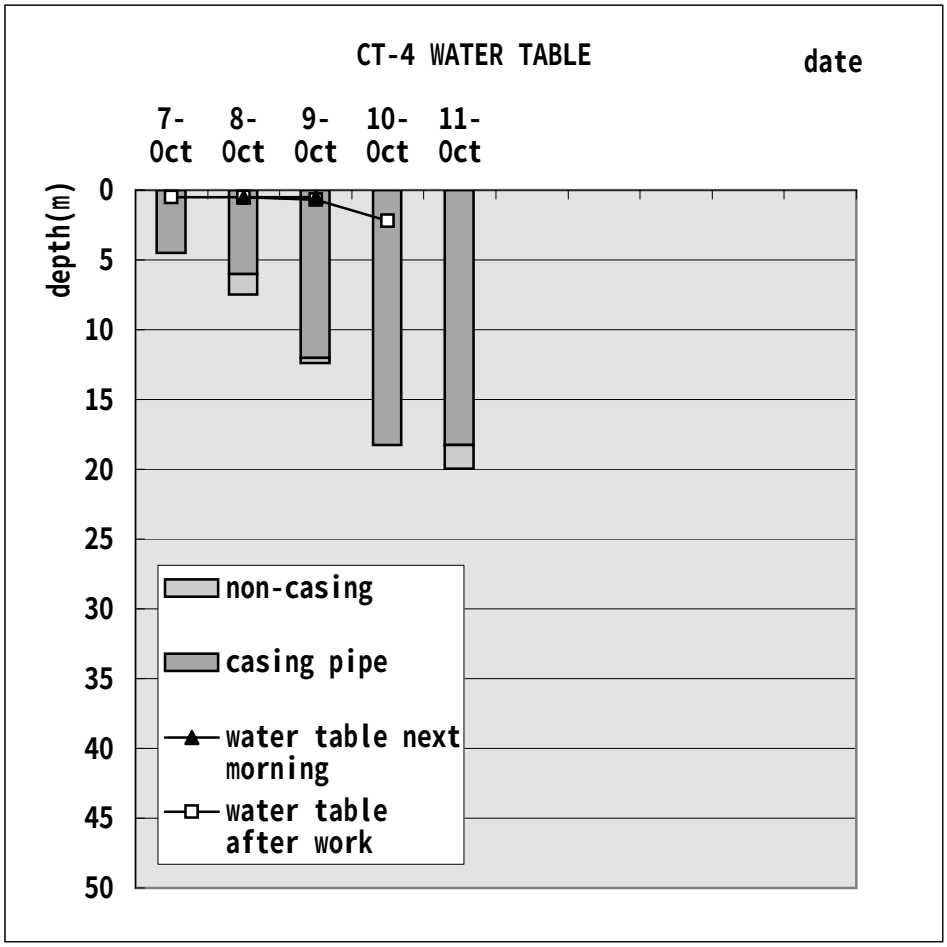
Boring No. CT-3 20m **Conduit**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
28-Sep	4.20		3.50	4.20	0.00	1.50	1.95	5					
29-Sep	13.20	3.00		11.20	2.00	3.00	3.15	10					
30-Sep	18.10		4.60	16.95	1.15	4.50		>50					
1-Oct	20.35	4.05		16.95	3.40	15.00		>50					



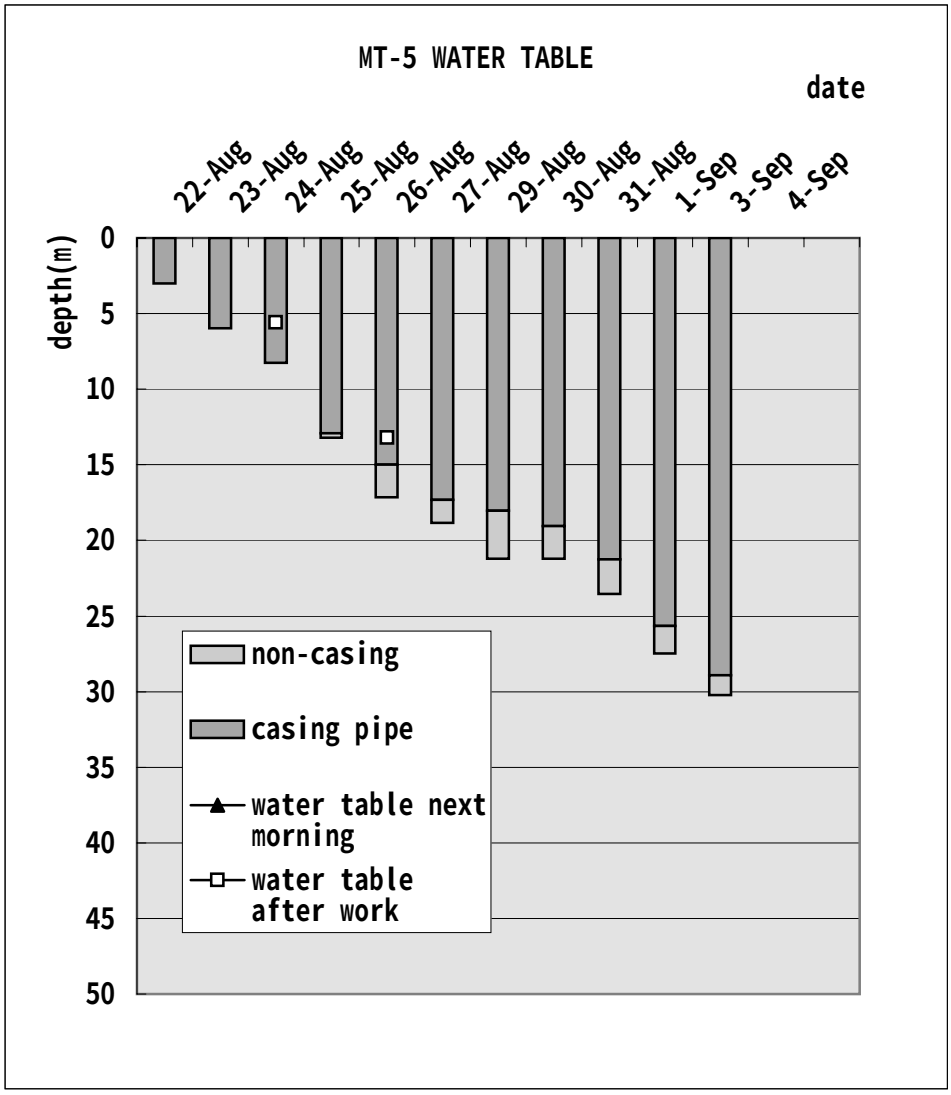
Boring No. CT-4 20m **Conduit**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
7-Oct	4.50	0.50		4.50	0.00	1.50	1.95	1					
8-Oct	7.50	0.50	0.50	6.00	1.50	3.00	3.45	7					
9-Oct	12.45	0.70	0.50	12.00	0.45	6.00	6.45	9					
10-Oct	18.25	2.20		18.25	0.00	7.50	7.75	24					
11-Oct	20.00			18.25	1.75	9.00	9.45	20					
						10.50	10.95	17					
						12.00	12.45	23					
						14.00	14.45	11					



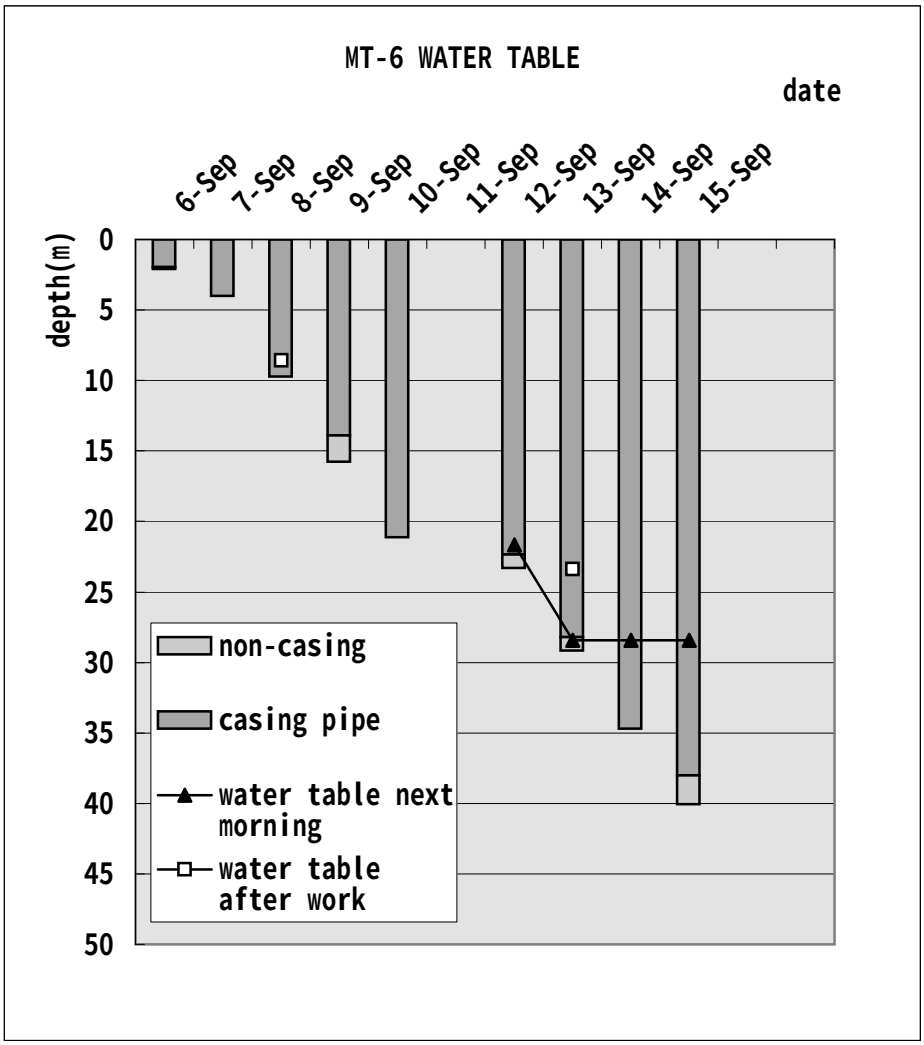
Boring No. MT-5 30m **Main Tunnel**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
22-Aug	3.00			3.00	0.00	0.00	0.45	4					14.1 m leak
23-Aug	5.95			5.95	0.00	1.50	1.95	5					17.64 m leak
24-Aug	8.25	5.60		8.25	0.00	3.00	3.45	5					28.25 m leak
25-Aug	13.25			12.90	0.35	4.50	4.95	4					
26-Aug	17.20	13.20		15.00	2.20	7.00	7.45	26					
27-Aug	18.90			17.30	1.60	9.25	9.70	58					
29-Aug	21.25			18.05	3.20	10.80	11.25	45					
30-Aug	21.25			19.05	2.20								18m- collapse
31-Aug	23.60			21.25	2.35								
1-Sep	27.50			25.65	1.85								
3-Sep	30.25			28.90	1.35								
4-Sep	30.25												



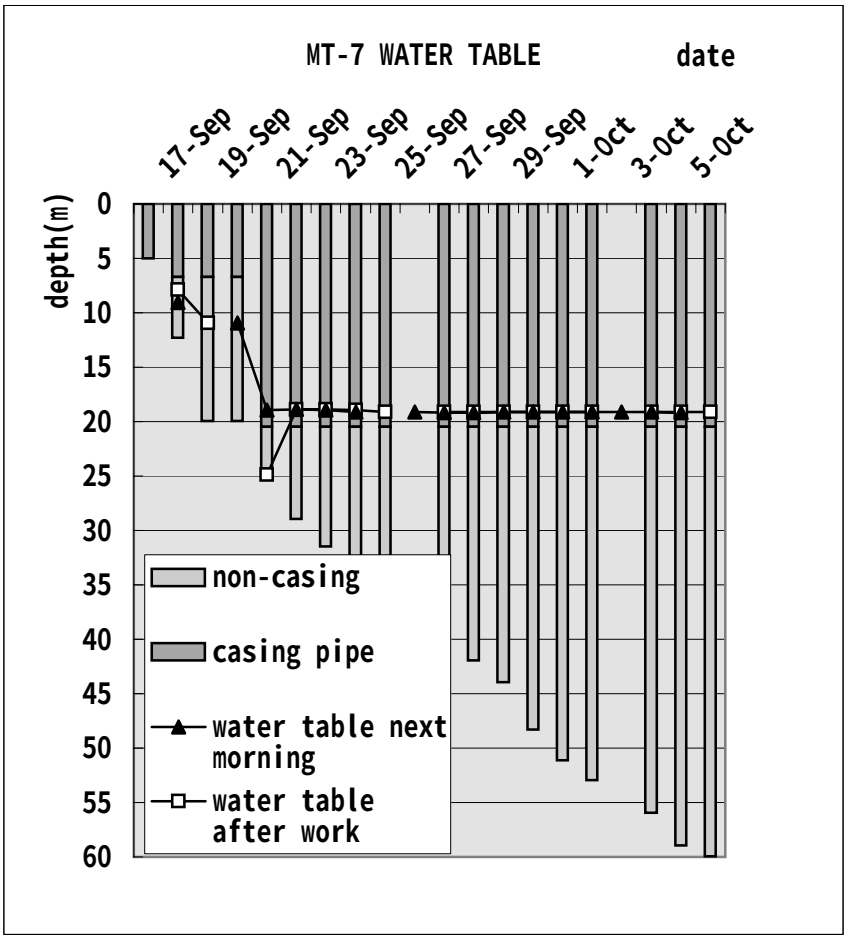
Boring No. MT-6 40m **Main Tunnel**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
6-Sep	2.15			1.95	0.20	0.00	0.45	1					22.65 m leak
7-Sep	4.00			4.00	0.00	1.50	1.95	57					38.95 m leak
8-Sep	9.70	8.60		9.70	0.00	3.00	3.45	61					
9-Sep	15.80			13.90	1.90	5.75	6.20	16					
10-Sep	21.10			21.10	0.00	9.25	9.70	74					
11-Sep						10.65	11.10	33					
12-Sep	23.35		21.65	22.35	1.00	12.40	12.60	>50					
13-Sep	29.20	23.40	28.45	28.20	1.00								
14-Sep	34.70		28.45	34.70	0.00								
15-Sep	40.10		28.45	38.00	2.10								



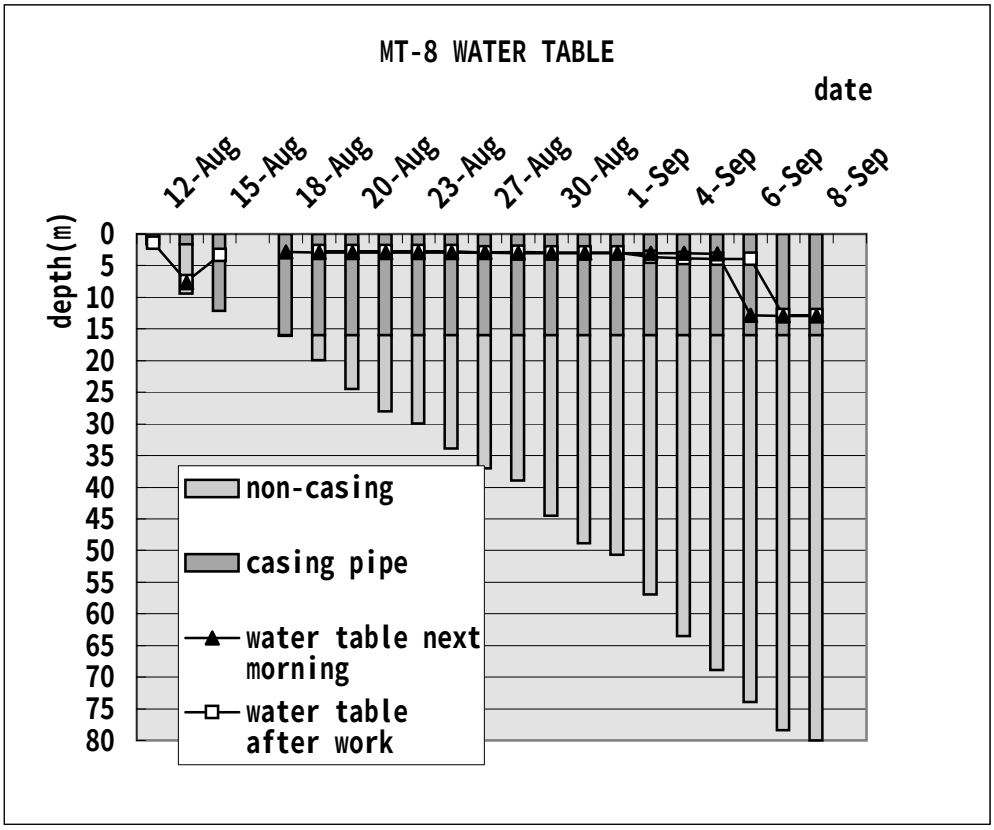
Boring No. MT-7 60 m **Surge Chamber**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
17-Sep	5.00			5.00	0.00	0.00	0.45	6	25.50	29.00	0.1		
18-Sep	12.38	7.89	9.04	6.72	5.66	1.55	2.00	8	29.00	34.36	0.3		
19-Sep	20.00	10.95		6.72	13.28	3.00	3.45	16	34.25	39.00	0		
20-Sep	20.00		10.92	6.72	13.28	4.55	5.00	12	39.00	44.00	0		
21-Sep	25.00	24.86	18.95	20.48	4.52	6.00	6.45	7	43.90	49.00	0		
22-Sep	29.00	18.90	18.90	20.48	8.52	7.55	7.68	>50	49.00	54.00	0		
23-Sep	31.50	18.90	18.95	20.48	11.02	9.00	9.27	>50	54.00	59.00	0		
24-Sep	34.36	18.92	19.10	20.48	13.88	10.55	11.00	42	57.50	60.00	0		
25-Sep	37.00	19.10		20.48	16.52	12.00	12.38	>50					
26-Sep			19.14		0.00	13.00	13.45	16					
27-Sep	40.00	19.10	19.15	20.48	19.52	15.00	15.45	14					
28-Sep	42.00	19.12	19.16	20.48	21.52	16.55	17.00	18					
29-Sep	44.00	19.12	19.12	20.48	23.52	18.00	18.24	>50					
30-Sep	48.37	19.10	19.11	20.48	27.89	19.55	19.68	>50					
1-Oct	51.16	19.10	19.12	20.48	30.68								
2-Oct	53.00	19.10	19.14	20.48	32.52								
3-Oct			19.14		0.00								
4-Oct	56.00	19.11	19.12	20.48	35.52								
5-Oct	59.00	19.10	19.15	20.48	38.52								
6-Oct	60.00	19.12		20.48	39.52								



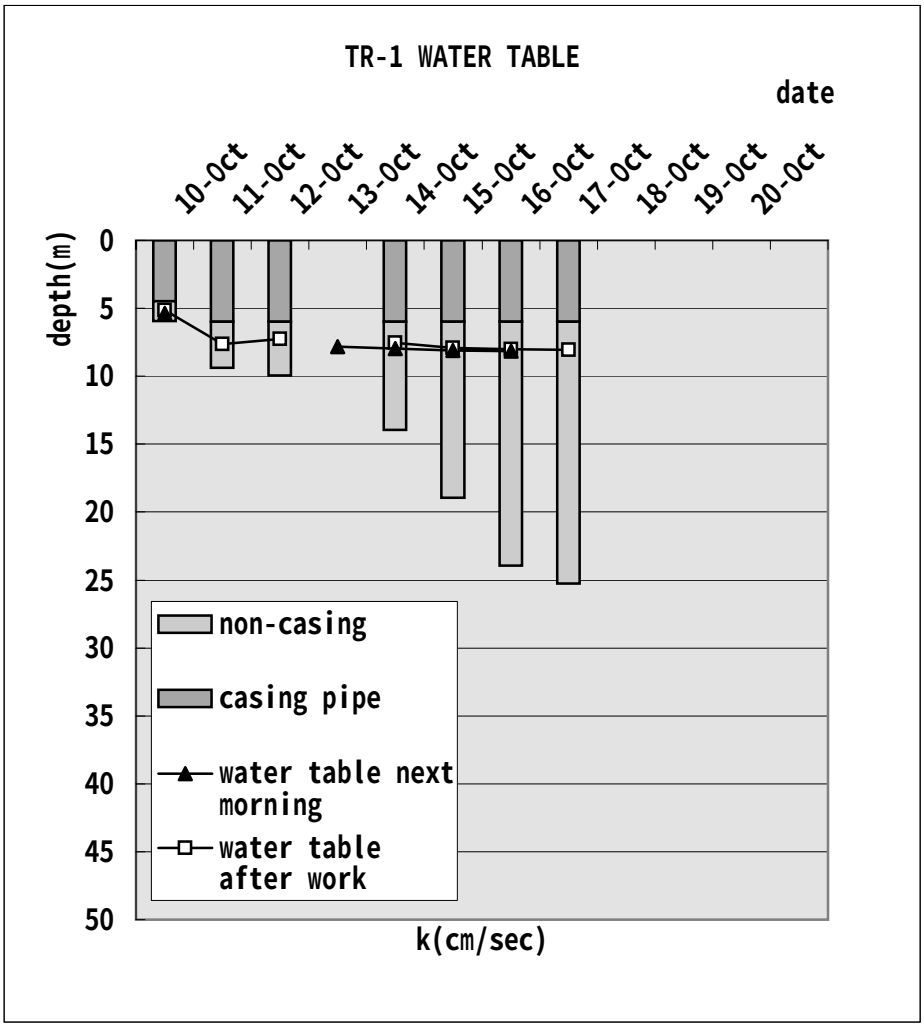
Boring No. MT-8 80m **Main Tunnel**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
12-Aug	1.60	1.45		1.60	0.00	0.00	0.45	5	16.50	20.00	0.4		72.06 m leak
13-Aug	9.50	7.53	7.68	1.60	7.90	2.00	2.24	>50	19.50	24.55	0.3		
15-Aug	16.18	3.35		12.18					24.60	29.00	0.0		
16-Aug									29.00	34.00	0.0		
18-Aug	16.18		2.88	16.00	0.18				34.00	39.00	0.0		
19-Aug	20.00	2.69	2.89	16.00	4.00				39.15	44.63	0.0		
20-Aug	24.55	2.75	2.92	16.00	8.55				44.50	49.00	0.0		
22-Aug	28.10	2.77	2.90	16.00	12.10				49.00	54.00	0.0		
23-Aug	30.00	2.69	2.91	16.00	14.00				54.00	59.00	0.0		
26-Aug	34.00	2.78	2.97	16.00	18.00				59.00	64.00	0.0		
27-Aug	37.07	2.90	2.96	16.00	21.07				64.00	69.00	0.0		
28-Aug	39.00	2.88	3.01	16.00	23.00				69.00	74.00	26.6	3.54×10^{-4}	
30-Aug	44.63	2.92	3.02	16.00	28.63				73.50	78.46	0.0		
31-Aug	49.00	2.94	3.04	16.00	33.00				78.00	80.06	0.1		
1-Sep	50.75	2.97	3.04	16.00	34.75								
3-Sep	57.00	3.62	3.04	16.00	41.00								
4-Sep	63.61	3.84	3.02	16.00	47.61								
5-Sep	69.00	3.98	3.16	16.00	53.00								
6-Sep	74.00	3.98	12.84	16.00	58.00								
7-Sep	78.46	12.82	12.94	16.00	62.46								
8-Sep	80.06	12.86	12.95	16.00	64.06								



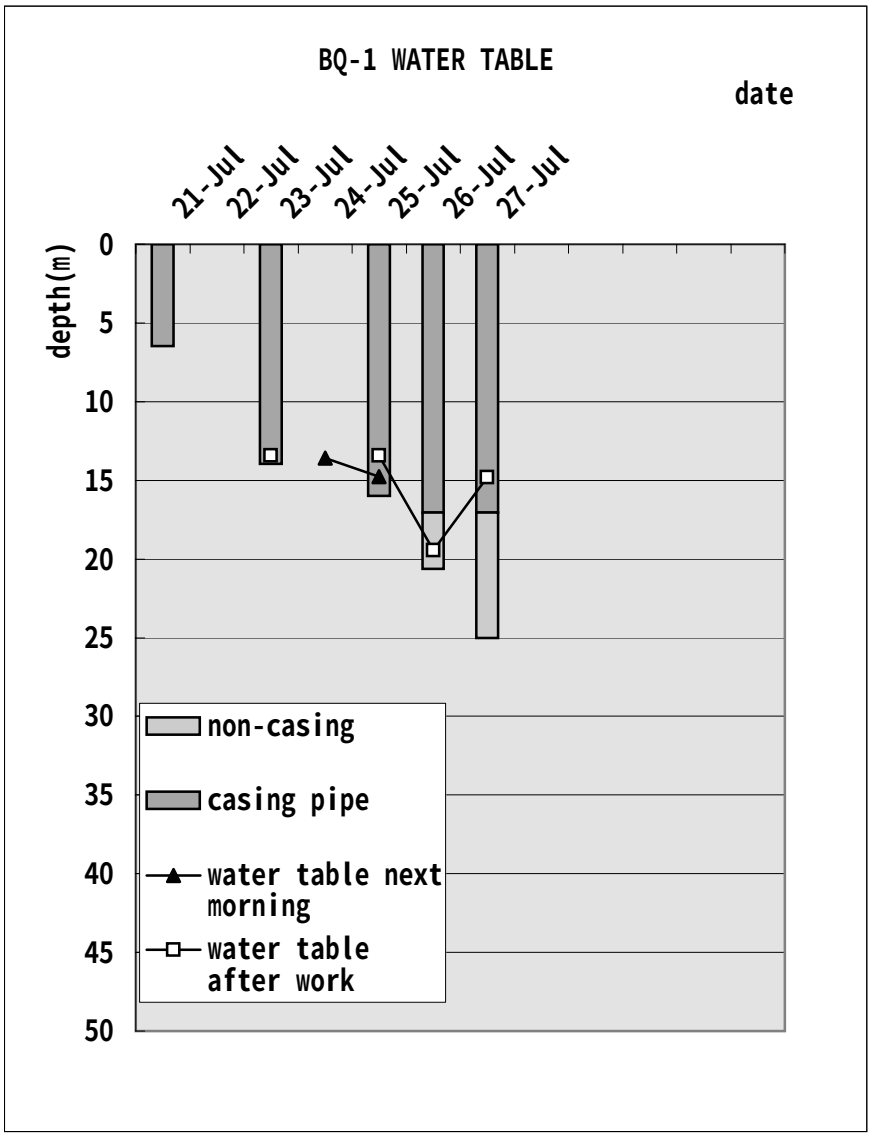
Boring No. TR-1 35m **Tailrace**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
10-Oct	6.00	5.13	5.38	4.50	1.50	0.00	0.45	6	9.5	14	0		
11-Oct	9.44	7.62		6.00	3.44	1.55	2.00	48	14	19	0		
12-Oct	10.00	7.26		6.00	4.00	3.00	3.27	>50	19.5	25.3	0		
13-Oct			7.84		0.00	4.50	4.68	>50					
14-Oct	14.00	7.56	7.96	6.00	8.00								
15-Oct	19.00	7.92	8.10	6.00	13.00								
16-Oct	24.00	8.02	8.15	6.00	18.00								
17-Oct	25.30	8.06		6.00	19.30								
18-Oct					0.00								
19-Oct					0.00								
20-Oct					0.00								



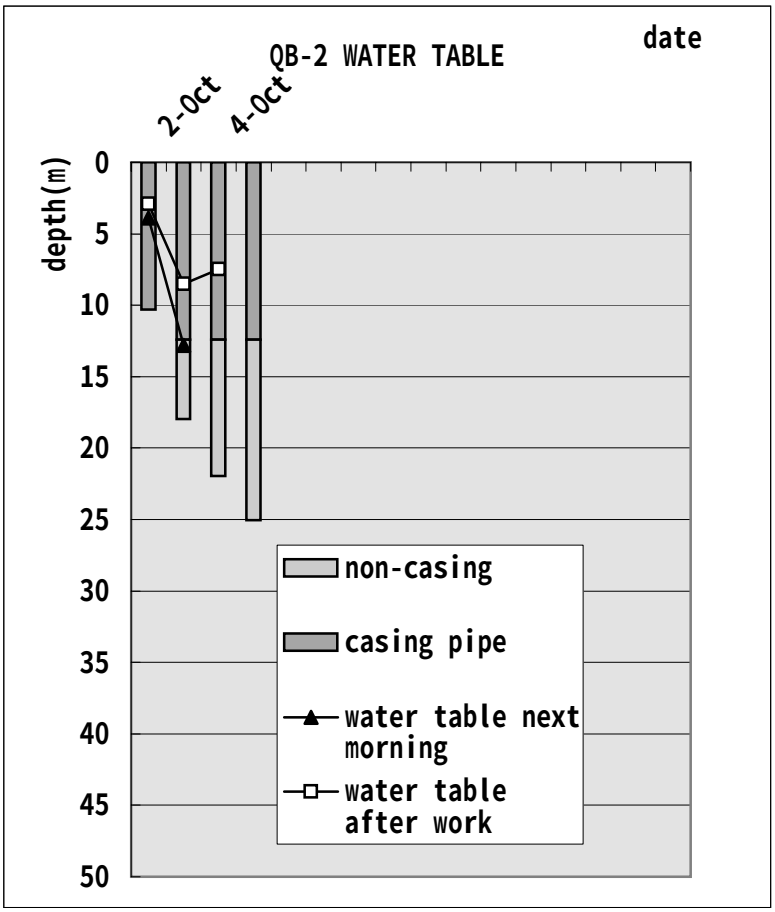
Boring No. BQ-1 25m **Quarry B**

Date	daily advance	water table after work	water table next morning	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-valu	k cm/se	
21-Jul	6.45			6.45	0.00	0.00	0.45	8					16.82 m leak
22-Jul					0.00	1.50	1.95	11					19.47 m leak
23-Jul	13.95	13.43		13.95	0.00	3.00	3.45	18					cemented
24-Jul			13.58			4.50	4.95	15					20.60 m
25-Jul	16.00	13.42	14.75	16.00	0.00	6.00	6.45	14					
26-Jul	20.65	19.45		17.05	3.60	7.50	7.95	15					
27-Jul	25.05	14.82		17.05	8.00	9.00	9.45	20					
						10.50	10.95	23					
						12.00	12.45	57					
						13.50	13.73	>50					



Boring No. **25m** **Quarry C**

Date	daily advance	water table after	water table next	casing pipe	non-casing	Standard Penetration Test			Lugion Test				Remarks
	depth (m)	(m)	(m)	(m)	(m)	from (m)	to (m)	N-value	from (m)	to (m)	Lu-value	k cm/sec	
2-Oct	10.30	2.90	3.90	10.30	0.00	0	0.45	4					
3-Oct	18.00	8.50	12.80	12.40	5.60								
4-Oct	22.00	7.50		12.40	9.60								
5-Oct	25.10			12.40	12.70								

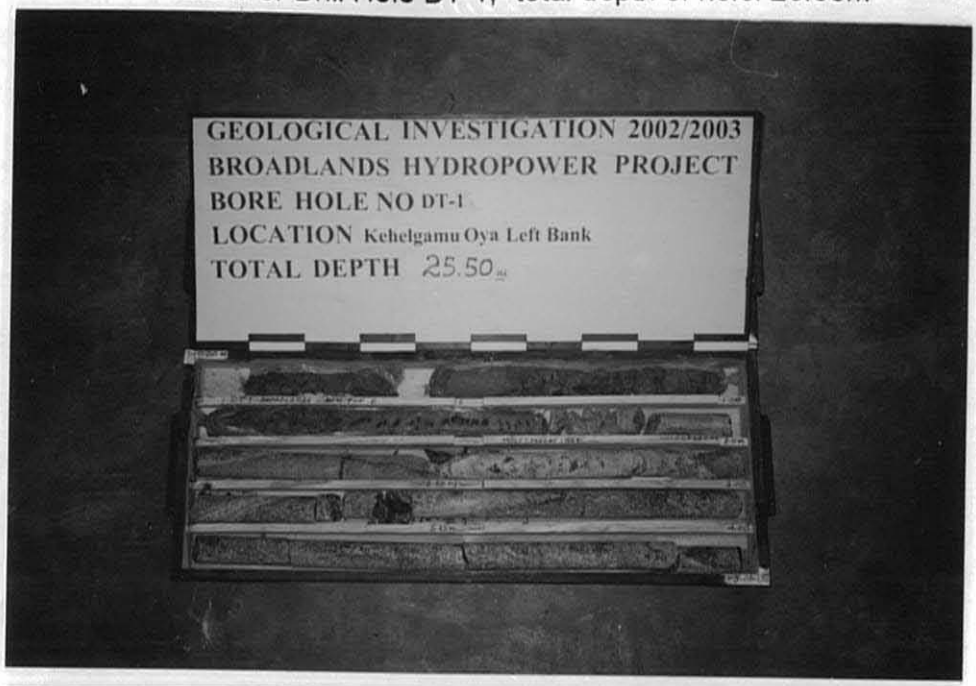


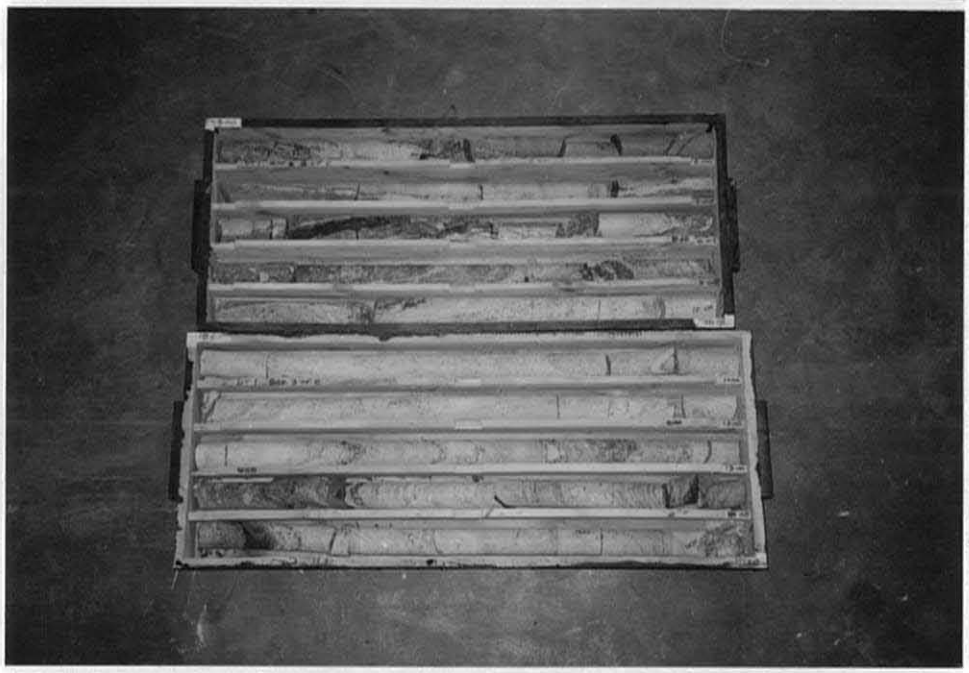
1.3 Photographs of Drilling Location and Drilling Core

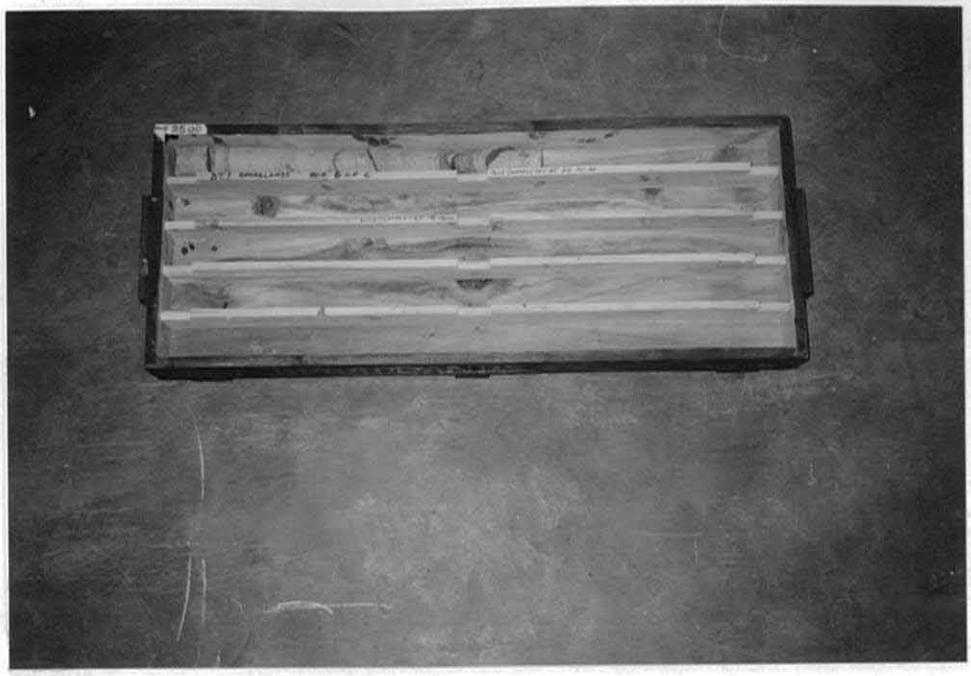
Plate # 1: Drilling Location of DT-1
Total depth of hole: 25.50m

Plate # 2: Hole monument of DT-1 with cap

Plate # 3: Drill Hole DT-1, total depth of hole: 25.50m







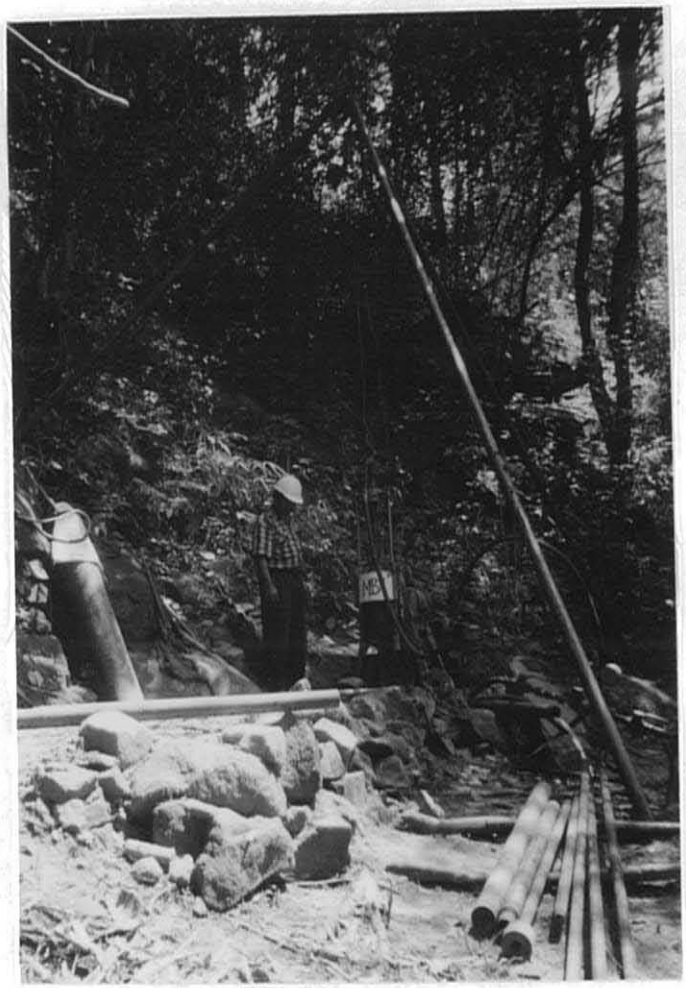


Plate # 4: Drilling Location of MB-1
Total depth of hole: 40.77m

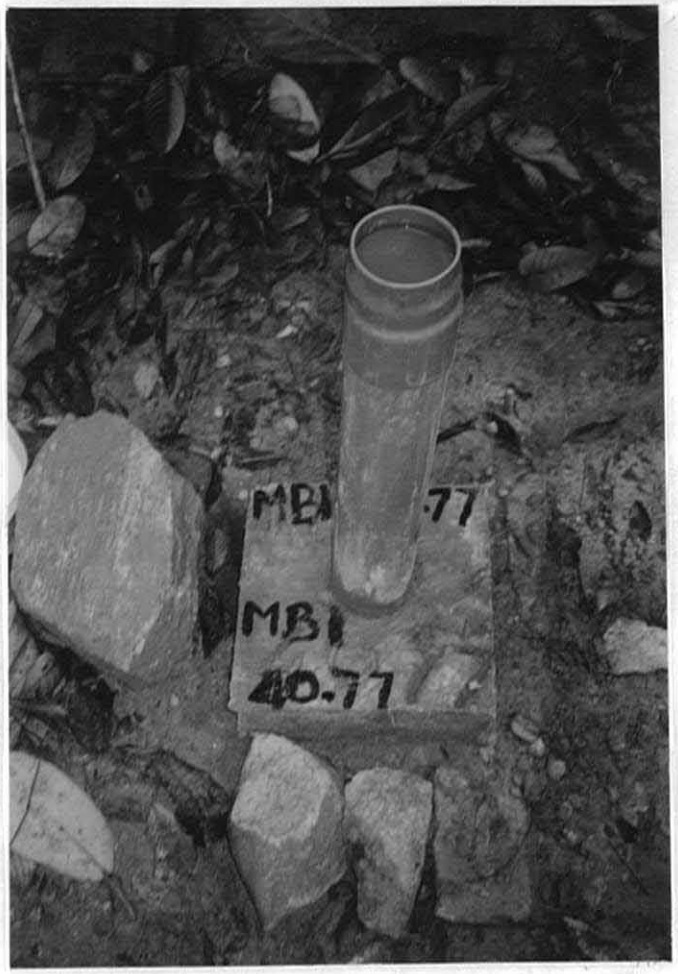
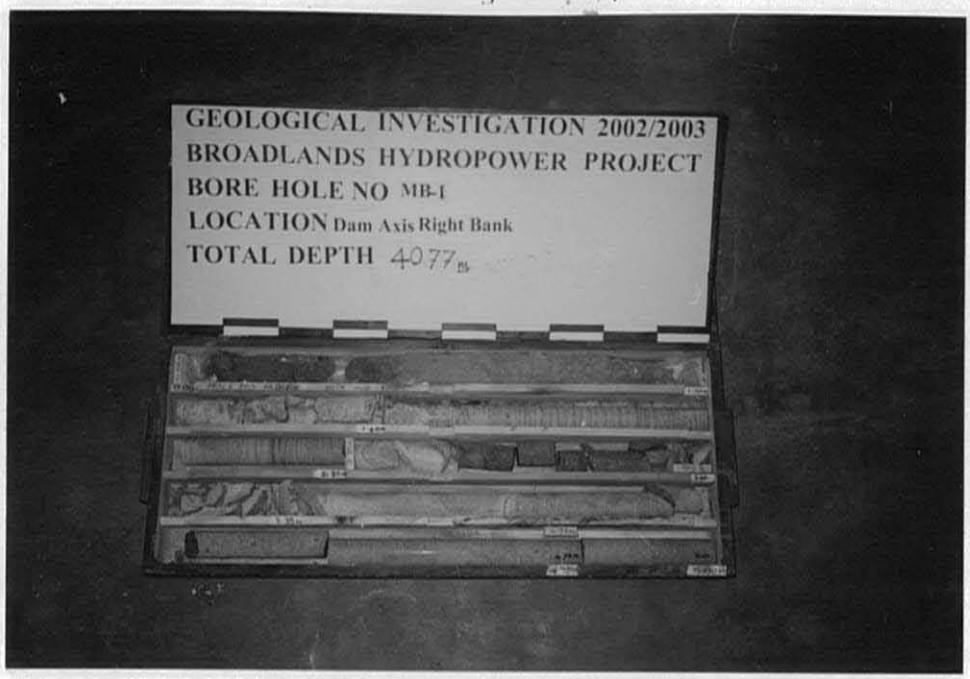
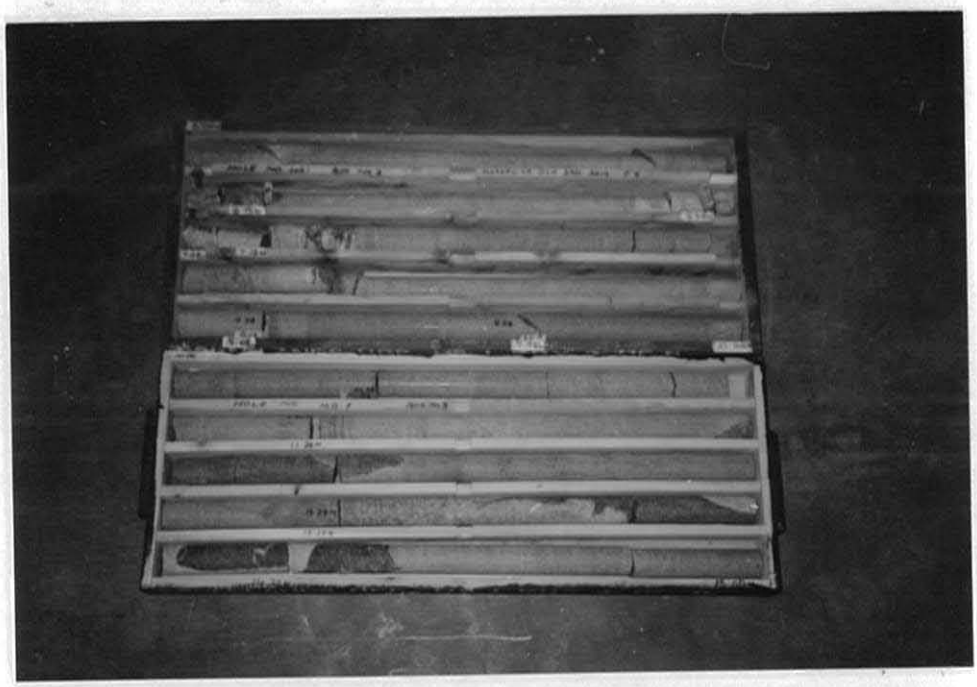
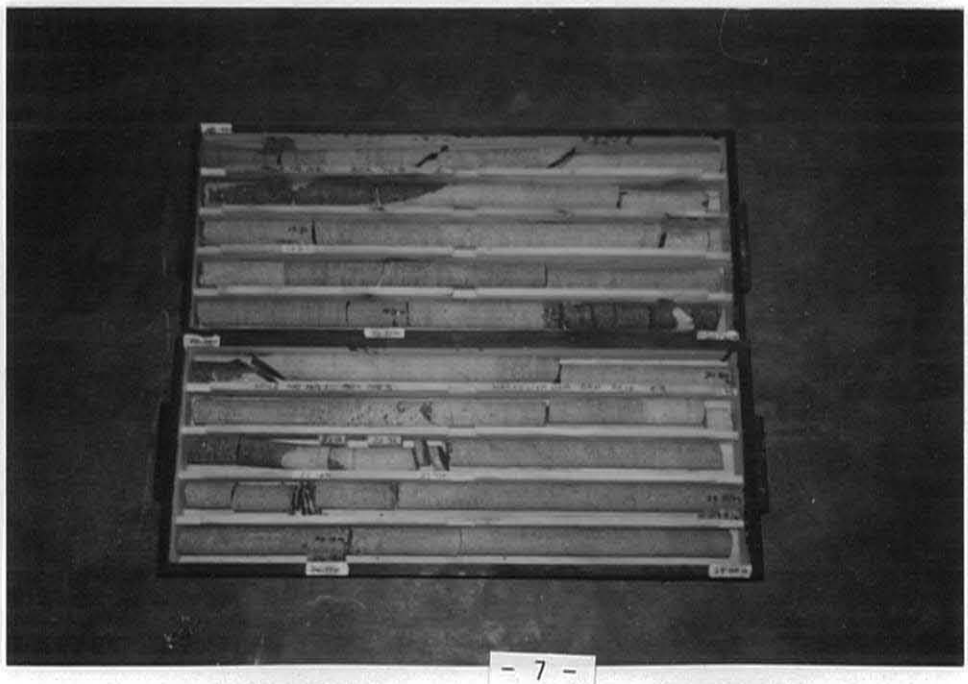


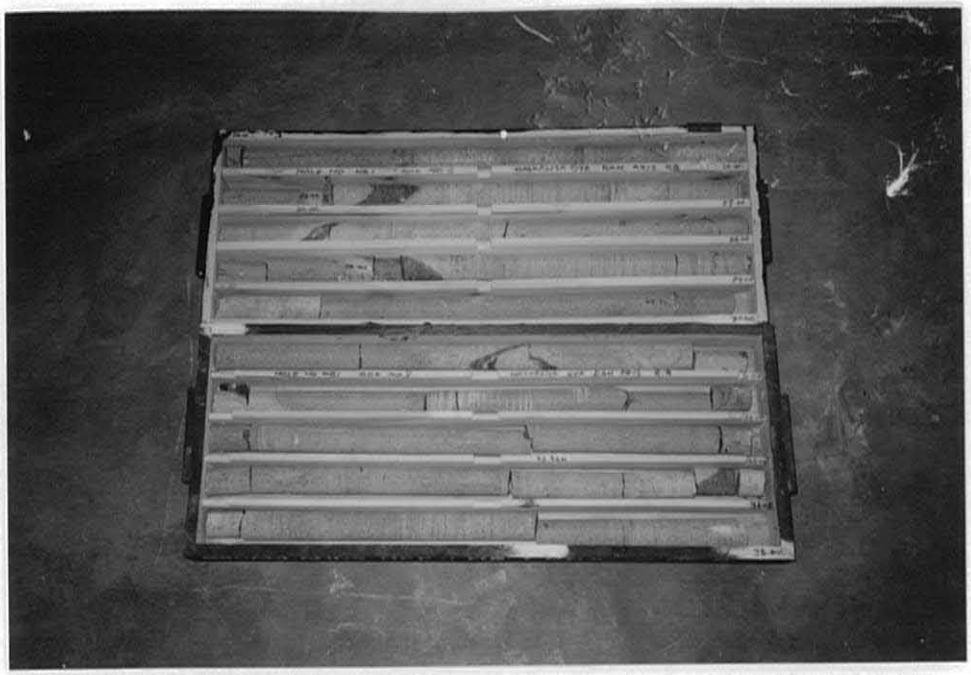
Plate # 5: Hole monument of MB-1 with cap

Plate # 6: Drill Hole MB-1, total depth of hole: 40.77 m









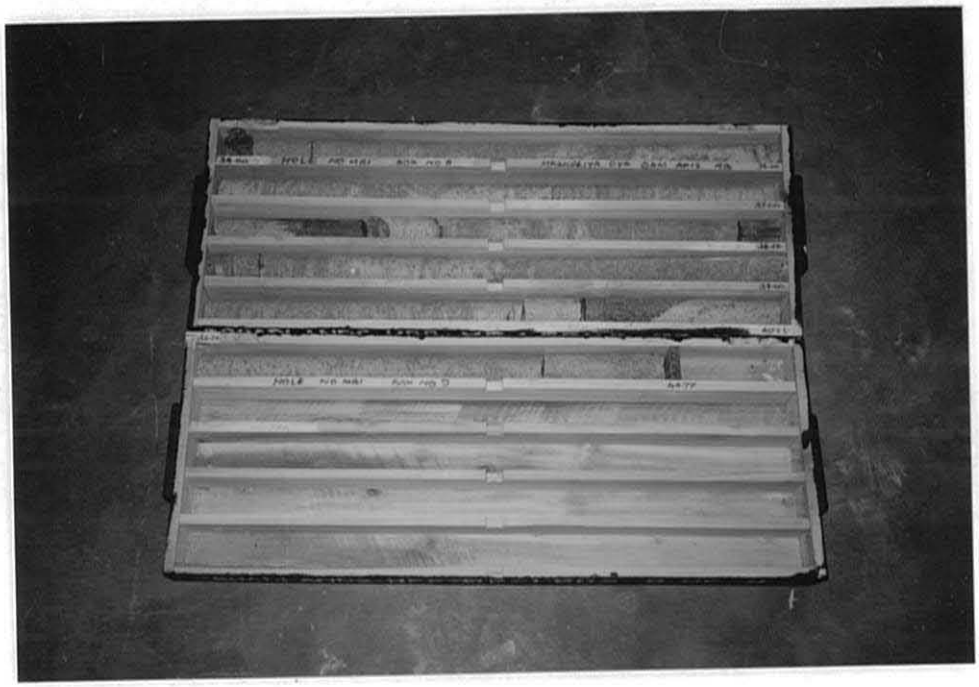


Plate # 7:: Drilling Location of MB-2
Total depth of hole: 40.13m

Plate # 8:: Hole monument of MB-2 with cap

Plate # 9: Drill Hole MB-2, total depth of hole: 40.13m

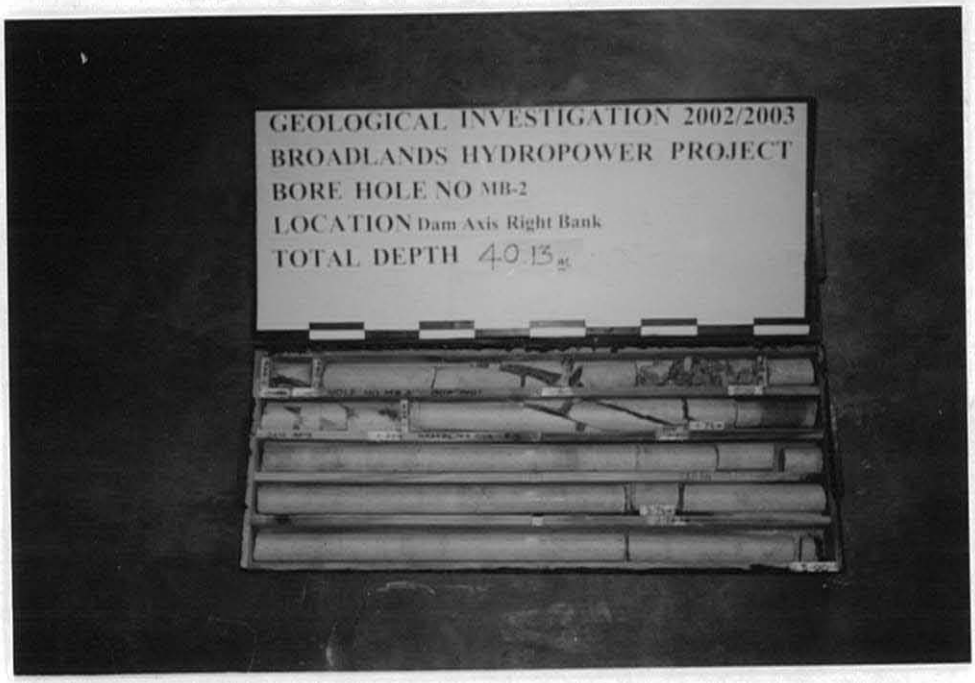
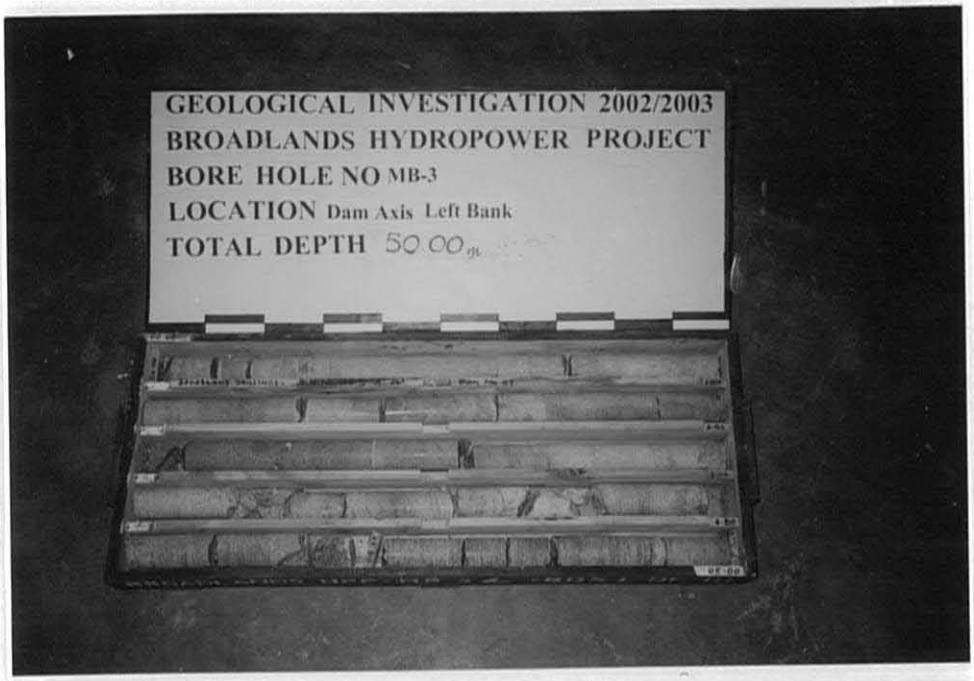
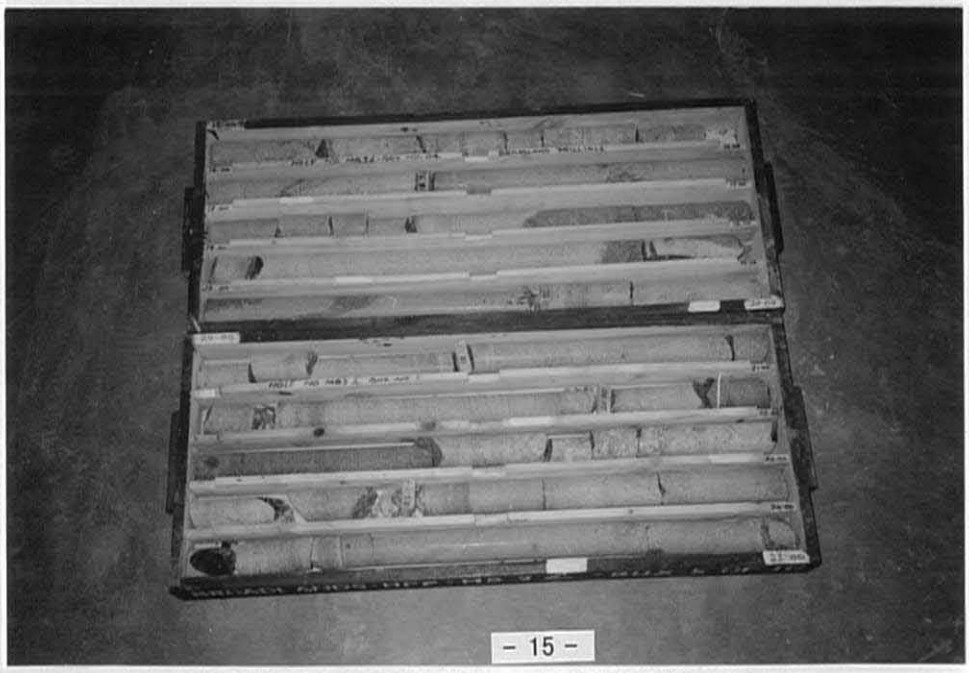


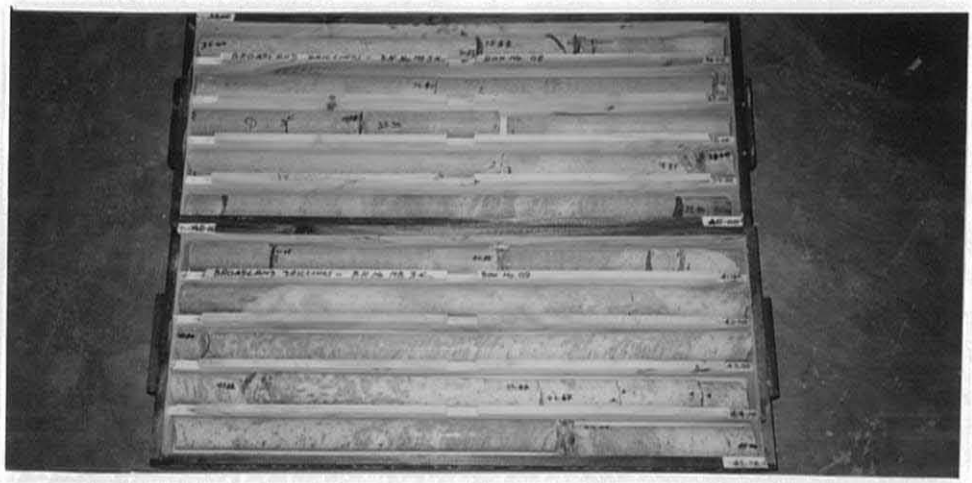
Plate # 10: Drilling Location of MB-3
Total depth of hole: 50.00m

Plate # 11: Hole monument of MB-3 with cap

Plate # 12: Drill Hole MB-3, total depth of hole: 50.00m







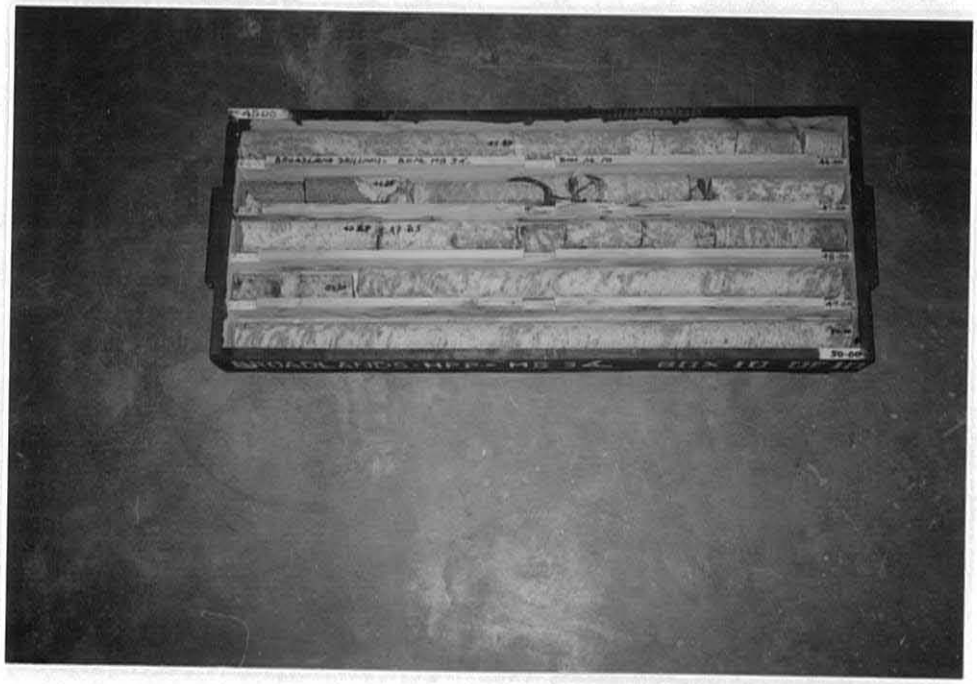


Plate # 13: Drilling Location of MB-4
Total depth of hole: 40.00m

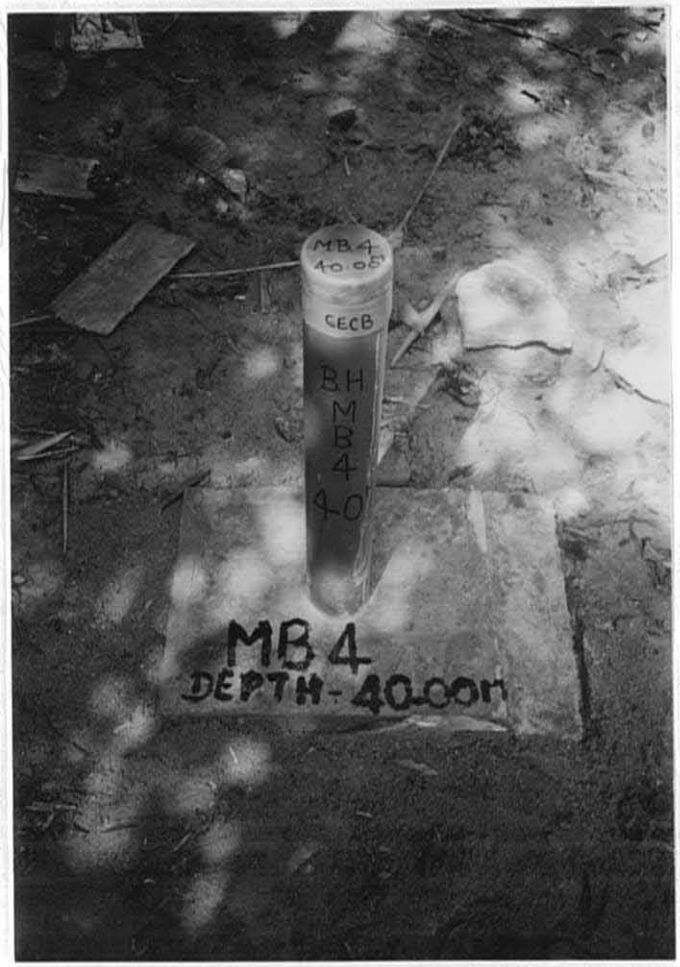
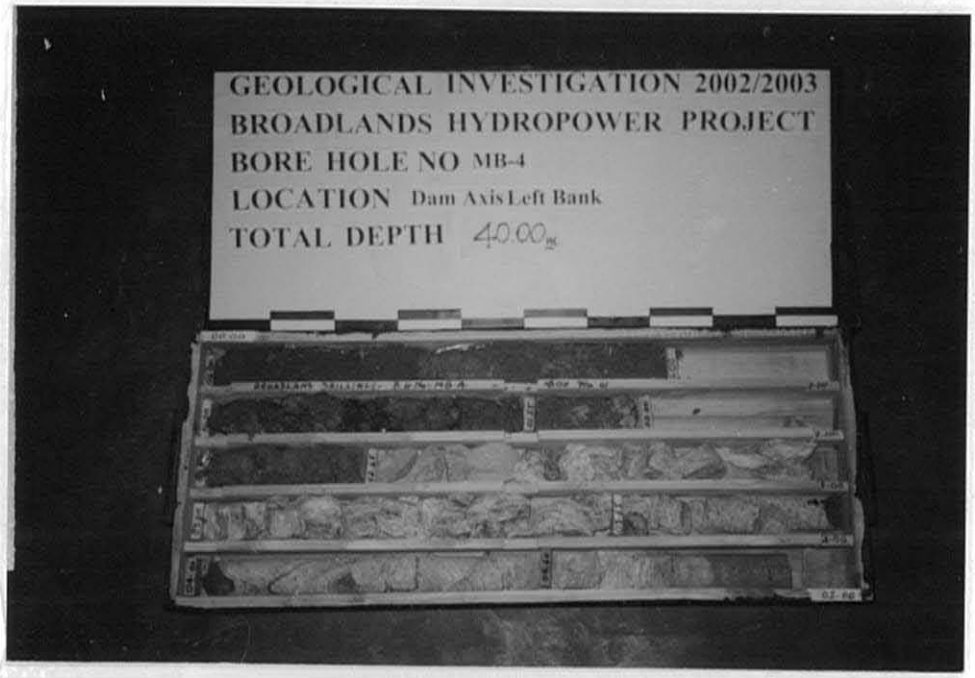
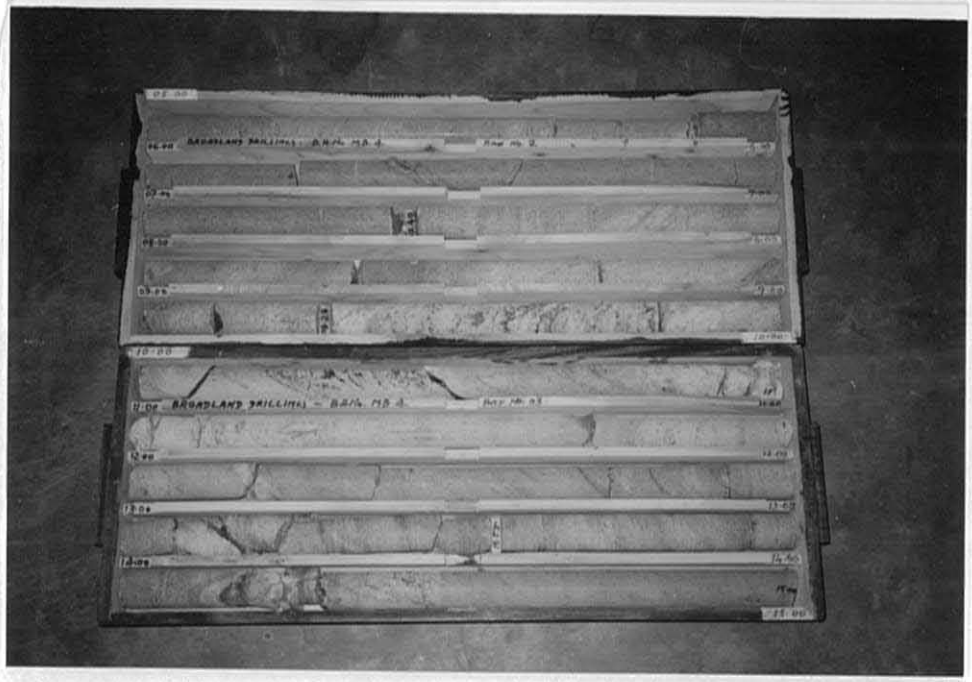
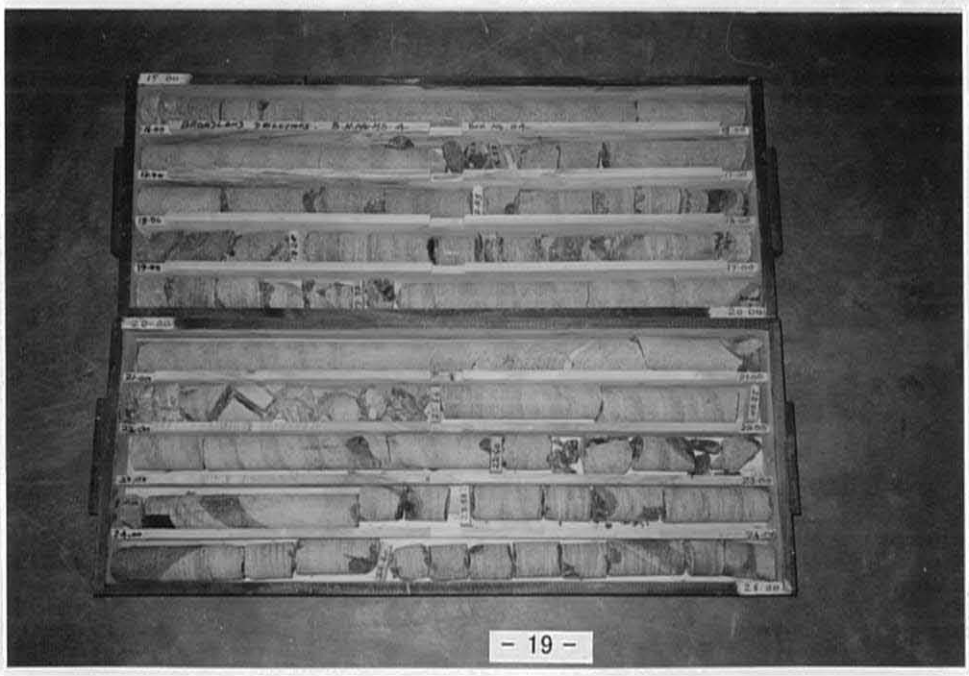


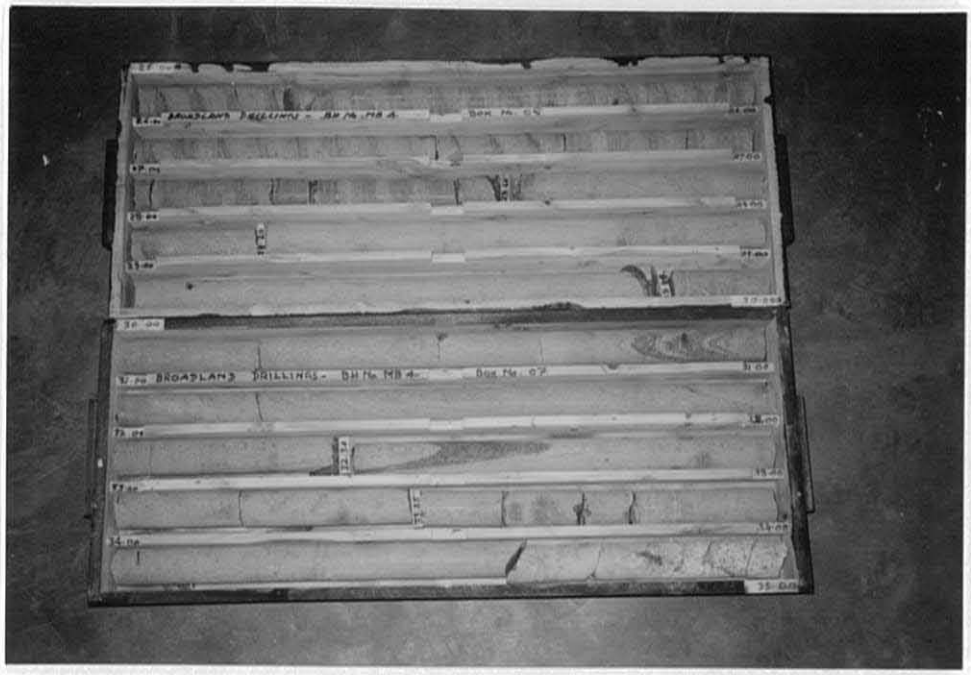
Plate # 14: Hole monument of MB-4 with cap

Plate # 15: Drill Hole MB-4, total depth of hole: 40.00m









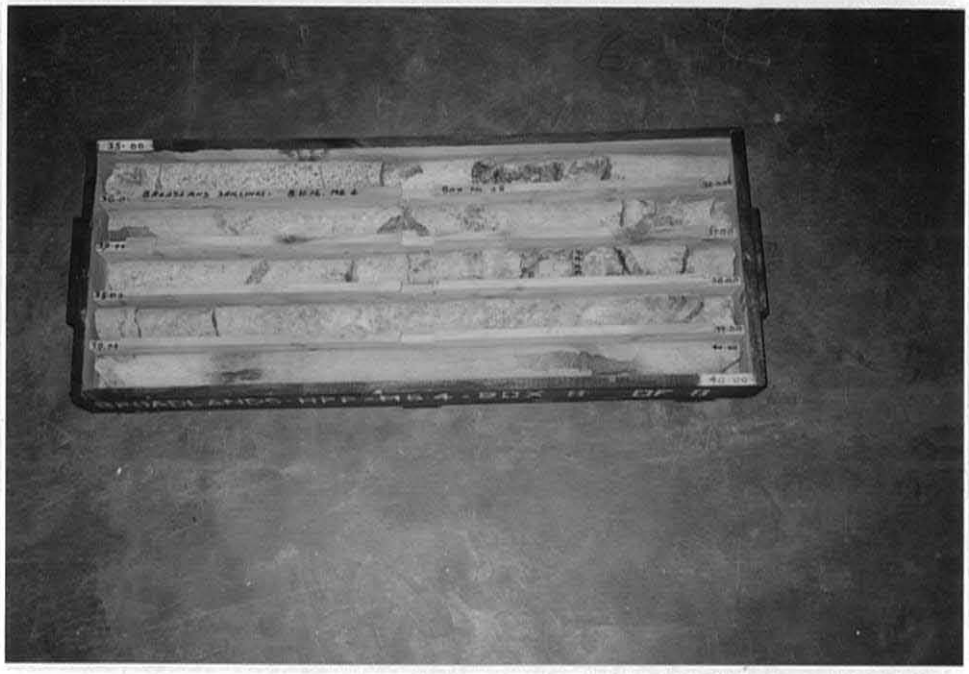
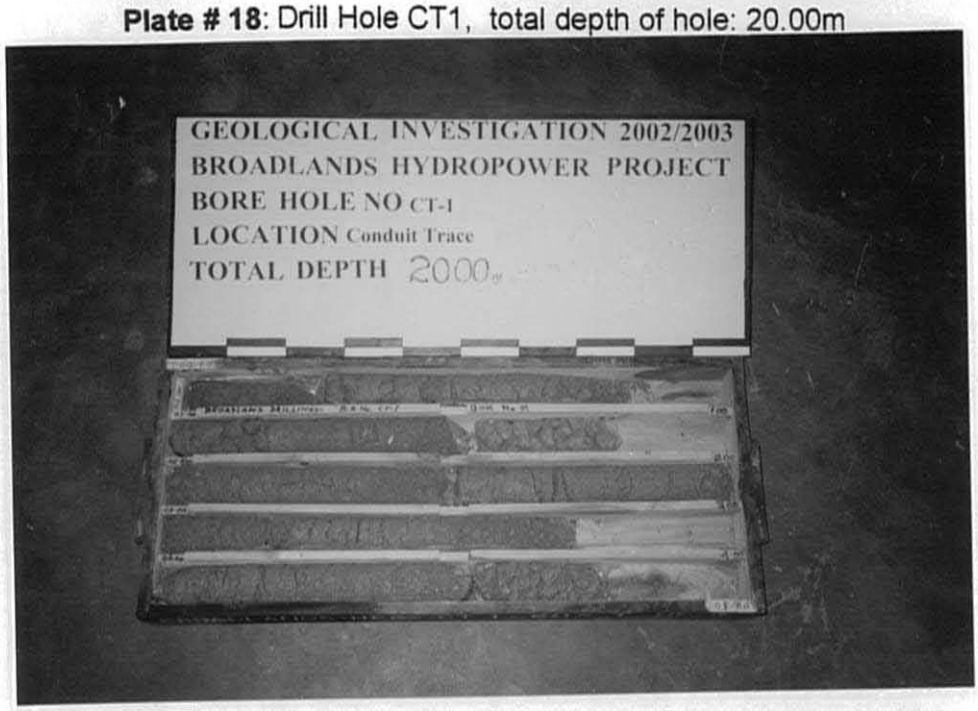


Plate # 16: Drilling Location of CT1
Total depth of hole: 20.00m

Plate # 17: Hole monument of CT1 with cap

Plate # 18: Drill Hole CT1, total depth of hole: 20.00m



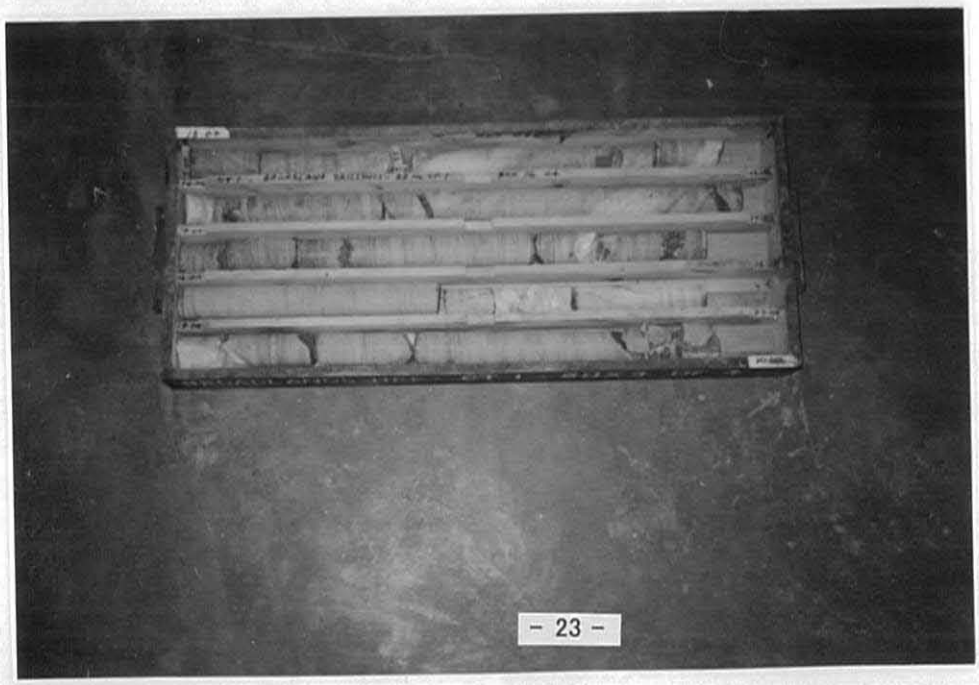
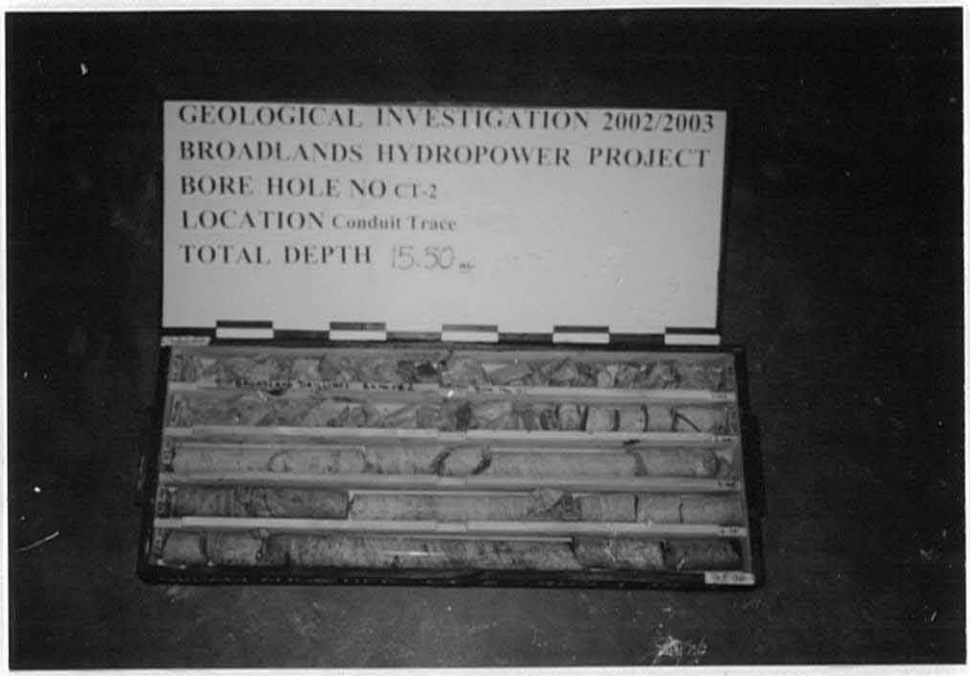


Plate # 19: Drilling Location of CT2
Total depth of hole: 15.50m

Plate # 20: Hole monument of CT2

Plate # 21: Drill Hole CT2, total depth of hole: 15.50m



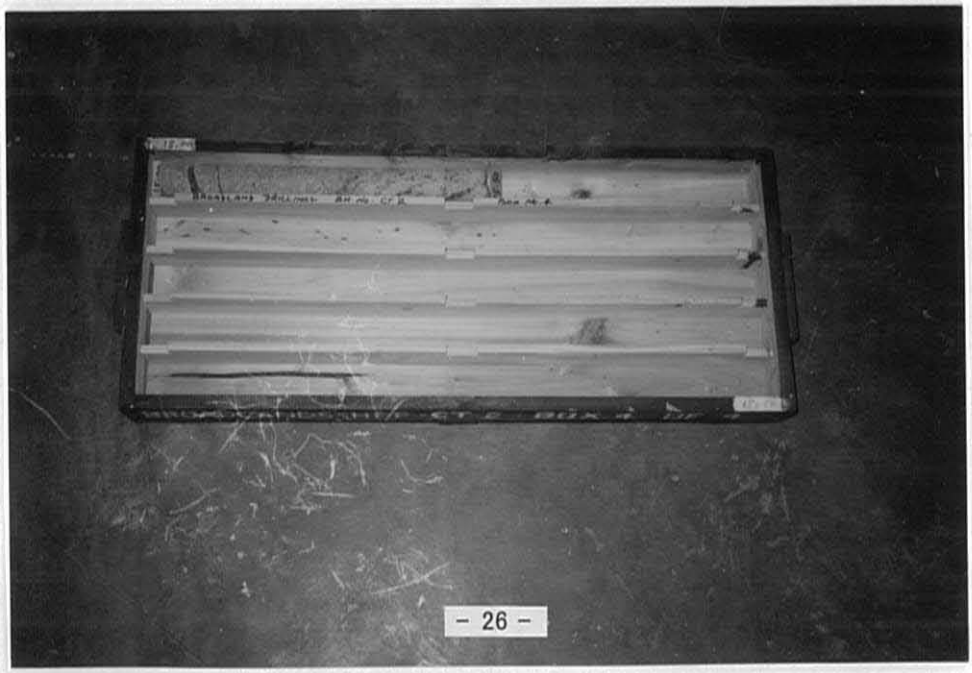


Plate # 22: Drilling Location of MT-1
Total depth of hole: 35.54m

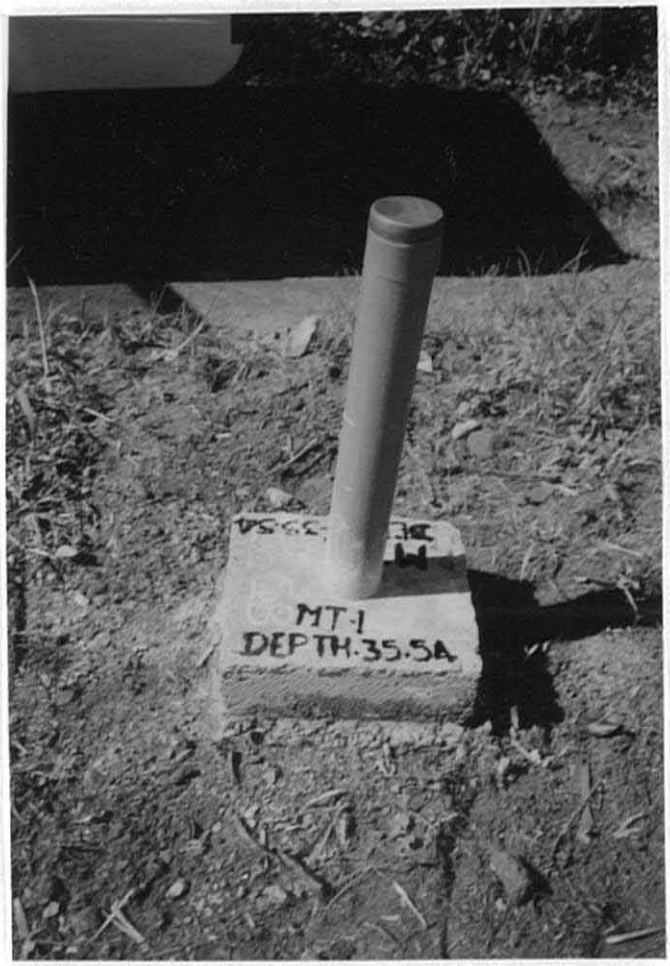
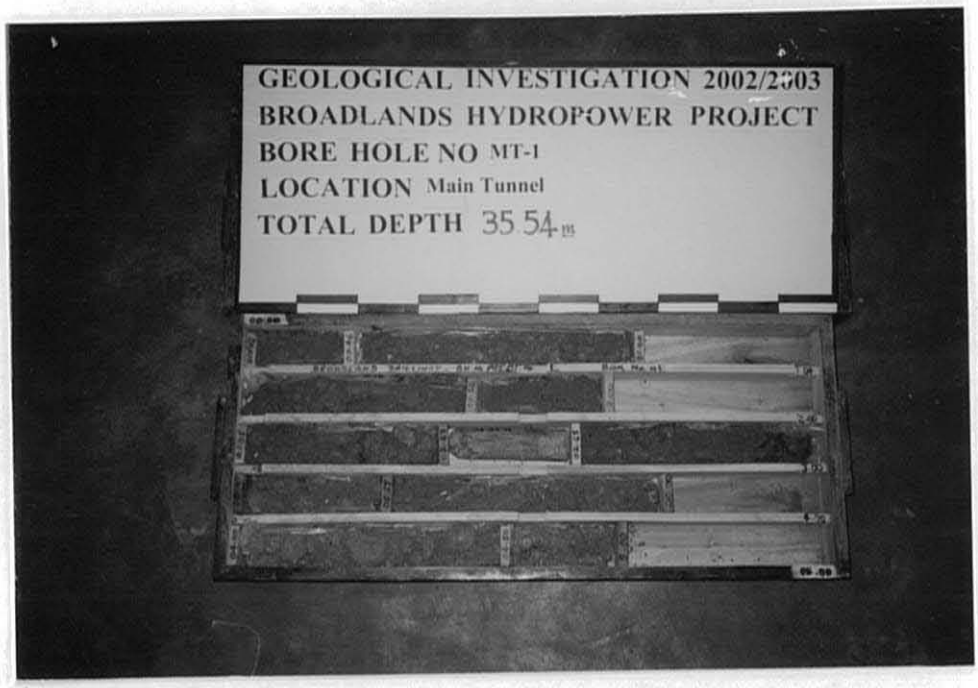
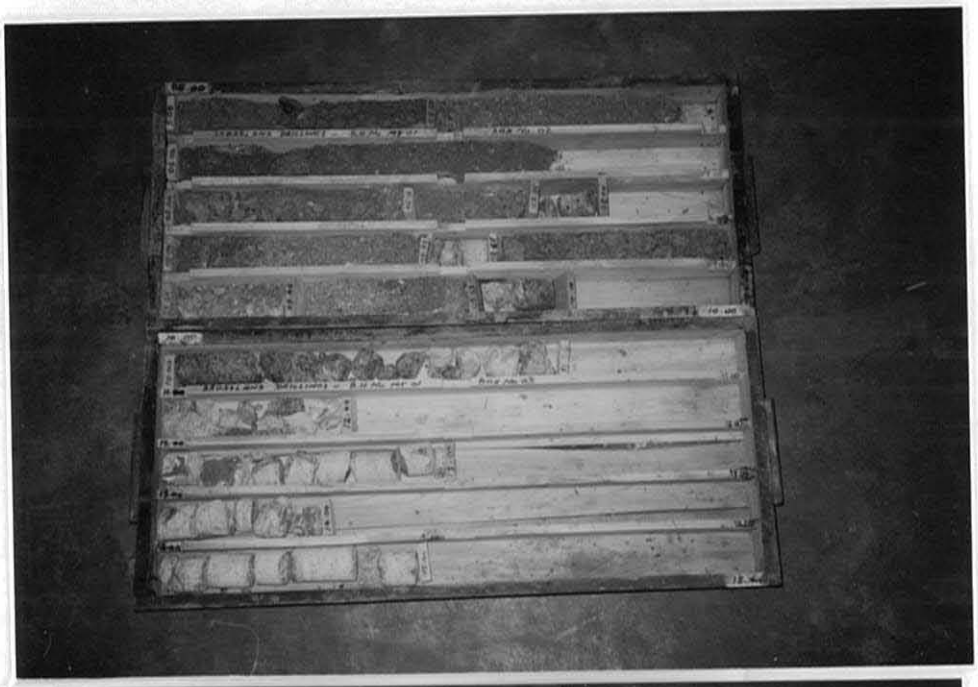
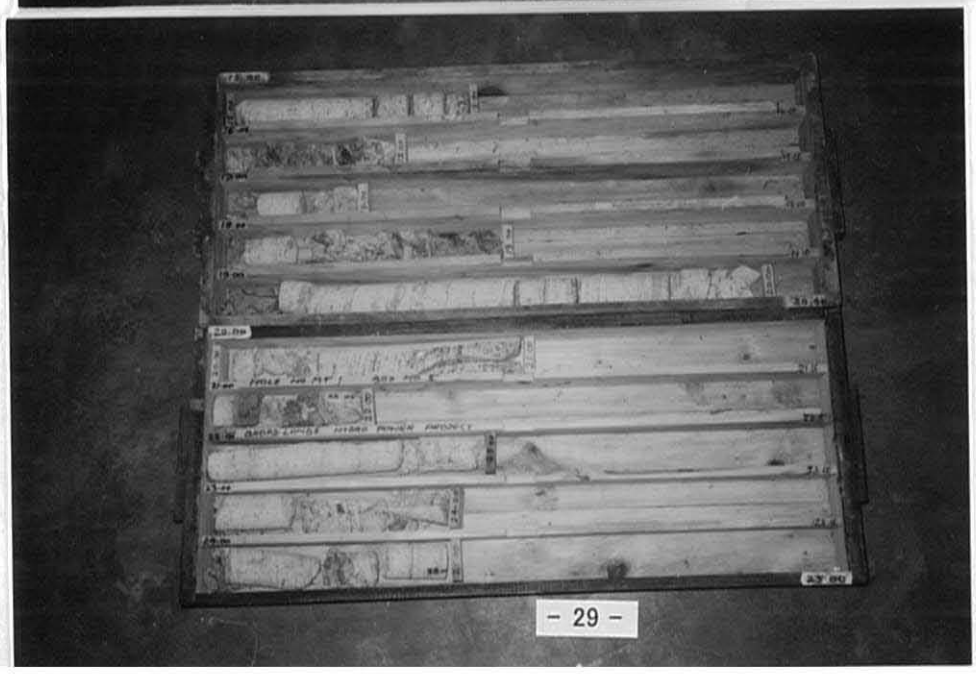


Plate # 23: Hole monument of MT-1 with cap

Plate # 24: Drill Hole MT-1, total depth of hole: 35.54m







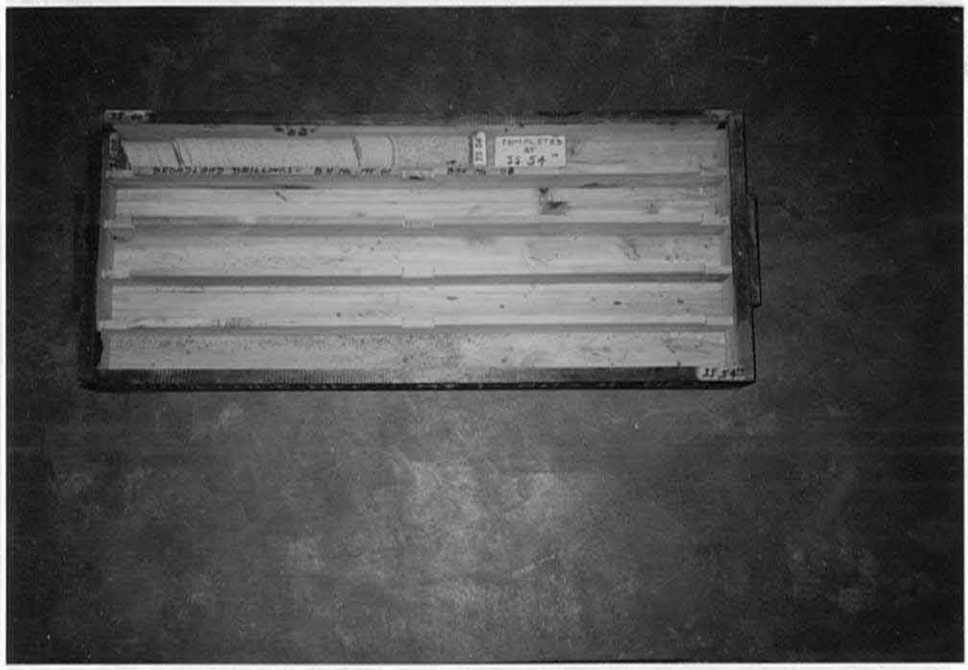
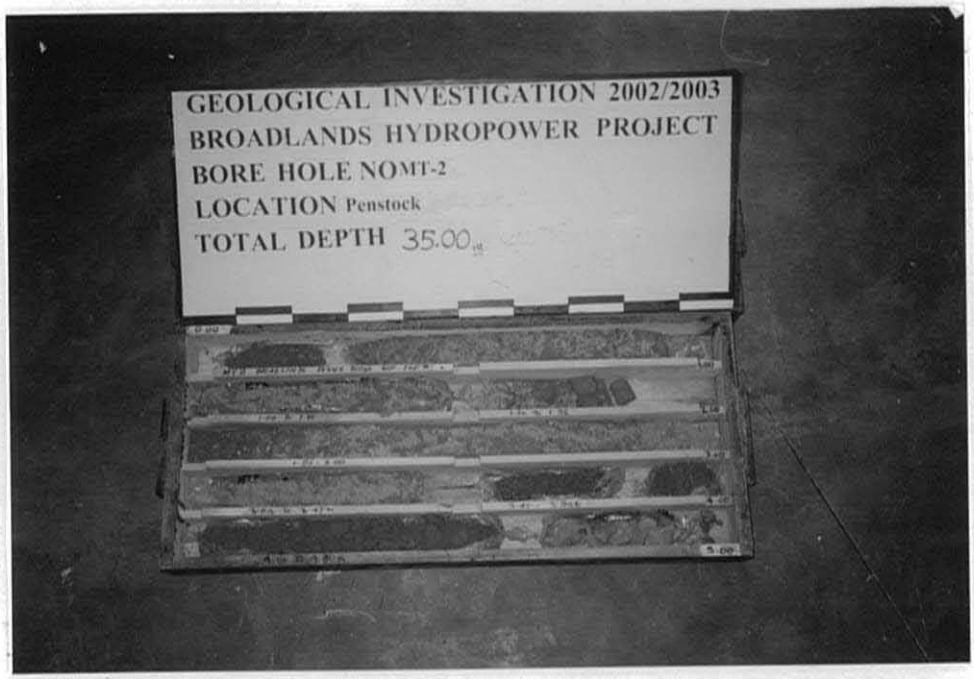
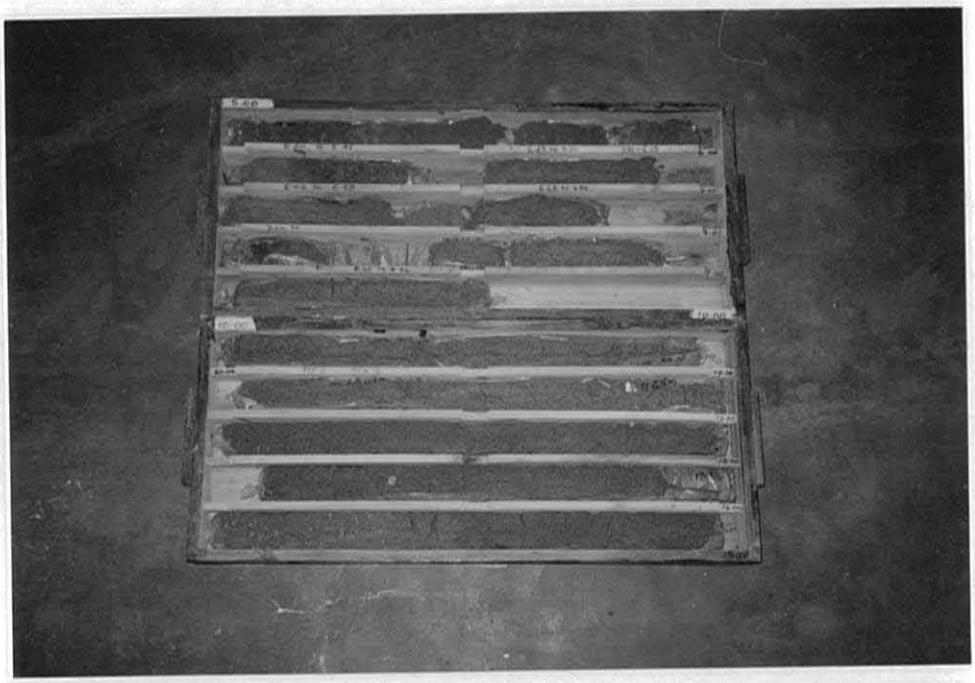


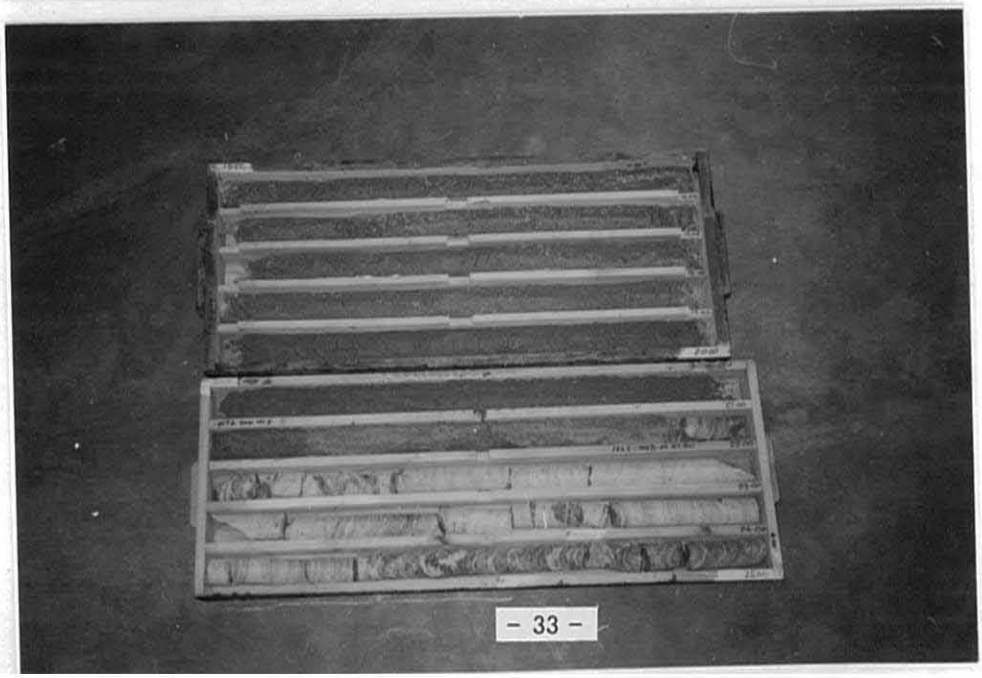
Plate # 25: Drilling Location of MT-2
Total depth of hole: 35.00m

Plate # 25: Hole monument of MT-2 with cap

Plate # 26: Drill Hole MT-2, total depth of hole: 35.00m







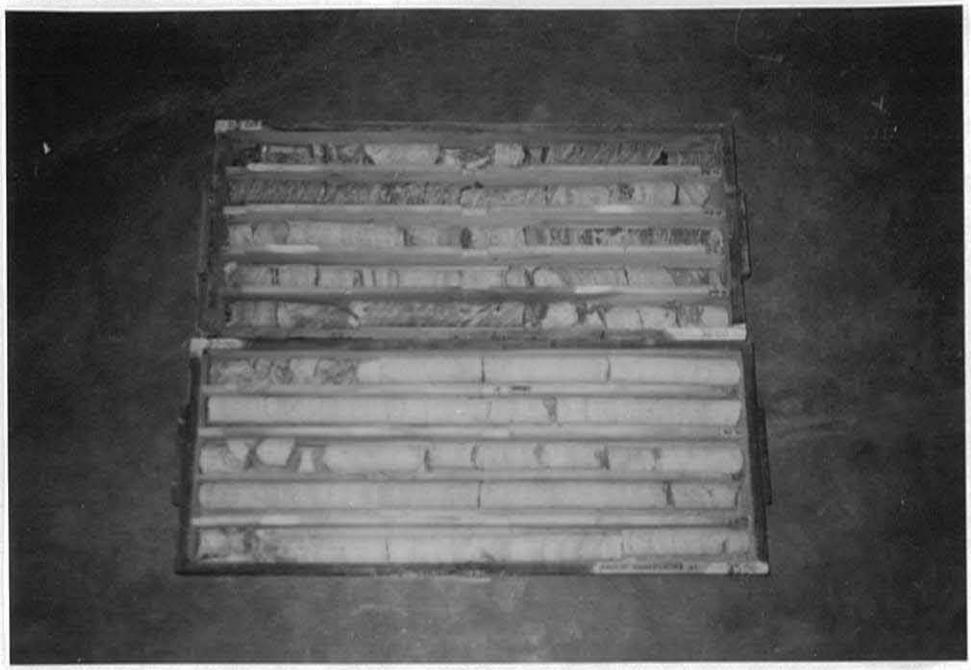
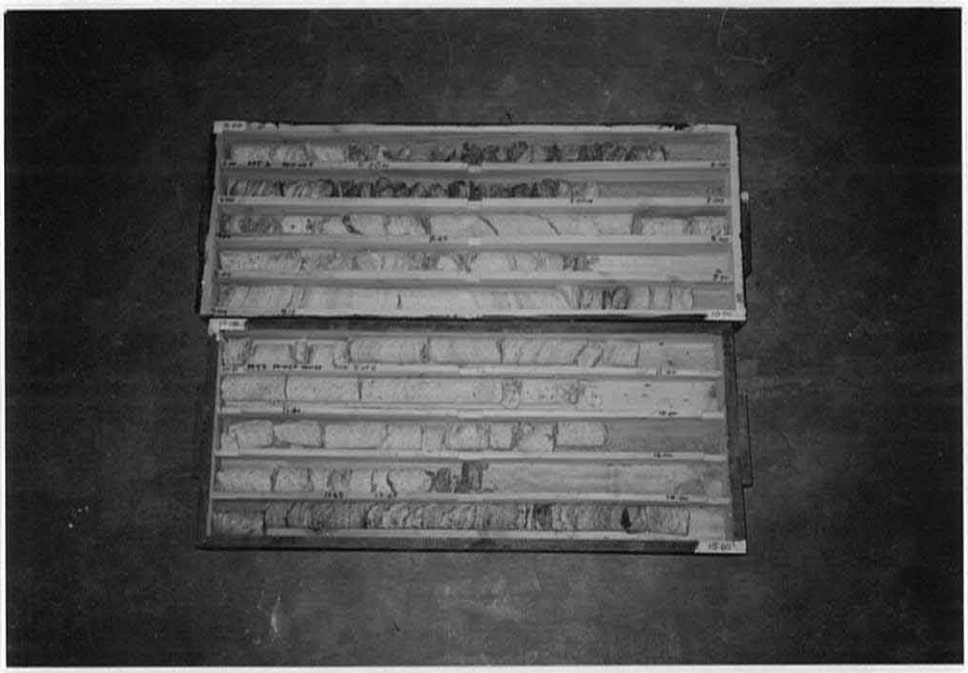
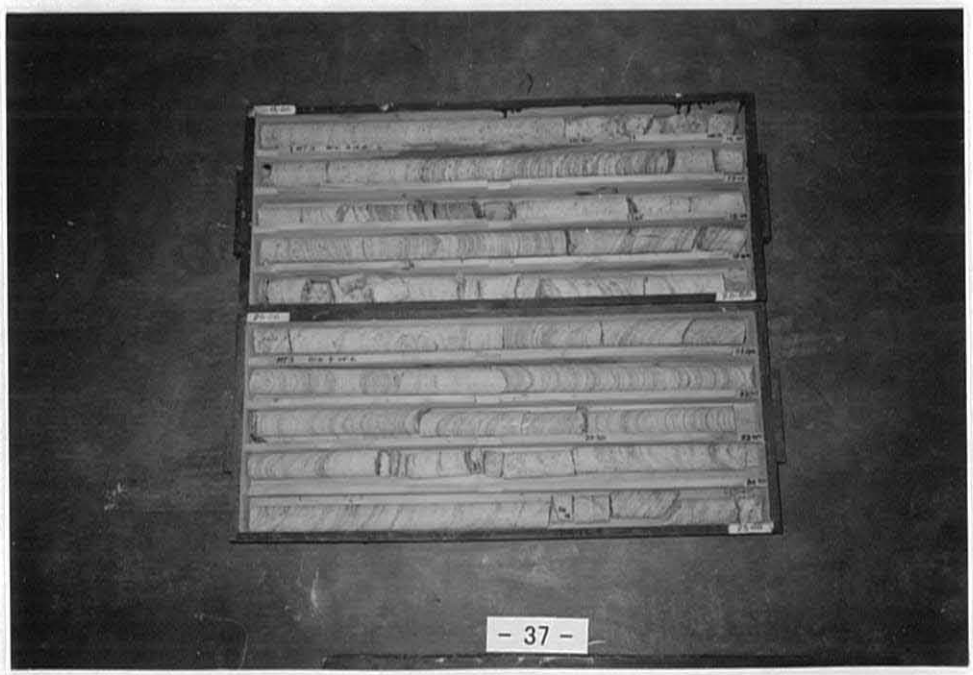


Plate # 27: Drilling Location of MT-3
Total depth of hole: 25.57m

Plate # 28: Hole monument of MT-3 with cap

Plate # 29: Drill Hole MT-3, total depth of hole: 25.57m





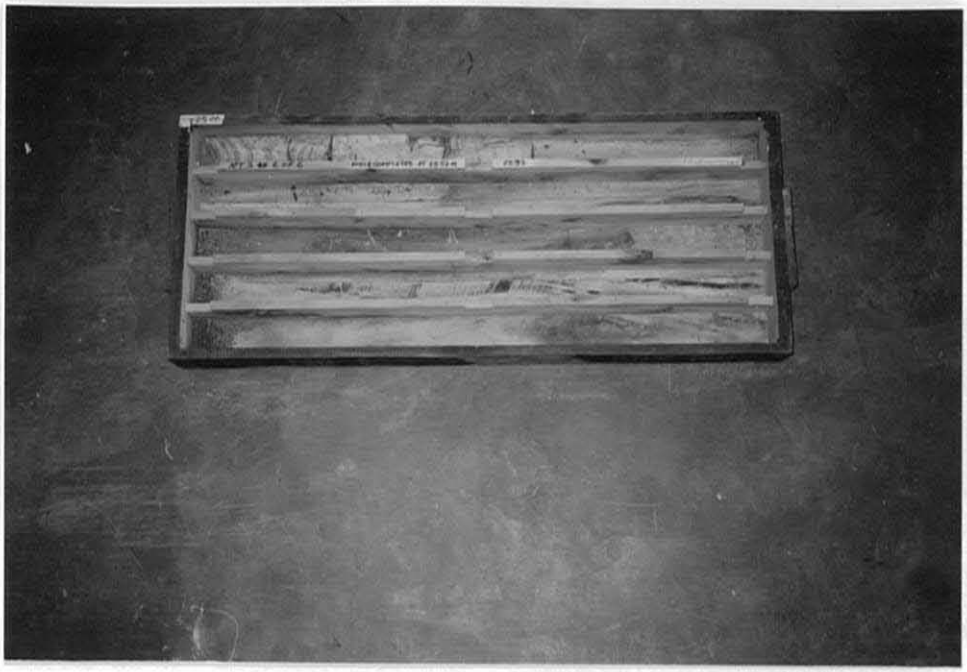
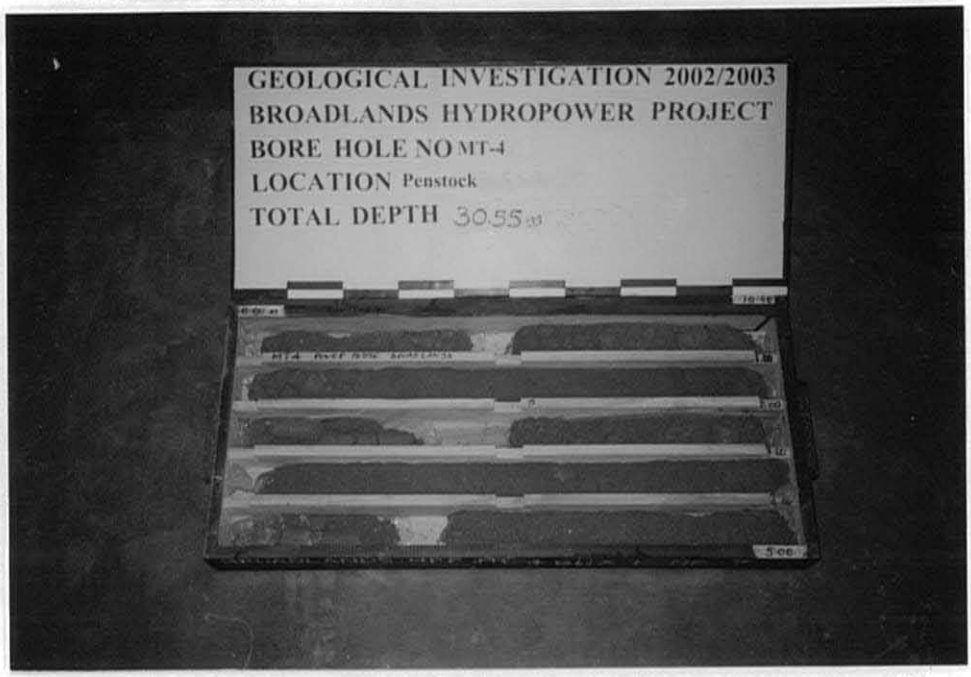


Plate # 30: Drilling Location of MT-4
Total depth of hole:30.55m

Plate # 31: Hole monument of MT-4 with cap

Plate # 32: Drill Hole MT-4, total depth of hole: 30.55m



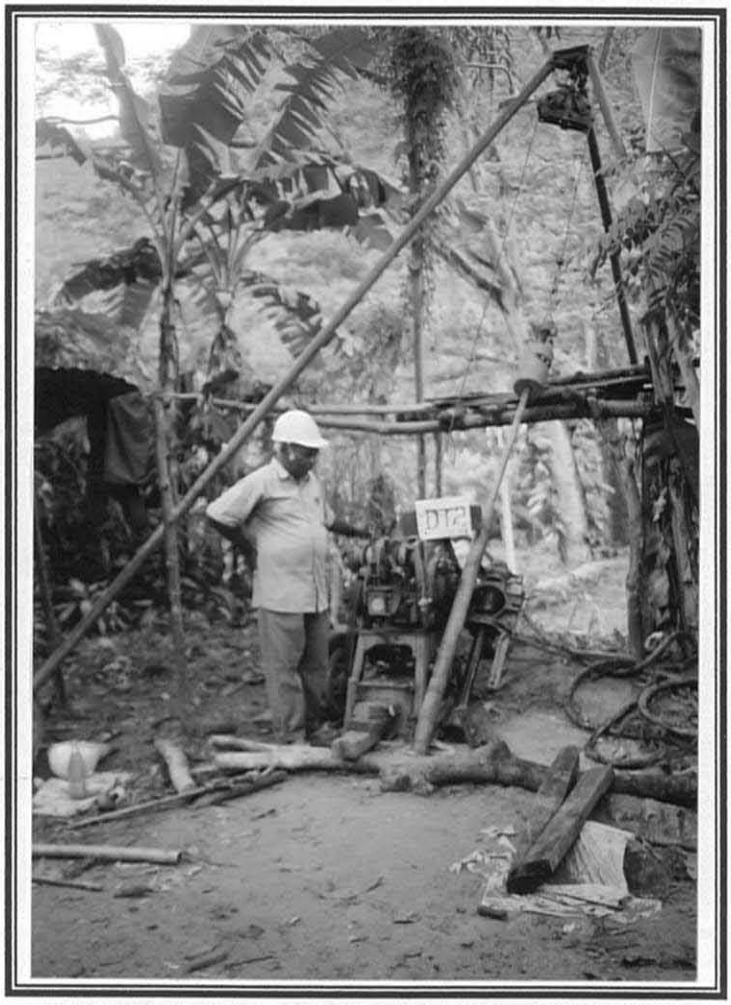


Plate # 1: Drilling Location of DT 2
total depth of hole 60.00m

Plate # 2: Drill Hole DT 2, total depth of hole 60.00m

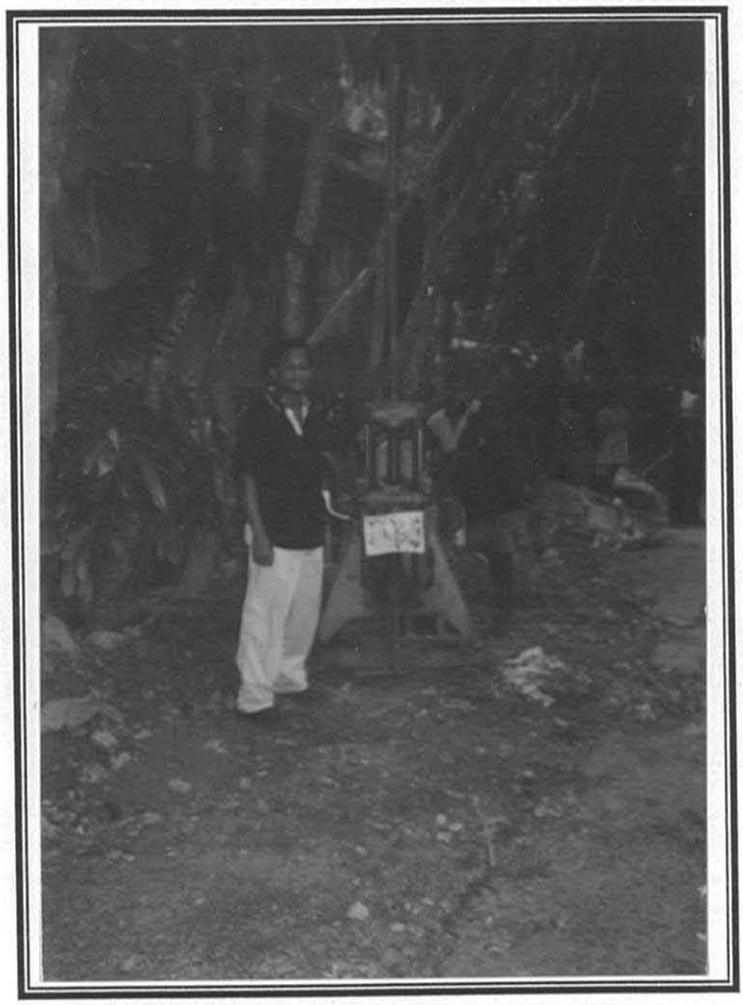
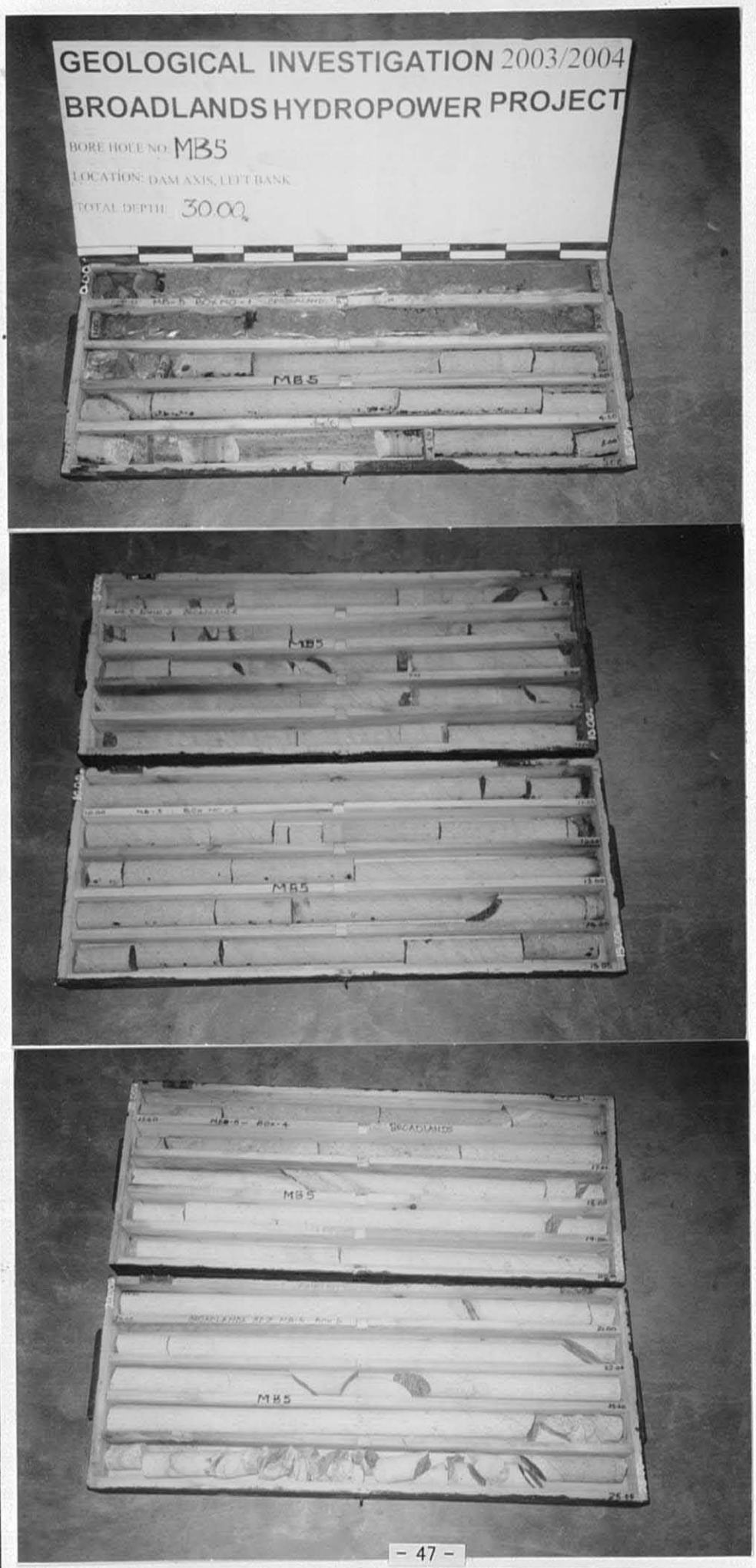


Plate # 3: Drilling Location of MB 5
total depth of hole 30.15m

Plate # 4: Hole monument of MB 5

Plate # 5: Drill Hole MB 5, total depth of hole 30.15m



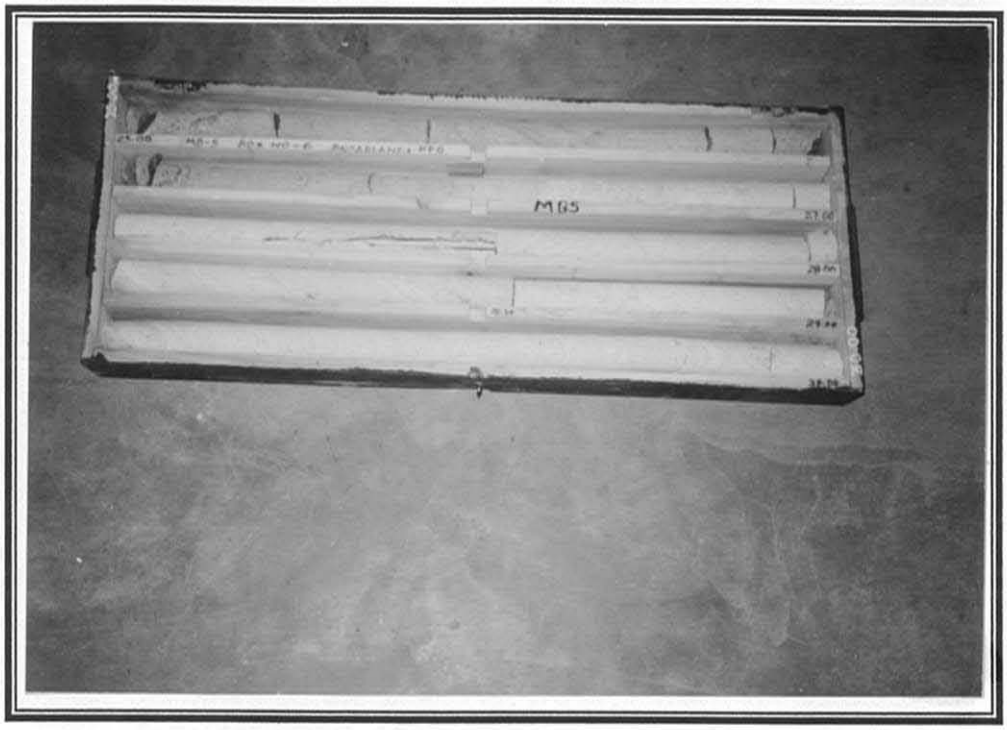


Plate # 5: Cont....

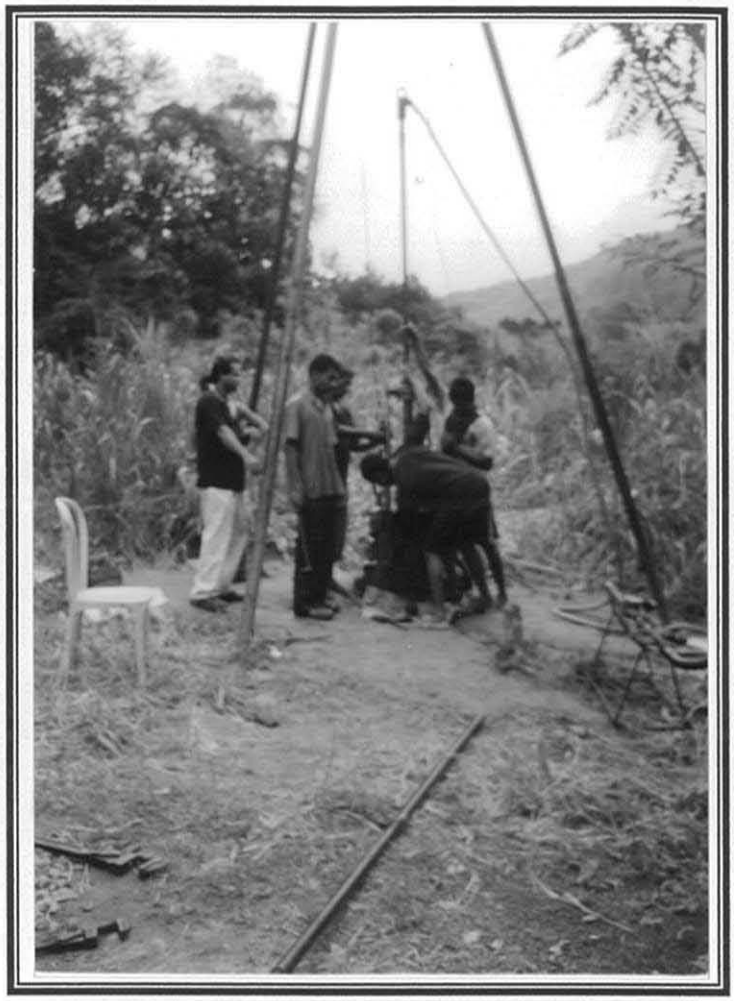


Plate # 6: Drilling Location of CT 3
total depth of hole 20.35m

Plate # 7: Hole monument of CT 3

Plate # 8: Drill Hole CT 3, total depth of hole 20.35m

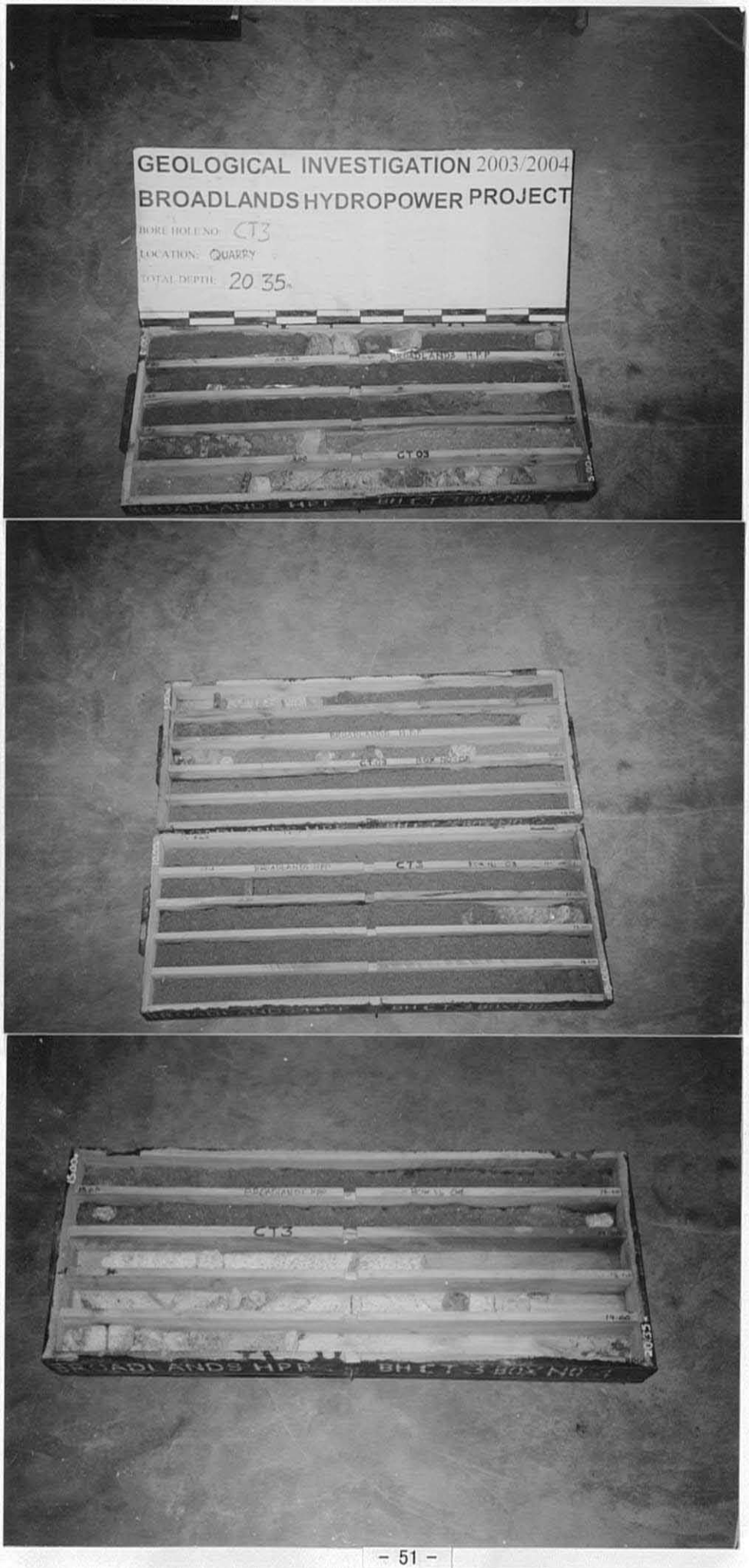


Plate # 9: Drilling Location of CT 4
total depth of hole 20.00m

Plate # 10: Hole monument of CT 4

Plate # 11: Drill Hole CT 3, total depth of hole 20.00m

Plate # 12: Drilling Location of MT 5
total depth of hole 30.25m

Plate # 13: Hole monument of MT 5

Plate # 14: Drill Hole MT 5, total depth of hole 30.25m

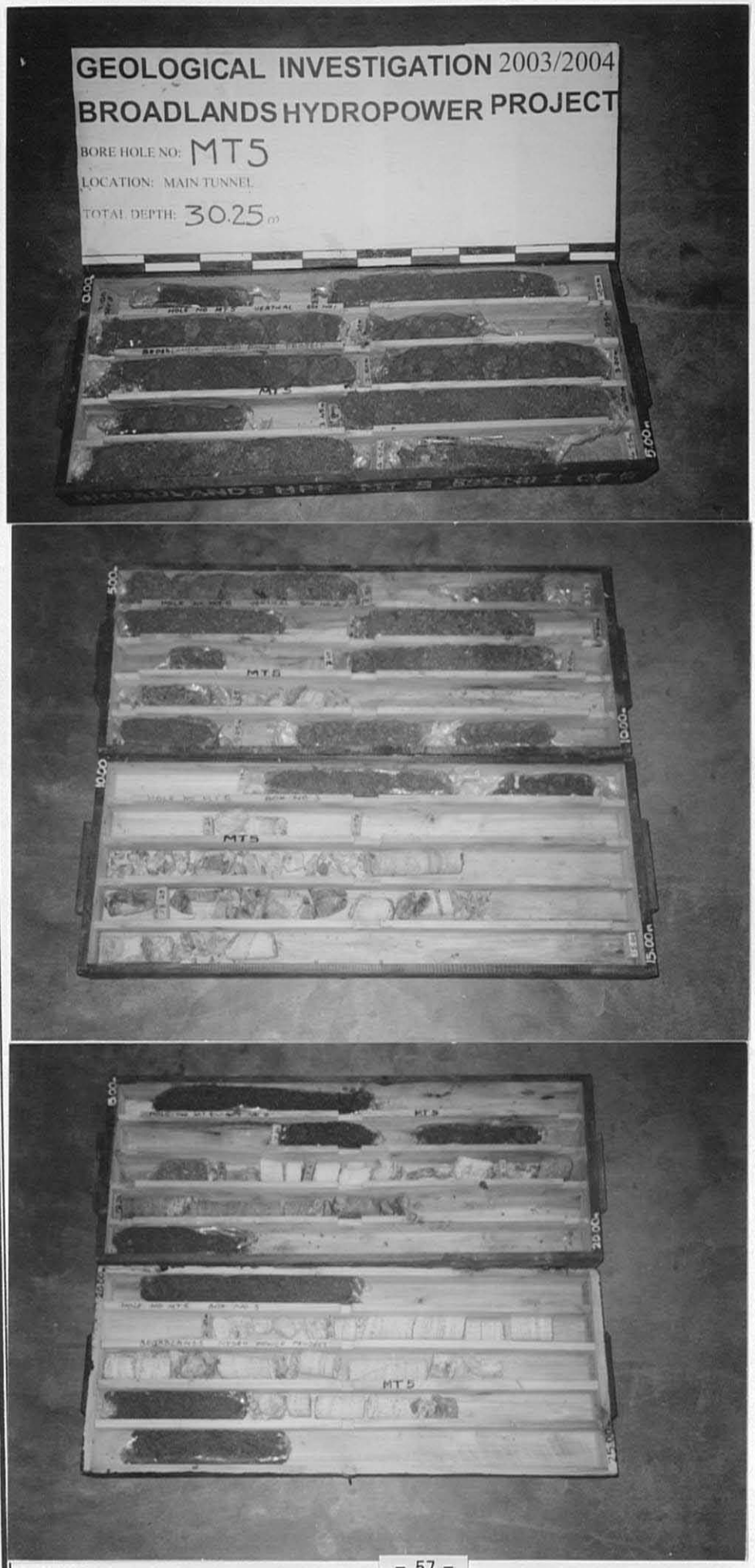
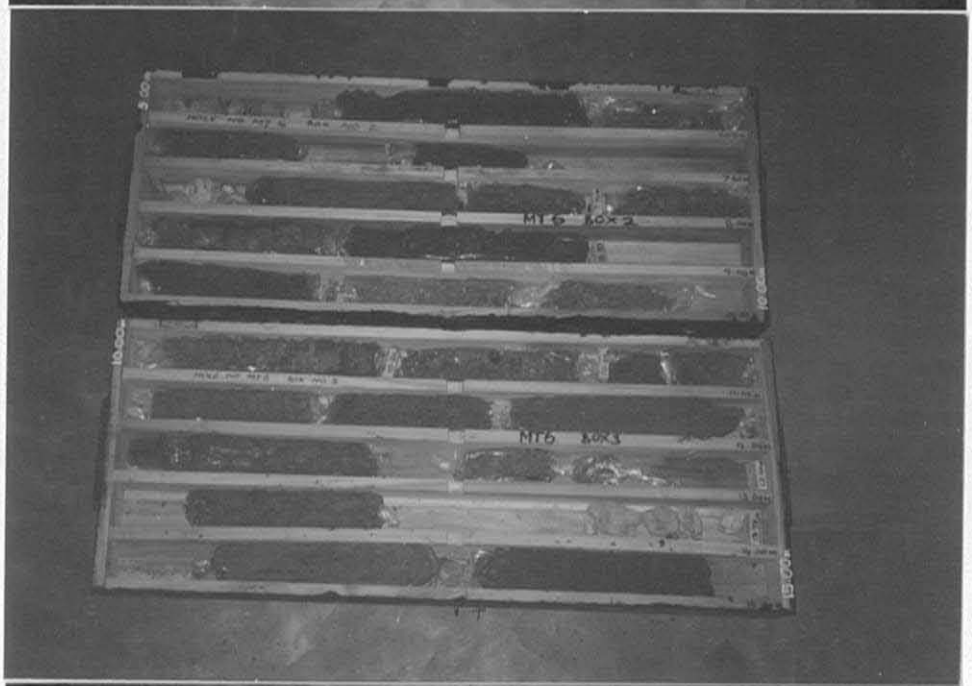


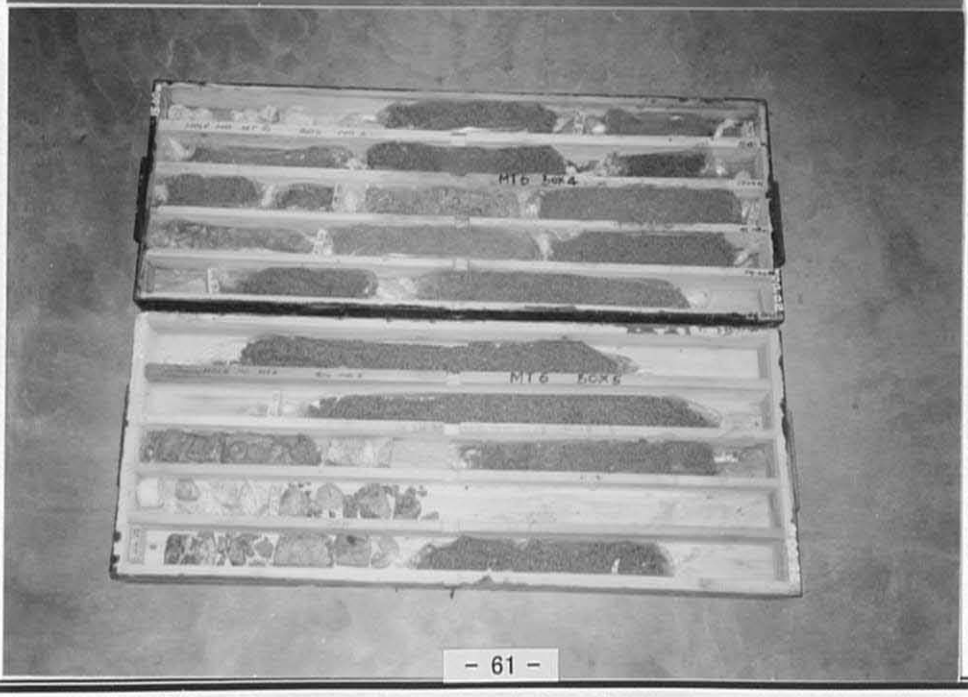
Plate # 14 : Cont....

Plate # 15: Drilling Location of MT 6
total depth of hole 40.10m

Plate # 16: Hole monument of MT 6

Plate # 17: Drill Hole MT 6, total depth of hole 40.10m





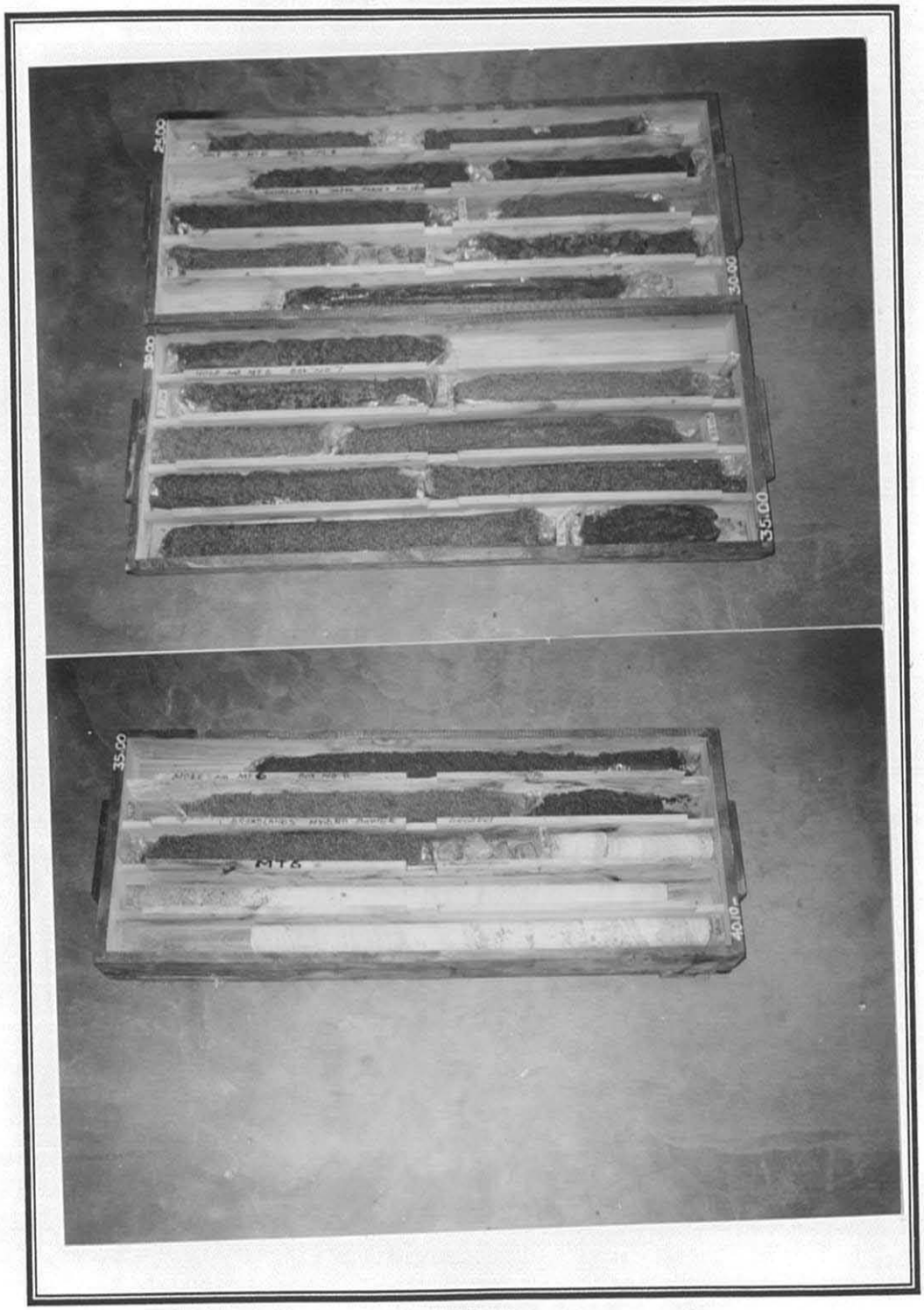


Plate # 17: Cont....

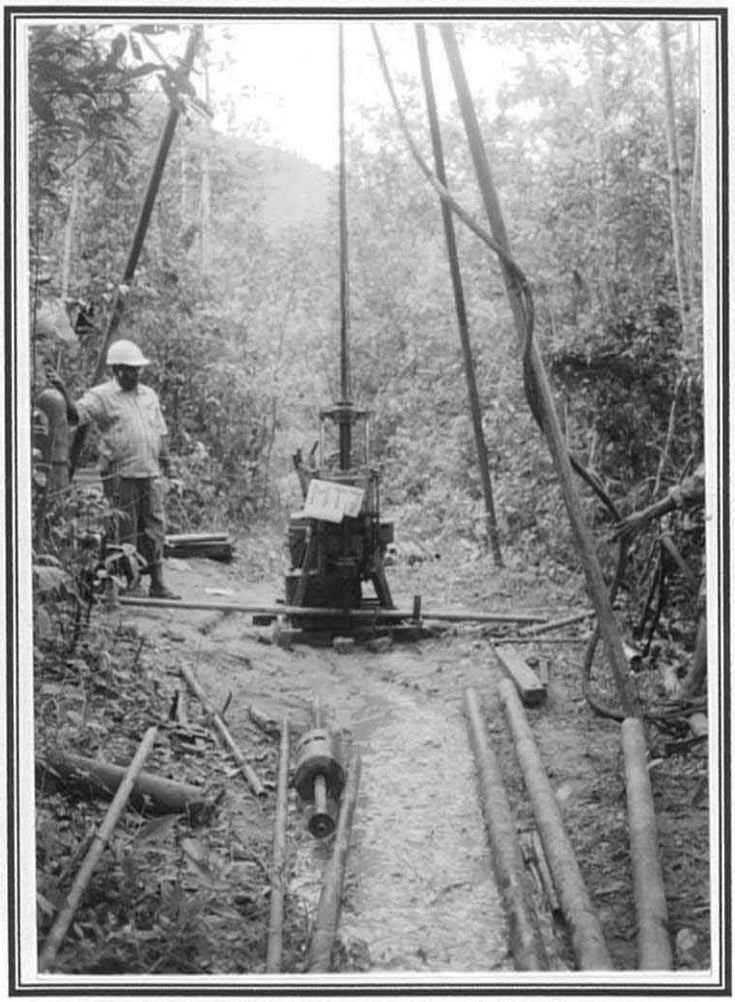
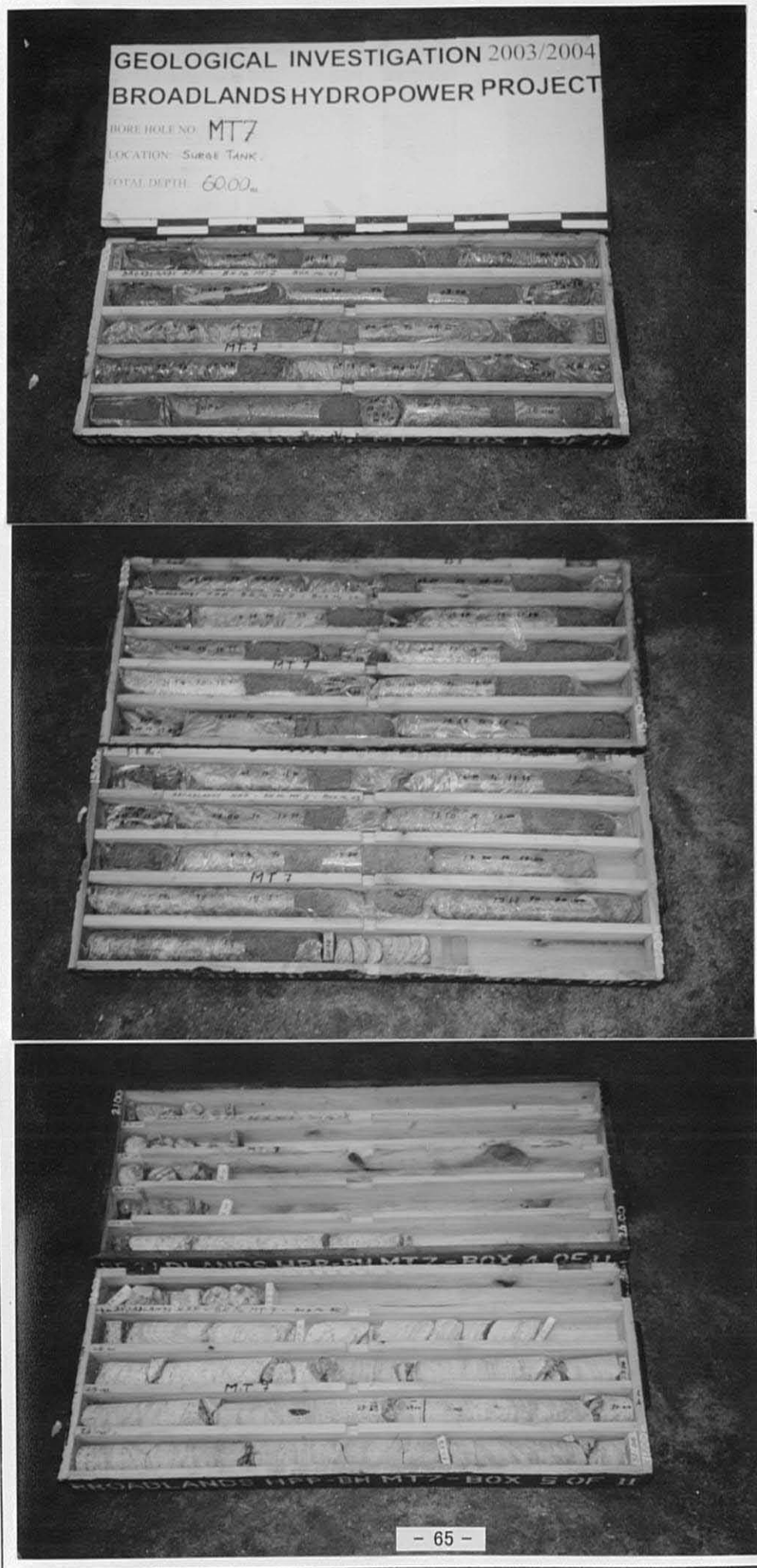


Plate # 18: Drilling Location of MT 7
total depth of hole 60.00m

Plate # 19: Hole monument of MT 7

Plate # 20: Drill Hole MT 7, total depth of hole 60.00m



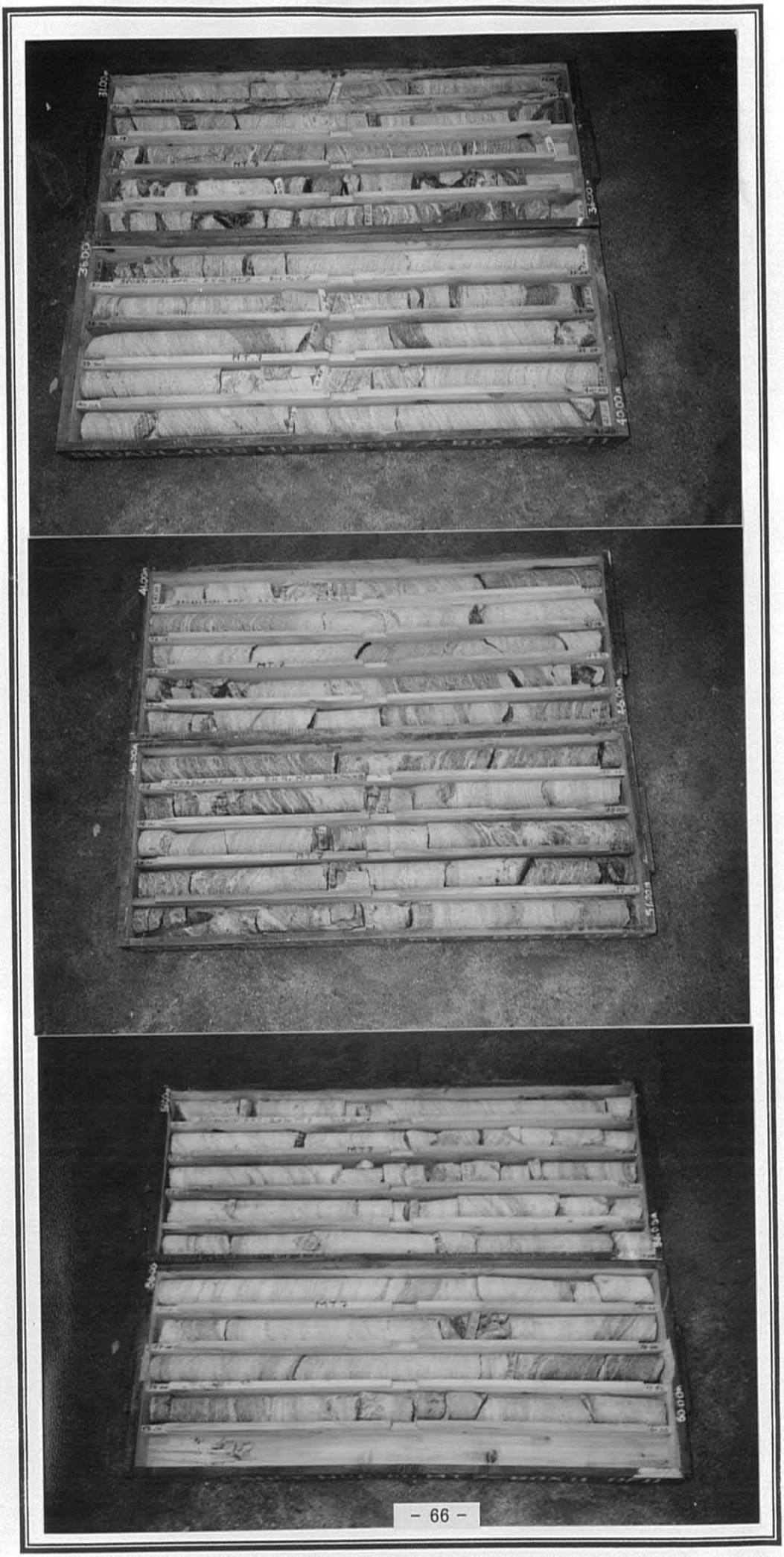
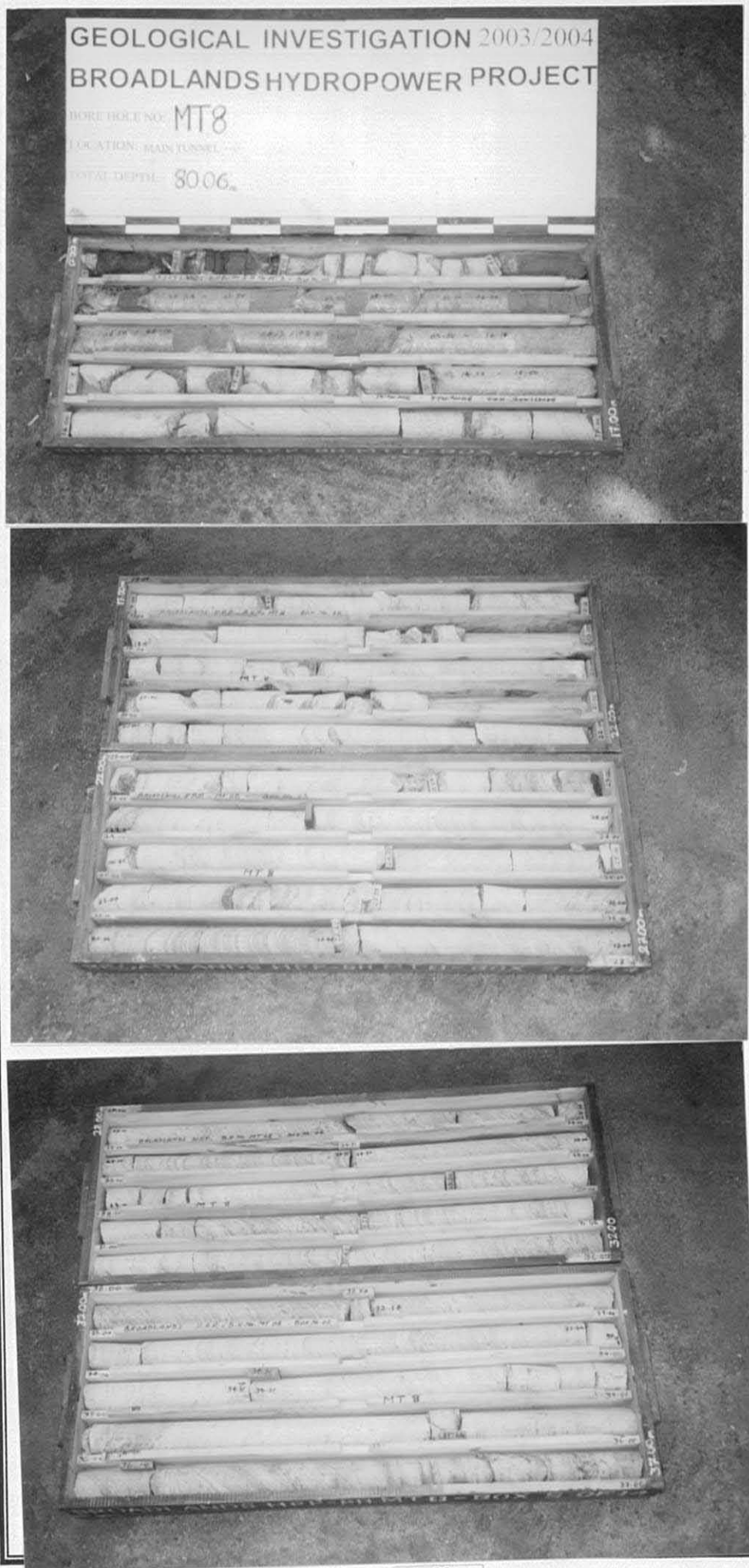


Plate # 20: Cont....

Plate # 21: Drilling Location of MT 8
total depth of hole 80.06m

Plate # 22: Hole monument of MT 8

Plate # 23: Drill Hole MT 8, total depth of hole 80.06m



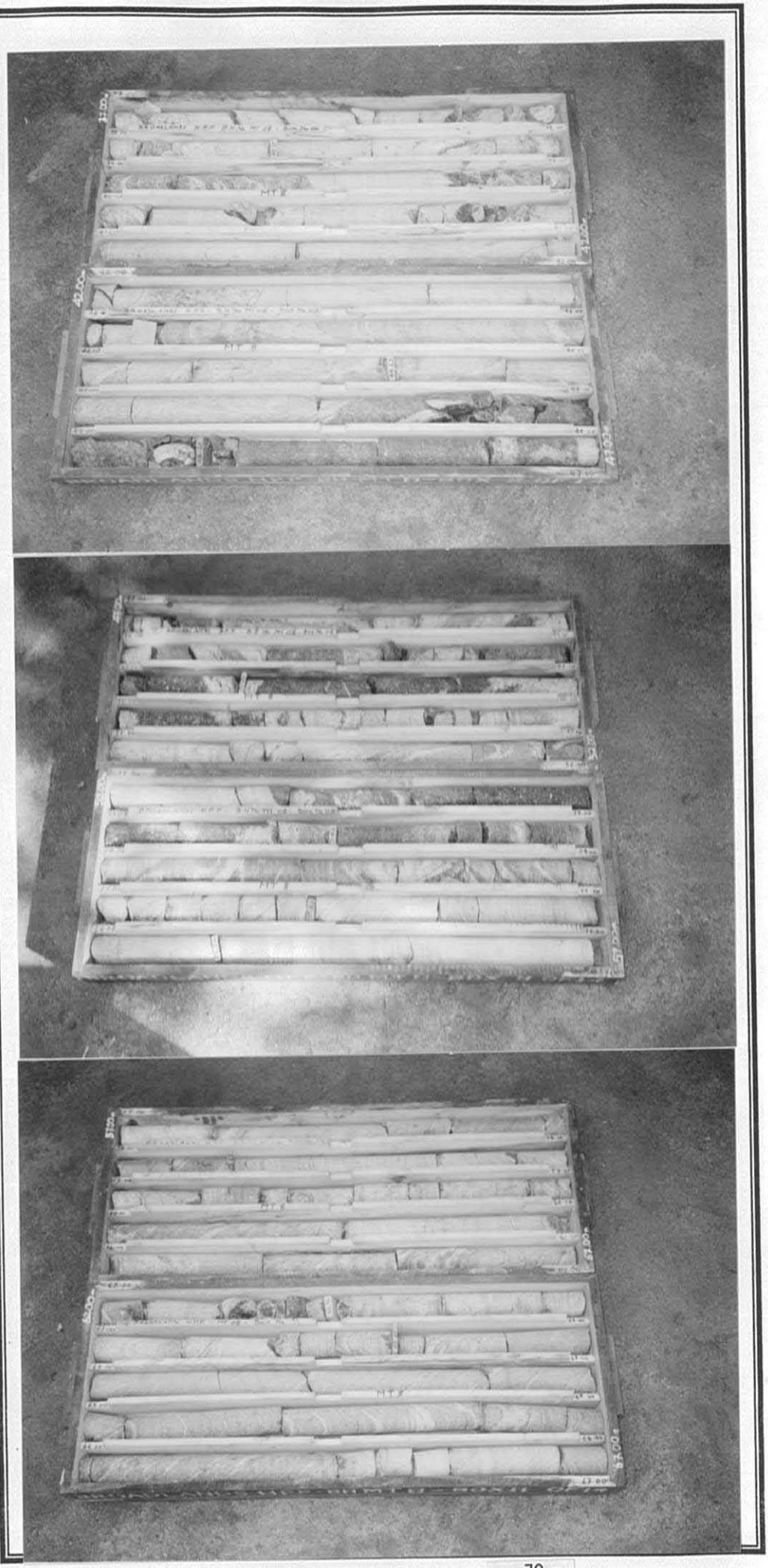


Plate # 23: Cont....

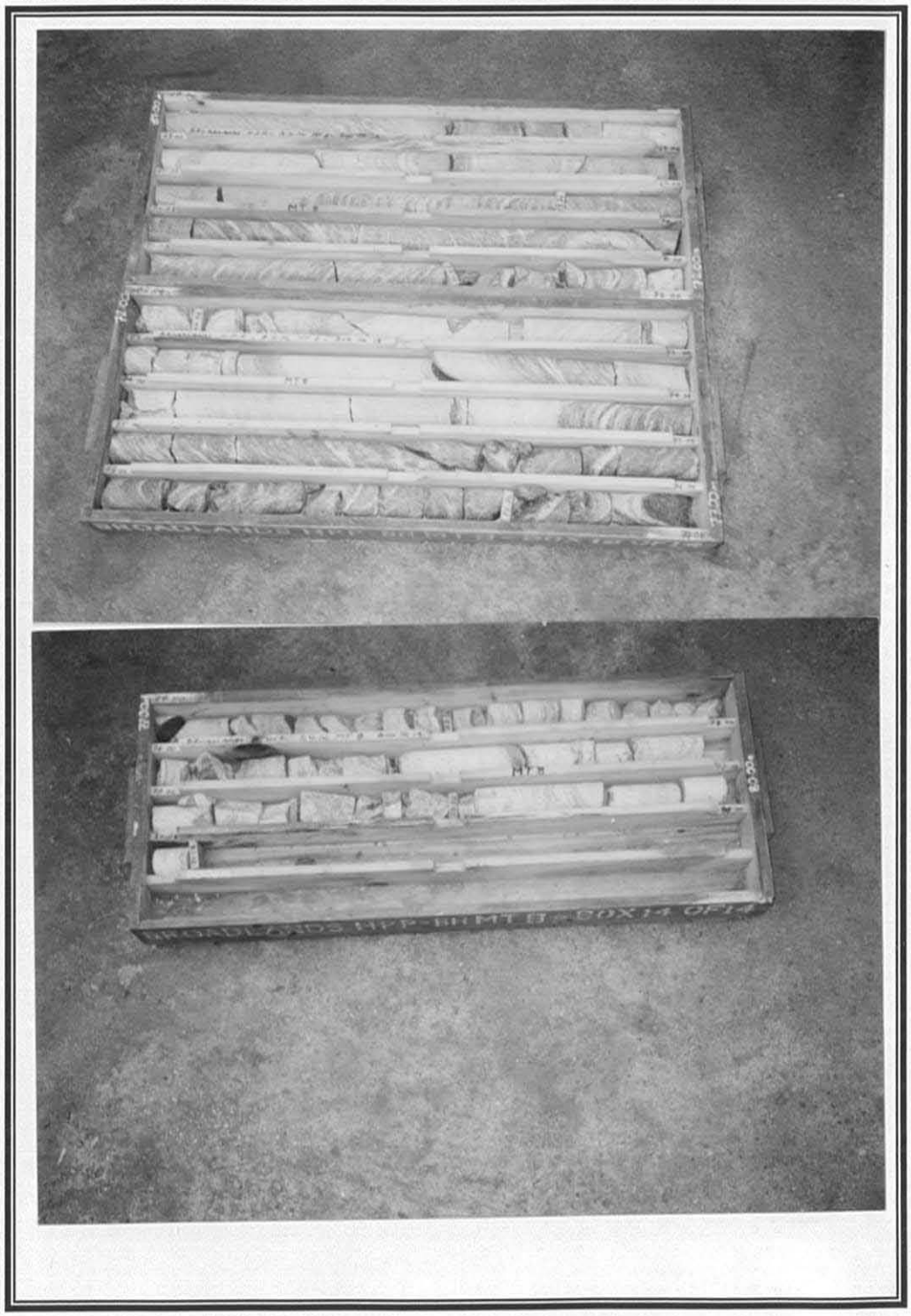


Plate # 23: Cont....

Plate # 24: Drilling Location of TR 1
total depth of hole 25.30m

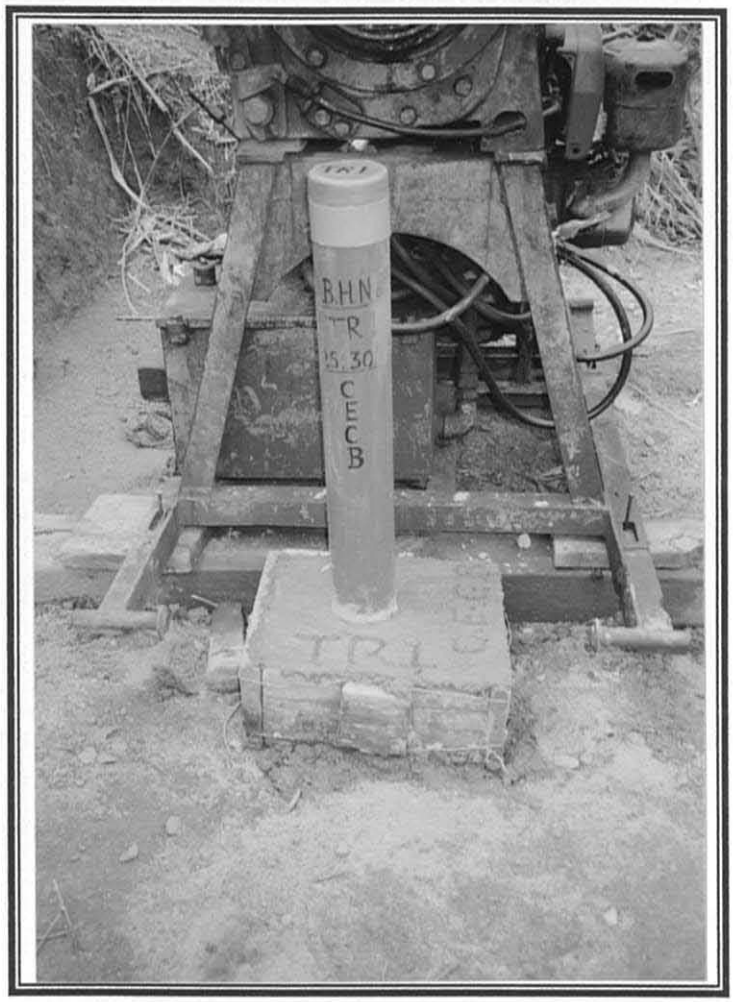


Plate # 25: Hole monument of TR 1

Plate # 26: Drill Hole TR 1, total depth of hole 25.30m

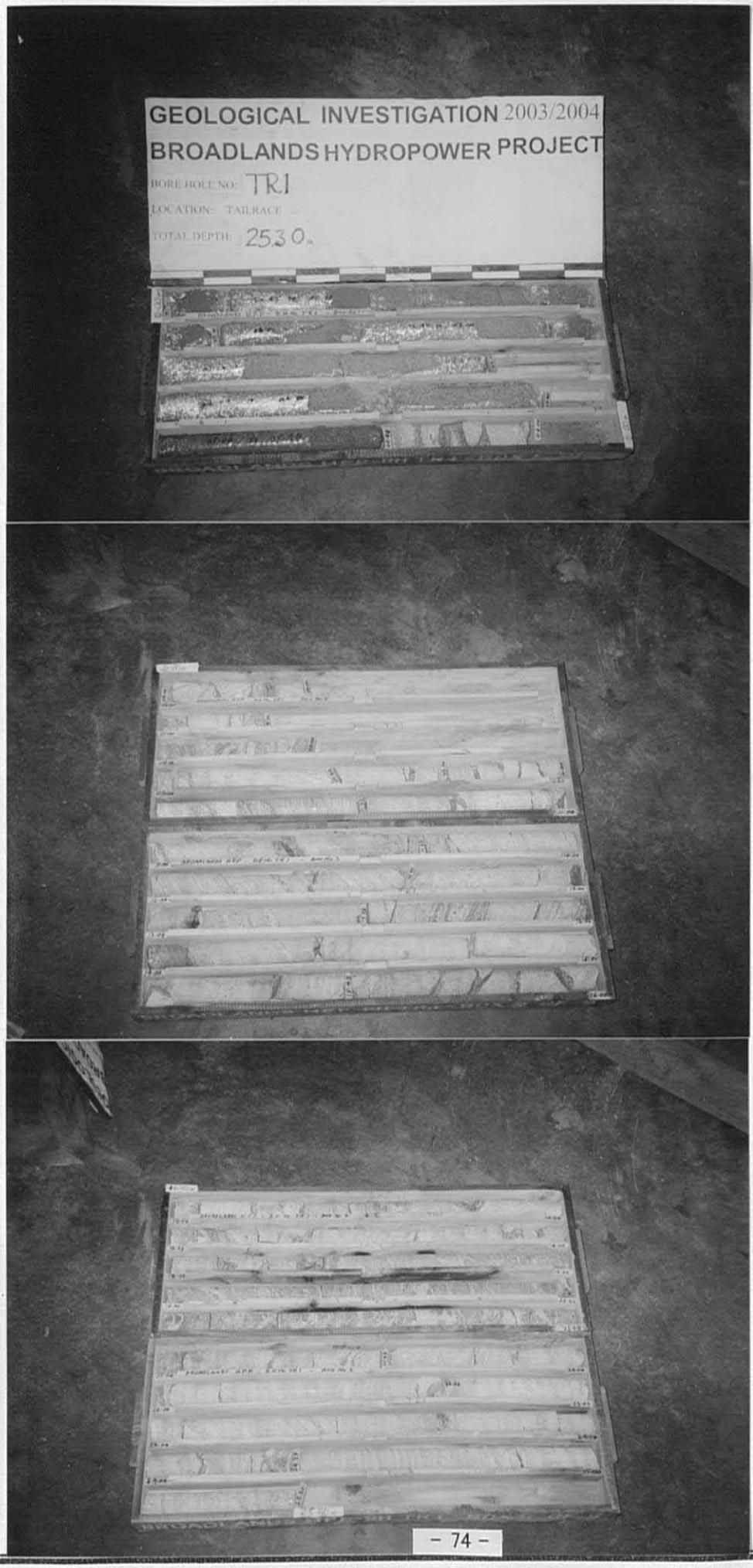


Plate # 27: Drill Hole BQ 1, total depth of hole 25.05m

Plate # 28: Drilling Location of BQ 2'
total depth of hole 25.10m

Plate # 29: Hole monument of BQ2'

Plate # 30: Drill Hole BQ 2', total depth of hole 25.10m