UNIVERSITI TEKNOLOGI MALAYSIA

Lecture 5:

DEVELOPMENT OF ALERT WARNING SYSTEM

PROF. Ir. Ts. DR. AZMAN BIN KASSIM
Pusat Kecemerlangan Kejuruteraan dan Teknologi (CREaTE)

Kursus Instrumentasi dan Pengawasan Cerun serta Sistem Amaran Awal
18-19 Julai 2019

UNIVERSITI TEKNOLOGI MALAYSIA

ALERT WARNING SYSTEM AT HUTAN LIPUR GUNUNG PULAI 1 JOHOR DARUL TAKZIM

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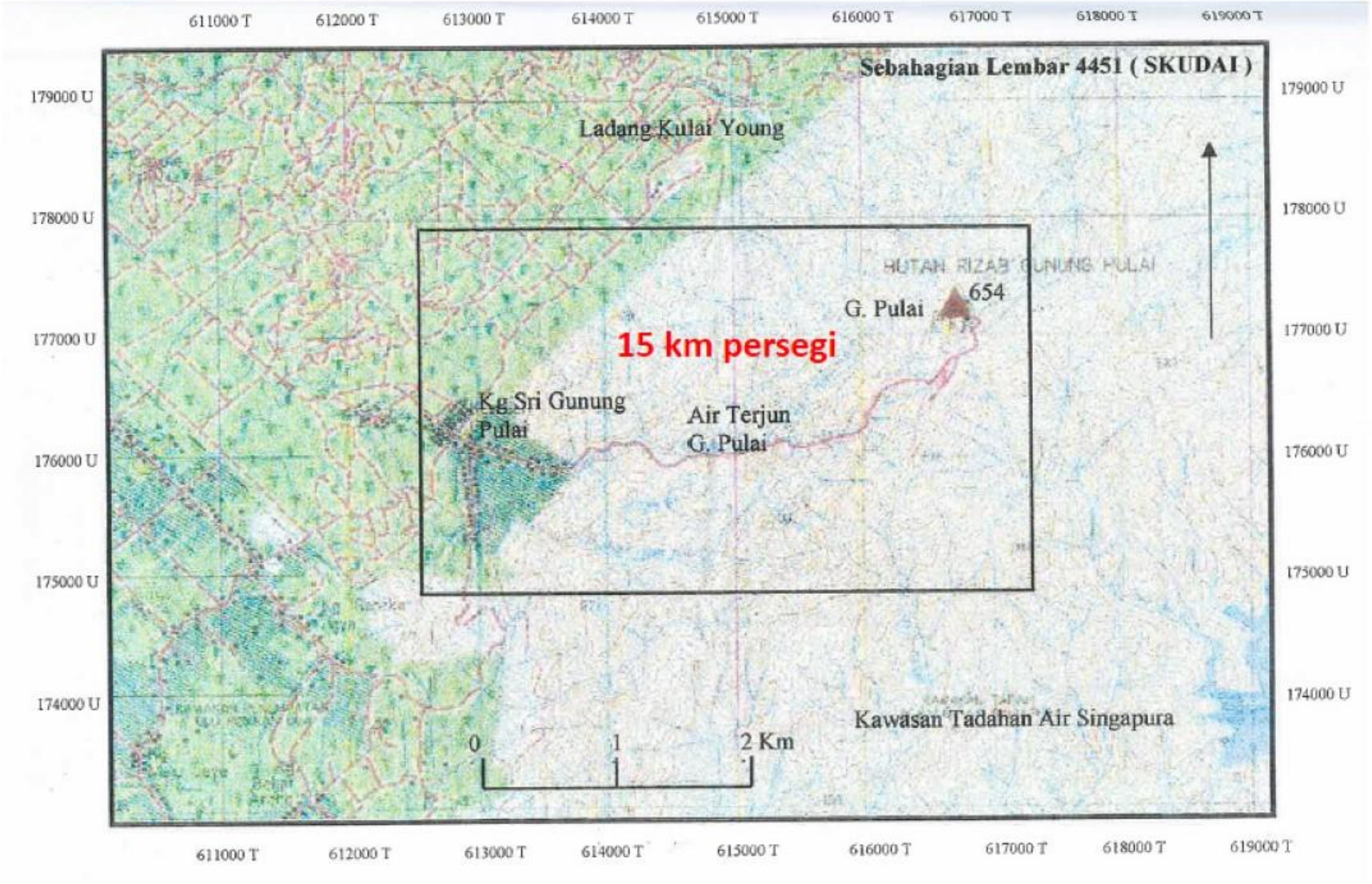
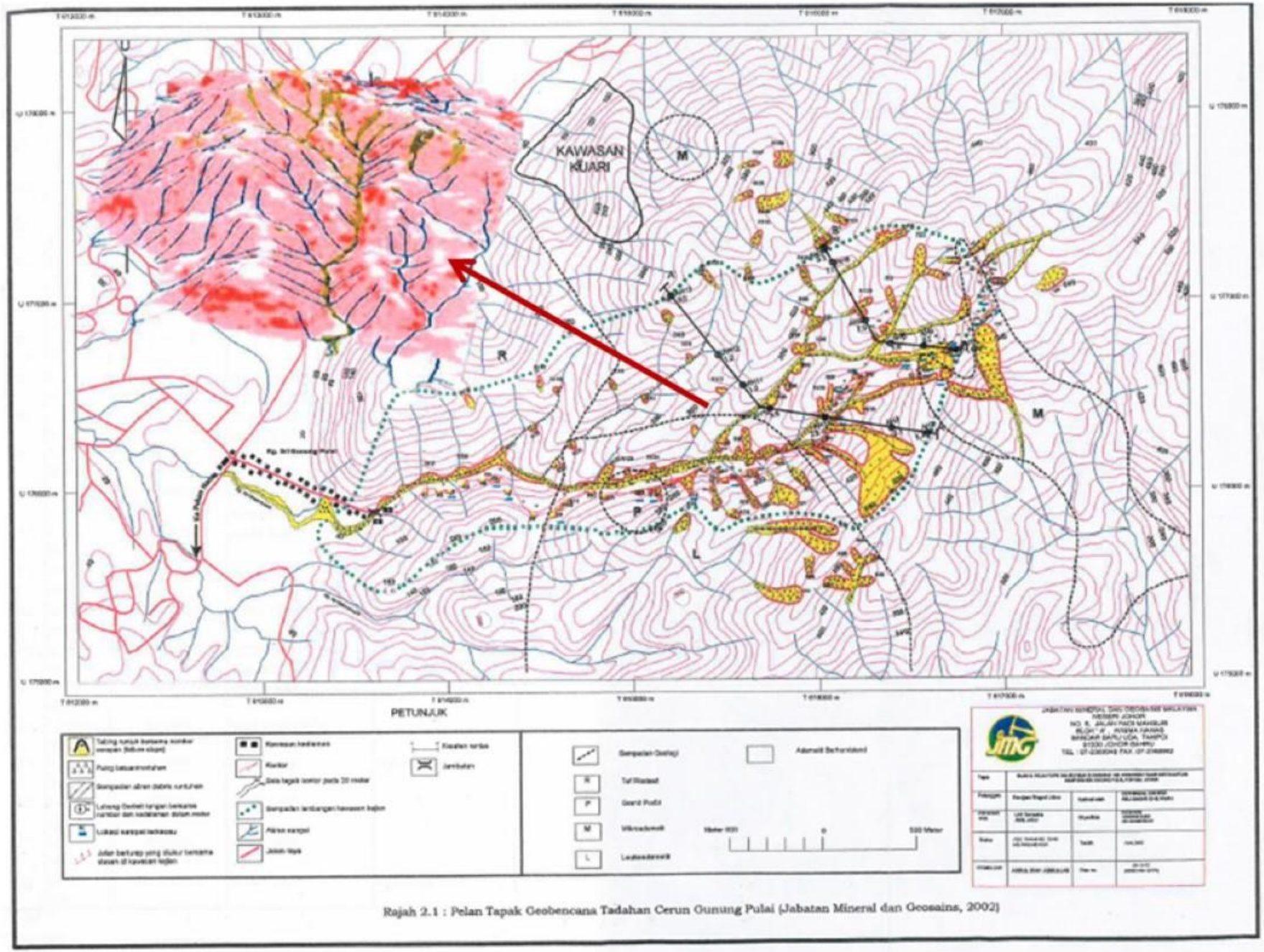
18-19 Mac 2021

KAWASAN TADAHAN SUNGAI AIR HITAM BESAR
HUTAN LIPUR GUNUNG PULAI 1





Rajah 2.1 : Pelan Tapak Geobencana Tadahan Cerun Gunung Pulai (Jabatan Mineral dan Geosains, 2002)

LATARBELAKANG

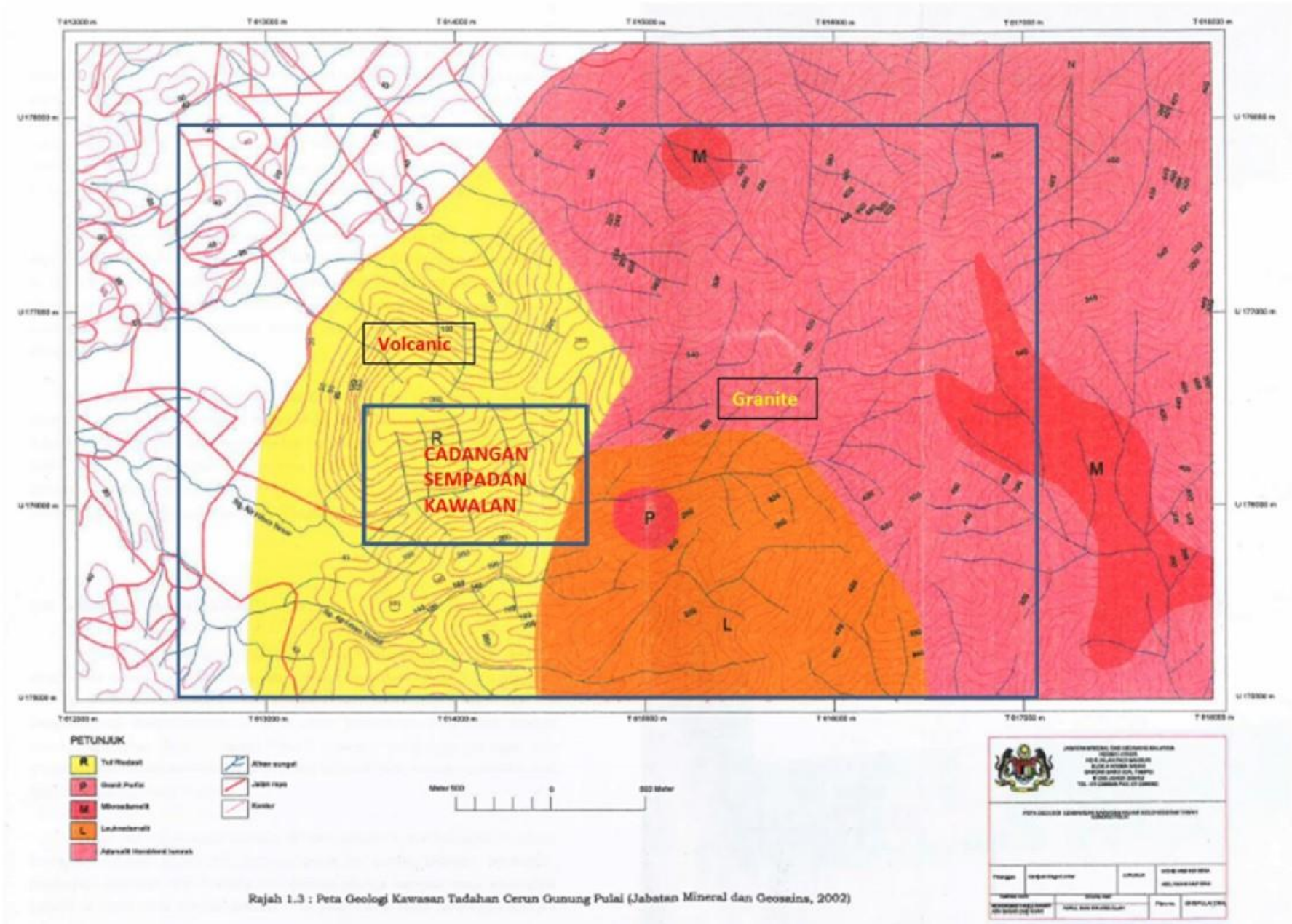
- Kejadian tanah runtuh dan aliran debris pada 27 Disember 2001
- Jawatankuasa Teknikal diketuai oleh UTM dilantik pada tahun 2002
- Laporan Penilaian disiapkan pada bulan Oktober 2002
- Hutan Lipur Gunung Pulai (HLGP) ditutup (sehingga hari ini)
- Exco Negeri Johor umumkan pembukaan semula HLGP pada 2 Februari 2009
- JMG keluarkan laporan Kajian Geobencana HLGP1 pada tahun 2011
- Mesyuarat Tapak di HLGP1 diadakan pada tahun 2014
- Tawaran perlantikan UTM menjalankan kajian semula oleh JPNJ pada Mei 2015
- Lawatan tapak penyelarasan 6 September 2015
- Kelulusan dan surat terima tawaran oleh UTSB pada 28 September 2015
- Harga lantikan kajian RM29,000

PENILAIAN KAJIAN GEOLOGI, GEOTEKNIK DAN HIDROLOGI DI PERSEKITARAN TADAHAN SUNGAI AIR HITAM BESAR, GUNUNG PULAI, KULAI

Penilaian tanah runtuh dan aliran debris pada 27 Disember 2001:

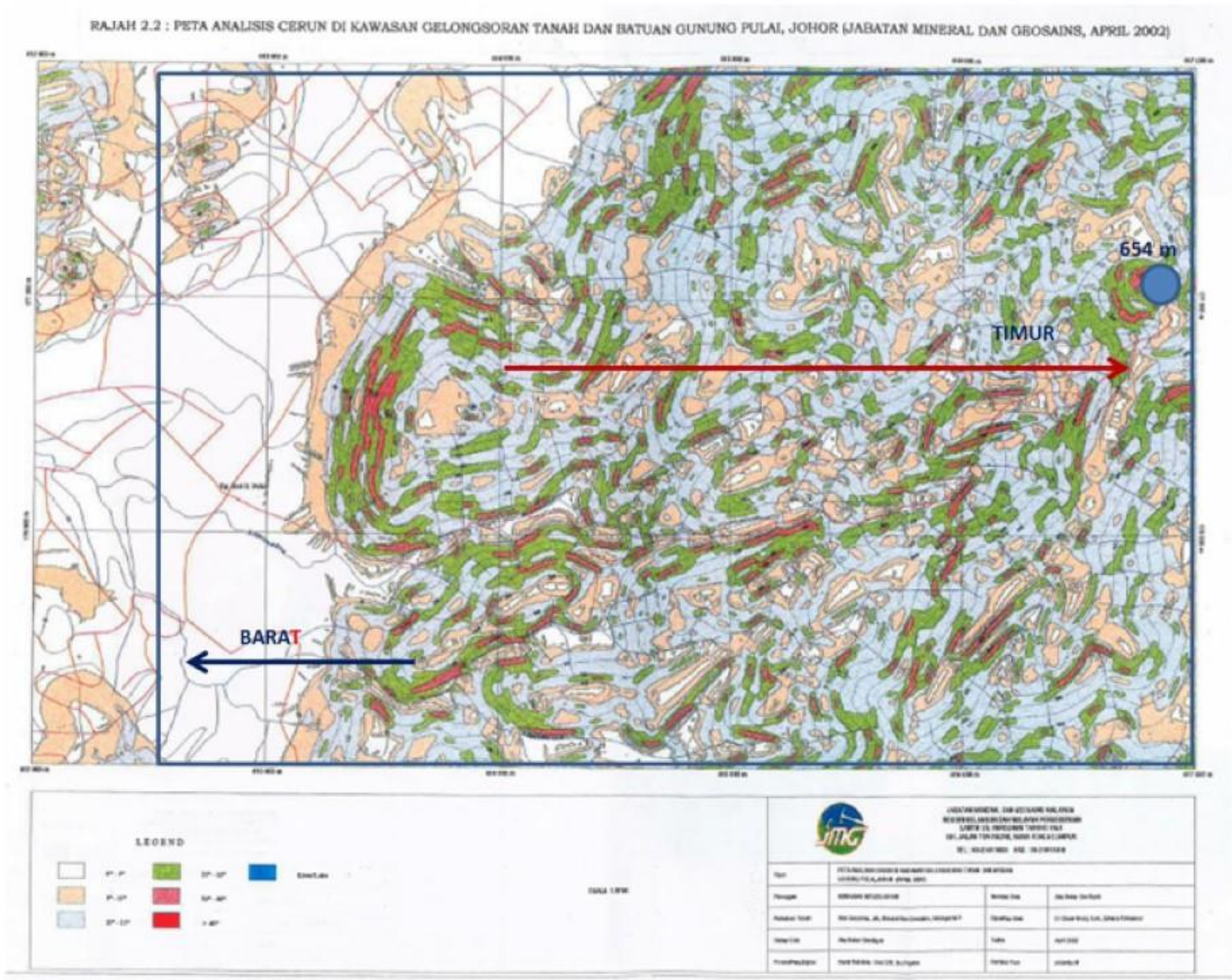
- 131 lokasi gelongsoran tanah
- Cerun semulajadi gagal bersudut > 35°
- 85% kawasan HLGP adalah Kelas IV
- Impak ribut Tropika Vamei (Taufan Vamei) > 70 knot
- Hujan lebat yang berlarutan 4 hari (pada 27 Disember = 220 mm)
- Jenis tanah dan tahap luluhawa
- 70% gelongsoran mempunyai arah kecondongan dengan satah kelemahan batuan
- Analisis hidrologi menunjukkan jumlah hujan bukan faktor utama tetapi terdapat pembentukan empangan
- Aktiviti pengkuarian tidak menyumbang secara langsung kepada kejadian gelongsoran
- Kejadian gelongsoran akan sentiasa berlaku (*cycles of recurrent*)

GEOLOGI KAWASAN



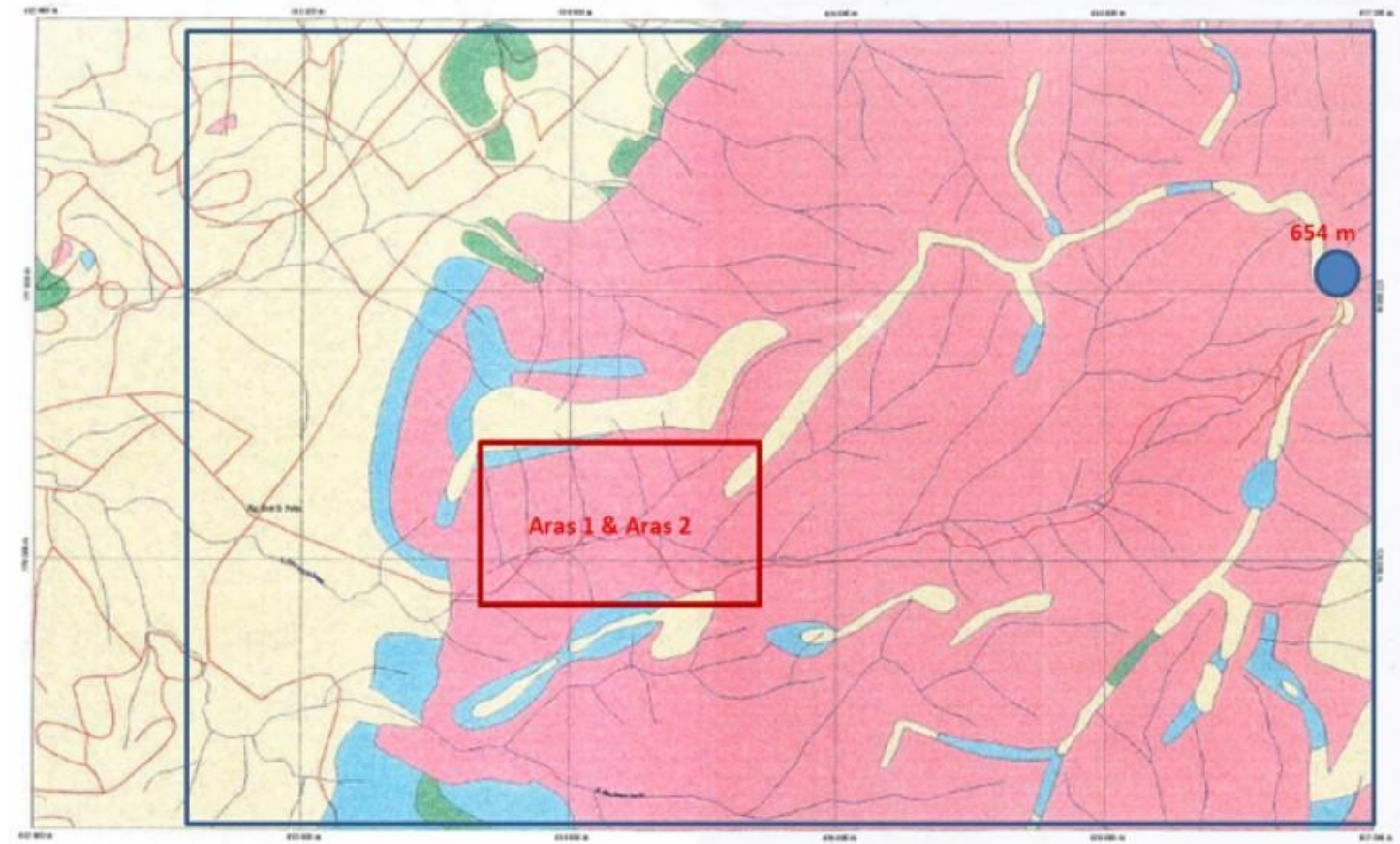
Rajah 1.3 : Peta Geologi Kawasan Tadahan Cerun Gunung Pulai (Jabatan Mineral dan Geosains, 2002)

PETA ANALISI CERUN



PETA GUNA TANAH

RAJAH 2.3 : PETA GUNA TANAH GELONGSORAN TANAH DAN BATUAN GUNUNG PULAI, JOHOR (JABATAN MINERAL DAN GEOSAINS, APRIL 2002)



KAJIAN SEMULA GEOLOGI, GEOTEKNIK DAN HIDROLOGI DI PERSEKITARAN TADAHAN SUNGAI AIR HITAM BESAR, GUNUNG PULAI, KULAI

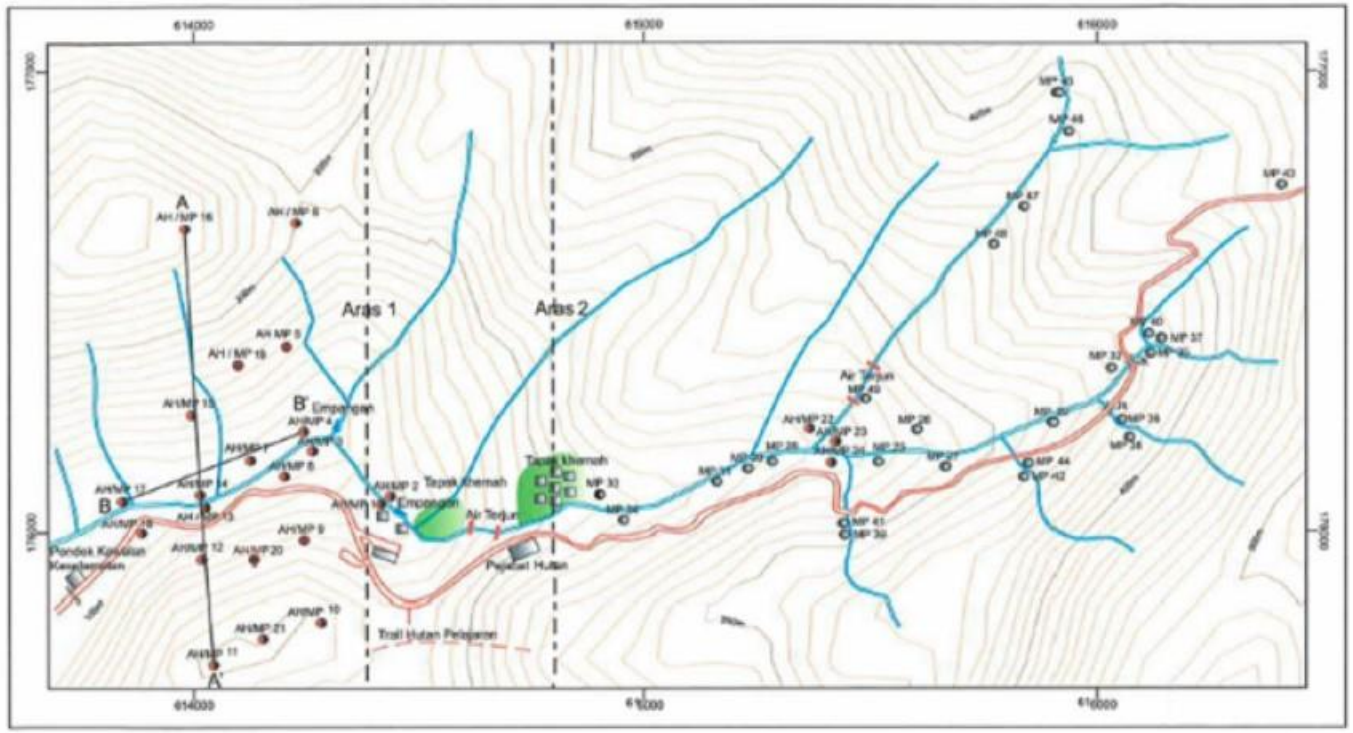
Syarat-syarat dan spesifikasi kajian selama 2 bulan:

- ❑Menghasilkan maklumat Peta Topografi, Penilaian Geologi dan Geoteknik, Penilaian Hidrologi, dan Analisa & Keputusan
- ❑Mengenalpasti langkah-langkah mitigasi serta kos yang terlibat untuk membangun semula HLGP1
- ❑Menyediakan satu laporan kajian semula Geologi, Geoteknik dan Hidrologi di Persekitaran Tadahan Sungai Air Hitam Besar, Gunung Pulai, Kulai

Laporan Kajian Geobencana HLGP1 (JMG, Johor, 2011):

- ❑Aras 1 dan Aras 2 di HLGP1 dibuka untuk orang awam dan pelawat

KERJA LAPANGAN DAN PENGUMPULAN DATA



U

Skala
1 : 10000

Petunjuk:

- Bangunan
- Sungai
- Jalan Berturap
- Tapak Perkhemahan
- Lubang Proba Mackintosh
- Lubang Gerimit Tangan / Proba Mackintosh
- Kontur
- Trail Hutan Pelajaran
- Air Terjun
- Jambatan Konkrit
- Empangan

Jabatan Mineral dan Geosains Malaysia
Negeri Johor

RAJAH : PETA TOPOGRAFI KAJIAN GEOBENCANA HUTAN LIPUR GUNUNG PULAI 1, KULAIJAYA, JOHOR.

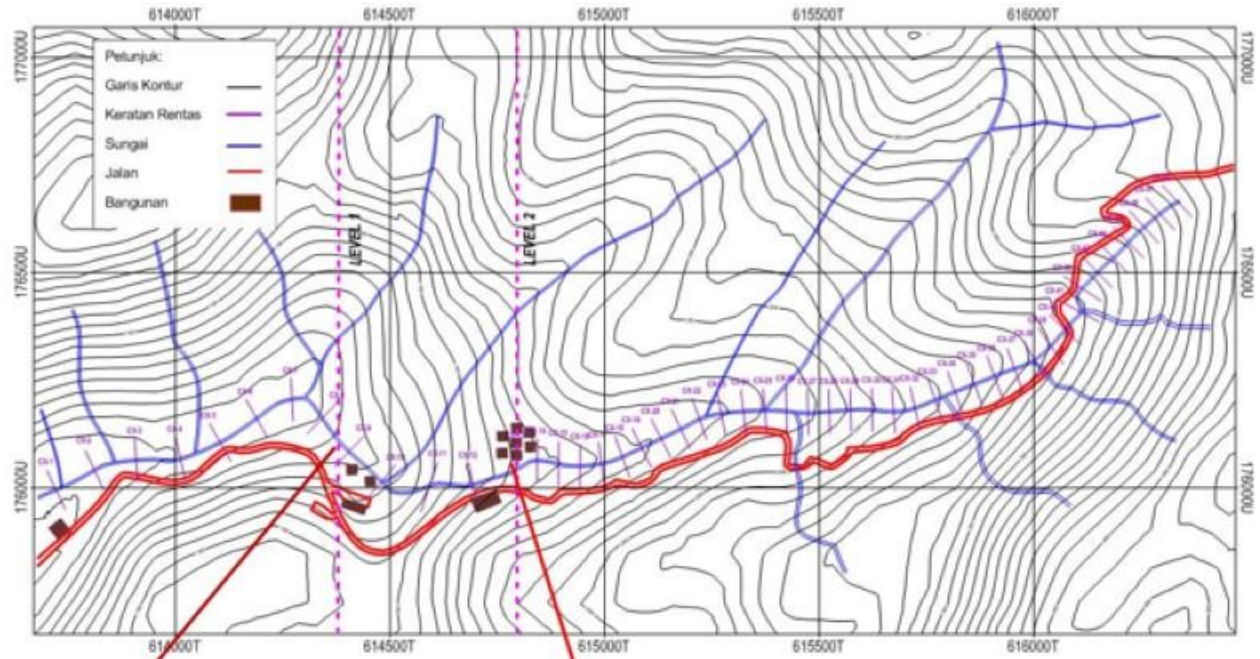
Disemak oleh : En. Mohammed Syahrizal Zakaria

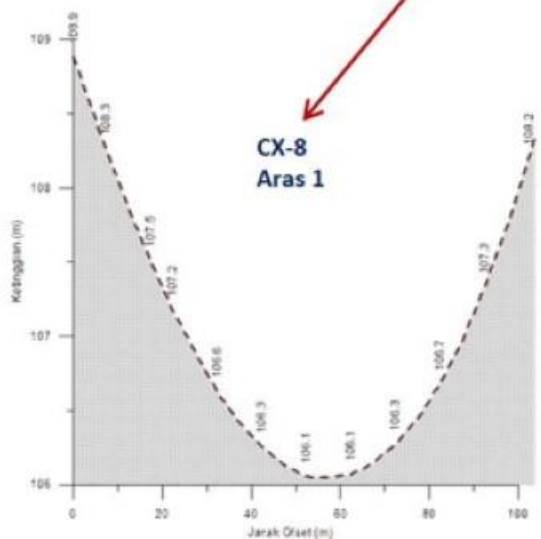
Di Ukur / Diproses Oleh : Md. Aris Md. Esa

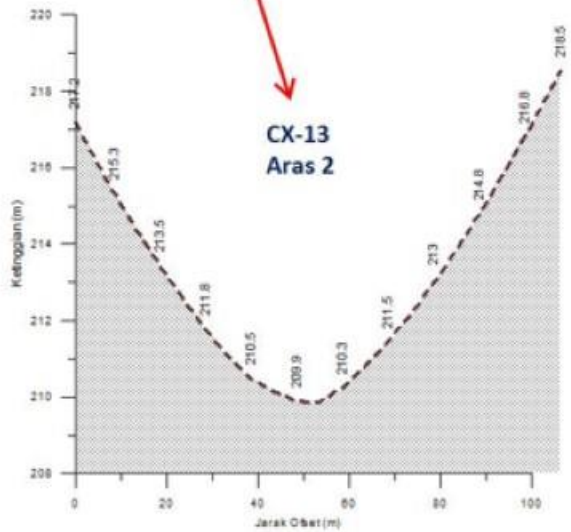
Dilukis oleh : Siti Normaliyana Binti Jumadi

No. Lukisan : JHR-77-10 cdr

(1) PENILAIAN GEOLOGI DAN GEOTEKNIK

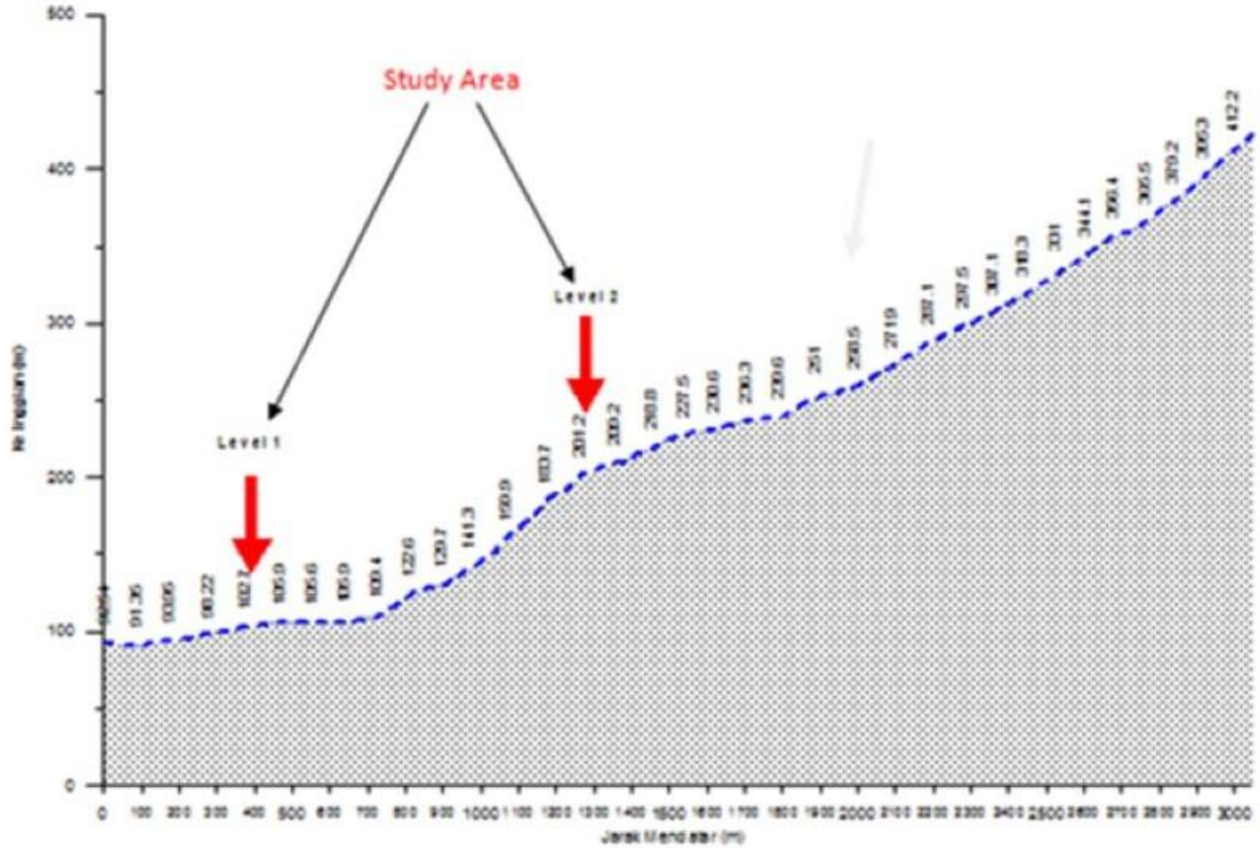






Cerun tebing kiri (Utara):
1.1% - 13.7%

Cerun tebing kanan (Selatan):
3.5% - 20.3%



Purata invert cerun : 11%

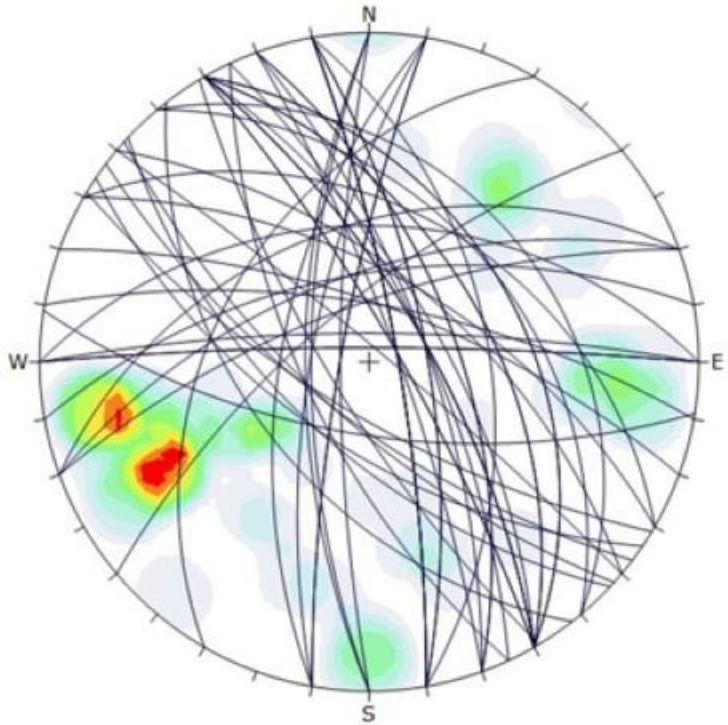
Invert Cerun Aras 1 (CX-8) : 13%

Invert Cerun Aras 2 (CX-13) : 14%

NISBAH PERATUSAN KESESUAIAN GUNA TANAH

KELAS	PERATUS	SUDUT KECURAMAN	HAD GEOTEKNIKAL
Kelas I	10	< 15°	RENDAH
Kelas II	2	15° – 25°	SEDERHANA
Kelas III	3	25° – 35°	TINGGI
Kelas IV	85	> 35°	AMAT TINGGI

SATAH KELEMAHAN BATUAN

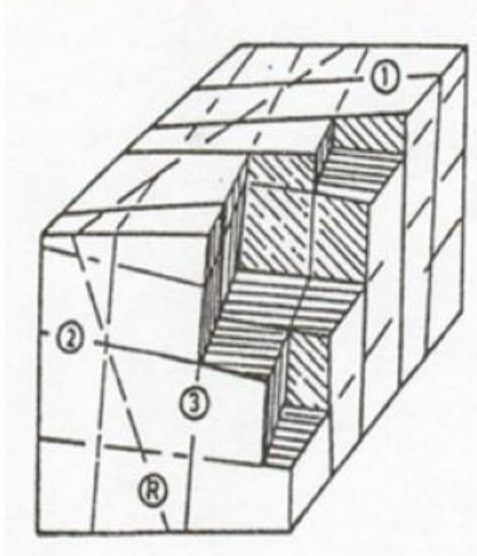


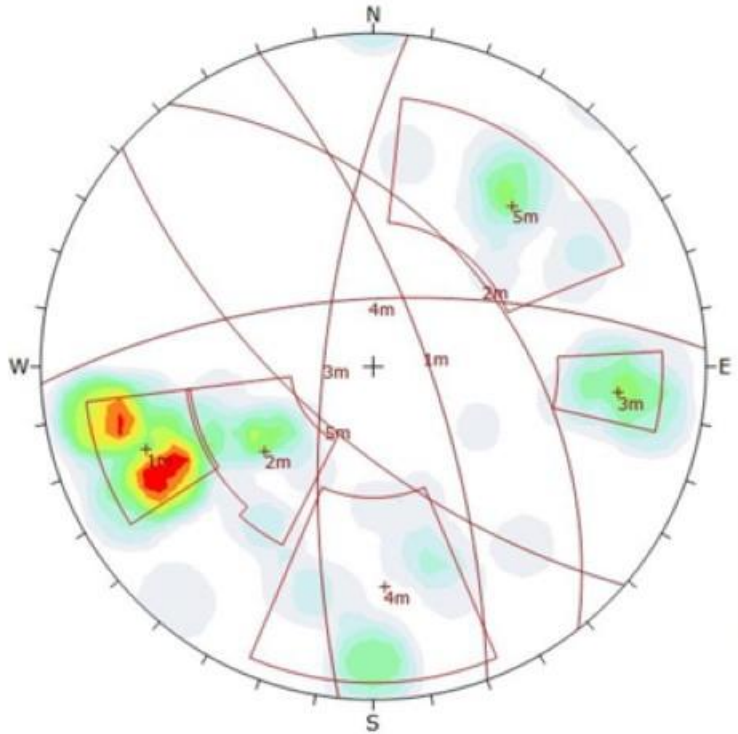
Color	Density Concentrations
	0.00 - 1.10
	1.10 - 2.20
	2.20 - 3.30
	3.30 - 4.40
	4.40 - 5.50
	5.50 - 6.60
	6.60 - 7.70
	7.70 - 8.80
	8.80 - 9.90
	9.90 - 11.00

Maximum Density	10.81%
Contour Data	Pole Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

Plot Mode	Pole Vectors
Vector Count	56 (56 Entries)
Hemisphere	Lower
Projection	Equal Angle

Pelotan stereo-net & polar, arah potensi kegagalan (*the direction of any potential failures*) dalam batuan boleh ditentukan





Color	Density Concentrations
	0.00 - 1.10 1.10 - 2.20 2.20 - 3.30 3.30 - 4.40 4.40 - 5.50 5.50 - 6.60 6.60 - 7.70 7.70 - 8.80 8.80 - 9.90 9.90 - 11.00

Maximum Density	10.81%
Contour Data	Pole Vectors
Contour Distribution	Fisher
Counting Circle Size	1.0%

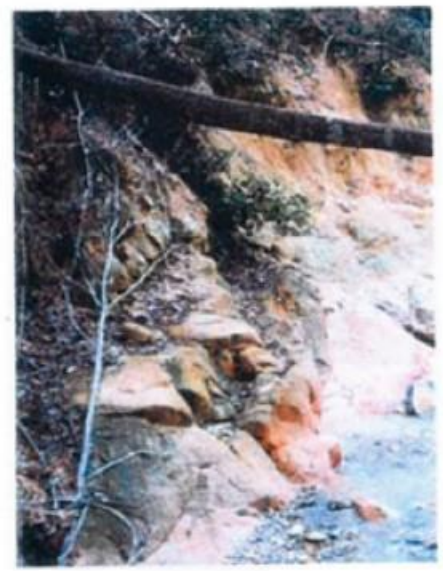
Plot Mode	Pole Vectors
Vector Count	56 (56 Entries)
Hemisphere	Lower
Projection	Equal Angle

Polar Number & Rating	Dip Direction	Dip Angle
1m	70° U	75°
2m	50° U	48°
3m	275° U	80°
4m	355° U	70°
5m	220° U	68°

Potensi gagal sendeng ke arah Timur :
TIDAK KRITIKAL

(Aras 1 dan Aras 2 terletak di arah Barat)

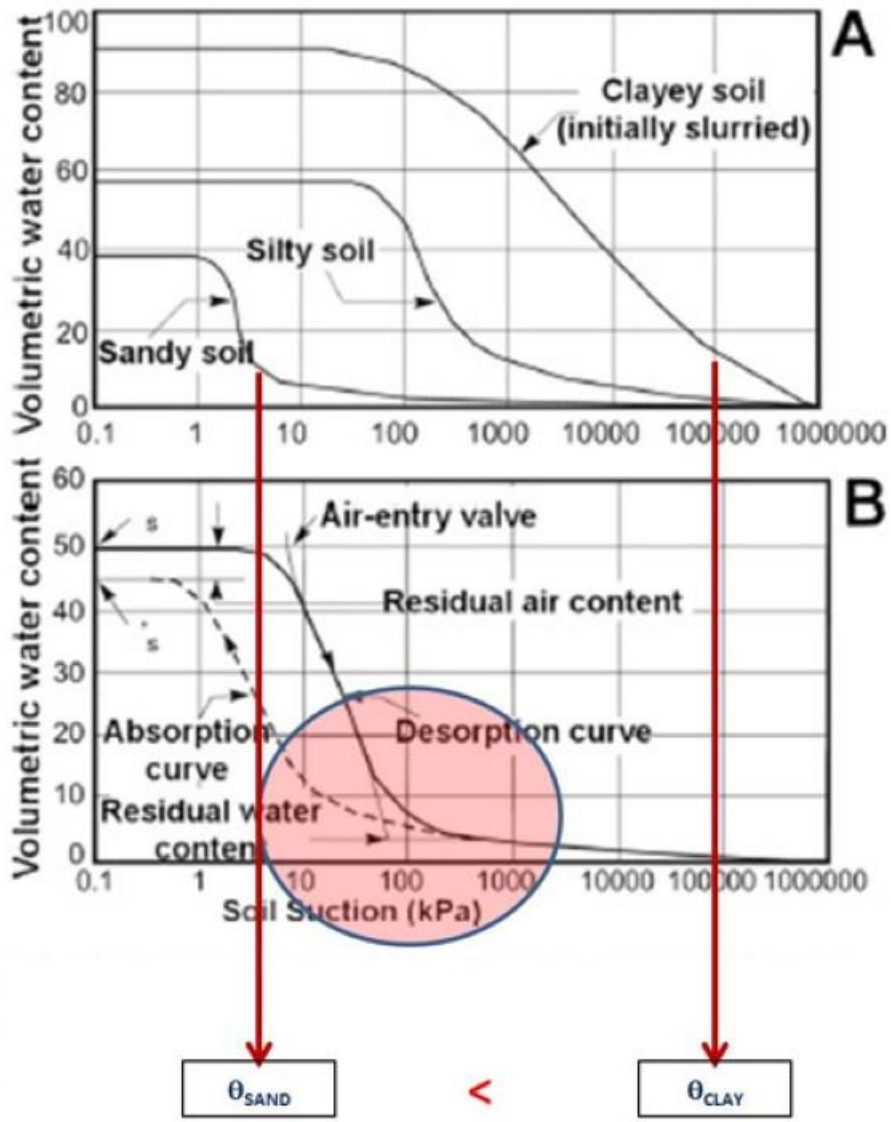
TAHAP LULUHAWA



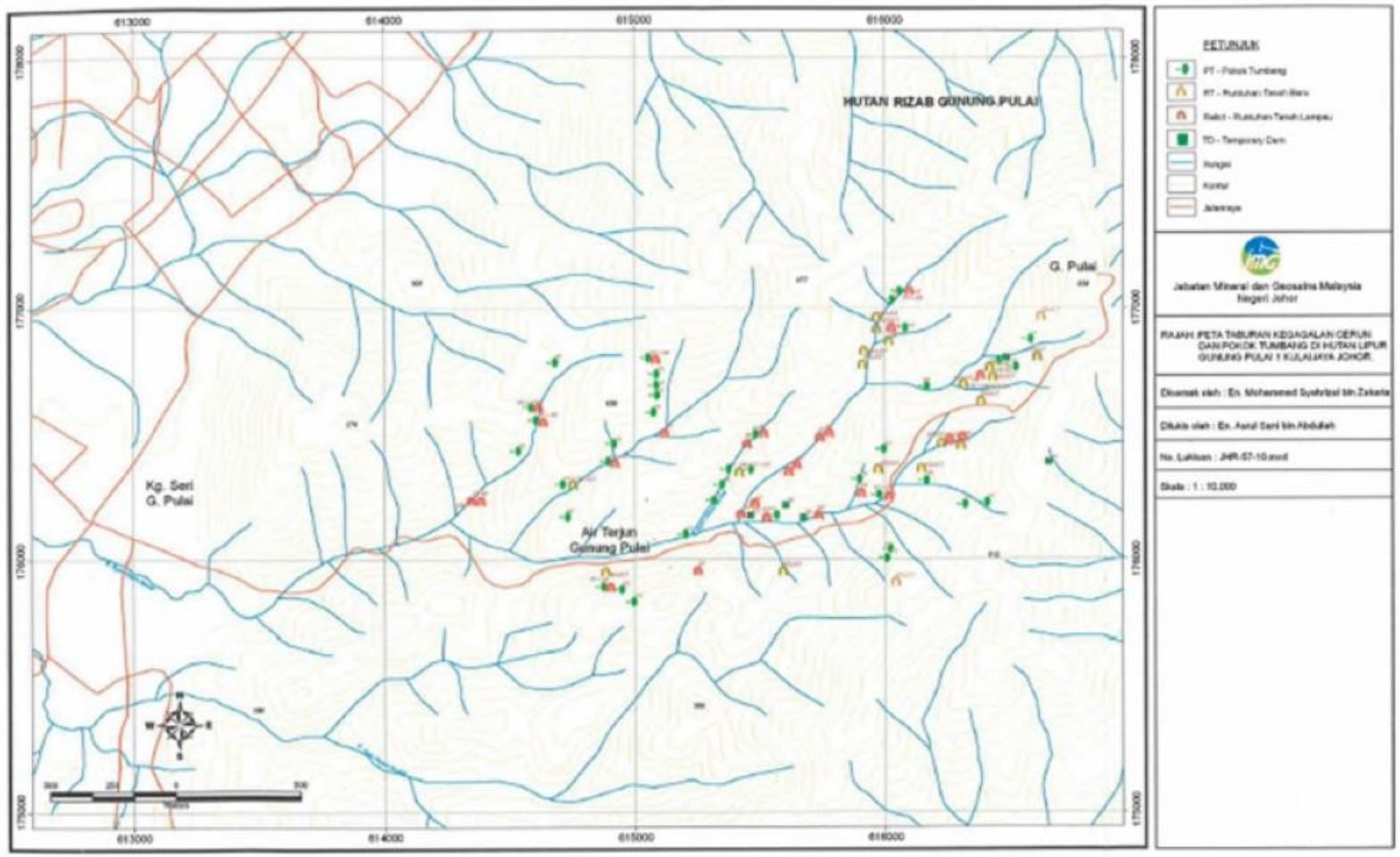
JENIS BATUAN	KAWASAN	JENIS TANAH	c (kN/m^2)	ϕ (Darjah)
Batu Volkanik	Barat	Tanah Liat	46	23
Batu Granit (Granitik)	Timur	Tanah Pasir	21	16

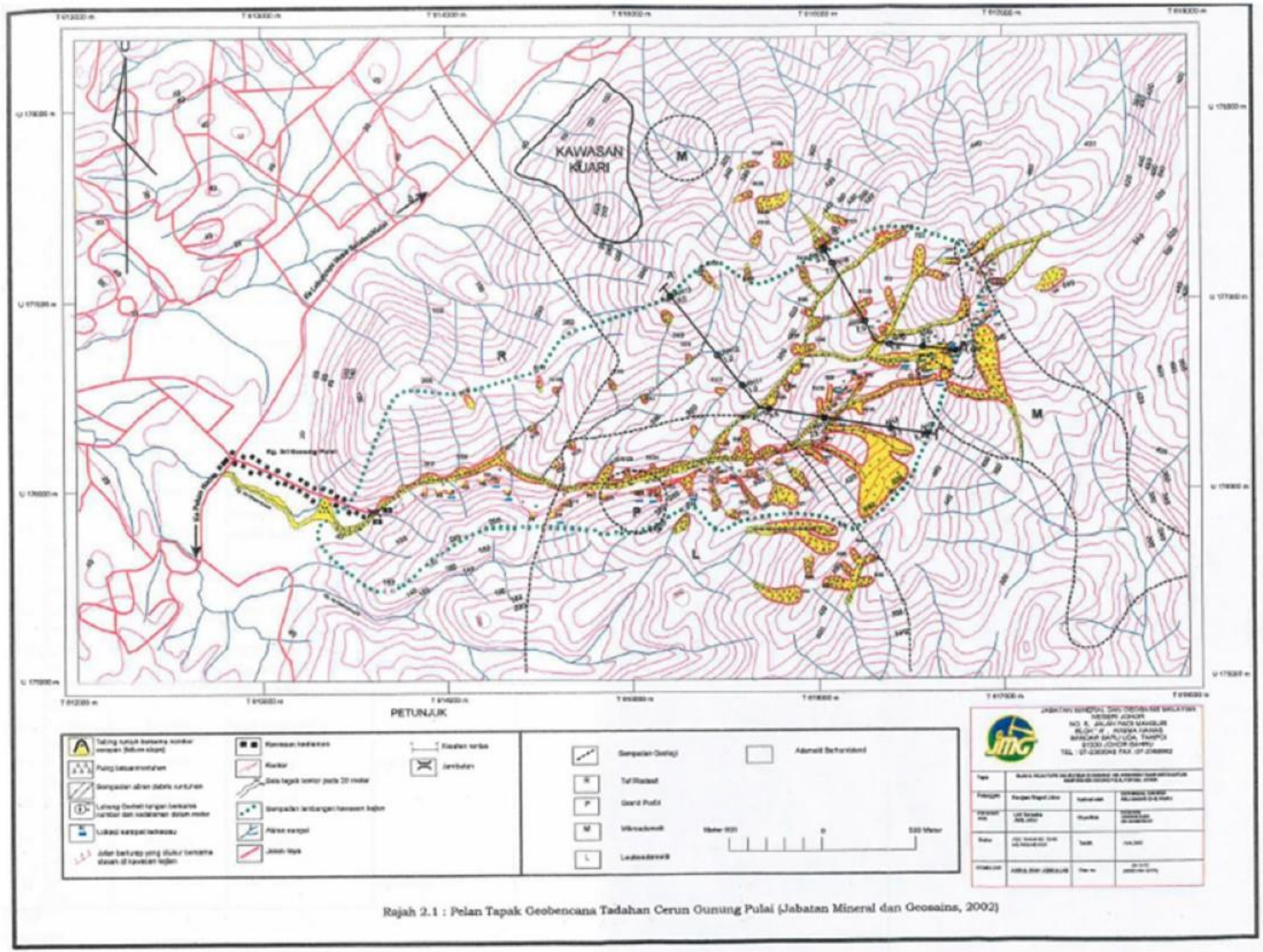
SUDUT SET KEKAR	70°	220°	275°	360°
PERATUS	40%	0%	12%	17%

PENGARUH HUJAN KE ATAS JENIS TANAH



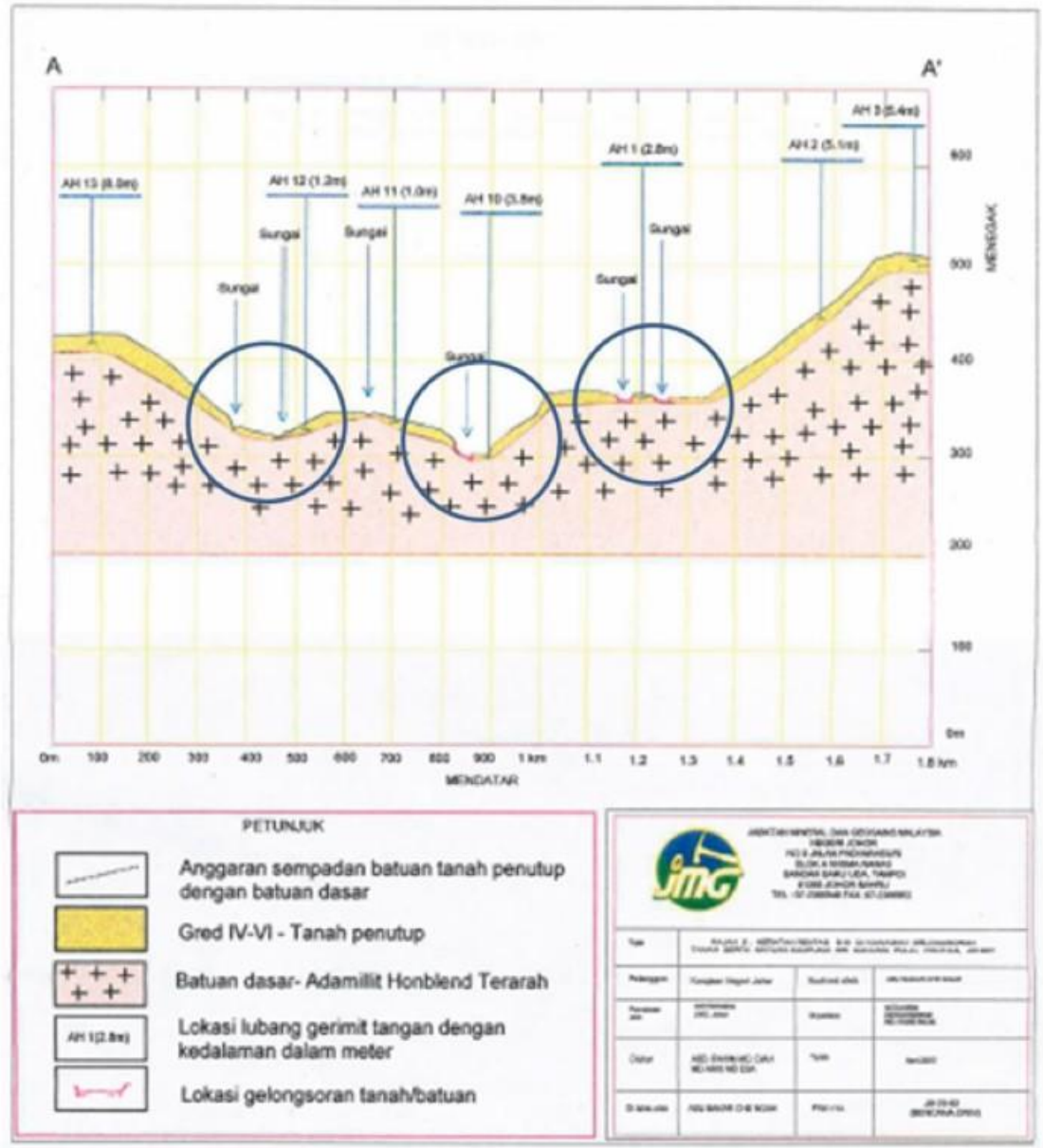
PETA TABURAN RUNTUHAN KINI



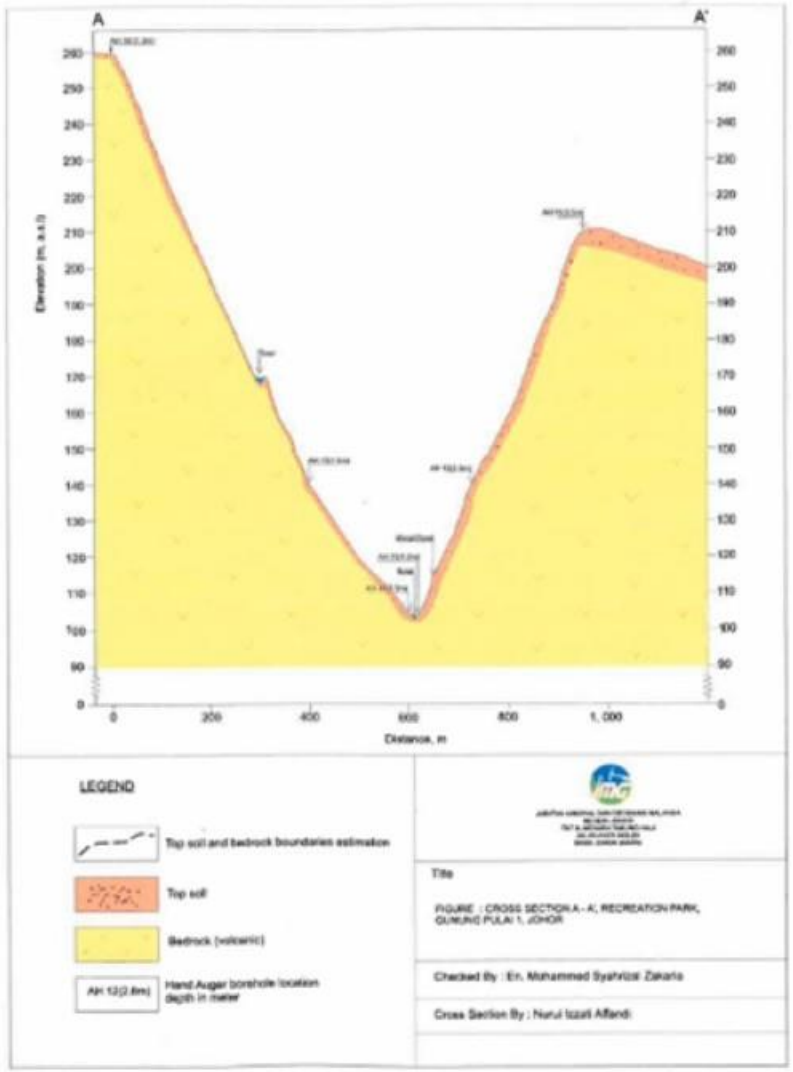


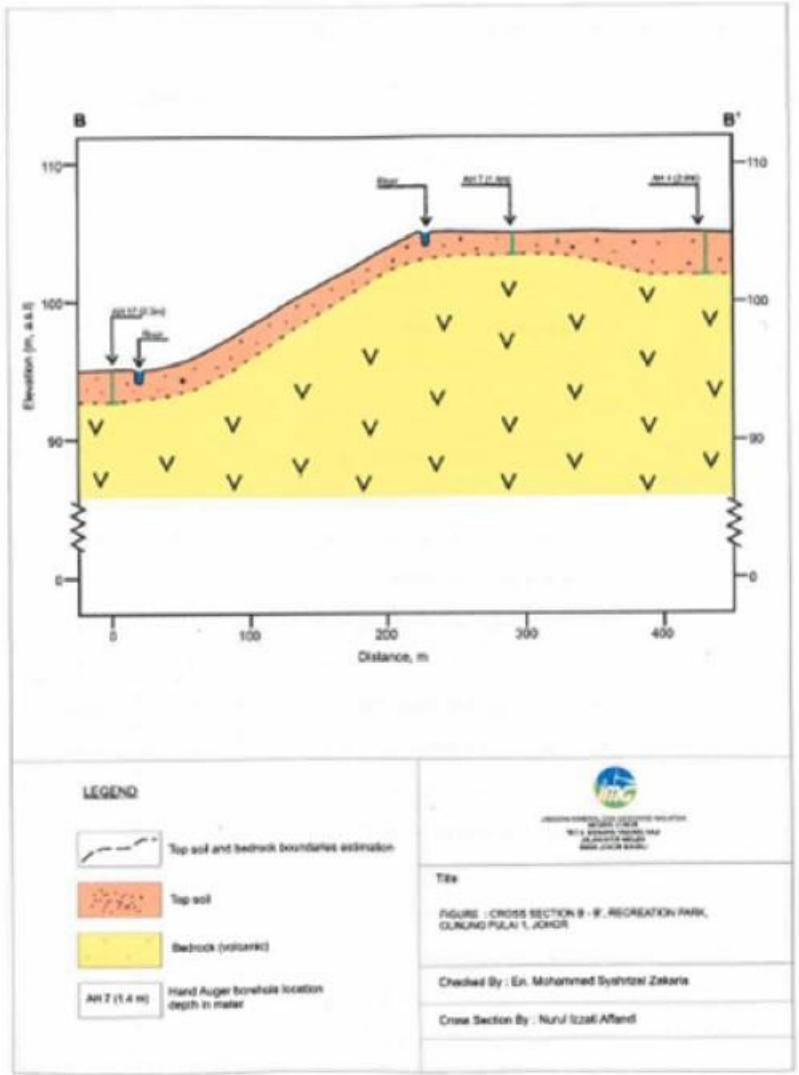
Rajah 2.1 : Pelan Tapak Geobencana Tadahan Cerun Gunung Pulai (Jabatan Mineral dan Geosains, 2002)

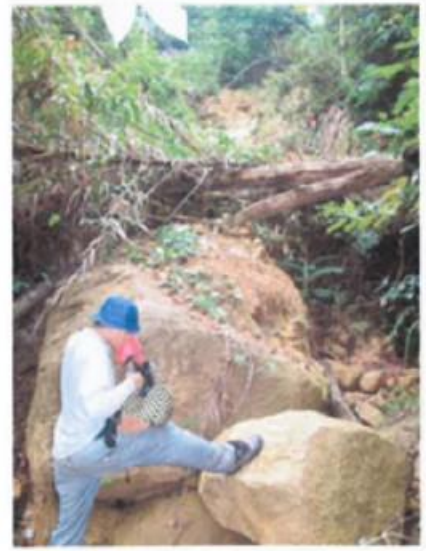
KERATAN RENTAS A-A'

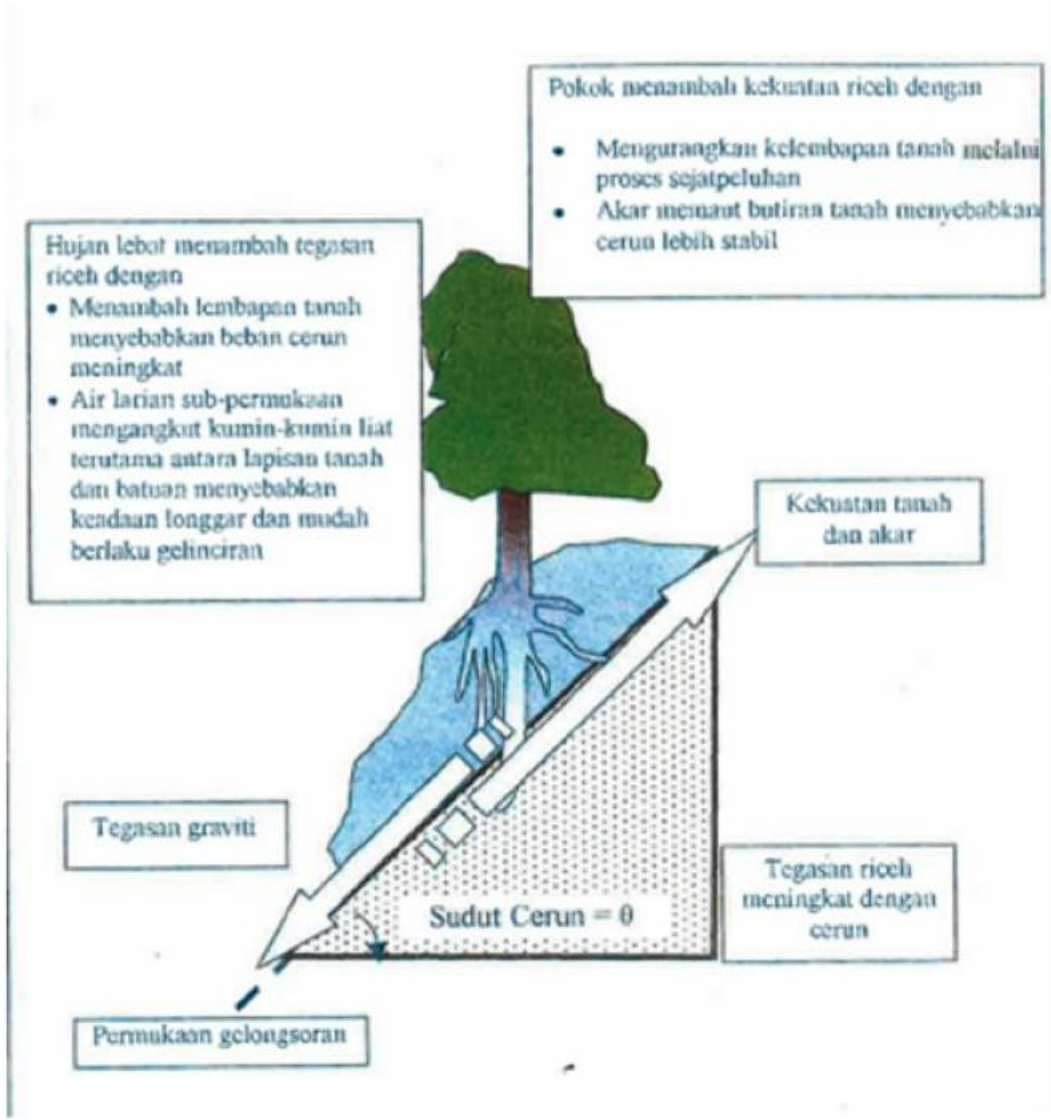


KERATAN RENTAS A-A' DAN B-B'








Pokok menambah kekuatan riceh dengan
• Mengurangkan kelembapan tanah melalui proses sejatpeluhan
• Akar menahan butiran tanah menyebabkan cerun lebih stabil
Hujan lebat menambah tegasan riceh dengan
• Menambah lembapan tanah menyebabkan beban cerun meningkat
• Air larian sub-permukaan mengangkut kumin-kumin liat terutama antara lapisan tanah dan batuan menyebabkan keadaan longgar dan mudah berlaku gelinciran
Kekuatan tanah dan akar
Tegasan graviti
Tegasan riceh meningkat dengan cerun
Sudut Cerun = θ
Permukaan gelongsoran

KERATAN RENTAS SUNGAI

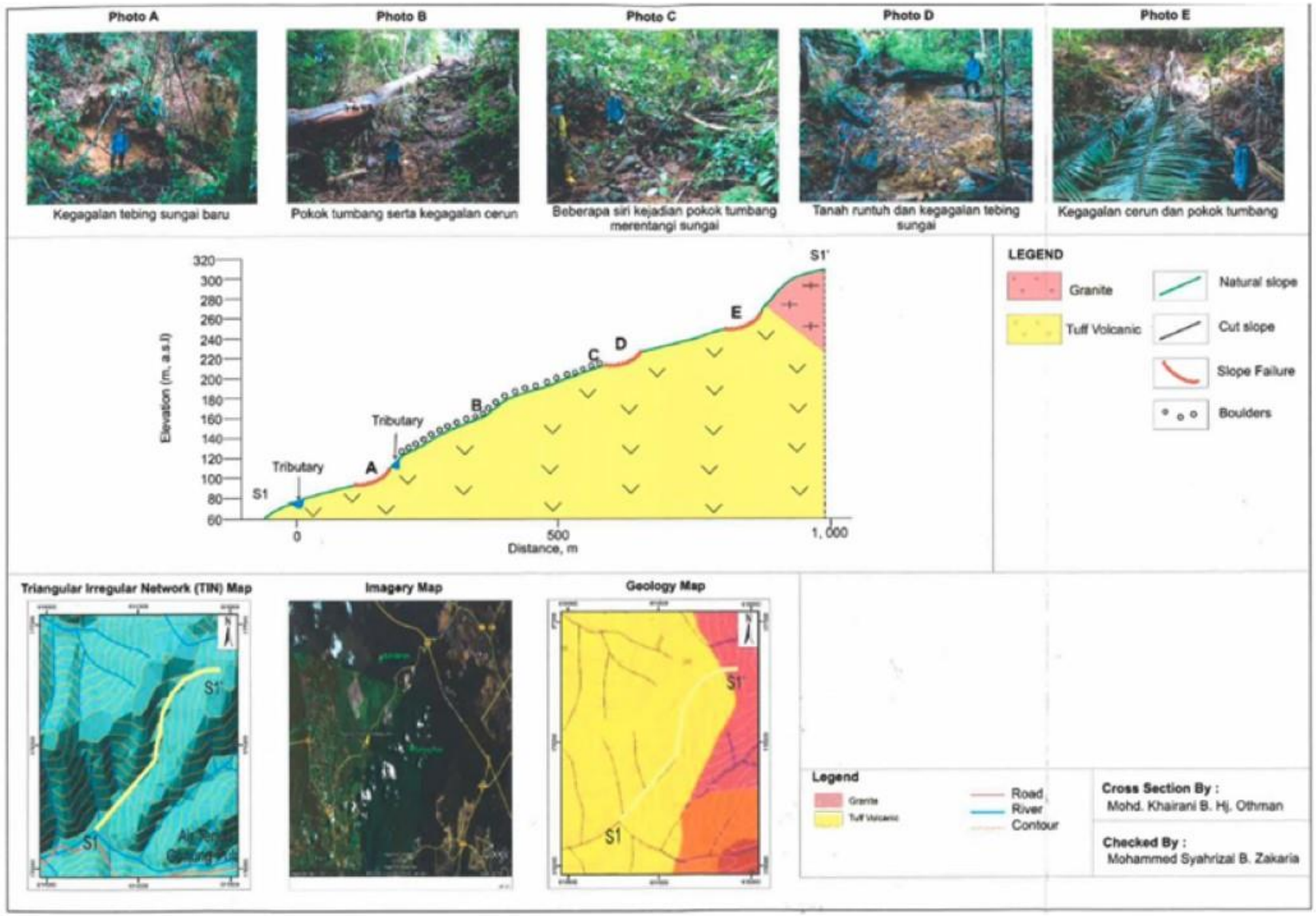


Photo A

Pokok tumbang merentangi sungai

Photo B

Kegagalan tebing sungai dan pokok tumbang

Photo C

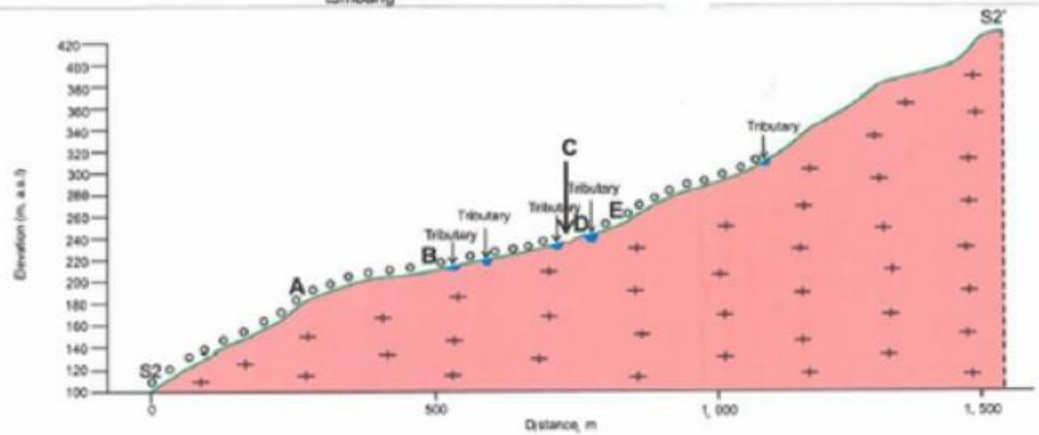
Kegagalan tebing sungai baru

Photo D

Pokok tumbang merentangi sungai

Photo E

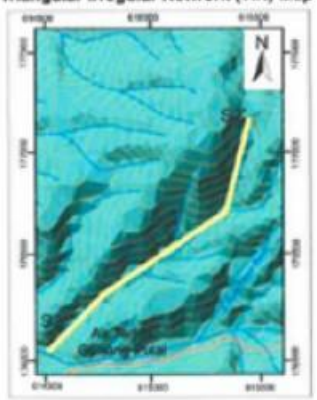
Pokok tumbang



LEGEND

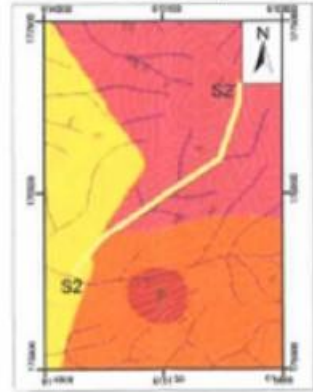
- Granite
- Natural slope
- Cut slope
- Slope Failure
- Boulders

Triangular Irregular Network (TIN) Map



Imagery Map

Geology Map



Legend

- Granite
- Road
- River
- Contour

Cross Section By :
Mohd. Khairani B. Hj. Othman

Checked By :
Mohammed Syahrizai B. Zakaria

Photo A

Beberapa siri kejadian pokok tumbang di bahagian sisi cerun

Photo B

Pokok tumbang

Photo C

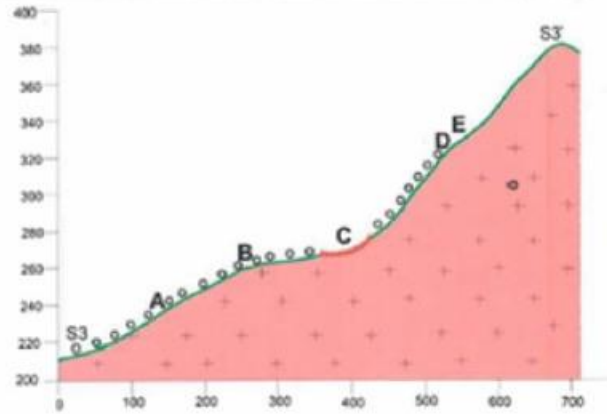
Kegagalan [illegible] sungai baru

Photo D

Pokok tumbang merentangi sungai

Photo E

Tanah runtuh lampau dan pokok tumbang



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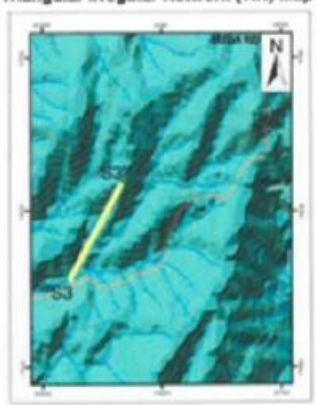


Imagery Map

Geology Map

Legend

- Granite
- Road
- River
- Contour

Cross Section By :

Mohd. Khairani B. Hj. Othman

Checked By :

Mohammed Syahrizal B. Zakaria

Photo A

Kegagalan tebing sungai dan longgokan bongkah batuan pelbagai saiz

Photo B

Kegagalan tebing sungai

Photo C

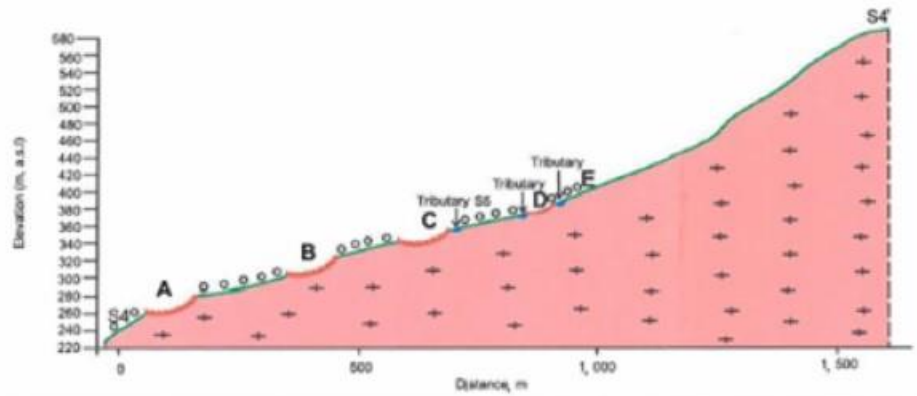
Kegagalan tebing sungai dan jatuhan bongkah batuan

Photo D

Kegagalan tebing sungai

Photo E

Himpunan pokok tumbang merentangi sungai bagi berupaya membentuk kolam takungan sementara



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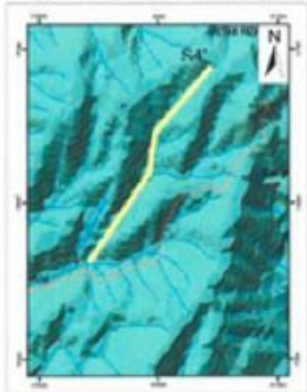
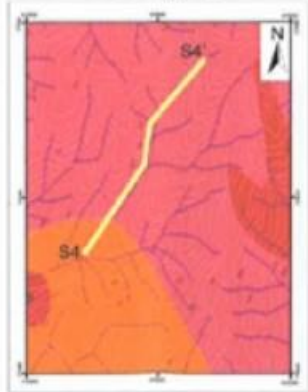


Imagery Map

Geology Map



Legend

- Granite
- Road
- River
- Contour

Cross Section By :

Mohd. Khairani B. Hj. Othman

Checked By :

Mohammed Syahrizal B. Zakaria

Photo A

Kegagalan tebing sungai dengan jatuhan bongkah batuan

Photo B

Kegagalan tebing sungai

Photo C

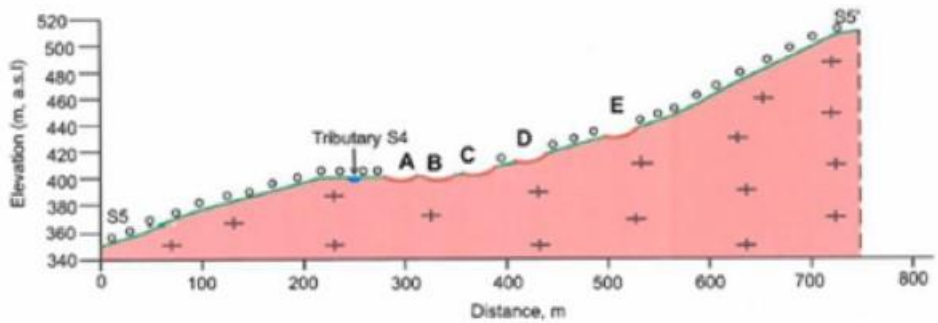
Tanah runtuh lampau dan kejadian pokok tumbang

Photo D

Beberapa siri kejadian pokok tumbang

Photo E

Tanah runtuh dan pokok tumbang yang berupaya membentuk kolam takungan sementara



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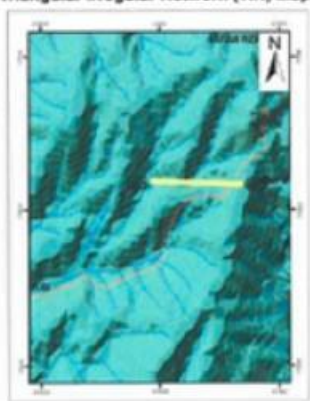


Imagery Map

Geology Map

Legend

- Granite
- Road
- River
- Contour

Cross Section By :

Mohd. Khairani B. Hj. Othman

Checked By :

Mohammed Syahrizal B. Zakaria

Photo A

Longgokan batang-batang pokok dan bongkah batuan

Photo B

Kegagalan tebing sungai

Photo C

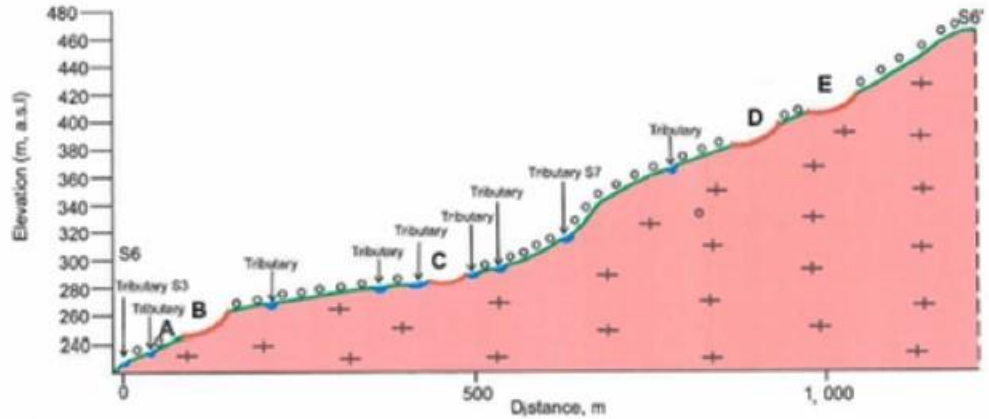
Tanah runtuh dan pokok tumbang

Photo D

Kegagalan tebing sungai

Photo E

Tanah runtuh baru



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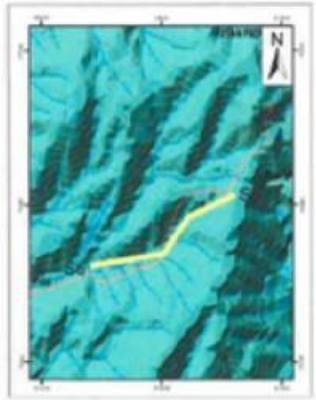
- Boulders

Triangular Irregular Network (TIN) Map



Imagery Map

Geology Map

Legend

- Granite
- Road
- River
- Contour

Cross Section By :

Mohd. Khairani B. Hj. Othman

Checked By :

Mohammed Syahrizal B. Zakaria

Photo A

Kawasan air terjun

Photo B

Tanah runtuh dan pokok tumbang yang boleh membentuk kolam takungan sementara

Photo C

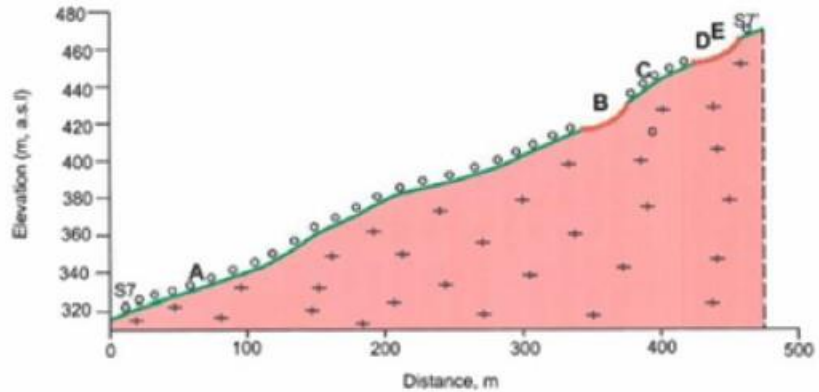
Kawasan air terjun

Photo D

Pokok tumbang merentangi sungai

Photo E

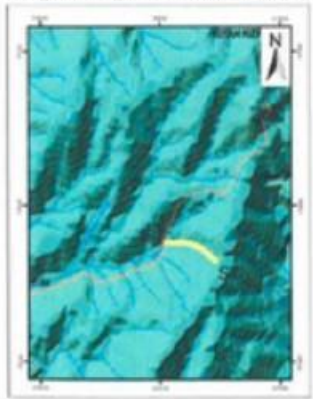
Tanah runtuh lampau



LEGEND

- Granite
- Natural slope
- Cut slope
- Slope Failure
- Boulders

Triangular Irregular Network (TIN) Map



Imagery Map

Geology Map

Legend

- Granite
- Road
- River
- Contour

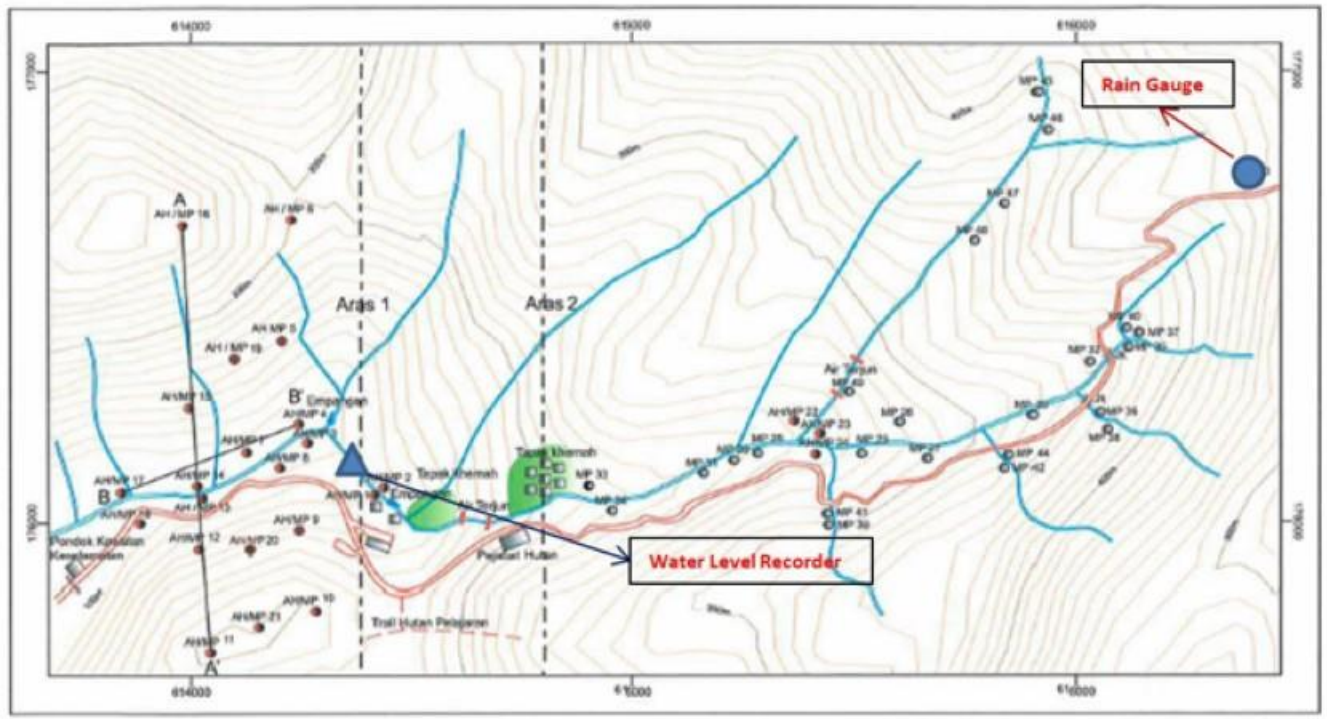
Cross Section By :

Mohd. Khairani B. Hj. Othman

Checked By :

Mohammed Syahrizal B. Zakaria

(2) PENILAIAN HIDRAUL DAN HIDROLOGI



Petunjuk:

- Bangunan
- Sungai
- Jalan Berturap
- Tapak Perkhemahan
- Lubang Proba Mackintosh
- Lubang Gerimit Tangan / Proba Mackintosh
- Kontur
- Trail Hutan Pelajaran
- Air Terjun
- Jambatan Konkrit
- Empangan

U

Skala
1 : 10000

Jabatan Mineral dan Geosains Malaysia
Negeri Johor

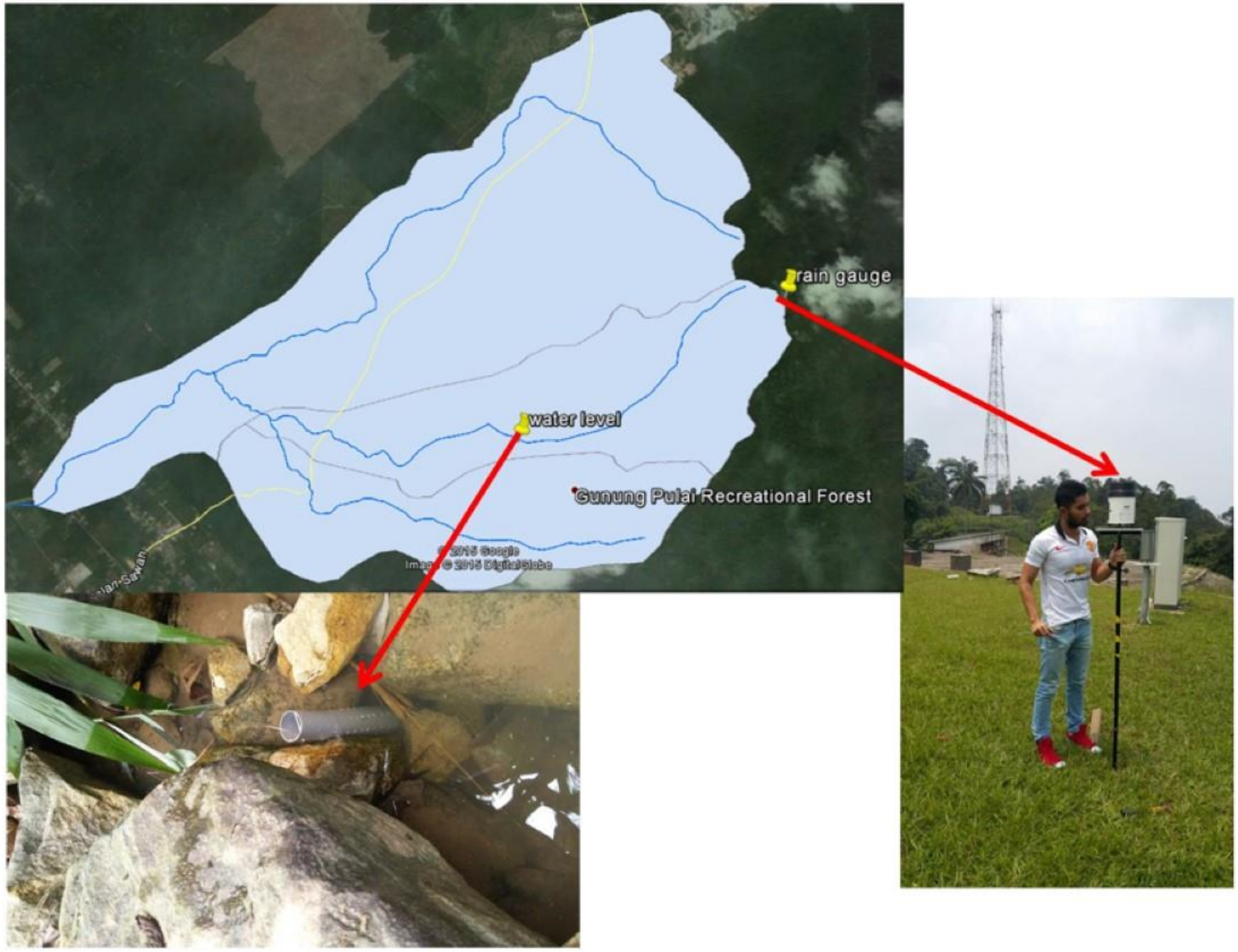
RAJAH : PETA TOPOGRAFI KAJIAN GEOBENCANA HUTAN LIPUR GUNUNG PULAI 1, KULAIJAYA, JOHOR.

Disemak oleh : En. Mohammed Syahrizal Zakaria

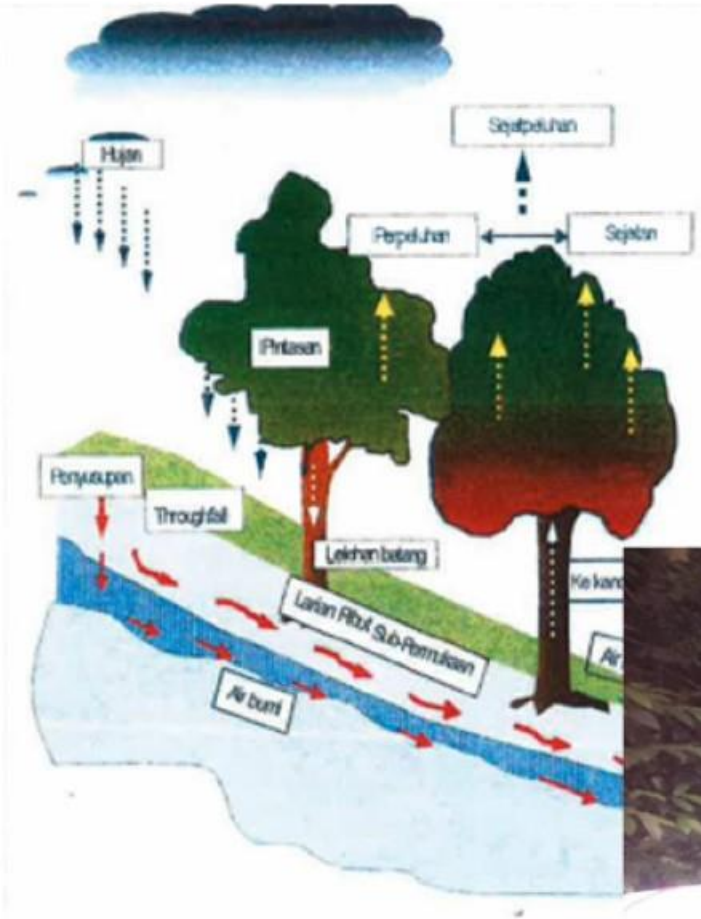
Di Ukur / Diproses Oleh : Md. Aris Md. Esa

Dilukis oleh : Siti Normaliyana Binti Jumadi

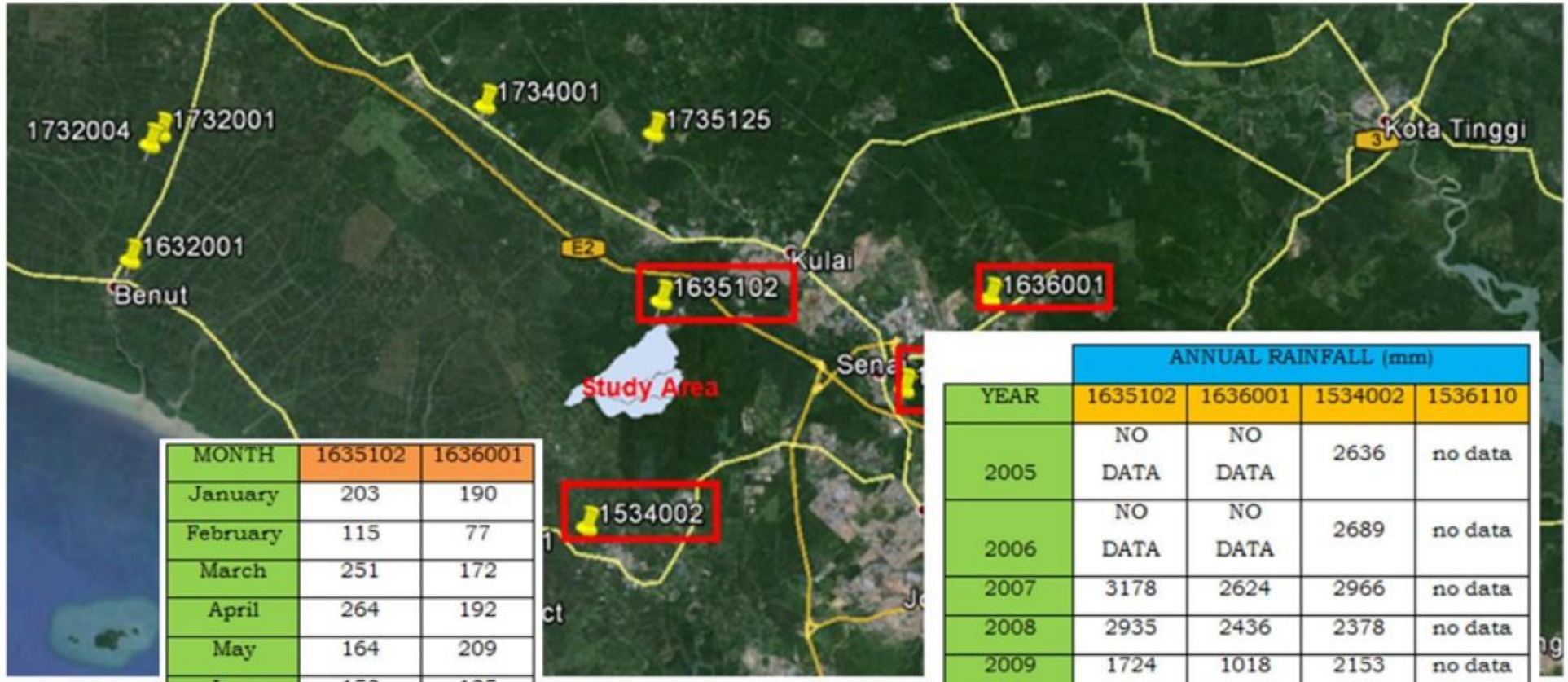
No. Lukisan : JHR-77-10 cdr


rain gauge
water level
Gunung Pulai Recreational Forest

KITARAN HIDROLOGI HUTAN

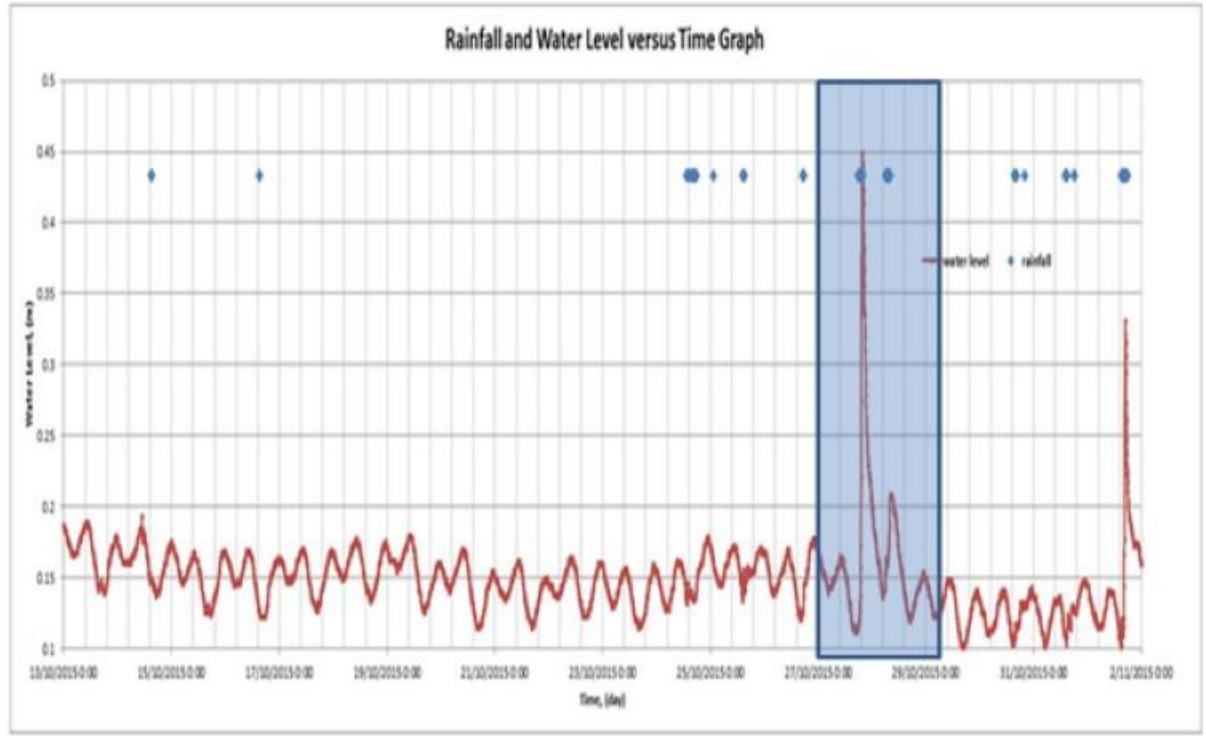


HASIL DAN ANALISA DATA TAPAK

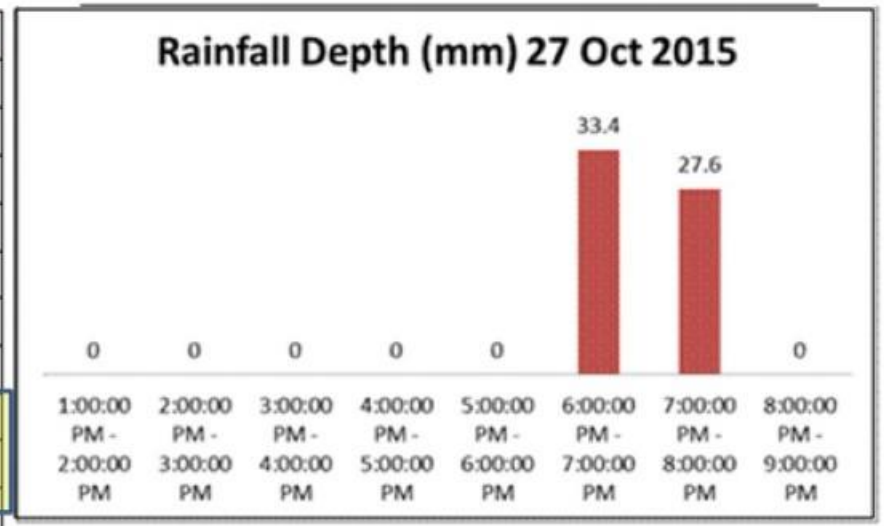


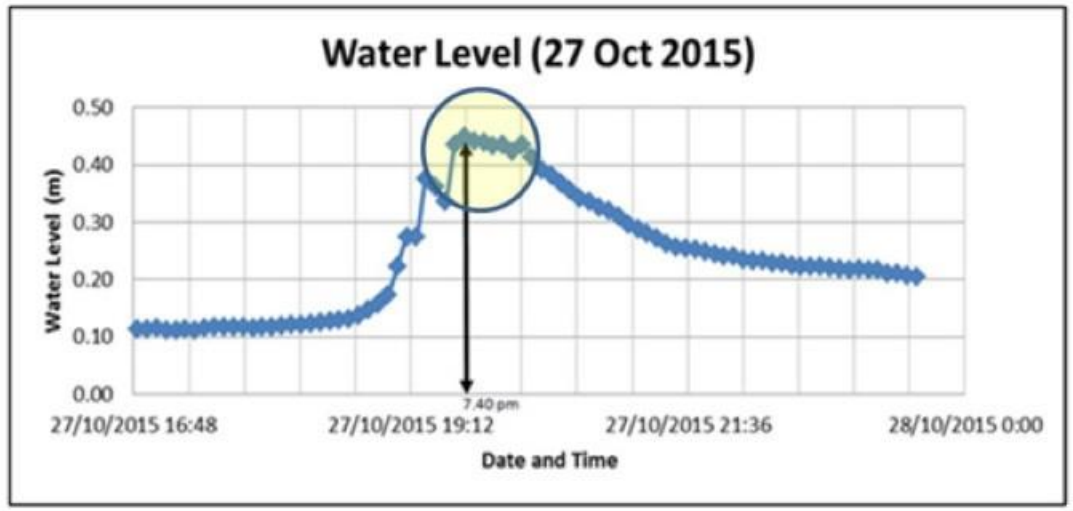
MONTH	1635102	1636001
January	203	190
February	115	77
March	251	172
April	264	192
May	164	209
June	152	125
July	156	184
August	218	225
September	229	184
October	224	217
November	290	257
December	281	209

	ANNUAL RAINFALL (mm)			
YEAR	1635102	1636001	1534002	1536110
2005	NO DATA	NO DATA	2636	no data
2006	NO DATA	NO DATA	2689	no data
2007	3178	2624	2966	no data
2008	2935	2436	2378	no data
2009	1724	1018	2153	no data
2010	2521	1847	2336	2697
2011	3113	2115	2618	2193
2012	2445	2652	2619	2332
2013	2355	2678	2725	2857
2014	2375	2633	2635	2647
2015	2272	2169	1397	1933
AVERAGE	2546	2241	2468	2443

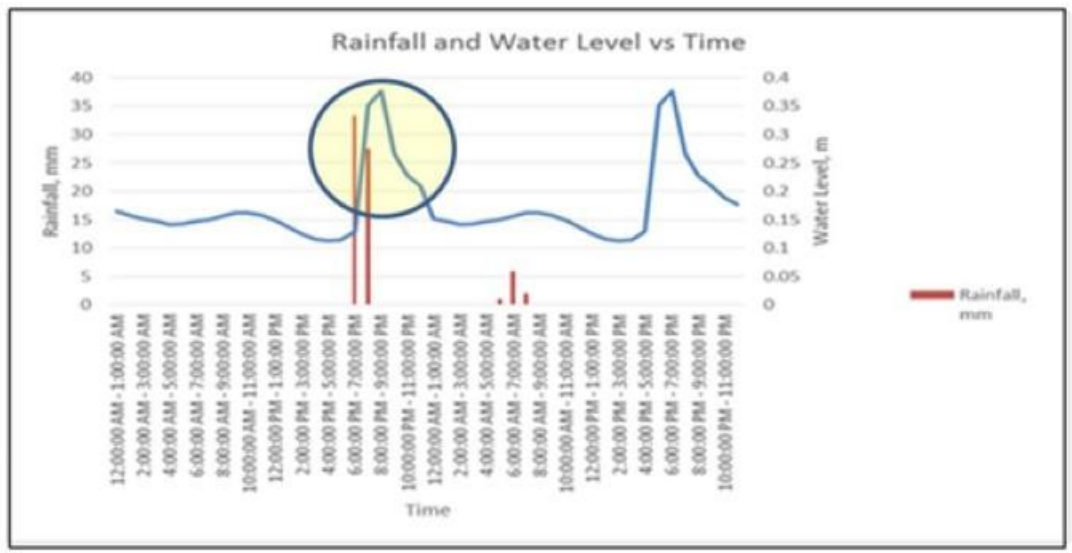


TIME	TICKING	RAINFALL,mm
11:00:00 AM - 12:00:00 PM	0	0
12:00:00 PM - 1:00:00 PM	0	0
1:00:00 PM - 2:00:00 PM	0	0
2:00:00 PM - 3:00:00 PM	0	0
3:00:00 PM - 4:00:00 PM	0	0
4:00:00 PM - 5:00:00 PM	0	0
5:00:00 PM - 6:00:00 PM	0	0
6:00:00 PM - 7:00:00 PM	167	33.4
7:00:00 PM - 8:00:00 PM	138	27.6
8:00:00 PM - 9:00:00 PM	0	0



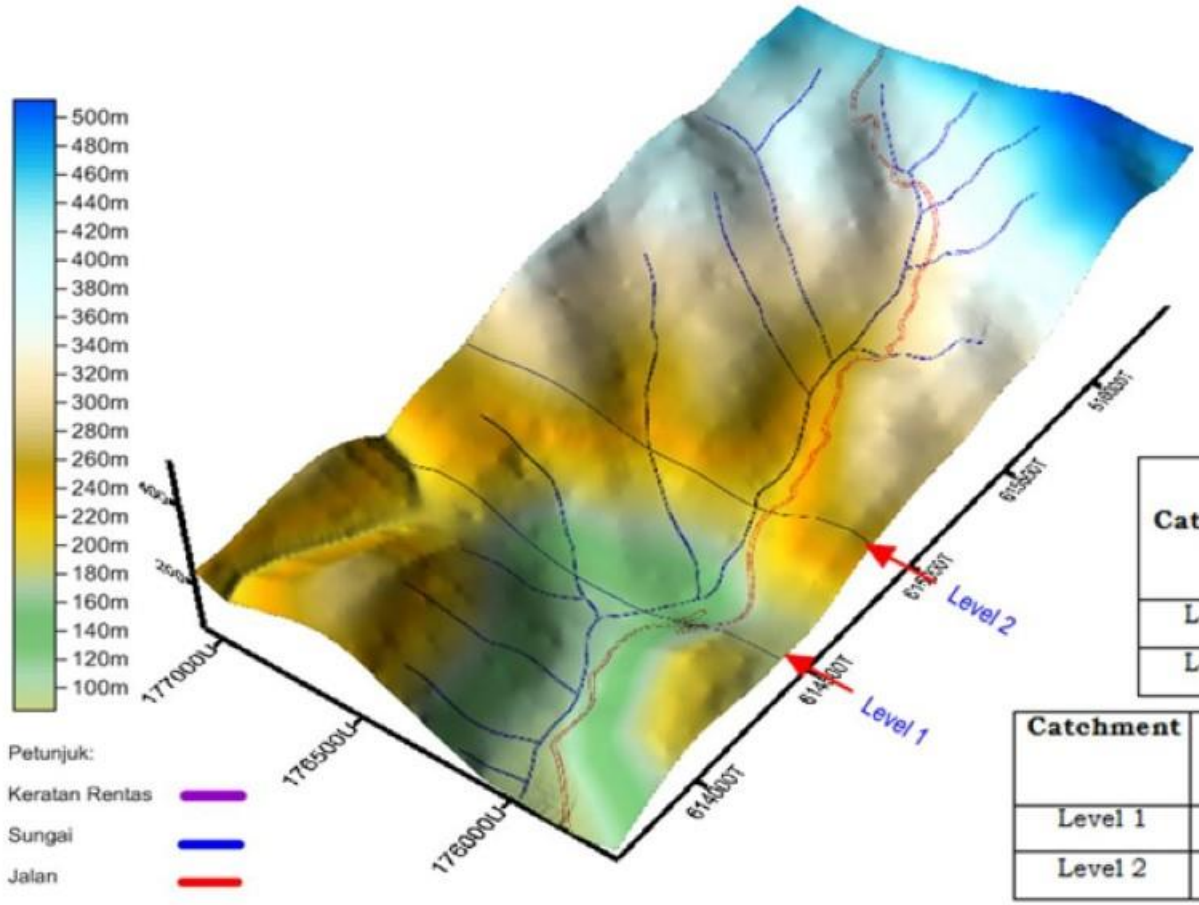


Dalam hujan: 61mm
Tempoh: 2 jam
ARI: 2 tahun (70.12)



Jarak: 2.5km
Masa tahan: 40 minit
Paras air: 0.5m
Halaju aliran: 1.1m/s

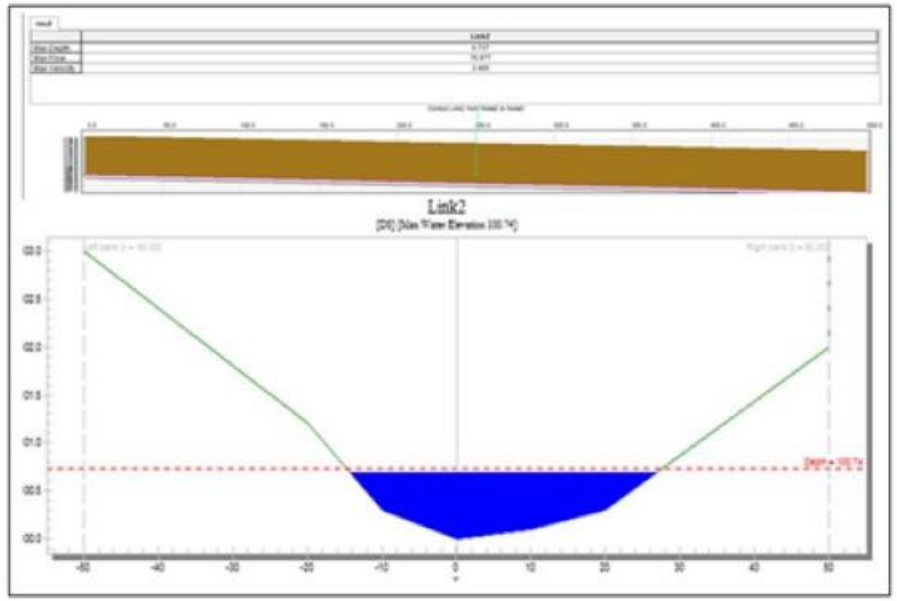
PERMODELAN HIDRAUL DAN HIDROLOGI

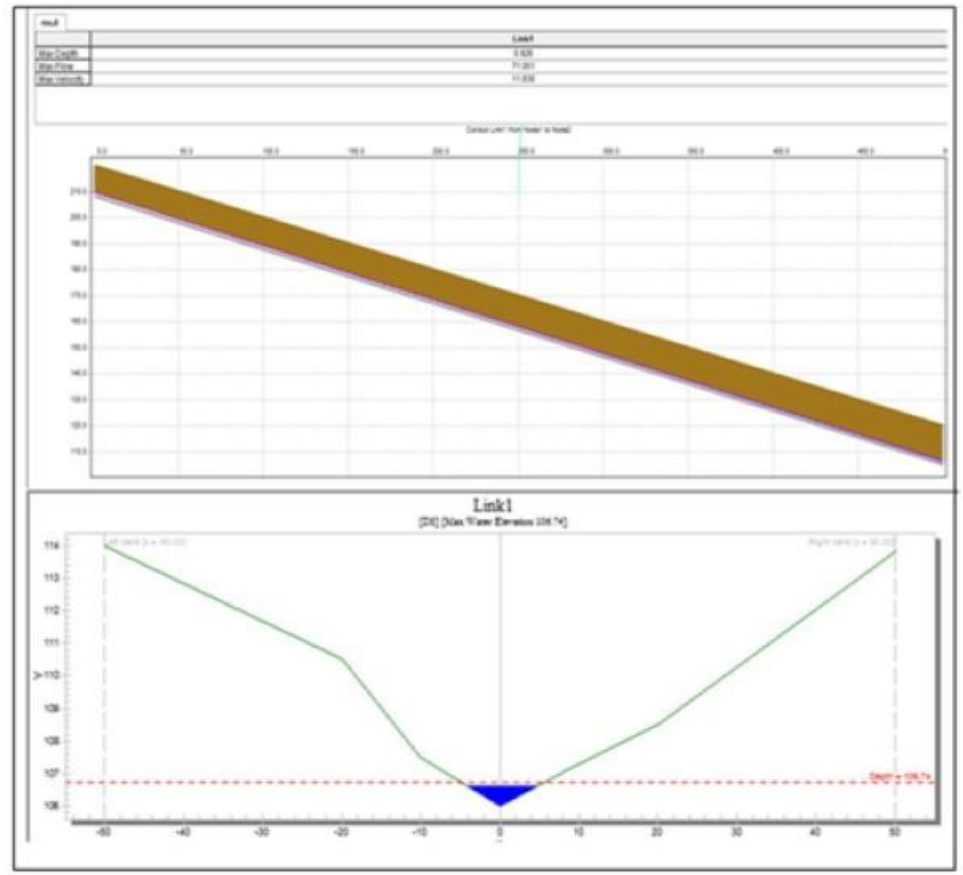


Catchment	Area (km^2)	L (km)	S (m/km)	t_c (min)	t_c (hr)
Level 1	7.5	2.5	130	45	0.8
Level 2	7.0	2	140	36	0.6

Catchment	Area (Ha)	4 Year (m^3/s)	50 Year (m^3/s)	100 Year (m^3/s)
Level 1	750	41	74	87
Level 2	700	37	62	81

Catchment	C. A. (ha)	L.C. (km)	U/S Chan. Elevation (m)	D/S Chan. Elevation (m)	Channel Slope (%)	Channel Slope (m/km)
Level 2	700	2.0	412	201	14	140
Level 1	750	2.5	412	103	13	130





CX-8 (Aras 1)
Halaju aliran = 11.8m/s

CX-13 (Aras 2)
Halaju aliran = 3.4m/s

PEMULIHARAN HUTAN LIPUR GUNUNG PULAI

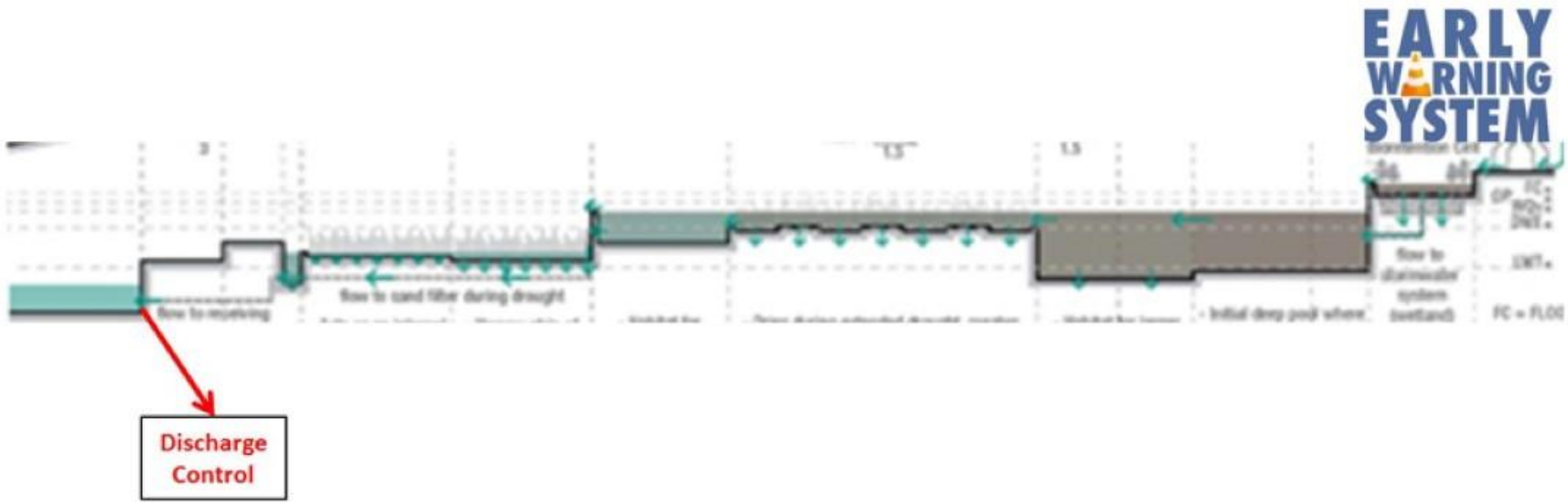
Jadual 7.1: Anggaran kos kerja-kerja terlibat yang dicadangkan untuk pemuliharan Hutan Lipur Gunung Pulai

BIL.	KERJA-KERJA TERLIBAT YANG DICADANGKAN	ANGGARAN KOS (RM)
1.	Kerja-kerja analisis dan rekabentuk ke atas sistem saliran termasuk membina sistem mitigasi di kawasan Hutan Lipur Gunung Pulai	400,000
2.	Pemetaan dalam mengenalpasti bahan bumi dan kawasan cerun berisiko tinggi termasuk pengumpulan data-data tanah dan batuan serta gunatanah di kawasan Hutan Lipur Gunung Pulai	400,000
3.	Perancangan dan memasang sistem amaran awal yang sesuai di kawasan Hutan Lipur Gunung Pulai	200,000
4.	Membaikpulih dan membina cerun-cerun stabil termasuk pembinaan dan pemasangan kaedah yang sesuai terutamanya dari keberkesanan dan kos di kawasan Hutan Lipur Gunung Pulai	5,000,000
5.	Memulihara persekitaran dan landskap di kawasan Hutan Lipur Gunung Pulai	2,000,000
6.	Membina semula infrastruktur termasuk kemudahan awam di kawasan Hutan Lipur Gunung Pulai	1,000,000
7.	Menaikkan taraf jambatan konkrit di jalan masuk Hutan Lipur Gunung Pulai	1,000,000
		10,000,000

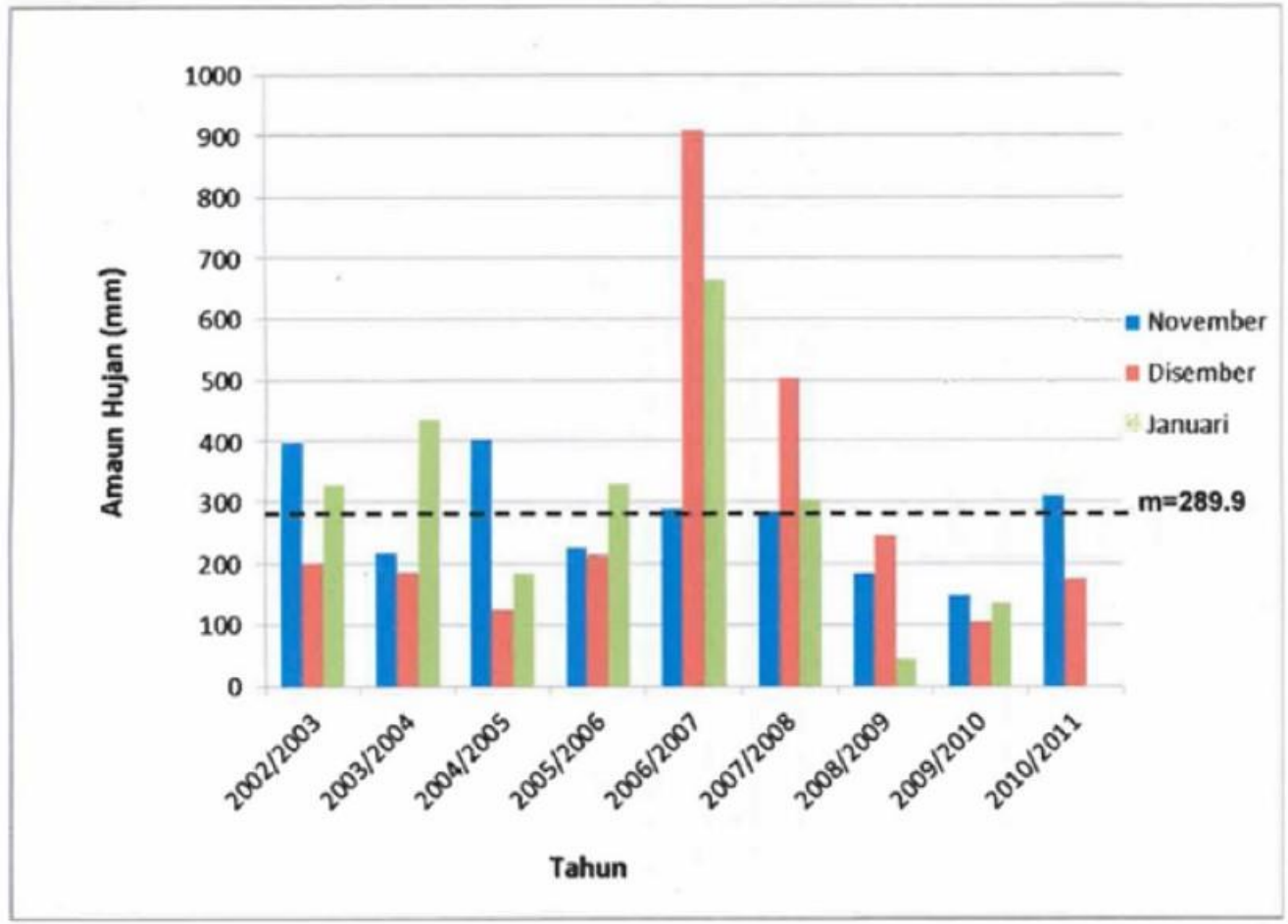
KAEDAH MITIGASI

(1) KAEDAH STRUKTUR TAKUNGAN

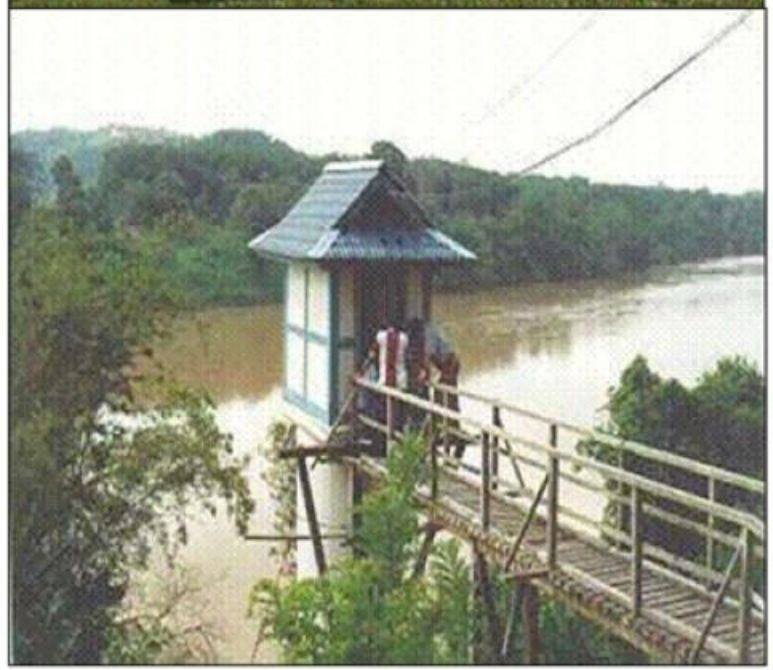
(2) KAEDAH TANPA STRUKTUR TAKUNGAN

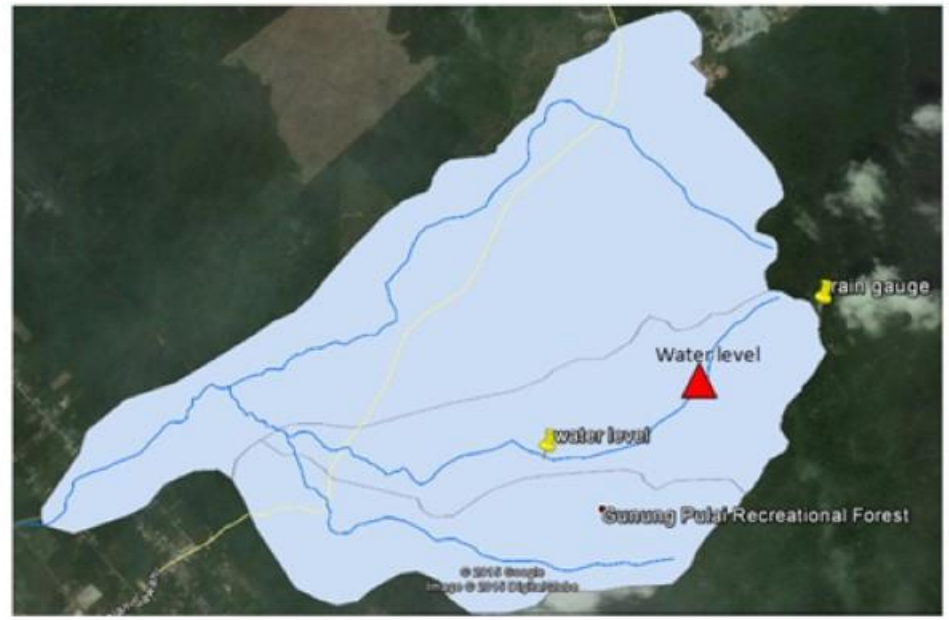


(3) KAEDAH HAD MASA LAWATAN



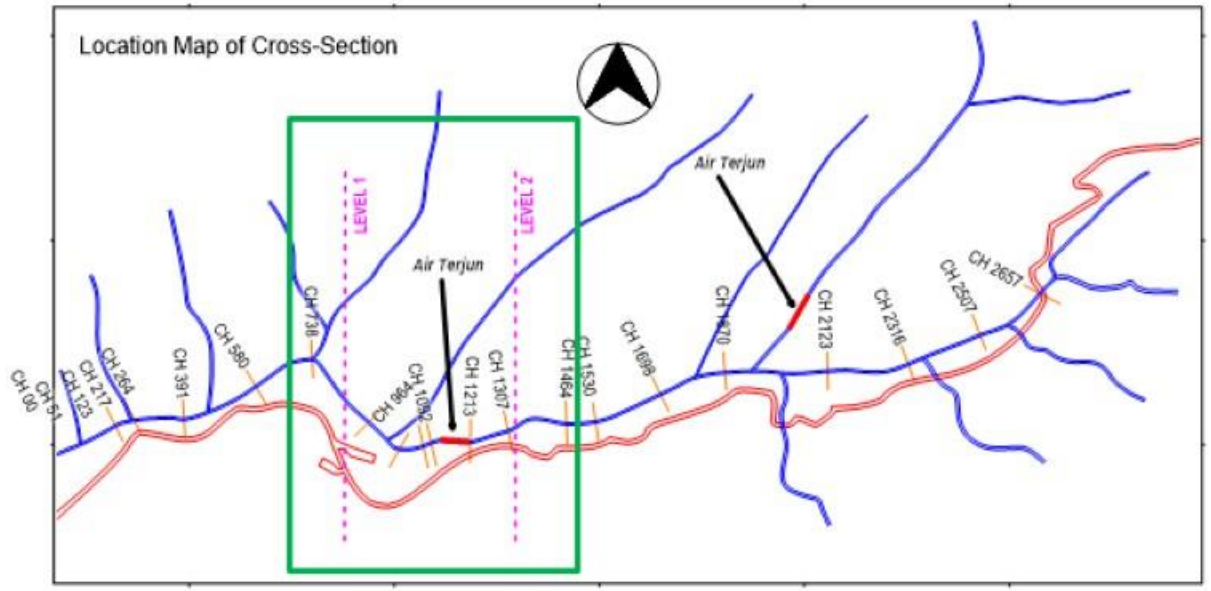
MANUAL/TELEMETRI SISTEM AMARAN AWAL

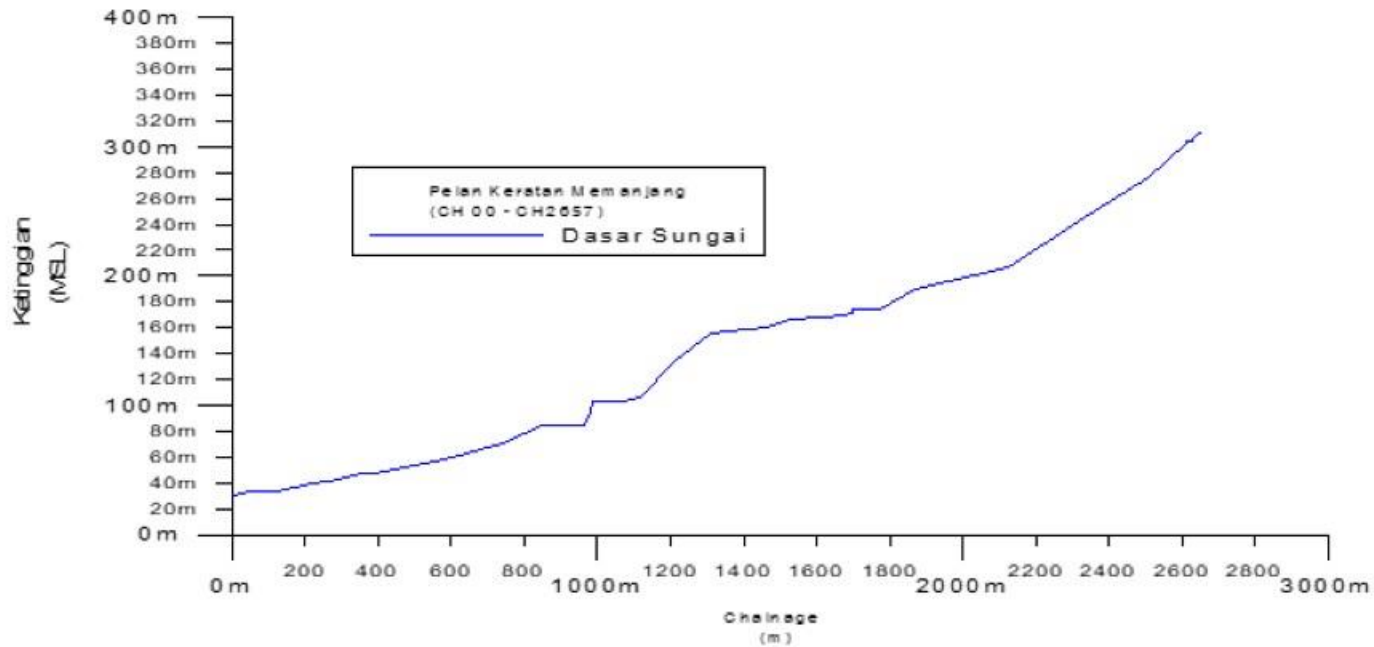


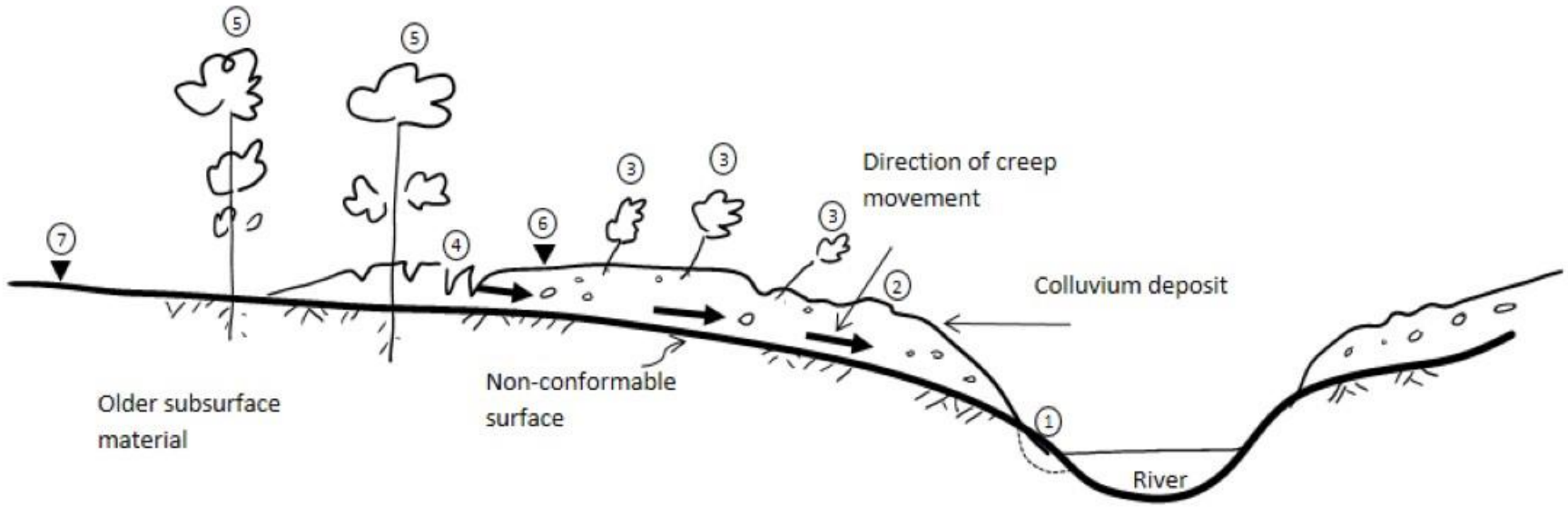


PROSEDUR PENGENDALIAN STANDARD (SOP)

SOP perlu dirangka untuk amalan oleh Pentadbir HLGP1 (JPNJ)


Location Map of Cross-Section
LEVEL 1
LEVEL 2
Air Terjun
Air Terjun
CH 00
CH 51
CH 123
CH 217
CH 264
CH 391
CH 560
CH 738
CH 964
CH 1092
CH 1213
CH 1307
CH 1464
CH 1530
CH 1698
CH 1870
CH 2123
CH 2316
CH 2507
CH 2657


Pelan Keratan Memanjang
(CH 00 - CH2657)
Dasar Sungai
Ketinggian
(MSL)
400 m
380m
360m
340m
320m
300 m
280m
260m
240m
220m
200 m
180m
160m
140m
120m
100 m
80m
60m
40m
20m
0 m
0 m
200
400
600
800
1000m
1200
1400
1600
1800
2000 m
2200
2400
2600
2800
3000m
Chainage
(m)



Legend:

(1) **Scouring**: Erosion that may along the river banks particularly after heavy rainfall. Can be noted by formation of relatively new erosional surface.

(2) **Ripple or bulging surface**: This surface feature normally occurs in the lower portion of the colluvium deposit. This is created by the differential movements within the colluvium body, as its upper portion is moving faster than its lower portion.

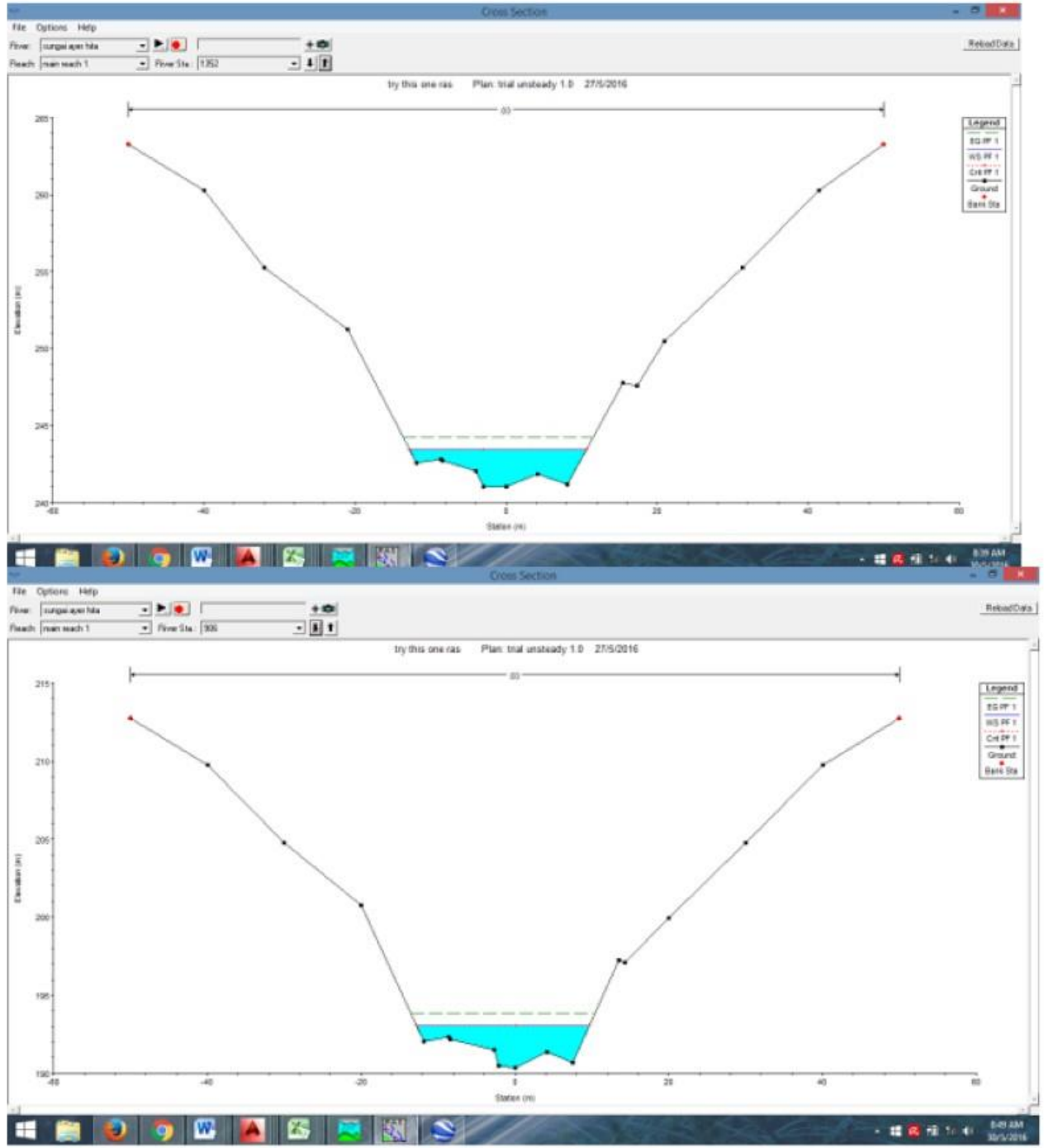
(3) **Inclining Trees**: This indication can be seen on new trees that grow after the deposition of the colluvium, and they are rooted in this deposit. It indicates slow movement (creep) of the collovium deposit in downslope direction.

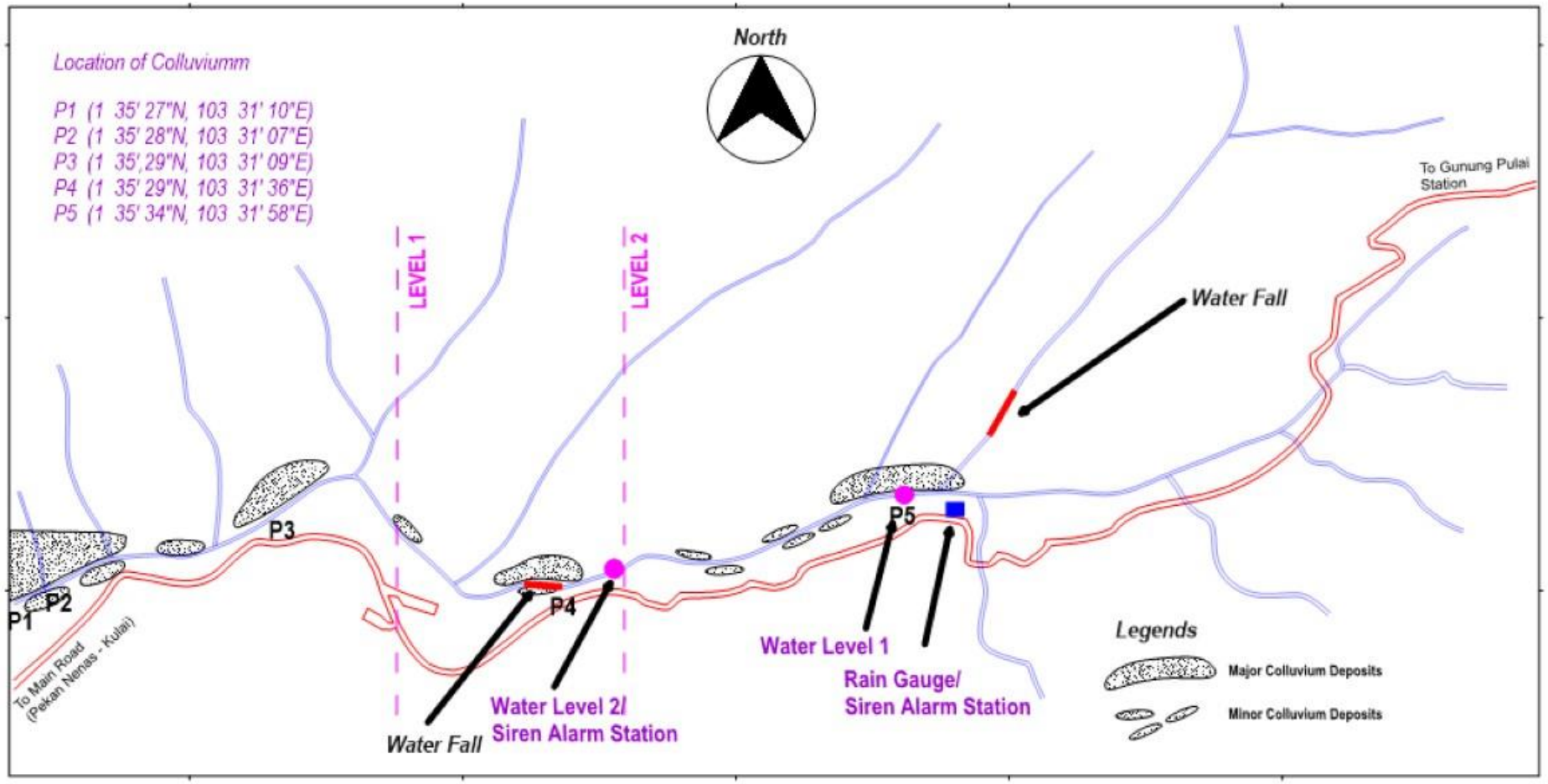
(4) **Tension Cracks**: These surface cracks are commonly found in the upper portion of the colluvium deposit, created by the differential creep movement within the deposit.

(5) **Older Trees:** These trees are not affected by the creep movement of the colluvium deposit as they grow and rooted in the older substrata material below the colluvium, or they are located in area outside the colluvium deposit.

(6) **New Ground Surface**: The ground surface created after deposition of colluvium on older ground surface. Substrata materials consist of materials being eroded and deposited during slope failure in December 2001).

(7) **Older Ground Surface.** These are the existing ground surfaces which are not covered by colluvium. This surface forms a non-conformable boundary with the newly deposited colluvium. Substrata materials may consists of older sediments deposited before the December 2001 incident.


Cross Section
File Options Help
River: sungai ayer hitam
Reach: main reach 1
River Sta.: 1352
ReloadData
try this one ras Plan: trial unsteady 1.0 27/5/2016
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Cross Section
File Options Help
River: sungai ayer hitam
Reach: main reach 1
River Sta.: 906
ReloadData
try this one ras Plan: trial unsteady 1.0 27/5/2016
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)

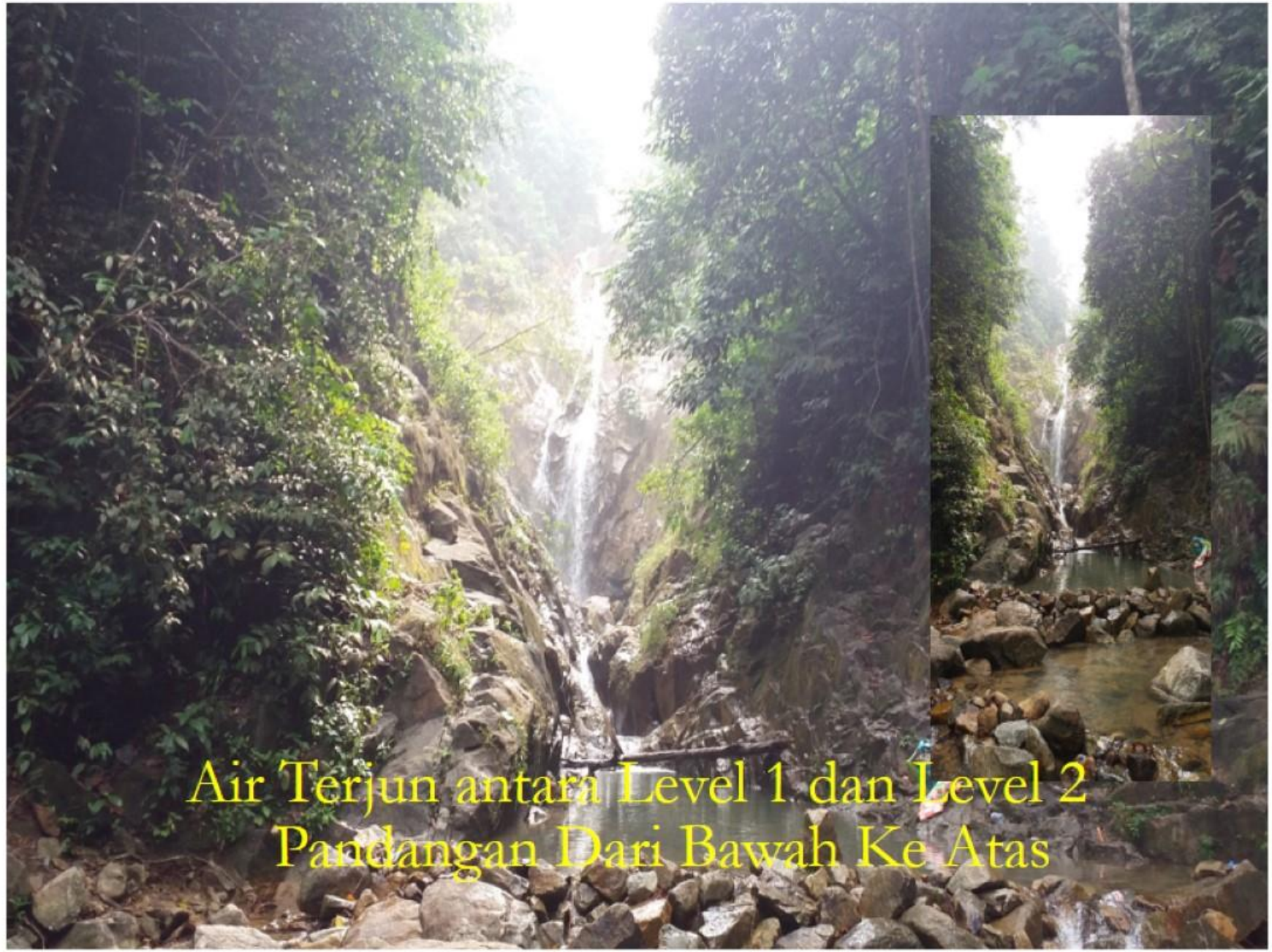

Location of Colluviumm
P1 (1 35' 27"N, 103 31' 10"E)
P2 (1 35' 28"N, 103 31' 07"E)
P3 (1 35',29"N, 103 31' 09"E)
P4 (1 35' 29"N, 103 31' 36"E)
P5 (1 35' 34"N, 103 31' 58"E)
North
LEVEL 1
LEVEL 2
To Gunung Pulai Station
Water Fall
P1
P2
P3
P4
P5
To Main Road (Pekan Nenas - Kulai)
Water Fall
Water Level 2/ Siren Alarm Station
Water Level 1
Rain Gauge/ Siren Alarm Station
Legends
Major Colluvium Deposits
Minor Colluvium Deposits


Air Terjun
antara Level 1 dan Level 2


Pandangan
Dari Atas
Ke Bawah


Pandangan
Selepas Air
Terjun

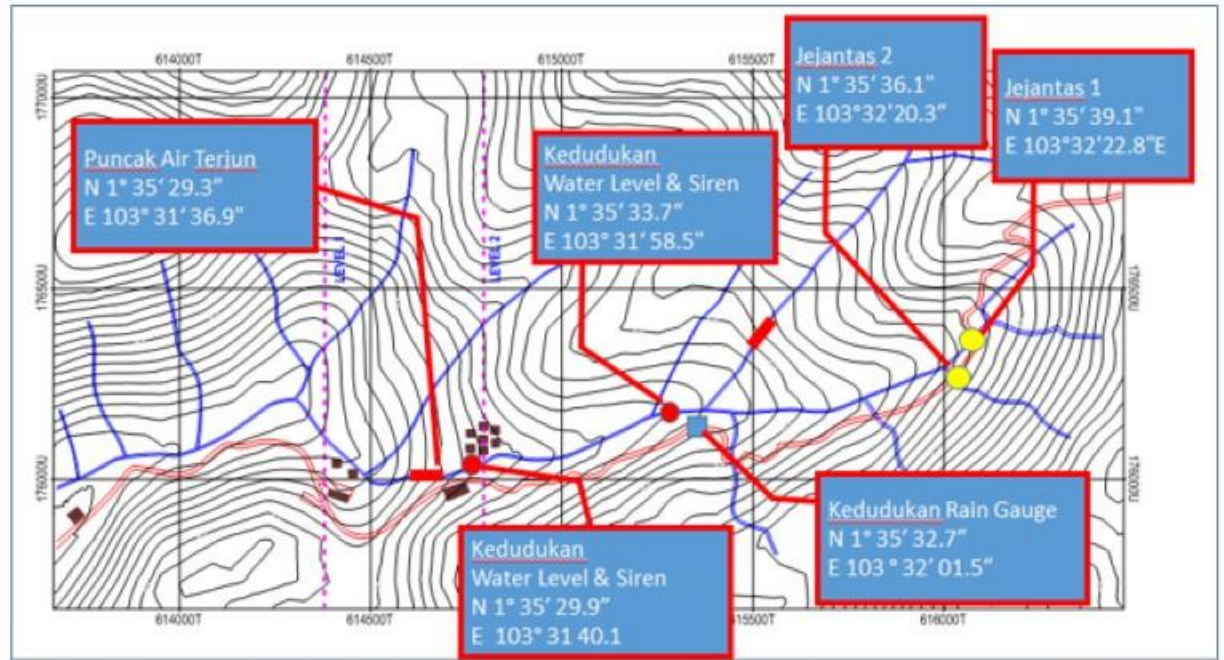

Lokasi di Level 2

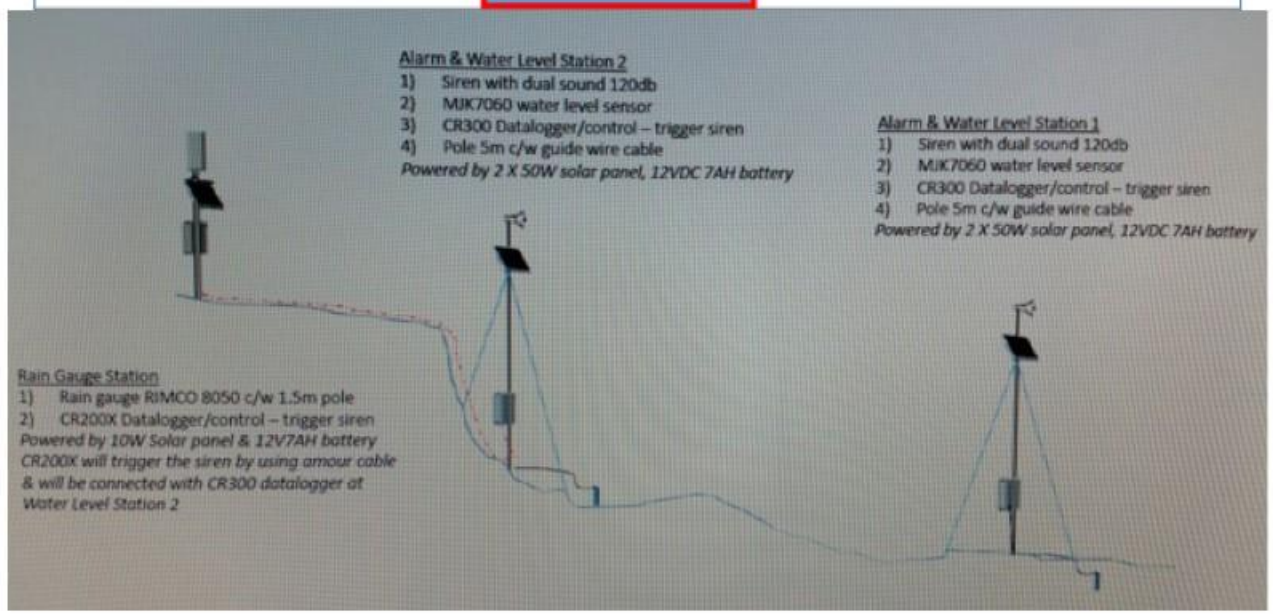


Air Terjun antara Level 1 dan Level 2
Pandangan Dari Bawah Ke Atas

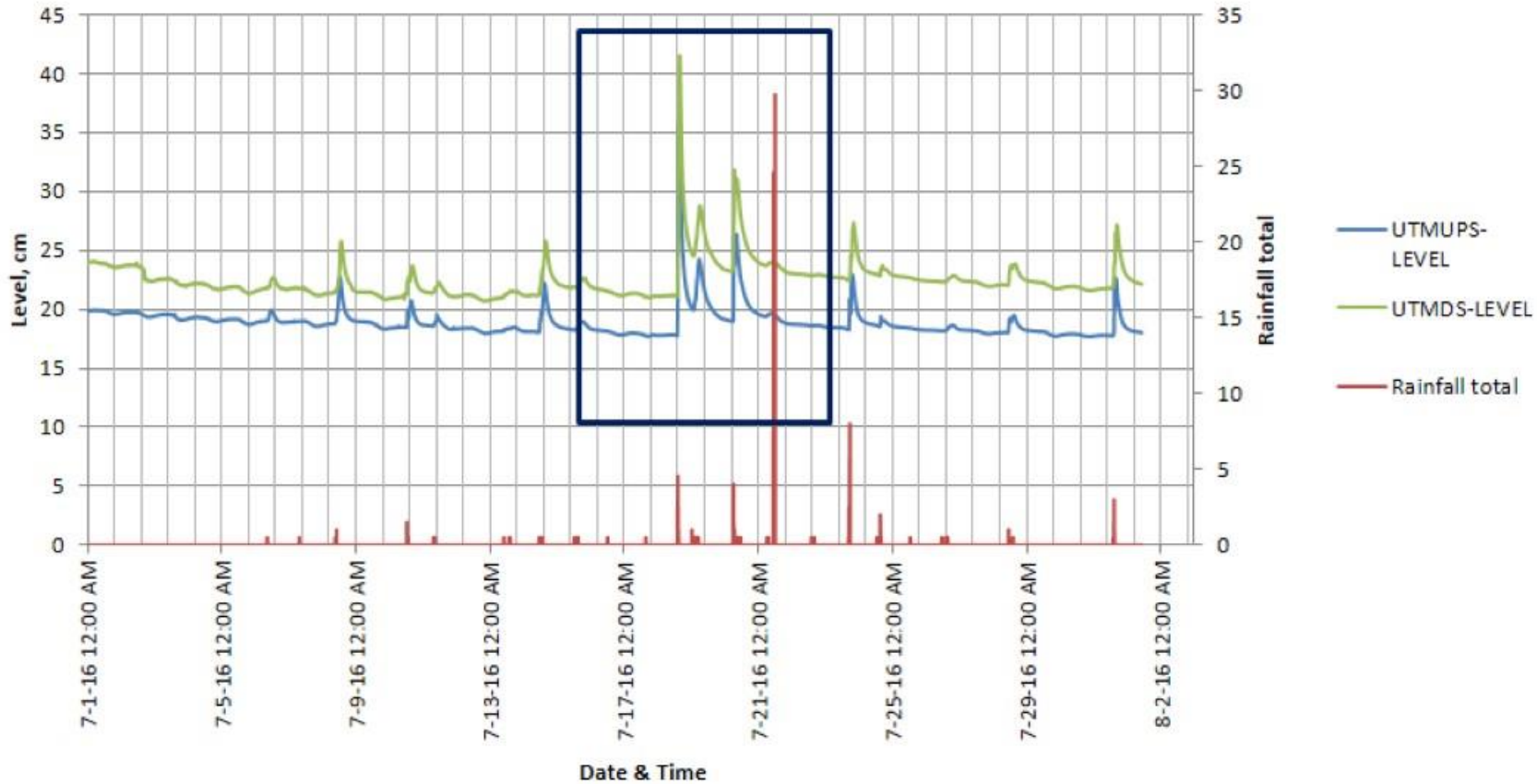

Lokasi di Level 1

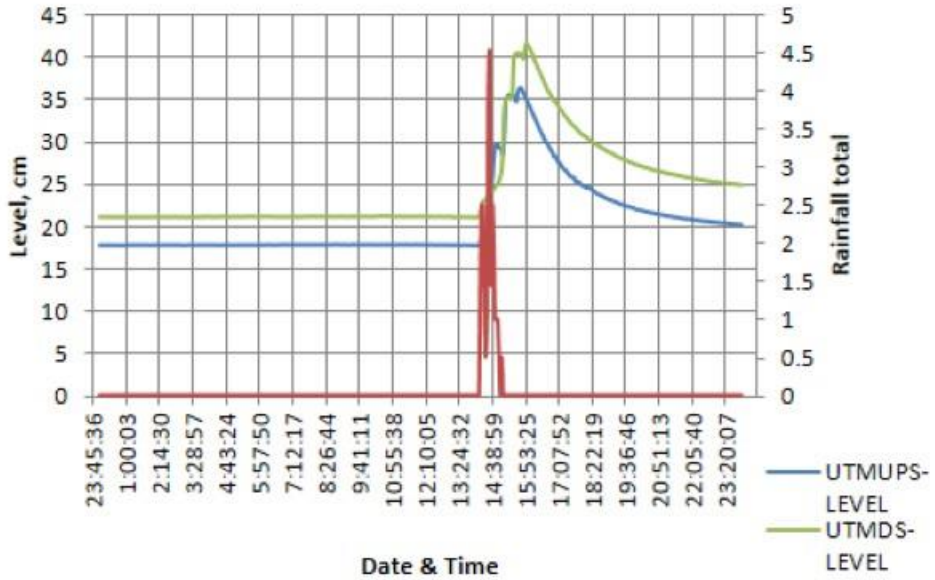
SISTEM AMARAN AWAL

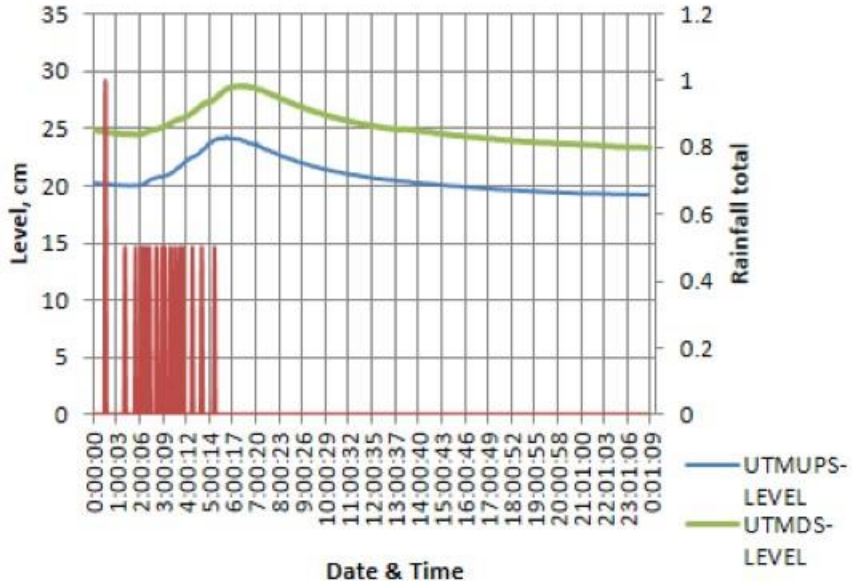


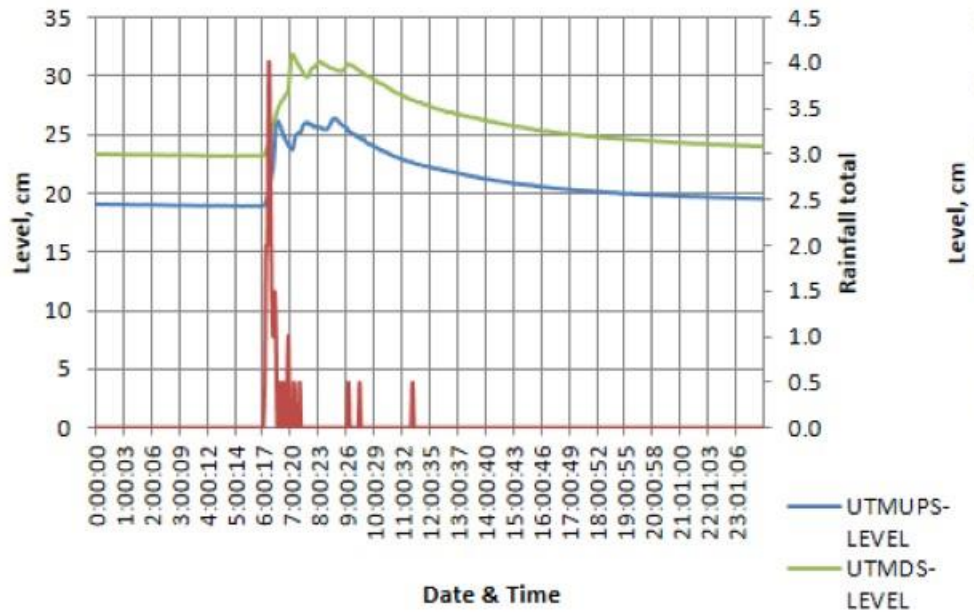


ANALISI DATA AWALAN

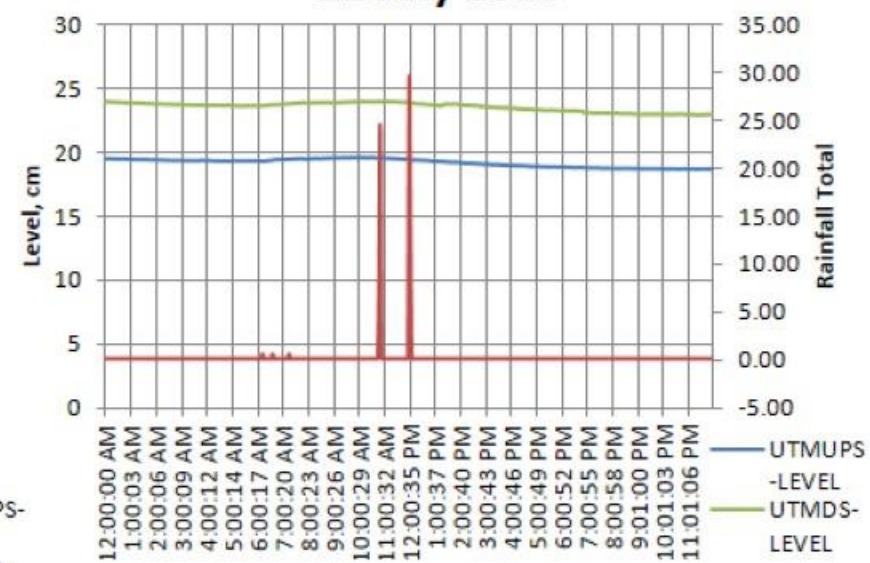



Level, cm
Rainfall total
Date & Time
UTMUPS-LEVEL
UTMDS-LEVEL


Level, cm
Rainfall total
Date & Time
UTMUPS-LEVEL
UTMDS-LEVEL


Level, cm
Rainfall total
Date & Time
UTMUPS-LEVEL
UTMDS-LEVEL

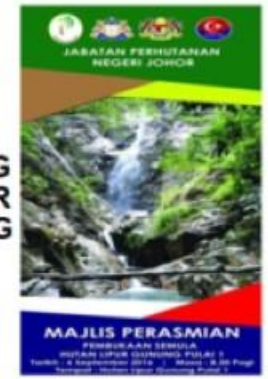
21 July 2016


Level, cm
Rainfall Total
UTMUPS-LEVEL
UTMDS-LEVEL

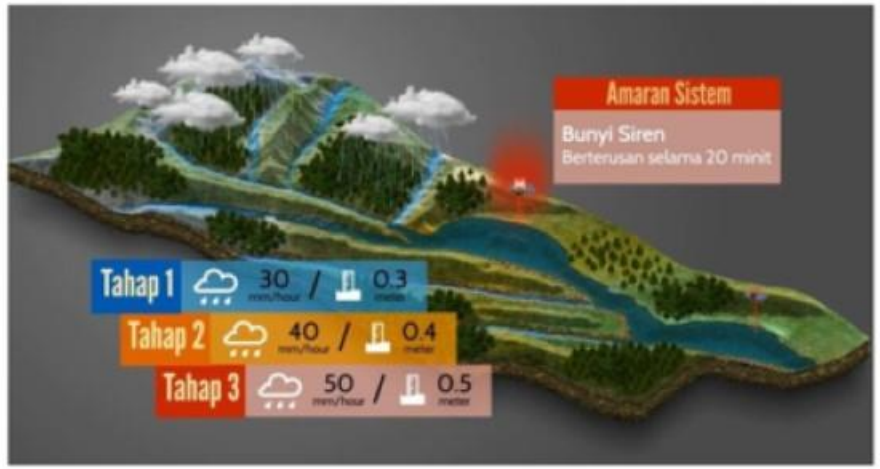
Station	Threshold Rainfall Intensity (mm/hr)	New Threshold Rainfall Intensity (mm/hr)		Threshold Depth of Water Level (m)	Siren Pattern	New Siren Pattern
Station 1 ("upstream")	20	30	OR	0.3	Run 5sec and stop 5sec for a period of 2minutes	Run 5sec and stop 5sec for a period of 5minutes
	25	40	OR	0.4	Run 20sec and stop 20sec for a period of 5minutes	Run 20sec and stop 20sec for a period of 10minutes
	30	50	OR	0.5	Run continuously for a period of 20minutes	Run continuously for a period of 20minutes
Station 2 ("dw-stream")				0.1	Run 5sec and stop 5sec for a period of 2minutes	Run 5sec and stop 5sec for a period of 5minutes
				0.2	Run 20sec and stop 20sec for a period of 5minutes	Run 20sec and stop 20sec for a period of 10minutes
				0.3	Run continuously for a period of 20minutes	Run continuously for a period of 20minutes

STANDARD OPERATING PROCEDURES MANUAL:

INSTALLATION OF AN EARLY WARNING SYSTEM AT SUNGAI AYER HITAM BESAR CATCHMENT AREA HUTAN LIPUR GUNUNG PULAI 1 (HLGP1), KULAI, JOHOR BAHRU



October 2016



LIMITATIONS ON USE OF THIS SOPM AND DISCLAIMER

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Encik Mohd For Mohd Amin
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Dr. Rini Asnida Abdullah
Encik Komarul Azlan Mohd Nasir
Encik Muhammad Azril Bin Hezmi
Encik Zulkifly Bin Abdul Wahid

ACKNOWLEDGEMENTS

I am very grateful to every person who has contributed, directly or indirectly, to the realization of this Standard Operating Procedures Manual (SOPM). I would like to extend my sincere thanks to all member of the UTM consultant team, as well as all other contributors.

Associate Professor Ir. Dr. Azman Kassim (Project Leader)

October 2016

TABLE OF CONTENTS

INTRODUCTION

CONCEPTUAL DESIGN FOR EARLY WARNING SYSTEM HUTAN LIPUR GUNUNG PULAI 1 (HLGP1) RECREATIONAL AREA

The Hutan Lipur Gunung Pulai 1 (HLGP1) recreational area is found to be prone to slope failures and landslides. On 27th December 2001, a massive landslide hit the area and it has caused not only losses of lives but also damages to properties and infrastructures. Consequently, a Special Technical Committee was formed in March 2002 by the State Government of Johor with the purpose of investigating and studying the main triggering factors that contributed to the 'extraordinary' landslide.

All findings derived from the evaluation study were presented and documented in a technical report submitted in 2002 (*Kajian Penilaian Geologi, Geoteknik & Hidrologi Kejadian Tanah Runtuh di Persekitaran Sungai Ayer Hitam Besar, Gunung Pulai, Pontian Johor*, 2002). In short, the Technical Committee has strongly recommended that the HLGP1 is to be closed to the public until the conservation and mitigation works are carried out.

As such, in February 2009, the Jabatan Perhutanan Negeri Johor (JPNJ) – HLGP1's administrators had decided that reassessment study is needed prior to the re-opening of the HLGP1 to the general public. The purpose of this study is to identify and evaluate solutions so that appropriate counter measurement actions could be drawn. The findings of this study were presented and documented in a Final Report submitted in 2015 (Geological, Geotechnical and Hidrological Reassessment Study on Landslide Occurrence at *Sungai Air Hitam Besar Catchment Area, Hutan Lipur Gunung Pulai 1, Kulai, Johor Darul Takzim*, 2015).

In short, the report has strongly recommended that an Early Warning System (EWS), which serves as mitigation measures to overcome any potential danger be installed in the HLGP1 recreational area. The hydrological and hydraulic simulations have shown that the existing capacity of the Sungai Air Hitam Besar and its flood plain is capable of carrying the 100 year surface run-off flood. However, the fast flowing run-off within the catchment area due to the naturally steep slope would yield very high stream velocity and could pose grave danger to the public and visitors.

Furthermore, the Geological and Geotechnical assessment has ascertained that the slopes in the HLGP1 area are prone and susceptible to natural or readily induced failures since 85% of Sungai Air Hitam Besar Catchment Area is classified in Class IV – Extreme Geotechnical Limitation (*in situ* terrain > 35° slope gradient).

Sungai Air Hitam Besar Catchment Area is a substantially vast area (> than 15km^2), thus, to carry out a major geological and geotechnical remediation or construction works within the catchment area would be very costly. Furthermore, extensive new developments due to the remediation or construction works could change the land use within the catchment area from the existing agricultural cover to less pervious cover. This in turn would definitely change the hydrology of the catchment – the change in land cover from pervious to impervious will result in the increase of surface run-off resulting in the increase of the water flow volume and its velocity, sedimentation rate and slope
failure/landslide recurrence within the study area.

Therefore, the conceptual design for an Early Warning System (EWS) is devised to obtain the lead-time for flood warning purposes. The non-structural approach, e.g. the EWS would provide adequate lead-time to the authorities to warn the public and visitors of the impending danger. The proposed EWS consists of a rainfall gauge and water level recorders that are connected to a warning siren at two locations, namely, STATION 1 and STATION 2. The "downstream" STATION 2 – second water level serves as a backup to the "upstream" STATION 1. The trigger function for the siren at STATION1 is set based on the rainfall amount and water level depth, whereas, the trigger at STATION2 is set solely on the water level depth. It should be noted that, the water depths serve as the main trigger function.

The EWS instrumentation was completely installed on 14 July 2016, and the system has been successfully calibrated based on a two-month field data collected. The HLGP1 is now officially re-opened on 6 September 2016.

PART 1:

INVENTORY AND SPECIFICATIONS

GENERAL

Hutan Lipur Gunung Pulai 1 (HLGP1) is located in the Sungai Air Hitam Besar Catchment Area. The catchment area is in natural form and is already protected with flood mitigation and drainage infrastructure made up of river flood plain and water falls.

The limits of the catchment area are between latitude 1° 35′ 21.85″ N to 1° 36′ 06.01″ N and longitude 103° 30′ 40.17″ E to 103° 32′ 45.5″ E, respectively (see Figure 1).

The range of altitude of the area is between 20m and 350m above the mean-sea-level (MSL).

The highest level is the peak of Gunung Pulai, which stands at 654m above MSL. There are two access roads to the study area; either via Pekan Nenas or Bandar Kulai, and it is located about 3km from the junction at Kg. Sri Gunung Pulai on the trunk road connecting Pekan Nenas and Bandar Kulai.

Figure 1 Location of the HLGP1 [Source: Part of topography map sheet number 4451 (SKUDAI)]

LOCATION OF THE EARLY WARNING SYSTEM

The early warning system (see Figure 2) consists of rainfall gauge and water level recorders that are connected to control boxes which record data and control the warning light and siren at two locations:

(1) STATION 1 – UTMUPS (Upperstream)
Rainfall gauge, siren and warning light

(2) STATION 1 - UTMUPS (Upperstream)
First water level recorder serves as a backup to the "upstream" warning system

(3) STATION 2 – UTMDS (Downstream)
Second water level recorder, siren and warning light.

Figure 2 shows the schematic of early warning system instrumentation and Figure 3 shows the location of the instrumentation.

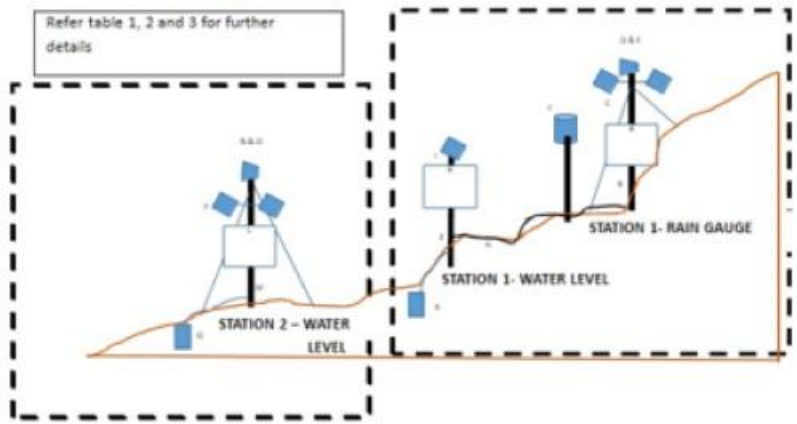


Figure 2 Schematic of Early Warning System Instrumentation

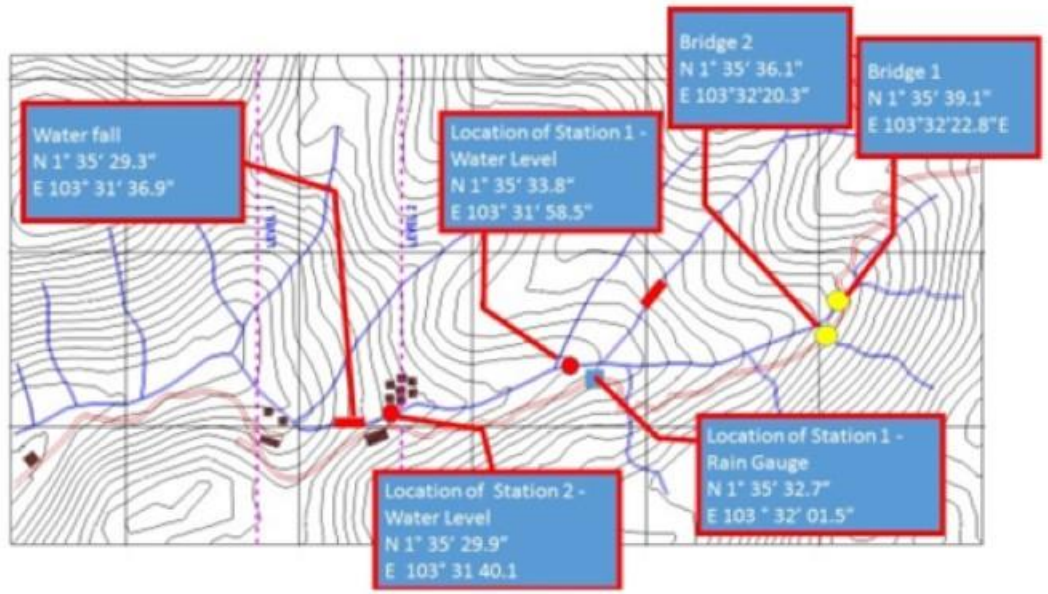


Figure 3 Location of Early Warning System Instrumentation

DETAILS OF GUNUNG PULAI EARLY WARNING SYSTEM INSTRUMENTATION

Table 1, 2 and 3 show the details of Gunung Pulai Early Warning System instrumentation. (Note: Also refer to Figure 2).

Table 4 summarizes the specifications for the proposed early warning system.

Table 1 Inventory of STATION 1 – UTMUPS (Upperstream)

STATION 1 – Rain Gauge, Siren & Warning Light		
No	Item	Quantity
A	Control Box - Control Data Logger CR 300 - Relay Panel - 12 V, 7 ah Battery - MD – 485 Multidrop Interface (RS-483c5) - MCB board - Solar Charger Control	1 1 1 2 1 1 1
B	5 m Pole Mask with Steel Guy Wire	1
C	50 W- 12V Solar Panel with mounting bracket	2
D	Alarm Siren System – (DSC-SD-30W)	1
E	Warning Light	1
F	Rain Gauge System (RIM 8050) Funnel : 200 mm Diameter, Tipping Bucket 1.5 m Pole Mask with Round Plate	1 1
G	300 m 1.5 mm Armour Cable Signal 2 Core	1

Table 2 Inventory of STATION 1 – UTMUPS (Upperstream)

STATION 1 – Water Level Recorder		
No	Item	Quantity
H	Control Box - Control Data Logger CR 300 - 12 V, 7 ah Battery - Solar Charger Control - MD – 485 Multidrop Interface (RS-485) - MCB board	1 1 1 1 1 1
I	20 W- 12V Solar Panel with Mounting Bracket	1
J	1.5 m Pole Mask	1
K	Hydrostatic Transmitter (7060-1413) Range 0-3 m with 12 m cable	1

Table 3 Inventory of Station 2 – UTMD5 (Downstream)

STATION 2 – Water Level Recorder & Warning Light		
No	Item	Quantity
L	Control Box - Control Data Logger CR 300 - MCB Board - Relay Panel - 12 V, 7 ah Battery - Solar Charger Control	1 1 1 1 2 1
M	5 m Pole Mask with Steel Guy Wire	1
N	30 W Alarm Siren System (DSC SD-30W)	2
O	Warning Light	2
P	50 W Solar Panel with Mounting Bracket	2
Q	Hydrostatic Transmitter (7060-1413) Range 0-3 m with 12 m Cable	1

ACTION PLAN

The Jabatan Perhutanan Negeri Johor should provide personnel to monitor the situation at the HLGP1 recreational area by monitoring the amount of rainfall depth and monitoring the water level that could trigger the siren. The siren at STATION 1 and STATION 2 will set off when the criteria are met as shown in Table 4.

The action plan should be executed as below:

GREEN: **FIRST WARNING**

1. At this stage, rangers should be on alert. The tide pole installed near the water level gauges must be checked to isolate instances of false alarms.
2. Rangers must also advise the general public within the area to be alert of any changes in conditions.

RED: **RIVER EVACUATION**

1. When the siren runs 20 seconds and stop 20 seconds for a period of 10 minutes, the EWS is now is in its second stage.
2. Due to the impending water level rise, rangers must ensure the general public is out of the water and the riverbanks and be prepared to leave the area. Rangers are to assist the public in the evacuation.
3.

ORANGE: **COMPLETE EVACUATION**

1. The final stage is triggered when the siren runs continuously for 20 minutes. This is an indication that the water level is dangerously high and not safe.
2. Rangers must ascertain that the area is totally evacuated and the public is out of harm's way.

Table 4 Specification of Early Warning System

Station	Threshold Rainfall Intensity (mm/hr)		Threshold Depth of Water Level (m)	Siren Pattern
STATION 1 (Upperstream)	30	OR	0.3	Run 5sec and stop 5sec for a period of 5minutes
	40	OR	0.4	Run 20sec and stop 20sec for a period of 10minutes
	50	OR	0.5	Run continuously for a period of 20minutes
STATION 2 (Downstream)			0.1	Run 5sec and stop 5sec for a period of 5minutes
			0.2	Run 20sec and stop 20sec for a period of 10minutes
			0.3	Run continuously for a period of 20minutes

* The siren will ONLY reset when the water depth has fallen below the 1st threshold value

PART 2:

DATALOGGER OPERATOR'S MANUAL

CR300-SERIES DATALOGGER

The CR300-Series datalogger (Figure 4) is a multipurpose, compact, low-cost measurement and control datalogger. It can measure most hydrological, meteorological, environmental and industrial sensors. They can concentrate data, making it available over varied networks, and deliver it using your preferred protocol. The CR300 series also performs automated on-site or remote decision making for control and mobile-to-mobile communications.

Figure 4 CR300-Series Datalogger

This Part 2 provides a detailed look at the CR300 series measurement and control datalogger and discusses the steps necessary to begin using it in early warning system instrumentation application.

READ AND UNDERSTAND the guides, which discuss the basic steps of setting up a basic CR300 procedure.

Following these steps, you will:

[1] Set up datalogger support software to communicate to a CR300 over a simple USB connection.

[2] Monitor live data.

[3] Create a program for the CR300 and send a program to CR300.

[4] Collect and view recorded data.

[1] SET UP DATALOGGER SUPPORT SOFTWARE TO COMMUNICATE TO A CR300 OVER A SIMPLE USB CONNECTION

(1) After the driver has been installed, connect the CR300 **USB** port to the PC with the included USB cable (pn 27555) – see Figure 4. The connection supplies 5V power over USB as well as a communication link.

(2) The Power LED (see Figure 4) indicates the program and power state of the CR300. Because the CR300 ships with a program set to run on power-up, the Power LED will quickly flash 3 times every 10 seconds when powered over USB.

(3) With the CR300 connected to the PC, a port titled **CR300** will appear in the **COM Port** list. Select the **CR300** COM Port. The number of your COM port may differ.

[2] MONITOR LIVE DATA

(1) Open Program *LoggerNet* from Program File. From the *LoggerNet* toolbar, click **Main | Connect** (see Figure 5).

(2) The **Table Monitor** is now displayed (Figure 6). Select a data table in the **Table Monitor** list.

(3) In the **Stations** list, select the **CR300Series** in the **Datalogger Type and Name** list.

(4) Press **Connect**.

(5) By default, the CR300 datalogger includes three tables: **Public**, **Status**, and **DataTableInfo**. Each of these tables only contains the most recent measurements.

Note:

Public table contains the measurements as they are made. It is updated at the scan interval set within the datalogger program. **Status** table includes information on the health of the datalogger and is updated every second when viewed.

DataTableInfo table reports statistics related to data tables. It is also updated every second when viewed.

(6) Select User-defined data tables update (**UTMUPS** or **UTMDS**) at the schedule set within the program.

Figure 5 *LoggerNet* Toolbar

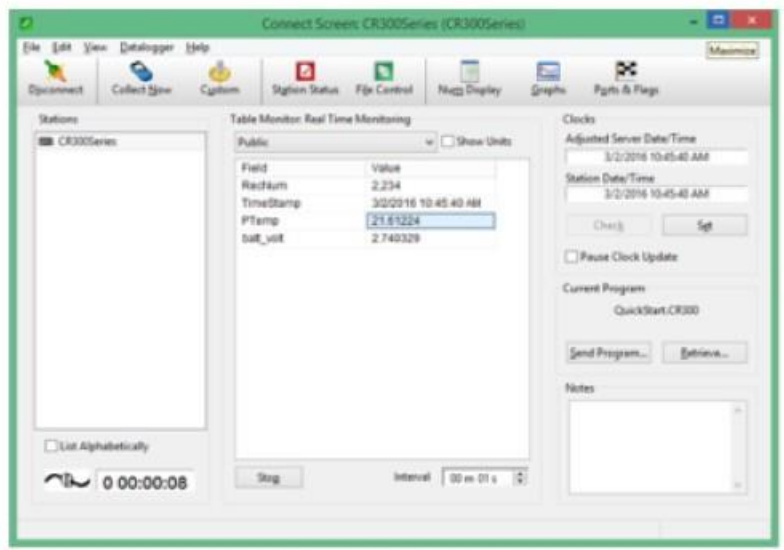


Figure 6 The Table Monitor

[3] SEND AND EDIT A PROGRAM

(1) The CR300 requires that a **CRBasic** program file be sent to its memory to direct measurement, processing, control, and data storage operations.

(2) The **Current Program will be displayed in Table Monitor** shows three programs currently running on the CR300:

   i. **PROGRAM 1:** Upperstream (Raingauge/Water Level Recorder/Siren)
   ii. **PROGRAM 2:** Upperstream (Water Level Recorder)
   iii. **PROGRAM 3:** Downstream (Water Level Recorder/Siren)

(3) Use **CRBasic Editor** to edit **Current Program.** From the *LoggerNet* toolbar, click **Program | CRBasic Editor** (see Figure 5) and Open **Current Program** file from C:\Campbellsci\Splitw. Edit

(4) **Current Program.**

(5) **Compile, Save and Send** to the CR300.

Note: A good practice is to always retrieve data from the CR300 before sending a program; otherwise, data may be lost. Some methods of sending a program give the option to retain data when possible. Regardless of the program upload tool used, data will be erased when a new program is sent.

PROGRAM 1
Filename: Upperstream(ModbusSlaveWaterLevel)time1208pmdate23616.CR300

```
'CR300 Series
'Created by Short Cut (3.2)

'Declare Variables and Units
Public BattV Public
PTemp_C Public
Rainfall, Level Public
Rainfall_Tot Public
Elapsed
Public triggerstatus = 2
Public Modbus(3),
Public ModbusResult
Public s, d


Units BattV=Volts
Units PTemp_C=Deg C
Units Level=cm
Units Rainfall_Tot = mm

'Define Data Tables
```

```
DataTable(UTMUPS,True,-1)
DataInterval(0,3,Min,10)
Sample(1,PTemp_C,FP2)
Totalize(1,Rainfall,FP2,False)
Sample(1,Rainfall,FP2)
Sample(1,Modbus(1),FP2)
Sample(1,Modbus(2),FP2)
Sample(1,Level,FP2) EndTable


Function TriggerSiren ( x, duration , Inc , Dec )
Public MyFlag s
= x
d = s + x
MyFlag = 1
Do
Elapsed = Timer (1,Sec,0 ) If
x = - 1 Then triggerstatus = 1
Else
If Elapsed = d Then s
= s + ( x * 2 )
d = s + x
EndIf
If Elapsed >= s AND Elapsed <= d Then
triggerstatus = 0
MyFlag = 0
Else
triggerstatus = 1
EndIf
EndIf
SW12( triggerstatus )
If Elapsed = duration Then
Rainfall_Tot = 0
EndIf
' If Level >= Inc OR Level <= Dec Then
' Exit Do
' EndIf
Loop While Elapsed < duration
SW12( 0 )
EndFunction



'Main Program

BeginProg
'Counter = False
'Main Scan
```

```
Scan(5,Sec,1,0)
'Default CR300 Datalogger Battery Voltage measurement 'BattV'
Battery(BattV)
'Default CR300 Datalogger Wiring Panel Temperature measurement 'PTemp_C'
PanelTemp(PTemp_C,50)
ModbusMaster (ModbusResult,ComRS232,9600,1,3,Modbus(),1,3,3,100,2)
'Generic 4-20 mA Input (using internal shunt) measurement 'Level'
PulseCount (Rainfall,1,P_SW,0,0,0.5,0)
Rainfall_Tot = Rainfall_Tot + Rainfall
Level = Modbus(3)


CallTable (UTMUPS)
TriggerSequence(1,0)
NextScan

SlowSequence
Do
WaitTriggerSequence
If Rainfall_Tot >= 30.0 AND Rainfall_Tot <= 39.9 Then
TriggerSiren( 5, 300, 10.9, 5)
Timer (1,Sec,3)
ElseIf Rainfall_Tot >= 40.0 AND Rainfall_Tot <= 49.9 Then
TriggerSiren( 20, 600, 30, 25)
Timer (1,Sec,3)
ElseIf Rainfall_Tot >= 50
TriggerSiren( -1, 1200, 4000, 30)
Timer (1,Sec,3)
Else
SW12( 0 )
EndIf


If Level >= 47.00 AND Level <= 56.99 Then
TriggerSiren( 5, 300, 40, 30 )
Timer (1,Sec,3)
ElseIf Level >= 57.00 AND Level <=  66.99 Then
TriggerSiren( 20, 600, 50, 40)
Timer (1,Sec,3)
ElseIf Level >= 67
TriggerSiren( -1, 1200, 4000, 60)
Timer (1,Sec,3)
Else
SW12( 0 )
EndIf
Loop While TRUE
EndSequence


EndProg
```

PROGRAM 2
Filename: UpperStream ModbusMaster.CR300

```
'CR300

'Declare Variables and Units
Public BattV
Public PTemp_C
Public Level
Public Modbus(3)
Public Variable(8) As Boolean

Units BattV=Volts
Units PTemp_C=Deg C

'Define Data Tables
DataTable(WaterLevel,True,-1)
DataInterval(0,3,Min,10)
Sample(1,BattV,FP2)
Sample(1,PTemp_C,FP2)
Sample(1,Level,FP2)
EndTable

'Main Program
BeginProg

'Modbus Slave Instruction
ModbusSlave (ComRS232,9600,1,Modbus(),Variable(),2)

'Main Scan
Scan(5,Sec,1,0)
'Default CR1000 Datalogger Battery Voltage measurement 'BattV'
Battery(BattV)
'Default CR1000 Datalogger Wiring Panel Temperature measurement 'PTemp_C'
PanelTemp(PTemp_C,_50Hz)
'Generic 4-20 mA Input (using internal shunt) measurement 'Level'
CurrentSE(Level,1,mV2500,1,True,0,50,18.75,-75)
'Call Data Tables and Store Data
CallTable WaterLevel
'Copy values/measurements to Modbus Array
Modbus(1)=BattV
Modbus(2)=PTemp_C
Modbus(3)=Level
NextScan
EndProg
```

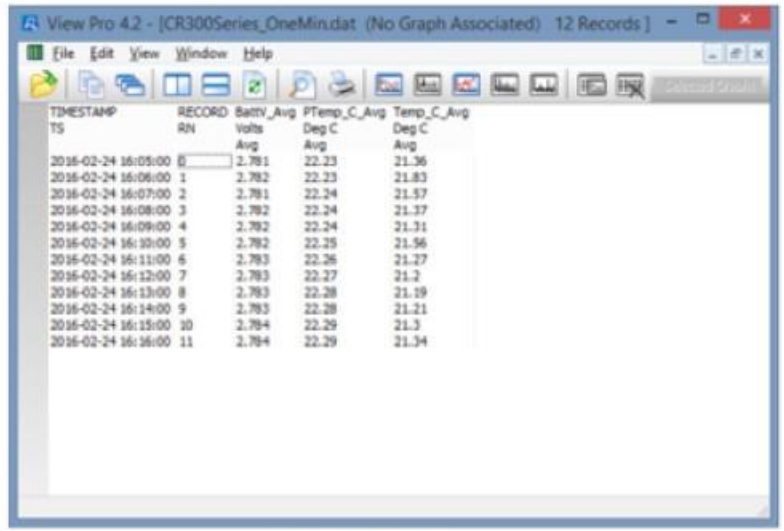
PROGRAM 3
Filename: Downstream(WaterLevel_Siren)time12pmdate230616.CR300

```
'CR300 Series
'Declare Variables and Units

Public BattV
Public PTemp_C
Public Level
Public Elapsed
Public s, d
Public triggerstatus = 2

Units BattV=Volts
Units PTemp_C=Deg C
Units Level=cm

'Define Data Tables
DataTable(UTMDS,True,-1)
DataInterval(0,3,Min,10)
Sample(1,PTemp_C,FP2)
Totalize(1,Level,FP2,False)
Sample(1,Level,FP2)
EndTable

Function TriggerSiren ( OnOff, duration , Inc , Dec )
Public MyFlag s
= OnOff
d = s + OnOff
MyFlag = 1
Do
Elapsed = Timer (1,Sec,0 ) If
OnOff = - 1 Then
triggerstatus = 1
Else
If Elapsed = d Then s
= s + ( OnOff * 2 ) d =
s + OnOff
EndIf
If Elapsed >= s AND Elapsed <= d Then
triggerstatus = 0
MyFlag = 0
Else
triggerstatus = 1
EndIf
EndIf
SW12( triggerstatus )
```

```
If Level >= Inc OR Level <= Dec Then
Exit Do
EndIf
Loop While Elapsed < duration
SW12( 0 )
EndFunction

'Main Program

BeginProg

'Main Scan
Scan(5,Sec,1,0)
'Default CR300 Datalogger Battery Voltage measurement 'BattV'
Battery(BattV)
'Default CR300 Datalogger Wiring Panel Temperature measurement 'PTemp_C'
PanelTemp(PTemp_C,50)
'Generic 4-20 mA Input (using internal shunt) measurement 'Level'
CurrentSE(Level,1,mV2500,1,True,0,50,18.75,-75)

CallTable (UTMDS)

TriggerSequence(1,0)
NextScan

SlowSequence
Do
WaitTriggerSequence
If Level >= 30 AND Level <= 39.99 Then
TriggerSiren( 5, 300, 20, 10 )
Timer (1,Sec,3)
Elself Level >= 40 AND Level <=49.99 Then
TriggerSiren( 20, 600 , 30, 20)
Timer (1,Sec,3)
Elself Level >= 50
TriggerSiren( -1, 1200, 400, 30 )
Timer (1,Sec,3)
Else
SW12( 0 )
EndIf
Loop While TRUE
EndSequence


EndProg
```

[4] COLLECT AND VIEW RECORDED DATA

(1) Open Program *LoggerNet* from Program File. From the *LoggerNet* toolbar, click **Main | Connect** (see Figure 5).
(2) The **Table Monitor** is now displayed (Figure 6). Select a data table in the **Table Monitor** list. In the **Stations** list, select the **CR300Series** in the **Datalogger Type and Name** list.
(3) Press **Connect**.
(4) Press **Collect Now**. The data will be collected to C:\Campbellsci\Loggernet data file (a **.data** extension).
Click **Microsoft Excel** and open data file.
(5) Alternative method: Use the *LoggerNet* toolbar, click **Data | View Pro**
(6) Click **File | Open** to open a file for viewing. In the dialog box (see Figure
(7) 7), select the data file to view (a data file has **.dat** extension). Click **Open.**



TIMESTAMP	RECORD	BattV_Avg	PTemp_C_Avg	Temp_C_Avg
TS	RN	Volts	Deg C	Deg C
		Avg	Avg	Avg
2016-02-24 16:05:00	0	2.781	22.23	21.36
2016-02-24 16:06:00	1	2.782	22.23	21.83
2016-02-24 16:07:00	2	2.781	22.24	21.57
2016-02-24 16:08:00	3	2.782	22.24	21.37
2016-02-24 16:09:00	4	2.782	22.24	21.31
2016-02-24 16:10:00	5	2.782	22.25	21.56
2016-02-24 16:11:00	6	2.783	22.26	21.27
2016-02-24 16:12:00	7	2.783	22.27	21.2
2016-02-24 16:13:00	8	2.783	22.28	21.19
2016-02-24 16:14:00	9	2.783	22.28	21.21
2016-02-24 16:15:00	10	2.784	22.29	21.3
2016-02-24 16:16:00	11	2.784	22.29	21.34

Figure 7 View Data

PART 3:

MONITORING, INSPECTION AND MAINTENANCE

OBSERVATION AND MONITORING OF COLLUVIUM DEPOSITS

Depositions of colluvium have been observed along the banks of Sungai Ayer Hitam Besar. The locations of these major deposits are indicated in Figure 8. The present state of equilibrium of the colluvium deposits is delicate and can be readily disturbed by changes in the surroundings, especially if any of these changes is abrupt and significant.

Appropriate actions are required from the JPNJ to monitor any sign of disturbances in these colluvium deposits, which, if unchecked may eventually lead to major instability.

Without any monitoring instrumentation installed in these deposits, any signs of instability and movement can only be effectively verified and evaluated by undertaking regular physical inspections and observations in the mentioned locations. Frequency of these field observations depends on the prevailing weather and the degree of changes and conditions of the area.

The recommended frequency is:

(1) **Once a month during dry season and normal weather conditions**
(2) **Once a week during monsoon and wet season.**

Inspections in the areas to be monitored (Figure 8) shall include verifying the occurrence of **any** or **all** of the features and indications shown in Figure 9. Other related SOPs proposed by this study are also applicable. The inspection shall commence from the riverbank and progressing upwards along the inclining slope until the end of the colluvium deposit.

The critical features and indications to be observed are:

1. Sign of **SCOURING** (Feature **[1]**) occurring on the face of the riverbank.
2. Occurrence of **RIPPLE** or **BULGING SURFACE** (Feature **[2]**) on the surface of the colluvium deposit.
3. Occurrence of **INCLINING TREES** (Feature **[3]**) which are normally new trees growing in the colluvium deposit.
4. Signs of formation of **TENSION CRACKS** (Feature **[4]**) in the upper portion of the colluvium deposit.

5. Occurrence of **GULLIES** created by the surface run-off water. These may be found within the colluvium deposit, in areas which are not covered with surface vegetation. Gullies are sign of erosion and may induce instability.

Notes:

[1] If any of the above-mentioned indications is observed or suspected to form, a more frequent observation shall be carried out, especially during the monsoon season.

[2] In any event of the alarm is triggered, provided that it is safe, inspection shall be carried out immediately. This is to verify any critical and significant changes to the areas being monitored.

[3] Each field inspection must be accompanied by a **brief report** which must include the following information - indication on creep movement of the colluvium as indicated by features **(a)** to **(e)** listed above; locations of occurrence; photographic images of the features observed. All reports must be compiled accordingly (according to date, month and year) to facilitate assessment and comparison to be made on movement and degree of the instability of the colluvium deposits and the surrounding areas.

MITIGATION MEASURES AND RESTRICTED ACTIVITIES IN THE AREAS BEING MONITORED

To ensure no drastic and sudden changes to the surroundings which may affect the state of equilibrium of the colluvium deposits, the following mitigation measures must be observed:

(1) Activities such as cutting down of existing trees and extensive clearing of surface vegetation must **NOT** be allowed.

(2) Major construction activities must be restricted to areas outside the buffer zone of Sungai Ayer Hitam Besar (30m from either side of the riverbanks).

(3) Activities that may trigger the instability on the riverbanks and colluvium deposits must not be allowed. These activities include deepening of the river, and re-profiling of the slopes and banks along Sungai Ayer Hitam Besar.

Consultation with the relevant authorities and their written permission must be obtained if any of the above activities were to be carried out. Prior assessments are required before any construction of structures in the monitored area is to be undertaken.

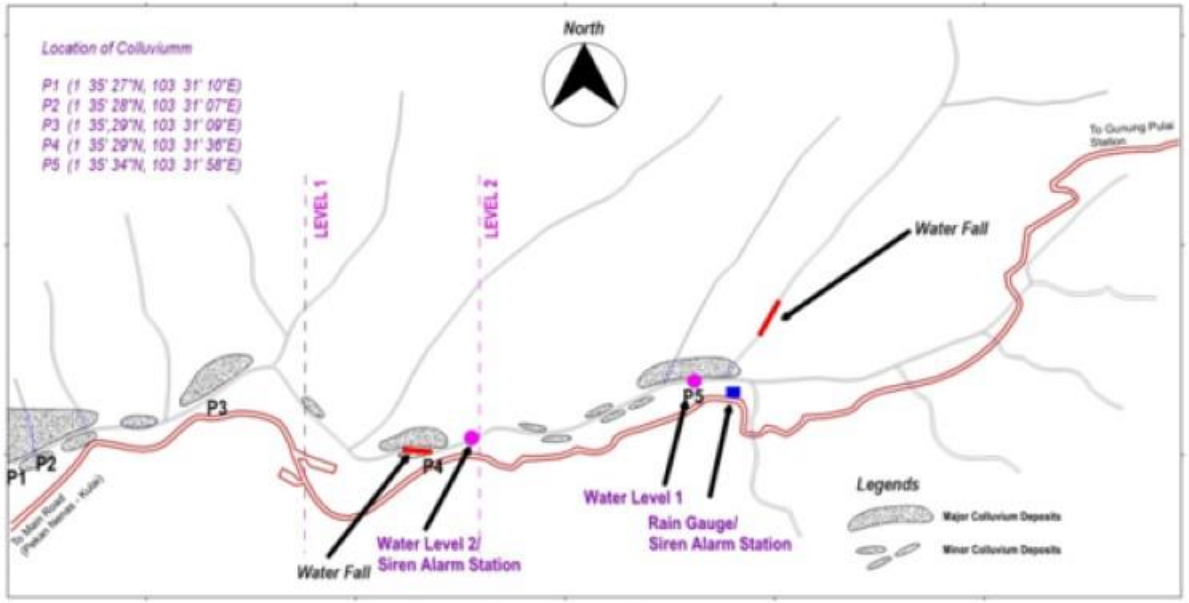
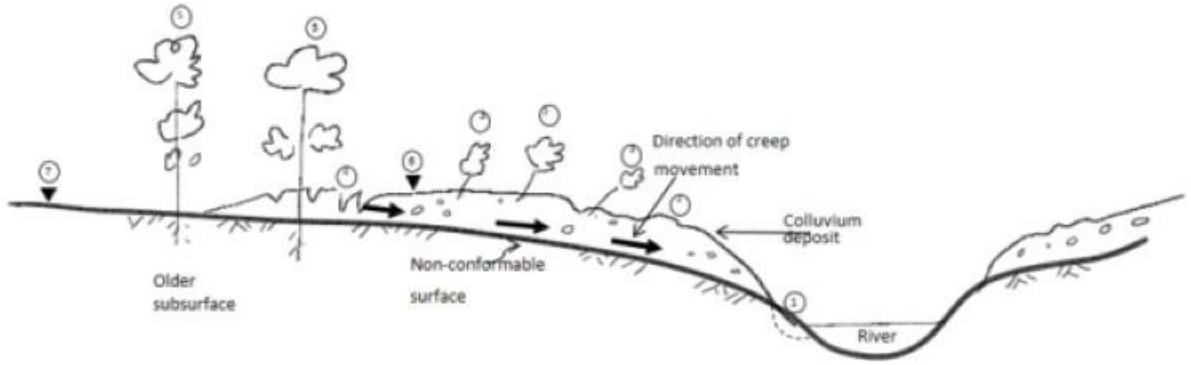


Figure 8 Distribution of Colluvium Deposits



Legend:

(1) **Scouring**: Erosion that may along the riverbanks particularly after heavy rainfall. Can be noted by formation of relatively new erosional surface.

(2) **Ripple or bulging surface**: This surface feature normally occurs in the lower portion of the colluvium deposit. This is created by the differential movements within the colluvium body, as its upper portion is moving faster than its lower portion.

(3) **Inclining Trees**: This indication can be seen on new trees that grow after the deposition of the colluvium, and they are rooted in this deposit. It indicates slow movement (creep) of the colluvium deposit in downslope direction.

(4) **Tension Cracks**: These surface cracks are commonly found in the upper portion of the colluvium deposit, created by the differential creep movement within the deposit.

(5) **Older Trees:** These trees are not affected by the creep movement of the colluvium deposit as they grow and rooted in the older substrata material below the colluvium, or they are located in area outside the colluvium deposit.

(6) **New Ground Surface**: The ground surface created after deposition of colluvium on older ground surface. Substrata materials consist of materials being eroded and deposited during slope failure in December 2001).

(7) **Older Ground Surface.** These are the existing ground surfaces which are not covered by colluvium. This surface forms a non-conformable boundary with the newly deposited colluvium. Substrata materials may consists of older sediments deposited before the December 2001 incident.

Figure 9 Cross-sectional Profile of Colluvium Deposits and Features as Indicators for Creep Movement and Instability

INSPECTION OF THE EARLY WARNING SYSTEM (EWS)

All Stations, e.g. STATION 1 – UTMUPS (Upperstream) and STATION 2 – UTMDS (Downstream) shall be inspected **WEEKLY** to ensure that the EWS is fully functional as per design.

The features and components to be inspected are:

1. **SOLAR PANEL:** Remove any canopy (created by the surrounding trees), fallen branches and leaves that cover the solar panels. The required canopy clearance is 10m radius for STATION 1 – UTMUPS (Upperstream), and 5m radius for both STATION 1 - UTMUPS (Upperstream – with water level recorder) and STATION 2 – UTMDS (Downstream). Ensure that the solar panels are facing to the **EAST direction**.
2. **RAIN GAUGE:** Remove any leaves or rubbish trapped inside the funnel.
3. **CABLE:** Check all cables for any damages and tend to any exposed cables. Ensure that all cables are secured.
4. **EWS BATTERY:** Check the functionality and charging level of the battery, ensure that the charge level indicator is always GREEN.
5. **CR300 CONTROL BOX:** All the electrical circuits and components in the box compartment must be free of moisture and precipitation. Ensure that the box seal is effective and wipe out any residual moisture. Place suitable moisture absorbing agent such as silica gels in the box and replace them regularly. **WATER LEVEL SENSOR:** The sensor is installed in the water and suspended above the river bed.
6. Shake this sensor lightly to clear any debris that might be blocking the sensor diaphragm.

GENERAL INSTRUCTION

(1) For safety and security reason, it is advisable to restrict visitors to **Level 2** only. Put up proper security fencing and appropriate signage to warn the public on this restriction.

(2) The limited time visit approach is to limit the access to the recreational area to during the monsoon season (October – January). This approach is more economical and allows the authorities some time to do maintenance work when the park is closed.

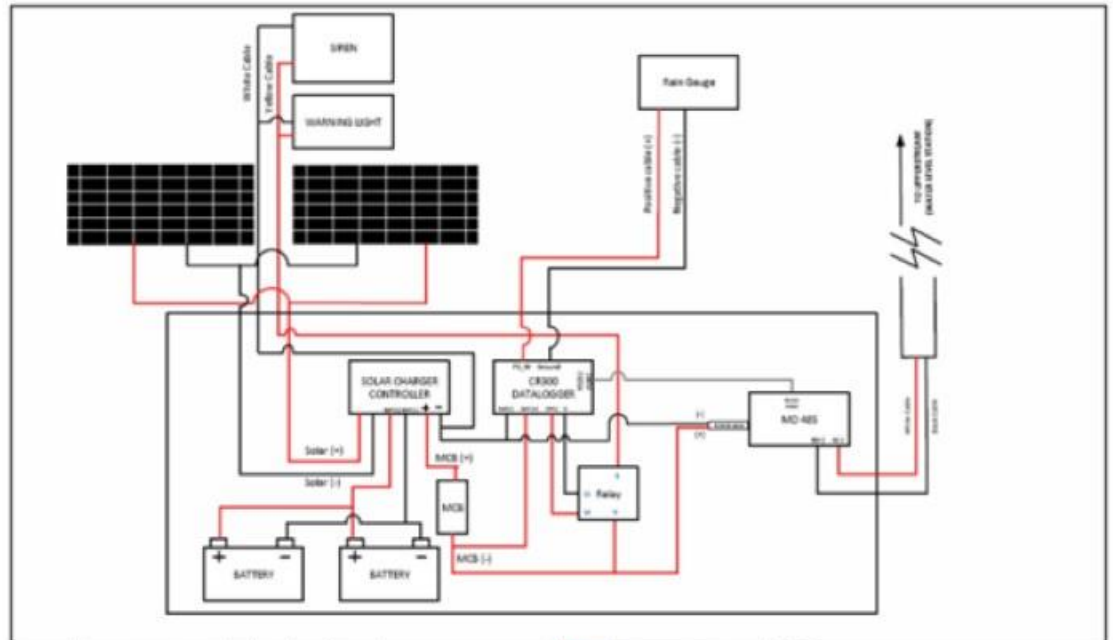
(3) The authority should provide personnel to monitor the situation at the recreational area during visiting hours by monitoring the amount of rainfall depth and monitoring the water level that could trigger the siren. If the siren fails to set off when the criteria are met, the siren should be on manually.

(4) The upstream area of the recreational park should be maintained regularly. Regular maintenance of the river in the upstream area has to be carried out by removing tree branches and tree trunks from blocking the water way.

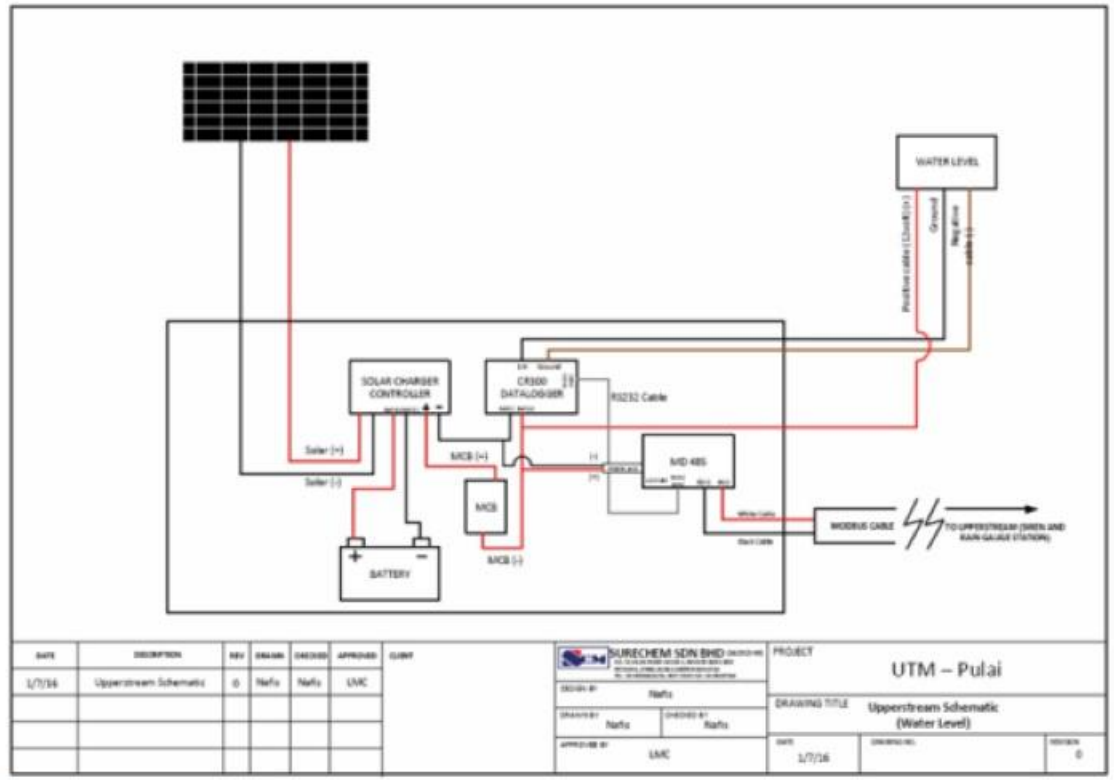
APPENDICES:

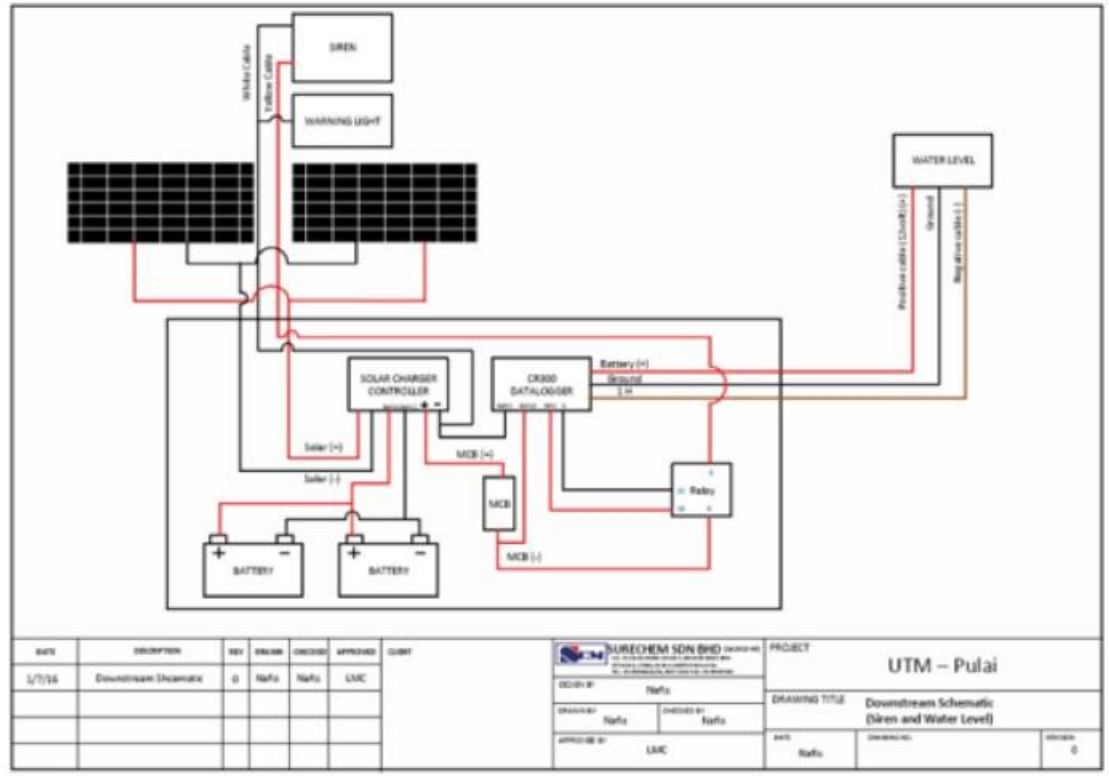
DRAWING CABLE SCHEMATIC

(1) STATION 1 – UTMUPS (Upperstream)	Rainfall gauge, siren and warning light
(2) STATION 1 – UTMUPS (Upperstream)	First water level recorder
(3) STATION 2 – UTMDS (Downstream)	2nd water level recorder, siren and warning light.



DATE	DESCRIPTION	REV	DRAWN	CHECKED	APPROVED	CLIENT
1/7/16	Downstream Sheamatic	0	Nafis	Nafis	LMC	


WATER LEVEL
SOLAR CHARGER CONTROLLER
CR300 DATALOGGER
RS232 Cable
Solar (+)
Solar (-)
MCB (+)
MCB
MCB (-)
BATTERY
MID 485
MODBUS CABLE
TO UPPERSTREAM (WATER LEVEL AND RAIN GAUGE STATION)
DATE
DESCRIPTION
REV
DRAWN
CHECKED
APPROVED
CLIENT
1/7/16
Upperstream Schematic
0
Nafis
Nafis
LMC
SURECHEM SDN BHD
PROJECT
UTM – Pulai
DESIGN BY
Nafis
DRAWN BY
Nafis
CHECKED BY
Nafis
APPROVED BY
LMC
DRAWING TITLE
Upperstream Schematic
(Water Level)
DATE
1/7/16
DRAWING NO.
REVISION
0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WARNING LIGHT
WATER LEVEL
SOLAR CHARGER CONTROLLER
CR300 DATALOGGER
Battery (+)
Ground
Solar (+)
Solar (-)
MCB (+)
MCB
MCB (-)
Relay
BATTERY
BATTERY
DATE
DESCRIPTION
REV
DRAWN
CHECKED
APPROVED
CLIENT
1/7/16
Downstream Shcematic
0
Nafis
Nafis
LMC
SURECHEM SDN BHD
PROJECT
UTM – Pulai
DRAWING TITLE
Downstream Schematic
(Siren and Water Level)
Nafis
LMC