



NSW DEPARTMENT OF PUBLIC WORKS AND SERVICES



Mt Penang Dam-Dam Safety Evaluation Prepared for the Festival Development Corporation

Dams & Civil

Report No: DC 02029 Date: May 2002

EXECUTIVE SUMMARY

The main purpose of this consultancy is to prepare a Surveillance Report-Type 3 on the existing dam, to satisfy the Dams Safety Committee's requirements.

This report presents the investigation, analyses and preparation of the Surveillance Report-Type 3, for the Mt Penang Dam to satisfy Dams Safety Committee's requirements. The work carried out involves setting-up a RAFTS computer model for the catchment draining into the dam to check the hydrology/hydraulics and stability (including earthquake loading) under various flood conditions, as required for the surveillance report. The stability analyses have been carried out using SLOPE/W.

Based on this study, it is concluded that:

• According to the soil parameter and the phreatic surface suggested, the factor of safety for the dam embankment is sufficient for:

a.) Steady Stateb.) 100 Year Storm Eventc.) 500 Year Storm Eventd) Rapid Draw Down

- The factor of safety for the dam embankment is also sufficient during seismic loading.
- Piping is unlikely to occur on the dam embankment.
- The dam embankment should be consistently monitored during the construction of the new irrigation dam, reinforced earth retaining structure, cascading water feature, minor buildings, vehicular pavements and carpark downstream of the existing dam.

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1 INTRODUCTION

1.1 Background

The Festival Development Corporation (FDC) has prepared a Master Plan for a major tourist attraction and business precinct at Mount Penang Parklands, covering an area of 156 hectares. The plan consists of facilities for: elegant sculptured gardens in a lakeside setting, an annual floral festival, sporting facilities, gardens, restaurants, cafes and business facilities for the Information Technology industry.

The Mount Penang Parklands is situated adjacent to the F3- Sydney to Newcastle Freeway on the Pacific Highway exit ramp to Gosford (See Figure 1).

1.2 Purpose

The main purpose of this consultancy is to prepare a Surveillance Report-Type 3 on the existing dam, to satisfy the Dams Safety Committee's requirements.

This report presents the investigation, analyses and preparation of the Surveillance Report-Type 3, for the Mt Penang Dam to satisfy Dams Safety Committee's requirements. The work carried out involves setting-up a RAFTS (WP Software) computer model for the catchment draining into the dam to check the hydrology/hydraulics and carry out stability analyses (including earthquake loading) under various flood conditions, as required for the surveillance report. The stability analyses have been carried out using SLOPE/W (Geo-Slope Int).

1.3 The existing Mt Penang Dam

The existing dam was built in the early 1980's as an irrigation source for the Mt.Penang Juvenile Correctional Centre. The dam has been built on a small creek draining a local catchment area of 56.7ha area.

The dam consists of a homogeneous earthfill embankment constructed essentially of silty sands with some traces of clay. The upstream face of the embankment has a slope of approximately 3.5(H) to 1.0(V). The downstream face has a slope of 3.5(H) to 1.0(V), and is grass covered.

A spillway has been constructed into the hillslope at the western end of the dam. The main embankment consists of a maximum height of up to 6m above the natural ground level. The storage capacity of the dam at Full Supply Level (FSL) has been estimated to be 48.63ML.

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We understand that a new irrigation dam, a reinforced earth retaining structure, a cascading water feature, some minor buildings, vehicular pavements and a carpark are to be constructed just downstream of the existing dam.

2 AVAILABLE DATA

2.1 For the RAFTS hydrologic/hydraulic investigation

The hydrology/hydraulics of the dam is based on an understanding of the stormwater runoff conditions draining the local catchment. It is essential to have details of physical parameters representative of the catchment, such as catchment boundary, catchment area, existing drainage/creek conveyance system, rainfall and dam storage capacity.

Given the absence of observed data for this study, available regional parameters and research data have been collected and used. Data for the study has been obtained from a number of sources including Australian Rainfall & Runoff, Central Mapping Authority, Gosford/Wyong Councils and the Bureau of Meteorology. To ensure realistic representation of the catchments, this regional data has been verified and calibrated against available data to validate the models.

2.1.1 Mapping

All the relevant maps and plans for the study were obtained and used in this study. Existing natural surface data for the catchment have been obtained from CMA topographic maps (scale 1:25,000) of Gosford, and orthophotomaps (scale 1:4,000) of Gosford (2797-VII-A and 2797-IV-C). This data have been confirmed by a field site survey, which was conducted by DPWS Geomatics Group (See Figure 2).

Detailed soil profiles of the catchment have been obtained from Soil Landscapes of Gosford-Lake Macquarie (CALM, 1993).

2.1.2 Site Inspection & catchment data

Specific information pertaining to the catchment pervious, impervious areas, landuse and vegetation cover for the catchment and the drainage/creek system has been verified from the site inspection.

All relevant data relating to upstream catchment data, ie topography, roads and drainage infrastructure was collected and base maps for the site were prepared. A link-node network was developed on RAFTS computer program for the catchment. These nodes formed the basis for the sub-catchments used in the modelling.

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2.1.3 Rainfall & Flood Records

Historic rainfall data used for this study has been obtained from the Bureau of Meteorology recording stations at Gosford and Kariong.

2.1.4 Design Storms

Design Storms have been obtained from the Intensity-Frequency-Duration (IFD) design rainfall curves, using the procedure outlined in the Australian Rainfall and Runoff (Institute of Engineers, 1997). These are reproduced in Appendix 1.

2.1.5 Survey Datum & Dam storage capacity

All levels used in this report are to Australian Height Datum (AHD).

The following Table 2-1 lists the surface area/storage/height statistics for the dam. The data was obtained from a recent hydrographic survey conducted by DPWS Geomatics Group (Refer to figure 2).

Height (m)	Surface Area(m ²)	Storage Volume Capacity (m ³)
172.0	0	0
172.5	65	7
173.0	636	147
173.5	1620	693
174.0	2929	1010
174.5	4783	3745
175.0	6207	4477
175.5	7656	7137
176.0	9253	14191
176.5	10900	19244
. 177.0	12606	25191
177.5	14335	31952
178.0	16304	39610
178.5	19213	48629

Table 2-1 Dam surface area/storage capacity/height statistics

2.1.6 Flood Flows

No streamflow records are available for the catchment to allow direct flood frequency analysis. Therefore, flood flows have been estimated using available storm and design rainfall data, and complimented by applying a combination of hydrologic and hydraulic modelling.

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2.2 For the SLOPE/W dam stability investigation

The dam embankment stability assessment has been based on the limited geotechnical investigation of the embankment by Jeffery & Katauskas (1999, 2001) and two additional borehole logs taken by the DPWS Geotechical and Envionmental group on the Dam embankment with soil samples tested for soil parameters (See Attachment 2). Data for the study has also been obtained from the DPWS geotechnical investigation and compared with a number of sources including Design of Small Dams (USBR), Geotechnical Engineering of Embankment Dams (Fell et al).

2.2.1 Embankment materials

The dam is a homogeneous filled earthfill embankment comprising of compacted silty sands with some traces of clay. The dam is underlain by weathered sandstone of a depth of approximately 6.0-6.9m below the crest level. The fill soils appeared to be uniformly compacted with consistent SPT values of N=7.

2.2.2 Phreatic Surface

From the borehole logs of the dam embankment, water inflow was recorded at 6.1-6.9m depth. The phreatic surface was difficult to establish since materials below the crest level were in a very moist state with some wet pockets in the soils. A suggested phreatic line approximately 2m below the crest level had been used to set up the SLOPE/W model for the slope stability analysis.

3 RAFTS & SLOPE/W MODEL

3.1 RAFTS hydrologic/hydraulic model

3.1.1 General

Hydrologic and hydraulic modelling were carried out for the 100 and 500 year ARI's using the runoff routing computer model RAFTS (WP Software). The model provides hydrographs showing peak outflows and runoff volumes from the catchment, for a particular set of catchment conditions. The model has also been used for the dam storage and spillway routing. The hydrologic/hydraulic modelling for various recurrence intervals provided vital information for the SLOPE/W (Geo-Slope Int.) dam stability models.

As no streamflow records are available to enable model calibration for verification purposes, the probabilistic Rational Method, as given in AR&R (Institute of Engineers, Australia), has been used to verify the model.

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3.1.2 Probabilistic Rational Method

Peak flows for the 100 and 500 year ARI's have been estimated for the Mt Penang Dam. The probabilistic Rational Method only provides peak flow estimates, whereas flood hydrographs are required for more detailed modelling and to check on the dam storage and spillway capacity. Therefore, the approach adopted was to obtain design storm rainfalls from AR&R 1997 and transform them to flows using RAFTS.

3.1.3 RAFTS Modelling

The RAFTS runoff routing model was used to transform the design rainfalls into flood hydrographs. The RAFTS model was used to generate hydrographs at the dam, for a set of catchment conditions and design rainfall events (Refer to Table 3.1 and Attachment 3). The model also produced flow rates, flow depths and corresponding flow velocities at dam spillway.

3.1.4 Design Rainfalls

Design storms were used for rainfall input. The design storms were input as a dimensionless temporal pattern (the proportion of total rainfall for each time increment of the storm) combined with average rainfall intensity for a particular storm duration. The typical design storm temporal patterns and appropriate rainfall intensities have been obtained from AR&R, 1997.

Intensity-frequency-duration (IFD) design rainfall curves have been produced for the catchment using the procedure described in Section 2.3 of AR&R. The appropriate extrapolation and interpolation techniques required in the procedure are ideally handled by computer, and for this study the IFD Design Rainfall Program (WP Software) has been utilised.

3.1.5 Loss Rates and Critical Storm Durations

In the absence of streamflow records, rainfall losses were estimated using an initial/continuing loss approach. Losses have to be applied to the design rainfalls to obtain excess rainfall, that is runoff. AR&R 1997, provides recommended initial and continuing loss rates for use with design rainfalls. Recommended initial losses are also available from Walsh et al..

To ensure that the loss relationships so derived are appropriate to the catchment it was considered reasonable to vary the initial loss rates within their order of accuracy, to see if peak flows resulting from RAFTS design rainfalls were comparable to the probabilistic rational method estimates. Sensitivity analyses was undertaken to determine the flood runoff estimates, using Zone 1 initial losses ranging from 10 to 25mm, and a continuing loss of 2.5mm/hour was selected.

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3.1.6 RAFTS Model

The catchment has been divided into 12 subcatchments, differentiated on the basis of topography, land use and percentage of pervious/impervious areas. Each subcatchment is represented by a node in the modelling and the drainage conveyance system is represented by links between these nodes.

Other parameters used in the model to describe the catchment and subcatchments included:

- the fraction of impervious and pervious areas within each subcatchment has been scaled off available maps and confirmed by site inspection. The impervious areas for each subcatchment ranged from 5% to 30%;
- the vectored slopes for each subcatchment has been determined from available contour plans for the catchment. The vectored slopes varied from 0.2% to 9%;
- the surface roughness has been based on the surface types. The values ranged from 0.025 for urban grassed areas to 0.05 for native bushland areas.

The "split subcatchment option" in RAFTS has been used to model 'residential areas' which is consistent with recommended practice. This option enables each subcatchment area to be separated into pervious and impervious areas allowing them to be routed to the catchment outlet.

3.1.7 Peak Flows

Table 3-1 summarises and compares the study results obtained using the RAFTS model and calculations based on the Probabilistic Rational Method. These values represent the peak flows at the dam.

CASE	Probablistic Rational Method Peak Inflow (m ³ /s)	RAFTS Peak Inflow (m ³ /s)	RAFTS Peak Outflow (m ³ /s)	Stage Used (mAHD)
100 Year ARI	9.8	9.4	5.5	178.97
500 Year ARI	14.5	14.2	8.9	179.15

Table 3-1 Summary of RAFTS and Probabilistic Rational Method results

Peak flow rates estimated using RAFTS are considered to represent the values that are likely to occur in the catchment.

The results show that for a 100 year ARI storm event, the spillway is over topped by 0.47m of water and for a 500 year ARI storm, the spillway is over topped by 0.65m.

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3.2 SLOPE/W dam stability model

3.2.1 General

Dam stability modelling were carried out using SLOPE/W (Geo-slope International). The model uses the limit equilibrium theory to solve for the factor of safety of earth and rock slopes. The model is based on Bishop's simplified method.

3.2.2 Cases analysed

Stability analyses models have been set up for the following cases/conditions using SLOPE/W:

- CASE 1: Steady State or Full Storage Level (FSL)
- CASE 2: 100 Year ARI Storm Event
- CASE 3: 500 Year ARI Storm Event
- CASE 4: Rapid Draw Down

The Full Supply level was estimated to be RL178.5 with an initial water level of RL178.41 obtained from the survey plan. From Section 3.1, the RAFTS model results show that the dam storage level for a 100 year ARI storm event was RL178.97, and RL179.15 for a 500 year ARI storm event. Two dam embankment sections have been analysed to determine the worst stability case.

3.2.3 Slope/W model

The cross-section with the maximum dam embankment height was selected for the stability analyses. Initially, phreatic surface 2m below the crest of the embankment (i.e. surfaces below which the soil is saturated) various pheratic surfaces have been analysed and the worst case has been reported in Table 3-3 have been modelled for each of the above cases on the embankment section.

The Bishops method for circular failure surface was used with the computer software package SLOPE/W, since it produced a more conservative value for the Factor of Safety (FOS) of the embankment.

3.2.4 Dam embankment material properties

The dam embankment properties have been obtained from the triaxial test on the dam embankment materials. Table 3-2 shows the soil properties used in the model.

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Depth (m)	Layer	Density (t/m ³)	Unit Weight (KN/m ³)	Cohesion (Kpa)	Angle of Friction (\$)
0-5.2	Silty Sand	2.1	21	3	36
5.2-6.5	Residual Silty Sand	2.2	22	3	38
6.5-6.9	Residual Clayey Sand	2	10	5	33
6.9 -	Weathered Sandstone	2.5	25	15	40

Table 3-2 Embankment Material Properties

Section AA (Borehole 1)

Section BB (Borehole 2)

Depth (m)	Layer	Density (t/m ³)	Unit Weight (KN/m ³)	Cohesion (Kpa)	Angle of Friction (φ)
0-2.5	Silty Sand	2.1	21	3	36
2.5-5.0	Residual/Slope wash	1.8	18	3	38
5.0-6.0	Residual Silty Sand	2.2	22	5	33
6.0 -	Weathered Sandstone	2.5	25	15	40

3.2.5 Pseudo static analyses using Slope/W

The pseudo-static analyses are normally used as a screen to determine when more rigorous deformation type analyses should be carried out. A series of runs was made on SLOPE/W covering Cases 1-4 (refer to section 3.2.2), with a range of soil properties to give the minium factor of safety of the dam embankment. Table 3-3 shows the minium Factor of Safety for the cases analysed.

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	FACTOR OF SAFETY (FOS	š)
	Section AA (Bore Hole 1)	Section BB (Bore Hole 2)
Full Supply Level	2.28	2.72
100 Year ARI Storm Event	2.22	2.47
500 Year ARI Storm Event	2.19	2.31
Rapid Draw Down	2.13	1.94

Table 3-3 Minimum Factor of Safety

3.2.6 Earthquake loading

Security against earthquake loading was determined by applying a pseudo-static inertial loading to the sliding mass contained within the critical circle on the downstream face of the dam for steady state loading. Using the seismic data from the Review of Seismicity for Mangrove Creek Dam (SRC), with this method an inertial force equal to a seismic coefficient multiplied by gravity and again multiplied by the mass of the sliding mass is applied at the centre of gravity of the sliding mass. The seismic coefficient equals to half the peak ground acceleration at bedrock. Therefore the following accelerations have been selected for the Mt Penang Dam earthquake analyses:

0	1 in 100 year earthquake event	0.0023g
	-	

• 1 in 1000 year earthquake event

Table 3-4 shows the minium Factor of Safety for the Mt Penang Dam under earthquake conditions.

0.035g

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		FACTOR OF SAFTY (FOS)			
	CASE	1 in 100 year earthquake event	1 in 1000 year earthquake event		
~	1	2.25	1.97		
u HI	2	2.19	1.92		
(B)	3	2.16	1.90		
Sec	4	2.11	1.85		
BB	1	2.69	2.37		
L L	2	2.25	2.16		
tio H2)	3	2.29	2.02		
Sec (BH	4	1.92	1.68		

Table 3-4 minium Factor of Safety for under earthquake conditions.

3.2.7 Earthquake loading results

Table 3-5 gives the Minimum Factor of Safety for embankment dams (Gan et al and USDI) is as follows:

	and a deter of barbey	
CASE	FACTOR OF SAFTY	
Steady state or Full Supply Level	1.50	
Rapid draw down	1.25	
Earthquake 1in 100 years	1.25	
Earthquake 1in 1000 years	1.20	

Table 3-5 minium Factor of Safety

2.2.3 Piping Analysis

Piping failure caused by the presence of dispersive soils of the embankment was considered as a possible contributor to excess deformation of the dam. This movement of fines known as "piping" greatly increases the risk of failure of the dam by developing erosion to an extent that a hole developes through the embankment causing a rapid loss of water from storage.

To determine whether there is movement of fines from the embankment, grading curves for the embankment soils were examined (See Appendix 2).

The criterion for piping not occurring are summerised below:

1. for all soils with a gravel component, the filters should be designed on the grading of that part of the soil finer than 4.76mm.

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- 2. impervious soil Group 2 (sandy silts, clays and clayey sands). For sandy (and gravelly) impervious soils with 40 to 80% by weight) of the portion finer than 4.76mm sileve) finer than 75 μ m sileve, the allowable filter for design should have D_{15F}<0.7mm
- 3. The filters for soil Group 2 must be composed wholly of sand or gravelly sand in which greater than 60% is coarser than 4.76mm and the maximum particle size is 50mm.
- 4. the above criteria can be applied for all soils in group 2 regardless of the shape of the particle size distribution curve.
- 5. the filters should not contain more than 5% fines passing 75μm, and the fines should be non-plastic. Where high permeability is required, not more than 2% fines passing 75μm should be allowed. This would be particularly important for vertical and horizontal drains.
- 6. the uniformity coefficient D_{60F}/D_{10F} should not exceed 20 times D_{60F} on coarse limit of filter, D_{10F} on fine filter limit
- 7. for major projects, particularly those involving dispersive soils, non-erosion filter tests as described by Sherard et al should be carried out using water with the same chemistry as the expected seepage water.

CRITERION	CRITERION SATISFIED	COMMENTS
1	YES	Grading <4.75mm
2	YES	D _{15F} <0.7mm
3	NO	1-2%>4.75mm
4	YES	Size does not matter
5	NO	20-22% passing 75µm
6	YES	D _{60F} /D _{10F} =8.25
7	NO	

The results of the piping analysis for the dam embankment are given below:

From the results, piping is unlikely to occur on the dam embankment.

4 **DISCUSSION**

The soil properties and phreatic surfaces govern the factor of safety. The minimum FOS shows that rapid draw down is the most critical state for embankment failure. The two embankment sections gave sufficient FOS for the different loading cases.

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5 CONCLUSION

The dam stability analyses show that the dam is sensitive to soil parameters and to different phreatic surfaces used. From the stability analysis model, rapid draw down is a governing criterion for the dam embankment. The factor of safety for all the cases analysed is sufficient for dam stability.

Loss of life would not be expected in the event of a dam failure due to flooding but the possibility cannot be ruled out and downstream economic loss may be huge considering the proposed development downstream by Festival Development Corporation.

6 **RECOMMENDATION**

The dam embankment should be consistently monitored during the construction of the new irrigation dam, reinforced earth retaining structure, cascading water feature, minor buildings, vehicular pavements and carpark downstream of the existing dam.

Spillway and down stream channel to be protected from further erosion using rip-rap or any other approved stabilisation procedures.

7 **REFERENCES**

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FIGURES

FIGURE 1: LOCALITY PLAN

LOCALITY PLAN



FIGURE 2: SURVEY AND HYDROGRAPHIC PLAN





ATTACHMENTS

ATTACHMENT 1: IFD TABLE

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*********** IFD Intensity - Frequency - Duration Design Rainfall Program (Version 2.2 - May 1995) This software determines IFD design rainfall in accordance with the algebraic procedures presented in Chapter 2 (Author : R.P. Canterford) of Australian Rainfall & Runoff(1987) ****** This software is supplied as is and without any warranties as to performance or any other warranties expressed or implied. (C) WP SOFTWARE 1988-1995 Ph. (06) 2531844 ****** *** INPUT DATA ECHO *** Mount Penang Dam 2 year, 1 hour intensity: 35.00 mm/hr 2 year, 12 hour intensity: 8.50 mm/hr 2 year, 72 hour intensity: 2.60 mm/hr 50 year, 1 hour intensity: 75.00 mm/hr 50 year, 12 hour intensity: 17.00 mm/hr

50 year, 72 hour intensity: 7.00 mm/hr Skewness: .00 Geographical factor for 6 minute, 2 yr storm: 4.30 Geographical factor for 6 minute, 50 yr storm: 15.90 Latitude : .0000 Longitude: .0000

*** OUTPUT IFD TABLE ***

Rainfall Intensity (mm/h) for Mount Penang Dam

Duration		Aver	age Stor	m Recurr	ence Int	erval (y	ears)	
	1	2	5	10	20	50	100	500
5m	87.07	112.51	146.10	165.76	191.53	225.34	251.15	312.83
6	81.58	105.47	137.18	155.75	180.09	212.04	236.44	294.81
7	77.00	99.60	129.71	147.39	170.51	200.90	224.11	279.69
8	73.09	94.58	123.33	140.23	162.31	191.35	213.55	266.72
9	69.69	90.23	117.78	134.00	155.18	183.04	204.34	255.41
10	66.70	86.39	112.89	128.50	148.87	175.69	196.21	245.41
11	64.04	82.97	108.53	123.60	143.25	169.14	188.95	236.47
12	61.65	79.90	104.61	119.19	138.20	163.24	182.41	228.42
13	59.49	77.13	101.06	115.19	133.61	157.88	176.47	221.11
14	57.52	74.59	97.82	111.54	129.42	153.00	171.06	214.44
15	55.72	72.27	94.85	108.20	125.58	148.51	166.08	208.30
16	54.06	70.14	92.11	105.11	122.04	144.37	161.49	202.64
17	52.52	68.16	89.58	102.26	118.76	140.54	157.24	197.39
18	51.10	66.33	87.22	99.61	115.72	136.98	153.28	192.51
20	48.53	63.03	82.98	94.82	110.21	130.54	146.14	183.68
25	43.36	56.37	74.41	85.14	99.08	117.50	131.65	165.76
30	39.41	51.28	67.85	77.73	90.53	107.49	120.52	151.96
35	36.28	47.24	62.62	71.82	83.72	99.49	111.62	140.93
40	33.72	43.94	58.34	66.97	78.12	92.92	104.31	131.84
45	31.58	41.17	54.75	62.90	73.43	87.40	98.16	124.19
50	29.76	38.82	51.69	59.43	69.42	82.68	92.90	117.65
55	28.19	36.78	49.05	56.42	65.94	78.59	88.34	111.97
60	26.81	35.00	46.73	53.78	62.89	75.00	84.34	106.97
75	23.73	30.95	41.22	47.38	55.35	65.92	74.07	93.81
90	21.45	27.95	37.15	42.66	49.79	59.24	66.52	84.13
2.0h	18.24	23.75	31.46	36.07	42.03	49.94	56.01	70.69
3.0	14.49	18.83	24.83	28.39	33.02	39.14	43.84	55.16
4.0	12.29	15.96	20.97	23.94	27.81	32.91	36.82	46.22
5.0	10.82	14.03	18.40	20.98	24.34	28.76	32.15	40.30
6.0	9.76	12.64	16.53	18.83	21.83	25.77	28.79	36.03
8.0	8.28	10.72	13.97	15.89	18.39	21.68	24.19	30.21
10.0	7.30	9.43	12.27	13.93	16.11	18.96	21.14	26.36
12.0	6.58	8.50	11.03	12.51	14.45	17.00	18.94	23.59
14.0	5.96	7.73	10.13	11.54	13.39	15.83	17.69	22.17
16.0	5.47	7.11	9.40	10.76	12.53	14.87	16.67	21.01
18.0	5.07	6.61	8.80	10.12	11.82	14.08	15.82	20.03
20.0	4.73	6.19	8.30	9.57	11.21	13.40	15.09	19.19
22.0	4.45	5.83	7.86	9.10	10.69	12.81	14.45	18.46
24.0	4.20	5.51	7.48	8.69	10.23	12.29	13.90	17.82
36.0	3.20	4.24	5.91	6.96	8.29	10.10	11.52	15.03
48.0	2.61	3.49	4.96	5.91	7.10	8.73	10.02	13.24
60.0	2.22	2.98	4.31	5.17	6.25	7.75	8.94	11.95
72.0	1.92	2.60	3.81	4.61	5.61	7.00	8.11	10.94

Note :

 Caution should be applied to intensities with an ARI > 100 years, due to the possible shortness of rainfall records. Refer to Section 2.6 of Volume 1 of AR&R, 1987 for more information. **ATTACHMENT 2: DPWS GEOTECHNICAL REPORT**



000	OF ANT	V DEPAR FUBLIC D SERVIC	WORKS GEC	TECH	NICAL	& ENVIRONMENTAL	BOREHOLE	BH1
PRO. LOC. CON	JECT: ATION TRAC	: M I: E TOR:	T. PENANG ARTHEN SAXON	DAM	EMBA	DS NKMENT DRILLER: P. CLOSE	DATE: 10/4/02 SURFACE RL: 179.0m RIG TYPE: EXPLORER M	лкі
DEPTH (m)	WATER	віт	SAMPLE or TEST	SOIL GROUP	GRAPHIC	Soli type, colour	SOIL DESCRIPTION r, consistency, grainsize, moisture	e,remarks
0 1 1 2 3 4 5 6 7 8 9	XX	Vee	SPT 3,4,3 N = 7 SPT 3,3,4 N = 7 U SPT 3,3,4 N = 7 U U SPT 3,3,4 N = 7 U SPT 5,7,7 N = 14	FILL FILL FILL FILL FILL FILL SM (v) ROCK		FILL - SILTY SAND dark grey; loose; mois FILL - CLAYEY SILT mixed yellow-brown, y loose; moist. FILL - SILTY SAND, fine to medium grain (SC); yellow-brown and dark grey pockets; loc FILL - CLAYEY SILT dark grey with light FILL - SILTY SAND contains clayey silt p fine to medium grain grey and orange-brown nearly wet. Gravelly FILL - SILTY SAND, medium grained; (dec light grey to white, m pockets; loose; very r Becoming orange-brown and dark orange-red gravel and rare large SILTY SAND with train medium grained; (dec light grey with minor moist to wet. - clay content increase SANDSTONE; extremely weathered grey. NOTES: 1. Vee bit refit to moderately weath 2. Water inflow at so Following completion borehole rose to a completion borehole rose to a completion borehole rose to a completion borehole rose to a completion borehole rose to a completion borehole rose to a completion borehole rose to a completion borehole rose to a completion borehole rose to a completion borehole rose to a com	with clay and grass roots; st. Y SAND, traces of gravel (SC grey-brown and dark grey-bro traces of clay and gravel (SM hed; contains pockets of claye and orange-brown, with light grey boose; very moist. with sand (CL), some root fi grey pockets; firm; very moist with traces of clay (SM); bockets; occasional fine gravel; hed; light grey and yellow-grey wn pockets; loose; very moist pocket at 2.9m. traces of clay (SM); omposed sandstone); hinor yellow-brown mottle in moist to wet. wn and light grey, minor dark pockets; contains traces of fi gravel. aces of gravel and clay; omposed sandstone); brown staining; medium dense ses below 6.5m depth. ; extremely weak; light grey ar usal at 7.15m on highly weath- ered sandstone. il/rock interface at 6.9m. of drilling water level in the depth of 6.6m.	0.2! 0.6(0.6(0.6(0.6(0.6(1.2(1.2(1.2(0.6(1.2(1.2(0.6(1.2(
U 0 SPT CPT	SAMP Undis Distu Stanc Cone	LE OR sturbe rbed dard F Pene	TEST d Penetration tration Test	v : vis l : labo Test	sual	WATER D Water Table P Water Inflow S	RILLING SUPERVISOR: C.KA ROJECT COORDINATOR:C.KA HEET 1 OF 1 SHEETS CALE 1 :50	ARWAJ ARWAJ

A STATEMENT

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Color	NS OF AN	W DEPA: FUBLIC D SERVI	RIMENT WORKS CKS	GEO	OTECH	INICAL	& ENVIRONMENTAL	BOREHOLE	BH2
PRO LOC CON	JECT A TION FRAC	: M N: H TOR:	T. PE EART S	ENANG THEN AXON	G PAN DAM N	RKLAN EMBA	DS NKMENT DRILLER: P. CLOSE	DATE: 10/4/02 SURFACE RL: 179.0m RIG TYPE: EXPLORER MKI	
DEPTH (m)	WATER	ВІТ	SAI	MPLE Dr EST	SOIL GROUP	GRAPHIC LOG	Soll type, colour	SOIL DESCRIPTION r. consistency, grainsize, moisture, re	marks
					FILL FILL FILL		FILL - CLAYEY SILT dark grey; loose; mois	Y SAND with grass roots; st to very moist.	0.15
1			SPT	3,4,5 N = 9	FILL		FILL - SILTY SAND rare gravel-sized san grey-brown and yello moist. FILL - SANDY CLAY dark grey-brown, dark	with clay (SC/SM); idstone fragments; w-brown; loose to medium dense EY SILT (CL/ML); grey and blue-grey; firm; moist;	0.80
2			SPT	2,3,3	FILL		Contains traces of we FILL -CLAYEY SILTY	ood fragments. SAND (SC), traces of gravel;	2.00
3		Vee	SPT	N = 6	SM/SC (v)		FILL - SILTY SAND fine to medium grain loose; very moist to r	wher; light grey, pink, minor 'k red; firm to stiff; moist to very with some clay (SM/SC); ed; light grey and yellow-brown; hearly wet.	
4			D	N = 5	SC (v)		SILTY SAND with so contains traces of or of clayey sand (SC); nearly wet.	me clay; ganics and fine gravel and pocke mid grey; loose; very moist to	4.00-
-5	×		SPT	3,6,7 N = 13	SM (v)		SILTY SAND with ca mid grey; firm; very m SILTY SAND, traces of (decomposed sandsto grained; medium dens	ay;; oist to wet. of gravel and clay; ne); light grey to white; medium e; very moist to wet.	5.00
	>				ROCK		SANDSTONE;	×	8.00-
-7							highly weathered; very NOTES: 1. Vee bit refu 2. The stratum 2.5m original surface depos 3. Water inflow at 6.1 completion of drilling, to a depth of 5.3m.	y weak; light grey. EN isal at 6.2m. to 4.0m depth is assessed to b it but may also be fill. m (soil/rock interface). Following water level in the borehole rose	D at 6.20
- 9 10	SAMPL Undist Distur Stand	E OR Turbec	IEST I	ation	v : visu I : labor Test	Jal atory	WATER DF Water Table SL	RILLING SUPERVISOR: C. KARWA	

s:\is\watertec\geotech\pcad\borelogs\gh44a.dgn - 10-Mav-02 10:00

and the second

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10:00

Unit W4K, 42 Wattle St, ULTIMO, NSW 2007 Telephone 02- 9552 4864 Facsimile 02-9552 3615



NSW DEPARTMENT OF PUBLIC WORKS AND SERVICES

			Contraction of the local division of the loc			and the second se		
CLIENT: DPWS GEOTE	CHNICAL	ENVIRON	MENTAL		E	BATCH No:	02	018
		SOIL SI	UMMAR	Y SHEET				
PROJECT: MT. PENANG	PARKLAN	DS			COM	PILED BY:	Z	ĽG
LOCATION: EARTH DAM						DATE:	29/04	/2002
General Information	Note: All te	st methods :	are as indica	ted on accor	npanying tes	st reports.		Aprile Contractor
Sample No.	5724	5725	5726	5727	5728	5731	5733	5734
Bore/Reference	1	1	1	1	1	2	2	2
Depth (m)	1.5 - 1.95	2.5 - 2.8	3.5 - 3.95	4.5 - 4.9	5.85 - 6.3	1.3 - 1.65	3.5 - 3.95	4.0 - 4 5
Sample Type	SPT	U	SPT	U	SPT	U	SPT	D
Soil Colour & Description	Grey and	Yellow	Yellow and	Light Grey	Light	Light Grey	Dark Grey	Dark
	Yellow	Brown and	Grey	Grey Brown	Grey	and Pink	Silty	Grey
	Silty Sand	Grey	Silty Sand	Silty	Silty	Silty	Clayey	Silty
	with Clay	Silty Clayey	with Clay	Sand	Sand	Clayey	Sand	Sand
	Chi ()	Sand			with Clay	Sand		with Clay
Onlined Classification	SM (V)	SM (V)	SM (v)	SM (v)	SM (v)	SC (v)	SM (v)	SM (v)
Field Mainture Content & Density	11.7	11.2	13.4	12.1	10.0			
Field Wat Depaits (1/=3)	11.7	11.5	12.6	12.1	10.0	13.9	13.6	14.2
Field Der Density (1/m ³)		2.11		2.11		2.12		
Soil Particle Density (t/m ²)		1.90		1.89		1.86		
Son Particle Density (Um ⁻)								
Cabble Size Distribution		0						_
Control Size (%)		0			0	0	0	
Gravel Size (%)		70			0	4	1	
Salid Size (%)		/8			82	72	74	
$\frac{\text{Sitt Size}}{\text{Clay Size}} \qquad (\%)$		21			18	24	25	
Effective Size (mm)								
Uniformity Coefficient								
Curvature Coefficient								
Plasticity								
Liquid Limit (%)			(
Plastic Limit (%)								
Plasticity Index (%)								
Linear Shrinkage (%)								
Dispersion					and a second with			
Dispersal Index	[Γ	T					
Percent Dispersion (%)								
Emerson Class No.								
Compaction					And Activity of Contractory			
Compaction Type		A CONTRACT OF A						
Optimum Moisture Content (%)								
Maximum Dry Density (t/m ³)								
Shear Strength								
Test Type		CU						
Placement Moisture Content (%)		11.3						
Placement Dry Density (t/m ³)		1.90	I					
Cohesion (C, kPa)		6						
Angle of Friction (Ø, deg.)		38	Γ	1				

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ATTACHMENT 3: MODELLING RESULTS



MOUNT PENANG DAM 100 Year Storm Event



MOUNT PENANG DAM 500 Year Storm Event

Run started at: 12th February 2002 14:03:42 RAFTS Data Echo Data File Name ---> C:\MYDOCU-1\MT-PEN-1\mount_pe.dat Debug Options ---> NO save preprocesed file data echo listing NO suppress preprocessing Input Data Format ---> Fixed Job Number ---> 1 of 1 : Mt Penang Routing Increment (DT) -----> 1. (mins) Storm Data Type (IRAIN) -----> 1 (Std. Storm) Printer Plot Scale (IGMF) -----> 2 (lines) 0 (Inactive) Inter-connecting Basins (INTCB) -----> "B" Multiplier (BX) -----> 1.000 Convergence Tolerance (RELTOL) for INTCB ---> .050 Maximum Iterations (MAXITER) for INTCB ----> 10 Length of Routing Period (NVAL) -----> 300 Std. Storm: Duration (STORM) -----> 30. (mins) Recurrence Interval (RET) ----> 500. (yrs) Intensity calculated using IFD coefficients Rainfall Coefficients : 1 Hour 12 Hour 72 Hour 2 Year 35.000 8.500 2.600 50 Year 75.000 17.000 7.000 Location Skew .000 : Geographic Factor (2 Year) : 4.300 Geographic Factor (50 Year) : 15.900 Latitiude 5 .0000 Longitude : .0000 Standard IFD Temporal Pattern Used. Zone : 1 Link Data: Lnk Link Join Job Out Inp Max Oflow Basin Fplg Gaug I'con Phil Old Oflo Plot Label Revw Typ No. Link Stat Opt Hyd Flow Link Opt. Sway Hyd Basin Loss Urb Frac File Res 2 1.000 .000 1 3 0 Ο. .000 0 0 0 .000 0 0 1.00 0 DAM 1 <<----- End of Link Data ----->> _____ Linklabel. DAM LRRM + RBFR + Lagging Link No. 1.000 Laurenson Model Data: <-----> Pervious (or Lumped) -----> Cat. Imperv. Slope B Init. Cont. Imp. Perv. Var Area (%) (%) Loss Loss Data 'n' 'n' 5.2 100.00 2.000 .0000 1.50 .00 1 .020 Sub-cat (Perv.) : .52 .52 .52 .52 .52 .52 .52 .52 .52 .52

WARNING 8 - LOSSES POSS. EXCEED RAIN <----> Impervious -----> Cat. Imperv. Slope B Init. Cont. Imp. Perv. Var Loss Loss Data 'n' 'n' Area (%) (%) 52.4 5.00 2.000 .0000 20.00 2.50 .025 0 0 Sub-cat (Imperv.) : 5.24 5.24 5.24 5.24 5.24 5.24 5.24 5.24 5.24 5.24 WARNING 8 - LOSSES POSS. EXCEED RAIN Retarding Basin Data: Spillway Outlet Pipe Stage Stage Weir S/S Parameters Pipe
 A1
 B1
 C1
 Length
 Dia.
 Width
 Height
 Invert
 Slope
 No.
 Disch
 Stor.
 S/D

 .0
 .0
 5.00
 .01
 10.00
 178.50
 172.50
 .01
 1
 0
 1
 0
 Outflow No. Unrouted Baseflow Lower Local Change Peak Basins Baseflow Lagging Orifice Inflow Defaults 0. 1 .000 .000 .000 .000 1 Spillway Routing Start. Flap Coeff. Incr. Elev. Gate 1.700 200.0 178. 0 No. of values ---> 13 Stage/Storge Co-ordinates: 172.50 173.00 173.50 174.00 174.50 Stage: 175.00 .0 693.0 1010.0 Storage: 147.0 3745.0 6477.0 176.00 176.50 177.00 177.50 175.50 Stage: 178.00 14191.0 19244.0 9937.0 25191.0 31952.0 Storage: 39610.0 178.50 Stage: 48629.0 Storage: Lag ----> .00 (mins) ******* ##### RUNTIME RESULTS ##### Max. no. of links allowed = 280 Max. no. of routng increments allowed = 600 Max. no. of rating curve points = 200 Max. no. of storm temporal points = 2000 Max. no. of channel subreaches = 55

Max link stack level = 20

Input Version number = 400

LINK DAM (1.000)

DOITETING THE

ROUTING INCREMENT (MINS)	=	1.00	
STORM DURATION (MINS)	=	30.	
RETURN PERIOD (YRS)	=	500.	
BX	=	1.0000	
TOTAL OF FIRST SUB-AREAS	(HA)	=	5.18
TOTAL OF SECOND SUB-AREA	S (HA)	=	52.42
TOTAL OF ALL SUB-AREAS (HA)	=	57.60

SUMM	ARY OF C	ATCHMEN	T AND	RAINFAI	L	DATA						
Link	Catch.	Area	Sl	ope	돵	Imper	rvious	Pe	ern	F	3	Link
Label	#1	#2	#1	#2		#1	#2	#1	#2		#2	Ma
	(hecta	ares)	()	₹)			(%)		11 44	π.4	#4	NO.
DAM	5.180	52.420	2.000	2.000	1	100.0	5.000	.020	.025	.0037	.1159	1.000

Link Label	Average Intensity	Init. L #1	oss #2	Cont. #1	Loss #2	Excess #1	Rain #2	Peak	Time	Link
	(mm/h)	(mm)	(mm)	/h)	(mm	π2)	(m^3/s)	Peak	Lag (mins)
DAM	151.96	1.500 20	.00	.0000	2.500	74.482 5	55.024	14.151	30.00	.0000

SUMMARY OF BASIN RESULTS

Link	Time	Peak	Time	Peak	Total		Basin	
Label	to	Inflow	to	Outflow	Inflow	Vol.	Vol.	Stage
DAM	Peak	(m^3/s)	Peak	(m^3/s)	(m^3)	Avail	Used	Used
DAM	30.00	14.15	41.00	8.850	32417.0	.0000	60302.1	L 179.15

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor	Dia	Width	Pipe Length	Pipe Slope
DAM	1.0	(m)	(m) .0100	(m) - 000	(m) 5.000	(%) .0100

Run completed at: 12th February 2002 14:03:47

Run started at: 12th February 2002 12:52:56 RAFTS Data Echo Data File Name ---> C:\MYDOCU-1\MT-PEN-1\mount pe.dat Debug Options ---> NO save preprocesed file data echo listing NO suppress preprocessing Input Data Format ---> Fixed Job Number ---> 1 of 1 : Mt Penang Routing Increment (DT) ----> 1. (mins) Storm Data Type (IRAIN) -----> 1 (Std. Storm) Printer Plot Scale (IGMF) -----> 2 (lines) 0 (Inactive) Inter-connecting Basins (INTCB) -----> "B" Multiplier (BX) -----> 1.000 Convergence Tolerance (RELTOL) for INTCB ---> .050 Maximum Iterations (MAXITER) for INTCB ----> 10 Length of Routing Period (NVAL) -----> 300 Std. Storm: Duration (STORM) -----> 30. (mins) Recurrence Interval (RET) -----> 100. (VIS) Intensity calculated using IFD coefficients Rainfall Coefficients : 1 Hour 12 Hour 72 Hour 2 Year 35.000 8.500 2.600 50 Year 75.000 17.000 7.000 Location Skew .000 : Geographic Factor (2 Year) : 4.300 Geographic Factor (50 Year) : 15.900 Latitiude .0000 : Longitude .0000 : Standard IFD Temporal Pattern Used. Zone: 1 Link Data: Lnk Link Join Job Out Inp Max Oflow Basin Fplg Gaug I'con Phil Old Oflo Plot Label Revw Typ No. Link Stat Opt Hyd Flow Link Opt. Sway Hyd Basin Loss Urb Frac File Res 2 1.000 Ο. .000 0 0 0 .000 0 0 .000 1 3 0 1.00 0 DAM 1 <<---- End of Link Data ----->> LRRM + RBFR + Lagging Linklabel. DAM Link No. 1.000 Laurenson Model Data: <----> Pervious (or Lumped) -----> Cat. Imperv. Slope B Init. Cont. Imp. Perv. Var Loss Loss Data 'n' 'n' Area (%) (%) 5.2 100.00 2.000 .0000 1.50 .00 1 .020 0 Sub-cat (Perv.) : .52 .52 .52 .52 .52 .52 .52 .52 .52 . 52

WARNING 8 - LOSSES POSS. EXCEED RAIN <----> Cat. Imperv. SlopeBInit. Cont. Imp. Perv. VarArea(%)(%)Loss Loss Data 'n' 'n' 52.4 5.00 2.000 .0000 20.00 2.50 0 .025 0 Sub-cat (Imperv.) : 5.24 WARNING 8 - LOSSES POSS. EXCEED RAIN Retarding Basin Data: S/S Parameters Pipe Spillway Outlet Pipe Stage Stage Weir Al B1 C1 Length Dia. Width Height Invert Slope No. Disch Stor. S/D .0 .0 .0 5.00 .01 10.00 178.50 172.50 .01 1 0 1 0 Outflow No. Unrouted Baseflow Lower Local Change Peak Basins Baseflow Lagging Orifice Inflow Defaults .000 1 .000 0. .000 .000 1 Spillway Routing Start. Flap Coeff. Incr. Elev. Gate Coeff. Incr. 1.700 200.0 178. 0 Stage/Storge Co-ordinates: No. of values ---> 13 173.00 Stage: 172.50 173.50 174.00 174.50 175.00 Storage: . 0 147.0 693.0 1010.0 3745.0 6477.0 Stage: 175.50 176.00 176.50 177.00 177.50 178.00 Storage: 9937.0 14191.0 19244.0 25191.0 31952.0 39610.0 Stage: 178.50 48629.0 Storage: Lag ----> .00 (mins) ************************ ##### RUNTIME RESULTS ****** ##### Max. no. of links allowed = 280 Max. no. of routng increments allowed = 600 Max. no. of rating curve points = 200 Max. no. of storm temporal points = 2000

Max. no. of channel subreaches = 55

Max link stack level = 20

Input Version number = 400

LINK DAM (1.000)

Mt Penang

> ROUTING INCREMENT (MINS) = 1.00 STORM DURATION (MINS) = 30. RETURN PERIOD (YRS) 100. = BX 1.0000 -TOTAL OF FIRST SUB-AREAS (HA) = 5.18 TOTAL OF SECOND SUB-AREAS (HA) = 52.42 TOTAL OF ALL SUB-AREAS (HA) = 57.60

SUMMARY OF CATCHMENT AND RAINFALL DATA

Link	Catch.	Area	Slo	ope	ક	Imper	vious	Pe	rn	E	3	Link
Label	#1	#2	#1	#2		#1	#2	#1	#2	#1	#2	No.
	(hect	ares)	(9	ł)		(8)					
DAM	5.180	52.420	2.000	2.000		100.0	5.000	.020	.025	.0037	.1159	1.000

Link Average Init. Loss Cont. Loss Excess Rain Peak Time Link Label Intensity #1 #2 #1 #2 #1 #2 Inflow to Lag (mm/h) (mm) (mm/h) (mm) (m^3/s) Peak (mins) DAM 120.54 1.500 20.00 .0000 2.500 58.772 39.355 9.406 30.00 .0000

SUMMARY OF BASIN RESULTS

Link	Time	Peak	Time	Peak	Total		Basin	
Label	to	Inflow	to	Outflow	Inflow	Vol.	Vol.	Stage
	Peak	(m^3/s)	Peak	(m^3/s)	(m^3)	Avail	Used	Used
DAM	30.00	9.405	46.00	5.522	23603.1	.0000	57152.4	4 178.97

SUMMARY OF BASIN OUTLET RESULTS

Link	No.	S/D	Dia	Width	Pipe	Pipe
Label	of	Factor			Length	Slope
		(m)	(m)	(m)	(m)	(
DAM	1.0		.0100	.000	5.000	.0100

Run completed at: 12th February 2002 12:53:01

MOUNT PENANG DAM (STABILITY ANALYSIS)

MODEL

The stability analysis is set up for the following conditions on slopew

CASE 1	Full Storage Level (FSL)	RL 178.5
CASE 2	100 Year Storm event	RL 178.97
CASE 3	500 Year Storm event	RL 179.15
CASE 4	Rapid Draw Down (RDD)	

SOIL PROPERTIES

Two bore hole logs were taken from the dam embankment giving the following data:

Section A-A (BH1)

Depth (m)	Layer	Density (t/m ³)	Unit Weight (KN/m ³)	Cohesion (kPa)	Angle of Friction]
0-5.2	Silty Sand	2.1	21	3	36	1
5.2-6.5	Residual Silty Sand	2.2	22	3	38	1
6.5-6.9	Residual Clayey Sand	2	20	5	33	1
6.9-	Sandstone		25	15	40	Assi

the position.

Section B-B (BH2)

Depth (m)	Layer		Density (t/m ³)	Unit Weight (KN/m ³)	Cohesion (kPa)	Angle of Friction
0-2.5	Silty Sand		2.1	21	3	36
2.5-5	Residual Silty	Sand	1.8	18	3	38
5.0-6.0	Decomposed	Sandstone	2.2	22	5	33
6.0-	Sandstone		2.5	25	15	40

the position.

SUMMARY OF SLOPEW RESULTS

l,

			Peak ground acceleration	Peak ground acceleration		
			0.0023g	0.035g		
			Seismic Loading			
_	Case	Sensitivity Analysis	(1:100) AEP	(1:1000) AEP		
	1	2.275	2.253	1.972		
3H IIO	2	2.216	2.194	1.92		
Sect AA (B	3	2.186	2.164	1.895		
	4	2.128	2.107	1.846		
- Â	1	2.72	2.694	2.374		
3H.	2 2.467		2.245	2.16		
a (F	3 2.309		2.287	2.02		
BB	4	1.937	1.918	1.687		

Seismic data taken from the review of seismic for Mangrove Creek by the SPC (2000)



Soil: 5 Description: Weathered Sandstone Soil Model: Mohr-Coulomb Unit Weight: 25 Cohesion: 15 Phi: 40 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 2 Description: Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 21 Cohesion: 3 Phi: 36 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 3 Description: Residual Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 22 Cohesion: 3 Phi: 38 Piezometric Line #: 1 Pore-Air Pressure: 0 Soil: 4 Description: Residual Clayey Sand Soil Model: Mohr-Coulomb Unit Weight: 20 Cohesion: 5 Phi: 33 Piezometric Line #: 1 Pore-Air Pressure: 0

4

Description: Section AA (BH1) Comments: 100 Year Storm Event File Name: BH1_100.slp Last Saved Date: 08/05/2002 Last Saved Time: 16:49:02 Analysis Method: Bishop Direction of Slip Movement: Right to Left Slip Surface Option: Grid and Radius P.W.P. Option: Piezometric Lines / Ru Tension Crack Option: (none) Seismic Coefficient: (none)

Soil: 1 Description: Water Soil Model: No Strength Unit Weight: 9.807 Piezometric Line #: 1 Pore-Air Pressure: 0



Soil: 5 Soil: 2 Soil: 4 Soil: 3 **Description: Weathered Sandstone Description: Silty Sand** Description: Residual Silty SandDescription: Residual Clayey Sand Soil Model: Mohr-Coulomb Soil Model: Mohr-CoulombSoil Model: Mohr-Coulomb Soil Model: Mohr-Coulomb Unit Weight: 25 Unit Weight: 21 Unit Weight: 20 Unit Weight: 22 Piezometric Line #: 1 Piezometric Line #: 1 Piezometric Line #: 1 Piezometric Line #: 1 Pore-Air Pressure: 0 Pore-Air Pressure: 0 Pore-Air Pressure: 0 Pore-Air Pressure: 0

Mount Penang Dam: Mount Penang Dam-Section AA Comments: 500 Year storm event File Name: BH1_500.slp Last Saved Date: 08/05/2002 Last Saved Time: 16:52:15 Analysis Method: Spensor Bishef Direction of Slip Movement: Right to Left Slip Surface Option: Grid and Radius P.W.P. Option: Piezometric Lines / Ru Tension Crack Option: (none) Seismic Coefficient: (none)

Soil: 1 Description: Water Soil Model: No Strength Unit Weight: 9.807 Piezometric Line #: 1 Pore-Air Pressure: 0



Soil: 2 Description: Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 21 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 3 Description: Residual Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 22 Piezometric Line #: 1 Pore-Air Pressure: 0 Soil: 4 Description: Residual Clayey Sand Soil Model: Mohr-Coulomb Unit Weight: 20 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 5

Description: Weathered Sandstone Soil Model: Mohr-Coulomb Unit Weight: 25 Piezometric Line #: 1 Pore-Air Pressure: 0



Soil: 2 Description: Residual Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 22 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 3 Description: Residual Clayey Sand Soil Model: Mohr-Coulomb Unit Weight: 20 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 4 Description: Weathered Sandstone Soil Model: Mohr-Coulomb Unit Weight: 25 Piezometric Line #: 1 Pore-Air Pressure: 0 Mount Penang Dam: Section BB (BH2) Comments: Full Supply Level (BH2) File Name: BH2_FSL.slp Last Saved Date: 08/05/2002 Last Saved Time: 16:23:40 Analysis Method: Bishop Direction of Slip Movement: Right to Left Slip Surface Option: Grid and Radius P.W.P. Option: Piezometric Lines / Ru Tension Crack Option: (none) Seismic Coefficient: (none)

> Soil: 1 Description: Water Soil Model: No Strength Unit Weight: 9.807 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 2 Description: Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 21 Piezometric Line #: 1 Pore-Air Pressure: 0 Soil: 3 Description: Residual silty sand Soil Model: Mohr-Coulomb Unit Weight: 18 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 4Soil: 5Description: Decomposed SandstoneDescription: Weathered SandstoneSoil Model: Mohr-CoulombSoil Model: Mohr-CoulombUnit Weight: 22Unit Weight: 25Piezometric Line #: 1Piezometric Line #: 1Pore-Air Pressure: 0Pore-Air Pressure: 0

Mount Penang Dam: Section BB (BH2) Comments: 100 Year storm event (BH2) File Name: BH2_100.slp Last Saved Date: 08/05/2002 Last Saved Time: 16:37:44 Analysis Method: Bishop Direction of Slip Movement: Right to Left Slip Surface Option: Grid and Radius P.W.P. Option: Piezometric Lines / Ru Tension Crack Option: (none) Seismic Coefficient: (none)

> Soil: 1 Description: Water Soil Model: No Strength Unit Weight: 9.807 Piezometric Line #: 1 Pore-Air Pressure: 0



Soil: 2 Description: Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 21 Piezometric Line #: 1 Pore-Air Pressure: 0 Soil: 3 Description: Residual silty sand Soil Model: Mohr-Coulomb Unit Weight: 18 Piezometric Line #: 1 Pore-Air Pressure: 0 Soil: 4Soil: 5Description: Decomposed SandstoneDescription: Weathered SandstoneSoil Model: Mohr-CoulombSoil Model: Mohr-CoulombUnit Weight: 22Unit Weight: 25Piezometric Line #: 1Piezometric Line #: 1Pore-Air Pressure: 0Pore-Air Pressure: 0

Mount Penang Dam: Section BB (BH2) Comments: 500 Year storm event (BH2) File Name: BH2_500.slp Last Saved Date: 08/05/2002 Last Saved Time: 16:34:05 Analysis Method: Bishop Direction of Slip Movement: Right to Left Slip Surface Option: Grid and Radius P.W.P. Option: Piezometric Lines / Ru Tension Crack Option: (none) Seismic Coefficient: (none)

> Soil: 1 Description: Water Soil Model: No Strength Unit Weight: 9.807 Piezometric Line #: 1 Pore-Air Pressure: 0



Soil: 2 Description: Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 21 Piezometric Line #: 1 Pore-Air Pressure: 0 Soil: 3 Description: Residual silty sand Soil Model: Mohr-Coulomb Unit Weight: 18 Piezometric Line #: 1 Pore-Air Pressure: 0 Soil: 4Soil: 5Description: Decomposed SandstoneDescription: Weathered SandstoneSoil Model: Mohr-CoulombSoil Model: Mohr-CoulombUnit Weight: 22Unit Weight: 25Piezometric Line #: 1Piezometric Line #: 1Pore-Air Pressure: 0Pore-Air Pressure: 0

Mount Penang Dam: Section BB (BH2) Comments: Rapid Draw Down File Name: BH2_RDD.slp Last Saved Date: 08/05/2002 Last Saved Time: 16:43:18 Analysis Method: Bishop Direction of Slip Movement: Left to Right Slip Surface Option: Grid and Radius P.W.P. Option: Piezometric Lines / Ru Tension Crack Option: (none) Seismic Coefficient: (none)

Soil: 1 Description: Silty Sand Soil Model: Mohr-Coulomb Unit Weight: 21 Piezometric Line #: 1 Pore-Air Pressure: 0

Soil: 2 Soil: 3 Soil: 4 Description: Residual silty same scription: Decomposed Sandstone Scription: Weathered Sandstone Soil Model: Mohr-Coulomb Soil Model: Mohr-Coulomb Soil Model: Mohr-Coulomb Unit Weight: 18 Unit Weight: 22 Unit Weight: 25 Piezometric Line #: 1 Piezometric Line #: 1 Piezometric Line #: 1 Pore-Air Pressure: 0 Pore-Air Pressure: 0 Pore-Air Pressure: 0

Soil: 5 Description: Foundation Soil Model: Mohr-Coulomb Unit Weight: 25 Piezometric Line #: 1 Pore-Air Pressure: 0 DSC SURVEILLANCE REPORT- TYPE 3

NSW Dams Safety Committee SURVEILLANCE REPORT - TYPE 3

1.	NAME OF	DAM:							
	Mount Pena	ang Dam							
2.	LOCATION	N OF DAM: (a) River, Stream:-N	lot applicable						
	(b) Topogra	aphic Map :-	Gosford 9131-2-S						
	(c) Grid Re	ference:	33.4° S lat, 151.4° E long						
3.	DAM OWNER: Festival Development Corporation Phone No: 02 4340 1002								
	Address:	Administration Building, Pacifi	c Highway, Mount Penang, Kariong,						
		NSW 2250.							
4.	TYPE OF I	DAM (Please Tick)							
	NSW 2250. TYPE OF DAM (Please Tick) Embankment - Zoned Earthfill Concrete (or Masonry) - Grav - Homogenous Earthfill - Arch - Earth & Rockfill - Butti - Rockfill with impervious face (e.g. concrete) - Combination of these or other types (Describe briefly).								
	Combinatio	on of these or other types (Descri	be briefly).						
5.	DAM SIZE	E - Height (m): ~ 6m Catchment Area (sq km or ha)	Storage (ML) 48.6 : 57.6 ha						
6.	HAZARD RATING: (Refer DSC 13) - "Sunny Day": Medium, Incremental: Medium								
7.	FLOOD C.	APABILITY (a) Inflow Flood Pe	ak:- m3/s						
	(h) Estimat	– Please refer DI	WS Report DC 02029						
	(c) Method	& date of calculation:							

REPORT

Please supplement Report with sketches and photographs where appropriate. Include explanatory notes where space provided is insufficient. Please provide a comment in each section to confirm all features are inspected (including not applicable, nil ,etc., if appropriate).

A. CONDITIONS AT TIME OF INSPECTION

- a) Weather: Sunny and Warm
- b) Storage Level: ~ R.L. 178.0m, 0.5m. below full supply level.
- c) Date of most recent rain (Station No. 61087-Gosford) Total rainfall recorded for the month of December, 2001 was 33.6mm.

EMBANKMENT DAM

General condition of upstream face?
Satisfactory. General grass cover and beaching in visible areas.

- 9. Location and extent of any cracks, slips, erosion, or subsidences in earth/rock materials: An eroded gully/seepage area was observed to the south of the southern embankment toe section.
- Location and extent of any cracks or other defects in concrete/bitumen or other impervious face: Not applicable.

- General condition of downstream face: Thick grass cover is obstructing close observation. A seepage area was observed on the southern side of the embankment.
- 12. Describe any leakage/seepage through dam, foundations or abutments (give location, quantity, clear or coloured):Evidence of seepage flow through the southern embankment and flowing along the

eroded gully located south of the southern toe. There is no seepage measuring device on site but the seepage is clear and appears to be small.

B. CONCRETE OR MASONRY DAM

 Location and extent of any defects such as cracks, surface deterioration, etc.: Not applicable.

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14. Describe any leakage/seepage through dam, foundation or abutments (give location, quantity, clear or coloured):
Not applicable.

15. Give details of any drains in the dam and state whether they are open or blocked. Are they flowing?Not applicable.

C. SPILLWAY

16. Type of spillway and nature of discharge channel (e.g. grassed, rock, concrete lined, etc.):

Grassed overflow spillway with a sloping crest and a poorly defined discharge channel.

- Location and extent of any erosion: Minor erosion observed in the discharge channel. Erosion in the southern gully apperas to be bottoming out on a rocky base.
- Location and extent of any obstructions to flow (logs, etc.): Not apparent.

- Location and extent of any defects in concrete or masonry: Not applicable.
- 20. Give number, size, type and condition of any gates or stoplogs (including operating
- Give number, size, type and condition of any gates or stoplogs (including operating facility):

Not applicable.

21. Provide information on the highest flood (and date of occurrence) passed by the spillway including height relative to crest of dam. Is the spillway capacity considered adequate and basis of assessment?

D. OUTLET WORKS

22. General description:

The pumped outlet works was located at the eastern end. The feeder channel was poorly defined and covered with thick grass. The additional feeder pipe for pumping in from an upstream creek system was not possible to be located.

23. State whether outlet works are in good working order, if not, give details: The pump was operating at the time of this inspection.

E. INSTRUMENTATION OR MEASURING POINTS

24. Brief description of instrumentation: Instrumentation not present on site. 25. Do instruments indicate normal behaviour of dam, if not, give details? Not applicable.

F. HAZARD RATINGS

(Please refer to Information Sheet DSC 13 for explanation).

26. State the adverse consequences which justify the sunny day hazard rating. A school and some buildings are located on the eastern end and there may be ample time to evacuate people. The damage to the buildings may be medium.

27. State the adverse consequences which justify the incremental flood hazard category. There may be medium scale damage to the buildings.

G. OTHER MATTERS

28. Are there any other matters within the owner's knowledge which could affect the safety of the dam?

The design and construction details (WAE) for the dam are not available. Thick grass cover prevents close observation of the embankment and the inlet and outlet channels.

29. Is the dam considered to be in a safe condition? Indicate any measures necessary to make the dam safe.

The dam appears to be in a safe condition. Spillway and the discharge channel should be well defined and protected against erosion damage. Design and construction details should be perused and compiled for reference. Thick grass cover should be reduced to allow closer inspection of the embankment, seepage areas, feeder channel, spillway and the outflow channel.

CERTIFICATION

This is to certify that the information submitted in this report is true and is based on a recent inspection of the dam and its associated works and is, to the best of my knowledge, true and correct.

Signature: -----

Mal Halwala Name of person making inspection

Senior Surveillance Engineer (Occupation, e.g. civil engineer, manager, etc.)

Date::

21-02-2002

This is to certify that I have read the above report and accept the findings.

Signature:	
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Name of Owner/Owner's authorised	representative

Date:

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NSW Dams Safety Committee: Staff Comments and Recommendation:

Surveillance Subcommittee's recommendations to the Committee:

Mount Penang Dam Surveillance Report Type 3, Feb., 2002



View of the storage from the southern corner of the dam



View from the east end (north of the pump house seen on the left corner)



Seepage gully south of the southern embankment



Lush vegetation on the southern embankment downstream face suggesting possible seepage area

Photographs-

Mount Penang Dam Surveillance Report Type 3, Feb., 2002



Seepage in the gully south of the southern embankment toe section



View of the spillway from the southern embankment



School and buildings on the eastern side





Monthly Rainfall reported at GOSFORD (NARARA RESEARCH STATION)

Period : 01 Dec2001 - 01 Jan2002 NB Stations yet to report have +++++ in their 'data' column

Explanation of header codes:-

date	data collected up to 0900 local time, 1st of the month
stn_num	station number
pr_name	station name
latitude	Latitude of the station in decimal degrees, where latitude south is a negative number (e.g30.83 deg)
longitude	Longitude of the station in decimal degrees (e.g. 143.83 deg)
stn height	Station height in meters above mean sea level
prec	Monthly precipitation (millimeters to 0.1) Stations yet to report have +++++ in this column)
dc	Precipitation period, number of days when rainfall was recorded
of	Observation quality code 0 = quality controlled (registered users data) 1,2,3 = no quality control + = no report, so no quality code

date :	stn_	:		pr_nam	e		: :	long	:]	.at	: s	tn :	month	:dc:o
yyyy-mm:	num	:					:		:		:he	ight:	precip	p: :f
		:					;		:		.:			
2001-12:	06108	7:GOSF	ORD (NARAR	A RESEARCH	STATION)	AWS	:19	51.33	1:-3	3.39	:	20.0:	33.6	5: 9:1



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