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Mid-Western Regional Council

Report for Redbank Creek Dam

Evaluation of Bypass Spillway Option

July 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Appendices

1. Introduction

1.1 Project Background

Redbank Creek Dam is a gravity arch dam with a maximum height of 16m from the foundation and has a crest length of 152m. The radius of curvature at the upstream face of the dam wall is 77m. The dam was constructed between 1897 and 1899, as a water supply dam for the town of Mudgee.

The dam was constructed without any contraction joints (vertically in the upstream downstream direction) and was constructed essentially in continuous lifts across the dam. Seven semi vertical cracks, transverse to the dam axis, have formed extending from the crest to the base of the dam. The average distance between the cracks is approximately 16.5m. These cracks are believed to have formed soon after the construction and were reported as early as 1909. Wade (1909) suggested that the vertical cracks are due to both drying shrinkage (water loss from the concrete after placement) and as a result of temperature variations (cracks close and open with changes of temperatures and with the absorption or loss of moisture by the concrete). It was further reported that the cracks almost disappear in the hot periods of summer when water levels are low or during winter when water levels are high, with their maximum opening occurring during winter with low water levels.

Past studies, including the PWD (1995) and GHD (2002), have demonstrated that the dam does not satisfy the current acceptable safety criteria guidelines. It was found that the dam has a deficient spillway discharge capacity and an inadequate factor of safety against sliding, even for the normal operation load case (reservoir at Full Supply Level). Despite this, the dam has stored water to the existing crest level and has passed floodwaters over the crest without failing or showing significant signs of distress.

In 2008, DOC developed a detailed design for stabilising the dam. The design included the following features:

- Cutting down of the crest to RL 535.11m AHD; i.e. 3.76m from the top of the existing crest at RL 538.87 m AHD;
- Provision of a drop inlet spillway to lower the full supply level to RL 532.61 m AHD;
- Installation of 21 post tensioned sub-vertical cables on the downstream face of the dam – the cables dip upstream at 60^{o} (to the horizontal) and pass from the concrete into the foundation at a distance of 0.5m from the upstream heel of the dam;
- Installation of 9 post tensioned vertical cables at the crest of the dam, contained within the body of the dam;
- Provision of foundation drains dipping upstream at approximately 60^{o} from ground level at the downstream toe of the dam;
- Provision for grouting of six vertical cracks;
- Repair of cracks and cavities;
- Provision of a waterproofing system for the upstream concrete surface; and
- Provision of a slab at the toe of the dam, as protection against foundation erosion at the toe of the

dam.

Subsequently, a 1.6 m diameter outlet pipe at RL 526.21m AHD has been installed through the dam. A toe erosion protection slab was also installed in the vicinity of the outlet pipe. The outlet pipe through the dam now means that the dam is unable to store water, apart from during floods when inflow exceeds outflow through the pipe. The dam therefore now acts as a flood retarding basin and there is no risk of a "Sunny Day" dam break event.

The existing dam reservoir is only fully filled and overtopped during severe storm events (in excess of 1:1,000 year AEP). Therefore, it was considered appropriate that the scope of the stabilisation work should be reviewed.

1.2 Scope of Study

Mid Western Regional Council engaged GHD Pty Ltd (GHD) in November 2009 to investigate the feasibility of constructing a bypass spillway on either the left or right abutment to mitigate the dam safety risk during severe flood events. GHD subsequently visited the site in February 2010 and it was agreed that the bypass spillway option had a number of challenges, including maintenance of access to the Avisford Nature Reserve for fire fighting equipment, cost of construction and issues surrounding erosion, both in the bypass channel and where flows would return to the river.

In view of the above and in the light of the fact that the dam now acts as a flood retarding structure, GHD was requested to evaluate the works necessary to maintain the stability of the dam, particularly whether some or all of the remaining elements of the Department of Commerce design (2008) would need to be implemented. This evaluation is contained in the GHD report “Redbank Creek Dam: Alternative Stabilisation Works” (May 2010).

The report recommended the following works:

- Reducing the crest level of the dam by approximately 3.7m,
- Installation of inclined stressed anchors along the toe of the dam over the highest dam sections,
- Miscellaneous works including security fencing, placing of rip rap, monitoring of the dam and maintenance of the early warning system.

In view of the fact that the dam is over 100 years old, Council wished to investigate alternative options for increasing the stability of the dam during large flood events and which would retain the dam essentially in its present condition. The installation of a channel spillway on either the right or left flank of the dam could provide a means of safely passing floods around the dam without imposing too large a load on the structure.

During the February 2010 site visit it was agreed that, should the bypass option be considered further, the most appropriate side on which to locate the spillway was the right bank, since this was less steep than the left bank and would therefore result in a more cost effective solution. However, an access track to the Avisford Nature Reserve for the control of fires is located on the right bank and would need to be realigned in the event a side channel spillway is constructed.

This report discusses the merits of installing a bypass spillway around the dam.

2. Concept Design of Spillway on Right Flank

2.1 Design Assumptions

In order to determine the spillway profile, it was necessary to make a number of assumptions in regard to the operation of the spillway. In order to be comparable to the option of reducing the overall height of the dam, and to provide a similar level of protection, the following assumptions were made:

- The spillway will commence operation at floods of return period greater than 1:100 years. Based on flood routing calculations the floor level for the spillway is set at RL 534.5 m.
- The spillway will pass the 1:100,000 year flood before water commences spilling over the spillway of the existing concrete dam.
- Cut slopes on the excavated spillway will be 1H:2V. Should this option be adopted, the stability of the cut slopes would need to be evaluated to ensure they are stable. In order to evaluate the slope stability, core drilling would be required.
- The spillway will be unlined. This assumption would need to be proved by additional site investigations (core drilling) in order to confirm the long-term stability of the spillway.

2.2 Conceptual Spillway Layout

Based on the design assumptions listed in Section 2.1 above, a 20 m wide channel would be required. The floor of the channel will be provided with a slope of 1V:150H. The channel will be approximately 110 m long. The fire track will follow its existing alignment into the spillway and a new track would be provided to link into the fire track on the upstream side of the spillway.

The proposed layout of the channel spillway is shown on Figure 1, which is included under Appendix A. Approximately 16,500 m3 of material will need to be excavated to form the channel. Much of this material is expected to be in weathered or partially weathered shale or mudstone horizons.

2.3 Works Required to Assure Stability of Existing Dam Wall

With reference to the GHD report “Redbank Creek Dam: Alternative Stabilisation Works” (May 2010), it will be necessary to assure the stability and continued reliability of the existing concrete wall. The following work would be required:

- Installation of inclined anchors at the toe of the dam, on the highest sections,
- Regular monitoring of cracks,
- Monitoring of the quality of concrete in the future, in respect of durability, weathering and continued ability to be “fit for purpose”.

In addition, the existing early warning system for flooding would need to be maintained.

3. Cost Estimate

Comparative cost estimates have been drawn up to compare the option of reducing the height of the dam to that of retaining the dam in its present condition and providing a spillway around the side of the dam.

Detailed cost estimates are provided in Appendix B. A summary of the cost estimates is given in Table 1 below.

Table 1 Comparative Costs

Item	Description	Option 1 Reduce Height of Dam	Option 2a Side Channel Spillway (unlined)	Option 2b Side Channel Spillway (lined)
1	Pre-construction documentation (EMP, OHS, QA, etc.)	30,000	30,000	30,000
2	Possession of Site, mobilisation, demobilisation	82,000	82,000	82,000
3	Earthworks	16,770	596,230	596,230
4	Concrete Works	735,110	40,000	564,000
5	Post-tensioning works on D/S face of Dam	605,380	605,380	605,380
6	Post-tensioning works for abutment strengthening	0	109,350	109,350
7	Erosion Protection	27,000	200,000	200,000
8	Reinstatement of fire track	0	50,000	50,000
9	Security Fencing	5,900	5,900	5,900
10	WAE drawings	5,470	5,470	5,470
11	Contract documentation, call and assess tenders	50,000	180,000	180,000
	Sub-total ($)	1,557,630	1,904,330	2,428,330
12a	Contingency on concrete dam related items (10%)	155,760	132,500	132,500
12b	Contingency on channel spillway related items (20%)		115,870	220,670
	Total ($)	**1,713,390**	**2,152,700**	**2,781,500**
	Relative Costs	**100%**	**126%**	**162%**

3.1 Points to note in regard to Cost Estimates

The following should be noted in regard to the cost estimates:

- The cost estimate for the post tensioning anchors and concrete is based on tender prices obtained late in 2008 for the works. The 2008 rates have been increased by 10% to take account of inflation since late 2008.
- The rates for the excavations and concrete works have been based on recent estimates compiled for similar works by a Quantity Surveyor.
- The conceptual design for the side channel spillway is based on incomplete geotechnical information. Should Council wish to pursue this option further, it is recommended that site specific geotechnical information should be obtained by a programme of drilling, pitting and site walkover by a geologist or geotechnical engineer.
- Provision has been included in the cost estimate for the side channel spillway of a retaining wall anchored to the foundations by prestressed anchors. Should Council wish to pursue this option, a detailed design would be required in order to determine the actual support that would be required for the concrete dam wall.
- The cost estimates for the channel spillway should be taken as indicative only as they are based on a preliminary concept design.
- Two cost estimates have been compiled for the channel spillway option. The reason for this is that there is no certainty at this stage that the rock will be suitable to resist flows if it is not lined. The two cost estimates are therefore intended to provide indicative upper and lower bound estimates for this option.
- An amount of $200,000 has been included in the channel spillway option for erosion protection works that would be required on the downstream side of the spillway. These works would also need to be considered in more detail should Council wish to pursue this option further.
- Additional design fees and an allowance for geotechnical site investigations have been included for the channel spillway option, since this work would be required should Council wish to proceed with this option.
- In view of the greater uncertainty in regard to the design of the channel spillway, a contingency of 20% has been included for those items related directly to the channel spillway. A contingency of 10% has been included for those items related to works required to stabilise the concrete dam, since these have been designed in detail and there is therefore less uncertainty in regard to the cost of this work.

4. Discussion

The comparative costs indicate a cost penalty of between 25% and 60% if the dam is to be retained in its present condition and a channel spillway provided on the left hand side of the dam. This is a relatively large cost differential.

The construction of the channel will result in reduced flood attenuation, since the spillway will operate from the 1:100 year flood, compared to the cut-down dam option which spills at about the 1:1,000 year flood.

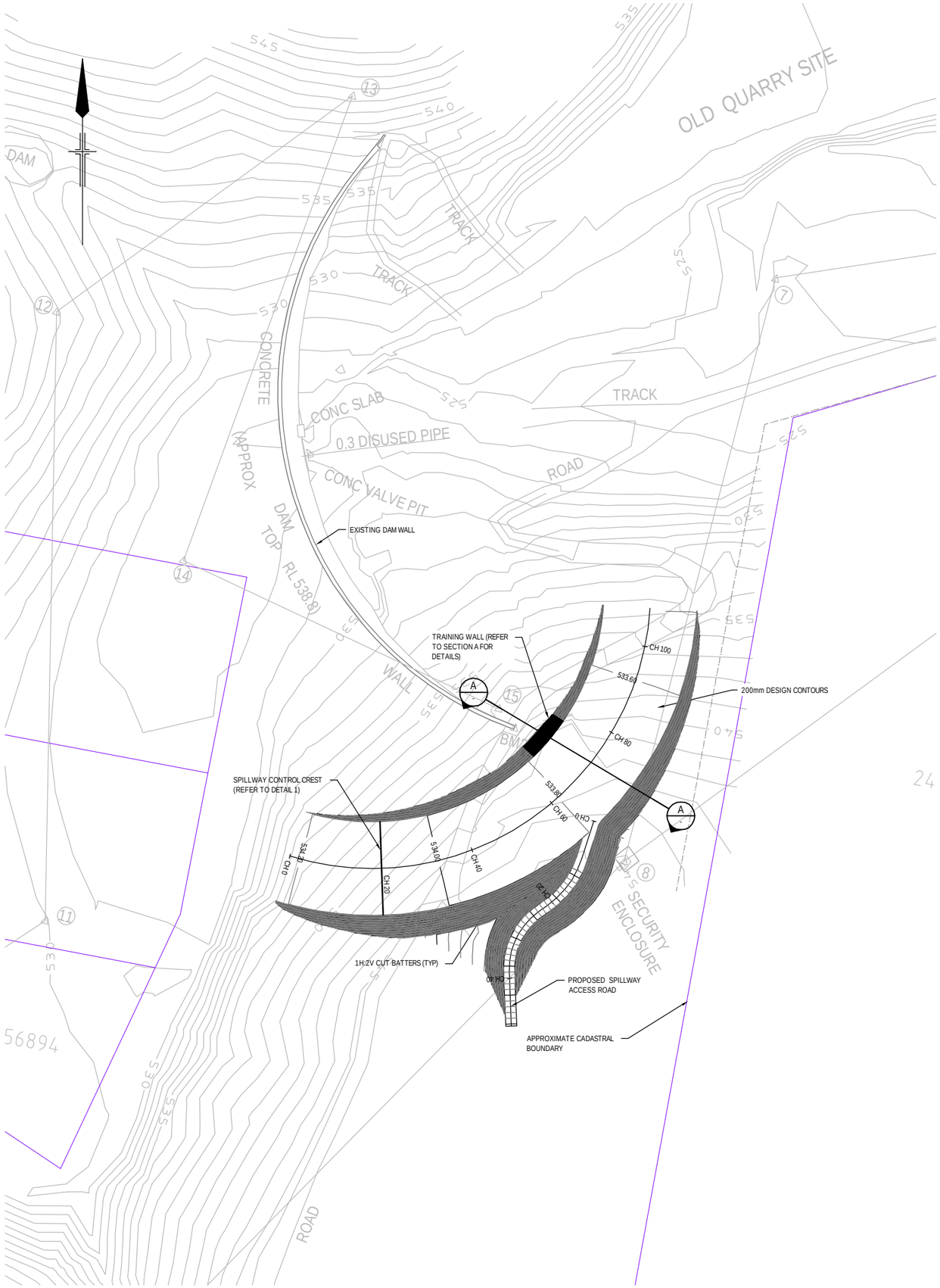
The side channel will result in additional environmental degradation due to the excavation and resultant material that will need to be wasted.

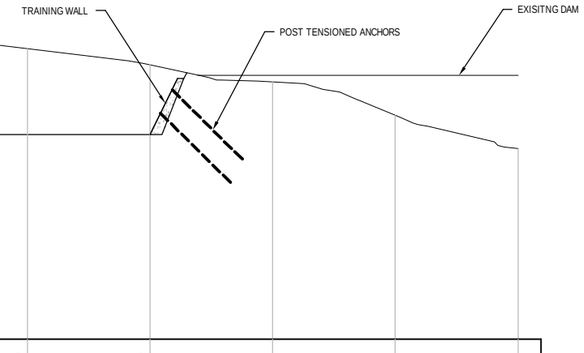
If the principal reason for retaining the dam in its present condition is based on its historical value, it is suggested that there are sufficient examples of this type of construction in other areas of NSW that the loss of a portion of this dam should not be an over-riding factor in the decision making process.

There appears therefore not to be any over-riding reasons for retaining the dam in its present form and it is recommended that Council proceed with the option of reducing the height of the dam by 3.76 m, as recommended in the GHD report “Redbank Creek Dam: Alternative Stabilisation Works” (May 2010).

Appendix A

Figures

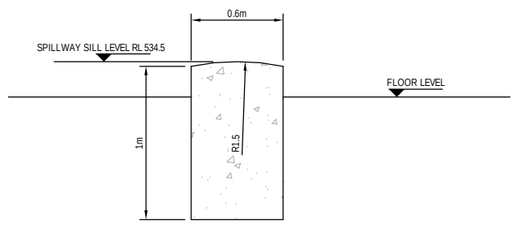




DATUM 517.0

SPILLWAY LEVEL		533.683	533.683	533.684			
EXISTING LEVEL	542.132	541.557	540.665	539.354	537.963	535.213	532.502
CHAINAGE	-20.000	-10.000	0.000	10.000	20.000	30.000	40.000

A SECTION
SCALE 1 : 250



SPILLWAY CONTROL CREST
DETAIL 1
SCALE 1:10

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

PRELIMINARY

rev	description	app'd	date
A	INITIAL ISSUE		

Mid - Western Regional Council
Redbank Creek Dam

Proposed Spillway Option General Layout

GHD CLIENTS | PEOPLE | PERFORMANCE

57-63 Herbert Street Artarmon NSW 2064 Australia
Locked Bag 2727 St Leonards NSW 1590
T 61 2 9462 4700 F 61 2 9462 4710
E stnmail@ghd.com W www.ghd.com

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scale 1:500 for A1 | job no. 21-19151
date JULY 2010 | rev no. A

approved SK001

Plot Date: 9 July 2010 - 2:45 PM Plotted by: Van Nguyen/Sydney/GHD/AU Cad File No: G:\21\19151\CADD\Drawings\21-19151-SK001.dwg

Appendix B

Cost Estimates

Option 1 - Reduce Dam Crest Level by 3.76m, Install Inclined Anchors on Downstream Face of Dam

Item No.	Description	Quantity	Unit	Rate	Cost
1	**Pre-Construction Documentation (EMP, OHS, QA etc)**	1	Item	Lump Sum	$30,000
2	**Possession of site, mobilisation, demobilisation**	1	Item	Lump Sum	$82,000
3	**Earthworks**				
3.1	Access ramps/tracks	1	Item	Lump Sum	$16,770
4	**Concrete Works**				
4.1	Excavate existing top section of the dam	1	Item	Lump Sum	$664,560
4.2	Reinforced concrete capping over cut-down crest (100mm thick)	1	Item	Lump Sum	$70,547
5	**Post Tensioning Works on D/S Face (4 strand-15.2mm dia.)**				
5.1	Estabilishment of Drilling Plant	1	Item	Lump Sum	$110,418
5.2	Setup for drilling P/T cable holes (4 strand - 15.2mm diam.)	1	Item	Lump Sum	$33,741
5.3	Core Drill Head Blocks	1	Item	Lump Sum	$27,733
5.4	Hammer Drill 150mm diam. Holes for P/T cables	378	m	$109	$41,302
	(for quantities between 280m - 475m)				
5.5	Setup for and water testing of P/T cable holes in the foundation	1	Item	Lump Sum	$4,803
5.6	Hookups for water proof grouting	1	Item	Lump Sum	$8,131
5.7	Water proof grouting of P/T cable holes	255	Bags	$43	$11,015
	(for quantities between 200 Bags to 400 Bags)				
5.8	Redrilling after water proof grouting	600	m	$83	$49,550
	(for quantities 400m to 750m)				
5.9	Supply and install 4 strand - 15.2mm diam. P/T cables along with	1	Item	Lump Sum	$165,419
	associated components (includes fabrication, handling and stressing)				
5.10	Hookup for grouting P/T cables	1	Item	Lump Sum	$11,943
5.11	Crane hire etc.	1	Item	Lump Sum	$55,512
5.12	Cement for grouting P/T cables	225	Bags	$43	$9,720
	(for quantities between 200 Bags to 400 Bags)				
5.13	Extra for work and material associated with post-tensioned test cable	1	Item	Lump Sum	$58,262
5.14	Anchor covers	1	Item	Lump Sum	$17,832
6	**Post Tensioning Works for Abutment Stenghening**				
	(5 No., 4 strand-15.2mm dia.)				
	Not Applicable	1	Item	Lump Sum	$0
7	**Erosion Protection**				
	Broken Concrete as rock protection (0.45m thick)	1	Item	Lump Sum	$22,000
	Geofabric filter cloth	1	Item	Lump Sum	$5,000
8	**Reinstatement of access track**				
	Not Applicable	1	Item	Lump Sum	$0
9	**Security Fencing**	1	Item	Lump Sum	$5,900
10	**WAE Drawings**	1	Item	Lump Sum	$5,470
	Total Construction Costs				**$1,507,625**
11	**Other**				
11.1	Design and Approvals	1	Item	Lump Sum	$0
11.2	Contract documentation, call and assess tenderers	1	Item	Lump Sum	$50,000
	Sub-Total				**$1,557,625**
12	**Contingency @ 10%**				$155,763
	Total Costs				**$1,713,388**

Option 2a - Install Inclined Anchors on Downstream Face of Dam and Excavate Spillway Channel around Right Abutment

Item No.	Description	Quantity	Unit	Rate	Cost
1	**Pre-Construction Documentation (EMP, OHS, QA etc)**	1	Item	Lump Sum	$30,000
2	**Possession of site, mobilisation, demobilisation**	1	Item	Lump Sum	$82,000
3	**Earthworks**				
3.1	Access ramps/tracks	1	Item	Lump Sum	$16,770
3.2	Excavate Spillway Channel	16,556	m^3	$35	$579,460
4	**Concrete Works**				
4.1	Excavate existing top section of the dam	0	Item	Lump Sum	$0
4.2	Reinforced concrete capping over cut-down crest (150 mm thick)	0	Item	Lump Sum	$0
4.3	Reinforced concrete wall for abutment strengthening	20	m^3	$2,000	$40,000
5	**Post Tensioning Works on D/S Face (21 No., 4 strand-15.2mm dia.)**				
5.1	Estabilishment of Drilling Plant	1	Item	Lump Sum	$110,418
5.2	Setup for drilling P/T cable holes (4 strand - 15.2 mm diam.)	1	Item	Lump Sum	$33,741
5.3	Core Drill Head Blocks	1	Item	Lump Sum	$27,733
5.4	Hammer Drill 150mm diam. Holes for P/T cables	378	m	$109	$41,302
	(for quantities between 280 m - 475 m)				
5.5	Setup for and water testing of P/T cable holes in the foundation	1	Item	Lump Sum	$4,803
5.6	Hookups for water proof grouting	1	Item	Lump Sum	$8,131
5.7	Water proof grouting of P/T cable holes	255	Bags	$43	$11,015
	(for quantities between 200 Bags to 400 Bags)				
5.8	Redrilling after water proof grouting	600	m	$83	$49,550
	(for quantities 400 m to 750 m)				
5.9	Supply and install 4 strand - 15.2mm diam. P/T cables along with	1	Item	Lump Sum	$165,419
	associated components (includes fabrication, handling and stressing)				
5.10	Hookup for grouting P/T cables	1	Item	Lump Sum	$11,943
5.11	Crane hire etc.	1	Item	Lump Sum	$55,512
5.12	Cement for grouting P/T cables	225	Bags	$43	$9,720
	(for quantities between 200 Bags to 400 Bags)				
5.13	Extra for work and material associated with post-tensioned test cable	1	Item	Lump Sum	$58,262
5.14	Anchor covers	1	Item	Lump Sum	$17,832
6	**Post Tensioning Works For Abutment Strengthening**				
	(5 No., 4 strand-15.2mm dia.)				
6.1	Setup for drilling P/T cable holes (4 strand - 15.2 mm diam.)	1	Item	Lump Sum	$8,034
6.2	Core Drill Head Blocks	1	Item	Lump Sum	$0
6.3	Hammer Drill 150mm diam. Holes for P/T cables	65	m	$217	$14,105
	(use rate for quantities between 110 m - 150 m)				
6.4	Setup for and water testing of P/T cable holes in the foundation	1	Item	$1,143	$1,143
6.5	Hookups for water proof grouting	1	Item	Lump Sum	$1,936
6.6	Water proof grouting of P/T cable holes	61	Bags	$56	$3,427
	(for quantities between 60 Bags to 120 Bags)				
6.7	Redrilling after water proof grouting	105	m	$164	$17,220
	(use rates for quantities 110 m to 150 m)				
6.8	Supply and install 4 strand - 15.2mm diam. P/T cables along with	1	Item	Lump Sum	$39,386
	associated components (includes fabrication, handling and stressing)				
6.9	Hookup for grouting P/T cables	1	Item	Lump Sum	$2,844
6.10	Cement for grouting P/T cables	54	Bags	$58	$3,134
	(use rate for quantities between 50 Bags to 100 Bags)				
6.11	Extra for work and material associated with post-tensioned test cable	1	Item	Lump Sum	$13,872
6.12	Anchor covers	1	Item	Lump Sum	$4,246
7	**Erosion Protection**	1	Item	Lump Sum	$200,000
8	**Replacement of Access Road**	1	Item	Lump Sum	$50,000
9	**Security Fencing**	1	Item	Lump Sum	$5,900
10	**WAE Drawings**	1	Item	Lump Sum	$5,470
	Total Construction Costs				**$1,724,325**
11	**Other**				
11.1	Design and Approvals	1	Item	Lump Sum	$50,000
11.2	Engineering Geotechnical Investigation	1	Item	Lump Sum	$80,000
11.3	Contract documentation, call and assess tenderers	1	Item	Lump Sum	$50,000
	Sub-Total				$1,904,325
12	**Contingency**				
12.1	Contingency @ 10% (Items 1, 2, 3, 5, 9 and 10)				$132,498
12.2	Contingency @ 20% (Items 4, 6, 7, 8 and 11)				$115,869
	Total Costs				**$2,152,692**

Option 2b - Install Inclined Anchors on Downstream Face of Dam and
Excavate Spillway Channel around Right Abutment and Line Channel with Reinforced Concrete

Item No.	Description	Quantity	Unit	Rate	Cost
1	**Pre-Construction Documentation (EMP, OHS, QA etc)**	1	Item	Lump Sum	$30,000
2	**Possession of site, mobilisation, demobilisation**	1	Item	Lump Sum	$82,000
3	**Earthworks**				
3.1	Access ramps/tracks	1	Item	Lump Sum	$16,770
3.2	Excavate Spillway Channel	16,556	m^3	$35	$579,460
4	**Concrete Works**				
4.1	Excavate existing top section of the dam	1	Item	Lump Sum	$0
4.2	Reinforced concrete capping over cut-down crest (150mm thick)	1	Item	Lump Sum	$0
4.3	Reinforced concrete wall for abutment strengthening in spillway channel	20	m^3	$2,000	$40,000
4.5	Reinforced concrete lining of spillway	262	m^2	$2,000	$524,000
5	**Post Tensioning Works on D/S Face (21 No., 4 strand-15.2mm dia.)**				
5.1	Estabilishment of Drilling Plant	1	Item	Lump Sum	$110,418
5.2	Setup for drilling P/T cable holes (4 strand - 15.2mm diam.)	1	Item	Lump Sum	$33,741
5.3	Core Drill Head Blocks	1	Item	Lump Sum	$27,733
5.4	Hammer Drill 150mm diam. Holes for P/T cables	378	m	$109	$41,302
	(for quantities between 280m - 475m)				
5.5	Setup for and water testing of P/T cable holes in the foundation	1	Item	Lump Sum	$4,803
5.6	Hookups for water proof grouting	1	Item	Lump Sum	$8,131
5.7	Water proof grouting of P/T cable holes	255	Bags	$43	$11,015
	(for quantities between 200 Bags to 400 Bags)				
5.8	Redrilling after water proof grouting	600	m	$83	$49,550
	(for quantities 400m to 750m)				
5.9	Supply and install 4 strand - 15.2mm diam. P/T cables along with	1	Item	Lump Sum	$165,419
	associated components (includes fabrication, handling and stressing)				
5.10	Hookup for grouting P/T cables	1	Item	Lump Sum	$11,943
5.11	Crane hire etc.	1	Item	Lump Sum	$55,512
5.12	Cement for grouting P/T cables	225	Bags	$43	$9,720
	(for quantities between 200 Bags to 400 Bags)				
5.13	Extra for work and material associated with post-tensioned test cable	1	Item	Lump Sum	$58,262
5.14	Anchor covers	1	Item	Lump Sum	$17,832
6	**Post Tensioning Works For Abutment Strengthening**				
	(5 No., 4 strand-15.2mm dia.)				
6.1	Setup for drilling P/T cable holes (4 strand - 15.2mm diam.)	1	Item	Lump Sum	$8,034
6.2	Core Drill Head Blocks	1	Item	Lump Sum	$0
6.3	Hammer Drill 150mm diam. Holes for P/T cables	65	m	$217	$14,105
	(use rate for quantities between 110m - 150m)				
6.4	Setup for and water testing of P/T cable holes in the foundation	1	Item	$1,143	$1,143
6.5	Hookups for water proof grouting	1	Item	Lump Sum	$1,936
6.6	Water proof grouting of P/T cable holes	61	Bags	$56	$3,427
	(for quantities between 60 Bags to 120 Bags)				
6.7	Redrilling after water proof grouting	105	m	$164	$17,220
	(use rates for quantities 110m to 150m)				
6.8	Supply and install 4 strand - 15.2mm diam. P/T cables along with	1	Item	Lump Sum	$39,386
	associated components (includes fabrication, handling and stressing)				
6.9	Hookup for grouting P/T cables	1	Item	Lump Sum	$2,844
6.10	Cement for grouting P/T cables	54	Bags	$58	$3,134
	(use rate for quantities between 50 Bags to 100 Bags)				
6.11	Extra for work and material associated with post-tensioned test cable	1	Item	Lump Sum	$13,872
6.12	Anchor covers	1	Item	Lump Sum	$4,246
7	**Erosion Protection**	1	Item	Lump Sum	$200,000
8	**Replacement of Access Road**	1	Item	Lump Sum	$50,000
9	**Security Fencing**	1	Item	Lump Sum	$5,900
10	**WAE Drawings**	1	Item	Lump Sum	$5,470
	Total Construction Costs				**$2,248,325**
11	**Other**				
11.1	Design and Approvals	1	Item	Lump Sum	$50,000
11.2	Engineering Geotechnical Investigation	1	Item	Lump Sum	$80,000
11.3	Contract documentation, call and assess tenderers	1	Item	Lump Sum	$50,000
	Sub-Total				$2,428,325
12	**Contingency**				
12.1	Contingency @ 10% (Items 1, 2, 3, 5, 9 and10)				$132,498
12.2	Contingency @ 20% (Items 4, 6, 7, 8 and 11)				$220,669
	Total Costs				**$2,781,492**

GHD

133 Castlereagh St, Sydney, NSW 2000

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T: 2 9239 7100 F: 2 9239 7199 E: sydmail@ghd.com.au

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Document Status

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		Name	Signature	Name	Signature	Date
Final	T Ng	P Ballantine		P Ballantine		07/2010