WIVENHOE DAM

ANNUAL DAM SAFETY INSPECTION 2008

Date of Inspection:	11 November 2008	
Inspected by:	John Tibaldi – Seqwater	
	Barton Maher – Seqwater	
	Mick Drews - Seqwater	
Others present:	Carl Roberts - Seqwater	
	Doug Grigg - Seqwater	
Report Prepared by:	John Tibaldi (RPEQ 2525)	
Field Conditions:	Clear	☒
	Cloudy	☐
	Overcast	☐
	Rain	☐
	Rainfall	Nil

EXECUTIVE SUMMARY

On 1 July 2008, the ownership of Wivenhoe Dam was transferred to the new Seqwater entity. This is the first dam safety inspection to occur at the dam since that change in ownership. This report does not consider WH&S issues that are unrelated to dam safety.

The dam is generally in good condition. Prior to the inspection, the previous Annual Inspection and Comprehensive Inspection were reviewed. No outstanding issues remain from those reports.

The primary issues arising from the inspection relate to vegetation control and erosion protection on the earth embankments, fuse plugs and saddle dams. There is also an issue relating to labelling of the dam safety instrumentation. Neither of these issues is currently of major concern.

Similar to other Seqwater dams, dam documentation needs to be reviewed and upgraded to meet the new Seqwater standards. This work will be undertaken during 2008/09 with support and training to site staff to be provided by Seqwater's Dam Safety Group.

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1.0 DESCRIPTION

WIVENHOE DAM		
POPULATION AT RISK	- Sunny Day Failure - Flood	244000 > 1000 (Not fully assessed)
Type of dam		Gated concrete spillway, earth and rockfill embankment with 2 saddle dams.
Dam Owner		Seqwater
Construction Completed		1984
Watercourse		Located on the Brisbane River near Fernvale.
Catchment Area		7,020 km^2
Length of dam		2,300 m
Maximum Height		50 m
Clear length of spillway		60 m
Number of radial spillway gates		5
Size of each Radial Gate		12 m wide x 16.6 m high
Full Supply level		EL 67.0 m
Top of Closed Radial Gate		EL 73.0 m
Dam Crest Level - Embankment Level - Concrete Parapet Wall		EL 79.0 m EL 80.1 m
Storage capacity at F.S.L.		1 150 000 ML
Peak water level as a result of PMF		Dam overtopped
Spillway Capacity (Including fuse plugs)		28,100 m^3/s (EL 79.0 m)
Maximum discharge as a result of PMF		37,400 m^3/s
AEP of Spillway Capacity (Including fuse plugs)		In 100, 000 (EL 79.0 m)

2.0 DAM STATUS

Date	11 November 2008
Reservoir Water Surface Elevation	54.74 m
Percentage Full	26 %
Reservoir Water Level Relative to FSL	-12.26 m
Spillway Releases:	Nil

3.0 DAM OPERATION AND DOCUMENTATION

Dam Safety Documentation such as the Emergency Action Plan, the Standing Operating Procedures, and the Operation and Maintenance Manual were produced by the previous SEQWater (the former owners of the dam) and are currently being reviewed and updated by Seqwater.

Inspection Recommendation:

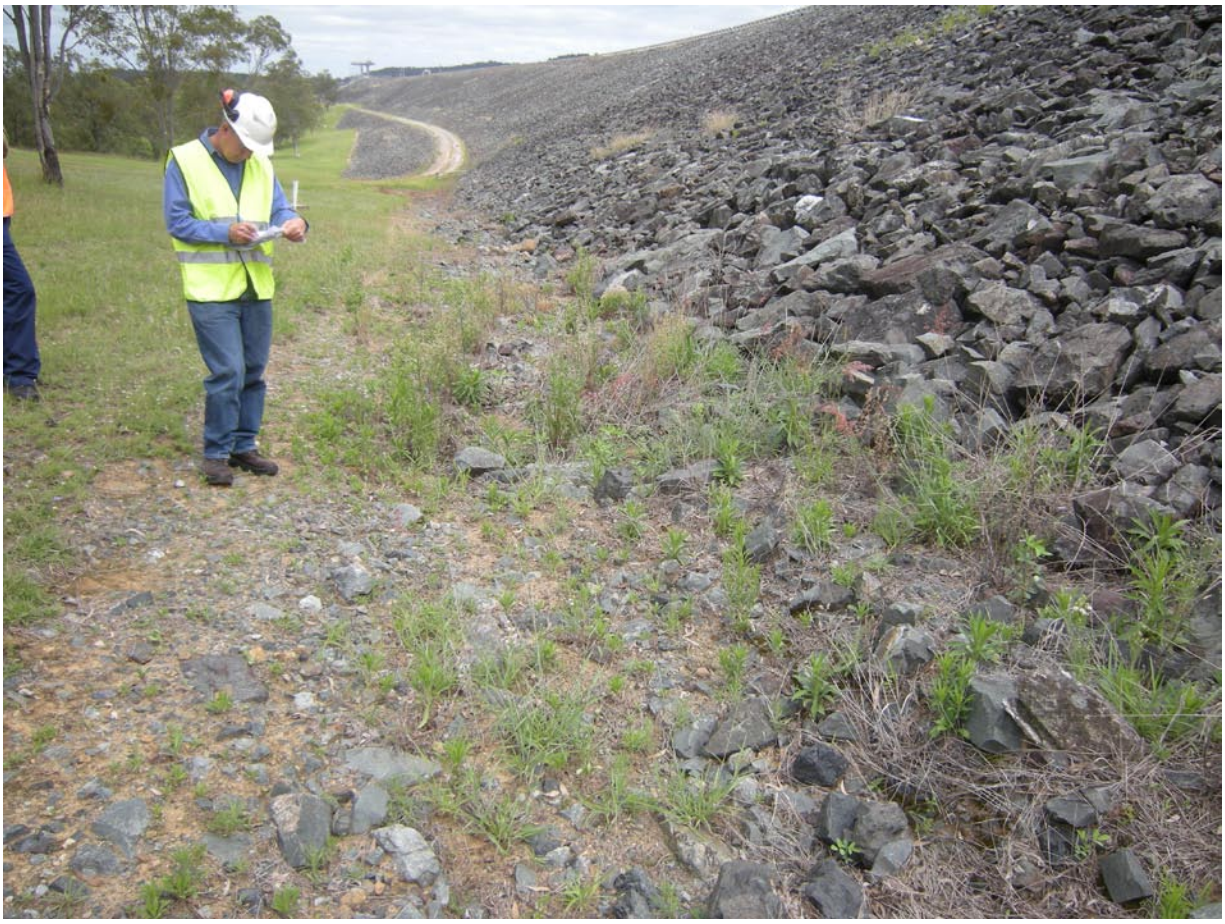
- ***Update the Dam Safety Documentation to reflect the new Seqwater arrangements.***

4.0 LOGBOOK

A traditional logbook is currently in place at Wivenhoe Dam. A logbook is maintained generally to record the date of inspections and instrument monitoring, to note maintenance undertaken, and to note unusual events (e.g. seismic activity, floods, change in seepage patterns, etc.) to assist in maintaining the safety management of the dam. Notes in the logbook may assist in identifying the time and cause of incidents which may provide early warning for potential failure mechanisms.

5.0 DAM EMBANKMENT

Wivenhoe Dam is a 56 m high, zoned earth and rock embankment separated into two parts by a concrete gravity spillway, controlled by five radial gates. Two saddle dam embankments are located on the left side of the reservoir. A secondary spillway consisting of three fuse plug embankments was constructed on the right abutment in 2005.



Wivenhoe Dam – Left Bank Zoned Embankment

The Left Bank embankment is approximately 1.1 kilometres long and has a sloping upstream core protected by both upstream and downstream filters and supported by a downstream shell of miscellaneous fill. Batter slopes are 3 horizontal to 1 vertical on the upstream face and 2 horizontal to 1 vertical on the downstream face. Riprap is in place on both the upstream and downstream shoulders of the embankment.

The Right Bank embankment is 1.2 kilometres long and 56 metres high with a central clay core. The embankment contains both upstream and downstream filters supported by outer shells of compacted sandstone with river run gravel in the upper portion. The shoulder slopes are 2 horizontal to 1 vertical with a local steepening in the upper portion to 1.5 horizontal to 1 vertical. Riprap is in place on both the upstream and downstream shoulders of the embankment.

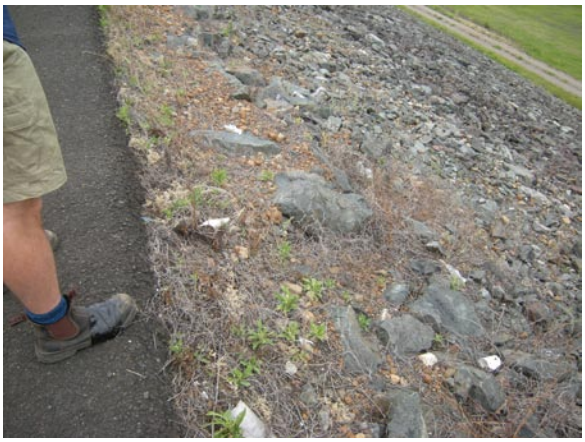
Two saddle dams close off low saddles on the left abutment of the dam. Saddle Dam 1 is a homogeneous embankment constructed from miscellaneous fill. Saddle Dam 2 is the higher of the two embankments and is constructed with a central clay core and random fill shoulders. Rip Rap is provided for both embankment on the upstream face for wave protection and the downstream slope is topsoiled and grassed. The Saddle Dams have a crest level at EL 80 and have a maximum height of 10 m. The Saddle Dams only retain water during flood operation.

The crest and upstream and downstream faces of the earth embankments and saddle dams were generally maintained in a satisfactory condition. However, some deficiencies in civil maintenance were identified and these are listed below, along with recommendations for remedial actions.

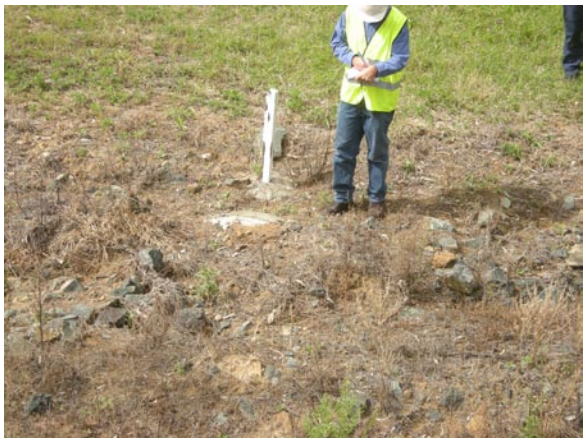
Inspection Recommendations:

<u>Left Bank Embankment (Downstream Area)</u>

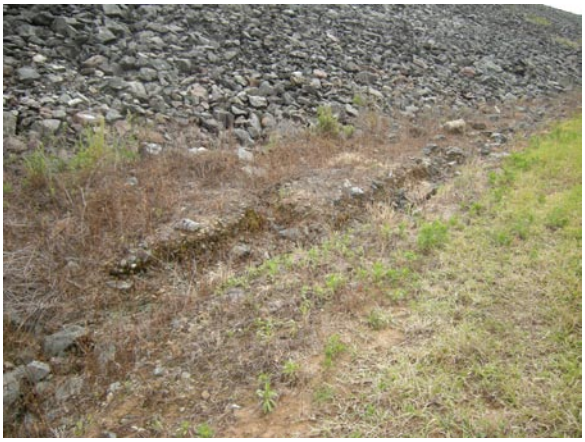
- ***Due to breakdown of rip rap on the downstream side of the embankment, some areas of rip rap are close to requiring replenishment. These areas should be closely monitored for signs of any erosion damage. Presently the areas generally appear sound and stable.***
- ***Erosion repairs are required along the downstream toe of the embankment. This erosion has been caused by runoff from rainfall events along the toe drain. The access road adjacent to this toe should also be repaired (regraded) and maintained.***
- ***There is a series of pipelines that gather runoff from the toe drains for outflow into suitable natural drainage points. Some of the inspection pits on these pipelines have been buried under silt transported by runoff from rainfall events. All inspection pit lids are to be cleared and repaired. The pits are then to be marked and numbered with suitable marker posts. Each pit is to be inspected on a six monthly basis. Written records of these inspections are to be provided to the Principal Engineer Dam Safety.***
- ***The outfall arrangement from the toe drain collection pipeline is to be repaired and maintained. The pipeline may be broken in this area and this should be investigated (using a pipeline camera if appropriate) and repaired as necessary. Outflow from this pipeline should be recorded at the same frequency as the nearby V-notch weirs (weekly).***



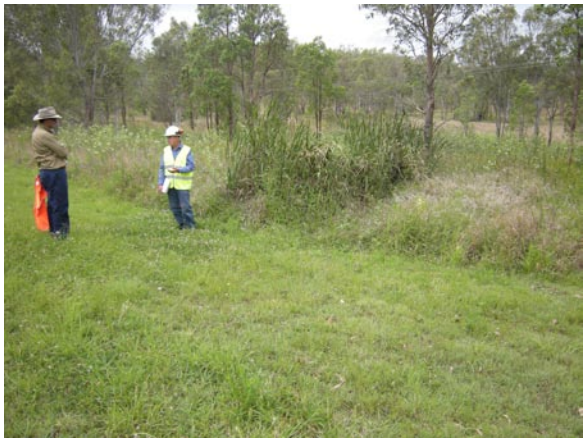
Areas with poor rip rap cover



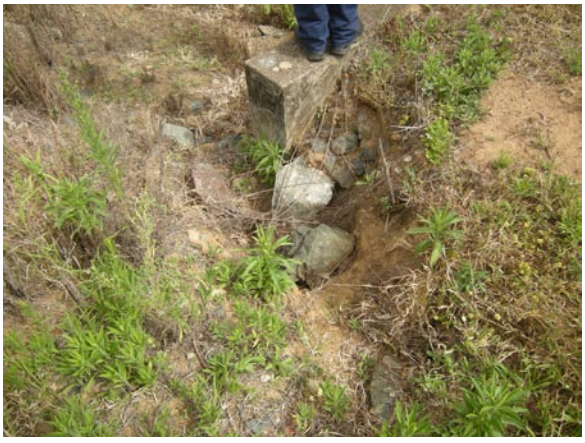
Silted Inspection Pit



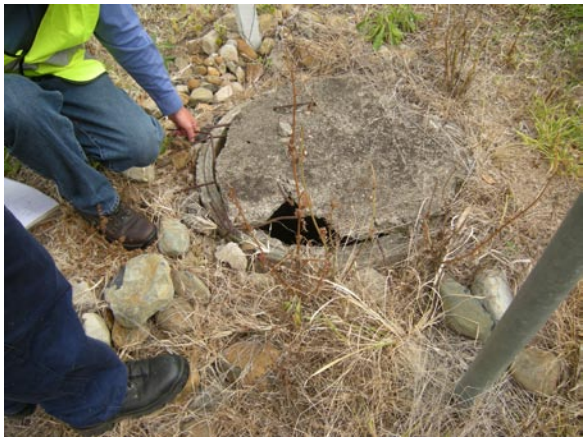
Erosion areas to be repaired along toe



Pipe Outflow to be repaired and maintained



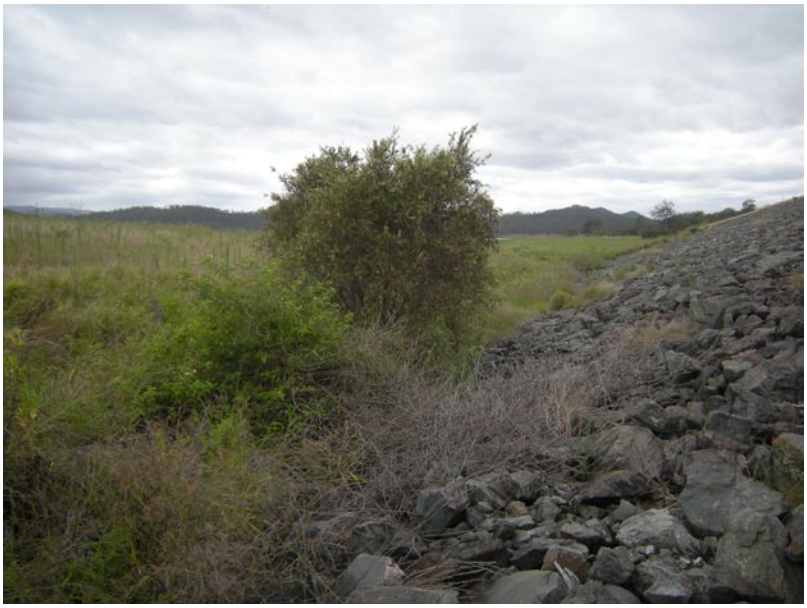
Erosion areas to be repaired along toe



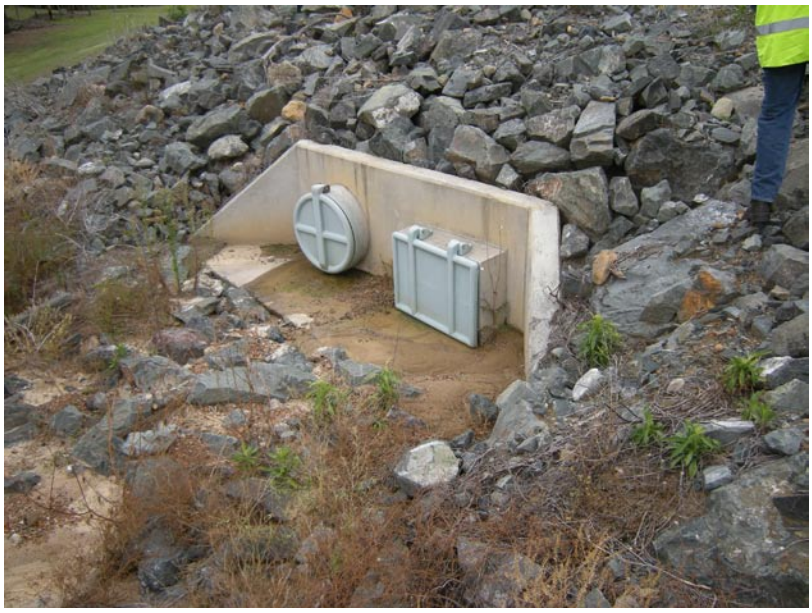
Broken inspection pit cover

Left Bank Embankment (Upstream Area)

- ***The vegetation near the spillway that may cause debris problems during flow events is to be removed.***
- ***Vegetation growing on the embankment is to be sprayed with a suitable herbicide.***
- ***Debris is to be removed from around the flap gate drains near the left bank end of embankment and these gates are to be inspected and cleaned out on a quarterly basis.***
- ***All trees within five metres of the toe of the embankment are to be removed.***



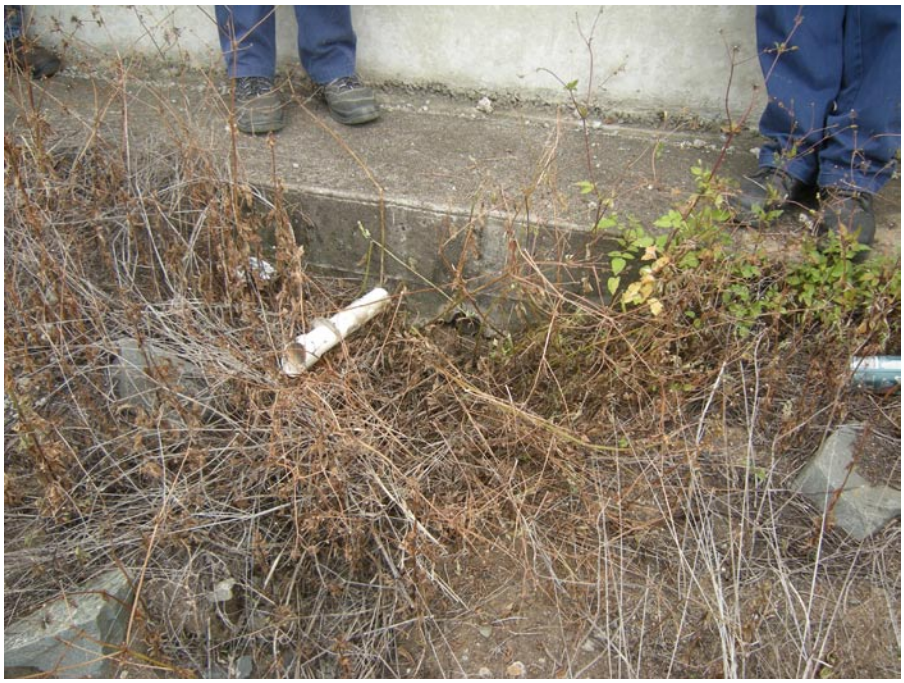
Trees to be removed



Flap gate drains

Dam Crest

- ***The broken road drains are to be repaired/modified so that they work in a reliable fashion to drain the road in a way that maintains vehicular safety for the public road users. A facility is to be installed to allow the dam operators to block these drains should the dam level be likely to reach the base of the wave wall (in these circumstances the road would be closed due to flooding and would not be used by the public).***



Broken/Blocked Road Drain

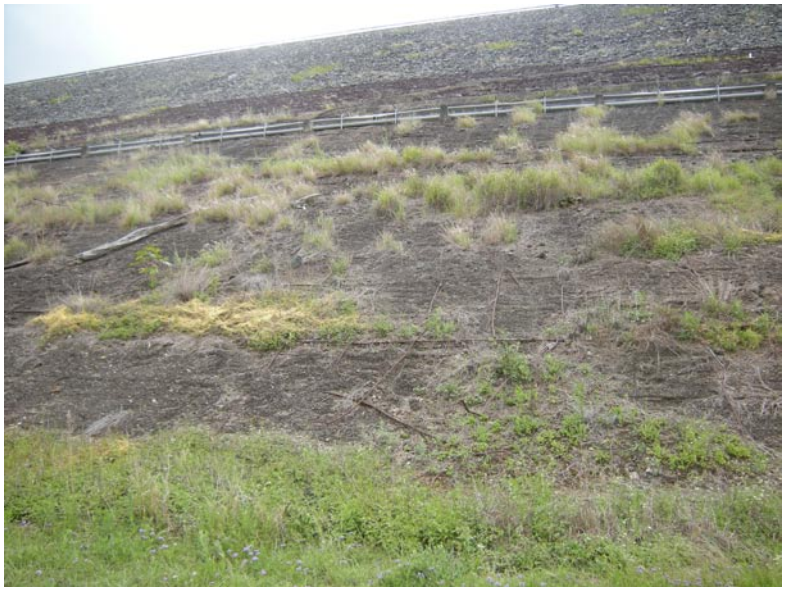
Broken/Blocked Road Drain

Spillway Channel

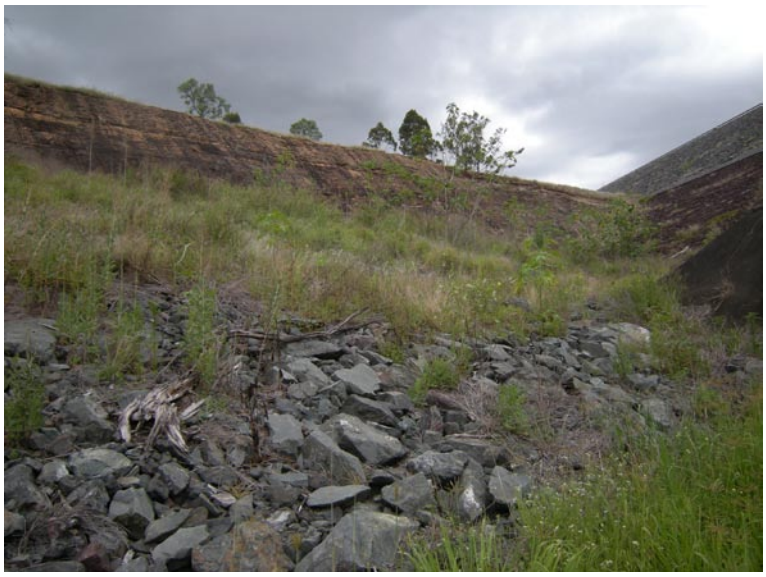
- ***Vegetation growing in the rip rap is to be sprayed with a suitable herbicide.***

Right Bank Embankment

- ***Vegetation growing in the rip rap and concrete faced rock is to be sprayed with a suitable herbicide (particularly in the area of the old river diversion).***



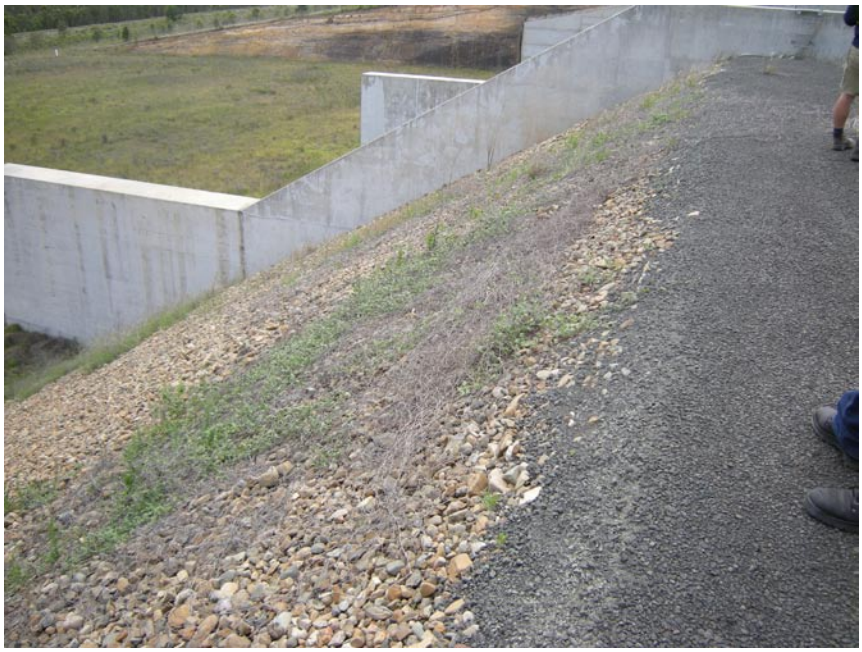
Vegetation to be sprayed



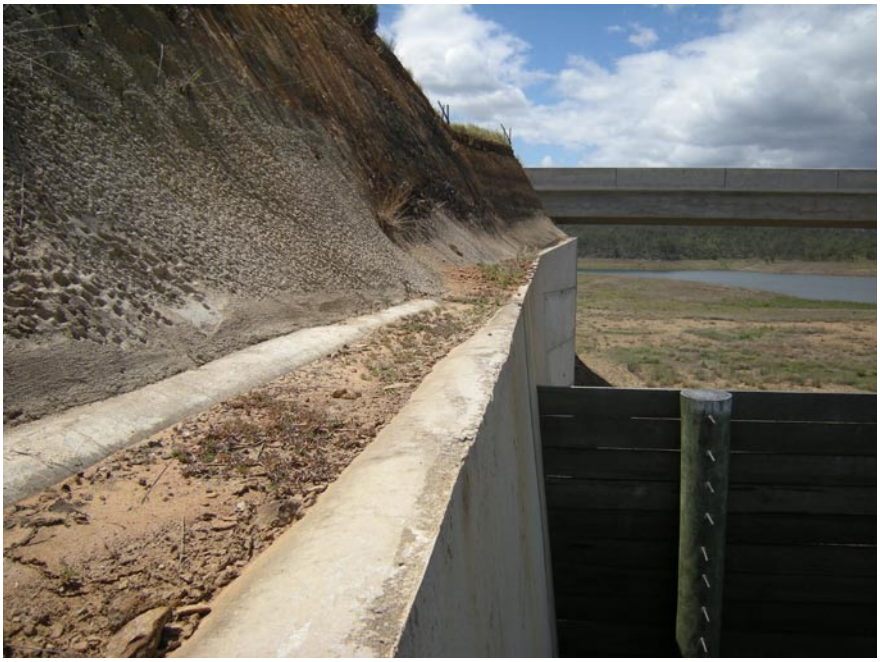
Vegetation to be sprayed

Fuse Plug Embankments

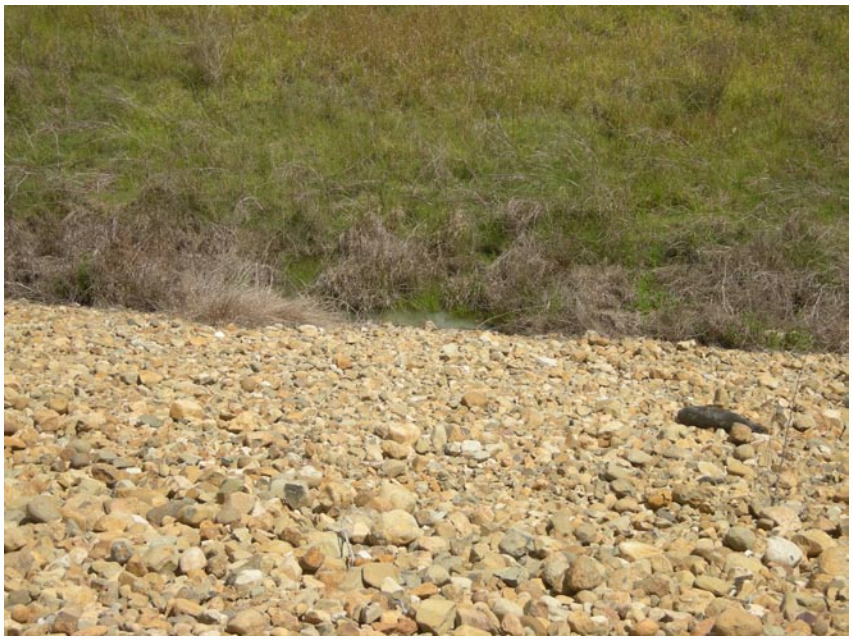
- ***Vegetation growing in the embankments is to be sprayed with a suitable herbicide.***
- ***The drain above the right bank fuse plug is to be cleaned.***
- ***The water ponding along the downstream toe of the fuse plugs is to be permanently drained away and a five metre wide track is to be constructed along the toe for inspection and dam surveillance purposes.***



Vegetation to be sprayed



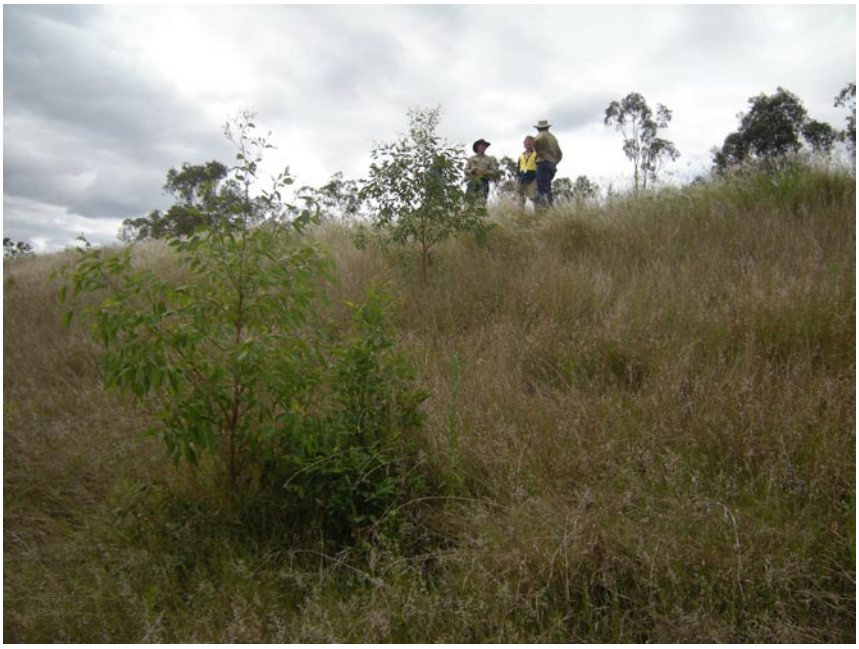
Drain to be cleaned



Water ponding along toe of fuse plug embankments to be permanently drained

<u>Saddle Dams</u>

- ***The numerous trees on the saddle dams are to be removed and no trees are to be allowed within five metres of the toe of the saddle dams.***
- ***The saddle dams are to be mowed to allow proper inspection and are to be mowed just prior to the next Annual Inspection.***



Trees on Saddle Dams to be removed

6.0 SPILLWAY

The spillway is located in a low saddle between the two dam earth and rockfill embankments and is controlled by five radial gates supported on a mass concrete ogee crest. The radial gates are 12 metres wide by 16 metres high and discharge via a flip bucket spillway to an unlined rock discharge channel. The five radial gates are operated by hydraulic motor driven wire rope winches, one on each side of each gate. The power units for the spillway gates and penstock gate are located in a winch room in the left abutment of the dam. Also located in this winch room is an auxiliary diesel operated hydraulic unit capable of operating the gates.

A left bank underground control complex in the dam comprises the winch room, water quality control room, main high voltage substation, main switchboard, fire control equipment, storeroom diesel alternator set, and ventilation system. A 79 tonne travelling gantry crane on the service bridge over the spillway structure serves to handle the bulkhead gate used for maintenance of the radial gates. A smaller gantry over the intake structure is used for handling the trashracks and water quality baulks.

The spillway and associated gates, hoisting gear and cranes looked to be in good condition. The only issue identified was the poor condition of the gauge boards that serve as the radial gate position indicators. Undertaking regular routine maintenance in accordance with the dam Operation and Maintenance Manuals appears to be producing good results and it is important that this program is continued. The trees on the benched areas of the spillway channel, downstream of the radial gates were also identified as a problem and these trees are to be removed as these have the potential to cause significant damaged to the spillway channel should they be uprooted in a storm event.

Inspection Recommendation:

- ***Remove the trees on the benched areas of the spillway channel, downstream of the radial gates.***
- ***Replace the gauge boards that are used to determine radial gate position).***

7.0 RESERVOIR RIM AND DOWNSTREAM WATERWAY

The reservoir rim slopes appear generally stable and above the Full Supply Level are relatively well vegetated with no signs of slips or movement that would be of concern from a dam safety perspective.

There were also no slips or restrictions that would prevent spillway outflow or raise tail water levels to an unacceptable level during a dam outflow event.

8.0 OUTLET WORKS

The outlet works extend over 4 monoliths LH11 to LH14 with the entrances to the penstock and river outlet being in Monolith 11 and the regulating valves in Monolith 14. At the entrance to the outlet works in Monolith 11 is a 3.6 metre diameter penstock, located below a 1.9 metre diameter river outlet. A single fixed wheel bulkhead gate is provided to command either outlet (but not both outlets at the same time) to provide for emergency closure or dewatering.

The 3.6m diameter penstock is sealed off with a semi-ellipsoidal dome. A 1.5 metre diameter offtake from this penstock provides an outlet into the river that diverts water through a mini hydro Power Station constructed in 2002. Control of this conduit is provided through mini-hydro facility. The second outlet into the river is a 1.5 metre diameter stainless steel Fixed Cone Dispersion Valve located at the downstream end of the 1.9 metre diameter river outlet.

Within the intake structure in the left abutment there is an arrangement of trashracks and six telescoping vertical lift gates to allow selective withdrawal of water for quality control purposes.

The mechanical equipment in the outlet works was inspected and found to be in generally good condition. Internal inspection of the conduits and valves had occurred within the last five years and will occur again at or before the next five year comprehensive inspection. Issues were identified that relate to water leaking into the outlet works area through the service penetrations to the mini-hydro facility and these water leaks should be repaired.

The sandstone cliffs adjacent to the outlet works also continue to erode and the rock debris generated by this erosion is causing a hazard both to personnel and the dam infrastructure (particularly in the electrical switch yard). This hazard should be investigated and eliminated through the construction of.

Inspection Recommendations:

- ***Seal the service penetrations to the mini-hydro facility as these are causing water leaks into the outlet works.***

- ***Suitable engineering works are to be constructed to eliminate the hazard to persons and dam infrastructure caused by the erosion of the sandstone cliffs adjacent to the outlet works.***

Eroding sandstone cliffs

9.0 INSTRUMENTATION

Surveillance instrumentation at the dam monitors movement of the dam embankment, seepage and pressure within the embankment. The instrumentation consists of:

- 10 foundation drains.
- 65 hydraulic piezometers
- 24 surface settlement points
- 2 V-notch weirs
- 1 automatic water level recorder

The instrumentation was inspected, and the following works recommendations were made:

Inspection Recommendations:

- ***All seepage measuring points, survey points and foundation drains are to be suitably labelled and numbered on site and a suitable engineering plan prepared to show instrumentation point locations and corresponding numbering.***
- ***Trees are to be cleared to allow suitable line of site access to the survey stations.***
- ***The inclinometer access is to be upgraded to allow safe access by personnel undertaking instrument readings.***
- ***The post tensioning anchors are to be load tested in accordance with ANCOLD guidelines.***

10.0 RECOMMENDATIONS

ANNUAL DAM SAFETY INSPECTION SEPTEMBER 2008

Section Reference	Recommendation	Rating (See Below)
3.0	• ***Update the Dam Safety Documentation to reflect the new Seqwater arrangements.***	**3**
5.0	***<u>Left Bank Embankment (Downstream Area)</u>***	
	• ***Due to breakdown of rip rap on the downstream side of the embankment, some areas of rip rap are close to requiring replenishment. These areas should be closely monitored for signs of any erosion damage. Presently the areas generally appear sound and stable.***	**4**
	• ***Erosion repairs are required along the downstream toe of the embankment. This erosion has been caused by runoff from rainfall events along the toe drain. The access road adjacent to this toe should also be repaired (regraded) and maintained.***	**2**
	• ***There is a series of pipelines that gather runoff from the toe drains for outflow into suitable natural drainage points. Some of the inspection pits on these pipelines have been buried under silt transported by runoff from rainfall events. All inspection pit lids are to be cleared and repaired. The pits are then to be marked and numbered with suitable marker posts. Each pit is to be inspected on a six monthly basis. Written records of these inspections are to be provided to the Principal Engineer Dam Safety.***	**2**
	• ***The outfall arrangement from the toe drain collection pipeline is to be repaired and maintained. The pipeline may be broken in this area and this should be investigated (using a pipeline camera if appropriate) and repaired as necessary. Outflow from this pipeline should be recorded at the same frequency as the nearby V-notch weirs (weekly).***	**2**

	Left Bank Embankment (Upstream Area)	
	• ***The vegetation near the spillway that may cause debris problems during flow events is to be removed.***	**3**
	• ***Vegetation growing on the embankment is to be sprayed with a suitable herbicide.***	**2**
	• ***Debris is to be removed from around the flap gate drains near the left bank end of embankment and these gates are to be inspected and cleaned out on a quarterly basis.***	**2**
	• ***All trees within five metres of the toe of the embankment are to be removed.***	**3**
	Dam Crest	
	• ***The broken road drains are to be repaired/modified so that they work in a reliable fashion to drain the road in a way that maintains vehicular safety for the public road users. A facility is to be installed to allow the dam operators to block these drains should the dam level be likely to reach the base of the wave wall (in these circumstances the road would be closed due to flooding and would not be used by the public).***	**3**
	Spillway Channel	
	• ***Vegetation growing in the rip rap is to be sprayed with a suitable herbicide.***	**3**
	Right Bank Embankment	
	• ***Vegetation growing in the rip rap and concrete faced rock is to be sprayed with a suitable herbicide (particularly in the area of the old river diversion).***	**2**
	Fuse Plug Embankments	
	• ***Vegetation growing in the embankments is to be sprayed with a suitable herbicide.***	**2**
	• ***The drain above the right bank fuse plug is to be cleaned.***	**2**
	• ***The water ponding along the downstream toe of the fuse plugs is to be permanently drained away and a five metre wide track is to be constructed along the toe for***	**3**

	inspection and dam surveillance purposes.	
	<u>Saddle Dams</u>	
	• ***The numerous trees on the saddle dams are to be removed and no trees are to be allowed within five metres of the toe of the saddle dams.***	**3**
	• ***The saddle dams are to be mowed to allow proper inspection and are to be mowed just prior to the next Annual Inspection.***	**2**
6.0	• ***Remove the trees on the benched areas of the spillway channel, downstream of the radial gates.***	**3**
	• ***Replace the gauge boards that are used to determine radial gate position).***	**1**
8.0	• ***Seal the service penetrations to the mini-hydro facility as these are causing water leaks into the outlet works.***	**3**
	• ***Suitable engineering works are to be constructed to eliminate the hazard to persons and dam infrastructure caused by the erosion of the sandstone cliffs adjacent to the outlet works.***	**3**
9.0	• ***All seepage measuring points, survey points and foundation drains are to be suitably labelled and numbered on site and a suitable engineering plan prepared to show instrumentation point locations and corresponding numbering.***	**3**
	• ***Trees are to be cleared to allow suitable line of site access to the survey stations.***	**3**
	• ***The inclinometer access is to be upgraded to allow safe access by personnel undertaking instrument readings.***	**3**
	• ***The post tensioning anchors are to be load tested in accordance with ANCOLD guidelines.***	**3**

Legend of Criticality Rating

Rating 1	Rectification required immediately, i.e. within 1 month
Rating 2	Rectification required within 3 months
Rating 3	Rectification required within 12 months
Rating 4	Ongoing