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2. Project Rationale

2.1 Need for the Project

The Gold Coast City Council is undertaking the Stage 3 upgrade of Hinze Dam to meet three key objectives:

- reduce flooding in the lower Nerang River catchment by increasing the flood mitigation capability of Hinze Dam;
- increasing the storage capacity of the dam and the water supply available from Hinze Dam; and
- ensuring that the dam complies with current safety standards and guidelines.

2.1.1 Flood Mitigation

The lower Nerang River flows through dense residential, community and commercial areas in the suburbs of Carrara, Nerang, Burleigh Waters, Benowa, Miami, Surfers Paradise, Mermaid Waters, Main Beach, Robina, Mudgeeraba and Burleigh Heads. Major rainfall events in the Nerang River catchment can cause flooding to properties and infrastructure in this area. The flood mitigation component of the dam upgrade will reduce peak flood flows and delay the release of floodwater into the lower reaches of the floodplain. By reducing the rate at which floodwater is released from the dam, the number of properties potentially affected by flooding in the lower catchment would be reduced, as would peak flood levels and flooding damage.

Currently 4,441 properties downstream of Hinze Dam could be affected in a 1in 100 year Average Recurrence Interval (ARI) flood event. The effect of raising the dam in respect to flood mitigation is a reduction of 3,284 affected properties.

The personal costs of flooding can be immense – in terms of potential loss of life, financial and personal losses. Personal losses include damage to homes and valued items, loss of family possessions, and damage to fittings, whilst the psychological effects can include anxiety, stress and depression. Older people may be particularly at risk in floods, both from the perspective of personal losses, and from a personal safety perspective due to a higher level of frailty and disability. One quarter of the Gold Coast's population is aged over 55 years, and this proportion will reach about 32% in 2021.

Flooding also currently has significant impacts on commercial and industrial properties, public utilities and infrastructure on the Nerang River floodplain. The reduction in flooding risk represents a significant community benefit to downstream areas and the broader community through the reduction in the economic, social and environmental impacts associated with flooding.

2.1.2 Water Supply

The Hinze Dam is the main bulk water supply source for the Gold Coast region. The Project constitutes an augmentation of the water supply within the South East Queensland Region, which is particularly significant given the effect of recent drought conditions decreasing dam levels across South East Queensland, and subsequent water restrictions placed on residents and businesses.

The Gold Coast Water Futures report (GCWF) (GCCC 2005c) outlined strategies and options for increasing water supply to the Gold Coast region over the next 50 years and identified the raising of Hinze Dam for water supply as a key element in the overall security of supply for the region. The South East Queensland Regional Water Supply Strategy (SEQRWSS) (DNRW and BCC 2004/2005) has identified a need for a range of measures that will provide enough water for short, medium and long term needs for the South East Queensland region. The raising of Hinze Dam is one of the medium to long term initiatives identified in the strategy to increase water availability and security.

In response to the current water supply emergency in South East Queensland, the State Government passed a Regulation to secure the essential water supply needs of the region. An emergency Regulation under the *Water Act*

2000 was made on the 9th August 2006 (*Water Amendment Regulation (No. 6) 2006*). Within the *Regulation*, Schedule 10B: Measure 11 – Hinze Dam Stage 3 requires that the Stage 3 raising of the dam deliver a target of 16 ML/d of additional yield by 31st December 2010. It also requires that the Project prepare for associated water harvesting. Water harvesting is the diversion of run off from adjacent catchments into Hinze Dam.

The Gold Coast Local Government Area (LGA) population was projected to reach more than half a million people by December 2006, and will continue to grow by an average of 2.4% per year between 2001 and 2026[1]. Increased supply of water, and confidence that supply is adequate, will support the forecast population increase, and allow urban development to proceed as outlined in the South East Queensland Regional Plan[2,] and detailed in Gold Coast City Council's (draft) Local Growth Management Strategy.

The Hinze Dam Stage 3 Project will increase the available yield from the dam to 225 ML/d.

2.1.3 Upgrade to Meet Current Dam Safety Standards and Guidelines

The *Water Act 2000* provides the regulatory framework for dam safety of water dams in Queensland and requires that the owners of referable dams must operate and maintain dams in accordance with the Guidelines on Acceptable Flood Capacity for Dams (DNRW 2007c). By virtue of its height and storage capacity Hinze Dam is a referable dam. Recent revisions to dam safety requirements and design inputs (extreme flood events hydrology) requires elements of the upgrade of Hinze Dam for compliance with these guidelines and standards.[3]. In order to comply with these guidelines and standards the raised dam and modified spillway must be capable of passing the Probable Maximum Flood (PMF) determined for the dam without overtopping of the dam crest.

2.2 Relationship to other Projects

The raising of Hinze Dam is integral to both local and regional water supply strategies.

At the regional level the SEQWRSS has been developed with the intention of providing a secure water supply for future regional growth. It aims to do this through three strategies:

- high value and best use of water;
- efficient use of water; and
- development of additional water supplies.

The proposed additional water supplies include desalination, recycled water, new storages and the upgrading of existing storages. Hinze Dam has been identified by the SEQWRSS as one of the dams to be raised as part of the regional water supply strategy. It is predicted to supply in the order of an additional 6000 ML/a.

The *Water Amendment Regulation (No. 6) 2006* provides for a coordinated set of actions to be undertaken by all local governments, their water supply businesses and the State in order to implement the water strategy for South-East Queensland and to meet the water requirements of the region. The *Regulation* requires local governments and other service providers to undertake a number of measures, to ensure that all elements of the legislation are implemented in a timely and coordinated way. Timelines for completion of the actions, as well as State funding contributions for some actions, are outlined in this regulation.

[1] Gold Coast City Council (2006) Population Projections to 2026, prepared for the Priority Infrastructure Plan, by Planning Information Forecasting Unit, DLGPSR
[2] Queensland Government (2005) South East Queensland Regional Plan 2006 - 2026
[3] NRW – Draft guidelines on the selection of acceptable flood capacity for dams (Information note)

Key elements of the strategy include the following:

- establishing a water grid that enables water to be moved between storage facilities throughout South-East Queensland;
- dreating additional water through the construction of a desalination facility to introduce additional supplies of water into the water grid; and
- increasing the capacity of existing storage systems by
  - accessing underground water supplies;
  - water harvesting; and
  - raising dam and weir walls if practicable.

Under Schedule 10B Measures of the *Regulation*, in relation to Hinze Dam, GCCC is responsible for Measure 11:

Description of Measure	Service Provider	Target (ML/day)	Date
11 Take all necessary steps to prepare for, and construct, Hinze Dam Stage 3 and prepare for associated water harvesting works	Gold Coast City Council	16	31December 2010

Water Harvesting is proposed by the South East Queensland Regional Supply Strategy to potentially increase the yield for the Hinze Dam from river catchments adjacent to the Hinze Dam. The potential to use water harvesting depends on the storage capacity of Hinze Dam. The South East Queensland Regional Supply Strategy assessed the potential to transfer flows from the streams such as the Coomera River, Canungra Creek and Mudgeeraba Creek. The reported timing for the water harvesting into a raised (Stage 3) Hinze Dam is 2016.

While water harvesting from adjacent catchments is **NOT** included in the scope of this project the *Water Amendment Regulation (No.6) 2006* requires that Hinze Dam Stage 3 prepare for associated water harvesting works. In response, the final configuration for the raising of the dam included consideration for the future need to store additional inflows from water harvesting.

A key element of the proposed water grid is a series of pipelines between the existing water supply systems, allowing the transfer of water in times of critical need. Hinze Dam would be part of the Southern Regional Water Pipeline network, connecting Brisbane, Ipswich, Beaudesert, Logan and the Gold Coast. In addition to this major connector, other connections are being constructed between the Gold Coast City water reticulation system and the system in Logan City. Upon completion Hinze Dam Stage 3 will have the capacity to contribute a portion of the 20 ML/d transfer proposed for Logan from the Gold Coast.

At the local level, the GCWF Strategy has predicted a future water requirement of 466 ML per day by 2056. In order to meet this need a suite of initiatives were identified and these are summarised in **Table 2-1**.

Table 2-1 Gold Coast Water Supply Strategy

Initiatives		ML/day
Existing supply	Hinze Dam and Little Nerang Dam	191
	Wivenhoe Dam via Logan Pipeline	35
New initiatives	Desalination (1)	41-55
	Leakage and pressure management	30
	Rainwater tanks	20
	Raising of Hinze Dam	10-24
	Recycled water	20
	Southern Regional Water Pipeline	55
	Water conservation	50
Emerging and localised initiatives	Greywater	Local use
	Groundwater	Local use
	Indirect potable reuse	Still under investigation
	Stormwater harvesting	Local use
Total water supplied in 2056		**466**

(1) GCCC portion of regional desalination plant output of 125 ML/d
Source: Gold Coast Water Futures Strategy 2006-2056

These represent investment in a diverse integrated range of water sources in order to provide a more robust water supply system.

The State Government has identified that purified recycled water (PRW) will be a permanent and ongoing part of the potable water supplies to South East Queensland. The Gold Coast Waterfuture Recycled Water Strategy is a long-term plan that will identify ways to use and manage recycled water over the next 50 years. The Strategy is currently being developed by Gold Coast Water in partnership with a community-based Recycled Water Strategy Advisory Committee. The Advisory Committee consists of 24 representatives from community and resident groups, industry and environmental bodies, recycled water user groups, and Gold Coast City Council (Councillors and Council officers), and five Queensland State Government and expert advisers. Working in consultation with Gold Coast residents, the committee will explore complex technical, financial, social and environmental challenges to develop an innovative and adaptable Recycled Water Strategy. The introduction of PRW into Hinze Dam is **NOT** part of the scope of this project. However potential elements of a Recycled Water Strategy may influence the future operation of the dam. Such elements may include the introduction of a volume of PRW into the storage or the replacement of releases from the dam with PRW. The influence of the introduction of such elements has been factored into design process of the Project.

2.3 Project Alternatives

2.3.1 No Project Alternative

The alternative of not upgrading the dam was assessed in terms of the three key objectives of the Project, flood mitigation, water supply and dam safety.

Flood Mitigation

Currently 4212 existing residences and 229 commercial / industrial properties downstream of Hinze Dam could be affected in a 1 in 100 year ARI flood event. Raising the dam for flood mitigation purposes would reduce the number of properties affected by this flood by 3284 to 1157 properties.

If the Project does not proceed it is unlikely a significant reduction in flood risk could be achieved via any alternative means. The economic and social consequences of a major flood on the Nerang River floodplain would be significant at local, regional and national levels. Not only would the flood affect the residents of the area but it would also impact tourists and the tourism industry and could have the potential of damaging the reputation of the region in the tourism market. An assessment of the economic cost of flooding associated with a 1 in 100 year ARI flood event, undertaken by the Alliance, for the "do nothing" case indicated net economic losses in the region of approximately $120 million.

The social impacts of a major flood would also be significant given the large population at risk on the flood plain and the resources available to manage such an emergency. Whilst there will be a risk of loss of life during such an event the psychological effects caused by damage to the family home and personal possessions is likely to cause anxiety, stress and depression. Older people may be particularly at risk in floods, both from the perspective of personal losses, and from a personal safety perspective due to a higher level of frailty and disability. One quarter of the Gold Coast's population is aged over 55 years, and this proportion will reach about 32% in 2021[4].

Flooding also affects community facilities at both local and citywide levels, given that substantial community infrastructure is located in downstream areas. Facilities associated with sporting fields, which are often located near water courses and in low lying areas, are particularly affected. Few community organisations have the resources to protect their facilities, and recovery from flood damage is time consuming and expensive at the community level. The reduction in flooding risk represents a significant community benefit to downstream areas and the broader community. This benefit would not be attained if the Project did not proceed.

Water Supply

If the Project did not proceed then Gold Coast City Council would be in breach of the subordinate legislation made under the *Water Act 2000* titled *Water Amendment Regulation (No.6) 2006*. This legislation specifically requires that the Stage 3 raising of the dam delivers a target of 16 ML/d of additional yield by 31st December 2010. Financial penalties are associated with such a non compliance.

If the dam is not raised for water supply the State Governments ability to deliver the South East Queensland Regional Supply Strategy would also be compromised. Elements of the *Water Resource (Gold Coast) Plan 2006* and *Water Resource (Logan Basin) Plan* 2007 would also be unlikely to be delivered in full, particularly in relation to water harvesting from adjacent catchments. The GCWF strategy would also have to be revised as Hinze Dam Stage 3 plays a key role in delivering its water supply outcomes detailed in **Table 2-1** through the provision of 10 – 24 ML/d of additional water supply. The outcome would be a reduction in available water supply to the Gold Coast and the entire South East Queensland region. When potential water harvesting yields are considered the reduction in available water supply to the region could be in the range of 16 000 to 26 000 Ml/a (or 43 ML/d to 71 ML/d).

Dam Safety

Whilst the dam is intrinsically safe, the current dam configuration is no longer compliant with the recently upgraded Guidelines on Acceptable Flood Capacity for Dams (DNRW 2007c). The magnitude of the Probable Maximum Flood, the design flood that the dam must be able to pass without overtopping has also increased due to revisions of Bureau of Meteorology estimates of extreme rainfall in the dam catchment. The Dam Safety Regulator in Queensland has advised that under the requirements of the *Water Act 2000* the dam owner, Gold Coast City Council must make the dam compliant by 2015. Therefore if this Project does not proceed, the Council will still be required in the near future to undertake substantial works to the dam's embankments and spillways. From a dam safety perspective the *"no project"* alternative is not a viable option.

[4] Gold Coast City Council (2006) Population Projections to 2026, prepared for the Priority Infrastructure Plan, by Planning Information Forecasting Unit, DLGPSR

2.3.2 Alternatives to the Project

Flood Mitigation

The Gold Coast City Council has undertaken significant investigations over the last 15 years into the most appropriate flood mitigation strategy for the Nerang Floodplain. Numerous studies have been undertaken over the years to identify possible means of reducing flood damage and risk and a number of structures are in place today that provide a level of flood mitigation benefits

The Merrimac / Carrara Floodplain Advisory Committee was established in 1996 to advise Council on planning, development and management of the floodplain and to produce a Hydraulic Master Plan and Structure Plan for the Merrimac / Carrara floodplain. Together, these two documents define how to maintain and enhance the storage and passage of floodwater in the floodplain. The principles have been adopted into Planning Codes under the Gold Coast City Council Planning Scheme and are strictly applied when development applications are assessed.

The Merrimac / Carrara Floodplain Advisory Committee also recommended further investigations into physical flood mitigation works. The Committee reviewed numerous previous investigations which focused on modifications to the amount of water entering into the river from Hinze Dam, flows through the river and its eventual release into the Broadwater and ocean. Some of these proved to bring minimal benefits, others were not practical, some not viable and others not acceptable to the community. Their final recommendations focused on the options with the greatest flood benefit and community acceptance.

The physical flood mitigation options considered are briefly described below. It should be emphasised that numerous scenarios of each option were modelled in detail. A summary of the major options considered are given below:

Option: BENOWA FLOOD CHANNEL - Increasing the volume of floodwaters carried through the Benowa Flood Channel.

The Benowa Flood Channel was designed to replicate the natural overland flow path of floodwater as it breaks from the northern bank of the Nerang River to the east of Royal Pines Golf Course. Investigations were undertaken to determine whether the volume of floodwater carried through Benowa Flood Channel could be increased, thereby creating further flood relief without increasing peak flood levels downstream and altering the non-tidal nature of the Benowa flood system.

Option: DREDGING - Improving conveyance of floodwaters in the lower reaches of the Nerang River by dredging.

This option included dredging the Nerang River from Florida Gardens Canal to the Gold Coast Highway Bridge, dredging of Florida Gardens Canal and Little Tallebudgera Creeks and widening of Florida Gardens Canal to allow greater volumes of water to move more freely to the river mouth. The purpose of these works was to accelerate the release of floodwaters from the creeks and its movement through the lower reaches of the river before the arrival of the peak flow from the upper catchment of the Nerang River.

Option: BRIDGE IMPROVEMENTS - Improving conveyance of floodwaters in the lower reaches of the Nerang River through bridge improvements.

This option considered replacing Via Roma and Chevron Island East bridges with structures designed to improve conveyance of floodwater through the lower reaches of the Nerang River.

Option: HINZE DAM - Raising the height of the Hinze Dam wall

A number of alternatives were investigated based on varying heights of the dam wall, various spillway configurations and varying the flood storage capacity. The most favourable were included in an economic analysis. The purpose of raising the Hinze Dam is to delay the release of floodwaters into the floodplain by raising the dam wall to store a greater volume of water and selecting a spillway configuration that lowers the rate of discharge from the dam. Delaying the discharge, results in peak flows from the Nerang River being separated from the peak inflows from Mudgeeraba, Bonogin and Worongary Creeks, thereby reducing peak flood levels throughout the lower catchment and notably in the suburbs of Mermaid Waters, Broadbeach Waters and Burleigh Waters.

Conclusion

Preliminary economic social and environmental impact assessment of the range of options described above identified that the most effective physical flood mitigation measure was the raising of Hinze Dam. GCCC adopted the raising of Hinze Dam as the preferred option on the 5 March 2004.

Water Supply

The Gold Coast City Council has investigated a broad range of water supply alternatives; some of the significant options are outlined in **Table 2-2**.

- **Table 2-2 Gold Coast City Council - Water Supply Options Investigated**

Supply Options	Description
Additional ponding upstream of Hinze Dam	Construction of a series of weirs upstream of Hinze dam to provide additional storage volume
Cloud seeding	Artificial generation of rainfall
Damming the Broadwater	Construction of embankments across the Broadwater to create a freshwater storage separated from the ocean
Dams and yields	Investigation of additional dam sites and the evaluation of potential yields
Desalination	Conversion of seawater to potable water
Evaporation control	Covering the surface of water storages in order to reduce the amount of water lost as evaporation
Greywater	Reuse of household wastewater (on a personal scale)
Groundwater	Water extracted from underground sources
Indirect potable reuse	Highly treated wastewater is pumped back into Hinze dam and mixed into the drinking water supply. (The water is treated again at the time of extraction)
Rainwater tanks	On site rainwater collection from roof tops
Recycled water for non potable use	Treatment and reuse of wastewater for non potable purposes, e.g. industrial
Recycled water for environmental flows	Treatment and reuse of wastewater for river flow (as a substitute for current environmental releases from the dam)
River barrages	Construction of weirs across coastal river estuaries in order to harvest freshwater flows
Stormwater harvesting	Capture of stormwater runoff for later reuse
Water conservation	Reduction of user demand through a variety of initiatives
Water pressure and leakage management	A range of measures designed to reduce consumption associated with excessive pressure and system failures.

Source: Gold Coast Water Futures Strategy 2006-2056

These options were evaluated by the Gold Coast Waterfuture Advisory committee with community consultation. Consideration was given to economic, social and environmental impacts as well as the diversity and adaptability of the options. The raising of Hinze Dam for water supply is one element of a diverse and integrated range of water sources in order to provide a more robust water supply system for the region. Previously urban water planning had concentrated heavily on supply from dams; in light of current drought conditions and issues of climate variability and climate change these sources on their own provide less security of supply.

GCCC adopted that the raising of Hinze Dam include provision for water supply on the 22 November 2004.

2.3.3 Dam Configuration Alternatives

Options Evaluation Approach

The Hinze Dam Alliance was established by Gold Coast City Council in October 2006 to optimise the design, prepare cost estimates, obtain environmental and other approvals, and to construct Hinze Dam Stage 3.

An early part of the Alliance's brief was to undertake an optimisation study mainly focused on the storage configuration (specifically water supply and dam safety components of the raising) by investigating aspects such as yield versus height, acceptable flood capacity for the dam and environmental and economic considerations. The Alliance adopted a five step optimisation process to identify and holistically evaluate the optimal arrangement for Hinze Dam Stage 3. Each step included stakeholder workshops with representatives from Alliance design, environmental, communications, and construction teams, Gold Coast City Council and Gold Coast Water Officers, members of Councils' independent expert review team, the Queensland Dam Safety Regulator (Department of Natural Resources and Water) and Community Advisory Committee members.

Broadly, the process included:

- Optimisation Foundation Workshop (25 October 2006) to clarify and integrate project objectives and agree on the optimisation evaluation methodology;
- Options Initiation Workshop (6 November 2006) to agree on the range and types of options to be considered in the optimisation study;
- Options Shortlisting Workshop (6 December 2006) to evaluate and compare 12 "broad" options and shortlist up to three options for further assessment;
- Options Value Management Workshop (13 December 2006) to identify value improvements to the short-listed options to reduce costs and risks and enhance benefits; and
- Preferred Option Workshop (19 January 2007) to identify and recommend a preferred option for the Stage 3 upgrade.

Throughout the development and evaluation of the Stage 3 upgrade options, the Hinze Dam Alliance has actively engaged the community through consultation with affected stakeholder groups as well as the wider community. A project Community Advisory Committee (CAC) was also established as a specific reference group, with this group being involved in the decision making process and evaluation of each potential upgrade option.

Evaluation Methodology

A fully quantitative cost benefit analysis was developed for the optimisation study for holistic evaluation of the options including economic, social, and environmental considerations. The quantitative assessment included certain costs (with probabilistic costing to assign uncertainty), and potential costs (risk that events may occur and cost required to manage, or mitigate impacts).

In broad terms, the optimisation cost benefit analysis included the following categories:

- capital costs for project delivery (construction and commissioning);
- risk costs for project delivery (potential risks that could occur during construction or commissioning, including potential changes to design). The majority of environmental and social impact costs were included in the risk cost component of the evaluation recognising that a full evaluation of the impacts would be defined in the Environmental Impact Statement;
- environmental costs (e.g. compensatory habitat required for loss of ecosystems from increase reservoir Full Supply Level);
- operating costs (including continuance of water supply, and increased operating costs for flood mitigation where relevant);
- operating risk costs (potential events that could occur during operation that would incur costs – e.g. risk of flood mitigation gate operations);

- economic value of flood mitigation benefits – included as recurring annual benefit to the value of the reduction in average annual flood damages expected from the Project; and
- economic value of increased water supply – included as a recurring annual benefit of the value of water.

Each of the broad range options were evaluated based on these categories.

Upgrade Options

A number of options were considered and evaluated as part of the upgrade. The process undertaken and the subsequent steps are described in the following section.

Initial Options

To achieve the dam safety objective the Alliance identified that a range of spillway options were possible. The spillway configuration (for flood mitigation and dam safety) and full supply level (for water supply) determined the required dam crest level for dam safety.

A "top-down" and "bottom-up" approach was undertaken to bound the potential range of spillway configuration options and storage configuration options. In general all options were developed to provide an approximately equal level of flood mitigation benefit.

The approach utilised the following basic principles:

- top-Down (High Dam), where the Dam Crest Level was set at Council's nominated level of RL 106.0m AHD, and various spillway configurations and dimensions were investigated to establish the highest practical full supply level with sufficient flood storage to meet dam safety requirements. This end of the spectrum basically represented highest benefit in terms of water supply yield; and
- bottom-Up (Low Dam), where the Full Supply Level was set at Council's nominated level of RL 92.5 m AHD, and various spillway configurations and dimensions were investigated to establish the minimum practical dam crest level. This represented the lowest potential cost options (smaller dam) for Hinze Dam Stage 3.

It should be noted that the decision to consider the Low Dam options (FSL at RL 92.5m AHD) was made on the basis of Council's nominated configuration for Hinze Dam and prior yield hydrology modelling. Hence, at that time it was not confirmed that such options could achieve the 16ML/day increase in water supply yield as required by *Water Amendment Regulation No. 6 (2006).*

At the options initiation workshop, 48 options were identified which included varying combinations of full supply level and spillway configurations and combinations. Broadly, the potential spillway configuration types included combinations as described in **Table 2-3**.

- **Table 2-3 Potential Spillway Configurations**

Primary Spillway For Flood Mitigation	Primary Spillway for Dam Safety (extreme floods)	Auxiliary Spillway for Dam Safety
Narrow low level ogee crest spillway with crest at full supply.	High level ungated ogee crest spillway	Ungated / unrestricted overflow spillway (broad crest).
Radial gate option on ogee crest spillway.	Fusegate spillway on broad crest sill.	Erodible earthen embankment fuseplug spillway.
		Fusegate spillway.
		Labyrinth spillway.

The options initiation workshop agreed broad technical practicality, precedence, and feasibility criteria, to quickly screen the 48 options to a manageable number of broad options for further concept design, investigation, and assessment. The technical criteria included factors such as:

- maximum total practical width for a primary spillway;
- likely maximum width and level for a secondary spillway;
- maximum practical height of fusegates, fuseplug embankments, labyrinth walls and practical radial gate arrangements;
- preference to avoid combinations of multiple fusing spillways of differing types (e.g. avoid fuseplug spillway combined with fusegate spillway); and
- desirable fusing levels for fusing type spillways.

Two other key outcomes of the options initiation workshop were:

- an active flood mitigation option (i.e. with radial or other spillway gates to be operated actively for flood control) should be retained in the mix of options; and
- a Greenfield spillway option should be considered (i.e. decommission the existing spillway and construct a new primary spillway at the proposed auxiliary location on the left abutment).

Broad Range Options

Following the options initiation workshop and initial technical screening, 12 broad range options were developed for further consideration. These options included 6 configurations of spillway combinations, and 2 storage configurations (Low Dam and High Dam) for each spillway configuration options.

The 12 options considered are summarised in **Table 2-4**.

It should be noted that the estimates of incremental yield from Stage 2 for each option listed in the table were adopted using a "base case yield" for Stage 2 as the Historical No Failure Yield (HNFY) from preliminary DNRW hydrologic modelling analyses. In subsequent detailed yield assessments, the base case Stage 2 yield has been adopted as Gold Coast City Council's entitlement as specified in the Interim Resource Operations Licence (iROL) (DNRMW 2006a), which differs slightly from the modelled Stage 2 yield. Nonetheless, the indicative incremental yield estimates were adequate for relative comparison of the benefits of each option.

Options Evaluation

The broad range options were developed to a preliminary concept design level sufficient for relative cost comparisons for options evaluation. The level of design was limited to sufficient work to evaluate order of magnitude cost differences between options (basically prefeasibility level design). At that stage of the Alliance activities, information from design investigations particularly for the embankment design was limited and was still in the planning stage of investigation. The cost estimates therefore assumed equal assumptions for key design factors (such as foundations depths and works to treat risks with complex and uncertain geology at the right abutment). Many of the significant design uncertainties were allocated as risk costs in the evaluation.

Each of the twelve options identified were evaluated utilising the methodology described above. Specific details regarding the evaluation methodology and results for each of the individual options have been documented within the Hinze Dam Stage 3 Optimisation Report. A summary of the short-listed and selected options for the upgrade is provided in the following sections.

Options Short-listing

The broad range options were presented to stakeholders at the Options Short-listing Workshop held on 6 December 2006. The discussions included description of the type, function, distinguishing features, environmental and constructability implications of each option.

The workshop then discussed the outcomes of the evaluations and risks. The following conclusions were made in the workshop:

- the low dam options with Full Supply Level at RL 92.5 m AHD were less favourable in economic terms than the corresponding high dam options with higher Full Supply Level. A key factor contributing to this finding were cost components (particularly risk costs) that were relatively insensitive to the Full Supply Level. Hence, the higher Full Supply Level options which provided additional benefit (increased yield and water supply benefit) at relatively low incremental cost, results in better benefit cost ratios;
- the low dam options with Full Supply Level at RL 92.5 m AHD did not meet the requirement for a minimum of 16 ML/day increase in water supply yield as required by *Water Amendment Regulation No. 6.* The workshop agreed that these options should not be selected in the shortlist of options to move forward;
- the radial gate option PS2-High was significantly more costly than other options largely due to the additional capital cost, additional operating costs, and additional risks associated with active flood mitigation with gate operations. This option also provided significantly higher benefits with increased water supply yield (FSL at EL 96.0) and some potential to enhance the flood mitigation benefits slightly with strategic operation of the flood gates. However, it was also determined that slight to moderate errors in the gate operations related to sensitive timing of the gate operations could significantly diminish the flood mitigation benefits. GCCC stakeholders expressed a clear preference for passive flood mitigation to avoid the costs and risks associated with gate operations and that this option was considered too expensive. On this basis, Option PS2-High was eliminated from further consideration;
- the benefit-cost assessment showed that Option PS1-High was the only option that could be distinguished as likely to be more economically favourable than other options; and
- the auxiliary spillway options AS7, AS9, AS10, and AS11 were considered equal in the benefit-cost assessment given the likely accuracy of cost and risk cost estimates. The workshop then agreed that selection from these options should be based on experienced engineering judgment, particularly in relation to the dam safety performance. Discussions among the workshop participants identified that option AS9 would be the most favourable of these options based on simplicity of design, and no reliance on fusing elements (such as Fuseplugs or Fusegates) for safe passage of extreme floods.

The workshop concluded with agreement to select options PS1-High and AS9-High as the short-listed options for the next phase of the optimisation study.

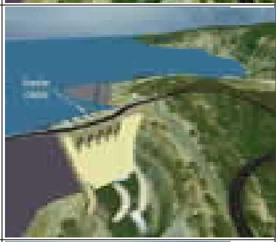
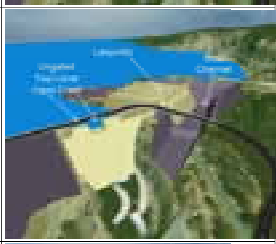
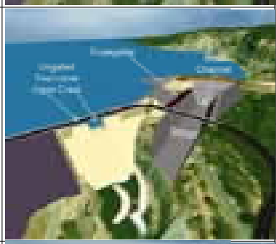
On 12 December 2006, the short-listed options were presented to the Community Advisory Committee (CAC – established by Gold Coast City Council to advise on community interests in the Project). At this meeting, the CAC endorsed the short-listed options for further consideration.

Subsequent to the CAC endorsement, a value management workshop was held on 13 December 2006 to identify risks and opportunities for the short-listed options and the overall project. The workshop focused on the differences between the short-listed options as well as other project opportunities and risks that were common to the options and would not significantly affect the preferred option selection. Key outcomes of the workshop, of relevance to the optimization study were:

- option PS1-High (Fusegates on the primary spillway) involved risks associated with the potential for Fusegates to block in the downstream chute in an extreme flood that would cause the Fusegates to tip; and
- option PS1-High required further consideration of how a Fusegate could be replaced on the primary spillway after an extreme flood that would cause one or more Fusegates to tip. However, it was acknowledge that with the proposed concept design for this option, loss of Fusegate would not compromise dam safety and would not compromise water supply yield (Full Supply Storage Capacity). Hence, the main concern associated with loss of a Fusegate would be temporary loss of flood mitigation benefits until the Fusegate(s) could be replaced;

Table 2-4 Broad Range Spillway Options

Hinze Dam Stage III
Optimisation Phase
Summary of Broad Range Spillway Options
for 6 December 2006 Workshop

Option	Description		Dam Crest Level (mAHD)	Full Supply Level (mAHD)	Incremental Water Yield from Stage 2 (ML/year)	Spillway Type: Radial (Tainter) Gates	Spillway Type: Fusegates	Spillway Type: Fuseplug	Spillway Type: Labyrinth	Spillway Type: Auxiliary Spillway Channel
PS1 - High FSL	16m wide ungated ogee crest to mitigate the 100 year flood located on the primary spillway. 5m high Fusegates located along the primary spillway with crest level 0.5m above the peak 100 year water level. Fusegates total approx. 84m in length. Fusegates first tip at around 10,000 year flood.		106.0	94.5	6,800					
PS1 - Low Dam			104.6	92.5	5,500					
PS2 - High FSL	4 - 9.25m wide x 14m high radial (tainter) gates located on the primary spillway. The sill for the radial gates is at 89.0mAHD. Gate operating rules would be established to mitigate flows (up to 500 year flood) and fully operate during extreme flood events for dam safety.		106.0	96.0	8,000					
PS2 - Low Dam			104.0	92.5	5,500					
AS7 - High FSL	16m wide ungated ogee crest to mitigate the 100 year flood located on the primary spillway. High level ogee crest located in primary spillway (width of 34m). 6.5m high fuseplug embankments located along an auxiliary spillway. Fuseplug embankments total approx. 80m in length. Fuseplug embankments breach at around the 10,000 year flood.		106.0	94.5	6,800					
AS7 - Low Dam			104.5	92.5	5,500					
AS9 - High FSL	16m wide ungated ogee crest to mitigate the 100 year flood located on the primary spillway. High level ogee crest located in primary spillway (width of 34m). 5m high labyrinth spillway structure located along an auxiliary spillway. Labyrinth weir width total approx. 80m in length. Labyrinth spillway first begins to overflow around the 1,000 year flood.		106.0	94.0	6,500					
AS9 - Low Dam			104.8	92.5	5,500					
AS10 - High FSL	16m wide ungated ogee crest to mitigate the 100 year flood located on the primary spillway. High level ogee crest located in primary spillway (width of 34m). 6m high Fusegates located along an auxiliary spillway. Fusegates total approx. 80m in length. Fusegates first tip at around the 10,000 year flood.		106.0	94.5	6,800					
AS10- Low Dam			104.4	92.5	5,500					
AS11 - High FSL	Decommission Stage 2 Service Spillway. 16m wide ungated ogee crest to mitigate the 100 year flood. 5m high labyrinth spillway structure that overflows to a concrete lined side-channel. Labyrinth weir width total approx. 100m in length. Labyrinth spillway first begins to overflow around 500 year flood.		106.0	94.0	6,500					
AS11 - Low Dam			104.6	92.5	5,500					

- option PS1-High required further consideration of the need to involve a specialist subcontractor to supply, install, and test the Fusegates, and how this may affect the Alliance performance particularly in relation to delivery timeframe;
- option PS1-High required further consideration of the risks associated with the need for blasting close to the existing spillway structure to excavate a larger spillway channel;
- option AS9-High required further consideration associated with uncertain geology and foundation condition at the auxiliary spillway location. The geotechnical risks were identified to potentially include:
  - risk of excessive leakage and associated extent and cost of grouting of the auxiliary spillway;
  - risk of slope instability associated with the deep cut required to excavate the auxiliary spillway side channel;
  - potential and uncertain need for extensive erosion protection works to the base and sides of the side channel excavation if poor quality rock were encountered in the side channel excavation; and
  - potential need for blasting relatively close the existing spillway structure should hard rock be encountered in the auxiliary side channel excavation.
- opportunities for AS9-High should be explored for optimization of the auxiliary labyrinth arrangement to determine if the Full Supply Level could be increased from EL 94.0 m AHD (as at options short-listing phase) to EL 94.5 m AHD. This could equalize the water supply storage capacity between the two short-listed options to enable a clearer decision for preferred option selection;
- option AS9-High required further consideration of the impact on recreation opportunities associated with the left abutment area required to provide the auxiliary spillway and side channel; and
- the need for public access across the main dam wall and spillway, and specifically the need for a spillway bridge, required further consideration. In particular the potential to eliminate the need for a spillway bridge would produce greater cost savings for Option AS9-High which would otherwise require a bridge across the main spillway and a second bridge across the auxiliary spillway side channel.

These issues were taken into consideration as part of the options development phase.

Options Development

Further design development and investigations were undertaken after the Value Management workshop to prepare additional information and evaluations to facilitate selection of a preferred option.

The options which were further developed as part of this phase were:

- Option PS1-High; and
- Option AS9-High.

The specific details of each of these options are briefly described in **Table 2-4**.

Common to both options developed under this phase of the Project was the assessment of the downstream chute upgrade. The hydraulic capacity of the downstream chute was undertaken via 3D hydraulic modelling to assess its capacity based on the peak maximum flow which could be released from the dam.

The assessment identified that the existing chute flow capacity (in the order of 2700 m^3/s) was significantly less than the revised estimate of the PMF outflow for the two short-listed options PS1-High and AS9-High (PMF outflow approximately 6000 m^3/s and 5600 m^3/s respectively. It was considered that the existing chute walls would need to be raised by approximately 4 m to contain the PMF outflow within the chute walls. Preliminary structural review of the existing chute walls identified that the existing walls could not be practically extended, and that demolition of the existing walls and reconstruction of new higher walls would be required. The quantities and cost estimates for Options PS1-High and AS9-High were subsequently revised to incorporate these findings of the need to upgrade the downstream chute.

During the further development of the short-listed options, the Alliance had identified and developed a variation of Option PS1 to further minimise risks by eliminating need for Fusegates and excavation to widen the existing spillway channel. This option known as option PS1A included the following key features:

- primary spillway with a two level ogee crest spillway (similar to the current spillway arrangement). The narrow low level spillway would provide passive flood mitigation by restricting the rate of flood outflow for small to large floods (up to 1 in 100 AEP) and the high level spillway provided capacity for extreme floods to meet dam safety criteria;
- the spillway arrangement would fit neatly within the existing spillway channel excavation thereby avoiding the need to widen the spillway channel;
- full supply level at RL 94.5m AHD (similar to alternative short-listed options PS1 and AS9);
- dam crest level at RL 108.4m AHD to safely contain the PMF; and
- peak PMF outflow of approximately 3600 m^3/s.

Option PS1A had not previously been considered viable in the earlier development of options because the Dam Crest Level exceeded Council’s nominated limit of RL 106.0m AHD. However, the Alliance design and construction teams identified that there were several advantages of the new PS1A option that warranted inclusion in the short-listed options for selection of the preferred option. These advantages included:

- simplicity of the primary spillway with no moving parts of fusing elements. The similarity to the existing spillway was particularly seen as an advantage for community acceptance;
- eliminated the need to install fusegates and associated risks for construction and fusegate operation (e.g. blockage potential);
- eliminated the need to widen the existing spillway channel and associated risks of blasting;
- maintained opportunities to provide recreational use areas at the left abutment that would otherwise be significantly constrained by the AS9-High option;
- significantly reduced the requirements to upgrade the downstream chute. It was identified that the additional flood attenuation for extreme floods provided by this option reduced the magnitude of the peak PMF outflow. It was identified that raising of the chute walls by 1 to 2 m would be required and that this could be achieved by extending the existing chute walls; and
- least risk associated with uncertainty of the foundation conditions (geology and geotechnical) for the spillway.

It was identified that the new PS1A short-listed option would require significantly greater quantities of rockfill, clay core, and filters to construct the embankment to a higher level than the alternative options. However, it was also identified that there would be significant savings for the spillway works due to the simplicity of the design and reduced need to upgrade the downstream chute.

The new short-listed option PS1A was presented to the CAC on 16 January 2007. At this meeting, the CAC endorsed inclusion of this new option for the preferred option selection process.

At this stage of the Optimisation Study, evaluations and agreement had not yet been finalized regarding the need to provide a public access bridge across the spillway. Hence, the design development, evaluation and selection of the preferred option proceeded on the basis the design would require a bridge over the spillway (and bridge over the auxiliary spillway side channel for Option AS9).

An overall summary of the three short-listed options is presented in **Table 2-5**.

Short-Listed Option Evaluation

For selection of a preferred option, the short-listed options PS1, AS9, and PS1A, were evaluated using the same methodology applied for evaluation of the prior broad range options at the options short-listing phase.

The following areas were revised:

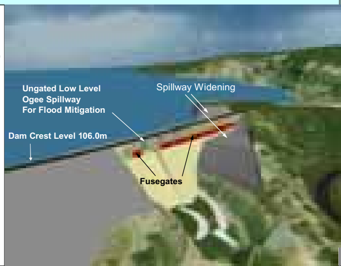
- capital cost estimates, based on the updated concept designs of the short-listed options, including the additional identified requirements to upgrade the downstream chute;
- project risks (overall project and option specific risks). This included additional risk identified for the options after prior short-listing based on additional design and investigation information, and re-evaluation of the probabilities, consequences, and risk costs of each risk; and
- operating costs, operating risk costs, water supply benefits, and flood mitigation benefits.

To assist the short-listed options evaluation, the differences in major works quantities was also reviewed, in particular to distinguish the differences between higher embankment volumes and reduce spillway works for the PS1A option compared to the alternative PS1 and AS9 options.

Relative comparisons of each of the options, and benefit-cost comparison were also undertaken. From these activities, Option PS1A was determined to afford the greatest benefits for the target cost.

Table 2-5 Short-Listed Dam Upgrade Options

Hinze Dam Stage III
Optimisation Phase
Summary of Short-listed Spillway Options
for 19 January 2007 Workshop

Option	Description		Dam Crest Level (mAHD)	Full Supply Level (mAHD)	PMF Peak Outflow (m3/s)	Incremental Water Yield from Stage 2 (ML/year)	Spillway Type: Fusegates	Spillway Type: High Level Ogees	Spillway Type: Labyrinth	Spillway Type: Auxiliary Spillway Channel
PS1	15m wide ungated ogee crest to mitigate the 100 year flood located on the primary spillway. 5m high Fusegates located along the primary spillway with top of Fusegates above the peak 200 year water level. Fusegates total approx. 98.8m in length. Fusegates first tip at around 10,000 year flood.		106.0	94.5	6,000	6,800				
PS1A	15m wide ungated ogee crest to mitigate the 100 year flood located on the primary spillway. High Level ogee crests (55m total width) overflow in 200 year flood		108.4	94.5	3,600	6,800				
AS9	15m wide ungated ogee crest to mitigate the 100 year flood located on the primary spillway. High level ogee crest located in primary spillway (width of 35m). 4m high labyrinth spillway structure located along an auxiliary spillway. Labyrinth length 135m and overflows around the 500 year flood.		106.0	94.5	5,600	6,800				

Preferred Option Selection

The updated three short-listed options were presented to stakeholders at the Preferred Option Selection Workshop held on 19 January 2007. The discussions in the workshop included:

- updated descriptions of the concept designs for the short-listed options;
- key features and reasoning for the new third short-listed option PS1A;
- implications of the requirements to upgrade the downstream chute and key differences between option PS1/AS9 and PS1A;
- environmental and recreational use implications of each option;
- information on the flexibility of each option to accommodate future changes in the PMF;
- a comparison of preliminary dam safety risk assessment of the existing dam and proposed three short-listed options;
- implication of initial estimates of the likely construction timeframe; and
- outcomes of the updated benefit-cost evaluations of the short-listed options.

In summary, the outcomes of the workshop discussions included:

- the new third short-listed option, PS1A, was considered in general terms to be favourable due to the simplicity of the design and similarity to the existing spillway arrangement;
- the smaller extent of upgrade of the downstream chute for Option PS1A was considered to be a significant differentiator to the alternative short-listed options PS1 and AS9;
- options PS1 and PS1A (primary spillway without auxiliary spillway) were considered an advantage for recreation use potential around the dam;
- on balance all options were considered to provide a relatively equal level of flexibility to cater for future change in the PMF. Option PS1A would potentially be slightly more expensive if a raise of the embankment would be required for increased PMF, however the works to upgrade the downstream chute could balance the additional costs, and Option PS1A maintained flexibility to develop an auxiliary spillway (similar to AS9) if required;
- the preliminary quantified dam safety risk assessment showed that all of the short-listed options would meet ANCOLD 2003 Guidelines for Tolerable Risk and would significant decrease the dam safety risk profile compared to the existing Stage 2 dam which does not meet ANCOLD guidelines. There were no discernable differences in the quantified risk assessment results for the three short-listed options. However, experience engineering judgement concluded that Option PS1A was slightly more favourable due to the simplicity of the design;
- options PS1A and AS9 had a slight advantage over option PS1 for construction timeframe. The PS1 option required slightly longer construction timeframe (approximately 2 months) due to the need to install Fusegates near the end of the construction schedule. However, on balance all options were considered relatively equal for construction timeframe given that detailed design and construction planning had not been undertaken at this stage of the Project;
- the economic benefits of the short-listed options were equal; and
- option PS1A was clearly favourable in economic terms with an estimated 10% cost saving compared to Options PS1 and AS9. The primary factor in this conclusion was the lesser extent of work required to upgrade the downstream chute. The cost savings for concrete quantities for Option PS1A outweighed the additional costs for larger embankment construction quantities.

The workshop unanimously agreed that Option PS1A should be the preferred option for the Hinze Dam Stage 3 Upgrade.

Community Advisory Committee Endorsement

Subsequent to the Preferred Option Selection Workshop, the Alliance met with the CAC on 30 January 2007. At this meeting the CAC endorsed the selection of Option PS1A as the preferred option for the Hinze Dam Stage 3 Upgrade.

Gold Coast City Council Endorsement and Resolutions

The preferred option recommendation (PS1A) for the Hinze Dam Stage 3 was reviewed and considered at the Gold Coast City Council meeting on 12 February 2007. The Council meeting unanimously endorsed Option PS1A as the preferred option, and also passed Council resolutions to upgrade the objectives of the Project. These resolutions included:

- the flood mitigation objective for Hinze Dam Stage 3 is to reduce the peak 1 in 100 year ARI flood flow from Hinze Dam by 50%. The preferred option meets this criterion and the criterion effectively ensures that the flood mitigation performance is the same as that previously envisaged by Gold Coast City Council. The revised criteria were approved in recognition that the previous criterion (79 000 ML flood mitigation storage capacity) was no longer applicable as the preferred option did not require operation of flood gates for flood mitigation; and
- the Dam Crest Level was approved at RL 108.5m AHD. This resolution recognised that the preferred Option PS1A (with higher embankment crest level) was considered more optimal that alternative options that complied with Council's previous resolution for a Dam Crest Level at RL 106.0m AHD.

2.4 Project Costs and Benefits

A summary of the costs and benefits of the Project are contained in this section. Full details of the economic and social analysis undertaken are presented in **Section 16.**

2.4.1 Economic Impact

State and Regional Economic Impacts

The Project is expected to cost $382.1 million in total, comprised of approximately $30.9 million in the design and engineering and $351.2 million in the construction of the dam. It is expected that the majority of expenditure will be retained within the Queensland and South East Queensland economies due to the nature of the construction, with much of the input material being sourced from the area surrounding the dam.

The direct labour force associated with the design phase of the development includes approximately 75 full time equivalent (FTE) employees. The construction workforce is expected to build up and peak at approximately 230 FTE for a period of approximately 18 months before declining. There are on average approximately 162 FTE employees per month over the 36 month construction phase.

The economic impact of the design and construction phases of the Project on both the Queensland and the Gold Coast Local Government Area (LGA) economies are summarised in **Table 2-6**.

Table 2-6 Impact of Design & Construction Phase ($ 2006)

	Queensland				Gold Coast LGA			
	Output ($M)	Value Added ($M)	Income ($M)	Emp. (FTE)	Output ($M)	Value Added ($M)	Income ($M)	Emp. (FTE)
Direct	$310.3	$133.7	$46.0	602	$248.9	$107.7	$35.0	532
Flow-on	$224.3	$92.4	$49.2	849	$174.6	$71.4	$37.8	569
Total	$534.6	$226.1	$95.2	1451	$423.5	$179.1	$72.8	1100

Source: Hinze Dam Alliance based on data from Queensland Office of the Government Statistician (2002)

The economic impact of the design and construction phase of the Project is positive. The key points from the impact assessment include an additional:

- $534.6 million in output (direct and indirect) to the Queensland economy, with $423.5 million to the local Gold Coast economy;
- $226.1 million in value added production (direct and indirect) to the Queensland economy, with $179.1 million to the local Gold Coast economy;
- $95.2 million in wages and salaries (direct and indirect) to the Queensland economy, with $72.8 million to the local Gold Coast economy; and
- 1 451 employment positions over the life of the Project (direct and indirect) to the Queensland economy, with 1 100 to the local Gold Coast economy over the life of the Project.

The nature of the operations at Hinze Dam is not expected to change materially following the completion of the upgrade. Therefore there is not expected to be any significant change associated with the economic impact of the operation.

Local Economic Impacts

There is a cafe that currently services visitors to the Hinze Dam, with the majority of patronage being visitors to the site for amenity or recreational purposes. In accordance with the lease over the facility this cafe will not operate during the construction phase. The closure is due to public safety considerations during the early stages of construction and ultimately the facility will need to be removed / relocated to allow the raising of the dam embankment. The turnover of the existing cafe is not available. An estimated annual turnover of $281 250 (based on estimated visitor numbers and assumed spend rates) was used to determine the economic impact of the closure. The estimated annual impact is detailed in **Table 2-7**.

- **Table 2-7 Impact of Cafe Closure ($ 2006)**

	Output ($M)	Value Added ($M)	Income ($M)
Direct	$0.375	$0.174	$0.104
Flow-on	$0.281	$0.117	$0.036
Total	$0.656	$0.291	$0.140

Note: There is not expected to be any significant difference between the impact of the operation of the café to the Queensland economy and the local study area (Gold Coast LGA).
Source: Hinze Dam Alliance based on data from Queensland Office of the Government Statistician (2002).

The reduction in economic activity resulting from the closure of the cafe during the Project construction phase is small relative to the additional economic activity generated by design and construction.

Other Businesses

There may also be some economic impacts associated with removing recreational access to the dam for a period on businesses in the local area who may have supplied food/drink for picnic/BBQ purposes for both individual or small group visitors and organised events. However, these are expected to be minimal and localised. It is reasonable to expect that previous recreational users would move their recreational activities elsewhere within the Gold Coast LGA.

There is not expected to be any other tangible operating impacts incurred by existing businesses in the study area as a result of the construction phase.

2.4.2 Flood Mitigation Benefits

The Project will deliver significant benefits to the region through reduction in:

- risk of flooding on the Nerang River floodplain;
- number of properties flooded; and
- flood damages.

Properties Flooded

The Project will significantly reduce the number of properties flooded over a broad range of flood events. The number of properties protected from over floor flooding is summarised in **Table 2-8**.

Table 2-8 Reduction in the Number of Properties Flooded

Flood Event ARI	Reduction in properties flooded		
	Residential	Commercial/ Industrial	Total
10	36	4	40
20	126	18	144
50	449	49	498
100	3166	118	3284

Flood Damages

The flood damages assessment was undertaken to determine the scope of damages to the community (business, infrastructure, environmental, quality of life, etc.) in existing conditions and to assess the impacts of the upgrade of Hinze Dam and its associated flood mitigation attributes in monetary terms.

Tangible flood damages are those to which a monetary value can be assigned and include property damages (internal, structural, and external), business losses, clean-up and recovery costs. Intangible flood damages are those to which a monetary value cannot be assigned and include risk of death, anxiety, inconvenience and disruption of social activities. Both are a function of flood magnitude.

A monetary assessment of flood damages focuses predominantly on the tangible damages. Intangible damages are important and are included where they may be quantified and valued.

Flood damages were calculated using the methodology described in the Queensland Department of Emergency Services Flood Assessment Guidelines (2002a).

Table 2-9 summarises the economic impact of a 1 in 100 year ARI flood event for existing conditions. Similar assessments were undertaken for the following flood events:

- 1 in 10 year ARI;
- 1 in 20 year ARI;
- 1 in 50 year ARI;
- 1 in 100 year ARI;
- 1 in 200 year ARI;
- 1 in 500 year ARI;
- 1 in 1000 year ARI;
- 1 in 10 000 year ARI; and
- Probable Maximum Flood (PMF).

Table 2-9 Loss Assessment 1 in 100 year Flood Event: Base Case ($ 2006)

Loss Type	Economic Loss to the Region ($M)	Benefits to the Region			Net Economic Loss ($M)
		NDRA[b] ($M)	Insurance ($M)	Total ($M)	
Direct					
Residential[a]	$95.7		$9.6	$9.6	$86.1
Commercial	$7.4		$0.7	$0.7	$6.7
Infrastructure	$21.2	$13.0	$0.0	$13.0	$8.2
Vehicles & Boats	$26.3		$21.9	$21.9	$4.3
Indirect					
Business disruption	$2.3				$2.3
Transport network disruption	$4.4				$4.4
Tourism	$4.5				$4.5
Disaster response and relief	$1.1	$0.9		$0.9	$0.2
Intangible					
Death, injury and health	$7.5				$7.5
Environmental	$0.6				$0.6
Total	**$171.0**	**$13.9**	**$32.3**	**$46.2**	**$124.8**

Notes: (a) Includes loss of memorabilia. (b) Natural Disaster Relief Arrangements funding
Source: Hinze Dam Alliance based on GCCC hydraulic modelling

The assessment for the 1 in 100 year ARI flood event for the base case (existing conditions) scenario indicates a net economic loss for the region of approximately $124.8 million.

The assessment for the 1 in 100 year ARI flood event for the proposed Project scenario indicates a net economic loss of approximately $41.1 million. **Table 2-10** lists the economic losses for this case.

Table 2-10 Loss Assessment 1 in 100 year Flood Event: Project Scenario ($2006)

Loss Type	Economic Loss to the Region ($M)	Benefits to the Region			Net Economic Loss ($M)
		NDRA[b] ($M)	Insurance ($M)	Total ($M)	
Direct					
Residential[a]	$25.6		$2.6	$2.6	$23.1
Commercial	$4.7		$0.5	$0.5	$4.2
Infrastructure	$9.3	$5.7	$0.0	$5.7	$3.6
Vehicles & Boats(b)	$6.8		$5.7	$5.7	$1.1
Indirect					
Business disruption	$3.2				$3.2
Transport network disruption	$6.0				$6.0
Tourism	$4.5				$4.5
Disaster response and relief	$0.3	$0.3		$0.3	$0.1
Intangible					
Death, injury and health	$2.0				$2.0
Environmental	$0.2				$0.2
Total	**$62.7**	**$6.0**	**$8.8**	**$14.7**	**$47.9**

Notes: (a) Includes loss of memorabilia. (b) Natural Disaster Relief Arrangements funding
Source: Hinze Dam Alliance based on GCCC hydraulic modelling

For a 1 in 100 year ARI flood event, this equates to a reduction in the net economic loss experienced by the region attributable to the proposed upgrade of the dam of approximately $76.9 million. This is a 62% reduction in the estimated 1 in 100 year ARI flood damages for the Nerang River flood plain.

By combining the range of damage estimates for the floods considered for each case considered an average annual damage (AAD) or annual damage cost to the community for accepting a given floodplain condition is determined. The AAD is commonly used in flood management studies, as it is a useful single value indicator of the financial vulnerability of a community to flooding in existing conditions and of the benefit of proposed mitigation schemes. The benefits of flood mitigation will be the average annual losses prevented by the mitigation measure.

The net economic damages from each flood event, the average annual damages (AAD) value generated for the base case (existing conditions) and the Project scenario and the reductions achieved are shown in **Table 2-11**.

- **Table 2-11 Average Annual Damages (AAD): Comparison ($2006)**

Flood Event ARI	Net Economic Damages ($M)		
	Base Case ($M)	Project Scenario ($M)	Reduction ($M)
10	$16.4	$14.0	$2.4
20	$28.9	$25.1	$3.8
50	$46.1	$35.8	$10.3
100	$124.8	$47.9	$76.9
200	$285.1	$83.1	$202.0
500	$568.9	$160.9	$408.0
1000	$1176.3	$749.6	$426.7
10 000	$1366.7	$1310.0	$567.0
PMF	$3047.2	$2790.7	$256.5
AAD	**$7.66**	**$4.59**	**$3.07**

Notes: ARI: Average recurrence interval. PMF: Probable maximum flood.
Source: Hinze Dam Alliance based on GCCC hydraulic modelling

From **Table 2-11** it can be seen that the Project delivers a 40 percent reduction ($3.07M) in the Average Annual Damages caused by flooding over the existing conditions case. This reduction in flood damages will be a significant benefit to the regional, State and national economies.

2.4.3 Social Benefits and Impacts

The net community benefits of the Project are substantial and significant at the local, city and regional level, whilst some short term negative impacts on neighborhood amenity and recreational access may be experienced. Whilst nearest residents may find construction effects such as increased traffic or noise annoying or stressful, the sum of effects is not expected to substantially diminish quality of life at the neighbourhood or community level, or to affect community well being. This is on the basis that the Hinze Dam Alliance, as the environmental and construction manager, will ensure noise and access impacts are sufficiently mitigated through implementation of an environmental management plan.

Permanent benefits of the dam's operation are expected to include:

- avoidance of flooding and flood damage for more than 3200 properties on the Nerang River flood plain;
- increased security of the water supply to meet existing and future demands;
- support for the Gold Coast's planned urban development and population growth;
- increased safety of the dam wall infrastructure for flood protection purposes; and
- potential for increased recreational amenity due to safer boat ramps and the creation of the lakeside park.

Impacts which are likely to be experienced during construction include:

- limitations on land and water-based activities in the vicinity of the dam wall, and some restrictions to recreational access at the northern part of the dam reserve;
- potential for construction noise to be audible and annoying at nearest residences;
- a diminution of the visual amenity during construction for some residences with views to the dam;
- potential for a decrease in the sale prices of properties if construction impacts are considered deleterious by the buyer;
- an increase in traffic to and from the construction site on Gilston, Nerang-Murwillumbah and Advancetown Roads;
- potential for anxiety about the effects of blasting on private property and community safety;
- loss of local amenity value offered by the Dam Tasty Cafe;
- inconvenience of restricted access across the dam wall;
- removal of the rowing course;
- impact on the Scouts' camping ground at the south western reach of the dam;
- potential for additional flooding in a 1 in 100 year flood event of five additional properties, with no residential buildings affected; and
- potential for increased visitation to Numinbah Forest Reserve.

Given the scale at which benefits will be experienced (e.g. the large number of properties for whom flood mitigation will be achieved, and increased water supply for Gold Coast City), the Project's benefits are considered significant at local and citywide levels.