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7. Surface Water Resources and Water Quality

7.1 Surface Water Resources

This section of the EIS describes the likely impacts of the Project on the surface waters of the Nerang catchment.

The Project involves raising the existing Hinze dam wall crest height from RL 93.5m AHD to RL 108.5m AHD and increasing the Full Supply Level from RL 82.2m AHD to RL 94.5m AHD. This will increase the inundation area of the dam by approximately 53.3km^2 as well as affecting the downstream flow regime, flood frequency and extent.

7.1.1 Background

During the optimisation and design phase of the Project extensive consultation was undertaken with the Department of Natural Resources and Water (DNRW). Models were obtained from DNRW and a briefing held to regarding the use of the models. Consultation was also undertaken in relation to:

- the desired outcomes in relation to the strategic reserves established by the Water Resource Plans;
- the FSL of the dam;
- the optimal outcome and buffer storage requirements; and
- requirements to achieve compliance with the Water Amendment Regulation No.6.

In addition, consultation was also undertaken with Gold Coast Water (GCW) regarding the hydrological modelling outcomes in the context of Gold Coast Waterfutures.

Consultation with representatives from the Queensland Water Commission was undertaken in relation to potential water harvesting options.

7.1.2 Description of the Nerang River Catchment

Catchment Characteristics

The major streams of the Nerang River catchment are the Nerang River, Little Nerang Creek and Mudgeeraba Creek. The catchment area covers a total of 494.9km^2 and is described further in **Table 7-1**.

- **Table 7-1 Nerang River Catchment**

Sub-catchment	Area (km^2)
Nerang River (below Hinze Dam)	173.0
Nerang River (above Hinze Dam)	207.0
Little Nerang Creek	40.8
Mudgeeraba Creek	74.1
Total Catchment	**494.9**

The Nerang River headwaters are situated within in the McPherson ranges, which are forested and largely undistrubed. The Nerang and Little Nerang Creeks flow north easterly, through predominantly agricultural land, before converging at Hinze Dam. Downstream of the dam the river continues north east through foothills and the township of Nerang before flowing east across floodplains towards the coast. Mudgeeraba Creek joins the Nerang River a few kilometres upstream of the Southport Broadwater, where the river enters the ocean.

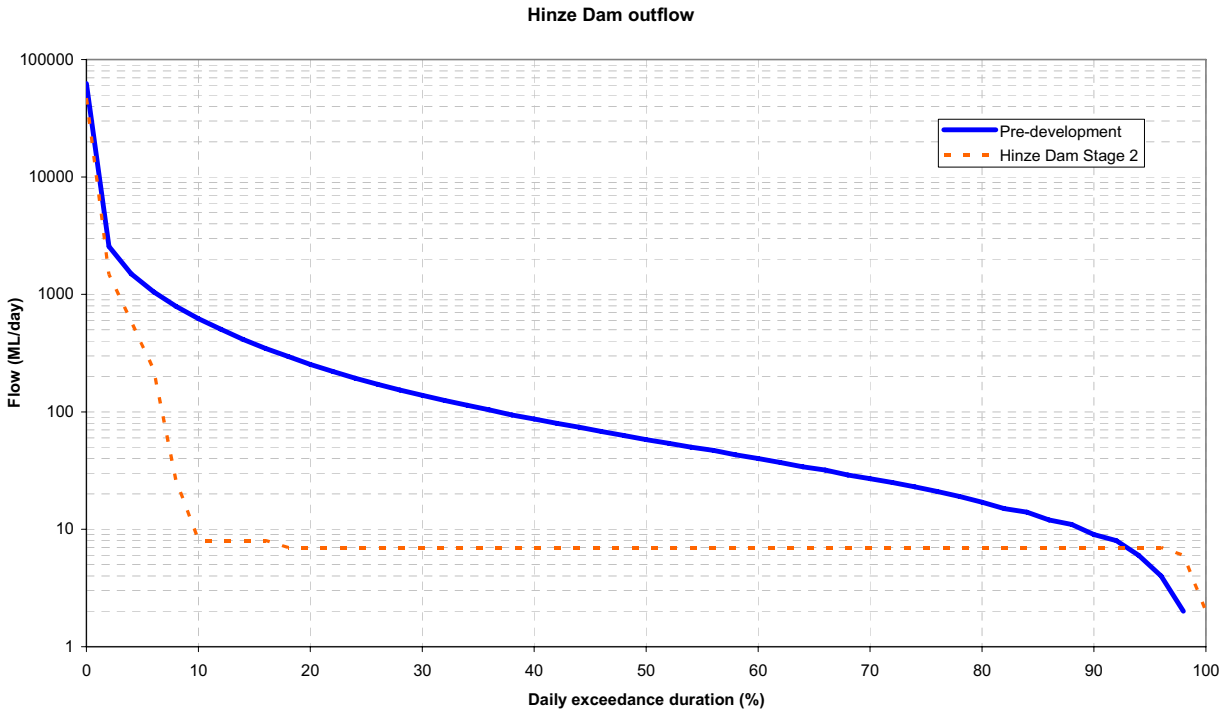
Approximately two thirds of the Nerang River catchment comprising national parks, conservation areas, rural land uses and rural residential lots. The remainder of the catchment is urban, comprising industrial, commercial and medium to high density residential areas.

Hinze Dam is situated on the Nerang River at Adopted Middle Thread Distance (AMTD) 36.4 km. The dam was originally constructed in 1976 with a capacity of 42 400 ML and upgraded to 161 070 ML (Stage 2) in 1989. The dam has a catchment area of 210km^2, almost half of the Nerang River catchment, and has had a significant impact on the flow regime of the Nerang River.

Hydrologic modelling of the Nerang River catchment has been undertaken using the Integrated Quantity Quality Model (IQQM) to assess the impacts of the Project on the Nerang River. This program uses historical records of rainfall, evaporation, streamflow, extractions and development in order to simulate river system operations. The IQQM has been used to assess the impacts of the Project on the Nerang River.

Hinze Dam as it currently operates, captures all of the low flows and the majority of the medium to high flows into the dam, spilling once every 2.5 years, on average. A relatively constant low flow release is made from the dam which is intended as both a compensation release to downstream users as well as an environmental release. The low flow release maintains the river at a rate of 7 ML/d for approximately 90% of the time, whereas the natural river flow (pre-development) would have been above 7 ML/d for over 90% of the time (**Figure 7-1**).

- **Figure 7-1 Hinze Dam Impact on Daily Flow Duration**



These changes to the flow regime of the river, since the construction of the dam, have caused significant modifications to the downstream environment. The Technical Advisory Panel to the Moreton and Gold Coast Water Resource Plans has rated the middle reaches of the Nerang Rivers as moderately to highly disturbed and the lower reaches, including the Broadwater, as highly disturbed. The headwaters of the Nerang and Little Nerang Creek remain as having natural or near-natural conditions, with very high ecological values.

Current Water Uses

Current water use in the Nerang River catchment is estimated as approximately 80% urban use and 20% industrial/rural and agricultural (DNRMW 2006c). The majority of urban water supply in the catchment is sourced from Hinze Dam and Little Nerang Dam.

The urban supply is the only supplemented water supply in the Nerang River catchment, extracting approximately 69 000 ML/a. All other water users in the catchment rely on unsupplemented flows, i.e. 'run of river' flows. A

summary of the unsupplemented water licences in the Nerang River catchment is presented in **Table 7-2**. If the existing entitlements are fully utilised the average annual extraction is estimated at 3605 ML/a (DNRMW 2006c).

Table 7-2 Unsupplemented Surface Water Licences

Catchment	Area based licences		Volumetric licences		Waterharvesting
	No. of entitlements	Area (ha)	No. of entitlements	Allocation (ML)	No. of entitlements
Nerang River	83	452	13	68	4

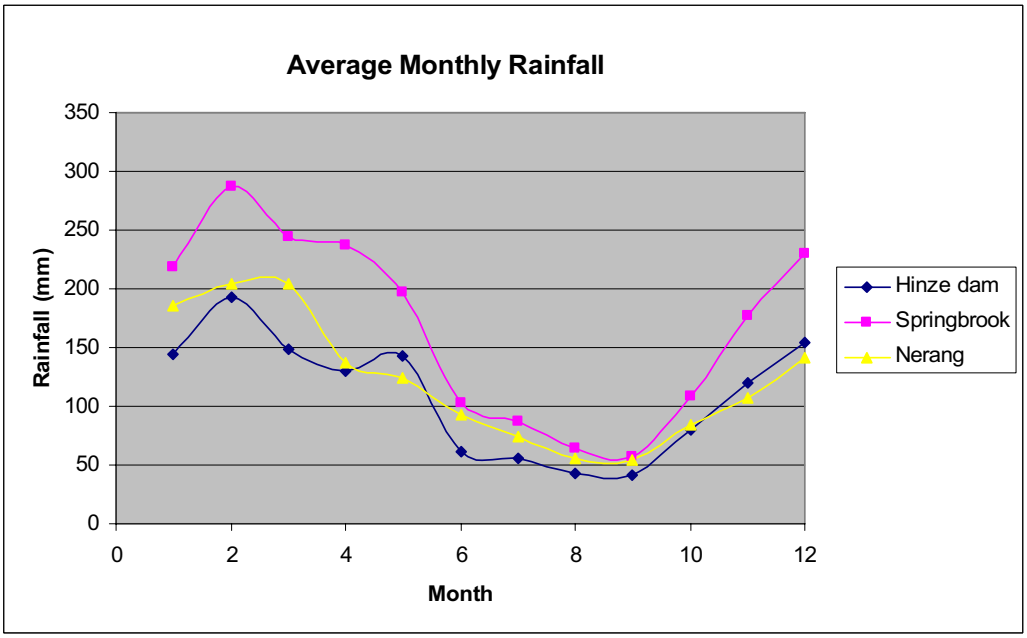
Source: DNRM 2005

There are currently sixty unsupplemented water licenses downstream of Hinze Dam and two unsupplemented licences downstream of Little Nerang Dam. While there is no supply arrangement for these licenses a passflow release is made from both Hinze Dam and Little Nerang Dam, acting as a compensation flow for the downstream users.

7.1.3 Climate

Rainfall across the catchment displays significant seasonal variation, with a summer dominant rainfall pattern. **Figure 7-2** shows the monthly rainfall pattern at three key sites; Hinze dam, Springbrook Forestry and Nerang (Gilston Road). Monthly variation is particularly extreme at Springbrook.

Figure 7-2 Nerang River Catchment - Average Monthly Rainfall



Overall the rainfall variability in this region is very high, as can be seen by the differences between the minimum and maximum rainfall at each site (**Table 7-3)**. The region has also experienced several periods of drought over the past 100 years.

Table 7-3 Nerang River Catchment - Rainfall Data

Site	Annual Rainfall			Monthly Rainfall
	Minimum (mm)	Maximum (mm)	Mean (mm)	Mean (mm)
Hinze Dam	616	2134	1330	110
Springbrook Forestry	1313	5649	3023	253
Nerang, Gilston Rd	528	2839	1464	122

Source: Bureau of Meteorology 2007

The average annual evaporation at Hinze dam is 1479 mm. As shown in **Table 7-4** between the months of June and January monthly evaporation exceeds rainfall.

Table 7-4 Hinze Dam - Average Monthly Rainfall and Evaporation

Hinze Dam	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Mean Rainfall (mm)	145	193	148	130	143	62	56	43	42	80	120	154
Monthly Mean Evaporation (mm)	165	141	132	105	80	71	82	99	132	151	153	172

Source: Bureau of Meteorology 2007

7.1.4 Surface Water Hydrology

This section describes the existing water resources of the Nerang catchment in terms of streamflow, existing water storage structures, the current operation of storages, environmental values, flooding characteristics and the provisions of the *Water Resource (Gold Coast) Plan 2006* (WRP).

Streamflow

Streamflow within the Nerang River catchment varies seasonally, peaking over summer. The stream gauges in the Nerang catchment are described in **Table 7-5**. Data from these gauges has been used in the hydrologic modelling of this Project.

Table 7-5 Streamflow Gauging Stations within the Nerang River Catchment

Gauge no.	Stream	Location	AMTD (km)	Catchment Area (km^2)	Period of record	Mean Monthly flow (ML/month)	Mean Annual flow (ML/a)
146002A	Nerang R	Nerang	23.0	239.4	1918-1954	12 388	151 475
146002B	Nerang R	Glenhurst	22.4	239.4	1967-	10 751	126 875
146004A	Little Nerang ck	Neranwood	13.2	40.6	1926-1962	4217	50 847
146009A	Little Nerang ck	4.0 km	4.0	52.7	1962-1974	3724	31 795
146011A	Nerang R	Whipbird	45.1	122.8	1965-1986	6487	78 623
146017A	Nerang R	Hinze Dam DS Intake	36.4	212.5	1976-1986	5068	67 443
146018A	Little Nerang ck	Hinze Dam US Intake	6.8		1976-1989		Height only

Source: DNRW 2007a

There are two gauges at Hinze Dam however only one of them (GS146017A) has recorded flow data. The gauge data covers 10 years when Hinze Dam Stage 1 was in place, and can be used to give an indication of the seasonal variation of flow into Hinze Dam, as shown in **Table 7-6**. Peak flows into the dam occur from March to June.

The Nerang River flow regime was assessed by a Technical Advisory Panel (TAP) during the preparation of the *Water Resource (Gold Coast) Plan 2006* (WRP). The TAP found that the construction of Hinze Dam has had a significant impact on the downstream condition of the river, as the dam captures all low and medium flows, as well as part of the high flows. A small constant release is made from the dam as an environmental release and compensation for downstream irrigators. This low flow now forms the majority of the existing flow regime. No medium flows are released from the dam and high flows are only released when the dam spills, which occurs approximately once every 2.5 years.

Table 7-6 Monthly Inflow at Hinze Dam (GS146017A) 1976-1986

Month	Mean Daily Flow	Monthly Flow (ML/month)		
	(ML/d)	Mean	Minimum	Maximum
January	222	6209	0	23 455
February	222	5639	0	22 003
March	401	11 175	0	42 276
April	341	9185	0	52 021
May	353	9846	0	45 534
June	264	7138	0	43 939
July	99	2758	0	7906
August	61	1689	0	8347
September	15	416	0	4159
October	10	266	0	2654
November	109	2958	0	17 215
December	127	3538	0	25 034

Source: DNRW, 2007a

Existing Water Storage Structures and Waterway Barriers

There are two existing storages in the Nerang River catchment; Little Nerang Dam and Hinze Dam, their details are summarised in **Table 7-7**. The two dams supply the majority of the urban water demand to the Gold Coast and are owned and operated by the Gold Coast City Council (GCCC).

GCCC also operates two navigation locks that give access from the tidal waterways of the Nerang River into lake systems. The first lock is located at Carrara and provides access from the Robina Lakes and Clear Island Waters to the Nerang River. The second lock is located between Saltwater Terrace and John Dalley Drive at Monterey Keys, providing access from Monterey Keys Lake at Helensvale to Saltwater Creek (GCCC, 2007b). **Section 10** of this EIS describes three other minor barriers on the Nerang River.

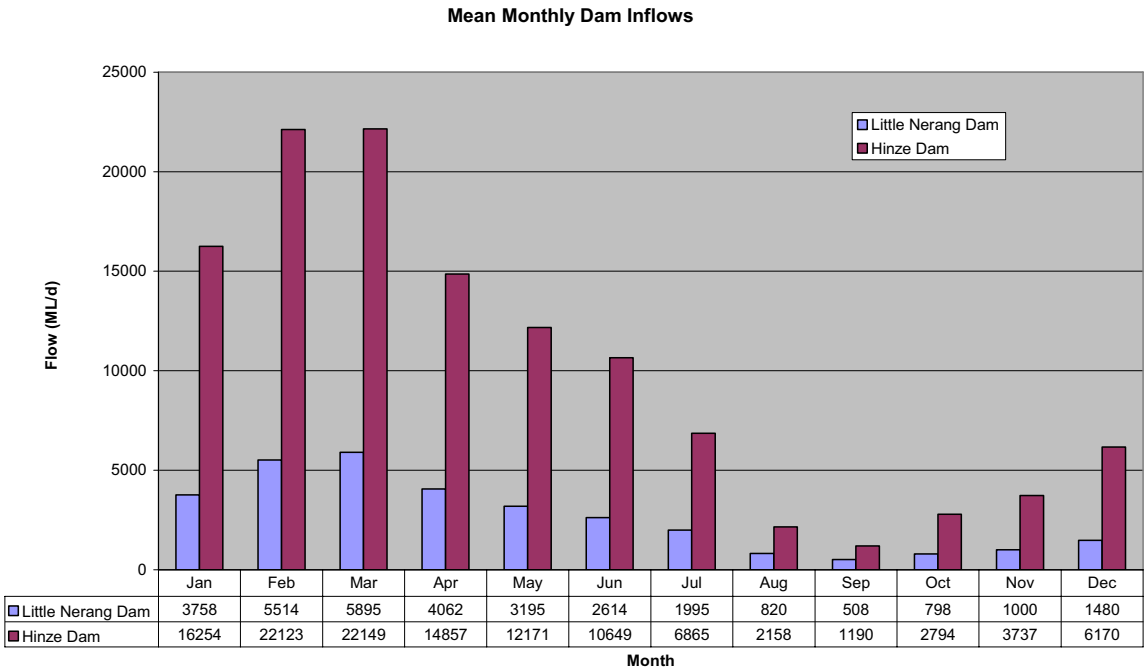
Table 7-7 Existing Storages within the Nerang River Catchment

Storage Characteristics	Little Nerang Dam	Hinze Dam (Stage 2)
Full Storage Volume (ML)	9280	161 070
Full Storage Height (m AHD)	168.03	82.2
Catchment area (km^2)	35	210
AMTD (km)	16.1	36.4
Completed	1961	1976 (upgraded to Stage 2 in 1989)

The current mean monthly flows into Hinze Dam and Little Nerang Dam are presented in **Figure 7-3**. The inflows to Little Nerang Dam are very close to the natural flows due to a lack of development in the upstream catchment. However, the inflows to Hinze Dam show significant reduction from the natural condition, particularly the flows below 100 ML/d. This is due to upstream extraction for town water supplies and irrigation purposes.

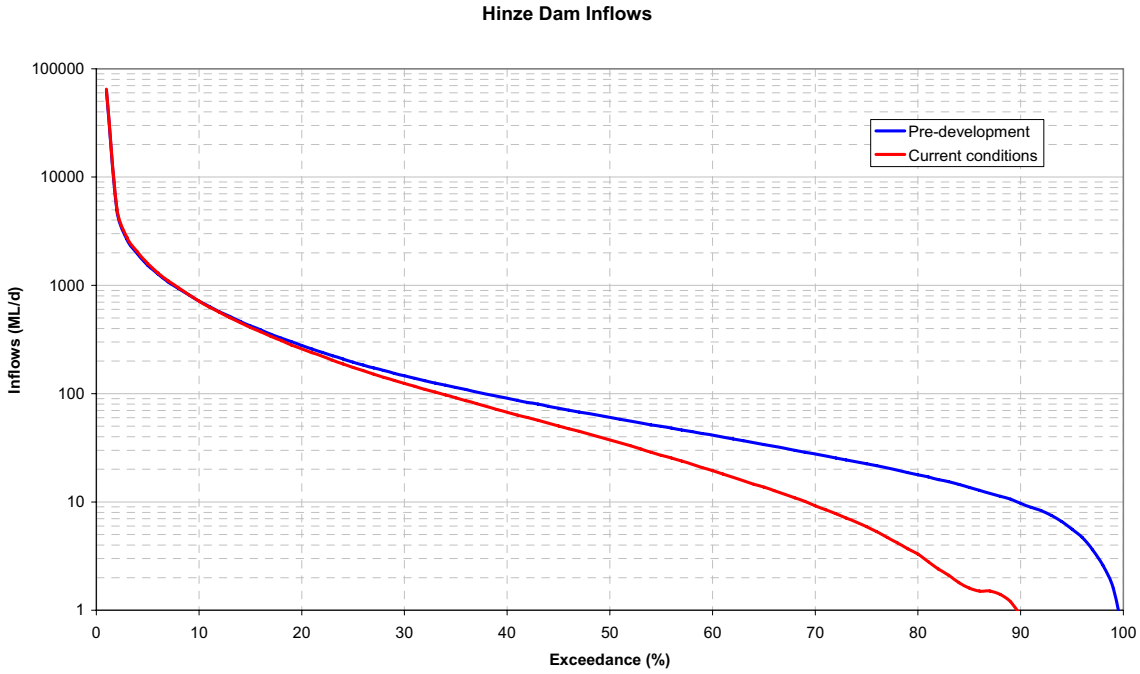
An exceedance curve of the inflows to Hinze Dam is shown in **Figure 7-4**.

■ **Figure 7-3 Mean Monthly Dam Inflows (Existing Conditions)**



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Little Nerang Dam	3758	5514	5895	4062	3195	2614	1995	820	508	798	1000	1480
Hinze Dam	16254	22123	22149	14857	12171	10649	6865	2158	1190	2794	3737	6170

■ **Figure 7-4 Hinze Dam Inflows - Daily Exceedence Curve (Existing Conditions)**



Current Operation of Storages

The Gold Coast City water supply is sourced from both Hinze Dam and Little Nerang Dam, and is referred to as a combined yield. The Gold Coast City Council (GCCC) has an urban allocation of 76,300 ML/a from the two storages. However, for planning purposes GCCC assumes that the current available yield is 69,900 ML/a (DNRMW 2006a). The allocation is based on the no failure yield from the dam when operated to the dead storage volume, while GCCC in the operation of the dam assumes the available yield based on the ability of the intake towers to access the stored water.

The current consumption for Gold Coast City is in the order of 69,000 ML/a with the demand pattern varying throughout the year as shown in **Table 7-8**. The average demand is 189 ML/d with a peak occurring in December and January at 220 ML/d (GCCC, 2005). This is due to hot weather and the peak of the tourist season increasing the water demand.

Table 7-8 Gold Coast City Water Supply - Demand Pattern

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% of Annual demand	9.62	8.22	8.05	7.97	7.16	7.36	7.59	8.11	8.62	9.03	8.67	9.60
Monthly demand (ML)*	6724	5746	5627	5571	5005	5145	5305	5669	6025	6312	6060	6710

*based on an annual demand of 69,900 ML
Source: Gold Coast Water, 2004

Raw water from the two storages is treated at Molendinar and Mudgeeraba Water Treatment Plants (WTPs). Molendinar WTP receives water from Hinze Dam while Mudgeeraba WTP receives water from both Hinze Dam and Little Nerang Dam. The WTPs have a combined capacity to treat up to 296 ML/d (GCCC, 2005).

Environmental Values of Water Resources

The water resources of the Nerang catchment are used for a wide variety of direct and indirect purposes. These include recreation, visual amenity, drinking water, irrigation water, etc. Their environmental values, as identified by the *Environmental Protection (Water) Policy 1997*, are presented in **Table 7-9**. These values were considered during the development of the WRP.

Table 7-9 Environmental Values for the Waters of the Nerang Catchment

	Upper Nerang River	Hinze Dam	Little Nerang Dam	Lower Nerang River	Other Freshwater tributaries	Other wetlands, lakes and reservoirs	Ground waters	Tidal canals, constructed estuaries, marinas and boat harbours
Aquatic Ecosystems	H	✓	✓	M	✓	✓	✓	H
Human consumption	M	✓	✓	L	✓	✓		M
Primary recreation	M	✓	✓	L	✓	✓		H
Secondary recreation	L	✓	✓	M	✓	✓		H
Visual recreation	H	✓	✓	M	✓	✓		M
Cultural and spiritual values	H	✓	✓	L	✓	✓		L
Industrial use	L			L				L
Aquaculture	L			L				L
Drinking water	H	✓	✓	L			✓	L
Irrigation	H			H	✓		✓	L
Stock water	H			M	✓		✓	L
Farm supply	M			M	✓		✓	L
Oystering				L				L
Seagrass				L				H

Source: EPA 2006

1 ✓ means that the value is selected for protection

2 H, M or L indicate a high, medium or low importance on the value

3 Blank indicates that the value is not selected for protection

The environmental values of the Nerang catchment waterways were also assessed by the TAP against the Moreton and Gold Coast WRPs (DNRMW 2006b). The TAP rated the headwaters of the Nerang and Little Nerang Creeks as having natural or near-natural conditions, with very high ecological values. The other reaches of the Nerang River are moderately to highly disturbed, although some of them support rare or threatened native flora and fauna. The Broadwater is rated as highly disturbed but retains significant ecological values.

Water Resource (Gold Coast) Plan

One of the primary objectives of the Gold Coast WRP is the sustainable management of water resources in the catchment. In order to achieve this the WRP specifies a range of environmental flow objectives (EFOs) and water allocation security objectives (WASOs) that must be met. Three key scenarios have been developed for the Gold Coast WRP IQQM; pre-development, current condition and full entitlement. The pre-development scenario represents the natural condition of the Nerang River catchment. The current conditions scenario represents the catchment as it exists at present, while the full entitlement scenario represents the catchment when all water licences are used to their maximum capacity. Future development scenarios, such as Hinze Dam Stage 3, are developed from the full entitlement scenario.

The environmental flow objectives for the Gold Coast catchment are outlined in the *Water Resource (Gold Coast) Plan 2006*, Schedule 5. Their aim is to maintain key flow conditions within the catchment in order to ensure ecosystem health.

The performance indicators cover a range of low flow, medium to high flow and seasonal flow statistics and compare the river flow of development scenarios with the pre-development flow at specific locations, or reporting nodes. For this EIS the reporting node of interest is Nerang River at end of system (AMTD 0.0 km) and the specific environmental flow objectives are described in **Table 7-10**. An explanation of the environmental flow objectives is provided in **Appendix F.7.1**.

Flood Characteristics

The Nerang River floodplain system is situated downstream of Hinze Dam and represents an area of approximately 90 $km^{2.}$ The floodplains have been extensively developed, primarily as interlinked tidal canal estates. Much of this development took place before there was a thorough appreciation of the risks of flood, hazard and flood damage. The only undeveloped section of the floodplain is the Merrimac/Carrara floodplain (approximately 22 km^2) which lies between the Nerang River and Mudgeeraba Creek. This area is under pressure to be developed even though it currently provides temporary floodwater storage.

There have been six moderate to major flood events in the region since river height records began in 1920. These floods were caused by a variety of weather conditions including tropical cyclones, tropical low-pressure systems and thunderstorms. Recorded flood levels for three areas that are relevant to the Project are described in **Table 7-11.** The reporting sites for these records are shown in **Figure 7-5.** Predicted flood levels for 10 locations on the Nerang flood plain are outlined in Error! Reference source not found.. These flood levels were modelled by the Australian Geological Survey Organisation as part of an assessment of the natural hazards and risks of South-East Queensland. The flood level for planning purposes for the Nerang River floodplain is the 1 in 100 year flood (1% AEP). The raising of Hinze Dam in 1989 increased its flood mitigation capacity however it is estimated that a one in 100 year flood would still cause significant flooding, achieving overfloor flooding in approximately 4441 properties (GCCC 2007a).

Table 7-10 Environmental Flow Objectives - Nerang River (End of System)

Low Flow Objectives		
50% daily flow (aim for flow to be equalled or exceeded on 35-65% of days in the month of the simulation period)	ML	Minimum % of days
January	187	30
February	353	30
March	412	30
April	246	28
May	164	28
June	129	28
July	85	24
August	48	23
September	33	19
October	33	22
November	48	29
December	86	30
90% daily flow (aim for flow to be equalled or exceeded on more than 75% of days in the month of the simulation period)	ML	Minimum % of days
January	7	67
February	22	72
March	54	64
April	44	61
May	28	62
June	21	60
July	14	56
August	8	48
September	4	47
October	3	55
November	3	59
December	6	58
Daily flow less than 1 ML	2-10 % of days	
Periods of low flow -		
1-3 months	0-3	
3-6 months	0-0	
6 months & longer	0-0	
Medium to High Flow Objectives		
Mean annual flow	66% of Pre-development flow	
Seasonal Flow Patterns		
Flow regime class	Late summer flow	
Annual proportional flow deviation	≤ 2.0	

Table 7-11 Major Historical Flood Events on the Nerang River System

River Height Station (m AHD)	Feb 1931	Jan 1947	Feb 1954	Jun 1967	Jan 1974 (1)	Jan 1974 (2)	Apr 1988	May 1996
Hinze Dam	n/a	n/a	n/a	n/a	n/a	n/a	4.28	3.24
Clearview	8.84	9.32	9.83	10.18	10.22	9.16	5.86	5.48
Evandale	2.85	2.62	2.87	2.25	-	2.87	-	-

*The construction of Hinze Dam (1976) has had a significant impact on flooding events.
Source: Bureau of Meteorology 2007

Table 7-12 Nerang River Catchment – Predicted Flood Levels

Location	Predicted flood level (m AHD)		
	5% AEP	2% AEP	1%AEP
Nerang	5.00	5.73	6.28
Royal Pines Resort	3.59	4.19	4.67
Sun Lakelands	3.25	3.87	4.41
Sorrento	2.97	3.47	3.97
Clear Island Waters	3.27	3.90	4.40
Bond University	3.02	3.65	4.11
Mermaid Waters	3.00	3.58	4.07
Broadbeach Waters	2.66	3.22	3.69
Isle of Capri	2.19	2.71	3.19
Paradise Waters	1.64	2.05	2.49

Source: Middelmann et al. 2000

N

0 1 2 4

Kilometres

Scale - 1:100,000

Projection: MGA Zone 56

Figure 7-5

Flood Reporting Sites

Hinze Dam Stage 3 EIS

N

0 1 2 4

Kilometres

Scale - 1:100,000

Projection: MGA Zone 56

Figure 7-6

Nerang River Catchment Downstream

Hinze Dam Stage 3 EIS

7.1.5 Impacts on Surface Water Resources

This section describes the impacts of the Project on the Nerang catchment. Areas addressed are surface water hydrology, impacts on existing users, environmental releases and changes to flooding.

A range of assessments have been undertaken in order to assess the impact of the Project; water resources impacts were assessed through the Integrated Quantity Quality Model (IQQM) while flooding impacts were assessed through Urban Runoff and Basin System (URBS) modelling, MIKE11 flood modelling and MIKE21 hydraulic modelling.

Yield Assessment

In order to determine whether the optimal dam configuration and Full Supply Level (FSL) meets GCCC's objectives relating to flood mitigation, water supply and dam safety yield assessments were conducted based on the Gold Coast WRP IQQM.

Compliance Parameters

The water supply objective for Hinze Dam Stage 3 is governed by State Government legislation and a resolution from Gold Coast City Council. These are summarised in the following sections.

Water Amendment Regulation (No. 6) 2006

On the 8th August 2006 the State Government released the *Water Amendment Regulation (No. 6) 2006*. Schedule 10B: Measure 11 – Hinze Dam Stage 3 requires that the Stage 3 raising delivers a target of 16 ML/d of additional yield by 31st December 2010. It also requires that the Project prepare for associated water harvesting works.

Gold Coast City Council holds an Interim Resource Operations Licence (iROL) for the operation of the Nerang Water Supply Scheme issued in July 2006. This iROL, established by the State Government, specifies an existing water supply entitlement of 76,300 ML/a (209 ML/d). Therefore in order to comply with the *Water Amendment Regulation (No. 6) 2006* the target yield for the Stage 3 raising is 225 ML/d, or 82,140 ML/a. This is based on increasing the existing entitlement of 209 ML/d by the required 16 ML/d.

Gold Coast City Council's resolution of the 22 November 2004 (G04.1122.032)

In November 2004 Gold Coast City Council passed a resolution in relation to the daily yield from the increased water storage provided by Hinze Dam Stage 3.

The resolution (G04.1122.032) states:

2. *That for the design and investigation of construction of stage 3, Council adopts the constraints that determine daily yield from the increased water storage of:*

   a *Buffer storage of 12% of Stage 2 volume*

   b *79,000 ML of storage area for flood mitigation purposes*

   c *Environmental flows of 7ML per day*

In accordance with item a of the resolution the target yield for Stage 3 of 225 ML/d has been determined with a buffer storage of 19,192 ML which is 12% of the Stage 2 volume.

Item b of the resolution is no longer applicable following Council's decision on the 5 March 2007 to adopt a 50 % reduction in peak flood flows as the flood mitigation performance indicator.

In relation to item c the final Gold Coast Water Resource Plan (December 2006) and associated models have been reviewed. Discussions with DNRW staff and a review of the IQQM model confirmed that the environmental flow release requirement for Hinze Dam Stage 3 is 7.25 ML/d. All assessments have included an environmental flow release of 7.25 ML/d.

In order to meet these requirements a range of full supply levels between RL 90m AHD and RL 100m AHD were assessed. The results of investigations identified that the target yield of 225 ML/d (actual modelled yield was 225.6 ML/d), could be supplied with operational parameters of a buffer storage of 19 192 ML and environmental flow releases of 7.25ML/d at RL 94.5m AHD.

The adopted FSL of RL 94.5m AHD will provide a water supply storage capacity of 309 700 ML. This is an increase of 148 630 ML from the current storage of 161 070 ML.

Water Resource (Gold Coast) Plan - Strategic Reserve and Water Harvesting

The Gold Coast WRP preserves existing water entitlements and makes provision for a strategic reserve of up to 30000 ML/a of additional water supply to the region. The strategic reserve consists of, amongst other things, additional yield from the Hinze Dam catchment as well as water harvesting into the dam from adjacent catchments.

The hydrologic modelling demonstrates that an adopted FSL of RL 94.5m AHD will deliver an additional yield of 16 ML/d from the Nerang River catchment and accommodate future water harvesting into Hinze Dam as may occur under the Gold Coast and Logan Basin Water Resource Plans. While hydrologic assessments have demonstrated that water harvesting can be supported by the proposed raising of the dam, the actual water harvesting activities are not part of the scope of this Project.

The assessment confirmed that raising the dam to an FSL of RL 94.5m AHD as part of Hinze Dam Stage 3 will result in compliance with the *Water Resource (Gold Coast) Plan December 2006* and the requirements of Schedule 10B Measure 11 of the *Water Amendment Regulation (No. 6) 2006* in terms of additional yield and preparedness for future water harvesting.

7.1.6 Surface Water Hydrology

Upon completion of the Project the water storage capacity of Hinze Dam will increase by 148 630 ML. At the dam full storage volume the inundated area is estimated to increase from 972ha to 1505ha. Further changes are summarised in **Table 7-13**.

- **Table 7-13 Hinze Dam Storage Characteristics**

Storage Characteristics		Hinze Dam – Stage 2	Hinze Dam – Stage 3
Full Supply Level	(m AHD)	82.2	94.5
Storage Volume at FSL	(ML)	161 070	309 700
Dead Storage Volume	(ML)	2180	2180
Crest Elevation	(m AHD)	93.5	108.5

An assessment of the current conditions of the Nerang River and Little Nerang River was made by the TAP to the Gold Coast Water Resource Plan. Key findings from this assessment included:

- the headwaters of the Nerang River and Little Nerang River are largely in a natural or near natural condition;
- the Nerang River, upstream of Hinze Dam pondage, and Little Nerang Creek, between Little Nerang Dam and Hinze Dam, show minor to moderate change from the pre-development condition; and
- downstream of Hinze Dam the Nerang River has undergone major change from the reference condition, particularly the Nerang River estuary which has been completely altered from its natural condition through canal development and channelisation. (DNRMW 2006b)

The raising of Hinze Dam is expected to have the following hydrologic impacts:

- the headwaters of the Nerang River and Little Nerang Creek will experience no impacts;
- the area inundated by Hinze Dam will increase, however flows upstream of the pondage will be unaffected; and
- reaches downstream of Hinze Dam will experience a reduction in the number and volume of medium to high flows. Low flow releases from the dam will continue in their current arrangement.

Factors which affect river condition include the development of water resources, land use, riparian zone modifications and instream modifications. In general the condition of a river section reflects a combination of development factors.

Flow Statistics

Hydrologic modelling has been undertaken in order to assess the performance of the Project. The WRP IQQM model was provided by DNRW for the existing case and as the basis for the Hinze Dam Stage 3 model. Yield assessments were based on the Historical No Failure Yield (HNFY) of the system. This is the maximum volume of water that can be supplied from the dam for every year of the simulation period. The HNFY for the existing case is 76 300 ML/a while the HNFY for the proposed Stage 3 configuration supplies 83 804 ML/a. Both volumes are supplied with 100% monthly reliability throughout the simulation period, 01/01/1890 to 30/06/2000.

Flow statistics for three sites downstream of Hinze Dam have been prepared in order to evaluate the impact of the Project. Each site has been evaluated for the following scenarios; pre-development (natural conditions), Hinze Dam Stage 2 (existing conditions) and Hinze Dam Stage 3. Low flow statistics are presented in Error! Reference source not found. and Medium and High flow statistics are presented in **Table 7-14**.

The adopted Nerang River reporting sites were:

- Hinze Dam outflow (AMTD 36.3 km);
- Glenhurst gauging station (AMTD 23.0 km); and
- Nerang River Estuary (AMTD 0.0 km).

The three adopted reporting sites are representative of different sections of the Nerang River. The Hinze Dam outflow represents the flow directly below the dam wall and measures the environmental flow release made from the dam as well as any spills or overflow events. The Glenhurst site is representative of the flow on the Nerang River between Hinze Dam and the floodplains; it includes inflows from minor tributaries. Flow at the Nerang River Estuary represents the flow at the Nerang River floodplain; this includes inflow from Mudgeeraba Creek and other tributaries. Flow at the estuary show much lower levels of impact from the raising of Hinze Dam.

There is very little change from the existing conditions to Hinze Dam Stage 3 in the low flow statistics presented in Error! Reference source not found.. The medium and high flow statistics in **Table 7-14** show a reduction in the mean annual flow and the ARIs, while the APFD is increased. These results are in line with the objectives of the Project to provide downstream flood mitigation by reducing flood flows.

Table 7-14 Nerang River - Medium & High Flow Statistics

Medium & High Flow Objectives		Existing conditions	Hinze Dam Stage 3	% of existing conditions
Hinze Dam outflow				
Mean Annual Flow	(ML/a)	43 944	33 951	77.3
1.5 yr ARI	(ML/d)	9	9	100.0
5 yr ARI	(ML/d)	9112	4130	45.3
20 yr ARI	(ML/d)	21 862	11 210	51.3
APFD	(ML/d)	4.13	4.58	n/a
Glenhurst GS				
Mean Annual Flow	(ML/a)	55 692	45 700	82.1
1.5 yr ARI	(ML/d)	762	669	87.8
5 yr ARI	(ML/d)	10 071	4835	48.0
20 yr ARI	(ML/d)	23 469	12 344	52.6
APFD	(ML/d)	3.81	4.23	n/a
Nerang River estuary				
Mean Annual Flow	(ML/a)	192 379	182 291	94.8
1.5 yr ARI	(ML/d)	8342	8342	100.0
5 yr ARI	(ML/d)	30 959	30 554	98.7
20 yr ARI	(ML/d)	53 352	51 707	96.9
APFD	(ML/d)	1.76	1.98	n/a

Environmental Flow Objectives

The environmental flow objectives have also been calculated for the WRP reporting node C; Nerang River at end of system (AMTD 0.0 km), and are presented in **Table 7-15**.

The Project meets all of the specified environmental flow objectives.

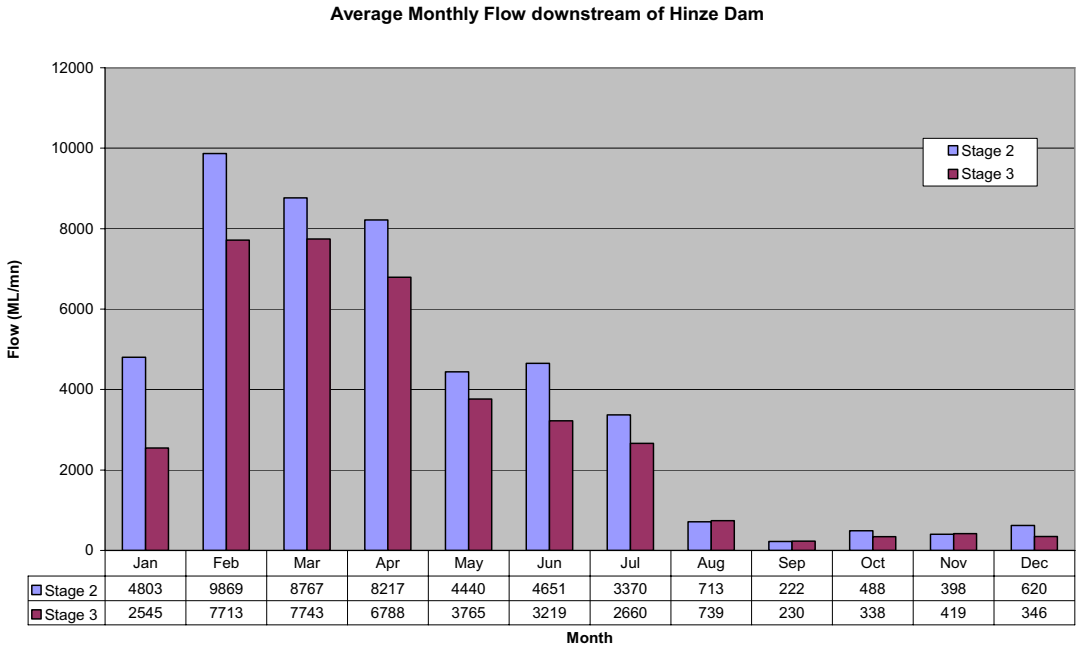
Table 7-15 Sage 3 Environmental Flow Objectives - Nerang River Estuary

WRP specified Environmental Flow Objectives			Current Case	Hinze Dam Stage 3
Low Flow Objectives				
50% daily flow (aim for flow to be equalled or exceeded on 35-65% of days in the month of the simulation period)	ML	Minimum % of days		
January	187	30	35.3	35.0
February	353	30	34.7	35.5
March	412	30	36.1	36.5
April	246	28	35.1	36.7
May	164	28	34.4	35.4
June	129	28	32.6	34.1
July	85	24	28.3	29.2
August	48	23	27.4	27.6
September	33	19	25.3	25.2
October	33	22	26.9	26.9
November	48	29	33.9	33.9
December	86	30	33.7	33.7
90% daily flow (aim for flow to be equalled or exceeded on more than 75% of days in the month of the simulation period)	ML	Minimum % of days		
January	7	67	75.2	75.1
February	22	72	78.8	78.8
March	54	64	71.4	71.4
April	44	61	68.6	68.6
May	28	62	71.6	71.6
June	21	60	71.5	71.5
July	14	56	59.1	57.2
August	8	48	56.9	56.8
September	4	47	61.5	61.4
October	3	55	66.3	66.3
November	3	59	70.1	70.1
December	6	58	67.2	67.3
Daily flow less than 1 ML	2-10 % of days		5.8%	5.8%
Periods of low flow -				
1-3 months	0-3		3	3
3-6 months	0-0		0	0
6 months & longer	0-0		0	0
Medium to High Flow Objectives				
Mean annual flow	66% of Pre-development		70.6%	66.9%
Seasonal Flow Patterns				
Flow regime class	Late summer flow		Late summer flow	Late summer flow
Annual proportional flow deviation	2.0		1.76	1.98

Downstream Flows

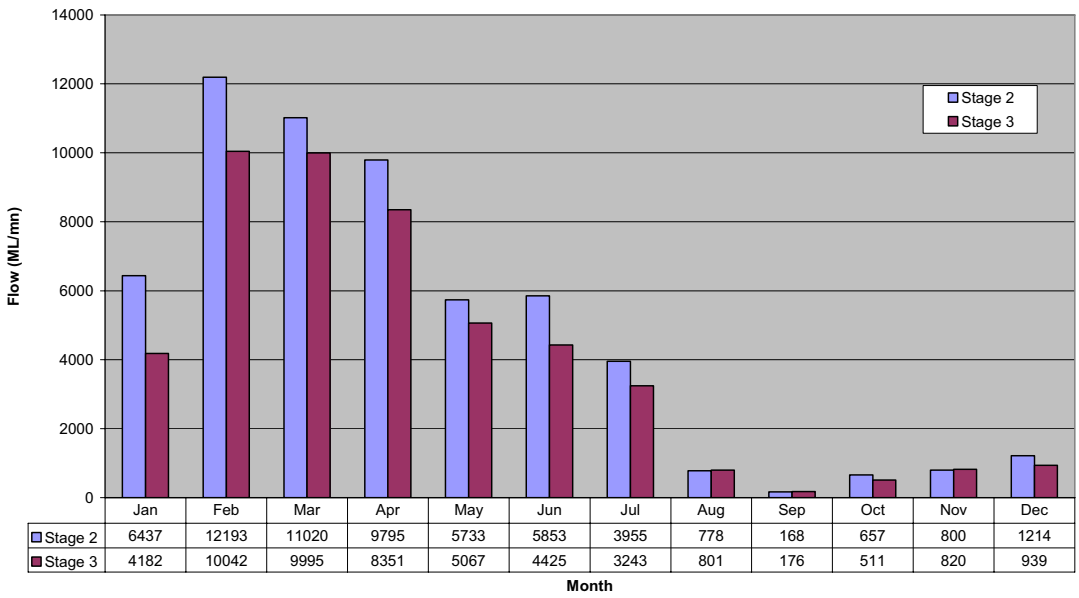
The Project will result in a reduction in average monthly flow volume below the dam, with the greatest impact being seen in the late summer months. These are the months of highest flow, with the greatest likelihood of flood occurrence. The following graphs show the average monthly flows directly downstream of Hinze Dam, **Figure 7-7**, at Glenhurst GS, Monthly Flow at Glenhurst **Figure 7-8** and at the Nerang River Estuary, **Figure 7-9**.

Figure 7-7 Monthly Flow downstream of Hinze Dam



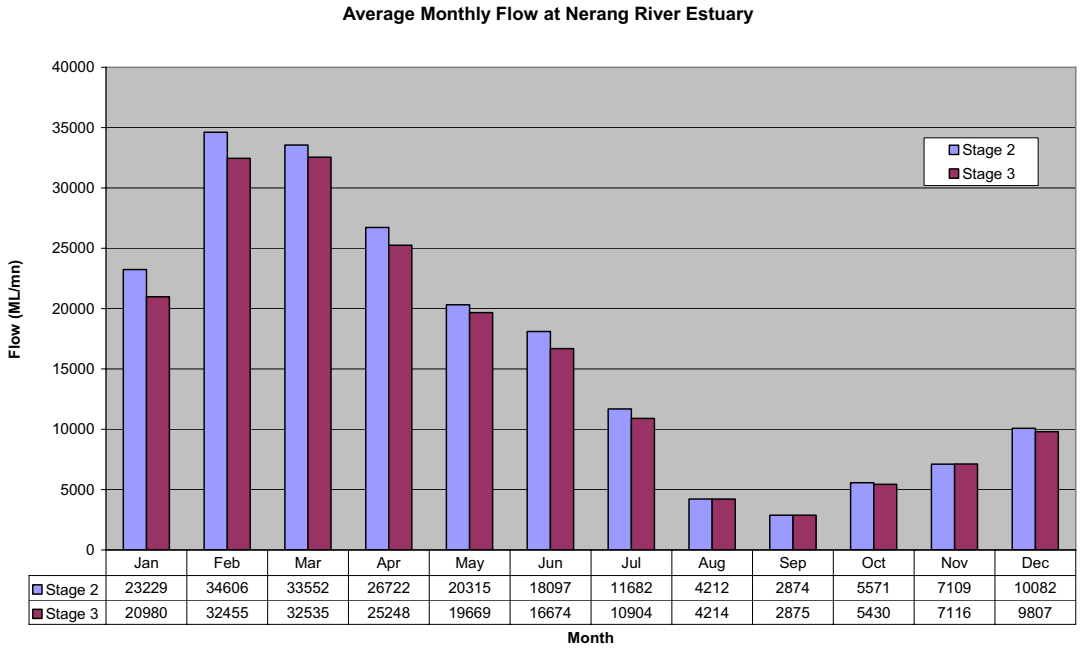
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stage 2	4803	9869	8767	8217	4440	4651	3370	713	222	488	398	620
Stage 3	2545	7713	7743	6788	3765	3219	2660	739	230	338	419	346

Figure 7-8 Monthly Flow at Glenhurst GS



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stage 2	6437	12193	11020	9795	5733	5853	3955	778	168	657	800	1214
Stage 3	4182	10042	9995	8351	5067	4425	3243	801	176	511	820	939

Figure 7-9 Monthly Flow at Nerang River Estuary



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stage 2	23229	34606	33552	26722	20315	18097	11682	4212	2874	5571	7109	10082
Stage 3	20980	32455	32535	25248	19669	16674	10904	4214	2875	5430	7116	9807

The Nerang River flow regime is already highly impacted on by the construction of Hinze Dam, as the dam captures all of the low and medium flows and some of the high flows. Flow duration curves show that the Project will have very little further impact on the downstream river flow. The impact of the Project reduces as the river approaches the tidal zone. This is due to the inflow of various tributaries along the Nerang River, including Mudgeeraba Creek.

The following flow duration curves show the daily flow exceedance directly downstream of Hinze Dam (**Figure 7-10**), at Glenhurst GS (**Figure 7-11**) and at the Nerang River Estuary (Error! Reference source not found.).

At the Hinze Dam outflow the flow is greater than 10 ML/d for less than 10% of the time. For approximately 90% of the time the flow consists of a constant release of about 7.25 ML/d, which is released from the dam as an environmental release and compensation flow. This release will not be changed by the Project.

Further downstream (**Figure 7-11** and Error! Reference source not found.**)** the release from Hinze Dam is augmented by tributary inflows, including flow from Mudgeeraba Creek. These additional inflows increase the flow regime but it is still heavily impacted by the existing dam. The construction of Hinze Dam Stage 3 will not significantly alter the existing flow regime of the Nerang River.

Figure 7-10 Daily Flow Duration Curves Downstream of Hinze Dam

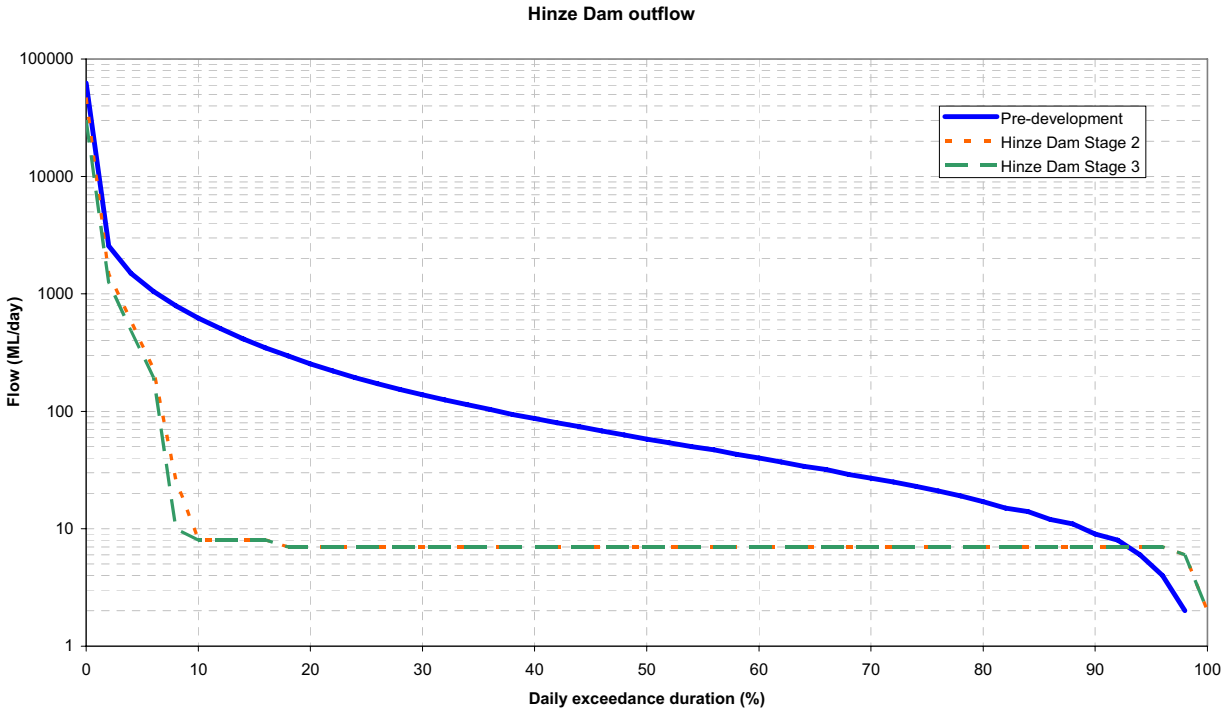
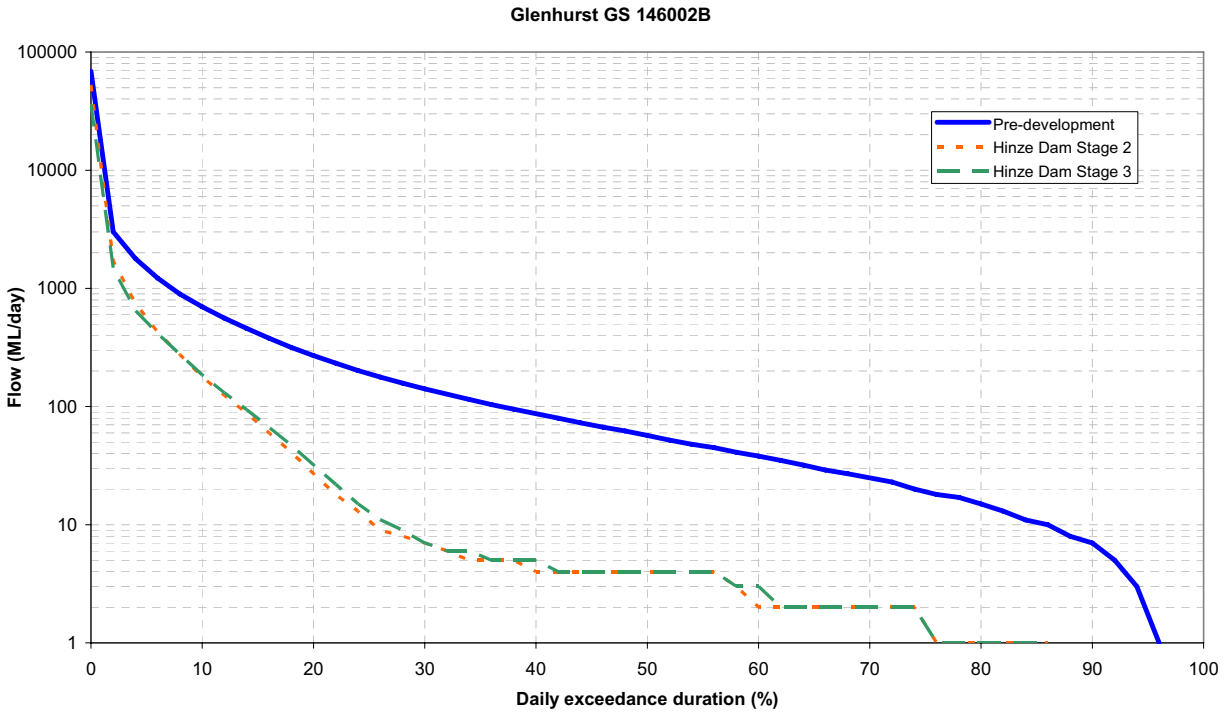
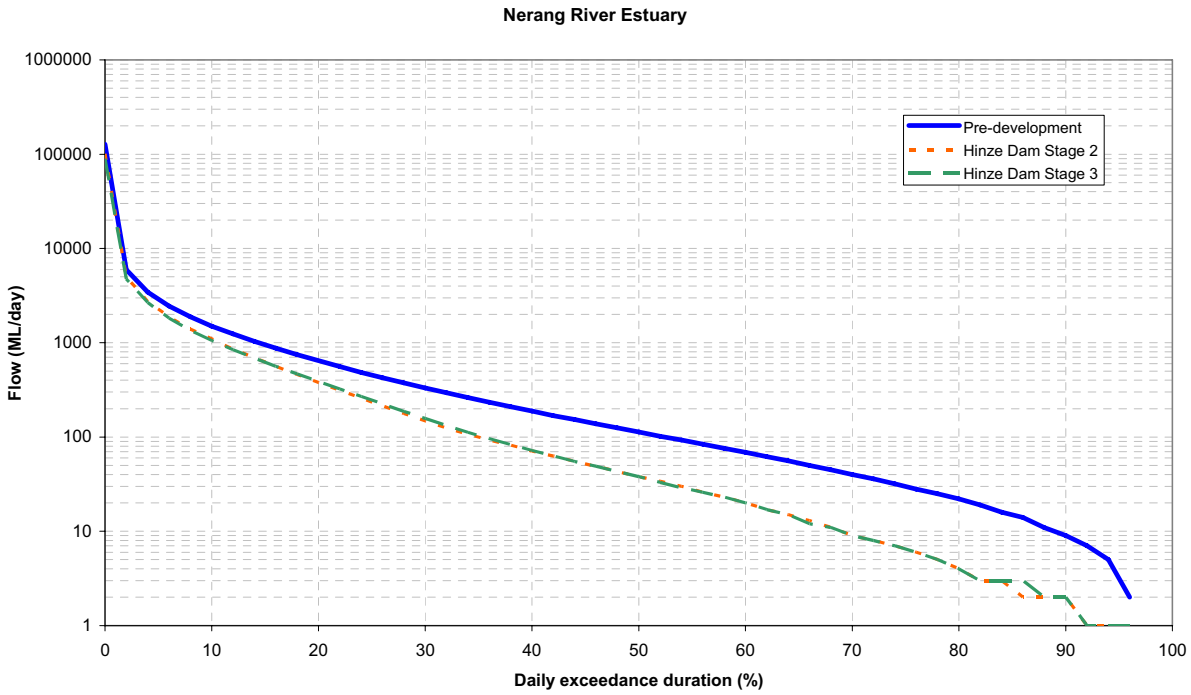


Figure 7-11 Daily Flow Duration Curves at Glenhurst GS



■ **Figure 7-12 Daily Flow Duration Curves at Nerang River Estuary**

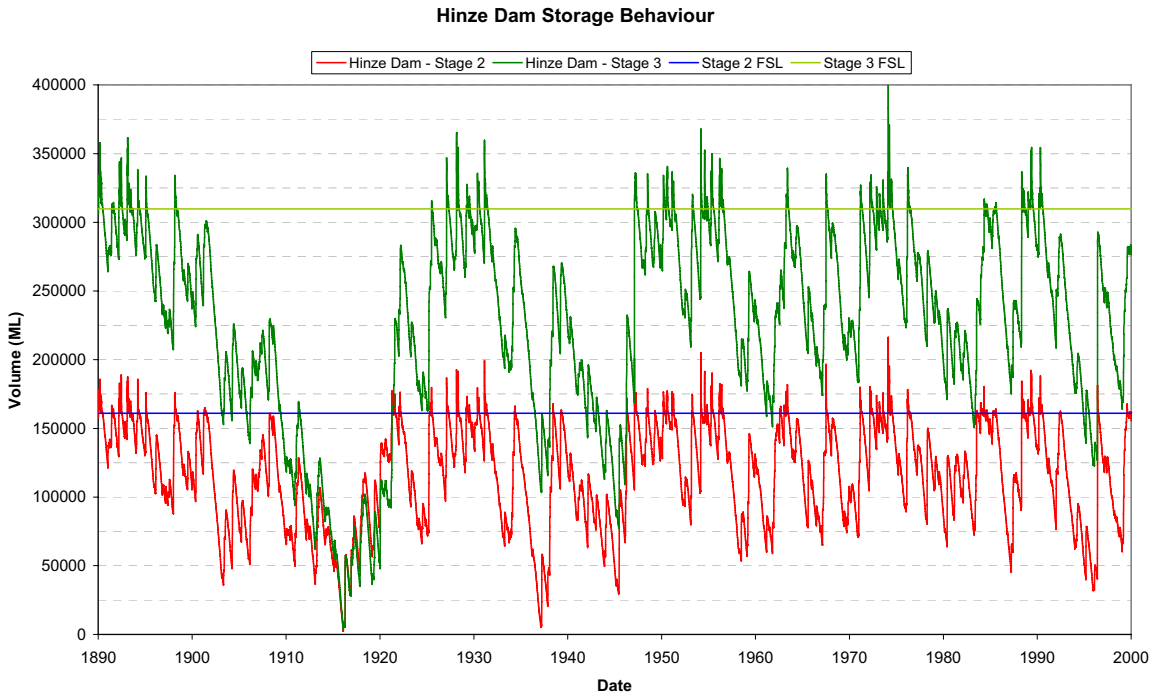


Hinze Dam Storage Behaviour

The response of the Hinze Dam storage has been assessed using the IQQM model. The following graph, **Figure 7-13**, shows the modelled storage behaviour for Hinze Dam Stage 2 and Stage 3. The modelled annual demand is the Historical No Failure Yield (HNFY) of the dam. This is the maximum volume that can be extracted from the storage without reaching the dead storage level. The HNFY is constrained by the period of lowest inflows to the dam, for Hinze Dam the critical period is around 1910 to 1920.

These investigations identify that based on the historical sequence assessed (1890-2000), the current dam is at full or near full capacity (i.e. less than 1m below FSL) for 25% of the time. Hinze Dam Stage 3 is predicted to display similar behaviour, with the dam being at full or near full capacity for 18% of the time.

■ **Figure 7-13 Hinze Dam - Modelled Storage Behaviour**



Hinze Dam Spills

The Project will impact upon spills from the dam, affecting the spill volume, duration and frequency of occurrence. Key spill statistics are summarised in **Table 7-16**. They show that the number of days of spill (total and average) will reduce by 2%, the total volume will reduce significantly and as the number of years with spills reduces, the length of time between spills will increase. These results are in line with the objectives of the Project to provide downstream flood mitigation to the Gold Coast region.

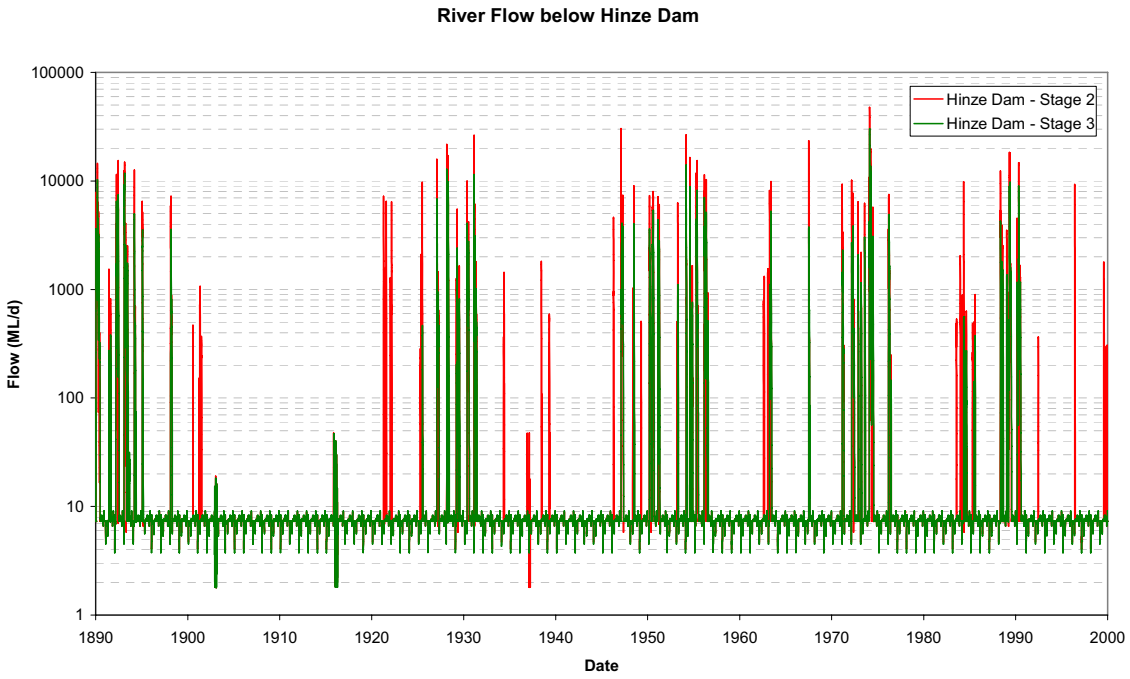
■ **Table 7-16 Hinze Dam - Spill Statistics**

Spill Statistics		Stage 2	Stage 3	Change
Total no. of days of spill		3401	3334	- 2 %
Average no. of days of spill per year		30.6	30	- 2 %
Total volume of spills	(ML)	4 832 086	3 726 630	- 23 %
Total no. of years with spills		48	33	- 31 %
Mean period between spills	(years)	1.0	1.7	+ 0.7 years
Longest period between spills	(years)	19.9	27.2	+ 7.3 years

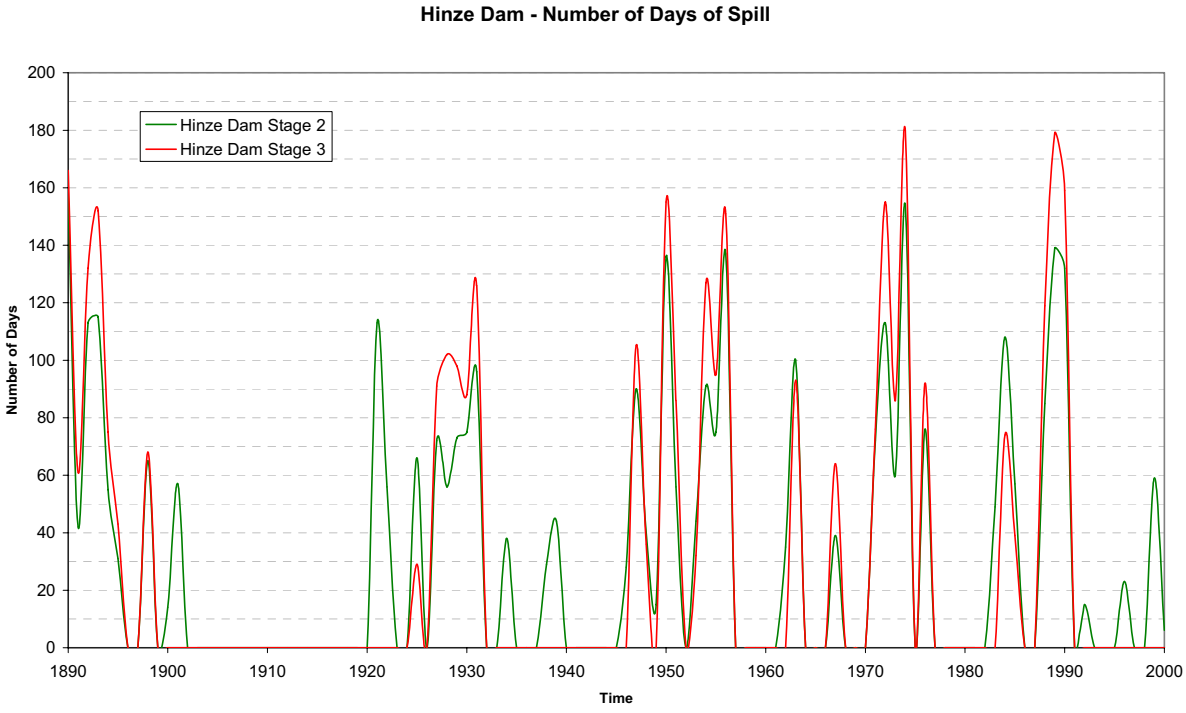
*based on the historical sequence, 1890-2000

The spill statistics are further illustrated in **Figure 7-14** and **Figure 7-15**, **Figure 7-14** shows the modelled flow downstream of Hinze Dam for the existing case (Stage 2) and for Hinze Dam Stage 3. The flow includes the environmental release as well as any spills from the dam. For the majority of the simulation period the flow is made up of the environmental release of 7 ML/d, as was also shown in **Figure 7-10**. The number of days of spill are presented in **Figure 7-15,** this shows the reduction in the duration of the spill events. For the current dam configuration the longest period of no spills is between 1902 and 1920, the construction of Stage 3 would extend this period by 7 years.

■ **Figure 7-14 Hinze Dam Environmental Releases and Spills**



■ **Figure 7-15 Hinze Dam - Number of Days of Spill**



Impacts on Existing Water Users

The Gold Coast WRP specifies Water Allocation Security Objectives (WASOs) for each group of water users in the plan area. The WASOs are intended to provide a level of protection against any future activities that might erode the value of an allocation. For example, the construction of new infrastructure or the granting of new water entitlements.

The Project meets all of the WASOs specified in the WRP. The WRP requires high priority supplemented water (the Gold Coast urban supply) to have 95 to 100% monthly reliability (i.e. the full allocation is supplied in 95-100% of months in the simulation period). Hydrologic modelling of the existing arrangements and Hinze Dam Stage 3 reports 100% reliability for both cases.

The objectives for unsupplemented water are presented in **Table 7-17**, they vary according to the region and the type of allocation, i.e. area based irrigation or water harvesting. The unsupplemented water WASOs are not affected by the Project. Overall, the Project will not have any adverse impacts on existing users in the Nerang catchment.

- **Table 7-17 Nerang Catchment - Water Allocation Security Objectives**

Unsupplemented Water		Stage 2	Stage 3
Irrigator Group	Objective %	70% Unsupplemented Water Sharing Index %	70% Unsupplemented Water Sharing Index %
Unsupplemented Irrigation			
Upper Nerang	86	91.2	91.2
Lower Nerang	81	86.6	86.6
Mudgeeraba	78	83.3	83.3
Unsupplemented Water Harvesting			
Upper Nerang	95	100	100
Lower Nerang	95	100	100
Mudgeeraba	95	100	100

Environmental Flow Release Strategy

In order to meet the flow objectives described in **Table 7-10** the river flow downstream of Little Nerang Dam and Hinze Dam is supplemented by low flow releases from both dams. These releases are intended as compensation flows for downstream landowners as well as an environmental benefit. Medium to high flows are not released from Hinze Dam as the downstream area is highly developed and vulnerable to flooding.

The Nerang Water Supply Scheme iROL (DNRMW 2006a) specifies the following passflow rules from Hinze Dam and Little Nerang Dam.

- Hinze Dam Passflows:
  - when the FSL of Hinze dam is less than EL 66.69 m AHD 50% of the sum of the inflows into Hinze dam and Little Nerang Dam must be released, up to a maximum of 6 ML/d; or
  - if the FSL of Hinze dam is greater than EL 66.69 m AHD the sum of the inflows into Hinze dam and Little Nerang Dam must be released, up to a maximum of 6 ML/d.
- Little Nerang Dam Passflows:
  - if the inflow into Little Nerang Dam is less than 6 ML/d release 50% of the inflow; or
  - if the inflow into Little Nerang Dam is greater than 6 ML/d release 3 ML/d

The Nerang iROL was released in July 2006. Modelling of the Nerang system has been undertaken with a constant environmental release of 7.25 ML/d from Hinze Dam and 0.86 ML/d from Little Nerang Dam in order to meet the environmental flow objectives set out in the WRP. The final environmental flow release strategy will be refined as part of the development of the Resource Operations Plan (ROP) in accordance with the WRP.

Total Environmental Releases

Current modelling shows that the total environmental releases from both Hinze Dam and Little Nerang Dam will not be affected by the Project. The average monthly and annual releases are summarised in **Table 7-18**.

Table 7-18 Total Environmental Releases

Source	Average Monthly Environmental Release (ML/month)	Average Annual Environmental Release (ML/a)
Hinze Dam	221	2650
Little Nerang Dam	26.25	315

The hydrologic modelling for the Project has focused on the historical no failure yield (HNFY) of Hinze Dam. This is the maximum amount of water that the dam is able to supply every year for the historical simulation period. Under an HNFY scenario the dam never reaches the dead storage level, and the environmental releases (which are only restricted when the dams reach their dead storage levels) are not affected.

The current level of use is below the HNFY and is expected to remain so for the near future, therefore the total environmental releases will not be affected.

7.1.7 Impacts on Flooding

The following section describes the changes to upstream and downstream flooding; including extent, frequency and duration.

Downstream Flooding

Currently there are 4212 existing residences and 229 commercial/industrial properties downstream of Hinze Dam could be affected in a 1 in 100 year ARI flood event. If the Project does not proceed it is unlikely a significant reduction in flood risk could be achieved via any alternative.

The economic and social impacts of a major flood on the Nerang River floodplain would be significant at local, regional and national levels. Flooding would affect properties, tourists and the tourism industry, community facilities, potentially causing loss of life and significant psychological stress to residents. The economic and social impacts of flooding are discussed in detail in **Section 16**. Hydrologic and hydraulic modelling indicates that the Project will provide a significant reduction in flood impact at all levels of flooding. Flood impact has been assessed for Hinze Dam Stage 2 and Stage 3 for flood peak levels, flood peak discharges and affected area.

Table 7-19 summarises the reduction in peak flood levels at Glenhurst GS, downstream of Hinze Dam. At all flood frequencies tested the Project will significantly reduce the peak flood levels experienced.

Table 7-19 Peak Flood levels at Glenhurst GS

Flood Frequency	Peak Flood Levels (m SD*)		
(ARI)	Stage 2	Stage 3	Reduction (m)
2	7.55	6.27	1.28
5	9.05	7.34	1.71
10	9.85	8.04	1.81
20	10.46	8.54	1.92
50	10.92	9.00	1.92
100	11.33	9.73	1.60

*SD – State Datum

Table 7-20 summarises the peak instantaneous flood discharge directly downstream of Hinze Dam for the current dam configuration and for the proposed Stage 3. As shown in the table the proposed Stage 3 design meets the flood mitigation criteria of at least 50% reduction in peak outflows from Hinze Dam for events up to a 1 in 100 year ARI.

Table 7-20 Hinze Dam Outflow Peak Discharges

Flood Frequency	Peak Outflow (m^3/s)		
(ARI)	Stage 2	Stage 3	Reduction (%)
10	594	208	65 %
20	759	268	65 %
50	919	396	57 %
100	1113	558	50 %

Table 7-21 summarises the peak instantaneous flood discharge at Glenhurst GS (approximately 13.3 km downstream of Hinze Dam) for the current dam configuration and for the proposed Stage 3. At all of the flood frequencies assessed the Project reduced the peak flood discharge.

Table 7-21 Glenhurst GS Peak Discharges

Flood Frequency	Peak Discharge (m^3/s)		
(ARI)	Stage 2	Stage 3	Reduction (%)
10	634	271	57 %
20	810	338	58 %
50	984	427	57 %
100	1190	601	49 %

Table 7-22 summarises the reduction in flood affected area downstream of Hinze Dam provided by the proposed upgrade of the dam. The inundated area at FSL and the flood affected area for the 1 in 100 year flood and the 1 in 50 year flood are also shown in **Figure 3-3**.

Table 7-22 Flood Affected Area

Flood Frequency (ARI)	Area (km^2)		
	Stage 2	Stage 3	Reduction
10	36.6	34.4	6 %
20	39.3	37.2	5 %
50	43.6	39.7	9 %
100	49.7	43.5	13 %
200	53.9	46.5	14 %
500	59.4	50.2	15 %
1000 - 48 hr	65.7	60.5	8 %
10 000 – 48 hr	73.0	70.6	3 %
PMF – 36hr	81.4	80.5	1 %

Source: GCCC, 2007a

Upstream Flooding

Hydraulic modelling of flooding in the reaches upstream of the Nerang River and Little Nerang Creek has been conducted for a range of Average Recurrence Intervals (ARI) using MIKE11. The modelling results are based on available topographic information sourced from Airborne Laser Survey (ALS).

Ten modelling scenarios were assessed to provide the results discussed below. For the current dam and proposed Stage 3 dams, the 100, 50, 20, 10 and 5 year ARI storms were routed through the creeks, reservoir and spillway in the MIKE11 model.

The peak flood heights for the current dam configuration and proposed Stage 3 are presented in **Table 7-23** with the corresponding change in inundated area for that event (See also **Figure 13-6** and **Figure 13-7**). The level of impact that the Project will have on the upstream inundated area is consistent across the range of flood events tested.

Table 7-23 Peak Flood Levels at Hinze Dam Wall

Flood Frequency ARI	Peak Flood Level at Hinze Dam Wall (m AHD)		Change in Inundated Area (ha)
	Current Dam	Stage 3	
100	89.61	101.03	+ 415
50	88.87	100.3	+ 416
20	88.11	99.51	+ 415
10	87.07	98.55	+ 419
5	86.23	97.76	+ 423

Nerang River Flood Impacts (Western Arm)

The modelled peak flood levels for the current dam configuration and proposed Stage 3 coincide between Nerang-Murwillumbah Road Bridge and Pocket Road Bridge, approximately 1 km downstream of Pocket Road Bridge on the Nerang River. Past this point there is no further impact on flood levels from the proposed Stage 3 upgrade. Impacts on flood levels for this area are also shown in **Figure 6-12**.

Properties on the Nerang River (Western Arm) will not be affected by changes to flood levels caused by the proposed Stage 3 upgrade.

The Numinbah Forest Reserve covers an area of approximately 2184 ha and is located immediately adjacent to the Project site. The FSL and 1 in 100 year ARI will extend over part of the Numinbah Forest Reserve (see **Figure 6-12**). This is discussed in further detail in **Section 6** of this EIS.

There are two bridges on the Nerang River, upstream of Hinze Dam, which are potentially affected by flooding; the Nerang-Murwillumbah Road Bridge and the Pocket Road Bridge.

The Nerang-Murwillumbah Road Bridge does not overtop in the 1 in 100 year ARI flood for the current or proposed dam configurations. The current flood immunity for this bridge is greater than the 1 in 100 year ARI. The results of flood modelling at this site are presented in **Table 7-24**.

The Pocket Road Bridge has a current flood immunity of less than the 1 in 5 year ARI event based on the current deck level of RL 98.0 m AHD. The peak flood levels at the bridge site predicted for the 5 year through to the 1 in 100 year ARI floods are not affected by the Stage 3 dam raise; however, the time of submergence will increase for all events. The hydraulic modelling results for Pocket Road Bridge depicting impacts on flood levels and times of submergence are summarised in **Table 7-25**. The estimated increase in time of submergence ranges from approximately 36 hours during the 1 in 100 AEP to approximately 4 hours during the 1 in 5 AEP flood events.

The deck level of the Pocket Road Bridge will be raised to an elevation of approximately 104.0 m AHD to ensure a flood immunity of 1 in 10 year ARI for the Stage 3 upgrade. This level of flood immunity was requested by GCCC Roads Asset Management Business Unit of the Engineering Services Department. This will be a significant improvement in the level of service provided to the residents of the Pocket Road district, with the flood immunity of the bridge increased from less than 1 in 5 year ARI to 1 in 10 year ARI and the total time of submergence for the 1 in 100 year ARI flood reduced from 76 hours to approximately 7 hours.

Table 7-24 Modelled Peak Flood Levels at the Nerang-Murwillumbah Road Bridge

ARI	Dam Stage	Peak Discharge (m^3/s)	Water Level (m AHD) 235 m Upstream of Bridge	Water Level (m AHD) at Bridge	Water Level (m AHD) 340 m Downstream of Bridge
100	3	1079	101.0	101.0	101.0
100	2	1120	90.6	90.0	89.7
50	3	946	100.3	100.3	100.3
50	2	980	90.0	89.3	89.0
20	3	862	99.5	99.5	99.5
20	2	890	89.6	88.6	88.2
10	3	720	98.6	98.6	98.6
10	2	740	88.9	87.8	87.2
5	3	574	97.8	97.8	97.8
5	2	591	88.2	87.0	86.3

Table 7-25 Flood Impacts at Pocket Road Bridge

ARI	Dam Stage	Peak Discharge (m^3/s)	Peak Flood Level (m AHD)	Max. Depth Flow over Bridge (m)	Estimated Time of Submergence (hours)
100	3	1125	105.2	7.2	112
100	2	1125	105.2	7.2	76
50	3	983	104.8	6.8	106
50	2	983	104.8	6.8	75
20	3	892	104.5	6.5	101
20	2	893	104.5	6.5	64
10	3	743	104.0	6.0	75
10	2	742	104.0	6.0	59
5	3	592	103.1	5.1	49
5	2	592	103.1	5.1	45

The proposed Stage 3 FSL will back up to the confluence of Pine Creek and the Nerang River. This will impact upon the flood levels in Pine Creek, affecting the road embankments along the Nerang-Murwillumbah Road and the western end of Gold Coast-Springbrook Road which are partially inundated either permanently at FSL or during the 1 in 50 year ARI and the 1 in 100 year ARI (see **Figure 6-12** and **Figure 6-13**). This would compromise the integrity and stability of the embankments causing safety concerns and increased maintenance costs. This is discussed in further detail in **Section 6**.

Little Nerang Creek Flood Impacts (Eastern Arm)

The modelled peak flood levels for the current dam configuration and proposed Stage 3 coincide approximately 400 m downstream of Springbrook Road Bridge on Little Nerang Creek. Past this point there is no further impact on flood levels from the proposed Stage 3 upgrade. Impacts on flood levels for this area are shown in **Figure 6-11**.

Five freehold properties on Gold Coast-Springbrook Road adjacent to Little Nerang Creek will be affected by the changed 1 in 100 year ARI flood level, however two of the properties are owned by GCCC. These properties will be partially inundated for a short period of time during the 1 in 100 year ARI flood. Easements are proposed for the areas inundated and will be obtained through voluntary agreement with the land holders. The details for this proposal will be finalised during detailed design phase and are discussed further in **Section 6**.

The Springbrook Road Bridge over Little Nerang Creek is potentially affected by flooding and was investigated for flood impacts. The Springbrook Road Bridge was found not to overtop in the 1 in 100 year ARI flood for both the current and proposed dam configurations. The current flood immunity for this bridge is greater than the 1 in 100 year ARI. The results of flood modelling at this site are presented in **Table 7-26**.

Table 7-26 Modelled Peak Flood Levels at the Springbrook Road Bridge

ARI	Dam Stage	Peak Discharge (m^3/s)	Water Level (m AHD) 37 m Upstream of Bridge	Water Level (m AHD) at Bridge	Water Level (m AHD) 36 m Downstream of Bridge
100	3	598	105.3	105.0	104.8
100	2	598	105.3	105.0	104.8
50	3	524	104.9	104.8	104.6
50	2	524	104.9	104.8	104.6
20	3	478	104.8	104.6	104.4
20	2	478	104.7	104.6	104.4
10	3	399	104.4	104.3	104.0
10	2	399	104.4	104.3	104.0
5	3	319	104.0	103.9	103.6
5	2	319	104.0	103.9	103.6

A section of the Gold Coast Springbrook Road downstream of the Springbrook Road Bridge (refer to **Figure 6-11**) has an existing flood immunity of approximately 1 in 50 year ARI. The proposed Stage 3 dam will increase flood levels and will reduce the current level of flood immunity. To mitigate these impacts the road will be raised to an elevation of approximately 100.3 m AHD to provide an immunity of 1 in 50 year ARI following the Stage 3 upgrade. The final level will be determined in the detailed design phase in consultation with the Department of Main Roads. Impacts on roads and infrastructure are discussed in further detail in **Section 6**.

The Nerang River, Little Nerang Creek, and Pocket Road Bridge are currently being surveyed. Following the completion of this survey, the Mike11 model will be updated. Replacement bridge plans are being developed and the upgrade to Pocket Road Bridge will be re-assessed at an early stage in detailed design to confirm that the new bridge has a 1 in 10 year ARI flood immunity.

7.1.8 Mitigation Measures

The following sections provide a summary of the recommended mitigation measures to be implemented to minimise the impacts on water resources resulting from the Project works.

Construction

During construction the dam will continue to operate in accordance with current requirements as detailed in the iROL. This will include the maintenance of the current level of environmental flow releases.

The construction program has been developed to ensure that the flood risk associated with the current dam configuration is not increased during construction. Detailed hydrological modelling was undertaken to establish the existing flood risk. These modelling tools were used to develop and test the sequence of construction for the dam raising to ensure an appropriate flood risk was maintained.

The Dam Safety Emergency Plan will be implemented during construction to close up any exposed works area prior to flood levels reaching critical levels. The catchment area of Hinze Dam is relatively small and storm events of relatively short duration can result in short warning times before the reservoir level rises. Investigations have shown that for the first six to eight hours after the start of rainfall, the reservoir would likely exhibit minimal or small rises in level. If rainfall intensities match the response of the catchment, the reservoir can rise quickly at up to 0.4 to 0.5 m/hour after six to eight hours of rainfall.

The following information sources of information will be used to assist with triggering response levels in the Dam Safety Emergency Plan:

- storm information, warnings, and probabilistic rainfall forecasts issued by the Bureau of Meteorology (BOM);
- rainfall gauges within the catchment area – currently automatically sent to the BOM at 1mm intervals. It is proposed to install communication equipment at site construction office to allow direct rainfall data to be sent to construction personnel and supporting hydrologists for more immediate monitoring and response.
- a streamflow gauge is planned to be installed by Gold Coast Water on the Nerang River upstream of Hinze Dam during 2007 (required to comply with the iROL). Further investigations will be undertaken during the detailed design phase of the Project to investigate how this planned gauge can be incorporated into the flood monitoring programme for the construction;
- automated reservoir level monitoring – sent to the BOM at 50mm intervals;
- the reservoir level; its level at the time of the works and the rate of rise during a flood event;
- flood forecasting undertaken by the BOM. Further consultation will be undertaken with BOM to determine the reliability and prioritisation of flood forecasting relative to other BOM forecasting responsibilities; and
- independent flood forecasting to be undertaken by design team hydrologists supporting the construction personnel during construction.

Operation

Mitigation measures associated with the operation of the dam are detailed below:

Nerang River / Western Arm

- the sections of Numinbah Forest Reserve inundated due to the raised FSL of the dam will be acquired by GCCC from the State Government. The tenure acquisition process over these areas will be dependant on the designation of the Forest Reserve. It is likely that the GCCC will be required to offset this area with a suitable vegetated site as a condition of the acquisition process. In this case the Council may offer an area on the southern area of lot 4 SP164198, which is adjacent to the Numinbah Forest Reserve. The tenure acquisition process is detailed in **Section 6**;
- mitigation of the flooding impacts on the Nerang-Murwillumbah Road will be provided via works to the affected embankments and drainage structures as detailed in **Section 13**; and
- to offset the flooding impacts on Pocket Road a new bridge will be constructed as detailed in **Section 13**.

Little Nerang Creek / Eastern Arm

- the 1 in 100 year ARI flood level will temporarily inundate portions of 5 freehold properties on Gold Coast-Springbrook Road adjacent to little Nerang Creek (refer Section 6 for details). Easements are proposed for the areas inundated in a 1 in 100 year ARI flood and will be obtained through voluntary agreement with the land holders. This is detailed further in **Section 6**; and
- to offset the flooding impacts on the Gold Coast-Springbrook Road works will be undertaken to raise the road to provide 1 in 50 year ARI immunity. These works will be undertaken over a length of approximately 700 m commencing approximately 250 m east of the Little Nerang Creek Bridge. Details are provided in **Section 13**.