4. Issues in the Williams River Catchment Upstream of Seaham Weir

The effect of the Project would extend downstream of the storage, decreasing as distance from the dam increases and as other intervening catchment influences come into play.

For the purpose of the environmental assessment, the downstream study boundary was nominally set at Seaham Weir. It should be noted that this does not imply that the effect of the dam ceases at this location. Rather the effect of it, relative to other influences within the Williams River catchment is diminished such that it has negligible material effect on hydrology and related aspects such as aquatic and geomorphic ecosystems.

It is noted that issues relating to the Part 3A assessment for the construction and operation of Tillegra Dam are separate to the ongoing development of the water sharing plan for the region. As releases from Seaham Weir are currently managed under Hunter Water's existing water management licence its modification would occur under a separate process. Modification of the Seaham Weir licence would need to address water resource management issues for the whole catchment and would be regulated through the water sharing plan.

This section of the submissions report responds to issues relating to the Williams River catchment upstream of Seaham Weir while the environmental issues downstream of the weir are addressed in Section 6.

4.1 Water quality

Several submissions were received regarding the potential impacts of Tillegra Dam on water quality both in-storage and in the downstream reaches of the Williams River. These issues can be summarised as follows:

1 **Mitigation of construction impacts:** concerns were raised that the management of water quality impacts during the construction phase of the project has not been addressed in the EA. DECCW recommends erosion and sediment control measures be implemented in accordance with 'The Blue Book' and be formalised as conditions of Project approval (Section 4.1.1)

2 **In-storage water quality:** concerns have been raised that increased nutrients, changed biota and surrounding land use would impact in-storage water quality. DECCW and I&I NSW recommend the proposed mitigation measures to maintain in storage water quality be formalised in the project approval. The NSW Rural Fire Service recommends consideration be given to the management of vegetation and access within the catchment with respect to fire fighting and hazard reduction operations to minimise the impacts of bushfire on water quality. (Section 4.1.2)

3 **Multi-level offtake:** a submission was concerned that even with the implementation of a multi-level offtake releases from the storage would have a different chemistry and temperature from that naturally occurring in the Williams River and would have ecological impacts on the downstream environment. (Section 4.1.3)

4 **Downstream water quality:** a number of submissions were concerned that the reduction in flows down the Williams River, particularly during the filling phase, would lead to poor water quality as a result of silt and debris build-up, lack of pool flushing and the release of cold water. (Section 4.1.4)

5 **Water quality sampling:** submissions requested further clarification on the absence of water quality sampling at sites W11, W12 and Seaham Weir Pool should be provided. (Section 4.1.5)

4.1.1 Mitigation of construction impacts

Concerns were raised in submissions that the management of water quality during the construction phase was not adequately addressed. DECCW recommends erosion and sediment control measures be implemented in accordance with 'The Blue Book' and be formalised as conditions of Project approval.

The management of water quality impacts during the construction phase of the Project are considered in Section 10.11 of the EA Report. It is noted that the majority of water quality impacts would occur in the immediate Project area and would be related to construction of the dam wall and associated road relocations and detours. The potential impacts may include increased turbidity and suspended solids at or downstream of the construction sites and the accidental release of hazardous substances to waterways.

The impacts would be managed through a formal erosion and sediment control plan which would comprise part of the overall construction CEMP. This is also covered in the Final Statement of Commitments.

Mitigation measures can be summarised as follows:

- Control erosion at construction sites by minimising vegetation clearance and progressively restabilising sites following construction activities
- Reduce the export of sediment from construction sites by establishing appropriate sediment basins, fences and/or barriers to remove particles from site runoff prior to entry into waterways
- Develop appropriate management protocols for the responsible delivery, storage, use, disposal of hazardous material and suitable response strategies in the event of spills.

4.1.2 In-storage water quality

Concerns have been raised that increased nutrients, changed biota and surrounding land use would impact in-storage water quality. DECCW and I&I NSW recommend the proposed mitigation measures to maintain in storage water quality be formalised in the Project Approval. The NSW RFS recommends consideration be given to the management of vegetation and access within the catchment with respect to fire fighting and hazard reduction operations to minimise the impacts of bushfire on water quality.

As is typical with any large water supply storage, it is acknowledged that Tillegra Dam would likely experience temperature and oxygen stratification during the summer months, periodic outbreaks of blue-green algae and would trap sediment and nutrients within its storage area.

The expected nutrient and blue-green algae concentrations within the storage were estimated in Section 10.6.3 of the EA Report and are not likely to be a significant issue during standard operation of the dam. Expected phosphorus and nitrogen concentrations in the storage were estimated to be approximately half the inflow concentrations due to the dilution associated with the large volume of the storage. These low nutrient concentrations during standard operation are expected to give a reduced frequency of blue-green algae outbreaks in the surface waters.

Catchment management measures would be employed to reduce the export of sediments and nutrients from the catchment into the dam and aid in the maintenance of in-storage water quality. An integrated land use plan to manage activities around and within the storage would be further refined. The draft integrated land use plan is provided in Working Paper N, Volume 6 of the EA Report. The draft plan includes mitigation measures such as a vegetated buffer (nominal 50m width) around the storage perimeter, stock exclusion and ongoing water quality monitoring. Monitoring would be particularly important during the filling period when nutrient concentrations are expected to be higher as a result of decaying vegetation. The implementation of the ILUP and in-storage monitoring program to manage potential risks to water quality are addressed in the Final Statement of Commitments.

The NSW RFS has recommended that consideration be given to the management of vegetation and access within the catchment with respect to fire fighting and hazard reduction operations to minimise the impacts of bushfire on water quality. The draft ILUP outlines the draft bushfire risk management plan. The objective of the bushfire plan is to protect human life, facilitate evacuation of the public from the area in times of bushfire, facilitate access for fire fighting activities and prevent the impact of fire to infrastructure and assets within the Tillegra Dam project area. The plan addresses fire access trails and breaks and states Hunter Water would maintain/establish fire access trails at specified locations. Additionally, Hunter Water would participate in hazard reduction programs implemented by the RFS and local community. The baseline bushfire plan would be further refined should the Project be approved.

4.1.3 Multi-level offtake

A submission was concerned that even with the implementation of a multi-level offtake releases from the storage would have a different chemistry and temperature from that naturally occurring in the Williams River and would have ecological impacts on the downstream environment.

An assessment of the likely in-storage characteristics of the dam indicate that the use of a multi-level offtake, in conjunction with vertical water quality monitoring data would enable the selection of appropriate withdrawal depths to meet the downstream water quality requirements. As part of the in-storage assessment a hydrodynamic model was developed for the proposed Tillegra storage based on the comparable Glennies Creek system (refer Section 5.4 of the EA Report). Based on the model results which predicted the annual vertical variability in temperature, dissolved oxygen and cyanobacteria water releases of an acceptable quality would be achieved through an in-take structure set at 6-8 metres below the surface. It is noted that during the first filling period, there is a possibility that water quality would not be suitable for release. During these periods releases would not be made from Tillegra Dam and river flows would be supplemented from Chichester Dam.

The proposed water quality monitoring program would ensure the water released from the storage would be of comparable quality to the water flowing into the storage (refer Section 9 for additional information on monitoring).

4.1.4 Downstream water quality

A number of submissions were concerned that the reduction in flows down the Williams River, particularly during the filling phase, would lead to poor water quality as a result of silt and debris build-up, lack of pool flushing and the release of cold water.

The volume, timing, frequency and quality of water released from the proposed Tillegra Dam would largely influence the quality of water in the immediate downstream environment. The preferred release strategy for the storage was developed based on the river flow objectives and guidelines provided by the former Department of Water and Energy (DWE)[1]. One of the river flow objectives is to 'minimise downstream water quality impacts of storage releases' and as such the preferred release strategy has been designed to help protect the water quality in the downstream reaches of the Williams River.

The quality of the released water would be managed through the installation of a multi-level offtake. The multi-level offtake in conjunction with appropriate release depths and monitoring programs would minimise the release of cold, deoxygenated waters to the river downstream.

The type of releases in terms of volume, timing and frequency would also help maintain the water quality downstream of the storage. The preferred release strategy has been based on analysis of the existing flow components of the Williams River incorporating low, moderate, fresh and flooding flows. The proposed variability in flow and protection of flow components would limit the accumulation of nutrients, increase the pool flushing times, increase dissolved oxygen and suppress conditions favourable to blue-green algae and mosquito breeding.

Additionally, the preferred release strategy would maintain the natural rates of rise and fall of the Williams River thus reducing the potential for bank slumping and the associated increase in sedimentation and water turbidity. It should be noted that the impacts of Tillegra Dam on the flow regime and water quality below the confluence with the Chichester River would be less pronounced as Chichester Dam spills for a significant portion of the time. Additionally, the water quality downstream of the storage is influenced by other factors including the quality of local runoff and land use within the catchment.

During the filling phase a minimum of six fresh events per year (consisting of a peak of 270 ML/d) would be released to maintain ecosystem health. These fresh releases were specifically proposed to address potential impacts likely to eventuate during the filling period. Should the quality of water during the initial stages of filling be poor, as a result of decomposing vegetation, additional releases would be made from Chichester Dam to protect water quality. This would ensure that the downstream environment is protected and water remains available for stock and domestic purposes.

4.1.5 Water quality sampling

Submissions suggested that further clarification on the absence of water quality sampling at sites W11, W12

[1] Now part of DECCW

and Seaham Weir Pool should be provided.

For the purposes of the environmental assessment the Williams River was divided into five reaches from its headwaters in the Barrington Tops to its confluence with the Hunter River at Raymond Terrace. Within these five reaches water quality, geomorphological, aquatic ecology sampling sites were chosen and are summarised in Table 4.1 (refer Section 3.2, Working Paper A of the EA Report for further information).

Table 4.1 River reaches and sampling sites

Reach	Reach description	Site name	Type of sampling			
1	Upper Williams River to Storage FSL	W1	WQ-P	WQ-Lab	AE	
		W2	WQ-P	WQ-Lab	AE	
2	Storage	W3	WQ-P		AE	
		W4	WQ-P	WQ-Lab	AE	
		W5	WQ-P		AE	
		W6	WQ-P	WQ-Lab	AE	
3	Storage to Glen Martin	W7	WQ-P		AE	FG
		W8	WQ-P	WQ-Lab	AE	FG
		W9	WQ-P	WQ-Lab	AE	FG
		W10	WQ-P	WQ-Lab	AE	FG
		W11		WQ-Lab		FG
		W12		WQ-Lab		FG
4	Seaham Weir Pool	SWP	WQ-P	WQ-Lab		
5	Seaham Weir to Hunter River confluence	N/A	No sampling			

WQ-P: Physico-chemical water quality sampling (26 Nov and 5 Dec 2007)

WQ-Lab – Laboratory water quality sampling (5th and 6th Dec 07)

AE – Aquatic ecology sampling (26 Nov and 5 Dec 2007)

FG – Fluvial geomorphology sampling

Water samples were collected on 5 and 6 December 2007 at sites W1, W2, W4, W6, W8-W12 and SWP and sent for laboratory analysis. Sites W3, W5 and W7 were not selected for water quality sampling based on their proximity to surrounding sites which, on the basis of visual observation by the field sampling team, were assessed to have a similar quality of water.

Physico-chemical water quality measurements were collected at the same time as the aquatic ecology macroinvertebrate and fish sampling was undertaken, between 26 November and 5 December 2007. Physico-chemical water quality and aquatic ecology samples were collected at all sites with the exception of site W11 and W12 due to elevated flows at the downstream end of the Williams River at the time of sampling.

The NSW AusRivAS protocol suggests optimal sampling be carried out at least two weeks after recent flood events as high flows can affect the composition of macroinvertebrate communities. Additionally, the NSW AusRivAS spring sampling period is between 15 September and 15 December 2007. As such, aquatic ecology and water quality sampling was not undertaken at a later date as by the time river flows had dropped to appropriate levels the AusRivAS sampling period had expired.

A comprehensive water quality monitoring program is proposed which would provide baseline data at all the above mentioned sites (refer Section 9 for additional information on proposed monitoring). It is noted that

Hunter Water already undertakes daily water quality samples from several sites within the Williams River and has collected 25 years worth of baseline data in this regard. This monitoring program would be revised to continue the comprehensive monitoring during the Tillegra Dam project.

4.2 Fluvial geomorphology

Numerous submissions were received relating to the fluvial geomorphology aspects of the project. The issues raised can be summarised as follows.

1 **Bank erosion and slumping:** Submissions suggested that a lack of information was provided regarding fluctuations in water levels within Seaham Weir Pool and the impacts on bank erosion and slumping. (Section 4.2.1)

2 **Foreshore erosion**: Submissions suggested that foreshore erosion at low storage levels has not been assessed and that mass slope failure risk (foreshore erosion) has not been assessed. Additionally, it was suggested that erosion where streams enter the dam has not been assessed. (Section 4.2.2)

3 **Bed level erosion**: Submissions suggested that the risk of bed level erosion on tributaries has not been assessed. (Section 4.2.3)

4 **Delta formation**: Submissions raised concern that the potential for delta formation at the upstream limit of inundation in tributary streams, including the Williams River has not been assessed and suggested that the EA Report fails to address impact on river and ecology through formation of deltas and progress upstream from the dam perimeter. (Section 4.2.4)

5 **River styles assessment**: Submissions suggested that the River Styles assessment has not been referenced and geomorphic character of the river has not been properly described. (Section 4.2.5)

6 **Assessment of bed stability impacts**: Submissions suggested that the EA presented a flawed assessment of bed stability impacts. (Section 4.2.6)

7 **Risk of bank instability**: Submissions suggested that the EA Report claims of low risk bank instability are not justified. (Section 4.2.7)

8 **Barrier to sediment flow**: Submissions suggested that the permanent barrier to sediment flows would mean the riverbed below the dam would erode to bedrock, lowering the watertable throughout the Williams catchment and permanently alter the geomorphology. (Section 4.2.8)

9 **Intensity of downstream flushing**: Submissions suggested that the dam would reduce the intensity of downstream high flow flushing and scouring events to maintain health of the river. (Section 4.2.9)

10 **Material transport regime**: A submission suggested that the altered bed material transport regime would present a risk to increasing bank instability, but the risk is considered to be relatively low. (Section 4.2.10)

11 **Downstream impacts**: Submissions suggested that impacts on Williams River include downstream bed scouring, bed lowering would cause downstream tributaries to "hang" and activate "nick" points. (Section 4.2.11)

12 **Environmental Flow and Geomorphic Objectives**: DECCW suggested that the environmental flow and geomorphic objectives are commendable but are not achievable and create false expectation for the proponent. (Section 4.2.12)

13 **Channel adjustment**: NOW suggested that there is no evidence that channel adjustment downstream would replace sediment trapped by dam and that alterations would change bank stability. (Section 4.2.13)

14 **Floodplain connectivity**: It has been suggested that the report incorrectly refers to the Williams River and floodplain as being disconnected. (Section 4.2.14)

15 **Monitoring:** I&I NSW suggested that the condition of approval should include monitoring of geomorphic stability and have mitigation strategies in place. (Section 4.2.15).

16 **Deposition of silt on floodplains:** A submission was concerned that the disruption to flows of the Williams River would decrease the deposition of silt over the river flats (Section 4.2.16).

4.2.1 Bank erosion and slumping

Submissions suggested that a lack of information was provided regarding fluctuations in water levels within Seaham Weir Pool and the impacts on bank erosion and slumping

This issue was discussed in Sections 2.11.4.3 and 3.4, Working Paper B of the EA Report. The main cause of erosion is thought to be power boating in the upper weir pool and in the lower weir pool cattle access and wind waves are involved. These issues are unrelated to the proposed Tillegra Dam. Water level fluctuations, if rapid enough, could result in bank slumping. Changes to the pattern of water levels in Seaham Weir are largely controlled by operation of the weir itself. The weir gates are opened during large events, and this practice would not change with Tillegra Dam operational. Operating levels for the weir pool are specified by the licence that is not being considered under this program and hence the weir pool would continue to operate in accordance with the licence.

4.2.2 Foreshore erosion

Submissions suggested that foreshore erosion at low storage levels has not been assessed and that mass slope failure risk (foreshore erosion) has not been assessed. Additionally, it was suggested that erosion where streams enter the dam has not been assessed.

In Section 2.10.1 of Working Paper B of the EA Report it was noted that the dam will be operated to be usually within 96-100% of capacity and that this will concentrate erosion over the top part (<1 m) of the rim of the storage. Any erosion at lower levels would be a small percentage of total erosion. When water level falls lower than 96% full, total mass of eroded material becomes less because the perimeter becomes shorter. As the predicted overall volume of eroded material is very small compared to the dam capacity, any infrequent erosion at levels lower than 96% capacity would constitute a relatively small mass of material.

The rate of sediment deposition in the dam was covered in Section 3.5 of Working Paper B. The total rate of deposition was estimated to be 0.2% of dam capacity in 100 years. Shoreline erosion would continue until rock was reached, and would virtually cease after that. There is no particular storage level where deposition in the dam equals erosion of the shoreline.

In Section 2.10.1 of Working Paper B of the EA Report it is noted that

> In the case of Tillegra Dam it was assumed that the drawdown rate would be so slow that the bank soils would be able to drain, so slumping due to surcharge of saturated banks would probably not be a general problem.

The Project Statement of Commitments include substantial tree planting and land management works. This would encourage landscape stability and reduce, but not eliminate entirely, the risk of foreshore erosion.

Any area within the inundation limits of the impoundment is considered to be within the dam, and no longer a section of river that can be maintained in its former state. So, these sections would likely have altered vegetation and increased bank erosion, similar to the remainder of the dam's perimeter. The dam perimeter morphology would ultimately stabilise and in the interim period these processes pose little threat to the environment. As such stream erosion at the dam foreshore is not a process of concern.

4.2.3 Bed level erosion

Submissions suggested that the risk of bed level erosion on tributaries had not been assessed.

The dam would increase the base level of the tributaries whereas headcuts are the result of lowering of the base level. When the dam is at a low level, the base level of the tributaries remains the same and is still higher than it would have been without the dam. The headwater streams are also bedrock controlled so head cutting leading to bed level erosion is not a process of concern.

4.2.4 Delta formation

Submissions raised concern that the potential for delta formation at the upstream limit of inundation in tributary streams, including the Williams River, had not been assessed. It was also suggested that the EA Report failed to address impact on river and ecology through formation of deltas and progress upstream from the storage perimeter.

Delta formation is associated with slowing of velocity where the stream meets the impounded water. Any impact on water levels in the tributary at times of flooding would be very localised, and within the general zone of the extent of the impoundment. Inflowing tributaries are relatively steep, so backwater effects from the dam cannot extend very far upstream. The growth of a delta at the entry point of a tributary, and its backwater effect, would be extremely difficult to model due, among other reasons, to lack of suitable input data to model such a complex physical process. Given this, and its relatively low process rate and small process magnitude, compared to other geomorphic processes, it was not attempted.

Deltas would form where tributaries enter the impoundment, and this is part of the process of sediment trapping by the dam that was covered in Working Paper B of the EA Report. The upstream extent of any delta from the impoundment perimeter would be governed by the sediment transport capacity of the channel, the bed material size and preceding flood flows. These tributaries are relatively steep, so under flood conditions, when the sediment is transported, the backwater would not extend upstream very far from where the tributary meets the dam. There was no data available to make predictions about the rate of progression of this process, or the ultimate size and extent of any deltas.

Delta formation impacts should they occur would predominately relate to a very small reach of channel just upstream of the dam perimeter. Compared to the length of channel that is completely submerged, and the length of channel impacted downstream of the dam, the amount of river channel affected by delta formation would be negligible.

4.2.5 RiverStyles assessment

Submissions suggested that the RiverStyles assessment had not been referenced and the geomorphic character of the river had not been properly described.

There is no inherent reason why the RiverStyles assessment is relevant to the assessment of the potential impacts of proposed Tillegra Dam. The geomorphology work referred to by Erskine and others, and the work undertaken during the course of this environmental assessment, was conducted at greater detail than the River Styles mapping.

If Site 11 is a reference reach for the RiverStyles assessment, then that is not indicated in Cook and Schneider (2006). In fact, the term ‘reference reach’ is not used in Cook and Schneider (2006).

It was claimed that the description of Site 11 is at odds with that of Cook and Schneider (2006). Cook and Schneider (2006) do not refer to this site at all. In any case, even if the RiverStyles approach assessed this reach to be “stable and within the natural range of variability for good condition reaches of this type” it would not preclude the possibility of erosion or avulsion, which are both natural processes that occur in “stable” streams.

On page 75 of Working Paper B of the EA Report, Site 11 was incorrectly indicated to be upstream of Dungog. This was a typographical error, and the word “upstream” should be replaced with “downstream”.

The history of channel change in the Williams over historical times has been well documented by Erskine. It is true that rivers can naturally incise and aggrade, without human disturbance, and nowhere in the EA Report is this contradicted.

Cook and Schneider (2006, p. 28) shows RiverStyle PCVS - Planform controlled, Low sinuosity, gravel from Tillegra to Glen William, and RiverStyle PCVS - Bedrock Controlled, gravel to Clarence Town. From Clarence Town to Seaham it is Water storage (not a geomorphic river style). From Seaham to Raymond Terrace it is LUV – CC Tidal.

There is no contradiction in the RiverStyles of Cook and Schneider (2006) and any description of the geomorphology of the river made in the fluvial geomorphology assessment (Working Paper B of the EA Report).

For PCVS, adjustment is 'Within this valley setting the bed adjustments are generally dependent on material availability and the history of bedload transport events with bed levels often constrained by bedrock outcrops' Cook and Schneider (2006, p. 34). On page 36 of their report, Cook and Schneider (2006) list the threats to PCVS, which include: avulsion, channel incision, sediment starvation and hydrology alteration caused by large in-stream infrastructure and streambank erosion. These were all covered in Working Paper B of the EA Report.

The description of form and process in Cook and Schneider (2006) is not at odds with that in the fluvial geomorphology working paper, with the main difference being the much higher level of detail in the working paper. RiverStyles is a generalised approach to geomorphology at the basin scale, while the working paper was a detailed process study, which was appropriate for the required assessment.

4.2.6 Assessment of bed stability impacts

Submissions suggested that the EA presented a flawed assessment of bed stability impacts.

The Trinity River was cited as a comparable case, but only in the sense that it is a gravel bed river with a dam, where geomorphic response was investigated. These are two different rivers, and any observations made on the Trinity do not contradict any specific predictions made for the Williams River.

The claim that there are no full channel width spanning bedrock bars to control bed erosion until around Glen Martin may or may not be true, no data were provided. In any case, stream works have been undertaken to stabilise the channel. There is no doubt that bedrock outcrops in the channel, and this would slow the rate of incision due to bed sediment scour. The EA Report accepted that sediment scour was likely, but predicted that the scour was likely to be spatially variable (as observed on the Trinity River example), and that general significant bed lowering along its entire length was unlikely.

The potential for headcuts in tributaries due to bed lowering of the Williams River relies entirely on the supposition that the bed would lower significantly. As it was concluded that the bed was unlikely to lower significantly in a general way, there was no need to assess tributary incision. There could be local incision near the mouth of a tributary that promoted tributary incision, but the likelihood, location and severity of these processes cannot be predicted. Any discussion of this process would be highly speculative.

Working Paper B of the EA Report accepted that the dam would interrupt sediment transport, estimated the volume of this sediment and made suggestions for amelioration.

4.2.7 Risk of bank instability

Submissions suggested that the EA Report claims of low risk bank instability are not justified.

On page 78 of Working Paper B of the EA Report, it is noted that

> The implication of the combined effects of reduced bed material mobilisation, increased chance of macrophyte colonisation, and reduced disruption to in-stream vegetation is that under the base case 'with dam' scenario, over time the channel would become more stable, with more in-stream vegetation. The flows would still maintain the basic geomorphic processes, but the useable (by biota) channel area may contract

somewhat. This effect was predicted to lessen with distance from the proposed dam.

The contraction refers to available habitat area within the river, which contracts due to vegetation colonisation. This does not, however, relate to morphological changes.

The claim that bed lowering would cause bank instability is based on the speculation that the bed would lower significantly through rapid nick point progression. The working paper made a case that general significant bed lowering was less likely than localised scour, and this position has not changed.

The working paper accepted that the dam would interrupt sediment transport, estimated the volume of this sediment and made suggestions for amelioration.

4.2.8 Barrier to sediment flow

Submissions suggested that the permanent barrier to sediment flows would mean the river bed below the dam would erode to bedrock, lowering the watertable throughout the Williams catchment and permanently alter the geomorphology.

Assuming that the river bed did scour to bedrock, the depth to bedrock would determine the depth of lowering. Any lowering of the bed would have a localised effect on the elevation of the water table near the river, and not impact the watertables of the entire catchment. Working Paper B of the EA Report accepted that the dam would interrupt sediment transport, estimated the volume of this sediment and made suggestions for amelioration.

4.2.9 Intensity of downstream flushing

Submissions suggested that the dam would reduce the intensity of downstream high flow flushing and scouring events to maintain health of the river.

The change in frequency of flushing flows was assessed and reported in Working Paper B. It was found that flushing of silt and sand from the bed surface would continue to be a common event under the base case ‘with dam’ scenario.

4.2.10 Material transport regime

A submission suggested that the altered bed material transport regime would present a risk to increasing bank instability, but the risk is considered to be relatively low.

Hunter Water agrees that the existence of bank erosion at the present time indicates nothing more than that the river is behaving in a normal way (as erosion is a natural process). This issue does not conflict with the findings of the EA Report and as such no further assessment is required.

4.2.11 Downstream impacts

Submissions suggested that impacts on Williams River include downstream bed scouring, bed lowering would cause downstream tributaries to ‘hang’ and activate ‘nick’ points

Hunter Water note that there is a risk of this happening, however, Working Paper B of the EA Report predicted that local scour was more likely than general bed lowering due to the natural stability of the bed imparted by bedrock outcrops and by stream works.

4.2.12 Environmental flow and geomorphic management objectives

DECCW suggested that the environmental flow and geomorphic objectives were commendable but not achievable and therefore created false expectation for the Project.

Hunter Water notes that the objectives are set in order to maintain existing levels of stream health, and as such are appropriate. Should these objectives have been determined to be not possible, such conclusions would have been noted as part of the environmental assessment process. Hunter Water suggests that an approach of simply setting objectives that pre-supposes the degree of achievement is not appropriate.

4.2.13 Channel adjustment

NOW suggested that there was no evidence that channel adjustment downstream would replace sediment trapped by dam and that alterations would change bank stability.

The EA Report did not state that the adjustments would replace sediment trapped. It was stated that sediment inputs would continue as normal, but it was not stated that this would make up for the trapped sediment. The report notes that sediment supply would be reduced, and also that sediment transport would on average be reduced due to the dam's impacts on lowering flood frequency.

Hunter Water agrees that the supposedly 'proven' relationship between reduced bedload and increased bank stability is likely to apply in situations where the bed is significantly lowered due to the bedload interruption, and where the banks are relatively unstable. In the case of the Williams River, this is not necessarily a certain outcome. Firstly there is no reason to assume that general bed lowering is more likely than localised scour, secondly the banks of the Williams River are already eroding in some places, and not in others, so erosion has multiple causes; thirdly, much of the river is incised and has high shear stresses – high enough to cause bank instability. It would be difficult to predict the relative change in likelihood of, or extent of, bank erosion in response to spatially variable bed scour.

4.2.14 Floodplain connectivity

It was suggested that the EA Report incorrectly refers to the Williams River and floodplain as being disconnected.

The claim that the Williams River is not an incised stream is inconsistent with the literature with the hydraulic analysis. The Working Paper noted that the degree of incision varied and was greater at the upstream end of the study area.

Further, the Working Paper makes no mention that the Williams River and floodplain are disconnected. Rather, the report quantifies the degree of connectivity through hydrologic and hydraulic analysis.

4.2.15 Monitoring

I&I NSW and NOW suggested that the conditions of approval should include monitoring of geomorphic stability and have mitigation strategies in place.

Working Paper B stated that

> Any bed scour associated with operation of the proposed dam would likely involve localised scour in areas of deep deposits of bed material (i.e. gravel bars could degrade), general removal of the finer component of the bed material (leading to bed armouring – a coarse upper layer) and greater exposure of bedrock outcrops.

So, there was no denial of scouring impacts.

The recommended monitoring measures were described as follows:

> There would be some value in including geomorphological variables in an ongoing monitoring program. Bank erosion is a notoriously difficult phenomenon to measure, and even more difficult to explain, as there are numerous contributing factors. Interpretation also requires a long term data set of baseline conditions covering a large number of sites, otherwise it cannot be known whether the measured rate of change is slower or faster than previously, and whether the observed changes are systemic or local. Simply measuring change does not indicate the cause of change.

Bed levels would be more readily surveyed and interpreted, provided sufficient measurements were undertaken (as there is considerable 'noise' in observed bed levels at any particular point on the river). Any long term observed change to bed levels could be attributed directly to the bed material transport process, and this process is predicted to be altered by the proposed dam. Thus, bed stability could be monitored using a hypothesis testing approach, while an investigation of bank stability would likely be confounded."

Consequently Hunter Water is in agreement with and would implement the proposed monitoring approach but cautions that any monitoring program would have its limitations. Refer to Chapter 9 for further discussion of proposed monitoring.

4.2.16 Deposition of silt on floodplains

A submission was concerned that the disruption to flows of the Williams River would decrease the deposition of silt over the river flats.

It is acknowledged that the combined effects of reducing peak flows during major floods and reducing silt and organic loads passing the dam may lead to reduced loads to floodplain pastures downstream.

It is difficult to assess the likely magnitude of this possible load reduction as the processes are very specific to local topography, the presence of flood control gates and flow regime. Below Dungog the contribution of the loads derived from upstream of Tillegra Dam would be relatively small and as such Hunter Water believes potential impacts on floodplain silt loads would not be significant.

4.3 Aquatic ecology

Numerous submissions were received relating to the aquatic ecology aspects of the project. The issues raised can be summarised as follows.

1 **Fishway at Tillegra Dam:** a large number of submissions were concerned about the absence of a fishway at Tillegra Dam and the loss of river connectivity in this reach of river. (Section 4.3.1)

2 **Specialist recommendations:** a large number of respondents were concerned that the project proponent has not given sufficient consideration to Working Paper C (Aquatic Ecology) recommendations, particularly with regard to riverine connectivity and the need to build a fishway. (Section 4.3.2)

3 **Aquatic ecology impacts:** submissions were concerned that the dam would have substantial and irreversible impacts on aquatic ecology in the upstream and downstream riverine environments. Specifically submissions were concerned that the dam would impact on migratory fish (in particular Australian Bass), macroinvertebrates and mussel populations. (Section 4.3.3)

4 **Increased barriers for fish passage:** I&I NSW was concerned that the reduction in wetted width of channels and the increase in low flows during the filling period would result in the potential increases in natural and artificial barriers to fish. (Section 4.3.4)

5 **Capacity of the Williams River to support increased fish populations:** the I&I NSW submission expressed concern over the lack of certainty that even with the improvements to fish passage at Seaham Weir, the Williams River, could support increased populations of fish due to the potential reduction in fish habitat and food sources associated with the Project. (Section 4.3.5)

6 **Introduced species:** submissions were concerned that the new impoundment would favour introduced species, such as carp as its life cycle is more suited to still waters. . It was noted that a key threat to the freshwater catfish is competition from introduced species such as carp. (Section 4.3.6)

7 **Recreational fishing:** submissions were concerned the dam may impact migratory fish, in particular Australian Bass populations, which would have flow-on effects to the socioeconomic value the regional

recreational fishing industry. (Section 4.3.7)

8 **Fish mortality:** concerns were raised that fish, in particular Australian Bass, would swim over the spillway during overtopping events. It was also noted that preferential use of the tower, operation of the Hydro Electricity Plant (HEP) and Balickera Canal pumping station may lead to fish damage and/or mortality. (Section 4.3.8)

9 **Methodology:** a number of submissions were concerned that the data collection for the EA was inadequate. Some felt that the AusRivAS methodology was incorrectly applied. (Section 4.3.9)

10 **Weed invasion:** a number of submissions were concerned that the potential for weed invasion as a result of altered hydrology has not been considered and that remediation actions have not been proposed. (Section 4.3.10)

11 **Cold water pollution:** the potential for cold water pollution to impact on fish and aquatic invertebrate assemblages. (Section 4.3.11)

4.3.1 Fishway at Tillegra Dam

A large number of submissions were concerned about the absence of a fishway at Tillegra Dam and the loss of river connectivity in this reach of river.

It is acknowledged that a new dam at Tillegra would lead to a further barrier to fish passage in the Williams River unless a fishway is constructed to maintain the linkages between fish populations and allow fish passage past the dam. Additionally, is it acknowledged that migratory fish species are known to occur at the dam site and that the upper 50 kilometres of the Williams River would be isolated.

It is not proposed to build a fishway at Tillegra Dam. It is considered there would be greater environmental and social benefits by taking a catchment wide view of opportunities to offset these impacts for less cost than to build a fishway.

As such, the following offsets are proposed which would provide both substantial improvements to fish passage along several hundred kilometres of rivers within the region and other aquatic improvements:

- Remediation of fish passage at four high priority barriers in the Hunter Catchment. Subject to final confirmation from I&I NSW this would include a fishway at Seaham Weir, Liddell Gauging Station (Hunter River at Jerries Plains) Dora Creek Weir and Barnsley Creek Weir. Alternative sites are listed in the NSW Weir Review for the Hunter and could include such sites as Cross Keys Road, Paterson River
- The re-introduction of at least 10 kilometres worth of large woody debris into the Williams River to provide for enhanced geomorphic and habitat diversity within the Williams River
- The sponsorship of a comprehensive monitoring and research program including components such as habitat mapping, fish surveys, movement patterns and habitat utilisation monitoring, PIT tagging and LWD monitoring
- A five year community small grants scheme of $100,000 per year for the rehabilitation and management of wetlands, riparian zones and in-stream aquatic habitat within public lands (total cost $792,000).

The package was developed in consultation with I&I NSW (Fisheries). It is believed the proposed offsets would provide greater environmental benefits to the wider Hunter catchment for less cost than the provision of a fishway at Tillegra. Hunter Water is committed to undertaking aquatic mitigation measures and providing appropriate offsets.

4.3.2 Specialist recommendations

A large number of respondents were concerned that the project proponent has not given sufficient consideration to Working Paper C *Aquatic Ecology* recommendations, particularly with regard to riverine connectivity and the need to build a fishway

Specialist subconsultants were engaged to undertake the aquatic assessment to examine the potential effects of dam construction and operation on aquatic habitats of the Williams River. This assessment is provided in Working Papers C and D. These specialist investigations provided an ecological status of the Williams River, identified threatened fauna species, populations and communities present and predicted the impacts of dam construction and operation on river ecology.

Additionally, recommendations for environmental flows required to maintain ecological structure and function of the Williams River were provided. The majority of these recommendations have been incorporated into the preferred release strategy for the dam and proposed monitoring programs. It is acknowledged, however, that the consultant's recommendation for provision of a fishway was not incorporated into the overall Project. The decision was made after due consideration of estimated cost ($30 million), environmental and social benefits within the whole catchment (refer Section 4.3.1 for further information).

The following recommendations were made by specialist subconsultants and incorporated into the Project:

- Environmental flows – the release strategy has been changed from the base case assessed by the consultants to more closely mimic historical flows (change in seasonality, magnitude, appropriate rates of rise and fall)
- Fishway – the Project has included replacement of the existing submerged orifice fishway at Seaham Weir as noted as part of the aquatic offsets package listed in Section 4.3.1
- Monitoring program – the Project has committed to undertake a monitoring program to examine the potential effects of the environmental releases could have on aquatic biota (refer Section 9)
- Sediment control – sediment and erosion control measures would be implemented during construction of the dam and associated infrastructure
- Lake habitat – where it would not pose a risk to watercraft or other aquatic recreational activities, vegetation in the inundation area would be left in place to serve as habitat for fish. Stocking of Tillegra Dam was cited as a possible management option (refer Working Paper N).

The aquatic ecology specialists also recommended the replenishment of scoured bed material. As noted in Section 10.12.2 of the EA Report, the augmentation of sediment supply downstream of Tillegra Dam is not proposed as the strategy is difficult to implement, impractical due to the availability of clean gravel and cost prohibitive.

4.3.3 Aquatic ecology impacts

Submissions were concerned that the dam would have substantial and irreversible impacts on aquatic ecology in the upstream and downstream riverine environments. Specifically submissions were concerned that the dam would impact on migratory fish (in particular Australian Bass), macroinvertebrates, mussel populations and riparian vegetation.

It is acknowledged that the construction and operation of the proposed Tillegra Dam would have some unavoidable impacts on the aquatic and riparian ecology of the Williams River. These impacts have been identified and subsequently eliminated or mitigated where possible. Where mitigation was not possible appropriate offset measures have been proposed.

The preferred environmental release strategy from the storage would ensure the aquatic ecology of the Williams River is maintained to an acceptable level and the releases would eliminate the majority of impacts associated with fish and macroinvertebrate habitat, recruitment, diversity and abundance. The transparent release to the 30th percentile would maintain low and moderate flows which would enable fish passage and maintain in-stream habitat connectivity. Additionally, the releases from the storage would mimic the natural river flows triggering fish migration during fresh events and maintaining structure and form of habitats (refer Section 4.4.3 for further information on the preferred release strategy). It should also be noted the impact of Tillegra Dam would be less pronounced with distance downstream as other inflows would contribute to overall river flows.

The impacts on the aquatic ecology of the Williams River are set out in Sections 10 and 11 of the EA Report as well as Working Papers C and E. The potential impacts on the aquatic ecology of the Williams River would

include:

- The direct loss of 19.2 kilometres of in-stream (lotic) habitat
- A barrier to fish passage in the upper catchment of the Williams River (15% of the Williams River catchment)
- Cumulative loss of fish passage within the Williams River, with the consideration of the existing Chichester Dam being located on a major tributary of the Williams River
- Localised extinction of six species in the river system upstream of the proposed dam which require the ability to migrate to the estuary to breed. A further three species (long finned eel, short finned eel and Cox's gudgeon) are predicted to have reduced abundance.

A suite of management measures has been developed to minimise, manage and offset these impacts (refer Section 4.3.1).

Migratory fish and Australian Bass

The impacts on fish populations of the Williams River are addressed in Section 5.3 of Working Paper C of the EA Report.

The barrier created by the dam wall would result in the expiration of several diadromous fish species above the barrier due to recruitment failure because juveniles and adults would be unable to spawn and/or upstream to colonise in the absence of a fish passage structure. These species include sea mullet, freshwater mullet, striped gudgeon, freshwater herring and the Australian Bass. The exceptions are long finned eel, short finned eel and Cox's gudgeon which are able to climb weirs and dams, although it would be expected there abundances would decline.

Other species likely to maintain populations above the dam wall are potamodromous (or undefined) and include the freshwater catfish, the flathead gudgeon, the dwarf flathead, smelt and in the introduced mosquito fish. The Australian Bass population would be maintained through artificial stocking.

Macroinvertebrates and mussels

The impacts on aquatic macroinvertebrates are addressed in Section 5.4 of Working Paper C of the EA Report.

Macroinvertebrate diversity in the Williams River is dependent on habitat complexity as many taxa have close associations with particular habitat forms (eg alternating pool and riffle sequences, gravel banks/bars). Taxa are adapted to the temporal variability of the natural flow regime. Therefore the impacts on macroinvertebrates, including the freshwater mussel would be minimised if the hydrological and geomorphological processes that structure physical habitat, determine water quality and create flow seasonality are maintained.

It is acknowledged that the inundation area would initially involve the loss of much of the aquatic macroinvertebrate fauna associated with lotic (flowing) habitat, especially those taxa requiring high levels of oxygen that are specific to riffles and high energy flows. The impacted taxa include: the mayflies, toebiters, beetles and stoneflies. Lakes with rivers flowing into them do share some river fauna, such as those found in pool edge habitats. Over time it is possible a different assemblage of macroinvertebrates would establish itself in the reservoir, one adapted to lacustrine environments.

Downstream of the dam wall the transparent releases to the 30th percentile would ensure that wetted width of the channel over shallow habitat such as riffles and gravel/sand bars would be maintained and therefore the abundance and diversity of macroinvertebrates, including freshwater mussels would also be maintained.

Riparian vegetation

Riparian vegetation and EECs are dealt with in Section 4.5.5. The native aquatic macrophytes (fluvial vegetation) recorded in the Williams River are generally common and widespread and can be expected to colonise the margins of Tillegra Dam if conditions are favourable for them to grow. This is particularly the case with common reed (*Phragmites australis*) and cumbungi (*Typha orientalis*) which are fairly ubiquitous along the

east coast of Australia in standing water. Water fern (*Azolla filiculoides*) is likely to be carried into the dam on the legs of waterbirds.

Long-necked turtles

It is acknowledged that there would be an impact on the Eastern long-necked turtle (*Chelodina longicollis*) population within the Williams River. The impacts on this species would be similar to those for the platypus (refer Section 4.5.2) and relate principally to the removal of riverine habitat along the 19.2 kilometre reach of the Williams River within the inundation area. The dam would also constrain movement along the river.

The Eastern long-necked turtle has a very wide natural distribution, which includes eastern Australia from mid Queensland through most of NSW to Victoria. The species inhabits almost any type of relatively slow moving water body from farm dams to major rivers and lakes.

The EA Report includes a comprehensive range of measures intended to mitigate and offset terrestrial and aquatic ecology impacts. Revisions and enhancements to these have been documented in this submissions report which would provide improved environmental outcomes. These include:

- Riparian rehabilitation in a new national park and in tributaries upstream Chichester Dam (as described in Chapter 4.5);
- Strategic placement of woody debris within feeder creeks entering the storage, to improve general bank stability and aquatic habitat within the dam.

While not targeted specifically at the affected long-necked turtle population, these measures would be equally effective in mitigating impacts on this species.

Environmental flow releases from the dam would replicate low and moderate flows within the Williams River. Normal high flows and floods, although suppressed, would continue to occur below the dam wall. This would ensure that individuals of this species elsewhere in the river would not be adversely impacted.

At FSL (full supply level) the length of the shoreline of the storage would be approximately 125 kilometres. It is expected that a significant amount of this could be potential habitat. As indicated in the EA Report, the preferred operational mode for the storage is to maintain water level between 90-100% of FSL. Measures such as placement of woody debris within this zone would encourage habitat development.

4.3.4 Increased barriers for fish passage

I&I NSW was concerned that the reduction in wetted width of channels and the increase in low flows during the filling period would result in the potential increases in natural and artificial barriers to fish.

Transparent environmental flows to the 30th percentile (100 ML/d) released from Tillegra Dam would preserve the low and moderate flows in the Williams River. These releases would ensure the wetted width and hence fish passage would be maintained during the critical low flow periods. These transparent releases would be maintained during both the filling and operational phases of the Project.

Hunter Water would implement a monitoring program to demonstrate the efficacy of mitigation measures designed to reduce the dam impacts. This monitoring program would include components to measure aquatic habitat and fish passage. Hunter Water would also implement an aquatic ecosystem offset package.

4.3.5 Capacity of Williams River to support increased fish populations

The I&I NSW submission expressed concern over the lack of certainty that even with the improvements to fish passage at Seaham Weir, the Williams River, could support increased populations of fish due to the potential reduction in fish habitat and food sources associated with the Project.

The proposed vertical slot fishway at Seaham Weir aims to allow the freshwater herring and striped (sea) mullet commonly found in the Hunter River but predominately absent in the Williams River, access to the river above

Seaham Weir. The proposal to improve fish passage at Seaham Weir would therefore restore fish population diversity (biodiversity) in the Williams River.

The improved fishway would also assist a number of diadromous species more successfully complete their life cycles, therefore contributing to recruitment into the fishery above Seaham Weir. This would improve the abundance of fish species within the Williams River; however it is acknowledged that the aquatic habitat in the Williams River and its carrying capacity is finite.

The construction of a vertical slot fishway would therefore not be a direct offset for aquatic habitat nor was this proposed; rather it improves access to existing habitat allowing it to be fully utilised by many fish species with different ecological niches. This is why the aquatic habitat and conservation offsetting package agreed to between Hunter Water and I&I also includes provision for rehabilitating a number of other priority barriers to fish passage to ensure that within the greater Hunter catchment, while access to some habitat is lost on the upper Williams River above Tillegra Dam, overall within the wider catchment there would actually be a net improvement to the amount of riverine habitat accessible to Australian native fish.

The provision of improved fish passage as proposed for Seaham Weir has therefore been clarified with I&I. The Department has noted that the upgrade of Seaham Weir fishway should still occur as proposed as it still holds considerable value for improving the general environment of the Williams River.

4.3.6 Introduced species

Submissions were concerned that the new impoundment would favour introduced species, such as carp as there life cycle is more suited to these still waters. It was noted that a key threat to the freshwater catfish is competition from introduced species such as carp.

As the reservoir fills, the lotic (flowing) habitat that forms the Williams River would be replaced by the lentic (still) habitat of the storage. It is acknowledged that this would be an environment favourable to carp (*Cyprinus carpio*), an introduced species.

It is noted that carp are predicted to be present within the study area and should they become established in the storage area their population may proliferate. Additionally, carp can cause considerable damage to aquatic macrophytes and lower water quality through the resuspension of benthic sediments.

There are limited practicable methods to reduce carp numbers within the storage given that the species is already present in the river, however, the impacts of carp within the storage would be monitored. The population could be periodically culled if necessary and if approved by I&I NSW.

4.3.7 Recreational fishing

Submissions were concerned the dam may impact migratory fish, in particular Australian Bass populations, which would have flow-on effects to the socioeconomic value the regional recreational fishing industry.

Section 10.8.1 of the EA Report provides details of native fish species in the region and identifies potential impacts that are likely to occur following the construction of the dam. It acknowledges that a number of diadromous fish that migrate to estuarine habitats to spawn (catadromous) or at regular life history stages (amphidromous) would be excluded from the storage and the river above the storage area. Australian Bass, which is a catadromous species, is therefore expected to disappear from the upper reaches of the Williams River unless artificially stocked in the storage. Fish stocking has been cited as a possible management option for Tillegra Dam (refer Working Paper N). Stocking of the storage with Australian Bass is considered a satisfactory approach to provide and maintain recreational fishing in the region.

Hunter Water would implement a monitoring program to demonstrate the efficacy of mitigation measures designed to reduce the dam impacts. This monitoring program would include components to measure aquatic habitat and fish passage. Hunter Water would also implement an aquatic ecosystem offset package.

4.3.8 Fish mortality

Submissions were concerned that fish, in particular Australian Bass, would swim over the spillway during overtopping events. It was also noted that preferential use of the tower, operation of the mini HEP plant and Balickera Canal pumping station may lead to fish damage and/or mortality.

It is acknowledged there is potential for fish and turtles to swim over the spillway during overtopping events which may lead to mortality. The impacts are not regarded as significant based on the volume of the storage and the potential for fauna to overtop the spillway is considered low.

Operation of the multi-level offtake structure and the mini HEP plant may also lead to fish mortality, however, this could be managed by the inclusion of exclusion devices at detailed design. These devices would limit the potential for damage to occur to native fish.

Following operation and construction of Tillegra Dam, additional water would be extracted from Seaham Weir Pool via Balickera pumping station. Most fish instinctively respond to water movement by swimming head first into flows (away from inlet works) and existing screening would minimise the risk of damage occurring to adult fish. The increased extraction, however, may lead to increased fish mortality, particularly of juvenile fish which are weaker swimmers. Currently there is no practical technique available that would allow the scope of such impacts to be measured nor are there any pragmatic mitigating strategies that could be implemented to reduce such risk.

It should be noted that no listed threatened or protected fish or aquatic macroinvertebrate species occur within the study area.

4.3.9 Methodology

A number of submissions were concerned that aquatic ecology study was too brief, the data collection was inadequate and that downstream effects were not adequately addressed. Some felt that the AusRivAS methodology was incorrectly applied.

The aquatic assessment to examine the potential effects of dam construction and operation on aquatic habitats of the Williams River assessment is provided in Working Papers C and D of the EA Report. This assessment provides an ecological status of the Williams River, identifies threatened fauna species, populations and communities present and predicts the impacts of dam construction and operation on river ecology. Field investigations were undertaken to supplement existing works and data sets within the Hunter Region.

The aquatic ecology field investigations collected data at a number of selected sites upstream, within and downstream of the proposed inundation area. It is noted that the surveys were carried out on one occasion only, however, this information was supplemented by other sources of information including existing fish fauna and macroinvertebrate studies carried out in the region and database searches. It is believed that the level of data collection, literature review and subsequent analysis are adequate to assess the potential aquatic ecology impacts on the Williams River.

A monitoring program is proposed to assess the impacts on the aquatic ecology of the Williams River (refer Section 9). As the last in-stream storage constructed in NSW occurred approximately 30 years ago, this represents an opportunity to collect data to fully characterise construction impacts and develop protocols that can be used by dam operators to reduce impacts of existing structures.

AusRiVAS

The NSW Australian River Assessment System (AusRivAS) is a rapid assessment methodology to determine the environmental condition of a waterway based on comparisons to a reference condition. The AusRivAS models will only give reliable results if they samples are taken in the spring or autumn sampling seasons, from September 15 to December 15 and from March 15 to June15 respectively.

The field samples collected as part of the aquatic ecology assessment were taken between 26-28 November

2007 and again between 3-6 December 2007. This sampling is consistent with the AusRivAS spring period and the methodology has been applied correctly. The individual season model, opposed to a combined season model, has been used for this assessment.

Data from sites W8 to W10 were taken under slightly elevated flows suggesting some reduction in invertebrate diversity and numbers for any given taxon may have been observed. It was therefore acknowledged that these sites may be considered slightly more impacted than they actually are. Sites W11 and 12 were excluded from aquatic ecology sampling at the time because it is unsafe to sample in high flow conditions as well as yielding confounding data. Once river flows had dropped below flood level the AusRivAS sampling period had finished.

4.3.10 Weed invasion

A number of submissions were concerned that the potential for weed invasion as a result of altered hydrology has not been considered and that remediation actions have not been proposed.

In-storage

Any problematic introduced species of aquatic flora that become established in the storage area once that dam is completed would be dealt with by Hunter Water as part of normal maintenance and operation of the Tillegra Dam.

The following species in particular would be monitored as they have the potential to infest large areas of the impoundment:

- Water hyacinth (*Eichornia crassipes*)
- Alligator weed (*Alternanthera philoxeroides*)
- Glush weed (*Hygrophila costata*)
- Longleaf ludwigia (*Ludwigia longifolia*)
- Canadian pondweed (*Elodea canadensis*).

Downstream

As noted in the Working Paper B of the EA Report the altered hydrology within the Williams River downstream of the dam would lead to altered channel and overbank hydraulics, meaning that some physical features (such as bars, benches and floodplain surfaces) would experience reduced frequency of inundation. The implication of this is a change in vegetation composition and structure, that is immediately downstream of the dam the river would likely become more ‘terrestrial’.

Shrubs and trees would encroach on the river channel. It is acknowledged that weed species may also colonise these areas. The increased vegetation, however, is likely to improve habitat conditions for macroinvertebrates and fish and also act to slow the bed scouring process. The dam would have a significant flood mitigation effect and therefore the removal of vegetation would not be required for reducing the flood risk. No specific mitigation measures are proposed so channel adjustment would take place following construction and operation of the dam.

4.3.11 Cold water pollution

Submissions were concerned there is potential for cold water pollution to impact on fish and aquatic invertebrate assemblages.

It is well documented that the release of cold water from storages has the potential to impact the aquatic ecology downstream. The Project incorporates the installation and operation of a multi-level offtake structure which would enable selection of water with an acceptable quality to meet the downstream riverine requirements. Selection of an appropriate release depth, including released water temperature is discussed in Section 6.3.2 of Working Paper A of the EA Report. A primary purpose of including the off take tower as part of

the project is to ensure that water releases can be properly managed and that the issue of cold water pollution can be addressed.

A hydrodynamic model (refer Section 5.4.2 of Working Paper A of the EA Report) was developed to determine the likely thermal characteristics of the proposed storage and release water temperatures. Model results show that the storage typically would stratify during spring/summer and with cooling in autumn and winter it would gradually become well mixed from surface to bottom. The surface waters from the 5-10 metre layer would reasonably mimic natural stream water temperatures and would not cause a significant effect on the downstream temperatures or flow-on effects on fish and aquatic invertebrate assemblages.

The operation of the multi-level offtake and the selection of appropriate release depths would be informed by the upstream and in-storage monitoring program. River temperatures upstream of the storage would be monitored along with vertical temperatures within the storage to inform this selection process (refer Section 9 for more information).

4.4 Environmental flows

Environmental flow releases from the Williams River is one of the key areas covered by the environmental assessment and as such several submissions were received regarding the potential impacts of changing the flow regime of the Williams River. The issues can be summarised as follows.

1 **Impact on the Williams River and its environment:** a large number of submissions were received that suggested Tillegra Dam would have a major impact on the biological and hydrological health of the Williams River. These submissions were concerned about the impacts on the Williams River in general terms with regards to its biological and hydrological health. (Section 4.4.1)

2 **Water sharing plan:** submissions were concerned that insufficient consideration was given to the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan (HUAWSP) and to a 'whole of catchment' approach in the development of the preferred environmental release strategy. A submission noted the EA provides no indication on how water would be removed under the water sharing plan. (Section 4.4.2)

3 **Preferred environmental flow releases at Tillegra Dam:** submissions were concerned that the proposed changes in flow regime would not meet downstream requirements of the Williams River and that the preferred release strategy is not the best option for the Williams River (Section 4.4.3)

4 **Extent of impact:** submissions were concerned about the extent over which the predicted impacts would occur and questioned why impacts would be of lesser significance downstream of the Williams and Chichester Rivers confluence. (Section 4.4.4)

5 **Seaham Weir Pool:** a number of submissions were concerned that environmental impacts of reduced flows to Seaham Weir Pool have not been adequately addressed, in particular the impact of water level change on adjoining farm drainage. Submissions also questioned how water levels within the weir pool would be managed by Hunter Water. (Section 4.4.5)

6 **Irrigator access rights:** a number of submissions were concerned about existing irrigator rights and whether the proposed flow regime would affect the availability of water for irrigators along the Williams River and in Seaham Weir Pool. Submissions were concerned that the commercial impact on the regional economy has not been assessed. (Section 4.4.6)

7 **Existing ecosystem of the Williams River:** submissions were concerned that the current condition of the Williams River has been understated and that the EA fails to recognise previous work undertaken in the river. A large majority of submissions were concerned that the proposal would negatively impact the Williams River which is: (a) the last free flowing river in NSW; (b) a pristine river; and (c) the only remaining healthy river in the Hunter Catchment. (Section 4.4.7)

8 **Length of filling time:** submissions are concerned about the lack of clarity in regards to the filling time and the potential effect on the downstream ecosystem as a result of a prolonged filling time.

(Section 4.4.8)

4.4.1 Impact on the Williams River and its environment

A large number of submissions were received that suggested Tillegra Dam would have a major impact on the Williams River and its environment. These submissions were concerned about the impacts on the Williams River in general terms with regards to its biological and hydrological health.

The assessment and management of impacts on the Williams River is one of the key areas covered in the environmental assessment and is provided in Chapter 10 of the EA Report. Supporting specialist investigations are documented in Working Papers A, B, C, D and E.

It is acknowledged that the construction and operation of Tillegra Dam would have some unavoidable environmental impacts on the Williams River and its environment. These impacts have been mitigated through development of an appropriate release strategy from the dam that would maintain the essential features of the hydrological regime which in turn support the key geomorphic and ecological processes of the Williams River.

The preferred environmental release strategy was developed through separate but inter-inked specialist investigations into water quality, hydrology, fluvial geomorphology and aquatic and riparian ecology. Consideration was also given to the potential impacts on the Ramsar wetland in the Hunter estuary (Appendix 6 to the EA Report). It has been possible to develop a release strategy which minimises these environmental impacts while meeting the competing requirements of Hunter Water and irrigators.

The following sections provide further information and clarification on specific issues relating to the assessment and management of impacts on the Williams River.

4.4.2 Water sharing plan

Submissions were concerned that insufficient consideration was given to the *Hunter Unregulated and Alluvial Water Sources Water Sharing Plan* (HUAWSP) and to a 'whole of catchment' approach in the development of the preferred environmental release strategy. A submission noted the EA provides no indication on how water would be removed under the water sharing plan.

Due consideration has been given to the HUAWSP in the development of environmental flows, however, it should be noted that issues relating to the construction and operation of Tillegra Dam are separate to the ongoing development of the water sharing plan for the region. The HUAWSP would consider the integrated management of water resources across the whole Hunter River catchment.

The HUAWSP includes rules for protecting the environment, water extraction, managing licence holders' water accounts and water trading in 39 water sources. The sources include the William's River water source which is divided into two management zones; the Williams River Management Zone and the Seaham Weir Management Zone. The HUAWSP became operational from 1 August 2009. The plan makes an allowance to include the management of Tillegra Dam within its water management framework, should the project proceed.

The preferred environmental flow release strategy for the proposed Tillegra Dam has been developed with consideration of the water sharing plan for the region and the NSW legislated water management framework, as requested by the DGRs. Numerous discussions have been held between Hunter Water and NOW throughout the project in regards to surface water hydrology, run-of-river transfers and transparent and translucent environmental flow releases. The preferred release strategy presented in the EA is an outcome of these discussions and the comprehensive assessment of ecosystem impacts of changes to the flow regime.

Hunter Water acknowledges there is a need for further ongoing discussion with NOW regarding the final environmental flow release strategy and the flow provisions past Seaham Weir adopted in the HUAWSP. The preferred release strategy identified in the EA provides a sound basis for further discussions. The HUAWSP has the provision to include amendments to the plan following finalization of the water sharing plan rules and construction of Tillegra Dam.

Specific details on how the share components in the Williams River Water Source under the HUAWSP would be allocated to Tillegra Dam (to meet increased extraction demands at Seaham Weir) would be decided when the final release strategy is approved by DoP and NOW. If approved, Tillegra Dam and associated infrastructure (dam wall, spillway, multi-level offtake) would be incorporated into Hunter Water's Major Water Utility Licence and the HUAWSP.

4.4.3 Preferred environmental flow releases at Tillegra Dam

Preferred release strategy and change in river flow

Submissions were concerned that the proposed changes in flow regime would not meet downstream requirements of the Williams River and that the preferred release strategy is not the best option for the Williams River. Submissions also noted that the proposed environmental release strategy would have a significant impact on flows, particularly during the medium and high rainfall events and during the filling period.

The proposed flow regime from Tillegra Dam was developed based on an understanding of the relationships between flow components of the Williams River and ecosystem responses. The proposed flow regime aims to maintain the ecological processes of the river by mimicking the key characteristics of the natural flow regime as set out in the River Flow Objectives (RFOs) developed by the former DWE. Surface water licences and drought security for the Lower Hunter region were also considered in development of the release strategy.

It is believed the preferred release strategy identified in the EA Report is the best option to meet the downstream ecosystem requirements of the Williams River while considering the competing issues of drought security and surface water irrigation rights. Refinement of the environmental release strategy would be an ongoing process with improvements incorporated over time as part of the adaptive management approach mandated by the *Water Management Act 2000.* Such an adaptive management approach would be informed by an extensive monitoring program (refer Section 9 for further detail).

Development of the preferred environmental release strategy is described in Section 10.5 and Working Paper D of the EA Report. A brief summary of the development is provided as follows that illustrates the environmental release strategy presented in the EA Report meets the downstream requirements of the river.

Development of the preferred release strategy - overview

As a starting point a base case environmental release strategy was developed which comprised 100% transparent releases to the 90th percentile exceedance flow (7.4 ML/d), 60% translucent releases from the 90th to the 30th percentile exceedances (7.4 to 100 ML/d), a constant 63 ML/d released for flows greater than the 30th percentile exceedance (100 ML/d) and constant run-of-river transfers (ranging from 250 to 500 ML/d for a particular month).

The impacts of the proposed base case flow regime on the Williams River ecosystem were assessed in regards to hydrology, water quality, geomorphology and aquatic ecology.

The changes to the hydrological regime under the base case scenario include an increase in majority of flows with the exception of high flows and a change in the seasonality of flows. The geomorphological impacts of the base case release strategy on the frequency of geomorphic processes, the frequency of inundation of geomorphic forms and the impacts on bed sediment and bank stability were assessed. Potential geomorphic impacts under the base case release strategy include altered channel and overbank flows leading to reduced frequency of inundation of physical features (bars, benches, floodplains), reduced sediment transport and a reduction of the base level of the Williams River. The aquatic ecology impacts of the base case release strategy were discussed in regards to macroinvertebrates, fish passage and fish recruitment. Ecological impacts include a reduction in navigable flows for fish and a decrease in recruitment for those taxa that have life histories adapted to low flows during the spring months. Clearly this base case release strategy, if implemented would likely result in significant impacts on the ecosystem.

Following the hydrology, geomorphic and aquatic ecology assessments refinements to the base case release strategy were proposed to better meet the downstream riverine requirements to a suitable level of protection.

The opportunities identified to improve the base case release strategy include; an increase in transparent flows to more closely match historic low and moderate flows; modifications to the run-of-river transfers to maintain high flow events; a change in the seasonality of releases to trigger ecological processes; include a minimum number of releases per year to maintain ecological integrity during drought times; and to increase releases at Chichester Dam to compensate for reductions in flows along the upper reach of the Williams River. These improvements are discussed in Section 10.5 and Working Paper D of the EA Report.

The preferred environmental release strategy was developed following the above assessment of hydrology, water quality, geomorphology and aquatic ecology requirements of the river and includes:

- 100% transparent releases to the 30th percentile exceedance (100 ML/d) at Tillegra Dam
- Peaked 1500ML run-of-river transfers declining over a 10 day period (to mimic the natural hydrograph)
- Additional peaked 270ML flows to ensure a minimum of six fresh events from the dam per year (to augment where necessary any combination of spillway flows or run-of-river flows)
- Preferential use of 'multi-level offtake tower to limit extent of uncontrolled spillway flows
- 100% transparent releases to the 95th percentile exceedance (20 ML/d) at Chichester Dam as part of the holistic approach to managing the river.

It is noted that the preferred environmental release strategy represents a significant environmentally sympathetic improvement compared to current environmental release strategies operating in many other NSW storages. This is because other storages are constrained with their management options due to historical allocations and undertakings. Further their operation can be constrained depending on the purpose for which they were constructed. Tillegra Dam has no such constraints as a new proposal and the release strategy has been designed in a manner to maximise the benefits that an integrated environmental flow and release regime can provide.

Change in river flows

During standard operation of Tillegra Dam the preferred release flows would closely mimic the historic flows at Glen Martin. The annual flows at Glen Martin over 77 years of data (1931 to 2007) for the historic and preferred release strategy are illustrated in Figure 4.1 and the daily percentile exceedance for the historic and the preferred release flows at Glen Martin are shown in Table 4.2.

Comparison of historic flows and the preferred release strategy shows the majority of the low and moderate flows (up to the 50th percentile exceedance) would increase while the fresh and flood flows would decrease. Concurrently the mean flow would decrease at Glen Martin from 743 to 663 ML/d (a reduction of around 10.8%).

The preferred operational release strategy represents a loss of peak flows (greater than 100 ML/d) relative to the historical distribution. The loss of high flows would be less pronounced with distance downstream and impacts would be concentrated in the reach below the dam wall and upstream of the Chichester River. The proportion of flow contributed by the Tillegra catchment to flows in the Williams River decreases following inflows from the Chichester River and other tributary catchments along the Williams River.

Peak events

To illustrate the change to peak flow a comparison between the historic and the preferred release peak flows is shown in Figure 4.2 for the period July 2003 to June 2004. Peak flow events were defined as events which are at least three days apart and have flows greater than 20 ML/d difference between the historic/preferred releases and the base flow.

It should be noted that the number of events from the 77 years of record that satisfy the criteria totalled 1,895 (or average of 25 events per year) for the historic data and 2,000 events (or average of 26 events per year) for the preferred release flows. This increase in the number of events is due mainly to the addition of the six 270 ML/d releases as part of the preferred environmental release strategy.

The peak flow statistics show the 10th percentile event (approximately 2.5 events per year) is 8,768 ML/d for the observed flow data and 6,328 ML/d for the modelled scenario.

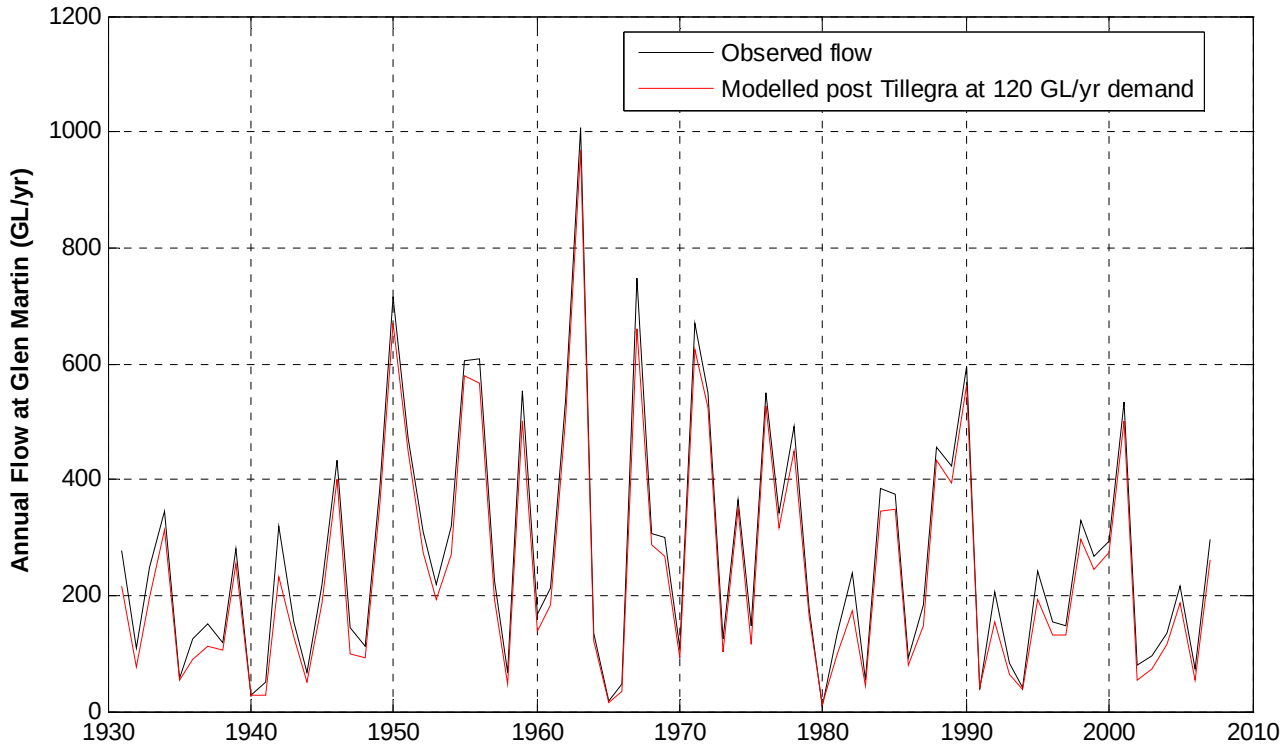

Figure 4.1 Historic and preferred release flows at Glen Martin

Table 4.2 Glen Martin historic and modelled release flows.

Statistic	Historic flow (ML/d)	Preferred environmental release strategy (ML/d)*
Maximum	127,029	107,173
5th percentile exceedance	3,166	2,585
10th percentile exceedance	1,139	1,053
20th percentile exceedance	490	386
30th percentile exceedance	282	230
50th percentile exceedance	104	102
80th percentile exceedance	26	33
90th percentile exceedance	11	17
95th percentile exceedance	3	8
Minimum	0	0
Mean	743	663

*Tillegra Dam transparent to 30th percentile, Chichester Dam transparent to 95th percentile tower flow,

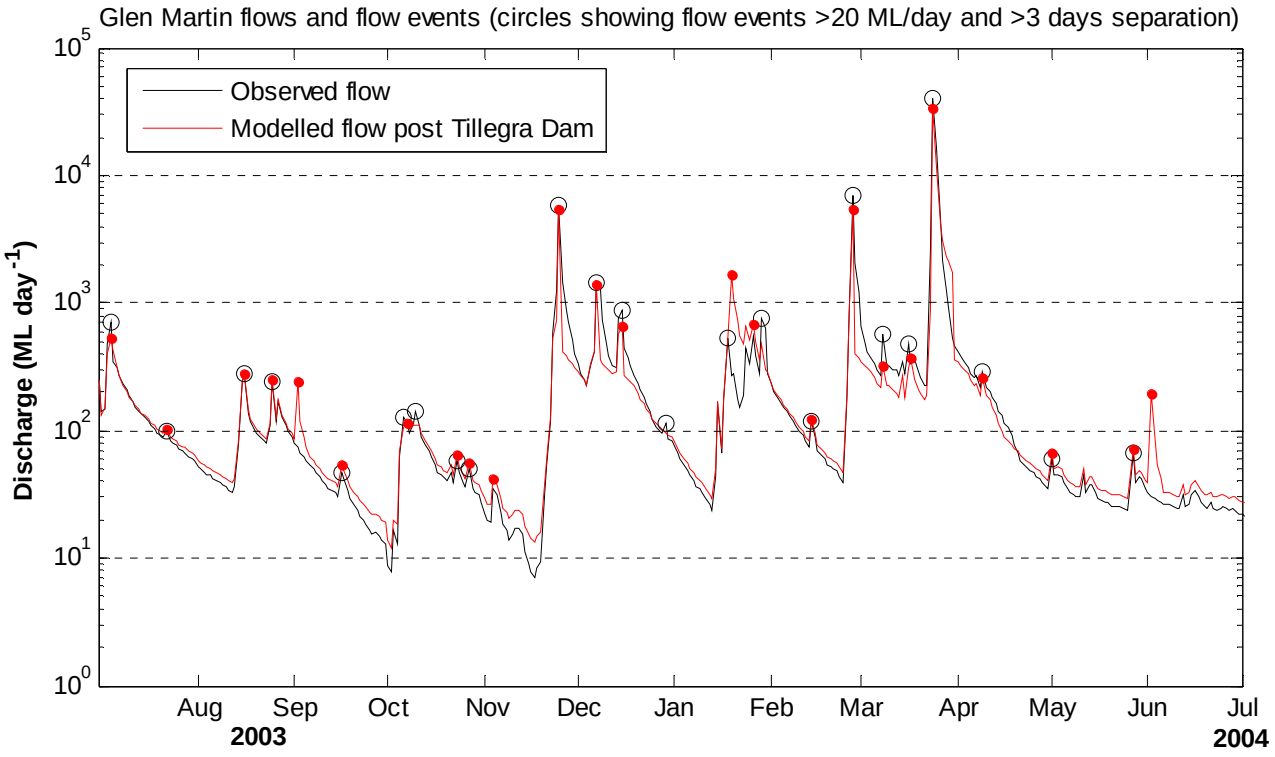

Figure 4.2 Peak flow events at Glen Martin

Filling phase

During the filling phase the preferred release strategy would consist of:

- 100% transparent releases to the 30th percentile exceedance (100 ML/d) at Tillegra Dam
- 100% transparent releases to the 95th percentile exceedance (20 ML/d) at Chichester Dam as part of the holistic approach to managing the river
- Minimum of six fresh releases per annum (consisting of natural spills, fresh releases or run-of-river transfers of any combination). Fresh releases would be peaked 270ML flows for 1.5-2 days and would be preferentially made in the months of Jan, Mar, Apr, May, Jul or Aug.

Should the filling period be prolonged additional releases would be made from the storage.

Preferred release strategy and supplementary DGRs

A submission was concerned that as the release strategy is still being developed the supplementary DGRs have not been met.

The supplementary DGRs requested Hunter Water provide a description of the proposed release strategy. The proposed/preferred release strategy was presented in the EA and was developed based on the assessment of available information relating to hydrology, water quality, aquatic ecology and fluvial geomorphology.

It is noted, however, that the development of an environmental release strategy is an ongoing process and may be improved over time based on information gleaned from the extensive monitoring program proposed as part of the project (refer Section 9 for further detail). It is believed the preferred release strategy outlined in the EA is state-of-the-art, meets the DGRs and provides a robust starting framework for an adaptive management approach to setting environmental flow conditions.

Adaptive management

Submissions recommended an adaptive management approach be implemented to improve the release strategy over time.

The preferred release strategy was presented in the EA Report for the consideration of NOW and the community, for potential incorporation into the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources.* The preferred release strategy, however, would be part of an adaptive management approach which would be informed by the proposed environmental monitoring. This recommendation has been included in the Statement of Commitments. It is also noted that Hunter Water is legally compelled to work within an adaptive management framework under the NSW *Water Management Act 2000.*

4.4.4 Extent of impact

Submissions were concerned about the extent over which the predicted impacts would occur and questioned why impacts would be of lesser significance downstream of the Williams and Chichester Rivers confluence.

The proposed environmental release strategy is transparent to the 30th percentile exceedance flows (100 ML/d) which means 70% of the time natural flows entering into the dam would be released. The remainder of the time flows from the dam are capped at 100 ML/d. Above the cap, the dam would capture the high flow events which occur 30% of the time, for storage and later release down the river.

The loss of high flows would be less pronounced with distance downstream from the dam and the impacts would be concentrated in the reach below the dam wall and upstream of the Williams and Chichester River confluence. This occurs because direct catchment runoff and tributary inflows still occur downstream of the dam site.

A reduction in mean flow would still be experienced downstream of the confluence, however, the impacts associated with this reduction would be less pronounced as the proportion of river flow contributed by the Tillegra catchment to flows in the Williams River would decrease following inflows from the Chichester River. Other tributaries and local runoff would also provide additional flow into the Williams River.

The average flow down the Chichester River is approximately 250 ML/d which is similar to the average flow down the Williams River at Tillegra (approximately 260 ML/d). The high flows (5th percentile exceedance) are also similar at the 2 locations (915-970 ML/d). Following dam construction the average flow down the Williams River at Tillegra would be 209 ML/d.

The historic and modelled release flows at Tillegra and Glen Martin are shown in Table 4.3. These results demonstrate that the influence of Tillegra Dam would decrease with distance from the dam. The mean decrease in flow at Tillegra pre and post dam would be around 20%. This percentage would decrease to only 7% at Glen Martin.

4.4.5 Seaham Weir Pool

A number of submissions were concerned that environmental impacts of reduced flows to Seaham Weir Pool have not been adequately addressed, in particular the impact of water level change on adjoining farm drainage. Submissions also questioned how water levels within the weir pool would be managed by Hunter Water.

The impacts of reduced flows to Seaham Weir Pool have been addressed in Sections 10.7 and 10.8 of the EA Report. Operation of Tillegra Dam at full demand would increase low/moderate flows, reduce peak flows and reduce the average flow into the weir pool. Water levels in the weir pool would be similar to current levels as the weir pool would be operated in accordance with Hunter Water's existing Water Management Licence. The licence sets specific water level ranges, full licence conditions are provided in Section 2.2.2 of Working Paper D.

Table 4.3 Tillegra and Glen Martin historic and modelled daily release flows

Statistic	Tillegra			Glen Martin		
	Historic Flow (ML/d)	Preferred environmental release strategy (ML/d)	Change in flow (%)	Historic Flow (ML/d)	Preferred environmental release strategy (ML/d)	Change in flow (%)
Maximum	56,488	3,0274	-46	127,029	107,173	-16
5th percentile exceedance	915	892	-3	3,166	2,585	-18
10th percentile exceedance	416	444	7	1,139	1,053	-8
20th percentile exceedance	171	194	13	490	386	-21
30th percentile exceedance	98	100	2	282	230	-18
50th percentile exceedance	47	55	17	104	102	-2
80th percentile exceedance	16	17	6	26	33	27
90th percentile exceedance	7	8	14	11	17	55
95th percentile exceedance	2	2	0	3	8	167
Minimum	0	1	-	0	0	0
Mean	**262**	**209**	**-20**	**743**	**689**	**-7**

As only minor changes in water levels are expected (refer Table 4.3) the impacts on shoreline erosion, riparian vegetation and aquatic ecology are not regarded as significant. The impact of the water level changes on adjoining farms would not be significant as less flow would be entering the weir pool and the magnitude of peak flows would be reduced. This means that a small number of floodgates situated within the weir pool would operate more effectively and less manipulation of the Hunter Water weir pool gates would be required. Hunter Water proposes to operate the weir pool in accordance with the current licence, and accordingly no changes to existing weir pool levels or the weir pool environment is predicted.

Hunter Water has committed to undertaking a monitoring program within the river, including the weir pool to allow adaptive management of the river to occur in accordance with the *Water Management Act 2000.* This would ensure the environmental integrity of the system is maintained.

4.4.6 Irrigator access rights

A number of submissions were concerned about existing irrigator rights and whether the proposed flow regime would affect the availability of water for irrigators along the Williams River and in Seaham Weir Pool.

The proposed environmental release strategy for the dam, in particular the transparent flow component would ensure existing surface water extractors would not be affected. Under the current HUAWSP the cease to pump levels are established for users above and within the Seaham Weir Pool. The low flows throughout the Williams River would be maintained during the construction, filling and operational phases of the project which would ensure the long term viability of irrigation in the catchment.

Users above Seaham Weir Pool have a cease to pump level at Glen Martin of 6 ML/d or 15 ML/d for accredited and non-accredited users respectively. A comparison of the cease to pump flows at Glen Martin for the historic and preferred release strategy is provided in Table 4.4.

Table 4.4 Percent exceedances for historic flows and the preferred release strategy flows at Glen Martin

Glen Martin Flows	Discharge (ML/d)	All data (%)	Spring (%)	Summer (%)	Autumn (%)	Winter (%)
Historic	6	93.1	89.8	85.8	96.8	99.8
	15	87.6	80.2	78.0	96.7	100.0
Preferred release strategy	6	96.2	95.0	91.4	98.5	99.9
	15	91.3	86.5	83.2	96.1	99.4

The table demonstrates that irrigators would be substantially better off with up to an additional 10-14 days per year on average, during which they would be able to irrigate. This is well above the existing baseline case.

For users within the weir pool cease to pump levels occur when water levels are equal to or less than 0.38 m weir pool height. As low flows entering the weir pool are essentially unaltered (Table 4.4) and Hunter Water would continue to operate Seaham Weir in accordance with licence requirements, the percentage of time irrigators would be able to extract water would remain essentially unchanged following dam construction.

During the filling phase of the Project there is a potential risk to water quality which may affect the releases during this time. Should releases be postponed for a few months until the water quality improves, the matter of maintaining irrigator rights would be managed by implementation of one or some combination of the following options:

- Tankered supply of water being provided to stock and domestic users
- Increased releases being made from Chichester Dam to compensate for any flow reduction in the river from the Upper Williams River subcatchment, thereby limiting any impacts to approximately four kilometres of river directly below the dam, to the Chichester confluence
- Provision of stock feed/fodder to any party immediately below the dam, and the confluence of the Chichester River, who would have otherwise have provided feed or produced hay/fodder through irrigation.
- Direct financial compensation being paid to any farmer immediately below the dam and above the confluence of the Chichester River where it can be demonstrated that a reduction in water has caused the loss of an irrigated crop or otherwise caused a financial loss through reduced agricultural production as a direct result of Hunter Water not releasing water from the dam in accordance with the proposed environmental and operational flow regime.

These mitigation measures are addressed in the Final Statement of Commitments.

4.4.7 Existing ecosystem of the Williams River

Current ecosystem condition and previous work

Submissions were concerned that the current condition of the Williams River has been understated and that the EA fails to recognise previous work undertaken in the river.

The existing environment of the Williams River is summarised in Section 10.2 of the EA Report. The existing environment is described with regards to hydrology, water quality groundwater, fluvial geomorphology, aquatic and riparian ecology, the Hunter Estuary and the current operation of the system. It is acknowledged that limited information was provided in the EA with regards to previous work undertaken by the Dungog Shire Council, HCRCMA, DECCW, landholders and community groups to enhance the biodiversity with the Williams River. It is noted the following remediation works have been undertaken within the Williams River catchment: experimental re-introduction of woody debris, replanting of riparian vegetation, improvements in fish passage

and bank armouring and stabilisation.

The proposed mitigation and offset strategies proposed by Hunter Water would complement the works already undertaken in the catchment and would include:

- Re-introduction of 10 kilometres worth of large woody debris into the Williams River to provide for enhanced geomorphic and habitat diversity
- Remediation of fish passage at four high priority barriers in the Hunter Catchment
- A five year community grants scheme for rehabilitation and management of wetlands, riparian zones and in-stream aquatic habitat within public lands
- Sponsorship of a comprehensive monitoring and research program including components such as habitat mapping, fish surveys, movement patterns and habitat utilisation monitoring, PIT tagging and large woody debris (LWD) monitoring.

Proposed monitoring would provide additional baseline data to assess impacts associated with the dam.

Current ecosystem condition

A large majority of submissions were concerned that the proposal would negatively impact the Williams River which is: (a) the last free flowing river in NSW; (b) a pristine river; and (c) the only remaining healthy river in the Hunter Catchment.

The Williams River has been regulated since 1967 with the construction of Seaham Weir at the downstream end of the catchment (approximately 14 kilometres upstream of the confluence with the Williams and Hunter River's confluence). Additionally, Chichester Dam on the Chichester River, a major tributary of the Williams River, was constructed in 1926. It is noted that construction of Tillegra Dam would provide additional regulation of the Williams River at the top end of the catchment, however, the river has already undergone many forms of regulation. The preferred environmental release regime would ensure the existing natural variability in flows of Williams River would be maintained.

The Williams River catchment has been highly modified for agriculture and urban development with cattle grazing as the main land use activity. The existing condition of the Williams River catchment is reflective of this land use activity.

There are three main urban areas occur along the length of the river: Dungog, Clarence Town and Seaham. The river channel has been substantially modified since the 1940s as a result of desnagging and other river training works. There are a number of barriers to aquatic movement, the most obvious of which are the Seaham Weir and Chichester Dam.

Field investigations undertaken as part of the environmental assessment provide an overview of the existing condition of the Williams River:

- The study area from above the proposed dam to the Seaham Weir pool shows signs of human activity with elevated nutrients (nitrate, nitrite and total phosphorus) and depressed dissolved oxygen relative to the ANZECC 2000 guidelines for the protection of aquatic ecosystems
- The macroinvertebrate results were generally near reference case for rural catchments, which is to say impacted by the surrounding agricultural land use
- The signal 2 scores indicate mild to moderate pollution, most pronounced in the pools. The relatively higher indices in riffle sequences would most likely be due to aeration.
- Remnant vegetation in the study area consists of thin strips of vegetation along waterways, scattered paddock trees and the occasional stand are the only available habitat in a rural landscape.

It is noted that rehabilitation works have been undertaken throughout the catchment. An extensive monitoring program has been proposed which would ensure the current health of the Williams River (in terms of water quality, aquatic and riparian ecology and fluvial geomorphology) would be maintained (refer Section 9 for further information).

Historic Williams River flows

A submission was concerned that the average quoted flow for Williams River, 95.5 GL/yr, has been skewed by the wet years of the 1950s and 1960s.

The EA Reports that the average flow down the Williams River at Tillegra is 95.5 GL/yr, which equates to around 261.5 ML/d. These averages are based on daily flow observations collected at the Tillegra Bridge gauging site for the period 1931 to 2008. It is acknowledged that the value presented is an average over the 77 years of data which incorporates high, medium and low flow periods. The average yearly flow ranges from 6 GL/yr in 1980 to 329 GL/yr in 1963.

4.4.8 Length of filling time

Submissions are concerned about the lack of clarity in regards to the filling time and the potential effect on the downstream ecosystem as a result of a prolonged filling time.

The duration of the filling phase would depend on a number of factors including local rainfall in the dam catchment and the environmental release strategy adopted. The EA provides two estimates of filling time, however, it is acknowledged that both estimates do not account for the preferred release strategy as this is currently unknown until formally approved by DoP and NOW.

The first estimate of filling time is provided in Section 3.4.2, Working Paper A of the EA Report which estimates filling time would range between three years (during wet periods) to nine years (during drought periods). It should be noted that this estimate takes into account evaporation from the storage surface but does not incorporate environmental releases.

A second estimate of the filling time, under three scenarios of five years duration, is provided in the Section 5.3.3, Working Paper D of the EA Report. Scenarios incorporate a high inflow period (1997-2001), a median inflow period (199-2003) and a low inflow period (2002-2006). The estimates of filling time were based on historic inflow records for the period 1989 to 2007 (period for which three hourly data was available), evaporation from the reservoir surface area and the base case environmental release strategy during years 1 and 2 of the filling phase (90/30 transparent translucent releases and 6 fresh events; peak of 270 ML/d for 1.5-2 days). Based on these estimates, after five years of filling the storage would be approximately; 87% full during a high inflow period; 66% full during an average inflow period; and 33% full during a low inflow period.

To mitigate impacts of reduced flows downstream of the storage during the filling period a minimum of six events in addition to the transparent releases would be made to simulate the movement of fresh events through the system. A fresh event would comprise a flow curve with a peak of 270 ML/d for duration of 1.5-2 days and would be preferentially released during Jan, Mar, Apr, May July or Aug to support downstream ecological processes such as fish spawning.

These 270 ML peak flow ‘fresh events’ were specifically incorporated into the projects Statement of Commitments to address short term impact that would otherwise be derived from extending filling times.

It is acknowledged that construction and operation of proposed Tillegra Dam would lead to some unavoidable environmental impacts particularly just downstream of the dam wall. For example, flood flows directly below the dam would be reduced but the effects of this reduce below the confluence of the Williams and Chichester Rivers. The inclusion of small fresh events as detailed and the event based run of river transfers would, however, significantly mitigate this issue. It is also noted that the dam does not need to be full for operational releases to be made. Under the adaptive management protocols adopted for the project higher flow releases could be considered should the filling period be prolonged.

4.5 Terrestrial ecology

Concerns raised about the terrestrial ecology component of the EA Report ranged from concern for specific threatened species in the study area to the inadequacy of proposed mitigation offsets and assessment methodologies. The main issues can be summarised as follows.

1 **Adequacy of the ecological methodology:** A number of respondents were concerned that the timing, scope and search effort of the terrestrial ecology surveys were inadequate and therefore give insufficient information for the EA Report. (Section 4.5.1)

2 **Impact on local fauna habitat and populations:** a large number of respondents were concerned that the proposed dam would reduce habitat for species such as the platypus, koala, stuttering frog and spotted-tailed quoll, and cause subsequent population decline. (Section 4.5.2)

3 **Loss of paddock trees and hollows:** a small number of respondents were concerned about the loss of paddock trees and their habitat value for birds and bats. (Section 4.5.3)

4 **Offsets to mitigate impact:** numerous respondents thought that the likely impact would be irreversible, significant and incapable of being offset. A number of respondents were resolute that the mitigation measures and proposed offsets were not adequate or capable of making up for the significant loss of habitat, species and communities. (Section 4.5.4)

5 **Loss of endangered ecological communities:** respondents were concerned about the loss of EEC within the dam inundation area. (Section 4.5.5)

6 **Terrestrial ecology management and monitoring:** a number of submissions provided suggestions for the management and monitoring of terrestrial impacts and others expressed concern about the lack of detail in the management plans and the lack or level of funding commitment. (Section 4.5.6)

7 **Seaham Swamp Nature Reserve:** one submission commented that the effect of the project on Seaham Swamp Nature Reserve, a significant breeding site for the cattle egret (*Ardea ibis*), has not been investigated in the EA Report. (Section 4.5.7)

8 **Groundwater Dependent Ecosystems:** the NOW submission commented that the EA terrestrial ecology studies did not adequately consider the Water Management Principles of the Water Management Act 2000 with respect to Groundwater Dependent Ecosystems (GDEs). (Section 4.5.8)

4.5.1 Adequacy of the ecological methodology

A number of respondents were concerned that the terrestrial ecology information gathered for the EA Report would be insufficient because of the limited timing and scope of the surveys. Factors such as geographical scope, search effort and timing of the terrestrial and aquatic surveys were project challenges that were identified and acknowledged in the EA Report.

Specifically, the inundation area of the planned dam is approximately 21 km^2 (2,100 ha) and the study area, including potential road routes, was approximately 40 km^2. A complete survey of every square metre of this area to document all flora and fauna living within the area would take several years. As a consequence a sampling (as opposed to surveying) approach was taken.

Sampling is a routine technique used with a number of scientific disciplines, the social sciences and medicine to understand an issue. Vary rarely is it practical to undertake a complete census. To ensure limitations on the sampling approach were managed, the field surveys were based on industry standards and concentrated on target priority areas, ensuring that the assessment methodology provided a representative sample of all habitat types in the study area.

Seasonal aspects of flora and fauna surveys

Field surveys of fauna and flora were undertaken over several days in November 2007 and January 2008. It has been suggested that these surveys were not sufficient to identify the full range of native flora and fauna species due to the effect of season on the outcomes of the survey.

It is acknowledged that some species of Australian fauna and flora do respond broadly to a variety of different

factors (particularly weather and disturbance) and can also be highly ephemeral, transient and cryptic. Therefore, all flora and fauna surveys, no matter how comprehensive, are only ever a snapshot of the times when they are carried out, and it is acknowledged that this is also the case with the Tillegra Dam EA terrestrial ecology studies.

While it is recognised that ecological surveys should ideally cover four seasons and this would have been preferable for the EA, the majority of the area to be impacted by the project through inundation, some 1,821 ha - approximately 90% of inundation area - contained predominately highly disturbed pasture land with the occasional scattered paddock tree. It was reasonably considered that the likelihood of these areas containing transient, ephemeral or cryptic species of any note, which could not be observed in the late spring and summer sampling survey, was very low. The fieldwork was also supplemented by other sources of information including existing studies carried out in the region, and targeted surveys in areas of known likely habitat by experienced ecologists.

4.5.2 Impact on local flora, fauna, and habitat

Many respondents were concerned that the proposed dam would further fragment and isolate habitats for threatened species. Concerns were also raised that some species would be specifically detrimentally impacted, such as the koala, platypus, stuttering frog, and spotted quoll.

The EA Report specifically noted that the proposed dam would inundate vegetation and fauna habitat. This would further impact on a number of flora and fauna species. Indeed, a total of 157 fauna species and 315 flora species were identified as occurring within the inundation area with this described in Chapter 11 of the EA Report.

Within the scope of the proposed action however, the impacts on local flora, fauna and habitat is not considered to be significant. Further the long term viability of any species, population or ecological community was determined not to be impaired by virtue of the project proceeding.

The management of impacts to fauna habitat and individual fauna during construction would be managed with a Construction Environmental Management Plan. This plan would include detail of mitigation measures such as pre-clearing surveys, relocation of hollow logs and woody debris, and the engagement of a wildlife handler during construction. These and other mitigation measures such as offsetting (described later in this chapter) would reduce and monitor any impact on flora and fauna during construction.

Koalas

Respondents felt the proposal posed an unacceptable impact on koalas by the destruction of their local habitat and removal of a local breeding population with the potential to risk local extinction.

Koala records and the sightings noted in Working Paper E (last paragraph, page 89) are associated with patches of vegetation on upper slopes and ridges. These include the Tillegra Travelling Stock Reserve (site 4), the patch of vegetation on the ridge to the north (site 3, near the northern abutment of the proposed dam), in the consolidated carbon and biodiversity corridor (site 14) at the top of a line of vegetation which would form part of an exit corridor and on the southern flanks of Mount Toonumbue at the margin of the combined corridor.

The koalas most likely to be displaced by the proposal would have their territories centred on the Tillegra Travelling Stock Reserve (about 30 ha) and the patch of vegetation on the ridge just to the north (approximately 10 ha). Depending on the sex, age dominance distributions of the individuals and the quality of the habitat there may be 3-5 animals directly affected.

While some overlap between females is tolerated, and a male's home range may overlap with several females, any offspring would be forced out of these two small patches into the surrounding rural landscape. It is very unlikely that there are any home ranges based entirely in the scattered paddock trees in the remainder of the proposed footprint. These sub-adult recruits would establish a home range centred on another larger group of trees, often moving for considerable time and distances (40 to 50 kilometres).

Given that only 3-5 koalas are likely to be affected, their home range and dispersal behaviour, it is considered improbable that the project would directly contribute to the removal of a local breeding population and causing the koala to become extinct within the locality.

Within the Project Statement of Commitments, it is also noted that a substantial area of Hunter Water-owned land currently cleared for agriculture but outside the proposed inundation area would be planted with trees, allowed to regenerate naturally or be otherwise protected with the intent that this would provide additional habitat in the future for the koala, as well as other native fauna. As this habitat would be of exactly the same type and quality of that lost as a result of the Project, it is expected this would result in the establishment of enough habitat to support a population in excess of 200 koalas depending on the exact quality and type of trees established. The Project is therefore expected to have a net positive effect over the longer term for this species.

Platypus

Chapters 10 and 11 of the EA Report and Working Paper E (Section 4.7 page 90) acknowledge that there would be a significant impact on an estimated 40 platypuses. The principal mechanism would be via removing their home ranges along the 19.2 kilometres of river to be inundated. The proposed dam structure would also sever the connection between upper and lower reaches.

Many submissions refer to the size of the local platypus population. One response included repeated observations in several pool riffle sequences in or near the proposed dam area, which were a well presented and credible account of multiple sightings of several individuals.

Working Paper E estimated that the proposal would directly affect approximately 40 individuals. This is consistent with upper estimates in available literature - assuming good quality habitat similar to that in the cited studies - along the entire reach of the proposed inundation area. Dr Grant, a recognised platypus expert in NSW, who was consulted on the original assessment work, has made a submission noting that the inundation area almost certainly supports the estimated 40 animals and in actual fact there could be more. Potentially up to 2-3 animals per kilometre within parts of the river that has good quality riparian habitat.

Hunter Water acknowledges that it is not possible to prevent all impacts to the platypus population that reside within the proposed inundation area. This occurs as the habitat within the reservoir area would be irretrievably altered into a large lacustrine environment which is not ideal for the species and this habitat cannot be replaced or offset. Accordingly, some impacts would need to be accepted in the trade-off against the social and economic benefits of the project.

While impacts cannot be prevented in totality, Hunter Water has made a number of commitments to reduce potential impacts to platypus populations. These include:

- Riparian rehabilitation in a new national park and in tributaries upstream of Chichester Dam (as described later in this section)
- Strategic placement of woody debris within feeder creeks entering the storage to improve general bank stability and aquatic habitat within the storage
- Possible translocation of individuals from the directly affected area of the impoundment, where such work would not create an issue with genetic diversity and the overall integrity of the receiving population, and also where existing individuals would not be displaced within the receiving environment. Hunter Water has noted that it does not consider this to be a mitigating strategy relevant to habitat loss but it could lessen potential impacts on individual platypus that would otherwise be affected through displacement from the river during the first filling of the storage

It is noted that environmental flows from the dam would replicate low and moderate flows within the Williams River. Normal high flows and floods, although suppressed, would continue to occur below the dam wall. This would ensure that individuals elsewhere in the river would not be adversely impacted.

Respondents have expressed concerns that platypuses would struggle to maintain condition in cold water in the storage and downstream of the dam. This would not occur however, as within the storage, water above the thermocline, temperature would match existing waters or may in fact be warmer, particularly in the top few metres of water during summer. During winter, the storage is likely to be well mixed, with a stable temperature

similar to the existing river. The proposal also includes a multilevel off-take which would permit close thermal matching to receiving waters downstream. Releases and downstream temperature would be monitored to ensure that ambient water temperatures are maintained in the river.

It is also noted that the platypus has a very wide natural distribution which includes near-freezing water. Further, there are records of platypus both above and below Chichester and Lostock Dams. This supports the view that local populations are able to adapt to the disturbance created through the construction of a major water storage.

Amphibians

The most active time for amphibians is during the spring and summers months. The ecological survey specifically targeted frogs as a fauna subset for specific investigation. In total, 16 species of frogs were found, all of which are relatively common.

Despite the fact that the initial frog surveys identified no threatened species of frog within the study area, Hunter Water made the decision to err on the side of caution and extend the assessment work with the engagement of an amphibian expert, Dr Arthur White from Biosphere Environmental Consultants. This action was taken by Hunter Water, as it was known from wildlife atlas records and general knowledge of the EA project team, that there was a potential, albeit small, for up to five endangered species of frogs to occur within the Williams River catchment. These species are the Booroolong frog, the green and golden bell frog, the green-thighed frog, the giant barred frog and the stuttering frog,

A full site inspection and habitat association was undertaken for these species by Dr White and his advice was that there was no or very limited potential for these species to occur within the site. This result was not totally unexpected as:

- The Booroolong frog is generally taken to be a western drainage species now generally restricted to the south west slopes of NSW. The potential to be found in an eastern flowing stream from the Great Dividing Range, such as the Williams River, is considered to be highly unlikely.
- Green and golden bell frogs are susceptible to infection from Chytrid fungus and generally persist only in areas where waters are slightly saline, which acts as a prophylactic control to the infection. The waters of the upper Williams are very low in salt and dissolved solids.
- The green-thighed frog and the giant barred frog have specific habitat requirements, none of which were found to exist within the inundation area.
- While there was potential for the stuttering frog to occur, the habitat was fragmented and limited. Further the stuttering frog is generally found at higher altitudes and seldom seen in rivers or streams unless they are fish free. They are also considered to be potentially threatened by Chytrid fungus and the noxious mosquito fish (or plague minnow), *Gambusia holbrooki*, both factors which are noted by the NSW Scientific Committee as key threatening processes. As noted, the Williams River is fresh water and the aquatic ecology survey found 12 species of native fish species to be present at the study site, as well as the mosquito fish.

Two submissions raised concerns about the stuttering frog. It was later alleged in the Newcastle local news in November 2009 that a stuttering frog had been found on the Tillegra Dam site in January 2009 and handed over to the No Tillegra Dam Group[2]. The frog was brought by the NTDG to Professor Michael Mahoney of Newcastle University for identification. In an interview on Newcastle ABC local radio on 16 November 2009, Professor Mahoney advised, however, that he was told that the frog had been found in the vicinity of upper Salisbury above the proposed inundation area. The presence of frogs in this area is not unexpected as resident populations are known to exist in the rainforest creeks of the higher altitudes around Barrington Tops and also within the nearby catchment of Myall Creek near Chichester Dam that flows to the Karuah River. These populations, however, would not be affected by the Project.

In summary, Hunter Water maintains the survey and assessment techniques to locate threatened frog species that may be affected by the dam project are valid and suitable for the purpose of the environmental assessment

[2] The Newcastle Herald, 16 November 2009

process. As mentioned in the EA Report, the likelihood of any threatened frog species existing within the study area is extremely small. There are only two locations of suitable remnant habitat, which are small and fragmented, and all the evidence suggests that any previously existing population in these habitats may have already disappeared as a result of historical changes to the habitat such fragmentation, drought, and flooding.

Other environmental factors, such as the existence of the mosquito fish, *Gambusia holbrooki,* and the potential for *Chytrid* fungus to occur, indicates strongly that any past population of threatened frogs within the river have previously been impacted to such an extent that construction of the dam is unlikely to impact their population status.

Spotted-tail Quoll

A number of respondents felt that spotted-tail quoll (*Dasyurus maculates)* would lose habitat due to the proposal. While a number of recorded sightings exist within the study area, this species was not detected during the field surveys. Some potential small remnant habitat areas for the species was located within the study area. However, given the large home range of the species, it was considered more likely that it would occur in larger tracts of bushland north and south of the subject site, including Barrington Tops National Park.

Given this large home range, and the tendency of the species to use multiple den locations within its large territory, it is unlikely that the loss of one den site for an individual would greatly affect the livelihood of the Spotted-tail Quoll. While the proposed dam may reduce general opportunities for movement across the landscape, given the available habitat nearby and the offset commitments to create a substantial carbon offset and biodiversity corridor and national park, no substantive impacts from the project are considered likely.

Orchids

One submission noted that orchids can be highly cryptic and that the ecological field work would not have been able to identify all orchids within the inundation area. It is accepted that this may indeed be the case and it was specifically noted in the EA Report technical paper that several years can in fact be required to successfully identify all species.

However, Hunter Water argues that this does not invalidate the environmental assessment because: (i) orchid species such as the hyacinth orchid, *Dipodium punctatum,* were found during surveys, and (ii) likely impacts on threatened orchids such as the tiger orchid, *Cymbidium canaliculatum,* and the leafless tongue orchid, *Cryptostylis hunteriana,* were considered and found not likely to be impacted.

With the majority of the project area subject to grazing for over a century, the frequency and abundance of ground dwelling orchids in the inundation area is likely to be severely limited. There is, however, the possibility of epiphytic orchids occurring within the River Oak riparian community, although subject species are not considered to be endangered.

Hunter Water would therefore commit to arranging the translocation of epiphytic orchids from the riparian zone (should they occur) to above the full supply level of the dam, or to other suitable locations within close proximity such as Chichester Dam, subject to approval by the NSW Department of Planning with the concurrence of the DECCW. A number of samples could also be collected for any interested botanic garden, as well as moved to and incorporated into tree planting and landscaping works proposed for visitor areas below the dam wall.

Other species

A submission noted that no snake species were found during the assessment. It is noted in the EA Report that during ecological surveys, there was a concerted effort to survey for all reptiles and in fact fourteen lizard species were recorded and one unidentified snake skin. The EA Report also noted that brown snakes may be expected in the inundation area.

Snakes are generally relatively fast moving and avoid contact with humans. The surveys were carried out during the warmer months of the year when snakes are at their most active but they are not readily captured in pit traps or traps. A lack of coarse woody debris or other structure on the ground, which is often the case in

agricultural landscapes, can lead to a scarcity in their numbers and opportunities for finding them. Any snakes that may be within the inundation are expected to relocate to higher ground as inundation occurs.

One respondent noted concern about loss of habitat for the bandicoot (particular species not named). There are about six species of bandicoot in Australia, only one of which was likely to be found within the study area. This bandicoot species, *Perameles nasuta,* the common long nosed bandicoot, was in fact observed in the vicinity of the travelling stock route where the dam wall would be constructed. This species is common and widespread throughout NSW, particularly in coastal areas. While a small area of habitat would be lost during the construction period, impacts on this species would be insignificant.

Other respondents were concerned about the proposal negatively impacting on the habitat and population of the regent honeyeater (*Xanthomyza Phrygia*) and the swift parrot (*Lathamus discolour*). Working Paper E discussed in detail the likelihood of the proposal greatly affecting the lifecycle of either the regent honeyeater or the swift parrot and determined it unlikely. In addition, no records of either species exist for the study location, re-affirming that no impacts are expected.

One respondent was concerned that habitat loss during the construction of the new Salisbury Road had not been considered during the EA Report. Hunter Water reiterates that the ecological assessment aimed at characterising the flora and fauna within the entire study area by sampling within all different vegetation types. Furthermore, the route selection process for the road has been undertaken in a manner to ensure that the road alignment misses all major vegetation remnants to the greatest extent possible.

The final Salisbury Road alignment was arrived at after consideration of a number of options and community consultation. It provides a safe road for motorists while refining the alignment to avoid highly vegetated areas and maximising the effectiveness to fauna of the proposed carbon offset and biodiversity habitat corridor. While all due care has been taken to choose the most suitable route, some minor subsequent loss of habitat during the construction of the new road is unavoidable but is considered to be insignificant and compensated by the offsetting strategies proposed for the overall project.

4.5.3 Loss of paddock trees and hollows

A number of submissions noted that paddock trees contained important environmental attributes such as hollows for fauna to nest within. The removal of hollow bearing trees is a significant issue for native fauna that depend on these trees for shelter and breeding.

The loss of hollow bearing paddock trees is considered to be an unavoidable consequence of the project. Hunter Water has, however, committed to installing a variety of different shaped and sized nest boxes within vegetation established around the storage. These nest boxes would be installed in consultation with DECCW, and they would be maintained for the life of the project, given that it would take a very long time for trees to reach a similar level of maturity where hollows were generated.

While preservation of hollow bearing trees would be preferable, the installation of nest boxes and relocation of hollow logs and other material above the full supply level of the dam is considered an adequate approach in the circumstances to address and mitigate this issue.

4.5.4 Offsets to mitigate impact

A number of submissions indicated that in their view, offsets proposed within the EA Report would not be suitable in mitigating environmental impacts, particularly by not achieving a suitable level of offsetting that could be considered to be ‘like for like’. A number of submissions were also received recommending alternate offsetting arrangements be adopted.

Originally within the EA Report, a proposal was put forward to create a 1,680 ha carbon offset and biodiversity corridor. The corridor consisted of a nominal buffer of at least 50 metres width around the entire storage, with additional land subsequently dedicated to a corridor along the eastern margin of the storage. This created a significant swath of vegetation in the landscape promoting a wildlife corridor between the Barrington Tops and remnant riparian vegetation below the dam.

The corridor was designed to maximise the greatest community benefit possible from the investment of approximately $30 million dollars. While the corridor was designed to primarily offset carbon emissions, improve landscape habitat connectivity and provide biodiversity outcomes, the secondary benefits included catchment protection, improved water quality within the proposed reservoir and a spatial extent within which to install infrastructure supporting public access. Public access opportunities were proposed to be managed by a management plan that and included low impact, passive recreational activities such as bushwalking, hiking, swimming, fishing and boating.

The EA Report for the proposal had acknowledged that a 'like for like' outcome could not be obtained within the corridor for riparian vegetation, however it was considered that an acceptable if not better conservation outcome would occur within the circumstance of the planned corridor as it would;

- Replace and exceed the impacted area by about a factor of 10
- Conserve other important vegetation types such as sub-tropical rainforest EEC
- Be augmented with sponsored riparian plantings on private land downstream of the dam to provide a 'like for like' component within the overall offset package.

Several million dollars had been earmarked for sponsored riparian plantings downstream of the dam wall that would have re-established riparian vegetation to the same extent of that lost by virtue of the project proceeding. This work would have also promoted geomorphological stability of the river and improved the aquatic environment within the remainder of the river.

It is noted, however, that some submissions have re-iterated the fact that the proposed corridor would not provide an adequate offset for riparian vegetation on a "like for like" basis and further it is the view of several government submissions that the corridor would not provide for a better conservation outcome.

Accordingly, Hunter Water has revised the carbon and biodiversity offsetting proposal to align more closely with DECCW's *Principles for the use of biodiversity offsets in NSW* and removed the uncertainty that was considered to be related to the proposed sponsored tree planting program on private land, as requested by at least one of the government submissions.

The original carbon offset and biodiversity offset consisted of dedicating or undertaking works on a total area of 1,822 ha. This included preserving 470 ha of existing vegetation on land owned by Hunter Water, rehabilitating 1,207 ha of cleared farmland owned by Hunter Water and sponsoring 145 ha of riparian planting works on private freehold land.

The revised commitment made by Hunter Water in order to address the concerns is the dedication of a 1,323 ha national park to the NSW Government that contains riparian and river flat floodplain suitable for rehabilitation with eucalypt forest.

This commitment would:

- Provide certainty that quantifiable on-ground environmental works would be delivered in riparian areas of the Williams Catchment. Hunter Water would perform the rehabilitation work prior to the land being transferred to the NSW Government. In co-operation with DECCW, the work would be undertaken over a five year period prior to DECCW assuming operational control.
- By siting the proposed national park at Chichester, provide an area that complements other government initiatives, such as the Great Eastern Ranges Initiative (GERI – Alps to Atherton) corridor, in order to contribute to broader ecosystem resilience planned for Eastern Australia in response to potential climate change impacts on natural systems.
- Strengthen and contribute to the expansion of the existing Barrington Tops National Park and the World Heritage concurrently designated Gondwana Rainforests of Australia (formerly the Central Eastern Rainforest Reserves of Australia or CERRA).

The dedication of the land would shift the offsetting focus to the consolidation of the proposed carbon and biodiversity corridor on the eastern side of the reservoir to provide a more contiguous linkage between the Barrington Tops national park and the riparian vegetation downstream of the proposed dam site, that currently represents the main habitat corridor for native fauna within the Williams Catchment.

The buffer area around the proposed reservoir to promote catchment protection, water quality and sustainable activities in the vicinity of the dam would be retained. The total 2,800 ha of land that would need to be allocated to facilitate the revised proposal is described as follows;

- The total area of the national park proposed is 1,323 ha
- The proposed national park includes an area of 97 ha of river flat floodplain suitable for rehabilitation with EEC *River-flat Eucalypt Forest on Coastal Floodplains*
- A consolidated carbon and biodiversity offset corridor containing 709 ha of land
- Retention of the 50m buffer area around the dam shoreline between FSL 152.3 and RL154 m. This contains an area available for tree planting or natural regeneration of approximately 768 ha.

The DECCW offsetting principles, in summary form, include the concept that:

- Impacts must be avoided first by using prevention and mitigation measures
- All regulatory requirements must be met
- Offsets must never reward ongoing poor performance
- Offsets should complement other government programs
- Offsets must be underpinned by sound ecological principles
- Offsets should aim to result in a net improvement in biodiversity over time
- Offsets must be enduring
- Offsets should be agreed prior to the impact occurring
- Offsets must be quantifiable
- Offsets must be targeted – they must offset impacts on a like for like or better basis
- Offsets must be appropriately located – they must offset impacts in the same region
- Offsets must be supplementary – beyond existing requirements and not already funded by another scheme
- Offsets and their actions must be enforceable.

Hunter Water believes the new proposal addresses these principles by:

- Complementing other government programs such as the GERI project, designed to produce significant biodiversity conservation outcomes
- Underpinning sound ecological principles by including and promoting the protection biodiversity at multiple levels, from genetic to ecosystem levels, including several endangered ecological communities (EEC)
- In the longer term allowing for extensive tracts of native vegetation to be regenerated and established by about a factor of 12, including a large area of river flats providing a 'like for like' component within the offsetting proposal
- Both the proposed national park, which would be owned and managed by DECCW, and the offset corridor and buffer, which would be owned and managed by Hunter Water, would be enduring. Revocation of a national park in NSW would generally require an Act of parliament to be passed and land managed by Hunter Water directly within a catchment area of a dam must be maintained to meet legislated requirements for managing drinking water and public health risks
- The offset requires the approval of DoP and DEWHA in their roles as determining authorities
- The revised offset proposal is targeted, it includes a 'like for like' component and due to its optimisation to complement other government initiatives, it provides for a 'better' conservation outcome
- The revised offset proposal is appropriately located within the Williams Catchment and would contribute to the ongoing environmental health of the entire River system in lieu of the other possible benefits that may have accrued through the proposed sponsored tree planting program
- The revised offset proposal is supplementary to any existing requirement. For example, Hunter Water is under no obligation to offset carbon emissions under either State or Commonwealth legislation and the

creation of the carbon and biodiversity corridor offset is entirely voluntary, designed to manage project specific impacts in the most efficient and advantageous manner possible. Hunter Water believes the approach of maximising the utility of the carbon and biodiversity offset proposal in tandem, is preferable in this specific case to investing in plantation forestry. Plantation forestry may provide excellent economic benefits to the community, however, more value is obtained from maintaining a healthy catchment, including terrestrial and aquatic ecosystems

- The offset proposal is enforceable with reference to the planning approval process within NSW and, in addition, possible approval conditions that may be issued under the EPBC Act.

With the exception of the rehabilitation of the river flats and establishment of the walking / hiking trail for which Hunter Water is willing to fund (the twin dams walk proposed in the EA Report), all subsequent management actions and works undertaken over the longer term, where and if necessary, would be the responsibility of the DECCW within the national park.

Therefore, without detracting from the importance of all available habitats that would be lost in a fragmented rural context, the most effective means of retaining or improving ecosystem viability is in consolidating or buffering larger areas and providing connection between them. Hunter Water believes that the offset proposal would achieve this at a local, bioregional and national scale.

4.5.5 Loss of endangered ecological communities

There were some submissions that expressed concern the unknown long term impact of the project on EECs could result in further reduction in the local occurrence of ECCs and that the EA Report had failed to assess the importance of the EEC.

Hunter Water disagrees that the EA Report failed to assess the importance of the EEC. In fact, it is acknowledged in the EA that 0.2 ha of *Lowland Rainforest* EEC and 145 ha of *River-flat Eucalypt Forest on Coastal Floodplains* EEC would be inundated. This area represents 0.00008% of the *Lowland Rainforest* in the region and 0.7% of the *River-flat Eucalypt Forest on Coastal Floodplains* in the region. The EA Report notes that the loss of EEC is unavoidable and would be mitigated through the offset program.

The proposed offset for the EEC loss is described above in Section 1.1.4. The offset proposal retains the upper portions of the gullies where the EEC *Lowland Rainforest* fragments occur and provides an area of 97 ha of river flat floodplain above Chichester Dam, as part of the proposed 1,323 ha national park, suitable for restoration and rehabilitation with EEC *River-flat Eucalypt Forest on Coastal Floodplains*.

4.5.6 Terrestrial ecology management and monitoring

A number of submissions provided suggestions for the management and monitoring of potential terrestrial impacts during construction and operation. A number of submissions were also concerned about the lack of detail in management plans and the lack of funding. One submission was concerned that the weed and pest management plans lacked detail and funding commitment.

Hunter Water reiterates its commitment to environment management the provision of appropriate environmental monitoring programs. Details of environmental management plans (EMP) for terrestrial ecology are outlined in the Statement of Commitment and summarised below. An EMP is expected to form part of the conditions of approval for the Project if approved and the final EMP would be subject to approval by DoP and DECCW.

Construction environmental management plan

A construction CEMP would be prepared prior to commencement of construction and require approval by DoP with concurrence from DECCW. It would include sub plans and focussed specialist procedures that would address vegetation management, fauna management and weed management. Areas of sensitive vegetation would be identified and fenced off by ecologist(s) prior to any work commencing.

In addition to these measures, wildlife handlers would work with the ecologist(s) at least a week before any clearing begins. They would then be present during clearing to ensure fauna are allowed to leave the area and should the need arise for fauna observed during felling or injured on the ground, the handler would:

- Coordinate with plant operators to stop at a safe point
- Facilitate passive relocation
- Rescue and actively relocate those in immediate danger
- Retrieve injured animals for care and safe relocation.

Rescued or actively relocated animals would be held briefly for observation to ensure they do not return to danger then released into the exit corridors or other suitable habitat. In the unlikely event of an accident injured animals would be treated until ready for release in cooperation with local wildlife carers.

Weed management in the proposed clearing areas would begin well in advance of all other works to ensure that mulch and logs to be reused would not contain unviable material.

Environmental management

The object of the EA was to assess the impact of the Tillegra Dam proposal, attempt to minimise that loss, then manage or offset the remainder.

The loss of habitat in the inundation area is unavoidable. The thin strips of riparian vegetation along the Williams River and its tributaries, scattered paddock trees and the occasional stand of trees are the only available habitat in an otherwise rural landscape.

Given the location, size and nature of the dam proposal theses impacts cannot be avoided or greatly reduced, however it is proposed to manage and offset these effects with 'like for like' or better as stated previously.

4.5.7 Seaham Swamp Nature Reserve

One submission commented that the EA Report did not assess the impact of the Project on the Seaham Swamp Nature Reserve which is located near the Seaham Weir. The swamp is located adjacent to the Williams River and connected to the river through two artificial drains. The hydrology of the site is generally controlled by its own subcatchment. Further, it is noted that the reserve is located downstream of Seaham Weir.

The Project would have no material effect on the Seaham Swamp Nature Reserve for the same reasons as presented in the EA Report with respect to consideration of potential impact on the Hunter Estuary Ramsar Wetlands. Accordingly, specific assessment of potential impacts on this reserve is not considered necessary.

4.5.8 Groundwater Dependent Ecosystems

The NOW submission commented that the terrestrial ecology studies did not adequately consider the Water Management Principles of the *Water Management Act 2000* with respect to GDEs.

It is noted that the NSW GDE policy does not state that all GDEs must be preserved as indicated in the submission, rather policy promotes their overall conservation and the preservation of the most sensitive ecosystems.

The EA Report acknowledges the unavoidable loss of 145 ha of *River-flat Eucalypt Forest on Coastal Floodplains*, which may be considered as groundwater dependent EEC. Therefore, in order to ensure that such vulnerable and valuable ecosystems are protected as best as possible (in keeping with the intent of Principle 1 of NSW GDEs), Hunter Water has proposed an offset of 97 ha of local river flat floodplain above Chichester Dam, as part of the proposed 1,323 ha national park, for restoration and rehabilitation with EEC *River-flat Eucalypt Forest on Coastal Floodplains*.

In addition, the Terrestrial Ecology Working Paper E (Section 3.1.3, page 38) noted that:

> The Final Determination states that the (*River-flat Eucalypt Forest on Coastal Floodplains)* EEC has a tall open tree layer of eucalypts. The tree layer in some sections of riparian vegetation along the rivers and creeks consists entirely of river oak (*Casuarina cunninghamiana*) with eucalypts absent. This form is regarded as a variant of the EEC, since *C. cunninghamiana* is stated as being characteristic of the small tree layer, even though stands of this species are quite tall (at least as tall as the eucalypts) in the study area. … The EEC is stated as occurring on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Floodplains are defined in the Final Determination as 'level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less' (NSW Scientific Committee 2004a). It could be argued that riparian zone disturbance since European settlement may have reduced the frequency of flooding of the upper Williams River to less than once in 100 years as postulated in studies cited by Gippel and Anderson (2008). This being the case, the community would not be on a true floodplain according to and required by the definition in the Final Determination.

Preliminary HEC-RAS hydraulic modelling indicates that at least half of the 145 ha does not in fact actually flood and accordingly, does not constitute an EEC. However, from a conservation perspective there is no value downplaying the value of the riparian vegetation and *River-flat Eucalypt Forest on Coastal Floodplains* EEC that would be lost. Hunter Water believes that the significance of the loss would be negated by the 97 ha offset, which would provide a unique opportunity to replace the EEC at a local level. The additional national park offset proposal would also contribute to wider biodiversity conservation targets and values identified under NSW Government policies.