

# Ord River Irrigation Area - Weaber Plain Development Project

Aquatic Fauna Management Plan

Approved by DSEWPaC on  
**1 February 2013**

Prepared for  
LandCorp  
by Strategen

December 2012



**STRATEGEN**  
environmental consultants



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December 2012

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# 1. Introduction

This Aquatic Fauna Management Plan has been prepared to ensure appropriate management measures are in place to protect particular *Environmental Protection and Biodiversity Act 1999* (EPBC Act) listed threatened species which have the potential to be affected by the Weaber Plain Development Project (proposal).

## 1.1 Project background

The Western Australian Government intends to develop an area of land for irrigated agriculture across the Weaber Plain in the Kimberley region of Western Australia, approximately 30 km north – northeast of Kununurra and adjoining the existing Ord River Irrigation Area. Key components or environmental aspects of the proposal relevant to aquatic fauna management include:

- contaminated stormwater runoff (agricultural fertilisers and agrochemicals) via Border Creek into the Keep River may affect water quality and lead to habitat degradation particularly during low river flow
- discharge of excess abstracted groundwater to the Keep River during high river flows may affect water quality and lead to habitat degradation
- discharges to the Border Creek and the Keep River discharge area, may increase erosion especially during periods of surplus stormwater runoff
- increased human activity may increase the spread and introduction of aquatic weeds, pests and plant pathogens in to the Border Creek and Keep River
- increased contribution of groundwater to low river flows in the Keep River.

The proposal will require land clearing for farms, sourcing of road building materials, construction of the main M2 channel and smaller distribution channels to service agricultural lots, roads, power supply infrastructure, and stormwater management, groundwater management, drainage and flood protection infrastructure. The proposal also involves release of irrigation water from Lake Argyle, which will be conveyed via the Ord River and Lake Kununurra and gravity-fed to the proposed area via the M2 channel.

## 1.2 Commonwealth approval

The Australian Government determined in June 2010 that the project required approval under the EPBC Act as the proposal was considered to have the potential to impact on a number of matters of National Environmental Significance (matters of NES). The proposal was assessed and has been approved, subject to a number of EPBC conditions, issued on 13 September 2011.

## 1.3 Purpose and scope of management plan

The purpose of this management plan is to address the protection of listed threatened aquatic fauna species in the Keep River prescribed in Condition 10 of EPBC Act Approval 2010/5491. Those specifically mentioned in the condition include:

- the critically endangered Speartooth Shark (*Glyphis glyphis*)
- the endangered Northern River Shark (*Glyphis garricki*)
- the vulnerable Dwarf Sawfish (*Pristis clavata*)
- the vulnerable Freshwater Sawfish (*Pristis microdon*).

This plan has been prepared for the proposal and addresses each requirement of Condition 10 of the EPBC approval (see section 1.4). It outlines specific protective and monitoring measures that will be implemented for the protection of the listed species and requires approval from the Minister for Sustainability, Environment, Water, Population and Communities prior to the clearance of farm lots and must be implemented under Condition 10.

The prevention and management of impacts to listed threatened aquatic fauna is addressed in detail in the Groundwater Management Plan (Strategen 2012a), the Stormwater and Groundwater Discharge Management Plan (Strategen 2012b) and Weed, Plant Pathogen and Pest Management Plan (Strategen 2012c). The purpose of these management plans are outlined in section 1.5.

## 1.4 Requirements of condition 10 of Commonwealth approval

The preparation of an Aquatic Fauna Management Plan is required by condition 10 in order to protect listed threatened species in the Keep River. Table 1 is a guide showing where each part or requirements of this condition have been addressed in this management plan.

Table 1 EPBC requirements

Item	EPBC requirement	Section addressed in this management plan.
10A	A targeted, non lethal baseline surveying program for listed threatened species that are likely to occur in the Keep River. This must include the critically endangered Speartooth Shark ( <i>Glyphis glyphis</i> ), the endangered Northern River Shark ( <i>Glyphis garricki</i> ), the vulnerable Dwarf Sawfish ( <i>Pristis clavata</i> ) and the vulnerable Freshwater Sawfish ( <i>Pristis microdon</i> ). The methodology of the baseline surveying program must be developed in consultation with the <b>Independent Review Group</b> . Surveys must be conducted over a period of 3 years and must be undertaken in the four Keep River Pools (K1, K2, K3 and K4) and at least 3 sites in the Keep River Estuary.	See section 2.3.
10B	Details of water quality and flow requirements including relevant downstream environmental quality parameters, in accordance with ANZECC guidelines.	See section 2.3.
10C	A monitoring program in the Keep River pools to be undertaken to ensure water quality and flow does not exceed trigger values.	See section 2.3.
10D	Details of an outcome based risk assessment which utilises data collected during the baseline monitoring program to determine the potential for risk to listed species at an individual and local population level.	See section 2.3 and 2.4.
10E	Details of management objectives, management actions, performance standards and contingency measures to mitigate impacts on listed aquatic fauna species in the Keep River.	See section 2.3.
10F	Regular and ongoing inspection of the Border Creek and Keep River for weeds, plant pathogens, and pest animals and methods to prevent the introduction and provide for quick control of weeds, plant pathogens and pest animals in the Border Creek and Keep River as a result of the action.	See section 2.3. The proponent has control of these potential issues within the proposal area and will implement a range of management measures (State and Australian Government requirement of conditions). The majority of the development area is surrounded by buffer area and interface issues associated with weeds will be managed. The proponent does not control activities on land surrounding Border Creek and Keep River but will implement controls within the proposal area to contain impacts.
10G	A targeted aquatic fauna monitoring program to be undertaken to measure the success of management measures to inform an adaptive management approach.	See section 2.3.
10H	Protocols and timelines for review and reporting to the Department.	See section 2.5 and 2.6.

## 1.5 Relationship to other management plans

Other current Weaber Plain Development Project management plans which prescribe controls on environmental aspects of this project that may potentially affect aquatic fauna include:

- Groundwater Management Plan (Strategen 2012a)
- Stormwater and Groundwater Discharge Management Plan (Strategen 2012b)
- Weed, Plant Pathogen and Pest Management Plan (Strategen 2012c).

The Groundwater Management Plan outlines a number of measures to prevent, avoid or minimise groundwater rise and potential associated salinity issues as well as control excess groundwater seepage to Keep River at K4 pool and reduce requirements to pump groundwater and discharge to Keep River.

The Stormwater and Groundwater Discharge Management Plan outline a number of management measures to avoid, prevent or minimise impacts on water quality from discharges to Keep River and Border Creek that may in turn potentially affect relevant listed threatened species potentially inhabiting Keep River.

The Weed, Plant Pathogen and Pest Management Plan outlines proposed management and monitoring measures to reduce the spread and introduction of new species of aquatic and terrestrial weeds into the Weaber Plain and Border Creek/ Keep River system to avoid impacts on the habitat of listed threatened species.

## 1.6 Description of factor

There are four aquatic species that are listed threatened aquatic species that have been recorded or are considered likely to occur in the Keep River due to the nature of the environment and are specifically addressed by Condition 10 (Table 2). These include:

- the critically endangered Speartooth Shark (*Glyphis glyphis*)
- the endangered Northern River Shark (*Glyphis garricki*)
- the vulnerable Dwarf Sawfish (*Pristis clavata*)
- the vulnerable Freshwater Sawfish (*Pristis microdon*).

Table 2 Matters of NES summary

Species & Status	Habitat	Likelihood of occurrence in the Keep River	Current key threats to species	Potential threats from development
Speartooth Shark <i>Glyphis glyphis</i> Critically endangered	Records suggest they occur in tidal rivers and estuaries, indicating that large tropical river systems appear to be the primary habitat for this shark. However they have also been found in varying levels of salinity from very low to that similar to seawater. Speartooth sharks are known to migrate inshore to breed. There are roughly around 250 remaining individuals in the wild.	There have been no known sighting or records in the Keep River; however, given the nature of the available habitat it is possible they occur.	Gillnetting, recreational fishing and habitat degradation.	Discharge of stormwater and excess groundwater and increased groundwater seepage to K4 pool. In particular low river flows pose the greatest risk. Introduction of aquatic pests and weeds may affect the quality of habitat.

Species & Status	Habitat	Likelihood of occurrence in the Keep River	Current key threats to species	Potential threats from development
Northern River Shark <i>Glyphis garricki</i> Endangered	Northern River Sharks are found in lower reaches of larger tropical river systems, macrotidal bays and inshore marine habitats. It has previously been sighted in the Adelaide and East and South Alligator River systems, the Kimberley Coast and King Sound.	There have been no known sighting or records in the Keep River; however, given the nature of the available habitat, it is possible they occur.	Gillnetting, recreational fishing and habitat degradation.	Discharge of stormwater and excess groundwater and increased groundwater seepage to K4 pool. In particular low river flows pose the greatest risk. Introduction of aquatic pests and weeds may affect the quality of habitat.
Dwarf Sawfish <i>Pristis clavata</i> Vulnerable	Is predominantly found in shallow waters (2-3m) in coastal and estuarine areas of tropical Australia, extending some distance into freshwater. It has been sighted in several catchments including the Keep River, Victoria River, Buffalo Creek, Rapid Creek and South Alligator River. A study in north-western Australia found that estuarine habitats are used as nursery areas (Thorburn <i>et al.</i> 2007, 2008). Adults are known to seasonally migrate back into inshore waters, (Peveall (2007) in DSEWPac, SPRAT 2010) although it is unclear how far offshore the adults travel, as captures in offshore surveys are very uncommon.	There are records from the upper Keep River estuary.	Gillnetting, recreational fishing and habitat degradation.	Discharge of stormwater and excess groundwater and increased groundwater seepage to K4 pool. In particular low river flows pose the greatest risk. Introduction of aquatic pest and weeds may affect the quality of habitat.
Freshwater Sawfish <i>Pristis microdon</i> Vulnerable	Can potentially occur in all large rivers of Northern Australia, ranging from the Fitzroy River in Western Australia to the western side of Cape York Peninsula, Queensland. This includes the Keep River. They spend the first three–four years of their life in freshwater and as they reach maturity the large mature animals tend to prefer the coastal and offshore waters up to 25 m in depth.	There have been sightings in the Keep River estuary and in the Keep River in Pools K2, K4, and as far upstream as Policemans Hole in Keep River National Park.	Gillnetting, recreational fishing and habitat degradation.	Discharge of stormwater and excess groundwater and increased groundwater seepage to K4 pool. In particular low river flows pose the greatest risk. Introduction of aquatic pest and weeds may affect the quality of habitat.

These species are naturally uncommon species. Data are limited and there is still a high level of uncertainty of the ecology of these species. Nonetheless, these species are well adapted to living in highly variable environments of salinity, flow (tidal and season driven) and turbidity. The ability of these species to occur in such dynamic, constantly changing habitats indicate a high degree of adaptability, which suggests they will have a degree of tolerance to changes in water quality in the event of a potential impact.

### 1.6.1 Summary description of the Border Creek and Keep River

The major watercourse downstream of the proposal is the Keep River system. The Keep River has a catchment of approximately 319 000 ha (at Legune Road Crossing) and experiences highly variable annual flows (Kinhill 2000). Border Creek flows east from the Proposal area to join the Keep River downstream of Legune Road Crossing, contributing approximately 10% of the Keep River flows. Border Creek experiences only sporadic flows after heavy rainfall, with historical flow data recording no flows

between June and September (Kinhill 2000). The Weaber Plain contributes very little runoff to Border Creek and ultimately the Keep River except during prolonged heavy rainfall events. Catchment flow modelling also indicates that peak flows in the Keep River usually occur after peak flows from the proposal area. This delay ensures that on most occasions discharge from Border Creek is subsequently flushed by delayed flows down the Keep River. More detailed information on the water quality and flows in these systems is provided in the Stormwater and Groundwater Management Plan.

A three year baseline water quality monitoring program of the Keep River was initiated in 2010 and interim water quality trigger values have been developed (Bennett & George 2011; WRM 2011). Results from the 2010/2011 baseline water quality sampling program show large inter and intra seasonal variations in salinity and nutrient concentrations. During the early part of the 2010/2011 wet season the total nitrogen (TN) and total phosphorus (TP) concentrations reached up to 10–100 times the ANZECC & ARMCANZ (2000) guideline values in the Keep River (DAFWA 2011). This will likely reflect early wet season removal of accumulated nutrients from heavily grazed pastoral land on the Weaber and Knox plains.

Natural processes in northern rivers have been found to be responsible for seasonal aquatic fauna deaths. Episodic flows into isolated riverine pools after the dry season or after periods of no rainfall and low flow can result in the depletion of oxygen (as a result of eutrophication, high biological oxygen demand and a rapid increase in turbidity) and can lead to fish kills (ERISS 2001).

### 1.6.2 Stormwater discharge and tailwater management system

Irrigation tailwater and stormwater discharge associated with runoff from the proposal will be managed via a tailwater management system, representing current best practice in farm water management. This system comprises of tailwater from irrigated areas being collected, stored, conveyed and re-used on farms as part of irrigation water supply. During intense rainfall that generates surplus stormwater that exceeds the capacity of the tailwater retention system, the tailwater retention system will overflow and runoff to a designated point to flow into Border Creek.

### 1.6.3 Groundwater discharge

During the low river flow periods, any abstracted groundwater will be discharged into the irrigation channels and shandied with irrigation water from the M2 channel. The blending of abstracted groundwater will be managed to ensure that irrigation supply does not exceed the 480 mg/L Total Dissolved Solids (TDS) limit for irrigation supply. Recent modelling suggests that shandied irrigation water is more likely to have a TDS of 240 mg/L. If required to control groundwater levels, groundwater may be abstracted and discharged into the Keep River at the K1 pool during periods when flows in the Keep River are sufficient to ensure adequate dilution to below the salinity trigger value and provide subsequent flushing from the system. The indicative discharge location would be at the K1 pool or downstream in the Keep River Estuary. Other potential contingency actions, pending analysis prior to groundwater discharge, could include increased groundwater discharge to Ord Stage 1 or 2 channels as well as discharge to the lower Keep River Estuary. The discharge outfall will be designed to promote rapid mixing of the groundwater releases with the river water so that the mixing zone is minimised.

More detailed information on the management actions (including contingencies) to manage discharge of excess groundwater and stormwater is provided in the Stormwater and Groundwater Discharge Management Plan.

### 1.6.4 Groundwater seepage

Increased groundwater recharge from increased rainfall in the Keep River catchment over the past decade has resulted in increased baseflow and changes to water quality of the lower Keep River pools. Following above average wet season rains in 1999/2000, the Keep River at Legune Road Crossing has changed from seasonal, to perennial, with a baseflow of approximately 25 L/sec throughout the dry season. Modelling by KBR (2011) has been completed to facilitate predictions of where groundwater rise is expected to occur within the Proposal Area. Groundwater baseflow to the K4 Pool from the Weaber Plain has been modelled under baseline and several development scenarios (KBR 2011). The baseflow rate is

expected to further increase by approximately 63%, as a result of recent climate-forced groundwater level rise (KBR 2011). Under these natural conditions the baseflow salinity at the K4 Pool is likely to increase to 900 mg/L TDS, reflecting the naturally higher salinity of groundwater compared with residual surface water in K4. The modelled change in the future modelled baseflow into K4 Pool is expected to be between approximately 43% for development with no groundwater management (Scenario 2), and 8% for development with groundwater management (Scenario 3) (KBR 2011).

The model determined that the application of management measures to control groundwater level in the proposed action area will also be able to control the discharge of baseflow to the K4 Pool, and thus future changes to the baseflow are considered to be negligible in comparison to the natural changes that have taken place since 2000. Given at least 20 years of changed flow regime (2000-2020) as a result of natural climate – induced recharge, any additional minor change in baseflow compared to that of no development, and flexibility in the pumping regime to manage flows, indicates that the K4 Pool will not be significantly affected. Therefore, it is considered unlikely that the proposed action will have a significant effect on Matters of NES as a consequence of groundwater accretion in the Weaber Plain as a result of the proposal.

### 1.6.5 Weed, plant pathogen and pests

The purpose of the Weed, Plant pathogen and Pests sub plan is to prevent the introduction of declared and environmental weeds, plants pathogens and pests into the proposal area and alongside irrigation channels where such weeds, plant pathogens and pests may ultimately end up in the Keep River. This can potentially lead to an adverse effect on threatened aquatic fauna. No introduced aquatic animal or plant species were recorded in the M2 area during surveys (Kinhill 2000); however, due to the proposed installation of the irrigation channel, certain native aquatic plant species can potentially become a weed issue in irrigation channels, as has occurred in the existing M1 irrigation channel.

A total of 21 terrestrial weed species have been found in the M2 project area of which six are declared noxious weeds (Table 3). Of the declared species, none are aquatic plants, with *Sida cordifolia*, *Parkinsonia aculeate* and *Hyptis suaveolens* the only species favouring riparian zones. Prolific growth of submerged aquatic plants and algae may block the irrigation channels and affect the flow of water to irrigators and consequently is controlled by the Ord Irrigation Cooperative in consultation with the Water Corporation using the herbicide Acrolein (prop-2-enal) which is regularly applied as an algaecide and aquatic herbicide (Storey et al. 1997). The growth of vegetation in the channels, if not controlled, is considered an issue as it creates breeding areas for mosquitoes (Stanley 1972; Mackenzie and Broom 1999), hence any vegetation in irrigation channels is considered a weed and will be controlled as currently occurs in the M1 channel. Chemical control also minimises the potential for spread of aquatic weed species via the M1 or M2 channels. There are currently no known plant pathogens in the proposal area and eleven pest animals have been recorded (Table 4).

Table 3 Declared noxious weeds species recorded in the M2 project area

Botanical name	Common name	Category	
		WA	National
<i>Sida acuta</i>	Spinyhead sida	P1	N/A
<i>Sida cordifolia</i>	Flannel weed	P1	N/A
<i>Parkinsonia aculeata</i>	Parkinsonia	P1/4	A weed of national significance that is widespread in the Kimberley region
<i>Sorghum halepense</i>	Johnson grass	Prohibited	N/A
<i>Hyptis suaveolens</i>	Hyptis	Prohibited	N/A
<i>Acanthospermum hispidum</i>	Star burr, Goat's head	Prohibited	N/A

Table 4 Pest animals recorded, or may potentially occur, in the Weaber Plain project area and surrounds

Species name	Common name	Category
<i>Bos indicus</i>	Cattle	A1, A2, A3
<i>Bubalus bubalis</i>	Buffalo*	A1, A2, A3
<i>Bufo marinus</i>	Cane Toad	A1, A2, A3
<i>Felis catus</i>	Cat	Exempt
<i>Mus musculus</i>	House mouse	Exempt from declaration
<i>Rattus rattus</i>	Black Rat	Exempt from declaration
<i>Rattus villosissimus</i>	Long-haired rat	A7
<i>Sus scrofa</i>	Feral pig*	A4, A5, A6

\*Sighted in the Keep River National Park (WRM pers comm.)

Both the Ord and Keep River are considered to be free from feral fishes at this point in time and the only introduced aquatic species that may potentially invade the Keep River is the red claw (*Cherax quadricarinatus*), a freshwater crustacean which was unintentionally introduced to the Ord River in recent years (Thorburn 2011). Extended irrigation channels provide potential for the spread of this species into the Keep River System, although the species is not currently known to occur in irrigation channels, to date, there is no evidence of red claw in irrigation channels. This may be due to the use of acrolein to control vegetation in the existing channels, which is toxic to crustaceans, and may inadvertently control the occurrence of red claw in the M1 channel. The potential exists however, for red claw to be inadvertently introduced to the Keep River via recreational fishers who collect red claw from the Ord system to use as bait on day trips to the lower Keep (Francis Bright [Department of Agriculture and Food] 2012, pers comm. 18 January). There are also no known exotic aquatic macrophytes in the Border Creek/Keep River system. However, any aquatic weeds that could become established in the Ord in future years, given proximity to Kununurra and people, would be controlled in the M1 and M2 channels using acrolein.

Whilst surveys have identified the occurrence of weeds and pests in the greater M2 Area, there no detailed survey of the Keep River from which quantification of potential introductions from the proposal can be assessed.

## 2. Management

### 2.1 Environmental aspects to be managed

There are a number of environmental aspects associated with the proposal that have the potential to affect the listed threatened aquatic fauna in the Keep River system if not managed, the key ones being:

- contaminated stormwater runoff (agricultural fertilisers and agrochemicals) via Border Creek into the Keep River may affect water quality and lead to habitat degradation particularly during low river flows
- discharge of excess abstracted groundwater to the Keep River during high river flows may affect water quality and lead to habitat degradation
- discharges to the Border Creek and the Keep River discharge area, may increase erosion especially during periods of surplus stormwater runoff
- increased human activity may increase the spread and introduction of aquatic weeds, pests and plant pathogens in to the Border Creek and Keep River
- increased contribution of groundwater to dry season base flow into the Keep River.

The introduction or spread of aquatic weeds, plant pathogens and aquatic pest animals by the Development may also potentially indirectly affect listed threatened aquatic species due to changes in habitat and predator - prey relationships. However, the implementation, of the combination of management measures described below and in the Weed, Plant Pathogen and Pest Management Sub-plan is considered sufficient to reduce the likelihood of any significant environmental impacts occurring to relevant NES species as a result of the potential spread of weeds from the Development.

The environmental aspects listed above are specifically managed by implementation of the Stormwater and Groundwater Discharge Management Plan and Weed, Plant Pathogens and Pest Management Plan. This management plan refers to the management actions contained in these plans, as well as details of the requirements of Condition 10 of EPBC Act Approval 2010/5491 not covered in these other management plans.

### 2.2 Environmental objectives

The overall objective of this Aquatic Fauna Management Plan in conjunction with the implementation of the management plans referenced in section 1.5 above is to protect listed threatened aquatic fauna species, with specific objectives for the management of listed threatened aquatic fauna outlined in Table 5.

Table 5 Environmental objectives and key performance indicators for aquatic fauna

Environmental Objective	Key performance indicators
Maintain the habitat of the Keep River by managing stormwater quality.	Water quality of stormwater run-off from the proposal area.
Maintain the aquatic fauna habitat of the Keep River by managing groundwater rise and minimising groundwater discharge to Keep River to minimise contribution of groundwater seepage to dry season baseflows.	Groundwater levels within the proposal area. Quantity and quality of pumped groundwater discharged to Keep River in the wet season. Changes in aquatic macroinvertebrates and fish in the Keep River.
Minimise the potential for spreading and introducing weeds, plant pathogens and pest animals to the Border Creek/Keep River system.	Audit results of implementation of the Weed, Plant Pathogen and Pest Animals Management Plan.

## 2.3 Protective actions

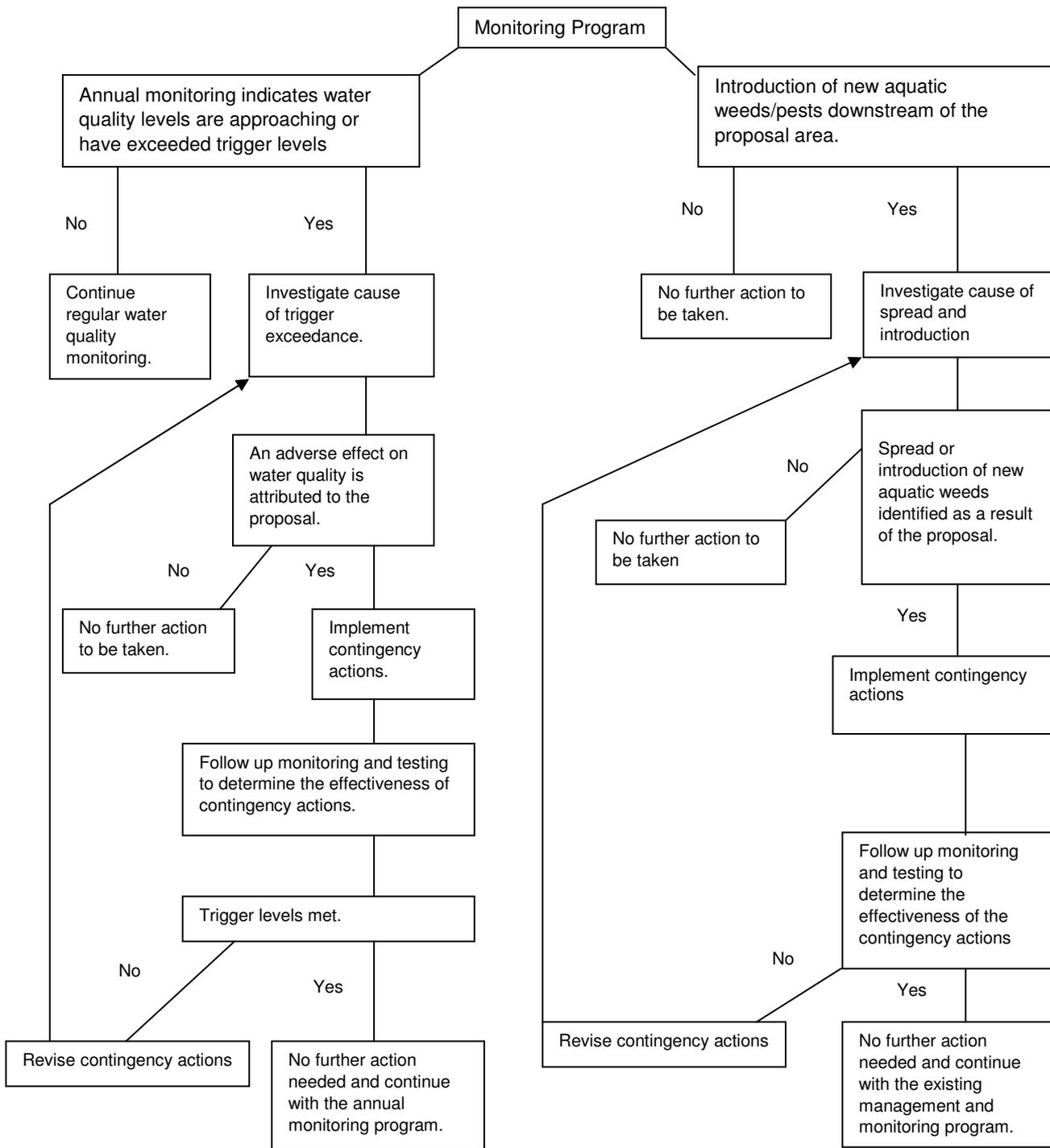
In order to achieve the environmental management objectives for aquatic fauna, a range of protective actions will be implemented (Table 6).

Table 6 Protective actions for aquatic fauna

Item	Action	Purpose	Timing	Responsibility
1	Complete a targeted non lethal baseline surveying program for the Speartooth Shark ( <i>Glyphis glyphis</i> ), Northern River Shark ( <i>Glyphis garricki</i> ), Dwarf Sawfish ( <i>Pristis clavata</i> ) and the Freshwater Sawfish ( <i>Pristis microdon</i> ) in the Keep River. Surveys must be conducted over a period of 3 years and must be undertaken in the four Keep River Pools (K1, K2, K3 and K4) and at least 3 sites in the Keep River Estuary.	Establishing relative population sizes of listed species, estimating the value of these pools as nursery habitat for listed species and providing a baseline against which future changes may be assessed.	Establish baseline over three years, commencing September 2011 (i.e. covering the period September 2011, September 2012 and September 2013) with sampling completed prior to commencement of irrigation.	Proponent
2	Determine seasonal baseline water quality values for the Keep River pools in accordance with ANZECC guidelines as per Item 8 & 9, Table 3 of the Stormwater and Groundwater Discharge Management Plan.	To protect and maintain the habitat and population numbers of threatened aquatic fauna in the Keep River.	Prior to commencement of irrigation.	Project Director/ Proponent
3	Refine flow trigger values for the Keep River and Border Creek gauging station based on the refined discharge dilution model as per Item 13, Table 3 of the Stormwater and Groundwater Discharge Management Plan.	To determine when flow rates in the Keep River fall below a minimum flow rate that no longer enables flushing	Prior to commencement of irrigation.	Proponent
4	Monitor water quality (as per chemicals and nutrients listed in Table 2 of the Stormwater and Groundwater Discharge Management Plan and the Chemical Management Sub-plan) at the stormwater outlet from the development area, determined in consultation with DAFWA, DoW and DEC. As per Item 12, Table 3 of the Stormwater and Groundwater Discharge Management Plan.	To protect and maintain the habitat and population numbers of aquatic fauna in the Keep River.	Bi annually to commence upon commencement of construction.	Proponent
5	Implement the Weed, Plant Pathogen and Pest Management Plan. Preventing introduction of Aquatic weeds, aquatic pests and pathogens. The use of chemicals such as acrolein to control the spread of weeds in the M1/M2 channels in the event of introduction.	To ensure effective control of weeds by the appropriate parties.	As required by the Weed, Plant Pathogen and Pest Management Plan.	Proponent
6	*Inspect Border Creek and Keep River channel and riparian zone for aquatic and terrestrial weeds, evidence of plant pathogens and pest animals that may have been introduced by the Project.	To ensure the proposal does not introduce any new weeds, plant pathogens or pest animals to Border Creek and Keep River.	Annually during the early to mid dry season, commencing prior to the commencement of irrigation.	Proponent

Item	Action	Purpose	Timing	Responsibility
7	Undertake an outcome based risk assessment for listed threatened aquatic fauna using data collected during the baseline monitoring program to determine the potential for risk to listed species at an individual and local population level (as outlined in Section 2.4).	To provide information for adaptive management of listed threatened aquatic fauna species.	Prior to commencement of irrigation, following 3 years of baseline surveys.	Proponent
8	Educate farmers on implementation of farm management practices for the protection of threatened aquatic fauna through an induction. This can be followed up by repeat education sessions where required.	To protect the habitat of threatened aquatic fauna in the Keep River.	Each farmer, lessee and/or farm manager is to be inducted within three months of purchase of the land.	Proponent
9	Induct construction personnel on threatened aquatic fauna, highlighting potential for fauna to be affected during construction works.	To protect the habitat of threatened aquatic fauna in the Keep River.	All construction personnel to be inducted on the site within one week of commencing work.	Proponent
10	Prepare an operational management plan based on the data collected from baseline monitoring and in accordance with targets in Table 7.	To protect the habitat of threatened aquatic fauna after construction.	Within 3 months of the completion of baseline monitoring.	Proponent

\*The Proponent has control of these potential issues within the Proposal Area and implements a range of management measures (state and Australian Government requirement of conditions). The majority of the Project Area is surrounded by Buffer Area and interface issues associated with weeds will be managed. The Proponent does not control activities on land surrounding Border Creek and Keep River but will implement controls within the Project Area to contain impacts.



Note: this diagram summarises details outlined in this Aquatic Fauna Management Plan, as well as requirements of the Groundwater Management Plan and the Storm water and Groundwater Discharge Management Plan.

Figure 1 Decision flow chart for the management of water quality and aquatic weeds in the Border Creek/Keep River system

Table 7 Monitoring regime and corrective actions

Item	Activity and location	Frequency	Target	Corrective Action	Responsibility
1	Telemetered flow monitoring at Development Gauge, existing gauging stations along Border Creek and the Keep River and in groundwater discharge pipe.	Continuous (hourly) flow monitoring when stormwater or groundwater discharge occurs.	<p>No discharge of surplus groundwater to the Keep River unless there is sufficient threshold natural flow (as described in Table 3 of the Stormwater and Groundwater Discharge Management Plan).</p> <p>No significant environmental consequences (as defined in Table 8) from stormwater and groundwater discharges on the health of aquatic ecosystems.</p>	<p>Within one week of a report of a breach causing significant environmental consequences (as defined in Table 8), the corrective actions stated below will be initiated:</p> <ol style="list-style-type: none"> <li>1. In consultation with a <i>Glyphis</i> and <i>Pristis</i> expert investigate cause, which could include examining management practices and identifying instances when water may have been unnecessarily discharged during the low flow periods.</li> <li>2. Conduct water quality sampling program of analytes determined in Table 3, Item 10 of the Stormwater and Groundwater Discharge Management Plan) upstream and downstream of the discharge point.</li> <li>3. Initiate processes to identify whether remedial action is required in consultation with a <i>Glyphis</i> and <i>Pristis</i> expert. Remedial actions could include:                             <ul style="list-style-type: none"> <li>• releasing irrigation water from the M2 channel into Border Creek</li> <li>• installing additional erosion protection</li> <li>• educating farm owners/managers</li> <li>• revision of management practices (including groundwater discharge rules).</li> </ul> </li> <li>4. Implement remedial action/s as required.</li> <li>5. Monitor success of remedial action/s over a time period determined in consultation with a <i>Glyphis</i> and <i>Pristis</i> expert (as a minimum: weekly for at least one month following remedial action).</li> <li>6. Undertake alternative action, as agreed with a <i>Glyphis</i> and <i>Pristis</i> expert, if monitoring finds remedial action is not/will not address initial issue.</li> <li>7. Report on any findings as a result of monitoring in accordance with Section 2.5.</li> </ol>	Proponent

Item	Activity and location	Frequency	Target	Corrective Action	Responsibility
2	Aquatic ecology monitoring (including aquatic invertebrates and fish) in the Keep River pools (K1, K2, K3 and K4) and threatened aquatic ecology monitoring at 3 sites in the Keep River estuary (EST1, EST2, EST3). Monitoring to be supported by concurrent sampling at 5 control/ reference locations to differentiate natural changes from those potentially resulting from the action.	Initially for three years to establish a baseline, and then for a further three years post development. Baseline sampling: Annually in the late dry season commencing September 2011 (i.e. covering a period September 2011, September 2012 and September 2013). Ongoing sampling: Annually in the late dry season commencing after commencement of irrigation. If there is no detectable effect, then frequency is reduced to three-yearly.	No significant environmental consequences (as defined in Table 8) to AUSRIVAS macroinvertebrate category and fish assemblage composition. This can be resulting from stormwater, surplus groundwater and groundwater seepage increases, as compared against reference sites that reflect natural variability in ecosystem health.	Within one week of a report of significant environmental consequences (as defined in Table 8) in the AUSRIVAS macroinvertebrate category and fish assemblage composition, the corrective actions stated below will be initiated: <ol style="list-style-type: none"> <li>Investigate cause over a period of approximately 12 months. This includes investigating management practices and determining whether ecological health of aquatic fauna has deteriorated.</li> <li>In consultation with a <i>Glyphis</i> and <i>Pristis</i> expert identify whether remedial action is required. Remedial actions could include: <ul style="list-style-type: none"> <li>releasing irrigation water from the M2 channel</li> <li>increasing the pumping rates of the eastern bores to reduce groundwater seepage</li> <li>discharging groundwater into the K1 pool or the upper Keep River estuary (as described in table 4 in the Stormwater and Groundwater Discharge Management Plan)</li> <li>potentially, pending analysis, increasing groundwater pumping into the Ord Stage 1 or 2 supply channel during periods of low river flow</li> <li>installing additional erosion protection</li> <li>educating farm owners/managers</li> <li>revision of management practices (including groundwater discharge rules)</li> <li>review flow monitoring data.</li> </ul> </li> <li>Implement remedial action/s, as advised by a <i>Glyphis</i> and <i>Pristis</i> expert</li> <li>Monitor success of remedial action/s over a time period determined in consultation with a <i>Glyphis</i> and <i>Pristis</i> expert (as a minimum: weekly for at least one month following remedial action).</li> <li>Undertake alternative action, as agreed with a <i>Glyphis</i> and <i>Pristis</i> expert, if monitoring finds remedial action is not/will not address initial issue.</li> <li>Report on any findings as a result of monitoring in accordance with Section 2.5.</li> </ol>	Proponent

Item	Activity and location	Frequency	Target	Corrective Action	Responsibility
3	Conduct water quality monitoring (as listed in Item 10, 12, and 14 of Table 3 of the Stormwater and Groundwater Discharge Management Plan) at the stormwater outlet from the Development Area.	Automated flow proportional sampling (with sub daily capability) at stormwater outlet at the Development Area. During dry season in Keep River. Commencing prior to commencement of irrigation	Levels in discharge are unlikely to cause exceedance of water quality triggers, including relevant downstream environmental quality parameters, in accordance with ANZECC guidelines, in Keep River pools or estuary.	As guided by outputs from the OSWM, within one week of identifying exceedance of trigger levels, the corrective actions stated below will be initiated:  1. Initiate intensive water quality sampling program upstream and downstream of discharge point (as listed in table 3 Item 10 and 12 of the Stormwater and Groundwater Discharge Management Plan). 2. Investigate cause, including investigating management practices and determining whether water quality has deteriorated as a result of discharge from the Development Area. 3. Identify whether remedial action is required. Remedial actions could include: <ul style="list-style-type: none"> <li>• releasing irrigation water from the M2 channel into Border Creek</li> <li>• installing additional erosion protection</li> <li>• educating of farm owners/managers</li> <li>• revision of management practices (including groundwater discharge rules).</li> </ul> 4. Implement remedial action/s as required. 5. Monitor success of remedial action/s. 6. Undertake alternative action, if monitoring finds remedial action is not/will not address initial issue. 7. Report on any findings as a result of monitoring in accordance with Section 2.5.	Project Director/ Proponent
4	Annual surveys for aquatic weeds, plant pathogens or aquatic pest animals introduced to Border Creek and Keep River, e.g. Red Claw crayfish and Salvinia.	Annually in the dry season, prior to the end of August. Commencing prior to commencement of irrigation.	No new aquatic weeds, plant pathogens or aquatic pest animal species observed or recorded in Border Creek or Keep River.	Within one week of identification of new species, the corrective actions stated below will be initiated:  1. Investigate cause for introduction. 2. Map the distribution of the newly introduced species within a month of the survey. 3. Plan and implement a rapid control program in consultation with relevant agencies and landowners (need to inform DAFWA in the case of identifying a declared noxious weed species and DEC in the case of identifying a priority environmental weed) within two months of the survey. 4. Re-educate contractors/farm owners/managers of the importance of hygiene control measures within a month of the survey. 5. Monitor success of control program, and in consultation with DAFWA and DEC (in the case of priority environmental weeds), undertake alternative action, if monitoring finds remedial action is not/will not address initial issue.	Project Director/ Proponent

## 2.4 Outcome risk assessment approach

The risk assessment for listed threatened aquatic fauna species of interest will be based on the likelihood and consequences outlined in Table 8 and Table 9, with the risk matrix in Table 10.

An outcome based risk assessment will be carried out based on Table 8, Table 9 and Table 10 when sufficient information is available from baseline surveys to establish risk to listed threatened aquatic species. This assessment will be developed in consultation with the **IRG** and will be conducted by ecologists with aquatic fauna experience.

Table 8 Definitions of consequences

Consequence rating	Environmental consequence
1 – Catastrophic	<ul style="list-style-type: none"> <li>• Extinction of one or more 'listed threatened aquatic species' from the Keep River system as a result of the project.</li> </ul>
2 – Massive	<ul style="list-style-type: none"> <li>• Localised loss of a 'listed threatened aquatic species' from one sampling site as a result of the project; and/or</li> <li>• Abundance of 'listed threatened aquatic species' is less than 50% of baseline; and/or</li> <li>• Species richness and composition of aquatic macroinvertebrates is less than 80% of baseline; and/or</li> <li>• Species richness and composition of fish species is less than 80% of baseline.</li> </ul>
3 – Major	<ul style="list-style-type: none"> <li>• Abundance of 'listed threatened aquatic species' is less than 75% of baseline; and/or</li> <li>• Species richness and composition of aquatic macroinvertebrates is 80 -89% of baseline; and/or</li> <li>• Species richness and composition of aquatic macroinvertebrates is 80 -89% of baseline.</li> </ul>
4 – Moderate/Significant	<ul style="list-style-type: none"> <li>• Abundance of 'listed threatened aquatic species' show a decline, but population size is greater than 75% of baseline; and/or</li> <li>• Species richness and composition of aquatic macroinvertebrates is 90 -94% of baseline; and/or</li> <li>• Species richness and composition of fish is 90 -94% of baseline.</li> </ul>
5 – Minor	<ul style="list-style-type: none"> <li>• No decline in abundance of 'listed threatened aquatic species'; and/or</li> <li>• Species richness and composition of aquatic macroinvertebrates is 95 -99% of baseline; and/or</li> <li>• Species richness and composition of fish is 95 -99% of baseline.</li> </ul>
6 – Negligible	<ul style="list-style-type: none"> <li>• No decline in abundance of 'listed threatened aquatic species'; and,</li> <li>• Species richness and composition of aquatic macroinvertebrates equivalent to baseline/reference; and</li> <li>• Species richness and composition of fish equivalent to baseline/reference.</li> </ul>

Table 9 Definitions of likelihood

Likelihood definitions	
1 – Almost certain	Common repeating occurrence, ongoing. Will occur most often. Planned occurrence/action.
2 – Likely	Will probably occur in most circumstances. There is at least a 50% chance that it may happen.
3 – Possible/occasionally	Might occur at some time. Could occur but not often. There is between 5%-50% chance that it could happen.
4 – Unlikely	Unusual occurrence. Unexpected.
5 – Rare/Improbable	May occur only in exceptional circumstances. Unheard of.

Table 10 Risk matrix

	Negligible/ Slight	Minor	Moderate/ Significant	Major	Massive	Catastrophic
Almost certain	Low	Medium	High	Extreme	Extreme	Extreme
Likely	Low	Low	Medium	High	Extreme	Extreme
Possible/ occasionally	Very Low	Low	Low	Medium	High	Extreme
Unlikely	Very Low	Very Low	Low	Low	Medium	High
Rare/ Improbable	Very Low	Very Low	Very Low	Low	Low	Medium

## 2.5 Performance reporting

Performance reporting of this Aquatic Fauna Management Plan will be implemented consistent with the reporting requirements set out in the Ord River Irrigation Area – Weaber Plain Development Project Environmental Management Plan (Ord EMP), which includes systematic, comprehensive and informative reports on environmental management and monitoring for the Proposal Area (Strategen 2011a). Under this regime, performance will be reported in:

- an Annual Environmental Report (AER)
- a Triennial Performance Review Report.

Both the AER and triennial Performance Review Report will be prepared by the Proponent. The reports will be provided to the relevant regulatory authorities and made publicly available.

### 2.5.1 Annual Environmental Report

The AER will:

- describe the status of work activities and environmental management
- outline the status of implementation of Procedure 14 of Statement 830 (relates to the creation of conservation reserves)
- achievement of targets
- identify any contingencies triggered over the previous 12 months
- provide an interpretations and trend analysis of monitoring results from the previous 12 months
- outline developments scheduled to occur in the next 12 months
- outline the effectiveness of the environmental management measures currently implemented.

### 2.5.2 Triennial Performance Review Report

A triennial Performance Review Report will be prepared and will address the above over the three year period plus the following:

- outline the status of implementation of Procedure 14 of Statement 830 (State approval)
- outline the effectiveness of the environmental management measures currently implemented and detail actual environmental performance against:
  - \* targets
  - \* achievement of environmental objectives reported on by the WA Environmental Protection Authority (EPA) (2000, 2001) DLPE (2000) and DIPE (2002) and the objective of this plan
  - \* commitments documented in Schedule 2 of Statement 830 (State approval).

### 2.5.3 Audit

Consistent with Condition 19 of the EPBC approval, an independent audit of compliance with conditions will be conducted and the resultant report will be submitted to the Australian Government Minister. The same audit report will be submitted to address that compliance reporting required by Statement 830 (State approval).

Where there is an exceedance in trigger levels or target levels are not met or any non conformance this will be reported to the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the **IRG** in the first instance, where further action and reporting will commence.

## 2.6 Review and revision

Consistent with the Ord EMP, the Aquatic Fauna Management Plan will be reviewed by the Proponent as part of the annual and triennial environmental reporting process. The plan will be revised as required based on assessment of monitoring results and assessment of performance, which may include updating the sampling frequency and water quality parameters sampled.

Construction personnel will be notified of revisions to the plan at a site briefing or using other suitable methods as required. In addition, the Proponent will ensure that continued improvement of the plan occurs in response to environmental incident resolutions, audit findings, monitoring results, and changes in regulatory requirements.

The Department of Agriculture and Food (DAFWA), Department of Environment and Conservation (DEC), Department of Water (DoW) and the **IRG** will be advised of any changes to the management actions and will be provided with the revised Stormwater and Groundwater Discharge Management Plan as required. Major changes as determined by the Proponent or the **IRG** will be undertaken only in consultation with DAFWA, DEC, DoW; **IRG** and submitted to DSEWPaC for approval based on the advice of these agencies.

In accordance with Condition 15 of the approval (EPBC 2010/5491) if the proponent wishes to carry out any activity not in accordance with any of the management plans as specified in the conditions, the person taking the action must submit to the Department for the Minister's written approval a revised version of that management plan. The varied activity shall not commence until the Minister has approved the varied management plan in writing.

### 3. Stakeholder consultation

Table 11 outlines the comments received from DEC and the **Independent Review Group** in regard to this Aquatic Fauna Management Plan.

Table 11 Stakeholder comments

Item	Comment	Proponent response
DEC		
Table 6–item 1	Baseline threatened fish species survey. This to be completed “before cropping commences” but does this mean before any possible irrigation water releases or groundwater abstraction releases? i.e. does cropping mean irrigation or harvesting. If just the latter then there may be changes to the Keep River prior to completing the baseline (which means it's not baseline). I query this because item 2 (determining water quality thresholds) has to be completed 'prior to commencement of irrigation'.	Cropping refers to the commencement of crop cultivation and therefore prior to commencement of irrigation. Discharge of groundwater is unlikely to be required in the first 10 years after commencement of cultivation. Therefore, baseline surveys for both aquatic fauna and water quality will be completed prior to commencement of irrigation and the discharge of groundwater.
Table 6–item 5	Is the proposed weed control agent one of the chemicals to be monitored under item 4? If not then should be.	Monitoring of chemicals is covered within the Chemical Management sub-plan. This will include all chemicals used in the irrigation channel and would include acrolein if used.
Table 6–item 6	I suggest that annual weed inspections too infrequent. Quarterly would be better. I suggest getting advice from Greg Keighery on this but with weeds the quicker you can get on top of them the better.	Greg Keighery confirmed that annual inspections conducted during the dry to mid dry season are sufficient. Most weeds require a year or several to seed and establish new populations yearly inspections should prevent these establishing.
Table 7–item 2	Post development monitoring of aquatic invertebrates and fish is listed as an action in Table 7 (Monitoring regime and corrective actions), but fauna monitoring is not listed as a management action in Table 6. Surely biological monitoring should be an action in Table 6 (and then expanded upon in Table 7).	The structure of this management plan, in differentiating the management and monitoring actions, is consistent with all other management plans and was considered acceptable by OEPA for the Weaber Plain Development Project.
Figure 1 and associated text	The flow chart suggests that if aquatic weeds are found (presumably in Border Creek or Keep River discharge points as well as the irrigation channels—but this not clear) but the occurrence of the weeds was not a result of the proposal, then no action needs to be taken. I suggest DEC requires that the proponents need to manage all aquatic weeds on their zone of influence (the irrigation areas and associated discharge points) as a good neighbour policy, irrespective of who or what caused them to get there. i.e. if they occur on Weaber Plains they could then get into the Keep and then into Keep River NP. i.e. the proponents should accept responsibility for controlling all weeds that occur on or escape from the Weaber Plains irrigation area.	The aquatic weed monitoring referred to in Figure 1 relates to monitoring downstream of the proposal area not within the proposal area. One of the first boxes in the flow chart will be amended to include the text 'downstream of the proposal'. The proponent has control of potential weed issues within the proposal area and implements a range of management measures (State and Australian Government requirement of conditions). These measures include preparing and implementing a Weed Control Program to manage the potential introduction and spread of weeds within the Weaber Plain Development Area, as per the Weed, Plant Pathogen and Pest management sub-plan in the Weaber Plain Development Project Environmental Management Plan (EMP) (Strategen 2012c). The proponent does not control activities on land surrounding Border Creek and Keep River but will implement controls within the proposal area to contain impacts as well as controlling any introductions to the Border Creek/Keep River system that may have occurred as a result of the proposal.

Item	Comment	Proponent response
Table 7-item 2	<p>In the Introduction (page 1) it is stated that '<i>contaminated stormwater runoff (agricultural fertilisers and agrochemicals) via Border Creek into the Keep River may affect water quality and lead to habitat degradation particularly late in the dry season</i>'. This seems to conflict with the groundwater and stormwater management proposals (page 5) which preclude dry season discharges to Keep River, although it is possible that such contamination in late wet season discharges could persist (and concentrate) during the dry. There are AUSRIVAS models for both spring (end of dry season) and autumn (end of wet season) but the Aquatic Fauna Management Plan only suggests sampling for the end of wet season/early dry season (Item 2 of Table 7). Given that some water quality problems could be more pronounced in the late dry season I suggest that DEC recommends water quality and invertebrate (AUSRIVAS) monitoring in the late dry season for the same period and frequency as the late wet sampling (i.e. initially annually for 3 years, then 3 yearly).</p>	<p>Section 1 (the Introduction) has been amended to note rather than 'dry season' it is more 'low river flow', as has section 1.6.3.</p> <p>Stormwater discharge to Border Creek will only occur where the rainfall event exceeds the capacity of the tailwater retention system. Groundwater discharge to Keep River will not occur during low river flow periods, it will only occur when flows in the Keep River are sufficient to ensure adequate dilution and flushing of the system.</p> <p>Timing of aquatic fauna sampling has been changed to late dry season as it integrates any impacts from the late wet season and is consistent with the timing of previous aquatic fauna monitoring events.</p>
Table 7-item 3	<p>Water quality at overflow discharge location only to be 'periodic when overflow occurs'. Monitoring of the irrigation channels and storage areas is probably covered by the other management plans, but the proponents should have a good understanding of water quality in the irrigation system prior to release rather than only at release so that any dilution effects can be calculated prior to release.</p>	<p>A register of all chemicals applied on farms in the Development Area will be maintained to provide an understanding of the chemicals that may be present in tailwater, as described in the Chemicals Management Sub-plan of the EMP (Strategen 2011d). Ord Stage 1 data has also been used to provide baseline data for water quality from the Development Area until sufficient data has been collected from the discharge location. This is expected to be a worst case scenario as the Ord Stage 1 does not include a tailwater management system. This as well as the Operational Surface Water Model is considered sufficient to ensure no detrimental impact to the downstream environment as a result of the project.</p> <p>Monitoring at the discharge location outfall provides a true and accurate measure of the overall water quality rather than individual water samples taken at each farm lot prior to release.</p> <p>Any additional stormwater will flow to Border Creek and then to the Keep River, where it will be combined with any other catchment flows. The quality of this stormwater has been assumed to be equivalent to D4 drain water quality associated with Ord Stage 1. In the 12 years of monitoring the D4 drain (and it is noted that Ord Stage 1 does not implement a tailwater management system which will be established for the Proposed Action) the only chemicals and nutrients recorded above the detection limits were total nitrogen (TN), total phosphorous (TP), endosulfan and atrazine. Of these chemicals, endosulfan has now been banned and will not be utilised in the Weaber Plain Development Project, and although atrazine (recorded at 0.1 µg/L) was present the recording was at a level significantly below the most stringent ANZECC &amp; ARM CANZ (2000) 99% species protection level (0.7 µg/L). The concentration of TN and TP from the D4 drain are also below the levels found in the recent wet season monitoring of the Keep River.</p>

Item	Comment	Proponent response
Independent Review Group		
Section 2.3	Rename management actions to protective actions	This is reflected in section 2.3.
Table 6 item 8	Include management actions relation to education and training of farmers, workforce etc from other management plans	This action has been added to Table 6.
Table 6 item 10	Include additional management action for implementation after data has been collected i.e. Operational Management Plan.	This is reflected in Table 6 item 10.
Table 7	Revise corrective actions, such as including a time limit for investigating the cause.	Corrective actions have been updated accordingly.

The above comments have been duplicated directly and may contain typographic errors.

## 4. References

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- WRM (Wetland Research Management) 2011, *ORIA Stage II: Weaber Plain / Keep River Water Quality and Aquatic Fauna Sampling, 2009-2010*, unpublished report to Strategen Pty Ltd, February 2011.