Fisheries Victoria

Department of Primary Industries

Translocation risk assessment for Devilbend and Bittern Reservoirs for stocking select recreational (fish) species.

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1 INTRODUCTION

Parks Victoria is in the final stages of drafting a Management Plan for the Devilbend Natural Features Reserve. The planning will focus on developing an environmentally sustainable park and ensuring that any recreational use is consistent with conservation objectives. A range of activities are being considered for approval, with advice provided by an Advisory Group. The activities being considered include recreational fishing. This is consistent with recent Victorian Government 2006 election commitments and current Government policy to look at options for developing new fishing opportunities and fisheries. One of the identified new opportunities is the Devilbend Reservoir on the Mornington Peninsula.

One of the steps in developing the Devilbend and Bittern Reservoirs as stocked fisheries is to conduct a risk assessment for submission to the Translocation Evaluation Panel (TEP). The risk assessment must demonstrate that the translocation meets the requirements of the Guidelines for Assessing Translocations of Live Aquatic Organisms in Victoria. The established risk evaluation process includes consideration of the values of the site and the potential impacts of the translocated species.

Some of the environmental values of the site are high and there is community support for an ecologically viable, conservation-focussed, park. The site supports more than 150 native plant species and 80 significant fauna species. The nationally vulnerable Dwarf Galaxias fish has historically been found in the catch drain and nearby creeks (though not in recent surveys; McGuckin 2007), but has never been found in the reservoirs themselves.

The Growling Grass Frog was last recorded at the site in 1978, the reasons for its absence are unknown but it is known this species are subject to impacts from exotic fish species (Heard et al. 2004) such as Gambusia and Redfin but also require extensive grasslands next to permanent water. The most recent survey by Monash (Thompson and Walker 2009) did not detect this species. Regardless the addition of further predatory species is unlikely to increase the risks that the species, if found would face at Devilbend and Bittern Reservoirs, and is not considered further.

The reserve is home to the threatened Blue-billed Duck and the White-bellied Sea-Eagle, the latter species being dependent upon aquatic fauna such as fish and macro-crustaceans (Stamation and Lyon 2009). As such these two species of bird represent other significant bird species which may be present or are newly recognised onsite (such as the recent sighting of nesting Caspian Terns, Jo Richards, Parks Victoria pers. comm.) as one species that represents the piscivorous species (Sea Eagle) and the other represents the invertebrate dependent species (Blue-Bill Duck).

There are also several exotic aquatic species such as Redfin Perch, Eastern Gambusia, Goldfish and Marron (McGuckin 2001 & 2007; Thompson and Walker In Prep). There is also community support for a range of recreational activities in the Reserve, in particular recreational angling and development of a stocked fishery in the reservoirs.

The impacts or threats posed by the stocked fish include predation upon, or competition with, significant species; ecosystem effects; genetic impacts; and disease introduction. The risk assessment needs to consider all these values and impacts (taking account of the likelihood and consequences of these impacts occurring), however there may be mitigation options which exist, and assessing these will allow documenting any residual risk that managers can take into account in proceeding or not with any proposed translocation.

1.1 Aim and Scope of the Risk Assessment

The objective of this project is to undertake an independent, scientific risk assessment of the stocking of select recreational fish species in Devilbend and Bittern Reservoirs. The risk assessment is to be based on the approved proforma for submission to the Translocation Evaluation Panel (TEP). The proforma assesses environmental risks, but also takes into account social and economic factors of the proposed translocation to allow an informed decision in regard to the proposal.

1.2 Structure of the Risk Assessment

There are two documents making up this risk assessment. This document which follows the general approach to ecological risk assessment adopted by EPA Victoria (EPA Victoria 2004) and used in several recent projects by Lloyd Environmental (e.g. Lloyd et al. 2008, Newall and Lloyd 2008) and a second document, the TEP Risk Assessment Proforma, which uses the outputs from this primary report. The TEP Risk Assessment Proforma is provided as Appendix 1 to this document and must be read in conjunction with this supporting risk assessment.

2 BACKGROUND INFORMATION

2.1 Devilbend and Bittern Reservoirs

Bittern and Devilbend reservoirs are decommissioned Melbourne Water storages which were previously filled by transferring water directly into the storage piped from nearby reservoirs. The local catchment inflow is excluded using a catch-drain (Figure 2.1 & Figure 2.2). Bittern is much smaller than Devilbend in capacity and drains into Devilbend Reservoir. Devilbend Reservoir overflows into Devilbend Creek and then into Balcombe Creek (Figure 2.3).

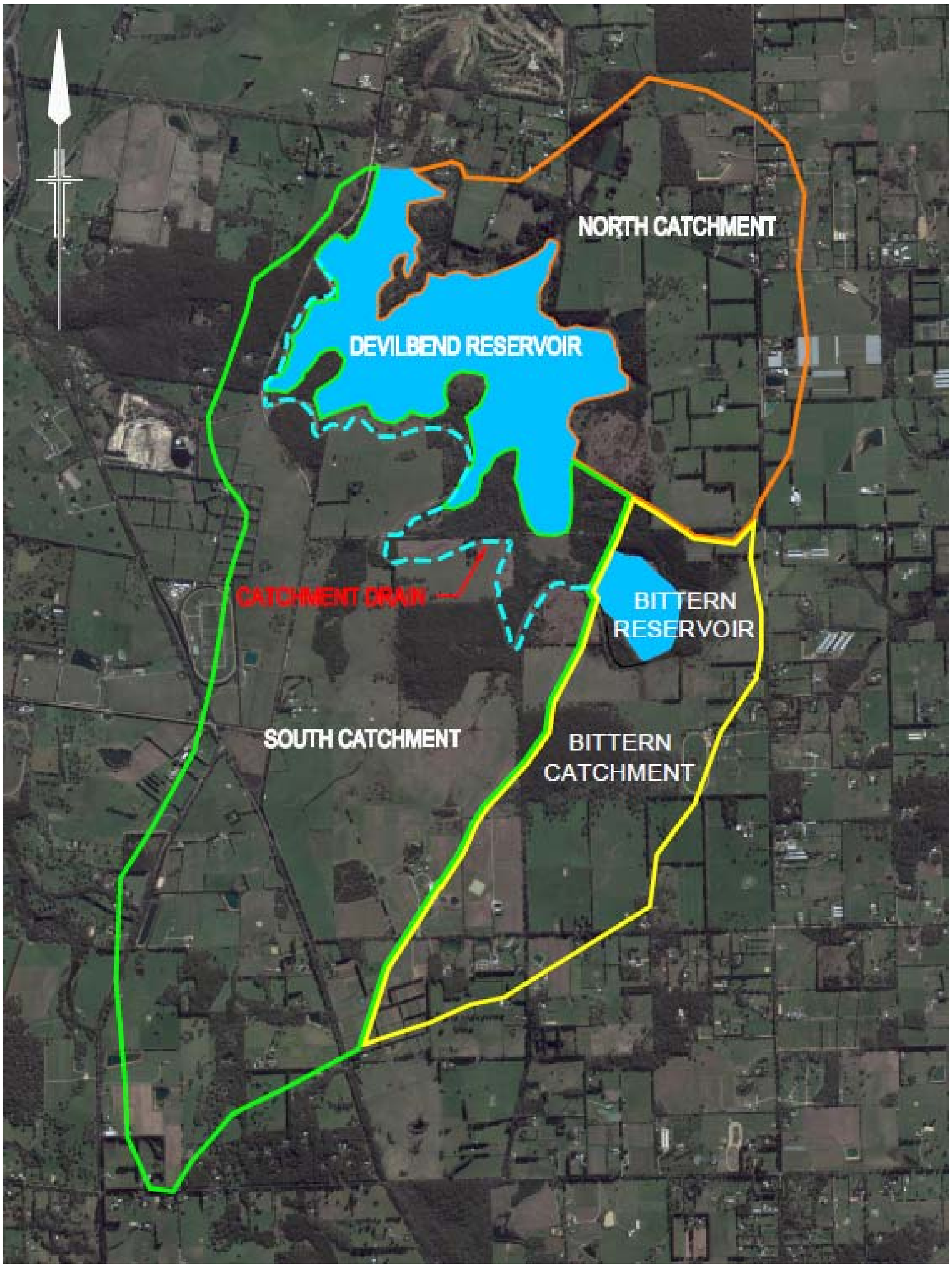

Figure 2.1 Devilbend Reservoir and its upstream catchments (GHD 2008)
(note the catch-drain runs along the southern edge of Bittern Reservoir and all the way along Devilbend Reservoir into Devilbend Creek to completely by-pass these storages)

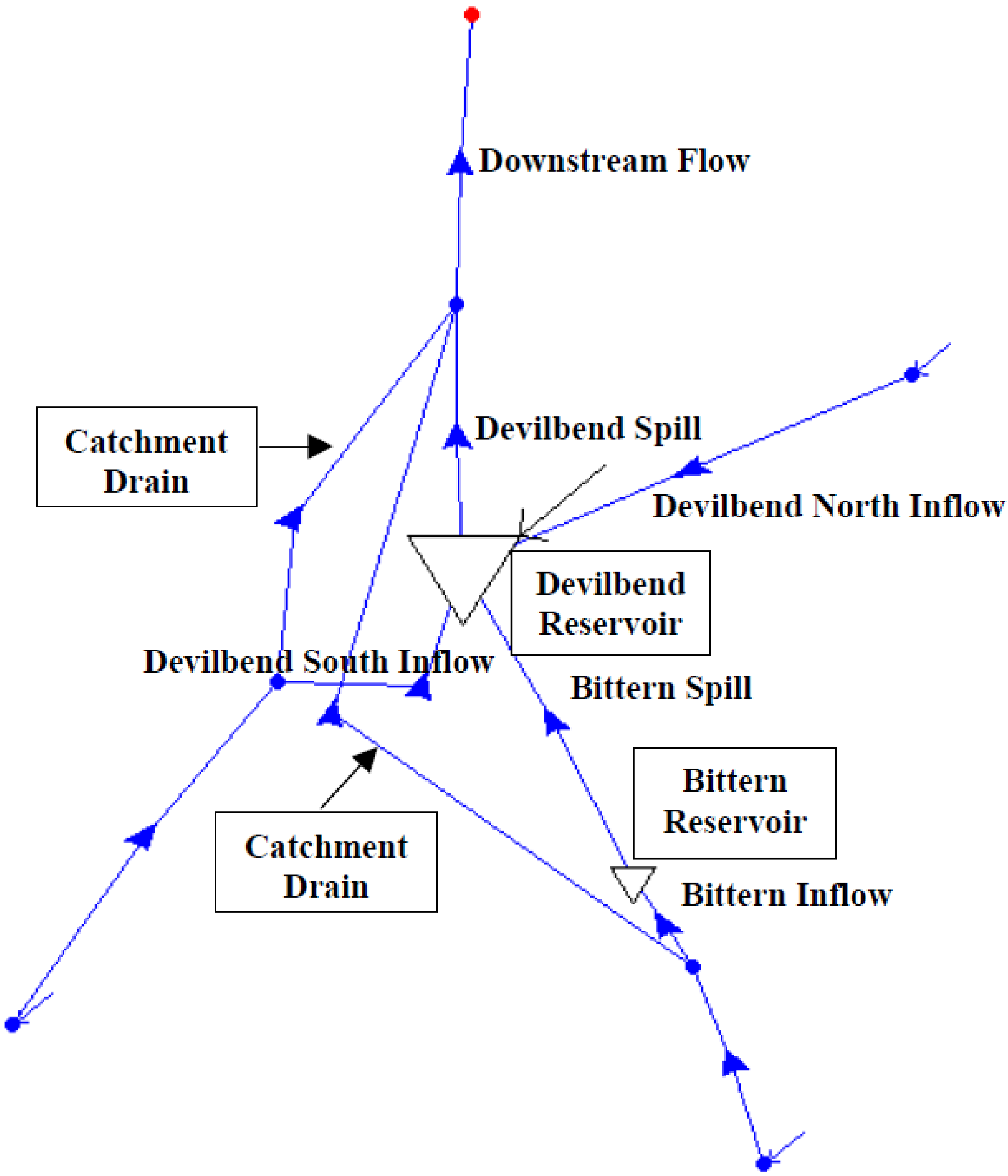

Figure 2.2 Hydrodynamics diagram of the Devilbend and Bittern Reservoirs and catchments (GHD 2008)

Figure 2.3 Devilbend Reservoir and its downstream catchment

Devilbend and Bittern Reservoirs are constructed habitats but are well established with complex aquatic habitats such as woody debris, rocky sections, gravel substrates and extensive aquatic vegetation and also excellent water quality. These sites would provide excellent habitat for many fish species. There are several exotic species already established, such as of Redfin Perch, Eastern Gambusia and Marron, however, these are unlikely to affect survival of any stocked species due to excellent cover (extensive aquatic vegetation beds) available.

Currently, only the Devilbend Reservoir spills in around 20% of years under historic conditions and around 7% under median climate change scenario conditions. Bittern does not currently spill and is less likely to under climate change scenarios. Two options for managing reservoir water levels have been examined (based on the median climate change scenario) – removal of catch drains (Option 1) and winter fill option (where 50% of flows from May to Oct would be diverted from local catchments into the reservoir – Option 2). Removal of the catch drains means that Bittern Reservoir would spill 80% of years (up from 0% with catch drains) and that Devilbend would spill 85% of years. Unregulated the winter fill option means that Bittern and Devilbend would spill about 55% of years (Table 2.1; Figure 2.4 & Figure 2.5).

Table 2.1 Reservoir Spill Frequency under various Management Scenarios (GHD 2008)

Scenario	Devilbend % of Years	Bittern % of Years
Current	20%	0%
Current with Climate Change	7%	0%
No Catch-drain	85%	80%
Winterfill – Preferred Option 50% of flows from May to Oct	55%	55%

Under the Parks Victoria preferred operating regime (Winterfill - Option 2), these reservoirs are essentially open systems. At the current spillway levels (and proposed inflows from the catch drains), water would leave both reservoirs about one in every two years. Bittern would spill into Devilbend Reservoir only. Devilbend would spill into Devilbend Creek via its spillway. The spillway is a broad concrete crest which spills directly into the creek, via a steep fall in a concrete channel. There are currently no screens or trash racks to prevent fish movement over the spillway.

This risk assessment is based on the Winterfill - Option 2. It should be noted that relevant approvals to undertake this option are being progressed by Parks Victoria with Melbourne Water. In the event that these approvals are delayed or not received or if this option is not adopted then the associated risk of spill would be greatly reduced. As highlighted under the climate change scenario Bittern would never spill and Devilbend would spill only 1 in 12 years.

Conversely, if Option 1 is considered in management of environmental flows to Devilbend Creek then the frequency of spills and mitigation measures proposed would need to be reviewed to ensure the risks are managed.

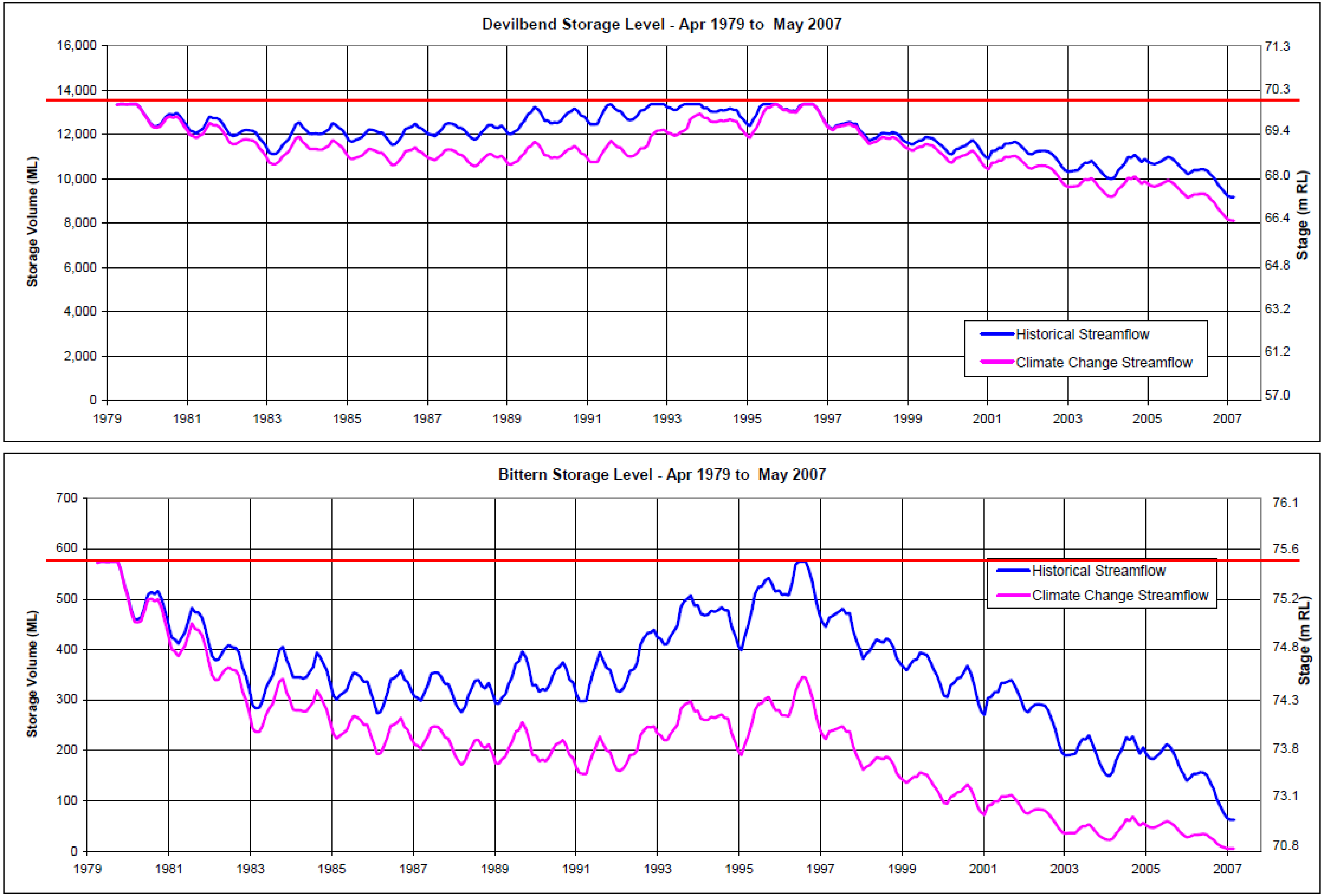

Figure 2.4 Devilbend and Bittern Reservoir water levels under historical and climate change streamflow scenarios (GHD 2008). Note: red lines indicate reservoir spill levels.

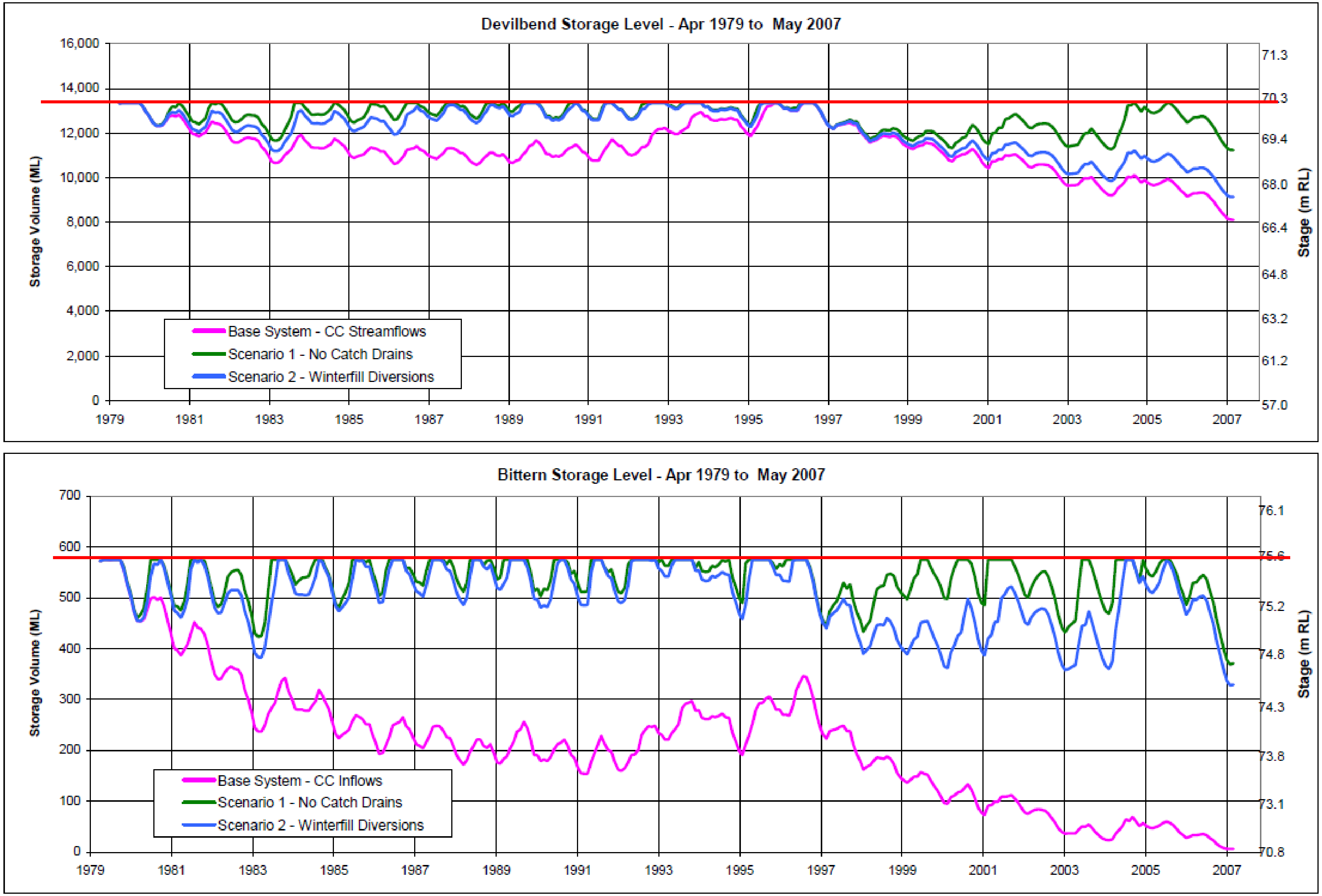

Figure 2.5 Devilbend and Bittern Reservoir water levels under Base and 2 Management streamflow scenarios (GHD 2008). Note: red lines indicate reservoir spill levels.

2.2 Devilbend and Balcombe Creek System (potential receiving water)

The Devilbend and Balcombe Creek System are the potential receiving waters for overflows of the Devilbend and Bittern Reservoirs. It is a small creek which arises near Mt Eliza and flows into Port Phillip Bay near Mt Martha. The majority of Devilbend Creek flows through largely cleared farmland, there is dense but narrow riparian habitat and good quality fish habitat. Devilbend Creek and its tributary streams Balcombe and Tuerong Creeks have suitable freshwater habitat provided by the tree-lined creeks, deep pools and constructed lakes in the system. Melbourne Water (2007) rate these streams as having overall moderate environmental value but aquatic life being rated excellent and good water quality, vegetation, habitat and stream stability. The sediment is predominantly muddy or silty substrates in the freshwater reaches and sandy substrate in the estuary (ANGA 2005).

The water quality of Balcombe Creek has been monitored by Melbourne Water monthly since 1993 which indicates that the oxygen and temperature environment is within the tolerance range of both trout species with only 1 recording below the critical minima as indicated for trout of 2.5mg/L (Molony 2001). This measure occurred in March 2009 and very few low DO events (below 4mg/L) in the entire record. Of the 16 years of record, it indicates that a record of below 2.5mg/L is less than an 1 in 100 year event and the 10th percentile is 4.21 mg/L (meaning it is better than 4.21 mg/L for 90% of the time). This indicates that Balcombe Creek is a well oxygenated system. The temperature of the stream is always within suitable temperatures for both trout species (see section 2.3.2).

It should be noted that this data is from Balcombe Creek and that conditions may be different in Devilbend Creek. However, it has been assumed water quality is similar as factors which would negatively impacts upon water quality (lack of riparian vegetation, shallow pools) are countered by positive factors (more reliable, historically, catchment streamflows along Devilbend Creek, Melbourne Water 2007).

Table 2.2 Temperature and Dissolved Oxygen Statistics (data supplied by Melbourne Water) for Balcombe Creek

Statistic	Temperature (^{o}C)	Dissolved Oxygen (mg/L)
Minimum	6.9	2.3
1st Percentile	6.99	2.78
10th Percentile	9.3	4.21
25th Percentile	11	5.4
Median	14	7.1
75th Percentile	16.8	8.6
Maximum	23.6	12.1

Balcombe Creek has a wider riparian zone but a smaller and less reliable (in terms of freshwater flows) catchment. Devilbend Creek has historically had a reliable flow, with most flows diverted around the upstream Reservoirs. This may change with some of the higher flows being diverted into the Reservoirs in future management scenarios but base flows should remain strong, although diminished due to climate change (GHD 2008). The system contains Short-finned Eel, Common Galaxias, Spotted Galaxias, Flat-headed Gudgeon, Dwarf Galaxias and Southern Pygmy Perch (ANGFA 2005).

The Devilbend, Tuerong and Balcombe Creek have been known as one of the more reliable systems for Dwarf Galaxias on the Mornington Peninsula (McGuckin 2007) until the drought and no fish have been found in surveys of the catch drains or the reservoirs (McGuckin 2007; Thompson and Walker, In Prep.). Figure 2.6 illustrates the distribution of Dwarf Galaxias within the catchment over time. Dwarf Galaxias have never been captured within either Devilbend or Bittern Reservoirs despite suitable habitat being present within the reservoirs for this species. Nonetheless, surveys in the recent years have located some populations in Balcombe Creek and Tuerong Creek, downstream of Devilbend Reservoir (ANGFA 2005, SEITA 2008). The Dwarf Galaxias which were found in Tuerong Creek in 2007 were part of the EES studies for the Frankston ByPass (SEITA 2008).

The estuarine section of Balcombe Creek also contains Yellow-eye Mullet, Trevally and Black Bream. Estuary Perch have been recorded in nearby estuaries and are possibly within the Balcombe Creek estuary as well. The Balcombe Estuary is one of the highest value estuaries in the Port Phillip and Westernport Bays region (BERG 2008; Melbourne Water 2007).

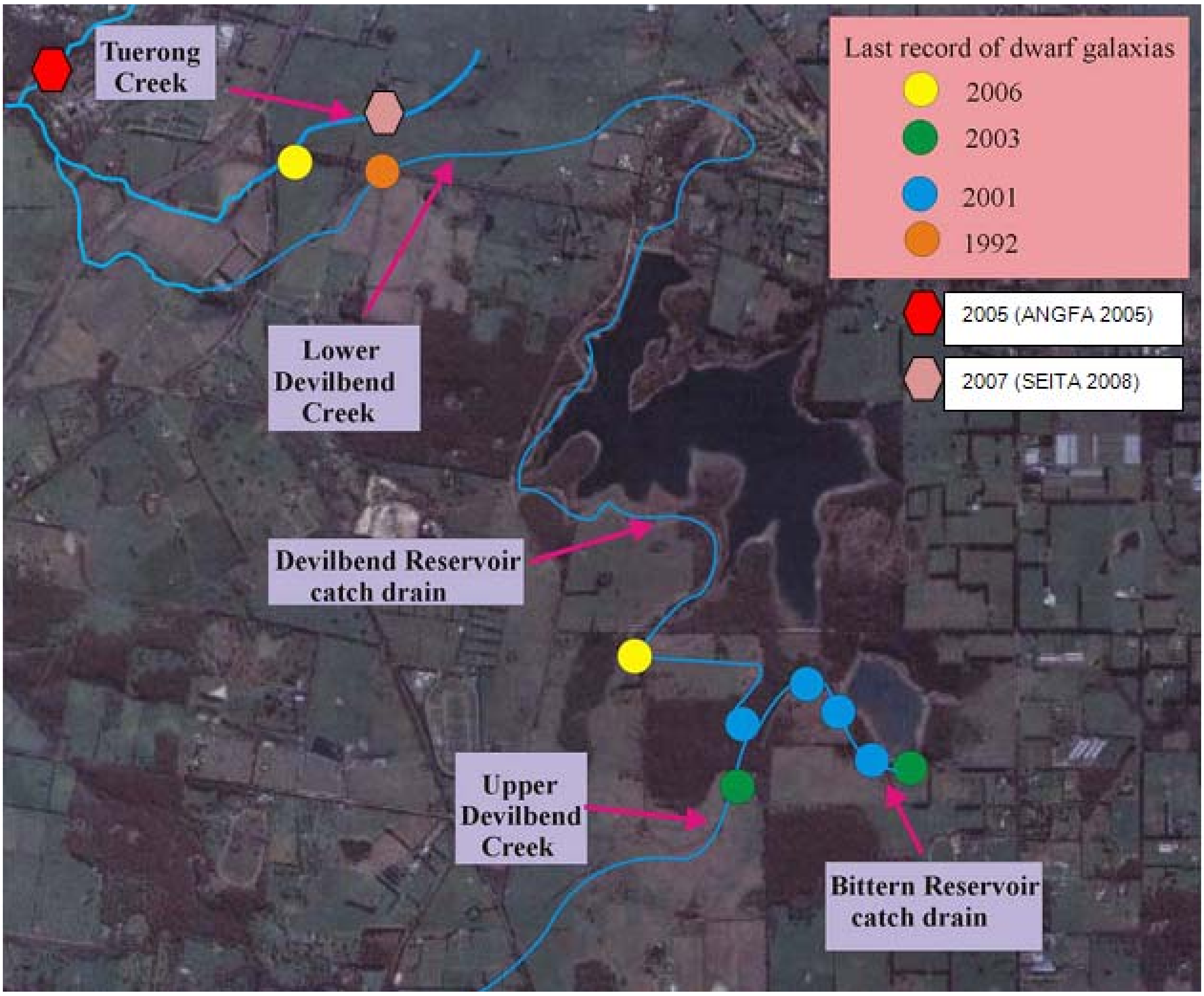

Figure 2.6 Dwarf Galaxias distribution (adapted from McGuckin 2007) updated with additional identification locations of surveyed fish in 2005 and 2007

2.3 Fish Species Proposed to be Translocated

Three species are proposed for translocation:

- Australian Bass, *Macquaria novemaculeata*
- Rainbow Trout, *Oncorhynchus mykiss*
- Brown Trout, *Salmo trutta*

2.3.1 Australian Bass

Australian Bass is a native species but its range extends along the east coast of Australia around to Wilson's Promontory (i.e. its natural range does not extend as far west as Port Phillip Bay). Australian Bass have high salinity tolerances (up to sea water) but spend most of their time in freshwaters but eggs or sperm do not survive in freshwaters. Australian Bass breed at temperatures between 14-19^{o}C, temperature tolerances of adults unknown but they inhabit areas of fast flowing waters and are likely to be quite cold tolerant.

The diet of Australian bass varies significantly between habitat and season, however insects, fish and large crustaceans are the most important prey types (Harris 1985). Harris (1985) found that almost every available prey type was included in the diet of Australian Bass such as fish (the most important food recorded in Australian Bass); insects; crustaceans; and terrestrial vertebrates (such as skinks, frogs and birds) and plant material.

It is unknown at present where the source of Australian Bass will be derived. It has been assumed for the purposes of the risk assessment that all fish will be produced in a facility which has an ongoing stock health surveillance program that meets DPI requirements and where there have been no unexplained disease outbreaks at the source facility in the past 24 months. In addition, because of the uncertainty of the source of the Australian Bass stock, it has been assumed that the Australian Bass to be translocated would be assessed (using a sub-sample of the consignment being sacrificed and tested for the presence of notifiable diseases) and provided with a certificate of stock health.

2.3.2 Brown and Rainbow Trout

The salmonid species (Brown and Rainbow trout) are not native to the region but are stocked extensively in Victoria for recreational or commercial purposes. For optimum growth and survival, Brown & Rainbow trout require cool, well oxygenated waters of low salinity with Rainbow Trout having slightly higher temperature tolerances compared to Browns. However, both species are adaptable and broadly tolerant of water quality and temperature conditions enabling them to inhabit a relatively wide range of systems within SE Australia (Arthington & McKenzie 1997).

Molony (2001) summarised the environmental requirements of both Trout species and these show that the critical thermal maxima (CTM) for Rainbow Trout is approximately 24 - 26°C, 10-22°C as an optimal range. Brown trout are reported as having slightly lower maximum CTMs of up to 23.5°C - 26.7°C, with an optimal range of 8 - 17°C. Therefore, both species of trout can tolerate a range of high temperatures with Rainbow Trout tolerating slightly higher temperature than Brown Trout, especially when reproductive success is examined (Molony 2001). Both species can withstand salinities up to 30 (just below sea water). Dissolved oxygen is one of the most critical requirements for trout survival with neither species found in waters below 2.5 mg/L though generally above 4 or 5 mg/L is required for successful growth and survival (Molony 2001).

Brown and Rainbow Trout both feed on a variety of animals including aquatic macro-invertebrates, (crustaceans, molluscs, insects), small fishes and any terrestrial insects which fall into the water.

Brown Trout live for up 22 years whereas Rainbow have maximum ages of up to 11 years (Fishbase 2009). In practice, most Brown Trout live up to 4-5 years (or longer) with Rainbow Trout perhaps only 3-4 years but occasional individuals do survive up to 14 years (for Brown Trout) and somewhat less for Rainbow Trout (Douglas and Kylie 2004; Kylie & Douglas 2008). Brown Trout juveniles (> 0+) are known to be highly dispersive, typically moving downstream from upper sub-catchments with age (Davies 2005).

Stock would be sourced from the DPI Snobs Creek aquaculture facility and stocked as yearlings 150-300gm. The source of the stock will be aquaculture bred fish (in the case of Salmonoids either the DPI facility at Snobs Creek or suppliers to Fisheries Victoria). It has been assumed for the purposes of the risk assessment that all fish will be produced in a facility which has an ongoing stock health surveillance program that meets DPI requirements and where there have been no unexplained disease outbreaks at the source facility in the past 24 months.

3 PROJECT METHODS

The following project plan consisted of 5 major tasks:

- Task 1: Review and Scoping
- Task 2: Information Review
- Task 3: Field Inspection
- Task 4: Risk Assessment
- Task 5: Reporting

The following project details detail the tasks and the outputs.

3.1 Task 1: Review and Scoping

The project began with an inception meeting with Fisheries Victoria to ensure the objectives of the project were understood, and all the relevant background information was collected and collated. The meeting agreed upon the major tasks and timeframes to enable the project plan to be refined.

3.2 Task 2: Information Review

The second task developed an "information log" (or Info-Log), to document the reports and information resources available to the project. The Info-Log was used to summarise which documents were obtained for the project. The Info-Log was updated throughout the project. This information was reviewed and a list of potential issues identified. This list of issues was assessed in the field and later in an internal consultant's workshop.

3.3 Task 3: Field Inspection

The field inspection allowed an onsite meeting with Fisheries Victoria and Parks Victoria, was used to confirm the list of issues and to inspect the site. The site inspection examined the system in terms of suitable habitat for the fish, determined the connectivity with up-stream and down-stream waterways, identified potentially affected waters, and assessed any identified issues. These issues were then fed into the preliminary risk assessment.

3.4 Task 4: Risk Assessment

The risk assessment followed the Victoria EPA-developed Ecological Risk Assessment process, which has six steps:

1. Develop an explicit statement of investigation (problem formulation) for the risk assessment;
2. Identification of the values associated with the waters to be stocked and any connected waterways;
3. Identification of the threats posed to the values associated with the proposed translocations;
4. Undertake a preliminary risk assessment with existing information and local knowledge;
5. Documentation of gaps identified and assumptions made during the process; and,
6. Recommendations for appropriate risk mitigation actions to protect values and reduce threats to these values.

The Translocation Risk Assessment proforma which is used for assess submissions to the Translocation Evaluation Panel was filled out as part of step 4 and shown in Appendix 1.

In this study, the risk analysis was semi-quantitative, that is, risks were ranked, based on known data or literature and extrapolated to the site. The analysis is therefore described as "preliminary", to distinguish it from a quantitative analysis. The preliminary risk analysis required the determination of a consequence level and likelihood (or probability) rating of each threat causing any impacts each value. The qualitative nature of the analyses required documentation of the logic used in allocating ratings. This is provided in the sections below.

3.4.1 Identifying and incorporating the values

Key values of the site and its surrounding catchment were identified through a review of relevant literature, discussions with site managers, and a site inspection.

The risk analysis process is designed to qualify the risks associated with the translocation of the fish species. The process uses a qualitative analysis to describe the magnitude of the potential consequences and the likelihood that the consequences may occur. This form of analysis is broadly accepted for environmental purposes (Australian Standards, 2004) because of the limited knowledge of ecosystem thresholds and ecosystem responses associated with natural resource management actions.

In this risk assessment, a consequence table was designed based on the selected endpoints (refer Section 5), displaying a range of severity levels of consequence to each endpoint. The consequence ratings for each threat were allocated on the basis of the potential for impact upon each value – in essence a "worst-case scenario" rating. A likelihood scale was also derived, categorising the probabilities of each threat being realised. The consequence and likelihood tables are presented in a later section (Section 7 – Risk Assessment). The tables were used in a workshop of the authors to determine the risks of the stocking proposals, and then rank the species in order of risk rating (risk prioritisation). It is important to recognise that this approach provides a general guide only, as there can be problems associated with allocating a numerical value to a categorical ranking. For this reason, the risk rankings are considered as indicative only, with lines of logic being presented to facilitate examination of the decision-making.

3.4.2 Risk Characterisation

The outcomes of the preliminary analysis were subsequently described in terms of their relationship to the site and its surrounding catchment (risk characterisation). This process defined what the risk analysis means for the creeks. The process is completed with discussion of uncertainties and consideration of limitations resulting from knowledge gaps and assumptions.

3.4.3 Management Action Recommendations

The key threats, their risk ratings and associated knowledge gaps/assumptions were subsequently tabulated with recommended management actions for risk reduction. Management actions can include ameliorative actions to lessen risks, monitoring (with adaptive management planning) and/or further assessments.

3.5 Task 5: Reporting

The draft risk assessment was produced to allow written and verbal comments to be made on the report. In order to facilitate this, a formal presentation was made in which the report's findings were presented to key Fisheries Victoria staff after the draft document was delivered. The risk assessment was finalised by responding to comments received.

4 VALUES & THREATS

4.1 Values

A list of values for the Devilbend and Bittern Reservoirs, and the Devilbend and Balcombe Creeks was restricted to those values that could potentially be impacted by the introduction of brown trout, rainbow trout and Australian Bass. These included:

1. The existing fish community in Devilbend & Bittern Reservoirs (the primary value being potential angling opportunities and natural ecosystem value)
2. The current fish community in Devilbend Creek and Balcombe Creek system (the primary value being the natural ecosystem apart from the threatened Dwarf Galaxiid)
3. A significant fish species (Dwarf Galaxiid) in Devilbend Creek and Balcombe Creek system (the primary value being the continued support for species listed as nationally vulnerable)
4. The White-bellied Sea Eagle (a threatened species within Victoria) nest within the Devilbend Reserve (this also represents other significant bird species which feed upon fish)
5. The Blue-billed Duck (a threatened species within Victoria) population that uses Devilbend Reservoir (this also represents other significant bird species which feed upon macroinvertebrates)

The potential pathways of the key threats posed to each value, through stocking with brown trout and rainbow trout and Australian Bass are listed in Sections 4.1.1 to 4.1.5.

4.1.1 Current fish community in Devilbend & Bittern Reservoirs (threats to the potential angling value and natural ecosystem value). This value could be impacted through the following pathways:

- Mature Brown Trout, Rainbow Trout and Australian Bass may prey upon existing fish species in Devilbend & Bittern Reservoirs, changing the structure of current fish assemblages in the reservoirs and impacting on the angling quality and natural ecosystem value of the water bodies;
- Brown Trout, Rainbow Trout and Australian Bass may compete with existing fish species in Devilbend & Bittern Reservoirs, leading to the loss or reduction of some species; and
- Stocking of Brown Trout, Rainbow Trout and Australian Bass may introduce disease and/or parasites to the waterbodies, threatening existing fish species in the reservoirs.

4.1.2 Current fish community in Devilbend Creek and Balcombe Creek system (must at least maintain current ecological condition). This value could be impacted through the following pathways:

- Mature Brown Trout, Rainbow Trout and Australian Bass may prey upon existing fish species in Devilbend Creek and Balcombe Creek system
- Stocked juvenile Brown Trout and Rainbow Trout and stocked and breeding Australian Bass may compete with existing fish species in Devilbend Creek and Balcombe Creek system

- Stocking of Brown Trout, Rainbow Trout and Australian Bass may introduce disease and/or parasites to the waterbodies, threatening existing fish species in Devilbend Creek and Balcombe Creek system

4.1.3 Significant fish species (Dwarf Galaxiid) in Devilbend Creek and Balcombe Creek system. This value could be impacted through the following pathways:

- Mature Brown Trout, Rainbow Trout and Australian Bass may prey upon Dwarf Galaxiids in the Devilbend Creek and Balcombe Creek system
- Juvenile Brown Trout, Rainbow Trout and Australian Bass may compete with Dwarf Galaxiids in Devilbend Creek and Balcombe Creek system
- Stocking of Brown Trout, Rainbow Trout and Australian Bass may introduce disease and/or parasites to the waterbodies, threatening Dwarf Galaxiids in Devilbend Creek and Balcombe Creek system

4.1.4 White-bellied Sea Eagle population. This value could be impacted through the following pathways:

- Introduction of Brown Trout, Rainbow Trout and Australian Bass may impact on current fish community in Devilbend Reservoir, reducing food availability for resident White-bellied Sea Eagles
- Introduction of Brown Trout, Rainbow Trout and Australian Bass may impact on current fish community in Devilbend Creek and Balcombe Creek system, reducing food availability for resident White-bellied Sea Eagles
- This would also represent other significant bird species which feed upon fish.

4.1.5 Blue-billed Duck population. This value could be impacted through the following pathways:

- Introduction of Brown Trout, Rainbow Trout and Australian Bass may impact on current macroinvertebrate biomass in Devilbend Reservoir, reducing food availability for Blue-billed Duck
- This would also represent other significant bird species which feed upon macroinvertebrates

4.2 Threats

The threats presented below were used in the qualitative risk assessment (see Section 7). Although largely a rewording of some potential pathways presented in Section 4.1 (above), each threat that was used in the qualitative risk assessment needs to be described as a discrete component.

4.2.1 Predation in Reservoirs (fish)

The introduction of the three piscivorous species to the reservoirs creates a predation threat to the populations of existing species. All three species are aggressive feeders and could feed on juveniles and adults of smaller fish species within the reservoirs.

4.2.2 Predation in Reservoirs (macroinvertebrates)

All three species proposed for introduction are known to be predators of macroinvertebrates. Diets for the introduced species will vary with age of the individuals and would range from small zooplankton being consumed by juveniles, through larval stages of larger insects, to larger crustaceans such as yabbies.

4.2.3 Competition in Reservoirs (fish impacts)

The proposed species for introduction have the potential to compete with existing species in the reservoirs for food and habitat. In particular, the existing population of introduced Redfin Perch may have overlapping resource requirements with the three proposed introductions. To some extent, juveniles of the proposed introductions may compete with the smaller native species in the reservoirs.

4.2.4 Introduction of Disease to Reservoirs

There is a potential threat that an individual of any of the species proposed for introduction may be carrying pathogenic bacteria, viruses, fungi or protozoa. If any pathogens establish, they may impact on the biota of the reservoirs.

Escape from Reservoirs

Escape from the reservoir is the key process for the threats 4.2.5 to 4.2.8 to occur and this is therefore described. During large rainfall events, the reservoirs may overflow and discharge into the Devilbend Creek. During these overflows there is a potential threat of biota from the reservoirs to be washed into the Devilbend and Balcombe Creek system. The probability of fish escaping will depend upon frequency of spills, the type of species (Bass are more likely to be triggered to swim downstream during a rain event [Harris 1985 and Harris et al. 1986]; a percentage of young brown trout are also triggered to swim downstream in such conditions [Davies 2005]) and the magnitude of the spill.

4.2.5 Predation in Creeks

Similar to predation in the reservoirs, there exists the potential threat of predation by the proposed introductions upon the juveniles and adults of smaller fish species within the creek systems.

4.2.6 Predation in Creeks (macroinvertebrates)

Predation by the proposed introductions upon the creek macroinvertebrate fauna is also a risk to the values identified in the study. In particular, any juveniles that escape from the reservoirs or offspring of adults (in the case of Australian Bass) that escape pose a threat to the macroinvertebrate fauna of the system of small receiving creeks and the estuary.

4.2.7 Competition in Creeks (juvenile stages of escapees)

The adults of the species proposed for introduction are unlikely to compete with the fish species present in the creek systems. However, juveniles of the proposed introductions may compete with the current fish fauna within the creeks.

4.2.8 Introduction of Disease to Creeks

Similar to the reservoirs, there is a potential threat that an individual of any of the species proposed for introduction may be carrying pathogenic bacteria, viruses, fungi or protozoa. Any introduced pathogens could escape to the creek systems and establish, subsequently impacting upon the creeks' biota.

4.2.9 Reduced food for Sea Eagles

Any impact on the number of individuals or species within the reservoirs or creek systems has the potential to threaten the food resources of the resident White-bellied Sea Eagles of the site.

4.2.10 Reduced food for Blue-billed Duck

Any impact on the number of individuals or species of macroinvertebrates within the reservoirs or creek systems has the potential to threaten the food resources of the resident Blue-billed Duck population of the site.

4.3 Ecosystem level impacts

Stocking alone (at the levels contemplated with the large Devilbend and Bittern Reservoirs) is unlikely to result in the complex ecosystem level impacts such as restructuring food webs and changing nutrient cycling (Lloyd et al 1998 & 2000; Berg et al 1997; Benndorf 1990). This is further supported by the already large population of the piscivore, Redfin, present within the reservoirs (McGuckin 2001) and the likelihood that further predator introductions would not lead to an increased predatory impact on native fish or other ecosystem components.

In fact, Benndorf (1990) showed that high piscivore diversity increases stability and reliability of food web manipulations. Drenner (2002) found most studies did not find piscivore effects on phytoplankton biomass and therefore did not support the trophic cascading interactions hypothesis. In Lake Hume, high densities of planktivorous stages of alien European perch (*Perca fluviatilis*) did not translate into declining trends for plankton in the reservoir (Matveev and Matveeva 2005). The authors concluded that the community was structured by nutrient levels and water level fluctuations (Matveev and Matveeva 2005).

Clearly, these type of impacts are complex to understand and little information is available to provide valid input to this semi-quantitative risk assessment.

5 STATEMENT OF INVESTIGATION

Within a risk assessment, a statement of investigation clearly states the question being asked of the assessment and defines the measurement endpoints that can be used to assess impacts to the key values of the ecosystem.

The investigative question for this risk assessment is:

> **What are the risks posed to the current assemblages and populations of Devilbend and Bittern Reservoirs and the Devilbend / Balcombe Creek systems by translocating (introducing) Brown Trout, Rainbow Trout and Australian Bass?**

Using the values and threats identified in Section 4, the specific values and their measurement endpoints are presented in Table 5.1.

Table 5.1: Measurement endpoints for each value in the risk assessment

Value (Assessment endpoint)	Measurement Endpoint
Current fish community in Devilbend Reservoir	Angling worth and natural ecosystem value – maintaining current potential standards
Dwarf Galaxiid population in Devilbend Creek and Balcombe Creek system	No reduction in population number and distribution
Current fish community in Devilbend Creek and Balcombe Creek system	Maintain ecological structure and function of community
White-bellied Sea Eagle population (as representative of other piscivorous birds)	No reduction in population number
Blue-billed Duck population (as representative of other macroinvertebrate eating birds)	No reduction in number of individuals using the reservoir(s), within bounds of natural variability

6 CONCEPTUAL MODEL

The conceptual model for the translocation of Brown Trout, Rainbow Trout and Australian Bass to Devilbend and Bittern Reservoirs (Figure 6.1 & 6.2) displays pathways for interaction within the reservoirs as well as pathways for interactions in the event of these species escaping to the Devilbend and Balcombe Creek system. Each set of interactions includes the possibility of predation, competition and disease introduction. The pathways ultimately link to the five values listed in Table 5.1.

The stocking of the reservoirs with piscivorous predator species creates a potential threat to the structure and functioning of the current fish assemblages within the reservoirs, through predation upon the smaller species that occur in the reservoirs. Similarly, there is a potential threat of the stocked species competing with existing species for food (e.g. macroinvertebrates) and habitat, thereby impacting on the current fish assemblages. Clearly, the introduction of diseases to the water bodies would be a potential impact on the fish assemblages within the reservoirs and therefore subsequently fish eating birds (such as the Sea Eagle).

The potential for the stocked fish to reduce the biomass of aquatic macroinvertebrates within the reservoirs (represented by the brown box in Figure 6.1 & 6.2) also has the potential to impact the population of Blue-billed Duck and other like feeders that use the reservoirs, as the food for these birds includes the larvae of midge, caddisflies and dragonflies (Stamation and Lyon 2009).

The potential interactions between threats and values increase in the event of escapes from the reservoirs to the receiving creek systems. The complexity of the interactions also increases in the event of an escape. Two reasons for this increase in number and complexity of interactions are: (i) the fish assemblages in the creek systems are valued more as functioning aquatic ecosystems rather than for angling; and (ii) there is a significant fish species, in limited numbers, within these creek systems.

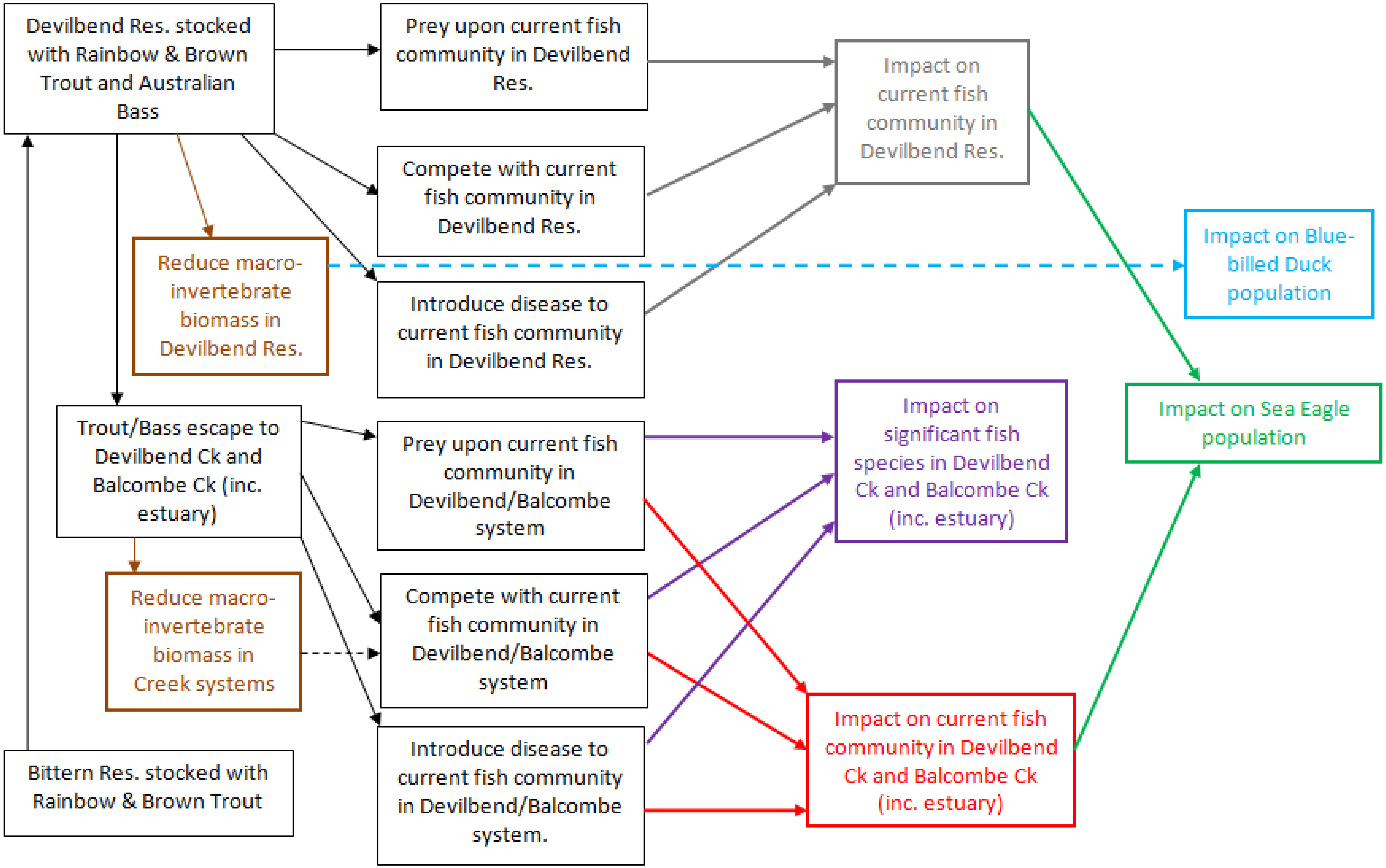

Figure 6.1: Conceptual Model of threat pathways to values in Devilbend Reservoir study area

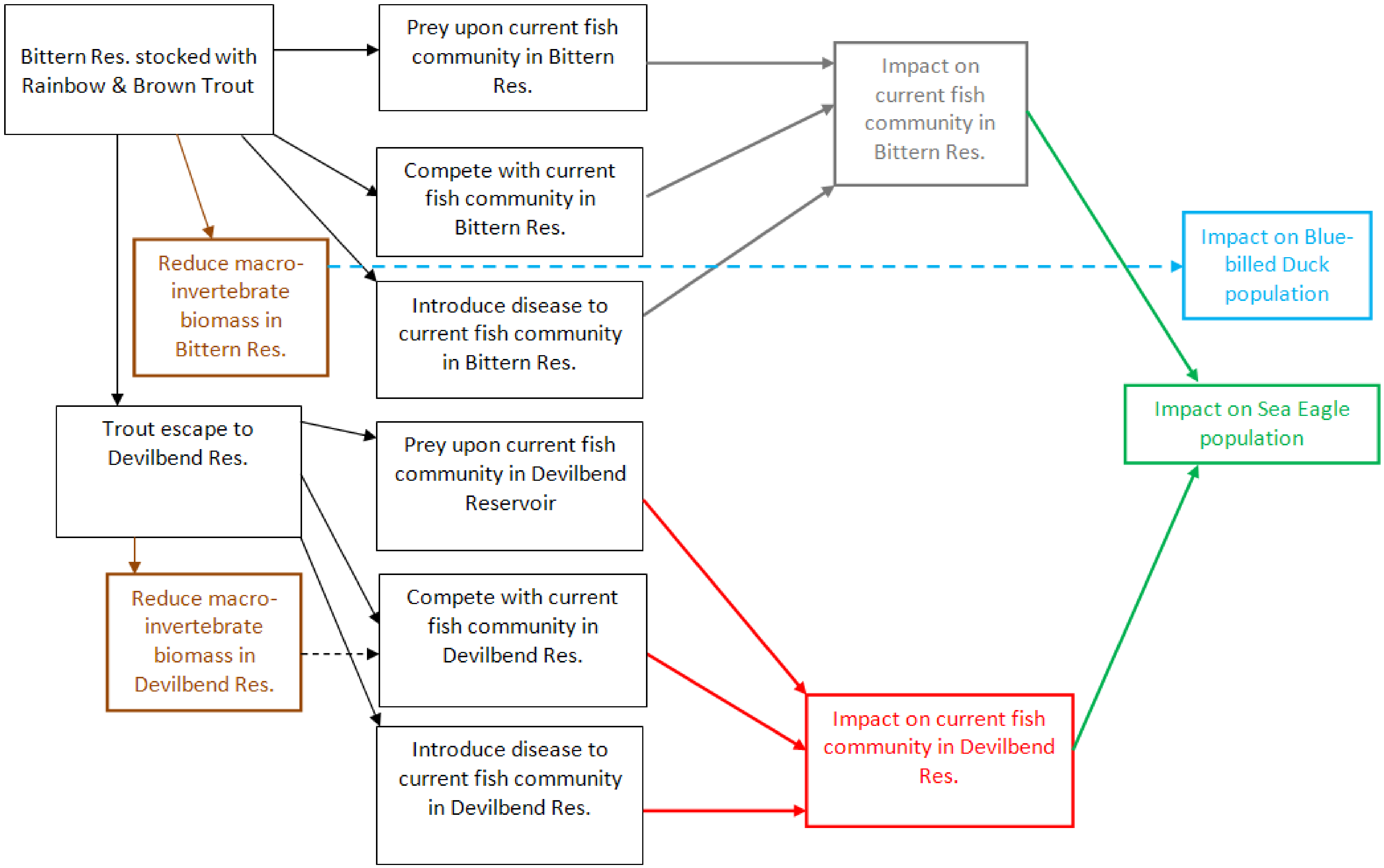

Figure 6.2: Conceptual Model of threat pathways to values in Bittern Reservoir study area

7 RISK ANALYSIS

The qualitative risk analysis required the determination of a consequence level and likelihood (or probability) of each threat causing any impacts on the values, for each of the three species proposed for introduction. The qualitative nature of the analyses required documentation of the logic used in allocating ratings. This is provided in the sections below. The introductions were evaluated by allocating a risk score to each species under each threat to relevant values. The risk scores were calculated as the product of consequence (Table 7.1) and likelihood (Table 7.2) under typical conditions within the reservoirs.

Table 7.1: Consequence levels of impacts on the values of the study area

Consequence Severity Level	Descriptor	Consequence to the current assemblages or populations in Devilbend Reservoir, Creek or Reserve
4	Very High	Long-term loss of existing community or population
3	High	Long-term reduction of existing community or population
2	Moderate	Long-term maintenance of existing community or population, but with short- or medium-term reduction in numbers
1	Low	Long-term maintenance of existing community or population at current numbers

Table 7.2: Likelihood ratings for threats to the values of the study area

Likelihood Rating	Descriptor	Definition
5	Near certain	Confident that the translocation will impact the community or population
4	Highly likely	The translocation is expected to impact the community or population
3	Likely	The translocation is likely to impact the community or population
2	Unlikely	The translocation is unlikely to impact the community or population
1	Highly unlikely	Confident that the translocation will not impact the community or population

Risk is simply calculated by the multiplication of both likelihood and consequence scores and the resulting score is qualitatively assigned into 3 categories of low, medium and high risk (Table 7.3).

Table 7.3: Final Risk Scores for the Assessment

		Consequence			
		1	2	3	4
Likelihood	1	1	2	3	4
	2	2	4	6	8
	3	3	6	9	12
	4	4	8	12	16
	5	5	10	15	20

Low Risk
Moderate Risk
High Risk

In this study, the risk posed by stocking the three proposed fish species was firstly calculated individually for each species.

Table 7.4 provides the consequence and likelihood scores for the risk assessment for Devilbend Reservoir for Brown Trout (BT), Rainbow Trout (RT) and Australian Bass (AB). Table 7.5 provides the risk scores for the risk analysis for Devilbend Reservoir for the three species.

The rationale for the allocation of the consequence and likelihood scores for each threat is presented for each value in Sections 7.1 to 7.5, below. The results for Bittern Reservoir were identical to those of Devilbend Reservoir, with the exception of the Australian Bass results, as there is no proposal to stock Bittern Reservoir with Australian Bass.

7.1 Risk analysis results and rationale for the value 'Fish Community in Reservoirs'

As the geographic scope of this value was the reservoirs, the five threats relating to impacts on the creek systems were not assessed for this value (shaded grey in Tables 7.4 and 7.5). The first threat evaluated was 'Predation in Reservoirs (fish impacts)'. As noted in Table 5.1, the measurement endpoint for this value is the angling worth and natural ecosystem value. Given that the reservoirs currently contain a large, predatory exotic fish population (Redfin Perch; McGuckin 2001), the introduction of one or more species of piscivorous fish was considered to have a low or moderate consequence (rating 1 for Rainbow Trout because of shorter lifespan and rating 2 for the other two species) on the angling worth and the natural ecosystem value of the reservoirs.. In order for stocked species to become established, it is likely that some the Redfin Perch will be displaced by the fish introductions and predator pressure would not increase. Therefore it would be of no consequence to the angling worth and natural ecosystem value of the reservoirs. Redfin are considered as voracious, or more so, than all three proposed species. Further, the introductions would be considered better angling species, resulting in an improvement to the angling worth. The likelihood of any negative impacts was rated 'unlikely' (rating 2). This led to a Low risk score for all three proposed species (2 for Rainbow Trout; 4 for Brown Trout and Australian Bass).

Similar to the threat of fish predation, the threat of macroinvertebrate predation impacting on the current fish community is also low due to the existing population of Redfin Perch in the reservoirs. Redfin Perch are predators of aquatic macroinvertebrates and the consequences of increased competition with the proposed introduced species were considered low or moderate consequence in terms of angling worth (rating 1 for Rainbow Trout because of shorter lifespan and rating 2 for the other two species). The likelihood of any negative impacts was rated 'unlikely' (rating 2), leading to a Low risk score for all three proposed species (2 for Rainbow Trout; 4 for Brown Trout and Australian Bass).

The threat to angling and natural ecosystem value posed by overall competition (for habitat as well as food sources) between the proposed introductions and the current assemblages has a slightly higher consequence (rating 2) for the Brown Trout and Australian Bass, due to their longevity. In contrast, the lower life expectancy of Rainbow Trout kept the consequence rating to 1 (low). For all three species, any impact was considered 'unlikely' due to the existing population of Redfin Perch in the reservoirs. This resulted in a risk score of 4 (Low) for the Brown Trout and the Australian Bass, and a score of 2 (also Low) for the Rainbow Trout.

A key assumption of this assessment is that rigorous procedures will be followed in any translocation, including adherence to the procedures set out in the Protocols for the Translocation of Fish in Victorian Inland Public Waters (Department of Primary Industries 2005) for eliminating introductions of pathogens. Assuming these procedures are followed correctly, the possible consequences and likelihood of that threat being realised were rated as 'low' and 'highly unlikely' respectively (rating 1 and 1), leading to Low risk score of 1.

As discussed above, the introduction of additional fish species is considered a low risk to the existing angling or natural ecosystem value of the reservoirs. The proposed introductions will add new species to the existing fish community but is not expected to impact the availability of fish for angling or natural ecosystem values of the reservoirs. This is also the case for the availability of fish as prey for the site's resident White-bellied Sea Eagles. As the site is likely to be one of several food sources for the Sea Eagles and because there is a low risk to changes in the fishing worth of the site, the introductions will have a low consequence on the Sea Eagle residents. Similarly, the likelihood of any impacts is 'very unlikely' resulting in a Low risk score of (1 X 1 =) 1.

7.2 Risk analysis results and rationale for the value 'Fish Community in Devilbend Creek and Balcombe Creek system'

As the geographic scope of this value was the creek systems, the four threats relating to impacts on the reservoirs were not assessed for this value (shaded grey in Tables 7.4 and 7.5). This value is markedly different to the previous, as the focus is on the ecological condition of the fish community, downstream of the reservoirs . The creek systems are small, with dense riparian cover and containing small native species (e.g. Hardyhead, Gudgeons, Pygmy Perch, and Dwarf Galaxias) and shortfinned eels.

Review of the hydrological modelling for the site (GHD 2008) suggests that the reservoirs are expected to overflow in 55% of years under the preferred management scenario (see section 2). The risks of predation and competition from translocated fish are underpinned by escape of fish.

Without spill or escape mitigation this creates a high likelihood of the proposed introduced species escaping and surviving to the receiving creek systems. If the escaped individuals are juvenile, they are likely to compete with the smaller native species in the creek systems. Consequences of an escape are likely to be medium- or short-term for the two Trout species, as they will not breed if they escape. For the Australian Bass, however, there is a possibility that they might breed and/or hybridise with Estuary Perch in the Balcombe Creek estuary (if present) or those in nearby estuaries. Even a few individuals of these predatory species, if they were to become established to a site within a creek, they are likely to exert an ongoing predatory pressure on small native fish for 2-4 years (in the case of trout) and even longer for Australian Bass, even if none of the breed. However, there is some chance that Australian Bass will breed and establish self-sustaining populations.

In the event of escape the introduction of new predators to the creek system are likely to have ongoing consequences for the existing fish community (given the low numbers of exotic predators already present within the creek system). The longevity of Brown Trout and the potential for Australian Bass to breed within the system means that the consequences for these impacts could be long-term (rating 3), whereas the shorter life-span for Rainbow Trout suggests that consequences would more likely be restricted to the short- to medium-term (rating 2). For all three species, the likelihood of an impact was assessed as highly likely (likelihood rating 4) given the predatory nature of the species and their high likelihood of escape. Therefore the risk rating for impacts of predation on the creek fish communities was calculated as 12 (High) for the Brown Trout and Australian Bass, and 8 (Moderate) for the Rainbow Trout.

Similar to the threat of fish predation, the threat of macroinvertebrate predation impacting on the current fish community of the creek systems is also highly likely (given the low numbers of exotic predators already present within the creek system) for all three species (likelihood rating 4). All three species are considered voracious feeders and the longevity of Brown Trout and the potential for Australian Bass to breed within the system means that the consequences for these impacts could be long-term (rating 3), giving both these species a High risk rating of 12. The shorter life-span for Rainbow Trout suggests that consequences would more likely be restricted to the short- to medium-term (rating 2), resulting in a risk rating of 8 (Moderate) for the Rainbow Trout.

The threat of juvenile stages of the escaped species competing with native fish in the creek systems was considered 'likely' (likelihood rating = 3) to have some impact. Brown Trout and Australian Bass have a tendency to travel downstream on flow events, so this makes it more likely that these species will escape from the reservoir if it spills (Harris 1985, Harris et al. 1986; Davies 2005). The two trout species would be new competitors. Although they will not breed within the creek systems and any escaped fish will not remain for more than the short-to medium term, they could be replaced by reservoir overflows, having a potential long-term impact and resulting in a consequence rating of 3. The Australian Bass also received a consequence rating of 3 as although it is a native species similar to other possible native competitors such as Estuary Perch, the fact that it may be able to breed within the system means that it may have ongoing and higher numbers of juveniles in the systems. Therefore all three species received a risk rating of 9 for the threat of competition with the creek fish communities. This risk is reinforced by the stocking strategy likely to see fish stocked each year for 5 years, in the first instance.

Similar to the threat of diseases impacting the fish community at the reservoir, the possible consequences and likelihood of that threat being realised in the fish communities of the creek systems were rated as 'low' and 'highly unlikely' respectively (rating 1 and 1), leading to a Low risk score of 1. The fact that the fish communities of the creek system are unlikely to provide substantial food for the White-bellied Sea Eagles resulted in there being a 'highly unlikely' likelihood rating and a low consequence of impacts upon the fish community with respect to this value.

7.3 Risk analysis results and rationale for the value 'Dwarf Galaxiid population in Devilbend Creek and Balcombe Creek system'

Again, with the geographic scope of this value being restricted to the creek systems, the four threats relating to impacts on the reservoirs were not assessed for this value. For all three proposed species, the likelihood of escaping and individuals establishing was regarded as highly likely and as all the translocated fish are long- lived predators (in comparison to the short-lived Dwarf Galaxiids), the consequences to the Dwarf Galaxiid population could be long-term.

The introduction and survival of new predators to the creek system will have consequences for the existing Dwarf Galaxiid population. The longevity of Brown Trout and the potential for Australian Bass to breed within the system means that the consequences for these impacts could be long-term (rating 3), whereas the shorter life-span for Rainbow Trout suggests that consequences would more likely be restricted to the short- to medium-term (rating 2). For all three species, the likelihood of an impact was assessed as highly likely (likelihood rating 4) given the predatory nature of the species and their high likelihood of escape. Therefore the risk rating for impacts of predation on the Dwarf Galaxiid population was calculated as 12 (High) for the Brown Trout and Australian Bass, and 8 (Moderate) for the Rainbow Trout.

The impact, rationale and assessment outcomes for the impact of the introduced species upon macroinvertebrates for Dwarf Galaxiids are the same as for the general fish community of the creeks. The threat of reduced macroinvertebrates due to increased predation impacting on the Dwarf Galaxiids is considered highly likely for all three species (likelihood rating 4). Similarly, the longevity of Brown Trout and the potential for Australian Bass to breed within the system indicates potential long-term consequences (rating 3), giving both these species a High risk rating of 12. The shorter life-span for Rainbow Trout indicates that consequences would more likely be restricted to the short- to medium-term (rating 2), resulting in a risk rating of 8 (Moderate) for the Rainbow Trout.

The threat of juvenile stages of the escaped species competing with Dwarf Galaxiids in the creek systems was considered ‘likely’ (likelihood rating = 3) to have some impact. The two trout species would be new competitors. Although they will not breed within the creek systems and any escaped trout will not remain for more than the short- to medium term, they could be regularly replaced by reservoir overflows, having a potential long-term impact and resulting in a consequence rating of 3. The Australian Bass also received a consequence rating of 3 as although it is a native species similar to other possible native competitors such as Estuary Perch, the fact that it may be able to breed within the system means that it may have ongoing and higher numbers of juveniles in the systems (the rating is lessened somewhat due to the fact that this is a predator similar to locally native fish (Estuary Perch). Therefore all three species received a risk rating of 9 for the threat of competition with the Dwarf Galaxiid population.

Similar to the threat of diseases impacting the fish community at the reservoir, the possible consequences and likelihood of that threat being realised in the Dwarf Galaxiid population in the creek systems were rated as ‘low’ and ‘highly unlikely’ respectively (rating 1 and 1), leading to a Low risk score of 1. The fact that the Dwarf Galaxiid population of the creek system are unlikely to provide substantial food for the White-bellied Sea Eagles resulted in there being a ’highly unlikely’ likelihood rating and a low consequence of impacts upon the fish community with respect to this value.

7.4 Risk analysis results and rationale for the value ‘White-bellied Sea Eagle residents’

The introduction of additional fish species to the reservoirs and creek systems is highly unlikely (rating 1) to lead to any impact on bird populations (consequence rating 1) as establishment of new predators within the system will be a replacement of existing predators. This is more likely to result in a change of the community assemblage than a change in structure or biomass. For this reason, all risks to the White-bellied Sea Eagle residents received a risk rating of 1 (Low risk). This would also apply to other piscivorous birds in the reservoir.

7.5 Risk analysis results and rationale for the value 'Blue-billed Duck Population'

The only threat from the proposed introductions that was considered a possible risk to Blue-billed Ducks was the increased predation of macroinvertebrates in the reservoirs. This is because Blue-billed ducks are common on the reservoirs and macroinvertebrates form part of their diet. However, given that the reservoirs currently contain a large predatory fish population (Redfin Perch), the introduction of one or more species of piscivorous fish was considered to have a low consequence (rating 1). If the introductions resulted in the Redfin Perch being replaced as the top predator, it is unlikely (likelihood rating 2) to have any consequence upon the macroinvertebrates and hence the Blue-billed Ducks. This led to a Low risk score of 2 for all three proposed species. This would also apply to other macro-invertebrate eating birds in the reservoir.

Table 7.4: Risk Assessment for Devilbend Reservoir (Consequence X Likelihood). BT = Brown Trout, RT = Rainbow Trout, AB = Australian Bass

Threat / Value	Predation in Reservoirs (fish impacts)	Predation in Reservoirs (macro-invertebrate impacts)	Competition in Reservoirs (fish impacts)	Introduction of Disease to Reservoirs*	Predation in Creeks (fish impacts)	Predation in Creeks (macro-invert. impacts)	Competition in Creeks (juvenile stages of escapees)	Introduction of Disease to Creeks	Reduced food for Sea Eagles
Fish Community in Reservoirs	BT:2 X 2 RT:1 X 2 AB:2 X 2	BT:2X 2 RT:1 X 2 AB:2 X 2	BT:2 X 2 RT:1 X 2 AB:2 X 2	BT:1 X 1 RT:1 X 1 AB:1 X 1					BT:1 X 1 RT:1 X 1 AB:1 X 1
Fish Community in Creek System					BT:3 X 4 RT:2 x 4 AB:3 x 4	BT:3 X 4 RT:2 x 4 AB:3 x 4	BT:3 x 3 RT:3 x 3 AB:3 x 3	BT:1 x 1 RT:1 x 1 AB:1 x 1	BT:1 x 1 RT:1 x 1 AB:1 x 1
Dwarf Galaxiids in Creek System					BT:3 x 4 RT:2 x 4 AB:3 x 4	BT:3 x 4 RT:2 x 4 AB:3 x 4	BT:3 x 3 RT:3 x 3 AB:3 x 3	BT:1 x 1 RT:1 x 1 AB:1 x 1	
White-bellied Sea Eagle residents	BT:1 X 1 RT:1 X 1 AB:1 X 1	BT:1 X 1 RT:1 X 1 AB:1 X 1	BT:1 X 1 RT:1 X 1 AB:1 X 1	BT:1 X 1 RT:1 X 1 AB:1 X 1					BT:1 x 1 RT:1 x 1 AB:1 x 1
Blue-billed Duck Population		BT:1 X 2 RT:1 X 2 AB:1 X 2							

*assumes appropriate biosecurity measures are in place (certified disease free)

Table 7.5: Risk Scores for Devilbend Reservoir. BT = Brown Trout, RT = Rainbow Trout, AB = Australian Bass

Threat / Value	Predation in Reservoirs (fish impacts)	Predation in Reservoirs (macro-invertebrate impacts)	Competition in Reservoirs (fish impacts)	Introduction of Disease to Reservoirs*	Predation in Creeks (fish)	Predation in Creeks (macro-invert. impacts)	Competition in Creeks (juvenile stages of escapees)	Introduction of Disease to Creeks	Reduced food for Sea Eagles
Fish Community in Reservoir	BT: **4** RT: **2** AB: **4**	BT: **4** RT: **2** AB: **4**	BT: **4** RT: **2** AB: **4**	BT: **1** RT: **1** AB: **1**					BT: **1** RT: **1** AB: **1**
Fish Community in Creek System					BT: **12** RT: **8** AB: **12**	BT: **12** RT: **8** AB: **12**	BT: **9** RT: **9** AB: **9**	BT: **1** RT: **1** AB: **1**	BT: **1** RT: **1** AB: **1**
Dwarf Galaxiids in Creek System					BT: **12** RT: **8** AB: **12**	BT: **12** RT: **8** AB: **12**	BT: **9** RT: **9** AB: **9**	BT: **1** RT: **1** AB: **1**	
White-bellied Sea Eagle residents	BT: **1** RT: **1** AB: **1**	BT: **1** RT: **1** AB: **1**	BT: **1** RT: **1** AB: **1**	BT: **1** RT: **1** AB: **1**					BT: **1** RT: **1** AB: **1**
Blue-billed Duck Population		BT: **2** RT: **2** AB: **2**							

7.6 Knowledge Gaps and Assumptions

A lack of complete knowledge and understanding of environmental systems requires the use of assumptions when undertaking risk assessments. In this study, the major knowledge gaps centre on the likelihood of individuals escaping, surviving escape from the reservoirs and the successful establishment of escapees in the downstream environments. This is particularly relevant in the context of the existing piscivore (Redfin Perch) in Devilbend Reservoir. McGuckin (2001) showed large numbers of Redfin Perch present within the reservoirs using a range of gear and this is used as the basis of the risk assessment. Thompson and Walker (2009) also concluded that Redfin were likely to be the dominant large bodied fish in the reservoirs despite low numbers caught in their survey (as their techniques were unlikely to reflect these population levels).

Redfin Perch have a maximum life expectancy of 22 years (Fishbase 2009 – see www.fishbase.org) with many individuals living about half this time (Dr Michael Shirley. SKM New Zealand, pers comm.). As the current probability of overflow from the reservoir is 20% (i.e. one year in five), it is reasonable to expect that this species has had the opportunity to escape and establish to the downstream environment. Surveys of the creeks systems (ANGFA 2005, McGuckin 2001, 2007, SEITA 2008) have not recorded Redfin Perch (McGuckin 2001 lists Redfin present within the creek in a table but data in his appendices shows the species was not recorded), indicating that either the surveys have been undertaken at times or places or in ways that were not conducive to catching this species, or that Redfin Perch do not escape and establish in the creek systems. A more likely scenario is that any escaped fish had died out when surveys were done. The last spill was in 1996 and the next survey in the system downstream of the reservoirs was 2001 (McGuckin 2001). Natural mortality would mean fewer fish through time, making these harder to detect.

In this risk assessment, we have assumed that there is a possibility that the proposed stocking species can escape, with or without the Redfin Perch. Brown Trout and Australian Bass have a tendency to travel downstream on flow events (Harris 1985, Harris et al. 1986, Davies 2005), so this makes it more likely that these species will escape from the reservoir if it spills. We have also assumed that if the Redfin Perch is already in the creek systems (though in low numbers) then the addition of new predators will amplify, rather than replace, predation and competition pressures on the native species in the creeks. Any additional predator species is likely to add a further pressure on the survival of Dwarf Galaxias populations, which is not currently present.

The situation is different in the reservoirs as these have large populations of Redfin, so it is assumed that introduced predators (stocked species) would need to displace some of these fish to become established, so impacts on macroinvertebrates and fish in the Reservoirs would be low compared to the current situation.

8 CONCLUSIONS

The risks associated with stocking Brown Trout, Rainbow Trout and Australian Bass into Devilbend and Bittern Reservoirs can be divided into two groups, those risks restricted to impacts within the reservoirs and those risks that may impact on the ecosystem in the downstream receiving waters. All risks assessed within the reservoir have low risk ratings for all three species. However, risks associated with escape from Devilbend Reservoir have resulted in moderate risks from Rainbow Trout and high risks from Brown Trout and Australian Bass.

In the absence of effective controls (to prevent fish escape) the stockings are likely to trigger a referral to DEWHA to assess if this is a controlled action on Dwarf Galaxias (under the EPBC Act), given the current spill frequencies. These risks would be higher if the proposed management strategy of breaching the catch drains is implemented. There is a documented process for consideration of any referral under the EPBC Act. However, these risks could be reduced to low and not significant, if risk mitigation measures (such as those based on the strategy outlined below) are implemented, and these substantially reduce the likelihood of stocked species escaping from the reservoirs.

8.1 Risk Mitigation

A risk management strategy would be required to reduce the identified moderate and high risks to no significant impact. It is clear that a multi-management response would be most effective. This could include:

1. Reduce frequency of spills from Devilbend Reservoir to a very low probability by controlled releases through a meshed outlet structure (which would need to be designed or tested for effectiveness).

2. Investigate the feasibility of controlling escape from Devilbend Reservoir via the spillway through use of screens, implementing a multilayered approach (trash rack, followed by appropriately sized screen(s)). This control strategy (steps 1 above and this step) would need detailed engineering, hydrology and fish biologist advice, to ensure it was successful in preventing fish escape.

3. Stock one and two year old Rainbow and Brown Trout into Devilbend and Bittern Reservoirs. In the lowered risk of escape (.ie. after implementation of point 1 & 2 above) the consequence of escape would be reduced due to their average longevity surviving only 3-5 years and not being able to reproduce. The size of this species at stocking would also assist in development of effective screening.

4. Stock Estuary Perch instead of Australian Bass as the native species in Devilbend Reservoir. This species is endemic to the catchment and could be propagated from a local genetic population.

The disease risks are low from the proposed translocations if standard biosecurity procedures are followed.

Finally as stated earlier, this risk assessment is based on the Winterfill - Option 2. It should be noted that relevant approvals to undertake this option are being progressed by Parks Victoria. In the event that these approvals are delayed or not received or if this option is not adopted then the associated risk of spill would be reduced. As highlighted under the climate change scenario Bittern would never spill and Devilbend would spill only 1 in 12 years. The risks associated with the stockings would then need to be re-evaluated as some would reduce further. Further, other strategies to manage reservoir water levels may also increase spill frequency, so if these are employed then this will also affect the risks identified in this report. If the basis of future hydrological management is changed, the risks assessed would need to be reviewed.

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10 APPENDIX 1: TEP RISK ASSESSMENT PROFORMA

Risk Assessment Proforma and Instructions for the Translocation of Live Aquatic Organisms

1. Proponent and Risk Assessor Details.

1.1 Proponent

The proponent is the person, business or organisation who is responsible for the translocation. If a business or organisation name is supplied, additional details must be provided in Contact name. Where applicable, it is recommended that e-mail and or facsimile be provided as such forms of communication may reduce time-lines for communication with the proponent.

Proponent Name

Fisheries Victoria

Contact name (if proponent is a business or organisation name)

Peter Lawson

Postal address: PO Box 103, Geelong,

State: Victoria …………………………………………..……………Post Code: 3220………..……………….……..……

Telephone (03) 5226 4667..…………..……..…………………Facsimile (03) 5226 4725……………..…………

E- mail: Peter.Lawson@dpi.vic.gov.au ………………….……………………………………………………...

1.2 Risk Assessor

In the case where a proponent (or applicant on behalf of a proponent) is contracting an independent risk assessor to conduct the risk assessment, details of the risk assessor should be provided. Where applicable, it is recommended that e-mail and or facsimile be provided as such forms of communication may reduce time-lines for communication with the proponent.

Name:	Lance Lloyd	
Postal address	PO Box 3014, SYNDAL, Vic, 3149	
State: Victoria		Post Code: 3149
Telephone:	(03) 9884 5559	Facsimile (03) 9884 7405
E- mail:	lance@lloydenviro.com.au	

Relevant Qualifications: B.Sc., M.Sc., MAIBiol

Lance undertook his M.Sc. by research on the impacts of an exotic fish (*Gambusia holbrooki*) on the small fish fauna and their ecology in the lower River Murray. Since then he has worked Common Carp, Redfin Perch, and various introduced fish in Australia examining risk assessments, impacts and management controls. He regularly undertakes risk assessments of species importation into Australia, using the Australian Government standard method. He has undertaken about 20 specific risk assessments in the last few years in areas of fish ecology and water quality.

Lance was assisted in this risk assessment by Dr Peter Newall (Consulting Aquatic Ecologist, 19 Cecil Street, Williamstown, VIC 3016, Mob: 0400 665 943; Email: p.newall@bigpond.com). *Relevant Qualifications:* B.Sc. (Hons). M.Env.Sci., Ph.D. Peter has 25 years experience in aquatic ecology, catchment management and the water industry. He has led or contributed to several ERA projects on streams, including, Seven Creeks, Ryans & Holland Cks, Merri Ck and Tullaroop Ck.

2. Escape or Release - Likelihood

2.1 Will the transport medium and equipment be treated before transport?

The transport medium and equipment used to transport the proposed species for translocation, organisms can harbour infectious organisms and unwanted pests. Appropriate disinfection procedures and appropriately designed transport vessels may reduce the load of infectious organisms or reduce the likelihood of spillage en-route. International standards of procedures can be found as Appendix 1 the full manual can be located on the Office International des Epizooites (OIE) website www.oie.int in the Manual of Diagnostic Tests for Aquatic Animals 2003.
Yes. Equipment to be used will be cleaned, disinfected (using an OIE approved disinfectant) and air-dried prior to use. Transport medium will be disinfected (using an OIE approved disinfectant) prior to use.

2.2 Will the transport medium be treated using appropriate methods after the translocation?

Refer instructions of 2.1
Yes. Equipment used will be cleaned, disinfected (using an OIE approved disinfectant) and air-dried following use. Transport medium will be disinfected (using an OIE approved disinfectant) after use and disposed of via sewage system.

Important note for questions 2.3 - 2.8

Questions 2.3 -2.8 applies to closed and semi-closed systems only. If your translocation event is the stocking of organisms into a system that is defined as an open system please disregard questions 2.3 -2.8 and proceed to question 2.9. A definition of each system is provided in the Glossary of terms.

2.3 How close and accessible are nearby watercourses?

The risk of escape from closed or semi-closed systems can be heightened where the facility is in close proximity to a waterway. In addition, infectious organisms found in untreated effluent water may be transported via a watercourse to larger waterways that contain susceptible species. Please estimate the distance from the nearest waterway and identify the potential watercourses that could transport organisms, including fish, pathogens or other pests. Please also clarify the height of the proposed stocking area in relation to the 1 in 100 year flood level. Seasonal waterflows should also be considered. This information can be found on the Department of Sustainability and Environment website: www.dse.vic.gov.au.
Bittern and Devilbend reservoirs are decommissioned Melbourne Water storages which were previously filled by transferring water directly into the storage piped from nearby reservoirs and the local catchment inflow excluded using a catch-drain. Bittern is much smaller than Devilbend in capacity and drains into Devilbend Reservoir. Devilbend Reservoir overflows into Devilbend Creek and then into Balcombe Creek. Currently, only the Devilbend Reservoir spills in around 20% of years under historic conditions and around 7% under median climate change scenario conditions. Bittern does not currently spill and is less likely to under climate change scenarios. Two options for managing reservoir water levels have been examined (based on the median climate change scenario) – removal of catch drains and winter fill option (where 50% of flows from May to Oct would be diverted from local catchments into the reservoir). Removal of the catch drains means that Bittern Reservoir would spill 80% of years (up from 0% with catch drains) and that Devilbend will spill 85% of years. The winter fill option means that Bittern and Devilbend would spill about 55% of the time. Therefore, while these reservoirs will capture and hold much of the water from the catchment, under the modelled scenarios and historically, there will be many years in each decade when spills are likely, resulting in potential escapes of any fish.

2.4 Is the facility fully enclosed and secure from unauthorised access?

Fully enclosed and secure systems can effectively reduce the risk of escape of aquatic organisms. The level of physical security is also important as it prevents unauthorised access to the property. Provide details of the security measures in place or proposed to be in place at the site.

In historical operations, these reservoirs are static water bodies with no spills from Bittern Reservoir (therefore containing any fish present) and infrequent spills from Devilbend. Modelled flow regimes indicated that these reservoirs are likely to overflow much more frequently and act as open systems.

2.5 Based on knowledge of the facility's waste water treatment and disposal, and the capability to contain all life stages of the organism, are any life stages likely to be released from the facility during normal operations?

Effective screening of waste water outflow is an important mechanism to prevent escape of stocked species. However, such screening needs to take into account all life stages of the stocked species including eggs, larvae, fingerling, sub-adult and adult forms. For both closed and semi closed systems describe the mechanisms in place to control organism and water movement throughout the system. In the case of semi-closed systems please also provide details of the containment mechanisms used to control outputs of water or organisms from the system with particular focus on measures to restrict over filling.

NA – There are currently no facilities for filtering or sterilisation of water leaving the site.

2.6 Based on knowledge of the facility's waste water filtration, sterilisation and disposal, are any diseases present in the facility that are likely to escape?

It is imperative to consider the diversity of unwanted organisms that may harbour in wastewater and, recognise that some life stages of infectious organisms are well adapted to withstand unfavourable conditions. It is therefore appropriate that wastewater treatment methods are well designed to eradicate all infectious organisms. Provide details of treatment systems with reference to OIE disinfection standards where possible.

There are no facilities for filtering or sterilisation of water leaving the site, but stocked fish will be disease free.

2.7 Does the facility have adequate contingency plans in the event of a technical failure?

Technical failures of fish farms may result in unplanned release of water and or stock from the facility. In some cases, facilities are unable to cope with such events and water and or stock are discharged to the surrounding environment. Please provide details of the contingencies and design elements that will be used to contain any stock and water in the case of technical failure.

These reservoirs are regularly maintained by Melbourne Water including a comprehensive dam safety program, so failures of the wall or outlet structures are unlikely to occur. Extensive contingency plans are in place for dam failure.

A risk management strategy to mitigate the likelihood of escape is planned to be implemented:
It involves reducing the modelled frequency of spills from Devilbend Reservoir by controlled releases through a meshed outlet structure. In addition to investigating the feasibility of controlling escape from Devilbend Reservoir via the spillway through use of screens, implementing a multilayered approach (trash rack, followed by appropriately sized screen(s)) aiming to reduce the risk of escape to a very low probability. The control strategy would need detailed engineering, hydrology and fish biology advice, to ensure it was successful in reducing escapement.

2.8 Have local environmental issues (e.g. flooding) been considered in containment planning?

In the first instance, local environmental issues may be discovered and responded to when applying for a planning permit. Examples of local environmental considerations may include, but not be limited to the properties tendency to flood, environmental overlays in the local planning scheme, the proximity to threatened species, international governmental agreements eg. Ramsar wetlands or, other important national or state wetlands. Consult with your local council or Department of Sustainability and Environment office for further information about important environmental sites and environmental issues in your area.
Currently, only the Devilbend Reservoir spills in around 20% of years under historic conditions and around 7% under median climate change scenario conditions. Bittern does not currently spill and is less likely to under climate change scenarios. Two options for managing reservoir water levels have been examined (based on the median climate change scenario) – removal of catch drains and winter fill option (where 50% of flows from May to Oct would be diverted from local catchments into the reservoir). Removal of the catch drains means that Bittern Reservoir would spill 80% of years (up from 0% with catch drains) and that Devilbend will spill 85% of years. The winter fill option means that Bittern and Devilbend would spill about 55% of the time. However, as detailed in 2.7 and summarised in 2.16 potential escape mitigation measures are planned. Other water level management regimes may require re-assessment of the risks posed by the more frequent spills with respect to fish escape.

2.9 What is the nature of any disease surveillance programs in the source area and/or facility?

Understanding the health status of organisms in an aquaculture facility is an important economic and environmental consideration. Programs to monitor fish mortalities and disease can include the regular screening of fish and or wastewater. Monitoring of fish and wastewater can also allow an aquaculture to measure the effectiveness of their treatment system. Provide details of any monitoring programs that are undertaken in the source area or facility.
The source of the stock will be aquaculture bred fish (in the case of Salmonoids either the DPI facility at Snobs Creek or suppliers to Fisheries Victoria) or special aquaculture program to produce Australian Bass (source unknown at present). It has been assumed for the purposes of the risk assessment that all fish will be produced in a facility which has an ongoing stock health surveillance program that meets DPI requirements and where there have been no unexplained disease outbreaks at the source facility in the past 24 months.

2.10 Are there any disease, parasite or unexplained mortality issues in the source area?

Mortalities of the stocked organisms can occur for a range of reasons. In closed and semi closed systems poor husbandry and diet amongst other causes can lead to stress, decreasing the organisms' ability to fight infection and allowing secondary infections to affect the animal. Facilities may also harbour parasites such as flukes and tapeworms and other species, and the translocation of these must also be restricted. Open system mortalities may arise from water quality problems such as deoxygenation. Provide details as to whether there have been any disease, parasite or unexplained mortalities in the source area or facility.
It has been assumed for the purposes of the risk assessment that all fish will be produced in a facility which has an ongoing stock health surveillance program that meets DPI requirements and where there have been no unexplained disease outbreaks at the source facility in the past 24 months.

2.11 Will the consignment be reliably certified free of known diseases, and if so by whom?

While a health certificate is not a requirement for translocation it can minimise the risk of disease transfer. Certification can generally be arranged with the source hatchery. Certification should be provided by a competent authority, which may include a registered veterinarian or a person nominated by the relevant state. International translocations require AQIS approval. In the case where a health certificate will accompany the consignment please provide details of the competent authority and tests to be conducted.
It has been assumed for the purposes of the risk assessment that all fish will be produced in a facility which has an ongoing stock health surveillance program that meets DPI requirements and where there have been no unexplained disease outbreaks at the source facility in the past 24 months. In addition, because of the uncertainty of the source of the Australian Bass stock, it has been assumed that the Australian Bass to be translocated would be assessed (using a sub-sample of the consignment being sacrificed and tested for the presence of notifiable diseases) and provided with a certificate of stock health.

2.12 What is the OIE disease zoning status of the source and destination areas?

According to OIE guidelines, there are three classes of disease zoning: free, surveillance and infected. The OIE has generally classed disease zones at a country level rather than by state. Australia currently has not developed disease-zoning classifications for a number of aquatic animal diseases however in the case where organisms are to be translocated from international sources, the point of origin may be an area with a particular zonal classification. Information of these zones can be obtained from the relevant countries export approval authority or through the OIE.

OIE Disease Status is "Free" for all of Australia for the major notifiable diseases. Redfin are present in both reservoirs and therefore it is possible that EHN Virus could be present (given that Redfin are known carriers of the disease).

2.13 What quarantine processes and/or treatments will the consignment be subject to?

Quarantining of new stock is an established best practice approach for many aquaculture facilities. Quarantine provisions are best developed to manage the risks associated with particular species and source areas. Australian standards for quarantining stock should be used in each case. Pre export and post export quarantine procedures can be obtained from AQIS at www.aqis.gov.au Alternatively quarantine procedures may be customised for the species. Provide details of the quarantine and treatment processes that you intend to subject the consignment to.

Given the consignment is certified disease free, then quarantine and disease treatment is not required.

2.14 Are undesirable species (e.g. parasites, blue green algae, fish) likely to be translocated with the consignment that are not currently found in the target location?

Translocating the target species may cause parasites or diseases present in the source area to also be translocated. List parasites and diseases species present in the source area and provide details as to whether any of these species are likely to be transported with the consignment. Refer 2.1. Various publications on fish diseases and parasites may assist the proponent in answering this question.

The transport media will be treated (disinfected) so any undesirable parasites, bacteria or blue green algae will be eliminated. The hatchery producing the stock will begin with recently filled ponds or facilities to produce stock, so undesirable fish species will be eliminated.

2.15 Will the consignment be reliably certified free of undesirable accompanying species? If so, by whom?

A competent aquatic veterinarian authority can provide a level of assurance that the translocated species are correctly identified and that the consignment is free of any undesirable species. Provide details of the competent authority that will certify the consignment free of undesirable species. Refer 2.11.

It has been assumed for the purposes of the risk assessment that the DPI aquatic veterinarian authority that provide assurance that the translocated species are correctly identified and that the consignment is free of any undesirable species.

2.16 Based on the answers to Questions 2.1 to 2.15, what is the likelihood of escape?

This question asks the proponent to consolidate responses to all questions in this section and provide a summary argument on the likelihood of escape with particular reference to the effectiveness of proposed control measures at managing the risk of escape or release, including the threat of disease and parasite transfer

Summary argument:
Based on the preferred modelling option and with no flow mitigation in place the likelihood of escape of all three species would be high as modelling indicates that the two reservoirs will spill approximately 55% of the time (i.e. averaging just over 5 times in ten years) making it likely that some fish will escape a number of times in the stated lifetimes of the fish. There are currently no containment facilities in the spillway.

However, a risk management strategy to mitigate the likelihood of escape to a very low probability, is planned to be implemented:
It involves reducing the modelled frequency of spills from Devilbend Reservoir by controlled releases through a meshed outlet structure. In addition to investigating the feasibility of controlling escape from Devilbend Reservoir via the spillway through use of screens, implementing a multilayered approach (trash rack, followed by appropriately sized screen(s)).

The disease risks are low from the proposed translocations if standard biosecurity procedures are followed.

Finally as stated earlier, this risk assessment is based on the Winterfill Option - 2. It should be noted that relevant approvals to undertake this option are being progressed by Parks Victoria with Melbourne Water. In the event that these approvals are delayed or not received or if this option is not adopted then the associated risk of spill would be reduced. As highlighted under the climate change scenario Bittern would never spill and Devilbend would spill only 1 in 12 years. The risks associated with the stockings would then need to be re-evaluated as some would reduce further.

3. Escape / Release - Consequences

3.1 What species (including diseases and parasites) are likely to escape?

This question requires the proponent to provide details of species that are likely to escape from the area where the translocation is to occur. Please provide details of any parasites and diseases that may also be translocated in the transport medium or in or on the subject species of the translocation. Refer 2.14.

The stocked species such as Brown Trout, Rainbow Trout and Australian Bass as well as existing predatory fish, such as Redfin, may potentially escape from the reservoirs given the frequency of modelled spills over the reservoir spillways, if mitigation measures are not put in place. Redfin have not been recorded downstream but the site has not spilled for about ten to fifteen years prior to sampling and surveys may not have sampled suitable habitat for these species immediately downstream of the Devilbend Reservoir (such as large pools and the golf course lake).

3.2 In the event of an escape, what life stages (e.g. gametes, fertilised eggs, juveniles, adults, etc.) are likely to escape?

Certain events may make it possible for the translocated species to escape from the system it is held in, eg Flood, transport via waterfowl and vermin. However these transport vectors may only make it possible for certain life stages to be released. Provide details of the life stages that may be released during an escape event.

None of the species are expected to breed in the reservoirs or in the freshwater creeks, so the life stages are likely to be post-larvae, juveniles and adults depending on species and time since stocking.

3.3 In the event of an escape how many individuals are likely to escape?

The consequence of a handful of species being released during an escape event may be less than that of an event where thousands of the one species are released, however both escapes may constitute a risk. Please provide details of the number of organisms likely to escape during an escape event.

It is unknown how many individuals might escape, but even small numbers, every couple of years, will result in predator populations in the creeks habitats downstream (e.g. pools) without an effective escape mitigation strategy. Australian Bass could possibly migrate downstream from freshwater to the estuary in May to August following flow events, breeding in the estuary (Harris & Rowland, 1996, Growns and James 2005).

3.4 Based on the answers to Questions 3.1 to 3.3, what are the consequences of escape?

The proponent must provide a consolidated response to all questions in this section and provide a summary argument on the consequence of escape with particular reference to the effectiveness of proposed control measures for managing these risks.

Summary argument:
Without escape mitigation, the species proposed to be stocked (Brown Trout, Rainbow Trout and Australian Bass) and the locally abundant Redfin Perch would be expected to escape. These escapes would be likely to occur because of the frequency of reservoir spills (approx. one in two years) under the preferred modelled scenario. There are large pools and a golf course lake immediately downstream of the Devilbend Reservoir which are likely to provide suitable habitat for all species. It is likely that stocked juveniles (and adults as time passes) will be the life stages escaping. It is unknown how many individuals might escape, but even small numbers, every couple of years (based on modelled spill frequency), will result in predator populations in the creeks habitats downstream (e.g. pools) without an effective escape mitigation strategy. Australian Bass migrate downstream from freshwater to the estuary in May to August following flow events breeding the estuary (Harris & Rowland, 1996, Growns and James 2005). This means that Australian Bass pose the highest risk, as they may establish a breeding population, whereas the trout species could be controlled in the medium-term by ceasing to stock.

A number of additional risk mitigation options will be implemented to manage the consequences of escape (these assume the escape likelihood is mitigated (see 2.16):

1. Stock one and two year old Rainbow and Brown Trout into Devilbend and Bittern Reservoirs. In the lowered likelihood of escape (ie after implementation of escape mitigation – refer 2.16) the consequence of escape would be reduced due to their average longevity surviving only 3-5 years and not being able to reproduce. The size of the species at stocking would also assist in development of effective screening.
2. Stock Estuary Perch instead of Australian Bass as the native species in Devilbend Reservoir. This species is endemic to the catchment and could be propagated from a local genetic population.

4. Survival - Likelihood

4.1 Is the natural and/or current range of the species/genetic stock known?

A species' natural range is an area where that species is found prior to any translocation events occurring. The current range of a species may differ to its natural range through a number of reasons including habitat degradation or over-fishing. Genetic homogeneity of a species may also differ between areas due to separation of a species through physical barriers. The proponent should provide details of both the natural and current range of the species and where information is available on the genetic homogeneity of the species describe if meta-populations of the species occur.

The salmonid species (Brown and Rainbow trout) are not native to the region. Brood stock would arise from the DPI Snobs Creek aquaculture facility. Australian Bass is a native species but its range extends along the east coast of Australia around to Wilson's Promontory (i.e. its natural range does not extend as far west as Port Phillip Bay). Source, supply and genetic matters for Bass to be determined.

4.2 Are the temperature and water quality requirements for survival known and are they available in the potential receiving waters?

If the water quality requirements of the species to be translocated exist in the receiving waters the likelihood of survival is increased. The proponent should provide information demonstrating water quality requirements of the species to be translocated and those that are found in the potential receiving waters. Parameters that may be provided include temperature, dissolved oxygen, pH and salinity.

The temperature and water quality of the receiving waters is within the tolerance range of both salmonid species and Australian Bass. Australian Bass have high salinity tolerances (up to sea water) but spend most of their time in freshwaters but eggs or sperm do not survive in freshwaters. Australian Bass breed at temperatures between 14-19 degree, temperature tolerances of adults unknown but they inhabit areas of fast flowing waters and are likely to be quite cold tolerant. For optimal growth and survival, Brown & Rainbow trout require cool, well oxygenated waters of low salinity with Rainbow Trout having slightly higher temperature tolerances compared to Browns.

4.3 Are the habitat requirements for survival known and are they available in the potential receiving waters?

Habitat requirements of species are also important for survival in the potential receiving waters. Some species require rocky substrates to graze algae from others are pelagic and can adapt to a range of open water habitats such as streams or lakes. Please describe whether the habitat required for survival of the target species, potential diseases or parasites to be translocated is known and whether that habitat is present in the potential receiving water.

The habitats downstream are likely to be suitable for the salmonids and Australian Bass but the salmonids are unlikely to breed in Devilbend or Balcombe Creek as these have muddy or silty substrates in the freshwater reaches. Australian Bass may breed in the Balcombe Creek estuary, if they escape to there, as it provides suitable habitat. Brown and Rainbow Trout breed in loose gravel beds in small tributary streams running to lakes a situation which doesn't occur in Devilbend or Bittern Reservoirs, so breeding is unlikely to be successful.

4.4 Are the food requirements of the species known and are they available in the potential receiving waters?

Certain species have specific food requirements for survival, which if not met the likelihood of survival may be reduced. Provide details of any specific food requirements that the species may have and details as to whether these are found in the potential receiving waters.

The diet of Australian bass varies significantly between habitat and season, however insects, fish and large crustaceans are the most important prey types (Harris 1985). Harris (1985) found that almost every available prey type was included in the diet of Australian Bass such as fish (the most important food recorded in Australian Bass); insects; crustaceans; and terrestrial vertebrates (such as skinks, frogs and birds) and plant material.
Brown and Rainbow Trout feed on a variety of animals including aquatic macroinvertebrates, (crustaceans, molluscs, insects), small fishes and any terrestrial insects which fall into the water.

4.5 How `natural` is the target area (some species colonise disturbed areas more effectively)?

Target areas, which are undisturbed, may not be suitable for some species that prefer a more disturbed environment. Alternatively a disturbed area may reduce the likelihood of species survival for species requiring pristine habitats. The level of disturbance of the target area should be provided. Also provide details as to whether the receiving waters demonstrates a level of disturbance that is suitable to the translocated species.
For Closed and Semi-Closed Systems, applicants are also encouraged to consider how 'natural' the potential receiving waters are.

Devilbend and Bittern Reservoirs are constructed habitats but are well established with complex aquatic habitats such as woody debris, rocky sections, gravel substrates and extensive aquatic vegetation and also excellent water quality. This site would provide excellent habitat for all three species proposed. There are several exotic species such as Redfin Perch, Eastern Gambusia and marron, however, these are unlikely to affect survival of any stocked species due to excellent cover (extensive aquatic vegetation beds) available.

4.6 For diseases and parasites, are suitable hosts likely to be available in the target area?

Many diseases and parasites are opportunistic and can infect a range of hosts in the target area. Others are species specific and can only affect a particular host. Please provide details as to whether a suitable host species is likely to be found in target area. Also refer 4.2. If the receiving water is not suitable for host species survival then the likelihood of survival of diseases and parasites may also be reduced.
For Closed and Semi-Closed Systems, applicants are also encouraged to consider availability of suitable hosts in the potential receiving waters.

The reservoirs already hold significant populations of Redfin Perch and Eastern Gambusia and these would carry the normal range of diseases and parasites which are wide-spread in Australian waters (*Chillodonella*, *Ichthyophtherius* and *Trichodina* spp., and possibly EHNV). No major fish kills or significant problems have been reported with fish from Devilbend or Bittern Reservoirs. These parasites would most likely exist in low levels in fish downstream as well.

4.7 Based on the answers to Questions 4.1 to 4.6, what is the likelihood of survival?

In consideration of the responses made to questions 4.1-4.6 provide a detailed summary describing the likelihood of survival of the target species, parasites and pathogens in the target area and potential receiving waters.

Summary argument:

The stocked species will all survive well in the reservoirs and the potential receiving waters. However, trout species are unlikely to breed in the reservoirs. Devilbend and Bittern Reservoirs provide complex aquatic habitats such as woody debris, rocky sections, gravel substrates and extensive aquatic vegetation and also have excellent water quality. The reservoirs would already hold populations of parasites which are wide-spread in Australian waters (*Chillodonella*, *Ichthyophtherius* and *Trichodina* spp.) and the fish translocations are unlikely to affect this profile.

5. Survival Consequences

5.1 Is the species endemic to the target area?

A species endemic to the target area poses a lower risk to the environment than non-endemic species eg Golden perch in the Murray-Darling. Provide historical evidence demonstrating the target species is endemic to the target area.
For Closed and Semi-Closed Systems, applicants are also encouraged to consider if the species is endemic to the potential receiving waters.

The salmonid species (Brown and Rainbow Trout) are not native to the region. They have not been recorded in the downstream creeks in past surveys and apart from 1000 Rainbow Trout in 1971 for a shrimp control experiment), they have not been stocked into the reservoirs or the streams upstream or downstream of the reservoirs. Australian Bass is a native species but its range extends along the east coast of Australia around to Wilson's Prom. A single Australian Bass was recorded from Patterson Lakes and several have been reported from the Yarra River below Dights Falls, though it is possible these were indeed misidentified Estuary Perch as these areas are well outside the recognised range for Australian Bass.

5.2 Is the species currently found in the target area?

The presence of the target species in the target area indicates that survival of the species in those receiving waters is highly likely. However the presence of that species may not mean that all stages of the lifecycle can be supported in that system. Please provide details as to whether the target species is currently found in the target area. Information that may be able to assist in this response, in the case where a species to be translocated is a recreationally targeted species, can be located on the DPI website in the Guide to the Inland Angling Waters of Victoria.
For Closed and Semi-Closed Systems, applicants are also encouraged to consider whether the species is found in the potential receiving waters.

The salmonid species (Brown and Rainbow trout) are not native to the region, they have not been recorded in the downstream creeks in past surveys, nor have they been previously stocked into the reservoirs (apart from 1000 Rainbow Trout in 1971) or the streams upstream or downstream of the reservoirs. Australian Bass is a native species but its range extends along the east coast of Australia around to Wilson's Prom. A single Australian Bass was recorded from Patterson Lakes and several have been reported from the Yarra River below Dights Falls, though it is possible these were indeed misidentified Estuary Perch as these areas are well outside the recognised range for Australian Bass.

5.3 Is the species likely to be a significant competitor/predator in the target area?

The impact of a species on the target area can be measured in a number of ways. Two potential impacts are predation on species within the target area and competition for food and/or habitat. Provide details on whether the species to be translocated are likely to be a predator or competitor with other species endemic to the target area.
For Closed and Semi-Closed Systems, applicants are also encouraged to consider if the species is likely to be a significant competitor/predator in the potential receiving waters.

Depending on the numbers stocked, all of the proposed species for translocation are likely to act as significant predators for small native fish such as pygmy perch, and *Galaxias* species and the stocked juvenile fish may also be competitors before they become piscivorous. Adult fish may also compete with eels if they are present within the Reservoirs. However, within the reservoirs, given the high Redfin populations, the addition of these predators are unlikely to pose increased risks to native fish present.

5.4 Is the species likely to alter the physical environment?

Some species habits may have an effect on the physical habitat in which they live, eg yabbies are known for burrowing potentially causing seepage of ponds. The proponent must provide details of the species habits and whether those habits could have a physical effect on the environment in the target area and potential receiving waters.
These species are unlikely to affect the physical environment.

5.5 Is the species likely to destabilise local plant communities?

Further to 5.4 the habits of some species may destabilise local plant communities. Please provide details of the species behavioural characteristics and evidence as to whether the target species is or is not likely to cause an effect on local plant communities in the target area and potential receiving waters.
These species are unlikely to affect the aquatic plant communities.

5.6 What effects are any released diseases or parasites likely to have in the potential receiving waters without completing their full life cycle?

Some diseases and parasites may be able to effect species within the potential receiving waters without completing their life cycle. Provide details of the effects that potential diseases or parasites identified in 3.1, could have on species that are found in the potential receiving waters even without them completing their full life cycle.
It is unlikely that any released diseases will have any impact as this risk will be effectively managed by biosecurity measures as outlined in the Public Waters Stocking Protocol. Downstream environments and fish populations have probably already been exposed by diseases and parasites common to Redfin and Eastern Gambusia which currently inhabit the Reservoirs.

5.7 Based on the answers to Questions 5.1 to 5.6, what are the consequences of survival?

In consideration of the responses made to questions 5.1-5.6 provide a detailed summary describing the likely consequences of survival of the target species, parasites and pathogens in the potential receiving waters.
Summary argument: The proposed fish to be translocated are not native to the region, are not present in the downstream creeks, nor have they been previously stocked into the reservoirs (apart from 1000 Rainbow Trout in 1971) or the streams upstream or downstream of the reservoirs. Without fish escape mitigation, all of the proposed species for translocation are likely to form significant predators for small native fish (including listed species such as Dwarf Galaxias downstream) and the stocked juvenile fish may also be competitors with the small native fish before they become piscivorous. Adult fish may also compete with eels if they are present within the Reservoirs. Within the reservoirs, given the high Redfin populations, the addition of these predators are unlikely to pose increased risks to native fish present. The proposed translocation species are not unlikely to affect the physical environment, aquatic plant communities, nor will any released ubiquitous diseases have any impacts.

6. Establishment - Likelihood

6.1 Are the environmental requirements for the completion of all stages of the life cycle known and are they available in the potential receiving waters?

Many species require certain environmental conditions to successfully complete all stages of their life cycle. For example many warm water natives require a temperature increase to spawn. The proponent should demonstrate the environmental conditions required for the completion of all life stages of the target species and identified parasites or diseases and whether or not they are present in the potential receiving waters.
It is unlikely that the two salmonid species would establish self sustaining populations due to the lack of habitat for trout to breed, also much of the creek would be shallow and too warm for significant populations to persist but deeper pools and constructed lakes in the system would allow individuals to persist. Australian Bass could establish self-sustaining populations as conditions required for their reproduction already exist in the estuary of Balcombe Creek and freshwater habitat is provided by the tree-lined creeks, deep pools and constructed lakes in the system.

6.2 For diseases and parasites, are carriers and hosts required for the completion of all stages of the life cycle known; and are they available in the potential receiving waters?

Refer instructions to 6.1.
It is unlikely that any released diseases will have any impact as this risk will be effectively managed by biosecurity measures as outlined in the Public Waters Stocking Protocol. Downstream environments and fish populations have probably already been exposed by diseases and parasites common to Redfin and Eastern Gambusia which currently inhabit the Reservoirs.

6.3 Is the ability of the species to hybridise with local species known?

Hybridisation of species may occur where two separate species interbreed and produce offspring. Viable offspring such as in some abalone species or unviable offspring may be produced from this cross breeding. If a species can interbreed with another species in the potential receiving water, then the likelihood of a hybrid population in that waterway increases. Please provided details as to whether or not the target species will be able to interbreed with species in the potential receiving waters and in the case that this may occur, will the offspring be viable or unviable.
The two trout species will not hybridise with other fish. However, Australian Bass are known to hybridise with Estuary Perch (Jerry et al. 1999) and that changes in stream flows in many estuarine systems seem to be resulting in the contraction of estuarine habitat, closer proximity of breeding Australian Bass and Estuary Perch and therefore hybridisation is more likely into the future (Hindell, pers. comm.).

6.4 Based on the answers to Questions 6.1 to 6.3, what is the likelihood of establishment?

In consideration of the responses made to questions 6.1 -6.3 provide a detailed summary describing the likelihood of establishment of the target species in the potential receiving water
Summary argument: While, it is unlikely that the two salmonid species would establish self sustaining populations, Australian Bass could establish self-sustaining populations in the estuary of Balcombe Creek and the freshwater creeks between Devilbend Reservoir and the estuary. It is highly unlikely that any released diseases will have any impact on the fish of the receiving waters. While the two trout species will not hybridise with other fish, Australian Bass are known to hybridise with Estuary Perch and given the relatively restricted nature of the Balcombe Creek estuary this is likely to occur.

7. Establishment - Consequences

7.1 How `natural` are the potential receiving waters (in unique or pristine areas, the consequences of establishment are likely to be considered to be more important)?

The consequences of a non-endemic species establishing itself within a pristine area may be considered a greater risk that an area where the waterway is degraded or has a number on non-endemic species already within it. Please indicate in your response the level of disturbance the waterway has been subject to and what these disturbances are, eg snag removal, bank erosion etc.

The receiving waters have been altered through upstream and adjacent landuse changes, through riparian vegetation removal (in some areas) and decline in water quality due to agricultural run-off, however, Melbourne Water and Waterwatch testing shows relatively good water quality (Low turbidity, good dissolved oxygen, low nutrient levels) and good macroinvertebrate populations indicating a healthy aquatic ecosystem.

7.2 Are there any endangered or rare species in the potential receiving waters?

A list of threatened species can be obtained from the Department of Sustainability and Environment web page. The proponent must consider whether the species proposed to be stocked will pose a risk to other aquatic fauna/flora, which may include invertebrates, amphibians and reptiles. In the case where threatened species are located in the potential receiving waters demonstrate whether the target species will have an effect on them.

The Dwarf Galaxias (which is EPBC Act and FFG Act listed as vulnerable) has been found in habitats upstream of the Reservoir and in some downstream tributaries of the catchment. The species is not present in the Reservoirs and has never been recorded there. The unmitigated risk assessment shows that this species may be subject to moderate (Rainbow Trout) or high (Brown Trout, Australian bass) risks due to predation if the stocked species escape from the Reservoirs. The threatened Blue-billed Ducks (EPBC Act listed) and the White bellied Sea-Eagle (FFG Act listed) are also present (Stamation & Lyon (2009), which received low risks in the assessment and are unlikely to be affected by proposed stocking. These species of birds provide a good model of how other, similar, species would respond to the stockings.

7.3 Is the species subject to an eradication or minimisation program in the target area?

It is important to ensure that where a species is subject to an eradication program in a particular area that the translocation will not re-introduce the species into the area. Information as to whether the species in subject to such a program can be obtained through your local DPI / DSE office.
For closed and semi-closed systems consideration should be given to eradication programs in the potential receiving waters.

None of the 3 species proposed to be stocked are subject to an eradication program in the system.

7.4 Is the organism genetically modified?

Species that have been genetically modified may be more suited to an environment than species endemic to that area and may therefore displace these species through competition for food and habitat. Please provide details as to whether the species has been genetically modified and what are the implications of the modifications.

None of the 3 species proposed to be stocked will be genetically modified.

7.5 Should the species establish in water bodies, is it likely that it can be eradicated?

There are many examples of animal translocations that have resulted in the establishment of feral populations. In most of these cases attempts to prevent their spread or eradicate the species has not been successful. Please provide details as to whether it is likely that the species to be translocated could be eradicated from the *__potential receiving waters.__*

Eradication of the proposed salmonid species would eventually occur by ceasing stocking and allowing the fish to senesce as none would breed in the Reservoirs. The salmonids are unlikely to breed in the creek system downstream and therefore ceasing stocking will result in the fish dying-out (after 3-5 years on average for salmonids). It would be difficult to eradicate Australian Bass within the downstream environments as the species may breed in the Balcombe Creek estuary and become self-sustaining.

7.6 Based on knowledge of the species' growth, reproductive characteristics and behaviour, is the species likely to displace local species in similar ecological niches?

The displacement of species through competition for similar ecological niches can be as damaging to biodiversity as predation or habitat destruction. Provide details as to whether any life stages of the species proposed to be translocated may displace species found in the *__potential receiving waters__.*

All three proposed fish species are larger than most native fish in the system with the exception of shortfinned eels, which occupy different habitats and niches than the proposed stocked species. The reservoirs have large Redfin Perch populations so the addition of the proposed species for stocking is unlikely to significantly increase competition with native fish in the reservoirs .

7.7 Based on knowledge of the species' behaviour and physical characteristics, is it likely to be a significant predator in the potential receiving waters?

The possibility of predation by the species proposed for translocation on species found in the potential receiving waters must also be considered. Refer 5.3. Noting that most recreational species in Victoria are predatory by nature provide details as to whether any life stages of the species proposed for translocation may predate on species found in the *__potential receiving waters__.*

Both Trout species and Australian Bass are well known predatory species in both lake and stream habitats. It is likely that survival of all proposed species in the reservoirs will be high impact on invertebrates initially, but shifting to fish as the fish grow and mature. However, the reservoirs have large Redfin Perch populations, so the addition of the proposed species for stocking is unlikely to increase predation markedly with native fish in the reservoirs, as stocked species will displace some of the Redfin population. However, given the current open nature of the system, and the predicted frequency of reservoir spills, and the fact that Brown Trout and Australian Bass have a tendency to travel downstream on flow events (Harris 1985, Harris et al. 1986, Davies 2005), it is likely that individuals of all three species may escape downstream and reside in downstream pools, streams and estuaries. In the event of escape these fish, are likely to exert an additional predatory pressure on native fish, given the restricted nature of the habitats (such as shallow streams and small pools). It is assumed that Redfin Perch are already in the creek systems (though in low numbers) then the addition of new predators will amplify, rather than replace, predation and competition pressures on the native species in the creeks. Any additional predator species is likely to add a further pressure on the survival of Dwarf Galaxias populations, which is not currently present.

7.8 Based on knowledge of the species' behaviour and physical characteristics, is it likely to alter the physical environment in the potential receiving waters?

Some species through behaviour or physical characteristics may cause damage to the environment. This damage can alter the physical environment, which in turn can reduce available habitat and food for endemic species in that area. Provide details as to whether the species proposed for translocation could alter the physical environment of the *__potential receiving waters__. Also Refer 5.5*

None of the proposed species for translocation are known disturb or alter the physical environment.

7.9 Based on knowledge of the species' behaviour and physical characteristics, is it likely to destabilise plant communities in the potential receiving waters?

Provide details, based on knowledge of the target species, as to whether the species is likely to destabilise plant communities within the potential receiving waters. Also Refer 7.8, 5.5.
None of the proposed species for translocation are known to destabilise plant communities that are likely to be present within the potential receiving waters.

7.10 Is the consignment of the same genetic stock as local populations?

The mixing of genetic stocks can reduce the genetic integrity of species and in turn may reduce it's resistance to disease or certain environmental conditions. It is therefore important that genetic stocks are not mixed in order to maintain genetic integrity within natural populations. Provide details describing the source of the stock and whether there are genetic differences between those stocks.
None of the proposed fish species for translocations are currently present within the system; therefore this question is not applicable.

7.11 What effects are any released diseases or parasites likely to have in the potential receiving waters?

Some diseases and parasites are host specific. Therefore the effect of these on the receiving waters will alter depending on the inhabitants of those waters. Provide details of the potential effects that any diseases or parasites that may be transported could have on species found in the potential receiving waters.
There are unlikely to be any novel diseases or parasites introduced by the proposed stocking and therefore there is unlikely to be any impact from release diseases or parasites on other fish species in the potential receiving waters.

7.12 Based on the answers to Questions 7.1 to 7.11, what are the consequences of establishment?

Based on questions 7.1-7.11 what are the consequences of establishment of the target species or diseases and parasites that may be transported with the species on the potential receiving waters.
Summary argument: The potential receiving waters while altered to some degree have a healthy aquatic ecosystems and good water quality, resulting in a high likelihood of survival of the proposed species for translocation. The system supports several listed species such as Dwarf Galaxias, Blue-billed Ducks; White bellied Sea-Eagle and also 14 international listed migratory shorebird species. The reservoirs themselves do not support any threatened fish though they do support the listed bird species and several native fish likely to be subjected by predation by the translocated species but the risks are rated low for these impacts, largely due to large current populations of Redfin Perch. Eradication of the proposed fish species would eventually occur by ceasing stocking and allowing the fish to senesce as none would breed in the Reservoirs or the creek (with the exception of Australian Bass which would breed in the in the Balcombe Creek estuary downstream). The majority of the stocked Brown and Rainbow trout are only expected to live 3-5 years. Both Trout species and Australian Bass are well known to be predatory species but both reservoirs have large Redfin Perch populations, so the addition of the proposed species for stocking is unlikely to increase predation markedly with native fish in the reservoirs. However, given the current open nature of the system, and the predicted frequency of reservoir spills, and the fact that Brown Trout and Australian Bass have a tendency to travel downstream on flow events (Harris 1985, Harris et al. 1986, Davies 2005), it is likely that individuals of all three species may escape downstream and reside in downstream pools, streams and estuaries. In the event of escape these fish, are likely to exert an additional predatory pressure on native fish, given the restricted nature of the habitats (such as shallow streams and small pools). It is assumed that Redfin Perch are already in the creek systems (though in low numbers) then the addition of new predators will amplify, rather than replace, predation and competition pressures on the native species in the creeks. Any additional predator species is likely to add a further pressure on the survival of Dwarf Galaxias populations, which is not currently present. These fish, even if they do not establish self-sustaining populations, are likely to exert a predatory pressure on native fish, given the restricted nature of the habitats (such as shallow streams and small pools). This would create additional predatory pressure than the current conditions as the previous spills from the reservoir were up to 15 years ago and few Redfin Perch are likely to be present downstream. Without escape mitigation, this could further threaten the nationally listed, Dwarf Galaxias. Few other consequences are likely.

8. Socio-Economic

8.1 What are the social or community impacts associated with your proposal to translocate?

Describe the social benefits that may be gained from the proposal to translocate an organism e.g. fish for tourism. Detail whether these social benefits will "out weigh" any of the social aspects of other activities in the proposed receiving waters e.g. damage to other recreational fisheries.
There is strong community support for appropriate recreational activities in the Devilbend Reserve. A number of activities have been included in the draft Management Plan and recreational fishing is one of them. Recreational fishing is one of Victoria's (and Australia's) most popular leisure activities. It is valued by the community for its relaxing values, exposure to the natural environment and supplementary food supplies. The proposed translocation is aimed at giving recreational fishers more opportunity to enjoy this past time, through the development of a stock enhanced recreational fishery. Given, there are limited inland fishing opportunities in the Mornington Peninsula it is likely to attract larger numbers of visitors to the region. It will also provide local residents with fishing options that they have previously not been able to experience and will be a significant boost for opportunities for children on school holidays due to the proximity of the storages to metropolitan Melbourne.

8.2 What are the estimated economic impacts associated with your proposal to translocate?

Provide details of the economic impacts of the proposal. These may be positive effects such as regional employment and tourism or negative effects such as eradication and or recovery programs.
The stocking of Devilbend will create a significant inland fishing opportunity on the Mornington Peninsula. Recreational fishing currently contributes well in excess of $400m to the Victorian economy annually (DAFF National Recreational Fishing Survey 2001) and it is anticipated that Devilbend will attract recreational anglers keen to target freshwater fish whilst enjoying the other benefits the Peninsula has to offer. This will create a further economic stimulus to the region and build capacity across the hospitality, retail and accommodation sector. It is difficult to estimate the actual economic benefits for the establishment of this one site as a recreational fishery but given its proximity, and ease of access, to Melbourne it is likely to be considerable.

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APPENDIX 1

Disinfection of Fish Farms

Disinfection and Method of use as per OIE, International Aquatic Animal Health Code 2003.

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Process	Indications	Method of Use*	Comments
Physical			
Desiccation, Light	Fish pathogens on earthen bottoms	Dry for 3 months at an average temperature of 18^{o}C	Drying period can be reduced by the use of a chemical disinfectant
Dry Heat	Fish pathogens on concrete, stone iron, ceramic surfaces	Flame-blower, blow-lamp	
Damp heat	Fish pathogens in transport vehicle tanks	Steam at 100^{0}C for 5 minutes	
Ultra -violet rays	Viruses and bacteria *Myosporidian* spores in water Infectious pancreatic necrosis (IPN) and nodavirus (VNN/VER) in water	10mJ/ cm^2 35mJ/ cm^2 125-200mJ/cm^2	Minimum lethal dose
Chemical			
Quaternary ammonia	Virus, bacteria, hands Gill bacteria, plastic surfaces	1mg/ L for 1 minute 2mg/ L for 15 minutes	Infectious Pancreatic Necrosis virus resistant.
Calcium[a] oxide	Fish pathogens on dried earthen-base	0.5kg/m^2 for 4 weeks	Replace in water and empty disinfected pools keeping the effluent at pH <8.5
Calcium (Hypochlorite)	Bacteria and viruses on all clean surfaces and in water	30mg available chlorine / litre left to inactivate for several days	Can be neutralised with sodium thiosulfate
Calcium[a] cyanamide	Spores on earthen bottoms	3000 kg/ ha on dry surfaces; leave in contact for 1 month	
Formalin	Fish pathogens in sealed premises	Release from formogenic substances, generally trioxymethylene. Comply with instructions	
Iodine (iodophors)	Bacteria Viruses Hands, smooth surfaces Eyed eggs Gametes during fertilisation Nets, boots and clothing	 >200mg iodine/ litre a few seconds 100 mg iodine / litre for 10 minutes 25 mg iodine/litre for several hours 200 mg iodine / litre	

Ozone	Sterilisation of water, fish pathogens	.2-1mg / litre for 3 minutes	Costly
Sodium[a] (hydroxide)	Fish pathogens on resistant surfaces with cracks	Mixture: Sodium hydroxide 100g, Teepol® 10 g, Calcium hydroxide 500 g, Water 10 litres. Spray, 1 Litre / 10m^2 leave for 48 Hours.	The most active disinfectant $Ca(OH)_2$ stains the surfaces treated; Teepol® is a tensio-active agent Turn Water on, checking pH
Sodium[a] (hypochlorite)	Bacteria and viruses on all clean surfaces and in water	30 mg available chlorine / litre. Leave to inactivate for a few days or neutralise with Na thiosulfate after 3 hours	
Sodium[a] (hypochlorite)	Nets, boots and clothing	200 mg available chlorine / litre for several minutes	
Sodium[a] (hypochlorite)	Hands	Rinse with clean water or neutralise with thiosulfate	

a. Dangerous. Personnel must be protected. Protect skin, eyes and respiratory tract with a suitable barrier.

* The concentrations indicated are those for the active substance. NB Chemicals must be approved for the prescribed use and used according to the manufacturer's specifications