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Riverine Recovery

Riverine Recovery

Weir pool manipulation – vegetation and wetland inundation

TECHNICAL NOTE

WATER FOR GOOD

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This is Version 6 of the *Riverine Recovery weir pool manipulation – vegetation and wetland inundation.*

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Overview

This *Technical Note* presents the modelled effect of raising weir heights above their normal operational level in the South Australian section of the River Murray on floodplain vegetation and wetlands. The spatial analysis was calculated in ESRI ArcGIS® using existing floodplain vegetation and wetland spatial data and data provided by the hydraulic modelling component of the *Weir Pool Manipulation – Riverine Recovery Project*. A number of river flow and weir height scenarios are presented for each of the six South Australian River Murray weirs (for the purposes of this report, weirs are defined as the combined lock and weir infrastructure).

The effect of increasing the height of the weir varied between weirs and for the different flow and weir height scenarios. The relative area of permanent and temporary wetlands inundated differed between weirs. Generally, the river red gum woodland vegetation group was preferentially inundated under the different scenarios, with lignum shrubland and samphire shrubland also often inundated. For all weirs healthy and unhealthy stands of river red gum trees were inundated by the different weir raising scenarios, although the area varied considerably between weirs. Only in a few scenarios were healthy black box trees inundated. The influence of the weir raising was generally noticed closer to the weirs, but there were examples of wetlands near the adjacent upstream weir being inundated. Generally, flow rates of 20 GL/d inundated similar areas to flow rates of 10 GL/d.

Weirs 1-6

Five scenarios were analysed for Weir 1: weir raisings of 25, 50 and 106 cm at a flow rate of 10 GL/d and weir raisings of 50 and 106 cm at a flow rate of 20 GL/d. The modelling showed:

- Raising the weir level by 106 cm at 10 GL/d inundated an additional 652 ha (1449%) of floodplain vegetation compared to normal levels at the same flows. This was a larger area of the floodplain than the 50 cm rise.
- For a given weir level there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of river red gum woodland, lignum shrubland and flood dependent grassland were inundated for all five scenarios compared to other vegetation groups.
- A greater additional area of healthy and unhealthy river red gum trees and unhealthy black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands.
- The extent of the weir pool raise extended over much of the reach: most of the vegetation inundation was closer to Weir 1, but near Weir 2 a number of wetlands were inundated.

Three scenarios were analysed for Weir 2: weir raisings of 35 and 70 cm at a flow rate of 10 GL/d and a weir raising of 35 cm at a flow rate of 20 GL/d. The modelling showed:

- Raising the weir level by 70 cm at 10 GL/d inundated an additional 185 ha (321%) of floodplain vegetation compared to normal levels at the same flows. This was a larger area of the floodplain than the 35 cm rise.
- For a given weir level there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of samphire shrubland and river red gum woodland were inundated than other vegetation groups.
- A greater additional area of dead and unhealthy river red gum trees and healthy black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands.
- The extent of the weir pool raise extended over much of the reach: most of the vegetation inundation was closer to Weir 2, but near Weir 3 wetlands were inundated.

Three scenarios were analysed for Weir 3: weir raisings of 35 cm at flow rates of 10 and 20 GL/d and a weir raising of 30 cm at a flow rate of 50 GL/d. The modelling showed:

- Raising the weir by 59 cm at 10 GL/d inundated an additional 1220 ha (561%) of floodplain vegetation compared to normal levels at the same flows.
- Proportionally larger areas of lignum shrubland, samphire shrubland and river red gum woodland were inundated than other vegetation groups.
- A greater additional area of healthy river red gum and black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of permanent wetlands than temporary wetlands.
- The extent of the weir pool raise extended over approximately half of the distance between Weirs 3 and 4.

Four scenarios were analysed for Weir 4: weir raisings of 60 and 114 cm at flow rates of 10 and 20 GL/d. The modelling showed:

- Raising the weir level by 114 cm at a flow of 10 GL/d inundated an additional 1282 ha (443%) of floodplain vegetation compared to normal levels at the same flows. This was almost three times the inundated area of the floodplain than the 60 cm rise.
- For a given weir level, there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of river red gum woodland and samphire shrubland were inundated than other vegetation groups.

- A greater additional area of healthy and unhealthy river red gum trees and dead black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of permanent wetlands and saline wetlands than temporary wetlands.
- The influence of raising the weir extended over most of the distance between Weirs 4 and 5, although the effects of the weir raising were greater closer to Weir 4.

Four scenarios were analysed for Weir 5: a weir raising of 50 cm at flow rates of 10, 30, 40 and 50 GL/d. The modelling showed:

- Raising the weir level by 50 cm at 10 GL/d inundated an additional 760 ha (432%) of floodplain vegetation compared to the normal levels at the same flows. The higher the flow, the greater the total area of floodplain inundated.
- Proportionally larger areas of river red gum woodland and samphire shrubland were inundated than other vegetation groups.
- A greater additional area of healthy and unhealthy river red gum trees and dead black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of permanent wetlands than temporary and saline wetlands.
- The extent of the weir pool raise extended over approximately half of the distance between Weirs 5 and 6, but was concentrated near existing channels.

Two scenarios were analysed for Weir 6: weir raisings of 62 cm at flow rates of 10 and 20 GL/d. The modelling showed:

- Raising the weir level by 62 cm at 10 GL/d inundated an additional 280 ha (181%) of floodplain vegetation compared to normal levels at the same flows.
- For a given weir level, there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of river red gum woodland were inundated than other vegetation groups.
- A greater additional area of healthy and unhealthy river red gum trees were inundated by weir raising than the other condition classes.
- Few black box trees were inundated by the scenarios.
- Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands.
- The influence of the raising the weir was evident closer to main channel, but did not extend over the whole floodplain.

1. Introduction

The aim of this *Technical Note* is to outline the spatial extent of the inundation of floodplain vegetation and wetlands that may result from increasing the height of the six weirs on the River Murray in South Australia. This information is developed to provide a basis for understanding the possible benefits that manipulating the height of a weir will have on the floodplain vegetation and wetlands. To do this the outputs of the hydraulic modelling component of the *Weir Pool Manipulation – Riverine Recovery Project* were compared to spatial vegetation and wetland data on the River Murray floodplain. A number of flow and weir raising scenarios were assessed for each of the six weirs, which were provided by the *Weir Pool Manipulation – Riverine Recovery Project*.

This *Technical Note* does not include information on how the floodplain vegetation and wetlands may respond to inundation. Conceptual models on the ecological response to inundation are outlined in *Monitoring and Evaluation Program – Riverine Recovery Project*. Similarly, this *Technical Note* does not make recommendations on optimal flow regimes or weir operations for the benefit of floodplain vegetation and wetlands; information that can be found elsewhere (e.g. Cooling *et al.* 2010). The analysis focuses on floodplain inundation, and does not cover other river environments, such as flowing river habitat, which are essential components of a functioning river system (Ecological Associates, 2010).

2. Approach

2.1 Analysis

There are six sets of locks and weirs on the River Murray in South Australia between the Murray Mouth and the South Australian border, commonly referred to as Locks 1 to 6 (Table 1). At each site there is both a lock and a weir; the lock is used for boat navigation, and the weir is used to manipulate the height of water upstream of the lock and weir. The weirs are adjusted based on the flow in the main channel to maintain the normal weir operational level (Table 1). In this *Technical Note*, 'normal weir operational level' is referred to as 'normal level'; 'Weir A' refers to the lock and weir infrastructure; 'Weir A floodplain' refers to the floodplain between Weir A and the adjacent weir upstream; and 'Weir A pool' refers to the pool of water created by the presence of Weir A.

The aim of this analysis was to assess the effect of raising the height of the weirs above normal levels on the inundation of the River Murray floodplain. For the purposes of this analysis, the River Murray floodplain in South Australia is defined by the extent of inundation reached by the 1956 flood. A range of flow and weir raising heights are presented for each weir (Table 1).

Table 1: The location of Weirs 1-6 on the River Murray in South Australia, their normal operational level (normal level) and scenarios assessed. Further information on the structures of the locks and weirs can found in Aquaterra (2009).

	Distance upstream from Murray Mouth (km)	Distance to adjacent weir upstream (km)	Normal level (m AHD)	Weir pool manipulation scenarios: flow (GL/d) and weir height (cm, above normal level)
Weir 1	274.3	87.8	3.2	10 GL/d: 50 cm and 106 cm 20 GL/d: 25 cm, 50 cm and 106 cm
Weir 2	362.1	69.3	6.1	10 GL/d: 35 cm and 70 cm 20 GL/d: 35 cm
Weir 3	431.4	84.8	9.8	10 GL/d: 59 cm 30 GL/d: 59 cm 50 GL/d: 30 cm
Weir 4	516.2	46.2	13.2	10 GL/d: 60 cm and 114 cm 20 GL/d: 60 cm and 114 cm
Weir 5	562.4	57.4	16.3	10 GL/d: 50 cm 30 GL/d: 50 cm 40 GL/d: 50 cm 50 GL/d: 50 cm
Weir 6	619.8	76.8	19.25	10 GL/d: 62 cm 20 GL/d: 62 cm

ESRI ArcGIS® was used to calculate the area of floodplain vegetation, wetlands and trees inundated under the different scenarios at the different weirs. Inundation shapefiles for the different scenarios (provided by *Riverine Recovery - Weir Pool Hydraulic modelling*) were intersected with vegetation, wetland and tree condition shapefiles created for the different weir floodplains. This created a new shapefile, which was used to calculate the area of inundation and the number of wetlands inundated. Further information on the floodplain shapefiles is given in the following section and a detailed description of the ESRI ArcGIS® methodology is outlined in Appendix A.

The analysis focussed on calculating and comparing the area of vegetation, wetland or trees inundated under the different flow scenarios. Two types of area are referred to throughout the report:

- The total area, which is the total area of floodplain inundated caused by a given scenario. For example, in Figure 1 the total area inundated is shown by the combination of dark blue and yellow; the total area inundated by a 50 cm raise at Weir 5 is greater for 50 GL/d (bottom-right figure) than for 10 GL/d (top-right figure).

- The additional area, which is the additional area inundated caused by raising the weir above the normal level for a specified flow rate. For example, in Figure 1 the additional area caused by raising the level of Weir 5 by 50 cm at 10 GL/d is shown as yellow (top-right figure), with the normal level inundation at 10 GL/d (top figures) shown as blue. Similarly, the additional area caused by raising the level of Weir 5 by 50 cm at 50 GL/d is shown as yellow (bottom-right figure), with the normal level inundation at 50 GL/d (bottom figures) shown as blue. The additional area caused by raising is greater for 10 GL/d flow (top-right figure) than 50 GL/d (bottom-right figure).

Both total area and additional area provide valuable information: the total area on the effect of the flow and weir raising and the additional area on the effect of raising the height only.

Many of the examples presented in the report, including figures and tables, are focussed on the 10 GL/d flow scenario. The 10 GL/d flow was identified by the *Riverine Recovery Project* team as the most likely scenario to be used for weir pool manipulations. In many cases the results were similar to 20 GL/d flow scenarios.

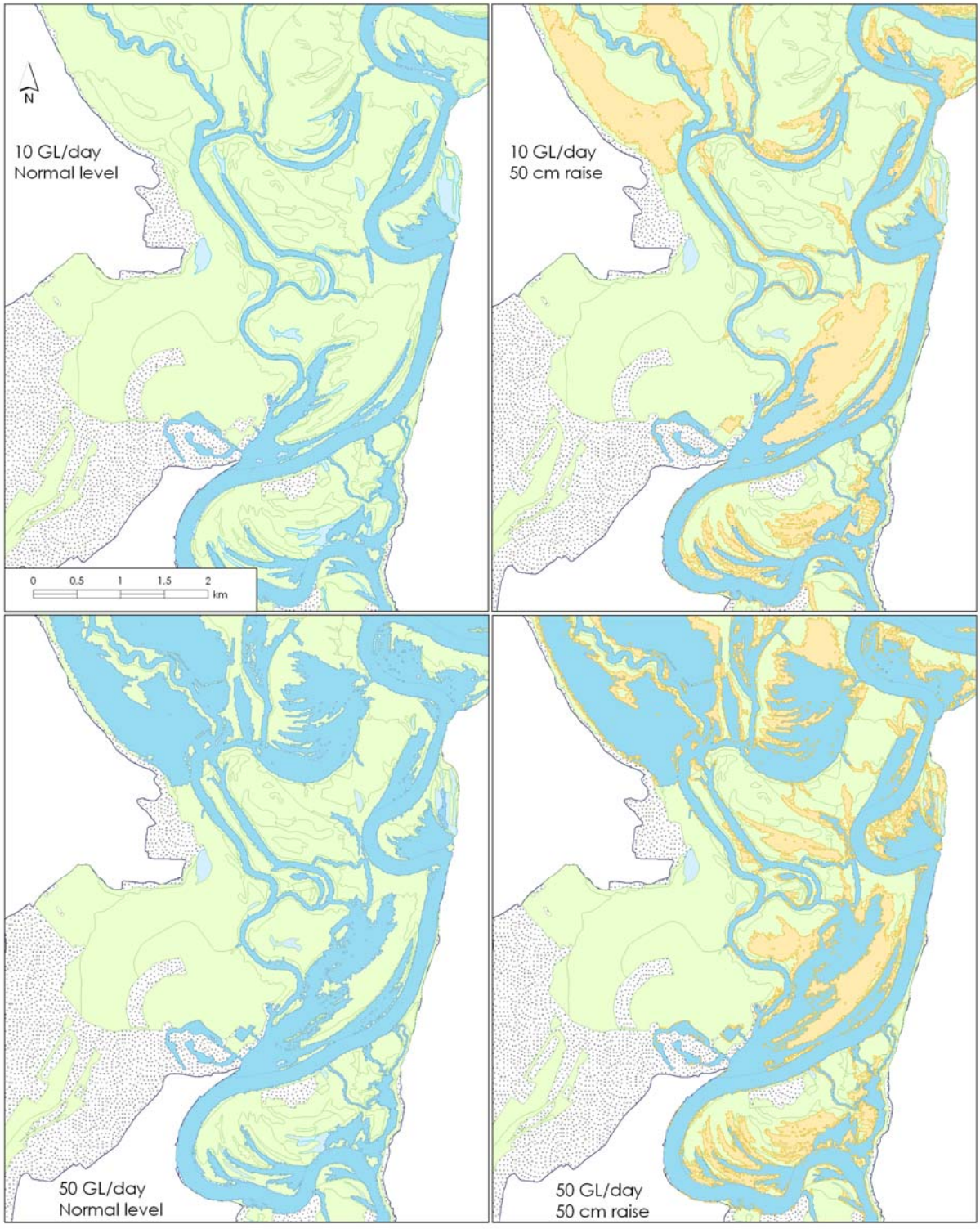

Figure 1: Inundation of a section of the floodplain above Weir 5. Flow is from top to bottom of the figure. Green shows the vegetation areas, lighter blue shows the wetlands not inundated at normal level and spotted areas show parts of the floodplain not covered by vegetation or wetlands. The darker blue shows the inundation due to the flow at normal level (10 GL/d for the top figures, and 50 GL/d for the bottom figures) and yellow shows the additional floodplain inundation due to increasing the height of weir by 50 cm (right figures).

2.2 Floodplain shapefiles

2.2.1 Vegetation

Floodplain vegetation spatial information was sourced from the South Australian Department of Environment and Natural Resources (DEWNR) floodplain vegetation spatial layer. The shapefile included information on dominant and associated species. The vegetation shapefile covered most of the River Murray floodplain, except non-vegetated areas, such as wetlands and towns. Where the vegetation shapefile and wetland shapefile (see description below) spatially overlaid each other, the wetland shapefile took precedence because the area was considered to hold wetland characteristics even if it contained vegetation.

More than 60 vegetation associations were described in the vegetation shapefile attributes. For this analysis, these were reduced to ten vegetation groups, based on a combination of:

- dominant species
- water regime functional group classification.

All species listed in the vegetation shapefile were assigned to a water regime functional group based on Nicol *et al* (2010) and Gehrig and Nicol (2010) (modified from Brock and Casanova (1997), see also Casanova (2011)), as described in Table 2. The water regime functional group was not known for a few species. However, these species were uncommon and so this did not affect the classification of the 60 shapefile vegetation associations into the ten vegetation groups (Table 3). A list of all associated species for each vegetation group and the water regime functional group for each species is provided in Appendix B. Table 4 provides further information on the water regime preferences of the dominant species for the ten vegetation groups.

Table 2: Water regime functional group classification of plant species based on water regime preferences (adapted from Nicol *et al* (2010), modified from Brock and Casanova (1997), see also Casanova (2011))

FUNCTIONAL GROUP	ABBREVIATION	WATER REGIME PREFERENCE
Emergent	E	Static shallow water <1 m or permanently saturated soil.
Amphibious fluctuation tolerators - emergent	AFTE	Fluctuating water levels, plants do not respond morphologically to flooding and drying and will tolerate short-term submergence (<2 weeks).
Amphibious fluctuation tolerators – low growing	AFTL	Fluctuating water levels, plants do not respond morphologically to flooding and drying and are generally small herbaceous species.
Amphibious fluctuation tolerators - woody	AFTW	Fluctuating water levels, plants do not respond morphologically to flooding and drying and are large perennial woody species.
Flood dependent	FD	Temporary inundation, plants germinate on newly exposed soil after flooding but not in response to rainfall.
Terrestrial damp	TDA	Will tolerate inundation for short periods (<2 weeks) but require high soil moisture throughout their life cycle.
Terrestrial dry	TDR	Will not tolerate inundation and tolerates low soil moisture for extended periods.
Salt tolerant	SAT	Water regime preference can vary from permanent shallow water to dry 90% of the time but all species are tolerant to high soil or water salinity.

Table 3: An overview of the ten vegetation groups used to classify the vegetation association information from the floodplain vegetation shapefile

VEGETATION GROUP	DOMINANT SPECIES	DOMINANT SPECIE'S FUNCTIONAL GROUP	ASSOCIATED SPECIES FUNCTIONAL GROUPS	DOMINANT SPECIE'S SALINITY TOLERANCE
River red gum woodland	*Eucalyptus camaldulensis*	AFTW	AFTE, AFTW, E, FD, TDR.	Moderate (20,000 µS/cm)
Lignum shrubland	*Muehlenbeckia florulenta*	AFTW	AFTE, FD, TDA, TDR	Moderate
Black box woodland	*Eucalyptus largiflorens*	AFTW	AFTE, AFTW, TDR, FD, SAT.	Moderate (40,000 µS/cm)
River coobah woodland	*Acacia stenophylla*	AFTW	AFTW, TDR	Moderate
Tea tree woodland	*Melaleuca halmaturorum, Melaleuca lanceolata*	AFTW, TDR	AFTE, AFTW, AFTL, TDA, TDR, SAT.	High (*Melaleuca halmaturorum* - 44,000 mg/L)
Mallee shrubland	*Eucalyptus brachycalyx, Eucalyptus dumosa,*	TDR	TDR.	Unknown
Emergent sedgeland	emergent *Muehlenbeckia florulenta, Phragmites australis, Typha domingensis*	E, (E - AFTW)	E, FD, AFTW, AFRP, TDA, TDR.	Moderate (*Phragmites australis* 22,500 mg/L, *Typha domingensis* 13,000 mg/L)
Flood dependent grassland	*Agrostis avenacea var. avenacea (NC), Eragrostis australasica, Sporobolus virginicus*	FD, TDA	AFTE, AFTW, FD, TDR, SAT.	Unknown-High
Samphire shrubland	*Sarcoconia quinqueflora, Tecticornia spp.*	AFTE	AFTE, AFTL, TDA, SAT.	High (*Sarcoconia quinqueflora* 53,000 mg/L)
Terrestrial dry shrubland	*Atriplex spp., Chenopodium nitrariaceum, Maireana spp., Lycium australe, Dodonea viscosa, (emergent) Acacia victoriae, Disphyma crassifolium ssp. clavellatum*	TDR	AFTE, FD, TDR, SAT.	Generally high ('salt tolerant')

Table 4: Water regime preferences of the dominant species for the ten vegetation groups (based on Roberts and Marston 2011; Doeg *et al* 2011)

VEGETATION GROUP	WATER REGIME PREFERENCES
River red gum woodland	*Eucalyptus camaldulensis* (Roberts and Marston 2011) HEALTH: Flood frequency of 1-3 years, for 5-7 months (forest) and 2-4 years for 2-4 months (woodland) (variability encouraged). Spring-Summer flooding beneficial. REGENERATION: Germination on wet soil - recession of flooding in Spring/Summer favourable, supplementary (same to first year) shallow (20-30 cm) flooding for 4-6 weeks or rainfall important.
Lignum shrubland	*Muehlenbeckia florulenta* (Roberts and Marston 2011) HEALTH: Flood frequency 1-5 years (large shrubs can be used as nesting platforms), for 3-7 months, at a depth less than 1 m. REGENERATION: Seed release in autumn; dispersal flooding and post-flood germination optimally autumn-winter. Supplementary short (4-6 weeks), shallow (5-15 cm) flooding in spring/summer within first 3 years beneficial.
Black box woodland	*Eucalyptus largiflorens* (Roberts and Marston 2011) HEALTH: Flood frequency of 3-7 years, for 3-6 months. REGENERATION: Germination on wet soil - recession of flooding in Spring/Summer favourable, supplementary (first year) shallow flooding or rainfall important.
River coobah woodland	*Acacia stenophylla* (Roberts and Marston 2011) HEALTH: Flood frequency of 3-7 years, for 2-3 months.
Tea tree woodland	*Melaleuca halmaturorum* (Doeg *et al* 2011) HEALTH: Groundwater within 2-3 m of surface for at least 3 months each year. RECRUITMENT: Damp soil for at least 3 months of the year, at least 1 in 10 years.
Mallee shrubland	By definition, Terrestrial Dry species do not tolerate inundation and tolerate low soil moisture for extended periods.
Emergent sedgeland	*Phragmites australis,* (Roberts and Marston 2011) HEALTH: Annual flooding, depth 10-100 cm, for 8-12 months, in spring to autumn. REGENERATION: primarily from rhizomes (see above). *Typha domingensis* (Roberts and Marston 2011) HEALTH: Annual flooding of 0.3-1.5 m for 8-12 months, preferably autumn-winter. REGENERATION: shallow flooding (5-50 cm) in summer-autumn.
Flood dependent grassland	*Eragrostis australasica* (Roberts and Marston 2011) HEALTH: Flooding 2-7 years, shallow (10-50 cm) for 1-6 months (less than 9 months). REGENERATION: likely flooding needed within 7 years, based on seed longevity.
Samphire shrubland	*Tecticornia spp.* (Doeg *et al* 2011) HEALTH: Surface water depth <50 cm for at least 6-9 months of the year. RECRUITMENT: Damp soil for at least 3 months of the year, at least 1 in 3 years.
Terrestrial dry shrubland	By definition, Terrestrial Dry species do not tolerate inundation and tolerate low soil moisture for extended periods.

2.2.2 Wetlands

The wetland shapefile contained information from the South Australian Aquatic Ecosystems (SAAE) Wetland Classification Project (Jones and Miles 2009) and information from the Wetland Prioritisation Project (Butcher *et al* 2007). Attribute information included hydrologic regime and connectivity, ecological rank, conservation rank and threat status for each wetland polygon.

For this analysis, the 12 Aquatic Ecosystem wetland types were divided into three primary categories based on their hydrologic regime (permanent, temporary and saline; Table 5). The wetland types within each category would be expected to exhibit similar responses to inundation. Some wetlands described as temporary by the wetland shapefile were modelled (*Weir Pool Manipulation – Riverine Recovery Project*) as partially or fully inundated at normal levels for flows of ≥10 GL/d. The discrepancy in what was labelled temporary and what is inundated is likely a result of: wetlands having commence-to-flow threshold below 10 GL/d (the lowest flow modelled in the *Weir Pool Manipulation Project*); and different information, such as different sill levels, being used for *River Murray Classification Project* (Jones and Miles, 2009) and the hydraulic modelling of the *Weir Pool Manipulation Project*. This *Technical Note* reports the inundation of different wetland categories based on the SAAE classification (Table 5), but does not analyse the accuracy of wetland connections.

Table 5: SAAE wetland classes included in the three wetland categories used in this analysis

WETLAND CATEGORY	INCLUDED SAAE CLASSES
Permanent	Permanent Lake - Terminal Branch (PLTB), Permanent Lake - Throughflow (PLTF), Permanent Swamp - Terminal Branch (PSTB), Permanent Swamp - Throughflow (PSTF), Permanent Reach (PR)
Temporary	Temporary Wetland - Overbank Flow (TWOB), Temporary Wetland - Terminal Branch (TWTB), Temporary Wetland - Throughflow (TWTF), Seasonal Reach (SR), Ephemeral Reach (ER), Floodplain (FP)
Saline	Saline Swamp (SSw)

For this analysis, further information on each wetland is provided by its 'conservation-threat' class. Each wetland on the South Australian River Murray floodplain had been assigned an ecological, conservation and threat rating by the *Wetland Prioritisation Project* (Butcher *et al* 2007). The ecological value was determined by threatened flora and fauna, habitat structure and extent and hydrological regime diversity (Butcher *et al* 2007). The conservation value was determined by both the ecological value of the wetland and a rarity and representativeness value (Butcher *et al* 2007). The threat value was determined by local salinity, alterations to the hydrological regimes and land-use intensity (Butcher *et al* 2007). These values were combined into five 'conservation-threat' categories, based on a combination of conservation and threat values, as described by Jones and Miles (2009) (Figure 2). Those wetlands with the highest conservation value and lowest threat value rate the highest (CT1) on the conservation-threat matrix. The values CT1-CT5 are used in this analysis to give an indication of the characteristics of the wetlands.

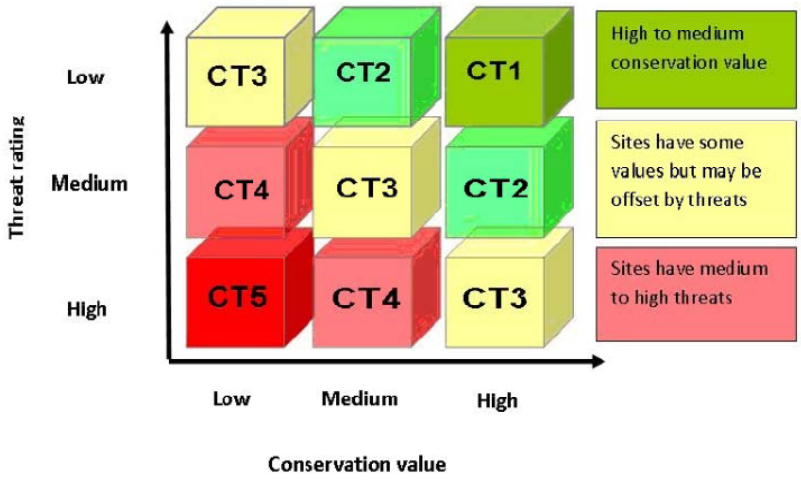

Figure 2: Conservation value versus threat rating matrix (Jones and Miles 2009)

2.2.3 Tree condition

Additional information on floodplain tree condition was provided by the 2002 DEWNR tree condition shapefile. This shapefile assigned polygons of treed areas on the floodplain, with the attributes describing the dominant tree species and the condition (healthy, unhealthy or dead) of that tree species. For this analysis, the condition of the dominant tree species was used.

Unlike the vegetation shapefile, the tree condition shapefile only covers areas that have trees on the floodplain, although the condition may not be assessed for all areas with trees. The tree condition shapefile describes the dominant tree species, but these trees may not be the dominant floodplain vegetation species in that area. For example in an area where lignum (*Muehlenbeckia florulenta*) is the dominant floodplain vegetation species, but river red gum (*Eucalyptus camaldulensis*) is the dominant tree species, the vegetation shapefile would nominate the area as 'lignum shrubland', but the tree condition file as 'river red gum'. Therefore, the two shapefiles are not directly comparable, but together they provide complementary information on the floodplain vegetation.

3. Weir 1

3.1 Summary

Five scenarios were analysed for Weir 1: weir raisings of 25, 50 and 106 cm at a flow rate of 10 GL/d and weir raisings of 50 and 106 cm at a flow rate of 20 GL/d. The modelling showed:

- Raising the weir level by 106 cm at 10 GL/d inundated an additional 652 ha (1449%) of floodplain vegetation compared to normal levels at the same flows. This was a larger area of the floodplain than the 50 cm rise.
- For a given weir level there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of river red gum woodland, lignum shrubland and flood dependent grassland were inundated for all five scenarios compared to other vegetation groups.
- A greater additional area of healthy and unhealthy river red gum trees and unhealthy black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands.
- The extent of the weir pool raise extended over much of the reach: most of the vegetation inundation was closer to Weir 1, but near Weir 2 a number of wetlands were inundated.

3.2 Normal level inundation

Modelled inundation of the floodplain at normal level for the two Weir 1 flow scenarios of 10 GL/d and 20 GL/d is outlined in Table 6. Slightly more of the floodplain (vegetation and wetland) was inundated at 20 GL/d than 10 GL/d at normal levels (0 cm weir raising).

Table 6: The Weir 1 floodplain and the area inundated at different flows with the weir at normal level.

Category	Area of floodplain (ha)	Area inundated at 10 GL/d (ha)	% of area inundated at 10 GL/d	Area inundated at 20 GL/d (ha)	% of area inundated at 20 GL/d
TOTAL WEIR 1 FLOODPLAIN*	***7717***	***1017***	***13%***	***1162***	***15%***
VEGETATION (TOTAL AREA)	**5,740**	**45**	**0.8%**	**121**	**2.1%**
Black box woodland	1147	2.1	0.2	4.7	0.4
Emergent sedgeland	12	0.9	8.2	1.9	16.5
Flood dependent grassland	217	1.2	0.6	13	5.7
Lignum shrubland	1066	0.7	0.1	7.3	0.7
Mallee shrubland	2.0	0.1	2.9	0.1	3.3
River coobah woodland	13	0.1	0.4	0.1	0.6
River red gum woodland	2657	40	1.5	88	3.3
Samphire shrubland	183	0.6	0.3	3.1	1.7
Tea tree woodland	69	-	0.0	-	0.0
Terrestrial dry shrubland	374	0.8	0.2	3.9	1.0
WETLANDS (TOTAL AREA)	**1977**	**972**	**49.2%**	**1041**	**52.6%**
Permanent	1194	966	80.9%	1013	84.8%
Temporary	767	6	0.8%	28	3.7%
Saline	16	-		-	

*Total floodplain is the addition of vegetation and wetlands, but does not include other areas such as towns

3.3 Weir raising

3.3.1 Overview

An overview of the additional area of vegetation and wetlands inundated due to weir pool raising is shown in Table 7 and Figure 3. The additional area is that for weir pool raisings at a given flow i.e. the area inundated by weir pool raisings at 20 GL/d were compared against that of normal level at 20 GL/d.

At a flow of 10 GL/d the additional area of vegetation inundated with a weir pool raising of 106 cm was 652 ha (Table 7). This represents 12% of the total vegetation area not inundated at normal level at 10 GL/d and was a 1449% increase in the area inundated when the river was operated at normal level (45 ha). At 10 GL/d, raising the weir by 106 cm inundated an extra 361 ha of wetland when compared to the 972 ha inundated at normal level. This was an increase of 37%.

The additional vegetation and wetland area inundated was greater at 10 GL/d than 20 GL/d (see the 106 cm weir raising scenario) (Table 7; Figure 3). However, the total inundation area was greater for the 20 GL/d scenario as the normal level inundation area was greater for 20 GL/d than 10 GL/d (Figure 4). There was little difference in the area inundated by the 10 GL/d and 20 GL/d flow scenarios; this holds for most Weir 1 spatial inundation analyses (Table 7, Figure 3 and Figure 4).

Table 7: The additional area of vegetation and wetlands inundated due to raising the weir. Additional area is the area above the normal level inundation for the given flow

	Vegetation			Wetlands		
Scenario	**Additional area inundated (ha)**	**% of total vegetation area not inundated at normal level, now inundated**	**% increase in inundated area when compared to normal level for same flow**	**Additional area inundated (ha)**	**% of total wetland area not inundated at normal level, now inundated**	**% increase in inundated area when compared to normal level for same flow**
10 GL/d 50 cm	178	3%	395%	217	22%	22%
10 GL/d 106 cm	652	12%	1449%	361	36%	37%
20 GL/d 25 cm	24	0.4%	20%	118	13%	11%
20 GL/d 50 cm	173	3%	143%	216	23%	21%
20 GL/d 106 cm	637	11%	526%	329	35%	32%

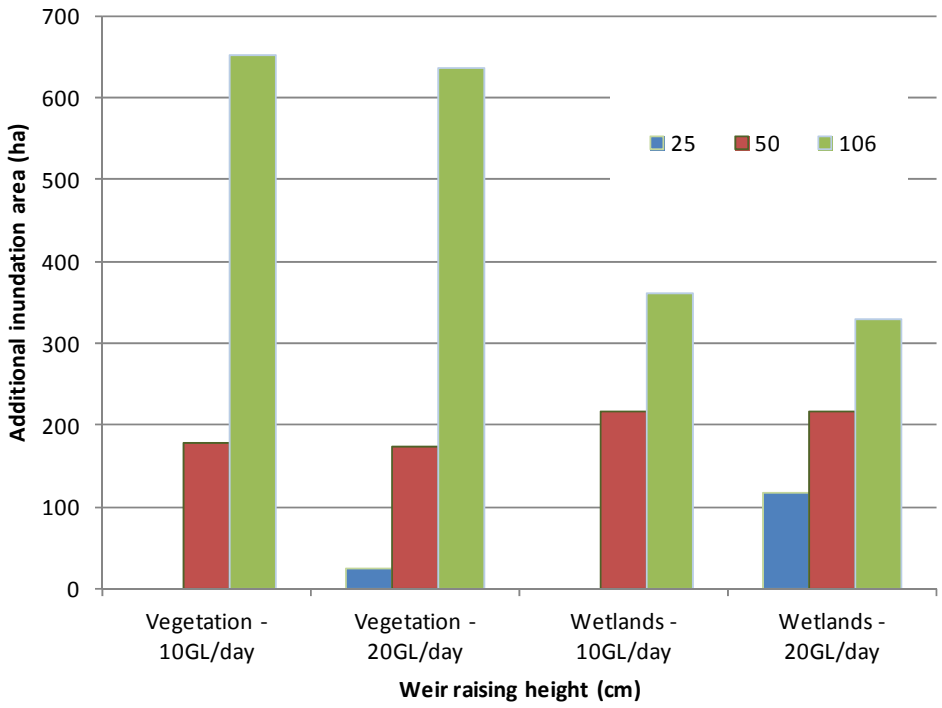

Figure 3: Additional area of vegetation and wetlands inundated under the different flow and weir raising scenarios at Weir 1. Weir pool raises of 25, 50 and 106 cm are shown (blue, red and green, respectively). Additional area is the area above the normal level inundation for the given flow

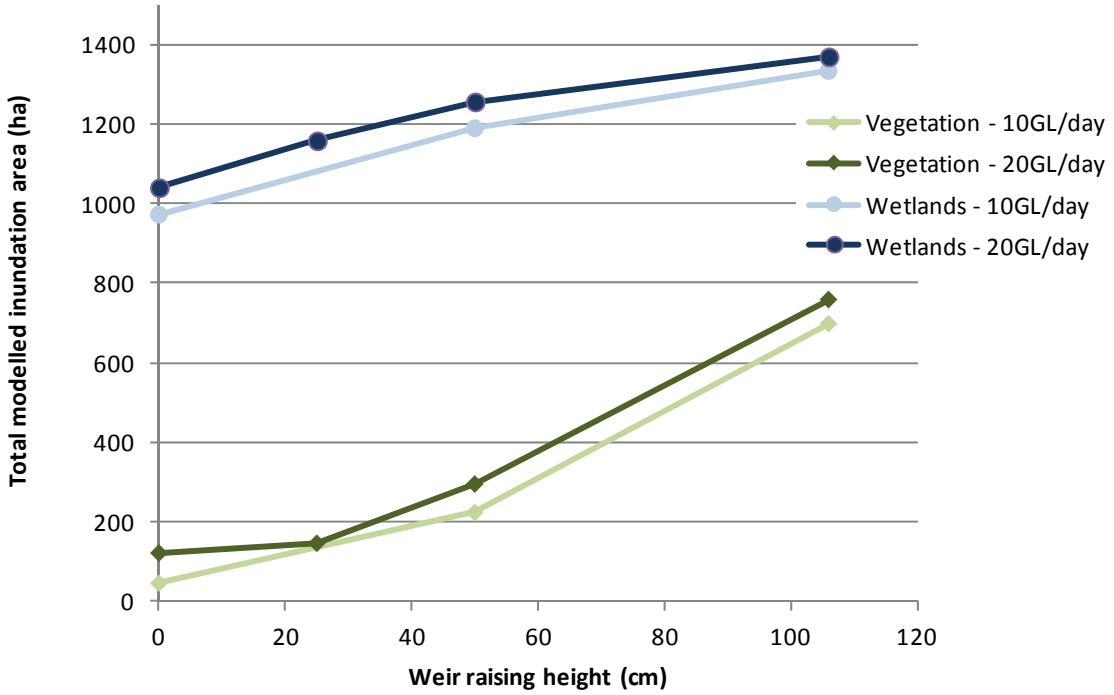

Figure 4: Total area of vegetation and wetlands inundated on the Weir 1 floodplain at normal level (0 cm weir raise) and at the different weir raising scenarios for 10 GL/d and 20 GL/d

3.3.2 Spatial extent

Raising Weir 1 by 106 cm inundated more of the floodplain than a raise of 50 cm at a flow of 10 GL/d (Figure 5). The influence of the weir raising extended over most of distance between Weirs 1 and 2 (Figure 6). Closer to Weir 1, vegetation and wetlands were inundated, whereas closer to Weir 2, wetland inundation dominated. A similar pattern was observed for 20 GL/d.

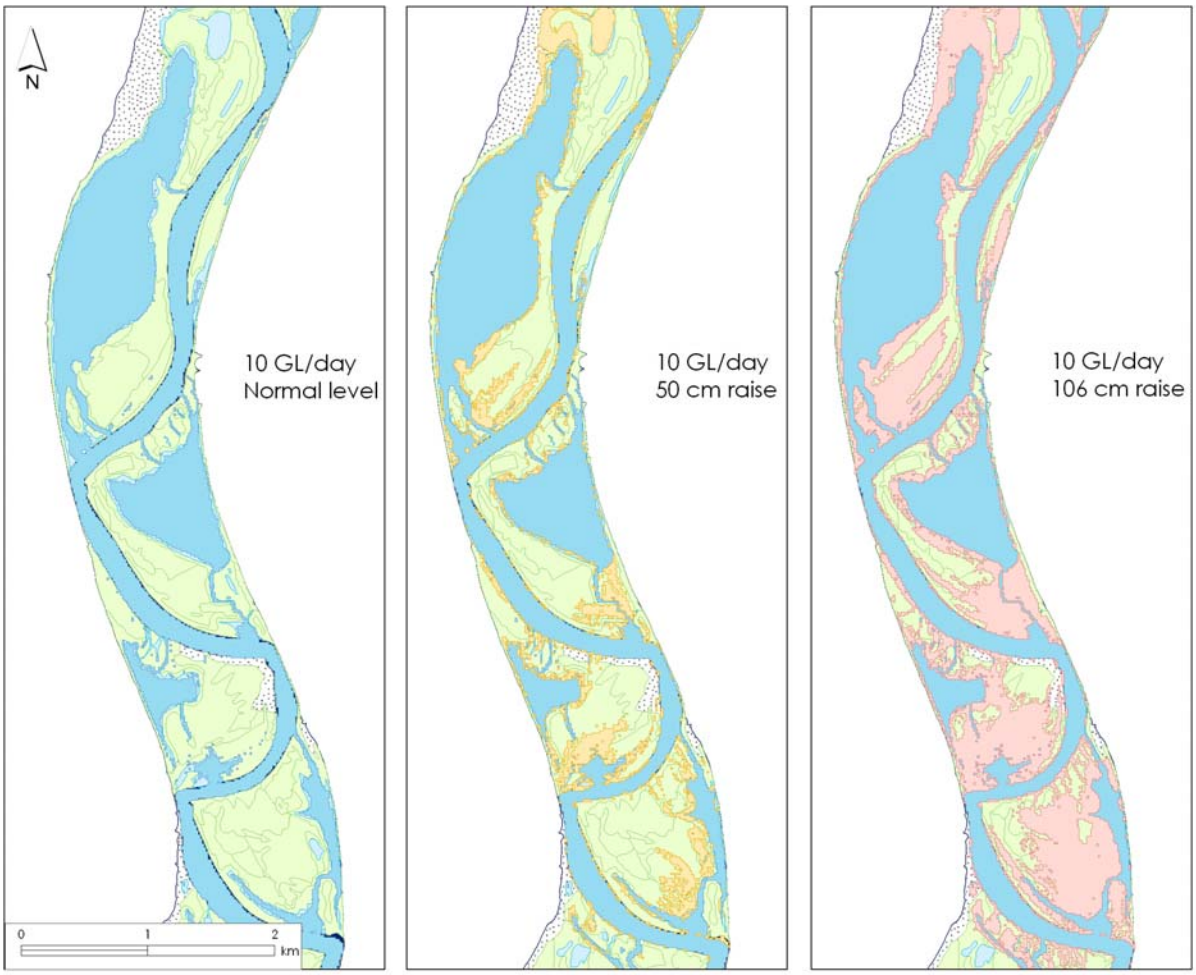

Figure 5: Inundation of Weir 1 floodplain. Area shown is from approximately seven kilometres upstream of the Weir; flow is from top to bottom of the figure. Green shows the vegetation areas, light blue shades are wetlands not inundated at normal level and spotted areas parts of the floodplain not covered by vegetation or wetlands. The darker blue shows the normal level inundation at 10 GL/d. The yellow area shows the additional area inundated above normal level for 10 GL/d with a 50 cm weir raise (middle figure) and the pink area shows the additional area inundated above normal level for 10 GL/d with a 106 cm weir raise (right figure)

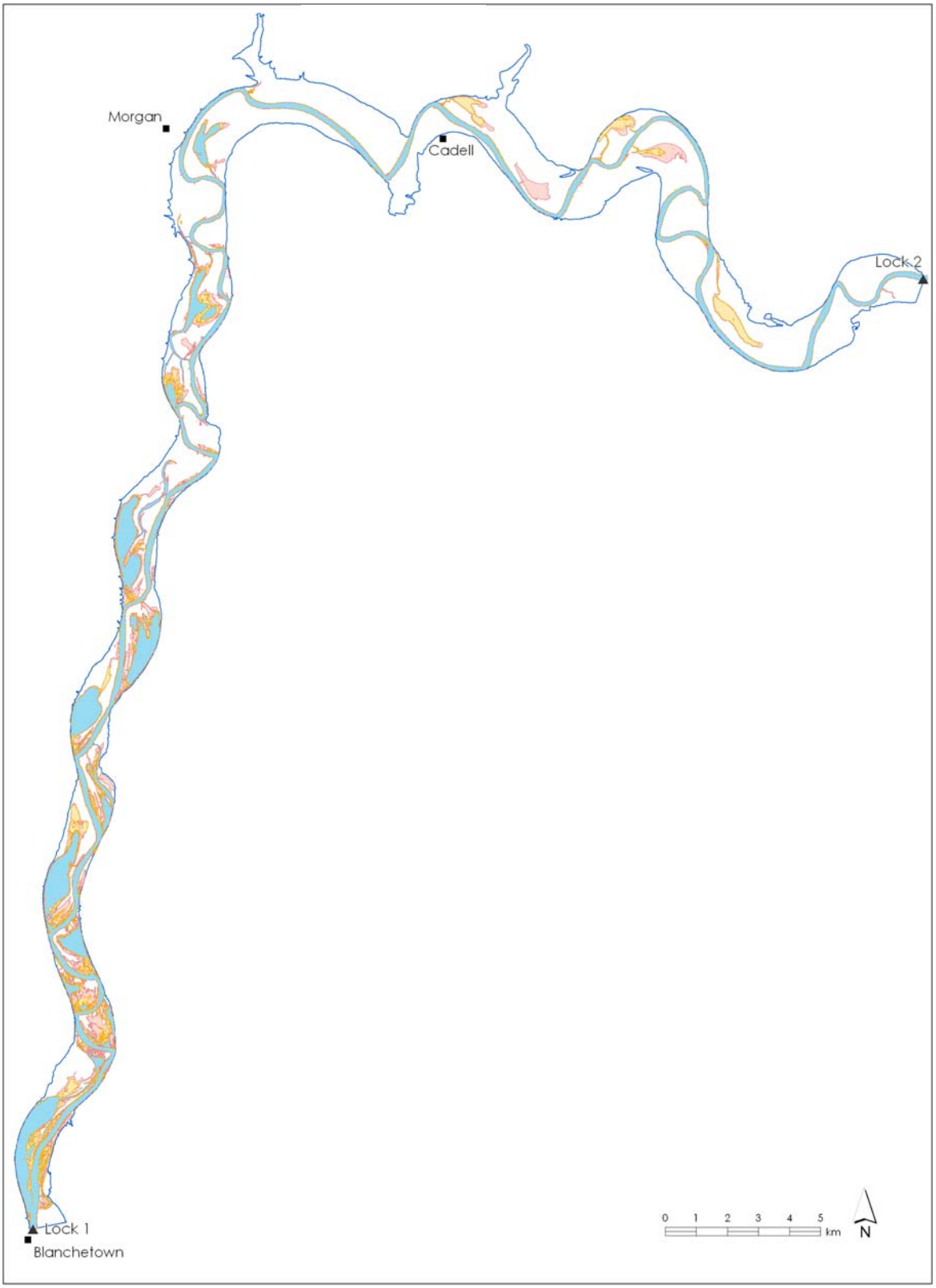

Figure 6: Inundation of the Weir 1 floodplain. An outline of the floodplain is shown by the dark blue line, approximately finishing near Weirs 1 and 2. Normal level inundation at 10 GL/d is shown by the blue area, including the main River Murray channel. Yellow areas show the additional area of inundation caused by raising the weir at Weir 1 by 50 cm and the pink and yellow area combined show the additional area of inundation caused by raising the weir at Weir 1 by 106 cm. Flow is from top right to bottom left of the figure

3.3.3 Vegetation

River red gum woodland, lignum shrubland and flood dependent grassland vegetation groups had the greatest additional inundation area under all flow and weir raising scenarios (Figure 7). The additional area inundated increased 3-4 times for each vegetation group from a 50 cm to 106 cm weir raise.

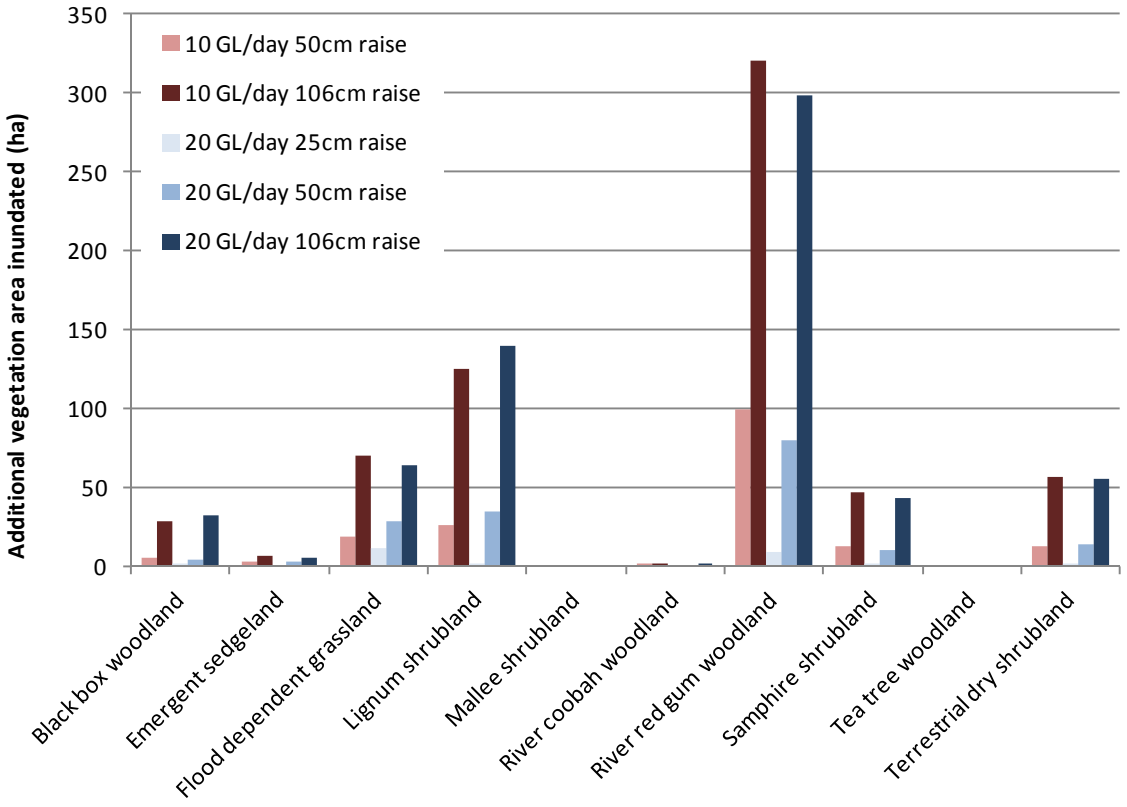

Figure 7: Additional area of the vegetation groups inundated under the different flow and weir raising scenarios at Weir 1. Additional area is the area above the normal level inundation for the given flow

The vegetation groups river red gum woodland, lignum shrubland and flood dependent grassland had the greatest total inundation area under all flow and weir raising scenarios (Figure 8). The total inundation area was greater for the 20 GL/d scenarios than the 10 GL/d scenarios (for the same weir raising).

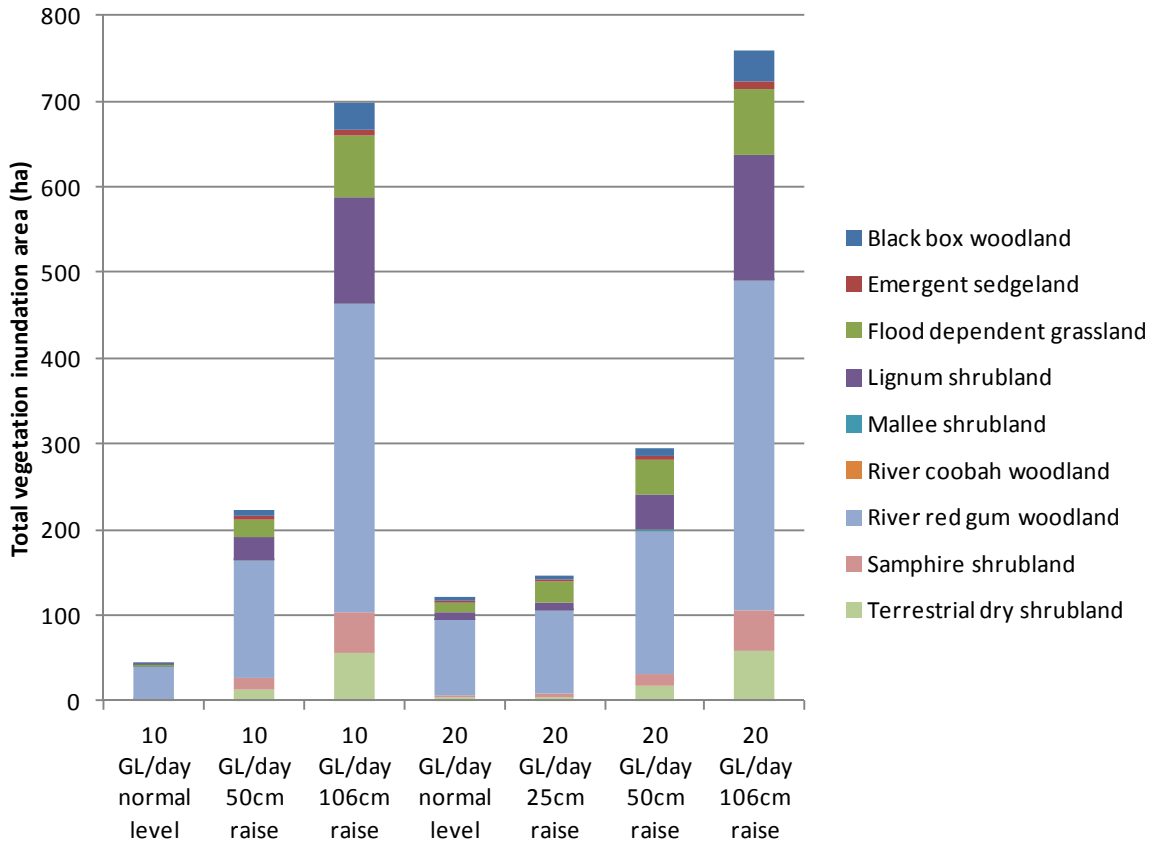

Figure 8: Total vegetation area inundated under normal level and the different flow and weir raising scenarios at Weir 1

Not all vegetation groups were equally inundated by the two weir pool raising scenarios (Table 7). For example, river red gum woodland comprised 46.3% of the vegetation on the Weir 1 floodplain. At 10 GL/d and a 50 cm weir raise, 138.2 ha of river red gum woodland area was inundated, which was equivalent to 5.2% of the total river red gum woodland area across the entire vegetated floodplain. However river red gum woodland comprised 62% of the 223 ha area inundated by the 10 GL/d 50 cm rise, indicating that they were preferentially favoured by the weir raising. Conversely, black box woodland comprised 20% of the Weir 1 floodplain vegetation area, but only 3% of the inundated area for the 10 GL/d, 50 cm rise (with 6.7 ha inundated; equivalent to 0.6% of the total black Box woodland area on the Weir 1 floodplain). A weir raising of 50 cm at 10 GL/d inundated 3.9% of the Weir 1 floodplain vegetation, and a weir raising of 106 cm at 10 GL/d inundated 12.2% of the Weir 1 floodplain vegetation (Table 8). Whilst data for weir pool raisings at 10 GL/d are presented the inundation response is likely to be similar for 20 GL/d as the area of inundation was similar.

Table 8: Effect of Weir 1 raising on floodplain vegetation groups and the composition of the vegetation groups on the total floodplain. Shown are the areas of each vegetation group inundated; the percentage of each group inundated; and the percentage of the total vegetation area inundated

			10 GL/d, 50 cm raise			10 GL/d, 106 cm raise		
Vegetation group	Total floodplain area (ha)	% of total floodplain vegetation area (composition of)	Total area inundated (ha)	% of vegetation group inundated	% of total vegetation area inundated	Total area inundated (ha)	% of vegetation group inundated	% of total vegetation area inundated
Black box woodland	1147	20.0	6.7	0.6	3.0	30	2.6	4.3
Emergent sedgeland	12	0.2	4.1	35.2	1.8	7.1	61.8	1.0
Flood dependent grassland	217	3.8	20	9.4	9.1	72	33.0	10.3
Lignum shrubland	1066	18.6	27	2.5	12.1	125	11.7	17.9
Mallee shrubland	2.0	0.0	0.1	2.9	0.0	0.1	2.9	0.0
River coobah woodland	13	0.2	0.1	0.7	0.0	0.7	5.5	0.1
River red gum woodland	2657	46.3	138	5.2	62.0	359	13.5	51.4
Samphire shrubland	183	3.2	14	7.4	6.1	47	25.7	6.8
Tea tree woodland	69	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Terrestrial dry shrubland	374	6.5	13.0	3.5	5.8	57	15.2	8.1
TOTAL VEGETATION AREA	**5740**	**100**	**223**	**3.9**	**100**	**697.8**	**12.2**	**100**

3.3.4 Wetlands

Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands (Figure 9). Most of the permanent wetland area inundated at normal level and for the range of raising scenarios was in the CT2 conservation-threat class (Figure 10). This was reflective of the classes that exist on the floodplain, although the CT4 class wetlands were not inundated to the extent that they exist on the floodplain. Most of the temporary wetland area inundated at normal level and for the range of raising scenarios was CT3 conservation-threat class, which was reflective of the classes on the floodplain (Figure 11). For both temporary and permanent wetlands weir raising had little effect on the proportional area of the conservation-threat classes inundated compared to normal levels.

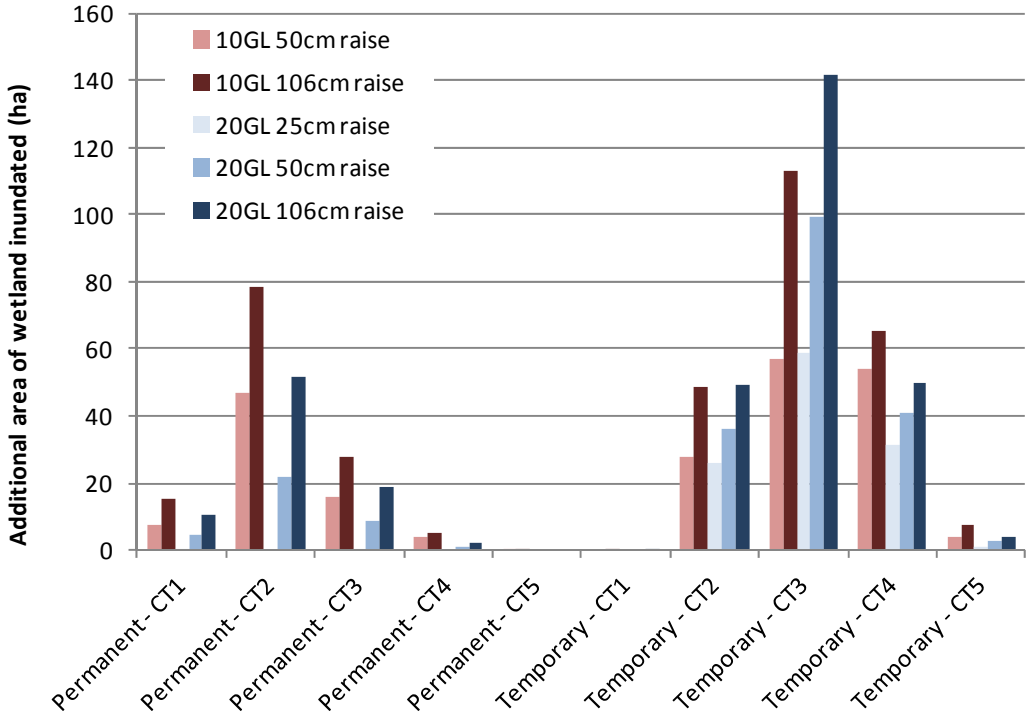

Figure 9: Additional area of permanent and temporary wetlands for each conservation-threat class inundated under the different flow and weir raising scenarios at Weir 1. Additional area is the area above the normal level inundation for the given flow

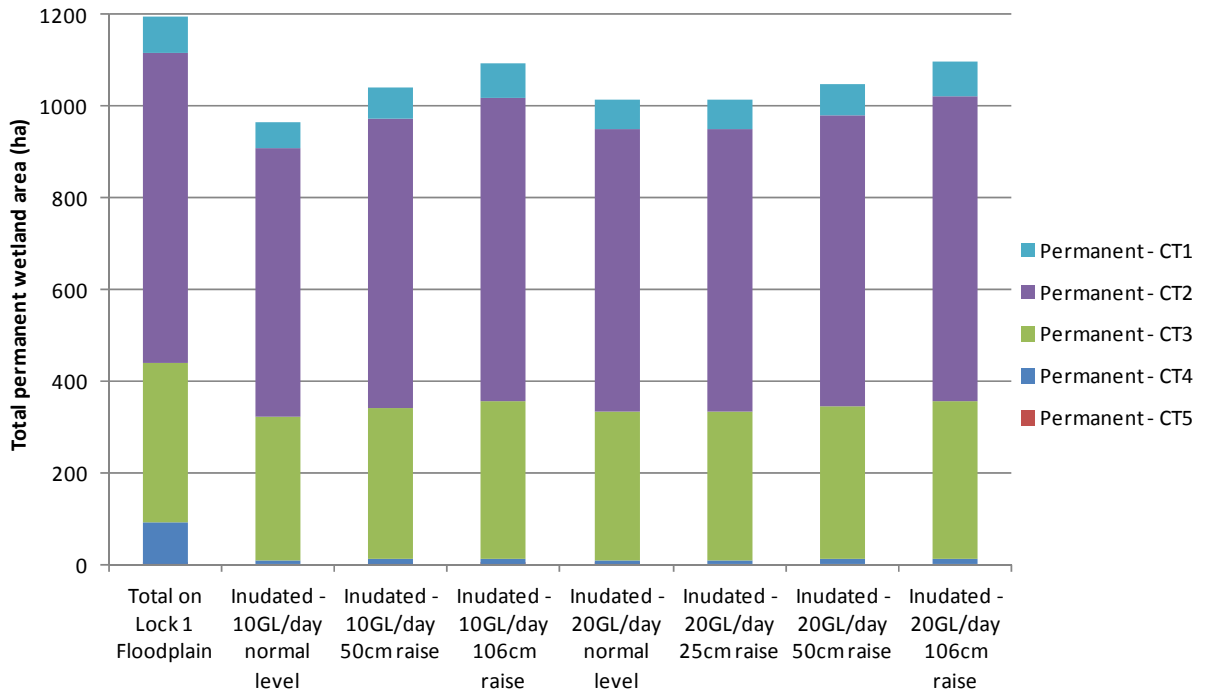

Figure 10: Total area of permanent wetland conservation-threat classes on Weir 1 floodplain and inundated under normal level and the different flow and weir raising scenarios

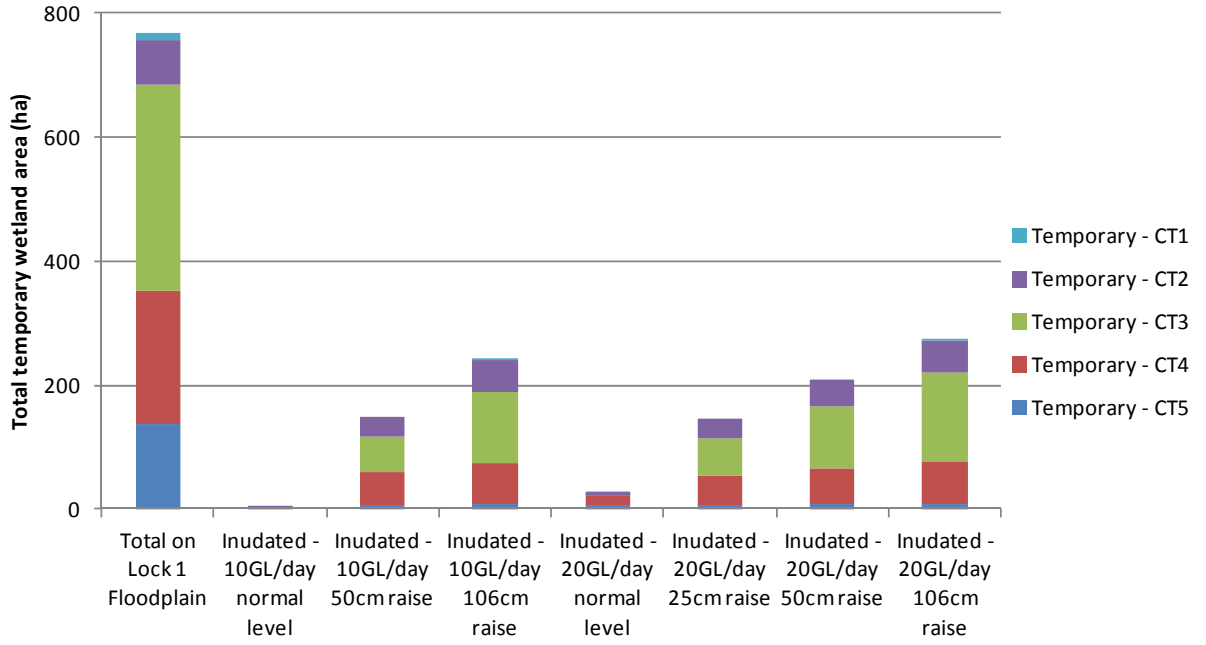

Figure 11: Total area of temporary wetland conservation-threat classes on Weir 1 floodplain and inundated under normal level and the different flow and weir raising scenarios

At a 20 GL/d flow and 50 cm raise, 1,256 ha of wetlands were inundated, which was equivalent to 63.6% of the total floodplain wetland area (Table 9). Twenty-three percent of wetland area not inundated at normal level was inundated by raising the weir 50 cm at a flow of 20 GL/d.

The flow scenarios of 10 GL/d and 20 GL/d were similar, but there was a difference in the permanent and temporary wetland areas inundated: for a 106 cm raise 91.5% (10 GL/d) and 91.8% (20 GL/d) of permanent wetland area was inundated, but only 31.4% (10 GL/d) and 35.7% (20 GL/d) of temporary wetland area was inundated (Table 9).

Table 9: Inundation of total, permanent and temporary wetland area on the Weir 1 floodplain. Shown are the area and percentage area inundated and the percentage area inundated that is not inundated at normal level

Scenario	TOTAL WETLAND AREA – 1977 ha			PERMANENT WETLAND AREA – 1194 ha			TEMPORARY WETLAND AREA – 767 ha		
	total wetland area inundated (ha)	% of total wetland area on Weir 1 floodplain inundated	% of total wetland area inundated not inundated at normal level	permanent wetland area inundated (ha)	% of total permanent wetland area on Weir 1 floodplain inundated	% of total permanent wetland area inundated not inundated at normal level	temporary wetland area inundated (ha)	% of total temporary wetland area on Weir 1 floodplain inundated	% of total temporary wetland area inundated not inundated at normal level
10 GL/d, normal level	972	49.2	-	966	80.9	-	6	0.8	-
10 GL/d, 50 cm raise	1190	60.2	21.6	1041	87.2	32.7	143	19.4	18.7
10 GL/d, 106 cm raise	1333	67.4	35.9	1092	91.5	55.4	235	31.4	30.9
20 GL/d, normal level	1041	52.6	-	1012	84.8	-	28	3.7	-
20 GL/d, 25 cm raise	1159	58.6	12.6	1013	84.8	0.3	117	19.0	15.9
20 GL/d, 50 cm raise	1256	63.6	23.0	1049	87.9	20.1	179	27.0	24.3
20 GL/d, 106 cm raise	1370	69.3	35.1	1096	91.8	46.6	246	35.7	33.3

There were 140 temporary wetlands on the Weir 1 floodplain, 13 of which were modelled as fully or partially inundated at normal level for a 20 GL/d flow (Table 10). Twenty-seven temporary wetlands were affected by a weir raising of 50 cm at 20 GL/d, either through an increase in the area of the individual wetlands or inundation dry wetlands. Similar numbers of permanent and temporary wetlands were affected by a weir raise of 106 cm for both 10 GL/d and 20 GL/d, but more permanent than temporary wetlands were affected by the 50 cm rise.

Table 10: The number of wetlands on the Weir 1 floodplain, the number of wetlands fully or partially inundated at normal level for different flows and the number of wetlands affected by raising the weir for the wetland categories and conservation classes. Wetlands 'affected' by raising the weir are those whose inundated area increased due to the weir raising.

Wetland category	Weir 1 total number of wetlands	number of wetlands inundated 10 GL/d, normal level	number of wetlands affected by 50 cm raise at 10 GL/d,	number of wetlands affected by 106 cm raise at 10 GL/d	number of wetlands inundated 20 GL/d, normal level	number of wetlands affected by 25 cm raise at 20 GL/d	number of wetlands affected by 50 cm raise at 20 GL/d	number of wetlands affected by 106 cm raise at 20 GL/d
PERMANENT	**47**	**39**	**38**	**45**	**44**	**2**	**35**	**43**
CT1	8	7	7	8	7	1	7	8
CT2	22	21	17	21	22	0	15	20
CT3	12	8	10	12	11	1	10	12
CT4	4	3	3	3	3	0	3	3
CT5	1	0	1	1	1	0	0	0
SALINE	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CT3	1	0	0	0	0	0	0	0
TEMPORARY	**140**	**10**	**27**	**50**	**13**	**7**	**27**	**49**
CT1	2	0	0	1	0	0	0	1
CT2	13	3	6	9	4	1	5	9
CT3	36	2	5	9	2	1	5	9
CT4	54	5	13	20	5	3	11	17
CT5	35		3	11	2	2	6	13
TOTAL	**188**	**49**	**65**	**95**	**57**	**9**	**62**	**92**

3.3.5 Tree condition

Healthy and unhealthy river red gum trees had the greatest additional area inundated by the weir raising (Figure 12). A greater additional area of unhealthy black box than healthy black box was inundated by the weir pool raising (Figure 12).

Weir pool raising inundated both healthy and unhealthy stands of river red gum (Figure 13) and black box (Figure 14). Raising the weir pool by 106 cm increased the proportion of healthy river red gum inundated when compared to the 50 cm raise and at normal level for both flow scenarios (Figure 13). In comparison, raising the weir pool by 106 cm increased the proportion of unhealthy black box inundated when compared to the 50 cm raise and at normal level for both flow scenarios (Figure 14). The 106 cm raise for both flow scenarios inundated >20 ha of unhealthy black box (Figure 14).

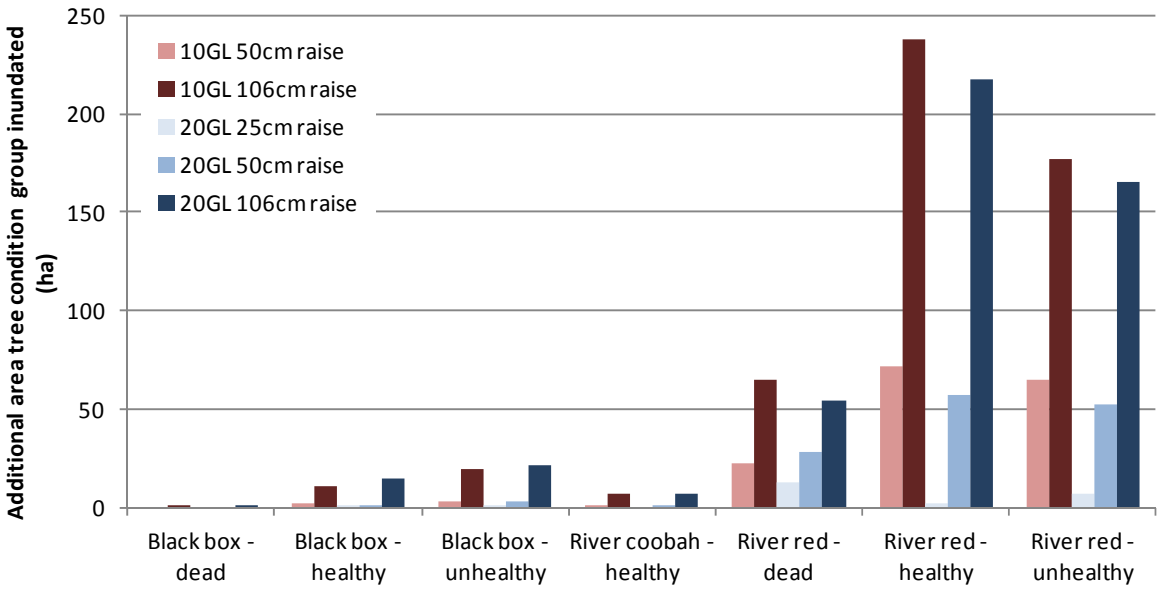

Figure 12: Additional area of tree condition categories inundated under the different flow and weir raising scenarios at Weir 1. Additional area is that above the normal level inundation for the given flow

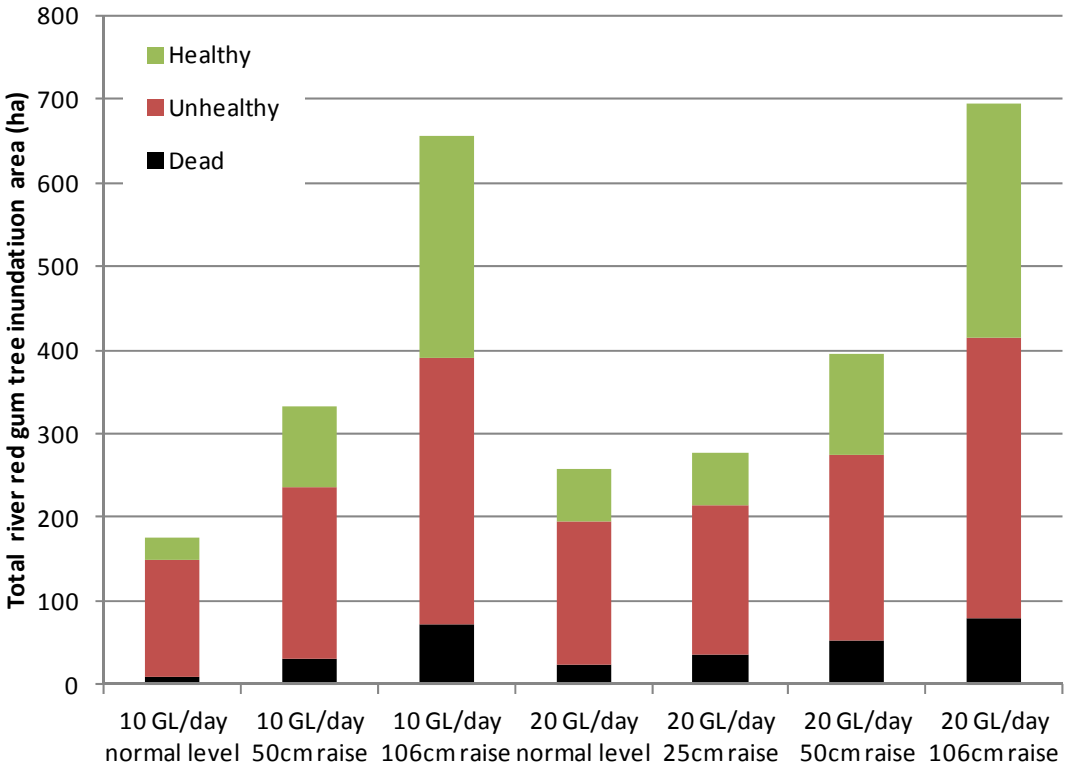

Figure 13: Total inundated area of river red gum trees under normal level and the different flow and weir raising scenarios at Weir 1

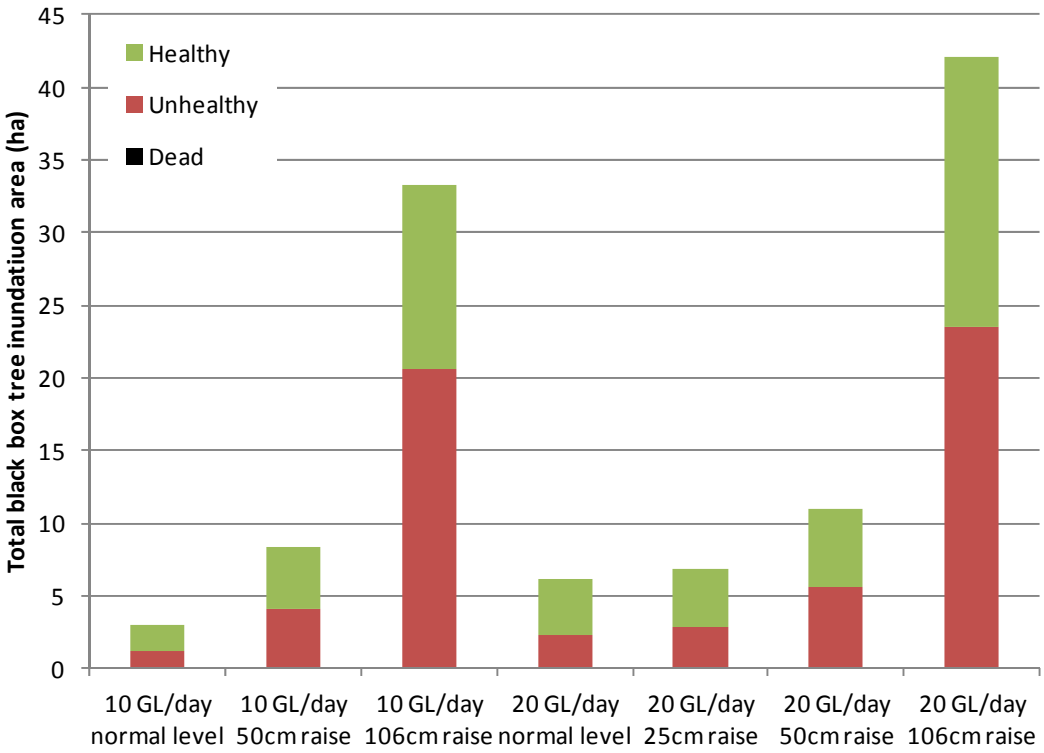

Figure 14: Total inundated area of black box trees under normal level and the different flow and weir raising scenarios at Weir 1

Approximately 19% of healthy river red gum trees not inundated at normal level were inundated by a weir raising of 106 cm (both 10 GL/d and 20 GL/d), but only 2% of healthy black box trees were inundated (Table 11). Similarly, 11% unhealthy river red gum and 4% of unhealthy black box trees not inundated at normal level were inundated by a weir raising of 106 cm (both 10 GL/d and 20 GL/d). Five percent of all river red gum trees on the Weir 1 floodplain not inundated at normal level were inundated with a 50 cm weir raising, but only 0.4% of all black box trees on the Weir 1 floodplain. It needs to be noted that these values are not comparable to those calculated for the river red gum woodland and black box woodland vegetation groups described previously.

Table 11: The percentage of the tree condition area not inundated at normal level, inundated under the different flow and weir raising scenarios at Weir 1 (above the normal level inundation for a given flow), for the different categories of tree condition. The percent areas are the area of the relevant tree condition category not inundated at normal levels, inundated under the different scenarios. The total percentage for each tree is that of all trees in all classes inundated across the floodplain.

	Percentage of area not inundated at normal level, inundated under the different scenarios (%)				
	10 GL/d, 50 cm raise	**10 GL/d, 106cm raise**	**20 GL/d, 25 cm raise**	**20 GL/d, 50 cm raise**	**20 GL/d, 106cm raise**
Total black box	0.4	2.5	0.1	0.4	2.9
Dead black box	0.0	1.1	0.0	0.0	1.6
Healthy black box	0.3	1.5	0.0	0.2	2.0
Unhealthy black box	0.6	4.0	0.1	0.7	4.3
Total river coobah	3.2	25.2	0.0	0.1	26.4
Healthy river coobah	3.2	25.2	0.0	0.1	26.4
Total river red gum	5.1	15.6	0.7	4.6	14.6
Dead river red gum	7.8	22.8	4.7	10.5	20.3
Healthy river red gum	5.9	19.8	0.2	4.9	18.6
Unhealthy river red gum	4.1	11.2	0.4	3.4	10.7
Combined total	**3.7**	**11.7**	**0.5**	**3.3**	**11.1**

4. Weir 2

4.1 Summary

Three scenarios were analysed for Weir 2: weir raisings of 35 and 70 cm at a flow rate of 10 GL/d and a weir raising of 35 cm at a flow rate of 20 GL/d. The modelling showed:

- Raising the weir level by 70 cm at 10 GL/d inundated an additional 185 ha (321%) of floodplain vegetation compared to normal levels at the same flows. This was a larger area of the floodplain than the 35 cm rise.
- For a given weir level there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of samphire shrubland and river red gum woodland were inundated than other vegetation groups.
- A greater additional area of dead and unhealthy river red gum trees and healthy black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands.
- The extent of the weir pool raise extended over much of the reach: most of the vegetation inundation was closer to Weir 2, but near Weir 3 wetlands were inundated.

4.2 Normal level inundation

Inundation of the floodplain at normal level for the two Weir 2 scenario flows of 10 GL/d and 20 GL/d is outlined in Table 12. Slightly more of the total floodplain (vegetation and wetland) was inundated at 20 GL/d than 10 GL/d.

Table 12: The Weir 2 floodplain and the area inundated at different flows with the weir at normal level

Category	Area of floodplain (ha)	Area inundated at 10 GL/d (ha)	% of area inundated at 10 GL/d	Area inundated at 20 GL/d (ha)	% of area inundated at 20 GL/d
TOTAL WEIR 2 FLOODPLAIN*	***5,999***	***782***	***13.0%***	***879***	***14.6***
VEGETATION (TOTAL AREA)	**4812**	**58**	**1.2%**	**99**	**2.1%**
Black box woodland	1649	10	0.6	18	1.1
Emergent sedgeland	23	1.7	7.3	2.7	11.9
Flood dependent grassland	166	0.5	0.3	1.1	0.7
Lignum shrubland	946	4.2	0.4	6.1	0.6
Mallee shrubland	4.2	0.0	0.8	0.1	2.4
River coobah woodland	60	0.6	0.9	0.6	1.0
River red gum woodland	1501	35	2.3	51	3.4
Samphire shrubland	335	4.9	1.5	18	5.5
Terrestrial dry shrubland	129	0.2	0.2	1.3	1.0
WETLANDS (TOTAL AREA)	**1187**	**724**	**61.0%**	**780**	**65.7%**
Permanent	670	536	80.0%	549	81.9%
Temporary	420	99	23.6%	140	33.3%
Saline	97	89	92.1%	91	94.4%

*Total floodplain is the addition of vegetation and wetlands, but does not include other areas such as towns

4.3 Weir raising

4.3.1 Overview

An overview of the additional area of vegetation and wetlands inundated due to raising the weir is shown in Table 13 and Figure 15. The additional area is that for weir pool raisings at a given flow i.e. the inundated area caused by weir pool raisings at 20 GL/d were compared against that of normal level at 20 GL/d.

At a flow of 10 GL/d the additional area of vegetation inundated with a weir pool raising of 70 cm was 185 ha (Table 13). This represents 3.9% of the total vegetation area not inundated at normal level at 10 GL/d and was a 321% increase in the area inundated when the river was operated at normal level (58 ha). At 10 GL/d, raising the weir by 70 cm inundated at extra 124 ha of wetland when compared to the 724 ha inundated at normal level. This was an increase of 17%.

Table 13: The additional area of vegetation and wetlands inundated due to raising the weir. Additional area is the area above the normal level inundation for the given flow

	Vegetation			Wetlands		
Scenario	Additional area inundated (ha)	% of total vegetation area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow	Additional area inundated (ha)	% of total wetland area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow
10 GL/d 35cm	57	1.2%	99%	74	16%	10%
10 GL/d 70 cm	185	3.9%	321%	124	27%	17%
20 GL/d 35 cm	68	1.5%	69%	59	15%	7.5%

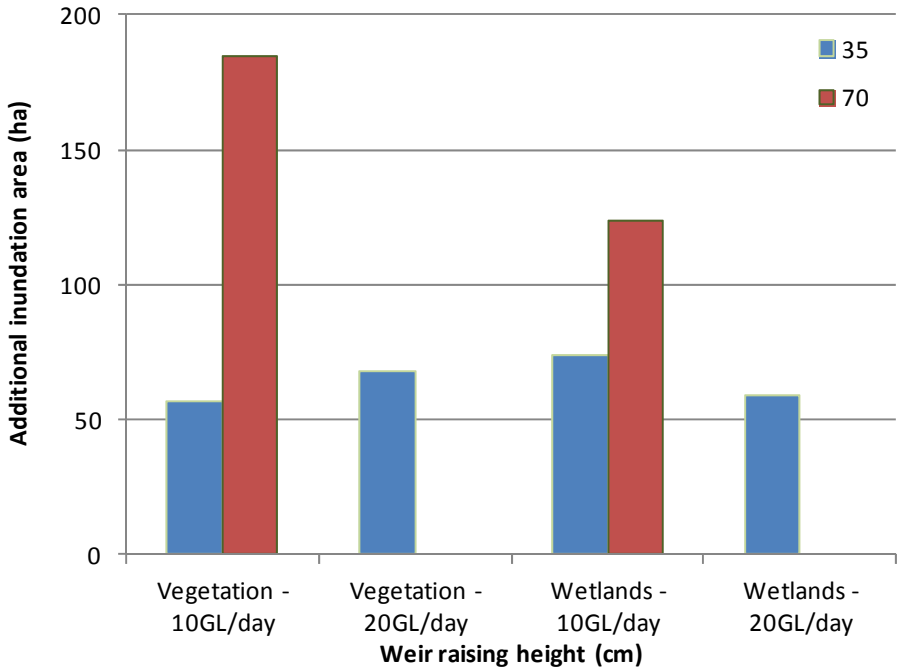

Figure 15: Additional area of vegetation and wetlands inundated under the different flow and weir raising scenarios at Weir 2. Weir pool raises of 35 and 70 cm are shown (blue and red, respectively). Additional area is the area above the normal level inundation for the given flow

The additional wetland area inundated was greater for the 10 GL/d than 20 GL/d scenarios (see the 35 cm weir raising scenario) (Table 13; Figure 15). However the total inundation area was greater for the 20 GL/d scenario, as the normal level inundation area was greater for 20 GL/d than 10 GL/d (Figure 16).

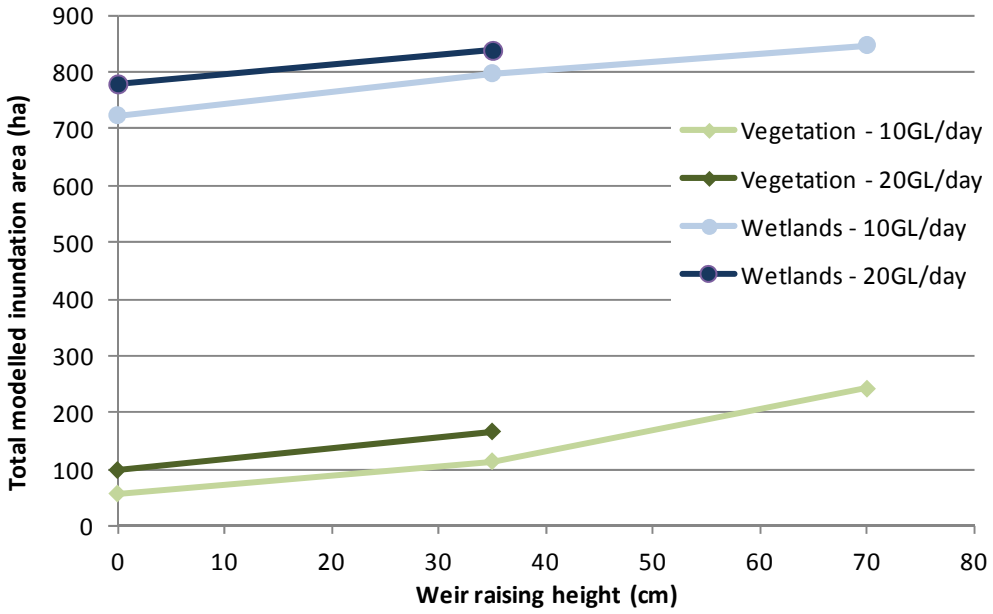

Figure 16: Total area inundated of vegetation and wetlands on the Weir 2 floodplain at normal level (0 cm weir raise) and at the different weir raising scenarios for 10 GL/d and 20 GL/d

4.3.2 Spatial extent

In some parts of the floodplain raising the weir 35 cm (at 10 GL/d) had little effect, whereas the 70 cm raise inundated parts of the floodplain vegetation and wetlands (Figure 17). The influence of the weir raising extended over most of the distance between Weirs 2 and 3 (Figure 18). Closer to Weir 2, vegetation and wetlands were inundated, whereas closer to Weir 3, wetland inundation was more apparent. A similar pattern was observed for 20 GL/d.

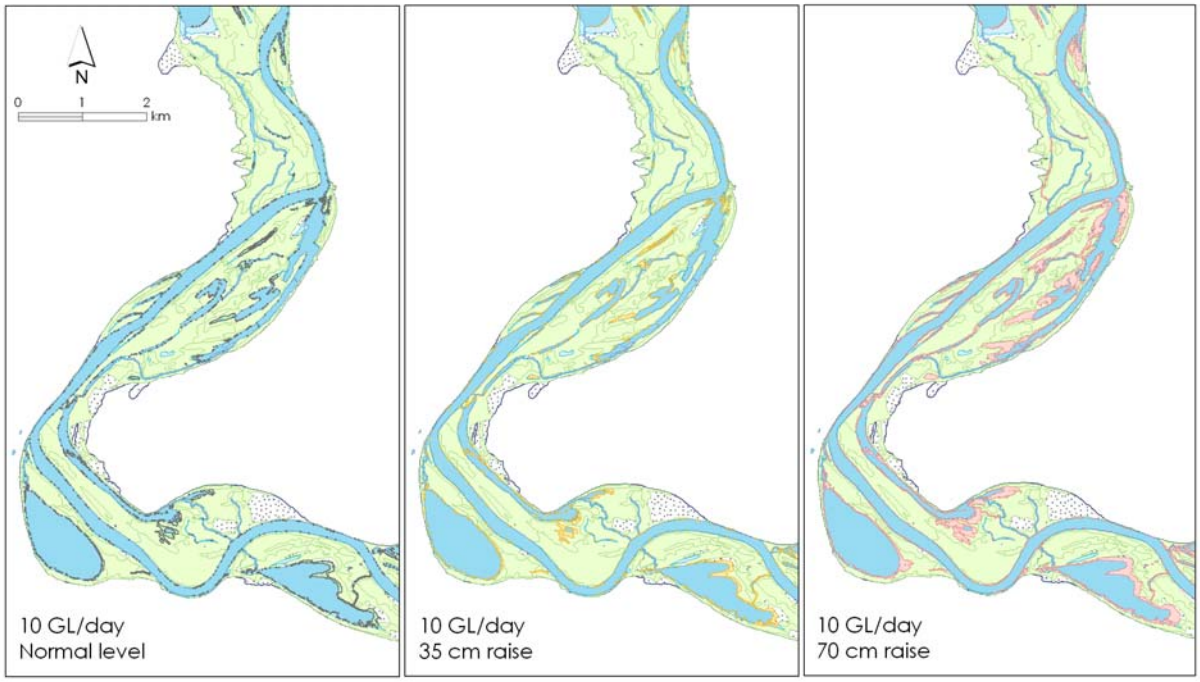

Figure 17: Inundation of Weir 2 floodplain. Area shown is from approximately three kilometres upstream of the Weir; flow is from bottom to top of the figure. Green shades show the vegetation areas, light blue shades are wetlands not inundated at normal level and spotted areas parts of the floodplain not covered by vegetation or wetlands. The darker blue shows the normal level inundation at 10 GL/d. The yellow area shows the additional area inundated above normal level for 10 GL/d with a 35 cm weir raise (middle figure) and the pink area shows the additional area inundated above normal level for 10 GL/d with a 70 cm weir raise (right figure)

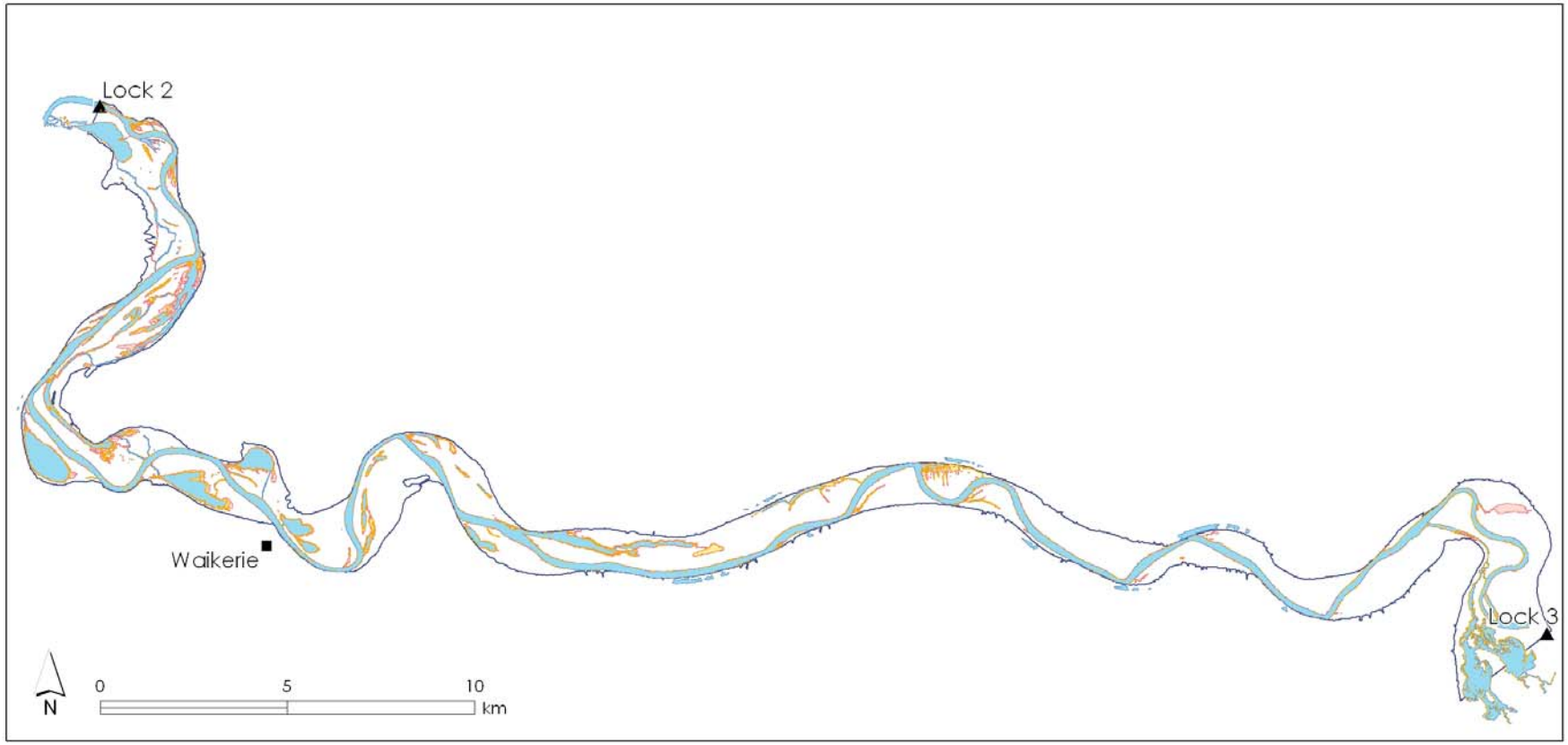

Figure 18: Inundation of the Weir 2 floodplain. An outline of the floodplain is shown by the dark blue line, approximately finishing near Weirs 2 and 3. Normal level inundation at 10 GL/d is shown by the blue shade, including the main River Murray channel. Yellow areas show the additional area of inundation caused by raising the weir at Weir 2 by 35 cm and the pink and yellow area combined show the additional area of inundation caused by raising the weir at Weir 2 by 70 cm. Flow is from right to left of the figure

4.3.3 Vegetation

River red gum woodland and samphire shrubland vegetation groups had the greatest additional inundation area under all flow and weir raising scenarios. The additional area inundated increased 2-4 times for each vegetation group from a 35 cm to 70 cm weir raise (10 GL/d, Figure 19).

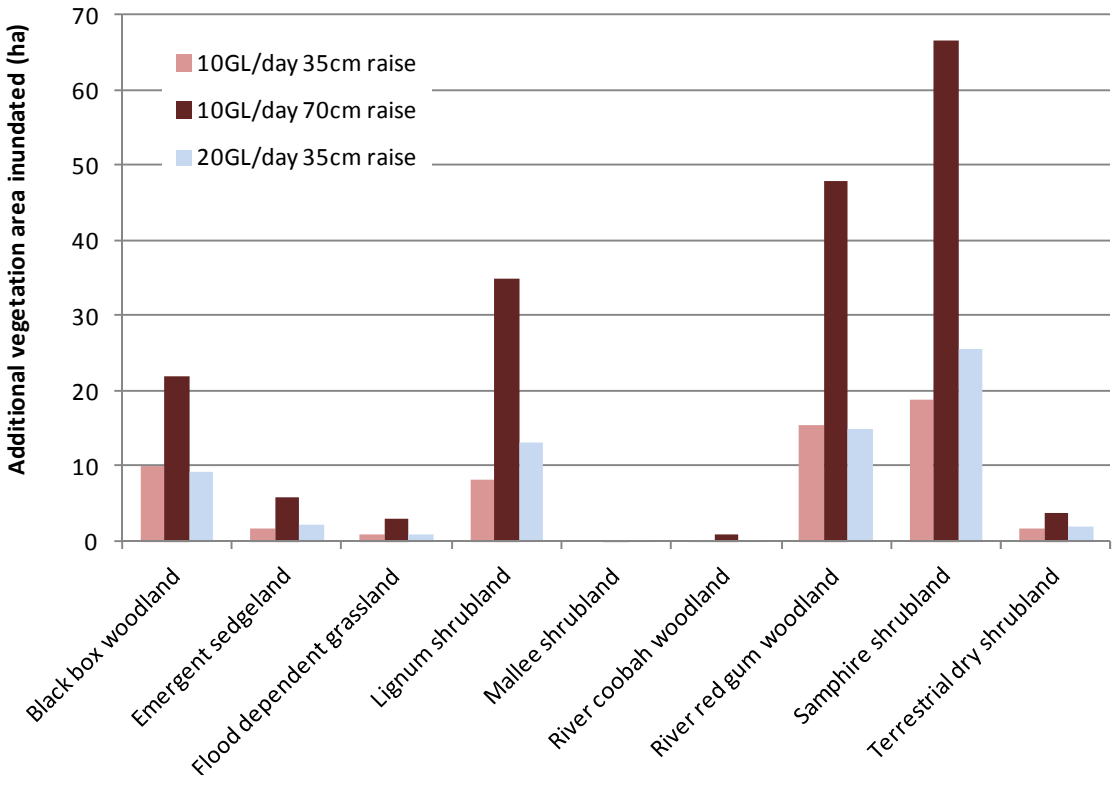

Figure 19: Additional area of the vegetation groups inundated under the different flow and weir raising scenarios at Weir 2. Additional area is the area above the normal level inundation for the given flow

The vegetation groups river red gum woodland and samphire shrubland had the greatest total inundation area under all flow and weir raising scenarios (Figure 20). The total inundation area was greater for the 20 GL/d scenarios than the 10 GL/d scenarios (for the same weir raising of 35 cm).

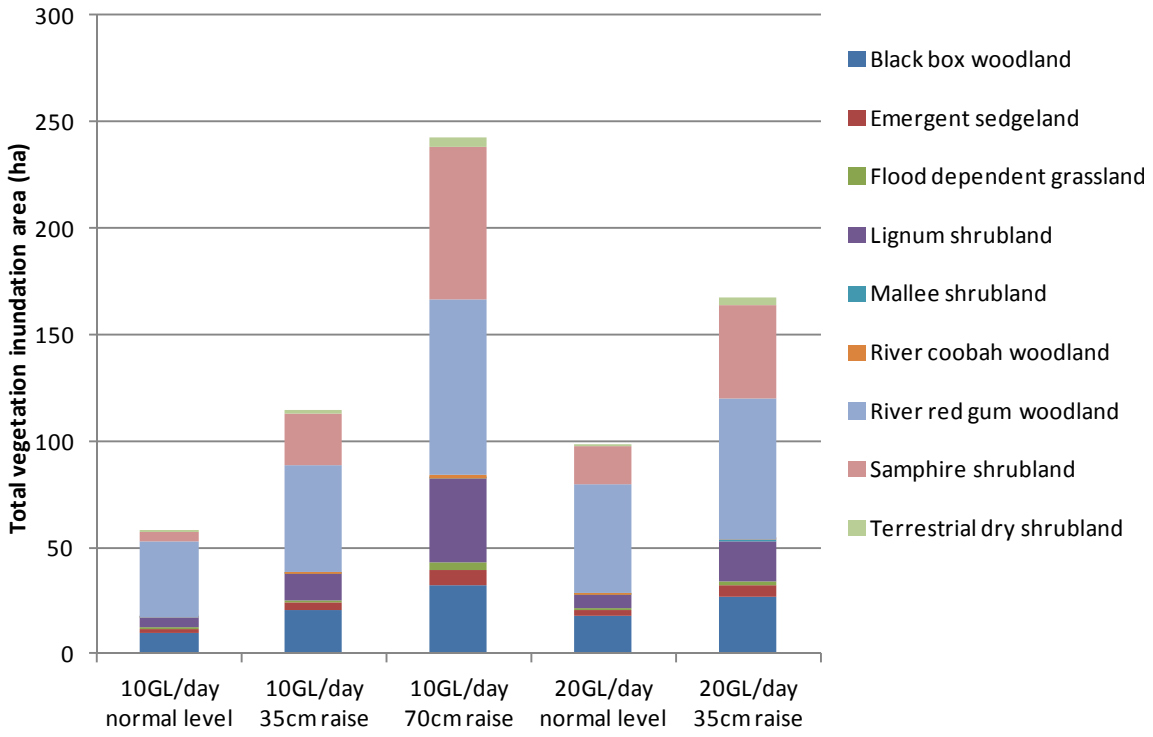

Figure 20: Total vegetation area inundated under normal level and the different flow and weir raising scenarios at Weir 2

Figure 20 shows the composition of the vegetation groups on the total floodplain; the area of these inundated at 10 GL/d for the 35 cm and 70 cm weir raisings; the percentage of each group inundated under these scenarios and the percentage of the total vegetation area inundated under these scenarios.

Not all vegetation groups were equally inundated by the weir pool raising scenarios (Table 14). For example, river red gum woodland comprised 31.2% of the vegetation on the Weir 2 floodplain. At 10 GL/d and a 35 cm weir raise, 50.5 ha of river red gum woodland area was inundated, which was equivalent to 3.4% of the total river red gum woodland area across the entire vegetated floodplain. However river red gum woodland comprised 44.1% of the 115 ha area inundated by the 10 GL/d and 35 cm. This indicates that they were preferentially favoured by the weir raising. Conversely, black box woodland comprised 34.3% of the Weir 2 floodplain vegetation area, but only 17.7% of the inundated area for the 10 GL/d, 35 cm rise (with 20.2 ha inundated; equivalent to 1.2% of the total black box woodland area on the Weir 2 floodplain). At 10 GL/d a weir raising of 35 cm inundated 2.4% of the Weir 2 floodplain vegetation and a weir raising of 70 cm inundated 5.0% of the Weir 2 floodplain vegetation (Table 14). Whilst data for weir pool raisings at 10 GL/d are presented the inundation response is likely to be similar for 20 GL/d as the area of inundation was similar.

Table 14: Effect of Weir 2 raising on floodplain vegetation groups and the composition of the vegetation groups on the total floodplain. Shown are the areas of each vegetation group inundated; the percentage of each group inundated; and the percentage of the total vegetation area inundated.

			10 GL/d, 35 cm raise			10 GL/d, 70 cm raise		
Vegetation group	Total floodplain area (ha)	% of total floodplain vegetation area (composition of)	Total area inundated (ha)	% of vegetation group inundated	% of total vegetation area inundated (composition of)	Total area inundated (ha)	% of vegetation group inundated	% of total vegetation area inundated (composition of)
Black Box woodland	1649	34.3	20	1.2	17.7	32	1.9	13.3
Emergent sedgeland	23	0.5	3.5	15.1	3.0	7.4	32.3	3.1
Flood dependent grassland	166	3.5	1.5	0.9	1.3	3.5	2.1	1.5
Lignum shrubland	946	19.7	12	1.3	10.8	39	4.1	16.2
Mallee shrubland	4	0.1	0.0	0.8	0.0	0.1	3.2	0.1
River Coobah woodland	60	1.2	0.7	1.2	0.6	1.4	2.4	0.6
River Red Gum woodland	1501	31.2	51	3.4	44.1	83	5.5	34.2
Samphire shrubland	335	7.0	24	7.1	20.7	71	21.3	29.5
Terrestrial dry shrubland	129	2.7	1.9	1.5	1.7	4.0	3.1	1.7
TOTAL VEGETATION AREA	**4812**	**100**	**115**	**2.4**	**100**	**242**	**5.0**	**100**

4.3.4 Wetlands

Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands (Figure 21). Most of the permanent wetland area inundated at normal level and for the raising scenarios was conservation-threat class CT2, which was reflective of the classes on the floodplain (Figure 22). Most of the temporary wetland area inundated at normal level and for raising scenarios was conservation-threat class CT4, despite a greater area of CT3 wetlands on the floodplain (Figure 23). Most of the saline wetland area inundated at normal level and for the range of raising scenarios was conservation-threat class CT3, which was reflective of the classes on the floodplain (Figure 24). For permanent, temporary and saline wetlands, weir raising had little effect on the proportional area of different conservation-threat classes inundated.

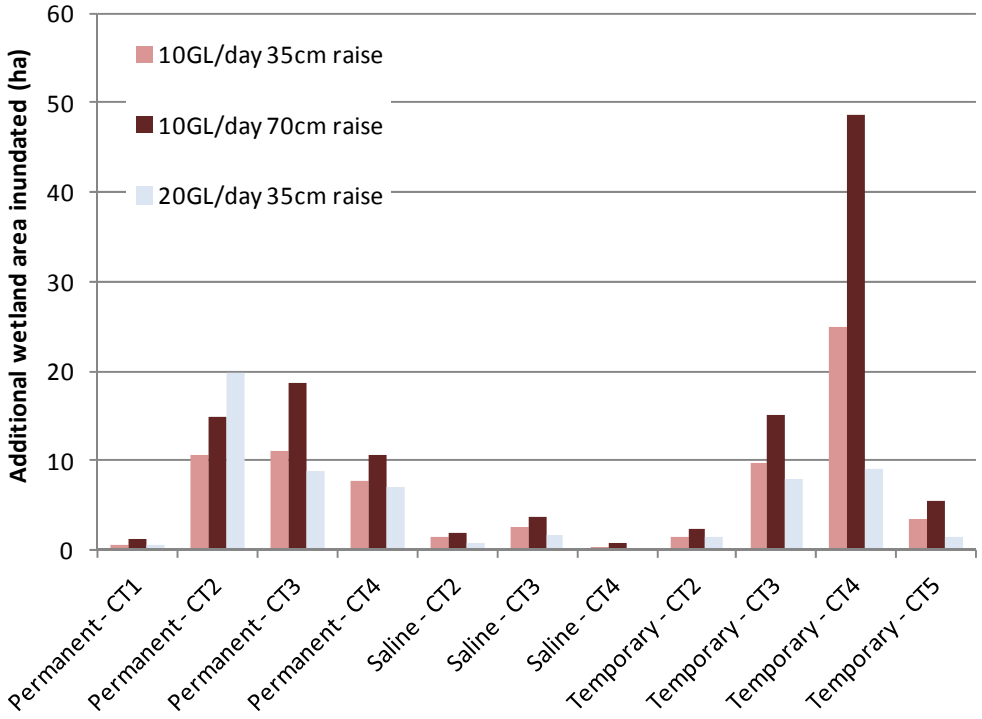

Figure 21: Additional area of permanent, saline and temporary wetlands organised by conservation-threat class inundated under the different flow and weir raising scenarios at Weir 2. Additional area is the area above the normal level inundation for the given flow

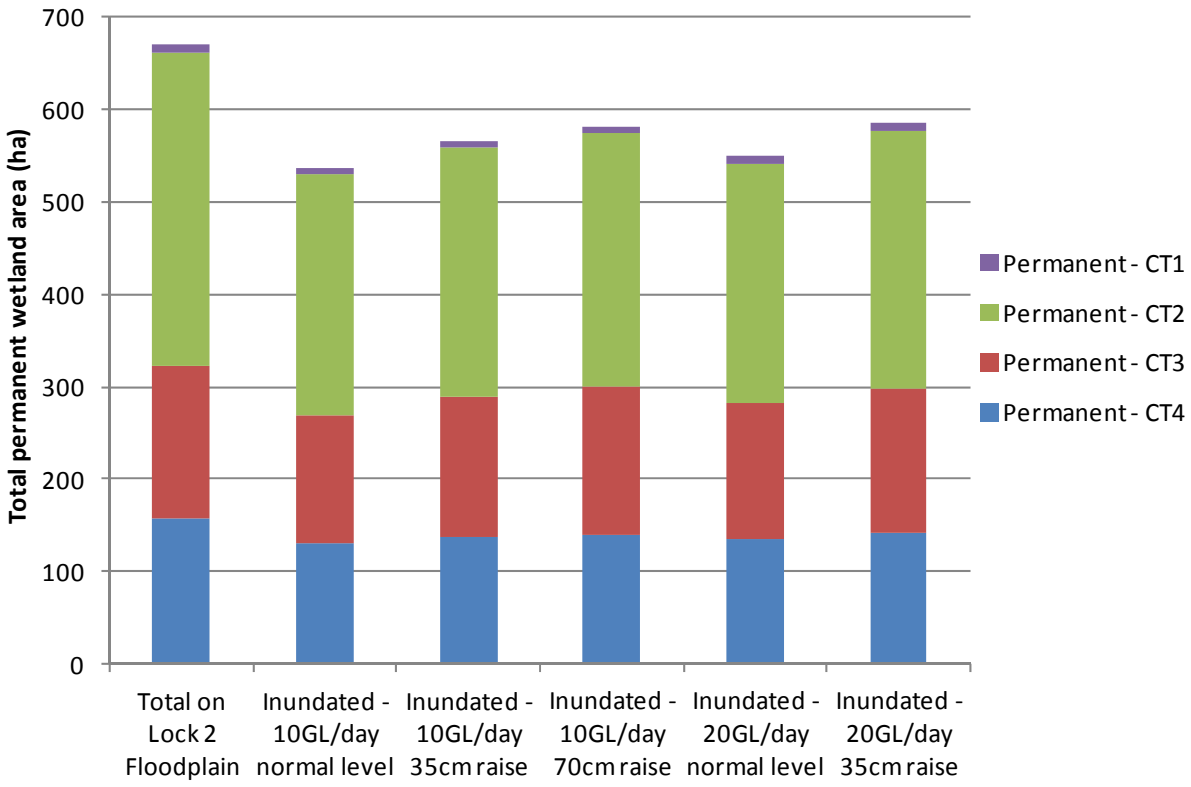

Figure 22: Total area of permanent wetland conservation-threat classes on Weir 2 floodplain and inundated under normal level and the different flow and weir raising scenarios

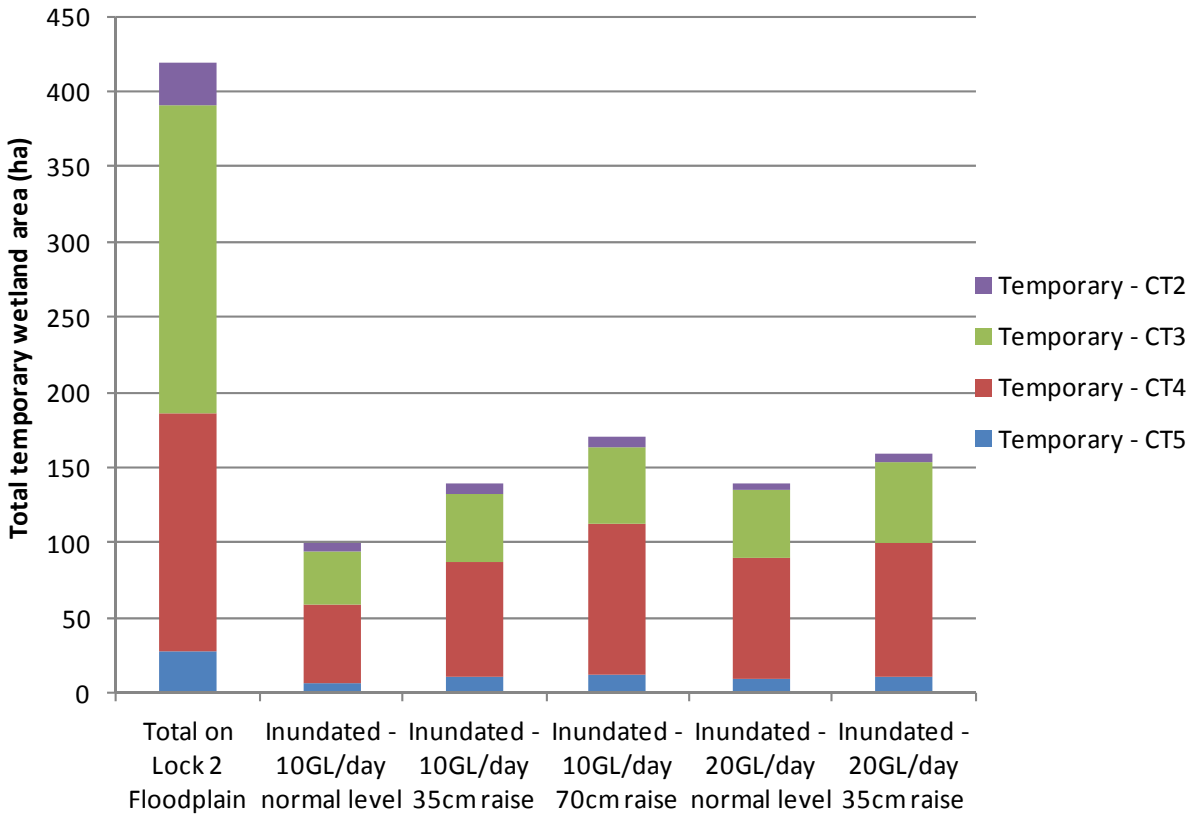

Figure 23: Total area of temporary wetland conservation-threat classes on Weir 2 floodplain and inundated under normal level and the different flow and weir raising scenarios

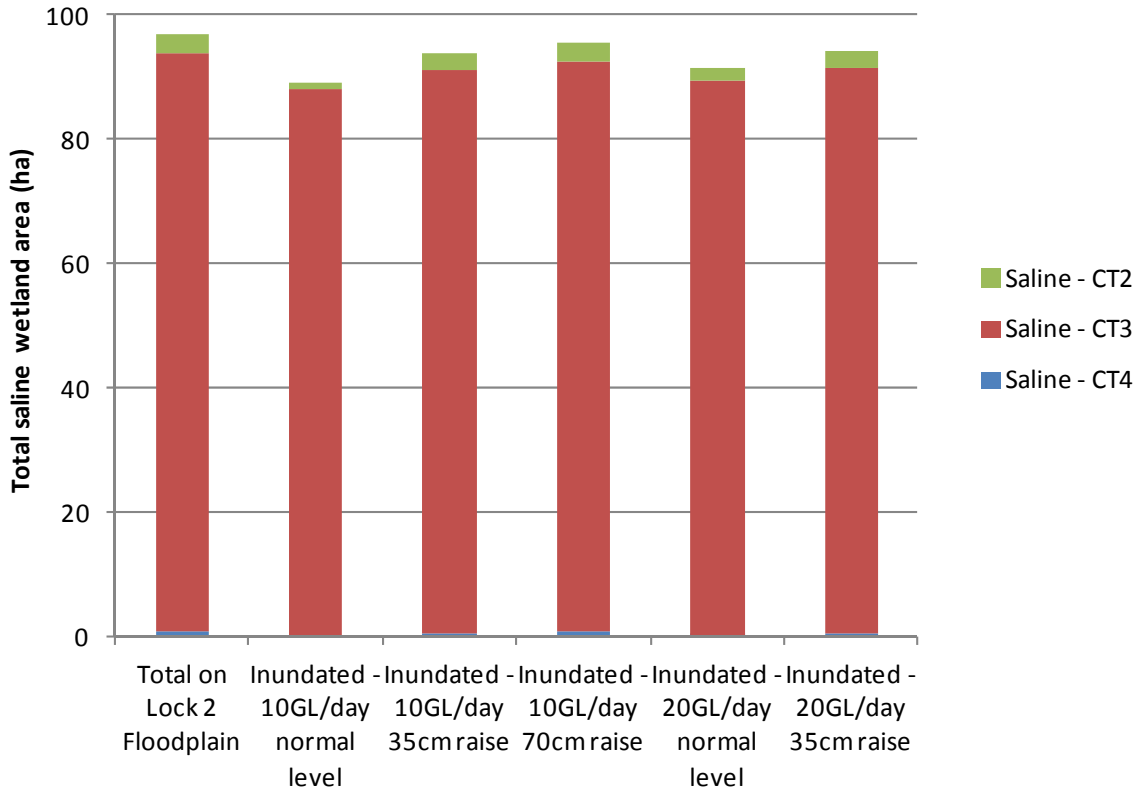

Figure 24: Total area of saline wetland conservation-threat classes on Weir 2 floodplain and inundated under normal level and the different flow and weir raising scenarios

At 20 GL/d and a 35 cm raise, 840 ha of the total wetland area was inundated, which was equivalent to 70.7% of the total floodplain wetland area (Table 15). Fifteen percent of wetland area not inundated at normal level was inundated by raising the weir 35 cm at a flow of 20 GL/d.

Increasing the flow and/or raising the weir increased the wetland area inundated: 61% of the total wetland area was inundated at 10 GL/d and normal level, compared to 70.7% at 20 GL/d and normal level, and 71.5% at 10 GL/d with a 70 cm weir raise (Table 15).

Table 15: Inundation of total, permanent and temporary wetland area on the Weir 2 floodplain. Shown are the area and percentage area inundated and the percentage area inundated that is not inundated at normal level

Scenario	TOTAL WETLAND AREA – 1187 ha			PERMANENT WETLAND AREA – 670 ha			TEMPORARY WETLAND AREA – 420 ha		
	Total wetland area inundated (ha)	% of total wetland area on Weir 2 floodplain inundated	% of total wetland area not inundated at normal level now inundated	Permanent wetland area inundated (ha)	% of total permanent wetland area on Weir 2 floodplain inundated	% of total permanent wetland area not inundated at normal level now inundated	Temporary wetland area inundated (ha)	% of total temporary wetland area on Weir 2 floodplain inundated	% of total temporary wetland area not inundated at normal level now inundated
10 GL/d, normal level	724	61.0	-	536	80.0	-	99	23.6	-
10 GL/d, 35 cm raise	799	67.3	16.1	566	84.4	22.3	139	33.1	12.4
10 GL/d, 70 cm raise	848	71.5	26.8	581	86.7	33.9	171	40.8	22.4
20 GL/d, normal level	780	65.7	-	549	81.9	-	140	33.3	-
20 GL/d, 35cm raise	840	70.7	14.5	585	87.3	29.9	160	38.1	7.1

There were 30 permanent wetlands on the Weir 2 floodplain, 28 of which were modelled as fully or partially inundated at normal level for a 20 GL/d flow (Table 16). There was an increase in inundation area in 23 permanent wetlands at a weir raising of 35 cm at 20 GL/d. The rise in level may either increase a wetland's inundation area or inundate dry wetlands. More temporary wetlands were affected by raising the weir than permanent or saline wetlands (Table 16).

Table 16: The number of wetlands on the Weir 2 floodplain, the number of wetlands fully or partially inundated at normal level for different flows and the number of wetlands affected by raising the weir for the wetland categories and conservation classes. Wetlands 'affected' by raising the weir are those whose inundated area increased due to the weir raising

Wetland category	Weir 2 total number of wetlands	Number of wetlands inundated 10 GL/d, normal level	Number of wetlands affected by 35 cm raise at 10 GL/d	Number of wetlands affected by 70 cm raise at 10 GL/d	Number of wetlands inundated 20 GL/d, normal level	Number of wetlands affected by 35 cm raise at 20 GL/d
PERMANENT	**30**	**28**	**22**	**23**	**28**	**23**
CT1	3	3	2	2	3	2
CT2	12	12	9	9	12	10
CT3	10	8	7	8	8	7
CT4	5	5	4	4	5	4
SALINE	**3**	**2**	**3**	**3**	**3**	**3**
CT2	1	1	1	1	1	1
CT3	1	1	1	1	1	1
CT4	1	0	1	1	1	1
TEMPORARY	**142**	**41**	**40**	**46**	**52**	**43**
CT2	12	3	4	4	3	4
CT3	46	11	12	13	15	14
CT4	55	18	18	21	22	20
CT5	29	9	6	8	12	5
TOTAL	**175**	**71**	**65**	**72**	**83**	**69**

4.3.5 Tree condition

More dead river red gum trees were inundated than healthy or unhealthy river red gum trees (Figure 25), but the maximum difference between areas of dead and healthy river red gum trees inundated was only 5.6 ha (at 10 GL/d and a 70 cm raise). Healthy and unhealthy areas of black box were inundated, with only a small area (0.03 ha) of dead black box inundated (Figure 25).

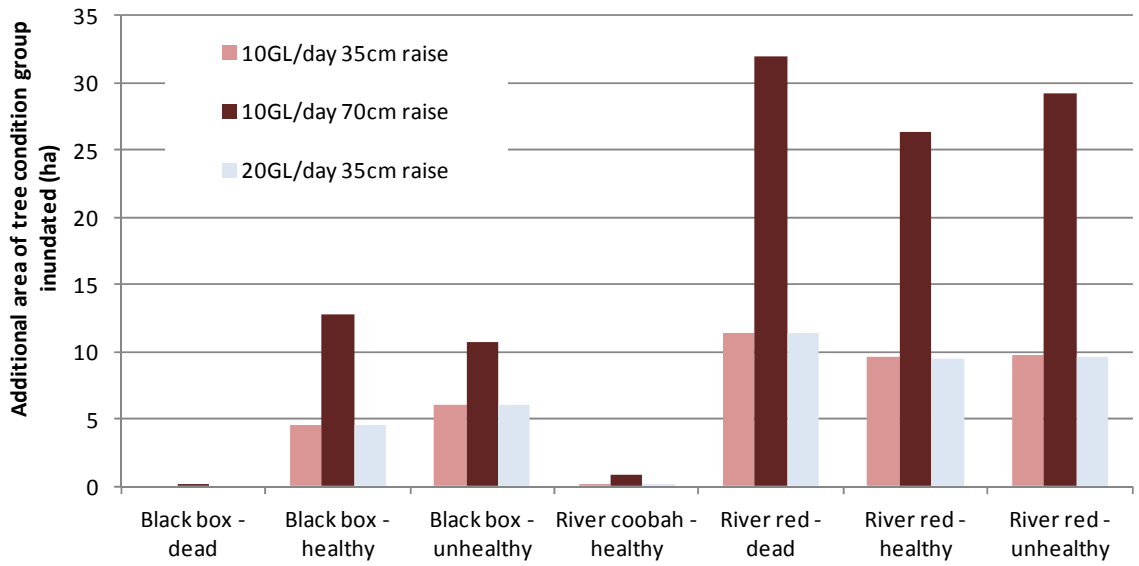

Figure 25: Additional area of tree condition categories inundated under the different flow and weir raising scenarios at Weir 2. Additional area is that above the normal level inundation for the given flow

Weir pool raising inundated both healthy and unhealthy stands of river red gum (Figure 26) and black box (Figure 27) trees; the proportion of healthy, unhealthy and dead trees was similar between the flow and weir raising scenarios.

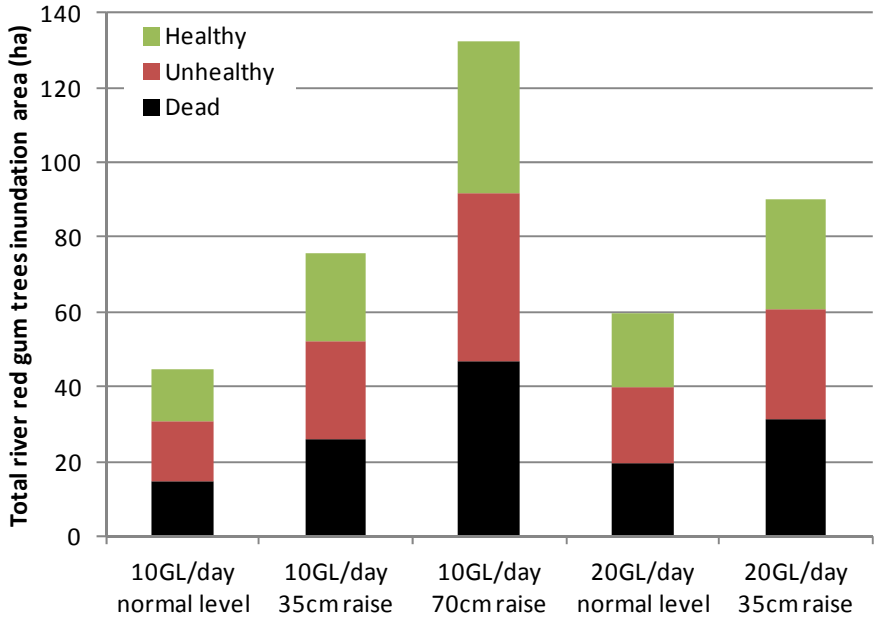

Figure 26: Total inundated area of river red gum trees under normal level and the different flow and weir raising scenarios at Weir 2

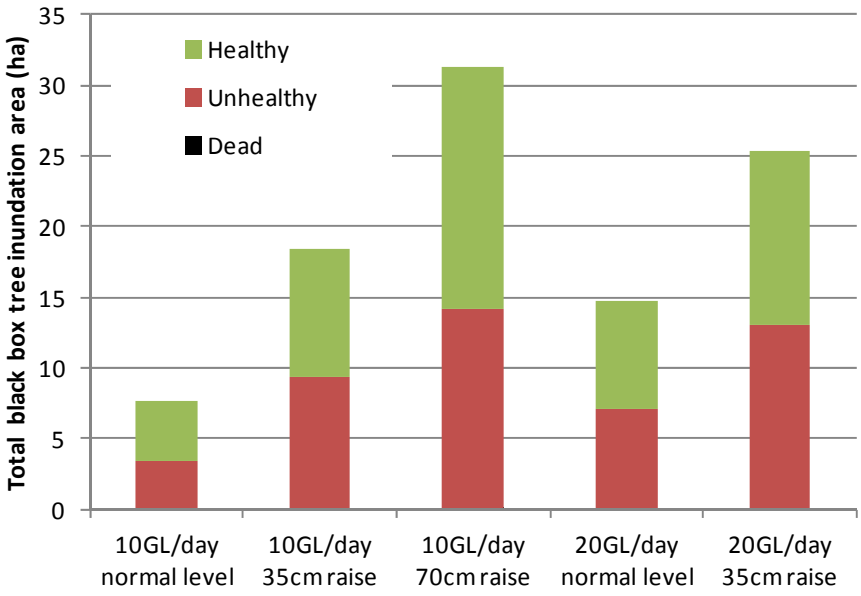

Figure 27: Total inundated area of black box trees under normal level and the different flow and weir raising scenarios at Weir 2

At 10 GL/d, 4% of healthy river red gum trees and 1.3 % of healthy black box trees not inundated at normal level were inundated by a weir raising of 70 cm (Table 17). Similarly, at 10 GL/d 3.2 % of dead river red gum trees and 1.4 % of unhealthy black box trees not inundated at normal level were inundated by a weir raising of 70 cm. It needs to be noted that these values are not comparable to those calculated for the river red gum woodland and black box woodland vegetation groups described previously.

Table 17: The percentage of the tree condition area not inundated at normal level, inundated under the different flow and weir raising scenarios at Weir 2 (above the normal level inundation for the given flow), for the different categories of tree condition. The percent areas are the area of the relevant tree condition category not inundated at normal levels, inundated under the different scenarios. The total percentage for each tree is that of all trees in all classes inundated across the floodplain.

	Percentage of area not inundated at normal level, inundated under the different scenarios (%)		
	10 GL/d, 35 cm raise	10 GL/d, 70 cm raise	20 GL/d, 35 cm raise
Total black box	0.6	1.4	0.6
Dead black box	0	0.8	0
Healthy black box	0.5	1.3	0.5
Unhealthy black box	0.8	1.4	0.8
Total river coobah	0.3	1.5	0.3
Healthy river coobah	0.3	1.7	0.3
Unhealthy river coobah	0.0	0.0	0.0
Total river red gum	1.7	4.8	1.7
Dead river red gum	5.8	16.3	5.8
Healthy river red gum	1.4	3.8	1.4
Unhealthy river red gum	1.1	3.2	1.1
Combined total	1.2	3.1	1.1

5. Weir 3

5.1 Summary

Three scenarios were analysed for Weir 3: weir raisings of 35 cm at flow rates of 10 and 20 GL/d and a weir raising of 30 cm at a flow rate of 50 GL/d. The modelling showed:

- Raising the weir by 59 cm at 10 GL/d inundated an additional 1220 ha (561%) of floodplain vegetation compared to normal levels at the same flows.
- Proportionally larger areas of lignum shrubland, samphire shrubland and river red gum woodland were inundated than other vegetation groups.
- A greater additional area of healthy river red gum and black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of permanent wetlands than temporary wetlands.
- The extent of the weir pool raise extended over approximately half of the distance between Weirs 3 and 4.

5.2 Normal level inundation

Inundation of the floodplain at normal level for the three Weir 3 scenario flows of 10 GL/d, 30 GL/d and 50 GL/d is outlined in Table 18. The modelling shows, the higher the flow, the more floodplain (vegetation and wetland) was inundated. At 50 GL/d, 11.7% of the total vegetation area was inundated and 90.9% of the total wetland area (Table 18).

Table 18: The Weir 3 floodplain and the area inundated at different flows with the weir at normal level

Category	Area of floodplain (ha)	Area inundated at 10 GL/d (ha)	% of area inundated at 10 GL/d	Area inundated at 30 GL/d (ha)	% of area inundated at 30 GL/d	Area inundated at 50 GL/d (ha)	% of area inundated at 50 GL/d
TOTAL WEIR 3 FLOODPLAIN*	***19,884***	***4374***	***22.0%***	***5073***	***25.5%***	***6279***	***31.5%***
VEGETATION (TOTAL AREA)	**14,900**	**219**	**1.5%**	**694**	**4.7%**	**1748**	**11.7%**
Black box woodland	3340	29	0.9	54	1.6	147	4.4
Emergent sedgeland	90	8.4	9.4	18	19.8	29	32.2
Flood dependent grassland	686	0.6	0.1	24	3.5	78	11.4
Lignum shrubland	3584	19	0.5	131	3.7	495	13.8
Mallee shrubland	0.3	0	0.0	0	0.0	0	0.0
River coobah woodland	37	0.4	1.0	1.5	3.9	3.1	8.3
River red gum woodland	3230	120	3.7	282	8.7	598	18.5
Samphire shrubland	2163	23	1.0	93	4.3	243	11.2
Tea tree woodland	155	0.2	0.1	0.3	0.2	0.5	0.4
Terrestrial dry shrubland	1615	18	1.1	91	5.6	155	9.6
WETLANDS (TOTAL AREA)	**4984**	**4155**	**83.4%**	**4,379**	**87.9%**	**4,531**	**90.9%**
Permanent	3902	3699	94.8%	3745	96.0%	3773	96.7%
Temporary	540	106	19.6%	188	34.9%	268	49.8%
Saline	543	350	64.6%	446	82.2%	489	90.2%

*Total floodplain is the addition of vegetation and wetlands, but does not include other areas such as towns

5.3 Weir raising

5.3.1 Overview

An overview of the additional area of vegetation and wetlands inundated due to raising the weir above normal level inundation is shown in Table 19 and Figure 28. At 10 GL/d the additional vegetation area inundated above normal level inundation when the weir was raised 59 cm was 1229 ha (Table 19). This represents 8.4% of the vegetation area not inundated at normal level and was a 561% increase in the area inundated when the river was operated at normal level (219 ha). The weir raising inundated less wetland area than vegetation area. At 10 GL/d a weir raising of 59 cm inundated an additional 247 ha of wetland area, compared to 4,155 ha at normal level. This was an increase of 5.9% and represents 30% of the wetland area that was not inundated at normal level.

Table 19: The additional area of vegetation and wetlands inundated due to raising the weir. Additional area is the area above the normal level inundation for the given flow

	Vegetation			Wetlands		
Scenario	Additional area inundated (ha)	% of total vegetation area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow	Additional area inundated (ha)	% of total wetland area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow
10 GL/d 59 cm	1229	8.4%	561%	247	30%	5.9%
30 GL/d 59 cm	1573	11%	227%	207	34%	4.7%
50 GL/d 30 cm	1030	7.2%	59%	121	27%	2.7%

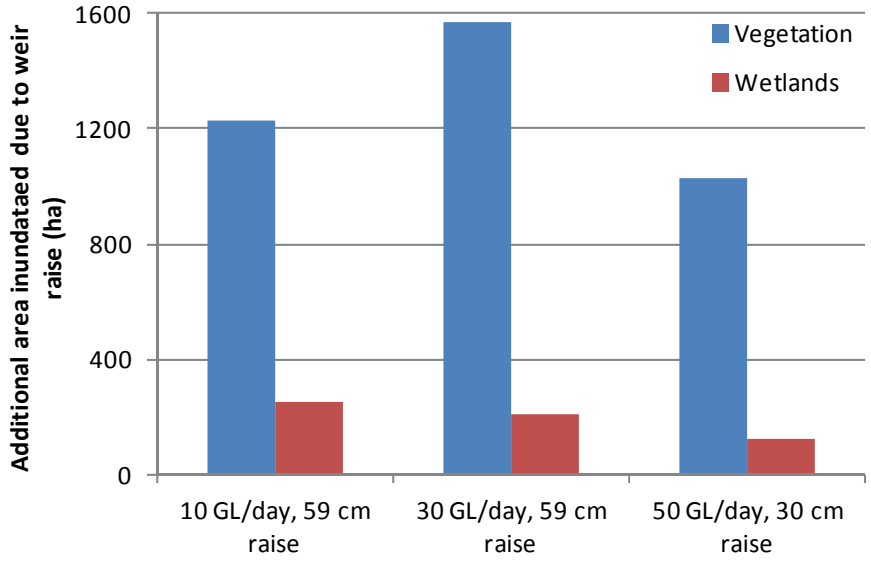

Figure 28: Additional area of vegetation and wetlands inundated under the different flow and weir raising scenarios at Weir 3. Additional area is the area above the normal level inundation for the given flow

The additional inundation of wetland area was higher for 10 GL/d than 30 GL/d (at a 59 cm weir raise) (Table 19; Figure 28). However, the total wetland inundation area was greater for the 30 GL/d scenario, as the normal level inundation area was greater for 30 GL/d than 10 GL/d (Figure 29). Both increased flow and weir level, increased the total floodplain inundation area (Figure 29).

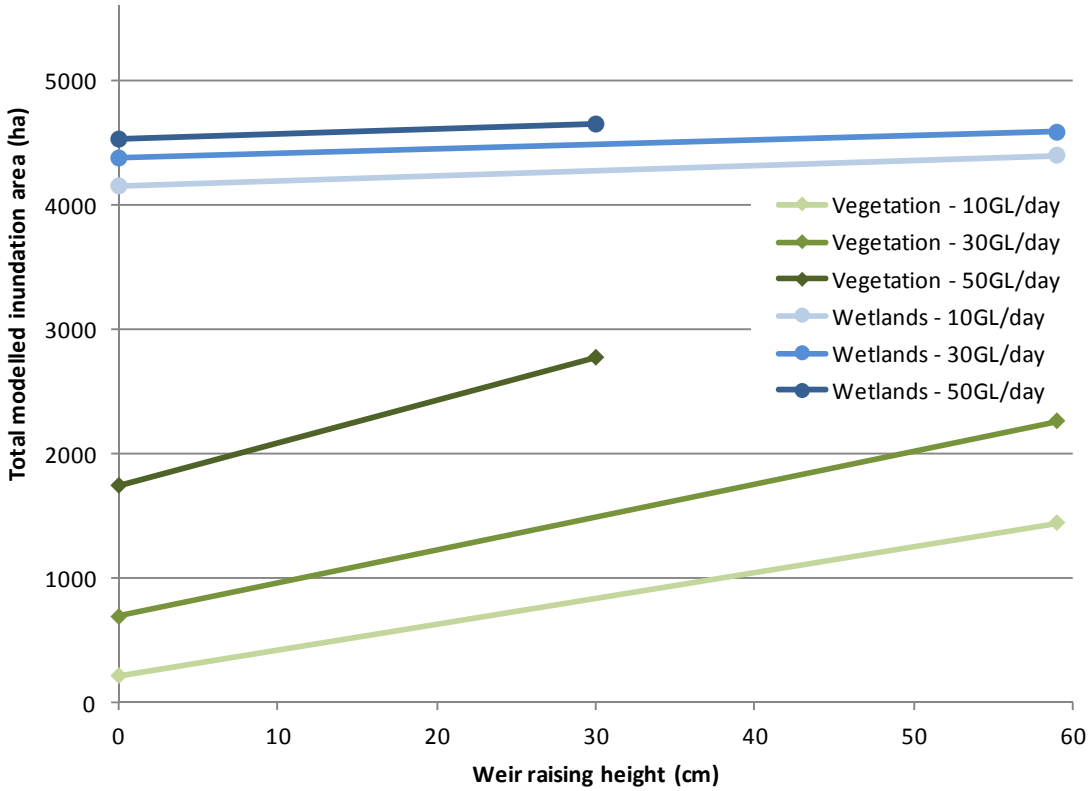

Figure 29: Total area inundated of vegetation and wetlands on the Weir 3 floodplain at normal level (0 cm weir raise) and at the different weir raising scenarios for 10 GL/d, 30 GL/d and 50 GL/d

5.3.2 Spatial extent

The weir raising inundated wetlands and vegetation in close proximity to wetlands (Figure 30). The influence of the raising the weir 59 cm at 10 GL/d extended over approximately half of the distance between Weirs 3 and 4 (Figure 31). A similar pattern was observed for 30 GL/d and 50 GL/d.

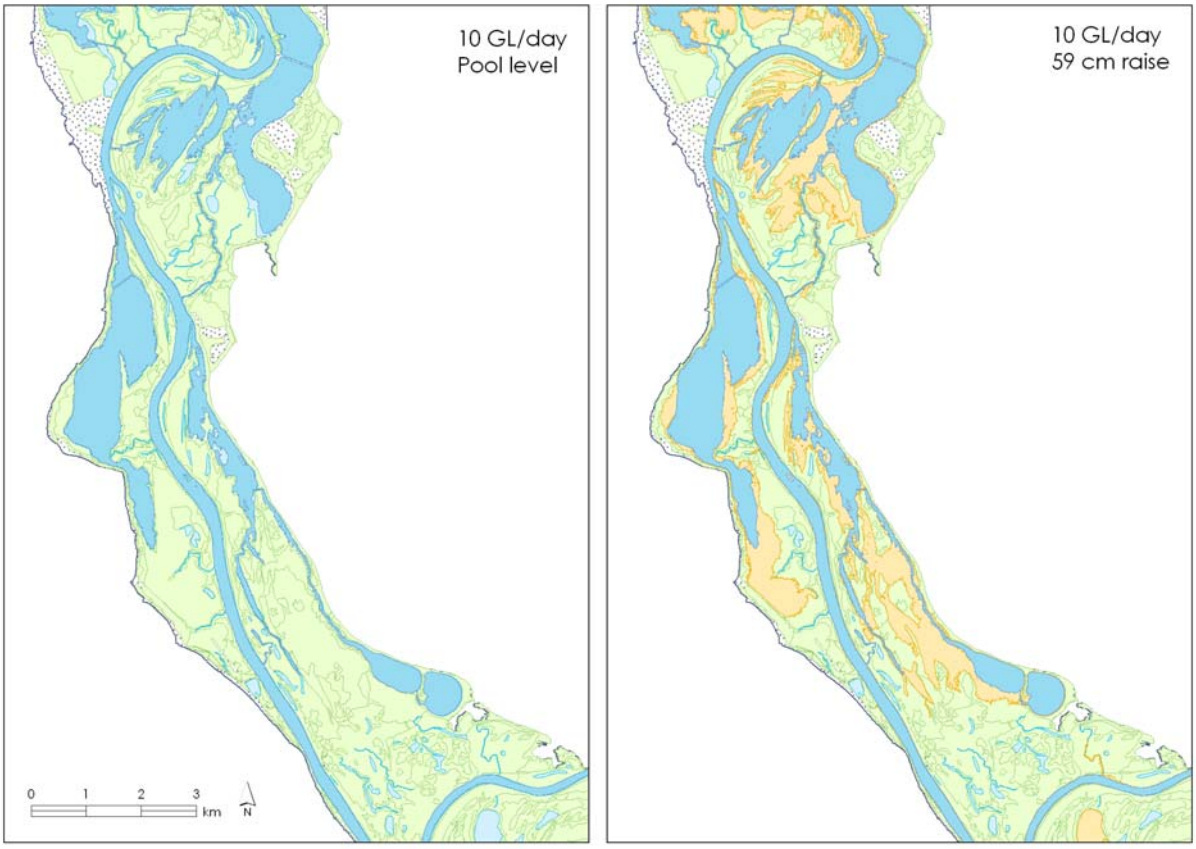

Figure 30: Inundation of Weir 3 floodplain. Area shown is from approximately 15 km upstream of the Weir; flow is from bottom to top of the figure. Green shades show the vegetation areas, light blue shades show wetlands not inundated at normal level and spotted areas parts of the floodplain not covered by vegetation or wetlands. The darker blue shows the normal level inundation at 10 GL/d. The yellow area shows the additional area inundated above normal level for 10 GL/d with a 59 cm raise (right figure)

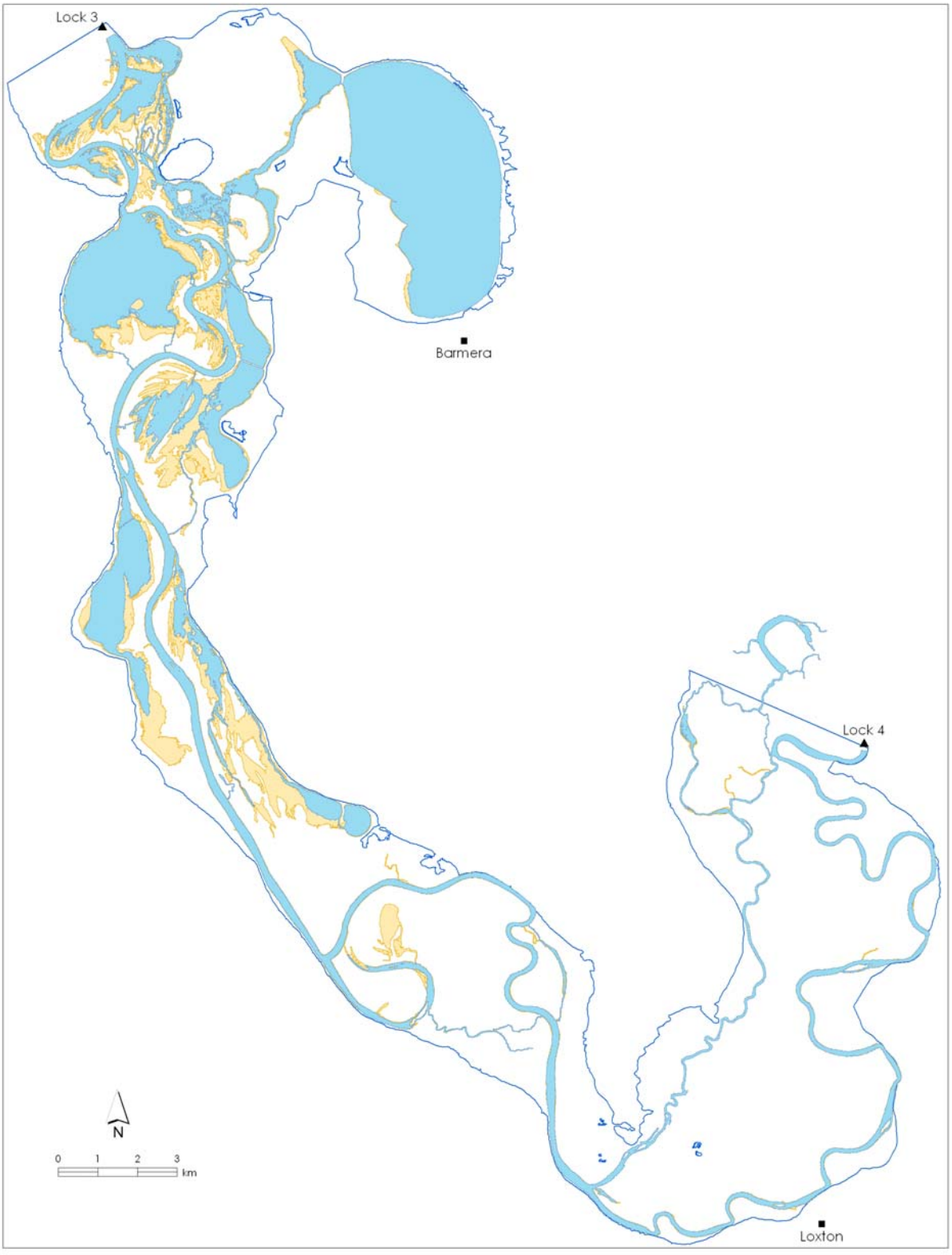

Figure 31: Inundation of the Weir 3 floodplain. An outline of the floodplain is shown by the dark blue line, approximately finishing near Weirs 3 and 4. Normal level inundation at 10 GL/d is shown by the blue shade, including the main River Murray channel. Yellow areas show the additional area of inundation caused by raising the weir at Weir 3 by 59 cm. Flow is from right to left of the figure

5.3.3 Vegetation

Lignum shrubland and samphire shrubland vegetation groups had the greatest additional inundation area under all flow and weir raising scenarios (Figure 32).

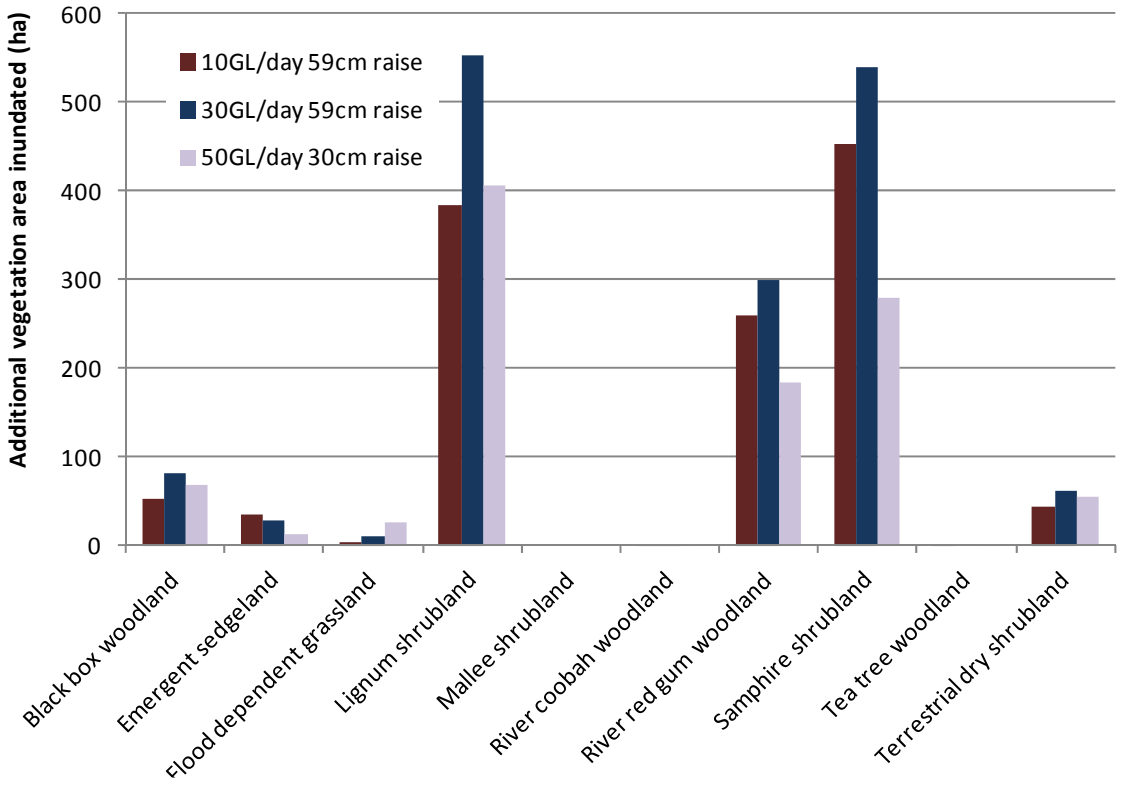

Figure 32: Additional area of the vegetation groups inundated under the different flow and weir raising scenarios at Weir 3. Additional area is the area above the normal level inundation for the given flow

Raising the weir increased the area of vegetation inundated (Figure 33). The vegetation groups lignum shrubland, samphire shrubland and river red gum woodland had the greatest total inundation area under all flow and weir raising scenarios.

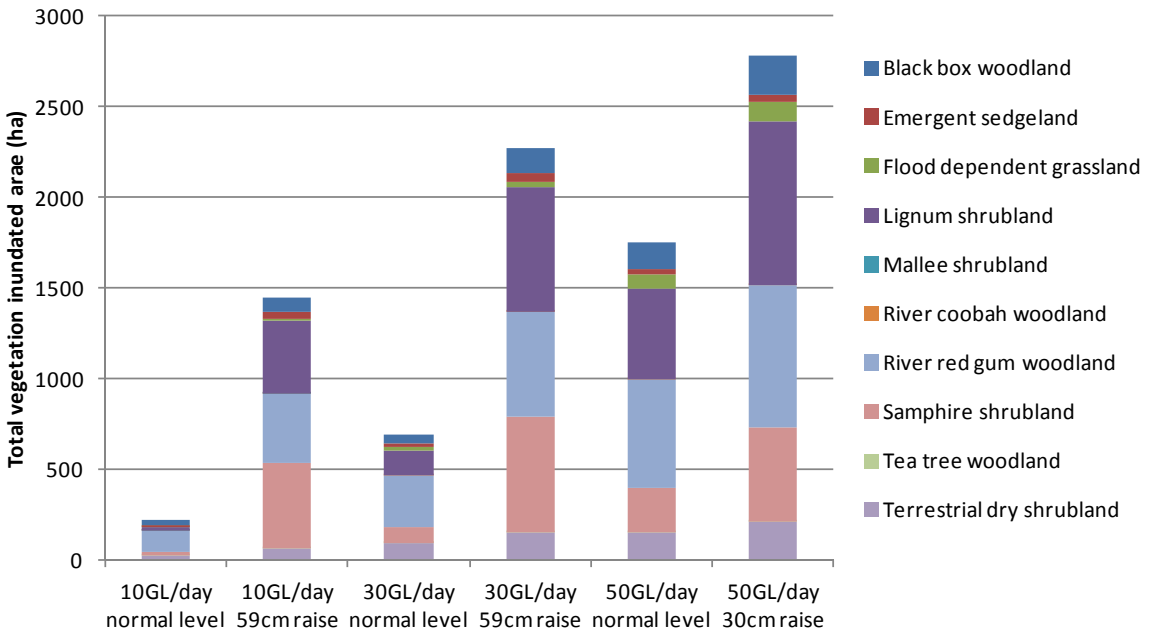

Figure 33: Total vegetation area inundated under normal level and the different flow and weir raising scenarios at Weir 3

Not all vegetation groups were equally inundated by the weir pool raising scenarios (Table 20). For example, river red gum woodland comprised 21.7% of the vegetation on the Weir 3 floodplain. At 10 GL/d and a 59 cm weir raise, 380 ha of river red gum woodland area was inundated, which was equivalent to 11.8% of the total river red gum area across the entire vegetated floodplain. However, river red gum woodland comprised 26.2% of the 1,448 ha area inundated by the 10 GL/d 59 cm raise. This indicates they were preferentially favoured by the weir raising. Conversely, black box woodland comprised 22.4% of the Weir 3 floodplain vegetation area, but 5.6% of the inundated area at 10 GL/d 59 cm weir raise (with 80.6 ha inundated, equivalent to 2.4% of the total black box woodland area on the Weir 2 floodplain). A weir raising of 59 cm at 10 GL/d and 30 GL/d inundated 9.7% and 15.2% of the Weir 3 floodplain vegetation, respectively (Table 20). A similar pattern of variability in composition of floodplain vegetation groups to vegetation groups inundated by weir raising is likely for the 50 GL/d scenario.

Table 20: Effect of Weir 3 raising on floodplain vegetation groups and the composition of the vegetation groups on the total floodplain. Shown are the areas of each vegetation group inundated; the percentage of each group inundated; and the percentage of the total vegetation area inundated.

			10 GL/d, 59 cm raise			30 GL/d, 59 cm raise		
Vegetation group	Total floodplain area (ha)	% of total floodplain vegetation area (composition of)	Total area inundated (ha)	% of vegetation group inundated	% of total vegetation area inundated (composition of)	Total area inundated (ha)	% of vegetation group inundated	% of total vegetation area inundated (composition of)
Blackbox woodland	3340	22.4	80.6	2.4	5.6	135	4.0	6.0
Emergent sedgeland	90	0.6	42.5	47.4	2.9	45.3	50.5	2.0
Flood dependent grassland	686	4.6	4.0	0.6	0.3	33.6	4.9	1.5
Lignum shrubland	3584	24.1	404	11.3	27.9	683	19.1	30.1
Mallee shrubland	0.3	0.0	0.0	1.2	0.0	0.0	0.0	0.0
River coobah woodland	37	0.3	0.6	1.7	0.0	1.8	4.7	0.1
River red rum woodland	3230	21.7	380	11.8	26.2	582	18.0	25.7
Samphire shrubland	2163	14.5	476	22.0	32.8	633	29.3	27.9
Tea tree woodland	155	1.0	0.2	0.2	0.0	0.3	0.2	0.0
Terrestrial dry shrubland	1615	10.8	60.9	3.8	4.2	153	9.5	6.7
TOTAL VEGETATION AREA	**14,900**	**100**	**1448**	**9.7**	**100**	**2267**	**15.2**	**100**

5.3.4 Wetlands

Weir raising inundated a larger additional area of permanent wetlands than temporary or saline wetlands (Figure 34). Most of the permanent and temporary wetland areas inundated at normal level and for the range of raising scenarios were conservation-threat class CT3 (Figure 35; Figure 36). This was reflective of the classes on the floodplain, although for temporary wetlands, CT5 wetlands were not inundated at normal levels. Most of the saline wetland area inundated at normal level and for the range of raising scenarios was conservation-threat class CT2, which was reflective of the classes on the floodplain (Figure 37). For permanent, temporary and saline wetlands weir raising had little effect on the proportional area of different conservation-threat classes inundated.

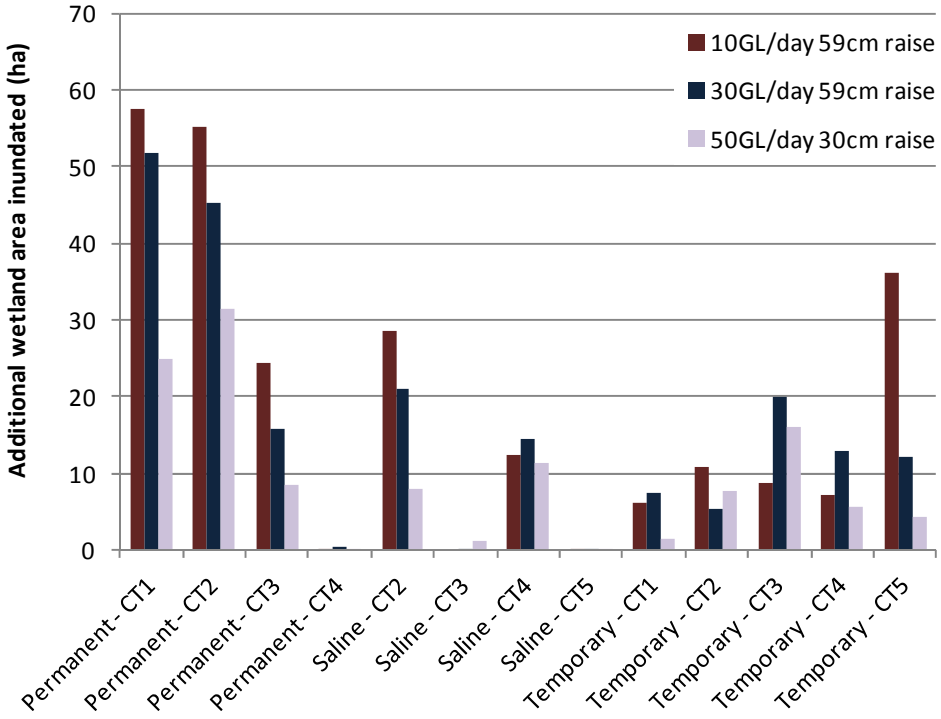

Figure 34: Additional area of permanent, saline and temporary wetland organised by conservation-threat class inundated under the different flow and weir raising scenarios at Weir 3. Additional area is the area above the normal level inundation for the given flow

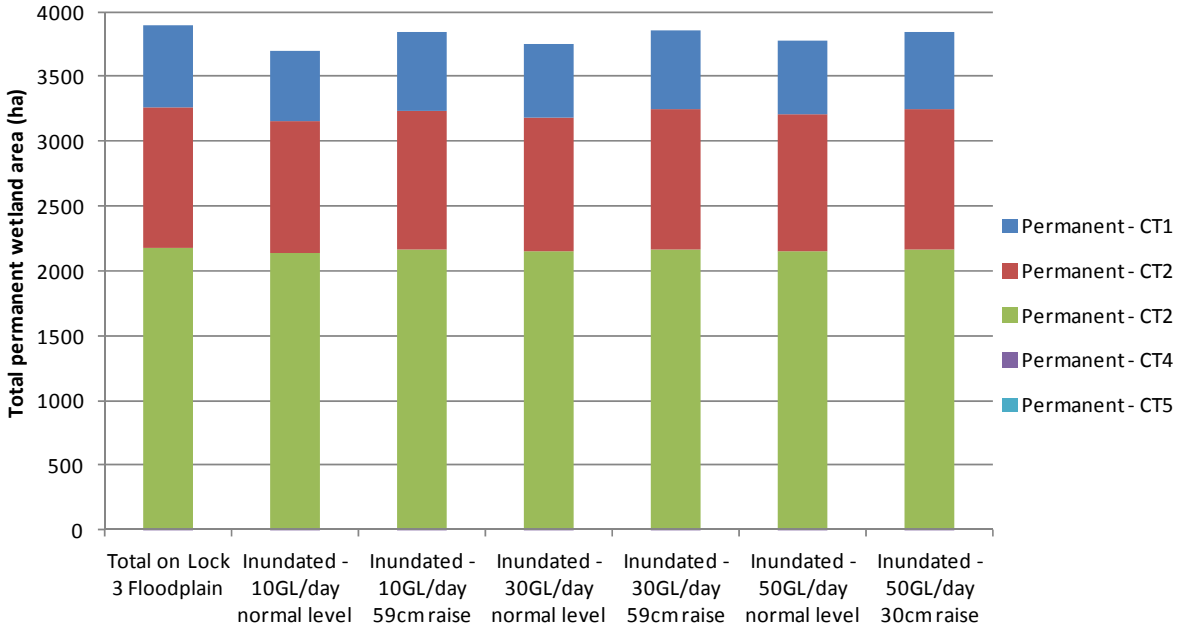

Figure 35: Total area of permanent wetland conservation-threat classes on Weir 3 floodplain and inundated under normal level and the different flow/weir raising scenarios

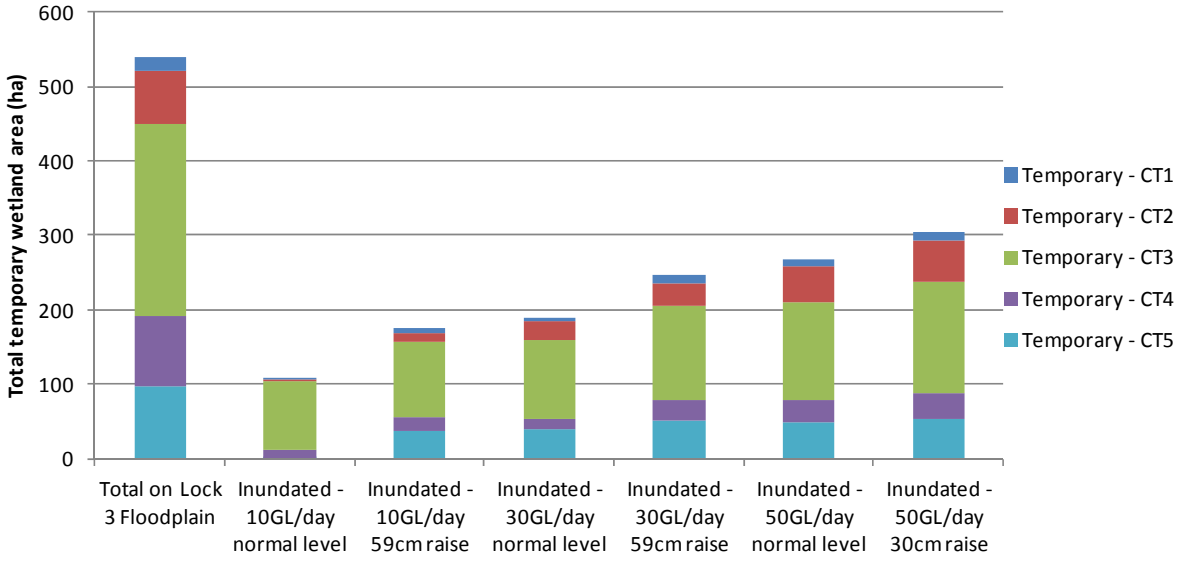

Figure 36: Total area of temporary wetland conservation-threat classes on Weir 3 floodplain and inundated under normal level and the different flow/weir raising scenarios

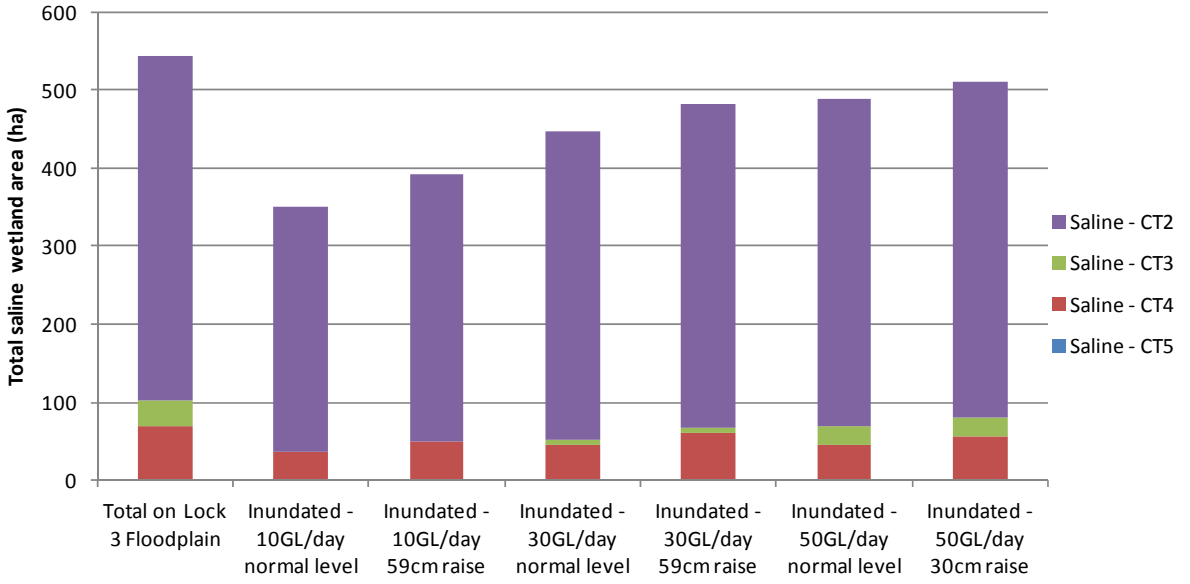

Figure 37: Total area of saline wetland conservation-threat classes on Weir 3 floodplain and inundated under normal level and the different flow/weir raising scenarios.

At a 30 GL/d flow and 59 cm raise, 246 ha of temporary wetlands were inundated, which was equivalent to 45.6% of the temporary floodplain wetland area (Table 21). At 30 GL/d, of the temporary wetland area not inundated at normal level, 16.5% of this area was inundated by raising the weir 59 cm. More permanent wetland area than temporary or saline wetland area was inundated under all scenarios; 3,837 ha (98.3% of permanent wetland area) at 10 GL/d with a 59 cm raise, compared to 175 ha (32.4%) of temporary wetland area and 392 ha (72%) of saline wetland area (Table 21).

Table 21: Inundation of permanent, temporary and saline wetland area on the Weir 3 floodplain. Shown are the area and percentage area inundated and the percentage area inundated that is not inundated at normal level.

Scenario	PERMANENT WETLAND AREA – 3902 ha			TEMPORARY WETLAND AREA – 540 ha			SALINE WETLAND AREA - 543 ha		
	Permanent wetland area inundated (ha)	% of total permanent wetland area on Weir 3 floodplain inundated	% of total permanent wetland area not inundated at normal level now inundated	Temporary wetland area inundated (ha)	% of total temporary wetland area on Weir 3 floodplain inundated	% of total temporary wetland area not inundated at normal level now inundated	Saline wetland area inundated (ha)	% of total saline wetland area on Weir 3 floodplain inundated	% of total saline wetland area not inundated at normal level now inundated
10 GL/d, normal level	3699	94.8	-	106	19.6	-	350	64.6	-
10 GL/d, 59 cm raise	3837	98.3	67.8	175	32.4	15.9	392	72	21.4
30 GL/d, normal level	3745	96.0	-	188	34.9	-	446	82.2	-
30 GL/d, 59 cm raise	3858	98.9	72.0	246	45.6	16.5	482	88.8	37.0
50 GL/d, normal level	3773	96.7	-	268	49.8	-	489	90.2	-
50 GL/d, 30 cm raise	3838	98.4	50.6	304	56.3	13.0	510	94.0	38.9

There were 10 saline wetlands on the Weir 3 floodplain, nine of which were modelled as fully or partially inundated at normal level for a 50 GL/d flow (Table 22). Seven saline wetlands were affected by a weir raising of 30 cm at 50 GL/d. The rise in level may either increase a wetland's inundation area or inundate dry wetlands. There were more temporary wetlands (203) on the floodplain than permanent wetlands (45), but more permanent than temporary wetlands were affected by raising the weir: 38 permanent wetlands compared to 25 temporary wetlands were affected for a weir raise of 59 cm at 10 GL/d.

Table 22: The number of wetlands on the Weir 3 floodplain, the number of wetlands fully or partially inundated at normal level for different flows and the number of wetlands affected by raising the weir for the wetland categories and conservation classes. Wetlands 'affected' by raising the weir are those whose inundated area increased due to the weir raising

Wetland category	Weir 3 total number of wetlands	Number of wetlands inundated 10 GL/d, normal level	Number of wetlands affected by 59 cm raise at 10 GL/d	Number of wetlands inundated 30 GL/d, normal level	Number of wetlands affected by 59 cm raise at 30 GL/d,	Number of wetlands inundated 50 GL/d, normal level	Number of wetlands affected by 30 cm raise at 50 GL/d
PERMANENT	**45**	**40**	**38**	**41**	**39**	**42**	**32**
CT1	13	12	12	12	11	12	10
CT2	15	14	13	14	13	15	11
CT3	15	13	12	14	14	14	10
CT4	1	1	1	1	1	1	1
CT5	1	0	0	0	0	0	0
SALINE	**10**	**4**	**4**	**8**	**8**	**9**	**7**
CT2	4	2	2	4	4	4	4
CT3	3	0	0	1	1	2	1
CT4	2	1	1	2	2	2	1
CT5	1	1	1	1	1	1	1
TEMPORARY	**203**	**16**	**25**	**41**	**65**	**79**	**59**
CT1	9	2	4	3	5	7	5
CT2	23	1	4	9	7	13	12
CT3	75	6	7	13	27	27	20
CT4	60	4	9	8	15	21	13
CT5	36	3	1	8	11	11	9
TOTAL	**258**	**60**	**67**	**90**	**112**	**130**	**98**

5.3.5 Tree condition

Healthy river red gums had the greatest additional area inundated by the weir raising, although an increase in inundation area was apparent for all categories (healthy, unhealthy and dead) of both river red gum and black box trees (Figure 38).

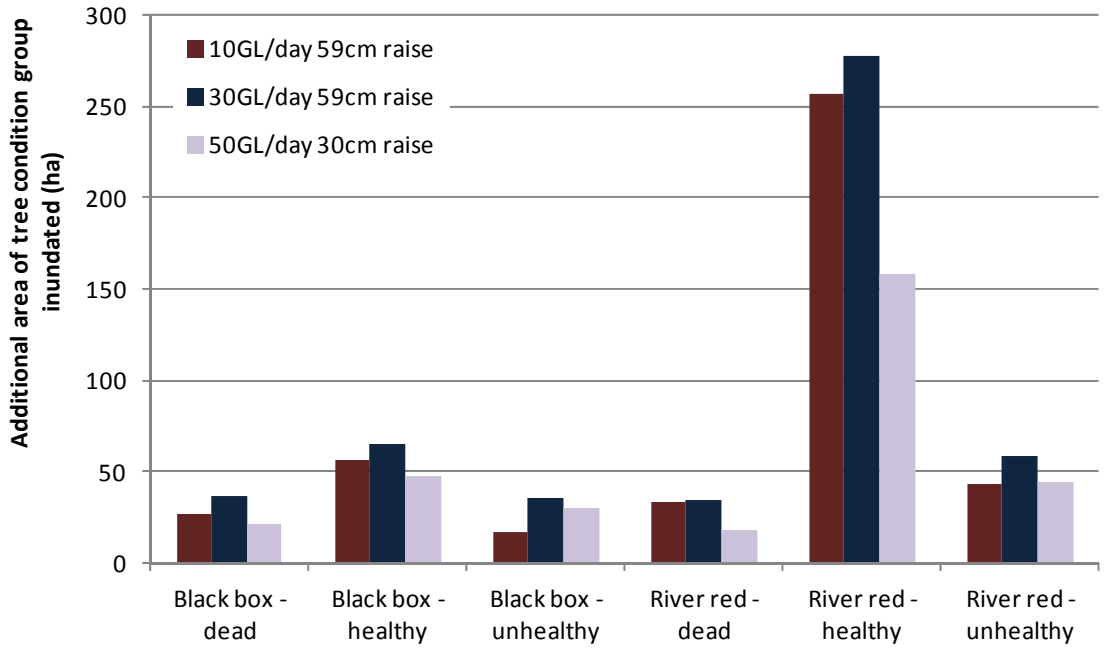

Figure 38: Additional area of tree condition categories inundated under the different flow and weir raising scenarios at Weir 3. Additional area is that above the normal level inundation for the given flow

A greater proportion of healthy river red gum trees were inundated by a weir raising than at normal level (Figure 39). Healthy and unhealthy stands of black box trees were inundated under all scenarios (Figure 40).

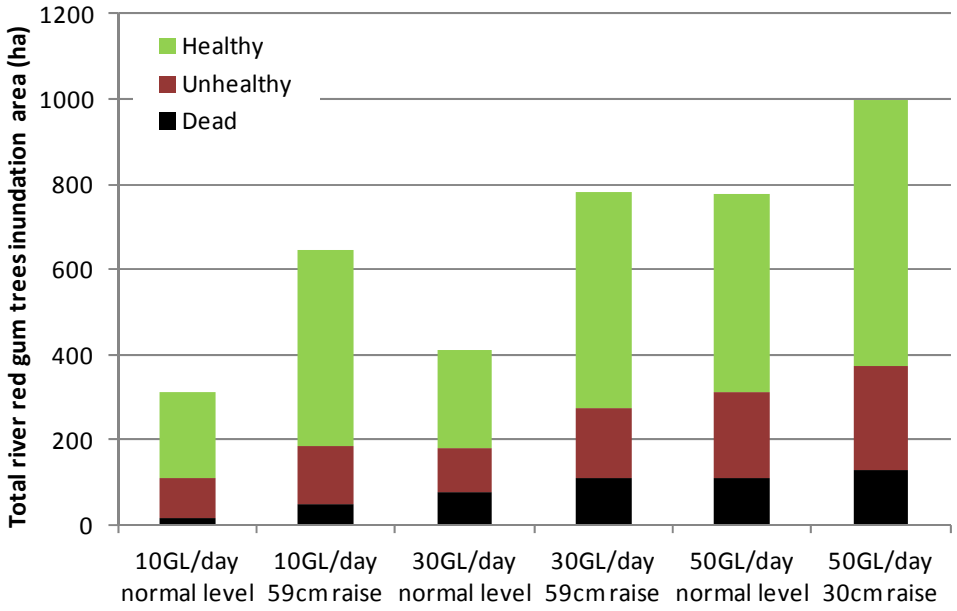

Figure 39: Total inundated area of river red gum trees under normal level and the different flow and weir raising scenarios at Weir 3

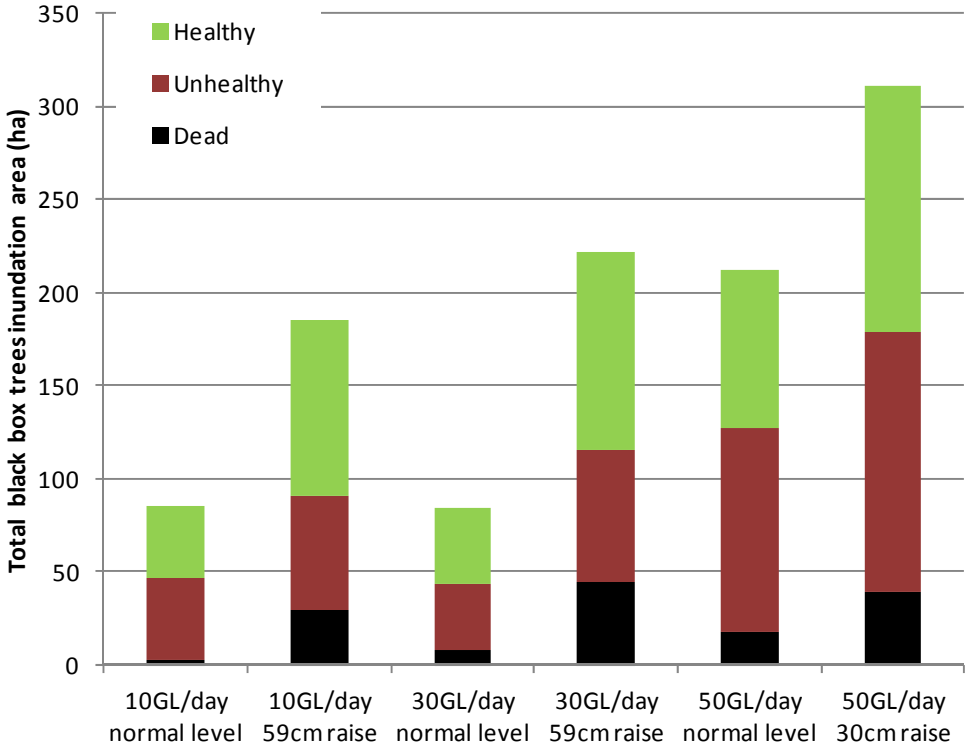

Figure 40: Total inundated area of black box trees under normal level and the different flow and weir raising scenarios at Weir 3

Thirteen percent of healthy river red gum trees not inundated at normal level were inundated by a weir raising of 59 cm at 10 GL/d, but only 4.0% of healthy black box trees were inundated (Table 23). Similarly, at 10 GL/d 15.0 % of dead river red gum trees not inundated at normal level were inundated by a weir raising of 59 cm and 0.8% of unhealthy black box trees were inundated. It needs to be noted that these values are not comparable to those calculated for the river red gum woodland and black box woodland vegetation groups described previously.

Table 23: The percentage of the tree condition area not inundated at normal level, inundated under the different flow and weir raising scenarios at Weir 3 (above the normal level inundation for the given flow), for the different categories of tree condition. The percent areas are the area of the relevant tree condition category not inundated at normal levels, inundated under the different scenarios. The total percentage for each tree is that of all trees in all classes inundated across the floodplain.

	Percentage of area not inundated at normal level, inundated under the different scenarios (%)		
	10 GL/d, 59 cm raise	30 GL/d, 59 cm raise	50 GL/d, 30 cm raise
Total black box	3	4	3
Dead black box	7.8	11.0	6.5
Healthy black box	4.0	4.6	3.5
Unhealthy black box	0.8	1.7	1.5
Total river coobah	0.2	0.3	4
Healthy river coobah	0.1	0.2	5.4
Unhealthy river coobah	0.7	0.6	0.4
Total river red gum	10	11	8
Dead river red gum	15.0	21.0	14.0
Healthy river red gum	12.7	14.0	9.1
Unhealthy river red gum	3.9	5.3	4.4
Combined total	6	7	5

6. Weir 4

6.1 Summary

Four scenarios were analysed for Weir 4: weir raisings of 60 and 114 cm at flow rates of 10 and 20 GL/d. The modelling showed:

- Raising the weir level by 114 cm at a flow of 10 GL/d inundated an additional 1,282 ha (443%) of floodplain vegetation compared to normal levels at the same flows. This was almost three times the inundated area of the floodplain than the 60 cm rise.
- For a given weir level, there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of river red gum woodland and samphire shrubland were inundated than other vegetation groups.
- A greater additional area of healthy and unhealthy river red gum trees and dead black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of permanent and saline wetlands than temporary wetlands.
- The influence of raising the weir extended over most of the distance between Weirs 4 and 5, although the effects of the weir raising were greater closer to Weir 4.

6.2 Normal level inundation

Inundation of the floodplain at normal level for the two Weir 4 scenario flows of 10 GL/d and 20 GL/d is outlined in Table 24. More of the floodplain (vegetation and wetland) was inundated at 20 GL/d at normal level than at 10 GL/d.

Table 24: The Weir 4 floodplain and the area inundated at different flows with the weir at normal level

Category	Area of floodplain (ha)	Area inundated at 10 GL/d (ha)	% of area inundated at 10 GL/d	Area inundated at 20 GL/d (ha)	% of area inundated at 20 GL/d
TOTAL WEIR 4 FLOODPLAIN*	***14,397***	***1740***	***12.1***	***1869***	***13.0***
VEGETATION (TOTAL AREA)	**11,956**	**290**	**2.4**	**335**	**2.8**
Black box woodland	3134	26	0.8	30	1.0
Emergent sedgeland	96	4	4.0	4	4.2
Flood dependent grassland	710	7	0.9	12	1.6
Lignum shrubland	1585	49	3.1	52	3.3
Mallee shrubland	1	0.2	15.4	0.2	18.6
River coobah woodland	12	0	0.0	0	0.0
River red gum woodland	2223	136	6.1	162	7.3
Samphire shrubland	1328	22	1.7	25	1.9
Tea tree woodland	505	4	0.7	4	0.8
Terrestrial dry shrubland	2363	43	1.8	47	2.0
WETLANDS (TOTAL AREA)	**2441**	**1450**	**59.4**	**1534**	**62.8**
Permanent	1584	1303	82.2	1326	83.7
Temporary	457	67	14.8	70	15.3
Saline	400	80	20.0	138	34.5

*Total floodplain is the addition of vegetation and wetlands, but does not include other areas such as towns

6.3 Weir raising

6.3.1 Overview

An overview of the additional area of vegetation and wetlands inundated due to raising the weir is shown in Table 25 and Figure 41. The additional area is that for weir pool raisings at a given flow. i.e. the area inundated by weir pool raisings at 20 GL/d were compared against that of normal level at 20 GL/d.

At a flow of 10 GL/d the additional vegetation area inundated when the weir was raised 114 cm was 1282 ha. This represents 11.0% of the total vegetation area not inundated at normal level at 10 GL/d and was a 443% increase in the area inundated when the river was operated at normal level (290 ha) (Table 25). At 10 GL/d, raising the weir 114 cm inundated an additional 460 ha over the 1,450 ha inundated at normal level for 10 GL/d. This was an increase of 32% and represents 46% of the wetland area on Weir 4 floodplain that was not inundated at normal level for 10 GL/d.

Table 25: The additional area of vegetation and wetlands inundated due to raising the weir. Additional area is the area above the normal level inundation for the given flow

	Vegetation			Wetlands		
Scenario	Additional area inundated (ha)	% of total vegetation area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow	Additional area inundated (ha)	% of total wetland area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow
10 GL/d 60 cm	446	3.8%	154%	296	30%	20%
10 GL/d 114 cm	1282	11%	443%	460	46%	32%
20 GL/d 60 cm	553	4.9%	165%	268	30%	17%
20 GL/d 114 cm	1417	13%	423%	430	47%	28%

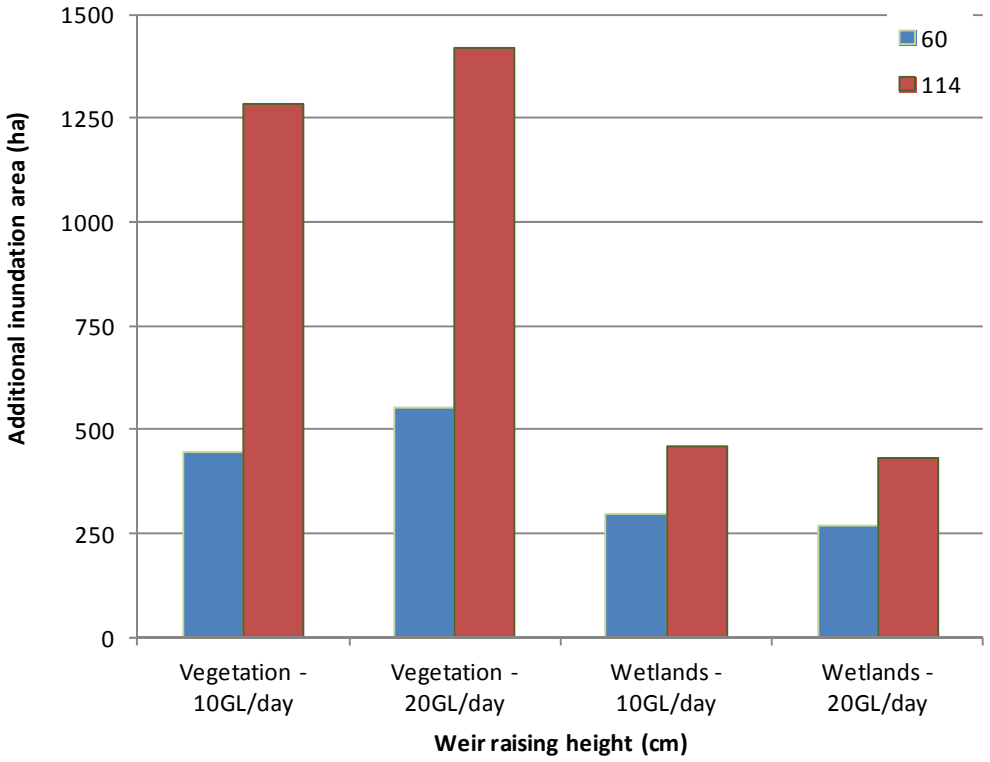

Figure 41: Additional area of vegetation and wetlands inundated under the different flow and weir raising scenarios at Weir 4. Weir pool raises of 60 and 114 cm are shown (blue and red, respectively). Additional area is the area above the normal level inundation for the given flow

The additional vegetation area inundated was greater for 20 GL/d than 10 GL/d (Table 25 and Figure 41). The additional wetland area inundated was greater for the 10 GL/d than 20 GL/d (Table 25 and Figure 41), but the total inundation area was greater for the 20 GL/d scenario, as the normal level inundation area was greater for 20 GL/d than 10 GL/d (Figure 42). There was little difference between the flow scenarios of 10 GL/d and 20 GL/d; this holds for most Weir 4 spatial inundation analysis (Table 25, Figure 41 and Figure 42).

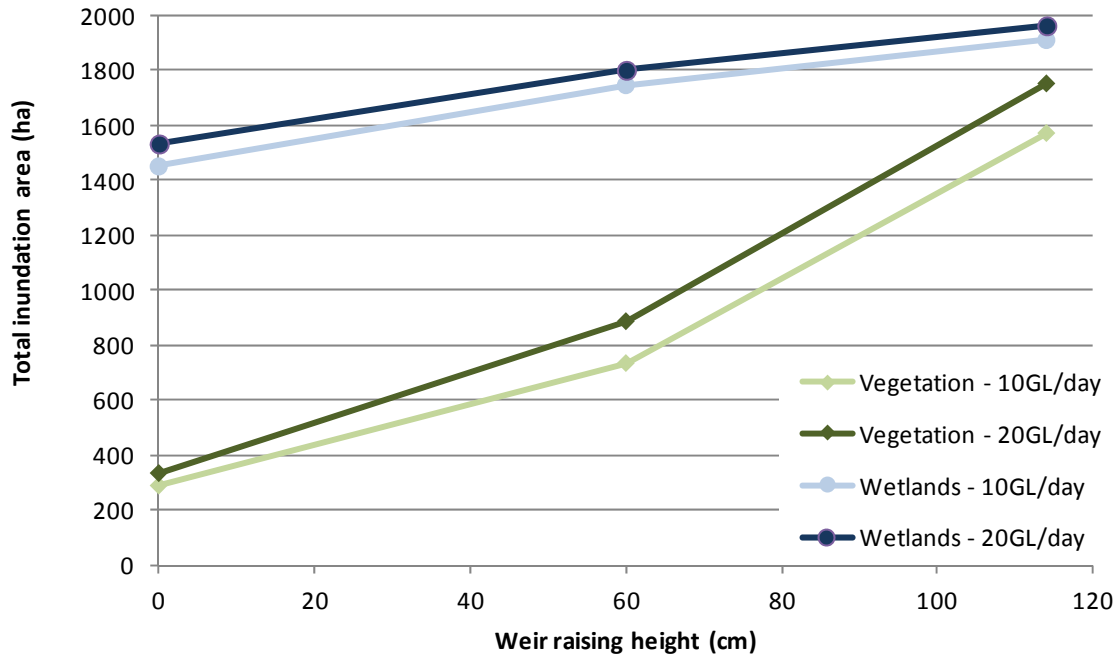

Figure 42: Total area inundated of vegetation and wetlands on the Weir 4 floodplain at normal level (0 cm weir raise) and at the different weir raising scenarios for 10 GL/d and 20 GL/d

6.3.2 Spatial extent

Raising the weir at Weir 4 by 114 cm inundated more of the floodplain than a raise of 60 cm at a flow of 10 GL/d (Figure 43). The influence of raising the weir extended over most of the distance between Weirs 4 and 5 (Figure 44) at 10 GL/d. However, the effects of the weir raising were greater closer to Weir 4. A similar pattern was observed for 20 GL/d.

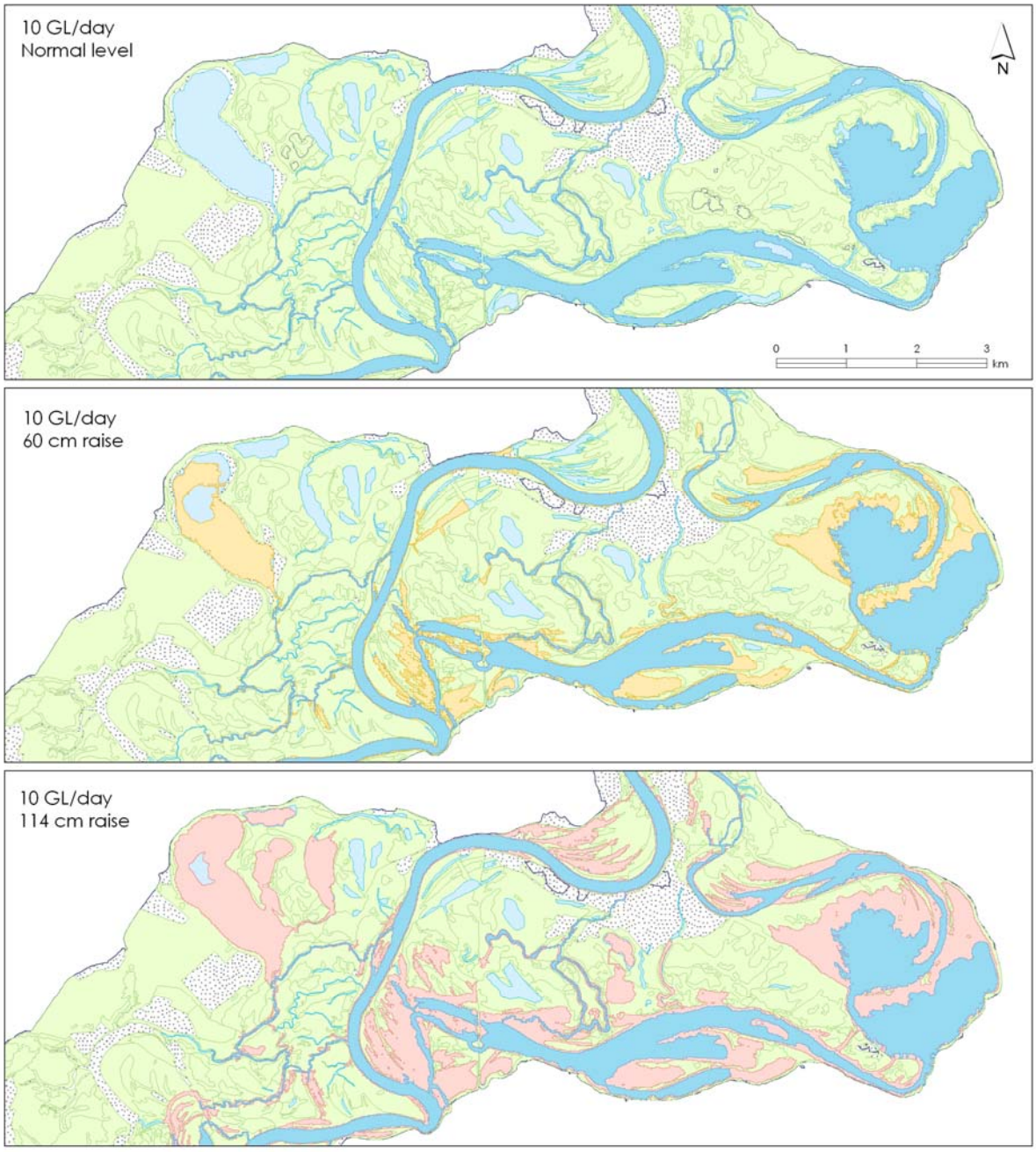

Figure 43: Inundation of Weir 4 floodplain. Area shown is from approximately one kilometre upstream of the Weir; flow is from top to bottom of the figure. Green shades show the vegetation areas, light blue shades are wetlands not inundated at normal level and spotted areas parts of the floodplain not covered by vegetation or wetlands. The darker blue shows the normal level inundation at 10 GL/d. The yellow area shows the additional area inundated above normal level for 10 GL/d with a 60 cm weir raise (middle figure) and the pink area shows the additional area inundated above normal level for 10 GL/d with a 114 cm weir raise (bottom figure)

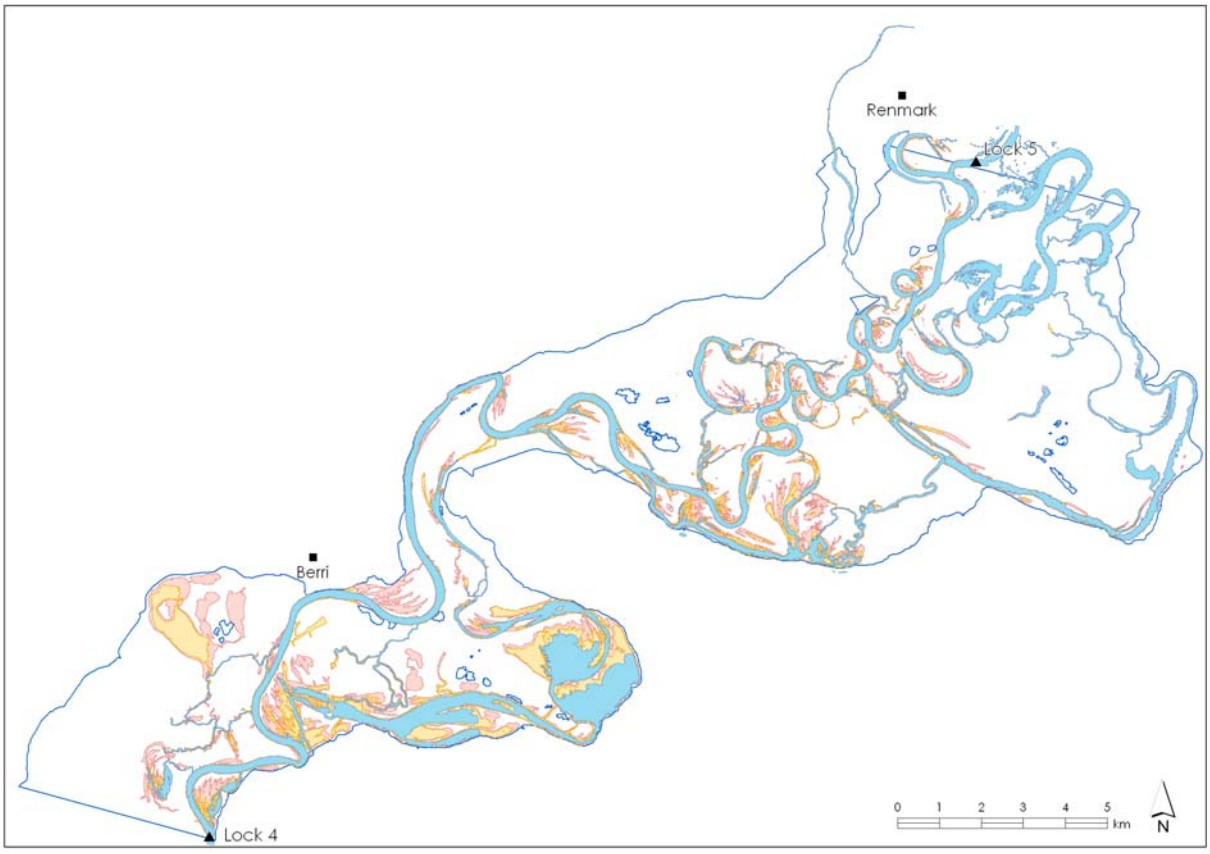

Figure 44: Inundation of the Weir 4 floodplain. An outline of the floodplain is shown by the dark blue line, approximately finishing near Weirs 4 and 5. Normal level inundation at 10 GL/d is shown by the blue shade, including the main River Murray channel. Yellow areas show the additional area of inundation caused by raising the weir at Weir 4 by 60 cm and the pink and yellow area combined show the additional area of inundation caused by raising the weir at Weir 4 by114 cm. Flow is from right to left of the figure

6.3.3 Vegetation

River red gum woodland and samphire shrubland vegetation groups had the greatest additional inundation area under all flow and weir raising scenarios. At 10 GL/d the additional area inundated increased 2-3 times for each vegetation group from a 60 cm to 114 cm weir raise (Figure 45).

The vegetation groups river red gum woodland and samphire shrubland had the greatest total inundation area under all flow and weir raising scenarios (Figure 46). The total inundation area was greater for the 20 GL/d scenarios than the 10 GL/d scenarios (for the same weir raising).

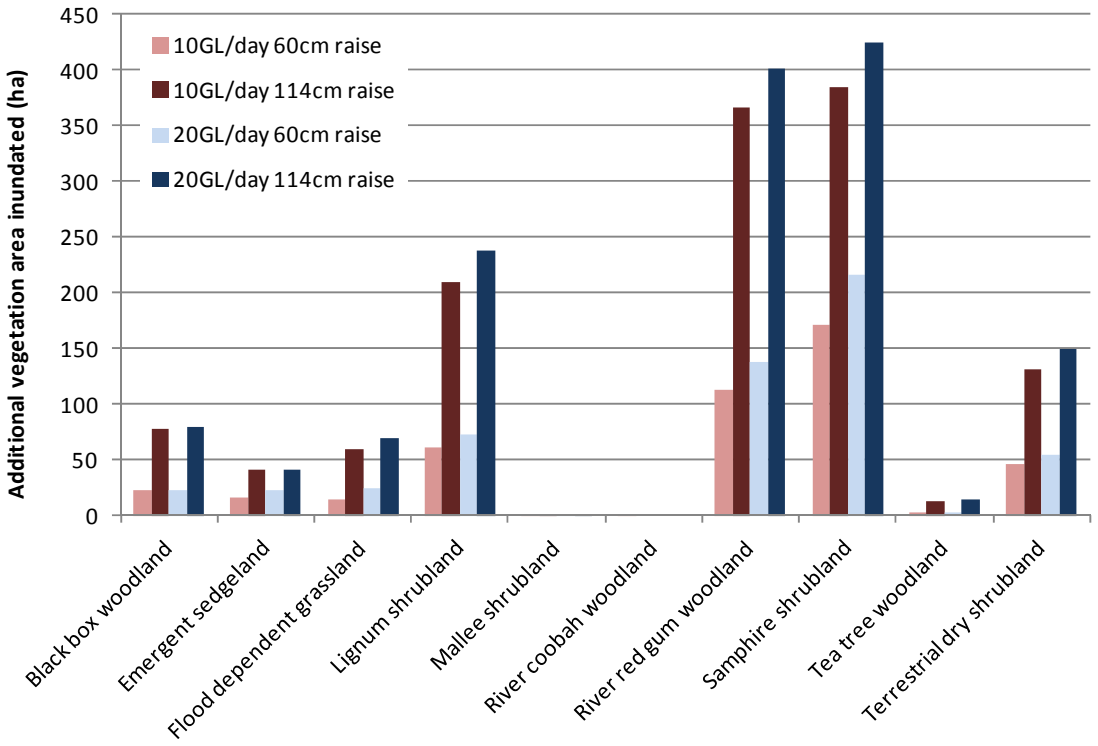

Figure 45: Additional area of the vegetation groups inundated under the different flow and weir raising scenarios at Weir 4. Additional area is the area the normal level inundation for the given flow

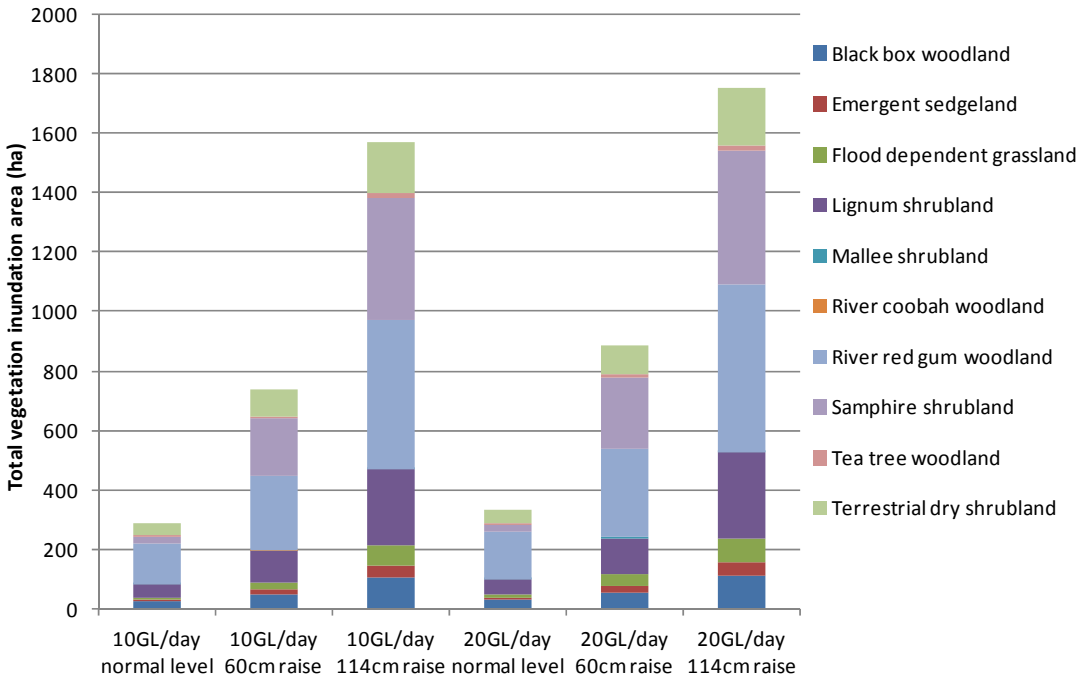

Figure 46: Total vegetation area inundated under normal level and the different flow and weir raising scenarios at Weir 4

Not all vegetation groups were equally inundated by the weir pool raising scenarios (Table 26). For example, river red gum woodland area comprised 18.6% of the vegetation of the Weir 4 floodplain. At 10 GL/d and a 60 cm weir raise, 249 ha of river red gum woodland area was inundated, equivalent to 11.2% of the total river red gum woodland area across the entire vegetated floodplain. However, river red gum woodland comprised 33.8% of the 735 ha inundated by the 10 GL/d 60 cm weir raise. This indicates they were preferentially favoured by the weir raising. Conversely, black box woodland comprised 26.2% of the Weir 4 floodplain vegetation area, but 6.6% of the inundated area at 10 GL/d, 60 cm weir raise (with 48.2 ha inundated; equivalent to 1.5% of the total black box woodland area on the Weir 4 floodplain). At 10 GL/d, a weir raising of 60 cm and 114 cm inundated 6.2% and 13.1% of the Weir 4 floodplain vegetation (Table 26). Whilst data for weir pool raisings at 10 GL/d are presented, the inundation response is likely to be similar for 20 GL/d as the area of inundation was similar.

Table 26: Effect of Weir 4 raising on floodplain vegetation groups and the composition of the vegetation groups on the total floodplain. Shown are the areas of each vegetation group inundated; the percentage of each group inundated; and the percentage of the total vegetation area inundated

			10 GL/d, 60 cm raise			10 GL/d, 114 cm raise		
Vegetation group	**Total floodplain area (ha)**	**% of total floodplain vegetation area (composition of)**	**Total area inundated (ha)**	**% of vegetation group inundated**	**% of total vegetation area inundated (composition of)**	**Total area inundated (ha)**	**% of vegetation group inundated**	**% of total vegetation area inundated (composition of)**
Black box woodland	3134	26.2	49	1.5	6.6	103	3.3	6.6
Emergent sedgeland	96	0.8	20	20.4	2.6	44	46.7	2.8
Flood dependent grassland	710	5.9	21	2.9	2.8	65	9.2	4.1
Lignum shrubland	1585	13.3	110	6.9	14.9	258	16.3	16.4
Mallee shrubland	1	0.0	0.4	29.8	0.1	0.9	71.2	0.1
River coobah woodland	12	0.1	1.3	10.6	0.2	0.0	0.0	0.0
River red gum woodland	2223	18.6	249	11.2	33.8	502	22.6	31.9
Samphire shrubland	1328	11.1	193	14.5	26.2	407	30.7	25.9
Tea tree woodland	505	4.2	6.3	1.3	0.9	17	3.3	1.1
Terrestrial dry shrubland	2363	19.8	88	3.7	12.0	174	7.4	11.1
TOTAL VEGETATION AREA	**11,956**	**100.0**	**735**	**6.2**	**100.0**	**1572**	**13.1**	**100.0**

6.3.4 Wetlands

Raising the weir inundated a larger additional area of permanent and saline wetlands than temporary wetlands (Figure 47). Most of the permanent wetland area inundated at normal level and for the range of raising scenarios was conservation-threat class CT2, which was reflective of the classes on the floodplain (Figure 48). There was a more even spread in conservation-threat classes for the temporary wetland area, although classes CT3-CT5 dominated over classes CT1-CT2 (Figure 49). The inundation of temporary wetland classes was reflective of the classes that exist on the floodplain. Most of the saline wetland area inundated at normal level and for the range of raising scenarios was conservation-threat CT3 class (Figure 50). There was little inundation of CT5 class wetlands compared to the area of these wetlands that exists on the floodplain. For permanent, temporary and saline wetlands weir raising had little effect the proportional area of different conservation-threat classes inundated.

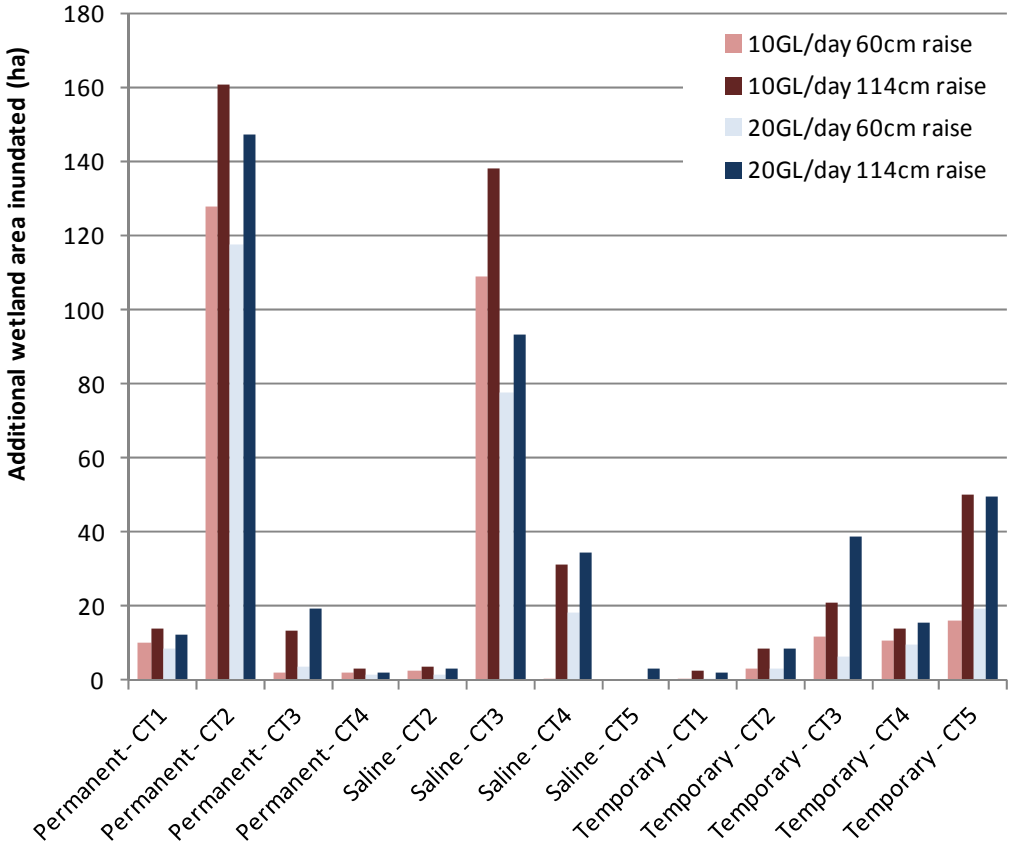

Figure 47: Additional area of permanent, saline and temporary wetland organised by conservation-threat class inundated under the different flow and weir raising scenarios at Weir 4. Additional area is the area above the normal level inundation for the given flow

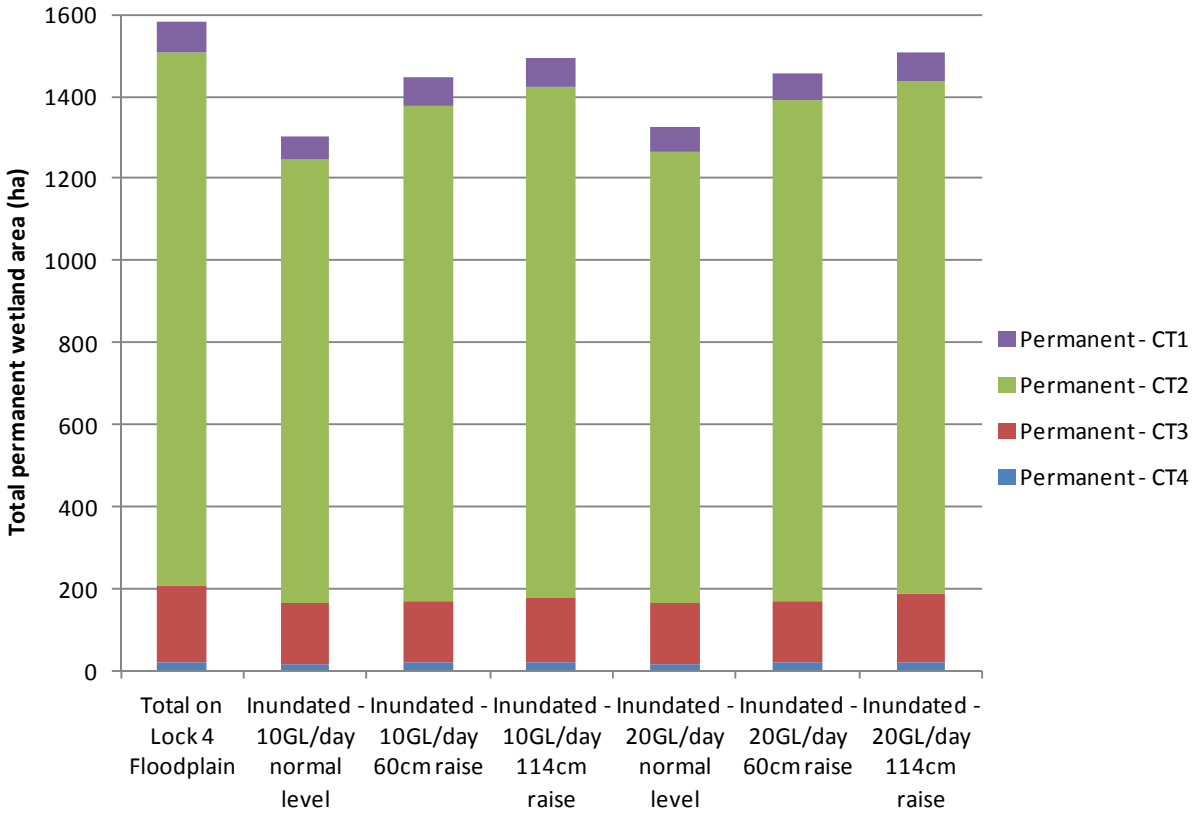

Figure 48: Total area of permanent wetland conservation-threat classes on Weir 4 floodplain and inundated under normal level and the different flow/weir raising scenarios

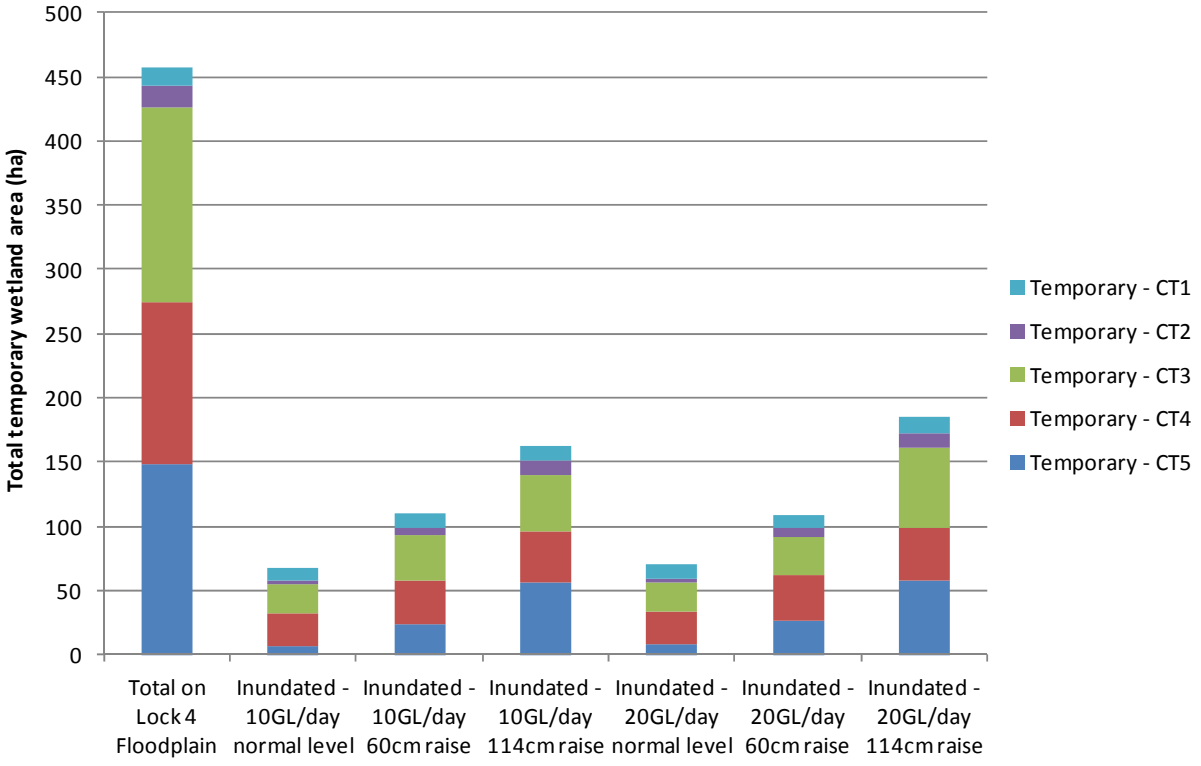

Figure 49: Total area of temporary wetland conservation-threat classes on Weir 4 floodplain and inundated under normal level and the different flow/weir raising scenarios

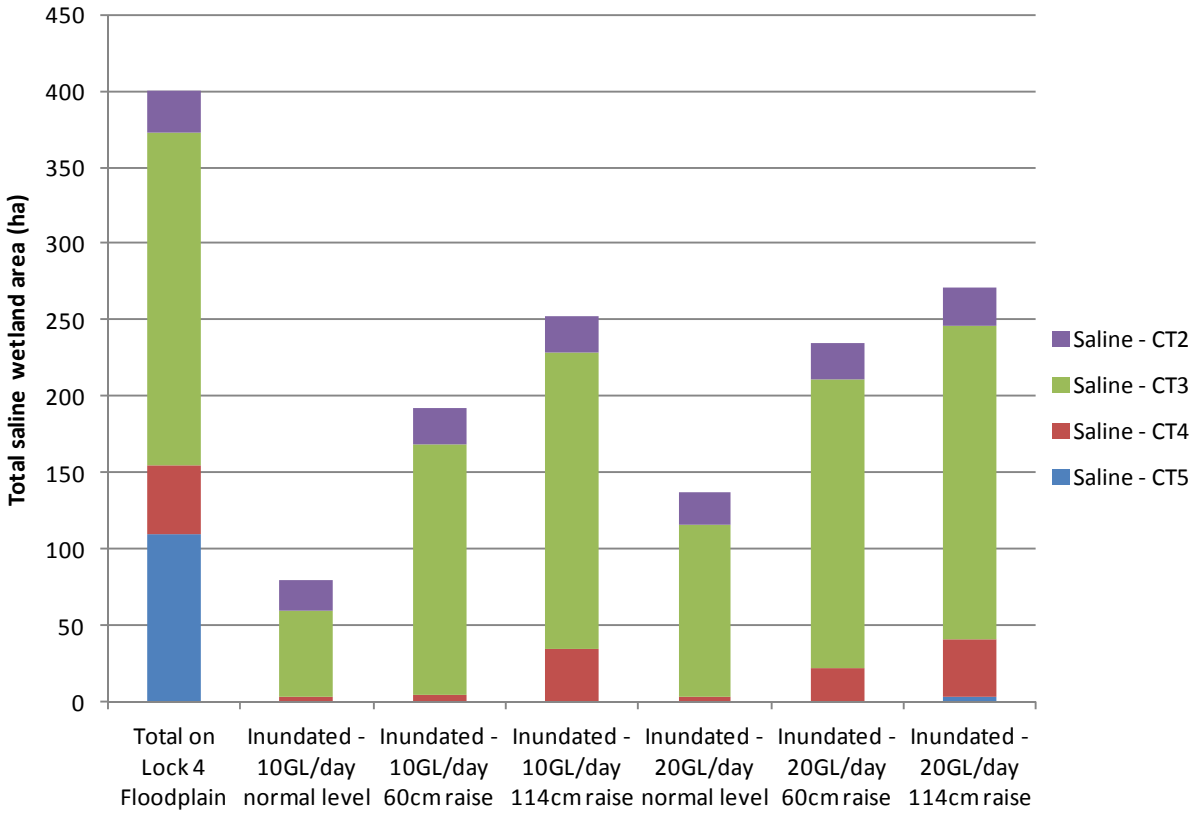

Figure 50: Total area of saline wetland conservation-threat classes on Weir 4 floodplain and inundated under normal level and the different flow/weir raising scenarios

At a 10 GL/d flow and 114 cm raise, 163 ha of temporary wetland area was inundated, which was equivalent to 35.6% of the temporary wetland area on the Weir 4 floodplain (Table 27). Twenty-five percent of the temporary wetland area not inundated at normal level at 10 GL/d was inundated by raising the weir 114 cm (Table 27).

There was a difference in the permanent and temporary wetland areas inundated: for a 114 cm raise 94.3% (10 GL/d) and 95.2% (20 GL/d) of permanent wetland area was inundated, but only 35.6% (10 GL/d) and 40.4% (20 GL/d) of temporary wetland area was inundated (Table 27).

Table 27: Inundation of permanent, temporary and saline wetland area on the Weir 4 floodplain. Shown are the area and percentage area inundated and the percentage area inundated that is not inundated at normal level.

Scenario	PERMANENT WETLAND AREA – 1584 ha			TEMPORARY WETLAND AREA – 457 ha			SALINE WETLAND AREA - 400 ha		
	Permanent wetland area inundated (ha)	% of total permanent wetland area on Weir 4 floodplain inundated	% of total permanent wetland area not inundated at normal level now inundated	Temporary wetland area inundated (ha)	% of total temporary wetland area on Weir 4 floodplain inundated	% of total temporary wetland area not inundated at normal level now inundated	Saline wetland area inundated (ha)	% of total saline wetland area on Weir 4 floodplain inundated	% of total saline wetland area not inundated at normal level now inundated
10 GL/d normal level	1303	82.2	-	67	14.8	-	80	20.0	-
10 GL/d 60 cm raise	1445	91.2	50.5	109	23.9	10.8	192	48.0	35.0
10 GL/d 114 cm raise	1494	94.3	68.0	163	35.6	24.5	253	63.3	54.1
20 GL/d normal level	1326	83.7	-	70	15.3	-	138	34.5	-
20 GL/d 60 cm raise	1458	92.0	51.1	109	23.8	10.1	185	58.8	37.2
20 GL/d 114 cm raise	1508	95.2	70.3	185	40.4	29.7	271	67.9	51.0

There were 15 saline wetlands on the Weir 4 floodplain, five of which were fully or partially inundated at normal level at 10 GL/d (Table 28). Eight saline wetlands were affected by a weir raising of 114 cm at 10 GL/d. The rise in level may either increase a wetland's inundation area or inundate dry wetlands. Similar numbers of permanent (39) and temporary (41) wetlands were affected by a weir raise of 60 cm at 10 GL/d, but more temporary wetlands (77) than permanent wetlands (53) were affected by raising the weir to the higher level of 114 cm (at 10 GL/d) (Table 28).

Table 28: The number of wetlands on the Weir 4 floodplain, the number of wetlands fully or partially inundated at normal level for different flows and the number of wetlands affected by raising the weir for the wetland categories and conservation classes. Wetlands 'affected' by raising the weir are those whose inundated area increased due to the weir raising

Wetland category	Weir 4 total number of wetlands	Number of wetlands inundated 10 GL/d, normal level	Number of wetlands affected by 60 cm raise at 10 GL/d	Number of wetlands affected by 114 cm raise at 10 GL/d	Number of wetlands inundated 20 GL/d, normal level	Number of wetlands affected by 60 cm raise at 20 GL/d	Number of wetlands affected by 114 cm raise at 20 GL/d
PERMANENT	**60**	**52**	**39**	**53**	**52**	**48**	**53**
CT1	15	13	12	13	13	11	12
CT2	28	25	15	23	25	23	24
CT3	14	13	10	14	13	11	14
CT4	3	1	2	3	1	3	3
SALINE	**15**	**5**	**5**	**8**	**5**	**7**	**10**
CT2	1	1	1	1	1	1	1
CT3	5	3	3	4	3	3	5
CT4	5	1	1	3	1	3	3
CT5	4	0	0	0	0	0	1
TEMPORARY	**185**	**46**	**41**	**77**	**48**	**45**	**82**
CT1	6	4	3	5	4	4	5
CT2	15	4	4	10	5	4	10
CT3	45	14	6	20	14	8	22
CT4	66	17	15	19	18	14	19
CT5	53	7	13	23	7	15	26
TOTAL	**260**	**103**	**85**	**138**	**105**	**100**	**145**

6.3.5 Tree condition

Healthy and unhealthy river red gums had the greatest additional area inundated by raising the weir (Figure 51). More unhealthy and dead black boxes were inundated than healthy trees (Figure 51).

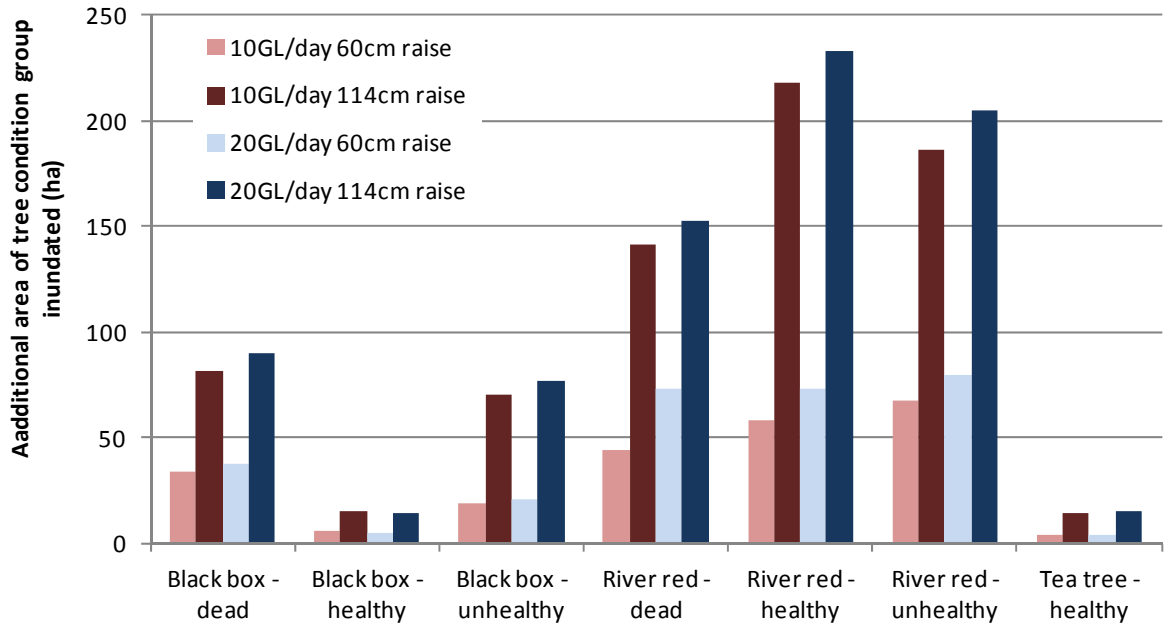

Figure 51: Additional area of tree condition groups inundated under the different flow and weir raising scenarios at Weir 4. Additional area is that above the normal level inundation for the given flow

The weir pool raising inundated both healthy and unhealthy stands of river red gum trees (Figure 52). More dead and unhealthy black box trees were inundated under all scenarios than healthy trees (Figure 53).

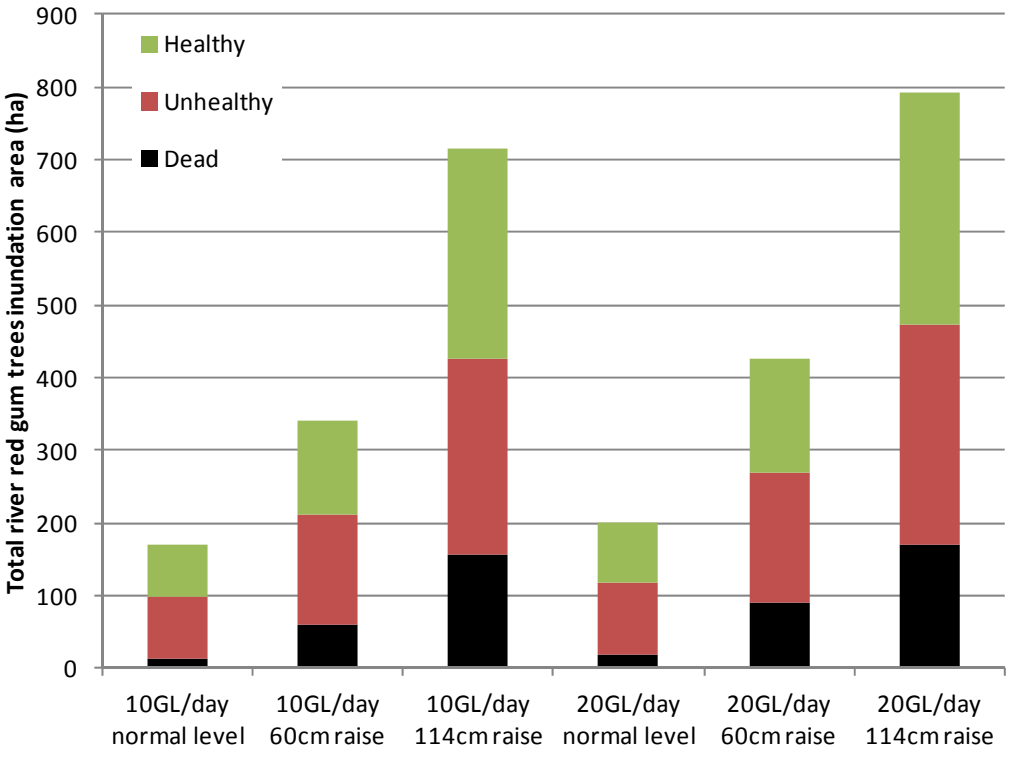

Figure 52: Total inundated area of river red gum trees under normal level and the different flow and weir raising scenarios at Weir 4

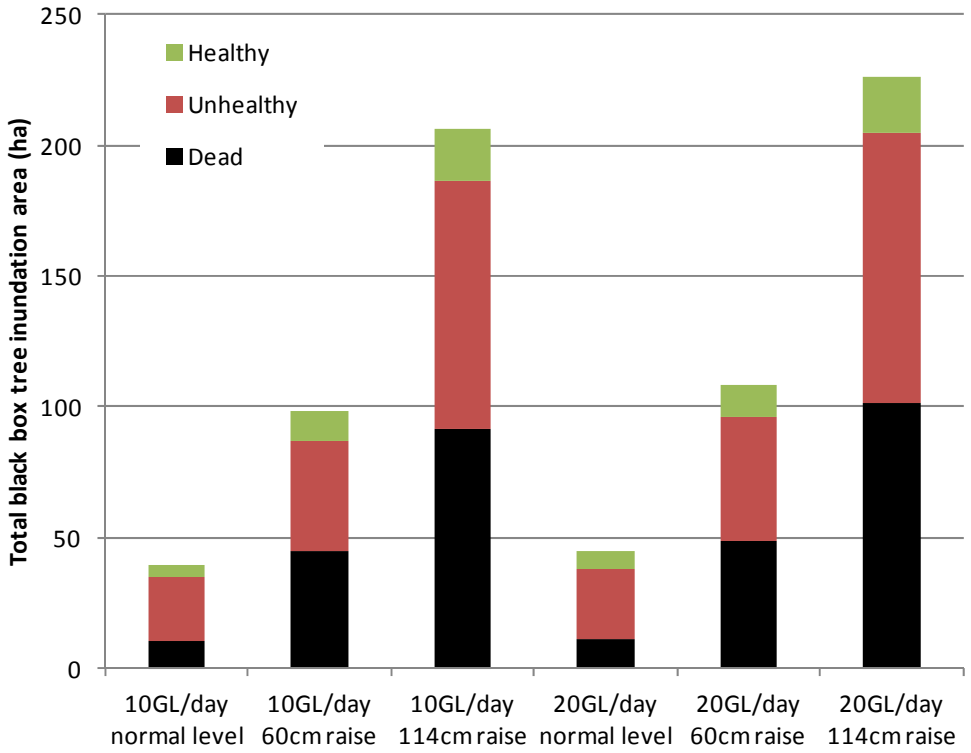

Figure 53: Total inundated area of black box trees under normal level and the different flow and weir raising scenarios at Weir 4

At 10 GL/d, 20% of healthy river red gum trees and 3.3% of healthy black box trees not inundated at normal level were inundated by a weir raising of 114 cm (Table 29). Similarly, at 10 GL/d 53% of dead river red gum trees and 2.4 % of unhealthy black box trees not inundated at normal level were inundated by a weir raising of 114 cm. It needs to be noted that these values are not comparable to those calculated for the river red gum woodland and black box woodland vegetation groups described previously.

Table 29: The percentage of the tree condition area not inundated at normal level, inundated under the different flow and weir raising scenarios at Weir 4 (above the normal level inundation for the given flow), for the different categories of tree condition. The percent areas are the area of the relevant tree condition category not inundated at normal levels, inundated under the different scenarios. The total percentage for each tree is that of all trees in all classes inundated across the floodplain.

	Percentage of area not inundated at normal level, inundated under the different scenarios (%)			
	10 GL/d 60 cm raise	10 GL/d 114 cm raise	20 GL/d 60 cm raise	20 GL/d 114 cm raise
Total black box	1.5	4.3	1.6	4.7
Dead black box	6.9	16.3	7.5	18.1
Healthy black box	1.3	3.3	1.0	3.0
Unhealthy black box	0.6	2.4	0.7	2.6
Total mallee	16.9	66.0	16.7	64.7
Healthy mallee	16.9	66.0	16.7	64.7
Total river coobah	6.0	5.9	0.7	6.0
Dead river coobah	99.7	100.0	99.8	100.0
Healthy river coobah	0.0	0.0	0.0	0.0
Unhealthy river coobah	5.8	5.7	0.0	5.7
Total river red gum	6.9	22.0	9.2	24.1
Dead river red gum	16.7	53.0	27.6	57.9
Healthy river red gum	5.3	20.0	6.8	21.7
Unhealthy river red gum	6.0	16.6	7.1	18.4
Total tea tree	0.7	2.9	0.8	3.1
Healthy tea tree	0.7	2.9	0.8	3.1
Combined total	**3.4**	**10.6**	**4.3**	**11.6**

7. Weir 5

7.1 Summary

Four scenarios were analysed for Weir 5: a weir raising of 50 cm at flow rates of 10, 30, 40 and 50 GL/d. The modelling showed:

- Raising the weir level by 50 cm at 10 GL/d inundated an additional 760 ha (432%) of floodplain vegetation compared to the normal levels at the same flows. The higher the flow, the greater the total area of floodplain inundated.
- Proportionally larger areas of river red gum woodland and samphire shrubland were inundated than other vegetation groups.
- A greater additional area of healthy and unhealthy river red gum trees and dead black box trees were inundated by weir raising than the other condition classes.
- Weir raising inundated a larger additional area of permanent wetlands than temporary and saline wetlands.
- The extent of the weir pool raise extended over approximately half of the distance between Weirs 5 and 6, but was concentrated near existing channels.

7.2 Normal level inundation

Inundation of the floodplain at normal level for the four Weir 3 scenario flows of 10 GL/d, 30 GL/d, 40 GL/d and 50 GL/d is outlined in Table 30. The higher the flow, the more floodplain (vegetation and wetlands) was inundated. At 10 GL/d, 1,604 ha of floodplain was inundated, increasing to 2708 ha at 50 GL/d.

Table 30: The Weir 5 floodplain and the area inundated at different flows with the weir at normal level

Category	Area of floodplain (ha)	Area inundated at 10 GL/d (ha)	% of area inundated at 10 GL/d	Area inundated at 30 GL/d (ha)	% of area inundated at 30 GL/d	Area inundated at 40 GL/d (ha)	% of area inundated at 40 GL/d	Area inundated at 50 GL/d (ha)	% of area inundated at 50 GL/d
TOTAL WEIR 5 FLOODPLAIN*	***18,800***	***1604***	***8.5***	***2311***	***12.3***	***3180***	***16.9***	***4369***	***23.2***
VEGETATION (TOTAL AREA)	**16,463**	**176**	**1.1**	**776**	**4.7**	**1582**	**9.6**	**2708**	**16.4**
Black box woodland	3646	13	0.4	39	1.1	80	2.2	136	3.7
Emergent sedgeland	81	3	3.3	17	20.3	36	44.2	46	56.6
Flood dependent grassland	126	0	0.0	5	3.6	20	15.6	55	43.3
Lignum shrubland	1455	3	0.2	22	1.5	86	5.9	253	17.4
Mallee shrubland	0.8	0	0.0	0	0.0	0	0.0	0	0.0
River coobah woodland	123	0	0.0	3	2.6	21	17.1	47	37.9
River red gum woodland	3742	113	3.0	392	10.5	717	19.2	1148	30.7
Samphire shrubland	2089	43	2.1	256	12.2	472	22.6	704	33.7
Tea tree woodland	309	0	0.0	1	0.3	1	0.5	2	0.8
Terrestrial dry shrubland	4892	0.8	0.0	43	0.9	148	3.0	318	6.5
WETLANDS (TOTAL AREA)	**2337**	**1428**	**61.1**	**1535**	**65.7**	**1598**	**68.4**	**1661**	**71.1**
Permanent	1224	1130	90.9	1181	95.0	1199	96.4	1207	97.1
Temporary	790	6	0.7	57	7.3	99	12.5	151	19.2
Saline	304	292	96.2	296	97.4	301	99.0	302	99.5

Total floodplain is the addition of vegetation and wetlands, but does not include other areas such as towns

7.3 Weir raising

7.3.1 Overview

An overview of the additional vegetation and wetland area inundated due to raising the weir is shown in Table 31 and Figure 54. The additional area is that for weir pool raisings at a given flow. e.g. the inundated area of weir pool raisings at 20 GL/d were compared against that of normal level at 20 GL/d.

At a flow of 10 GL/d the additional vegetation area inundated above normal level inundation when the weir was raised 50 cm was 760 ha. This represents 4.7% of the total vegetation area not inundated at normal level and a 432% increase in the area inundated when the river was operated at normal level (176 ha). The weir raising inundated less wetland area than vegetation area. At 10 GL/d, a weir raising of 50 cm inundated an additional 100 ha of wetland area. This represented 11.0% of the wetland area that was not inundated at normal level and only a 6.9% increase in the area inundated at normal level (1,428 ha).

Table 31: The additional area of vegetation and wetlands inundated due to raising the weir. Additional area is the area above the normal level inundation for the given flow

	Vegetation			Wetlands		
Scenario	Additional area inundated (ha)	% of total vegetation area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow	Additional area inundated (ha)	% of total wetland area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow
10 GL/d 50 cm	760	4.7%	432%	100	11.0%	6.9%
30 GL/d 50 cm	934	6.0%	120%	64	8.0%	4.2%
40 GL/d 50 cm	957	6.4%	61%	46	6.3%	2.9%
50 GL/d 50 cm	733	5.3%	27%	30	4.5%	1.8%

The additional inundation area of vegetation was greater for the 10 GL/d, 30 GL/d and 40 GL/d flow scenarios than the 50 GL/d flow scenario (at a 50 cm weir raise) (Table 31 and Figure 54). However, the total vegetation inundation area was greatest for the 50 GL/d scenario (Figure 55), as the normal level inundation area was greatest for the 50 GL/d flow. Similarly, although the additional wetland area inundated by the weir raise decreased for the flow scenarios of 10 GL/d to 50 GL/d (Table 31 and Figure 54), the total wetland inundation area increased slightly, due to the different normal level inundation areas for the different flows (Figure 55). There was little difference in the flow scenarios for the wetland area at Weir 5, while the vegetation inundation area increased with increasing flow and weir height (Figure 55).

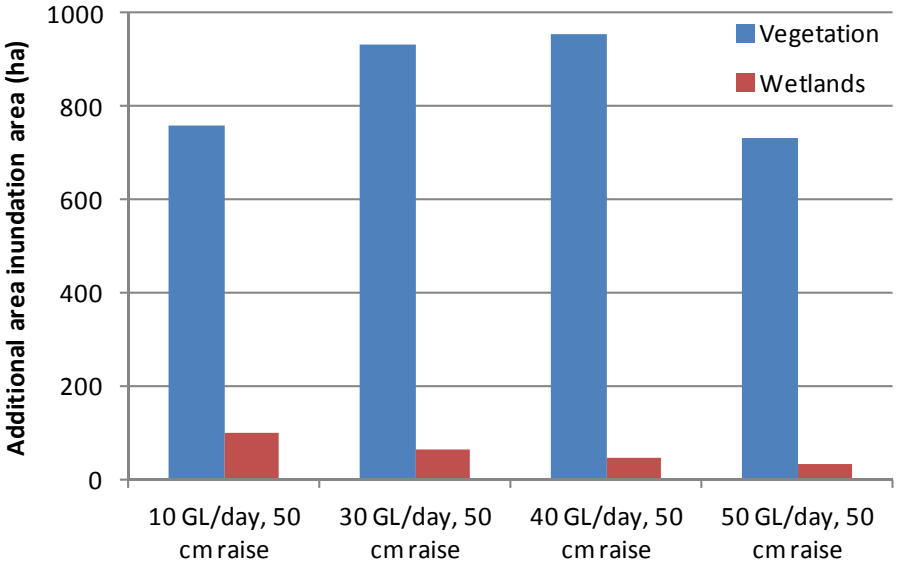

Figure 54: Additional area of vegetation and wetlands inundated under the different flow and weir raising scenarios at Weir 5. Additional area is the area above the normal level inundation for the given flow

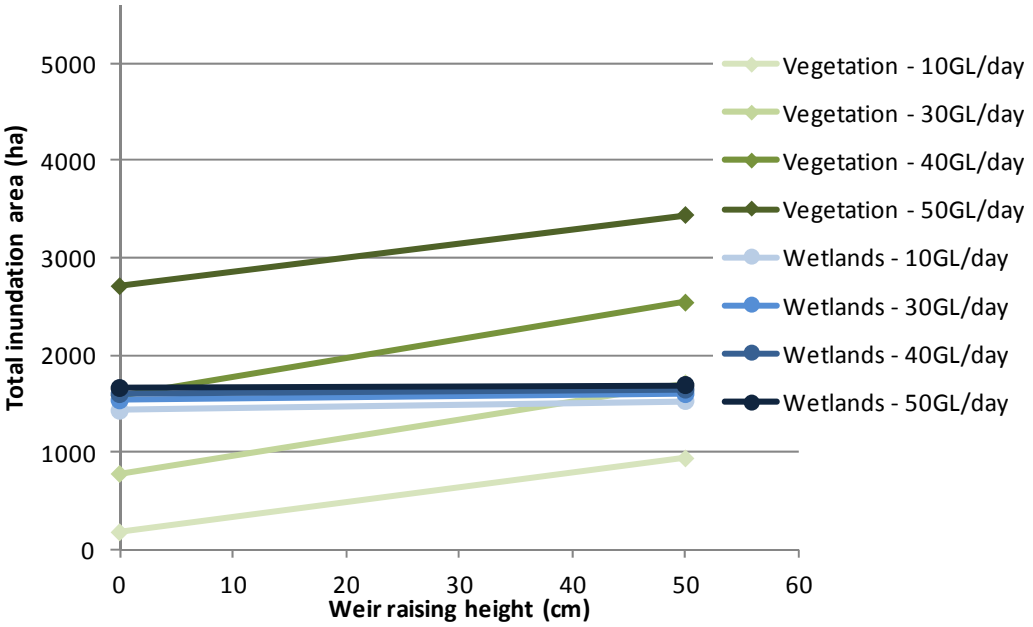

Figure 55: Total area inundated of vegetation and wetlands on the Weir 5 floodplain at normal level (0 cm weir raise) and at the different weir raising scenarios for 10 GL/d, 30 GL/d, 40 GL/d and 50 GL/d

7.3.2 Spatial extent

Raising the weir 50 cm at 10 GL/d inundated areas of vegetation and wetland (Figure 56). At 10 GL/d, the influence of the raising the weir 50 cm extended over approximately half of the distance between Weirs 5 and 6, but was concentrated near existing channels (Figure 57). Similar patterns were observed for the greater flows.

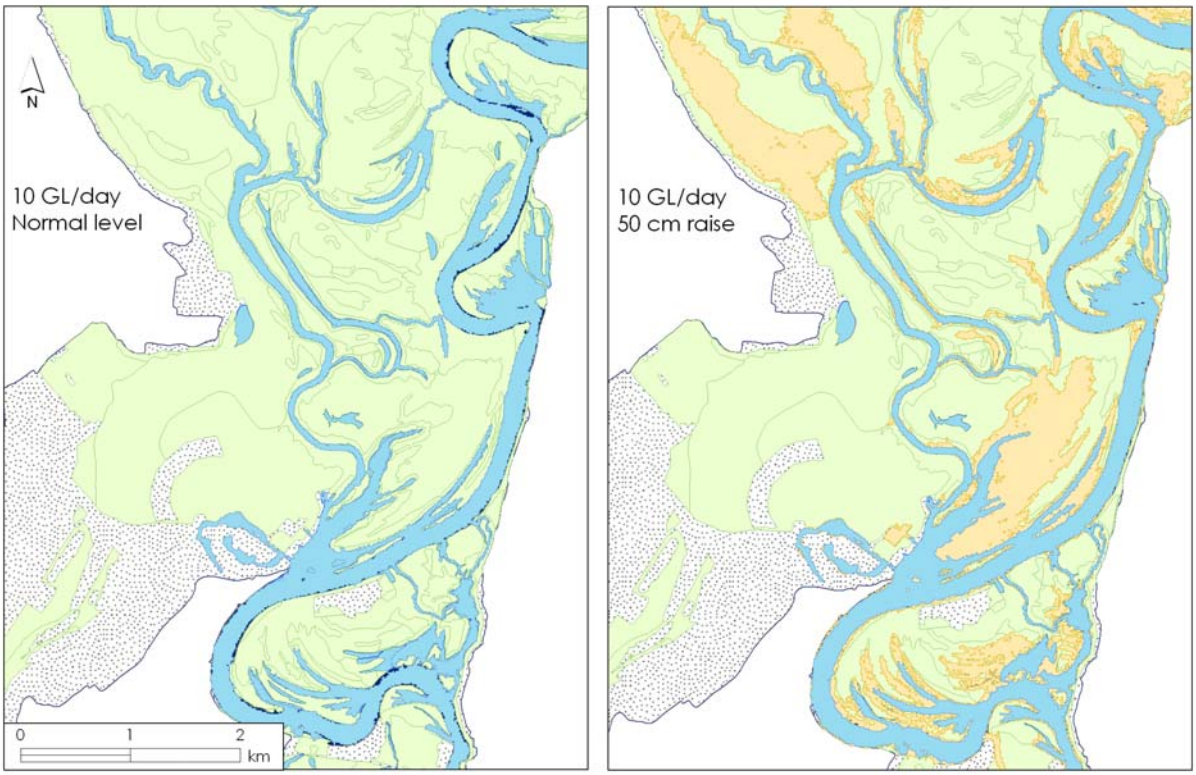

Figure 56: Inundation of Weir 5 floodplain. Area shown is from approximately one kilometre upstream of the Weir; flow is from top to bottom of the figure. Green shades show the vegetation areas, light blue shades wetlands not inundated at normal level and spotted areas parts of the floodplain not covered by vegetation or wetlands. The darker blue shows the normal level inundation at 10 GL/d. The yellow area shows the additional area inundated above normal level for 10 GL/d with a 50 cm raise (right figure)

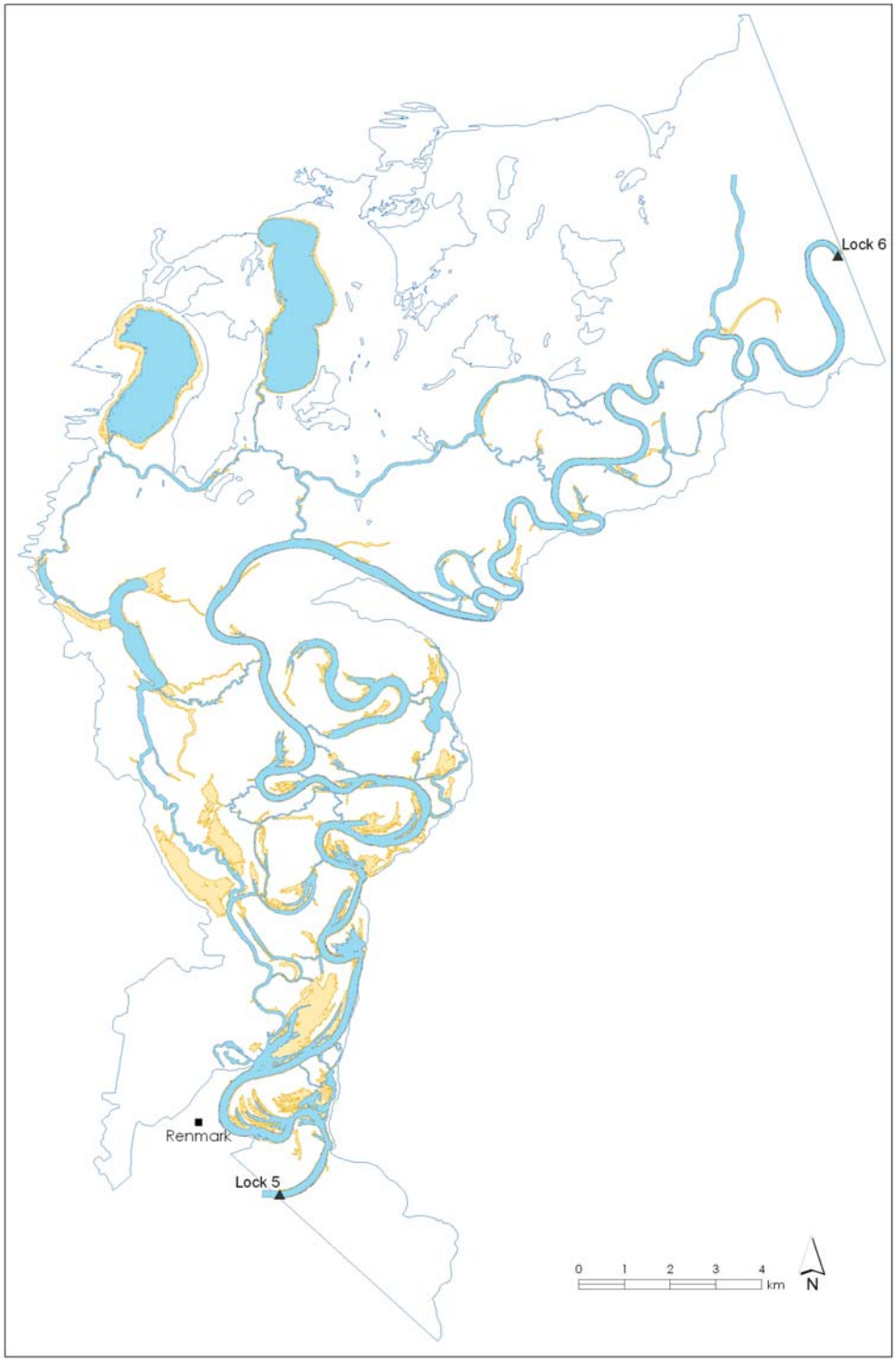

Figure 57: Inundation of the Weir 5 floodplain. An outline of the floodplain is shown by the dark blue line, approximately finishing near Weirs 5 and 6. Normal level inundation at 10 GL/d is shown by the blue shade, including the main River Murray channel. Yellow areas show the additional area of inundation caused by raising the weir at Weir 5 by 50 cm. Flow is from top to bottom of the figure

7.3.3 Vegetation

River red gum woodland and samphire shrubland vegetation groups had the greatest additional inundation area under all flow and weir raising scenarios, with the 40 GL/d scenario generally inundating the greatest additional area (Figure 58).

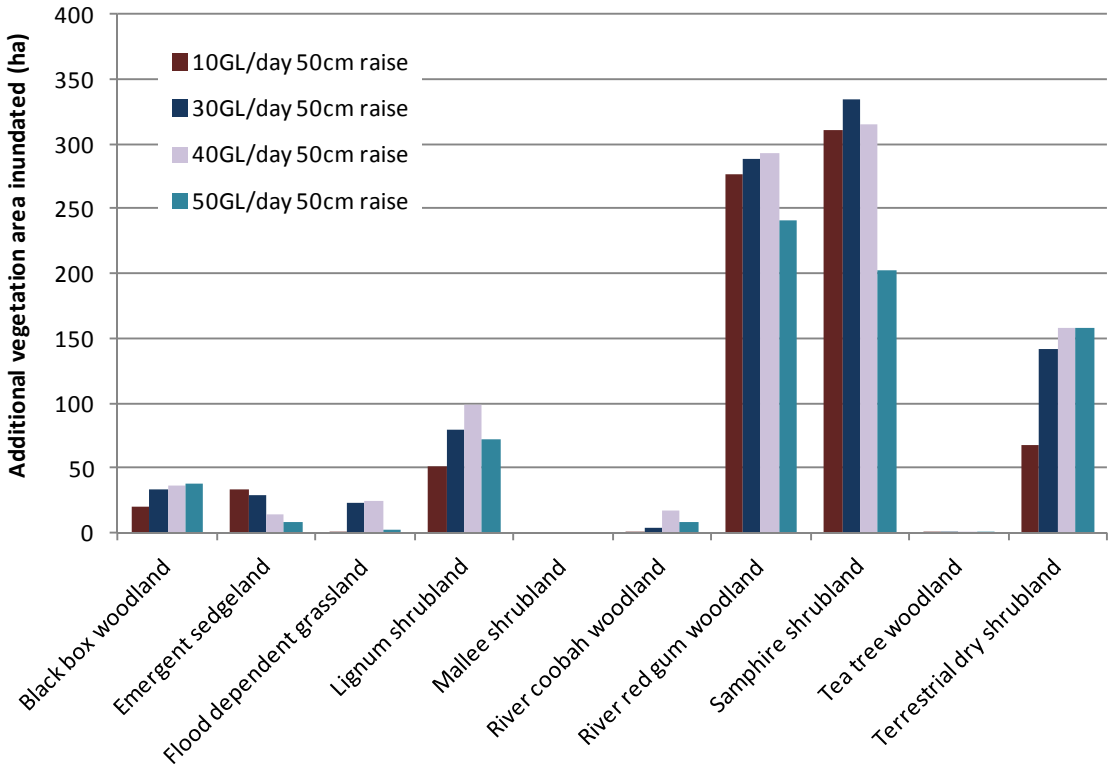

Figure 58: Additional area of the vegetation groups inundated under the different flow and weir raising scenarios at Weir 5. Additional area is the area above the normal level inundation for the given flow

The vegetation groups river red gum woodland and samphire shrubland had the greatest total inundation area under all flow and weir raising scenarios (Figure 59). The total inundation area was greatest for the 50 GL/d scenarios (Figure 59).

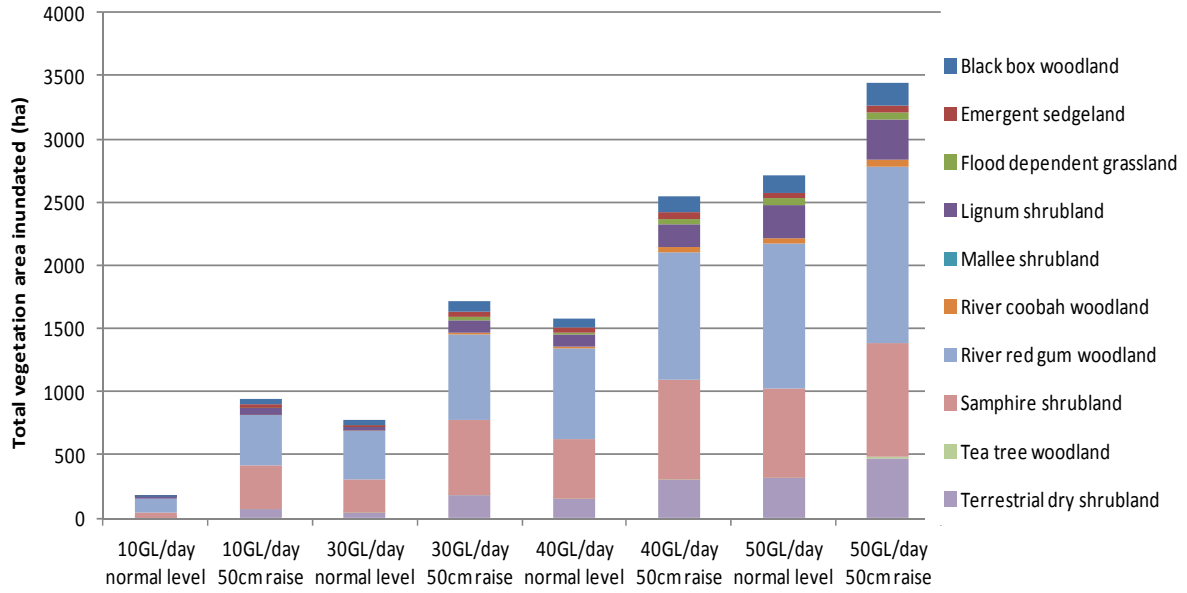

Figure 59: Total vegetation area inundated under normal level and the different flow and weir raising scenarios at Weir 5

Not all vegetation groups were equally inundated by the weir pool raising scenarios (Table 32). For example, river red gum woodland area comprised 22.7% of the vegetation on the Weir 5 floodplain. At 10 GL/d and a 50 cm weir raise, 390 ha of river red gum woodland area was inundated, which was equivalent to 10.4% of the total river red gum woodland area across the entire vegetated floodplain. However, river red gum woodland area comprised 41.6% of the 936 ha inundated by the 10 GL/d, 50 cm weir raise. This indicates they were preferentially favoured by the weir raising. Conversely, black box woodland comprised 22.1% of the Weir 5 floodplain vegetation area, but 3.6% of the inundated area for the 10 GL/d, 50 cm weir raise (with 33.5 ha inundated; equivalent to 3.6% of the total black box woodland area on the Weir 5 floodplain). Weir raisings of 50 cm at 10 GL/d and 30 GL/d inundated 5.7% and 10.4% of the Weir 5 floodplain vegetation, respectively (Table 32). Whilst the data for the 10 GL/d and 30 GL/d scenarios are presented, similar patterns of preferential inundation are likely for the 40 GL/d and 50 GL/d scenarios.

Table 32: Effect of Weir 5 raising on floodplain vegetation groups and the composition of the vegetation groups on the total floodplain. Shown are the areas of each vegetation group inundated; the percentage of each group inundated; and the percentage of the total vegetation area inundated.

			10 GL/d 50 cm raise			30 GL/d 50 cm raise		
Vegetation group	**Total floodplain area (ha)**	**% of total floodplain vegetation area (composition of)**	**Total area inundated (ha)**	**% of vegetation group inundated**	**% of total vegetation area inundated (composition of)**	**Total area inundated (ha)**	**% of vegetation group inundated**	**% of total vegetation area inundated (composition of)**
Black box woodland	3646	22.1	33.5	0.9	3.6	72.9	2.0	4.3
Emergent sedgeland	81	0.5	36.0	44.5	3.8	44.7	55.2	2.6
Flood dependent grassland	126	0.8	0.8	0.7	0.1	26.8	21.3	1.6
Lignum shrubland	1455	8.8	53.2	3.7	5.7	102.2	7.0	6.0
Mallee shrubland	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
River coobah woodland	123	0.7	0.3	0.3	0.0	6.9	5.6	0.4
River red gum woodland	3742	22.7	389.7	10.4	41.6	681.0	18.2	39.8
Samphire shrubland	2089	12.7	354.2	17.0	37.8	590.5	28.3	34.5
Tea tree woodland	309	1.9	0.1	0.0	0.0	1.3	0.4	0.1
Terrestrial dry shrubland	4892	29.7	68.2	1.4	7.3	184.3	3.8	10.8
TOTAL VEGETATION AREA	**16463**	**100.0**	**936**	**5.7**	**100.0**	**1711**	**10.4**	**100.0**

7.3.4 Wetlands

Weir raising inundated a larger additional permanent wetland area than temporary or saline wetland area (Figure 60). Most of the permanent wetland area inundated at normal level and for the raising scenarios was conservation-threat class CT1, which was reflective of the classes on the floodplain (Figure 61). There was a more even spread in conservation-threat classes for the temporary wetland area (Figure 62). The scenarios inundated the greatest area of CT3 wetlands, although CT5 class wetlands had the greatest area on the floodplain. Most of the saline wetland area inundated at normal level and for the range of raising scenarios was conservation-threat class CT2, which was reflective of the classes on the floodplain (Figure 63). For permanent and saline wetlands, weir raising had little effect on changing the proportion of wetland area of different conservation-threat class inundated at normal level.

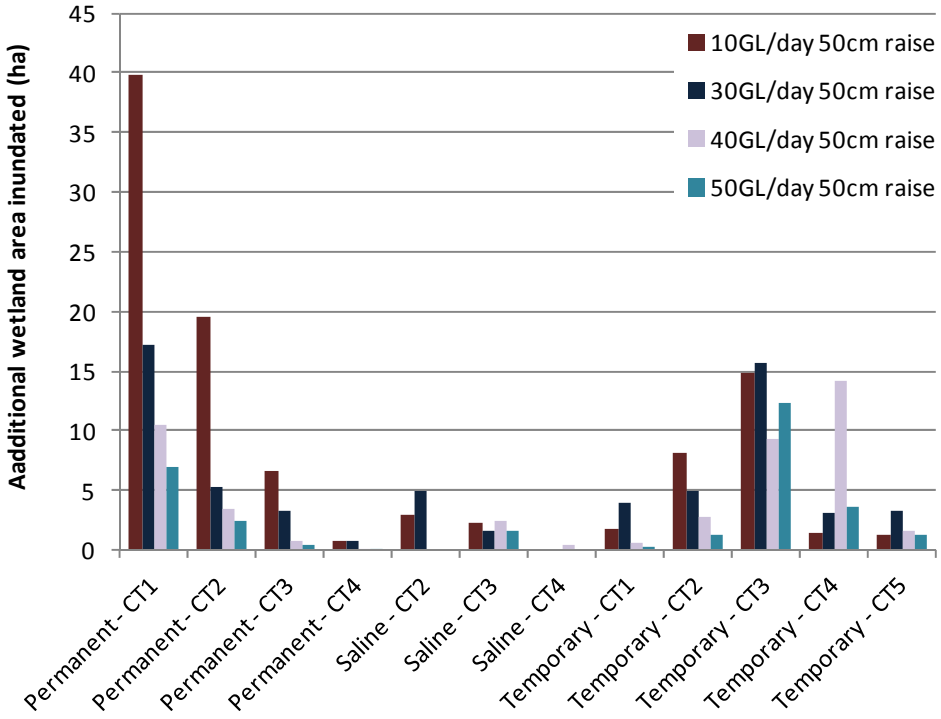

Figure 60: Additional area of permanent, saline and temporary wetland organised by conservation-threat class inundated under the different flow and weir raising scenarios at Weir 5. Additional area is the area above the normal level inundation for the given flow

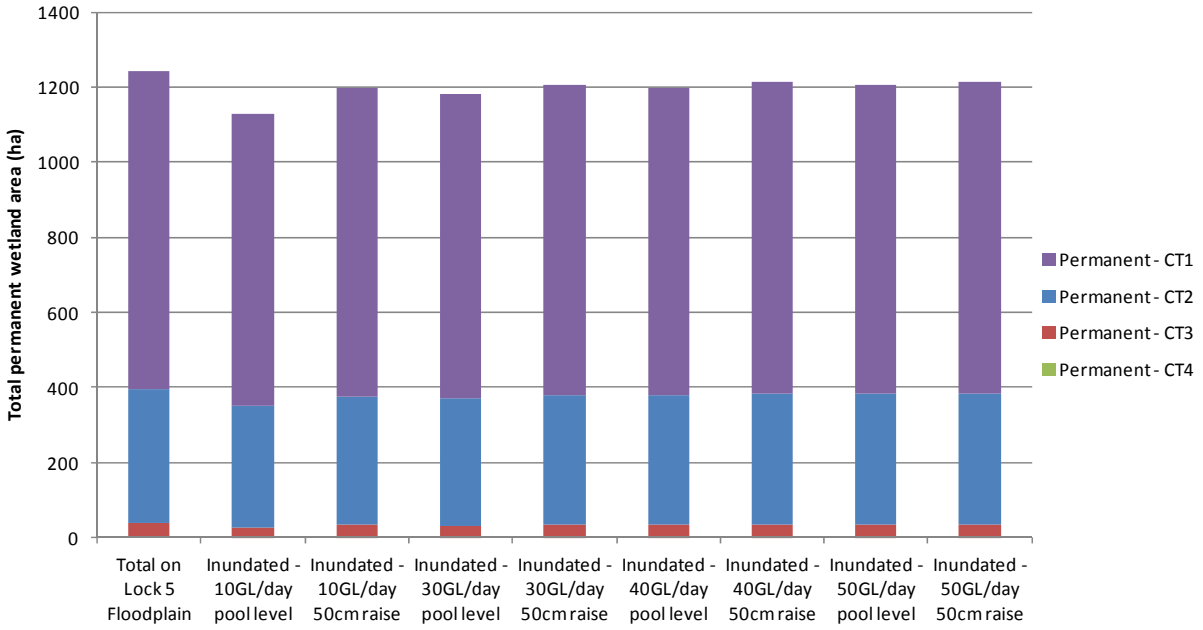

Figure 61: Total area of permanent wetland conservation-threat classes on Weir 5 floodplain and inundated under normal level and the different flow/weir raising scenarios

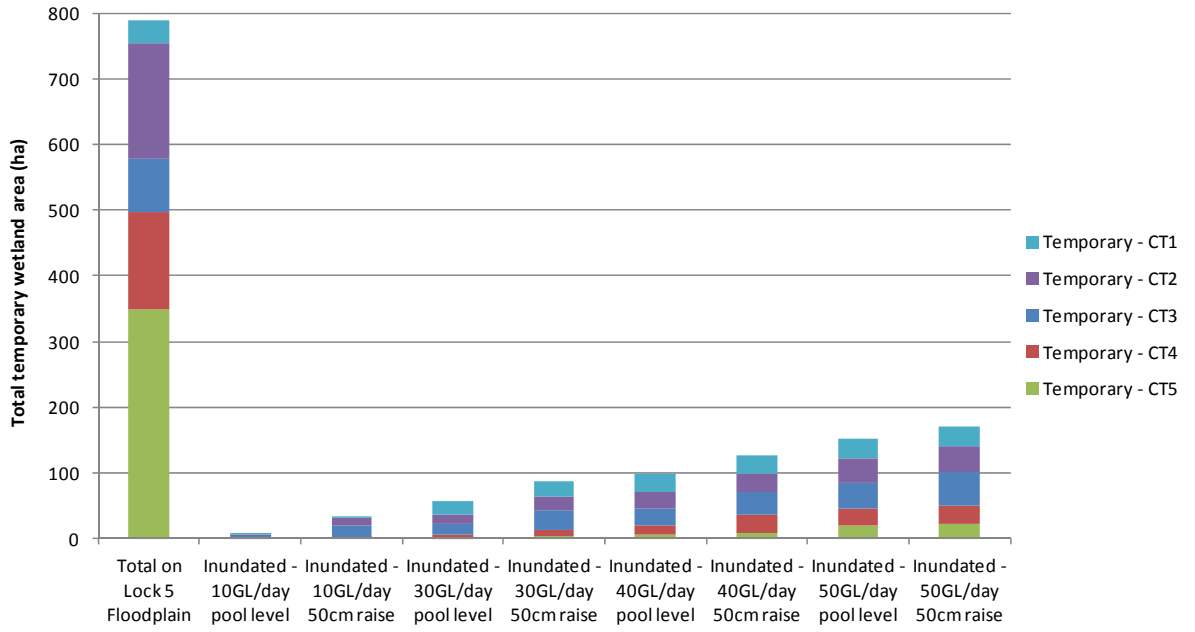

Figure 62: Total area of temporary wetland conservation-threat classes on Weir 5 floodplain and inundated under normal level and the different flow/weir raising scenarios

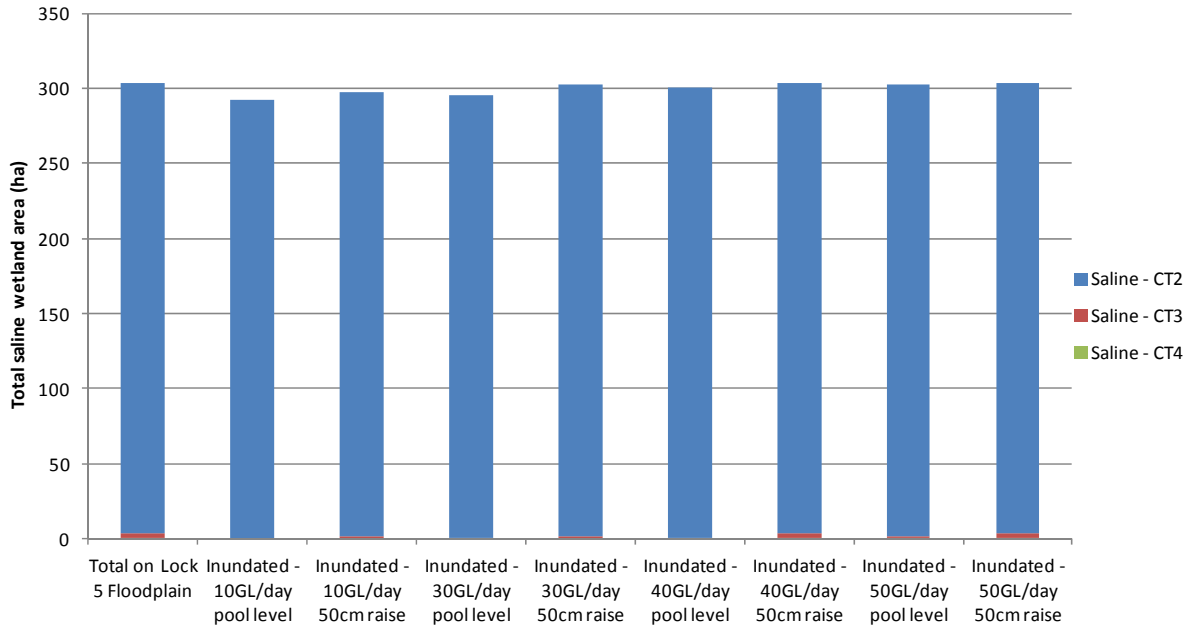

Figure 63: Total area of saline wetland conservation-threat classes on Weir 5 floodplain and inundated under normal level and the different flow/weir raising scenarios

At a 30 GL/d flow and 50 cm raise, 88 ha of temporary wetland area was inundated, which was equivalent to 11.2% of the total temporary wetland area on the Weir 5 floodplain (Table 33). For all flow scenarios more permanent wetland area was inundated than temporary wetland area: at 10 GL/d and a 50 cm raise 1,197 ha of permanent wetland area was inundated (90.9% of total permanent wetland area), compared to 33 ha (4.2%) of temporary wetland area was inundated (Table 33).

Table 33: Inundation of permanent, temporary and saline wetland area on the Weir 5 floodplain. Shown are the area and percentage area inundated and the percentage area inundated that is not inundated at normal level

Scenario	PERMANENT WETLAND AREA – 1244 ha			TEMPORARY WETLAND AREA – 790 ha			SALINE WETLAND AREA - 304 ha		
	Permanent wetland area inundated (ha)	% of total permanent wetland area on Weir 5 floodplain inundated	% of total permanent wetland area not inundated at normal level now inundated	Temporary wetland area inundated (ha)	% of total temporary wetland area on Weir 5 floodplain inundated	% of total temporary wetland area not inundated at normal level now inundated	Saline wetland area inundated (ha)	% of total saline wetland area on Weir 5 floodplain inundated	% of total saline wetland area not inundated at normal level now inundated
10 GL/d normal level	1130	90.9	-	6	0.7	-	292	96.2	-
10 GL/d 50 cm raise	1197	96.3	58.9	33	4.2	3.5	297	97.9	44.7
30 GL/d normal level	1181	95.0	-	57	7.3	-	296	97.4	-
30 GL/d 50 cm raise	1208	97.1	42.6	88	11.2	4.2	303	99.5	82.7
40 GL/d normal level	1199	96.4	-	99	12.5	-	301	99.0	-
40 GL/d 50 cm raise	1214	97.6	32.9	127	16.1	4.1	304	100.0	96.8
50 GL/d normal level	1207	97.1	-	151	19.2	-	302	99.5	-
50 GL/d 50 cm raise	1217	97.9	27.1	170	21.6	3.0	304	100.00	97.5

There were 77 permanent wetlands on the Weir 5 floodplain, of which 73 were modelled as fully or partially inundated at normal level for flow a 50 GL/d (Table 34). Thirty-nine permanent wetlands were affected by a weir raising of 50 cm at 50 GL/d. The rise in level may either increase a wetland's inundation area or inundate dry wetlands. More permanent wetlands than temporary wetlands were affected by the weir raising over all flow scenarios. For example, 69 permanent wetlands were affected compared to 22 temporary wetlands for the 10 GL/d and 50 cm raise scenario.

Table 34: The number of wetlands on the Weir 5 floodplain, the number of wetlands fully or partially inundated at normal level for different flows and the number of wetlands affected by raising the weir for the wetland categories and conservation classes. Wetlands 'affected' by raising the weir are those whose inundated area increased due to the weir raising.

Wetland category	Weir 5 total number of wetlands	Number of wetlands inundated 10 GL/d, normal level	Number of wetlands affected by 50 cm raise at 10 GL/d	Number of wetlands inundated 30 GL/d, normal level	Number of wetlands affected by 50 cm raise at 30 GL/d	Number of wetlands inundated 40 GL/d, normal level	Number of wetlands affected by 50 cm raise at 40 GL/d	Number of wetlands inundated 50 GL/d, normal level	Number of wetlands affected by 50 cm raise at 50 GL/d
PERMANENT	**77**	**65**	**69**	**67**	**53**	**73**	**46**	**73**	**39**
CT1	33	31	33	31	25	32	21	32	19
CT2	29	25	25	26	18	27	18	27	13
CT3	13	8	10	9	9	12	6	12	6
CT4	2	1	1	1	1	2	1	2	1
SALINE	**8**	**1**	**3**	**2**	**3**	**4**	**4**	**7**	**2**
CT3	3	1	1	1	2	3	0	3	0
CT4	3	0	2	1	1	1	2	2	2
CT5	2	0	0	0	0	0	2	2	0
TEMPORARY	**117**	**13**	**22**	**36**	**30**	**47**	**32**	**61**	**30**
CT1	7	2	2	6	6	6	3	6	4
CT2	16	2	6	9	8	11	9	14	8
CT3	40	8	11	17	11	21	10	26	11
CT4	36	0	2	3	3	5	8	10	4
CT5	18	1	1	1	2	4	2	5	3
TOTAL	**202**	**79**	**94**	**105**	**86**	**124**	**82**	**141**	**71**

7.3.5 Tree condition

Healthy and unhealthy river red gums had the greatest area inundated by the weir raising (Figure 64). A greater additional area of unhealthy and dead black box than healthy black box were inundated weir pool raising (Figure 64).

The weir pool raising inundated a greater healthy area than unhealthy area of river red gum trees (Figure 65). Over 50% black box trees inundated under all scenarios were classified as dead (Figure 66).

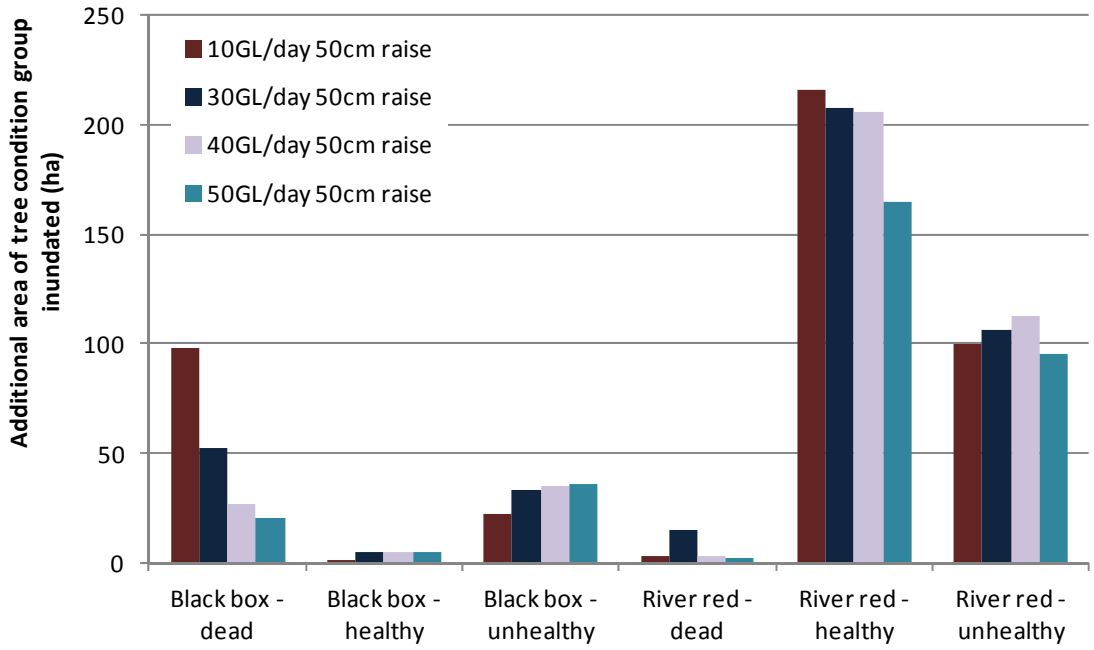

Figure 64: Additional area of tree condition categories inundated under the different flow and weir raising scenarios at Weir 5. Additional area is that above the normal level inundation for the given flow

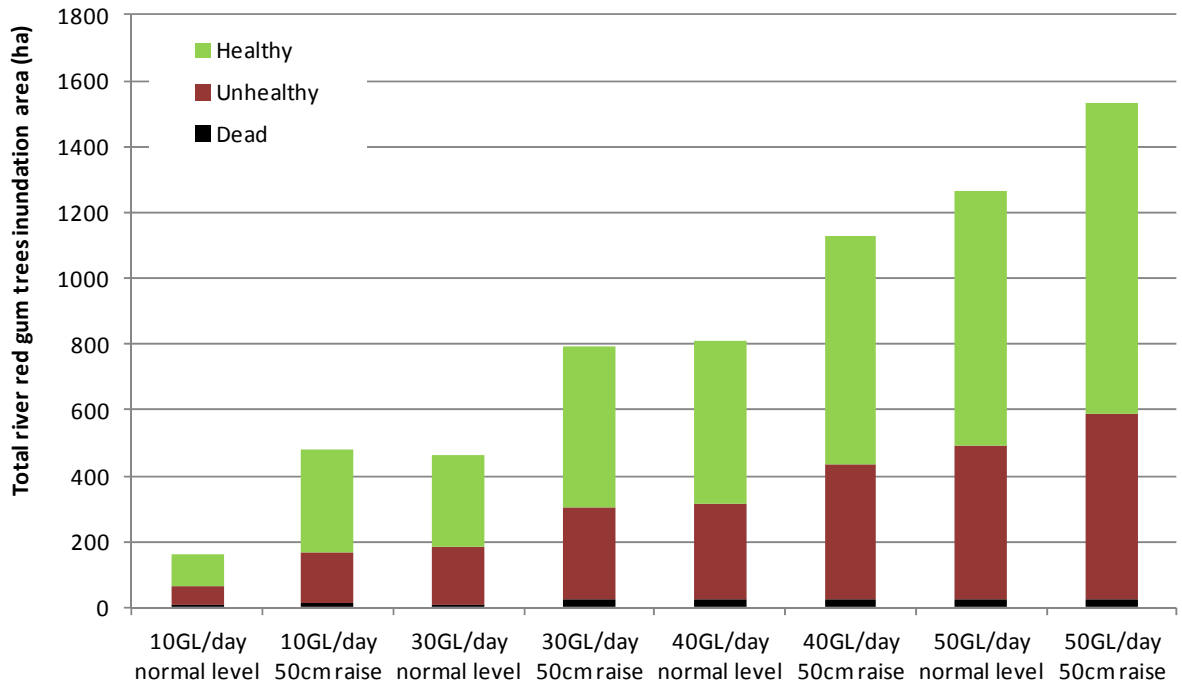

Figure 65: Total inundated area of river red gum trees under normal level and the different flow and weir raising scenarios at Weir 5

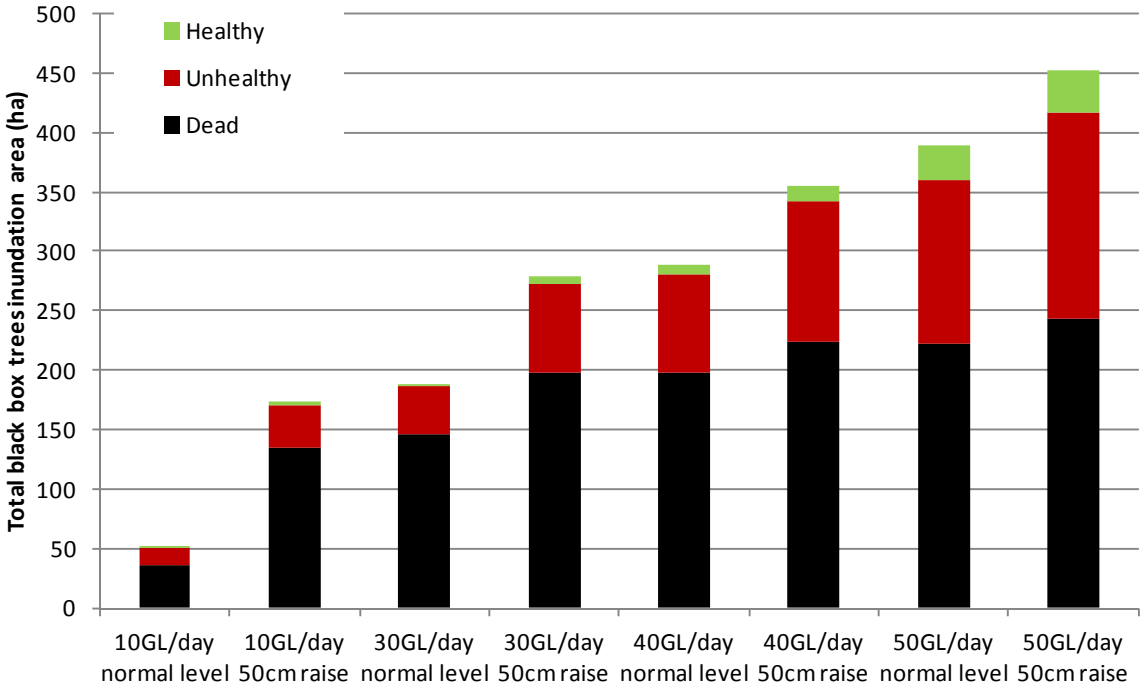

Figure 66: Total inundated area of black box trees under normal level and the different flow and weir raising scenarios at Weir 5

Ten percent of healthy river red gum trees not inundated at normal level were inundated by a weir raising of 50 cm at 10 GL/d, but only 0.4 % of healthy black box trees were inundated (Table 35). It needs to be noted that these values are not comparable to those calculated for the river red gum woodland and black box woodland vegetation groups described previously.

Table 35: The percentage of the tree condition area not inundated at normal level, inundated under the different flow and weir raising scenarios at Weir 5 (above the normal level inundation for the given flow), for the different categories of tree condition. The percent areas are the area of the relevant tree condition category not inundated at normal levels, inundated under the different scenarios. The total percentage for each tree is that of all trees in all classes inundated across the floodplain.

	Percentage of area not inundated at normal level, inundated under the different scenarios (%)			
	10 GL/d 50 cm raise	30 GL/d 50 cm raise	40 GL/d 50 cm raise	50 GL/d 50 cm raise
Total black box	3	2	2	2
Dead black box	33.8	28.8	20.5	19.7
Healthy black box	0.4	1.2	1.3	1.5
Unhealthy black box	0.7	1.0	1.0	1.1
Total river coobah	0.3	2.9	15	11
Dead river coobah	0.0	0.0	0.0	0.0
Healthy river coobah	0.0	0.0	1.5	4.3
Unhealthy river coobah	0.3	3.4	17.7	12.3
Total river red gum	8	9	10	9
Dead river red gum	7.9	43.2	13.6	11.4
Healthy river red gum	9.6	10.1	11.1	10.6
Unhealthy river red gum	6.1	7.0	8.1	7.8
Total tea tree	0	0.1	0.2	0.4
Healthy tea tree	0.0	0.1	0.2	0.4
Combined total	**5**	**5**	**5**	**5**

8. Weir 6

8.1 Summary

Two scenarios were analysed for Weir 6: weir raisings of 62 cm at flow rates of 10 and 20 GL/d. The modelling showed:

- Raising the weir level by 62 cm at 10 GL/d inundated an additional 280 ha (181%) of floodplain vegetation compared to normal levels at the same flows.
- For a given weir level, there was little difference in the area inundated between the two flow scenarios.
- Proportionally larger areas of river red gum woodland were inundated than other vegetation groups.
- A greater additional area of healthy and unhealthy river red gum trees were inundated by weir raising than the other condition classes.
- Few black box trees were inundated by the scenarios.
- Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands.
- The influence of the raising the weir was evident closer to main channel, but did not extend over the whole floodplain.

8.2 Normal level inundation

Inundation of the floodplain at normal level for the two Weir 6 scenario flows of 10 GL/d and 20 GL/d is outlined in Table 36. The modelled 20 GL/d flow at normal level (0 cm weir raising) inundated only slightly more of the floodplain (vegetation and wetland) than the 10 GL/d flow.

Table 36: The Weir 6 floodplain and the area inundated at different flows with the weir at normal level

Category	Area of floodplain (ha)	Area inundated at 10 GL/d (ha)	% of area inundated at 10 GL/d	Area inundated at 20 GL/d (ha)	% of area inundated at 20 GL/d
TOTAL WEIR 6 FLOODPLAIN*	***11,610***	***756***	***6.5***	***770***	***6.6***
VEGETATION (TOTAL AREA)	**10,298**	**154**	**1.5**	**164**	**1.6**
Black box woodland	2281	4.8	0.2	5.2	0.2
Emergent sedgeland	17	3.9	23.3	4.1	24.4
Flood dependent grassland	67	2.1	3.1	2.3	3.4
Lignum shrubland	1456	11	0.7	11	0.7
River coobah woodland	104	18	16.8	19	18.6
River red gum woodland	3196	73	2.3	78	2.4
Samphire shrubland	568	22	3.9	24	4.1
Tea tree woodland	310	1.1	0.3	1.3	0.4
Terrestrial dry shrubland	2300	19	0.8	20	0.9
WETLANDS (TOTAL AREA)	**1312**	**602**	**45.9**	**606**	**46.2**
Permanent	466	369	79.1	369	79.3
Temporary	846	234	27.6	237	28.0

Total floodplain is the addition of vegetation and wetlands, but does not include other areas such as towns

8.3 Weir raising

8.3.1 Overview

An overview of the additional area of vegetation and wetlands inundated due to raising the weir is shown in Table 37 and Figure 67. The additional area is that for weir pool raisings at given flow. i.e the inundated area of weir pool raisings at 20 GL/d were compared against that of normal level at 20 GL/d.

At a flow of 10 GL/d the additional vegetation area inundated above normal level inundation when the weir was raised 62 cm was 280 ha (Table 37). This represents 3% of the total vegetation area not inundated at normal level and was a 181% increase in the area inundated when the river was operated at normal level (154 ha). Weir raising inundated less additional wetland area than vegetation area. At 10 GL/d, a weir raising of 62 cm inundated an additional 65 ha of wetland area. This represented 9% of the wetland area that was not inundated at normal level, an increase of 11% over normal level inundation (602 ha).

Table 37: The additional area of vegetation and wetlands inundated due to raising the weir. Additional area is the area above the normal level inundation for the given flow

	Vegetation			Wetlands		
Scenario	Additional area inundated (ha)	% of total vegetation area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow	Additional area inundated (ha)	% of total wetland area not inundated at normal level, now inundated	% increase in inundated area when compared to normal level for same flow
10 GL/d 62cm	280	2.8%	181%	65	9.1%	10.8%
20 GL/d 62cm	352	3.5%	214%	64	9.0%	10.5%

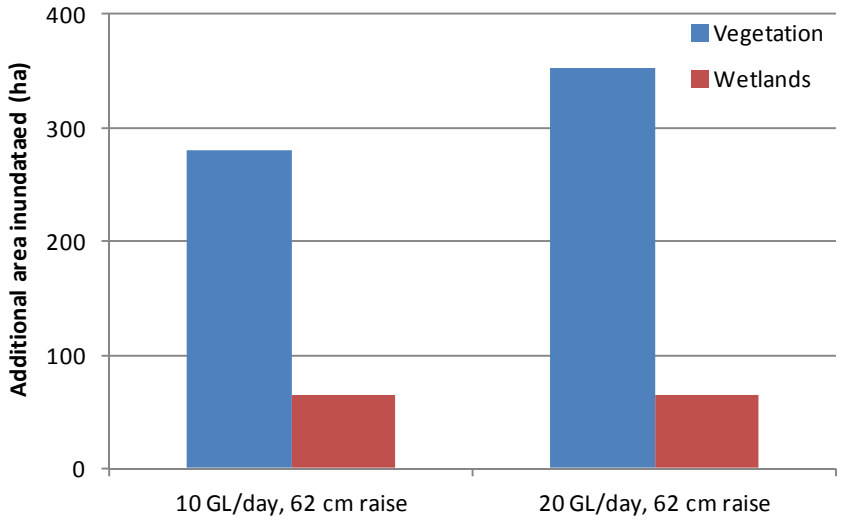

Figure 67: Additional area of vegetation and wetlands inundated under the different flow and weir raising scenarios at Weir 6. Additional area is the area above the normal level inundation for the given flow

A 62 cm weir rise at 20 GL/d inundated a greater additional area of vegetation than a rise of the same magnitude at 10 GL/d, whilst there was little difference for additional wetland area (Figure 67). Figure 68 shows the total inundation of vegetation and wetland area. The flow scenarios of 10 GL/d and 20 GL/d were similar for wetlands, but the 20 GL/d flow scenario inundated a greater vegetation area than 10 GL/d at a weir height of 62 cm.

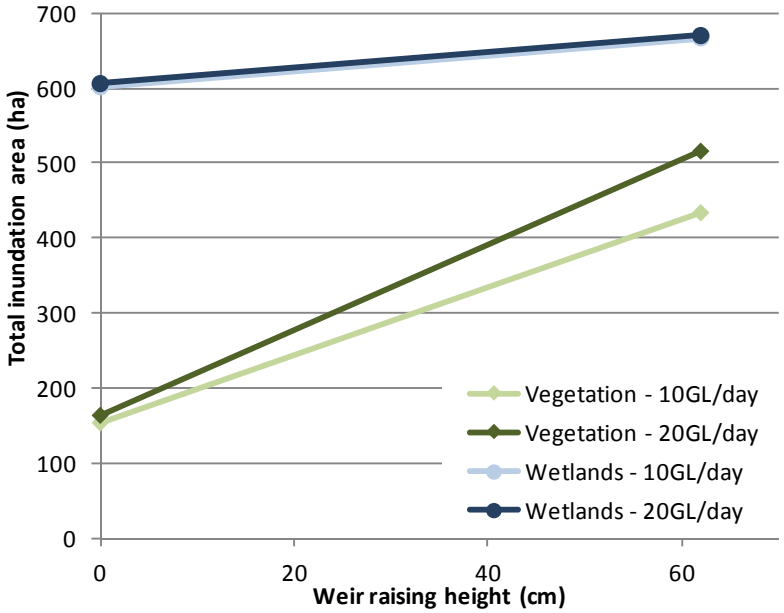

Figure 68: Total area inundated of vegetation and wetlands on the Weir 6 floodplain at normal level (0 cm weir raise) and at the different weir raising scenarios for 10 GL/d and 20 GL/d

8.3.2 Spatial extent

Raising the weir 62 cm inundated vegetation and wetlands on the floodplain (Figure 69, for 10 GL/d). The influence of the raising the weir 62 cm at 10 GL/d was more apparent closer to main channel and did not extend over the whole floodplain (Figure 70).

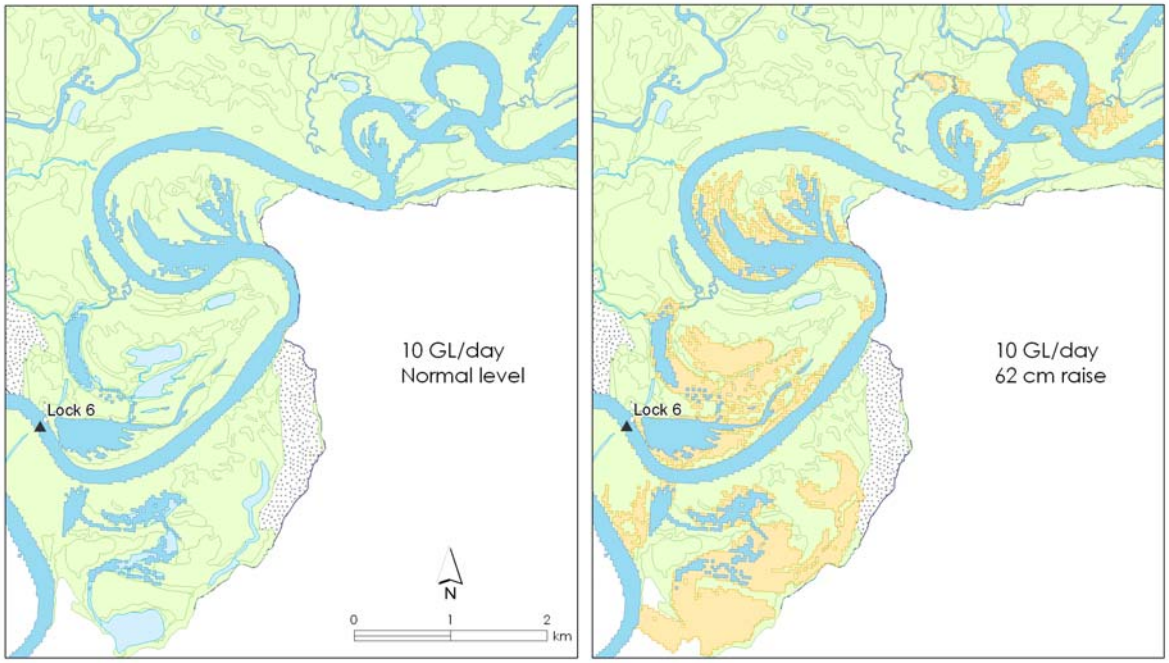

Figure 69: Inundation of Weir 6 floodplain. Flow is from top to bottom of the figure. Green shades show the vegetation areas, light blue shades wetlands not inundated at normal level and spotted areas parts of the floodplain not covered by vegetation or wetlands. The darker blue shows the normal level inundation at 10 GL/d. The yellow area shows the additional area inundated above normal level for 10 GL/d with a 62 cm raise (right figure)

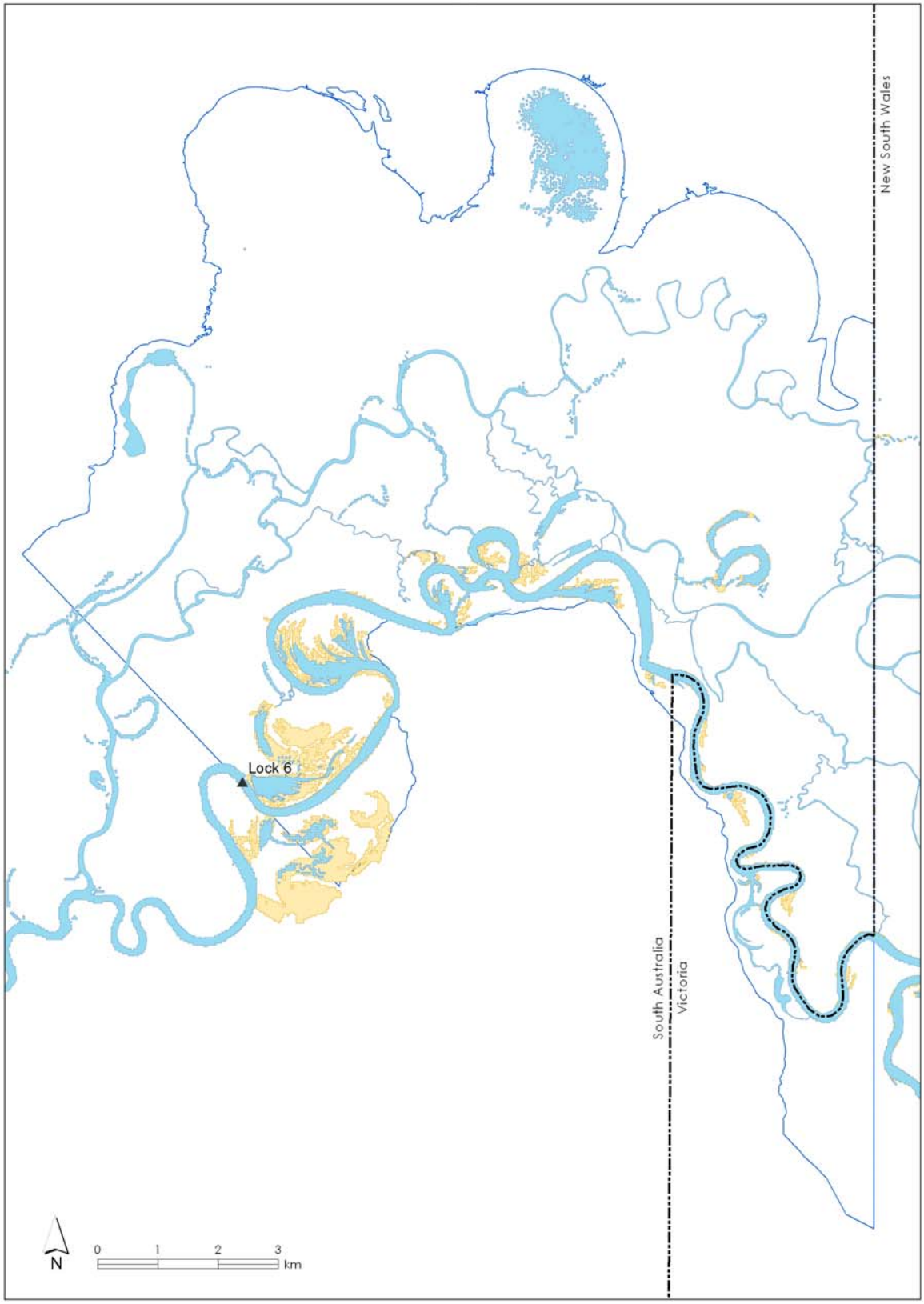

Figure 70: Inundation of the Weir 6 floodplain. An outline of the floodplain is shown by the blue line, approximately finishing near Weirs 6 and the South Australian border. Normal level inundation at 10 GL/d is shown by the blue shade, including the main River Murray channel. Yellow areas show the additional area of inundation caused by raising the weir at Weir 6 by 62 cm. Flow is from right to left of the figure

8.3.3 Vegetation

River red gum woodland, and to a lesser extent lignum shrubland, had the greatest additional inundation area under both weir raising scenarios (Figure 71).

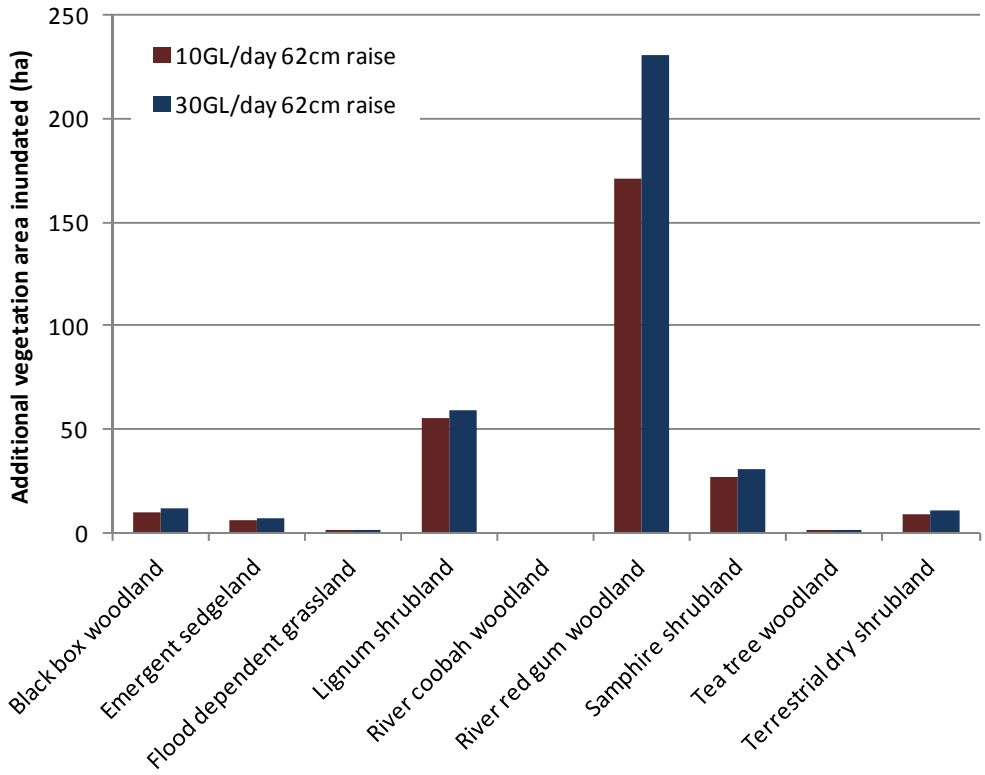

Figure 71: Additional area of the vegetation groups inundated under the different flow and weir raising scenarios at Weir 6. Additional area is the area above the normal level inundation for the given flow

The vegetation groups river red gum woodland and lignum shrubland had the greatest total inundation area under all flow and weir raising scenarios, with the weir raising having the greatest effect on the inundation of river red gum woodland (Figure 72). The total inundation area was slightly greater for the 20 GL/d scenarios than the 10 GL/d scenarios (Figure 72).

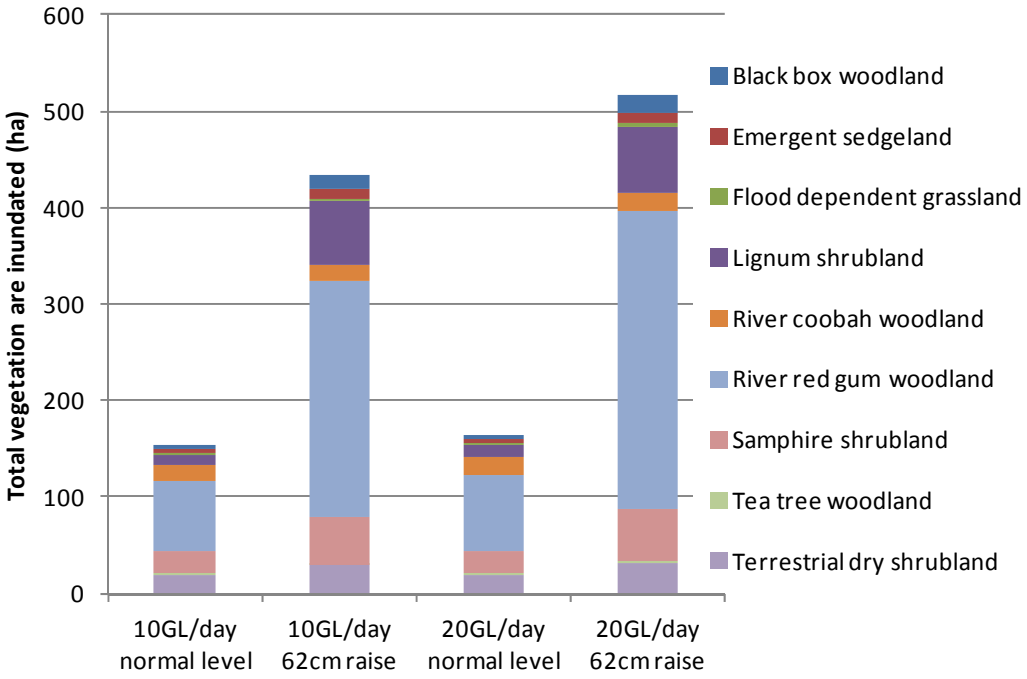

Figure 72: Total vegetation area inundated under normal level and the different flow and weir raising scenarios at Weir 6

Not all vegetation groups were equally inundated by the weir pool raising scenarios (Table 38). For example, river red gum woodland comprised 31.0% of the vegetation on the Weir 6 floodplain. At 10 GL/d and a 62 cm weir raise, 244 ha of river red gum woodland area was inundated, which was equivalent to 7.6% of the total river red gum woodland area across the entire vegetated floodplain. However, river red gum woodland comprised 56.3% of the 434 ha inundated by the 10 GL/d, 62 cm weir raising. This indicates they were preferentially favoured by the weir raising. Conversely, black box woodland comprised 22.1% of the Weir 6 floodplain vegetation area, but 3.5% of the inundated area at 10 GL/d and a 62 cm weir raise (with 15 ha inundated; equivalent to 0.7% of the total black box woodland area on the Weir 6 floodplain). A weir raising of 62 cm at 10 GL/d and 20 GL/d inundated 4.2% and 5.0% of the Weir 6 floodplain vegetation, respectively (Table 38).

Table 38: Effect of Weir 6 raising on floodplain vegetation groups and the composition of the vegetation groups on the total floodplain. Shown are the areas of each vegetation group inundated; the percentage of each group inundated; and the percentage of the total vegetation area inundated

			10 GL/d 62 cm raise			20 GL/d 62 cm raise		
Vegetation group	**Total floodplain area (ha)**	**% of total floodplain vegetation area (composition of)**	**Total area inundated (ha)**	**% of vegetation group inundated**	**% of total vegetation area inundated (composition of)**	**Total area inundated (ha)**	**% of vegetation group inundated**	**% of total vegetation area inundated (composition of)**
Black box woodland	2281	22.1	15	0.7	3.5	17	0.8	3.3
Emergent sedgeland	17	0.2	9.5	57.1	2.2	11	67.0	2.2
Flood dependent grassland	67	0.6	2.5	3.8	0.6	3.2	4.8	0.6
Lignum shrubland	1456	14.1	66	4.5	15.1	70	4.8	13.5
River coobah woodland	104	1.0	18	16.8	4.0	19	18.6	3.7
River red gum woodland	3196	31.0	244	7.6	56.3	309	9.7	59.8
Samphire shrubland	568	5.5	50	8.7	11.5	54	9.6	10.5
Tea tree woodland	310	3.0	1.7	0.5	0.4	1.7	0.6	0.3
Terrestrial dry shrubland	2300	22.3	28	1.2	6.5	31	1.3	5.9
TOTAL VEGETATION AREA	**10,298**	**100.0**	**434**	**4.2**	**100.0**	**516**	**5.0**	**100.0**

8.3.4 Wetlands

Weir raising inundated a larger additional area of temporary wetlands than permanent wetlands (Figure 73). Most of the permanent wetland area inundated at normal level and for the range of raising scenarios was conservation-threat class CT1, which was reflective of the classes on the floodplain (Figure 74). Most of the temporary wetland area inundated at normal level and for the raising scenarios was conservation-threat class CT2, which was reflective of the classes on the floodplain (Figure 75). For both temporary and permanent wetlands, weir raising had little effect on the proportional area inundated of wetlands of different conservation-threat classes.

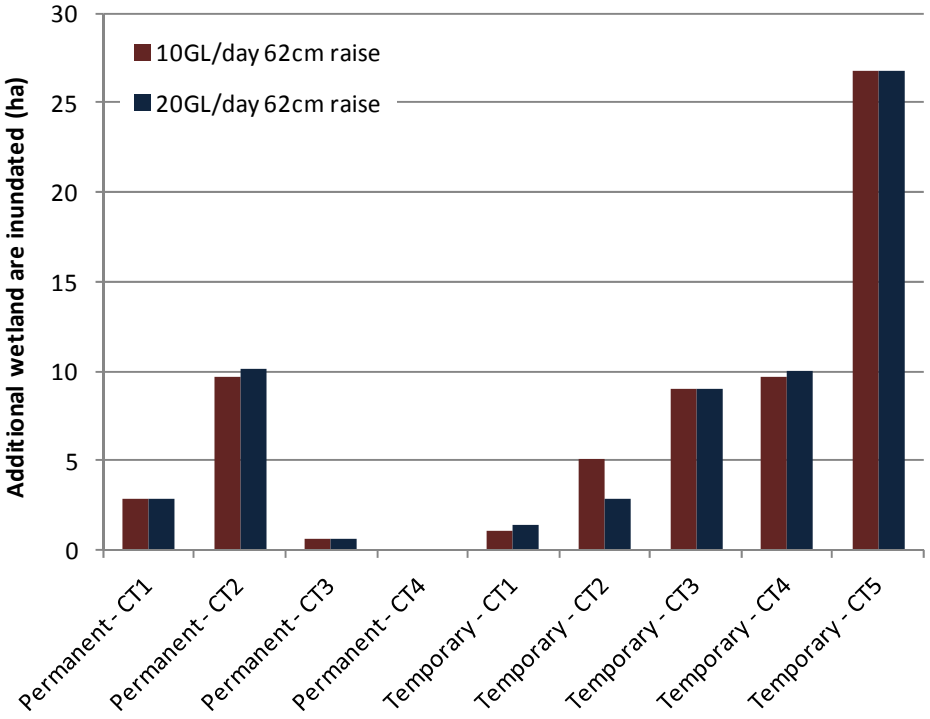

Figure 73: Additional area of permanent and temporary wetlands organised by conservation-threat class inundated under the different flow and weir raising scenarios at Weir 6. Additional area is the area above the normal level inundation for the given flow

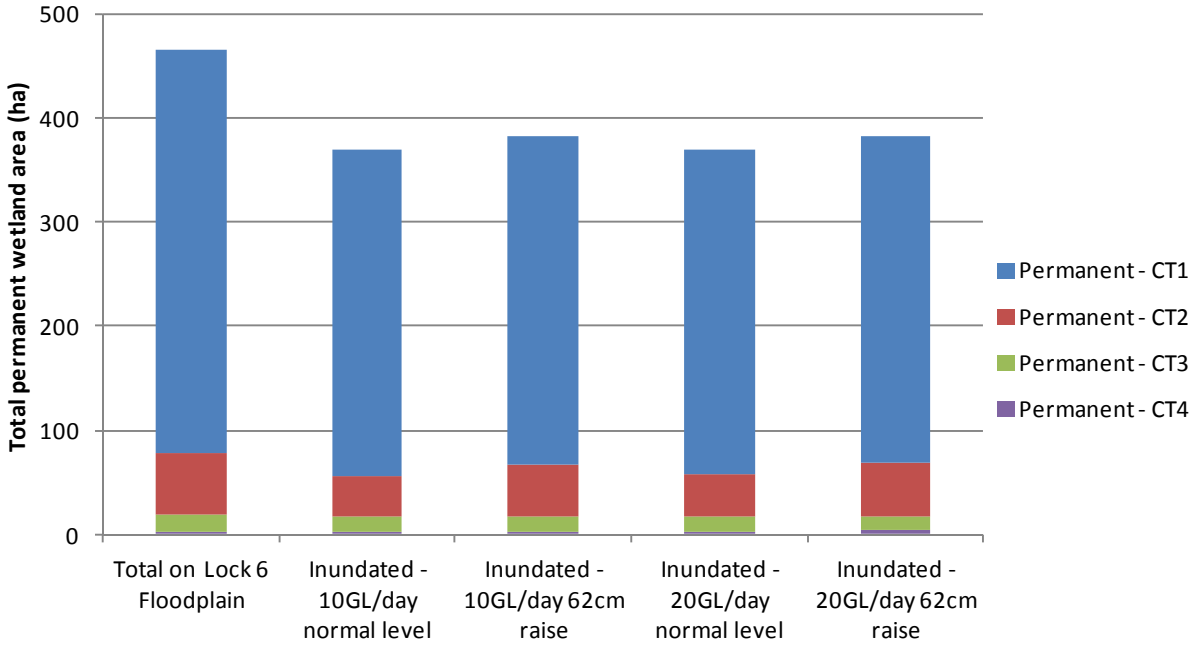

Figure 74: Total area of permanent wetland conservation-threat classes on Weir 6 floodplain and inundated under normal level and the different flow/weir raising scenarios

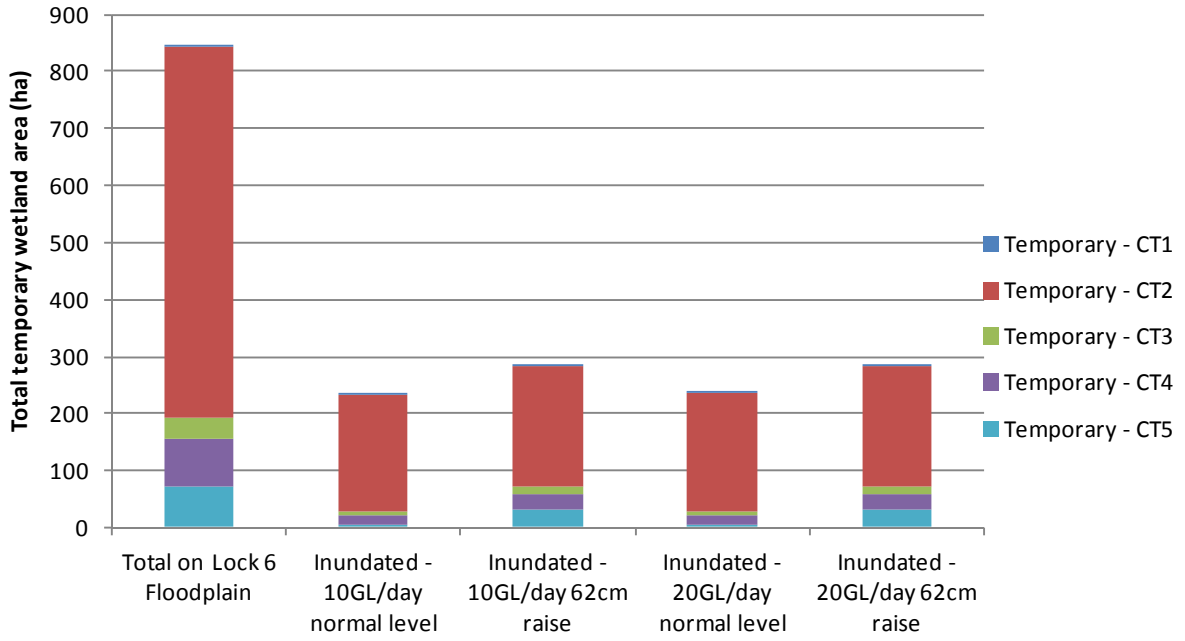

Figure 75: Total area of temporary wetland conservation-threat classes on Weir 6 floodplain and inundated under normal level and the different flow/weir raising scenarios

At a 10 GL/d flow and 62 cm raise, 667 ha of wetland area was inundated, which was equivalent to 50.8% of the total wetland area on the floodplain (Table 39). Nine percent of wetland area not inundated at normal level was inundated by raising the weir 62 cm (for both 10 GL/d and 20 GL/d).

There was a difference in the permanent and temporary wetland areas inundated. For a 62 cm raise 82.0% (10 GL/d) and 82.2% (20 GL/d) of permanent wetland area was inundated, but only 33.7% (10 GL/d) and 33.9% (20 GL/d) of temporary wetland area was inundated (Table 39).

Table 39: Inundation of total, permanent and temporary wetland area on the Weir 6 floodplain. Shown are the area and percentage area inundated and the percentage area inundated that is not inundated at normal level

Scenario	TOTAL WETLAND AREA – ha			PERMANENT WETLAND AREA – ha			TEMPORARY WETLAND AREA - ha		
	Total wetland area inundated (ha)	% of total wetland area on Weir 6 floodplain inundated	% of total wetland area not inundated at normal level now inundated	Permanent wetland area inundated (ha)	% of total permanent wetland area on Weir 6 floodplain inundated	% of total permanent wetland area not inundated at normal level now inundated	Temporary wetland area inundated (ha)	% of total temporary wetland area on Weir 6 floodplain inundated	% of total temporary wetland area not inundated at normal level now inundated
10 GL/d normal level	602	45.9	-	369	79.1	-	234	27.6	-
10 GL/d 62 cm raise	667	50.8	9.1	382	82.0	13.6	286	33.7	8.4
20 GL/d normal level	606	46.2	-	369	79.3	-	237	28.0	-
20 GL/d 62 cm raise	670	51.0	9.0	383	82.2	14.1	287	33.9	8.2

There were 78 temporary wetlands on the Weir 6 floodplain, 21 of which were modelled as fully or partially inundated at normal level for both 10 GL/d and 20 GL/d (Table 40). Eleven temporary wetlands were affected by raising the weir 62 cm (both flows). The rise in level may either increase a wetland's inundation area or inundate dry wetlands. More temporary wetlands (11) than permanent wetlands (6) were affected by a weir raise of 62 cm at both 10 GL/d and 20 GL/d (Table 40).

Table 40: The number of wetlands on the Weir 6 floodplain, the number of wetlands fully or partially inundated at normal level for different flows and the number of wetlands affected by raising the weir for the wetland categories and conservation classes. Wetlands 'affected' by raising the weir are those whose inundated area increased due to the weir raising

Wetland category	Weir 6 total number of wetlands	Number of wetlands inundated 10 GL/d, normal level	Number of wetlands affected by 62 cm raise at 10 GL/d	Number of wetlands inundated 20 GL/d, normal level	Number of wetlands affected by 62 cm raise at 20 GL/d
PERMANENT	**41**	**40**	**6**	**40**	**6**
CT1	17	17	1	17	1
CT2	16	16	4	16	4
CT3	6	5	1	5	1
CT4	2	2	0	2	0
TEMPORARY	**78**	**21**	**11**	**21**	**11**
CT1	3	1	1	1	1
CT2	14	8	3	8	3
CT3	19	8	3	8	3
CT4	21	2	1	2	1
CT5	21	2	3	2	3
TOTAL	**119**	**61**	**17**	**61**	**17**

8.3.5 Tree condition

Healthy and unhealthy river red gums had the greatest additional area inundated by raising the weir 62 cm at Weir 6 (Figure 76). Additional areas of healthy and dead black box and dead river red gum inundated were less than 1 ha (Figure 76).

More healthy than unhealthy areas of river red gum trees were inundated under all scenarios (Figure 77). Few healthy black box trees were inundated under all scenarios (Figure 78).

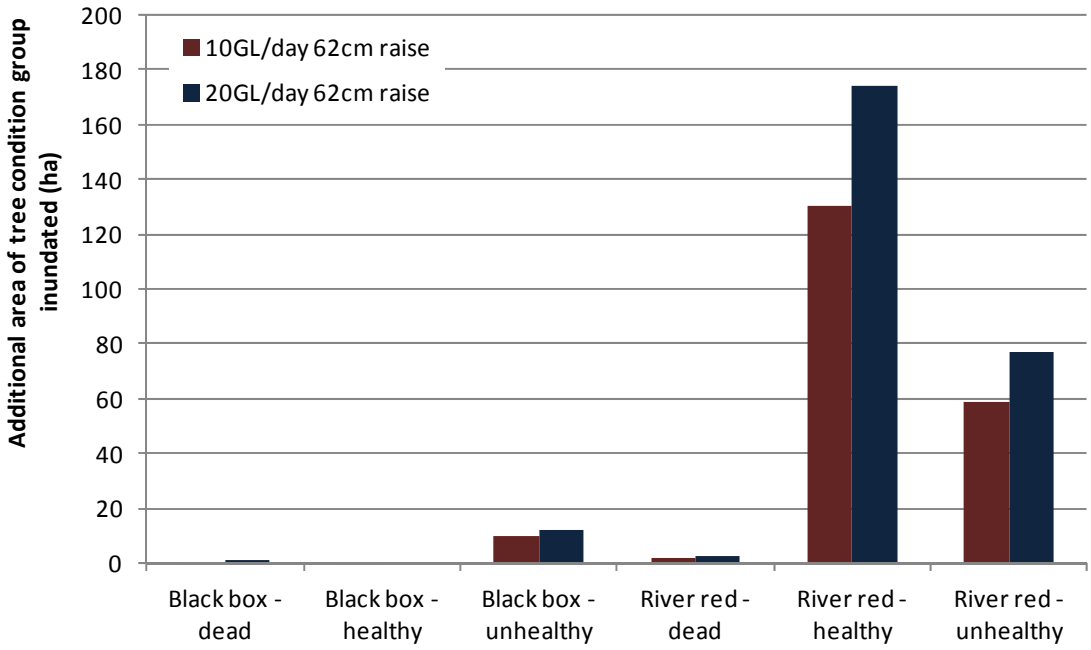

Figure 76: Additional area of tree condition categories inundated under the different flow and weir raising scenarios at Weir 6. Additional area is that above the normal level inundation for the given flow

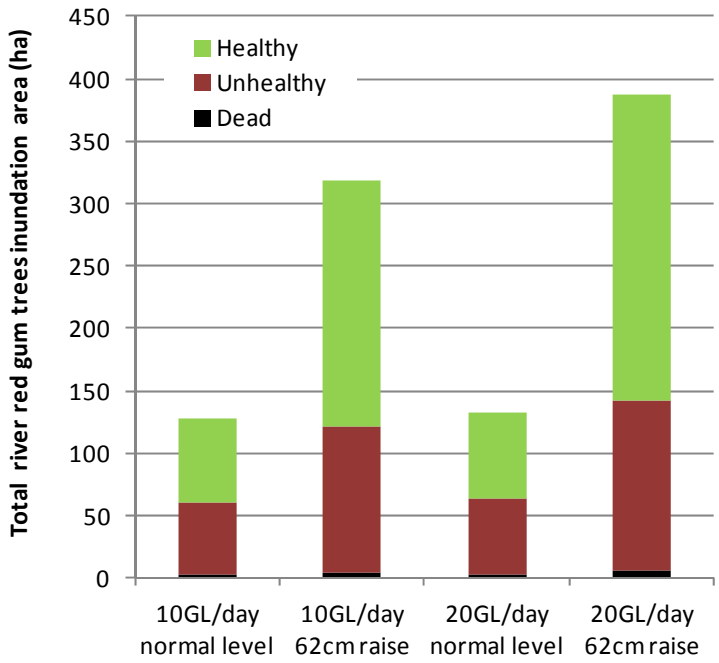

Figure 77: Total inundated area of river red gum trees under normal level and the different flow and weir raising scenarios at Weir 6

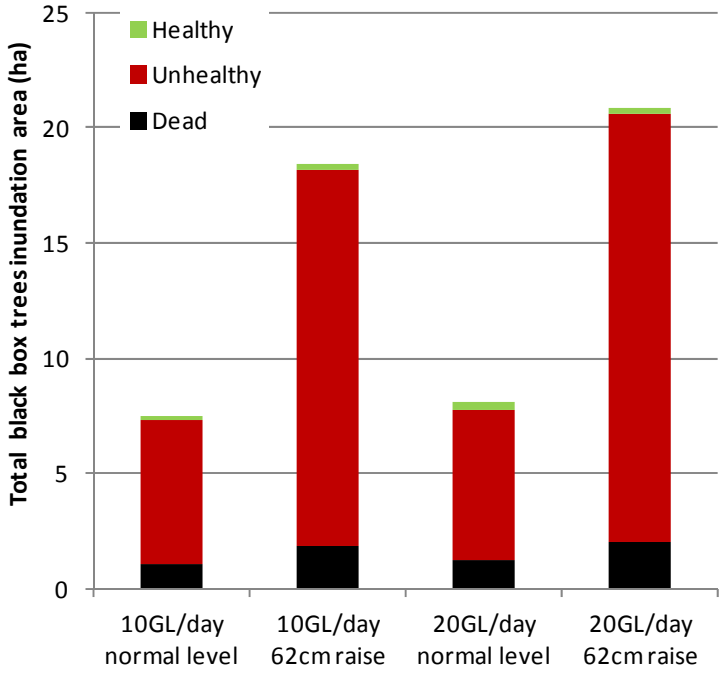

Figure 78: Total inundated area of black box trees under normal level and the different flow and weir raising scenarios at Weir 6

Seven percent of healthy river red gum trees not inundated at normal level were inundated by a weir raising of 62 cm at 10 GL/d (Table 41), but less than 1% of healthy black box trees were inundated. Similarly, at 10 GL/d 4.9% of unhealthy river red gum trees not inundated at normal level were inundated by a weir raising of 62 cm and 0.5% of unhealthy black box trees were inundated. It needs to be noted that these values are not comparable to those calculated for the river red gum woodland and black box woodland vegetation groups described previously.

Table 41: The percentage of the tree condition area not inundated at normal level, inundated under the different flow and weir raising scenarios at Weir 6 (above the normal level inundation for the given flow), for the different categories of tree condition. The percent areas are the area of the relevant tree condition category not inundated at normal levels, inundated under the different scenarios. The total percentage for each tree is that of all trees in all classes inundated across the floodplain

	Percentage of area not inundated at normal level, inundated under the different scenarios (%)	
	10 GL/d 62 cm raise	20 GL/d 62 cm raise
Total black box	0.9	1
Dead black box	0.4	0.5
Healthy black box	0.0	0.0
Unhealthy black box	0.5	0.6
Total river red gum	6	8
Dead river red gum	32	40
Healthy river red gum	6.5	8.6
Unhealthy river red gum	4.9	6.5
Total tea tree	0.2	0
Healthy tea tree	0.2	0.0
Unhealthy tea tree	0.0	0.0
Combined total	**3**	**4**

9. Weir comparison

9.1 Total inundation area

The analysis indicated that the area inundated at Weirs 1, 2 and 6 were similar for comparable flow and weir raising scenarios (Figure 79). Weir 4 and 5 were similar to each other, with greater areas inundated than for Weirs 1, 2 and 6. The greatest inundation area was observed for Weir 3 for comparable flow and weir raising scenarios. Weir raising to the same level but at higher flow increased the total inundated area for Weirs 3 and 5 (Figure 80).

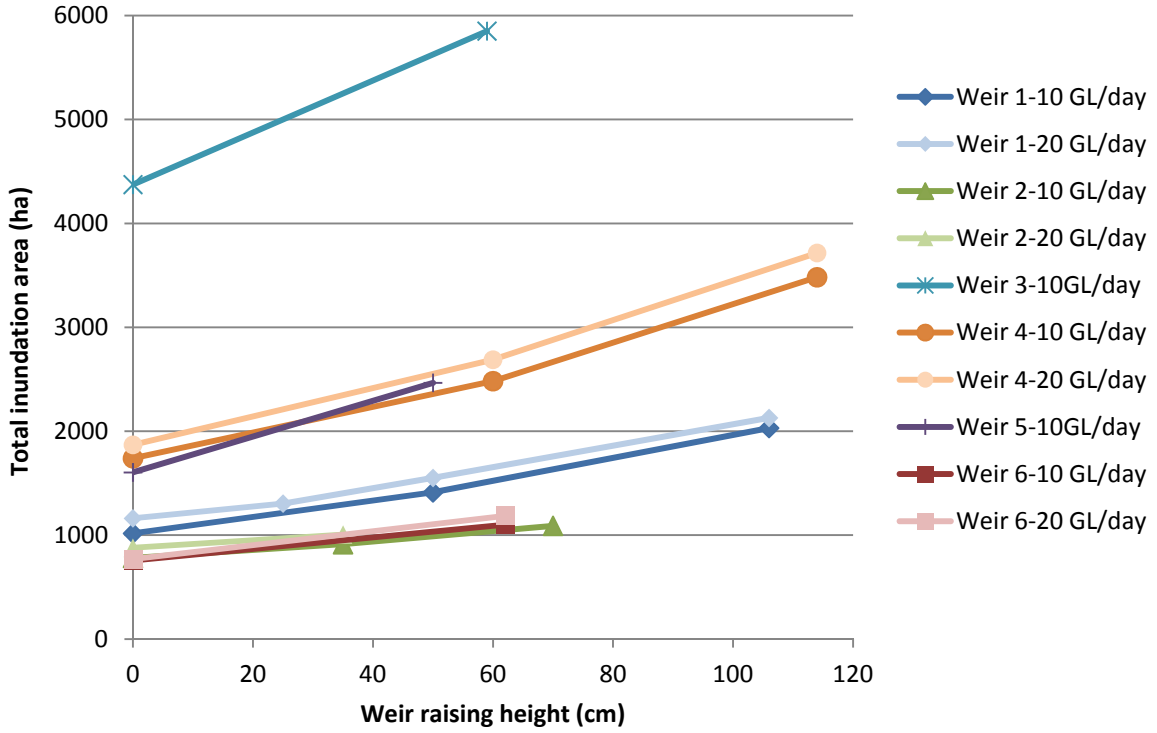

Figure 79: Total floodplain area (vegetation plus wetlands) inundated under flows of 10 GL/d and 20 GL/d, at different weir heights, for the different Weirs. See also Figure 80 for further flow scenarios

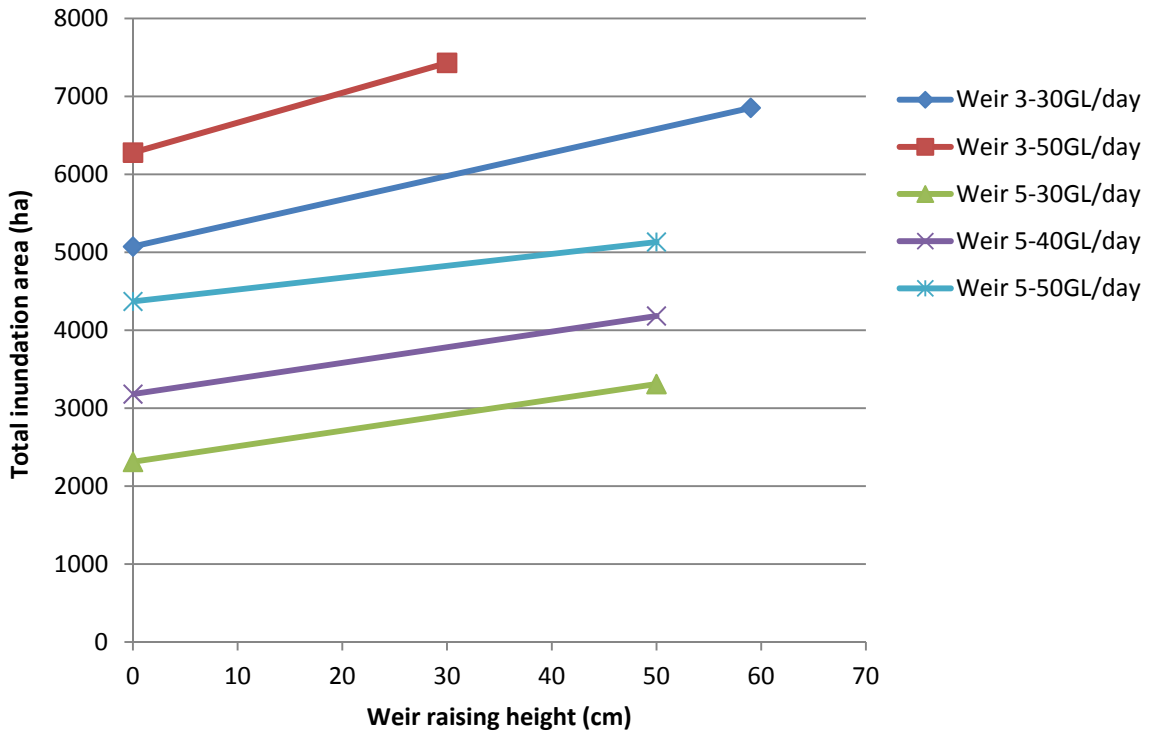

Figure 80: Total floodplain area (vegetation plus wetlands) inundated under flow of 30 GL/d to 50 GL/d, at different weir heights, for the different Weirs. See also Figure 79 for further flow scenarios

Weir 3 also had the greatest percentage area of the floodplain inundated (Figure 81). Weirs 1, 2 and 4 had a smaller percentage of their total floodplain area inundated, whilst Weirs 5 and 6 had the lowest. Increased flows inundated a greater percentage of the total floodplain area. Weir raising to the same level, but at higher flow increased the percentage of the total inundated area for Weirs 3 and 5 (Figure 82).

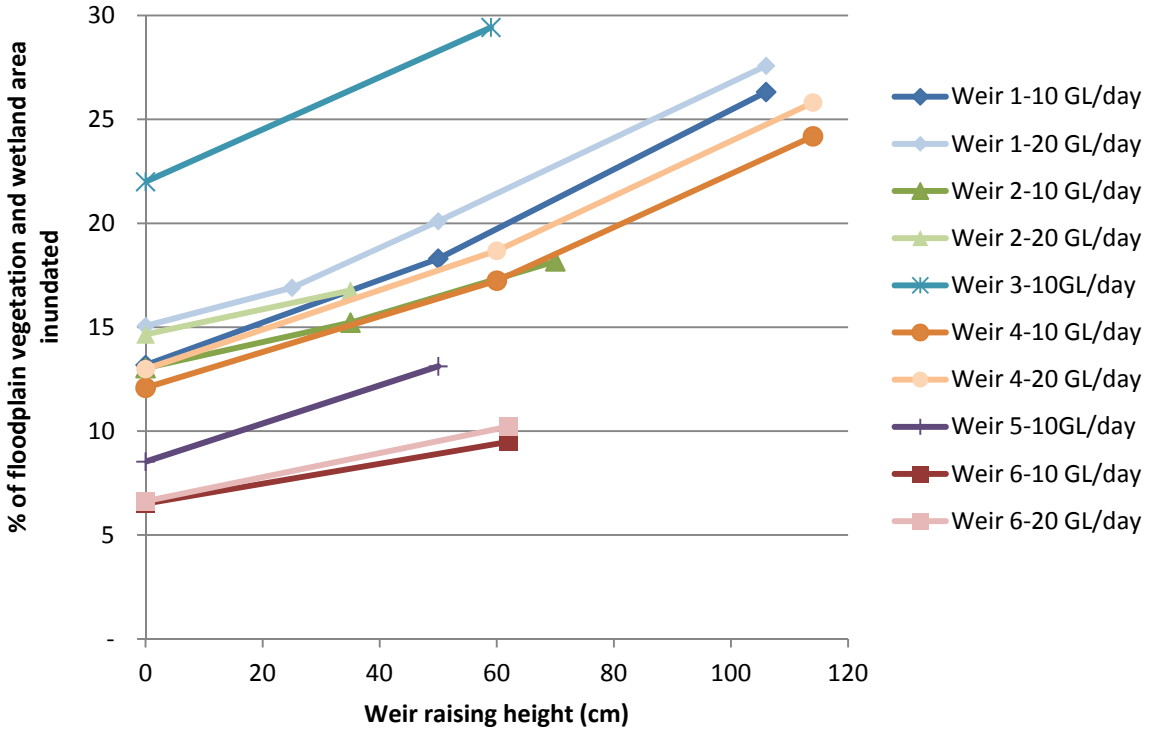

Figure 81: Percent of the floodplain (vegetation and wetlands) inundated under flows of 10 GL/d and 20 GL/d, at different weir heights, for the different Weirs. See also Figure 82 for further flow scenarios

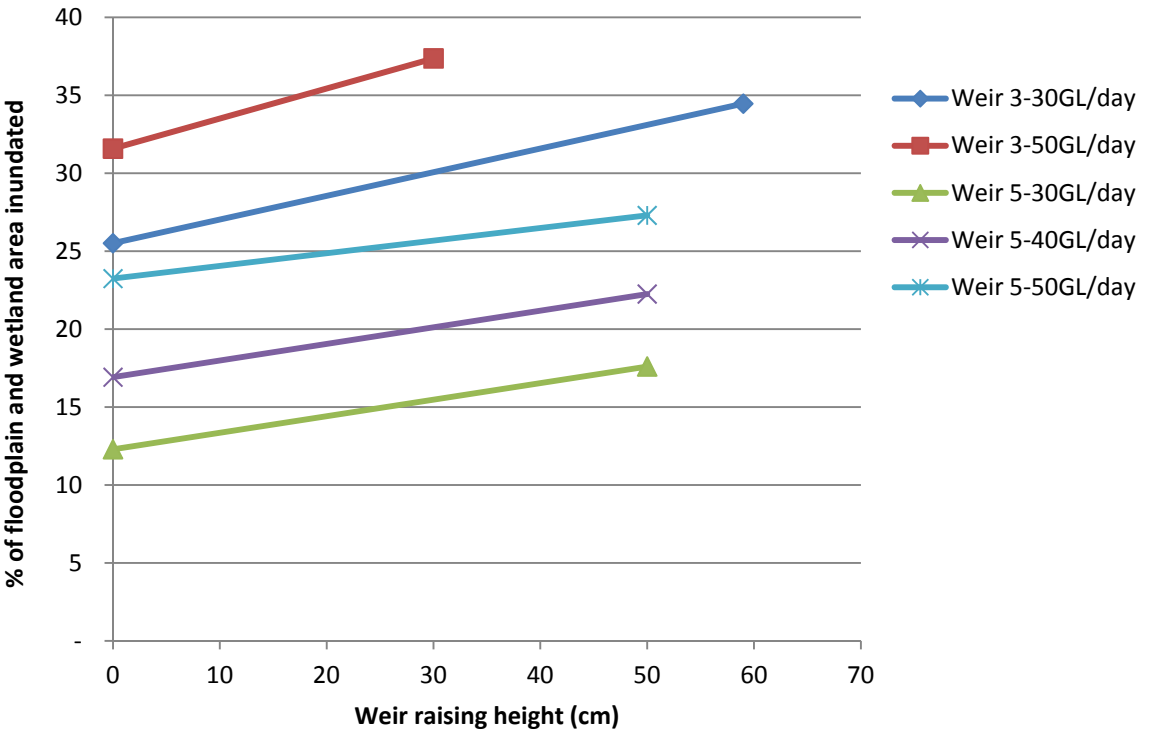

Figure 82: Percent of the floodplain (vegetation and wetlands) inundated under flows of 30 GL/d to 50 GL/d, at different weir heights, for the different Weirs. See also Figure 81 for further flow scenarios

9.2 Additional inundation area due to weir raising

Figure 83 and Figure 84 show the percentage of additional inundation area that was vegetation (above normal level inundation for the given flows). The percentage of wetland inundated is 100% minus the value shown on the graph. The effect of the weir raising varies between weir reaches and flow scenarios. For example, of the additional area inundated by a 50 cm weir raising at 10 GL/d at Weir 1, 45% was vegetation and 55% wetland (Figure 83). At the same weir, for the same flow, when the weir was raised to 106 cm, 65% of the additional inundation area was vegetated area and 35% was wetland area. Of the scenarios investigated at a flow of 10 GL/d or 20 GL/d, the greatest percentage of additional inundated area that was vegetated was 88%, at Weir 5 when the weir was raised 50 cm at 10 GL/d (Figure 83). At higher flows (30-50 GL/d), the percentage of the additional inundation area that was vegetated on the Weir 3 and 5 floodplains was greater; 83-96% for the different scenarios (Figure 84).

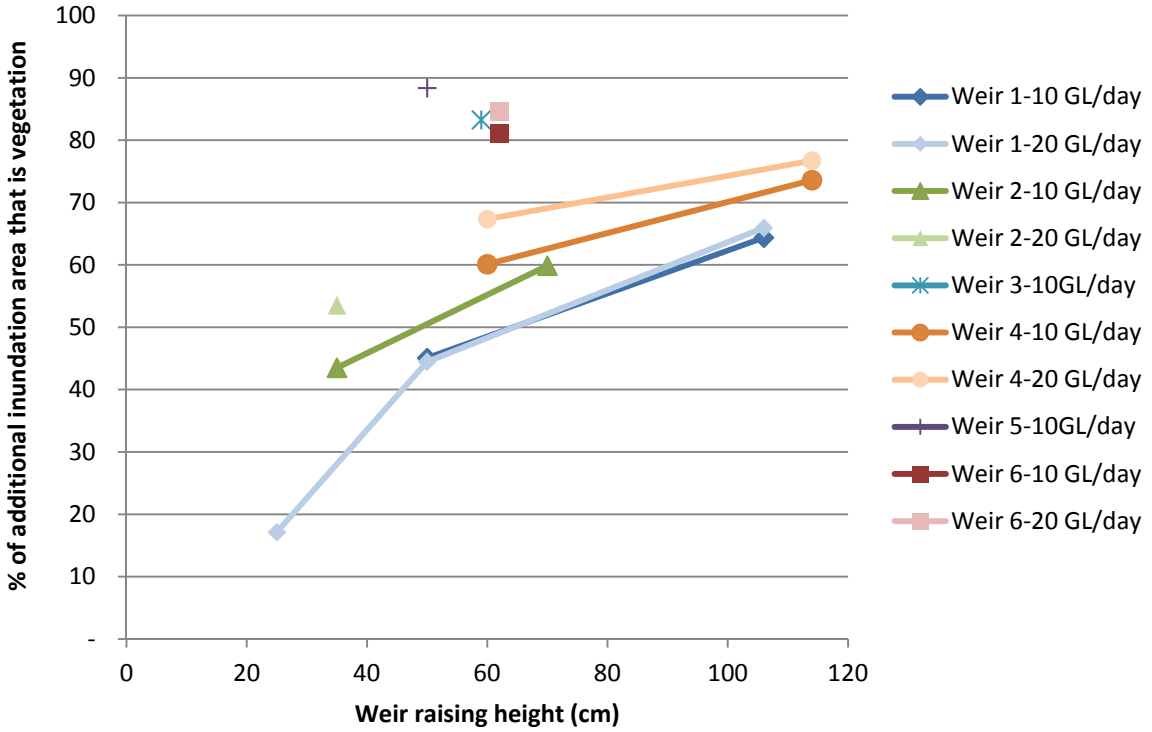

Figure 83: The percent of the additional floodplain area inundated (vegetation and wetlands, excluding normal level inundation) that is inundated vegetation for flows of 10 GL/d and 20 GL/d at different weir raising heights for the different weirs. The percent that is the wetland area inundated would be 100 minus the vegetation percent shown on the graph. See also Figure 84 for further flow scenarios

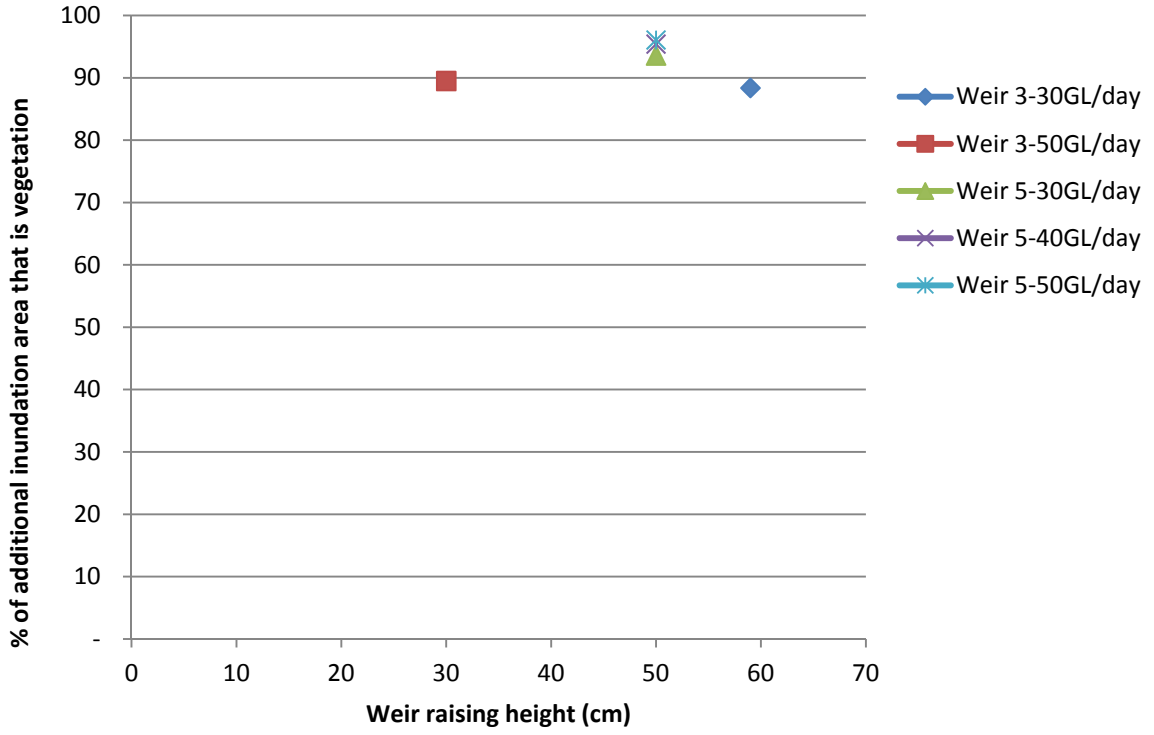

Figure 84: The percent of the additional floodplain area inundated (vegetation and wetlands, excluding normal level inundation) that is inundated vegetation for flows of 30 GL/d to 50 GL/d at different weir raising heights for Weirs 3 and 5. The percent that is the wetland area inundated would be 100 minus the vegetation percent shown on the graph. See also Figure 83 for further flow scenarios

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Appendix A: ESRI ArcGIS® Methodology

BASE LAYERS

Spatial Layers used:

- SA_VEG_FP.shp (held by DEWNR, now DEWNR, metadata through ISHARE, number 422)
- RM_WetlandPrioritisation_Final2010B.gdb; prio_entre_RM_LL_Final_2010 (attribute table) (held by DEWNR, now DEWNR)
- RMTreeHealth2002.shp (held by DEWNR, now DEWNR, metadata through ISHARE, number 773)

Methodology:

1. Floodplain vegetation layer:
    a. Delete all polygons <0.01ha or unlabelled
    b. Create new attribute field 'func_group'. Categorise polygons into one of ten 'func_groups' based on first (dominant) species listed in attribute 'SAVEG_DESC', as outlined in Table 3.
    c. Cut SA_VEG_FP.shp to weir pool size - new layer Lock*_veg.shp
2. Wetland layer:
    a. Union attribute table to 2010_SAAE_wetlands.shp
    b. Delete all polygons <0.01ha or unlabelled.
    c. Create new attribute field 'RRP_class'. Categorise polygons into one of three classes based on attribute 'WETCODE', as outlined in Table 5.
    d. Create new attribute field 'CT1_5'. Categorise polygons into one of five classes based on attribute 'CT_RANK10', as outlined in Figure 2.
    e. Cut shapefile to weir pool size – new layer Lock*_wetlands_final.shp
3. Floodplain vegetation layer:
    a. Intersect Lock*_fpveg.shp and Lock*_wetland.shp – new layer Lock*_fpveg_wetland_intersect.shp
    b. Select by location those areas that are identical between Lock*_fpveg.shp and Lock*_fpveg_wetland_intersect.shp. Delete selected polygons –– new layer Lock*_veg_final.shp
    c. Create new field, calculate new areas. Delete areas <0.01ha.

4. Tree health layer:

    a. Delete all polygons <0.01ha or unlabelled. Cut to weir pool size – new layer Lock*_treehealth_final.shp

    b. Analysis on attributes 'TREESP1' and 'HEALTH1'.

Summary:

Base floodplain information consisting of two, non overlaying layers:

- Lock*_veg_final.shp
- Lock*_wetland_final.shp

Additional information on floodplain (overlaying above layers to various degrees):

- Lock*_treehealth_final.shp

INUNDATION CALCULATIONS

Spatial layers used:

- Lock*_veg_final.shp
- Lock*_wetland_final.shp
- Lock*_treehealth.shp
- Lock*_*GL_*cm.shp

Methodology:

1. Different flows, zero weir raising:

    a. Intersect Lock*_*GL_0cm.shp with Lock*_wetland_final.shp – create a new layer Lock*_intersect_*GL0m_wetland_.shp

        i. Create new attribute field and calculate polygon sizes.

        ii. Delete polygons ≤0.0225 ha (equivalent to one pixel from raster inundation layer).

    b. Repeat process for:

        i. Lock*_*GL_0cm.shp and Lock*_veg_final.shp – new layer Lock*_intersect_*GL0m_veg_.shp

        ii. Lock*_*GL_0cm.shp and Lock*_treehealth_final.shp – new layer Lock*_intersect_*GL0m_treehealth_.shp

2. Different flows, different weir raising:

    a. Union Lock*_*GL_0cm.shp with Lock*_*GL_*cm.shp – new layer Lock*_union*GL0m*m.shp

    b. Select by location those areas that are identical between Lock*_union*GL0m*m.shp and Lock*_*GL_0cm.shp, delete selected polygons – create new layer Lock*_diff*GL0m*m.shp

    c. Intersect Lock*_veg_final.shp with Lock*_diff*GL0m*m.shp – new layer Lock*_intersect_*GLdiff*cm_veg.shp

        i. Create new attribute field and calculate polygon sizes.

        ii. Delete polygons ≤0.0225 ha (equivalent to one pixel from raster inundation layer).

    d. Repeat process for:

        i. Lock*_diff*GL_0cm.shp and Lock*_wetlands_final.shp – new layer Lock*_intersect_*GLdiff*cm_wetlands.shp

        ii. Lock*_diff*GL_0cm.shp and Lock*_treehealth_final.shp – new layer Lock*_intersect_*GLdiff*cm_treehealth.shp

Appendix B: Vegetation group information

A full list of each species that can be found in the different vegetation groups used in this analysis is given in Table 42. A list of all the species, and their water regime functional classification, where known, is provided in Table 43.

Table 42: Dominant and other species associated with the ten vegetation groups used for this analysis.

Vegetation Group	Dominant species (based on shapefile attribute SAVEG_DESC)	Associated species (in different combinations of) (based on shapefile attribute SAVEG-DESC)
River red gum woodland	*Eucalyptus camaldulensis*	*Acacia stenophylla, Enchylaena tomentosa var. tomentosa, Eucalyptus largiflorens, Cyperus gymnocaulos, Muehlenbeckia florulenta, Phragmites australis , Senecio cunninghamii var. cunninghamii, Setaria jubiflora.*
Lignum shrubland	*Muehlenbeckia florulenta*	*Enchylaena tomentosa var. tomentosa, Sporobolus mitchellii, Sporobolus virginicus, Suaeda australis, Tecticornia pergranulata ssp. pergranulata.*
Black box woodland	*Eucalyptus largiflorens*	*Acacia stenophylla, Atriplex rhagodioides, Callistemon brachyandrus, Chenopodium nitrariaceum, Disphyma crassifolium ssp. clavellatum, Enchylaena tomentosa var. tomentosa, Eremophila divaricata ssp. divaricata, Eucalyptus camaldulensis var. camaldulensis, Maireana pyramidata, Muehlenbeckia florulenta, Setaria jubiflora, Tecticornia indica ssp. leiostachya, Tecticornia pergranulata ssp. pergranulata.*
River coobah woodland	*Acacia stenophylla*	*Chenopodium nitrariaceum, Enchylaena tomentosa var. tomentosa, Muehlenbeckia florulenta*
Tea tree woodland	*Melaleuca halmaturorum, Melaleuca lanceolata*	*Disphyma crassifolium ssp. clavellatum, Enchylaena tomentosa var. tomentosa, Eucalyptus largiflorens, Frankenia pauciflora var., Juncus kraussii, Samolus repens, Sarcocornia quinqueflora, Suaeda australis.*
Mallee shrubland	*Eucalyptus brachycalyx, Eucalyptus cyanophylla, Eucalyptus dumosa, Eucalyptus gracilis, Eucalyptus leptophylla, Eucalyptus porosa*	*Acacia stenophylla, Atriplex vesicaria ssp., Austrostipa sp., Beyeria opaca, Chenopodium desertorum, Danthonia sp., Enchylaena tomentosa var. tomentosa, Eucalyptus dumosa, Eucalyptus gracilis, Eucalyptus leptophylla, Eucalyptus oleosa ssp. ampliata, Eucalyptus oleosa ssp. oleosa, Eucalyptus socialis ssp., Grevillea huegelii, Helichrysum leucopsideum, Lepidosperma concavum, Maireana pentatropis, Maireana pyramidata, Melaleuca lanceolata, Muehlenbeckia florulenta, Olearia mueller, Senna artemisioides ssp. petiolaris (NC), Sclerolaena diacantha/uniflora, Triodia irritans, Zygophyllum apiculatum.*
Emergent sedgeland	*emergent Muehlenbeckia florulenta, Phragmites australis, Typha domingensis, Typha orentalis, (Salix babylonica)*	*Aster subulatus, Bolboschoenus caldwellii, Paspalum distichum, Paspalum vaginatum, Phragmites australis, Suaeda australis, Schoenoplectus validus, Typha domingensis.*

Vegetation Group	**Dominant species (based on shapefile attribute SAVEG_DESC)**	**Associated species (in different combinations of) (based on shapefile attribute SAVEG-DESC)**
Flood dependent grassland	*Agrostis avenacea var. avenacea (NC), Eragrostis australasica, Juncus krausii, Gahnia filum, Sporobolus virginicus*	*Gahnia trifida, Juncus kraussii, Muehlenbeckia florulenta, Samolus repens, Sarcocornia quinqueflora, Sclerolaena tricuspis, Senecio glossanthus (NC), Sporobolus mitchellii, Suaeda australis, Trichanthodium skirrophorum.*
Samphire shrubland	*Sarcoconia quinqueflora*, *Tecticornia* spp., *Suaeda australis*	*Disphyma crassifolium ssp. clavellatum, Hordeum marinum, Samolus repens, Sarcocornia quinqueflora, Suaeda australis, Tecticornia spp.*
Terrestrial dry shrubland	*(emergent) Acacia victoriae, (emergent) Alectryon oleifolius ssp. canescens, Angianthus tomentosus, Atriplex* spp., *Chenopodium nitrariaceum, Dodonea viscosa ssp. angustissima, Disphyma crassifolium ssp. clavellatum, Geijera linearifolia, Lomandra effusa, Lycium australe, Maireana spp., Myoporum platycarpum, Polycalymma stuartii, Sclerolaena tricuspis*	*Acacia sp., Alectryon oleifolius ssp. canescens, Atriplex lindleyi ssp. lindleyi, Atriplex paludosa ssp. cordata, Atriplex rhagodioides, Atriplex semibaccata, Atriplex stipitata, Atriplex vesicaria ssp., Austrostipa sp., Austrodanthonia caespitosa, Brachycome lineariloba, Calotis hispidula, Carrichtera annua, Disphyma crassifolium ssp. clavellatum, Dissocarpus paradoxus, Enchylaena tomentosa var. tomentosa, Enneapogon avenaceus, Enneapogon intermedius, Enneapogan nigricans, Eragrostis australasica, Eremophila sturtii, Eriochiton sclerolaenoides, Lycium australe, Maireana aphylla, Maireana astrotricha, Maireana brevifolia, Maireana pentatropis, Maireana pyramidata, Maireana sedifolia, Maireana trichoptera, Myoporum platycarpum ssp., Nitraria billardierei, Plantago cunninghamii, Rhagodia spinescens, Rhagodia ulicina, Rhodanthe pygmaea, Schismus barbatus, Sclerolaena brachyptera, Sclerolaena dicantha, Sclerolaena muricata var. muricata, Sclerolaena obliquicuspis, Sclerolaena tricuspis, Sclerolaena ventricosa, Senna artemisioides ssp., Tetragonia eremaea/tetragonoides, Tecticornia pergranulata ssp. pergranulata, Tecticornia tenuis, Zygophyllum spp.*

Table 43: List of all the species identified in the floodplain vegetation file, and their water regime functional classification, where known, from Nicol *et al* (2010), Gehrig and Nicol (2010, and Doeg *et al* (2011). See Table 2 for water regime functional group classification code.

Species	Functional Group	Species	Functional Group
(emergent) Acacia victoriae	TDR-E	*Lepidosperma concavum*	TDR
Acacia stenophylla	AFTW	*Lomandra effusa*	-
Agrostis avenacea var. avenacea (NC)	FD	*Lycium australe*	TDR
Alectryon oleifolius ssp. canescens	TDR	*Maireana brevifolia*	TDR
Angianthus tomentosus	SAT	*Maireana aphylla*	-
Aster subulatus	AFTE	*Maireana astrotricha*	-
Atriplex lindleyi ssp. lindleyi	TDR	*Maireana pentatropis*	TDR
Atriplex limbata	TDR	*Maireana pyramidata*	TDR
Atriplex paludosa ssp. cordata	AFTE	*Maireana sedifolia*	-
Atriplex rhagodioides	-	*Maireana trichoptera*	-
Atriplex semibaccata	TDR	*Melaleuca halmaturorum*	AFTW
Atriplex stipitata	TDR	*Melaleuca lanceolata*	TDR
Atriplex vesicaria ssp.	TDR	*Muehlenbeckia florulenta*	AFTW
Austrostipa sp.	TDR	*Myoporum platycarpum ssp.*	TDR
Austrodanthonia caespitosa	-	*Nitraria billardierei*	TDR
Beyeria opaca	-	*Olearia mueller*	-
Bolboschoenus caldwellii	E	*Paspalum distichum*	AFRP
Brachycome lineariloba	FD	*Paspalum vaginatum*	TDA
Callistemon brachyandrus	AFTW	*Phragmites australis*	E
Calotis hispidula	FD	*Plantago cunninghamii*	TDR
Carrichtera annua	TDR	*Polycalymma sturtii*	TDR
Chenopodium desertorum	TDR	*Rhagodia spinescens*	TDR
Chenopodium nitrariaceum	TDR	*Rhagodia ulicina*	-
Cyperus gymnocaulos	AFTE	*Rhodanthe pygmaea*	TDR
Danthonia sp.	TDR	*Salix babylonica*	E
Disphyma crassifolium ssp. clavellatum	*SAT*	*Samolus repens*	AFTL
Dissocarpus paradoxus	TDR	*Sarcocornia quinqueflora*	AFTE
Dodonea viscosa ssp. angustissima	TDR	*Schismus barbatus*	TDR
Enchylaena tomentosa var. tomentosa	TDR	*Schoenoplectus validus*	E
Enneapogon avenaceus	-	*Sclerolaena brachyptera*	TDR
Enneapogon intermedius	-	*Sclerolaena diacantha/uniflora*	TDR
Enneapogon nigricans	TDR	*Sclerolaena muricata var. muricata*	TDR
Eragrostis australasica	FD	*Sclerolaena obliquicuspis*	TDR
Eremophila divaricata ssp. divaricata	FD	*Sclerolaena tricuspis*	TDR
Eremophila sturtii	TDR	*Sclerolaena ventricosa*	-
Eriochiton sclerolaenoides	TDR	*Senecio cunninghamii var. cunninghamii,*	FD
Eucalyptus brachycalyx	-	*Senecio glossanthus (NC)*	FD
Eucalyptus camaldulensis (var. camaldulensis)	AFTW	*Senna artemisioides ssp. petiolaris (NC)*	TDR
Eucalyptus cyanophylla	(TDR?)	*Setaria jubiflora*	-
Eucalyptus dumosa	(TDR?)	*Sporobolus mitchellii*	FD

Species	Functional Group	Species	Functional Group
Eucalyptus gracilis	TDR	*Sporobolus virginicus*	TDA
Eucalyptus largiflorens	AFTW	*Suaeda australis*	TDA
Eucalyptus leptophylla	(TDR?)	*Tecticornia arbuscula*	AFTE
Eucalyptus oleosa	TDR	*Tecticornia indica ssp. leiostachya*	AFTE
Eucalyptus porosa	(TDR?)	*Tecticornia pergranulata ssp. pergranulata*	AFTE
Eucalyptus socialis ssp.	(TDR?)		
Frankenia pauciflora var.	*SAT*	*Tecticornia tenuis*	AFTE
Gahnia filum	AFTE	*Tecticornia triandra*	AFTE
Gahnia trifida	-	*Tetragonia eremaea/tetragonoides*	TDR
Geijera linearifolia	-	*Trichanthodium skirrophorum*	SAT
Grevillea huegelii	TDR	*Triodia irritans*	-
Helichrysum leucopsideum	(TDR?)	*Typha domingensis*	E
Hordeum marinum	?	*Typha orientalis*	E
Juncus kraussii	AFTE	*Zygophyllum apiculatum*	TDR

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