10. Policies

The following legislation and policies affect the management of all or part of the Boyters Lane Wetland and Playing Fields site.

10.1. Environmental Planning and Assessment Act 1979

When considering development applications within the estuarine catchment boundary, local Councils must incorporate the provisions set out in any environmental planning instrument for the area, including final and draft State Environmental Planning Policies (SEPPs) and Regional Environmental Plans (REPs) (NSW Government, 1992).

Management Plan recommendations become policy statements to be implemented through the range of plans, strategies and management practices - for local Councils this includes zoning and development standards in LEPs, DCPs and building and engineering policies on which assessment of development applications is based.

10.2. NSW Fisheries Management Act 1994

This Act sets out legal tools for the management of fish stocks and associated aquatic habitats, including licences, fines, closures, bag limits, habitat protection plans, and aquatic reserves. NSW Fisheries is the Agency overseeing the implementation of the Act. Aquatic vegetation, such as mangroves and seagrasses, are protected from destruction or damage. Threatened species are also protected under Part 7A of the Act.

All works or activities that may impact on fish stocks and/or their associated habitat must comply with this Act by obtaining any licences or approvals that are required. Therefore, any works within the Boyters Lane site that may impact on fish passage or aquatic vegetation, such as the shoring of Teal Lagoon or the removal of mangroves, will first need approval from NSW Fisheries.

10.3. Rivers and Foreshores Improvement Act 1948

The R&FI Act was designed to control activities that have the potential to cause adverse impacts such as increased erosion or siltation, bed lowering, bank collapse, stream diversion or obstruction, and ecological damage. Works that affect navigation comes under this Act. The proposed footbridge across Spencers Creek falls within the issue of navigation impacts. Therefore, any footbridge design would need to address navigational impacts from height above high tide levels and pylon placements.

10.4. Crown Lands Act 1989

The Crown Lands Act is a tool used by State government (currently the NSW Lands division of DIPNR) to manage the Crown land within NSW. Without authority from NSW Lands, it is illegal to reside, erect a structure, graze or drive stock, clear, dig up, enclose, interfere with or leave any rubbish on or in Crown lands.

There is a proposal for Council to acquire the Crown lands adjacent to the Boyters Lane property. This can be achieved through Part 4 of the Act, which pertains to the sales (Division 2), leasing (Division 3) and vesting (Division 7) of Crown land.

The following principles of the Act must be respected whenever issues of land use on Crown lands are considered:

(a) environmental protection principles be observed,

(b) the natural resources of the land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible,

(c) public use and enjoyment of the land be encouraged,

(d) the land should be used and managed in such a way that both the land and its resources are sustained in perpetuity, and

(e) Crown lands be used in the best interests of the State consistent with the above principles.

10.5. Local Government Act 1993

Once the land becomes public land managed by Council, it must be classified and a management plan drafted for the site. In the case of the Boyters Lane site, the adjoining Crown land would be classified as Public Wetland and Public Sportsground. The following excerpts from the Local Government Act (1993) describes the management requirements for these two land classifications:

"*Section 36F: Core objectives for management of community land categorised as a sportsground*

The core objectives for management of community land categorised as a sportsground are:

(a) to encourage, promote and facilitate recreational pursuits in the community involving organised and informal sporting activities and games, and

(b) to ensure that such activities are managed having regard to any adverse impact on nearby residences.

Section 36K: Core objectives for management of community land categorised as wetland

The core objectives for management of community land categorised as wetland are:

(a) to protect the biodiversity and ecological values of wetlands, with particular reference to their hydrological environment (including water quality and water flow), and to the flora, fauna and habitat values of the wetlands, and

(b) to restore and regenerate degraded wetlands, and

(c) to facilitate community education in relation to wetlands, and the community use of wetlands, without compromising the ecological values of wetlands."

10.6. Rural Fires Act 1997

The Rural Fires Act 1997 (RF Act) was enacted to establish the NSW Rural Fire Service and define its functions, and to make provision for the prevention, mitigation and suppression of rural fires. Section 63 of the RF Act requires all public authorities, landowners and occupiers to accept a duty to prevent the occurrence of and to minimise the spread of bushfires within their property. Although grassland is classed as a 'low' risk vegetation type (RFS, 2001), the fire risk on the Boyters Lane site will require management, particularly in view of the likely staging of revegetation projects for the different management units of the site.

Vegetation management may require hazard reduction techniques to reduce fuel loads and limit the paths available to the passage of a bushfire event. Techniques available for bushfire hazard reduction works include:

• Mechanical slashing, and

• Hazard reduction burns

Council's present grass-slashing management imposes a cost in machinery and labour, but reduces the fire risk substantially. Although hazard reduction burning is currently viewed as the most economically viable and effective method of reducing bushfire hazards for larger areas (RFS, 2001), this method is generally unsuitable for the site because of smoke nuisance, and impacts on wildlife. However, burning of small areas under control conditions is considered suitable as a means of encouraging germination of native vegetation species.

The Protection of the Environment Operations (Control of Burning) Regulation 2000 allows hazard reduction burning as permitted by the RF Act. Although section 133 of the Protection of the Environment Operations Act, 1997 allows the EPA to ban hazard reduction burns on certain days, the legislation is intended to make sure such burning occurs in appropriate weather for smoke dispersion.

Further information regarding hazard reduction burning can be found in Guidelines to the Regulation of Open Burning in NSW, produced by the NSW RFS in collaboration with the EPA. Burning requirements under the R F Act 1997 and Rural Fires Regulation 2002 are summarised under these points: 'The burning of waste material and the management of vegetation (fuels) on properties are also of concern. Care must be taken to prevent the spread of a bushfire as well as to protect the community from hazards created by the lighting of fires'.

Open burning is regulated under the R F Act 1997 and the Rural Fires Regulation 2002, and relevant legislation requirements to manage fire risk on the Boyters Lane site include:

- Bush Fire Management Committees preparing bushfire risk management plans and operations plans (section 52 of the Act)
- landowners or occupiers of land undertaking hazard reduction to prevent the spread of a fire on or from the land (section 63 of the Act)
- the Commissioner of the NSW Rural Fire Service implementing hazard reduction when public authorities fail to exercise their duties under the Rural Fires Act 1997

- public authorities providing controls on roadside fire protection
- the lighting of fires being controlled close to buildings in fire districts (section 86 of the Act)
- prohibitions on the lighting, use and maintenance of open fires during bushfire danger periods without a permit (section 87 of the Act)
- total fire bans being declared that prevent the lighting of fires, and permits being suspended for the duration of the ban (section 99 of the Act).

A local Bush Fire Risk Management Plan should set out the steps to be taken in managing the bushfire hazard on the property under s.63. and coordinated with the local Rural Fire Service.

10.7. Threatened Species Conservation Act 1995

In New South Wales, threatened species, communities and critical habitat in New South Wales are protected by the Threatened Species Conservation Act. The Act provides for the identification, conservation and recovery of threatened species and their populations and communities, and to reduce the threats faced by those species. Human activities that may impact on threatened species or their habitats must be assessed.

An independent Scientific Committee has been set up under the Act to determine which species, populations and ecological communities should to be listed as endangered, vulnerable or extinct under the act, and also to determine key threatening processes.

Any works carried out on the site that may impact on the threatened species that frequent the area will require a licence under Section 91 of the Act. For example, the removal of Teal Berm may result in a change of habitat within Teal Lagoon, and therefore impact on the habitat used by the Black-necked Stork

10.8. The NSW Coastal Policy

The 1997 NSW Coastal Policy is the major Policy governing planning and management of the coastal zone. The Policy aims to provide for population growth and economic development without placing the natural, cultural, spiritual and heritage values of the coastal environment at risk. To achieve this, the Policy has a strong integrating philosophy based on the principles of ecologically sustainable development (ESD).

The Policy addresses a number of key coastal themes including:

- Population growth in terms of physical locations and absolute limits;
- Coastal water quality issues, especially in estuaries;
- Disturbance of acid sulfate soils;
- Establishing an adequate, comprehensive and representative system of reserves;
- Better integration of the range of government agencies and community organisations involved in coastal planning and management;

- Indigenous and European cultural heritage; and
- Integration of the principles of ESD into coastal zone management and decision making.

The 1997 Coastal Policy includes coastal waters and lands one kilometre landward of the open coast high water mark, and land within one kilometre of coastal rivers, lakes, lagoons, estuaries and islands. The policy requires that: water quality will be maintained or improved, fisheries habitats protected and restored where possible; and coastal lands and aquatic environments with conservation values will be assessed and appropriate measures put in place to protect them (NSW Government, 1997).

All NSW Government Agencies are to take account of the policy in the preparation of their own policies and programs. Local councils are required to take account of the policy through a s.117 direction under the *Environmental Protection and Assessment Act 1979* in the preparation of LEPs and when considering development applications (NSW Government, 1997).

10.9. SEPP 14 and 26

State Environment Planning Policies (or SEPPs) are legally binding across NSW. SEPP 14 (Coastal Wetlands) mandates that classified wetlands will be preserved and protected for environmental and economic reasons. Formal consent is required to clear, drain or fill designated wetlands. SEPP 26 (Littoral Rainforests) protects littoral rainforest from inappropriate development proposals. Kempsey Shire Council has mapped the areas of SEPP 14 and SEPP 26, and these maps are accessible through Council.

Map BB028-5 (Appendix 4) shows the SEPP 14 wetland areas adjacent or close to the Boyters Lane study site. There are three registered wetlands within the immediate area of the Boyters Lane site:

- Wetland No. 443, to the east across Spencers Creek, considered to be the closest of the three to the study site;
- Wetland No. 447, to the north across Spencers Creek; and
- Wetland No. 444, to the west, within the creek on Pelican Island.

These protected wetlands do not have a hydrologic (except if large floods) or terrestrial corridor to the Boyters Lane site. There is likely however to be a functional aerial connection for birds, bats and insects to move among the ecosystems. The rehabilitation and revegetation of the Boyters Lane site would reinforce this connectivity by providing another link in movement potential for a range of species, as well as a further source of genetic material from species that develop on the site over time. Boyters Lane Wetlands would naturally develop as a SEPP 14 Wetland-standard ecosystem to enhance the other three nearby, and others on a regional basis.

10.10. Coastal Protection Package

The NSW Premier and Deputy Premier announced the Coastal Protection Package on 26 June 2001. The $11.7 million Package includes several components, outlined below:

10.10.1. Comprehensive Coastal Assessment

Comprehensive Coastal Assessment (CCA) is a key element of the Coastal Protection Package. It is a whole-of-government $8.6 million three-year program that aims to identify, analyse and assess data and information on the physical, biological, social, and economic values of the State's coastline.

Although the program is at an early stage, it is planned that the CCA will provide a wide range of information about the features and values of the land, estuaries, people and industries of the coast, and identify trends affecting them.

At the completion of the CCA, the State Government, local government, industry and communities will have better information available for improved State, regional and local planning and management decisions to better protect the coast. It will provide a regional context to inform local decision-making and strategic planning and will establish working partnerships between local and State Government.

10.10.2. SEPP 71 - Coastal Protection

The policy aims to protect and manage the natural, cultural, recreational and economic attributes of the NSW coastal zone. It also aims to ensure that development within the coastal zone occurs in a strategic manner, and that development is appropriate and suitably located in context to the adjacent and surrounding coastal attributes. Lastly the policy seeks to ensure that coastal development does not place life and property in conflict or at risk.

Land that comes under SEPP 71 includes all land within one kilometre of coastal waters, estuaries and bays. The policy is an interim measure until:

- Regional Strategies prepared under the PlanFIRST program are implemented with equivalent provisions for the coastal zone;
- The Comprehensive Coastal Assessment (CCA) being coordinated by the Resource and Conservation Division of PlanningNSW is completed, thus enabling better data and tools to be available for improved decision-making on coastal planning and management.

Certain significant development under SEPP 71 cannot be undertaken, whilst other development can only proceed under prescribed conditions. For the Boyters Lane site, the following issues need to be considered:

a) *Public access to the foreshore*

   No restrictions are envisaged to public access. A proposed picnic area near Boyters Lane would enable well-managed public access to a beautiful section of Spencers Creek. With revegetation, walking access beneath forest would allow walkers, nature enthusiasts and fishers to easily access the entire south bank of Spencers Creek.

b) *Detrimental impact of development on amenity of the foreshore*

   The development of the playing fields and associated amenities block is set back from the foreshore, therefore having little impact on the amenity of the foreshore. However, without a barrier planting between the playing fields and the wetland, the visual amenity of the overall site as viewed from across Spencers Creek may be impacted.

c) *Measures to conserve animals, plants and fish*

   The proposal poses a slight risk of impact on fauna and flora, however, a primary objective of this plan has been to minimise impacts on fauna and flora. It is expected that the proposal would have a positive benefit for local biodiversity by restoring degraded

grassland and wetland habitats. The maintenance of the extant values of Teal Lagoon would reduce impacts on waterbirds, whilst the retention of grassland and sedgeland habitat near Teal Lagoon would provide foraging habitat for grass owls.

d) Potential impacts on water quality

By changing the south west corner of the site from pasture grass to playing fields, an increase in runoff from the fields to the wetlands is expected during rain events. Regardless of whether the Council will or will not use fertilisers on the site, there may be the use of some pesticides and/or herbicides to combat bindii weeds and black beetle, should they occur. The site has never been sprayed for weeds or pests, and therefore the adjoining wetlands have never been subjected to poisons. To reduce the potential of the wetlands to be impacted on as a result of spraying, the following management actions should be taken:

1. A management plan for the use, timing and application of sprays should be developed and adhered to; and
2. A stormwater treatment wetland should be considered for the area between the playing fields and Teal Lagoon (refer to Section 11.1.3 Stormwater Management)

10.11. The Catchment Blueprint

The Integrated Catchment Management Plan for the Mid North Coast 2002 – 2012 (The Blueprint) was prepared by the Mid North Coast Catchment Management Board (MNCCMB) "to provide a clear directive for action and investment in catchment natural resources". The Blueprint is consistent with National and State Policy, involving consultation with key stakeholder groups.

The MNCCMB assessed the priority natural resource and environment management issues in the Mid North Coast catchments as Biodiversity, Stream Health, Landuse Planning, Soils, and Vegetation.

The MNCCMB has adopted a "targets approach" to catchment repair under the Blueprint, and drafted the following objectives:

- Land use that is strategically planned, sustainable and efficient in its use of resources;
- Healthy aquatic ecosystems, with water quality and quantity meeting the needs of the environment and the community;
- Soils managed for sustainability and productivity;
- Vegetation managed for sustainability and productivity, and native flora enhanced;
- Biodiversity and natural ecosystems conserved and enhanced.

The Blueprint has a life of 10 years and the aim is that investment in the priority management actions will have a large impact in improving the environmental health and prosperity of the Mid North Coast catchments.

Wetlands are seen as very suitable for restoration and better management in partnership with landholders because of the multiple benefits in biodiversity, waterway health, and economic and social benefits from healthier fisheries. Another of the Blueprint projects is the mapping of estuary resources, including seagrass and mangrove areas, by NSW Fisheries.

These maps will provide good baseline information for estuary managers and the community to assess changes over time.

10.12. NSW Estuary Management Policy and Manual

The primary goal of the Policy is to achieve an integrated, balanced, responsible and ecologically sustainable use of estuaries.

The two specific objectives of the Policy are:

- Protection of estuarine habitats and ecosystems in the long-term
- Preparation and implementation of a balanced long-term plan for the sustainable use of each estuary and its catchment

The boundaries of the estuary study can stretch as far inland, seaward and along the coast as necessary to take in management issues that may impact on the ecological and recreational values of the estuary, as well as development controls (NSW Government, 1992).

10.13. NSW Wetlands Management Policy

The Boyters Lane wetlands rehabilitation project accords with the NSW Wetlands Management Policy, which has as its major objective to halt and where possible reverse:

- Loss of wetland vegetation
- Declining water quality
- Declining natural productivity
- Loss of biological diversity, and
- Declining natural flood mitigation

The common goal for guiding decision making about wetlands is "The ecologically sustainable use, management and conservation of wetlands in NSW for the benefit of present and future generations" (NSW Government, 1996). To achieve this goal, the following principles have been adopted:

- Maintain water regimes;
- Encourage land use practices that maintain or rehabilitate wetlands;
- Allow for suitable water distribution to and from wetlands in new developments;
- Water entering the natural wetlands will be of sufficient quality so as not to degrade the wetlands;
- The construction of purpose-built wetlands on the site of viable natural ones will be discouraged;

- Natural wetlands should not be destroyed, but when imperatives require it, the rehabilitation or construction of a wetland should occur;
- Degraded wetlands will be actively rehabilitated as far as is practical;
- Wetlands of regional or national significance will be conserved; and
- The adoption of a stewardship ethos and co-operative action between all stakeholders is necessary for effective wetland management.

10.14. Kempsey LEP 1987

10.14.1. Zoning

The Kempsey Shire Local Environmental Plan 1987 (the LEP) has zoned the Boyters Lane site as Rural 1(a1) (Map BB028-7, Appendix 4). Under this zoning, playing fields are permissible given compliance with relevant zoning prescriptions of the LEP. (Kempsey Shire Council, 1987 as amended).

The objectives of Open Space 6(a) zoning are:

(a) to identify publicly owned land that is used or is capable of being used for the purpose of active or passive recreation; and

(b) to conserve and protect the visual and environmental qualities of foreshore reserves and encourage development compatible with the natural environment and landscape; and

(c) to encourage the development of public recreation in a manner which maximises the satisfaction of the community's diverse recreational needs; and

(d) to enable development associated with, ancillary to, or supportive of uses compatible with those uses.

10.14.2. Acid Sulfate Soils

Development on land containing potential acid sulfate soils

The LEP describes under Section 56

56. (1) This clause applies to land, identified as being subject to acid sulfate risk, shown edged heavy black on the acid sulfate soils map.

(2) A person must not, without the consent of the Council, carry out works on land to which this clause applies.

(3) For the purposes of subclause (2), "works" includes any landform alteration that results in the disturbance of acid sulfate soils (such as occurs in the carrying out of agriculture, the construction of dams, the maintenance of existing drains, flood mitigation works or any other works which will alter groundwater levels). In this clause, "landform alteration" includes the placement, disposal and use of fill material comprised of actual acid sulfate soils or potential acid sulfate soils.

(4) The council must not grant such consent unless it has considered:

(a) a preliminary soil assessment to ascertain the presence or absence of acid sulfate soils within the area of the proposed works, unless the applicant agrees that acid sulfate soils are present within the area of the proposed works; and

(b) where the preliminary soil assessment ascertains, (or the applicant agrees) that acid sulfate soils are present, whether or not an acid sulfate soils management plan has been prepared in accordance with DCP No 30 Management of Acid Sulfate soils; and

(c) the likelihood of the proposed development resulting in the oxidation of acid sulfate soils and the discharge of acid water from the area of proposed works; and

(d) any comments received from any relevant public authority the Council may consult with in respect of the application.

(5) Notwithstanding any other provision of this plan, this clause also applies to the placement of any acid sulfate soil on or under any land.

(6) This clause does not require consent for the carrying out of those works if:

a) a copy of a preliminary assessment of the proposed works undertaken in accordance with the Acid Sulfate Soils Assessment and Management Guidelines has been given to the Council, and

b) the Council has provided written advice to the person proposing to carry out works confirming that results of the preliminary assessment indicate the proposed works need not be carried out pursuant to an acid sulfate oils management plan prepared in accordance with the Acid Sulfate Soils Assessment and Management Guidelines.

(7) Public authorities

This clause requires consent for development to be carried out by the Council, or drainage unions despite clause 35 and items 2 and 11 of Schedule 1 to the Environmental Planning and Assessment Model Provisions 1980.

(8) Special provisions for Council

Notwithstanding the provisions of subclause (7), the following types of development may be carried out by the Council on land to which this clause applies without consent:

a) development consisting of emergency work;

b) development consisting of routine maintenance; and

c) development consisting of minor work, and development ancillary to that development, such as the carrying out of excavation work, the construction of accessways and the provision of power supplies.

(9) Despite subclause (8), development consisting of routine maintenance or minor work may be carried out by the Council only with consent if the development is on a site listed as a heritage item in Schedule 1.

(10) Where the Council carries out development described in subclause (8) and encounters, or is reasonably likely to encounter, actual or potential acid sulfate soils, the Council shall

properly deal with those soils in accordance with the Acid Sulfate Soils Assessment and Management Guidelines, so as to minimise the actual or potential impact to the environment arising from disturbance of the soils.

(11) In this clause:

"Council's Works" means such works as are owned or controlled by the Council.

"Emergency Work" means the repair or replacement of any part of the Council's works:

a) because it has been (or is being) damaged by a natural disaster, an accident, an act of vandalism or a like occurrence, or

b) because it has ceased to function or suddenly ceased to function adequately, and includes work reasonably necessary to prevent or limit any further damage or malfunction.

"Engineering Works" means works carried out under the supervision of a suitably qualified engineer and using equipment or plant. Such works may consist of or include any of the following:

- construction of roads, bridges, buildings, levees, dams, railways or drains;

- laying of pipes, cables or conduits;

- levelling of the ground;

- extractive industries or mining;

- dewatering;

- flood mitigation works;

and may consist of or include an agricultural-related work.

"Minor Work" means new work affected by the Council (other than drainage work), which has a value not greater than $20,000.

"Routine Maintenance" means the periodic inspection, cleaning, repair and replacement of the Council's works but does not include work that would result in an increase in the design capacity of any part of those works or necessitate the deepening of an existing works capacity.

11. Management Options

11.1. Management Areas

The following management areas are shown on Map BB028-8 (Appendix 4), and relate to the table in Section 13 of the Strategy.

11.1.1. Area 1 – Playing fields

Barrier Planting

To reduce the impact of the lights on the inhabitants of the wetland, a barrier planting is recommended (see Map BB028-9, Appendix 4). This would be situated between the fields and constructed wetland (see Map BB028-9, Appendix 4). Trees and shrubs ideal for this site are *Casuarina glauca* and selected rainforest species (see Section 12 Revegetation). A planting of at least three trees wide, with a stepped structure, combined with the correct design of lights, will greatly reduce the intensity and impact of light reaching the wetland. Restricting the width of the planting to about 7 metres will reduce the likelihood of birds leaving Teal Lagoon due to a reduction in their line-of-sight. Planting should occur before the playing fields are constructed, to allow for adequate growth by the time the lights are installed. The plantings would also provide an appropriate screen to allow access to the proposed bird hide.

Osprey Poles

Ospreys often construct nests on artificial structures, such as power poles. It is proposed to provide one artificial nest site near the northeastern corner of Teal Lagoon. The artificial nest would include a 21m pole with nest platform and feeding and roosting perches.

This pole is expected to cost about $1000 ($500 for the pole, $500 for transport and placement).

11.1.2. Area 2 – East edge of playing fields

Stormwater Management

The development of the playing fields may introduce fertilisers and will increase runoff from the site. Without proper management, Teal Lagoon and the surrounding wetland would receive untreated runoff possibly containing elevated nutrients during rain periods. The runoff could also contain hydrocarbons from the parking area.

This section describes stormwater quality and quantity control measures that would normally apply to any development requiring consent under the *Environmental Planning and Assessment Act 1979*. There are also requirements for approval of carrying out stormwater drainage works in accordance with Section 68 of the *Local Government Act 1993*.

Development covered by these Acts includes 'any land development or use which may impact on the quality of runoff and drainage discharging from the site or to any natural or artificial waterway water body'. The Boyters Lane playing fields will represent an intensification of land use, and even if no drainage is installed the works are likely to result in an increase in peak wet weather discharges to Teal Lagoon from the closely mowed fields compared with the existing long grass.

The use of fertiliser is also possible, particularly if heavy usage occurs in future years. Herbicide application is probable, at least for Bindii. Minimal application of these materials, and only when necessary, is recommended, but some contamination of runoff should be assumed.

Along with the recommended reduction of these potential pollutants at source, a stormwater treatment and detention facility such as a constructed wetland will be of benefit. Such a wetland can combine treatment and detention functions to reduce potential impacts on Teal Lagoon, and add considerably to the aquatic ecology values of the whole site. Biodiversity will benefit from the added freshwater species that will colonise the wetland, with wetland plants providing nesting material, refuge and food for birds. Several species of frogs are likely to inhabit the wetland, including *Litoria fallax, Crinia signifera, Limnodynastes peronii,* and *Litoria freycineti*, with another ten to twelve possible species depending on the plant association that develops, and the proximity of particular frog populations.

Free Water Surface wetlands are being used successfully in this role, with design principles laid out in design manuals such as the NSW DLWC Constructed Wetlands Manual. The concept is illustrated in Figure 3.

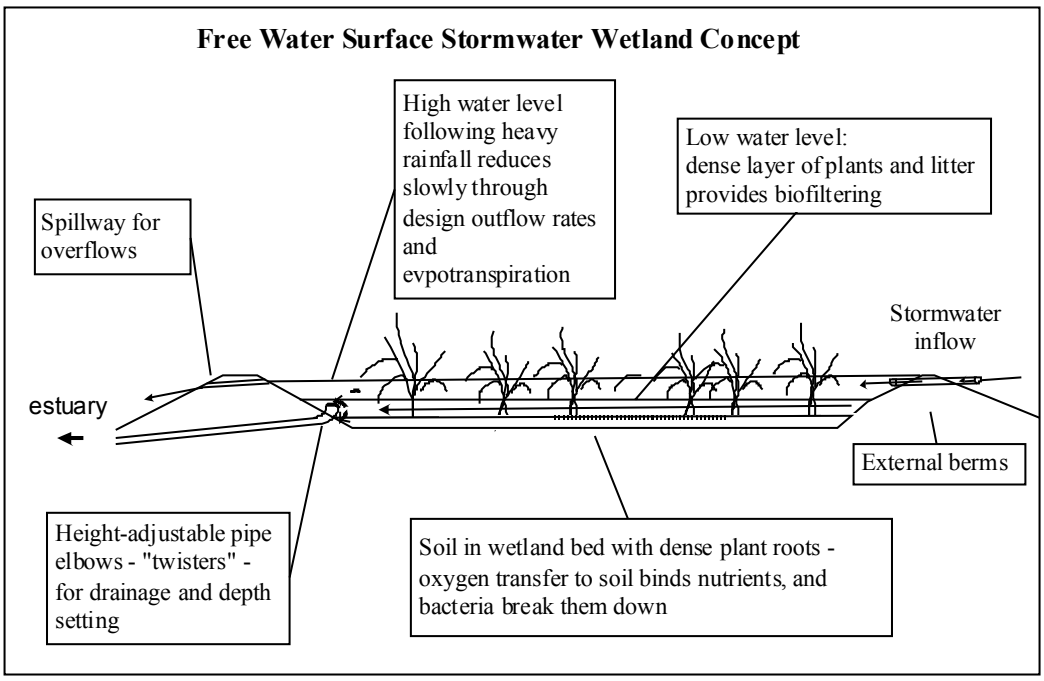

Figure 3: Outline of stormwater wetland configuration

The area available for a wetland is about 2,500 square meters - 100m long by 25m wide (Map BB028-10, Appendix 4). With a design depth of about 33cm, the wetland volume would be about 800m^3, and could receive and detain the potential runoff from a 13mm rain event. Assuming some retention of the rainfall in the soil and grass, this detention figure is a reasonable prediction. This area of wetland also represents a little over 4% of the catchment - also a reasonable figure in line with stormwater industry standards (Constructed Wetlands Manual, 1998).

The soil requirement can be calculated as a function of berm length and cross-sectional area. Berms need to be about 0.4m in height to retain water, with the outside berm top at about 1.2m AHD. The western and southern berms would be basically cut into the slope from the playing fields. The eastern and northern berms together would be about 125m long, with a cross-sectional area of 1.3m^2. The soil required would therefore be about 160m^3, plus a few cubic meters for trimming. AutoCAD design analysis would be needed to detail 'cut and fill' volumes of soil but preliminary assessment suggests abundant cut volumes would be available from removing the grass and surface soil.

This type of shallow treatment wetland is designed to provide nutrient, faecal coliform and colloidal sediment removal. The wetland can be planted with wetland plants observed to be common in the area, including *Baumea, Bolboschoenus, Eleocharis, Triglochin* and *Schoenoplectus*. There are very few maintenance requirements for shallow treatment wetlands.

Very little sediment is likely to enter the wetlands if soil erosion on the playing fields is minimised. An operating depth of 330mm has been selected because this depth is the most suitable depth in the elevation context, and to ensure robust growth of wetland macrophytes, which in turn will ensure sustainable stormwater treatment capacity.

The construction requirements of such a wetland are not high. An excavator may be used to remove surface soil and place it on the berms. The berms would be rolled and compacted to contain water 33cm deep. The wetland bed can be rotary-hoed both to provide loose planting topsoil, and moderate compaction of the subsoil beneath from the hoe action.

Areas that appear suitable for this purpose are the slightly lower zones outside the proposed screen plantings around the playing fields. The northern area is at a lower elevation than the eastern area, and appears more suitable as saltmarsh or sedgeland.

The eastern area soil surface has been surveyed to be slightly higher at about 0.75-1.0m AHD, with an appropriate gravity step from the playing fields tree-screen zone of about 0.3m from the playing fields surface to the likely water surface of the wetland, and sufficient soil volume for wetland berm and other requirements. With a sufficiently wide overflow spillway to the main estuary, unpolluted runoff from heavy rainfall events can be routed to the tidal system. The general concept is outlined in Figure 4. A larger area may be available following further assessment at the Detailed Design stage.

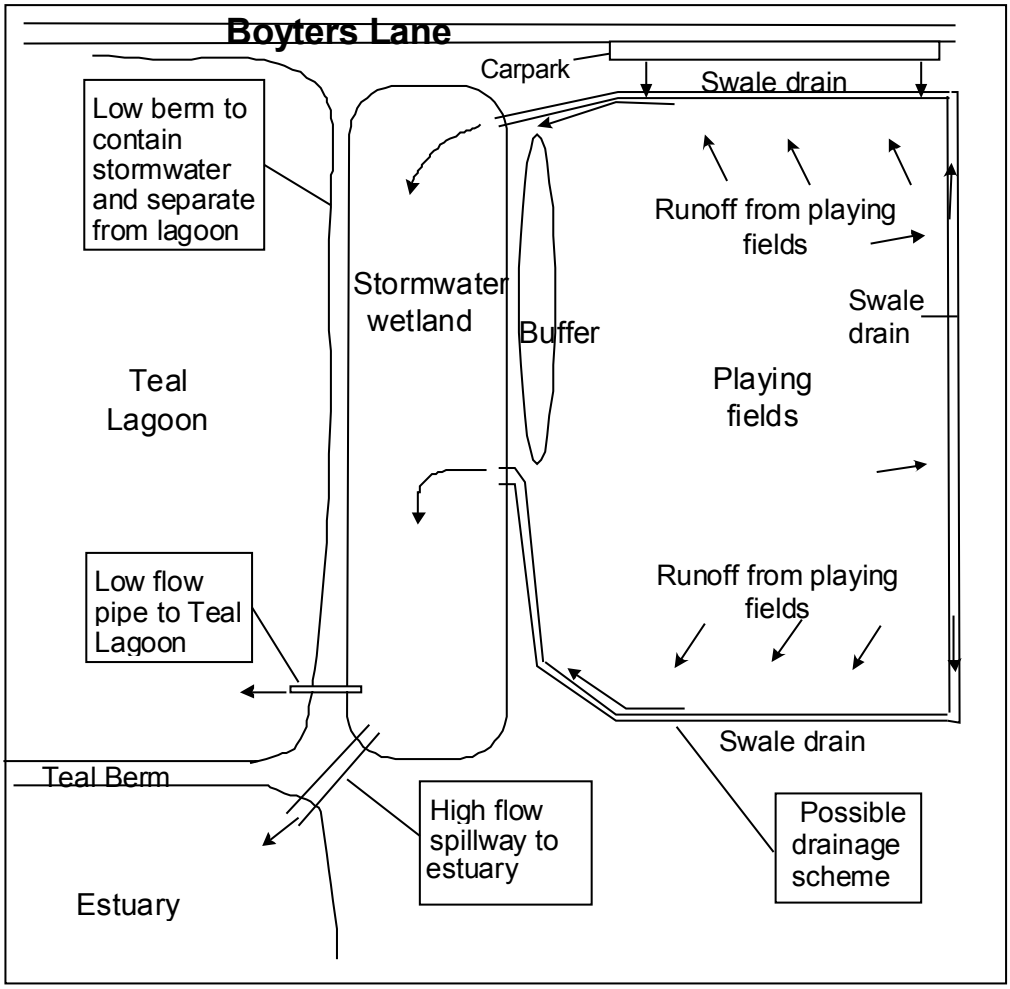

Figure 4: Potential layout of a stormwater wetland showing likely flow patterns

It is considered that a wetland bed level of about 0.8m AHD (Figure 5) will provide reasonable height above saline groundwater, while allowing a sufficient detention volume and gravity step from playing fields to wetland to Teal Lagoon. A Detailed Concept Design document with design drawings will be required prior to construction. This document should address:

1. Detailed review of available land area and topography using 0.1m contour survey data, as a basis for landscape design that integrates a constructed wetland with the proposed playing fields.

2. Detailed survey and assessment of soils information for the purpose of constructed wetland seepage control, construction suitability, and interaction with water quality.

3. Develop options for wetland configuration that optimise use of the site based on runoff, the most favourable flow paths, carry out an assessment of hydrology, and finalise costings.

4. Report on wetland outflow water quality and quantity predictions, confirming the wetland modelling results above.

5. Detailed drawings for construction.

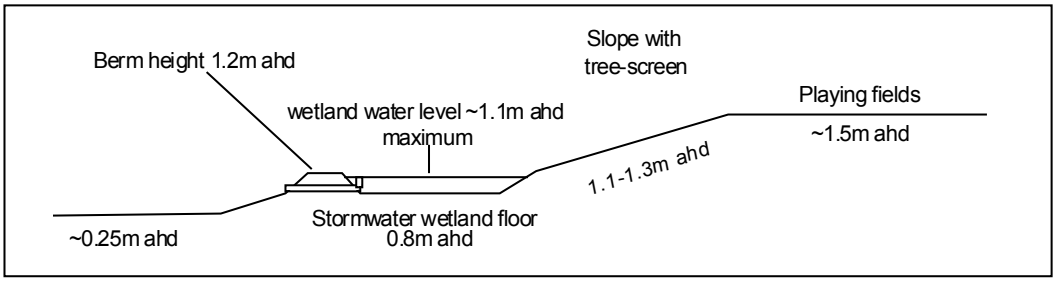

Figure 5: Simple elevation layout of proposed stormwater wetland

Preliminary sediment size analysis to determine clay content and other mineralogy has been carried out on one soil sample - a composite from several kilograms of soils collected from three different areas of the main berm across the central and eastern embayments (Appendix 3).

The samples were broken out of the walls of the berm at about 30cm below surface. This soil sample was analysed at the Southern Cross University Environmental Analysis Laboratory, the report indicated that the textural classification is of 'Fine Sandy Clay Loam' with massive to weak structure, with clay content typically 20--30%, and indicative permeability of 0.06-0.5m per day. This permeability assessment is based only on the texture and is thought to underestimate the ability of this fine wetland soil to hold water when wet. All the soil particles passed through a 0.6mm screen, and 75% passed through a 0.075mm screen mesh, indicating fine clay-rich soil, generally suitable for wetland construction.

Similar wetlands in the Boyters Lane area were observed to hold water even in very dry conditions. Placement of the wetland just above the high tide level would increase its ability to stay moist or wet during dry periods. The inclusion of a spillway at the design height removes the risk of the wetland being too deep, and drowning the plants. The installation of a pipe outlet to pass low flows to Teal Lagoon mimicking natural freshwater flows would enable the lowering of water levels if necessary to maintain wetland plant health. This is a commonly-used management tool in constructed wetlands.

Further assessment of the soils would be necessary during Detailed Design.

Swales (shallow grassed channels) would be suitable to install around the playing fields to channel stormwater to this area, as there is no sub-surface drainage proposed. This design approach would also provide an initial treatment of the stormwater before entering the constructed wetland.

Adaptively revegetate

Other options for this area include encouraging saltmarsh colonisation or revegetating with native species. By scraping the grass and surface soil away to a level suitable for saltmarsh recruitment, an increase in saltmarsh area will result. However, assessments must be made before works are carried out to determine the ASS status.

For areas higher than the saltmarsh level, planting native sedges would be suitable (see Section 12 Revegetation). These plantings would provide limited filtering of pollutants entering Teal Lagoon with runoff from the playing fields during rain events.

11.1.3. Area 3 – North edge of playing fields

Adaptively manage saltmarsh

Extending the saltmarsh area north of the playing fields appears practical (Plate 10, below and Map BB028-11, Appendix 4). By scraping the grass and surface soil away to the adjacent saltmarsh level, an increase in saltmarsh area will result. However, assessments must be made before works are carried out to determine the ASS status.

Plate 10: North-western corner of playing field site

Stormwater Management

A stormwater wetland, similar to that suggested for Area 2, could be constructed for Area 3. The lower slope of the area, compared to Area 2, would allow a larger wetland to be built, however this would require higher volumes of soil for the berms surrounding the wetland.

Again, swales would be required around the fields to channel stormwater to this area, which would provide an initial treatment of the stormwater before entering the constructed wetland.

11.1.4. Area 4 – Teal Lagoon

Option 1: Do nothing

The Teal Berm is likely to break down but may last for several years. There is little evidence about the rate of degradation of the berm over recent years, although pieces of rubble lie scattered at the foot of the berm wall. The dynamics of tidal flow suggest that the obvious multiple channels will destabilise the structure over time, and a single channel may break

out. No signs of plastics or other possibly toxic rubbish were seen in the rubble, and the pollution risk from this option is considered low.

The disadvantages of this option include the continuing restrictions on fish passage, and the continuance into the indefinite future of an unnatural situation. The main advantages are the interim maintenance of waterbird habitat, and the low cost - which may be considered as the rational transfer of management resources to arguably more productive and restorative actions.

Option 2: Seal berm and install dropboard

Teal Berm is permeable, as can be seen clearly during tidal flow when water passes through small channels along the structure to Teal Lagoon. The two 150mm pipes in the berm are predominantly blocked, resulting in the observed process that the majority of tidal flows are passing through the multiple small channels in the berm wall.

The option of sealing and reinforcing the berm with soil, possibly soil removed from the eastern sections of the main berm, and installing a Water Control Structure (WCS) would require disturbing the site for a period while the works were carried out. This action would provide better control over flows into and out of Teal Lagoon.

Wood (2002) detailed the main issues associated with water control structures in an agricultural situation - these are adapted for the Teal Lagoon case:

- Potential impacts of sea level change should be considered
- Manual vs. Automatic structures:

1) Suitability for any particular style needs to be determined on a case-by-case basis

2) Need to consider the requirements of the structure managers - don't want to be constantly attending

3) Influence of potential flood risk

4) Low risk for manual structures

5) Higher risk for automatic (use manual backup at these times)

6) All automatic structures need a manual override system

7) Whatever the management regime of the gate, it needs an 'owner' for maintenance, operation etc.

Considering the cost and complexity of an automatic structure, a manual device is considered appropriate. Although no hard evidence appears to be available concerning the relative values of pipe-based structures versus gate-type structures for fish passage, the opinion expressed by several people experienced in these types of projects that pipes, with their relatively small dark entrances, tended to be less attractive to fish. NSW Fisheries personnel also expressed a preference for a dropboard structure.

The addition of a dropboard – a weir arrangement in which boards can be inserted or removed to adjust water height - has evolved as a favoured option for a Water Control Structure during consultation for this Plan (Figure 6).

One major problem with any WCS, besides cost, is that allowing fish passage almost guarantees the incursion of mangrove propagules, and vice versa.

Mangrove seeds are more prevalent in the seeding season of winter to spring, and a screen (suggest 20mm mesh) to filter out seeds can be trialed for that period, whilst removal of the screen would allow fish passage during the rest of the year. Consultation with designers and managers of similar structures (widely used in ASS runoff control) suggests operational difficulties in screening out mangrove propagules mainly because the screens become clogged with debris, leading to flow restriction and possible damage to the structure.

This option would also allow the retention of high-tide water or rainfall with boards, to flood and drown mangrove seedlings, resulting in an increase in the distance of line-of-sight and general habitat values for the waterbirds. The dropboard would be managed by Council, in consultation with key stakeholders including landowners, conservation groups, and the Boyters Lane Management Committee. It became evident during the preparation of this Plan that enough people are interested in the site and its future to form a management group if Council calls for members. The group could be a Working Group of the Committee, or a Landcare Group could be formed for the site.

It is envisaged that following initial setting of boards, and a period of observations, the management group would be able to quickly set an appropriate tidal flow regime. Annual review would enable a formal process of assessment and adaptive management. Occupational Health and Safety requirements must be addressed, and would mainly be concerned with assuring safe access across the device. This would normally be undertaken by installing a short footbridge with handrails.

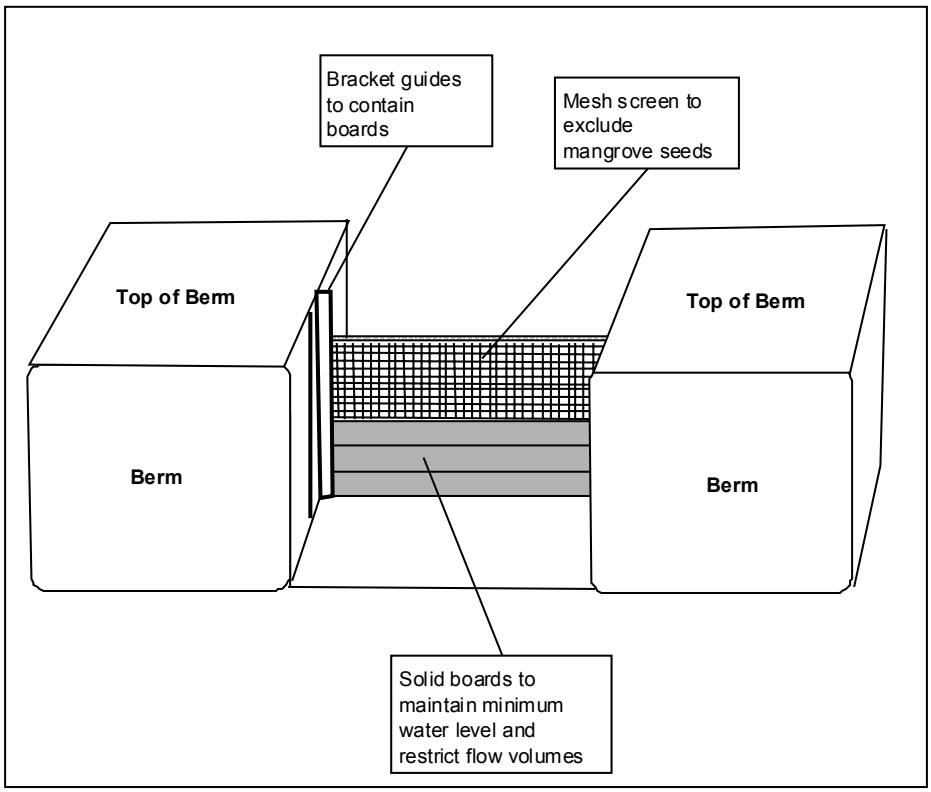

Figure 6: Dropboard concept

Option 3: Reinforce the berm with rock

This option recognises that the berm could become unstable. The berm would be reinforced against further erosion, whilst allowing the existing permeability to remain. A shallow spillway would allow overtopping for fish passage during an upper range of tide heights (Figure 7).

The placement of rock on either side of Teal Berm would require some disturbance, but less than sealing the berm. This option allows continued tidal exchange. Without a spillway, this option excludes mangrove seeds but does not allow fish passage. With a spillway, mangrove seeds would enter the Lagoon in limited numbers, with the added advantage of slightly limited fish passage. In this option small-scale annual removal of mangrove seedlings would be necessary.

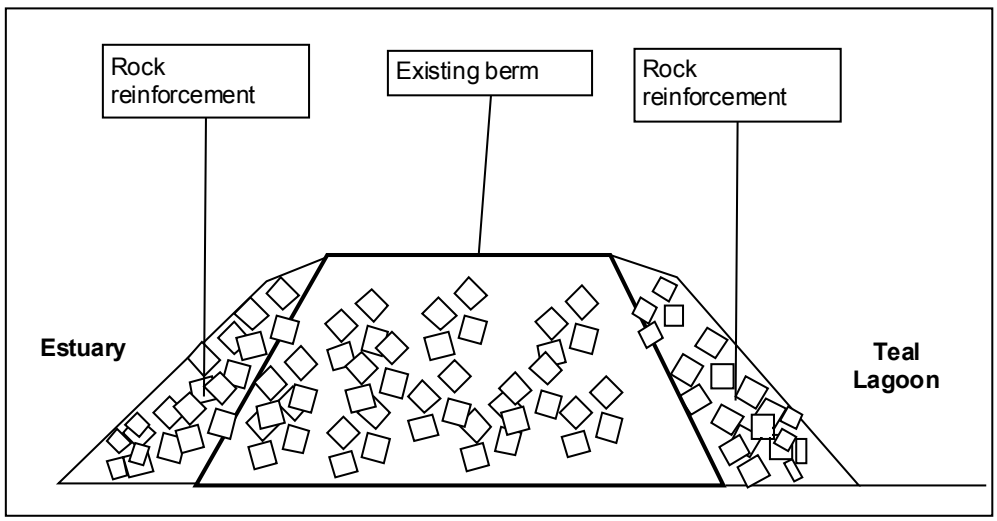

Figure 7: Outline of rock reinforcement option

Option 4: Remove the berm

This option would bring the lagoon to fully tidal conditions and allow full fish passage. There are issues associated with salt water penetration including the following:

- the likely intensive colonisation of Teal Lagoon by mangroves;
- the subsequent loss of waterbird habitat;
- potential detrimental effects on threatened species; and
- the inundation of private property with salt water.

If the berm was to be removed, the rubble wall would be excavated and reused as fill or taken to landfill.

NSW Fisheries Legislation issues in Teal Lagoon management

NSW Fisheries has management responsibilities in regard to fish and fish habitat under the Fisheries Management Act 1994, Marine Parks Act 1997 and the Fisheries Amendment Act

1997. Activities such as the regulation of water flows, the erection of physical barriers such as dams and weirs, the construction of river and estuary management works, and dredging are assessed.

In particular, fish passage may be required through obstructions through some form of fishway, if they alter, modify or construct a dam, weir or floodgate. Therefore, any proposal that involves construction, modification or alteration, which requires approval by a public authority (including local government) must be referred to NSW Fisheries for determination (Dwyer, 2002). This provision will apply to the Teal Lagoon situation.

The degree to which any water control structure is opened varies from site to site. A safe operational level is usually decided on over a twelve month trial period in consultation with the key stakeholders and is included in a management plan for that particular drainage system. This approach is conservative but provides for long term tidal exchange, which also reduces the need for floodgate managers to continually adjust the sluice gate opening (NSW Fisheries, 2002).

11.1.5. Area 5 – West elevated land

Options for land on the east side of Teal Lagoon vary substantially, from reforestation to wetland construction. Both these options would increase the biodiversity value of the subject land, however, reforestation with trees and shrubs would most likely reduce the value of Teal Lagoon for waterbirds by reducing visibility. Conversely, there is concern over the feasibility of proposing several constructed wetlands. A suitable compromise may be to plant grasses and sedges that will provide foraging habitat for grass owls and maintain waterbird sight distances.

A constructed freshwater wetland on this area would feature many of the same design characteristics as the proposed stormwater wetland in Area 2. Minimal earthworks would be required, with the main task being removal of the Kikuyu grass and shallow topsoil to a general depth of 35-40cm, with some deeper macroinvertebrate habitat areas of 60-70cm.

Section 12 Revegetation addresses methods for vegetating with grasses and sedges. This approach would benefit the Grass Owl, and less earthworks would be required. This option also reduces the potential impact of plant height on bird line-of-sight requirements.

11.1.6. Area 6 – Estuary

A cement pipe exists in the north of the site, channelling some tidal flows to the eastern mangroves and saltmarsh. Sediments are eroding from around the pipe, making the pipe redundant. Removal of the pipe would allow the area to go back to natural conditions. There would be an initial disturbance in sediments as the pipe is removed however this would be minimal and localised.

11.1.7. Area 7 – Central inlet

Do nothing

According to anecdotal evidence, the erosion within the Main Berm has occurred only relatively recently. By allowing the berm to erode naturally, there would be no costs involved, however it is uncertain how much of the berm would erode, or over what time period.

Remove the berm

By removing the berm from the entrance to the Central Inlet, fish passage would improve and the area would return to its previous natural condition. However, with the increased tidal flushing will come an increase in mangrove propagules. The colonisation rate of mangroves will be determined greatly by the extent of saltmarsh and *Juncus* remaining within the inlet over time. As it is difficult to determine the exact impacts on the vegetation it is also recommended that the area be monitored, either by Council staff or by research students. If the berm is removed it is suggested that the best option for disposing of the berm material is to place it back in the depression beside the berm from which it apparently originally removed. A mini-excavator may be the most suitable machine for this task.

Repair the berm

Another option for the area is to repair the damaged berm and either control the tidal exchange between the estuary and the Central Inlet by maintaining the 150mm pipes, or stop tidal exchange completely.

11.1.8. Area 8 – Central elevated land

This area can be revegetated with native grasses and sedges as and when funding becomes available. Leaving the site vegetated with Kikuyu grass will pose a risk of Kikuyu re-establishing in other revegetated areas, such as Area 5 and Area 10, these being directly connected to Area 8. A suitable planting approach is outlined in Section 12 Revegetation.

11.1.9. Area 9 – East inlet

Remove the berm

By removing the berm from the entrance to the East Inlet, fish passage will improve and the area will return to its previous natural condition. However, with the increased tidal flushing will come an increase in mangrove propagules. The colonisation rate of mangroves will be determined greatly by the extent of saltmarsh and *Juncus* remaining within the inlet over time. If the berm is to be removed, it is recommended that a similar method to that for the Central Inlet be followed.

Manage the berm

Other options for the area is to either do nothing or reinforce the berm against erosion. By doing nothing, the berm is left to naturally erode over time. There are no costs involved with this option, and while it keeps the inlet in its current condition, there remains no fish passage into and out of the inlet.

Reinforcing the berm allows for either control of the tidal exchange between the estuary and the Central Inlet by maintaining the 150mm pipes, or stopping tidal exchange completely by removing or blocking the pipes. Again, there will be no fish passage into the inlet with this option. However, if the section of Main Berm leading into Area 7 (Central Inlet) was removed, it could be advantageous to leave the berm section across the entrance to the East Inlet, in order to make long-term comparisons between the two inlets in regards to habitat change. Should the removal of the Central Inlet berm prove successful, an assessment of the removal of the East Inlet berm could be carried out.

11.1.10. Area 10 – East elevated land

To help reduce the visual impact of the sewer pump station, a barrier of trees should be planted. This planting can continue north until just past the Casuarinas (Map BB028-12, Appendix 4) to restore the original riparian vegetation of the area. Plants in this area would include the species listed in Section 12 Revegetation.

11.1.11. Area 11 – Roadside vegetation

Barrier planting

To reduce the impacts of increased traffic volumes along Boyters Lane, especially at night, it is recommended that a thick barrier of native species such as Lillypilly spp. be planted between the road and Teal Lagoon be increased to form a thicker barrier (Map BB028-9, Appendix 4). This barrier planting should also extend along the road towards the parking lots and towards South West Rocks Road by 30 to 40 meters, to reduce obtuse lighting and dust impacts. A suitable planting approach is outlined in Section 12 Revegetation.

11.2. Other Community Facilities

11.2.1. Recommendations for lights

As outlined in Section 9.2.1 Playing Field Issues, Type D environmental lights are recommended, to be designed by lighting engineers. Designers will assess the light type, the location and height of poles.

11.2.2. Accessway Routes

A number of pedestrian and cycleway routes have been identified to connect the new playing fields to the township of South West Rocks. These routes are shown on Map BB028-13 (Appendix 4).

Base materials for paths are listed in Table 5, with their associated approximate costs. These costs can vary depending on the supplier and works location. A walking path and shared cycleway is generally 1.5m wide, or up to 2m wide for higher user volumes. For Boyters Lane, a track width of 1.5m is assumed. By sealing the accessway, long-term maintenance is reduced and the level of service for users in improved.

Table 5: Materials and Approximate Costs for Accessway Materials

Material	Description	Cost per lineal metre
Gravel	1500mm wide gravel track, 150mm thick	$45 to $55
Asphalt	25mm Asphalt surface, 1500mm wide	$10 to $15
Boardwalk	Simple low level boardwalk, 1500mm wide, up to 600mm above ground, no handrails	$280

The long-term plan by Council to link the Boyters Lane site with residential areas on the northern side of Spencers Creek involves constructing a footbridge across the creek capable of carrying both pedestrians and cyclists. There are two options for the creek crossing:

1. New pedestrian footbridge on the northern side of the site, and

2. Walkway addition on the northern side of the existing road bridge on South West Rocks Road.

The design of the new bridge would need to be assessed under the Rivers and Foreshore Improvement Act (1948) for any impacts to the navigability of the waterway. The new bridge would be approximately 80m long and at this stage no investigation of the abutments or creek bed has been carried out. A ballpark cost estimate for this construction is $200,000-$250,000. By constructing a new walkway across Spencers Creek from the residential area, access to the wetland becomes easier for domestic animals such as dogs and cats, particularly at night.

The addition of a pedestrian walkway to the existing road bridge will be considerably cheaper and will also require less design and approval costs.

Maintenance

Long term maintenance of the access options also needs to be considered in the options assessment. Potential maintenance activities are summarised as follows:

- repair gravel track surface – yearly
- repair asphalt surface – five-yearly
- timber replacement on boardwalks – five-yearly
- bridge structure repairs – ten-yearly
- painting and bridge surface repair – yearly

Route 1. Through wetland along Main Berm

Route 1 requires bridge to be constructed across Spencers Creek that is suitable for boat passage underneath. This can be relatively costly, with estimates of above $200,000-$250,000, based on similar constructions elsewhere in NSW.

One advantage of this route is that the main elevated berm is already present. However, this is an expensive option because of the repair required to the degrading berms on the site. The route also crosses a number of low-lying areas where an elevated boardwalk may be required. While this option is the shortest distance from the township to the playing fields, it crosses the most difficult terrain on the site, travelling across old, poorly constructed berms in a poor state of repair. Construction access is also difficult and relies on Teal Berm as the primary access. In the long term this route will require more maintenance than the other routes proposed.

Distance = approx. 795m

Maintenance Level = High

Plate 11: Initial concept position of walkway, across berms

Route 2. Along Spencers Creek and Boyters Lane

Route 2 consists of a new bridge across Spencers Creek with the track continuing along the creek around the eastern and southern edge of wetlands, following Boyters Lane to the playing fields. This route would be much easier for construction purposes, as it avoids the difficult areas of the site.

The main path-related works would be to remove the existing topsoil of the pathway, supply, place and compact 150mm thick gravel, and seal with asphalt.

This option reduces the risk of wetland fragmentation and bird flushing, while still allowing boardwalks or walkways into some areas. Some short paths branching off from the main route would allow visitors to the site to get closer to the wetland at particular points. The track generally follows the creek bank and does not traverse any difficult terrain. Construction access can be gained from Boyters Lane.

Distance = approx. 1090m

Maintenance Level = Medium to Low

Route 3. Along Boyters Lane

Route 3 requires a footbridge to be attached to the northern side of South West Rocks Road bridge over Spencers Creek, estimated to be about $30,000. The walkway would follow Boyters Lane only, with some short walks into parts of the wetland. The route would require a sealed path only, with no boardwalks required. This option is the most cost-effective, however the educational goals of Council would not be met.

Distance = approx. 600m (from Spencers Creek), plus offshoot paths

Maintenance Level = Low

Route 4. Along Boyters Road and around Spencers Creek

This option requires a footbridge to be attached to the northern side of South West Rocks Road bridge over Spencers Creek. The path would divide into two separate paths – the first, a "dead-end" path, would follow Spencers Creek to the northern end of the site, while the second would follow Boyters Lane to the playing fields, with some short walks into parts of the wetland. This option caters for both those people interested in the wetland, and those just determined to get to the playing fields.

Distance = approx. 1080m, plus offshoot or loop paths

Maintenance Level = Low

Figure 8: Artist impression of a walkway through the rehabilitated south-east corner

In determining the approximate costs for the four routes (Table 6), it was assumed that the accessway would be sealed. For sections of the paths that are adjacent to the road, a lower cost was assumed.

Table 6: Indicative Costs of Accessway Options

Route	Description	Track Construction			Creek Crossing		Total Estimate
		Length (m)	Approx. Cost/m	Total	Type	Approx. Cost	
One	*Route through centre of site.*						
	i)Teal Berm and Central Elevated Land	392	$65	$25,480	Footbridge at north of site	$250,000	$363,400
	ii) Main Berm – boardwalk	314	$280	$87,920			
Two	*Route along creekbank*						
	i) Within site boundary	636	$65	$41,340	Footbridge at north of site	$250,000	$304,420
	ii) Sharing road	327	$40	$13,040			
Three	*Route along road*						
	i) Within site boundary	21	$65	$1,430	Footbridge attached to existing road bridge	$30,000	$54,550
	ii) Sharing road	578	$40	$23,120			
Four	*Route along road and along creekbank*						
	i) Within site boundary	157	$65	$10,205	Footbridge attached to existing road bridge	$30,000	$84,705
	ii) Sharing road	327	$40	$13,040			
	iii) Along creek bank	484	$65	$31,460			

Notes on cost estimates:
- These figures are presented as a guide only for the purposes of comparing options
- Actual costs may vary depending on specific site conditions
- Track costs assume surface is sealed with asphalt
- These costs do not include GST.

11.2.3. Bird Hides

It is proposed to construct one bird hide overlooking Teal Lagoon. Important points to consider in designing a bird hide include: aspect, concealed entry for visitors, back screen to reduce silhouette, screen around the base to stop birds getting under the hide, provision of seating, provision of variable observation heights, small bench to rest bird books and binoculars, and ability to observe several areas of the wetland. Vandalism can be a problem with bird hides. Lockable structures can attract attention and damage, whilst simpler structures allow access but are much less expensive to repair damage.

Based on the above considerations it is proposed to construct a wooden bird hide on the western side of Teal Lagoon (refer to Figure 1 in the appended Fauna Report by Sandpiper Environmental for location). This hide would overlook the lagoon and constructed wetland. A detailed design would be required that satisfies Councils construction standard and the specific requirements of the site. A hide will cost between $5,000 and $10,000 to construct.

11.2.4. Education Information

The Boyters Lane Wetland will be a showpiece of environmental restoration and rehabilitation, with great value for Council and community. The Wetland will also act as a model for other communities considering similar projects, and provide lessons in appropriate remediation techniques for other sites in Kempsey Shire. The Wetland project objectives and the information gained from implementing the Management Plan can be communicated in a number of ways.

The objectives of a community environmental communication strategy could be:

- Raise the profile of the Boyters Lane Wetland as an example of how development of community facilities can proceed in harmony with nature
- Encourage community understanding and appreciation of wetland values such as rich bird and estuarine life
- Encourage community 'ownership' of the site and the project
- Build the partnership between Council and community

The environmental education component should aim to reach regional environmental groups, general community and interest groups, government agency staff, universities and schools. In particular local schools in South West Rocks and surrounding areas should be contacted by Council and informed about the project with a view to the schools undertaking field trips to the site. Educational materials such as photographs of the different zones of the site, and descriptions of the life of the animals and plants of the Wetland can be used in the classrooms.

Some key messages include for example:

- the Boyters Lane Wetland - a place of birds, fish, crabs and prawns
- the Boyters Lane Wetland - a place of peace and quiet
- the Boyters Lane Wetland - a place of restored environment

Interpretive signs would be distributed at key locations along the walkway. Each sign would cover a different aspect of wetland ecology, relevant to its location. Topics covered by signs may include:

- Ecology of estuarine habitats, i.e. mudflats, saltmarsh, mangroves, and the interactions between invertebrates, fish and birds.
- Waterbirds commonly recorded at the Boyters Lane Wetland, their identification and habits.
- Information on wetland functions and values
- The history of the site and the measures adopted to restore and manage habitats
- Describe regeneration planting
- Overview of the ecology and management of floodplain wetlands on the Macleay River Floodplain.

This type of interpretive signage is now well advanced in design and attractiveness. Metal sign boards with strong fixings generally cost about $400-$500 each for a size of about 800mm by 800mm.

There is a good opportunity to involve Aboriginal people in the development of interpretive signage. The Booroongen Djugun College expressed interest in contributing to this aspect.

11.2.5. Viewing Platform

It is proposed to construct one viewing platform in the eastern side of the wetland. The platform would be of a simple design, with one edge situated at the entrance ground level and the other edge projecting over the wetland. The outer edge may be between 1 and 2 m above the ground depending on the slope of the bank. A wooden rail should be constructed around the edge of the platform.

The size of the platform could vary depending on the availability of funds and the expected demand for such a facility. A platform that is 4*3m may be sufficient to cater for the anticipated use of the wetland. The cost of such as platform would vary depending on the stability of surrounding ground and Councils construction standard.

11.2.6. Vehicle Control and Road Maintenance

The road from South West Rocks Road to at least the western boundary of the playing fields will need to be sealed, in order to cope with the increased traffic. The road is also likely to be too narrow in its present state to safely handle an increase in traffic. Widening of the road where possible is recommended, without impacting on the barrier planting to the wetland or the wetland itself. Council staff have advised that the road will be upgraded in line with Standards.

Another issue is the intersection of Boyters Lane with South West Rocks Road. There have been strong concerns regarding the adequateness of the current intersection system, and calls for a possible roundabout or similar traffic control structure being implemented, to reduce the risk of accidents.

Screen vegetation would be planted between the path and wetlands, particularly Teal Lagoon. Signs would also be erected in the vicinity of Teal Lagoon to warn motorists that birds cross the road in that area. To minimise the risk of road strike a 50km speed zone may be appropriate for the section of Boyters Lane that runs adjacent to the wetland and sports fields.

11.2.7. Picnic Facilities

A valuable suggestion to recommend the placement of picnic facilities near Spencers Creek was made by a community member for this Plan (see Map BB028-12, Appendix 4). The proposal was based on the argument that along with general community use as a day picnic area, people who might ordinarily not have a lot of interest in biodiversity may be introduced to the natural values and beauty of the site through enjoying recreation on the site.

The concept includes the allocation of about 900m^2 (about 30m x 30m) of landscaped parking area with several picnic tables and a shelter on the western bank of Spencers Creek, near the road bridge. The landscaping should include shrubs and shade trees. Barbecue facilities would add to the attractiveness. Interpretive signage regarding the wetlands and forest complex would inform visitors about the project and the layout of the wetlands. Paths could lead from the picnic area to join site paths to designated viewing points.

Planning for potential litter pollution should include signage and provision of appropriately placed rubbish bins.

12. Revegetation

Site investigations have shown that there are opportunities for revegetation. Well planned revegetation activities will serve to:

- Enhance and extend fauna habitat
- Improve connectivity between existing stands of native vegetation
- Protect and stabilize site soils.

The principal vegetation communities found within the subject site, as described within section 5 are:

- Mangrove forest, Saltmarsh, Swamp Oak Forest, and *Juncus/Schoenoplectus* complex

Species selection for the revegetation activities must be informed by site characteristics including:

- Soils
- Hydrology
- Aspect
- Salinity

Revegetation activities are unlikely to be successful if site conditions are not addressed, which may result in the waste of limited resources. The publication *Revegetating Streams in the Macleay Catchment. A Guide to Species and Planting Methods* (Raine and Gardner (1997) lists and describes suitable plant species for the Toe, Middle and Upper positions in relation to streams of the Macleay area (Figure 9). The relevant sections for this Plan are the Eastern streams, including the lower Macleay River. The recommendations include species suitable for poorly drained sites. This could apply to the Boyters Lane site, with its high water table and proximity to tidal waters.

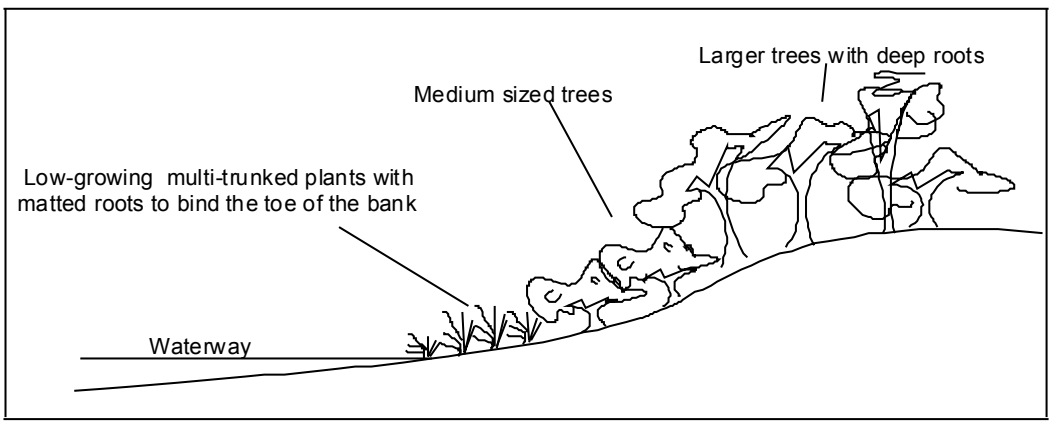

Figure 9: Outline of vegetation sequence as a guide for revegetation. *Adapted from Raine and Gardner (1997)*

For the Toe, species such as Creek Lilly Pillies (*Acmena smithii*), *Casuarina cunninghamiana*, *C. glauca*, *Leptospermum brachyandrum*, *Lomandra hystrix* and *L. longifolia*, *Melaleuca bracteata*, *Phragmites australis*, and *Tristaniopsis laurina* are suggested for poorly drained sites, with the added recommendation that *C. glauca* (Swamp Oak) should only be planted on sites where it already exists. For the Middle zone the Guide recommends a range of 19 species including *Acacia*, *Acmena* (lilly pilly), *Callistemon*, Figs, *Guioa*, *Melaleuca* and White Cedar species.

Atkinson (1999) assessed vegetation distribution in the area, and stated that although there has been no comprehensive mapping of the vegetation for the Kempsey area generally, a number of patterns have been identified. Subtropical and dry rainforest occurs in protected gullies and south-facing slopes mainly on deep red (volcanic) krasnozem soils, more often in the mountains but also were once extensive along the Macleay lower reaches on the river levee banks. Atkinson (1999) described the swamp sclerophyll forests of coastal lowlands on poorly drained sites that are inundated for appreciable periods. Their structure ranged from open to low closed forest about 15m in height, occasionally to 30m height.

"They usually consist of almost pure stands of swamp oak (*Casuarina glauca*) or broad-leaved paperbark (*Melaleuca quinquenervia*), and grade inland from cheoppod (saltmarsh) to swamp oak (in higher salinity) or to paperbark" (Atkinson, 1999). The understorey is usually composed of sedges.

Atkinson (1999) also stated that a range of rushes and sedges are common in swampy areas with standing water. *Juncus kraussii* (the salt rush on the Boyters Lane site) and sand couch (*Sporobulus virginicus*) are found on the estuarine mudflats just above high tide level with occasional emergents of swamp oak. Swamp Mahogany (*Eucalyptus robusta*) is also found on low-lying areas, usually slightly higher in elevation than paperbark and swamp oak, but also associated with these species. Associated sedges include *Gahnia clarkei, Restio tetraphyllus* and the wetland fern *Blechnum camfieldii*.

Several community representatives and individuals expressed a preference for including rainforest species where possible in revegetation plans for the site.

Consultation with Kempsey district Landcare coordinator Lindy Brown indicated that no large scale Landcare plantings have been carried out in the saline low-lying soils of the lower floodplain that would be applicable to the Boyters Lane site. It is recommended that before rainforest plants are introduced, areas within the site that could potentially support rainforest species be identified in greater detail.

12.1. Rainforest Revegetation

As stated in the previous section, historically subtropical and dry rainforest occurs in protected gullies and south-facing slopes mainly on deep red (volcanic) krasnozem soils, more often in the mountains, but these were also once extensive along the Macleay lower reaches on the river levee banks.

Rainforest revegetation should only occur in areas capable of supporting mesic species. Alex Floyd, a leading expert in Australian rainforest ecology (author of the two volumes of *Australian Rainforests in New South Wales*) was asked for an opinion on the question of vegetation of the site.

Based on this and other advice received it is likely that the original vegetation of the site was predominantly swamp forest dominated by *Casuarina glauca*, with associated *M. quinquenervia* and *E. robusta*, and ground covers of *Hydrocotyle*, and *Juncus kraussii.* Some vines such as silkpod (*Parsonia straminea*) are common in this vegetation type (Atkinson, 1999). In relation to the use of rainforest species in revegetating the site, no definite guidelines based on other plantings are available for the area, and there is therefore a substantial risk involved in planting rainforest in the saline, low-lying soils. Greening Australia (1999) stated that "recovery may not occur where conditions are contrary to the biological requirements of the individual plants".

Alex suggested a range of species which may be suitable for these saline low-lying areas, such as: *Melaleuca quinquenervia, Melaleuca styphelioides, Callistemon salignus, Casuarina glauca, Elaeocarpus obovatus, Myoporum acuminatum*.

Further advice was received from a range of Natural Resource Management personnel with local knowledge of the area, and the consensus of opinion is that rainforest in that area would have been confined to the raised river levees, where the lighter alluvial well-drained soils and less saline water would favour the range of rainforest species.

However, if mounding is possible to provide better drainage, then the range can be extended to include: *Guioa semiglauca, Glochidion ferdinandi, Cupaniopsis anacardioides, Alphitonia excelsa, Podocarpus elatus, Pittosporum undulatum, Melastoma malabathricum, Aphananthe philippensis, Streblus brunonianus, Ficus coronata, Acronychia oblongifolia, Syzygium francisii*.

A similar landscape at nearby Killick Creek was assessed for vegetation type, and Figure 10 shows that a small number of rainforest species may be suitable for the higher ground.

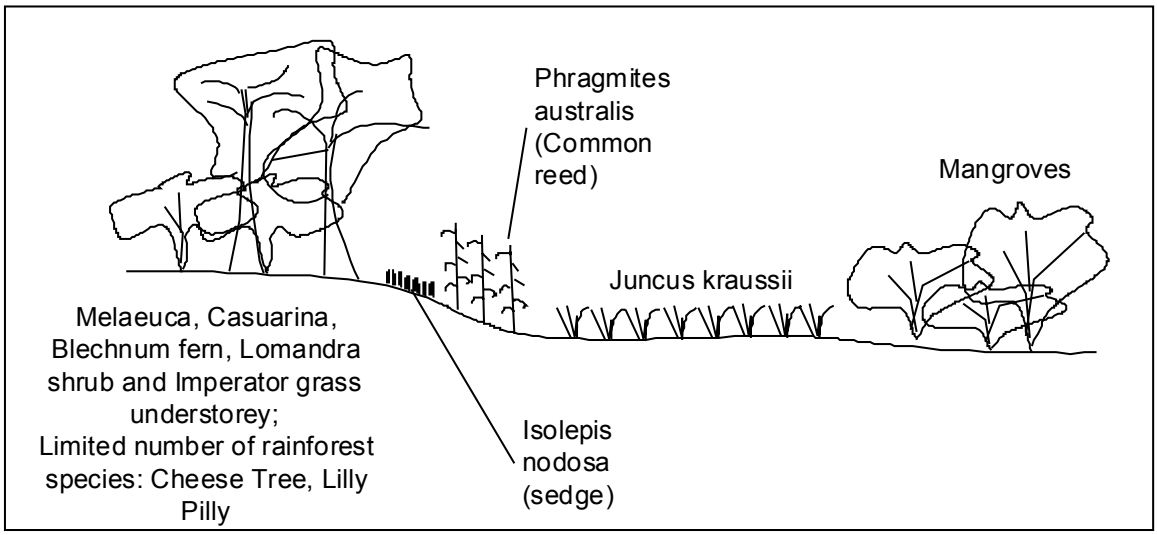

Figure 10: Species distribution in a similar landscape at Killick Creek.

It is questionable if it is desirable or even ecologically responsible to artificially create conditions suitable for establishing rainforest species. However, there is a consensus that a smaller range of rainforest species may be suitable for higher ground on the site if correctly established, and it is suggested that mixed plantings of the species listed above on higher ground should be installed, in conjunction with recommended 'bush food' species.

A trial planting should be carried out on a limited area to determine firstly if selected species will establish at all, and secondly to observe growth rates as a guide to long term survival, particularly in the context of likely competition from swamp forest seedlings over the long term. These rainforest plantings should be limited to the higher ground near the southern edge of the site. No instances have been reported of natural rainforest revegetation occurring in these areas. It is expected that all rainforest plantings would be planned revegetation projects by contractors using nursery-grown plants.

It is essential that all stock is raised using seed from trees growing in or close to this locality and under comparable ecological conditions. A Riverbank Restoration Guide for the nearby Nambucca River (Nambucca Valley Landcare, undated) listed C. glauca, the River Lily (*Crinium pedunculatum*), Hard Quandong (*Eleocharis obovatus*), Guioa (*Guioa semiglauca*), the Cheese Tree (*Glochidion ferdinandi*), Lomandra and Tuckeroo as suitable for toe-to-bank planting, with again *C. glauca,* and a range of species such as Foambark, Red Ash, Broad-leaved paperbark, Rusty-leaved Fig, Deciduous Fig, Cudgerie, Blackbutt, White Bottlebrush, *Acacia melanoxylon* and Grey Ironbark for top-of-bank situations.

Council is presently undertaking a revegetation project on a riverbank site at nearby Jerseyville. The planting plan for this project was provided by Eppie and Tony Jacques of Thumb Creek Nursery at Taylors Arm. When consulted Mrs. Jacques reported on findings from previous plantings in the general area, and suggested that rainforest may be successful in some low-lying areas. She had inspected a property nearby, and had identified a number of rainforest trees that appeared to be growing naturally in a similar environment to the Boyters Lane site and would potentially be suitable for planting on the Boyters Lane site: Guioa (*Guioa semiglauca*), Cheese tree (*Glochidion ferdinandi*), Blueberry ash (*Eleocharis obovata*), Foambark (*Jagera pseudorus*), Scentless Rosewood (*Synoum glandulosum*), Coastal tuckeroo (*Cupaniopsis anarcardioides*), Native Daphne (*Pittosporum undulatum*), Red ash (*Alphitonia excelsa*), Rusty fig (*Ficus rubiginosa*), Small-leaf fig (*Ficus obliqua*), Broad leaf paperbark (*Melaleuca quinquenervia*).

For the higher ground, suitable for windbreaks and 'bush tucker' plants: Cudgerie (*Flindersia schottiana*), Weeping lillypilly (*Waterhousia floribunda*), Water gum (*Tristaniopsis laurina*), Blueberry ash (*Eleocharis obovata*), Guioa (*Guioa semiglauca*), White callistemon (*Callistemon saligna*).

One important factor in revegetation, particularly of rainforest, is the risk of frost damage or death to young plants. Frost damage can devastate a planting. There are few defenses. Leaf-coating products are available and some are now reputed to be more effective than in the past. Plants can be covered with plastic or cardboard to prevent frost settling downwards onto them, but this introduces higher costs, maintenance requirements, and can result in a large litter problem in the case of storms or floods. Some plants are also more frost-resistant than others, but in severe frost years the risk is high. Mulch application does not help.

Acacia melanoxylon (Black or Sally Wattle) is one tree species now used extensively in rainforest plantings elsewhere on the North Coast as it is generally seen as the only plant to survive and thrive in frosty sites, and then provide a reasonable cover for rainforest plantings at a later date. The optimum approach is likely to be a mix of wattles and rainforest on the higher ground, with application of anti-frost treatment.

12.2. Bush Food Plants

Aboriginal people consulted during the preparation of this Plan have requested that 'bush tucker' plants be included in the planting list for revegetation of the site. A number of relevant

plant species are known as being used both by Aboriginal people in traditional culture, and by contemporary growers for a slowly developing bush foods industry. Aboriginal people selected food that was available and ate it for nutrition. Local knowledge of which plants were edible, palatable, or delicious, as well as the best time for harvest, harvest and preparation methods, were passed down by word of mouth from generation to generation. Some plants or their fruits are less toxic at certain times.

The Association of Societies for Growing Australian Plants (ASGAP) (http://farrer.csu.edu.au/ASGAP/) possesses and disseminates knowledge of species and their use, and a comprehensive treatment is found in Low (1988). Many species are useful as bush foods.

Wattle species include *A. longifolia, A. decurrens, A. floribunda. Acacia* species are found throughout Australia in most climate and soil types. The seeds of many are edible when finely ground, and can be made into damper. *A. sophorae, A. decurrens and A. floribunda* are also ideal plantings for areas that experience heavy frosts. Many Acacia types can also play multiple roles in mixed plantings: - wind break, forage, timber and gum producer (noticeably *A. decurrens*).

Podocarpus elatus: Plum pine - Illawarra Plum - Plum Pine sauce can increasingly be found on menus around the country as an accompaniment to meat dishes. It is also high on the list for farm forestry, having an excellent fine grain and dark wood. It is a rainforest tree but adapts well to a wide range of conditions. Reasonable soil and ample moisture are necessary for optimum fruiting. Trees are male or female and a mix is needed for good fruit production.

Native raspberries are small to medium prickly shrubs, and the sweet red berries can be gathered and eaten raw. *Rubus moluccanus*, also known as *Rubus hillii*, has a metallic sheen on the underside of the leaf. It bears white flowers followed by 10mm red berries in spring to summer. Other species include *Rubus parvifolius* and *Rubus rosifolius*.

Ficus coronata, the Creek sandpaper fig, is a bushy tree with rough, sandpapery leaves, often found near creek banks. The 20mm furry fruit are dark when ripe, and appear on the trunk and larger branches. The fruit is edible raw when fully ripe, but the furry skin can irritate, and should be peeled off first. A number of other native figs are palatable also - e.g. *Ficus fraseri* and *Ficus opposita* - both figs with sandpapery leaves, *Ficus congesta*, and *Ficus racemosa*, the cluster fig which has quite large 50mm fruit in bunches off the trunk (ASGAP, 2004).

These species should further assessed when a planting plan is constructed, but it is expected that all would be planted on higher ground with rainforest species.

12.3. Swamp Forest Revegetation

It is likely that the swamp forest evident on the site will eventually dominate the vegetation on all lower-elevation areas, especially on the 'fingers' that intersect the estuarine embayments. *C. glauca* has been observed in many similar landscapes to be very effective in colonising through copious seed production and germination. *C. glauca* also has the benefit of being an effective anti-weed plant, with its thick litter layer and shade.

Revegetation techniques in this case should be based on principles laid out by Greening Australia (1999): firstly, in ecological restoration projects many ecosystem responses are

unpredictable, and secondly, there is a need for ongoing innovation in restoration techniques. The resulting adaptive management approach includes:

- setting goals
- developing and implementing interim strategies
- monitoring the strategies' implementation
- modifying the decisions and practices in the light of the new information

The two major goals are: (i) clearly identify the vegetation type, association or community desired for the site, and (ii) unless conditions have changed irreversibly, the endpoint vegetation goals should be modelled on the composition and dynamics of the indigenous vegetation communities (Greening Australia, 1999).

The first appropriate approach for a fragmented landscape such as the Boyters Lane site is to facilitate natural regeneration. Planting or direct seeding is only carried out where the native plants are clearly incapable of self-regeneration. This approach is based on the likely success of the native plants, the natural selection processes of the plant stock native to the site, and the mechanisms of recovery can provide insight into the longer-term optimum revegetation approach. This method can be improved by undertaking trials to trigger germination from soil seed banks using fire, smoke, tillage or irrigation (the last is not considered suitable for Boyters Lane). These trials can also provide good information on plant associations for the site (Greening Australia, 1999).

In summary, the most appropriate revegetation approach to the site for the non-estuarine areas not in zones sensitive to bird activity is to:

(i) carry our trial plantings of mixed rainforest species on higher ground near the Boyters Lane roadway, the proposed picnic site near Spencers Creek, and the screen plantings around the playing fields, and

(ii) to begin germination trials of the swamp forest association by allocating trial areas for close slashing, small-scale burning, and light tillage using a scarifier. There is a risk of weeds with these methods, and engagement of a contractor to monitor and maintain the trial areas should be considered.

These methods should be used to achieve the site revegetation goal of restoring as far as possible the natural flora and fauna associations of the site, in the context of severe landscape modifications over a long period that have substantially changed the nature of the site ecology.

It is considered that this vegetation type carries the only substantial fire risk on the site. A specific fire risk management action would be to allow fire truck access along the two eastern areas of proposed forest with a 4m wide track, or as agreed with RFS. These tracks would require slashing once per year.

12.4. Revegetation of areas near waterbird habitat

This Plan describes habitat requirements of the waterbirds present in and around Teal Lagoon, and suggests that no trees should be planted near the birds' roosting, breeding and foraging areas to increase the habitat value of the site. Other vegetation options include:

1. Leaving the Kikuyu grass in place: advantages include resistance of the thick grass to weed invasion, and maintenance of Grass Owl habitat; disadvantages are the maintenance requirement because of fire risk, and possibly the public perception that the site is not managed. The maintenance requirement may be as few as three slashings per year - at the beginning of spring, and again at the end of spring when the fire risk is approaching its highest level, as well as after strong wet season growth.

2. Planting native grasses: Atkinson (1999) identified the dominant native grasses of the general area as including blady grass (*Imperata cylindrica*), kangaroo grass (*Themeda australis*), wallaby grass (*Danthonia longifolia*) and Lomandra (*Lomandra longifolia*). However, most of these grasses (Imperata excepted) were not likely to have been present on the Boyters Lane site prior to European settlement because of the likely presence of swamp forest. The grasses generally prefer well-drained soils on higher ground. Native grasses can also be difficult to germinate from broadcast seeding, and contractors will rarely provide firm assurance of germination success. A native grass specialist nursery consulted for this Plan suggested that the most assured planting method would be to plant grass seedlings and manage them as for a sedge or shrub planting, with herbicide weed control and possibly jute matting. The disadvantage of this approach is in the requirement for large-scale site preparation such as repeat herbicide application over three months, and the subsequent necessity for intensive weed maintenance during the likely slow colonisation of the site by the grasses. The grass seedling density required would be as high as 15/m^2, at a unit cost of $0.30 per seedling, plus maintenance. The total cost can be as high as $5 per square meter. One option is to broadcast *Themeda* seed with *Lomandra* and *Gahnia* seed; another is to seed the quick-growing cover crop, the introduced but sterile rye corn grass which only grows for one season. Native grasses would then colonise the rye.

3. Planting native sedges: Sedges such as *Lomandra*, *Gahnia* spp., *Juncus*, and *Poa* are often used in this situation. A contractor would normally be engaged to provide a site planting plan with follow-up maintenance. Costs are commonly $5 per square meter. Grasses and sedges tend to require higher initial investment, but the intensive maintenance period is generally shorter at about one year, compared with the rainforest maintenance requirement of about three years depending on conditions such as rainfall and weeds.

12.5. Saltmarsh

Consideration of vegetating appropriate areas with saltmarsh species is an option for two of the site management areas. In some ways this option is straightforward: provide the appropriate soil bed at the correct elevation band and saltmarsh will colonise. Only the highest tides will inundate the selected zone, providing good anti-weed protection.

We recommend that more detailed observation and topographic survey should be undertaken, with the aim of better understanding the movement of tides through the site. Unfiltered channels permitting easy access for tides will allow infiltration of mangroves. Isolated pools of water must be avoided because these will allow survival of saltmarsh mosquitoes, particularly if fish cannot access the pools.

Recommended actions:

- Determine appropriate levels by survey to 100mm contours, based on existing saltmarsh communities

- Assess detail of soil requirements
- Weeding for the sites as a whole is important, however if an appropriate inundation regime is implemented, high salinity will kill off unwanted species within the saltmarsh. *Juncus acutus* is a potential threat, but was not observed on site.

Revegetation:

- Re-establishment of appropriate substrate and water levels will aid natural recolonisation by saltmarsh species
- Direct seeding may be effective

Propagation of plant material in a nursery is time consuming and expensive, however it may represent a viable option if limited material is available locally for transplanting.

13. Monitoring

Ongoing assessment and analysis of resource management projects is now a fundamental component of contemporary approaches to achieving healthy catchments and estuaries. The NSW Healthy Rivers Commission reports of the last few years have established strong principles of monitoring and accountability for land and water management.

These principles should be followed by creating clear management goals, clear statements of responsibilities and outcomes to be gained through partnerships, and accountability at the end of each planning cycle for the particular system. Adaptive management has also been a strong theme, and monitoring of project implementation is the only real way of providing the information needed to change management direction when required.

The information requirements for monitoring progress of the Boyters Lane site towards the vision adopted by Council and community in the final Management Plan will relate primarily to changes in the condition of water, fauna and vegetation.

The design of a monitoring program should be appropriate to the sensitivity of the waterbody, the environmental concerns on the site, important potential pollutants, organisms to be monitored, and pollution sources in the catchment.

13.1. Water quality

One advantage in the design of the water monitoring program is the small size of the Boyters Lane catchment. The road itself is the catchment boundary, and except for large floods, the only runoff will be from rainfall on the site itself. The only likely pollutants would therefore be from the abundant bird life in Teal Lagoon, and potentially from the playing fields.

Birds can contribute significant quantities of nutrients and faecal coliform bacteria to water, especially confined waterbodies with few wetland plants. If saltwater flushing is limited in estuaries, materials such as nutrients and bacteria can accumulate to be a problem, with possible algal blooms and high bacteria counts.

Monitoring of flushing efficiency over time is therefore advisable. The difficulty of measuring or modelling tidal flows through structures such as the Teal Berm suggests that monitoring of salinity gradients would be the optimum approach. This can be done by measuring salinity, pH and Electrical Conductivity on a monthly basis as part of Council's regular waterway monitoring program. The cost of analysis of these three physicochemical parameters by Council's Laboratory is $14.30. Allow a half hour of staff time at $50 per hour, means a total cost of about $40 per month.

Measurement of nutrient status could be achieved either by analysing the Chlorophyll *a* (indicator of algal presence) levels at $29.70 per sample, and/or by specific measurement of the major nutrients Total Nitrogen ($34.20 per sample), Oxidised Nitrogen ($28.50), Total Kjeldahl Nitrogen ($28.50), and Total Phosphorus (20.50). All these together would provide a reasonably detailed picture of the nutrient status of Teal Lagoon.

However, such a detailed analysis may be considered excessive when the total cost is $181.40 per month. A balance must be struck between obtaining a correct analysis for management purposes, and the accumulation of expensive data for its own sake. One option is to measure only the physicochemical indicators of salinity, pH and Electrical Conductivity

at $40 per month, with sampling staff to note visible commonsense indications of water quality. These would be Secchi Disc depth (a standard white disc is used to estimate water clarity), water colour, and the presence or absence of algae.

One sampling of Teal Lagoon water was undertaken for this Plan (Table 7), following a major rainfall event. Runoff was seeping slowly through the saturated kikuyu grass towards and into the lagoon. The sampling pattern shows this freshwater influence, with pH, EC and Salinity in the lower range. Although the Chlorophyll *a* concentration is quite high, it is not surprising given the large number of birds and limited tidal exchange of the lagoon. Although filamentous algae is present, severe algal blooms do not appear to be occurring. A single sampling is not sufficient to form a basis for management actions. Water quality and salinity will vary substantially during seasons. Long term monitoring will provide sufficient information for adaptive management.

Table 7: Water quality results from Teal Lagoon (one sample, October 25)

Parameter	Teal Lagoon Water	Common Range of Lower Estuarine Water
pH	7.64	~7.5-8.5
Electrical Conductivity (EC) (dS/m)	20.6	55-58
Chlorophyll 'a' (mg/L)	0.131	n/a
Salinity (parts per thousand)	12.8	30-35

Data and observations should be entered in a spreadsheet, and the monthly pattern over time will provide a good understanding of trends, as well as alert the management group to any serious anomalies that may indicate a need for management action - for example to increase tidal exchange.

The best and safest position for the sampling point in Teal Lagoon is about midway along the western shore, to integrate the effects of high tidal exchange near the berm with the less active water and higher bird numbers in the shallower area of the lagoon.

If a constructed stormwater wetland is installed, a specific monitoring plan would be included in the detailed concept design. This plan would probably recommend quarterly nutrient sampling and analysis, with occasional rainfall event monitoring.

13.2. Fauna

Monitoring of fauna populations on the subject site could include various components, however, it is recommended that monitoring should focus on changes in vertebrate and invertebrate abundance and diversity within restored habitats, and waterbird abundance and diversity within Teal Lagoon. Various other aspects of the site could be monitored, and the final design of a monitoring program may be influenced by funds, community demand and agency requirements following review.

Teal Lagoon is an obvious choice for monitoring. Regardless of the final management option selected, the Lagoon will pose a number of management challenges. The Lagoon provides an important habitat for waterbirds and information on how birds respond to the selected management regime will be essential for the long-term management of the lagoon. Some of the management options, such as the construction of a culvert with dropboards, would

require feedback on the response of waterbirds and their habitat to develop an appropriate management regime.

There is a considerable body of information on the species of waterbirds recorded within Teal Lagoon. This information could be of value in assessing the impact of the selected management option, although the data would need to be interrogated to ascertain its value for this purpose. It is proposed that a basic monitoring program be designed that provides information on the abundance and diversity of waterbirds before and after any changes in management occur. This program could also monitor key aspects of waterbird habitat, such as vegetation growth and invertebrates.

Members of the local community who have experience identifying and counting waterbirds could undertake surveys on a seasonal basis (i.e. four times per year) with specialist input during the design phase.

Birds may also be good indicators of change in restored habitats, although other fauna such as frogs, reptiles and butterflies could also be included in a monitoring program. Fauna inhabiting restored areas could be monitored using replicate 100m * 10m transects established throughout the wetland. These transects could be monitored on a seasonal basis to obtain information on the abundance and diversity of target species/groups. Over time this information would prove useful in determining how fauna respond to changes in habitat associated with the restoration project.

13.3. Flora

Vegetation changes both in existing natural areas and in zones proposed for revegetation with native plants would be monitored primarily by regeneration contractors who undertake the work. Vegetation Management Plans are commonly used to underpin substantial planting projects, at a cost of about $5,000 for a moderately large site such as at Boyters Lane. An example of a typical Vegetation Management Plan is provided in Appendix 5.

Monitoring of revegetation includes visual assessment of plant health, counting of survivors and calculation of losses. Replacement of plants may be needed in some cases.