Creek Management Policies for Joes, Wimbie, Short Beach and Surfside Creeks, Batemans Bay

FINAL REPORT

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1 INTRODUCTION

This document presents Creek Management Policies for:

1. Wimbie Creek;
2. Short Beach Creek;
3. Joes Creek; and
4. Surfside Creek.

The development of formal entrance management policies for these creeks has been the primary driver for the development of the Creek Management Policies. In addition to entrance management, additional management recommendations are made for other aspects of the creeks, which have been noted to require active management, eg odour problems etc.

In a sense the Creek Management Policies presented in this document are a scaled down version of an Estuary Management Plan and are aimed at improving both environmental and social aspects of the creeks.

1.1 Creek Management Policy Context

There are a number of State Government Policies and Guidelines supporting the management of estuarine creeks in a manner that promotes the maintenance of natural processes.

The objective of the NSW State Rivers and Estuaries Policy is to manage the rivers and estuaries of NSW in ways which:

- Slow, halt or reverse the overall rate of degradation in their systems;
- Ensure the long-term sustainability of their essential biophysical functions; and
- Maintain the beneficial use of these resources.

The NSW Estuary Management Policy (1992) is a component policy of the NSW State Rivers and Estuaries Policy (1992). It advocates the sustainable use and management of estuaries through the production and implementation of Estuary Management Plans. The Creek Management Policies will serve a similar function to an Estuary Management Plan and will be incorporated within the Batemans Bay and Clyde River Estuary Management Plan.

Basic principles to be applied in formulating management decisions regarding estuaries are detailed in the NSW Government Estuary Management Manual and include:

- Developments and activities near intermittently opening coastal creeks should be strictly controlled with the objective of maintaining a level of water quality suitable for fish and other aquatic life;
- Whenever possible, estuarine foreshores, wetlands and aquatic habitats should be preserved in their natural state;

- Estuarine habitats should be protected by appropriate zoning and development controls; this applies particularly to saltmarshes, mangroves, seagrass beds, islands and other areas of importance to nature conservation;
- Developments or activities should not be allowed to restrict tidal exchange, tidal inundation of low-lying lands, or fish passage; and
- Areas zoned for development should be separated by 'buffer zones' of adequate width from ecologically sensitive areas, especially wetlands.

1.2 Entrance Management

Records indicate that the entrances to each of these creeks open naturally and have at times been opened artificially. The historic reasons for opening the creeks includes alleviating flooding of low-lying assets, improving water quality as a result of toxic spills, sewer pump station overflows and alleviating odour problems. However, opening of the creeks has been performed on an "as needs" basis without consideration for the broader environmental impacts of these actions, and without any formal consultation with other natural resource managers, eg NSW Fisheries.

The development of a formal procedure for entrance management (i.e. opening) of the creeks has been the primary driver for the development of the Creek Management Policies. Provisions for entrance management will include:

- The procedures to be followed by Eurobodalla Shire Council (ESC) for artificially opening these creek entrances, should this course of action be necessary;
- The conditions that should be satisfied prior to an artificial opening;
- The responses of authorities to natural opening events; and
- A program of actions to reinstate as far as practicable natural entrance behaviour.

It is worthwhile noting that NSW Fisheries through their publication, Aquatic Habitat Management and Fish Conservation Policy and Guidelines (1998), support minimum interference with estuarine creek barriers. NSW Fisheries support natural processes being allowed to operate to the greatest extent possible. Further, Fisheries do not support the artificial opening of a creek unless there is a threat to public health or safety from flooding or water quality deterioration.

1.3 Aims and Objectives

The aim of these Creek Management Policies is to provide ESC, State Government and the community with a detailed procedure for the short and long-term management of Wimbie Creek, Short Beach Creek, Joes Creek and Surfside Creek which takes into consideration pertinent social, technical and environmental factors.

The Creek Management Policies and associated Review of Environmental Factors will be reviewed regularly and updated to incorporate new information and address the community and government's changing needs.

The specific objectives of the Policy are to:

- Manage the creek in a fashion that is consistent with the principles of ecologically sustainable development;
- Ensure that entrance opening follows as natural a regime as possible, within the constraints of property inundation and flooding of infrastructure;
- Give due consideration to social impacts of creek management policies, specifically to possible odour impacts, amenity, aesthetics and recreation potential;
- Ensure that the health of the creeks and hence their ability to support aquatic ecosystems is maintained and, where possible, improved;
- Gain broad based community understanding and support for adopted creek management policies;
- Deter unauthorised opening of the creeks;
- Streamline the decision-making and approval process in relation to artificial opening events;
- Provide a mechanism for review and update of this policy, when required;
- Ensure the appropriate level of environmental assessment and consultation is undertaken before the creeks are artificially opened;
- Clarify responsibilities and accountabilities in relation to artificially opening the creeks;
- Clarify when, where and how the creeks are artificially opened; and
- Detail the procedure for monitoring the creek entrances after they have opened.

1.4 General Description of Creeks

The "creeks" considered in this document are all relatively small Intermittently Closed and Open Lakes and Lagoons (ICOLLs). There are approximately 30 of these small ICOLLs along the Eurobodalla Coast. They are characterised by small creeks of about 200 metres to 1 km in length and widths of 20-40 m. The physical and ecological functioning of these ICOLLs is poorly understood.

The ICOLLs considered in this report have partly urbanised catchments and the effects of land use changes on these systems remains poorly understood. This is of concern as, collectively, these small coastal creeks may be important for maintaining biodiversity on a local and regional scale. The presence of malodour, stagnation, degraded riparian zones, increased instances of eutrophication and associated algal blooms commonly seen in these small ICOLLs are symptomatic of catchment degradation and environmental stress (University of Canberra, 2002).

The creeks being assessed in this report are particularly susceptible to catchment or oceanic effects due to their small size and low assimilative capacity, which reduces their ability to buffer sudden changes.

The Creek Management Policies will be reviewed and commented on by all relevant State Government agencies, ESC and the community representatives on the Batemans Bay & Clyde River Estuary Management Committee prior to acceptance.

1.5 Current Situation

Breaching of the entrance barriers to Wimbie Creek, Short Beach Creek, Joes Creek and Surfside Creek is periodically undertaken by ESC either to alleviate odour problems associated with the creeks or as a flood prevention strategy for nearby homes and other assets.

ESC is informed of the odour problems by complaints from residents living near these creeks. The levels of odour from the creeks vary throughout the year, but are typically worse during the summer months.

This process of opening the creeks is presently somewhat informal and is performed without prior consultation with other government departments such as the Department of Infrastructure, Planning and Natural Resources, NSW Fisheries, Waterways Authority etc. Also, the broader environmental implications of the current creek management approaches have, to date, not been considered.

1.6 Relationship to Other Documents

In preparing the various Creek Management Policies, background information of a technical (e.g. scientific, town planning and engineering) and social (e.g. previous community consultation studies, Creekcare data etc) nature has been reviewed. Technical information used in the preparation of the Creek Management Policies is included in the Background Information Document.

Accompanying this Policy is a Review of Environmental Factors (REF), prepared in accordance with the requirements of the *Environmental Planning and Assessment Act, 1979*, for artificial opening of the creeks. The objective of the REF is to detail the environmental impacts of artificially opening the creeks.

1.7 Management Strategies

The following sections present details of the proposed management strategies for each creek. Management strategies have been provided under a number of headings to provide clarity. Where possible, photos have been included to demonstrate relevant points.

2 WIMBIE CREEK

2.1 Background Information

Refer to the Background Information Document for more detailed information.

2.2 Entrance Management

Wimbie Creek typically opens naturally before flooding is an issue. In the past, the primary cause for artificial creek opening has been to alleviate excessive odours. Artificial opening of Wimbie Creek for this reason is now infrequent, with the last opening occurring a number of years ago (N. Eyles, pers. comm., 2003).

No formal flood study has been performed for Wimbie Creek, hence no inundation information is presently available. Also, no formal survey of floor levels and other significant assets has been performed to allow identification of low-lying assets in the area. However, a spot level of 2.0 m AHD was identified at the rear of the lowest lots on Newth Place and in the interim period until additional survey data becomes available, this level will be considered as the highest acceptable level of Wimbie Creek, prior to an artificial creek opening. This level was determined from ESC sewer base plans (1:1000 with 1 metre contour interval).

Figure 2-1 shows the presence of homes on Newth Place close to Wimbie Creek.

From creek water level monitoring undertaken in Wimbie Creek since August 2000, the highest observed or recorded water level within the creek was approximately 1.5m AHD. Further, the beach berm level at this relatively sheltered location has been recorded between 0.55m and 0.96m AHD. Hence, the critical creek level of 2.0 m AHD is unlikely to be reached unless there is a significant build-up of sand at the entrance to the creek. This is unlikely based local observations.

Flood levels could be measured from the flood gauge installed on the Wimbie Creek Footbridge as shown on Figure 2-2. Local residents could monitor the gauge and notify Council when critical levels are approached.

Figure 2-1 Homes on Newth Place adjacent to Wimbie Creek

When the creek is opened a channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals of Wimbie Creek in the indicative location shown in Figure 2-2 using mechanical equipment, most likely a backhoe. The machine will access the site as much as possible via established tracks and unvegetated areas. Care will be taken to avoid damage to, or disturbance of, vegetated areas of sand dunes. Excavation will only be undertaken if, one of the following essential criteria are achieved:

- Creek water level at or exceeding 2.0 m AHD; and
- Creek water level is between 1.8 and 2.0 metres AHD and heavy rain is predicted in the catchment.

The location of the entrance excavation will be selected to mimic as far as possible the natural behaviour of entrance openings.

The excavated sand will be placed to the side of the excavated channel and will not be removed from site. The preferred size of excavated channel dimension is 2 wide, with the bed graded to the ocean. Excavation will cease once an outward flow of water has been established. The total excavation time will typically be 2 to 3 hours' duration for a small backhoe.

Flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other estuaries has shown that if excavation is in the area of the natural entrance channel, the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. The location of the channel will be constrained to the south in this case by the presence of rocky outcrops.

Completion of the excavated channel will generally be undertaken during the early falling stage of the tidal cycle. This should ensure the maximum water level difference between the water in the creek and the ocean is maintained for the first few hours of outflow, thereby enhancing scour potential.

From studies performed on Dee Why Lagoon (Gordon, 1981), the success of a breakout will be reduced by the presence of heavy seas; hence no creek opening should be undertaken if heavy seas prevail.

The REF assesses the environmental impacts of this entrance management policy.

2.2.1 Odour

Opening of the creek in the past has allowed oxygenated ocean waters to mix with creek waters, causing the gas producing reactions to cease. However, this method of creek opening addresses only the symptoms of excessive organic loading and not the cause, and its continuation is not recommended. Methods for controlling organic inputs are discussed in Section 2.3.

Location of Channel Opening for Wimbie Creek Figure 2-2

2.3 Other Management Actions

Odour is one of the primary drivers for the development of additional management measures for Wimbie Creek. Additional management actions have been developed to address this and other issues and/or to improve a particular aspects of the creek, such as amenity. A number of the management actions have been determined from review of previous reports, site inspections and discussions with local residents and ESC staff.

2.3.1 Removal of Sea Wrack

The addition of sea wrack from the ocean to Wimbie Creek has been identified as one of the primary causes for odour generation in this creek. The processes by which odour is generated is discussed in detail in the Background Information document.

Sea wrack (mainly kelp) is washed onto Wimbie Beach and into Wimbie Creek as a result of strong onshore winds and high seas. Figure 2-3 shows a relatively light load of sea wrack on Wimbie Beach and rotting sea wrack in the entrance of Wimbie Creek noted during a recent site inspection. It is reported that sea wrack at this location in particular can build up to far greater amounts than those depicted in the photographs (R. Dalton pers. comm.). The quantity of material present on the beach and in the creek should be regularly monitored and controlled.

Removal of sea wrack will assist in improving water quality in the creek; this in turn will assist in improving the aesthetics of the creek as there will be less opportunity for the formation of algal rafts and mats. The process of removal of wrack from NSW beaches for commercial purposes requires the approval of NSW Fisheries. A permit under Clause 60 of the *Fisheries Management (Aquaculture) Regulations 1995* will be necessary. Contact with NSW Fisheries should be made.

It is recommended that inspections after strong onshore winds and high seas by nominated local community members be performed. If excessive sea wrack is noted in the creek or in a location likely to enter the creek, a nominated representative of Council should be contacted and removal of the sea wrack performed. The most efficient method of collecting sea wrack will need to be determined by Council, but it may involve mechanical removal by backhoe and truck. Collected material is a valuable fertilising material and its legal reuse via a nursery as a processed compost material could be considered. Alternatively local nurseries may perform the clean up operation free of charge, however, care would need to be employed in ensuring that they don't remove additional materials unnecessarily.

Small quantities of sea wrack in the entrance may be beneficial as they provide a localised source of nutrients to macroinvertebrates in the creek bed sediments and are unlikely to cause widespread odour problems.

Figure 2-3 Sea Wrack on Wimbie Beach and in the lower reaches of Wimbie Creek

2.3.2 Addition of Crushed Oyster Shell

The addition of crushed oyster shells has been raised as a possibility for odour control within the creek. Oyster shells are composed of calcium carbonate which undergoes a chemical reaction in acidic environments and will raise pH levels. The rate of reaction is directly proportional to the acidity of the water which is generally only ever mildly acidic. Calcium carbonate is not expected to be effective as an odour control agent as it is likely to be relatively quickly covered by organic materials or sediments washed into the creek, thereby limiting its contact with the water column. Also, odour in Wimbie Creek is caused by the decomposition of organic materials which results in anoxic conditions. It is not expected that the addition of calcium carbonate will have any significant effect in preventing the formation of anoxic conditions and hence odour generation.

2.3.3 Catchment Management

Catchment management will assist in limiting the quantities of organic material entering Wimbie Creek and hence bring about an improvement in the stormwater entering Wimbie creek. This in turn will assist in improving the water quality and aesthetics of the creek, as there will be fewer nutrients available for the formation of algal rafts and less litter in the creek.

Nutrients enter Wimbie Creek via stormwater collected in the Wimbie Creek catchment during rain events. The nutrients may either be in a dissolved form (these are not visible to the eye, but come from a variety of sources such as animal faeces, sewage or fertilisers etc) or in a particulate form, bound to small clay or silt particles which can be collected and moved by the stormwater.

2.3.3.1 Urban Stormwater Quality Management Plan

The Urban Stormwater Quality Management Plan (USQMP) for Eurobodalla Shire includes a number of relevant recommendations for particular areas across the shire which relate to the improvement of stormwater quality via a range of catchment management actions. Broad areas of management include:

- Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality;

- Stormwater re-use strategies to be incorporated into Council's water supply strategies/ development control plans;
- Complete & implement Integrated Waste Management System;
- Improve environmental outcomes associated with new development & redevelopment;
- Improve environmental outcomes associated with existing development; and
- Improve base data on water quality.

Supporting these broad objectives is a range of management options, many of which, if implemented in the Wimbie Creek catchment, would have a significant benefit in terms of improving stormwater quality. Specific examples are detailed below:

Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality

- *Provision of a skilled and motivated workforce* - There has been a large increase in the knowledge base surrounding urban stormwater and its effect on the environment over the past decade, it is important to ensure that all staff continue to be adequately trained in the field of Soil and Water Management;
- *Infrastructure strategies/project investigation continue to take account of environment issues, including urban stormwater quality management* – Council works in the catchment can have in impact on downstream water quality, the effect of these need to be taken into consideration during the planning, design and construction phases.
- *Maintenance of urban roads* – Opportunities to introduce street sweeping along roads that drain directly to the creek should be investigated in order to reduce the regular organic load discharging to the creek. Any unsealed roads that may contribute sediment should be investigated for sealing. Sealed roads in poor condition should be investigated for resealing.
- *Maintenance of parks & reserves* – Maintenance staff need to be aware of the importance of riparian vegetation to ensure that it is not destroyed by mowing etc. Also there is a need to ensure that adequate waste bins with lids are provided and that these are emptied regularly.
- *Continue to support the Clean-up Australia campaign* – Campaigns such as this could be used to provide a focus on local creek cleanups.
- *Adoption of mowing practises that inhibit the movement of litter/trash (& other pollutants) into waterways* – This would help reduce the loads of organics and trash entering the creeks. Organic matter such as grass is highly labile (i.e. is broken down easily) and it will more readily consume oxygen.
- *Reserve management plans to take account of stormwater quality management objectives* – It is important that the management of the reserves assists in managing creeks by providing riparian buffers.
- *Opportunities for enlisting the services of volunteer groups for various works contributing to improved environmental outcomes be investigated* – This will be useful in monitoring creek conditions, eg odour, water quality monitoring and assisting in other activities such as creek cleanouts and riparian tree planting activities etc.

Improve environmental outcomes associated with new development & redevelopment

- *Strategic links from land use and development control planning to creek management polices.* The vulnerability of Wimbie Creek should be considered in land use and development control planning within the catchment, e.g. no increase in nutrient loads to creek should result from development etc.
- *Land identified in LEPs and DCPs by way of open space, no development zones and/or constrained land use to provide protection of the environment, including consideration of potential impacts on stream flows, water quality, riparian vegetation & aquatic ecosystems.* Council reserves along the length of Wimbie Creek should be utilised as far as possible for improving water quality and riparian vegetation. This will have flow on effects for the aquatic ecosystems within Wimbie Creek.
- *All new DCPs provide for the need to consider stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems.* The needs of Wimbie Creek should be specified in DCPs for the catchment, e.g. no increase in nutrient loads to creek, no increase in peak flows or stormwater volumes etc.
- *Subdivision guidelines be amended to require consideration of stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems prior to granting approval of the proposed subdivision layout. Applications for subdivisions greater than ten lots to be supported by an environmental study from an appropriately qualified and experienced environmental consultant.* New approaches to designing urban subdivisions such as those based around Water Sensitive Urban Design should be promoted in the subdivision guidelines.
- *Soil & Water Management during construction for small-scale residential developments*. These practices should be continued with increased emphasis on education of builders and enforcement of regulations. New approaches may need to be investigated to improve current performance, such as certification of compliance, bond systems etc.

Improve environmental outcomes associated with existing development

- *Development over and above single residences be conditioned to provide a site specific Soil & Water Management Plan to address both potential short and long term impacts on stormwater quality management outcomes.*
- *Continue to foster and support community involvement in environmental issues including stormwater quality management through local Landcare, Dunecare & Creekcare committees*
- *Foster water quality monitoring of local waterways by Creekcare groups*
- *Pursue grant funding opportunities to run localised education campaigns to supplement State government education campaigns*
- *Make use of existing Council newsletters to educate residents, making use of existing EPA resources where possible*
- *Continue drain stencilling to reinforce to the community where stormwater ends up*

2.3.3.2 Specific Catchment Management Recommendations for Wimbie Creek

The control of diffuse forms of nutrient can be difficult in established urban areas. However, with careful review of current systems, opportunities for retrofit may be identified. One such example of a retrofit has been identified from site inspections. The culvert at the end of Highview Avenue could be removed and stormwater allowed to flow overland through the broad area of vegetated open space (approximately 10 to 15m wide) between the cul-de-sac and the creek. The pipe as shown in Figure 2-4 has been installed poorly or water flow has scoured out soil surrounding the pipe, presenting a hazard for those walking or running along the creek bank.

Figure 2-4 Stormwater pipe exit location at Highview Avenue

Site inspections revealed that significant quantities of organic material, mainly in the form of garden wastes, eg lawn clippings, tree trimmings etc were being dumped in Council Reserve lands along the banks of Wimbie Creek as shown in Figure 2-5. In particular, there have been reports of dumped lawn clippings and garden waste on mangroves along Wimbie Creek (D. Mackenzie, pers. comm. 2003). It is believed that local residents are responsible for these actions.

Local residents will need to be made aware of the potential impact that increased nutrient input to the creek has upon odour. This could be achieved through a targeted education campaign enacted either through handouts or a local meeting coordinated though Creekcare representatives. The educational material could focus on correct disposal of garden waste, collection and correct disposal of animal faeces, and more benign or 'environmentally friendly' methods of garden fertilisation. Refer to Section 2.3.7 for more details relating to potential community education actions.

There may be additional nutrients entering the creek from point sources further up in the catchment, i.e. the refuse tip, quarry and sewage treatment works, however, no evidence of these inputs has been found in this, or previous scientific investigations.

Figure 2-5 Vegetation disposal along banks of Wimbie Creek

2.3.4 Creek Aesthetics and Amenity

The abovementioned catchment management practices will limit nutrient input to the creek. This will improve creek aesthetics in several ways including:

- Reducing conditions suitable to the formation of floating algal rafts and algal mats on the creek bed (algal rafts/mats noted during site inspections are shown in Figure 2-6);
- Reducing the quantity of black sulphidic materials formed on the creek bed (an example of the sulphide deposits noted during site inspections is shown in Figure 2-6); and
- Generally improving the clarity and appearance of creek waters.

During site inspections additional opportunities to improve creek aesthetics and/or recreational amenity were noted. These include:

- A 'one off' campaign to remove old or unused creek structures like the old crossing shown in Figure 2-7. This structure has probably failed as a result of old age or a flood event. There were some metal stakes and other potentially hazardous structures, like the pipe shown in Figure 2-4 that if fixed would improve the safety and recreational amenity of the creek.
- An annual campaign to remove other forms of human derived wastes, such as drink bottles, plastic bags etc. This could be tied in with Clean Up Australia Day activities.
- An annual campaign to remove excessive quantities of organic material in or near the creek, such as lawn and garden cuttings, weeds (garden escapees) and algae. This could be tied in with Clean Up Australia Day activities. However, it is not recommended to "desnag" the creek, as these obstructions provide habitat for fish species which are known to use the creek on occasions.

Figure 2-6 Algal rafts/mats in creek and sulphide deposits on creek bank

- Riparian zone management to improve the quality of the riparian vegetation which is sparse in many locations along the creek. Also gaps in the tree cover were noted during site inspections and this allows sunlight to reach the water and fuel photosynthetic reactions which allow algae to grow and multiply. In order to achieve the desired result, a study of the condition of the riparian corridor by a suitably qualified person in order to prepare a planting schedule for the Reserve is recommended. The Planting schedule should consider the provision of walkways/egress routes and needs of the creek for shelter and provision of habitat. Riparian management should be designed to assist in stabilisation of creek bank structures as some bank erosion was noted in areas. Also, tree species to be planted should be consistent with the dominant floral communities in that area which consist mainly of *Corymbia maculata* (Spotted Gum), *E. paniculata, E. botryoides* and/or E. *saligna* which are coastal species, common in the whole shire in the coastal zone. Additional bird or animal attracting tree/shrub species may assist in improving the faunal diversity in this region, further improving its aesthetics and recreational potential.
- Regular campaigns to remove and/or monitor weed growth along creek banks. The encroachment of urban development and urban gardens has allowed weeds to be carried or spread to Wimbie Creek. Weed infestation is likely to inhibit the growth of native species as weeds can out-compete the natives in the early growing stages. The weed removal campaigns may need to co-ordinate or be integrated into current Shire wide weed management practices.
- Better delineation of Council Reserve land. At present there is insufficient signage to identify Council Reserve land. If the Reserve boundary is marked this may encourage people to recreate in the area, as they will know that they are not trespassing. It will also encourage homeowners not to dispose of wastes outside their land boundary. If signage is used, it should stipulate that there is to be no dumping of wastes in Wimbie Creek.

Figure 2-7 Abandoned Creek Crossing

2.3.5 Interrelationship of Management Option Impacts

Each management option proposed has an impact on one or more aspects of the creek. Table 2-1 details the various management options selected for Wimbie Creek and identifies the interrelationships between them.

Table 2-1 Interrelationships between Management Option Impacts

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
Creek opening to prevent flooding	will result in tidal flushing with oceanic waters, this may or may not improve the water quality in Wimbie Creek as it depends on what the water quality was like prior to opening.	is likely to reduce sedimentation as sediment laden floodwaters will be washed out to sea. The opening is also likely to result in some scour of sediments. These will be washed into the ocean or deposited on the beach.	can cause macro-invertebrates in the sediments to be washed into the ocean. This provides a source of food for fish. The opening may allow for recruitment/loss of species such as fish and prawns to/from the creek.	is likely to disturb sediments. This may result in the temporary release of hydrogen sulphide gas. The opening generally results in tidal flushing which tends to improve the appearance and smell of creek waters thereby improving aesthetics. Reduced water levels increase opportunities for passive recreation, eg walking.
Catchment management to limit sediment and organic input	will have the effect of improving water quality in the creek.	will have the effect of reducing sediment inputs to the creek.	will assist in improve the ecological functioning of the creek, by reducing the occurrence of anoxia and macroalgae blooms.	will have the effect of reducing the occurrence of odour. is unlikely to have little effect on recreational potential of the creek.

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
Berm management to prevent sea wrack input	will have the effect of improving water quality in the creek.	will have no effect on sedimentation.	will assist in improving the ecological functioning of the creek, by reducing the occurrence of anoxia and macroalgae blooms in the creek.	will have the effect of reducing the occurrence of odour. The removal of sea wrack will increase opportunities for recreation in front of the creek.
Removal of old creek structures	will have no effect on water quality.	will have no effect on sedimentation.	will have no effect on ecology.	will have no effect on odour. This will improve the aesthetics of the creek and hence passive recreational potential.
Annual campaign to remove human derived waste materials	may have some effect in improving water quality in the creek depending on what waste is removed.	will have no effect on sedimentation.	may assist in improving creek ecology depending on what wastes are removed. It will assist in reducing the numbers of pest species that scavenge in the waste, eg rats, crows etc.	may assist in reducing odour from the creek, depending on the types of waste removed. This will improve the aesthetics of the creek and hence passive recreational potential.
Improve riparian corridor and shade coverage	will have the effect of improving water quality in the creek by reducing potential for algal growth and removing sediments from stormwater.	is likely to assist in reducing sedimentation by trapping sediments prior to entry to the creek.	will improve terrestrial ecology around the creek, by providing additional habitat.	will have an effect on reducing odour inputs, by limiting nutrient and sediment input and reducing opportunities for algal blooms. This will improve the aesthetics of the creek by reducing opportunities for algal blooms and hence passive recreational potential.
Campaigns to reduce weed infestation	will have no effect on water quality.	will have no effect on sedimentation.	will improve terrestrial ecology around the creek, by allowing native species to grow.	will have no effect on odour. This will improve the aesthetics of the creek and hence passive recreational potential.
Delineation of council reserves	may have some spin-off effects that assist in improving water quality in the creek.	will have no effect on sedimentation.	will improve terrestrial ecology around the creek, as greater control over the Reserve management will limit the planting and spread of weed species and dumping of wastes in this area.	may assist in reducing odour from the creek by discouraging organic inputs from nearby residents. This will improve ability of residents and visitors to traverse along the creek without trespassing or being accused of trespassing.
Community Education Campaigns	is likely to have a positive effect on water quality.	is likely to have a positive effect on sedimentation.	is likely to have a positive effect on ecology.	is likely to have a positive effect on amenity and odour.

2.3.6 Implementation of Strategies

A program for the implementation of these strategies including an estimated cost for each strategy is included in Table 2-2.

Table 2-2 Wimbie Creek Management Options Implementation Program and Cost Estimates

	Implementation Period	Estimated Costs
Creek opening to prevent flooding	As needs basis	Cost per opening is estimated at $600.00 (based on 5 hours plant hire at $120/hr).
Catchment management to limit sediment and organic input	Ongoing	The estimation of costs for this item is not possible in this study.
Berm management to prevent sea wrack input	As needs basis	Dependent on adopted arrangements and quantity of materials deposited. Possibly $1,000 per clean-up for backhoe or loader and truck by ESC.
Removal of old creek structures	Once Off	Estimated cost $5000.00 (based on 60 hours labour at $50/hr and equipment costs of $2000) to remove structures, backfill and replant areas and dispose of material.
Annual campaign to remove human derived waste materials	Annual event	Estimated cost $1800.00 (based on 36 hours labour at $50/hr to arrange and attend cleanup.
Improve riparian corridor and shade coverage	Initial study and planting operation Ongoing maintenance (once per year)	Estimated cost $2000.00 for development of planting schedule for creek. Estimated cost of $3000.00 for coordinating riparian corridor replanting (based on 40 hours labour at $50/hr) and plant supply costs. Note that this amount is basically associated with managing the replanting exercise. It is anticipated that local community members will assist in planting. Ongoing maintenance cost estimate of $1600.00 (based on 32 hours labour at $50/hr).
Campaigns to reduce weed infestation	Regular campaigns	Estimated cost $800.00 (based on 16 hours labour at $50/hr).
Delineation of council reserves	Once off	Estimated cost $2000.00 (based on 16 hours labour at $50/hr) and additional costs for sign preparation.
Community Education Campaigns	Once every two years	Estimated cost $2000.00 (based on 16 hours labour at $50/hr) and additional costs for preparing and distributing education material and arranging meetings/inspections etc.

2.3.7 Community Education

The homeowners within the catchment of Wimbie Creek (particularly the lower reaches) would benefit from a targeted community education program in relation to creek odour. The transfer of information would increase their understanding of a commonly occurring situation and may assist to lessen their concerns.

Strategies to inform and/or educate the community include:

- Half day field trip within the catchment area headed up by a Council or Creekcare member to show community members first hand examples of what is causing odour problems within the catchment, e.g. the input of sea wrack at the mouth of the creek, evidence of sediment input from

the catchment, evidence of illegally dumped lawn clippings/vegetation/rubbish with the catchment etc; and

- Community brochure.

The education brochure could be set out under the following headings:

1. Current status of Wimbie Creek;
2. Factors contributing to odour generation;
3. Wimbie Creek Management Policy Implementation; and
4. How you can assist or be involved.

The education campaign should be aimed at gaining support of the local community and possibly enlisting their help in monitoring creek condition.

2.3.8 Additional/Future Information Requirements

To aid in the future management of Wimbie Creek, it will be useful to identify possible changes in the creek with the implementation of the Management Strategy. Hence it is recommended that:

- Water quality monitoring is continued within the creek;
- Review opportunities to implement recommendations of USQMP to Wimbie Creek catchment by Council;
- Catchment based water quality monitoring is undertaken on an annual basis to allow for possible identification of any point source pollution, e.g. from refuse tip, sewage treatment works, quarry or other urban developments. Targeted sampling may best be performed prior to, during and after storm events at a range of locations which may receive point source pollution; and
- Water level and creek condition monitoring is continued within the creek.

2.4 Wimbie Creek Management Policies

Odour, hydrologic and water quality process and macroinvertebrate populations of Wimbie Creek have been relatively well studied over the past 10 years. There is a sufficient quantity of information available to allow for management strategies to be prepared for the creek. These have been divided into Entrance Management and Other Management Policies.

2.4.1 Entrance Management Policy

Artificial opening of Wimbie Creek via mechanical excavation will only be undertaken if, one of the following essential criteria are achieved:

- Creek water level at or exceeding 2.0 m AHD; and
- Creek water level is between 1.8 and 2.0 metres AHD and heavy rain is predicted in the catchment.

When measured by the local community from a gauge on the Wimbie Creek footbridge.

2.4.2 Other Management Policies

Other management policies proposed for Wimbie Creek include:

- Ongoing inspection and removal of sea wrack from the entrance of Wimbie Creek.
- Ongoing control of inputs (particularly sediment and organic materials) to Wimbie Creek from both the catchment and from the ocean. This option includes Council reviewing and implementing recommendations of the its USQMP in the Wimbie Creek catchment where possible;
- A 'one off' campaign to remove old creek structures;
- An annual campaign to remove human derived material and excessive quantities of organics from creek bank, possibly coordinated with Cleanup Australia Day activities;
- Re-establish and/or improve riparian vegetation along the creek banks and increase shade coverage of creek. Ongoing maintenance of the riparian vegetation;
- Regular campaigns to control weed infestation along creek banks;
- Better delineation of Council Reserve land to discourage illegal dumping of wastes and encourage usage of the creek corridor for recreational purposes;
- Biannual community education campaign;
- Continuation and/or initiation of other information collection programs.

3 SHORT BEACH CREEK

3.1 Background Information

Refer to the Background Information Document for more detailed information.

3.2 Entrance Management

Short Beach Creek regularly opens naturally to the ocean as a result of stream flows that scour out the entrance. However, there has been recent incidents whereby the creek has been opened artificially to flush out a spillage from the sewage pumping station adjacent to Short Beach Creek and Casey's Beach, and to flush out a toxic substance which had washed into the creek and caused a fish kill (K. Tarbuck, pers. comm., 2003).

A formal flood study has been performed for Short Beach Creek in 1989, however this flooding assessments was of limited use in determining if assets such as houses would be flooded for a given rainfall event. From a review of ESC sewer base plans (1:1000 with 1 metre contour interval), Short Beach Creek floor level survey and discussions with local residents, it has been determined that the critical flood levels occur at the Pleasurelea Caravan Park.

The critical level for opening of Short Beach Creek to avoid flooding of the Pleasurelea Caravan Park is yet to be determined. Flood levels should be measured at a gauge to be installed upstream of the Beach Road Bridge. It should be noted that Short Beach Creek normally opens naturally and that flooding is an issue during extremely heavy rain when the flood gradient elevates creek levels at Pleasurelea Caravan Park.

The flood levels could be monitored by nominated local residents, Caravan Park proprietor and/or nominated council staff.

When the creek is to be opened a channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals of Short Beach Creek in the indicative location shown in Figure 3-1 using mechanical equipment, most likely a backhoe. The machine will access the site as much as possible via established tracks and unvegetated areas. Care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes.

The excavation will only be undertaken if, one of the following essential criteria are achieved:

- Creek water level at or exceeding 1.3 m AHD **(to be confirmed by survey)**; or
- Creek water level is between 1.0 and 1.3 metres AHD and heavy rain is predicted in the catchment.

The location of the entrance excavation will be selected to mimic as far as possible the natural behaviour of entrance openings.

The excavated sand will be pushed to the side of the excavated channel and will not be removed from site. The preferred size of excavated channel dimension is 2 m wide, with the bed graded to the

ocean. Excavation will cease once an outward flow of water has been established. The total excavation time will typically be of 1 to 2 hours' duration.

Flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes/creeks has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts.

Completion of the excavated channel will generally be undertaken during the falling stage of the tidal cycle. This should ensure that the maximum water level difference between the water in the creek and the ocean is maintained for the first few hours of outflow thereby enhancing scour potential.

From studies performed on Dee Why Lagoon (Gordon, 1981), the success of a breakout will be reduced by the presence of heavy seas; hence no creek opening should be undertaken if heavy seas prevail.

The REF assesses the environmental impacts of this entrance management policy.

3.2.1 Odour

The entrapment and decomposition of sea wrack in the creek mouth region appears to be the primary cause of odour in this region. However, historically the creek has not typically been opened to alleviate odour problems.

3.3 Other Management Actions

Odour is a driver for the development of additional management measures for Short Beach Creek, particularly for the southern branch which has a greater number of odour instances reported to Council.

Additional management actions have been developed to address this and other issues and/or to improve a particular aspects of the creek, such as amenity. A number of the management actions have been determined from review of previous reports, site inspections and discussions with local residents and ESC staff.

3.3.1 Removal of Sea Wrack

The addition of sea wrack from the ocean to Short Beach Creek has been identified as a cause for odour generation in this creek, particularly near the entrance zone. The processes by which odour is generated is discussed in detail in the Background Information document.

Sea wrack (mainly kelp) is washed onto Caseys Beach and into Short Beach Creek as a result of strong onshore winds and high seas. The quantity of material present on Caseys Beach and in the entrance zone should be regularly monitored and controlled. Figure 2-3 shows the entrance zone of Short Beach Creek with only limited quantities of sea wrack present.

Location of Channel Opening for Short Beach Creek

Figure 3-1

Removal of sea wrack will assist in improving water quality in the creek; this in turn will assist in improving the aesthetics of the creek, as there will be less opportunity for the formation of algal rafts and mats. The process of removal of wrack from NSW beaches for commercial purposes requires the approval of NSW Fisheries. A permit under Clause 60 of the *Fisheries Management (Aquaculture) Regulations 1995* will be necessary. Contact with NSW Fisheries should be made.

It is recommended that inspections after strong onshore winds and high seas by nominated local community members be performed. If excessive sea wrack is noted in the creek or in a location likely to enter the creek, a nominated representative of Council should be contacted and removal of the sea wrack performed. The most efficient method of collecting sea wrack will need to be determined by Council, but it may involve mechanical removal by backhoe and truck. Collected material is a valuable fertilising material and its legal reuse via a nursery as a processed compost material could be considered. Alternatively local nurseries may perform the clean up operation free of charge, however, care would need to be employed in ensuring that they don't remove additional materials unnecessarily.

Small quantities of sea wrack in the entrance may be beneficial as they provide a localised source of nutrients to macroinvertebrates in the creek bed sediments and are unlikely to cause widespread odour problems.

Figure 3-2 Entrance channel of Short Beach Creek showing limited sea wrack

3.3.2 Addition of Crushed Oyster Shell

The addition of crushed oyster shells has been raised as a possibility for odour control within the creek. Oyster shells are composed of calcium carbonate which undergoes a chemical reaction in acidic environments and will raise pH levels. The rate of reaction is directly proportional to the acidity of the water which is generally only ever mildly acidic. Calcium carbonate is not expected to be effective as an odour control agent as it is likely to be relatively quickly covered by organic materials or sediments washed into the creek, thereby limiting its contact with the water column. Also, odour in Short Beach Creek is caused by the decomposition of organic materials which results in anoxic conditions. It is not expected that the addition of calcium carbonate will have any significant effect in preventing the formation of anoxic conditions and hence odour generation.

3.3.3 Catchment Management

Catchment management will assist in limiting the quantities of organic material entering Short Beach Creek and hence bring about an improvement in the stormwater entering Short Beach Creek. This in turn will assist in improving the water quality and aesthetics of the creek, as there will be fewer nutrients available for the formation of algal rafts and less litter in the creek.

Nutrients enter Short Beach Creek via stormwater collected in the Short Beach Creek catchment during rain events. The nutrients may either be in a dissolved form (these are not visible to the eye, but come from a variety of sources such as animal faeces, sewage or fertilisers etc) or in a particulate form, bound to small clay or silt particles which can be collected and moved by the stormwater.

3.3.3.1 Urban Stormwater Quality Management Plan

The Urban Stormwater Quality Management Plan (USQMP) for Eurobodalla Shire includes a number of relevant recommendations for particular areas across the shire which relate to the improvement of stormwater quality via a range of catchment management actions. Broad areas of management include:

- Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality;
- Stormwater re-use strategies to be incorporated into Council's water supply strategies/ development control plans;
- Complete & implement Integrated Waste Management System;
- Improve environmental outcomes associated with new development & redevelopment;
- Improve environmental outcomes associated with existing development; and
- Improve base data on water quality.

Supporting these broad objectives is a range of management options, many of which, if implemented in the Short Beach Creek catchment, would have a significant benefit in terms of improving stormwater quality. Specific examples are detailed below:

Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality

- *Provision of a skilled and motivated workforce* - There has been a large increase in the knowledge base surrounding urban stormwater and its effect on the environment over the past decade, it is important to ensure that all staff continue to be adequately trained in the field of Soil and Water Management;
- *Infrastructure strategies/project investigation continue to take account of environment issues, including urban stormwater quality management* – Council works in the catchment can have in impact on downstream water quality, the effect of these need to be taken into consideration during the planning, design and construction phases.
- *Maintenance of urban roads* – Opportunities to introduce street sweeping along roads that drain directly to the creek should be investigated in order to reduce the regular organic load

discharging to the creek. Any unsealed roads that may contribute sediment should be investigated for sealing. Sealed roads in poor condition should be investigated for resealing.

- *Maintenance of parks & reserves* – Maintenance staff need to be aware of the importance of riparian vegetation to ensure that it is not destroyed by mowing etc. Also there is a need to ensure that adequate waste bins with lids are provided and that these are emptied regularly.
- *Continue to support the Clean-up Australia campaign* – Campaigns such as this could be used to provide a focus on local creek cleanups.
- *Adoption of mowing practises that inhibit the movement of litter/trash (& other pollutants) into waterways* – This would help reduce the loads of organics and trash entering the creeks. Organic matter such as grass is highly labile (i.e. is broken down easily) and it will more readily consume oxygen.
- *Reserve management plans to take account of stormwater quality management objectives* – It is important that the management of the reserves assists in managing creeks by providing riparian buffers.
- *Opportunities for enlisting the services of volunteer groups for various works contributing to improved environmental outcomes be investigated* – This will be useful in monitoring creek conditions, eg odour, water quality monitoring and assisting in other activities such as creek cleanouts and riparian tree planting activities etc.

Improve environmental outcomes associated with new development & redevelopment

- *Strategic links from land use and development control planning to creek management polices.* The vulnerability of Short Beach Creek should be considered in land use and development control planning within the catchment, e.g. no increase in nutrient loads to creek should result from development etc.
- *Land identified in LEPs and DCPs by way of open space, no development zones and/or constrained land use to provide protection of the environment, including consideration of potential impacts on stream flows, water quality, riparian vegetation & aquatic ecosystems.* Council reserves along the length of Short Beach Creek should be utilised as far as possible for improving water quality and riparian vegetation. This will have flow on effects for the aquatic ecosystems within Short Beach Creek.
- *All new DCPs provide for the need to consider stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems.* The needs of Short Beach Creek should be specified in DCPs for the catchment, e.g. no increase in nutrient loads to creek, no increase in peak flows or stormwater volumes etc.
- *Subdivision guidelines be amended to require consideration of stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems prior to granting approval of the proposed subdivision layout. Applications for subdivisions greater than ten lots to be supported by an environmental study from an appropriately qualified and experienced environmental consultant.* New approaches to designing urban subdivisions such as those based around Water Sensitive Urban Design should be promoted in the subdivision guidelines.

- *Soil & Water Management during construction for small-scale residential developments*. These practices should be continued with increased emphasis on education of builders and enforcement of regulations. New approaches may need to be investigated to improve current performance, such as certification of compliance, bond systems etc.

Improve environmental outcomes associated with existing development

- *Development over and above single residences be conditioned to provide a site specific Soil & Water Management Plan to address both potential short and long term impacts on stormwater quality management outcomes.*
- *Continue to foster and support community involvement in environmental issues including stormwater quality management through local Landcare, Dunecare & Creekcare committees*
- *Foster water quality monitoring of local waterways by Creekcare groups*
- *Pursue grant funding opportunities to run localised education campaigns to supplement State government education campaigns*
- *Make use of existing Council newsletters to educate residents, making use of existing EPA resources where possible*
- *Continue drain stencilling to reinforce to the community where stormwater ends up*

3.3.3.2 Specific Catchment Management Recommendations for Short Beach Creek

All new developments within the catchment should have stringent erosion and sediment control programs enforced during the construction phase. Poor examples of erosion and sediment control for a new urban subdivision in the mid to lower reaches of the Short Beach Creek catchment were noted during site inspections performed in April 2003.

Site inspections revealed that significant quantities of organic material, mainly in the form of garden wastes, eg lawn clippings, tree trimmings etc were being dumped in Council Reserve lands along the banks of Short Beach Creek as shown in Figure 3-3.

Figure 3-3 Vegetation disposal along banks of Short Beach Creek.

3.3.4 Creek Aesthetics and Amenity

The abovementioned catchment management practices will limit nutrient input to the creek. This will improve creek aesthetics in several ways including:

- Reducing conditions suitable to the formation of floating algal rafts and algal mats on the creek bed;
- Reducing the quantity of black sulphidic materials formed on the creek bed; and
- Generally improving the clarity and appearance of creek waters.

During site inspections additional opportunities to improve creek aesthetics and/or recreational amenity were noted. These include:

- An annual campaign to remove other forms of human derived wastes, such as drink bottles, plastic bags etc. This could be tied in with Clean Up Australia Day activities.
- An annual campaign to remove excessive quantities of organic material in or near the creek, such as lawn and garden cuttings, weeds (garden escapees) and algae. This could also be tied in with Cleanup Australia Day activities. However, it is not recommended to "desnag" the creek, as these obstructions can provide habitat for fish species which are known to use the creek on occasions.
- Riparian zone management to improve the quality of the riparian vegetation. Sparsely vegetated riparian strips (particularly along the southern branch of the creek) should be planted to minimise amounts of sunlight reaching the water (and fuelling photosynthetic reactions which allow algae to grow and multiply). In order to achieve the desired result a study of the condition of the riparian corridor by a suitably qualified person, in order to prepare a planting schedule for the Reserve is recommended. The Planting schedule should consider the provision of walkways/egress routes and needs of creek for shelter and provision of habitat. Riparian management should be designed to assist in stabilisation of creek bank structures as some bank erosion was noted in areas. Also tree species to be planted should be consistent with the dominant floral communities in that area which consist mainly of *E. maculata* (Spotted Gum), *E. paniculata*, *E. botryoides* and/or E. *saligna* which are coastal species, common in the whole shire in the coastal zone. Additional bird or animal attracting tree/shrub species may assist in improving the faunal diversity in this region, further improving its aesthetics and recreational potential.
- Regular campaigns to remove and/or monitor weed growth along creek banks. The encroachment of urban development and urban gardens is likely to have allowed weeds to be carried or spread into the Creek. Weed infestation is likely to inhibit the growth of native species as weeds can out-compete the natives in the early growing stages. The weed removal campaigns may need to co-ordinate or be integrated into current Shire wide weed management practices.
- Eurobodalla Shire Council has commissioned a study into emergency works for the four major trunk sewer pumping stations at Batemans Bay, including Pumping Station G at the mouth of Short beach Creek at Caseys Beach. An early draft of this study **recommends installation at Pumping Station G of additional overflow storage, in order to reduce the likelihood of uncontrolled sewage overflows**. The concept provides the system with 8 hours storage at Average Dry Weather Flow. The system currently can overflow after about 3.5 hours. The

design allows for growth within the catchment over a 30-year period. While this study has not yet been adopted, it is likely that Council will support its findings. This will be a positive step towards better management of sewage overflow to the creek.

Some of the actions mentioned above also relate to management actions included in the USQMP.

3.3.5 Interrelationship of Management Option Impacts

Each management option proposed has an impact on one or more aspects of the creek. Table 3-1 details the various management options selected for Short Beach Creek and identifies the interrelationships between them.

Table 3-1 Interrelationships between Management Option Impacts

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
Creek opening to prevent flooding	will result in tidal flushing with oceanic waters, this may or may not improve the water quality in Short Beach Creek as it depends on what the water quality was like prior to opening.	is likely to reduce sedimentation as sediment laden floodwaters will be washed out to sea. The opening is also likely to result in some scour of sediments. These will be washed into the ocean or deposited on the beach.	can cause macro-invertebrates in the sediments to be washed into the ocean. This provides a source of food for fish. The opening may allow for recruitment/loss of species such as fish and prawns to/from the creek.	is likely to disturb sediments. This may result in the temporary release of hydrogen sulphide gas. The opening generally results in tidal flushing which tends to improve the appearance and smell of creek waters thereby improving aesthetics. Reduced water levels increase opportunities for passive recreation, eg walking.
Catchment management to limit sediment and organic input	will have the effect of improving water quality in the creek.	will have the effect of reducing sediment inputs to the creek.	will assist in improve the ecological functioning of the creek, by reducing the occurrence of anoxia and macroalgae blooms.	will have the effect of reducing the occurrence of odour. This is unlikely to have little effect on recreational potential of the creek.
Berm management to prevent sea wrack input	will have the effect of improving water quality in the creek.	will have no effect on sedimentation.	will assist in improving the ecological functioning of the creek, by reducing the occurrence of anoxia and macroalgae blooms in the creek.	will have the effect of reducing the occurrence of odour. The removal of sea wrack will increase opportunities for recreation in front of the creek.
Annual campaign to remove human derived waste materials	may have some effect in improving water quality in the creek depending on what waste is removed.	will have no effect on sedimentation.	may assist in improving creek ecology depending on what wastes are removed. It will assist in reducing the numbers of pest species that scavenge in the waste, eg rats, crows etc.	may assist in reducing odour from the creek, depending on the types of waste removed. This will improve the aesthetics of the creek and hence recreational potential.
Improve riparian corridor and shade	will have the effect of improving water quality in the creek by reducing potential	is likely to assist in reducing sedimentation by trapping sediments prior to entry to the creek.	will improve terrestrial ecology around the creek, by providing additional habitat.	will have an effect on reducing odour inputs, by limiting nutrient and sediment input and

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
coverage	for algal growth and removing sediments from stormwater.			reducing opportunities for algal blooms. will improve the aesthetics of the creek by reducing opportunities for algal blooms and hence passive recreational potential.
Campaigns to reduce weed infestation	will have no effect on water quality.	will have no effect on sedimentation.	will improve terrestrial ecology around the creek, by allowing native species to grow.	will have no effect on odour. This will improve the aesthetics of the creek and hence passive recreational potential.
Community Education Campaigns	is likely to have a positive effect on water quality.	is likely to have a positive effect on sedimentation.	is likely to have a positive effect on ecology.	is likely to have a positive effect on amenity and odour.

3.3.6 Implementation of Strategies

A program for the implementation of these strategies including an estimated cost for each strategy is included in Table 3-2.

Table 3-2 Short Beach Creek Management Options Implementation Program and Cost Estimates

	Implementation Period	Estimated Costs
Creek opening to prevent flooding	As needs basis	Cost per opening is estimated at $360.00 (based on 3 hours plant hire at $120/hr).
Catchment management to limit sediment and organic input	Ongoing	The estimation of costs for this item is not possible in this study.
Berm management to prevent sea wrack input	As needs basis	Dependent on adopted arrangements and quantity of materials deposited. Possibly $1,000 per clean-up for backhoe or loader and truck by ESC.
Annual campaign to remove human derived waste materials	Annual event	Estimated cost $1800.00 (based on 36 hours labour at $50/hr to arrange and attend cleanup.
Improve riparian corridor and shade coverage	Initial study and planting operation Ongoing maintenance (once per year)	Estimated cost $2000.00 for development of planting schedule for creek. Estimated cost of $3000.00 for coordinating riparian corridor replanting (based on 40 hours labour at $50/hr) and plant supply costs. Note that this amount is basically associated with managing the replanting exercise. It is expected that local community members will assist in planting. Ongoing maintenance cost estimate of $1600.00 (based on 32 hours labour at $50/hr).
Campaigns to reduce weed infestation	Regular campaigns	Estimated cost $800.00 (based on 16 hours labour at $50/hr).
Continue Community Education Campaigns	Once every two years	Estimated cost $2000.00 (based on 16 hours labour at $50/hr) and additional costs for preparing and distributing education material and arranging meetings/inspections etc.

3.3.7 Community Education

Continue with current community education programs regarding the creek function and proposed management. The community education programs should aim to cover the:

- Current status of Short Beach Creek;
- Factors contributing to odour generation (in the southern branch);
- Short Beach Creek Management Policy Implementation; and
- Ways that people can assist or be involved.

The education campaign should be aimed at gaining support of the local community and possibly enlisting their help in monitoring creek condition.

3.3.8 Additional/Future Information Requirements

To aid in the future management of Short Beach Creek, it will be useful to identify possible changes in the creek with the implementation of the Management Strategy. Hence it is recommended that:

- Water quality monitoring within the creek;
- Review opportunities to implement recommendations of USQMP to Short Beach Creek catchment by Council;
- Catchment based water quality monitoring is undertaken on an annual basis to allow for possible identification of any point source pollution, e.g. urban developments. Targeted sampling may best be performed prior to, during and after storm events at a range of locations which may receive point source pollution; and
- Water level and creek condition monitoring within the creek.

3.4 Summary of Management Options

Few studies have been performed on Short Beach Creek, however, there is a sufficient body of information available to allow for the preparation of management policies. These have been divided into Entrance Management and Other Management Policies.

3.4.1 Entrance Management Policy

Artificial opening of Short Beach Creek via mechanical excavation will only be undertaken if, one of the following essential criteria are achieved:

- Creek water level at or exceeding 1.3 m AHD **(to be confirmed by survey)**; or
- Creek water level is between 1.0 and 1.3 metres AHD and heavy rain is predicted in the catchment.

Flood levels are to be read from a gauge, to be installed, upstream of the Beach Road Bridge.

3.4.2 Other Management Policies

The management approaches proposed for Short Beach Creek are summarised as:

- Ongoing control of material inputs (particularly sediment and organic materials) to Short Beach Creek from both the catchment and from the ocean. This option includes reviewing and implementing recommendations of the USQMP;
- An annual campaign to remove human derived material and excessive quantities of organics from creek bank;
- Re-establish and/or improve riparian strip along creek banks and increase shade coverage of creek (particularly on southern branch of creek) and ongoing maintenance of riparian zone;
- Regular campaigns to control weed infestation along creek banks;
- Continuing with community education campaigns; and
- Continue or initiate further information data collection activities.

4 JOES CREEK

4.1.1 Background Information

Refer to the Background Information Document for more information.

4.1.2 Entrance Management

In the past the primary reason for artificially opening Joes Creek has been to prevent or alleviate flooding conditions at the Glenhaven Caravan Village and Birdland Animal Park. It is has been artificially opened several times over the past few years.

The environmental implications of the recommended management strategies are detailed in the Review of Environmental Factors.

A formal flood study was been performed for Joes Creek in 1989 as part of other developments within the catchment, however this flooding assessments was of limited use in determining if assets such as houses would be flooded for a given rainfall event. From a review of ESC sewer base plans (1:1000 with 1 metre contour interval), ESC survey for Corrigans Beach Plan of Management and discussions with local residents it has been determined that the critical flood level in Joes Creek to avoid potential flooding of Glenhaven Caravan Village and Birdland Animal Park is approximately 1.3 m AHD. Creek levels can be monitored from an existing gauge on the downstream side of the Beach Road footbridge as shown in Figure 4-1.

The proprietors of both Birdland and Glenhaven Caravan Park routinely monitor water levels. The adoption of a formal opening level will provide some certainty to the opening regime. However, regular monitoring during rain events will be necessary.

When the creek is to be opened a channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals of Corrigans Beach in the locations shown in Figure 4-1 using mechanical equipment, most likely a backhoe or dozer. The machine will access the site via established roads from Glenhaven Caravan Park. Care will be taken to avoid damage to or disturbance of vegetated areas of sand dunes.

The excavation will only be undertaken if, one of the following essential criteria are achieved:

- Creek water level at or exceeding 1.4 m AHD; or
- Creek water level is between 1.2 and 1.4 metres AHD and heavy rain is predicted in the catchment.

The location of the entrance excavation will be selected to mimic as far as possible the natural behaviour of entrance openings.

The excavated sand will be pushed to the side of the excavated channel and will not be removed from site. The preferred size of excavated channel dimension is 2 m wide, with the bed graded to the ocean. Excavation will cease once an outward flow of water has been established. The total excavation time will typically be of a few hours' duration.

Location of Channel Opening for Joes Creek **Figure 4-1**

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes/creeks has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts.

Completion of the excavated channel will generally be undertaken during the falling stage of the tidal cycle. This should ensure that the maximum water level difference between the water in the creek and the ocean is maintained for the first few hours of outflow thereby enhancing scour potential.

From studies performed on Dee Why Lagoon (Gordon, 1981), the success of a breakout will be reduced by the presence of heavy seas; hence no creek opening should be undertaken if heavy seas prevail.

The REF assesses the environmental impacts of this entrance management policy.

4.1.3 Odour

Water quality data collected for Joes Creek indicates that the water quality remains relatively high and anoxic conditions that can lead to the formation of hydrogen sulphide gas rarely develop. This is likely to be a function of Joes Creek's higher buffering capacity (due to its larger physical size in relation to its catchment).

Also, based on local observations, the opening of Joes Creek has occasionally exposed or disturbed significant amounts of bed sediment. The exposed or disturbed sediment has released hydrogen sulphide gas several days afterward causing localised odour problems.

Due to the present high berm level at Joes Creek (1.09m to 1.38m AHD), it is considered unlikely that significant quantities of seaweed material are able to enter the creek as a result of wave action. Entrance conditions may change as a result of a flood event which scours out the entrance and allow waves to wash seaweed into the creek. However, the creek is on average open only 9% of the time, so this eventuality is unlikely.

4.2 Other Management Actions

Joes Creek appears to be relatively stable (based on limited water quality data), however, without a significant odour problem. Additional management actions have been developed to address this and other issues and/or to improve particular aspects of the creek, such as amenity. A number of the management actions have been determined from review of previous reports, site inspections and discussions with local residents and ESC staff.

4.2.1 Removal of Sea Wrack

Although not expected to be an issue for Joes Creek, the presence of excessive quantities of sea wrack in the creek should be monitored and reported to Council. Figure 4-2 shows the condition of the beach berm during a site inspection (April 2003). The lack of sea wrack is notable.

Figure 4-2 Joes Creek entrance berm

4.2.2 Catchment Management

Catchment management will assist in limiting the quantities of organic material entering Joes Creek and hence bring about an improvement in the stormwater entering Joes Creek. This in turn will assist in improving the water quality and aesthetics of the creek, as there will be fewer nutrients available for the formation of algal rafts and less litter in the creek.

Nutrients enter Joes Creek via stormwater collected in the Joes Creek catchment during rain events. The nutrients may either be in a dissolved form (these are not visible to the eye, but come from a variety of sources such as animal faeces, sewage or fertilisers etc) or in a particulate form, bound to small clay or silt particles which can be collected and moved by the stormwater.

4.2.2.1 Urban Stormwater Quality Management Plan

The Urban Stormwater Quality Management Plan (USQMP) for Eurobodalla Shire includes a number of relevant recommendations for particular areas across the shire which relate to the improvement of stormwater quality via a range of catchment management actions. Broad areas of management include:

- Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality;
- Stormwater re-use strategies to be incorporated into Council's water supply strategies/ development control plans;
- Complete & implement Integrated Waste Management System;
- Improve environmental outcomes associated with new development & redevelopment;
- Improve environmental outcomes associated with existing development; and
- Improve base data on water quality.

Supporting these broad objectives is a range of management options, many of which, if implemented in the Joes Creek catchment, would have a significant benefit in terms of improving stormwater quality. Specific examples are detailed below:

Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality

- *Provision of a skilled and motivated workforce* - There has been a large increase in the knowledge base surrounding urban stormwater and its effect on the environment over the past decade, it is important to ensure that all staff continue to be adequately trained in the field of Soil and Water Management;
- *Infrastructure strategies/project investigation continue to take account of environment issues, including urban stormwater quality management* – Council works in the catchment can have in impact on downstream water quality, the effect of these need to be taken into consideration during the planning, design and construction phases.
- *Maintenance of urban roads* – Opportunities to introduce street sweeping along roads that drain directly to the creek should be investigated in order to reduce the regular organic load discharging to the creek. Any unsealed roads that may contribute sediment should be investigated for sealing. Sealed roads in poor condition should be investigated for resealing.
- *Maintenance of parks & reserves* – Maintenance staff need to be aware of the importance of riparian vegetation to ensure that it is not destroyed by mowing etc. Also there is a need to ensure that adequate waste bins with lids are provided and that these are emptied regularly.
- *Continue to support the Clean-up Australia campaign* – Campaigns such as this could be used to provide a focus on local creek cleanups.
- *Adoption of mowing practises that inhibit the movement of litter/trash (& other pollutants) into waterways* – This would help reduce the loads of organics and trash entering the creeks. Organic matter such as grass is highly labile (i.e. is broken down easily) and it will more readily consume oxygen.
- *Reserve management plans to take account of stormwater quality management objectives* – It is important that the management of the reserves assists in managing creeks by providing riparian buffers.
- *Opportunities for enlisting the services of volunteer groups for various works contributing to improved environmental outcomes be investigated* – This will be useful in monitoring creek conditions, eg odour, water quality monitoring and assisting in other activities such as creek cleanouts and riparian tree planting activities etc.

Improve environmental outcomes associated with new development & redevelopment

- *Strategic links from land use and development control planning to creek management polices.* The vulnerability of Joes Creek should be considered in land use and development control planning within the catchment, e.g. no increase in nutrient loads to creek should result from development etc.
- *Land identified in LEPs and DCPs by way of open space, no development zones and/or constrained land use to provide protection of the environment, including consideration of potential impacts on stream flows, water quality, riparian vegetation & aquatic ecosystems.* Council reserves along the length of Joes Creek should be utilised as far as possible for improving water quality and riparian vegetation. This will have flow on effects for the aquatic ecosystems within Joes Creek.

- *All new DCPs provide for the need to consider stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems.* The needs of Joes Creek should be specified in DCPs for the catchment, e.g. no increase in nutrient loads to creek, no increase in peak flows or stormwater volumes etc.
- *Subdivision guidelines be amended to require consideration of stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems prior to granting approval of the proposed subdivision layout. Applications for subdivisions greater than ten lots to be supported by an environmental study from an appropriately qualified and experienced environmental consultant.* New approaches to designing urban subdivisions such as those based around Water Sensitive Urban Design should be promoted in the subdivision guidelines.
- *Soil & Water Management during construction for small-scale residential developments*. These practices should be continued with increased emphasis on education of builders and enforcement of regulations. New approaches may need to be investigated to improve current performance, such as certification of compliance, bond systems etc.

Improve environmental outcomes associated with existing development

- *Development over and above single residences be conditioned to provide a site specific Soil & Water Management Plan to address both potential short and long term impacts on stormwater quality management outcomes.*
- *Continue to foster and support community involvement in environmental issues including stormwater quality management through local Landcare, Dunecare & Creekcare committees*
- *Foster water quality monitoring of local waterways by Creekcare groups*
- *Pursue grant funding opportunities to run localised education campaigns to supplement State government education campaigns*
- *Make use of existing Council newsletters to educate residents, making use of existing EPA resources where possible*
- *Continue drain stencilling to reinforce to the community where stormwater ends up*

4.2.3 Creek Aesthetics and Amenity

The abovementioned catchment management practices will limit nutrient input to the creek. This will improve creek aesthetics in several ways including:

- Reducing conditions suitable to the formation of floating algal rafts and algal mats on the creek bed;
- Reducing the quantity of black sulphidic materials formed on the creek bed; and
- Generally improving the clarity and appearance of creek waters.

During site inspections additional opportunities to improve creek aesthetics and/or recreational amenity were noted. These include:

- An annual campaign to remove other forms of human derived wastes, such as drink bottles, plastic bags etc. This could be tied in with Clean Up Australia Day activities.
- An annual campaign to remove excessive quantities of organic material in or near the creek, such as lawn and garden cuttings, weeds (garden escapees) and algae. This could also be tied in with Clean Up Australia Day activities. However, it is not recommended to "desnag" the creek, as these obstructions can provide habitat for fish species which are known to use the creek on occasions.
- Implement riparian zone management to improve the quality of the riparian vegetation. The present condition of the riparian zone and needs to be determined. This may require input from a qualified specialist. Opportunities for improving the riparian zone should be explored and promoted.
- Regular campaigns to remove and/or monitor weed growth along creek banks. The encroachment of urban development and urban gardens is likely to have allowed weeds to be carried or spread into the Creek. Weed infestation is likely to inhibit the growth of native species as weeds can out-compete the natives in the early growing stages. The weed removal campaigns may need to co-ordinate or be integrated into current Shire wide weed management practices.
- Support the recommendations of the Corrigans Beach Reserve Plan of Management which supports the relocation of the caravan park development to be outside the riparian zone.
- Further assessments of the ecological value of Joes Creek needs to be performed. Observations indicate that Joes Creek can at times support a significant range and quantity of fish and other aquatic species. However, the relative value of this habitat is unknown. This habitats can be adversely affected by the formation of hydrogen sulphide gas which is believed to be toxic to a range of in-stream biota and may result in fish kills (R. Dalton, pers. comm. 2003). Creek opening may relieve the formation of hydrogen sulphide and prevent adverse effects to in-stream biota.

4.2.4 Interrelationship of Management Option Impacts

Each management option proposed has an impact on one or more aspects of the creek. Table 4-1 details the various management options selected for Joes Creek and identifies the interrelationships between them.

Table 4-1 Interrelationships between Management Option Impacts

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
Creek opening to prevent flooding	will result in tidal flushing with oceanic waters, this may or may not improve the water quality in Joes Creek as it depends on what the water quality was like prior to opening.	is likely to reduce sedimentation as sediment laden floodwaters will be washed out to sea. The opening is also likely to result in some scour of sediments. These will be washed into the ocean or deposited on the beach.	can cause macro-invertebrates in the sediments to be washed into the ocean. This provides a source of food for fish. The opening may allow for recruitment/loss of species such as fish and prawns to/from the creek.	is likely to disturb sediments. This may result in the temporary release of hydrogen sulphide gas. generally results in tidal flushing which tends to improve the appearance and smell of creek waters thereby improving aesthetics.

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
				Reduced water levels increase opportunities for passive recreation, eg walking.
Catchment management to limit sediment and organic input	will have the effect of improving water quality in the creek.	will have the effect of reducing sediment inputs to the creek.	will assist in improve the ecological functioning of the creek, by reducing the occurrence of anoxia and macroalgae blooms.	will have the effect of reducing the occurrence of odour. This is unlikely to have little effect on recreational potential of the creek.
Annual campaign to remove human derived waste materials	may have some effect in improving water quality in the creek depending on what waste is removed.	will have no effect on sedimentation.	may assist in improving creek ecology depending on what wastes are removed. It will assist in reducing the numbers of pest species that scavenge in the waste, eg rats, crows etc.	may assist in reducing odour from the creek, depending on the types of waste removed. This will improve the aesthetics of the creek and hence recreational potential.
Improve riparian corridor and shade coverage	will have the effect of improving water quality in the creek by reducing potential for algal growth and removing sediments from stormwater.	is likely to assist in reducing sedimentation by trapping sediments prior to entry to the creek.	will improve terrestrial ecology around the creek, by providing additional habitat.	will have an effect on reducing odour inputs, by limiting nutrient and sediment input and reducing opportunities for algal blooms. will improve the aesthetics of the creek by reducing opportunities for algal blooms and hence passive recreational potential.
Campaigns to reduce weed infestation	will have no effect on water quality.	will have no effect on sedimentation.	will improve terrestrial ecology around the creek, by allowing native species to grow.	will have no effect on odour. This will improve the aesthetics of the creek and hence passive recreational potential.
Community Education Campaigns	is likely to have a positive effect on water quality.	is likely to have a positive effect on sedimentation.	is likely to have a positive effect on ecology.	is likely to have a positive effect on amenity and odour.

4.2.5 Implementation of Strategies

A program for the implementation of these strategies including an estimated cost for each strategy is included in Table 4-2.

Table 4-2 Joes Creek Management Options Implementation Program and Cost Estimates

	Implementation Period	Estimated Costs
Creek opening to prevent flooding	As needs basis	Cost per opening is estimated at $600.00 (based on 5 hours plant hire at $120/hr).
Catchment management to limit sediment and organic input	Ongoing	The estimation of costs for this item is not possible in this study.

	Implementation Period	Estimated Costs
Annual campaign to remove human derived waste materials	Annual event	Estimated cost $1800.00 (based on 36 hours labour at $50/hr to arrange and attend cleanup.
Improve riparian corridor and shade coverage	Initial study and planting operation Ongoing maintenance (once per year)	Estimated cost $2000.00 for development of planting schedule for creek. Estimated cost of $3000.00 for coordinating riparian corridor replanting (based on 40 hours labour at $50/hr) and plant supply costs. Note that this amount is basically associated with managing the replanting exercise. It is expected that local community members will assist in planting. Ongoing maintenance cost estimate of $1600.00 (based on 32 hours labour at $50/hr).
Campaigns to reduce weed infestation	Regular campaigns	Estimated cost $800.00 (based on 16 hours labour at $50/hr).
Community Education Campaigns	Once every two years	Estimated cost $2000.00 (based on 16 hours labour at $50/hr) and additional costs for preparing and distributing education material and arranging meetings/inspections etc.
Further assessments of ecological value of Joes Creek	Once off study	Estimated cost $3000.00. Feedback of results into next update of Creek Management Policy

4.2.6 Community Education

Continue with current community education programs regarding the creek function and proposed management. The community education programs should aim to cover the:

- Current status of Joes Creek;
- Factors that may contribute to odour generation/poor water quality;
- Joes Creek Management Policy Implementation; and
- Ways that people can assist or be involved.

The education campaign should be aimed at gaining support of the local community and possibly enlisting their help in monitoring creek condition.

4.2.7 Additional/Future Information Requirements

To aid in the future management of Joes Creek, it will be useful to identify possible changes in the creek with the implementation of the Management Strategy. Hence it is recommended that:

- Water quality monitoring within the creek is continued;
- Review opportunities to implement recommendations of USQMP to Joes Creek catchment by Council;
- Catchment based water quality monitoring is undertaken on an annual basis to allow for possible identification of any point source pollution, e.g. urban developments. Targeted sampling may best be performed prior to, during and after storm events at a range of locations which may receive point source pollution; and
- Water level and creek condition monitoring within the creek is continued.

4.3 Joes Creek Management Policies

Joes Creek has been relatively well studied over the past several years and there is generally a sufficient body of information available to allow for the preparation of management strategies. These have been divided into Entrance Management and Other Management Policies.

4.3.1 Entrance Management Policy

Artificial opening of Joes Creek via mechanical excavation will only be undertaken if, one of the following essential criteria are achieved:

- Creek water level at or exceeding 1.4 m AHD; or
- Creek water level is between 1.2 and 1.4 metres AHD and heavy rain is predicted in the catchment.

When measured for a gauge to be installed on the Joes Creek footbridge.

4.3.2 Other Management Policies

The management approaches proposed for Joes Creek are summarised as:

- Although not expected to be an issue for Joes Creek, the presence of excessive quantities of sea wrack in the creek should be monitored and reported to Council;
- Ongoing control of material inputs (particularly sediment and organic materials) to Joes Creek from its catchment. This option includes reviewing and implementing recommendations of USQMP;
- Annual campaign to remove human derived material and excessive quantities of organics from creek bank;
- Re-establish and/or improve riparian strip along creek banks and ongoing maintenance;
- Regular campaigns to control weed infestation along creek banks;
- Continue with community education campaigns;
- Continue or initiate further information data collection activities; and
- Review layout of Glenhaven Caravan Village during potential future relocation to ensure low lying assets in the Village have a reduced or negligible influence on creek opening levels.

5 SURFSIDE CREEK

5.1.1 Background Information

Refer to the Background Information Document for more information.

5.2 Entrance Management

In the past the primary causes for opening Surfside Creek has been to prevent or alleviate flooding. On occasions the creek does overtop its banks although no flooding of houses has been known to occur. However, flood waters at levels beyond 1.62m AHD may cross McLeod Street, causing a local traffic hazard and potentially over time damage or weaken the road pavement. Surfside Creek has been opened artificially several times over the past few years.

A formal flood study was been performed for Surfside Creek in 2000 as part of Batemans Bay Primary School Relocation, however this flooding assessments was of limited use in determining if assets such as houses would be flooded for a given rainfall event.

However, from a review of road plans and ESC sewer base plans (1:1000 with 1 metre contour interval) it is estimated that flooding of McLeod Street will occur if flood levels exceed 1.62 m AHD. To prevent houses from flooding at higher flood levels, and to protect the McLeod Street pavement, routine removal of sand from the downstream side of the culverts, immediately prior to when the water level in Surfside Creek reaches the top (i.e. obvert) of the culverts (at approximately 1.5 m AHD) is recommended. Sand covering the culverts under McLeod Street is shown in Figure 5-1. To facilitate the monitoring of water levels a gauge should be installed upstream of the McLeod Street culverts. Nominated local residents and/or council staff should monitor flood levels.

Figure 5-1 Sand covered outlets of culverts under McLeod Street

If the sand is removed and rain continues and water levels in the creek continue to rise, waters can then start to push through and scour out the culverts. If the sand is removed and it doesn't continue to rain the creek waters will trickle through the blocked pipes. It is not expected that this will achieve a significant reduction in creek water levels, however, the flooding situation is being proactively managed and road pavement damage won't occur.

Sand will be removed and collected using mechanical equipment as part of the clean out operations. Collected sand will be placed on the eroded McLeods Beach, which is down drift from the culverts.

The location of the sand removal and channel that will be required to be excavated through the unvegetated sand barrier of Surfside Beach is shown in Figure 5-2. The machine will access the site as much as possible via established roads and unvegetated areas. Care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes.

Water may scour out the culverts after the sand is removed. The flowing water may then scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted, but experience at this site and at other similar openings has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts.

The environmental implications of the recommended management strategy is detailed in the Review of Environmental Factors.

5.2.1 Odour

Odour from the creek has in the past been a primary driver for initiation of entrance management activities. Opening allows oxygenated ocean waters to mix with creek waters, causing the gas producing reactions to cease. However, this method of creek opening addresses only the symptoms of excessive organic loading and not the cause, and its continuation is not recommended. Methods for controlling organic inputs are discussed in Section 5.3.

Also, local observations indicate that the opening of Surfside Creek typically exposes or disturbs significant amounts of creek bed sediment. The exposure or disturbance causes the sediment to release hydrogen sulphide gas causing severe localised odour problems. Black, sulphide containing sediments can also be redistributed onto Surfside Beach, discolouring the sand and creating a strong sulphurous smell.

5.3 Other Management Actions

5.3.1 Catchment Management

Organic materials that enter Surfside Creek from either the catchment (via stormwater) are the primary reason for odour generation (note that there is no water quality data for Surfside Creek to support this conclusions). Local observation indicates that odours are worst when the creek has been closed for a long period of time (i.e. 3 to 6 months). Organic materials rarely enter from the ocean entrance as this typically closes rapidly once creek flows decrease. Also the McLeod Street culverts normally present a significant physical impediment to the movement of sea wrack into the creek.

Catchment management will assist in limiting the quantities of organic material entering Surfside Creek and hence bring about an improvement in the stormwater entering Surfside Creek. This in turn will assist in improving the water quality and aesthetics of the creek, as there will be fewer nutrients available for the formation of algal rafts and less litter in the creek.

Location of Channel Opening for Surfside Creek **Figure 5-2**

Nutrients enter Surfside Creek via stormwater collected in the Surfside Creek catchment during rain events. The nutrients may either be in a dissolved form (these are not visible to the eye, but come from a variety of sources such as animal faeces, sewage or fertilisers etc) or in a particulate form, bound to small clay or silt particles which can be collected and moved by the stormwater.

Most of the catchment runoff will enter the wetland at the end of the creek. Overflow from the wetland will enter Surfside Creek. The creek also receives runoff from the Batemans Bay Primary School and other nearby urban areas.

The wetland is managed under a separate Plan for Management (Resource Design and Management, 1993).

5.3.1.1 Urban Stormwater Quality Management Plan

The Urban Stormwater Quality Management Plan (USQMP) for Eurobodalla Shire includes a number of relevant recommendations for particular areas across the shire which relate to the improvement of stormwater quality via a range of catchment management actions. Broad areas of management include:

- Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality;
- Stormwater re-use strategies to be incorporated into Council's water supply strategies/ development control plans;
- Complete & implement Integrated Waste Management System;
- Improve environmental outcomes associated with new development & redevelopment;
- Improve environmental outcomes associated with existing development; and
- Improve base data on water quality.

Supporting these broad objectives is a range of management options, many of which, if implemented in the Surfside Creek catchment, would have a significant benefit in terms of improving stormwater quality. Specific examples are detailed below:

Council to continue to demonstrate leadership in the local community by limiting the potential impacts of its own works & services on urban stormwater quality

- *Provision of a skilled and motivated workforce* - There has been a large increase in the knowledge base surrounding urban stormwater and its effect on the environment over the past decade, it is important to ensure that all staff continue to be adequately trained in the field of Soil and Water Management;
- *Infrastructure strategies/project investigation continue to take account of environment issues, including urban stormwater quality management* – Council works in the catchment can have in impact on downstream water quality, the effect of these need to be taken into consideration during the planning, design and construction phases.
- *Maintenance of urban roads* – Opportunities to introduce street sweeping along roads that drain directly to the creek should be investigated in order to reduce the regular organic load

discharging to the creek. Any unsealed roads that may contribute sediment should be investigated for sealing. Sealed roads in poor condition should be investigated for resealing.

- *Maintenance of parks & reserves* – Maintenance staff need to be aware of the importance of riparian vegetation to ensure that it is not destroyed by mowing etc. Also there is a need to ensure that adequate waste bins with lids are provided and that these are emptied regularly.
- *Continue to support the Clean-up Australia campaign* – Campaigns such as this could be used to provide a focus on local creek cleanups.
- *Adoption of mowing practises that inhibit the movement of litter/trash (& other pollutants) into waterways* – This would help reduce the loads of organics and trash entering the creeks. Organic matter such as grass is highly labile (i.e. is broken down easily) and it will more readily consume oxygen.
- *Reserve management plans to take account of stormwater quality management objectives* – It is important that the management of the reserves assists in managing creeks by providing riparian buffers.
- *Opportunities for enlisting the services of volunteer groups for various works contributing to improved environmental outcomes be investigated* – This will be useful in monitoring creek conditions, eg odour, water quality monitoring and assisting in other activities such as creek cleanouts and riparian tree planting activities etc.

Improve environmental outcomes associated with new development & redevelopment

- *Strategic links from land use and development control planning to creek management polices.* The vulnerability of Surfside Creek should be considered in land use and development control planning within the catchment, e.g. no increase in nutrient loads to creek should result from development etc.
- *Land identified in LEPs and DCPs by way of open space, no development zones and/or constrained land use to provide protection of the environment, including consideration of potential impacts on stream flows, water quality, riparian vegetation & aquatic ecosystems.* Council reserves along the length of Surfside Creek should be utilised as far as possible for improving water quality and riparian vegetation. This will have flow on effects for the aquatic ecosystems within Surfside Creek.
- *All new DCPs provide for the need to consider stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems.* The needs of Surfside Creek should be specified in DCPs for the catchment, e.g. no increase in nutrient loads to creek, no increase in peak flows or stormwater volumes etc.
- *Subdivision guidelines be amended to require consideration of stormwater quality management outcomes including potential impacts on stream flows (both yield & peak flows), water quality, riparian vegetation & aquatic ecosystems prior to granting approval of the proposed subdivision layout. Applications for subdivisions greater than ten lots to be supported by an environmental study from an appropriately qualified and experienced environmental consultant.* New approaches to designing urban subdivisions such as those based around Water Sensitive Urban Design should be promoted in the subdivision guidelines.

- *Soil & Water Management during construction for small-scale residential developments*. These practices should be continued with increased emphasis on education of builders and enforcement of regulations. New approaches may need to be investigated to improve current performance, such as certification of compliance, bond systems etc.

Improve environmental outcomes associated with existing development

- *Development over and above single residences be conditioned to provide a site specific Soil & Water Management Plan to address both potential short and long term impacts on stormwater quality management outcomes.*
- *Continue to foster and support community involvement in environmental issues including stormwater quality management through local Landcare, Dunecare & Creekcare committees*
- *Foster water quality monitoring of local waterways by Creekcare groups*
- *Pursue grant funding opportunities to run localised education campaigns to supplement State government education campaigns*
- *Make use of existing Council newsletters to educate residents, making use of existing EPA resources where possible*
- *Continue drain stencilling to reinforce to the community where stormwater ends up*

5.3.2 Creek Aesthetics and Amenity

The abovementioned catchment management practices will limit nutrient input to the creek. This will improve creek aesthetics in several ways including:

- Reducing conditions suitable to the formation of floating algal rafts and algal mats on the creek bed;
- Reducing the quantity of black sulphide materials deposited on the creek bed; and
- Generally improving the clarity and appearance creek waters.

During site inspections additional opportunities to improve creek aesthetics and/or recreational potential were noted. These include:

- An annual campaign to remove other forms of human derived wastes, such as drink bottles, plastic bags etc. This could be tied in with Cleanup Australia Day activities.
- An annual campaign to remove excessive quantities of organic material in or near the creek, such as lawn and garden cuttings, weeds (garden escapees) and algae. This could also be tied in with Clean Up Australia Day activities. However, it is not recommended to "desnag" the creek.
- Implement riparian zone management to improve the quality of the riparian vegetation. The present condition of the riparian zone and needs to be determined. This may require input from a qualified specialist. Opportunities for improving the riparian zone should be explored and promoted.
- Regular campaigns to remove and/or monitor weed growth along creek banks. The encroachment of urban development and urban gardens is likely to have allowed weeds to be carried or spread into the Creek. Weed infestation is likely to inhibit the growth of native species

as weeds can out-compete the natives in the early growing stages. The weed removal campaigns may need to co-ordinate or be integrated into current Shire wide weed management practices.

5.3.3 Interrelationship of Management Option Impacts

Each management option proposed has an impact on one or more aspects of the creek. Table 5-1 details the various management options selected for Surfside Creek and identifies the interrelationships between them.

Table 5-1 Interrelationships between Management Option Impacts

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
Creek opening to prevent flooding	Opening of creek (i.e. management of sand build-up) will result in tidal flushing with oceanic waters, this may or may not improve the water quality in Surfside Creek as it depends on what the water quality was like prior to opening.	is likely to reduce sedimentation as sediment laden floodwaters will be washed out to sea. The opening is also likely to result in some scour of sediments. These will be washed into the ocean or deposited on the beach.	can cause macro-invertebrates in the sediments to be washed into the ocean. This provides a source of food for fish. The opening may allow for recruitment/loss of species such as fish and prawns to/from the creek.	is likely to disturb sediments. This may result in the temporary release of hydrogen sulphide gas. generally results in tidal flushing which tends to improve the appearance and smell of creek waters thereby improving aesthetics. Reduced water levels increase opportunities for passive recreation, eg walking. assists in improving quality of sand at McLeods Beach
Catchment management to limit sediment and organic input	will have the effect of improving water quality in the creek.	will have the effect of reducing sediment inputs to the creek.	will assist in improving the ecological functioning of the creek, by reducing the occurrence of anoxia and macroalgae blooms.	will have the effect of reducing the occurrence of odour. This is unlikely to have little effect on recreational potential of the creek.
Annual campaign to remove human derived waste materials	may have some effect in improving water quality in the creek depending on what waste is removed.	will have no effect on sedimentation.	may assist in improving creek ecology depending on what wastes are removed. It will assist in reducing the numbers of pest species that scavenge in the waste, eg rats, crows etc.	may assist in reducing odour from the creek, depending on the types of waste removed. This will improve the aesthetics of the creek and hence recreational potential.
Improve riparian corridor and shade coverage	will have the effect of improving water quality in the creek by reducing potential for algal growth and removing sediments from stormwater.	is likely to assist in reducing sedimentation by trapping sediments prior to entry to the creek.	will improve terrestrial ecology around the creek, by providing additional habitat.	will have an effect on reducing odour inputs, by limiting nutrient and sediment input and reducing opportunities for algal blooms. will improve the aesthetics of the creek by reducing opportunities for algal blooms and hence passive recreational potential.

	Water Quality	Sedimentation	Ecology	Recreation and Aesthetics
Campaigns to reduce weed infestation	will have no effect on water quality.	will have no effect on sedimentation.	will improve terrestrial ecology around the creek, by allowing native species to grow.	will have no effect on odour. This will improve the aesthetics of the creek and hence passive recreational potential.
Community Education Campaigns	is likely to have a positive effect on water quality.	is likely to have a positive effect on sedimentation.	is likely to have a positive effect on ecology.	is likely to have a positive effect on amenity and odour.

5.3.4 Implementation of Strategies

A program for the implementation of these strategies including an estimated cost for each strategy is included in Table 5-2.

Table 5-2 Surfside Creek Management Options Implementation Program and Cost Estimates

	Implementation Period	Estimated Costs
Creek opening/Sand Removal to prevent flooding	As needs basis	Cost per opening is estimated at $800.00 (based on 5 hours plant hire at $120/hr).
Catchment management to limit sediment and organic input	Ongoing	The estimation of costs for this item is not possible in this study.
Annual campaign to remove human derived waste materials	Annual event	Estimated cost $1800.00 (based on 36 hours labour at $50/hr to arrange and attend cleanup.
Improve riparian corridor and shade coverage	Initial study and planting operation Ongoing maintenance (once per year)	Estimated cost $2000.00 for development of planting schedule for creek. Estimated cost of $3000.00 for coordinating riparian corridor replanting (based on 40 hours labour at $50/hr) and plant supply costs. Note that this amount is basically associated with managing the replanting exercise. It is expected that local community members will assist in planting. Ongoing maintenance cost estimate of $1600.00 (based on 32 hours labour at $50/hr).
Campaigns to reduce weed infestation	Regular campaigns	Estimated cost $800.00 (based on 16 hours labour at $50/hr).
Community Education Campaigns	Once every two years	Estimated cost $2000.00 (based on 16 hours labour at $50/hr) and additional costs for preparing and distributing education material and arranging meetings/inspections etc.

5.3.5 Community Education

Continue with current community education programs regarding the creek function and proposed management. The community education programs should aim to cover the:

- Current status of Surfside Creek;
- Factors that may contribute to odour generation/poor water quality;
- Surfside Creek Management Policy Implementation; and

- Ways that people can assist or be involved.

The education campaign should be aimed at gaining support of the local community and possibly enlisting their help in monitoring creek condition.

5.3.6 Additional/Future Information Requirements

To aid in the future management of Surfside Creek, it will be useful to identify possible changes in the creek with the implementation of the Management Strategy. Hence it is recommended that:

- Water quality monitoring within the creek is commenced;
- Review opportunities to implement recommendations of USQMP to Surfside Creek catchment by Council;
- Catchment based water quality monitoring is undertaken on an annual basis to allow for possible identification of any point source pollution, e.g. urban developments. Targeted sampling may best be performed prior to, during and after storm events at a range of locations which may receive point source pollution; and
- Water level and creek condition monitoring within the creek is commenced.

5.4 Joes Creek Management Policies

There is little information available for Surfside Creek. However, the available information has been used in the preparation of management strategies for the creek. Management policies have been divided into those relating to the entrance and other broader management policies.

5.4.1 Entrance Management Policy

The routine removal of sand from the downstream side of the culverts, immediately prior to when the water level in Surfside Creek reaches the top (i.e. obvert) of the culverts (at approximately 1.5 m AHD) is recommended. Sand should be collected and redistributed onto McLeods Beach.

5.4.2 Other Management Policies

Other management policies proposed for Surfside Creek are summarised as:

- Ongoing control of material inputs (particularly sediment and organic materials) to Surfside Creek from its catchment. This option includes reviewing and implementing recommendations of USQMP;
- Annual campaign to remove human derived material and excessive quantities of organics from creek bank;
- Re-establish and/or improve riparian strip along creek banks and ongoing maintenance;
- Regular campaigns to control weed infestation along creek banks;
- Continue with community education campaigns;
- Continue or initiate further information data collection activities; and
- Review and continue to implement Plan for Management for Wetland No. 214.

6 STATUTORY PROVISIONS

6.1 State Environmental Planning Policy No. 35 – Maintenance Dredging of Tidal Waterways

The maintenance dredging of a tidal waterway to enable it to function as a tidal waterway, or to resume its function as a tidal waterway, may be carried out in accordance with 'State Environmental Planning Policy No. 35 – Maintenance Dredging of Tidal Waterways' (SEPP 35).

In the case of Short Beach, Short Beach, Joes and Surfside Creeks, which are all intermittently open to the ocean, the primary purpose of maintenance dredging is to alleviate problems associated with flooding or prolonged inundation around the creek/lagoon. In this case, SEPP 35 has been determined to not apply to the activity. Rather, Council's LEP is the relevant planning instrument. However, the requirements of Schedule 2 of SEPP 35 are considered to provide guidance to council on appropriate consultation processes with government agencies.

6.2 Environmental Planning and Assessment Act 1979

Clause 35 of the *Environmental Planning and Assessment (EP&A) Act* Model Provisions has been adopted under Eurobodalla Shire Council's Urban Local Environment Plan. This allows council to assess the impact of creek opening flood mitigation works under Part 5 of the EP&A Act.

The obligation under Part 5 of the EP&A Act is to consider the likely environmental impacts of the activity and to consider the appropriate level of environmental assessment that is required. For opening of a creek entrance, this may be in the form of a Review of Environmental Factors, but if the potential impacts were considered significant, an Environmental Impact Statement would be required. Either assessment should consider the impacts associated with repeat openings over a long period and under a range of conditions, rather than a single opening, so that it does not have to be reproduced each time an opening is necessary. Although this assessment is by its strategic nature a generic one, it must take into consideration specific conditions at the time of any proposed opening. The Review of Environmental Factors (REF) that forms part of this policy serves this purpose.

6.3 Crown Lands Act 1989

Local Councils proposing maintenance dredging on Crown land are required to obtain a licence from the Department of Lands under Part 4, Division 4 of the *Crown Lands Act.* A land assessment prepared in accordance with the *Crown Lands Act*, which identifies the proposal as a preferred use, will generally be required before approval is granted. A land assessment may be waived where it is in the public interest to do so and due regard has been given to the principles of Crown land management.

The State will generally require the payment of some royalty for material removed off site and on-sold. This arrangement will generally be undertaken under the authority of a licence agreement between Department of Lands and the relevant authority or the authority's contractor. Approval is also required where a contractor is undertaking maintenance dredging for public authorities and the material will be removed from the system, that is, taken, stockpiled or sold.

Whilst Eurobodalla Shire Council has care and control of the entrance area above mean high water mark, excavation will be below this level and will therefore affect Crown Land. As such, the department will be requested to issue a licence to ESC to carry out maintenance dredging at these creek entrances in accordance with the conditions outlined in the Policy. In this instance the licence requested will be for a period of five years (which is the period up to and including the first review of these documents). As no material is to be removed off site no royalty will be payable.

6.4 Threatened Species Conservation Act 1995

This Act requires an assessment of whether threatened species, populations or ecological communities are likely to be affected by the activity. This assessment is in the form of an eight-part test of significance. If a significant effect on threatened species is likely, a species impact statement must be completed and concurrence of or consultation with the Director-General of the National Parks and Wildlife Service is required.

The policy outlines threatened species issues and responds to them in terms of entrance and creek management.

6.5 Fisheries Management Act 1994

This Act requires an assessment of whether threatened species of fish and marine vegetation, populations or ecological communities are likely to be affected by the activity. If a significant effect on threatened species is likely, a species impact statement must be completed and concurrence of or consultation with NSW Fisheries is required.

Sections 198 and 200 of the *Fisheries Management Act* require a local council proposing to undertake dredging works to obtain a permit. These sections do not apply if the dredging is authorised under the *Crown Lands Act 1989* or by another relevant authority (other than a local government). Sections 204 and 205 (damage to marine vegetation) could apply if seagrasses were to be damaged.

Clause 60 of the Regulations could require a permit for removal of kelp and other sea wrack from beaches, proposed for some creeks as part of management of excessive organic material.

The works proposed under this policy are likely to be authorised under the *Crown Lands Act* and will be confined to the unvegetated entrance area. There are no threatened fish species issues identified from species found at these creeks. As such, approvals under the *Fisheries Management Act* will not be required.

6.6 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is Commonwealth legislation that protects matters of national environmental significance. It acts in parallel with the TSC Act and requires separate tests of significance, should listed species or processes be potentially impacted by the works.

Under Part 9 of the EPBC Act (1999) an action that has, may have or is likely to have a significant impact on a matter of national environmental significance may only be taken with approval of the Commonwealth Minister for the Environment.

The EPBC Act lists migratory species protected under international agreements (JAMBA and CAMBA).

6.7 National Parks and Wildlife Act 1974

It is an offence under this Act to knowingly destroy an Aboriginal site, relic or artefact. No Aboriginal site, relic or artefact has been recorded from the area where entrance opening works will be carried out, and as entrance barriers are extremely dynamic environments it is unlikely that any would be present in this locality.

A licence is also required if the lake opening will impact on protected wildlife (other than threatened species). Potential impacts upon wildlife are addressed in the accompanying REF.

6.8 Aboriginal Land Rights Act 1983

This legislation would be relevant where an Aboriginal land claim has been made which affects submerged Crown Land or areas of Crown Land that may be proposed for processing, storage or use of dredged material. The *Commonwealth Native Title Act (1993)* and *Native Title (New South Wales) Act (1994)* may also be relevant in this regard.

7 CONSULTATION

This Creek Management Policy, whilst not eliminating the need for consultation or the need to obtain relevant approvals, will significantly streamline the process of entrance opening.

The unpredictable nature of rainfall and the rapid response of these small ICOLLs often result in Council having to take urgent action within a matter of hours to prevent flooding. Hence, the Policy documents in advance the conditions under which the creek entrance is opened and gains the agreement of all affected parties to those pre-conditions for opening. When emergencies do arise, quick reference to affected parties can be made whilst still complying with the relevant legislation. It should be noted, however, if any determining authority considers that an activity is likely to significantly affect the environment then an EIS is required.

Should application of this policy determine that breaching of the entrance bar is required, ESC shall give notice to the bodies listed in Table 7-1. This notice shall be in writing by e-mail or facsimile marked urgent, specifying that opening of the creek is required in the near future, the reasons for opening and a proposed timing of opening.

Table 7-1 List of Contacts for Creek Opening

Department	Contact	Region	Telephone	Fax
Department of Infrastructure, Planning and Natural Resources	Estuaries Manager	Sydney/South Coast Region	(02) 4224 9639	(02) 4224 9651
NSW Fisheries	Senior Conservation Manager	Nowra	(02) 4423 2200	(02) 4423 2007
NSW Department of Environment and Conservation	Regional Manager	South Coast	(02) 4226 8100	(02) 4227 2348
Department of Lands			(02) 4428 6900	(02) 4428 6988
Batemans Bay / Clyde River Estuary Management Committee	The Coordinator		(02) 4474 1211	(02) 4474 1234

Any matters concerning the opening that have been raised by the above agencies within three days of the giving of notice shall be satisfactorily addressed by ESC prior to entrance opening works commencing. For emergency situations, (such as when water levels have rapidly risen above the critical levels identified in this policy and a natural breakout is unlikely to occur) notification to the above bodies is still required, but the three-day consultation period can be reduced at the discretion of ESC. This is subject to council satisfying itself that the accompanying REF is a suitable level of environmental assessment.

The above contact details and position titles may well be amended in time. Accordingly, this list should be reviewed by council and updated from time to time. Amendment of these details does not constitute a policy amendment.

An e-mail based contact list may prove most convenient but, as this would identify individual officers and may change regularly, details are not listed within the policy.

8 RESPONSIBILITY & PROCEDURES FOR CREEK OPENING

8.1 Responsibilities

ESC is responsible for creek opening, should intervention be necessary. The Council officer responsible for carrying out consultation with other agencies and for making any subsequent decision to open the lake is the Infrastructure Planning Engineer. This staff member will also be responsible for overseeing the monitoring function detailed in Section 8.3 in conjunction with field staff.

The Council officer responsible for plant management and on-site control is the Works Manager. The procedures and assessments outlined in this document will be made available to the Works Manager to ensure the opening is made in the location and to the dimensions required.

8.2 Procedures

The procedure is to be planned so that where possible the actual opening of the creek occurs shortly after the tide turns from high to low, for the lower tide of the day.

The opening should be sufficient for scour flow to develop. Normally a sand plug will be left at the creek end of the entrance channel until the remainder of the channel is established.

Possible contamination of adjacent surf beaches should be considered while the creek is emptying, for at least the first 7 days. Appropriate action should be taken to protect public health and safety at the site while excavation equipment is operating.

8.3 Entrance Monitoring

8.3.1 Artificial Openings

When artificial openings have been carried out, monitoring of the entrance should be undertaken (refer recording sheet in Appendix A) to determine the efficiency of the opening, and for use in possible future studies.

For each opening attempt, the following data will be recorded:

- level of lake prior to opening;
- date and time of opening;
- location and length of excavation;
- approximate width and depth of initial channel;
- Batemans Bay swell conditions (wave level and direction);
- preceding rainfall;
- date of closure and cause; and
- digital photographs.

To aid the gathering of this data, flood marker gauge plates shall be installed to cover the full range of creek levels, and with metre marks clearly delineated.

8.3.2 Natural Openings

Monitoring will also include natural entrance breakouts, recording time and date of natural opening, the date of lake closure, and any other relevant comments. Monitoring is to be carried out by Council or dedicated Creekcare volunteers or staff.

The information is to be recorded on a standard monitoring sheet (refer Appendix A) which is to be completed for every entrance opening, whether artificial or natural.

9 REVIEW AND UPDATE OF THIS POLICY

It is recommended that this Policy and accompanying REF be incorporated in the Batemans Bay and Clyde River Estuary Management Plan. The Estuary Management Plan will be subject to update and review, as such this Policy and accompanying REF will be reviewed as part of that process. Review of the policy will include analysis of all extra survey and monitoring data collected over that period to ensure that predictions outlined in the current REF are correct.

10 REFERENCES

Gordon A. D. (1981) *The Behaviour of Lagoon Inlets*, Fifth Australian Conference on Coastal and Ocean Engineering, Perth.

Resource Design and Management Pty Ltd (1993), *Plan of Management Batemans Bay Wetland 214.*

University of Canberra (2002) *Monitoring of the effects of urbanisation and natural breaching on the health of small south coast estuaries*.

APPENDIX A: CREEK ENTRANCE MONITORING DATA SHEET

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Opening Date	Natural (N) or Artificial (A)	Level (m) of Beach Berm	Location of Breach (A or B)	Time & Date	Lake Level (m AHD)	Channel Details		
						Alignment	Width (m)	Depth (m)
				Initial Breach (** indicates photo taken)				
Wave Level	Wave Direction	Rainfall	Wind Direction	Ongoing Channel Development				
				Full Breakout Final Dimensions				

Closure Date -	

Initial wave level/direction ..... **Preceding rainfall** .....……

Initial wind strength/direction ..... **Further rainfall** ……

Cause of closure ……