

OPERATION & MAINTENANCE MANUAL

FOR THE ENVIROPODS ,BASINS AND BIO RETENTION SWALES



AT PART LOT 4 DP 771597 & PORTION 4

OFF LEO DRIVE, NARRAWALLEE

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SECTION 1

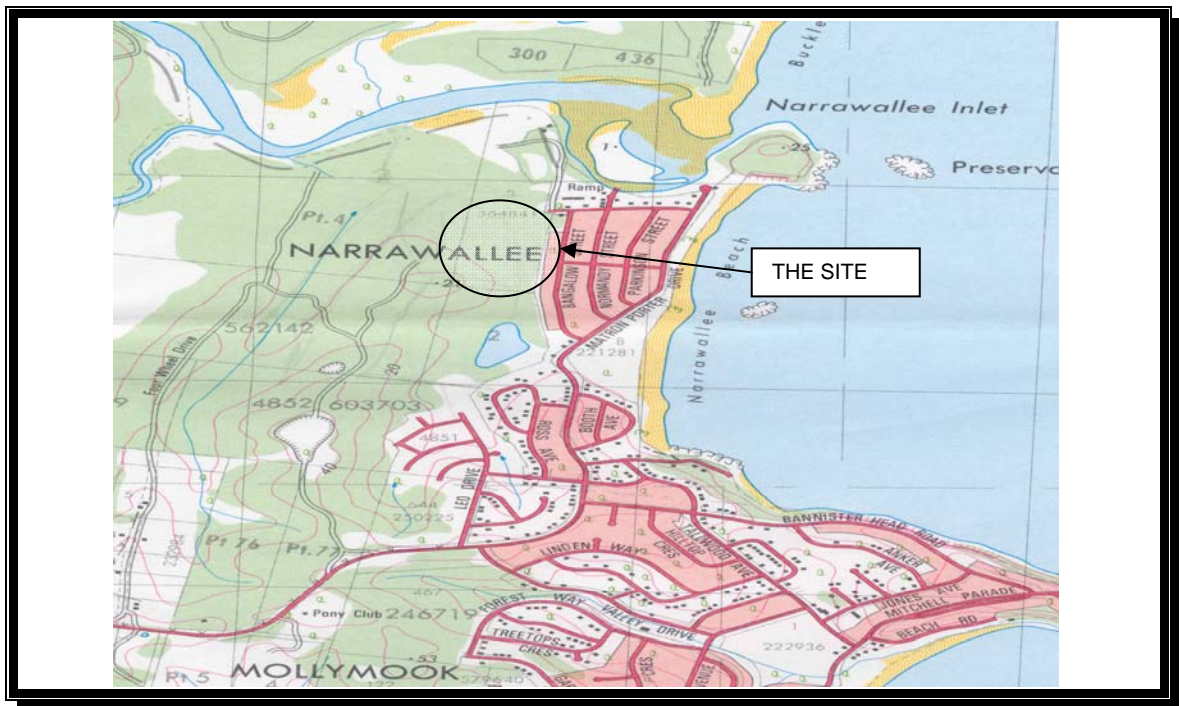
WATER CYCLE MANAGEMENT, BIO RETENTION SWALE & ENVIROPOD OVERVIEW

1.0 INTRODUCTION

The purpose of this manual is to provide personnel with a set of guidelines for successful maintenance and operation of combined detention basins/ Bio Retention Swales located in the proposed residential subdivision of Part of Lot 4 DP 771597 and Portion 4 off Leo Drive, Narrawallee. The manual is intended only for Pit inserts "Enviropods", basin, Bio Retention Swales and terrestrial plantings on the banks of the constructed basins. The manual is not intended for other landscape areas within the subdivision, or riparian zones which have no designed water quality purpose. The manual is to be used for the final operational configuration of the basin. It is not intended for use when the basin is in use as part of the Soil and Water Management measures for the subdivision

The manual has been prepared for Hazcorp Pty Ltd as a requirement by Shoalhaven Council for Development Consent and subsequently Construction Certificate approval. The manual after Subdivision handover to Shoalhaven Council will be forwarded to the appropriate department for ongoing maintenance requirements.

1.1 SITE LOCATION



The detention/water quality basins have been designed as part of the proposed subdivision of Part of Lot 4 DP 771597 and Portion 4 off Leo Drive, Narrawallee. Basin locations are shown in Figure 1 in the Appendix. Generally all Bio Retention Swales are combined with a stormwater detention function to cater for flows up to the 5yr ARI event. The water quantity detention stored above the extended detention depth of the Bio Retention Swale.

1.2 PURPOSE OF THE MANUAL

The Operation and Maintenance Manual is essential for the constructed basins to:

- Ensure the Bio Retention Swales and “Enviropod” pit inserts function as intended.
- Maintain a stable vegetation community.
- Allow operational staff to make educated decisions in order to manage the detention water quality basin with minimal outside advice.
- Ensure the long term sustainability of the system, and minimise the need for major modifications

1.3 MANUAL OVERVIEW

The manual consists of 6 sections

Section 1: Water Cycle Management Detention Basin, Bio Retention Swales and “Enviropods”, Overview

Section 2: Detention Basin, Bio Retention Swales and “Enviropods”, Establishment Phase.

This phase involves specific maintenance measures while vegetation is establishing

Section 3: Detention Basin, Bio Retention Swales and “Enviropods”, Basic Maintenance Phase

This phase covers the majority of maintenance and management of the system during normal operation conditions.

Section 4: Terrestrial Vegetation Maintenance as part of the formed banks of the Bio Retention Swales.

Section 5: Detention Basin, Bio Retention Swales and "Enviropods"
Monitoring and Maintenance checklists.

Section 6: Detention Basin, Bio Retention Swales and "Enviropods"
Indicative Maintenance Costs during the establishment and
ongoing Basic Maintenance phases.

Section 7: Bibliography and Appendix

Management of Extreme Events.

Management of extreme events will be addressed in both the Establishment phase and the Basic Maintenance phase. These events occur outside of the normal ranges of operation, and include events such as prolonged periods of drought and flooding. If not managed appropriately, these extreme events may have significant impacts on the health and performance of the system.

1.4 WATER CYCLE MANAGEMENT - "ENVIROPOD" & BIO RETENTION SWALE FUNCTION

1.4.1 Litter and Sediment Control

Local drainage throughout the development should be filtered prior to discharge into the downstream drainage systems, Bio Retention Swales and the riparian corridors.

It is proposed that pit inserts are installed on all kerb inlet pits prior to discharging into the Bio Retention Swales. The pit inserts are designed to remove vegetative matter, visible oils and greases and up to 80% of sediment load from all storms up to the 5yr ARI design event. The pit insert proposed are "Enviropods" by Ingall Environmental Services which can catch sediments down to 200 µm in size.

1.4.2 Nutrient Removal and Detention Control

All piped flows will be discharged into Bio Retention Swales for treatment. The Bio Retention Swales have been designed to treat flows up to the 1yr ARI, flows in excess of these including 100yr ARI flows are either directed around or through the Bio Retention Swale, depending upon the configuration of the particular basin. The Bio Retention Swales have been designed to restrict 5yr Urban flows to pre development conditions before being discharged into creeks.

Bio Retention Swales have been adopted as stormwater control measure to facilitate the removal of fine particulates, suspended solids and nutrients from the developed site.

Typical details of the Bio Retention Swale system and the pipe drainage system connections are provided in the Stormwater Management Report by J Wyndham Prince dated the 21st April 2005

The proposed Bio Retention Swale consists of a gravel filled trench located at the toe of the road batter. The surface of the Bio Retention Swales is typically treated as a grassed swale. The Bio Retention Swale is typically 0.8m deep. These systems would be designed to treat 1 yr flows from the upstream catchment. Treatment is attained by detention of flows and nutrient stripping by bio films which establish on the surface of the gravel. A series of baffles and choked outlets are used to promote extended detention times within the trench. The Bio Retention Swale will incorporate a bio filtration trench throughout the full length of the swale. A series of weir structures at designated intervals and levels will create a series of small bio retention storages serving the western sub catchments of the proposed subdivision.

The Bio Retention Swale will have an average extended detention zone of 300mm depth which will service 1 year ARI flows from the urban development. Additional storage provided above the 300mm depth will act as detention storage to limit the 5 yr ARI urban flows to pre development levels before discharging to the swamp forest. The detention storage function will be achieved through a restricted outlet pipe which connects to a level spreader constructed on the western side of the swale.

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SECTION 2

DETENTION BASIN, BIO RETENTION SWALE & ENVIROPODS OPERATION AND MAINTENANCE

ESTABLISHMENT PHASE

2.0 WATER CYCLE MANAGEMENT DESCRIPTION AND OVERVIEW

The Water Cycle Management for Stormwater Quality and Quantity Control consist of

- Enviropod pit inserts on all Kerb inlet pits.
- A surcharge and line dewatering pit.
- An extended detention area for water quantity management.
- A Bio Retention Swale area complete with specified treatment media trench and subsoil pipes.
- Outlet pits with orifice control or pipe acting as orifice control.
- Stacked rock retaining walls on some basins.
- Dewatering lines and level spreader.

The basins receive water from the subdivision via various sized concrete pipes and overflow from the road in storm events greater than a 5yr ARI. Piped events flow through a Pit insert "Enviropod" (Ingal). These devices intercept trash and vegetative material from road and lots before entering the pipe system. Flows up to the 1 yr ARI are then detented in the Bio Retention Swales for treatment through the bio filtration trench. The larger particles in the water column are settled out due to detention. Nutrients in the water column are treated via vertical movement through the Bio Filtration trench. The subsoil pipes at the base of the Filtration Trench de water the Filtration trench via a controlled outlet that conveys the cleaned water to the level spreader and discharges to existing Creeks or riparian zones. Flows in excess of the 1 yr ARI treatable event and up to the 5yr event are detained and discharged via either a flow control pit with orifice or flow control pipe acting as an orifice.

Bio Retention Swale Operating Parameters

| Raingarden No | Bed RL | Extended Detention RL | 5 yr ARI TWL |
|---------------|--------|-----------------------|--------------|
| 1 | - | - | - |
| 2 | - | - | - |
| 3 | - | - | - |
| 4 | - | - | - |
| 5 | - | - | - |
| 6 | - | - | - |
| 7 | - | - | - |
| 8 | - | - | - |
| 9 | - | - | - |

Refer to J Wyndham Prince plan No's for detailed construction drawings.

2.1 ESTABLISHMENT PHASE MAINTENANCE

Establishment phase maintenance guidelines that follow are divided into structural elements of the basin / Bio Retention Swale and the vegetation parameters for the basin

2.1.1 Structural Elements

The Basin / Bio Retention Swale will perform to the designed parameters if the following critical areas are monitored.

- Blockage of the inlet pits and "Enviropod" inserts
- Ponding, clogging and blockage of the filter media
- Sediment build up.
- Outlet pipe and pit blockage.
- Debris build up
- Erosion of bed material

Inlet pit and "Enviropod" Inserts

The Inlet pit and "Enviropods" should be inspected every 4 months (or after a major rainfall event) for blockage and rubbish removed from the pit insert. The rubbish removed should be disposed at a council approved refuse site.

Rubbish that has bypassed the pit inserts should be removed from the basins and disposed as above.

Ponding Clogging and blockage of filter media.

The Bio Retention Swale and basin should be inspected every 3 months (or after a major rainfall event) to determine if any areas are ponding or clogging. These areas should be investigated and actions to rectify the problem implemented.

Rectification could include, rodding of the subsoil network, to remove blockage or loosening the soil profile in the area of ponding.

Sediment Build Up

Sediment will build up in the detention basin and Bio Retention Swale. It should be inspected every 3 months (or after a major rainfall event). If the sediment load is clogging the operation of the Filtration Trench and restricting plant growth it should be removed.

Outlet Pipe and pit blockage.

The dewatering line should be inspected every 3 months (or after a major rainfall event) to ensure that the system has no blockages and is operating as designed. The Orifice control pit should also be inspected 3 monthly (or after a major rainfall event) for any blockages or damage and determine what rectification is necessary.

Debris Build up

Debris washed into the basin that has bypassed the pit inserts or dead plant material from within the basin should be removed at three monthly intervals (or after a major rainfall event). The debris could block the orifice plate and impair the function of the basin for water quantity control.

Erosion

The bed material of the Bio Retention Swale and basin are subject to erosion from major storm events. Filtration Trench Media depth may be reduced and media lost from the Bio Retention Swale system in larger events. The basin must be checked for channelling and erosion every 3 months or after major rainfall events.

2.1.2 Planting elements

The “establishment phase” aims to protect juvenile plantings both in the Bio Retention Swale Filtration trench media area and detention basin. The phase typically covers a 12 to 24 month period from the time of planting and until the plants become tolerant of local conditions. The most important activities necessary to maintain and enhance plant growth during the establishment phase include.

- Correct moisture levels in the soil.
- Monitoring plant growth.
- Replanting
- Weed control
- Monitoring damage to plants caused by fauna.

Moisture levels in Soil During Establishment.

Correct moisture levels in the Bio Retention Swale are essential to plant survival. The Swale is a free draining soil environment. The surrounding soil environment, could become very dry and limit plant growth. It would be advisable while plants establish, to restrict the pipe outlet, so as to keep soil moisture levels at the correct level for plant growth. The following measures should be noted for the establishment period.

- The first month after planting is the critical time for watering. Young plants require heavy watering every three (3) days. If very hot or windy days are encountered soon after planting then additional watering will be required. 50mm of water per week as a minimum should be adopted as a general guide
- If irrigation by sprinklers is not feasible, then flood irrigation should be employed as an alternative – this involves raising the water levels over the entire basin then draining via the pit outlet.
- After the first month of maintenance, planted areas should be watered to maintain a healthy condition free of water stress, then gradually

reduce water application to harden plants and turf to natural climatic conditions.

Monitoring Plant Establishment and Replanting

The following activities are suggested to monitor plant health and establishment over the first 12 to 24 months.

- Set up monitoring points to photograph and document progress of revegetation at 6 monthly intervals
- Monitor weed densities and record control measures most effective.

Bio Retention Swale plants and turf areas should be monitored every fortnight during the first two months of the establishment phase, and then on a 3 monthly basis. Extra monitoring may be required during extreme conditions such as after high rainfall events and severe drought.

It may be necessary to install additional plants or turf if the following occur

- Survival rates of plants are below 85%
- Plants appear unhealthy.
- Predation by fauna has removed stock.
- Channels and scouring have occurred through the turfed area.

Throughout the establishment phase it may be necessary to review individual species tolerance. Some planted species may not tolerate local conditions within the Bio Retention Swale and may need to be replaced with species that are growing well.

Weed Control

Weeds compete with establishing plants for light, nutrients in the soil and space. Due to the disturbance in subdivision construction, weed infestation could be a significant problem at establishment. As the catchment becomes more stable and the planted basin becomes established, weeds should become less of a problem.

It is preferable to manually remove weeds before their abundant growth requires herbicide application

- During the warmer months from late spring to early autumn, the site should be monitored fortnightly and weeded as required.
- During the cooler months, from mid autumn to early spring, the site should be monitored and cleared of weeds on a monthly basis.

Manual weed removal

Smaller weeds or juvenile specimens can be removed by hand tools to minimise disturbance. The whole weed as well as the root system should be removed. The removal of very large or deep rooted specimens, may

require removal by machinery. The weed spoil and seeds should be disposed at a council approved waste refuse.

Chemical weed Control

If the weed infestation is too large to remove by hand chemical control can be successfully applied. Non residual glyphosate herbicides including (Nufarm Weedmaster and Bi active Roundup) are appropriate. Care should be used when spraying chemicals as the overspray will effect surrounding plant life. Sprays should not be used on windy days or when rain is likely within 12 hours. Alternative application methods to spraying include the cut and paint method and the scrape and paint method.

Fauna Damage

Damage to newly planted tube and cell stock can be caused by a variety of fauna. These include birds, feral herbivores (Rabbits) and native herbivores (Wallabies, Wombats). Attack to plant life should be monitored. If birds are removing seedlings, then larger plants should be replanted. If native or feral herbivores are causing lost plants, then protective bagging could be used. If feral pest are causing great damage, it is recommended that appropriate measures to control pests be implemented. This is particularly important in regard to herbivores such as Rabbits. Without control large numbers of newly planted cell and tubestock could be lost.

2.2 MANAGEMENT OF EXTREME EVENTS

Drought

In the event of a severe drought, newly established plants and turf may die or retreat below ground. In prolonged periods of drought

- Monitor plant health for signs of stress every 3 months
- Prevent drying of the soil by using sprinkler irrigation, particularly in areas containing water stressed plants.
- Choke outlet flow device and flood irrigate.

Flood

Immediately following a flood or significant storm event, the entire system should be assessed for scouring, bank collapse, plant loss, debris build up and general damage. If necessary repair or replant to emulate pre event conditions to prevent further damage.

Extreme flow conditions may also introduce noxious weed species into the system. Post event management should therefore place a high priority on monitoring for noxious weed and undesirable species.

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SECTION 3

DETENTION BASIN, BIO RETENTION SWALE & ENVIROPODS OPERATION AND MAINTENANCE

BASIC MAINTENANCE PHASE

3.1 BASIC BASIN, BIO RETENTION SWALE AND ENVIROPOD MAINTENANCE

Following the establishment period a basic or normal monitoring and maintenance regime is appropriate. If the basin/ Bio Retention Swale system is not maintained frequently, the entire Filtration Trench media bed may need replacement, due to the clogging of the media with fine sediment particles. Frequent maintenance will be more cost effective in the long term. A detailed maintenance schedule for all components of the system is contained in the monitoring section. The basin /Bio Retention Swale will perform to the designed parameters if the following critical areas are monitored.

- Blockage of the inlet pits and “Enviropod” pit inserts
- Ponding clogging and blockage of the filter media
- Sediment build up.
- Outlet pipe and pit blockage.
- Debris build up
- Erosion
- Plant survival.
- Weed invasion

Inlet pit and “Enviropod Inserts

The Inlet pit and pit insert should be inspected every 6 months (or after a major rainfall event) for blockage and rubbish removed from the litter bag. The rubbish removed should be disposed at a council approved refuse site. Rubbish that has bypassed the pit inserts should be removed from the basins and disposed as above.

Ponding Clogging and blockage of filter media.

The Bio Retention Swale and basin should be inspected every 6 months (or after a major rainfall event) to determine if any areas are ponding or clogging. These areas should be investigated and actions to rectify the problem implemented.

Sediment Build Up

Sediment will build up in the detention basins and Bio Retention Swale. It should be inspected every 6 months (or after a major rainfall event). If the sediment load is clogging the operation of the Filtration Trench media and restricting plant and turf growth it should be removed.

Outlet Pipe and pit blockage.

The dewatering line should be inspected every 6 months (or after a major rainfall event) to ensure that the system has no blockages and is operating

as designed. The Orifice control pit should also be inspected 6 monthly (or after a major rainfall event) for any blockages or damage and determine what rectification is necessary.

Debris Build up

Debris washed into the basin that has bypassed the pit inserts or plant debris from within the basin should be removed at six monthly intervals (or after a major rainfall event). The debris could block the orifice plate and impair the function of the basin for water quantity control.

Erosion

The bed material of the Bio Retention Swale and basin are subject to erosion from major storm events. Filtration Trench media depth may be reduced and media lost from the Bio Retention Swale system in larger events. The Bio Retention Swale must be checked for channelling and erosion every 6 months or after major rainfall events.

Plant Survival

Regular long term maintenance of the Bio Retention Swale and basin plants is essential to ensure that the basin functions as designed. Plant Health and cover should be monitored on a 6 monthly basis (or after a major rainfall event)

Additional plants should be installed if

- Survival rates are below 85%
- An obvious channel in plant stands or turf has appeared
- Plants and turf areas have been removed by predation or storm event.

Plants that are in senescence (hibernation) should not be confused with those that are dead or unhealthy. Senescence generally occurs over the winter months. The plants may appear brown or loose their foliage. They differ from dead or unhealthy plants by: Remnants of viable plant growth are visible, green shoots at the base and the root system is firmly anchored.

Weed Control

Weeds compete with establishing plants for light, nutrients in the soil and space. Due to the disturbance in subdivision construction, weed infestation could be a significant problem at establishment. As the catchment becomes more stable and the planted basin becomes established, weeds should become less of a problem.

It is preferable to manually remove weeds before their abundant growth requires herbicide application

- During the warmer months from late spring to early autumn, the site should be monitored 2 monthly and weeded as required.
- During the cooler months, from mid autumn to early spring, the site

should be monitored 3 monthly and weeded as required.

Chemical weed Control

If the weed infestation is too large to remove by hand chemical control can be successfully applied. Non residual glyphosate herbicides including (Nufarm Weedmaster and Bi active Roundup) are appropriate. Care should be used when spraying chemicals as the overspray will effect surrounding plant life. Sprays should not be used on windy days or when rain is likely within 12hours. Alternative application methods to spraying include the cut and paint method and the scrape and paint method.

3.2 MANAGEMENT OF EXTREME EVENTS

Drought

In the event of a severe drought, established plants may die or retreat below ground. In prolonged periods of drought

- Monitor plant health for signs of stress every 3 months
- Prevent drying of the soil by using sprinkler irrigation, particularly in areas containing water stressed plants.
- Choke outlet flow device and flood irrigate.

Flood

Immediately following a flood or significant storm event, the entire system should be assessed for scouring, bank collapse, plant loss, debris build up and general damage. If necessary repair or replant to emulate pre event conditions to prevent further damage.

Extreme flow conditions may also introduce noxious weed species into the system. Post event management should therefore place a high priority on monitoring for noxious weed and undesirable species.

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SECTION 4

TERRESTRIAL VEGETATION MANAGEMENT AND MAINTENANCE

4.0 TERRESTRIAL VEGETATION MANAGEMENT

This section covers the monitoring and maintenance of terrestrial vegetation planted as part of the basin walls and disturbed areas from construction. This area covers both the outer walls associated with the construction of the Bio Retention Swale. This manual is not intended for the riparian areas or other landscaped areas as part of the subdivision.

4.1 ESTABLISHMENT PHASE

The establishment phase aims to protect juvenile plants until they become tolerant of local conditions. This phase typically covers a 12 – 18 month period after planting. The most important activities necessary to maintain terrestrial growth during the establishment phase include:

- Watering
- Weed control
- Replanting and reseeding
- Juvenile plant protection
- Restriction of public access
- Monitoring plant establishment

Watering

The first month after planting is the critical time for watering. Young plants require heavy watering every three (3) days. If very hot or windy days are encountered soon after planting then additional watering will be required. 50mm of water per week as a minimum should be adopted as a general guide.

After the first month of maintenance planted areas should be progressively hardened off to natural climatic conditions

Weed Control

Weed growth should be monitored every 3 months. It may be necessary to remove weeds more frequently in the summer months, when weed growth is rapid or after storm events.

Weeds at the site are to be controlled by the following methods. (Bi active Roundup is the only permitted Herbicide)

- Manually remove weeds by hand where possible
- Herbicide application by “cutting and painting” woody weeds that occur on the bank slope zone. Leaving roots and stumps in the ground to protect stability of banks.

- Targeted herbicide application to non woody weeds. The herbicide should be environmentally acceptable, such as a non residual glyphosate herbicide (Bi active Roundup) at the recommended maximum rate.
- Herbicide application by “scraping and painting” of exotic vines and scramblers
- Herbicide application by “drilling” large woody weeds such as privet. Leaving roots and stumps in the ground to protect stability of banks

Replanting and Reseeding

Re vegetated areas should be monitored 3 monthly to ensure 85% plant survival. Damaged or dead plants should be removed and replaced with same species.

Re planting should not be carried out in unsuitable weather conditions such as extreme heat, cold or wind or rain.

Juvenile Plant Protection

The use of protective bags is recommended if there is a chance of feral or native animals grazing on planted tube stock or competition from weeds is strong.

Milk cartons or bamboo and plastic bags can be used. Three stakes are to be used for the plastic bag method, with the stakes angled outwards and centred around the plant. The bags should be removed once the plant is established and is in vigorous growth. A minimum of 6 months.

Restriction of Public Access

Fence off revegetated zones to deter pedestrian traffic.

Monitoring Plant Establishment

The following activities are suggested to monitor plant health and establishment over the first 12 to 18 months.

- Set up monitoring points to photograph and document progress of revegetation at 6 monthly intervals
- Carry out plant counts to ensure 85% establishment
- Monitor weed densities and record control measures most effective.

4.2 BASIC TERRESTRIAL MAINTENANCE

Once the terrestrial vegetation has established, plant growth and general health should be monitored every 6 months, the maintenance program should include the following:

- Weed Control
- Plant replacement
- Watering
- Erosion control
- Rubbish removal

Weed Control

Weeds will be less of a problem once vegetation is established. Weeds should be monitored every 6 months and growth controlled in accordance with methods listed in establishment phase.

Plant Replacement and Reseeding

Monitor for failed or damaged plants every 6 months. Replace if significant losses have occurred, greater than 20 %.

Watering.

Supplementary watering should not be necessary after the plants have established.

Erosion

Monitor every 6 months, banks for bare areas and identify any areas that are showing signs of erosion. Address erosion causes and replant.

Rubbish removal

Rubbish should be removed after storm events and every 6 months. Rubbish should be disposed of at a council approved refuse site.

4.3 MANAGEMENT OF EXTREME EVENTS

Drought

In the event of a severe drought, established plants may die or retreat below ground. In prolonged periods of drought

- Monitor plant health for signs of stress every 3 months

Flood

Immediately following a flood or significant storm event, the entire system should be assessed for scouring, bank collapse, plant loss, debris build up and

general damage. If necessary repair or replant to emulate pre event conditions to prevent further damage.

Extreme flow conditions may also introduce noxious weed species into the system. Post event management should therefore place a high priority on monitoring for noxious weed and undesirable species

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SECTION 5

DETENTION BASIN, BIO RETENTION SWALE & ENVIROPODS OPERATION AND MAINTENANCE

MAINTENANCE & INSPECTION CHECKLISTS

DETENTION BASIN, BIO RETENTION SWALE & ENVIROPOD SYSTEM
 MAINTENANCE AND INSPECTION CHECKLIST
 ESTABLISHMENT PHASE

| ITEMS INSPECTED | Checked | | Maintenance Needed | | Inspection frequency |
|---|---------|---|--------------------|---|----------------------|
| | Y | N | Y | N | |
| | | | | | |
| DEBRIS CLEANOUT | | | | | 3m |
| Basin and Bio Retention swale surface clear of debris | | | | | |
| Inlet area clear of debris | | | | | |
| Outlet pit clear of debris | | | | | |
| | | | | | |
| PIT INSERTS & OUTLET PIT | | | | | 3m |
| Pit Inserts clear of rubbish and functioning | | | | | |
| Outlet pipe clear and functioning | | | | | |
| Orifice plate clear of blockage | | | | | |
| | | | | | |
| BASIN SURFACE | | | | | 3m |
| Basin floor inspected for silt build up | | | | | |
| Silt needs to be removed | | | | | |
| Bio Retention Swale not ponding between storm events | | | | | |
| Filtration Trench media not blocked | | | | | |
| Evidence or surface erosion | | | | | |
| Filtration Trench media needs replacing | | | | | |
| | | | | | |
| BASIN VEGETATION | | | | | 3m |
| Soil moisture adequate | | | | | |
| Vegetation condition | | | | | |
| Vegetation coverage | | | | | |
| Vegetation trimming/ maintenance | | | | | |
| Weed infestation | | | | | |

Inspection Frequency Key

M = Monthly

3m = Three monthly

6m = Six monthly

DETENTION BASIN, BIO RETENTION SWALE & ENVIROPOD SYSTEM

MAINTENANCE AND INSPECTION CHECKLIST

BASIC MAINTENANCE

| ITEMS INSPECTED | Checked | | Maintenance Needed | | Inspection frequency |
|---|---------|---|--------------------|---|----------------------|
| | Y | N | Y | N | |
| | | | | | |
| DEBRIS CLEANOUT | | | | | 6m |
| Basin and Bio Retention swale surface clear of debris | | | | | |
| Inlet area clear of debris | | | | | |
| Outlet pit clear of debris | | | | | |
| | | | | | |
| PIT INSERTS & OUTLET PIT | | | | | 6m |
| Pit inserts clear of rubbish and functioning | | | | | |
| Outlet pipe clear and functioning | | | | | |
| Orifice plate clear of blockage | | | | | |
| | | | | | |
| BASIN SURFACE | | | | | 6m |
| Basin floor inspected for silt build up | | | | | |
| Silt needs to be removed | | | | | |
| Bio Retention Swale not ponding between storm events | | | | | |
| Filtration Trench media not blocked | | | | | |
| Evidence or surface erosion | | | | | |
| Filtration Trench media needs replacing | | | | | |
| | | | | | |
| BASIN VEGETATION | | | | | 6m |
| Soil moisture adequate | | | | | |
| Vegetation condition | | | | | |
| Vegetation coverage | | | | | |
| Vegetation trimming/ maintenance | | | | | |
| Weed infestation | | | | | |

Inspection Frequency Key

M = Monthly

3m = Three monthly

6m = Six monthly

TERRESTRIAL VEGETATION MAINTENANCE AND INSPECTION CHECKLIST

ESTABLISHMENT PHASE

| ITEMS INSPECTED | Checked | | Maintenance Needed | | Inspection frequency |
|--|---------|---|--------------------|---|----------------------|
| | Y | N | Y | N | |
| | | | | | |
| TERRESTRIAL VEGETATION | | | | | 3m |
| Soil moisture adequate | | | | | |
| Vegetation condition | | | | | |
| Dead plants identified and replaced | | | | | |
| Vegetation coverage | | | | | |
| Alternative species used if soil moisture unsuitable | | | | | |
| Vegetation trimming/ maintenance | | | | | |
| Weed infestation | | | | | |

Inspection Frequency Key

M = Monthly

3m = Three monthly

6m = Six monthly

TERRESTRIAL VEGETATION MAINTENANCE AND INSPECTION CHECKLIST

BASIC MAINTENANCE

| ITEMS INSPECTED | Checked | | Maintenance Needed | | Inspection frequency |
|--|---------|---|--------------------|---|----------------------|
| | Y | N | Y | N | |
| | | | | | |
| TERRESTRIAL VEGETATION | | | | | 6m |
| Soil moisture adequate | | | | | |
| Vegetation condition | | | | | |
| Dead plants identified and replaced | | | | | |
| Vegetation coverage | | | | | |
| Alternative species used if soil moisture unsuitable | | | | | |
| Vegetation trimming/ maintenance | | | | | |
| Weed infestation | | | | | |

Inspection Frequency Key

M = Monthly

3m = Three monthly

6m = Six monthly

Narrawallee
Subdivision

SECTION 6

DETENTION BASIN, BIO RETENTION SWALE & ENVIROPODS OPERATION AND MAINTENANCE

INDICATIVE MAINTENANCE COST ESTIMATES

Enviropod Pit Inserts

Establishment Phase 2 Years

| Bio Retention Swale No | Catchment area ha | Approx No's | No. of Visits / year | Cost per unit / visit \$ | Total Establishment phase costs (per year) |
|------------------------|-------------------|-------------|----------------------|--------------------------|--|
| 1 | 3.04 | 21 | 3 | 25 | \$1,596.00 |
| 2 | 1.25 | 9 | 3 | 25 | \$656.25 |
| 3 | 1.25 | 9 | 3 | 25 | \$656.25 |
| 4 | 1 | 7 | 3 | 25 | \$525.00 |
| 5 | 1.08 | 8 | 3 | 25 | \$567.00 |
| 6 | 1 | 7 | 3 | 25 | \$525.00 |
| 7 | 0.9 | 6 | 3 | 25 | \$472.50 |
| 8 | 0.81 | 6 | 3 | 25 | \$425.25 |
| 9 | 3.52 | 25 | 3 | 25 | \$1,848.00 |
| No swale | 6.26 | 44 | 3 | 25 | \$3,286.50 |
| No swale | 1.44 | 10 | 3 | 25 | \$756.00 |
| | | | | Total cost | \$11,313.75 |

The above cost per unit allows for replacement of damaged filters and disposal of trapped pollutants

Bio Retention Swale / Detention Basin

Establishment Phase 2 Years

| Bio Retention Swale No | Catchment area ha | Bio Retention Swale, Detention basin area in sqm's | No. of Visits / year | Cost per sq.m \$ | Total Establishment phase costs (per year) |
|------------------------|-------------------|--|----------------------|-------------------|--|
| 1 | 3.04 | 729.6 | 3 | 1 | \$2,188.80 |
| 2 | 1.25 | 300.0 | 3 | 1 | \$900.00 |
| 3 | 1.25 | 300.0 | 3 | 1 | \$900.00 |
| 4 | 1 | 240.0 | 3 | 1 | \$720.00 |
| 5 | 1.08 | 259.2 | 3 | 1 | \$777.60 |
| 6 | 1 | 240.0 | 3 | 1 | \$720.00 |
| 7 | 0.9 | 216.0 | 3 | 1 | \$648.00 |
| 8 | 0.81 | 194.4 | 3 | 1 | \$583.20 |
| 9 | 3.52 | 844.8 | 3 | 1 | \$2,534.40 |
| No swale | 6.26 | | | | |
| No swale | 1.44 | | | | |
| | | | | Total cost | \$9,972.00 |

The above cost allows for maintenance of turf areas and some native grass, sedge plantings

Enviropod Pit Inserts

Basic Maintenance Phase

| Bio Retention Swale No | Catchment area ha | Approx No's | No. of Visits / year | Cost per unit / visit \$ | Total Maintenance costs per year |
|------------------------|-------------------|-------------|----------------------|--------------------------|----------------------------------|
| 1 | 3.04 | 21 | 2 | 25 | \$1,064.00 |
| 2 | 1.25 | 9 | 2 | 25 | \$437.50 |
| 3 | 1.25 | 9 | 2 | 25 | \$437.50 |
| 4 | 1 | 7 | 2 | 25 | \$350.00 |
| 5 | 1.08 | 8 | 2 | 25 | \$378.00 |
| 6 | 1 | 7 | 2 | 25 | \$350.00 |
| 7 | 0.9 | 6 | 2 | 25 | \$315.00 |
| 8 | 0.81 | 6 | 2 | 25 | \$283.50 |
| 9 | 3.52 | 25 | 2 | 25 | \$1,232.00 |
| No swale | 6.26 | 44 | 2 | 25 | \$2,191.00 |
| No swale | 1.44 | 10 | 2 | 25 | \$504.00 |
| | | | | Total cost | \$7,542.50 |

The above cost per unit allows for replacement of damaged filters and disposal of trapped pollutants

Bio Retention Swale / Detention Basin

Basic Maintenance Phase

| Bio Retention Swale No | Catchment area ha | Bio Retention Swale, Detention basin area in sqm's | No. of Visits / year | Cost per sq.m \$ | Total Maintenance costs per year |
|------------------------|-------------------|--|----------------------|----------------------|----------------------------------|
| 1 | 3.04 | 729.6 | 2 | 1.35 | \$1,969.92 |
| 2 | 1.25 | 300.0 | 2 | 1.35 | \$810.00 |
| 3 | 1.25 | 300.0 | 2 | 1.35 | \$810.00 |
| 4 | 1 | 240.0 | 2 | 1.35 | \$648.00 |
| 5 | 1.08 | 259.2 | 2 | 1.35 | \$699.84 |
| 6 | 1 | 240.0 | 2 | 1.35 | \$648.00 |
| 7 | 0.9 | 216.0 | 2 | 1.35 | \$583.20 |
| 8 | 0.81 | 194.4 | 2 | 1.35 | \$524.88 |
| 9 | 3.52 | 844.8 | 2 | 1.35 | \$2,280.96 |
| No swale | 6.26 | | | | |
| No swale | 1.44 | | | | |
| | | | | Total cost | \$8,974.80 |
| | | | | | |
| | | | | Cost per year | \$8,974.80 |
| | | | | Additional costs (*) | \$1,990 |
| | | | | Total Cost | \$10,964.80 |

The cost for mowing grass per year has been allowed at \$2.50/sqm an allowance of \$0.2/sqm for other plants within the swale has been allowed for
 In addition to the total cost per year an allowance (*) to replace 30% of the filtration Trench media and new plantings for the disturbed media every 15years should be added to the above total cost
 This cost has been calculated on a sqm rate for the combined total area of the raingardens

| | |
|---------------------------------------|---------|
| Filtration Trench media area | 350 |
| Gravel media replacement cost per sqm | \$30/m2 |
| Replanting cost per sqm | \$10/m2 |

7.0 BIBLIOGRAPHY

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8.0 APPENDIX

