ASHBOURNE RESIDENTIAL DEVELOPMENT

STORMWATER OPERATIONS & MAINTENANCE PLAN

PROJECT INFORMATION

CLIENT	Matamata Developments Ltd
PROJECT	289001

DOCUMENT CONTROL

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1. Introduction

1.1. Background

Maven Waikato Ltd have been engaged by Matamata Developments Ltd to undertake Infrastructure Design in support of Ashbourne Residential Development at 127 Station Road, Matamata.

1.2. Purpose of this report

The purpose of this operation and maintenance report is to ensure the correct ongoing operation of the stormwater quality management devices of Ashbourne Residential development. The information provided herein outlines the methodology associated with the stormwater infrastructure onsite. This report is to be read in conjunction with the engineering drawings around stormwater management within the site held between WRC and Matamata-Piako District Council (MPDC).

It is the responsibility of the nominated maintenance contractor for MPDC to carry out maintenance of the stormwater system devices. The maintenance will be in generally accordance with this document, WRC Stormwater Guidelines and MPDC's SW Guidelines.

1.3. Stormwater Assets

The Public Assets constructed which will require operation and maintenance are:

- Stormwater discharge from Ashbourne Residential will be conveyed via roadside soakage trench and piped network (perforated), and road for OLFP to Soakage Basin A and B.
- For catchment C and D, stormwater discharge will be conveyed via roadside soakage trench with piped network (perforated), or piped network (non-perforated) and road for OLFP to Stormwater Wetland C and D.
- Raingardens constructed within the road reserves providing quality for whole catchment. These devices are at-source rain gardens providing water quality, infiltration, and detention.
- Stormwater Greenway which carries stormwater runoff from Catchment B.

1.4. Contact Information

A summary of the contact information relating to the ownership, maintenance manager, and designer for the stormwater system is included below.

Asset ID:		**Resource Consent Number:**	
Location:	127 Station Road, Matamata	Development Name / Legal Description:	
Asset Owner Details:			
Name:	Matamata-Piako	Postal Address: PO Box 266, Te Aroha 3342 Physical Address: Te Aroha Office - 35 Kenrick Street, Te Aroha Matamata-Piako Civic and Memorial Centre - 11 Tainui Street, Matamata Morrinsville Area Office - 56-62 Canada Street, Morrinsville	
Telephone Number:	0800 746 467		
Email:	Refer to Online Contact Form		
Maintenance Manager Emergency Contact Details			
Name:	MPDC call centre	Address: 56-62 Canada Street, Morrinsville	
Telephone Number: (Daytime)	0800 746 467		
Telephone Number: (Out-Of-Hours)	0800 746 467		
Email:	Relevant operational area inbox		

Designer Details:		
Name:	Dean Morris	19 Kaimiro Street, Pukete, Hamilton 3200
Telephone Number:	09 242 2724	
Email:	deanm@maven.co.nz	
Applicant Details		
Name:	Matamata Developments Ltd	Address: 127 Station Road, Matamata
Telephone Number		
Email:		
Landowner Details:		
Name:	Matamata Developments Ltd	
Telephone Number		
Email:		
Notes / Restrictions / Access		

2. Stormwater System Description

2.1. Site Description

The Ashbourne Residential area is a circa 45.2ha block of land within the Matamata-Piako District. The current site access is through 127 Station Road in Matamata. The site adjoins with the new Highgrove Development to the north-west, and Peakedale and Pippins Development to the east, and the remainder of the site is surrounded by agricultural land.

There is an existing stormwater swale that follows the southern and western boundary. The Waitoa River which runs south to north is approximately 1km to the west of the subject site.

The site has an existing farmhouse located at 127 Station Road. Most of the site is low-lying flat farmland, that is interspersed with artificial farm drains.

2.2. Design Standards

The MPDC Development Manual sets out design and construction standards for stormwater and requires all land development projects to be provided with a mean of stormwater disposal.

Stormwater systems have been designed in accordance with RITS and other relevant standards including the MPDC Development Manual 2010 and caters for the primary pipe system up to the 10-year event as well as the secondary system and overland flow paths to manage excess runoff that cater for events exceeding the capacity of the primary piped system for events exceeding the 10-year event.

2.3. Stormwater Management Plan (SMP)

The planned development straddles the existing Network Discharge Consent ('NDC') boundary. As the development relates to undeveloped land stormwater discharge consents have been obtained from Waikato Regional Council.

The overarching stormwater strategy has been derived from the Maven Waikato SMP which sets out the high-level, best practice approach to stormwater management within the Ashbourne Residential development site. The SMP outlines the overarching stormwater management principles which will form the basis of stormwater design to support future development on the proposed sites.

Furthermore, the stormwater management strategy, as detailed within the SMP, establishes a robust long term stormwater solution, which integrates desired urban form outcomes, with the mitigation of flooding (flood plains and OLFPs) and consideration of best-practice design outcomes as detailed within relevant Waikato guidance documents.

The key components of the Ashbourne stormwater management strategy are as follows:

- Stormwater conveyance for 10yr cc ARI rainfall event
- Overland flow paths for (100yr – 10yr) cc ARI rainfall event to be accommodated within the site and conveyed to basins.
- Treatment of runoff prior to discharge into receiving environment in accordance with TP10 / GD01 / Waikato Stormwater Management Guidelines (WRC Technical Report 2018/01).
- Usage of soakage where possible

For further details please refer to the SMP prepared by Maven Waikato Ltd dated April 2025.

2.4. Capacity and Quality

Stormwater Strategy for Lot Areas

Roof runoff is managed using inert roofing materials, while driveway runoff is directed through a catch pit with a sump for pre-treatment before disposal into a private soakage device. Overflow is located in the catchpit system for flows surpassing the 10-year event within the lot areas. Excess flows will be diverted into the downstream basin via the road carriageway.

Stormwater Strategy for Road Carriageway

The initial runoff volume (WQV) is treated via proposed roadside raingardens. the proposed rain gardens are integrated with the roadside soakage trench combined to cater for the 10-year event. Flows exceeding the 10-year soakage capacity are redirected back into the road carriageway and get discharged at the downstream stormwater Basin.

Stormwater Strategy for SW Basin A

These basins forms critical part of the overall stormwater Mitigation system. They have been sized to accommodate the 100-year event or excess flows from both the road carriageway and on lot flows exceeding the 10-year event. Additionally, the upstream inflows particularly in basins A and D has been accounted for as well in these basins. it is anticipated that through soakage and storage capacity of the proposed basins, no flows are expected to discharge into the downstream environment from these basins.

Stormwater Strategy for SW Basin B and Greenway

Stormwater Basin B is connected with the greenway and both serve a dual purpose; Attenuating flows from Catchment B flows (to at least 80% pre-development) and conveying flows from the southern solar farm and external inflow from the southern external catchment as depicted in plans.

Stormwater Strategy for SW Wetland C and D

These wetlands forms critical part of the overall stormwater Mitigation system. Roof runoff for these catchments will be directed to individual on-lot detention tanks sized to attenuate up to the 10-year ARI (including climate change) discharging at 80% of the pre-development peak flow.

Road runoffs within the Catchments will be divided between sections of the corridor with soakage systems (providing retention up to the 10-year ARI cc event) and sections without soakage that drain directly to the downstream wetlands. For storm events exceeding the 10-year ARI cc event, overflows from the on-lot detention tanks and from the road soakage systems, along with runoff from the non-soakage road areas, will be conveyed via the road drainage system to the proposed stormwater wetland.

2.4.1. Hydrogeological Assessment

Wallbridge Gilbert Aztec Ltd has been prepared the Hydrogeology – Assessment of Effects for the Ashbourne construction. Please consult the Hydrogeological Effects Assessment prepared by WGA Ltd which provides detailed guidance on hydrogeological measures.

2.5. Flooding

The WRC hazard portal has indicated there is potential flooding along the western side of Highgrove Development in the 100 years storm event, however there is no flooding indicated within the subject development.

A flood model has been developed and calibrated using the region's observed rainfall and river data. The model has been used to test a sensitivity scenario in which all primary stormwater devices are blocked. Even under this worst-case condition, the model demonstrates that the development

maintains flood immunity, with only minor exceedances expected to be mitigated through detailed design refinements.

2.6. Overland Flow

Additional branches of OLFPs will be created as roading corridors are formed. The following measures will be adopted to mitigate their effects of these overland flowpaths on the proposed development.

- Identify and maintain natural overland flow/watercourse locations to convey concentrated stormwater from the site. Utilise existing culverts (where possible) to maintain the same discharge locations, post development.
- Identify and retain any upstream OLFPs and/or watercourses to avoid any upstream flooding.
- Ensure OLFPs are to be designed where possible within the roading network and discharge into watercourses and 100-year detention devices.

The preliminary OLFP design is shown in Maven Associates drawings C460 contained within Appendix A. summary of results provided below Detailed design of the OLFPs will be provided at future detail design stage following the approval of the resource consent.

An assessment of the post development overland flow paths (OLFPs) has been carried out to evaluate the behaviour of surface runoff in the road carriageway under the proposed stormwater management system. The design scenario is based on the RCP8.5 climate change scenario, incorporating all proposed soakage and treatment devices and the assessment is done through Autodesk Hydroflo software. The OLFPs represents the conveyance of surface runoff as a result of the proposed system during the 100-year storm event.

Flow depths and velocities were assessed at key locations throughout the development covering all the various road/Accessway typologies ensuring and confirming conveyance of the OLFP is viable through proposed carriageway. See below table showing results at the key locations.

	SECTION	CATCHMENT AREA HA	FLOWRATE m3/s	MAX DEPTH m	VELOCITY m/s	DEPTH x VELOCITY
CATCHMENT A	1	3.1	0.6	0.137	0.77	0.105
	2	6.2	1.1	0.158	0.97	0.153
	3	2.9	0.6	0.131	0.82	0.107
CATCHMENT B	1	5.9	0.9	0.167	0.81	0.135
	2	2.3	0.3	0.116	0.59	0.068
	3	1.1	0.2	0.091	0.61	0.056
	4	12.5	1.5	0.216	0.79	0.171
	5	4.2	0.6	0.121	0.912	0.110
CATCHMENT C	1	2.3	0.5	0.125	0.81	0.101
CATCHMENT D	1	2.8	0.3	0.116	0.59	0.068
	2	2.7	0.3	0.109	0.59	0.064

Table 1: OLFP Results

Most OLFP sections comply with standard design thresholds. However, three sections recorded maximum water depths above the 150mm guideline.

- Catchment A – Section 2: Max Depth = 0.158
- Catchment B – Section 4: Max Depth = 0.216
- Catchment C – Section 1: Max Depth = 0.137m (just below threshold)

Despite minor exceedances in depth, depth x velocity (m2/s) values remain well below critical safety thresholds defined in Austroads 2012 Part 5, which specify;

- < 0.4m^2/s pedestrian Safety

- <0.6m^2/s for vehicle safety

The highest recorded value was 0.171m^2/s confirming safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads conveyed into roadside treatment and 10year mitigation devices prior to spilling back (during event above the 10year) onto the road and get discharged into the proposed basins or Greenway.
It is noted that a separate flood sensitivity analysis has been completed using HEC-RAS 2D modelling assuming all stormwater devices are fully blocked. The assessment detailed in section 7 of SMP, evaluates overland flow behaviour under worst case flooding conditions within and surrounding the site.

3. Stormwater System Devices

3.1. Raingardens

Raingardens are the primary stormwater treatment mechanism for Ashbourne Residential development. They have been designed to treat stormwater run-off from hardstand areas such as roads, footpaths, car parks etc. by filtering it through vegetation and then soaking vertically through an organic loam soil mix before draining into the piped stormwater network.

Vegetation

Vegetation enhances raingarden performance for stormwater treatment and therefore requires close attention.

Maintenance includes fertilising plants, removing noxious plants or weeds, re-establishing plants that die and maintaining mulch cover.

Regular inspections by the responsible entity must be done to ensure that the desired vegetation remains and is not overtaken by invasive undesirable plants.

In some situations, the replacement of the planted vegetation by a volunteer species may be beneficial, but only if the invasive species provides equal or increased water quality benefits and is accepted by the owners of the site.

Plants

Use native plants as per the approved landscaping plans to replace plants if this is required.

Sediment

Sediments accumulate in raingardens. Removal should occur when surface ponding lasts significantly longer than the one day drain time, which indicates surface clogging. When sediments are to be removed, it is essential to restore the vegetation and soil conditions to the originally constructed condition.

Sediment removal will necessitate disturbance of the vegetation, so steps will have to be taken to re-establish the vegetation upon completion of sediment removal.

Erosion control in the contributing drainage area also will be necessary to prevent scour and excessive sedimentation in the rain garden until there is once again a dense stand of vegetation.

Sediment may also impede effective performance of a rain garden by clogging the soil surface and preventing design storms from being treated. If stormwater backs up into the upstream drainage area, overflow may occur and bypass the treatment area.

Debris

Similar to other types of practices, debris removal is an ongoing maintenance function at all rain garden systems.

Debris, if not removed, can block inlets or outlets, and can be unsightly if located in a visible location.

Soil

Only use approved raingarden soil (usually a sandy loam compost) which is readily available at some horticultural centres.

Drainage Testing

If water is not observed freely draining from the rain garden outlet it may be blocked. Back wash through the outlet and/or maintenance access port until the rain garden is freely draining. If this does not help then the soil may be blocked and need to be removed, pipes inspected/cleared.

Avoid

- The use of sprays to kill weeds or algae as this will contaminate the downstream waterways.
- Do not compact the rain garden soil mix.
- Do not add clay or silt in the rain garden soil mix as this will restrict infiltration.

Inspection requirements

- Debris cleanout
  - Removal of debris
  - No dumping of wastes into raingarden
  - Litter has been removed
- Vegetation
  - Plant height not less than design water depth
  - Fertilised per specifications
  - No evidence of erosion
  - Is planting composition still according to approved plans
  - No placement of inappropriate plants
- Dewatering and sedimentation
  - Raingarden dewaters between storms
  - No evidence of standing water
  - No evidence of surface clogging
  - Sediments should not be > than 20% raingarden design depth
- Outlets / Overflow Spillway
  - No evidence of erosion
  - No evidence of any blockages
- Integrity of Biofilter
  - Raingarden has not been blocked or filled inappropriately
  - Mulch layer still in place
  - Noxious plants or weeds removed

Maintenance procedures

Timing	Component	Action
Following storms	Grass filter strip, kerbing, and paved area	Remove rubbish, leaves, and other debris from the grass filter strip and surrounding drainage area

	Ponding area	Clear inflow points of sediments, rubbish, and leaves Check for erosion or gouging and repair Test drainage of ponding area
	Mulch	Mulch may need to be redistributed or added around inflow points.
3 monthly	Grass filter strip, kerbing, and paved area	Mow no shorter than 50mm. Re-sow grass as necessary. Remove rubbish, leaves, and other debris. Remove excess mulch/soil if required.
	Ponding area	Clear inflow points of built-up sediment, rubbish, and leaves. Check for erosion or gouging.
	Mulch layer	Remove rubbish, leaves, and other debris. After storm events, mulch may need to be redistributed or added around inflow points.
	Plants	Water establishing plants monthly during extended dry periods. Check plant health and replace dead plants. Use native species to suit garden conditions. Remove weeds – do not use herbicides, pesticides, and fertilisers.
Annually	Ponding area	Clear inflow points of sediment, rubbish, and leaves. Check for erosion or gouging and repair. Check all water has drained 24 hours after heavy rain.
	Raingarden soil mix	Check soil level is below surrounding hard surface level and overflow grate.
	Mulch layer	Check surface of mulch for build-up of sediment, remove and replace.
	Underdrain system	Use inspection well to check underdrain is working properly.

Troubleshooting

Symptom	Possible problems	Solutions
Stormwater runoff is bypassing the raingarden	Local earthworks increasing sediment load to raingarden, blocking raingarden outlets, or raising surface level of the raingarden	Check surface of the raingarden is below the surrounding areas. Remove any sediments and debris from inflow areas and from the surface of the raingarden. Protect raingarden from future construction sediments.
	Rubbish and other debris blocking the inflow points to the raingarden	Regularly remove rubbish leaves, and any other debris from inflow points.
Raingarden is ponding for longer than 24 hours	Incorrect blend of soil mix	Replace soil mix with the correct raingarden soil mix.

Stormwater and/or mulch flowing off the raingarden	The soil within the garden compacted during construction or other activities	Loosen the top 500mm of soil by tiling or forking.
	Raingarden filled with too much mulch or soil	Remove excess mulch or soil so that surface of ponding area is approximately 200-300mm below the surrounding hard surfaces and overflow
Sulphur smell coming from the raingarden	Plants and soils lacking oxygen.	Inspect raingarden after rain event to check garden drains within 12 to 24hours.
Erosion and gouging occurring within the raingarden	Kerbs and other hard structures channelling stormwater flow.	Create openings in the kerb to increase number and width of run off points or replace kerbing with a different design.

3.2. Soakage Basin & Wetland

Soakage basins and wetlands have been designed to restrict surface water flows from the site to predevelopment levels by retaining surface water on site within catchment areas.

3.2.1. Soakage Basin

The Ashbourne Residential development includes the construction of two (2) stormwater basins which will act primarily as dry ponds and will not have a permanent water level. These basins are primarily for stormwater attenuation. The design allows for infiltration within the base of stormwater basins. Each stormwater basin will have a maintenance access track around the perimeter, with sufficient widths for an excavator and cartage trucks.

3.2.2. Wetland

The Ashbourne Residential development includes the construction of two (2) stormwater wetlands. Road runoffs within the Catchments will be divided between sections of the corridor with soakage systems (providing retention up to the 10-year ARI cc event) and sections without soakage that drain directly to the downstream wetlands. For storm events exceeding the 10-year ARI cc event, overflows from the on-lot detention tanks and from the road soakage systems, along with runoff from the non-soakage road areas, will be conveyed via the road drainage system to the proposed stormwater wetland.

Inspection requirements

- Embankment & Emergency Spillway
  - Level of spillway
  - Vegetation and ground cover
  - Freeboard
  - No evidence of embankment erosion
  - Removal of debris on emergency spillway
- Riser & Service Spillway
  - No low flow orifice obstructed
  - No excessive sediment accumulation inside the riser
  - Function of outfall channels
  - Slope protection
  - No rip-rap failures

- Wetland
    - No undesirable vegetation growth
    - Removal of floating debris
    - No visible pollution
    - No evidence of edge erosion
- Dry Pond
    - Vegetation cover
    - No presence of undesirable vegetation
    - No standing water of wet spots
    - Sediment and/or trash not accumulated
    - Low flow channels not observed

- Sediment Forebays
    - Sediment is not accumulated more than 50%
    - Provision of access of maintenance

Maintenance procedures

Timing	Component	Action
Following storms / Monthly	Inlet	Inspect and remove rubbish and debris from inlets.
	Trash racks and debris screens	Inspect and clear all litter, including leaves, rubbish, branches, and any other materials.
	Sediment forebay	Check the forebay for accumulated sediment. Test sediments for contaminants prior to dredging and dispose of sediment to landfill or similar, suitable for contaminant levels.
	Risers, control structures, grates, outlet pipes, skimmers, weirs, and orifices	Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Clear and remove all blockages to avoid local flooding. Inspect outflow pipes for leaky joints or soil piping erosion. Check if anti-seep collars need repair or replacement. Check outfall and water discharge areas for erosion and restore and stabilise erosion.
	Emergency overflow or spillway	Check emergency overflow path remains clear of debris and blockages and remove any blockages. Check flow paths for erosion and repair as necessary.
	Erosion and bank stability	Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling.
	Water body	Remove rubbish and other floating debris from wetland pond.
	Wildlife	Remove dead animals to prevent disease spread.

	Soil	Inspect for loss of soil on wetland banks from erosion.
Annually	Valves and pumps	Check pumps and valves. Check moving parts for corrosion and lubricate.
2+ years	Wetland liners	Inspect liner for leaks and fix as per manufacturers or design specifications.
	Sediment forebay	Check the forebay for accumulated sediment. Test sediment for contaminants prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

Troubleshooting

Symptom	Possible problems	Solutions
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary,
	Outlets structures are clogged	Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants	Remove plants by hand. (no herbicide)
	A maintenance valve is open	Check drain valves and shut if open
	Water leaking from cracks in outlet structure	Inspect for cracks and repair as necessary. Inspect for leaky joints at outlet pipes and repair.
	Wetland in area of changing groundwater levels	Pond will remain dry as long as groundwater levels are low. Design for pond should have taken this into account, so this may be normal for this wetland.
Stormwater discharging from the wetland looks dirty, muddy, or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area	Check catchment for erosion areas, including construction works. Check erosion controls are in place.
	Forebay full of sediment	Forebay usually needs more frequent clearing of sediment than wetland pond.
	Local works disturbing soils, with rain washing these into wetland	Check erosion and sediment controls in place on local construction sites.
Pond banks are eroding	Water flowing down pond banks is eroding soils	Minor erosion can be repaired by replacing soil and stabilising with planting or other methods.
	Stormwater outlet pipes direct flow at banks	Cause of erosion from direct discharge may be required, for example, by extending pipes down into pond. Extensive erosion due to continuing discharge may require erosion protection.

Water is leaking form the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly.	Qualified contractors should make immediate repairs. It usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks.

3.3. Temporary Swales

Temporary swales for stage 3 and 4 of Ashbourne Development will be constructed to capture surface water from rainfall events exceeding 100 year and discharge to stormwater basin B.
The temporary swales shall be inspected in line with the Waikato Stormwater Management Guideline 2020. This will include manual/mechanical prevention of undesired overgrowth from taking over the area (mowing/weeding) and manual debris and sediment removal from the outlets discharging into the temporary swales.

Inspection requirements

- Debris cleanout
  - Removal of debris
  - No dumping of wastes into swales
  - Litter has been removed
- Vegetation
  - Plant height not less than design water depth
  - Fertilised per specifications
  - No evidence of erosion
  - Grass height not greater than 250mm
  - No placement of inappropriate plants
- Dewatering
  - Swales dewater between storms
  - No evidence of standing water

Maintenance procedures

Timing	Component	Action
Following storms	Inflow points	Check for scouring, channelling, and erosion and repair as necessary.
	Side slopes	Check for scouring, channelling, and erosion and repair by adding soil and replanting as necessary.
	Channel base	Check for scouring, channelling, and erosion and repair by adding soil and replanting as necessary.
	Plants and soil	Check stormwater is filtering through soil following stormwater runoff. Remove weeds.
Monthly	Outlet	Check for scouring or erosion and repair to suit.
	Inflow points	Remove rubbish and debris.
	Channel base	If grassed, mow channel no shorter than 150mm Re-seed bare patches of grass.
	Plants and soil	Replant gaps and water new plants in dry conditions until established.
Two yearly	Outlet	Remove rubbish and debris from outlet grate or catchpit.

	Channel base	Check for boggy patches and ponding water. Check soil is not compacted and aerate surface or tip up dips to repair.
	Grass, plants, and soil	Remove weeds, rubbish, and debris. Re-plant gaps and re-seed bare patches, and water if required to establish. Aerate soil to prevent natural compaction. Check Stormwater is filtering through soil.

Troubleshooting

Symptom	Possible problems	Solutions
Water not draining	Soil compacted	Aerate soil with rotating aerator or core.
	Soil clogged with fine sediments	Remove top layer of soil and replace, turning soil.
	Underdrain, if present, may be blocked	Re-build underdrain.
Water flowing straight to outlet	Soil not free draining	Aerate soil, replace top layer of soil, replace soil with free draining mix.
	Swale slope is too steep	If slope is over 5%, construct check dams to slow flows.
	Plants or grass is not dense enough	Leave grass longer, and re-seed to increase density.
Scouring / Channels appearing	Inflow is concentrated at inlets	Remove blockages including rubbish, debris, and sediment build up.

4. Reporting and Scheduling

Recording and Reporting of Operation and Maintenance activities to the WRC

Recording of information and device tracking are important components of the maintenance of stormwater system devices. It is important that site operator and/or owners track maintenance by use of database. This helps inspectors to understand what devices need to be inspected, when they need to be inspected, and when was the last maintenance. Contractors nominated by MPDC will record operation and maintenance activities and report to Waikato Regional Council by use of a database. Established checklists will be used during the inspection and maintenance activities, and the activities will never rely on the memory of any one individual.

Appendix A – Auckland Council's Wetlands Operation and Maintenance Guide

WETLANDS

Operation & Maintanence Guide

STORMWATER DEVICE INFORMATION SERIES

Auckland Council

Te Kaunihera o Tāmaki Makaurau

What are constructed wetlands?

Constructed wetlands are large shallow planted ponds that filter stormwater runoff, slow flows and help control flooding downstream. Similar to natural wetlands, they look attractive and provide home and shelter to wildlife. Constructed wetlands help remove sediments, nutrients and contaminants from incoming stormwater before discharging to downstream stormwater system or waterways.

This guide offers a general description of constructed wetlands. Each constructed wetland is specifically designed to suit a particular site, so construction details will be on design and site construction plans. Correct construction levels are crucial for supplying suitable drainage for wetland plants.

How and when should maintenance be carried out?

Constructed wetlands need to be maintained in two main ways. Firstly, so they continue to work as designed (filtering stormwater, slowing flows and controlling downstream flooding) and secondly, to look attractive. A full inspection of constructed wetlands should take place a year after construction is completed.

This may be carried out by the construction contractor to coincide with the end of the defects liability period. The tables below give only typical timelines and actions for maintaining constructed wetlands. This is a general guide - each wetland should have its own detailed maintenance plan to suit the particular catchment size, pollutant loads and inflows.

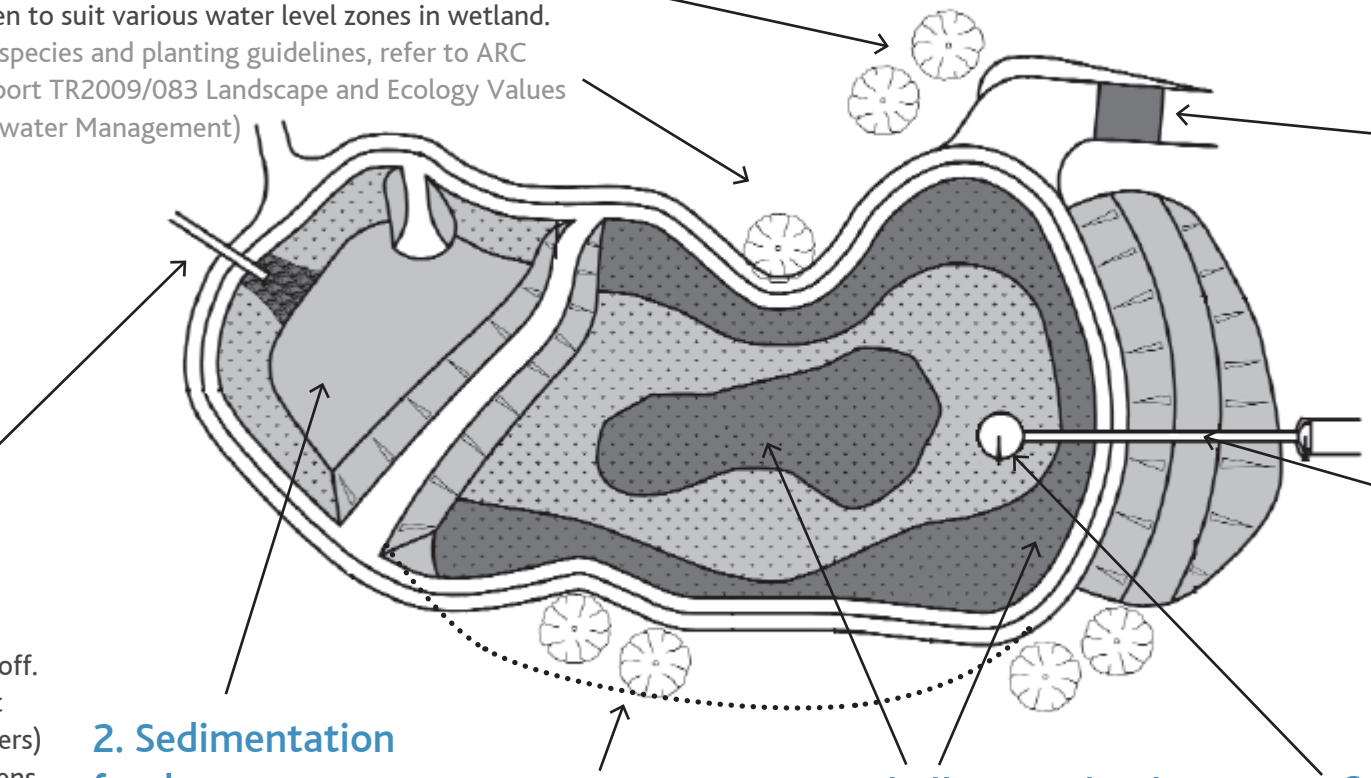
WARNING - CONTAMINATED SOIL

Constructed wetlands treat stormwater run-off, so will collect contaminants in the sediments of the pond and forebay. All material removed from these sites should be tested for contaminants before being disposed of at a suitable secure landfill.

Eight key components of a constructed wetland

5. Plants

Usually native plants, in the pond and on littoral shelf.
Species chosen to suit various water level zones in wetland.
(For suitable species and planting guidelines, refer to ARC Technical Report TR2009/083 Landscape and Ecology Values within Stormwater Management)



7. Emergency overflow

Structure to allow extreme heavy rain flows to bypass wetland and drain downstream, to prevent overtopping of wetland banks. May be in outlet riser or separate.

8. Anti-seep collars

Collars are fitted to all pipework to prevent pond leakage and potential bank collapse from erosion.

1. Inlet

Inlet pipe, receiving runoff. Erosion controls at inlet (rip rap, energy dissipaters) slow flows. Debris screens or trash racks capture rubbish.

2. Sedimentation forebay (if included)

Forebay helps slow runoff and sediment drops to the bottom. Separated from main pond by a bund or low dam.

3. Main wetland

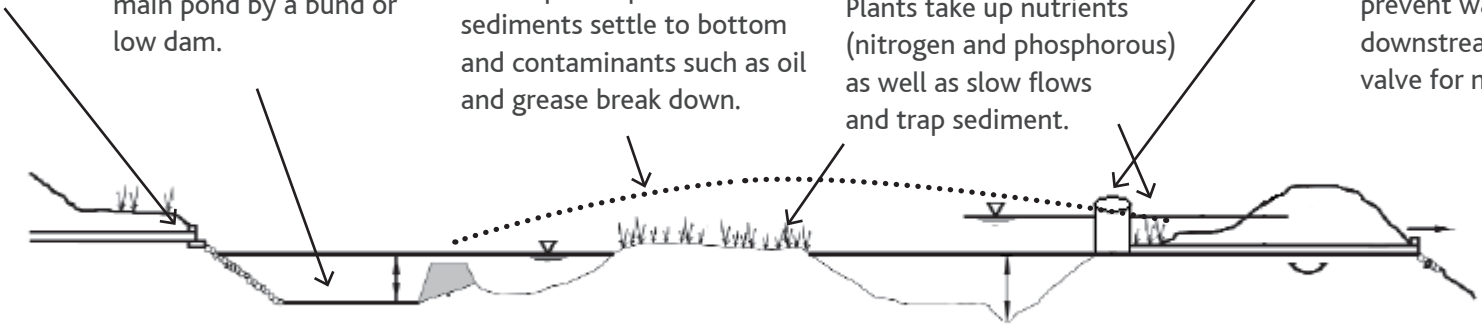
Shallow wide pond of variable depth to 1m, planted with aquatic species. Fine sediments settle to bottom and contaminants such as oil and grease break down.

4. Shallow wetland area

(Littoral shelf) Shoreline of the pond, planted with swamp species submerged at times. Plants take up nutrients (nitrogen and phosphorous) as well as slow flows and trap sediment.

6. Risers/outlets

Outlet riser pipe or weir for discharge of treated runoff. Risers may have scruffy dome to trap debris, or baffles/skimmer to prevent water life and debris from flowing downstream. Some risers have drain-down valve for maintenance.



MAINTENANCE SCHEDULE

Timing	Component	Action
Following storms	Inlet	• Inspect and remove rubbish and debris from inlets. • Check area around inlet, especially energy dissipation (rip rap) structures for erosion and cracking, and if present, repair.
	Trash racks and debris screens (if fitted)	• Inspect and clear all litter, including leaves, rubbish, branches and any other material that would block flows. Check racks for corrosion and replace if necessary.
	Sediment forebay	• Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. • Test sediments for contaminants (eg heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.
	Bund	• Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Blockage could be sediment build up, floating debris, rubbish. • Control structures could be overgrown with vegetation. • Clear and remove all blockages to avoid local flooding. Areas around control structure need to be clear of vegetation and rubbish to maintain stormwater flow. A boat may be required to access the outlet. • Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion. • Check energy dissipaters are adequate.
	Emergency overflow or spillway	• Check emergency overflow path remains clear of debris and blockages, and remove any blockages. Check flow path for erosion and repair as necessary. Structural repairs must be repaired immediately to avoid catastrophic failure.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
Following storms	Erosion and bank stability	• Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling. • Remove woody vegetation growth (unless species specifically included in pond planting plans) to avoid future root damage to banks. Removal will require bank material replacement and repair, compacted to design specification of maximum 90% dry soil density. • Inspect for pedestrian and cycle traffic or pathways on banks. • Either restrict traffic by closing paths off, or provide suitable resistant ground cover to avoid erosion from traffic.
	Water body	• Remove rubbish and other floating debris from wetland pond. • Inspect for algal blooms (usually dense water discolouration or surface scum) or fish kills – these could indicate water has extremely low levels of oxygen (eutrophication), or high nutrient loads or pollutants. • Test water quality if these problems suspected.
	Wildlife	• Control pest species so they do not threaten birds and aquatic life of the wetland. • Remove dead animals, especially water birds, to prevent disease spread. Wet areas where mosquito (mosquito larvae) could breed need careful maintenance.
	Soil	• Inspect for loss of soil on wetland banks from erosion. If plants are struggling to grow soil fertilizer may be required, but extra care must be taken to prevent fertilizer from entering wetland and local waterways.
Monthly	Inlet	• Inspect and remove rubbish and debris from inlets.
	Trash racks and debris screens (if fitted)	• Inspect and clear all litter, including leaves, rubbish, branches and any other material that would block flows. • Check racks for corrosion and replace if necessary.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
Monthly	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Blockage could be sediment build up, floating debris, rubbish. Control structures could be overgrown with vegetation. • Clear and remove all blockages to avoid local flooding. Areas around control structure need to be clear of vegetation and rubbish to maintain stormwater flow. • Boat may be required to access outlet.
	Emergency overflow or spillway	• Check emergency overflow path remains clear of debris and blockages, and remove any blockages. • Check flow path for erosion and repair as necessary. Structural repairs must be repaired immediately to avoid catastrophic failure.
	Erosion and bank stability	• Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling. • Remove woody vegetation growth (unless species specifically included in pond planting plans) to avoid future root damage to banks. Removal will require bank material replacement and repair, compacted to design specification (of maximum 90% dry soil density). • Inspect for pedestrian and cycle traffic or pathways on banks. • Either restrict traffic by closing paths off, or provide suitable resistant ground cover to avoid erosion from traffic.
	Landscaping	• Clear wetland plants of weeds and prune and replace three-monthly. Mow split grass around pond monthly. Schedules may vary depending on seasonal growth.
	Water body	• Remove rubbish and other floating debris from wetland pond. Inspect for algal blooms (usually dense water discolouration or surface scum) or fish kills – these could indicate water has extremely low levels of oxygen (eutrophication), or high nutrient loads or pollutants. Test water quality if these problems suspected.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
6 Monthly	Wildlife	• Control pest species so they do not threaten birds and aquatic life of the wetland. Remove dead animals, especially water birds, to prevent disease spread. • Wet areas where mosquito (mosquito larvae) could breed need careful maintenance.
	Soil	• Inspect for loss of soil on wetland banks from erosion. If plants are struggling to grow soil fertilizer may be required, but extra care must be taken to prevent fertilizer from entering wetland and local waterways.
	Inlet	• Check area around inlet, especially energy dissipation (rip rap) structures for erosion and cracking, and if present, repair.
	Bund	• Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion. Check energy dissipaters are adequate.
	Littoral zones	• Inspect wetland plants for exotic or invasive/nuisance water species and remove. • Control may be done manually, or with appropriate herbicide by properly licensed and registered professional. Follow up inspections may be needed during growing season.
Anually	Valves and pumps	• Check pumps and valves, if present, are functioning properly. • Check moving parts for corrosion and lubricate if required.
2+ Years	Wetland liner	• Inspect liner for leaks and fix as per manufacturer's or design specifications.
	Sediment forebay	• Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. • Test sediments for contaminants (eg heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

TROUBLESHOOTING

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	• Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary. Refer decision to supervisor if necessary.
	Outlet structures are clogged	• Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants (such as raupo) clogging pond area	• Remove plants by hand – do not use herbicides.
	A maintenance valve is open.	• Check drain valves and shut if open.
	Water leaking from cracks in outlet structure.	• Inspect for cracks and repair as necessary. • Inspect for leaky joints at outlet pipes and repair.
	Wetland in area of changing groundwater levels.	• Pond will remain dry as long as groundwater levels are low. • Design for pond should have taken this into account, so this may be normal for this wetland.
	Ground water levels have dropped due to drought conditions	• Drought conditions cannot be solved, until wet season restores wetland pond levels. Use drought opportunity to clean sediments from forebay and repair stormwater infrastructure.
Stormwater discharging from the wetland looks dirty, muddy or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area.	• Check catchment for erosion areas, including construction works. • Check erosion controls are in place. Add or repair erosion control as required.
	Forebay full of sediment.	• Forebay usually needs more frequent clearing of sediment than wetland pond. Dredging required when forebay water storage is around 50% of total volume.
	Local works disturbing soils, with rain washing these into wetland.	• Check erosion and sediment controls in place on local construction sites. • Repair if necessary and stabilise areas of exposed soil where erosion occurring.
	Wetland outlet constructed too close to inlet, preventing treatment of water before discharge.	• Should have been designed to suit. Well placed baffles or islands in wetland may redirect and slow flows to increase treatment between inlet and outlet points.

TROUBLESHOOTING cont...

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Wetland plants are growing over the edges and across surface of the pond	Wetland plants are growing in shallow edges of pond.	• Constructed wetlands are designed to have plants growing large fringes across pond. No action required unless plants are affecting pond function, for instance, clogging outlet structure.
Pond banks are eroding	Water flowing down pond banks is eroding soils.	• Minor erosion can be repaired by replacing soil and stabilising with planting or other methods.
	Stormwater outlet pipes direct flow at banks.	• Cause of erosion from direct discharge may be repaired, for instance, by extending pipes down into pond. • Extensive erosion due to continuing discharge may require erosion protection such as rip-rap, geotextile.
Water is leaking from the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly (or at all). This can lead to failure of banks.	• Failure of pond banks can cause major damage at pond and downstream, so qualified construction contractors should make immediate repairs. This usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks reconstructed to original design specifications.
Dead or dying birds	Botulism is a common killer of pond birds. Birds ingest toxins produced by the bacteria Clostridium botulinum, either from the water or by eating maggots or other infected food sources. Botulism can occur when water levels are low, often mid to late summer when pond water stagnates. It can also appear after algal blooms, when water oxygen levels are low.	• Remove all dead birds and animals from the area to reduce the spread of Botulism. Avoid algal blooms (see below). • Maintain flows through the ponds to avoid stagnant water. Improve shading over the water.

TROUBLESHOOTING cont...

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Algal blooms (Yellow, green, red or blue-green coloured scum on the surface of the water.)	Algae is naturally present in waterways. Algal blooms occur in good growing conditions, including stagnant or slow moving water, high levels of nutrients, and warm and sunny weather.	• Avoid blooms by reducing nutrients entering the wetland, (for instance, controlling fertilizers from the surrounding area) and by maintaining water flows. • Although there are a number of suggested ways to deal with blooms, few are proven to work. The use of barley straw bales in the pond may work in some cases.
Animal pests present	Dense plant cover and abundant food supply in wetlands supports many animals, including pest species.	• Thin out vegetation where possible. • Set traps and poison in the area, using recommended procedures such as careful poison placement and providing warning signs.
Plants on edge of pond dying	Plants are suffering extreme wet and dry conditions.	• Choose plant varieties suitable to local conditions. • New plants need watering until established. • Replace unsuitable varieties.

Quick maintenance checks

- ✓ Check for leaks and erosion on and around banks, especially at leak collars.
- ✓ Regularly clear rubbish and dead vegetation around outlet structures, trash racks and forebay.
- ✓ Remove dead birds in case of botulism, especially in hot, humid conditions
- ✓ Keep new plants watered and control weed species.

Avoid

- ✗ Do not let erosion go unchecked. Repair, and replace erosion controls if necessary.
- ✗ Do not let forebay volume reach over half-full of sediment. Dredge and dispose of to suitable landfill.
- ✗ Prevent fertilizers, pesticides and herbicides entering the pond to avoid algal blooms and polluting downstream waterways.
- ✗ Do not ignore algal blooms and unusually dirty or dark pond water. These can affect the health of the wetland and downstream waterways.

Appendix B – Recommended Maintenance Event and Frequency Checklists

Waikato REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

STORMWATER MAINTENANCE INSPECTION FORM

Inspector:
Date:
Time:
Weather: Rainfall over previous 2-3 days?

File No:

Site Name:		ID No:	
Location		Catchment:	
		Needs immediate attention	
		Not Applicable	

SWALE AND FILTER STRIP PRACTICE MAINTENANCE INSPECTION CHECKLIST	×	Required Y / N	✓	Okay	?	Clarification Required

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Swale And Filter Strip Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
DEBRIS CLEANOUT	Y		Y	N	**M**	**CHECK DAMS / ENERGY DISSIPATORS / SUMPS**	Y	N	Y	N	**A**
1. Swales and filter strips and contributing areas clean of debris											
2. No dumping of wastes into swales or filter strips											
3. Litter (branches, etc) have been removed											
VEGETATION					**M**						
4. Plant height not less than design water depth											
5. Fertilised per specifications											
6. No evidence of erosion											
7. Grass height not greater than 250mm											
8. Is plant composition according to design plans											
9. No placement of inappropriate plants											
DEWATERING					**M**						
10. Swales and filter strips dewater between storms											
11. No evidence of standing water											

Inspection Frequency Key **A = Annual, M = Monthly**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Waikato REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

STORMWATER MAINTENANCE INSPECTION FORM

Inspector:
Date:
Time:
Weather: Rainfall over previous 2-3 days?

Site Name:		File No:	
Location:		Consent No:	
		Catchment:	

RAIN GARDEN MAINTENANCE INSPECTION CHECKLIST	×	Needs immediate attention	✓	Okay	?	Clarification Required
	-	Not Applicable				

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Rain Garden Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
DEBRIS CLEANOUT	Y	N	Y	N	**M**	**OUTLETS/OVERFLOW SPILLWAY**	Y	N	Y	N	**A, AMS**
1. Rain gardens and contributing areas clean of debris						13. Good condition, no need for repair					
2. No dumping of yard wastes into rain garden						14. No evidence of erosion					
3. Litter (branches, etc) have been removed						15. No evidence of any blockages					
VEGETATION					**3M**	**INTEGRITY OF BIOFILTER**					**A**
4. Planting height not less than design water depth						16. Rain garden has not been blocked or filled inappropriately					
5. Fertilised per specifications						17. Mulch layer still in place					
6. No evidence of erosion						18. Noxious plants or weeds removed					
7. Is plant composition still according to approved plans											
8. No placement of inappropriate plants											
DEWATERING AND SEDIMENTATION											
9. Rain garden dewaters between storms					**3M**						
10. No evidence of standing water											
11. No evidence of surface clogging											
12. Sediments should not be > than 20% of rain garden design depth											

Inspection Frequency Key **A = Annual, M = Monthly, AMS = After Major Storm**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Waikato REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

STORMWATER MAINTENANCE INSPECTION FORM

Inspector:
Date:
Time:
Weather: Rainfall over previous 2-3 days?

Site Name:		File No:	
Location		Consent No:	
		Catchment:	

INFILTRATION TRENCH MAINTENANCE INSPECTION CHECKLIST

× Needs immediate attention
– Not Applicable
✓ Okay
? Clarification Required

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Infiltration Trench Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
DEBRIS CLEANOUT	Y	N	Y	N	**M**	**INLETS**	Y	N	Y	N	**A**
1. Trench surface clear of debris						13. Good condition					
2. Inlet areas clear of debris						14. No evidence of erosion					
3. Inflow pipes clear of debris						**OUTLETS/OVERFLOW SPILLWAY**					**A**
4. Overflow spillway clear of debris						15. Good condition, no need for repair					
SEDIMENT TRAPS, FOREBAYS, OR PRETREATMENT SWALES					**A**	16. No evidence of erosion					
5. Obviously trapping sediment						**AGGREGATE REPAIRS**					**A**
6. Greater than 50% of storage volume remaining						17. Surface of aggregate clean					
VEGETATION					**M**	18. Top layer of stone does not need replacement					
7. Mowing done when needed						19. Trench does not need rehabilitation					
8. Fertilized per specifications						**VEGETATED SURFACE**					**M**
9. No evidence of erosion						20. No evidence of erosion					
DEWATERING					**3M**	21. Perforated inlet functioning adequately					
10. Trench dewaters between storms						22. Water does not stand on vegetative surface					
SEDIMENT CLEANOUT OF TRENCH					**A**	23. Good vegetative cover exists					
11. No evidence of sedimentation in trench											
12. Sediment accumulation does not yet require cleanout											

Inspection Frequency Key **A = Annual, M = Monthly**

INSPECTORS REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Waikato REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

STORMWATER MAINTENANCE INSPECTION FORM

Inspector:	
Date:	
Time:	
Weather: Rainfall over previous 2-3 days?	
Page 1 of 2	

Site Name:		File No:	
Location:		Consent No:	
		Catchment:	

STORMWATER POND/WETLAND MAINTENANCE INSPECTION CHECKLIST

× Needs immediate attention
– Not Applicable
✓ Okay
? Clarification Required

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Pond/Wetland Components:

Items Inspected	Checked Y	Checked N	Maintenance Needed Y	Maintenance Needed N	Inspection Frequency
EMBANKMENT & EMERGENCY SPILLWAY					**A,S**
1. Is the spillway level?					
2. Adequate vegetation & ground cover?					
3. Appropriate plants / weeds?					
4. Adequate freeboard?					
5. Embankment erosion evident?					
6. Cracking, bulging or sliding of dam					
a) Upstream embankment					
b) Downstream embankment					
c) At or beyond toe upstream					
d) At or beyond toe downstream					
e) Emergency spillway					
7. Pond & toe drains clear & functioning?					
8. Evidence of animal burrows?					
9. Seeps/leaks on downstream face?					
10. Vertical & horizontal alignment of top of dam as per As-Built plans?					
11. Emergency spillway clear of obstructions & debris					
12. Provision of access for maintenance?					
a) By hand?					
b) For machinery?					
13. Other?					
RISER & SERVICE SPILLWAY					**A**
Type: Reinforced concrete					
Metal pipe					
Masonry					
14. Low flow orifice obstructed?					
15. Low flow trash rack:					
a) Is debris removal necessary?					
b) Is corrosion evident?					
16. Weir trash rack maintenance					
a) Is debris removal required?					
b) Is corrosion evident?					
17. Is there excessive sediment accumulation inside the riser?					
18. Metal pipe condition	Good		Fair		Poor
19. Outfall channels functioning?					

Items Inspected	Checked Y	Checked N	Maintenance Needed Y	Maintenance Needed N	Inspection Frequency
20. Concrete/Masonry condition Riser and barrels:					
a) Cracks or displacement?					
b) Minor spalling (.0.25mm)?					
c) Major spalling (rebars exposed)?					
d) Joint failures?					
e) Water tightness adequate?					
21. Pond drain valve:					
a) Operational / exercised?					
b) Chained and locked?					
22. Slope protection or rip-rap failures?					
23. Other?					
PERMANENT POOL (WET POND)					**3M**
24. Undesirable vegetative growth?					
25. Removal of floating debris required?					
26. Visible pollution?					
27. Evidence of 'edge' erosion?					
28. Other?					
DRY POND					**3M**
29. Adequate vegetation cover?					
30. Presence of undesirable vegetation / woody growth?					
31. Standing water or wet spots?					
32. Sediment and/or trash accumulation?					
33. Low flow channels unobstructed?					
34. Other?					
SEDIMENT FOREBAYS					
35. Is sediment accumulation > 50% (maintenance req'd immed. If Yes)					
36. Provision of access for maintenance:					
a) By hand?					
b) For machinery?					
OUTFALLS INTO PONDS					**A,S**
37. Riprap failures?					
38. Condition of endwalls / headwalls	Good		Fair		Poor
39. Evidence of slope erosion?					
40. Condition of any inflow pipes.	Good		Fair		Poor
41. Other?					

Items Inspected	Checked Y	Checked N	Maintenance Needed Y	Maintenance Needed N	Inspection Frequency
OTHER					**6M**
CONSTRUCTED WETLAND AREAS					**A**

1

41. Encroachments on pond or easement area?						45. Vegetation healthy and growing?						
42. Complaints from residents?						46. Evidence of invasive species?						
43. Aesthetics						47. Excessive sedimentation in wetland area?						
a) grass mowing required?												
b) graffiti removal needed?												
c) other (specify)?												
44. Any public hazards (specify)?												

Inspection Frequency Key **A = Annual, M = Monthly, S = after monthly storm**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Appendix C – Troubleshooting Guide

Timing	Component	Action
		• Remove weeds – do not use herbicides, pesticides and fertilisers as these chemicals will pollute the stormwater runoff.
Annually	Ponding area	• Clear inflow points of sediment, rubbish and leaves. • Check for erosion or gouging and repair. • Check all water has drained 24 hours after heavy rain. • Alternatively test drainage of ponding area. Dig a hole 200mm wide x 200mm deep. Pour in 10 litres of water in hole. Check drainage rate over 1 hour period – minimum 25mm/hour. • If crust of fine sediment present on surface of soil mix, remove with spade and rework using rake. Top up soil and mulch as necessary (ensuring level is below surrounding hard surface and overflow). Dispose of contaminated crusted topsoil in a secure landfill (unless soil testing shows no contamination).
	Rain garden soil mix	• Check soil level is below surrounding hard surface level and overflow grate. Use drainage test described above to check soil is free draining. •
	Mulch layer (bark, pebbles, etc.)	• Check surface of mulch for build-up of sediment, remove and replace as required.
	Underdrain system	• Use inspection well (if present) to check underdrain is working properly. • Check rain garden draining freely using the drainage test described above. If rain garden is not free-draining, the underdrain may be blocked. Try back-washing under drain from the outlet. If still blocked, the rain garden may need plants and rain garden soil mix removed and replaced.

Table 18-5: Troubleshooting for bioretention devices[175]

Symptom	Possible problems	Solution
Stormwater runoff is bypassing the rain garden	Local earthworks increasing sediment load to rain garden, blocking rain garden outlets or raising surface level of the rain garden	• Check surface of the rain garden is below the surrounding areas. • Remove any sediments and debris from inflow areas and from the surface of the rain garden. • Protect rain garden from future construction sediments.
	Rubbish and other debris blocking the inflow points to the rain garden	• Regularly remove rubbish, leaves and any other debris from inflow points.
Rain garden is ponding for longer than 24 hours	Incorrect blend of soil mix	• Replace soil mix with the correct rain garden soil mix. Do Ribbon test or Percolation test to test soil mix is free-draining.

[175] Auckland Council Rain Garden Operation and Maintenance Guide

Symptom	Possible problems	Solution
Stormwater and/or mulch flowing off the rain garden	The soil within the garden compacted during construction or other activities.	• Loosen the top 500mm of soil by tilling or forking. Discourage vehicle, pedestrian and bicycle access to the rain garden.
	Layer of fine sediment settled on the garden surface	• Remove fine sediment layer and turn over the top layer of rain garden soil mix. Protect rain garden from surrounding sediment run off.
	Rain garden filled with too much mulch or soil	• Remove excess mulch or soil so that surface of ponding area is approximately 200-300mm below the surrounding hard surfaces and overflow.
	Overflows or discharge pipes clogged with sediments or debris	• Clear overflow and discharge pipes.
	Planting or rain garden soil mix clogged	• It may be necessary to remove some of the rain garden soil mix and replace with fresh rain garden soil mix.
Sulphur smell coming from the rain garden	Plants and soils lacking oxygen (anaerobic conditions). Organic material rotting within the garden The underdrain clogged and water is not properly draining out of the garden	• Inspect rain garden after rain event to check garden drains within 12 – 24 hours (see solutions above for rain garden ponding)
Erosion and gouging occurring within the rain garden	Kerbs and other hard structures channelling stormwater flow (rain gardens require an event sheet of flow of water to operate effectively)	• Create openings in the kerb to increase number and width of run off points, or replace kerbing with a different design (eg. kerbing slightly raised off the ground)
	Inflow points are too concentrated	• Increase kerb opening size by cutting kerbs or replacing with different design. If this is not possible install rip-rap (i.e. stones set into concrete) at the inflow point to spread flow and reduce erosion.
Plants are stressed or dying. Symptoms may include yellowing of leaves, unseasonal leaf fall, wilting.	Plant varieties selected for rain garden are unsuitable for the location and/or extreme wet/dry conditions.	• Select plants appropriate for the location (eg. full shade, partial shade, full sun, etc.) • Due to their hardy nature, native plants are recommended.
	Ponding or excessively long periods of flooding cause plants to become stressed or die.	• Inspect rain garden after rain event to check garden drains within 12 – 24 hour. If not, see above solutions for rain garden ponding.
	The plants poisoned by runoff from a hazards spill (fuel, paint, oil, etc).	• Check soil and mulch for evidence of heavily polluted runoff (eg. rainbow slick, coloured mulch, etc.)
	Pollutants accumulated in the rain garden reached a toxic level for plants.	• If contamination is extensive, clean out raingarden soil mix and replace fresh soil and new plants.
	The plants dehydrated from extended dry conditions	• Newly established plants need watering. • Check soil moisture content and water plants if dry.

Symptom	Possible problems	Solution
		• Establishing plants need watering in dry weather.
	Plants stressed due to attack by plant pests or diseases. Pests may include insects of animals.	• Check for leaf damage or pests and consult gardening manuals or a garden centre for the best treatment. • Stressed plants need replacing with healthy variety or pest-resistance species.
	Rain garden soil mix compacted	• Loosen the top 500mm of soil by tilling or forking. Do not allow vehicle, pedestrian and bicycle access to the rain garden.

18.2.1.4 Infiltration devices

Infiltration devices are very sensitive to impaired performance if excessive amounts of sediments or oils and greases are introduced into them. The greatest problem is clogging of soils in the sides and bottom or in the case of permeable paving surface clogging. This can occur fairly rapidly if inflow sediment loads are not reduced by pre-treatment devices.

Other contaminants, which are attached to sediments, are not considered a clogging concern.

Another problem is poor drainage as a result of high water table, groundwater mounding or a confining soil layer. Prolonged wetness encourages micro-organism growths that tend to clog soils.

18.2.1.5 Ponds and wetlands

Sediment forebay clogged with sediment and needing to be cleaned out

One of the greatest benefits of stormwater management ponds and wetlands is their resilient performance even when excessive contaminant loads enter them. However, performance will suffer if sediment is introduced in large amounts over a lengthy time frame. Sediments reduce the volume of storage and reduce extended detention times, which ultimately reduce the pond or wetland's contaminant reduction potential.

This impaired function is not something that tends to occur dramatically in a short time period but rather occurs cumulatively over a longer time period if the incoming sediment load is consistently elevated.

Another problem that ponds and wetlands have that other devices do not have to such an extent is maintenance problems associated with debris clogging inlets and outlet areas. While other devices can have visual issues related to debris, pond outlets can become blocked, especially the extended detention orifices. Clogging of these outfall orifices can cause significant adverse effects by elevating water in the pond or wetland and potentially killing the vegetation, increasing safety concerns and increasing the zone of saturation in the pond or wetland embankment.

A recommended maintenance schedule for wetlands is provided below:

Timing	Component	Action
	Bund	• Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion. Check energy dissipaters are adequate.
	Littoral zones	• Inspect wetland plants for exotic or invasive/nuisance water species and remove. • Control may be done manually, or with appropriate herbicide by properly licensed and registered professionals. Follow up inspections may be needed during growing season.
Annually	Valves and pumps	• Check pumps and valves, if present, are functioning properly. • Check moving parts for corrosion and lubricate if required.
2+ years	Wetland liners	• Inspect liner for leaks and fix as per manufacturer's or design specifications.
	Sediment forebay	• Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. • Test sediment for contaminants (eg. heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

Table 18-7: Trouble shooting for wetland[177]

Symptom	Possible problems	Solution
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	• Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary. Refer decision to supervisor if necessary.
	Outlet structures are clogged	• Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants (such as raupo) clogging pond area	• Remove plants by hand, do not use herbicide.
	A maintenance valve is open	• Check drain valves and shut if open
	Water leaking from cracks in outlet structure	• Inspect for cracks and repair as necessary • Inspect for leaky joints at outlet pipes and repair

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Symptom	Possible problems	Solution
	Wetland in area of changing groundwater levels	• Pond will remain dry as long as groundwater levels are low. • Design for pond should have taken this into account, so this may be normal for this wetland.
	Groundwater levels have dropped due to drought conditions	• Drought conditions cannot be solved, until wet season restores wetland pond levels. Use drought opportunity to clean sediments from forebay and repair stormwater infrastructure.
Stormwater discharging from the wetland looks dirty, muddy or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area	• Check catchment for erosion areas, including construction works. • Check erosion controls are in place. Add or repair erosion control as required
	Forebay full of sediment	• Forebay usually needs more frequent clearing of sediment than wetland pond. Dredging required when forebay water storage is around 50% of total volume.
	Local works disturbing soils, with rain washing these into wetland	• Check erosion and sediment controls in place on local construction sites • Repair if necessary and stabilise areas of exposed soil where erosion occurring
	Wetland outlet constructed too close to inlet, preventing treatment of water before discharge	• Should have been designed to suit. Well placed baffles or islands in wetland may redirect and slow flows to increase treatment between inlet and outlet points.
Wetland plants are growing over the edges and across surface of the pond	Wetland plants are growing in shallow edges of pond	• Constructed wetlands are designed to have plants growing large fringes across pond. No action required unless plants are affecting pond function, for instance, clogging outlet structure.
Pond banks are eroding	Water flowing down pond banks is eroding soils	• Minor erosion can be repaired by replacing soil and stabilising with planting or other methods
	Stormwater outlet pipes direct flow at banks	• Cause of erosion from direct discharge may be repaired, for instance, by extending pipes down into pond. • Extensive erosion due to continuing discharge may require erosion protection such as rip-rap, geotextile.
Water is leaking from the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly (or at all). This can lead to failure of banks.	• Failure of pond banks can cause major damage at pond and downstream, so qualified construction contractors should make immediate repairs. This usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks

Symptom	Possible problems	Solution
		reconstructed to original design specifications.
Dead or dying birds	Botulism is a common killer of pond birds. Birds ingest toxins produced by the bacteria Clostridium botulinum, either from the water or by eating maggots or other infected food sources. Botulism can occur when water levels are low, often mid to late summer when pond water stagnates. It can also appear after algal blooms, when water oxygen levels are low.	• Remove all dead birds and animals from the area to reduce the spread of Botulism. Avoid algal blooms (see below). • Maintain flows through the ponds to avoid stagnant water. Improve shading over the water.
Algal blooms (yellow, green, red or blue-green coloured scum on the surface of the water)	Algae is naturally present in waterways. Algal blooms occur in good growing conditions, including stagnant or slow moving water, high levels of nutrients, and warm and sunny weather	• Avoid blooms by reducing nutrients entering the wetland, (for instance, controlling fertilizers from the surrounding area) and by maintaining water flows. • Although there are a number of suggested ways to deal with blooms, few are proven to work. The use of barley straw bales in the pond may work in some cases.
Animal pests present	Dense plant cover and abundant food supply in wetlands supports many animals, including pest species	• Thin out vegetation where possible. • Set traps and poison in the area, using recommended procedures such as careful poison placement and providing warning signs.
Plants on edge of pond dying	Plants are suffering extreme wet and dry conditions.	• Choose plant varieties suitable to local conditions. • New plants need watering until established. • Replace unsuitable varieties.

18.2.1.6 Green roofs

Principal reasons why this device performance can deteriorate are the following:

- Impermeable membrane failure due to leakage, puncture or UV deterioration
- Excessive weed growth outcompeting planted growth
- Ponding of water on flat roofs
- Concentration of flows across the green roof causing scour and discharge at locations not designed for
- Clogging of substrate, and
- Plugged outlets.

18.2.1.7 Water tanks

Water tank function can be compromised mainly due to two reasons:

1. Inadequate water supply where demand exceeds supply, and
2. The tank outlets or downspouts become clogged due to excessive vegetative entry into the tank from roof spouting.