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# Maitahi Village - Stormwater Management

## Water Sensitive Design Report

**Final**

Prepared for CCKV Maitai Dev Co LP

## Document Control

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# Contents

# 1. Context

Morphum Environmental Ltd (Morphum) were engaged to support the stormwater design of the Maitahi Kākā Hill Development in the Matai Valley, Nelson. Morphum's role is to provide technical water sensitive design (WSD) expertise to the project team to ensure the development has robust and resilient stormwater management integrated across the site to support the aspirations to protect and enhance the freshwater values and ecological conditions of Kākā Stream and the Maitai/Maitahi River. This will be achieved by the implementation of best practise water sensitive design to meet the requirements of Schedule X (NRMP). This report describes the proposed stormwater treatment concept and design assumptions and should be read in conjunction with the full Stormwater Management Plan (SMP) which has been prepared by Tonkin & Taylor. The SMP should be referred to for specific site context, further details, and site plan/maps.

## 1.1. Water Sensitive Design Scope

Morphum were engaged to provide specialist design services including overall WSD strategy development, sizing of stormwater management elements and input into integration with landscape architecture. These works are intended to ensure the appropriate design and implementation of water quality treatment devices and hydrological controls for operational stormwater from all impervious surfaces throughout the development, including roads, residential lots, commercial areas and the Arvida retirement villages. Principles of water sensitive design have been applied at multiple layers of the development and hence has been an iterative process with the civil and landscape design teams.

## 1.2. Defined Objectives

The site was recently rezoned for residential development through private plan change 28 (PPC28). This plan change introduced 'Schedule X' which is now operative and sets out requirements that must be met for development within the plan change area. These Schedule X requirements take precedent over the standards of the Nelson Tasman Land Development Manual (LDM) and were agreed on through PPC28 to provide certainty that the development from existing rural land use could be done in a manner which protected and enhanced freshwater values across the site and downstream. The Schedule X provisions have informed our design approach specifically those which respond to stormwater treatment and water sensitive design. Key provisions from Schedule X are included below:

***RE6.3*** *- A comprehensive and integrated management approach including, but not limited to:*

- *A. Prioritising the health and well-being of surface waterbodies in a manner that maintains or enhances cultural, recreational and ecosystem values.*
- *B. Ensuring integrated stormwater management, erosion and sediment control and flood hazard*
- *C. Ensuring urban development:*
    - *a. Uses 'green infrastructure' engineering solutions to mimic and work with natural processes;*
    - *b. Retains, restores and enhances existing elements of the natural drainage system, and integrates these elements into the urban landscape;*
    - *c. Conserves the use of water resources through rainwater capture and reuse to meet non potable demands; and*

   d. *Requires that building materials either exclude or be finished in a manner that prevents water runoff from containing copper or zinc.*

D. *Ensuring Water Sensitive Design principles are utilised in the planning and implementation stages.*
E. *Mimicking pre-development hydrology through retention and detention by matching pre-development mean annual volume of stormwater runoff and pre-development channel forming flows in Kākā Stream to reduce the risk of scour, sediment mobilisation and adverse impacts on instream biota.*
F. *Providing for the 'first flush' of all site generated stormwater (excluding where on lot reuse or infiltration occurs) to be passed through constructed vegetated treatment devices to avoid temperature fluctuations and minimise concentrations of copper, zinc, hydrocarbons, nutrients and sediment to the smallest amount practicable prior to discharge to Kākā Stream, existing wetlands or Maitahi/Mahitahi River. First flush is to be based on treating 80-85% of mean annual volume or stormwater resulting from 3-month ARI Rainfall events (25mm rainfall depth or 10mm/hr rainfall intensity).*
H. *Requiring the mapping of areas with suitable infiltration capacity and factoring in design to optimise groundwater recharge where viable as part of integrated water sensitive design strategy. Infiltration capacity is to be protected through construction and optimised in-fill areas with specific design and construction of permeable fill.*
I. *Providing and protecting overland flow paths through road design and other dedicated pathways to pass peak flows from upper slopes safely.*
K. *Restoring and enhancing the lower reaches of Kākā Stream through a continuous riparian corridor (Blue-Green Spine) with:*
   a. *The corridor reflecting natural topography;*
   b. *Channel meanders and flood benches;*
   c. *Robust riparian vegetation;*
   d. *Peak flood capacity;*
   e. *Ecosystem function and habitat;*
   f. *Stormwater treatment wetlands in areas of suitable topography;*
   g. *Public access via well designed walking/cycling paths (excluding roads except at crossing points); and*
   h. *Natural character values.*
M. *Providing for the co-location of stormwater treatment wetlands/rain-gardens within the Kākā Stream Blue-Green Spine where this is the most appropriate option to: protect the main stream, increase ecological values, and provide high quality public amenity. Where stormwater treatment is located in the Blue-Green Spine the design shall ensure a minimum 10m riparian buffer between any device and the stream and support ongoing maintenance access.*
N. *Managing earthworks and compaction outside residential zones to minimise changes to the hydraulic response of flows directly or indirectly discharging into the Kākā Stream and its tributaries.*
O. *Including on-lot management of water quality/quantity through rainwater capture and reuse and soakage (where viable) so as to conserve and reuse water for non-potable internal and external purposes.*
P. *Providing for the integration of peak flood attenuation within the Blue-Green Spine, while ensuring: that stream ecology (including fish passage) is preserved; any off line stormwater treatment devices are protected; natural character is maintained or enhanced; and the health and safety of community and visitors is protected.*

## 1.3. Design Approach

Greenfield urban development can result in adverse impacts due to the generation and discharge of urban contaminants and the change in hydrology which results in increased stormwater volumes and flowrates during small frequent rainfall events. These impacts are a direct reflection of the increase in impervious surfaces including roofs, hardstand and roads which prevent the natural interception and evapotranspiration of rainfall by vegetation/shallow soils and result in contaminants including heavy metals, hydrocarbons, sediments and nutrients discharging to receiving waterways as well as biophysical contaminants including temperature and fluctuating dissolved oxygen which are known to adversely impact of freshwater ecology.

A water sensitive design approach must address the characteristics of runoff from impervious surfaces to avoid negatively impacting the health of receiving freshwater environments. The aim of WSD is therefore to mimic the natural hydrological response of the catchment and remove contaminates from runoff before discharge to receiving waterways. The proposed stormwater management strategy for the Maitahi Village Development will achieve a high level of environmental protection and meet the requirements of PC28 through three key stormwater management techniques:

1. Capture and reuse of roof runoff at lot scale. This will be achieved through rainwater reuse tanks plumbed for internal non potable reuse (toilet flushing) to replicate natural interception and evapotranspiration for medium density dwellings in the western and central catchment.
2. Treatment of all road and hardstand (driveways) and untreated roofs (where rainwater reuse not adopted) runoff before discharge to receiving environment through mix of biological, chemical and physical processes in constructed stormwater treatment wetlands and isolated proprietary devices where necessary.
3. Discharge of treated flows from wetlands to areas of constructed ephemeral channels and soakage wetlands to buffer the stream from hydrological changes and support groundwater recharge.

Based on the proposed site wide water sensitive design approach, runoff from impervious surfaces will be effectively managed to ensure that flows which ultimately discharge to Kākā Stream will only occur in moderate to large rainfall events and will have either passed through a comprehensive treatment train to appropriately manage the first flush of rainfall or, in the case of large rainfall events, will have purposely bypassed the constructed wetlands to avoid potential damage of biological processes.

# 2. Proposed Water Sensitive Design Elements

The site of the Maitahi Village project is separated into a series of development typologies with different building densities and development conditions in each. For each of these areas, estimates of the expected impervious area and presence or absence of on-lot reuses tanks informs the requirements for stormwater quality treatment and frequent flow soakage. The stormwater network for the development operates in three sub catchments, each with a treatment wetland and ephemeral soakage wetland at the downstream end prior to discharge to Kākā stream. The proposed constructed wetlands are sized to capture first flush stormwater from impervious surfaces across the connected catchment. Treatment wetlands are sized at 4% of the contributing impervious catchment area. The ephemeral soakage wetlands are sized to infiltrate the first 10mm of rainfall across the impervious catchment (excluding roofs using reuses tanks) within a 24hr period. This is intended to mimic the natural interception, evapotranspiration and infiltration of the natural predeveloped catchment which generates surface runoff only after becoming saturated by the first portion of rain.

## 2.1. On lot Reuse Tanks

For the medium density development zone in the western and central sub catchments rainwater reuse tanks shall be integrated into each dwelling and will be plumbed to internal non-potable uses including toilets and cold water laundry. Table 2 shows the assumptions applied in the sizing of proposed tanks.

Table 1: Water Reuse Assumptions

| | |
|---|---|
| **No. people per dwelling** | 2.9 |
| **Water demand (L/person/d)** | 165 |
| **Water demand (L/dwelling/d)** | 479 |
| **Non-potable fraction - internal (%)** | 40 |
| **Non-potable fraction - external (%)** | 15 |
| **Constant daily reuse (toilet & laundry) (kL/dwelling/d)** | 0.191 |
| **Variable annual reuse (irrigation) (kL/dwelling/y)** | 26.2 |

Runoff from a range of roof areas was modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). Ten years of local rainfall data and different tank sizes were tested to optimise the efficiency and runoff reduction. These tanks were selected based on demonstrating approximately 25% reduction in the mean annual rainfall volume and to capture the first flush of stormwater to mitigate potential water quality impacts. Table 2 provides a summary of the required rainwater reuse tank sizes to achieve the intended hydrological controls.

Table 2 Required rainwater reuse tank sizing.

| **Connected roof area ($m^2$)** | **0-99** | **100 -149** | **150 -199** | **200+** |
|---|---|---|---|---|
| **Required tank Volume (L)** | 2,500 | 3,000 | 4,000 | 5,000 |

This addresses the increase in runoff volume associated with impervious surfaces, by reducing the runoff from the roof areas by approximately 25%.

Development lots which include rainwater reuse tanks are therefore determined to effectively 'self-manage' stormwater from their roof areas which are therefore subtracted from the effective catchment area applied in the sizing of downstream treatment wetlands.

The roof area for tank sizing assumed 85% of the impervious area for the total is roof with, the remaining 15% of impervious area constituting the driveway which will drain toward the road and public stormwater network.

Rainwater reuse tanks will be designed to overflow to the stormwater network, but this will only occur during large events or in periods of prolonged rainfall when the undeveloped catchment would naturally be saturated and generating runoff. Whilst rainwater reuse tanks will provide capture an initial portion of high intensity rain events following prolonged dry spells this has not been allowed for in flood modelling which has assumed that reuse tanks are full at the start of large rain events.

## 2.2. Constructed treatment wetlands

Water quality treatment to remove urban contaminates such as dissolved heavy metals and hydrocarbons will be provided by constructed treatment wetlands. The proposed wetlands will include a permanent depth of water (on average 350 mm with variable depths up to 1,200 mm) and will be densely planted with emergent aquatic vegetation. The central and southern wetlands will also include a 350 mm deep extended detention depth which will be engaged during rainfall events with an average drawdown over 24 – 48 hours following rainfall. Runoff from the connected catchment will flow through the vegetated wetlands following rainfall with contaminants removed through physical, biological and chemical processes. The key features of the proposed treatment wetlands will be:

1. Upstream bypass structure to direct water quality flows to the wetlands with high flows (>1/3 of the 2-year ARI) to discharge direct to the stream
2. Outlet from network with appropriate erosion protection and access for routine inspection and maintenance
3. Sediment pool (forebay) designed to remove coarser particulate contaminants with maintenance access. The forebay will be approximately 10% of the total footprint.
4. Concrete level spreader/submerged weir to distribute uniform flow across the full width of the wetlands
5. Wetland area with water depth ranging between 100 – 1200mm and variety of suitable local plants. The main wetland area will comprise 80% of the total footprint and will be heavily vegetated with shallow and deep marsh species
6. Open water outlet pool with submerged outlet pipe, hydraulic control for extended detention and connection to downstream ephemeral soakage wetland
7. Impermeable lining to prevent drawdown between rainfall events and support biological processes in wetland.

Figure 1 shows an image of a recently constructed wetland with the open water on the right being the sediment forebay.

Figure 1 Constructed stormwater wetland with forebay to the right of path

## 2.3. Ephemeral soakage wetlands

Roof water reuse tanks are not proposed for the high density lots due to space limitations or for a portion of the southern catchment where there is available space for soakage in the proposed integrated ephemeral wetlands. Therefore, all sub catchments will include dedicated retention devices to provide hydrological controls and reduce the volume of stormwater discharged to Kākā Stream in small frequent rainfall events. For catchments which do not include rainwater reuse, this is provided in the form of centralised planted dry basins which receive runoff from the treatment wetlands. Each basin has a set storage volume that allows the first flush of treated stormwater to infiltrate to ground (storage for 10mm of rain across the connected impervious catchment). Drawdown is based on preliminary infiltration rates that will support drawdown of stored water over a 24 hour timeframe. If the rainfall event exceeds the first flush volume the basin will then spill to the stream channel via a defined spillway outlet weir. This will provide effective stormwater retention and mitigates the impacts of development on frequent flow hydrology. The key features of the ephemeral soakage wetland are;

1. Outlet connection from adjacent treatment wetland with appropriate erosion protection
2. Planted basin with ~1m maximum depth of standing water following rainfall
3. Suitable substrate for infiltration without excessive construction phase compaction
4. Outlet weir to stream channel with appropriate erosion protection for longer duration events

# 3. Summary of Catchment Solutions

The development area has been divided into three hydrological sub catchments which will drain into separate treatment trains prior to discharge to Kākā Stream. These have been delineated based on a combination of the natural topography and site levels and the availability of space within the Kākā stream green corridor suitable for the integration of the proposed constructed wetland systems (including stormwater treatment and dedicated soakage).

## 3.1. Western Sub Catchment

The western sub catchment is on the true right bank of Kākā Stream and covers the Arvida B retirement village site, 84 residential lots and several public roads. Table 3 shows the sizing details for impervious surfaces and treatment devices in the catchment. Figures provided in the Stormwater Management report and landscape package should be referred to for details on the location of catchments and proposed treatment wetlands. Due to the steep topography on the true right bank of the re-aligned Kākā Stream, the constructed wetland is required to step over several elevations with a connecting reach of vegetated swale (with drop structures) and another drop structure across the lower wetland terrace also. The detailed design of this system will need to carefully consider the hydraulics to support intended function and ensure flows are spread across the full width. Any water quality improvements associated with the swale connections between wetland swells have not been accounted for in the inferred water quality modelling but will provide further improvements. The treatment area shown in Table 3 for the constructed wetland is the sum of the 3 tiers shown in landscape plans.

Table 3: Western sub catchment sizing details

| | |
|---|---|
| **Total contributing road area** | 18,400 $m^2$ |
| **Disconnected roof area (reuse tanks)** | 20,400 $m^2$ |
| **Hardstand to wetland (lots with tanks and general)** | 14,100 $m^2$ |
| **High density zone (roofs)** | 7,300 $m^2$ |
| **Half of Arvida B (roof & driveways)** | 10,700 $m^2$ |
| **Total connected impervious catchment** | 50,500$m^2$ |
| **Constructed wetland treatment area** | *1,450 $m^2$ |
| **Ephemeral soakage area** | *350 $m^2$ |

It is noted that the current wetland design remains slightly undersized for the assumed catchment. At detailed design and once actual development areas are fully resolved this will be refined through potentially increasing the footprint of the wetland, designing inlet hydraulic to align with clause F of Schedule X 6.3 and reducing the overall catchment imperviousness.

Half of Arvida B is unable to drain toward the inlet end of the proposed treatment wetland. Road and roof surfaces in this zone will therefore be treated by proprietary filter devices (specification yet to be determined) and discharged toward the nearby overland flow path without on-lot retention. This development area will therefore not meet the full requirements of the Clause E of Schedule X 6.3 however it makes up a small (~ 15%) and spatially constrained portion of the impervious catchment. The opportunity for this runoff to be retained via soakage will be investigated further at detailed design in tandem with the specification of a suitable proprietary device but residual shortfall may remain.

## 3.2. Central Sub catchment

The central sub catchment is on the true left bank of Kākā Stream and covers Half of the Arvida A retirement village site, 35 residential lots, a small commercial zone and several public roads. Table 4 shows the sizing details for impervious surfaces and treatment devices in the catchment.

Table 4: Central sub catchment sizing details

| | |
|---|---|
| **Total contributing road area** | 10,260 $m^2$ |
| **Disconnected roof area (reuse tanks)** | 7860 $m^2$ |
| **Driveways to wetland (lots with tanks)** | 7,600 $m^2$ |
| **High density zone (roofs)** | 4,470 $m^2$ |
| **Half of Arvida A (roof & driveways)** | 23,750 $m^2$ |
| **Total connected impervious catchment** | 46,080 $m^2$ |
| **Constructed wetland treatment area** | 1,840 m2 |
| **Ephemeral soakage area** | 460 m2 |

## 3.3. Eastern sub catchment

The eastern sub catchment is located on the east side of the Arvida A south of the central area. This sub catchment include half of the Arvida A retirement village site, 54 residential lots and several public roads. Table 5 shows the sizing details for impervious surfaces and treatment devices in the catchment.

Table 5: Southern sub catchment sizing details

| | |
|---|---|
| **Total contributing road area** | 9,200 m2 |
| **Total contributing roof & driveways** | 20,000 m2 |
| **Half of Arvida A (roof & driveways)** | 23,750 m2 |

| | |
|---|---|
| **Total connected impervious catchment** | 52,950 m2 |
| **Constructed wetland treatment area** | 2,100 m2 |
| **Ephemeral soakage area** | 530 m2 |

## 3.4. Maintenance and Operation

The proposed stormwater management devices will require reactive and proactive maintenance. Design of all wetlands and soakage basins will ensure all devices has suitable vehicle access to the forebays for intermittent sediment removal. Monitoring the wetland for blockages after storms and ensuring invasive plant species do not overwhelm the wetlands or outlets will also be important for operation. A detailed maintenance plan with maps and clear explanations of requirements for each feature will be prepared and provided prior to construction, this document can be used to inform contractor engagement for maintenance works after establishment and vesting.

Arvida (or the nominated the retirement village operator) will need to enter a maintenance contract for upkeep of any onsite proprietary storm filter devices confirmed during detailed design and ensure that residents and contractors are aware of the connection with downstream wetland systems and the need to protect these and Kākā Stream from unintended discharges.

The upkeep of reuse tanks will be the responsibility of the property owner, but a consent notice should be written to ensure this responsibility is properly administered.

# 4. Summary

For the Maitahi Village project water sensitive design is used to meet the requirements of Nelson City Council's schedule X provisions by mimicking the natural hydrology of the Kākā Stream catchment and treating stormwater runoff from impervious surfaces through constructed wetland systems. On lot water reuse and first flush soakage basins are used to mitigate the increase in runoff volumes from development. Constructed wetlands shall receive inflows from impervious surfaces and provide controlled water quality treatment with extended detention to manage a range of water quality issues prior to discharge to the ephemeral soakage basins. Further, all roofing materials shall be specified to avoid the generation of Zinc or Copper. The integration of these stormwater management devices and measures within the blue green corridor defined by the restored Kākā Stream will support the wider ecological/biodiversity aspirations alongside other benefits related to landscape amenity, community connections and passive recreation. The combination of these water sensitive design elements means the development will meet national best practise standards and likely improve downstream water quality as sediment and nutrient runoff from agricultural practise is replaced with urban design that manages contaminates and hydrology to a high standard.

MORPHUM environmental

*Co-creating a thriving ecosystem*


**NEW ZEALAND**

Auckland

Level 4, 18 Sale Street

Auckland Central, Auckland 1010

Tel: +64 9 377 9779

Waikato

65 Victoria St

Hamilton 3204

Wellington

9 Tory Street, Te Aro

Wellington 6011

Tel: +64 4 802 4987

Christchurch

Level 3, 69 Cambridge Terrace

Christchurch 8013

**AUSTRALIA**

Melbourne

Level 20, 31 Queen Street

Melbourne 3000

Tel: +61 3 9111 5640

info@morphum.com | www.morphum.com