



Ref: 22016

28 March 2022

Dr Tim Lequeux and Ms Dani Nicolson

RE: Preliminary Stormwater Management Options – 177 Tomahawk Road, Dunedin

1 Introduction

Dr Tim Lequeux and Ms Dani Nicolson are landowners of 177 Tomahawk Road, Dunedin. This property is currently considered in the Dunedin City Council proposed District Plan (2GP) Variation 2 hearing. The landowners propose to re-zone the property from its existing rural land use to general residential 1 zoning. To support this process, advice has been sought regarding stormwater management options for the site.

1.1 Scope of Work

Dr Tim Lequeux and Ms Dani Nicolson (hereafter, the landowners) engaged e3Scientific Ltd (e3s) to provide stormwater management advice to support their submission in the 2GP Variation 2 process led by the Dunedin City Council (DCC). The Variation 2 process considers changes to enable additional housing capacity through re-zoning specific sites. This report discusses preliminary stormwater management options for 177 Tomahawk Road if the re-zoning occurred and development of residential lots adjacent to Gloucester Street were to go ahead, with the intention of enhancing the quality of stormwater discharge. This report is informed by a desktop review and the recommendations discussed in this report are supported by a site walk-over. If development is to proceed, further specifics of hardstand and roofed area

and a detailed site investigation is required to inform appropriate size of stormwater management infrastructure prior to commencement of development.

1.2 Limitations

e3Scientific Limited (e3s) performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental science profession. No warranties, express or implied, are made. The confidence in the findings is limited by the Scope of Work.

The results of this assessment are based upon site inspections conducted by e3s personnel, and information provided by desktop review of available literature. All conclusions and recommendations regarding the properties are the professional opinions of e3s personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, e3s assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside e3s, or developments resulting from situations outside the scope of this project.

2 Site Description

2.1 General site features

A visual assessment of the site for potential land-based stormwater infrastructure was completed on 3 December 2021. 177 Tomahawk Road is a 7.7 ha property, east facing and sloping from the north boundary along Gloucester Street to the lower boundary bordering Tomahawk Lagoon (Figure 1).

The land is primarily in pasture with a few stands of trees and other vegetation. There is a horse training track on the lower aspect of the property adjacent to Tomahawk Road and the Tomahawk Lagoon.

There are a number of buildings on the site including two dwellings accessed from Gloucester Street (one is uninhabited), horse stables and an abandoned dwelling accessed from Tomahawk Road via the training track.

There is approximately 500 m² gravel hardstand area near the inhabited dwelling. Stormwater from the roof is currently discharged onto the sloping paddock approximately 8 m from the dwelling. No scouring is present at the discharge site and the area has been recently planted with flax *Phormium tenax* and hebe *stricata*.



Figure 1: Location of 177 Tomahawk Road property, with property boundary in red.

The upper section of the property is moderately sloping adjacent to Gloucester St however transitions to more steeply sloping land in the central area of the site before tapering to a gentle slope which runs out to the lower extent of the property (Figure 2). Two gullies in the central part of the site have associated steep localised slopes, they are well vegetated with broom. The lower section of the property is modified and flattened to form a horse training track.



Figure 2: Site topography (source: DCC webmaps)

Historical aerial imagery from 1947 indicate the land marginal to the lagoon margin has been filled to create the existing track infrastructure (Figure 3). Ponding water on the lower paddocks during the site visit (Figure 4) indicate this area may be suited to a constructed wetland.



Figure 3: Retrolens aerial imagery showing less modified margin of Tomahawk Lagoon circa 1947. 177 Tomahawk Road Property boundary indicated by red outline. Sourced from <http://retrolens.nz> and licensed by LINZ CC-BY 3.0



Figure 4: Site photo of stables and training track. Ponding surface water visible in background.

2.2 Existing stormwater features

The property is within the Tomahawk Lagoon Catchment. There are no direct discharges of stormwater from the property to the lagoon. Most of the site drains to the flat, low lying training track area where it ponds and soaks to ground (or evaporates). In very high rainfall events it is assumed that water would over flow from the ponding areas to the lagoon. The site is situated close to the lagoon outlet. Figure 5 below shows the proximity of the land to the Tomahawk Lagoon.



Figure 5: Tomahawk Lagoon Catchment (white dashed), 177 Tomahawk Road (red), upper and lower lagoons (blue)

The Tomahawk Lagoon catchment is not within the DCC Stormwater Integrated Catchment Management Plan area and there is no DCC stormwater network available for the 177 Tomahawk Road site to discharge into.

There is DCC stormwater infrastructure in close proximity to the site. North of the site on Gloucester Street stormwater is conveyed away from the site. However southwest of the site stormwater is conveyed to and discharges onto the site (refer to Figure 6 and Section 2.2.1).

Green dashed lines in Figure 6 indicate DCC stormwater pipes, the green dots indicate pipe outlets. Blue dashed lines indicate approximate gully locations. The solid white line indicates the approximate catchment boundary for an area where flows potentially concentrate on 177 Tomahawk Road. The area identified for stormwater infrastructure has capacity to treat stormwater from a catchment area larger than the property itself. The size of the site, adjacent catchments and proposed development area are outlined in Table 1.

Table 1: Area of catchment, site and proposed development

Description	Area
Southwest catchment discharging to site	3.1 hectares
Catchment contributing to site treatment location	7.5 hectares
177 Tomahawk Road - total site size	7.7 hectares
Proposed residential development area	1.1 hectares

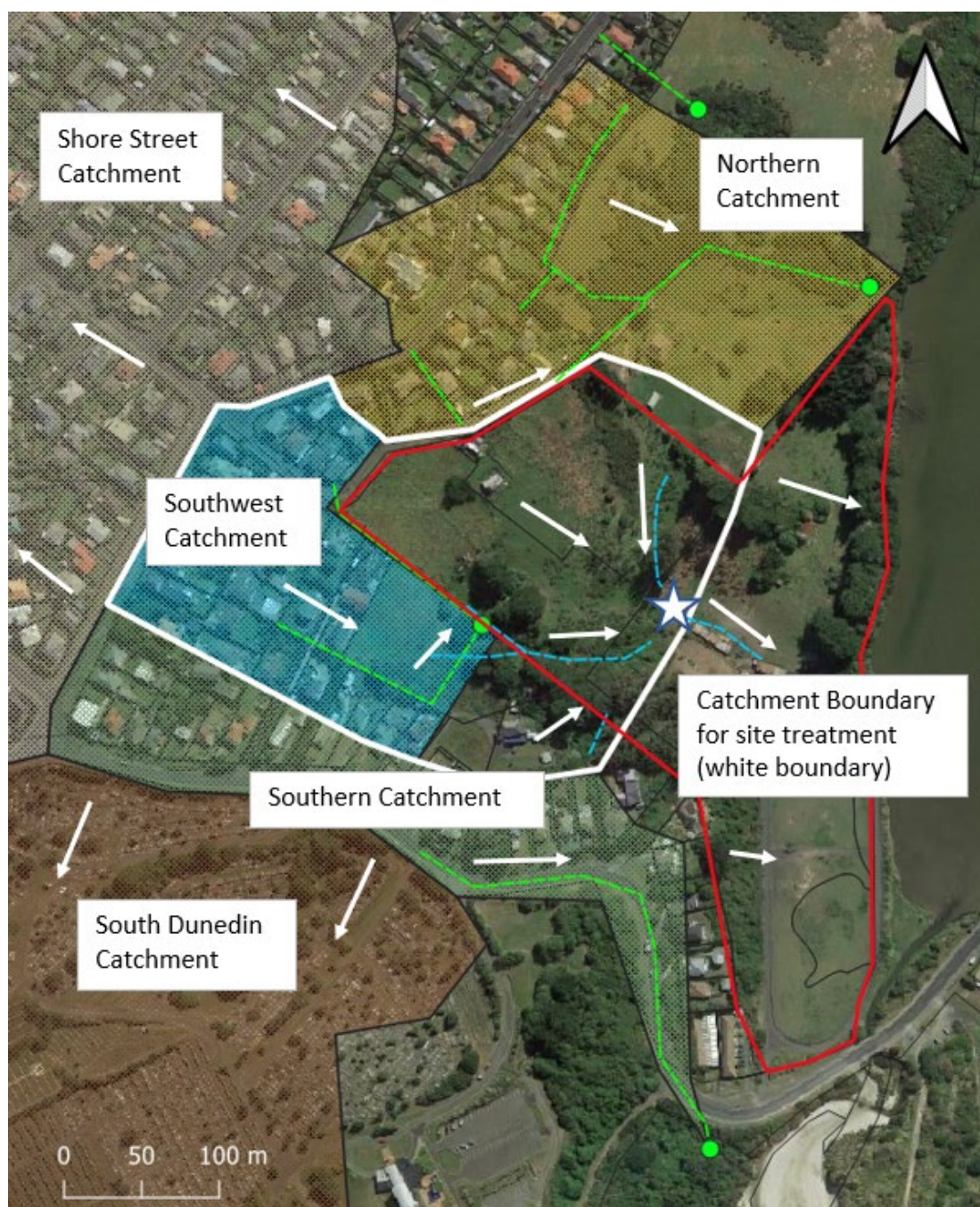


Figure 6: Stormwater catchments and DCC infrastructure (green). White arrows indicate flow direction. Blue dashed line indicates approximate gully/flow paths. White star indicates potential location of stormwater management infrastructure.

2.2.1 Stormwater inflows to the property

Prior to urbanisation the land north of Gloucester Street would have drained to 177 Tomahawk Road, however DCC stormwater infrastructure along Gloucester Street diverts this runoff to the northern catchment (Figure 6). There is a portion of rural

catchment north of the site (54 Gloucester Street) that naturally drains to the property. This area is included in stormwater calculations.

Stormwater from development southwest of the property currently discharges via two outlets (Figure 7) into the same gully on 177 Tomahawk Road. The stormwater is untreated and causing scour of the hillside and is not retained within the soak hole (Figure 8).

Recently, resource consent has been granted for development of eleven dwellings on neighbouring 155 Tomahawk Road (within the southwest catchment). Stormwater from this development is likely to join the existing DCC stormwater system and increase the volume of stormwater discharged onto 177 Tomahawk Road.



Figure 7: Stormwater discharge pipes at boundary of 177 Tomahawk Road, with untreated stormwater flowing to a soak hole.



Figure 8: Stormwater erodes the hillside and enters a deteriorated soak hole where it flows into a 30 cm wide hole within 177 Tomahawk Road.

2.2.2 Seep

There is a natural seep present at the top of the property, approximately 80 m from the northwest boundary. The seep reportedly remains wet throughout summer months and flow may be observed during winter (*pers. comm.* Tim Lequeux, 3 December 2021). At the time of the site visit no flow was visible from the seep (Figure 9).



Figure 9: A natural seep approximately 80 m from the Gloucester Street boundary downhill (left) and uphill (right).

3 Tomahawk Lagoon

Tomahawk Lagoon is a regionally significant wetland consisting of two shallow brackish lagoons joined by a narrow channel. The larger of the two lagoons has a small opening which is intermittently open to the sea. Schedules 1A (Natural Values) and 9 (Significant Wetlands) of the Regional Plan: Water (RPW) (ORC, 2018) identify a range of values associated with Tomahawk Lagoon. Those directly associated with the water quality and aquatic ecology of the lagoon are contained in Table 2.

Table 2: Tomahawk Lagoon Ecological Values from the Regional Plan: Water (ORC, 2018).

Schedule	Values	Value Description
Schedule 1A (Natural Values)	<i>Ecosystem Values</i>	Lagoon which contains a silt/mud substrate
		Has riparian vegetation of significance to aquatic habitats
		Free of aquatic pest plants
		Significant presence of trout and eels
		Contains indigenous invertebrates threatened with extinction
Schedule 9 (Significant Wetlands)	<i>Type A1 values</i>	Contains habitat for nationally or internationally rare or threatened species or communities
		Has presence of threatened plant species on the margins of the lagoon
	<i>Type A4 values</i>	Lagoon has a high degree of wetland naturalness
	<i>Type A5 values</i>	This type of wetland is scarce in Otago in terms of its ecological and physical character
	<i>Type A8 values</i>	Regionally significant habitat for waterfowl and waders
		Habitat for native fish and eels

The lagoon catchment is primarily farmland, however residential suburbs also make up the catchment with the suburb of Ocean Grove to the east of the lagoon, and the suburb of Andersons Bay above the lagoon to the west.

The water quality of the Tomahawk Lagoon is believed to be poor with high levels of phosphorus and nitrogen recorded in the upper and lower lagoons. Reports of

cyanobacteria and toxic algal blooms related to poor water quality are common, and it is believed that the primary cause of this results from historic pastoral land-use practices such as aerial top-dressing with superphosphate. Algal blooms are more common during summer months due to environmental conditions such as low rainfall, warm temperatures, and more sunlight.

4 Stormwater Associated Contaminants

Stormwater-derived chemical contamination in urban waterways is a common and often underestimated result of urban stormwater schemes. Benthic sediments often contain copper, zinc and lead concentrations exceeding Interim Sediment Quality Guidelines (ISQG) (ANZG, 2018) as well as polycyclic aromatic hydrocarbons (PAHs). Dissolved concentrations of heavy metals such as copper and zinc can also be present in the water column, particularly after wet-weather flows (Milne & Watts, 2008). These contaminants may enter the stormwater via unpainted galvanized roofs, fungicide use and ash particles from poorly controlled residential burning (e.g. wood burners or garden waste burn-offs). Litter and sedimentation are also identified as stormwater contaminants contributing to poor water quality. Stormwater often carries high sediment load and poor stormwater design can cause sediment release through mechanisms including ground scour, erosion and slumping.

5 Stormwater Management

5.1 Background

The property has been initially declined for re-zoning as part of the preparation of the Variation 2 proposal due to DCC's assessment that the complexity of stormwater discharge from the site would likely require discharge into Tomahawk Lagoon. It is also noted that any impact of development on water quality of this waterbody is unacceptable.

5.2 Proposed Development

If the re-zoning is successful, the landowners propose to develop eight sections along the top of the property, adjacent to Gloucester Street (see Figure 10, supplied by

client). Additional development on wider areas of the site may be considered in the future, however this assessment is for the initial eight sections.

The applicant has noted that the bottom of the property is less favourable for development due to ecological and cultural values, and a high water table creating physical constraints for installing infrastructure.

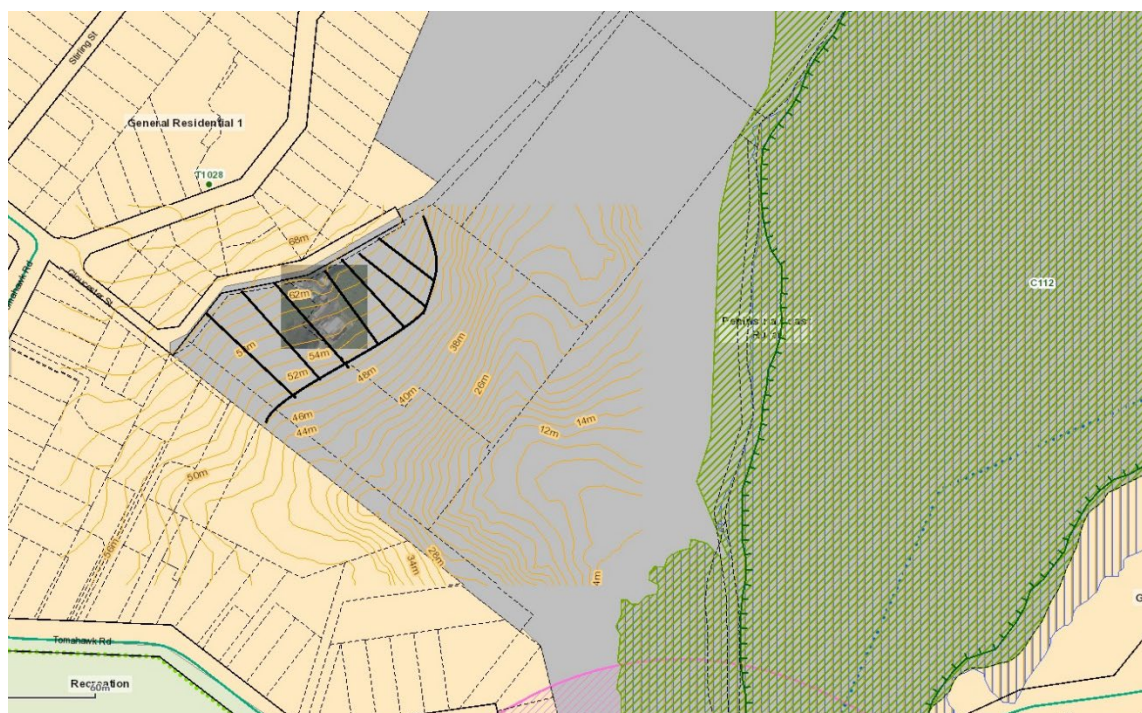


Figure 10: Proposed development of 177 Tomahawk Road.

5.3 Proposed stormwater management

The appropriate treatment of stormwater will ensure that any water entering the Tomahawk Lagoon will be of a quality which would cause no adverse effect to this regionally significant wetland.

It is proposed to use a treatment train approach to treat and discharge stormwater from developed areas on site. This will include individual sumps and then shared dry detention, swale and a constructed wetland.

Runoff from developed hardstand on each lot will drain into sumps before entering a stormwater pipe and discharging to a shared management system on 177 Tomahawk Road. To further reduce runoff volume, it is proposed that rainwater from roof catchments will initially be stored in tanks to water gardens. Once storage tanks are full the overflow will join the stormwater system.

The proposed location of the stormwater pipe discharge to the detention basin is approximately 130 m west of Tomahawk Lagoon (Figure 11). This discharge point has been selected due to its location outside of the coastal hazards area and coastal character area (Figure 12). Constructing the detention basin at the 12 m contour allows for stormwater quality to be improved prior to reaching the groundwater table. This site is above the area predicted to have a low water table (Barrell, Glassey, Cox, & Smith, 2014). This location is also where the overland flow from the site naturally converges.

The stormwater pipe outlet will have baffles and rock protection to minimise scour and erosion. Stormwater will enter a dry detention basin planted with appropriate native vegetation to capture the 'first flush' of rainfall and allow for contaminants to settle. The stormwater infrastructure design will consider existing soil saturation to ensure small slips and slumps in the property do not occur below the outfall and detention pond. Prior to development progressing, the depth of the water table depth and soakage capacity of the detention basin area will be confirmed to further inform infrastructure design. The detention basin design and planting should have consideration for ecological and landscape values alongside meeting drainage and water quality goals.

Stormwater will drain from the detention pond via a planted 2 m wide swale to provide for additional water quality improvements before entering a constructed wetland. Bunding also planted with native vegetation may be used down slope of the swale to ensure overland flow from extreme rainfall events do not reach the lagoon.

The design and construction of the constructed wetland should be undertaken in such a way that future maintenance can be readily carried out.

The design of stormwater conveyance and treatment devices shall be designed using New Zealand guidelines (for example Christchurch City Council – Waterways, Wetland and Drainage Guide (2012) or Auckland City Council – GD01).



Figure 11: Proposed stormwater management infrastructure for 177 Tomahawk Road, Dunedin. Blue area indicates swale placement allowing overland flow to enter constructed wetland.

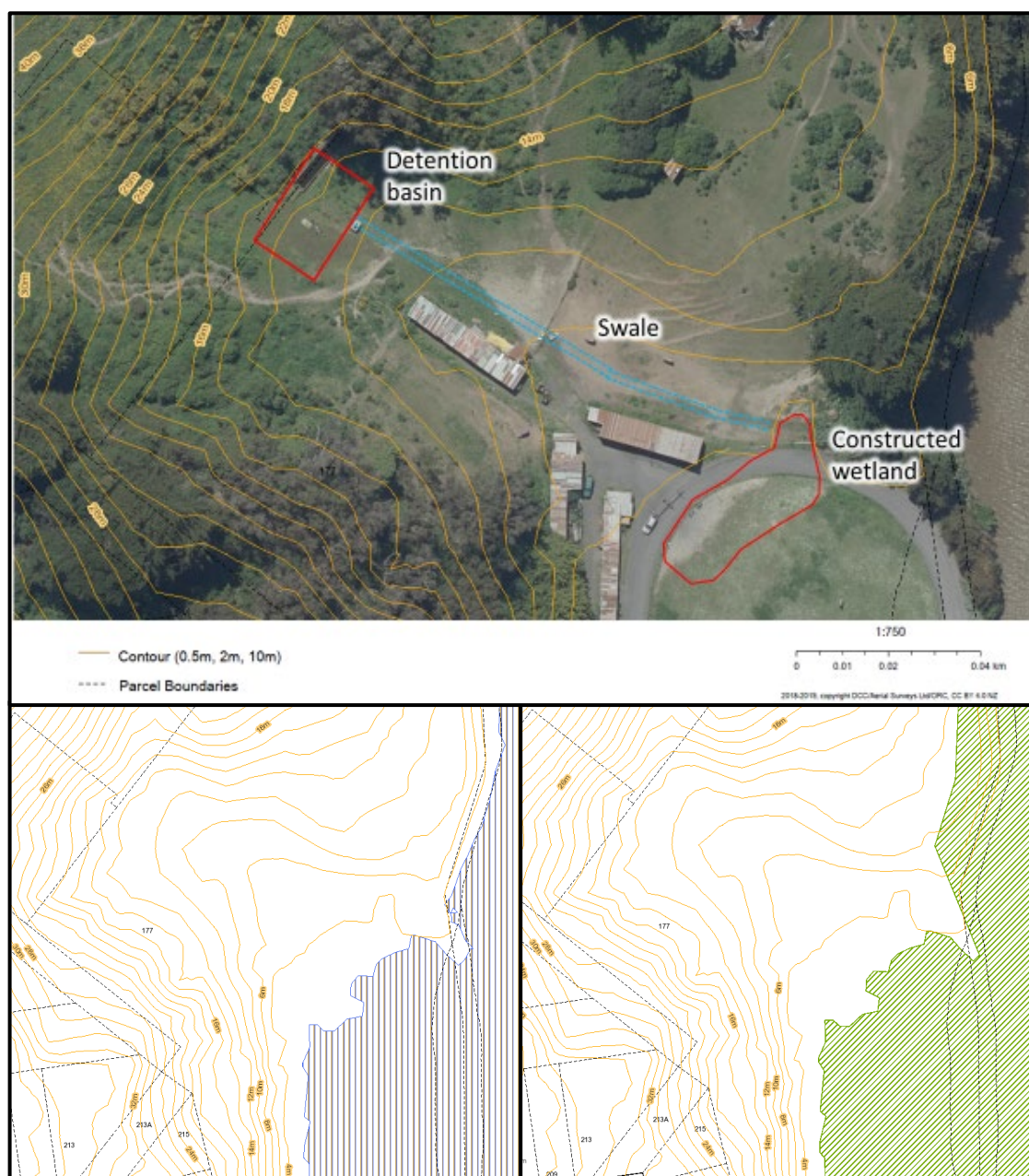


Figure 12: Clockwise from top: Proposed stormwater management infrastructure over 2 m contour; DCC natural coastal character planning overlay zone in green; DCC Hazard 3 (coastal) planning overlay zone in blue.

5.4 Stormwater Treatment Volume

The designated area for the detention basin shown in Figure 11 above is approximately 330 m². This indicates that adequate land is available to treat the

stormwater from the development. Table 3 below provides a highly conservativeⁱ analysis of stormwater treatment volumes required for the development on Gloucester Street. This provides a ballpark figure for treatment storage volumes required for a rainfall event.

Table 3: Stormwater treatment volume analysis (development area only)

Development area	11,000 m ²
First flush depth	25 mm
Impervious Area of development	65% impervious
Volume of stormwater to be treated	180 m³

5.5 Stormwater Flows from adjacent property

Though the volume of these independent stormwater inputs would require further assessment, the proposed area for stormwater treatment infrastructure is likely to have capacity to treat stormwater from neighbouring properties (Table 4). Discharge of neighbouring stormwater sources to land infrastructure would allow contaminants to be removed and ensure better outcomes for water quality of the receiving environment.

Table 4: Stormwater treatment volume for a rainfall event in the adjacent catchment

Southwest Catchment area	33,000 m ²
First flush depth	25 mm
Impervious Area of development	65% impervious
Volume of stormwater to be treated	540 m³

ⁱ Note that this is conservative due to the impervious area most likely to be lower given the large lot sizes, also the applicant proposes to collect and store roof water for reuse on site.

6 Ecological and Water Quality Effects of Stormwater Discharge on Tomahawk Lagoon

This section outlines an assessment of environmental effects of stormwater on water quality and aquatic ecology, the state of Tomahawk Lagoon, and considers the effect of this proposed stormwater mitigation plan on these factors.

The Tomahawk Lagoon provides a number of aquatic ecological values identified by ORC (Schedules 1A and 9, as listed in Table 2 of this report). Based on this, the lagoon appears to support significant numbers of native aquatic species, some threatened with extinction, and their associated habitats. It is also noted to have a high degree of naturalness and is a scarce wetland habitat type in Otago (Table 2).

As Tomahawk Lagoon experiences significant adverse effects from anthropogenic inputs (historic and present), coupled with its morphodynamic state (i.e. shallow, distribution of sediment via mixing and flushing, and sea-barrier closure), it is important to ensure no additional contaminant loading occurs. The proposed development could have significant adverse effects on water and sediment quality and the ecology of Tomahawk Lagoon if untreated waters were to discharge to the lagoon. Through this stormwater mitigation plan stormwater and associated sediment will be discharged to land for appropriate treatment. This will ensure that the lagoon habitat is not further degraded by additional anthropogenic contaminant loading as required by the National Policy Statement for Freshwater Management (New Zealand Government, 2020) and regional plans (ORC, 2018).

The proposed stormwater discharge to land will allow removal of sediment, any contaminants bound to sediment and uptake of dissolved contaminants by vegetation. As no stormwater is proposed to be discharged to the Tomahawk Lagoon, stormwater from any development of 177 Tomahawk Road is not expected to provide an extra source of contaminants and nutrients to this waterbody.

The effect of appropriate mitigation of this discharge to land, as outlined by this Stormwater Infrastructure Proposal, is to produce a negligible effect on water quality

and ecological values of Tomahawk Lagoon. Monitoring stormwater infrastructure on a regular basis (and during stormwater events) for the two years following development will enable prompt remediation options to be undertaken should unexpected adverse effects be observed. This sampling regimen is further outlined in Section 7 of this report.

7 Proposed Stormwater Management Option

The proposed mitigation options include the following:

- Planting;
- Rain barrels;
- Sumps;
- Baffles and rock scour protection;
- Dry detention basin;
- Swales and bunding;
- Constructed wetland, and;
- Educational activities for residents.

These options are considered appropriate to reduce the contaminant loading and bio-accumulation at this site. However, the following best practices are recommended:

- Planting:
 - The planting site will not be sprayed in preparation for planting;
 - An appropriate native riparian planting plan will be prepared by an expert which will specifically aid in the uptake of heavy metals such as zinc, copper and lead as well as nutrients (particularly in the wetland);
 - The planting plan will aid with slope stabilisation and aim to prevent sediment mobilisation;
 - The planting will aim to reduce excess overland water flow from heavy rainfall events;
 - The planting zone will be maintained and remedied where necessary; and
 - The planting plan should be finalised prior to outfall construction commencing and should be completed within two months of outfall construction.

- Rain barrels:
 - Rain barrels will provide initial attenuation of flow from the developed areas by storing rooftop runoff before overflow joins the receiving infrastructure.
 - Interception of rooftop runoff will reduce the total volume of stormwater that needs to be treated by the downstream stormwater system.
- Sumps:
 - Should be emptied when necessary and associated fill disposed of off-site with consideration given to testing for heavy metals, PAHs and other contaminants.
- Baffle structures and rock outlet scour protection:
 - Should be visually inspected every 6-12 months and maintained to ensure effective operation.
- Dry detention basin:
 - The dry detention basin is intended to attenuate peak flows, allow settling and provide some infiltration.
 - Prior to construction an Accidental Discovery Protocol should be developed.
 - After construction, the detention basin should be visually inspected during rainfall events to ensure it is operating as designed.
 - Maintenance activities should include appropriate landscaping/maintenance of inlets, outlets and the basin itself, as well as removal of sediment and other debris.
- Swales and bunding:
 - These structures will convey overland flow while allowing for some infiltration, pollutant removal and further attenuation of peak flows.
 - A planting plan of appropriate native vegetation should be completed.
 - Maintenance activities should include landscaping and removal of any debris that may obstruct flow.
- Constructed Wetland:
 - A planting and management plan should be complete by an appropriately qualified terrestrial ecologist with consideration given to selecting vegetation which will maximize the uptake and removal of pollutants.
 - The wetland should be inspected multiple times per year for the first three years of operation to assess plant health, remove pest species and observe

water levels. Plants may require physical support, watering and/or mulching for the first three years until they become established.

- Educational activities for residents:
 - Should include education on, litter, car washing, paint cleaning, pesticide/fungicide use, and residential burning/ash and ensure residents follow the DCC Stormwater Quality Bylaw 2020.

If the development proceeds, the following monitoring regimen is recommended:

- Sediment and water quality sampling should be undertaken by a suitably qualified environmental scientist prior to, and at completion, of the proposed stormwater development and should test for:
 - Heavy metals, PAHs, nitrogen and phosphorus at:
 - The proposed discharge location;
 - A site along the adjacent lagoon shoreline that lies within the predicted groundwater flow; and
 - Overland flow path from the proposed discharge location.
- Sampling should also be undertaken during a stormwater event and include sampling and flow measurements of the stormwater discharged.
- Ongoing frequency of this sampling could be determined after the results from the stormwater event are analysed, however should not be longer than 6 monthly for the first 2 years.
- If no adverse effects are observed and ISQG (ANZG, 2018) are not exceeded within the first two years of sampling, the sampling regimen may be re-assessed, and frequency could be reduced.

This data will ensure mitigation options are working as anticipated and enable direct comparisons to be made regarding any adverse effects occurring from the stormwater discharge.

8 Summary and Conclusions

It is considered that stormwater discharge resulting from residential development of 177 Tomahawk Road would have land-based infrastructure options available to ensure stormwater is not required to be discharged to Tomahawk Lagoon. Provided the following recommendations are followed, residential development would have

negligible effect on the ecology and water/sediment quality of the Regionally Significant Tomahawk Lagoon. These recommendations are summarised as follows:

- An appropriate planting plan is prepared prior to infrastructure construction commencement.
- Sumps are visually checked regularly and emptied when required. Fill should be tested for contaminants.
- Pipe outlet scour protection should be visually inspected every 6-12 months and maintained to ensure effective operation.
- Following construction, the dry detention basin, swale, bunding and constructed wetland should be inspected regularly and during rainfall events to ensure they are operating as designed. If any operational issues are found the appropriate modifications should be made.
- Resident education should include instruction on management of litter, car washing, paint cleaning, pesticide/fungicide use, and residential burning/ash.
- Sediment and water sampling are completed prior to stormwater discharge commencement and will also be completed during a stormwater event and at regular intervals (within six months) for the first two years.

If you have any questions regarding the information provided in this report, please contact Sarah Johnstone on Sarah.Johnstone@e3scientific.co.nz.

Yours sincerely,

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References

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