Ravensdown Napier Stormwater Improvements

High-Level Stormwater and Process Water Options Review

Ravensdown

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Executive summary

Scope of work

Ravensdown Limited (Ravensdown) have engaged Aurecon New Zealand Ltd (Aurecon) to complete a high-level stormwater and process water options review for their Napier Awatoto works site (the Site) alongside the Ravensdown Project Team and other technical advisors. Ravensdown hold an existing water discharge permit for this Site which expires in May 2022. An application for a new discharge permit based on the chosen option detailed in this report will be lodged with the Hawke's Bay Regional Council (HBRC) by 30 November 2021 (six months prior to the expiry date) in order to continue to operate under the existing discharge permit under section 124 of the Resource Management Act 1991 (RMA).

This options assessment was undertaken to assist Ravensdown with its obligations under section 105 of the RMA which requires the consideration of alternative methods of discharge, including as to whether the discharge could be into any other receiving environment. In addition to this, the regulatory framework surrounding discharges into surface water has become significantly more stringent over recent years meaning that the site's existing stormwater and process water management requires improvements to be undertaken to meet the relevant regulatory standards and the expectations of stakeholders.

Existing stormwater and process water discharge

The Site discharge currently consists of stormwater, as well as process water. Some stormwater is re-used in the manufacturing process. Treatment mainly consists of pH management, and settling in the existing settling pond, as well as the addition of dilution water. Outflows from the settling pond make their way to the Ravensdown Drain which discharges to the Tūtaekurī Blind Arm, then west into the main stem of the Tūtaekurī River. The Tūtaekurī River then flows east to the Waitangi Estuary which discharges into the Pacific Ocean.

Sampling of the discharge and the receiving environment is currently undertaken to confirm compliance with the water quality conditions of the existing discharge permit DP040143Wa / AUTH-114016-02.

Future effluent quality requirements

For this assessment, different potential receiving environments for the discharge have been considered:

- Continued discharge to the Tūtaekurī River/Waitangi Estuary
- Discharge to the marine environment of Hawke Bay
- Discharge to land
- Discharge to Napier City Council (NCC) Wastewater Treatment Plant (WWTP)

Mitchell Daysh have undertaken a thorough review of the planning instruments that are relevant to the site. This shows that there have been significant changes to the planning framework since the previous resource discharge permit was granted. Instruments now provide stronger water quality protection, and identification and protection of the Waitangi Estuary as a significant environment, compared to when the previous discharge permit was granted. There are a number of planning documents relevant, particularly for the Tūtaekurī River/Waitangi Estuary where there are overlapping and sometimes differing water quality requirements in different documents. Where different regulatory documents require different standards and there is not clear guidance on which document takes precedence over another, the most conservative standard has been considered. The assessment of the existing discharge against the water quality standards for the Tūtaekurī River/Waitangi Estuary shows that for many contaminants the water quality requirements are significantly lower than the levels of contaminants in the discharge.

Streamlined Environmental have undertaken a dilution study and recommended that a dilution of 2.8 should be used if the discharge is occurring at low tide (or if the discharge is constant regardless of tide state), and 4.9 if the discharge was undertaken to take advantage of the greater dilution occurring at high tide. This level of dilution is significantly lower than the level of dilution used for the previous resource consent process.

Regardless of applied dilution, additional treatment will be required to meet the water quality standards.

Consideration has been given to the potential for the stormwater and process water from the Site to be discharged via the NCC WWTP. If this were to be pursued there are two potential options – discharging via NCC's outfall structure but under a separate discharge permit or discharging via the WWTP under NCC's existing discharge permit. There are pro's and con's to each approach. Discussion with NCC would need to be progressed further to confirm the water quality requirements.

Source control

Reducing sources of contamination has been considered in order to meet the discharge requirements. Ravensdown currently undertake source control, including road sweeping across the site, spill management, dust management, and sump and pipe cleaning.

Ravensdown also carry out regular site improvements and planned capital upgrade works as necessary. Further upgrades to reduce the concentrations of contaminants which enter the stormwater system are also being considered as part of a Source Control Management Plan for the Site, such as the installation of additional curtains on rock bays, improvements to site guttering, replacement of building roofs and existing buildings, and the resealing of hardstand surfaces.

Stormwater and process water treatment devices

A number of water quality treatment devices have been considered for the treatment of the water discharges from the site. Those considered appropriate for detailed assessment are as follows:

- Settling pond (including chemical and flocculant dosing)
- Bioretention basin
- Wetland
- Bioreactor
- Filter media
- Clarifier
- Membrane filter plant

Each device has different advantages and disadvantages, such as their ability to remove contaminants, the space requirements, associated amenity values, and maintenance requirements. The ability for these devices to be pieced together to offer an appropriate treatment solution has been addressed as part of the options assessment.

Stormwater and process water management options

The stormwater and process water management options for the Site that have been considered by the Technical and Project Team are:

- Discharge to the Tūtaekurī River/Waitangi Estuary
  - Option 1a: Status quo
  - Option 1b: Wetland treatment train

- Option 1c: Membrane filter plant
- Discharge to Hawke Bay
  - Option 2a: NCC WWTP outfall
  - Option 2b: Ravensdown site-specific sea outfall
- Discharge to land
  - Option 3a: Spray irrigation
  - Option 3b: Soakage and rapid infiltration
- Combination of options
  - Option 4: Split of high and low risk contaminant areas and discharge to an appropriate receiving environment.

Several options were suggested to the project team during stakeholder engagement or considered by the project team but discounted as infeasible without further investigation. These included installing a wastewater treatment plant for the site, discharge to NCC's Cross Country Drain, discharge via evaporation, and re-use of stormwater off-site (e.g., trucking to orchards or other water users).

Typical stormwater management in the Hawke's Bay region requires treatment rainfall event of approximately 23mm for the site[1]. However, given the industrial nature of the site, its associated contaminants and the lack of an observed first flush effect at this and similar sites, it is expected that water quality treatment will need to be provided to a higher level. Thus, for the purposes of preliminary treatment sizing, it has been assumed that the first 25 mm of rainfall on the site will be fully handled by the treatment system, with accommodations made for partially treating up to 50mm of rainfall.

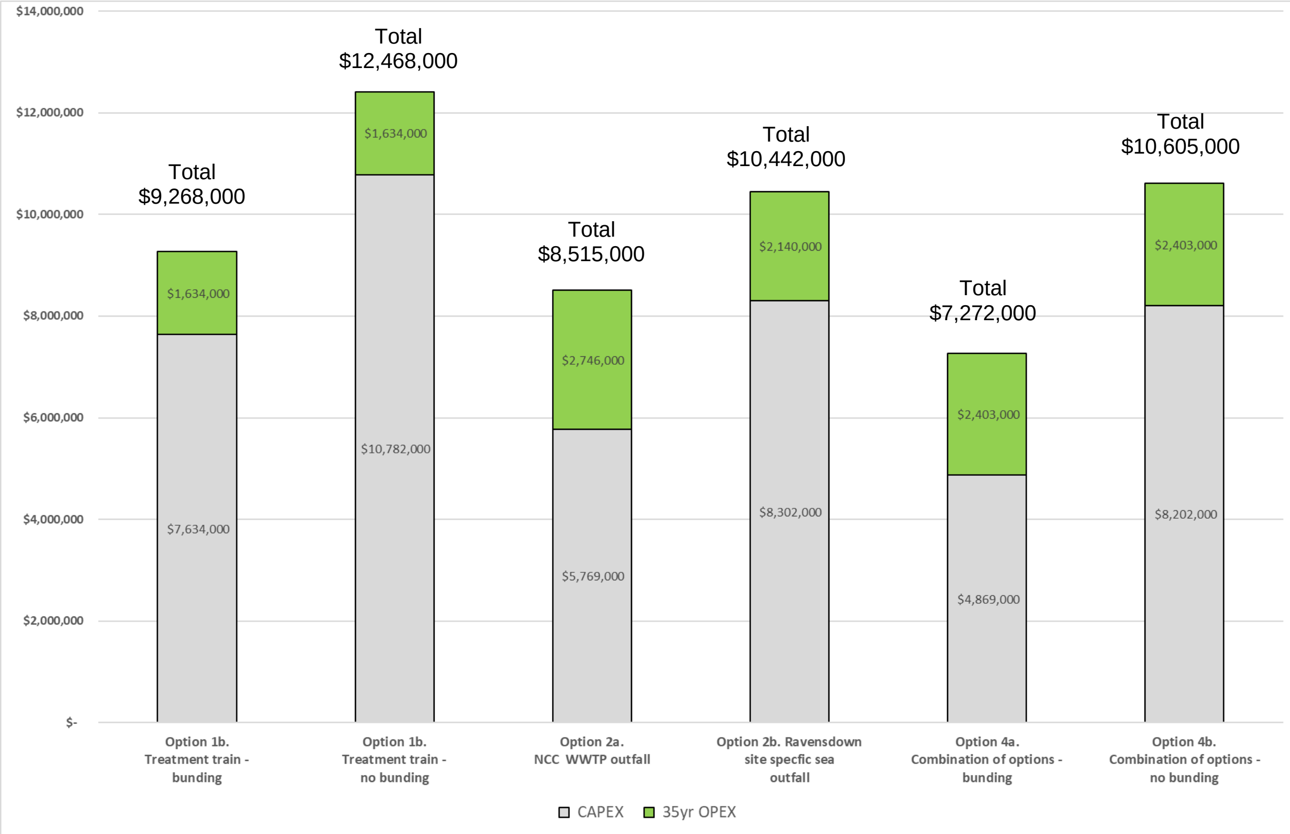
Due to the nature of extreme rainfall events, there will always be events which cannot be accommodated within any stormwater treatment system. As such a bypass to the receiving environment without full treatment would be necessary.

Potential treatment devices, sizing requirements and operations and maintenance considerations for each treatment option have been described to assist with assessing the high-level feasibility, benefits and drawbacks of each potential management option.

Cost estimates

Cost estimates were developed for the most feasible alternatives based on construction (CAPEX) and operations and maintenance (OPEX) costs from projects around New Zealand that Aurecon has been involved in. The costs are high-level in nature and are intended to incorporate the most significant costs associated with the construction and operations of each option.

[1] Hawkes Bay Waterway Design Guidelines, Stormwater Management Section 6.3.1, Earl Shaver / Aqua Terra International Ltd., May 2009



Executive Summary Figure 1: Cost estimate summary: CAPEX and 35-year OPEX

Preliminary safety in design assessment

A preliminary SiD register has been developed for the high-level management options presented in this report to help assess the comparative risks of installing the different options.

Stormwater and process water treatment options assessment method

A multi-criteria decision analysis (MCDA) was developed to compare the options for treatment and discharge of stormwater and process water from the Site. The MCDA assisted with determining whether any options were not viable and could be eliminated from further consideration and design development. It also compared the stormwater and process water management options for the site to help with determining preferred alternatives which should be taken further in the engineering design process, to reach a final option.

The objective agreed for the project was: “To establish the most sustainable long-term solution for the treatment and discharge of stormwater and process water from the Ravensdown Napier Works to enable the continued operation of the site”.

The assessment was undertaken based on ten assessment criteria grouped under the headings “Technical”, “Consenting and environmental”, “Financial” and “Stakeholder”.

- Land storage requirement
- Safety in design
- System / technological complexity and reliability
- Consistency with regional / national planning framework
- Ability to meet receiving environment limits / guidelines
- Future proof (climate / other unpredictability)
- Capital cost
- Operational cost

- Mana Whenua values
- Other stakeholder considerations / concerns

The criteria were weighted between 1 (least important) and 3 (most important), and scored between 1 (lowest score) and 5 (highest score), with an additional 0 score for options considered to be not acceptable or have a "fatal flaw". The first eight criteria were scored by the project team, and the final two were scored by Mana Whenua representatives and the Technical Focus Group of stakeholders (respectively).

The MCDA process resulted in the "combination of options" receiving the highest score and it has therefore been developed as the preferred option. Further investigation on the feasibility of a discharge to land as part of this option has been progressed and is detailed in the following two reports "Project description-Ravensdown Napier stormwater and process water management" and "Ravensdown stormwater and process water discharge-land discharge effects and management".

Regardless of the option, mana whenua and stakeholders expect that contaminant concentrations in the discharge will be reduced over time through improved source control and treatment on site. Ravensdown are also committed to enhancing the environment in an area of the Waitangi Estuary near the Site through a Habitat Abundance Restoration Programme (HARP) which will be established in conjunction with the HBRC, Mana Whenua and other key stakeholders.

Project risks

Risks to the Ravensdown Napier stormwater improvement project include:

- Alternative views of Stakeholders that have not been otherwise canvassed throughout the TFG process.
- Variation from the cost estimates developed to date.
- Changing water quality requirements and an inability to meet critical regulatory requirements in the receiving environment.
- Variation from assumptions around the treatment ability of the devices considered.
- Biological processes in treatment devices and non-standard mixes of contaminants meaning that water quality outcomes may differ from those assumed in this assessment.
- Lack of information about the water quality from different catchments on site.
- Failing to meet community expectations for treatment particularly where some stormwater discharges will be required without treatment during extreme rainfall events.
- Uncertainty around feasibility of discharging into land.

Conclusions

This report has been prepared to assist Ravensdown with assessing the options for management of stormwater and process water from their existing fertiliser plant in Awatoto, Napier. Ravensdown recognise the need to make changes to their existing stormwater management to meet regulatory and community expectations

This assessment has considered discharge to three different receiving environments – surface water within the Tūtaekurī River/Waitangi Estuary, the marine environment of Hawke Bay, and discharge to land. Each of these environments has different requirements for the level of treatment to remove contaminants before discharge.

The assessment has considered different options for discharge to each of these environments. The high level feasibility, benefits, constraints, safety risks and costs for each option have been considered. These factors have fed into an MCDA which has incorporated feedback from a variety of stakeholders from the community, including Mana Whenua.

Based on the MCDA, continuing with the status quo is not considered to be viable. NCC have also communicated their concern about any discharge to land due to the site's location in the Napier drinking water source protection zone. However, the TFG did prefer a discharge to land option so more investigation of the technical feasibility of this has been progressed. Overall, the highest scoring option in the MCDA process was a combination of options.

The details of the proposed stormwater system need to be developed further as part of the detailed design after the discharge permit has been granted. The development of the concept design will require technical information to confirm whether discharge onto Ravensdown's land is feasible, and to confirm the actual sources and loads of contaminants from each catchment within the site to help fine tune the treatment options.

The concept design and project strategy should consider the project risks going forward. In particular, the conditions of consent must recognise the limitations in the estimates of the treatment performance of the stormwater system, and the ability of any stormwater system with biological components to meet water quality requirements 100% of the time.

A key component of the stormwater and process water management strategy going forward will be source control, through using non-structural and structural measures to avoid contamination of stormwater in the first place. This will meet stakeholder and Mana Whenua expectations, as well as providing the best value for money for Ravensdown, and improved environmental outcomes.

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1 Introduction

Ravensdown Limited (Ravensdown) have engaged Aurecon New Zealand Ltd (Aurecon) to complete a high-level stormwater and process water options review for their Napier Awatoto works site (the Site) alongside the Ravensdown Project Team and other technical advisors. Ravensdown hold an existing water discharge permit for this Site which expires in May 2022. An application for a new discharge permit based on the chosen option detailed in this report will be lodged with the Hawke's Bay Regional Council (HBRC) by 30 November 2021 (six months prior to the expiry date) in order to continue to operate under the existing discharge permit under section 124 of the Resource Management Act 1991 (RMA).

This options assessment was undertaken to assist Ravensdown with its obligations under section 105 of the RMA which requires the consideration of alternative methods of discharge, including as to whether the discharge could be into any other receiving environment. In addition to this, the regulatory framework surrounding discharges into surface water has become significantly more stringent over recent years meaning that the site's existing stormwater and process water management requires some improvements to be undertaken to meet the relevant regulatory standards and the expectations of stakeholders.

As such, to assist with renewal of the water discharge permit, Ravensdown has requested that Aurecon assess and report on alternative options for treatment and disposal of stormwater and process water generated from the Awatoto site. This report details the options considered, and the conclusions reached.

2 Scope of work

The scope of the high-level stormwater options assessment is to:

- Summarise stormwater treatment devices suitable for the site and their pro's and con's
- Assess the following range of stormwater and process water management options for the site:
  - No action/ status quo
  - Treatment train
  - Sea outfall:
    - Discharge via Napier City Council (NCC) Wastewater Treatment Plant (WWTP) outfall
    - Discharge to a proprietary Ravensdown sea outfall
  - Membrane filter plant
  - Land discharge, via spray irrigation
  - Splitting high and low contaminated areas with discharge to a range of the above options
- Assess each option for:
  - Technical feasibility
  - Economic viability (capital and operational costs)
  - Implementation time horizon
- Summarise above findings in a multi-criteria options matrix
- Include a brief discussion of potential non-structural site improvements and potential impacts.
- Summarise project risks

3 Overview of existing stormwater and process water

3.1 Existing stormwater and process water discharge

The Site is split into four stormwater catchments (refer to Figure 1, overleaf):

- Catchment 1: Truck wash and exit
- Catchment 2: Despatch and manufacturing
- Catchment 3: Site office, intake store, melting and acid plant north
- Catchment 4: Acid plant south

Process water that flows into the stormwater system is generated during acid plant operations and from blowdown water from the cooling towers, south of the acid plant.

Catchment 1 is the most northern section of the site. In addition to flows from the Ravensdown site, this catchment also receives inflows from the adjacent property occupied by Sandford Transport. The Sandford site includes a truck wash facility which is drained to the Ravensdown stormwater system. Runoff from the catchment (including roof runoff and flow from the truck wash area) is collected in various catchpits and channels which direct the stormwater to a covered drain before flowing to the “main drain”, parallel to Waitangi Road.

Catchment 2 is located just south of Catchment 1, water collected from catchpits and channels in this area, travels south through the covered box concrete drain. Stormwater collected in Catchment 1 (excluding overflow into the main drain) and Catchment 2 connect into a sump to the north of the site office. This sump consists of a large concrete pit, covered with a steel grating. From the sump, the collected water can either be pumped into the grey water tank located across the road or, in the event of high-water volume, flow over a weir to then enter the main drain. Water in the grey water tank is re-used during the manufacturing process.

Catchment 3 consists of four separate areas that discharge to the main drain: the site office area, carpark, the intake area, the melter and sulphur stores area and the north-eastern side of the acid plant. The intake, melter and sulphur store areas collect stormwater runoff through catchpits which are piped to a sump located just north of the site office sump which is gravity fed into the main drain. The remaining portion of Catchment 3 is the northern section of the acid plant. In this area, runoff is collected in a series of catchpits and channels west of the acid plant control room and storage pool and discharged to the main drain, near the Archimedes basin.

Catchment 4 collects stormwater runoff from the southern and western portions of the acid plant that is piped to the neutralising pit, located on the western side of the acid plant adjacent to the site road. Water in the neutralising pit is combined with process water and treated for pH before being discharged to the main drain. Dilution water is also continuously added within this catchment.

Between Catchment 4 and the settling pond is approximately 300 m of gravel road, with open grass field on either side of the road. Swales on either side of the road collect the stormwater runoff from the grass field to the east of the road, and half of the stormwater runoff from the grass field to the west of the road. The swales are blocked at the downstream end and there are no overland flow paths discharging this area. Water collected in the swales infiltrates to ground.

The stormwater and process water from the above described areas which is not re-used on site ultimately discharges to the settling pond located at the southern end of the site. Outflows from the settling pond make their way to the Ravensdown Drain which discharges to the Tūtaekurī Blind Arm, then west into the main stem of the Tūtaekurī River. The Tūtaekurī River then flows east to the Waitangi Estuary which discharges into the Pacific Ocean.

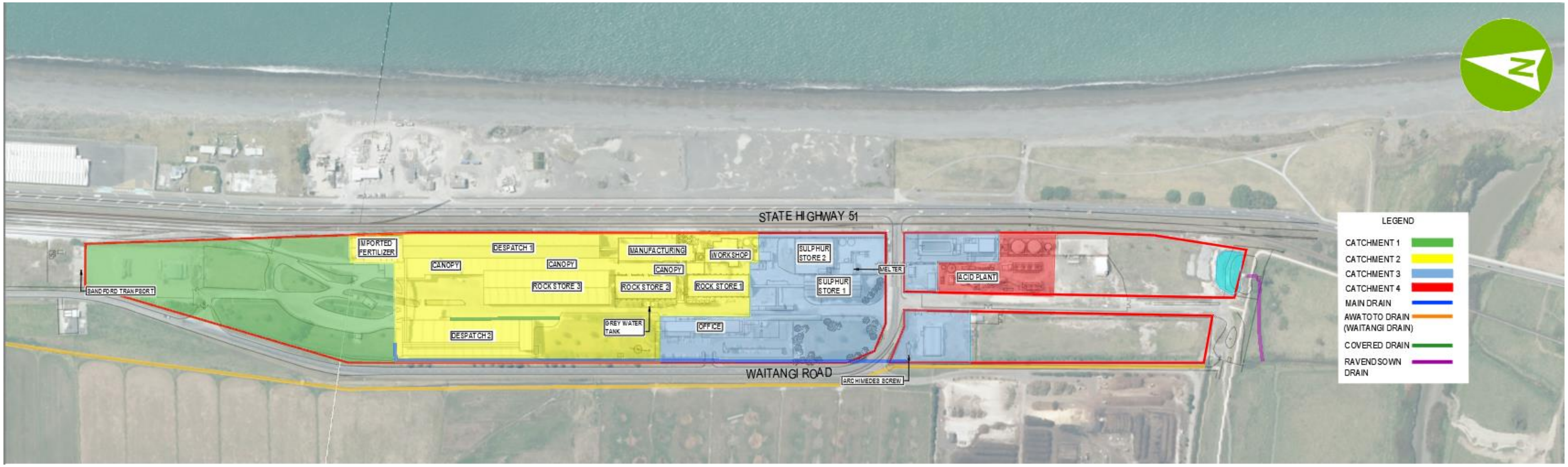

Figure 1 Ravensdown Napier site and catchments

A process diagram of the stormwater and process water system is shown in Figure 2 below.

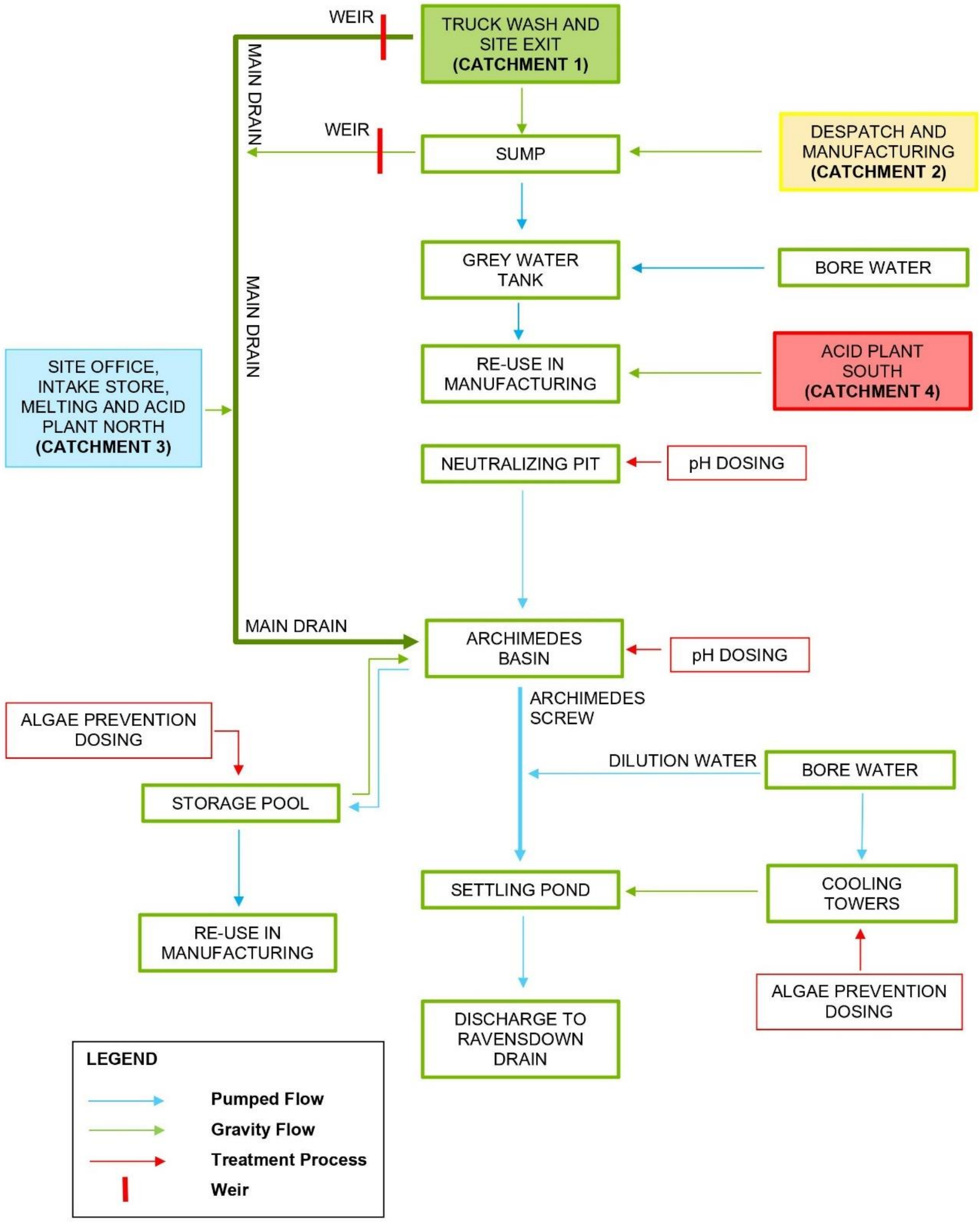

Figure 2 Summary of Ravensdown Napier processes

3.2 Existing discharge permit

The site currently operates under the discharge permit DP040143Wa / AUTH-114016-02 which governs the current stormwater and process water discharge, initially granted by the Hawke's Bay Regional Council (HBRC) on 11 June 2007 (refer Appendix A). This discharge permit specifies water quality limits for the discharge from the site. Going forward however it is anticipated that the consented water quality limits will be more stringent. This is due to updates to regulatory requirements since this permit was granted.

3.3 Existing effluent quality

The existing discharge permit requires ongoing monitoring of the stormwater and process water discharge and receiving environment. Monitoring across the site is undertaken at the following frequency:

- Weekly sampling (flow proportional, composite) of the stormwater and process water discharge
- Monthly sampling of the receiving environment
- Six monthly, analysis of a composite water quality sample collected from the discharge over a week
- Six monthly, sampling of a "first flush" event
- Four yearly monitoring of the receiving environment, including for fish and macrofaunal communities, periphyton, sediment and water quality

A summary of weekly discharge quality data from 2012-2019 from the settling pond outlet prior to discharge is summarised in Table 1 and

Table 2 below. This information has been reproduced from Aquanet Consulting report on water quality and ecological monitoring from 2019[1].

Table 1: Summary of discharge quality data Aquanet Consulting 2019[2]

	Discharge flow (L/s)	pH	Fluoride (g/m^3)	SS (g/m^3)	Soluble Reactive Phosphorus (SRP) (g/m^3)	TP (g/m^3)
All data (1 July 2012-31 July 2019)						
Average	2.5	7.2	4.4	7.9	7.6	8.3
50% ile (median)	2.5	7.2	3.2	6.0	6.6	7.0
95% ile	5.2	7.9	11.6	20.8	15.0	16.7
99% ile	6.7	8.1	18.3	43.4	20.4	23.0
Samples	253	364	366	365	366	366

Table 2: Summary of discharge quality data Aquanet Consulting 2019[2]

	Discharge flow (L/s)		pH		Fluoride (g/m^3)		SS (g/m^3)		SRP (g/m^3)		TP (g/m^3)	
	2012-2015	2015-2019	2012-2015	2015-2019	2012-2015	2015-2019	2012-2015	2015-2019	2012-2015	2015-2019	2012-2015	2015-2019
Average	2.2	3.0	7.3	7.1	4.7	4.2	9.4	6.8	8.4	6.9	9.4	7.5
50% ile (median)	2.2	2.7	7.4	7.1	3.7	2.9	6.0	5.0	7.5	6.1	8.0	6.6
95% ile	5.0	5.5	7.8	7.9	11.0	11.7	25.4	15.0	17.8	13.6	19.8	14.8
99% ile	6.4	7.3	8.0	8.1	15.5	23.1	45.8	26.7	21.4	19.0	23.6	21.0

[2] "Ravensdown Napier discharge to the lower Tūtaekurī River and Waitangi Estuary: Water quality and ecology monitoring, 2019", Aquanet Consulting, December 2019

4 Future effluent quality requirements

The treated stormwater and process water flows could be discharged to a range of receiving environments which surround the site. Different water quality standards are relevant for each receiving environment based on the different regulatory requirements, and the level of dilution provided in that environment. For example, discharges to the marine environment of Hawke Bay would receive a much greater dilution than discharges into the Tūtaekurī Blind Arm / Waitangi Estuary (refer Figure 1).

4.1 Potential future receiving environments

The existing effluent is discharged to the Tūtaekurī Blind Arm via the Ravensdown Drain. There are however a range of other potential receiving environments for the treated flows surrounding the site which have been considered. In summary the potential future receiving environments for the discharge are:

- Continued discharge to the Tūtaekurī River/Waitangi Estuary
- Discharge to the marine environment of Hawke Bay
- Discharge to land
- Discharge to Napier City Council (NCC) Wastewater Treatment Plant (WWTP)

Ravensdown own approximately 17.5 ha of land directly west of the site which could be used for discharge to land. Furthermore, the NCC WWTP is located approximately 500m from the northern boundary of the site and the discharge could potentially be piped to this plant for discharge via the outfall associated with the WWTP.

4.2 Potential future water quality requirements

Mitchell Daysh have undertaken a thorough review of the planning instruments that are relevant to the site. This shows that there have been significant changes to the planning framework since the previous discharge permit was granted. Instruments now provide stronger water quality protection, and identification and protection of this area as a significant environment, compared to when the previous discharge permit was granted. The following statutory documents have been reviewed by Mitchell Daysh to determine the most relevant standards related to future stormwater and process water discharges from the site:

- The Resource Management Act (**RMA**)
- Resource Management (National Environmental Standards for Freshwater) Regulation 2020 (**NES-FW**)
- Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007 (**NES-DW**)
- National Policy Statement for Freshwater Management (**NPS-FW**)
- Hawke's Bay Regional Coastal Environment Plan (**RCEP**)
- Hawke's Bay Regional Resource Management Plan (**RRMP**)
- Proposed Plan Change 7-Outstanding Water Bodies (**OWB Plan Change**)
- Plan Change 9-TANK (Tūtaekurī, Ahuriri, Ngaruroro, Karamu) Catchment Plan (**TANK Plan Change**), including updates recommended by council officers in their s42A report to the hearing panel

The planning assessment indicates that there are a large number of water quality standards, guidelines and criteria relevant to the discharge, spread across a number of different regulatory documents. It is typically acceptable for compliance with water quality standards / guidelines / targets to be determined "following reasonable mixing".

4.3 Future versus existing effluent quality

To assess the different treatment options, it is important to know what level of treatment will be needed to meet the requirements of the receiving environment. For discharges into the Tūtaekurī River/Waitangi Estuary, discharges to land and discharges to Hawke Bay the assessment is based on the targets and standards set in the regulatory documents for the area.

The relevant regulatory documents are:

- NPS-FW
- TANK Plan Change
- RCEP

There are overlapping standards set for the Tūtaekurī River and Waitangi Estuary in these different documents. These are summarised in Table 3 below with a comparison to the existing effluent quality calculated by Streamlined Environmental based on site sampling between 2007 and April 2020.

Water quality standards for discharge to the marine environment of Hawke Bay have been derived from review of the RCEP.

Water quality standards for discharge to land have been included in this table, based on the advice of Mitchell Daysh. There are different standards for discharges to land depending on whether the discharge is in the area governed by the RCEP or the area governed by the RRMP. It has been assumed that the discharge will be in the RRMP area, as this covers the majority of the site.

The intention of this table is to guide the treatment system design process. Where different regulatory documents require different standards and there is not clear guidance on which document takes precedence over another, the most conservative standard is listed.

For the purpose of the treatment system design, water quality targets need to be relevant to the quality of the water discharged from the site. Some of the water quality standards / guidelines / targets in the regulatory documents are not in a form that is applicable to the design process. In particular, the regulatory documents include some water quality targets referring to a percentage increase of the particular contaminant in the receiving environment, and some have targets for visual clarity in the waterbody. These have been excluded from the table below because they are not useful for defining the required water quality (although they may still be considered as part of the resource consent process).

Table 3: Summary of target and existing contaminant concentrations

Contaminants		Guideline / standard value (mg/L)			Concentration in existing discharge (mg/L)
		Tūtaekurī River/Waitangi Estuary	Hawke Bay	Land	
–		(surface water)	(marine environment)	(ground water)	
Soluble reactive phosphorus	Annual median of no fewer than 8 samples in a 12- month period	0.015[2]	-	-	7.8[5]
Ammoniacal nitrogen [10]	Receiving environment concentration	0.1[2]	-	-	0.403[5]
Nitrate nitrogen	Receiving environment concentration	0.05[2] (Improving trend by 2040)	-	<1[2]	4.98[5]
Nitrate	Maximum	0.195[3]	-	50[2, 4]	8.46[8]
Total nitrogen	Receiving environment concentration	0.11[2] (Improving trend by 2040)	-	-	5.39[5]
Total suspended solids (TSS)		25[3]	-	-	5 [5]
pH		7.0-8.5[2]	6.5-9.0[3]	7.0 – 8.5[2, 4]	21% of records since 2018 less than 7.0, and 0% greater than 8
Fluoride		-	-	1.5[2, 4]	39.79[7]
Al		0.055[2, 3]	-	0.1[2, 4]	3.04[7]
Cu		0.0013[2, 3]	-	1[2, 4]	0.21[7]
Cd		0.0055[2, 3]	-	0.004[2, 4]	0.05[7]
Cr		0.027[2, 3]	-	0.05[2, 4]	0.043[7]
Ni		0.07[2, 3]	-	0.08[2, 4]	-[9]
Zn		0.015[2, 3]	-	1.5[2, 4]	0.478[7]

(1) NPS-FW
(2) TANK Plan Change, s42A Addendum report
(3) RCEP
(4) RRMP
(5) Median of measurements collected since 2007
(6) 95th percentile of measurements collected since 2007
(7) Maximum value of measurements collected since 2007
(8) 80th percentile of measurements collected since 2007
(9) Nickel is measured in the receiving environment but not in the discharge, so there is no direct comparison to the discharge standards
(10) Unionised ammonia based on pH8 at 20 deg C, all flows

Table 3 shows that the water quality standards for the Tūtaekurī/Waitangi Estuary for many contaminants are significantly lower than the levels of contaminants in the discharge.

Fluoride is not a common component of stormwater. There are no numerical standards for fluoride in surface water or marine water set in the regulatory documents, or in the Australia and New Zealand Guidelines for

Fresh and Marine Water Quality 2018. For the purposes of this assessment a guideline derived for Ravensdown's Ravensbourne, Dunedin site by Hickey[3] has been used. This is 5 milligrams per litre.

It is important to note that these water quality standards need to be met following reasonable mixing. Streamlined Environmental[4] have undertaken a dye study to assess the dilution of stormwater and process water that is likely to occur in the Awatoto Drain. Streamlined Environmental have recommended that a dilution of 2.8 should be used if the discharge is occurring at low tide (or if the discharge is constant regardless of tide state), and 4.9 if the discharge was undertaken to take advantage of the greater dilution occurring at high tide. This level of dilution is significantly lower than the level of dilution used for the previous resource consent process. To demonstrate indicatively how this dilution will assist with achieving the guideline values, Table 4 applies this dilution factor to the existing discharge quality.

Table 4: Tūtaekurī River/Waitangi Estuary water quality standards with dilution applied, in comparison to existing discharge quality

Contaminants		Guideline / standard value (mg/L)	Concentration in existing discharge with dilution applied – discharge at any tide state (mg/L)	Concentration in existing discharge with dilution applied – discharge at high tide (mg/L)
Soluble reactive phosphorus	Annual median of no fewer than 8 samples in a 12- month period	0.015	2.79	1.59
Ammoniacal nitrogen	Receiving environment concentration	0.1	0.014	0.08
Nitrate nitrogen	Receiving environment concentration (improving trend by 2040)	0.05	1.78	1.02
Nitrate	Maximum	0.195	3.02	1.73
Total nitrogen	Receiving environment concentration (Improving trend by 2040)	0.11	1.93	1.10
Total suspended solids (TSS)		25	1.79	1.02
pH		6.5-9	N/A	N/A
Fluoride		5-	14.21	8.12
Al		0.055	1.09	0.62
Cu		0.0013	0.08	0.04
Cd		0.0055	0.02	0.01
Cr		0.027	0.02	0.01
Ni		0.07	No data available	No data available
Zn		0.015	0.17	0.10

[3] "Review of fluoride toxicity in relation to Ravensbourne discharge to Otago Harbour". NIWA, 2004 and "Ravensdown fertiliser works: supplementary technical report", NIWA 2004.
[4] "Current State and Assessment of Effects on the Aquatic Environment Associated with the Ravensdown Napier", Streamlined Environmental/Boffa Miskell, 2021

With this level of dilution applied, additional treatment will be required to meet the water quality standards.

There are a number of contaminants which Ravensdown have testing results for, but there is no numerical guideline value specified in the regulatory documents (some of these contaminants have guidelines relating to a maximum percentage increase in the receiving environment, but as discussed above these have been excluded from this summary due to the complexity of back calculating that to a required discharge from the site). Table 5 below outlines the contaminants without guidelines.

Table 5: Contaminants without numerical regulatory guidelines

Contaminants without guidelines
Dissolved oxygen
Nitrite
Nitrite/Nitrate
Periphyton
Temperature
Total Sulphur
Total Kjeldahl Nitrogen (TKN)

4.4 Discharge via NCC WWTP

NCC hold a discharge permit (AUTH-118503-02) to discharge domestic sewage and industrial wastewater into Hawke Bay at Awatoto via a marine outfall which expires on 6 December 2037. The existing discharge permit provides for a discharge of up to 1,400 L/s via a diffuser structure which provides at least 100:1 dilution of the wastewater and include limits for a number of contaminants within the discharge.

Three potential options were considered for the discharge of stormwater and process water from the Napier works via the NCC outfall.

- Discharge via NCC's outfall structure, but Ravensdown obtain a separate discharge permit.

  Pros:

  - Avoids taking up capacity in the WWTP and may therefore require lower financial contributions to NCC as a result.

  Cons:

  - NCC's outfall structure may not have sufficient capacity to accept the discharge.
  - The discharge will require onsite treatment prior to discharge.
  - Ravensdown would need to obtain their own discharge permit to discharge.

- Discharge via NCC's outfall structure, in accordance with the conditions of NCC's existing discharge permit. The discharge from Ravensdown would need to comply with the requirements of the discharge permit NCC holds for the discharge.

  Pros:

  - Ravensdown would not require their own discharge permit for the discharge, as it would be managed under NCC's discharge permit.
  - Avoids taking up capacity in the WWTP and may therefore require lower financial contributions to NCC as a result.

  Cons

  - NCC's outfall structure may not have sufficient capacity to accept the discharge.
  - The discharge will require onsite treatment prior to discharge.
  - Ravensdown would be subject to the terms of a consent which is beyond its control.

- Discharge through the NCC WWTP. Treatment would be provided by the plant.

  Pros:

  - Treatment would largely take place off site, limited treatment would be required on site.

  Cons:

  - Subject to WWTP capacity limitations
  - Would likely incur additional financial contributions

    Ravensdown would be subject to potentially variable discharge quality requirements (i.e. trade waste standards) that are beyond its control

The contaminant concentrations and loads of contaminants authorised by the discharge permit are as per Table 6

Table 6: Contaminant concentration and loads of concentrations required by NCC discharge permit

Analyte	Maximum concentration (g/m³)	Maximum load (kg/day)
Total Ammonia-N	91	2912
Cd	0.55	17.6
CR III	2.74	87.7
CR VI	0.44	14.1
Cu	0.13	4.16
Pb	0.44	14.1
Hg	0.04	1.3
Ni	7	224
Zn	1.5	48
Analyte	**Average load (kg/day)***	**Maximum load (kg/day)**
cBOD	18,000	22,400
TSS	18,000	22,400
Total fats, oil and grease	7,000	8,800
pH		6.5-8.5

*Loads are based on an average annual flow of 32,000 m^3/day.
The average load should be based on a 12-month rolling mean

A meeting was held with representatives from NCC and the project team on the 9 July 2021 to discuss whether a discharge via the NCC WWTP was feasible. NCC confirmed that their preference would be for Ravensdown to provide their own pre-treatment of the discharge prior to discharging either via the WWTP or directly to the WWTP outfall pipe. NCC also confirmed that if any option is progressed further a development contribution for use of the infrastructure would be payable. The amount payable could not be specified at this stage but NCC confirmed a lower contribution would be required if the discharge did not go through the WWTP.

If Ravensdown's stormwater and process water was to be discharged under NCC's existing discharge permit it would be mixed/diluted with other discharges from the wastewater network. Discussions with NCC would need to be progressed further to confirm what the current contaminant loads in the discharge are, and what contaminant loads from Ravensdown would be acceptable to NCC. NCC's existing discharge permit does not have water quality requirements for key contaminants of concern from Ravensdown's site e.g. nutrients and fluoride.

One risk of discharging via NCC's WWTP and/or outfall is that NCC's discharge via the ocean outfall is only consented for another 16 years and the existing sea outfall is compromised with NCC indicating it would require replacement within a 5-year period. It is also possible that NCC could move the wastewater discharge to a different location or receiving environment, or that a new discharge permit would only be issued for a short period. If the NCC outfall was to alter location or format Ravensdown would also need to reconsider their discharge location/strategy (possibly only a few years after beginning to discharge).

5 Source control

Reducing sources of contamination has been considered in order to meet the discharge requirements discussed above. Source control measures can be put into two categories – non-structural (e.g. site management measures) and structural (e.g. changes to buildings to reduce the potential for contaminants to escape).

5.1 Existing product source control

Controlling contaminants at their source and preventing these from entering the stormwater and process water runoff is the most effective means of reducing contaminants in the runoff from the site. Sediment containing contaminants collects on hardstand surfaces from airborne product settling on the site and from product moved around the site by vehicles. During rainfall events contaminants are collected in runoff from hardstand surfaces such as roads, which ultimately drain into the stormwater system on site. Ravensdown's current source control measures include:

- Road sweeping
- Spill management
- Dust management
- Sump and pipe cleaning

Road sweeping is undertaken weekly across the entire site from the site entrance at the most northern portion of the site to the site exit weekly. A new sweeper truck with improved sweeping ability has recently been taken into operation. Ravensdown also hire a contractor to sweep the roads after product for fertiliser production is delivered to site, this normally occurs every 3 to 4 months. This is done with a vacuum truck.

Spill management has been implemented to ensure that product spills are swept up immediately to avoid these spreading across the site. Product spillages may occur when fertiliser is packaged at the despatch area. Periodic housekeeping also takes place to remove any spilled product around walkways and storage sheds that are unable to be accessed by the road sweeping described above.

Dust management processes are applied to minimise the amount of airborne product that settles on site and eventually makes its way into the stormwater system following a rainfall event. This is done through trucks being loaded within enclosed buildings (Despatch 1 and 2). Large curtains have also been installed over one of the rock bays to reduce the raw product dust spreading around site, further installations across the site are also planned. Additionally, a Bobcat is used to scrape up product from the floors in Manufacture daily. Equipment such as loaders and plant in Manufacture and Despatch areas are also blown down on a regular basis.

Sump and pipe cleaning are undertaken every 3 and 6 months respectively. This removes any build-up of contaminants within the infrastructure and prevents this from being discharged into the stormwater system.

5.2 Structural site improvements

Ravensdown carry out regular site improvements and planned capital upgrade works. The following site improvements would be expected to reduce the potential for fertiliser products and raw materials to enter stormwater catchments, and therefore reduce the concentrations of contaminants which enter the stormwater system:

Installation of additional curtains on rock bays evaluation of the effectiveness of the curtains already installed is planned for later this year. If deemed effective, installation of additional curtains is expected to be completed later this year.

Installation of site guttering is an ongoing project and undertaken as required. The improvement of guttering within Despatch building 2 is currently ongoing.

Repair of building roofs is included as part of a long-term plan for the site, incremental improvements are completed on an annual basis.

Replacement of the melter and sulphur store is planned for some time in the next 2-5 years for the melter store and within 18 months for the sulphur store. Replacement of the sulphur store will create a significant improvement for the site as product is currently able to escape from the building through areas which are not sufficiently sealed. Furthermore, it will move sulphur handling inside which will prevent sulphur escaping to the environment and receiving water.

Resealing of hardstand surfaces is included as part of a long-term plan for the site. Asphalt surfaces are progressively being replaced by concrete and potholes are being addressed as they arise.

New scrubber stacks are being installed in the area between Despatch 1 and Manufacture. This work provides an opportunity to install a roof in this area. Roofing this area will have a significant impact on containing contaminants within this area and preventing them from making their way into stormwater runoff from the site

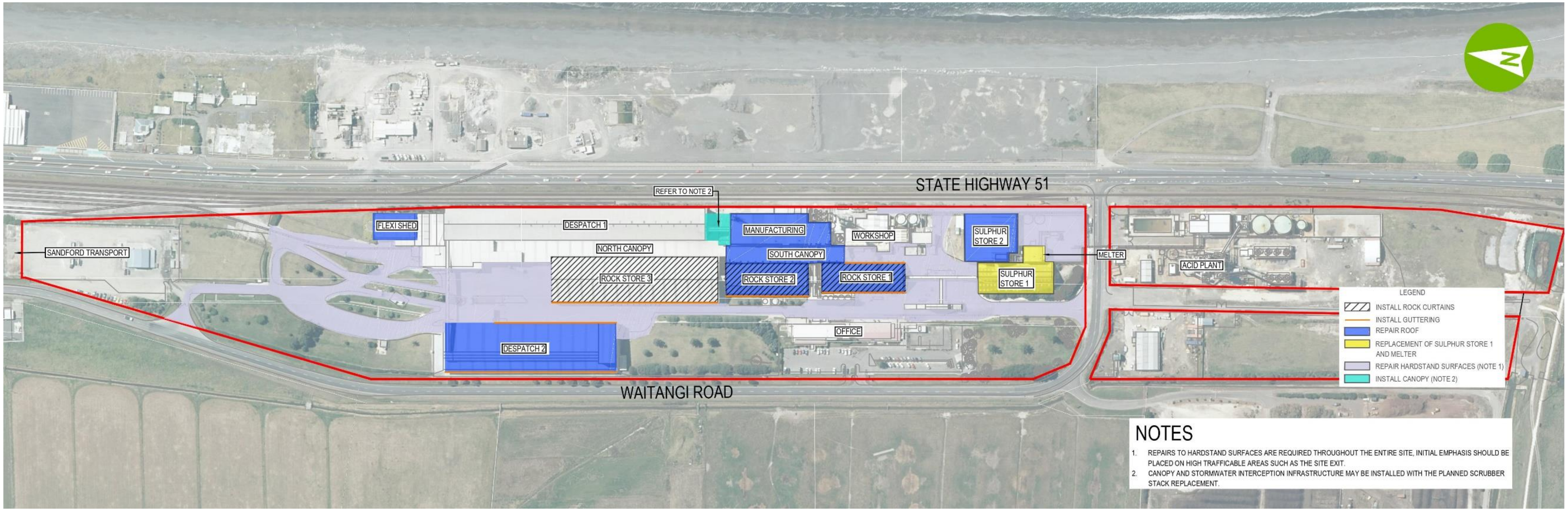

Figure 3 Ravensdown proposed structural improvements

6 Stormwater and process water treatment devices

This section of the report considers individual treatment devices that may be deployed at the site to treat stormwater and process water prior to discharge. Each device is capable of treating different contaminants at varying efficiencies. Furthermore, each device has different secondary characteristics that may affect its suitability for use on the site such as land area required, ongoing maintenance requirements, secondary discharge streams, energy requirements and amenity values.

Stormwater contaminants generally fall into two broad categories:

- Suspended and;
- Dissolved.

Suspended contaminants are solids that retain their physical structure within water. As these compounds are generally orders of magnitude larger than a water molecule, they can mostly be removed through physical processes.

Dissolved contaminants are compounds that break down to their molecular or ionic structure within water. These contaminants are more difficult to treat, often requiring a combination of chemical or biological processes to facilitate removal.

Contaminants may be removed using various physical, chemical and biological processes. These processes are outlined in general terms below and are discussed in greater detail in the individual treatment options.

Sedimentation is a physical process through which suspended contaminants settle out of still water. Sedimentation is effective for removing particulate-based contaminants such as suspended solids and insoluble heavy metals. Sedimentation can also remove some soluble contaminants that adsorb or attach to suspended sediment. The efficacy of sedimentation-based treatment devices is generally a function of the residence time within the device – longer residence times allow for removal of finer particles at the expense of a larger volume for a given treatment rate / volume. The efficacy of sedimentation devices can be increased through the addition of chemical flocculants, which allow for 'clumping' of suspended sediment to create larger particles that settle out more readily.

Media filtration is a process that involves passing water through a porous media. In a media filter, contaminants are removed through either physical filtration (i.e. becoming 'trapped' by the pores in the media), by chemically adsorbing onto the media itself or by an ion exchange process where harmful ions from the water are chemically exchanged with more inert ions from the media. There are numerous media types available that are intended to facilitate the removal of various contaminants.

Membrane filtration is a process that involves using high pressure to push water through a porous membrane. The porous membrane acts as a barrier to retain larger particles, while allowing smaller molecules to pass through. Filter membranes are available with various pore sizes - the smaller the membrane pores are, the finer particles the membrane filter can remove.

Chemical treatment is treatment through the addition of chemical substances to the water. These chemicals react with the contaminants, either rendering them into inert compounds or by forming a particulate which may be removed through a physical process such as sedimentation or filtration.

Biological treatment allows for the removal of contaminants through biologic processes that either convert them into inert compounds or accumulate them in solid biomass that may be physically removed from the system. Biological treatment can either take place in purpose-built industrial facilities within a treatment plant or within land treatment "green infrastructure" facilities. "Green infrastructure" is a term used for stormwater treatment devices that are typically vegetated and aim to remove contaminants through mimicking natural biological processes. These devices include wetlands, bioretention basins and bioreactors.

Based on the contaminants within Ravensdown discharge water the treatment devices being considered are:

- Settling pond (including chemical and flocculant dosing)
- Bioretention basin
- Wetland
- Bioreactor
- Filter media
- Clarifier
- Membrane filter plant

While there are numerous other water quality treatment devices, the selected devices are those that have a proven track record for removal of the given contaminants in a stormwater environment and are therefore the most appropriate for treatment of the stormwater and process water on site.

The following sections provide a summary of each treatment device (as summarised above) including the advantages and disadvantages of each. This is followed by a traffic light summary table which highlights the characteristics of each device.

6.1 Settling pond

A settling pond is a basin or lagoon which collects and stores water. The primary function of a settling pond is to reduce the concentration of particulate contaminants through sedimentation. Settling ponds provide good removal for sediment and suspended particles and may also provide some removal of some dissolved contaminants such as metals which may bind to sediment.

Particles in water remain suspended due to the shear stress in moving water. Settling ponds function by providing a low velocity pool to allow suspended sediments to drop out. A critical design factor in settling ponds is the average residence time of water within the pond. Providing longer residence times allows for finer particles to be removed.

The primary metric used for the design of settling ponds is residence time (drain time). As smaller particles have slower fall rates, increasing residence times allow for removal of finer particles. Settling ponds should rely on uniform incoming flow conditions into, and through the pond to achieve optimum results. High flows can result in higher velocities, shorter residence times and, potentially, short circuiting, reducing the overall efficacy of the device. High flows can also stir up / re-suspend settled sediments. The size of the settling pond is directly proportional to the volume of runoff and peak flow design.

The efficacy of settling ponds may be increased through chemical dosing. Flocculants are chemicals that attract suspend sediment particles to form larger compound particles that are more easily settled within the pond. Precipitants are chemicals that may be added to the water to chemically react with target contaminants to form a solid that settles out in the pond. Whilst the use of chemical dosing can greatly increase the operational efficacy of a settling pond, such systems also greatly increase the maintenance requirements and require significant monitoring to ensure that the dosing is appropriate for the site.

Because of their simplicity and high efficacy in removing suspended contaminants, settling ponds are often used as the first in a series of treatment train devices to reduce the load on subsequent devices.

Figure 4 Settling pond, Ravensdown Napier site

A summary of the advantages and disadvantages of using a settling pond to treat the Ravensdown stormwater and process water runoff is provided in Table 7 below.

Table 7: Summary of advantages and disadvantages of using a settling pond[5]

Advantages	Disadvantages
▪ Removal of TSS ▪ Easy operation, with well proven design ▪ High ecological potential, aesthetic and amenity benefits ▪ Flocculation may provide enhanced removal of some contaminants ▪ Can reduce burden on subsequent treatment devices	▪ Anaerobic conditions can occur without regular flow – this can cause undesired performance, including leaching of contaminants ▪ Colonisation by algae or other species could increase maintenance ▪ Large volumes (land consumption, excavation) needed ▪ Requires routine removal (dredging) of sediment ▪ Does not effectively treat dissolved contaminants including many nutrients and heavy metals ▪ High flow by-pass may be required to avoid re-suspension of sediments during large storm events

6.2 Bioretention basin

A bioretention basin filters water through an engineered media intended to facilitate biotreatment processes. Bioretention basins with submerged zones are designed to allow water to transition through an anoxic state for enhanced removal of some contaminants such as ammoniacal nitrates and dissolved reactive phosphorous prior to discharging into an underdrain. It has been shown that providing a carbon source in the submerged zone may greatly increase the removal of dissolved phosphates. Figure 5 is an example of a bioretention basin with a submerged zone.

[5] https://www.susdrain.org/delivering-suds/using-suds/suds components/retention_and_detention/retention_ponds.html

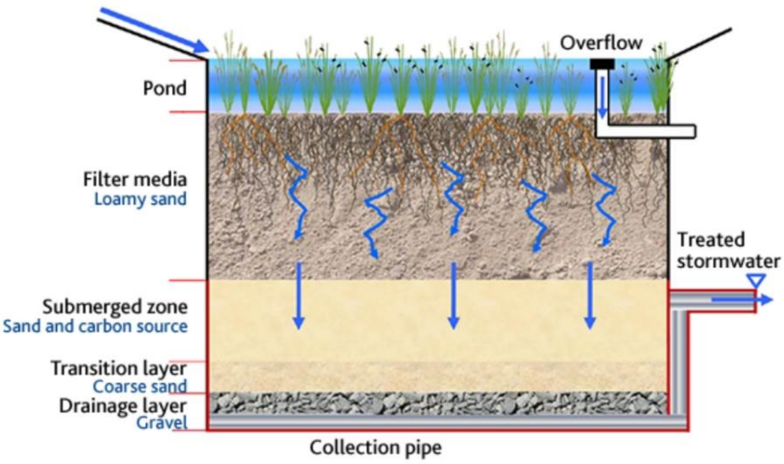

Figure 5 Bioretention basin example

Bioretention basins can remove coarse sediment on the surface, however high sediment loads may quickly clog the media surface. The majority of the targeted pollutants are removed through anoxic processes (such as denitrification) in a submerged zone.

The overall contaminant removal of a bioretention basin is dependent on both the treatment undertaken prior to the water entering the basin and the residence time in the anoxic zone. As denitrification processes are inherently biological processes, the removal efficacy can be influenced by factors including water temperature and interaction with other constituents. As with all water treatment devices, bioretention basins have reduced removal efficacy during periods of high flow. As bioretention basins rely on infiltration through soil media, they are particularly prone to bypass due to overloading.

Pre-treatment to remove coarse sediment is required for bioretention basins, as high sediment loads will quickly clog the soil media. Another important consideration is the depth to groundwater table – although most site applications would utilise an underdrain system to drain the bioretention basin, excavation into high groundwater areas would require an impervious liner to minimise the interaction between the infiltration device and the groundwater.

A summary of the advantages and disadvantages of using a bioretention basin to treat the Ravensdown stormwater and process water runoff is shown in Table 8 below:

Table 8: Summary of advantages and disadvantages of using a bioretention basin[6]

Advantages	Disadvantages
▪ Removal of particulates and some dissolved pollutants, including phosphorus and ammoniacal nitrates ▪ High efficiency of removing bacteria and sediment ▪ Medium efficiency of trapping nutrients and oxygen demanding material ▪ Provides amenity value	▪ Risk of sediment clogging the infiltration surface ▪ Poor removal of fluoride and metals ▪ Risk of groundwater contamination in infiltration if unlined ▪ Potential for metals to accumulate at the base of the basin ▪ Inadequate maintenance can cause high failure rate ▪ Large land area needed

6.3 Wetland

Wetlands are a biological treatment system consisting of an ecosystem where the land is covered in water either temporarily or permanently. Wetlands trap nutrients by adsorption and bio-film growth from the vegetation onsite. Wetland vegetation varies between sites depending on the soil composition, topography, climate and region.

6 https://www.environment.nsw.gov.au/resources/stormwater/usp/treattech.pdf

Wetlands can trap fine suspended solids through sedimentation, transform organic components and regulate oxidation/reduction process of sediment. They also provide an area for disinfection by UV exposure and uptake through the vegetation. Figure 6 is an example of a wetland at Prestons' subdivision in Christchurch.

Figure 6 Prestons subdivision wetlands, Christchurch (Aurecon)

The key elements for successful wetland treatment are uniform flow distribution, maximising contact time with macrophytes, minimising overloading of organic matter to the wetland, and an effective operations and maintenance strategy for sediment removal and weed management. Additionally, the removal of coarse sediment upstream (i.e. in a settling pond) of the system is fundamental to preventing the wetland systems from becoming choked with sediment. It is important to note that, as wetlands rely on biological processes for treatment the removal efficiency can be extremely variable, ranging between 20-80% for some contaminants based on influent characteristics, seasonal effects and other influences.

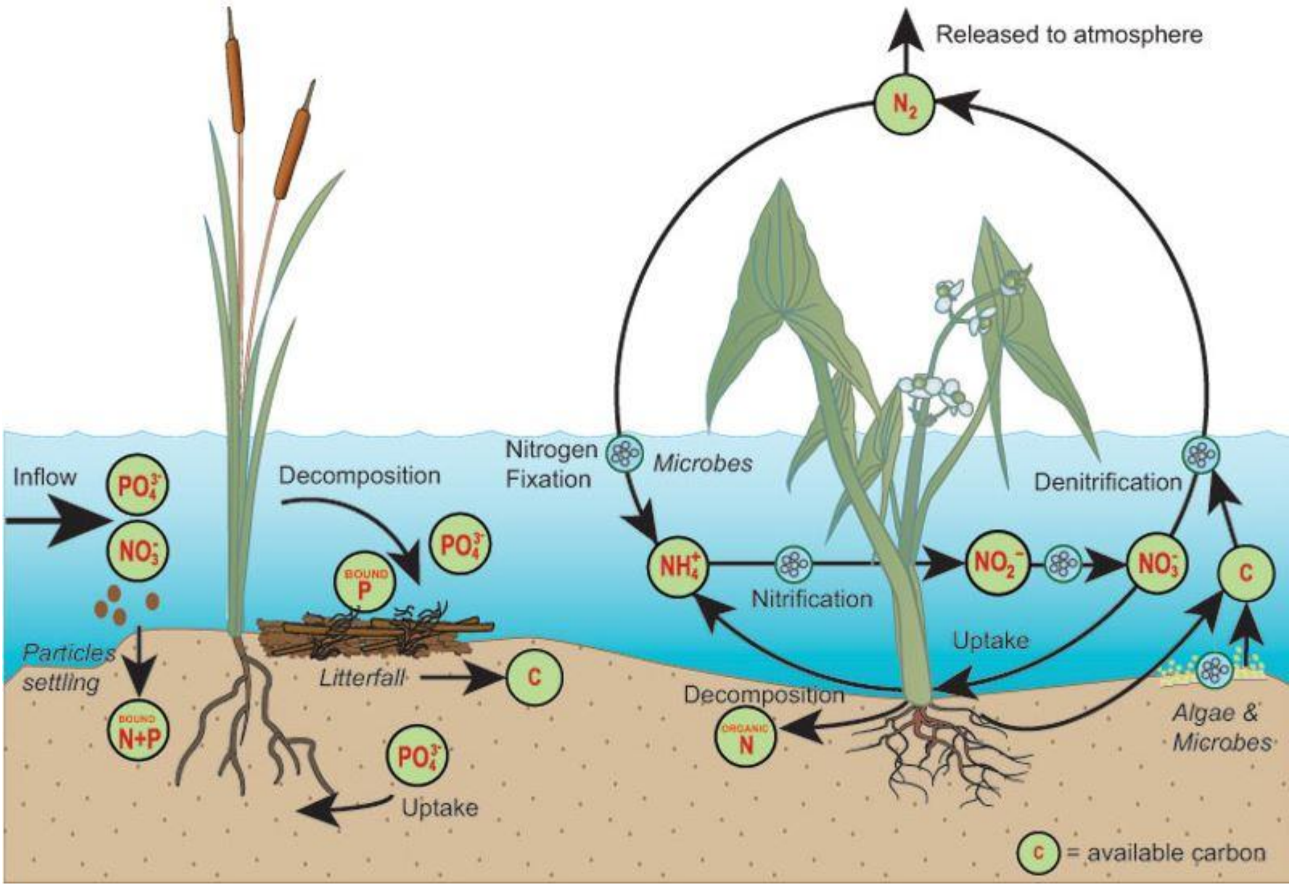

Figure 7 Denitrification processes in wetlands (IAN, University of Maryland)

A summary of the advantages and disadvantages of using a wetland to treat the Ravensdown stormwater and process water runoff is shown in Table 9 below.

Table 9: Summary of advantages and disadvantages of using a wetland[7]

Advantages	Disadvantages
▪ Removes nitrates, TSS, and some heavy metals ▪ Provides amenity values ▪ Traps fines suspended solids ▪ Regulates oxidation and reduction processes ▪ Provides a substrate for bio-film growth ▪ Provides a habitat for a wide variety of wildlife	▪ Large land area needed relative to the treatment provided ▪ Poor removal of fluoride, ammoniacal nitrates, and dissolved reactive phosphorus ▪ Potential breeding grounds for mosquitoes and other pests ▪ Colonisation by invasive species could increase maintenance ▪ Wetlands may produce atmospheric methane through the anaerobic decomposition of organic matter ▪ Requires a consistent baseflow and limited fluctuations in water level to maintain plant species ▪ Potentially significant ongoing maintenance requirements ▪ Can moderately increase the concentration of some nutrients ▪ High flow by-pass may be required to avoid re-suspension of sediments during large storm events

[7] https://sciencing.com/positive-effects-of-floods-12489990.html and https://www.environment.nsw.gov.au/resources/stormwater/usp/treattech.pd, https://www.doc.govt.nz/nature/habitats/wetlands/ and BM - Treatment of flower farm wastewater effluents using constructed wetlands in lake Naivasha, Kenya.pdf

6.4 Bioreactor

Similar to a bioretention basin, a bioreactor converts the nitrate in water into nitrogen gas by using microbes and a carbon source under anoxic conditions. The bioreactor is placed perpendicular to the flow of water to allow for denitrification to occur as water passes through the media.

The media of a bioreactor consist of woodchips, activated carbon or other carbon sources. An inlet and outlet structure are required for this process, along with a sediment trap upstream to prevent clogging.

An example of a bioreactor is shown as per Figure 8and Figure 9 below:

Figure 8 Wood chip bioreactor (Queensland Government)

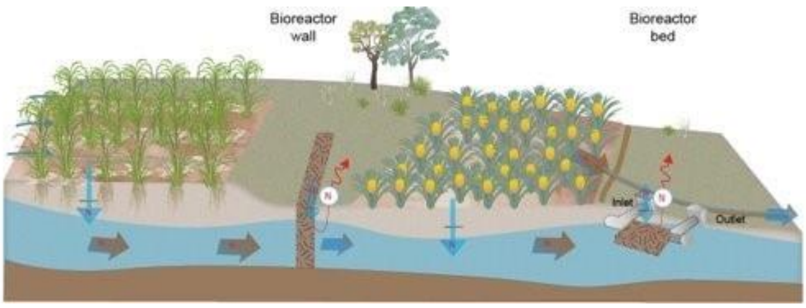

Figure 9 Bioreactor designed by the Queensland Government

A summary of the advantages and disadvantages of using a bioreactor to treat the Ravensdown stormwater and process water runoff is shown in Table 10 below.

Table 10: Summary of advantages and disadvantages of using a bioreactor[8]

Advantages	Disadvantages
▪ Removes nitrates, TSS, phosphorus, and moderate removal of heavy metals ▪ Provides amenity values ▪ Easy to clean ▪ Simple to construct	▪ Poor removal of fluoride ▪ Large land area needed ▪ Requires baseflow ▪ Requires ongoing maintenance

[8] https://wetlandinfo.des.qld.gov.au/wetlands/management/treatment-systems/for-agriculture/treatment-sys-nav-page/bioreactors

6.5 Filter media

For this treatment process, the flow enters the system and passes through filter media where solids are physically filtered out, the soluble pollutants attach to the media (adsorption), or ions are exchanged with ions from the filter media. Many diverse types of media can be used, and the installation can consist of individual filter cartridges or media filter beds. Examples of some filter media devices are shown in Figure 10 and Figure 11 below.

Figure 10 Stormfilter, Stormwater360 device

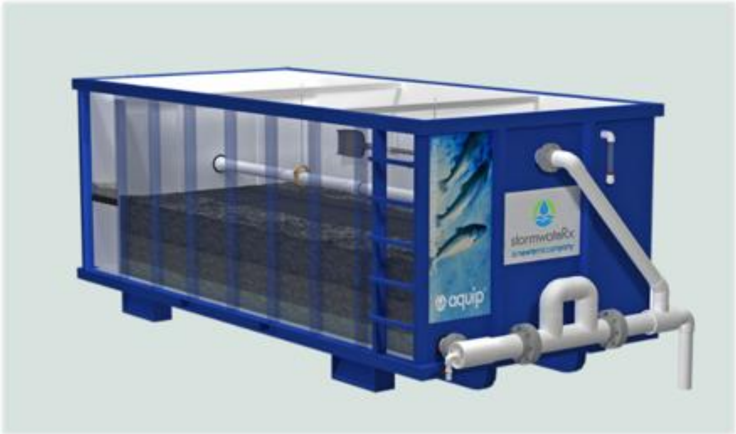

Figure 11 Aquip, Stormaterx device

The performance of the filter is highly dependent on the hydraulic loading rate, residence time, graduation, depth and type of media used, and pollutant characteristics.

There are numerous types of media that can be used to target different site-specific contaminants. Media filters can also be used in combination to maximise pollutant removal effectiveness. Table 11 contains a summary of some common media filters and their respective target pollutants.

Table 11: Summary of filter media and target pollutants[9]

Media type	Target pollutants
Perlite	TSS Oil Grease
ZPG	Soluble metals TSS Oils Grease Organics Ammonium
Zeolite	Soluble metals Ammonium Some organics
GAC (Granular Activated Carbon)	Oil Grease Organics
Mussel shells[10]	TSS Copper Zinc
Iron slag[11]	TSS Nitrates Ammonium Phosphorus

A summary of the advantages and disadvantages of using filter media to treat the Ravensdown stormwater and process water runoff is shown in Table 12 below.

Table 12: Summary of advantages and disadvantages of using filter media

Advantages	Disadvantages
▪ Removes heavy metals, TSS, and moderate nutrients (phosphorus) ▪ Able to be retrofitted to stormwater network ▪ Compact	▪ Poor removal of fluoride ▪ Filter media requires routine replacement

6.6 Clarifier

Clarifiers are devices that are common in wastewater treatment plant applications. Clarifiers utilise coagulants to form sediment clumps (flocs) and precipitants prior to a sedimentation stage. Some clarifiers utilise microsand to buffer the effect of raw water flows and load variations, thus allowing the process to adapt to changing conditions. Ravensdown have invested in the development of a clarifier system that utilises polyferric sulphate (PFS) as a coagulant that is intended to treat dairy effluent. This system has shown significant removal of SRP, aluminium and copper, with moderate removal of total nitrogen and

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9 https://www.stormwater360.co.nz/products/stormwater-management/filtration/prod/stormfilter
10 https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=830
11 http://tur-www1.massey.ac.nz/~rhaverka/ShiltonWR2006.pdf

fluoride[12]. An important consideration with the selection of a clarifier is the management of the unclarified water / sludge. This volume of water contains significant levels of contaminants that requires handling through a separate process. This process could include reuse in the manufacture process or further treatment through trade waste. The image below shows an example of the clarifier.

Figure 12 Clarifier

A summary of the advantages and disadvantages of using a clarifier to treat the Ravensdown stormwater and process water runoff is shown in Table 13 below

Table 13: Summary of advantages and disadvantages of clarifier treatment devices

Advantages	Disadvantages
▪ Very high levels of removal of TSS, SRP, Al and Cu	▪ Requires a continuous input of coagulant
▪ Moderate removal of Total N and Fluoride	▪ Effluent water requires further handling / disposal
▪ Able to be retrofitted to stormwater network	▪ Treatment can result in pH reduction
▪ Compact	

6.7 Membrane filter plant

Membrane filters are supplied with pore sizes ranging between 0.0001 – 10 microns. The material selected for the filter is dependent on the pore size required to remove the target constituents. As the membrane pore size decreases, exponentially higher pressures are required to operate the membrane filter, with associated energy requirements. The chart below indicates a range of membrane pore sizes, and the contaminants each range can be expected to remove.

[12] Removal of Fluoride Ions from Aqueous Solution Using Ferric Hydroxide Hiroshi NAKAZAWA, Kazuhito NISHIKAWA2 and Wataru HAREYAMA

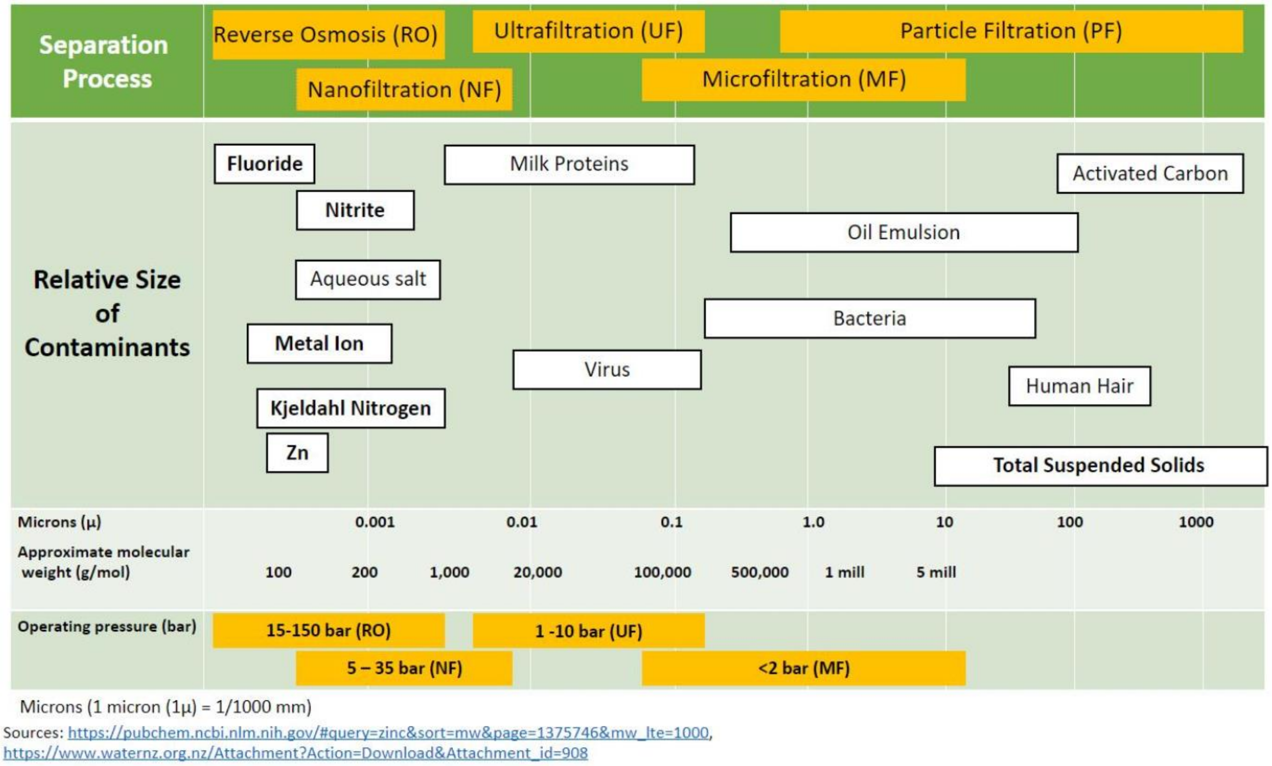

Figure 13 Membrane Filter Contaminant Removal

A summary of the advantages and disadvantages of using a membrane filter to treat the Ravensdown stormwater and process water runoff is shown in Table 14 below.

Table 14: Summary of advantages and disadvantages of using a membrane filter[13]

Advantages	Disadvantages
▪ Can remove all key contaminants ▪ Up to 100% removal efficiency ▪ Minimal maintenance	▪ High capital investment and operational costs ▪ Extremely energy intensive, with a resulting high carbon footprint ▪ Backwash or reject water requires additional management and can have significant volume.

This method is extremely effective and successful for water treatment and can produce water that is near potable standard. However, membrane filters require a lot of energy to provide this level of service.

6.8 Summary of treatment devices

A summary of the treatment devices is shown in Table 15 below. A traffic light system has been adopted when considering the removal efficiencies of contaminants where green, orange and red have good, medium and poor contaminant removal abilities respectively.

13 https://wetlandinfo.des.qld.gov.au/wetlands/management/treatment-systems/for-agriculture/treatment-sys-nav-page/bioreactors

Table 15: Summary of stormwater treatment devices removal capability and requirements

		Settling pond	Bioretention basin	Wetland	Bioreactor	Filter media	Clarifier	Membrane filter
Removal of Contaminant	Total Suspended Solids (TSS)							
	Nutrients	Suspended nutrient removal. Potential removal of dissolved nutrients with chemical precipitation	Moderate removal of Ammoniacal nitrates and SRP	Moderate removal Non-dissolved nutrients in conventional wetlands			Very High Removal of SRP, Moderate removal of others	
	Heavy metals	Suspended heavy metals	Some heavy metals removed through phyto-remediation	Some heavy metals removed through phyto-remediation		Constituent-specific media required	Some heavy metals removed through precipitation	
	Fluoride	Potential for removal with chemical precipitation				Anion exchange media has some efficacy, but is very dependent on pH and may be affected by other ions	Removal of fluoride down to approx. 3mg/L	Reverse osmosis required for removal
Amenity values		Yes	Yes	Yes	Yes	No	No	No
Land area requirements		Large	Large	Large	Medium	Small	Small	Small
Maintenance requirements		Routine removal of sediment, keeping pond clear of rubbish and debris, embankment maintenance, removing excess sediment from basin, inflow and outflow pipes.	Sediment removal / dredging, establishment of plant species, embankment maintenance, reconstruction of filter bed (if necessary), spill response.	Vegetation management, Monthly checks for leaks, erosion and clearing rubbish and dead vegetation.	Need to maintain saturated conditions to sustain the longevity of denitrifying wood chip bioreactors.	Routine changing of media filter	Requires continuous coagulant supply. Non-clarified water / sludge requires handling and/or treatment	Management of backwash / reject water
Volumetric or flow rate based treatment		Volumetric	Volumetric	Volumetric	Flow Rate	Flow Rate	Flow Rate	Flow Rate
Requires other treatment methods		Yes	Yes	Yes	Yes	Yes	Yes	No – however pre-treatment may significantly decrease energy requirements and maintenance needs

7 Stormwater and Process water management options

The stormwater and process water management options considered for the Site can be broadly categorised based on the discharge receiving environment. The potential discharge receiving environments, and the options assessed against each are summarised below:

- Discharge to the Tūtaekurī River /Waitangi Estuary
  - Option1a: Status quo – This option would maintain the existing discharge arrangement with only minor changes to the present-day configuration.
  - Option 1b: Wetland treatment train – This option would treat stormwater and process water in a series of treatment facilities, including a large treatment wetland, prior to discharge to the estuary at the current discharge location.
  - Option 1c: Membrane filter plant – This option would utilise a membrane filter plant to remove contaminants prior to discharge to the estuary at the current discharge location.
- Discharge to Hawke Bay (marine environment)
  - Option 2a: NCC WWTP outfall – This option would discharge stormwater and process water to the sea using the existing sea outfall at the NCC WWTP. Depending on the level of treatment required, the option may require pre-treatment at the Site. The discharge could either be to the outfall or through the wastewater treatment plant.
  - Option 2b: Ravensdown site-specific sea outfall – This option would discharge stormwater and process water to the marine environment via a new sea outfall from the Site.
- Discharge to land
  - Option 3a: Spray irrigation – This option would apply treated stormwater and process water to a large area via agricultural irrigation infrastructure, from where it would be taken up by plants or infiltrate to groundwater.
  - Option 3b: Soakage and rapid infiltration – This option would discharge stormwater and process water directly to land via a purpose-built groundwater rapid infiltration pit.
- Combination of options
  - Option 4: Split of high and low risk contaminant areas – This option would discharge high contaminant generating portions of the site to an appropriate receiving environment.

It is noted that treatment of stormwater and process water would likely be necessary before discharging to water or onto land., However for each discharge option, there are likely to be several different combinations of pre-treatment devices that could achieve the required water quality. For simplicity, each discharge option is considered with a single treatment option. Complex combinations of treatment devices have not been explicitly considered against each option as this would result in a large number of potential options.

7.1 Discounted options

Several options have been suggested to the project team during stakeholder engagement or considered by the project team but discounted as infeasible based on Aurecon's technical expertise and knowledge of the Sites stormwater and process water discharge. These are briefly discussed below:

7.1.1 Wastewater treatment plant

In industrial settings, it is common for wastewater to be treated in purpose-built treatment plants. These wastewater plants typically utilise a combination of physical, chemical and biological mechanisms to treat water to a high level before releasing to the environment. Such plants rely on a steady state condition to function – the influent water arrives at a continuous rate with stable and predictable concentrations of contaminants. Additionally, biological processes such as activated sludge, trickling filters and contact biofilters rely on a consistent stream of nutrients to maintain a healthy population of microbial agents. As stormwater arrives at very irregular intervals and sampling has shown significant variance in the concentration of subject contaminants, such steady-state treatment systems are generally not fit for purpose for bulk stormwater treatment. Additionally, due to the high volumes generated by storm events, traditional wastewater treatment devices are often not able to manage these high volumes without significant attenuation. For these reasons, traditional wastewater treatment processes have been excluded from this analysis of site-wide stormwater and process water treatment strategies. Where wastewater processes can supplement stormwater treatment through treatment of targeted hotspot areas or through treatment of process water inputs, these devices may be considered as the design progresses.

7.1.2 Cross Country Drain

The Cross Country Drain (CCD) is a 4.3 km open drainage channel located south of Napier and is designed to provide drainage capacity for areas south of Napier City. Flows from the drain are ultimately pumped via three rising mains discharging onto Awatoto beach. Discharge into this drain has been considered but was discounted because of the distance to the drain (approximately 2 km of piping would be required from the site), and because the water from the CCD runs off as surface flows over the beach which may not be viewed as appropriate by the community.

7.1.3 Evaporation

Disposal of stormwater and process water solely by evaporation would avoid discharges to land, marine or estuarine environments. However this method is unlikely to be feasible due to low evaporation rates typically being available during wet weather when most stormwater accumulates, particularly during winter months.

7.1.4 Offsite stormwater re-use

Re-use of water off-site was suggested to the project team, for example that stormwater and process water could be stored on-site and provided to land-owners for irrigation. This would likely require movement of water using tanker trucks to other properties. This option would allow stormwater and process water to be discharged onto land outside the Napier Source Protection Zone. However, this option is unlikely to be feasible due to irrigation demand being generally low when stormwater generation is high. Other disadvantages of this option are high traffic generation if water was removed from site using tanker trucks (the most likely scenario), and carbon emissions from these vehicles.

7.2 Treatment system sizing base calculations

To size stormwater treatment devices, a design event for treatment must be established. Due to the nature of extreme rainfall events, there will always be events which cannot be accommodated within any stormwater treatment system and will need to bypass to the receiving environment without full treatment. The threshold for what volume should be discharged and what should be retained and treated is likely to driven by the effects of the discharge, guidance from regulatory authorities and stakeholder views. Water balance and water quality modelling can be performed as part of future design to confirm the expected treatment efficacy for various storm events.

Typical stormwater management in the Hawke’s Bay region allows for treatment volume for 90%-95% of all rainfall events. HBRC have simplified this metric to be equal to 1/3 of the 2-year 24-hour event, which corresponds to a depth of approximately 23mm for the site. However, given the industrial nature of the site, its associated contaminants and the lack of an observed first flush effect, it is expected that water quality treatment will need to be provided to a higher level. Thus, for the purposes of preliminary treatment sizing, it has been assumed that the first 25 mm of rainfall on the site will be fully handled by the treatment system, with accommodations made for partially treating up to 50-75mm of rainfall, with higher capture volumes targeted at the most critical catchments.

In order to establish the runoff volume resulting from the design rain events, historic rainfall and discharge data was examined. For this exercise, the weekly discharge was correlated to the recorded discharge on site with the recorded rainfall data by NIWA. Using these values, the base weekly discharge (i.e. the average discharge without rain) was calculated to be approximately 2,000 m^3/week and the effective runoff coefficient was calculated to be 0.45. A summary of the calculations used to develop this relationship is shown in Appendix B.

The design of this project is based on the following standards and criteria:

1. Stormwater Management Devices in the Auckland Region **GD01**
2. Hawke's Bay Waterway Guidelines - Stormwater Management
3. Napier Code of Practice for Subdivision and Land Development
4. HIRDS rain data

Stormwater devices can broadly be defined as either volume-based or flow-based. Volume-based devices are designed to capture, store, and treat a specific water quality volume, whereas flow-based devices continuously treat up to a specified flow rate[14]. It is noted that where treatment devices are constructed in series, volume-based devices can significantly attenuate peak flows, reducing the peak flow rate on subsequent flow-based devices – devices with a shorter required residence time in essence become flow based treatment devices when installed after a device with a higher residence time. A summary of the nature of the explored stormwater devices is shown in Table 16 below:

Table 16: Summary of nature of stormwater devices (volume or flow based)

Nature of stormwater device	Stormwater treatment device
Volume based	Settling pond Bioretention basin Wetlands
Flow based	Media filter Membrane filter Bioreactor

It is noted that, while the indicative sizing shown on the configuration figures within each option represents a reasonable approximation for the footprint of potential treatment devices, the size and location calculated for the devices are subject to change. Site investigations and water modelling are required to confirm the size and location of the devices. This will be done during detailed design of the treatment option.

7.3 Discharge to Tūtaekurī River/Waitangi Estuary

Three options have been considered that discharge to the Tūtaekurī River/Waitangi Estuary. These options are discussed in detail in the following sections.

7.3.1 Status quo (Option 1a)

This management option assumes that no, or only minor, changes are made to the existing stormwater and process water management strategy as per Figure 14. The existing management strategy includes dilution water, pH dosing and a settling pond.

Although the site generally complies with the water quality requirements in the existing discharge permit conditions, these do not necessarily reflect the modern regulatory environment and community expectations. A higher standard of treatment is likely to be expected by regulators and the community going forward.

[14] Designing stormwater treatment devices- resilient consideration and implications, Brockbank, Jonathan

A visual representation of this option is seen in Figure 14.

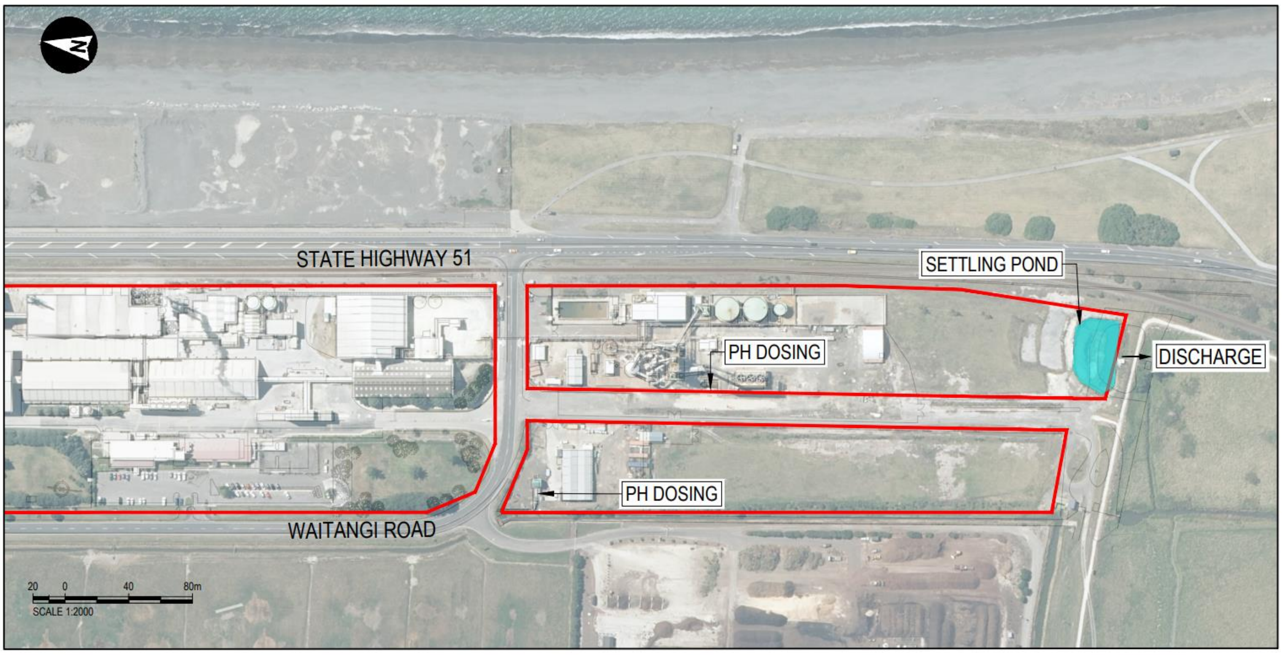

Figure 14 Status quo management option

7.3.2 Wetland treatment train (Option 1b)

A treatment train is the combination of devices that treat water sequentially to deliver the target quality or quantity of stormwater. Each device can target different contaminants, the order of which is strategically selected to maximise removal efficiency. When considering the contaminants present within the dischargeable water, the order as follows is a potential treatment train option for the Ravensdown Napier site:

- Settling pond
- Wetland
- Bioretention basin
- Media filter

A visual representation of the treatment train layout can be seen in Figure 15 below.

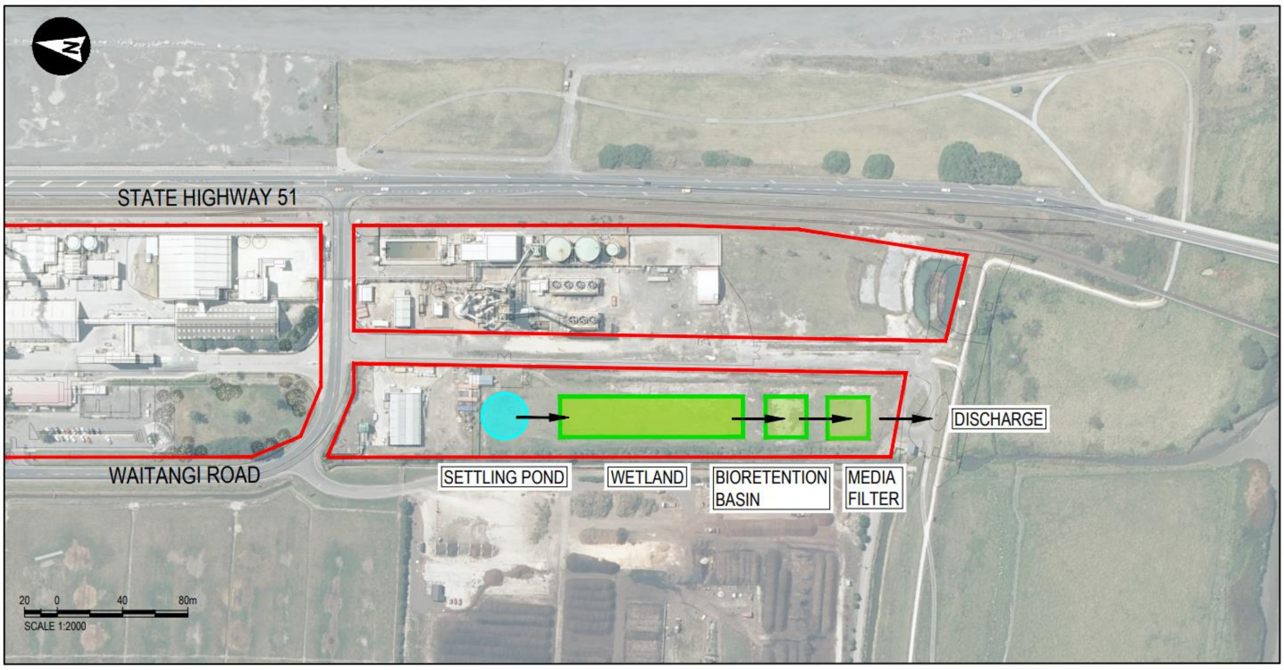

Figure 15 Treatment train stormwater management option

Sizing of land-based treatment train

The treatment devices specified in section 7.2 above have been sized using the standards outlined above. A summary of the sizing is shown in Table 17 below (refer to Option 1b in Appendix C for further details):

Table 17: Summary of a treatment train device sizes

Treatment device	Hydraulic Residence Time	Treatment device volume (m^3)	Treatment flow (L/s)
Settling pond	12h	2000 / 2100	N/A
Wetland	48h	2400	N/A
Bioretention basin	72h	2700	N/A
Media filter	N/A	N/A	10

It is noted that the combined settling pond / wetland system has a volume representing 50 mm of rainfall across the site, which significantly exceeds traditional water quality design volumes. Events larger than 25 mm would reduce the residence time in the settling pond but will be treated by the wetland. Allowing for overflow into the bioretention basin, events up to 75 mm would be captured by this system with reduced treatment efficacy. Events exceeding 75 mm would bypass the system and be released untreated to the estuary. Water balance and water quality modelling can be utilised in future design phases to better optimise the sizing and operations of the proposed system, quantify expected outcomes, and event-based operation statistics.

Operations and maintenance considerations

There are considerable long-term maintenance requirements associated with a land-based treatment train. Some of the ongoing maintenance needs are outlined in Table 18 below:

Table 18: Summary of land-based treatment train operations and maintenance activities

Component	Maintenance or Operational Activity	Approximate Interval	Notes
All components	Remove accumulated debris, inspect for blockages	Monthly	
	Maintain valves and pumps	6 months	
	Inspect system for erosion, leaks and other damage	6 months	
Settling pond	Dredge accumulated sediment	2 years	Dredged sediment requires waste handling
Wetland	Maintain baseflow	Continuous	Baseflow required to maintain healthy species and prevent algal blooms
	Maintain landscaping	Monthly	Clear weeds, prune and replace vegetation as needed
Bioretention Basin	Maintain landscaping	Monthly	Clear weeds, prune and replace vegetation as needed
	Clear underdrain	Yearly	
	Replace bioretention media (carbon source)	10 year	May only need partial replacement of surface media
Media Filter	Replace media	2 years	Media replacement interval is highly dependent on contaminant loading

7.3.3 Membrane filter plant (Option 1c)

A stormwater and process water management option for the Ravensdown Napier site is to install a membrane filter plant on site as shown in Figure 16 below. A membrane treatment plant would be capable of filtering the discharged water to a high standard prior to discharge.

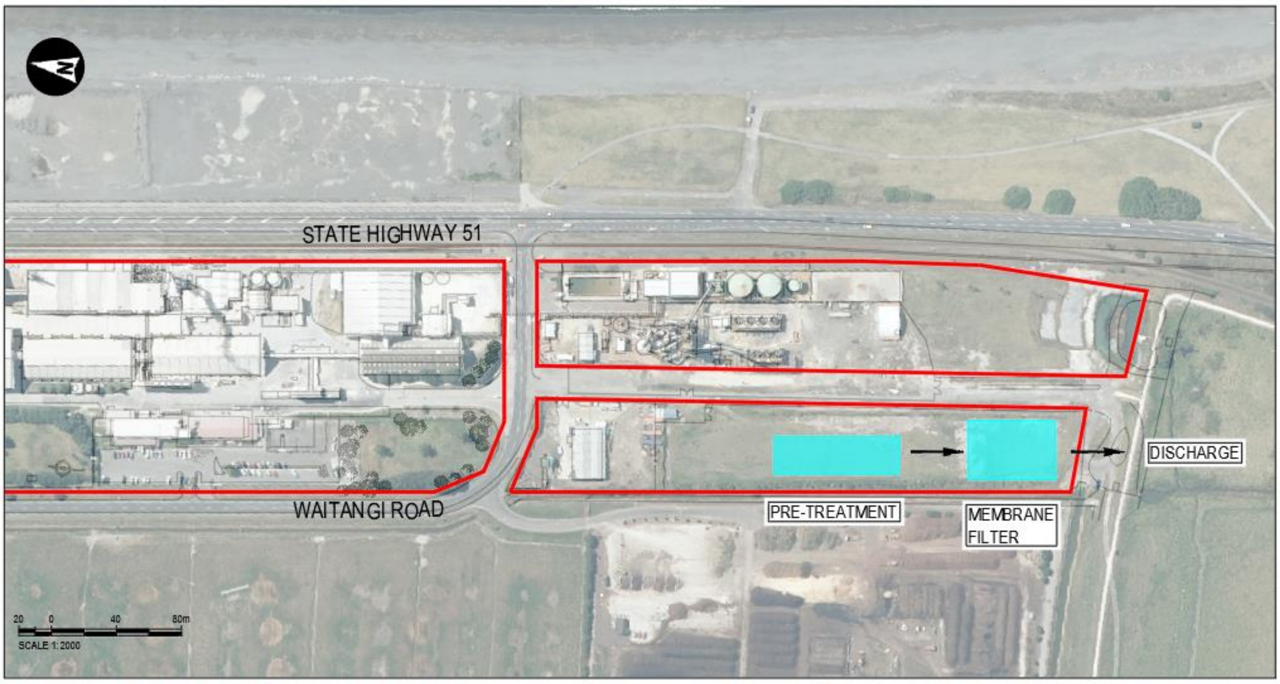

Figure 16 Membrane filter management option

Although membrane filter plants are capable of treating high concentrations of contaminants, their operations may be significantly improved through pre-treatment. Pre-treatment can reduce the contaminant loads removed by the membrane filter, which in turn reduces the overall energy use and volume of backwash or reject water generated. Additionally, pre-treatment utilising a volumetric treatment device such as a settling pond, allows for significant peak flow rate reduction, allowing for a reduced plant size.

Sizing of membrane filter plant

The treatment devices have been sized using the standards outlined in Section 7.2. A summary of the sizing of this option is shown in Table 19 below.

Table 19: Summary of a membrane filter device sizes

Treatment device	Hydraulic Residence Time	Stormwater treatment device volume (m^3)	Stormwater treatment flow (L/s)
Settling / Attenuation pond	24h	1850	N/A
Membrane Filter Plant	N/A	N/A	42

Note: the sizing of these devices assumes that dilution water will no longer be needed

Operations and maintenance considerations

There are a number of long-term maintenance considerations associated with the operation of a membrane filter plant. Some of the ongoing maintenance needs are outlined in Table 19 below:

Table 20: Summary of membrane filter plant operations and maintenance activities

Component	Maintenance or Operational Activity	Approximate Interval	Notes
All components	Remove accumulated debris, inspect for blockages	Monthly	
	Maintain valves and pumps	6 months	
	Inspect system for erosion, leaks and other damage	6 months	
Settling pond	Dredge accumulated sediment	2 years	Dredged sediment requires waste handling
Membrane Filter	Energy use	Continuous	Very high energy requirements for high-removal membrane filters.
	Backwash filters	Continuous	Backwash water / sludges require appropriate handling

7.4 Discharge to Hawke Bay

7.4.1 NCC WWTP outfall (Option 2a)

NCC operate a WWTP approximately 500 metres from the northern boundary of the Site which ultimately discharges via a sea outfall. The discharge of the Sites stormwater and process water to the NCC WWTP (Figure 17) has been considered as follows:

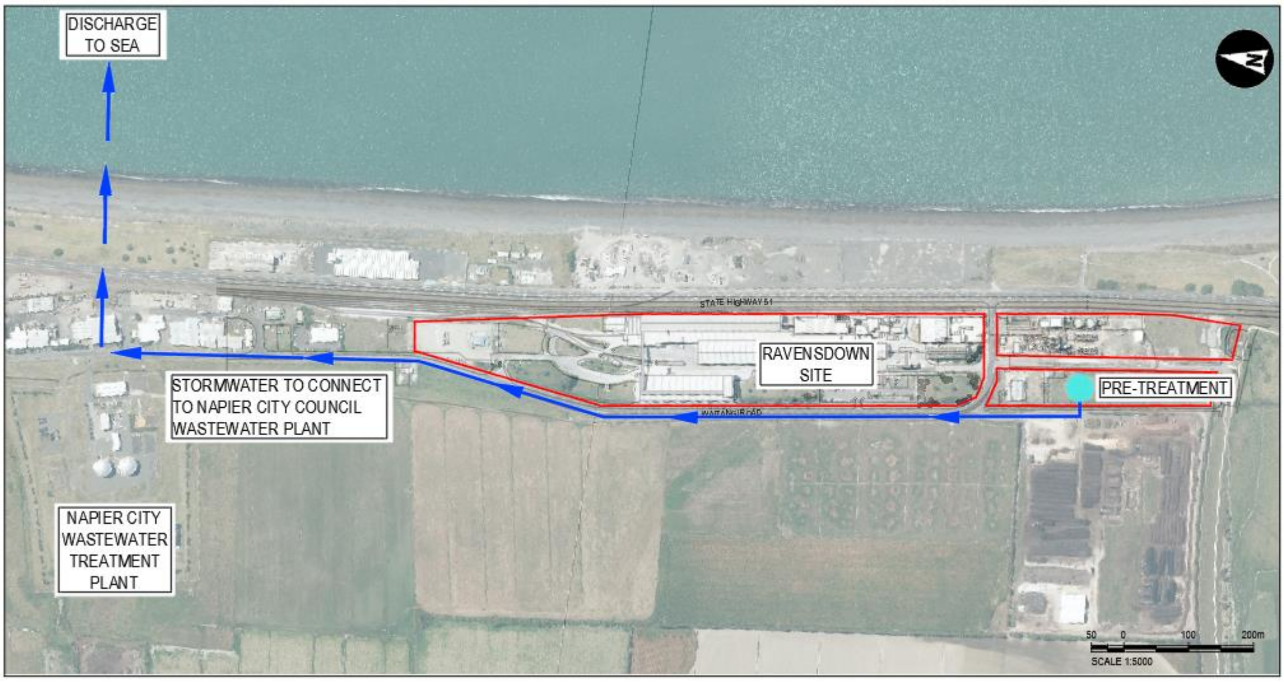

Figure 17 Discharge to NCC WWTP sea outfall management option

- Stormwater and process water treated on site and connected directly to the NCC wastewater sea outfall:

  Prior to discharging to the NCC wastewater sea outfall, the site's stormwater and process water would undergo treatment to meet acceptable quality for discharge to the marine environment as per Figure 17. Conceptual pre-treatment for this option includes a settling / attenuation pond followed by a media filter prior to discharge directly to the NCC sea outfall. The actual level of treatment required will depend on input from external stakeholders.

- Minimal pre-treatment and connect to the WWTP:

  For this scenario, the majority of the required treatment would occur at the NCC WWTP. Prior to connecting to the treatment plant, the water would be stored in a holding / attenuation basin that would provide some level of treatment through settlement before discharging to the plant.

Regardless Ravensdown's stormwater and process water would be required to be pumped (pressurised system) to connect to either the WWTP or to the sea outfall. Technical design of the connection to the NCC wastewater sea outfall will be further considered if this option is selected for further development as part of a preferred management option.

Sizing of treatment devices

The treatment devices have been sized using the standards as outlined in Section 7.2. A summary of the sizing of said options are shown in Table 21 below (refer to Option 2a in Appendix C for further details).

Table 21: Summary of NCC WWTP treatment device sizes

Option	Treatment device	Treatment device volume (m^3)	Treatment flow (L/s)
1. Pre-treated and connect directly to the NCC wastewater sea outfall	Settling pond	1850 (conditional of increase in discharge rate)	-
	Media filter or Clarifier	N/A	10
	Discharge to NCC WWTP outfall	N/A	10

Option	Treatment device	Treatment device volume (m^3)	Treatment flow (L/s)
2. No pre-treatment and connected to NCC wastewater treatment plant	Holding basin	1850 (conditional of increase in discharge rate)	-
	Discharge to NCC WWTP		10

Note: the sizing of these devices assumes that dilution water will no longer be needed

The current NCC trade waste bylaw permits discharges up to an instantaneous flow rate of 2 L/s into the WWTP. Based on historic rainfall volumes, this discharge rate would not be suitable for discharging stormwater from the Site with any level of attenuation / holding ponds. As such, for this option to be considered viable a trade waste consent would be required to allow a higher maximum discharge rate (and for the discharge to include stormwater). This discharge rate could however potentially be accommodated using instrumentation to limit releases to times when the full capacity of the plant's discharge is not being utilised.

Operations and maintenance considerations

There are several long-term maintenance considerations associated with the operations of a trade waste discharge. Some of the ongoing maintenance needs are outlined below:

Table 22: Summary of trade waste operations and maintenance activities

Component	Maintenance or Operational Activity	Approximate Interval	Notes
All components	Remove accumulated debris, inspect for blockages	Monthly	
	Maintain valves and pumps	6 months	
	Inspect system for erosion, leaks and other damage	6 months	
Settling pond	Dredge accumulated sediment	2 years	Dredged sediment requires waste handling
Media Filter (if required)	Replace media	2 years	Media replacement interval is highly dependent on contaminant loading.

7.4.2 Ravensdown site specific sea outfall (Option 2b)

The construction of a Ravensdown specific sea outfall as shown in Figure 18 below has been included in the assessment of options for the discharge from the Site.

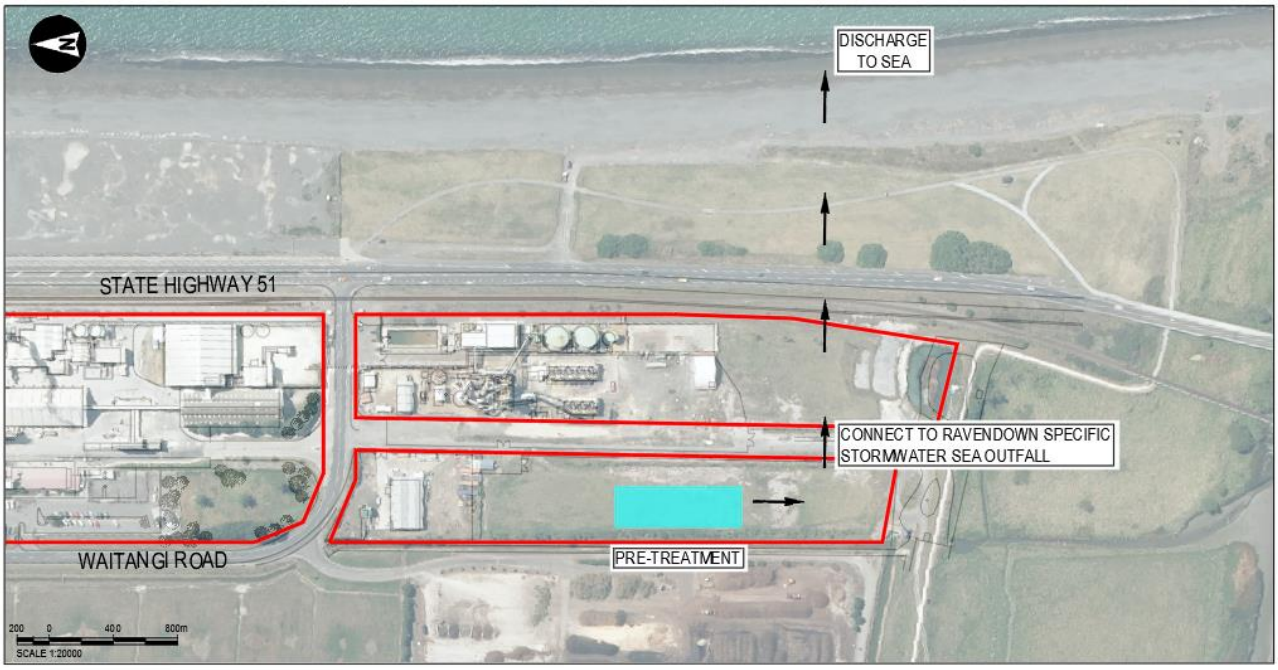

Figure 18 Discharge to Ravensdown specific sea outfall management option

Based on the volume of discharge and pipe distance of the NCC wastewater sea outfall, it is assumed the manifold length would be required to be 500 m from the low tide mark. At this distance, it is assumed that based on the discharging contaminant levels there would be an adequate level of mixing with the receiving marine environment. Further technical engineering and environmental assessment would be required to determine appropriate manifold length to allow for adequate dilution if this option was considered viable for the Sites discharge.

It is assumed that pre-treatment would be required prior to discharging to a Ravensdown specific sea outfall and the level of treatment would need to be confirmed. However, there are multiple combinations of treatment devices available to pre-treat the site's stormwater and process water including:

- Settling / Attenuation pond
- Media filter

Sizing of treatment devices

The treatment devices have been sized using the standards in Section 7.2. A summary of the sizing is shown in Table 23 below (refer to Option 2b in Appendix C for further details):

Table 23: Summary of Ravensdown specific sea outfall treatment device sizes

Option	Treatment device	Treatment device volume (m^3)	Treatment flow (L/s)
Pre-treated and discharged through a Ravensdown specific sea outfall	Settling pond	1,850 (conditional on allowable discharge rate)	-
	Media filter	-	10

Note: the sizing of the sea outfall assumes that dilution water will no longer be needed

Operations and maintenance considerations

There are a number of long-term maintenance considerations associated with the operation of a site-specific sea outfall. Some of the ongoing maintenance needs are outlined below:

Table 24: Summary of trade waste operations and maintenance activities

Component	Maintenance or Operational Activity	Approximate Interval	Notes
All components	Remove accumulated debris, inspect for blockages	Monthly	
	Maintain valves and pumps	6 months	
	Inspect system for erosion, leaks and other damage	6 months	
Settling pond	Dredge accumulated sediment	2 years	Dredged sediment requires waste handling
Media filter	Replace media	2 years	Media replacement interval is highly dependent on contaminant loading.
Undersea discharge pipe	Inspection of marine pipeline diffuser outlets and pipeline in general; boat and divers Diffuser maintenance; boat and divers Replace diffusers; boat and divers	1 year; for 2 or 3 years. Then every 2 – 5 years (see notes) 5-7 years 35 years	Monitoring marine pipeline pump discharge flowrate and pressures will identify any issues with marine pipeline. Inspection every 1 to 2 years recommended.

7.5 Discharge to land

Several land discharge options have been considered. As the site and its surrounding area are within the Napier drinking water Source Protection Zone, any land discharge option would include treatment using methodology described above prior to discharge. Should this option be selected for consideration, it is recommended that specialist consultant services be engaged to assess any potential interaction with groundwater.

7.5.1 Spray irrigation (Option 3a)

Discharging treated water to land using spray irrigation is a potential option for the site. Under this option, treated water would be diverted to an precision irrigation system utilising land adjacent to the site for the purposes of irrigating a crop. Ravensdown currently own approximately 17.5ha of land adjacent to the site that would be practical for this purpose

This option includes the land-based treatment train option, as described in section 7.3.2, to minimise the levels of contaminants discharged within the groundwater Source Protection Zone. Additionally, spray irrigation has the added benefit of providing additional treatment through the natural land-based processes that occur in an agricultural environment through plant uptake of contaminants. These processes would provide for additional removal of any remaining contaminants prior to infiltration to groundwater.

This option is practical for the discharge of moderate amounts of stormwater discharge, however following significant rainfall, it is unlikely that all water could be discharged through irrigation due to large volumes and high soil water content limiting the potential discharge rate. Therefore, discharge by spray irrigation would likely need to be undertaken in combination with a high flow discharge option.

Further investigation to determine maximum discharge rates by suitably qualified and experienced professionals in the fields of groundwater management and agricultural irrigation would provide certainty in relation to these factors.

Sizing of treatment devices

Refer to section 7.3.2 for the sizing and description of the proposed treatment devices for this option. The sizing of the spray irrigation infrastructure is highly dependent on the allowable land discharge rate, which would require consultation with a groundwater/geotechnical engineer. It is recommended that Ravensdown firstly engage a groundwater/geotechnical engineer to undertake an assessment of effects for discharge to land and secondly engage a specialist irrigation consultant to specify the technical details of the required system..

Operations and maintenance considerations

Discharge through a spray irrigation system carries significant operational costs, as it requires agricultural management of the irrigation system and the establishment, maintenance and harvesting of the crop being irrigated, in addition to the considerations of the Wetland treatment train (refer section 7.3.2) It is recommended that Ravensdown engage a specialist irrigation consultant to identify the specific operational requirements of this system and the agricultural management.

7.5.2 Soakage and rapid infiltration (Option 3b)

Discharge to land may also be accommodated through rapid infiltration. Rapid infiltration devices generally consist of an excavated pit or trench filled with high-void rock that is designed to facilitate infiltration to land.

As with the spray irrigation option, this option would require a significant level of treatment prior to discharge due to the location within the Napier drinking water Source Protection Zone. As such, this option also includes the land-based treatment train option, as described in section 7.3.2.

The applicability of rapid infiltration is highly dependent on soil and groundwater conditions. It is recommended that Ravensdown engage a groundwater/geotechnical engineer to assess the viability of this option in addition to undertaking an assessment of effects for discharge to land.

Sizing of treatment devices

Refer to section 7.3.2 for the sizing and description of the proposed treatment devices for this option. The sizing of a rapid infiltration system is highly dependent on groundwater and soil characteristics. It is recommended that Ravensdown firstly engage a groundwater/geotechnical engineer to undertake an assessment of effects for discharge to land and secondly engage a specialist irrigation consultant to specify the technical details of the required system.

Operations and maintenance considerations

Discharge of treated water through a rapid infiltration system is generally relatively low maintenance and would not add significantly to the maintenance required for the treatment train (see section 7.3.2). The primary maintenance concerns are around the potential clogging of the system with sediment, which should be largely mitigated by the comprehensive upstream treatment. However, as some level of sediment would still be expected to enter the system, the infiltration media may require replacement over a long interval of approximately 20 years. An additional consideration is the potential for sea level rise to impact the infiltration system. Rises in sea level may require utilisation of a larger infiltration area or even changing to a different discharge strategy altogether.

7.6 Combination of options

7.6.1 Split of high and low risk contamination areas (Option 4)

Splitting the outflow from different portions of the Site to different treatment devices and/or receiving environments is a potential option for the Site. Figure 19 illustrates several of the potential options. Utilising a split flow method allows for managing stormwater and process water differently based on the source, as different parts of the Site have different contaminant levels and components. Therefore, contaminants that are hard to remove or are especially sensitive in one receiving environment can be handled differently from the rest of the water from the Site. This could reduce the size (and therefore cost) of the treatment system.

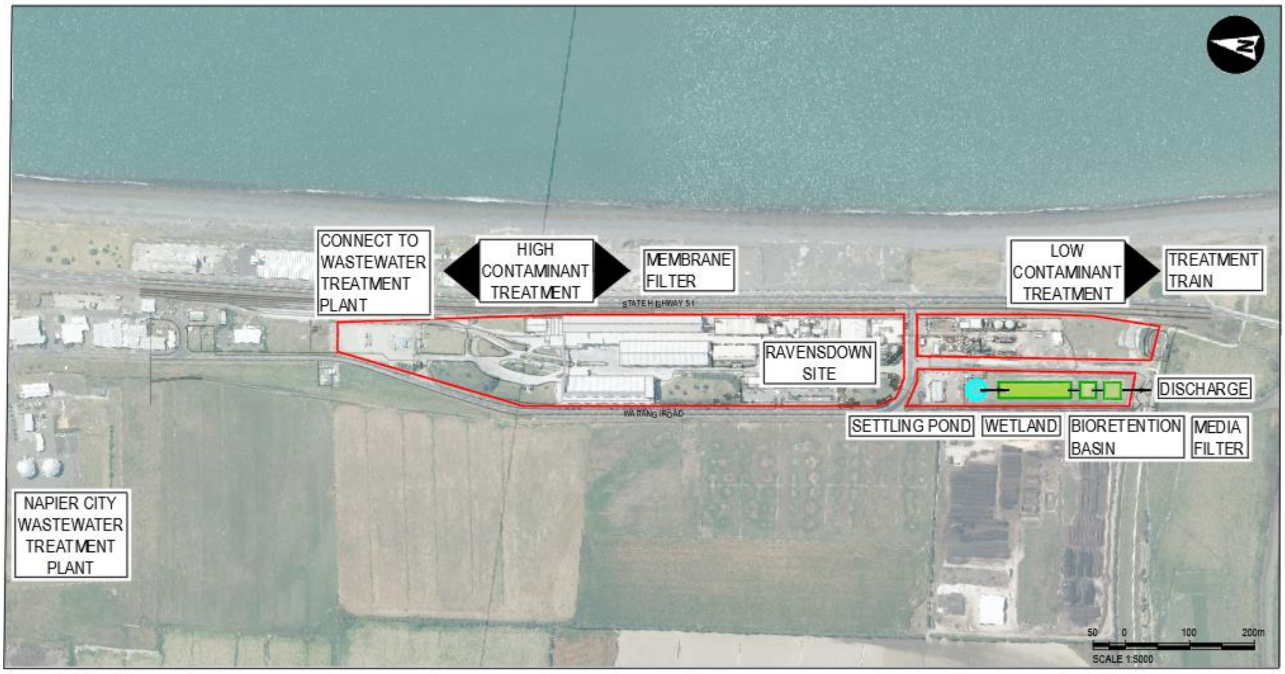

Figure 19 Split of high and low risk contaminants management option

Prior to undertaking design of a split flow management strategy, the relative contaminant levels from different portions of the Site must first be established. As per reccomendations from Aurecon, Ravensdown are implementing a site-wide sampling strategy to facilitate the identification of contaminant sources. Based on the site operations, it is likely that some of the more challenging contaminants (i.e. nutrients, dissolved heavy metals, and flouride) have similar origin areas – these areas may be able to be isolated and treated differently than the rest of the site's stormwater.

There are multiple ways to utilise a split flow approach, adopting various management options as discussed above. The following options have been considered for the management of the highly contaminated stormwater and process water:

- Trade waste discharge to NCC WWTP or its outfall. As previously discussed, this can be arranged several ways:
  - Treat on site and connect directly to the outfall manifold. For this portion of the system for the options assessment, it is assumed this option would consist of:
    - Settling / attenuation pond
    - Media filter
    - Trade waste line to NCC WWTP outfall
  - Stormwater and process water to be treated by the NCC WWTP. Prior to connecting to the treatment plant, the water will be stored in a settling / attenuation basin.
    - Settling / attenuation pond
    - Trade waste line to NCC WWTP outfall

- Treatment utilising a membrane filter, prior to discharge to the Tūtaekurī River/Waitangi Estuary. As discussed previously, this system could consist of the following components
  - Settling / attenuation pond
  - Membrane filter plant

There are multiple combinations of treatment devices to treat the site's less contaminated stormwater and process water. For the purposes of assessing this option, the following land-based treatment train has been considered, representing a simplified version of the system described in section7.3.2

- Treatment train
  - Settling pond
  - Wetland

7.6.2 Sizing of treatment devices

The treatment devices have been sized using the resources as outlined in Section 7.2. It was assumed that one third of the site's flow will be considered as highly contaminated, and the corresponding two thirds will be low contaminants. A summary of the sizing is shown in Table 25 below (refer to Option 4 in Appendix C for further details):

Table 25: Summary of split flow treatment device sizes

Level of contamination of area	Option	Treatment device	Treatment device volume (m^3)	Treatment flow (L/s)
High	1. Pre-treated and connect directly to the NCC wastewater sea outfall:	Settling pond	730	-
		Media filter	-	5
		Discharge to NCC WWTP outfall		5
	2. No pre-treatment and connect to NCC wastewater treatment plant	Holding basin	730	-
		Discharge to NCC WWTP		5
	3. Membrane filter plant	Settling / attenuation pond	730	-
		Membrane filter		5
Low	Land-based treatment train	Settling pond	1430	-
		Wetland	2860	-

7.6.3 Operations and maintenance considerations

The operations and maintenance of a split flow approach will be as described in each individual section above. It is noted however, that although a split flow approach would have a combination of operational considerations, managing different parts of the site separately may result in a reduced overall maintenance burden. For example, by removing the highly nutrient rich water from a wetland treatment device, controlling algae blooms may be made significantly easier. Likewise, by limiting the inputs to a membrane filter plant, the resulting energy requirement and backwash water handling would consequently be lower.

8 Cost estimates

High-level costings for the options was developed as follows:

- Discharge to the Tūtaekurī River /Waitangi Estuary
  - Option1a: Status quo – option not costed as it involves no significant change to the existing system
  - Option 1b: Wetland treatment train – This option consists of the Wetland treatment train as described in section 7.3.2. Two costs were developed for this option, with results presented in Figure 19 below:
    - Option 1b – Bunded - this solution implies the land-based treatment systems are partially constructed above ground using site won material. This option has the advantage of requiring less disposal of contaminated material as the material can be used in the bunding.
    - Option 1b – Not bunded - this solution implies conventional construction of the treatment train with devices below ground. As a result, any excavated material will need to be disposed of at an appropriate disposal facility.
  - Option 1c: Membrane filter plant as described in section 7.3.3. This option was not costed, as the supplier was unable to provide price but suggested the cost would be significant, likely in the order of $15 to $20 million dollars.
- Discharge to Hawke Bay (marine environment)
  - Option 2a: NCC WWTP outfall as described in section 7.4.1 – option costed with result presented in Figure 19 below.
  - Option 2b: Ravensdown site-specific sea outfall as described in section 7.4.2 – option costed with result presented in Figure 19 below.
- Discharge to land
  - Option 3a: Spray irrigation as described in section 7.5.1 – this option has not been costed. Further work is being undertaken by a specialist consultant which will aid in the cost estimate for this option.
  - Option 3b: Soakage and rapid infiltration as described in section 7.5.2 – as above for spray irrigation, option not costed.
- Combination of options
  - Option 4: Split of high and low risk contaminant areas – for the purposes of understanding the range of potential costs associated with contaminated soil management, two costs were developed for this option. Both options are considered functionally equivalent from a treatment outcome standpoint, as they differ only in the management of earthworks. Results for this option are presented in Figure 19 below:
    - Option 4a – Bunded-refer to Wetland treatment train- bunded (option 1b) for explanation.
    - Option 4b – Not bunded-refer to Wetland treatment train-not bunded (option 1b) for explanation.

The costings for the options were developed based on construction (CAPEX) and operations and maintenance (OPEX) costs from projects around New Zealand that Aurecon has been involved in. The costs are high-level in nature and are intended to incorporate the most significant costs associated with the construction and operations of each option. It is noted that the proposed adaptive management approach will extend the capital expenditure time frame for a period of 5-8 years, and escalation of costs may be a factor in this timeframe.

Each costing has the following six base headings:

1. Preliminary & General
2. Erosion and Sediment Control
3. Stormwater Earthworks
4. Stormwater Infrastructure

5. Electrical and Mechanical Works
6. Landscaping Works
7. 35 Year Operations & Maintenance

All headings contain lump sum items. To understand the way the rates were developed for these lump sum items, refer to Appendix C.

The volumes necessary to store the specified storm event, as identified in Section 7.2 were used to calculate the approximate earthworks volumes required.

The figure below shows the CAPEX and 35-year OPEX costs of the different options for a 60/40 contaminated soil split (60% contaminated soil and 40% clean soil). Calculations were also completed for a 70/30 contaminated soil split. The cost difference between these two options was relatively small hence the 60/40 split is presented below and in the calculations in Appendix C.

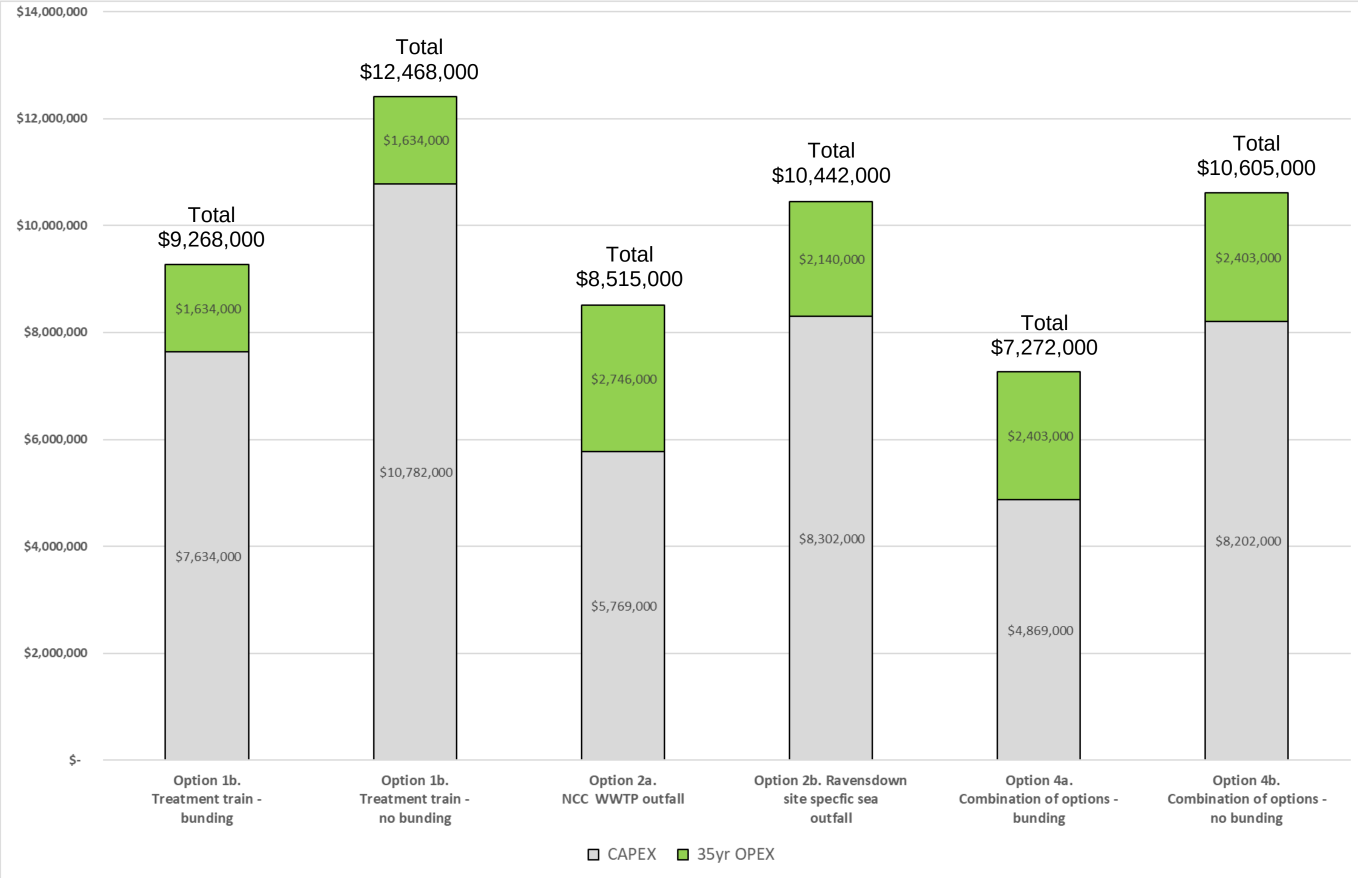

Figure 20 Cost estimate summary: CAPEX and 35-year OPEX

8.1 Rates development

The rates utilised to develop the cost estimates presented in Figure 20 have been derived utilising a number of available data sources as follows:

- Rates used are based on comparable Aurecon projects including cost to complete similar stormwater work in 2020 at Ravensdown in Hornby, Christchurch.
- Rates for disposal of contaminated material have been determined through correspondence with Omarunui Landfill in Hastings.

The following assumptions apply to the cost estimates in general:

- Cost estimates provided are high level and provided for the purposes of relative options comparison.
- Estimates exclude consenting, liaison, professional fees, modelling, etc. This work can be time consuming and costs significant.

- A 20% contingency has been applied across all estimates.
- Cost estimates are for physical and operational work only (i.e. these costs do not include design fees, procurement and contract management and commissioning, these costs are generally 10% to 15% of the overall capital expenditure).
- The high-level cost for 35 years operation and maintenance included in Figure 19 uses average yearly figures and incorporate replacements and running costs.
- Sizing of basins is based on holding runoff from a 25 mm rainfall event in each basin (50mm total).

The following specific assumptions apply to Option 2b: Ravensdown site-specific sea outfall:

- Assumes marine pipeline laid on surface and anchored in place with concrete blocks
- Assumes a 500 m long marine pipeline adequate for dispersion
- Dispersion modelling required to confirm required length of marine pipeline and number and spacing of diffusers has not been undertaken.
- Assumes a design flowrate of 10 L/s

Refer to Appendix C for a more detailed breakdown of costings.

8.2 Limitations of costings

The following limitations apply to the information utilised to complete the costings for each option.

- **Age of information**-the rates for Ravensdown in Hornby, Christchurch were supplied in 2019. However, given the similarities between the work these were considered a good comparison.
- **Soil contamination**-A preliminary site investigation (PSI) and detailed site investigation (DSI) to identify potentially contaminated soils has been undertaken in parallel to the options assessment therefore the results of these investigations have not been considered in this assessment. To allow for this Aurecon has taken a conservative approach assuming a 60-70% contamination rate of excavated materials. The management and disposal of contaminated soils are governed by a Contaminated Site Management Plan (CSMP) which is developed for sites in advance of construction, detailing how the material is to be dealt with. Based on specific requirements in the plan additional costs may apply on top of land disposal rates. Omarunui Landfill have indicated that they have limits on the concentration of contaminants they can accept. If levels encountered on site exceed those accepted by the landfill this will require a different management approach, which would have an impact on the costs.
- **Market rates at time of tender**-the rates utilised do not take into account the market at the time this work goes to tender. The rates can be significantly different to competing tender submissions depending on factors such as:
  - Desire of contractor to win work, driving the contractor to submit a price that significantly undercuts their competitors.
  - Rates are calculated based on local knowledge and identified economies of scale in dealing with larger quantities.

9 Preliminary safety in design assessment

The purpose of safety in design (SiD) is to identify potential hazards with the aim to eliminate, isolate or minimise the risk of injury throughout the life cycle of the assets. This encompasses the design, construction, operation, maintenance and decommissioning of the infrastructure.

A preliminary SiD register has been developed for the high-level management options presented in this report, the full register is included in Appendix D. The residual risks, those identified as greater than moderate (high or extreme) following consideration of control measures, are summarised in **Table 26**.

The safety in design assessment is a live document and will be updated as the design progresses. It is recommended that a safety in design workshop is undertaken between the design staff and representatives from Ravensdown (including maintenance and operations staff) as the design develops.

Table 26: SiD residual risks

Risk #	Risk Source (Hazard)	Event / Cause / Consequence	Control Measure (Risk Treatment)	Residual Risk Rating
Construction and Commissioning Phase				
2.22	Deep open trenches/ excavations (all options)	• Risk of trench sides caving as a result of deep excavations e.g. construction of deep basins • Risk of machinery/people falling into the excavation as a result of trench collapse	• Construct benching for deep trenches where possible. • Use trench shields (for trenches >1.5m) • Observe safe distances between plant and unsupported trench edges • Actuated valves to allow pipes to be shallower have been considered. • Design ensures pipes are as shallow as possible • Follow process as identified in 2.11.	**High**
2.24	Working in deep trenches/ Excavations i.e. >1.5m (all options)	• Trench or excavation collapse • The site has a high Ground Water Level (GWL) therefore has an increased risk of groundwater entering the trench • During a rainfall event, water can enter trenches	• Use shields and bench excavations where required • Implement correct dewatering measures • Worksafe to be notified when undertaking notifiable works. • No personnel to be in trenches when dump trucks are in close proximity. • Ensure appropriate dewatering methodology is implemented when dewatering is required. • Remove the need for dewatering by backfilling trenches when heavy rainfall event is expected. • Where trenches meet the definition of a confined space, use confined space entry procedures (see 2.14)	**High**

10 Stormwater and process water treatment options assessment method

A multi-criteria decision analysis (MCDA) has been developed to compare options for treatment and discharge of stormwater and process water from the Ravensdown Napier site. The assessment undertaken at this stage and as part of this report will assist with:

- Determining whether any options are not viable and can be eliminated from further consideration and design development
- Comparing the stormwater and process water management options for the site to help with determining preferred alternatives which should be taken further in the engineering design process, to reach a final option.

It is relevant to note that this report represents a relatively early stage in identifying the stormwater and process water management options for the site. Three potential receiving environments have been identified, and there are several options in terms of treatment devices and trains which could be employed prior to discharging water to each of those environments. Due to the large number of feasible combinations the multi-criteria analysis has made assumptions about the treatment devices or treatment trains which will likely be used prior to discharge to any receiving environment. However, it is possible that the final option selected may choose a different combination from those represented here in order to meet specific objectives (e.g. specific water quality or discharge quantity requirements).

10.1 Project objective

The following project objective was determined for the MCDA process:

“To establish the most sustainable long-term solution for the treatment and discharge of stormwater and process water from the Ravensdown Napier Works to enable the continued operation of the site”.

This objective was agreed between the project team and the Technical Focus Group (TFG) of stakeholders convened to provide input on the project during a meeting on the 16 July 2021. Minutes of this discussion, including attendees, are provided in Appendix E.

10.2 Criteria selection

Ten assessment criteria grouped under the headings “Technical”, “Consenting and environmental”, “Financial” and “Stakeholder”, have been selected as representing the key attributes for the treatment and disposal system to be successful. The criteria were agreed during a technical workshop held on 6 May 2021. The assessment team present at that workshop included representatives from Ravensdown (Helen Hurring, Napier Consents Manager; and Andrew Torrens, Site Manager), Mitchell Daysh Ltd (Stephen Daysh and Anita Anderson, Planning), Aurecon (Anna Lindgren and David Delagarza, Stormwater Engineering; Helen Caley, Environmental Planning), PDP (Neil Thomas, Groundwater) and Streamlined Environmental (Ngaire Thomas, Estuarine and Marine Ecology).

The rationale for selection of the assessment criteria for the multi-criteria analysis is described in Table 27.

Table 27: Rationale for assessment criteria

	Criterion	Rationale for criterion selection
Technical	Land storage requirement	Some stormwater and process water treatment and management options (e.g. wetlands, irrigation to land) require a large amount of space. The treatment option selected must fit within the land area available. Unlike many existing and long-established sites, Ravensdown Napier has land within their property boundaries which is available for use for stormwater and process water treatment and management. However, using this space for stormwater and process water treatment and management will limit the potential for it to be used for other purposes (e.g. expansion or relocation of other site processes) in the future.
	Safety in design	Health and safety is a high priority for Ravensdown as an employer, and some design solutions have more inherent risks than others during construction and/or during operation and maintenance. The best strategy for health and safety is always to eliminate the risk entirely, as opposed to developing mitigation strategies.
	System / technological complexity and reliability	Many stormwater systems have variability in their performance. This can be due to many factors such as the variable volume and quality of stormwater; natural variability in biological processes due to factors such as weather conditions, time of year, temperature, and other factors. In addition, Ravensdown's site has an unusual combination of contaminants compared to many urban sites. This may require an unorthodox combination of treatment devices to manage the contaminant types and concentrations. Combining these stormwater devices in unorthodox ways and/or the atypical nature of the stormwater could reduce the certainty that the treatment train will be effective. Additionally,

		these non-standard contaminants may interact with each other and treatment technologies in an unforeseen manner. It is important that the treatment solution implemented is effective in order to meet stakeholder and regulator expectations, to meet environmental limits, and to provide a cost-effective solution for Ravensdown.
Consenting and environmental	Consistency with regional / national planning framework	In order for the site to continue to operate, a new discharge permit must be obtained. A discharge permit will be more easily obtained for a solution that is consistent with the regional and national planning framework. Consistency with the regional and national planning framework will also reduce time, costs and pressure of the resource consent process for both Ravensdown and the community. Some solutions may require additional consents, with varying levels of difficulty in obtaining them.
	Ability to meet receiving environment limits / guidelines	As part of Ravensdown's environmental responsibility, a key criterion for the treatment system's ability to consistently meet environmental limits / targets / guidelines.
	Future proof (climate / other unpredictability)	The site is located in an area that is susceptible to future changes, e.g. sea level rise, which could cause flooding / coastal inundation and alter groundwater levels, which could particularly affect structures in the coastal marine area. Future changes in climate and weather are likely to change rainfall depths and intensities. Changes to climate and weather could also alter how biological treatment systems function (e.g. the types of plants that can survive, temperature ranges for functioning etc). Beyond the physical factors, changing societal expectations may alter Ravensdown's social license to undertake discharge activities.
Financial	Capital cost	The financial cost of the initial construction of the stormwater and process water treatment and management system as well as the associated uncertainty in cost.

	Operational cost	The financial cost of the ongoing operation and maintenance of the stormwater and process water treatment and management system. This may include removal and disposal of secondary waste streams such as sludge or contaminated water remaining post-treatment.
Stakeholder	Mana Whenua values	The values of Mana Whenua need to be carefully considered due to the significance of the area to local iwi. Consideration of these values, including the emphasis placed on protecting "te mana o te wai" is also a key part of the RMA framework and national guidance.
	Other stakeholder considerations / concerns	The concerns and values of other stakeholders who live, work or use the area are also an important consideration when selecting the system.

10.3 Criteria scoring and weighting

The criteria have been assessed using a scoring of 1 (lowest score, poor option) to 5 (highest score, excellent option), with an option that is "middle of the road" or "average" in terms of that criterion scoring 3. For example, an option that is expected to have significant ecological effects would score 1 in that category, whereas an option expected to have few or no effects (or effects that can be mitigated) scoring 5.

At the time of this initial assessment the design of the treatment system and devices is at a relatively early stage. There are large ranges in potential costs for some devices, depending on the final design decisions made. For this reason, the scoring on the financial criteria have been undertaken relative to one another rather than strictly quantitatively. At this stage the assessment of operational costs has been undertaken based on engineering experience with similar sites.

An additional "not acceptable" (N/A) / "fatal flaw" category has been used where the score is considered so low it makes the option non-viable in that category, for example:

- An option that will have residual contaminant loads well beyond the water quality targets for the receiving environment.
- An option which stakeholder group(s) are fundamentally opposed to.
- An option that is not economically viable / unaffordable.
- An option which is not technically feasible for a site of this type.

Scores were reached by discussion and consensus.

The eight criteria relating to technical, environmental and consenting and cost were scored during a technical workshop held on 6 May 2021 (refer to section 10.2 for the group undertaking the scoring). The relative scoring of the technical, environmental and consenting and cost factors were updated to reflect discussions between the project team and NCC, and updated costings, on 13 July 2021.

The two remaining criteria represented stakeholder views. The Mana Whenua views were scored by representatives of the Mana Whenua groups on 14 July 2021. The final category, "other stakeholder concerns" was scored during the meeting of the TFG on 16 July 2021.The criteria have been weighted with a ranking between 1 (lower importance) and 3 (higher importance), as set out in Table 28. The summary table with scoring is included in Figure 21. The full assessment including more detailed descriptions of the reasons for the scoring of each category is included in Appendix F.

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Table 28: Rationale for assessment criteria scoring and weighting

	Criterion	Notes to scoring	Notes to weighting
Technical	Land storage requirement	Increased land area requirement will limit other uses of Ravensdown's site. Scores have been given relative to one another. The land area used by the existing system has been considered to be the baseline (best rating). An N/A rating would be given to an option which cannot be accommodated within the available land owned by Ravensdown.	**Weighting: 1** This has been rated as a lower importance score because while it is a consideration for Ravensdown, it does not affect the environment or community beyond the site boundary. Furthermore, Ravensdown do have some space available.
	Safety in design	Both construction and ongoing risks should be considered in the rating. An N/A rating would be given to an option with high risks that cannot be managed or mitigated.	**Weighting: 2** This has been rated as being of moderate importance due to the requirements of legislation and Ravensdown's desire to keep its people and the community safe. However, any options with unacceptably high health and safety risks would be rated "fatal flaw".
	System / technological complexity and reliability	Considerations include: • number of devices required • whether the technology is currently available and tried/tested for a site of this type • the technological complexity of the devices proposed	**Weighting: 2** In order to meet the desired outcomes for the project it is desirable to have a system that functions effectively. This attribute has not been given the highest rating to avoid valuing certainty of outcome over the system performance (i.e. the existing treatment pond has a known performance, but it is considered more important that a higher level of treatment is achieved).
Consenting and environmental	Consistency with regional / national planning framework	Considered based on comparison to national and regional planning instruments. An N/A rating would be an option considered unable to be supported to obtain a resource consent.	**Weighting: 3** An option that does not meet national / regional planning direction is unlikely to obtain approval and be able to move forward to construction.
	Ability to meet receiving environment limits / guidelines	Consideration of factors such as: • compliance with relevant water quality standards / targets / guidelines (including dilution available) • sensitivity of the receiving ecosystem • impacts on the biophysical environment in which the ecosystem exists • life supporting capacity of soil and water	**Weighting: 3** This is weighted highly due to Ravensdown's organisational values as well as community expectations.
	Future proof (climate / other unpredictability)	The site is susceptible to potential future changes. Scoring this criterion has considered factors such as: • certainty of future availability of the solution proposed (e.g. reliance on existing consents held by others) • certainty of community acceptance / "social licence" for activity going forward, considering potential changes in societal views or norms • robustness of solution in the face of changing weather and climate patterns and variability	**Weighting: 2** This factor has been given a moderate rating because there are many potential changes and perturbations relevant to this site due to its coastal location. However this has not been scored 3 due to the level of uncertainty in predicting effects in this category.
Financial	Capital cost	At the time of this initial assessment the design is at an early stage and therefore there are a number of assumptions made. This means that some cost estimates are variable depending on the real world findings (e.g. the amount of soil which needs to be disposed of off-site to landfill during construction and whether that material is contaminated). Options that have lower certainty around the likely cost have been scored lower than an option with a similar median cost but higher certainty around costs. At this stage Ravensdown have not advised what cost range is not acceptable in terms of the capital cost.	**Weighting: 2** This factor has been scored as being of moderate importance as Ravensdown recognise the need for investment to reach a good outcome across other criteria, and there is a need to balance business and environmental sustainability. However, Ravensdown are a significant company for New Zealand primary industries, and a significant employer for the Napier area therefore the financial viability of the site is also important.
	Operational cost	The ongoing operational costs are also an important consideration. All water management systems will have an ongoing operational requirement. At this stage Ravensdown have not advised what cost range is not acceptable in terms of the operational costs.	**Weighting: 2** This factor has been scored as being of moderate importance as Ravensdown recognise the need for investment to reach a good outcome across other criteria. However, Ravensdown are a significant company for New Zealand primary industries, and a significant employer for the Napier area therefore the financial viability of the site is also important.
Stakeholder	Mana Whenua values	Assessment undertaken by Mana Whenua.	**Weighting: 3** This weighting recognises the importance of the Awatoto and Waitangi Estuary areas for iwi. It also acknowledges the value of kaitiakitanga, and other matters set out in sections 6, 7 and 8 of the RMA. This weighting also recognises the emphasis placed on protecting Te Mana o te Wai in national guidance documents relating to freshwater.
	Other stakeholder considerations / concerns	Assessment undertaken by stakeholders.	**Weighting: 2** This weighting recognises the value of the area for stakeholders including the requirement to protect the local aquifer for drinking supply, as well as significance for aesthetic and recreational purposes.

Figure 21 Scoring of MCA matrix

		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land / Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total Score*
Criteria Weighting [4] 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
Tūtaekurī River / Waitangi Estuary	**Option 1a: Status quo**	5	4	4	0	0	2	5	4	0	1	46
	Option1b: Wetland treatment train	3	3	1	4	3	3	1	2	2	3	59
	Option 1c: Membrane filter plant	4	4	3	5	5	2	0	1	1	1	60
Hawke Bay	**Option 2a: Discharge via NCC WWTP outfall (sea outfall pipe)**	1	4	3	2	5	1	4	3	3	3	70
	Option 2b: Ravensdown site-specific sea outfall	3	2	3	3	4	2	2	2	4	2	64
Land	**Option 3a: Spray irrigation Pre-treatment+ spray irrigation**	1	4	4	0	4	3	3	3	2	3	62
	Option 3b: Soakage and rapid infiltration Pre-treatment + soakage/ rapid infiltration	4	4	4	0	4	3	3	4	2	2	64
Combination of options	**Option 4: Split of high and low risk contaminant areas Split flow to NCC stormwater and/or trade waste infrastructure and treatment train**	3	3	2	4	4	3	3	3	4	5	82

10.4 Preferred outcome

Based on the MCDA process the “status quo” was considered not acceptable or to have a “fatal flaw” across three categories (consistency with planning framework, ability to meet receiving environment limits, and mana whenua values) and is unlikely to be viable.

Three other options were given a 0 score in one category. The cost of the membrane filter option was considered unacceptable and the TFG members also had concerns about the sustainability of this option due to the waste which would need to be managed from the process, and the energy use of this option.

The discharge to land options were also given a 0 score in the “consistency with planning framework” category based on the fact that the site is located in the Napier Source Protection Zone. In terms of the planning framework itself, this location does not make discharge to land prohibited. However, written feedback was received from NCC advising that they would not support a discharge to land option due to this Source Protection Zone. Despite this, the mana whenua and TFG members in their discussions noted that many regulatory authorities view discharges to land as preferable to discharge to water, and recommended that the technical viability of discharge to land be fully investigated, particularly for stormwater from parts of the site with lower contaminant loads. Regarding the discharge to land options, the mana whenua parties preferred discharge to the marine environment as they considered that Tangaroa has a better ability to assimilate contaminants than Papatūānuku in this instance.

Based on the scoring, the preferred option was for a “combination of treatment options”, with the opportunity to discharge both to land and the Tūtaekurī River/Waitangi Estuary, and with the possibility of a future discharge to the marine environment (e.g. via the NCC outfall) if necessary to manage any stormwater and process water with elevated levels of particular contaminants and meet water quality expectations. This combination option will manage the stormwater and process water from different parts of the site differently, treating the specific contaminants as close to their source as possible. This was viewed as the most appropriate management method by the TFG. Further investigation is underway to confirm whether discharge of some stormwater and process water onto land is technically viable, and any adverse effects on the Napier Source Protection Zone are avoided.

The proposed treatment devices, management of different stormwater catchments of the site and most suitable locations for this option are outlined in the Project Description documentation.

Regardless of the option, mana whenua and stakeholders expect that contaminant concentrations in the discharge will be reduced over time through improved source control. Ravensdown also propose to commit to a habitat abundance project in the Tūtaekurī River/Waitangi Estuary area through a partnership with Stakeholders and the HBRC.

11 Conclusions

This report has been prepared to assist Ravensdown with assessing the options for the management of stormwater and process water from their existing fertiliser plant in Awatoto, Napier. Ravensdown recognise the need to make changes to their existing stormwater management to meet regulatory and community expectations.

This assessment has considered discharge to three different receiving environments – surface water within the Tūtaekurī River/Waitangi Estuary, the marine environment of Hawke Bay, and discharge to land. Each of these environments has different requirements around the level of treatment to remove contaminants before discharge.

The assessment has considered different options for discharge to each of these environments. The high-level feasibility, benefits, constraints, safety risks and costs for each option have been considered. These factors have fed into a MCDA which has incorporated feedback from a variety of stakeholders from the community, including Mana Whenua.

Based on the MCDA assessment, continuing with the status quo is not considered to be viable. NCC have also communicated their concern about any discharge to land due to the site's location in the Napier drinking water source protection zone. However, the TFG did prefer a discharge to land option so more investigation of the technical feasibility of this is underway. Overall, the preferred option was a combination of options.

The details of the proposed treatment system need to be developed further as part of the detailed design after the discharge permit has been granted. The development of the detailed design will require technical information to confirm whether discharge onto Ravensdown's land is feasible, and to confirm the actual sources and loads of contaminants from each catchment within the site to help fine tune the treatment options.

The concept design and project strategy should consider the project risks going forward. In particular, the discharge permit assessment and conditions of consent must recognise the limitations in the estimates of the treatment performance of the stormwater system, and the ability of any stormwater system with biological components to meet water quality requirements 100% of the time.

A key component of the stormwater and process water management strategy going forward will be source control, through using non-structural and structural measures to avoid contamination of stormwater in the first place. This will meet Mana Whenua expectations, as well as providing the best value for money for Ravensdown, and improved environmental outcomes.

Appendix A

Existing discharge permit (DP040143Wa/ AUTH-114016-02)

Hawke's Bay Regional Council +
159 Dalton Street
Private Bag 6006
Napier, New Zealand
Tel 06 835 9200 +
Fax 06 835 3601
Freephone 0800 108 838
www.hbrc.govt.nz +

Our Ref: DP040143Wa

14th October 2013

Ravensdown Fertiliser Co-operative
Private Bag 6012
Hawke's Bay Mail Centre
Napier 4142

Dear Sir / Madam

NOTIFICATION OF DECISION

The Regional Council has reviewed your resource consent, under sections 128-132 of the Resource Management Act. A copy of the revised consent document is enclosed.

Your resource consent is an important legal document which you should keep as a permanent record. It is important that you read your consent and understand the conditions that the Council has imposed. It is your responsibility as the consent holder to adhere to those conditions.

Check your consent document thoroughly, if any information is wrong you must advise us within 15 working days, we will be able to address any minor mistakes within 15 working days at no cost, if you do not advise us within 15 working days, and there is a mistake, a change to consent conditions and costs will apply for any corrections.

Costs

The Council will calculate the final cost of processing your application and will send a separate invoice if the total cost exceeds the deposit you have paid, or will refund any money owning.

All costs incurred by the Hawke's Bay Regional Council as a result of the collection of any debt relating to the processing of this application, and monitoring of the consent, shall be borne by the consent holder. Council reserves the right to produce this document, and any other relevant information, in support of any claim.

Processing Time

The timeframes for processing this review were extended under s.37A of the RMA. This extension was with your approval.

Objection and Appeal Provisions

If you are not satisfied with any aspect of this decision you can make a formal objection, in writing to the Council within 15 working days of receiving this notification. If following this objection process you are still not satisfied with the decision, you may appeal to the

Environment Court. Note that you cannot exercise your consent until any objection or appeal is resolved.

If you have any questions or wish to discuss any aspect of your consent or the objection/appeal provisions please contact the consents officer who processed your application in the first instance.

Yours faithfully

Malcolm Miller
Manager Consents
RESOURCE MANAGEMENT GROUP

General Advice Notes

1. In accordance with Section 36 of the Resource Management Act 1991, resource consent applicants are responsible for paying costs relating to receiving, processing and granting resource consents. The total amount payable will be communicated to you as soon as practicable. Any deposit already paid will be deducted from the total cost.

2. In accordance with Section 36 of the Resource Management Act 1991 and the Council's Annual Plan, Council's reasonable administration, supervision and monitoring costs, including the cost of any inspections and costs associated with collection, analysis interpretation and reporting of any data reasonably required to monitor compliance with consent conditions or the impact of this consent on the environment, shall be met by the consent holder.

3. Where a resource consent has been issued for any type of construction (e.g. dam, bridge, jetty) this consent does not constitute authority to build and it may be necessary for you to apply for a Building Consent from the relevant territorial authority.

4. This consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.

5. The permit is transferable to another owner or occupier of the land concerned, upon application, on the same conditions and for the same use as originally granted (s.134-137 RMA).

6. The consent holder may apply to change the conditions of the consent (except for the duration) (s.127 RMA).

7. Any person carrying out activities allowed by this consent, either with the explicit or implied permission of the consent holder, must do so as if the resource consent had been granted to that person as well as the holder of the consent. The consent holder is advised to inform those persons of the consent conditions, as any action by or cost to this Council resulting from non-compliance with the consent conditions will be directed to the consent holder (s.3A RMA).

8. Any enforcement officer, having written authority from the Council, may at all reasonable times go on, into, under, or over any place or structure (except a dwelling/house) for the purposes of inspection and taking samples to determine compliance with the consent conditions (s.332 RMA).

9. In accordance with Section 116(1AB) of the Resource Management Act 1991, if an objection has been made on this consent, the resource consent commences when the objection has been decided or withdrawn. If no objection has been made the consent commences on the date that the decision is notified under section 114 of the Resource Management Act 1991, or on a later date if this date is stated in the resource consent.

10. As the consent holder it is your responsibility to inform the Hawke's Bay Regional Council's Consents section of any change to your contact details. Upon any sale of the property, you must apply for your resource consent to be transferred. **Transfers are unable to be facilitated through the rates information that this Council holds.**

HAWKE'S BAY
REGIONAL COUNCIL

RESOURCE CONSENT

Discharge Permit

In accordance with the provisions of the Resource Management Act 1991, and subject to the attached conditions, Hawke's Bay Regional Council (the Council) grants a resource consent for a discretionary activity to:

Ravensdown Fertiliser Co-operative
Private Bag 6012
Hawke's Bay Mail Centre
Napier 4142

to discharge contaminants into water for the purpose of disposing of stormwater, cooling water from air compressors and a hydraulic drive, water from drinking fountains and a truck wash, water from cooling towers and high pressure boilers, and rinse water from a boiler water treatment plant into the Tutaekuri River (Waitangi Estuary).

LOCATION

Address of site:	808 Waitangi Road, Awatoto
Legal description:	Secs 26,44, Pt Section 32, 43, Lot 4, DP 8546 & Closed Road, Blk I, Clive SD.
Map reference:	V21: E2846961 N6175494

CONSENT DURATION

This consent is granted for a period expiring on 31 May 2022.

Malcolm Miller
Manager Consents
RESOURCE MANAGEMENT GROUP
Under authority delegated by Hawke's Bay Regional Council
14th October 2013

This consent was originally granted on 22nd March 2007, and subsequently changed in accordance with s128 of the RMA, see consent history page 8.

CONDITIONS

1. All works and structures relating to this resource consent shall be designed and constructed to conform to the best engineering practices and at all times maintained to a safe and serviceable standard.

2. The consent holder shall undertake all operations in accordance with any drawings, specifications, statements of intent and other information supplied as part of the application for this resource consent. If a conflict arises between any conditions of this consent and the application, the conditions of this consent will prevail.

3. For the purposes of this consent, the zone of reasonable mixing of the discharge, to which the Class AE (HB) receiving water quality standards does not apply, shall be the Ravensdown Drain and 90 m down the Awatoto Drain (GPS Co-ordinates N6175341, E2846875).

4. The consent holder shall ensure that the discharge complies with the following standards at the outlet of the settling pond, as shown on Figure 3 submitted with the application and attached:

   a) pH to be within 6.5 – 8.5.

   b) Fluoride not to exceed 30 mg/litre.

   c) Suspended Solids not to exceed 100 mg/litre.

   d) Rate of discharge not to exceed 265 litres /second.

   e) Total phosphorus:

   From the date of the commencement of this consent until 30 June 2012:

   - Over any 12 month period the concentration of total phosphorus shall not exceed 35 mg/litre for more than 95% of the time;
   - Over any 12 month period the concentration of total phosphorus shall not exceed 40 mg/litre for more than 99% of the time.

   From the 1st of July 2012:

   - Over any 12 month period the concentration of total phosphorus shall not exceed 17 mg/litre for more than 95% of the time;
   - Over any 12 month period the concentration of total phosphorus shall not exceed 22 mg/litre for more than 99% of the time.

   f) Soluble Reactive Phosphorus:

   From the date of the commencement of this consent until 30 June 2012:

   - Over any 12 month period the concentration of soluble reactive phosphorus shall not exceed 30 mg/litre for more than 95% of the time;
   - Over any 12 month period the concentration of soluble reactive phosphorus shall not exceed 35 mg/litre for more than 99% of the time.

   From the 1st of July 2012:

- Over any 12 month period the concentration of soluble reactive phosphorus shall not exceed 15 mg/litre for more than 95% of the time;
- Over any 12 month period the concentration of soluble reactive phosphorus shall not exceed 20 mg/litre for more than 99% of the time.

5. The consent holder shall carry out the following monitoring programme at the consent holders expense:

   a) A sampling station shall be maintained at the outlet of the settlement pond and be accessible to the Council officers, or its agents at all times.

   b) A representative, flow-proportional, composite sample (sampled continuously over a period of 24 hours) shall be collected from the sampling station, referred to in Condition 5a, at least once per week and tested for the following parameters:

      i) pH;

      ii) total phosphorus;

      iii) soluble reactive phosphorus;

      iv) fluoride;

      v) suspended solids

   Results shall be recorded on a mass per unit volume of discharge basis and the volume of discharge shall also be recorded. The records shall be forwarded to the Council at monthly intervals, along with an assessment of compliance against condition 4.

   c) A representative, flow-proportional, composite sample (sampled continuously over a period of one week) shall be collected from the sampling station, referred to in Condition 5a, at six monthly intervals and tested for the following parameters:

      i) total copper

      ii) total zinc

      iii) total cadmium

      iv) total chrome

      v) total aluminium

      vi) total sulphur

   Results shall be taken on a mass per unit volume of discharge basis and the volume of discharge taken shall also be recorded. The records shall be forwarded to the Council at six monthly intervals.

   d) All sampling and surveys shall be carried out by a person suitably qualified and experienced in this field and authorised by the Council (Manager: Regulation).

   e) All analyses in accordance with conditions of this consent shall be carried out by an independently IANZ accredited laboratory and authorised by the Council (Manager: Regulation).

f) The consent holder shall calibrate and operate any meters required for monitoring in accordance with the manufacturer's specifications, or to the reasonable satisfaction of the Chief Executive of the Hawke's Bay Regional Council.

6. Every fourth year starting from the commencement of this consent, the consent holder shall monitor the following components in the receiving environment at their expense:

a) the structure of macrofaunal communities to determine both temporal and spatial changes in the community composition. Species diversity, richness, abundance and evenness shall be determined for the benthic macrofauna, and data should be subjected to appropriate multi-variate analyses in relations to chemical and physical measurements.

b) sediment quality to determine sediment health, and potential accumulation of contaminants within the sediments.

Sediments should be analysed for:

- total copper
- total cadmium
- total chromium
- total zinc
- fluoride
- total phosphorus
- sulphur
- sediment composition
- nickel

Metal	**Detection Limit**
Total Copper	2 mg/kg (screen)
Total Cadmium	0.1 mg/kg (screen)
Total Chromium	2 mg/kg (screen)
Total Zinc	4 mg/kg (screen)
Total Mercury	0.1 mg/kg (screen)
Total Nickel	2 mg/kg (screen)

c) Cancelled.

d) chlorophyll a concentrations as an indicator of potential nutrient enrichment.

e) presence/absence of fish species.

f) periphyton biomass and taxonomy as an indicator of potential nutrient enrichment.

g) undertake Whole Effluent Toxicity Testing to determine the effects of the combined discharge on organisms in the receiving environment on three test species at 100: 1 dilution.

h) Every month[1], starting from the commencement date of this consent, the consent holder shall monitor, at their expense, at the locations indicated by a green star in Appendix 2, receiving water quality to determine whether contaminants of concern are present and in what concentrations.

Receiving water should be analysed for:

- Temperature
- Salinity
- Dissolved oxygen
- pH
- Suspended Solids
- Chlorophyll a
- Ammoniacal Nitrogen
- Nitrate Nitrogen
- Nitrite Nitrogen
- Nitrate + Nitrite Nitrogen
- Total Nitrogen
- SRP
- TP
- Sulphur
- Fluoride
- Metals (Al, Cd, Cr, Cu, Zn and Ni)

Metal	**Detection Limit**
Aluminium	0.003 mg/L (trace)
Cadmium	0.00005 mg/L (trace)
Chromium	0.0005 mg/l (trace)
Copper	0.0005 mg/l (trace)
Zinc	0.001 mg/l (trace)
Mercury	0.00008 mg/l (trace)
Nickel	0.0005 mg/l (trace)

[1]For the avoidance of doubt it is acknowledged that monitoring can only occur when there is flow present in the Waitangi Drain. If there is no or very low flows in Waitangi Drain the consent holder must inform the Council (Manager Resource Use) that they have been unable to undertake the required sampling as soon as practicable, and within 7 days of trying to undertake the sampling. Evidence (eg. photos of flows in the drain at the time) should be provided to confirm this.

i) Each year, on two occasions (one during either January or February, and one during June, July or August) the consent holder shall monitor stormwater discharged in the "first flush" of a rainfall event. Samples shall be taken at the locations indicated by a red star in Appendix 2 and analysed for the same contaminants and at the same detection limits as specified in condition 6 (h) except for chlorophyll a which samples do not need to be analysed for.

7. The consent holder shall submit a monitoring program, designed to meet the requirements of Condition 6, to the satisfaction of the Council (Manager: Environmental Regulation), prior to the receiving environment monitoring occurring in accordance with Condition 7.

8. Within three months of the receiving environment monitoring taking place in accordance with Condition 7, the consent holder shall submit a report to the Hawke's Bay Regional Council detailing results and analysis of the monitoring, and a summary of conclusions.

9. The consent holder shall prepare an annual report for the period of July to June each year, and before 31 October submit it to the Hawke's Bay Regional Council. The report shall summarise monitoring and compliance to the consent conditions and discuss any non-compliance and recommended necessary actions to achieve compliance.

Advice Note

1. For the avoidance of doubt, a monitoring program detailing how monthly monitoring of receiving water quality will be undertaken, must be submitted to the Council (Manager: Regulation) prior to the water quality monitoring commencing.

2. With regards to Condition 6 (i), 'the first flush' is considered to occur within the first hour of a discharge commencing, and is preferably within the first 30 minutes of the discharge commencing.

Review of Consent Conditions by the Council

The Council may review conditions of this consent pursuant to sections 128, 129, 130, 131 and 132 of the Resource Management Act 1991. The actual and reasonable costs of any review undertaken will be charged to the consent holder, in accordance with s.36(1) of the Resource Management Act.

Times of service of notice of any review: During the month of May in any year.

Purposes of review:

To deal with any adverse effect on the environment that may arise from the exercise of this consent, which it is appropriate to deal with at that time or which became evident after the date of issue.

To require the adoption of the best practicable option to remove or reduce any effects on the environment.

To modify any monitoring programme (including potentially decreasing the frequency of monitoring required by conditions 6(h) and 6(i)), or to require additional monitoring if there is evidence that current monitoring requirements are inappropriate or inadequate.

Reasons for Decision

The reasons for granting the consent, including the plans, policies and any other statutory provisions that were considered, are in the application report enclosed with this document. Specific reasons for each condition of this consent are set out in Appendix 1.

Monitoring Note

Routine monitoring

Routine monitoring inspections will be undertaken by Council officers at a frequency of no more than twice every year to check compliance with the conditions of the consent. The costs of **any** routine monitoring will be charged to the consent holder in accordance with the Council's Annual Plan of the time.

Non-routine monitoring

"Non routine" monitoring will be undertaken if there is cause to consider (e.g. following a complaint from the public, or routine monitoring) that the consent holder is in breach of the conditions of this consent. The cost of non-routine monitoring will be charged to the consent holder in the event that non-compliance with conditions is determined, or if the consent holder is deemed not to be fulfilling the obligations specified in section 17(1) of the Resource Management Act 1991 (RMA) shown below.

Section 17(1) of the RMA 1991 states:

Every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of the person, whether or not the activity is carried on in accordance with

a) any of sections 10, 10A, 10B, and 20A; or

b) a national environmental standard, a rule, a resource consent, or a designation.

Consent Impact Monitoring

In accordance with section 36 of the RMA (which includes the requirement to consult with the consent holder) the Council may levy additional charges for the cost of monitoring the environmental effects of this consent, either in isolation or in combination with other nearby consents. Any such charge would generally be set through the Council's Annual Plan process.

DEBT RECOVERY

It is agreed by the consent holder that it is a term of the granting of this resource consent that all costs incurred by the Hawke's Bay Regional Council for, and incidental to, the collection of any debt relating to the monitoring of this resource consent shall be borne by the consent holder as a debt due to the Council, and for that purpose the Council reserves the right to produce this document in support of any claim for recovery.

CONSENT HISTORY

Consent No. (Version)	Date	Event	Relevant Rule Number	Plan
DP040143W	11/06/2007	Consent initially granted	Rule 52	Proposed Regional Resource Management Plan as at February 2005
DP040143Wa	14/10/2013	Consent reviewed. Conditions 6 (h) and (i) added, condition 9 modified, advice notes added and one review clause altered	Section 128	Resource Management Act

APPENDIX 1: CONSENT CONDITION ANALYSIS

CONDITION No.	CONDITION TITLE	DETERMINATION OF COMPLIANCE	REASONS FOR CONDITION	Reason for Limit
1.	Best engineering practice	inspection by Council officers.	Proper construction and maintenance is crucial to the performance of stormwater systems.	N/A
2.	In accordance with the application	Inspection by Council officers	The actual and potential effects of the discharge were assessed on the basis of the activity applied for. Should a different activity be undertaken, there might be unforeseen adverse effects.	N/A
3.	Mixing zone	Sampling by Council officers	To allow for the initial dilution of the discharge, without compromising the receiving water body as a whole.	The mixing zone has been defined to ensure that other constituent parts of the discharge (eg. metals) do not exceed guideline criteria outside of this zone.
4.	Discharge standards for - pH, Fluoride, suspended solids, total phosphorus & soluble reactive phosphorus.	Inspections of monitoring results by Council officers. Condition 5.	All these contaminants have the potential to result in significant adverse effects within the receiving environment.	Information provided by the Council scientists.
5.	Discharge monitoring	Inspections of report by Councils officers	To ensure compliance with condition 4.	N/A
6.	Receiving environment monitoring	Inspections of report by Councils officers	To assess whether the discharge is resulting in any adverse effects within the receiving environment.	Four years is considered reasonable without being to onerous on the applicant
7.	Monitoring program approval	Approval letter gained from the Council.	To ensure the monitoring programme will enable valid conclusions to be made re. the components outlined in Condition 6.	N/A
8.	Receiving environment monitoring	Report provided by the date	To identify if the effects the discharge if having, if any, on the receiving	N/A

CONDITION No.	CONDITION TITLE	DETERMINATION OF COMPLIANCE	REASONS FOR CONDITION	Reason for Limit
	report		environment.	
9.	Annual Report	Report provided by the date	To check compliance with consent conditions	Annual reporting is generally reasonable, without being to onerous on the applicant.

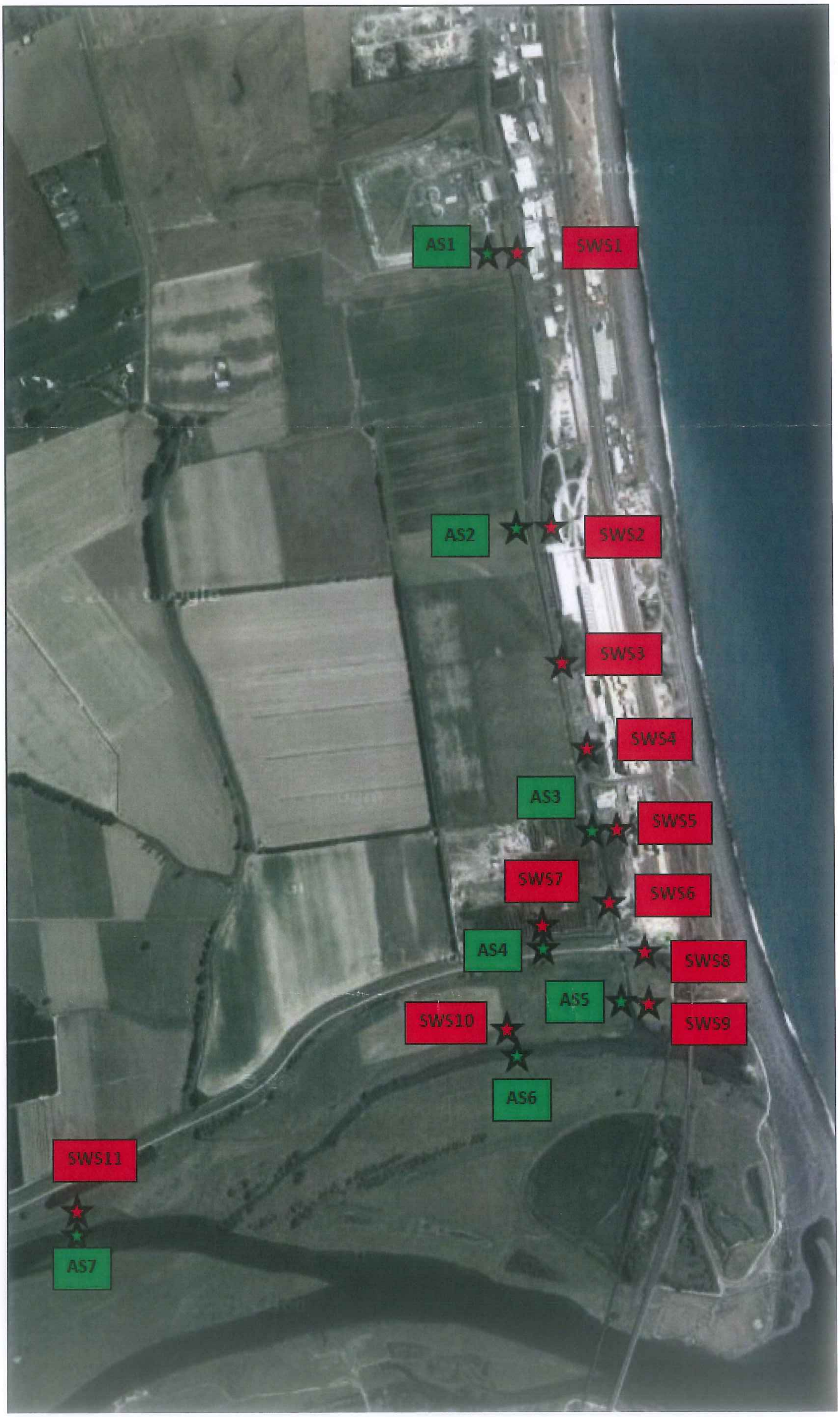
Figure 3: Aerial Photgraph
Location of Facilities/Services

Scale: approx 1: 10,000@ A4
Date: May 2004

Drawing No: 8214RAV-0A3
Sheet No. 3 of 3
Sheets

GLASSON POTTS FOWLER
6 Linton St, PO Box 562 Palmerston North, New Zealand
Ph (06) 354-4501 Fax (06)354-4516 Email:pn@gpll.co.nz

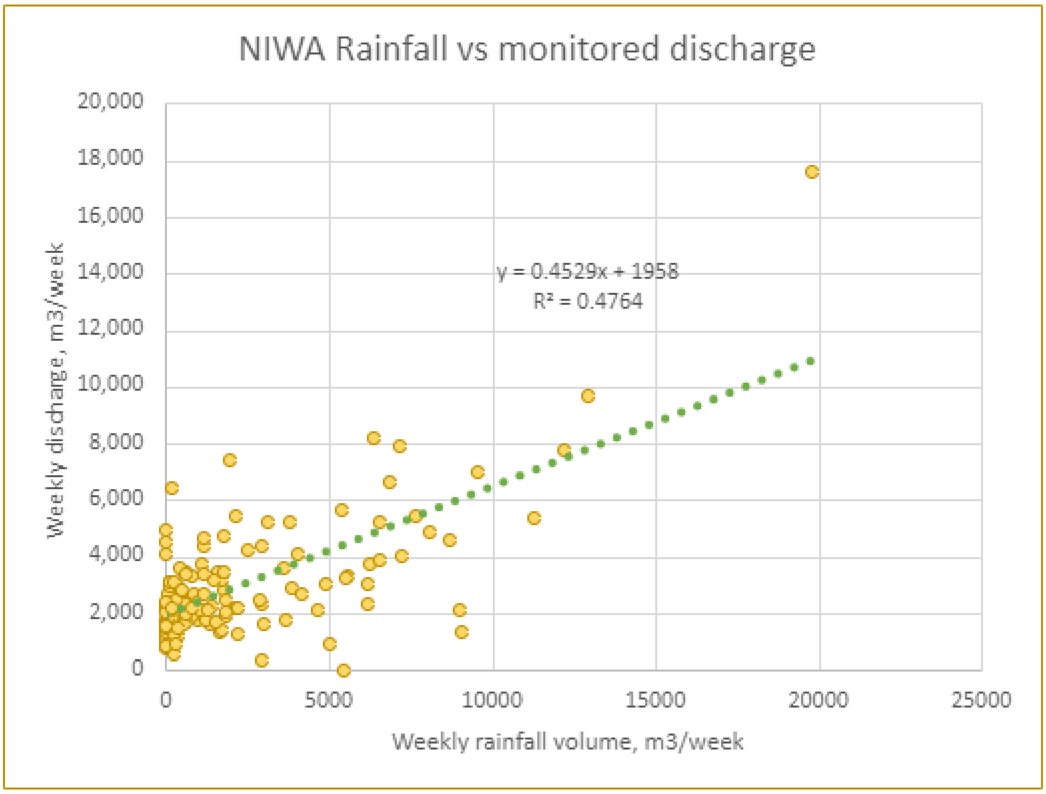
APPENDIX 2. LOCATION OF SAMPLING POINTS



Appendix B
Rainfall and discharge relationship

In order to calculate sizing of stormwater treatment devices accurately, it was important to determine the volume of discharge that would be present on site. This began with finding the relationship between the current monitored discharge from the settling pond and the rainfall data supplied by NIWA.

The rainfall data was provided as daily rainfall, however, the Ravensdown discharge was recorded in weekly periods. Thus, the first step was to match the daily rainfall information with the corresponding discharge monitored on site. Completing this gave a coefficient of 0.45.



From here, this relationship was used to determine the infiltration rate for the site and base weekly flow rate of approximately 2,000 m³/week.

The sizing of the treatment devices was designed based on the weekly base flow plus the extreme rain event. In this case the rain event design was for 25 mm across the site.

Appendix C

Summary of sizing calculations, rates development and cost estimates

Note: Only calculation for 60/40 (40% clean) soil split presented

SCHEDULE OF QUANTITIES - FOR PRICING						
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS						
OPTION 1B: TREATMENT TRAIN BUNDED - SETTLING POND, WETLAND, INFILTRATION BASIN						

Option Description:

A treatment train is the combination of stormwater management devices that treat water sequentially to deliver the target quality or quantity of stormwater. Each device can target different contaminants, the order of which is strategically selected to maximise removal efficiency. When considering the contaminants present within the dischargeable water, the order as followed is a potential treatment train option for the Ravensdown Awatoto site:

1. Settling pond
2. Wetland
3. Bioretention basin
4. Media filter

This option looks at completeing this Treatment Train option with bunding onsite utilising the excavated materials, assuming they are suitable as fill, and contaminated so requiring encapsulation. The high level calcs for this assume that the excavated material is equal to the amount needed for the bunding. The excavation does exceed the amount required for the bunding and therefore this excess is to be taken from site. Assumed 60% of excavated cut is contaminated within the boundaries of the site, 40% estimated as clean of the excess. We have made variations of this 60/40 split for the costings estimate.

Allowance for physical works only. Excludes; consenting, liaison, professional fees, modelling, etc which can add significant costs.

		Unit	Qty	Rate	Amount	High Level Costing Comments
1.00	**Preliminary & General**					
1.01	Allow for all items to meet the contractors obligations	LS	1	$ 675,400.00	$ 675,400.00	Rate is calculated as 12% of construction works costs (this includes subtotals 3 to 6, excluding P&G and ESC)
	Preliminary & General subtotal				**$ 675,400.00**	
2.00	**Erosion and Sediment Control**					
2.01	Produce HBRC approved Erosion and Sediment Control Plan and implement these according to the requirements	LS	1	$ 58,400	$ 58,400	Rate is calculated by comparing to the Hornby ESC cost ($42k) to the SW Basins Civil contract works area for all 3 basins and infrastructure (roughly 13,900m2 area). This works out to be about $3 per meter square. The area for Awatoto is measured to include all the working area as 32,210m2. Contractor 'per m2' cost likely to be smaller based on economy of scale, and local condition of site. We have applied 60% of $3 per m2, which equates to $1.81 per m2, as this seems more reasonable.
	Erosion and Sediment Control subtotal				**$ 58,400.00**	
3.00	**Stormwater Treatment Train Earthworks with bunding**					
3.01	Cost to carryout general works required for the storage basin (includes items such as clearance, geosynthetic clay liner etc, and resurfacing)	LS	1	$ 1,442,620	$ 1,442,620.07	Rate is calculated based on the total earthworks cost of Hornby basin 1 (720m3) which works out to $179.34 per unit m3. Proposed Settling pond to be 8045 m3. Cost encompasses: 3.07-3.17 from Hornby spreadhseet and 100mm top soil and cut soil.
3.02	Excavation from basin areas to **form soil encapsulated bunds**. Includes onsite cartage, stockpiling, placement of contaminated material, supply and install of HDPE liner and all works necessary to meet the encapsulation requirements and achieve bund stability.	m3	2555	$ 120.00	$ 306,619.84	Rate is calculated from Hornby SP3 Soil Encapsulation of contaminated materials.
3.03	Cut to waste of contaminated soils (incl. topsoil) include excavation, stockpiling, contaminant sampling, carting to specialised landfill (Omarunui landfill) and disposal costs. Based on 60% of the basin excavated total being contaminated.	ton	1659	$ 254	$ 422,104	Rate is calculated based on Omarunui Landfill fixed dump fees for "Special Waste" noted at a minimum charge of $179.40 per tonne, this may be larger as waste from Ravensdown is classified as out of Hastings District. An estimated $75 for excavation, stockpiling with overheads and profit have been added. Note that the $75 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. https://www.hastingsdc.govt.nz/services/rubbish-and-recycling/omarunui-landfill/fees-and-charges/
3.04	Cut to waste of 'clean' soils include excavation, stockpiling, contaminant sampling, carting to NCC cleanfill site and disposal costs. Based on 40% of the basin excavated total being classed as clean.	ton	1106	$ 192	$ 212,214	Rate is calculated based on Omarunui Landfill fixed dump fees for standard refuse "in Hastings District" noted as $136.85 per tonne on site. An estimated $55 for excavation, stockpiling, overheads and profit have been added. Note that the $55 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. This is assuming that all remaining excavated soils are needing to be removed from site. There could be some significant cost savings here if they were able to utilise/keep site won material on site.
3.05	Dewatering (using spears). Cost includes setup and pack down of equipment	LS	1	$ 208,412	$ 208,412	Rate is calculated based on 1 days assumed.
	Storage Pond Earthworks subtotal				**$ 2,591,969.75**	
4.00	**Stormwater Treatment Train Infrastructure**					
4.01	Cost to install infrastructure for storage pond (costs of pumps and electrical control system included in electrical and mechanical)	LS	1	$ 1,668,899.22	$ 1,668,899.22	Rate is calculated based on Hornby basin 1 (720m3) which works out to $207.47 per m3.
	Settling pond Infrastructure subtotal				**$ 1,668,899.22**	
5.00	**Electrical and Mechanical Works**					
5.01	Process equipment, instrumentation, mechanical, piping, electrication and automation	LS	1	$ 139,162.08	$ 139,162.08	Rate is calculated based on cost of Hornby basin 1 electrical works (720m3) which works out to $17.30 per unit m3.
	Electrical and Mechanical subtotal				**$ 139,162.08**	
6.00	**Landscaping Works**					
6.01	Landscaping works include the supply and install of items such as matting, planting, bark mulch, fencing, a year of maintenance and reinstatement of surfaces	LS	1	$ 1,227,763.47	$ 1,227,763.47	Rate is calculated based on cost of Hornby basin 1 landscape works (720m3) which works out to $152.63 per unit m3. This is then applied to the total excavated volume for this project.
	Landscaping Works Subtotal				**$ 1,227,763.47**	
	Construction Works Total				**$ 6,361,594.51**	
	Contingency 20%				**$ 1,272,318.90**	
	High Level CAPEX Total				**$ 7,634,000.00**	

	CAPEX AND 35 YEARS OPEX	**$ 9,268,000**

OPTION 1B: TREATMENT TRAIN BUNDED

Bunding calculations

Design Parameters

whole site volume	8044	m3	on costing spreadsheet
wetland volume size	2859	m3	half will be excavated and half will be bunded up
bioretention basin	2662	m3	all excavated (no bunding)
Settling pond	2523	m3	all bunded (no excavation)
perimeter of settling pond	140.7	m	
perimeter of wetland	292.9	m	

Wetland

h	0.5	m	
top width	1	m	
slope	3	1:3 slope ratio	
bottom width	3.5	m	
area	2	m2	
bund length	292.9	m	length 2* width
Bunding wetland	586	m3	
excavation of wetland (half)	1429	m3	

Settling pond

h	2	m
top width	1	m
slope	3	1:3 slope ratio
bottom width	6.5	m
area	14	m2
bund length	140.7	m
bunding	1969.5	

Dumping/Bunding

Excavation	4091	m3	
Bunding	2555	m3	on costing spreadsheet
Dumping to landfill	1536	m3	on costing spreadsheet

25 mm design event

Settling pond

Settling pond calculations		unit	comments
drain time	24	hours	
Depth	1.7	m	
calculated storage	2103	m3	
outflow rate	24.3	L/s	
Indicative Sizing			
Area	1237	m2	
Sides	35.2	m	

Wetland

Wetland calcuations		unit	comments
inflow rate	24.33607391		
drain time	48	hours	
Depth	1.0	m	
calculated storage	2382	m3	
outflow rate	13.8	L/s	48 hours detention GD01 SWMD
Indicative Sizing			
Area	2382	m2	
Sides	48.8	m	

BioRetention Basin

Bioretention Basin calculations			comments
inflow rate	13.8	L/s	
V (void ratio)	0.65		
Media Depth	2.00	m	
retention time	72.0	hours	
V (tot)	2662	m3	
Indicative Sizing			
A (device)	1331	m2	
Sides	36.5	m	

Total sizing

	Volume (m3)	Additional %	Total volume (m3)	sides	perimeter
Settling pond	2103	20	2523	35.2	140.7
Wetland	2382	20	2859	48.8	292.9
Bioretention basin	2662	0	2662	36.5	145.9
			8044		

Design Parameters

Treatment Rainfall Depth	25	mm
Treatment Rainfall Intensity	10	mm/hr
Catchment Size	161000	m2
Effective C Value	0.45	mm/mm
Weekly Base Inflow	1958	m3

SCHEDULE OF QUANTITIES - FOR PRICING
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS
OPTION 1B: TREATMENT TRAIN NOT BUNDED - SETTLING POND, WETLAND, INFILTRATION BASIN

Option Description:

A treatment train is the combination of stormwater management devices that treat water sequentially to deliver the target quality or quantity of stormwater. Each device can target different contaminants, the order of which is strategically selected to maximise removal efficiency. When considering the contaminants present within the dischargeable water, the order as followed is a potential treatment train option for the Ravensdown Awatoto site:

1. Settling pond
2. Wetland
3. Bioretention basin
4. Media filter

Basins are fully excavated in this option. Assumed 60% of excavated cut is contaminated within the boundaries of the site, 40% estimated as clean. We have made variations of this 60/40 split for the costings estimate.

Allowance for physical works only. Excludes; consenting, liaison, professional fees, modelling, etc which can add significant costs.

		Unit	Qty	Rate	Amount	High Level Costing Comments
1.00	**Preliminary & General (P&G)**					
1.01	Allow for all items to meet the contractors obligations	LS	1	$ 961,000	$ 961,000	Rate is calculated as 12% of construction works costs (this includes subtotals 3 to 6, excluding P&G and ESC)
	Preliminary & General subtotal				**$ 961,000**	
2.00	**Erosion and Sediment Control (ESC)**					
2.01	Produce HBRC approved Erosion and Sediment Control Plan and implement these according to the requirements	LS	1	$ 58,400	$ 58,400	Rate is calculated by comparing to the Hornby ESC cost ($42k) to the SW Basins Civil contract works area for all 3 basins and infrastructure (roughly 13,900m2 area). This works out to be about $3 per meter square. The area for Awatoto is measured to include all the working area as 32,210m2. Contractor 'per m2' cost likely to be smaller based on economy of scale, and local condition of site. We have applied 60% of $3 per m2 which equates to $1.81 per m2, as this seems more reasonable.
	Erosion and Sediment Control subtotal				**$ 58,400**	
3.00	**Stormwater Settling Pond, Wetland and Infiltration Basin Earthworks**					
3.01	Cost to carryout general works required for the storage basin (includes items such as clearance, geosynthetic clay liner etc, and resurfacing). Excavation covered under Cut to waste items	LS	1	$ 1,442,620	$ 1,442,620	Rate is calculated based on the total earthworks cost of Hornby basin 1 (720m3) which works out to $179.34 per unit m3. Proposed Settling pond to be 8045 m3. Cost encompasses: 3.07-3.17 from Hornby spreadhseet and 100mm top soil and cut soil.
3.02	Cut to waste of contaminated soils (incl. topsoil) include excavation, stockpiling, contaminant sampling, carting to specialised landfill (Omarunui landfill) and disposal costs. Based on 60% of the basin excavated total being contaminated.	ton	8688	$ 254	$ 2,210,119	Rate is calculated based on Omarunui Landfill fixed dump fees for "Special Waste" noted at a minimum charge of $179.40 per tonne, this may be larger as waste from Ravensdown is classified as out of Hastings District. An estimated $75 for excavation, stockpiling with overheads and profit have been added. Note that the $75 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. https://www.hastingsdc.govt.nz/services/rubbish-and-recycling/omarunui-landfill/fees-and-charges/
3.03	Cut to waste of 'clean' soils include excavation, stockpiling, contaminant sampling, carting to NCC cleanfill site and disposal costs. Based on 40% of the basin excavated total being classed as clean.	ton	5792	$ 192	$ 1,111,141	Rate is calculated based on Omarunui Landfill fixed dump fees for standard refuse "out of Hastings District" noted as $136.85 per tonne on site. An estimated $55 for excavation, stockpiling, overheads and profit have been added. Note that the $55 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. This is assuming that all remaining excavated soils are needing to be removed from site. There could be some significant cost savings here if they were able to utilise/keep site won material on site.
3.04	Dewatering (using spears). Cost includes setup and pack down of equipment	LS	1	$ 208,412	$ 208,412	Rate is calculated based on 65 days assumed.
	Storage Pond Earthworks subtotal				**$ 4,972,291.68**	
4.00	**Stormwater Settling Pond, Wetland and Infiltration Basin Infrastructure**					
4.01	Cost to install infrastructure for storage pond (costs of pumps and electrical control system included in electrical and mechanical)	LS	1	$ 1,668,899	$ 1,668,899	Rate is calculated based on Hornby basin 1 (720m3) which works out to $207.47 per m3.
	Settling pond Infrastructure subtotal				**$ 1,668,899.22**	
5.00	**Electrical and Mechanical Works**					
5.01	Process equipment, instrumentation, mechanical, piping, electrication and automation	LS	1	$ 139,162	$ 139,162	Rate is calculated based on cost of Hornby basin 1 electrical works (720m3) which works out to $17.30 per unit m3.
	Electrical and Mechanical subtotal				**$ 139,162**	
6.00	**Landscaping Works**					
6.01	Landscaping works include the supply and install of items such as matting, planting, bark mulch, fencing, a year of maintenance and reinstatement of surfaces	LS	1	$ 1,227,763	$ 1,227,763	Rate is calculated based on cost of Hornby basin 1 landscape works (720m3) which works out to $152.63 per unit m3. This is then applied to the total excavated volume for this project.
	Landscaping Works Subtotal				**$ 1,227,763.47**	
	Construction Works Total				**$ 9,027,516.45**	
	Contingency 20%				**$ 1,805,503.29**	
	High Level CAPEX Total				**$ 10,834,000.00**	

	CAPEX AND 35 YEARS OPEX	**$ 12,468,000**

OPTION 1B: TREATMENT TRAIN NOT BUNDED - SETTLING POND, WETLAND, INFILTRATION BASIN

25 mm design event

Design Parameters

Treatment Rainfall Depth	25	mm
Treatment Rainfall Intensity	10	mm/hr
Catchment Size	161000	m2
Effective C Value	0	mm/mm
Weekly Base Inflow	1958	m3

Settling pond

Settling pond calculations		unit	comments
drain time	24	hours	
Depth	1.7	m	
calculated storage	2103	m3	
outflow rate	24.3	L/s	
Indicative Sizing			
Area	1237	m2	
Sides	35	m	

Wetland

Wetland calcuations		unit	comments
inflow rate	24.3		
drain time	48	hours	
Depth	1.0	m	
calculated storage	2382	m3	
outflow rate	13.8	L/s	48 hours detention GD01 SWMD
Indicative Sizing			
Area	2382	m2	
Sides	48.8	m	

BioRetention Basin

Bioretention Basin calculations			comments		
inflow rate	13.8	L/s			
V (void ratio)	0.65				
Media Depth	2.00	m			
retention time	72.0	hours			
V (tot)	2662	m3			
			drain rate		
Indicative Sizing				10.27031388	L/S
A (device)	1331	m2			
Sides	36	m			

Excavation costs

	Volume (m3)	Additional %	Total volume (m3)	sides	perimeter
Settling pond	2103	20	2523	35.169	140.6752384
Wetland	2382	20	2859	48.809	244.0466693
Infiltration basin	2662	0	2662	36.483	145.9332822
			8044		

SCHEDULE OF QUANTITIES - HIGH LEVEL PRICING
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS
OPTION 1B: TREATMENT TRAIN BUNDED OR NOT BUNDED - SETTLING POND, WETLAND, INFILTRATION BASIN
OPEX

Option Description:

Treatment Train to Estuary (10l/s Total):
- settling pond - wetland - drain discharge - estuary

	Description	Unit	Qty	Rate	Amount
1.00	**Regular Inspections and Minor Preventative Maintenance:** 1.5hr every 2 weeks	freq / yr	26	$ 105	$ 2,730
2.00	**Pump, Electrical & Mecanical:** O&M long term average incl. replacements - various intervals	LS avg	1	$ 4,152	$ 4,152
3.00	**Settling Pond (10l/s):** Dredge settling pond every 2 years	freq / yr	0.5	$ 20,000	$ 10,000
5.00	**Wetland (10/s):** monthly inspections, vegitation mantenace, inlet/outle maintenance, etc	LS avg	1.0	$ 22,000	$ 22,000
				Total	$ 38,882.00
				Contingency 20%	$ 7,776.40
				High Level Yearly O&M Total	**$ 46,658.40**
				35 years O&M Total	**$ 1,634,000.00**

SCHEDULE OF QUANTITIES - HIGH LEVEL PRICING
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS
OPTION 2A: NAPIER CITY COUNCIL (NCC) WASTE WATER TREATMENT PLANT (WWTP) SEA OUTFALL
CAPEX

Option Description:
NCC operate a WWTP approximately 500 m from the Ravensdown site which ultimately discharges via a sea outfall. There are multiple ways to utilise the NCC WWTP. This would be either pre-treated and connect directly to the NCC wastewater sea outfall or no pre treatment and connect to NCC wastewater treatment plant. Regardless of the option, Ravensdown stormwater and process water will be required to be pumped (pressurised system) to connect to either the wastewater treatment plant or to the treatment plants' sea outfall. Design considerations of how a direct connection is made to the NCC sea outfall will be had if Ravensdown select this as their preferred stormwater management option. Basins are fully excavated. Assumed 60% of excavated cut is contaminated within the boundaries of the site, 40% estimated as clean.

Allowance for physical works only. Excludes; consenting, liaison, professional fees, modelling, etc which can add significant costs.

	Description	Unit	Qty	Rate	Amount	High Level Costing Comments
1.00	**Preliminary & General (P&G)**					
1.01	Allow for all items to meet the contractors obligations	LS	1	$ 508,444	$ 508,444	Rate is calculated as 12% of construction works costs (this includes subtotals 3 to 6, excluding P&G and ESC)
	Preliminary & General subtotal				**$ 508,444**	
2.00	**Erosion and Sediment Control (ESC)**					
2.01	Produce HBRC approved Erosion and Sediment Control Plan and implement these according to the requirements	LS	1	$ 61,300	$ 61,300	Rate is calculated by comparing to the Hornby ESC cost ($42k) to the SW Basins Civil contract works area for all 3 basins and infrastructure (roughly 13,900m2 area). This works out to be about $3 per meter square. The area for Awatoto is measured to include all the working area as 32,210m2. Contractor 'per m2' cost likely to be smaller based on economy of scale, and local condition of site. We have applied 60% of $3 per m2 which equates to $1.81 per m2, as this seems more reasonable. We also add in $1.8 x length of NCC outfall trench (1620m).
	Erosion and Sediment Control subtotal				**$ 61,300**	
3.00	**Stormwater Storage Pond Earthworks**					
3.01	Cost to carryout general earthworks required for the storage basin (includes items such as clearance, geosynthetic clay liner etc, and resurfacing)	LS	1	$ 719,230	$ 719,230	Rate is calculated based on the total earthworks cost of Hornby basin 1 (720m3) which works out to $179.34 per unit m3. Proposed settling pond to be 4011 m3. Cost encompasses: 3.07-3.17 from Hornby spreadhseet and 100mm top soil and cut soil.
3.02	Cut to waste of contaminated soils (incl. topsoil) include excavation, stockpiling, contaminant sampling, carting to specialised landfill (Omarunui landfill) and disposal costs. Based on 60% of the basin excavated total being contaminated.	ton	4331	$ 254	$ 1,101,874	Rate is calculated based on Omarunui Landfill fixed dump fees for "Special Waste" noted at a minimum charge of $179.40 per tonne, this may be larger as waste from Ravensdown is classified as out of Hastings District. An estimated $75 for excavation, stockpiling with overheads and profit have been added. Note that the $75 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. https://www.hastingsdc.govt.nz/services/rubbish-and-recycling/omarunui-landfill/fees-and-charges/
3.03	Cut to waste of 'clean' soils include excavation, stockpiling, contaminant sampling, carting to NCC cleanfill site and disposal costs. Based on 40% of the basin excavated total being classed as clean.	ton	2888	$ 192	$ 553,969	Rate is calculated based on Omarunui Landfill fixed dump fees for standard refuse "out of Hastings District" noted as $136.85 per tonne on site. An estimated $55 for excavation, stockpiling, overheads and profit have been added. Note that the $55 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. This is assuming that all remaining excavated soils are needing to be removed from site. There could be some significant cost savings here if they were able to utilise/keep site won material on site.
3.04	Dewatering (using spears). Cost includes setup and pack down of equipment	LS	1	$ 208,412	$ 208,412	Rate is calculated based on 70 days assumed.
	Stormwater Storage Pond Earthworks subtotal				**$ 2,583,484**	
4.00	**Stormwater Storage Basin Infrastructure**					
4.01	Cost to install infrastructure for storage pond (costs of pumps and electrical control system included in electrical and mechanical)	LS	1	$ 832,044	$ 832,044	Rate is calculated based on Hornby basin 1 (720m3) which works out to $207.47 per m3. Hornby spreadsheet items 4.01-4.22 were used to help calculate this.
4.02	Cost to trench, supply and install pressure pipeline from storage pond to NCC wastewater treatment plant outfall through roading corridor.	LS	1	$ 110,012	$ 110,012	Rate is calculated from a Tauranga project lineal cost identified as $65 per linear m. Length of trench is calculated as 1,620m. Assumed trench cut is suitable to reuse. We have applied surface reinstatement costs of $2.5 /m2 for reinstatement of topsoil and grass for the full length, less the road crossing. Reinstatement of road crossing 7m by 1m x $97 per m squared of ashphalting. Likely only need chipseal, however this is providing a conservative price. Excludes TMP, which is assumed in the P&G.
4.03	Cost for connection to NCC outfall pipe	LS	1	$ 30,000	$ 30,000	Rate is not calculated, it is an estimate only. This will be specific to NCC requirements.
	Settling pond Infrastructure subtotal				**$ 972,055**	
5.00	**Media Fiilter**					
5.01	Supply and Install Turnkey Media Filter Treatment System: StormwateRx Aquip or similar	LS	1	$ 600,000	$ 600,000	Capital cost of media filter $300,000 - $700,000. A figure of $500,000 selected and $100,000 added for install and commissioning.
	Media Filter subtotal				**$ 600,000**	
5.00	**Pumps & Controls: Electrical and Mechanical Works**					
5.01	Process equipment, instrumentation, mechanical, piping, electrication and automation	LS	1	$ 69,380	$ 69,380	Rate is calculated based on cost of Hornby basin 1 electrical works (720m3) which works out to $17.30 per unit m3.
	Electrical and Mechanical subtotal				**$ 69,380**	
6.00	**Landscaping Works**					
6.01	Landscaping works include the supply and install of items such as matting, planting, bark mulch, fencing, a year of maintenance and reinstatement of surfaces	LS	1	$ 612,112	$ 612,112	Rate is calculated based on cost of Hornby basin 1 landscape works (720m3) which works out to $152.63 per unit m3. This is then applied to the total excavated volume for this project.
	Landscaping Works Subtotal				**$ 612,112**	
	Construction Works Total				**$ 4,806,775.78**	
	Contingency 20%				**$ 961,355.16**	
	High Level CAPEX Total				**$ 5,769,000.00**	

	CAPEX AND 35 YEARS OPEX	**$ 8,515,000**

OPTION 2A: NAPIER CITY COUNCIL (NCC) WASTE WATER TREATMENT PLANT (WWTP) SEA OUTFALL

NCC sea outfall

Settling pond

Settling pond calculations		unit
drain time	24	hours
Depth	1.7	m
calculated storage	1823	m3
outflow rate	21.1	L/s
Indicative Sizing		
Area	1072	m2
Sides	32.7	m

BioRetention Basin

Bioretention Basin calculations			
inflow rate	21.1	L/s	
V (void ratio)	0.65		
Media Depth	2.00	m	
retention time	72.0	hours	
V (tot)	1823	m3	
outflow rate	8.4	L/s	Above allowable discharge rate
Indicative Sizing			
A (device)	911	m2	
Sides	30.2	m	

	Volume (m3)	Additional %	Total volume (m3)
Storage Pond	1822.9225	20	2187.507
Bioretention basin	1822.92	0	1822.9
			4010.4

Design Parameters

Treatment Rainfall Depth	25	mm	
Allowable discharge rate	2	L/s	dictated by NCC
Catchment Size	161000	m2	
Effective C Value	0.45	mm/mm	
Weekly Base Inflow	0	m3	

SCHEDULE OF QUANTITIES - HIGH LEVEL PRICING
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS
OPTION 2A: NAPIER CITY COUNCIL (NCC) WASTE WATER TREATMENT PLANT (WWTP) SEA OUTFALL
OPEX

Option Description:

10l/s to NCC WWTP Trade waste discharge
NCC operate a WWTP approximately 500m from the Ravensdown site which ultimately discharges via a sea outfall.
Settling pond, media filter pre-treatment prior to connection to NCC WWTP assumed.
Ravensdown stormwater and process water will be required to be pumped (pressurised system) to connect to either the WWTP or to the treatment plants' sea outfall.
Design considerations of how a direct connection is made to the NCC sea outfall will be had if Ravensdown select this as their preferred stormwater management option. Basins are fully excavated.

	Description	Unit	Qty	Rate	Amount
1.00	**Regular Inspections and Minor Preventative Maintenance:** 1.5hr everyy 2 weeks	freq / yr	26	$ 105	$ 2,730
2.00	**Pump, Electrical & Mecanical:** O&M long term average incl. replacements - various intervals	LS avg	1	$ 20,047	$ 20,047
3.00	**Settling Pond:** Dredge settling pond every 2 years	freq / yr	0.5	$ 20,000	$ 10,000
4.00	**Media Filter (10l/s):** Replace filter media	freq / yr	0.5	$ 20,000	$ 10,000
5.00	**NCC Tradewaste Fees:** Current NCC rate of 0.29 $/m3 under review. 50% Increase assumed	m3	51948	$ 0.44	$ 22,597
				Total	$ 65,374.78
				Contingency 20%	$ 13,074.96
				High Level Yearly O&M Total	**$ 78,449.74**
				35 years O&M Total	**$ 2,746,000.00**

SCHEDULE OF QUANTITIES - HIGH LEVEL PRICING
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS
OPTION 2B: RAVENSDOWN SITE SPECIFIC SEA OUTFALL

Option Description:

A stormwater management option for the Ravensdown Awatoto site is to install a Ravensdown specific sea outfall. Based on the volume of discharge and pipe distance of the NCC WWTP sea outfall, it is assumed the pipe length would be 500m from the low tide mark. At this distance, it is assumed that based on the discharging contaminant levels there will be adequate level of mixing with the receiving (ocean) environment. It is assumed that pre-treatment will be required prior to discharging to a Ravensdown specific sea outfall. The level of treatment is unknown at this stage and will be confirmed through ongoing consultation with NCC if this becomes the chosen stormwater management option. Basins are fully excavated. Assumed 60% of excavated cut is contaminated within the boundaries of the site, 40% estimated as clean. We have made variations of this 60/40 split for the costings estimate.

Dedicated Outfall Assumptions:
1. High level estimate only.
2. Assumes marine pipeline laid on surface and anchoured in place with concrete blocks
3. Assumes a 500m long marine pipeline adequate for dispersion.
4. Dispersion modelling required to confirm requried length of marine pipeline and number and spacing of diffusers.
5. Assumes design flowrate of 10l/s

Allowance for physical works only. Excludes; consenting, liaison, professional fees, modelling, etc which can add significant costs

		Unit	Qauntity	Rate	Amount	High Level Costing Comments
1.00	**Preliminary & General (P&G)**					
1.01	Allow for all items to meet the contractors obligations	LS	1	$ 734,950	$ 734,950	Rate is calculated as 12% of construction works costs (this includes subtotals 3 to 6, excluding P&G and ESC)
	Preliminary & General subtotal				**$ 734,950**	12% of overall project cost
2.00	**Erosion and Sediment Control (ESC)**					
2.01	Produce HBRC approved Erosion and Sediment Control Plan and implement these according to the requirements	LS	1	$ 58,400	$ 58,400	Rate is calculated by comparing to the Hornby ESC cost ($42k) to the SW Basins Civil contract works area for all 3 basins and infrastructure (roughly 13,900m2 area). This works out to be about $3 per meter square. The area for Awatoto is measured to include all the working area as 32,210m2. Contractor 'per m2' cost likely to be smaller based on economy of scale, and local condition of site. We have applied 60% of $3 per m2 which equates to $1.81 per m2, as this seems more reasonable.
	Erosion and Sediment Control subtotal				**$ 58,400**	
3.00	**Stormwater Storage Pond Earthworks (Option 1)**					
3.01	Cost to carryout general works required for the storage basin (includes items such as clearance, geosynthetic clay liner etc, and resurfacing)	LS	1	$ 719,230	$ 719,230	Rate is calculated based on the total earthworks cost of Hornby basin 1 (720m3) which works out to $179.34 per unit m3. Proposed Settling pond to be 4011 m3.
3.02	Cut to waste of contaminated soils (incl. topsoil) include excavation, stockpiling, contaminant sampling, carting to specialised landfill (Omarunui landfill) and disposal costs. Based on 60% of the basin excavated total being contaminated.	ton	4331	$ 254	$ 1,101,874	Rate is calculated based on Omarunui Landfill fixed dump fees for "Special Waste" noted at a minimum charge of $179.40 per tonne, this may be larger as waste from Ravensdown is classified as out of Hastings District. An estimated $75 for excavation, stockpiling with overheads and profit have been added. Note that the $75 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. https://www.hastingsdc.govt.nz/services/rubbish-and-recycling/omarunui-landfill/fees-and-charges/
3.03	Cut to waste of 'clean' soils include excavation, stockpiling, contaminant sampling, carting to NCC cleanfill site and disposal costs. Based on 40% of the basin excavated total being classed as clean.	ton	2888	$ 192	$ 553,969	Rate is calculated based on Omarunui Landfill fixed dump fees for standard refuse "out of Hastings District" noted as $136.85 per tonne on site. An estimated $55 for excavation, stockpiling, overheads and profit have been added. Note that the $55 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. This is assuming that all remaining excavated soils are needing to be removed from site. There could be some significant cost savings here if they were able to utilise/keep site won material on site.
3.04	Dewatering (using spears). Cost includes setup and pack down of equipment	LS	1	$ 208,412	$ 208,412	Rate is calculated based on 70 days assumed.
	Storage Pond Earthworks subtotal				**$ 2,583,484**	
4.00	**Stormwater Storage Basin Infrastructure - including Sea Outfall**					
4.01	Cost to install infrastructure for storage pond (costs of pumps and electrical control system included in electrical and mechanical)	LS	1	$ 832,044	$ 832,044	Rate is calculated based on Hornby basin 1 (720m3) which works out to $207.47 per m3.
4.02	Cost to supply and install an sea outfall - costs include P&G and ESCP specific to this task, land trenching, thrusting under SH and rail line, seabed pipe laying.	LS	1	$ 2,027,565	$ 2,027,565	Rate has been calculated as a high level cost estimate.
	Settling pond Infrastructure subtotal				**$ 2,859,609**	
5.00	**Electrical and Mechanical Works**					
5.01	Process equipment, instrumentation, mechanical, piping, electrication and automation	LS	1	$ 69,380	$ 69,380	Rate is calculated based on cost of Hornby basin 1 electrical works (720m3) which works out to $17.30 per unit m3.
	Electrical and Mechanical subtotal				**$ 69,380**	
6.00	**Landscaping Works**					
6.01	Landscaping works include the supply and install of items such as matting, planting, bark mulch, fencing, a year of maintenance and reinstatement of surfaces	LS	1	$ 612,112	$ 612,112	Rate is calculated based on cost of Hornby basin 1 landscape works (720m3) which works out to $152.63 per unit m3. This is then applied to the total excavated volume for this project.
	Landscaping Works Subtotal				**$ 612,112**	
	Construction Works Total				**$ 6,917,935.70**	
	Contingency 20%				**$ 1,383,587.14**	
	High Level CAPEX Total				**$ 8,302,000.00**	
	CAPEX AND 35 YEARS OPEX				**$ 10,442,000**	

OPTION 2B: RAVENSDOWN SITE SPECIFIC SEA OUTFALL

Settling pond			
Settling pond calculations		unit	
drain time	24	hours	
Depth	1.7	m	
calculated storage	1823	m3	
outflow rate	21.1	L/s	
Indicative Sizing			
Area	1072	m2	
Sides	32.7	m	

BioRetention Basin			
Bioretention Basin calculations			
inflow rate	21.1	L/s	
V (void ratio)	0.65		
Media Depth	2.0	m	
retention time	72.0	hours	
V (tot)	1823	m3	
outflow rate	8.4	L/s	Above allowable discharge rate
Indicative Sizing			
A (device)	911	m2	
Sides	30.2	m	

	Volume (m3)	Additional %	Total volume (m3)
Storage Pond	1823	20	2188
Bioretention basin	1823	0	1823
			4010

SCHEDULE OF QUANTITIES - HIGH LEVEL PRICING
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS
OPTION 2B: RAVENSDOWN SITE SPECIFIC SEA OUTFALL
OPEX

Option Description:

10 l/s Discharge to a 500m long Ravensdown Awatoto Marine Pipeline and ocean outfall.
Settling pond, media filter pre-treatment prior to discharge to Ravensdown Marine outfall assumed.
Ravensdown stormwater and process water will be required to be pumped (pressurised system) to sea outfall.

	Description	Unit	Qty	Rate	Amount
1.00	**Regular Inspections and Minor Preventative Maintenance:** 1.5hr every 2 weeks	freq / yr	26	$ 105	$ 2,730
2.00	**Pump, Electrical & Mecanical:** O&M long term average incl. replacements - various intervals	LS avg	1	$ 18,901	$ 18,901
3.00	**Settling Pond:** Dredge settling pond every 2 years	freq / yr	0.5	$ 20,000	$ 10,000
4.00	**Media Filter (10l/s):** Replace filter media	freq / yr	0.5	$ 20,000	$ 10,000
5.00	**Marine Pipeline:**				
5.01	Inspection of marine pipeline diffuser outlets and pipeline in general; boat and divers. 3 yr on avg	LS avg	0.3	$ 10,000	$ 3,333
5.02	Diffuser maintenance; boat and divers: 6yr on avg	LS avg	0.2	$ 17,000	$ 2,833
5.03	Replace diffusers; boat and divers: Every 35 yr	LS avg	0.03	$ 110,000	$ 3,143
				Total	$ 50,940.92
				Contingency 20%	$ 10,188.18
				High Level Yearly O&M Total	**$ 61,129.11**
				35 years O&M Total	**$ 2,140,000.00**

SCHEDULE OF QUANTITIES - HIGH LEVEL PRICING

RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS

OPTION 4A: COMBINATION OF OPTIONS: WITH HALF GOING TO TREATMENT TRAIN AND HALF GOING TO NCC WWTP SEA OUTFALL - BUNDED

Option Description:

A stormwater management option for the Ravensdown site is a split flow methodology. Utilising a split flow method allows for differing levels of treatment based on the nature and concentration of contaminants present within the storm and process water. Therefore, contaminants that are hard to remove (fluoride) can undergo targeted treatment. This could reduce the size (and therefore cost) of the treatment device to treat said targeted storm and process water. Through deliniation of contaminant pathways, as recommended in Aurecon's Memo, the areas which are deemed to have high or low contaminantion (either stormwater or process water) will be derived. This option looks at completeing this split option with bunding onsite utilising the excavated materials, assuming they are suitable as fill, and contaminated so requiring encapsulation. The high level calcs for this assume that the excavated material is equal to the amount needed for the bunding, and therefore no import or export required.

Install pressure pipeline from storage pond to NCC WWTP outfall through roading corridor.
Allowance for physical works only. Excludes; consenting, liaison, professional fees, modelling, etc which can add significant costs

		Unit	Qty	Rate	Amount	High Level Costing Comments
1.00	**Preliminary & General (P&G)**					
1.01	Allow for all items to meet the contractors obligations	LS	1	$ 428,500.00	$ 428,500.00	Rate is calculated as 12% of construction works costs (this includes subtotals 3 to 6, excluding P&G and ESC)
	Preliminary & General subtotal				**$ 428,500.00**	
2.00	**Erosion and Sediment Control (ESC)**					
2.01	Produce HBRC approved Erosion and Sediment Control Plan and implement these according to the requirements	LS	1	$ 58,400	$ 58,400	Rate is calculated by comparing to the Hornby ESC cost ($42k) to the SW Basins Civil contract works area for all 3 basins and infrastructure (roughly 13,900m2 area). This works out to be about $3 per meter square. The area for Awatoto is measured to include all the working area as 32,210m2. Contractor 'per m2' cost likely to be smaller based on economy of scale, and local condition of site. We have applied 60% of $3 per m2, which equates to $1.81 per m2, as this seems more reasonable.
	Erosion and Sediment Control subtotal				**$ 58,400.00**	
3.00	**Stormwater Treatment Train Earthworks with bunding**					
3.01	Cost to carryout general works required for the storage basin (includes items such as clearance, geosynthetic clay liner etc, and resurfacing)	LS	1	$ 899,808	$ 899,807.61	Rate is calculated based on the total earthworks cost of Hornby basin 1 (720m3) which works out to $179.34 per unit m3. Proposed Settling pond to be 1430 m3
3.02	Excavation from basin areas to form soil encapsulated bunds. Includes onsite cartage, stockpiling, placement of contaminated material, supply and install of HDPE liner and all works necessary to meet the encapsulation requirements and achieve bund stability.	m3	1430	$ 120.00	$ 171,600.00	Rate is calculated from Hornby SP3 Soil Encapsulation of contaminated materials.
	Cut to waste of contaminated soils (incl. topsoil) include excavation, stockpiling, contaminant sampling, carting to specialised landfill (Omarunui landfill) and disposal costs. Based on 60% of the basin excavated total being contaminated.	ton	672	$ 254	$ 170,942.06	Rate is calculated based on Omarunui Landfill fixed dump fees for "Special Waste" noted at a minimum charge of $179.40 per tonne, this may be larger as waste from Ravensdown is classified as out of Hastings District. An estimated $75 for excavation, stockpiling with overheads and profit have been added. Note that the $75 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. https://www.hastingsdc.govt.nz/services/rubbish-and-recycling/omarunui-landfill/fees-and-charges/
	Cut to waste of 'clean' soils include excavation, stockpiling, contaminant sampling, carting to NCC cleanfill site and disposal costs. Based on 40% of the basin excavated total being classed as clean.	ton	448	$ 192	$ 85,941.39	Rate is calculated based on Omarunui Landfill fixed dump fees for standard refuse "out of Hastings District" noted as $136.85 per tonne on site. An estimated $55 for excavation, stockpiling, overheads and profit have been added. Note that the $55 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. This is assuming that all remaining excavated soils are needing to be removed from site. There could be some significant cost savings here if they were able to utilise/keep site won material on site.
3.03	Dewatering (using spears). Cost includes setup and pack down of equipment	LS	1	$ 208,412	$ 208,412	Rate is calculated based on 1 days assumed.
	Storage Pond Earthworks subtotal				**$ 1,536,702.81**	
4.00	**Stormwater Treatment Train Infrastructure - including trench and connect to NCC Sea Outfall**					
4.01	Cost to install infrastructure for storage pond (costs of pumps and electrical control system included in electrical and mechanical)	LS	1	$ 1,040,945	$ 1,040,945	Rate is calculated based on Hornby basin 1 (720m3) which works out to $207.47 per m3. "Hornby spreadsheet with comments.xlsx" items 4.01-4.22 were used to help calculate this.
4.02	Cost to trench, supply and install pressure pipeline from storage pond to NCC wastewater treatment plant outfall through roading corridor.	LS	1	$ 110,012	$ 110,012	Rate is calculated from a Tauranga project lineal cost identified as $65 per linear m. Length of trench is calculated as 1,620m. Assumed trench cut is suitable to reuse. We have applied surface reinstatement costs of $2.5 /m2 for reinstatement of topsoil and grass for the full length, less the road crossing. Reinstatement of road crossing 7m by 1m x $97 per m squared of ashphalting. Likely only need chipseal, however this is providing a conservative price. Excludes TMP, which is assumed in the P&G.
4.03	Cost for connection to NCC outfall pipe	LS	1	$ 30,000	$ 30,000	Rate is not calculated, it is an estimate only. This will be specific to NCC requirements.
	Settling pond Infrastructure subtotal				**$ 1,180,956.54**	
5.00	**Electrical and Mechanical Works**					
5.01	Process equipment, instrumentation, mechanical, piping, electrication and automation	LS	1	$ 86,799.77	$ 86,799.77	Rate is calculated based on cost of Hornby basin 1 electrical works (720m3) which works out to $17.30 per unit m3.
	Electrical and Mechanical subtotal				**$ 86,799.77**	
6.00	**Landscaping Works**					
6.01	Landscaping works include the supply and install of items such as matting, planting, bark mulch, fencing, a year of maintenance and reinstatement of surfaces	LS	1	$ 765,794.77	$ 765,794.77	Rate is calculated based on cost of Hornby basin 1 landscape works (720m3) which works out to $152.63 per unit m3. This is then applied to the total excavated volume for this project.
	Landscaping Works Subtotal				**$ 765,794.77**	
	Construction Works Total				**$ 4,057,153.90**	
	Contingency 20%				**$ 811,430.78**	
	High Level CAPEX Total				**$ 4,869,000.00**	

	CAPEX AND 35 YEARS OPEX	**$ 7,272,000**

OPTION 4A: COMBINATION OF OPTIONS: BUNDED

Bunding calculations

Design Parameters

whole site volume	5017	m3	on costing spreadsheet
			half will be excavated and half
wetland volume size	2859	m3	will be bunded up
bioretention basin	0.0	m3	all excavated (no bunding)
Settling pond	2159	m3	all bunded (no excavation)
perimeter of settling pond	116.0	m	
perimeter of wetland	213.9	m	

Wetland

h	0.5	m	
top width	1	m	
slope	3	1:3 slope ratio	
bottom width	3.5	m	
area	2	m2	
bund length	213.9	m	length 2* width
Bunding wetland	428	m3	
excavation of wetland (half)	1429	m3	

Settling pond

h	2	m	
top width	1	m	
slope	3	1:3 slope ratio	
bottom width	6.5	m	
area	14	m2	
bund length	116.0	m	
bunding	1624	m3	

Dumping/Bunding

Excavation	1429	m3	
Bunding	2052	m3	on costing spreadsheet
Dumping to landfill	622	m3	on costing spreadsheet

50 mm design event - Low contaminated

Settling pond

Settling pond calculations		unit	comments
drain time	24	hours	
Depth	1.7	m	
calculated storage	1191	m3	
outflow rate	13.78675389	L/s	
Indicative Sizing			
Area	701	m2	
Sides	26.5	m	

Wetland

Wetland calcuations		unit	comments
inflow rate	13.8		
drain time	48	hours	
Depth	1.0	m	
calculated storage	2382.4	m3	
outflow rate	13.8	L/s	48 hours detention GD01 SWMD
Indicative Sizing			
Area	2382	m2	
Sides	48.8	m	

50 mm design event - High contaminated

Settling pond/ attenuation basin

Settling pond calculations		unit	comments
drain time	24	hours	
Depth	1.7	m	
calculated storage	607.6	m3	
outflow rate	7.0	L/s	
Indicative Sizing			
Area	357	m2	
Sides	18.9	m	

Excavation costs

	Volume (m3)	**Additional %**	**Total volume (m3)**
Settling pond	607.6	20	729.1
			729.1

SCHEDULE OF QUANTITIES - FOR PRICING

RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS

OPTION 4B: COMBINATION OF OPTIONS: WITH HALF GOING TO TREATMENT TRAIN AND HALF GOING TO NCC WWTP SEA OUTFALL - NOT BUNDED

Option Description:

A stormwater management option for the Ravensdown site is a split flow methodology. Utilising a split flow method allows for differing levels of treatment based on the nature and concentration of contaminants present within the storm and process water. Therefore, contaminants that are hard to remove (fluoride) can undergo targeted treatment. This could reduce the size (and therefore cost) of the treatment device to treat said targeted storm and process water. Through delineation of contaminant pathways, as recommended in Aurecon's Memo, the areas which are deemed to have high or low contaminantion (either stormwater or process water) will be derived. This option looks at completeing this split option with no bunding onsite. Basins are fully excavated. Assumed 60% of excavated cut is contaminated within the boundaries of the site, 40% estimated as clean. We have made variations of this 60/40 split for the costings estimate.

Install pressure pipeline from storage pond to NCC WWTP outfall through roading corridor.
Allowance for physical works only. Excludes; consenting, liaison, professional fees, modelling, etc which can add significant costs

		Unit	Qty	Rate	Amount	High Level Costing Comments
1.00	**Preliminary & General (P&G)**					
1.01	Allow for all items to meet the contractors obligations	LS	1	$ 726,000	$ 726,000	Rate is calculated as 12% of construction works costs (this includes subtotals 3 to 6, excluding P&G and ESC)
	Preliminary & General subtotal				**$ 726,000**	
2.00	**Erosion and Sediment Control (ESC)**					
2.01	Produce HBRC approved Erosion and Sediment Control Plan and implement these according to the requirements	LS	1	$ 58,400	$ 58,400	Rate is calculated by comparing to the Hornby ESC cost ($42k) to the SW Basins Civil contract works area for all 3 basins and infrastructure (roughly 13,900m2 area). This works out to be about $3 per meter square. The area for Awatoto is measured to include all the working area as 32,210m2. Contractor 'per m2' cost likely to be smaller based on economy of scale, and local condition of site. We have applied 60% of $3 per m2 which equates to $1.81 per m2, as this seems more reasonable.
	Erosion and Sediment Control subtotal				**$ 58,400**	
3.00	**Stormwater Treatment Train and Storage Pond Earthworks**					
3.01	Cost to carryout general works required for the storage basin (includes items such as clearance, geosynthetic clay liner etc, and resurfacing). Excavation covered under Cut to waste items	LS	1	$ 1,054,519	$ 1,054,519	Rate is calculated based on the total earthworks cost of Hornby basin 1 (720m3) which works out to $179.34 per unit m3. Proposed Settling pond to be 5880 m3
3.02	Cut to waste of contaminated soils (incl. topsoil) include excavation, stockpiling, contaminant sampling, carting to specialised landfill (Omarunui landfill) and disposal costs. Based on 60% of the basin excavated total being contaminated.	ton	6350	$ 254	$ 1,615,542	Rate is calculated based on Omarunui Landfill fixed dump fees for "Special Waste" noted at a minimum charge of $179.40 per tonne, this may be larger as waste from Ravensdown is classified as out of Hastings District. An estimated $75 for excavation, stockpiling with overheads and profit have been added. Note that the $75 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. https://www.hastingsdc.govt.nz/services/rubbish-and-recycling/omarunui-landfill/fees-and-charges/
3.03	Cut to waste of 'clean' soils include excavation, stockpiling, contaminant sampling, carting to NCC cleanfill site and disposal costs. Based on 40% of the basin excavated total being classed as clean.	ton	4234	$ 192	$ 812,216	Rate is calculated based on Omarunui Landfill fixed dump fees for standard refuse "out of Hastings District" noted as $136.85 per tonne on site. An estimated $55 for excavation, stockpiling, overheads and profit have been added. Note that the $55 may be reduced by competing tender submissions that would be calculated based on local knowledge of efficiencies in dealing with larger quantities. This is assuming that all remaining excavated soils are needing to be removed from site. There could be some significant cost savings here if they were able to utilise/keep site won material on site.
3.04	Dewatering (using spears). Cost includes setup and pack down of equipment	LS	1	$ 208,412	$ 208,412	Rate is calculated based on 1 days assumed.
	Storage Pond Earthworks subtotal				**$ 3,690,689**	
4.00	**Stormwater Treatment Train Infrastructure - including trench and connect to NCC WWTP Sea Outfall**					
4.01	Cost to install infrastructure for storage pond (costs of pumps and electrical control system included in electrical and mechanical)	LS	1	$ 1,219,924	$ 1,219,924	Rate is calculated based on Hornby basin 1 (720m3) which works out to $207.47 per m3.
4.02	Cost to trench, supply and install pressure pipeline from storage pond to NCC wastewater treatment plant outfall through roading corridor.	LS	1	$ 110,012	$ 110,012	Rate is calculated from a Tauranga project lineal cost identified as $65 per linear m. Length of trench is calculated as 1,620m. Assumed trench cut is suitable to reuse. We have applied surface reinstatement costs of $2.5 /m2 for reinstatement of topsoil and grass for the full length, less the road crossing. Reinstatement of road crossing 7m by 1m x $97 per m squared of ashphalting. Likely only need chipseal, however this is providing a conservative price. Excludes TMP, which is assumed in the P&G.
4.03	Cost for connection to NCC outfall pipe	LS	1	$ 30,000	$ 30,000	Rate is not calculated, it is an estimate only. This will be specific to NCC requirements.
	Settling pond Infrastructure subtotal				**$ 1,359,935**	
5.00	**Electrical and Mechanical Works**					
5.01	Process equipment, instrumentation, mechanical, piping, electrication and automation	LS	1	$ 101,724	$ 101,724	Rate is calculated based on cost of Hornby basin 1 electrical works (720m3) which works out to $17.30 per unit m3.
	Electrical and Mechanical subtotal				**$ 101,724**	
6.00	**Landscaping Works**					
6.01	Landscaping works include the supply and install of items such as matting, planting, bark mulch, fencing, a year of maintenance and reinstatement of surfaces	LS	1	$ 897,464	$ 897,464	Rate is calculated based on cost of Hornby basin 1 landscape works (720m3) which works out to $152.63 per unit m3. This is then applied to the total excavated volume for this project.
	Landscaping Works Subtotal				**$ 897,464**	
	Construction Works Total				**$ 6,834,212.37**	
	Contingency 20%				**$ 1,366,842.47**	
	High Level CAPEX Total				**$ 8,202,000.00**	

	CAPEX AND 35 YEARS OPEX	**$ 10,605,000**

OPTION 4B: COMBINATION OF OPTIONS: WITH HALF GOING TO TREATMENT TRAIN AND HALF GOING TO NCC WWTP SEA OUTFALL - NOT BUNDED

50 mm design event - Low contaminated

Settling pond			
Settling pond calculations		unit	comments
drain time	24	hours	
Depth	1.7	m	
calculated storage	1402	m3	
outflow rate	16.2	L/s	
Indicative Sizing			
Area	824	m2	
Sides	28.7	m	

Wetland			
Wetland calcuations		unit	comments
inflow rate	16.2		
drain time	48	hours	
Depth	1.0	m	
calculated storage	2382	m3	
outflow rate	13.8	L/s	48 hours detention GD01 SWMD
Indicative Sizing			
Area	2382	m2	
Sides	48.8	m	

50 mm design event - High contaminated

Settling pond			
Settling pond calculations		unit	comments
drain time	72	hours	
Depth	1.7	m	
calculated storage	608	m3	
outflow rate	2.3	L/s	
Indicative Sizing			
Area	357	m2	
Sides	18.9	m	

BioRetention Basin			
Bioretention Basin calculations			comments
inflow rate	2.3	L/s	
V (void ratio)	0.65		
Media Depth	2.00	m	
retention time	72.0	hours	
V (tot)	608	m3	
outflow rate	2.8	L/s	
Indicative Sizing			
A (device)	304	m2	
Sides	17.4	m	

Excavation costs			
	Volume (m3	**Additional %**	**Total volume (m3)**
Settling pond	608	20	729
Bioretention basin	608	0	608
			1337

SCHEDULE OF QUANTITIES - HIGH LEVEL PRICING
RAVENSDOWN AWATOTO - HIGH LEVEL STORMWATER OPTIONS
OPTION 4B: COMBINATION OF OPTIONS: WITH HALF GOING TO TREATMENT TRAIN AND HALF GOING TO NCC WWTP SEA OUTFALL - BUNDED AND NOT BUNDED
OPEX

Option Description:

Split Option (10l/s Total):
<u>5l/s to NCC Tradewaste:</u>
- settling pond - media filter - 1200m 110OD PE pressure main - NCC WWTP - Ocean Outfall

<u>5l/s Treatment Trin to Estuary:</u>
- settling pond - wetland - drain discharge - estuary

	Description	Unit	Qty	Rate	Amount
1.00	**Regular Inspections and Minor Preventative Maintenance:** 1.5hr every 2 weeks	freq / yr	26	$ 105	$ 2,730
2.00	**Pump, Electrical & Mecanical:** O&M long term average incl. replacements - various intervals	LS avg	1	$ 10,674	$ 10,674
3.00	**Settling Pond (10l/s):** Dredge settling pond every 2 years	freq / yr	0.5	$ 20,000	$ 10,000
4.00	**Media Filter (5l/s):** Replace filter media	freq / yr	0.5	$ 15,000	$ 7,500
5.00	**NCC Tradewaste Fees:** Current NCC rate of 0.29 $/m3 under review. 50% Increase assumed	m3	25974	$ 0.44	$ 11,299
6.00	**Wetland (5/s):** monthly inspections, vegitation mantenace, inlet/outle maintenance, etc	LS avg	1.0	$ 15,000	$ 15,000
				Total	$ 57,202.21
				Contingency 20%	$ 11,440.44
				High Level Yearly O&M Total	**$ 68,642.65**
				35 years O&M Total	**$ 2,403,000.00**

Appendix D
SiD risk register

Safe Design Risk Register – Ravensdown Stormwater Improvements

Client	Ravensdown	**Workshop Date**	6/05/2021
Stakeholders	Ravensdown , HBRC, NCC, surrounding residents	**Revision No.**	A
Meeting Attendees	Aurecon - Ben Henry, Sam Morris, Alice Hoskins	**Project No.**	509619
		Project Manager	Anna Lindgren
		Client Contact	Helen Hurring

Risk Rating Matrix

Most Likely Consequence	Likelihood of occurrence: 5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

Notes:

1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
3. The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	**Risk Source (Hazard)**	**Event / Cause / Consequence**	**Persons Affected**	**Likelihood**	**Consequence**	**Risk Rating**	**Control Measure (Risk Treatment)**	**Likelihood**	**Consequence**	**Risk Rating**	**Risk Owner**	**Implement Control - Y/N?**	**SiD Workshop Action / Comment (or justification if no action)**	**SiD Workshop Action Owner(s)**	**Timing / Date**	**Status (Open / Closed)**
Design Phase (Pre-construction)																
1.01	Site inspections	• Injury as a result of accident during site inspection on a busy manufacturing site. Specific hazards include: ○ Heavy truck and plant movements e.g, large truck and trailer units and loaders ○ Exposure to hazardous chemicals (caustic) ○ Slips, trips and falls.	Site inspectors, Ravensdown staff, and tenderer walkovers	3 - Likely	C - Serious	High	• Follow Aurecon and Ravensdown Health and Safety (H&S) procedures to assist in identifying and managing hazards prior and during site visits. • Be escorted by Ravensdown representative at all times or complete Ravensdown Site Induction • Conduct Task Based Risk Assessment and Take 5 before any work on site. • Give way to vehicle traffic, follow pedestrian areas. • Vehicle traffic have right of way.	2 - Unlikely	C - Serious	Moderate	Persons conducting site visit and Ravensdown representative	Yes	Refer Control Measure	Persons conducting site vist and Ravensdown Representative	Ongoing	Open
1.02	COVID-19	Manual processes impacted by human access in the event of a Covid "second wave" in NZ . This can restrict access for investigations. Causes: Access for site investigations restricted Impact: Increased construction costs and risk	Site inspectors and Ravensdown staff	3 - Likely	D - Significant	Moderate	• Follow Aurecon and Ravensdown H&S procedures regarding covid-19 • If unwell do not undertake site inspection	2 - Unlikely	D - Significant	Low	Persons conducting site visit and Ravensdown representative	yes	Refer Control Measure.	Persons conducting site vist and Ravensdown Representative	Ongoing	Open
1.03	Surveying and other investigative work such as contamination and potholing investigation	Additional risks include penetrative ground investigation which can incur greater risks such as; service strike, heightened risk of vehicle and plant movement around site and exposure to hazardous materials when carrying out investigative work. Work may also include working within the roading corridor of Waitangi Road. Additionally, work may also include the oceon parralel to site.	People visting site for investigatie work	3 - Likely	C - Serious	High	• Work permit to be acquired for any work carried out on site • Ravensdown induction must be carried out for anyone not escorted by Ravensdown staff. • Contractor undertaking additional testing to plan works in an efficient manner to minimise exposure to risk. • Service plans to be given to potholing staff to inform relative location of services • If working outside the Ravensdown Awatoto site (such as on Waitangi Road) permits will likely need to be obtained from the local authority and a separate traffic management plan may need to be lodged, as per requirements. This also may include working adjacent and within the Hawke Bay (ocean).	2 - Unlikely	C - Serious	Moderate	Persons conducting site visit and Ravensdown representative	Yes	Refer Control Measure. Designers to as much as pratically possible to limit the frequency and scope of investigative works. When preparing the potholing and additional testing scope, critical services locations (such as HV power) are to be flagged as unknown, and care must be taken when potholing. Locating services prior to infrastructure design will minimise potential clashes during construction. Geotechnical investigations planned to be done in parallel of potholing and or hydroexcavations to allow for safter inspection of the insitu soils. This also includes potential clashes if excavation takes place outside of the Ravensdown Awatoto site.	Aurecon	Ongoing	Open
Construction and Commissioning Phase																
2.01	Live construction within a busy fertiliser manufacturing and distribution site.	• Injury as a result of accident during construction due to high volumes of different heavy vehicle movement and staff. • Mismanagement of construction and site operations causing confusion and disorder thereby creating an unsafe workplace with high risk of injuries.	Contractors/Client/Operations/Designers	4 - Good chance	C - Serious	High	• Contractors and Ravensdown to communicate closely on a regular basis regarding the movement of staff and plant, progress of construction and any safety concerns. • Aurecon/Ravensdown/Contractor to coordinate programmes and staff to ensure the safety of everyone on site. • Contractor to follow Ravensdown's Work Permit procedures •Coordinate construction methodology with Ravensdown. •Exclusion zone to be determined in construction methodolgy •Detour may be required if lanes are closed due to construction. •Design to consider locations in places outside of traffic lanes as much as possible. Infrastructure linked to the potential basin/ponds to be located in areas to minimise disruptions to vehicle movments.	2 - Unlikely	C - Serious	Moderate	Contractor / Ravensdown	Yes	•Set up regular site progress meeting to update each party on the happenings on site. • Ravensdown and Aurecon to take lead in managing the construction programme and operations onsite. •Ravensdown to create site specific safety plan for this project •Traffic management to be implemented i.e. consider stop go traffic controller or temporary traffic signals if required. Follow traditional traffic management practices. Contractor to provide construction safety management plans for review by Ravensdown and Aurecon, prior to commencing work on site. Aurecon to include requirements to meet in the specification.	Contractor / Ravensdown / Aurecon	Ongoing	Open
2.02	Management of Contract	• Issues arise with programming and ensuring the contractor is meeting milestone targets. • Quality of installation is not monitored appropriately during construction and issues identified early.	Engineer / Contractor / Principal	3 - Likely	C - Serious	High	• Ensure an appropriately qualified Engineer to the Contract and Engineer's Representative to manage and monitor the work regularly enough. • Aurecon can provide Design RFI support.	1 - Very unlikely	C - Serious	Moderate	Engineer / Contractor / Principal	Yes	This is to be managed closer to the time that the construction phase is approved.	Engineer / Contractor / Principal	Ongoing	Open
2.03	Trenching within roading corridor (Waitangi Road - Napier City Council (NCC) Wastewater Treatment Plant (WWTP) sea outfall)	• Conflict with traffic • Utility clashes or strikes • Overhead powerline strikes (refer identified item 2.23) • Damage to stock fencing resulting in the stock escaping	Contractors//Designers	3 - Likely	C - Serious	High	• Designer to identify on the design drawings the known overheads and underground utilities as provided by the utility providers. • Contractor to carry out a site walkover to identify visible risks and organise a service locate along the full length of the trench alignment and pothole to confirm any critical locations such as any underground utilities around the substation. • Contractor to organise through the local authority the necessary permits to work in the road corridor and provide a traffic management plan. This is to be shared with Aurecon and NCC. • Follow guidelines as outlined in 2.01 and 2.23	2 - Unlikely	C - Serious	Moderate	Contractor	Yes	Refer control measures.	Contractor	Ongoing	Open
2.04	Installation of sea outfall pipe to Ravensdown specific sea outfall	• Increased site risk due to installing within the ocean • Working in water causing a drowning risk • Boat traffic	Contractors//Designers	3 - Likely	C - Serious	High	• Contractor to monitor for boat traffic including: harbour boats, private boats kayaks etc. Unorthorised boats are not to have access to the construction site (floating barriers to be considered)	2 - Unlikely	C - Serious	Moderate		Yes	Refer control measures.	Contractor	Ongoing	Open
2.05	Making connection to existing NCC WWTP	• Contractor damages the pipe during connection procedure resulting in spill of treated sewerage and plant shutdown. • Design risks haven't been properly considered and accounted for resulting in a failure of the connection.	Contractor / Designer / NCC	2 - Unlikely	B - Critical	High	• Contractor to ensure that the right procedures for connection are followed and that the suitable NCC Engineer/Personnel are present when making the connection. • Designers to have held discussions with the asset owner to identify all the risks in making the connection and get approval confirming the asset owner is satisfied with the proposed connection design.	1 - Very unlikely	C - Serious	Moderate	Contractor / Designer / NCC	Yes	This is a high risk operation and will require accurate detailed design	Contractor / Ravensdown / Aurecon	Ongoing	Open

Safe Design Risk Register – Ravensdown Stormwater Improvements

Client	Ravensdown	**Workshop Date**	6/05/2021
Stakeholders	Ravensdown , HBRC, NCC, surrounding residents	**Revision No.**	A
Meeting Attendees	Aurecon - Ben Henry, Sam Morris, Alice Hoskins	**Project No.**	509619
		Project Manager	Anna Lindgren
		Client Contact	Helen Hurring

Risk Rating Matrix

Most Likely Consequence	Likelihood of occurrence: 5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

Notes:

1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
3. The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	SiD Workshop Action / Comment (or justification if no action)	SiD Workshop Action Owner(s)	Timing / Date	Status (Open / Closed)
2.06	Site Inspections	• Injury as a result of accident during site inspection on a busy manufacturing and live construction site. Specific hazards include: ○ Heavy construction machinery e.g. Contractor excavators, loaders and truck and trailer units. ○ Heavy Ravensdown truck and plant movements e.g large truck and trailer units and loaders ○ Large stockpiles of excavated material located within the site	Contractor/Client/Engineer	2 - Unlikely	C - Serious	Moderate	• Follow Aurecon, Ravensdown and Contractor H&S procedures to assist in identifying and managing hazards prior and during site visits. • All staff working regularly onsite must be site inducted or escorted by a Ravensdown representative at all times. • Aurecon to meet internal H&S requirements (Conduct a task based risk assesment and Take 5 before undertaking any work onsite).	2 - Unlikely	C - Serious	Moderate	Contractor/Ravensdwon/Aurecon	Yes	•Clearly delineate where construction sites are and specify exclusion zones on plans •Ensure contractor is fully aware of the traffic plan within the site and has their own TMP working in coordination. Stockpile Storage will be required for construction of storage ponds and trenching. Plans to show agreed storage and work areas. Operational traffic plan in Aurecon Specification for Contractor Information. Location of stockpile location and site entrances to be shown on the ESCP	Contractor / Ravensdown / Aurecon	Ongoing	Open
2.07	Site access and movement of mobile machinery	• Unsuitable access and room for plant and machinery movement around working area creating risks such as collisions between plant (including between the Contractor and Ravensdown)	Contractor/Client	2 - Unlikely	C - Serious	Moderate	• Ensure there is sufficient working space and access for Contractor. • Construction methodolgy to include plans of working areas, location of stockpiles, trenches and access. • Refer to item 2.01.	2 - Unlikely	C - Serious	Moderate	Contractor/Ravensdwon	Yes	•Contractor to meet prior to construction with Ravensdown to discuss methodology on how they plan to execute the construction. • Contractor to communicate needs and concerns to Ravensdown/Aurecon. • Ravensdown to communicate with its operators and staff about the construction programme and implement any additional controls to ensure the safety of the Contractor and Ravensdown staff. • Ravensdown to communicate with the contractors regarding an appropriate area to set up a site office. Ravensdown to provide a traffic plan (including exclusion zones) within the site to be encompassed in the Operations and Maintenance Manual (OOM). • Ravensdown is to coordinate with the site contractors any changes to the trafic management and any restrictions due to business site operations.	Contractor / Ravensdown / Aurecon	Ongoing	Open
2.08	Dust	• Dust/airbourne chemical inhalation (e.g. excavated contaminated material or manufacturing products) and eye irritation. • Reduced visibility to operate equipment safely. • Dust affecting neighbouring properties. • Potential risk of exposure to ACM (asbestos containing materials) and other contamintnats entrained in the soils	Community / Contractor / Aurecon / Ravensdown	3 - Likely	D - Significant	Moderate	• Dust control management strategy to be included in the Specifications and Erosion and Sediment Control Plan. • Contractor to implement suitable measures to manage dust and contaminated material during construction. • Ravensdown to organise a site specific CSMP (contaminated site management plan) which is to be followed by all. This will require a contamination specialist to assess the site. • Any contamination identified during pre consruction are to be highlighted to the contractor to ensure appropriate site measures. •Correct PPE to be used	2 - Unlikely	D - Significant	Low	Contractor / Aurecon / Ravensdown	Yes	• Ensure dust control management strategy included in the specifications and ESCP. • Implement ESCP and provide regular inspection and maintenance of control measures. Ravensdown will likely need to engage a reliable local engineering firm to carry out the site inspections and manage the contract during construction. •Select an experienced and knowledgeable contractor in identifying asbestos containing material if asbestos is likely to be encourtered on site. •Ravensdown to supply Contractor with Dust Management Plan for Ravensdown manufacturing activities •Inform Contractor of known contaminanted areas on plans •Design to avoid all known hazardous contaminated areas where possible •Dust discharge during construction is covered under section 6.4 of the Hawkes Bay Resource Management Plan. The contractor shall supply a dust management plan prior to starting work. A tool box meeting between the contaminated land specilist for the project and the contractor is to take place at the beginning of the project to inform the contractor on how to handle contaminated material during construction.	Contractor / Ravensdown / Aurecon	Ongoing	Open
2.09	Service strike during construction	• Damage to services during construction, leading to injury from exposure to services such as gas, power and wastewater. • Disruption to communications, water supply etc as a result of service strike. • Unknown power services on site • Unknown submarine cables	Contractor	3 - Likely	B - Critical	Extreme	• Potholing will conducted during detailed design to minimise this risk. Potholing is proposed in areas where high risk services such as HV power. • Used Ground Penetrating Radar (GPR) to identify the locations of unknown services along the alignment in areas of proposed infrastructure. • Hydroexcavate where unexpected services have been found • Appropriate separation distance is included between proposed services and the existing services that will be designed. • Where possible isolate (shut down) the service when constructing in the vicinity. • Spotters must be used. • Investigation of potential underground cables to be considered. Majority of services are telecom or 3 waters services, hence a clash would not cuase serious harm.	2 - Unlikely	C - Serious	Moderate	Contractor / Ravensdown	Yes	Aurecon is to review the outcomes from potholing and other additional testing done on site. This will feed into the proposed design where high risk services are to be avoided.	Aurecon	Ongoing	Open
2.10	Service Relocation	• H&S risk associated with working with live services	Contractor	3 - Likely	B - Critical	Extreme	•Contactor to work with Ravensdown and communicate temporary shut down of sercices when required. •Potholing and GPR to be completed in detailed design for design footprints •Design basins and infrastructure to eliminate the need to relocate high risk services if possible	1 - Very unlikely	D - Significant	Low	Contractor / Ravensdown	Yes	•GPR pipe alignments to reduce the risk of service clashes	Aurecon	Ongoing	Open
2.11	Excessive noise	• Damage to hearing via exposure to excessive noise. • Complaints from neighbours as a result of excessive noise.	Contractor/Community	1 - Very unlikely	C - Serious	Moderate	• Work to be undertaken in accordance with NCC guidelines. • All personnel must wear appropriate Personal Protection Equipment (PPE) ear muffs during construction and operation including ear protection as required. • Operating of machinery only to be undertaken within consented hours. • Contractor to follow Ravensdowns provided H&S standards	1 - Very unlikely	C - Serious	Moderate	Contractor / Ravensdown	Yes	• NCC noise restrictions to be encompassed in the civil specification • Notify any neighbouring impacted sites prior to starting construction regarding upcoming works and potential noise.	Contractor / Ravensdown / Aurecon	Ongoing	Open
2.12	Trips and falls	• Trips/slips due to uneven ground and messy worksite and associated injuries. •Injury from falling at elevated heights i.e. open trenches	Contractor	3 - Likely	D - Significant	Moderate	• Contractor to ensure a safe working environment for everyone onsite - stated in specifications. • Valve and pit covers to be flush with surrounding ground to remove trip hazards. • Be aware of surroundings when navigating around the site. • Any excavations to be properly fenced or otherwise protected. Potholes to be filled after locates are complete. •Safety boots (less in the administrative building) to be worn at all times when on site • Exclusion zones around open areas • Fencing to be installed where there is a risk of falling. e.g. around open trenches	2 - Unlikely	D - Significant	Low	Contractor	Yes	As per control measure.	Contractor	Ongoing	Open

Safe Design Risk Register – Ravensdown Stormwater Improvements

Client	Ravensdown	**Workshop Date**	6/05/2021
Stakeholders	Ravensdown , HBRC, NCC, surrounding residents	**Revision No.**	A
Meeting Attendees	Aurecon - Ben Henry, Sam Morris, Alice Hoskins	**Project No.**	509619
		Project Manager	Anna Lindgren
		Client Contact	Helen Hurring

Risk Rating Matrix

	Likelihood of occurrence				
Most Likely Consequence	5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

Notes:

1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
3. The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	SiD Workshop Action / Comment (or justification if no action)	SiD Workshop Action Owner(s)	Timing / Date	Status (Open / Closed)
2.13	Earthquakes / Aftershocks / Tsunami threat	• Risk of injury during earthquakes / aftershocks i.e. collapse of trenches or stockpiles • Ravensdown Awatato site boarders the ocean. Risk of Incoming tsunami wave	Contractor	2 - Unlikely	C - Serious	Moderate	• Have emergency response plans in place to prevent the injury. Contractor to refer to Ravensdown H&S and evactuation procedures • Contractors to avoid any high risk areas including near the stockpiles, trenches and buildings if an earthquake occurs •Emergency plan to be covered off with Contractor •Exclusion zone fom buildings •Contractor to be aware of tsunami warning siron noise	2 - Unlikely	C - Serious	Moderate	Contractor / Ravensdown	Yes	As per control measure.	Contractor	Ongoing	Open
2.14	Public Access (works very exposed to public eye)	• A member of the public or Ravensdown subcontractor is injured through interaction with the construction site • There is a cycle trail near the southern boundary of the Ravensdown Awatato site. The works on site is very exposed to the users on the cycle trail.	Community	3 - Likely	D - Significant	Moderate	• Contractor to implement measures to restrict and manage public access to work site e.g. fencing and construction site signage even within Ravensdown land. •Construction site fences	1 - Very unlikely	D - Significant	Low	Contractor / Ravensdown	Yes	As per control measure.	Contractor	Ongoing	Open
2.15	Water in trenches and ponding in basins during storm events	• Deep open trenches and excavations with ponding water creating risk of drowning and unstable saturated soils	Contractor	2 - Unlikely	B - Critical	High	• Contractor to monitor forecasts daily, ensuring channel and pipe networks are free from obstructions. • Contractors and their equipment gear to be moved out of water channels prior to any event. • Ensure fencing around any deep open excavations. • Follow confined space entry procedures when appropriate • Cover open excacations before rain • Contractor to consider dewatering methods if excessive water enters a holding basin and or trenchs	1 - Very unlikely	D - Significant	Low	Contractor	Yes	x	Contractor	Ongoing	Open
2.16	High Ground Water Level (GWL) expected on site	• It is expected due to the site's proximity to the sea, and a large waterway that GWLs will be high on site (affected by tidal and seasonal influences). • There is a risk of ground water entering any excavations made on site causing delays in work. • Excavated walls could become saturated and unstable causing wall collapse due to excessive water entering the area.	Contractor / Designer	4 - Good chance	C - Serious	High	• Designers to identify the seasonal and tidal variation of GWLs and how this will affect the excavations on site. • Dewatering methods to be identified such as sheet piling, dewatering spears, or a submersible pump. Pumping methodology to be determined for dewatering of holding basins, trenches or other excavated areas after large storm events. • Open trenches and other excavations to be backfilled as soon as possible. • Shield trenches and other excavation wall protection measures should be installed where appropriate (following 2.22 if the trench depth is >1.5m)	2 - Unlikely	C - Serious	Moderate	Contractor	Yes	Specification to include approriate dewatering methods and other high ground water protection measures. Costings to include the use of dewatering spears into costs (costly) assuming GWL is high.	Contractor	Ongoing	Open
2.17	Operations stockpile storage area	• Running out of space for operational stockpile storage effecting continuation of works. • Having to pay expensive disposal fees (variances)	Contractor/Ravensdown/ Aurecon	3 - Likely	D - Significant	Moderate	Dedicate a suitable area that is sufficiently sized for stockpiling the storage ponds and trench material into different contaminated levels as necessary. Ensure excavation on site continues in an efficient manner and avoids premature stockpile disposal due to limited space.	2 - Unlikely	D - Significant	Low	Aurecon/Contractor /Ravensdown	Yes	As per control measure.	Contractor / Ravensdown	Ongoing	Open
2.18	Site fencing during construction	• Fences blown down during high winds, risking injury to anyone nearby and potentially allowing access to the site.	Contractor/Community	3 - Likely	D - Significant	Moderate	• Contractor to ensure all fences are appropriately secured and clamps are used.	2 - Unlikely	D - Significant	Low	Contractor	Yes	As per control measure.	Contractor	Ongoing	Open
2.19	Contamination encountered during construction	• Dangers associated with exposure to contaminated site, i.e. asbestos, fertiliser.	Contractor	4 - Good chance	D - Significant	High	• Follow site specific CSMP are followed • The contractor shall complete all work in accordance with the relevant NCC Construction and Work Safe NZ guidelines and regulations for removal of contaminated material. • If contaminated material to remain on site, appropriate control measures to prevent exposure or dispersion • Work shall be undertaken by competent persons.	2 - Unlikely	D - Significant	Low	Contractor	Yes	• Inform Contractor of known contaminanted areas on plans • Design to avoid all known hazardous contaminated areas.	Aurecon	Ongoing	Open
2.20	Suspended loads	• Lifting of concrete structures i.e. manholes, pipes and trench shields create risk of lifting equipment failure and/or risk of striking people or plant with suspended load.	Contractor	1 - Very unlikely	A - Disastrous	High	• The contractor shall complete all work in accordance with the relevant NCC Construction and Work Safe NZ guidelines and regulations. • No personnel shall work beneath suspended loads. • Correct lifting equipment and procedures to be used, including the use of safety pin • All testing of lifting equipment up to date and meeting standards. • Excavaters lifting loads must have safety pin in place if carrying suspended loads. • Spotters must be present when operating plant to lift loads • Lifting of unusually shaped structures to be considered with care. At present there is no unusual infrastructure proposed.	1 - Very unlikely	D - Significant	Low	Contractor	Yes	As per control measure.	Contractor	Ongoing	Open

Safe Design Risk Register – Ravensdown Stormwater Improvements

Client	Ravensdown	**Workshop Date**	6/05/2021		
Stakeholders	Ravensdown , HBRC, NCC, surrounding residents	**Revision No.**	A		
Meeting Attendees	Aurecon - Ben Henry, Sam Morris, Alice Hoskins	**Project No.**	509619		
		Project Manager	Anna Lindgren		
		Client Contact	Helen Hurring		

Risk Rating Matrix

	Likelihood of occurrence				
Most Likely Consequence	5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

Notes:

1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
3. The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	**Risk Source (Hazard)**	**Event / Cause / Consequence**	**Persons Affected**	**Likelihood**	**Consequence**	**Risk Rating**	**Control Measure (Risk Treatment)**	**Likelihood**	**Consequence**	**Risk Rating**	**Risk Owner**	**Implement Control - Y/N?**	**SiD Workshop Action / Comment (or justification if no action)**	**SiD Workshop Action Owner(s)**	**Timing / Date**	**Status (Open / Closed)**
2.21	Confined space entry	• H&S risk associated with work within a confined space. i.e. manhole access, flow splitter manhole access	Contractor	3 - Likely	D - Significant	Moderate	• Avoid the need to enter confined spaces such as manholes through appropriate construction methodology planning • When confined space entry is unavoidable, workers to be properly licensed and follow established WorkSafe guidelines for confined space entry • The use of a vertical spindle pump will be explored which removes the requirement to enter the respective manhole. • Manholes to be adequately sized for installation/construction of valves etc.	2 - Unlikely	D - Significant	Low	Contractor	Yes	Investigate the ability to bring up fittings to ground level, this could include designing to account for the use of spindles to activate valves, pumps that can be riased or lowered into deep manholes. Suitable access for certified maintenance access.	Aurecon	Ongoing	Open
2.22	Deep open trenches/excavations	• Risk of trench sides caving as a result of deep excavations e.g. construction of deep basins • Risk of machinery/people falling into the excavation as a result of trench collapse	Contractor	3 - Likely	B - Critical	Extreme	• Construct benching for deep trenches where possible, so it's easy to get out if someone falls in. • Use trench shields (for trenches >1.5m) • Observe safe distances between plant and unsupported trench edges • Actuated valves to allow pipes to be more shallow have been considerered. • Design ensures pipes are as shallow as possible • Follow process as identified in 2.16	1 - Very unlikely	B - Critical	High	Contractor	Yes	As per control measure.	Contractor	Ongoing	Open
2.23	Overhead power lines and power poles	• Risk of striking poles when operating machinery on site or on Waitangi road	Designer / Contractor	2 - Unlikely	C - Serious	Moderate	• Designer to locate any proposed manhole structures or any structure that requires lifting using an excavator away from overhead powerlines. • Contractor to identify areas of potential overhead strike and have a management plan to mitigate risk.	1 - Very unlikely	C - Serious	Moderate	Contractor	Yes	Any overhead powerlines and power poles to be indentified. Design considerations will be made to avoid the neccesity to use machinary in areas with overhead power cables. This will be consideration of an appropriate chosen alignment, and where unavoidable the contractor is to identify a methodology to mitigate the risks in the management plan and implement this.	Aurecon	Ongoing	Open
2.24	Working in deep trenches/Excavations i.e. >1.5m	• Trench or excavation collapse • The site has a high groudwater level therefore has an increased risk of groundwater entering the trench • During a rainfall event, water can enter trenches	Contractor	3 - Likely	B - Critical	Extreme	• Use shields and bench excavations where required • Implement correct dewatering measures • Worksafe to be notified when undertaking notifable works. • No personnel to be in trenches when dump trucks are in close proximity. • Ensure appropriate dewatering methodology is implemented when dewatering is required. • Remove the need for dewatering by backfilling trenches when heavy rainfall event is expected. • Where trenches meet the definition of a confined space, use confined space entry procedures (see 2.21)	2 - Unlikely	B - Critical	High	Contractor	Yes	As per control measure.	Contractor	Ongoing	Open
Operations Phase																
3.01	Ponding of water within green infrastructure such as basins and ponds	• Green infrastructure may have a significant volume of water within them in rainfall events, creating a risk of drowning if anyone fell into them. • Risk of car driving into green basins/ponds.	Client	1 - Very unlikely	A - Disastrous	High	• Prevent access to the edge of the green infrastructure and minimise likelihood of people falling in. A minimum 1.2m high fence to be installed around pond perimeter. • Reduce risk of falling into green infrastructure by minimising the grades depth, where steep slopes are unavoidable, provide means for escape. • Locate green infrastructure in an area that minimises the risk of internal truck movement conflicting, if this cannot be avoided a suitable vehicle barrier or tree plantings shall be considered • Lower stage of the green infrastructure shall be approx. 1m deep - shallow enough for adult to escape. • Lockable pool type fencing to be installed around all green infrastructure - to be considered further. Pool type fencing required where green infrastructure is not in site perimeter and/or flatten slopes. Potentially bollards with chain link could be used. •Self-maintaining landscaping will reduce the need to maintain near the green infrastructure	1 - Very unlikely	C - Serious	Moderate	Ravensdown	Yes	•Work with landscaper to prevent public vehicles/people from accessing pond through either bunds or trees. •Investigate reduced-maintenance vegetation • Consider the use of appropriate fencing around any green infrastructure •Design flatter slopes for easier escape 1:3 to 1:4 where possible	Aurecon	Ongoing	Open
3.02	Ongoing water quality sampling during rainfall events	• Risk of falling into manholes when obtaining sample - risk heightened during rainfall when it is wet and slippery • Risk of injury from lifting heavy manhole lids	Client	3 - Likely	D - Significant	Moderate	• Use continuous water quality sampling technology to prevent the need to collect samples during rainfall events. Samples can be collected when there is no flow or wet surfaces present. • Remove the need to enter manhole when collecting samples through an elevated sample collection or similar. •Extension arm sampler used for grab samplers.	1 - Very unlikely	D - Significant	Low	Ravensdown	Yes	• If sampling is required as part of Ravensdown new discharge consent with HBRC, an automatic smapling should be considered. • If possible, remove the need to lift heavy manhole lids. Webforge grating could be used if appropriate • Consider removing the need to remove the manhole lid.	Aurecon	Ongoing	Open

Safe Design Risk Register – Ravensdown Stormwater Improvements

Client	Ravensdown	**Workshop Date**	6/05/2021	
Stakeholders	Ravensdown , HBRC, NCC, surrounding residents	**Revision No.**	A	
Meeting Attendees	Aurecon - Ben Henry, Sam Morris, Alice Hoskins	**Project No.**	509619	
		Project Manager	Anna Lindgren	
		Client Contact	Helen Hurring	

Risk Rating Matrix

	Likelihood of occurrence				
Most Likely Consequence	5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

Notes:

1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
3. The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	**Risk Source (Hazard)**	**Event / Cause / Consequence**	**Persons Affected**	**Likelihood**	**Consequence**	**Risk Rating**	**Control Measure (Risk Treatment)**	**Likelihood**	**Consequence**	**Risk Rating**	**Risk Owner**	**Implement Control - Y/N?**	**SiD Workshop Action / Comment (or justification if no action)**	**SiD Workshop Action Owner(s)**	**Timing / Date**	**Status (Open / Closed)**
3.03	Pump/valves and overral outlet Maintenance	• Operations staff will be required to troubleshoot the pump for it to be operational again. This will pose an H&S risk particularly if the green infrastructure is full. • Maintainable infrastructure may be outside of the Ravensdown Awatoto site boundary.	Client	3 - Likely	D - Significant	Moderate	• Pump to be located in an accessible location i.e. pump located at ground level. stabilised platform to allow access • Operations and maintenance manual shall have common troubleshooting approaches with simple and easy to understand instructions. • Use identical equipment throughout site for easy maintenance and interoperability • A gravity discharge bypass will be provided to allow for some discharge during pump outage • If maintenance is required outside of the Ravensdown Awatoto site, a traffic management plan is required as per 2.03	2 - Unlikely	D - Significant	Low	Ravensdown	Yes	• Fitting to be designed above ground to remove the need for maintaining with confined spaces • Provide stablised access, confirm type of forklift used at Ravensdown • Single phase power and water to be provided for ease of maintenance. • Vehicle access to any discharge point to be considered to enable flushing the system	Aurecon	Ongoing	Open
3.04	Clearing blockages when green infrastructure is in operation during a rainfall event	Safety risks associated with clearing debris from: outlet grills, sump grating, valves, pumps. Biggest risk is clearing of grills especially if under water making it difficult to clear and access. Clearing blockages near running/standing deep water poses a drowning risk	Client	3 - Likely	C - Serious	High	•Design considerations to be made to remove the likelihood of the outlet being blocked i..e providing pre-treatment in an oil and grit separator • If a grill is encompassed within the green infrastructure, accessibility during rainfall events, the material to avoid slip hazards will be considered.	2 - Unlikely	C - Serious	Moderate	Ravensdown	Yes	• Eliminate grate from outlet pipe to minimise risk of pipe clogging. Debris would acccumulate in manhole, where it may be more easily removed	Aurecon	Ongoing	Open
3.05	Public Access	Risk of public entering the site and interacting with the green infrastructure. There is a cycle route on the southern boundrary of the site which is at close proximity to the proposed green infrastructure. Risk of harm (exposure to contaminants or drowning) is high when green infrastructure is full.	Client	2 - Unlikely	B - Critical	High	• Consider providing a high fence along the southern boundary so that green infrastructure is out of sight from public eye or the fence is not able to be climbed. If the green infrastructure is out of view there is less likelihood public would enter the site (via the vehicle entrance or over the fence) to inspect the green infrastructure. • Control measures as per item for ponding water shall be implemented to reduce the consequences • Tree planting to be considered • Refer 3.01 regarding pool type fencing	1 - Very unlikely	C - Serious	Moderate	Ravensdown	Yes	As per control measure Fencing to be considered as design porgresses	Aurecon	Ongoing	Open
Maintenance Phase																
4.01	Mowing of grass surfaces, removal of sediment within green infrastructure	• Accident due to steep slopes i.e. overturning of mower	Client	2 - Unlikely	C - Serious	Moderate	• Slopes will be flat enough to allow mowers to operate safely if grassed. • Eliminate the need for mowing where steep slopes are present with planting at the lower stages • Remove need for maintaining base of green infrastructure frequently using a rock / concrete lined base or providing and upstream sediment tank i.e. oil and grit separator • Provide access ramp at minimum 1V:12H batters if ride-on mower required • Upstream oil/grit separator to remove frequency of sediment • Concrete low flow channel to collect any residual sediment. This will be easier to maintain/wash down.	1 - Very unlikely	C - Serious	Moderate	Ravensdown	Yes	•Work with landscape architect to design plantings that have minimal maintenance requirements including irrigation and grass. Where irrigation is required, consider automated irrigation. •Water source and services required to maintain green infrastructure to be close by •Pretreatment for sedienment upstream of green infrastructure to considered to reduce the need to remove sediment at the bottom of the green infrastructure. • Concrete low flow channel to make it easier to clear sediment if it reaches the green infrastructure. Steps may be required to access low flow channel. • Check with landscaper surviveability of plants under water for long duration	Aurecon	Ongoing	Open
4.02	Access to inlets for clearing blockage	• Fall/slip into green infrastructure during maintenance • Drowning risk if the green infrastructure has water in it. • The pipe connecting to the NCC WWTP sea outfall is a pressurised systems and therefore no inspection points/chambers can be installed	Client	1 - Very unlikely	B - Critical	High	• Provide access point for maintenance in a location away from spill way if possible i.e. at an elevated level. • Pipe connecting to NCC sea outfall to include air scour valves • Design grill to be within reach from the top of the green infrastructure. • See item 3.01	1 - Very unlikely	C - Serious	Moderate	Aurecon/ Ravensdown	Yes	As per control measure.	Aurecon	Ongoing	Open
4.03	Inspection of manholes	• Risk of being hit by vehicle while inspecting manholes from the top. • Confined spaces risk • Fall risk	Client	2 - Unlikely	B - Critical	High	• Design manholes, especially those requiring frequent maintenance, in locations to allow inspection away from live traffic lanes if possible. • Design system to minimise need to enter manholes for routine maintenance activities. • If inspection of manhole in traffic lane required, ensure spotter is present or inspect manholes during shut-down hours • Ladder access to be considered. Maintenance staff to bring own ladder to remove risk of corroded ladder rungs within manhole. Or stainless-steel rungs to be considered. • Provide enough access to maintain valves/pumps/fittings within manhole • Ensure personnel carrying out maintenance is trained in confined spaces entry and follow appropriate confined space procedures.	1 - Very unlikely	D - Significant	Low	Ravensdown	Yes	•Consider Webforge grating on manholes so larger access available to visually inspect without having to remove the lid	Aurecon	Ongoing	Open
4.04	Access splitter chamber (if these have been included) for clearing blockage during event	• Fall/slip into chamber during maintenance. • Flow splitter manholes require more frequent access than normal manholes. • Operational risk is involved if manhole is within road reserve • Confined spaces risks	Client	3 - Likely	D - Significant	Moderate	• Consider if access is adequate to maintain manhole i.e. double manhole lid if required. • Consider installing upstream sediment tank i.e. oil and grit separator to remove the need to access the flow splitter. This should minimise blockage risk and therefore the need to enter manhole structure • Ensure personnel carrying out maintenance is trained in confined space entry. • Locate flow splitter manholes or any access chambers that require regular inspection in a safe location away from the road corridor and overland flow path. • Minimise the depth of manholes • Ensure personnel carrying out maintenance is trained in confined space entry.	2 - Unlikely	D - Significant	Low	Ravensdown/ Aurecon	Yes	As above to allow inspection from above	Aurecon	Ongoing	Open

Safe Design Risk Register – Ravensdown Stormwater Improvements

Client	Ravensdown	**Workshop Date**	6/05/2021
Stakeholders	Ravensdown , HBRC, NCC, surrounding residents	**Revision No.**	A
Meeting Attendees	Aurecon - Ben Henry, Sam Morris, Alice Hoskins	**Project No.**	509619
		Project Manager	Anna Lindgren
		Client Contact	Helen Hurring

Risk Rating Matrix

Most Likely Consequence	Likelihood of occurrence: 5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

Notes:

1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
3. The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	SiD Workshop Action / Comment (or justification if no action)	SiD Workshop Action Owner(s)	Timing / Date	Status (Open / Closed)
4.05	Pump Maintenance	• Potential confined spaces risks when maintaining pump within manhole	Client	3 - Likely	D - Significant	Moderate	• Pump can be located in an accessible location i.e. at ground level • Operations and maintenance manual shall have common troubleshooting approaches with simple and easy to understand instructions.	2 - Unlikely	E - Minor	Low	Ravensdown	Yes	• Consider the use of a quick release camlock fitting at any discharge outlets. This allows for easy replacement and maintenance.	Aurecon	Ongoing	Open
4.06	Valve, flow meter and non return valve maintenance	• Confined space risks	Client	3 - Likely	D - Significant	Moderate	• Manhole shall be large enough to easily maintain valves. • Valves automatically open and close. This will remove the need for regular manual maintenance and prolong the life of the valve. • Valves to be located in dry manhole to reduce risk of flooding • Appropriate confined space entry procedures to be followed. Ravensdown noted that confined space entry is not unusual for staff onsite.	2 - Unlikely	E - Minor	Low	Ravensdown	Yes	• Configure equipment and fittings in the discharge outlet manhole to allow adequate clearance for maintenance, or design system to have most equipment above ground to remove need to enter manhole (confined space).	Aurecon	Ongoing	Open
4.07	Spray irrigation of stormwater and process water option	• Accumulation of contaminants in soil and vegetation • Potential contamination of deep aquifer • Land receiving spray irrigation could subside (collapse) • Ravensdown Awatoto site within NCC Water Source Protection zone.	Engineer/planner	5 - Very likely	C - Serious	Extreme	• Due to site being within the water source protection zone, option is not possible unless no impact of discharge can be proven	1 - Very unlikely	E - Minor	Low		No				Open
Modification, Demolition and Dismantling Phases																
5.01	Modification or decommissioning of ponds	• Modification of potential flow splitter manholes will be required to decommission the ponds. • Risks associated with removing or modifying the weir within the flow splitter manhole may be located within a confined space, therefore requiring confined space training.	Client	2 - Unlikely	D - Significant	Low	• Demolition contractor to develop a decommissioning strategy with Ravensdown	1 - Very unlikely	D - Significant	Low	Ravensdown/ Contractor	Yes	As per control measure Flowsplitter manholes have been designed with either weirs that can be removed through the existing manhole and/or with an opening that allows access to both sides of the weir.	Aurecon	Ongoing	Open
5.02	Modification or decommissioning of pumps	• Risks associated with removing or modifying pumps as they may be located within a confined space, therefore requiring confined space training.	Client	2 - Unlikely	D - Significant	Low	• Demolition contractor to develop a decommissioning strategy with Ravensdown	1 - Very unlikely	D - Significant	Low	Ravensdown	Yes	As per control measure As above	Aurecon	Ongoing	Open

Appendix E
TFG meeting minutes 16 July 2021

RAVENSDOWN RESOURCE CONSENT RENEWAL PROJECT

TECHNICAL FOCUS GROUP

MEETING 3 MINUTES - DRAFT[1]

DATE	Friday 16 July 2021
TIME	8:30am - 12:00 pm
VENUE	Ravensdown Ltd, Awatoto, LNI Upstairs Meeting Room and Video Conference

IN ATTENDANCE

Andrew Torrens - Ravensdown

Helen Hurring - Ravensdown

Stephen Daysh - Mitchell Daysh

Anita Anderson - Mitchell Daysh

Jamie Thompson - Ravensdown

Marlane Harmer - Ravensdown

Anna Lindgren - Aurecon

Helen Caley - Aurecon

David Delagarza - Aurecon

Malcom Miller - HBRC

Tania Diack - HBRC

Shane Kelly (Coast and Catchment) - HBRC Technical Advisor (linked via teams)

Andrew Curtis (PDP) - HBRC Technical Advisor (linked via teams)

Andrew Gass - NCC

Aki Paipper - Kohupātiki Marae

Margie McGuire - Kohupātiki Marae

Chad Tareha - Ngāti Pārau Hapū

Jenny Mauger - Kahungunu ki Te Matau a Māui

Shade Smith - Ngati Kahungunu Iwi Inc

Sam Robinson - Ravensdown Customer

Senitra Nathan-Marsh - DOC

Reynold Ball - HBDHB

Fred Sugden - Taradale High School

Madison Milley - Taradale High School

Elliot Morell - Taradale High School

Nigel Halpin - BioRich

Tom Kay - Forest & Bird (linked via teams)

APOLOGIES

Matthew Brady - DOC

Kyle Christensen (Kyle Christensen Consulting) - HBRC Technical Advisor

Bridget Wilton - Horticentre Ltd

Ami Coughlan - Fish and Game

Bruce Wills - Ravensdown (Director)

1. Introductions and Karakia

- The Aurecon team advising Ravensdown introduced themselves to the group.
  - Anna Lindgren - Associate, Water
  - David Delagarza - Lead Engineer, Water

[1] To discuss and confirm at TFG Meeting 4.

– Helen Caley - Manager, Environment and Planning

2. Draft Minutes - TFG Meeting 2, 18 May 2021

- The minutes of the second meeting of the TFG, dated 18 May 2021, were confirmed as a true and correct record of the meeting.

  Moved - Chad Tareha
  Seconded - Jamie Thompson
  Carried unanimously

- The meeting minutes will be finalised and attached to the minutes of Meeting 3 (Attachment 1) and added to the project website.

3. Introduction to Multi Criteria Decision Making Framework

- "Banana's" video - *https://www.youtube.com/watch?v=7OoKJHvsUbo (to 2min 35sec)*
- Stephen provided a definition a Multi Criteria Analysis (MCDA) and noted that its purpose is to "*serve as an aid to thinking and decision making, but not to take the decision*".
- Stephen summarised the scoring process as follows:
  - Ravensdown and their technical advisors have developed a range of potential feasible options to manage the process water and stormwater from the site discharging to three receiving environments (ocean, estuary and land). Each option is scored against 10 different criteria under four categories (Technical, Consenting and Environmental, Financial and Stakeholder). The criteria are weighted depending on their relative importance.
  - The options were being presented to the TFG and the group were invited to share their views and ideas on each and come to a collective agreement (where possible) to provide a score for each option against the "Stakeholder" criterion.
  - The Mana Whenua representatives on the TFG had scored the Mana Whenua criterion at a separate meeting and the Ravensdown Project Team and Technical Team have scored the other criteria.
  - The representatives from HBRC and their technical advisors would be observing the scoring process only, as they are the regulators for the resource consent process.
  - Ravensdown would make the final decision as to the option they would progress through the resource consent application process, but after considering all the advice and views gained through the MCDA exercise.
  - The Project Team will complete a Discharge Strategy and Project Description for the chosen options which would then be subject to expert assessment of effects studies.
  - An assessment of the Environmental Effects will be completed with the application which will be lodged with the HBRC by the end of November 2021.
  - The TFG will be updated through the pre-application processes.

4. Agree Objective

- The following objective for the MCDA process was presented and agreed to by the members of the TFG.

  To establish the most sustainable long-term solution for the treatment and discharge of stormwater and process water from the Ravensdown Napier Works to enable the continued operation of the site.

5. Agree Weighting

See Meeting 3 Agenda -Attachment 2 and Introductory Presentation (project website).

- Stephen explained the rationale for the weighting of the criteria. While all criteria are important, many are not all necessarily of the same weight for decision making. A weighting of 1 is for criteria considered of lower importance, and 3 is for criteria considered higher importance. The weighting is used in the calculation of the final scores for the options.
- The TFG was asked for feedback on the proposed weighting presented and all agreed that the weighting developed for each criterion was appropriate.

6. Presentation of alternatives options developed under s105 of the RMA - Anna Lindgren, David Delagarza, Helen Caley (Aurecon)

See Aurecon Presentation (project website).

- The Aurecon team presented the options available to Ravensdown for the management, treatment and discharge of the site process water and stormwater, considering the three receiving environments - ocean, estuary and land.
- It was noted any discharge to land in the vicinity of the site would need to consider the Napier Source Protection Zone for the Napier city drinking water. Napier City Council have provided feedback that they would not support any discharge to land in this area. Stephen explained that a discharge to land in the source protection zone is not prohibited under the current TANK plan, however there would be a need to provide a high standard of proof to demonstrate the level of effects from any discharge and any risk to drinking water.
- Aurecon explained the various treatment devices being investigated:
  - Settling Pond - for removal of suspended solids. Generally, the first step in any treatment process.
  - Wetland - relies on natural processes for removal of many contaminants. Quite high removal of many nutrients, removal of some metals and some suspended or dissolved contaminants.
  - Bioretention Basin and Bioreactor - biological processes for enhanced removal of phosphorus and ammoniacal nitrates. Require a continuous flow of water to maintain a healthy environment which is challenging when the system is relying on stormwater.
  - Filter Media - water is passed through a media and contaminants either absorb onto the media or create an ion exchange process. Examples of media used in other situations include rocks or oyster shells. The media needs to target the particular element requiring removal.
  - Clarifier - an enhanced settling pond with an additional chemical dosing process where a flocculation or precipitation chemical is added. Potential for a high removal of dissolved reactive phosphorus.
  - Membrane Filter Plant – Effective for filtration of suspended particles however an additional process is required for dissolved contaminants. Very energy intensive process. Results in two wastewater streams - a very clean water, and a highly concentrated contaminated water stream that needs further management.
- Aurecon also noted that systems are generally designed to capture the 90th or 95th percentile storm events.
- All options would follow appropriate source control to manage and reduce the likelihood of contaminants entering stormwater across the site. This will be included in the discharge strategy for the chosen option.

7. Scoring of Stakeholder criteria

See attached final Matrix.

- Stephen introduced the Stakeholder criteria and explained that the group should provide their thoughts on each option and come to an agreement on a score between 1 (unfavourable) and 5 (preferred). Comments were recorded in the matrix. Stephen then led the group through the scoring of the "Stakeholder" criteria for each option.

8. Explanation of Mana Whenua criteria scores

- Stephen explained that the project team met with the TFG Mana Whenua representatives on 14 July to score the "Mana Whenua Values" criteria for each option.
- Jenny summarised the Mana Whenua scoring and advised that they were aligned with the TFG's discussions at this meeting, noting that a discharge to Tangaroa was their highest rated option as it provided for mixing with Tāwhirimātea and Tamanuiterā. The second highest rated option was a combination with the higher risk areas discharging to Tangaroa or Papatūānuku and the lower risk areas with the highest quality of water to the Waitangi Estuary.
- Shade noted that they have an obligation as kaitiaki and that enhancement and restoration was equally important.
- Margie provided the group a historical account of the land and rivers.

Agreed Action 1:	Helen H and Anita to follow up with Margie and discuss producing a map of the area based on Margie's description.

9. Final Ranking of Options

See attached final Matrix.

- Helen C displayed the overall ranking of the options following the scoring process. The top scoring option was the "Combination of Options" with a final score of 82.

10. Next meeting

- The next TFG meeting will be to present the discharge strategy for the resource consent application.

Meeting Closed at 11.54am

Minutes prepared by Helen Hurring and Anita Anderson ravensdown

Attachment 1: FINAL Minutes, TFG Meeting 2, 18 May 2021

RAVENSDOWN RESOURCE CONSENT RENEWAL PROJECT

TECHNICAL FOCUS GROUP

MEETING 2 MINUTES - FINAL[1]

DATE	Tuesday 18 May 2021
TIME	12:00pm - 4:00pm
VENUE	Kohupatiki Marae, Kohupatiki Road, Clive

IN ATTENDANCE

- Andrew Torrens - Ravensdown
- Helen Hurring - Ravensdown
- Stephen Daysh - Mitchell Daysh
- Anita Anderson - Mitchell Daysh
- Jamie Thompson - Ravensdown
- Marlane Harmer - Ravensdown
- Ngaire Phillips - Streamlined Environmental
- Richard Chilton - Tonkin+Taylor
- Francesca Kelly - Environmental Medicine Ltd (linked via teams)
- Jack Blunden - HBRC
- Malcom Miller - HBRC
- Tania Diack - HBRC
- Shane Kelly (Coast and Catchment) - HBRC Technical Advisor (linked via teams)
- Kyle Christensen (Kyle Christensen Consulting) - HBRC Technical Advisor (linked via teams)
- Aki Paipper - Kohupātiki Marae
- Margi McGuire - Kohupātiki Marae
- Taylor Materoa - Kohupātiki Marae
- Nigel Halpin - BioRich
- Sam Robinson - Ravensdown Customer
- Matthew Brady - DOC
- Senitra Nathan-Marsh - DOC
- Reynold Ball - HBDHB
- Tom Kay - Forest & Bird (linked via teams) (part of meeting)
- Fred Sugden - Taradale High School
- Madison Milley - Taradale High School
- Elliot Morell - Taradale High School
- Shade Smith - Ngati Kahungunu Iwi Inc (part of meeting)
- Jenny Mauger - Kahungunu ki Te Matau a Māui, Gazetted Customary Fisheries Rohe Moana

APOLOGIES

- Andrew Curtis (PDP) - HBRC Technical Advisor
- Tania Eden - Te Taiwhenua o Te Whanganui-a-Orutū
- Bruce Wills - Ravensdown (Director)
- Chad Tareha - Ngāti Pārau Hapū (Present for Powhiri)
- Ami Coughlan - Fish and Game

[1] Confirmed at TFG Meeting 3, 16 July 2021.

1. Powhiri and Lunch

The (Technical Focus Group) TFG members were welcomed onto Kohupatiki Marae.

2. Karakia, Opening and Introductions

- The following members attending the meeting for the first time introduced themselves to the group.
  - Jenny Mauger - Kahungunu ki Te Matau a Māui, Co-Chair Gazetted Customary Fisheries Rohe Moana. Attending to support the mana whenua hapū. Jenny provided a background to her experience and family history in the area.
  - Madison Milley - Taradale High School student. Attending to gain knowledge from the process.
  - Elliot Morell - Taradale High School student. Attending to see the process and learn and absorb knowledge.
  - Fred Sugden - Taradale High School student. Here to learn and understand how this discharge affects our waterways.
  - Kyle Christensen - HBRC Technical Advisor for stormwater and river engineering.

3. Draft Minutes - TFG Meeting 1 15 April 2021

- Stephen asked the group for any comments or questions on the draft minutes of Meeting 1 and addressed each of the meeting action as follows:
  1. TFG representation
     - Horticulture representative (Jamie) - Danielle Adsett from NZ Apple and Pears was unable to come. In discussion with Bostock NZ regarding attendance.
     - HBRC Asset Management Team (Tania) – Kyle Christensen attending.
     - Shade Smith and NKII - (Stephen, Margi). Shade was hoping to attend TFG2 after he has finished at another meeting.
     - Taradale High School representative (Andrew) – three students attending - Fred, Madie and Elliot.
  2. Webpage - Ravensdown is working on getting the website ready to go live in the next week. Will include TFG meeting minutes.
  3. TFG Terms of Reference - finalised. Will be added to the website.
  4. Consent compliance - Webpage to include HBRC Compliance Monitoring Reports.
  5. Presentation on Ravensdown's research projects – not being presented at TFG Meeting 2 due to time constraints. Jamie noted that there is a Horticulture Field Day in early June and invited TFG members to attend.
- The minutes of first meeting of the TFG, dated 15 April 2021, were confirmed as a true and correct record of the meeting.

  Moved - Malcolm Miller
  Seconded - Matt Brady
  Carried unanimously
- The meeting minutes will be finalised and attached to the minutes of meeting two (Attachment 1) and added to the project website.

Agreed Action 1: Helen to send the TFG members an invitation to the Horticulture Field Day

4. Presentation - Aki Paipper, Kohupātiki Marae

See the project website for a copy of the presentation.

- Aki provided the group background to the Ngāti Hori and Kohupātiki Marae whanau's historical connection to the lower Karamu Stream and Waitangi Estuary, outlining concerns about the degradation of the waterway, the work that has been done to improve the state of the catchment through Operation Patiki[2] and their involvement in processes such as the TANK Plan Change process.

5. Presentation - Dr Ngaire Phillips, Streamlined Environmental Ltd

See the project website for a copy of the presentation.

- Ngaire summarised the baseline monitoring and investigations being undertaken by Ravensdown on the current stormwater and process water discharge to the Awatoto Drain (and the ultimate receiving environment of the Tūtaekūri River and Waitangi Estuary).
- It was confirmed that Ngaire's work to date did not look forward to what the replacement discharge permit would involve. This will be determined in consultation with the TFG after technical advice. Ngaire will then progress a detailed assessment of ecological and water quality effects based on the chosen discharge strategy.
- TFG members asked questions and provided comment on the following matters. *These will be considered by Ravensdown and the technical team in the preparation of the baseline and future assessment reports.*
  - Current consent compliance and consent limits.
  - Location of the current discharge relative to upstream and downstream sampling sites, the monitoring programme, and flow of the surrounding drains.
  - Historical overflows from the Ravensdown stormwater.
  - Origin of fluoride in the process.
  - Dispersion of the dye used in the the dye study.
- Stephen noted that the baseline assessment will be used in the consideration of the discharge strategy for the new consent which Ravensdown will ask for feedback on from the TFG members at the next meeting.

6. Presentation - Richard Chilton, Tonkin + Taylor

See the project website for a copy of the presentation.

- Richard provided an overview of the current discharges to air from the Napier works and responded to questions and comments from the TFG members.
- The same process of determining the new air discharge strategy as discussed previously will be applied to the air discharge but recognising that there is only one possible receiving environment and plant the air discharge relates to.
- TFG members asked questions and provided comment on the following matters. *These will be considered by Ravensdown and the technical team in the preparation of the baseline and future assessment reports.*

[2] Also see the Ngati Hori Freshwater Management Plan https://www.hbrc.govt.nz/assets/Document-Library/Publications/Tangata-Whenua/Ngati-Hori-Freshwater-Resources-Management-Plan.pdf

  - Ability to shut plant down if discharge conditions are unsuitable.
  - Monitoring programme and sampling equipment.
  - Odour (SO_2).
  - Fugitive emissions from the site.
  - Human health effects.
  - Modelling methodology.
  - Discharge from the proposed single 50m stack.

7. Presentation - Dr Francesca Kelly, Environmental Medicine Limited

See the project website for a copy of the presentation.

- Francesca provided an overview of environmental health effects assessment of the current discharges to air and water from the Napier works.
- TFG members asked questions and provided comment on the following matters. *These will be considered by Ravensdown and the technical team in the finalisation of the baseline and future assessment reports.*
  - Concentration of fluoride in food, water and other products (e.g., toothpaste) vs ambient fluoride associated with the Ravensdown discharge.
  - Accumulation of metals and other contaminants in fish and harvested food.

8. Next meeting

- Stephen noted the technical team are currently reviewing the discharge options for the site and that these will be presented to the TFG at the next meeting in late June and enable discussion and input by the TFG members before a final discharge strategy is settled on.

9. Final Questions and Comments

- Andrew noted that Ravensdown is committed to an open and honest process for the resource consent renewal project and that presentations show that there are a lot of aspects that Ravensdown are doing well with, while improvements are necessary in other areas. Ravensdown accepts the need for improvement, which has included the recent significant investment in new emission control equipment to improve the air discharge from the plant. The team is also looking at the options for the water discharge and how it can be improved as well as potential enhancements to the receiving environment.
- Any questions related to the meetings presentations can be emailed to Helen at helen.hurring@ravensdown.co.nz. Helen will pass these on to the relevant expert.

Meeting Closed at 4:00 pm.

Minutes prepared by Helen Hurring and Anita Anderson ravensdown

Attachment 2: Options Assessment Matrix

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
DEVELOPED BY CORE PROJECT AND TECHNICAL TEAM [1] - 6 MAY 2021, with updates to options and scoring to reflect discussions with NCC, and updated costings 13 July 2021, and mana whenua and Technical Focus Group feedback on 14 and 16 July respectively.

		CRITERIA										
		Technical			**Consenting & Environmental**			**Financial [2]**		**Stakeholder [3]**		
RECEIVING ENVIRONMENT	**OPTION**	***Land/Storage requirement***	***Safety in design***	***System / technological complexity and reliability***	***Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)***	***Ability to meet receiving environment limits / guidelines***	***Future-proof (climate / other unpredictability)***	***Capital cost***	***Operational costs***	***Mana Whenua Values***	***Other Stakeholder Considerations / Concerns***	***Total score***
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
Tūtaekurī / Waitangi Estuary	**Status quo**	**5** No additional land requirement.	**4** Some of the manual processes require work with caustic chemicals, outside of normal business hours and potential exposure to flooding hazards. Eliminates construction risk.	**4** Currently well understood methods, but some manual inputs needed Minor improvements to the settling pond, including lining, or adding flocculation could enhance ecological outcome. Treatment ability / outcome are well understood	**0** Limited detectable ecological and water quality effects downstream of the mixing zone boundary. Dialogue with Mana Whenua Hapu has indicated that the status quo discharge is unacceptable from a cultural values perspective.	**0** Based on the current discharge, some new receiving environment standards in the regional plan and other planning instruments (e.g. NES, NPSFM, TANK) would not be met.	**2** The existing settling pond is unlined and subject to potential inflows and groundwater discharges due to rising groundwater due to sea level rise. Developing public sentiment and associated policy is moving toward a higher standard of environmental outcomes.	**5** Cost = Low No capital cost associated with status quo Potential cost with liner installation	**4** Cost = Medium-Low Minimal maintenance is required long term – especially around the aging infrastructure and manual processes	**0** Indication from mana whenua hapu is that the status quo is unacceptable and won't be supported.	**1** Some think zero score. Others think no science to suggest it should be a zero score, but should score low and shouldn't continue, particularly for a 35 year consent duration. There are other inputs into the receiving environment and Ravensdown shouldn't necessarily be held to a higher standard than other contributors.	46
	Wetland Treatment train Assume a settling pond, constructed wetland, infiltration basin and media filter would form the treatment train prior to discharge to the estuary. Potential for enhancing habitat values in riparian areas of wetland around discharge area.	**3** Land would needed for settling pond, wetland basins, infiltration basins	**3** Issues with potential deep water, stormwater pits, pipes, pumps, high maintenance requirements carry inherent risks Significant construction activities involved Risk associated with handling potential contaminated soils (if area around current pond is used)	**1** Combinations of treatment devices, likely requiring adaptive management – this implies long term monitoring and modifying the function of the system. There are some targeted phosphate removal devices (adsorbent and precipitant) that may achieve high levels of phosphorous removal Green infrastructure cannot provide 100% removal rate (cannot guarantee a certain water discharge quality on a consistent basis)	**4** Would require an assessment of effects relating to ecology and water quality and groundwater aspects. Needs to be tested with Mana Whenua hapu regarding acceptability of final discharge to the estuary after treatment though land-based systems.	**3** Depends on whether targets are mass or concentration based	**3** Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc	**1** Cost = High-Medium Costs variable depending on construction methodology **Note: costings are only indicative at this stage**	**2** Cost = High-Medium **Note: costings are only indicative at this stage**	**2** Estuary is not always flushing - sometimes blocked / closed. Restoration / enhancement of environment as well is preferred.	**3** Still going into the Waitangi Estuary which has high ecological values, but provides treatment. Potential to create additional habitat with constructed wetland. Ability to provide some continuous improvement. Water quality of discharge would need to be suitable for the receiving environment standards.	59

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
DEVELOPED BY CORE PROJECT AND TECHNICAL TEAM [1] - 6 MAY 2021, with updates to options and scoring to reflect discussions with NCC, and updated costings 13 July 2021, and mana whenua and Technical Focus Group feedback on 14 and 16 July respectively.

		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
	Membrane filter	**4** Could allow for significant water reuse on site (e.g. in cooling towers, acid processes, etc.) May need holding / attenuation ponds to accommodate lower treatment rates	**4** Well understood risks, high pressure flow	**3** Inherent challenges with operating a filter plant, however technology is well known and treatment ability highly reliable May have potential for treating only highly-contaminated portions of the site. Need to manage highly contaminated waste discharge.	**5** Would need an assessment of effects.	**5**	**2** Very high energy requirements. High energy use implies significant carbon discharge	**0** **Cost = High** **Note: costings are only indicative at this stage**	**1** **Cost = High** **Note: costings are only indicative at this stage**	**1** Concern about high energy usage and carbon footprint, and also contaminated waste stream that will need to be managed.	**1** Trading one problem for another - issues with adding CO2, and high cost, and contaminated waste stream to be managed.	**60**

Criteria Score	0	1	2	3	4	5
	Not Acceptable / Fatal Flaw	Lowest Score				Highest Score

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
DEVELOPED BY CORE PROJECT AND TECHNICAL TEAM [1] - 6 MAY 2021, with updates to options and scoring to reflect discussions with NCC, and updated costings 13 July 2021, and mana whenua and Technical Focus Group feedback on 14 and 16 July respectively.

		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
Marine Water (ocean)	**Discharge via NCC wastewater infrastructure (sea outfall pipe)**	1 Attenuation ponds will likely be needed to meet metered discharge requirements. • This technique is used at the Ravensdown Hornby site (max 4 L/s as agreed with CCC – NCC have indicated 2 L/s would likely be required). • Potential for treatment to be combined with attenuation. • This might be anything from a shipping container sized media filter to a large wetland. Would require land / right of way easements to accommodate pipe. Ravensdown does have land holdings to facilitate attenuation / treatment options. May need a Papatuanuku Channel per the existing NCC wastewater discharge consent.	4 Potential issues with deep water / pump out pits, etc. Inherent risks with long pipeline construction and maintenance. Risks seem to be manageable based on past experience, this can be facilitated through standard engineering design.	3 Likely some level of automation required to manage flows and discharges from the site. This would be very similar to the system constructed at Ravensdown Hornby. Potential complexity around interfacing with NCC systems. Could be managed through fail-safes. Depends on whether discharge is via NCC treatment plant or not, but treatment reliability highly dependent on the consent limits and whether discharge under the existing NCC consent is possible. Potential challenge with treating DRP. Need to consider combined effects of additional contaminant discharge.	2 Working assumption following discussion with NCC is that NCC may not approve discharge under the existing discharge permit and Ravensdown would require its own separate discharge permit for discharge to the marine environment. This option would require integration of complex consenting and effects matters as between NCC and Ravensdown. Consideration would need to be given to unconsented discharges due to a pipeline or pump failure. This could be managed through ensuring construction methodology consistent with sewer lines. Experience shows that ocean discharge solutions are complex to consent and effects need to be shown to be minor and ideally input from Mana Whenua hapu on any treatment methods to limit cultural effects will be important. Consideration of the need for a resource consent for attenuation ponds and flood discharges. Discharge below treatment plant effluent may require change of consent conditions **(to be confirmed via check of consent and with NCC).**	5 Existing site sampling data indicates site discharge meets limits in the discharge consent for domestic and industrial wastewater into Hawke Bay. Analysis would be required to ensure that the relative contribution from Ravensdown allow for NCC to meet limits in their discharge permits and receiving environment limits. Greater dilution afforded by the open coastal environment, which is positive in terms of environmental effects.	1 NCC discharge strategy/location may change when existing resource consent comes up for renewal (2037, or earlier due to the need to upgrade the infrastructure) – beyond Ravensdown's control. May require treatment strategies beyond what is currently envisioned. This option ties Ravensdown to the duration and conditions associated with the existing and / or new discharge permits that NCC will hold. This situation may provide long term unknown constraints on the plant. The NCC outfall pipe is located in a highly turbulent marine environment and has recently been compromised, with leaking wastewater (requiring industries to cease / reduce discharge temporarily). The integrity of any updated pipeline will be a risk. This option would require strong partnership between NCC and Ravensdown.	4 Cost = Medium **Note: costings are only indicative at this stage.** Includes: • Treatment. • Cost of the pipeline. • Cost of the connection. Any applicable development contributions - would require a bespoke DC agreement to be negotiated between Ravensdown and NCC on the basis that Ravensdown would pay the capital and operating costs for the infrastructure. There is also the potential to need to contribute to infrastructure replacement and re-consenting costs as part of the reconsenting of the NCC outfall. Flows would not contribute to added inflow to the treatment plant.	3 Cost = Medium **Note: costings are only indicative at this stage.** Depends on fees required by NCC for ongoing discharges to their system. Costs associated with treatment, dependent on the treatment option chosen. Ongoing pump costs and pipeline maintenance – subject to discussions with NCC over the ownership of the pipeline.	3 Initial understanding with NCC consent was that wastewater from industrial sites would be treated on individual sites but appears that may not be the case - good to have this process and clearly understand what the discharge will consist of. Want pre-treatment to an acceptable level regardless of receiving environment. Discharge to ocean preferable to discharge onto land within NCC drinking water source zone. Need for onsite treatment acknowledged, with redundancy built in to provide for climate change.	3 Out of Ravensdown's control - relying on others to manage their discharge. Concern about lack of capacity in NCC network - attenuation would need to be provided on site. Options to provide treatment on site to ensure discharge is of appropriate standard. There is a risk to being reliant on NCC's infrastructure - especially with climate change and other changes in the area. Has efficiency with assisting NCC with constructing their outfall rather than constructing their own.	70

Criteria Score	0	1	2	3	4	5
	Not Acceptable / Fatal Flaw	Lowest Score				Highest Score

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
DEVELOPED BY CORE PROJECT AND TECHNICAL TEAM [1] - 6 MAY 2021, with updates to options and scoring to reflect discussions with NCC, and updated costings 13 July 2021, and mana whenua and Technical Focus Group feedback on 14 and 16 July respectively.

		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
	Ravensdown site-specific sea outfall	**3** Would likely require some attenuation, however smaller than the trade waste option. Assume there would be no/minimal volume constraints. Land area possibly required for treatment, varying from small filter to large wetland. Would require land / right of way easements to accommodate pipe and an easement with Waka Kotahi across the state highway. Ravensdown does have land holdings to facilitate attenuation / treatment options if Winstone site is acquired (across the state highway), treatment could occur on the seaward side of the highway as part of a land restoration project. This would also require an agreement with HBRC / DOC to cross the foreshore area. MACA legislation would require an agreement with Mana Whenua who are assigned the foreshore and seabed land rights (currently working through a high court process in relation to Hawke Bay).	**2** Underwater construction and maintenance of ocean outfall pipelines carries risk.	**3** Depends on method of pre-treatment (assuming some is required), but likely a previously used and understood treatment method. Requires engineering a new structure in a high energy marine environment Significant difficulty in constructing an underwater pipeline across the foreshore and surf zone. The working assumption is that given the flows and volumes, a shorter pipeline than the existing NCC outfall (1.5km) could be facilitated. Additional attenuation may allow for reduced flowrates and a shorter pipeline. Less ability to utilise dilution (from NCC wastewater / stormwater) existing outflows to manage receiving environment effects, especially in the mixing zone.	**3** Would require a full assessment of effects on water quality and ecology. There is recent existing data from the Pan Pac and Napier Port consent processes (alongside ecological assessments, environment court findings, and mitigation and monitoring schemes). Experience shows that ocean discharge solutions are complex to consent and effects need to be shown to be minor and ideally input from Mana Whenua hapu on any treatment methods to limit cultural effects will be important.	**4** Depends on consent requirements – would likely require some level of treatment prior to discharge. Significantly greater dilution afforded by open coastal environment when compared with estuarine discharges. There is recent existing data from the PanPac and Napier Port consent processes (alongside ecological assessments, environment court findings, and mitigation and monitoring schemes)	**2** Likely complexities with maintaining structure in the high energy coastal environment, especially with climate change. Sea level rise will be a significant consideration. Coastal area in the vicinity of Ravensdown has been accreting – design would need to facilitate long term accretion potential. Long term uncertainty in the erosion / accretion potential of the coastal environment. Does not rely on third party consent holder (NCC) who will have to be responsible for the long term management of Ravensdown's discharge inputs. Consent would not be coupled to the consent renewal period of the NCC discharge permits, enabling Ravensdown to seek a long term consent (up to 35 years, as allowed by the RMA). An additional factor is that the NCC discharge has to be renewed on or before 2037 and there is a possibility that the ocean discharge will not continue to be authorised.	**2** Cost = High **Note: costings are only indicative at this stage.** Land side infrastructure would be very similar to the trade waste option, however the construction of the undersea pipeline would carry significant cost.	**2** Cost = High-Medium **Note: costings are only indicative at this stage.** Significant cost associated with the maintenance of underwater structure.	**4** Direct discharge with control over discharge is preferable to discharging via NCC outfall - provides more opportunity for Ravensdown to work in partnership with mana whenua for continuous improvement and separate from the complexity of working with NCC. Discharge into the ocean preferable ecologically - provide better dilution and lower effects to benthic ecology - acknowledge that discharging contaminants to water is not agreeable culturally. Need to minimise effects and enhance the environment - not acceptable to walk away from estuary which has been damaged and begin same discharge to a different environment. Preference would be to treat the discharge highly before discharge. Preference for an approach of promoting abundance rather than simply reducing the effects.	**2** Ravensdown have more control over their own discharge - some people view as being better than the NCC outfall option. Very costly option. Potential for outfall blockage due to intermittent flow and proximity to high energy shore. Outfall area can limit fishing to protect pipe, so this provides some protection to the environment, and can add some biodiversity (hard structure for organisms to settle on) - ability to create environmental enhancement by creating artificial reef / habitat for mussels etc. Mussels were historically abundant in Hawke Bay.	**64**

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
DEVELOPED BY CORE PROJECT AND TECHNICAL TEAM [1] - 6 MAY 2021, with updates to options and scoring to reflect discussions with NCC, and updated costings 13 July 2021, and mana whenua and Technical Focus Group feedback on 14 and 16 July respectively.

		CRITERIA										
		Technical			**Consenting & Environmental**			**Financial [2]**		**Stakeholder [3]**		
RECEIVING ENVIRONMENT	**OPTION**	***Land/Storage requirement***	***Safety in design***	***System / technological complexity and reliability***	***Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)***	***Ability to meet receiving environment limits / guidelines***	***Future-proof (climate / other unpredictability)***	***Capital cost***	***Operational costs***	***Mana Whenua Values***	***Other Stakeholder Considerations / Concerns***	***Total score***
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
Land discharge	**Pre-treatment+ spray or border dyke irrigation**	1 Spray irrigation has a high land requirement – use of land for spray irrigation would limit future potential use of the land At a 5mm/day application rate, approximately 40ha of land would be required to facilitate all stormwater and process water. Using border dyke irrigation could result in lower land requirements Spray irrigation timing would be dependent on groundwater levels	4 Potential issues with accumulation of contaminants in soil and vegetation Potential issues with deep water / pump out pits, etc. Potential for contamination of deep aquifers, however upward pressure and silts would likely restrict this	4 Would likely require pre-treatment, this would be the most complex component. Spray irrigation is a previously used and understood discharge method May result in surface discharges during high rainfall Groundwater mounding would be a potential issue	0 Issues with discharging into Napier City drinking water source protection zone. Needs to consider potential changes to the hydrology – both groundwater and surface water interactions and effects on wetland habitats.	4 Could be a viable solution in concert with another treatment option to reduce volumes requiring treatment and discharge to ocean / estuary. Depends on what groundwater guideline values are, level of treatment provided, existing contaminant concentrations in groundwater Fluoride and heavy metals not removed by pre-treatment would accumulate in soils and this may limit the applicability of this option – need advice from plant and public health experts to determine the fate of these contaminants in the environment.	3 Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc Rising sea levels would result in higher groundwater levels, restricting the applicability of this option in the future May not be sustainable in the long term due to accumulation of contaminants in the soils.	3 Cost = Medium **Note: costings are only indicative, no costing undertaken**	3 Cost = Medium **Note: costings are only indicative at this stage**	2 Concern about potential to affect water used for drinking. Concern about potential for accumulation of contaminants in land, although this would depend on level of treatment and contaminant concentrations. Using Papatuanuku for treatment is generally preferable to discharge into water. Would be a preferable option if it were outside the source protection zone. Tangaroa has a better ability to assimilate this discharge rather than Papatuanuku. Tangaroa is assisted by Tawhirimatea (wind) and Tamanuitera (sun). Despite these views, mana whenua would like further information about a land based proposal to provide a certain solution given the potential for climate change risks (e.g. sea level rise, coastal inundation).	3 Concern about ability to find additional area for irrigation if needed. Preferable to discharge into the river. Most councils prefer land based discharge over discharges into surface water so could merit a higher score, however the sensitivity of the source protection zone is noted. Potential for discharge onto land outside source protection zone was discussed, but this would be some distance away. Flood management area and potential for sea level and groundwater level rise with climate change also a consideration. Land discharge is a preferred option and should be fully investigated. Potential to use plants for contaminant uptake could be considered.	**62**

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
DEVELOPED BY CORE PROJECT AND TECHNICAL TEAM [1] - 6 MAY 2021, with updates to options and scoring to reflect discussions with NCC, and updated costings 13 July 2021, and mana whenua and Technical Focus Group feedback on 14 and 16 July respectively.

		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
	Pre-treatment + soakage/ rapid infiltration Assume pre-treatment provided	**4** Low surface footprint – can build over the top of soakpits	**4** Potential deep excavation during construction. Potential risk of subsidence	**4** Likely to be restricted by high groundwater levels observed on site – groundwater mounding would be a potential issue If shallow groundwater is already saline, discharging fluoride may be more acceptable. Depends on method of pre-treatment, but likely a previously used and understood treatment method	**0** Issues with discharging into Napier City drinking water source protection zone. Needs to consider potential changes to the hydrology – both groundwater and surface water interactions and effects on wetland habitats	**4** Depends on what groundwater guideline values are, level of treatment provided, existing contaminant concentrations in groundwater Unknown what restrictions there may be on the groundwater and surface water receiving environment	**3** Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc Rising sea levels would result in higher groundwater levels, restricting the applicability of this option in the future	**3** Cost = Medium **Note: costings are only indicative, no costing undertaken**	**4** Cost = Medium-Low **Note: costings are only indicative at this stage**	**2** Concern about potential to affect water used for drinking. Concern about potential for accumulation of contaminants in land, although this would depend on level of treatment and contaminant concentrations. Using Papatuanuku for treatment is generally preferable to discharge into water.	**2** Concern about contaminants potentially entering groundwater. Most councils prefer land based discharge over discharges into surface water so could merit a higher score, however the sensitivity of the source protection zone is noted. Potential for discharge onto land outside source protection zone was discussed, but this would be some distance away. Flood management area and potential for sea level and groundwater level rise with climate change also a consideration.	**64**

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
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		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
Combination of options	Split flow to NCC stormwater and/or trade waste infrastructure and treatment train	**3** Will depend on specific options chosen	**3** Similar to options above with excavations required	**2** Allows more contaminated catchments / hard to treat contaminants to be removed from treatment train, however will need more than one system, and consideration of which catchment to send to each	**4** Depends on options selected and how catchments/ contaminants are to be managed, but may be able to deal with concerns about water quality and contaminant discharge to particular environments Experience shows that ocean discharge solutions are complex to consent and effects need to be shown to be minor and ideally input from Mana Whenua hapu on any treatment methods to limit cultural effects will be important.	**4** Depends on options selected and how catchments/ contaminants are to be managed, but may be able to deal with concerns about water quality and contaminant discharge to particular environments	**3** Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc	**3** Cost = Medium-high, variable depending on the construction methodology **Note: costings are only indicative at this stage**	**3** Cost = Medium **Note: costings are only indicative at this stage**	**4** Understanding is that the higher risk areas would discharge to Tangaroa or Papatuanuku, and lower risk areas would discharge to the Waitangi Estuary. This combination option is seen as sensible from a sustainability and cultural perspective as it is responsive and sensitive to the respective parts of the site.	**5** Able to take the best parts of all of the other options. Better dilution is likely available in the estuary in winter. Cleaner portion could discharge to estuary at times, and to land at times depending on soil moisture.	**82**

Notes:

1 **Core Project Team**
Ravensdown - Andrew Torrens, Helen Hurring
Mitchell Daysh Ltd - Stephen Daysh

Technical Team:
Aurecon - David Delagarza, Anna Lindgren, Helen Caley
Streamlined Environmental - Ngaire Phillips
PDP - Neil Thomas

2 Costs Range = High=1, High-Medium=2, Medium=3, Medium-Low=4, Low=5

3 Scoring undertaken by Mana Whenua / TFG.

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

Appendix F
MCDA options matrix

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
DEVELOPED BY CORE PROJECT AND TECHNICAL TEAM [1] - 6 MAY 2021, with updates to options and scoring to reflect discussions with NCC, and updated costings 13 July 2021, and mana whenua and Technical Focus Group feedback on 14 and 16 July respectively.

		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
Tūtaekurī / Waitangi Estuary	**Option 1a: Status quo**	**5** No additional land requirement.	**4** Some of the manual processes require work with caustic chemicals, outside of normal business hours and potential exposure to flooding hazards. Eliminates construction risk.	**4** Currently well understood methods, but some manual inputs needed Minor improvements to the settling pond, including lining, or adding flocculation could enhance ecological outcome. Treatment ability / outcome are well understood	**0** Limited detectable ecological and water quality effects downstream of the mixing zone boundary. Dialogue with Mana Whenua Hapu has indicated that the status quo discharge is unacceptable from a cultural values perspective.	**0** Based on the current discharge, some new receiving environment standards in the regional plan and other planning instruments (e.g. NES, NPSFM, TANK) would not be met.	**2** The existing settling pond is unlined and subject to potential inflows and groundwater discharges due to rising groundwater due to sea level rise. Developing public sentiment and associated policy is moving toward a higher standard of environmental outcomes.	**5** Cost = Low No capital cost associated with status quo Potential cost with liner installation	**4** Cost = Medium-Low Minimal maintenance is required long term – especially around the aging infrastructure and manual processes	**0** Indication from mana whenua hapu is that the status quo is unacceptable and won't be supported.	**1** Some think zero score. Others think no science to suggest it should be a zero score, but should score low and shouldn't continue, particularly for a 35 year consent duration. There are other inputs into the receiving environment and Ravensdown shouldn't necessarily be held to a higher standard than other contributors.	**46**
	Option 1b: Wetland treatment train Assume a settling pond, constructed wetland, infiltration basin and media filter would form the treatment train prior to discharge to the estuary. Potential for enhancing habitat values in riparian areas of wetland around discharge area.	**3** Land would needed for settling pond, wetland basins, infiltration basins	**3** Issues with potential deep water, stormwater pits, pipes, pumps, high maintenance requirements carry inherent risks Significant construction activities involved Risk associated with handling potential contaminated soils (if area around current pond is used)	**1** Combinations of treatment devices, likely requiring adaptive management – this implies long term monitoring and modifying the function of the system. There are some targeted phosphate removal devices (adsorbent and precipitant) that may achieve high levels of phosphorous removal Green infrastructure cannot provide 100% removal rate (cannot guarantee a certain water discharge quality on a consistent basis)	**4** Would require an assessment of effects relating to ecology and water quality and groundwater aspects. Needs to be tested with Mana Whenua hapu regarding acceptability of final discharge to the estuary after treatment though land-based systems.	**3** Depends on whether targets are mass or concentration based	**3** Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc	**1** Cost = High-Medium Costs variable depending on construction methodology **Note: costings are only indicative at this stage**	**2** Cost = High-Medium **Note: costings are only indicative at this stage**	**2** Estuary is not always flushing - sometimes blocked / closed. Restoration / enhancement of environment as well is preferred.	**3** Still going into the Waitangi Estuary which has high ecological values, but provides treatment. Potential to create additional habitat with constructed wetland. Ability to provide some continuous improvement. Water quality of discharge would need to be suitable for the receiving environment standards.	**59**

Criteria Score	**0** Not Acceptable / Fatal Flaw	**1** Lowest Score	**2**	**3**	**4**	**5** Highest Score

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		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
	Option 1c: Membrane filter plant	**4** Could allow for significant water reuse on site (e.g. in cooling towers, acid processes, etc.) May need holding / attenuation ponds to accommodate lower treatment rates	**4** Well understood risks, high pressure flow	**3** Inherent challenges with operating a filter plant, however technology is well known and treatment ability highly reliable May have potential for treating only highly-contaminated portions of the site. Need to manage highly contaminated waste discharge.	**5** Would need an assessment of effects.	**5**	**2** Very high energy requirements. High energy use implies significant carbon discharge	**0** **Cost = High** **Note: costings are only indicative at this stage**	**1** **Cost = High** **Note: costings are only indicative at this stage**	**1** Concern about high energy usage and carbon footprint, and also contaminated waste stream that will need to be managed.	**1** Trading one problem for another - issues with adding CO2, and high cost, and contaminated waste stream to be managed.	**60**

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

RAVENSDOWN STORMWATER AND PROCESS WATER DISCHARGE OPTIONS ASSESSMENT MATRIX
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Marine Water (ocean)	**Option 2a: Discharge via NCC WWTP outfall (sea outfall pipe)**	**1** Attenuation ponds will likely be needed to meet metered discharge requirements. • This technique is used at the Ravensdown Hornby site (max 4 L/s as agreed with CCC – NCC have indicated 2 L/s would likely be required). • Potential for treatment to be combined with attenuation. • This might be anything from a shipping container sized media filter to a large wetland. Would require land / right of way easements to accommodate pipe. Ravensdown does have land holdings to facilitate attenuation / treatment options. May need a Papatuanuku Channel per the existing NCC wastewater discharge consent.	**4** Potential issues with deep water / pump out pits, etc. Inherent risks with long pipeline construction and maintenance. Risks seem to be manageable based on past experience, this can be facilitated through standard engineering design.	**3** Likely some level of automation required to manage flows and discharges from the site. This would be very similar to the system constructed at Ravensdown Hornby. Potential complexity around interfacing with NCC systems. Could be managed through fail-safes. Depends on whether discharge is via NCC treatment plant or not, but treatment reliability highly dependent on the consent limits and whether discharge under the existing NCC consent is possible. Potential challenge with treating DRP. Need to consider combined effects of additional contaminant discharge.	**2** Working assumption following discussion with NCC is that NCC may not approve discharge under the existing discharge permit and Ravensdown would require its own separate discharge permit for discharge to the marine environment. This option would require integration of complex consenting and effects matters as between NCC and Ravensdown. Consideration would need to be given to unconsented discharges due to a pipeline or pump failure. This could be managed through ensuring construction methodology consistent with sewer lines. Experience shows that ocean discharge solutions are complex to consent and effects need to be shown to be minor and ideally input from Mana Whenua hapu on any treatment methods to limit cultural effects will be important. Consideration of the need for a resource consent for attenuation ponds and flood discharges. Discharge below treatment plant effluent may require change of consent conditions **(to be confirmed via check of consent and with NCC).**	**5** Existing site sampling data indicates site discharge meets limits in the discharge consent for domestic and industrial wastewater into Hawke Bay. Analysis would be required to ensure that the relative contribution from Ravensdown allow for NCC to meet limits in their discharge permits and receiving environment limits. Greater dilution afforded by the open coastal environment, which is positive in terms of environmental effects.	**1** NCC discharge strategy/location may change when existing resource consent comes up for renewal (2037, or earlier due to the need to upgrade the infrastructure) – beyond Ravensdown's control. May require treatment strategies beyond what is currently envisioned. This option ties Ravensdown to the duration and conditions associated with the existing and / or new discharge permits that NCC will hold. This situation may provide long term unknown constraints on the plant. The NCC outfall pipe is located in a highly turbulent marine environment and has recently been compromised, with leaking wastewater (requiring industries to cease / reduce discharge temporarily). The integrity of any updated pipeline will be a risk. This option would require strong partnership between NCC and Ravensdown.	**4** Cost = Medium **Note: costings are only indicative at this stage.** Includes: • Treatment. • Cost of the pipeline. • Cost of the connection. Any applicable development contributions - would require a bespoke DC agreement to be negotiated between Ravensdown and NCC on the basis that Ravensdown would pay the capital and operating costs for the infrastructure. There is also the potential to need to contribute to infrastructure replacement and re-consenting costs as part of the reconsenting of the NCC outfall. Flows would not contribute to added inflow to the treatment plant.	**3** Cost = Medium **Note: costings are only indicative at this stage.** Depends on fees required by NCC for ongoing discharges to their system. Costs associated with treatment, dependent on the treatment option chosen. Ongoing pump costs and pipeline maintenance – subject to discussions with NCC over the ownership of the pipeline.	**3** Initial understanding with NCC consent was that wastewater from industrial sites would be treated on individual sites but appears that may not be the case - good to have this process and clearly understand what the discharge will consist of. Want pre-treatment to an acceptable level regardless of receiving environment. Discharge to ocean preferable to discharge onto land within NCC drinking water source zone. Need for onsite treatment acknowledged, with redundancy built in to provide for climate change.	**3** Out of Ravensdown's control - relying on others to manage their stormwater. Concern about lack of capacity in NCC network - attenuation would need to be provided on site. Options to provide treatment on site to ensure discharge is of appropriate standard. There is a risk to being reliant on NCC's infrastructure - especially with climate change and other changes in the area. Has efficiency with assisting NCC with constructing their outfall rather than constructing their own.	70
	Option 2b: Ravensdown site-specific sea outfall	**3** Would likely require some attenuation, however smaller than the trade waste option. Assume there would be no/minimal volume	**2** Underwater construction and maintenance of ocean outfall pipelines carries risk.	**3** Depends on method of pre-treatment (assuming some is required), but likely a previously used and understood treatment method. Requires	**3** Would require a full assessment of effects on water quality and ecology. There is recent existing data from the Pan Pac	**4** Depends on consent requirements – would likely require some level of treatment prior to discharge.	**2** Likely complexities with maintaining structure in the high energy coastal environment, especially with climate change.	**2** Cost = High **Note: costings are only indicative at this stage.**	**2** Cost = High-Medium **Note: costings are only indicative at this stage.** Significant cost associated with the	**4** Direct discharge with control over discharge is preferable to discharging via NCC outfall - provides more	**2** Ravensdown have more control over their own discharge - some people view as being better than the NCC outfall option. Very costly option. Potential for outfall blockage due to	64

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

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		constraints. Land area possibly required for treatment, varying from small filter to large wetland. Would require land / right of way easements to accommodate pipe and an easement with Waka Kotahi across the state highway. Ravensdown does have land holdings to facilitate attenuation / treatment options if Winstone site is acquired (across the state highway), treatment could occur on the seaward side of the highway as part of a land restoration project. This would also require an agreement with HBRC / DOC to cross the foreshore area. MACA legislation would require an agreement with Mana Whenua who are assigned the foreshore and seabed land rights (currently working through a high court process in relation to Hawke Bay).		engineering a new structure in a high energy marine environment Significant difficulty in constructing an underwater pipeline across the foreshore and surf zone. The working assumption is that given the flows and volumes, a shorter pipeline than the existing NCC outfall (1.5km) could be facilitated. Additional attenuation may allow for reduced flowrates and a shorter pipeline. Less ability to utilise dilution (from NCC wastewater / stormwater) existing outflows to manage receiving environment effects, especially in the mixing zone.	and Napier Port consent processes (alongside ecological assessments, environment court findings, and mitigation and monitoring schemes). Experience shows that ocean discharge solutions are complex to consent and effects need to be shown to be minor and ideally input from Mana Whenua hapu on any treatment methods to limit cultural effects will be important.	Significantly greater dilution afforded by open coastal environment when compared with estuarine discharges. There is recent existing data from the PanPac and Napier Port consent processes (alongside ecological assessments, environment court findings, and mitigation and monitoring schemes)	Sea level rise will be a significant consideration. Coastal area in the vicinity of Ravensdown has been accreting – design would need to facilitate long term accretion potential. Long term uncertainty in the erosion / accretion potential of the coastal environment. Does not rely on third party consent holder (NCC) who will have to be responsible for the long term management of Ravensdown's discharge inputs. Consent would not be coupled to the consent renewal period of the NCC discharge permits, enabling Ravensdown to seek a long term consent (up to 35 years, as allowed by the RMA). An additional factor is that the NCC discharge has to be renewed on or before 2037 and there is a possibility that the ocean discharge will not continue to be authorised.	Land side infrastructure would be very similar to the trade waste option, however the construction of the undersea pipeline would carry significant cost.	maintenance of underwater structure.	opportunity for Ravensdown to work in partnership with mana whenua for continuous improvement, and separate from the complexity of working with NCC. Discharge into the ocean preferable ecologically - provide better dilution and lower effects to benthic ecology - acknowledge that discharging contaminants to water is not agreeable culturally. Need to minimise effects and enhance the environment - not acceptable to walk away from estuary which has been damaged and begin same discharge to a different environment. Preference would be to treat the discharge highly before discharge. Preference for an approach of promoting abundance rather than simply reducing the effects.	intermittent flow and proximity to high energy shore. Outfall area can limit fishing to protect pipe, so this provides some protection to the environment, and can add some biodiversity (hard structure for organisms to settle on) - ability to create environmental enhancement by creating artificial reef / habitat for mussels etc. Mussels were historically abundant in Hawke Bay.	
Land discharge	**Option 3a: Spray irrigation - Pre-treatment+ spray irrigation**	**1** Spray irrigation has a high land requirement – use of land for spray irrigation would limit future potential use of the land At a 5mm/day application rate, approximately 40ha of land would be required to facilitate all	**4** Potential issues with accumulation of contaminants in soil and vegetation Potential issues with deep water / pump out pits, etc. Potential for contamination of deep aquifers, however upward pressure and	**4** Would likely require pre-treatment, this would be the most complex component. Spray irrigation is a previously used and understood discharge method May result in surface discharges during high rainfall Groundwater	**0** Issues with discharging into Napier City drinking water source protection zone. Needs to consider potential changes to the hydrology – both groundwater and surface water interactions and effects on wetland habitats.	**4** Could be a viable solution in concert with another treatment option to reduce volumes requiring treatment and discharge to ocean / estuary. Depends on what groundwater guideline values are, level of treatment provided,	**3** Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc Rising sea levels would result in higher groundwater levels, restricting the	**3** Cost = Medium **Note: costings are only indicative, no costing undertaken**	**3** Cost = Medium **Note: costings are only indicative at this stage**	**2** Concern about potential to affect water used for drinking. Concern about potential for accumulation of contaminants in land, although this would depend on level of treatment and	**3** Concern about ability to find additional area for irrigation if needed. Preferable to discharge into the river. Most councils prefer land based discharge over discharges into surface water so could merit a higher score, however the sensitivity of the source protection zone is noted. Potential for discharge onto land outside source	**62**

Criteria Score	0	1	2	3	4	5
	Not Acceptable / Fatal Flaw	Lowest Score				Highest Score

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		CRITERIA										
		Technical			Consenting & Environmental			Financial [2]		Stakeholder [3]		
RECEIVING ENVIRONMENT	OPTION	*Land/Storage requirement*	*Safety in design*	*System / technological complexity and reliability*	*Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)*	*Ability to meet receiving environment limits / guidelines*	*Future-proof (climate / other unpredictability)*	*Capital cost*	*Operational costs*	*Mana Whenua Values*	*Other Stakeholder Considerations / Concerns*	*Total score*
Criteria Weighting 1 = Lower importance 3 = Higher importance		1	2	2	3	3	2	2	2	3	3	
		stormwater and process water. Using border dyke irrigation could result in lower land requirements Spray irrigation timing would be dependent on groundwater levels	silts would likely restrict this	mounding would be a potential issue		existing contaminant concentrations in groundwater Fluoride and heavy metals not removed by pre-treatment would accumulate in soils and this may limit the applicability of this option – need advice from plant and public health experts to determine the fate of these contaminants in the environment.	applicability of this option in the future May not be sustainable in the long term due to accumulation of contaminants in the soils.			contaminant concentrations. Using Papatuanuku for treatment is generally preferable to discharge into water. Would be a preferable option if it were outside the source protection zone. Tangaroa has a better ability to assimilate this discharge rather than Papatuanuku. Tangaroa is assisted by Tawhirimatea (wind) and Tamanuitera (sun). Despite these views, mana whenua would like further information about a land based proposal to provide a certain solution given the potential for climate change risks (eg. sea level rise, coastal inundation).	protection zone was discussed, but this would be some distance away. Flood management area and potential for sea level and groundwater level rise with climate change also a consideration. Land discharge is a preferred option and should be fully investigated. Potential to use plants for contaminant uptake could be considered.	

Criteria Score	0 Not Acceptable / Fatal Flaw	1 Lowest Score	2	3	4	5 Highest Score

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		CRITERIA										
		Technical			**Consenting & Environmental**			**Financial [2]**		**Stakeholder [3]**		
RECEIVING ENVIRONMENT	**OPTION**	***Land/Storage requirement***	***Safety in design***	***System / technological complexity and reliability***	***Consistency with regional / national planning framework (RMA or NCC permits for trade waste / stormwater)***	***Ability to meet receiving environment limits / guidelines***	***Future-proof (climate / other unpredictability)***	***Capital cost***	***Operational costs***	***Mana Whenua Values***	***Other Stakeholder Considerations / Concerns***	***Total score***
Criteria Weighting 1 = Lower importance 3 = Higher importance		**1**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	
	Option 3b: Soakage and rapid infiltration-Pre-treatment + soakage/ rapid infiltration Assume pre-treatment provided	**4** Low surface footprint – can build over the top of soakpits	**4** Potential deep excavation during construction. Potential risk of subsidence	**4** Likely to be restricted by high groundwater levels observed on site – groundwater mounding would be a potential issue If shallow groundwater is already saline, discharging fluoride may be more acceptable. Depends on method of pre-treatment, but likely a previously used and understood treatment method	**0** Issues with discharging into Napier City drinking water source protection zone. Needs to consider potential changes to the hydrology – both groundwater and surface water interactions and effects on wetland habitats	**4** Depends on what groundwater guideline values are, level of treatment provided, existing contaminant concentrations in groundwater Unknown what restrictions there may be on the groundwater and surface water receiving environment	**3** Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc Rising sea levels would result in higher groundwater levels, restricting the applicability of this option in the future	**3** Cost = Medium **Note: costings are only indicative, no costing undertaken**	**4** Cost = Medium-Low **Note: costings are only indicative at this stage**	**2** Concern about potential to affect water used for drinking. Concern about potential for accumulation of contaminants in land, although this would depend on level of treatment and contaminant concentrations. Using Papatuanuku for treatment is generally preferable to discharge into water**.**	**2** Concern about contaminants potentially entering groundwater. Most councils prefer land based discharge over discharges into surface water so could merit a higher score, however the sensitivity of the source protection zone is noted. Potential for discharge onto land outside source protection zone was discussed, but this would be some distance away. Flood management area and potential for sea level and groundwater level rise with climate change also a consideration.	**64**
Combination of options	**Option 4: Split of high and low risk contaminant areas Split flow to NCC stormwater and/or trade waste infrastructure and treatment train**	**3** Will depend on specific options chosen	**3** Similar to options above with excavations required	**2** Allows more contaminated catchments / hard to treat contaminants to be removed from treatment train, however will need more than one system, and consideration of which catchment to send to each	**4** Depends on options selected and how catchments/ contaminants are to be managed, but may be able to deal with concerns about water quality and contaminant discharge to particular environments Experience shows that ocean discharge solutions are complex to consent and effects need to be shown to be minor and ideally input from Mana Whenua hapu on any treatment methods to limit cultural effects will be important.	**4** Depends on options selected and how catchments/ contaminants are to be managed, but may be able to deal with concerns about water quality and contaminant discharge to particular environments	**3** Depends on option selected, but potentially changes in groundwater regime, vegetated systems affected by climate change, etc	**3** Cost = Medium-high, variable depending on the construction methodology **Note: costings are only indicative at this stage**	**3** Cost = Medium **Note: costings are only indicative at this stage**	**4** Understanding is that the higher risk areas would discharge to Tangaroa or Papatuanuku, and lower risk areas would discharge to the Waitangi Estuary. This combination option is seen as sensible from a sustainability and cultural perspective as it is responsive and sensitive to the respective parts of the site.	**5** Able to take the best parts of all of the other options. Better dilution is likely available in the estuary in winter. Cleaner portion could discharge to estuary at times, and to land at times depending on soil moisture.	**82**

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Notes:

1 **Core Project Team**
Ravensdown - Andrew Torrens, Helen Hurring
Mitchell Daysh Ltd - Stephen Daysh

Technical Team:
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Streamlined Environmental - Ngaire Phillips
PDP - Neil Thomas

2 Costs Range = High=1, High-Medium=2, Medium=3, Medium-Low=4, Low=5

3 Scoring undertaken by Mana Whenua / TFG.

Criteria Score	**0** Not Acceptable / Fatal Flaw	**1** Lowest Score	**2**	**3**	**4**	**5** Highest Score

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