REPORT

For a comprehensive understanding of this report, please also refer to the relevant s92 responses

Auckland Regional Landfill

Sediment and Erosion Control Assessment

Prepared for
Waste Management NZ Ltd

Prepared by
Tonkin & Taylor Ltd

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1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by Waste Management NZ Ltd (WMNZ) to undertake an Assessment of Environmental Effects associated with the discharge of sediment during the development of the proposed Auckland Regional Landfill.

This Erosion and Sediment Control assessment describes the proposed sediment management controls during the initial enabling stages of the project and the potential discharges of sediment. This report is intended to inform feasibility level design of the proposed landfill and access road and to support an application for resource consent.

1.1 Scope of work

The scope of this report is to:

- Identify erosion and sediment control requirements for the initial enabling stages of the project;
- Assess the potential effects associated with the discharges of sediment during the enabling earthworks including the construction of the access road, bin exchange area, stockpiles and stormwater treatment ponds; and
- Prepare this technical assessment to support the Assessment of Environmental Effects Assessment.

2 Project overview

2.1 Introduction

The project comprises the construction of a landfill with a capacity of approximately 25.8 Mm^3 to provide for the disposal of municipal solid waste for a period in excess of 35 years. The overall project will comprise:

- An initial site establishment and construction programme to provide site access and construction of the initial infrastructure; and
- The on-going operational phase.

These are discussed in more detail below.

2.2 Site establishment and initial construction

The development of the landfill and associated infrastructure including access road will require a number of construction activities which have the potential to generate sediment.

The initial establishment phase will include the following construction activities:

- Earthworks for the construction of the landfill access road including the bridge;
- The construction of the stockpiles and the clay borrow (these will be used to place excess material from the earthworks);
- Earthworks associated with the construction of the landfill sediment control ponds; and
- Earthworks associated with the bin exchange area platform.

These activities are expected to be limited to a period of three to four years.

2.3 On-going landfill operation

The landfill activities are described in detail within the Engineering report (Technical Report N, Volume 2). In summary the landfill activities include:

- On-going development of landfill cells;
- Stockpiling and removal of soil and clay within Stockpiles 1, 2 and the clay borrow to provide soil and clay for development of landfill cells and cover;
- Placement of waste within the completed cells; and
- Placement of interim and long term cover.

3 Environmental setting

3.1 Site location

The proposed landfill is located in the Wayby Valley area, approximately 6 km southeast of Wellsford and 70 km north of Auckland. The landfill is proposed to be constructed in a northwest facing valley currently vegetated with plantation pine forest. This portion of the site is described as the Eastern Block or Forestry Block. The landfill will be constructed entirely in the catchment of this valley, at the head of the catchment. Access roads and some ancillary facilities will be constructed in neighbouring catchments.

Access to the landfill is proposed off State Highway 1 just south of the Hōteo River Bridge, where a sealed road will be constructed approximately 2 km in length up a valley opening up onto SH1 before crossing a ridge into the main landfill valley. This portion of the site is described as the Southern Block.

Small portions of an adjacent farm block, described herein as the Western Block, will be utilised as required for the long-term stockpiling of soils required for landfill operation, and as a source for obtaining suitable clay soils for landfill liner construction.

A full description of the site can be found in the AEE[1].

3.2 Receiving environment

3.2.1 Introduction

The site contains a variety of water courses, both permanent and intermittent and how these are managed in relation to sediment and discharges as part of this project is a key component to this report.

The potential discharges of sediment from the proposed works could potentially have impacts on the immediate downstream environment, the Hōteo River and ultimately the Kaipara Harbour. The different receiving environments differ in their sensitivity to sediment effects and characteristics and therefore we have considered each environment in turn.

3.2.2 Immediate downstream environment

The project footprint will discharge into a number of tributaries of the Hōteo River including tributaries of the Waiteraire Stream on the western boundary of the site.

A full ecological assessment has been undertaken as reported in the Assessment of Aquatic Ecological Values and Effects Report (Technical Report G, Volume 2). The key features of the receiving environment in relation to sensitivities are as follows:

- Despite much of the landholdings being in exotic forestry, the stream systems are relatively stable and ecological values high. Stream ecological valuation scores show that for the most part, streams within the WMNZ landholdings have high ecological function, driven primarily by high riparian shading, limited channel modification and high quality in stream habitat.
- A Natural Stream Management Area (NSMA) identified in the AUP in the Southern Block has the highest ecological values as measured by standard ecological indices. However, the Eastern Block values is also high considering the land use of the catchment (being forestry).
- Much of the Western Block is in agricultural land, although two ecologically significant wetlands are located in the northern and southern parts of the block. Each of these is

[1] Tonkin + Taylor, Assessment of Environmental Effects (Volume 1) May 2019

recognised as being a Wetland Management Area, and threatened bird species have been recorded within them. They are expected to be particularly susceptible to changes in hydrology and sedimentation.

- Stockpile 2 is proposed to be located in a valley system, which includes a tributary of the Waiteraire Stream, which is upstream of an NSMA and Significant Ecological Area (SEA). Across the area, hard bottom substrates dominate, which are relatively rare in the Auckland region and contribute to shaping the macroinvertebrate communities present. To the south, the project footprint is bound by native forest in the Sunnybrook Scenic Reserve, which is a designated SEA.
- Macroinvertebrate indices indicate that water and habitat quality within the Southern Block, Eastern Block and Stockpile 2 areas are of good to excellent quality, a result of intact riparian margins and relatively stable catchment characteristics.

The proportion of pollution-sensitive EPT (Ephemeroptera, Plecoptera and Trichoptera) species was highest in the Southern Block. Seven species of native fish have been recorded within the wider catchment, including two ‘at risk-declining’ species (long fin eel and inanga) and banded kokopu, which are particularly sensitive to suspended sediment. Freshwater mussels (kakahi) have also been recorded within the catchment; these are classified as at-risk declining.

3.2.3 Hōteo River

The main channel of the Hōteo River is adjacent to and immediately downstream of the site and is identified as an NSMA and SEA. The incised meanders of the Hōteo are identified as being an Outstanding Natural Feature (ONF). The Hōteo River mouth at the Kaipara Harbour is a marine SEA.

In 2014 Auckland Council commissioned an Environment and Socio-economic Review of the Hōteo River Catchment[2].The Hōteo River has been identified as a priority due to the threat posed by river sedimentation to the snapper breeding ground in the Kaipara Harbour.

The Hōteo River catchment comprises 405 km^2, with the predominant landuses comprising pastoral land and exotic plantation forestry. The catchment has a very low population with the only urban area falling in the catchment being Wellsford.

The study has identified that the key drivers for erosion are stream bank erosion, overland flow erosion and mass movement (slips) during rainfall events. The main sources of erosion in the catchment at present are reported as:

- Stream banks in the lower reaches of the Hōteo;
- Stream banks within flood plains;
- Pasture covered steep land; and
- Rolling land on fractured sub-catchments which include the Wayby sub-catchment.

Water quality in the Hōteo River is reported as ‘good’ in 2016, and ‘poor’ in 2015 and 2013. The causes of the ‘poor’ result is due to increased turbidity and phosphorus levels measured in the river.

The focus on the Hōteo River is the potential for sediment being discharged into the Kaipara Harbour.

3.2.4 Kaipara Harbour

The Kaipara Harbour is a large enclosed estuarine harbour, with the total area placing the Kaipara Harbour as one of the largest harbours in the world. The Kaipara Harbour is has been identified as

[2] Auckland Council, Hōteo River Catchment: Environment and Socio-economic Review, Technical Report 2014/021, August 2014.

being sensitive to sedimentation effects due to the harbour providing a key snapper breeding ground with large sea grass beds present including close to the mouth of the Hōteo River.

Auckland Council and Northland Regional Council have recently commissioned a study into sediment effects and mitigation options for the Kaipara Harbour[3] due to concerns around increased sedimentation within the harbour.

3.3 Rainfall

The project footprint is located within the Wayby Valley, north of Auckland. The closest meteorological station is located approximately 3 km south of the project footprint (Mahurangi RAWS @ Forest) which has been operated since February 2013. The project footprint is located on the edge of the Wayby Valley Catchment in the middle of the Dome Forest.

The annual recorded rainfalls for the previous five years are shown in Figure 3.1, as well as the long term average for the Auckland Region based on published data from NIWA.

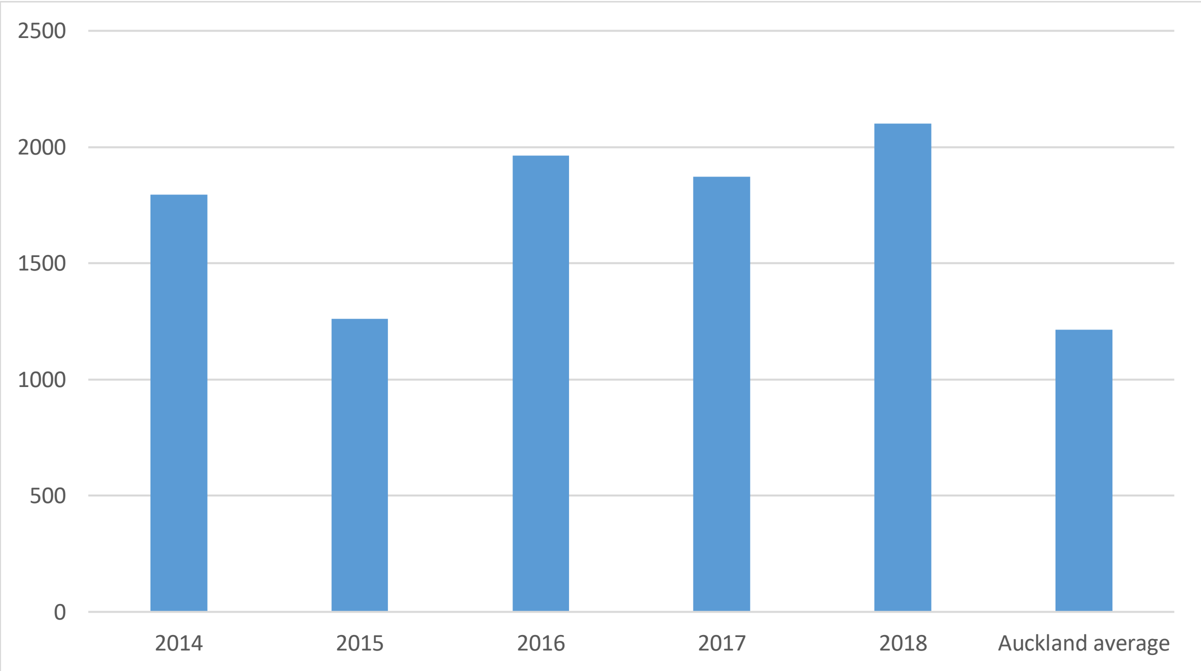

Figure 3.1: Annual rainfall (mm) Mahurangi Raws @ Forest 2014 to 2017 and NIWA

The meteorological data indicates that the annual rainfall within the Wayby Valley is greater than within the Auckland Region, with annual rainfall rates of up to 2,000 mm/ year compared to annual rainfall rates within the rest of the region of 1200 to 1300 mm/ year.

While the annual rainfall is higher within the Wayby Valley, a review of hourly rainfall rates shows that peak hourly intensities are similar to those within the broader region. The peak hourly rainfall intensity over the past five years was 41mm, which can be compared to the peak intensity within the Auckland Region of 40.4mm[4].

The higher annual rainfall is due to a higher number of days with rainfall, and rainfall events typically occurring for longer periods of time, and lower intensity events having higher rainfall rates.

[3] Kaipara Harbour Sediment Mitigation Study: summary, Streamlined environmental, 30 January 2018.
[4] Chappell, P.R. 2013. The climate and weather of Auckland. NIWA Science and Technology Series 60

3.4 Topography and geomorphology

The geology and geomorphology is described in detail within the Geotechnical Interpretative report (see Technical Report B, Volume 2).

In general terms, the project footprint is characterised by a ridge and gully topography, which has been deeply incised by west-north-west draining water courses that form tributaries of the Hōteo River.

The majority of natural slopes encountered in the project area are gently (≤18°) to moderately (19° to 25°) inclined. The south facing slopes are generally steeper than the north facing slopes indicating that the north facing slopes are bedding concordant (dip slopes) and the south facing slopes are bedding discordant (scarp slopes).

The project footprint is primarily underlain by Pakiri Formation sedimentary rocks of the Waitemata Group. Northland Allochthon has not been identified within Valley 1 but appears to be on the lowland to the west of the valley. Tauranga Group alluvial sediments were encountered at the base of the road access valley, with these materials encountered around low lying streams.

3.5 Existing sediment quality in immediate receiving environment

Baseline monitoring within the project footprint has been undertaken to obtain information on the current water quality including the level of sediment within the immediate receiving environment. The results to date are reported in the Baseline Monitoring report (Technical Report F, Volume 2).

To date eight rounds of monitoring have been undertaken. The monitoring results have been compared to Auckland Council monitoring data for the Mahurangi Redwoods Catchment. The results are within similar ranges to the Mahurangi site and are generally indicative of excellent water quality with suspended solids concentrations recorded up to 14 mg/l.

3.6 Sediment loads

We have reviewed the published data for sediment loads from studies in existing catchments in the Auckland Region[5]. Monitoring of sediment runoff from a redwood forest in the Mahurangi Catchment, approximately 15 km to the south of WMNZ landholdings, was undertaken between 1 July 1994 and 30 June 1995 with a sediment yield of 172 ± 19 t/km^2/year reported. The annual sediment loads were calculated based on sediment samples over 34 events between 1994 and 1998, and river level and flow data over 3.67 years.

The redwoods catchment is underlain with sandstone or coarse siltstones. It has steep sided valleys with mean annual rainfall above the region average. This is similar to the WMNZ landholdings which are predominantly underlain by Pakiri Formation sediments which consists of alternating layers of sandstone and siltstone.

More recent monitoring has been undertaken on the Weiti Forestry catchment which has reported much lower sediment loads than those reported for the redwoods catchment (37 t/km^2/ year). We note that the geology of the Weiti catchment comprises mudstone and limestones, which differs from both the Redwoods and the WMNZ landholdings. The catchment is also much flatter with a mean slope of 0.25 m/m and a maximum slope of 1.37 m/m compared to 2.33 m/m in the Redwood catchment. The Weiti catchment has also reported much lower annual rainfall, with rainfalls within the typical range for the Auckland Region.

[5] Analysis of Sediment Yields within the Auckland Region, TR2009/064, Auckland Regional Council

Auckland Council has also undertaken a study on the Hōteo River Catchment which has calculated an average sediment yield within the overall Hōteo Catchment of 74.3 t/km^2/year from all land uses with yields varying for the different catchments and the highest loads of up to 300 t/km^2/year reported for farmland catchments.

For the assessment of sediment effects we have used the following sediment yield values for the different land uses.

Table 3.1: Sediment yields

Land use type	Sediment yield (t/km^2/year)
Plantation Forestry	172
Farmland	167
Bush	48
Stabilised grassed areas (based on farmland)	167
Stabilised areas replanted with bush	48

The different land uses within the existing catchments including the proposed landfill footprint, the access road and the stockpile locations and the existing sediment loads are outlined in Table 3.2 and Table 3.3 below.

Table 3.2: Catchment areas (ha) and current land uses

	Plantation forestry	Farmland	Bush	Total area
Landfill footprint	110	-	-	110
Access road	-	-	85	85
Western Block	21	229	40	290
Stockpile 2 location	15	-	-	15
Total	146	229	125	500

Table 3.3: Existing sediment loads

	Plantation forestry (tpa)	Farmland (tpa)	Bush (tpa)	Total (tpa)	Overall sediment loads t/km^2/year
Landfill footprint	189.2	-	-	189.2	172
Access road	-	-	40.8	40.8	48
Western Block	36.1	382.4	19.2	437.8	151
Stockpile 2 location	25.8	-	-	25.8	172
Total	251.1	382.4	60	693.55	139

The total calculated sediment load from the existing catchments is 693.55 tpa based on the current land use.

4 Site establishment and initial construction erosion and sediment control

4.1 Overview of construction activities

The development of the associated infrastructure for the landfill includes the access road, bridge, stockpiles and the ponds which comprise the sediment control system.

The construction works are anticipated to extend over 3 to 4 earthworks seasons. In general the works will be undertaken as follows:

- Construction of Stockpile 1, and the clay borrow area – these will be used to stockpile clay and soil for use within the landfill operation which is excavated during cut operations for the construction of the access road and bin exchange area;
- Construction of the access road – commencing from the top and bottom of the catchment and continuing up and down the valley;
- Construction of the landfill water sediment control ponds including the wetland; and
- Construction of the bin exchange area.

Construction of Stockpile 2 will only be undertaken once Stockpile 1 is full.

4.2 Approach to erosion and sediment control

The approach to erosion and sediment control for the construction works is based on the following hierarchy of controls:

- Development of site specific erosion and sediment control plans for the works;
- Implementation of erosion control measures to minimise or avoid generation of sediment;
- Implementation of sediment control measures to minimise the discharge of sediment from the works; and
- Receiving environment monitoring, to confirm the effectiveness of the measures and to ensure measures adapt to minimise the generation and discharge of sediment.

More detail on each of the approaches is discussed further in the following sections.

4.2.1 Construction Erosion and Sediment Management Plan

A Construction Erosion and Sediment Management Plan (CESMP) has been prepared for the project (attached as Appendix A). The CESMP has been prepared to document the earthworks and sediment control procedures that will be required during the initial construction phases and sets out the process for WMNZ and its contractors to follow to develop a project-specific Erosion and Sediment Control Plan (ESCP) when individual works are known.

The CESMP requires development of a project specific ESCP for the earthworks associated with each area of work. In particular, project specific ESCP's will be required for the construction of the wetland and sediment ponds, the access road and the stockpile sediment ponds.

The CESMP includes an adaptive approach utilising both implementation of best practice controls as well as monitoring (see section 4.2.2 below) to provide a feedback loop to evaluate the performance of the erosion and sediment controls in place.

4.2.2 Erosion controls

The measures proposed are based on the controls and principles outlined in GD05 and are summarised in Table 4.1 below.

Table 4.1: Erosion control practices

Typical control	Comments	Key design criteria	Relevant section of GD05
Clean water diversion	It is anticipated that diversion of clean water around earthworks areas will be undertaken for all activities. Although this is recommended, there may be some areas where due to limitations due to the terrain or available space, that diversion of clean water is not possible.	Prevent clean surface water and stormwater from the surrounding area entering the work site. Use a bund constructed of stabilised material (e.g. hotmix or compacted soil/hardfill wrapped in geotextile cloth) around the perimeter of the site to divert clean surface or stormwater run-off. Bund height should be a minimum of 200 mm high. Where possible use bunds in conjunction with retaining existing stormwater reticulation systems (e.g. curb and channels).	E2.0
Stabilised access ways	The main access to and from the various parts of the site will be stabilised, to minimise tracking and movement of sediment off-site. It is also anticipated that at the main access points that wheel wash facilities will be provided.	Minimise tracking of material off-site from vehicle movements. Each individual project should have defined entrance and/or exits to the work area. Use a 50-150 mm aggregate laid 150 mm thick on geotextile to create a stabilised access way. Use a speed hump to ensure the access way drains back into the site; this allows for the brushing or washing of tyres if required. Where possible utilise existing sealed access ways.	E2.6
Stabilisation of exposed areas	Progressive stabilisation of all areas will be undertaken. As the proposal involves the use of a number of permanent stockpile locations, it is expected that only small stockpiles would be located within the works areas.	Temporary stockpiles (e.g. topsoil) or large stripped areas (e.g. >250 m^2) are to minimised and shall be stabilised if not worked for more than 2 weeks. Stockpiles and exposed areas are to be stabilised or covered using control measures such as geotextile, aggregate etc.	E3.0
Minimise open areas and use of staging of works	Staging of the works allows for the minimum open areas at any point of time. This can be used in conjunction with progressive stabilisation and ensuring only those areas which require earthworks being opened.	Ensure the extent of works is clearly identified prior to commencing work including identification of areas which can be protected or stabilised without undertaking earthworks. Where possible, the maximum extent of works at any point in time shall be minimised and areas stabilised prior to opening new areas.	E1.2

4.2.3 Sediment control

The measures proposed are based on the controls and principles outlined in GD05 and are summarised in Table 4.2 below.

Table 4.2: Sediment control practices

Typical control	Comments	Key design criteria	Relevant section of GD05
Sediment retention ponds	Permanent sediment control ponds are proposed for Stockpiles 1 and 2, the clay borrow and the topsoil stockpile. It is not likely that due to the constraints within the catchments that temporary sediment retention ponds will be used during construction works. While these are not anticipated, the development of the site specific sediment control plans must still consider their use where possible.	• Suitable where sufficient gradient exists to drain to sediment pond and for large development areas only – for most larger sites, the use of decanting earth bunds are more suitable; • Size based on a minimum volume of 3 % of the contributing catchment; • Length to width ratio of 3:1 to 5:1. • Full design of ponds including inlet and outlet structures required.	F1.1
Decanting earth bunds	The use of decanting earth bunds is expected where there is adequate room for these to be constructed without significant additional earthworks or vegetation removal. It is likely that decanting earth bunds can be constructed for the access road using existing overland flow paths and tributaries.	• Maximise the volume of storage impounded to maximise the duration of settlement; • Size based on a minimum volume of 1 % of the contributing catchment; • Maximum embankment height of 1 m; • Provide 30 % dead storage; • Minimum width is 2 m and length to width ratio no less than 3:1 and no greater than 5:1; • Use of a floating T-bar dewatering device is recommended; • Recommended decant rate is 0.3 l/s/1,000 m^2; • Should include both a primary and emergency spillway (designed for the 1 % AEP event); • The use of flocculent should be considered.	F1.2
Silt fence	Silt fences will be used at all works areas. Where other sediment control measures are not possible, it is expected that multiple silt fences will be used	• To be installed along the perimeter of the work area where 'dirty water' run-off from the work area will discharge.	F1.3

Typical control	Comments	Key design criteria	Relevant section of GD05
	(e.g. in steep sections of the access road valley).	• Silt fence must be supported by a top-wire to be run between wooden battens/waratahs placed at 2 to 4 m centres and embedded a minimum of 400 mm into the ground. • Silt fence fabric is to be installed 600 mm above ground level and trenched in 200 mm below ground. The site side of the trench is to be backfilled and well compacted to secure the silt fence. • Joins in lengths of silt fence fabric are to be done by doubling fabric around a waratah or stapling each fabric end to a batten and butting together.	

Silt socks	The use of silt socks are not expected to be used and where possible the use of silt fences are recommended.	• Silt socks are used to intercept and filter 'dirty water' run-off from the work area.
		• They have limited capacity (compared to silt fences) and can only be used for small, flat and isolated work areas were the:
		  ○ Maximum slope length is 100 to 150 m with <2% fall; or
		  ○ Maximum slope length is 40 to 60 m with a fall of 2-10%
		• To be installed along the perimeter of the work area where 'dirty water' run-off from the work site will discharge.
		• Joins in lengths of silt socks are to be overlapped a minimum of 1 m or according to supplier recommendation.
		• Placed to ensure continuous contact with the ground surface and secured with pegs/stakes were appropriate.
			F1.5

4.3 Construction activity specific approaches

While the specific construction methodologies will be developed during the detailed design phase, in general terms, the approach to managing sediment during the initial construction stages are outlined below.

4.3.1 Stockpiles 1, 2 and clay borrow

The Stockpiles 1 and 2 and the clay borrow area will each have an associated permanent sediment control pond to provide on-going management of runoff from the placement and removal of material. The permanent ponds for each area have been sized based on 3 % of the relevant stockpile / borrow area. The ponds will be constructed prior to placement of any material in the stockpiles or excavation from the borrow.

Additional controls will be used during operation including stabilisation of placed material, clean water diversions around the areas where material is being placed or removed and silt fences within the works areas.

The construction of the sediment ponds will be undertaken during dry weather where possible, with controls in place including super silt fences.

The key controls are as follows:

Erosion controls:

- Clean water diversions and/ or pumping water around the works area depending on spring flows.
- Progressive stabilisation.

Sediment controls:

- Decanting earth bunds.
- Silt fence.

4.3.2 Landfill access road

Construction of the access road will involve cutting and filling along the access route. Due to the restrictions within the access road valley, and the overall approach of minimising vegetation clearance, the road will be constructed in stages.

The key controls are as follows:

Erosion controls:

- Use of clean water diversions where possible, to direct clean water around the works areas.
- Undertaking the works progressively to minimise the open areas.
- Progressive stabilisation.

Sediment controls:

- Use of super silt fences downstream of the works areas.
- Use of decanting earth bunds.

4.3.3 Landfill access road bridge

Construction of the bridge will require the construction of piles near the stream bed, as well as construction of earth embankments at both ends. The key controls are as follows:

Erosion controls:

- Minimising piling works and works within or near the watercourse to dry weather periods;
- Undertaking the works progressively to minimise the open areas.
- Progressive stabilisation.

Sediment controls:

- Use of super silt fences downstream of the works areas; and
- Use of sediment ponds.

4.3.4 Landfill ponds

To minimise any effects from the discharge of sediment during the initial construction works for the first stage of the landfill including construction of the access roads and the work platforms for the workshop, Sediment pond 1 will be constructed first to provide temporary sediment control. This will provide sediment control for the construction of the upstream ponds and works.

The key controls are as follows:

Erosion controls:

- Clean water diversions and/ or pumping water around the works area depending on spring flows; and
- Progressive stabilisation.

Sediment controls:

- Decanting earth bunds; and
- Silt fence.

4.3.5 Bin exchange area

The construction of the bin exchange area will require significant cutting and removal of material to create the working platform.

Subject to sufficient room being available, it is likely that the works will include construction of a sediment control pond for sediment control prior to discharge. In addition, due to the limited distance between the works areas and the stream, the use of erosion controls including progressive stabilisation will be key to minimise the generation of sediment.

The key controls are as follows:

Erosion controls:

- Use of clean water diversions where possible, to direct clean water around the works areas;
- Undertaking the works progressively to minimise the open areas; and
- Progressive stabilisation

Sediment controls:

- Use of super silt fences downstream of the works areas; and
- Use of sediment ponds.

4.4 Sediment loads

Sedimentation within both the Hōteo River and the Kaipara Harbour is of particular concern within the Region. Due to the concerns Auckland Council and Northland Regional Council have undertaken joint research into the level of sedimentation within the Kaipara Harbour, the potential sources of sediment and possible mitigation scenarios over the past few years.

To understand the potential effects associated with sediment from the development of the proposed landfill, we have reviewed the current level of sediment being discharged from the site catchments and the potential sediment loads during the construction of the landfill.

Construction sediment loads have been calculated using the Universal Soil Loss Equation (USLE). The USLE calculation was developed by the United States Department of Agriculture to estimate erosion rates from different land use practices. The USLE calculation is commonly used in the Auckland Region to estimate sediment loads from earthworks activities.

The USLE calculation sheets are attached in Appendix B.

The USLE calculation has been undertaken with and without sediment controls in place. While the specific sediment control measures will be determined during the detailed design phases, in general terms as outlined in Sections 4.2 and 4.3 above the following measures will be implemented along with the expected efficiencies outlined in Table 4.3 below.

Table 4.3: Sediment control methods and expected removal efficiencies

Sediment control method	Sediment removal efficiency
Super silt fence	80%
Decanting earth bund without chemical dosing	70%
Sediment retention pond without chemical dosing	70%
Sediment retention pond with chemical dosing	90%

In general it is anticipated that a range of sediment control measures will be utilised to reduce sediment flows including the use of silt fences, stabilisation and decanting earth bunds or sediment retention ponds. By applying multiple methods in series, overall sediment removal efficiencies during earthworks can be up to 99%.

Table 4.4: Calculated sediment loads during construction

Earthworks area	Maximum bare earth(ha) during works	Sediment yield without controls (t)	Sediment yield with controls (t)
Bin exchange area	0.75	486	24
Main access road	1.2	780	39
Stockpile 1	1.5	962	48
Stockpile 2	1.2	778	39
Clay borrow	1	648	33
Total	5.65	3,654	183-

5 On-going monitoring

On-going monitoring during the construction programme will be required to assist with the on-going sediment management. The monitoring will support an adaptive sediment management approach where the monitoring can provide feedback on the effectiveness of sediment controls and the need for modified or additional controls.

A sediment monitoring plan will be prepared for the construction works and will include at least the following:

- Weather forecasting will be required to schedule high risk activities including any works within or close to streams during fine weather windows;
- Visual inspections of the receiving environment while works are being undertaken; with any noticeable changes in water clarity of colour between upstream and downstream of the works areas resulting in a review of sediment control measures and practices with additional or modified practices to be implemented; and
- Fixed permanent continuous monitoring of turbidity downstream of the landfill and upstream of the works areas to provide a trigger of changes in turbidity due to works on-site.

5.1 Weather forecasting

Weather forecasting will be a key component of the project to ensure fine weather windows are identified for high risk works such as works within stream beds, installation of culverts, and bridge piling activities near stream beds

In addition, forecasting can provide an early warning toll of upcoming rain events, which can allow for stabilisation works and inspections of key erosion and sediment control measures.

Both short term and long term forecast maps will be reviewed daily by the project team, with the weather forecast used to plan work activities for the upcoming periods. The monitoring results at the closed meteorological station (Mahurangi Mews operated by Auckland Council) will also be reviewed and compared with the forecast predictions to better understand the future rain events.

5.2 Visual inspections

The contractors will be responsible for undertaking regular visual inspections of the following aspects during the works:

- The sediment control devices during and following any significant rain events. This is to ensure these are working effectively, and identify any improvements or repairs following significant rain events;
- The receiving environment both upstream and downstream during and after rain events at works locations to identify any noticeable changes in water clarity, sediment deposition within the streams.

Any changes in the receiving environment that are considered he result of the earthworks will require a review of the project specific ESCP to identify if additional measures are necessary such as additional stabilisation, reduction in open areas the use of flocculation or additional sediment control measures.

5.3 Monitoring

Fixed turbidity monitoring will be installed upstream and downstream of the road access and bridge construction works to provide a trigger for investigation. In addition, manual sampling will be undertaken within works areas. This will include the following monitoring locations:

- Permanent turbidity monitoring upstream of the works during construction of the access road;
- Permanent turbidity downstream of the access road and bridge works within the Waitarere Stream; and
- Manual sampling downstream of the stockpiles while significant works are being undertaken (including the initial establishment stages).

The monitoring results will be compared with trigger levels that will be developed as part of the SSESCP based on industry good practice and the evaluation of the background monitoring results.

5.4 Review and investigation

The results of the monitoring programme will be used to trigger the need to review and investigate both the effectiveness of measures, and the potential effects of any sediment discharges. The review shall include the following key aspects:

- Evaluation of the performance of erosion and sediment control measures to manage sediment effects to identify measures that are the most effective or whether measures were installed and/or operated correctly;
- The need for additional controls to avoid future discharges of sediment;
- Whether additional inspections and monitoring is required, including post event ecological monitoring of the receiving environment to establish the potential effects.

The monitoring programme provides for an effective feedback loop and allows for an adaptive approach to monitoring sediment discharges.

6 Approach to assessment

6.1 Risk based approach

We have developed a surface water strategy for the project based on the specific requirements for each area. This has been undertaken using a risk based approach which considers the sensitivity of the receiving environment both immediate and further downstream and the activities undertaken in each catchment.

The purpose of the strategy is to assist in the identification of areas of the site and activities which may have a high risk of adverse effects if not effectively managed. This assists in identifying the level of controls required, or increased confidence that the proposed controls will be effective.

The strategy has been based on the key parameters outline in Table 6.1 and Table 6.2 below.

Table 6.1: Sensitivity of receiving environment

	Sediment
Low	Receiving environment has a large catchment to provide mixing; Large number of existing sources of sediment; Limited evidence of ecological values sensitive to changes in sediment quality.
Medium	Receiving environment has a moderate size catchment to provide mixing; Other sources of sediment but no significant sources; Some evidence of ecological values sensitive to changes in sediment quality.
High	Receiving environment has limited catchment size reducing level of mixing Limited sources of sediment; Ecological values having a high sensitivity to changes in sediment quality.

Table 6.2: Generation potential

	Sediment
Low	Areas used for clean vehicles or limited vehicle use (e.g. office areas) and areas stabilised. Earthworks in flat areas where water is likely to pond within the works areas.
Medium	Areas with only minor earthworks and limited open areas or areas predominantly stabilised. Earthworks in moderate rolling terrain.
High	Areas of the site with significant earthworks and open areas. Earthworks in steep terrain.

The overall risk can then be identified for each of the different potential effects based on the overall risk is Table 6.3 below.

Table 6.3: Overall risk

		Sensitivity of receiving environment		
		Low	**Medium**	**High**
Generation potential	**Low**	Very low	Low	Moderate
	Medium	Low	Moderate	High
	High	Moderate	High	Very High

6.2 Risk evaluation

Based on the risk based approach outlined above, we have evaluated each catchment and overall activity. Based on the approach, where the sensitivity of the receiving environment has a high sensitivity, the lowest the risk can be reduced to, even with controls is moderate.

This is due to the fact that the proposal relates to the proposed generation potential with controls only able to reduce the generation potential with the sensitivity of the receiving environment is fixed.

Table 6.4: Risk evaluation

Area	Generation potential	Sensitivity of receiving environment	Initial risk	Physical controls	Modified generation potential	Modified risk with standard controls
Southern Block (Access road)	Medium	High	High	None	Low	Moderate
Eastern Block (Landfill)	High	Medium	Very High	Sediment ponds and wetland	Low	Low
Western Block (Stockpile 1)	High	High	Very High	Sediment ponds	Low	Moderate
Upper Waiteraire Block (Stockpile 2)	High	High	Very High	Sediment ponds	Low	Moderate
Western Block (Topsoil stockpile	High	High	Very High	Sediment ponds	Low	Moderate
Western Block (Clay burrow)	High	High	Very High	Sediment ponds	Low	Moderate
Southern Block (Bin exchange area)	Medium	Medium	Moderate	Low	Low	Low

The initial risk assessment has identified a number of catchments with a very high risk of effects from the proposal without mitigation. These include the Western Block (where a number of wetlands are present) and the Southern and Upper Waiteraire Blocks were the ecological investigation has identified the existing streams have high ecological values. With mitigation in place, the risks are between low to moderate.

7 Assessment of effects on the environment

The construction of the landfill and associated infrastructure including the access road, bridge, stockpiles and bin exchange area have the potential to result in effects associated with discharges of sediment during earthworks.

The objectives for land disturbances activities under the AUPOiP require land disturbance activities to be undertaken in a manner that protects the safety of people and avoids, remedies and mitigates adverse effects on the environment by minimising sediment generation and controlling land disturbance activities.

The policies outlined this should be achieved through the use of best practicable options for erosion and sediment control and manage the amount of land being disturbed at any time.

The proposed works will be undertaken in accordance with industry best practice including methods to minimise sediment generation such as minimising open areas, progressive stabilisation and clean water diversion drains. Construction activities will also include sediment control measures including the use of silt fences, decanting earth bunds and sediment ponds.

The construction works will be undertaken in accordance with the overall Earthworks and Construction Management Plan which requires preparation of site specific sediment control plans for different activities and areas, as well as on-going monitoring. The monitoring will provide feedback to enable an adaptive approach to be used, where additional controls or measures used where there is a greater risk of sediment discharges and/ or monitoring indicates that additional controls are required.

USLE calculations have also been undertaken for the proposed construction works. Based on the estimated sediment yields, the total calculated sediment yield from construction activities is 183 tonnes.

It is anticipated that the works will be spread over three to four earthworks seasons with works to be staged during each season. Therefore, the actual annual sediment loads will vary over the construction period.

Considering the use of best practice methods, and an adaptive approach including monitoring within the receiving environment the effects from sediment discharges during construction works should be able to be appropriately controlled to ensure the risk of effects from sediment discharges are acceptable.

8 Conclusion

The Erosion and Sediment Control assessment has been prepared to support an application for resource consent to establish the proposed Auckland Regional Landfill at a location in the Wayby Valley.

The sensitivity of the receiving environment to changes in sediment loads is high including the immediate receiving environment in particular due to a number of sensitive wetlands, the Hōteo River and the Kaipara Harbour which are sensitive to increased sedimentation. In particular, concerns due to smothering of reed beds in the Kaipara Harbour potentially impacting on snapper breeding grounds is a key concern in the region.

The potential construction works if not effectively managed can have effects on sediment loads within the catchment, with unmitigated loads significantly higher than existing loads.

Due to the sensitivity of the receiving environment, the use of best practice erosion and sediment control methods along with an adaptive approach to sediment control including monitoring within the receiving environment and weather forecasting to identify dry periods for activities with a high risk of sediment generation are proposed. These controls and measures will ensure the discharge of sediment during works is minimised.

Therefore, the effects from sediment discharges during construction works should able to be appropriately controlled to ensure effects are no more than minor.

The on-going monitoring programme will also be implemented which will evaluate the on-going effectiveness of the measures.

9 Applicability

This report has been prepared for the exclusive use of our client Waste Management NZ Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Rob van de Munckhof	Simonne Eldridge
Principal Environmental Engineer	Project Director

rvdm
p:\1005069\issued documents\final application for lodgement may 2019\volume 2 - technical reports\technical report r - sediment and erosion control assessment\sediment and erosion control assessment.docx

Appendix A: Drawings

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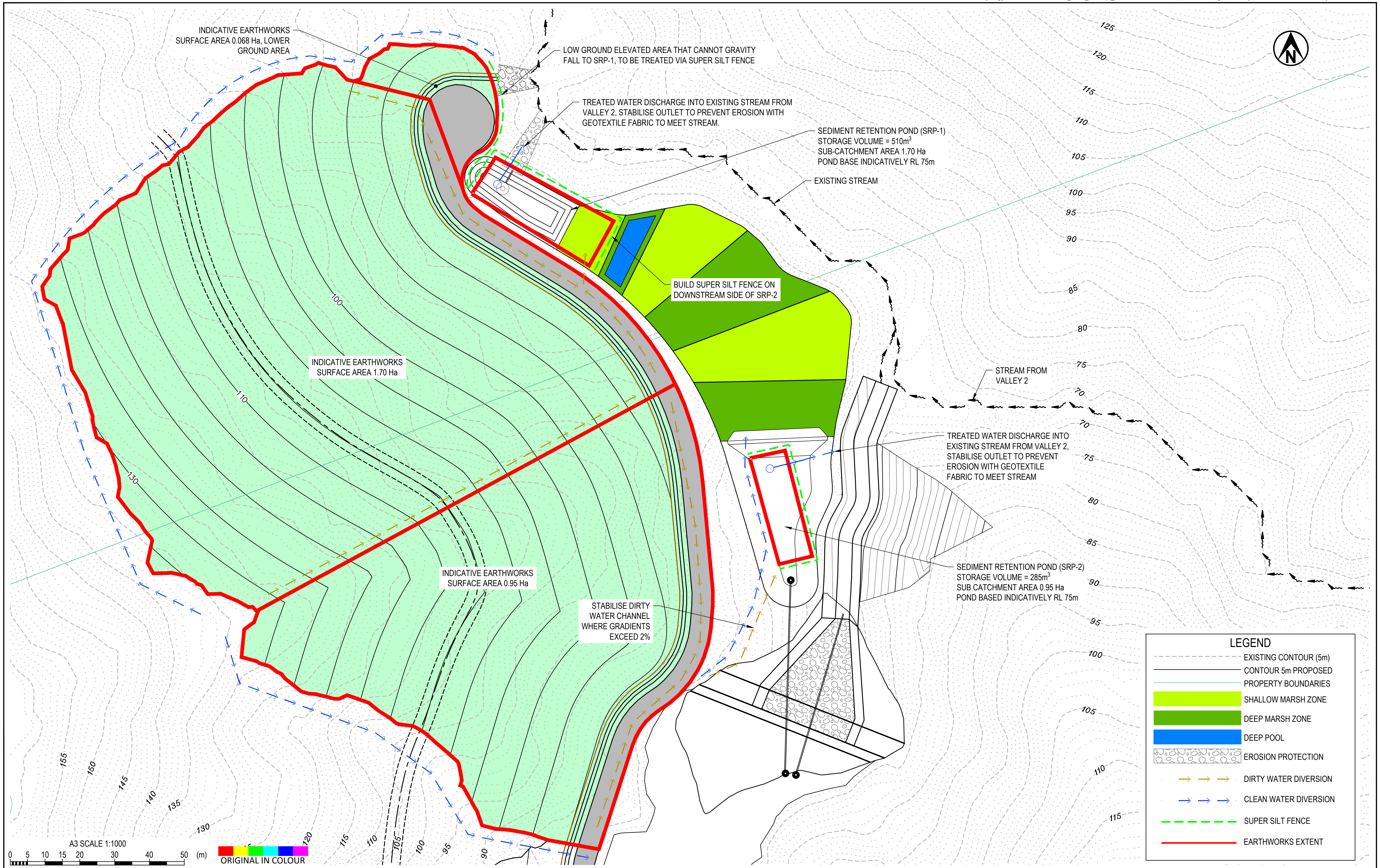

NOTES:

1. ALL EROSION AND SEDIMENT CONTROL DEVICES TO BE CONSTRUCTED IN ACCORDANCE WITH THE AUCKLAND COUNCIL EROSION AND SEDIMENT CONTROL GUIDE FOR LAND DISTURBING ACTIVITIES IN THE AUCKLAND REGION, JUNE 2016, GD05.
2. ALL SEDIMENT CONTROLS ARE CONCEPTUAL ONLY AND WILL BE CONFIRMED AT DETAIL DESIGN PHASE.

Tonkin+Taylor

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PROJECT No.	1005069	
DESIGNED	SL	May.19
DRAWN	LOJA	May.19
CHECKED	RVDM	May.19
APPROVED		DATE

CLIENT **WASTE MANAGEMENT NZ LTD**

PROJECT **AUCKLAND REGIONAL LANDFILL**

TITLE EROSION AND SEDIMENT CONTROL PLAN PROPOSED WETLAND SCHEMATIC

SCALE (A3) 1:1000 FIG No. CSMP-1 REV 1

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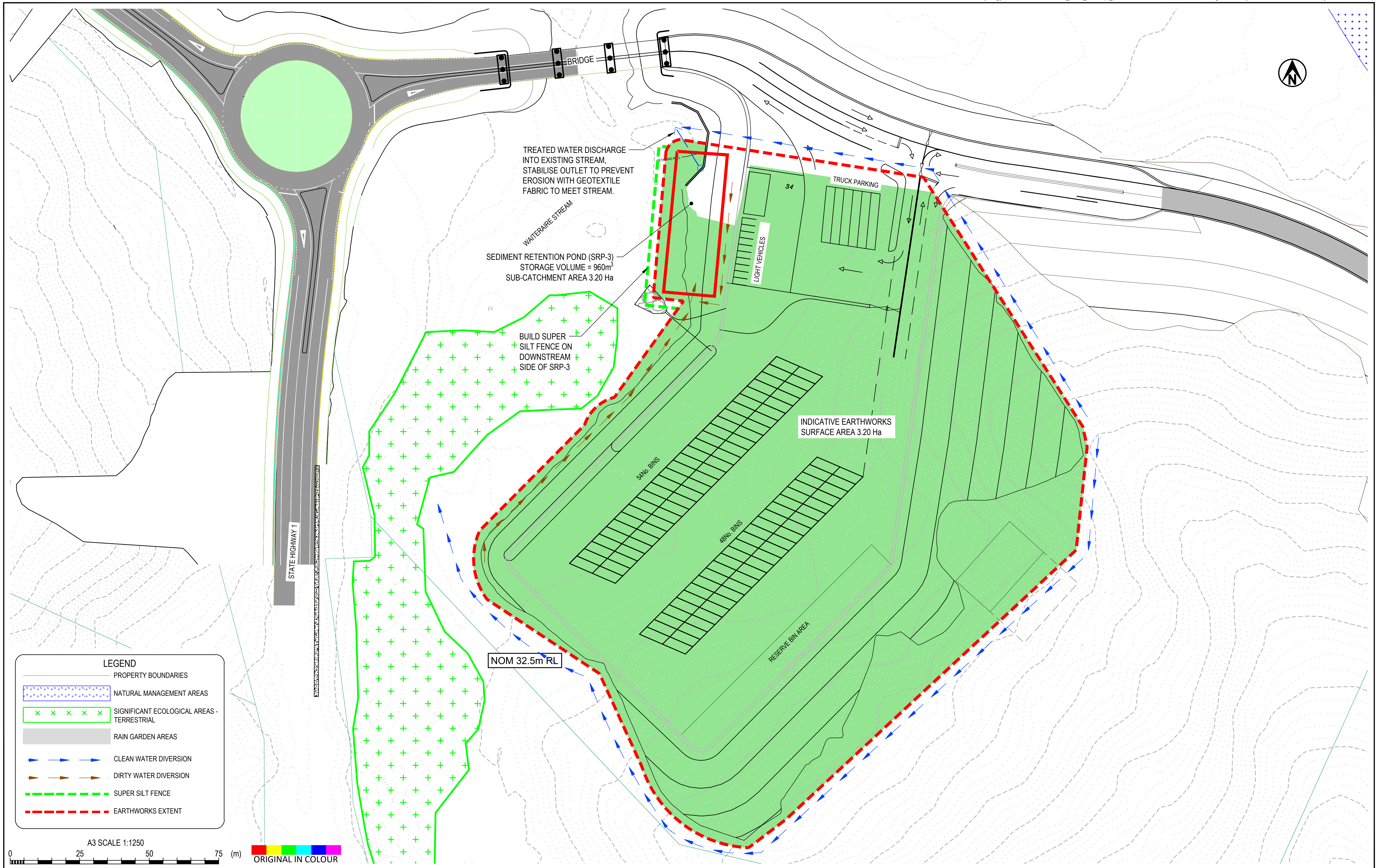

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CLIENT	WASTE MANAGEMENT NZ LTD
PROJECT	AUCKLAND REGIONAL LANDFILL
TITLE	EROSION AND SEDIMENT CONTROL PLAN BIN EXCHANGE AREA AND LANDFILL ACCESS ROAD
SCALE (A3)	1:1250
FIG No.	CSMP-2
REV	1

Appendix B: Draft Construction Erosion and Sediment Control Plan

REPORT

Draft Construction Erosion and Sediment Management Plan

Auckland Regional landfill

Prepared for
Waste Management NZ Limited

Prepared by
Tonkin & Taylor Ltd

Date
May 2019

Job Number
1005069

Exceptional thinking together
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Document Control

Title: Draft Construction Erosion and Sediment Management Plan					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
30/05/19	1.0	Final draft	R. van de Munckhof	J. Quinn	S. Eldridge

Table of contents

1 Introduction

1.1 Purpose of this plan

Waste Management NZ Limited (WMNZ) is seeking to develop a new landfill at Wayby Valley in Auckland. As part of the development of the landfill, erosion and sediment control works will be required during both the development of the site and on-going landfilling.

This Construction Erosion and Sediment Management Plan (CESMP) has been prepared to document the earthworks and sediment control procedures that will be required during the initial construction phases and sets out the process for WMNZ and its contractors to follow to develop a project-specific Erosion and Sediment Control Plan (ESCP) when individual works are known.

This plan provides a suite of controls relevant to the type and scale of earthworks to be undertaken with respect to the individual projects within the areas. The process for identifying the specific controls to be implemented and requirement for the preparation of a project specific ESCP is also detailed in this Plan.

Sediment control during the operation of the landfill is covered by a separated sediment control plan which will be included within the overall Landfill Management Plan.

1.2 Site description

The proposed landfill is located in the Wayby Valley area, approximately 6 km southwest of Wellsford and 70 km north of Auckland. The landfill is to be constructed in a northwest facing valley currently vegetated with pine forest. This portion of the site is described as the Eastern Block. The landfill will be constructed entirely in the catchment of this valley, at the head of the catchment. Access roads and some ancillary facilities will be constructed in neighbouring catchments.

Access to the landfill is proposed off State Highway 1 just south of the Hōteo River Bridge, where a sealed road will be constructed

1.2.1 Site environmental settings

The proposed landfill footprint is currently covered by exotic plantation forestry, which, at the time of harvest, will result in a range of adverse effects on a variety of flora and fauna, and habitat loss including effects associated with sediment loss and water quality. The effects associated with the clearance of pine forestry are outside of the scope of the project as any future harvesting will be undertaken by a third party and not by WMNZ, and will proceed whether or not WMNZ proceeds with their proposed project.

The Western Block is currently an operational farm and the Southern Block comprises regenerating native vegetation and plantation wattle. A tributary of the Waiteraire Stream within the Southern Block is a Natural Stream Management Area (NSMA) with high ecological value.

The main channel of the Hōteo River is adjacent to and immediately downstream of the site and is identified as a NSMA and Significant Ecological Area (SEA) under the Auckland Unitary Plan Operative in Part (AUP). The incised meanders of the Hōteo are identified as being an Outstanding Natural Feature (ONF). The Hōteo River mouth at the Kaipara Harbour is a marine SEA and is sensitive to sedimentation.

To the south, the site is bound by native forest in the Sunnybrook Scenic Reserve, which is a designated SEA.

1.3 Proposed development

The development of the landfill and associated infrastructure including access road will require a number of construction activities which have the potential to generate sediment.

The initial establishment works will include the following:

- Earthworks for the construction of the landfill access road;
- The construction of the stockpiles and the clay borrow area (these will be used to place excess material from the earthworks);
- The construction of the bridge;
- Earthworks associated with the construction of the main landfill wetland and sediment ponds; and
- Earthworks associated with the bin exchange area platform.

These activities are expected to be limited to a period of three to four years.

1.3.1 Scope of this CESMP

The proposed works covered by this plan include the following activities:

- Construction of the main access road;
- Earthworks associated with the formation of the bin exchange area platform;
- Preliminary earthworks associated with the temporary access to the landfill and construction of the main landfill wetland and sediment ponds;
- Earthworks associated with the formation of the office, workshop and renewable energy centre platforms; and
- Construction of the sediment ponds for the stockpile locations.

Sediment control associated with the construction and on-going management of the landfill and the stockpiles is not covered by this plan and are subject to the controls outlined in the Landfill Management Plan.

2 Plan management and control

2.1 Roles and responsibilities

WMNZ is responsible for ensuring the works are undertaken in accordance with this Plan. In particular, WMNZ is responsible for:

- Making this CESMP available to the Contractors for the works;
- Working with the Contractors to assist in the identification of the appropriate erosion and sediment controls for the project;
- Reviewing the project specific ESCPs provided by the Contractors;
- Ensuring the contractors implement and maintain the controls detailed in the project specific ESCP during the project;
- Maintaining a record of all works, project specific ESCPs, and compliance records; and
- Ensuring compliance with resource consent conditions.

2.2 Distribution

The following parties will be provided with this CESMP:

- WMNZ;
- All main contractors undertaking works on-site; and
- Auckland Council.

2.3 Review and update

This plan shall be reviewed and updated by WMNZ based on feedback from the Contractors and Auckland Council, to reflect any improvements in procedures.

Any changes made should not reduce the level of controls unless there is good evidence for the change. Any substantive changes to this Plan may be required to be approved by Auckland Council prior to implementation.

3 Earthworks management requirements and constraints

3.1 Regulatory requirements

Chapters E11 and E12 of the Auckland Unitary Plan Operative in Part (AUP) outlines specific regional requirements for land disturbance (i.e. earthwork) management. When undertaking earthworks, consideration will need to be given to the earthwork objectives of the AUP. These relate to the following key aspects of earthworks:

- Works are to be undertaken in a manner that protects the safety of people and avoids, remedies and/or mitigates adverse effects on the environment.
- Sediment generation is minimised.
- Works are controlled to achieve soil conservation.

The AUP requires a best practicable option assessment to determine the appropriate sediment and erosion controls based on the nature and scale of the activity. Technical guidance for the selection, design and use of erosion and sediment control for earthworks is provided in the Auckland Council *Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*, June 2016 (GD05).

3.2 Site specific constraints

The proposed works will be undertaken within a number of different catchments and receiving environments. A number of the proposed works areas are located within areas with specific constraints or where there are high value ecological environments downstream. We have undertaken a review of the proposed works and locations to identify any specific requirements or constraints which may direct the sediment measures required which are summarised in Table 3.1.

Table 3.1: Summary of constraints

Works	Physical constraints within immediate works area	Overall receiving environment sensitivity
New road and access off SH1, including a new bridge over the Waiteraire Stream at the site entrance	Parts of the site are located within a flood plain.	Works located adjacent to the Waiteraire Stream which is a tributary of the Hōteo River which ultimately flows into the Kaipara Harbour. Both the Hōteo River and the Kaipara are sensitive to sedimentation. The works are also located immediately upstream of an SEA and NSMA.

Works	Physical constraints within immediate works area	Overall receiving environment sensitivity
Bin exchange area	No specific physical constraints	Works located adjacent to the Waiteraire Stream which is a tributary of the Hōteo River which ultimately flows into the Kaipara Harbour. Both the Hōteo River and the Kaipara are sensitive to sedimentation. The works are also located immediately upstream of an SEA and adjacent to an NSMA. Existing vegetation expected to provide habitat for threatened native bats.
Main access road	Works undertaken on steep slopes.	Works located adjacent to the Waiteraire Stream which is a tributary of the Hōteo River which ultimately flows into the Kaipara Harbour. Both the Hōteo River and the Kaipara are sensitive to sedimentation. Need to minimise removal of vegetation which provides habitat for threatened native bat
Construction of wetland and sediment ponds for landfill	Works undertaken within a narrow valley.	Downstream environment identified as having high ecological values.
Formation of office and workshop platforms	No specific physical constraints	Works will be undertaken after the formation of the main wetland and ponds. Downstream environment identified as having high ecological values.
Formation of energy centre platform	No specific physical constraints	Works will be undertaken after the formation of the main wetland and ponds. Downstream environment identified as having high ecological values.
Construction of sediment ponds for stockpile locations.	No specific physical constraints within specific works area.	Works undertaken above sensitive ecological environments including SEA wetlands, SEA terrestrial vegetation or NSMA.

4 Requirements for individual works

For each works area, the Contractors must provide a project specific ESCP for the earthworks associated with that project. The ESCP should assess and detail the following:

1. The location and total area of earthworks;
2. The volume of earthworks. This is to include details of the volumes to be excavated, stockpiled, re-used and disposed of off-site;
3. The location of erosion controls (e.g. perimeter control such as a clean water diversion bunds);
4. The location of sediment controls (e.g silt fence along low point of site where surface water will discharge from site or around stockpile areas);
5. Staging of the earthworks (if appropriate). If works are to be staged the details of each of the above need to be detailed for each stage of the works and means of progressive stabilisation of exposed areas identified.
6. Key responsibilities for implementing and maintaining the controls detailed in the project specific ESCP during the project;
7. The location of the site entrance and means to control tracking of dirt off-site;

8 The frequency and responsibility for monitoring the effectiveness of controls and the undertaking of any maintenance;

9 The details for decommissioning controls; and

10 A scaled plan of the project with the above items detailed. For individual projects which are more complex (due to size, duration or phasing of the works) the ESCP shall be supported by a short report which outlines the proposed approach and controls.

Example site specific erosion and sediment control plans have been prepared for the Wetland and the bin exchange areas. These are attached as Appendix A.

5 Earthwork management controls

5.1 Standard earthworks management controls

The following sections provide guidance on the selection of erosion and sediment control measures to be implemented for each individual works. The measures proposed are based on the controls and principles outlined in GD05.

The proposed control measures are based on the following principles:

1 Minimise disturbance.

2 Keep clean and dirty water separate and treat dirty water prior to discharge.

3 Monitor the controls and conditions to suit site circumstances (including weather).

Table 5.1 provides the appropriate erosion controls to minimise the generation of sediment laden water from the work areas. Table 5.2 and Table 5.3 provide appropriate sediment controls in addition to ancillary considerations for earthworks management.

Table 5.1: Erosion control practices

Typical control	Key design criteria	Relevant section of GD05
Clean water diversion	Prevent clean surface water and stormwater from the surrounding area entering the work site. Use a bund constructed of stabilised material (e.g. hotmix or compacted soil/hardfill wrapped in geotextile cloth) around the perimeter of the site to divert clean surface or stormwater run-off. Bund height should be a minimum of 200 mm high. Where possible use bunds in conjunction with retaining existing stormwater reticulation systems (e.g. curb and channels).	E2.0
Stabilised access ways	Minimise tracking of material off-site from vehicle movements. Each individual project should have defined entrance and/or exits to the work area. Use a 50-150 mm aggregate laid 150 mm thick on geotextile to create a stabilised access way. Use a speed hump to ensure the access way drains back into the site; this allows for the brushing or washing of tyres if required. Where possible utilise existing sealed access ways.	E2.6
Stabilisation of exposed areas	Stockpiles (e.g. topsoil) or large stripped areas (e.g. >250 m^2) are to be stabilised if not worked for more than 2 weeks.	E3.0

Typical control	Key design criteria	Relevant section of GD05
	Stockpiles and exposed areas are to be stabilised or covered using control measures such as geotextile, aggregate etc.	

Table 5.2: Sediment control practices

Typical control	Key design criteria	Relevant section of GD05
Sediment retention ponds	• Suitable where sufficient gradient exists to drain to sediment pond and for large development areas only – for most larger sites, the use of decanting earth bunds are more suitable; • Size based on a minimum volume of 3 % of the contributing catchment; • Length to width ratio of 3:1 to 5:1. • Full design of ponds including inlet and outlet structures required. • The use of flocculent should be considered.	F1.1
Decanting earth bunds	• Maximise the volume of storage impounded to maximise the duration of settlement; • Size based on a minimum volume of 1 % of the contributing catchment; • Maximum embankment height of 1 m; • Provide 30 % dead storage; • Minimum width is 2 m and length to width ratio no less than 3:1 and no greater than 5:1; • Use of a floating T-bar dewatering device is recommended; • Recommended decant rate is 0.3 l/s/1,000 m^2; • Should include both a primary and emergency spillway (designed for the 1 % AEP event); • The use of flocculent should be considered.	F1.2
Silt fence	• To be installed along the perimeter of the work area where 'dirty water' run-off from the work area will discharge. • Silt fence must be supported by a top-wire to be run between wooden battens/waratahs placed at 2 to 4 m centres and embedded a minimum of 400 mm into the ground. • Silt fence fabric is to be installed 600 mm above ground level and trenched in 200 mm below ground. The site side of the trench is to be backfilled and well compacted to secure the silt fence. • Joins in lengths of silt fence fabric are to be done by doubling fabric around a waratah or stapling each fabric end to a batten and butting together.	F1.3

Silt socks	• Silt socks are used to intercept and filter 'dirty water' run-off from the work area.
	• They have limited capacity (compared to silt fences) and can only be used for small, flat and isolated work areas were the:
	    ○ Maximum slope length is 100 to 150 m with <2% fall; or
	    ○ Maximum slope length is 40 to 60 m with a fall of 2-10%
		F1.5

Typical control	Key design criteria	Relevant section of GD05
	• To be installed along the perimeter of the work area where 'dirty water' run-off from the work site will discharge. • Joins in lengths of silt socks are to be overlapped a minimum of 1 m or according to supplier recommendation. • Placed to ensure continuous contact with the ground surface and secured with pegs/stakes were appropriate.	
Stormwater inlet protection	• For stormwater inlets that must remain operational within the work area, the catchment that falls to the inlet needs to be minimised and a silt fence installed around the inlet • For inlets adjacent to the access ways of work areas, a silt sock or a proprietary device in combination with silt sock are commonly used as a secondary protection measure	F1.6

Table 5.3: Ancillary considerations

Typical control	Key design criteria	Relevant section of GD05

Dewatering	• Earthworks are to be undertaken in such a manner to minimise the accumulation/ponding of water.
	• If water from within the work area needs to be removed through pumping then care must be taken to ensure such an activity is closely managed and monitored ensuring:
	  ○ Sediment within the water has settled out with a minimum 100 mm clarity required prior to pumping.
	  ○ Pumps are to be set up to dewater from the top of the water and to minimise disturbance of the settled water.
	• A variety of other options also exist in which sediment can be removed by pumping the water through a turkey nest or pipe sock.
	• A sucker truck may be used if all other options for pumping and disposal on the site are unworkable and if truck access is possible to remove water from the landfill and take it to an appropriate off-site facility.
		G1.0

Dust	• Generation of dust from the work area needs to be visually monitored and controlled.
	• Typically dust control measures include:
	  ○ Limit vehicle movements and speed on unsealed areas
	  ○ Remove/clean fines from sealed areas
	  ○ Limit stockpiling and/or cover during sustained dry and windy condition
	  ○ Minimise the extent of disturbed areas by undertaking works in a staged manner
	  ○ Dampen down work areas with water
		G9.0

Monitoring and maintenance	• A copy of the project specific ESCP should be held on site. • Weekly inspection (as a minimum) of all controls should be undertaken. • Additional inspection before and after heavy rainfall should also be undertaken.	C1.5.7

Typical control	Key design criteria	Relevant section of GD05
	• Accumulated sediment should be cleaned out regularly and disposed of appropriately. • Any damaged or underperforming control should be maintained and/or remediated.	
Decommissioning controls	• Only once the work area is permanently stabilised can the controls be removed. • During removal care is to be taken to ensure any built up sediment is appropriately managed and any disturbed areas immediately stabilised.	C1.6

Unexpected/ accidental discovery	• Should the unlikely event of 'sensitive material' be uncovered (e.g. human remains, archaeological artefact, etc.):
	  ○ Works are to cease within 20 m of the discovery and the area secured.
	  ○ The relevant parties are to be immediately notified
		n/a

5.2 Area specific requirements

While Section 5.1 outlines the erosion and sediment control measures that will be considered in the development of the ESCP, the site specific constraints and sensitivity of the receiving environment mean some specific measures should be considered. These are outlined in below.

Table 5.4: Area specific controls

Works	Works specific control measures	Comments
New road and access off SH1	• Sediment retention ponds; • Silt fence	Expected to follow standard good practice including the use of sediment ponds
Bin exchange area	• Sediment retention ponds; • Silt fence	Expected to follow standard good practice including the use of sediment ponds
Access road	• Double silt fence; • Progressive stabilisation and minimisation of open areas.	Due to the steep terrain, and need to minimise vegetation removal it is anticipated that there will be insufficient room to include sediment ponds. The use of additional silt fences and undertaking works to minimise open areas and progressive stabilisation required.
Construction of the bridge	• Minimising piling works and works within or near the watercourse to dry weather periods; • Undertaking the works progressively to minimise the open areas. • Super silt fences downstream of the works areas; and	Expected to follow standard good practice including the use of sediment ponds; Piling works near or within the watercourse will be programmed during dry weather.

Works	Works specific control measures	Comments
	• Sediment ponds.	
Formation of office and workshop platforms	• To be completed after construction of the main sediment pond for landfill	Providing works are timed correctly, works should be undertaken following standard good practice.
Formation of energy centre platform	• To be completed after construction of the main sediment pond for landfill	Providing works are timed correctly, works should be undertaken following standard good practice.
Construction of wetland and sediment ponds for landfill	• Sediment retention ponds; • Silt fence; • Requires pumping the stream around the works area.	Construction of an upstream pond and downstream pond to pipe the stream around the works will be required to avoid surface water from upstream entering the works areas. The first stage will require a sediment pond to be constructed downstream of the works areas and stabilised outlets. It is anticipated due to the limited room that the construction sediment pond will be converted into a permanent sediment pond on completion of works.
Construction of sediment ponds for stockpile locations.	• Decanting earth bunds; • Silt fence; • May require pumping water around the works area depending on spring flows.	Stockpile locations are upstream of high value ecological environments. Therefore, a high level of sediment control will be expected including the use of measures to minimise open areas and progressive stabilisation. It is expected that the outlet of the ponds would be formed first to provide a decant bund for the construction of the remaining pond.

6 Monitoring and maintenance

On-going monitoring during the construction programme will be required to assist with the on-going sediment management. The monitoring will support an adaptive sediment management approach where the monitoring can provide feedback on the effectiveness of sediment controls and the need for modified or additional controls.

A sediment monitoring plan will be prepared for the construction works and will include at least the following:

- Weather forecasting will be required to schedule high risk activities including any works within or close to streams during fine weather windows;
- Visual inspections of the receiving environment while works are being undertaken with any noticeable changes in water clarity of colour between upstream and downstream of the works areas resulting in a review of sediment control measures and practices with additional or modified practices to be implemented; and
- Fixed permanent continuous monitoring of turbidity downstream of the landfill and upstream of the works areas to provide a trigger of changes in turbidity due to works on-site.

7 Applicability

This report has been prepared for the exclusive use of our client Waste Management NZ Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
....	....
Rob Van de Munckhof	Simonne Eldridge
Principal Environmental Engineer	Project Director

rvdm

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Appendix A: Example erosion and sediment control plans

- **CSMP-1 Wetland**
- **CSMP-2 Bin exchange area**

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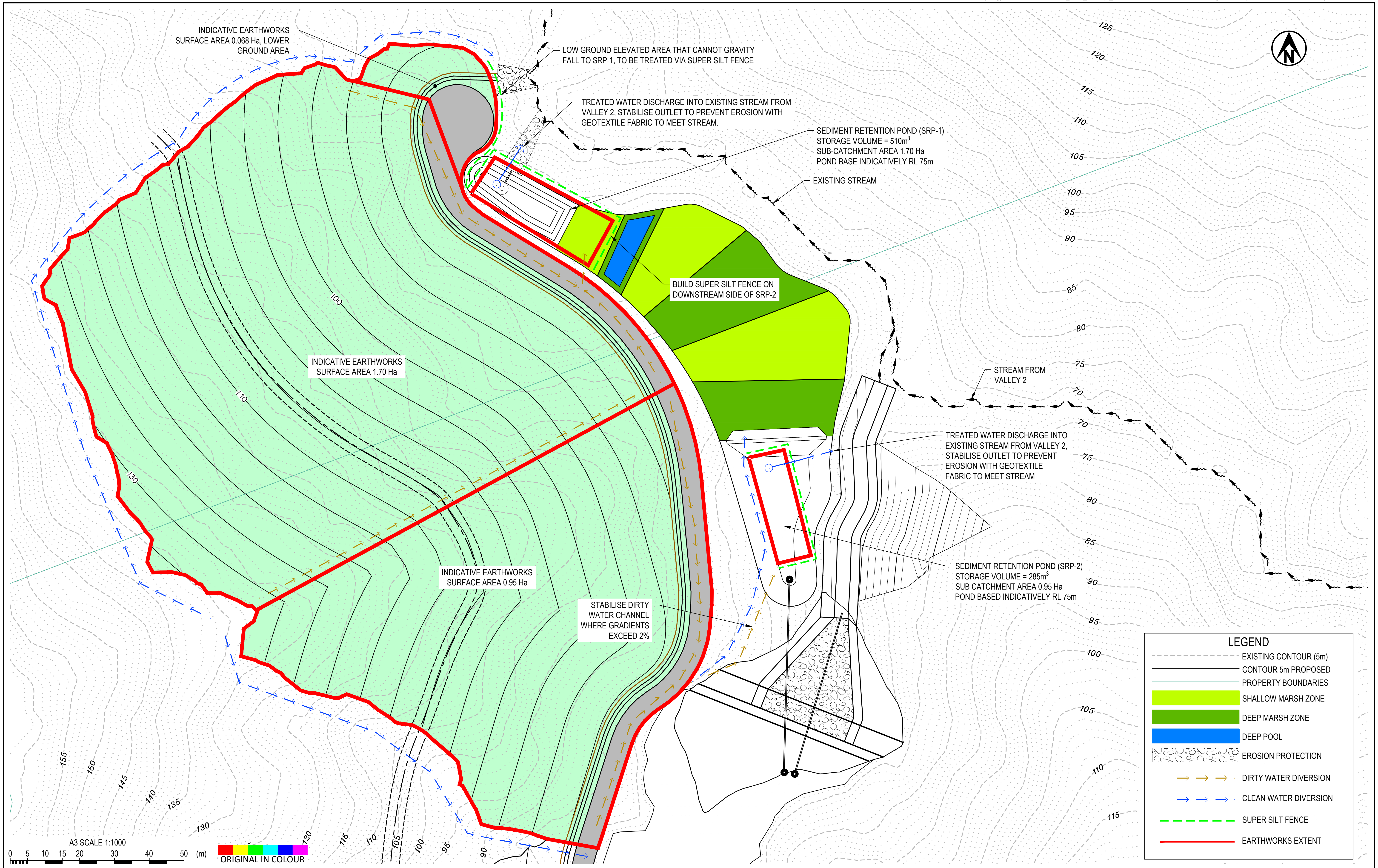

NOTES:
1. ALL EROSION AND SEDIMENT CONTROL DEVICES TO BE CONSTRUCTED IN ACCORDANCE WITH THE AUCKLAND COUNCIL EROSION AND SEDIMENT CONTROL GUIDE FOR LAND DISTURBING ACTIVITIES IN THE AUCKLAND REGION, JUNE 2016, GD05.
2. ALL SEDIMENT CONTROLS ARE CONCEPTUAL ONLY AND WILL BE CONFIRMED AT DETAIL DESIGN PHASE.

Tonkin+Taylor
Exceptional thinking together   www.tonkintaylor.co.nz

PROJECT No.	1005069	
DESIGNED	SL	May.19
DRAWN	LOJA	May.19
CHECKED	RVDM	May.19
APPROVED		DATE

CLIENT WASTE MANAGEMENT NZ LTD
PROJECT AUCKLAND REGIONAL LANDFILL
TITLE EROSION AND SEDIMENT CONTROL PLAN
PROPOSED WETLAND SCHEMATIC

SCALE (A3) 1:1000   FIG No. CSMP-1   REV 1

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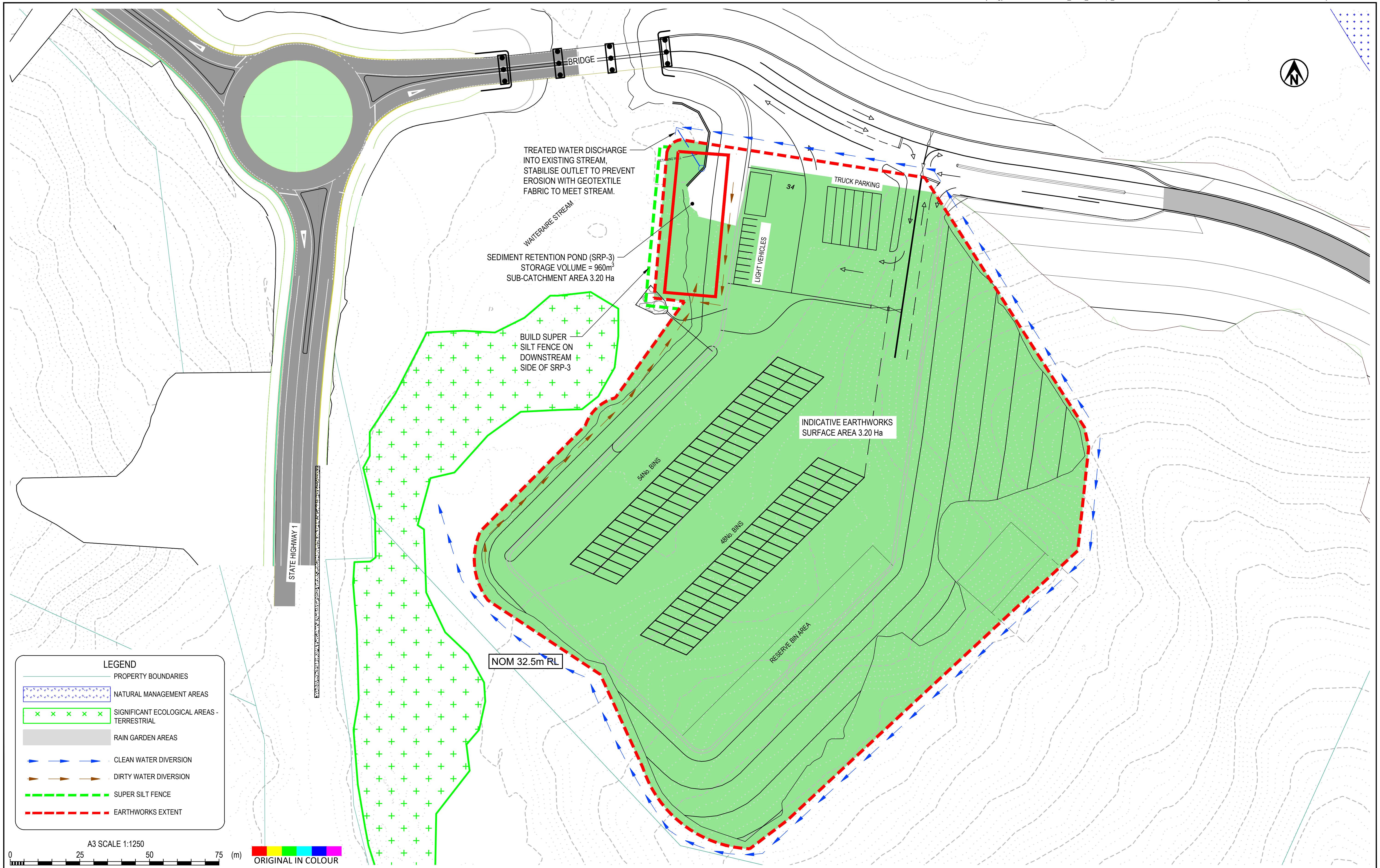
C:\12dSynergy\data\ALBTCAD\Polaris_WOL_Concept_55\CAD\FIG\Polaris-GM-CSMP-02.dwg 2019-May-24 11:36:19 AM Plotted By: LOVE JADVANI



NOTES:

1. ALL EROSION AND SEDIMENT CONTROL DEVICES TO BE CONSTRUCTED IN ACCORDANCE WITH THE AUCKLAND COUNCIL EROSION AND SEDIMENT CONTROL GUIDE FOR LAND DISTURBING ACTIVITIES IN THE AUCKLAND REGION, JUNE 2016, GD05.
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PROJECT No.	1005069	
DESIGNED	SL	May.19
DRAWN	LOJA	May.19
CHECKED	RVDM	May.19
APPROVED		DATE

CLIENT	WASTE MANAGEMENT NZ LTD
PROJECT	AUCKLAND REGIONAL LANDFILL
TITLE	EROSION AND SEDIMENT CONTROL PLAN BIN EXCHANGE AREA AND LANDFILL ACCESS ROAD

SCALE (A3) 1:1250 FIG No. CSMP-2 REV 1

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Appendix C: USLE Calculations

UNIVERSAL SOIL LOSS CALCULATIONS (USLR)			
Tonkin+Taylor		Project:	Polaris Landfill Design Project
Details:	USLR during construction	Job No:	1005069.1140
Computed:	AFRE	Date:	30/11/2018
Checked:		Date:	

Calculating Sediment Yield using the USLE Method

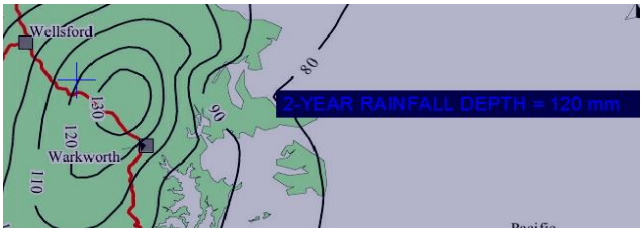
Assumptions:
Assume that the longest length is 50 m
Slope of the landfill phases is 1V:4H (25%)
Final cap is 1V:5H (20%)
Assume work from both ends, over 3 seasons, and 30% open at a time

12,000 Open EW per year

Sediment Generated, A = R.K.LS.C.P

Rainfall Erosion Index, R

R = $0.00828x\ p^{2.2} \times 1.7$
i= 110 mm from TP108 figure A1
p = 69.08 daily rainfall x 0.628
R = 156.6947
R = 160 J/hectare



Soil Erodibility Factor, K
Composition of soil (assumed to be uniform across site)

	Sand%	Silt%	Clay %	K	K_2	K_3
Stage 1						
Exposed ground	50	30	20	**0.28**	**0.38**	**0.50**

Silts/clays identified by bore logs info provided by Alex

K_2 - correction for organic content
K2 assumption: no organic matter 0% K1+0.1
K_3 - conversion from imperical to metric K2x1.32

Slope Length and Steepness Factor

	Length (m)	Grade (%)	LS Factor
Area 1	**100**	**50%**	**32.31**

Ground Cover and Roughness Factors
Assume bare soil (combination of the first three in Table 2)

C = 1	P = 1

USLE Sediment Generation Rates

Construction Area	LS Factor	R j/ha	K t/unitR	C	P	Sed. Gen^n t/ha/yr	Area m^2	Time (yrs)	Est. of Sed. Gen^d (t)	Sed. Deliv. Ratio	Sed. Control Eff (%)	Sed. Yield (tonnes)	Type of control
Road access	32.31	160	0.50	1	1	2593.07	12,000	0.5	1555.843	**0.5**	95%	38.896	
											Total	**38.896**	

UNIVERSAL SOIL LOSS CALCULATIONS (USLR)			
Tonkin+Taylor		Project:	Polaris Landfill Design Project
Details:	USLR bin exchange	Job No:	1005069.1140
Computed:	AFRE	Date:	30/11/2018
Checked:		Date:	

Calculating Sediment Yield using the USLE Method

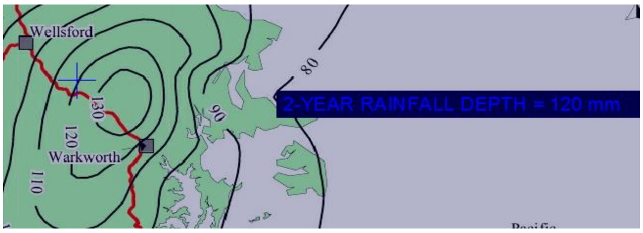
Assumptions:
Assume that the longest length is 50 m
Slope of the landfill phases is 1V:4H (25%)
Final cap is 1V:5H (20%)
Assuming that works will take 2 seasons, with 50% open

7,500 Open EW per year

Sediment Generated, A = R.K.LS.C.P

Rainfall Erosion Index, R

R = 0.00828x $p^{2.2}$ x 1.7
i= 110 mm from TP108 figure A1
p = 69.08 daily rainfall x 0.628
R = 156.6947
R = 160 J/hectare



Soil Erodibility Factor, K
Composition of soil (assumed to be uniform across site)

	Sand%	Silt%	Clay %	K	K_2	K_3
Stage 1						
Exposed ground	50	30	20	**0.28**	**0.38**	**0.50**

Silts/clays identified by bore logs info provided by Alex

K_2 - correction for organic content
K2 assumption: no organic matter 0% K1+0.1
K_3 - conversion from imperical to metric K2x1.32

Slope Length and Steepness Factor

	Length (m)	Grade (%)	LS Factor
Area 1	**50**	**50%**	**32.31**

Ground Cover and Roughness Factors
Assume bare soil (combination of the first three in Table 2)

C = 1	**P = 1**

USLE Sediment Generation Rates

Construction Area	LS Factor	R j/ha	K t/unitR	C	P	Sed. Gen^n t/ha/yr	Area m^2	Time (yrs)	Est. of Sed. Gen^d (t)	Sed. Deliv. Ratio	Sed. Control Eff (%)	Sed. Yield (tonnes)	Type of control
Road access	32.31	160	0.50	1	1	2593.07	7,500	0.5	972.402	**0.5**	95%	24.310	
											Total	**24.310**	

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UNIVERSAL SOIL LOSS CALCULATIONS (USLR)			
Tonkin+Taylor		Project:	Polaris Landfill Design Project
Details:	USLR clay stockpile	Job No:	1005069.1140
Computed:	AFRE	Date:	30/11/2018
Checked:		Date:	

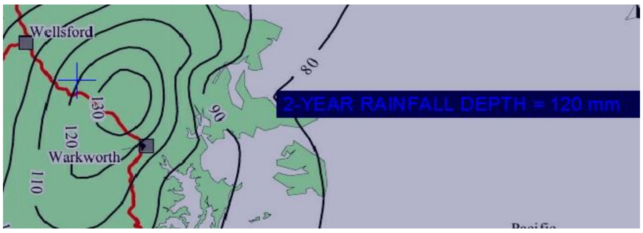
Calculating Sediment Yield using the USLE Method

Assumptions:
Assume that the longest length is 150 m
Slope of the Stockpile is 1V:4H (25%)
Final cap is 1V:5H (20%)
Assuming that takes 3 years to fill with 30% of current area open at any point — 9,900 Open EW per year

Sediment Generated, A = R.K.LS.C.P

Rainfall Erosion Index, R

R = 0.00828x $p^{2.2}$ x 1.7
i= 110 mm — from TP108 figure A1
p = 69.08 — daily rainfall x 0.628
R = 156.6947
R = 160 J/hectare



Soil Erodibility Factor, K
Composition of soil (assumed to be uniform across site)

	Sand%	Silt%	Clay %	K	K_2	K_3
Stage 1						
Exposed ground	50	30	20	**0.28**	**0.38**	**0.50**

Silts/clays identified by bore logs info provided by Alex

K_2 - correction for organic content
K2 assumption: no organic matter 0% — K1+0.1
K_3 - conversion from imperical to metric — K2x1.32

Slope Length and Steepness Factor

	Length (m)	Grade (%)	LS Factor
Area 1	**150**	**50%**	**32.31**

Ground Cover and Roughness Factors
Assume bare soil (combination of the first three in Table 2)

C = 1	P = 1

USLE Sediment Generation Rates

Construction Area	LS Factor	R j/ha	K t/unitR	C	P	Sed. Gen^n t/ha/yr	Area m^2	Time (yrs)	Est. of Sed. Gen^d (t)	Sed. Deliv. Ratio	Sed. Control Eff (%)	Sed. Yield (tonnes)	Type of control
Road access	32.31	160	0.50	1	1	2593.07	10,000	0.5	1296.536	**0.5**	95%	32.413	
											Total	**32.413**	

UNIVERSAL SOIL LOSS CALCULATIONS (USLR)			
Tonkin+Taylor		Project:	Polaris Landfill Design Project
Details:	USLR stockpile 1	Job No:	1005069.1140
Computed:	AFRE	Date:	30/11/2018
Checked:		Date:	

Calculating Sediment Yield using the USLE Method

Assumptions:

Assume that the longest length is 100 m

Slope of the Stockpile is 1V:4H (25%)

Final cap is 1V:5H (20%)

Assuming that takes 3 years to fill with 30% of current area open at any point 14,850 Open EW per year

Sediment Generated, A = R.K.LS.C.P

Rainfall Erosion Index, R

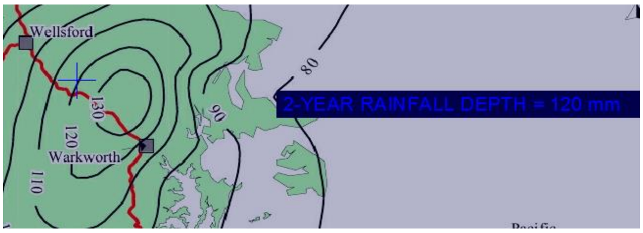
R = 0.00828x $p^{2.2}$ x 1.7

i= 110 mm from TP108 figure A1

p = 69.08 daily rainfall x 0.628

R = 156.6947

R = 160 J/hectare



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Composition of soil (assumed to be uniform across site)

	Sand%	Silt%	Clay %	K	K_2	K_3
Stage 1						
Exposed ground	50	30	20	**0.28**	**0.38**	**0.50**

Silts/clays identified by bore logs info provided by Alex

K_2 - correction for organic content

K2 assumption: no organic matter 0% K1+0.1

K_3 - conversion from imperical to metric K2x1.32

Slope Length and Steepness Factor

	Length (m)	Grade (%)	LS Factor
Area 1	**100**	**50%**	**32.31**

Ground Cover and Roughness Factors

Assume bare soil (combination of the first three in Table 2)

C = 1	**P =** 1

USLE Sediment Generation Rates

Construction Area	LS Factor	R j/ha	K t/unitR	C	P	Sed. Gen^n t/ha/yr	Area m^2	Time (yrs)	Est. of Sed. Gen^d (t)	Sed. Deliv. Ratio	Sed. Control Eff (%)	Sed. Yield (tonnes)	Type of control
Road access	32.31	160	0.50	1	1	2593.07	14,850	0.5	1925.355	**0.5**	95%	48.134	
											Total	**48.134**	

UNIVERSAL SOIL LOSS CALCULATIONS (USLR)			
Tonkin+Taylor		Project:	Polaris Landfill Design Project
Details:	USLR stockpile 1	Job No:	1005069.1140
Computed:	AFRE	Date:	30/11/2018
Checked:		Date:	

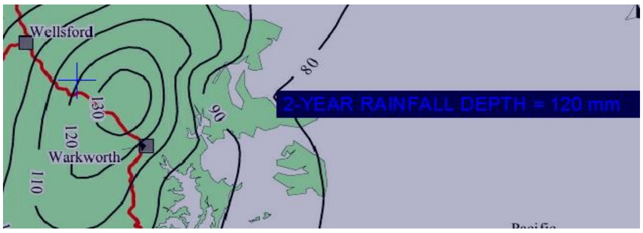
Calculating Sediment Yield using the USLE Method

Assumptions:
Assume that the longest length is 100 m
Slope of the Stockpile is 1V:4H (25%)
Final cap is 1V:5H (20%)
Assuming that takes 3 years to fill with 30% of current area open at any point — 11,988 Open EW per year

Sediment Generated, A = R.K.LS.C.P

Rainfall Erosion Index, R

R = 0.00828x $p^{2.2}$ x 1.7
i= **110** mm — from TP108 figure A1
p = 69.08 — daily rainfall x 0.628
R = 156.6947
R = 160 J/hectare



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Composition of soil (assumed to be uniform across site)

	Sand%	Silt%	Clay %	K	K_2	K_3
Stage 1						
Exposed ground	50	30	20	**0.28**	**0.38**	**0.50**

Silts/clays identified by bore logs info provided by Alex

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K_3 - conversion from imperical to metric — K2x1.32

Slope Length and Steepness Factor

	Length (m)	Grade (%)	LS Factor
Area 1	**100**	**50%**	**32.31**

Ground Cover and Roughness Factors
Assume bare soil (combination of the first three in Table 2) — **C = 1** **P = 1**

USLE Sediment Generation Rates

Construction Area	LS Factor	R j/ha	K t/unitR	C	P	Sed. Gen^n t/ha/yr	Area m^2	Time (yrs)	Est. of Sed. Gen^d (t)	Sed. Deliv. Ratio	Sed. Control Eff (%)	Sed. Yield (tonnes)	Type of control
Road access	32.31	160	0.50	1	1	2593.07	12,000	0.5	1555.843	0.5	95%	38.896	
											0	**38.896**	

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