Oparure Quarry South-Western Pit: Erosion and Sediment Control Plan

Prepared for

Graymont (NZ) Limited

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1.0 Introduction

1.1 Background

Graymont (NZ) Limited (Graymont) is proposing to establish The Oparure Quarry South-Western Pit ('SW Pit') on Oparure Road, Te Kuiti. This document outlines the objective and process that Graymont will follow to manage erosion and stormwater laden sediment associated with the construction and operation of the SW Pit and new haul road.

The SW Pit may open potentially 59.6 hectares (ha) by 2053, although by 2053 some the 37.7 ha of the 59.6 ha is anticipated to have been backfilled with rehabilitated overburden. The SW Pit and associated mining infrastructure include the construction of the following:

- Haul road (1,300 m or 3.0 ha)
- New pit (SW Pit)
- Engineered Landform in the new pit (SW Pit)
- Note – the placement of overburden in the Engineered Landform in the Oparure Quarry is covered in detail in the Oparure Erosion and Sediment Control Plan.

Erosion and sediment control (ESC) facilities are required around and within these elements to mitigate the potential adverse effects that sediment entrained in the stormwater runoff may have on the environment. This ESCP may also require changing to incorporate any requirements set out in the conditions of consent.

The measures identified in this ESCP are intended to be implemented as the quarry develops; however, it is important to note that the timing of some of the latter mine plans and associated ESC measures may be brought forward or deferred in response to market conditions. In the event some measures are not feasible to implement, due to construction techniques, changes to the quarry programming, or site constraints, then alternative effective measures shall be adopted, and will be designed to the same level of service outlined in this document.

1.2 Scope

This document establishes the framework which documents how Graymont will manage erosion and control sediment during the construction and operation of the SW Pit.

Figure 1 illustrates the overarching framework in the which the sediment and site stormwater is managed. This document (the 'Oparure Quarry South-Western Pit: Erosion and Sediment Control Plan') outlines the objectives, introduces the concepts and basis of design of the ESC structures, including roles and responsibilities associated with the implementation of the ESC Plans.

As the quarry develops, new areas or catchments will be intercepted; to manage the resultant changes to the flows and sediment loads in the stormwater runoff, subsequent 'Erosion and Sediment Control Stage Plans' (ESC Stage Plans) will be prepared. To aid the development of these ESC Stage Plans, an auxiliary toolbox will be applied which outlines the application of the control methods, associated assumptions, and details of how the erosion controls structures are designed and typical construction details ('Erosion and Sediment Control Toolkit').

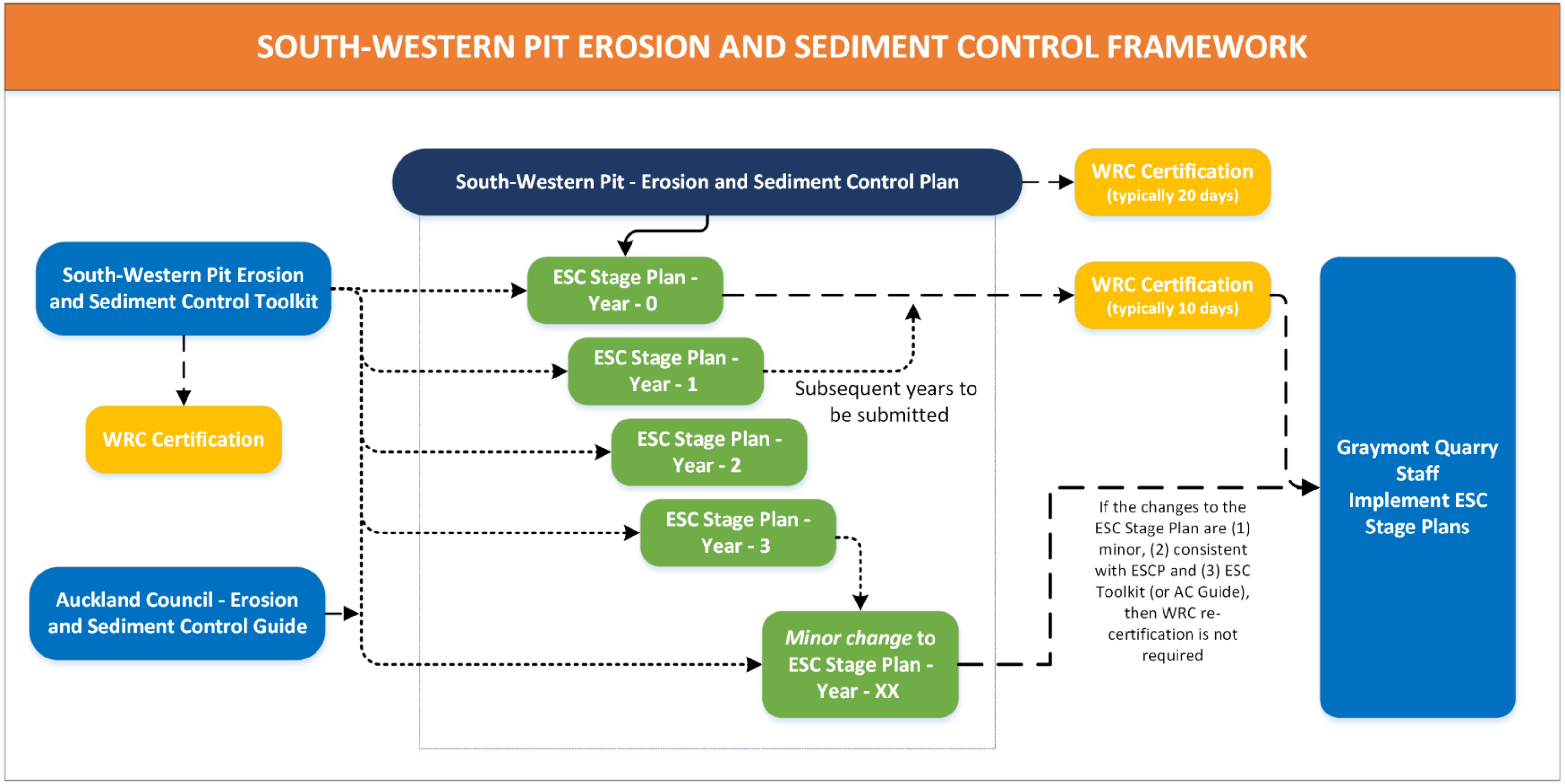


Figure 1: South-Western Pit Erosion and Sediment Control Framework

ESC Stage Plan for End of Year 1 and an indicative ESC Stage Plan for End of Year 53 have been prepared (Appendix B) and these (1) form exemplars for subsequent revisions and (2) demonstrate to WRC the level of engineering that informs the design of the ESC infrastructure.

These ESC Stage Plans is based on the November 2024 quarry plan, and that the quarry development plan may change as Graymont evolve the quarry plan and/or responds to the grade of the limestone exposed. Future ESC Stage Plans will not depart materially from the concepts presented in this document; as a consequent any effects of the stormwater discharges on the environment are expected to be similar, if not better, to the environmental effects outlined in the Water Assessment Report (PDP, 2026) and Aquatic Ecology Report (Stantec, 2026).

2.0 Erosion and Sediment Control Plan Status

The ESCP follows the principals in Auckland Council (AC 2016) Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region, Guideline Document (GD 2016/005).

It is important to note that the ESC measures in the published guidelines are predominantly intended for earthwork activities which are short-term in duration. As several of the structures, like the haul road and some of the pit high walls, will be in existence for in excess of 30 years, a higher 'level of service' may be required of some of the ESC measures associated with these structures.

Whilst GD 2016/005 has guidance for quarries that all ESC structures should be designed for the 5 percent annual exceedance probability[1] (AEP) critical duration rainfall event, some structures like the haul road have been designed for a more extreme 2 percent AEP event.

This ESCP represents intentions at the time of writing and are subject to change without changing the intent or level of mitigation proposed, following detailed mine planning, construction planning and completion of the detailed design of erosion and sediment control facilities. In addition, the ESCP may also require changing to incorporate any requirements that may be specified in the conditions of consent.

The measures identified in this draft ESCP are intended to be implemented and the uncertainty relates to when and where they will be in place. In the event some measures are not feasible to implement, due to construction techniques, programming, or site restraints, then alternative effective measures shall be adopted.

[1] 5% AEP rainfall event is equivalent to a 1 in 20-year rainfall event, whilst a 2% AEP is equivalent to 1 in 50-year event.

2.1 Final ESCP / ESC Stage Plan(s)

A final ESCP shall be finalised following receipt of all necessary consents and will incorporate any additional changes to the quarry plans and/or construction planning. In addition, the detailed design process may identify site or other restraints that require the ESCP to be modified.

This ESCP has drawn upon the principles in the following document:

- Auckland Council's Guideline Document 2016/005 ('Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region', AC 2016);

However, this ESCP recognises and accounts for the site-specific rainfall and/or soil properties at the quarry.

In addition, the ESCP sets out responsibilities for ESCP implementation, including construction standards, installation measures, inspections and maintenance, detailing contingency measures, storm damage assessment and repairs and report requirements.

As outlined in Figure 1, yearly ESC Stage Plans will be prepared that consider the "forward works programme" for the upcoming year. ESC Stage Plan specify considers how exposed or disturbed areas will be managed and progressive stabilisation in the upcoming year, and any specific erosion control measures for the year.

3.0 Site Description

3.1 Layout

Graymont's existing Oparure limestone quarry located just off Oparure Road, Te Kuiti encompasses some 37.9 ha of existing quarry pit, 8.0 ha of run of mine or quarry area (ROM), and approximately 4.2 ha overburden engineered landform. The proposed SW Pit is 600 m to the west of the existing pit.
Once fully developed the SW Pit it will expose some 38.9 ha of limestone (or 59.6 including highwall and rehabilitated land). The new pit will be accessed via a 1,300 m long haul road linking the pit to the ROM.

3.2 Site Soils and Erosion Potential

The overburden, which is typically 22 m thick, comprises four distinct layers as summarised below:

Table 1: Overburden Properties

Material	Thickness (typical)	% Clay	% Silt	%Sand	%Gravel	Source
Topsoil	<0.2 m	25-38	65-56	10-18	0	2
Brown Ash (silty clay)	4.5 m	47	43	10	0	1
Papa – sandy mudstone	10 - 16 m	33	43	48	6	1
Caprock – upper limestone (waste)	2 m	Waste rock – not applicable				-

Notes:
1. *Adams (2018)*
2. *S-Map – Landcare Research (2019)*

3.2.1 Topsoil

Currently the fertile topsoil layer supports pastural grass, which is grazed by sheep and cattle. The soils are classified as 'typic orthic allophanic' and are well draining, with a permeability in the range of 4 – 72 mm/h (Landcare Research, 2019).

As outlined in detail in the Topsoil Management Plan, the topsoil will be selectively recovered and stockpiled for future rehabilitation activities. To maintain the soil fertility, the stockpile depth shall not exceed 2.5 m in depth.

The topsoil, in a disturbed state, is highly mobile and requires specific controls to mitigate the risk of the topsoil being mobilised during rainfall events and/or drying out and contributing to a possible dust nuisance.

3.2.2 Brown Ash

This is a Quaternary volcanic ash, clay layer. Due to the high mobility of this silty-clay layer, material handling is typically limited to periods of dry weather. Therefore, it is proposed that any stripped Brown Ash shall be placed in the overburden dump and / or ultimately a subsoil layer for the final capping / rehabilitation of overburden engineered landform (OPA) surface (i.e. below the topsoil layer).

3.2.3 Papa

Papa was formed in the Early Miocene, and is weakly bedded to massive, calcareous fine to sandy mudstone. Papa is a very weak to weak mudstone, and slakes rapidly on exposure (Adams, 2018). As mudstone overburden fill, the mudstone forms firms silty clay and weak mudstone lump (mudstone slakes with moisture to clay).

3.2.4 Caprock

The Caprock of the Otorohanga Limestone, of the latest Oligocene earliest Miocene, and is a capping limestone of medium strength light grey flaggy limestone (Adams, 2018).

The management of overburden below the topsoil layer is detailed in Section 7.0 of this ESCP.

4.0 Key Principles of Erosion and Sediment Control

The erosion and sediment control principals and measures outlined in this plan and applied in the ESC Stage Plans are consistent with good ESC practises defined by Auckland Council (2016) GD 2016/005 (Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region).

4.1 Erosion Control

Erosion control is the management of surfaces to minimise the potential for erosion to occur. Good erosion control practice will reduce the need for remedial measures later. For example, this may take the form of stabilising surfaces with hay or mulch prior to a forecasted heavy rainfall event, minimising the open space to be worked through staging, or diverting clean surface water from adjacent land uses from entering the earthworks site.

Erosion control devices that will be implemented as part of the plan will include:

- Diversion of clean water via riprap (aggregate) or grass topsoil lined bunds where applicable;
- Water table drains and benched slopes on steep faces (greater than 25% slope and/or greater than 20 m vertical height);
- Staging of exposed working areas; and
- Stabilisation of steep faces/highwalls via grassing, hydro seeding or hay mulching.

Due to the potential risk of suspended and dissolved solids in the quarry impacted surface water entering the Karst system and eventually daylighting in the Mangawhitikau Stream, then:

- Sediment retention ponds shall not be placed directly above the location of the ‘Subterrain Camelot Stream’.

Details and indicative layout of the proposed ESC devices for the quarry are described in Section 8.0 and the ESC Stage Plan – EOY 1 included in Appendix B.

4.2 Sediment Control

Sediment control is the management of surface water discharging to the receiving environment. As this surface water may entrain sediment as it moves across bare earth surfaces, construction and operation of suitable devices is required to retain this water and allow suspended sediments to settle out. Discharge to a receiving environment can occur once suspended sediments are removed from the surface water to an acceptable level (as determined on a site-by-site basis).

Sediment control devices that are proposed as part of the plan include:

- Benches
- Grassing
- Forebays and infiltration sumps

All proposed devices are consistent with standard practice as defined by GD 2016/005 (AC, 2016) but have been designed to provide a higher level of service (Table 2). The development of the design of these ESC devices are discussed in Section 8.0.

Should a rain event be forecasted that is expected to exceed the current 24-hour 20-year ARI (or 5% AEP, being **>130 mm in 24 hours**), then additional stabilisation of any exposed topsoil or overburden slopes within the stripping area may be required. This may consist of the application of a spray-on polymer, hay mulch across exposed surfaces or other surface treatments to minimise the risk of sediment erosion.

A check of all site control devices will also be carried out to ensure that devices are functioning correctly prior to the forecast rainfall. Maintenance of devices will be carried out if required (see Section 10.2). A follow-up site inspection will be undertaken following the rainfall event and maintenance carried out if required, in accordance with the Trigger Action Response Plan(s) (TARPs) in Appendix D.

4.3 Winter Works

No earthworks or stripping is to be performed during the period May 1st to September 30th, unless specific approval is obtained from WRC.

If any earthworks must be performed after the end of May and before the end of September, then a 'Winter Earthworks Application' must be submitted to the WRC by the Environmental Advisor by April 1st.

The site must be appropriately stabilised by the 30th of April unless approved in writing by Waikato Regional Council.

All written permission (submitted and authorised) must be saved for future reference.

5.0 Scope and Nature of Earthworks

5.1 Quarry Stage Plans

Graymont (2024) has developed the quarry stage plans for the proposed quarry, which are reproduced in Appendix A. Based on these quarry plans, it is anticipated that the quarry will impact approximately 12.4 ha at EOY 1 and ultimately 57.4 ha at EOY 53; by EOY 53 some 37.8 ha is anticipated to have backfilled with overburden and rehabilitated.

5.2 Haul Road

A 1.3 km haul road (3.0 ha) will be constructed between the SW Pit and Oparure Quarry. Due to the number of heavy vehicle trucks moving between the SW Pit and the lime processing plant in the Oparure Quarry there is a potential to mobilise limestone during rainfall events.

As presented in the ESC Stage Plan – EOY 1 (Appendix B) a series of water table drains and sediment pits are proposed to control the sediment in any runoff from the Haul Road. Appendix B includes the design of these specific erosion and sediment control measures.

5.3 South-Western Pit

The exposed surface of the quarry will increase from 12.4 ha in Year 1 to 38.9 ha by Year 53 (or 57.4 ha including highwalls and rehabilitated overburden). Initially the topsoil is stripped, then overburden removed to expose the quarried limestone.

5.4 Engineered Landform (overburden dump)

During the initial stage of the quarry development, overburden will be placed in the Oparure Quarry. Around Year 18, the overburden will be progressive backfilled in the quarried-out pit. By Year 53 the in-pit engineered landform (overburden dump) is expected to extend some 37.7 ha.

5.5 Extent of Soil Disturbance

An analysis of the current quarry plans would suggest the quarry will influence up to 57.4 ha by 2053, of which approximately 37.8 ha will ultimately be recovered overburden and rehabilitated back to pasture.

During the initial stages of quarry development, a topsoil stockpile will be constructed near the Haul Road estimated to around 3.2 Ha in size. As the recovered overburden reaches the final landform shape, this recovered topsoil will be placed are grasses (as outlined in the Topsoil Management Plan).

6.0 Overburden Management

Below the topsoil layer, the overburden at the site comprises of brown ash (silty clay), papa (sandy mudstone), and low-grade Piopio limestone (cap rock). These materials may be rapidly mobilized in stormwater runoff, therefore, this ESCP incorporates a methodology for minimizing the potential adverse effects of sediment from overburden on the receiving environment.

6.1 Overburden Volumes and Thickness

Overburden volumes and thickness are based on the Graymont geology model for SW Pit, which is based on exploration boreholes and interpolation between boreholes. The overburden isopach (thickness) model based on contouring of the borehole data indicates an average thickness of approximately 7.6 m (range 0-44 m, median 7.1 m). The volume of overburden is therefore estimated to be approximately 7,971,100 m^3.

The overburden volume and thickness are a best estimate at this stage. Refinement of the geological (and overburden) models as additional information becomes available will be carried out as the project progresses.

6.2 Overburden Stripping

Stripping will be undertaken in campaigns (typically annually) in alignment with quarry stages and includes vegetation removal, topsoil stripping / stockpiling (Section 7), large scale excavation of overburden, and haulage of overburden to disposal sites.

Following quarrying and closure of the site, Graymont propose to return as much of the disturbed area as possible to productive farmland by filling with overburden following by topsoil and grassing.

6.3 Overburden Disposal / Placement (ELF)

Topsoil will be recovered separately from other overburden materials (further discussed in Section 6 of this ESCP) and will be used for rehabilitation and planting including for final slopes of the overburden Engineered Landforms (ELFs).

Non-topsoil overburden will require disposal. The proposed strategy for disposal is placement into quarried pits (i.e. Oparure Pit and progressively the SW Pit after Year 18) as overburden ELFs.

The methodology for construction of the in-pit overburden ELFs is similar to that adopted for the Oparure Pit, namely:

- Bottom-up construction methodology involving placement of competent rock bunds at the toe of the landform, extending the bund width as the fill height increases.

- Overburden is then placed in controlled lifts and compacted (dozer and truck movements) with placement of weak materials toward the rear of benches, encapsulated with competent mudstone or limestone to avoid continuous weak layers.
- Placing of internal rock layers, within the landform, to improve stability and drainage as needed and agreed with the geotechnical engineer. Monitoring of drainage performance should be included with routine inspections of the overburden ELF.

The objective of the in-pit overburden disposal is to infill as much of the quarry pit space as possible so as to restore the landscape to a natural form and maximise reinstatement of productive farmland.

6.3.1 Geotechnical Stability of Placed Overburden

The final slope of the ELFs is flat and is graded west to east (1v:23.5h / 2.5%). The final slope to the north should be constructed using a similar construction methodology to the Oparure Overburden ELF; buttressed (using 35 – 40 m wide buttress at the toe of the slope and be benched). The recommended final inter bench slope shall not exceed 1v:2.5h (40%) to facilitate rehabilitation, grassing, planting, grazing, access and to minimise erosion. With the implementation of this construction methodology, slope instability issues for placed overburden are considered low risk.

7.0 Erosion and Sediment Control Measures

7.1 Design Standards

Due to the duration of the quarrying activity, and that some ESC measures identified in this plan will be in place for in excess of 50 years, a two-tier level of service (design standard) is proposed. Where the ESC measures are required to manage stormwater for longer than 5 years, then these measures shall be designed to accommodate a 50-year annual return interval (ARI or 2% annual exceedance probability (AEP)) critical rainfall event). Whilst temporary and/or short-duration ESC measures (< 5 years) shall be design for a 20-year ARI, which is consistent with GD 2016/005 (AC, 2016).

A summary of the proposed ESC measures for the various ‘work areas’ covered in the ESCP, and associated design standards presented in Table 2.

Table 2: Erosion and Sediment Control Design Standard

Location	Control Measure	Design Storm
Overburden	Clean water diversion	2 % AEP
	Short - medium term drains or benches (≤ 5 years)	5 % AEP
	Long-term drains or benches (>5 years)	2 % AEP
Haul Road	Clean water diversion	2 % AEP
	Water tables and other drains / chutes	2 % AEP
Topsoil Dump	Clean water diversion	2 % AEP
	Erosion and sediment control measures	5 % AEP
Quarry Pit	Clean water diversion	2 % AEP
	Short - medium term drains or benches (≤ 5 years)	5 % AEP
	Long-term drains or benches (>5 years)	2 % AEP
	Pit Sump	5 % AEP, max. of 2 days storage

7.2 Proposed Erosion and Sediment Control Measures

Whilst GD 2016/005 and other similar guides provide for a suite of ESC measures to mitigate the effects that erosion and/or sediment in stormwater may have on the environment; several likely measures have been identified as suitable for the SW Pit. As outlined in the following sections, these suites of measures fall into four broad categories.

7.2.1 Diversion and Water table Drains

In general, diverted *clean* stormwater (in diversion drains) and sediment laden stormwater (in water tables) will need additional measures to check the velocity of the stormwater in the drain and in turn capture and retain any entrained sediments in the stormwater. The typical measures that could be employed, are presented in Table 3, and are applicable to all areas of the proposed works.

Table 3: Drains – Erosion and Sediment Control Measures

Measure	Detail	Example
Diversion drain	**Detail:** Diversion drains intercept clean runoff that slopes and prevent it from entering working areas. Typically, these will be installed above Haul Road and above the quarry pit to direct clean runoff away from the pit or haul road. These shall be Installed in accordance with GD 2016/005 (AC, 2016). **Timing:** Install prior to works commencing.	
Water table	**Detail:** A channel excavated parallel to a road or track to convey stormwater away and around the carriageway, improving the road stability. Installed in accordance with GD 2016/005 (AC, 2016). **Timing:** Install during the construction of haul or access roads, prior to works commencing.	
Flumes or chutes	**Detail:** A flume fabricated from materials such as geotextile fabric, concrete canvas, steel or plastic half-round pipes, rock, sandbags or construction ply. Installed in accordance with GD 2016/005 (AC, 2016). **Timing:** Install prior to commencement of earthworks.	
Check dams	**Detail:** Small structures of loose rock or sandbags placed in series across open drains or small channels to reduce flow velocity. Installed in accordance with GD 2016/005 (AC, 2016). **Timing:** Immediately prior to earthworks.	

Table 3: Drains – Erosion and Sediment Control Measures		
Measure	**Detail**	**Example**
Soft armour channel lining	**Detail:** Install geotextile lining on channels and outlets where erosion may be an issue. Installed in accordance with GD 2016/005 (AC, 2016). **Timing:** Install immediately following construction of channels/culverts.	
Hard armour channel lining	**Detail:** Install hard armour lining in high-velocity channels and as energy dissipaters at outlets. Designed and installed in accordance with GD 2016/005 (AC, 2016). **Timing:** Install during construction of channels/outlet structures.	

7.2.2 Benches and Surface Treatments

The high walls and overburden engineered landform will need to be benched, to reduce the flow lengths and velocity of any stormwater pass over the surface, which in turn reduces the entrainment of sediment into the stormwater. Whilst drains will typically be installed to direct the direct-runoff from these slopes, some perched groundwater or surface runoff may pass over the faces of the highwall(s) and be collected in drains to be constructed at the toe of the high walls / engineered landforms.

As outlined in Table 4 several benching and surface controls are proposed.

Table 4: Benches and Surface Erosion and Sediment Control Measures

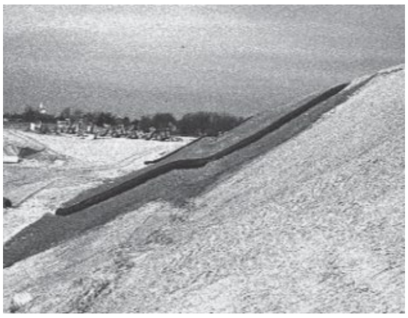
Measure	Detail	Example
Benched Slopes	**Detail:** Shortening of flow lengths down slopes to reduce velocities and prevent concentration of runoff. Installed in accordance with the most conservative of either (1) Adams (2018) being slope stability requirement or (2) GD 2016/005 (AC, 2016). **Timing:** Apply throughout the construction of quarry and associated infrastructure.	
Grass or Hydroseeding	**Detail:** In the dryer and favourable growing month grass seed can be applied. Whilst hydroseeding is recommended for establishing grass on areas steeper than about 3:1 and outside the usual grass establishment period. Apply the hydroseed mix via a vehicle mounted cannon, or, for inaccessible areas, a hand-held hose and nozzle. Grassing or hydroseeding should follow the principals outlined in GD 2016/005 (AC, 2016). **Timing:** Apply throughout the construction of quarry and associated infrastructure.	
Mulch	**Detail:** Mulching can be used as an alternative to temporary grassing where short to medium-term protection is required on disturbed areas that are likely to remain exposed and unworked for a period of time. Mulching is often used as a temporary surface cover until more favourable seeding conditions occur. **Timing:** Apply throughout the construction of quarry and associated infrastructure.	

Table 4: Benches and Surface Erosion and Sediment Control Measures

Measure	Detail	Example
Roughening	**Detail:** Roughening the surface of a bare soil is a temporary erosion control procedure that significantly reduces runoff velocity, promotes infiltration, delays formation of rills and can significantly reduce short-term soil losses. Roughening can also reduce wind velocities at ground level, making a soil less prone to wind erosion. **Timing:** Apply throughout the construction of quarry and associated infrastructure.	

7.2.3 Quarry Planning

Effective quarry planning can be one of the most effective measures to minimise the risk of sediment being entrained into stormwater runoff. Effective planning incorporates the following elements:

Table 5: Quarry Planning – Erosion and Sediment Control Measures

Measure	Detail
Integrated Quarry Planning	**Detail:** An integrated quarry plan will consider not only the recovery of the geological resource and associated overburden, but will include (1) waste dump / engineered landform, (2) rehabilitation of the engineered landform, (3) vehicle movements, (4) potential adverse effects on the environment (erosion and sediment control, dust, groundwater, surface water, aquatic ecology, and terrestrial ecology). **Timing:** Quarry development and throughout the development of the quarry.
Minimise Exposed Surfaces	**Detail:** Associated with the integrated quarry planning is the minimisation of magnitude of the exposed overburden, soil and subsoil surfaces. The rate of sediment loss is proportional to the area of exposed surfaces. **Timing:** Apply throughout the development of the quarry.
Rehabilitate ELF - as soon as practical	**Detail:** The prompt rehabilitation of the waste dump / engineered landform has the potential to minimise the entrainment of suspended solids into stormwater runoff over the overburden material. **Timing:** Apply throughout the construction of quarry**.**

8.0 Erosion and Sediment Control – Stage Plans

8.1 Long-term Erosion and Sediment Control Structures

The Haul Road, Topsoil Stockpile, and Overburden Engineered Landform are three significant quarry structures that are maintained during the life of the quarry. The ESC measures associated with these long-term quarry structures are addressed in the remainder of Section 8.1; whilst the specific design of the ESC measures is summarised in the 'ESC Stage Plan for EOY 1' presented in Appendix B.

Topsoil Stockpile Erosion and Sediment Control

The topsoil stockpile area will have the following ESC measures:

- Grass seed spreading or hydroseeding of any stockpiles that will exist for greater than six months, to minimise the mobilisation of topsoil.
- Construction of a diversion bund that will form a drain around the stockpile site, which will direct any sediment laden stormwater to one of two sediment retention ponds for further treatment.
- Construction of two sediment retention ponds to reduce the sediment load leaving the Topsoil Stockpile Area.

Haul Road Erosion and Sediment Control

The 'haul road' will comprise water tables (drains) on each side of the haul road to direct the runoff from the haul road to either the existing or the new pit.

As presented in Figure 1 (Appendix B), two 'clean water' diversion bunds are required to direct clean catchments away from the haul road water tables, the basis of design and dimensions of which are tabulated in Appendix B.

Two culverts are required to be constructed under the haul road to convey stormwater runoff from the southern water table to the existing pit, as indicatively shown in Figure 1 (Appendix B).

In-Pit (OPA) Overburden Engineered Landform Erosion and Sediment Control

As outlined in the Overburden Placement Area (OPA) overburden engineered landform design approach, rockfill buttresses constructed of relatively competent waste rockfill (mudstone, caprock and interburden), form the external face of the landform. As a consequence, no stormwater is expected to flow over the external face of the landform during construction. However, during the placement of the mudstone / clay (Mahoenui Mudstone and Kauroa Ash) overburden, in the centre of the landform, and during the rehabilitation of the landform there is the potential of erosion / sediment entrainment during rainfall events. However, these are mitigated as outlined below.

Mudstone and Clay Placement:

Mudstone and clay overburden is progressively placed, via dozer and truck, in approximately 10 m cells within the overburden landform. The cells are ultimately encapsulated with more competent rockfill in bunds with placement of internal rock layers, within the landform, to improve stability and drainage as needed and agreed with the geotechnical engineer. During rainfall events, entrained sediment in the runoff will infiltrate and gravitate into either the bund or the existing drainage layers. As currently exists, the stormwater will discharge as interflow from the base of the landform onto the quarry floor and then infiltrate through the quarry floor factures into the regional groundwater system.

Rehabilitation of the OPA:

The OPA surface will ultimately be rehabilitated with recovered topsoil. The benches in the landform buttress will remain but will be regraded to allow any intercepted stormwater to travel along the bench to the edge / pit wall. On the wall of the pit, armoured drop-structures will be constructed to direct stormwater to base of the quarry.

It is anticipated the topsoiling will be undertaken in stages, and the exposed surface hydroseeded promptly to minimise the erosion and loss to topsoil.

8.2 Common Erosion and Sediment Control Measures

8.2.1 Opencast Pit Erosion and Sediment Control

As presented in Appendix B several ESC measures are proposed, including clean water diversion bunds to direct away any stormwater running into the quarry operations, and directing quarry impacted stormwater to soak holes in the quarry floor.

Clean Water Diversion Bunds

The quarry / mine plan envisages several of the highwalls developed in Year 1, will be retained for some 50 years, before they ultimately quarried out. To protect the integrity of these highwalls and minimise erosion, clean water diversion bunds are proposed to be constructed at the head of the highwalls, directing any intercepted clean stormwater runoff away from the highwall and quarry pit. Any exposed bund surfaces will be revegetated by grassing sowing or hydroseeding as soon as practicable.

The catchments reporting to these bunds vary in size from 0.2 ha to 1.8 ha, for simplicity it is proposed to standardise the bund design for catchments up to 2.0 ha and catchment slopes up to 25 %; any future catchments in excess of these constraints will require a site-specific design.

Highwall Erosion Sediment Control

Due to the height of the highwall, all four sedimentary layers will be exposed. Initially erosion and sediment loss will be greater in the first two upper layers, being the topsoil and the brown ash layers. Hence these two layers will be hydroseeded, as soon as practical, to minimise erosion.

Benches will be provided in the Papa (sandy mudstone) and Caprock layers of the highwall, which will be graded slightly (transverse) to one corner or other of the pit. The slight grade will encourage runoff or interflow to flow controllably into the pit and minimise the risk of sheet erosion or rill and gully erosion in the mudstone.

As observed in the current pit the Mahoenui Mudstone readily slakes upon exposure, the resultant sand and silt can sustain grass / vegetation. Once the surface of the mudstone benches is suitably slaked, it is proposed to then hydroseed the surface to control further erosion.

In-Pit Erosion and Sediment Control

The ESC measures to be applied within the pit and/or during stripping of topsoil and overburden include the following:

- Drains at the toe of the highwalls to intercept any stormwater runoff and direct them to one of two soakage points in quarry pit floor.
- To aid sediment recovery of larger particles, being sand size and greater, a series of check dams shall be placed in the drains and periodically cleaned out.

8.3 ESC Stage Plans – Approach

The ESC Stage Plan for the first year of the pit's life is appended to Appendix B. This stage plan provides an example of the level of design detail and information to be supplied to WRC for subsequent ESC Stage Plan certifications.

As presented in Appendix B, the ESC Stage Plan has two elements:

1. Drawing illustrating the location of the ESC Measures, and
2. Technical Memorandum – Design of ESC Measures.

The Technical Memorandum summarising the proposed ESC measures to be employed and the basis of design of these measures. As illustrated in Appendix B the memorandum has the following structure:

- Background – outlines the status of the current ESC measures and the purpose of this ESC Stage Plan.

- Scope – summarises the scope of the proposed earthworks covered by the stage plan, and the outlines the additional quarry that is requiring ESC measures to be installed.
- ESC Measures – summarises the proposed measures to be installed.
- Basis of Design of the key ESC Measures – this section will summarise the key assumptions, basis of design, and resultant size or dimensions of the ESC measure(s).
- Maintenance, Monitoring and Inspection – summarises any special requirements over and above those outlined in the SW Pit ESCP.
- Approvals – outlines any special requirements associated with the approval of the ESC Stage Plan.

9.0 Maintenance, Monitoring and Inspections

9.1 Responsibilities

The following table outlines the roles and responsibilities that are proposed as part of the plan:

Table 6: Monitoring and Maintenance Roles and Responsibilities

Monitoring and maintenance roles	Position responsible
Implementation of the plan	Environmental Advisor
Two-weekly inspection of site sediment control devices	Oparure Superintendent
Weekly update to site staff	Oparure Superintendent
Storm event forecasting	Environmental Advisor
Water quality sample collections	Environmental Advisor
Storm event response and sample collection	Environmental Advisor

The Environmental Advisor will be responsible for implementing the plan, storm event forecasting and responding to storm events to collect physical surface water quality samples for analysis of suspended sediments. This will include:

- Ensuring a dedicated location on site for record keeping of versions of the plan;
- Ensuring a dedicated location on site for record keeping of all site control device inspections. Records may alternatively be stored online;

- Completion of routine inspections of all erosion sediment control and trigger action response plans (TARPs), see Appendix D;
- Review of as-built drawings of site control devices and submission to WRC;
- Any roles and responsibilities described in the plan are assigned to suitably qualified person(s) and that such person(s) receive appropriate training as and when required;
- Ensuring a suitably qualified or trained person undertakes collection of water quality samples as required;
- Organise a weekly forecast from a weather forecasting service to feed into weekly quarry schedules;
- Record storm event monitoring for inclusion in annual report to WRC;
- Ensuring reporting deadlines are met; and
- Reporting as necessary to WRC.

The Oparure Superintendent will be responsible for fortnightly inspections of devices and updates to staff. This will include:

- Preparing as-built drawings of site control devices. This can include photos and surveys sourced from UAVs as evidence of compliance;
- Communicating to site staff the status of site control devices and required maintenance / repairs; and
- Carrying out maintenance / repairs of site control devices.

9.2 Routine Monitoring and Maintenance

9.2.1 Device Monitoring

All site sediment devices will be visually inspected two-weekly as a minimum for structural integrity. Inspection of site sediment controls will also occur if a rainfall event exceeds 50 mm / 24 hours.

Inspections will be recorded using an online tool and will include a photo of each sediment control device. The inspection will be a tick box sheet that allows a pass / fail assessment to be made once scoring is complete. Maintenance will be carried out should a site control device fail the assessment.

Records of all inspections will be kept on site.

9.2.2 Device Maintenance

During routine and event inspections a trigger action response plan (TARP) should be followed for each site control device. The TARP will identify the condition of the device based on visual inspection and nominate the required actions for the Environmental Advisor or delegate. Should a site control device be found to be non-complying (either through damage or insufficient repair, or if deemed to be full of sediment), then maintenance of the device will be required. The maintenance will be carried out as soon as practical but within the timeframe set out in the relevant TARP as set out in Appendix D.

Photos should be taken during all TARP inspections and particularly both before and after any maintenance work to show the repairs. Records of device maintenance will be submitted as part of each annual report.

Should the maintenance of the device require removal of sediment (“mucking out”), then all sediment that has been removed will be transferred to an overburden stockpile for long term storage.

9.2.3 Water Quality and Aquatic Ecology Monitoring

The consent requires Graymont to monitor the water quality of the (1) unnamed tributary that flows to the Camelot Stream, and (2) upgradient of both the SW Pit and Gate Spring, and (3) downstream of the Gate Spring / Mangawhitikau Steam confluence, as well as ecological monitoring in the Mangawhitikau Stream.

Depending on the water quality observations some additional investigations or changes to the management of erosion and sediment control devices may be required; as outlined in the TARP in Appendix D.

10.0 Spill Prevention and Response

Spill prevention and response measures will be in general accordance with the site’s Spill Response Plan.

In general, spill of quarry material is cleaned up with an excavator or loader and placed in the appropriate area.

Petrochemical spills that occur from machinery are to be cleaned up immediately using spill kits located on larger vehicles or from the station kits located around the site. Waste is to be collected and disposed at an approved facility and an incident entered in the internal reporting system.

11.0 Education and Communication

All relevant site staff will be familiar with the plan. To achieve this, Graymont will present this to site staff at a Business Review (a standard monthly meeting). Any changes to this plan will be communicated during toolbox talks.

For new site staff, Graymont will incorporate a briefing of the plan into all employee inductions and new staff should accompany the Oparure Superintendent on one weekly inspection.

At the beginning of each overburden stripping season (or issuing of an Outline Plan of Works), all site staff involved with stripping will attend a one-hour 'refresher' meeting. At this meeting the site control devices for the upcoming season will be discussed along with an overview of the methodology of erosion and sediment control.

12.0 Reporting

The resource consent outlines a series of specific monitoring requirements associated with the management of construction phase stormwater from the site.

Depending on the outcome and associated conditions of any resource consents, Graymont may be required to monitor and report on the performance of the ESC measures.

13.0 Summary and Conclusions

This document outlines the proposed approach / method to minimise the effects of sediment entrained in stormwater may have on the environment. Specific ESC controls are proposed around the topsoil stockpile area, which will intercept and direct any stormwater to one of two sediment retention ponds. Treated stormwater, as currently exists, will be directed to one of the many Tomos on the site where the stormwater will infiltrate into the regional groundwater system.

A haul road is to be constructed between the existing quarry and the SW Pit. As outlined in Appendix B, benching and hydroseeding of exposed embankments, and water tables on the berm of the road are the principal controls to minimise erosion / sediment entrainment in the stormwater. Like the topsoil stockpile area, treated construction phase stormwater is directed into the existing pit where it infiltrates into the regional groundwater system.

The opencast quarry pit ESC measures involve directing clean stormwater away from the quarry and the highwalls, benching and hydroseeding of the highwalls, and water table drains at the toe of the highwalls which will direct any intercepted groundwater and stormwater to sumps in the pit floor. From the sumps, water infiltrates into the regional groundwater system.

This management plan, especially in a quarry context, is a 'living document', the ESCP will evolve as advances in the understanding of the receiving environment, understanding of the erosion potential of the soil, and changes in quarry plans occur. This revision of the ESCP is intended to provide the reader an understanding of the concepts that Graymont should implement to manage water, and sediment during the construction, operation and rehabilitation of the SW Pit.

As such, many of the elements outlined in this plan are only conceptual at this stage, for example the SRPs and diversion channels / bunds. These and other ESC features require further detailed design consideration before they can be constructed and implemented.

14.0 Management Plan Approval and Revision

This plan will be reviewed, redrafted, and certified in accordance with the Resource Consent Conditions, and Graymont's management procedures.

Once certified, the ESCP will be reviewed at **least every three years** by Graymont and if changes are made to the plan shall be submitted to WRC for re-certification.

More frequent reviews may also occur due to any significant[2] change in the operations of the SW Pit or findings from any incidents and community complaint investigations. Reasons for making changes to ESCP shall be documented. A copy of the original ESCP document and subsequent versions will be kept and marked as obsolete. Each new/updated version will be issued with a version number and date to prevent obsolete documentation from being used.

15.0 References

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Appendix A: High Intensity Rainfall Design System (HIRDS)

The HIRDS (Version 4) was assessed to predict the design high intensity rainfall depths for the proposed ESC structures (https://hirds.niwa.co.nz/). The table below represents the rainfall depth-duration-frequency (measured in mm) based the RCP4.5 (4.5 W m^{-2} representative concentration pathway) scenario for the period 2031-2050; as identified by the IPCC Fifth Assessment (IPCC, 2013).

Table 7: Erosion and Sediment Control – Design Rainfall Depth-Duration-Frequency Table

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	10.4	14.4	17.4	23.6	31.6	48.9	63.4	81.5	103	118	130	140
2	0.5	11.4	15.8	19	25.8	34.6	53.3	68.9	88.2	112	128	140	151
5	0.2	15	20.6	24.7	33.4	44.5	67.9	87.4	111	140	160	175	187
10	0.1	17.8	24.3	29.1	39.1	51.9	78.8	101	128	161	183	200	214
20	0.05	20.7	28.2	33.7	45.1	59.6	90.1	115	145	182	206	225	240
30	0.033	22.5	30.6	36.5	48.8	64.4	96.9	123	155	194	220	240	256
40	0.025	23.8	32.4	38.6	51.5	67.8	102	130	163	203	230	250	267
50	0.02	24.9	33.8	40.2	53.6	70.5	106	134	169	210	238	259	276
60	0.017	25.8	35	41.6	55.4	72.7	109	138	173	216	244	266	283
80	0.012	27.2	36.8	43.7	58.2	76.3	114	144	181	225	254	276	295
100	0.01	28.3	38.3	45.5	60.4	79.1	118	149	187	232	262	285	303
250	0.004	33.1	44.6	52.8	69.8	91	135	170	211	261	294	319	339

Appendix B: Erosion and Sediment Control Stage Plans

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solutions for your environment

ESC Stage Plan – EOY1

PROJECT	Oparure Quarry South-Western Pit	PREPARED BY	Dion Todd and Mark Ellis
CLIENT	Graymont New Zealand Limited	DATE	30/06/2026 (Revision 2.2)

1.0 Background

This ESC Stage Plan has been prepared for Graymont New Zealand Limited's (Graymont) Oparure Quarry South-Western Pit ('SW Pit') which is located to the west of the existing Oparure limestone quarry, and west of Te Kuiti, Waikato.

This document has been prepared by Pattle Delamore Partners Ltd (PDP) and intended to form the exemplar of future ESC Stage Plans, which may be prepared by Graymont in the future. A new stage plan will be developed and issued to WRC for certification, and prepared on at least an annual basis; however, mid-year plans may be issued to capture significant changes in the ESC management approach and/or significant changes to the Quarry Plan.

2.0 Scope

This stage plan specifically addresses the design of ESC infrastructure associated with the initial development of the SW Pit and the structures that should be present at the End of Year 1 (EOY 1).

The design of the ESC infrastructure has been undertaken in accordance with the 'Oparure Quarry South-Western Pit: Erosion and Sediment Control Plan' and 'Oparure Quarry South-Western Pit: Erosion and Sediment Control Toolkit'.

3.0 Design of Haul Road ESC Infrastructure

3.1 ESC Measures

The following measures shall be applied to manage the sediment-laden stormwater associated with the Haul Road:

- Hydroseeding of any exposed high walls, to minimise the mobilisation of topsoil.
- Construction of a clean water diversion bund to direct clean runoff away from the haul road.
- Construction of water tables along the haul road to manage sediment-laden runoff.
- Construction of sediment cut-offs and pits to manage sediment-laden runoff.

The 'haul road' will comprise water tables (drains) on each side of the haul road to direct the runoff from the haul road to either the existing or the new pit. The water table has been designed to accommodate the largest catchment / portion of the haul road reporting to a water table.

Two 'clean water' diversion bunds are required to direct clean catchments away from the haul road water tables. The basis of design and dimensions are tabulated in Table 1.

Two culverts are required to be constructed under the haul road to convey stormwater runoff from the southern water table to the existing pit. A preliminary design would suggest that the eastern culvert at the toe of the haul road would require a single 400 mm diameter culvert and would accommodate a design flow of 0.51 m^3/s, being the peak flow from the contributing water table and clean-water diversion drain above the haul road. Whilst it may be possible to opt for a slightly smaller culvert midway up the haul road, being 350 mm in diameter based on a design flow of 0.18 m^3/s.

3.2 Catchment

The catchment for the clean water diversion bund collects clean stormwater from the surrounding grassed areas. The catchment for the water table / drains collects sediment-laden stormwater water from the haul road.

3.3 Diversion Bund / Drain

The basis of design of the diversion bund / drains that divert clean stormwater is outlined in Table 1 as Haul Road C and Haul Road D.

3.1 Water table / Drain

The basis of design of the water table / drains that run along the haul road is outlined in Table 1 as Haul Road A and Haul Road B.

3.2 Water table Sediment Pits

The sediment pits are an excavation that acts as a soakage bay where stormwater runoff is collected and left to soak into the ground. Sediment pits will be at least 1 m deep and will be constructed at least every 40 m along the water table drain. The exact locations of the sediment pits will be chosen to suit the terrain and the infiltration of the pit subsoils (e.g. clay/weather mudstone will provide seepage rates to ground compared to pits constructed in limestone).

Table 1: Haul Road Drains / Bunds

Catchment	Area (ha)	Catchment Slope (%)	Runoff Coefficient	Tc (min)	Design Rainfall (mm/hr)	Peak Flow (m^3/s)	Channel slope (%)	Channel Depth (m)	Top Channel Width (m)	Rip-rap diameter (d_{50} mm)	Design Discharge capacity (m^3/s)
Haul Road A	1.39	4.38	0.5	24.2	92.55	0.18	4.38	0.24	1.36[1]	60	0.18
Haul Road B	2.01	4.38	0.51	18.4	109.11	0.31	4.38	0.25	1.60[1]	75	0.31
Haul Road C	5.84	6.00	0.15	28.4	83.8	0.20	7.08	0.25	1.38[2]	100	0.20
Haul Road D	0.92	2.18	0.15	13.5	132.47	0.05	1	0.18	1.12[2]	30	0.05

Notes:

1. *Trapezoid channel profile; base width 0.2 m, side slope 1V:2H, 0.1 m freeboard*
2. *Bund forms an equivalent triangular channel; 1V:2H slope of channel sides, 0.1 m freeboard*

4.0 Design of Topsoil Stockpile ESC Infrastructure

4.1 ESC Measures

The following measures shall be applied to manage the movement of topsoil stockpile area will have the following ESC measures:

- Hydroseeding of any stockpiles that will exist for greater than six months to minimise the mobilisation of topsoil.
- Construction of a diversion bund that will form a drain around the stockpile site, which will direct any sediment-laden stormwater to one of two sediment retention ponds for further treatment.
- Construction of two sediment retention ponds to reduce the sediment load leaving the Topsoil Stockpile Area.

4.2 Catchment

A bund will encapsulate the Topsoil Stockpile Area, being 3.2 ha. The catchment will comprise a combination of existing grassland, internal roads, topsoil stockpile, and re-grassed topsoil stockpile. The catchment contributes to four stockpile diversion bunds, with the largest catchment being 1.2 ha.

4.3 Diversion Bund / Drain

The basis of design of the diversion bund / drains that will encompass the topsoil stockpile is outlined below:

- Design Inflow: 0.10 m^3/s
  - As determined by the Rational Method, where:
    - A = 12,000 m^2 (being the largest catchment to one of the four drains)
    - C = 0.2
    - T_c = 10 mins,
    - I = 149.4 mm/hr (being 50-year ARI)
- Drain – triangular with at least 100 mm freeboard and 1V:2H slopes
- Channel Slope: 1.2 % (being the estimated design slope of one steepest stockpile drain)
- Results – Drain Dimension
  - 0.3 m x 1.3 m (depth (incl. freeboard) x width)
  - Unlined with aggregate riprap between 30 mm to 100 mm

4.4 Sediment Retention Pond - North

The sediment retention pond is based on the approach outlined in WRC (2014) but has been scaled up to provide a higher level of service due to the long-term nature of the pond.

The WRC (2014) sizing methodology is based on a 10 hour 5-year ARI event; and a forebay based on 10% of the sedimentation basin volume. As outlined in the Oparure Quarry South-Western Pit Erosion and Sediment Control Plan, the pond has been designed to provide treatment for a 20-year ARI event (5% AEP) and has been scaled accordingly.

Assumptions and parameters used for this SRP sizing include:

Graymont ESC Sediment Retention Pond

- Design Volume: 630 m^3
  - Catchment: 1.7 ha (scaled up from 1.3 ha)
  - Slope: 1.7%
- Dead Storage: 180 m^3 (29%)
- Live Storage: 450 m^3 (71%)
- Results – Pond Dimensions
  - Forebay
    - 60 m^3, depth: 1 m, length: 10 m (base of pond), width: 6 m
  - Main Pond
    - 30 m x 10 m (length x width (base of pond))
    - Depth: 0.6 m (dead volume), 1.5 m (design depth), 2.0 m (coping level)

4.5 Sediment Retention Pond - South

The sediment retention pond is based on the approach outlined in WRC (2014) but has been scaled up to provide a higher level of service due to the long-term nature of the pond.

The WRC (2014) sizing methodology is based on a 10 hour 5-year ARI event; and a forebay based on 10% of the sedimentation basin volume. As outlined in the Oparure Quarry South-Western Pit Erosion and Sediment Control Plan, the pond has been designed to provide treatment for a 20-year ARI event (5% AEP) and has been scaled accordingly.

Assumptions and parameters used for this SRP sizing include:

Graymont ESC Sediment Retention Pond

- Design Volume: 735 m^3
  - Catchment: 2.4 ha (scaled up from 1.8 ha)
  - Slope: 1.7%
- Dead Storage: 210 m^3 (29%)
- Live Storage: 525 m^3 (71%)
- Results – Pond Dimensions
  - Forebay
    - 70 m^3, depth: 1 m, length: 10 m (base of pond), width: 7 m
  - Main Pond
    - 35 m x 10 m (length x width (base of pond))
    - Depth: 0.6 m (dead volume), 1.5 m (design depth), 2.0 m (coping level)

5.0 Design of SW Pit ESC Infrastructure

5.1 ESC Measures

The following ESC measures shall be applied to manage the stormwater and sediment within the SW Pit:

- Grassing (or hydroseeding) of topsoil, volcanic ash and/or weathered mudstone
- Benching of any highwalls to minimise the mobilisation of topsoil.

- Drains at the toe of the highwalls to intercept any stormwater runoff and direct them to the SRP in the pit floor.
- Construction of one sediment retention pond to reduce the sediment load leaving the pit.

5.2 Catchment

The SW Pit catchment is 12.6 ha. The catchment will comprise a combination of existing grassland, a section of the internal haul road, exposed limestone, overburden, and hydroseeded quarry highwalls. The catchments for the water tables / drains will vary depending on the state of the quarry and its ground slope. The largest potential catchment for one water table / drain is estimated to be 3.7 ha.

5.3 Water table / Drain

The basis of design of the water table / drains at the toe of the highwalls is outlined below:

- Design Inflow: 0.5 m^3/s
  - As determined by the Rational Method, where:
    - A = 37,000 m^2 (being the biggest estimated catchment for water table / drains)
    - C = 0.39
    - T_c = 10 mins,
    - I = 124.2 mm/hr (being 20-year ARI)
- Drain – trapezoidal with a 1 m base, and 1V:2H side slopes
- Channel Slope: 1 %
- Results – Drain Dimension
  - 0.4 m x 2.6 m (depth (incl. freeboard) x top width)
  - Unlined with aggregate riprap between 30 mm to 100 mm D_{50}

5.4 Infiltration Sediment Retention Pond – SW Pit

The basis of design of the SW pit infiltration sediment retention pond is outlined below:

- Catchment: 84,600 m^2
  - Quarry floor: 55,000 m^2
  - Stripping: 29,600 m^2
- Level of Service: 2-year ARI.
  - Critical events greater than this will surcharge the pond and spill onto the quarry floor.
- Infiltration Rate: 12 m/day (via gross fractures in the limestone)
- Dead Storage: 210 m^3 (29%)
- Runoff Coefficient (for storage):
  - Quarry floor: 0.35 (fractured limestone)
  - Stripped Topsoil: 0.15
- Result – Infiltration Sediment Retention Pond:
  - Active Volume: 760 m^3
  - Dimensions: 10m x 38m x 2m (WxLxD)
  - Dead Volume : additional 0.3m
  - Sand Filter Media:

        - 0.3m of 2A sand, regraded to remove particles less than 0.6mm
        - 0.2m of pea gravel (5-10mm) to support the sand media

- Forebay
    - 70 m3, depth: 1 m, length: 7 m (base of pond), width: 10 m
    - 35 m x 10 m (length x width (base of pond))
    - Depth: 0.6 m (dead volume), 1.5 m (spillway)

5.5 Clean Water Diversion Bund

The basis of design of the water table / drains at the toe of the highwalls is outlined below:

- Design Inflow: 0.45 m^3/s
    - As determined by the Rational Method, where:
        - A = 54000 m^2 (being the catchment of the largest proposed clean water diversion bund)
        - C = 0.2
        - T_c = 10 mins,
        - I = 149.4 mm/hr (being 50-year ARI)
- Drain – trapezoidal with a 0.25 m base, and 1V:2H side slopes
- Channel Slope: 10 % (average slope of the steepest section of clean water diversion bund)
- Results – Drain Dimension
    - 0.4 m x 2 m (depth (incl. freeboard) x top width)
    - Lined with HDPE liner with aggregate riprap between 140 mm to 150 mm D50

6.0 References

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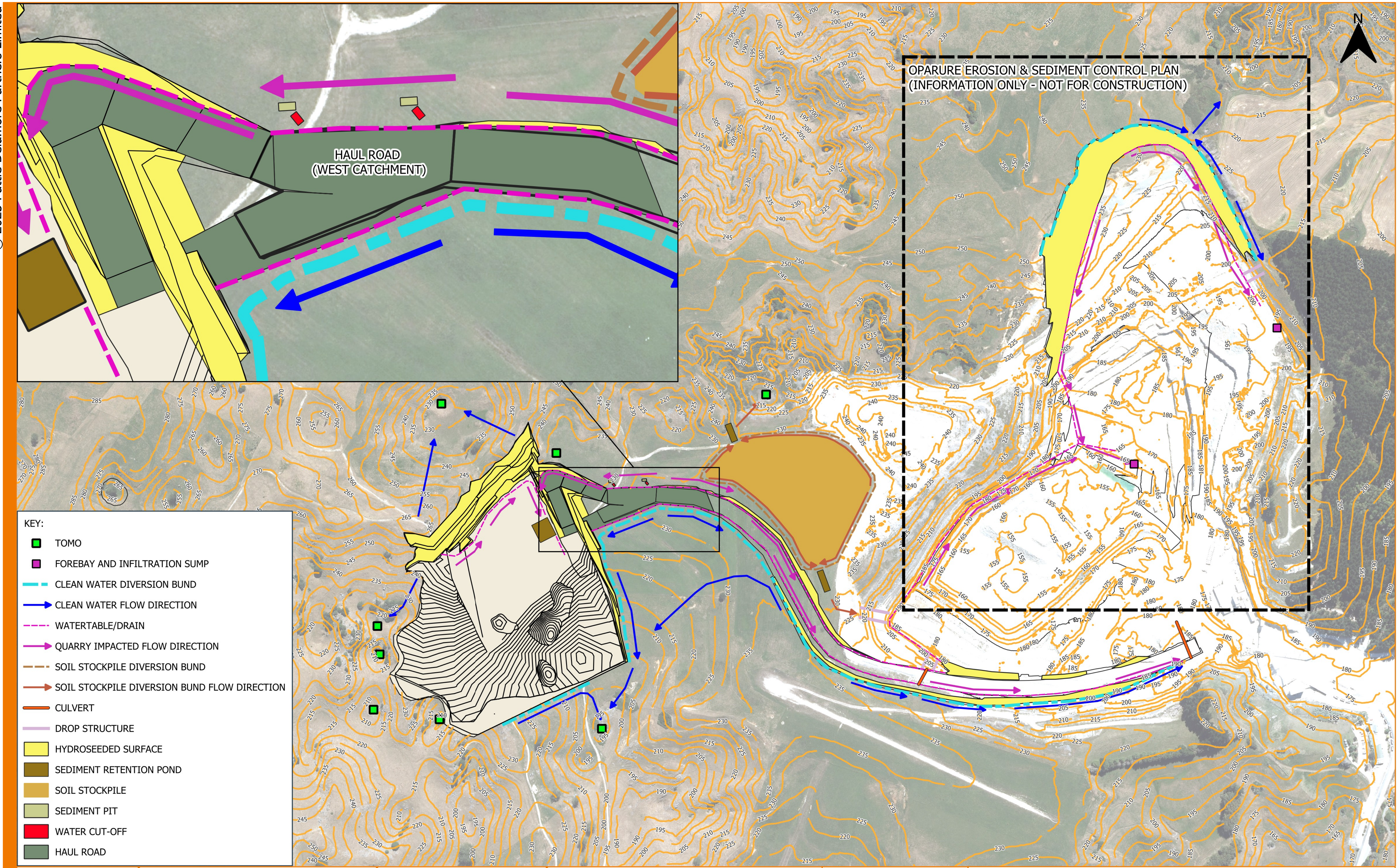
7.0 Limitations

This document has been prepared by Pattle Delamore Partners Limited (PDP) based on information provided by Graymont New Zealand Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This document has been prepared by PDP on the specific instructions of Graymont New Zealand Limited for the limited purposes described in the memorandum. PDP accepts no liability if the memorandum is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Prepared by	Reviewed and Approved by
Dion Todd	M J Ellis
Dion Todd	**Mark Ellis**
Environmental Engineer	Technical Director – Water Infrastructure



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METRES (A3)

SCALE : 1:5,500

NO.	REVISION	DATE	BY
B	DRAFT	JUN 25	HK
A	DRAFT	MAR 25	DT

NOTES

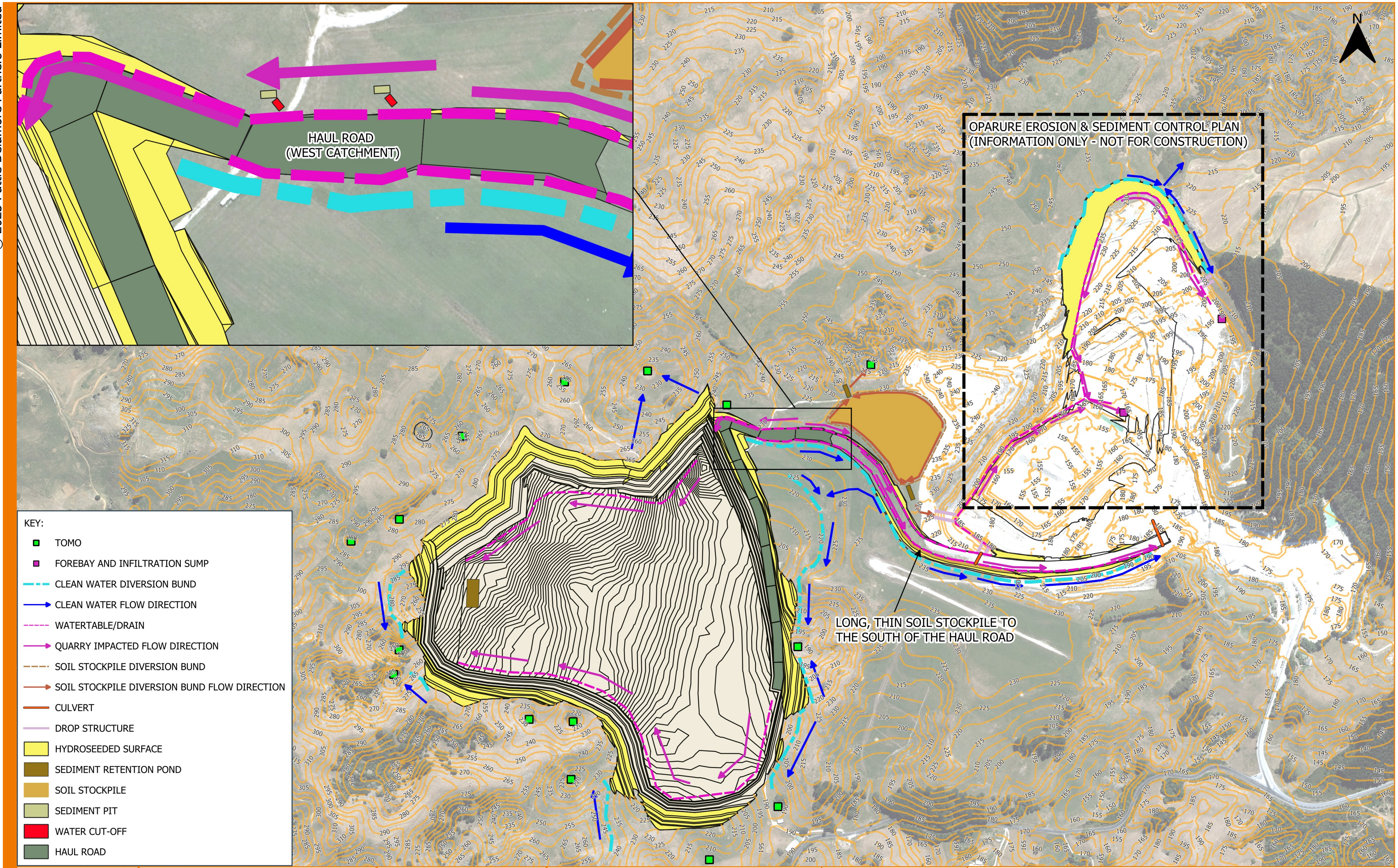
1. AERIAL IMAGERY SOURCED FROM THE LINZ DATA SERVICE [https://data.linz.govt.nz] AND LICENCED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

CLIENT

GRAYMONT

FIGURE 01: EROSION & SEDIMENT CONTROL MEASURES - EOY1

SOUTH-WESTERN PIT - EROSION & SEDIMENT CONTROL



S:\C03870\822\PROJECT\802_COPY_Existing_Catchments_RevD.qgz

pdp

0 100 200 m

METRES (A3)

SCALE : 1:8,000

NO.	REVISION	DATE	BY
B	DRAFT	JUN 25	HK
A	DRAFT	MAR 25	DT

NOTES

1. AERIAL IMAGERY SOURCED FROM THE LINZ DATA SERVICE [https://data.linz.govt.nz] AND LICENCED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

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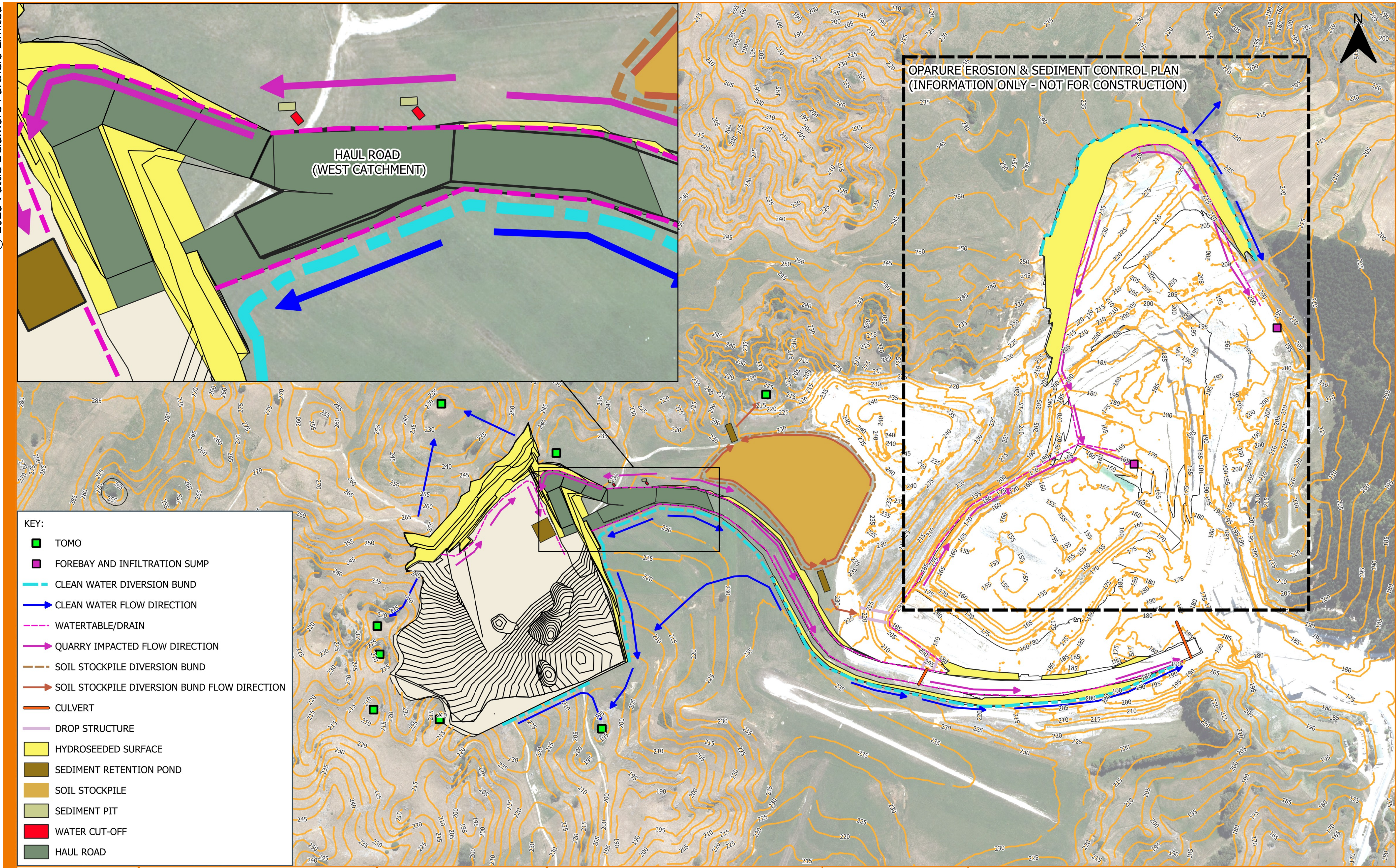
FIGURE 01: EROSION & SEDIMENT CONTROL MEASURES - EOY53

SOUTH-WESTERN PIT - EROSION & SEDIMENT CONTROL



S:\C03870\822\PROJECT\802_COPY_Existing_Catchments_RevD.qgz

pdp

0 100 200 m

METRES (A3)

SCALE : 1:5,500

NO.	REVISION	DATE	BY
B	DRAFT	JUN 25	HK
A	DRAFT	MAR 25	DT

NOTES

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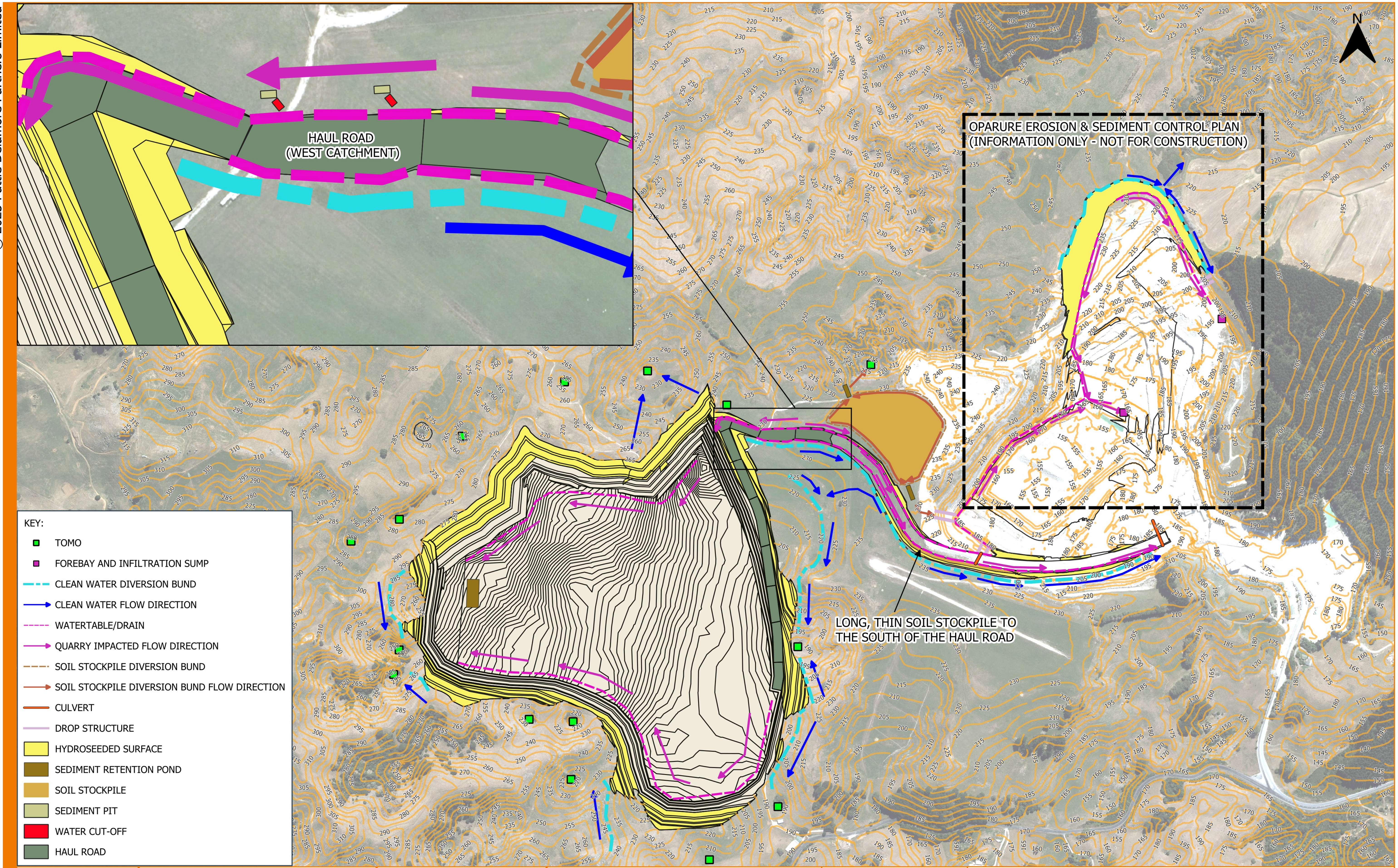
FIGURE 01: EROSION & SEDIMENT CONTROL MEASURES - EOY1

SOUTH-WESTERN PIT - EROSION & SEDIMENT CONTROL



S:\C03870\822\PROJECT\802_COPY_Existing_Catchments_RevD.qgz

pdp

0 100 200 m

METRES (A3)

SCALE : 1:8,000

NO.	REVISION	DATE	BY
B	DRAFT	JUN 25	HK
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FIGURE 01: EROSION & SEDIMENT CONTROL MEASURES - EOY53

SOUTH-WESTERN PIT - EROSION & SEDIMENT CONTROL

Appendix C: Trigger Response Action Plans

Table 1: Trigger Response Action Plans

Monitoring	Trigger	Action
Watertable Drains	Level 1	
	Visual Inspection • Minor erosion of channels observed during or following heavy rainfall • Capacity of channel not exceeded	• Note location • Notify Site Engineer to arrange to have channel repaired. • Re-inspect channels when flow conditions have returned to normal. • Continue to monitor
	Level 2	
	Visual Inspection • Significant erosion of channels or deposition observed during or following heavy rainfall • Capacity of channel not exceeded	• Note location • Notify Site Engineer and Quarry Manager – arrange to have channel repaired • Notify Environmental Manager • Re-inspect channels when flow conditions have returned to normal. • Continue to monitor • Arrange for repair and/or redesign and repair within the next 7 days
	Level 3	
	Visual Inspection • Significant erosion of channels or deposition observed during or following heavy rainfall • Capacity of channel exceeded, and uncontrolled discharge observed	• Notify Quarry Manager and evacuate personnel from affected area. • Monitor and observe continuously and determine an appropriate exclusion zone • Implement a physical monitoring plan if appropriate • Determine and implement appropriate remedial options • Notify Environmental Manager who will contact Waikato Regional Council where necessary
Highwalls – Daily Inspection	Level 1	
	Visual Inspection • Minor instability/erosion of fill slopes identified • Minor settlement of fill identified (could result in local ponding)	• Note location • Notify Site Engineer, implement appropriate repairs

Table 1: Trigger Response Action Plans

Monitoring	Trigger	Action
	Level 2	
	Visual Inspection • Significant instability of fill slopes identified generating significant sediment discharge • Significant deformation observed in critical locations	• Notify Geotechnical Engineer, Quarry Manager, H&S Manager, and Environment Manager • Define and demarcate exclusion zone around failure including above and below the failure to mitigate H&S risk • Inspect every two hours and note any additional failures or development of tension cracks, implement appropriate deformation monitoring • Develop solutions to remediate the risk
	Level 3	
	Visual Inspection • Significant instability of fill slopes identified generating significant sediment discharge • Significant deformation observed in critical locations • Deformation is recognised as on-going, possibly inferring larger scale failure or settlement into a tomo	• Notify Geotechnical Engineer, Quarry Manager, H&S Manager, and Environment Manager • Define and demarcate exclusion zone around failure including above and below the failure to mitigate H&S risk • Monitor continuously and be alert for increases in rate of deformation • Implement measures to mitigate the risk
Haul Roads – Visual Observations	**Level 1**	
	Visual observations • Minor rutting or erosion of road surface • Cut or fill slopes do not show instability • Minor spillage on roads • Minor blocking of table drains	• Note location • Inform Site Engineer • Clear table drains
	Level 2	
	Visual observations • Significant rutting or erosion of road surface • Significant failures of cut or fill slopes, but not blocking road • Significant spillage on roads	• Inform Quarry Manager and Environment Manager • Site engineer to develop and implement remedial strategies

Table 1: Trigger Response Action Plans		
Monitoring	**Trigger**	**Action**
	• Significant blocking of table drains potentially leading to uncontrolled overflow	
	Level 3	
	Visual observations • Significant failures of cut or fill slopes blocking road • Significant blocking of table drains leading to uncontrolled overflow	• Notify Quarry Manager and Environment Manager • Ensure traffic is controlled to avoid accidents • Implement appropriate temporary signage as required • Develop and implement remedial works as soon as possible
Infiltration Sumps	**Level 1**	
	Visual Inspection • Infiltration sump largely free of sediment, minor silt deposition. • Minor or no erosion of sump inlet(s) or walls	• Normal operation
	Level 2	
	Visual Inspection • Infiltration sump contains significant sediment. • Inlet is significantly eroded or blocked with sediment. • Sump walls are eroded and in poor condition	• Note location • Notify Site Engineer. • Continue to monitor. • Arrange for repair and/or redesign and repair within the next 7 days
	Level 3	
	Visual Inspection • Infiltration sump blocked with sediment preventing infiltration, flooding of the immediate area is likely to occur during heavy rainfall. • Inlet is significantly damaged or blocked causing uncontrolled overflows into the quarry. • Sump walls are significantly eroded and at risk of collapse.	• Notify Quarry Manager, H&S Manager and Environmental Manager. • Quarry Manager to evacuate personnel from affected area if heavy rain/flooding is occurring. • Monitor and observe continuously and determine an appropriate exclusion zone during heavy rain. • Determine and implement appropriate remedial options including repair and/or redesign and repair as soon as practical. •

Table 1: Trigger Response Action Plans		
Monitoring	**Trigger**	**Action**
Water Quality and Aquatic Ecology Monitoring	• **Level 1**	
	Turbidity – Gate Spring / Mangawhitakau Stream Confluence • Less than 20% increase of daily mean turbidity, compared to upstream daily mean turbidity and baseline conditions. **Fine Sediment Survey – Mangawhitakau Stream** • Less than 20% change in deposited sediment cover **Benthic macroinvertebrate and Invertebrate Sampling – Mangawhitakau Stream** • MCI and QMCI scores remain in the same NPSFM attribute band **Periphyton Survey – Mangawhitakau Stream** • Less than 20% change in periphyton cover	• Normal operation, continue monitoring as per normal.
	Level 2	
	Turbidity – Gate Spring / Mangawhitakau Stream Confluence • 20% increase of daily mean turbidity, compared to upstream daily mean turbidity (and baseline conditions), occurs in two rounds of consecutive monitoring. **Fine Sediment Survey – Mangawhitakau Stream** • Greater or equal to a 20% change in deposited sediment cover; that occurs in two or more rounds of consecutive monitoring. **Benthic macroinvertebrate and Invertebrate Sampling – Mangawhitakau Stream** • A change in NPSFM attribute band due to MCI and QMCI scores, that occurs in two or more rounds of consecutive monitoring.	• Notify Quarry Manager, H&S Manager and Environmental Manager. • Repeat monitoring programme. • Investigate the likely root cause of the change in water quality or aquatic ecological parameter; including possible changes to the management of erosion and sediment devices.

Table 1: Trigger Response Action Plans		
Monitoring	**Trigger**	**Action**
	Periphyton Survey – Mangawhitakau Stream • Greater or equal to a 20% change in periphyton cover; that occurs in two or more rounds of consecutive monitoring.	
	Level 3	
	Turbidity – Gate Spring / Mangawhitakau Stream Confluence • 20% increase of daily mean turbidity, compared to upstream daily mean turbidity (and baseline conditions), occurs three or more times in a 18 month period of monitoring. **Fine Sediment Survey – Mangawhitakau Stream** • Greater or equal to a 20% change in deposited sediment cover; that occurs in four or more rounds of consecutive monitoring. **Benthic macroinvertebrate and Invertebrate Sampling – Mangawhitakau Stream** • A change in NPSFM attribute band due to MCI and QMCI scores, that occurs in four or more rounds of consecutive monitoring. **Periphyton Survey – Mangawhitakau Stream** • Greater or equal to a 20% change in periphyton cover; that occurs; that occurs in four or more rounds of consecutive monitoring.	• Notify Quarry Manager, H&S Manager and Environmental Manager. • Investigate the likely root cause of the change in water quality or aquatic ecological parameter; including possible changes of the management of erosion and sediment control devices. • Implement the recommended changes identified in the root cause investigation. • Environmental Manager will notify Waikato Regional Council of the occurrence and status of the investigations (and implemented changes) where necessary.