Construction Water Assessment Report

December 2017

Ridley Dunphy Environmental Ltd and Mt Messenger Alliance

Technical Report 13

NZ TRANSPORT AGENCY WAKA KOTAHI
Mt Messenger Bypass
New Zealand Government

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Contents

Glossary

Glossary of Abbreviations

Abbreviation	Definition
AEE	Assessment of Environmental Effects
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
BPO	Best Practicable Option
CEMP	Construction Environmental Management Plan
SCWMP	Site Specific Management Plans
CWMP	Construction Water Management Plan
DEB	Decanting Earth Bund
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
RMA	Resource Management Act 1991
SF	Silt Fence
SH3	State Highway 3
SRP	Sediment Retention Pond
SSF	Super Silt Fence
TRC	Taranaki Regional Council
TRFWP	Taranaki Regional Fresh Water Plan
TRPS	Taranaki Regional Policy Statement
TRSP	Taranaki Regional Soil Plan
TSS	Total Suspended Solids
USLE	Universal Soil Loss Equation

Glossary of Terms

Term	Definition
Annual Exceedance Probability Storm Event	The probability of exceeding a given storm discharge or flood level within a period of one year. For example, equivalent return period terms 100-year ARI = 100 year.
Average Recurrence Interval	The average time period between rainfall or flow events which equal or exceed a given magnitude.
Construction Runoff	Any runoff, sediment laden or otherwise, that flows as a result of the construction related activities. Typically results from rain events.
Culvert	A pipe with an inlet from a watercourse and outlet to a watercourse, designed to convey water under a specific structure (such as a road).
Earthworks	The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting or filling operations.
Erosion control	Methods to prevent or minimise the erosion of soil, in order to minimise the adverse effects that land disturbing activities may have on a receiving environment.
Flocculation	The process whereby fine particles suspended in the water column clump together and settle. In some instances, this can occur naturally, such as when fresh clay-laden flows mix with saline water, as occurs in estuaries. Flocculation can be used to promote rapid settling in sediment retention ponds by the addition of flocculating chemicals (flocculants).
Land disturbing activity	Any disturbance to the ground surface that may result in soil erosion through the action of wind or water.
Sediment control	Capturing sediment that has been eroded and entrained in overland flow before it enters the receiving environment.
Sediment delivery ratio	The proportion of the soil eroded from within a catchment area that reaches sediment treatment controls.
Sediment generation	That sediment that is generated on the site of earthwork activity prior to treatment through any sediment retention device.
Sediment retention pond	A detention structure that is used during the construction phase of earthworks activity to treat any sediment laden runoff and retain sediment.
Sediment yield	That sediment which leaves the sediment retention devices and enters the receiving environment can be expressed in many ways including

Term	Definition
	suspended sediment concentration or a mass load on a time basis or an aerial basis.
Stabilisation	Achieving a stabilised area which is defined as an area inherently resistant to erosion such as rock, or rendered resistant by the application of aggregate, geotextile, vegetation or mulch. Where vegetation is to be used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once an 80% vegetation cover has been established.
Stormwater	Water from rain events that flows from the completed areas (both pervious and impervious) of the motorway after the construction period.
Stormwater pond	A stormwater management device which detains runoff, typically from a design storm, and then discharges it, usually at the pre-development peak discharge rate. It can also provide water quality treatment primarily through sedimentation. A stormwater pond can either be a dry pond which is normally dry between storm events, or a wet pond which has a standing pool of water.
Project	The construction and ongoing operation of a new section of State Highway 3 (SH3), generally between Uruti and Ahititi to the north of New Plymouth. The Project will be located off-line from the existing SH3, traversing land to the east of Parininihi / Mount Messenger and the existing State highway
Wetland	Permanent vegetated stormwater treatment device designed to remove a range of contaminants, providing superior water quality treatment to wet ponds with increased filtering and biological treatment performance.

Executive Summary

This report assesses the construction water related effects of the proposed Mt Messenger Bypass project (the Project).

Existing environment

The Project area consists of high quality habitat for indigenous terrestrial and aquatic flora and fauna. The geology is dominated by papa mudstone, which has a large influence on stream substrate, where the gravels are soft and a relatively high amount of fine sediment is present at the stream bed. The Project will require works within the Magapepeke (sub catchment of the Tongaporutu catchment) and Mimi catchments.

The topography of the area is characterised by steep slopes (typically greater than 20%), and areas of valley floor with slopes typically less than 10%. In general, the Project is located within the lower slopes above the valley floor, to avoid both the steeper slopes and the wetter valley floor environment.

It is essential that the erosion and sediment measures and practices implemented during construction recognise the natural, ecological and habitat values of the Project area and manage the discharge of sediment, and other construction related discharges, to avoid or mitigate adverse effects.

Land disturbance effects

Construction of the Project will occur over a total area of approximately 36 hectares. Of this, 19 hectares comprises the proposed road alignment and works to enable construction (e.g. access, spoil disposal sites, laydown and yards) are likely to occur within a further 17 hectares.

Approximately 960, 000m^3 of excavated (cut) material will be generated from the site. Approximately 890, 000m^3 of material will be placed in fill embankments on-site. As such, any excess of fill will be created and disposed of within the designation boundaries either in disposal sites or embankments (refer to Section 1.13.4 of the AEE for further detail).

The potential adverse effects associated with the construction phase discharges from the site includes:

- Effects on the natural, ecological and amenity values of the receiving environment;
- Cumulative effects on the downstream receiving environment;
- Effects on human or animal (stock) health from contaminated drinking water; and
- Effects on recreational values of downstream watercourses and the coastal environment.

Land disturbance guidance documents

The construction water management approach has been informed by the Taranaki Regional Council (TRC) statutory documents (Regional Freshwater and Soil Plans), along with non-statutory land disturbance guidance documents from TRC (*Guidelines for Earthworks in the*

Taranaki Region) and the Transport Agency (*Erosion and Sediment Control Guidelines for State Highway Infrastructure*).

The Transport Agency Guideline is assessed as representing best practice erosion and sediment control over TRC guidelines. Adopting practices set out in the Transport Agency Guideline is considered to achieve the necessary environmental outcomes for this Project, and is selected as the principle guideline document for this Project.

Management of adverse effects

A range of structural and non-structural construction water management measures are proposed for the Project. Erosion control will be the highest priority in the design of erosion and sediment control measures as it prevents sediment generation in the first instance; and is particularly important when managing works on steep slopes.

Conceptual erosion and sediment control plans have been developed for the Project to illustrate that the sediment yields arising from the construction works can be managed effectively.

Implementation of a monitoring programme will also allow for ongoing water quality monitoring and ecological assessment during construction to check that construction water management measures are appropriate, are correctly installed and that methodologies are being followed and are functioning effectively.

A Construction Water Management Plan (CWMP) will be prepared prior to construction (a framework is provided with this CWAR). The CWMP will provide the overall approach and guidance for construction water management during construction of the Project. In addition, Site Specific Management Plans (SCWMPs) will be prepared for specific construction sites and/or activities, in accordance with the general principles of the CWMP.

Overall, provided that appropriate construction water management measures are implemented in accordance with this CWAR and the CWMP, any adverse construction water related effects arising from the construction of the Project will be less than minor. This conclusion is supported in the Aquatic, Marine and Vegetation Assessment Reports.

1 Introduction

1.1 Purpose and scope of this report

This Construction Water Assessment Report (CWAR) forms part of a suite of technical reports prepared for the NZ Transport Agency's Mt Messenger Bypass project (the Project). Its purpose is to inform the Assessment of Effects on the Environment Report (AEE) and to support the resource consent applications and Notice of Requirement to alter the existing State Highway designation, which are required to enable the Project to proceed.

This report assesses the effects of construction water associated with the Project which follows the alignment as shown on the Project Drawings in Volume 2: Drawing Set. Construction water refers to direct discharge of construction water that potentially contains contaminants such as indirect run-off from the earthwork activities and associated sediment.

This report:

a Identifies and describes the existing environment (Section 4);

b Describes the potential effects of construction-related water management (including the management of erosion and sedimentation) on the receiving environment (Sections 6-10);

c Recommends methods, practices and standards to be implemented and complied with as far as practicable during construction in order to avoid, remedy or minimise potential effects during construction of the Project (Sections 6 and 7);

d Sets out considerations of environmental risk from the Project and of receiving environment values and sensitivities (Section 5); and

e Describes the approach for managing construction water effects, including the development of a Construction Water Management Plan (CWMP) and Specific Construction Water Management Plans (SCWMPs) (Section 6). The Construction Environmental Management Plan (CEMP) in Volume 5 provides the CWMP, which will be further developed prior to construction commencement.

With consideration of items a - e above, this CWAR presents an assessment of the potential effects from construction water discharges from the Project during construction.

1.2 Project description

The Project involves the construction of a new section of State Highway 3 (SH3), generally between Uruti and Ahititi, to the north of New Plymouth. This new section of SH3 will bypass the existing steep, narrow and winding section of the current highway at Mt Messenger. The Project comprises a new section of two lane highway, approximately 6 km in length, located to the east of the existing SH3 alignment.

The northern extent of the Project is 9.2km stream distance from the Tongaporutu River mouth (marine environment), and the southern extent is 21.5km stream distance from the Mimi Stream mouth (marine environment).

The primary objectives of the Project are to enhance the safety, resilience and journey time reliability of travel on SH3 and contribute to enhanced local and regional economic growth and productivity for people and freight.

A full description of the Project including its design, construction and operation is provided in the AEE, contained in Volume 1: AEE, and is shown on the Drawings in Volume 2: Drawing Set.

1.3 Construction Water Management Plan

Within this CWAR, a key reference is the Construction Water Management Plan (CWMP) provided within the CEMP. This CWMP sets out the methodologies and the associated measures that can be implemented for the Project, also illustrated through drawings. The CWMP provides confidence that the Project can be constructed with appropriate and effective water management measures in place.

Prior to construction, a final CWMP will be developed to confirm the overall design and approach and provide guidance for construction water management during construction of the Project.

1.4 Associated reports

Related technical reports prepared for the Project include:

- Aquatic Ecology Assessment Report (Technical Report 7b); and
- Marine Ecology Assessment Report (Technical Report 7g).

This CWAR outlines the potential construction water effects that may result from the Project. The Aquatic and Marine Ecology Assessment Reports have informed the CWAR by way of identifying sensitive environments, which has advised the selection of appropriate measures.

Collectively, the water related assessments contained in the reports mentioned above provide a comprehensive set of recommendations for mitigation measures and practices to avoid, mitigate or remedy the potential adverse effects of the Project on the environment. The CWAR summarises the key technical information and assumptions on which the collective assessments are based, and cross references other Project reports where appropriate.

2 Construction method

The construction overview section of the AEE contains a full description of the proposed construction method for the Project. This is not repeated in full below, however key elements relevant to the context of this CWAR are provided.

To inform this CWAR, the following Project attributes have been used:

- The proposed new alignment comprises a total area of approximately 19ha. Of this, 13 ha is located within the Tongaporutu catchment and 6ha located within the Mimi catchment. The additional footprint for construction works will be over approximately 17ha and are likely to comprise (indicative only):
  - Access tracks: 5.5ha
  - Provisional spoil disposal sites: 7ha
  - Temporary stockpiling, laydown and yard areas: 4ha
- Of the 36ha of total earthworks, on an aerial basis 30% is expected to occur within the Mimi catchment and 70% within the Tongaporutu catchment.
- Earthworks volumes comprise:
  - Bulk structural cut of approximately 960,000 m^3;
  - Bulk structural fill of approximately 890,000 m^3;
  - Disposal of surplus structural material of approximately 70,000m^3; and
  - Disposal of unsuitable material of approximately 75,000m^3.
  - Additional earthwork volumes associated with site establishment earthworks will be generated in discrete areas within the footprint of works to create access, yards and establish erosion and sediment control (referred as Establishment works, refer Section 2.2 below). Drawing MMA-DES-CON-E1-DRG-1054 (attached to the AEE) illustrates indicative extent of such works.

2.1 Construction zones

For construction planning purposes and to effectively manage works, the Project area is divided into two regions (north and south). The regions roughly follow the natural split of the Project area into the Tongaporutu and Mimi catchments (refer to the AEE). The construction regions are further spilt into nine construction zones as outlined in the AEE and illustrated by Drawing MMA-DES-CON-E1-DRG-1051 – 1054, attached in the AEE. The zones generally reflect the nature of construction works (e.g. earthworks, or tunnel construction, or bridge construction).

An overview of the construction works proposed within each construction region and zones is provided in the AEE.

2.2 Construction stages

The key construction stages for each region and zone comprise:

- **Preparatory works** – *Initial works to enable Establishment Works and Construction Works such as site surveys and investigations, monitoring set-up and some land disturbance.*
- **Establishment works** – *Progressively opening up the site including, for example, constructing and/or widening access tracks to reach and construct sediment ponds; followed by vegetation clearance, stream diversions, and construction of full width access tracks and construction yards.*
- **Construction works** – *Ground improvement, bulk earthworks (including cut and fill activities), drainage installation, bridge construction, tunnelling, pavements and surfacing, reinstatement of site following the completion of construction, landscaping, installation of permanent road furniture and ancillary works.*

From an erosion and sediment control perspective, the proposed construction methodology and sequence is a practical approach to achieving the bulk earthworks required for the Project. This incorporates consideration of water management methodologies and includes erosion and sediment control implementation.

The construction staging above provides a general sequence of works and has informed the preparation of this CWAR, the conceptual erosion and sediment control plans (provided in Volume 2) and the CWMP (provided in the CEMP). Specific erosion and sediment control methodologies and associated details will be confirmed within the final CWMP and SCWMPs, which will be developed by Project and provided to Taranaki Regional Council (TRC) prior to associated construction works. Section 6 of this CWAR provides further detail on this process.

2.3 Construction discharge locations

The conceptual erosion and sediment control plans demonstrate an effective erosion and sediment control strategy. While acknowledging that these plans are conceptual in nature, the locations of the associated sediment retention devices and discharge points have been considered as part of the development of this CWAR. The discharge from primary sediment control devices i.e. sediment retention ponds, SRPs, are indicated by the position of SRPs in the conceptual erosion and sediment control plans (provided in Volume 2).

All construction related runoff discharges will either be to a land environment or direct to freshwater systems. Discharges to land are considered beneficial, as a land-based buffer zone will have a 'polishing' effect on the discharged runoff. Where discharges are direct to freshwater systems, the outlet will be protected with geotextile and riprap material (if necessary) to minimise erosion of the stream bank and bed at that point.

The sensitivity of the downstream environments are summarised in Section 4.4 below. There are no known specific freshwater environments where construction related discharges cannot occur due to ecological constraints.

Table 2.1 below lists the SRPs identified within the CWMP that discharge to permanent stream systems (as defined in the Freshwater Ecology Assessment Report). SRP locations and catchment extents are indicatively shown in the conceptual erosion and sediment control plans (provided in Volume 2).

Table 2.1 – Sediment Retention Pond Discharges

Construction Zone[1]	**SRP ID (indicative)**[2]	**Catchment extent (alignment chainage)**	**Discharge environment**
Zone 2	YARD SRP/FILL 1A	Off alignment	Mangapepeke Stream
Zone 2	SRP-1	CH 350 – CH 550	Mangapepeke Stream
Zone 2	SRP-2	CH 550 – CH 825	Mangapepeke Stream
Zone 2	SRP-3	CH 825 – CH 1350	Mangapepeke Stream
Zone 2	SRP-FILL 2A/2B	Off alignment	Mangapepeke Stream
Zone 2	SRP-4	CH 1350 – CH 1850	Mangapepeke Stream
Zone 2	SRP-5	CH 1850 – CH 2300	Mangapepeke Stream
Zone 3	SRP-6	CH 2300 – CH 2700	Mangapepeke Stream
Zone 3	SRP-7	CH 2700 – CH 3400	Mangapepeke Stream
Zone 5	SRP-8	CH 3650 – CH 4025	Upper tributary of the Kahikatea wetland
Zone 5 - 7	SRP-9	CH 4025 – CH 4500	Mimi Stream
Zone 10	SRP-FILL 4	Off alignment	Mimi Stream

Notes: 1) Refer Drawing MMA-DES-CON-E1-GRG-1001 for zone extents. 2) SRP IDs to be updated once pond locations are confirmed. For Construction purposes SRP IDs shall take the format of SRP-XXXX, where XXXX is the pond location based on the road chainage.

3 Statutory and non-statutory context

This section of the CWAR outlines a high level review of the statutory and non-statutory provisions relevant to this assessment. It focuses on the Taranaki Regional Council (TRC) assessment criteria of the Regional Freshwater Plan for Taranaki and Regional Soil Plan for Taranaki which apply to construction related discharges and water management.

The relevant legislative and statutory provisions of the Resource Management Act 1991 (RMA), National Policy Statements and the Taranaki Regional Policy Statement are not outlined within this CWAR (please refer to the AEE for these provisions).

An assessment against the relevant criteria from the Regional Freshwater Plan and Regional Soil Plan for Taranaki are provided in Section 9 of this CWAR.

3.1 Statutory framework

3.1.1 Taranaki Regional Plans

The primary statutory management tools for water quality, land disturbing activities, erosion, sediment generation and deposition in the Taranaki Region are summarised below:

3.1.2 Regional Freshwater Plan for Taranaki

The Regional Freshwater Plan for Taranaki (Freshwater Plan) promotes the sustainable management of the region's freshwater resources through various objectives and policies (contained within the AEE) and by applying rules and conditions to various activities. While the Freshwater Plan is currently under review, the relevant rules have been considered within this CWAR.

The relevant rules include the following:

<u>Permitted Activity</u>

- Discharges of stormwater and sediment deriving from soil disturbance activities of between 1 and 8ha (Rule 26) into surface water and/or onto or into land in circumstances where sediment from the soil disturbance may enter water.
    - The discharge shall not derive from an area of soil disturbance greater than 8 ha;
    - The discharge shall not derive from a volume of soil disturbance greater than 24,000 m^3;
    - The discharge shall not derive from soil disturbance which takes place between 1 May and 31 October;
    - The discharge shall not derive from soil disturbance which takes place within a defined urban catchment;
    - Soil stabilisation shall be undertaken as soon as practicable after the completion of the works;
    - Discharge to surface water shall contain less than 100 g/m^3 suspended solids;

- Discharge to surface water shall not give rise to any or all of the following effects in the receiving water after reasonable mixing:
    - a the production of any conspicuous oil or grease films, scums, or foams, or floatable or suspended materials;
    - b any conspicuous change in the colour or visual clarity;
    - c any emission of objectionable odour;
    - d the rendering of fresh water unsuitable for consumption by farm animals;
    - e any significant adverse effects on aquatic life.

The Project exceeds the Permitted Activity criteria and therefore consent as a discretionary activity is required in accordance with Rule 27. Key matters of discretion from within this rule framework include

- Approval of a site erosion and sediment control management plan and the matters contained therein;
- Setting of conditions relating to adverse effects on water quality and the values of the waterbody;
- Timing of works;
- Any measures necessary to reinstate the land following the completion of the activity;
- Monitoring and information requirements;
- Duration of consent;
- Review of conditions of consent and the timing and purpose of the review; and
- Payment of administrative charges and financial contributions.

3.1.3 Regional Soil Plan for Taranaki

The Regional Soil Plan for Taranaki (Soil Plan) addresses soil loss and soil health issues largely through objectives and policies and also non-regulatory methods (refer to the AEE). While the Soil Plan is currently under review, the relevant rules have been considered within this CWAR.

3.1.4 Assessment Criteria

The AEE outlines the assessment criteria relevant to the Project. These criteria are summarised below and are assessed within Section 9 of this CWAR.

- the natural, ecological and amenity values of the receiving environment;
- the allowance for reasonable mixing zones and sufficient flows;
- the potential for cumulative effects;
- the actual or potential risks to human and animal health from the discharge;
- the degree to which the needs of other resource users may be compromised;
- the effect of the discharge on the natural state of the receiving environment;
- measures to avoid, remedy or mitigate the effects of contaminants to be discharged;

- measures to reduce the volume and toxicity of the contaminant; and
- the use of the best practicable option for the treatment and disposal of contaminants.

3.2 Non-statutory framework

3.2.1 Taranaki Regional Council guidance document

The TRC *Guidelines for Earthworks in the Taranaki Region, October 2006* (TRC Guideline) outlines practical, cost-effective measures that can be applied to earthwork activities to prevent or minimise the adverse effects of those activities on the environment[1], particularly on water quality.

The purpose of the TRC Guideline is to promote good erosion and sediment control management practices for earthworks by outlining the general principles of erosion and sediment control, and providing a range of cost-effective erosion and sediment control practices that can be used for various earthwork activities. In doing this, the TRC Guideline also promotes solutions to minimise the adverse environmental effects on water quality associated with soil disturbance from earthwork activities in the Taranaki region.

The principles set out in the TRC Guideline has helped to inform the construction water management strategy for the Project outlined in this CWAR and the CWMP.

3.2.2 The Transport Agency guidance documents

The NZ Transport Agency has several guiding documents in relation to erosion and sediment control, including:

- **The Transport Agency State Highway Environmental Plan (Transport Agency 2008) (Environmental Plan)**

  The Environmental Plan provides a framework for the construction water runoff and contains a series of erosion and sediment control objectives for roading projects in New Zealand. The key erosion and sediment management objectives are:

  - Ensure construction and maintenance activities avoid, remedy or mitigate effects of soil erosion, sediment run-off and sediment deposition;
  - Identify areas susceptible to erosion and sediment deposition and implement erosion and sediment control measures appropriate to each situation with particular emphasis on higher risk locations; and
  - Use bio-engineering and low-impact design practices where practicable.

  The Environmental Plan also contains the following objectives relating to water resources and stormwater run-off during state highway construction:

  - W1 - Ensure run-off from State highways complies with RMA requirements;
  - W2 - Limit the adverse effects of run-off from state highways on sensitive receiving environments;

[1] *Section 1.0 Background from TRC Guideline*

- W3 – Ensure stormwater treatment devices on the network are effective; and
- W4 – Optimise the value of water management through partnership with others.

- **Erosion and Sediment Control Guidelines for State Highway Infrastructure – Construction Stormwater Management (Transport Agency 2014) (Transport Agency Guideline).**

The Transport Agency Guideline is intended to provide the minimum requirements for erosion and sediment control with respect to State highway construction projects. The key principles of the Transport Agency Guideline are included in Appendix A of this CWAR.

This Transport Agency Guideline has a similar outcome focus to the TRC Guideline, which is to identify a series of principles and practices to minimise sediment yields from earthwork projects.

As the Transport Agency Guideline is specific to State highway projects, it has been adopted as the principal guidance document in preparing this CWAR[2].

[2] *Pers comm TRC and advisors August 2017*

4 Existing environment

4.1 Rainfall

There is limited specific hydrological data in the vicinity of the Project, with the nearest rainfall gauge located approximately 20km away. All design storms for the Project implementation have therefore been derived from NIWA's hydrological system HIRDS V3.

Additionally, a local landowner at the northern end of the Project alignment has collected daily rainfall figures since 2012. These are presented below from 2012 through to 2016 (refer Figure 4.1). These illustrate a reasonable spread of rainfall over a 12 month period. Annual rainfall equates to approximately 2000 mm with approximately 40% of this falling over the 4 month period from May to August. Lower rainfall in January to March indicate a drier period.

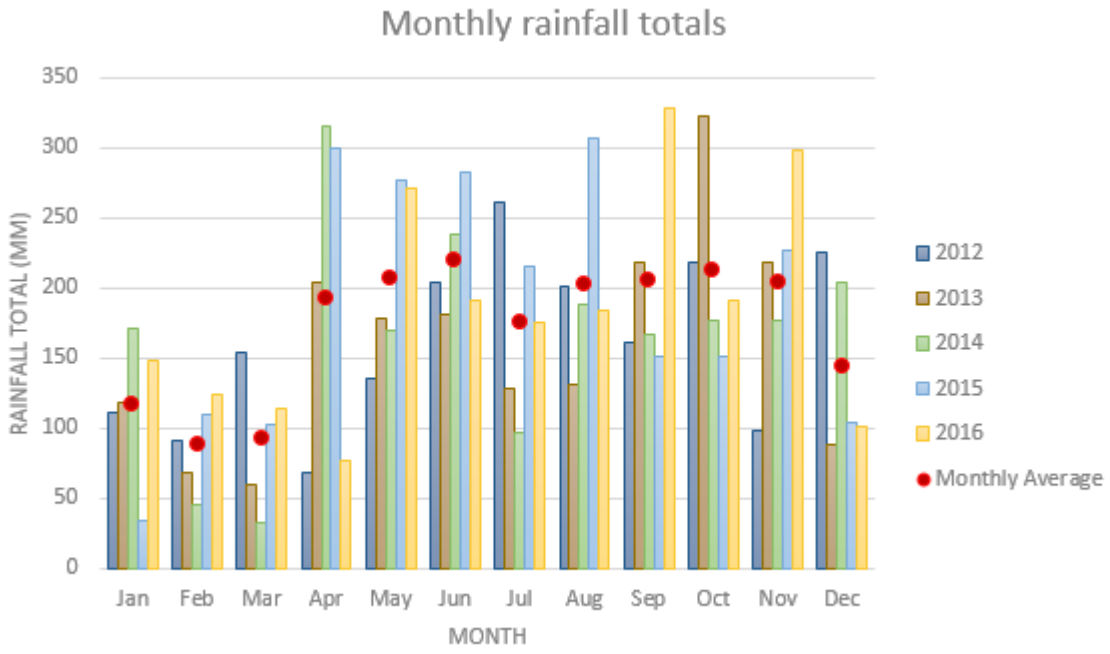


Figure 4.1 – Rainfall recorded by local landowner, 2012 – 2016

4.2 Catchment description and topography

4.2.1 Catchment description

The Mount Messenger Parininihi area is situated in the North Taranaki Ecological District. The local area includes areas of high quality habitat for indigenous terrestrial and aquatic flora and fauna. The geology is dominated by papa mudstone, which has a considerable influence on stream substrate, where the gravels are soft and a relatively high amount of fine sediment is present at the stream bed.

The Project will require works within the Mangapepeke and Mimi catchments.

The Mangapepeke is a subcatchment of the Tongaporutu catchment immediately above the extent of works (Mangapepeke Stream) and comprises an area of 332ha. The Tongaporutu catchment comprises a total area of 21,237ha.

The Mimi catchment comprises a total area of 13,235ha. The catchment extent immediately above the Project works comprises an area of 978ha.

This confirms the very large catchment areas within which the Project is located.

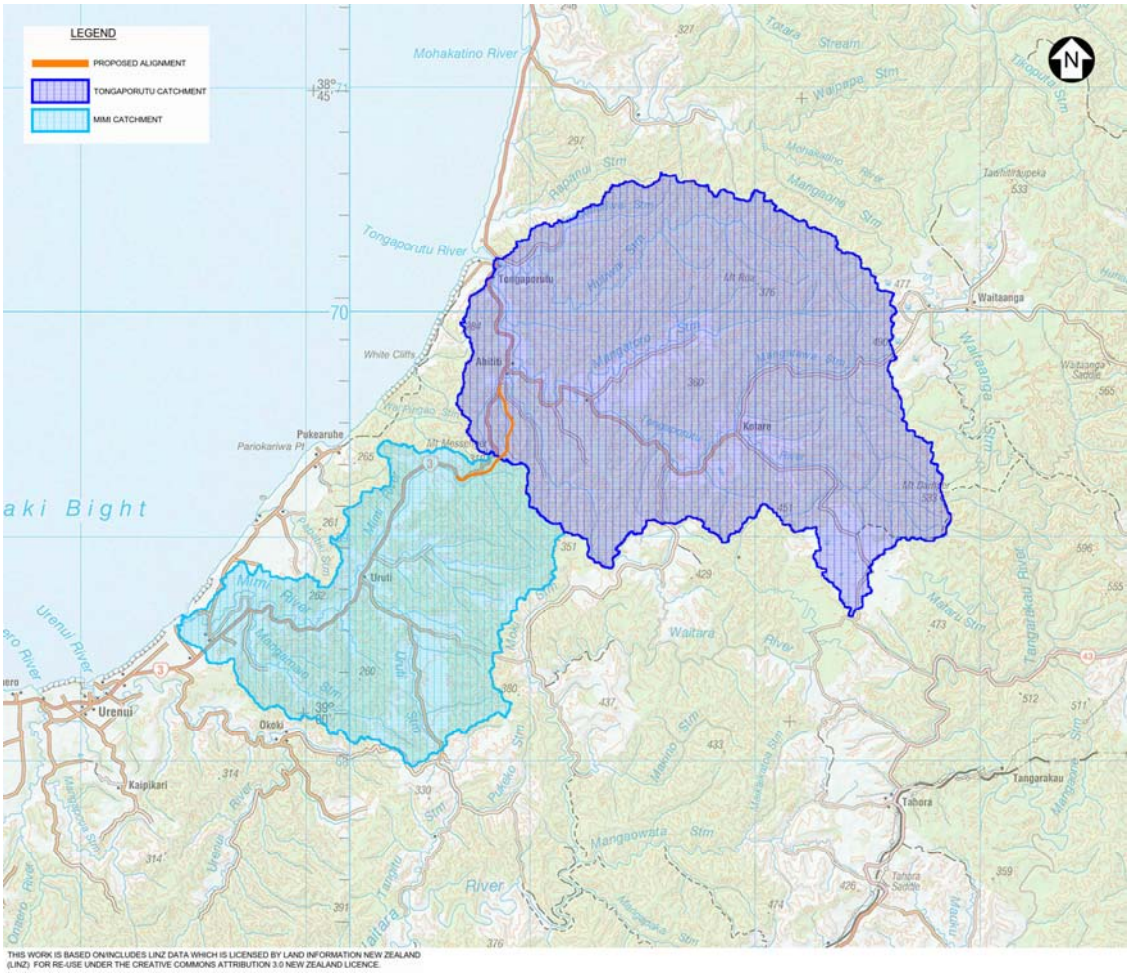
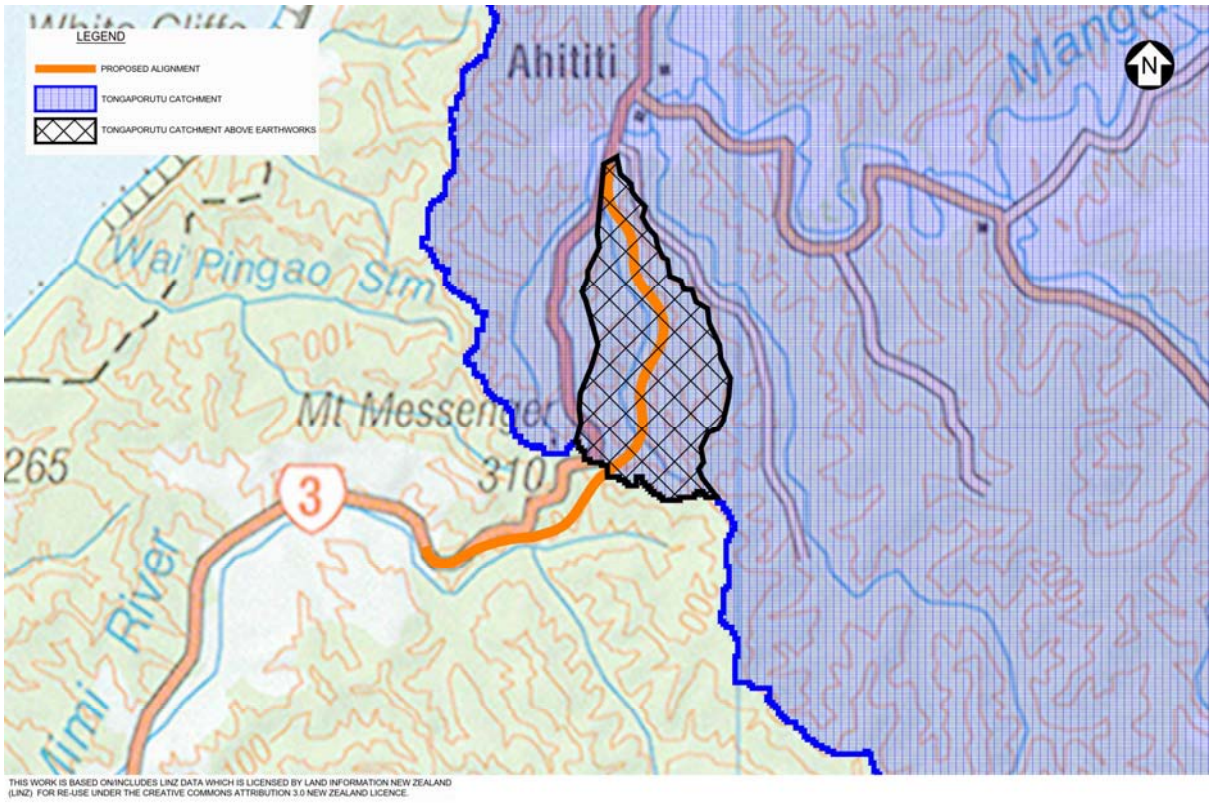


Figure 4.2 – Project Alignment and Associated Full Catchment Areas



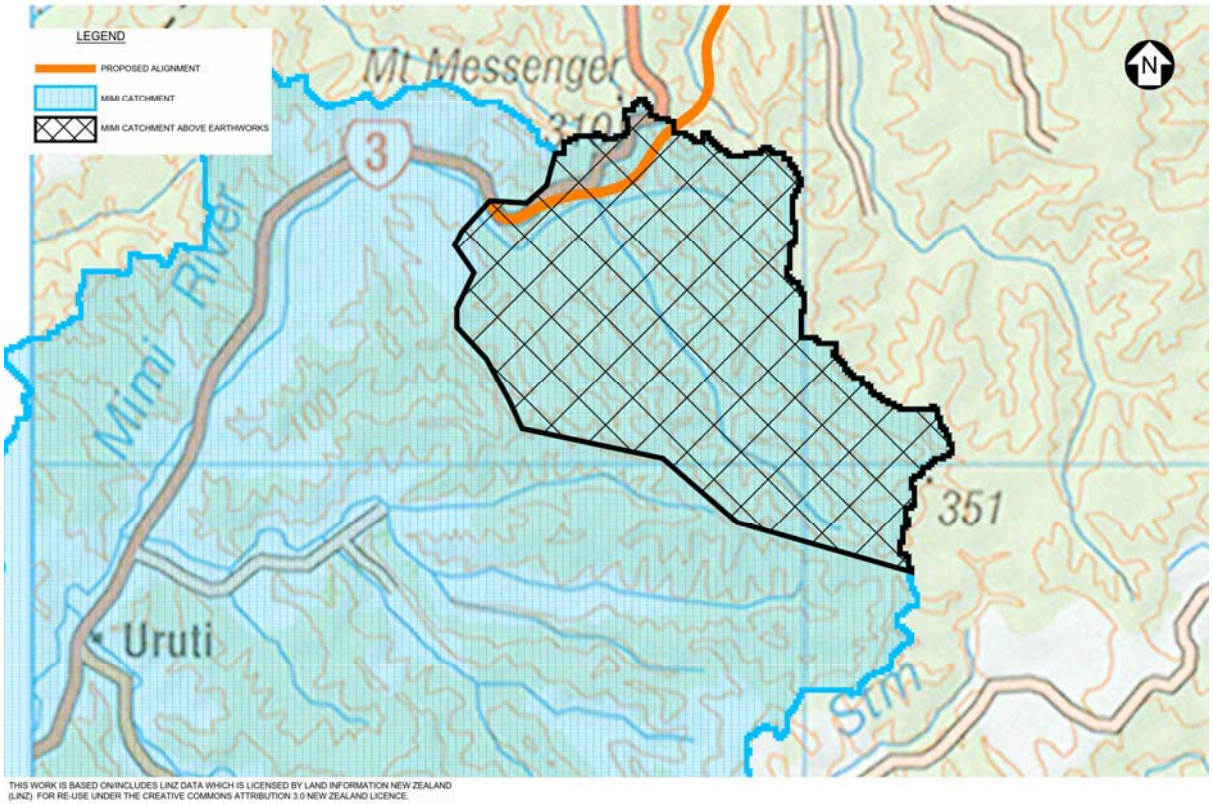


Figure 4.3 – Project Alignment and Catchment Areas immediately above Project. Top: Tongaporutu catchment. Bottom: Mimi catchment.

4.2.2 Topography

The topography of the Project area is illustrated on the Drawings provided in Appendix B of this CWAR. These drawings show the steep slopes (typically greater than 20%), which comprise a large portion of the Project alignment.

Where the Project alignment follows the valley floor, slopes are typically less than 10%.

The transition between the valley floor and the steeper areas can be quite "abrupt", however generally the Project alignment is located within the lower slopes above the valley floor, to avoid both the steeper locations and also to avoid the wet valley floor environment.

It is essential that the erosion and sediment measures and practices implemented during construction recognise the natural, ecological and habitat values of the Project area and manage the discharge of sediment to avoid or mitigate adverse effects.

4.3 Water quality

Overall water quality of the catchments located within or surrounding the Project area has been characterised based on existing knowledge of the location and also site visits to the Project alignment. Streams within the area are characterised by soft sediments where significant scour (bank and bed) has been observed. The streams have been subject to significant feral pig damage, and cattle access to the streams within the valley floor has caused further streambank slumping and high sediment loads.

Water quality observed during site visits of 19 July 2017, 28 August 2017 and 23 November 2017 to the Project site, during periods of fine weather has visual clarity of greater than 100mm (refer Plate 5-1 below). Deposited sediment is observed at the banks and base of the Mangapepeke Stream, and also in the Kahikatea Wetland.

While a specific comprehensive baseline monitoring programme is yet to be completed, it is assessed as highly likely that during periods of rainfall, water quality will decline. This is likely due to increased suspended sediment loads from natural and stock induced erosion.

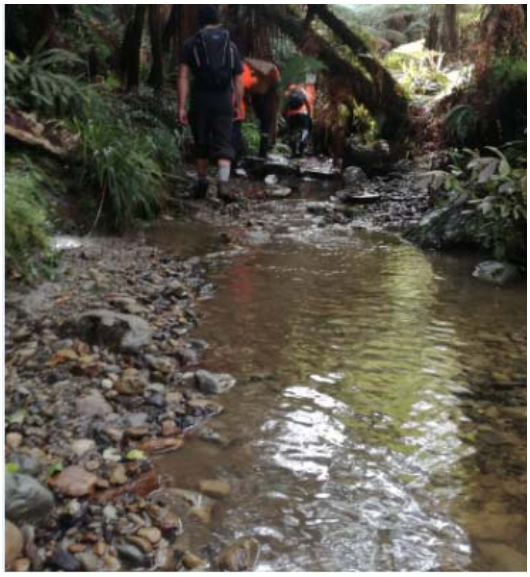
	
Photo 1: Mangapepeke Stream observed 19 July 2017	Photo 2: Tributary to the Kahikatea wetland observed 28 August 2017

Plate 4.1 – Site Photographs

4.3.1 Mangapepeke Catchment

The Mangapepeke Stream drains north-west to the Tongaporutu River. The Tongaporutu River subsequently discharges to the downstream coastal environment.

The Mangapepeke catchment is predominantly covered in indigenous forest. The valley through which the stream meanders is dominated by pasture and grazed wetland. Wetland vegetation is present at the valley floor where the ground is poorly drained. A detailed description of the Mangapepeke stream is set out in Section 4.1.1 of the Aquatic Ecology Assessment Report.

Fish species have been captured in the lower reaches and steeper sites as described in the Aquatic Ecology Assessment Report.

Aquatic macroinvertebrate communities and Stream Ecological Valuation (SEV) of the main stem of Mangapepeke Stream and representative tributaries indicate fair to good water quality in the lower reaches, improving to 'good' and 'excellent' water quality further upstream. The Aquatic Ecology Assessment Report also notes that some tributaries have been recently excavated and straightened (e.g at the lower end of the valley) which has considerably reduced the habitat values.

4.3.2 Mimi Catchment

The Mimi River flows south-west, discharging to the coast between Waiiti and Urenui. The catchment is predominantly covered in indigenous forest but the valley through which the main stream meanders is predominated by pasture and grazed wetland. A detailed

description of the Mimi River is set out in Section 4.1.2 of the Aquatic Ecology Assessment Report.

There is a kahikatea, pukatea swamp forest downstream, which has a recognised high ecological value. Fish species have been caught in the lower reaches and steeper sites, of which many are classified as "At Risk – Declining".

Aquatic macroinvertebrate communities and SEV scores indicate high to very high water quality/ condition along the main stem of Mimi River and forested headwater streams. The small tributaries flowing through the pasture are heavily modified and impacted by stock and are of 'poor' ecological condition.

4.4 Overall sensitivity of the receiving environment

With respect to the freshwater environment, higher value locations identified within the Project area include the kahikatea swamp forest in the Mimi catchment, and all associated headwaters of the Mangapepeke and Mimi Streams outside of the project footprint and currently not impacted by stock.

Given these higher values in some identified locations, the potential for effects on existing freshwater ecology during construction is a key consideration of the construction water management approach particularly in regard to discharge location and quality. Short term construction effects are discussed further in Section 5.2 of the Aquatic Ecology Assessment Report.

With respect to the marine environment, it has been identified that there are significant coastal values downstream of the Project site, including:

- Parininihi Marine Reserve – Pariokariwa Reef sponge garden;
- Fisheries – snapper spawning, trevally, tarakihi and others;
- Maui's dolphin;
- Soft sediment benthic fauna; and
- Seabirds.

The degree to which these values may be adversely affected is dependent upon how much, and how far, suspended sediment would travel from the Project earthworks. It is noted that the Project is a significant distance from the coastal marine area (9.2 km stream distance from the Tongaporutu River mouth and 21.5 km stream distance from the Mimi Stream mouth). Additionally, the large size of the wider catchments demonstrates the very small footprint of the Project within the context of the overall marine environment, as illustrated in Table 4.1below.

The construction water management approach within this CWAR recognises that all practices employed to minimise effects on freshwater values will also minimise any potential effects from the Project (while considered unlikely) on the marine environment.

Table 4.1 – Project Earthwork Catchment Areas

Catchment	Project Earthworks (ha)[1]	Catchment Area at Coast (ha)	Project % of Catchment Area
Tongaporutu Catchment	24.6	21,237	0.12%
Mimi Catchment	11.4	13,235	0.09%

Note 1: Earthwork areas include the alignment footprint and provision for establishing works such as access tracks, yards and fill disposal sites.

5 Sediment risk assessment

5.1 Risk assessment

The Project is linear in nature and therefore likely to involve concurrent works occurring in several areas within construction management regions and zones. These earthworks areas will be subject to deliberate timing of works and ongoing stabilisation as works progress to minimise the potential for erosion.

Construction related environmental risk for projects of this nature are typically the exposure of bare land from earthworks to rainfall (particularly within steep topography), and works within or adjacent to watercourses.

To assist with understanding the nature and magnitude of this risk, the existing topography has been assessed, from which a range of slope classifications have been identified within the Project footprint. As detailed in Section 4 of this CWAR, there are steep slopes associated with a large portion of the Project alignment with slopes typically greater than 20%. Where the Project alignment follows the valley floor these slopes are however typically less than 10%.

All areas will be subject to a high level of detailed erosion and sediment control planning design and ongoing monitoring programme as described in Section 8 of this CWAR. The monitoring programme will have particular focus on ensuring all controls are working as intended and are achieving the required outcomes.

It also recognised that wetter periods (e.g. May to August) may pose a higher risk for sediment discharges. Construction activity within this period will need to reflect this higher risk. This will be achieved through the SCWMP process, whereby works during wetter periods will require additional management procedures which shall be described in the relevant SCWMP document.

Sediment yield risk is assessed for the proposed earthworks within the Project area, in the context of both event probability and associated consequence. The area of Project earthworks is considered small at less than 40 ha overall (including an indicative footprint for associated construction works) in the context of the overall catchment area.

The earthworks will also be undertaken in various stages in a lineal fashion. The risk from the earthworks themselves can be reduced by progressively stabilising as works proceed and by reducing slope length as much as practically possible through the provision of contour drains across cut slopes while earthworks are occurring.

A 14 day maximum period of leaving exposed areas with no works is assessed as a critical element, and will in itself, encourage progressive stabilisation. In addition, the implementation of a comprehensive monitoring programme (as per Section 8 of this CWAR) will allow for the reduction in risk through progressive stabilisation.

The greatest area of potential sediment generation and yield for this Project relates to:

- Works within and adjacent to watercourses and wetlands, such as proposed fills, culvert placement, stream diversions and bridge works; and
- Cut and fill operations on steep slope areas.

It is recognised that these areas comprise a large part of Project works. Within these areas, both erosion and sediment controls will be installed to minimise, capture and treat sediment laden runoff that may enter the receiving environments. Chemical treatment within SRPs and DEBs will allow for improved treatment efficiencies of these devices and is another critical element of reducing potential risk of sediment yields. Additionally, the duration and timing of works will be minimised as far as practical to minimise disturbed soils exposed to heavy rainfall as discussed in Section 5.2 below. It is recommended that as part of the SCWMP process, the exposure of works to heavy rainfall are assessed and specific actions to manage this risk are identified and implemented.

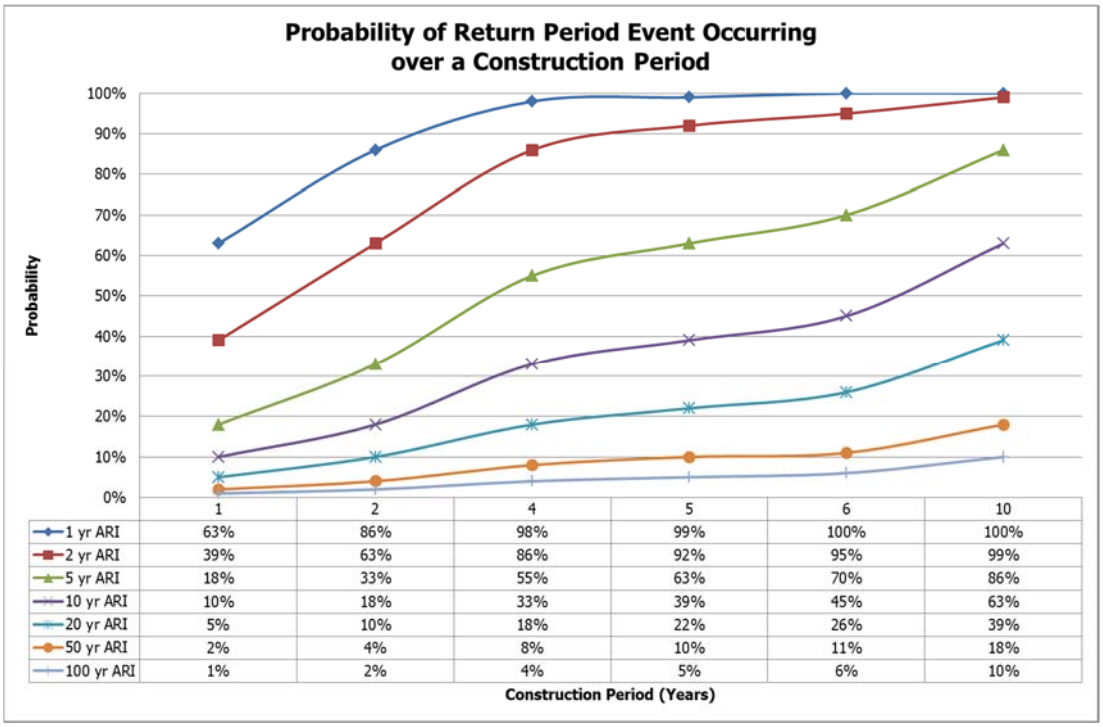
It is considered that there is minimal value in completing Universal Soil Loss Equation (USLE) calculations for the Project to further explore the risk profile. The slope maps (as within Appendix B of this CWAR) illustrate clearly the areas of higher slope class, which also represent the higher risk locations. All of these areas require significant attention to detail, implementation and maintenance of all erosion and sediment control measures to reduce the risk profile during construction.

5.2 Rainfall probability

Rainfall is recognised as the key driver of sediment yield. Whilst extreme rainfall events with high return periods occur relatively infrequently, when a construction project extends over several years the probability of a high return period event occurring over the construction period increases.

For example, the probability of a 100-year Annual Recurrence Interval (ARI) rainfall event occurring in any given year is 1%. However, the probability of its occurrence increases by 1% per year (i.e. for a 5-year construction programme the probability of a 100-year rainfall event occurring is 5%).

Figure 5.1 shows the probability of a rain event being equalled or exceeded in a range of construction periods from one to ten years. Rainfall probabilities are based on NIWA HIRDS V3 data for the Project site.



	1	2	4	5	6	10
1 yr ARI	63%	86%	98%	99%	100%	100%
2 yr ARI	39%	63%	86%	92%	95%	99%
5 yr ARI	18%	33%	55%	63%	70%	86%
10 yr ARI	10%	18%	33%	39%	45%	63%
20 yr ARI	5%	10%	18%	22%	26%	39%
50 yr ARI	2%	4%	8%	10%	11%	18%
100 yr ARI	1%	2%	4%	5%	6%	10%

Figure 5.1 – Rainfall probability graph

It can be seen that during a 4 year construction period (as proposed for the Project), there is a 98% probability of a 1 year ARI rainfall event occurring and a 55% probability of a 5 year ARI rainfall event occurring. For the 20 year, 50 year and 100 year ARI rainfall events the probability of occurrence are 18%, 8% and 4% respectively.

Given the probabilities for the anticipated Project duration, rainfall up to the 5 year ARI rainfall event is considered to present the highest risk to Project works.

The rainfall analysis also demonstrated that should the construction period extend beyond the 4 year proposed construction programme, then the probability of a higher return period rainfall event occurring also increases.

It is important to note that while no winter works exclusion period is considered necessary, bulk earthworks may not occur over a full calendar year, typically due to soil compaction constraints, and will naturally peak during the traditionally drier summer periods where heavy rainfall is anticipated less likely to occur (based on the limited local records described in Section 4.1).

5.3 Discussion on potential sediment yields

This section discusses the potential sediment yields from the Project earthworks and places this in the context of the catchment and current state. Visual assessments indicate that the catchment areas are currently subject to significant "natural" sediment yields in the absence of the Project.

The sediment yield additional to that which naturally occurrs will be proportional to the area of bulk earthworks. As such, the sediment yield resulting from the Project are considered to have only a small increase overall on a catchment or sub catchment basis, as:

- Project earthworks comprise a very small percentage (less than 0.12%) of the wider catchment area (Table 4.1 above); and
- Project earthworks comprise a small percentage (less than 7.4%) of catchment area immediately above the earthworks (Table 5.1 below).

Table 5.1 - Project Earthwork Catchment Areas

Catchment	Project Earthworks (ha)[1]	Catchment Area above Earthworks (ha)	Project % of Upstream Catchment Area
Tongaporutu Catchment	24.6	332.4	7.4%
Mimi Catchment	11.4	978.4	1.2%

Note 1: Earthworks include the alignment footprint and provision for establishing works such as access tracks, yards and fill disposal sites

When assessing potential sediment yields themselves, there is a direct relationship between sediment yield and soil types and slope classification for the Project. For the purpose of assessing effects of sediment through a sediment yield comparative assessment, Project soil types (with a high clay content) and slopes are considered similar for this Project to the recently consented (and now subject to construction) Puhoi to Warkworth motorway project (P2WK).

As part of the assessment of sediment effects for P2WK, sediment yield calculations were undertaken with these distinguished between flat country and hill country locations. Through the P2WK assessment process, flat country was assessed as yielding 22.9 tonnes/ha/year with hill country yielding 49.1 tonnes/ha/year[3]. Assuming similar erosion and sediment control provisions between P2WK and this Project, it is assessed that sediment yields per ha for the Project will be similar, or within a margin to allow a preliminary assessment, to 49.1 tonnes/ha/year[4]. For the purposes of remaining conservative, the higher hill country location sediment yield was utilised.

Table 5.2 below extrapolates the P2WK sediment yield data for the Project and presents indicative annual sediment yields.

[3] *Puhoi to Warkworth CWAR Section 7.6*

[4] *Puhoi to Warkworth CWAR Section 7.6*

Table 5.2 – Extrapolated Annual Sediment Yield

Catchment	Project Earthworks (ha)	Potential Sediment Yield from Project Earthworks (tonnes/year). (excludes potential natural yield)
Tongaporutu Catchment	24.6	1207
Mimi Catchment	11.4	560
Total	**36.0**	**1767**

It is important that these yields are not considered in absolute terms and are instead utilised in a comparative manner to provide an indication of the potential quantum of sediment that may result.

To allow comparison of Project yields to baseline or existing sediment yields, a baseline sediment yield from the existing catchment is estimated. For the P2WK project, background sediment yields were calculated from monitoring and modelling to equate to 7.9 tonnes per ha per year[5]. This yield is applied to the wider Project catchments to estimate the potential Project annual sediment yields on a catchment wide basis, as set out in Table 5.3 below.

Table 5.3 – Comparative Sediment Yield – Full Catchment

Catchment	Project Earthworks (ha)	Potential Sediment Yield from Earthworks (tonnes/year)	Potential Background Sediment Yield from Full Catchment (tonnes/year)	Potential % increase in Sediment Yields from Project
Tongaporutu Catchment	24.6	1207	167,770[6]	0.7
Mimi Catchment	11.4	560	104,550[7]	0.5

[5] *Puhoi to Warkworth CWAR Sections 3.2.1 and 7.3.2*

[6] 21237 ha multiplied by 7.9 tonnes per ha

[7] 13235 ha multiplied by 7.9 tonnes per ha

Table 5.4 below applies the baseline yield estimate of 7.9 tonnes per ha per year to the catchment immediately above extent of works and provides a comparison of Project annual sediment yields on the sub-catchment basis.

Table 5.4 - Comparative Sediment Yield – Sub-catchment

Catchment	Project Earthworks (ha)	Potential Sediment Yield from Earthworks (tonnes/year)	Potential Background Sediment Yield from Catchment above Works Extent (tonnes/year)	Potential % increase in Sediment Yields from Project
Mangapepeke Catchment	24.6	1207	2,625	46
Mimi Catchment	11.4	560	7,729	7.2

On a wider catchment basis for both catchments, the Project is likely to result in an insignificant increase in potential sediment yields to the marine environment, equating to less than 1% on an annual basis. On a sub-catchment basis, this equates to potentially less than 8% annual increase for the Mimi catchment, and potentially 46% annual increase for the Mangapepeke catchment. Works in the Mangapepeke catchment are small in the context of the wider catchment, and involves works directly within headwater stream systems. Any effects associated with works in this catchment will be in the immediate vicinity of the works location and particular care is required to ensure effective erosion and sediment control measures are implemented and maintained, with a robust monitoring programme as outlined within Section 8 of this CWAR.

In addition it is assessed that sediment that discharges from sediment retention devices in the Mangapepeke catchment will be of a fine particle size and will likely remain in suspension for long periods of time with minimal settlement within the immediate environment. The potential effects of such discharges from the Project on the downstream receiving environment (i.e. short term effects) are discussed the Aquatic and Marine Ecology Assessment Reports.

6 Overview of Construction Water Management

The focus of construction water management for this Project is erosion and sediment control, and the associated principles and practices as set out in Sections 7.1 – 7.5 below. The management of non-sediment contaminants related to construction activities is also addressed in Section 6.6.

6.1 Erosion and sedimentation process

Erosion occurs when the surface of the land is worn away (eroded) by the action of water, wind, ice or geological processes. Through the erosion process, soil particles are dislodged, generally by rainfall and surface water flow. As rain falls, water droplets concentrate and form small flows. As this flow moves down a slope, the combined energy of the rain droplets and the concentration of flows has the potential to dislodge soil particles from the surface of the land.

Sedimentation occurs when these soil particles are deposited. The amount of sediment generated depends on the erodibility of the soil, the energy created by the intensity of the rain event, the site conditions (for example the slope and the slope length) and the area of bare earth or unstabilised ground open to rainfall.

The following terms represent the key aspects of erosion and sediment control:

- **Sediment generation** – this highlights the generation potential of the area in question and is based on slope, slope length, soils, rainfall and erosion control factors.
- **Sediment delivery** – this relates to the amount of eroded material that is not retained onsite in depressions and within the site's natural contours prior to it entering any sediment treatment devices.
- **Sediment yield** – the amount of sediment that leaves the site and enters the receiving environment.

Erosion control is based on the practical prevention of sediment generation in the first instance. If erosion control measures and practices are effective then sediment generation will be minimised and the primary reliance on the sediment control measures is reduced.

Sediment control refers to management of the sediment after it has been generated. It is inevitable that some sediment will be generated through land disturbance activities even with industry best practice erosion control measures in place. Sediment control measures are designed to capture this sediment to minimise any resultant sediment-laden discharges to waterways.

Rather than primarily relying on sediment control measures, reducing erosion will have the direct effect of reducing sediment generation and therefore less sediment laden runoff will need to be intercepted, treated and discharged from the sediment control measures.

In addition to erosion and sediment control structural practices, which include physical measures such as sediment retention ponds, the Project will use a series of non-structural practices that will focus on various site management practices, such as staging and sequencing of construction works, and providing an appropriate level of resourcing for environmental management and monitoring.

With the above in mind, the erosion and sediment control measures for the Project are designed to minimise the extent of soil erosion and manage any resultant sediment yield. Erosion control will be the highest priority in the design of Project erosion and sediment control measures as it prevents sediment generation in the first instance. This is particularly important when considering the steep existing slopes associated with the Project.

Non-structural measures will also be crucial in avoiding significant environmental effects. Examples of structural and non-structural measures include:

- Structural
  - Erosion and sediment control specific device installation;
  - Baffles within all SRPs;
  - SRP decant pulleys; and
  - Chemical treatment devices.
- Non-Structural
  - Training and staff education;
  - Construction methodologies and sequencing;
  - Monitoring including pre, during and post rain inspections;
  - Implementation of a monitoring programme which allows continuous improvement in response to monitoring outcomes as required; and
  - Selection of all discharge locations (and the timing) to the receiving environment to ensure sensitive areas and times are avoided as much as practicable.
  - Implementing of a monitoring programme which allows continuous improvement in response to monitoring outcomes when required; and
  - Selection of all discharge locations (and the timing) to the receiving environment to minimise potential effects on sensitive environments (where practical)

6.2 Best practice implementation

In preparing this CWAR the authors have adopted the Transport Agency Guideline (outlined in Section 3.2) to represent industry best practice erosion and sediment control to achieve the necessary environmental outcomes for this Project. In some circumstances, however, there will be specific practical reasons for not implementing controls in strict accordance with the Transport Agency Guideline. In particular, with the slope categories on the Project there are constraints with respect to installing devices to full design standards and volume criteria. These are discussed further within Section 6 and 7 of this CWAR and will be detailed within the individual SCWMPs. This represents an industry best practice approach.

As outlined in Section 4 of this CWAR, the Project's receiving environment includes a range of freshwater, terrestrial and amenity values, which are detailed within the Aquatic Ecology Assessment Report. It is essential that the erosion and sediment measures and practices implemented during construction of the Project recognise these values and manage the discharge of sediment accordingly to avoid or mitigate adverse effects.

It is our experience that the Transport Agency has demonstrated a proven track record with respect to erosion and sediment control associated with large infrastructure projects. Many of its previous projects have demonstrated the effectiveness of the Transport Agency's management approach. This is typically based on an overarching erosion and sediment control framework coupled with SCWMPs, or equivalent, (focused on the management of specific sites and activities) throughout the Project construction phase and enables specific areas of high ecological value to be recognised and managed. This track record has been previously illustrated through projects such as the Northern Gateway, Hobsonville, Waterview Tunnel, Tauranga Eastern Link and Puhoi to Warkworth projects.

The development of the erosion and sediment control measures for the Project is based on utilisation of industry best practice, and applying a management approach which continually adapts and improves as the Project progresses. This is detailed within Section 8 of this CWAR. Importantly, the principles outlined in Section 6.3 of this CWAR will form key considerations throughout the full construction period.

6.3 Construction water management principles

The key objectives and principles for construction water management are set out within the CWAR and are repeated below:

6.3.1 Overall Objective

All construction works will be undertaken in accordance with the best methods and practice available at the time of construction to:

- Minimise the volume and area of the proposed earthworks required for the Project through the Project design matching expected soil types and geology while meeting the road geometry requirements;
- Minimise the potential for sediment generation and sediment yield while maximising the effectiveness of erosion and sediment control measures associated with earthworks; and
- Take all reasonable steps to avoid or minimise potential adverse effects on freshwater and marine water environments within or beyond the Project works boundary, with particular regard to reducing opportunities for sediment generation and discharge of non-sediment contaminants.

6.3.2 Key Principles for all Construction Works

1. Construction water management measures will, where practicable, be undertaken and implemented with a hierarchy and priority order as follows:

- Erosion control will be provided for in all circumstances by minimising sediment generation through a range of structural (physical measures) and non-structural (methodologies and construction sequencing) erosion control measures.
- Sediment control will be implemented for all sediment laden discharges with SRPs considered the most viable and effective sediment control solution for main construction works. SRPs will be rationalised within the Project area to ensure they are fully utilised, centralised and effective and do not create unnecessary earthworks in themselves.

2. Construction water management measures will be outlined in the Project final CWMP. All erosion and sediment controls will, where practicable, meet the minimum criteria of the Transport Agency Guidelines and will incorporate innovative ideas and procedures to match the local challenges and opportunities.

3. The development of SCWMPs, in accordance with the direction and principles of the CWMP, will allow for future innovation, flexibility and practicality of approach to erosion and sediment control and shall allow the ability to adapt appropriately to changing conditions.

4. Progressive and rapid stabilisation, both temporary and permanent, of disturbed areas using mulch, aggregate and geotextiles will be on-going during the construction phase. Temporary stabilisation will apply particularly with respect to stockpiles, ground improvement locations where topsoil is removed, concentrated flow paths and batter establishment. Permeant stabilisation will be carried out in accordance with the Landscape and Environment Design Framework, and is likely to comprise establishing of vegetation (e.g. topsoil and planting), placing of mulch and exposing of rock.

   Stabilisation will need to be appropriate to the soil surface geology with the intent of achieving an 80% vegetative cover or non-erodible surface over the entire exposed area of earthworked areas. Stabilisation is designed for both erosion control and dust minimisation and will be progressively implemented, including temporary stabilisation of those areas of earthworks not actively worked for more than a 14-day period.

5. All SRPs and decanting earth bunds (DEBs), if utilised, will be fitted with floating decants with a mechanism to control (or cease) outflow during dewatering pumping activities to these structures if required. This mechanism could take the form of a manual decant pulley system or plug. Pumping will be such that pump volumes will only be to the same level as that able to be fully captured within the retention structure and discharged out the designed decant structure.

6. Stream works will be undertaken in a manner that recognises the higher risk of this activity, from a sediment generation and discharge perspective, and the sensitivity of the receiving environments. Where practical, works with active stream channels, and any associated works with streams will be undertaken in a “dry” environment. This will be based upon diversion of flows around the area of works or undertaking construction “off-line”. Consideration will also be given to downstream water users (if any), peak fish spawning and fish migration periods (if relevant), during which time instream works will be carefully managed.

7. A monitoring and management approach which allows continuous improvement in response to monitoring outcomes will be utilised for the construction activity through:

    a A risk assessment within the SCWMPs which will act as a tool to help identify construction risk, identify any specific risk management approaches and advise the construction planning and approach to construction water management; and

    b Proactive water quality monitoring, both qualitative and quantitative, will occur as part of the Project implementation as a way of assessing the effectiveness of the treatment and allowing for improvements/modifications as the Project works continue. Qualitative monitoring will include visual surveys of the downstream environment. Quantitative monitoring will include sampling and testing of erosion and sediment device discharges for turbidity, clarity and/or total suspended solids to assess against baseline water quality parameters.

6.4 Erosion and sediment control plan development

As the Project works include earthworks which have the potential to result in sedimentation effects on streams, the key focus during construction works remains on erosion and sediment control. However, this CWAR also considers management of other construction related activities, which are likely to have potential effects on water (e.g. concrete use).

6.4.1 Construction Water Management Plan

Prior to construction, a CWMP will be developed to provide the overall approach and guidance for construction water management during construction of the Project. The position of the CWMP in the framework is shown in Figure 6.1 below.

The CWMP will be a live document that will be reviewed and updated, if necessary, during the course of the Project to reflect material changes associated with construction techniques, communication, mitigation or the natural environment. The CWMP will primarily be based upon the erosion and sediment control principles detailed within this CWAR and will reconfirm the methodologies and general construction sequence to be followed. The benefits of allowing this management plan approach to be established by the Project team prior to construction is to allow for contractor innovation and flexibility. The CWMP will form the guidance for all SCWMPs prepared for the Project.

6.4.2 Specific Construction Water Management Plans (SCWMPs)

For each area of work, prior to construction activity, detailed location and/or activity specific management plans (SCWMPs) will be required. The position of the SCWMPs in the framework is shown in Figure 6.1 below. The SCWMPs will be prepared in accordance with the general principles of this CWAR and the CWMP. The SCWMPs will enable the various parties to have further input into the specific construction water measures and methodologies to be implemented. This will allow for enhanced outcomes and the opportunity for implementing innovative practices, particularly in sensitive locations. The SCWMPs also allow for the learning from the Project's monitoring programme (Section 8 of this CWAR) to be applied for continuous improvement in response to monitoring outcomes as required.

In general, SCWMPs should consider a number of factors including:

- The specific construction activity to be undertaken;
- The soil types to be encountered;
- Area and volume of earthworks and stream works at specific locations, and identification of the downstream receiving environment;
- Locations of all earthworks and stream works;
- Methods for managing construction water effects for specific activities;
- Duration of the earthworks and stream works;
- Time of the year that the stream works are to be undertaken, and where applicable, the measures to be implemented to respond to any heightened weather risks at that time;
- Stabilisation methods and timing to reduce the open area at key locations to assist with a reduction in sediment generation;
- Chemical treatment (flocculation) at sediment retention ponds and decanting earth bunds;
- Construction water related monitoring programme, including the procedures for adapting the controls to appropriately respond to the monitoring findings; and
- Associated exposure risk for higher risk activity. Exposure risk is determined by assessing nature of works, timing of works and rainfall probabilities or weather forecast (where available).

SCWMPs will be submitted for certification prior to the commencement of works to which they apply. The SCWMPs will provide the detailed design, specific erosion and sediment control measure location, staging and sequencing of works for that location and consider the best practicable option for managing construction water effects.

The SCWMPs will take into account the environmental and ecological values of the specific work areas and determine the most effective and appropriate form of erosion and sediment control devices and management practices for the discrete location or activity.

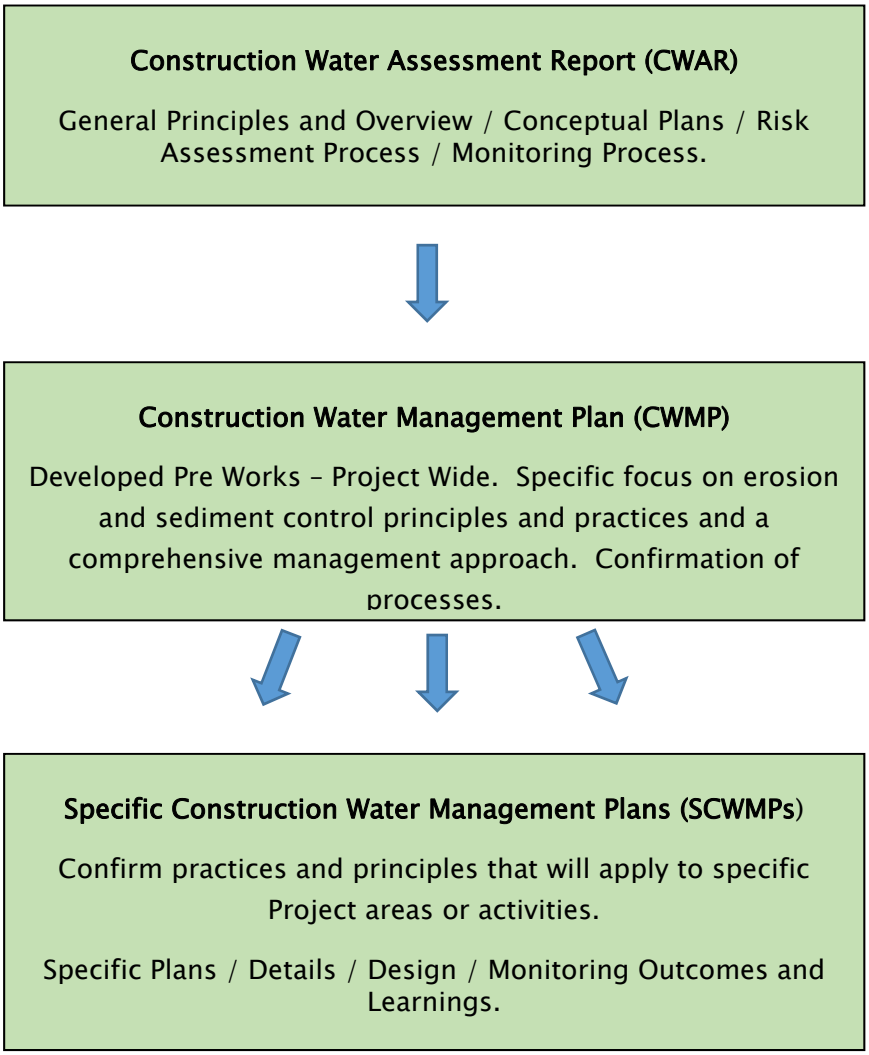


Figure 6.1 – CWAR, CWMP and SCWMP Framework

The CWMP and SCWMPs development process above relies on having an experienced and involved team to ensure all relevant aspects of the Project are taken into consideration as part of planning and decision making. This will ensure adequate resources, commitment and expertise are provided to erosion and sediment controls from start to finish of the Project (design through to disestablishment).

6.5 Management of construction activities

As part of the erosion and sediment control assessment detailed in this CWAR, conceptual erosion and sediment control plans have been developed for the whole of the Project alignment. The Mt Messenger Alliance erosion and sediment control team, in conjunction with the wider environmental team of experts, determined that preparation of the conceptual plans is appropriate and assists with assessment of the environmental effects of any sediment yield entering the receiving freshwater and marine environments for the Project as a whole.

The Project route has been visited and the practicality of the proposed erosion and sediment control measures assessed with the conceptual erosion and sediment control plans. While these erosion and sediment control plans are conceptual but provide sufficient information and confidence to illustrate that the sediment generation and yields arising from the construction works can be managed effectively.

The erosion and sediment control details have been developed with reference to the conceptual construction staging developed for the Project and are based on a 3-year construction period.

The details of methodologies and practices required to manage construction-related runoff from specific construction activities required for the Project are outlined within the CWMP in addition to specific details of measures to be implemented for each of the construction zones.

6.6 Non-sediment contaminants

Non-sediment contaminants generally consist of site and materials management measures that may directly or indirectly discharge into the receiving environment from site activity.

Potential non-sediment contaminants used in construction activity on the Project are listed in Table 6.1 below with Table 6.2 also providing the management approach for these contaminants:

Table 6.1 - Potential non-sediment contaminants

Product / work activity	Potential contaminants	Indicator	Non-visible potential contaminants
Adhesives	• Adhesives • Glues • Resins • Epoxy • PVC Cement	Oily sheen or discoloration from some products	• Phenols • Formaldehydes • Asbestos • Benzene and • Naphthalene
Asphalt Paving	Hot and Cold Mix Asphalt	Oil Sheen	Oil, petroleum distillates, Poly aromatic hydrocarbons
Cleaning Products	Cleaners, ammonia, lye, caustic sodas, bleaching agents, chromate salts	Discolouration	Acidity / alkalinity
Concrete	Cement	Discolouration	Alkalinity (High pH)
Flocculants	Specific to Flocculant used but can include pH and aluminium	Clarity	• Aluminium toxicity • pH
Sanitary Waste	Portable Toilets, disturbance of sewer lines	Discolouration, sanitary waste	Bacteria, Biological Oxygen Demand, Pathogens
Vehicle and Equipment Use	Equipment operation, maintenance, washing, refuelling	Oil sheen, sediment	Total Petroleum, hydrocarbons, coolants, benzene and derivatives

Table 6.2 - Potential non-sediment contaminants - management approach

Product / work activity	Potential contaminant management
Adhesives	• Store materials in an area that is not subject to rainfall contact • Use adhesives carefully and clean up any spilled material • Properly dispose of containers in designated disposal areas once empty
Asphalt paving	• Water runoff should discharge to a treatment system designed to capture hydrocarbons
Cleaning products	• Store materials in an area that is not subject to rainfall contact • Use adhesives carefully and clean up any spilled material • Properly dispose of containers in designated disposal areas once empty
Concrete	• Concrete truck chutes, pumps and internals should only be washed out into the formed areas awaiting installation of concrete • Unused concrete remaining in trucks shall be returned to the concrete supplier yard • Hand tools should only be washed out into the formed areas awaiting installation of concrete
Flocculants	Refer to Section 7.3.6 of this CWAR • Ensure the use of flocculants follows an approved flocculant management plan and industry best practice • Regularly measure pH of the discharge from sediment retention devices
Sanitary waste	• Avoid knocking over portable toilets • Place portable toilets away from site vehicle movement areas • Service portable toilets regularly • Empty portable toilets before they are moved • Avoid breaking sanitary sewer lines that may exist onsite
Vehicle and equipment use	• Fuel storage tanks shall be bunded to store a minimum of 100% of the tank's capacity. No bulk fuel storage is expected for the Project and mobile refuelling will occur. • Procedures and practices shall be put in place to minimise or eliminate the discharge of lubricants, coolants or hydraulic fluids to the receiving environment • Have spill prevention and control measures and procedures in place

7 Erosion and sediment control

7.1 Risk management approach to erosion and sediment control

A proactive risk approach will be adopted for the construction phase, whereby prior to construction works commencing, the site conditions and associated resources will be assessed for the exposure risk and relevant SCWMP updated as required.

While for all locations, the full suite of both structural and non-structural erosion and sediment controls will apply, for higher risk sites, there will be a more significant monitoring presence, ensuring progressive stabilisation continues to occur and working within more defined fine weather windows.

This risk management approach will be outlined in the final CWMP and specific procedures will detailed within the relevant SCWMPs.

7.2 Key erosion control measures

In general, the erosion control measures to be applied to the Project are as follows.

7.2.1 Construction staging and sequencing

The extent of exposed soil and length of time that an area is exposed has a direct influence on the sediment yield leaving a particular area of the site. Bulk earthworks and construction activities will be staged and sequenced as part of the normal construction programme while also having the effect of limiting the area of exposed soil required to complete an element of the work. Open earthworks areas will be progressively stabilised to reduce the potential for erosion to occur.

Where areas within the Project are not worked for more than a 14 day period they will be stabilised. This will ensure areas are not left exposed for long periods of time and will therefore reduce the potential for sediment generation (and subsequent yields). In addition, the anticipated 4 year construction duration will also assist with reducing the duration of exposed areas of open earthworks.

Stabilisation may include use of mulch and/or other woody organic matter, geotextile and the use of hard fill material.

Progressive and rapid stabilisation of disturbed areas will be ongoing throughout the Project. Mulch will include hay/straw and wood bark (generated where possible onsite through the removal and mulching of existing vegetation) as appropriate. Stabilisation will particularly apply at stockpile areas and batter establishment to reduce both erosion and dust generation.

Mulch will typically be applied to slopes of less than 15 degrees where erodible soils are exposed, however combined with an approved tackifier greater slope angles can be subject to mulching. Hydromulch products can also be utilised in this circumstance. For these higher slope angles alternatives may need to be considered, and could include pinned

geotextile, coir matting and/or spray polymer products. Spray polymer products shall only be specified where the product is demonstrated locally to achieve a stabilised surface.

Where rock is exposed in a slope (i.e rock cuttings) and is demonstrated to be geotechnically stable and not subject to surface erosion, it shall be considered stabilised.

The development of SCWMPs will outline the specific stabilisation requirements and timing.

Stabilisation will be undertaken with three key purposes:

- To achieve the progressive stabilisation as specified within consent conditions for the Project;
- To reduce the open area of higher risk locations to assist with a reduction in sediment generation; and
- To address any potential effects in response to the monitoring programme.

To ensure stabilisation is effective in reducing erosion, either temporary or permanent, it is assessed that stabilisation trials should occur early in the construction process with visual monitoring of the outcomes. The trials should assess:

- A range of stabilisation options, including the effectiveness of mulch, hydromulch and/or polymer (if required) on site soils; and
- Geotechnical and surface stability of exposed rock.

The purpose of the trial is to provide a process where options and alternatives can be assessed. The results of the trials will also establish a direct link between earthworks activity, stabilisation techniques and their direct effect on sediment yields.

7.2.2 Clean and dirty water diversions (CWD and DWD)

CWDs provide for the controlled conveyance of upslope runoff and will be used on the Project to minimise water from the catchment above the works from entering the Project construction area. DWDs will be utilised to safely allow the transfer of construction flows from disturbed areas to the sediment control devices.

Transport Agency Guidelines suggest the minimum capacity required for clean and dirty water diversion is to confine the peak rate of runoff from the 100 year design storm so that runoff can be conveyed appropriately around the earthworks footprint or to sediment control measures. CWDs and DWDs which convey the 20 year ARI rain event with a 300mm freeboard are considered consistent with the Transport Agency Guidelines as this sizing criteria equates to the same capacity as a 100 year ARI rain event (without freeboard).

For the conceptual erosion and sediment control plans developed as part of this CWAR sizing and ability to install such CWD and DWD within the Project has been assessed. There are some Project locations where clean water diversions will not be able to be installed to full capacity (generally on slopes greater than 30%). In such circumstances, alternatives will be assessed including:

- Reducing the capacity of the CWD to an achievable design and reducing duration and or risk of the specific Project works;

- Allowing the movement of clean water through the earthworks site in a controlled manner; and/or
- Increasing the volume of the downstream sediment control device to allow for the extra upstream catchment, within the constraints of the device design catchment and capacity.

Sizing calculations of all clean and dirty water diversion channels will be confirmed within the SCWMPs.

CWD and DWD will be stabilised dependent upon soil type and slope for the specific area of works. If, through the development of SCWMPs, velocities are calculated that exceed erosion thresholds, channel stabilisation shall be specified.

A maintenance programme will be implemented during Project construction activity to identify and remove any resulting sediment deposited within the DWDs channels, as set out in Section 7 of the CWMP. During construction, excavated pits or sumps, to a capacity of $2m^3$ per sump, will also be positioned along the channels at 50m intervals to drop out and retain the maximum amount of sediment on site.

7.2.3 Contour drains

Contour drains are temporary ridges or excavated channels or a combination of the two that are constructed to convey water across a slope at a minimum gradient. They reduce the slope length and therefore the velocity of water flowing down disturbed slopes and hence reduce the erosive power of construction runoff. These will be utilised within the Project on an as-required basis.

7.2.4 Rock check dams

Check dams are small dams made of rock (imported to the Project as required) or other non-erodible material constructed across a swale or channel to act as a control structure. The purpose of a check dam is to reduce the velocity of flow within the channel and prevent scour of the channel surface. Check dams also allow for some settlement of suspended solids within the channel.

7.2.5 Pipe drop structure / flume

Temporary pipe drop structures or flumes are constructed to convey construction runoff down a slope face without causing erosion of the slope and will be used to ensure no scour of these batters occurs. These structures will be implemented as per the CWMP.

7.2.6 Stabilised construction entrance way

Stabilised construction entrance ways are stabilised pads of aggregate placed on a filter base located where construction traffic will exit or enter a construction site. They help to prevent site entry and exit points from becoming a source of sediment and also help to reduce dust generation and disturbance along public roads.

No vehicles will be allowed to leave the Project site unless tyres are clean, meaning vehicles will not contribute to sediment deposition on public road surfaces.

7.3 Key sediment control measures

Sediment control on the Project will involve the interception and treatment of sediment-laden runoff from the various construction areas along the Project and will be carried out in accordance with the Transport Agency Guidelines. Sediment control will be established through the use of recognised sediment control measures and site management practices.

Sediment control devices will be located outside the 20 year ARI flood level where this can be practically achieved. It is recognised there will be some limited ability within the lower valley floor locations to achieve this. In that case where sediment control devices are required within the 20 year ARI flood level, they will be designed to capture the minimum catchment area, have measures to protect the outer bund from scour and structural failure and will be subject to an increased inspection and maintenance regime.

With the consideration of associated discharge levels (relative levels from discharge point to SRP invert levels) the establishment of a higher bund around the extent of the device will be established to minimise overtopping from flood waters.

The general sediment control measures and principles to be used on the Project are outlined in Section 7.3.1- 7.3.6 below.

7.3.1 Sediment retention pond (SRP)

Treatment of construction runoff will be carried out to ensure sediment is removed to the maximum extent possible from the construction runoff before being discharged to the receiving environment.

SRPs will be designed in accordance with the volume criterion applied in relation to catchment size as per the Transport Agency Guideline. In summary:

- Chemical treatment will be applied to all SRPs.
- Where possible, SRPs volumes will be sized to the Transport Agency Guideline sizing criteria. If site constraints limit pond capacities, it shall be specifically assessed in the SCWMPs.
- Forebays of SRPs will be designed to capture the majority of the sediment entering the SRP. The forebay volume shall equal to 10% of the design pond volume.
- Where possible, the length to width ratio of sediment retention ponds shall be between 3:1 and 5:1. Baffles maybe installed if this recommended pond shape cannot practically be achieved due to space constraint.
- The outlet structure will include a floating T-bar decanting device. The decanting rate shall be achieved through drilling holes in rows along the decant arm. The recommended decant design set out in the Transport Agency Guideline will be followed. The lowest decant will be positioned to ensure dead storage of 30% of the total volume.
- A stabilised emergency spillway will be capable of accommodating the 100-year ARI event without eroding. The freeboard on the pond embankments will allow the 100-year ARI event to pass through the SRP without breaching the SRP embankments.

The CWMP provides typical details which illustrate the design of a SRP. It is noted that as part of the SRP construction, it will be necessary to do the following:

- Remove any unsuitable material and confirm ground conditions as appropriate for SRP establishment. This could be achieved by reviewing geotechnical investigation data near the proposed SRP site (where available). In addition, the SRP will be constructed of suitable and stable material and confirmed to be geotechnically robust in the context of the surrounding environment;
- Confirm specific design for the SRP if located within the flood plain location; and
- For all SRPs, prior to SRP establishment a Super Silt Fence or Silt Fence will be installed downstream of the associated works area to capture any associated sediment that may result.

The construction detail and sizing will be provided in the relevant SCWMPs.

7.3.2 Decanting earth bund (DEB)

DEBs are impoundment areas where ponding of sediment-laden runoff can occur and which provide time for suspended solids to settle out before the runoff is discharged to the receiving environment.

DEBs will be designed as per the Transport Agency Guidelines. In summary:

- Chemical treatment will be applied to all DEBs.
- DEBs will be constructed with ideal length to width ratio of 3:1, but not exceeding 5:1.
- All DEBs will be fitted with floating decants.
- All spillways from the DEBs will be constructed to safely pass the 100-year ARI rain event without eroding.

The CWMP provides a typical detail which illustrates the design of a DEB.

7.3.3 Pumping activities

Where possible, if water is impounded and requires discharge, this will occur via gravity flow rather than pumping. All pumping activities will discharge to the nearest SRP or DEB for treatment, prior to entering the receiving environment. However, if impounded water is of an acceptable discharge quality (minimum clarity of 100mm) within the impoundment, then pumping may occur direct to a stream environment. Care will need to occur to ensure the point of discharge does not become a point of scour.

SRPs and DEBs which are to receive pumping discharges will have a mechanism to control outflow (such as a manual decant pulley system or manual plug) in place prior to pumping activities. They device will only discharge once an acceptable standard of discharge quality can be achieved (100mm of visual clarity minimum). The pumping rates and volumes to SRPs and DEBs will be designed for the total pump volume to be fully captured within the retention structure.

7.3.4 Container impoundment systems (CIS)

In locations where SRPs or DEBs cannot be located due to slope, space constraints or stability issues, container impoundment systems will be used. These will be retrofitted with a decant system and subject to chemical flocculation. Such systems will be used primarily in the early stages of earthworks for small catchment areas prior to the ability to develop SRP structures. The CWMP provides a typical detail which illustrates a CIS.

7.3.5 Super silt fence (SSF) and Silt Fences and Filter Socks

Super silt fences and silt fences are fabric fences reinforced with stakes to create a physical barrier to minimise sediment laden flows leaving the area of earthworks. This barrier acts as a detention and filter for these flows to ensure sediment yield is minimised. The design and placement of silt fences and super silt fences will be based on the relevant criteria in the Transport Agency Guidelines. SSFs will be used in those areas of work adjacent to, or in the immediate vicinity of watercourses.

To minimise the risk of the fences being undermined, the fabric will be installed with a minimum 200mm of fabric placed upslope at the base of the trench. This provides an increased level of resilience to that set out by the TRC Guidelines.

Filter socks will be used throughout the Project area and designed and implemented as per the Transport Agency Guidelines.

7.3.6 Flocculation

Flocculation is a chemical treatment method for increasing the retention of suspended solids from construction earthworks runoff in SRPs and DEBs. Flocculant is added to the construction runoff flowing into a SRP or DEB via a rainfall activated system (flocculant shed) or via manual batch dosing.

The use of flocculation chemicals is known to increase the efficiency of SRPs and DEBs and can reduce overall sediment yield.

Testing undertaken on Project soils to date demonstrates that chemically treating sediment laden water reduces turbidity at a much faster rate to untreated water. Appendix C of this CWAR provides the results of this flocculation testing undertaken. The samples generally comprise very mobile clay or very fine colloidal particles which remained in suspension. This could potentially create insufficient settling issues in a SRP. All of the samples tested were easy to treat and required low dose rates of flocculant to achieve an acceptable settled water clarity/turbidity.

Table 7.1 below summarises the ‘unassisted’ settling of the soils tested (without any addition of chemicals). This table shows that there is some natural settlement of the soil samples. However, it is considered that the natural rate and extent of settlement to be inadequate and chemical assistance is likely required to achieve satisfactory settlement.

Table 7.1 - Unassisted Settling Test Results

Time (Hours)	Sample 1 Cut CH 2150	Sample 2 CH 2350 Stream Alluvium	Sample 3 Tunnel Cut
	NTU		
0	>1000	>1000	>1000
1	>1000	>1000	>1000
2	>1000	725	796
3	>1000	494	655
6	>1000	378	430
12	>1000	215	206
24	400	175	163
32	349	157	130
48	266	132	101
72	181	111	84

Following the Unassisted Settling Tests, settlement tests were undertaken using a range of chemical flocculants that could be used on this Project.

The samples tested with chemical flocculants achieved turbidity levels of less than 20 Nephelometric Turbidity Units (NTU) within very short time periods.

The bench tests demonstrated two key elements:

- That there are chemical flocculants readily available on the market that are proven to be successful and will achieve the required flocculation of the suspended sediments from the soil types that will be encountered within the Project; and
- That the level of treatment necessary, based on the tests undertaken, illustrate that low flocculation dosage rates are required.

It is therefore considered that chemical treatment of SRPs and DEBs will be a key sediment management tool on the Project and it is proposed that all Project SRPs and DEBs require chemical treatment with a flocculant appropriate for the soil type and discharge location. The design, establishment, operation, maintenance and monitoring of chemical dosing systems will be specifically determined through the SCWMP process.

Furthermore, the proposed monitoring programme discussed in Section 8 of this CWAR, will include quantitative monitoring to ensure that appropriate water quality is being achieved from the discharge of construction runoff and also that any residual effects of any flocculants used are minor only.

7.4 Decommissioning of devices

All erosion and sediment control measures will remain in place until such a time as the catchment contributing to that device is stabilised. Once the contributing catchment is considered stabilised the erosion and sediment control measure will be decommissioned. The decision process and procedure for this will be outlined within the SCWMPs.

8 Monitoring

It is recommended that a detailed monitoring programme be developed for the Project (referred to as a Construction Water Discharges Monitoring Programme). The focus of this monitoring programme is the management of sediment yield from the Project. It is assessed that without such a monitoring programme, the ability to successfully implement effective erosion and sediment controls that respond to the Project constraints and improve the control measures and management approach as required, will be greatly reduced.

The monitoring programme will involve ongoing site monitoring throughout the construction phase to check that construction water management measures have been installed correctly, and methodologies are being followed and are functioning effectively.

Monitoring results will be used to identify potential long term risks to freshwater and marine ecology based on pre-determined management trigger levels. These triggers are not effects triggers but will identify a potential effects point at which investigation and improvement opportunities should be considered by the construction team.

Water management measures and methodologies may be identified as requiring modification or improvement, including those causing raised levels of sedimentation based on the pre-set trigger levels.

The monitoring programme will include the assessment to determine what further measures are required to reduce sediment yield. The monitoring will also include a continual feedback loop until it has been verified that the implemented responses have been successful in minimising sediment yields from the Project. There will be an established link to any baseline monitoring undertaken including the formulation of any monitoring triggers. It is recommended that the full monitoring programme be documented within a Monitoring Programme to be confirmed and submitted prior to works commencing.

8.1 Qualitative monitoring

8.1.1 Receiving environment – On-site visual assessments

The Project team will have an important role in ensuring that visual assessments of the receiving environment are undertaken regularly throughout the works period, with particular attention paid to assessment before, during and after periods of rainfall.

In the context of visual assessment, the receiving environment is defined as the immediate receiving environment adjacent and downstream of the area of works.

Any noticeable change in water clarity following a rainfall event, and considered the result of earthworks activity, will result in a review of the erosion and sediment control measures and practices. Additional measures (such as further stabilisation, amendment of flocculation) will be implemented and changes made as necessary.

8.1.2 Weather forecasting during Project implementation

Weather forecast monitoring will form an important part of the Project implementation so that higher risk activities such as stream diversions and activities will only occur during a suitable fine weather window.

Weather forecasting is a tool that is extensively used with most land-disturbing activities and provides early warning to contractors of upcoming weather events, and prompts site preparation for the event. The project will utilise readily available forecast methodologies including metvuw.com and also metservice.com. Forecast maps should be reviewed daily and assessed for periods of wet weather as required. In addition, the actual rainfall on site will be recorded and comparative assessment of forecast and actual will allow for more accurate forecasting as the Project progresses.

8.1.3 On-site monitoring of water management devices

Monitoring of management devices (referred to as 'devices monitoring') will be required to demonstrate environmental compliance for the Project during the construction period. Environmental compliance will be achieved through appropriate installation, location, maintenance, and monitoring of these devices. It is important that within the context of monitoring, the devices are not restricted to physical structures but also include work practices and methodologies.

The purpose of the devices monitoring will be to check that all practices, control measures and devices are constructed, operated and maintained so they remain fully effective at all times.

Devices monitoring is aimed at the early detection of activities or problems that have the potential to result in an adverse environmental effect. The devices monitoring will act as the immediate site trigger. Devices monitoring can be combined with scheduled ecological monitoring for more detailed 'trigger event' monitoring.

The frequency of the devices monitoring will vary throughout the year and reflect areas of changing activity and risk within the Project area. During the construction period, the monitoring will be undertaken daily and more frequently during trigger rainfall events (refer Section 8.2.3). Trigger rainfall will be measured onsite.

8.1.4 Flocculation monitoring

A core part of flocculation management is monitoring to check that the systems are all working as anticipated and to provide information to facilitate management of the flocculation systems. Chemical flocculants are available that are successful in achieving sediment settlement of the soil types that will be encountered on the Project. It is recommended that monitoring be undertaken in the form of checking the treated detention device discharge and receiving environment pH levels at weekly intervals (where chemicals which potentially impact pH are used) and during rain events of greater than 25mm within a 24 hour period. This will be directly linked to the Construction Water Discharges Monitoring Programme and also any flocculation management plan required as part of the SCWMP process.

It is noted that some of the flocculants available have no effect on pH levels and if such chemicals are used on this Project then there will be no requirement to monitor discharge pH levels.

8.2 Quantitative monitoring

In addition to the on-site monitoring of water management devices as detailed above, quantitative monitoring will be undertaken on the Project. The objective of this monitoring programme is to provide data for an array of rainstorms of different magnitudes and intensities, as well as providing information on the actual sediment concentrations in discharges from the site during the earthworks period.

8.2.1 Sediment discharge monitoring

It is recommended that manual monitoring of outflow turbidity and/or total suspended solids associated with a selection of SRPs (to be confirmed through the SCWMPs but to represent a minimum 50% of the SRPs utilised on site) occur where practicable and within the health and safety constraints of the Project. This manual monitoring allows for comparative analysis between samples and also with any baseline data collected. In addition, monitoring of the receiving environment through manual sampling (flow, turbidity and total suspended solids), both upstream and downstream of discharges, will occur where practicable. Water quality triggers will be determined within the Construction Water Discharges Monitoring Programme to be implemented for the Project works.

Sediment discharge monitoring enables identification of periods when discharge water quality may not be satisfactory. This information will help construction staff to specifically target these periods and if necessary adjust the erosion and sediment control measures and practices onsite.

As an example, if water quality shows a particular device or activity having a consistent high sediment concentration (measured through total suspended solids or turbidity) this could indicate a problem with the device or within the catchment and enable 'fine tuning' of the management of sediment within that contributing catchment location.

8.2.2 Pre and post-earthwork monitoring of freshwater habitats

Prior to the start of earthworks water quality and habitat surveys will be undertaken in the freshwater habitats within and downstream of the Project in order to establish a robust pre earthworks baseline. These surveys should be repeated at regular intervals through the Project implementation (eg annually) and also following key construction activities. All annual surveys will be undertaken at a similar time of year to ensure comparative analysis can occur.

Freshwater surveys will occur at selected established sites. These sites, along with the monitoring detail will be confirmed within the Construction Water Discharges Monitoring Programme to be developed.

The purpose of the freshwater habitat monitoring is to identify potential changes on the freshwater environments arising from construction discharges. The results of the surveys

will inform appropriate management responses to avoid, remedy or mitigate any potential adverse effects on freshwater environments.

8.2.3 Triggered monitoring

Rainfall has a direct effect on the performance of erosion and sediment control measures. Experience suggests that high intensity rainfall of short duration can have the same, if not worse effect as continuous rainfall over a 24 hour period. To maximise the success of erosion and sediment control measures, site management and construction planning must take into account measured rainfall to instigate audits and inspections.

Rainfall events shall instigate monitoring and inspection to check the condition and continued effectiveness of the sediment control measures (referred to as trigger rainfall). As an initial trigger rainfall greater than 25mm in a 24 hour period will instigate this process, however this may be revised once rainfall on site is better understood.

Other triggers to instigate monitoring will include:

- Spillage/accident reports that cause a discharge of sediment or contaminants to the aquatic environment; and/or
- Obvious degradation of the receiving environment immediately downstream of the SRPs such as accumulation of sediment, conspicuous oil/grease, scums/foams, floatable matter, fish kills, discolouration of water or significantly increased growth of nuisance algae.

Monitoring to identify potential effects from construction related discharges will be carried out in accordance with an agreed Construction Water Discharges Monitoring Programme. It is suggested that this includes determination of sediment deposition from the Project (if any), that has occurred in the downstream freshwater environment.

Monitoring data and/or site observations which indicate poor performance or failure of treatment measures will instigate the following within a 48 hour period:

- Inspect the earthworks site, all erosion and sediment controls and associated management procedures to identify any problems or activities likely to have contributed to increased sediment discharge to the receiving environment;
- Collect further samples from device discharges as necessary; and
- Remedy any identified problems, and implement any further controls on activities that are likely to contribute to increased sediment discharge.

8.3 Monitoring response to indicators of effects

The Construction Water Discharges Monitoring Programme will identify thresholds to instigate a site investigation of potential effects on the receiving environments as a result of construction water discharge.

If monitoring results indicate these thresholds are exceeded, the following steps will be undertaken:

- In the first instance, investigate a possible (cause-effect) association with the Project;

- Should this investigation establish linkages between the adverse effect and on-site practices, then investigate alterations to the operational methods (including modifications to environmental control measures and methodologies) as a first order response; and
- Assess the effectiveness of the alterations in operational methods by conducting further monitoring to alleviate/avoid adverse effects on the environment.

Factors to be considered in the decision chain relating to the above would include the need for, and nature of, any remedial action.

The most likely cause of an effect could be incorrect installation of devices, sub-optimal performance of the measures and methodologies implemented and/or damage from heavy rainfall/storm events.

It is considered that the implementation of the measures and methodologies as detailed within the CWAR will ensure that the possibility of such an occurrence is minimised. In addition, the monitoring programme will provide a 'check and balance' and will provide the opportunity for continuous improvement as necessary throughout the construction period.

8.4 Reporting

Routine site inspections will be recorded using the weekly checklist provided in the Transport Agency Guidelines. The inspections will include qualitative monitoring of the following:

- The integrity and effectiveness of all construction related water management devices;
- Construction activities onsite upstream of the erosion and sediment control device;
- General site conditions and other land disturbing activities occurring within the catchment; and
- General status of the immediate receiving environment.

To ensure a full understanding of changes to the area of works, prior to construction commencing, photographs should be taken in the vicinity of proposed discharge outlet points and any streams in the vicinity of the works. These records will illustrate the visual state of the receiving environment at and within the vicinity of the discharge point. This photographic record will be compiled into a log book and will allow a visual comparison of before, during and at completion of the construction of the Project.

9 Assessment of construction effects

This section sets out an assessment of effects associated with the construction water management aspects of the Project. The specific assessment criteria from the relevant statutory documents outlined in Section 3 have been used to inform the matters considered in this assessment.

The assessment considers the effects of construction related discharges and in particular those associated with sediment yields from land disturbing activities, including earthworks. In addition to the assessment provided in this section, the effects of construction-related water discharges from the Project are assessed in the Aquatic and Marine Ecology Assessment Reports. Design and methodologies adopted within this CWAR are based on a best practicable option approach. While developed and tested systems will be employed during construction to achieve the necessary outcomes, these systems must be backed up by a monitoring programme linked to identification for continuous improvement, as described in the sections above.

9.1 Construction water management assessment

Key assessment criteria associated with construction water management are detailed below. The AEE further expands on these criteria within the context of the overarching legislative and statutory framework for the Project.

9.1.1 Assessment criteria

9.1.1.1 Natural, ecological and amenity values of the receiving environment

The knowledge of the baseline water quality assessed for the Project area and the site visits undertaken (outlined in Section 4 of this CWAR) demonstrate that the water quality within the Project area is poor during rain events due to naturally occurring, and stock induced high sediment yields.

The high ecological and amenity values of the Project area are noted, in particular the values of the southern Kahikatea Wetland environment.

Construction water management measures outlined in this CWAR will be implemented during construction of the Project to ensure the existing ecological, amenity and natural values of the receiving environmental are maintained. A monitoring programme will be implemented to measure the success and effectiveness, or otherwise of the treatment measures is a crucial element of successful and effective construction water management.

9.1.1.2 Allowance for reasonable mixing zones and sufficient flows

The Project is located in the headwaters of the Mangapepeke Stream and the Mimi catchment with a large area of the wider catchment areas below the extent of works. This, coupled with the significant stream distance to the coast, provides confidence that the increase in sediment yields at the coastal margin associated with construction of the Project will be insignificant.

With the risk assessment process undertaken, it is considered that any effects of construction water discharges on Project related waterbodies will be managed appropriately.

9.1.1.3 Potential for cumulative effects

The increase in sediment yields from current background sediment is low and our assessment indicates there will be no cumulative effects on the downstream receiving environment from the Project discharges during construction. The construction period is short and represents an effective and efficient process to achieve the necessary works in the shortest period possible, reducing risk throughout.

9.1.1.4 Actual or potential risks to human and animal health from the discharge

Minimal risks exist for human and/or animal health as a result of construction water related discharges. Stock currently appear to take drinking water from downstream environments, directly out of the stream systems and there may be a minor effect on this drinking water quality. However, following any sediment discharge, this water quality will quickly recover to a quality suitable for stock purposes. Other construction related contaminants have a higher risk of effect on human and animal health, however these are to be utilised based on a "no discharge" principle. For example, if cement laden water is to be discharged from the site, it will be fully treated prior to discharge such that risk is reduced to less than minor.

9.1.1.5 Degree to which the needs of other resource users may be compromised

The construction related discharges associated with the Project are assessed as having no impact on any other resource users within the general Project vicinity or wider catchment location.

9.1.1.6 Effect of the discharge on the natural state of the receiving environment

Construction water management measures will be implemented during construction to ensure that the natural state of the downstream receiving environment is not compromised by any discharges. A monitoring programme will be implemented to measure the success and effectiveness, or otherwise of the treatment measures is a crucial element of successful and effective construction water management.

9.1.1.7 Measures to avoid, remedy or mitigate the effects of contaminants to be discharged

Within the CWAR and CWMP a range of construction water and erosion and sediment control measures to be implemented during Project works have been detailed. These measures are based on industry best practice and have been illustrated as "achievable" and effective through the assessment process. Drawings to support the implementation of these measures have been included in the CWMP.

9.1.1.8 Measures to reduce the volume and toxicity of the contaminant

All construction related discharges from the Project area, including sediment, will be subject to relevant and proven measures and techniques that will have the direct effect of reducing the volume and toxicity of any such contaminant. These are detailed within the CWAR and CWMP.

9.1.1.9 Use of the best practicable option for the treatment and disposal of contaminants

Treatment measures for all construction water discharges from the Project are based on best practicable options. In addition, a monitoring programme will be implemented to measure the success and effectiveness, or otherwise of these treatment measures.

9.1.1.10 Oil and grease films

Oil and grease may be released in very small amounts due to accidental spills. Any conspicuous oil and grease films that develop would be temporary. It is considered that this risk can be managed by the SCWMPs. With this SCWMPin place, any effect will be less than minor.

9.1.1.11 Floatable or suspended material

The release of small quantities of floatable materials (in particular litter) may occur during construction. It is considered that the risk of conspicuous floatable or suspended material can be managed by the SCWMPs and with good site management practices. With this management in place any effect will be less than minor.

9.1.1.12 Water colour and clarity

The estimated increase in sediment yield during rain events may result in a change in water colour and clarity. Existing site and receiving environment conditions indicate that water clarity is currently low during rain events.

Any sediment yield from the construction areas will be of fine clays and silts and may contribute to changes in colour. Conspicuous changes in colour and clarity in the freshwater systems within or downstream of the Project area will be temporary and occur during and post storm events. If higher levels of total suspended solids result, this will coincide largely with the natural change in colour and clarity that will occur during storm events. There is estimated to be a lag of between 24 – 48 hours, when SRPs continue to discharge once streams have returned to baseflow.

Overall, it is considered that the effects on colour and clarity to be less than minor and any effects will be temporary.

9.1.1.13 Recreation

Recreational values of associated waterbodies may include swimming, fishing (whitebaiting / eeling) or food gathering activities. In the freshwater receiving environments, the greatest changes in colour and clarity can be expected during and immediately following rain events. Any temporary changes in water colour and clarity associated with the Project will have less than minor effects on any recreational values. No adverse effects on recreational values are expected at the downstream coastal marine area from the Project.

9.2 Overall effects assessment

Overall, the effects of construction related water discharges will be less than minor. Environmental control measures will be implemented as part of the Project construction. These will be implemented in accordance with SCWMPs on an as-required basis. All discharges will be treated to an industry best practice standard which will be exceeded in many circumstances and includes chemical treatment, non-structural control measures, comprehensive methodologies and stabilisation techniques.

Comprehensive monitoring will take place which will confirm the ongoing effectiveness of the water management devices (including erosion and sediment controls) on the site, allow for effects assessment against receiving environment triggers and in turn allow for ongoing assessment and improvements of control measures as necessary.

10 Recommendations and conclusions

The following key points are noted for the construction water management methodologies for the Project.

- The statutory framework and policy guidance from TRC and the Transport Agency in relation to bulk earthworks and land disturbance require the implementation of appropriate construction water management controls, including construction and maintenance of these devices, during the construction of State highway projects.
- The Project requires small areas and relatively small volumes of earthworks and this in itself provides confidence in the ability to effectively manage all discharges to an effective and acceptable level.
- A range of construction water management measures (including erosion and sediment control measures) are proposed for the Project. These will be designed, implemented and maintained in order to achieve, where practicable, the requirements of the Transport Agency Guidelines. Erosion and sediment control will be based on both structural and non-structural measures with an emphasis placed on the non-structural management techniques. A range of innovative measures will be implemented.
- The Project's construction related water management will rely on the preparation of a CWMP and SCWMPs prepared by the Project team prior to any construction activity taking place to which the Plans relate. This process will allow for contractor input flexibility and further innovation in the erosion and sediment control approach for the Project.
- A monitoring programme will be implemented during construction, which will allow for ongoing water quality and ecological assessment of the construction programme. The monitoring programme will measure the success and effectiveness, or otherwise of these treatment measures and identify improvement opportunities for construction water methodologies in response to monitoring outcomes.

Conditions of consent which respond to the measures and methodologies outlined in this CWAR are recommended. With the implementation of the measures and methods described in this report the overall effects of construction discharges on receiving waters will be less than minor.

11 References

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Appendices

Appendix A: Transport Agency Guideline Principles

Appendix B: Project Slope Classification

Appendix C: Flocculation Soil Testing