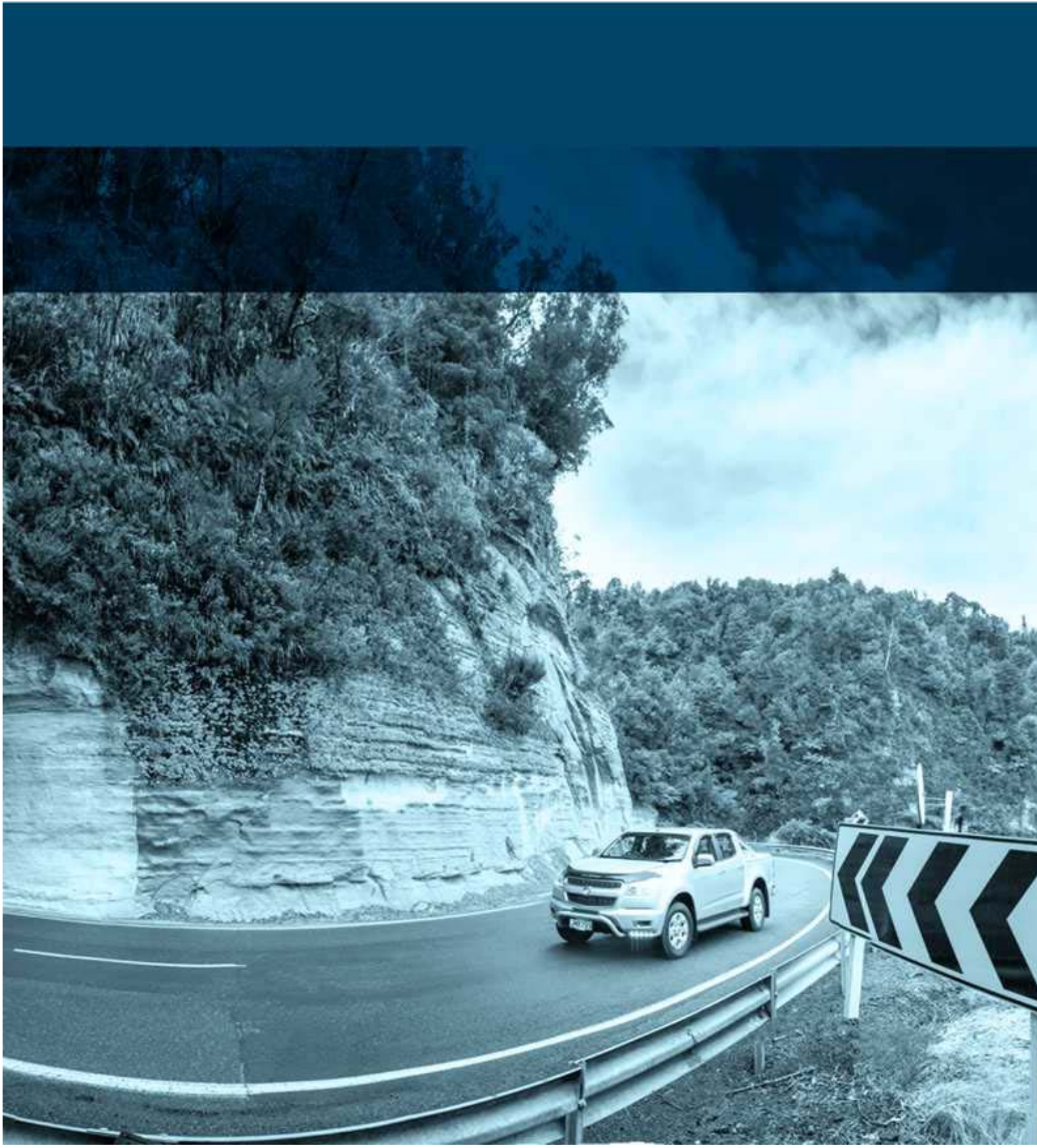


Section 4 - Project description



4 Project description

4.1 Introduction

The Project involves 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. This new section of SH3 will bypass the existing steep, narrow and winding section of highway at Mt Messenger. Specifically, the Project comprises a new section of two lane highway, approximately 6km in length, located to the east of the existing SH3 alignment.

The Project will include the following key design aspects:

- A two lane road alignment (one traffic lane in each direction) with tie-ins to the existing SH3 corridor at the north and south of the alignment;
- A tunnel (approximately 240m in length) through the ridgeline near the existing Mt Messenger rest area, with an associated tunnel control building and emergency water-supply tanks;
- A 120m long bridge over a wetland on a tributary of the Mimi River;
- Ten rock cuttings up to a depth of about 60m and along a combined distance of approximately 2.6km (including the tunnel portals);
- Thirteen earth embankments up to about 40m in height (but typically less than 5m high), along a combined distance of approximately 2.5km;
- Retaining walls and MSE embankments; and
- Stormwater treatment and attenuation facilities (including stormwater retention ponds, swales and road drainage network).

These design aspects are discussed in further detail within this section. This section of the AEE should be read in conjunction with the drawing set in Volume 2¹⁹.

A fundamental part of the overall Project is a package of mitigation and biodiversity offsets. The biodiversity offsets include pest management over a substantial area (560ha) of native forest, along with restoration planting. The details of the mitigation and biodiversity offset package are described in Technical Report 7h (Volume 3) and Section 9.8.9, and are summarised in Section 4.2.3 below.

4.2 Design Philosophy

4.2.1 Design Approach

The Project will be a new, two lane, dual carriageway over a length of 6km (including the tie-ins to the existing SH3 and improved sight lines to a curve south of the southern tie-in), located generally to the east of Mt Messenger and the existing SH3 alignment.

The design approach for the Project has been to:

- Design the Project to the relevant design standards;

¹⁹ It is noted that the Project has been developed to a consent level design stage. As the design and investigation process continues it is possible that some design details may change.

- Enhance the resilience of the State Highway network;
- Adopt a whole of life approach to Project design, operation and maintenance requirements;
- Maintain connectivity provided by existing infrastructure, including property and farm access as appropriate;
- Acknowledge the cultural significance of the area to Ngāti Tama and provide for their kaitiaki responsibilities in the design process, as described in Section 4.2.2 below (and in Section 9.7); and
- Avoid, remedy, mitigate or offset associated adverse effects on the environment. In this regard, a fundamental part of the Project has been to avoid effects where this is possible (e.g. route selection), and then to mitigation and offset any residual effect (refer Section 4.2.3 below).

The existing section of SH3 that will be bypassed by the new alignment will likely become a local road, managed by New Plymouth District Council (refer Section 4.18).

4.2.2 Ngāti Tama cultural inputs

The Transport Agency has been working closely with Ngāti Tama in developing the design for the Project, with a focus on avoiding, mitigating or offsetting effects on cultural values, landscape and ecological values. This will continue over the duration of the Project.

As outlined in Section 0 and 8.4.1 of this AEE, the wider Project area is culturally significant to Ngāti Tama. The Project presents a number of unique design opportunities to develop the cultural narrative for the Project, including developing appropriate means of cultural expression within the integrated design treatments of elements, such as the tunnel and the bridge crossing over the Mimi swamp forest. Interpretation and celebration of the cultural landscape narrative is a key design principle that will continue as part of the design process for the Project.

‘Recognising culture’ and the human relationship to the land and the environment, including continuing the partnership with Ngāti Tama through the detail design, construction and operation of the Project, will provide opportunities for Ngāti Tama to express their mana whenua and kaitiakitanga responsibilities. Section 9.7 and 9.9 outline this in more detail.

4.2.3 Mitigation and biodiversity offset package

As noted above, a key part of the Project design is a comprehensive mitigation and biodiversity offset package. This is described in detail in Technical Report 7h (refer Volume 3) and in Section 9.8.9. The mitigation and biodiversity offset package is focused on achieving a net gain in biodiversity in the medium term following the completion of construction. The package comprises:

- Intensive, multi-species pest management over an area of 560ha²⁰, with the focus being on controlling rats, possums, mustelids, feral cats, feral pigs and goats to very low densities, and fencing to exclude livestock. This management will continue in

²⁰ This area comprises a core area of 222ha and a buffer area of 340ha, giving a total area of 562ha. 560ha has been used through the application documentation as an approximation for the overall pest management area.

perpetuity (or until such time as pest management in its current form is no longer necessary to sustain the levels of biodiversity created).

- Restoration planting of 6ha of swamp forest.
- Planting of 200 seedlings of the same species for every significant tree²¹ that has to be felled.
- Riparian planting and livestock exclusion of approximately 8.9km of existing stream. Planted riparian margins of at least 10m each side of the channel will be created.
- Restoration planting of all secondary scrub areas along the footprint plus temporary construction areas such as access tracks and storage areas that retain conditions suitable for planting, being approximately 9ha in total.

In addition, the Transport Agency will rehabilitate fill areas with early successional plant species, stream diversion channels with riparian species, and enhance steep cut faces to promote natural plant regeneration where this is feasible.

Pest management and swamp forest restoration offsets have been developed in accordance with the New Zealand Government's *Guidance on Good Practice Biodiversity Offsetting in New Zealand* (August 2014), which is consistent with international guidelines for biodiversity offsetting.

The locations where the mitigation and biodiversity offset package will be implemented are shown in Technical Report 7h and on the landscape drawings in Volume 2 (Drawings MMA-DES-UDL-CO-DRG-1000 to 1010). Implementation details for the package will be contained in the Ecology and Landscape Management Plan (ELMP).

The expected outcomes are described in Technical Report 7h. In summary, a broad range of the indigenous flora and fauna present within the mitigation and offset area will benefit from the management of pest animals to permanently low densities and the establishment of new areas of swamp forest, shrubland and riparian habitat. The proposed mitigation will not only increase the area of healthy indigenous vegetation but will greatly improve the connectedness of the forested areas. The net result will be a significant increase in healthy available habitat, enhanced recruitment rates amongst a wide range of indigenous animals, improved condition of the remaining significant forest trees, especially totara and rata, and increased regeneration of many of the more palatable plant species.

Over time, further ecological benefits will accrue as a result of the offset programme. For example, the conditions created in the offset area will increase the likelihood of the survival and successful nesting of any kōkako that move east from the release sites in the western Parininihi land.

²¹ Refer to Technical report 7h in Volume 3 for details. Individual trees are shown on the landscape drawings in the drawing set (Volume 2, drawings MMA-DES-UDL-CO-DRG-1000 to 1010)

4.2.4 Landscape and Environment Design

The Landscape and Environment Design Framework (LEDF) (Technical Report 8b, Volume 3) sets out the landscape and environmental design outcomes for the Project and how these fulfil the Transport Agency's landscape and environmental design policy requirements²².

The overall design concept for the Project is for an alignment that is integrated with the landscape and delivers an outstanding scenic highway. The Project will form a new "valley-to-valley" bypass of the existing SH3 alignment.

The following principles have been developed with respect to the landscape and environmental design aspects of the Project:

- Retain key landforms and ridgelines by using a tunnel;
- Minimise stream and valley crossings;
- Develop cut faces that echo natural slope angles;
- Seek to enable natural successional re-vegetation of the roadside;
- Seek to enable landscape restoration where feasible;
- Provide an opportunity for cultural expression and recognition; and
- Deliver an enhanced driver experience and scenic amenity.

Landscape and design considerations for the Project detailed in the LEDF include:

- The road alignment;
- Earthworks (including cut and fill slopes) and MSE fills;
- The bridge and tunnel structures;
- The stormwater network;
- Highway furniture (barriers, lighting, signage); and
- Landscape treatment and planting.

Further detail on these specific design considerations in accordance with the principles outlined above is provided in the LEDF.

The LEDF also includes conceptual Landscape Plans for the Project that outline the proposed landscape and design features.

4.3 Design Standards and Guidelines

The design of the Project, including the geometric layout and operation of the route, stormwater management, structures and the tunnel have been developed based on the following guidelines and standards:

- Transport Agency design standards and guidelines;

²² The LEDF takes its direction generally from the NZTA publication: *Environmental design framework guidelines*. That guideline notes that the purpose of the [LEDF] is to aid with 'integration of large scale and/or complex road infrastructure projects into the surrounding environment.'

- The Association of Australian and New Zealand road transport and traffic authorities (AUSTROADS) standards;
- Taranaki Regional Council and New Plymouth District Council standards and guidelines;
- New Zealand Standards and relevant International Standards; and
- Utilities standards.

The relevant guidelines and standards that have been used in the development of the Project are outlined in the respective sections below.

4.3.1 Safety in Design and Whole of Life

Safety in Design and Whole of Life have been integral to the design development process. These considerations have informed the design approach to enhance the safety of the Project and reduce environmental, cultural and social effects through the design, construction, operation and maintenance phases. Consideration has been given to matters including:

- **Pavement and surfacing** – predicted traffic volumes, pavement design life and maintenance requirements;
- **Stormwater collection and treatment** – consideration of drainage design and maintenance requirements, taking into account aesthetic considerations (culverts, swales, wetlands);
- **Landscaping** – choice of plant species and maintenance requirements, pest management to assist with revegetation;
- **Structures** – consideration of material types and design of bridge, retaining wall and embankment structures;
- **Tunnel** – consideration of construction methodology, durability, maintenance access and interval, energy saving lighting and minimisation of installed equipment; and
- **Traffic services** – barriers, traffic signage, line marking.

4.4 Road Design

The design of the alignment is shown in detail on the drawing set in Volume 2, which should be read in conjunction with this section.

4.4.1 Carriageway Design

The carriageway will generally incorporate the following (as outlined in Figure 4.1):

- 3.5m wide traffic lanes in each direction;
- 1.5m wide paved shoulders widened as required for sighting distance around curves;
- 1.2m wide shoulders through the tunnel (with a 600mm wide central flush median);
- On the bridge the outside shoulder width is 1.5m, and the inside shoulder width is 3.0m to allow for sighting distance around the curve; and
- Wire rope safety barriers on the outside of each shoulder along the full alignment length (apart from through the bridge and tunnel where concrete barriers will be used) Consideration is also being given to using steel ‘W’ section barriers in some areas.

A verge/swale will extend the length of the alignment, varying in width between around 3 – 4.7m. The verge width varies according to the local geometry of the road, whether the road is located in areas of cut or fill, the stormwater drainage network and roadside barrier locations (refer to Section 4.16.1 for further detail on the stormwater network for the Project).

The Project does not provide climbing lanes or slow vehicle bays. However, 1.5m shoulders will be provided along the alignment (with slightly narrower shoulders in the tunnel). Together with the improved forward visibility and 100km/h operating speed, this will improve the opportunities for safer informal passing across the full length of the Project alignment. The Project designation contains sufficient space to enable future provision of climbing lanes or slow vehicle bays if considered appropriate at some point in the future.

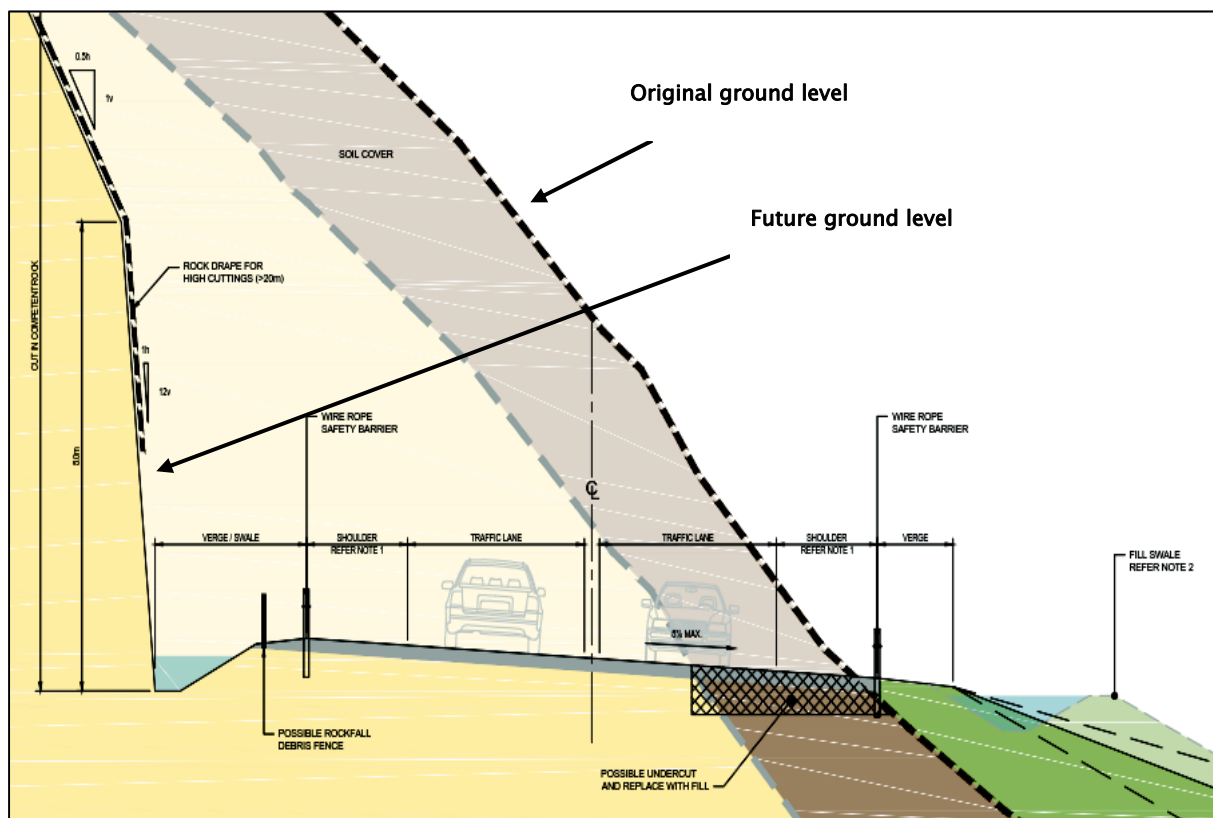


Figure 4.1 – Typical cross section of the carriageway at a cutting

4.4.2 Carriageway Design Standards

The Project has been designed in accordance with the standards outlined in Table 4.1.

Table 4.1 – Project Design Standards

Parameter	Value
Posted Speed	100km/h
Safe Operating Speed	100km/h ¹
Minimum Stopping Sight Distance ³	151m ²
Minimum Curve Radii	460m
Maximum Gradient	<ul style="list-style-type: none"> 7.5% southbound (distance of 925m with a grade greater than 6%); and 7.0% northbound (distance of 675m with a grade greater than 6%).

¹ A detailed risk assessment will be undertaken as part of the design development to determine whether safety considerations warrant a lower posted speed through the tunnel

² To be corrected for grades exceeding +/-3% (-15m/+25m) with an object height of 0.4m. Minimum SSD determined using 90km/h vehicle speed or alternatively a deceleration rate of 0.46g at 100km/h, due to the excessive widening required for higher speeds in highly sensitive environment.

4.4.3 Operating Speed and Travel Time

The alignment has been designed to a 100km/h operating speed. For traffic travelling at this speed, the alignment will result in an average travel time of 3:36 minutes through the bypass, a travel time saving of approximately 4:05 minutes (half the existing travel time of 8 minutes and 45 seconds for both north-bound and south-bound traffic)²³. This will be a significant travel time saving in the context of this length of road, coupled with a safer and more user friendly route than the existing road.

It is unlikely that all vehicles will travel at the posted operating speed of 100km/h through the alignment. In particular, trucks (and cars following trucks) will likely travel at a slower speed through the steeper sections of the route.

The average operating speed across the Mt Messenger section of SH3 has been assessed as outlined in Table 4.2, taking into account the grades of the new alignment, along with typical vehicle composition.

²³ Obtained from google traffic application API platform, where travel times across the Project area were observed for a week-long period.

Table 4.2 – Operating Speeds (Average of all time periods and vehicles)

Operating Speeds (km/h)	Existing SH3 (7.4km length)	Mt Messenger Bypass (6km length)
Mt Messenger	56km/h	77.6km/h

In relation to heavy vehicle travel times along the new alignment in comparison to the existing Mt Messenger section of SH3, analysis indicates these will be as follows:

- Heavy Commercial Vehicle (HCV) travel time of 13:08 minutes over the existing 7.4km length of SH3 in the existing scenario;
- HCV travel time of 6:28 minutes over the 6km length of the new alignment (a saving of 6:40 minutes).

As such, the reduced length of the new alignment, coupled with the reduced grades across the route (compared to the existing section of SH3) will reduce the average travel times for Heavy Vehicles by approximately half of the existing travel times.

4.5 Alignment Description by Regions

The alignment of the Project is 6km in length, extending from the existing SH3 corridor approximately 1km south of Mangaonga Road through to a point near the property located at 2454 Mokau Road, Urenui where it will ‘tie’ back into SH3.

The Project area is divided into two regions:

- Northern Region from the northern tie into the southern tunnel portal (Chainage 0–3625); and
- Southern Region from the southern tunnel portal to the southern curve where sight lines are improved (Chainage 3625–5950).

4.5.1 Northern Region

From the northern tie in point (south of Mangaonga Road) the alignment heads south, sitting to the east of the existing SH3. The maximum distance between the new alignment and existing SH3 is approximately 1km.

The alignment traverses the lower Mangapepeke valley via the valley floor and then the eastern valley slopes to the upper Managapepeke catchment (Chainage 2850), over a distance of approximately 2km. This will require a series of cuts and fill embankments generally less than 5m high, with one embankment approximately 16m high.

In the upper Mangapepeke valley, from Chainage 2850 through to Chainage 3300 (a length of 450m), the alignment will be located on a large fill embankment, approximately 40m high, at the northern approach to the new Mt Messenger Tunnel. The gradient of the road gradually increases to around 7.5% through this section of the alignment, reaching a maximum elevation of 114m at the new tunnel.

4.5.2 New Mt Messenger Tunnel

The Mt Messenger Tunnel will extend over a length of approximately 240m through the main ridgeline between the Mangapepeke valley and the Mimi valley, to the east of Mt Messenger (Chainage 3400 – 3653). Further detail on the design of the tunnel is presented in Section 4.15.

4.5.3 Southern Region

The alignment will continue south, staying to the east of the existing SH3 (maximum 250m west of SH3), located on a large fill embankment approximately 16m in height through to Chainage 3925. A large cut slope, approximately 49m in height is located between Chainage 3900 – 4150.

From Chainage 4150, the alignment is bridged across the Mimi swamp forest, located on a tributary of the Mimi River. The bridge will be approximately 120m in length and 20m above the valley (refer to Section 4.14 for further detail on the bridge structure). The gradient of the alignment through this section will be around 7%.

The alignment then continues south through a series of smaller cuts and fills to the east of SH3 and into the Mimi valley. The gradient decreases to less than 1% as the alignment traverses the floor of the Mimi valley, before connecting with the existing SH3 route. The southern tie in to SH3 will be located at Chainage 5150.

To the south of the southern tie-in, the verge adjacent to the northbound lane of the existing SH3 corridor will be widened to improve sight lines.

The new alignment is shown on Figure 4.2.

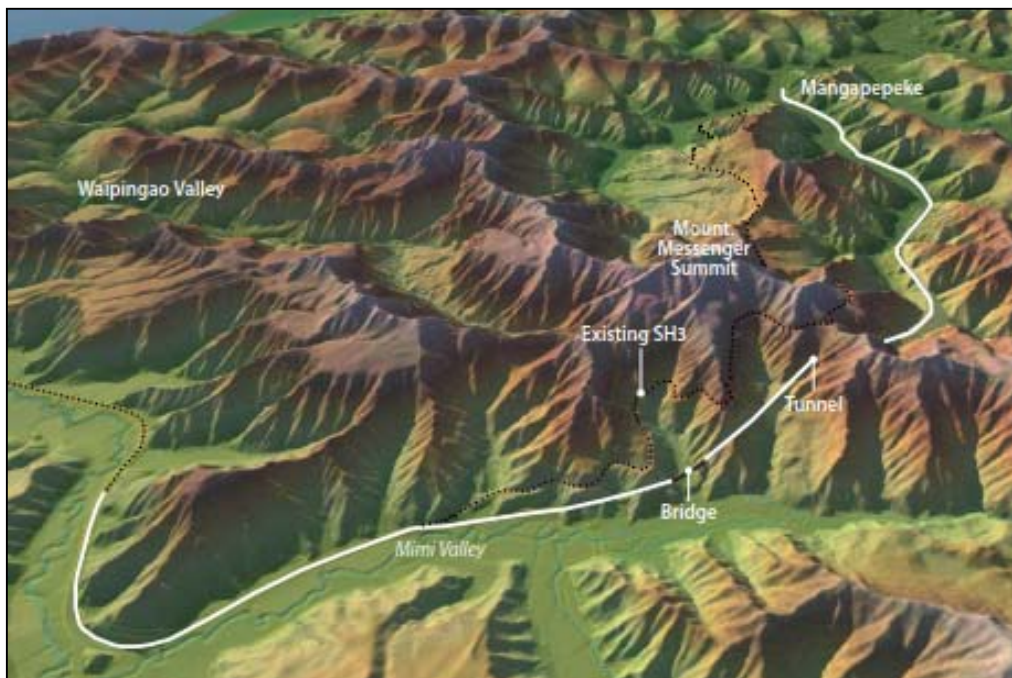


Figure 4.2 – Elevation model looking from the south to the north along the alignment

4.6 SH3 Tie-In Points

The alignment includes connections to the existing SH3 at the northern and southern extents of the Project. The tie-ins will be in the form of local T intersections arrangements designed in accordance with Austroads Part 4A.

There are no existing local roads impacted by the Project alignment.

4.7 Property Access

There are four private properties that are currently accessed from the existing section of SH3 which is being bypassed, including Ngāti Tama's Parininihi land block. Access to these properties connecting with SH3 is intended to be retained through the use of the bypassed section of SH3.

One property in the south (2528 Mokau Road) will require a new dedicated accessway to be formed directly onto the new SH3 alignment.

Property access arrangements will be finalised once the Project designation is confirmed and through the SH3 revocation process (refer Section 4.18).

4.8 Pedestrian and Cycling Provision

While cyclists and pedestrians are not commonly seen along this section of SH3, the carriageway width will be suitable for pedestrians and cyclists, with 1.5m shoulders provided next to the traffic lanes along the alignment, and 1.2m in the tunnel.

The increased width of the paved shoulders along the length of the alignment will provide cyclists with greater space and improved cycling conditions in comparison to the existing SH3 carriageway, which has shoulders of 0.5–1.5m wide.

4.9 Walking Track Access

The Project will provide safer conditions for users of the Mt Messenger and Kiwi Road walking tracks. A new parking area will be established for this purpose at a suitable location adjacent to the existing SH3 carriageway, which will have very low traffic volumes when the new bypass is operational.

4.10 Maintenance Bays

The design approach has focused on the provision of maintenance bays in those locations along the alignment where maintenance will be essential to the safe and efficient functioning of the state highway corridor, such as the inlets to culverts.

The road drainage network minimises the use of catchpit inlets, replacing these with open drainage channels where possible. Wetlands have been consolidated and located at the extents of the Project and at Chainage 1650 – 1700 where access is practical. Open drainage channels will be in natural rock or, where on earthworks, are proposed to be vegetated or rip-rap lined minimising the need for maintenance.

Consequently, provision of maintenance bays will be considered for the following features:

- Major culverts;
- Bridge abutments;

- Tunnel portals and tunnel control building; and
- Wetlands.

The maintenance bays will be protected by safety barriers.

4.11 Traffic Services

Traffic services along the alignment will include features such as:

- Permanent road signs;
- Road lighting at intersections and the tunnel;
- Road markings; and
- Barrier protection.

These features are detailed in Table 4.3.

Traffic services will be designed in accordance with the relevant standards. These services may be renewed and upgraded from time to time as required for the safe and efficient operation of the Project.

Table 4.3 – Traffic Services

Traffic Service	Design Details
Road Signage and Marking	<ul style="list-style-type: none"> • Signage and marking along the route will comply with the Transport Agency’s Traffic Control Devices manual (TCD) including the Manual of Traffic Signs and Markings (MOTSAM) • Pavement markings, delineation, edge and lane lines will be installed according to the Transport Agency’s Standard Specifications (M/7, P/22, T/8, M/20 and M24)
Lighting	<ul style="list-style-type: none"> • Lighting will be provided at the two local road intersections and in the tunnel, which will be lit at all times to provide for the safe and efficient operation. Lighting within the tunnel will be adjusted to respond to the ambient conditions (refer Section 4.15.2 for further detail). • Lighting will be designed to meet AS/NZS 1158 ‘Category V’ requirements. LED road lighting luminaires are proposed where lighting is required and will meet the requirements of AS/NZS 1158.5:2014 Lighting for roads and public spaces – Part 5: Tunnels and underpasses
Barriers	<ul style="list-style-type: none"> • Wire rope safety barriers (TL-4 (NCHRP 350) or TL-3 (MASH)) will be installed on the outside of the road shoulders adjacent to the verge. Posts and wires will be unpainted galvanised finish. • Rigid concrete barriers will be used along the bridge and through the tunnel, with semi-rigid barriers on the approaches to the bridge and tunnel. (refer to Figure 4.3). • Semi-rigid barriers and a ‘curved rail treatment’ will be installed at intersections along the alignment and private property access points, as required. • All barrier protection installed along the alignment will be designed in accordance with the following standards (or any equivalent documents replacing those standards which apply at the time of construction):

Traffic Service	Design Details
	<ul style="list-style-type: none"> ○ NZTA M23 – Specification for Road Safety Barrier Systems; ○ AS/NZS 3845.1:2015 – AS/NZS 3845 :1999 – Road Safety Barrier Systems; and ○ Austroads Guide to Road Design Part 6: Roadside Design, Safety and Barriers.

Typical barrier details are shown in Figure 4.3.

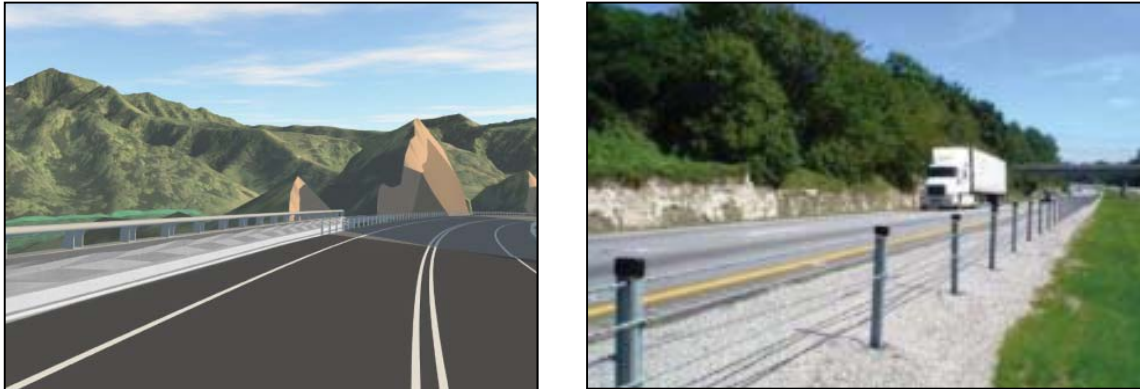


Figure 4.3 – Typical Barrier details (rigid and wire rope)

4.12 Pavements and Surfacing

All pavements will be designed in accordance with Austroads (2009) Pavement Design Guide and the Transit New Zealand supplement (2010/11).

The general pavement and surfacing philosophy is as follows:

- **Pavement** – will comprise granular sub-base and base layers along the alignment, including in the tunnel. Cement modification of the base-course will be considered as part of the design process to improve the performance of the pavement.
- **Surfacing** – chip seal is proposed along the alignment with the exception of the bridge deck and tunnel where it is proposed Stone Mastic Asphalt (SMA) surfacing will be used.

The final pavement and surfacing design will take into account the following:

- Subgrade strength and differential settlement issues;
- Requirements for sub-surface drainage;
- Rehabilitation of existing pavements;
- Construction methodology and impact on existing traffic;
- Use of locally available materials and recycling of existing pavement materials where possible and
- Surfacing considerations, such as high vehicle stress areas.

4.13 Cut Slopes and Fill Embankments

The alignment will extend through steep terrain bisecting a number of valleys and ridges. Accordingly, a number of cut slopes approximately 25m to 60m in height and embankments up to 27m in height will be required along the alignment. The Geotechnical Appraisal

Report (Technical Report 14, Volume 3) describes the typical cut slope and embankment designs.

4.13.1 Cut Slopes

Based on the geological structure of the Project area, cut slopes will be designed on the basis of the following geometry:

- From road verge level, an 8m high cut in rock formed at 12V:1H (approximately 85°).
- From the top of the 12V:1H cut, 1V:0.5H (approximately 63°).
- On the upslope of the cutting (where the existing ground level typically continues to rise above the top of the cut), the 1V:0.5H profile will continue to the ground surface, with soil nails where required to stabilise the surficial materials.
- On the downslope side of the cutting (where the existing ground surface typically drops away from the top of the cut), the batter slope of the upper 5m of the cut has been reduced to 1V:2H (approximately 26°) to avoid the need for soil nailing.

A typical cutting profile is shown in Figure 4.4.

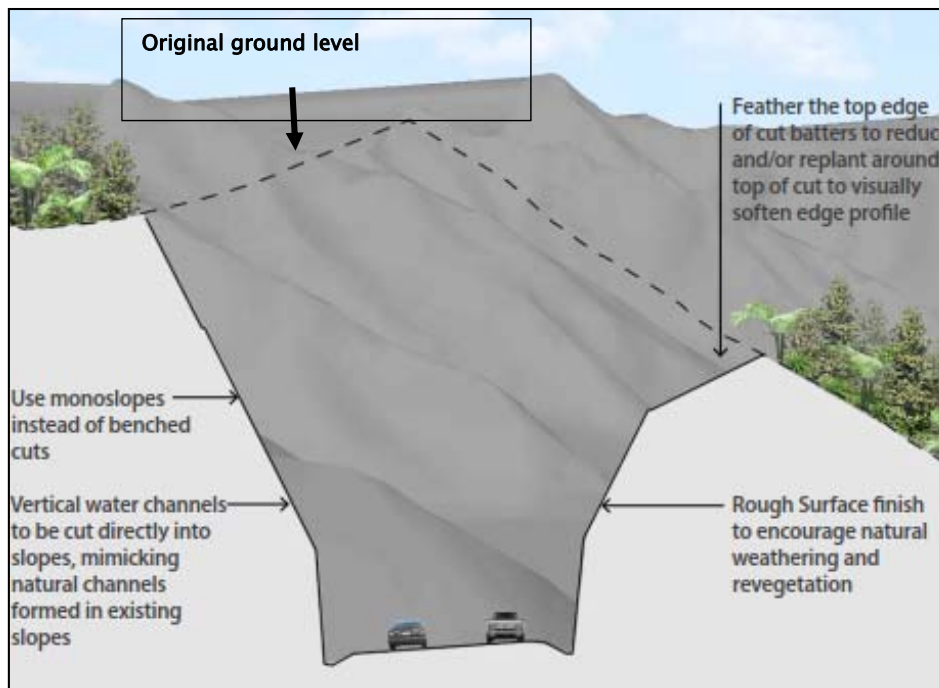


Figure 4.4 – Typical Cut Slope Profile

Cut slopes will either be actively re-vegetated or allowed to revegetate naturally over time, as shown in Figure 4.5 and outlined in the LEDF.

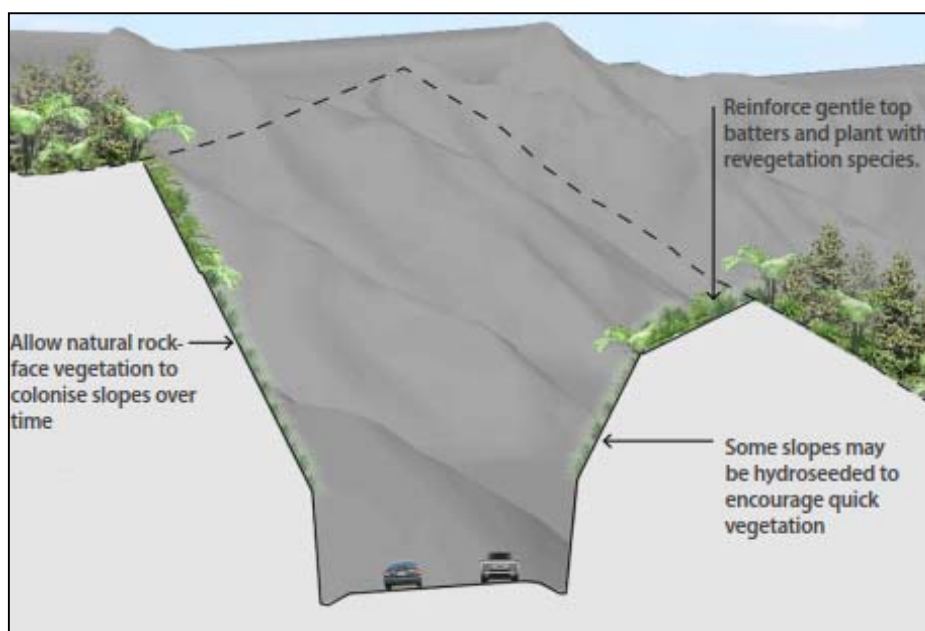


Figure 4.5 – Typical revegetated cut slope

A summary of the main cut slopes required along the alignment is provided in Table 4.4.

Table 4.4 – Main Cut Slopes along the Alignment

Chainage (m)		Approx. Length (m)	Approx. Depth (m)
From	To		
260	490	230	48
1100	1280	180	52
1560	1670	110	26
1950	2280	330	38
2450	2850	400	57
3300	3400	100	32
3630	3680	50	29
3900	4140	240	49
4270	4370	100	31
4430	4550	120	30

NOTES:

¹ Currently assumed 5m depth of soil / completely weathered rock which requires soil nailing for stability when cut at 1 in 0.5 on upslope side of cutting. For downslope side, upper 5m of cut is formed at 1V:2H.

² Cutting extends to tunnel portal.

4.13.2 Embankments

Embankment slopes will vary from 14° for typical embankments, through to 45° for steeper embankments.

Detailed and site specific embankment designs will be carried out during detailed design, in accordance with standard geotechnical guidelines and accepted New Zealand design criteria

and standards. It is noted that embankment designs are currently preliminary and profiles may change as the design development progresses, or in response to changes in construction methods or the need for additional placement of fill.

Based on the ground conditions of the Project area and the road alignment, embankment profiles will be designed on the basis of a ‘core’ of general fill with 1V:1H batters, supported by buttress slopes constructed to 1V:4H (14°) or 1V:3H (18°). The buttress slopes will be either general fill or landscaping fill, which is not suitable for use in the core (i.e. derived from excavated soil and completely weathered rock).

The embankments required along the alignment can generally be divided into two types, which reflect the different ground conditions along the alignment (refer to Table 4.5). The embankments will require the placement of large volumes of fill material, along with localised stabilisation measures.

Table 4.5 – Embankment Typologies

Embankment Type	Design Details
<p>Low Embankments Typically lower (<5m high) embankments constructed on relatively level ground along the edge of the valleys at the southern and northern ends of the alignment.</p>	<ul style="list-style-type: none"> • Lower embankments will typically be underlain by deep, very soft to soft and highly compressible soils. • Design of these embankments will be driven by maintaining stability of the embankments in the short term, requiring staged construction, limiting long-term total and differential settlements and seismic displacements. • Embankment construction may require the use of a geofabric / geotextile separator layer with a basal drainage blanket, a high strength geotextile basal reinforcement and preload fill.
<p>Higher Embankments Larger (up to 40m high) embankments constructed across elevated gullies along the central portion of the alignment</p>	<ul style="list-style-type: none"> • Higher embankments may require undercutting of weak surface soils and/or the installation of a drainage blanket or a supporting raft for maintaining stability of the embankment • Depending upon the permeability of fill materials available and the embankment height, intermediate sub-horizontal drainage layers may be required to control the build-up of pore pressures within the embankment during construction.

A typical embankment profile is shown in Figure 4.6.

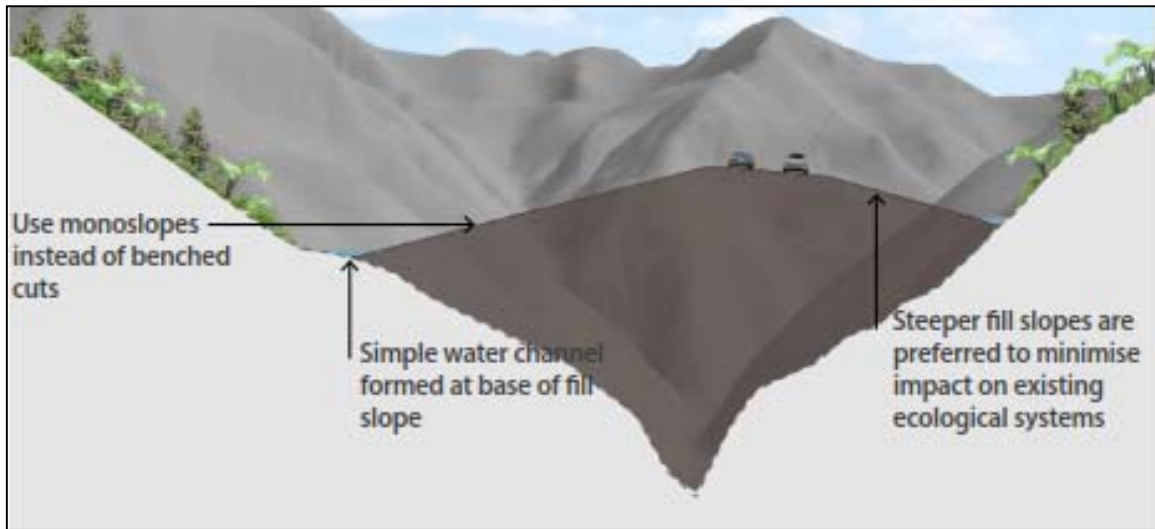


Figure 4.6 – Typical embankment profile

Embankments will revegetate over time as shown in Figure 4.7 and outlined in the LEDF (Technical Report 8b, Volume 3).

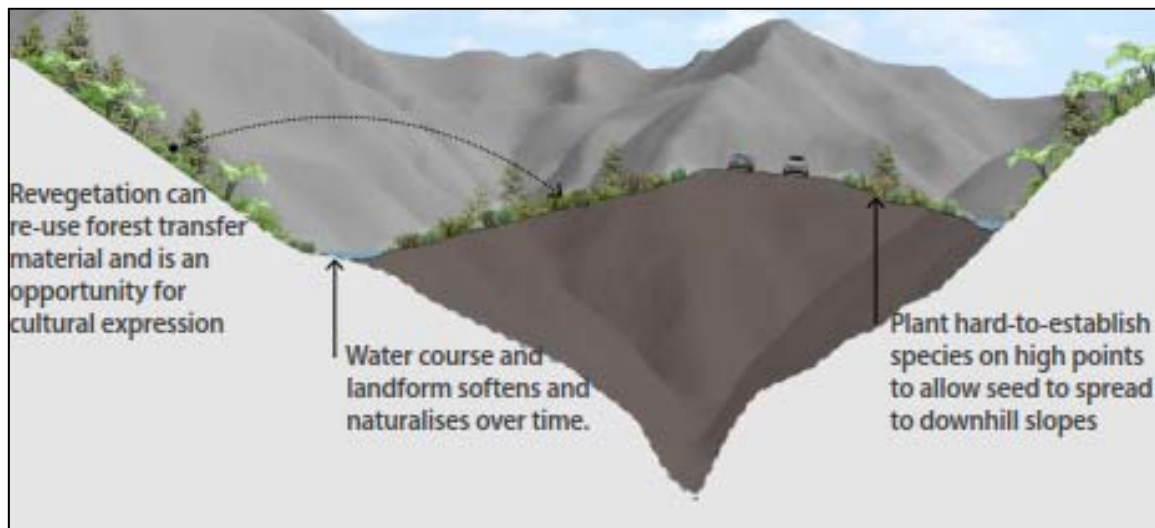


Figure 4.7 – Typical revegetated embankment

A summary of the main embankments along the alignment is provided in Table 4.6.

Table 4.6 – Main Embankments along the Alignment

Chainage (m)		Approx. Length (m)	Approx. Height (m)	Anticipated Subgrade Materials
From	To			
550	970	420	3.0	Alluvium + slope deposits on sidelong ground.
1300	1370	70	3.5	Alluvium + slope deposits on sidelong ground.
1510	1560	50	3.5	Predominantly alluvium.
1700	1950	250	3.5	Alluvium + slope deposits on sidelong ground.
2300	2430	130	16.0	Slope deposits / Alluvium.
2850	3300	450	40.0	Across base of gully – slope and alluvial materials.
3680	3890	210	16.0	Across base of gully – slope and alluvial materials.
4370	4420	50	6.0	Slope deposits / Alluvium.
4560	4660	100	4.0	Predominantly alluvium.
4740	4790	100	1.5	Predominantly alluvium.

The Geotechnical Appraisal Report (Technical Report 14, Volume 3) presents further details on embankment design.

4.13.3 Retaining Walls and MSE Slopes

Two MSE embankments will be located along the alignment to provide additional stability where steeper embankments (greater than 45°) will be required and are subject to space constraints in order to avoid impacts on areas of high ecological values. MSE walls will be located at:

- Chainage 2300 – 2430 – which crosses a steep sided gully in the valley of the Mangapepeke Stream. The embankment will be up to 16m high and extends over a length of approximately 130m, grading into rock cuts at either end²⁴.
- Chainage 4370 to 4420 – located across a short gully feeding into the Mimi River towards the southern end of the route. The embankment will be up to 5.0m high and extend over a length of around 50m.

²⁴ Recently completed geotechnical investigations at this location indicate soft soils to a depth greater than expected. While an MSE embankment is proposed at this location ongoing design development could determine that the MSE embankment is replaced by a bridge spanning the gully or an alternative embankment solution.

MSE slopes will comprise geogrid reinforcement placed horizontally as layers of embankment fill are built up, finished with a grassed slope facing.

Further MSE walls or retaining wall may be required at additional locations along the alignment, such as the bridge abutments, or to minimise the length of culverts passing beneath high embankments. This will be confirmed during final design of the Project.

Further detail on MSE slopes and retaining walls can be found in the Geotechnical Appraisal Report (Technical Report 14, Volume 3).

4.14 Bridge Structure

The alignment includes the construction of one bridge located between Chainage 4150 and 4270. The bridge will be approximately 120m long, crossing the steep sided and flat bottomed valley occupied by the high ecological value Mimi swamp forest.

The key design aspects of the bridge are:

- The bridge will be a three span steel ladder deck superstructure with a composite concrete deck slab. The middle span will be approximately 50m in length while the two outer spans will be approximately 35m in length. The bridge deck will be approximately 12.8m wide.
- The structure will comprise inclined steel frame piers supported from the sides of the valley.
- The piers will be constructed on a rock slope and founded on reinforced concrete pads. Mini-piles may be installed if necessary depending on the depth to competent rock. Rock bolts and/or netting drapes may need to be installed to control stability and local rock-fall near pier foundations.
- The bridge abutments will be reinforced concrete, founded on rock, with bored piles as required depending on the depth to competent rock.

The bridge design of steel piers and steel superstructure will enable the bridge components to be lifted in place and the bridge constructed from the abutments with large cranes. As such, access to the valley floor below and the construction of large staging platforms will not be required, minimising effects on this environment.

Figure 4.8 shows the typical bridge arrangement (from a similar example at the Matahorua Gorge) while the drawing set in Volume 2 provides the bridge design details.



Figure 4.8 – Similar Bridge Arrangement (Matahorua Gorge)

4.14.1 Design Standards

The bridge will be constructed in accordance with the relevant Transport Agency and New Zealand and Australian design standards for bridges, concrete and steel structure standards, as follows:

- The Transport Agency Bridge Manual, Third edition, Amendment 2, May 2016;
- NZS 1170.5:2004 Structural Design Actions – Earthquake Actions, New Zealand;
- NZS 3101:1995 Concrete Structures Standard;
- NZS 3404:1997 Steel Structures Standard; and
- AS 5100 Australian Standard for Bridge Design.

Key aspects of the design are outlined in Table 4.7 – Bridge Design Aspects.

Table 4.7 – Bridge Design Aspects

Design Aspect	Design Details
Bridge Width	<ul style="list-style-type: none"> • With allowance for centre line markings, the carriageway width between barriers is approximately 11.8m. Allowing 0.5m width on each side for edge barriers gives an overall bridge deck width of 12.8m.
Lane and Shoulder Width	<ul style="list-style-type: none"> • The bridge will carry two 3.5m wide lanes of traffic and is on a 460m radius horizontal curve. The curve requires the bridge deck to have an 8% cross fall. • The outside shoulder width is 1.5m, and the inside shoulder width is 3.0m to allow for sighting distance around the curve.
Barriers	<ul style="list-style-type: none"> • Edge protection on the bridge will be provided by TL-5 HT type barriers in accordance with the Transport Agency Bridge Manual. These barriers comprise a concrete wall and steel top rail.
Vertical Clearance	<ul style="list-style-type: none"> • The bridge is on a 7% longitudinal gradient, so the height of the bridge deck above the valley floor varies. However, the maximum vertical clearance between the underside of the deck and the floor of the valley is approximately 20m.
Design Loading	<ul style="list-style-type: none"> • The bridge will be designed for HN-HO-72 live traffic live loading in accordance with the Transport Agency Bridge Manual. • All other design loads (including dead load, seismic, wind etc.) will be determined in accordance with the relevant design standards noted above on the basis of a 100 year design life and Importance Level 3 for the structure.
Materials and Finishes	<ul style="list-style-type: none"> • Weathering steel is preferred for the structure (however suitability is to be confirmed given proximity of the structure to the coast). Otherwise, normal grades of steel will be used, in conjunction with high durability, long lasting coating systems. • Plain or regular pattern concrete finishes are proposed for the bridge finishes. <p>Refer to the LEDF (Technical Report 8b, Volume 3) for further detail on the visual appearance, materials and finishes of the bridge.</p>
Drainage	Bridge drainage will be as follows:

Design Aspect	Design Details
	<ul style="list-style-type: none"> • Stormwater upstream of the bridge will be collected and conveyed in a piped system within the bridge structure. • Runoff from the bridge deck will be directed off the traffic lanes by the cross fall, conveyed along the channel at the edge of the bridge deck and piped to a constructed wetland located at the southern end of the alignment. • Drainage inlets on the bridge structure will not be required.

Refer to the bridge drawings in Volume 2 for the general arrangement and typical sections of the bridge.

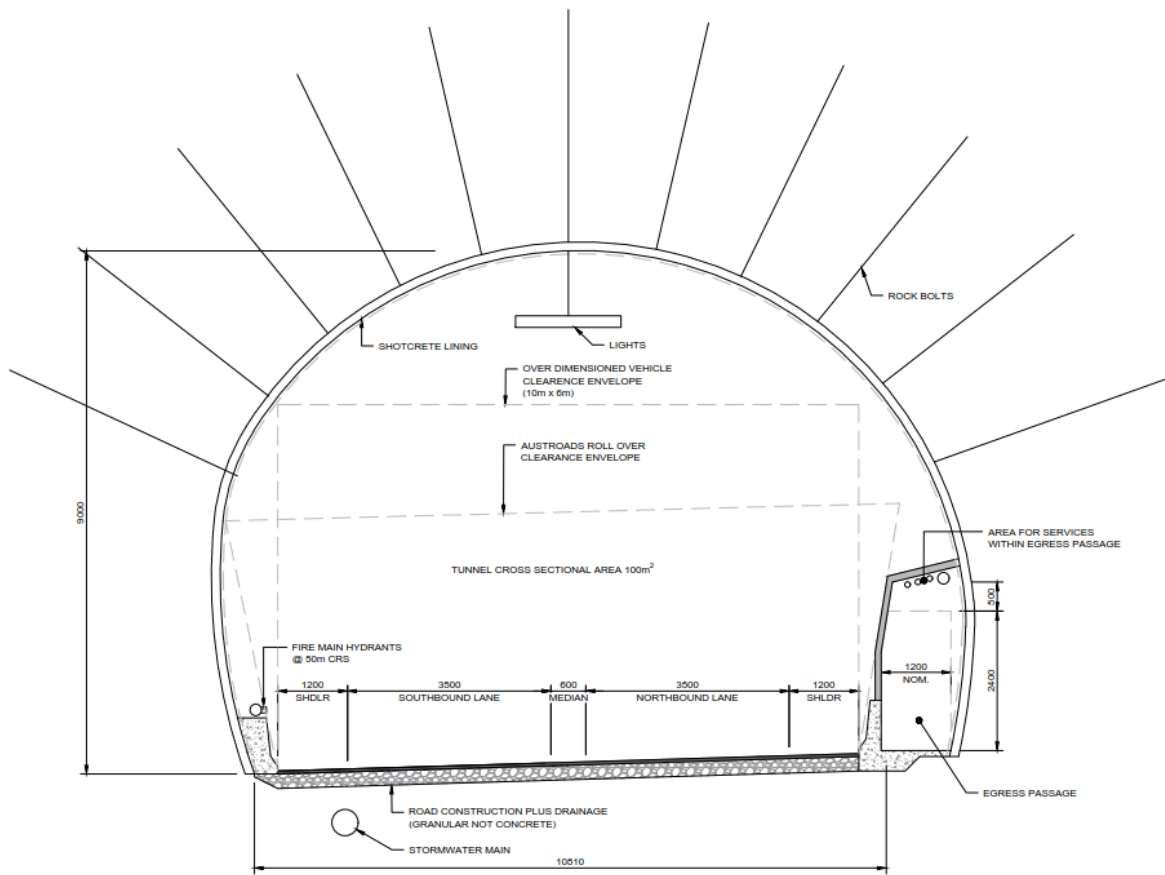
4.15 Tunnel

The alignment includes a tunnel, approximately 240m in length, through the ridgeline to the east of Mt Messenger. This avoids the significant adverse effects that would be associated with a cut through this ridgeline. The tunnel will be in the order of 93m below the crest of the ridge.

The key design aspects of the tunnel will be as follows:

- The tunnel cross-section is dictated by the need to cater for over-dimension vehicles for which a clearance envelope of 10m x 6m is required. A cross-section through the tunnel is shown in Figure 4.9;
- The tunnel will be an arch shape (refer to Figure 4.9), around 10m high with a maximum cover depth in excess of 80m;
- The road cross-section in the tunnel differs from that elsewhere along the route as follows:
 - Lane widths remain at 3.5m but will be separated by a 600mm wide flush median to provide separation of traffic while allowing people to cross the road and reach the egress passage if required in an emergency;
 - Shoulder widths will be 1.2m, and will provide sufficient width for use by cyclists.
- Roof support is likely to be by means of rock bolts, with a shotcrete lining;
- Approximately 25 to 30m deep rock cuttings will be required at the approach to each tunnel portal. The tunnel portal will extend clear of the adjoining rock face to allow for a barrier to protect the roadway from the potential of rock fall debris (refer to Figure 4.11);
- The tunnel will include a fire-rated emergency egress passage for pedestrians;
- A tunnel control building housing the main electrical plant for the tunnel will be required. This will be located alongside the northbound carriageway to the south of the tunnel. Fire hydrant water tanks will be located above the tunnel at the existing rest area at the SH3 Mt Messenger summit;
- Wash-down water and any hydrant water will be carried away via catch pits and subsurface drains connected to the main highway drainage system; and

- The tunnel will be monitored and some equipment controlled from the Transport Agency's Traffic Operations Centre.



TYPICAL MID SECTION TUNNEL CROSS SECTION
SCALE: 1:50

Figure 4.9 - Typical tunnel cross-section



Figure 4.10 - Indicative view of tunnel approach showing the main tunnel portal and safety barriers



Figure 4.11 – Indicative view of the tunnel portal and rock fall protection

Further details on the tunnel, tunnel control building and water tanks are presented in the drawings in Volume 2. The LEDF provides further detail on the design of the tunnel portals, as a significant gateway feature along the route.

The key tunnel design and operation aspects are further detailed below. Dangerous goods vehicles will be permitted to use the tunnel.

4.15.1 Power supply

An electrical power supply will be provided to a point of connection to provide the permanent electrical supply required for operation of the tunnel. It is likely this will be from a new underground cable installed adjacent to the new alignment.

A generator located in the control building (refer Section 4.15.5) will provide back-up power for electrical systems in the tunnel.

4.15.2 Tunnel and Egress Passage Lighting

Lighting of the tunnel roadway and emergency egress passage will be provided along the full length of the tunnel for general and night-time illumination.

Road lighting will be provided at the tunnel approaches. Emergency lighting is outlined in Section 4.15.4.1.

The design of tunnel lighting, emergency lighting, and electrical services will be in accordance with the relevant New Zealand and Australian codes and standards.

4.15.3 Tunnel Operation and Control System

The tunnel operations and management and control system will be controlled locally in the tunnel control building and remotely from the Transport Agency's Traffic Control Centre.

Warning signs will be provided within and outside of the tunnel. Remotely operated barriers will prevent traffic entering the tunnel during an incident.

Given the tunnel's short length and bi-directional operations no mechanical ventilation or deluge system are required.

4.15.4 Fire & Life Safety

4.15.4.1 Emergency Egress

An emergency egress passage will be provided with fire-rated doors spaced regularly along the side of the tunnel. The passage will meet accessibility requirements and will be lit and monitored remotely.

4.15.4.2 Fire Hydrant System

A fire hydrant water system will deliver water to dual head hydrants located at intervals along the tunnel. Three water tanks with a total capacity of 350,000 litres will be installed at the rest area on the existing SH3, above the tunnel. Water supply for the tanks will be by tankers. The tanks will be screened with vegetation as shown in Figure 4.12 – Water tanks at the existing SH3 rest area

.

The length of the tunnel and traffic volumes are such that a fire suppressant deluge system and smoke handling ventilation are not required.



Figure 4.12 – Water tanks at the existing SH3 rest area

4.15.4.3 Tunnel Safety Requirements

Tunnel safety equipment will include:

- A public address system, a fire detection system and closed circuit television (CCTV) system (consisting of CCTV cameras mounted within the tunnels and egress passage to provide continuous coverage of the tunnel interior and exit portals). The systems will be monitored from the Transport Agency's Traffic Operations Centre.
- Signage and strobe lighting to guide pedestrians to the exit doors in an emergency.
- Emergency lighting in the tunnel and egress passage with connection to an uninterruptible power supply (UPS).
- External traffic barriers and signage.

4.15.5 Tunnel control building

A tunnel control building housing the main electrical plant and control equipment will likely be located in the vicinity of the southern approach to the tunnel (refer Figure 4.13 for indicative details).

Electrical plant housed within the control building will include the main switchboard, UPS, emergency generator and associated fuel and electrical infrastructure. General lighting and power controls will also be located in the plantroom. External security lighting with motion sensor controls may be installed. Outside the building an access road off the highway will be provided to the building, which will be set back from the main carriageway, fenced and screened by planting.

The plantroom will be the minimum size required to house the tunnel equipment and provide safe access for both maintenance and future replacement (approximately 15m long, 8m wide and 6m high. Solar panels may be installed on the control building roof, to supplement power supply to the plantroom and tunnel systems. A power company transformer will be located outside.

The tunnel is required to comply with the Building Act 1990 and regulations. Fire systems are subject to the Compliance Schedules and the associated regulator testing. The building will be designed to address Crime Prevention Through Environmental Design (CPTED) considerations.

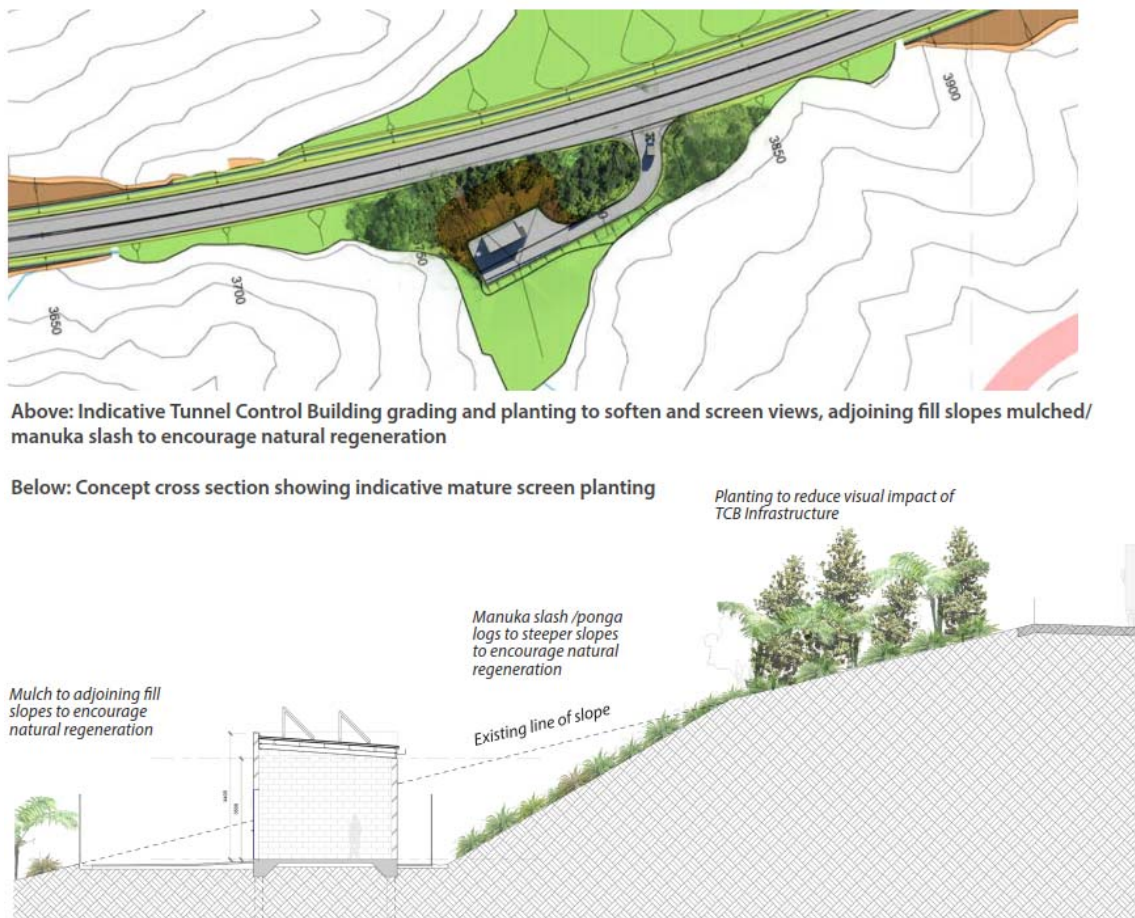


Figure 4.13 - Tunnel control building

4.16 Operational Stormwater Management

This section outlines the stormwater management proposed for the operation of the Project. (Stormwater treatment proposed during construction of the Project is outlined in Section 5 of this AEE.)

The stormwater design for the operation of the Project is based on having a stormwater network that is fit for purpose and meets the relevant Transport Agency, Taranaki Regional Council and Austroads standards (including the Transport Agency's *Stormwater Treatment Standard for State Highway Infrastructure*) and is appropriate for the rural environment in which the Project is located. Key features of the Project's operational phase stormwater design are as follows:

- Runoff will be collected and conveyed in a safe, low-maintenance and simple drainage network;
- Culvert crossings will be used to maintain flows across valleys and natural flowpaths within the Project area;
- Stream diversions will be minimised where practical, and existing streams improved where diversions are necessary;
- Constructed wetlands will collect road run-off and provide treatment, extended detention to minimise scour/erosion of streams and contain emergency spills; and
- Fish passage, where it exists naturally.

4.16.1 Stormwater Conveyance and Treatment

The Project will increase the area of impervious surface in both the Mangapepeke Stream and Mimi River catchments. However, in absolute terms the impervious area remains very low. Where stormwater ponds are planned in the lower Mangapepeke Stream the impervious surface will be about 2.4% of the catchment; while in the Mimi River it will be 0.7% of the catchment after the Project completion (refer Technical Report 7b in Volume 3, for further detail in this regard).

The catchment areas identified for stormwater treatment include:

- All new road surfaces, including pavement, median, shoulder, drainage channels; and
- Rock cuts and re-vegetated areas above rocks cuts where stormwater cannot be readily intercepted.

Stormwater quality treatment will be designed to:

- Reduce total suspended solids (TSS) in accordance with the Transport Agency's Stormwater Treatment Standards on a long term average basis
- Reduce contaminants, including particulate trace metals, particulate nutrients, oil, grease and bacteria on sediments; and
- Remove gross litter and floatables, such as oil and volatile hydrocarbons.

Stormwater quantity will be designed to:

- Convey flow as a minimum for the extended detention flow, as defined by the Transport Agency's *Stormwater Treatment Standard* and, where no acceptable alternative overland flow path is available, the 100 year ARI flow;

- Minimise erosion of streams by providing extended detention and controlled release of runoff generated in a rainfall event of 36mm, discharged over a 24 hour period.

The stormwater drainage network and treatment system for the Project will comprise the following (described in further detail in subsequent sections):

- Open roadside channels (swales) constructed along the alignment to convey flows up to the extended detention flow rate collected from the road surface downstream to the valley floors to constructed wetlands.
- Stormwater will then be contained, treated and detained in the wetlands, prior to discharging to the receiving environment.
- Where the alignment crosses natural valleys and watercourses on fill embankments, culverts will be installed to provide for the conveyance of flows from one side of embankment to the other and enable the continuation of streams and overland flowpaths. Where fill embankments are located parallel to watercourses, the watercourses will be diverted along the toes of the embankments.
- Runoff from the bridge will be collected and conveyed along the face of the barrier. Upstream flows discharging across the bridge deck will be minimised by diverting upstream flows greater than the Extended Detention storm event.
- As the tunnel will be located adjacent to the high-point in the road geometry, there will be no upstream catchment flowing through the tunnel. Where drainage is provided within the tunnel, this will be specifically designed to ensure that this cannot promote the spread of fire.

Refer to Drawings MAA-DES-DNG-DRG-1000-1010 in Volume 2 for details of the Project's stormwater conveyance and treatment system.

4.16.1.1 Swales

Swales will be used to convey and provide some pre-treatment of runoff from the road surface, upstream of the constructed wetlands. All swales will be designed in accordance with the Transport Agency's *Stormwater Treatment Standard for State Highway Infrastructure*. Three swale typologies will be used for the Project. Typical details are shown in Figure 4.14:

- Type 1 - unlined swale in natural rock
- Type 2 - vegetated swale and
- Type 3 - lined channel.

Where practicable, swales will also be used to provide stand-alone treatment to portions of road at the extremities of the Project area.

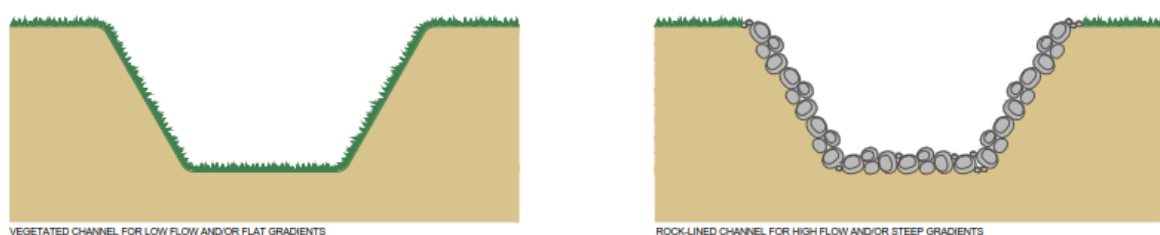


Figure 4.14 – Typical swale design

Refer to the stormwater drawings in Volume 2 for further detail.

4.16.1.2 Constructed Wetlands

Constructed wetlands will be used to treat surface runoff from the road. Two constructed wetlands will be located within the northern region while a third will be located within the southern region as outlined in Table 4.8.

Constructed wetlands perform well as treatment devices, removing suspended solids (can remove 75% TSS on a long-term basis), heavy metals, hydrocarbons, and other traffic-related pollutants, as well as providing additional filtering and biological treatment. In addition to water quality treatment, the constructed wetlands will also provide for extended detention. The constructed wetlands will be developed in accordance with the Transport Agency *Stormwater Treatment Standard for State Highway Infrastructure*.

In general the constructed wetlands will be designed and operated as follows:

- The surface area of the constructed wetlands will be sized based on 2% of the total contributing catchment.
- Water depths will be typically range between 0.15 – 1 m.
- Stormwater will be discharged from the conveyance network into the wetland forebay where coarse sediment will settle out. Flows will then enter the main vegetated area of the wetland, where fine particulates and dissolved pollutants will be removed.
- Treated water will discharge through the outlet to the receiving environment.

Table 4.8 – Constructed Wetlands

Wetland ID and Chainage	Impervious Catchment Area (m ²)	Pervious Catchment Area (m ²) *	Total Catchment Area (m ²)	Surface Water Area Required (m ²)	Functions
W1 Ch 640 – 675	11,900	20,570	32,470	650	Water quality treatment and extended detention
W2 Ch 1650 – 1700	18,600	39,500	58,100	1200	Water quality treatment and extended detention
W3 Ch 4720 – 4750	11,580	20,400	31,980	650	Water quality treatment and extended detention

*Treatment for pervious areas is not necessary, however if pervious areas are contributing to the wetland, the equivalent Water Quality Volume will be allowed for.

The wetlands will be planted, with indicative details shown on Figure 4.15. Typical design details for constructed wetlands are provided in the drawing set in Volume 2.



Figure 4.15 – Typical constructed wetland design and planting

4.16.2 Permanent Stream Diversions

Permanent stream diversions will be required where it is necessary to realign a natural stream channel (or section of stream channel) for the Project. A summary of the stream diversions required for the Project is provided in Table 4.9 below (refer also to the stream diversion drawings in Volume 2).

Stream typologies have been developed as follows (and as shown in Figure 4.16 and on the stream diversion drawing):

- **Stream Diversion Type 1** – Lowland stream that will require recreation of habitats associated with a natural lowland stream. Approximately 450m of Type 1 stream diversions will be required for the Project.
- **Stream Diversion Type 2** – Steep stream that will require the recreation of habitats associated with natural steep streams. Approximately 2500m of Type 2 stream diversions will be required for the Project.

Table 4.9 – Stream Diversions Summary

Stream	Approximate Length (m)	Stream Type	Stream gradient	Fish passage type ¹	Diversion Type
Mangapepeke Stream (Ch. 700–775m)	75	Perennial	Low (0.5–1% gradient)	Swimming	Type 1
Minor Tributary of Mangapepeke (Ch. 600m)	90	Perennial	Low (0.5–1% gradient)	Swimming	Type 1
Tributary of the Mangapepeke Stream (Ch. 1050m)	900	Perennial	Steep	Climbing	Type 2
Tributary of the Mangapepeke Stream (Ch. 1100m)	200	Perennial	Steep	Climbing	Type 2
Mangapepeke Stream (Ch. 1650–1950m)	220	Perennial	Low (0.5–1% gradient)	Swimming	Type 1
Upper reaches of Mangapepeke Stream (Ch. 2800–2900m)	100	Perennial	Steep	Climbing	Type 2
Upper reaches of Mangapepeke Stream (Ch. 3000–3350m)	350	Perennial	Steep	Climbing	Type 2
Tributary of Mimi River (Ch. 3650–3900m)	300	Perennial	Steep	Climbing	Type 2
Tributary of Mimi River (Ch. 4750m)	230	Perennial	Steep	Climbing	Type 2
Minor tributary of Mimi River (Ch. 5225–5300m)	75	Perennial	Low (0.5–1% gradient)	Swimming	Type 1
Minor tributary of Mimi River (Ch. 5450–5750)	340	Intermittent	Low (0.5–1% gradient)	Swimming	Type 2
Upstream & Downstream of Culverts	20–30 each	Varies	Varies	Varies	Varies

Notes:

¹ Designed for fish passage provision to reflect nature of fish community in upstream waters

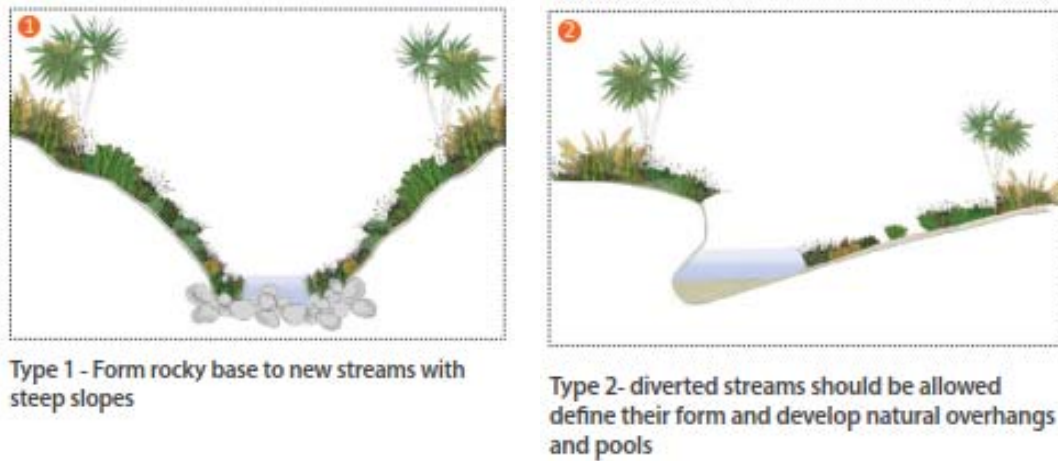


Figure 4.16 – Stream diversion typologies

All diversions will be undertaken in accordance with the following principles:

- Diversions will seek to replicate the character of the overland flowpath and/or watercourse;
- Re-aligned overland flowpaths and/or watercourses will have similar hydraulic capacity to existing channels;
- Where floodplain flow is interrupted, additional waterway capacity will be provided in compensation;
- Reconstructed watercourses will replicate the natural materials and characteristics of the original watercourse to ensure similar ecological functions are maintained;
- Fish-passage will be restored where it is interrupted and determined to be necessary by the freshwater ecologist; and
- Culverts are likely to have minor (10 – 15m) stream diversions upstream and downstream of inlets and outlets to ensure required levels are achieved and culverts are located on firm ground.

4.16.3 Cross Culverts

4.16.3.1 Culvert Details

Culverts will be required along the alignment to provide for the conveyance of flows from one side of the alignment to the other and enable the continuation of streams and overland flowpaths. The Project will require the installation of culverts on both permanent and intermittent watercourses, as outlined in Table 4.10 and shown on the culvert drawings in Volume 2. The total length of culverts to be installed along the alignment is in the order of 1200m.

Table 4.10 – Summary of Permanent Culverts

Culvert #	Chainage	Catchment (ha)	Diameter (mm)	Length (m)	Cover (m)	Grade (5)	Fish Passage	Permanent flow	Debris Fence ²⁵
1	250	3.82	1050	24	1.2	1	Type 1	No	None
2	300	1.80	825	26	1.2	1	None	No	None
3	570	9.31	1500	67	1.2	1	Type 2	No	None
4	750	1.91	600	81	1.2	1	Type 2	Yes	None
5	870	9.41	1350	87	1.2	3	Type 2	No	Debris Fence
6	1300	6.82	1350	27	1.2	1	Type 2	No	Debris Fence
7	1500	5.78	1200	36	1.2	3	Type 2	No	Debris Fence
8	1700	7.95	1200	35	1.2	4	Type 1	No	Debris Fence
9	1850	66.78	4x1350	56	2	0.5	Type 2	Yes	Debris Fence
10	2220	1.99	750	37	1.2	1	None	No	Debris Fence
11	2300	1.55	750	25	4	17	Type 2	No	Debris Fence
12	2400	9.84	1200	74	12	7	Type 1	Yes	Debris Fence
13	2700	1.65	600	15	1.2	14	None	No	Debris Fence
14	2900	4.72	900	117	16	16	Type 1	Yes	Debris Fence
15	2960	50.49	2550	210	26	1	Type 2	Yes	Debris Fence
16	3800	13.64	1500	115	11	3	Type 1	Yes	Debris Fence
17	4400	3.04	825	22	1.2	14	Type 1	Yes	Debris Fence
18	4750	25.54	2100	29	1.2	1	Type 2	Yes	None
19	4750	25.54	2100	43	1.2	1	Type 2	Yes	None
20	5150	13.55	1650	40	1.2	1	Type 2	No	None
21	5650	11.90	1350	34	1.2	1	Type 2	Yes	None

The drawings in Volume 2 provide typical culvert design details.

²⁵ Subject to confirmation during detailed design

Culverts will be designed with best practice consideration of fish passage, erosion control and debris management, and energy dissipation as described in the following sections.

4.16.3.2 Fish Passage

Fish species are limited to climbing fish in the steeper, upper reaches of the catchments within the Project area while the lower, flatter valley floors are inhabited by a mix of climbing and swimming species (refer to Technical Report 7b, Volume 3). The new culverts will incorporate fish passage as follows (refer drawing set in Volume 2):

- **Steep culverts** – fish passage will be provided by flexible plastic baffles that will accumulate sediment and form riffles and rest areas for fish during typical flow conditions (Type 1 fish passage).
- **Shallow grade culverts** – the culverts will be oversized and the invert sunken below bed level such that the original streambed reforms (Type 2 fish passage).

4.16.3.3 Debris Control Measures

Debris can accumulate at culvert inlets or become lodged in the inlet structure, which can lead to the blockage of culvert entrances and impact flow capacity through the culvert.

Debris control measures will be installed at culvert inlets located in densely vegetated areas with a high risk of debris generation. Typically, debris control fences will be installed upstream of culverts to prevent the downstream passage of debris, such as logs, that have the potential for blocking culvert entries.

A secondary scruffy dome inlet will also be provided in some locations so that should the primary inlet of a culvert block in a storm event, flows are not impeded and significant ponding does not occur.

Refer to the drawings in Volume 2 for typical debris control details.

4.16.3.4 Scour Protection and Energy Dissipation

High velocity flows at stormwater discharge point / culvert outlet structures can result in the scour and erosion of downstream channels and stream banks. All outlet structures will be designed with rip rap basins to provide adequate energy dissipation and erosion protection measures. Rip rap basins are a rock lined basin containing a pool of water at the culvert outlet. Rock aprons may be provided to further spread flows and reduce flow velocity before it discharges to the downstream receiving environment. Rip rap basins will be sized for the 100 year ARI storm event to minimise the requirement for maintenance given access to culverts will be difficult post construction. Refer to the drawings in Volume 2 for typical rip rap basin details.

4.17 Network Utilities

Existing services that will be affected by the construction works include Vodafone and Chorus cables in the verge of SH3. Local diversions of these cables are likely to be necessary where the Project intersects the existing road. The extent and scope of any diversions will be discussed with the relevant service authorities.

4.18 Revocation of existing SH3

The Transport Agency has initiated a process with the District Council to establish the future requirements for the existing section of SH3 that will be bypassed on completion of the Project. This includes addressing ongoing access requirements for existing land owners with access off this section of highway. The process had not been completed at the time of lodging these applications and is not a matter for consideration under the RMA. The Transport Agency will consult with affected landowners with access onto the bypassed section of SH3, including with Ngāti Tama. Once the revocation process has been complete ownership and control for this section of road will transfer to the District Council.

