4. HIGHWAY OUTCOMES

Farming use (foreground) and kauri bush (rear) at approximate chainage 52300

4. HIGHWAY OUTCOMES

DESIGN STATEMENT

The Warkworth sector, like the other two sectors, has its own distinct qualities, with a variety of landscapes along the length of the motorway. While the motorway design responds to each of these different landscapes, consistency in the design and use of motorway elements is also important, to maintain continuity and familiarity for the road user.

As has been the case in all sectors, the design for the Warkworth sector has focused on reducing the vertical alignment of the motorway, resulting in a preference for embankments over bridges. The lowering of the alignment seats the motorway in the landscape and this effect is pronounced in this sector, particularly as it tends to follow valleys rather than traversing them. The lowered alignment and the landscape enhancements will help screen the motorway and achieve the ULDF outcome for an understated presence, being visually less apparent. This also provides road-users with glimpses of the rural character of the area around Warkworth and open expansive views that provide visual contrast to other areas of dense planting.

The most significant built element in this sector, other than the motorway, is the viaduct across the kauri forest to the west of Perry Road (now called Te Arawhiti Pua Ngahere); the design of Te Arawhiti Pua Ngahere has been carefully considered to minimise the extent of kauri forest clearance in this area and will provide a 'fly-over' experience for motorists.

The road edge, beyond motorway safety furniture, will contain the drainage infrastructure. Weeds will be managed by both the design and minimal control to provide a clean road edge. Cut batters will be less significant and considerably less dominant in the Warkworth sector than elsewhere along the alignment. Planted fill batters will vertically host the motorway.

Motorway furniture will have a standard appearance due to the uniform grey colour, the use of similar materials, and set back from the road. The design and minimisation of poles and gantries reduces visual motorway clutter, maintains clean lines, and contributes to a 'clean, uncluttered highway'.

The motorway outcomes have been well established with the Pūhoi and Moir Hill and Hīkauae Creek sectors and the same language is continued throughout this sector. As this section of Ara Tūhono ends at State Highway 1 north of Warkworth, there is an interchange with a roundabout for access by road users to the north and south. This roundabout will incorporate lighting in the same manner as Pūhoi, and light poles will be placed prominently to ensure the safe use of the roundabout.

4.1 NAMING

The ULDF states structures (e.g. viaducts and bridges) and landscape features should be appropriately named. The Transport Agency and Hōkai Nuku have agreed on the following motorway feature names- Te Arawhiti Pua Ngahere for the viaduct through the kauri forest, Tūhono ki Kōurawhero for the junction that will connect to the next stage to Wellsford and Pukerito for the Northern connection to SH1. Access tracks and underpasses on private property have no official title, the names shown and mentioned in this ULDSP are used at descriptors only.

Te Arawhiti Pua Ngahere

This is the name given to the structure that passes through the area of forest with significant kauri located at chainage 52100. It combines the symbols of ecology, seed and bush, and reflects on the historical role of Mahurangi's ancient kauri forests as a catalyst for European settlement and their subsequent industrial deforestation. The name Te Arawhiti Pua Ngahere includes the notion of regeneration, celebrating the resiliance of the region's indigenous trees and acknowledging the mana of kauri as an elder to all living things in Aotearoa.

Tūhono Ki Kōurawhero

The proposed junction where Wyllie Road connects to the second stage of Ara Tūhono (which links Warkworth to Wellsford) is to be named Tūhono ki Kōurawhero (journey over the Kōurawhero area). This junction is not within the Project area, however the name will still apply to this area. A neighbouring river to the Project area in close proximity to Wyllie Road is known by Ngāti Manuhiri as Kōurawhero. Kōurawhero is the name of the original Māori land block and of a stream nearby and symbolises the abundance of the freshwater crayfish that once filled the river. These were a regional delicacy and source of pride for the local people.

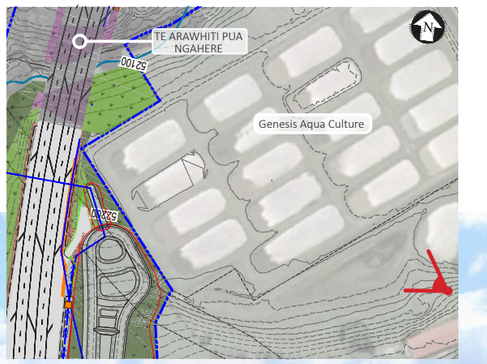
Pukerito

This is the name given to the area where the motorway intersects with existing SH1. The name can be translated as "middle hill", and signifies the general area as a gully between two hills.

4.2 VIADUCTS AND BRIDGES

There are three bridges in the Warkworth sector; one which crosses the Kauri forest, one which crosses the Mahurangi River, and another which crosses Woodcocks Road. The ULDF and aesthetic considerations have governed the design of each structure.

All bridges along the alignment are neutral grey in colour and have been designed to create a cohesive and clean aesthetic [D37]. The bridges in the Warkworth sector are not designed as 'iconic' structures; rather the design integrates them into the rural environment. The local road bridges are addressed in Section 5.4.



Sketch of Te Arawhiti Pua Ngahere looking north west

[1]Safe Roads Alliance

Bridges over Woodcocks Road and Mahurangi River

The motorway crosses Woodcocks Road and the Mahurangi River within a 250m distance. To span these features, two bridges will be constructed and the short section of motorway between the two bridges will be built on earth embankments. The ULDF describes the outcome to maximise openness and views beneath bridges through the utilisation of open spill through (diagonally sloping) abutments beneath the motorway.

Woodcocks Road Bridge

The Woodcocks Road Bridge is an approximately 20m long concrete structure with vertical abutment MSE (mechanically satbilised earth) walls and is primarily focussed on maintaining local road connections under the motorway. Connectivity is carefully considered in the realignment of Woodcocks Road, in elevating the motorway so that the local road remains at its existing grade. The design leaves Woodcocks Road straighter and safer by supporting good visibility on the approach and through the underpass for local road users [ULDF 5.3]. Space has been allocated under Woodcocks Road Bridge to allow for future footpaths and a cyclepath to be built. 1.8m has been allocated for a footpath on the northern side and 3m on the southern side for a footpath/cyclepath (refer elevation bottom right).

The bridge uses vertical splayed abutments rather than spill through abutments to provide a robust design that fits within the geotechnical constraints of the site, that have become clear through further site investigations since the preparation of the ULDF. The straightening of Woodcocks Road helps to address openness and visibility. The perspective included on this page indicates the expected visual connectivity through and around the bridge approach [ULDF 4.2].

Open angled, sloping wing walls that taper down to road level with the embankment slope will be splayed to give the bridge a more open feel and draw the eye through the bridge. The bridge is 26m wide with a clear span of 20m, this means that the bridge abutments are not hard against the road edge on both sides and there is capacity to accommodate road users passing underneath. Climbers on the bridge wing walls will soften the structure to blend back into the adjacent landscape. The bridge and wing walls will be softened with roadside landscape planting and this will provide visual interest and create a greater feeling of openness [ULDF 4.2].

Across the top of Woodcocks Road Bridge (at motorway level), TL5 concrete bridge barriers with steel rails will be provided as per other bridges on the motorway. The TL5 concrete bridge barriers transition into thrie-beam barriers between the bridges (thrie-beam barriers then transition to wire rope barriers for the remainder of the motorway).

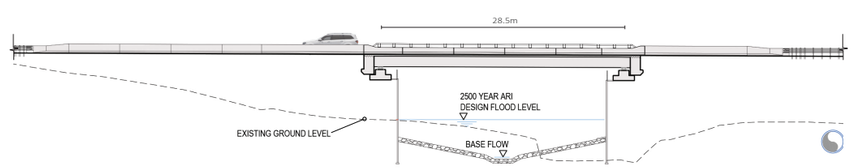
The proposed realignment of Wyllie Road and surrounding local roads, is addressed in section 5.3. Woodcocks Road is to be straightened at the bridge location to provide open and clear sightlines beneath and through the bridge.

The motorway alignment enables Woodcocks Road to remain at grade, and the surrounding land uses to be reflected in the landscape design. In particular, planting up to the edge of the corridor helps to clarify and stitch very different landscape patterns together [ULDF sections 4.2, 5.3 and 5.4].

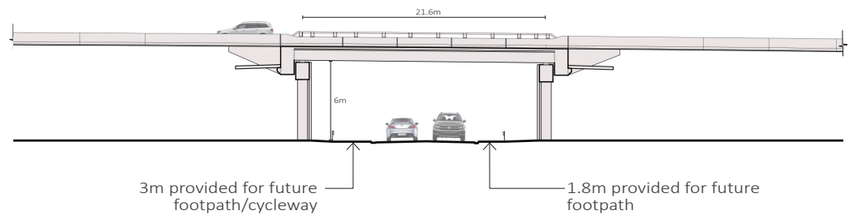
Mahurangi River Bridge

The motorway will cross Mahurangi River between chainage 49000 and 49100. To maintain river water flows and enable the retention of a natural watercourse, a bridge with a clear single span of 24m will be installed approximately 200m to the north of Woodcocks Road Bridge. Pedestrian access under the bridge has been allowed for in the design.

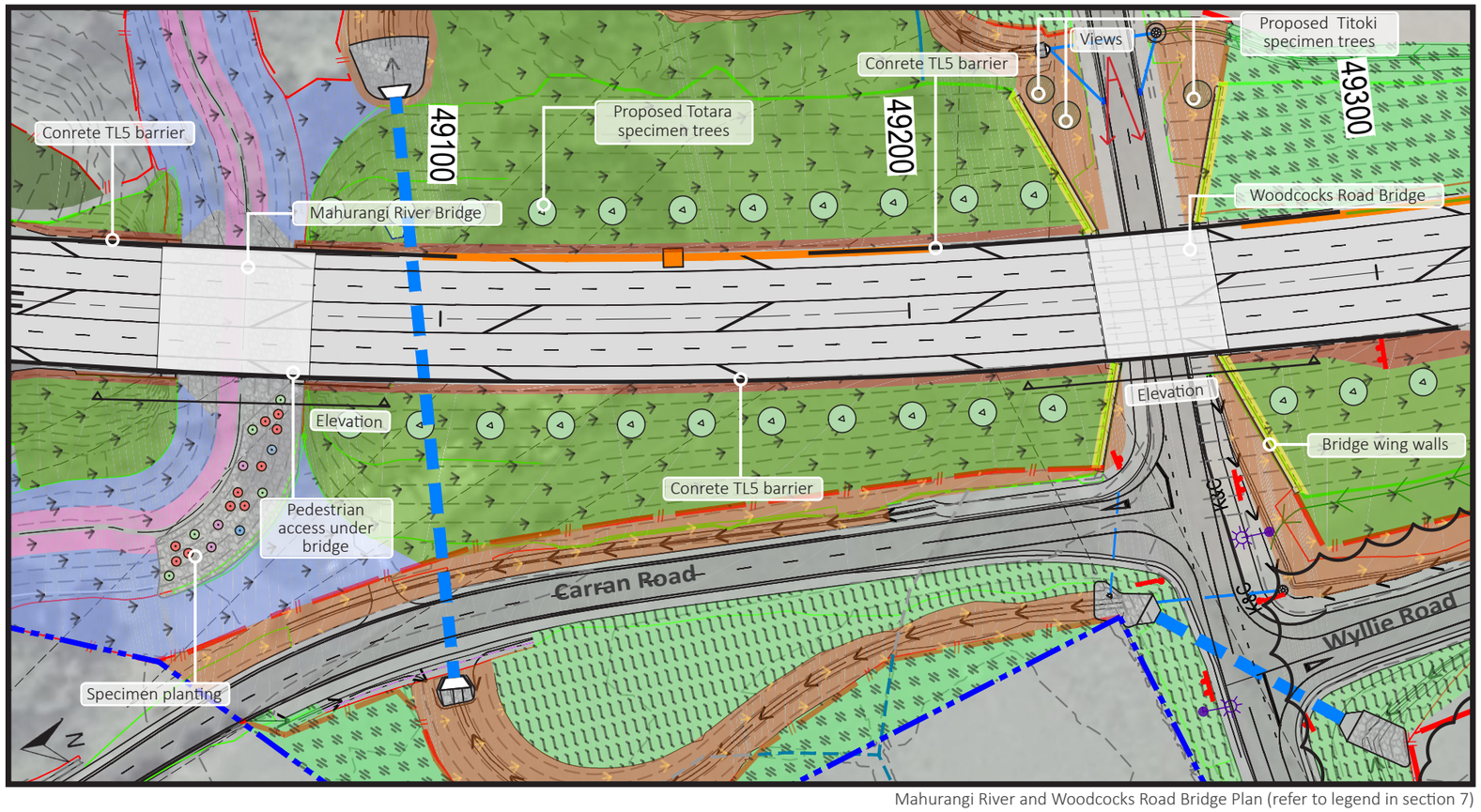
Motorway users will see TL5 concrete barriers as they travel over Mahurangi River Bridge. The bridge will not be easily visible to local road nor motorway users.



Mahurangi River Bridge Elevation
Not to scale



Woodcocks Road Bridge Elevation
Not to scale



Mahurangi River and Woodcocks Road Bridge Plan (refer to legend in section 7)

A sketch of Woodcocks Road Bridge View (east to west)

Te Arawhiti Pua Ngahere

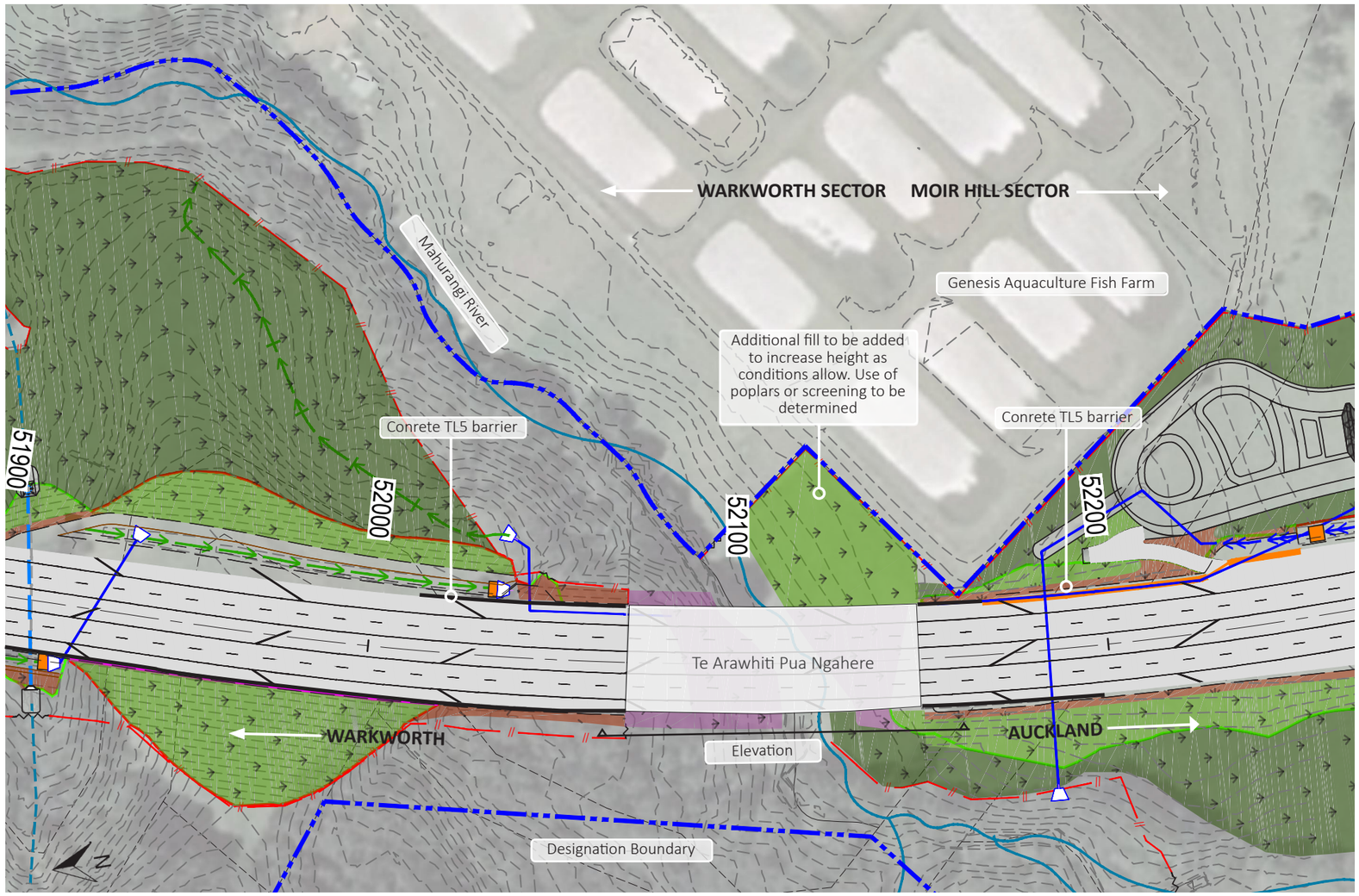
A 75m long viaduct, named Te Arawhiti Pua Ngahere by Hōkai Nuku, is required to cross the Mahurangi River and kauri forest at chainage 52100. The viaduct is supported by two piers and two abutments, and the beams are at a shallow depth to hide in the background. TL5 concrete barriers are utilised across the structure and will transition to w-section barriers, before integrating back to wire rope barriers on each side.

As road users travel north, the low viaduct will cross the Mahurangi River, and rise gently through the grove of native forest close to ground level. The forest will be immediately adjacent to the carriageway and at a level where the sides and main canopy of trees will be clearly visible to road users. The ULDF has specific requirements for this viaduct, seeking to minimise effects on kauri forest and stream, and to reduce obtrusiveness from nearby houses on Perry Road [D63A(e)]. The viaduct achieves the ULDF objectives by adopting a low vertical alignment, cut into the contours on either side of the viaduct, supported by retaining walls. This allows the viaduct to be low and the span to be as short as possible to minimise visual impacts. It also reduces effects on large kauri trees, estimated to be 350-500 years old, in this area as only a narrow, approximate 35m wide, swathe of existing vegetation has been lost. The unaffected kauri forest and supplementary planting will provide some screening of the viaduct structure in addition to the lowered alignment.

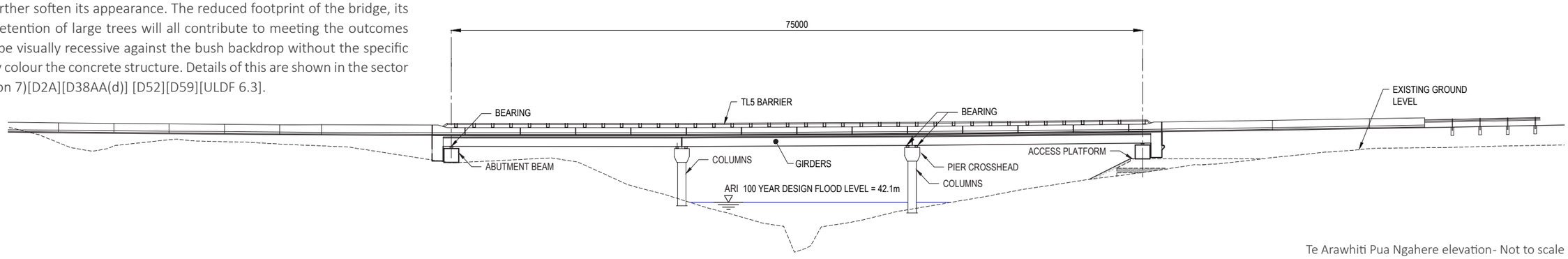
The area to the east of Mahurangi River and viaduct will be planted with the terrestrial mitigation plant species mix (refer section 5.10 and to the adjacent figure) to stitch the native forest across the motorway. This includes tall canopy species that will over time grow to provide further screening and contribute to the concealment of the road from the east.

Section 6.3 of the ULDF lists the specific outcome to soften the appearance of the motorway from the Perry Road area. The hillslope north east of the viaduct will be planted to stitch the kauri bush across the motorway from the Perry Road area, providing some compensation for the cleared canopy species and to repair cleared edges. In the Perry Road area, planting will be undertaken as soon as practicable to allow for maximum growth. The ULDF also includes the outcome of 'retaining as much of the existing row of poplars, and planting additional poplars in the vicinity, to soften views of the viaduct from the Perry Road area.' The outcome of softening the views is achieved by the indigenous mitigation planting, the planting depicted on the embankments, and the existing riparian bush to be retained, will be sufficient to soften the revised highway design. In this area, none of the poplars within designation can be retained due to the earthworks footprint in this narrow area. This is more favourable ecologically as it will tie in with extensive mitigation along the Mahurangi River (Right Branch).

A gravity fed watering system utilising stormwater run-off from the road and a specific plant mix has been developed for the area beneath the viaduct to stitch the landscape beneath it and further soften its appearance. The reduced footprint of the bridge, its low height, and retention of large trees will all contribute to meeting the outcomes of the ULDF and be visually recessive against the bush backdrop without the specific need to artificially colour the concrete structure. Details of this are shown in the sector plans (refer Section 7)[D2A][D38AA(d)] [D52][D59][ULDF 6.3].



Plan of Te Arawhiti Pua Ngahere and context area (refer to legend in section 7)



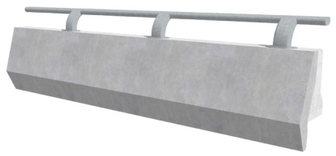
Te Arawhiti Pua Ngahere elevation- Not to scale

Bridge Barrier Transition Design

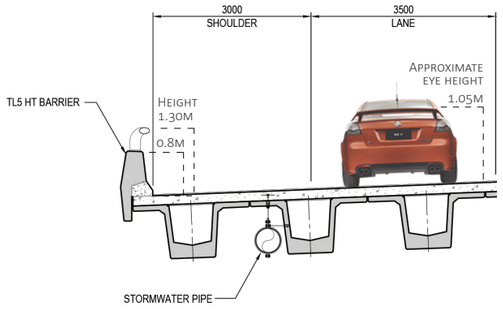
The concrete barriers have been extended, which visually anchors the bridge to the landscape (ULDF section 4.3).

Bridge Barrier Design

The barrier design and barrier height to be used optimises views from the viaducts and bridges for vehicle occupants.



Typical bridge barrier



Typical bridge barrier and eye level heights

Indicative Te Arawhiti Pua Ngahere in the landscape

Indicative Te Arawhiti Pua Ngahere section through the kauri forest (chainage 52100)

4.3 BARRIERS

Project-Wide Barrier Systems

The ULDF barriers outcomes seek clean lines and a refined, minimalistic aesthetic. The Project provides a standardised layout of continuous wire rope barriers. Provision is made for breaks in the barrier for maintenance access, emergency services and emergency stopping. Concrete barriers will protect some motorway furniture (including sign gantries). CCTV, emergency telephones and utility cabinets will generally be located within maintenance bays behind wire rope barriers for easy access and protection. Retaining walls have been avoided where possible.

Median and side barriers will generally be wire rope, which is the first preference expressed in the ULDF [4.3]. The exceptions will be where assets such as sign gantries are located in the median and concrete barriers are used to protect these. Concrete side barriers are also used just north of Te Arawhiti Pua Ngahere to minimise the impact on the kauri forest, allowing filling behind the barriers and therefore reducing the number of trees to be removed.

Barriers provide an important function; they deflect and reduce the likelihood of vehicles from colliding with each other and offer additional protection of structures or utilities adjacent to the motorway. The median and road side barriers have been designed together to provide a clean, continuous line following the length of the motorway route to align with the ULDF outcomes. The consistent surface treatment and minimalist detail of the barrier gives effect to the uncluttered motorway outcome [ULDF 3.1, 4.4] [D36]. As consistent with the rest of the alignment, to create a clean aesthetic outcome, signs and other road 'furniture' have been located outside of road barriers to avoid the need for additional individual protective barriers within the motorway footprint [D36(a)] [D37].

Audio tactile profiled markings (rumble strips) will be installed to alert drivers when vehicles begin to stray from lanes. This method is used to increase safety for road users.

Local Road Barriers

Road safety barriers will be provided on the local road alignment (as required) to protect motorists from hazards and reduce the risk of vehicles leaving the road. In general, a semi-rigid w-section guard rail barrier (or similar) will be installed along the roadside to protect against roadside hazards. The use of wire rope barrier on local roads is impractical given extent and scale. To maintain the rural character, local road barriers will be used sparingly.

Bridge Barriers

The barrier form used on other bridges along the alignment, including Te Arawhiti Pua Ngahere, Mahurangi Bridge and Woodcocks Bridge is a TL5 barrier, (refer to image on page 17) which is a concrete barrier with steel top rail. This barrier reduces the height of the concrete portion of barrier and provides for wide, elevated views from the bridge for vehicles as well as supporting its 'light' and open appearance. The gap between the top of the concrete and the steel top rail along the viaduct and bridges provide a more transparent barrier form, giving the road user an optimised view from the bridge compared to a traditional 1100mm high concrete barrier [ULDF section 4.3] [D37(aa)].

When driving onto a bridge, the leading edge of the side barrier will transition up the height of the concrete barrier. This transition is made through use of standard barriers, each slightly increasing in height. This will start with a metal w-section barrier followed by the thrie beam to help protect the end anchor point of the wire rope barrier. Concrete barriers will be connected to the thrie beam barrier and this transitions to a TL5 concrete barrier across the bridge. As motorists travel off the bridge, the concrete will transition direct to the wire barrier, this will result in a sudden change in height, but this should not significantly impact the visual continuity for road users as the eye will be drawn down the line of the wire rope extending into the horizon.

The 140m section of the motorway between Mahurangi River Bridge and Woodcocks Road Bridge, will use a thrie-beam edge barrier (refer to section 4.7) in place of a wire rope barrier. The thrie-beam edge barrier will be used because the length between the two bridges is too short for wire rope barriers to be effective to deflect vehicles in an accident. The use of the thrie-beam will minimises transitions between barriers, which is consistent with the ULDF.

Graffiti Prevention

Graffiti resistant protective coatings will be applied to all new structural elements, concrete barriers (both sides and top) and urban design features:

- 1.2m from an accessible top edge
- 2.7m above adjacent ground level or base level
- 1.5m horizontally from an accessible substructure element

Steel components that are accessible will be protected by an anti-graffiti top coat, which will allow removal of the graffiti without damaging the corrosion protection system [D36(a)] [ULDF 5.4].

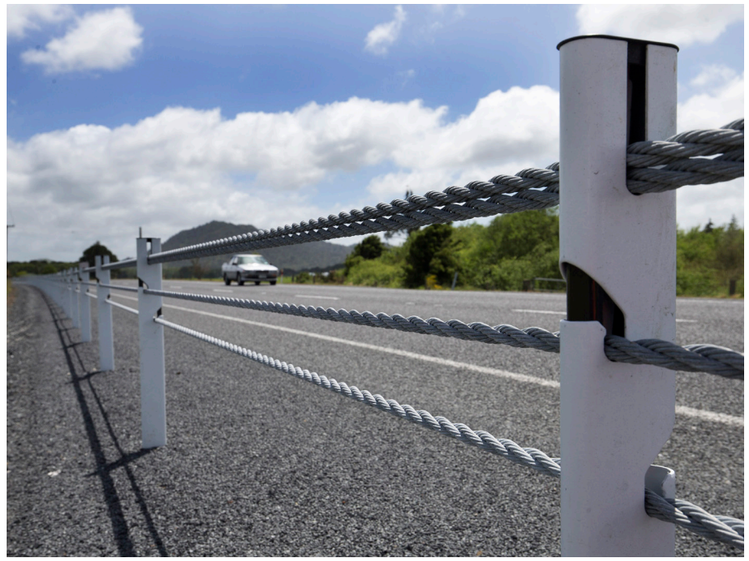
4.4 MEDIANS

The median barrier will be wire rope held by galvanised steel posts where appropriate, and the median area will be fully paved (not planted or grassed). The surface treatment will be consistent, supporting a minimalistic and unobtrusive appearance and draws users attention to other urban design and landscape elements within the footprint of the motorway. Barriers perform best when located on a hard surface with consistent grading; the design provides a median width of 4-6m to reduce the likelihood of vehicle strikes. The paved median complies with the NZTA's Safe Systems approach and TM-2503 "Guidelines for Edge Protection and Medians on Dual Carriageway Roads, incorporating a Safe System Philosophy" [ULDF section 4, 4.4].

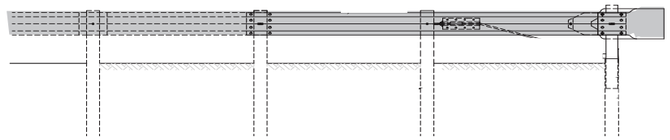
NZTA landscaping guidelines state; "avoid designs, such as narrow central grassed medians which require the closure of active traffic lanes to be mown and maintained." The paved central median, whilst not a ULDF preference, does achieve other ULDF outcomes, contributing to an 'uncluttered highway', a clean road scape and continuous unbroken surfaces [ULDF 4.3, 4.4, 4.13]. Benefits from the use of a paved median include:

- Less need for maintenance activities in the median, which also results in fewer lane closures for maintenance activities
- A safe road for users and maintenance workers
- Avoids issues of plant survival in engineered ground
- Paved medians (unlike grassed medians) are less likely to be prone to water-infiltration of the pavement
- Avoidance of weeds (and the need for spraying) – See also section 4.14 for further details on Weed management

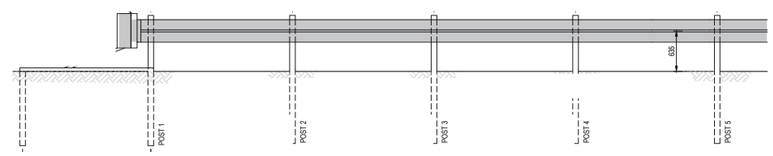
As well as the medians, the interface between the paved roadside shoulder and swale has been designed to minimise weed growth, by limiting areas where weeds might establish by the introduction of hard, engineered surfaces (See also section 4.12 and 4.14).



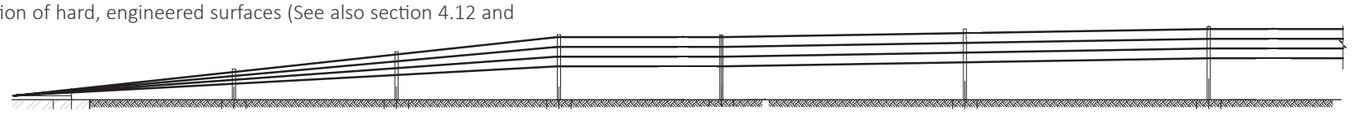
Similar wire rope barriers along the road sides and medians will be used[1]



Metal barrier with trailing end terminal



Metal barrier with leading end terminal



Wire rope barrier transition detail

[1]Safe Roads Alliance

Dark night sky[1]

4.5 NOISE MITIGATION

The pavement surface type for the length of the new motorway carriageway is to be Open Graded Porous Asphalt (OGPA). This type of surfacing treatment minimises road noise by reducing tyre noise omitted from motorway traffic. [ULDF section 4.5, 4.11, D71].

This sector contains one continuous 379m long concrete TL5 barrier with a height of 0.91m, which will be located to the west of the Mahurangi River Bridge. Noise standards in the designation conditions apply to the Project [D36(a)].

4.6 LIGHTING

Light poles are required in specific areas of the Warkworth sector around the Kaipara Flats Road and Goatley Road intersections, the approaches to and around the northern roundabout (between Chainage 47,000 to Chainage 47,340) for safety and operational reasons [ULDF section 4.7]. Whilst lighting will be visible from some properties in Viv Davie-Martin Drive, it is significantly distanced from these homes, being approximately 700m from the nearest house to street light.

Lights with energy efficient LED luminaires will be used to prevent excess spill light, glare and upward waste light to reduce effects both for road users and for residents living near the motorway [D75].

The mitred light poles integrate with furniture along the motorway and the wider regional motorway network. They will be 12m high, evenly spaced at 50m intervals (there may be occasional exceptions where other factors necessitate intervals), and have a galvanised finish.

The remaining stretch of this part of the Warkworth sector does not require lighting, and therefore the natural and rural character of the area will be retained. The dark night sky also allows for a natural night environment for bats, birds and other fauna [ULDF section 4.7].

4.7 POLES AND GANTRIES

Motorway furniture, which includes poles and gantries, is made up of different forms and shapes which fulfil different functions. This furniture suite has been carefully developed for use on Transport Agency road assets over time and not only incorporates consideration for aesthetic design but also operational safety and maintenance. The furniture adopted on this Project is consistent with that used across the State Highway network. Although the suite used is inconsistent in the shape of the furniture, consistency is obtained through use of similar materials and colour.

At intermittent distances, there will be closed circuit television cameras (CCTV), which have been configured to cover the length of the sector, two sign gantries and approximately 17 road signs (refer page 21). Other infrastructure utilities that road users can expect to see will include cameras, gates for access tracks, roadside cabinets to house service equipment, and emergency telephones.

There are two main types of gantry, a circular hollow section gantry (CHS gantry) with curved outreach arms, and a truss gantry with a more angular form. These forms are shown on the highway furniture diagram on the following page and in this sector there is one of each type. The CHS gantry is used for static signs. The CHS gantry is safer to maintain and discourages unlawful access and damage over the truss gantry. The truss gantry is used specifically for VMS signage and provides the necessary access for the required regular VMS maintenance. The highway furniture diagram shows that the two types of gantries have different forms, one curved and thick and the other more narrow and angular. If they were to be seen in the same viewshaft, the two contrasting forms may be accentuated, however in this sector these two gantries are separated by approximately 2.5kms and will not be seen together in a single view. Although these gantries have contrasting forms, their designs are driven by function, safety and to provide consistency across the state highway network and are therefore considered to achieve the ULDF outcome of 'a coherent suite of highway furniture'. A further ULDF outcome is to 'minimise variety of poles and posts …to reduce clutter' [ULDF 4.6] and this has been achieved within the constraints of the higher level project outcome of "safety".

Signs along the alignment are necessarily varied depending on use and information to be conveyed. They include both static signs and variable message signs. Locations of signs are shown on the plans in Section 7.

Poles, gantries, and signs are consistently set back from the road and barriers; their spatial arrangement has been guided by the 'Safe Systems Approach' to facilitate safety for road users, allow for simpler maintenance and mitigate visual inconsistencies.

The galvanised steel poles that hold the wire rope will be consistently spaced, a minimum of 3m apart and set back 3.1m from the outside edge of the traffic lane. Sign poles are outside the wire rope deflection zone to prevent the need for further safety barriers or measures that would clutter the clean line aesthetic of the motorway. Sign poles are located with a minimum clearance of between 1.54 and 2.15m from the wire rope barrier to take into account the roll allowance and deflection zone that reduces the likelihood of damage or injury in the case of road accidents. Lights are located a minimum of 1m from barriers and will be set out consistently. The other furniture is typically located in maintenance bays and set back from the main carriageway.

While assets are generally located within maintenance bays and behind wire rope barriers, concrete barriers are provided on the shoulder to mirror the median concrete barrier protection level for gantries and assets located within the median.

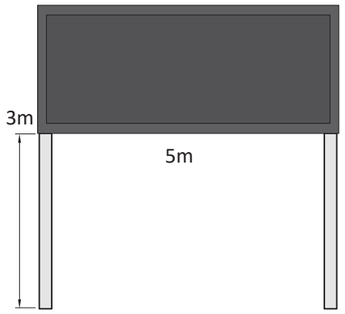
The minimisation of poles and gantries and the standard appearance and spacing of motorway furniture will reduce visual motorway clutter, maintain clean lines, and contribute towards a 'clean, uncluttered highway' [ULDF 3.1, 4.6] (refer to section 4.15 for motorway furniture descriptions and locations).

Example of mitred street lights (Southern Motorway at Grafton Road)[2]

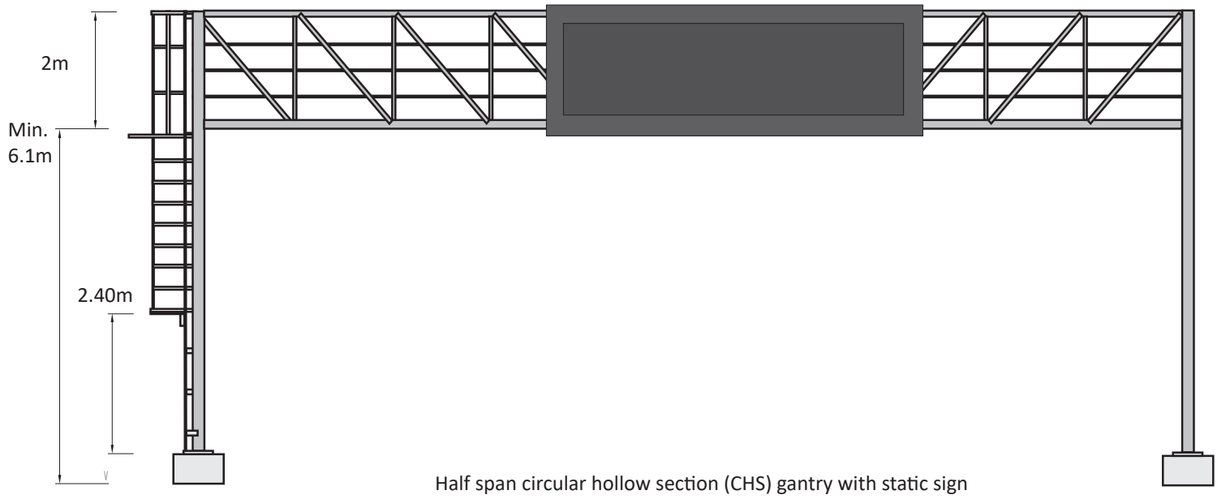
Motorway furniture element	Approximate Numbers
Automatic number plate recognition cameras	18
Automatic video incident detection cameras	2
Sign gantry	1 motorway VMS on a truss gantry 1 partial CHS gantry
CCTV camera	8 CCTV cameras on 15m poles 800m maximum longitudinal spacing between cameras
Concrete barriers	On bridges and to protect static sign gantries and ITS assets
Road side sign	Approximately 31 signs Set back a minimum of 1.54m to 2.15m behind wire rope barrier
Combined Overheight Warning Signs (OHWS) and Regional Variable Message Signs (VMS)	3 post mounted (2 combined with overheight warning sign) 1 on a gantry (with a CCTV camera) Set back a minimum of 2.15m behind wire rope barrier
Variable speed limit sign	6
Wire rope barrier	Entire road alignment 3m spacing between posts, set back 3.1m from the edge of the outside traffic lane
W-section (metal) barrier	140m length between Mahurangi River and Woodcocks Road Bridge on both sides of motorway

[1]Skyseeker, 2017 [2]Russellstreet, 2011

Over height warning sign (OHWS) and/or Variable message sign (VMS)

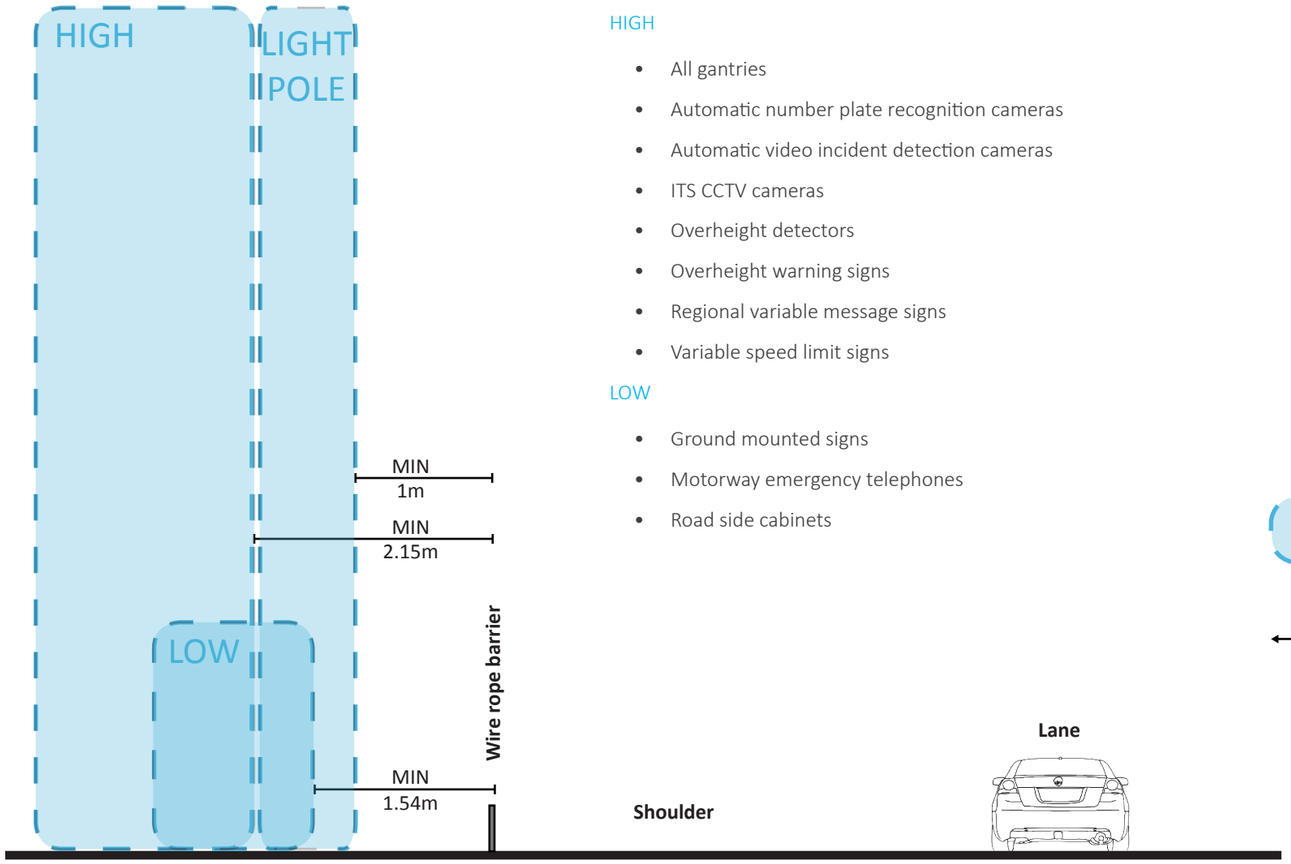


Half span truss gantry with variable message sign (VMS) (the final truss gantry design to be confirmed - a cantilever may be used)



Half span circular hollow section (CHS) gantry with static sign

Typical motorway furniture used along the Project alignment



Spacing of high and low furniture

HIGH

- All gantries
- Automatic number plate recognition cameras
- Automatic video incident detection cameras
- ITS CCTV cameras
- Overheight detectors
- Overheight warning signs
- Regional variable message signs
- Variable speed limit signs

LOW

- Ground mounted signs
- Motorway emergency telephones
- Road side cabinets

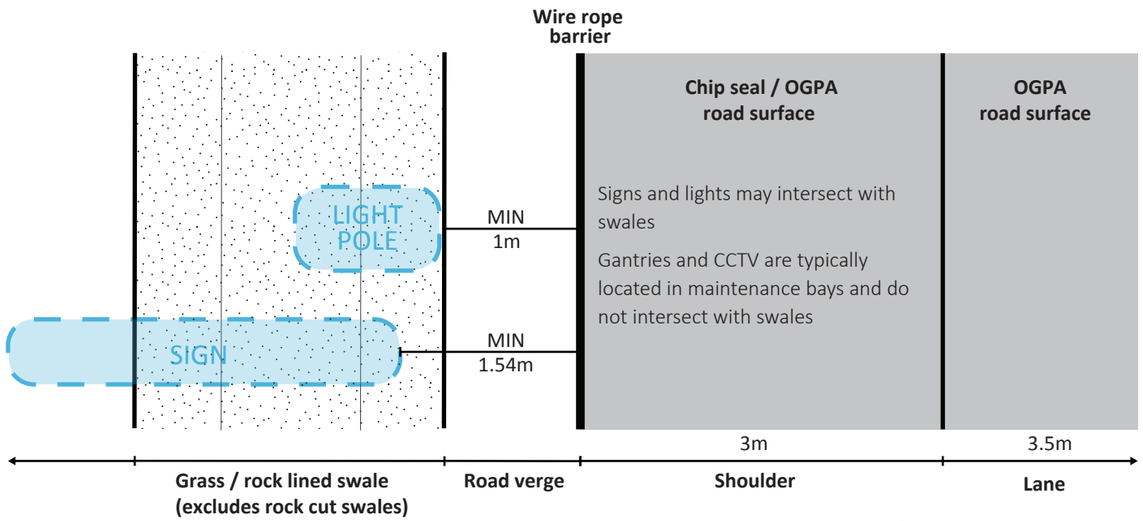
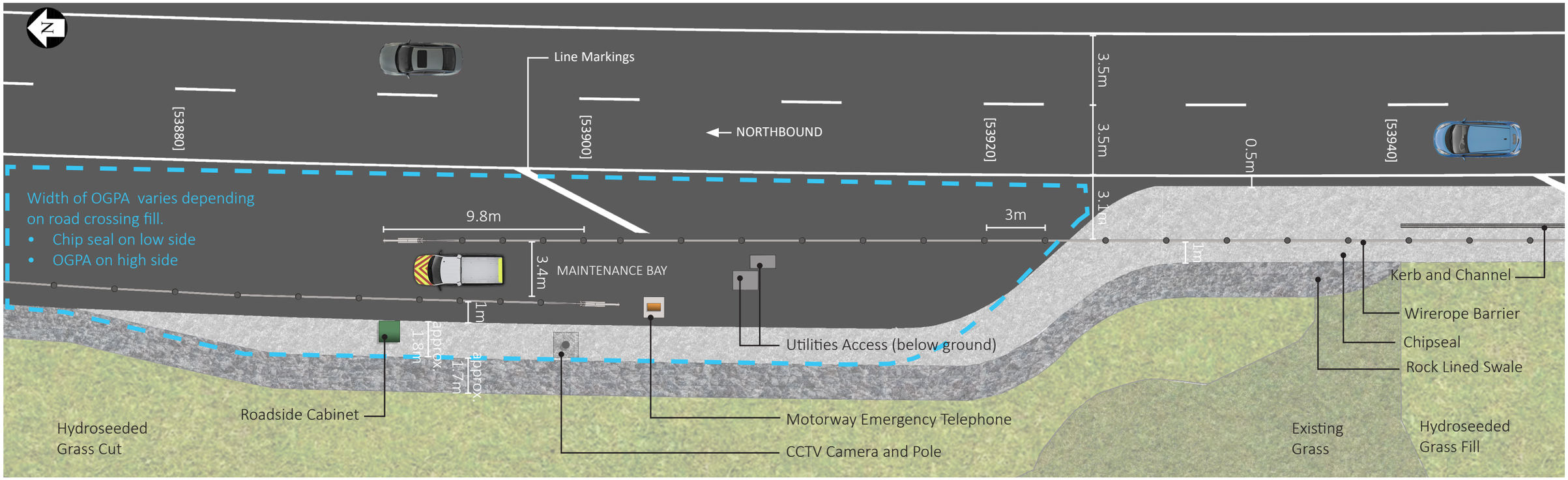


Diagram of typical highway furniture set out- plan view

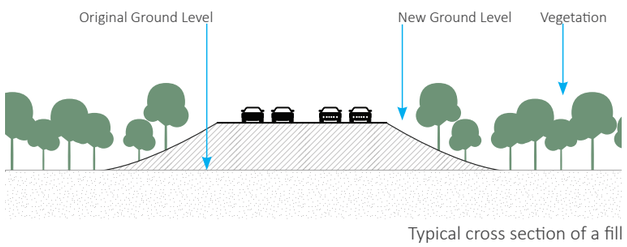


Typical maintenance bay details demonstrating the spatial relationship between motorway furniture

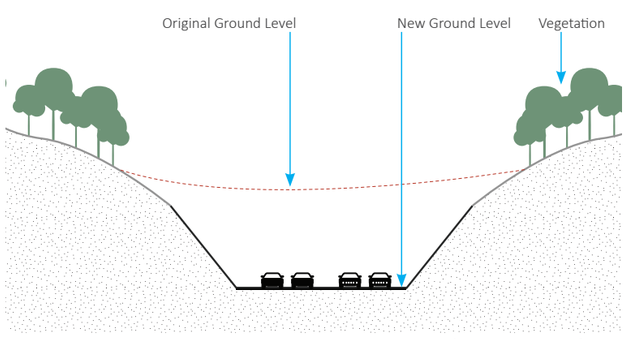
4.8 CUT AND FILL BATTERS

Cut and fill areas are required to level the motorway alignment and marry it with the existing ground level.

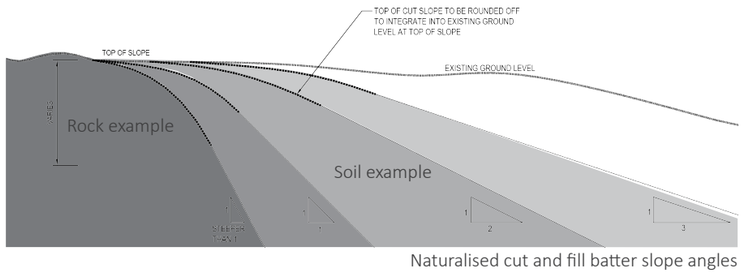
As the Warkworth sector is predominantly low-lying farmland, there are few large cuts and more embankments with reasonably flat slopes. The exception to this is a prominent cut area located to the north of Te Arawhiti Pua Ngahere. The viaduct will sit approximately 8.5m above the ground at its highest point, and the high cut batters will be left as rock. Low cut batters in rolling terrain will be graded to a slope that will blend into the surrounding topography and natural ground. The batters will be covered with topsoil and planted or grassed to match the adjacent land [D36(c)] [D37].



Typical cross section of a fill



Typical cross section of a cut



Naturalised cut and fill batter slope angles

Cut slopes on the Northern Gateway Toll Road which will be similar in nature to Ara Tūhono[1]

4.9 HIGH CUT BATTERS

Rock Cut Batters

Where there are steep rock cuts (such as to chainage 50750), the rock will be left exposed to showcase the geology as a key feature of the journey, which will contribute to a minimalist and natural aesthetic [ULDF section 4.8 and 4.9].

A fixed drapery wire mesh may be used on rock faces to stabilise the cut slopes and contain loose and falling debris, as such, the mesh is an important safety feature. The mesh will allow the underlying rock to be visible, not disguise the rock face, and will have a uniform 'finish' height of 4.7m above the carriageway so as to not be in the direct line of sight of road users and provide motorists with a consistent, uncluttered line. To allow the underlying rock to be visible and provide mesh transparency, the mesh will have uniform sized 'holes', it will be grey in colour and consistent with the underlying grey rock colour. The rock is expected to be a blue-grey at time of construction and will weather to a lighter grey colour – the mesh is expected to 'weather' and fade to a slightly lighter grey colour. The mesh will be draped across the rock face and only secured where required for stability. The mesh will be suspended from a series of steel anchors and wire ropes at the crest of the rock cut; due to this height above the carriageway, the anchors and rope are unlikely to be visible to road users. The only places where the use and length of wire mesh may vary will be where geotechnical conditions dictate the mesh to fall further down the slope [D37][ULDF section 4.9].

Where poor quality rock is encountered during construction, additional stabilisation measures for rock faces may be necessary. Stabilisation is utilised to help prevent the risk of rock failure or rock fall onto the road, minimising the risk of road closure and injury to road users. The extent and type of stabilisation measures utilised will be determined on a case by case basis, using an "observational approach" for the specific design of the rock cuttings. Design evaluation processes will be used to determine which treatment from a toolbox of options are used. The tool to be used depends on a number of factors (geological conditions, durability, location, cost). The treatment options are as follows; (1) flattening the slope (to reduce failure risk), (2) wire mesh (similar to drapery mesh) which allows the underlying rock to be visible, (3) rock-bolts, or (4) spray on concrete (shotcrete). Shotcrete is the least favoured treatment option, both in terms of construction preference and in terms of the ULDF outcomes. If it is needed, it will be used sparingly and only where deemed necessary. If required, the shotcrete will be coloured to blend in with the surrounding rock [ULDF 4.9, 4.11] [D36(a)][D37].

Rock mesh and bolts to be used along the tops of cuts

4.10 LOW FILL BATTERS

Low-medium fill batters in the Warkworth sector will be between 2-10m high and graded to have gentle slopes to blend into surrounding contours (4H:1V in most places). All slopes will be topsoiled and planted with appropriate low flammability landscaping relevant to the context of the area as required by the ULDF [4.12]. Fill batters in close proximity to stream courses will be replanted in compliance with the ULDF [4.11]. Cross sections for detailed examples of cut and fill batters (not representative of any one place) as shown in Section 4.14 [D36(a)] [D37].

[1] Google Maps Street View @ 2015

Kerb and channel on the Northern Gateway Toll Road, similar to those used on the Project[1]

Possum[2]

Example of landscape planting on batters

4.11 ROADSIDE MARGINS AND DRAINAGE

The roadside drainage includes swales, kerb and channel (a concrete structure at the edge of the road, designed to guide stormwater and provide an edge to the road), catchpits and sediment traps (containment areas that settle the sediment contained in stormwater before discharging it to the wetlands). These have been designed as part of the coherent suite of motorway elements as these make up part of the motorway aesthetic and contribute to the outcome of an 'uncluttered, clean highway'. The drainage features will be cohesive, linear, and flush with the road surface and consistently spaced in relation to other motorway edge treatments, including the road side barriers and the road edge, to provide clean and uncluttered sight lines as preferred by the ULDF [4.13].

The stormwater conveyance infrastructure comprises pipes, and swales with lining materials of grass or rock and kerb and channel. Rock lined swales are used in steep sections of roads and on steep gradients to collect stormwater runoff from the rock cut, and grass-lined swales on flatter sections, reinforcing the adjacent landscape character. Kerb and channel is used at the top of soil fill slopes to reduce the size (footprint) of embankments, minimise visual impacts, earthworks and impacts on terrestrial and aquatic ecology.

In areas where the cuts expose the rock soil, the swales drain to sediment traps before entering the stormwater wetlands. Section 4.13 and 4.14 indicate that the opportunity for weed growth will be minimised along the road edge due to the positioning of the roadside motorway furniture and infrastructure and because the sediment traps will cleared of residual sediment as part of the maintenance regime.

Drainage elements will help to establish a clean line behind the road edge barriers. Typically drainage elements will be at a constant offset from the barriers. For swales (except rock cut swales), highway furniture in the form of signs will be placed at a standard offset, and depending on the size of the sign, may intersect the swale; light poles are treated similarly and may also intersect the shoulder of the swale. Signs and light poles are secured with concrete footings and located in swales where necessary. Typically all other highway furniture is located in maintenance bays, and would not intersect swales. The road surface drainage design is consistent with that used in the central and southern sector, providing linear continuity along the motorway network, and minimising maintenance [D36(c)][D37(d)][ULDF 4.13]. The design and layout of the infrastructure is consistent along the motorway alignment and provides clean lines.

A green roadside appearance will be provided by planting which runs parallel to the motorway outside of the roadside barriers and drainage infrastructure (refer section 5.9). The road surface drainage design is consistent with that used in other sectors, providing linear continuity along the motorway network, and minimising maintenance including the use of sprays [D36(c)] [D37(d)] [ULDF 4.13].

4.12 PEST CONTROL

Mammalian pests can affect plant survivorship and inhibit natural regeneration processes through browsing foliage (e.g. possums, rabbits and mustelids) and the consumption of seeds (e.g. rats), therefore [D36(c)]:

- Pest mammals will be controlled to facilitate plant growth
- Baiting will be employed to reduce possum and rat numbers in forest systems and along the edges of wetland systems
- Regular monitoring for pest mammals will be undertaken

4.13 WEED MANAGEMENT

Along the entire alignment, weed growth will be minimised as much as practical to produce a clean edge (refer to cross sections in Section 4.14) while also minimising the need for herbicide maintenance. The interface area between the rock lined swales and chipseal (a pavement surface made up of layers of bitumen and aggregate) has been designed to minimise weed growth. The chipseal will extend to the edge of the swales. The swales will be lined with geofabric/geotextile (strong manufactured fabric used to prevent erosion and stabilise soil), rocks or grass and treated with pre-emergent herbicide to reduce the need for spraying. Sediment will be removed from sediment traps as part of maintenance, to avoid creating a medium for weed growth. Where weeds are unable to be minimised through design, they will be managed and controlled with herbicide and manual removal. Pre-emergent herbicide will prevent weeds from establishing and spot spraying will be used in some instances to keep pine seedlings, gorse, pampas and other weed species under control, while avoiding affecting adjacent planting [D36(c)].

Landscaping on the outside edge of the swale or kerb and channel will maintain green margins . The planting and grass hydro-seeding will commence as cut and fill areas and weed control is completed along the motorway alignment [ULDF 4.14].

Herbicide spraying will be used as a control method to minimise grass and vegetation growth along the route [ULDF 4.3, 4.4].

Hand removal of some species will be provided as a measure to prevent the spread of kauri dieback disease.

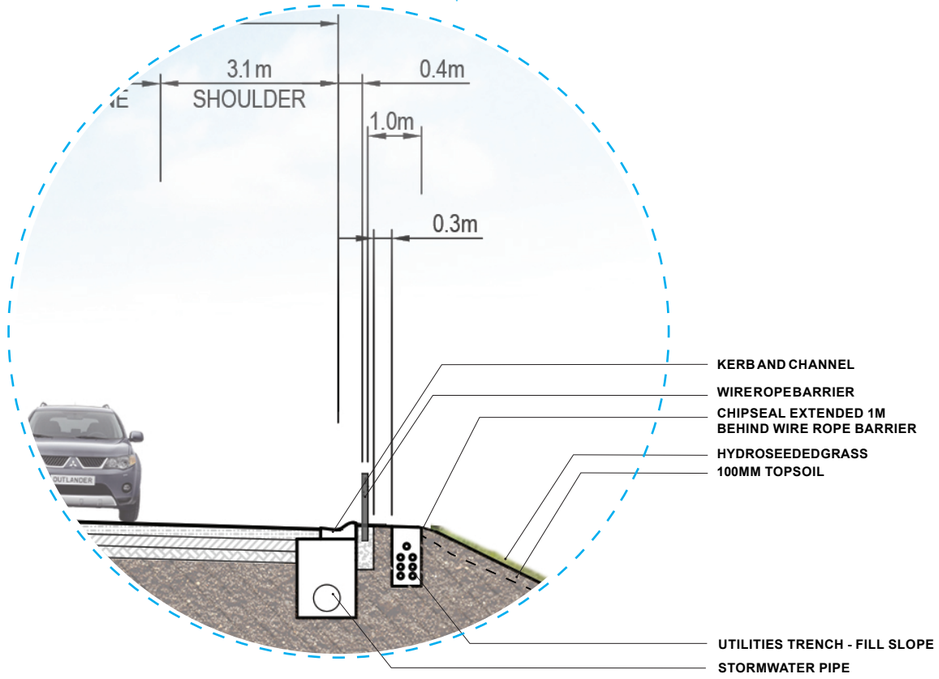
[1] Google Maps Street View @ 2015 [2] Tim Adams, 2015

4.14 ROAD ELEMENT CROSS SECTIONS

The following cross sections portray the combined result of the motorway elements, demonstrating; ‘a clean and uncluttered highway’, that is understated and free of distraction, with the edges providing a minimalist aesthetic and barriers maximising openness and clear, continuous lines [D37] [ULDF section 4.3].

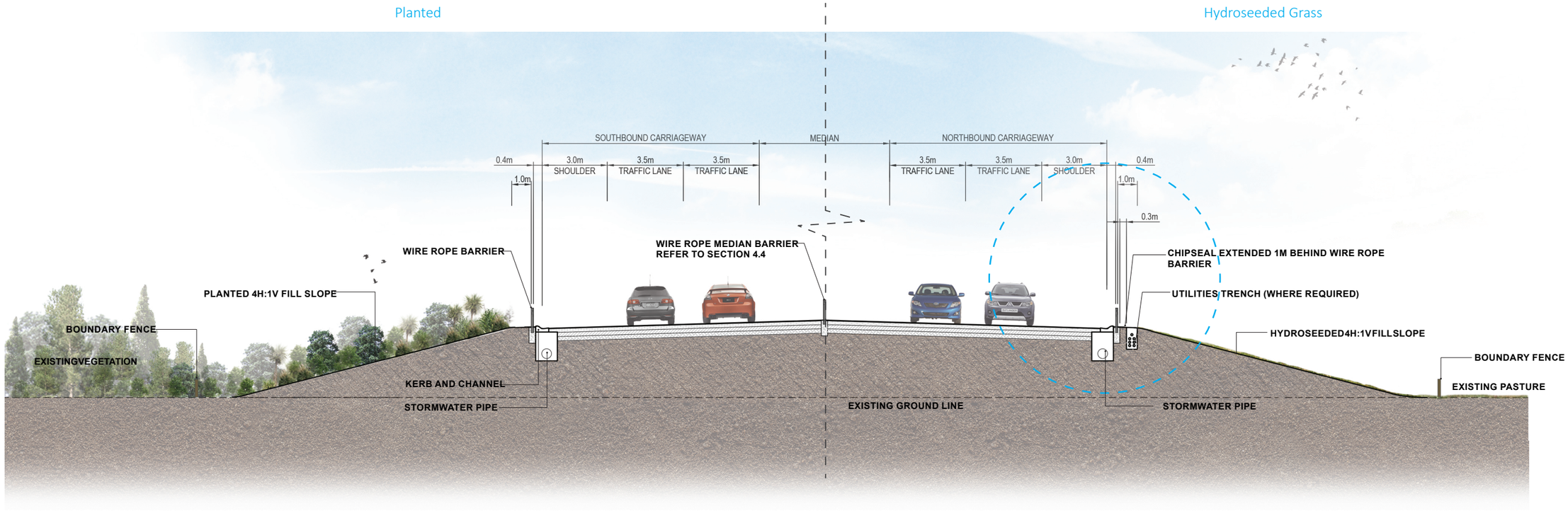
The expanded circular images emphasise the interface of motorway elements such as swales, kerb and channel, barriers and vegetation, to demonstrate a clean road edge.

Kerb and Channel on Fill Slope



Planted

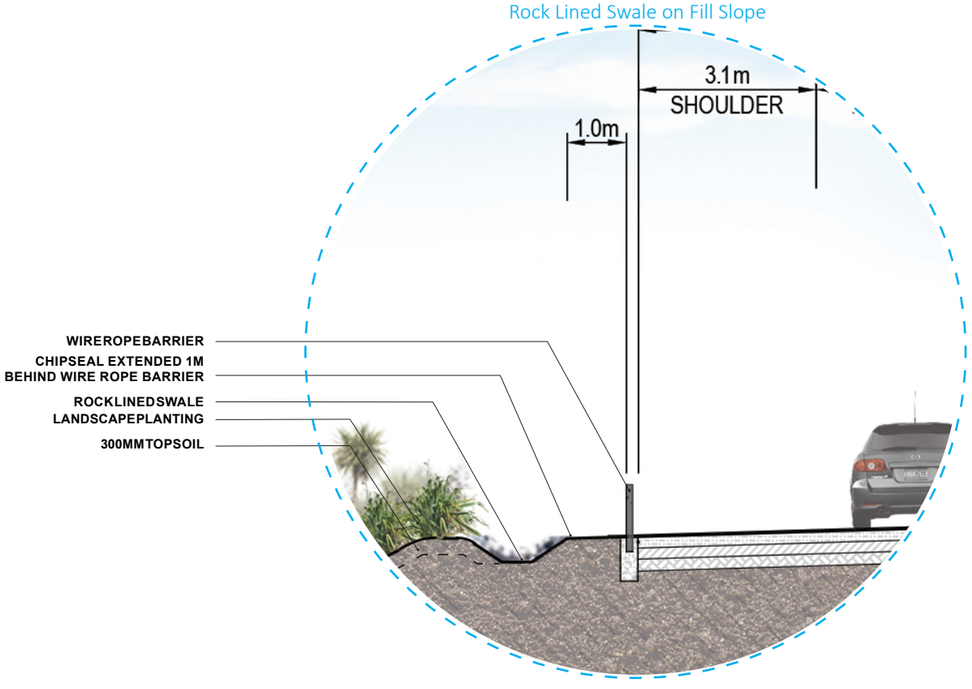
Hydroseeded Grass



Cross section - Typical 4H:1V fill embankment with kerbs showing examples of both landscape planting and hydroseeding on low fill batter slopes without swales

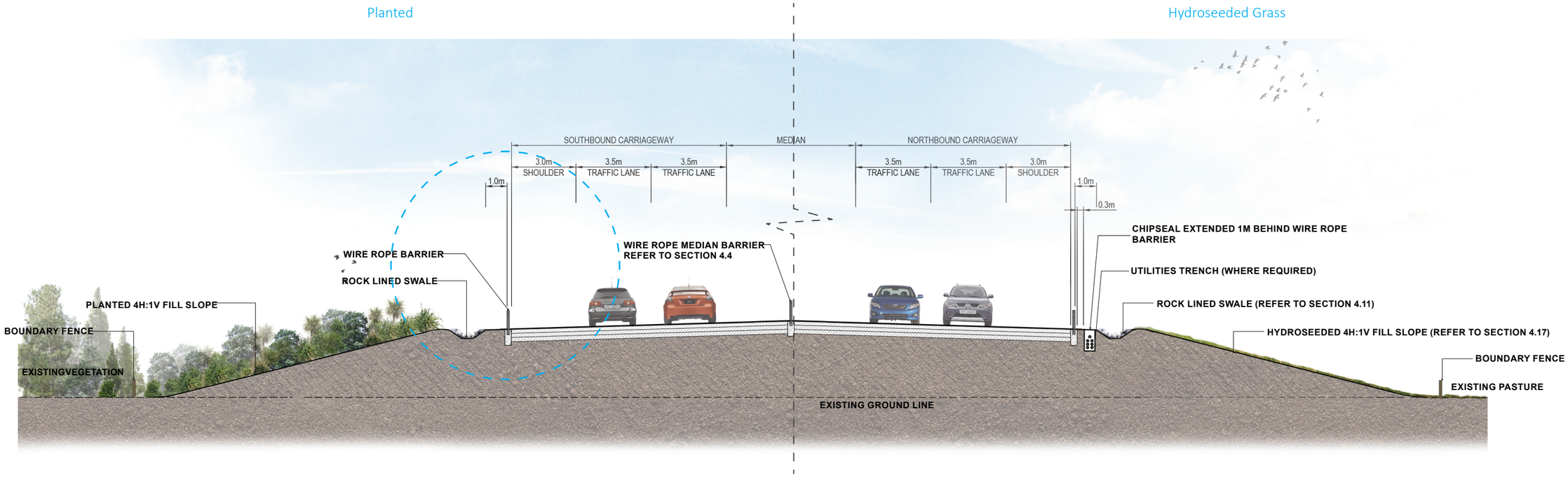
1:200 @ A3

Rock Lined Swale on Fill Slope



Planted

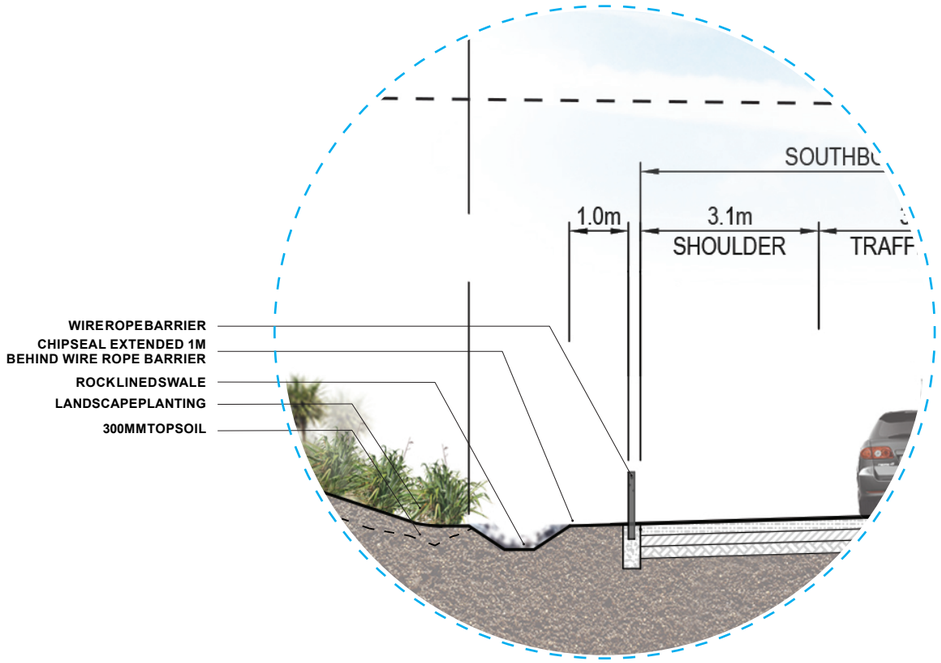
Hydroseeded Grass



Cross section - Typical 4H:1V fill embankment with swales showing examples of both landscape planting and hydroseeding on low fill batter slope with rock lined swale

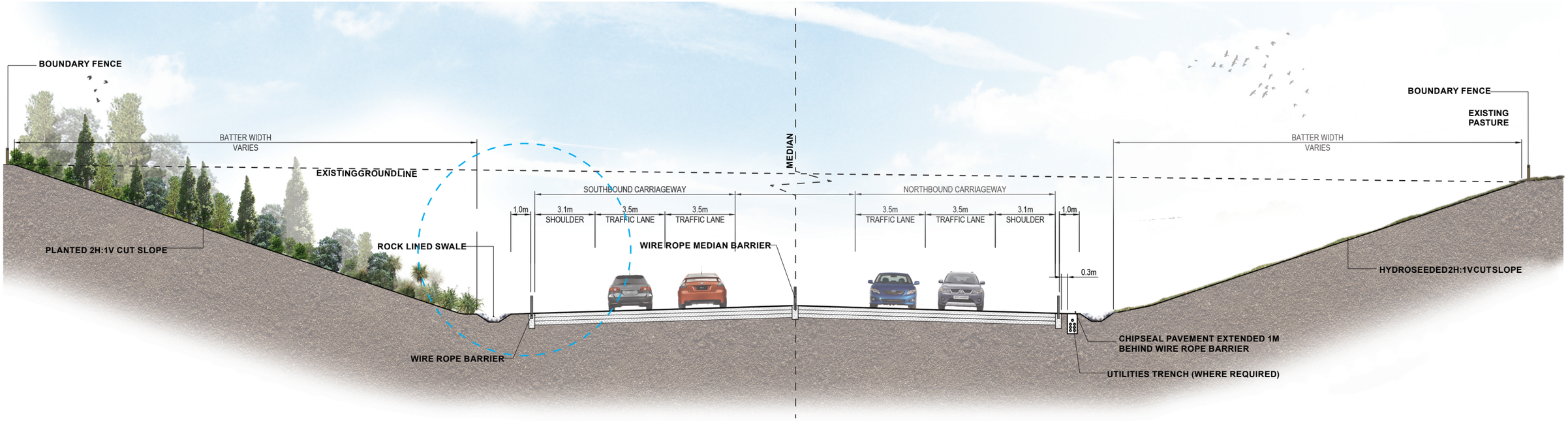
1:200 @ A3

Rock Lined Swale on Soil Cut Slope



Planted

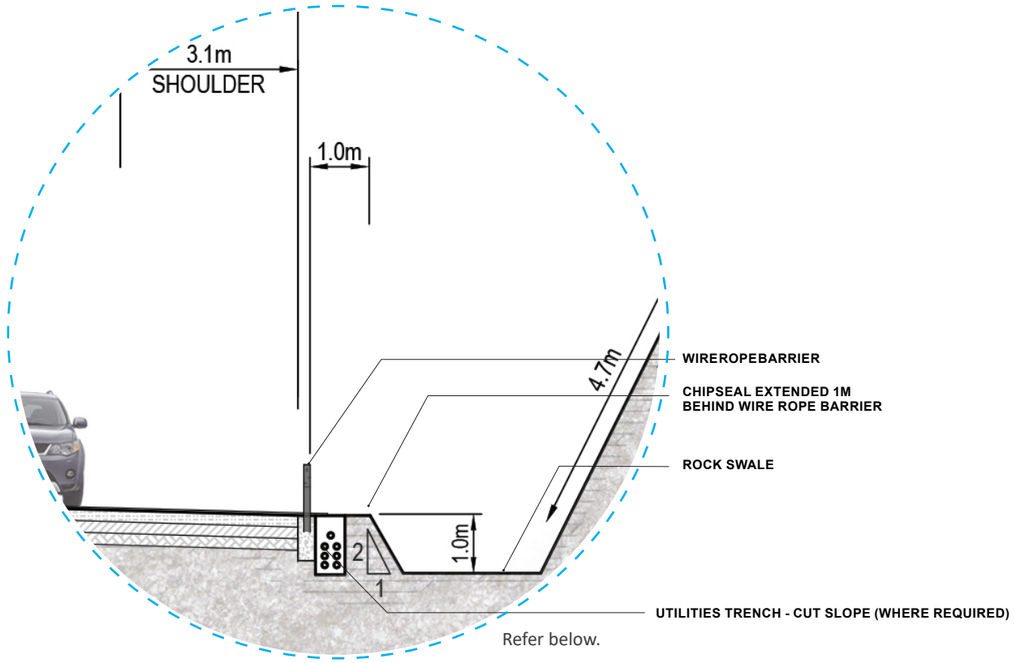
Hydroseeded Grass



Cross section - Typical 2H:1V cut embankments showing examples of both landscape planting and hydroseeding in area with low cut batters and swales

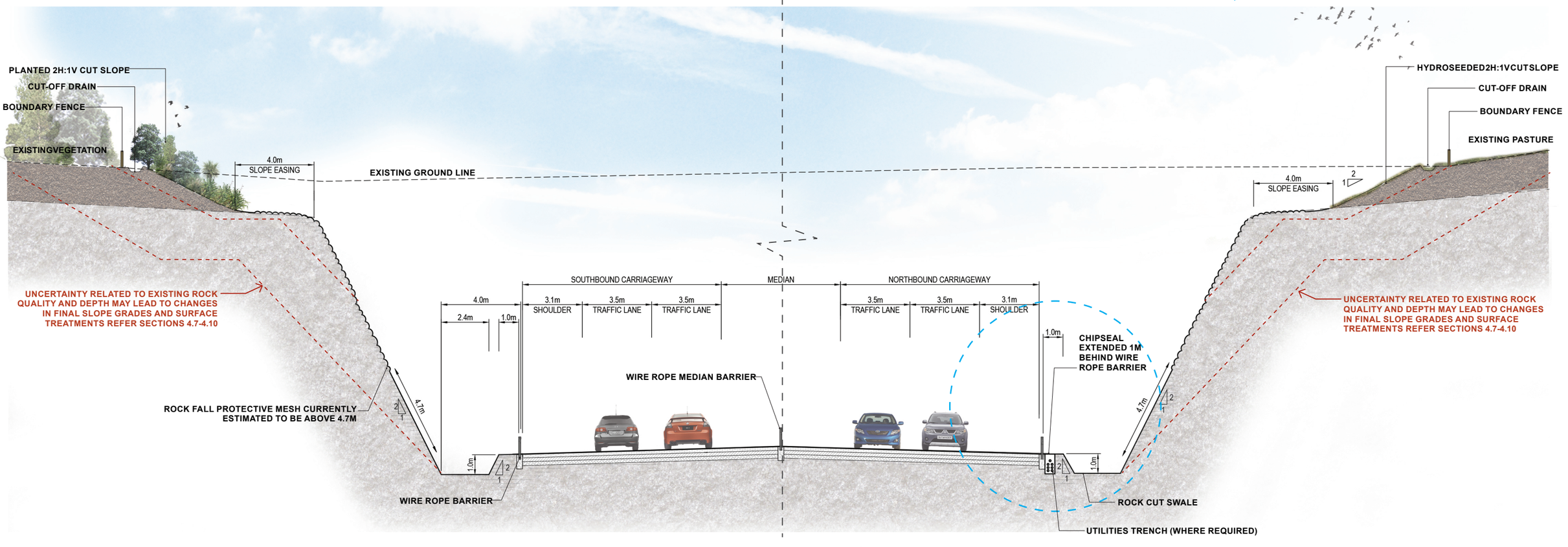
1:200 @ A3

Rock Swale on Rock Cut Slope



Planted

Hydroseeded Grass

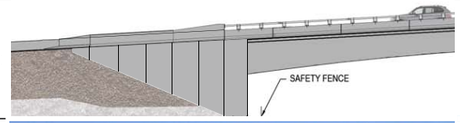
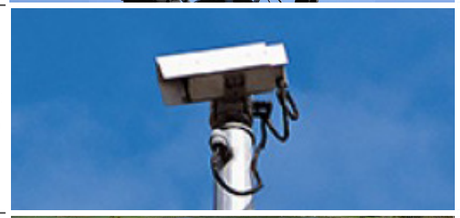
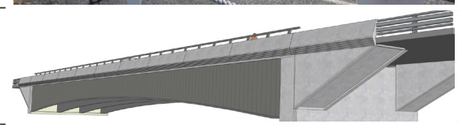
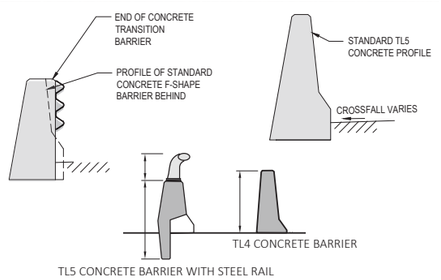


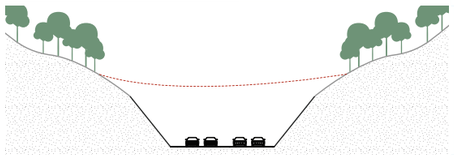
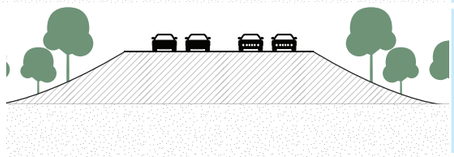
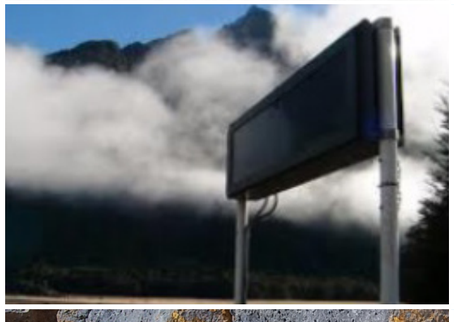
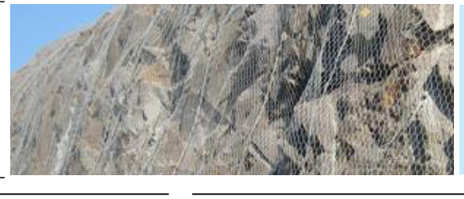
Cross section - Typical 1H:2V rock cuts showing examples of both landscape planting and hydroseeding in an area with high rock cut batters demonstrating continuous rock layback

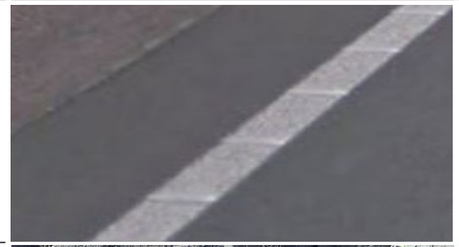
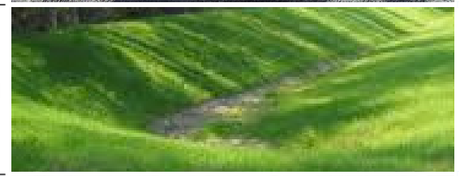
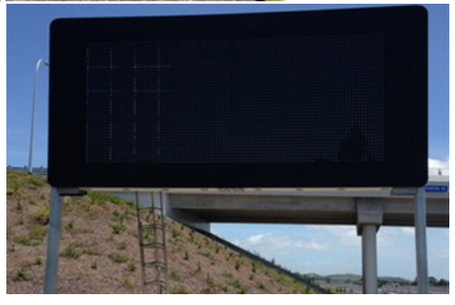
1:200 @ A3

4.15 TYPICAL MOTORWAY ELEMENTS

The motorway furniture is a cohesive suite of elements, simple in profile and restricted in colour. This limited palette reinforces the ULDF outcome of a cohesive and understated motorway [D36(a)]. Typical elements to be used in the design of the motorway.

Element	Example	Photo Reference	Definition	General Locations
Abutment		Section 5.4	A structure built to support the lateral pressure of a span at the ends of a bridge.	At the ends of bridges, such as Te Arawhiti Pua Ngahere and the two at Woodcocks and Mahurangi River.
Automatic Number Plate Recognition		Section 4.7 Photo taken by Adrian Pingstone, 2004	For the measurement of the level of service KPI an automatic number plate recognition system will be implemented.	Approximately 18 cameras in this sector, generally located around the Kaipara Flats Road intersection, the Matakana Link Road intersection and south of the Northern roundabout.
Automatic Video Incident Detection (AVID)		Section 4.7	The Automatic Video Incident Detection (AVID) System will be capable of providing, in real time, automatic incident detection using video feeds from the cameras installed on poles at entrances and exits along the motorway. Installed on 6m poles at various locations on the motorway.	2 at CH47100, 2 at the Northern roundabout.
Barrier- W-Section Guardrail (TL4)		Section 4.1 Photo from: Pexels, 2016	Semi-rigid W shape section galvanised steel motorway barrier.	Local roads and bridge transitions.
Barrier- Thrie Beam		Section 4.1- Google Maps Streetview @ 2015	Thrie-beam is a type of barrier that is two pieces of w-section guardrail formed into one single shape.	Thrie-beam guardrail are used in transition from w-section barriers to more rigid barriers, such as concrete. This is generally used on the approach to bridges and where there are stretches of less than 114m.
Barrier- Wire Rope (TL4)		Section 4.1	These are flexible safety barriers, built from steel wire ropes and mounted on posts. They are designed to break on impact, with their main purpose being to prevent vehicles from leaving the road or crossing the centreline.	Along the motorway, median and edge barriers are predominantly wire rope on galvanised steel posts.
Bridge		Section 5.4	A structure carrying a road across a river, road, or other obstacle.	Bridges in this sector include; Te Arawhiti Pua Ngahere, Mahurangi River Bridge and Woodcocks Bridge as described in section 4.2.
Cantilever Gantry		Section 4.7	An overhead structure supporting equipment such as signs.	There will be one gantry mounted overhead sign located at approximately chain 49000 northbound.
Catchpit Manhole		Section 4.10	A chamber with a grated lid to capture stormwater runoff from the motorway carriageway. Runoff is then conveyed to a wetland for treatment.	Along the edges of the motorway.
Concrete Barriers		Section 4.1	A concrete barrier is a high rigid barrier. TL4 and TL5 refer to Test Levels 4 and 5, where the higher the test level, the greater the ability to contain vehicles. On the project we use the following concrete barriers: • Concrete TL4 Barriers (915mm high) • Concrete TL5 barriers (same profile as the Concrete TL4 except 1070mm high) • Texas HT Barriers (bridge barriers)	Typically installed on bridges to provide continuous edge protection for vehicles. On bridges (Te Arawhiti Pua Ngahere, Mahurangi River Bridge and Woodcocks Bridge), barriers are concrete with a top rail to optimise views out into the wider landscape. Concrete barriers are used to protect static sign gantries and ITS assets.

Element	Example	Photo Reference	Definition	General Locations
Culvert		Section 5.6 Photo from: The Constructor Civil Engineering Home, 2017	A pipe carrying a stream or open drain under a road.	Approximate chainages; 47370, 47700, 47940, 48330, 49090, 49510, 49880, 50290, 50500, 50880, 51040, 51380, 51620, 51910.
Cut		Section 4.8	Terrain that is cut down from its present elevation to allow a smooth road gradient.	Elevated areas.
Embankment		Section 4.8	Fill that is placed over a low lying area e.g. gully to allow a smooth road gradient. Large fill embankments are present throughout this section.	Along the alignment in low lying areas, particularly around culverts and Soil Disposal Sites.
Variable Speed Limit Sign		Section 4.7	Sign will provide a variable speed limit display that can be adjusted to the road conditions depending on traffic, weather or any other cause.	6 in the north; 2 at approximately 47600 (pole), 48200 (pole) and 49000 (on a pole).
Mechanically Stabilised Earth (MSE) Wall		Section 4.2	Soil constructed with artificial reinforcing.	Bridge abutments.
Open Graded Porous Asphalt		Section 4.5	An open graded blend of coarse and fine aggregates, mineral filler and a bitumen based binder. This mixture is intended to be used where there is a requirement for texture depth, noise suppression and/or splash reduction.	Open graded porous asphalt (OGPA) has been selected as the final surfacing for the motorway. This will cover the entire carriageway width, except on shoulders on the "low side" of the carriageway and verge outside edge barriers.
Over height warning sign		Section 4.7	High visual impact warning signs dedicated to advising drivers of vehicles of their over height dimension detection erected at suitable locations to give the drivers adequate space to stop before entering the motorway and opportunities to detour by alternative routes. The warning signs will advise drivers of over height vehicles not to enter the motorway/tunnel and to detour to the appropriate route or stop. The over height warning signs will be installed after every detector, around 200 metres after the detection point.	2 located north of the Northern roundabout (combined with VMS). The sensors are generally located 200m from the signs.
Rock Bolt		Section 4.9	A rock bolt is a steel or fibreglass rod that is grouted to the ground, used to anchor and stabilise rock excavations.	Used in areas of rock cut where the ground is deemed to require further stabilisation.
Rock Fall Mesh		Section 4.9	Durable wire mesh used to stabilise the rock cut slopes and/or allow controlled movement of loose rocks to the base of the cut to be captured in the rock fall swale.	Used in areas of rock cut where rock fall is deemed a risk.

Element	Example	Photo Reference	Definition	General Locations
Rumble Strips (Audio Tactile Profiled Markings)		Section 4.1 New Zealand Transport Agency	Audio tactile profiled markings, commonly known as rumble strips, help prevent drivers from running off the road or straying across the centreline. Consisting of raised white ribs spaced at regular intervals along the edge of a road or down the centreline, they can be felt and heard when car wheels cross over them. The rumbling effect warns drivers that they are veering out of their lane.	Used along the white painted lines both along the edges and lane lines of the motorway.
Shotcrete		Section 4.89	Concrete that is sprayed onto a soil or rock face. Generally used in conjunction with rock bolts.	Rock cut faces where necessary for stabilisation.
Swale- Grass Lined		Section 4.12 Photo from: Thomas Engineering	A grassed swale is a constructed shallow, open channel appearing as a landscape feature. Grassed swales slows and controls the rate of the conveyance of storm water and acts as a filter to remove pollutants.	Grass lined swales on flatter sections, reinforcing the adjacent landscape character.
Swale- Rock Lined		Section 4.11- Google Maps Streetview @ 2014	A linear channel lined with erosion-resistant rock and designed to convoy runoff to an outlet.	Rock lined swales are used in steep sections of roads and on steep gradients.
Terminal- Leading End		Section 4.1- Google Maps Streetview @ 2014	A leading end terminal is used to absorb the kinetic energy of an impacting vehicle at a controlled rate.	Leading end of the barriers- first point of contact for on-coming traffic.
Terminal- Trailing End		Section 4.1- Google Maps Streetview @ 2014	The purpose of the trailing terminal is to anchor the end of a W-section barrier to keep the tensile strength in the rail.	Trailing end of the W-section barriers.
Terminal- Wire Rope		Section 4.1- Google Maps Streetview @ 2014	The purpose of the trailing terminal is to anchor the end of a wire rope barrier to keep the tensile strength in the rope system.	Ends of the wire rope safety barriers.
Utilities Trench		Section 4.13	A trench in the ground used to lay utility ducts.	Along the entire motorway.
Variable Message Sign (VMS)- Regional and Motorway		Sections 4.7	An electronic traffic sign used to give drivers information about accidents ahead, dangerous conditions, speed limits and/or special events. Regional VMS are roadside signs (image) at 300mm character height. Motorway VMS (4900 IT VMS gantry) are elevated over the motorway on truss gantries.	• Between Kaipara Flats Road Intersection and the Northern Roundabout (Regional and combined with OHWS) • Between Matakana Link Road Intersection and Hudson Road Intersection (Regional) • Between Matakana Link Road Intersection and the Northern Roundabout (Regional and combined with OHWS) • Chainage 49000 Northbound (Motorway)