4. HIGHWAY OUTCOMES

Farming land use, representative of Pūhoi sector environment

4. HIGHWAY OUTCOMES

DESIGN STATEMENT

The Pūhoi sector is an important connection to the Northern Gateway Toll Road. Consistency between the motorways is important, as is the distinction of the motorway in its own right. The Johnstone's Hill tunnels as act as physical barrier between the two motorways that allow the introduction of different elements.

A noticeable difference between the two highways will be the barriers. The northern end of the Northern Gateway Toll Road utilises concrete barriers on the approach to the tunnels whereas the motorway design employs wire rope barriers in all areas (with the exception of transitions). The design also employs paved median strips which, whilst consistent with the northern portion of Northern Gateway Toll Road, are generally inconsistent with the rest of the Northern Gateway Toll Road. Elements of the motorway exist within Northern Gateway Toll Road and will provide some consistency and familiarity for road users.

Emerging from the tunnels, road users will be presented with wide sweeping views of an interesting landscape. This section of the motorway features the interchange with the Hibiscus Coast Highway and viaducts over Ōkahu Inlet and Pūhoi River (Te Arawhiti ki Ōkahu and Te Arawhiti ki Pūhoi). Local lighting is required over the Ōkahu inlet and has been kept to a minimum, notwithstanding safety requirements. Consideration of lighting type and angle ensures that light spill is kept to a minimum. The rest of the alignment is unlit, except for the northern end.

The area around Pūhoi and the Te Arawhiti ki Pūhoi has existing residents sensitive to the new motorway. Open Graded Porous Asphalt has been used for the motorway to reduce noise produced and eliminate the need for noise barriers (other than the specific attenuation provided by barriers on the bridge and viaduct structures).

There are three key crossings in this sector; Ōkahu where the road crosses the coastal area; Pūhoi where it passes over Pūhoi Road and Pūhoi River; and over Watson Road.

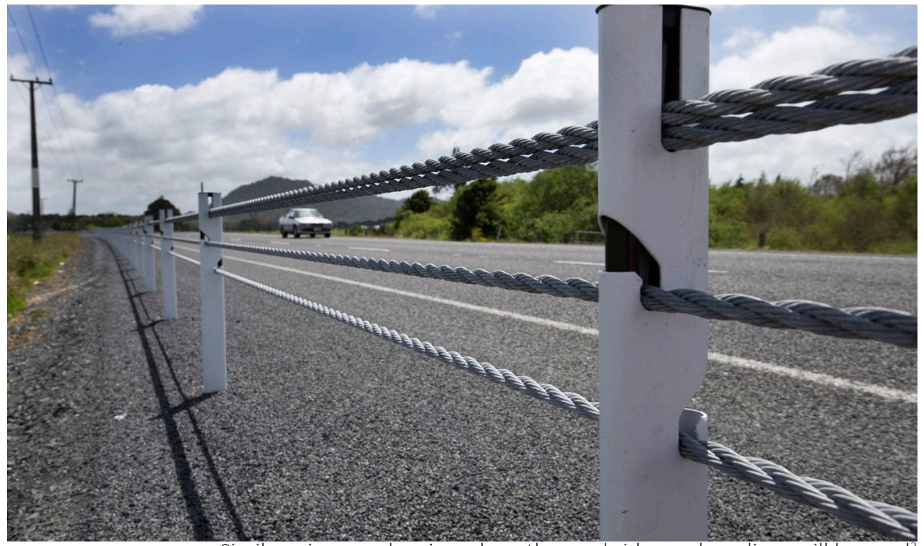
The Te Arawhiti ki Ōkahu will have three piers in the coastal area and a total of five piers. They are slim wall piers that cleanly connect to the bridge structure. The southernmost pier and abutment minimise impacts to Pā O Te Hēmara Tauhia situated on the predominant adjacent inlet.

Te Arawhiti ki Pūhoi is consistent in design with the Te Arawhiti ki Ōkahu; it has 5 piers, none of which intersect with the current alignment of the Pūhoi River. The southern abutment is close to the existing Pūhoi River and this 'closes in' the entrance to Pūhoi Road. There is opportunity to use decorating detailing on the abutment walls and art work (or similar) to mark the entrance to Pūhoi Township.

Both viaducts are slim and minimalist so that they appear as 'light' and unimposing on the landscape. Thought has been given to their appearance, both when viewed from afar and from below. Overall, balance has been sought to integrate them sufficiently into the landscape, acknowledge their presence, but not to overstate them within the attractive and unique land context within which they sit.

The Watson Road overpass will have one single bridge span, approximately 24m long with an abutment on each side of Watson Road. Given the short length of the bridge, there will be no piers.

Example of a trailing end terminal along the Auckland Southern Motorway[1]



Similar wire rope barriers along the road sides and medians will be used[2]

4.1 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 motorway furniture (including static and VMS sign gantries and CCTV), emergency telephones and utility cabinets will 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 be wire rope, which is the first preference expressed in the ULDF [4.3]. 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 highway outcome [ULDF 3.1, 4.4] [D36].

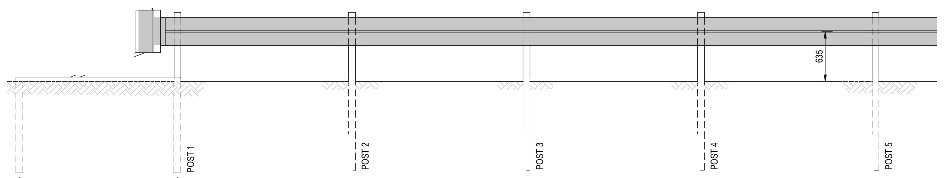
Audio tactile profiled markings (rumble strips) will be installed to alert drivers when vehicles begin to stray from lanes. This method is used to increase safety for road users. These will be visually indiscernible in blending in with the white lane markings.

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 highway footprint [D36(a)] [D37].

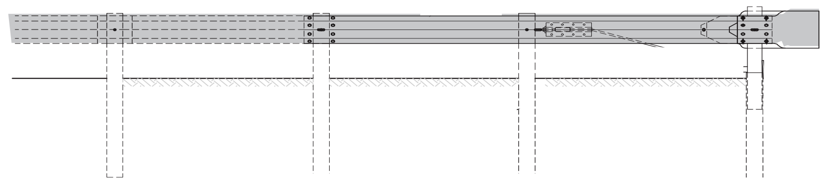
Bridge Barriers

The concrete barrier with steel rail used along the alignment for Te Arawhiti ki Ōkahu and Te Arawhiti ki Pūhoi is a specifically design TL5 barrier (refer image on next page) and Watson Road Bridge is a simple TL5 barrier. The barriers reduce 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 4.3 and D37(aa)). The barriers above the Hīkauae Farm underpass will be wire rope barriers.

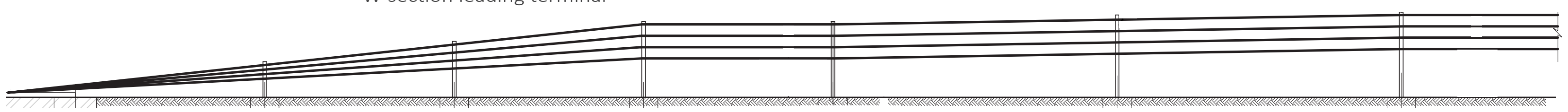
When driving onto a bridge (the leading edge), the side barrier will transition up the height of the concrete barrier. This transition is made through use of standard barriers, each slightly increasing in height This will start with a metal W-section barrier followed by the thrie beam. These help to 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 trailing edge) 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.



W-section leading terminal



W-section trailing terminal



Wire rope barrier terminal

[1]Google Maps Street View @ 2015 [2]Safe Roads Alliance

Medians

The median barrier will be wire rope held by galvanised steel posts, and the median area will be fully paved (not planted or grassed). The surface treatment will be consistent from road shoulder to shoulder, 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 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 median area 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).

Bridge Barrier Design

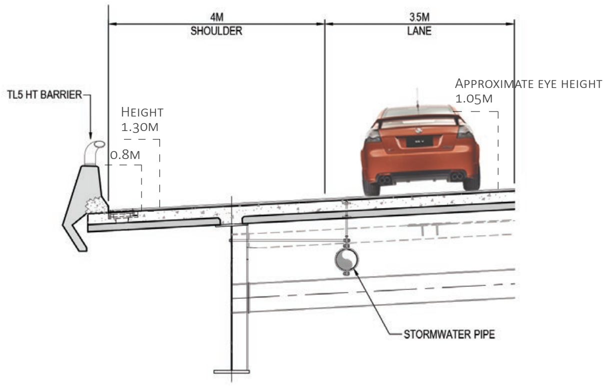
Overlooking the Ōkahu inlet

4.2 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 highway feature names – Te Kāinga Tawhito o Ngā Tūpuna and Te Pā o Te Hēmara Tauhia for the Pā to the north and south of Ōkahu, Te Arawhiti ki Ōkahu is the viaduct structure over Ōkahu inlet and Te Arawhiti ki Pūhoi is the viaduct structure over Pūhoi River [ULDF 4.1].

Te Arawhiti ki Ōkahu

Te Arawhiti ki Ōkahu is the name given to the structure that passes over Ōkahu Inlet located at chainage 64300 to 64500. This area has cultural, spiritual and historical significance to Hōkai Nuku members. Specifically, Te Arawhiti ki Ōkahu remembers the famous explorer Kahumatamomoe, who stayed with Ngāti Manuhiri when he travelled between the east and west coasts.



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

Not to scale

Tributary of Pūhoi River

Te Arawhiti ki Pūhoi

For Mana Whenua, Te Awa Pūhoi Awa remains a food source and an important inland route connecting the Kaipara and Mahurangi tribes. The name Te Arawhiti ki Pūhoi reflects this traditional link.

Manuhiri, the eponymous tupuna of Ngāti Manuhiri, and his brothers Ngāwhetu, from whom Ngāti Rango originate, and Maraeariki lived beside the Pūhoi river in the late seventeenth century. At Mihirau on the upper reaches of the river, a major peace making meeting was convened by Ngāti Manuhiri and their Te Kawerau relatives with a rival iwi, whereby the grand-daughter of Manuhiri, Te Kupe, was promised to a chief. The union was not successful however and further conflict ensued. When the land around the upper reaches of Te Awa Pūhoi was transacted with the Crown in 1862, the Ngati Manuhiri rangatira Te Kiri Kaiparaoa sought the protect of Mihirau, a waahi tapu, because of its association with his ancestors.

Te Kāinga Tawhito o Ngā Tūpuna

Te Kāinga Tawhito o Ngā Tūpuna is the name given to the Pā on the northern side of Ōkahu Inlet. This ancient pā settlement has been occupied by many families, which is reflected in this name.

Te Pā o Te Hēmara Tauhia

The name given to the Pā on the southern side of Ōkahu Inlet is Te Pā o Te Hēmara Tauhia. This area was one of the primary land blocks claimed by Te Hēmara Tauhia, a tupuna of Ngāti Rongo (Rango) who was baptised Te Hēmara after the CMS missionary James Hamlin. Two related Pā have been identified in the Billings Road area.

4.3 VIADUCTS AND BRIDGES

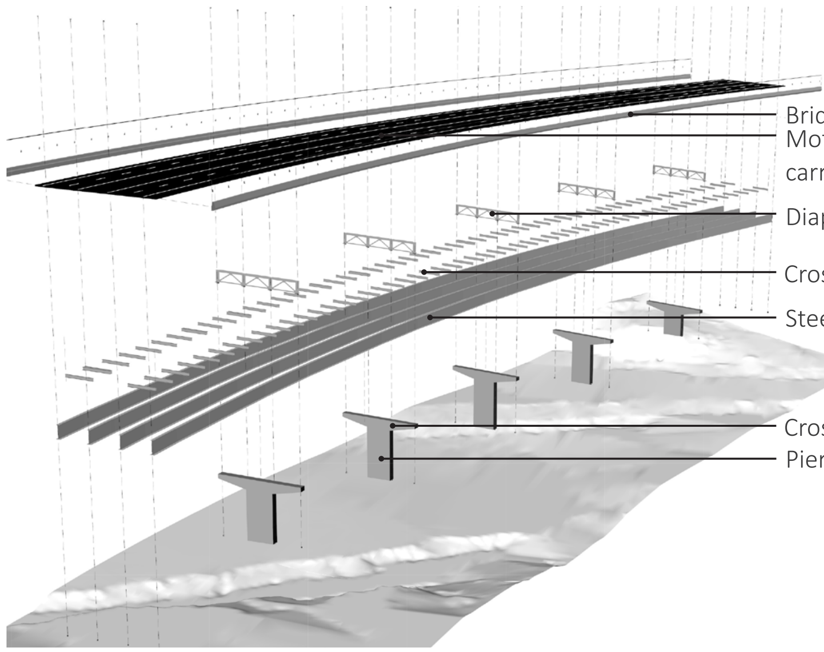
The viaducts and bridges have been designed to meet the following outcomes:

- Have aesthetically clean lines and refined details
- Both viaducts have been designed with the same basic structure as a 'pair'
- Allow the landscape to be stitched together beneath viaducts and bridges
- Both viaducts are elevated which enables clear views through them and a greater sense of 'stitching', more so than the existing SH1 bridge over the Pūhoi River
- There are no impediments to streams and local roads access so they pass unhindered
- Open (spill-through) abutments have been used on the northern ends of the viaducts to maximise openness and views beneath bridges
- Viaduct decks cantilever from outer girders with sufficient width to create a visually thinner edge
- Provide for safe inspection and maintenance access
- Maintain attractive long-term appearance, having regard to such matters as colour fastness and weathering (especially rainwater staining). The preference is to rely on integral material colour rather than painting

Ōkahu and Pūhoi Viaducts (Te Arawhiti ki Ōkahu and Te Arawhiti ki Pūhoi), Watson Road Bridge and Hīkauae Farm underpass are the viaduct and bridge structures within the Pūhoi Sector. Of these, the Ōkahu and Pūhoi viaducts are the most significant highway elements and new landmarks in this sector. The plans in section 7 show the locations of these elements. The ULDF requirements for bridges and viaducts have been key drivers of the design, these include: providing an understated, refined and minimalist aesthetic, with clean lines and uncluttered appearance to result in an elegant structure.

The viaducts and bridges will be striking features and accordingly have been designed as strong yet refined structures that sit within the landscape and draw attention to it, rather than distract from it. The bridges are less imposing and are therefore less obvious to motorway users. Planting around the structures has been designed to complement and 'stitch' the surrounding landscape together. The viaduct and bridge structures have been designed by a multi-disciplinary team including specialist bridge architects, structural engineers, Hōkai Nuku, ecologists, urban and landscape designers and the construction team, to integrate outcomes.

The viaducts over Ōkahu and Pūhoi are visually consistent with the 'family of bridges' – specifically fitting with the colour, barrier height and clean lines of the Moir Hill Bridge (located in the central sector). The two viaducts are separated by approximately one kilometre and have been designed to be 'read' from the surrounding landscape as one of a pair. Each viaduct is a similar length, has steel girders, a floating deck with carefully considered edge barrier, and a below deck superstructure. The bridge decks will appear as a simple horizontal element, and therefore provide a strong trajectory over the landscape. The viaducts have symmetrical pier layouts, to appear 'balanced' when viewed from a distance. The dynamism of the piers is reinforced by the barrier design, a 'folded' external face whose horizontal crease, and the pattern of light and shade it creates, emphasises the 'line' that each viaduct draws across the landscape. The viaducts achieve the intent of the ULDF – that "the viaducts over Ōkahu Inlet and the Pūhoi River should have a similar form and appearance". Considerable effort has been put into defining the appropriate proportions to conjure a 'viaduct' appearance while responding to the different design parameters.



Te Arawhiti ki Pūhoi exploded view

Visually, from a distance, much of the underside of each viaduct will not be visible, hidden by the outer girders. Some of the structural beams and under-workings of the bridge will remain visible to those directly below it, but the visual amenity of these will remain clean and simple. The viaduct structures have a clean aesthetic soffit with no services jutting out below. Services are inside the outer girder. The street lighting duct for Okahu Viaduct will be hidden inside the barrier to avoid being seen. The decks of the two viaducts have a 3m cantilever overhang to protect the steel girders from rain (like an umbrella), to prevent weeping and staining.

The viaducts over Ōkahu and Pūhoi have been carefully considered to maximise heights over water-bodies to allow for activities below, whilst minimising the visual effects on the wider landscape. Viaduct barriers have a gap between concrete barrier and steel rail to give road users an optimised view from each viaduct. The light grey concrete viaduct barriers maximise the contrast of the structure to the landscape. Bridge elements details are explained in section 4.1.

The resource and designation conditions which relate to the viaducts over Pūhoi River and Ōkahu inlet are achieved. Both viaducts have been designed to allow for the 100 year average rainfall interval event. Pier caps are located more than 500mm below benthic sediment level. Earthworks for the viaducts have been designed to minimise encroachments beyond the highway footprint [D2B] [D38AA(e)] [RC49] [RC69A] [RC69AA] [ULDF 4.2, 6.1].

Bridge Barrier Transition Design

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

A ULDF outcome for viaducts and bridges is to maximise openness and views beneath the structures. Spill through abutments help to achieve this, and have been used at the northern ends of both viaducts to tie in with the landscape. However, both viaducts feature solid abutments at their southern ends. For each, different factors have influenced the design rationale and an number of outcomes have had to be managed. The southern end of Te Arawhiti ki Ōkahu is tightly constrained by Te Pā o Te Hēmara Tauhia, and Pā site disturbance limitations, in combination with some localised instability from a landslide, have determined the structural design of this abutment. The key viewpoint under the viaduct is from the existing State Highway which, due to topography, has limited visibility of the southern end of the viaduct.

The southern end of Te Arawhiti ki Pūhoi does not have the same constraints as Ōkahu, instead efficiency and practically of the existing topography have driven the design. A closed abutment makes use of the existing landform avoiding the need for extensive earthwork re-grading to create open abutments. The existing road to Pūhoi is low and narrow, cut into the earth slope and is lined on either side with trees that loom over the road. It provides a sense of enclosure and isolation which enhances the impression of Pūhoi township as a quiet retreat, insulated from the outside world. The concrete closed abutment will be a feature along Pūhoi Road, in keeping with the context of the existing landscape and entrance to Pūhoi.

4.4 ŌKAHU INLET / TE ARAWHITI KI ŌKAHU

DESIGN STATEMENT

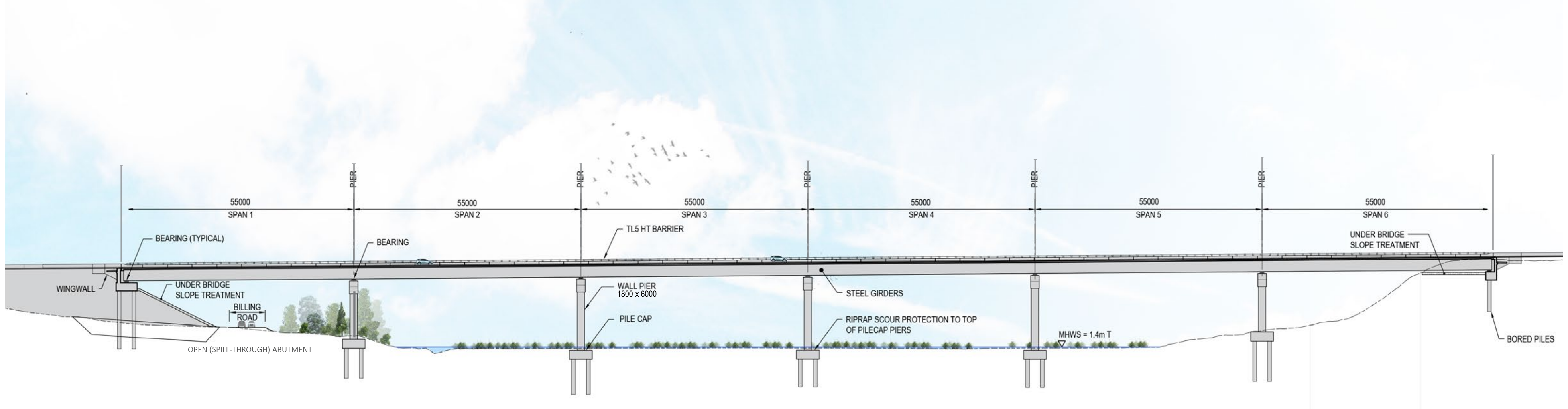
The Board of Inquiry conditions require the specific consideration of the viaduct over the Ōkahu inlet and its associated approach embankments. Te Arawhiti ki Ōkahu will mark the start and end point of the landscape journey on the motorway as the southernmost end of the Project. Te Arawhiti ki Ōkahu provides motorway users with an introduction to Ōkahu inlet, particularly those travelling north from Johnstones Hill tunnels and onto the viaduct. The landscape planting in this area provides a more formalised arrangement of planting mixes, including specimen trees (pōhutukawa) at the northern end of the viaduct that signify a special nature of the coastal area occupied by the viaduct [D38AA(e)] [RC69A] [RC69AA] [ULDF 4.2] [ULDF 6.1].

Te Arawhiti ki Ōkahu traverses the Ōkahu inlet with a single deck steel 'I' girder bridge, approximately 346m long and 17m above the coastal ground level. It has a symmetrical and elegant design, similar in form and appearance to Te Arawhiti ki Pūhoi. The design of the viaduct achieves the Board of Inquiry conditions RC69A and RC69AA. The viaduct has three piers within, and two outside of the Coastal Marine Area and the area of permanent occupation at benthic sediment level from the Ōkahu Inlet is 33m².

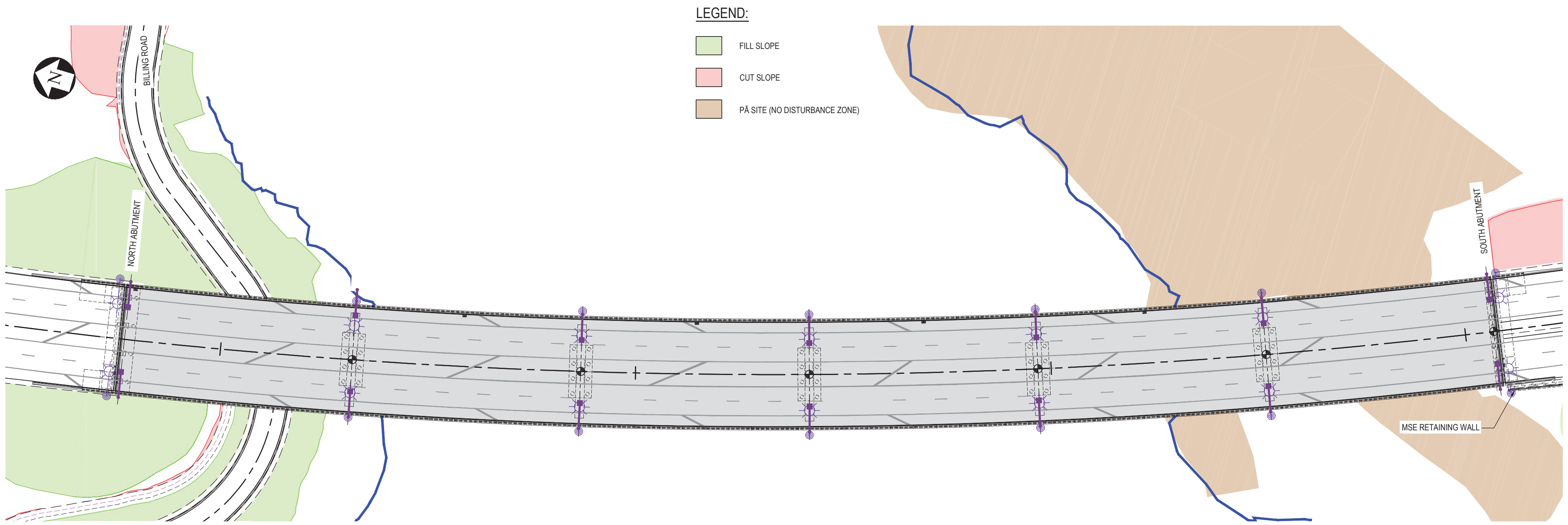
The footprint of the viaduct spans two Pā sites (Ngā Pā o Te Hēmara Tauhia); accordingly, the viaduct has a wide span and open (spill-through) abutment on the northern end to create visual connections between the two Pā sites, their associated settlement areas and the inlet, and maximise views under and through the bridge. The horizontal and vertical alignment of the viaduct structure, and location of abutments in relation to the pā has been specifically considered; the visual and physical relationship between the two pā and with the estuary is maintained. At the southern abutment the bridge will be supported by a MSE wall to mitigate an active land slide. Abutments will be armoured to avoid dusty and dead areas beneath the bridge and, to avoid disturbing the pā site, although only a portion of the southern abutment will be armoured.

The highway furniture of the Te Arawhiti ki Ōkahu includes bridge barriers, lighting and median wire rope barriers, all designed to appear complementary with similar setbacks to create clean lines and an uncluttered appearance. All items will be minimalist in both number and design (whilst not compromising any safety standard). From the bridge, motorway users will be able to see out into and appreciate the landscape between the lower (solid) bridge barrier and the top steel rail [ULDF 6.1 and D28]. The barriers have deep parapets that hang below the beams to create a clean edge. The top surface of the parapets are angled inward, towards the road, and bottom surfaces are angled outward to eliminate water staining. To create a clean aesthetic, minimising visibility and clutter, infrastructure services will be integrated into the deck or hung behind the outermost girder. Maintenance access will be provided to the beams of Te Arawhiti ki Ōkahu.

Pā Management Plan planting, existing vegetation, riparian planting around the stream and wetland (southern side of the inlet) and terrestrial mitigation planting (both sides of the viaduct), will provide an attractive area below the viaduct which encourages ecological connectivity. The western slope of the pā is expected to be replanted with pōhuehue and small ferns to provide successional plant cover. The planting between the tidal inlet and land area integrates and connects new planting into the existing landscape and supports a range of flora and fauna and creates a wildlife corridor. The elevation of the viaduct provides for east-west ecological connectivity [D37A] [ULDF 4.2] [ULDF 6.1].



Te Arawhiti ki Ōkahu section
Not to scale



Te Arawhiti ki Ōkahu plan
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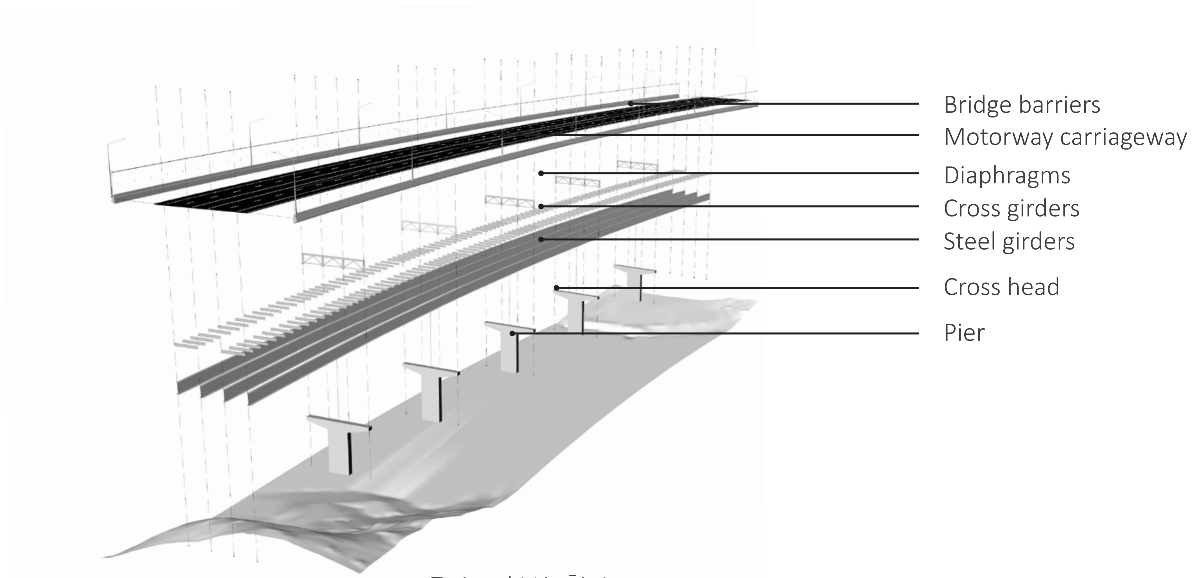


Te Arawhiti ki Ōkahu exploded view (looking south)

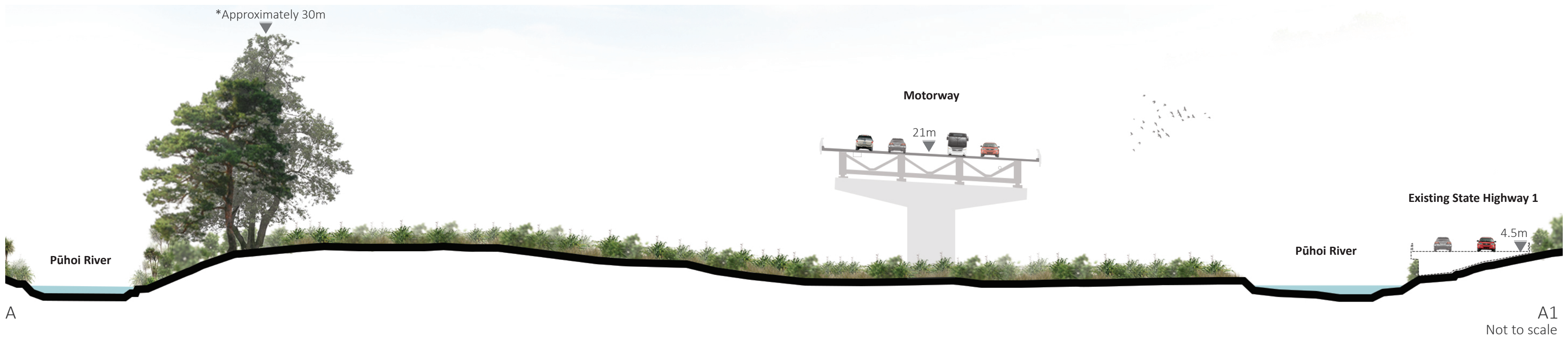
Te Arawhiti ki Ōkahu looking north east

4.5 TE ARAWHITI KI PŪHOI

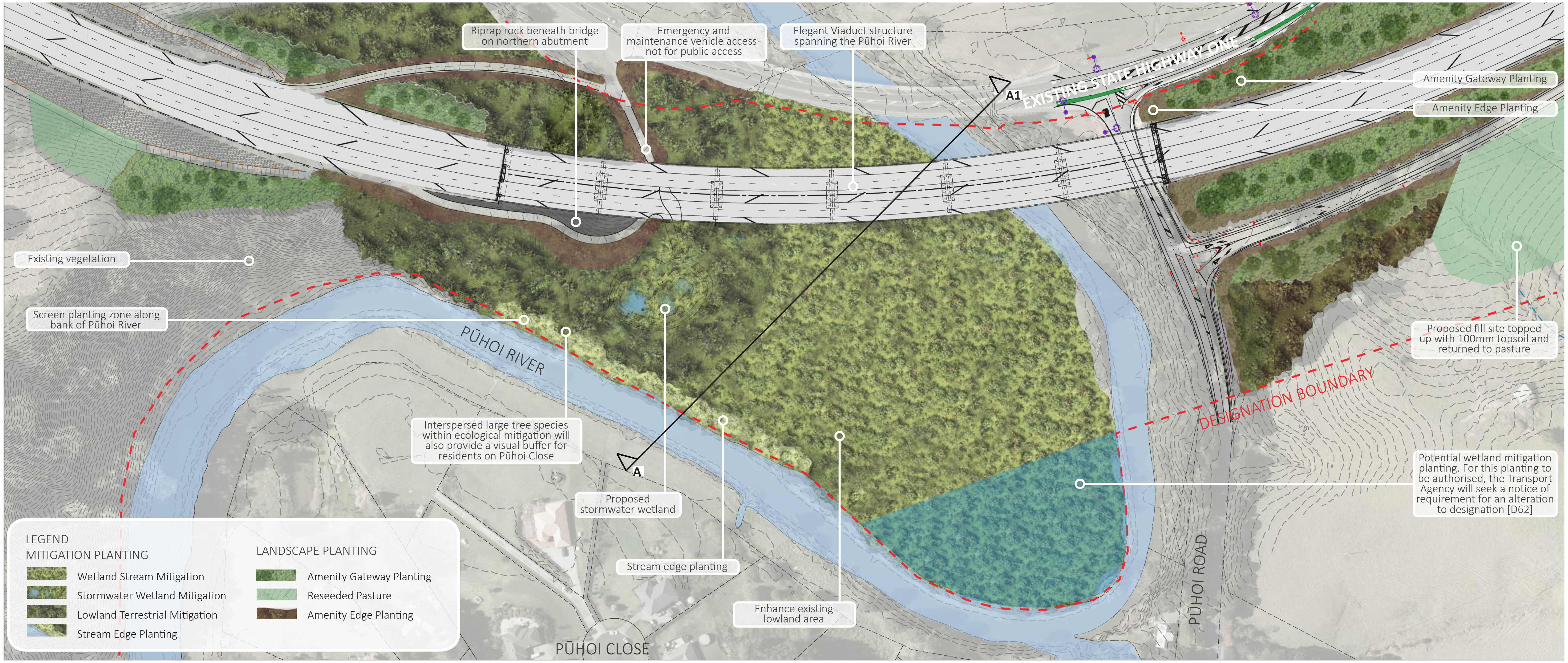
DESIGN STATEMENT

The Te Arawhiti ki Pūhoi will be a single deck steel 'I' girder bridge. The Te Arawhiti ki Pūhoi is a symmetrical span, steel girder bridge that spans Pūhoi Road and Pūhoi River and is approximately 12m high and 321m long.

The viaduct foundation design minimises occupation of the Pūhoi River flood plain; no piers are located in the existing course of the Pūhoi River. Because it will be visible from river users, Pūhoi residents, and obliquely by local road users, the viaduct substructure has been selected due to its aesthetic appearance. The highway furniture of the Te Arawhiti ki Pūhoi will include barriers and median wire rope barriers.



Te Arawhiti ki Pūhoi section (refer plan below)



Te Arawhiti ki Pūhoi Plan
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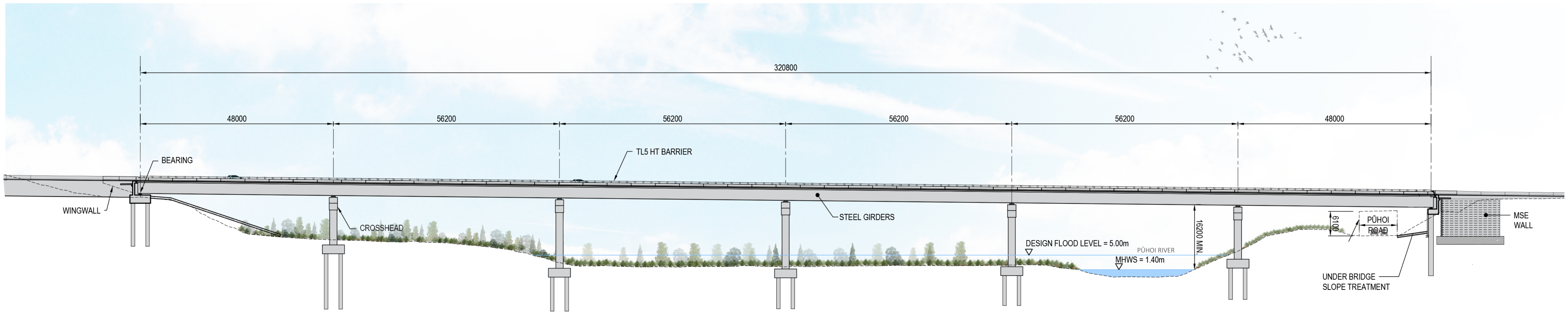

Te Arawhiti ki Pūhoi section
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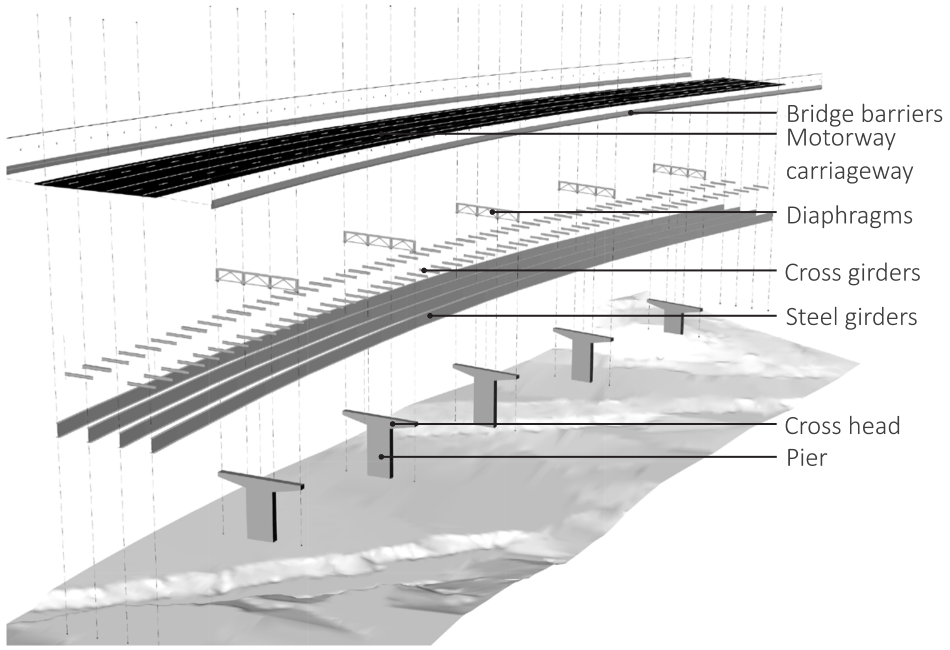
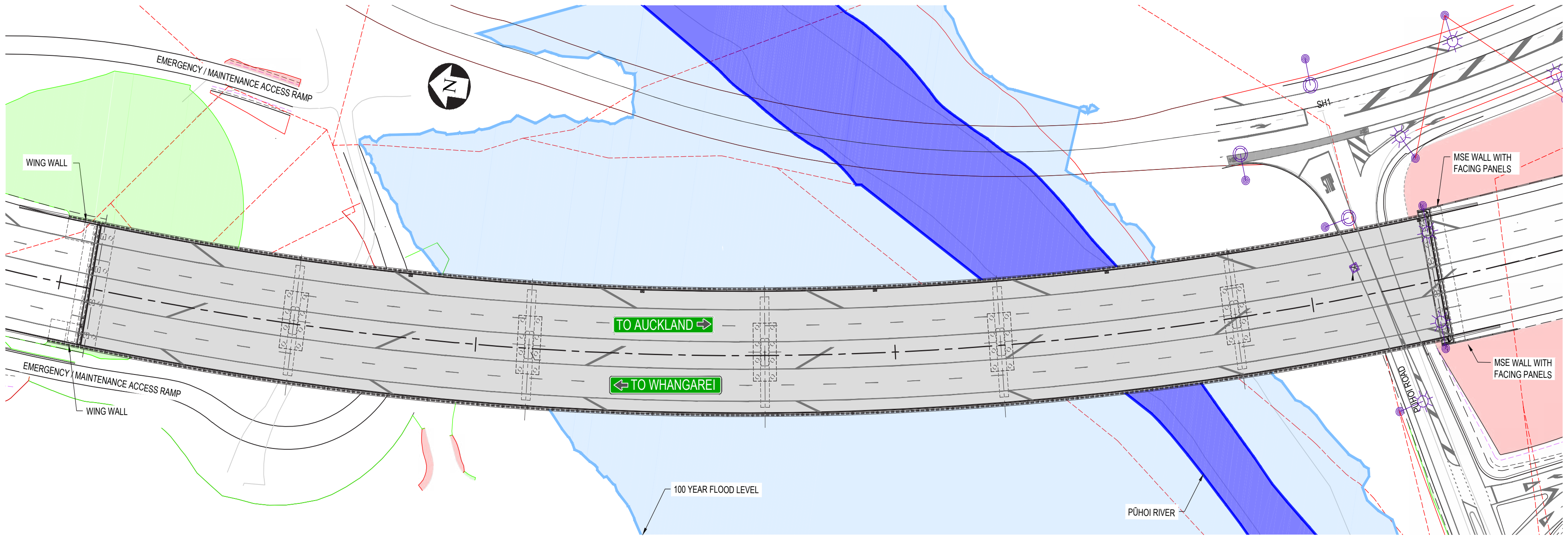


Te Arawhiti ki Pūhoi exploded view



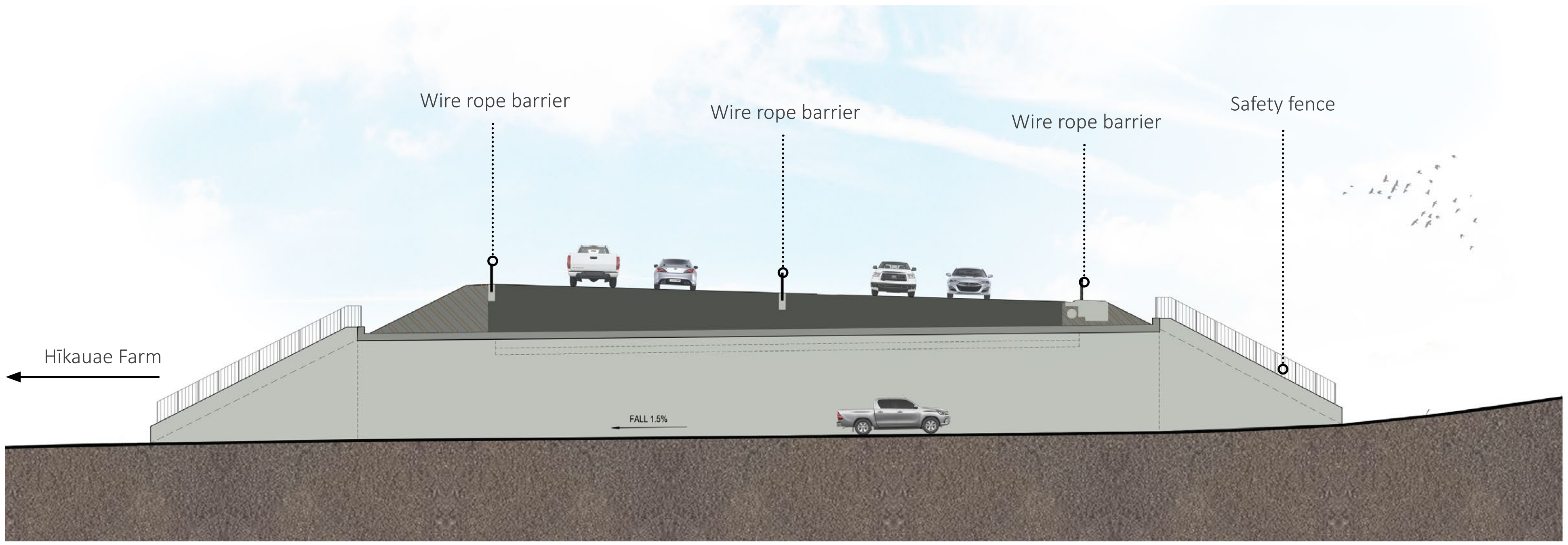
Te Arawhiti ki Pūhoi plan
Not to scale


Te Arawhiti ki Pūhoi looking south

Access to Hīkauae Farm

Access to Hīkauae Farm will be provided through an underpass to the private property under the motorway alignment, through an earth embankment. The underpass is located to the south of the intersection of SH1 and Mahurangi West Road (approximate chainage 59700). The concrete boxed structure will be approximately 4.5m high, 5m wide and 35m long, and will provide private access to the property bisected by the motorway. The underpass entrances will be planted with low-height plants to maintain driver sight-lines. This planting will integrate with the highway landscaping.

Motorway users are unlikely to know that they are travelling over the Hīkauae Farm underpass. Wire rope median and side barriers, will continue down the motorway in this area without disruption and be consistent with the adjacent highway furniture.



Access to Hīkauae Farm
Not to scale

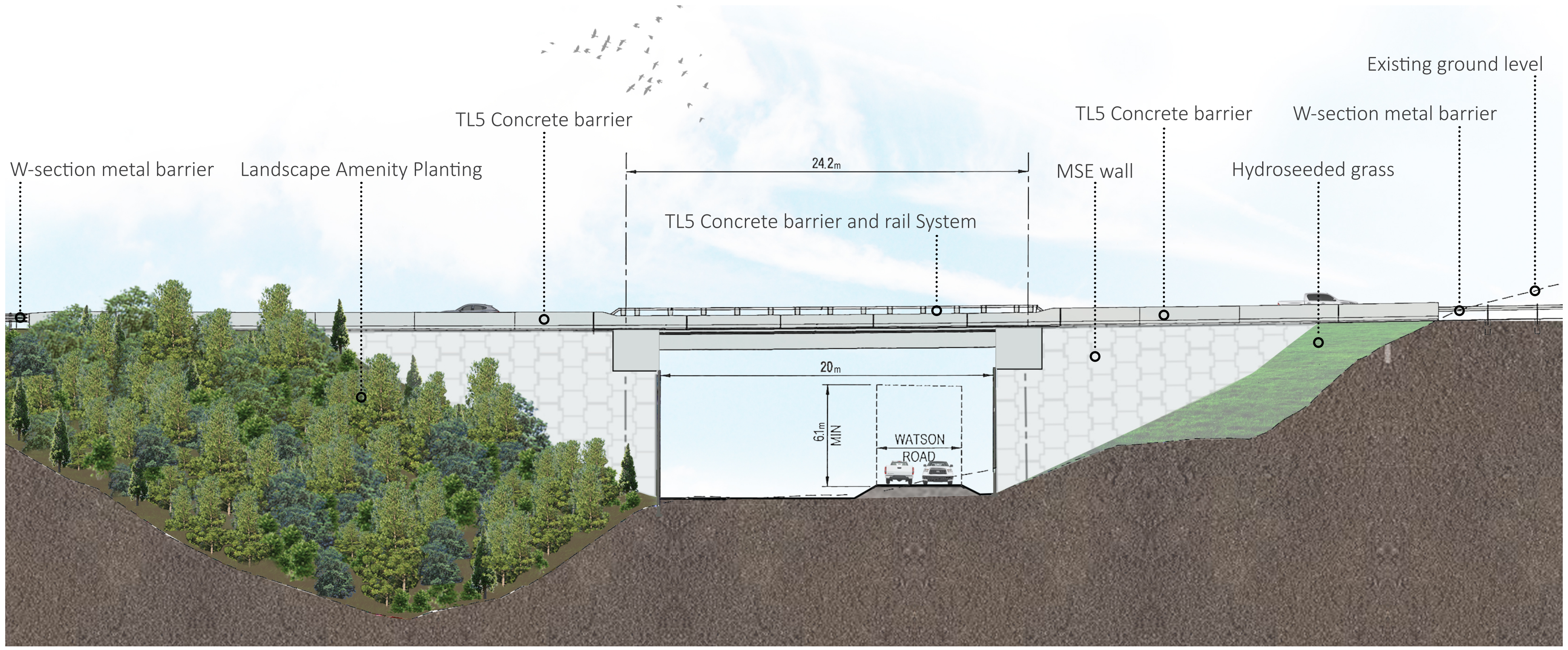
Watson Road Bridge

Watson Road Bridge facilitates the continuation of Watson Road below the motorway carriageway in the form of an underpass. The underpass has a total clear span of 20m and a vertical clearance of 7m. The remaining width may be used for future pedestrian and cycle facilities. It is a single span, reinforced concrete underpass structure.

Watson Road is a local no-exit track located approximately 500m south of the access to Hīkauae Farm, and will provide access to forest plantations. For motorway users, concrete bridge barriers will be the only visual demarcation of Watson Road Bridge; the bridge will otherwise, seamlessly transport the motorway carriageway.

A stream running parallel to Watson Road Bridge is culverted under the motorway as the topography of the area near the bridge does not allow for a swale alongside the road. The culvert has been located in this position in response to the surrounding topography and the height differences between the stream and Watson Road.

Culverting this stream results in a lower and more flexible motorway alignment that better fits with the landscape and reduces earthworks volumes overall. The stream adjacent to Watson Road will be carried underneath an embankment (approximately 20m in height above stream level) under the motorway, by a 2100mm diameter culvert. The area surrounding the culvert and stormwater inlet will be terrestrial mitigation planting and landscape restoration planting will be located along the path of the culvert towards the stormwater outlet.



Watson Road Bridge
Not to scale

Night sky long exposure at Mahurangi West[1]

4.6 LIGHTING

Light poles are required from the northern portal of the Johnstone's Hill Tunnels across the Te Arawhiti ki Ōkahu to the Pūhoi interchange and down the off ramp (approximate chainage 65000 to 63200) for safety and operational reasons [ULDF 4.7]. The area required to be lit will not be visible to many Pūhoi residents due to the distance to most properties and surrounding topography. Some street lights along Pūhoi Road will be replaced with LED lights which reduce light-spill

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 interchanges [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 different intervals), and have a galvanised finish.

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

4.7 NOISE MITIGATION

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

Condition D71 requires:

> *The Requiring Authority shall use Open Graded Porous Asphalt, or another road surface with equivalent or better low-noise generating characteristics, on the carriageways of the Project, as shown in Appendices G and H. Such a surface shall be implemented within 12 months following the Project being officially opened to general public traffic.*

There are no identified areas where further noise mitigation is required in this section of the alignment. Noise standards in the designation conditions will be met by the Project [D36(a)].

4.8 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, and although the suite used has an inconsistent use of form, 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, one sign gantry and several Variable Message Signs (VMS) and Over Height Warning Signs (OHWS) located in the Pūhoi sector. Other infrastructure utilities that road users can expect to see will include road signs, 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 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 highway furniture diagram shows that the two types of gantries have different forms, one curved and thick and the other more narrow and angular. 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 outcomes 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.

In this sector there is one cantilever truss gantry, located on the western side of the alignment at CH.64650. The truss gantry is used specifically for VMS signage and provides the necessary access for the required regular VMS maintenance. Locations of signs are shown on the plans in Section 7. This is located outside a maintenance bay, but adjacent to the Okahu viaduct so that the concrete barrier of the viaduct can be extended to provided protection and maintain a consistent line.

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 and allow for simpler maintenance and mitigate visual inconsistences. 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 (refer below for minimum setbacks) 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, but will be set out consistently. The other furniture is typically located in maintenance bays and set back from the main carriage way.

Furniture is generally located within maintenance bays and behind wire rope barriers. However in some instances concrete barriers provide protection for gantries and other furniture located outside of these areas. 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).

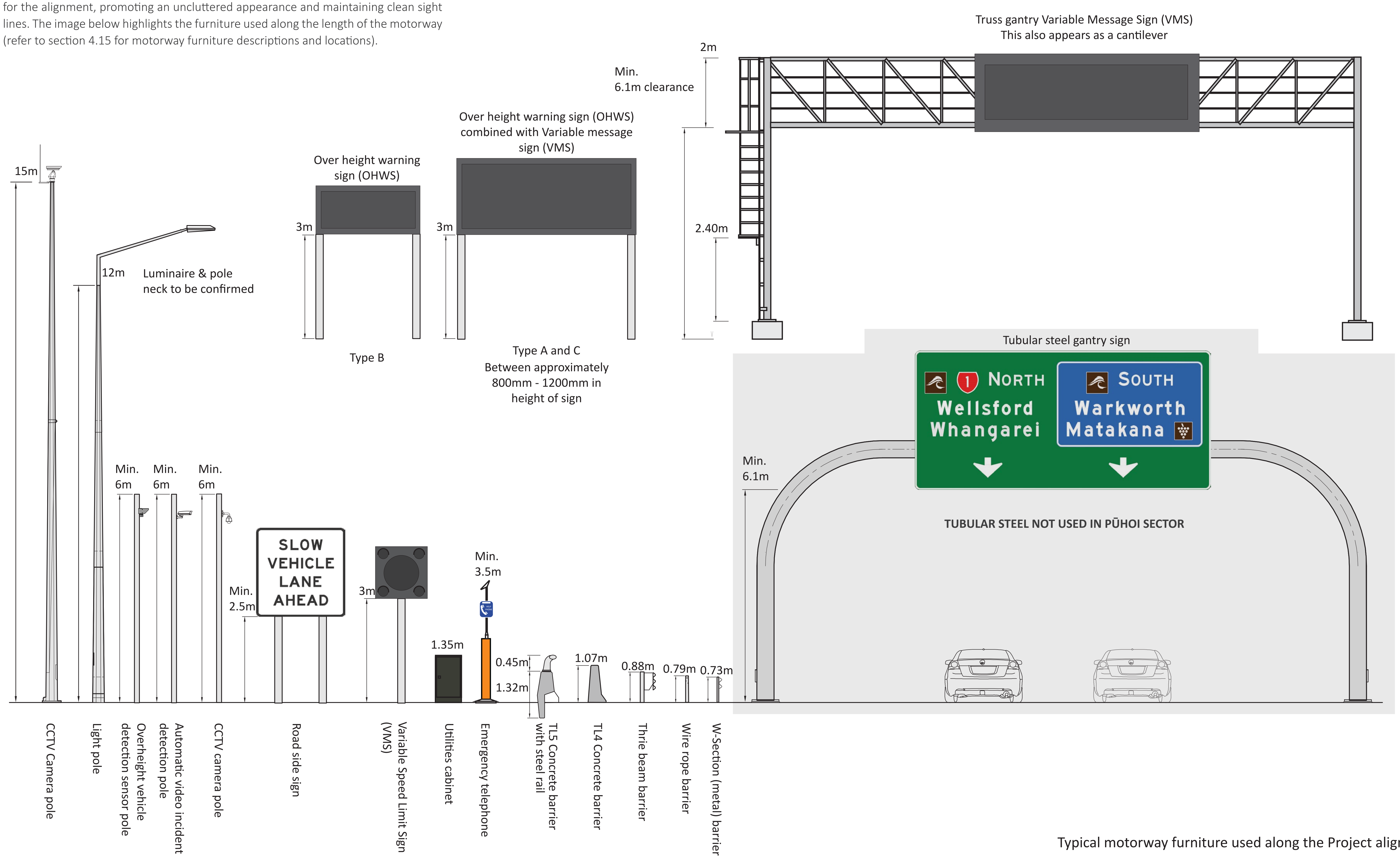
Motorway signs similar to those to be used on the Project[2]

Highway furniture element	Approximate Numbers	Approximate Spacing
CCTV camera	10 on poles 1 on a gantry (with the VMS)	800m longitudinal spacing between poles
Road side sign	Approximately 69 signs	Set back a minimum of 1.54m behind wire rope barrier
Variable message signs (VMS) truss gantry	1 cantilever truss gantry	Set behind concrete barrier adjacent to Okahu Viaduct
Concrete barrier	Bridge barriers	Te Arawhiti ki Pūhoi Te Arawhiti ki Ōkahu
Wire rope barrier	Road alignment	3m spacing between posts, set back 3.1m from the edge of the outside traffic lane
W-section (metal) barrier	4 locations	Johnstones Hill Tunnels tie-in Hibiscus Coast Highway Pūhoi Road Pūhoi emergency off-ramp
Variable message signs (VMS) and Over-height warning signs (OHWS)	6 on poles 1 on a cantilever truss gantry (with a CCTV camera)	Set back a minimum of 2.15m behind wire rope barrier

[1] Mahurangi West Wing Luxury Bed & Breakfast [2] Google Maps Street View @ 2015

Suite of highway furniture

The design uses consistent spacing and careful consideration of the set back from road edge to promote safety, functional requirements and clean visual lines. The wire rope poles will be of a consistent 2m (except for joins and breaks) spacing and will be located 3m from the edge of the outside traffic lane. Poles are located with a minimum clearance of between 1.5m and 2.15 to reduce the likelihood of damage or injury in the case of road accidents. These standards will set out a regular pattern for the alignment, promoting an uncluttered appearance and maintaining clean sight lines. The image below highlights the furniture used along the length of the motorway (refer to section 4.15 for motorway furniture descriptions and locations).



Typical motorway furniture used along the Project alignment

HIGH

- ITS cameras
- All gantries
- Overheight detectors
- Lane control signs
- Automatic video incident detection
- Automatic number plate recognition
- Overheight warning signs

LOW

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

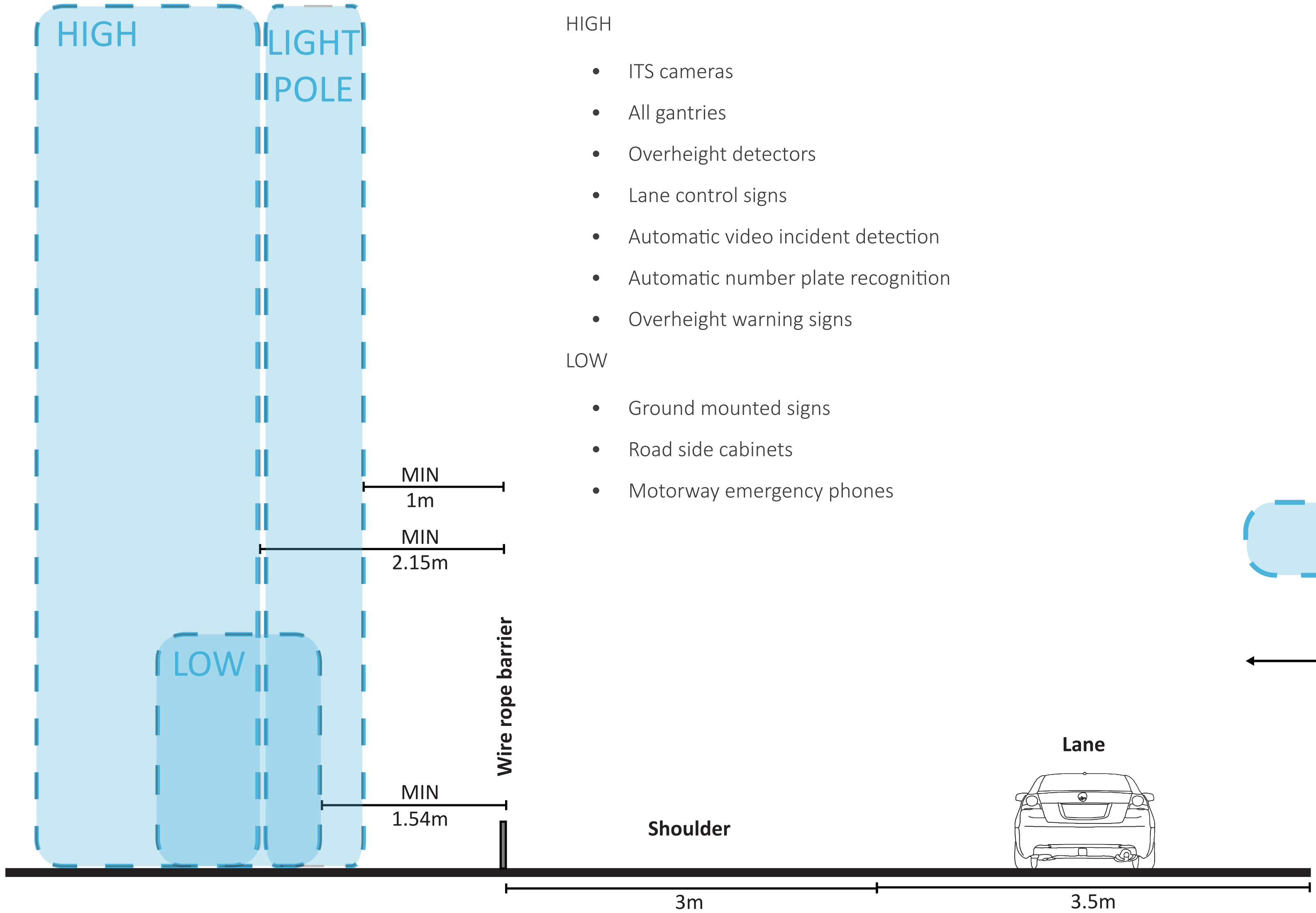


Diagram of typical spacing of highway furniture at high and low locations

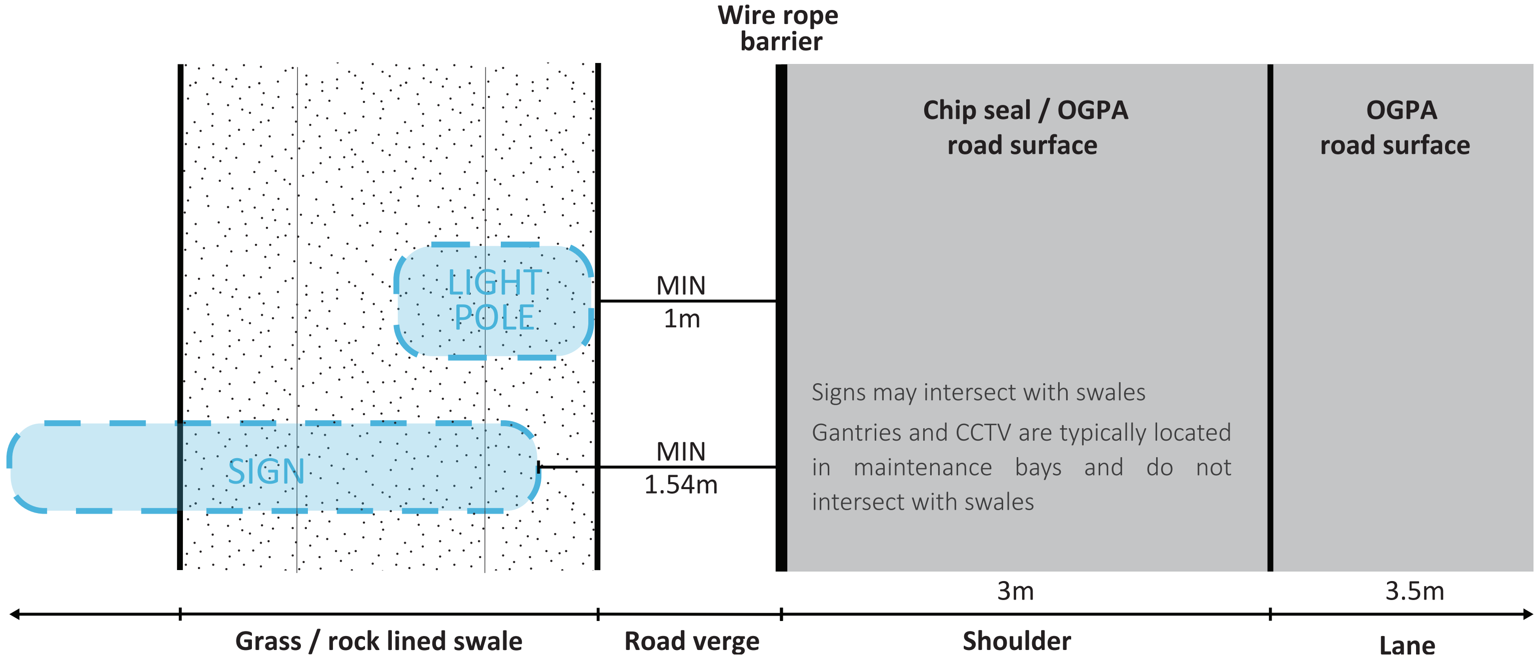
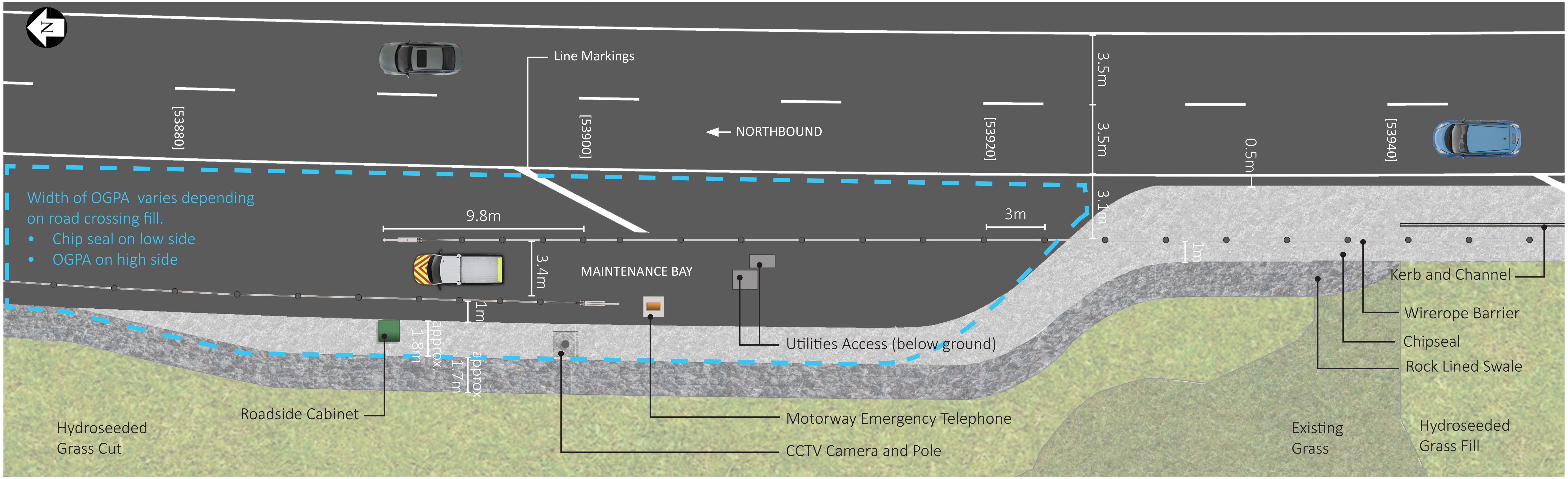


Diagram of typical highway furniture set out- plan view

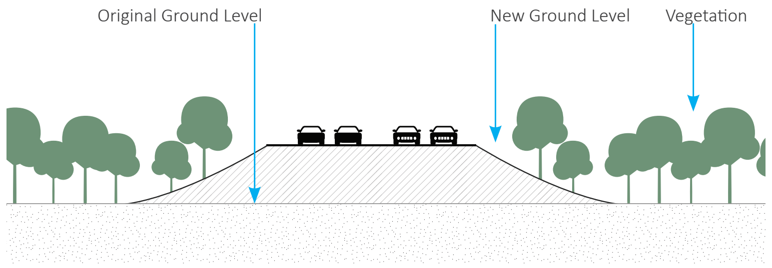


Typical maintenance bay details demonstrating the spatial relationship between highway furniture - Not to scale

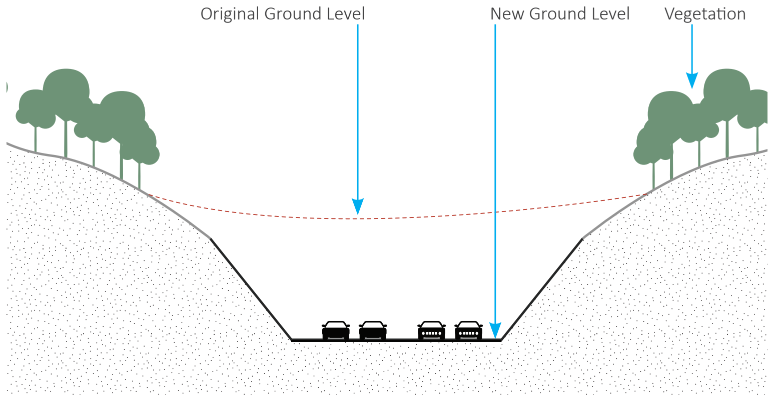
4.9 CUT AND FILL BATTERS

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

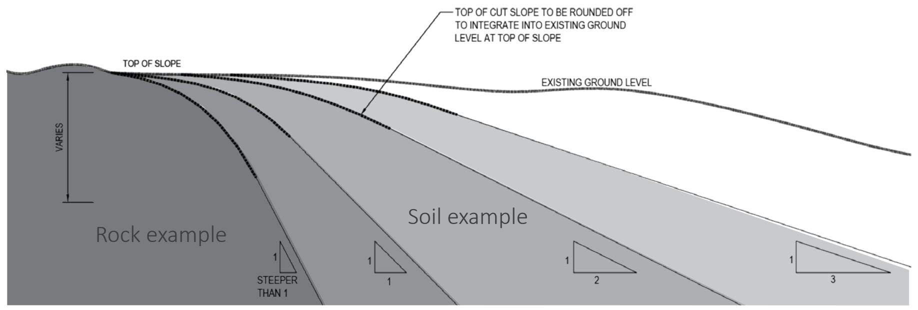
These cuts and fills result in a significant modification to the landform and slopes may need to change on site to respond to variation in rock location and bedding. Cuts are likely to be prominent through the sector, and contouring will be used to create a naturalised appearance as shown in the image below. The landscape treatments of these cuts will stitch these areas with the surrounding landscape, focusing ecological enhancements with adjacent areas of high value. A proportion of this sector will use hydro-seeded grass to stitch with the adjacent land uses [D36(a)] [D37] [ULDF 4.8].



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 the motorway[1]

4.10 HIGH CUT BATTERS

Rock cut batters

Where there are steep rock cuts (such as in the northern end of this sector), the rock will be left exposed to showcase the geology as a key feature of the journey, to create a minimalist and natural aesthetic [ULDF 4.8, 4.9].

A fixed drapery wire mesh will be used on the rock face to contain loose and falling debris. The mesh will allow the underlying rock to be visible and will have a uniform 'finish' height of 4.7m above the carriageway so as to not be in the direct line of site of road users and provide motorists with a consistent, uncluttered line. The only places where this may vary will be where geotechnical conditions dictate the mesh to 'fall' further down the slope. To provide mesh transparency, the mesh will have uniform sized 'holes' it will be grey in colour, consistent with the underlying grey rock colour (note, the rock is expected to be a blue-grey at time of construction and will weather to a lighter grey colour – the mesh is also expected to 'weather' and fade to a slightly lighter grey colour). This is considered to be a good outcome where the rock face is not disguised.

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 4.8, 4.9, 4.11] [D36(a)][D37].

Rockbolts used on the Waterview Connection

Shotcrete on the Waterview Connection

Landscaped batters

High cut batters comprising stabilised soil embankments will be matched to the adjacent landscape as shown in Section 7. As far as practical, where the highest point of the cut batter meets the natural landform the tops of the batters will be rounded and hydro-seeded with grass to soften and tie back into the landscape contours or planted dependent on the adjacent land uses. The contours of these areas are to be naturalised to tie them into the natural landform [D36(a)] [D37] [ULDF 4.8, 4.9].

4.11 HIGH FILL BATTERS

Areas of high fill batters will be of a constant slope with little variation and will be steeped where possible (1V:2H in most places) in order to minimise encroachment into existing riparian, indigenous vegetation areas and waterways, as required by the ULDF [section 4.8, 4.9 and 4.11]. Landscaping in fill areas will take a minimalist approach and will include hydro-seeded grass and low flammability plant mixes. Refer to the cross sections in Section 4.14 for detailed examples of cut and fill batters (not representative of any one place) [D36(a)] [D37] [ULDF 4.8, 4.9].

Along the motorway, the majority of fill batters in close proximity to stream courses will be replanted as guided by the ULDF [section 4.11]. A key philosophy driving the design of the motorway has been to focus on landscape, ecology and mitigation responses and treatments on areas throughout the alignment where the investment offers the greatest opportunity for benefit. The ULDF promotes the replanting of all fill batters that coincide with stream courses [ULDF 4.11], which is in contrast to the design approach. Further explanation of hydro-seeding and the design approach is covered in sections 5.7 and 5.17 [ULDF 4.8, 4.11].

[1] Google Maps Street View @ 2015

Rock lined swale on the Northern Gateway Toll Road, similar to those used on the Project[1]

4.12 ROADSIDE MARGINS AND DRAINAGE

The roadside drainage, which 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), has been designed as part of the coherent suite of highway 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 [ULDF 4.13].

The stormwater conveyance infrastructure comprises pipes, 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 4.14 indicates that the opportunity for weed growth will be minimised along the road edge due to the positioning of the roadside highway furniture and infrastructure and because the sediment traps will cleared of residual sediment as part of the maintenance regime.

Possum[2]

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. 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 the northern 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 5.8-5.10). 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].

4.13 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.

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

Example of landscape planting on earth batters

4.14 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 4.15).

The design of the interface area between the road side barrier, swales and 1m chip seal (a pavement surface made up of layers of bitumen and aggregate) area will minimise weed growth. The swales and drainage sediment traps will be treated with pre-emergent herbicide and swales lined with geo-fabric, rocks or grass to reduce the need for spraying. The chipseal will extend to the edge of the swales, which will be lined with geo-fabric/geotextile (strong manufactured fabric used to prevent erosion and stabilise soil) and rocks or grass.

Sediment will be removed from sediment traps to avoid 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 as guided by the ULDF. 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] [ULDF 4.4] [ULDF 4.13].

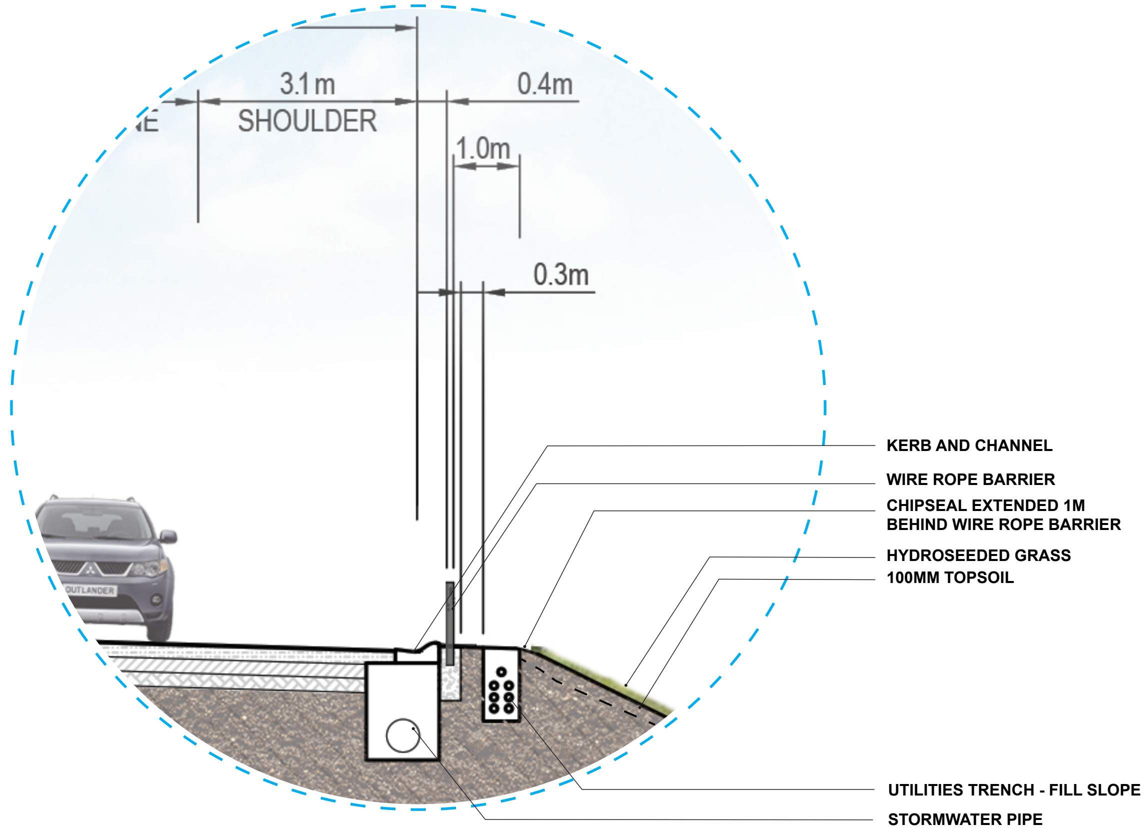
[1]Google Maps Street View @ 2015 [2]Brisbane City Council, 2003

4.15 ROAD ELEMENT CROSS SECTIONS

The following cross sections portray the combined result of the highway 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 4.3].

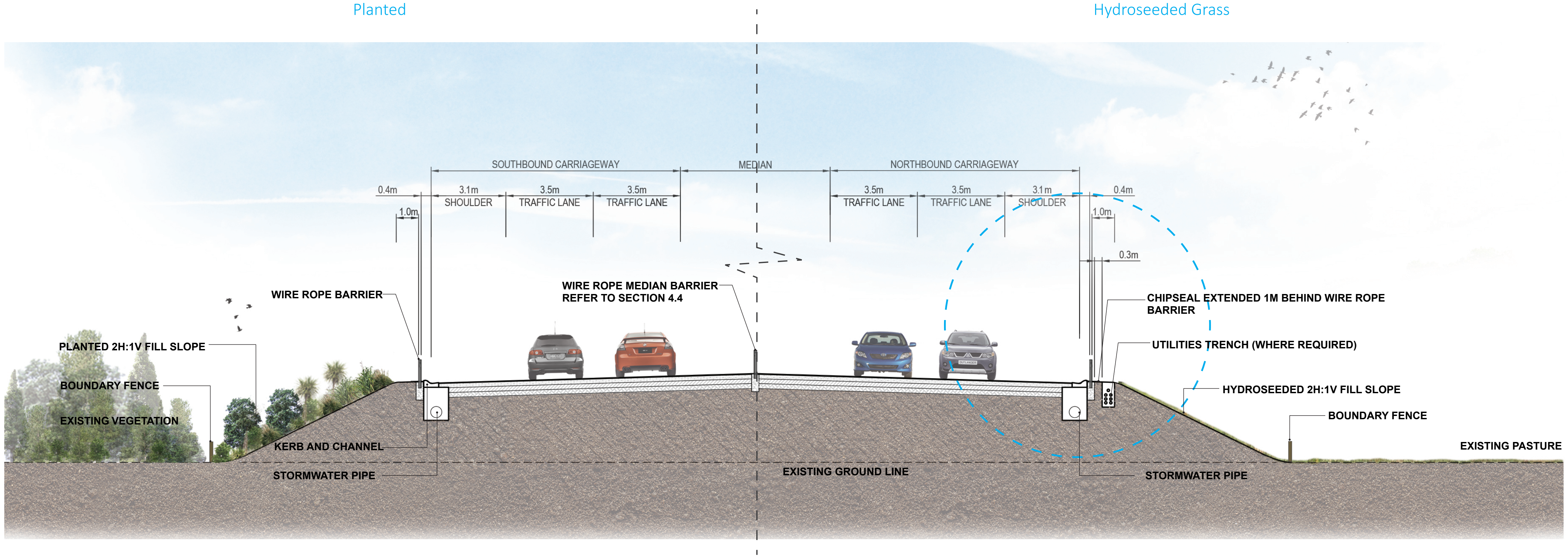
The expanded circular images emphasise the interface of highway elements such as swales, kerb and channel, barriers and vegetation, to demonstrate a clean road edge.

Kerb and Channel on Fill Slope



Planted

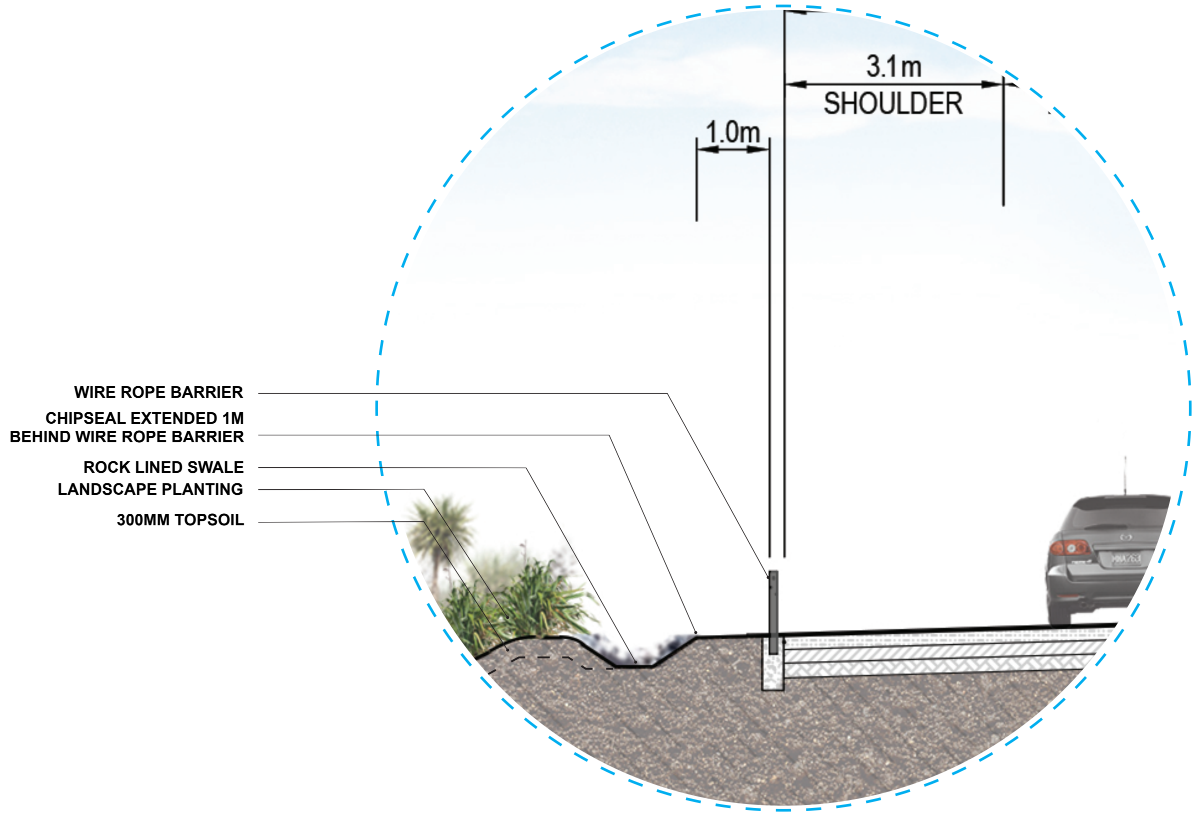
Hydroseeded Grass



Cross section - Typical 2H:1V fill embankment with kerbs showing examples of both landscape planting and hydroseeding on low fill batter slopes without swales

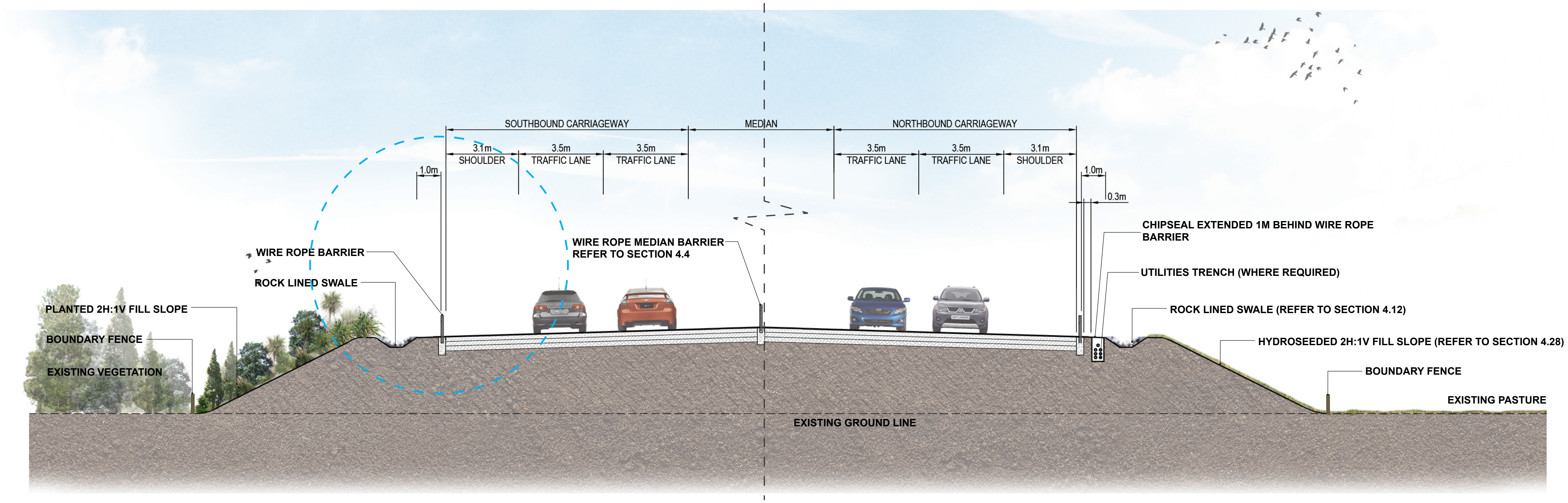
1:200 @ A3

Rock Lined Swale on Fill Slope



Planted

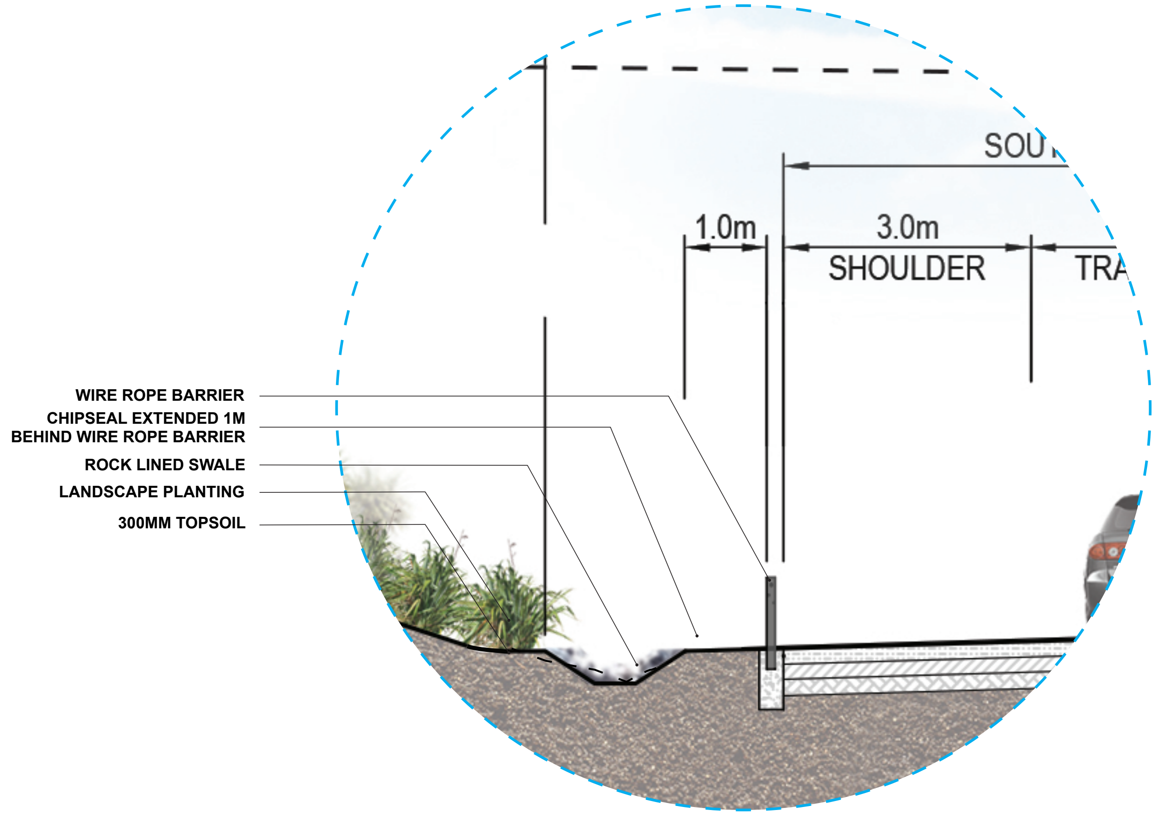
Hydroseeded Grass



Cross section - Typical 2H:1V fill embankment with swales showing examples of both landscape planting and hydroseeding on low fill batter slope with rock lined swale

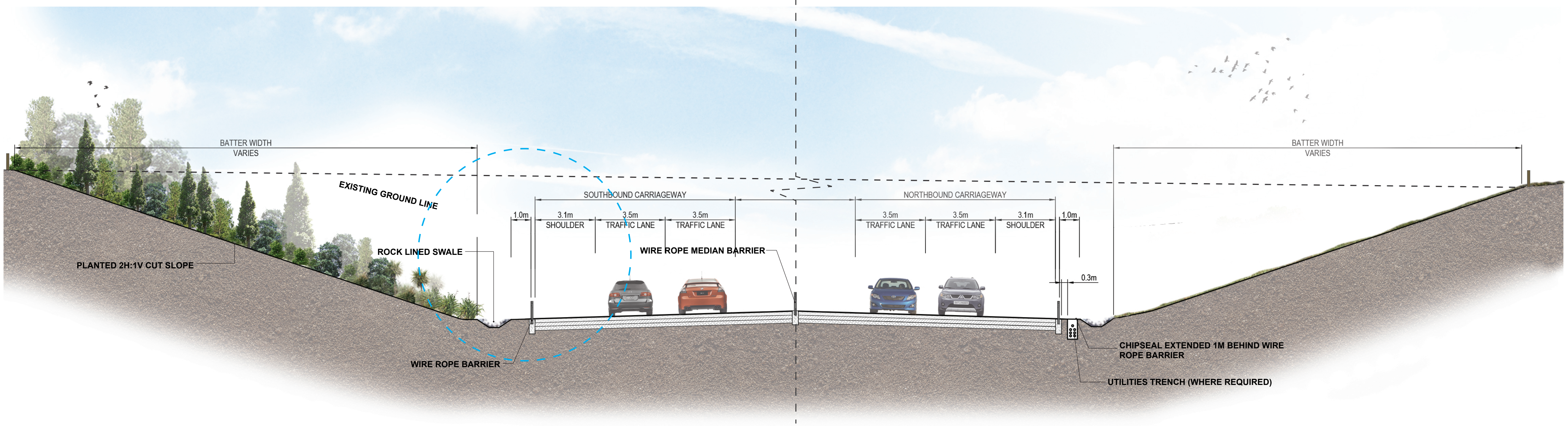
1:200 @ A3

Rock Lined Swale on Soil Cut Slope



Planted

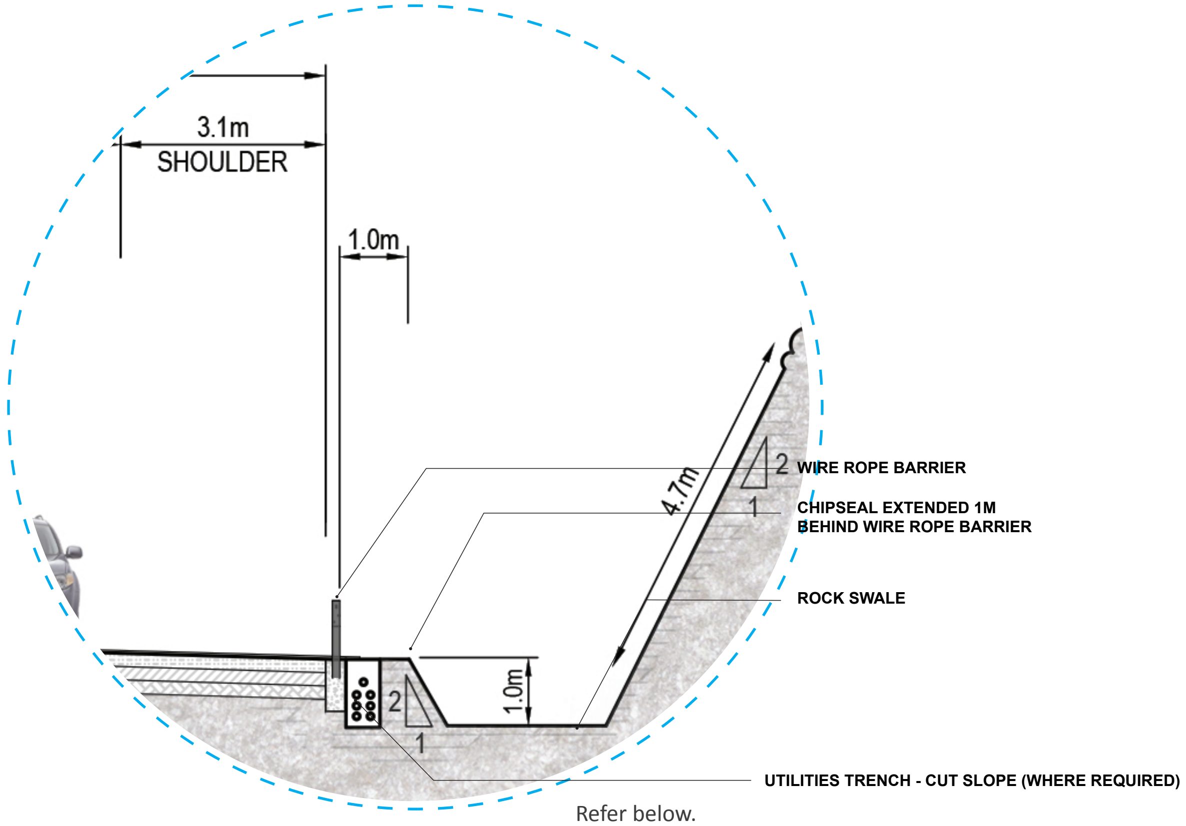
Hydroseeded Grass



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

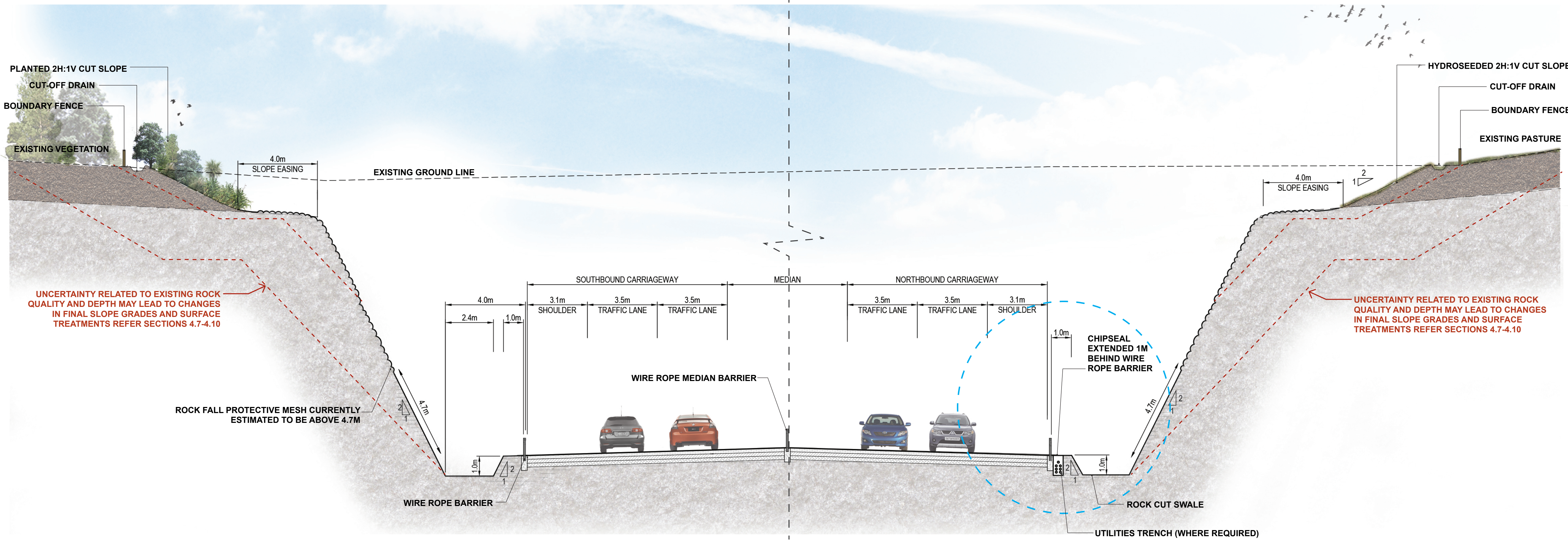
Rock Swale on Rock Cut Slope



Refer below.

Planted

Hydroseeded Grass

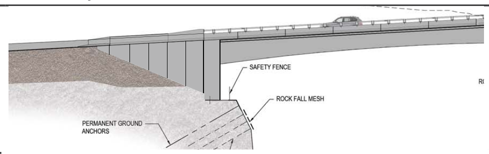
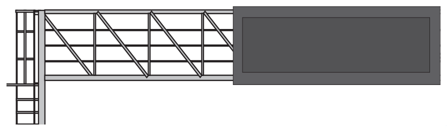
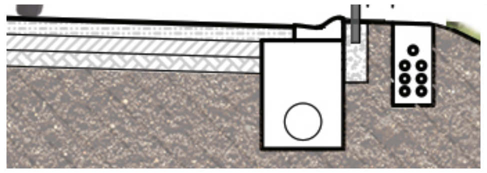
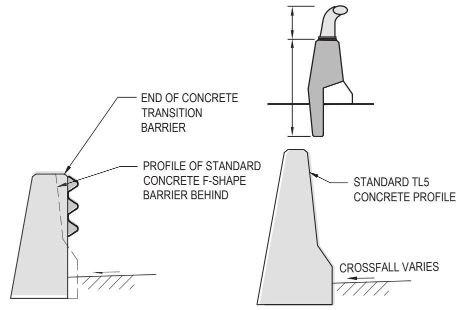


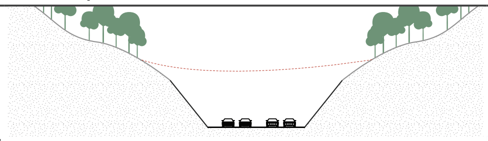
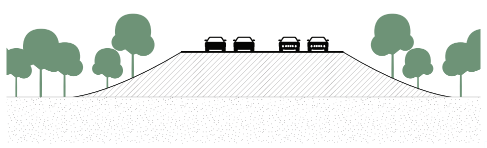
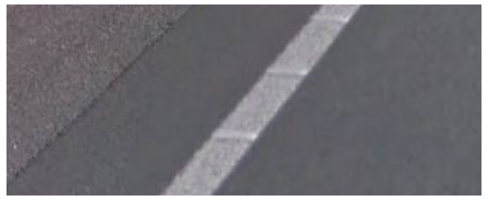
Cross section - Typical 1H:2V rock cuts showing examples of both landscape planting and hydroseeding in an area with high rock cut batters demonstrating continuous rock layback

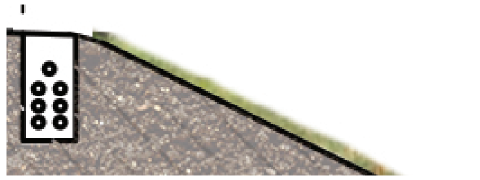
1:200 @ A3

4.16 HIGHWAY ELEMENTS

The highway 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 highway [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 either end of the bridge	Watson Road Bridge, Te Arawhiti ki Ōkahu and Te Arawhiti ki Pūhoi
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	There are approximately 4 in this zone, at the Pūhoi on-ramp, the Pūhoi off-ramp and two at the VMS cantilever gantry near the tunnel portal(Median span)
Automatic Video Incident Detection		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. Note: These cameras will be combined with the wrong-way detection at turn around points	
Barrier- Wire Rope		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	Watson Road Bridge at the approximate chainage 60250
Cantilever Truss Gantry		Section 4.6	An overhead structure supporting equipment such as signs	There will be one gantry mounted Variable Message Sign (VMS) at the approximate chainage 64700 (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) • Bridge TL5 Barriers (bridge barriers)	On bridges and viaducts, barriers are concrete with a top rail to optimise views out into the wider landscape. They have been designed integral to the bridge parapet, with an extended skirt to conceal services below the bridge deck and minimal embellishment to reinforce a clean, horizontal emphasis
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; 59540, 59820, 59930, 60250, 60500, 60810, 61160, 61360, 61660, 61860, 62310, 63060, 63560 and 63870

Element	Example	Photo Reference	Definition	General Locations
Cut		Section 4.7	Terrain that is cut down from its present elevation to allow a smooth road gradient	Elevated areas
Embankment		Section 4.7	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
Open Graded Porous Asphalt (OGPA)		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	OGPA has been selected as the final surfacing for the carriageway. This will cover the entire carriageway width, except on shoulders on the "low side" of the carriageway and verges outside edge barriers
Over height warning sign (OHWS)		Section 4.7	High visual impact warning signs are 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 must 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.	• 63330 (southbound)- dual pole- type B • Pūhoi Southbound On-Ramp- dual pole- type B • 63950 (southbound)- dual pole- type B • 62900 at Pūhoi Rd - SH1 Intersection Southbound (combined with VMS)- type C • SH1 (southbound) 10m from Pūhoi Southbound On Ramp- dual pole (combined with VMS) type A • SH1 (northbound) 200m from the Pūhoi Southbound On Ramp Turning point- dual pole (combined with VMS) - type A
Rock Bolt		Section 4.8	A rock bolt is a steel or fibreglass rod that is grouted to the ground, used to anchor and stablise rock excavations	Used in areas of rock cut where the ground is deemed to require further stabilisation
Rock Fall Mesh		Section 4.10	Durable wire mesh used to stabilise rock cuts 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
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 of 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 4.8	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 5.10 Photo from: Thomas Engineering, 2017	A grassed swale is a constructed shallow, open channel appearing as a landscape feature. Grassed swales slow and control the rate of the conveyance of storm water and act as a filter to remove pollutants	On flatter sections, reinforcing the adjacent landscape character
Swale- Rock Lined		Section 4.11 Photo from: Google Maps Streetview @ 2014	A linear channel lined with erosion-resistant rock and designed to convoy runoff to an outlet	On steep gradients. These will feature predominantly in steep cuts found in the centre of this section

Element	Example	Photo Reference	Definition	General Locations
Terminal- Semi-Rigid W-Section Barrier Leading End		Section 4.11 Photo from: 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- Semi-Rigid W-Section Barrier Trailing End		Section 4.1 Photo from: 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 Photo from: 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)		Section 4.6	An electronic traffic sign used to give drivers information about accidents ahead, dangerous conditions, speed limits and/or special events Some of these will have combined functions for Over-Height Warning Signs. Regional VMS are typically located on motorway on-ramps and access roads. In this sector there is one motorway VMS on the motorway mainline.	Approximate chainage: • 62900 at Pūhoi Rd - SH1 Intersection Southbound (combined with OHWS- type C) • SH1 (southbound) 10m from Pūhoi Southbound On Ramp - dual or single pole (combined with OHWS- type A) • SH1 (northbound) 200m from the Pūhoi Southbound On Ramp Turning point - dual or single pole (combined with OHWS- type A) • One cantilever gantry mounted Variable Message Sign (VMS) at the approximate chainage 64700 (northbound)
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	None in this sector
Viaduct		Section 5.4	A long bridge structure to carry a road across a valley or water	Te Arawhiti ki Pūhoi at the approximate chainage 62800 Te Arawhiti ki Ōkahu at the approximate chainage 64500