- Construction programme and timing of particular activities, to take advantage of seasonal weather conditions;
- Transport Agency construction guidelines and Auckland Council standards, relevant to the avoidance and minimisation of adverse effects on the environment;
- Practical implementation, access requirements, safety and cost considerations, and potential for staging;
- The use of well-established construction techniques while not precluding methods to maximise the opportunity for contractor innovations; and
- How open area limits will be set and managed through construction.

5.3. Indicative construction programme

It has been assumed that construction of the Project will start in 2030 and take 7 years to complete. Enabling works may be necessary and the construction programme anticipates this. Some relocation of utilities may be done in advance of the main construction period.

Construction of certain individual elements of the Project, such as the tunnels, the large viaduct crossing SH1 and the Hōteo River and some of the cut to fill operations, will require a construction duration of several years.

The indicative construction programme is based on the following typical sequence of works:

- Enabling works (forestry clearance if necessary, services relocation, site investigations);
- Early construction activities (site establishment, access and haul roads, trial embankments, environmental controls);
- Access to specific sites (culverting and access bridges);
- Ground improvements;
- Earthworks;
- Structures;
- Pavements and surfacing; and
- Completion works (traffic services, landscaping).

The specific staging and phasing of the work will be dependent on the method of procurement and contractor expertise, land acquisition, the availability of contractors and availability of other resources such as materials and construction equipment.

Many elements of the Project will be undertaken concurrently during the construction period. The total earthworks volume to be moved includes approximately 12.4 Million m^3 of cut and 9.6 Million m^3 of fill. Cut and fill bulk earthworks is the predominant activity during the construction programme. The programme has been based on 100 – 120 (average 110) days of bulk earthworks activity through the earthworks season of October to April.

The indicative construction programme adopts an open area limit of 75 ha within the Hōteo catchment. As set out in the Water and Marine Ecology assessments, the 75 ha open area limit is based primarily on modelling and expert assessment. This work confirms that the environmental risks associated with sediment discharges from up to 75 ha open area can be managed to an acceptable level through management controls and response mechanisms (addressed in section 10). The 75 ha maximum open area limit also enables efficient completion of the bulk earthworks for the

Project within an indicative 7 year construction programme. The modelling work is noted to be highly conservative and in practice, it is predicted that actual sediment yields will generally be lower than modelled.

No open area limit is assessed as being necessary in the Oruawharo or Mahurangi Catchments. As noted in the Water Assessment Report, the total area of earthworks for the Mahurangi catchment is materially less than the open area limits prescribed for P2Wk. The Marine Ecology assessment concludes that an open area upper limit is not necessary to manage effects in this catchment, recognising the other proposed controls to manage erosion and sediment generation. The area of earthworks within the Oruawharo catchment is similarly very small.

5.4. Construction sections

For the purposes of assessing the potential effects related to construction of the Project, the Project has been divided into three indicative construction sections based on delineation by major structures. These are set out in *Section 4* of the AEE.

5.4.1. South section

The South section extends from the Project tie in to P2Wk near Wyllie Road at Warkworth to the northern portal of the tunnel north west of Kraack Road. Key features of the Indicative Alignment in this section are:

- Approximately 5.5 km in length, passing west of Warkworth and west of the existing SH1;
- A southern tie-in to the Pūhoi to Warkworth motorway (which will become SH1);
- Warkworth Interchange consisting of free flow ramps as follows:
  - Northbound off-ramp to Warkworth passing under the mainline carriageway;
  - Northbound on-ramp to Whangārei passing over the mainline carriageway;
  - Southbound off-ramp to Warkworth connects into the P2Wk alignment west of the P2Wk termination roundabout;
  - Southbound on-ramp to Auckland utilises the southbound lanes of the P2Wk alignment.
- Mainline over Woodcocks Road (Bridge 01);
- Mainline under a realigned Kaipara Flats Road (Bridge 07);
- Realignments of Wyllie, Carran and Phillips Roads;
- A bridge over an ecologically sensitive wetland area north of Kaipara Flats Road (Bridge 22);
- Twin bore tunnels below Kraack Hill; and
- The southern tunnel portals.

5.4.2. Central section

The Central section extends from the northern tunnel portals to the northern abutment of the Hōteo Viaduct (Bridge 11). Key features of this section are:

- Approximately 6.6 km in length, passing to the west of the existing SH1 mostly through commercial plantation forestry and steep terrain;
- Northern tunnel portals;
- Mainline under Dibble Road (Bridge 09) and over River Road (Bridge 10);
- Crossing of the fuels and gas pipelines in the vicinity of the River Road bridge; and

- A viaduct structure over the existing SH1, the Hōteo River, Waiteraire Stream and native bush (Bridge 11).

5.4.3. North section

The North section extends from north of the Hōteo River to the tie-in with the existing SH1 north of Maeneene Road. Key features of this section are:

- Approximately 14.2 km in length passing through mainly farm land to the east of Wellsford and Te Hana;
- The Wellsford Interchange at Wayby Valley Road;
- Mainline under Rustybrook Road (Bridge 13), Farmers Lime Road (Bridge 15) and Silver Hill Road (Bridge 17);
- Mainline over Whangaripo Valley Road (Bridge 14);
- Two bridge crossings of the fuels and gas pipelines (Bridges 16 and 18);
- The Te Hana Interchange at Mangawhai Road;
- Bridge over the Maeneene Stream and realigned Maeneene and Waimanu Roads (Bridge 20); and
- Northern tie-in.

5.5. General construction aspects

5.5.1. Enabling and early works

Prior to the main phase of construction, there are a number of early activities that will be required along the alignment to facilitate construction. These will include activities such as:

- Further detailed site investigations (DSIs), including geotechnical, contaminated land and groundwater, and investigations to confirm the location of existing services;
- Baseline environmental investigations or surveys;
- Building and structure demolition and removal;
- Site establishment activities, including site access points, road sealing, access tracks, construction yards, temporary local road realignments and fencing;
- Establishing environmental mitigation measures (e.g. erosion and sediment controls); and
- Protecting and/or relocating of existing network utilities (as discussed in section 5.5.3).

5.5.2. Construction compounds

Indicative locations for construction compounds and bridge construction yards have been identified and are shown on Figure 5-2 to Figure 5-5 of this AEE. The proposed designation accommodates construction compounds and bridge construction yards. Final locations and areas required for the construction compounds and bridge construction yards will be confirmed at detailed design stage and once a contractor has been appointed.

Site office compounds

Each section will have a site office compound from which the individual section will be managed for the long-term duration of the Project. These compounds will include project offices, meeting rooms, ablution facilities, workshops for repairs and

maintenance of plant and equipment, lay down and storage areas for materials delivery and parking.

At this stage, it is envisaged that site office compounds could be established in the following locations:

1. South section office compound close to Warkworth, for ease of access to both Warkworth and Auckland. It would be suitable to incorporate the main office for the entire Project at this location.
2. Central section office compound would likely be established in the existing forest clearing/logging skid site off Dibble Road.
3. North section office compound alongside the intersection of Wayby Valley Road and SH1 for easy access to the existing SH1.

Bridge construction yards

Smaller construction yards will be established at each bridge site to accommodate the bridges teams and materials, plant and equipment. The construction yards will be established as required for the construction of each bridge and will be decommissioned at the completion of the associated bridge. These construction yards are likely to consist of 2 to 4 containers within a fenced compound.

5.5.3. Protection and relocation of existing network utilities

As outlined in section 4.3.8 of this AEE, existing network utilities affected by the construction of the Project will need to be maintained, protected or relocated.

The Transport Agency has a number of existing memorandums of understanding with network utility providers for similar works throughout the country. Initial discussions have been undertaken with network utility operators regarding the management of their assets during construction. Network utilities will be protected or relocated to the relevant provider's standards. Protection or relocation of existing utilities will generally occur prior to or in conjunction with the main construction phase of the Project. The scope and timing of the necessary utility relocation and protection works will be developed and agreed between the Transport Agency and network utility operators to enable continued operation, to mitigate any safety hazards and provide cost efficiency for the required works.

During the subsequent design phases construction methodologies will be developed in consultation with each network utility operator to manage effects of construction on network utilities.

Fuels and gas pipelines

The construction of the Indicative Alignment requires the relocation and/or bridging of sections of the fuels and gas pipelines. The pipelines are designated in the AUP(OP). Approval is required pursuant to section 177(1)(a) of the RMA from First Gas and Refining NZ prior to any works occurring in their existing designations. The Transport Agency is continuing to work with First Gas and Refining NZ to obtain approvals regarding the project interface with their assets, and how to address these interfaces. Any additional consents which may be necessary to authorise the relocation of the fuels and gas pipelines (e.g. for any associated works outside of the designation) will be subject to a separate process, once the alignment is confirmed and the extent of any relocation of the fuels and gas pipelines is agreed.

High voltage transmission lines

A high voltage transmission line, forming part of Transpower's National Grid, crosses the Indicative Alignment in the vicinity of the Te Hana interchange. The New Zealand Code of Practice for Electrical Safe Distances (NZECP:34) specifies minimum approach distances to all overhead power lines which will apply to the design of the Indicative Alignment and to the construction activities. A new transmission line support structure will be required to maintain clearance height distances above the new state highway as recommended by Transpower during early engagement with them.

The Transport Agency will continue discussions with Transpower regarding the specific design, approvals and construction methodology for protection of transmission assets.

Telecommunication

There are telecommunication facilities in proximity to the Indicative Alignment, including Vodafone, Spark and Kordia owned assets. The Transport Agency will continue to liaise with telecommunication utilities providers regarding the management of their activities during construction.

Watermain

The Indicative Alignment crosses over Watercare's Wellsford watermain and the construction works will be undertaken upstream of the water take points for both Warkworth and Wellsford's reticulated water supply (noting Watercare has transferred from surface water to groundwater abstraction for Warkworth). In addition, the Project proposes to culvert part of a watercourse which the discharge from the Wellsford wastewater treatment plant enters. The Transport Agency will continue discussion with Watercare regarding the management of activities during construction.

Power distribution

Vector's Wellsford Delivery Point for gas distribution and infrastructure for electricity distribution falls within the proposed designation and in proximity to the Indicative Alignment. The Transport Agency will liaise with Vector regarding the management of their activities during construction.

5.5.4. Earthworks

Earthworks quantities and distribution

The Project will involve large volumes of earthworks over approximately 310 ha. The total volume of cut material is approximately 12.4M m^3 and the total volume of fill material is approximately 9.6M m^3. The indicative construction methodology has been based on a typical range of earthworks per annum per section of between 800,000 m^3 to 1,100,000 m^3. The contractor will undertake a more detailed analysis that will likely result in optimisation of earthworks quantities and potential for a reduction of the overall construction programme. A summary of the indicative cut/fill requirements is provided below.

Table 5-1: Indicative earthworks quantities (m^3) for each construction section

	Total cut	Total fill	Cut suitable for reuse as structural fill	Structural Cut to Fill Surplus	Excess soil for disposal
South section	1,610,000	1,961,000	962,000	-203,000	0
Central section	6,169,000	3,393,000	3,807,000	554,000	2,550,000
North section	4,571,000	4,259,000	2,413,000	-45,000	829,000
TOTAL	**12,350,000**	**9,613,000**	**7,182,000**	**306,000**	**3,379,000**

The earthworks can be summarised as follows:

- The South section has a 203,000 m^3 shortfall of structural fill depending on earthworks optimisation during detailed design.
- The Central section is self-contained and has a 554,000 m^3 excess of structural cut to fill, depending on earthworks optimisation during detailed design.
- The North section is largely self-contained with a minor shortfall of structural fill (45,000 m^3) but generally can be considered to provide all the required fills from the cuts within this section.

Any shortfall (in particular in the South section) can be addressed by numerous options, including design refinements to reduce fill requirements or increase cut volumes, importing excess structural fill from the Central section, importing material from borrow areas within the proposed designation or importing overburden from existing quarries or a combination of these options. For assessment purposes a combination of these options has been considered.

The Indicative Alignment will generate up to approximately 3.4M m^3 of surplus earthworks material. Surplus material will occur where the material cannot be reused as engineered fill due it to being over-wet or of poor quality and/or the quantity of suitable cut material exceeds that of the required fill volume. Potential locations for soil disposal are shown on Figure 5-2 to Figure 5-4 below.

The majority of the soil disposal areas identified are located close to the Indicative Alignment and involve extensions to the uphill sides of embankments, using some large gullies above the road. The final soil disposal site locations for surplus material and final volumes will be determined during the detailed design phase of the Project and once a contractor has been appointed and the construction methodology confirmed. Potential soil disposal sites are accommodated within the proposed designation boundary.

Figure 5-1: Bulk earthworks on Northern Gateway Toll Road, similar to proposed earthworks through the commercial plantation forestry

Haul routes and access routes

Earthworks operations can be contained within the proposed designation boundary, including internal hauling of material, disposal of excess soil and potential establishment of material borrow sites. Given the likely requirement for importation of structural fill to the South section (either from the Central section or quarries further afield) and pavement material across the site, there will be material movement on public roads outside the proposed designation boundary. The indicative construction access routes along the existing SH1 and the local road network and indicative internal haul routes (haul roads) within the proposed designation boundary for earthworks, plant and materials are shown in on Figure 5-2 to Figure 5-4 below and described within this section. Additional but shorter access tracks will be constructed from these internal haul roads to specific locations, such as bridge sites and sites for ground improvement works.

In the southern extent of the South section (i.e. between Kaipara Flats Road and Woodcocks Road), access to the earthworks footprint is expected to be from local roads (Woodcocks Road, Carran Road and Kaipara Flats Road) as well as alongside the P2Wk motorway alignment. It is currently envisaged that the shortfall of structural fill in the South section is hauled in on a combination of these roads. Should surplus structural material from the Central section be used to meet the shortfall in the South section, the preferred haul route would be through either one of the bored tunnels. Until the tunnel bore is complete, material would need to be hauled using the forestry roads and SH1.

In the northern extent of the South section (i.e. from Kaipara Flats Road to the southern tunnel portals), the haul road is likely to be aligned within the earthworks

footprint, as the geology comprises of material suitable for haul roads. These haul routes will change in location and elevation as the earthworks progress but will remain within the proposed designation boundary.

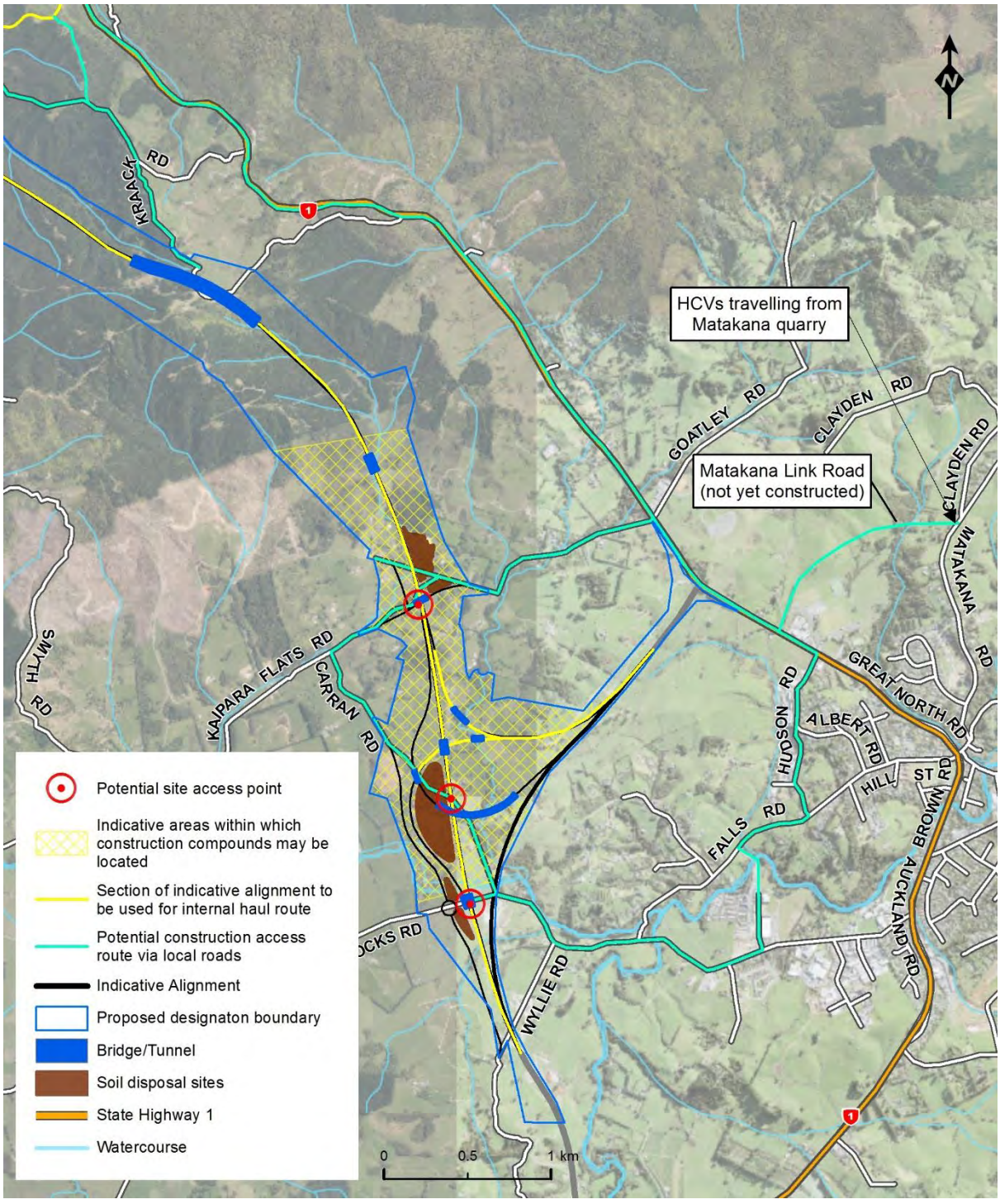

Figure 5-2 Construction: South section

The haul roads in the Central section are likely to be aligned generally within the earthworks footprint. Due to the steep topography, the primary haul road will follow the contours as much as possible to provide accessible gradients for earthworks

plant. Access to the primary haul road would likely be provided from SH1 via the existing forestry roads. Some existing forestry access roads between the existing SH1 and the Indicative Alignment are incorporated within the proposed designation in this Central section to ensure access is available to the earthworks footprint from SH1.

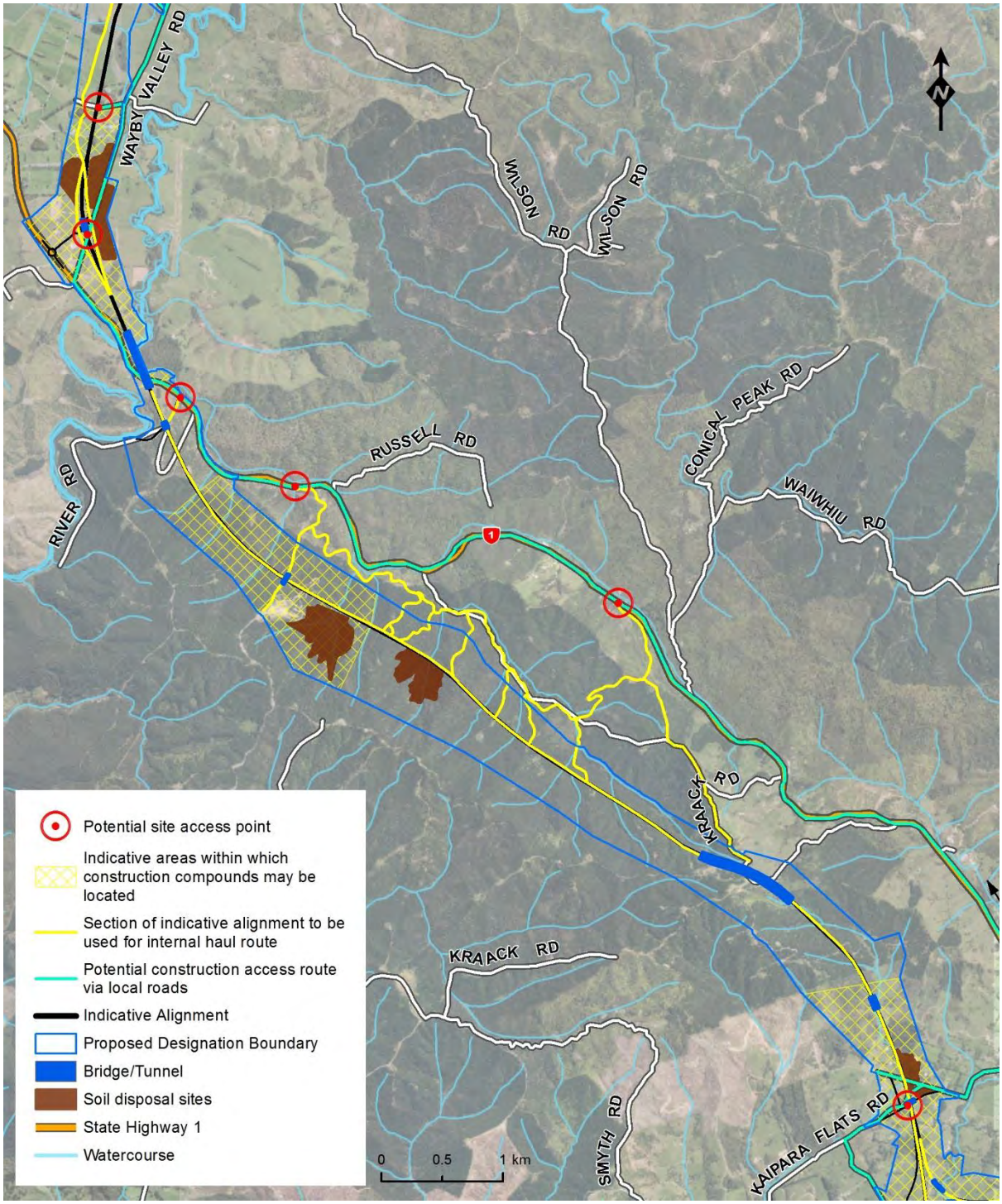

Figure 5-3: Construction: Central section

In the North section, there are areas of weaker materials (mudstone), and stronger materials (e.g. limestone). In areas of weaker materials, a haul route will be constructed outside the earthworks footprint, for construction purposes. In the

stronger limestone material, the haul route will generally be constructed within the earthworks footprint and will change in location and elevation as the earthworks progresses.

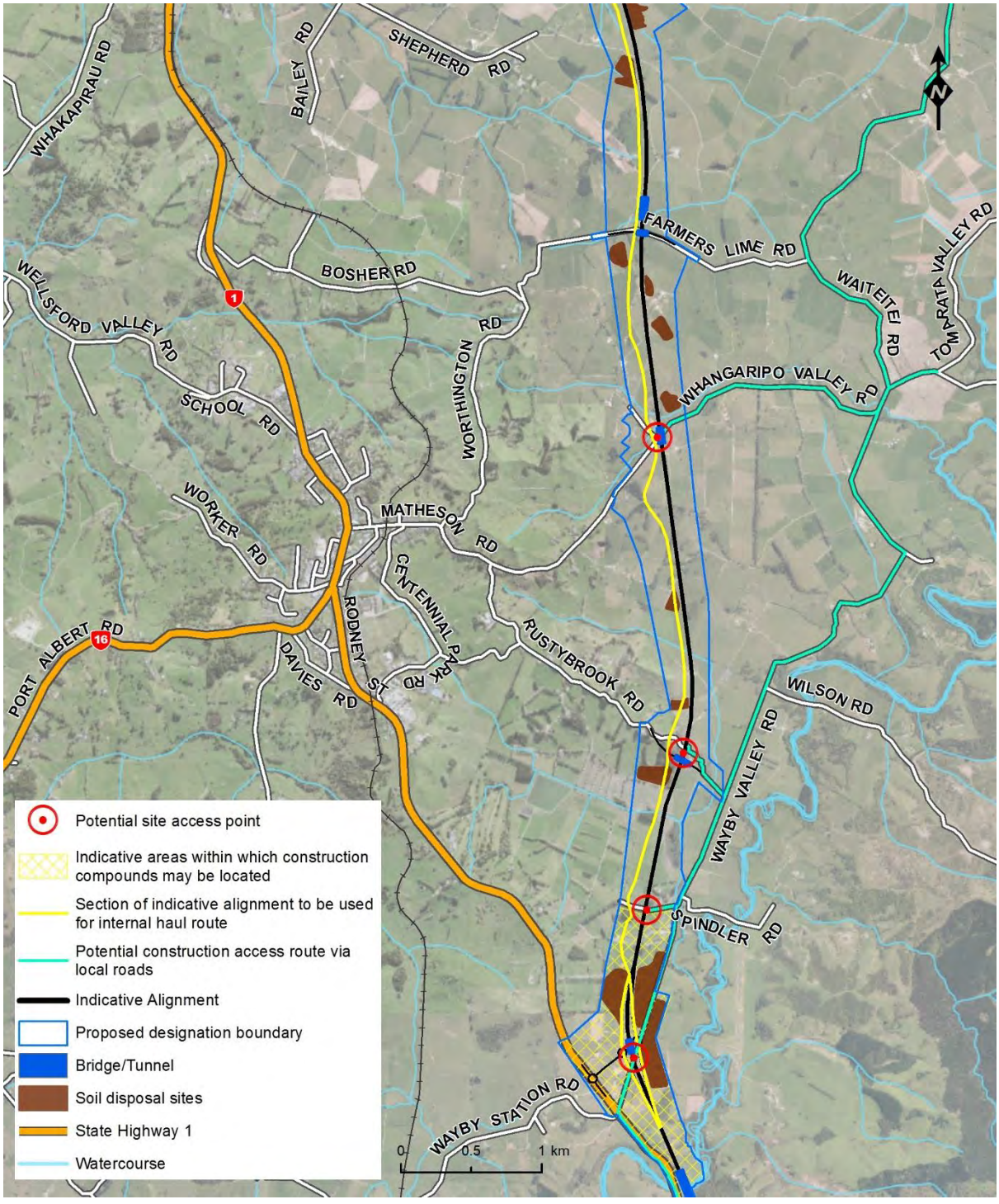

Figure 5-4: Construction southern extent of North section

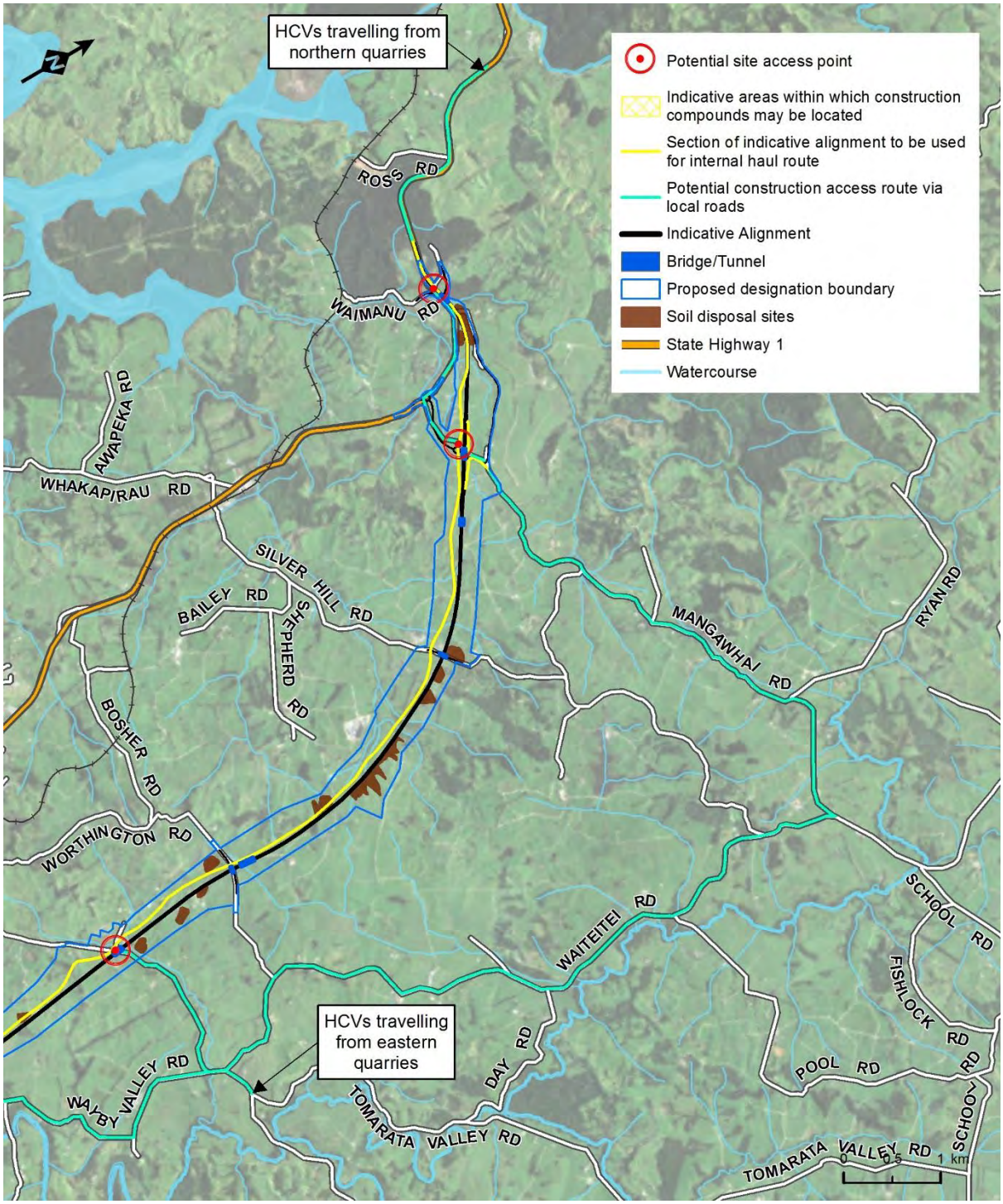

Figure 5-5: Construction northern extent of North section

To assist with the assessment of potential effects, the following four quarries in proximity to the Project have been used as the premise for the source of materials and resulting heavy traffic:

- Matakana Quarry: Approximately 20 km east of the South section;
- Rodney Aggregates Quarry: Approximately 16 km east of the North section;
- Atlas Quarry: Approximately 23 km north of the North section; and
- Millbrook Quarry: Approximately 35 km north of the North section.

The volume of construction aggregate procured from the individual quarries will be dependent on the available capacities and aggregate quality within these quarries or at other locations at the time of construction.

The overall volume of imported construction aggregates required for use on the Project is dependent on the availability of rock from within the site that may be suitable for crushing and reuse as construction aggregates. Areas with suitable underlying material within the proposed designation may be used as rock borrow sites to reduce the quantum of material required to be imported to the site.

Erosion and sediment control

The scale of the Project will require the disturbance of a large area of land within the proposed designation. An overriding principle for the Project has been to balance the land disturbance required against efficiencies in construction programme to minimise the amount of construction-related sediment from entering streams and watercourses and, in turn, the Mahurangi and Kaipara Harbours.

A key erosion and sediment control (ESC) principle will be to minimise the area and length of time that particular areas of ground are open through staging and sequencing of works and progressively stabilising open earthworks areas to reduce the potential for erosion to occur. This best practice approach will be used in conjunction with proven structural and non-structural control devices and methods. If monitoring confirms that the ESC devices are achieving higher standards of management than anticipated, it may be appropriate through conditions of consent to increase the proposed open area limit to reduce the construction programme.

Best practice erosion and sediment control measures will be implemented for the Project. The erosion and sediment control measures are discussed in further detail in section 9.2 and in summary will include:

- Working to industry best practice at the time of construction;
- Appropriate staging of the works, to appropriately limit the area of exposed earth open to the elements at any one point in time;
- Perimeter controls (predominantly earth bunds and drains) to divert clean water runoff away from the disturbed areas and divert sediment laden runoff to sediment retention devices;
- Progressive and rapid stabilisation of disturbed areas; and
- Sediment control devices, including sediment retention ponds (SRPs), decanting earth bunds (DEB) (where there is insufficient space to use ponds), sediment fences and silt socks.

The *Construction Water Management (ES-Series)* drawings contained in *Volume 3: Drawing Set* show how erosion and sediment control could be delivered for the Project.

Water use requirements for construction

Water will be required for construction activities; such as dust suppression. No resource consents for water takes are sought at this time. The contractor will be required to obtain sufficient water supply for construction of the Project. The potential source or sources are not yet known. If the contractor's chosen source requires resource consents, they will be required to obtain this from Auckland Council prior to the commencement of works.

Construction plant equipment

The typical earthmoving plant anticipated to be required for construction of the Project is identified in Table 5-2. This plant will be supported by an array of smaller plant for topsoil stripping, loading, drainage and structure construction purposes. The actual size, capacity and total plant numbers will be dependent on the required programme and number of work sites that could efficiently be operated in any section.

Table 5-2: Indicative earthmoving plant

Plant	Purpose	Conditions
Large off-road motorscrapers	Self-loading and carting	Soft soils in moderately sloping terrain
Large and medium sized excavators	Excavating	Soft and hard soils, including softer rock, in flat to steep terrain
Large bulldozers	Ripping and pushing	Soft and hard soils, including softer rock in flat to steep terrain
Large articulated dump trucks	Carting	Suitable for traversing moderately soft to hard material at moderately steep to flat grades
Large rigid-chassis dump trucks	Carting	Suitable for traversing firm material at moderate to flat grades
Medium-sized roller compactors	Compaction	Reasonably level surfaces

5.5.5. Construction traffic

Light vehicle movements

Light vehicle movements are associated with the workforce and expected visitors. For the purposes of the assessments, it is assumed that approximately 50% of the staff will be resident in Warkworth, Wellsford or the areas surrounding these centres. It is assumed that the remainder will travel mainly from Auckland, but also from as far afield as Whangārei. The indicative light vehicle movements are shown in the Table 5-3 below.

Table 5-3: Anticipated light vehicle movements per day (two way)

	Main Site Office	South section	Central section	North section	Visitors per day
Anticipated light vehicle movements to and from site	70-90	430-490	430-490	580-660	40-60

Heavy vehicle movements

Heavy vehicle movements on the road network will primarily be associated with the importation of fill to the South section (years 3, 4 and 5) and importation of pavement aggregates (years 6 and 7 for all construction sections). The highest traffic frequencies will occur on the roads directly between the quarries and the site and will reduce as the material is distributed via internal haul routes along the length of the site or if material is sourced within the Project area instead of external sources. For

the larger bridges, concrete delivery truck volumes of 4 to 6 per hour may generally be expected, with occasional peaks of 6 to 9 per hour.

Table 5-4 and Table 5-5 show possible scenarios for heavy vehicle movements associated with importation of fill to the South section and importation of pavement aggregate to all construction sections. A range of heavy vehicle movements are outlined to compare the extent of traffic movements if this were to occur over a shorter or longer construction period (2 year or 3 year haul). Two material sources have been assessed for the importation of fill to the South section, as outlined in section 5.5.4 being either from Matakana Quarry or from the Central section. Note, no assumptions have been made around the source for the importation of pavement aggregate for each of the construction sections, however the table provides a worst case scenario of importation requirements and truck movements on the public road network.

Table 5-4: Indicative assumptions for importation of fill to South section

Importation of fill to South section	From southern quarry		From Central section*	
	2 year haul	3 year haul	2 year haul	3 year haul
Fill volume per day (m3)	800	530	750	500
Volume of truck (m3)	14	14	10	10
Hours per day	9.5	9.5	9.5	9.5
Truck loads per day	57	38	75	50
Loads per hour	6	4	8	5
Loads per hour (two way)	12	8	16	10
Truck movements per day (two way)	114	76	152	95

* If the aggregate is taken through the tunnel from the Central section (as outlined in section 5.5.4) this would significantly reduce truck movements on the public road network

Table 5-5: Indicative assumptions for importation of pavement aggregates for each construction section

Importation of pavement aggregate	South section		Central section		North section	
	2 year haul	3 year haul	2 year haul	3 year haul	2 year haul	3 year haul
Fill volume per day (m3)	878	585	878	585	2,050	1,365
Volume of truck (m3)	14	14	14	14	14	14
Hours per day	9.5	9.5	9.5	9.5	9.5	9.5
Truck loads per day	63	42	63	42	146	98
Loads per hour	7	4	7	4	15	10
Loads per hour (two way)	14	8	14	8	31	20
Truck movements per day (two way)	133	76	133	76	295	190

Site access points

It is anticipated that the contractor will seek access to site using most of the local and all or some of the forestry roads that connect from the existing state highway to the Project works site. Site access is also anticipated at the tie-ins with the state highway at either end of the Project, particularly during pavement construction.

Traffic management

Construction of the Project will require temporary traffic management (TTM) on both the existing state highway and local roads. This may include:

- Shoulder and lane closures;
- Temporary deviations;
- Road closures/detours;
- Site access arrangements including acceleration and deceleration lanes; and
- Temporary speed limits.

In many instances construction activities can be undertaken off line, with temporary traffic management only needed where construction of tie-ins is required under live traffic. Some road realignments or bridge works will require the construction of temporary diversions to maintain through traffic. Temporary traffic management controls will be implemented in accordance with the standards in the Code of Practice for Temporary Traffic Management (CoPTTM) to ensure that the TTM measures are put in place safely and that the impacts on traffic are minimised as much as practicable.

The proposed temporary traffic management measures are discussed and assessed in section 9.5 of this AEE and detailed in the *Construction Traffic Assessment* in *Volume 2: Technical Assessment Reports*.

5.5.6. Vegetation removal/ protection

For assessment purposes, it has been assumed that the area of commercial plantation forestry within the proposed designation boundary which is necessary for construction purposes will be cleared prior to construction commencement (refer Figure 3-5 and Figure 3-6). As outlined in section 3.5.1, the forest within the proposed designation is likely to reach maturity around the same time as the Project pre-construction phase and is programmed to be progressively harvested from around 2025 – 2027. Project construction commencement is indicatively 2030.

The methodology for construction of bridges across the Mahurangi River (Left Branch) will be developed so that temporary construction activities do not occur within the river bed and, to the extent practicable, its riparian margins (which are identified as a SEA).

There are other SEA sites located within the proposed designation which are proposed to be protected to the extent practicable during construction, through delineation and protection of these areas. These include:

- Removal of vegetation within the riparian margin of the Mahurangi River Left Branch except as necessary to construct on and off ramps for the Warkworth interchange; and
- Avoiding removal of the swamp maire north of Phillips Road.

The construction of Bridge 11 across the Hōteo River, Waiteraire Stream and SH1 will require two sets of piers and foundations to be located within a native forest area which is identified as a Significant Ecological Area (SEA). Temporary access will be required to construct the piers. The bridge design has positioned the piers to minimise the impacts of construction access and activities within the SEA, illustrated in Figure 5-6 below. The impact of the access to these locations may be further mitigated by means of temporary bridges across the Waiteraire Stream and native forest reinstatement.

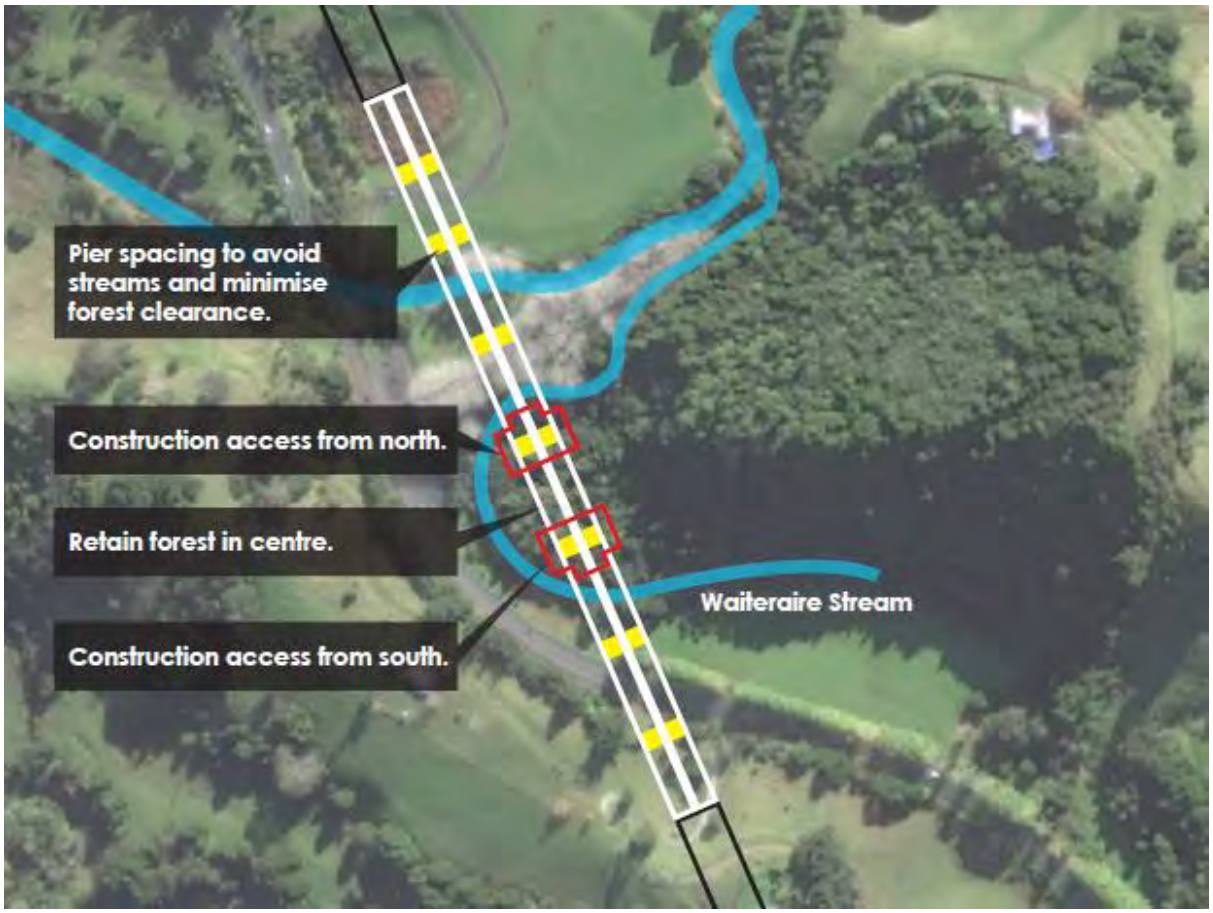

Figure 5-6: Proposed positioning of Bridge 11 piers within SEA

5.5.7. Works in watercourses

Stream realignment

Permanent stream diversions will be required to divert streams around or through permanent Project features, such as an embankment, bridge or culvert. Permanent stream diversions are discussed in section 4.3.9 of this AEE. Some temporary stream diversions will be required during the construction of the Project to allow construction works to progress, or to provide access to a construction area. In both cases, stream diversions will be necessary to establish an 'offline' environment to allow construction works to be completed outside of the active stream channel. This strategy will be based upon the temporary diversion of flows around the area of works or working immediately next to the stream.

Streams will be surveyed for the presence of fish species. If fish species are present, stream works will be programmed and undertaken, where practicable, so they do not occur during the fish spawning and migration periods (1 September to 30 November).

Culverts, erosion control and protection structures

Permanent culvert construction will be required in a number of locations throughout the Project. Temporary culverts are also likely to be required to allow construction vehicles to cross watercourses and overland flow paths during construction. All temporary culverts will be removed when no longer needed and the stream profile reinstated should any disturbance occur as a result of the temporary culvert.

Permanent culverts will be constructed in an off line environment, and thus isolated from the existing stream flows i.e. a temporary stream diversion will be required to divert flows prior to stream works commencing around the culvert construction site. Once completed, flows are then directed through the culvert.

Where culvert installation or an extension is required within a stream channel, the culvert works could be carried out either by bypassing the flows around the culvert footprint and establishing a stream diversion or by pumping the flows around the culvert works areas. Stream flows and fish passage requirements will determine which approach is used.

5.5.8. Hazardous substances and materials

As noted above, construction activities and site works will include a wide range of machinery and construction plant. The majority of this plant will be motorised and require a regular supply of fuels and oils. The machinery will require refuelling on-site, hence fuel, oils and other lubricants will be stored within the proposed designation.

The management of hazardous substances, including storage, handling, transport and disposal, will be subject to specific management practice and industry guidelines. This management will minimise potential effects on health and safety from exposure to hazardous substances and minimise potential for adverse effects on the environment.

5.5.9. Viaduct and bridges

The Project will require the construction of a number of bridges (21 bridges are shown on the Indicative Alignment).

Short span bridges, having spans of up to approximately 35 m in length, will most likely comprise of traditional precast beams. Precast beams may be lifted into place by either cranes or launching girders (used when access for lifting cranes is difficult, such as over wide waterways or where it is desirable to limit the construction footprint).

Long span bridges, having spans of more than 35 m in length, are likely to be constructed with structural steel beams or box girders.

Bridge 11 over the Hōteo River is approximately 490 m long, has spans of up to 65 m, and has a straight alignment. The viaduct is therefore well suited to span by span construction using an overhead gantry as used for the Waiwera Viaduct, shown in Figure 5-7. Piled foundations and columns will require access for a piling rig, cranes and other equipment required to construct the substructure (i.e. piers).

Alternative construction methods will be investigated further through detailed design and once a contractor is appointed. If concrete batching methods are proposed by the contractor instead of pre-cast, any consents required for establishing concrete batching plants will be sought by the contractor.

Figure 5-7: A launching gantry placing segmental box girder sections on the Waiwera Viaduct

Bridge 21 at the Warkworth interchange is approximately 555 m long and has spans of up to 65 m. Bridge 21 could be built using a similar construction methodology to that of Bridge 11.

5.5.10. Tunnels

Excavation of the twin tunnel bores would be undertaken most likely by using a track mounted roadheader and rock milling machinery, see Figure 5-8 below. The roadheader will excavate the upper section of the tunnel bore followed by the rock milling machinery to complete the lower section. The excavation will be temporarily supported whilst the permanent waterproof lining and support structure is completed.

The portals will follow the natural contours of the hill as much as practicable.

Groundwater inflow into the tunnels during excavation is expected to be limited to seepage from bedding planes and fault zones. Any inflow will be managed by temporary water management methods (bunds, table drains, pipes) and stored and treated within sediment devices prior to discharging as surface water.

Once operational, groundwater will be directed around the perimeter of the tunnel lining and collected in a piped system, to be collected, stored and treated by a treatment device prior to being discharged as surface water.

Figure 5-8: Excavation of lower bench by rock milling machine

5.5.11. Pavement construction

Pavement construction may be carried out in the last 12 months of each section of the Project following the completion of the bulk earthworks and the major structures, unless completed concurrently with the completion of earthworks activities.

It is anticipated that all pavement material will need to be imported. Aggregates required for pavement construction will be delivered to the site by truck and trailer. Material will generally be carted from the available quarries along local roads and the existing SH1.

5.5.12. Construction management plans

Construction of the Project will be managed through the development and implementation of a suite of management plans typical of large construction projects. The construction management plans form an integral part of how construction activities are managed to address the social, environmental and cultural effects identified in Section 9 of this AEE.

6. Statutory Context

6.1. Introduction

The purpose of this section is to set out the statutory framework against which the Project must be assessed. Relevant statutory matters are set out, including the relevant RMA planning documents as well as matters under other relevant legislation. It focuses particularly on those provisions of the RMA that are relevant to the application, including:

- Purpose and principles of the RMA (Part 2);
- Duties and restrictions (Part 3);
- NoRs for designations (Part 8); and
- Applications for resource consent (Part 6).

An assessment of the Project against the statutory framework is provided in Section 11 of this AEE.

In addition, this section identifies the statutory authorisations sought under the RMA for the Project. In summary, the Transport Agency is proposing a new designation for the construction, operation, and maintenance of a State highway.

The Transport Agency is seeking resource consents to authorise the following activities:

- Land disturbance activities including earthworks, roading, tracking, ground improvements, soil disposal, borrow sites and vegetation clearance under section 9(2) of the RMA;
- Activities in, on, under or over the bed of lakes, rivers and streams (including intermittent streams), including structures, stormwater outlets, erosion protection, restoration and enhancement under section 13 of the RMA;
- Diversion of water in rivers, streams and wetlands under section 14 of the RMA;
- New impervious surfaces for high use roads and diversion, and discharge of stormwater from new permanent impervious surfaces to land and water under sections 9(2), 14 and 15 of the RMA;
- Diversion of groundwater and associated dewatering caused by excavation and tunnelling under section 14 of the RMA;
- Discharges to air associated with mineral extraction activities and temporary crushing (rock borrow sites) under section 15 of the RMA.

6.2. Resource Management Act

6.2.1. Purpose and principles (Part 2)

Consideration of the NoR and of the applications for resource consent are subject to Part 2 of the RMA. Part 2 of the RMA is comprised of sections 5 to 8 and outlines the purpose and principles of the RMA.

Section 5 sets out the purpose of the RMA, being to promote the sustainable management of natural and physical resources, and states:

(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—

(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

Section 6 describes the matters of national importance that all persons exercising functions and powers under the RMA shall recognise and provide for. Matters (a), (b), (c), (d), (e), (f), (g) and (h) are of particular relevance to this Project. In summary, these matters relate to:

(a) … natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins…;

(b) …outstanding natural features and landscapes …;

(c) …significant indigenous vegetation and significant habitats of indigenous fauna;

(d) …public access to and along … lakes, and rivers;

(e) the relationship of Māori and their culture and traditions…;

(f) …historic heritage…;

(g) …protected customary rights; and

(h) …significant risks from natural hazards.

Section 7 sets out other matters to which particular regard shall be had. Of relevance to this Project are matters (a), (aa), (b), (ba), (c), (d), (f), (g) and (i). In summary matters relate to:

(a) kaitiakitanga;

(aa) the ethic of stewardship;

(b) the efficient use and development of natural and physical resources;

(c) the maintenance and enhancement of amenity values;

(d) intrinsic values of ecosystems;

(f) maintenance and enhancement of the quality of the environment;

(g) any finite characteristics of natural and physical resources; and

(i) the effects of climate change.

Section 8 requires all persons exercising functions and powers under the RMA to take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

6.2.2. Duties and restrictions (Part 3)

Part 3 of the RMA sets out a number of restrictions on the use of resources (including land and water), and on activities that impact on resources (such as the discharge of contaminants). Where relevant to this Project, these are summarised below:

Section 9 of the RMA imposes restrictions on the use of land. The Project will involve a number of land disturbance activities controlled under section 9(2) of the RMA. The proposed activities that would otherwise permitted or require consent under district rules (section 9(3) of the RMA) will be authorised by the proposed designation for the Project.

Section 13 of the RMA imposes restrictions on activities in, on, under and over the beds of lakes and rivers. There are streams in the Project area that will be affected by structures as part of the Project, through the installation of bridges and culverts.

Section 14 of the RMA relates to any take, use, damming or diversion of water. The Project will require temporary and permanent diversion of streams and diversion of water in wetlands, stormwater and groundwater diversion during construction and operation of the Project.

Section 15 of the RMA restricts discharges into or onto air, land or water. The Project will involve discharges to air, land and water during construction and operation.

The resource consents are set out in section 6.6 below.

6.2.3. Designations

As outlined in Section 1 of this AEE, the Transport Agency is a requiring authority and can give notice of its requirement to designate land for the state highway network in accordance with its statutory functions. The Transport Agency has given a notice of its requirement for a new designation in the AUP(OP) for the construction, operation, and maintenance of a state highway.

The process for considering a NoR for a designation is set out in Part 8 (sections 166 – 186) of the RMA. In accordance with section 168(2), where a matter is lodged with a territorial authority, a requiring authority may at any time give notice in the prescribed form to a territorial authority of its requirement for a designation for a project or work.

6.2.4. Resource consents

Territorial authorities must consider applications for resource consents under sections 104 to 112 and 138A of the RMA and may impose conditions under sections 108 and 108AA, if it chooses to grant consent.

6.2.5. Matters for consideration

As required by section 104, consent authorities considering applications for resource consent must, subject to Part 2, have regard to the following matters as assessed in this AEE:

RMA requirement	AEE reference
Actual and potential effects on the environment	Section 9: Assessment of effects on the environment and technical assessment reports contained in Volume 2
Measures proposed for the purpose of ensuring positive effects	Section 9: Assessment of effects on the environment Section 10: Management of effects on the environment
Relevant provisions of policy statements, environmental standards, plans and other regulations	Section 11: Statutory assessment
Other matters	Section 11: Statutory assessment

As required by section 171, consent authorities considering NoRs must, subject to Part 2, consider the effects on the environment having particular regard to the following matters as assessed in this AEE:

RMA requirement	AEE reference
Part 2 of the RMA	Section 11: Statutory assessment
Effects on the environment	Section 9: Assessment of effects on the environment and technical assessment reports contained in Volume 2
Relevant provisions of policy statements and plans	Section 11: Statutory assessment
Adequate consideration of alternatives	Section 7: Alternatives assessment
Necessity for achieving Requiring Authority objectives	Section 11: Statutory assessment
Other matters	Section 11: Statutory assessment

Section 105 of the RMA sets out further matters that must be considered in relation to the consents sought for the discharge of water and contaminants (stormwater and sediment) and dust from mineral extraction activities during construction of the Project and for the discharge of stormwater arising from the operation of the Project. The matters identified in section 105 of the RMA are assessed in section 9 and section 11 of this AEE demonstrates how the requirements of section 105 are met.

Relevant policy statements and plans are identified in section 6.2.7 below. An assessment against these provisions is provided in section 11 of this AEE.

In addition, there are a range of 'other matters' that must be considered, which can include matters outside the RMA, including non-statutory policy documents. A brief description of other matters relevant to the Project is outlined in section 6.3 to section 6.5 below. An assessment against other relevant matters is provided in section 11 of this AEE.

6.2.6. Restrictions on the power to grant consent

Section 107(1) of the RMA restricts the power to grant resource consent to discharge a contaminant or water where that discharge is likely, after reasonable mixing, to give

rise to any of a number of specified types of adverse effects. This restriction is subject to the exceptions listed at section 107(2), including where there are exceptional circumstances, or where the discharge is of a temporary nature.

A detailed assessment against section 107(1) is contained in section 11 of this AEE.

6.2.7. Planning and Policy Documents

The national, regional and district planning and policy documents relevant to the Project (prepared in accordance with the RMA) are listed below.

National Policy Statements

New Zealand Coastal Policy Statement (NZCPS): The NZCPS came into effect on 3 December 2010 and contains objectives and policies relating to New Zealand's coastal environment. As the Project will potentially impact on the coastal environment through discharges, specifically in the vicinity of the northern tie in and Warkworth Interchange, the NZCPS must be considered.

There are seven overarching objectives of the NZCPS which set out the high level direction for managing the coastal environment, and 23 policies that follow this direction. The objectives of the NZCPS include to:

- Safeguard and preserve the natural character of the coastal environment including its function, resilience, and sustaining ecosystems for future generations;
- Preserve the natural character of the coastal environment and protect natural features and landscape values;
- Take into account the principles of the Treaty of Waitangi;
- Maintain public access and open space opportunities in the coastal environment;
- Ensure coastal hazard risks taking account of climate change are managed;
- Enable people and communities to provide for their social, economic and cultural wellbeing; and
- Ensure management of the coastal environment recognises and provides for New Zealand's international obligations.

National Policy Statement for Freshwater Management (NPSFM): The NPSFM came into effect on 1 August 2014, and a range of amendments came into effect on 7 September 2017. It contains nine groups of objectives and policies:

- Te Mana o Te Wai;
- Water quality;
- Water quantity;
- Integrated management;
- National objectives framework;
- Monitoring plans;
- Accounting for freshwater takes and contaminants;
- Tangata whenua roles and interests; and
- Progressive implementation programme.

The relevance of the NPSFM to the Project will be through consideration of consents required under the AUP(OP), which gives effect to the NPSFM. An assessment of the Project in relation to the NPSFM is provided in section 11 of this AEE.

National Policy Statement on Electricity Transmission (NPSET): The NPSET came into effect on 10 April 2008. The objective of the NPSET is:

> *"[t]o recognise the national significance of the electricity transmission network by facilitating the operation, maintenance and upgrade of the existing transmission network and the establishment of new transmission resources to meet the needs of present and future generations, while:*
>
> *· managing the adverse environmental effects of the network; and*
>
> *· managing the adverse effects of other activities on the network."*

As there is an electricity transmission line running through the Project area, the effects of the Project on the electricity transmission network need to be considered and managed. An assessment of the Project in relation to the NPSET is provided in section 11 of this AEE.

National Policy Statement on Urban Development Capacity (NPSUDC): The NPSUDC came into effect on 1 December 2016. The NPSUDC provides direction to decision-makers under the RMA to provide for sufficient development capacity for housing and businesses to enable urban areas to grow and change in response to the needs of communities. In the NPSUDC, development capacity is defined as:

> *"the capacity of land intended for urban development based on: the zoning, objectives, policies, rules and overlays that apply to the land; and the provision of adequate infrastructure to support the development of the land".*

The NPSUDC is relevant to the Project to the extent that it has a function of improving transport access to identified growth areas (i.e. Warkworth and Wellsford). An assessment of the Project in relation to the NPSUDC is provided in section 11 of this AEE.

Hauraki Gulf Marine Park Act 2000 (HGMPA): The HGMPA recognises the national significance of the Hauraki Gulf, including the interrelationship between the Hauraki Gulf, its islands and catchments, and the ability of that interrelationship to sustain the life-supporting capacity of the environment.

The HGMPA outlines broad policy matters, which recognise the features that contribute to the national significance of the Hauraki Gulf and appropriate objectives for the Gulf's management.

Section 7 of the HGMPA recognises the Hauraki Gulf as an area of national significance. Section 8 of the HGMPA provides further specific direction on resource management matters that contribute to the Hauraki Gulf's significance. Under section 9(5) of the HGMPA, sections 7 and 8 are deemed to be national policy statement under the RMA in respect of matters relating to the Gulf.

Part of the Project area is located in the Mahurangi catchment which is a catchment of the Hauraki Gulf. The potential effects of the Project on the Mahurangi catchment are outlined in section 9 and an assessment against the HGMPA is provided in section 11 of this AEE.

National Environmental Standards

National Environmental Standards for Air Quality (NESAQ): The NESAQ is intended to protect public health and the environment of New Zealand by, among other things, setting national environmental standards for ambient air quality. Different parts of the NESAQ came into effect between 2004 and 2006.

There are five ambient air quality standards relevant to the Project. Schedule 1 of the NESAQ sets out the ambient air quality concentration limits for the following:

- Carbon monoxide;
- Nitrogen dioxide;
- Ozone;
- Fine particular matter (PM10); and
- Sulphur dioxide.

The construction and operation of the Project will not trigger the requirement for resource consent under the NESAQ. The potential effects of the Project on air quality are addressed in sections 9 and 11 of this AEE.

National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES Soil): The NES Soil establishes a nationally consistent set of planning controls and soil contaminant values. The NES Soil contains a national set of soil contaminant standards for 12 priority contaminants, for five standard land use scenarios (rural residential, residential, high density residential, recreational and commercial/industrial).

Previous and existing land uses within the Project area have been identified as Hazardous Activities and Industries List (HAIL) activities. An assessment of the Project in relation to the NES Soil is provided in section 11 of this AEE. The potential effects of land contamination are addressed in sections 9 and 11 of this AEE. Given the site specific nature of potential contaminated sites identified and the indicative nature of the alignment, if consents are required under the NES Soil for land disturbances these will be obtained after detailed design, but prior to the commencement of any construction works for the Project which may disturb potentially contaminated soils.

National Environmental Standards for Electricity Transmission Activities (NESETA): This NES is applicable to the Project as works to protect an existing electricity transmission line will be required. Any work on the existing transmission lines will be undertaken in liaison with Transpower and subject to their agreement. Any approvals required in accordance with the provisions of the NESETA will be sought prior to the commencement of any construction works for the Project within the vicinity of the transmission lines. Approvals under the NESETA are not sought as part of this Application.

National Environmental Standards for Sources of Human Drinking Water 2007 (NESSHDW): This NES requires regional councils to ensure that effects on drinking water sources are considered in decisions on resource consents and regional plans. No consents relating to this standard are required. The potential effects of the Project on the quality of drinking water sources (including Watercare's surface water take

from the Hōteo river and other potentially permitted water takes) are addressed in section 9 of this AEE.

National Environmental Standards for Plantation Forestry (NESPF): This NES came into effect on 1 May 2018. The NESPF objectives are to:

- maintain or improve the outcomes associated with plantation forestry activities; and
- increase the efficiency and certainty of managing plantation forestry activities.

The NESPF is relevant to the Project as part of the proposed designation is located within a plantation forestry area. Given this is a commercial plantation forest, consent (if required) is not being sought as part of this Application as the relevant areas may be cleared by the forestry operator prior to construction. If consent is required for forestry removal to facilitate construction of the Project, the Transport Agency will undertake the works in accordance with the NESPF provisions, including seeking any consent approvals prior to commencement of construction if necessary.

Auckland Unitary Plan

All provisions in the AUP(OP) relevant to the Project (regional plan and district plan) are operative, with the exception of some provisions within Chapter E15 – Vegetation Management and Biodiversity. The relevant objectives and policies are summarised below and discussed in greater detail in section 11 of this AEE.

AUP(OP): Regional Policy Statement

Relevant resource management issues addressed in the RPS section of the AUP(OP) are:

- Tāhuhu whakaruruhau ā-taone – Urban growth and form (Chapter B2);
- Ngā pūnaha hanganga, kawekawe me ngā pūngao – Infrastructure, transport and energy (Chapter B3);
- Te tiaki taonga tuku iho – Natural heritage (Chapter B4);
- Te tiaki taonga tuku iho – Built heritage and character (Chapter B5);
- Mana Whenua (Chapter B6);
- Toitū te whenua, toitū te taiao – Natural resources (Chapter B7);
- Toitū te taiwhenua – Coastal environment (B8);
- Toitū te tuawhenua – Rural environment (B9); and
- Ngā tūpono ki te taiao – Environmental risk (Chapter B10).

An assessment of the Project in relation to the RPS section of the AUP(OP) is provided in section 11 of this AEE.

AUP(OP): Regional Plan provisions

Activities covered by the Regional Plan section of the AUP(OP) which are relevant to the Project are:

- Earthworks (including on land slopes greater than 10 degrees, within the Sediment Control Protection Area and within SEAs);
- Vegetation alteration and removal (including within riparian margins, rural zones and SEAs);

- New structures within the beds of rivers, streams and wetlands and associated bed disturbance or depositing of any substance, reclamation, diversion of water and temporary damming of water;
- Diversion of rivers and streams;
- New impervious surfaces associated with high use roads;
- Diversion and discharge of stormwater from new impervious surfaces onto land or into water;
- Diversion, damming and discharge of treated sediment laden water associated with land disturbance activities;
- Groundwater diversion and dewatering associated with excavation and tunnelling;
- Drilling of bores;
- Groundwater takes;
- Discharges to air associated with road construction;
- Discharges to air from tunnels;
- Discharges to air from motor vehicles;
- Discharges to air from mineral extraction activities.

AUP(OP): District Plan provisions

Objectives and policies relating to the following activities covered by the District Plan section of the AUP(OP) are relevant to the Project:

- Infrastructure (new road) within the rural zone;
- Transport;
- Land disturbance;
- Vegetation alteration and removal;
- Heritage;
- Lighting;
- Signs;
- Noise and vibration;
- Mineral extraction from land;
- Flooding;
- Hazardous substances; and
- Activities in the rural zone.

AUP(OP) appeals

The policies of Chapter E15 Vegetation Management and Biodiversity (Regional Plan) of the AUP(OP) that are subject to appeal are not considered relevant to this Project as they relate to transferrable subdivision rights for vegetation projection:

AUP(OP) Plan Changes

Proposed Plan Change 4 (PC4) is an administrative Plan Change notified on 28 September 2017 that aims to correct technical errors and anomalies within a number of existing policies, rules, overlays and precincts and the GIS Viewer of the AUP(OP). PC4 does not seek to alter the outcomes of any of the objectives and policies of the AUP(OP). Neither does it introduce any new objectives, policies, rules, or zoning. Where relevant to the Project, this Plan Change has been considered.

Proposed Plan Changes 14, and 16 were notified on 29 November 2018 by Auckland Council and made operative on 17 January 2020. Plan Change 14 addresses the Auckland Wide and Overlay provisions and Plan Change 16 addresses the zone provisions. Plan Changes 15 and 17 were notified on 29 November 2018 by Auckland Council Plan. Change 15 addresses the coastal provisions and Plan Change 17 addresses provisions for the GIS Viewer. Both are subject to appeals. A number of changes within Plan Changes 15 and 17 have rules with immediate legal effect pursuant to rule 86B(3) of the RMA, amendments are also made to objectives, policies, rules and assessment criteria.

Private Plan Change 25: Warkworth North (PPC25) was notified 16 May 2019. Submissions for PPC25 close on 5 July 2019. The proposed private plan change is a request to rezone approximately 99 hectares of Future Urban zoned land to a mix of business and residential zones. The Private Plan Change went to a hearing in November 2019. There is no decision at the time of writing.

Plan Change 22: seeks additions to the following schedules:

- Schedule 12 sites and Places of Significance to Mana Whenua;
- Schedule 6 Outstanding Natural Features Overlay; and
- Schedule 14.1 Schedule of Historic Heritage.

Plan Change 22 (PC22) was notified by Auckland Council on 21 March 2019 with further submissions closing on 23 May 2019. A review of the additional sites sought by PC22 confirmed there are no sites located within the Project area and the Project does not traverse them.

As notified and at the time of writing, the plan changes identified and discussed above do not address matters germane to the Project or the suite of resource consents sought.

Northland Regional Policy Statement

The Northland Regional Policy Statement applies to the Project to the extent that sediment from stormwater discharges during construction may enter the marine receiving environment downstream. The Kaipara Harbour is located in part within the Northland Region jurisdiction. As such, the objectives and policies relating to water quality in the coastal environment have been considered as set out in section 11 of this AEE.

6.3. Other legislative matters

This section provides a brief introduction to the other legislation that will be relevant in the delivery of the Project. This section provides a context for other authorisations that may be necessary for the Project. Any authorisations required under other legislation are not applied for as part of the current application package and the requirement for additional authorisations is stated for completeness only. The additional authorisations will be applied for at the appropriate phase of the Project.

Other legislation that is relevant to the Project is outlined below.

6.3.1. Land Transport Management Act 2003

The LTMA provides the statutory framework for New Zealand's land transport system, including funding and managing land transport activities, and development. It is the statute under which the Transport Agency operates (in conjunction with the Government Roading Powers Act 1989).

Section 3 of the LTMA states its purpose to be to "*contribute to an effective, efficient, and safe land transport system in the public interest*". Consistent with that purpose, the Transport Agency's objective is to "*undertake its functions in a way that contributes to an effective, efficient and safe land transport system in the public interest*" (section 94 of LTMA). The Transport Agency's functions and principles under which the Transport Agency must operate are set out in section 1.2 of this AEE.

6.3.2. Public Works Act 1981

The Public Works Act 1981 (PWA) enables land to be acquired, either by agreement or by the compulsory processes set out in the PWA, for public works, including roads. It contains provisions for compensation for owners of land required for public works, and a process for the disposal of land no longer required for a public work.

A NoR for the designation of land (taking interim effect from the date the notice is given of the requirement for a designation) and a designation of land allows the owners of the land that is subject to the NoR or designation to apply to the Environment Court for an order obliging the requiring authority to acquire all or part of the land, in particular circumstances (section 185 of the RMA).

As of March 2020, the Crown has acquired approximately 16% of the land required for the Project (in addition to land already held by the Crown for the Project).

6.3.3. Heritage New Zealand Pouhere Taonga Act 2014

Under the Heritage New Zealand Pouhere Taonga Act 2014 (HNZPTA) no person may modify or destroy an archaeological site unless an authority is granted by Heritage New Zealand Pouhere Taonga whether or not the site is a recorded archaeological site.

The potential effects of the Project on archaeological/heritage sites are discussed in section 9 of this AEE. If required, an application will be made under the HNZPTA for an archaeological authority to cover construction works prior to commencement.

6.3.4. Wildlife Act 1953

The Wildlife Act 1953 addresses the protection and control of wild animals and birds, and the management of game. Permits are necessary under the Wildlife Act to deal with certain wildlife. The Wildlife Act also provides protection to some terrestrial invertebrates and marine species.

Part 1 of the Wildlife Act addresses the protection of wildlife. It provides varying levels of protection to different species. Most native birds, reptiles, bats and frogs are protected under the Wildlife Act. Some native and some introduced bird species have limited protection.

The potential effects of the Project on protected species are discussed in section 9 of this AEE. If required, an application will be made under the Wildlife Act for an authority to relocate any protected species prior to the commencement of construction of the Project.

6.3.5. Fisheries Act 1983

The Freshwater Fisheries Regulations 1983 (FFR) are regulations made under the Fisheries Act 1983. Part 6 of the FFR relates to fish passage and applies to "every dam or diversion structure in any natural river, stream, or water".

Under regulation 42(1):

> *"no person shall construct any culvert or ford in any natural river, stream, or water in such a way that the passage of fish would be impeded, without the written approval of the Director General incorporating such conditions as the Director-General thinks appropriate."*

These regulations require that the approval of the Director-General of Conservation be obtained for culverts where the passage of fish will be impeded. The Director-General can either:

- Issue a dispensation from the requirement to provide fish passage; or
- Specify that fish passage be provided and maintained.

The Indicative Alignment includes provision for all culverts required for the Project, to be designed to ensure adequate fish passage is provided where it is necessary.

Approval from the Director-General under the FFR is not expected to be required.

6.3.6. Marine and Coastal Area (Takutai Moana) Act 2011

The Marine and Coastal Area (Takutai Moana) Act 2011 acknowledges the importance of the marine and coastal area to all New Zealanders and provides for the recognition of the customary rights of iwi, hapū and whānau in the common marine and coastal area. Public access to the common marine and coastal area is guaranteed by the Act.

Numerous iwi groups have applied for recognition of customary interests under this Act, for the Mahurangi Harbour/Hauraki Gulf and the Kaipara Harbour. The Project does not seek any approvals for works or discharges within the common marine and coastal area.

6.4. Statutory acknowledgements

A statutory acknowledgement is a formal recognition by the Crown of a particular cultural, spiritual, historic and traditional association that an Iwi has with a specific area. The statutory acknowledgements provided under Treaty Settlement legislation for areas within Auckland are confirmed in the AUP(OP) at Appendix 21.

Statutory acknowledgements under the Ngati Manuhiri Claims Settlement Act 2012 relevant to the Project area include the Hōteo River statutory acknowledgement area. Statutory acknowledgements under the Te Uri o Hau Act Claims Settlement Act 2002 relevant to the Project area include the Kaipara Harbour Coastal Area (where discharges may potentially reach this harbour). No other statutory acknowledgements relate to the Project area.

6.5. Other relevant matters

For the resource consent applications, the consent authority must have regard to "any other matter the consent authority considers relevant and reasonably necessary to determine the application" (section 104(1)(c)). For the NoR, a consent authority must have particular regard to any other matter it considers reasonably necessary in order to make its decision (section 171(1)(d)).

The RMA does not define what matters are to be considered under these sections, however, it is accepted that these can include matters outside the RMA, including non-statutory processes. Case-by-case consideration of what other matters are relevant, is made by the consent authority considering resource consents and NoRs. As (generally) non-RMA planning documents, "other matters" have been selected as being particularly relevant for the Project for a range of reasons including:

- Having been through a public engagement process where feedback from the public has been sought;
- Prepared in accordance with other related legislation;
- Specifically mention the Warkworth to Wellsford project; or
- Are directly related to the objectives the Project is seeking to achieve (refer to Section 2 of this AEE).

6.6. Designations and resource consents

6.6.1. Notice of requirement

The Transport Agency has given a NoR for the designation of land required for the construction, operation and maintenance of a state highway.

Designation plans showing the land to which the NoR relates, and a schedule of land directly affected by the NoR. The drawings in *Volume 3: Drawing Set* also show the extent of the proposed designation.

In summary, the proposed designation directly affects the following types of landownership:

Table 6-1: Summary of land directly affected by the designation

Owner type	Area affected (ha) (Approximate)	No. of landowners
Private	1133	79
Crown	161	N/A
Road	50	N/A
Other (river bed)	2.38	N/A

Land subject to existing designations

Some of the land to be designated for the Project is already subject to existing designations held by the Transport Agency and other requiring authorities, as outlined in Table 6-2 below.

Table 6-2: Existing designations held by requiring authorities

Designation Reference	Requiring Authority	Purpose	Location
6769	NZ Transport Agency	The construction, operation and maintenance of a State highway (Ara Tūhono – Pūhoi to Wellsford Road of National Significance: Pūhoi to Warkworth Section)	From Johnston's Hill Tunnels to North of Warkworth
6763	NZ Transport Agency	State Highway 1	State Highway 1 from Titfords Bridge, Pūhoi to Ross Road (Kaipara District Council boundary), Topuni
6765	NZ Transport Agency	State Highway 1/Wayby Valley Road/Wayby Station Road intersection	State Highway 1 intersection with Wayby Station Road and Wayby Valley Road, Wellsford
2604	Chorus New Zealand Ltd	Kraack Hill Telecommunications Site – Telecommunication and radiocommunication and ancillary purposes	180 Kraack Road, Warkworth
751558	Spark NZ Trading Ltd	Kraack Hill Telecommunications Site – Telecommunication and radiocommunication and ancillary purposes	180 Kraack Road, Warkworth

[58] This is a secondary designation. Chorus New Zealand Ltd has the primary designation on the site pursuant to section 69XJ(3) of the Telecommunications Act 2001. See also: New Zealand Gazette No 180, 23 November 2011, pages 5223-5226.

Designation Reference	Requiring Authority	Purpose	Location
6500	New Zealand Refining Company Ltd (Refining NZ)	Petroleum pipeline: Rural Section – operation, maintenance and repair, upgrade and renewal of the existing petroleum transmission pipeline and ancillary facilities as required for the transportation of refined fuel products	102 Amreins Road, Taupaki to 109 Vipond Road, Topuni
9101	First Gas Ltd	Taupaki to Topuni Gas Pipeline – operation, maintenance and repair, upgrade and renewal of the existing gas transmission pipeline and ancillary facilities as required for the transportation of gas	102 Amreins Road, Taupaki to 109 Vipond Road, Topuni

In order to undertake work in accordance with a designation on land where there is an earlier designation in place, the written consent of the requiring authority for the earlier designation is required under section 177(1)(a). Prior to construction commencing on land subject to existing designations, approval under section 177(1)(a) will be required from:

- Chorus New Zealand Ltd;
- Spark NZ Trading Ltd;
- Refining NZ; and
- First Gas Ltd.

Designation lapse period

Section 184 of the RMA provides that a designation lapses, unless given effect to, on the expiry of five years after the date on which it is included in the district plan unless the designation specifies a different period.

Pursuant to section 184(1)(c), the Transport Agency proposes a lapse period of 15 years for the designation.

Land subject to existing resource consents

There are a number of parties that hold existing resource consents to establish and operate activities on sites either within the proposed designation boundary, or adjacent to the Project. Directly affected parties have all been contacted and an outline of these consents is provided in *Section 3: Existing environment*.

Project designation to be reviewed after construction

The proposed designation includes land required for both temporary and permanent works. Once construction is complete, the Transport Agency will review the designation area and may remove parts of the designation that are not required for the long term safe and efficient operation and maintenance of the state highway, using the process set out in section 182 of the RMA.

6.6.2. Outline Plan

Section 176A of the RMA requires that an outline plan must be submitted to a territorial authority before commencing construction of a project or work under a

designation. The outline plan must detail the information required in accordance with section 176(3).

The Transport Agency intends to submit outline plan(s) for relevant aspects of the Project to Auckland Council prior to the commencement of works. Further discussion around what is proposed to be included within the outline plan is contained in Section 10 of this AEE.

6.6.3. Activities requiring resource consent

The activities which require resource consent under the AUP(OP) are set out below. No resource consents are required under the legacy district or regional plans.

All key resource consents for the Project are being sought as part of this Application. If, after detailed design is complete, further or different resource consents are required, these approvals will be sought at that time. As noted above, once the detailed design is confirmed, other site specific consents such as under the NES (Soil), water takes for construction, and wastewater discharge consents from site offices will be sought by the contractor.

Consents sought as part of this application

The consents sought for the construction, operation and maintenance of the Project are identified in Table 6-3.

Table 6-3: Types of consents sought

RMA consent sought	Activity/scope of application	AUP(OP) Chapter/Rule reference	Activity status
Land disturbance activities			
Land use (s.9(2)) – earthworks	Earthworks undertaken Project wide, including all construction yards, access and haul roads and tracks, soil disposal sites, rock borrow sites and cut and fill activities; which specifically involve the following extent of earthworks: greater than 50,000 m2 where land has a slope less than 10 degrees outside the Sediment Control Protection Area (SCPA); greater than 2,500 m2 where the land has a slope equal to or greater than 10 degrees; greater than 2,500 m2 within the SCPA; between 10 m2 to 2,500 m2 and between 5 m3 to 2,500 m3 within a SEA. In particular in the following location(s): SEA_T_2287, SEA_T_683, SEA_T_6854, SEA_T_5541, SEA_T_6851 and SEA_T_685.	Infrastructure (E26) Rule E26.5.3.2 (A103), Rule E26.5.3.2 (A106), Rule E26.5.3.2 (A107). Rule E26.6.3.1 (A117) (relating to SEAs) Includes earthworks which do not comply with Standards E26.5.5.1, E26.5.5.2, E26.6.5.1 & E26.6.5.2.	Restricted discretionary
Land use (s.9(2)) – earthworks	Earthworks as described above, which exceed 2,500 m2 or 2,500 m3 within a	Infrastructure (E26) Rule E26.6.3.1 (A118)	Discretionary

RMA consent sought	Activity/scope of application	AUP(OP) Chapter/Rule reference	Activity status
	SEA; in particular in the following location(s): South of Wellsford interchange (SEA_T_6851) North of Hōteo viaduct (SEA_T_6854)		
Land use (s.9(2)) – vegetation alteration and removal	Vegetation alteration or removal undertaken Project wide within rural zones, riparian margins and SEA's, including the following: trees over 6 m in height, or 600 mm in girth (unless otherwise permitted). removal of vegetation within a SEA (of an area more than 20 m2). In particular in the following location(s): SEA_T_2287, SEA_T_683, SEA_T_6854, SEA_T_5541, SEA_T_6851 and SEA_T_685. removal of more than 50 m2 of vegetation within a riparian margin not identified as a SEA. removal of more than 250 m2 of vegetation outside the legal road in a rural zone.	Infrastructure (E26) Rule E26.3.3.1 (A77) Includes vegetation alteration or removal which do not comply with Standards E26.3.5.1 to E26.3.5.4.	Restricted discretionary
Land use (s.9(2)) – stormwater detention/ retention ponds	Stormwater retention/ detention wetlands for the Project	Infrastructure (E26) Rule E26.2.3.1 (A55)	Controlled
Works in watercourses and wetlands			
Land use (s.13) – new structures in, on, under or over the bed of rivers, streams and wetlands Water permit (s.14) – diversion and temporary damming of water associated with new structures	The construction and ongoing use of new structures in, on, under or over the bed of lakes, rivers, streams (including intermittent streams) and wetlands throughout the Project area, including associated bed disturbance or depositing any substance, reclamation, diversion of water and incidental temporary damming of water, restoration and enhancement[59]. Including, but not limited to, the following: temporary structures associated with the construction of bridges across Mahurangi River and Hōteo viaduct; bridges over the Mahurangi River and Hōteo viaduct;	Lakes, rivers, streams and wetlands (E3) Rule E3.4.1 (A26) Rule E3.4.1 (A27) Rule E3.4.1 (A29) Rule E3.4.1 (A33) Rule E3.4.1 (A34) Rule E3.4.1 (A39) Rule E3.4.1 (A44) Includes activities not complying with the general permitted activity standards in E3.6.1.1 or the specific activity standards in	Discretionary

[59] Reclamation consents are not required when installing culverts, fords and erosion protection structures (AUP(OP)).

RMA consent sought	Activity/scope of application	AUP(OP) Chapter/Rule reference	Activity status
	culverts and culvert extensions exceeding 30 m in length (outside overlays); erosion protection structures less than 30 m in length within overlays; stormwater outfalls and erosion protection structures within overlays. No culverts exceeding 30 m in length are proposed within overlays. No culverts within soil disposal sites are proposed.	E3.6.1.10 to E3.6.1.12 and E3.6.1.14 to E3.6.1.23 outside overlays60 Does not include activities which do not comply with the general permitted activity standards in E3.6.1.1 or the specific activity standards in E3.6.1.10 to E3.6.1.12 and E3.6.1.14 to E3.6.1.23 within overlays	
Water permit (s.14) –Diversion of intermittent and permanent watercourses	Diversion of rivers and streams to a new course and associated disturbance and sediment discharge throughout the Project area during construction and operation, including diversions associated with soil disposal sites, fill embankments and cut slopes. No diversion of rivers and streams are proposed within overlays.	Lakes, rivers, streams and wetlands (E3) Rule E3.4.1 (A19)	Discretionary
Diversion of groundwater			
Water permit (s.14) – diversion of groundwater	Diversion of groundwater and dewatering associated with the tunnel through the Kraack Hill area and deep cut slopes during construction and operation.	Taking, using, damming and diversion of water and drilling (E7) Rule E7.4.1 (A28) Rule E7.4.1 (A20)	Restricted discretionary
Stormwater diversion and discharge			
Water permit (s.14) – diversion of stormwater Discharge permit (s.15) – discharge of stormwater runoff into or onto land or water	Diversion and discharge of stormwater runoff from all new impervious surfaces (greater than 5,000 m2 of road) and alterations to existing surfaces associated with the ongoing use of the highway and local roads within the Project area.	Stormwater discharge and diversion (E8) Rule E8.4.1 (A10) Includes discharges which do not comply with Standard E8.6.1 and Standard E8.6.4.1	Discretionary
Land use (s.9(2)) – development of impervious surfaces for high use roads	All new impervious surfaces for high use roads within the extent of Project works associated with the State highway.	Stormwater quality – High contaminant generating car parks and high use roads (E9) Rule E9.4.1 (A7)	Controlled

[60] Overlays include Significant Ecological Areas (SEA's) and Natural Stream Management Areas (NSMA's).

RMA consent sought	Activity/scope of application	AUP(OP) Chapter/Rule reference	Activity status
		The controlled activity standards under E9.6.2.2 will be complied with.	
Air discharges			
Discharge permit (s.15) – discharges to air associated with temporary crushing	Temporary crushing of aggregates greater than 60 tonnes per hour where the activity complies with permitted standards or up to 60 tonnes per hour but does not comply with the permitted activity standards in E14.6.1.13.	Air quality (E14) Rule E.14.4.1 (A94) The restricted discretionary activity standards under E14.6.3.4 will be met.	Restricted discretionary

Activities considered to be permitted

The permitted activities that are relevant to the Project are identified within Appendix A of this AEE. Appendix A identifies a number of typical permitted land use activities and discharges associated with construction and operation of the Project, these are summarised below. The scale and nature of the Project means that the majority of the major components require resource consent.

The following activities associated with the Project are permitted:

- Discharge of dust from construction of roads;
- Diversion, damming and discharge of treated sediment laden water and dewatering water during construction when seeking a consent for earthworks;
- Structures solely under the bed of a river;
- Drilling holes or bores for geotechnical investigations and contamination investigations (unless located within sensitive areas e.g. historic heritage or mana whenua site of significance); and
- Discharges to air from motor vehicles and tunnels.

Bundling of activities

Where there are a group of activities where the effects overlap or where the activities are intrinsically linked (such that one activity could not occur without the others), it is appropriate for them to be considered holistically as a single bundle according to the most stringent activity status. The AUP(OP) contains guidance that activities should be bundled if the effects overlap.

The resource consents for this Project are appropriately bundled together and are considered as a whole. The most restrictive activity status applies and therefore the Project is considered as a **discretionary** activity.

Resource consent lapse period

Section 125 of the RMA provides that a resource consent lapses, unless given effect to, five years after the date of commencement of the consent unless a date is specified in the consent. Pursuant to section 125(1), the Transport Agency proposes a lapse period of 15 years for each of the resource consents.

The reasons for seeking 15 year lapse periods include:

- The national significance of the Project, its broad geographic extent, and its complexity in terms of the range and scale of the works involved;
- The need to protect the alignment for this strategic transport project, so that there is certainty that it can be constructed and operated when it is required;
- The need for adequate time to undertake property acquisition negotiations and processes, including access negotiations;
- The need for adequate time to complete further site investigations and design (preliminary, detailed and construction) of all aspects of the Project;
- The need for adequate time to complete construction procurement and tendering processes; and
- The need to provide sufficient time to construct the Project, which it is estimated could take approximately 7 years.

Duration

The Transport Agency is seeking resource consents for the following durations:

- Unlimited duration in respect of the land use consents under section 9(2);
- 15 years from the date of commencement under sections (9)(2), (14) and (15) of the RMA, in respect of consents required specifically for construction activities; and
- 35 years from the date of commencement under the sections (9)(2), (13), (14), (15) of the RMA, in respect of all other consents required for the long term operation of the Project.

7. Consideration of Alternatives

7.1. Introduction

This section describes the process and summarises the consideration that has been given to alternative routes, sites and methods for undertaking the Project as required under section 171(1)(b) of the RMA.

The alternative routes, sites and methods that have been considered in respect of the applications for the discharge of contaminants are addressed in Section 11 of this AEE.

Identification of the preferred transport solution to connect Auckland and Northland has involved numerous studies since 2006. Alternative routes and methods were assessed at the early stages of Project development, commencing at a broad scale and then systematically narrowing the geographic area from potential corridors down to the Indicative Alignment.

Early strategic studies completed in 2008 confirmed SH1 (as opposed to the SH16 corridor) as the preferred corridor to accommodate the forecast increased demand on the Auckland to Whangārei corridor. In 2010, a long list of corridor options for the Puhoi to Wellsford corrdior was developed and subsequently assessed. From the long list assessment, a short list was identified.

In 2016, a number of refined short-list options were considered which provided for a tie-in north of Te Hana, and connections to Te Hana, Mangawhai and Wellsford. From these short-list options, an Indicative Route from Warkworth to north of Te Hana was identified. In 2017, the Indicative Route was refined based on environmental and other constraints as well as inputs from the community engagement on the Project undertaken in February 2017. An Indicative Alignment for the Project was confirmed by the Transport Agency in 2017.

The process to confirm the Project and to define a corridor, Indicative Alignment and proposed designation boundary has been highly iterative. It has involved on-going refinement on the basis of information progressively derived from desk top studies, field work and detailed environmental investigations, operational and cost considerations, and engagement with key stakeholders and the community.

The key steps involved in the assessment process are summarised as follows (and as illustrated in Figure 7-1 below):

- Assessment of corridor options;
- Assessment of alignment options (including interchange options and tunnel alignment); and
- Refinement of Indicative Route to achieve the Indicative Alignment.

This section covers the inputs provided by environmental specialists to refine the alignment and identify options that would avoid significant effects. It sets out the tool used to assess the options, being a multi criteria analysis (MCA) framework, and explains how the MCA was adapted to suit the evaluation at each phase.

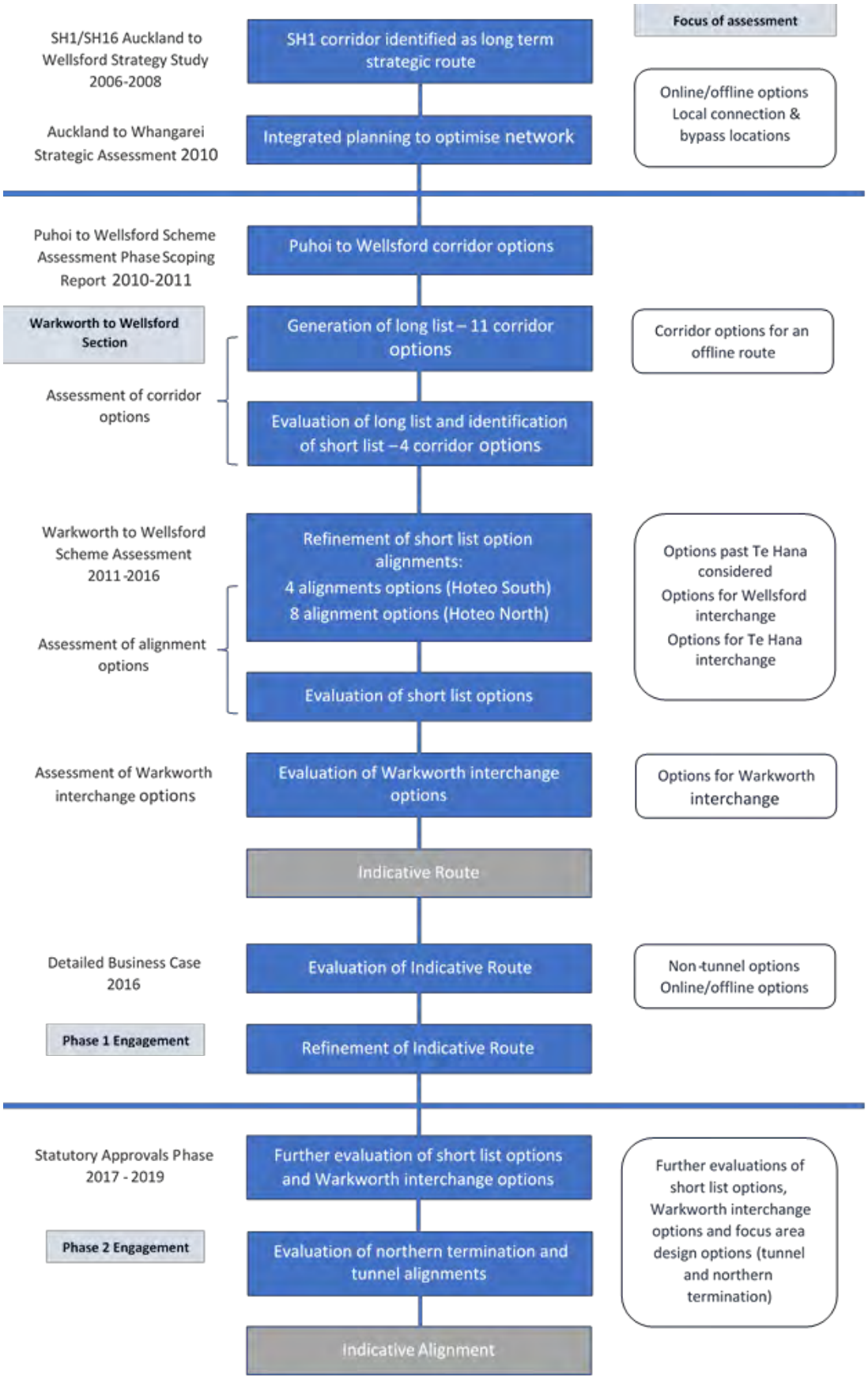

Figure 7-1: Options development process

7.2. Background and problem identification

The preliminary phases of the Pūhoi to Wellsford project development included strategic assessment work, a scoping phase and detailed scheme assessment. This work was undertaken over a considerable period from 2006 to 2016. During this period the Transport Agency introduced and adopted a "business case approach[61]" for transport planning and investment. The Pūhoi to Wellsford Project incorporates both a completed Scheme Assessment Report (SAR) and Detailed Business Case (DBC) to address the transition between the two processes.

As outlined in Section 2 of this AEE, the strategic investigations identified the problems with the existing transport network. These investigations examined both the inter-regional level (Northland to Auckland) and local issues and defined the project area as being from Warkworth to Wellsford (being part of the overall route from Pūhoi to Wellsford).

7.3. Evaluation framework and process

7.3.1. Introduction

Multi-criteria analysis (MCA) is a commonly used tool to guide the assessment of options for infrastructure. It is a useful tool to compare and assess alternative proposals or options where there are multiple considerations, and where there are a range of diverse effects which can range from beneficial to potentially adverse. The range of attributes that are relevant to a decision between options can be numerous and varied, and it is important to bring the information together in a consistent, reliable and credible way.

MCA was used to progress the scheme assessment and DBC phase works with criteria aligned with the LTMA. A more detailed environmental effects based MCA of the short list options was then undertaken in 2017 to more specifically address the tests in section 171(1)(b) of the RMA. This latter assessment was performed to ensure environmental effects and effects on private property have been appropriately considered across the short-listed options in the RMA context.

7.3.2. MCA assessment and evaluation methodology

The methodology for all MCA processes used across the key phases of the Project involved determining evaluation categories, confirming a rating system and then applying project specific evaluation criteria and rating each option. Criteria were refined as the Project developed through to a short-list level, to allow differentiation as the options became more specific. As the evaluation evolved from a framework that focused on the LTMA to a framework that focussed on the RMA, there were refinements to the evaluation criteria. However, the overall evaluation framework approach has remained consistent.

The MCA evaluation framework categories applied to the options consideration during the initial Project development phases (network planning, scoping, scheme

[61] https://treasury.govt.nz/information-and-services/state-sector-leadership/investment-management/better-business-cases/guidance

assessment, and DBC process) followed six evaluation categories which are consistent with the themes of the purpose and operating principles (LTMA sections 95 and 96) for the Transport Agency under the LTMA. These categories are identified in Table 7-1.

Table 7-1: LTMA MCA evaluation framework and assessment criteria

Category	Assessment criteria
Assisting Economic Development	The extent to which the option will enhance inter regional and national economic growth and productivity.
	The extent to which the option will improve movement of freight and people between Auckland and Northland.
	The extent to which the option will improve connectivity between the medium to long term growth areas in the northern Rodney area (Orewa, Warkworth and Wellsford).
	The extent to which the option will support local economic development.
Safety and Personal Security	The extent to which the option is expected to improve road safety in the area and reduce all road crashes.
	The extent to which the option will improve the network operational performance of the State highway and connection to the local network.
Improving Access and Mobility	The extent to which the option achieves the strategic (through traffic) function of SH1 as a national significant route linking the Auckland to Northland regions.
	The extent to which the option provides a strategic alternative to address route security, resilience and flexibility.
	The extent to which the option provides a strategic alternative to address a point incident.
	Proximity of the option's interchange location to activity nodes.
	The extent to which the option will improve the reliability of the transport network through providing a more robust and safer route between Auckland and Northland.
	The extent to which the option maintains convenient local access and connectivity.
	Impacts on and realignment of SH1 during construction.
	Extent of disruption/impact on operations (live traffic) during construction.
Protecting and Promoting Public Health	The extent to which the option can provide for walking and cycling to contribute to positive health outcomes and provide more transport choices, both through and between towns.
Environmental Sustainability	The extent to which the option will minimise the physical extent and significance of the project.
	The extent to which the option will avoid potential environmental impacts on areas of high ecological value or high landscape value.
	The extent to which the option will impact on coastal areas or water courses.

Category	Assessment criteria
	The extent to which the option will impact on sensitive receptors with regards to air quality and noise during both construction and operation.
	The extent to which the option will reduce overall energy use and greenhouse gas emissions (NEECS).
	The extent to which the option will avoid impacts on places of archaeological or heritage significance (e.g. Protected Items – RDC).
	The extent to which the option will avoid impacts on places of cultural significance.
	The extent to which the option will impact on communities during both construction and operation.
	The extent to which the option will minimise social effects on community facilities (e.g. schools, hospitals, sports fields).
	The extent to which the option will minimise socio-economic effects including community attractions and businesses.
	The extent to which the option will support regional and local land use planning intentions.
Value for Money	The overall cost of the option.
	Geotechnical cost risk (construction and operation).
	Constructability cost risk.
	The ability of the option to be tolled.
	The ability of the option to be staged.
	The extent to which difficulties through the consenting process may delay the date for opening RoNS.
	The extent to which the difficulty of construction may need the construction period to be extended – delaying the date for opening RoNS.
	Ability for PPP to construct final solution as part of Pūhoi-Warkworth project.

In order to consider the relevant matters under section 171 of the RMA in the options evaluation process, the MCA was modified during the latter evaluation processes. The modification resulted in the "Environmental Sustainability" category being substituted for the following more RMA-specific specialist areas as set out below:

- Air quality;
- Landscape and visual effects;
- Freshwater ecology;
- Terrestrial ecology;
- Noise and vibration;
- Groundwater;
- Operational water quality (stormwater management);
- Construction water quality (erosion and sediment control);
- Flooding;
- Heritage and archaeology;

- Cultural heritage; and
- Land contamination.

The corridor and alignment options were assessed against each of the criteria listed Table 7-2 typically using the seven point rating scale shown in Table 7-2 below. The s 171 evaluation ranging from significant adverse effect and significant positive effect.

Table 7-2: Rating scale - RMA evaluation

Symbol	SAR evaluation	S171 evaluation
+ + +	very strong positive effects	significant positive effect
+ +	strong positive effects	moderate positive effect
+	small / moderate positive effects	minor positive effect
0	neutral with regard to the base option	neutral /benign effect
-	small / moderate negative effects	minor adverse effect
- -	strong negative effects	moderate adverse effect
- - -	very strong negative effects	significant adverse effect

7.4. Options assessed during Project development

7.4.1. Overview

Options assessment is, of necessity, an inherently iterative process and this Project has been investigated over a number of years and at different scales. The options assessment has progressed from the inter-regional (strategic) level through to corridor selection, then alignment selection and at a more granular level for certain aspects such as interchange and tie-in location and design layout. The options development process has been informed by the fact that this Project is the second stage of the Pūhoi to Wellsford project, with an offline alignment for the first stage (Pūhoi to Warkworth) having already progressed through to construction.

7.4.2. Early strategic assessment work

Early strategic assessment established the parameters for the Project, by confirming the general corridor, form and indicative route. The various studies that contributed to informing the Indicative Route are illustrated in Figure 7-2.

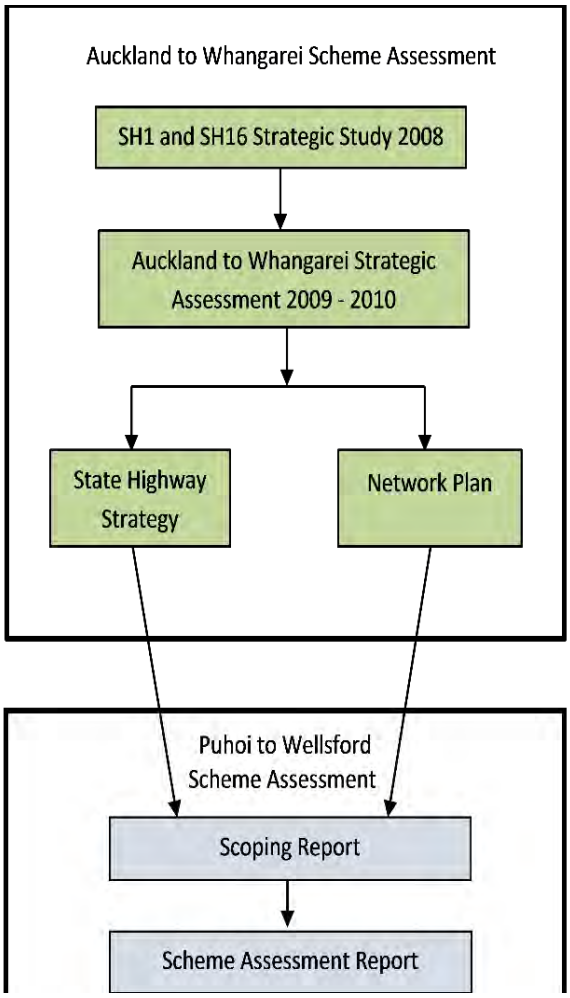

Figure 7-2: Early Strategic Assessment relationship

SH1 & SH16 Strategy Study

Between 2006-2008, the Transport Agency looked at the strategic transport needs between Auckland and Wellsford to determine the most appropriate corridor for development as the long-term roading investment focus for the region. As outlined in Section 2, this assessment considered the roles of the existing SH1 and SH16 corridors in providing strategic transport links to Wellsford and the north, together with potential new corridors. Options for the future functionality of SH1 and SH16 were assessed.

The conclusion of this assessment was that the SH1 corridor should provide the national/ inter-regional function and the regional function should be provided by the SH16 corridor. The assessment also recommended that SH1 from Pūhoi north to Wellsford be upgraded to a four lane dual carriageway.

Auckland to Whangārei Strategic Study and Network Plan

In 2009-2010 the Transport Agency undertook a strategic study of the transport requirements between Auckland and Whangārei. The assessment determined that:

- The state highway network is vital to the economic growth and sustainability of the Northland region;

- Travel demand arising from planned growth in the Auckland and Northland regions must be supported by an efficient, safe and economic highway system;
- An offline upgrade of SH1 between the northern termination of the existing tolled motorway (just south of Pūhoi) and Wellsford presented the most desirable response;
- Two broad corridors of interest were recommended to be investigated for this purpose, one being an inland corridor extending westward to meet and then follow the North Auckland Line railway to Wellsford, and the other extending more directly northwards to Warkworth and then on from there to Wellsford.

Following the strategic assessment work the Transport Agency developed a Network Plan that considered the wider transport network implications of the strategic assessment.

Online (widening of the existing SH1) and offline (independent of the SH1 but remaining within the wider SH1 'corridor') route options, bypass options of both Warkworth and Wellsford (to the east and west) and local connections to Warkworth and Wellsford were identified in the Network Plan. To determine a preferred network the Transport Agency and its advisors evaluated these options using the MCA evaluation tool in Table 7-1.

The options were assessed using a five point scoring system, options evaluated as having effects ranging from strongly positive to strongly negative.

Ten options were considered and following the MCA evaluation it was concluded that a new offline route in the broader SH1 corridor between Pūhoi and Wellsford was the option that best met the Transport Agency's objectives. The assessment provided clear guidance on the route configuration that was most appropriate to meet the strategic objectives set by the LTMA and GPS and objectives adopted for the Pūhoi to Wellsford project (four-lane offline alignment preferable to an online upgrade). This corridor was rated highest for improvements to strategic freight and tourism traffic, route security, resilience and road safety.

The Network Plan recommended the following alignments and connections relevant to the Project:

- A western bypass at Warkworth to facilitate access to proposed industrial and commercial development areas to the west of the town.
- A connection to SH1 at Warkworth. Northern, central and southern locations were considered and no clearly preferred location could be determined at the Network Plan level.
- An eastern bypass at Wellsford to facilitate access to proposed industrial/ commercial development to the south east of the town as well as the urban growth area proposed at Mangawhai.
- A connection to SH1 at Wellsford. A central location for this interchange was preferred at that time as it would provide direct access to Wellsford and improved access to Mangawhai. Southern, central and northern locations were assessed.

The Network Plan evaluation indicated that a bypass is preferred to address route security issues, with a bypass to the east providing greater benefit than a bypass to the west given the recommended location of the Pūhoi to Wellsford project alignment,

to the east of Wellsford. An eastern bypass would also provide a better connection to Mangawhai than one to the west. The Network Plan also recommended as eastern bypass of Te Hana to be revisited when outcomes of a study between Kaipara and Rodney District Councils was known. It is unclear whether that study ever progressed.

7.4.3. Pūhoi to Wellsford Scheme Assessment: Scoping Report

Network Plan recommendations were used as a starting point for the Pūhoi to Wellsford Scheme Assessment in 2010. The Scoping Report developed corridors and investigated the planning, environmental, design and construction requirements for upgrading the SH1 to four lanes for the Pūhoi to Wellsford project.

In developing route options for the project, known physical constraints (such as topography, environmental features such as streams and culturally significant areas) were mapped in layers to enable evaluation of constraints across the entire study area. Using these data layers, the study area was analysed in terms of a wide range of physical environmental and social constraints. This analysis enabled the development of a long-list of route options that would avoid or minimise effects on major constraints. A Geographical Information System (GIS) was used to generate a line of 'best fit' for each constraint. The line of best fit was that which has the least cumulative impacts over its length, based on the constraints identified. The long list was developed in two stages, reflecting the two sectors of the project (being Pūhoi to Warkworth and Warkworth to Wellsford, with the Pūhoi to Warkworth section being completed first followed by Warkworth to Wellsford). Workshops were held to provide opportunity to input professional knowledge/ experience to ensure all views were represented.

The starting point of the Warkworth to Wellsford assessments was chosen as Perry Road. This point was chosen as it represented a common point on the options that were short-listed for the Pūhoi top Warkworth section.

Eleven alignment options were developed for the Warkworth to Wellsford section long list assessment, all of which terminated to the north of Wellsford but south of Te Hana. These options are listed below and shown in Figure 7-3.

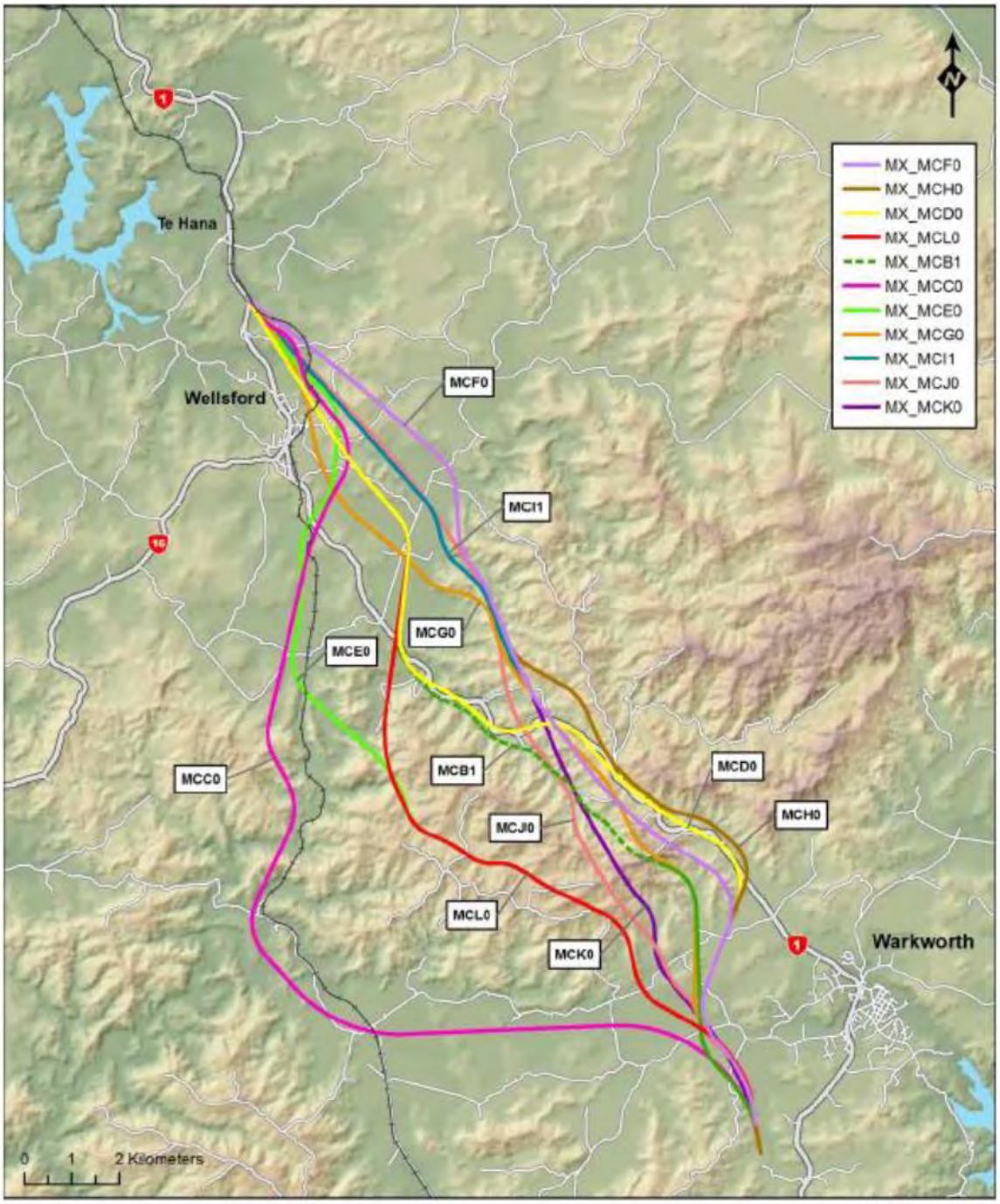

Figure 7-3: Long list of corridor options

- Western alignment (MCC0) – this alignment was approximately 28 km long. The alignment ran west across the Kaipara Flats and then generally northwards beside the railway corridor in order to avoid the difficult terrain around The Dome. The alignment crossed SH1 just south of Wellsford and continued around the eastern side of the town, crossing Worthington Road near its intersection with Matheson Road. This option was dependent on one specific corridor being selected for the Pūhoi to Warkworth Project.
- Mid-western alignments:

- MCE0 – this alignment was approximately 24 km long. From the Kaipara Flats, the alignment headed north-west through a valley that is generally parallel to the existing state highway, east of Smyth Road. Once clear of The Dome, the alignment headed north to the railway corridor then crossed SH1 just south of Wellsford and continued around the eastern side of the town, crossing Worthington Road near its intersection with Matheson Road.
- MCL0 – this alignment was approximately 23 km long. The alignment followed that of MCE0 through The Dome to the Hōteo River. From there it headed northeast across SH1 near Wayby Valley Road and continued around the eastern side of Wellsford, crossing Worthington Road near the intersection with Matheson Road.

- Eastern Alignments:
  - MCB1: this alignment was approximately 23 km long. The alignment intersected Kaipara Flats Road between Carran Road and Phillips Road and then ran along the eastern side of Saunders Road and SH1. The alignment crossed SH1 just south of Wayby Valley Road and continued around the eastern side of Wellsford, crossing Worthington Road near the intersection with Matheson Road.
  - MCJ0, MCK0, MCI1, MCG0 and MCF0: these alignments were all approximately 22 km long. They were similar in that they followed a broad strip crossing SH1 east of Saunders Road and continued around the eastern side of Wellsford. In the south, alignments MCJ0 and MCK0 were located on the western side of the strip whilst alignments MCI1, MCG0 and MCF0 were on the east. In the north, alignment MCG0 was located on the western side of the strip, closer to Wellsford, crossing Matheson Road near the intersection with Centennial Park Road. Alignments MCK0 and MCF0 were located on the eastern side of the strip, crossing Worthington Road near the intersection with Bosher Road. Alignments MCI1 and MCJ0 were located in the middle of the strip, crossing Worthington Road nearer to Matheson Road.
- Existing Highway (MCD0): this alignment was approximately 23 km long. The alignment broadly followed the SH1 corridor from north of Kaipara Flats Road to south of Wayby Valley Road. North of SH1, the alignment was the same as MCB1. This option was assessed as an offline, separate new road, albeit in the corridor of the existing SH1.
- East of Existing Highway (MCH0): this alignment was approximately 23 km long. It crossed SH1 just north of Kaipara Flats Road and continued along the eastern side of SH1. North of Russell Road, the alignment followed alignments MCK0 and MCF0.

The evaluation framework adopted for the assessment of the long-list options was developed from the MCA framework that was used in the Network Plan and refined to provide a more detailed quantitative and qualitative assessment of the options. It included functional/ engineering assessment, traffic assessment, environmental and social assessments and cost estimates.

The key findings on the eleven long list options were:

- All alignments were equal in assisting safety and personal security and protecting and promoting public health.
- The western alignment (MCC0) offered the lowest benefits in assisting economic development and improving access and mobility, as well as the highest negative effects in environmental sustainability, urban form, and value for money. Consequently, this alignment performed poorly overall.
- Alignment MCG0 offered comparatively low benefits in assisting economic development and improving access and mobility as well as higher negative effects in environmental sustainability and urban form. Consequently, this alignment performed poorly overall.
- Alignments MCE0, MCL0 and MCK0 provided average (mid-range) performance in most categories but offered the highest negative effect in value for money. Consequently, these alignments performed poorly overall.
- Whilst alignment MCH0 performed well in assisting economic development, it had comparatively high negative effects in environmental sustainability and urban form, as well as a comparatively high cost estimate.
- Alignments MCB1, MCJ0, MCI1 and MCF0 performed comparatively well in assisting economic development, improving access and mobility, and in environmental sustainability and urban form. Alignments MCJ0 and MCF0 had a neutral score in value for money, whilst options MCB1 and MCI1 had some benefits.
- Alignment MCD0 provided the highest benefit in value for money, however, this was balanced by higher negative effects in environmental sustainability and urban form than most other options.

In consideration of the overall performances of all alignments, MCB1, MCD0, MCF0 and MCI1 were, on balance, the best performing options. Consequently, these alignments were recommended for further consideration during the scheme assessment phase of the project.

The further consideration of options for the Pūhoi and Wellsford project was then split into two sections, Pūhoi to Warkworth and Warkworth to Wellsford for the subsequent work in the scheme assessment phase

7.4.4. Warkworth to Wellsford Online Options Assessment

A high level assessment of a range of online improvement options for the upgrade of SH1 between Warkworth and Wellsford was undertaken during the scheme assessment in 2010-2011. The online options developed were principally intended to consider a less costly option and focused on addressing safety issues through the Dome Valley and traffic issues in Wellsford as an interim measure. The online options were not able to address the Project objectives to the same extent as the offline options given the topographical and construction challenges.

Online options were considered in two separate sections; the Dome Valley and Wellsford sections as outlined below. These options are shown in Figure 7-4 below.

Warkworth to Hōteo River (Dome Valley)

The following options were developed and assessed as part of the online evaluation (including an off line option for comparison and options within and immediately adjacent to the existing SH1):

- Option 1: An offline route to the west of the existing SH1;
- Option 2: Online expressway – four lanes, 80 km/h expressway;
- Option 3: Significant upgrade of SH1 – upgrade to a 2+1 configuration (alternate direction passing lanes each approximately 1.5 km long provided through the length of the upgrade);
- Option 4: Moderate upgrade of SH1 – safety-focused upgrades based on the inclusion of a median barrier over the full length plus localised improvements, including some curve improvements and additional passing lanes;
- Option 5: Minor upgrade of SH1 – safety focused upgrade based on the inclusion of a median barrier over the full length.

Hōteo River to Wellsford (Wellsford Bypass)

The following options were developed and assessed as part of the SAR in 2010-2011:

- Option 1: An offline route to the east of SH1 and bypassing Wellsford;
- Option 2: Two lane Wellsford bypass – localised two lane bypass of Wellsford utilising the existing SH1 alignment north of Wayby Valley Road to a point just north of the Wellsford Golf Club and then through Wellsford to the east;
- Option 3: Four lanes through Wellsford – management of SH1 through Wellsford to provide four lanes with provision of an off-street parking facility in Wellsford and pedestrian signals or a pedestrian bridge on SH1.

Figure 7-4: Online options considered

During the early scheme assessment work in 2010-2011 the above options were reviewed in relation to specific RoNS criteria which applied at that time. The scheme assessment evaluation concluded that a full offline option (Option 1 in both the Warkworth to Hōteo River and the Hōteo River to Wellsford sections) delivered best on all criteria relative to the other options. The 80 km/h expressway (Option 2) in the Dome Valley area had a cost estimate that was comparable with Option 1 in this location, but performed less well against all other criteria, when compared with the offline option.

The other online options offered significant construction cost savings when compared to the offline option, but they delivered substantially less well on the

project objectives. It was noted that the online options were predicted to improve crash risks in comparison to the current road alignment, especially through the Dome Valley, with different options achieving different levels of improvement.

Option 2, four-laning through Wellsford township, was assessed as being unlikely to be acceptable to the community and unlikely to obtain consent. This was due to social impacts (greater segregation of the town and two schools on/in close proximity to the route) and perceived economic impacts from loss of car parking through the main centre of Wellsford. All other online options were considered to have environmental and social effects that were expected to be able to be avoided, remedied or mitigated. The evaluation of the online options was undertaken as part of the DBC which is discussed in section 7.4.7 below.

7.4.5. Warkworth to Wellsford Scheme Assessment

Alignment options

During the two tranches of the scheme assessment work (2010/2011 and 2016), the four short-listed alignments from the 2010 scoping phase were refined, updated and then evaluated through MCA using the LTMA derived evaluation criteria, MCA and scoring system explained in section 7.3.2.

Refinements of the short-listed alignments arose from additional desk top assessments and limited site inspections across a range of specialist areas in 2010/11 and 2016. As part of the 2016 work additional options were identified that responded to recommendations of the Programme Business Case (PBC)[62] (including a tie-in point north of Te Hana, rather than the initial tie-in north of Wellsford). These options were derived in a manner consistent with the options development process.

The study area for the route was split into two sections for effective assessment and evaluation. This allowed the options to be 'mixed and matched' depending on the assessment outcomes and recommendations for each sector. This "mix and match" was able to be done as there was a single common crossing point in the vicinity of SH1 and the Hōteo River.

The refined short-list options are illustrated in Figure 7-5 below and included four options in Hōteo South and eight options in Hōteo North.

[62] https://treasury.govt.nz/information-and-services/state-sector-leadership/investment-management/better-business-cases/guidance

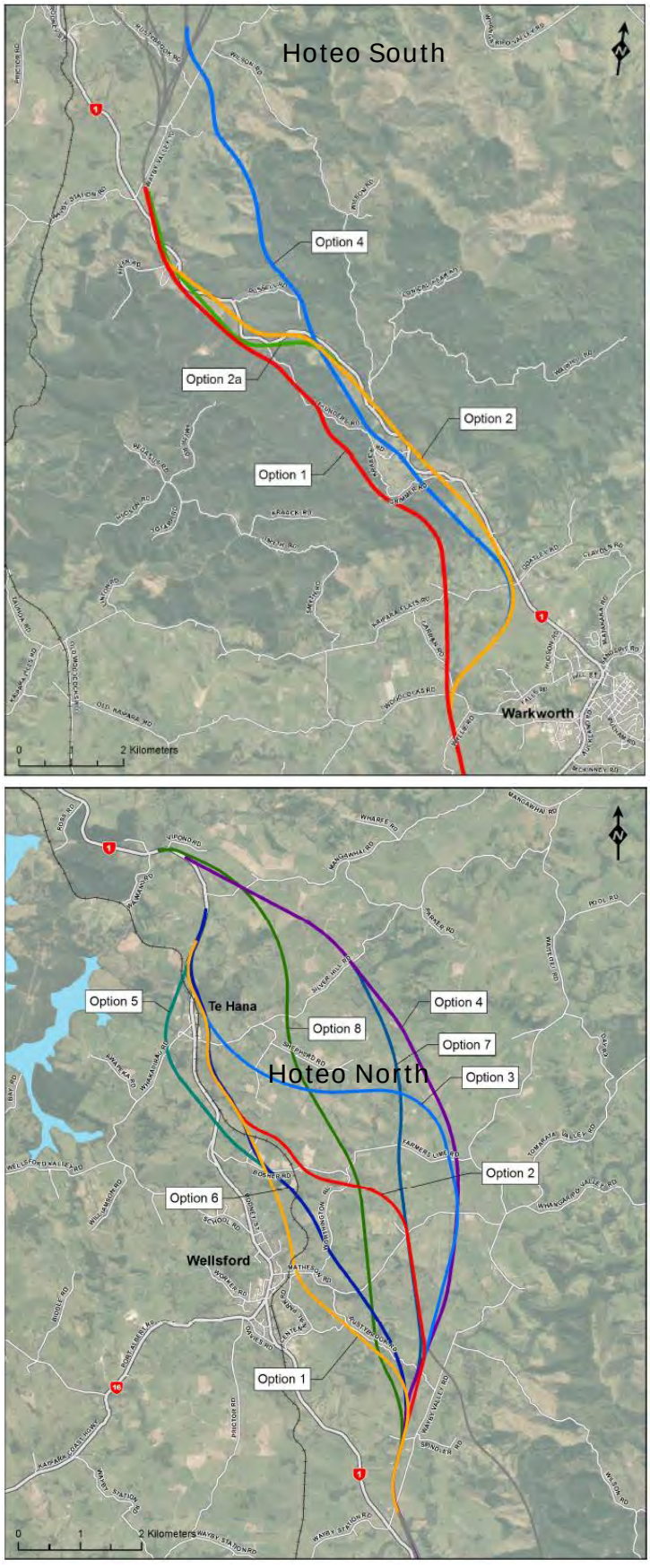

Figure 7-5: Short-list options

Option 1 was adopted as the selected option in Hōteo South. Option 1 was identified as having the following benefits compared to other short-list options:

- It was shorter than the other options which would result in improved movement of freight and people between Auckland and Northland.
- Its separation from SH1 provided greater route resilience than other options.
- It better avoids impact on areas of identified high ecological value and landscape value than other options.
- It was expected to have lower air and noise impacts on sensitive receivers due to its separation from the Dome Valley and associated sensitive receivers.
- It had lower geotechnical risks than the other options and lower constructability risks than most of the other options.

Option 7 was adopted as the selected option for Hōteo North. The selection of Option 7 provided the following benefits compared to other short-list options:

- It better avoided impact on identified areas of high ecological value or landscape value and on coastal areas and watercourses.
- It avoided areas of cultural significance.
- It avoided poor geological ground.
- It avoided community impacts.
- It avoided slip zones.
- It had a good cut-fill earthworks balance.
- It ran in proximity to an existing infrastructure corridor (fuels and gas pipelines and electricity transmission lines) which was seen to provide a logical barrier to development further east. The co-location of the road in proximity to the fuels and gas pipelines and electricity transmission lines, together with the presence of the adjacent ridgeline, make a natural and ensuring any future boundary to urban growth is not compromised.
- It provided better value for money.

The combined option 1 and option 7 formed the Indicative Route. The Indicative Route rated the best of all the options examined against the Project objectives for the following reasons:

- Its separation from SH1 provided greater route resilience than other options;
- It better avoided impact on areas of high ecological value, cultural value and landscape value than other options;
- It had lower geotechnical risks than the other options through The Dome and to the east of Wellsford;
- It provided for planned future growth around Warkworth and Wellsford in a complementary manner, whilst not compromising planned transport network upgrades or precluding further growth; and
- It represented an opportunity for Wellsford and Te Hana to develop and function better as community centres and tourist destinations.

7.4.6. Considerations of Interchange form and location

Warkworth Interchange

An analysis and assessment of interchange options at Warkworth was undertaken in November 2016.The general location of the Warkworth Interchange at a point north of Warkworth was informed by the Pūhoi to Warkworth scheme assessment process. The purpose of the Warkworth Interchange options assessment was to identify an interchange on the northern side of Warkworth and connection to the existing SH1, P2Wk and local road network.

Eight interchange designs were developed and assessed, including four service interchange options (simple interchanges that rely on roundabout / stop signs / traffic lights to control traffic exiting or entering the motorway), and four system interchange options (free flowing connections). The options considered are shown below (including Option I which is outlined in detail in section 7.5.3 below):

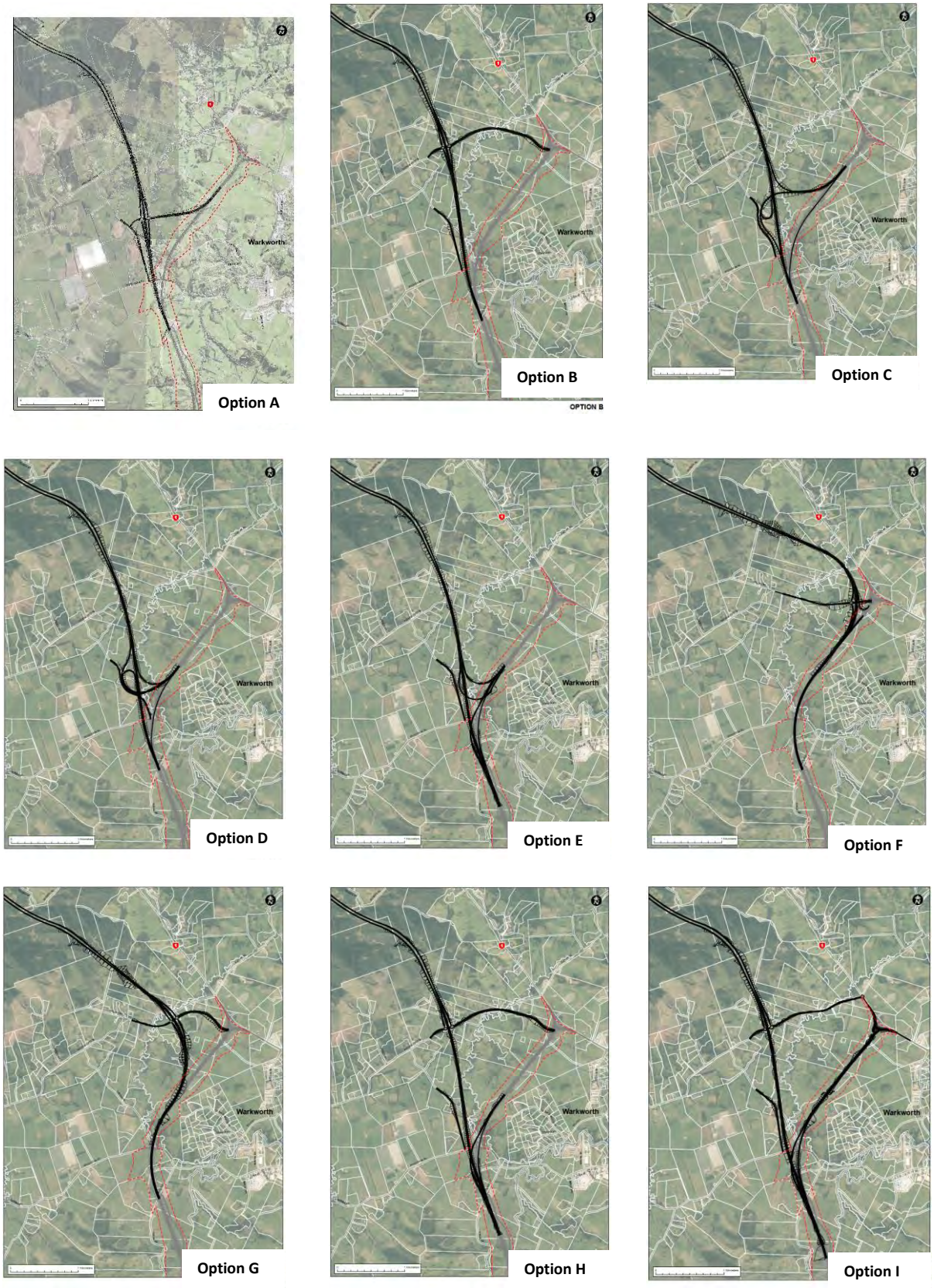

Figure 7-6: Warkworth Interchange options

The Warkworth Interchange options, as per the alignment options, were assessed using the evaluation criteria, MCA and scoring system explained in section 7.3.2 of this AEE.

Option H was the selected option after consideration of the outcomes of the MCA process, and was recommended as the preferred option subject to further refinement and public consultation. Option H was then further refined, prior to Phase 1 engagement in March 2017. "Option I" interchange, which was a modified version of Option H, formed part of the Phase 1 engagement. The key change was an additional roundabout connection and a reduced land take achieved through upgrading the eastern end of Kaipara Flats Road rather than constructing a new link road to serve traffic to and from the north.

Wellsford Interchange

A number of interchange options were considered at Wellsford during the scheme assessment. This included:

- Interchange form (layout);
- A single interchange at Whangaripo Valley Road;
- Split interchange south and north of Wellsford;
- Full interchanges south and north of Wellsford; and
- Different layout options for each of the above options.

Once the alignment far east of Wellsford was identified as the preferred option, the traffic analysis suggested that an interchange that far eastward would not attract sufficient vehicles, and most would choose to travel to Warkworth to join SH1. A southern interchange was identified as being necessary to avoid the dominant reliance on the SH1 through the Dome Valley. An assessment of these options concluded that two full interchanges, north and south of Wellsford, were preferred to a single interchange. This was due to:

- Making better use of existing infrastructure;
- A central Wellsford interchange would require extensive upgrades to Whangaripo Valley Road;
- Connectivity for the wider network (e.g. Twin Coast Discovery Highway);
- Difficulty in terrain, ground conditions and cost of a central interchange; and
- No transport advantage of a central interchange (travel times would not be improved vs two interchanges to the north and south)

The preferred Wellsford interchange (south) location was identified at Wayby Valley Road. This was due to:

- Urban design and landscape framework guidance;
- Extension of the Pūhoi to Wellsford project to the north of Te Hana, which connects to the Twin Coast Discovery Highway and SH16;
- Appropriate distance between the three proposed interchanges (Warkworth, Wellsford and Te Hana);
- Use of existing transport infrastructure;
- Potential connectivity to Mangawhai for resilience; and
- Operational flexibility with the proposed tunnels through the Dome Valley (by providing an interchange between Wellsford and the proposed tunnels).

Te Hana Interchange

In 2016, following recommendations from the PBC to address resilience and travel time issues through Te Hana, as well as ground conditions, topography and environmental and cultural considerations, options with a termination point extended to the north of Te Hana were considered. The extension to the northern terminus of the Project meant there was a need to consider the locations of interchanges at Wellsford and Te Hana.

The Te Hana Interchange location at Mangawhai Road was common for all of the alignment options in the scheme assessment which tied into SH1 south of Vipond Road (i.e. no other options were developed or considered for the general location of this interchange).

7.4.7. Detailed Business Case

This work, undertaken in 2017–2019, drew upon the earlier scheme assessment work (2010–2011) together with the more recent analysis (2016) to develop the detailed business case for this Project. This approach to analysis of the potential performance of a project against investment criteria is the Transport Agency's current practice for its projects and supersedes the previous Scheme Assessment approach which was current during the early work on the scheme as outlined above. The business case elements not covered by the scheme assessment work were addressed in the DBC. The DBC did not re-evaluate the offline alignment options considered in the scheme assessment work but included a further evaluation of online options using the same MCA criteria adopted for the shortlisted options assessment in order to test and confirm the initial outcomes on these options from the scheme assessment phase. Further consideration of the inclusion of a tunnel along the route was also addressed in the DBC.

Online vs offline

The MCA undertaken through the DBC phase confirmed that for both sections (Warkworth to Hōteo and Hōteo to Wellsford), in comparison with offline options, the online options performed worse than the "Do minimum" (with the Pūhoi to Warkworth section built) as a result of little benefit and increased adverse effects. In addition, all online options had considerable impacts during construction and did not fundamentally deliver against the objectives of the Project.

Alternatives to a tunnel

The DBC phase considered alternatives to the approximately 1 km long tunnel that was proposed as part of the Indicative Route. Alternative route alignments were considered in order to see if the tunnel could be avoided, given the costs of construction and operation and maintenance requirements associated with a tunnel.

A significant east-west ridge line to the north west of Warkworth is the key reason for the proposed tunnel, because suitable gradients for a high standard freight route need to be achieved (maximum grades of around 6%). The ridge feature is extensive and effectively runs from the existing SH1 westwards for several kilometres. Consequently, if the route were to be realigned in order to avoid the need for a tunnel, the route would have to be relocated significantly in order to avoid the east-west

ridge topography resulting in significant additional lengths of carriageway and associated costs

Relocation of the alignment eastwards would put the alignment in, or very close to, the SH1 corridor where significant geological instability exists, with numerous existing landslides and steep side slopes. Further east of SH1 was considered to have sub-optimal outcomes in respect of environmental effects and land instability factors. Routes in these locations had been considered as part of the long list and short listing processes summarised in sections 7.4.3 and 7.4.5 of this report, and were found not to offer the best outcomes.

Moving the route westwards to avoid the ridge and eliminate the tunnel would likely require a shift of several kilometres, would still require significant earthworks, and result in a significantly longer route, offsetting the cost saving from the removal of the tunnel. A westward shift would be less attractive to traffic as compared to the SH1 route which is more direct and would also prevent the route from achieving the advantages offered by aligning it in the NW-SE valley which lies to the north of the east-west ridge line. An alignment to the west would offer sub-optimal outcomes in terms of cost and environmental outcomes and was discounted accordingly.

7.5. Alternatives considered during Indicative Route design refinement

7.5.1. Evaluation framework and process

Alternatives were considered in 2017 and 2018 during the refinement of the Indicative Route following feedback from Phase 1 engagement, outcomes of a Road Safety Audit and preliminary environmental and geotechnical investigation work. This work determined an Indicative Alignment.

The evaluation carried out in 2017 enabled a detailed consideration of the potential environmental effects of the Project by the specialists appointed to support the statutory approvals phase. The inputs into the MCA by environmental specialists were intended to ensure that the decision making process was integrated both with relevant engineering and LTMA criteria and the statutory requirements under the RMA.

The evaluation involved the environmental specialists assessing the effects of the options against their specific field of expertise. The specialists undertook a high-level preliminary assessment of options, to determine whether any moderate or significant adverse environmental effects were likely, given that s.171(1)(b) of the RMA addresses 'significant adverse effects' in testing the adequacy of consideration given to alternatives. Assessments were undertaken for the following subject matter areas:

- Air quality;
- Landscape and visual effects
- Freshwater ecology;
- Terrestrial ecology;
- Noise and vibration;
- Groundwater;
- Operational water quality (stormwater management);

- Construction water quality (erosion and sediment control);
- Flooding;
- Heritage and archaeology;
- Cultural heritage; and
- Land contamination.

In addition, the other MCA categories and criteria, as outlined in section 7.4.2, were considered in the evaluation where relevant.

The environmental specialists used the same seven-point rating scale that was used in the scheme assessment phase MCA evaluation, but adapted it to range from significant adverse effect to significant positive effect, as shown in Table 7-2 below.

Table 7-2: Rating scale – RMA evaluation

Symbol	Meaning
+ + +	Triple positive – significant positive effect
+ +	Double positive – moderate positive effect
+	Positive – minor positive effect
0	Zero – neutral /benign effect
-	Negative – minor adverse effect
- -	Double negative – moderate adverse effect
- - -	Triple negative – significant adverse effect

Workshops were held for the alignment and Warkworth Interchange evaluations. They were attended by project team representatives, environmental specialists, an iwi advisor, legal advisors and Transport Agency staff. A detailed description of the options was provided at the workshops, to ensure specialists had a clear understanding of the options so that they could validate their assessment. Scoring was reviewed and updated where necessary following these workshops.

7.5.2. Evaluation of short list options

The scores from the "Environmental Sustainability and Urban Form" category criteria in the MCA evaluation were refined to reflect categories that focused on the spectrum of social, environmental and cultural matters to be addressed in the statutory approvals phase.

Each short list option was evaluated on its individual merits, against a "Do Minimum" scenario. The "Do Minimum" scenario consisted of the P2Wk project connecting to the existing SH1 at a roundabout north of Warkworth on the existing SH1, and the route north from there being on the existing SH1 through the Dome Valley. The specialist assessments did not initially consider mitigation except, where that would be an inherent part of the project – such as erosion and sediment control, or concrete barriers on bridges, which achieve noise mitigation.

Following an environmental specialist workshop, updated cost and engineering information was obtained for inputting into the MCA evaluation process. The specialists' environmental scores were compared with the original MCA criteria

ratings for the "Environmental Sustainability and Urban Form" category. This comparison revealed no substantive changes to the scoring and ranking of options across the environmental category and did not influence the ranking of the preferred options. As such, the original MCA scoring for that category did not change for evaluation purposes. The other criteria and categories were maintained as per the 2016 scheme assessment MCA, albeit with revised inputs where further information regarding costs and design amendments necessitated changes to the scoring or where criteria were deemed to be non-differentiators.

Sensitivity testing was undertaken to test whether there were any dominant criteria that were influencing the rankings.

The most favourable options identified by the revised MCA evaluation, and the subject matter area assessments undertaken in parallel, were Option 1 in the Hōteo South section and Options 4 and 7 in the Hōteo North section.

Whilst the overall scores for Options 4 and 7 in the Hōteo North section were the same in the subject matter area assessments, Option 7 did score slightly more favourably than Option 4 in relation to cultural heritage impacts (minor adverse for Option 7, moderate adverse for Option 4), while Option 4 scored slightly more favourably than Option 7 in relation to terrestrial ecology impacts (minor adverse for Option 4, moderate adverse for Option 7).

This analysis, including the sensitivity testing, confirmed the previously identified preference for the options that formed the preferred alignment for the Phase 1 engagement in early 2017 were appropriate. Notably, even when the environmental or engineering criteria were doubled, there was no notable difference in scoring or ranking of options.

7.5.3. Warkworth Interchange refinement

Following the Phase 1 engagement in March 2017, four further options (options 7-10) were developed for the Warkworth Interchange to take into account updated technical information and to address specific public consultation feedback.

The project team developed and progressed a refined MCA process to consider the resulting 13 interchange options. This refined process was established to:

i) test specific issues raised in public consultation feedback recorded in the Phase 1 engagement;

ii) fully evaluate Option I which had formed part of Phase 1 engagement, but was not assessed in detail prior to that; and

iii) enable more detailed consideration of the potential environmental effects of the project by the specialists appointed after the completion of the work to identify the Indicative Route, to support the statutory approvals phase.

The specialists evaluated and scored each of the interchange options, a workshop was held, and scores adjusted where appropriate. Following the environmental specialist workshop, more recent cost and engineering information was obtained for inputting into the MCA evaluation process.

The MCA criteria were updated, with the environmental and social criteria that were used in the scheme assessment MCA being replaced with the specific RMA

environmental assessment criteria and the options scored (as identified in Table 7-2). Sensitivity testing was undertaken to identify whether there were any dominant criteria that were influencing the rankings. The ranking of options was tested under a series of scenarios that saw the weighting for each of the categories doubled in turn, to confirm the robustness of the outcomes of the evaluation.

Following initial evaluation results, the Transport Agency provided preliminary feedback that the evaluation should also provide for the updated traffic modelling[63] to identify whether the predicted growth in and around Warkworth would have any influence on the preferred interchange option. Additionally, the Transport Agency confirmed three specific interchange criteria as follows:

- maintaining the free flow level of service that the travelling public (including the Warkworth community) would be accustomed to from the new P2Wk infrastructure;
- optimising to the extent practicable use of the infrastructure built for the P2Wk project; and
- not relying on local road connections, given uncertainty at that time as to the future local road network. (New roads and improvements to several local road projects are planned, but the timeframe for their construction completion relative to that of the Project is uncertain).

Following all of the above processes and consideration of the additional specific interchange criteria, a recommendation was made to the Transport Agency to proceed with Option C as the preferred Warkworth Interchange option.

The Transport Agency decided to progress Option C for the purposes of seeking designation and consents for the project, as, on balance, it best met the Transport Agency's interchange specific outcomes as outlined above. Option C maintains the high level of service provided by the P2Wk project because it has free flowing ramps and does not require that traffic move through additional intersections (compared to a service interchange which would result in a lower level of service). Option C does not rely on local road connections to maintain that level of service; and it optimises the use of P2Wk infrastructure (as the P2Wk southbound alignment will form the key southbound on-ramp and most of the northbound carriageway is also utilised). Compared to other system interchanges considered, Option C is safer because the ramps that carry movements with higher traffic volumes have a higher radius and therefore less crashes are likely as compared to other options

The Project team noted that while Option C was not the highest-ranking option from an environmental effects perspective, the effects were such that they could be mitigated. The environmental specialists did not identify any effects that would preclude the selection of Option C as the preferred option.

As part of its incorporation into the wider scheme Indicative Alignment, Option C was subsequently assessed through a road safety audit (RSA). A consequence of RSA comments, was that the geometry of the Northbound on-ramp within the interchange

[63] Technical Note: Transport Assessment of Interchange Options, Ian Clark: Flow Transportation Specialists, 7 June 2017

was amended so that the connection provides improved safety characteristics. This interchange layout was termed "Option C No Loop". All of the free-flow ramps connect with the P2Wk alignment to the south-west of the P2Wk northern terminus roundabout. Carran Road is diverted around the interchange to maintain local road connectivity but has no connection to the interchange.

7.5.4. Evaluation of northern termination

The Indicative Route as identified in the scheme assessment phase of the Project has the northern termination point located at the southern abutment of the existing Maeneene Stream bridge and approximately 170 m south of an existing staggered T-intersection of SH1 with Maeneene Road and Waimanu Road. An RSA report of the Indicative Route (the alignment that formed the basis of the Phase 1 engagement) was completed in July 2016. The audit identified safety concerns at the northern termination summarised as follows:

- Motorway terminating at a 7.0 m wide bridge;
- No provision for cyclists;
- Approach Sight Distance (ASD) from the left-hand curve to the bridge is short;
- No median protection through the bridge; and
- Poor sight distance to the intersection of Maeneene and Waimanu Roads with SH1.

Prior to resolving these safety issues, the Transport Agency undertook Phase 1 engagement on the Indicative Route in February 2017. Phase 1 engagement resulted in several individuals raising concerns over the safety aspects of the section of network around Maeneene Road, Waimanu Road and Vipond Road with the existing SH1.

A range of options to resolve these issues were identified. Two short-list options were progressed for evaluation (shown in Figure 7-7 and Figure 7-8) as follows:

- Option 1: New offline bridge and upgrade to at-grade intersection of Maeneene and Waimanu Roads with SH1 (JG01);
- Option 2: New offline bridge and grade separated intersection (JG02).

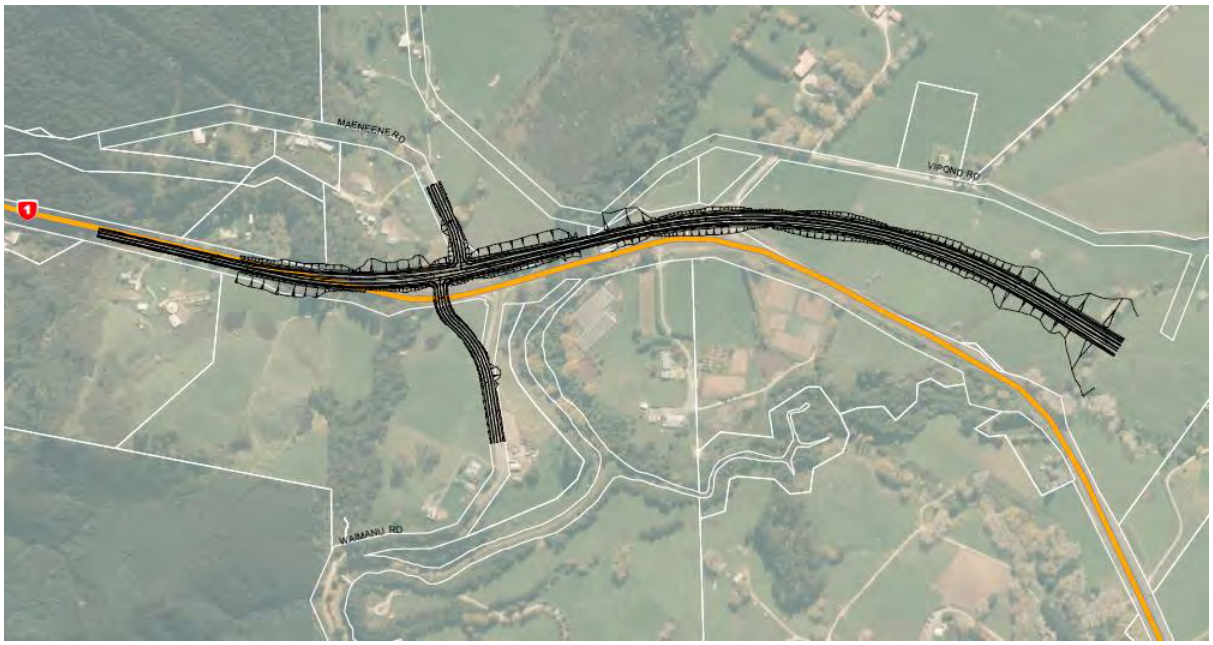

Figure 7-7: New offline bridge and upgrade to at-grade intersection (JG01)

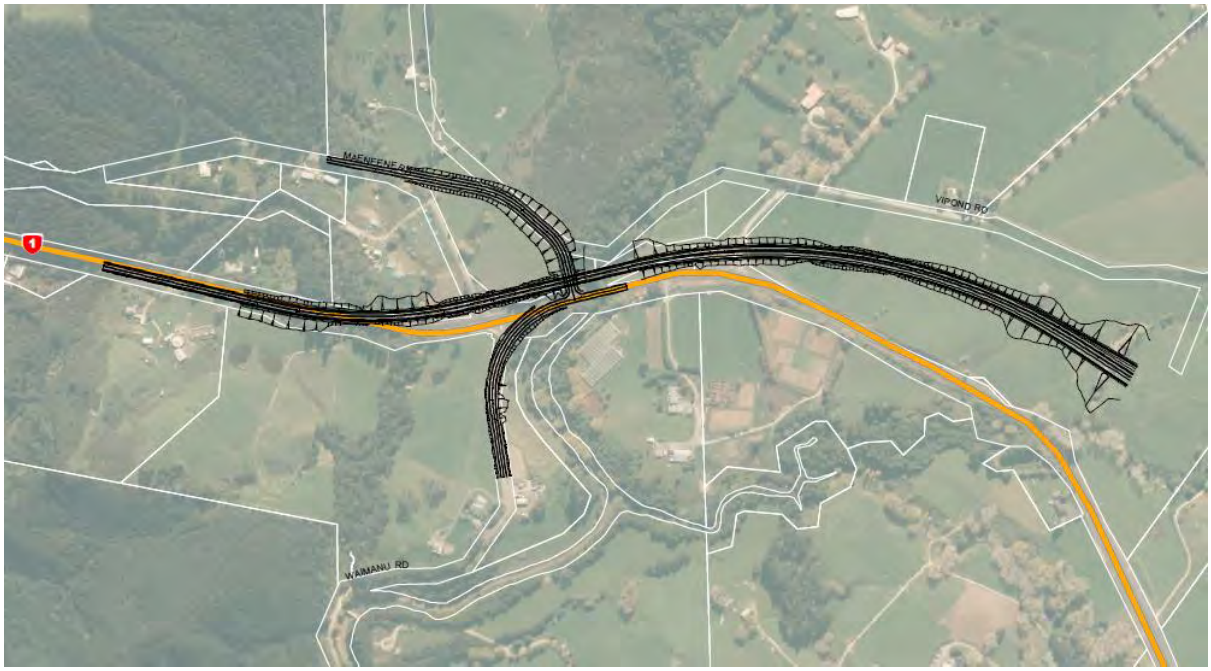

Figure 7-8: New offline bridge and grade separated intersection (JG02)

The MCA evaluation followed the process set out in 7.3 inlcuding the assessment of more RMA-specific specialist areas performed by environmental specialists to make sure that the relevant matters under section 171 of the RMA were considered in the options evaluation process.

Each option was considered against a baseline do-minimum option (Indicative Route option brought forward from the SAR phase) and all were assessed against the relevant LTMA and engineering and environmental criteria, and options rated and ranked in order based on their average score across these criteria. The options were rated, translated into quantitative scores, and ranked for each option across the

criteria. This assessment allowed the Project team to make a recommendation to the Transport Agency as to the option to include as the northern termination for the Indicative Alignment.

The relevant LTMA and engineering criteria considered to differentiate the options ("Safety and Personal Security", "Improving Access and Mobility" and "Value for Money") were evaluated based on professional judgement and the experience of the assessors. The other criteria from the MCA framework were deemed to be non-differentiators, largely given the scale of this component of the Project being so discrete.

There were no significant differences in cost between the options (when considered in relation to the cost of the Project as a whole). With respect to safety, the grade-separated intersection removed the intersection conflict point (at grade SH1 with local roads) and therefore provided an optimal safety solution for this section of the route. The grade separated intersection also provided better local road connectivity. Therefore, the assessment recorded a preference for Option 2 (new offline bridge and grade separated intersection).

The environmental specialists assessed and scored the environmental effects of each option. Most environmental factors did not differentiate between the two options. Both options would result in adverse effects given the works required in the vicinity of the Maeneene and Waimanu Streams. Option 2 scored lower for freshwater ecology given the greater earthworks volumes predicted in proximity to Maeneene Stream. Option 1 scored lower for landscape and visual matters given the state highway restricts access between Maeneene and Waimanu Roads. Overall, the specialist assessments did not reveal any significant effects that could not be mitigated. The assessments recorded a slight preference for Option 2.

The new offline alignment with grade-separated intersection (Option 2) was therefore confirmed as the preferred option.

7.5.5. Evaluation of tunnel alignment

Geotechnical investigations undertaken in April 2017 identified a series of geological features in the tunnel area (beneath and west of Kraack Road) that might affect the design, construction, operation and cost of the tunnel, in particular the presence of a fracture zone and high artesian water pressure. Following the results of further geotechnical investigation work, alternative alignments for the route passing beneath Kraack Road were identified and assessed to determine the feasibility of a safer, more cost effective tunnel alignment.

In August 2017, alternative options for the alignment to pass through the Kraack Hill area were assessed. A key engineering outcome for assessing alternative alignments was to minimise the extent of tunnel interfacing with fracture zones associated with fault lines, as well as minimising interaction with areas of high artesian water pressure. This could be achieved by changing the alignment to cross the fault traces at right angles (perpendicular), or to avoid them altogether.

The location of the tunnel portals within the surrounding topography was a key factor in assessing the feasibility and alignment of the tunnels. In addition to the Indicative Route Alignment (JG15), two alternative options for the alignment in the Kraack Hill

area were identified for assessment; one to the west of the existing alignment, and one to the east of the existing alignment as follows:

- Western Tunnel Alignment (JG16): This option realigned a section of the main alignment westwards into the adjacent valley south of the tunnel. The tunnel length is approximately 970 m. The length of the mainline realignment is approximately 7 km, extending from near Woodcocks Road to approximately 1.5 km north of the northern tunnel portal.
- Eastern Tunnel Alignment (JG18): This option realigned a section of the main alignment approximately 200 m eastwards adjacent to the tunnel (when compared to the refined Indicative Route). The tunnel length is approximately 850 m.

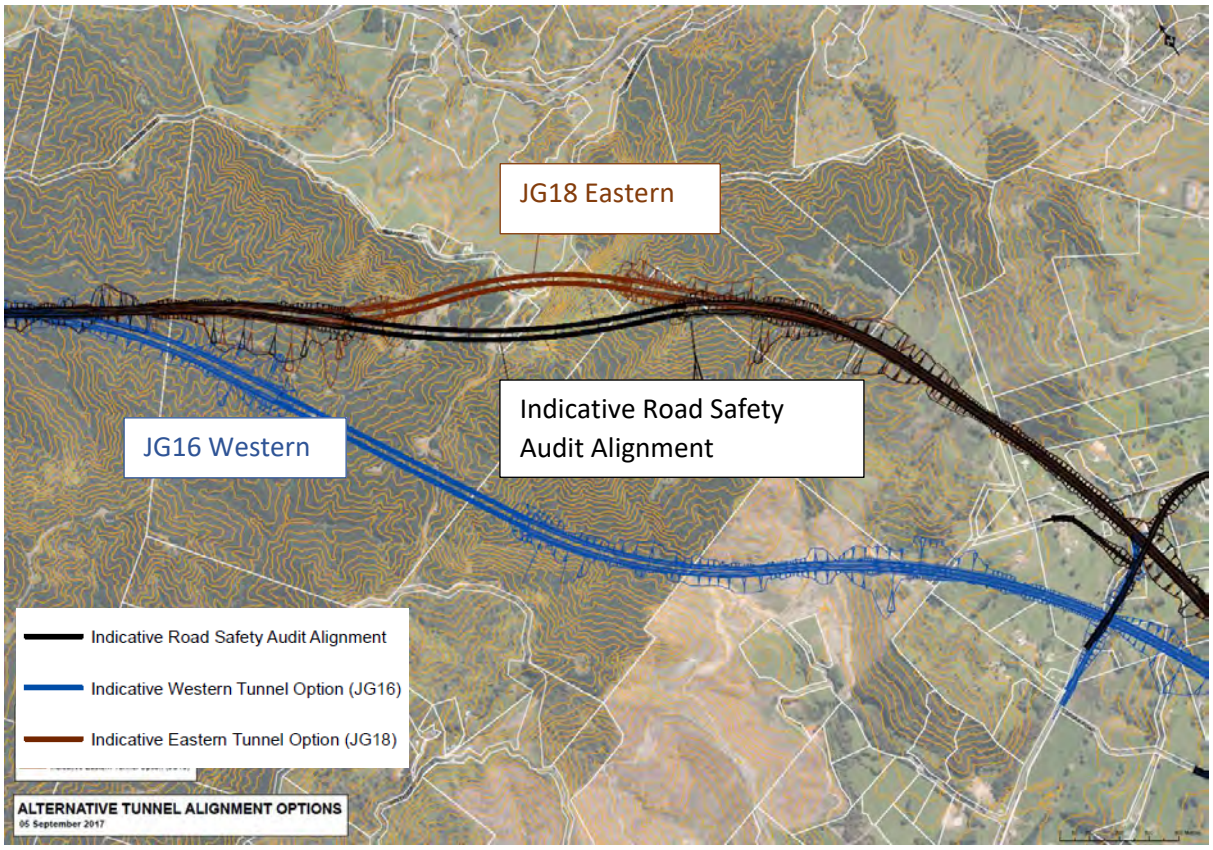

Figure 7-9: Alternative tunnel alignments

As for the northern termination alternatives assessment outlined above, the assessment of alternatives for the tunnel options used an MCA framework where the inputs into the MCA evaluation by environmental specialists were considered alongside LTMA and engineering criteria.

The majority of the LTMA and engineering criteria were deemed to be non-differentiators, as it was considered that all three alternative tunnel alignments had generally the same impacts. The exception to this was "Overall Cost of the Option". The eastern alignment was assessed as the lowest cost option, the savings were considered to be significant when taking into consideration the outcomes from the additional geotechnical investigations and interpretation.

The environmental specialists assessed the Project's effects under section 171 of the RMA and scored the environmental effects of each option based on the subject matters listed above. For the majority of environmental criteria, the effects were deemed to be the same for each of the three tunnel alignment options. Only one criterion was considered to be a differentiator – water quality and flooding. For this criterion the effects of the JG15 and JG18 alignments were scored Moderate, and Minor for JG16. Overall, the environmental specialist assessments did not identify any significant effects that could not be mitigated.

Overall, given the significant cost savings offered by the eastern alignment option and that there were no significant environmental effects identified, the eastern alignment (JG18) was evaluated as the preferred tunnel option.

7.5.6. Design refinements

Refinements to the Indicative Route alignment were made in response to community inputs and in response to the outcomes of further, more targeted environmental investigations. The main design development changes included the following:

- **Wayby Valley Road Roundabout**: A new roundabout was developed at the intersection of the existing SH1 and Wayby Valley Road. The roundabout replaced a T-intersection that was proposed in the Indicative Route. The roundabout provides a safer and more efficient intersection.
- **Mangawhai Road**: Changes were made to address effects of the Indicative Route on twelve properties of Charis Lane. A new roundabout intersection at the existing SH1 and Mangawhai Road was developed. The Te Hana Interchange was shifted northwest approximately 110 m and the western termination point of Mangawhai Road was reduced, primarily to avoid crossing the fuels and gas pipelines.

7.6. Conclusion

Since the commencement of the Project, there have been a number of assessments to identify the preferred transport solution and progressively refine the Project alignment and hence the Project's land requirements and effects. This process has spanned a number of years and in that time the work undertaken has adapted to amendments to both the Transport Agency's processes, project objectives and in the context of evolving planning frameworks and planned growth. The assessments have been carried out by way of evaluation frameworks which have had regard to criteria derived from LTMA, the RMA and the Project's overarching objectives. This process has been thorough and robust in terms of the requirements of section 171(1) of the RMA. The Indicative Alignment will provide a large number of benefits and avoid major environmental, social and cultural constraints within the Project area and is considered the best overall outcome.

8. Engagement and consultation

8.1. Introduction

This section provides an overview of stakeholder, iwi and public engagement for the Project. It addresses the purpose of engagement and consultation, summarises feedback including the tools and techniques implemented, the parties engaged and the engagement outcomes. This section then goes on to outline the common issues and themes raised by stakeholders, iwi partners, communities of Warkworth, Wellsford and Te Hana and the wider public.

Engaging and building relationships with people who are interested in, or affected by, the project, is an important part of the Project.

There is a long history of engagement that has influenced development of the Project, commencing in 2010 with engagement on the P-W project. The P-W project was subsequently split into two separate projects – P2Wk, and Warkworth to Wellsford. Engagement for the Warkworth to Wellsford Project has been informed by, and built upon, the earlier engagement for the Ara Tūhono Pūhoi to Wellsford project, the Pūhoi to Warkworth project and the Whangārei to Auckland Programme Business Case (engagement undertaken in 2016).

Engagement for the Project has been guided by an Engagement Plan developed using the principles and core values of the International Association for Public Participation (IAP2) and the Transport Agency's own guidelines for best practice consultation under the RMA, the LTMA and HNZPTA.

Engagement with stakeholders, iwi, landowners and neighbours has been ongoing throughout Project development. Commencing in early 2017, an engagement programme was developed in accordance with the Engagement Plan and has been or is being delivered as follows:

- Indicative route –The Project was formally introduced to stakeholders, landowners and the public with the production and distribution of a project newsletter and a series of key stakeholder briefings, hui, property owner meetings and public information sessions in February 2017 to present and gain feedback on an Indicative Route. Noting, prior to this targeted engagement with key stakeholders had occurred;
- Pre-lodgement – Following further technical investigations and analysis, the Indicative Alignment was presented to stakeholders, landowners and the public for further feedback from November 2018 to March 2019;
- Post-lodgement engagement following lodgement of the Application. Communications and engagement will continue throughout the public notification and hearing process.

The Transport Agency will continue to engage with the community and neighbours prior to and throughout construction of the Project.

8.2. Engagement purpose and objectives

The purpose of the Indicative Route engagement was to inform, consult and obtain feedback on the Indicative Route. This process informed some of the refinements undertaken in development of the Indicative Alignment presented to iwi partners, key stakeholders, landowners and the public during the Indicative Alignment engagement.

Specific objectives were identified by the Transport Agency for consultation on the Indicative Route and pre-lodgement engagement.

Indicative Route

Specific objectives for the Indicative Route included:

- Inform stakeholders, affected parties and communities such that they achieve an understanding of the proposal and its effects;
- Gather knowledge and input from stakeholders, affected parties and communities to inform the Project design and understanding of potential effects to inform this AEE;
- Build awareness of the Application;
- Maximise positive and minimise negative submissions by supporting the public in understanding the Project and its benefits and incorporating feedback where practicable to address concerns;
- Support directly affected landowners and neighbours in understanding the process, navigating requirements and locating information available, and assisting to address site issues and concerns where possible.

Pre-lodgement Engagement

Specific objectives for the Pre-lodgement engagement included:

- Inform and educate stakeholders on the Indicative Alignment;
- Continue to reinforce the background to the Project and why it is required;
- Advise the potentially affected parties and communities of the potential extent of the Indicative Alignment as well as any potential effects;
- Ensure key target audiences and stakeholders have an accurate understanding how the Project fits into strategic regional development;
- Provide consistent information;
- Engage constructively with key stakeholders/target audiences;
- Minimise uncertainty and dispel misinformation; and
- Maintain and enhance existing relationships.

8.3. Iwi consultation

Since 2010, the Transport Agency has had an established relationship with iwi on the wider Pūhoi to Wellsford project. A partnership was formed in 2010 by Mana Whenua within the project area, namely Ngāti Manuhiri (Ngāti Wai), Ngāti Mauku/Ngāti Kauwae (Te Uri o Hau), Ngāti Rango (Ngāti Whātua o Kaipara) and Ngāti Whātua iwi. This collective is called Hōkai Nuku. Hōkai Nuku is mandated by their members to ensure that the enhancement of cultural footprint and values associated with collective mana whenua interests is an integral component of the Project.

Since early 2017, the Transport Agency has met regularly with Hōkai Nuku representatives to discuss the Project. The Transport Agency and Hōkai Nuku continue to work collaboratively on the Project.

In mid-2017 all iwi with potential interests in the Project area (based on Auckland Council's list at that time for the Rodney Local Board area) were invited to a hui to share information on the Project identify their interests and confirm whether they wished to be engaged. In addition to the four iwi and hapu represented by Hōkai Nuku, Ngāti Paoa, Ngāti Maru and Te Kawerau a Maki also expressed an interest in the Project area and surrounds and have been subsequently engaged with regarding the Project. This engagement has involved hui and exchange of information.

Draft cultural assessments were received from Hōkai Nuku, Ngāti Maru and Te Kawerau a Maki. The key concerns raised in these assessments related to the Project's impact on cultural values associated with waterways, indigenous vegetation and fauna and identified cultural heritage sites. Recommendations presented in the assessments are outlined in section 9.18. The Transport Agency will continue to liaise with Mana Whenua throughout design and construction of the Project.

8.4. Stakeholders

Several stakeholder groups were identified for targeted consultation grouped as follows: directly affected landowners and neighbours, Government agencies, statutory organisations and interest groups, utility providers, community groups, and local businesses.

Key stakeholder briefings were held in February 2017. The purpose of the briefings was to present the full extent of Indicative Route prior to its public release on 17 February 2017. Further pre-lodgement engagement on the Indicative Alignment took place from November 2018 to March 2019. Consultation and engagement has been undertaken with the following stakeholders:

- Affected landowners and immediate neighbours;
- Hōkai Nuku;
- Auckland Council;
- Auckland Transport;
- Department of Conservation;
- Heritage New Zealand;
- Other road project groups: Safe Roads Alliance and Supporting Growth Alliance;
- Forest and Bird;
- Healthy Waters;
- Auckland Chamber of Commerce;
- NZ Council for Infrastructure Development;
- Auckland Business Forum;
- Infrastructure NZ;
- One Warkworth Business Association;
- Waste Management NZ
- Interest groups (Walking Access NZ, NZ Walkways Commission, Bike Auckland, Integrated Kaipara Harbour Management Group, Mangawhai Residents and

Ratepayers, Tomarata Rural Women's Group, Warkworth Transport Forum, Vision Wellsford and Federated Farmers);
- Utility providers (Refining NZ, First Gas, Watercare Service Limited, Transpower, Vector Limited, Chorus, Spark, 2degrees Mobile Limited, and Vodafone); and
- Road user organisations (emergency services, freight and driver associations, National Road Carriers, Heavy Haulage Association, Automobile Association).
- Other local authorities and related entities (Kaipara DC, Whangarei DC, Northland RC, Far North DC, Northland Mayoral Forum; Northland Regional Transport Committee.

8.4.1. Directly affected landowners and neighbours

Indicative Route engagement

Directly affected landowners have been identified as those owners whose properties are fully or partly within the proposed designation. This also includes leasees and licensees of potentially directly affected properties. Project neighbours are those whose properties border the proposed designation or adjoin a directly affected property.

In January 2017, 87 potentially affected landowners and neighbours were sent letters, informing them of the Project and extending an invitation for affected landowners to meet with the Transport Agency. Property maps showing the Indicative Route in relation to individual property and the potential scale of property requirement (whether it is likely to be a partial or full land acquisition) were provided via email or presented at the individual meetings.

Indicative Alignment engagement

In November 2018, 171 affected landowners and neighbours of affected landowners were sent letters outlining the changes to the proposed route, now called the Indicative Alignment. The letters invited property owners to meet with representatives of the Transport Agency from 21 November 2018, prior to the Indicative Alignment being presented at public information days from 28 February 2019.

Communications with landowners and neighbours have been continuous throughout the Project development, including three letters and ongoing liaison to support advance acquisition and arrangement of site visits.

8.4.2. Local government and statutory agencies

Auckland Council (Project Development)

The Transport Agency has been in close liaison with Auckland Council staff on a regular basis throughout Project development to discuss the Indicative Route and Indicative Alignment, technical inputs and consenting matters, while providing regular Project updates for general information purposes. A primary focus of the meetings held with Council's compliance team (who are currently working on the compliance monitoring of the P2Wk project), was to seek feedback on how the designation and consent conditions were working during the construction phase and whether there were any lessons to learn for this Project.

Engagement with Auckland Council resulted in alterations and refinements being made to the design of the Project. The Warkworth Interchange was a particular concern for the Council as they identified the potential for land to become landlocked or 'orphaned' within the original Indicative Route design. The Indicative Alignment includes refinements in response to these concerns.

Auckland Council (Regulatory)

A number of meetings have been held with Council's regulatory team, acknowledging the role they will have in the statutory process, and subsequent monitoring of conditions of the designation and resource consents for the Project, if approved.

Pre-lodgement discussions were undertaken with specialists within Auckland Council during the development of the Project. This has included specialists relating to ecology, stormwater, landscape and visual, heritage and archaeology. Meetings with these specialists included introductions of the Project, presentation of the Indicative Route and Indicative Alignment, and discussions regarding the assessment and effects of the Project relating to each specialist field. Potential designation and consent conditions were also discussed.

Local Boards

Joint meetings were held with the Rodney Local Board Infrastructure Committee and Auckland Council in May and August 2017. The issues raised related to the broader Auckland to Whangārei corridor and linkages with the "Heartland" cycling rides along the east coast. A written update on the Project was provided to the Rodney Local Board prior to lodgement.

Auckland Transport

Engagement with Auckland Transport on this Project has been ongoing, specifically in respect of the design standards of the Project and the integration of the Project with the local transport network (including road, pedestrian and cycleway elements). A key concern expressed during engagement with Auckland Transport has been how the Project will integrate with existing local roads and with planned upgrades to the local network. These discussions have influenced the refinements presented in the Indicative Alignment. Auckland Transport has been involved in the development of the draft conditions for the Project.

These aspects were discussed in regular meetings with Auckland Transport throughout the Project development. Ongoing meetings will continue as the Project develops.

Regular engagement occurred with the Safe Roads Alliance to discuss the Project interface. This included regular meetings, teaming up at respective project public engagement events, sharing information with shared landowners and coordination of external communications to support the Project. Site access points were considered collectively to ensure any safety implications were identified early.

Discussions were also held with the Supporting Growth Alliance regarding Project interfaces. Key aspects of discussion related to construction and approach to management, Auckland Council structure plan for Warkworth and the collaborative approach to traffic modelling.

Department of Conservation

The Project does not pass through land managed by DOC. Consultation with DOC has focused on the conservation values of sites within the Project area, the natural values of flora and fauna, management of erosion and sediment control, recreational access and opportunities and environmental effects and benefits. The main issue raised included early identification of relocation sites. Engagement with DOC around these key issues has influenced the mitigation proposed for the Project along with the proposed conditions. The Project does not encroach on Sunnybrook Reserve. DOC have been included in the development of the draft conditions. Ongoing engagement with DOC will continue as the Project progresses.

Heritage New Zealand

Heritage New Zealand has been engaged during development and assessment of the Project. During 2017 and in 2018, meetings were held to provide staff with an understanding of the Project's general alignment, identification of historic heritage features, and the potential effects of the Project on these features. Some of this engagement was carried out in conjunction with Auckland Council heritage experts. Engagement with Heritage New Zealand around these key areas of interest has influenced the mitigation proposed for the Project along with the proposed conditions. Ongoing engagement with Heritage New Zealand will continue, particularly regarding the later approvals required for the Project under the HNZPTA.

8.4.3. Utility providers

The Transport Agency has worked with utility providers with major infrastructure within the proposed designation. This engagement occurred during development of the alignment and design refinement to understand the location of existing services and to discuss any necessary relocations, proposed upgrades or new services required within the vicinity of the alignment. Engagement with utility providers included Refining NZ, First Gas, Watercare Services Limited (Watercare), Transpower, Vector Limited, Spark, 2degrees Mobile Limited, and Vodafone. Engagement with utility providers is ongoing.

Engagement with Refining NZ and First Gas has been undertaken to obtain information for the Project in relation to their fuels and gas pipelines that traverse through the Project area. Both network utility operators noted key matters to be addressed such as methods for crossings of the fuels and gas pipelines, security of ongoing operations, design of works around existing assets and potential settlement risks and maintenance access. The Indicative Alignment was refined where appropriate in response to these matters.

Watercare has been engaged with during the Project regarding design features and the interface between the Project and Watercare's water and wastewater assets. Watercare has a surface water take that has the potential to be impacted by Project related construction and operation discharges if works are not appropriately managed. The Project team has identified measures to manage impacts on Watercare, as discussed in section 9.2 and 9.12 of this AEE.

The Transport Agency has engaged with Transpower in relation to the potential impacts of the Project on the high voltage transmission lines which run across the

Project area in the vicinity of Mangawhai Road. Transpower advised that alterations will be required to their existing transmission line assets (an additional support structure, as described in section 4 of this AEE) to maintain clearance distances between the conductors and the mainline carriageway. Any resource consents required for the alterations of Transpower's transmission line assets will be sought prior to the works occurring.

8.4.4. Road user organisations

Road user organisations, including emergency services, freight associations and driver associations were consulted regarding the Project. This engagement sought to identify any areas of concern and solicit feedback on the alignment. Issues identified relate to lack of rest areas and stopping places for regional freight, particularly southbound. Generally, the feedback has been positive from these organisations due to the Project proposing to increase road safety.

8.4.5. Interest groups

Consultation was undertaken with organisations potentially interested in the Project, including Vision Wellsford, Forest and Bird, Walking Access, Bike Auckland, Fish and Game, and Federated Farmers.

Vision Wellsford support the Project, due to the business and growth opportunities as a result of the proximity to the road interchanges with Wellsford and the ability for travelling public to easily get on and off SH1. A key issue raised related to the Wellsford exit being curved to align better to the existing SH1 to create as a sense of arrival into Wellsford and prominent exit signage.

Consultation has also been undertaken with Waste Management NZ in relation to their future plan change and proposed resource consent applications to establish a new land fill. At the time of lodgement neither the plan change or resource consent applications had been notified.

8.5. Public engagement

8.5.1. Consultation on the Indicative Route

Public consultation commenced with information on the Transport Agency website which reflected the presentations at the information days including a map of the Indicative Route and supporting poster boards. The website also provided an animated fly through of the route along with five interview style videos covering specialist topics such as geology, design, planning and the environment.

Promotion of the public information days was made via digital advertising, printed brochures delivered to households via NZPost, website promotion, social media and newspaper (both digital and hardcopy) along with personalised landowner letters.

Five information days were held between 18–28 February 2017 in Warkworth, Wellsford and Te Hana. All five information days were well attended, attracting between 65 and 230 people.

8.5.2. Engagement on the Indicative Alignment and potential environmental effects

Public engagement for the Indicative Alignment commenced with updating of the Transport Agency website to present the refined Indicative Alignment. The website was updated with the information presented during the public information days and included an Indicative Alignment map and factsheet.

Promotion of the public information days was consistent with the approach taken during the consultation on the Indicative Route and included digital advertising, printed brochures, website promotion, social media, newspaper (both digital and hardcopy) along with the landowner letters.

Three information days were held between 28 February and 6 March 2019 in Warkworth, Wellsford and Te Hana. The Warkworth Hub office was also open for two half-day public drop in sessions on 28 February 2019 and 6 March 2019. As the Project is referenced within the Warkworth draft Structure Plan document, the project team representatives also attended Council's open days in Warkworth on 7 and 9 March 2019.

8.5.3. Feedback received from the Indicative Route and Indicative Alignment engagement

The targeted engagement with stakeholders, and the wider Indicative Route and Indicative Alignment engagement, generated a wide variety of feedback from stakeholders and the community. Several themes became evident during analysis of the feedback.

The primary themes identified in the feedback received during the Indicative Route and Indicative Alignment, were:

1. The feedback received generally presented universal support for the Project and its aims and objectives. Positive feedback was also received on the Transport Agency's objectives for the Project to improve safety, increase route resilience and travel time reliability.
2. Warkworth residents expressed the desire for a better solution for the Warkworth Interchange. The feedback stated that the Indicative Route design would have significant effects on properties and residents in the Kaipara Flat and Phillips Road area. A key concern was that so many properties were affected in these areas that the remaining residents would no longer function as a community.
3. Concern around the change to the nature of the Kaipara Flats Road area, including safety of the Kaipara Flats Road / SH1 intersection, noise, visual impact and potential effects on property value.
4. Flooding is an issue for residents around Kaipara Flats Road, and there was concern as to how the Project will adequately manage this and also avoid exacerbating and potentially improve the situation for local residents and private properties.
5. Support for a Warkworth southern interchange which is outside the scope of this Project.
6. The bypass of the Wellsford township was generally desired/accepted due to the current bottleneck and effects of trucks experienced in the town. However, there was some concern for businesses that serve passing trade, and a desire to ensure

the Wellsford town centre remains a stopping place for people travelling north and south.

7. Existing congestion through Wellsford, slow travel times due to growing traffic volumes and concern that with construction 10 years away from starting, the situation will continue to get worse with no plans for improvements.
8. A high number of truck movements including from quarries need to be considered in the design of intersections at the Wellsford and Te Hana interchanges – e.g slip lanes.
9. Mangawhai is growing exponentially, general feeling is traffic may still use Wayby Valley Road as Mangawhai Road is windy/unsafe. Complaints about drive speed and traffic volumes on Waiteitei Road heading to/from Mangawhai.
10. Flooding was a key concern for residents in the Wellsford interchange area around Wayby Valley Road – both flooding on the proposed highway and the potential to exacerbate existing flooding issues for farmers and increase water quality effects in the Hōteo River.
11. Design refinements were investigated around the Te Hana Interchange to reduce land impacts by making better use Mangawhai Road and on properties located on Charis Lane.
12. The location of the northern tie-in was of concern, particularly in relation to safety around Maeneene Bridge and the local roads which connect with the existing SH1. Generally, those commenting suggested that the route should tie-in further to the north between Ross Road and Kaiwaka.
13. There was a sense of pragmatism from some landowners, particularly in Wellsford and Te Hana, with them balancing their support for the Project's intent against the effect on their land, and what that means for them as individuals, families and communities.
14. Ensuring the Project is future proofed as tunnels can become restrictive if not wide enough/enough lanes.
15. Native vegetation is preferred over exotic pine forest.
16. Safety of current road through the Dome is a concern and a strong driver of community support for the Project.
17. Concern from Dome Valley residents about construction impacts (noise, vibration and construction traffic).
18. Vegetation pockets along the Project are valued by community. Anecdotally some have historical value. Impacts on these need to be considered and avoided where possible to maintain areas of environmental value.
19. Flora and fauna in and around streams and in pockets are highly valued in both the Warkworth and Wellsford areas.
20. Uncertainty regarding construction timeframes and the length of time 'in limbo' prior to active property purchase. Many landowners feel as though they are in a holding pattern with no certainty.
21. Impacts on farms, there is the feeling that the Project takes the "best land" on a number of larger farming blocks, leaving farmers with smaller/poorer lots to farm.
22. Severance of farms/farmlets making them unviable.
23. Most Te Hana residents that responded supported the extension of the northern tie-in on the Indicative Alignment as it alleviates some safety concerns raised in early consultation on the Indicative Route.

24. More general themes included:
    - Requests to minimise impacts on people, properties, farms and business as much as practicable through design and mitigation;
    - Views that the Project is necessary and should be constructed as soon as possible; and
    - Views that there is a desire for growth to continue in Northland, with an understanding that the Project will help facilitate this. There is a sense that this new section of state highway is just a small piece, and that further improvements should extend to at least Whangārei.

8.5.4. Post lodgement – Ongoing and future engagement

Ongoing communication and engagement with stakeholders and the community will be undertaken following lodgement of the Application. This will include ongoing discussions with key stakeholders, sharing Project information with interested parties, and providing updates via the Project website and local media.

A comprehensive communication plan will be developed and implemented prior to and for the duration of construction works.

8.6. Public communication channels

Communities interested in the Project are spread over a large area, reflecting the rural characteristics of the Project area, and the wide range of transport network customers. This distribution dictated the use of a variety of communication channels to ensure widespread dissemination of key messages and to ensure that opportunities to provide feedback on the Project were open to everyone.

Key channels of communication included information days, Project website, toll free telephone number, media, advertising, project website, videos, and printed and email newsletters.

8.6.1. Warkworth Hub

To complement the Public Information Days, the Warkworth Hub was established for the public to come in and view project information and to meet with the Transport Agency. This was specifically set up to facilitate face to face meetings with landowners and interested parties within the Project area, due to the Warkworth Hub being accessible for people affected by the Project.

8.7. Changes made as a result of engagement

All key themes identified in the feedback have been considered along with further technical information that has come to hand as the Project has progressed. Input received from the consultation process has informed the design and assessment process. For example, local knowledge has been valuable regarding flooding and ground conditions. The feedback has contributed to, but has not been solely responsible for, decisions regarding:

- Location and configuration of the indicative Warkworth Interchange;
- Variations to the alignment design around Charis Lane;
- Design of structures crossing over the fuels and gas pipelines;

- The proposed location of the designation boundary to manage practical matters, such as access and business management (eg stock movements) and
- The form of the northern tie in, in the vicinity of Maeneene Road and Waimanu Road.

9. Assessment of effects on the environment

9.1. Introduction and summary of effects on the environment

Overview

The assessment of effects on the environment for the Project has identified a wide range of actual and potential positive and adverse effects on the environment.

The significant positive effects of the Project relate to transport benefits, through improved safety, supporting safe cycling and walking, reduced journey times for general traffic and freight, increased capacity, improved route security by providing an alternative route resilient to incidents, improved travel time reliability, and improved accessibility. Through the transport benefits, there will be associated economic and environmental benefits, such as stormwater treatment leading to reduced contaminant loads for two river catchments, retiring of some land that contributes to the sediment load of the Kaipara Harbour, through landscaping and planting for mitigation and through design which will assist with more fuel efficient travel (through better gradients and less need to brake, accelerate and/or decelerate). As a result of moving a significant number of vehicles off the existing SH1 and on to the Project, there will be reduced noise and air emissions for existing receivers along SH1 including through Wellsford and Te Hana.

During construction there will be temporary adverse effects, including effects arising from construction water discharges, construction traffic, construction noise and vibration, and dust.

The Project will have some permanent adverse effects. Most notably these are associated with noise, stormwater discharges during operation, loss of streams and indigenous vegetation, and associated habitat for indigenous species; changes in hydrology and flooding, visual effects and loss of heritage values.

The indicative design for the Project has sought to avoid or mitigate adverse effects through the early identification of environmental constraints as part of the route selection process, design of Project elements and the proposed construction methodology. Potential adverse effects will be further avoided or mitigated through the implementation of designation and consent conditions requiring detailed design, construction and operation of the Project to achieve identified mitigation outcomes. Specific mitigation is proposed within sections 9.2 to 9.20 of this AEE. This mitigation will be implemented through the provisions of various management plans as set out in the proposed conditions.

9.1.1. Introduction

This section provides a summary of the actual and potential effects of the construction, operation and maintenance of the Project. The summary provides an overview of the effects associated with the Project and identifies whether they are positive or adverse and the scale at which they are likely to occur at (i.e. local, regional or national), and whether they are temporary or permanent.

Avoidance of adverse effects has been the first principle for the design of the Project. As noted in Section 7 of this AEE, identification of environmental constraints and

features was undertaken at the early stages of Project development to inform consideration of corridor and alignment options. Where avoidance has not been possible, mitigation measures have been proposed and are reflected in proposed designation and consent conditions.

As informed by the proposed harvest programme supplied by Rayonier Matariki during pre-lodgement engagement, this assessment of effects and supporting technical reports has assumed that the Matariki Forest will be harvested prior to the construction of the Project (i.e post harvest). As such, the clear-felled forest land forms part of the environment against which this Project has been assessed. For clarity section 9 of this AEE has been written on that basis with the exception of three sections. Sections 9.2 *Construction Water*, 9.5 *Terrestrial and Freshwater Ecology* and section 9.12 *Operational Water* and the corresponding technical reports (Water Assessment Report and Terrestrial and Freshwater Ecology Report) have considered both scenarios (i.e pre and post harvest) as the pre harvest scenario represents the worst case in terms of effects in relation to the relative changes to ecological values and water quality. Harvesting of the Matariki Forest is currently a permitted activity under the NESPF and therefore can be lawfully undertaken.

As outlined in sections 1 and 4 of this AEE, the Indicative Alignment is a preliminary alignment of a state highway that can be constructed within the proposed designation boundary. The final alignment for the Project will be refined and confirmed at the detailed design stage, through the outline plan process under section 176A of the RMA, and in compliance with the designation and consent conditions. The final design of the Project may move anywhere within the proposed designation boundary, and design features may change. The assessment of effects on the environment for the Project has been sensitivity tested, where relevant, as follows:

- The actual and potential effects on the environment of the Indicative Alignment were assessed;
- Consideration was given as to how the assessment of effects might change if the alignment (and ancillary components such as soil disposal sites or stormwater treatment devices) were to move horizontally or vertically within the proposed designation boundary;
- Consideration was given as to how the assessment of effects might change with lower or higher traffic growth than expected;
- Consideration was given as to how the assessment of effects might change if the harvesting of Matariki Forest did not occur prior to Project construction (applies to Section 9.2, 9.5 and Section 9.12); and
- Mitigation was recommended that addressed the effects of the Project, even in the event that the alignment changed within the designation boundary.

9.1.2. Structure of the assessment

The following sub-sections in Section 9, identified in Table 9-1, describe the assessment undertaken for the key topic areas. A summary of the resulting assessment is provided in section 9.1.3.

Table 9-1: Effects on the environment assessment topics

AEE Section	Topic
9.2	Construction water
9.3	Groundwater/ Hydrology
9.4	Ground settlement
9.5	Terrestrial and freshwater ecology
9.6	Marine ecology and coastal avifauna
9.7	Construction traffic
9.8	Construction noise and vibration
9.9	Construction air quality
9.10	Heritage/ archaeology
9.11	Land contamination
9.12	Operational water
9.13	Landscape and visual
9.14	Operational transport
9.15	Operational noise
9.16	Operational air quality
9.17	Social impacts
9.18	Cultural values
9.19	Economic
9.20	Land use and property

9.1.3. Summary of effects on the environment

The actual and potential effects of the construction, operation and maintenance of the Project are summarised in Table 9-2. This table provides a summary of the positive and adverse actual and potential effects of the Project, and the level and duration of these effects. There are opportunities or measures that can be taken to minimise or mitigate the adverse effects identified, and the table demonstrates the scale of effect following implementation of mitigation recommendations. These mitigation measures are identified in the assessments in sub-sections 9.2 – 9.20, and are summarised in Section 10. An integrated mitigation approach has been developed as a core part of the Project with consideration of Mana Whenua, ecology, heritage, landscape and hydrology to achieve an integrated approach.

Table 9-2: Summary of effects on the environment following implementation of recommended mitigation measures

Actual or potential environmental effect	Positive effect	Adverse effect	Local, regional or national level effect	Duration of effect	Scale of effect with mitigation
Construction water					
Effects on hydrology and floodplains from construction activities within the floodplain and wider catchments		✓	Local	Short-term	Minor
Effects on drinking water quality at any abstraction point		✓	Local	Short-term	Negligible
Effects on health of people and communities interaction with fresh water or marine water		✓	Local	Short -term	Negligible
Groundwater/Hydrogeology					
Effects on streams, wetlands and existing consented groundwater users from drawdown of groundwater arising from deep excavations and tunnel construction		✓	Local	Short-term during construction Long-term during operation	Less than minor
Ground settlement					
Impacts on buildings/ structures/network utilities		✓	Local	Long and short-term	No more than minor
Terrestrial and freshwater ecology					
Integration of ecosystems providing greater ecological resilience	✓		Local, regional	Long-term	Positive
Improved adaptive capacity of ecosystems through pest and weed control	✓		Local, regional	Long-term	Positive
Improved North-South ecosystem connectivity, in particular between the Mahurangi River (Left Branch) and the upper Kourawhero Stream catchments	✓		Local, regional	Long-term	Positive

Actual or potential environmental effect	Positive effect	Adverse effect	Local, regional or national level effect	Duration of effect	Scale of effect with mitigation
Removal of indigenous vegetation and impacts on fauna (bats, snails, lizards, birds) from loss of habitat, construction activities and creation of edge effects		✓	Local, regional	Medium-term prior to establishment of habitat.	Minor
Loss of stream ecosystems through culverting/soil disposal, increased sedimentation and stormwater runoff during operation and associated impacts on freshwater ecology from loss of habitat and disruption to fish passage/spawning		✓	Local, regional	Long-term	Minor
Loss of wetland ecosystems through removal of vegetation and hydraulic changes and impacts on fauna resulting from loss of habitat		✓	Local, regional	Long-term	Minor
Marine ecology and coastal avifauna					
Increase in sediment runoff from open earthworks areas during large rainfall events discharging to the Mahurangi and Kaipara Harbours during construction of the Project		✓	Local	Short-term following storm events Long-term accumulation	Less than minor
Effects on ecology in the Mahurangi and Kaipara Harbours arising from stormwater runoff during operation		✓	Local	Long-term accumulation	Negligible
Effects on Avifauna		✓	Local	Short-term	Less than minor
Construction traffic					
Effects on the local transport network and SH1 arising from temporary construction traffic		✓	Local, regional	Short-term during construction	Minor
Effects arising from temporary traffic management (TTM) including travel time and safety		✓	Local, regional	Short-term during construction	No more than minor
Construction noise and vibration					

Actual or potential environmental effect	Positive effect	Adverse effect	Local, regional or national level effect	Duration of effect	Scale of effect with mitigation
Temporary increased noise levels in proximity to the Project resulting from construction activities		✓	Local	Short-term during construction	More than minor
Temporary increased vibration in proximity to the Project resulting from construction activities		✓	Local	Short-term during construction	Minor
Construction air quality					
Reduced air quality in proximity to the Project resulting from dust emissions arising from temporary construction activities (earthworks, topsoil removal and spread, cut and fill operations, vehicle movements, rock crushing)		✓	Local	Short-term during construction	Minor
Heritage/Archaeology					
Effects on known archaeological and historic heritage sites resulting from Project construction		✓	Local	Long-term	Minor
Effects on unidentified subsurface archaeological remains during earthworks		✓	Local	Long-term	Minor
Contaminated land					
Effects on human health and the environment during construction arising from disturbance of contaminated land		✓	Local	Short-term during construction	Minor
Operational water					
Reduced fresh and marine water quality as a result of stormwater discharges (contaminant and sediment) and erosion/ increased stream flows (sediment)		✓	Local, regional	Short-term arising from storm events throughout the long-term operation of the Project	Minor

Actual or potential environmental effect	Positive effect	Adverse effect	Local, regional or national level effect	Duration of effect	Scale of effect with mitigation
Effects on water users (Watercare surface water take at Wellsford) as a result of reduced water quality following spill events		✓	Local	Short-term following spill events throughout the long-term operation of the Project	Minor
Changes in hydrology and increased flood risk due to increased impervious areas and catchment area, stream diversions, and change in drainage patterns.		✓	Local, regional	Long-term	Minor overall Moderate with respect to natural wetlands
Landscape and visual					
Impacts on landscape character, visual effects, modification of rural character and amenity values resulting from alteration of landforms and vegetation cover through vegetation removal and earthworks activities and introduction in changes to the landscape through the built elements of the Project		✓	Local	Medium to long-term until establishment of screening vegetation	Less than minor
Impacts on Outstanding Natural Features arising from construction works using existing road which traverses through the Project area and may result in minimal vegetation loss		✓	Local	Long-term	Less than minor
Impacts on areas of High Natural Character in the coastal environment arising from sedimentation during construction		✓	Local	Short-term following storm events with potential long-term accumulation	Less than minor
Operational traffic					
Improved safety	✓		Regional	Long-term	Significant Positive
Improved access through reduced journey times for general traffic and freight	✓		Regional	Long-term	Significant Positive

Actual or potential environmental effect	Positive effect	Adverse effect	Local, regional or national level effect	Duration of effect	Scale of effect with mitigation
Improved resilience through travel time reliability	✓		Regional	Long-term	Significant Positive
Increased capacity within the SH1 corridor	✓		Regional	Long-term	Significant Positive
Improved route security by providing an alternative route resilient to incidents	✓		Regional	Long-term	Significant Positive
Operational noise					
Improved noise levels from the reduced traffic volumes in areas around the existing SH1, particularly through Wellsford and Te Hana townships	✓		Local	Long-term	Positive
Operational air quality					
Improved air quality at locations along the existing SH1, particularly through Wellsford where exposure to air contaminants will be reduced from the reduced traffic volumes	✓		Local	Long-term	Positive
Reduced air quality at locations where the new state highway is proposed within areas where existing air quality is to a high standard		✓	Local	Long-term	Less than minor
Social					
Improvement of social well-being for the wider community	✓		Local	Long-term	Positive
General disruption to local communities (residents, commercial business owners) as a result of construction activities, including diversions, change in access, and noise.		✓	Local	Short-term	Minor
Reduced amenity in areas around the new state highway		✓	Local	medium-term	Minor

Actual or potential environmental effect	Positive effect	Adverse effect	Local, regional or national level effect	Duration of effect	Scale of effect with mitigation
Anxiety and worry caused by uncertainty, navigating the RMA process, and loss of existing social and family networks.		✓	Local	Short-term	Moderate
Cultural values					
Effects on potential urupa, Pa settlements and other cultural heritage areas		✓	Local	Long-term	More than minor
Loss of wetlands affecting important mahinga kai sources, effects on wetland functions and fauna habitat		✓	Local	Long-term	More than minor
Adverse effects on the mauri of the Mahurangi River, Hōteo River and Maeneene Stream and associated impacts on ecosystems that sustain taonga species and therefore people		✓	Local	Long-term	More than minor
Loss of vegetation, impacting habitat for taonga species that are threatened (kauri snails, lizards and Hochstetter's frogs) and general impact on fauna behaviour, abundance and diversity within the Project area		✓	Local	Long-term	More than minor
Reduced public awareness of the Te Hana Te Ao Marama Cultural Centre as a result of reduced traffic flows potentially affecting visitor numbers to the Centre		✓	Local	Long-term	More than minor
Economic					
Improved accessibility between Auckland and Northland with associated economic benefits	✓		Regional	Long-term	Significant Positive
Increased economic activity in Auckland and Northland during construction	✓		Regional	Short-term	Significant Positive
Improved economic performance resulting from improvements in journey time, resilience and reliability	✓		Regional	Long-term	Significant Positive

Actual or potential environmental effect	Positive effect	Adverse effect	Local, regional or national level effect	Duration of effect	Scale of effect with mitigation
Land use and property					
Temporary occupation of property for construction purposes including construction site compounds		✓	Local	Short-term	Moderate
Changed access to some properties		✓	Local	Long-term	Moderate
Effects of severance and the remaining viability of commercial farmland and commercial plantation forestry		✓	Local	Long-term	Moderate

9.2. Construction water

Overview

Construction of the Project will involve land disturbing activities including earthworks, streamworks and vegetation removal. These activities, if not appropriately managed, have the potential to increase the risk of sediment-laden runoff being discharged to the receiving environment. The Mahurangi River, Hōteo River and Oruawharo River catchments are the receiving environments for the Project which drain into two coastal waterbodies; the Mahurangi Harbour and the Kaipara Harbour.

Erosion and sediment control measures will be designed and implemented to minimise the effects of sediment runoff reducing water quality on these receiving environments. These measures will be based on best practice erosion and sediment control in Auckland as set out in Auckland Council and Transport Agency guidelines. Preliminary Erosion and Sediment Control drawings have been prepared to demonstrate how erosion and sediment control could be delivered for the Project. These drawings are contained in the *Construction Water Management (ES-Series)* drawings in *Volume 3: Drawing Set*.

There is the potential that during construction the Project could result in changes to hydrology and flooding within receiving watercourses associated with:

- Temporary and permanent culverts and stream diversions;
- Increased flows and a reduction in baseflows due to ground compaction, reduction of forestry and grassland, and increased impervious areas;
- Increased hydrological connectivity through positive drainage resulting in increased peak flows;
- Construction within the floodplain.

With mitigation measures in place, effects associated with the construction of the Project on water quality, water users and hydrological impacts will be negligible to minor and temporary in nature.

9.2.1. Introduction

This section summarises the findings of the assessment of the actual and potential effects associated with water during the construction of the Project outlined in the *Water Assessment Report in Volume 2* of this Application. The *Water Assessment Report* is supported by a number of technical reports and in referencing the *Water Assessment Report* here, refer to the whole suite of reports, in particular those relating to construction water management[64]. Effects associated with water in relation to the operation of the Project (also outlined in the *Water Assessment Report*) are summarised in section 9.12 of this AEE.

The *Water Assessment Report* provides a detailed description of the existing hydrological regime in the Project area and provides an assessment of the environmental effects of construction-related water on the receiving environment

[64] Catchment Sediment Modelling technical report, Water Quality technical report, Construction Water Management Design Report.

including sediment yields that result from earthworks activity. The *Water Assessment Report* describes the methodology used to model sediment to predict sediment yields during the construction of the Project and identifies methods and practices that will be implemented to minimise associated environmental effects. The assessment has been undertaken based on the identification of construction-related water issues and principles, the development of methodologies for key construction activities, an assessment of environmental risks associated with sediment yield and assessment of effects of the eventual sediment loads in the receiving environment.

The potential effects on ecology and habitat resulting from effects of construction-related water in the receiving environment have been assessed in the *Ecology Assessment* and *Marine Ecology and Coastal Avifauna Assessment* in Volume 2 of this Application and are summarised in sections 9.5 and 9.6.

9.2.2. The receiving environment

The hydrology and drainage catchments within the Project area are discussed in section 3.3.4 (Hydrology and drainage catchments) of this AEE. Section 3 also provides an outline of the downstream receiving coastal environment. Key aspects of the existing environment as they relate to construction water management are outlined below.

Catchment characteristics

The Project passes through three catchments, the Mahurangi River, the Hōteo River and the estuarine Oruawharo River. These catchments drain into two coastal waterbodies. The Mahurangi River flows to the Mahurangi Harbour and out to the Hauraki Gulf, whereas the Hōteo and Oruawharo Rivers flow westward to the Kaipara Harbour.

The existing landform, rainfall, geology and land-uses within the Mahurangi, Hōteo and Oruawharo River catchments affect their existing water and sediment quality.

The steepness of these catchments along the Project area varies, with steep catchments in the hills to the east and west of the Dome Valley and lower gradient catchments associated with the Mahurangi River and Hōteo River floodplains.

The soil types influence the generation of sediment when exposed by earthworks. Fine textured sedimentary and alluvial soils predominate in the Project area. The fine (silt and clay) fractions of these soils are susceptible to erosion, particularly in steep terrain.

Pastoral farming and commercial plantation forestry are the main land uses throughout the Mahurangi River catchment and the Hōteo River catchment, while in the Oruawharo the main land use is pastoral farming. There are also areas of indigenous forest, towns and crops within the catchments.

The Mahurangi and Hōteo Rivers are known to experience flood events with high risk flood areas located within the Project area at Kaipara Flats Road and Wayby Valley Road.

Water quality

The AUP(OP) Regional Policy Statement identifies both the Kaipara Harbour and Mahurangi Harbour as degraded from a water quality perspective due to human activities. The *Existing Water Quality* technical report concludes that existing water quality data, and data collected for this Project, indicates that nutrients and *E. Coli* are elevated in various freshwater sites across both catchments. This data indicates that metals are generally below guideline values, however copper is elevated at some freshwater sites in both the Mahurangi and Kaipara catchments. Elevated sediment levels are an issue for both catchments, with elevated turbidity and suspended sediments in freshwater, and elevated sedimentation in the upper reaches of both harbours. The lower Mahurangi Harbour has excellent saline water quality and the Kaipara Harbour has fair water quality in the southern Harbour and good saline water quality at the entrance of the Kaipara Harbour.

Catchment values and uses

Within the catchments the rivers, streams and downstream estuarine environments provide a range of ecological, recreational and resource functions and are suitable for a range of uses. The catchments and coastal environment:

- support aquatic ecosystems;
- provide a food source (Mana Whenua food gathering traditions such as shellfish, fishing and white baiting);
- provide a drinking source for stock;
- provide a source of irrigation;
- provide a drinking source for residents of Wellsford; and
- support recreational uses including swimming, boating, fishing and bankside amenity.

9.2.3. Construction water assessment methodology

The potential changes to the receiving water environment during the construction of the Project relate to changes in water quality arising from the discharge of sediment from earthworks during rain and flood events, discharge of sediment from in-stream activities, and discharge of other contaminants (such as oils, fuels and cement) from general construction activities. Due to the nature of the Project, it is anticipated that sediment generation and yield due to earthworks operations is likely to be the main driver of changes to water quality during construction of the Project.

In addition, construction of the Project may result in changes to catchment hydrology and flooding.

Sediment modelling

Catchment sediment modelling has been carried out to predict sediment load during the construction of the Project, as compared to background sediment.

Two models were used (one for the Mahurangi Harbour and the other for the southern Kaipara Harbour) to predict the construction-phase sediment loads within the Mahurangi, Hōteo and Oruawharo river catchments, and subsequent sediment loads delivered to the coast.

The modelling has been undertaken based on scenarios both with and without erosion and sediment controls in place. These methodologies and practices are summarised in section 9.2.4 below.

For the Mahurangi Harbour sediment generation, predictions were derived based on the BNZ/GLEAMS model built for the P2Wk project. It assumed a maximum active area of 43.4 ha and predicted mean annual sediment loads, daily event loads and loads related to maximum active earthworks areas related to 2 year, 10 year and 50 year ARI storm events. Peak earthworks activity was assumed to occur in years 1-3 of construction.

A model was built specifically for the Hōteo and Oruawharo catchments using the eWater SOURCE software (Welsh et al. 2012) as the Project sediment modelling platform and with the addition of the Daily SedNet component to simulate sediment erosion.

Two different construction scenarios were modelled for the Hōteo and Oruawharo catchments:

- **The changing land-cover scenario** – this scenario modelled the changing land-cover across an approximate 7-year construction period including changes between summer (October -April) and winter earthworks' extents (May - September). The land-cover is based upon the construction phasing contained in the Construction Water Design technical report. It is based on a 6 year bulk earthworks period and provides for an active area in summer which equates to the full open extent programmed in any given year and a winter value that is 20% of the area of the preceding summer area. It also considered sediment generation during a 2 year, 10 year and 50 year ARI storm event. This scenario reported mean annual sediment loads and daily event loads for each construction year.
- **The maximum active area extent scenario** – this scenario is modelled as the maximum active area of earthworks across the entire construction footprint. This scenario has a fixed land-cover and corresponds to the years 1-2 construction extent for the Hōteo catchment of 75 ha, and a maximum extent for the Oruawharo catchment of 25 ha. This scenario modelled sediment generation during a 2 year, 10 year and 50 year ARI storm event and assumed that these would occur during peak earthworks activity. This scenario reported storm event related sediment loads for each peak active area.

These construction sediment models include the use of erosion and sediment controls (ESC) based on an indicative ESC design for the Project. In summary, the modelling incorporates a number of activities that have the potential to generate sediment including:

- Earthworks, including bulk earthworks, tracking and trenching where rainfall encounters exposed earth;
- Works in and around streams and wetlands (e.g. culverts, retaining walls, piles and bridges) that disturb and entrain sediment; and
- Soil disposal.

Project area by catchment

The construction of the Project is estimated to require approximately 310 ha of earthworks. Table 9-3 of the AEE provides an outline of the extent of the Project within each of the catchments. These comparisons illustrate that the Project area within each catchment is a relatively small percentage of the catchment area. The magnitude of the potential effects of the Project is therefore limited by this consideration.

Table 9-3: Areas (approximate) affected by the Project within affected catchments

Catchment and sub-catchments	Total catchment area (ha)	Proposed designation footprint		Indicative Alignment impervious footprint[1]		Indicative earthworks footprint[2]	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
Mahurangi River catchment	5,670	225	25%	25	<1%	43.3	<1%
Mahurangi (right branch)	2,880	20	<1%	0.5	<1%	1.3	<1%
Mahurangi (left branch)	1,445	175	12%	20	1%	41	3%
Hōteo River catchment	39,815	905	2%	150	<1%	203	<1%
Kourawhero Stream	4,010	160	4%	20	<1%	23.7	<1%
Waiteraire Stream	1,415	395	28%	60	4 %	88.2	6%
Unnamed tributaries (H1 & H2)	735	150	20%	30	4%	91.5	5%
Unnamed tributary (H3)	455	75	16%	15	4%		
Unnamed tributary (W1)	500	40	8%	5	1%		
Oruawharo River	26,660	285	1%	45	<1%	63	<1%
Te Hana Creek	1,740	175	10%	20	1%	33	2%
Maeneene Creek	1,510	110	7%	25	2%	30	2%

1 – Indicative Alignment impervious footprint from Indicative Alignment (includes the road, interchanges, side roads and cut faces)

2 – Indicative earthworks footprint derived from conceptual areas of cut, fill and soil disposal sites to construct the Indicative Alignment.

9.2.4. Construction water management

The *Water Assessment Report* is based on the construction methodology developed for the Project (refer to section 5 of this AEE). This construction methodology indicates that construction activities will be carried out in stages and works within those stages will be sequenced to manage erosion and sedimentation.

The specific cut and fill locations and associated catchment boundaries, and soil disposal site locations will be finalised at detailed design.

Project approach to the management of construction water

Best practice ESC measures will be implemented during the construction phase of the Project to manage the sediment yield from the Project and avoid or mitigate effects on the freshwater and coastal receiving environments. All construction-related sediment runoff discharges are to a freshwater system after treatment.

The ESC for the Project will be designed and implemented with a hierarchy and priority order designed to minimise the extent of soil erosion and capture and retain, to the fullest practical extent, any resultant sediment yield generated from the upstream construction zone as follows:

- **Prevention:** Excluding clean water runoff from entering the active work areas, therefore preventing clean water runoff from combining with excavated spoil and/or construction material and will require the use of clean water diversion channels and/or bunds to divert runoff from the upstream side of the work area. This also includes avoidance of areas not necessary to earthworks and progressive stabilisation.
- **Capture:** Any sediment laden runoff generated within the working area will be captured using dirty water diversion channels and/or bunds on the downstream side of the construction site which will direct sediment-laden runoff from the site to an appropriate sediment control device. Sediment capture will be implemented through one or more sediment control measures.
- **Minimisation:** Minimising the length of time and the extent of the area of exposed/disturbed soil to reduce the potential for erosion generation. Timely stabilisation of exposed areas and the construction of impermeable areas will also reduce the potential for erosion to occur.
- **Staging and sequencing of Works:** Construction activity will be carried out in stages and works within those stages will be sequenced to manage erosion and sedimentation. Working areas will be progressively stabilised as the works progress.

Preliminary erosion and sediment control drawings have been developed to demonstrate the ability to install appropriate ESC devices for the Project. These drawings are contained in the *Construction Water Management* (*ES-Series)* drawings within the Drawing Set in *Volume 3*.

The key elements of construction related environmental risk for this Project are related primarily to works within, adjacent to, or connected to, freshwater and coastal environments and areas of steeper contour. High erosion risk areas include:

- Works within a sediment control protection area[65]; and
- Works in areas exceeding a slope of 10 degrees.

Potential effects of discharges from earthworks in these higher risk erosion areas will be managed through the implementation of appropriate ESC measures over and above those typically implemented. This may include the implementation of limits on the extents of open areas of earthworks, providing super silt fences down slope of sediment retention devices to provide a last line of defence, regular and

[65] Defined in the AUP(OP) as:
- 100m either side of a foredune or 100m landward of the coastal marine area (whatever is the more landward of mean high water springs); or
- 50m landward of the edge of a watercourse, or wetland of 1,000m² or more.

progressive stabilisation, increased frequency of inspection and maintenance of ESC measures and increased levels of monitoring.

A continuous improvement monitoring programme (explained in section 5.4 of the *Water Assessment Report*) will be implemented to provide both qualitative and quantitative monitoring outcomes to help inform the extent of construction activity on site and to influence and reduce the direct effect of construction works on the sediment yield into the receiving environment.

Non-sediment contaminants (i.e. cement, flocculants, fuel, oil) may directly or indirectly discharge into the receiving environment from site activities. Management of these non-sediment contaminants will be subject to specific best management practice and industry guidelines.

ESC principles

The key principles that have been applied to the Project relating to erosion and sediment control are set out in Table 9-4 below.

Table 9-4: Key ESC principles

Approach / Principle	Criteria
Erosion and Sediment Control Plan (ESCP)	The ESCP is the overarching erosion and sediment control plan that outlines and confirms the overall approach to construction water management. The ESCP includes the following elements: • ESCP design • Education and training of all site staff; • Implementation of a continuous improvement monitoring programme, which will form part of an overall Construction Environmental Management Plan (CEMP); • Process for the development of CESCPs; • Quality Assurance / Management System; • Proactive and reactive ESC maintenance Based on the indicative construction methodology and sequencing, and more detailed on site assessment of key activities (including looking at specific higher risk locations such as the Hōteo River bridge works), the methodologies identified and documented can be effectively implemented.
Construction Stage Erosion and Sediment Control Plans (CESCPs)	CESCPs are detailed erosion and sediment control plans which will be submitted to Council for certification for specific work areas and/or activities within the site. CESCPs will provide the detailed design, specific ESC measure location, staging and sequencing of works for that location and will be developed prior to works commencing in these locations. The CESCPs will determine specific measures to be employed and will also consider any alternatives that exist. The CESCPs will determine the most effective and appropriate form of construction water management devices and management practices required to manage discharges during the construction period in response to the environmental values for that location. As part of the Project implementation, the CESCPs will follow the principles and approach outlined within the *Water Assessment* and will also confirm specific design details.

Approach / Principle	Criteria
	The implementation of site specific CESCPs will further allow for innovation, flexibility and practicality of approach to construction related water management. They will enable the construction team to have ongoing input into the ESC measures and practices prior to and during construction. This CESCP process allows the construction water management measures utilised within the Project to continually adapt to changing construction, environmental and climatic conditions. CESCPs will include: • Contour information; • ESC measures for the works being undertaken within a particular construction area; • Chemical treatment design and details; • Catchment boundaries; • Location of the work; • Details of construction methods; • Design criteria, typical and site specific details of ESC measures including ensuring that all sediment retention ponds and decanting earth bunds have full access track provisions for maintenance at all times; • Identification of risk and sensitive area locations and the details of management (including contingency measures) around these aspects; • Details of open areas that exist for the project at the time of the CESCP and a programme for managing ongoing non-stabilised areas; • The identification of staff and resources who will manage and maintain ESCs; • The identification of staff who will monitor compliance with conditions; • Details of specific resources and responsibilities for managing environmental issues on site to ensure that any resultant conditions of consent are complied with; • Methods and procedures for decommissioning measures; and • Design details for managing the treatment, disposal and/or discharge of contaminants (e.g concrete wash water). In addition, each CESCP must clearly illustrate on a plan the specific location and boundaries of the CESCP (in the context of the wider Project) and what activities are addressed within them.
Construction staging and sequencing	Staging and sequencing are both important non-structural measures and will be implemented as necessary to achieve the progressive stabilisation on an ongoing basis. Detail of the staging and sequencing of works will be detailed within the CESCPs. The staging may include reduced area of working in winter. For the assessment it has been assumed in the winter the active area will be 20% of the area at the peak of the previous summer season, which reflects the wet nature of the period and the inability to achieve any necessary earthwork compaction standards. The 20% is assessed as a percentage of area that may be able to be successfully earthworked with progressive stabilisation in place. Dependent upon the ability to successfully implement earthwork activities over this winter period this 20% may well increase based on monitoring outcomes from the continuous improvement monitoring programme.
Device location and discharges	All ESC devices should be located outside the 20 year ARI flood level unless no other viable alternative exists. All construction related runoff discharges are either to a land environment or direct to freshwater systems with particular emphasis on avoidance of the

Approach / Principle	Criteria
	sensitive locations identified where practicable. Discharges to land are considered to be beneficial in that a land-based buffer zone will provide a 'polishing' effect of the discharged runoff. Where discharges are direct to freshwater systems, to minimise erosion of the stream bank and bed at that point, the outlet will be protected with geotextile and riprap material in the immediate vicinity of the outlet.
Non-Structural Measures	These elements include: • Proactive monitoring and reporting programme (as per Section 9 the *Water Assessment Report*); • Risk identification and management; • Progressive stabilisation as works progress; • Open area limit within the Hōteo catchment of 75 ha; • Staging and sequencing of specific work/activity programmes; and • Weather response.
Progressive stabilisation for erosion and dust management purposes	Progressive and rapid stabilisation of disturbed areas utilising top soil (where necessary) and seed, mulch and geotextiles will be ongoing throughout the Project. Stabilisation will be undertaken with three key purposes: • To achieve an effective erosion and sediment control programme inclusive of progressive stabilisation; • To reduce the exposed earthwork areas within higher risk locations to assist with a reduction in sediment generation; and • In response to the continuous improvement monitoring programme to address any potential effects or undesirable monitoring trends.
Streamworks	Works within or adjacent to freshwater streams are generally considered higher risk than other earthwork activities due to the close vicinity of the sensitive receiving environment and the associated increased potential for sediment yield. Within the Project, streamworks will be undertaken in a manner that recognises and responds to this risk. Where practical, streamwork activities and any associated works within these environments will be undertaken in an offline dry environment. This strategy will be based upon the temporary diversion of flows around the area of works or working immediately next to the stream with no formal stream diversion required. All streamworks will also be undertaken with consideration of fish spawning and migration periods.

ESC design criteria

Both Auckland Council and the Transport Agency have published guidelines and standards relating to the design, construction and management of ESC measures for land disturbing activities, which are applicable to the Project as identified below:

- Auckland Regional Council Technical Publication No. 90 – Erosion & Sediment control Guidelines for Land Disturbing Activities in the Auckland Region (TP90).
- Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region; June 2016; Guideline Document 2016/005 (GD05); Auckland Council.

- Erosion and Sediment Control Guidelines for State Highway Infrastructure; September 2014 (Transport Agency ESC Guidelines).
- Forestry Operations in the Auckland Region a Guideline for Erosion and Sediment Control; September 2007; Technical Publication 223 (TP223); Auckland Regional Council.

Construction water management for this Project will be implemented in accordance with all of these guidelines which provide information on the appropriate use, design and construction of ESC practices for the Auckland region. Where the guideline documents present a range of design criteria, the more onerous design criteria that are most protective of the environment for the design of the ESC measures have been adopted. Table 9-5 below summarises the key ESC design criteria that have been developed for the Project.

Table 9-5: Summary of key ESC design criteria

Device/methodology	Criteria
Erosion control measures	
Clean Water Diversions (CWD)	Clean water diversion channels and bunds will be designed to cater for the 1% annual exceedance probability (AEP) rainfall event.
Contour drains	Contour drains will be designed and implemented in accordance with GD05.
Dirty Water Diversions (DWD)	Dirty water runoff diversion channels will be sized to cater for the 1% AEP rainfall events. Sediment sumps with a minimum volume of 2 m^3 to be installed in all DWDs at a maximum distance of 50m between sumps.
Pipe drop structures/flumes	Flumes will be used to safely transfer runoff from the top of batters to the bottom of the batter slopes.
Rock check dams	Rock check dams will be designed and implemented in accordance with TP90.
Stabilised entrance ways	Stabilised entrance ways will be established at all entry and exit points of the site.
Sediment control measures	
Container impoundment systems	Container Impoundment Systems will be implemented as per Drawing ES-076. They will be based on a 3% volume criterion applied in relationship to catchment size and as such will apply to smaller catchment areas than DEBs and SRPs. Their primary purpose is for the initial earthworks in steep or constrained or constricted working areas prior to the formation of a SRP or DEB structures.
Decanting earth bunds (DEBs) and decant systems	All DEBs established will be based on a volume of 3% of the contributing catchment area and sized accordingly, subject to a to a maximum DEB catchment area of 3,000m^2 unless varied within the CESCPs. All DEBs will be fitted with floating decants. Decants will have a manual control mechanism (to prevent) outflow from the DEB during pumping activities to these structures.

Device/methodology	Criteria
Flocculation	Flocculation will be applied to SRPs and DEBs based on an approved Chemical Treatment Management Plan (CTP). Flocculation will be applied to DEBs with a catchment area above 500m^2, and all SRPs. For all contributing catchments over 2ha in area, two flocculation sheds will be installed per device for the purpose of increasing the volume of flocculant available and also for reducing the risk of failure if one of the flocculation systems fails or has reduced performance. Manual batch dosing will be applied as required. Flocculant socks will be utilised as alternative and/or additional measures as required.
Sediment retention ponds (SRPs)	All SRPs will be implemented based a 3% volume criterion applied in relationship to catchment size (i.e. 300 m^3 SRP volume per 10,000 m^2 of contributing catchment). All SRPs will be subject to a maximum catchment area of 50,000 m^2 unless varied within the CESCPs Baffles, decant pulleys and reverse slopes will be installed in all SRPs.
Super silt fences and silt fences (SSF)	All super silt fences and silt fences will be based upon the design criteria within TP90. SSF fabric will be installed with at least 200mm of fabric upslope at the base of the trench. In areas where sediment control devices are within 50 m of a watercourse, SSF will be utilised as a last line of defence such that if a failure of the primary control measure eventuates then the last line of defence will capture and treat such a discharge.

Construction activity management

The overall approach to ESC for the Project includes a number of construction activity specific ESC methodologies which have been developed to identify the ESC and pollution control measures and practices required to manage construction-related stormwater runoff. These methodologies are summarised in section 5.3 of the *Construction Water Design Technical Report* and will be further developed and detailed within the CESCPs to be produced prior to construction works commencing.

The activity-specific methodologies relate to the following construction activities:

- Stockpile establishment and management;
- Soil disposal site establishment and management;
- Temporary or permanent stream diversions;
- Culvert construction;
- Bridges;
- Concrete work;
- Pumping from excavations and shear keys;
- Chemical treatment of SRPs and DEBs (flocculation);
- Riprap placement;
- Stormwater wetland establishment;
- Access track and haul road establishment;
- Construction compounds and staging areas;

- Overall earthworks;
- Works within the flood plain; and
- Tunnel establishment.

9.2.5. Assessment of effects associated with water during construction

Effects on water quality

Conspicuous oil or grease films, scums or foams, or floatable or suspended materials

Oil and grease may be released in very small amounts due to accidental spills. Any conspicuous oil and grease films that develop would be temporary. The release of small quantities of floatable materials (in particular litter) may occur during construction and therefore will be temporary. These risks can be managed through construction management planning. With good management in place, and identified and confirmed within the CEMP and CESCPs, the effects on water quality are considered to be minor.

The receiving environment is not likely to develop nuisance films and scums as a result of construction water discharges.

Colour and clarity

The predicted increase in sediment yield during rain events is likely to result in a change in water colour and clarity of receiving waterways. Existing data and water quality sampling undertaken for the Project indicate that clarity is currently low in the Mahurangi River, the Hōteo River and its tributaries, Maeneene and Te Hana Creek. The sediment yield from the construction areas will consist of fine clays and silts. Conspicuous changes in colour and clarity in the rivers will be temporary and are expected to occur during and after storm events.

The catchment sediment model found that generally changes to sedimentation are more acute within smaller tributaries and smaller in the Mahurangi, Hōteo and Oruawharo Rivers. The largest predicted changes to sediment load were observed in the Waiteraire Stream, the Kourawhero Stream headwaters and the unnamed tributaries of the Hōteo River. The *Water Assessment Report* outlines an increase greater than 25% in TSS as a threshold for an unacceptable change in clarity in the Mahurangi Estuary and Kaipara Harbour.

In all events, the post-treatment increases in TSS concentrations are assessed to be less than the 25% threshold in the Mahurangi Estuary and Kaipara Harbour. In terms of an increase in sediment concentrations there is some relationship that can be established with the sediment loads as modelled. Effectively an increase in sediment loads will typically also result in an increase in sediment concentrations. On this basis the largest percentage increase in sediment loads is within the Kourawhero, Waiteraire and Tributary H2, and particularly for a 50 year ARI rain event. The specific nature of this sediment concentration is however not established. But based on previous water quality sampling results sediment concentrations of up to 2000 g/m^3 can occur at some periods during heavy rain events. Importantly, based on experience from other earthwork projects the sediment concentrations typically increases with flow rates and they often are for short periods of time and very quickly

decrease back to lower levels. This can occur within less than 24 hours of the rain event.

Overall, it is considered the effects on colour and clarity will be minor due to their localised extent and temporary duration.

Odour

Algal blooms and eutrophic conditions can cause objectionable odours. The predicted increases in particular nutrients are not expected to cause the conditions that would result in noticeable a change in odour in the streams or marine environment. It is considered the effects on odour will be negligible.

Summary

Overall, the effects on water quality will be minor and the effects will be temporary and can be mitigated.

Effects on water users

Drinking water

Watercare currently takes raw water for Wellsford's potable water supply from a surface water take from the Hōteo River upstream of Wilson Road. The raw water taken from the Hōteo River is treated to meet drinking water standards.

The Project construction at times is expected to increase the level of sediment within the Hōteo River, which can impact on the treatment of raw water. An increase in sediment will result in increased turbidity which has aesthetic effects. The *Water Assessment Report* predicts an increase in sediment load of less than 1% (mean annual sediment load increase) at both the Watercare water abstraction sites on the Hōteo River and Mahurangi River, noting that Watercare has recently switched to a groundwater take for Warkworth's water supply. Watercare still holds a consent for surface water abstraction to maintain flexibility. The turbidity of surface water within the Hōteo River at the water take abstraction sites regularly exceed the New Zealand Drinking Water Standard (NZDWS 2008) values, but the water is treated by Watercare to meet the relevant NZDWS values (less than 2.5 Nephelometric Turbidity Units).

There may be instances where the TSSs in the Hōteo River could potentially impact on the treatment plant operations. However, the assessment indicates that construction water discharges from the Project would have only a small influence on whether increases in suspended sediment might occur. The background sediment load would be the main driver for determining when the raw water quality is approaching the limits of the plant's treatment capabilities.

The release of sediment will also result in the release of particulate nitrogen. Nitrate and Nitrite are nutrient compounds with human health significance. The increase in nutrients as a consequence of increased sediment during the construction period is not expected to alter the quality of the source compared to NZ drinking water standard (NZDWS 2008) values for nitrite and nitrate, neither of which are elevated at the source in the monitoring data.

There is the potential for an accidental spill of contaminants to enter the Hōteo River during construction. If an accidental spill occurred, it is likely that a large proportion

of contaminants would be intercepted by the sediment retention devices, but some residual contaminants could be discharged into these rivers.

In the context of the construction water management techniques to be utilised within the Project; including, the open area limit, the continuous monitoring programme and the innovative practices proposed e.g sediment sumps in all diversion channels and rainfall activated flocculation devices, the effects of the Project on surface water drinking sources in the Hōteo River will be minor. The assessment recommends that Watercare be informed if a spill occurs or in the event of a larger rainfall event where large sediment loads are discharged from the site in the Hōteo catchment, so Watercare is able to determine what action, if any, is required.

Recreation

The existing water quality of river sites monitored in the *Water Assessment Report* exceed visual clarity indicators for swimming, meaning water quality is good for swimming.

The Mahurangi Estuary, Kaipara Harbour and Oruawharo River are popular for secondary contact (boating), and for swimming in some locations. The mid to upper parts of the Mahurangi Estuary have poor clarity, generally less than 1.6 m and do not meet the Australia and New Zealand Environment Conservation Council (ANZECC) contact recreation water quality guidelines for clarity. The clarity of the lower Mahurangi Estuary is good and meets standards for contact recreation, with clarity generally greater than 1.6 m. The suspended sediment concentration at the Kaipara Harbour mouth is below guideline values indicating that the elevated sediments from the Hōteo and Oruawharo River mouths settle out prior to reaching the Kaipara Harbour.

The increases in sediment load arising from the Project may result in changes in clarity that are noticeable, but it is not predicted that temporary changes in clarity will alter the suitability of the freshwater or marine receiving environments for contact recreation.

Overall, it is considered that the change in water quality associated with the construction runoff will have a negligible impact on the health of people and communities having contact with fresh water and/or marine water.

Other users

The predicted increase in sediment and sediment bound nutrients is expected to have a negligible effect on the drinking water quality for stock.

Apart from the Watercare surface water abstraction on the Hōteo River, there are no consented surface water abstractions on watercourses within the Mahurangi, Hōteo or Oruawharo catchments that are affected by the Project.

There may be an effect on permitted abstractions, if they are located close to discharge points assuming there is no filtration of the water take. However, the effect will be temporary, with TSS concentrations expected to return to background levels relatively quickly following rain events. The potential effect on existing and foreseeable water users is likely to be minor with potential moderate effects depending on the proximity of users to the Project discharges, and it is recommended

that effects on existing users, if they are impacted by construction sediment are managed (for example providing or replacing filters).

Effects on hydrology and flooding

There is the potential that construction works could result in changes to hydrology within receiving watercourses, including changes to catchment runoff, changes to catchment boundaries, changes to stream flow, and changes to stream channel and stream bed morphology.

Temporary and permanent culverts and stream diversions may result in increased flows within some streams and decreased flows within others. This is assessed in detail in the operational water assessment (section 9.12). The effects are likely to be similar during construction with relatively large changes for flows experienced in small tributaries and negligible changes within major streams. All temporary and permanent culverts and diversions will be designed to accommodate the 1 in 20-year rain fall event, and therefore there will be no change in flooding for events up to this size.

There is less than a 30% chance of an event larger than the 1 in 20-year flood occurring across the 7-year construction period. In the event of a larger flood occurring, there might be some localised flooding associated with culverts and stream diversions. No changes to flooding depth, extent or hazard are anticipated outside of the proposed designation boundary, as diversions will be designed in accordance with GD05. As such the effect is assessed to be negligible.

Increased flows and a reduction in baseflows may result due to ground compaction, reduction of forestry and grassland and increased impervious areas. In addition, peak flows could also increase due to increased hydrological connectivity through positive drainage. These effects will be reduced through the implementation of the SRPs and DEBs which will provide some retention of flood water, although the primary function is a reduction in suspended sediment. Any residual changes to hydrology are unlikely to be large, given that the Project will only account for a small percentage of the total stream and river catchments in the area. In addition, any changes would be short term and occur prior to the installation of the permanent drainage.

There is the potential for construction within the floodplain to result in changes to flooding outside of the proposed designation boundary, however these would be equal to or less than the changes associated with the operational phase and these effects are addressed in section 9.12.

9.2.6. Measures to avoid, remedy or mitigate actual or potential adverse effects

The *Water Assessment Report* outlines recommendations to avoid, remedy and mitigate effects during construction of the Project, which are discussed below. The ESC approach and key devices and methodologies and design criteria are outlined in Table 9-4 and Table 9-5. In addition to those measures already identified, notice will be given to Watercare in the event of a sediment spill above the Watercare water take for Wellsford's reticulated supply. Warkworth's water supply is currently abstracted from groundwater.

Continuous improvement monitoring programme

A continuous improvement monitoring programme will be implemented which will allow for ongoing water quality and ecological assessment of the construction programme. The continuous improvement monitoring programme will:

- Provide information for making effective decisions on necessary continuous improvement of erosion and sediment control measures (both structural and non-structural);
- Assist in understanding the outcome of on-site decisions to water quality and stream ecology, and support any determination of potential ecological effects from sediment discharged by the Project earthworks; and
- Quantify potential sediment discharges from the Project and enable appropriate site management responses and mitigation to be identified to reflect sediment yields.

The continuous improvement monitoring programme will include the following key components:

- Receiving environment visual assessments;
- Weather forecasting;
- On site monitoring of devices;
- Flocculation monitoring; and
- Quantitative water quality and flow monitoring.

The results of the monitoring programme will be used to identify where improvement to site devices is needed and identify future risks based on pre-determined trigger levels. The improvement monitoring programme will also inform the overall effectiveness of the conditions and may be used as the prompt to review conditions in a positive light as appropriate, either at the initiative of Auckland Council or the Transport Agency.

Flooding

The potential of flood risk during construction has been considered. In the first instance, works within floodplain areas have been avoided where possible. Where works are required within floodplain areas, in particular those associated with culvert placement, the risk profile is increased, and works methodologies will be adapted for these areas. Construction works within overland flow paths will be avoided where practicable to ensure the function of the overland flow path is retained. Particular methods will be adopted to ensure that works are undertaken during predicted fine weather windows and that stabilised flow paths are available if weather conditions deteriorate.

Streamworks

Where works are required to streams, prior to any streamworks commencing on the site, development of a final methodology for the streamworks (through a CESCP) will occur. Particular emphasis will be placed on timing, staging and sequencing of streamworks, to outline how effects on streams will be managed.

9.2.7. Conclusion

Construction activities, if not appropriately managed, have the potential to increase the risk of sediment-laden runoff and other contaminants being discharged to the receiving environment.

The *Water Assessment Report* has assessed the effects associated with construction and made the following recommendations:

- All works to achieveidentified construction water management objectives;
- ESC devices to be designed on a best practice approach and include details from GD05, TP90 and Transport Agency ESC Guidelines. In addition, some specific design criteria have been identified that will be adopted;
- Preparation of CEMP, ESCP, CTP and CESCPs for all land disturbance activities is required;
- A 14 day stabilisation requirement will apply on all open areas for earthworks;
- An open area earthworks limit of 75ha for Hōteo catchment with the ability to adapt as necessary and dependent upon monitoring outcomes;
- Specific consideration within the CSCPs of ESC methodologies for identified high risk locations;
- Specific consideration of methodologies for stream works activities through a CESCP;
- Incident notification (including in relation to incidents upstream of Watercare's Wellsford water take);
- Within the CEMP ongoing training to ensure environmental awareness is in place; and
- Implementation of a continuous improvement monitoring programme.

It is considered that if the measures outlined above are implemented, sediment yields resulting from the earthworks and construction activities can be managed, resulting in the works having negligible to minor adverse effects.

9.3. Groundwater/ Hydrogeology

Overview

Effects on the groundwater regime can arise from deep excavations and tunnel construction below the groundwater table and can impact groundwater levels, surface water resources and groundwater quality and quantity.

Drawdown from the proposed tunnels is confined to a narrow 500 m corridor parallel to the tunnels, with the majority of drawdown occurring within 250 m. This constrained drawdown in the vicinity of the tunnels is typical of construction dewatering effects within low permeability materials and there will be negligible impacts on existing groundwater users and groundwater dependent ecosystems outside of this drawdown area. Nine bores are located within the proposed designation boundary. None of these are located within the calculated drawdown areas.

Drawdown from the proposed cuts is confined to a narrow 230 m corridor parallel to the Indicative Alignment. However, groundwater drawdown of any significance (i.e. 5 m or greater) is constrained to the immediate vicinity of the cut along the Indicative Alignment. The relatively small lateral extent of drawdown arising from the indicative cuts is typical of construction dewatering effects within low permeability materials, with negligible impacts on existing groundwater users and groundwater dependent ecosystems expected outside of this area.

There is only one bore located within the calculated drawdown profile of the proposed cuts and this is located directly underneath the Indicative Alignment in an area of fill which will mean the bore will no longer be able to be utilised.

No effects have been identified on stream baseflow as a result of the cuts as no streams were identified in the vicinity of the drawdown profiles of the proposed cuts. However, if the alignment changes through detailed design and cuts extend to below the groundwater table and are located within 200 m of a stream, the change in baseflow should be modelled to determine any change to effects as assessed. Groundwater baseflow reduction in gullies within the calculated drawdown profile for the tunnels is likely to be small and unlikely to be detectable over and above the influence of surface water (stormwater) runoff.

No potential changes in groundwater level or flow which may affect surface water features such as streams/rivers, springs/seeps, ponds, wetlands, and drains have been identified.

Overall, the Project is expected to have less than minor effects arising from groundwater changes associated with the Project, including reduction in baseflows for watercourses fed by groundwater.

9.3.1. Introduction

This section summarises the findings of the assessment of the actual and potential effects of the Project on groundwater levels and flow outlined in the *Hydrogeology Assessment* contained in *Volume 2* of this Application.

The *Hydrogeology Assessment* provides a detailed description of the existing groundwater environment in the Project area, the methodology used to model and determine groundwater impacts and an assessment of the potential effects of the construction and operation of the Project on the existing groundwater regime.

9.3.2. Existing groundwater environment and assessment methodology

The influence of the underlying geological units on hydrogeological regimes found within the Project area are discussed in section 3.3.3 (Hydrogeology) of this AEE.

Aquifer recharge

The hydrogeological regime of the Project area comprises very low permeability rocks with no appreciable aquifers within the depth range of the Project excavations.

Two dimensional (2D) groundwater modelling and analytical assessment was undertaken to assess potential groundwater impacts anticipated to result from cuts/excavations along the Indicative Alignment and the proposed tunnels. Aquifer recharge, which is the flow or infiltration of water into the saturated zone of the subsurface profile, was calculated for the 2D groundwater and the deep groundwater recharge rate for hard rock in the area was assessed as 50 mm/year, or approximately 3.3% of annual rainfall.

Existing groundwater boreholes, use and abstraction

Regional borehole database records from Auckland Council showed a total of 119 boreholes drilled within 2 km of the centreline of the Indicative Alignment. Most of these 119 bores have been drilled in the vicinity of Warkworth. This area has been identified as the Mahurangi Waitemata High-Use Aquifer Management Area within the AUP(OP).

Groundwater levels

An understanding of groundwater levels, including depth to groundwater, seasonal fluctuations and vertical groundwater gradients is important to inform the assessment of effects on groundwater from the Project. Information relating to groundwater levels was obtained from various sources, including the Auckland Council database, previous investigations in the region of the Indicative Alignment and site specific information collected as part of the Project investigations.

Piezometer installation enabled groundwater level recording and monitoring. Multiple groundwater level measurements collected over time are important to provide an understanding of groundwater level recovery following drilling. Hydraulic testing was also undertaken in some boreholes to estimate aquifer hydraulic conductivity (the ability of an aquifer to transmit water). Twenty-two piezometers were installed during the site-specific investigation for this the Project and recorded the depth to groundwater within each formation as follows:

- Alluvium: between 0.05 and 0.5 metres below ground level (mbgl);
- Pakiri formation: between 1.6 and 125.9 mbgl; and
- Northland Allochthon: between -0.1 and 17.8 mbgl.

Although limited depth to groundwater information was obtained across the Project area, meaning a piezometric surface could not be generated, the *Hydrogeology*

Assessment has assumed that given the similar geological units and topography of the Indicative Alignment to P2Wk, the groundwater flow directions will broadly be consistent with those identified in the P2Wk Hydrogeological Assessment, as follows:

- Groundwater flow will follow surface drainage pathways and will change direction as the topographical control changes; and
- Groundwater levels will generally follow the topography.

9.3.3. Assessment of hydrogeology effects

The impact of the Project on groundwater will largely arise from deep excavations and tunnel construction below the groundwater table, which can impact on the natural groundwater regime in the following ways:

- Drawdown: groundwater drawdown reducing existing groundwater levels;
- Surface water resources: reduction in groundwater levels that may affect stream baseflow regimes, and alter present inflows and outflows from springs, streams, rivers, ponds and wetlands; and
- Groundwater quantity: reduction in groundwater quantity (yield) for existing abstraction bores through the alteration of groundwater flow patterns.

Potential groundwater drawdown

Drawdown is the reduction in groundwater level resulting from any form of development or activity, for example, pumping from a borehole or drainage through an excavation. The magnitude and maximum extent of drawdown are important considerations as these define the potential severity and zone of impact from the activity.

Groundwater drawdown during construction has been calculated for the proposed tunnel section of the Indicative Alignment and is relatively localised to the area surrounding the tunnels, with estimated drawdown of 0.5 m approximately 500 m from the alignment of the tunnels. Groundwater drawdown of any significance (assessed as being 5 m or greater) is constrained to within 250 m of the tunnel.

This constrained drawdown in the vicinity of the tunnels is typical of construction dewatering effects within low permeability materials. This would also apply if the alignment of the proposed tunnels changes within the designation boundary, as the geology is consistent with that used in the modelling.

A review of the major cuts (cuts in excess of 20 m height in Pakiri Formation and in excess of 10 m height in Northland Allochthon) along the Indicative Alignment was undertaken to determine which cuts were required to be assessed for potential groundwater drawdown. Of the 21 major cuts along the Indicative Alignment seven were assessed and the effects were determined to be very localised to the areas of the cuts. The maximum extent of drawdown is confined to a narrow 230 m corridor parallel to the Indicative Alignment. However, groundwater drawdown of any significance (i.e. 5 m or greater) is constrained to the immediate vicinity of the cut along the Indicative Alignment.

The relatively small lateral extent of drawdown arising from the indicative cuts is typical of construction dewatering effects within low permeability materials. This would also apply if the proposed cuts move within the proposed designation

boundary, as all of the geology in this area is consistent with that used in the modelling.

The effects associated with groundwater drawdown on existing groundwater users and stream baseflow are outlined below. Groundwater drawdown also has the potential to induce ground settlement in soft compressible sediments, such as alluvium and highly weathered rock or clay. The potential for settlement as a result of the groundwater drawdown is discussed in section 9.4.

Potential impact on neighbouring groundwater users

The 119 boreholes located within the 2 km radius of the Indicative Alignment were reviewed to determine if the modelled groundwater drawdown profile would impact any user of a registered groundwater abstraction. Most bores in the area are greater than 150 m in depth and provide only very small yields (< 1 L/s).

There are no bores located within the proposed designation within the calculated drawdown profiles for either the indicative cuts or tunnels, meaning there will be negligible impacts on existing groundwater users. One bore will be physically removed to allow for construction of the Project.

Potential stream baseflow reduction

The reduction in groundwater contributions to local streams (i.e. stream baseflow reduction) as a result of the Project was assessed and a review undertaken of potential streams within the calculated drawdown profiles for both the indicative tunnels and cuts.

No specific streams have been identified within the vicinity of the drawdown profiles of the cuts, so no effects were identified on stream baseflow as a result of the excavations for the Indicative Alignment. The level of effect on a stream baseflow is dependent on the depth and extent of the excavation, distance to a stream and the characteristics of the stream. If through detailed design, changes to the alignment are undertaken and require excavation that extends below the groundwater table and are located within 200 m of a stream, the change in stream baseflow should be modelled to determine potential effects.

Several gullies which enable surface water flow are located within the calculated drawdown profile for the tunnels, and although not specifically identified as streams, an assessment of potential effects on one of these gullies located within 200 m of the indicative tunnel alignment was undertaken. The assessment concluded that if baseflow reduction does occur within this gully, it is likely to be small (0.15 L/s maximum) and more likely to be a wet area (i.e. wet season groundwater seeps) rather than a permanent stream. It is expected that this level of reduction is unlikely to be detectable over and above the influence of surface water (stormwater) runoff.

Overall, the potential reduction in baseflow as a result of the Project, from a flow volume perspective, will be less than minor.

Groundwater and surface water interaction

Localised interaction between groundwater and surface water has been identified, as potential changes in groundwater level or flow may affect surface water features such as streams/rivers, springs/seeps, ponds, wetlands, and drains.

In areas underlain by the Pakiri Formation and the Northern Allochthon, where the topography is moderately steep to steep and with deeply incised valleys, flow rates are very low, and groundwater typically emerges at the base of slopes in the form of seeps, and along geological boundaries (sometimes partway up slopes) in the form of springs.

Some of these springs and seeps feed small streams, while in areas where alluvium has infilled the valleys, groundwater is responsible for the baseflow in the larger streams and rivers. Wetlands 17A – 24 (at 89D Phillips Road), as identified in the *Ecology Assessment Report* are predominately surface water fed by the numerous streams flowing off the slopes to the north. However, many of these streams will be fed from springs/seeps high up in the catchment which will not be affected by the impacts of the Project on groundwater.

9.3.4. Measures to avoid, remedy or mitigate actual or potential adverse effects

The *Hydrogeology Assessment* has not identified any mitigation or monitoring as being necessary for groundwater impacts from the Project. If detailed design of the Project requires an excavation that extends below the groundwater table and the excavation is within 200 m of a stream, the change in stream baseflow should be modelled and the design should be adjusted if necessary with advice from a suitably qualified ecologist.

9.3.5. Conclusion

The most significant hydrogeological potential impact from drawdown of groundwater associated with the Project is the reduction in stream baseflows and resulting flows to wetland areas. Overall and based on the low permeability of rocks and corresponding low groundwater flow rates throughout the Project area, impacts on these watercourses will be less than minor.

If the alignment changes through detailed design and cuts are required which extend to below the groundwater table and which are located within 200 m of a stream, the change in stream baseflow should be modelled to establish effects. It is considered appropriate to include a condition requiring this work to be undertaken should this scenario eventuate.

No impacts are anticipated resulting from the drawdown of groundwater on existing groundwater users, due to the limited extent of the drawdown. Furthermore, given the low permeability of rock and corresponding flow rates, and the proposed surface water collection and treatment system which will discharge collected groundwater back into natural water courses, operational effects are considered to be less than minor.

Based on the findings of the *Hydrogeology Assessment*, effects from the construction and operation of the Project on groundwater drawdown and associated effects on stream baseflow and groundwater users will be less than minor.

9.4. Ground settlement

Overview

Construction of the Project requires cutting and filling of ground surfaces at a number of locations along the Indicative Alignment and in some cases associated groundwater drawdown. The areas surrounding these locations can experience ground settlement due to the mechanical settlement of ground from the movement of retaining walls, the consolidation of the ground due to lowering of the groundwater and consolidation of the ground due to the construction of fills. This can result in total settlement and differential settlement which can affect buildings and structures, network utilities and transport infrastructure.

Ground settlement effects will be mitigated through the design of the Project e.g. specific geotechnical measures or by appropriate measures, such that effects on infrastructure and assets within the proposed designation boundary will be manageable in relation to relevant engineering criteria and no more than minor. No ground settlement effects are anticipated beyond the proposed designation boundary.

9.4.1. Introduction

This section presents the findings of investigations undertaken to determine the actual and potential effects of ground settlement arising from the Project.

9.4.2. Existing environment

Geology

The geology of the Project area is outlined in section 3 of this AEE. The features of particular relevance to the assessment of ground settlement effects are set out below.

In the Project area, the Indicative Alignment is underlain predominantly by sedimentary rocks of the Waitemata Group (Pakiri Formation) south of the Hōteo River and typically Northland Allochthon rocks to the north of the Hōteo River. Relatively soft estuarine and alluvial soils are present in low lying regions and in-filled valley floors in the Woodcocks Road, Carran Road, Kaipara Flats Road, Wayby Valley Road, Silver Hill Road and Vipond Road areas.

Buildings, assets and transport infrastructure

The majority of the buildings within the Project area can be characterised as dwellings or rural farm buildings. These are sparsely distributed throughout the Project area. They are also interspersed through the rural environment outside the proposed designation boundary.

The Project area includes network utilities; including the major, significant network utilities described in section 3 and specifically below:

- The fuels and gas pipelines which are located within the same trench. The Indicative Alignment crosses the fuels and gas pipelines in the vicinity of the Hōteo River bridge, Farmers Lime Road, and near Mangawhai Road at the location

of the proposed Te Hana Interchange. The fuels and gas pipelines also traverse alongside the proposed designation boundary for much of the alignment in the Hōteo North area.

- A 110 kV national grid electricity transmission line owned and operated by Transpower crosses to the north of Wellsford passing east of Te Hana. The Indicative Alignment crosses this corridor at the location of the proposed Te Hana Interchange. Two existing transmission towers are located within the proposed designation north of Mangawhai Road.

Transport infrastructure within the Project area is described in section 3 and includes numerous local roads providing access to small towns or settlements including Pakiri and Mangawhai.

9.4.3. Assessment methodology

Anticipated settlement arising from embankment construction has been qualitatively assessed for the Project based on known ground conditions and the type of construction work proposed and proximity to existing infrastructure and assets.

The effects of settlement arising from predicted groundwater drawdown were initially assessed in locations of known infrastructure and assets. Areas without any existing infrastructure were not assessed. Locations with groundwater drawdown further than 1.0 m from existing infrastructure were also eliminated. The *Hydrogeology Assessment Report* presents the predicted groundwater drawdown based on the depth of cutting excavation and existing ground water levels. Dwellings and other buildings located within the proposed designation boundary were excluded from the assessment as they will be unoccupied or demolished as part of the Project.

Ground surface settlement using one dimensional compression theory was considered to determine anticipated effects on infrastructure and assets.

9.4.4. Assessment of ground settlement effects

Settlement may occur within the Project construction footprint generally over the construction period but in some areas, settlement may continue into the operational phase.

Effects on infrastructure structures or utilities within the proposed designation boundary as a result of ground settlement associated with the Project are anticipated to be minimal for the following reasons:

- Settlement of embankments founded on Pakiri Formation and Northland Allochthon mudstones and limestone is unlikely to be significant as the foundation materials are stiff and relatively incompressible.
- Where embankments are founded in areas with shallow deposits of soft ground or alluvium it would be normal practice to remove the compressible materials and largely eliminate the settlement risk.
- Where alluvium is thicker and/or more extensive and it cannot be removed, the construction of an embankment will result in settlement. Immediate settlements are expected to take place during or immediately after construction of the embankment, but completion of settlement is expected to take several months or years.

- Many of the cuts are predicted to be formed above the groundwater level and thus will have no discernible impact on the groundwater table.
- Due to the relatively low permeability of the Pakiri Formation and Northland Allochthon rocks, groundwater drawdown is very localised to the areas of cuts along the Indicative Alignment.
- In many situations, the predicted drawdown is within the expected range of natural groundwater fluctuation.
- Groundwater drawdown where it extends to any structures is, for the most part, predicted to be limited to groundwater levels within the relatively strong rock formations that have very low compressibility. In the case where groundwater drawdown may occur in soil layers in the vicinity of any structures, it is predicted to result in only minor settlement of the surficial soils and be within acceptable tolerance levels.
- While groundwater will seep into a tunnel during and after construction, groundwater drawdown effects that would cause settlement of the ground above and around the tunnel are not expected.

No effects of ground settlement on buildings and infrastructure outside the proposed designation boundary are anticipated, and with appropriate mitigation in place as summarised below, no effects are anticipated on infrastructure immediately adjacent to the proposed works and within the designation boundary.

A house located at 161 Kraack Road is within the designation. The tunnels will pass beneath this house. However, tunnels will be at a depth of approximately 160 metres and within rock, and settlement is not considered to be likely.

9.4.5. Measures to avoid, remedy or mitigate adverse effects

To mitigate the risk of settlement to infrastructure and utilities located within or immediately adjacent to the proposed designation, there are a range of solutions that can be applied through geotechnical design to control these to acceptable settlement criteria. Design of these measures depends upon the site specific geotechnical properties, the expected settlement magnitude and the horizontal and vertical extent of the potentially compressible layers.

There will be close liaison with utility operators throughout the design and construction phase of the Project. Existing transmission towers within the proposed designation in the vicinity of Vipond Road will be monitored and protected if required.

9.4.6. Conclusion

The fuels and gas pipelines and the transmission towers are particularly sensitive to changes in grade due to ground settlement. Effects arising from ground settlement on these and other assets located within the proposed designation boundary can be mitigated through design. Consultation with utility operators will continue during the detail design and construction of the Project to confirm the need for any specific protection or monitoring of assets during construction. If required, this could include pre-construction surveys and ongoing monitoring during construction to allow appropriate remedial actions to be taken. Collaboration with network utility operators and confirmation of specific protection or monitoring of assets will be an essential part of the design and pre-construction phases. With mitigation measures in place the potential effects on Project infrastructure and assets arising from ground

settlement will be manageable in relation to engineering criteria and no more than minor.

9.5. Terrestrial and freshwater ecology

Overview

Construction of the Project will involve, among other things, earthworks resulting in clearance of vegetation and discharge of sediment laden water into streams, stream works, diversion of waterways and the construction of culverts, bridges and viaducts over watercourses. These activities have the potential to result in a loss of indigenous vegetation, degradation and loss of terrestrial habitat for snails, lizards, frogs, bats, and birds; degradation and loss of freshwater habitat and changes to fish passage.

The operational phase of the Project may result in permanent disturbance to fauna from light and noise from vehicles and the mainline carriageway will provide a physical barrier to less mobile fauna (i.e. lizards).

Priority ecological sites have been identified where site-specific attention is required. These sites will be avoided as much as practicable. These areas include: Mahurangi River (Left Branch) and associated riparian margins (SEA), wetlands within the upper Kourawhero Stream catchment, and wetlands within the Hōteo River floodplain.

There are stands of high value indigenous vegetation located within the Project area north of Warkworth and in the Hōteo North area. There are areas of high quality wetlands with significant terrestrial values located in the upper Kourawhero stream valley near Phillips Road and in the Hōteo floodplain near Wayby Valley Road. These terrestrial and wetland ecological values will be impacted by the Project.

A variety of native fauna is present within Matariki Forest, including several species such as long-tailed bats, Hochstetter's frogs and kauri snail that are of conservation interest due to their threat status. There are also lizards and geckos present throughout the Project area.

Freshwater habitat across the Indicative Alignment has great variation in its ecological value; from low value degraded pastoral streams to very high value streams within Matariki Forest.

The pine plantation is currently mid-way through the production cycle, and harvesting is currently planned to precede construction of the Project. Harvesting activity will itself impact on the current terrestrial fauna and freshwater ecological values identified.

Recommended mitigation measures for addressing adverse terrestrial and freshwater ecological effects include:

- confirming the outcomes of baseline surveys of ecological values prior to construction;
- survey and classification of watercourses affected by the Project prior to construction;
- as far as practicable, protecting specific high value features in the event the alignment moves within the proposed designation boundary;
- integration of the mitigation (terrestrial and wetland planting, and stream riparian planting) by focusing revegetation, fauna habitat enhancement and stream restoration within a few priority areas that contain existing high value features.

The purpose of this aggregated approach is to link to existing ecosystems, prevent fragmented mitigation and build resilience;
- retaining cross-project ecological corridors for bats and birds;
- protocols for capture and relocation of fauna that reflect seasonal constraints;
- relocation of species to protected and appropriate habitat;
- pest and weed control at mitigation and fauna relocation sites; and
- design requirements for fish passage.

When implemented, the recommended ecological mitigation will lead to a cohesive and enduring outcome for ecological diversity, function and connectivity in the region.

With the recommended mitigation in place, the overall effects of the project on terrestrial and freshwater ecological values is considered to be minor.

Positive ecological effects are anticipated for the Project which include increased ecological resilience and adaptive capacity and enhanced ecosystem connectivity. The scale of these positive effects is considered to be minor.

9.5.1. Introduction

This section summarises the assessment of the actual and potential effects on terrestrial, wetland and freshwater ecological values arising from impacts of construction and operation of the Project as outlined in the *Ecology Assessment Report* in *Volume 2* of this Application.

The *Ecology Assessment Report* identifies the existing ecological values and significance of terrestrial and freshwater areas within the proposed designation (and outside the proposed designation where relevant), assesses the actual and potential effects on those values arising from the construction and operation of the Project and identifies measures to avoid, remedy or mitigate the potential effects on ecological values.

For the purpose of the ecological assessment, the Project is divided into three sections (Warkworth North, Dome Valley Forest and Hōteo North).

The assessment of effects on the marine environments to the east (Mahurangi Harbour) and west (Kaipara Harbour) are included in section 9.6.

9.5.2. Assessment methodology

The focus of the methodology was on the identification and assessment of existing ecological values of sites and effects of the Project in accordance with the EIANZ Ecological Impact Assessment Guidelines (EIANZ, 2018).

The criteria for 'Ecological significance', as set out in the EIANZ Impact Assessment Criteria Guidelines (EIANZ 2018), were used to assess ecological values of terrestrial and wetland sites. Factors considered include representativeness, rarity/distinctiveness, diversity and pattern, and ecological context.

The assessment of potential freshwater ecological effects was informed by the predicted sediment loads from the Project and water quality assessments detailed in the *Water Assessment Report.*

The criteria used to assign ecological value to freshwater ecosystems were modified from the EIANZ guidelines, to better include the array of attributes assessed for freshwater environments in New Zealand. These modified EIANZ criteria have been applied to other similar roading projects.

The level, or severity, of adverse effects resulting from the Project on the ecological sites or process was determined by the magnitude of the effect, the nature of the effect, and the ecological value of the site, in accordance with EIANZ 2018. Based on the EIANZ 2018 where if a moderate level of effect occurs, typically, this would require mitigation. Terrestrial and wetland ecological values were assessed as follows:

- Desktop data review to determine the selection of terrestrial survey sites.
- Site walkovers, the ecological features selected as a result of the above desktop review were then visited by a botanist and a fauna specialist, and at times, kaitiaki from Hōkai Nuku.
- Specific fauna surveys for snails, frogs, birds and bat were undertaken at representative sites.
- Pest mammal field signs (vegetation damage, prints, scat, bark biting) and the occurrence of weed species was noted.

Freshwater ecological values were assessed as follows:

- Stream ecological valuations (SEV) were undertaken using the Auckland Council SEV Assessment Methodology at 14 sites and included surveying fish and macroinvertebrate community samples.
- At sites where a SEV was not undertaken a standard stream habitat assessment was carried out.
- Stream classification assessment was based on the definitions within the AUP(OP) being; river or stream, permanent stream, intermittent stream, ephemeral stream, overland flow path and artificial watercourse.

Due to the large size of the Project area it was not possible to visit all watercourses within the proposed designation boundary. Where site visits were not undertaken, the permanence of the stream was estimated from the Auckland Council Overland Flow Path Layer within Geomaps.

The *Ecology Assessment Report* is based on the Indicative Alignment; however, a sensitivity analysis was performed to give guidance on the extent to which potential changes to the alignment (and design and location of ancillary components) within the proposed designation boundary would alter the scale or severity of effects. The *Ecology Assessment* also considered sensitivity to the timing of the Project, particularly as it relates to harvesting of the Matariki Forest; the plantation pine forest traversed by the Project. Matariki's current harvest plans indicate that harvesting will occur prior to project commencement. The assessment considered both the pre and post harvest scenarios for the Matariki Forest.

For assessment purposes the Project area has been divided into three discrete sections along the course of the Indicative Alignment (south to north) and covering the land within the Project area as follows:

a) Warkworth North
b) Dome Valley Forest

c) Hōteo North

These sections are mapped on Figure 9-1 of this AEE.

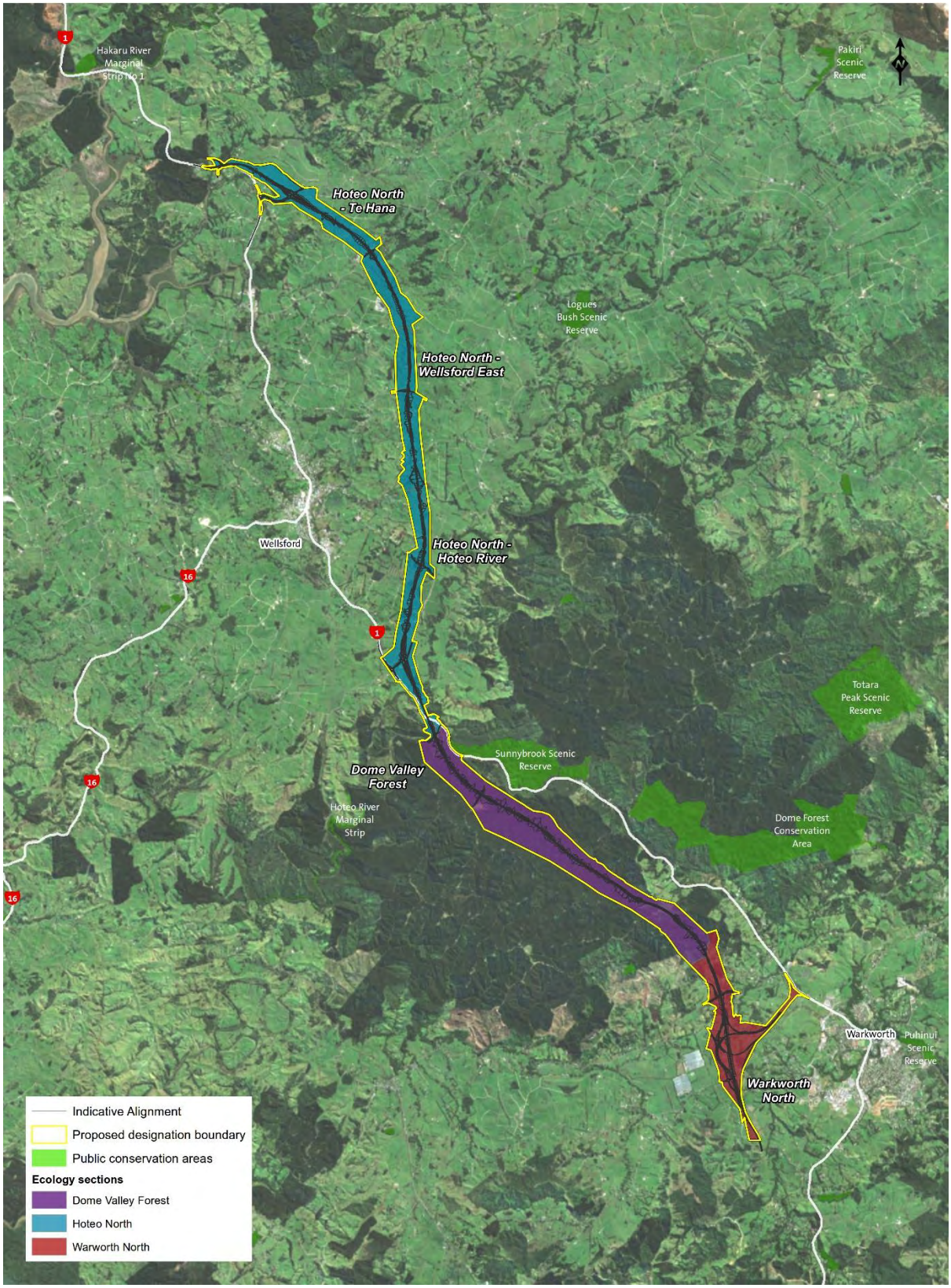

Figure 9-1: Ecology assessment sections

9.5.3. Assessment of terrestrial and wetland ecological values and effects

The effects of the Project on the terrestrial ecological values of the three sections vary and the summary below discusses each of these.

Warkworth North

Ecological values

The key attributes of the terrestrial and wetland ecological values of the Warkworth North section are:

- The majority of the section is currently in pastureland interspersed with lowland riparian forest, native forest remnants and several wetlands.
- Lowland riparian forest (podocarp-broadleaf forest) surrounds the Mahurangi River ranging between 30-150 m in width. This forest is identified as a SEA in the AUP(OP) and has been degraded due to stock access.
- Kānuka scrub is also common where agricultural land this has not been maintained and has a high likelihood of being occupied by geckos.
- Small wetland features (including exotic and raupo reedland) are interspersed throughout the landscape, which are generally degraded due to stock access.
- The large, open valley system in this area which is comprised of a mosaic of habitats including raupo reedlands, kahikatea forest, regenerating kānuka scrub and mature pines are suitable as communal roosts for long-tailed bats and the surveys undertaken confirmed that bats use this habitat.
- Three sites within the Indicative Alignment footprint in this section were identified as having 'High' or 'Very High' ecological value. These sites occur in the wide valley floor of the upper Kourawhero Stream that extends north into the Matariki Forest and south into the large floodplain of the Kaipara Flats between the Mahurangi River (Left Branch). This area would have formed a single large wetland ecosystem prior to agricultural development.

A summary of the ecological values of the sites surveyed is outlined in Table 9-6 and the sites are mapped in the Ecological Sites (ES) series drawings in *Volume 3, PES map series*.

Assessment of ecological effects

The potential adverse effects on terrestrial and wetland ecology in the Warkworth North area will include direct and indirect loss of vegetation, ecosystems and habitat and impacts on fauna. The magnitude and level of effects in the context of the EIANZ assessment criteria are outlined in Table 9-6. It is noted that a moderate level of effect using EIANZ would typically require mitigation and would therefore be considered significant in an RMA context.

Through design, direct impacts on High and Very High value wetland areas have been avoided as far as practicable through repositioning of the Indicative Alignment, design of embankments to minimise encroachment into wetland area and bridging (bridge 22), rather than culverting, the Upper Kourawhero Stream to maintain natural stream channel capacity and flooding pattern of the stream, also maintaining, as far as practicable, the existing hydrological conditions and connectivity for wetland sites.

The sensitivity analysis of the Indicative Alignment within the proposed designation boundary suggests that there is significant risk of further impacts on wetlands in the

upper Kourawhero catchment and in close proximity to the Mahurangi River (Left Branch) and the upper Kourawhero catchment (priority ecological sites) if the Indicative Alignment moves.