G EARTHWORKS, LANDFORM + SLOPE STABILISATION

Introduction

Earthworks are a major determinant of the aesthetic quality of a rural highway. As noted in Section B, this project is characterised by generally two types of landform. Undulating to steep terrain with rounded hills and ridges occurs to the north from the southern boundary of Newry State Forest to the Kalang River floodplain and again from the Kalang River Floodplain to the Short Cut Road overbridge, with a short section at the southern extent of the proposal where the foothills of the Nambucca State Forest cross the highway. The second landform type comprises the flat floodplain areas of Boggy Creek, Deep Creek, Oyster Creek and the Kalang River.

Significant benched cuts occur through forested areas in the north. At Stations 74km000 to 74km400 there is a wide cutting from which additional select material is to be won. In general, the earthworks have been designed to integrate with the adjoining existing landforms, taking into account a range of factors including topography, corridor width and engineering requirements. However, in order to achieve safe grades, fill embankments and/or bridge structures are required over gullies and cut excavations through ridges. The earthworks design is generally consistent with the requirements of Section 15.3 of Appendix 15: Urban Design Performance and Design Requirements, referenced requirements in Appendix 9: Geometric Performance and Design Requirements of the Scope of Works and Technical Criteria and the Roads and Maritime's Shotcrete Design Guidelines (June 2005). Particular attention has been and will continue to be paid to ensure that as far as possible the vertical and horizontal alignment of the new highway will be flowing and responsive to the landform along the route, to ensure a positive experience for drivers and viewers.

Except in EEC and forested areas (where extending the excavation would incur further clearing), the tops and bottom of batters will be rounded and feathered into the adjacent landform and the ends of batters in cuttings will be rounded and the batter progressively flattened for a minimum distance of 50m to blend the batters into the surrounding landform. All cut and fill batter interfaces will be modelled in the road MX design to ensure an integrated solution as per Appendix 15 of the SWTC. (Refer to Figure G.1.1).

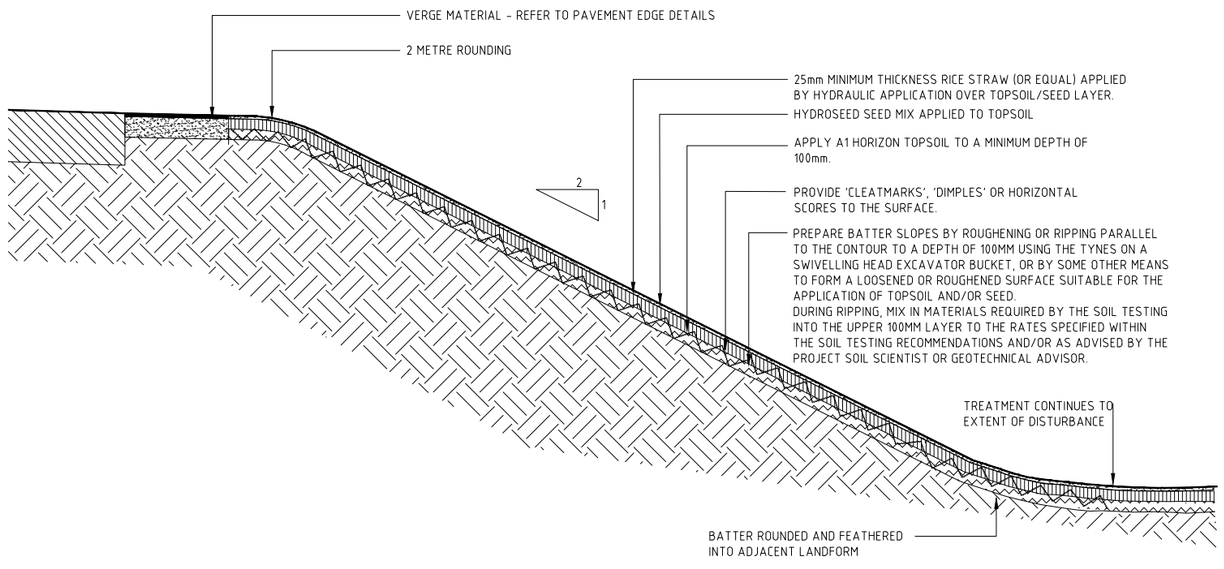


Figure G.1.1 Typical Batter Slope Treatment where there is sheet flow over batters

G.1 CROSS SECTIONS OF SIGNIFICANT CUTTINGS AND EMBANKMENTS

As illustrated in the following typical sections, the vertical alignment of the upgrade creates a number of significant cuttings and fill embankments (Refer to Figures G.1.1.2 to G.1.1.15).

Details of the design and treatment of embankments and cuttings include:

- All fill batters are at a maximum slope of 2:1 and 4:1 where there is sufficient width within the corridor. Where 2:1 batters transition to 1.5:1 at overbridges, organic mesh will be used to stabilise the batter surface for seeding.
- Tops and bottoms of batters will be rounded and feathered into the adjacent landform.
- Cuttings are more visible than embankments to highway users and therefore require careful design.
- Ends of cuttings will be rounded off and feathered into the adjacent landform.
- Widened cuttings will have additional tree plantings to reduce the visual impact of the cut.

G.1.1 Wide Cuttings

A wide cutting occurs from Station 70km000 to 70km400 (creating a 21m wide landscape zone each side of the carriageway) in order to maximise the amount of site-won material for use throughout the job. Wire rope barriers or landscaped mounds are installed to prevent motorists from stopping at these locations and allows tree planting closer to the carriageway. The area is to be seeded with tall shrubs with intermittent tree planting to reduce the visual impact of the cuttings.

The depth of the root zone in this landscape area will be to the depth of excavation of the road formation, at a minimum 700mm, or alternatively the soil profile will be mounded, providing adequate depth and space for trees to grow to their full mature size.

Given the new microclimate created by the cutting, rainforest trees from the mixed floodplain forest will be planted in this location to provide a dense landscaped screen.

Artists perspectives illustrate the effectiveness of the proposed landscape screen (Refer to Figure G.1.1.16).

G.1.2 Drainage sheet flow over batters due to removal of SO gutters.

It is proposed to remove SO gutters and allow stormwater to sheet directly over fill batters up to 5 metres high vertically. This will apply additional erosive pressure to the batters. The landscape strategies to be employed to help prevent erosion on fill batters in this situation include:

- Where sheet flow occurs in pasture/floodplain areas, Couch Grass is used in the native grass seed mix and the pasture grass seed mix. Couch establishes rapidly and forms a thick sward of rhizomes which will effectively resist erosion and it is tolerant of saline and acidic soils. Couch is regarded as a native and is prevalent in the adjoining paddocks, although it also occurs outside Australia. In addition, Carpet Grass is used in the pasture seed mix. Carpet Grass is a naturalised species in the area and found in the adjacent pasture. It establishes easily but is not aggressive;
- The use of Rice Straw mulch to 25mm over hydroseeding mixes. Rice straw is a superior binder to the mulch component generally applied with hydromulching. The two-step hydro application will significantly improve the early establishment of seeded batters;
- The use of site mulch berm windrows at the top and bottom of batters and along contour intervals of 3 metres on slopes during the establishment period;
- The addition of up to 50% composted site mulch (following advice from the soil scientist) added to site topsoil either at the stockpile site or by mixing on the prepared slope using the windrowed berms. Composted tub-ground site mulch is superb at resisting erosion;
- Where planting is required on such batters, use planting strategies such as long stem planting; and
- Direct return and preservation of the soil seedbank which will re-introduce the diversity of species and contribute to the resilience and resistance of vegetation to erosion in forested areas;
- Verge seal material will be extended over the rounding for 300mm.

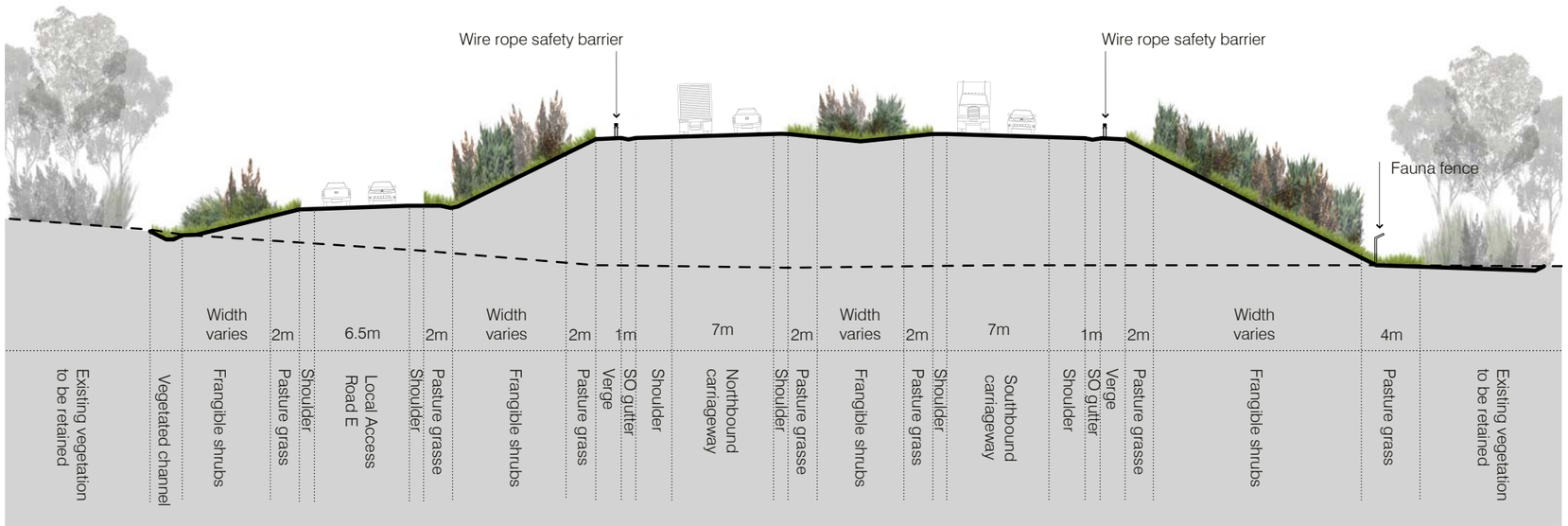


Figure G.1.1.2 Section at Station 69km700

0 50m

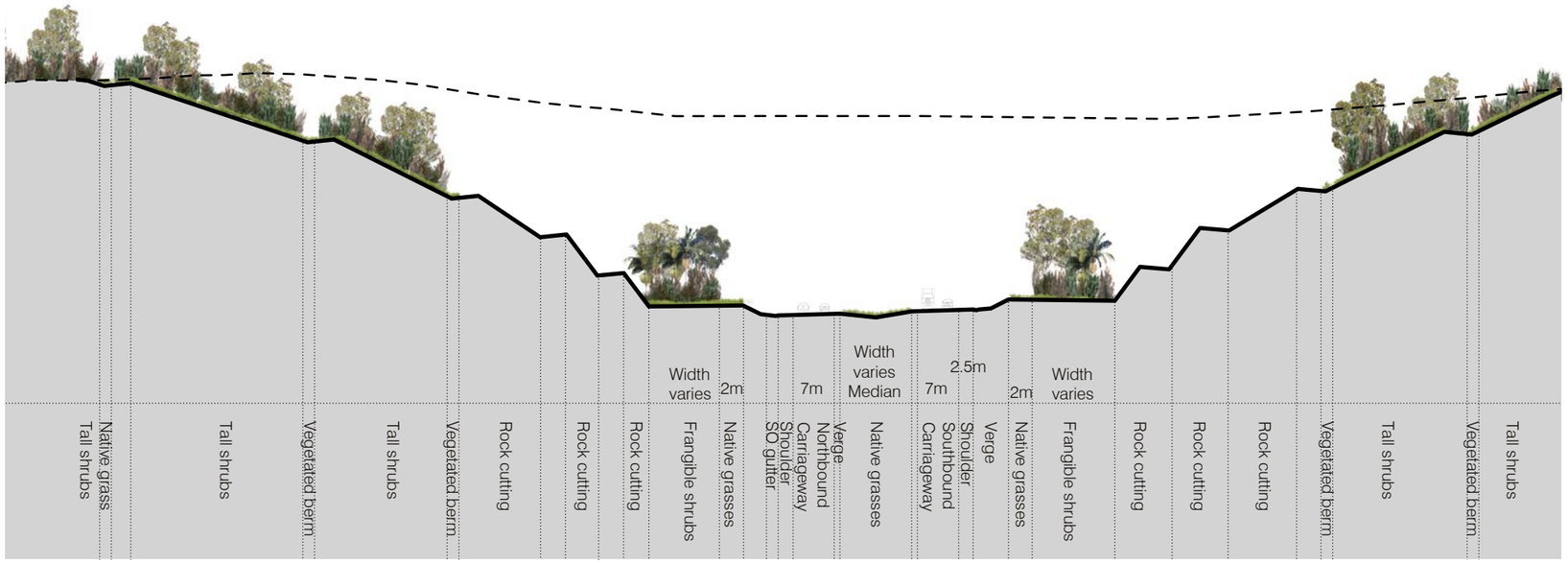


Figure G.1.1.3 Section at Station 74km350

0 20m

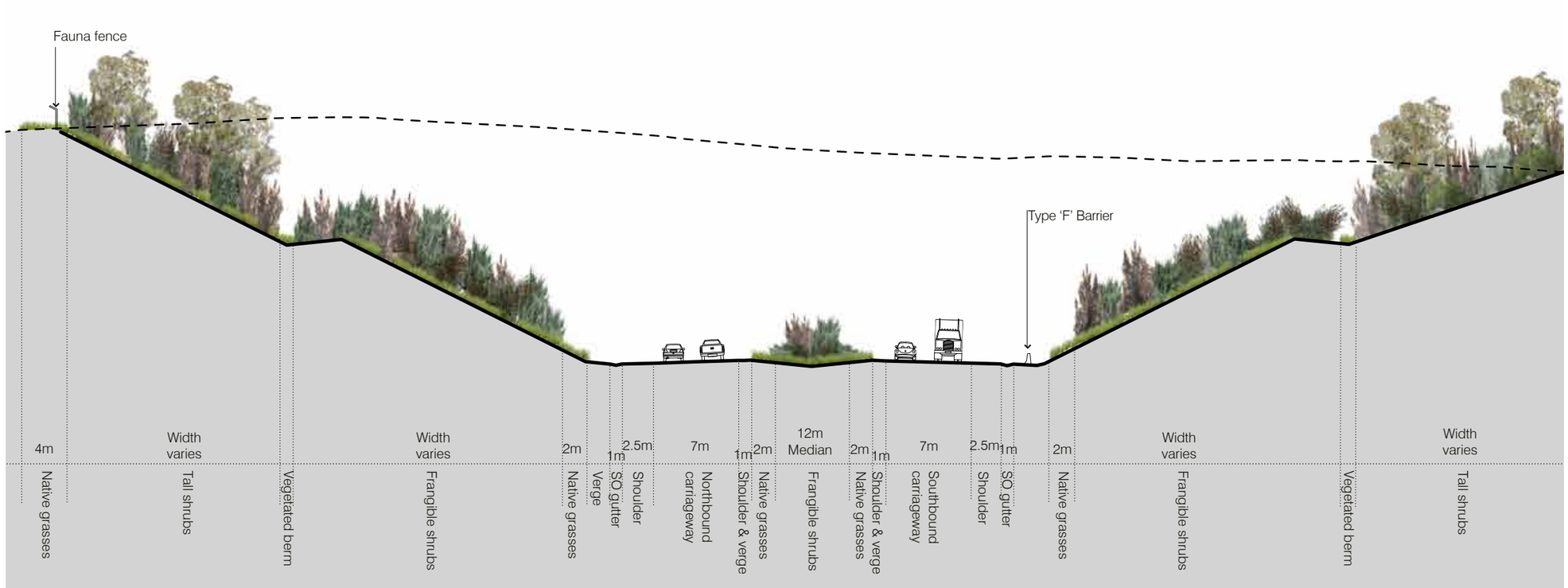


Figure G.1.1.4 Section at Station 78km550

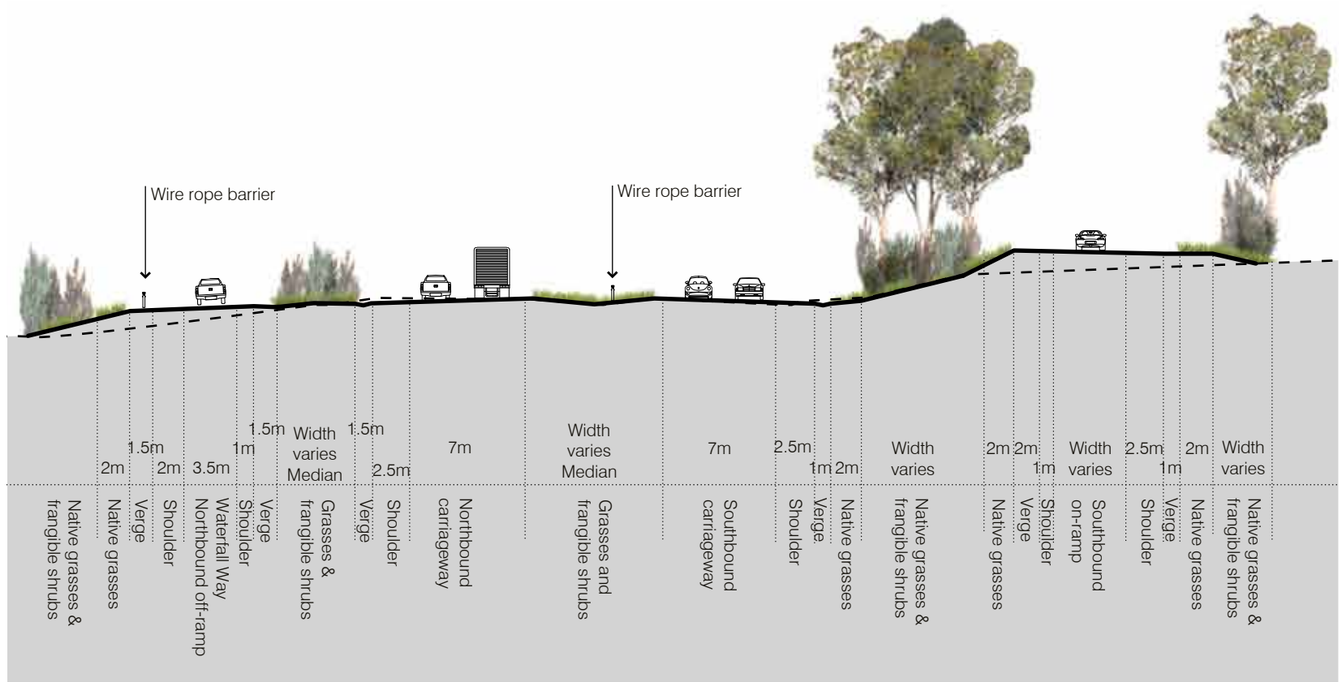


Figure G.1.1.5 Section at Station 82km800

View from 50m in the cut - northbound at approximate Station 74050

View from 50m in the cut - southbound at approximate Station 74400

Figure G.1.1.16 Artist perspectives showing landscape screening of wide cutting at or near maturity of vegetation - Station 70km000 to 70km400

G.2 SCHEDULE AND ILLUSTRATION OF FINISHES

G.2.1 Slope Stabilisation

The 2:1 slopes generally adopted throughout the project and steeper batters to 1.5:1 are vegetated to stabilise them. Where steeper cuts are required exposed rock is the preferred finish where possible. Should stabilisation be required using shotcrete this will be minimised as described in Section G.3. The only cut slopes which are expected to require stabilisation are in the widened cutting between Stations 74km000 and 74km400. Here it is expected that shotcrete will need to be applied to 50 percent of the lower slopes at 0.75:1 and 15 percent of the remaining slopes. From an urban design perspective this treatment is considered satisfactory because the widened base of the cutting provides ample opportunity for soil mounding and dense planting which will screen the cutting slopes (Refer Figures G.1.1.10 and G.1.1.16).

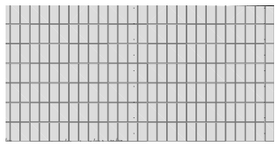
Concrete pavers are used to finish overbridge abutments. Stone boulders have been adopted as the preferred finish to the 1.5:1 slopes for the highway bridge abutments, as illustrated in the photo from the Kempsey Bypass project below. See H.1.2 Topsoil Treatments for the slope preparation required to establish vegetation.

G.2.2 Pre cast concrete panel walls

For the abutment walls to the bridges over the North Coast Railway the reinforced soil wall panel design has been designed so that horizontal joints are accentuated to provide strong horizontal banding and so that the vertical joints are minimised and less accentuated. For retaining walls, a vertical emphasis is provided (Refer to Section F). The panels are not pigmented avoiding fabrication issues of matching panel colours, the plain grey natural concrete colour contrasts well with vegetation, and the design is relatively simple allowing it to recess into the environment. The panel design accommodates all the required panel heights, providing fabrication and construction advantages.

G.2.3 Schedule and Illustration of Finishes

Table G.2.3.1 Locations and Illustrations of Finishes

Finish	Location and Notes	Illustration of Finish
Vegetated embankments	Preferred finish predominantly utilised on the project - exceptions noted below. Vegetation comprises pasture grasses or shrubs and groundcovers or sedges or a mixture according to location and context.	
Exposed Rock	Preferred finish as far as practicable.	
Concrete Pavers	Bridge abutments - Main Carriageway Overbridges only	
Rip Rap armour stone (stone boulders)	Underbridges abutments for scour protection	
Pre Cast Panels for Reinforced Soil Walls	Retaining walls where required - vertical emphasis (Refer Chapter (iii))	

G.3 SHOTCRETE AVOIDANCE AND MINIMISATION STRATEGY

G.3.1 Methodology to avoid and minimise use

In the Design for this project exposed areas of sprayed concrete (shotcrete) have been avoided as far as possible and in compliance with the criteria as listed in Appendix 15 of the SWTC, Section 15.3 (c).

During detailed design and construction every effort will continue to be made, in accordance with Appendix 15 section 15.3 of the Scope of Works and Technical Criteria, to achieve batter stabilisation without the use of shotcrete. Where its use cannot be avoided, shotcrete will comply with the requirements in Appendix 15 section 15.3.

G.3.2 Design Appearance

Where the use of shotcrete cannot be avoided:

- The extent of shotcrete will be minimised.
- The edges of the shotcrete will be masked off to avoid overspray.
- The colour and texture of the shotcrete will match the colour and texture of the adjacent rock batter (test panels will be provided) or be a dark recessive colour.
- Areas of shotcrete along rock seams will be recessed to allow the exposed rock to visually dominate.
- Shotcrete will have a wood float finish and a gun finish will be avoided.
- Soil nails and rock bolts will also be recessed and any supporting shotcrete finished with a wood float finish.
- Should areas of weak rock be exposed during construction, stone pitching using locally won rock will be considered to infill the weak areas.
- Shotcrete will be screened by plantings where possible.
- No shotcrete will be visible from the areas or around the abutments of bridges.

G.4 APPLICATION OF SHOTCRETE FOR ROCK SEAM STABILISATION

Figure G.4.1.1 shows the use of stone pitching to stabilise slopes and Figure G.4.1.2 illustrates the application of shotcrete for rock seam stabilisation.

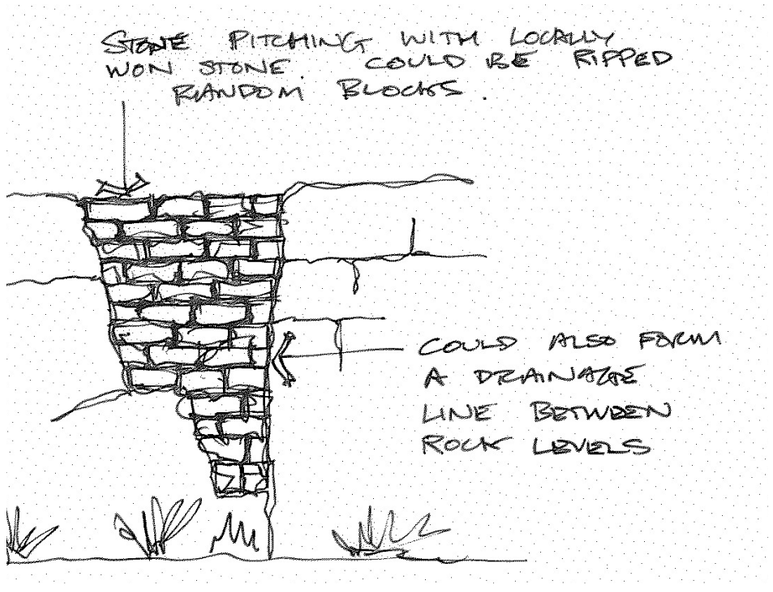
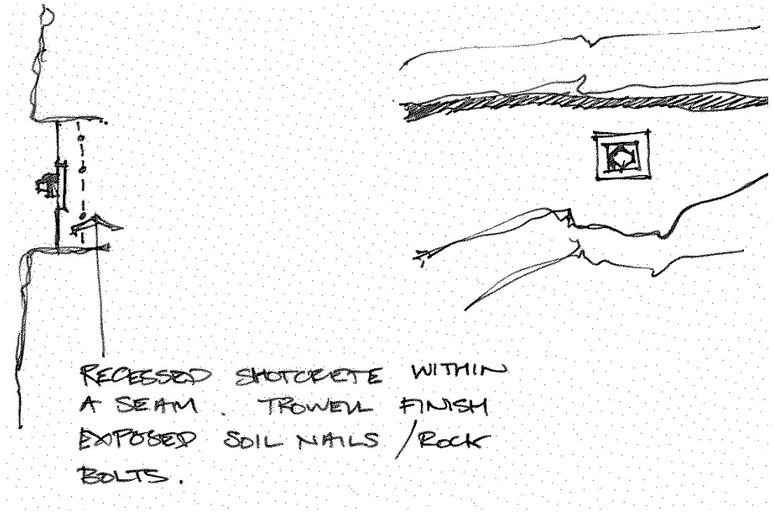


Figure G.4.1.1 Stone Pitching



Section Elevation

Figure G.4.1.2 Shotcrete in a weak seam (horizontal)

G.5 CONCRETE DRAINAGE CHANNELS

Where concrete/shotcrete channels are unavoidable and visible from the road or residences, planting will be designed to screen the channel. If following construction, concrete channels are observed to have residual visual impacts, a spray-on concrete dye (with a colour selected on site to best match ground conditions but likely to be darkly coloured) will be applied to the entire surface of the concrete.

H LANDSCAPE DESIGN

H.1 TOPSOIL MANAGEMENT AND TREATMENT

H.1.1 Management of Existing Topsoil

After all other requirements are met such as responding to the character of the landscape, views, safety clearances and other performance and safety requirements, the landscape design methodology focusses on the successful establishment of vegetation. A holistic approach which extends to the initial topsoil stripping is used in order to best achieve the biodiversity and protection outcomes for the project.

The management of site soil is an essential component of ensuring the long term viability of the landscaping for this project. Recent success on other Roads and Maritime projects testifies to the importance that topsoil management has to revegetation success.

There are 5 key aspects to the management of existing topsoil:

- Topsoil stripping to maintain the integrity of the topsoil from the existing vegetation communities;
- Direct return of topsoil (where feasible);
- Topsoil stockpile management procedures;
- Topsoil management zones; and
- Topsoil and composted mulch amelioration.

Topsoils from EEC and Non-EEC vegetation communities will be stripped and stockpiled together (hereafter referred to as Bushland Topsoils). Topsoil stripped from pasture areas is to be stripped and stockpiled separately (hereafter referred to as Landscape Topsoils).

Direct return is the procedure whereby site topsoil is returned to the batter location from which it was stripped either immediately or soon after formation. It is dependent on the construction staging and the full commitment of construction staff to the goals of the revegetation effort. Direct return will be implemented where construction staging allows. The landscape plans indicate where stripped topsoils are to be returned and topsoil treatments (soil depths, etc.).

Topsoil stockpile management and storage procedures are designed to ensure the survival of soil seedbank, microflora and micro-organisms in the stockpile for the duration of the stockpile period and until it is returned to revegetation areas. The stockpiles will be sized to maintain the viability of native seed with a maximum height of 2.5 metres and with 2:1 batter slopes as specified by R 44. Large, clearly legible signs will be placed and maintained on each stockpile, nominating vegetation community type, collection area (e.g. by station) and date of stockpiling. No soils should be stockpiled for greater than 18 months where possible.

Topsoil management zones can be derived from the vegetation communities to ensure that, where feasible, the topsoil with stored seed from each vegetation community is returned to a location with the same vegetation community. In some instances the exact extent of a zone will rationalized in order to assist the stripping and re-application. For instance a zone may be extended to the end of a batter if the distance to the end of a batter does not warrant a change in community type. For the purposes of stockpile management for this project, soils have been classified into 2 types;

Bushland Topsoils

Topsoil stripped within mapped vegetation communities (EEC and non-EEC) from which existing vegetation has been cleared. Strip and stockpile bushland topsoil from these communities and manage the stockpiles to retain the environmental integrity of the material and preserve the soil seedbank. Where feasible, stockpile separately by vegetation community type but can be stockpiled together.

Bushland Topsoil is for re-use where native seeding and planting is shown on the plans.

Bushland Topsoils are:

- White Mahogany/Grey Gum/Ironbark
- Blackbutt Dry Sclerophyll Forest
- Flooded Gum Open Forest
- Lowland Rainforest (EEC)
- Mixed Floodplain Forest (EEC)
- Swamp Mahogany/Paperbark – Swamp Forest (EEC)
- Swamp Oak - Swamp Forest (EEC)
- Freshwater Wetland (EEC) If soil from these locations is to be stripped, it will be returned to the wetland zone in the general location indicated excluding batter slopes.

Landscape Topsoils

Topsoil stripped from within existing pasture grass areas or where mapped in the Weed Management Plan as having a High Weed Density Abundance. Landscape topsoils may contain weed seeds and must be quarantined from Bushland Topsoils.

Landscape topsoils are only for re-use where pasture grass is shown on the plans.

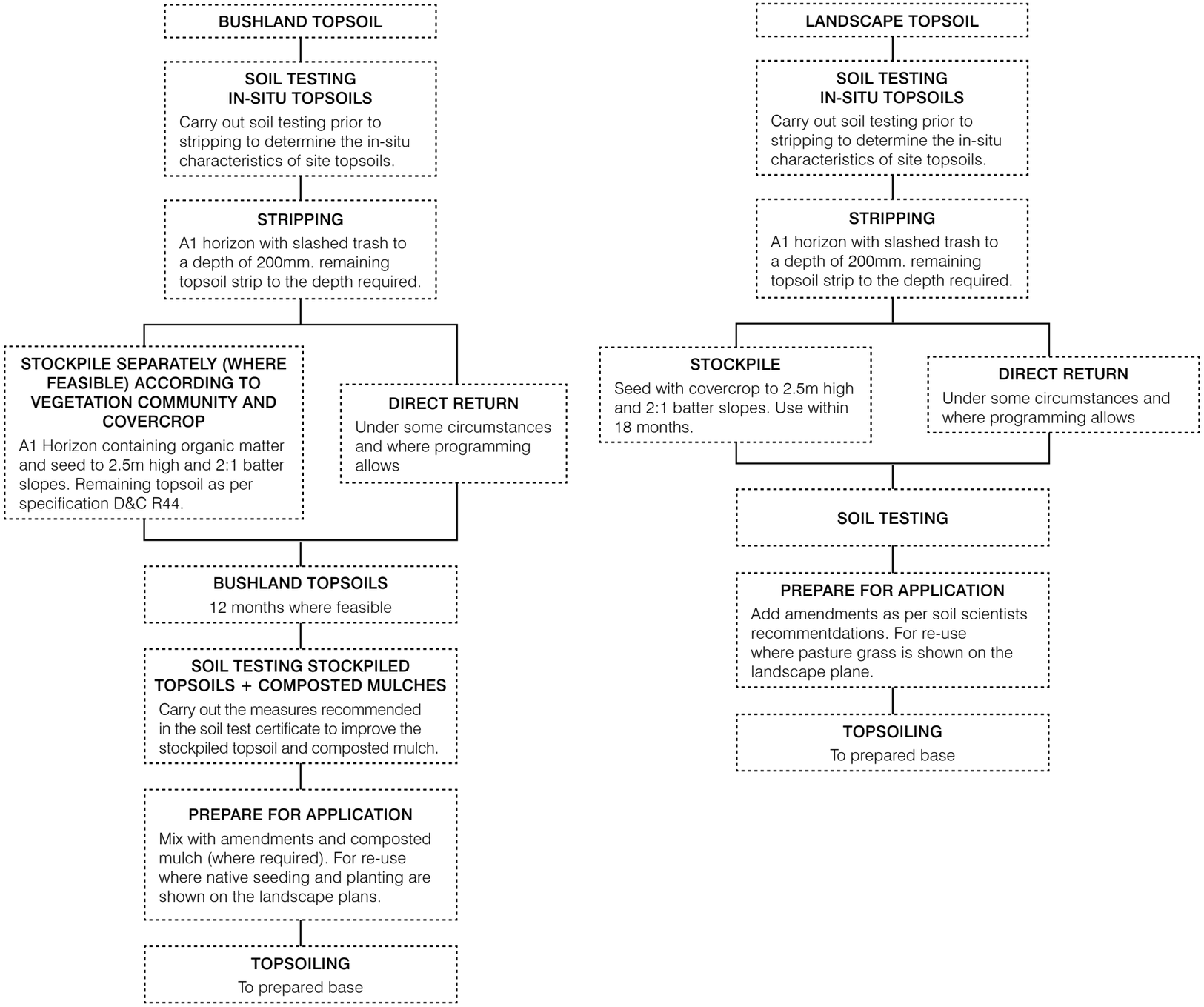
Composted Site Mulch

Composted mulches derived from site-won mulch which has been windrowed for a minimum of 6 months in a manner to accelerate composting may (dependent upon quantity and space available for composting) be mixed with site topsoil in order to increase its organic (carbon) content and to aid in erosion resistance on batters. The component of composted site mulches mixed with topsoils will be considered during the detailed design phase and will form part of the soil testing procedures with advice from the soil scientist, but may include up to 50% of composted mulch.

Composted tub-ground site mulch mixed with site topsoil in a 50/50 ratio with *Hardenbergia violaceae* which has germinated from soil stored seed.

Topsoil and composted mulch amelioration is required because site soils are highly acidic and therefore to raise the pH, to improve the composting process and hence to reduce the nitrogen drawdown effect of mulches, and to counter any major nutrient deficiencies that can inhibit germination, the project soil scientist will provide advice as to soil and compost additives to render the mix suitable for plant growth.

The procedure for handling of each topsoil type is illustrated in the following diagrams.



H.1.2 Topsoil Treatments

Topsoil treatments for all areas include:

- Ripping the subsoil or sub base (depth varies);
- Application of the site topsoil or site topsoil/composted mulch mix (depth varies);
- Application of seed mixes by hydroseeding (followed by strawmulching) or hydromulching; and
- Application of 75mm thick site-won woodchip mulch for planted areas.

7 topsoil treatments are used:

Topsoil Treatment 1: For seeded areas.

- Prepare the batter slopes by roughening parallel to the contour by cleatmarks, dimples or horizontal scores to form a loosened or roughened surface suitable for the application of topsoil/seed.
- During roughening, mix in any materials required by the soil testing into the upper 100mm layer to the rates specified within the soil testing recommendations or geotechnical advisor.
- Apply site-won topsoil to a minimum depth of 50mm, but not more than 100mm.
- Where site-won topsoil is mixed with up to 50% composted site mulch (or as directed by the soil test results), apply to a minimum depth of 100mm, but not more than 150mm. (topsoil and mulch should have been previously ameliorated and any additional materials required by soil testing mixed at the stockpile.)
- Spread out the topsoil or topsoil/composted mulch mix to an even surface but do not otherwise smooth or compact the surface.
- Apply appropriate hydromulch seed mix.
- For slopes steeper than 2H:1V and up to 1.5H:1V (eg; transitions from bridge abutments to 2:1 slopes) install Organic Fibre Mesh as per the specification over final topsoil preparation and prior to hydromulching.

Topsoil Treatment 2: For planted areas.

- Rip the subsoil to a depth of 300mm. Do not smooth or compact the roughened subsoil surface prior to the application of topsoil.
- Apply topsoil to a minimum depth of 150mm.
- Where site-won topsoil is mixed with up to 50% composted site mulch (or as directed by the soil test results), apply to a minimum depth of 150mm but not more than 200mm (topsoil and mulch should have been previously ameliorated and any additional materials required by soil testing mixed at the stockpile).
- Spread the topsoil but do not otherwise smooth or compact the surface.
- For tubestock planting: prepare 200x200x200mm deep hole;
- For advanced tree planting: prepare 400x400x400mm deep hole;
- For super advanced trees: prepare 600x600x600mm deep hole
- For semi-mature (75L) trees: prepare 1000x1000x800mm deep hole.
- Apply fertiliser at the recommended rates (refer to relevant version of modified specifications R179).
- Install advanced trees/tubestock and backfill with topsoil to finish flush with ground level.

Topsoil Treatment 3: For medians.

- Rip the subsoil to a depth of 150mm (Do not rip where subsoil drains or services may be impacted). Do not smooth or compact the roughened subsoil surface prior to the application of topsoil.
- Apply site-won topsoil to a depth of 100mm.
- Spread the topsoil but do not otherwise smooth or compact the surface except where pasture/native grass is to be applied, level and trim the surface flush with adjacent surfaces and roll to lightly compact.
- Apply appropriate hydromulch seed mix.

Topsoil Treatment 4: For all fill batters steeper than 3H:1V on the inside curve of superelevation and typically under 5m vertically where SO gutter is not used.

- As for Topsoil treatment 1 (up to point 5.) Topsoil is to be mixed with composted site mulch.
- Apply appropriate hydroseed seed mix.
- Apply strawmulching with binder over hydroseeding to a minimum thickness of 25mm.

Topsoil Treatment 5: For Water quality basins, vegetated swales and channels.

- As for topsoil treatment 1 except where inner slopes of basins continue to road formation batter slopes, use Organic Fibre Mesh (OFM) laid over the slope following topsoil spreading and preceding hydromulching to the extent of the topsoiling and/or to the top and bottom of the embankments.

Topsoil Treatment 6: For turfing.

- Cultivate all areas to be turfed to a depth of 100mm. Do not smooth or compact the roughened subsoil surface prior to the application of topsoil.
- Apply site-won topsoil to a minimum depth of 50mm.
- Spread the topsoil, level and trim the surface flush with adjacent surfaces to provide an even finish and roll to lightly compact.
- Lay turf in a stretcher-bond pattern perpendicular to the slope with tightly butted joints
- Water the turf immediately after laying to its full depth. Turf must not be allowed to dry out during the establishment period.
- Apply fertiliser at the recommended rates (refer to relevant version of modified Roads and Maritime specifications R178 and R179).

Topsoil Treatment 7: Deep soil profile in widened cut (Cut 20).

- Cut 20 is located in the Newry State Forest between Stations 74200 to 74400. The cut is designed to ensure that there is sufficient hard rock for the Project. The wider than usual landscaped zone at the base of the cut will be planted with rainforest species which in time will ameliorate the visual impact of the cut. The final depth of topsoil in this location will be determined during detail design but will be a minimum depth of 150mm. Earth mounding is proposed in this location which will contribute to optimum plant growth and grading of the base material will ensure that the sub-surface drains.

Topsoils in floodplain areas

In order to optimise programming/constructability and so as not to disturb potential acid sulphate soils, the topsoil in floodplain areas may not be stripped and a bridging layer will be placed directly over the in-situ topsoils. In this instance topsoils for batters on the floodplain will be imported from elsewhere on the alignment. Topsoils which do not contain a soil seedbank (in other words; A2 or B horizon soils) or landscape topsoils can be used where floodplain areas are to be seeded with pasture or native grasses. These areas will not benefit from soils containing a soil seedbank.

The mixing of composted site mulch with A2 or B horizon soils will improve them by adding organic matter and extend coverage.

Topsoils where road surface is to be removed

Where the existing highway or road surface is redundant and is to be removed, the site will be prepared for revegetation as follows:

- Remove the existing road surface and rip the area to the depth and extent of the select material zone (nom. 500mm). Avoid ripping within the dripline of established trees;
- Apply topsoil (A2 horizon topsoil is preferable given the depth, and no compost) to a depth to restore the final surface to 200-250mm below finished levels;
- Apply topsoil to a minimum depth of 100mm but not more than 150mm; and
- Apply appropriate hydromulch seed mix or planting in accordance with the landscape plans.

Progressive re-vegetation

Several elements go together to make up the progressive establishment of re-vegetation across the Project. These are:

- Staged implementation of the landscape installation - as sections of the earthworks are prepared the section is prepared as soon as practical for topsoiling followed by seeding.
- In accordance with Roads and Maritime specifications all prepared areas flatter than 3H:1V requiring revegetation are to be seeded within 2 days of completion of soil preparation or, if delayed by the weather conditions, as soon as weather conditions permit. Seeding will include cover crop, native seed, or a combination of the two.
- Open drains are to be vegetated within seven days of excavation.
- Use of cover crops for rapid stabilisation of bare soils. Cover crop may be applied separately or in conjunction with all other hydromulch mixes
- Planting is used where trees, shrubs and ground covers are required for early landscape and visual effect and for early landscape establishment in fauna movement corridors and adjacent to underpasses and below bridge structures and at creeksides.

In addition to the above, the topsoil management procedures which are devised to maximise the retention and germination from the soil seedbank, will ensure that native seed is already contained in any topsoiled areas. Since disturbance favours germination of colonising plants we can expect that fast growing pioneer species will germinate rapidly from topsoiled areas.

Areas which receive erosive pressures such as vegetated channels, water quality basins and slopes steeper than 2H:1V, will have organic fibre mesh installed in order to improve the establishment of the re-vegetation.

H.1.3 Water Quality Basins and Swales

Water quality basins will be “wet” basins with a fluctuating permanent depth. On occasions they will be dry. The strategy for basins is to prepare the margin zone of periodic wetting above and below the permanent water line (Topsoil treatment 5). The basins are to be seeded over the crest and down to the maximum water line with native grass seed mix (which contains endemic sedge species seed). In addition, wetland plants from the Freshwater Wetland Vegetation Community will be planted at the margins at a spacing of 1.5plants/m^2 from the maximum water level for a distance of two metres It is recognised that basins must be pumped clean following the construction phase of the works and therefore basins may be prepared and planting may proceed following this procedure.

Where long steep batters occur leading into the basin inner batter, organic fibre mesh will help to control erosion on the 2H:1V sides.

The permanent water quality basins are shown with a regular rectangular shape in the Preliminary Detailed Design, but will be subject to review to provide a more informal shape where possible during the detail design.

Temporary basins will be decommissioned and left in place after construction. The following proposed treatment scenarios have been devised to ensure that they do not hold water which could pose a safety hazard.

1- Basins where the outlet spillway is totally in fill. The spillway will be removed at the end of the construction period and the basin would remain dry. The outside embankments will have previously have been topsoiled and stabilised with cover crop. Following draining, the inner embankments will be topsoiled to 50mm depth and the whole of the basin hydromulched with native seed. The seed mix to be used at each location is shown on the landscape plans.

2- Basins where the spillway is partially in fill and partially in cut. The spillway will be removed down to existing ground levels and the remaining volume of the basin below ground level will be backfilled. The inner embankments will be topsoiled to 50mm depth and the whole of the basin hydromulched with native seed. The seed mix to be used at each location is shown on the landscape plans.

3- Basins that are totally in cut (holes in the ground, below existing levels). These basins will be backfilled and inner embankments will be topsoiled to 50mm depth and the whole of the basin hydromulched with native seed. The seed mix to be used at each location is shown on the landscape plans.

The following table lists the treatment proposed at each temporary basin.

Zone	Name	Type	Category
1A	TB 64.14 L	Temporary	2
1A	TB 66.00 L	Temporary	1
1A	TB 66.05 L	Temporary	3
1A	TB 66.53 L	Temporary	2
1B	TB 71.01 L	Temporary	2
1B	TB 71.09 L	Temporary	3
1B	TB 71.38 R	Temporary	3
1B	TB 72.14 R	Temporary	2
1B	TB 72.23 R	Temporary	1
1B	TB 72.46 R	Temporary	1
1B	TB 72.55 R	Temporary	1
1B	TB 72.70 R	Temporary	1
1B	TB 72.77 L	Temporary	1
1B	TB 72.84 R	Temporary	1
2A	TB 72.89 L	Temporary	1
2A	TB 73.64 M	Temporary	2
2A	TB 73.79 R	Temporary	1
2A	TB 73.90 L	Temporary	2
2A	TB 75.76 L	Temporary	1
2A	TB 75.88 R	Temporary	2
2B	TB 81.28 L	Temporary	1
2B	TB 82.32 R	Temporary	2
2B	TB 82.50 L	Temporary	1
2B	TB 82.98 R	Temporary	3
2B	TB 83.06 R	Temporary	2

Juncus Sp. and other endemic sedges colonizing a wet paddock on South Arm Road adjacent to where the proposed alignment crosses. Juncus occurs in the Freshwater Wetland vegetation community and is one of the sedges proposed for basin planting.

H.1.4 Planting in the Vicinity of Scour Protection

Scour protection is required at Bridge crossings over creeks, fauna underpasses and minor waterway diversions at:

- Boggy Creek at Station 62km700;
- Cows Creek at Station 63km600;
- Deep Creek at Station 64km900;
- McGraths Creek Floodplain 1 at Station 71km550;
- McGraths Creek Floodplain 2 at Station 71km930;
- Dalhousie Creek at Station 73km340;
- Creek at Station 74km800;
- Creek at Station 79km940;
- Incidental Bridges at Station 81km880 and
- Combined Bridges at Station 82km410.

Where required, tubestock native plants known to bind embankments (notably Lomandra hystrix and other tussock-type plants) will be pocket planted directly adjacent to the scour protection, both top and bottom, where shown on the landscape plans.

H.1.5 Landscape Mounds

Surplus site topsoil won from stripping operations that is in excess of the requirements for revegetation works on the project will be used to topsoil excess fill material spoil mounds used for the formation of landscaped mounds where shown on the landscape plans (to be included in the Final Detailed Design). Where excess topsoil remains, it will be used to increase topsoil depths generally. Similarly, excess site-won mulch will be used to mulch over excess spoil mounds. Where excess remains, the general mulch depth will be increased to range from 75mm – 100mm. A small quantity of mulch will be stockpiled in discrete locations for use by the landscape maintenance crew in topping up plantings with mulch to the specified depths.

Under most circumstances the slope of stand-alone mounds will be a maximum 1V:3H for improved planting and seeding establishment and natural appearance. Where the mound has been designed as a false-cut the slope can be consistent with the slope from which it extends. The radius at the top of the mound and transitions will be rounded to 10 metres minimum and up to 100 metres for the large mounds.

The shape of landscape mounds will be informal and responds to local conditions. Where possible, margins of mounds will be graded to blend with existing adjoining landform. Landscape mounds will be revegetated by hydromulching with selected native grasses and shrubs supplemented at selected locations (and generally where in view from adjacent properties) with direct planting of containerised trees and shrubs.

At this time final agreement with Roads and Maritime on the location of spoil mounds is still pending, however they are shown on the landscape plans as potential sites.

Refer to figure H.1.5.1 for a typical landscape mound treatment

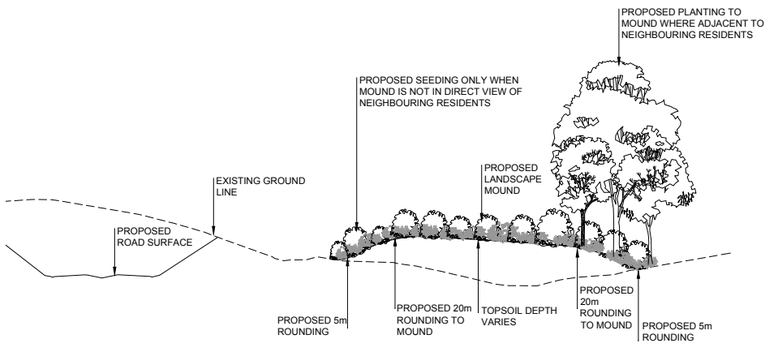


Figure H.1.5.1 Typical Mound Treatment

H.1.6 Visual Screening

The Visual Impact Assessment prepared for the Environmental Assessment identified that for the section between Nambucca Heads and Ballards Road, some residences within 150m would experience a high to medium visual impact of the Project and some residents of Auld Close, Valla Road, Deep Creek Road and East-West Road would experience a high visual impact.

In addition, The Nambucca Shire 20 year Structure Plan, November 2006–2026 identifies Boggy Creek as the proposed future town centre. This includes a proposed area dedicated to heavy industry, bulky goods and inter-modal transport. The location of the proposed industrial component is on both sides of the Pacific Highway, north of Nambucca Heads. The proposed industrial area starts where the Proposal crosses the existing North Coast Railway line and extends on the western side of the existing Pacific Highway until Deep Creek. The area to the immediate east of this, around Cow Creek is proposed as rural residential land. The visual impact on this area was considered low, with the exception of the proposed rural residential land which was considered to be a medium visual impact

For the section of the upgrade between Ballards Road to the existing Raleigh deviation, the visual impact is identified as low where the Project passes through forested areas as there are no viewers located in the area. The visual impact at the Kalang River valley and bridge crossing of the Proposal has been identified as high to very high, and the visual impact at the northern portion of this section is generally medium to high for the residents on the northern side of Short Cut Road with views to the Project. For residents on South Arm Road within 150 metres of the Project and Ridgewood Drive within 150 metres, the visual impact was identified as high. For residents within 150 metres of the modifications to the Waterfall Way interchange the visual impact was identified as medium. The interchange will be modified to include realignment of on and off ramps. These ramps on the eastern side would be closer to residences on Old Pacific Highway near the interchange. Proposed revegetation adjacent to the ramps will screen the Project and reduce the impacts.

Businesses affected by the proposal include Kara Kar in the south located opposite the rest area and east of the existing Old Pacific Highway. This business is screened from view of the Project due to existing vegetation. In the north, there is a Landscape supplies business on Short Cut Road (screened from view by a landscaped mound). Businesses on Alex Pike Drive will be screened from view by a combination of existing vegetation to be retained and proposed landscaping.

A desktop study has been conducted since the 15% design to ascertain where landscaping can be implemented to screen the affected residences from the highway. In almost all instances screening can be achieved by planting. Where it is identified that the proposed landscaping does not satisfy the visual screening requirements of adjacent residences and businesses (for example at the Kalang River where there are important views available for motorists which should be maintained) at-receptor landscaping will be considered in consultation with the relevant landowner and will be implemented during the construction of the Project.

At receptor landscaping can be more effective at screening as illustrated in the sketch figure H.1.6.1.

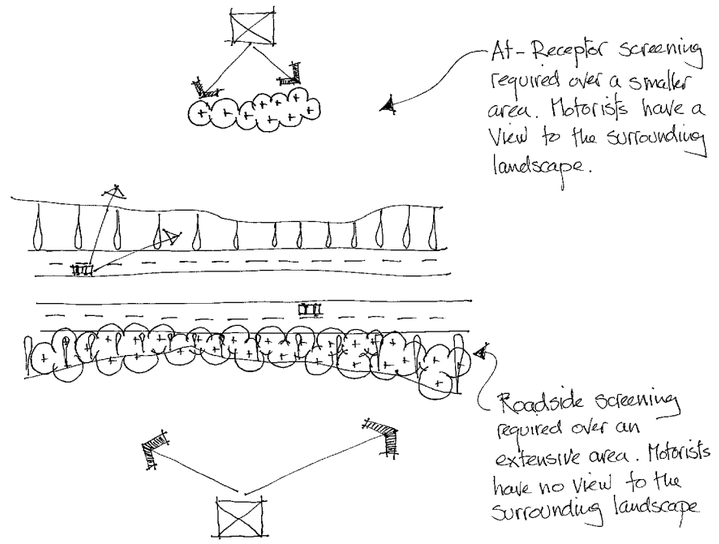


Figure H.1.6.1 Effectiveness of At-receptor landscape screening compared with roadside screening. Roadside screening blocks motorist views of the countryside.

Also since the 15% design, landscape mounds have been proposed (See H.1.5 above). Some of the landscaped mounds are proposed in locations where they contribute to the screening of affected residences.

H.1.7 Access Roads, Ancillary Sites, Temporary Creek Crossings and other Temporary Works.

Ancillary facilities are all temporary site infrastructure required to construct the upgrade and can include site compounds for offices, car parks, toilets sheds, hardstand and batch plants. Six major site compounds are proposed throughout the Project with a major site compound just south of Ballards Road on private land. Where temporary ancillary facilities are located within private lands, the contractor has made arrangements/agreements with the landholder regarding the condition of the subject lands at handover. All subject lands have been through an environmental approvals process.

Where ancillary facilities are located within Roads and Maritime owned land, the site is to be rehabilitated. The area disturbed will be restored at completion by removal of the surplus materials and the surface ripped to the depth and extent of the select material zone. Topsoil (with no compost or other organic matter) will be spread to a depth to restore the final surface to 100mm below finished levels, and A1 horizon topsoil spread to a minimum depth of 100mm. The appropriate hydromulch seed mix or planting will be applied in accordance with the landscape plans from the vegetation community in which the works occurs.

The following summarises the procedures to be followed to protect and minimise the impact of ancillary facilities on the environment:

- be located more than 50 metres from a waterway;
- have ready access to the road network or direct access to the construction corridor;
- be located in areas of low ecological significance and require minimal clearing of native vegetation (not beyond that already required by the Project);
- be located on relatively level land;
- be separated from the nearest residences by at least 200 metres (or at least 300 metres for a temporary batching plant);
- not unreasonably affect the land use of adjacent properties;
- be above the 20 ARI flood level unless a contingency plan to manage flooding is prepared and implemented;
- provide sufficient area for the storage of raw materials to minimise, to the greatest extent practical, the number of deliveries required outside standard construction hours; and
- be located in areas of low heritage conservation significance (including identified Aboriginal cultural value) and not impact on heritage sites beyond those already impacted by the Project.

Ancillary sites identified that do not meet the above criteria shall be assessed against this criteria to demonstrate how any impacts can be mitigated and managed to acceptable standards (including demonstrating consistency with Project impacts identified in the documents to the satisfaction of the Director General. Such assessment(s) can be submitted separately or as part of the Construction Environmental Management Plan.

Temporary Creek Crossings will be restored where disturbance has occurred as for Creek Crossings (Refer to H.2.5)

H.1.8 Stockpile Sites

A Stockpile Management Protocol (May 2013) specific to the NH2U Project outlines the locational criteria used to guide the placement of stockpiles and provides both standard and site-specific mitigation measures to be implemented to minimise impacts on the environment. Stockpile sites may typically be required to store material including, but not limited to:

Refer to the Construction Environment Management Plan (CEMP) for the criteria used to determine the location of stockpiles.

Acid Sulphate Soils (ASS) or mulch stockpile management, including leachate containment, will be in accordance with the SWMP. The Roads and Maritime publication Environmental Direction - Management of Tannins from Vegetation Mulch (January 2012) will be used as a reference document.

H.2 EXISTING VEGETATION PLANTING AND SEEDING AREAS

H.2.1 Revegetation Strategy

The landscape design is focused upon matching the context and character of the landscape through which it passes at the same time as being cognizant of the necessity for providing a cost-effective method of establishing such a large tract of vegetation. The landscape design also augments the existing vegetation patterns by connecting patches of remnant vegetation to each side of the highway and ensuring that the newly installed landscape is not always lining the roadside and creating a linear edge.

A key element of the strategy is the management of topsoil and providing the circumstances for natural regeneration. This is particularly important in forested areas where stored soil seed banks will be present within the existing topsoil, and can be preserved in the stripped topsoil to be returned, and where fringing trees and shrubs will disperse seed into the disturbed areas of the alignment.

Natural regeneration ensures that foreign genotypes are not introduced to the existing vegetation communities and also that the species diversity of the community is not diluted. It also has other benefits. It reduces fertilizer requirements (which can run off and cause algal blooms and fish death in waterways). It also introduces endemic species which are impractical to establish by other means, either because their seed is difficult to collect in quantity or to apply (Terrestrial Orchids, ferns and native lilies) or because they are opportunistic colonizers that will persist or colonise rapidly where conditions are favourable to them without the necessity to include them in seed mixes (*Pteridium esculentum* - Common Bracken and *Calochlaena dubia* – Soft Bracken). However all of these types of plants can be expected to re-colonise disturbed areas with the application of correct topsoil management procedures.

Ideal circumstances would see the majority of the alignment revegetated through natural regeneration, and with seeding mixes (described below) as a stop gap measure or back-up plan to be deployed where obvious failures in the topsoil strategy are observed.

Planting and seeding schedules have been devised based upon the plant communities identified in the Flora and Fauna assessments and also through ground-truthing investigation by the design team. Eight communities are identified as being relevant to the NH2U alignment.

Cleared lands also occur as a vegetation community type along the alignment. Flat cleared lands are used for grazing, orchards (mostly Macadamia) or hobby farms with occasional remnants of regenerating vegetation and often (as clearings occur on floodplain areas) wetland vegetation. The landscape treatment for cleared areas is generally to revegetate with pasture grasses or native grasses depending on the context, with scattered tree planting where required to retain/frame views to floodplains. Tree species will match the former vegetation community type that would have occurred prior to clearing as evidenced from vegetation remnants. Sedge planting for basins and channels will use species from the Freshwater Wetland vegetation community. Stripped topsoil from pasture areas must be quarantined from forest soils so that the weed seed contained in these soils is not returned to forest areas.

The eight vegetation communities are relatively undisturbed forested areas with Blackbutt Dry Sclerophyll Forest Community being the most abundant. Each of these communities has grass, groundcover and shrub species which are common to all communities, therefore four seed mixes have been developed for the alignment which can be used throughout. None of the mixes contain tree seed, Targeted tree planting of diagnostic tree species will provide the match with each particular vegetation community.

This is a valid approach for devising the seeding mixes since many of the species from minority vegetation communities recorded along the proposed alignment will not be suited for revegetation purposes on embankments where the microclimate for establishment is difficult.

Table H.2.1.1 Descriptions and Landscape Treatments of Vegetation Communities

Vegetation Community	Community Description	Landscape Treatment
Blackbutt Dry Sclerophyll Forest	The most abundant community crossed by the study area and associated with elevated hills and slopes The understorey is sparse with a tall shrub layer dominated by Allocasuarina and groundcover dense with grasses, ferns and herbs	Natural regeneration where feasible. Hydromulching shrubs and groundcovers with tree planting in selected locations.
Mixed Floodplain Forest (EEC)	Gullies in low elevated areas to 10 metres elevation including Newry and Little Newry State Forest, private lands north of Nambucca Heads, riparian zones of, Kalang River, Boggy Creek and Oyster Creek	Natural regeneration where feasible. Hydromulching shrubs and groundcovers with tree planting in selected locations. Planting is intensified at creek crossings where this community occurs.
White Mahogany/Grey Gum/ Ironbark Open Forest	Occupies mid-slope areas and minor gullies in the Newry State Forest and private properties north of the Kalang River	Natural regeneration where feasible. Hydromulching shrubs and groundcovers with tree planting in selected locations.
Flooded Gum Open Forest	Mid-slope areas and minor gullies at the North Coast Railway crossing, proposed rest area site, Cow Creek crossing, Western end of Burke Lane, patches between Burke Lane and Ballards Rd and patches south and north of the Kalang River floodplain.	Natural regeneration where feasible. Hydromulching shrubs and groundcovers with tree planting in selected locations.
Swamp Mahogany/Paperbark – Swamp Forest (EEC)	Predominantly east of the study area between Raleigh and the Kalang River. Smaller remnants occur adjacent to the existing highway and on private property adjoining Newry State Forest and remnants on low-lying areas on waterlogged soils adjoining creeks, wetlands and river flats.	Natural regeneration where feasible. Hydromulching shrubs and groundcovers with tree planting in selected locations. Planting is intensified at creek and fauna crossings where this community occurs.
Swamp Oak – Swamp Forest (EEC)	The floodplain of Deep Creek and in agricultural land at Raleigh and adjoining mangroves.	Natural regeneration where feasible. Hydromulching shrubs and groundcovers with tree planting in selected locations.
Freshwater Wetland - (EEC)	Occurs within damp depressions within cleared pasture adjoining Deep Creek and the Kalang River. Species from this community to be represented in basins along the upgrade.	Topsoil from this community will not be stripped. Species from this community to be represented in basins, drainage channels and frog ponds along the upgrade. Dominated by sedges and macrophytes. To be re-introduced via seeding and planting.

Informal avenue of Blackbutts on Boggy Creek Road (top) and at trail off South Arm Road amongst White Mahogany and Grey Gum (bottom). A precedent to be matched at local Road Intersections.

Excellent vegetation cover and species diversity resulting from topsoil management to preserve the soil seedbank at Pacific Highway Upgrade Glenugie. No Hydroseeding has been used on these embankments other than cover crop.

H.2.2 Seeding

Seed mixes have been developed for various purposes including:

- **Native Grass seed mix** containing endemic native grass and sedge species where mowing/maintenance may be required for medians, verges, fauna fence access, where sightlines must be maintained and to allow views. The mix contains sedges which are able to withstand infrequent mowing and ensure that species will persist where moist patches or standing water occur.

Schoenus melanostachys at the Martells Rd intersection site. Endemic sedges such as this species are found throughout the alignment and are able to withstand dry conditions. Sedges are included in the Native Grass seed mix.

- **Frangible shrubs seed mix** containing endemic native grasses, sedges and frangible shrubs species for embankment areas within the safety clearance zone (up to 11 metres from the edge of carriageway), and where headlight glare minimisation is required in the median.
- **Tall shrubs seed mix** containing endemic native grasses, sedges and shrubs and tall (non-frangible) shrubs species for use on embankments beyond the safety clearance zone.

Regenerating *Callistemon salignus* near Boggy Creek. One of the endemic shrub species to be used in the Tall shrubs seed mix which includes fast growing and easily established colonizing shrubs.

- **Pasture grass seeding mix** is included for areas where grass cover is required which includes both Couch Grass and Carpet Grass with cover crop. Couch establishes rapidly and forms a thick sward of rhizomes which will effectively resist erosion and is tolerant of saline and acidic soils and aluminium toxicity. Couch is regarded as a native and is prevalent in the adjoining paddocks, although it also occurs outside Australia. Carpet Grass is a naturalised species in the region and found in the adjacent pasture which establishes easily but is not aggressive.
- **Cover crop seed mix** of fast growing annual grasses is to be applied to all disturbed areas of the site. The purpose of the cover crop application is to stabilise the surface material, particularly batters, and to provide an effective barrier to erosion until the germination of native plants which are typically slower to germinate.

Depending upon programming and construction staging, the cover crop may be applied separately or (preferably) in conjunction with the final native seed mix. For pasture grass only mixes, the seed of couch, Carpet Grass and cover crop are applied simultaneously. Should the seeding fail at any time it can be reapplied until it establishes.

Cover crop seeding is also be used to minimise erosion and weed establishment on topsoil stockpiles.

Tree seed is not included in any of the seeding mixes. Trees are to be introduced by:

- Targeted planting;
- Return of topsoil containing a soil seedbank; and
- Opportunistic seeding from trees in the fringing forest vegetation of the alignment which can be anticipated to occur at the top and bottom of embankments away from the road edge within the first two years following preparation. (See B.7 Planting and Seeding Schedules)

The species selected for seeding mixes are those occurring along the proposal footprint known to be hardy, drought tolerant and to establish quickly from seed. For example *Acacia* species are represented in the seed mix but are not included in planting mixes. Species which are more difficult to establish from seed, and all tree species are included in planting only.

Pasture Grass Seeding Vs. Native Grass Seeding

Upon reviewing the areas of native grass seeding proposed in the Preliminary Detailed Design it was determined that native grasses would establish most successfully in the extensive forested areas throughout the alignment. This is due to there being no adjacent pasture areas present in the forest areas vicinity from which pasture species or other weed species can invade. On the other hand, when the alignment passes through largely disturbed areas (areas with a high occurrence of weeds) or areas where there is adjacent pasture, it would be unlikely that native grass can establish successfully due to competition from pasture species which colonise more rapidly and can easily invade from adjacent paddocks. Consequently the extent of Pasture Grass Seeding has been increased and the extent of Native Grass Seeding has been reduced. There is now approx.13km of pasture grass and 9km of native grass along the alignment.

There is also the advantage of aggregating the areas of pasture grass and native grass for the purposes of maintenance. Refer to Figure H.2.2.1 which illustrates the extent of native and pasture grass.

Seed Application and mulch

Generally seed is applied through hydromulching. However due to the increased risk from erosion on batters typically under 5 metres high where SO gutters are not used and where pavement runoff will spill over batters due to superelevation, the seed application for NH2U will also include a two-step application comprising hydroseeding of native seed, followed by a strawmulching application (applied hydraulically) of a minimum thickness of 25mm of rice or sugar cane straw. Rice or sugar cane straw has a superior binding capability and lasts longer than other mulches that are able to be applied hydraulically. This treatment will also be used where slopes steepen from 2H:1V and up to 1.5H:1V. Straw mulch does not present a risk to receiving environments from tannins.

Long Batters

In agreement with Roads and Maritime, short benches have been removed where the second batter slope was considered too short to warrant the inclusion of benching. Where slopes are greater than 10 metres in height, a synthetic reinforced erosion control mat will be installed under the topsoiling to counter possible increased erosive potential. Long batter locations are shown in the landscape plans.

Figure H.2.2.1 Map showing proposed extent of pasture grass seeding and native grassing

H.2.3 Planting

Planting mixes have been devised in accordance with extant vegetation communities crossed by the proposal in order to match the landscape context through which the alignment passes. Planting mixes contain predominantly trees because trees are the diagnostic species for each community. In addition all trees are to be planted (rather than seeded) in order to control their location in areas beyond clear zones and safety clearances as well as to prevent tall Eucalypts located in positions where they might overhang the corridor. A limited palette of shrubs and groundcovers from each community is also included for specific purposes such as screening, fauna crossings, bank stabilization and basins. (See H.4 Planting and Seeding Schedules)

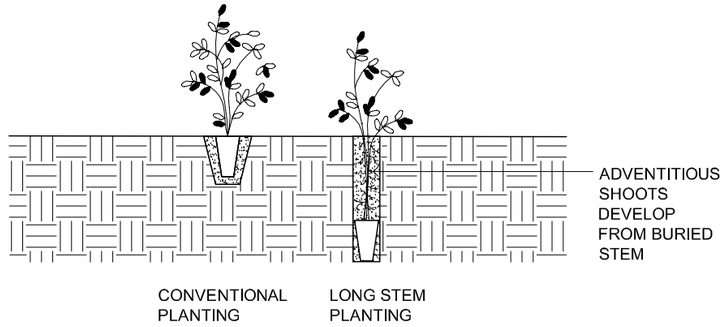
Planting also serves another important purpose – due to the lineal quality imposed by the fauna fence and the requirement to provide only grass cover for three metres each side of the fence, planting can function to connect disparate patches of vegetation which straddle the alignment laterally and thereby visually interrupt the linearity of the roadside edge.

Advanced Planting

Larger planting stock (min 25 Litre) is used for feature and marker plantings at the rest area and major intersections at not less than one tree/9m^2. As elsewhere, the feature planting is of diagnostic tree species, except at the rest area where Hoop Pines (75 Litre stock) and Cabbage Tree Palms are used (refer to section F.1) and at the widened cut where new microclimatic conditions favour the planting of endemic rainforest trees.

Long Stem Planting

Long stem planting will be deployed throughout the Project where feasible, where it will advantage establishment on fill batters and at creek crossings, with the exception of those species which cannot be procured as long stem stock. Long stem planting is the deeper planting of either especially grown stock (in order to develop an elongated stem) or stock which has been crowded in the nursery or has outgrown its pot. Long stem planting buffers the planting stock against heat and the drying out of surface soils because the roots are kept cool and moist at the deeper levels. New adventitious shoots develop from the stem in contact with the soil. Long stem planting is more resistant to the type of erosion encountered in the proximity of waterways. The procedure can also be deployed for most tussock and sedge species.



H.2.4 Typical landscape cross-sections

The typical landscape cross sections illustrate the adherence to safety clearance distances and where grasses, frangible shrubs and non-frangible shrubs are proposed to be used. Some of the standard clearances used are:

- Non-frangible vegetation at a minimum 11metres from the edge of travel lane;
- Frangible shrubs at a minimum of six metres from the edge of travel lane;
- Two metre wide native or pasture grass strip at the carriageway edge of medians;
- 4.3 metres wide frangible shrubs in median when in forested areas or where required to mitigate headlight glare;
- No shrubs in the 1.7 metre deflection zone behind wire rope barriers;
- Native grasses only within three metres of both sides of the fauna fence to allow for maintenance access; and
- No vegetation on benches in cuttings or fills.

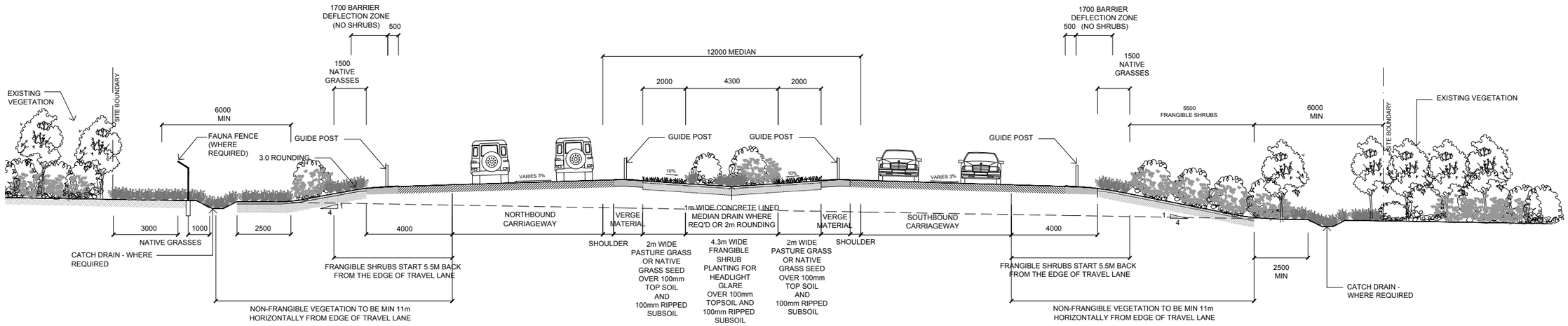


Figure H.2.4.1 Typical Cross Section 1: Typical low embankment < 2.5m high - normal crossfall

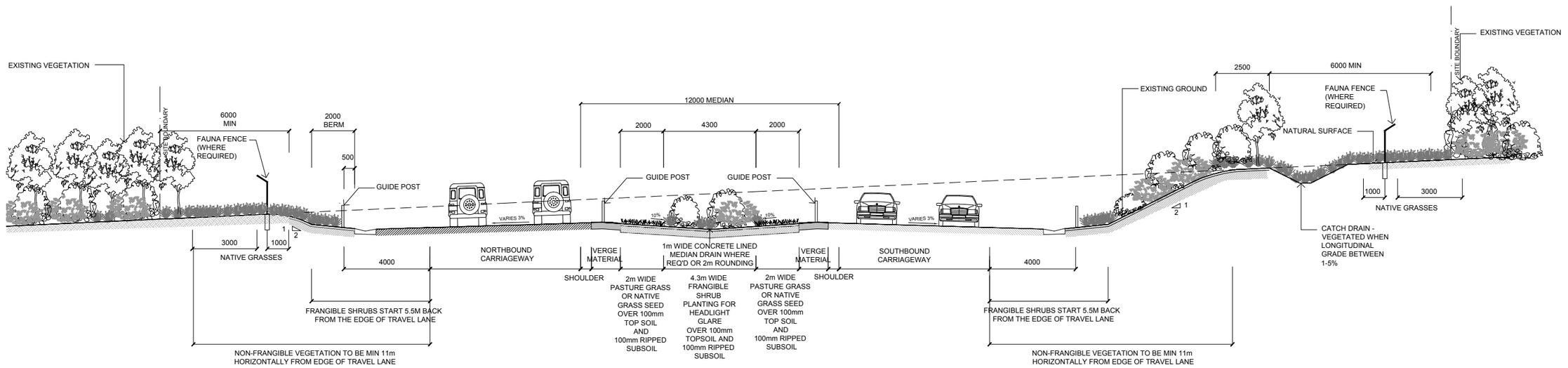


Figure H.2.4.2 Typical Cross Section 2: Typical shallow cutting < 10m high - normal crossfall

0 10 20m

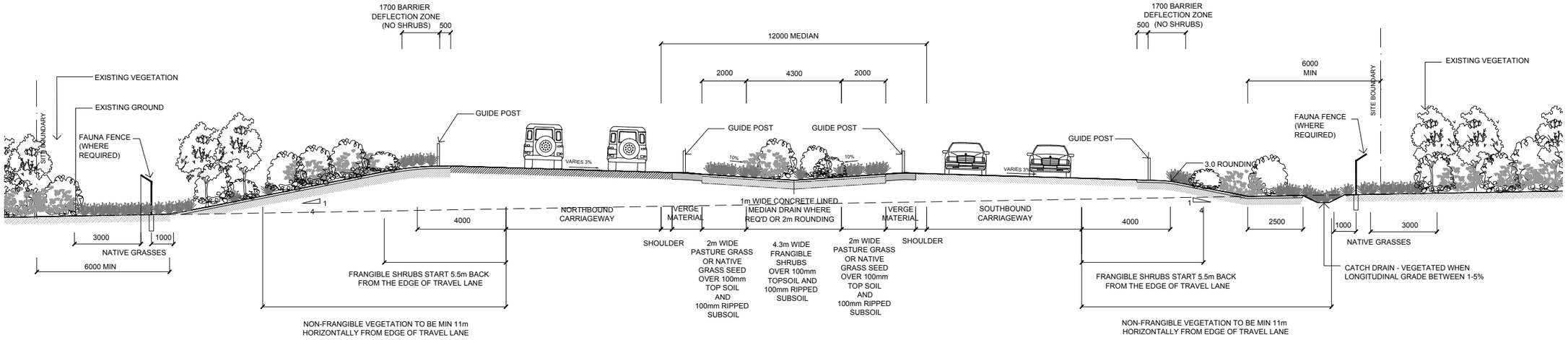


Figure H.2.4.3 Typical Cross Section 3: Typical low fill < 2.5m high - on superelevation

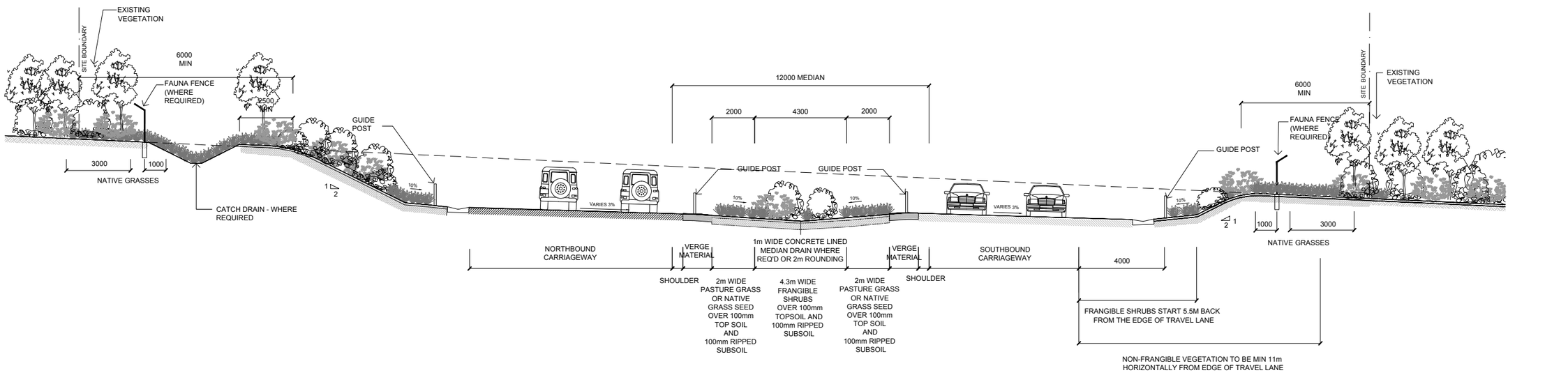


Figure H.2.4.4 Typical Cross Section 4: Typical shallow cutting < 10m high - on superelevation

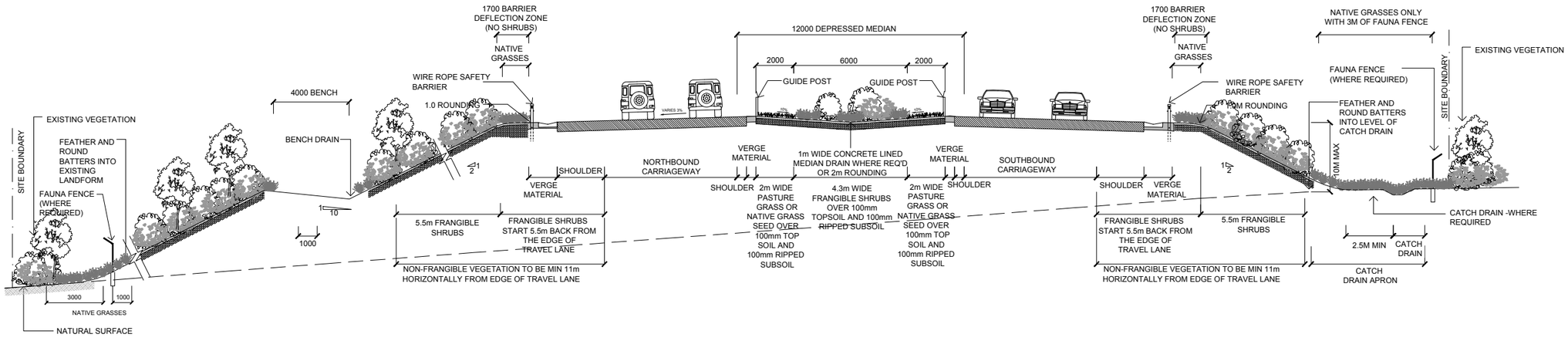


Figure H.2.4.5 Typical Cross Section 5: Typical high embankment > 2.5m high - normal crossfall

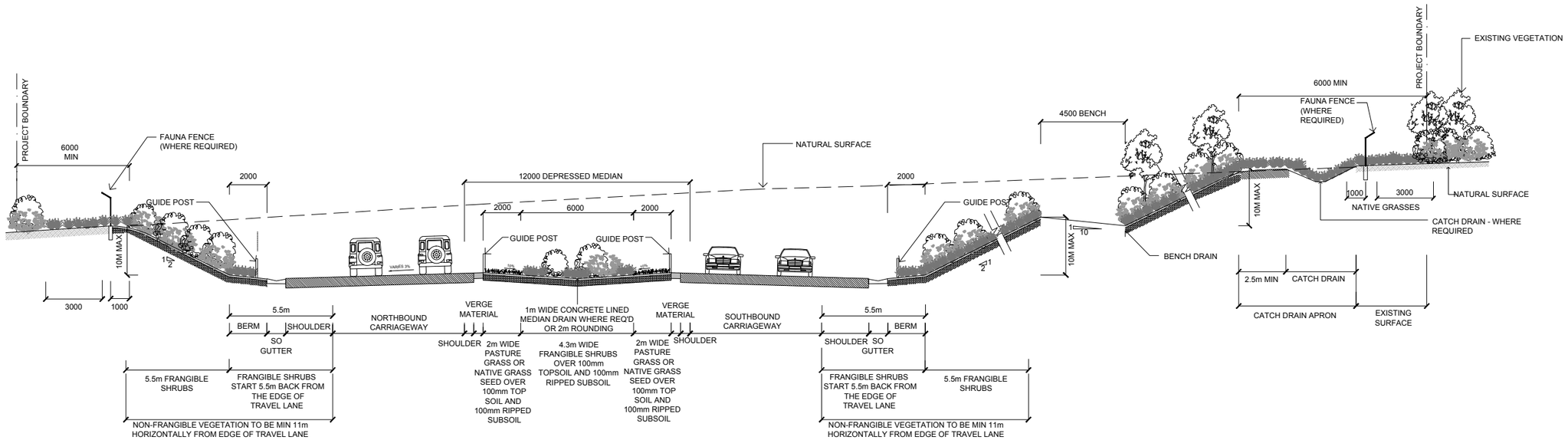


Figure H.2.4.6 Typical Cross Section 6: Typical deep cutting > 10m high with 2:1 batters - normal crossfall

0 10 20m

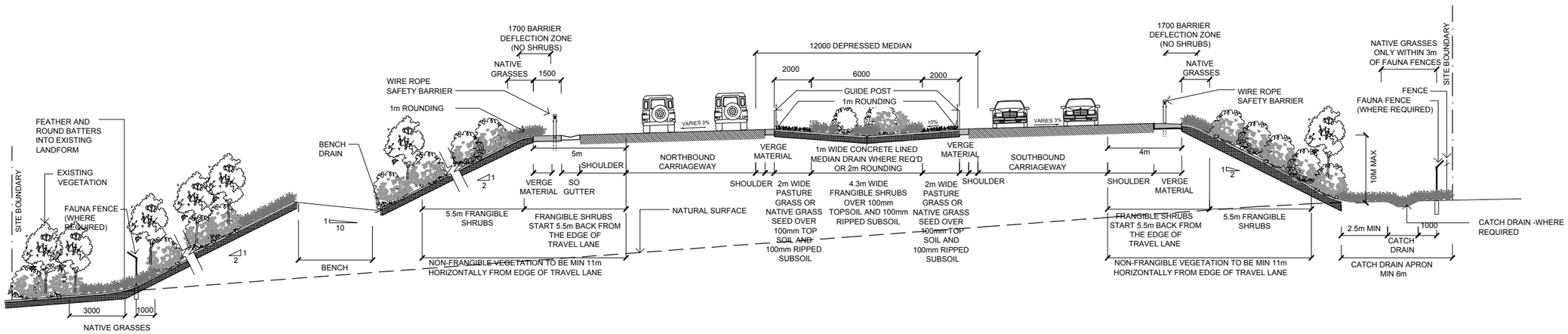


Figure H.2.4.7 Typical Cross Section 7: Typical high embankment > 2.5m high - on superelevation

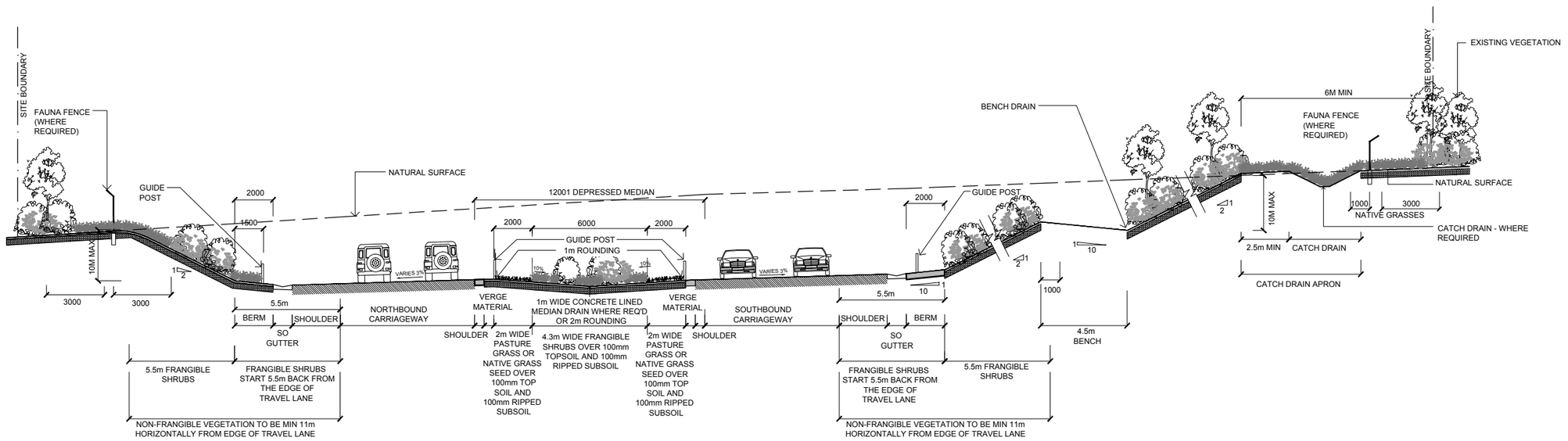


Figure H.2.4.8 Typical Cross Section 8: Typical deep cutting > 10m high with 2;1 batters - on superelevation

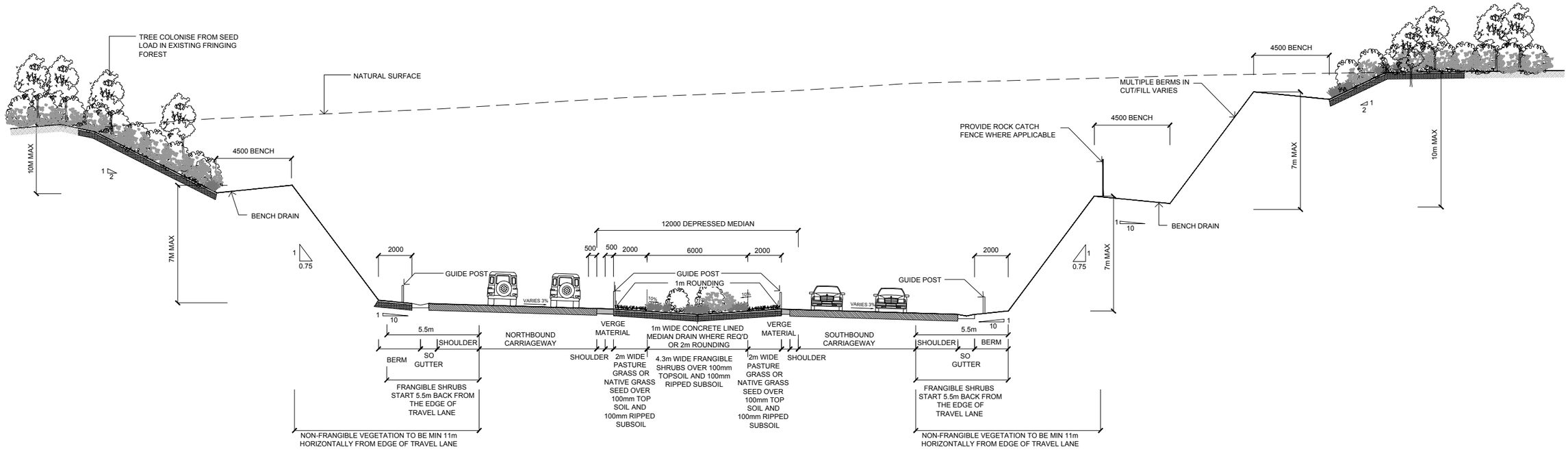


Figure H.2.4.9 Typical Cross Section 9: Typical rock cutting with .75:1 to 2:1 batters - on superelevation

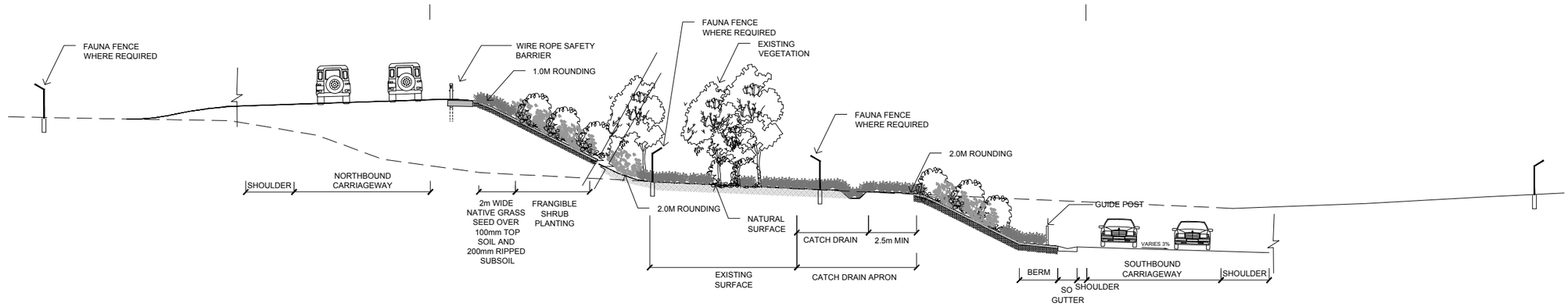


Figure H.2.4.10 Typical Cross Section 10: Widened median

H.2.5 Creek Rehabilitation, Fish and Fauna Crossings

Creeks affected by the alignment will be rehabilitated to return the creek to their former or better condition and to maximise wildlife habitat connectivity. Waterway realignments have been designed to mimic, to the greatest extent possible, the natural characteristics of the waterway that is being diverted.

Individual landscape plans will be prepared for each waterway crossing that is re-aligned to allow the construction of bridges. These include Boggy Creek, Cow Creek, Oyster Creek, Dalhousie Creek, McGraths Creek Floodplain 1 and 2 and unnamed creek at Stn 79900.

Generally the creeks are to be restored with riparian species planted directly into the replaced creek bed material and on embankments which have been topsoiled. The full extent of the low-flow channel and riparian benches are to be lined with organic fibre mesh or mat. Rock beaching is used to prevent erosion on the embankments facing the direction of flow and site-won felled timber logs with root wads are proposed to be buried into the bank in combination with bracing boulders. For further details of the waterway realignment treatments refer to Design Lot DT1 and DT2. For details of species to be used refer to the plant schedules.

Fish and fauna crossings comply with Appendix 15 of the SWTC in regard to biodiversity, protection and recovery measures, and will include other environmental design requirements described in table 1 of Appendix 5 of the SWTC. These requirements include plantings to attract fauna, allowing unobstructed views to, and through the underpass, and strategic tree plantings for fauna refuge. Many of the drainage lines and creeks crossed by the highway are intermittent and respond to seasonal rains.

There are 27 fauna underpasses (not including arboreal crossings) including 10 twin underbridges and 17 box culverts. The landscape treatments for each fall into several broad categories:

The typical landscape treatment for box culverts which combine drainage and fauna underpass in forest areas is shown in Figure H.3.5.2.

Measures to assist the landscape establishment at combined Fauna/Drainage crossings include:

- Organic fibre mesh pinned to embankments 2H:1V or steeper, over 50-100mm depth of additional topsoil through which tubestock sedges, macrophytes and tussocks are planted. The mesh is to cover the embankment to the top of the channel or to the extent of disturbed ground.
- Site rocks of various size from 500-1000mm in natural formation to assist holding down mesh and for scour protection where the new work interfaces with the existing creek channel (This treatment is for zones beyond scour protection and only where rocks occur in the natural creek bed).
- Beyond the zone of normal high water begins the typical landscape zone of trees shrubs and groundcovers with 100-200 additional topsoil if required and 75mm mulch if planted.
- Rice straw mulch is used in place of site-won tub-ground mulch in the proximity of riparian zones to prevent tannins from leaching into the waterways.
- Planting of riparian vegetation species including plants such as Lomandra hystrix and sedges known to bind embankments and resist erosion at creek crossings.

Table H.2.5.1 Locations and Treatments of Fauna Crossings

Station	Vegetation Community	Structure and purpose	Landscape Treatment
62km750 Twin Bridges over Boggy Creek Service Road Bridge over Boggy Creek 63km650 Cow Creek	Mixed Floodplain	Bridges over creeks or floodways in floodplain	For general fauna species. Tree shrub and groundcover planting to provide connectivity to existing remnant vegetation patches with species froom the extant vegetation community.
64km900 Deep Creek	Swamp Oak		
71km550 McGrath Ck Floodplain 1	Flooded Gum		
74km800	Mixed Floodplain		
76km990 81km885	Swamp Oak		
73km370/ 73km400 Dalhousie Ck	Blackbutt	Bridges over creeks in forested areas	Full complement of trees, shrubs, grasses and groundcovers to match the density of the existing forest.
79km865/ 79km930 twin bridges over unnamed Ck.	White Mahogany/Grey Gum		
Twin Bridges over North Coast Rail	Flooded Gum	Proposed as a replacement for deleted culvert at 61km690	Vegetation Clearances to rail to be observed
66km180 67km125 69km715	Blackbutt	Box culverts or pipes which combine drainage and fauna underpass in cleared/ pasture areas	For general fauna species. Depending on context, tree planting only with grasses to match context
82km405	Swamp Oak		
68km405 70km145 70km435 72km720 73km780 73km795 75km275	Blackbutt	Box culverts or pipes which combine drainage and fauna underpass in forest areas	Full complement of tree and shrubs and groundcover planting with planting to suit targeted species and match the density of the existing forest.
75km825	White Mahogany/Grey Gum		
76km320 76km560 78km795	Blackbutt		
80km220	White Mahogany/Grey Gum		

Fauna escape poles are located on the embankment out of the main channel and approximately two metres from the end of the headwall. A second pole is to be provided where existing trees are more than 10 metres from the first pole.

Frog Ponds

Where frog breeding ponds are required for Green-thighed Frogs as detailed in section 14.3 and 14.4 of Appendix 14 of the SWTC and below;

- Approximate Stn 74665 – Both side of the carriageway;
- Approximate Stn 79845 – Eastern side of carriageway; and
- Approximate Stn 80015 – Western side of carriageway.

Five frog ponds are required at each location. TYey will be constructed as shown in Figure H.2.5.1.

The final location and construction of each pond will be supervised by the Project Ecologist and undertaken in consultation with the EPA and will comply with the requirements specified in the Warrell Creek to Urunga – Green-thighed Frog Management Strategy (Appendix 14.4.pdf of Appendix 14 of the SWTC). Grasses and sedges from the Freshwater Wetland vegetation community (see plant schedules) will be planted to provide habitat and refuge from predators on the margins of the ponds.

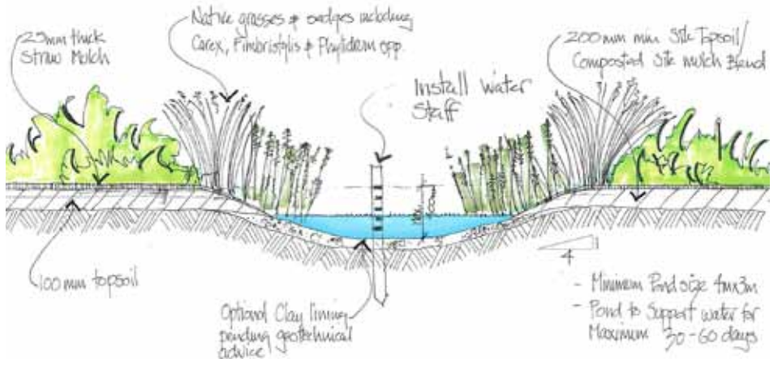
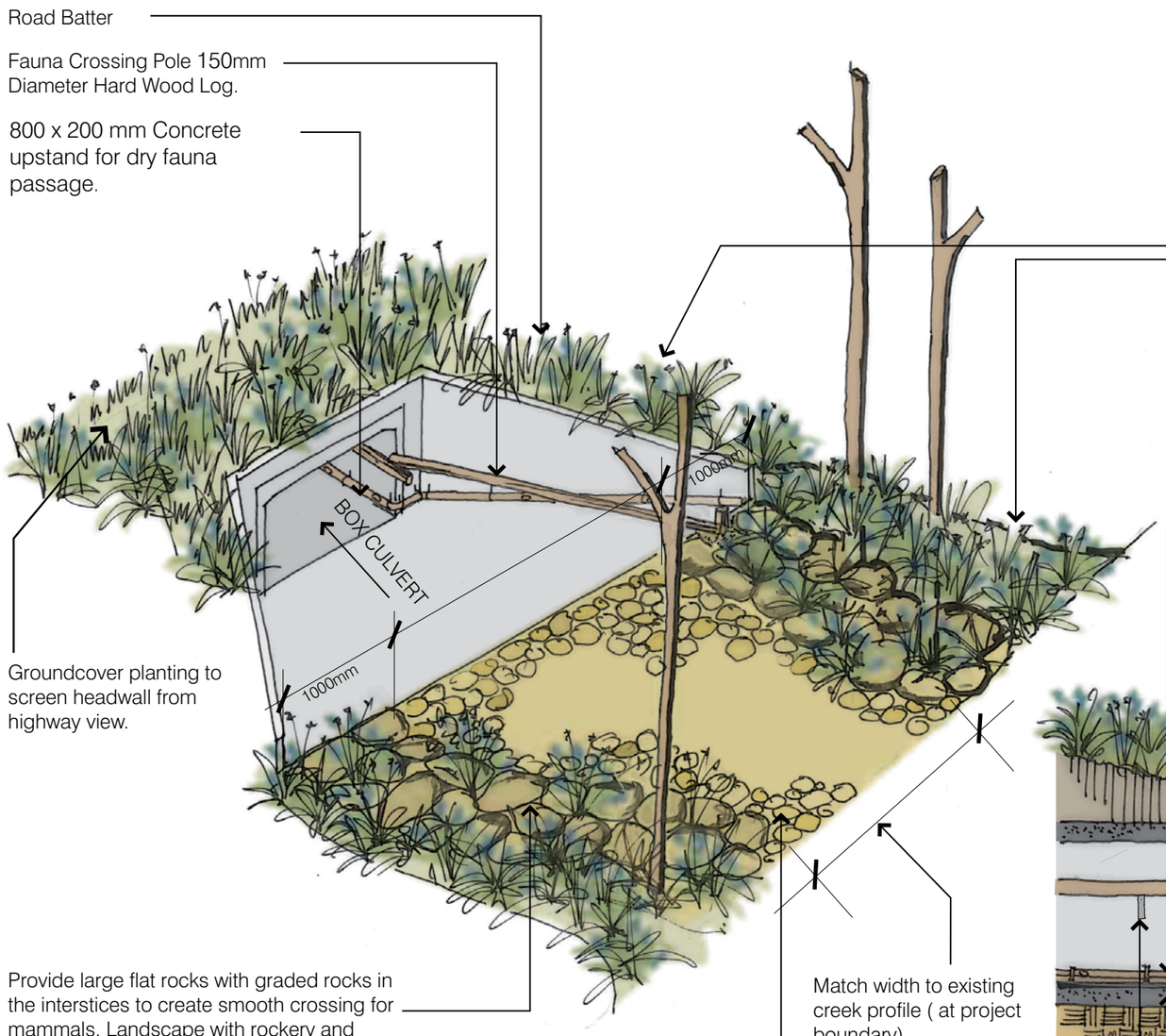
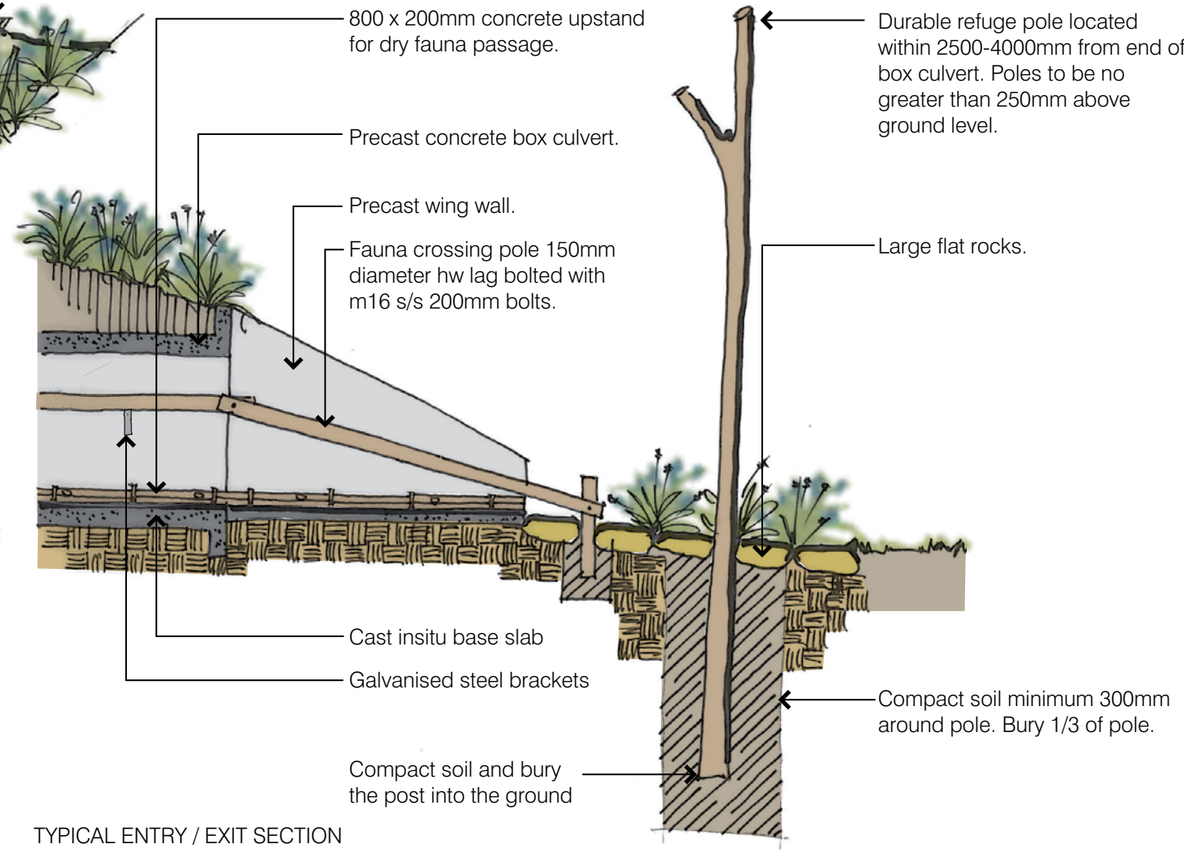


Figure H.2.5.1 Indicative landscape treatment for Green Thighed Frog Breeding Ponds



TYPICAL ENTRY / EXIT



TYPICAL ENTRY / EXIT SECTION

Figure H.2.5.2 Typical Box Culvert Treatment

H.3 URBAN AND LANDSCAPE DESIGN PLANS

Refer to Figure H.3.1 - H.3.23.

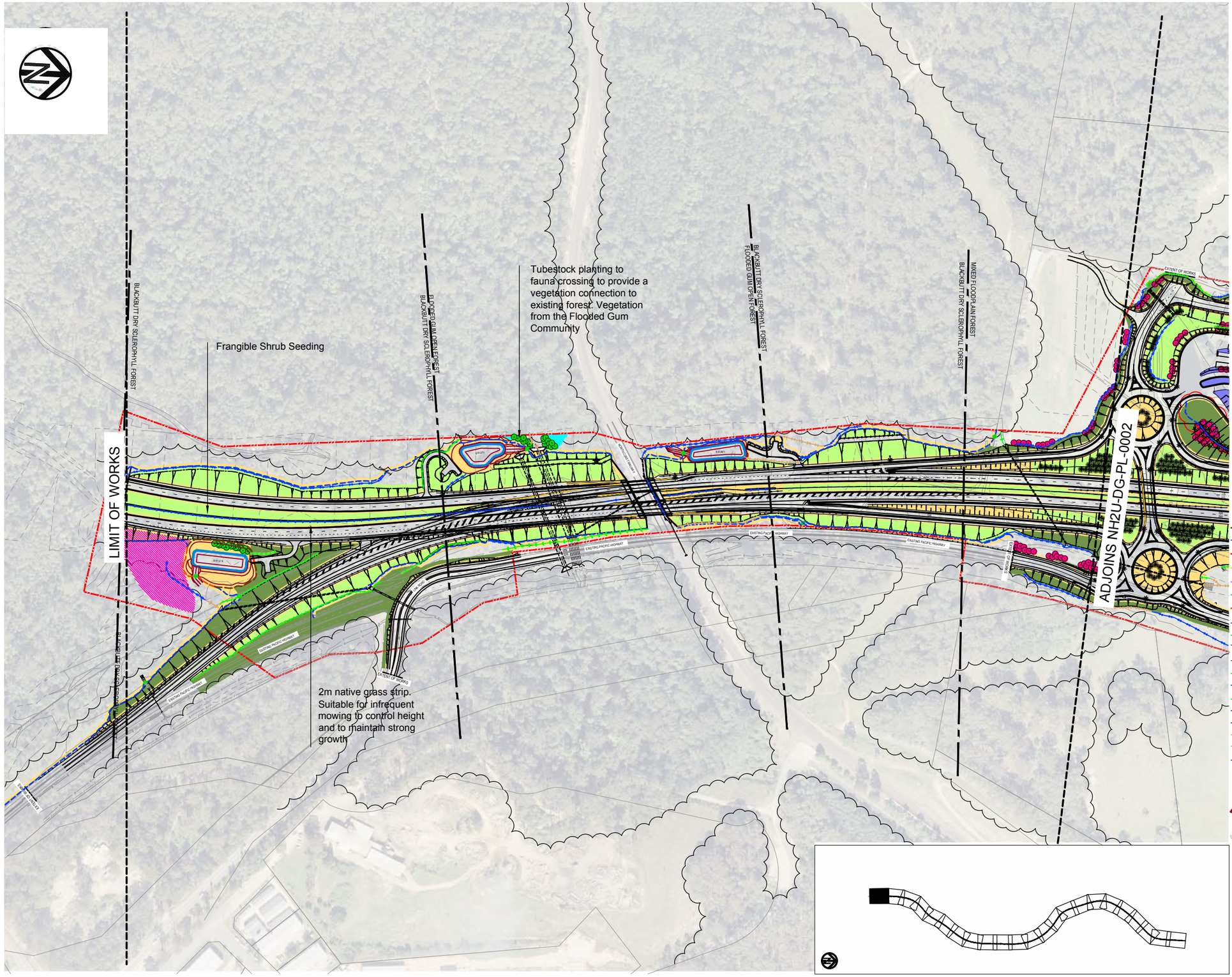
The following urban and landscape plans, drawn at 1:4000 on an aerial photographic base are based upon the principles outlined in the urban and landscape design strategy and proposed treatments. They illustrate the integrated urban design and landscape outcome for the project. The plans show:

- Existing adjacent context;
- Proposed landscape treatments along the route;
- Proposed landscape treatments at key interchanges;
- Wetland planting and detention ponds and associated screening where applicable;
- Visual screening of residences where required;
- Fauna underpasses;
- Landscape treatments of cuttings and embankments;
- Landscape treatment to reduce head light glare;
- Key views to be retained;
- Bridges;
- Retaining walls; and
- Rest Area.

Where visual screening is required for residences where it is currently not shown, consultation with affected receptors will be conducted in order to identify opportunities for providing at-receptor screen planting. Where agreed with the landowner, these measures will be implemented during the construction phase.

The landscape installation will be carried out progressively with topsoiling and seeding followed by planting of disturbed areas installed as work site becomes available. The implementation of topspoil management to preserve the soil seedbank will also aid in the progressive revegetation.

Further detail of the Rest Area is provided in Section F. Further detail for the landscape design is provided in Section G.



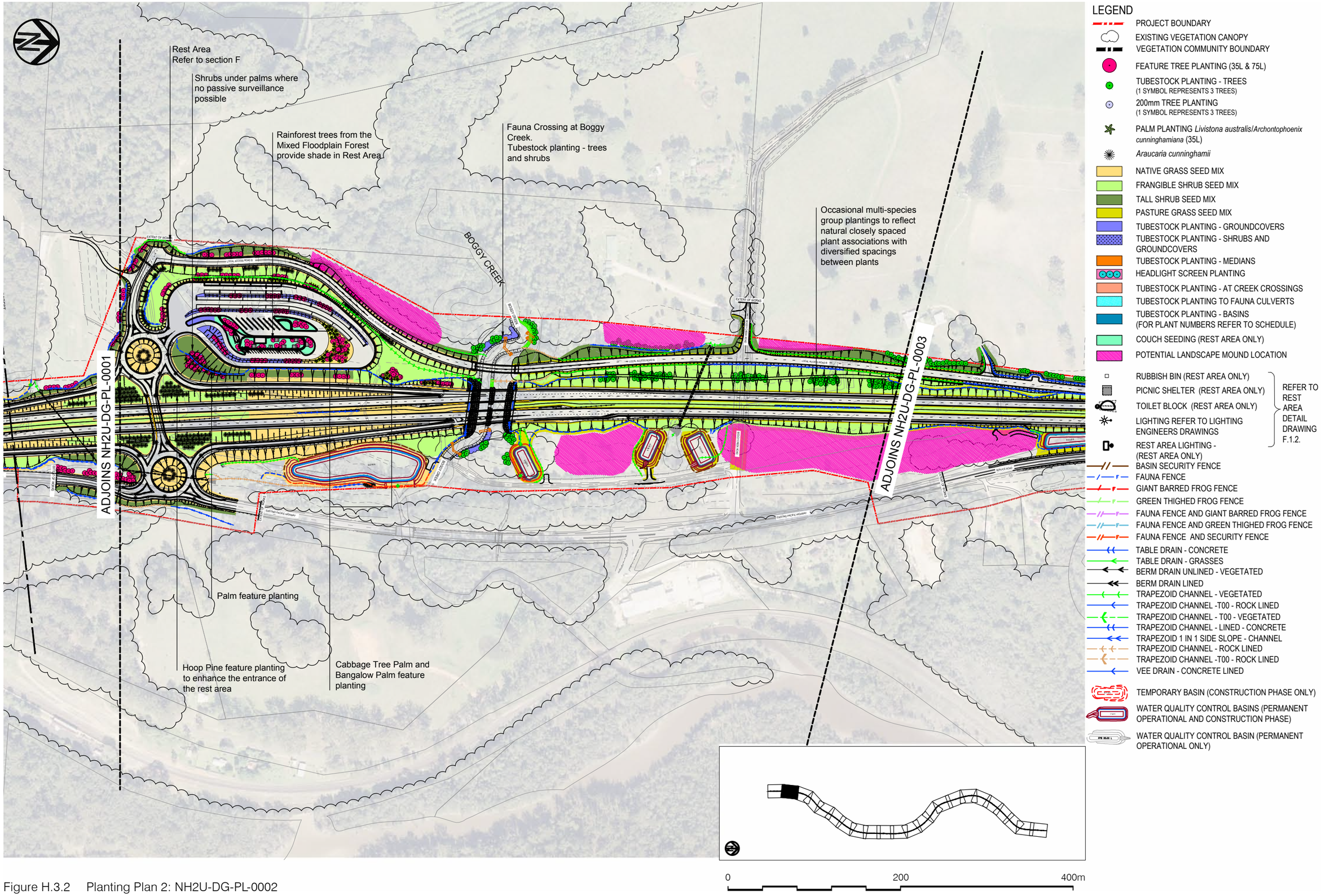
LEGEND

- PROJECT BOUNDARY
- EXISTING VEGETATION CANOPY
- VEGETATION COMMUNITY BOUNDARY
- FEATURE TREE PLANTING (35L & 75L)
- TUBESTOCK PLANTING - TREES (1 SYMBOL REPRESENTS 3 TREES)
- 200mm TREE PLANTING (1 SYMBOL REPRESENTS 3 TREES)
- PALM PLANTING *Livistona australis*/*Archontophoenix cunninghamiana* (35L)
- *Araucaria cunninghamii*
- NATIVE GRASS SEED MIX
- FRANGIBLE SHRUB SEED MIX
- TALL SHRUB SEED MIX
- PASTURE GRASS SEED MIX
- TUBESTOCK PLANTING - GROUNDCOVERS
- TUBESTOCK PLANTING - SHRUBS AND GROUNDCOVERS
- TUBESTOCK PLANTING - MEDIANS
- HEADLIGHT SCREEN PLANTING
- TUBESTOCK PLANTING - AT CREEK CROSSINGS
- TUBESTOCK PLANTING TO FAUNA CULVERTS
- TUBESTOCK PLANTING - BASINS (FOR PLANT NUMBERS REFER TO SCHEDULE)
- COUCH SEEDING (REST AREA ONLY)
- POTENTIAL LANDSCAPE MOUND LOCATION
- RUBBISH BIN (REST AREA ONLY)
- PICNIC SHELTER (REST AREA ONLY)
- TOILET BLOCK (REST AREA ONLY)
- LIGHTING REFER TO LIGHTING ENGINEERS DRAWINGS
- REST AREA LIGHTING - (REST AREA ONLY)

REFER TO REST AREA DETAIL DRAWING F.1.2.

- BASIN SECURITY FENCE
- FAUNA FENCE
- GIANT BARRED FROG FENCE
- GREEN THIGHED FROG FENCE
- FAUNA FENCE AND GIANT BARRED FROG FENCE
- FAUNA FENCE AND GREEN THIGHED FROG FENCE
- FAUNA FENCE AND SECURITY FENCE
- TABLE DRAIN - CONCRETE
- TABLE DRAIN - GRASSES
- BERM DRAIN UNLINED - VEGETATED
- BERM DRAIN LINED
- TRAPEZOID CHANNEL - VEGETATED
- TRAPEZOID CHANNEL -T00 - ROCK LINED
- TRAPEZOID CHANNEL - T00 - VEGETATED
- TRAPEZOID CHANNEL - LINED - CONCRETE
- TRAPEZOID 1 IN 1 SIDE SLOPE - CHANNEL
- TRAPEZOID CHANNEL - ROCK LINED
- TRAPEZOID CHANNEL -T00 - ROCK LINED
- VEE DRAIN - CONCRETE LINED
- TEMPORARY BASIN (CONSTRUCTION PHASE ONLY)
- WATER QUALITY CONTROL BASINS (PERMANENT OPERATIONAL AND CONSTRUCTION PHASE)
- WATER QUALITY CONTROL BASIN (PERMANENT OPERATIONAL ONLY)

Figure H.3.1 Planting Plan 1: NH2U-DG-PL-0001



LEGEND

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- TALL SHRUB SEED MIX
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- TUBESTOCK PLANTING - MEDIANS
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- TUBESTOCK PLANTING TO FAUNA CULVERTS
- TUBESTOCK PLANTING - BASINS (FOR PLANT NUMBERS REFER TO SCHEDULE)
- COUCH SEEDING (REST AREA ONLY)
- POTENTIAL LANDSCAPE MOUND LOCATION
- RUBBISH BIN (REST AREA ONLY)
- PICNIC SHELTER (REST AREA ONLY)
- TOILET BLOCK (REST AREA ONLY)
- LIGHTING REFER TO LIGHTING ENGINEERS DRAWINGS

REFER TO REST AREA DETAIL DRAWING F.1.2.

- REST AREA LIGHTING - (REST AREA ONLY)
- BASIN SECURITY FENCE
- FAUNA FENCE
- GIANT BARRED FROG FENCE
- GREEN THIGHED FROG FENCE
- FAUNA FENCE AND GIANT BARRED FROG FENCE
- FAUNA FENCE AND GREEN THIGHED FROG FENCE
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- TRAPEZOID CHANNEL -T00 - ROCK LINED
- VEE DRAIN - CONCRETE LINED
- TEMPORARY BASIN (CONSTRUCTION PHASE ONLY)
- WATER QUALITY CONTROL BASINS (PERMANENT OPERATIONAL AND CONSTRUCTION PHASE)
- WATER QUALITY CONTROL BASIN (PERMANENT OPERATIONAL ONLY)

Figure H.3.2 Planting Plan 2: NH2U-DG-PL-0002