BEFORE AN EXPERT PANEL
SOUTHLAND WIND FARM PROJECT

Under the	**FAST-TRACK APPROVALS ACT 2024**
In the matter of	an application for resource consents, a concession, wildlife approvals, an archaeological authority and approvals relating to complex freshwater fisheries activities in relation to the Southland Wind Farm project
By	**CONTACT ENERGY LIMITED**
	Applicant

SOUTHLAND WIND FARM TECHNICAL ASSESSMENT #9: CONSTRUCTION EFFECTS

LUKE DAVID GORDON, EDWYN LADLEY, VAUGHAN JOHN MARTIN AND LENNIE JAMES PALMER

18 August 2025

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. The Southland Wind Farm Project (**Project**) will be comprised of up to 55 wind turbines, each up to 220m in height, with associated infrastructure including access tracks, turbine hardstands, a substation, operations building, transmission line and a switching station (also referred to as a Grid Injection Point).

2. The Wind Farm Site spans approximately 5,800 hectares in eastern Southland, split between farmland (Jedburgh and Glencoe Stations) and plantation forestry (Matariki / Venlaw Forest), with the nearest turbine about 12 km east of Wyndham.

3. The area features a mix of cleared pasture, regenerating native bush (manuka/kanuka), sub-alpine vegetation, and plantation forestry (Douglas Fir and pine).

4. Approximately 72.8 km of access tracks will be constructed or upgraded to provide access to turbine locations, a further 5.4 km of tracks are required to provide access to the transmission line structures. Each turbine will feature a permanent hardstand and temporary laydown areas.

5. Earthworks have been modelled to assess earthworks volumes. The indicative layout and geometric design of tracks and hardstands has been refined to minimise impacts on wetlands and other sensitive environments, whilst meeting the geotechnical and other technical constraints.

6. The indicative proposed earthworks cover 161 ha for the wind farm and 5.3 ha for transmission infrastructure. Estimated volumes for the wind farm and transmission line include 1.92 million m^3 of cut and 770,000 m^3 of fill, resulting in a surplus fill of 1.15 million m^3.

7. Fourteen turbines are proposed to be located on the Jedburgh Plateau, which hosts a mosaic of wetland and shrubland habitats (~127 ha of wetland habitat of the 530ha total area of the Plateau). Extensive design refinements have minimised earthworks impact, limiting direct wetland disturbance to ~2 ha and an additional 1.7 ha within 10m of wetlands.

8. Temporary construction areas will be re-contoured and re-vegetated, with permanent infrastructure (hardstands, tracks, facilities) occupying 73.75 ha for the wind farm and ~3.2 ha for transmission line route.

9. Specific engineering measures are planned for earthworks near or within 10m of wetlands, tailored to the type of work (cut, fill, rock excavation, or foundation construction), to minimise the hydrological impacts on the wetlands. Mitigation measures have been developed in conjunction with the project hydrogeological expert.

10. Approximately 1.2 million m³ of surplus earthworks material will be generated. Fill will be deposited at designated Surplus Fill Disposal sites (**SFDs**) within the Wind Farm Site, avoiding sensitive exclusion areas such as wetlands, and designed to maintain hydrological neutrality. An indicative total of 101 SFD sites with a total footprint of 81.9 ha have been identified, through an iterative process with the Project team and in particular the Project terrestrial and wetland ecologists. The fill sites comprise the following types:

    (a) Blanket Fills: 1 to 3m depth of fill spread over gentle slopes, located near to access tracks.

    (b) Shoulder Fills: Placed directly adjacent to tracks or hardstands on gentle to moderate slopes, typically <5m fill depth, with structural fill toe support.

    (c) Gully Fills: Located in gully heads (only in Matariki / Venlaw Forest), up to 10m fill depth with structural fill toe, and engineered drainage channels to divert surface runoff around the fill.

11. To lessen the impact of earthworks on existing surface water runoff patterns, tracks and hardstands will be aligned along ridgelines, spurs, and knolls where possible. Stormwater culverts have been designed to maintain flow to streams and wetlands where natural flow paths (including ephemeral streams) will be dissected by the proposed earthworks.

12. A dense network of stormwater culverts will be implemented across the Jedburgh Plateau to preserve hydrological connectivity throughout the wetland mosaic.

13. Preliminary designs for nine notable stream crossings have been completed where the proposed tracks cross perennial or intermittent streams. The crossings include eight culverts and one bridge. The designs incorporate hydraulic and ecological considerations, particularly fish passage requirements.

14. Stream culverts are designed to either allow or prevent fish passage based on ecological assessments. Where required, culverts will be embedded 300 mm below the streambed. Trout barriers are created by elevating culvert inverts 1.0 m above the streambed.

15. Aggregates will be needed for constructing access tracks and hardstand pavements, and for batching concrete for turbine foundations. Pavement aggregates are expected to be sourced from nearby quarries or generated on-site through excavation and processing of less-weathered / stronger rock encountered during bulk earthworks excavations. Concrete aggregates will be imported from off-site quarries.

16. Aggregate volumes have been estimated based on a concept pavement and turbine foundation design. Approximately 21,000 truck and trailer vehicle return trips are estimated for aggregate delivery, assuming off-site sourcing of aggregates, plus a further ~1,500 cement delivery trucks.

17. To meet the high concrete demand for wind turbine foundations, two temporary batching facilities with dual plants will be established on-site. Their strategic placement will reduce transport distances and improve construction efficiency.

18. Construction activities will require up to 500 m^3/day of water including for dust suppression, earthworks conditioning, and concrete batching. Two stream abstraction sites within the Mimihau Stream catchment (within the Wind Farm Site) have been identified and monitored for flow suitability. Water takes will be limited to 5 L/s per site. To ensure supply continuity, water will be pumped to on-site storage ponds or tanks, enabling use during peak demand and dry conditions.

19. A draft Earthworks Management Plan (**EMP**), including Erosion and Sediment Control Plan (**ESCP**), has been prepared and will guide site-

specific management plans during construction. These plans will be reviewed and approved by the Council prior to works commencing.

20. The project adopts erosion and sediment control measures aligned with Auckland Council's GD05 guidelines. These include minimizing soil disturbance, diverting clean water, treating sediment-laden runoff, and implementing dust control measures.

21. Earthworks will be carried out in a staged manner across sub-catchments to minimize exposed soil areas and reduce erosion risk.

22. Specific earthworks controls are proposed for sensitive sites and high-risk activities such works within streams and wetlands, and surplus fill disposal sites.

23. Regular monitoring and maintenance of erosion, sediment, and dust control measures will be conducted throughout construction, as detailed in the Earthworks Management Plan. Minimum standards of water discharge shall be maintained throughout earthworks in accordance with the conditions of consent.

24. Post-earthworks, disturbed areas and fill batters will be stabilised using locally stockpiled topsoil (≤12 months old) spread to a minimum depth of 300 mm, followed by grass seeding or hydroseeding with non-invasive species.

INTRODUCTION

Qualifications and experience

25. The primary author of this assessment is Luke Gordon. Other contributing authors are Ed Ladley, Lennie Palmer and Vaughan Martin. Our qualifications and experience, and our specific roles in respect of the Southland Wind Farm and this report, are set out below.

26. Luke David Gordon:

    (a) Principal Civil Engineer and Director at Riley Consultants Ltd (**Riley**).

    (b) Academic qualifications and professional memberships:

(i) Bachelor of Engineering (Civil, Hons) Auckland University 2005.

(ii) Chartered Member of Engineering New Zealand since 2013.

(c) Work Experience:

(i) Luke has over 20 years' experience in civil engineering, including extensive design and project management experience in the renewable energy sector.

(d) Over the past decade, he has played a key role in more than six large-scale wind farm projects, including within the Southland region, as part of the resource consent delivery team and design-build teams. Luke has authored civil engineering technical assessments in support of resource consent for several of those wind farms.

(e) Luke has served as the lead civil engineer and design manager for wind farm civil balance of plant works. Luke leads a team of civil engineers and designers at Riley.

(f) Southland Wind Farm Involvement:

(i) Luke is the primary author of this assessment and has contributed to the preparation of the draft Construction Environmental Management Plan and Earthworks Management Plan.

27. Edwyn Ladley:

(a) Senior Geotechnical Engineer at Riley.

(b) Academic qualifications and professional memberships:

(i) Bachelor of Science (Geology), University of Canterbury, 1995.

(ii) Master of Science (Geology), Otago University, 1999.

(iii) Master of Engineering Science (Geotechnical and Engineering Geology), University of New South Wales, 2014.

(c) Member of Engineering New Zealand.

(d) Member of the New Zealand Geotechnical Society.

(e) Work experience:

   (i) Edwyn has over 25 years of broad engineering geology and geotechnical engineering practice including: tunnels, earthquake engineering, forensic engineering, slope stabilisation, dam safety, earthworks design and specifications. Edwyn has previously acted as an expert witness for forensic engineering and resource consent projects.

   (ii) Edwyn's wind farm experience spans the development cycle including pre-feasibility and resource consent assessments, design, and construction monitoring.

   (iii) He leads teams focused on provide clients with targeted and fit-for-purpose site investigations and geotechnical designs to de-risk and manage geotechnical considerations and constraints.

(f) Southland Wind Farm Involvement:

   (i) Led the geotechnical investigation, and geotechnical assessment and reporting to support Contact's resource consent application. Edwyn also led the Stage 2 geotechnical investigations that Contact undertook ca. 2024.

   (ii) Liaised with Riley's civil engineering and geometric modelling teams to provide geotechnically inputs and advice for the project layout and cut and fill slopes, subgrade conditions, and potential use on-site rock encountered (if any) for pavement aggregate.

   (iii) Liaised with Riley's civil engineering and geometric modelling teams to provide geotechnically inputs and advice for the project layout and cut and fill slopes, subgrade conditions, and potential use on-site rock encountered (if any) for pavement aggregate.

(iv) Liaised with Contact's wider resource consent team to discuss and advise on the geotechnical model and geological variability across the site, including the near-surface ground model underlying the Jedburgh Plateau.

28. Lennie James Palmer:

(a) Principal Hydrologist at Riley.

(b) Academic qualifications and professional memberships:

(i) Bachelor of Science, University of Otago 1986.

(ii) Master of Applied Science, University of Adelaide 1998.

(c) Work Experience:

(i) Lennie has over 20 years' experience in undertaking hydrological investigations and assessments including flood and low flow studies, catchment modelling, statistical analysis, environmental flow and compliance reporting.

(ii) He has worked for several consultancies and within the energy sector undertaking technical investigations, a number associated with water take and allocation. Lennie has had several years involved with field hydrology and hydrometric data management systems.

(d) Southland Wind Farm Involvement:

(i) Lennie has been involved with the hydrological assessment of the Mimihau Stream (Riley Ref: 220372-D), the establishment of stream monitoring at several locations within the catchment (Riley Ref: 220372-A) and the processing and analysis of this stream data (Riley Ref: 220372-H).

29. Vaughan John Martin:

(a) Principal Water Resource Engineer at Riley.

(b) Academic qualifications and professional memberships:

(i) Bachelor of Engineering (Civil, Hons) Auckland University 2000.

(ii) Chartered Member of Engineering New Zealand.

(c) Work Experience:

(i) Vaughan has over 25 years' experience in civil engineering, including design and construction experience with windfarms, hydroelectric power schemes irrigation dams and flood detention dams.

(ii) In more recent years, Vaughan's focus has turned to the more specific field of flood hydrology and hydraulic assessments.

(iii) He is an experienced hydraulic modeller, having undertaken design of large spillways for Medum and High PIC dams.

(iv) He recently provided input to the preparation of the New Zealand Dam Safety Guidelines (2024) regarding flood hydrology.

(d) Southland Wind Farm Involvement:

(i) Vaughan is the leading engineering hydrologist and hydraulic design engineer for the notable stream crossings. He was specifically involved with the preparation of the Stream Crossing Preliminary Design Report (Riley Ref: 220272-C).

Code of conduct

30. We confirm that we have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless we state otherwise, this assessment is within our area of expertise and we have not omitted to consider material facts known to us that might alter or detract from the opinions we express.

Purpose and scope of assessment

31. The purpose of this assessment is to highlight key elements of the design of the Project, and to assess core construction effects, to inform the applications under the Fast-track Approvals Act 2024 (**FTAA**).

32. The scope of the assessment includes:

    (a) Highlighting key elements of the Project design, including process matters and the philosophy informing the design;

    (b) Addressing geotechnical conditions at the Project site;

    (c) Addressing refinements that have been made to the Project design since the previous application for resource consents under the COVID-19 Recovery (Fast-track Consenting) Act 2020 (**Covid Fast-track application**) was lodged; including providing a more detailed level of design for civil works on the Jedburgh Plateau where a mosaic of wetland and shrubland habitats is located; and

    (d) Assessing core construction effects of the Project (and related mitigation / control measures), including in respect of:

        (i) earthworks (design, volumes and erosion and sediment control measures);

        (ii) surplus fill disposal (approach and effects management);

        (iii) stormwater management and stream crossings; and

        (iv) water supply / abstraction (to enable construction).

THE SOUTHLAND WIND FARM PROJECT ENVIRONMENT AND DESIGN

33. Contact Energy Limited (**Contact**) is seeking various approvals necessary for the construction, operation and maintenance of the Southland Wind Farm Project.

34. The full project description is provided in Part A the substantive application documents. We do not repeat it in our assessment, but here we highlight key elements of the Project and the design philosophy that has been applied. The figures referred to in this assessment that include

the reference (Part G) are included in Part G of the substantive application documents.

Proposed Development

35. The Project will consist of a total of up to 55 wind turbine generators (**WTG**), each up to 220m in height (measured to tip of turbine blade). Tracks will be formed to provide construction and ongoing maintenance access to the WTG sites.

36. The Project will include a permanent wind farm substation and operations and maintenance building located within the core 'Wind Farm Site'.

37. A transmission line will connect to a permanent Switching Station (or Grid Injection Point) beyond the Wind Farm Site. The Wind Farm Site, plus the transmission lie corridor and Grid Injection Point, make up the wider 'Project Site'.

38. Earthworks are required to construct the access tracks, with a typical maximum paved width of approximately 8m for the internal wind farm tracks and a width of approximately 6.5m for the construction access track to the site.

39. Earthworks are also required to form hardstands and laydown areas at each WTG location for storage and assembly of each WTG, including the WTG foundations.

40. Two entrances to the Wind Farm Site are proposed:

    (a) From the west of the Wind Farm Site, from the end of Thornhill Road (off Venlaw Road).

    (b) From the north of the Wind Farm Site, through the Port Blakely Forest (off Davidson Road West/Kaiwera Downs Road).

41. The Project Layout is shown in Figure 1 and Riley Civil Drawings in Part K of the application.

42. The construction of these Project elements is addressed in more detail later in this report.

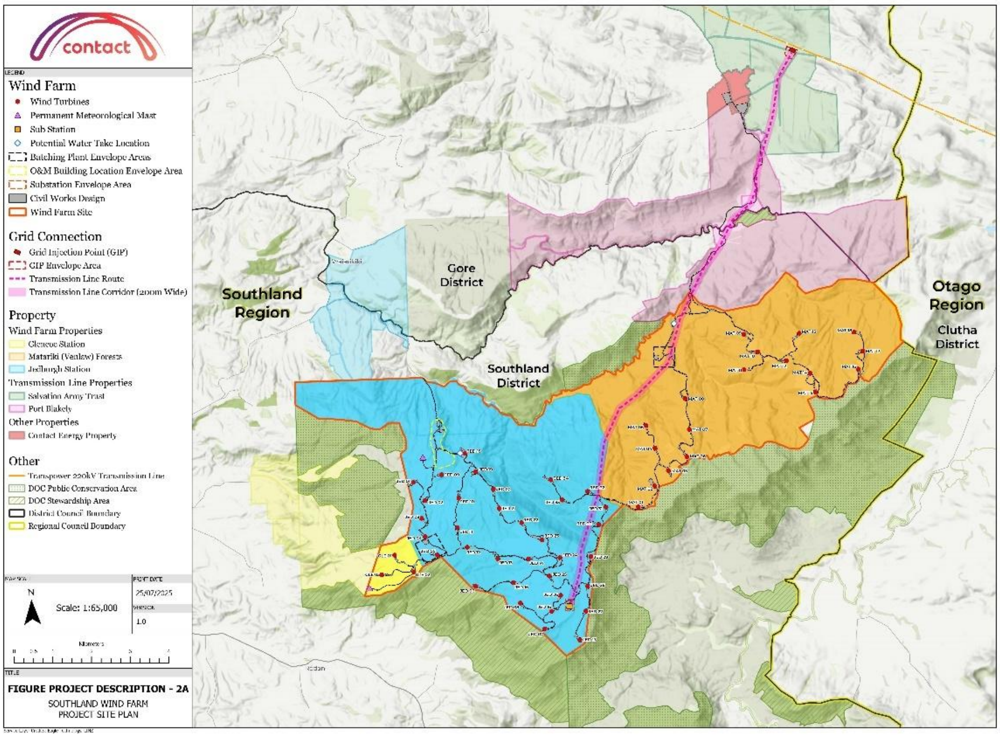


Figure 1: Preliminary Wind Farm Layout (Source: Figure Project Description – 2A (Part G))

Design Philosophy

43. In this section of our report we set out the overall philosophy / approach applied to turbine location and the design of the associated hardstands; and the tracks that will provide for access to and between turbines and to the transmission line infrastructure.

44. The approach to earthworks for the Project is addressed in detail later in this report.

Turbine locations and hardstand design

45. A preliminary 55 WTG layout was derived by Contact based on outcomes of preliminary wind measurements and modelling, high-level assessment of topographical constraints, and inter-turbine spacing. This layout was then refined based on other considerations, including the avoidance of wetlands within the Jedburgh Plateau (discussed further in the sections below) but also due to topographical constraints, separation distance to boundaries, transmission lines and the substation, noise and shadow flicker effects.

46. The overall Project footprint generally follows on from the layout of the turbines. Refining the layout of the turbines has been an iterative exercise, which continued through the previous Covid Fast-track consenting process, and subsequently (including in light of updated vegetation / habitat mapping). The current indicative Project footprint remains subject to confirmation during the detailed design process. However, in practice the flexibility to change the layout of the turbines (and the Project footprint overall) is constrained by:

(a) Conditions setting a 'turbine envelope zone' of a 200m radius (and subject to property boundaries) from the indicative location;

(b) Further conditions setting 'caps' on clearance of higher value habitats / vegetation types. For example, the 2.5ha cap on vegetation clearance will significantly restrict flexibility in the final design at Jedburgh Plateau;

(c) The need to have appropriate spacing between adjacent turbines, in terms of energy generation; and

(d) Topographical and other physical constraints that would render substantial design changes impractical.

47. Based on the refined indicative WTG positions, a design of the WTG hardstands was undertaken which considered the following:

(a) WTG supplier requirements for hardstand size and geometry, as noted below;

(b) Minimise earthworks footprint within wetlands and other sensitive areas, provide 10m setback from wetlands where practicable;

(c) Follow existing grades as closely as possible – to minimise cut/fill depths;

(d) Where practicable, position the hardstands on knolls, spurs or wide ridge features, to minimise earthworks to establish each turbine location and to maximise electricity generation;

(e) Align hardstands with the connecting access tracks to minimise footprint and earthworks; and

(f) Design as ‘end-of-line’ hardstands (with vehicle turnaround areas) where practicable – to minimise through-tracks through wetland and other sensitive areas.

48. WTG supplier specifications have been reviewed to determine indicative hardstand and laydown area dimensions to enable crane assembly and erection for the tower, nacelle, and blade components. For assessment purposes Riley have considered an indicative 6.6MW WTG, comprising a 170m rotor diameter, and 135m tower height. Based on this WTG size, an indicative hardstand configuration is shown in Figure 2. This hardstand configuration is a refinement of the hardstand assumed for design under the previous Covid Fast-track Act application, with the shape of the hardstand further optimised to minimise earthworks (particularly in and near wetlands, as discussed later in this report).

49. The permanent hardstand is a hardfill platform approximately 3,140m2 in area on one side of the access track, which will comprise the WTG, main crane and laydown areas for various WTG components. This hardstand will remain as a permanent hardfill platform for ongoing maintenance activities during the life of the wind farm.

50. The WTG suppliers require a gently sloping hardstand, typically with maximum 1% transverse and 1% longitudinal gradient.

51. In addition to the hardstand platform, a temporary laydown and cleared area of up to ~3,000m^2 will be used for the blade laydown, main crane boom assembly, support crane pads, and other ancillary equipment laydown. While these areas are included in the Project footprint (and vegetation / habitat clearance) figures, they are temporary and are re-vegetated (and typically re-contoured) following construction.

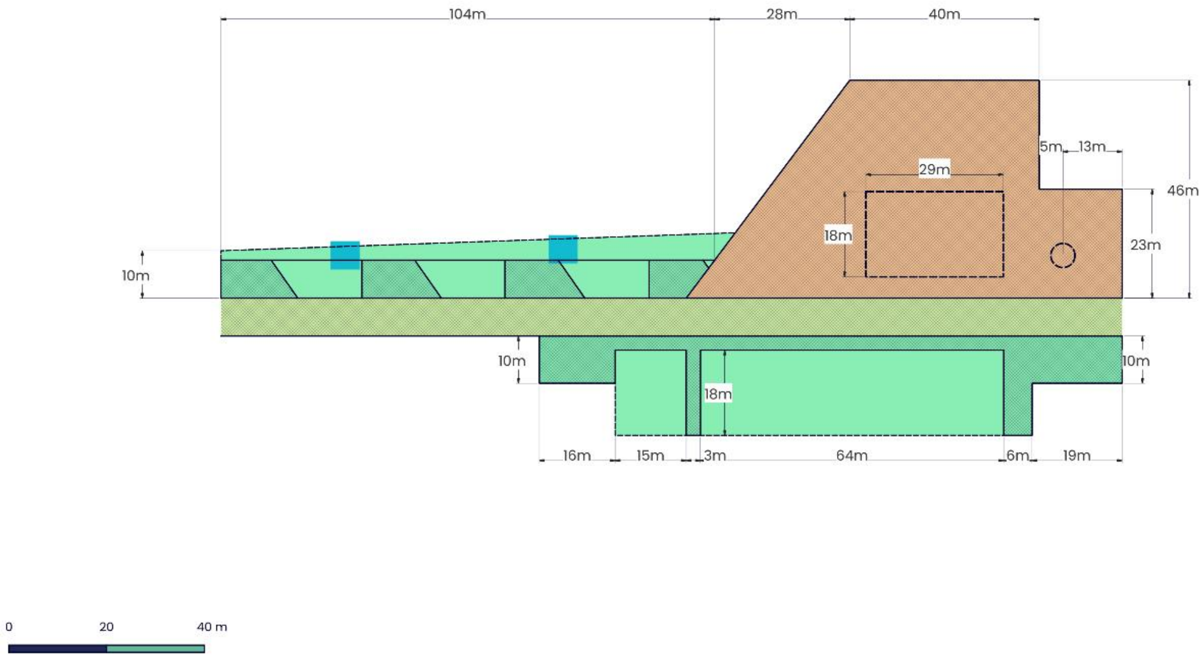


Figure 2: Indicative WTG Hardstand Configuration

Internal Tracks and Wind Farm Site Access Tracks

52. A total access track length of approximately 72.8km will be required, including the upgrade of the existing forestry track through the Port Blakely Forest, which is approximately 6.4km long. Of the 72.8km, approximately 25km will follow existing metalled farm and forestry tracks. An indicative design for this track network has been developed, and is the basis for the indicative footprint and vegetation / habitat clearance figures for the Project.

53. The internal (circulation) tracks within the Wind Farm Site that provide construction and operational access to the WTG locations will have a typical carriageway width of up to 8.0m to allow for the transportation of WTG components and the movement of mobile cranes between the WTG hardstands.

54. For sections of track servicing two or less WTGs, the tracks have been narrowed to 6.0m width, with localised widening on corners. This design refinement (and footprint reduction) has been made following the previous Covid Fast-track consenting process.

55. The access tracks to the Wind Farm Site will have a typical carriageway width of 6.5m (to accommodate two-way construction traffic, but not needing to allow for a mobile crane) although the route through the Port Blakely Forest will have localised widening on corners to allow for the transportation of the WTG components.

56. The guiding geometric requirements for access tracks are based on swept paths of the WTG blade transport vehicle and are outlined in Table 1.

Table 1: Preliminary Geometric Requirements for Wind Farm Access Tracks

Parameter	Max Longitudinal Gradient	Vertical Curve Radius	Min Horizontal Curve Radius	Minimum Trafficked Width
Site Entrances (to wind farm site)	13%(1)	550m	60m	6.5m
Internal Circulation tracks (between WTG's)	13%(1)	550m	60m	8m
End-of-line Tracks – two or less WTG's	13%(1)	550m	60m	6m

(1) Steeper sections are permitted if tractor pulling units are utilised, and/or metalled access tracks are stabilised – generally up to maximum of 16-18%.

57. Additional widening of corners (within areas of cut) will be required to accommodate the overhang and oversail of the turbine blade, dependant on the curve geometry. The preliminary access track design has considered the additional widening in accordance with the WTG supplier access track geometry specifications based on an indicative 85m long turbine blade. Indicative access track cross section profiles are included in the SWF Civil Design Drawings in in Part K of the application.

58. The terrain of the Wind Farm Site is varied, ranging from flat to steep. The geometric design of the tracks has considered the following:

(a) Align along existing farm and forestry tracks where practicable;

(b) Follow ridgelines where practicable and follow existing grades as closely as possible – to minimise cut/fill depths;

(c) Minimise the number of stream crossings;

(d) Avoid steep slopes where practicable and other geotechnically challenging features; and

(e) Where practicable, provide minimum 10m setback from water bodies and wetlands, and avoid other ecological sensitive areas such as high value vegetation.

Transmission Line Access Tracks

59. Access tracks will be formed to the transmission line structures (towers/pylons) and temporary pads will be formed adjacent to the structures. Approximately 6km of tracks will be required – following existing forestry tracks where possible.

60. The tracks will be designed for construction vehicles – including mobile crane and component deliveries.

61. The design criteria for the tracks are presented in Table 2. Following construction, the tracks require little maintenance as they are typically only required to accommodate 4WD access during the Wind Farm's operational phase.

Table 2: Preliminary Geometric Requirements for Transmission Line Access Tracks

Parameter	Max Longitudinal Gradient	Vertical Curve Radius	Min Horizontal Curve Radius	Minimum Trafficked Width
Transmission Line Access Tracks	16%	200m	50m(1)	4.5m

(1) Absolute minimum of 20m radius in constrained areas – track widening would likely be required.

Earthworks

62. Preliminary cut and fill batter slopes are provided in Table 3, based on preliminary geotechnical investigations and assessment of the subsurface conditions. This is an important starting point as it informs the geometric design and defines the earthworks footprint of the tracks, hardstands, and surplus fill disposals.

63. The preliminary earthworks design has been undertaken based on the prescribed batter slopes, no retaining walls are proposed.

Table 3: Preliminary Cut and Fill Batter Slopes (Subject to Confirmation During Detailed Design)

Batters	(V:H)	Inclination +/- horizontal (°)
Cut – Near-surface soils (includes Residual to Highly weathered rock)	1 : 1.75	30
Cut – Lower-Strength Bedrock profile (very weak to weak)	1 : 1	45
Cut – Higher-strength bedrock profile (mod. strong to strong)	2 : 1	63
Fill (engineered soil and rock fill)	1 : 3	18

64. The preliminary design level of the hardstands has been assessed based on the topography at the indicative WTG location, and a (geotechnical) preference for the WTG foundations to be founded on competent material – preferably bedrock. Based on this, a general maximum fill depth of 2m has been considered for determining the finished levels of the permanent WTG hardstands.

65. In general, having the permanent hardstands in fill will be advantageous, particularly within the plateau, as it will reduce the footprint of cut earthworks within wetlands. The final hardstand levels will be determined based on further Geotech investigations to determine subsurface conditions at each WTG location.

GEOTECHNICAL CONSIDERATIONS

66. The Geotechnical Assessment for the Project is included as Annexure B. This assessment is essentially as prepared for the previous Covid Fast-track consenting process, with relatively minor amendments for the current application.

67. Riley has undertaken a feasibility level geotechnical site investigation and interpretative assessment for the Southland Wind Farm, accessed primarily from Venlaw Road. This assessment has been primarily informed and developed based on our review of geotechnical investigations including:

(a) Five historic (ca. 2011) cored boreholes completed across the site for a previous development and downloaded from the New Zealand Geotechnical Database.

(b) An initial site investigation undertaken by Riley ca. 2023, and included visual mapping of exposures at the ground-surface, machine test pits, in-situ soil strength testing, sampling of selected soil and rock materials encountered, and scheduling of laboratory tests on selected samples.

68. In 2024 Contact engaged Riley to undertake a next stage of geotechnical investigations (Stage 2). Investigation details and results for the Stage 2 investigations, along with the historic and initial Riley investigation results (Para. 66) are compiled into a single Geotechnical Factual Report (GFR) (Riley ref: "Geotechnical Factual Report, Southland Wind Farm – Phase 2 Geotechnical Investigations", ref: 230488-C Issue 3.0, dated 21 February 2025).

69. Key findings and conclusions of the Geotechnical Assessment are outlined below.

70. No geotechnical fatal flaws have been identified. The Project should be subject to detailed design with construction undertaken by an experienced contractor.

71. Ground conditions vary laterally and vertically across the Wind Farm Site. The ground profile consists of variable sequences of near-surface 'unconsolidated soils' underlain by more-weathered 'lower-strength' bedrock. These units are underlain by less-weathered 'higher-strength' bedrock (also referred to as 'blue -rock').

72. The published regional-scale geology (1:250,000 scale) QMAP indicates the Wind Farm Site is underlain by bedrock consisting of fossiliferous sandstone, mudstone, with minor shell beds which are correlated to the Ferndale Group of the Murihiku Supergroup (GNS, 2003).

73. Two ground sequences differentiated include:

(a) 'Deep mantle' – where the cumulative thickness of soils and lower-strength bedrock form a relatively 'deep mantle' to generally over 6m depth. This is inferred to be the predominant sequence across the west and mid-sections of the proposed development (Jedburgh Station, Glencoe Station, through to the middle of Venlaw Forest, WTG MAT-08).

(b) 'Shallow mantle' – where the combined thickness of 'soils' and/or lower-strength bedrock profile is approximately 1m to 2m and locally up to 4m (i.e. higher-strength bedrock is likely to be encountered typically within a couple of metres of the ground -surface).

74. Localised near-surface 'perched' groundwater zones are anticipated at the Site (predominantly southern parts of the Jedburgh Station). These are likely to be predominantly present over low permeability bedrock (and to a lesser degree soils). These are inferred to relate to 'wet-areas' we observed at the ground-surface, and to 'high-value' wetland areas mapped separately by ecologists.

75. The general groundwater table, which is primarily controlled by water seeping through defects (cracks) in the bedrock, is expected at many metres to tens of metres below the ground-surface. Groundwater inflows to cuts are not expected to be a significant consideration for the development.

76. There is limited evidence of existing slope instability at the Wind Farm Site, and with appropriate engineering design and construction works the development should not result in any effective reduction in the slope instability. Areas where the access tracks and turbines are located close to existing moderate to steep hillslopes should be focus areas during detailed design.

77. The seismic hazard at the Wind Farm Site is relatively low in New Zealand terms, but the Site could be subject to ground shaking from movement (earthquakes) along distant and nearby geologically active faults. No active faults are identified within the Wind Farm Site.

78. Liquefaction of low-strength and saturated soils is not considered to be a risk. The general groundwater table is many metres below the ground-

surface, and the composition of the soils indicate a low to negligible susceptibility to liquefaction also.

79. Bulk earthworks cuts for most access tracks and turbine platforms are expected to predominantly encounter soils and lower-strength bedrock (i.e. deep-mantle sequence). Higher -strength bedrock is anticipated to be encountered near to the ground surface around the plateau-like area at the south end of Jedburgh Station, and in the north-east of the Venlaw Forest.

80. We expect that unconsolidated soils and lower-strength bedrock will be readily excavated with appropriately sized diggers (i.e. 20t to +30t) using rock buckets. The contractor may elect to undertake pre-ripping of corestones or local higher-strength bedrock horizons to maintain, or increase, productivity.

81. Heavy pre-excavation works is anticipated to be required to productively excavate some of the stronger rock with wider spaced defects (i.e. where defects in the higher-strength bedrock exceed approximately 0.3m to 0.5m spacing). Such measures include heavy pre-ripping (i.e. single tine on large excavator or bulldozer) or a hydraulic rock breaker attachment on a large excavator.

82. Pre-excavation blasting works may also be appropriate/necessary to efficiently excavate higher-strength rock where wider spaced defects are present (i.e. greater than approximately 0.6m).

83. The selection of pre-excavation techniques is site, and contractor, specific and can be influenced by the volume and depth of bedrock that requires excavation to achieve formation level.

84. Engineered fill will be required for access tracks and platforms. All cut materials except topsoil and organics can potentially be used for bulk fill (i.e. soils, lower-strength bedrock, and higher-strength bedrock). The earthworks will be undertaken in accordance with the detailed design, earthworks specification, and quality control programme. Some moisture control works, (i.e. drying) may be necessary with colluvium to achieve close to optimum moisture content. Rock fill blocks may need breaking to conform to grading specifications for this material.

85. We anticipate that turbine foundations will be a reinforced concrete pad (in our experience these can be approximately 20m diameter and up to 3m below the surrounding WTG platform level). Foundations on the rock will have adequate bearing strength and acceptable settlement. For foundations on soils either lowered bearing capacity can be applied or undercut to more competent material if this option is available. For soil type material foundation stiffness may be a constraint and would require specific consideration in design. Foundations will be confirmed during detailed design.

Aggregate supply

86. We expect that any Site-won least-weathered sandstone (blue-rock) encountered during bulk earthworks excavations could be processed to provide suitable pavement aggregates for the Site tracks and turbine hardstands.

87. Additional pavement aggregates will be imported to Site from nearby quarries. Details of potential off-site quarry locations and route maps to the Project Site entrances are shown in Figure Transport-3 (Part G), completed by others.

88. All concrete aggregates will need to be imported from suitable nearby quarries.

Geotechnical analysis during detailed design

89. The following assessments and analyses are expected to be developed and optimised during additional design phases, prior to construction.

90. Geotechnical investigations will be required to confirm the geotechnical model and horizontal and vertical variability across the Site. Investigations will include, but may not be limited to:

    (a) Mapping of selected rock and soil exposures at the ground-surface.

    (b) Relatively shallow machine test pits (**TP**).

(c) Deeper-seated machine cored boreholes (**MH**). These are generally located at proposed turbine platform / foundation locations.

(d) In-situ strength tests at selected depths, and in appropriate soils, in both TP and MH.

(e) Machine cone penetration tests (**CPT**) soundings – these are more appropriate through deeper sequences of soil and weakest rock.

(f) Geophysics techniques (on ground-surface and in selected boreholes) to assist defining the subsurface ground profiles, geological variability, and geotechnical conditions.

(g) Sampling of selected soil and rock materials encountered during the investigations (particularly TP and MH) and dispatching of selected sample for laboratory tests to assist the design and specification of the earthworks.

(h) Monitoring of the groundwater table e.g. generally using piezometer instruments installed in deeper machine boreholes.

91. Some of these investigations have been progressed across the Site by the Stage 2 programme that Contact commissioned in 2024.

92. The geotechnical information will likely be developed into a 3D computer model, which can be incorporated with geometric design software to provide estimates of materials (i.e soils, weaker rock, stronger rock etc) that will be encountered during bulk earthworks. excavations.

93. The investigation results will help confirm the ground and groundwater conditions, and confirm and optimise the design for various elements of the project (which will be undertaken by various engineering disciplines / parties i.e. civil balance of plant (**CBoP**), electrical balance of plant (**EBoP**) and wind turbine foundations:

(a) The earthworks volume assessment, parameters, implications on the construction programme and methodology, and the earthworks Specification – with the aim to minimise earthworks volumes and re-use as much site-won material as practicable.

(b) Cut and fill earthworks slope gradients.

(c) Access track and turbine hardstand pavement design (incorporating varying cut and fill subgrade parameters along the development).

(d) Confirm the shallow and deeper-seated slope stability risk to the access tracks and platforms, plant and facilities, and transmission route and towers is appropriate for the development. The design will develop management solutions if unacceptable slope instability is encountered (e.g. avoid or develop treatment measures).

(e) Design and specification of surplus fill disposal sites.

(f) Foundation and platform design for temporary / construction (e.g. batching plant, water storage, equipment laydown, and permanent plant and facilities (e.g. O&M building and compound).

(g) Wind turbine foundation design.

(h) Design of transmission tower foundations and access tracks.

94. There is a low potential that significant changes to the current geotechnical model / understanding of the Site will occur because of additional investigations and design stages. It is the nature of geotechnical investigations and construction phase that knowledge of the ground conditions progressively increases. If significant changes were to occur with this additional information these will be addressed by the designer to meet the project requirements.to mitigate any increased risk.

EARTHWORKS

Introduction

95. As for all wind farm developments, earthworks are a core component of the construction process for the Southland Wind Farm Project. Careful design and management of earthworks is required to ensure that potential adverse environmental effects are minimised.

96. A geometric design has been undertaken utilising 12D Model, a civil design software package, and LiDAR topographical information, as provided by

Aerial Surveys Limited as part of the Elevation Aotearoa project. The LiDAR data set has a reported vertical accuracy of 20cm @ 65% confidence level, thus providing a suitability accurate ground model from which the geometric design for the wind farm has been based.

97. The design encompasses all the bulk earthworks within the Wind Farm Site to form the access tracks, WTG Hardstands, and permanent and temporary site facility platforms (i.e. substation, Operations and Maintenance (**O&M**), Batching Plant, site compound, ancillary laydown areas).

98. The design also encompasses the works within the wider Project Site – including the access track through Port Blakely Forest, and the transmission line access tracks and construction pads.

Earthworks Quantities

99. We have carried out an assessment based on the maximum WTG numbers (55) and sizes (maximum 220m height to blade tip) being applied for to provide an indicative estimate for the earthwork volumes and areas.

100. A summary of the track lengths and the associated earthworks volumes and areas for the tracks and hardstands are shown in Table 4.

Table 4: Indicative Earthwork Quantities and Track Lengths

Description	Quantity
Wind Farm (incl. Access through Port Blakely Forest)	
Number of WTG's	55
Track Length (incl. length of tracks through WTG platforms)	72.8 km
Topsoil Strip(1)	-590,000m^3
Cut Volume(2)(3)(4)	-1,734,000m^3
Fill Volume(2)(3)(4)	665,000m^3
WTG Foundation Excavation Volume(5)	-138,000m^3
WTG Foundation Backfill Volume(5)	96,000m^3
Overall Surplus Fill Volume (excl. topsoil strip)	-1,111,000m^3

Description	Quantity
Total Earthworks Area(6)	161ha
Transmission Line – (access tracks and construction pads, GIP)	
Track length	5.6km
Cut volume(2)	-44,000m^3
Fill Volume(2)	9,000m^3
Surplus Fill Volume (excl. topsoil)	-35,000m^3
Total Earthworks Area	6.2ha

(1) Topsoil depth varies between 0.1m and 0.7m. 0.4m average assumed for earthworks assessment, excludes overlap with existing farm/forestry tracks.

(2) Volumes are calculated based on the difference between existing stripped ground surface (i.e. 0.4m topsoil – except overlap with tracks) and the finished subgrade surface (assuming average 0.25m new pavement thickness), i.e. excludes topsoil strip.

(3) Excludes excavations and backfill of WTG foundations.

(4) Earthworks includes WTG Access tracks and platforms, O&M facilities, substation, contractors site compound, concrete batching plant facility, storage and parking. Excludes Overhead Transmission Line and associated earthworks, surplus fill disposal sites.

(5) Based on foundation designs developed for similar sizes WTG's on other wind farms – 2,500m^3 excavation volume per WTG, 1,750m^3 backfill volume.

(6) Earthworks Area includes overlap with existing access tracks, excludes surplus fill disposal sites.

101. During detailed design stage and following finalisation of WTG locations through any necessary micro-siting, the track alignment and hardstand levels and gradients will be revised and optimised again to minimise total earthwork volumes and disturbance areas.

102. The temporary laydown and cleared areas will be revegetated following completion of the WTG construction works in those areas. The estimated disturbance areas associated with the Project during, and post-construction are shown in Table 5.

Table 5: Indicative Disturbance Areas Associated with the Wind Farm

Disturbance Areas	Total
<u>Wind Farm</u>	
During Construction (incl. cut and fill batters)	
WTG Platforms (excl. length of tracks through platforms)	43.8 ha
Access Tracks(3) (incl Access through Port Blakely Forest, incl. overlap with existing access tracks)	101.5 ha
Substation, O&M, and construction site facilities (batching plant, site compound etc.)	15.5 ha
Surplus Fill disposal sites(1)	81.9 ha(1)
Sub Total	242.7 ha
Post Construction (permanent hardfill and impervious surfaces)	
WTG Hardstands(2)	17.3 ha
Access Tracks(3)	54.7 ha
Substation and O&M facilities	1.75 ha
Sub Total	73.75 ha
<u>Transmission Line</u>	
During Construction (incl. cut and fill batters):	
Construction pads	2.2 ha
Access Tracks	3.1 ha
GIP/switchyard	0.9 ha
Sub Total	6.2 ha
Post Construction (permanent hardfill and impervious surfaces)	
Access Tracks(4)	2.4 ha
GIP	0.8 ha
Sub Total	3.2 ha

(1) Based on the full area of surplus fill disposal sites identified – with total storage volume = 1,479,000 m^3

(2) Based on 3,140m^2 permanent hardstand area remaining following construction per WTG platform – assumes temporary laydown and cleared areas are re-contoured and re-vegetated following construction of the WTG's.

(3) 71.7km total track length – 8m wide pavement for internal tracks (narrowing to 6.0m for end tracks with two or less WTG's), 6.5m wide pavement for site access tracks (6.4km access from Davidson Road West, 3.4km Thornhill Road Ext), 6.0m wide for access to site facilities – O&M, substation, site compounds (2.6km).

(4) 5.4km total track length – 4.5m pavement width. Construction pads to be re-vegetated

Earthworks within the Jedburgh Plateau

103. The Jedburgh Plateau is an area of approximately 530 ha located at the southern end of Jedburgh Station – and the southern end of the Wind Farm Site. The extent of the Plateau has been defined based on the topography, geology, vegetation and ecology. It can be described as an elevated exposed and relatively flat area, of between 520 – 630m elevation (approximately) with low stature vegetation. The area is used for farming, but not intensively.

104. There are 14 WTG's located within the Jedburgh Plateau.

105. One of the most notable features of the Jedburgh Plateau is the presence of a number of bog and fen wetlands, as part of the overall 'mosaic' of wetland and shrubland vegetation at the Jedburgh Plateau (along with some exotic pasture). One of the key reasons for the presence of wetlands on the Plateau is the shallow depth to bedrock – on most of the Plateau area the depth to the bedrock is less than 1m, resulting in a near-surface perched water table. There are approximately 127ha of wetlands within the 530ha Jedburgh Plateau area.

106. A significant amount of time, effort and attention has been spent on the location of the WTG's and the design of the civil works within the Jedburgh Plateau to ensure that the effects on the wetlands are minimised as far as practicable.

107. The geometric design of tracks and hardstands within the Jedburgh Plateau has been further refined from the previous Covid Fast-track application. There has been a particular focus on minimising potential adverse effects on the wetlands, including in consideration of the updated detailed wetland mapping completed by Wildlands (discussed in the Terrestrial and Wetland Ecology Report).

108. The end result is that the geometric design of access tracks and hardstands has been progressed to an advanced level in the Jedburgh Plateau area, to optimise the alignments to avoid as much of the wetlands as possible, and to locate and quantify the areas where wetlands are impacted.

109. Examples of the main areas of improvement to the geometry are presented in Table 6. Our exercise of refining the main earthworks footprint on the Jedburgh Plateau has been carried out in parallel with other refinement exercises intended to minimise effects on the environmental values of the Jedburgh Plateau:

(a) More detailed identification of Surplus Fill Disposal Sites; and

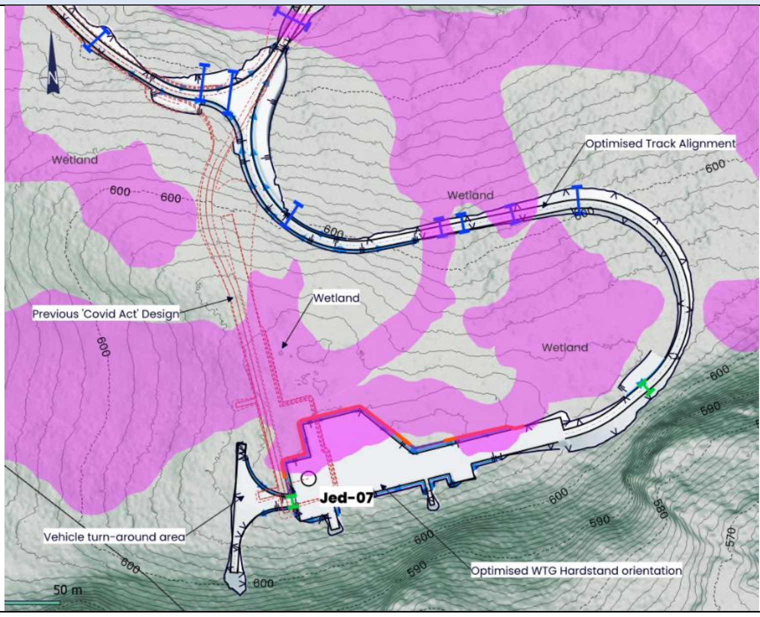
(b) Hydrological investigations / modelling, and development of design solutions to avoid / minimise indirect effects on wetlands not directly within the Project footprint.

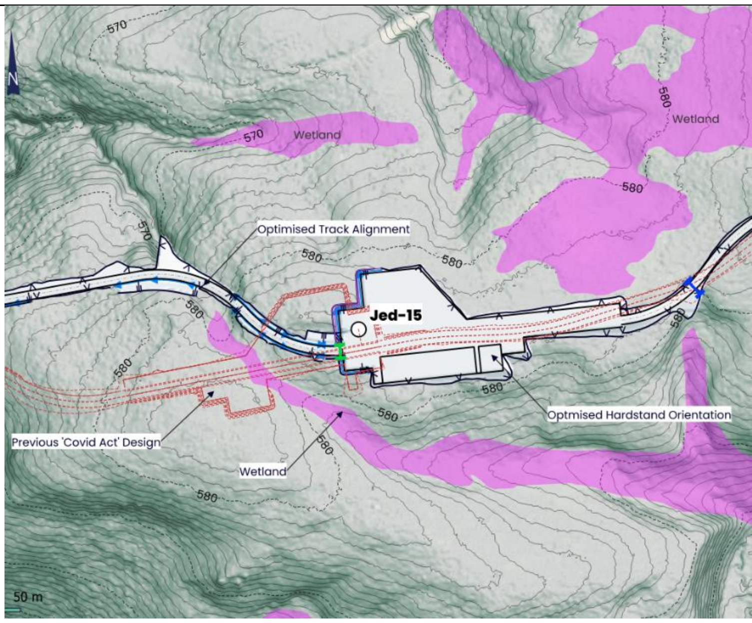
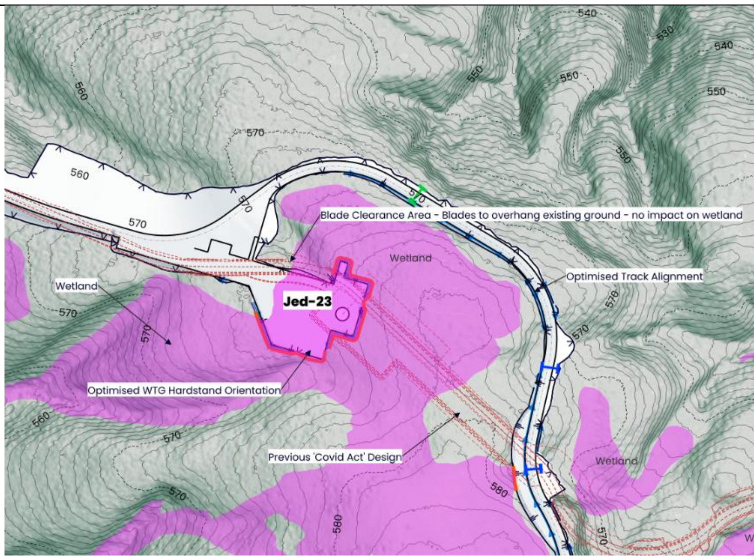
110. These matters are discussed later in this report.

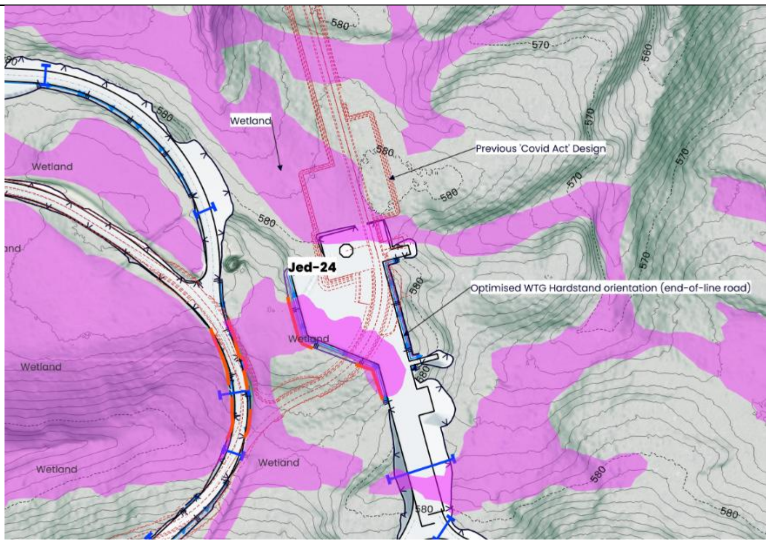
111. Based on the developed geometric design the footprint of earthworks within Jedburgh Plateau wetlands has been limited to approximately 2 ha, comprising 1.42 ha of cut, and 0.6ha of fill earthworks (no Surplus Fill Disposal Sites will be located within wetlands).

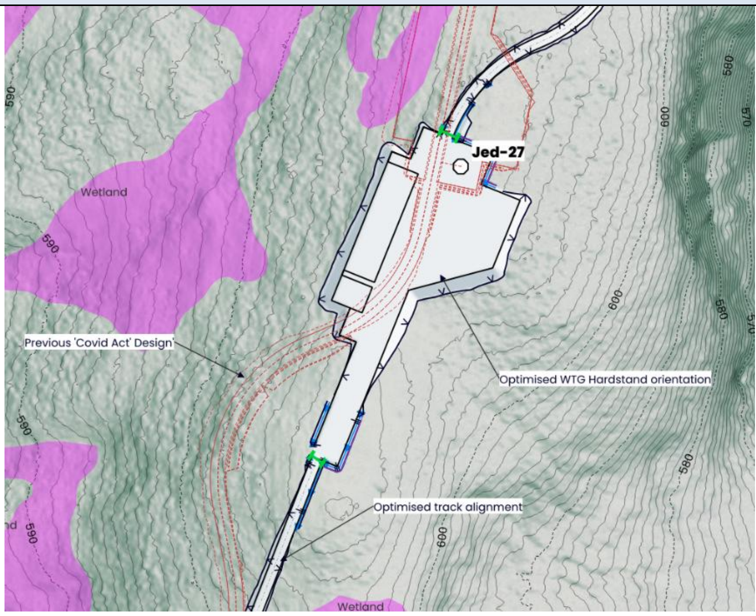
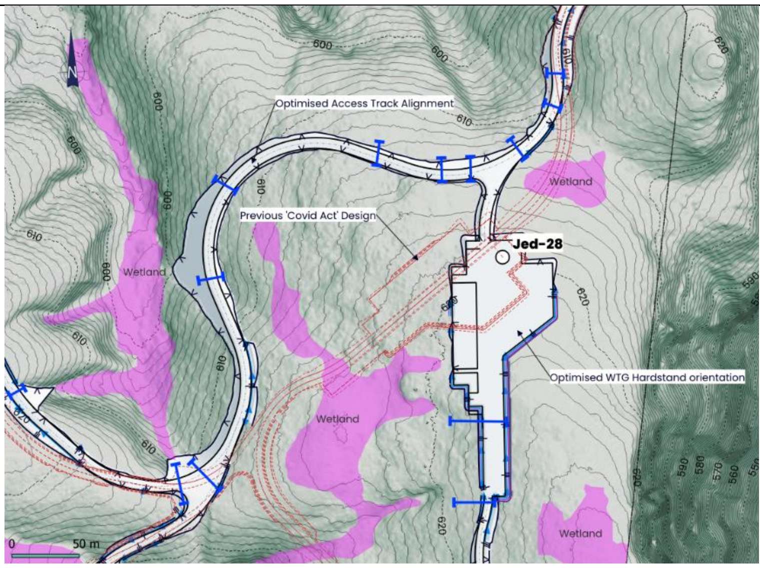
112. A further 1.7 ha of earthworks occurs within 10m of wetlands. Protecting these wetlands is a particular focus of the hydrological work and design responses discussed later in this report.

Table 6: Jedburgh Plateau Wetlands Avoidance / Minimisation Measures

Location and Description	**Figure**
Jed 07 hardstand has been flipped and rotated 90^{0} clockwise to reduce the encroachment on the wetland. The access track has been re-routed around the perimeter of the main body of the wetland to the east, crossing the wetland at the narrowest section. The design trade off is a longer access track.	

Location and Description	Figure
Reduction in wetland loss = 0.008 ha. Whilst this reduction is small, the new layout no longer severs the wetland in two, which will lessen the impact further.	
Jed 15 hardstand orientation has been flipped and the approach track has been re-routed to the north – downslope of the wetland. The design trade-off is a less direct and longer track alignment. Reduction in wetland loss = 0.075 ha.	
Jed 23 hardstand orientation has been flipped and rotated, and hardstand level raised so un-assembled blades will overhang the wetland - thus reducing the encroachment on the wetland. Changed to an end-of line hardstand, with single access form west. Access track re-routed to the north (downslope) of the wetland. The design trade-off is a longer access track located on steeper	

Location and Description	Figure
terrain, less flexibility in terms of turbine component delivery direction, and reversing manoeuvre required for turbine component delivery vehicles exiting the hardstand (less desirable). Reduction in wetland loss = 0.205 ha.	
Jed 24 hardstand orientation has been flipped to reduce the encroachment on the wetland. Changed to end-of-line hardstand with access from the south, so the track does not continue to the through the wetland to the north (track to Jed 23 relocated to the west – between wetlands). The design trade-off is less flexibility in terms of turbine component delivery direction, and reversing manoeuvre and additional turnaround area required for turbine component delivery vehicles exiting the hardstand. Reduction in wetland loss = 0.135 ha.	

Location and Description	Figure
Jed 27 hardstand orientation has been flipped - reducing the encroachment on the wetland. Access track re-routed to the east (downslope) of the wetland. The design trade-off is a slightly longer access track located on steeper terrain. Reduction in wetland loss = 0.233 ha.	
Jed 28 hardstand has been rotated 45^{0} counter-clockwise to avoid a wetland, the access track also now avoids wetlands. The design trade off is more cut earthworks to form the crane boom laydown area – as it is now located on higher ground. Reduction in wetland loss = 0.130 ha.	

Design and construction considerations to minimise adverse effects on wetlands (including hydrological connections)

113. In addition to the refinement exercise to minimise the Project footprint within wetlands, additional measures (earthworks design and culverts) will be implemented to minimise adverse effects on wetlands.

114. To that end, Williamson Water Advisory (**WWLA**) have prepared a conceptual hydrological design report (included in Part H to the substantive application documents) focusing on:

(a) Assessment of flow conditions in specific areas adjacent to wetlands (bogs and fens); and

(b) Design engineering mitigation to minimise hydrological impact on the wetlands and/or maintain water balance neutrality from proposed linear infrastructure construction. These measures include culverting beneath tracks and hardstands within the plateau to maintain hydrological connectivity between/to wetlands), as well formation of low permeability clay bunds where cut earthworks are proposed adjacent to wetlands.

115. The WWLA conceptual culverts and bunds are shown on the Riley Civil Drawings in in Part K of the application.

116. The engineering mitigation measures will be tailored for each circumstance where earthworks encroach on wetlands, and will depend on whether it is a cut or fill (as outlined below). The proposed measures have been developed in coordination with:

(a) Geotechnical Engineer (Riley);

(b) Hydrogeologist (Jon Williamson of WWLA); and

(c) Ecologist (Nick Goldwater and Dr Kelvin Lloyd of Wildlands and Roger MacGibbon of Tonkin & Taylor).

Excavations within wetlands

117. In this scenario a primary concern is seepage of water through the cut face, resulting in the partial dewatering of the wetland. To prevent this from happening a low permeability fill bund (using site won clays/silts) will be constructed prior to forming the cut face for the access track or hardstand. The bund will be keyed into the underlying competent ground. A diagrammatical example of the construction sequence is included in the SWF Civil Drawing set (in Part K of the application).

118. This detail may also be employed where a cut face is located near (within 10m) of a wetland, where it is assessed by the Engineer or Hydrogeologist that the proximity of the cut could result in seepage from the wetland.

119. The bund will be formed from selected soils and will have a very low permeability when compacted to an engineered standard (expected to be many magnitudes lower than the adjacent organic wetland soils). An earthworks specification will be developed by the Geotechnical Engineer, with compaction standards (air voids/dry densities) stipulated. The contractor will be required to demonstrate compliance based on a testing regime prescribed in the specification.

120. The low permeability bund methodology is endorsed by WWLA.

121. To provide hydrological connectivity between the dissected areas of the wetland, a series of stormwater culverts will be installed beneath the access track or hardstands at existing flow paths, which will convey surface flow to the wetland downstream. The design methodology for such culverts is addressed in the WWLA report.

Fill Embankment Through Wetlands

122. In this scenario the fill embankment (which will be founded on the clay/weathered rock layer underlying the wetland organic soils) will effectively be acting as a dam. Therefore, the primary concern is to provide hydrological connectivity between the dissected areas of the wetland (or to maintain flow to wetlands located downstream). To achieve this, a series of stormwater culverts will be installed through the fill embankment at existing flow paths, which will convey surface flow to the downstream wetland.

123. This design methodology for such culverts is addressed in the WWLA report. A diagrammatical example of the fill embankment through a wetland is included in the SWF Civil Drawing set (in Part K of the application).

Rock Excavation Close to Wetlands

124. In some locations excavations that are within or adjacent to wetlands, un-weathered rock will be encountered at shallow depths. Such rock will likely be removed with the aid of rock blasting techniques. Therefore, specific mitigation measures will be employed to ensure the blasting does not affect the sub-soil drainage or permeability of the subsurface layers

underlying the adjacent wetlands, and to limit the encroachment of earthworks into the wetlands.

125. As part of the previous Covid Fast-track application, Riley contacted blasting specialists Redbull Powder Company (Redbull) to discuss the methodologies and control measures that might be utilised for blasting near wetlands. Redbull were the blasting sub-contractor on Stage 1 of the nearby Kaiwera Downs Wind Farm construction. There are a range of techniques that Redbull have employed on other projects where a high degree of accuracy was required due to sensitive receiving environments; and which could be tailored to rock excavations in close proximity to wetlands.

126. Redbull suggests that blast trials are conducted away from final batters to define the most cost-effective method for the required excavation tolerances. Further details of the potential blasting methodology are included as part of the EMP.

WTG Foundations Close to Wetlands

127. Where WTG's are situated within existing wetlands, the base of the foundations will be formed at a lower level than the wetland. A typical example of this is WTG JED- 23 hardstand – refer to the SWF Civil Drawing set (in Part K of the application) for cross sectional drawing through JED-23 and the wetland. As illustrated on the drawing, separation (both horizontally and vertically) is maintained between the adjacent wetland and the concrete foundation, and a low permeability clay bund (referenced above) will reduce seepage paths between the two. Therefore under no circumstances will there be a risk of the concrete coming into contact with the wetlands. Furthermore, concrete pours will only be undertaken during dry weather, therefore no dewatering of the foundation excavations is anticipated during the concrete pours.

SURPLUS FILL DISPOSAL SITES

128. As presented above, based on a preliminary earthworks design, it is anticipated that close to 1.2 million, m^3 of excess material will be generated from the earthworks to form the Project Access Tracks and

Hardstands. To minimise hauling distances and cost, this material will be deposited at SFDs located within the Wind Farm Site.

(a) SFDs will be located close to areas of large surplus cut, and subject to the following exclusions / constraints;

(b) No disposal will take place into any areas identified as wetlands (or within a 10m setback from wetlands), or high value vegetation;

(c) No disposal will take place into any permanent or intermittent rivers or streams; and

(d) No disposal will place into very steep slopes >45 degrees (such as at gully side slopes).

129. The proposed SFD's can generally be characterized into three types:

(a) Blanket fills: Non-engineered fill is spread over gently or moderately sloping ground, typically 1-3m thick, average ~1.5m thick. Situated on ground with slopes <15% (typical). Usually located in grass paddocks or cleared forestry areas, close to tracks and hardstands. Blanket SFD's will be contoured so they do not impound nor divert surface water, generally following the pre-existing ground profile beneath. Therefore, surface runoff will simply sheet flow across the SFD finished surface. Refer Figure 3.

(b) Shoulder fills: Fill is placed butting up against tracks and hardstand fill embankments - located along ridgelines/spurs or knolls. Comprises a structural fill toe (for stability) with non-engineered fill place behind. Situated on ground with slopes <15% (typical). Max fill depths vary, typically <5m but can be up to 10m. Refer Figure 4.

(c) Gully fills: Fill placed into heads of gullies (outside of exclusion areas noted above). Comprises a structural fill toe (for stability) with non-engineered fill placed behind. Max fill depths generally between 5-10m. Overland flow from upstream catchment (minor catchments) is directed around the perimeter of the SFD via a rock line channel – to be sized for the 1% AEP rainfall event.

Refer Figure 5. Gully fills are limited to the Venlaw Forest as explained below.

130. The process of identifying suitable SFD sites was an iterative one with the Project team and in particular the Project terrestrial and wetland ecologists (Nick Goldwater, Dr Kelvin Lloyd and Roger MacGibbon).

131. Initially SFD sites were identified which limited the spatial area of fill disposal, however these included a number of gully fills on Jedburgh Station. Gully fills were subsequently removed from the Jedburgh Station portion of the Wind Farm Site, and generally limited in number.

132. The only gully fills now proposed are within exotic plantation forest within the Matariki / Venlaw Forest landholding. The forest contains accessible broad gully features, allowing for the efficient placement of large volumes of material in the gully heads, whilst being relatively low impact in terms of the vegetation type impacted.

133. Additionally, shoulder SFDs were identified adjacent to tracks and other earthworks where the topography allowed for this and each of these were modelled in 3D to calculate their individual volume.

134. The location of the three types of SFD's identified were discussed further with the ecologists which lead to the removal of some individual SFD sites and the reduction in size and movement of others. We liaised closely with the ecologists to avoid SFD sites in areas identified as particularly important for lizard and invertebrate biodiversity, and the Jedburgh Plateau Fauna Enhancement Area (which is a focus of proposed ecology restoration actions, as discussed in the Terrestrial and Wetland Ecology report).

135. The identification of the proposed SFD sites gave sufficient fill volumes across the entire windfarm site but also within six different areas within the site; Glencoe, Jedburgh pasture, Jedburgh Plateau, Venlaw west, Venlaw east and the access road in through Port Blakely.

136. The finished surface of the blanket SFD's will be contoured to general follow the pre-existing ground profile beneath, such that existing flow paths are maintained to downstream water bodies. In the case of gully SFD's – a permanent rock lined channel will be implemented to divert the

cleanwater flow around the perimeter of the fill site, refer Riley Drawings in Part K of the application for details.

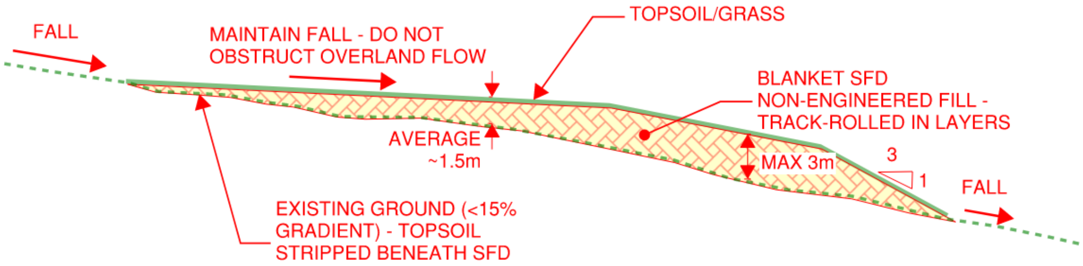


Figure 3: Blanket Type Surplus Fill Disposal Site – Typical Section

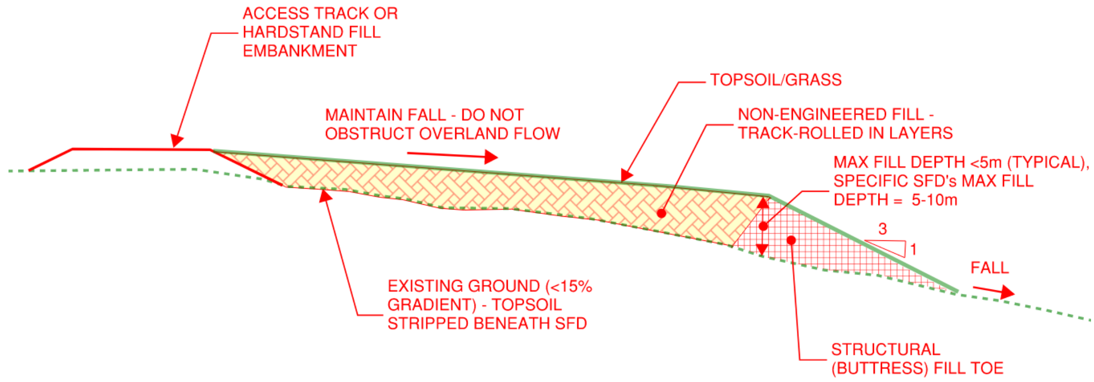


Figure 4: Shoulder Type Surplus Fill Disposal Site – Typical Section

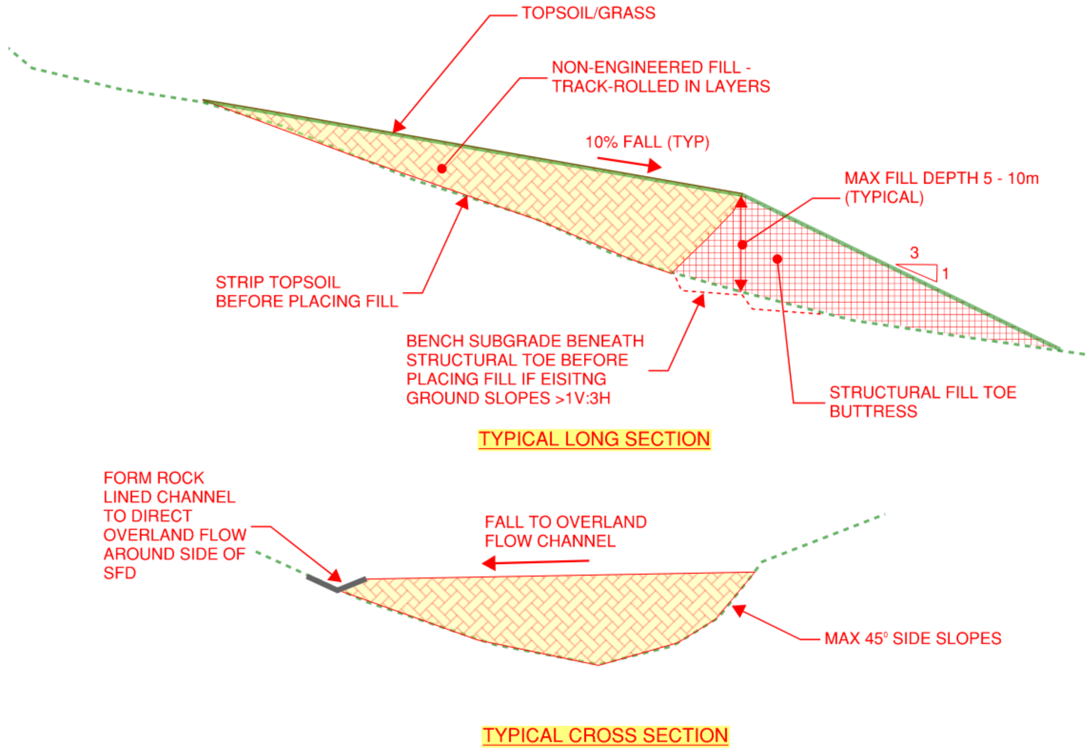


Figure 5: Gully Type Surplus Fill Disposal Site – Typical Sections

137. Each of the proposed shoulder and gully SFD sites have been modelled in 3D to assess storage capacity, whilst the blanket fills' storage capacity has been estimated on an area basis and assuming 1.5m average fill depth. A total of 101 SFD sites have been identified (9 gullies, 39 shoulders, 53 blankets). The locations, type, and storage volumes of each SFD are shown on Riley Drawings in Part K of the application. The total storage capacity of the identified SFD's is calculated as 1,479,000 m^3, with a footprint of 81.9 ha. This is sufficient for the 1,146,000 m^3 surplus (calculated in Table 4) plus allowance for a 15% material bulking factor, with 161,000 m^3 of additional storage capacity.

138. Within the Jedburgh Plateau 2 blanket fills and 6 shoulder fills have been designed, with a total storage capacity of approximately 165,000 m^3 and footprint of 8.2 ha. The Plateau SFD's have been carefully located to avoid impacts on wetlands and high value vegetation.

139. Based on the storage estimates noted above, not all the identified SFD's will be required and/or the full storage capacity of each may not be utilised. Equally, other suitable SFD sites may be identified during detailed design or pre-construction phase, subject to them complying with

the exclusion criteria noted above, and subject to ecologist input. An important exception is that no additional SFD sites will be identified and utilised at the Jedburgh Plateau.

140. The shoulder and gully type SFD's will have the following characteristics and requirements:

(a) An appropriately designed, and stable, toe-support will be constructed across the front of the fill area. The foundations of this toe will be keyed into the in-situ ground. All topsoil and soft compressible material beneath the toe foundation will be stripped. The toe support should be constructed with appropriately compacted material, such as well -graded coarse-grained rock/gravel.

(b) The structural fill forming the buttress fill will be constructed using selected as-dug materials readily compacted, durable, and not prone to collapse, swelling or consolidation. Materials such as highly plastic cohesive soils, organic material (peat) or organic soils are not appropriate for the buttress fill construction.

(c) Where the existing slopes of the proposed fill area are greater than 1v:3h (gully fills) the in-situ ground will be benched prior to the placement of fill.

(d) Adequate drainage measures will be installed to ensure pore pressures in the in-situ and fill material do not increase to levels where the slope stability of the fill site is dangerously reduced. Such measures should include placement of surface cut-off channels above the fill areas and subsurface drains.

(e) Care will be taken to ensure a uniform compaction of the excess fill material placed behind the structural buttress fill. This should usually be achieved by the general tracking of construction vehicles.

(f) Ground conditions, suitability, and slope stability of each disposal site will be verified via a site visit and, if necessary, a limited subsurface investigation in the area prior to and during construction.

STORMWATER MANAGEMENT AND STREAM CROSSINGS

Stormwater Management Principles

141. The wind farm tracks and hardstands will intercept surface water runoff and thus have the potential to affect existing drainage patterns within the Wind Farm Site. Key design principles employed in the stormwater management of the wind farm track and hardstands include:

(a) Tracks and hardstands to be located along ridgelines or spurs where practicable, to avoid impact on natural flow paths.

(b) Conserve the natural flow paths to natural streams and wetlands downstream. This will be achieved through the use of stormwater culverts where tracks and hardstands intercept the flow paths – thus maintaining the existing catchments and hydrology.

(c) Where practicable, allow stormwater runoff to sheet flow from access tracks, hardstands, and surplus fill disposals; across the natural topography – to reduce the number of culverts.

(d) Transmission line access tracks will be designed to enable runoff to head up/sheet flow across the pavement to avoid the need for culvert - noting the temporary nature of those tracks. The exception to this is where the transmission line access tracks cross intermittent or perennial streams – in which case stream culverts are required.

(e) Where stormwater is collected, mitigation of potential erosion along drains and at outlets with energy dissipation. This will be achieved through rock lined channels (table drains) along steep gradients and rock aprons at culvert outlets and table drain termination points.

(f) Protection of proposed infrastructure from erosion or overtopping with adequately sized culverts to convey flow beneath tracks and hardstands.

142. Riley have undertaken a site wide catchment assessment to determine the indicative location and design of proposed stormwater culverts which

will minimise the impacts on existing drainage patterns. The primary purpose of the stormwater culverts is to:

(a) Keep pavements free from surface water by preventing water ponding up within surface water drains, culverts are sized to pass flood flows;

(b) Maintain flow to streams and wetlands where earthworks intersect existing flow paths, thus maintaining the natural hydrology of the streams and wetlands; and

(c) For crossings of perennial and intermittent streams - maintain fish passage where fish passage is desirable (in the opinion of the freshwater ecologist), in accordance with National Environmental Standards for Freshwater (**NES-F**) Regulation 70, and giving effect to the proposed Southland Water and Land Plan (**SWLP**) Rules 55a and 59a.

143. As discussed above, WWLA have also designed a scheme of culverts to maintain hydrological connectivity to /between wetlands at Jedburgh Plateau.

Stormwater and Wetland Culvert Types

144. The proposed stormwater culverts can generally be broken down into four main types, details of which are included in the Riley SWF Civil Drawings (in Part K of the application):

145. Type A culverts (catchments < 40 ha, culvert size <= 1,200mm dia) – to be located within gully features/ephemeral streams (where there is no fish habitat) beneath access track fill embankments. Refer to appended A total of 16 Type A culverts have been identified based on the indicative Project layout.

146. Type B, C culverts (catchments < 40 ha, culvert size <= 1,200mm dia) – to be located at various locations along the access track and WTG hardstand table drains, to convey flow beneath the tracks and hardstands where they cross natural flow paths, to maintain surface flow to downstream water bodies. Type B culvert outlets terminate on earthwork fill embankment and thus incorporate a rock lined flume section to direct

flows to a riprap apron at the toe of the embankment. Type C culvert outlets terminate directly to the embankment toe (with a riprap apron). A total of 24 Type B and 27 Type C culverts have been identified based on the indicative Project layout.

147. Type D culverts (catchments < 40 ha, culvert size <= 1,200mm dia) – to be located at locations along access track and turbine platforms, to connect flow from one U/V ditch drain to another, conveying flow beneath tracks and hardstands where they cross natural flow paths or where a sag point is located along the track alignment. A total of 38 Type D culverts have been identified based on the indicative Project layout.

148. Stream Culverts and Bridges (catchments < 40 ha, culvert size <= 1,200mm dia) – to be located within intermittent or perennial streams which will be crossed by track fill embankments. These include the replacement of existing culverts and fords at existing farm/forestry track crossings. Fish passage to be provided except where fish passage has been identified as being detrimental to upstream habitats – in which case specific fish barrier measures have been designed. 8 stream culverts and 1 bridge location have been identified based on the indicative Project layout.

149. Wetland culverts (predominantly within Jedburgh Plateau) – designed to maintain hydrological connectivity between/to nearby wetlands. The conceptual design of these culverts are detailed in the WWLA Conceptual Hydrological Design. A total of 109 wetland culverts were identified for the Jedburgh Plateau, one of which was identified as one of the 8 stream culverts. These culverts are broken into 3 sub types:

(a) Type I – connecting segregated sections of wetland beneath a handstand or track in cut;

(b) Type II - connecting segregated sections of wetland beneath a track fill embankment; and

(c) Type III – directing flow beneath tracks or hardstands to maintain flow to nearby wetlands downstream.

Stormwater Culvert Design – Type A, B, C, D

150. A catchment analysis has been undertaken using the GRASS 8[1] module embedded within QGIS. Flow path analysis and determination of the pre-development catchments has been undertaken using the existing ground LiDAR survey. The survey was then merged with the design surface and flow paths re-calculated. Flow paths from pre- and post-development assessments were then compared and culverts positioned to maintain original flow paths to the downstream water bodies, where they otherwise would have been diverted by the proposed earthworks. Culverts were also positioned at sag points along the new track alignments.

151. Flow rates at identified culvert locations have been calculated using the Rational Method (NZ Building Code E1/VM1) based on rainfall data obtained from NIWA (Hirds) with variable runoff coefficients which consider the ground cover types present across the Wind Farm Site (Pasture, Brush/Scrub and Forest), and a climate change scenario of RCP 4.5 for the period 2081 – 2100.

152. Culverts are designed to pass flows from the 10% AEP rainfall event (in accordance with NZBC E1 VM1). In larger rainfall events the water will head up in the drains and culvert inlets and is permitted to overtop tracks and hardstands. The permanent hardstands comprising the permanent buildings/structures (substation and O&M) will be specifically designed to consider overland flow paths and provide freeboard above the flood levels for the appropriate rainfall events, in accordance with the asset owners requirements and provisions of the building code.

153. Calculated flow rates have been correlated to the maximum flowrate capacities, assuming inlet control, to give a required pipe size, which exceeds this capacity. The minimum diameter for all culverts shall be 300mm irrespective of catchment area and design flow rates, except in the Jedburgh Plateau area, where WWLA have modelled and sized specific culverts.

154. Stormwater culvert calculations are included as Annexure E for the hydrological and hydraulic assessment for type A, B, C and D culverts.

---

[1] GRASS 8 (Geographic Resources Analysis Support System) is an open-source GIS toolbox developed by academics across the world, embedded within QGIS, which is commonly used to undertake catchment analysis and flow path modelling.

The culvert sizing methodology based on catchment properties is presented in the tables below. Refer to Riley Drawings in Part K of the application for summary of all culvert sizes and locations.

Table 7: Indicative Stormwater Culvert Sizing – Pastured Land

Pastured Catchment				
Culvert Size	**Max Q (L/s)**	**Max Pervious Catchment Area (slopes <10%) (ha)**	**Max Pervious Catchment Area (slopes 10-20%) (ha)**	**Max Pervious Catchment Area (slopes >20%) (ha)**
300dia	110	2.12	1.82	1.59
375dia	190	3.67	3.14	2.75
450dia	300	5.79	4.96	4.34
525dia	450	8.68	7.44	6.51
600dia	620	11.96	10.25	8.97

Table 8: Indicative Stormwater Culvert Sizing – Brush/Scrub Ground Cover

Brush/Scrub Catchment				
Culvert Size	**Max Q (L/s)**	**Max Pervious Catchment Area (slopes <10%) (ha)**	**Max Pervious Catchment Area (slopes 10-20%) (ha)**	**Max Pervious Catchment Area (slopes >20%) (ha)**
300dia	110	2.55	2.12	1.82
375dia	190	4.4	3.67	3.14
450dia	300	6.95	5.79	4.96
525dia	450	10.41	8.68	7.44
600dia	620	14.35	11.96	10.25

Table 9: Indicative Stormwater Culvert Sizing – Forestry Land

Forested Catchment				
Culvert Size	**Max Q (L/s)**	**Max Pervious Catchment Area (slopes <10%) (ha)**	**Max Pervious Catchment Area (slopes 10-20%) (ha)**	**Max Pervious Catchment Area (slopes >20%) (ha)**
300dia	110	3.18	2.55	2.12
375dia	190	5.50	4.40	3.67
450dia	300	8.68	6.95	5.79
525dia	450	13.02	10.41	8.68
600dia	620	17.94	14.35	11.96

155. The culvert outlets will be specifically designed to provide energy dissipation to mitigate erosion effects. This will be achieved through rock rip-rip aprons, designed in accordance with Auckland Council's *TR2013/080 - Hydraulic Energy Management: Inlet and Outlet Design for Treatment Devices*, refer **Table 10**.

Table 10: Indicative Culvert Outlet Riprap Apron Sizing

Culvert Size (mm)	Riprap Apron Length (m)	Min Rip Rap Apron Width (m)	Min Stone Size d_{50} (m)	Min Stone Layer Depth (m)
300dia	3.5	0.9	0.2	0.4
375dia	4.4	1.2	0.2	0.4
450dia	5.3	1.4	0.2	0.4
525dia	6.3	1.6	0.25	0.5
600dia	7.3	1.8	0.25	0.5

Stream classification

156. Classifiable streams within the site have been identified according to the New Zealand River Environment Classification (**REC**) 2010, which comprehensively maps New Zealand's river network. This data was

accessed through the Ministry for the Environment via the MfE Data Service.

157. The MfE database identifies streams of orders 1 through 8 (minor through to major). The preliminary wind farm access track layout crosses order 1, 2, and 3 streams only. A total of 9 notable stream crossings have been identified which have catchments > 40 ha, which approximately corresponds to culverts >= 1,200mm diameter – a trigger for consent under SWLP Rule 59b. These stream crossings will be considered for fish passage in accordance with NES-F Regulation 70.

Stream Culvert and Bridge Design

158. The preliminary design of the identified stream crossings has been completed, refer to Preliminary Design Report (Riley ref: 220372-C) in Annexure C. The below sections are a summary of that report.

159. The nine stream crossing locations and design methodology with respect to fish passage are presented in Table 11. This approach has been verified with the project freshwater ecologists. Where fish passage is required, the culverts will be designed to meet the permitted activity rules of NES-F Regulation 70.

Table 11: Proposed Notable Stream Crossing Locations and Fish Passage

Location	Track	Chainage (m)	Stream Name	Existing/ Proposed Type	Fish Passage
NSC1	Port Blakely Forest Track	4305	Mimihau Stream North Branch	Ford/ Culvert	Trout passage prevention
NSC2	Matariki Main Track	1155	Mimihau Stream South Branch	Bridge/ Bridge	Bridge
NSC3	JED18	670	Mimihau Stream South Branch Tributary 1	Ford/ Culvert	Trout passage prevention
NSC4	JED19	35	Mimihau Stream South Branch Tributary 1	Ford/ Culvert	Fish passage

Location	Track	Chainage (m)	Stream Name	Existing/ Proposed Type	Fish Passage
NSC5	Port Blakely Forest Track	5010	Mimihau Stream North Branch Tributary 1	Ford/ Culvert	Fish passage
NSC6	Port Blakely Forest Track	1375	Kaiwera Stream East Branch	Culvert/ Culvert	Trout passage prevention
NSC7	Port Blakely Forest Track	3180	Mimihau Stream North Branch Tributary 2	Culvert/ Culvert	Fish passage
NSC8	Port Blakely Forest Track	1590	Kaiwera Stream East Branch	Ford/ Culvert	Fish passage
NSC9	Transmission Tower Access Track A5	255	Mimihau Stream South Branch Tributary 2	Nil/ Culvert	Fish passage

160. For the 100-year ARI RCP6.0 scenario, the specified culvert hydraulic design criteria is a maximum access track overtopping flood depth of 200mm.

161. For the 10-year ARI RCP6.0 scenario, the specified culvert hydraulic design criteria are:

(a) Minimum 500mm freeboard for wind farm access tracks; and

(b) Maximum overtopping flood depth of 200mm for transmission tower access tracks.

162. The fish passage crossings have been designed in general accordance with the permitted activity requirements of NES-F Regulation 70, including a minimum culvert embedment of 300mm in accordance with SWLP Rule 59a.

163. The trout prevention culverts will be raised so the culvert invert is 1.0m above the stream bed, creating a 1.0m vertical drop/barrier at the downstream end.

164. The specified bridge hydraulic design criteria is 600mm freeboard above the 100-year ARI RCP6.0 scenario peak flood level.

165. The design flows have been derived using conservative ratios from the NIWA web portal "NZ Rivers Flood Statistics" and favourable comparisons have been made to other methods.

166. The approximate locations of the notable stream crossings are shown in Figure Aquatic Ecology-2 (Part G). A summary of the stream culvert design is provided in Table 12. Where practicable, the tracks have been aligned perpendicular to the stream, and embankment heights minimised, to minimise the disturbance area and culvert lengths within streams. Refer Riley Stream Crossing Design Report (Ref 220372-C) included as Annexure C, for a full details of the stream culverts design methodology and preliminary design drawings.

Table 12: Proposed Notable Stream Crossing Preliminary Design

Location	Catchment Area (km^2)	River Environment Classification (MfE)	100-Year ARI RCP6.0 Design Flow (m^3/s)	Geometry (W x H) (m)[1.]	Existing Culvert Length (m)	Proposed Culvert Length[2.] (m)
NSC1	17.37	3	38.4	6.0 x 1.5	Ford	20
NSC2	12.28	3	29.1	Bridge	Bridge	n/a
NSC3	4.67	3	13.4	3.0 x 1.5	Ford	26
NSC4	2.85	2	9.0	5.5 x 1.0	Ford	20
NSC5	1.39	2	5.1	3.0 x 1.0	Ford	20
NSC6	1.23	2	4.6	2.0 x 1.0	10	20
NSC7	0.81	1	3.3	2.0 x 1.0	7	20
NSC8	0.80	1	3.3	2.0 x 1.0	Ford	20
NSC9	0.54	1	2.4	2.0 x 1.0	n/a	13

[1] Internal dimensions presented.

[2] Culvert lengths are conservatively estimated and will be refined at detailed design stage.

PAVEMENT DESIGN, AGGREGATE SOURCES AND CONCRETE WORKS

Pavement design

167. The pavement for the access tracks will be specifically designed for the development layout, anticipated subgrade, and heavy construction vehicle volumes. The design will ensure the access track pavements perform adequately for the duration of the construction works (when the pavements are most heavily loaded). Some intra- and post-construction maintenance of the tracks is likely. For the site access tracks, a metalled (unsealed) pavement from layers of unbound aggregate will be used.

168. To provide an estimation of the aggregate volumes, pavement designs for the access tracks will be based primarily on prescriptive design methodology, and recommendations, outlined in Austroads literature. This design technique requires input of subgrade California Bearing Ratio (**CBR**) values, and frequency of equivalent standard axles (i.e. standard 80kN) (**ESAs**).

169. The CBR values for the in-situ soil materials have been estimated based on a limited sample of Scala Penetrometer (Scala) testing performed by Riley at test pit locations. Based on our investigations and our experience with similar materials we expect that subgrade CBR for soil and weaker/weathered rock could have a CBR range between 2 and 10. CBR values for the less -weathered rock is expected to be +20.

170. An indicative pavement design has been developed based on the methods prescribed in the AUSTROADS Manual. The site traffic has been estimated based on the expected amount of construction materials to be delivered to site, plus vehicle movements relating to the construction of the wind farm. Post-construction traffic will be limited. Therefore, the estimated standard axles over the design life of the pavement are based primarily on construction traffic. Based on the envisaged traffic requirements, subgrade conditions, and experience on other windfarm sites, the pavement thickness will be approximately 150mm to 300mm. For the purposes of this assessment, we have assumed a 250mm average depth pavement, and we have conservatively ignored existing pavement thicknesses (i.e. where the proposed tracks follow existing farm and forestry tracks).

171. The pavement design is sensitive to the value of the subgrade CBR; therefore, the pavement thickness will depend largely on the degree of the subgrade improvement works undertaken. A lower confidence level for the pavement design may also be chosen (i.e. thinner pavement with higher risk of failure), given that the tracks will not be used for general public use, and post-construction traffic will be limited.

172. Subgrade improvement methods will be investigated at the detailed design stage to reduce pavement thickness. These measures may include dynamic compaction of subgrades or sub-excavation (undercut) and backfill with hardfill.

173. Comprehensive testing of subgrade (Scala) will be carried out at detailed design stage to develop a subgrade CBR profile for the site to confirm the pavement design. Laboratory testing will be carried out to measure CBR values for engineered fill.

174. Where the proposed wind farm tracks follow existing farm/forestry tracks, the existing granular pavement depths will be assessed, and depth of new pavement reduced accordingly (i.e. existing pavement overlay).

175. Stormwater control, along the access tracks and other areas of civil works, is essential to ensuring adequate performance of any pavement placed. Stormwater controls will consist of v and u-drains (table drains) where tracks and hardstands are in cut, along with numerous culverts which will convey flow beneath the tracks and hardstands where they cross natural flow paths.

Aggregate sources and quantities

176. Aggregates will be required to form access tracks and platform pavements, as well as for batching concrete for the WTG foundations.

177. Roading aggregates will be sourced from nearby quarries, or from excavations to form the WTG hardstand, WTG foundations, and access tracks (i.e. blue-rock excavated and processed on-site). The use of site-won rock for pavement aggregates is discussed further in the Riley Geotechnical Assessment.

178. Site-won aggregate (from blue-rock) is not considered suitable for structural concrete for the WTG foundations at the Wind Farm Site. Concrete aggregate (coarse aggregate and sand) will all need to be imported from suitable nearby offsite quarries.

179. Approximately a dozen offsite quarries have been identified, generally within a 20km to 50km radius of the site (predominantly to the north and west). Those quarries can produce GAP40 and GAP65 products which will likely be suitable for track pavement aggregates (subject to further assessment at detailed design stage). A couple of the quarries also produce aggregates suitable for concrete production. Details of the quarry locations and route maps to the Project Site entrances are shown in Figure Transport-3 (Part G), completed by others.

180. Riley has undertaken a preliminary assessment of aggregate quantities to estimate the subsequent traffic movements to and from the Project Site (for a range of vehicle sizes) – assuming aggregates are sourced from off-site quarries. Refer

181. Table 13 for quantities and assumptions.

Table 13: Estimated Aggregate Volumes and Corresponding Traffic Movements

	Sand/ Aggregate Volume per WTG		Total Sand/ Aggregate Volume (55 WTG)		Loose Cement Volume (WTG foundations)		Sand/Aggregate Delivery(4)			Cement Delivery(6)
	Loose Volume (m^3)	Solid Volume (m^3)	Loose Volume (m^3)	Solid Volume (m^3)	Per WTG (m^3)	Total	6-Wheel Truck Return Journeys	Artic Truck Return Journeys	Truck and Trailer Return Journeys	Cement Delivery Truck (16T payload)
WTG Foundations(1)(4)(6)	1,040	740	57,200	40,860	350	19,250	6,580	3,430	2,860	1,450
Wind Farm Tracks(2)(4)	-	-	209,700	136,750	-	-	24,100	12,560	10,490	-
Transmission Pylon Tracks and pads(7)	-	-	9,500	6,200	-	-	1,090	570	480	-
WTG platforms(5)(4)	1,610	1,050	88,550	57,750	-	-	10,180	5,300	4,430	-
Site Facility Platforms(3)	-	-	50,600	33,000	-	-	5,820	3,030	2,530	-
TOTAL:	2,650	1,790	415,550	274,560	350	19,250	47,770	24,860	20,760	1,450

(1) Based on foundation volume of $800m^3$ + $100m^3$ blinding concrete (levelling course) - based on prelim foundation design (750m3 - round up). And following calculation:

a. Wet volume = 800+100 = $900m^3$. Dry volume = 900*1.54 = $1,386m^3$. Assume 1:1:2 cement/sand/aggregate volume ratio (dry volume) for 40mPa concrete. Treat sand/aggregate as having the equivalent vehicle movement per m^3 - for simplicity.

(2) 54.7ha Pavement area (Table 5), 250mm pavement depth
(3) Assume conservative 250mm pavement depth, and based on following platform areas:
  a. 10,000m^2 for concrete batching plant facilities, x2
  b. 4,500m^2 O&M,
  c. 40,000m^2 Site Compound
  d. 13,000m^2 substation
  e. 53,000m^2 – other ancillary platforms (equipment and storage areas, etc)
  f. 7,750m^2 – switchyard/GIP
(4) Assuming 2,300kg/m^3 solid density for compacted aggregates (tracks and platforms), and 1,500kg/m^3 loose density (concrete aggregates), and following assumed truck payloads:
  a. 6 wheeler = 13T (8.7m^3 loose)
  b. Artic = 25T (16.7m^3 loose)
  c. Truck and Trailer = 30T (20m^3 loose)
(5) 4,200m2 hardfill platform (permanent and temporary) area, conservatively assume 250mm pavement depth.
(6) Cement loose bulk density = 1,200kg/m^3, assume 16T payload per cement delivery vehicle (32T gross weight).
(7) Assume 150mm hardfill depth for new access tracks and construction pads. Tracks 5.4 km length @4.5m width, pads 42No. @ 400m^2.

Concrete works

182. Due to the large volumes of concrete required to construct each WTG foundation, up to two temporary concrete batching plant facilities will be established on the Wind Farm Site during construction. Each of the batching plant facilities will comprise dual batching plants in order to supply the volume of concrete required.

183. Indicative locations of the two batching plant facilities are shown on Figure Project Description-5 (Part G); the final locations will be within the two identified evelope areas. This will provide a concrete supply source close to the construction work, thus improving the efficiency of construction traffic.

184. Furthermore, materials such as cement and aggregate may be delivered to the site by vehicles typically larger than standard concrete trucks, therefore, minimising the number of vehicle movements on the public road network.

WATER SUPPLY

185. As part of the hydrological investigation of the Mimihau Stream, Riley established three hydrometric monitoring locations in the catchment March 2023 (Site M1, M2 and M3). Nearly two years of Mimihau Stream monitoring data has since been collected, which has been processed and analysed (Riley Ref: 220372-H) (Annexure D). This section provides a brief overview of the outcomes of these assessments.

186. During wind farm construction there will be a water requirement for earthworks, concrete batching, dust suppression and general activities. The typical maximum daily demand will likely be between 250m^3-350m^3/day across all the construction activities requiring water but could peak at 500m^3/day on days when WTG concrete foundations pours are occurring. There will be no ongoing water take once the Southland Wind Farm is operational.

187. Two potential water supply sources have been identified, both located within the Mimihau Stream South Branch catchment, named Site M1 and Site M-2 (refer Figure Project Description-5 (Part G) for locations):

(a) M1: Mimihau Stream South Branch tributary (at NSC3, Jedburgh Station); and

(b) M2: Mimihau Stream South Branch (at NSC2, Matariki 'Venlaw' Forest).

188. On 29 March 2023, Riley established stream water level data loggers at the proposed water take locations (i.e. sites M1 and M2). The stream level has been recorded at these locations continuously since. Stream flow gaugings have also been undertaken, and water to stream flow ratings developed (so that the stream level data can be converted to stream flow data). Summary flow information from the analysis of this stream flow record is provided in **Table 14**.

Table 14: Mimihau Stream flow statistics. Period of record from 29 March 2023 to 10 March 2025.

Location	Catchment Area (km^2)	Mean flow (l/s)	Median flow (l/s)	95 percentile flow (l/s)
Site M1	4.6	153	115	65
Site M2	12.4	377	269	92

189. Given the water requirements of the wind farm construction (i.e. up to 500 m^3/day), and the rules as stipulated in Appendix K of the SWLP, Contact proposes a water take of:

(a) A maximum of 5 l/s at each site M1 and M2, but restricted when stream flows are Q95 (or lower), at which point water take shall comply with the permitted activity limits set in Rule 49(a) or 49(b) (whichever is applicable) in the SWLP.

(b) A maximum rate of take of 5 l/s corresponds to a (maximum) daily volume of 432m^3, which is close to the anticipated maximum daily demand of 500m^3. However, water take will be significantly restricted when flows are Q95 or lower. This means that water take will be significantly restricted for 5% of the time – or approximately 18 days a year.

190. To address the issue of not having enough water to meet construction demands during these periods of low stream flow (i.e. Q95 or lower), water storage tanks or ponds are proposed so that the stored water can be used during periods of high demand that coincide with periods of low stream flow.

191. Water would be pumped from the stream at either Site M1 or Site M2 (or potentially both) locations, to preliminary water tanks located close to the site of abstraction. From these water tanks, water would then again be pumped to the water storage ponds. These ponds (which would have a maximum capacity 10,000 m^3) would be located within the identified 'water storage and concrete batching facility' envelopes. The exact location of the storage ponds (and concrete batching plant facilities) within the identified envelopes will be determined during detailed design. Indicative locations are shown in Figure Project Description-5 (Part G).

192. Water quality testing will be undertaken to assess whether the stream water meets the requirements of *NZS 3121:2015 Water and aggregate for concrete,* in relation to the supply to the concrete batching plant/s. The stream water may require filtration/treatment to meet this standard.

193. Alternatively, batching plant water could be sourced from off-site, delivered to the on-site storage facilities via tankers. Based on a 900m^3 WTG foundation volume and assuming a 0.43 water/cement ratio and cement content of 420kg/m^3, a total of 160m^3 water would be required for each concrete foundation, or 8,800m^3 over 55 WTG's. Assuming a 30,000 litre (30 m^3) capacity for a tanker (truck and trailer configuration)

this would result in approximately 300 vehicle return journeys. The Transport Report (Rossiter (2025) included in Part H to the substantive application documents) has considered that water for concrete manufacture will be trucked to site.

TEMPORARY AND PERMANENT SITE FACILITIES

194. The following temporary and permanent site facilities are envisaged for the Project and form part of Riley preliminary earthworks design and aggregates volume estimates:

(a) 2x 10,000m^2 platform for 2x temporary batching plant facilities, located in Matariki / Venlaw Forest and Jedburgh Station.

(b) 4,500m^2 platform for the permanent O&M Facilities, which will include a building approximately 1,500m^2 in area, and a carpark with an area of approximately 1,500-3,000m^2, located off Thornhill Road (note that this location will also be used as a temporary Site Compound during construction).

(c) 40,000m^2 platform for the temporary Site Compound near the Davidson Road West site entrance (outside of the Wind Farm Site but within the wider Project Site).

(d) 13,000m^2 platform for the permanent wind farm substation likely located on southern plateau region of Jedburgh Station.

(e) Up to a total of 53,000m^2 for temporary laydown areas for WTG supplier equipment storage areas, overflow parking, etc – located near the site entrances (incl. outside of the Wind Farm Site but within the wider Project Site).

(f) 7,750m^2 grid injection point (GIP or switching station) located to the north of the Wind Farm Site (within the wider Project Site).

195. The temporary laydown areas will be re-vegetated (grassed) following construction, as will the cut and fill batters for the permanent platforms.

EARTHWORKS CONSTRUCTION AND EROSION AND SEDIMENT CONTROL

196. Comprehensive erosion and sediment control (**ESC**) measures will be put in place in order to minimise the effects of earthworks activities on the environment. During the previous Covid Fast-track consenting process, the consenting panel commissioned an erosion and sediment control peer review. Riley (Luke Gordon) carefully considered that peer review, provided a written response, then met to discuss matters with the peer reviewer. The measures proposed in this assessment (and associated management plans) reflects the outcome of that process.

197. The general principles for ESC will be the implementation of measures reducing the potential for erosion of exposed soils during land disturbing activities (erosion control), and to adopt retention devices that collect and retain sediment prior to discharge to the downstream receiving environment.

198. The ESC Practices outlined in the below sections and shown on the example plans in the SWF Civil Drawings in Part K of the application, follow the principles of Auckland Council's *GD05 Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region (2016).* This is the most recent version of Auckland Regional Council's Technical Publication No.90 (TP90), which was referenced in SDC's Subdivision, Land Use and Development Bylaw 2012.

199. Riley have prepared a Draft EMP, inclusive of a Draft ESCP. The EMP is appended to the Draft Construction Environmental Management Plan (**CEMP**) and included separately with the application documents. The EMP outlines the proposed measures to control sediment runoff and to mitigate erosion and dust arising from the earthworks.

200. Site Specific Management Plans (**SSMP**) will form part of the final CEMP which will be prepared by the Contractor and approved by Council prior to construction. The SSMPs will apply the principles of the EMP, and detail the location-specific ESC measures to be implemented at each stage of earthworks.

201. The general ESCP principles are as follows:

(a) Regular liaison between the Contractor(s), Engineer to Contract and the Regulatory Authorities' Representatives.

(b) Diversion of clean water away from the work site, where practicable.

(c) Minimise disturbance to the areas necessary to complete the construction activities.

(d) Avoid/control dust emissions through the use of appropriate dust mitigation measures.

(e) Where practicable, intercept and treat all sediment laden water from the work area prior to discharging into the downstream environment, particularly earthwork areas upslope of sensitive receiving environments such as wetlands.

(f) Implement measures to prevent construction traffic exiting the construction areas onto public roads/tracks with sediment and other materials attached to the undercarriage and tyres (i.e. wheel wash).

(g) Inspect the erosion and sediment control measures regularly and undertake any maintenance necessary to maximise the potential to retain sediment on the site.

(h) Undertake regular inspection and testing of discharges from sediment control devices, to verify minimum standards of discharge are being met in accordance with the SWLP – "Mataura 3" Surface Water Bodies for watercourses within the Mimihau Stream and Mokoreta River Catchments and 'Lowland Soft Bed' receiving water quality standards for watercourses within the Kaiwera Stream catchment.

(i) In the event of forecast for heavy rain, stabilise the site as far as practicable and close the works down.

(j) Ongoing assessment of the erosion and sediment control measures and, if required, adjust as the work progresses.

Earthworks Construction Methodology

202. Earthworks will be undertaken in a staged manner to reduce the area of exposed earthworks at any point in time throughout the construction period. The earthworks staging arrangement will form part of the EMP and SSMPs.

203. Due to the scale of the earthwork activities, earthworks are likely to be carried out simultaneously in adjacent sub-catchments by separate teams, this will accelerate the works and reduce length of time that the earthworks are exposed to the weather. The earthwork areas will be stabilised to prevent erosion of exposed surfaces following the completion of each sub-catchment stage.

204. For each stage of earthworks, sediment and erosion control measures will be implemented to:

(a) Divert clean water runoff away from earthwork areas; and

(b) Intercept sediment laden runoff from earthworks areas and direct to sediment retention devices (including chemical treatment where specified) before controlled release to the downstream receiving environment.

205. The construction sequence for the implementation of sediment control measures will follow these general guidelines:

General earthworks to form access tracks, WTG and site facility hardstands:

(a) Construct diversion bunds to direct clean stormwater runoff away from earthwork areas as works progress. Where practicable, the diversion bunds will follow close to the existing contours to minimise gradients and prevent significant channel erosion. Stormwater collected will be directed to safe discharge points and may require staggered silt fences at the outlets to dissipate flow rates.

(b) Construct a decant earth bund to retain flows from the temporary diversion bunds where specified.

(c) Place silt fence with returns around the extents of fill areas where the natural slopes exceed 18° and/or immediately adjacent to a wetland or water body where there is insufficient space to construct earth bunds.

(d) Strip topsoil from within the earthwork extents (to stockpiles) and form temporary diversion bunds to intercept sediment laden runoff (within fill areas). If the gradient of the diversion bunds used to intercept sediment laden runoff exceeds 5%, the channel should be stabilised with suitable materials to provide erosion protection (i.e. lined with geotextile fabric).

(e) Minimise to the extent practicable, the introduction and spreading of weeds, through the inspection and removal of vegetation from vehicle tyres between earthworks zones. This may be achieved through setup of a wash station at the stabilised entrance to each earthworks zone.

(f) Water shall be used to spread across exposed trafficked surfaces to reduce dust migration.

(g) Sediment control measures may not be required for earthworks where earthwork activities will not adversely affect the downstream environment and/or where the earthworks are minor and can be completed and stabilised during dry weather windows (cut and cover technique).

(h) Commence earthworks for the designated stage. At the end of each construction day, open drains and/or diversions bunds shall be formed within the exposed areas to reduce runoff lengths and divert sediment laden runoff to control devices.

(i) Install culverts servicing an open drain adjacent to a track. Excavate around the inlets of the culverts to allow storage capacity where suspended materials can settle out, (i.e. a small drop-out pit).

(j) Wrap geotextile fabric around the inlet of the culvert to intercept sediment laden runoff.

(k) Install drop-out pits at open drain termination points and include silt fence surround in locations within 50m of wetlands.

(l) As earthworks reach the designed vertical alignment, the pavement surface and shoulders should be lined with the basecourse and rock fill to stabilise the exposed surfaces.

(m) Topsoil and grass seed fill batters, hydro seed cut batters (in soils) on completion of the earthworks within each stage. Rock cut batters will be left in their natural state.

206. Construction Methodology on the Jedburgh Plateau – employ the same methodology as for general earthworks but employ the following additional control measures:

Hardstands or track cuts into or directly adjacent to wetlands:

(a) Site controls to be implemented to physically delineate the wetland and exclusion areas – in accordance with the CEMP and SSMP. The earthwork batter extents are to be setout by a suitably qualified surveyor

(b) Install erosion and sediment control measures in accordance with the SSMP.

(c) Form the low permeability bund (using site won clays/silts), key the bund into the underlying competent ground.

(d) During construction of the bund, coffer dams and/or dewatering pumps may be required to limit water ingress into the excavation. Any collected water within the excavation shall be returned (pumped) back to the adjacent wetland.

(e) Once the clay bund is in place, excavations to form the tracks or hardstand can commence. Care will need to be taken if hard rock is encountered in excavations adjacent to wetlands, to avoid damage to the hard pan beneath the wetland from the vibrations caused by the rock breaking. Fracturing of the hard rock will be undertaken using the blasting techniques verified during the establishment phase and by the trial blasting. Following blasting, the fractured rock will be carefully removed via excavator bucket to the specified design line and levels.

(f) During excavation works, clean water runoff that collects upstream of the clay bund shall be directed/pumped to downstream wetlands via flexible pipes.

(g) Once excavation has reached the final line and level, install the permanent wetland culverts as detailed on the stormwater drawings.

Fill embankments through wetlands:

(a) Install erosion and sediment control measures in accordance with the SSMP.

(b) Strip wetland organic material from the footprint of the embankment and remove to a fill disposal site.

(c) During construction, coffer dams and/or dewatering pumps may be required to limit water ingress into the excavation. Any collected water within the excavation shall be returned (pumped) back to the adjacent wetland.

(d) Commence construction of the fill embankment back up to original ground level.

(e) Install the wetland culverts as detailed on the stormwater drawings.

(f) Continue construction of the fill embankment.

207. Construction of SFDs shall be generally phased as follows:

(a) Construct diversion bunds (in accordance with GD05) to direct clean stormwater runoff away from the fill disposal/stockpile sites as works progress. Where practicable, the diversion bunds will follow close to the existing contours to prevent significant channel erosion. Stormwater collected will be directed to safe discharge points and may require a haybale barrier/staggering at the outlets to dissipate flow rates.

(b) Construct sediment retention ponds/earth decant bunds that will provide adequate retention of sediment laden runoff from the fill disposal/stockpile sites (including access tracks into the sites). The pond/earth decants will be positioned to ensure the diversion bunds intercepting sediment laden runoff can be adequately graded into the structures. The sediment retention ponds/earth decants will be designed in accordance with GD05.

(c) Construct diversion bunds (in accordance with GD05) to intercept sediment laden runoff and divert flows to the sediment retention pond. If the gradient of the diversion bunds exceeds 5%, the channel should be stabilised with suitable materials to provide erosion protection (i.e. lined with geotextile fabric).

(d) At the entry/exit point of the fill disposal/stockpile sites, construct a rock lined stabilised construction entrance. Inspect and remove vegetation from vehicle tyres to prevent the introduction and spreading of weeds.

(e) Undertake vegetation clearance, strip topsoil and organic material from the footprint of the SFD and place in stockpiles adjacent to the SFD (maximum height of 2m). Where practicable, cover the topsoil with geotextile to reduce erosion and weed growth.

(f) Cut benches into the subgrade (where ground slope > 1v:3h) and install subsoil drainage at the base of the gully features (where shown on the drawings).

(g) Construct engineered-fill buttress toe (for shoulder and gully-type fills), under the supervision of a suitably qualified civil or geotechnical engineer. Once the structural bund is complete, commence bulk filling of the non-engineered fill behind the toe – placing material in layers starting from the toe and working back up the slope.

(h) Once the SFD design level and finished surface profile is achieved, respread stockpiled topsoil and organic material, and grass seed (seed selection to be in accordance with the rehabilitation management plan). This will occur within 12 months of the SFD site strip, to make the use of the next planting season (in accordance with the rehabilitation management plan).

(i) Form the permanent rock lined overland flow channel around one side of the filled gully – to direct overland flow to the base of the fill toe (gully-type fills).

(j) Remove sediment control measures once all disturbed areas have established 80% grass coverage.

208. Works within streams – culvert crossings. The expected duration of Phase 1 works (works within the stream) for each culvert crossing is < 7 days:

(a) Phase 1:

(i) As far as is practicable undertake works during dry/low flow periods where no significant rain is forecast.

(ii) Construct diversion bunds to divert cleanwater runoff away from the working area.

(iii) Excavate a diversion channel, ensuring each end of the channel does not encroach into the watercourse. Stabilise the diversion channel with suitable materials to provide erosion protection.[2]

(iv) Construct non-erodible dams (using sand bags or similar) at the upstream end of the culvert to divert flows into the diversion channel.

(v) Construct non-erodible dams (using sand bags or similar) at the downstream end of the culvert. Downstream dam to feature a T-bar decant to drain the works area if required to keep the area dry from groundwater/water leakage.

(vi) Construct permanent culverts, wingwalls, riprap aprons, place riprap within the culvert as per design

[2] Where it is not practicable or necessary to construct a diversion channel (i.e. limited stream flows), the diversion channel (step 3 above) can be replaced with a pump system - to over-pump impounded water (from upstream of the bund) and discharge downstream of the works area. Pump to be rated to convey normal low (summer) flow rates, pump setup to include suitable fish screen.

(vii) Place and compact backfill material around the culvert to the soffit levels of the pipe/s.

(viii) Remove diversion bunds, and upstream and downstream dams, block off inlet and outlet to diversion channel - allowing flows to pass through the new culvert.

(b) Phase 2:

(i) Install silt fences around the base of the track fill embankment.

(ii) Continue with backfill over the culvert and forming of the fill embankment.

(iii) Form sediment control measures for approach tracks (e.g. drop out pits) and commence earthworks to form the tracks.

(iv) Stabilize the earthworks area and remove sediment controls.

209. Concrete Batching Plant Facility

(a) Specific perimeter controls will be implemented at the concrete batching plant facilities to capture surface water and sediment/contaminant runoff during the operational life of the facility.

(b) The batching plants will have a stabilised earth bund constructed around its perimeter to divert cleanwater runoff and contain sediment laden runoff.

(c) A containment area such as a sediment pond will be constructed to capture runoff and provide sufficient settlement of sediments prior to discharge to the downstream environment. The containment area will be lined to prevent any water seepage into the natural ground.

(d) The outlet from the pond will be controlled by a manually operated valve; if there is spilling of cement in the concrete batching plant area, the valve will be temporarily shut until the spillage is removed.

(e) Operation and monitoring of the pond and discharges will be carried out in accordance with the EMP.

Description of Proposed Sediment Control Devices

210. The management and design of the sediment, erosion, and dust control measures at the Project Site will be based on the area of the earthworks associated with the civil works for various phases of construction. The following techniques will be used to control sediment laden runoff and to prevent erosion of exposed ground. The techniques outlined below follow GD05 guidelines.

211. The EMP includes proposed application criteria of the control measures described below.

Cut and Cover

212. For sections of access track that follow close to existing grade and where the tracks are in cut, and located >10m from a wetland; a cut and cover technique will be employed as follows:

(a) As the track is formed, the excavated material will be loaded directly onto a dumper and transported to the nearest SFD as indicated on the drawings.

(b) The trackside v-drains and cut batter will be rapidly stabilised with hydroseed or rock lined (for v-drain with gradient >5%).

(c) The v-drain will then convey clean water runoff to culverts or discharge points.

213. The length of access track that is left exposed will depend on dry weather window and the timeframes for earthworks and stabilisation. Cuts will be stabilised prior to significant wet weather.

Stabilised Construction Entrance

214. A stabilised pad of aggregate on a filter cloth base will be located at the site entrance/s (and entrances to the SFD's – dependent on construction staging) where construction traffic will be entering and leaving. This will prevent the entrance from becoming a sediment source and minimise dust generation and tracking of soil onto the adjacent environments.

Wheel Wash

215. A wheel wash adjacent to the stabilised site entrance may be provided if required (dependent on the condition of internal tracks and cleanliness of vehicles exiting the Wind Farm Site). If required, the wheel wash may consist of a temporary mobile chamber or a shallow pit (stabilised with roading aggregates or hotmix) and will be filled with water from on-site water sources. The purpose of the wash is to clean the earthmoving truck tyres, and therefore, reduce the amount of sediment being tracked over public roads. The wheel wash will maintain a pool depth of 400mm to 500mm, and water will be replenished regularly (dirty water to be pumped and removed from site or overflow directed to sediment pond/decanting structures).

Runoff Diversion Channels and Cleanwater Diversion Bunds

216. Runoff diversion channels or bunds will be used to intercept and detain silt laden runoff and divert into drop-out pits, earth decant structures, or sediment ponds where specified. The channels shall be sized for the 5% AEP rainfall storm event plus 300mm freeboard, in accordance with GD05. Dewatering (pumping) may also be required at times for runoff not draining away in low gradient dirty water diversion bunds, particularly around WTG hardstands. In this instance, a mobile turkey's nest can be constructed and used for dewatering if 100mm of clarity cannot be achieved.

217. Cleanwater diversion bunds are to be constructed to intercept overland flow from upper catchments and divert around the earthwork sites. The bunds will be sized for the 5% AEP rainfall storm event plus 300mm freeboard, in accordance with GD05.

218. The channels and bunds, generally, have longitudinal gradients less than 2%. Where the grade exceeds this, or flow velocities are high, the channels may need to be lined with either rocks or geotextile fabric to prevent erosion of the underlying soils. The collected and diverted clean stormwater runoff will be disposed at safe locations in order to prevent erosion of the receiving environment.

Dropout Pits and Sumps

219. Drop out pits may be used on steep sections of access tracks to ensure sediment laden water is slowed down and silt is deposited out at regular intervals. Drop out pits may also be installed within dirty water diversion channels to allow heavier sediment particles to drop out before they enter the sediment retention device, reducing the load on the device; or at termination points of roadside open drains - prior to discharge across grass fields. Drop out pits are approximately 500mm to 1,000mm deep and 1000m wide. The pits will be maintained regularly with contained sediment being removed and disposed of appropriately.

220. Drop out pits may be used at the gently sloping WTG platforms in areas of cut. Runoff will be directed to and collected in the pit/sump where the heavier sediment will settle out before water is pumped (via floating offtake) to a turkeys nest[3] and/or grassed area, which will provide further filtration.

Stormwater Inlet Protection

221. It is proposed to excavate around the inlet of the culverts in the track side open drains to form a sump (small drop-out pit) to allow settlement of suspended material. During construction, geotextile fabric may be wrapped around the inlet of the culvert to intercept sediment laden runoff collected by the drain.

222. Temporary culverts are to be installed where required to maintain hydrological connectivity between segregated sections of wetlands, and/or to direct runoff to sediment control devices; until such time that the permanent culverts can be installed (generally relates to cut earthworks). These culverts have been sized for the 5% AEP rainfall event in accordance with GD05. The temporary culvert will be removed once the permanent culverts are in place.

Silt Fences

223. Silt fences may be used at various areas and times during construction. The silt fences will detain flows from the construction area so deposition

---

[3] Commonly used to impound water from pumped stormwater discharges, refer figure 106 from GD05 for example.

of transported silt can occur through settlement. Silt fences may be utilised at confined areas where the contributing catchment is small. 2m returns will require to be constructed on steeper slopes where the silt fence cannot follow the existing contours.

224. Silt fences may, generally, be utilised for slope lengths up to 40m (for slopes less than 10%), or up to 15m for steeper fill batter slopes. Due to the high wind conditions at the site, silt fences will not suitable for exposed areas, and therefore will only be utilised in spatially constrained areas where other controls are not practical to construct (e.g. stream crossings and adjacent to wetlands). Super silt fences may be required to withstand high winds in exposed areas.

Decanting Earth Bund

225. The decanting earth bunds (**DEB's**) will be used to intercept sediment laden runoff and minimise the amount of sediment leaving the site through settlement. The DEB's will include forebays and be fitted with a floating T-bar decant structure, similar to that used in a sediment pond, to increase settlement time and improve sediment removal efficiency of the device.

226. The bund will be sized to have a volume of approximately 2% to 3% of the contributing catchment area and provide an adequately sized spillway to pass a 1% AEP storm event. The decant inlet will be positioned to provide 50% live storage volume with a minimum distance of 5m from the inlet. The maximum catchment area contributing to the earth bund structures is typically 0.3ha in accordance with GD05 recommendations, however decants can be enlarged to cater to a larger catchment size on a case by case basis, catchments of up to 0.5ha have been used on other wind farm projects.

227. DEB's may incorporate a rain activated chemical treatment system where specified (refer to Chemical Treatment section below).

Sediment Retention Pond

228. Sediment retention ponds (**SRP's**) will be used to treat sediment laden runoff and reduce the volume of sediment leaving the site. SRP's may be used at the fill disposal sites or platforms, where large areas of

earthworks will remain exposed to erosion during the construction period, i.e. where catchment sizes exceed the capacity of a DEB.

229. SRP's should be positioned at a convenient collection point for the sediment laden runoff. This position should also allow for easy access to carry out routine maintenance of the structure. SRP's will be excavated into natural ground and embankments formed with engineered fill. The sediment retention ponds require specifically designed spillway arrangements to ensure overtopping of embankments does not occur during storm events.

230. The contributing catchment area for the sediment retention pond should be restricted to less than 3ha per pond. The minimum capacity of the pond should be $300m^3$ for each hectare of contributing catchment (3% of the contributing catchment) where an additional 10% of this volume is used as a sediment forebay.

231. However, the minimum capacity may be reduced to $200m^3$ for each hectare of contributing catchment where the earthwork slopes are less than 10%.

232. SRP's may incorporate a rain activated chemical treatment system where specified (refer to Chemical Treatment section below).

Chemical Treatment and Flocculation Management Plan

233. Water treatment chemicals can be applied to increase the rate of sediment settling out of the water column and is commonly used in conjunction with DEB's and SRP's. This helps to achieve the permitted levels of Total Suspended Solids (**TSS**) prior to discharge.

234. The necessity for chemical treatment will be dependent on the proximity to downstream water bodies, topography, and the soil composition of the earthworks catchment – i.e. in relation to how quickly the TSS settle out with or without the chemical additives. Given the large size and variable ground conditions across the Wind Farm Site (including the presence of near surface bedrock in some areas) it is envisaged that the requirement for chemical treatment will be assessed on a catchment-by-catchment basis.

235. A Draft Flocculation Management Plan (**FMP**) has been prepared by Riley and is included separately with the application. The FMP outlines methodologies for the application of chemical treatment for the SRP's and DEB's – via rain activated and passive systems. Coagulants (e.g. Alum/PAC) and Cationic PAM's (flocculants) will not be considered for the Project, due to their toxic properties and risk of changes to ph levels in the receiving streams and wetlands. On the other hand, Anionic PAM's are widely used in New Zealand and are generally considered safe and non-toxic to aquatic life at approved doses.

236. Bench testing of representative soil samples collected from site is yet to be undertaken. Based on bench testing that have been prepared for other wind farm projects in the wider region, the application of Anionic PAM's was found to be a somewhat effective liquid treatment method for TSS removal, for colluvium soils. However, it has also been observed that the natural settlement of sediment (with no chemical treatment) is quite rapid for some colluvium soils.

237. Therefore, comprehensive bench testing will be undertaken to determine the appropriate chemical treatment regime for the project, on a catchment basis. Chemical treatment will be prioritised (subject to soil conditions present) for sediment control devices which will be located within 50m of a wetland, or if the sediment control device is servicing a catchment > 1.5ha.

238. Whether or not rain activated systems are deemed necessary, chemical treatment products shall be available onsite as a back up to facilitate flocculant dosed treatment and as a contingency in the event of spill or discharge of contaminants, and/or during dewatering processes.

Sediment Yield Assessment

239. Representative sediment yield calculations have been carried out for sample earthworks operations – i.e. WTG hardstands, stream crossings, access tracks, and surplus fill disposal sites. The assessment utilises the Universal Soil Loss Equation (**USLE**) to demonstrate the effectiveness of various Erosion & Sediment Controls proposed above. Refer to the USLE assessment included as Annexure F.

Dust Control

240. If not managed appropriately, dust created during the construction phase can affect vegetation, be a nuisance to personnel, and can contribute to sediment loads. Dust can be made airborne by wind or vehicular movement or a mixture of both. Due to the nature of the works, dust will need to be controlled and managed during the construction phase. Activities considered likely to generate dust include the following:

(a) Vehicle movements.

(b) Removal and replacement of topsoil.

(c) Excavation of material.

(d) Stockpiles, especially uplifting of material from stockpiles.

(e) Loading of vehicles.

(f) Site clearance.

(g) Track construction.

(h) Foundation construction.

241. In the event of dust generation becoming obvious through earthwork activities, appropriate measures to reduce the dust release to acceptable levels shall be undertaken. Methods that will be adopted for the dust control measures are as follows:

(a) Ensure the track surface remains in a damp condition utilising water trucks as necessary until exposed earthworks are stabilised.

(b) Limit site traffic speed to a level to reduce the production of dust into the atmosphere.

(c) Stage earthworks during construction in order to isolate and reduce the area of exposed earthworks and re-vegetate exposed surfaces as soon as practical.

(d) Stabilised entrance at the entry/exit points of the wind farm site and fill disposal sites and provide a wheel wash at the main entrance.

(e) If necessary, earthwork activities may be limited in specific areas during periods of high wind.

242. Stockpiled material has the potential to create dust. Dust can be generated when material is added to or excavated from a stockpile. The following methods are proposed to control dust from stockpiles.

(a) Wet suppression via water trucks.

(b) Covered storage in more sensitive locations.

(c) Reduced/controlling stockpile height and slopes (reduce wind entrainment).

(d) In the extreme event that remedial measures are found to be ineffective for the control of dust, works may be suspended as a precautionary measure until conditions are suitable for resumption.

243. Water for dust suppression may be sourced from streams located within the Wind Farm Site – as outlined in the Water Supply section of this report.

Stabilisation of Earthworks Surfaces

244. Following earthworks, general disturbance areas and fill batters will be stabilised by respreading locally stockpiled topsoil (stockpiled for a duration < 12 months) to a minimum depth of 300mm, and applying grass seed (or hydro seed) - using non-invasive grass species such as brown top or rye grass.

245. The steeper cut batters will be stabilised with hydro seed (no topsoil), including polymer additives for erosion control where required.

246. Rock cut batters will be left in their natural state – i.e. no stabilisation measures are required.

247. Once 80% grass strike has been achieved (in accordance with GD05) , erosion and sediment control measures can be decommissioned, ensure that the areas affected by the decommissioning of the sediment control measures are rehabilitated as appropriate.

248. Refer to the Vegetation Management Plan (included separately with the application) for details of remedial planting to be undertaken following the earthworks stabilisation works.

Monitoring and Maintenance of Control Measures

249. Regular monitoring and maintenance will be carried out on the sediment, dust, and erosion control devices during the construction phase in accordance with the EMP and SSMP's. Refer to the draft EMP for further details (included separately with the application).

MANAGEMENT PLANS

250. Riley have prepared the following draft management plans for the Project, which have been prepared in accordance with the design and construction management philosophies outlined in this report. We have referred to the management plans throughout our report, but for ease of reference list the management plans and what they address below.

251. The final versions of the management plans will be subject to consultation and certification in accordance with the conditions of consent.

Construction Environmental Management Plan

252. The CEMP provides for the environmental management, through the establishment of appropriate management procedures, for all activities associated with the construction of the Project.

253. This is the overarching management plan, the other (construction related) management plans (relating to specific construction activities, such as those listed below) form part of the CEMP.

254. The CEMP provides key project information such as; key site personnel contact details, roles and responsibilities, staff induction processes, construction programme, hours of work, and regulatory approvals

255. The CEMP also outlines management procedures for construction activities which aren't covered under the other management plans.

Earthworks Management Plan, Erosion and Sediment Control Plan and Site-Specific Management Plans

256. The EMP provides for the environmental management, through the establishment of appropriate management procedures, for earthwork activities associated with the construction of the Project.

257. The EMP includes an ESCP and outlines the general management procedures relating to earthworks construction and impacts on wetlands, streams, vegetation, and construction of surplus fill disposal sites.

258. The EMP outlines the monitoring, maintenance and reporting requirements for earthworks activities and the associated controls, to achieve compliance with the minimum standards of water discharge in accordance with the conditions of consent.

259. The EMP will form the basis for the preparation of the SSMP's. The SSMP's will provide specific detail for construction of each stage/zone of earthworks, including the detailed erosion and sediment control plans.

Flocculation Management Plan

260. The FMP forms part of the EMP and outlines the management strategies for the chemical treatment of sediment laden water, to minimise adverse impacts of sediment loading in water bodies downstream of earthworks and sediment controls, and to achieve the minimum water discharge standards.

261. The final version of the FMP will include comprehensive bench testing of soil samples collected from around the site, to determine the most appropriate chemical treatment regime for respective catchments.

262. The FMP will be applicable for the duration of the earthworks phase of this project, and it will complement the Erosion and Sediment Control Plan outlined in the EMP, and will inform the SSMP's.

Luke David Gordon
Edwyn Ladley
Vaughan John Martin
Lennie James Palmer

ANNEXURES:

Riley SWF Civil Drawings are set out in Part K of the application

Annexure B: Riley Geotechnical Assessment, Ref 220372-B (Issue 3.0)

Annexure C: Preliminary Design Report Stream Crossing, Ref 220372-C (Issue 3.0)

Annexure D: Riley Hydrology Assessment - Mimihau Stream Catchment (construction water supply), Ref 220372-D (Issue 2.0)

Annexure E: Stormwater Culverts Calculations

Annexure F: Riley Sediment and Erosion Control Calculations