Appendix 11

PROJECT IRON BOOMERANG
east west line parks limited

Project Iron Boomerang

Rail Corridor Identification Pre-feasibility Study

EAST WEST LINE PARKS PTY LTD

“The Australian East-West Line & Global Smelting Parks Project”

Submitted to: 30 March 2007

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1.0 EXECUTIVE SUMMARY

The Iron Boomerang Project is East-West Line Parks P/L (EWLP) vision for a trans-continental railway linking the Central Queensland coal fields with the Pilbara iron ore region in Western Australia. Iron ore smelting plants at both ends of the railway will provide pig iron and/or steel for export from Queensland and Western Australia.

The objective of this pre-feasibility investigation into the rail line is to conduct a wide area search for potential corridors and to identify macro level land use constraints and opportunities. In assessing alternative feasible corridors, comparative construction cost estimates were also made.

The investigation was carried out using the Quantm corridor identification and alignment optimisation system. The use of this sophisticated technology allowed a much higher level of information to be generated at this pre-feasibility stage than would have been possible if a conventional approach had been adopted.

The project database was assembled from publicly available digital terrain models, land use and topographic information. EWLP provided unit construction costs and the operational requirements of the rail line, including maximum grade limits and minimum horizontal and vertical curve values.

EWLP stipulated that the Queensland end of the railway (start point) be located near Moranbah, with EWLP to use the existing Newlands system and proposed extension of this line to North Goonyella (the Northern Missing Link). In Western Australia the railway was to end (finish point) adjacent to Poonda Siding, located approximately 50km north of Newman on the existing Mt Newman – Port Hedland railway.

Significant waypoints for the corridors were also identified and included proposed crew change depot locations near Kynuna in Central Queensland, and near Ti Tree in the Northern Territory. An intermediate crew change depot in Western Australia was likely to be remote from any established settlement.

Based on this set of data, the Quantm system was utilised to generate up to 50 alignments in each 200km section of the study area between the start and finish points of the rail line. Sorting the alignments in order of construction cost identified the generally lower cost corridors. The topographical maps overlaid on the corridors and terrain facilitated the identification of potential issues that will need to be investigated in more detail in subsequent studies. Features of note within the identified corridors included:

- several major non-perennial river crossings,
- proximity to National Parks and mining leases,
- the need to secure access for the corridor to cross several areas that are under Aboriginal ownership/control, and
- located the approximate position of crossing points on existing rail and road infrastructure, and location relative to existing settlements.

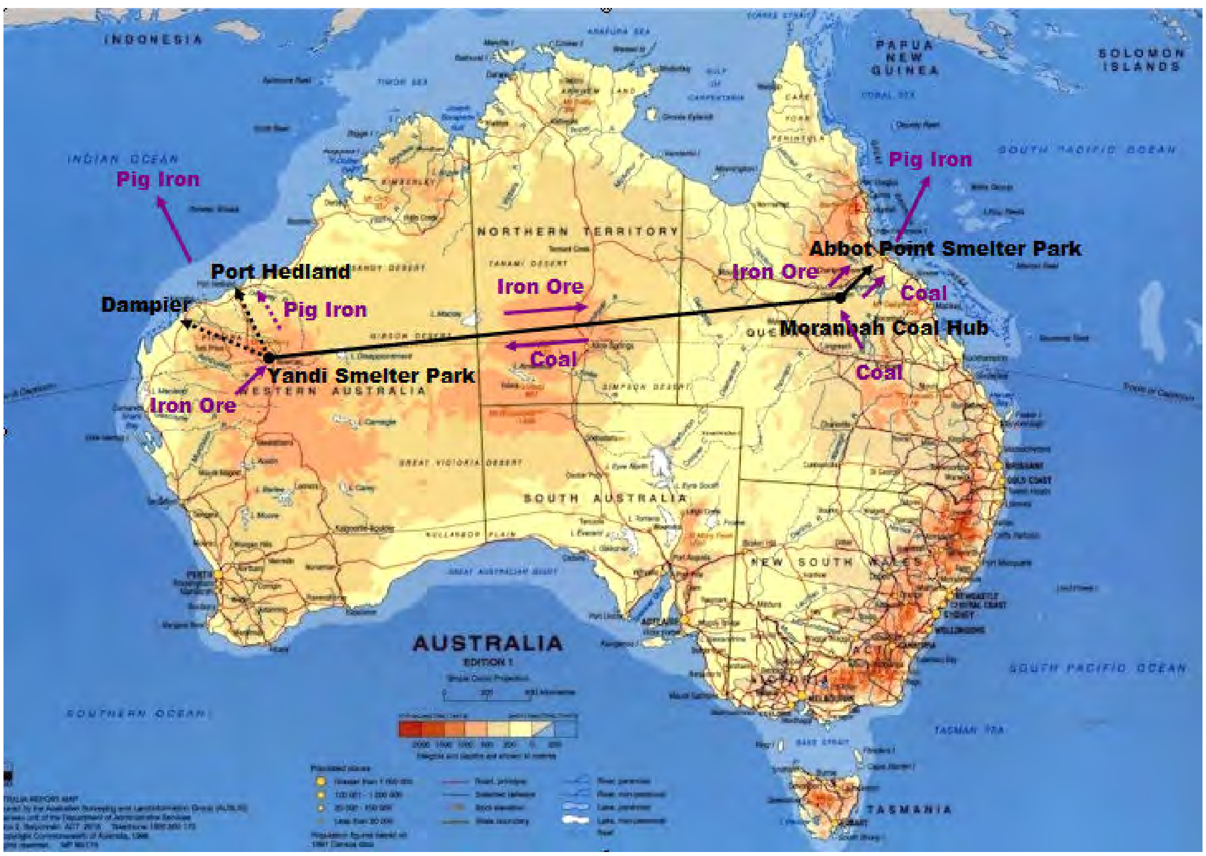
The investigation showed that the straight line distance between the East and West start/finish points was some 2,900km. With the initially targeted maximum gradient restricted to 0.5%, the lowest cost corridor that complied with this limit was 3,120 kms at an overall construction cost at 2006 prices of approximately $6.5 billion AUD.

The information in this report forms the foundation for subsequent, more detailed studies that would assess further the relative merits of the alternative corridors, develop optimum alignments within those corridors and to provide a higher level of certainty of cost outcomes.

2.0 BACKGROUND

The Project Iron Boomerang (PIB) concept is to construct and operate a heavy haul railway from coast to coast across the Australia continent near the Tropic of Capricorn. The line will travel from the North Queensland port of Abbot Point, through the coalfields of Central Queensland and extend to the iron ore region in the Pilbara, Western Australia where it will link into the existing iron ore railways to the Western Australia port of Port Hedland.

The East West Line railway (EWL) will be standard gauge, built to contemporary Pilbara iron ore railway standards, and linking to the existing and planned rail lines and iron ore mines in the Pilbara, and to proposed steel smelter parks at each end of the line. The EWL will link with the existing narrow gauge coal network in the Bowen Basin, accessing the existing and future coal mines in that region, via a transhipping facility near Riverside Mine (the Moranbah Coal Hub). The EWL will also be connected to the Adelaide to Darwin railway.



(Fig 2.a) Proposed Project Route, Smelter Parks and Movements of Mine Haul Materials.

The EWL will carry iron ore or coal in either direction to iron ore smelting plants located near Newman in Western Australia, and at Abbot Point. The coal hub near Moranbah will transfer coal from the narrow gauge network in Central Queensland for back-loading on trains heading to the west. Smelters will be located near the mine sites or ports, and will produce pig iron or steel, primarily for export. The EWL trains, running predominantly loaded in both directions, underpins a dramatic improvement in transport efficiency and environmental performance compared with current practices of shipping raw materials offshore for processing.

EWLP Pty Ltd has retained Quantm Pty Ltd to carry out the initial corridor identification and alignment development using Quantm's specialised software, which is an innovative and unique system for transport infrastructure optimisation. This Report describes the outcomes of this initial study and will form the basis for undertaking subsequent detailed feasibility work.

3.0 OBJECTIVES

The primary objective of this work is to demonstrate that a comprehensive search for favourable corridors has been made and to provide confirmation that there are a range of corridors where alignments are compatible with macro land use constraints and railway operational and engineering requirements.

Identified corridors will highlight the main land use considerations and flag potential opportunities and issues that will be addressed at subsequent, more detailed stages. The potential corridors should also be compatible with the geometric requirements of the rail line, i.e. be within maximum gradient and minimum curvature requirements for a heavy haul rail line.

Strategic construction cost comparisons between alternative corridors will also be made to identify least cost corridors that maintain compliance with land use, rail operational and engineering requirements.

It is recognised that at this pre-feasibility desk top study stage that many unknowns have been left out, particularly in regards to detailed topography, site specific geology, hydrology and flood impacts and localised land use. So as not to unduly skew the study results to one alignment or another on assumed data, the cost impacts of these items will be considered in the comparative cost, and an allowance made in the general contingencies for railway capital costs. This method is to give confidence that a railway which meets the required heavy haul gauge horizontal and vertical alignment criteria can be achieved within the overall route.

4.0 PROJECT AND RAIL OPERATIONAL CRITERIA

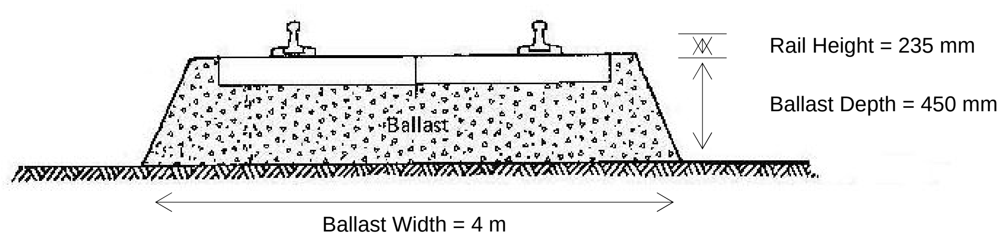
4.1 Specific Rail Requirements

4.1.1 Grades

Rail operational criteria used within the Quantm analysis was to account for the heaviest of haul requirements, this being the movement of iron ore eastwards from the Pilbara to the smelter parks in Queensland. Although slightly steeper grades heading westwards for coal / coke loading could be accommodated due to the different product density and volumes needed, EWLP decided that a maximum design grade of 1 in 200 (i.e. 0.5%) would account sufficiently for fully loaded diesel-electric locomotives moving in either directions for this initial stage evaluation.

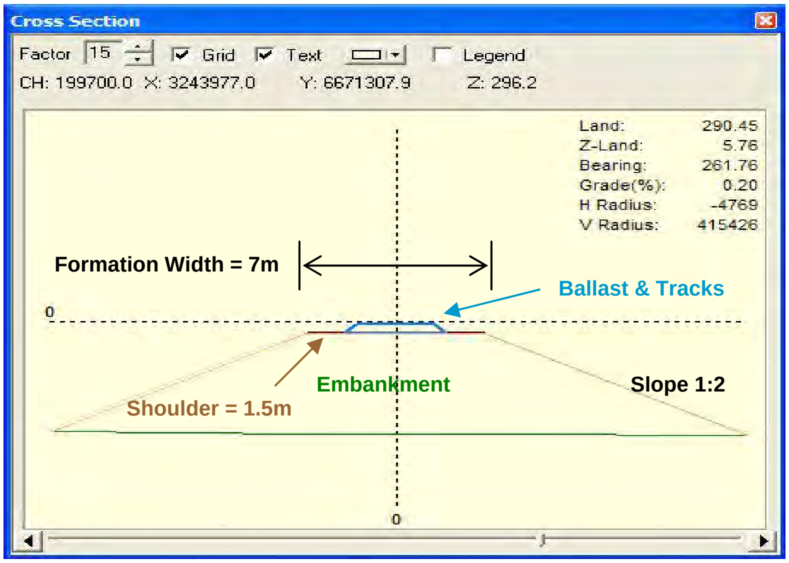
4.1.2 Standard Heavy Gauge & Cross Section

Rail alignment design was based on the standard heavy gauge system (1,435 mm). Ballast depth was specified as 450mm from top of sleeper, with a total depth of rail structure to sub-ballast of 685mm.



(Fig 4.a) Rail & Ballast Specifications.

The formation width of the rail corridor was 7m in both cut and fill, which included a 4m width for ballast and 1.5m shoulders. Although not included in the determination of alignments for this analysis, an overall corridor width of 50metres to include for an access track along the corridor was assumed.



(Fig 4.b) Rail Corridor Cross Section.

4.2 General Project Requirements

4.2.1 Start / Finish Points

EWLP stipulated the following start, finish and way points for the rail corridor.

Start Point: Immediately West of the Goonyalla Riverside Mine, which is located approximately 30km north of Moranbah and 180km west of Mackay in Central Queensland.

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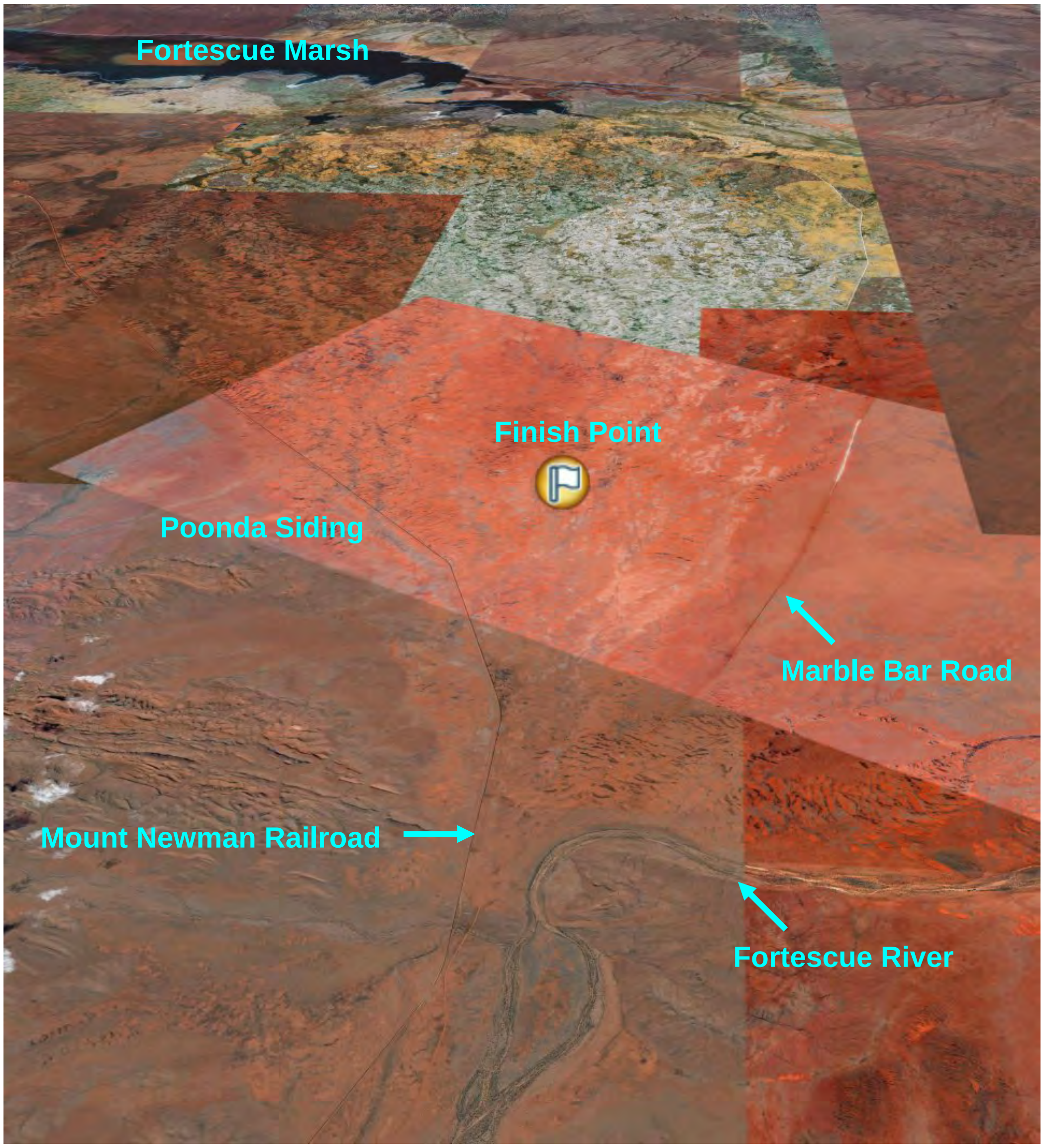
(Fig 4.c) Rail Corridor Start Point: West of Goonyalla Riverside Mine, Qld.

Finish Point: East of Poonda Siding located at the 334km point on the existing Mt Newman Railway, approximately 50km north of Newman, in the Fortescue River Valley, Pilbara, Western Australia.



(Fig 4.d) Rail Corridor Finish Point: East of Poonda Siding, Pilbara, WA.

4.2.2 Tie in Points with Existing Mine Haul Infrastructure

At the Queensland end, the Initial Smelter Park is proposed to be located adjacent to the existing export coal terminal at Abbot Point (near Bowen). The EWL is proposed to be co-located with the existing narrow gauge Newlands Line and along the proposed extension of this line to North Goonyella (the Northern Missing Link), which will be owned and operated by Queensland Rail (QR). The feasibility of constructing this section of railway has been carefully studied and established by Queensland Rail. This existing rail corridor will require selective widening to accommodate the EWL and future narrow gauge upgrades, and limited deviations to satisfy EWL grading requirements. For this level of analysis, no Quantm work was required on this section.

A narrow gauge electrified spur-line will be built to connect the existing QR Goonyella network near Riverside, to a transfer facility (the Moranbah Hub) for the transhipping of coal onto EWL trains for delivery to the WA smelters. Coal for the smelters at Abbot Point will be delivered via the QR narrow gauge network.

Similarly, at the Western Australian end the proposal for a smelter park east of the Poonda siding on the existing Mount Newman railway line will facilitate a means of rail connections with the Hammersley and Mt Newman systems (and possibly other new systems) to allow the transportation of the product to an export port (currently Port Hedland). It is believed that BHP Billiton will share the use of their existing Newman line with EWLP as the PIB will complement the marketing of iron ore from their existing mines.

4.2.3 Waypoints

EWLP require a number of waypoints along the rail corridor to serve as refuelling stations, maintenance depots, crew change over points, etc. If possible, these waypoints should be within close proximity to existing settlements where EWLP workers will reside and integrate into these communities, but far enough away that any adverse impact on the nearby community such as rail operating noise would be minimised.

Possible way-points suggested by EWLP included; Winton and Kynuna in Queensland, Ti-Tree in the Northern Territory, which is located approximately 185km North of Alice Springs, and a third location halfway between Ti-Tree and the Pilbara.

5.0 METHODOLOGY

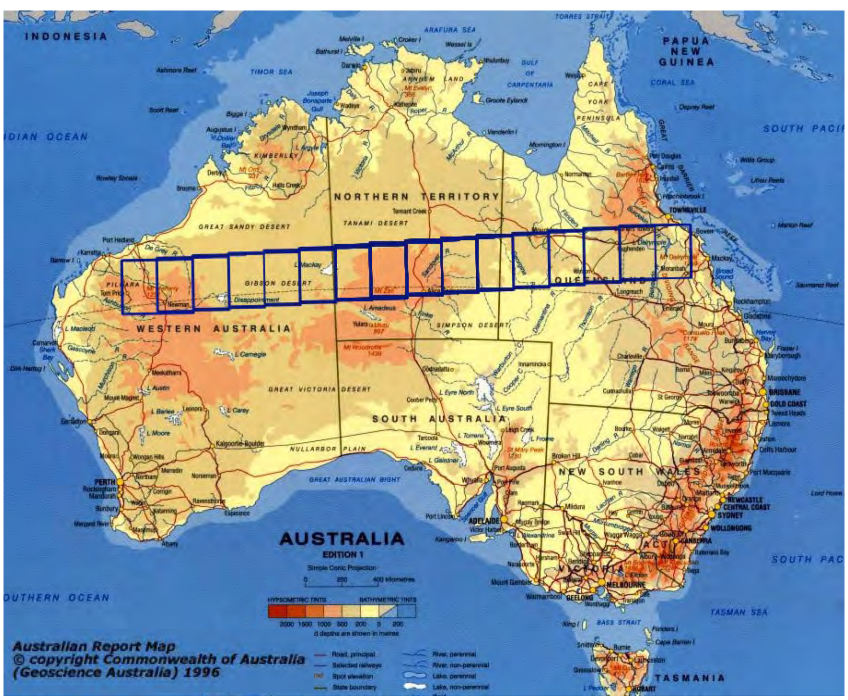
5.1 Quantm System

The Quantm system for corridor identification and alignment optimisation was the technology utilised to generate the results. This system identifies viable corridors and optimises alignments for rail carriageways. The system can take into consideration the land use constraints, unit construction costs [eg rails, sleepers, ballast, earthworks and structures], design geometry for the rail, existing linear features [eg roads, rail lines and rivers], and generates sets of alignments that comply with the criteria and are of lowest cost. The system is very fast at generating alignments compared to conventional methods, which allows a comprehensive search for corridor opportunities to be made and facilitates rapid sensitivity analysis of key parameters.

Quickly re-optimising alignments as new constraints emerge during investigations, stakeholder consultations or geotechnical studies can also significantly reduce planning times. The Quantm system is a great tool within the community consultation process in that it provides a transparent alignment selection methodology and an electronic audit trail of alignment development decisions. The Quantm System also provides a high level of confidence that an alignment which meets the engineering criteria can be achieved over the entire length.

5.2 Methodology Description

Total length of the rail line is in the order of 3,000km and to obtain the level of accuracy and detail required to meet the objectives, the rail study area was broken into 15 sections. Each of approximately 400km, made up of a 200km section plus a 100km overlap with each adjacent section as shown in the diagram below:



(Fig 5.a) Rail Corridor Study Area.

In order to ensure the set of lowest cost overall corridors are identified, the methodology utilised a floating start and finishing points for each section of the overall line. The cheapest corridors were then used as a basis for determining the transfer points between sections. The corridor and sub-corridor alternatives were then spliced together to form composite corridor options for the full 3,000km line.

The sequential steps in this methodology are summarised as follows:

Step 1: Data acquisition: Digital terrain data, existing roads and rail, water features, mining leases, ownership maps, topographic maps.

Step 2: Compile the geographic information into a single data base using a common projection system.

Step 3: Break the study area into 15 x 400 km sections.

Step 4: Utilising the Quantm system, generate sets of 50 alignments in the first section to identify corridor options.

Step 5: On the adjacent section, generate sets of 50 alignments from each of the corridor end points of the previous section to identify corridor options in the section.

Step 6: Continue process until all 15 sections have been processed.

Step 7: Compile a composite map of the corridor options across the full length of the rail line.

Step 8: Assess each of the corridors and sub-corridors for opportunities and issues relating to land use constraints and surface features.

Step 9: Prepare report on results.

Note: EWLP provided the engineering requirements, operational requirements, unit construction costs and the definition of constraints that were used in the Quantm system to generate the corridor options and identified the initially preferred corridor options from the Quantm generated alignments.

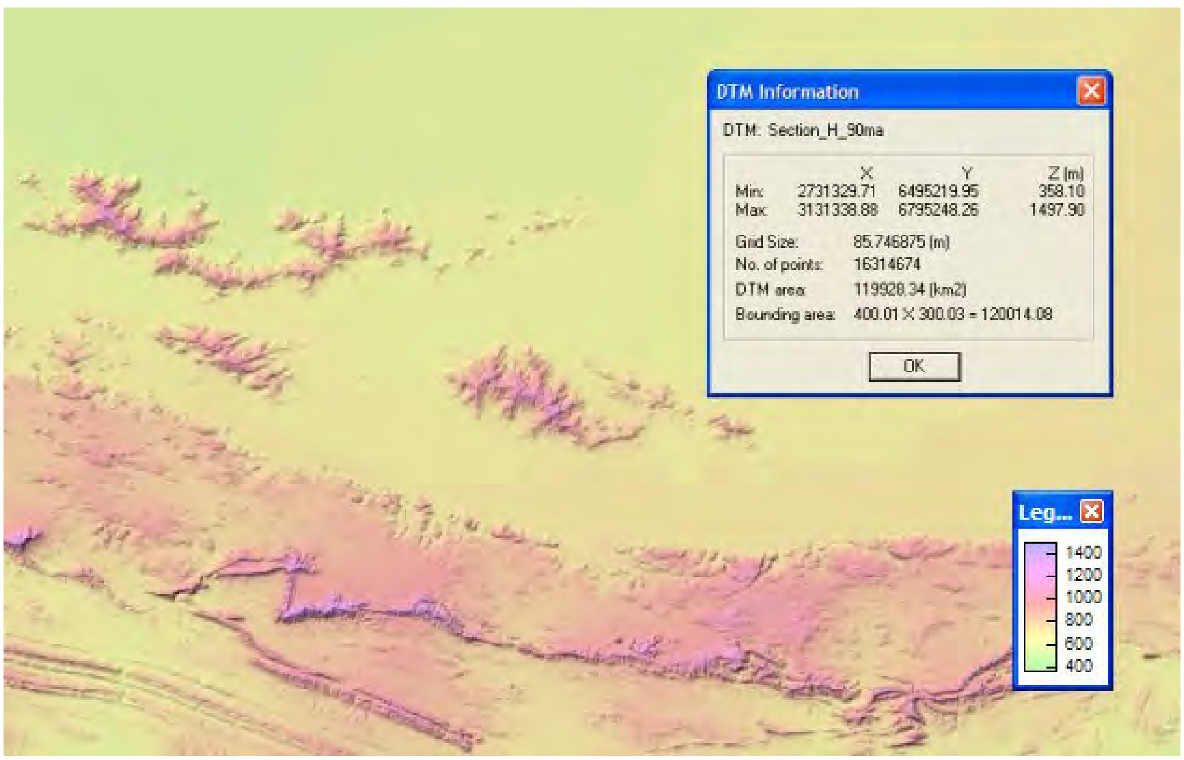
6.0 DATA ACQUISITION AND APPLICATION

6.1 Projection System

The Quantm system operates using Cartesian (X, Y, Z) co-ordinates and therefore requires a projection system to convert spherical (i.e. latitude, longitude) co-ordinates into Quantm compatible Cartesian co-ordinates. Due to the extreme scale of this project, a custom projection system was created to reduce the distorting effects of the earth's curvature. Since the project is primarily East-West oriented a Mercator projection with origin latitude -22°30'00" and central meridian 134°00'00" was deemed most appropriate. The standard WGS84 spheroid was used along with a 3,000,000m false Easting and 9,000,000m false Northing.

6.2 Terrain Data

Digital terrain data was acquired from the U.S. Geological Survey EROS Data Centre. This 3 arc second SRTM (Shuttle Radar Topography Mission) data was projected then converted into Quantm format. Once projected the final Quantm DTM (Digital Terrain Model) had a resolution of approximately 86m.



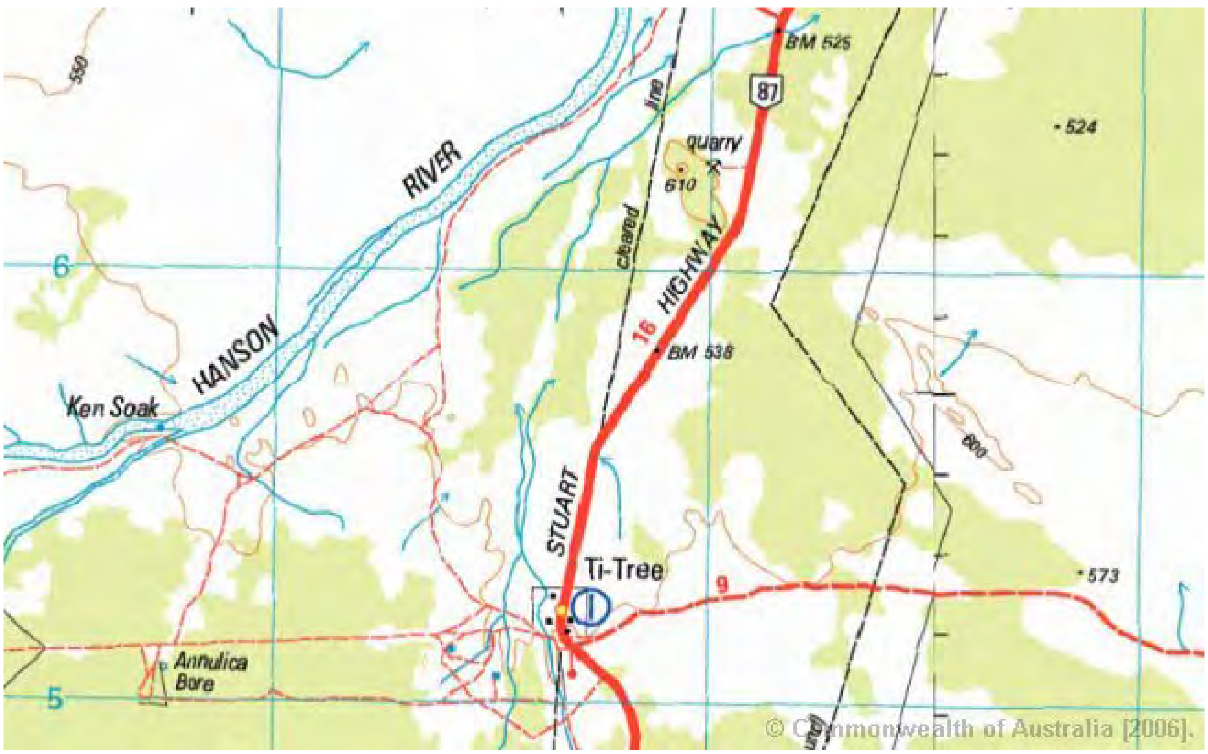
(Fig 6.a) Sample Image of Quantm 3D Digital Terrain Model.

6.3 Topographic Data

Topological maps obtained from the Australian Government's Geoscience Australia Website were used within Quantm to provide a seamless coverage of digital topological data across the entire study area. The maps form part of the GEODATA TOPO 250k 3rd Series and exist at a 1:250,000 scale resolution - i.e. 1cm on a map represents 2.5 km on the ground.

The series of maps were acquired in Enhanced Compressed Wavelet (ECW) format and then projected into the project coordinate system to align them within the project database. The drawings provide a vector representation of features on the earths surface and include natural and constructed features such as, but not limited to; existing road and rail infrastructure, land use areas, hydrography, vegetation, terrain, elevation, utilities and environmental boundaries.

The information gained by loading these maps within Quantm Integrator as a background image enabled more informed decisions on the appropriateness of corridor options, whilst ensuring their potential impact on communities and critical infrastructure would be noted and included in future analysis.

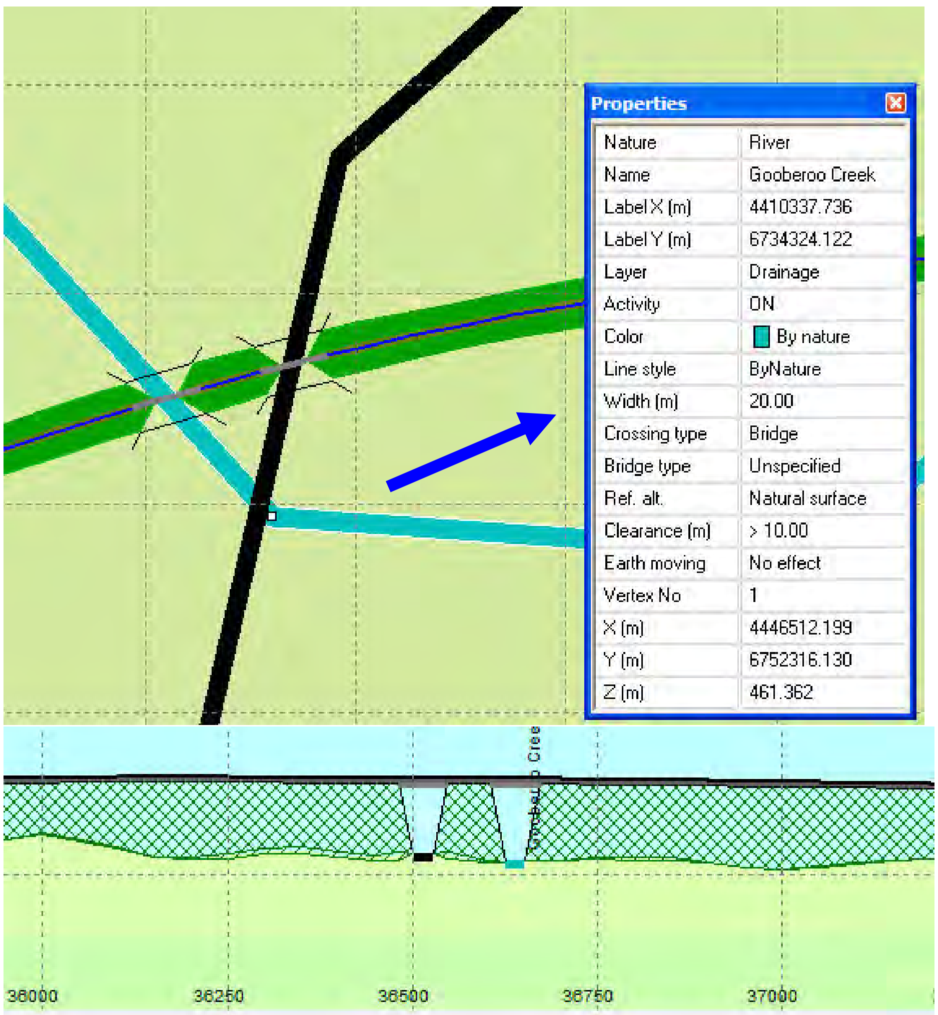


(Fig 6.b) Sample Image of Topological Map.

6.4 Roads, Rail, Water Courses

Existing road and rail infrastructure, together with water management areas, lakes and perennial/non-perennial drainage basins were acquired in digital format from Geoscience Australia. Although these were not included within this first stage of Quantm analysis and therefore did not actively influence the location of corridors, their influence on possible corridor options and the required structure crossings was noted for future consideration.

At this stage no hydrology studies have been carried out, nor have the necessary alignment adjustments and extra culvert or bridge structures across flood plains been considered. A key study requirement for the feasibility stage will be the determination of the required heights for crossing these flood plains.

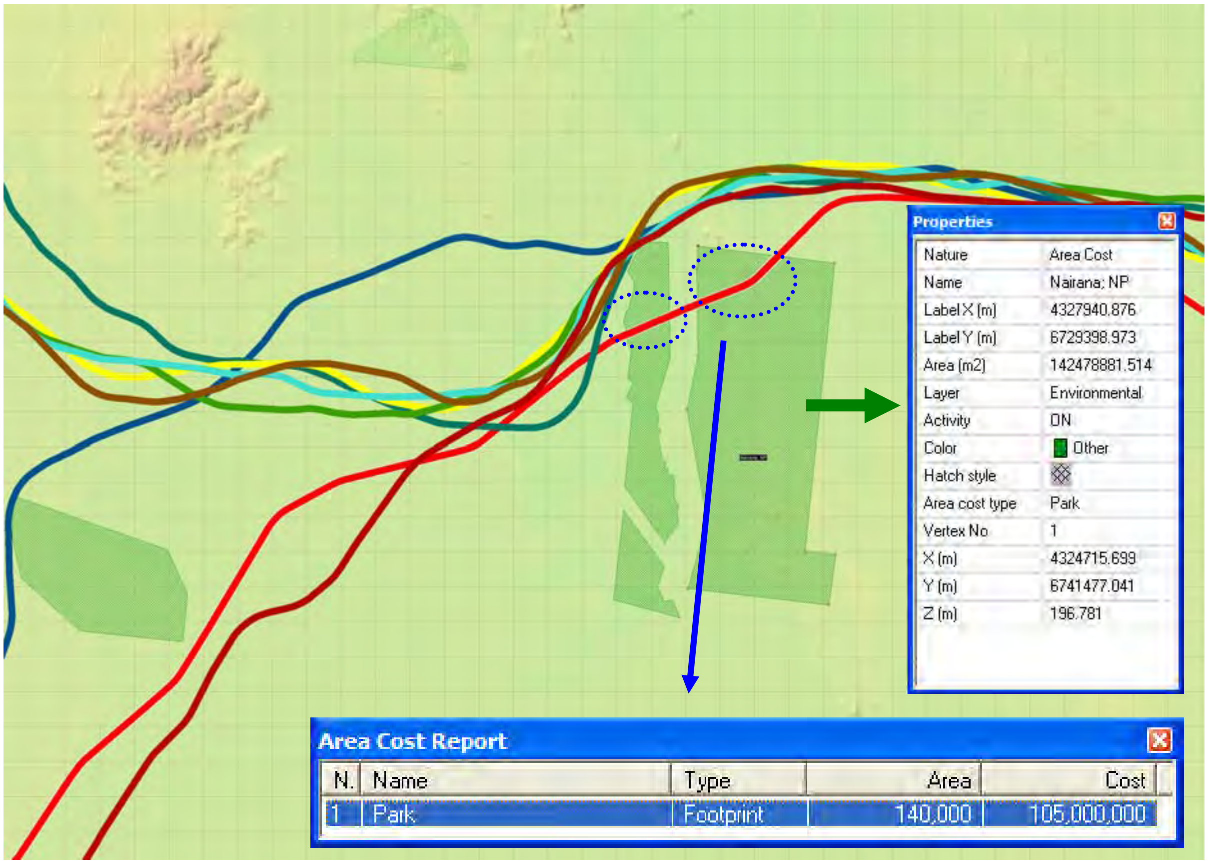


(Fig 6.c) Using Quantm to Constrain River & Highway features with Structure Crossings.

6.5 Land Usage / Environmental

Land-use and environmental data was assembled from Geoscience Australia and other state agencies which included populated places, utilities, national and state parks, crown lands and indigenous reserves. These constraints were not included within the system at this stage of the analysis. However, their influence on possible corridor options and the required structure crossings was noted for future consideration.

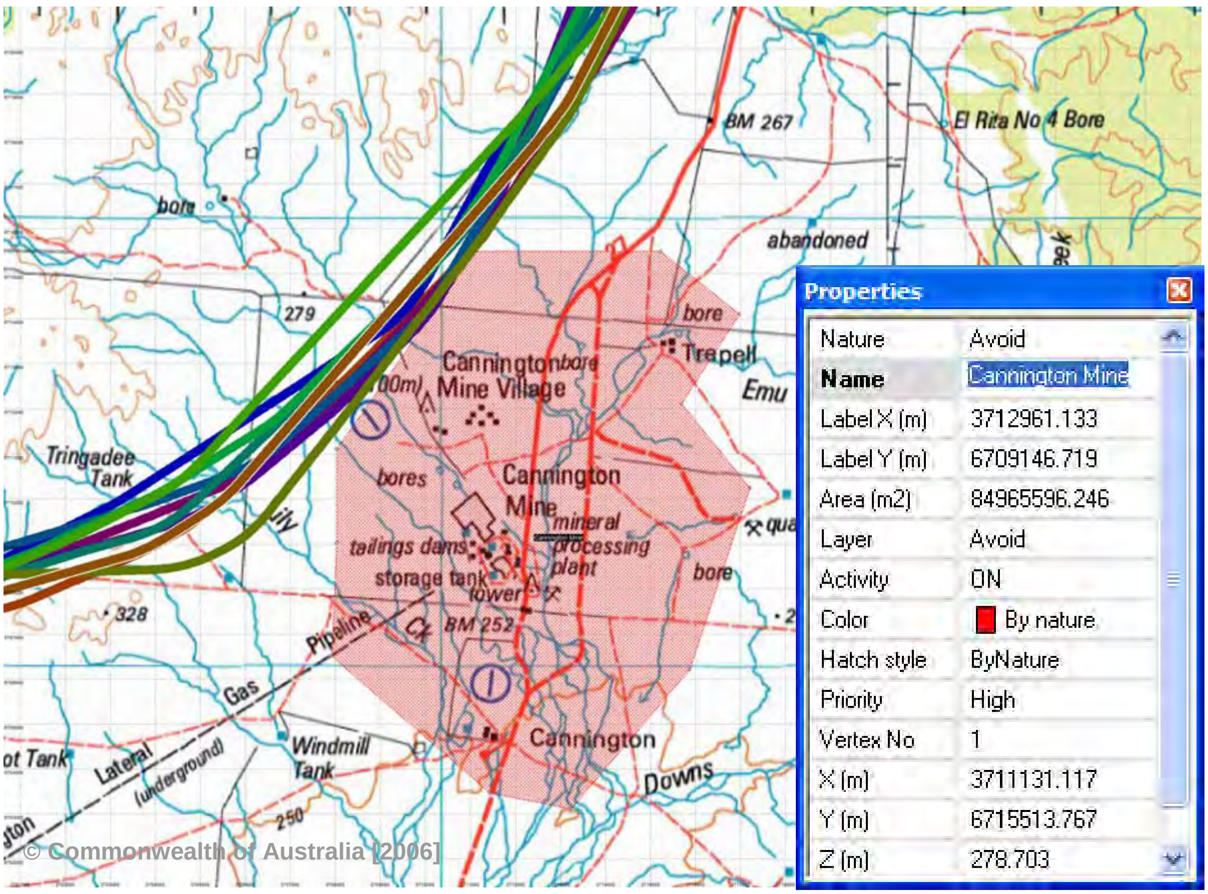
The following is an example that illustrates how these constraints could be included in future Quantm analysis to minimise their impact on sensitive environmental and land-use areas. The alignment marked in RED passes through the Nariana National Park. To minimise the impact on the National Park, but retain the low costs associated with this alignment, the alignment was "seeded" back into the Quantm system with the National Park attributed with a land acquisition cost. The resultant refined alignment options [shown in other colours] complied with this new constraint at a minimal or no extra cost.



(Fig 6.d) Using Quantm to define Areas of Land Acquisition such as Nairana National Park, Queensland.

6.6 Mineral Exploration Leases

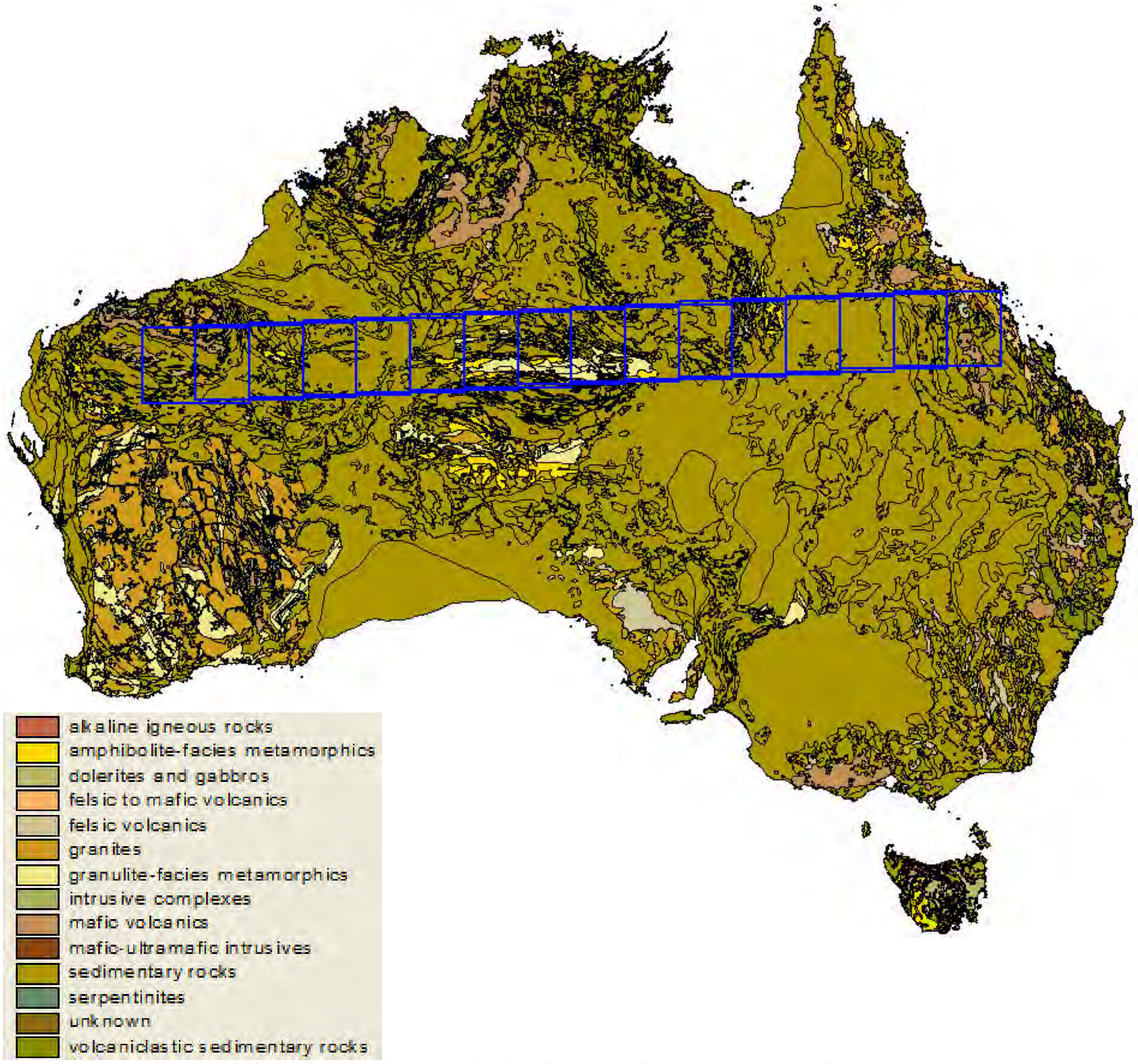
Current and proposed mining leases, exploration permits and licenses were sourced from the Queensland Government Department of Mines and Energy; Northern Territory Department of Primary Industry, Fisheries and Mines; and Western Australian Department of Industry and Resources. The datasets consisting of spatial information featuring boundary and attributes for the mining areas, where not constrained within Quantm and instead used to isolate areas that required further consideration in future studies.



(Fig 6.e) Defining existing Mining leases such as Cannington Mine, Queensland to avoidance will result in the system generating all alignments around these sensitive areas.

6.7 Geology

Data defining various geological regions was sourced, however due to the preliminary nature of this study was not utilized. It was noted that the real geological cost influence on the rail alignment would be site specific, and for this stage the geology could only be used to determine major obstacles as opposed to actual costs influences. Further fieldwork will be necessary to determine the relative properties of these different geological formations. For the purposes of this study a single default geology was used across the entire study area.



(Fig 6.f) Varying Geological Formations across Study Area.

6.8 Data Application

During this Pre-feasibility work, the primary data set that was used to generate corridor alternatives was the digital terrain model, rail geometric requirements and unit construction costs. The data sets pertaining to land use land ownership, roads, water courses, geology and mining leases etc were not used to influence the location of the corridors during this stage of the investigation. At this stage, these data sets were however used to note and highlight specific issues, opportunities and constraints that will be addressed in subsequent work.

7.0 MAJOR ASSUMPTIONS AND UNCERTAINTIES

7.1 Cost Estimates

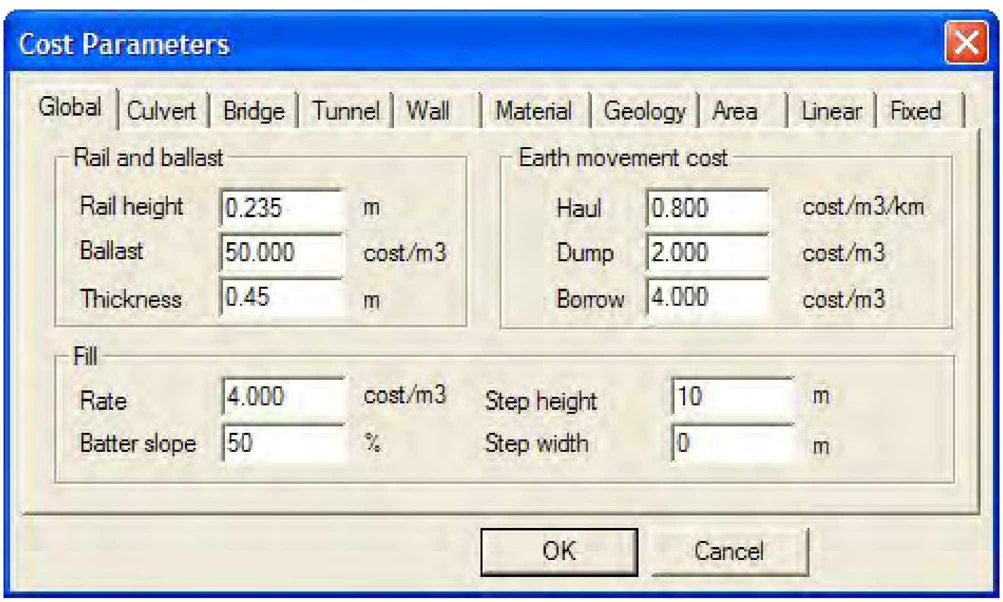
7.1.1 Global costs

Global costs are those that are applied over the entire study area and do not vary locally. A linear cost of $750/m was used throughout the study to cover track materials supply and track laying costs.

Other global cost rates include:

- Fill placement: $4.00/m^3
- Borrow material (import): $4.00/m^3
- Dump material (export): $2.00/m^3
- Haulage: $0.80/m^3/km
- Ballast supply & placement: $50.00/m^3

For the purpose of this study, and for comparative purposes in alignment selection, it was assumed that unit costs were independent of any variability in materials transport logistics, such as availability of suitable gravel for sub-ballast layer, crushed stone ballast, water for construction and pre-cast materials, which may vary significantly over the corridor length. Any extra costs for construction in remote areas will be accounted for in overheads and special costs at a later stage. All rates are in 2006 dollars and are based on recent historical data only.



(Fig 7.a) Global costs as utilised within the Quantm system.

7.1.2 Structure costs

The Quantm system required these rates to decide where it was more economical to place a structure rather than constructing very high embankments or generate deep cuttings. Viaduct, tunnel and retaining wall rates were estimated at the following values:

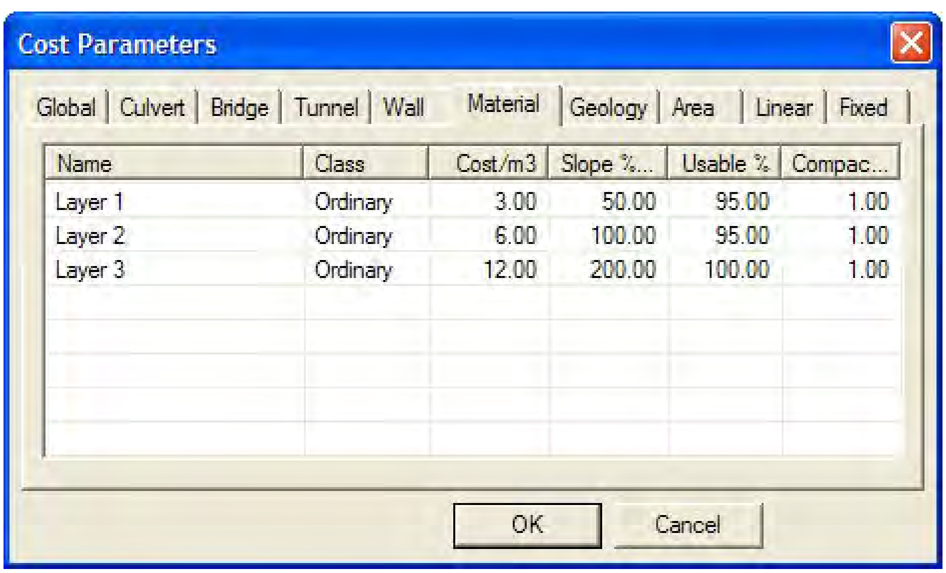
- Bridge (based on plan area): $3,000/m^2
- Tunnel (linear cost): $1,000,000/m
- Retaining wall (surface area): $1,500/m^2

7.2 Geotechnical Requirements

While digital data for geology had been acquired by Quantm, for this level of analysis the structure and properties of geological formations as these may impact on railway design and construction costs, were assumed to be consistent across the entire study area with respect to the global cost rates used to cost the overall capital costs.

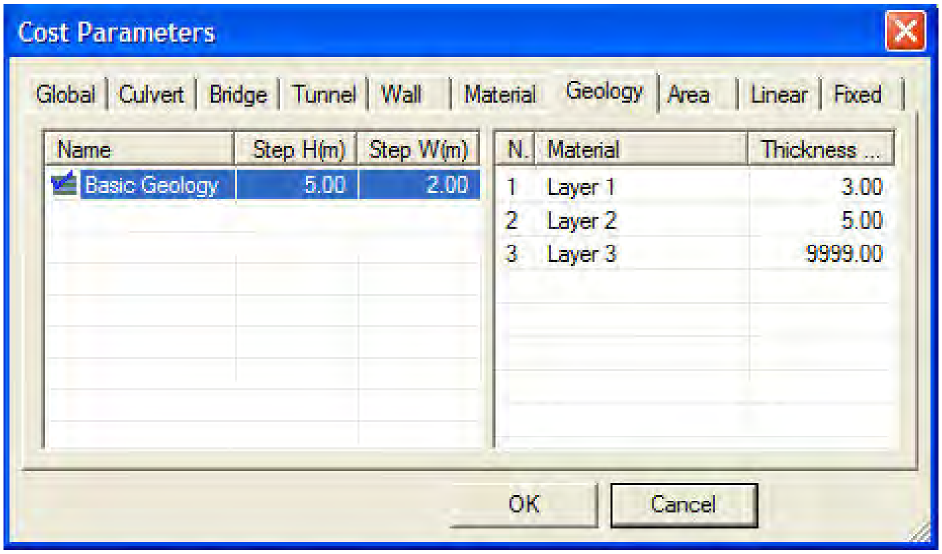
It was noted that to a large extent, the study area was across flat terrain with isolated areas of semi-rough and sandy formations that would require further consideration in future studies.

Three separate layers of material were defined with associated excavation rates, batter slopes, compaction rates, the fraction of usable material that could be used for fill, and the unusable part to be hauled away and discarded as dump. The material costs entered into the system for each material reflected the depth of excavation and material hardness, with an easily worked surface material, overlying harder, more costly material.



(Fig 7.b) Material structure & properties used within the Quantm system.

The default geology was based on three horizontal stratums, with the first starting at the natural surface and travelling down to a depth of 3m, second a further 5m deep, and the final stratum being of infinite thickness. Rail corridor cross section would requiring benching every 5m and be stepped 2m across.

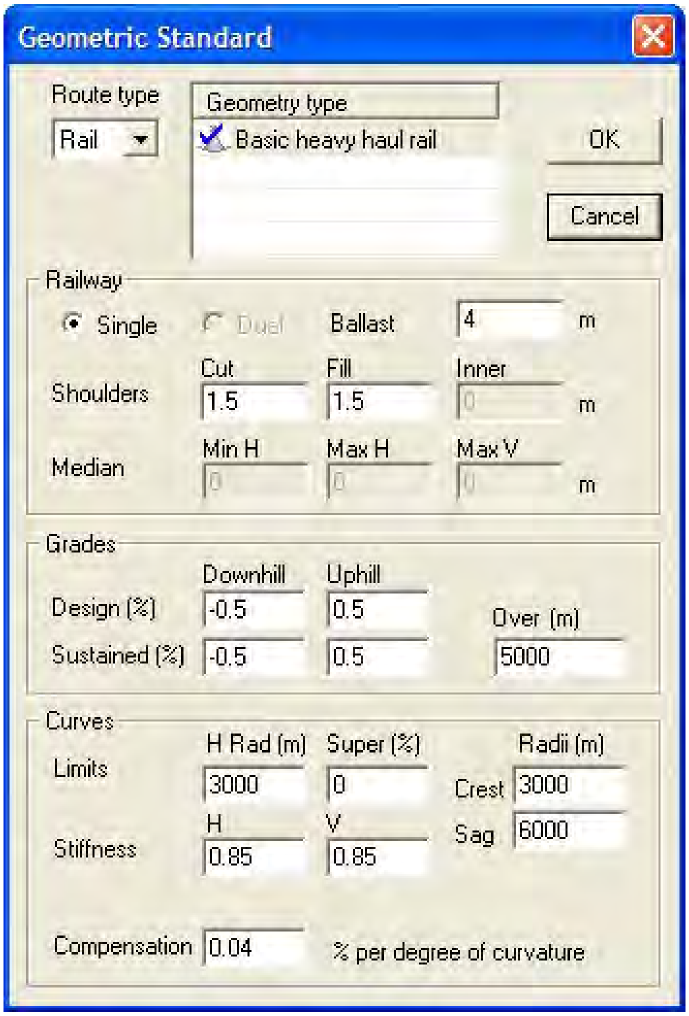


(Fig 7.c) Geology used within the Quantm system.

7.3 Geometric Criteria

Preliminary estimates of rail engineering parameters for curvature and compensation were selected based on similar heavy haul rail projects. These values were reviewed and confirmed by EWLP in an email to Quantm on 15/12/06. EWLP advised that these criteria are suitable for the heavy haul standard gauge trains to operate at a design speed of 80km/hr.

- Min Horizontal Radius: 3000m
- Min Vertical Radius for Crest: 3000m
- Min Vertical Radius for Sag: 6000m
- Gradient: 0.5%
- Curve Compensation: 0.04%



(Fig 7.d) Geometric standards used within the Quantm system.

7.4 Earthwork Limits & Mass Haul Considerations

Earthwork limits restricting the maximum height of embankments and maximum depth of cut were not deemed necessary for this first stage of work. This was based on the assumption that the small sections of terrain that were not flat would not generate high/deep escarpments across the landscape and therefore would not effect corridor location on a macro scale.

With the Rail Line broken up into 200km sections it was also assumed that mass haul would be balanced at the end of each section. It was noted however that mass haulage over this distance may be too excessive and a more practical mass haul balance would require the identification of possible natural spots for mass haul barriers, sources of fill or dump sites for spoil.

7.5 Sandy Desert Crossings Requirements

There is some uncertainty associated with crossing through Western Australia where the rail corridor will need to negotiate desert crossings through sandy areas such as The Gibson Desert, Great Sandy Deserts and the Little Sandy Desert. This may involve several hundred kilometres of track through or parallel to sand ridges of varying density, reaching heights of 15-20m in some locations.

Such crossings although not given any special attention within this stage of the analysis, will require consideration due to the effects of dune instability, soil erosion and acceleration of wheel and rail wear from drifting sands, if applicable. Mitigation of these effects in future studies using Quantm may come in the form of paralleling ridges, following an existing track where possible (e.g. Talawana Track), employing a flatter more stable cross section, using a wider formation to allow for fabrication and vegetation banks, and minimising the lengths of tracks crossing these desert areas, and further detailed engineering assessment of these areas will be required during the Detailed Feasibility stage.

7.6 Dry Creeks and Floodplains

There are numerous perennial/non-perennial river systems, wetlands and lakes located throughout the study area and at this stage their impact on rail corridor location and costs is uncertain. Some of the more major drainage systems that may have some level of impact on the rail corridor include; Wokingham Creek, the upper reaches of the Diamantina, Burke and Georgina Rivers in North West Queensland, together with Lake Mackay, Napperby Creek, Hanson River, Lander and Fortescue Rivers in Western Australia.

Catchment features, water levels, channel and flow patterns, discharge distribution and flood frequency could all have a bearing on the crossing type and clearance required over these systems. Crossing clearance will need to be at levels that ensure the track remains operational during the infrequent but possibly extended periods of inundation. Some may necessitate an expensive bridge made lengthy by the requirement to reach a certain clearance at a fairly low gradient. Others such as dry lakes and floodplains may only require the use of regularly spaced culverts to allow sheet flow to pass underneath, or raising the railroad onto an embankment to meet a minimum height above expected flood levels. There may also be the need to minimize the environmental impact of crossing over the sensitive ecosystems.

7.7 Indigenous & Environmental Areas

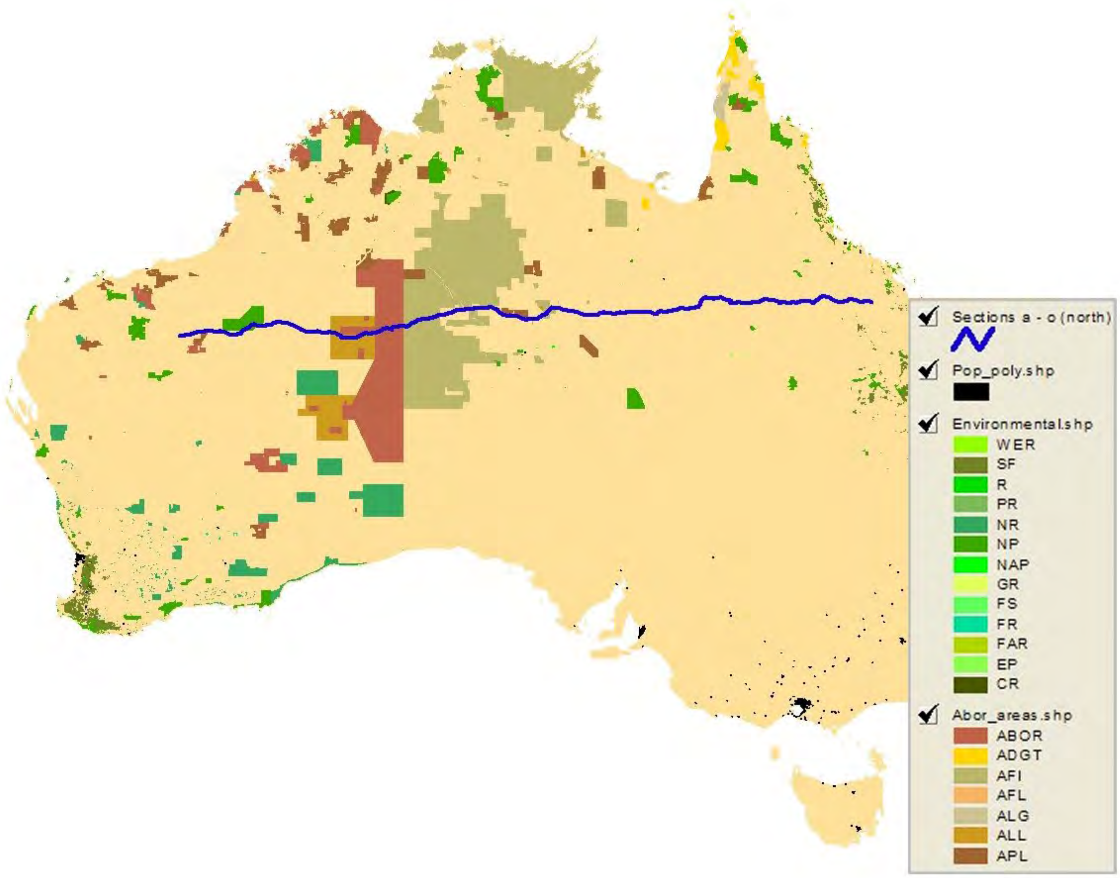
Visualisation of the GIS datasets identified various regions of land which may be affected by the proposed rail route. The two major types of regions, Indigenous and Environmental, will likely require avoidance or land access permitting in order for the railway to pass through them.

Whilst the entire corridor will be subject to need to identify and manage cultural heritage issues, and potentially be subject to Native Title claims from the traditional owners, the rail corridor will need to traverse current Aboriginal controlled lands, such as the Central Australia Aboriginal Reserve and Kiwirrkurra Aboriginal Reserve, both of which lie in Western Australia. There are also a small number of national and state reserves located across the study area including The Rudall River National Park in Western Australia and

Nairana and Bladensburg National Parks in Queensland. The impact of these social / environmental areas on the rail corridor is somewhat uncertain, and will be subject to further investigation, consultation and agreement with the various stakeholders.

There was no data included within this analysis to represent the boundaries of these sensitive constraints, however for future investigations various socially / environmentally sensitive areas can be defined as mitigation costs areas, and then changed to avoidance criteria to determine the engineering cost to protect these sensitive sites. The system can then demonstrate compliance with these criteria, and therefore demonstrate environmental consideration and avoidance to ensure a better public and environmental outcome.

The map below shows at a macro scale, where indigenous and environmental areas are located in relation to the favoured corridor. These are primarily Aboriginal controlled lands in the Northern Territory and Western Australia.



(Fig 8.b) Map showing major Indigenous and Environmental areas.

7.8 Cost Relativities

The raw corridor costs generated in this initial round of processing are based on assumed unit cost, terrain and alignment geometric requirements, for selected items used in comparative assessment of the various corridor options. They are a good guide as to the relative construction costs in 2006 dollars of the alternative corridors within the sections evaluated, but do not indicate full rail project costs such as contingences, overheads and profits, nor the impacts of remote areas and differential costs along the extended corridor.

The unit rates exclude the variable impacts of yet-to-be-determined sources of supply and the associated haul distances for major construction inputs such as water, gravel sub-ballast layers and track materials. In addition costs such as project management, detailed design, land acquisition and associated costs, train control, signaling and communications systems, and contingency provisions etc have are not included in the raw construction costs being calculated in Quantm for each of the corridors/alignments generated.

At this stage of the project development, an allowance for the total capital cost of the rail line will be the Quantm raw cost plus approximately 10% construction contingency, $500 million for bridges allowances and 65% for overheads and profit (percentages provided by EWLP). The anticipated capital costs hence total $6.4b. Note that the Quantm model and costing does not include the section from the Riverside stating point to Abbot Point.

During the next more detailed stage of alignment development factors such as:

- Drainage structures
- River crossings (culverts/bridges)
- Minor linear costs (fencing, etc.)
- Grade separated crossings of major highways/railways
- More accurate and detailed geological information and likely sources of ballast and gravel
- Design standards for crossing desert sections
- Avoidance or land mitigation of environmental areas
- Avoidance or land mitigation of other incompatible land-use areas

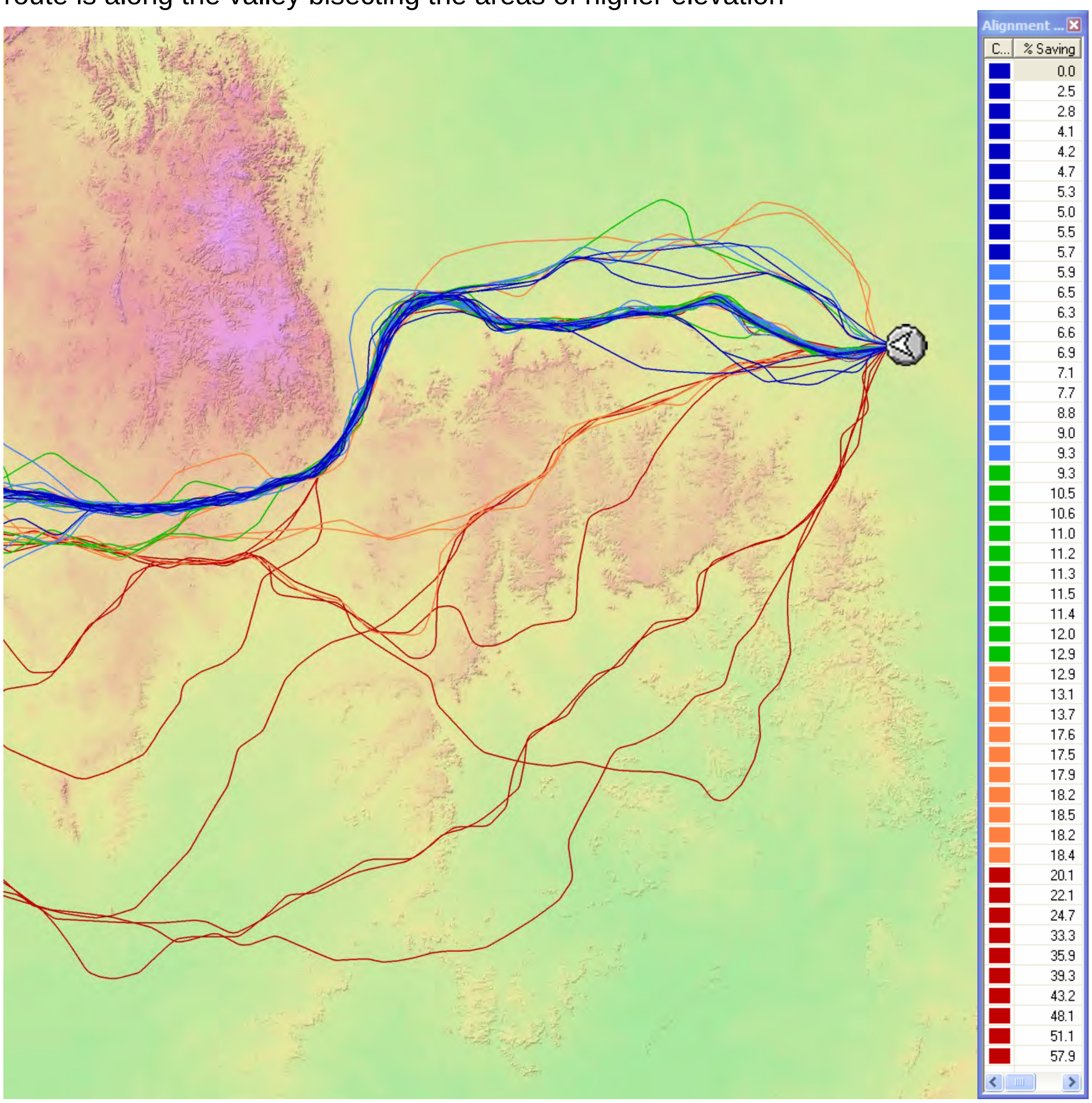
will be assessed individually as to their cost impact, which will increase the certainty and reduce the contingency factor.

8.0 CORRIDOR SEARCH

8.1 Corridor Search - Full Area

Quantm was used to perform free-to-roam searches across each of the fifteen sections comprising the study area. In free-to-roam mode, the Quantm system searches the whole terrain for low cost alternatives. The output is a range of up to fifty rail alignments spreading across the terrain model. Clumping of alignments indicates a favourable corridor. Colour coding the alignments in order of cost, highlights the lowers cost corridor. Using this functional capability of the Quantm system, provides evidence that the whole of the available area has been searched for viable corridors.

In the example below, which shows a set for results generated in Section D1, the lowest cost corridor is shown by the clumping of blue alignments. It can be seen that the cheapest route is along the valley bisecting the areas of higher elevation



(Fig 8.a) Example results set from Section D1 of 50 alignments coloured by cost.

8.2 Corridor Descriptions

Analysis of these results showed the key driver of corridor location to be grade related. The overall trend in the results is that the low cost corridors tended to favour the most direct route from section to section. Deviations from a straight line were forced by the very low maximum grade which resulted in to the corridors deviating to avoid any rough or mountainous terrain.

After the initial low cost corridors that met the geometric and grade constraints were identified, a collaborative review was carried out between Quantm and EWLP. The purpose of this was to identify any macro level features of importance which could impact the more favoured corridor alternatives. Each of these significant features will require special attention at the next level of investigation to modify the corridor in those specific areas to address each issue. These features have been summarised in the following table.

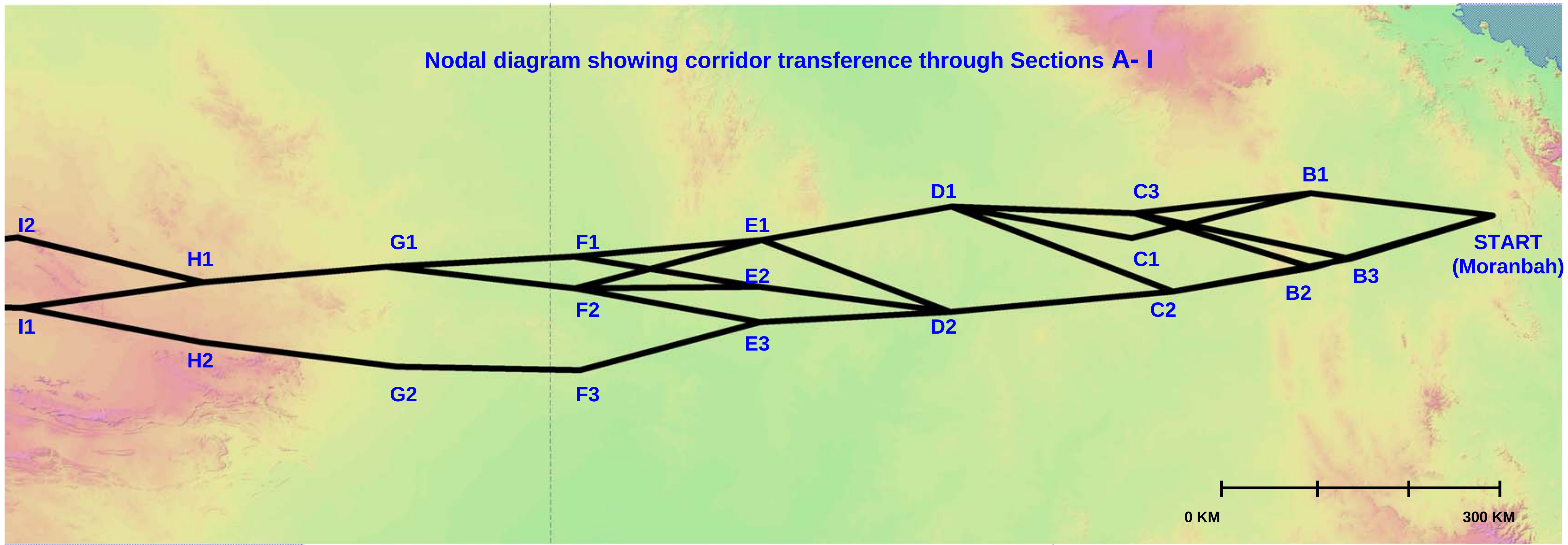
Table 8.a: Summary of Length, Cost and Significant features for Corridor Sections.

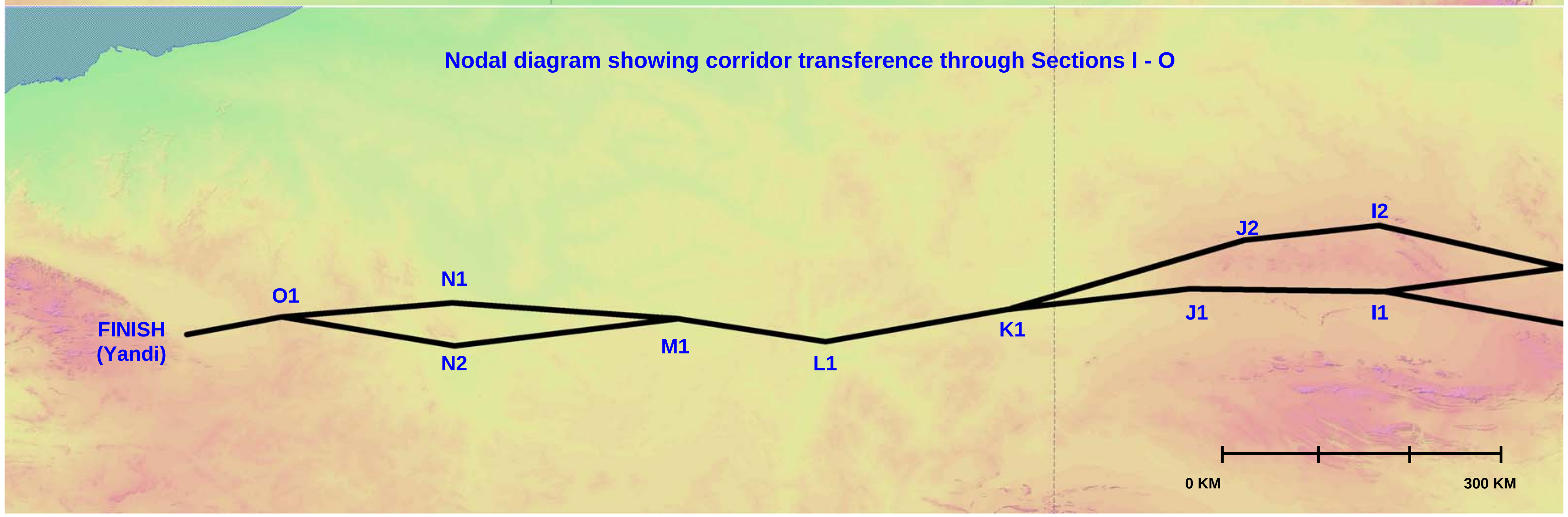
Corridor Section	Distance (km)	Raw Cost* ($)	Significant Features
A – B1	216.2	$238M.	Consideration to existing Mining leases, Gregory Developmental Road, Nairana National Park
A – B2	212.7	$232M.	Gregory Development Road, Twin Hills
A – B3	169.9	$179M.	Gregory Development Road, Twin Hills
B1 – C1	218.5	$215M	Small Dry Lakes, Lake Buchanan, Landsborough Creek
B1 – C3	224.9	$217M	Landsborough Creek
B2 – C2	172.6	$164M	Towerhill Creek, Lake Galilee, Lake Barcoorah
B2 – C3	228.9	$225M	
B3 – C2	217.4	$220M	
B3 – C3	264.4	$268M	
C1 - D1	222.4	$218M	Winton Highway, Winton Branch Railway, Wokingham Creek Landsborough Highway, Diamantina Creek, Winton Township
C2 – D1	273.7	$282M.	
C2 – D2	267.4	$282M.	Winton, Western River, Bladensburg National Park, Diamantina River
C3 – D1	221.0	$219M.	Kynuna
D1 – E1	246.6	$235M.	Diamantina River, Landsborough Highway, Mckinly River System, Cannington Mine (BHP), Chatsworth, Phosphate Hill Mine
D2 – E1	239.7	$236M.	
D2 – E2	231.7	$232M.	
D2 – E3	235.6	$238M.	

E1 – F1	223.4	$221M.	Phosphate Hill Mine, Diamantina Development Road, Georgina River
E1 – F2	227.0	$230M.	
E2 – F1	226.2	$236M.	
E2 – F2	213.8	$232M.	
E3 – F2	225.9	$225M.	
E3 – F3	226.8	$254M.	
F1 – G1	210.4	$198	Some Small Sand Dunes
F2 – G1	213.1	$207M.	
F3 – G2	223.0	$222M.	
G1 – H1	227.4	$217M.	Ooratippra Creek System, Sand Ridges, Bundey Creek, Sandover Highway, Sandover River
G2 – H2	225.0	$227M.	
H1 – I1	226.6	$211M.	Ti-Tree, Hanson River, Lander River
H1 – I2	223.8	$219M.	Stuart Highway, Alice Springs Darwin Railway, Darwin Gas Pipeline
H2 – I1	213.7	$199M.	
I1 – J1	216.7	$202M.	
I2 – J2	147.2	$139M.	Cockatoo Creek, Tanami Road, Yaloogarie Creek
J1 – K1	208.5	$203M.	
J2 – K1	279.6	$265M.	Sand Dunes, Lake MacKay, Central Australia Aboriginal Reserve
K1 – L1	219.0	$226M.	Kiwirrkurra Aboriginal Reserve , Sand Ridges through Gibson Desert
L1 – M1	170.9	$186M.	Patchy Sand Dunes
M1 – N1	274.2	$276M.	Rudall River National Park
M1 – N2	271.1	$293M.	Corridor not reviewed
N1 – O1	232.4	$238M.	Talawana Track, Little Sandy Desert
N2 – O1	228.3	$230M.	
O1 - Finish	105.0	$92.4M.	Fortescue River

* *Raw costs do not include contingencies, overheads, distance impacts, overheads or profits.*

In each of the following corridor drawings, the corridor marked as BLUE is the initial preferred corridor due primarily to its shorter length and lower raw cost.





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Scale: NTS
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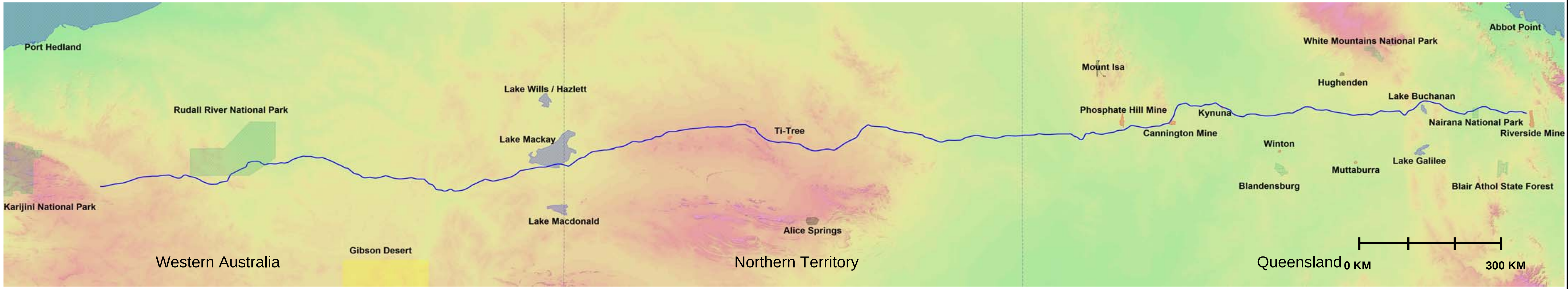

(Figure 8.b) – Illustration showing the Preferred Northern Corridor Route.

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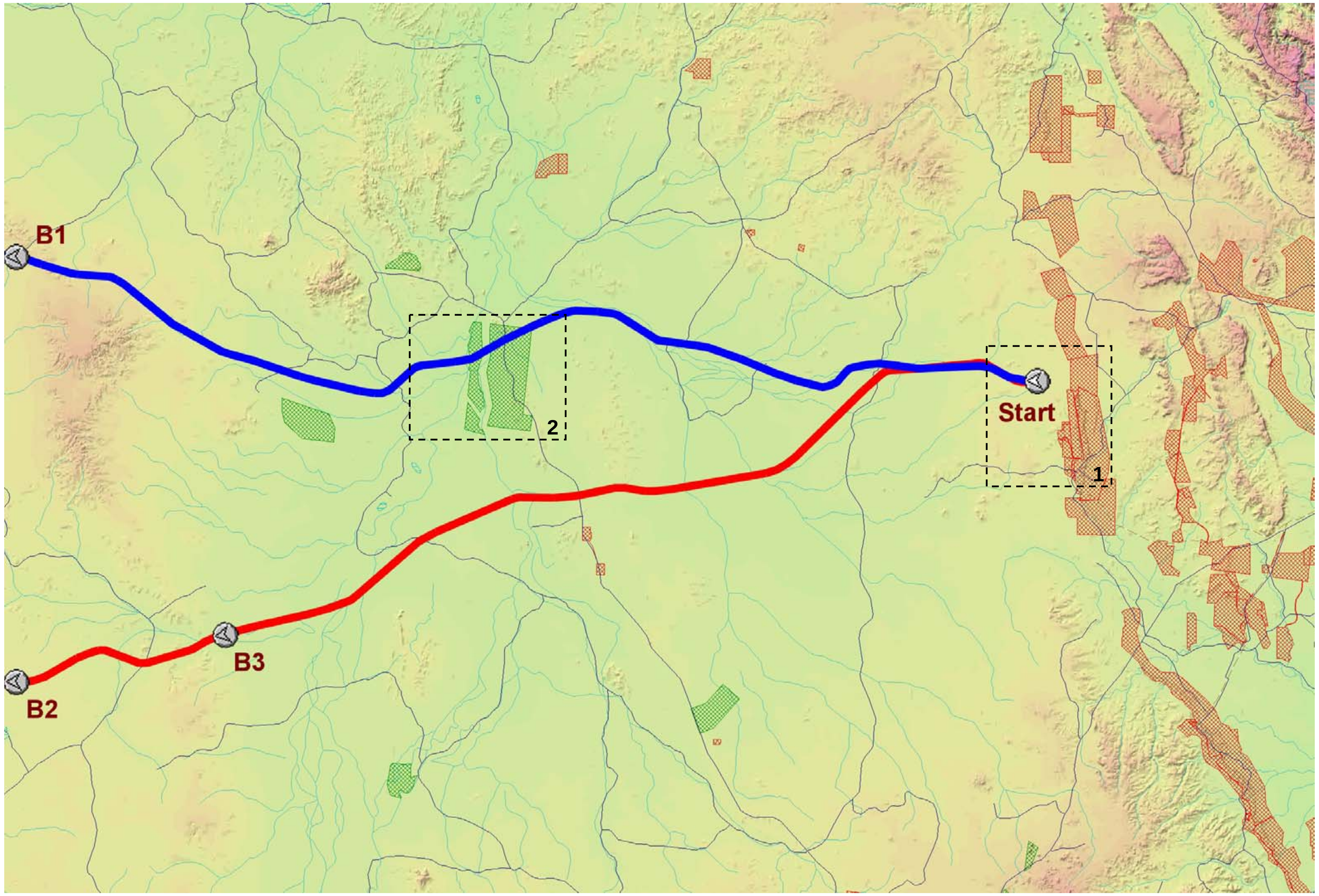
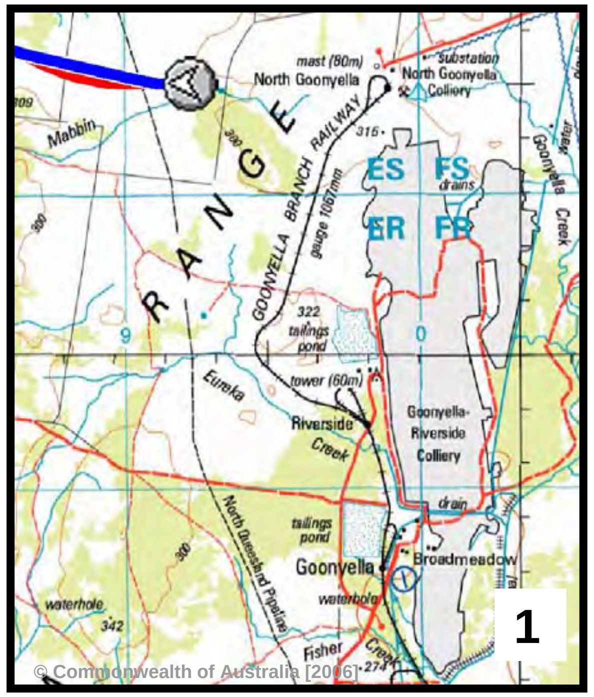
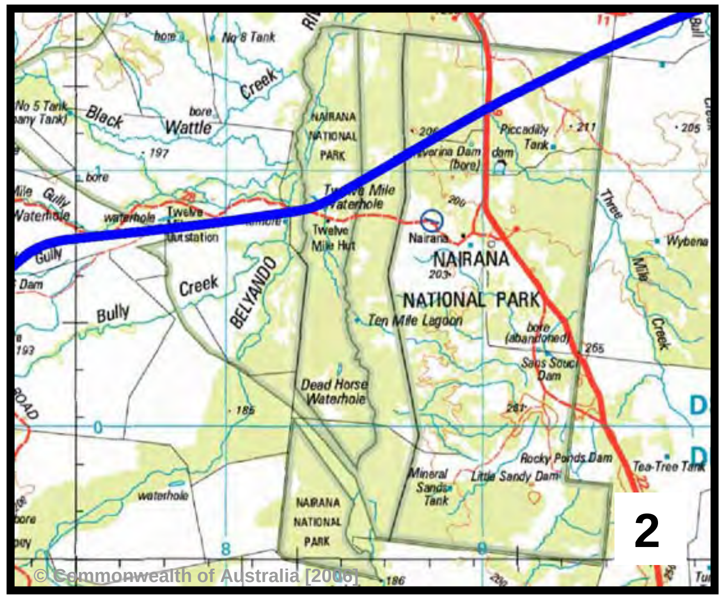




Goonyella-Riverside Mine



Nairana National Park

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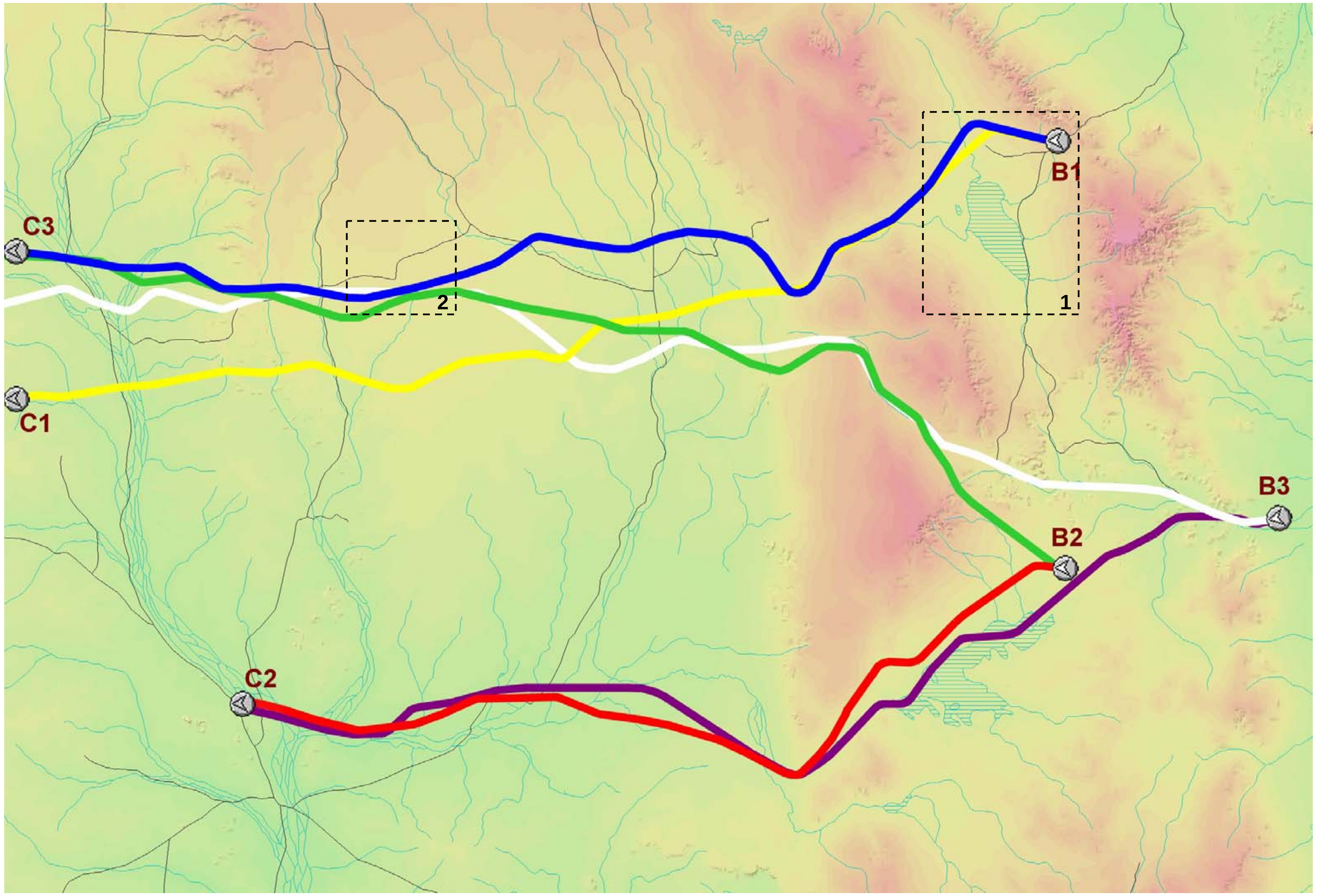
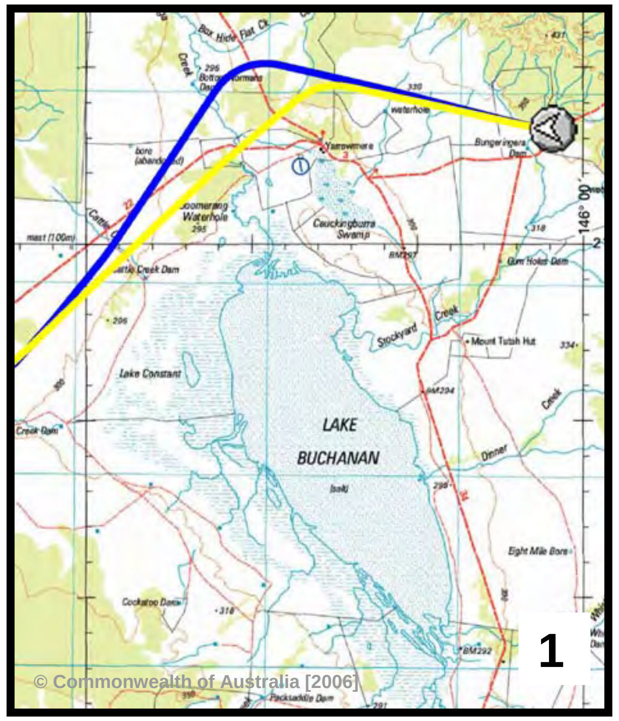
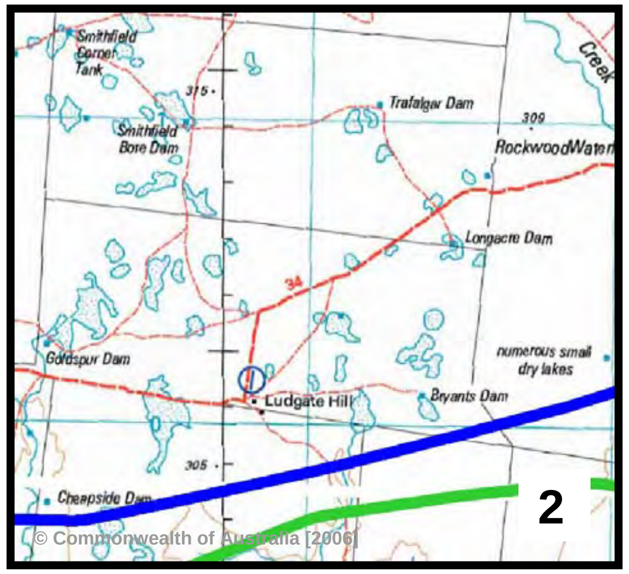
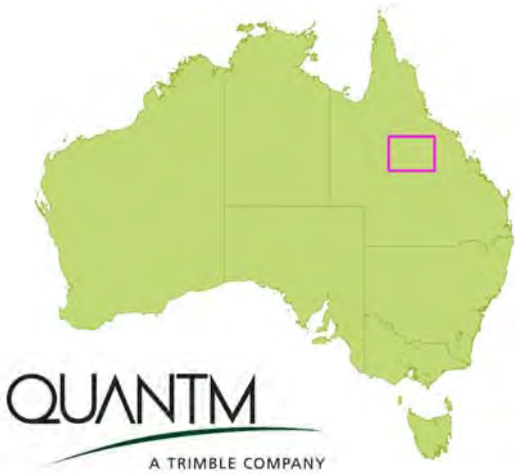




Lake Buchanan



Numerous small dry lakes



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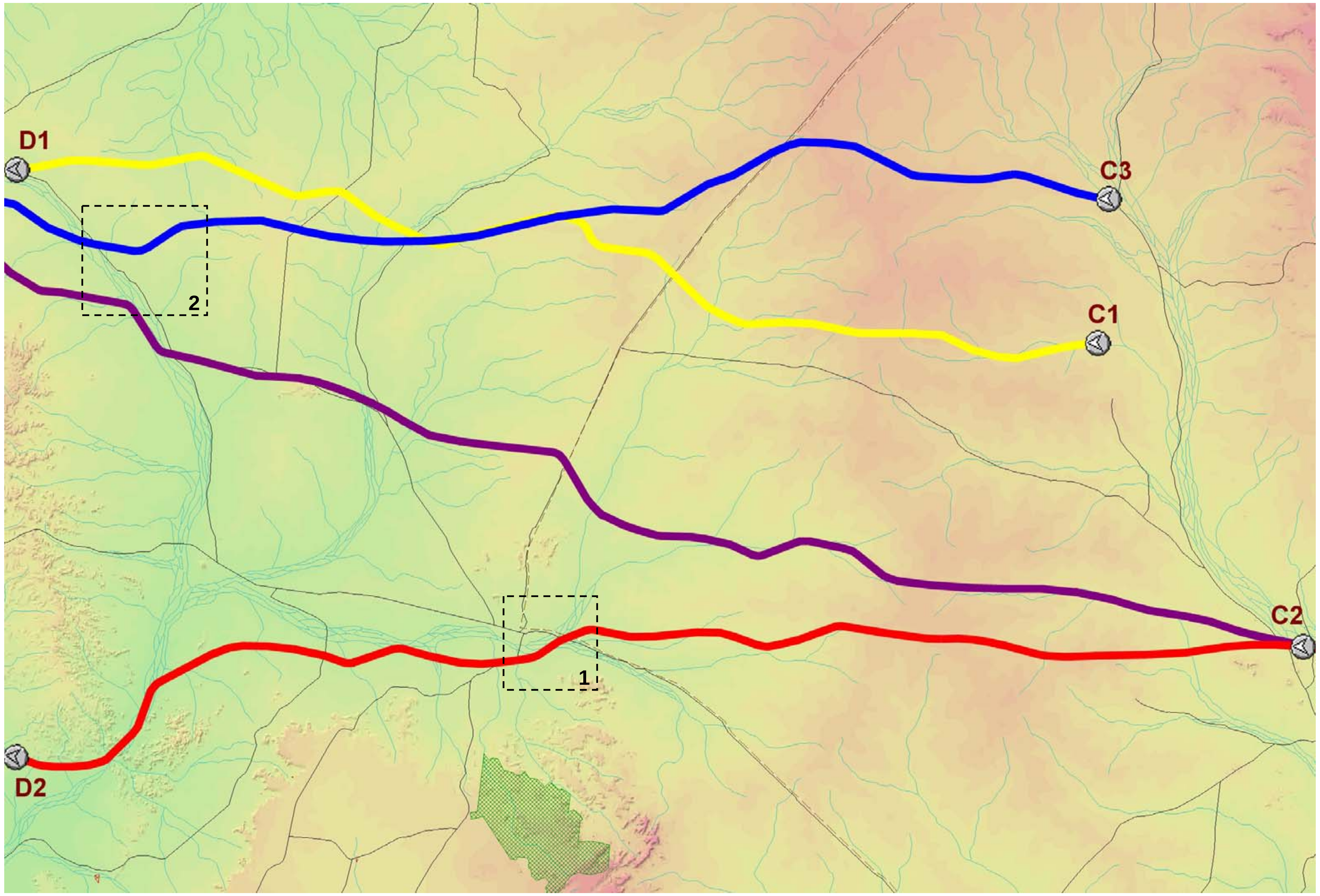
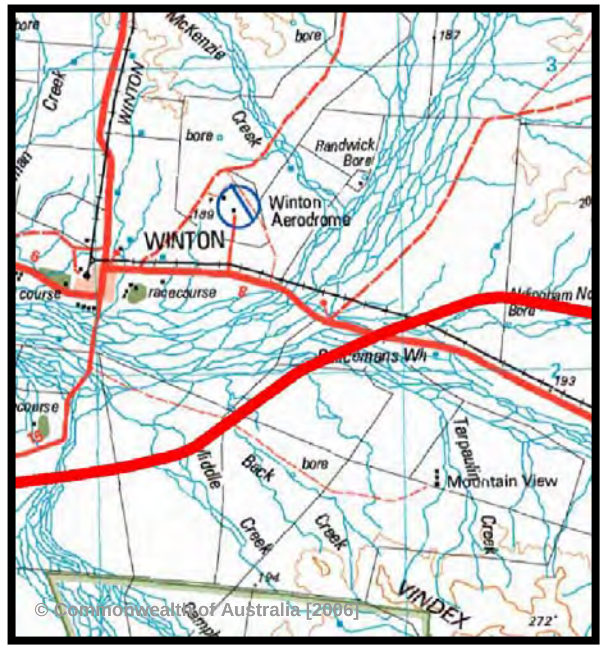
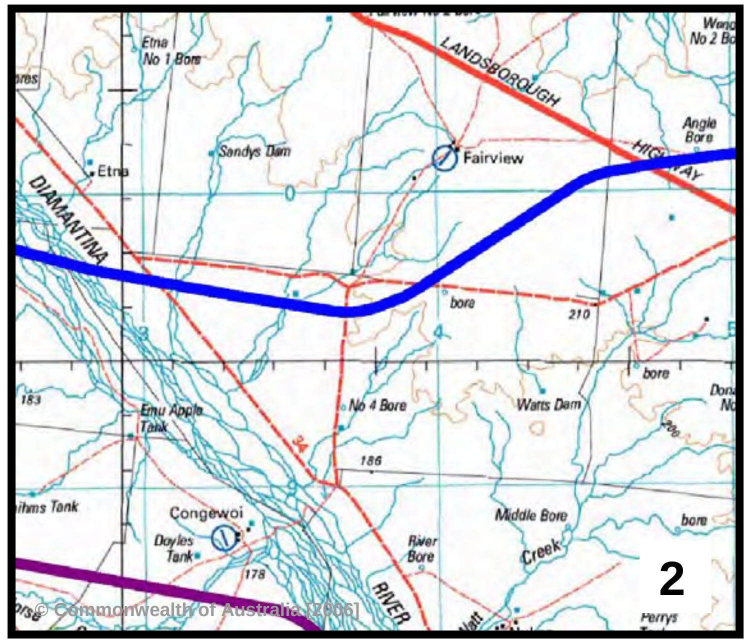




Winton Township



Diamantina River

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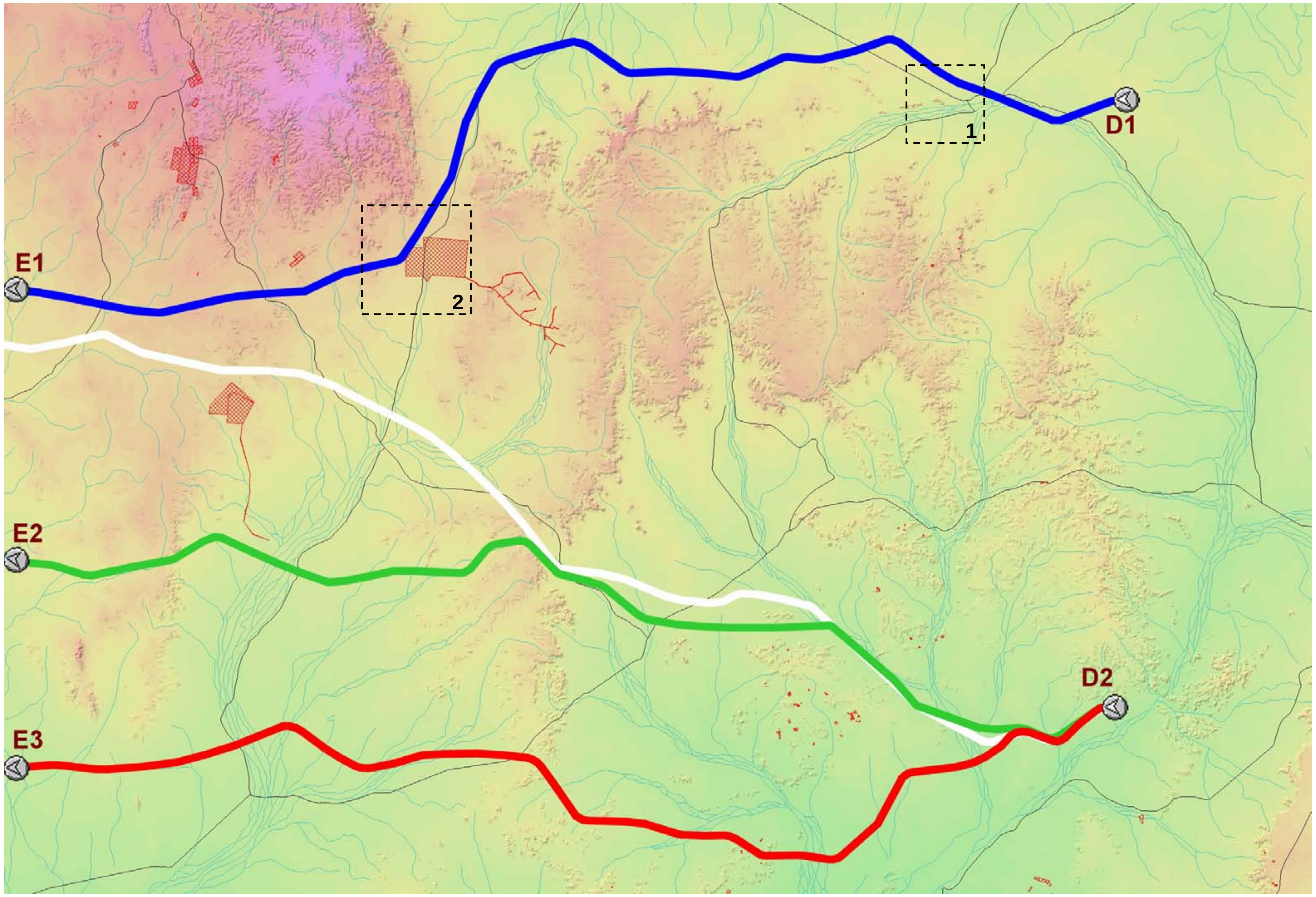
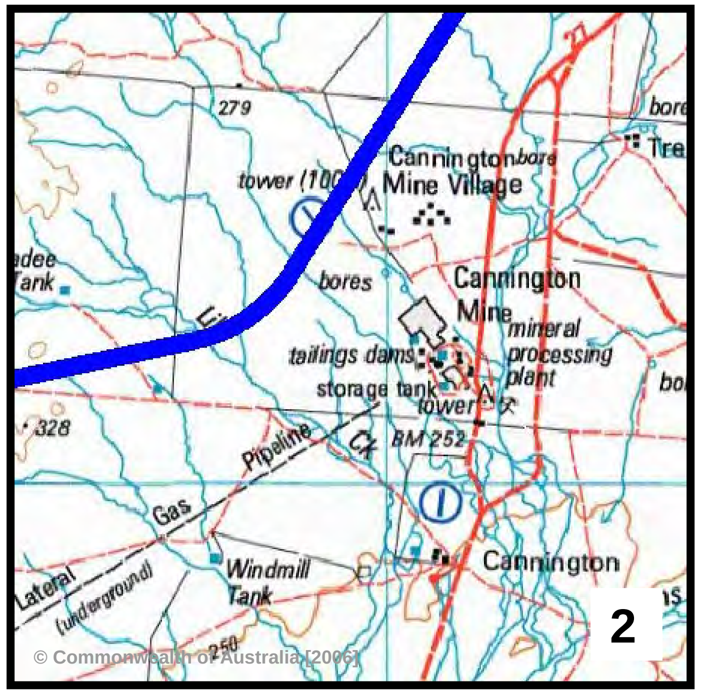


Kynuna Township



Cannington Mine

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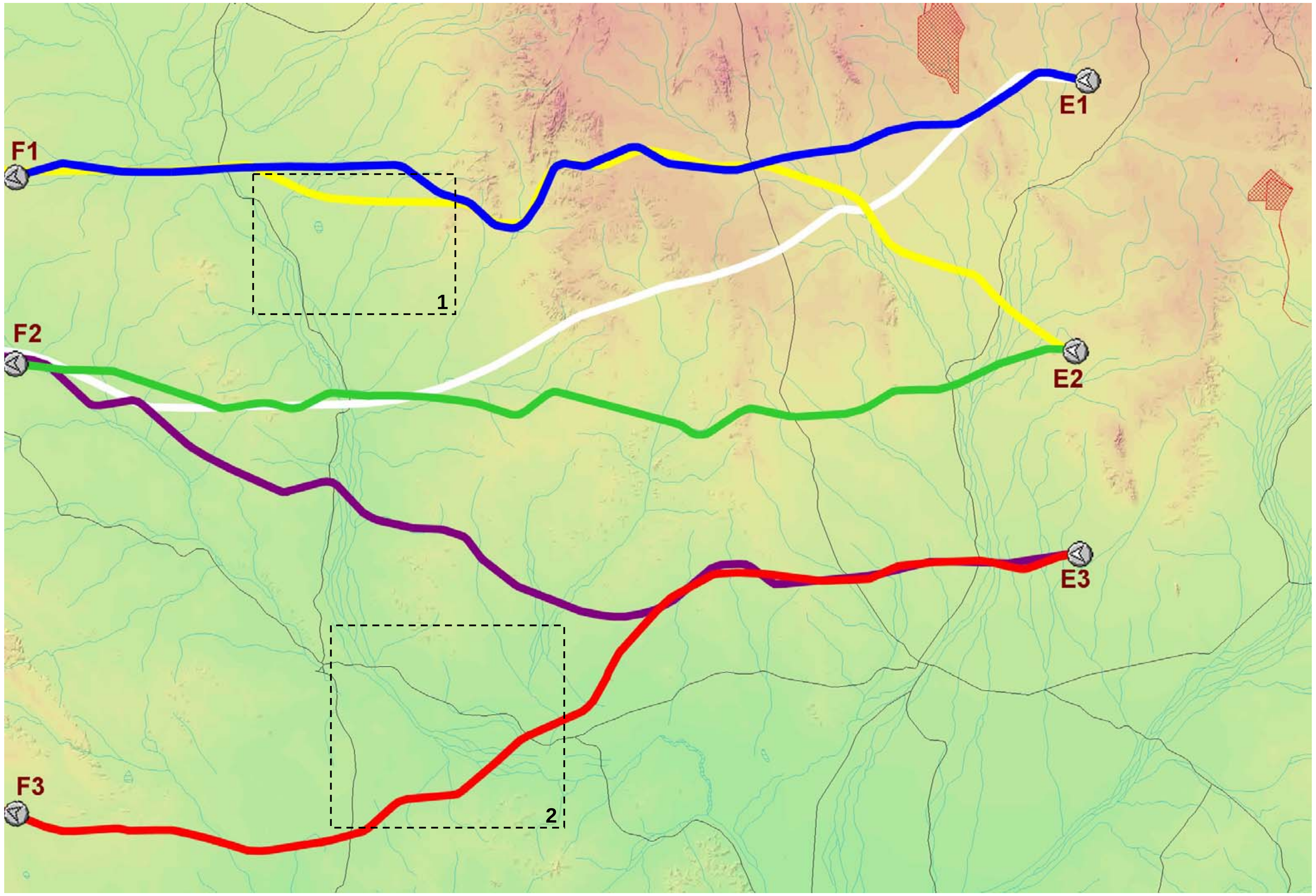
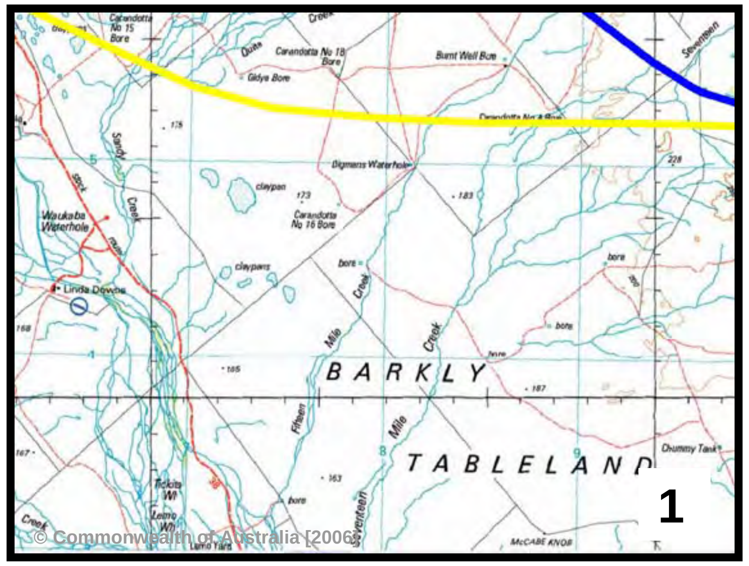
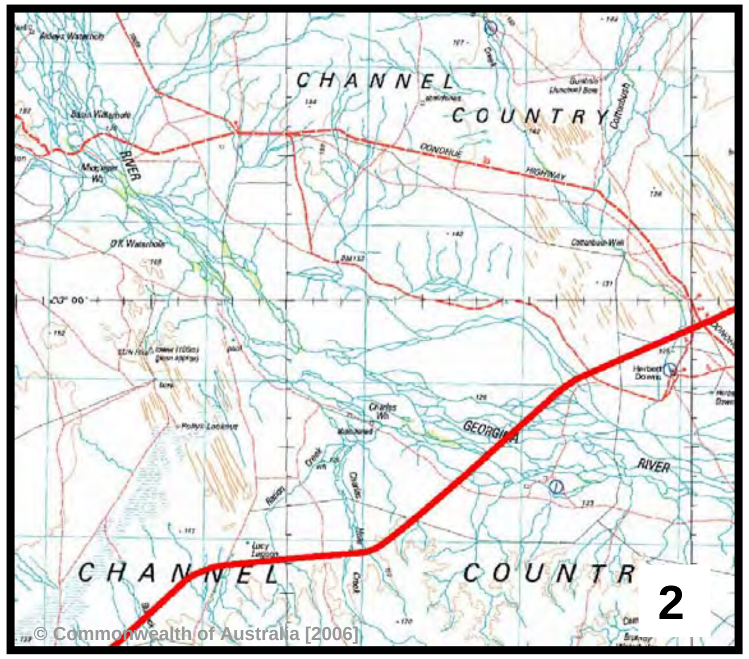




Barkly Tableland



Channel Country

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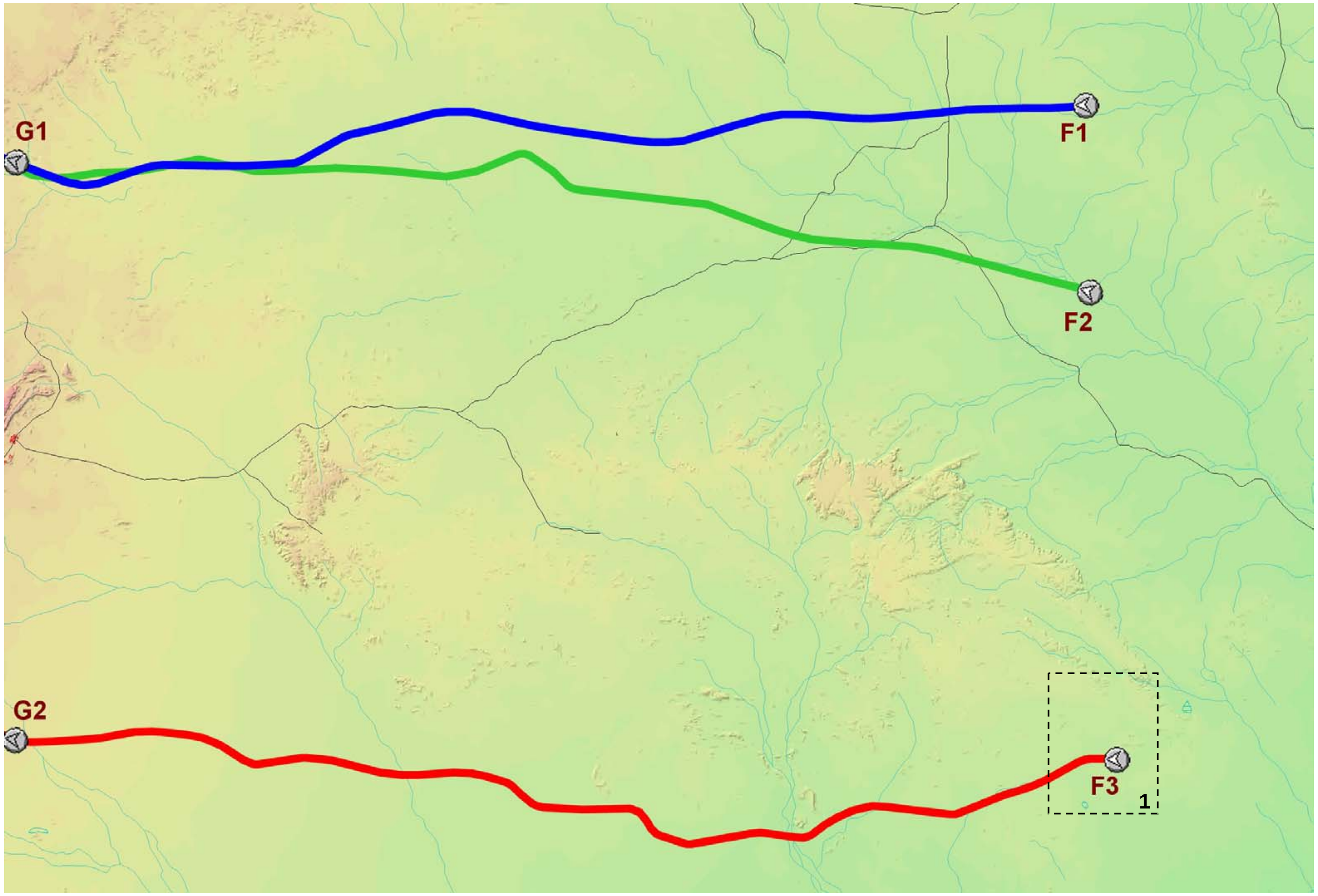

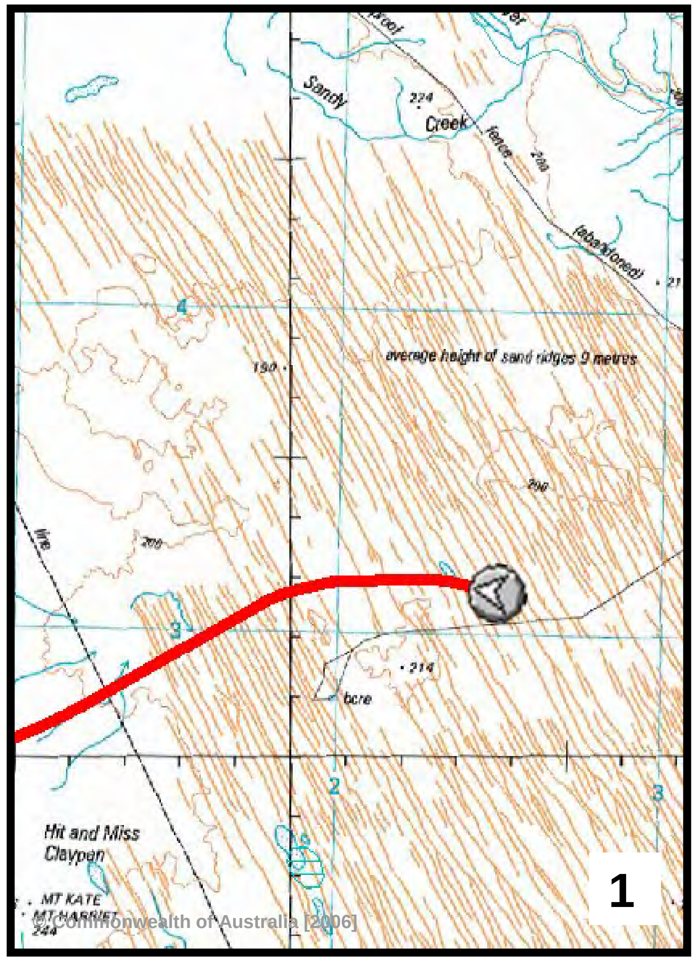

Simpson Desert

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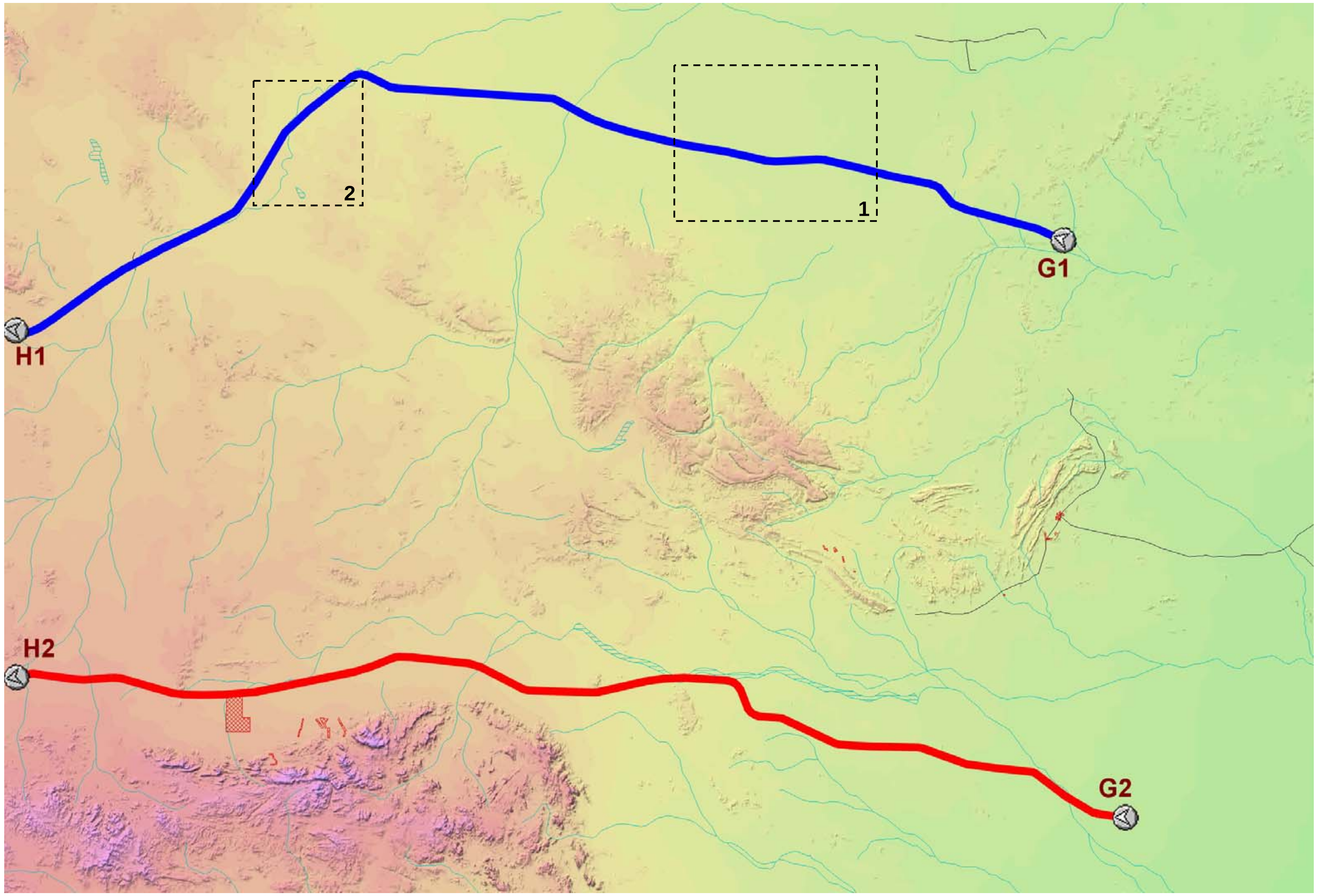
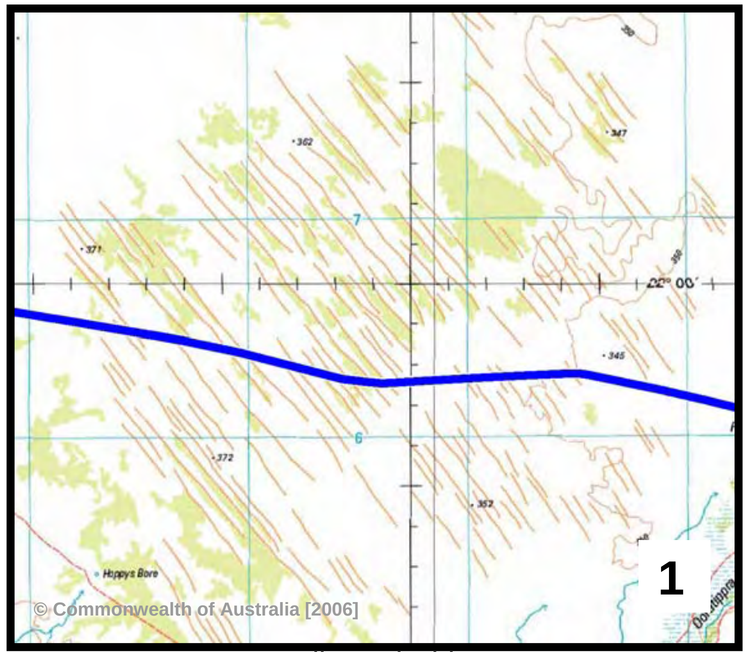
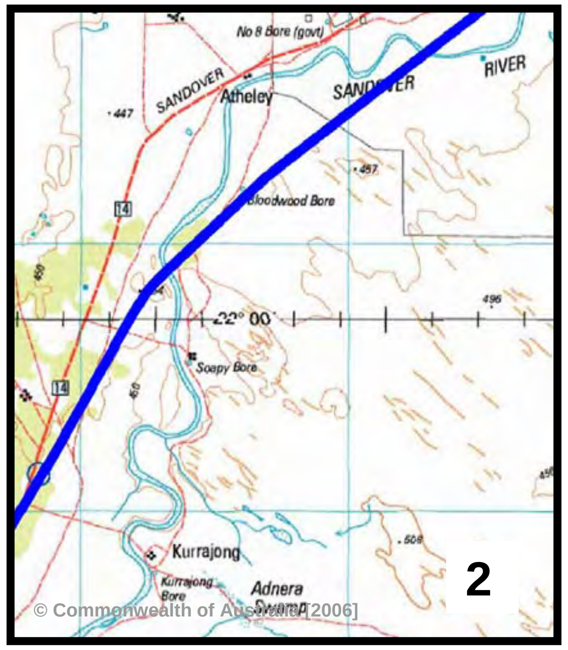




Small Sand Ridges



Sandover River

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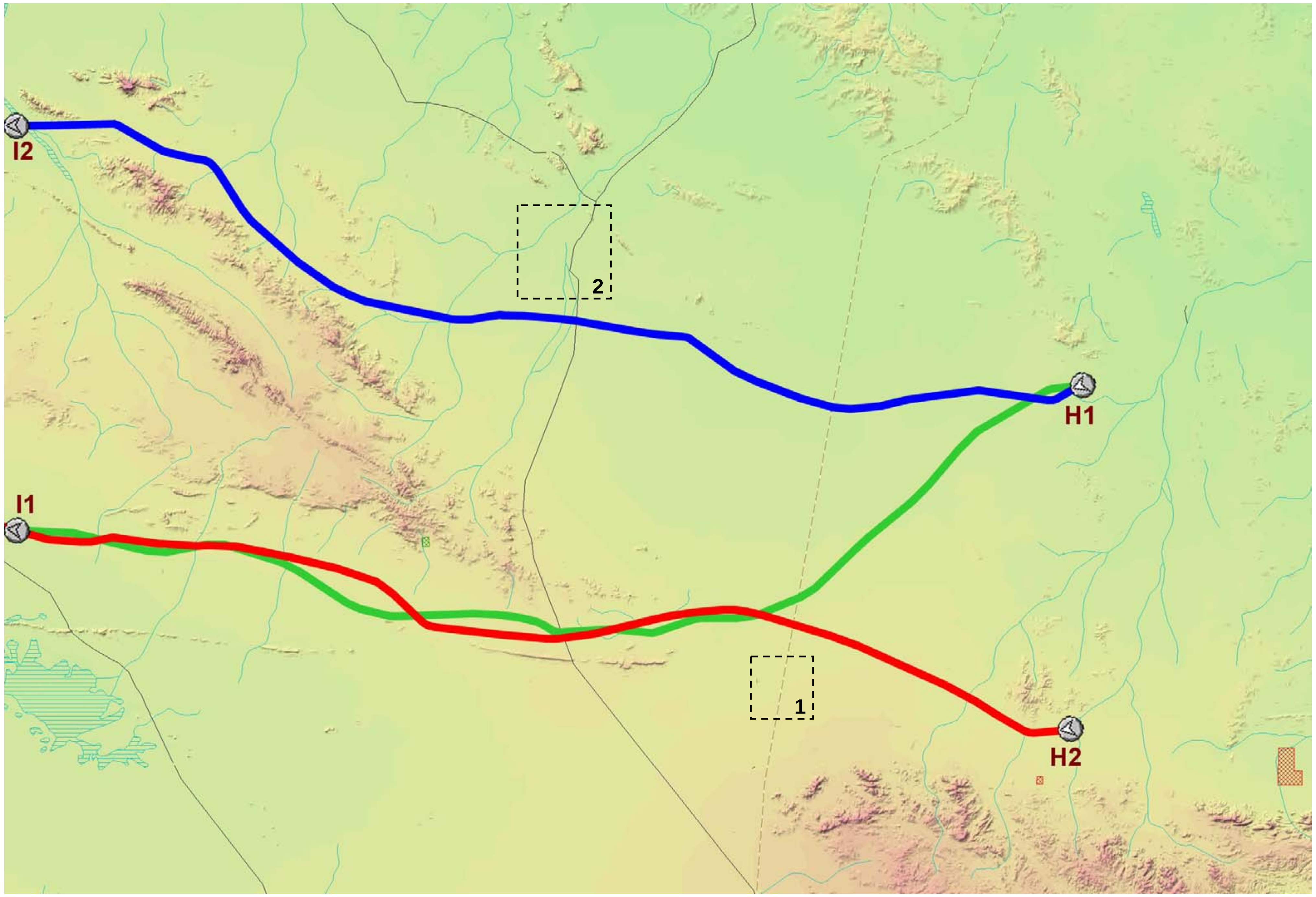

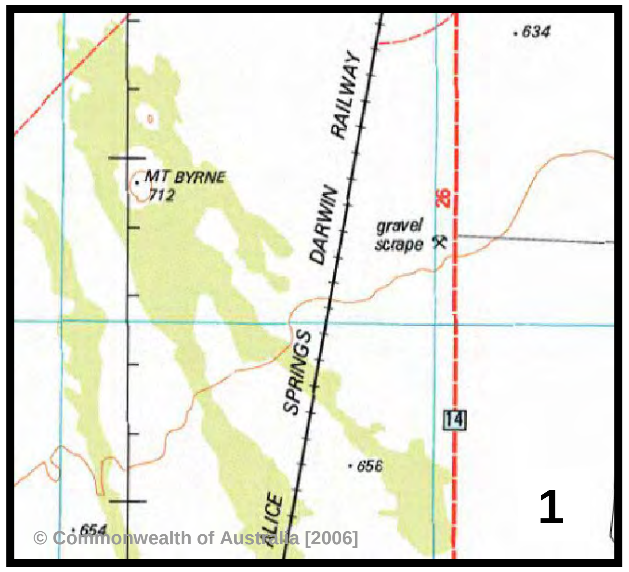

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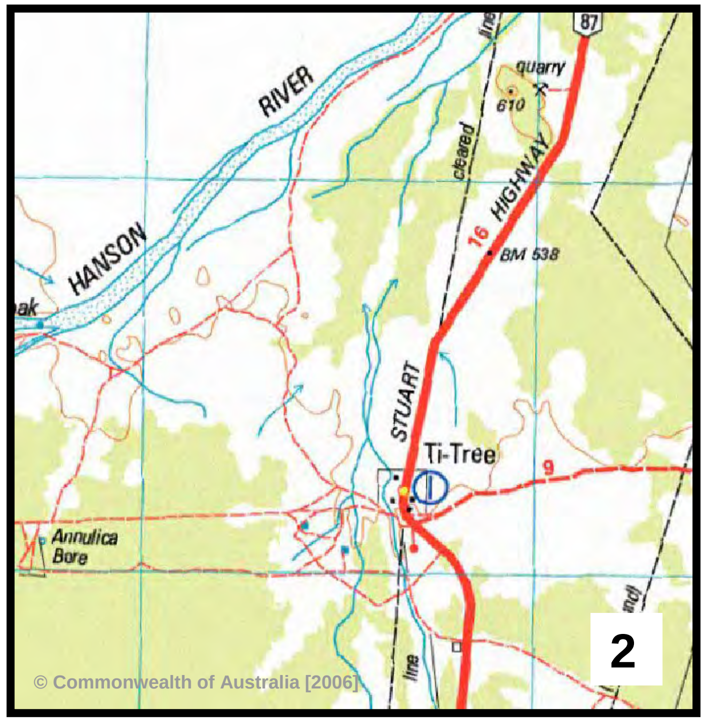

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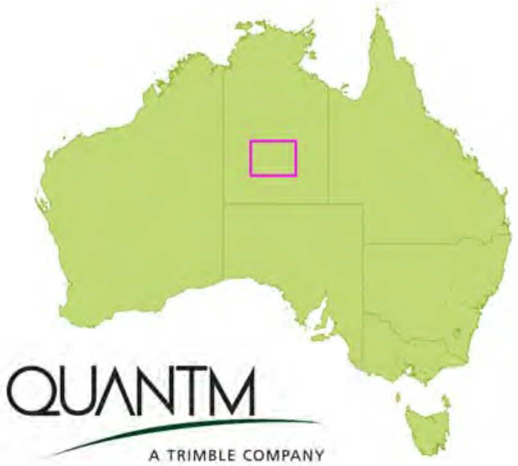

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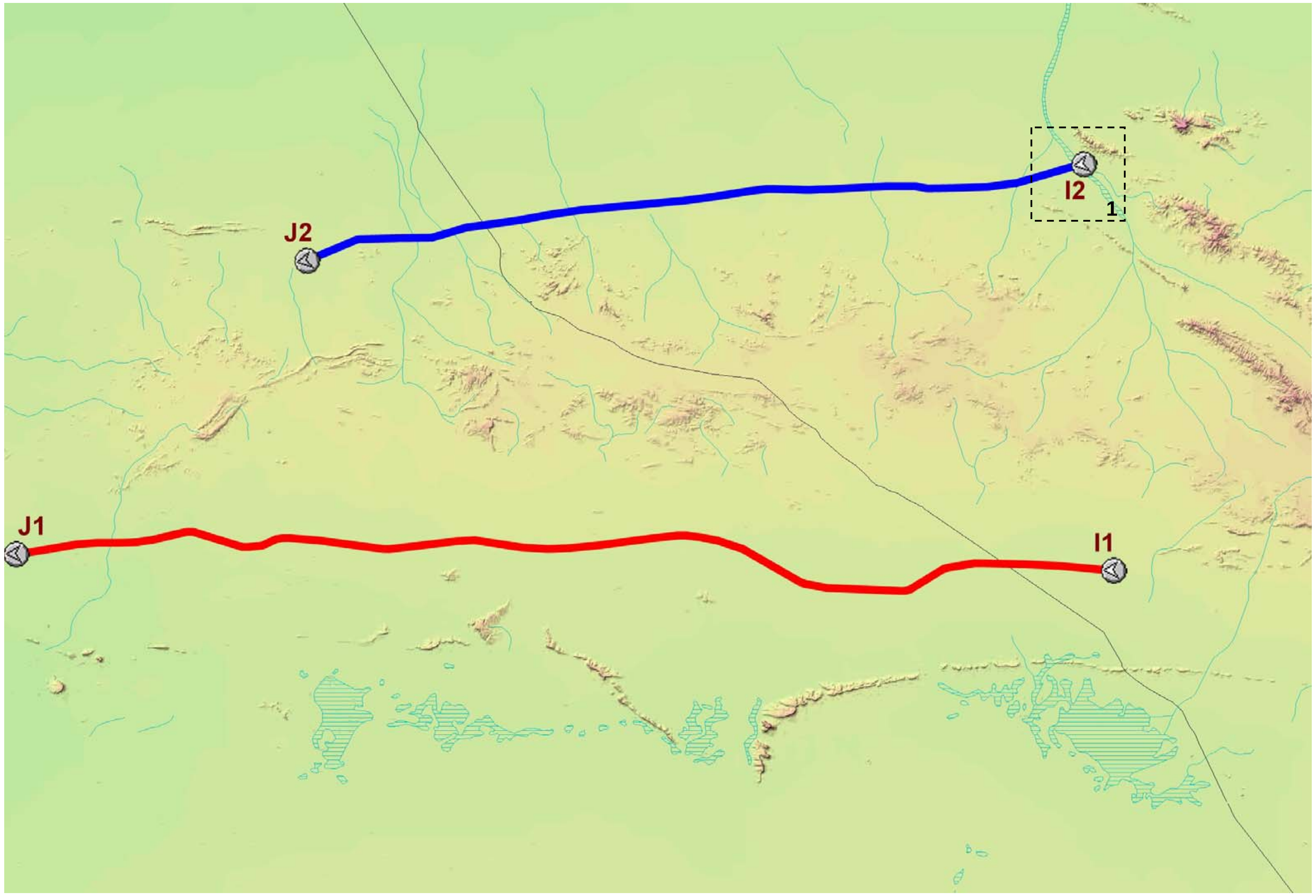

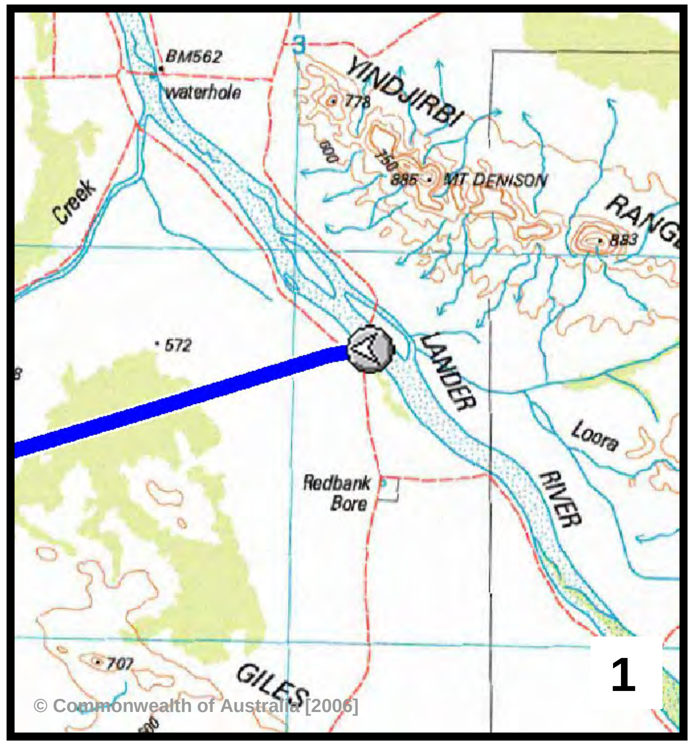

Lander River

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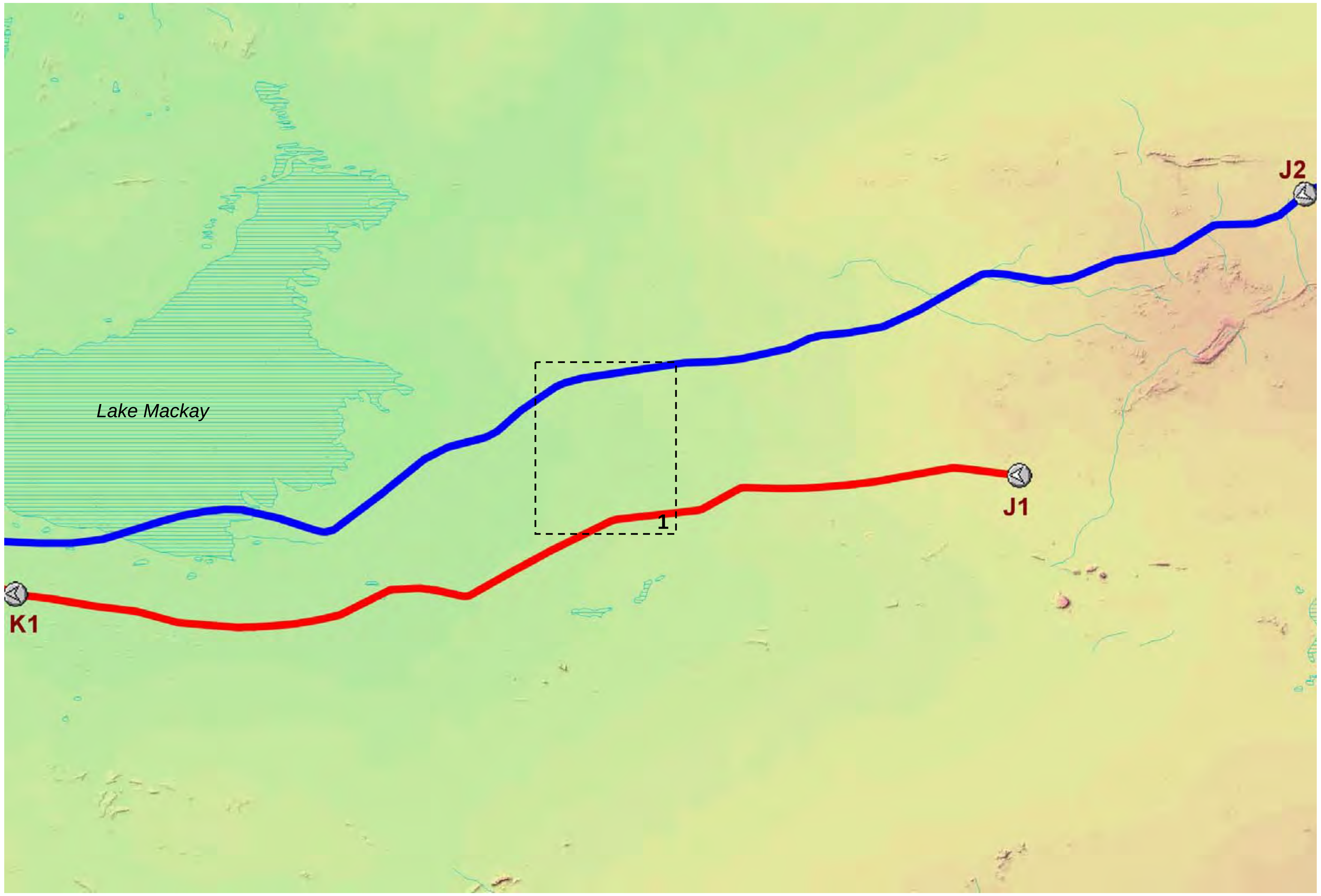

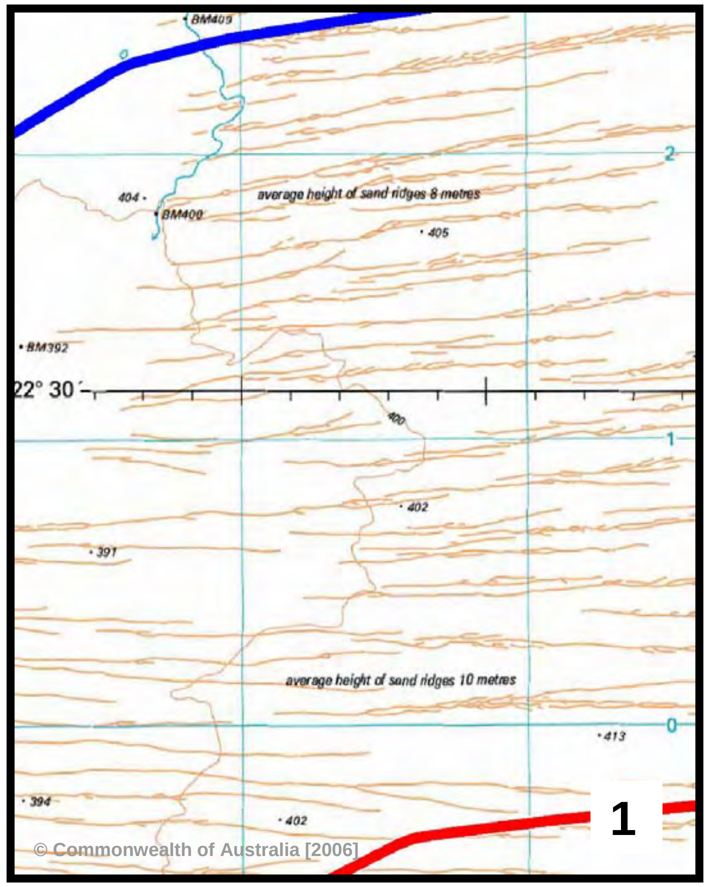

Sand Ridges

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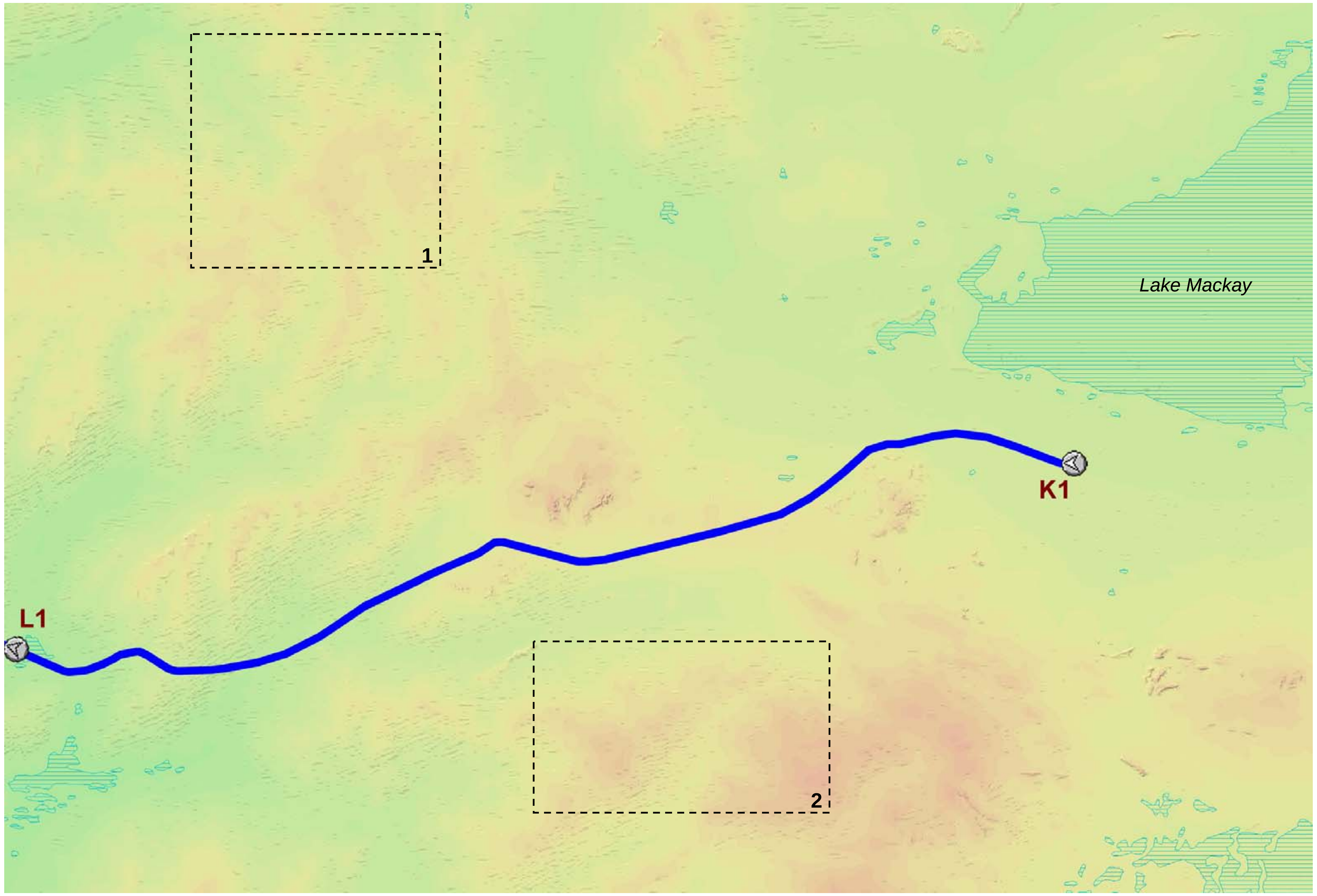
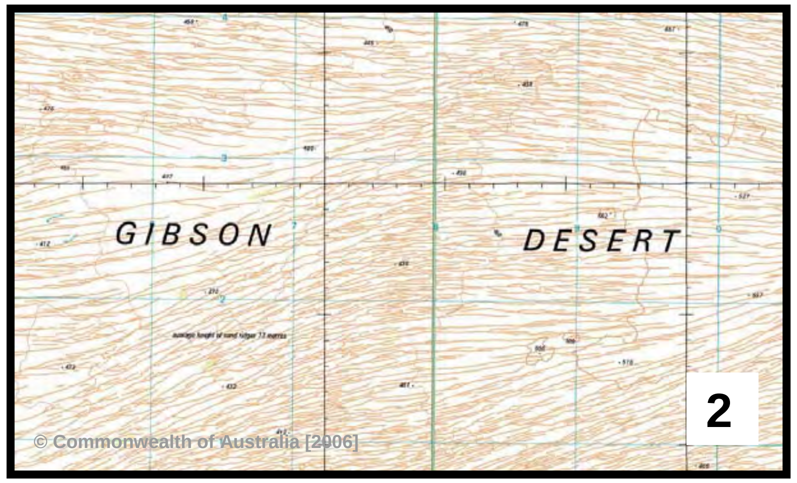


Great Sandy Desert



Gibson Desert

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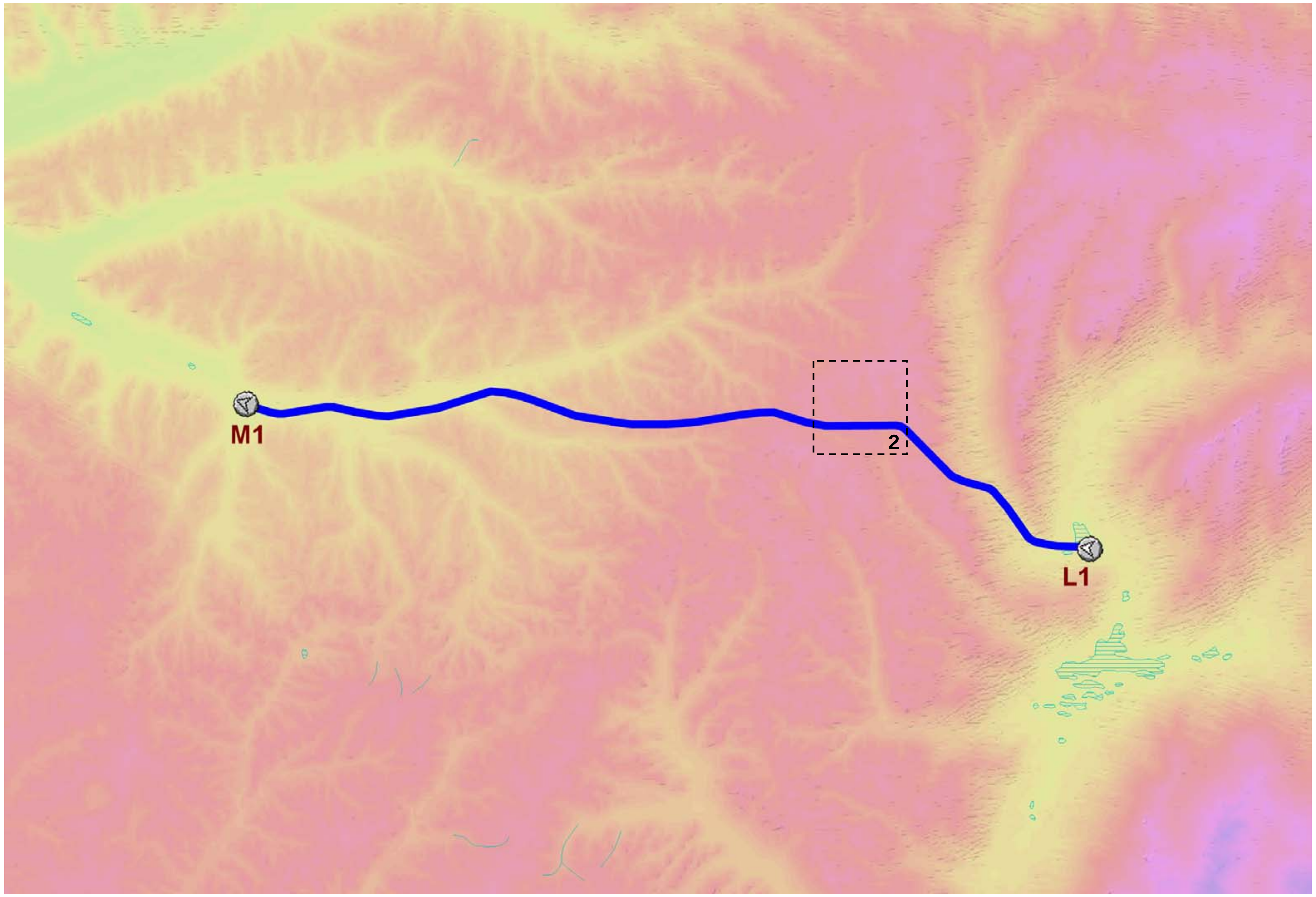

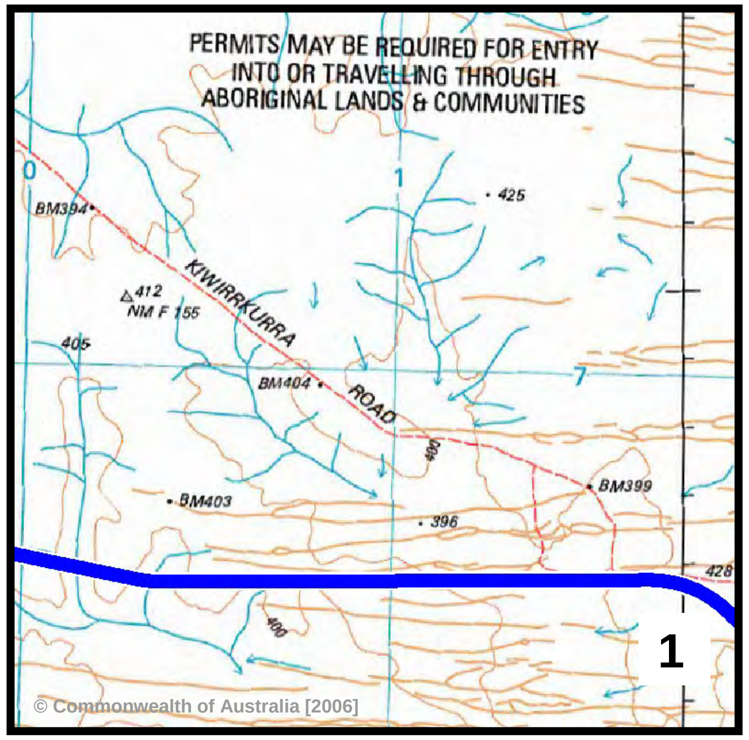

Kiwirrkurra Road

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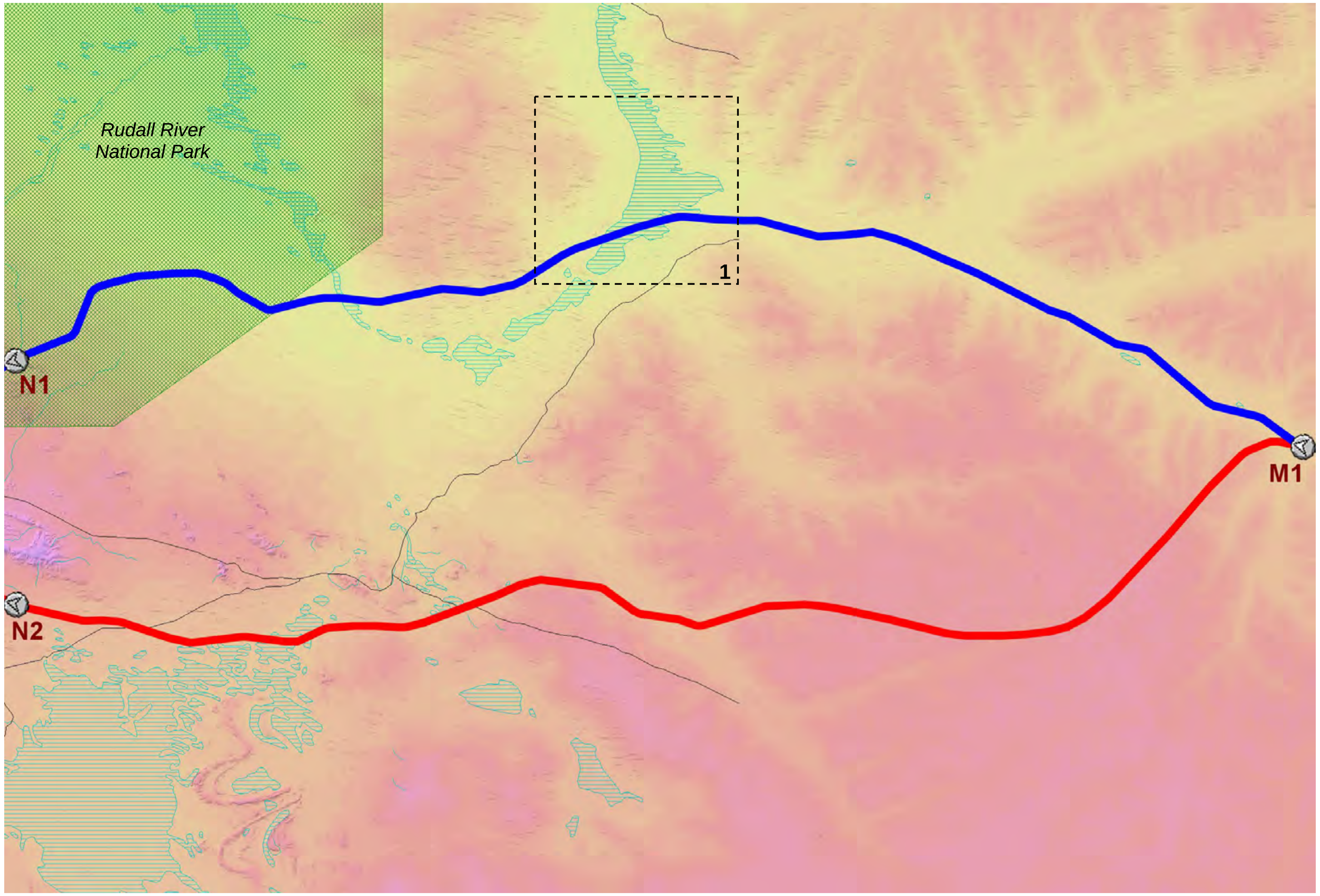
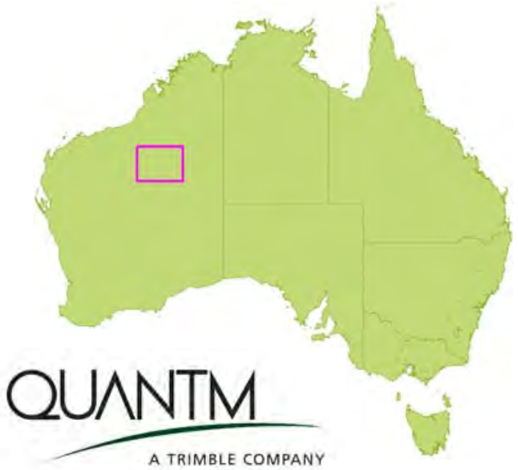


Lake Auld



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Scale: NTS
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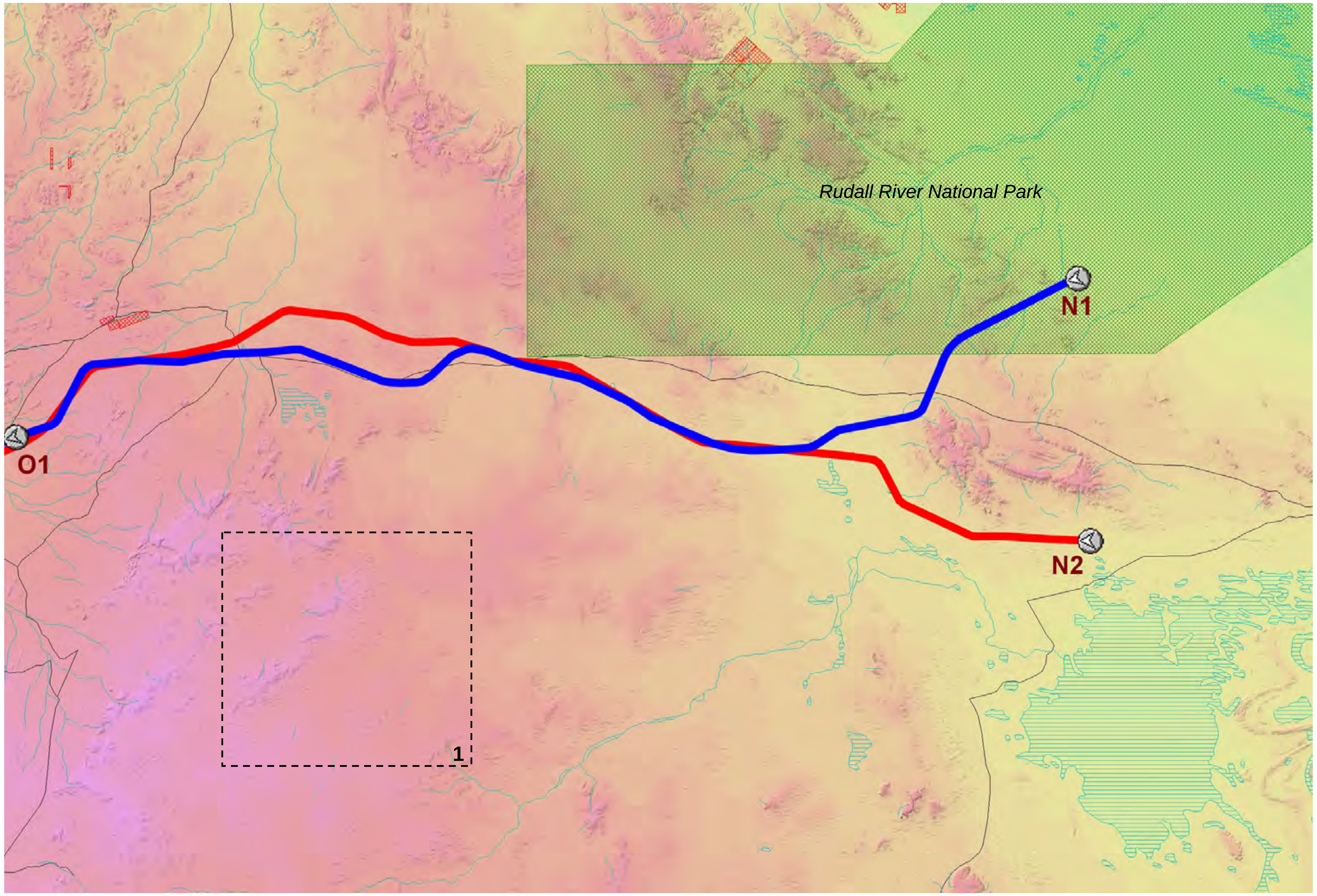

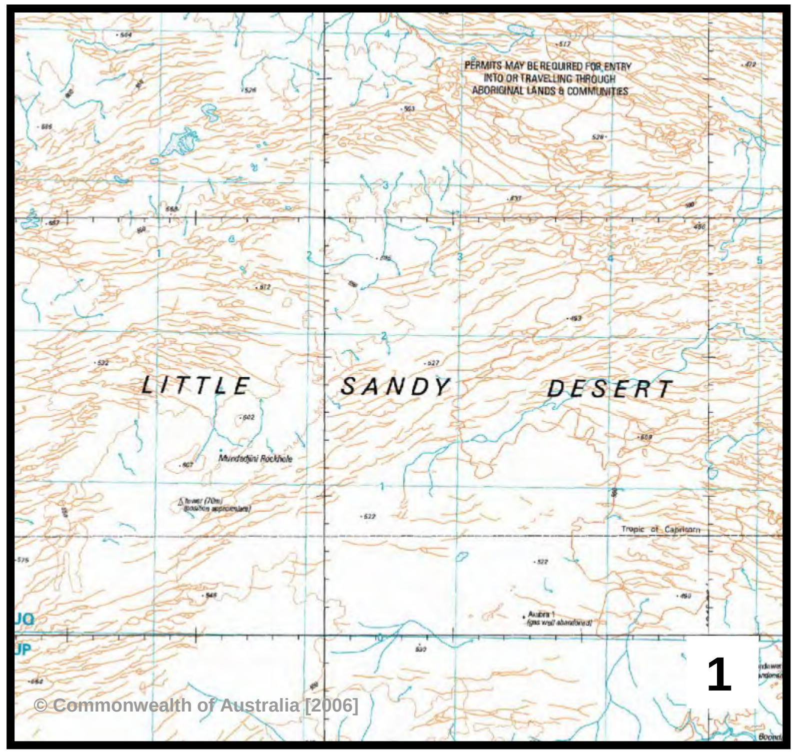

Little Sandy Desert

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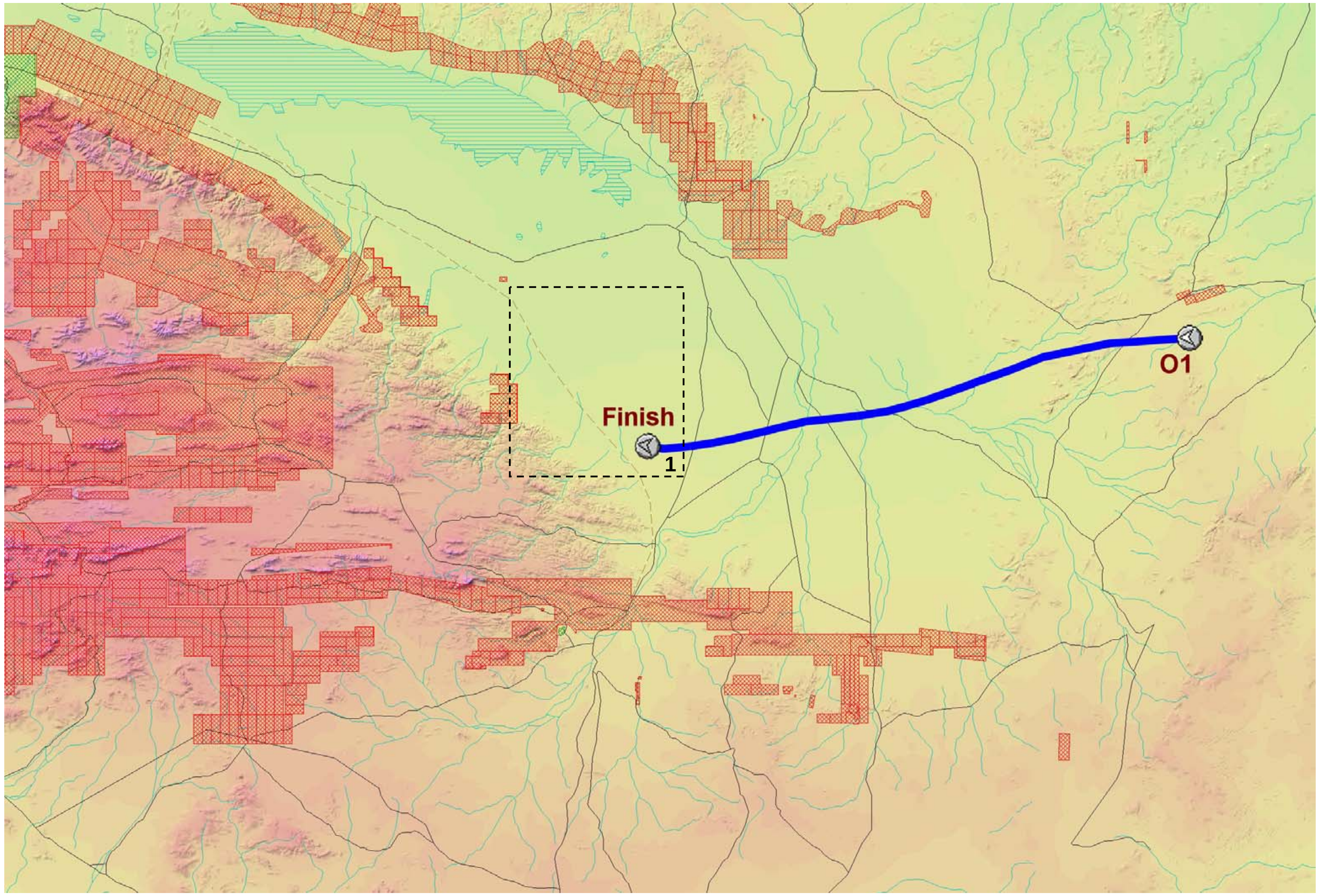

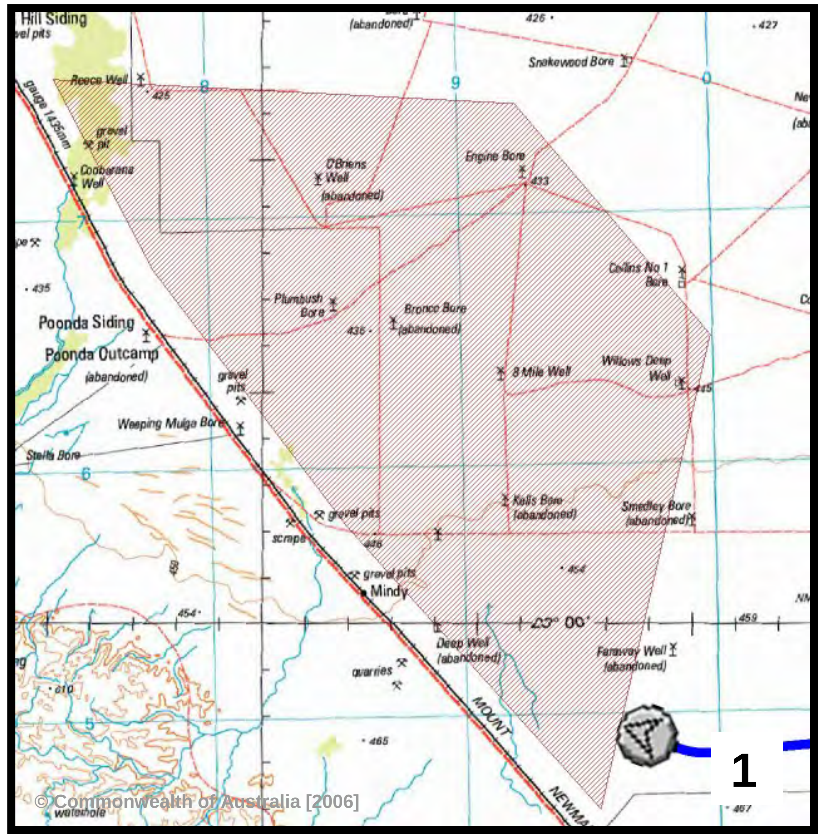

Proposed location of Newman Smelter Park

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PROJECT IRON BOOMERANG
east west line parks pty ltd

East West Line Parks Pty Ltd
Project Iron Boomerang:
Rail Corridor Identification Pre-feasibility Study

Date 5/2/2007
Scale: NTS
Drawing No PIB-RCI-01 Rev 0 – Section O

9.0 TYPICAL ALIGNMENT CHARACTERISTICS

9.1 Preferred Corridor

During the session held between Quantm and EWLP on the 23/01/2007, the results and outcomes for each corridor section were presented to the team. This revealed that a comprehensive search of the terrain model had already identified a number of favourable corridors. Alternatives were individually reviewed and critiqued within the Quantm software. Strategic construction cost comparisons were made on each, while their localised impact on macro scale environmental and land-use constraints were investigated by viewing the options super-imposed over topological maps. This led to the selection of the northern corridor route being preferred over others, mainly due to it meeting more of the project requirements and criteria for an early stage rail corridor route. The alignments shown in blue in the sectional drawings represent the EWLP preferred corridor (*refer to Section 8.3*).

The northern route was chosen for the following reasons:

- Exhibited minimal impacts on river systems, national parks, townships and existing mining leases. Those that were impacted could be easily constrained and avoided in further more detailed studies.

- More suitable site for the railway crew change, maintenance and refuelling depots along the route, in the vicinity of existing settlements (for example near Ti Tree in the Northern Territory and Kynuna in NW Queensland).

- Achieved the economic objective of minimising construction costs, with the 3120 km route having an approximate total raw construction cost of $3.3 billion AUD.

- In comparison to some of the other corridor options, the preferred route exhibited less intrusion across the sensitive deserts of Western Australia.

- Preferred route commenced immediately east of the Riverside Mine and finished near Poonda Siding on the Mt Newman rail system, within the proposed smelter park precinct. The EWL will utilise the existing Queensland Rail corridor from near the Riverside initiation point to access Abbot Point (via the Newlands Railway and the approved Northern Missing Link from North Goonyella to Newlands). This section was not evaluated by the Quantm model as it follows the existing rail corridor.

- Showed compatibility with the engineering requirements of heavy haul rail, such as maximum gradient and minimum horizontal and vertical curvature. At this early stage the key geometric requirement from an operational viewpoint is maintaining a 1:200 gradient (0.5%) in both directions. The Quantm generated route achieved this, with the majority of the route being under 0.2% grade.

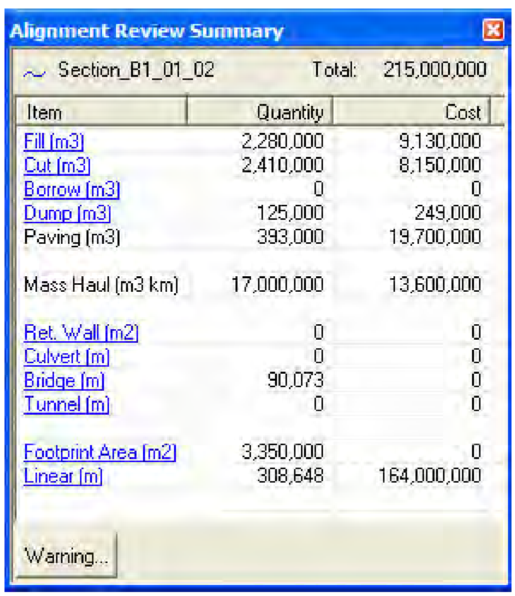
(Table 9.a) Break down of Gradient for Preferred Northern Route.

Category	Grade (%)*	Distance (km)
I	0.500 to 0.201	480
II	0.200 to 0.051	885
III	0.050 to -0.050	520
IV	-0.051 to -0.200	720
V	-0.201 to -0.500	500
	Total	**3120**

9.2 Civil works raw cost summary & reports

The Quantm system provides a much improved ability to analyse corridors and alternatives. To investigate rail corridors at a more detailed scale the Alignment Review Summary was used as a cost estimation tool to review the breakdown of construction quantities and costs. A number of consistent observations along the route where noted:

- Cut and Fill quantities provided a close balance within most sections.
- Mass Haul was not extensive in the context of the total comparative construction cost, indicating the system had minimised where possible excess cut and deficits of fill.
- There were very few, if any structures (bridge, tunnel and retaining wall) generated along the route, however this will change significantly when the impact of flooding is considered.
- Typically 70%-75% of construction cost was attributed to the linear cost which is the rail, sleepers and ballast. Due to this high cost penalty, the system tended to straighten out alignments where possible to minimise the route distance, which is also a desirable outcome for trip duration, crew shift considerations and fuel consumption.


Alignment Review Summary

Section_B1_01_02 Total: 215,000,000

Item	Quantity	Cost
Fill [m3]	2,280,000	9,130,000
Cut [m3]	2,410,000	8,150,000
Borrow [m3]	0	0
Dump [m3]	125,000	249,000
Paving [m3]	393,000	19,700,000
Mass Haul [m3 km]	17,000,000	13,600,000
Ret. Wall [m2]	0	0
Culvert [m]	0	0
Bridge [m]	90,073	0
Tunnel [m]	0	0
Footprint Area [m2]	3,350,000	0
Linear [m]	308,648	164,000,000

Warning...

(Fig 9. a) Alignment Review Summary Window.

In addition to the summary window, the system also has comprehensive reporting capabilities detailing location, geometrics, quantities and costs within user-defined intervals. In this study these were used to analyse the gradient along the route. The reporting functionality was also used to create a seamless composite route of the northern preferred corridor from each of the individual corridor sections.

Quantm Alignment Customised Report
Date: 02/07/07 17:55:50

Project: East-West Coal Line
Project ID: 941
Scenario: Section_B1_01
Alignment: Section_B1_01_02

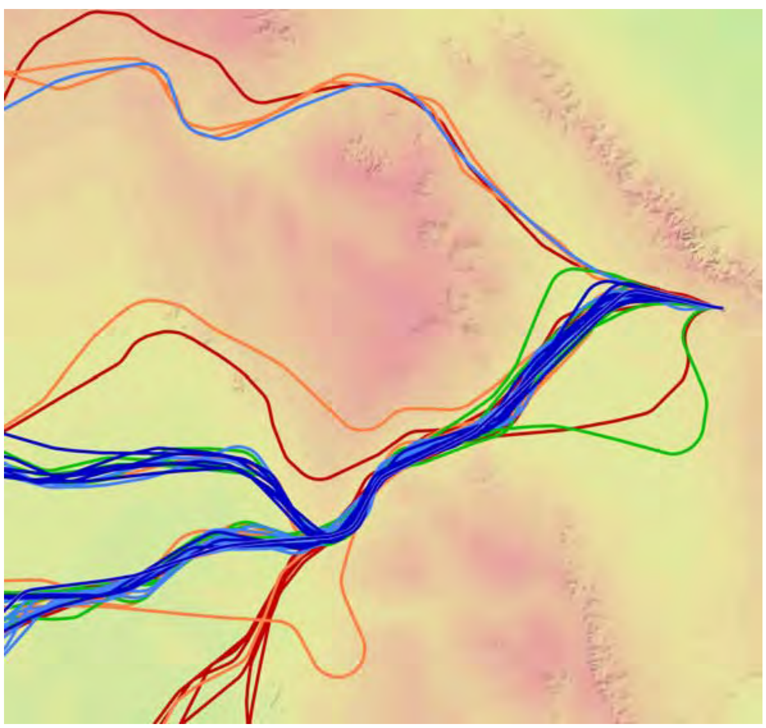
									Local quantities										
Dist 2D	Dist 3D	X	Y	R.E.	Land	R.E-Land	Bearing	Grade	H Radius	V Radius	Fill	Cut	Pavement	Mass Haul	Area	Wall	Culvert	Bridge
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(degrees	(%)	(m)	(m)	(m3)	(m3)	(m3)	(m3 km)	(m2)	(m2)	(m)	(m)
0	0	4232560	6754646	352.2	344.115	8.085	275	-0.31	-14365	581889	0	0	0	0	0	0	0	0
100	100	4232460	6754655	351.8984	344.075	7.824	275.3	-0.297	-14365	581889	15649	0	180	6820	3606	0	0	0
200	200	4232361	6754665	351.614	344.196	7.418	275.7	-0.28	-14365	581889	14518	0	180	8303	3477	0	0	0
300	300	4232261	6754675	351.3467	344.391	6.956	276.1	-0.263	-14365	581889	12954	0	180	9639	3292	0	0	0
400	400	4232162	6754686	351.0967	344.41	6.687	276.5	-0.246	-14365	581889	11813	0	180	10844	3152	0	0	0
500	500	4232063	6754698	350.8638	343.684	7.18	276.9	-0.229	-14365	581889	11915	0	180	12018	3169	0	0	0
600	600	4231963	6754711	350.6481	343.883	6.765	277.3	-0.211	-14365	581889	12525	0	180	13274	3241	0	0	0
700	700	4231864	6754724	350.4472	343.707	6.741	278	-0.198	-6624	837706	11583	0	180	14447	3124	0	0	0
800	800	4231765	6754739	350.2583	343.625	6.633	278.9	-0.186	-6624	837706	11623	0	180	15610	3128	0	0	0
900	900	4231667	6754756	350.0813	344.6	5.481	279.7	-0.174	-6624	837706	9659	0	180	16644	2864	0	0	0
1000	1000	4231568	6754774	349.9163	345.35	4.566	280.6	-0.162	-6624	837706	6444	0	180	17362	2387	0	0	0

(Fig 9. b) Alignment Report generated at 100m intervals.

9.3 Alignment sections: Plan, profile and cross sections

The Quantm system has an extensive reviewing capability that allows the operator to display the optimised rail alignment in plan, profile and dynamically in cross section. In this macro-level study these were predominantly used to identify low cost areas of the terrain and other patterns of alignments which can reveal much about potential corridors and the need to stick to certain locations and the freedom to deviate.

For example the figure below shows the rail alternatives clumping into two distinct corridors as they pass through the Great Dividing Range in Queensland. This strongly suggests that, from this particular start point, there are only two narrow passes available to negotiate the range at reasonable costs, however west of this there is more scope to deviate.

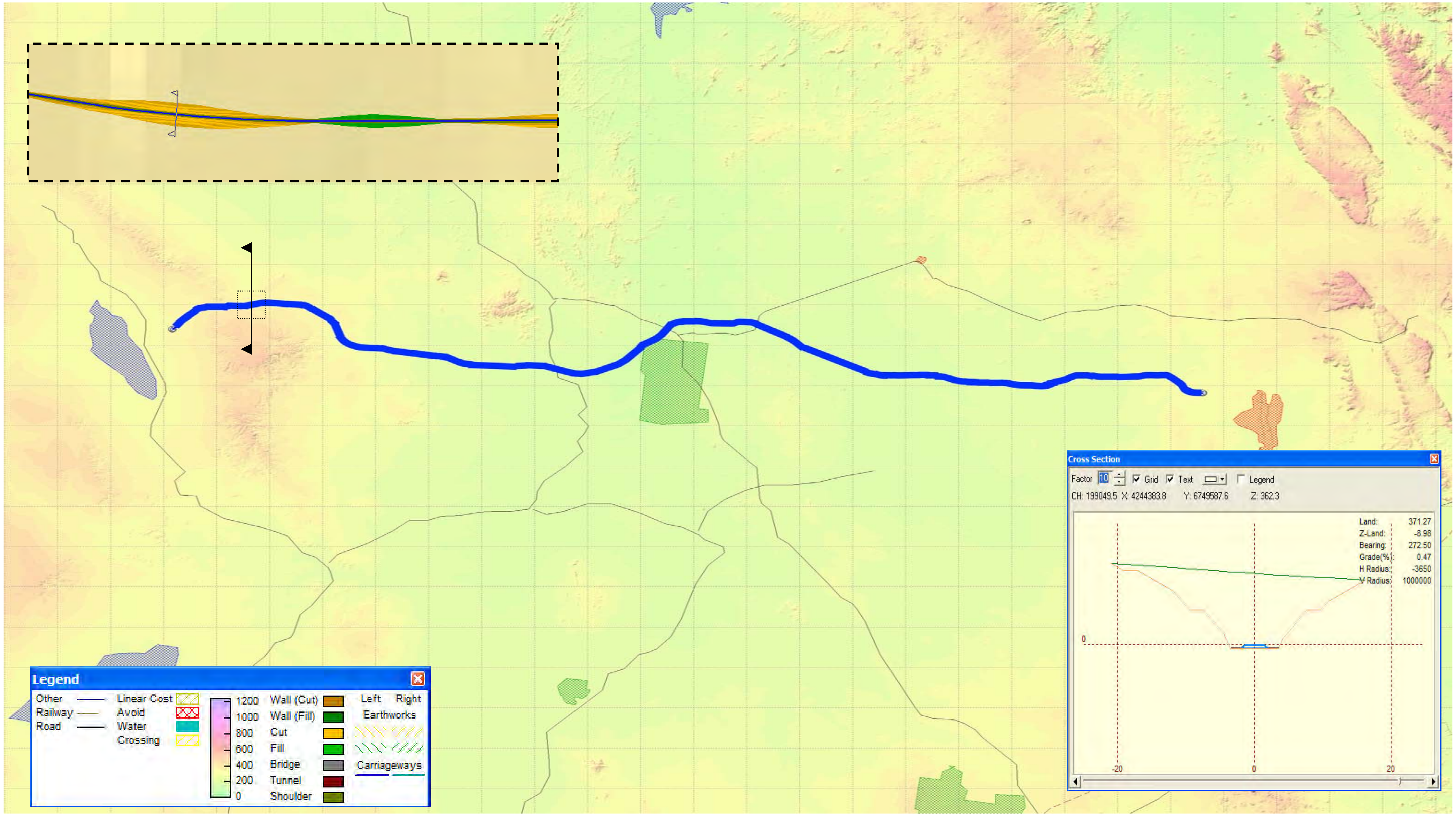


(Fig 9. c) Two corridors traversing different valleys in Section B.

In general rail routes converging into a narrow corridor indicates its importance in containing costs, whereas where routes fan out (such as across the deserts areas in Western Australia) indicates that cost is not an important driver in the alignment in plan and therefore provides more flexibility to satisfy other criteria with minimal impacts to costs.

Rail corridor cross sections were studied along the route using the Dynamic Cross Section tool. This allowed the altitude of the centreline to be viewed in relation to the natural surface and provided values of bearing, gradient, radius and horizontal curvature at any chainage along the route. During this study this information was mainly used to gain insight into where rail alternatives were approaching the maximum gradient when traversing difficult terrain, or tight corridor where the minimum radius was being approached.

Mass haul diagrams can also be generated within the Quantm System for each rail alternative showing the magnitude and direction of mass haul. This allows the rail engineer to gain insight into the dispersion of material throughout the alignment and determine where the balance points are. Figure 10.c shows a typically mass haul diagram generated from an alignment representing the northern corridor in section B. This could be used in future work to identify areas of surplus material or deficit of fill and therefore be used to designate areas for borrow and dump pits.



(Fig 10.d) Section A of the northern preferred corridor showing alignment in plan and dynamically in cross section.

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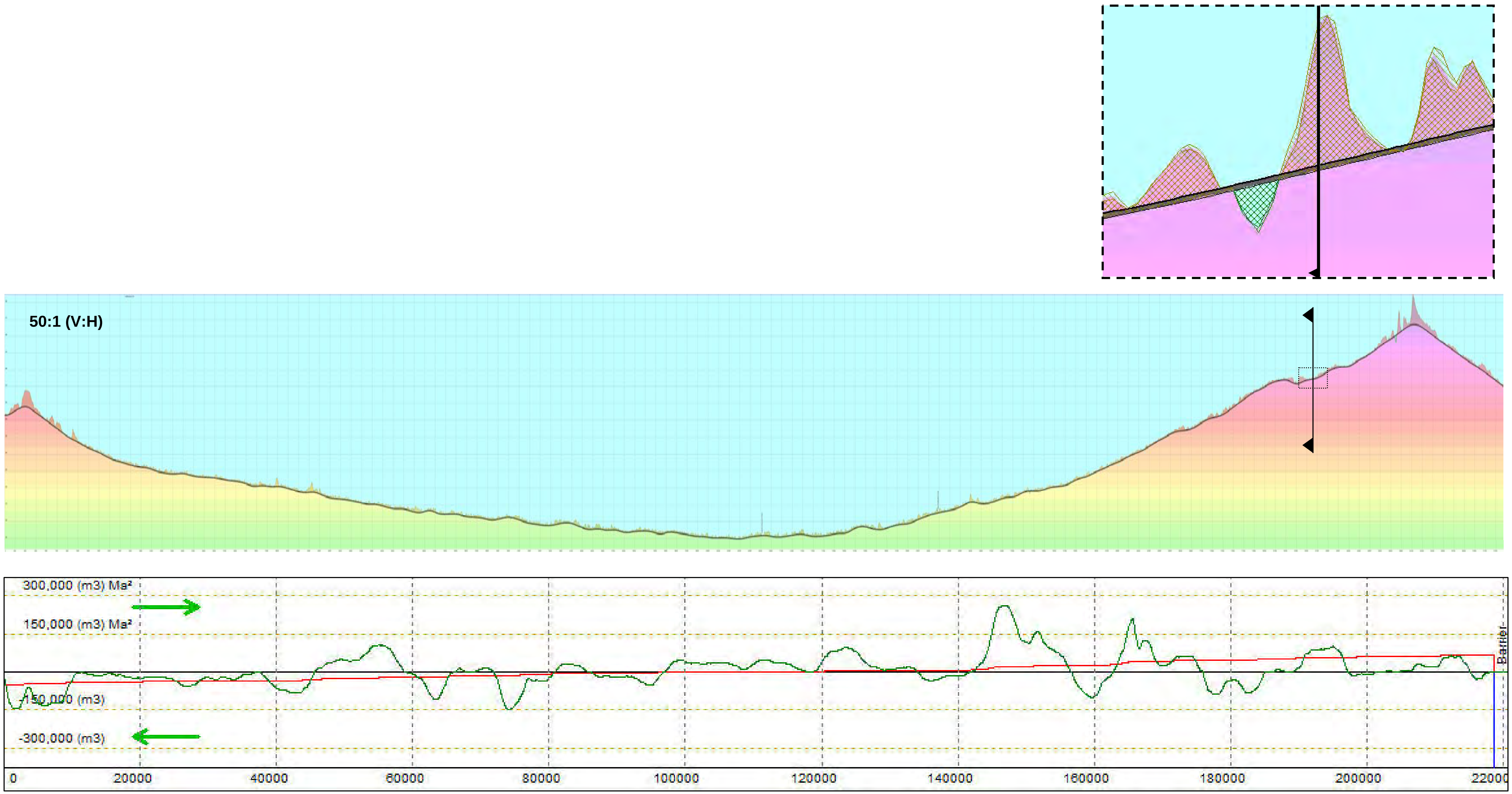

(Fig 10.e) Section B of the northern preferred corridor showing alignment in profile and mass haul movement underneath

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10.0 Conclusion

10.1 General Conclusions

The Quantm system has been used to demonstrate the engineering feasibility of the PIB rail project and had identified key to environmental, geological, mining and land-use constraints. The PIB provides for 3,120km of heavy standard gauge railway from Moranbah in Queensland to near Newman in Western Australia, at a maximum grade of 1:200 and a design speed of 80 km/hr.

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