1. Introduction

1.1 Study objective

In September 2007, Queensland Transport commissioned GHD to conduct a study to identify a route for a rail corridor (for freight traffic only) to connect the Port of Bundaberg [the Port] to the existing rail network via a spur off the North Coast line.

1.2 Purpose of this report

The Bundaberg Port Rail Link Study has identified a preferred corridor for a future rail link to the Port of Bundaberg.

This report documents the technical desktop study completed by GHD, and outlines a route for the rail corridor.

1.3 Background to this Study

1.3.1 Study area

In January 2005, GHD completed a desktop pre-feasibility study which considered a proposal for a possible future rail link to the Port of Bundaberg.

The pre-feasibility study identified four possible options for a corridor linking the North Coast line to the Port of Bundaberg. The study involved a desktop analysis and detailed evaluation of these options and recommended a preferred route.

The preferred route identified in the report extended from the North Coast Line north of the Burnett River to the Port of Bundaberg. The route identified provided the best outcome in terms of performance with minimum environmental impact. Performance in this context refers to the operational and engineering feasibility of the railway but also is a reflection on the corridor measured against the social, environmental and engineering criteria defined in the route selection process.

The outcome of the pre-feasibility study informed the area for investigation for this current study. That is, an area predominantly north of the Burnett River linking the North Coast Line to the Port of Bundaberg. A locality map of the area investigated is given at Figure 1.

1.3.2 Freight forecasts

To help develop the context of the study the project team completed an analysis of current demand for a rail link to the port (see Appendix H). This included review and analysis of known and potential commodity and freight sources that would potentially justify transfer by rail to the port over a 20 year horizon.

The study concluded that forecasts of a substantial increase in trade through the Port of Bundaberg are unlikely at this stage. The analysis found no new substantial freight sources.

Overall, the research identified that there is currently no demand to transport product to or from Bundaberg Port by rail. The need for a rail link to the port could not be economically justified until substantial rail-freight trades are identified.

It was therefore determined following completion of the corridor study that protection of the corridor within the local government planning scheme is not warranted at this stage.

Legend

- North Coast Line
- Port Land
- Major Road

1:120,000 (at A4)

0 1,000 2,000 3,000 4,000 5,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Locality Map

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Figure 1

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201 Charlotte Street Brisbane QLD 4000 **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com.au **W** www.ghd.com.au

Data source: NRW - DCDB, 2007. GA: Railway/2007. Created by: D Boitshoko

1.3.3 Terminus options

It was assumed that the railway spur will serve a balloon loop with a bulk material unloader and/or a hard stand area for handling freight. The balloon loop will be positioned on the north bank of the river to allow transfer to a shipping berth at the port.

There are a number of ways that freight and/or bulk product can be transported from a railway on the north side of the Burnett River to the port. The options for getting freight and/or commodities to a port berth are:

- A rail bridge across the Burnett River with a balloon loop positioned to serve to the existing south bank berth,
- A road bridge across the Burnett River to enable transport of goods from a north bank balloon loop to the existing south bank berth,
- A bulk material conveyor across the Burnett River to enable transport of bulk commodity from a north bank balloon loop to the existing south bank berth
- A new berth on the north bank served by a north bank balloon loop.

Options for crossing the river will be investigated if a need to construct the link is identified. For the purpose of this study, and for the future protection of a corridor link to the port, the balloon loop has been positioned to create a link to existing port land on the north bank of the Burnett River.

1.3.4 Requirements of the study corridor

The width of the corridor is to be sufficient for the future construction of a single track railway with maintenance and emergency access at formation level and provision for a second track. For this reason, a nominal corridor width of 50m has been used in all analysis and presentation of the corridor.

Design standards relevant to the development of corridor options include the QR Limited's *Civil Engineering Track Standards – Module 8 for New Construction*.

The following design parameters have been established for a possible future rail link:

- A moderate speed alignment (i.e. 80 km/hr desirable, 40 km/hr absolute minimum in constrained areas)
- Maximum grade 1 in 100 in both directions
- Structural Capacity for 300LA loading (AS5100)
- Consideration to be given to grade separated road crossings for any major roads.
- Minimise property impacts
- Minimise potential adverse environmental and social impacts
- Flood immunity for new railway construction and adequate hydraulic capacity suitable for a 100 year Average Recurrence Interval (ARI) event.
- QR Limited's *Standard Track Formation Corridor Widths* (sheet 5 of 6, drawing no. 2571)

- QR Limited's *Standard Clearances for Proposed Structures* (drawing no. 2461).

Given the freight analysis found there is no particular freight source for the possible future rail link, the spur junction will be designed to cater for traffic access to and egress from the North Coast Line in both directions.

This corridor study has also not included consideration of what, if any, upgrades would be required to the existing North Coast Line in the region to handle port generated rail traffic. These would be subject to the combination of growth in underlying North Coast Line rail traffic and specific port generated rail freight traffic.

2. Corridor Selection Process

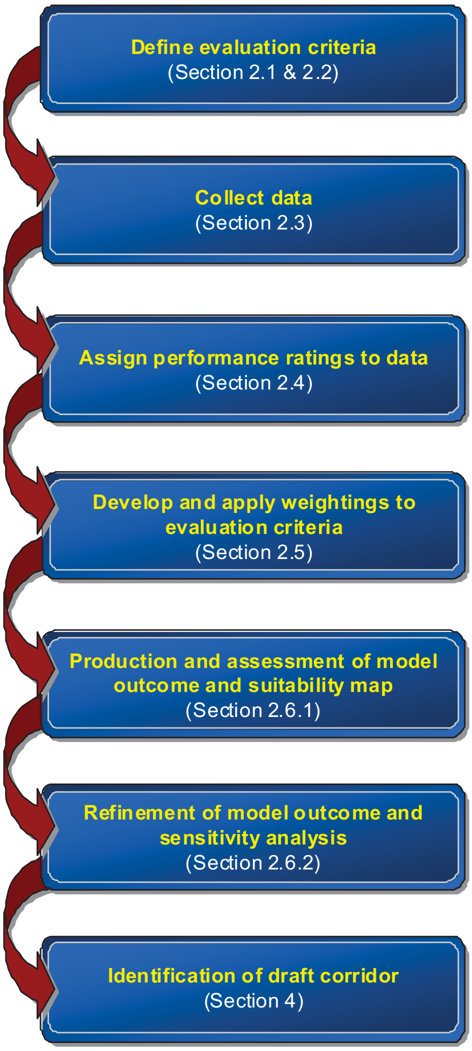
2.1 Overview

The corridor selection process identified a rail corridor linking the North Coast Line from a point north of the Burnett River to land owned by the Port of Bundaberg.

A multi criteria assessment framework was used to identify the rail corridor. This framework was used to identify, rank and weight the performance criteria that guided the corridor suitability modelling process. The multi criteria process adopted resulted in a balanced, transparent and traceable approach that considered environmental, social, physical and built environment criteria.

The rail corridor identified minimises possible potential impacts while optimising the operational performance of the potential future railway.

The flow chart below outlines the corridor selection process which is further explained in the sections below.



2.2 Multi criteria analysis

A multi criteria analysis is a process which makes quantitative (numerical) and qualitative (judgmental) analysis of each criteria considered, and combines these to achieve a balanced result.

The desktop multi-criteria analysis used for this study utilised various data based on environmental, social, physical and built environment criteria, to identify an alignment that is considered to be the optimal alignment based on the balance of issues considered.

The approach adopted for this study was to analyse the data in a spatial (or geographic) sense. A team of geospatial professionals collated the data, presented it in a spatial form (on maps) and then applied analysis techniques to combine the data to identify a corridor based on a modelling outcome. The modelling outcome was further refined to identify the rail corridor

2.3 Data sources

The following list details the data that were included in the corridor selection process, listed by criteria grouping.

Environmental values:

- Queensland Aquatic Habitat Areas;
  - Queensland Fish Habitat Areas (Department of Primary Industries)
  - Turtle Areas (Environmental Protection Agency)
- Regional Ecosystems (Environmental Protection Agency);
- RAMSAR Wetlands (Environmental Protection Agency);
- Directory of Important Wetlands (Environmental Protection Agency);
- Essential Habitat (Environmental Protection Agency);
- Protected Areas of Queensland – Estate (Environmental Protection Agency);
- Vegetation (Environmental Protection Agency);

Physical values:

- Potential Acid Sulfate Soils (Department of Natural Resources and Water);
- Slope derived from Contours (Department of Natural Resources and Water);
- Groundwater bore locations (Department of Natural Resources and Water);
- Flood inundation levels (GHD and Council website);
- Estuaries and water regions (Department of Natural Resources and Water);
- Soil Types (Department of Natural Resources and Water);
- Salinity Hazard (Department of Natural Resources and Water);
- Extractive Resource Areas (Department of Natural Resources and Water)
- Mining Tenure (Department of Natural Resources and Water)

Social values:

- Property Boundaries derived from DCDB (Department of Natural Resources and Water)
- Land Tenure derived from DCDB (Department of Natural Resources and Water);
- Lot Size derived from DCDB (Department of Natural Resources and Water)
- Good Quality Agricultural Land (Department of Natural Resources and Water)
- Queensland Heritage Register Boundaries (Environmental Protection Agency)

Built Environment values:

- Transport Infrastructure:
  - Road Network (Queensland Transport; DCDB);
- Utilities:
  - High Voltage powerlines (Ergon)
  - Water Pipelines (Sunwater)

Within each dataset (listed above) there may be a number of categories – which were discrete categorisations or continuous numerical models.

For instance, the ‘Remnant Vegetation’ dataset was represented as discrete categories. These included:

- Endangered vegetation
- Of Concern vegetation
- Not of concern vegetation
- Non-remnant vegetation
- Cleared vegetation

An example of a category represented as a continuous numerical model was the flooding dataset. Maps can be displayed showing flood depths (for a 1 in 100 year event) above natural surface. For the purpose of the corridor selection modelling, categories must be defined in order to assign performance criteria. Accordingly, flood depths were assigned to a category:

- Flood depth grater than 3m.
- Greater than 1 and less than 3m
- Less than 1m and greater than 0.5m
- Flood prone but less than 0.5m.
- Non Flood Prone Area.

2.4 Performance criteria

The modelling technique employed to identify a corridor requires each category in each dataset described in Section 2.3 is assigned a performance rating. This rating assigned represents the suitability of the area for a potential future rail link.

The ratings represent areas of constraint and opportunity for the rail corridor. These are given in Table 1:

Table 1 Performance rating descriptions

Rating	Description
Fatal flaw	Area completely unsuitable for further consideration
Highly Constrained	Area highly unsuitable for further consideration
Moderately Constrained	Area moderately unsuitable for further consideration
Absence of Constraints (Neutral)	Area that is neither a constraint or an opportunity
Highly suitable	Area completely suitable for further consideration

In developing the performance ratings for each category within each dataset, the following issues were considered:

- legislative requirements, for example, requirements to obtain permits to clear vegetation;
- environmental values and sensitivities and the need to protect ecosystems, species and wetlands;
- social values and sensitivities; and
- planned and existing transportation routes for co-location, safety and access considerations

For example, categories within the ‘Remnant Vegetation’ dataset were assigned the following categories:

Table 2 Example Ratings – Remnant Vegetation

Category	Rating
Endangered vegetation	Fatal flaw
Of Concern vegetation	Highly Constrained
Not of concern vegetation	Moderately Constrained
Non-remnant vegetation	Absence of Constraints (Neutral);
Cleared vegetation	Highly suitable

Again, categories in the ‘Flooding’ dataset were assigned the following categories:

Table 3 Example Ratings - Flooding

Category	Rating
Flood depth greater than 3m	Fatal flaw
Greater than 1 and less than 3m	Highly Constrained
Less than 1m and greater than 0.5m	Moderately Constrained
Flood prone but less than 0.5m	Absence of Constraints
Non Flood Prone Area	Highly suitable

The individual datasets, such as remnant vegetation or flooding, can be represented on a map that shows the areas categorised into each performance rating.

A summary of the ratings assigned to each dataset and category are provided at Appendix A.

Performance ratings for each of the criteria given in section 2.3 were developed by the project team and were presented spatially as individual 'constraints and opportunities' maps. These are also given in Appendix C.

The next stage of the corridor selection process is to collate the spatial data (maps) to form an overall 'constraints and opportunity' map.

2.5 Criteria weightings

In the modelling process, each dataset is assigned a weighting representing their relative importance in relation to all other criteria. For instance, certain environmental concerns may be considered more important than challenges presented by flood prone land. In order to reflect this in the modelling process, the ratings assigned to each dataset are weighted. Weighting each rating allows the performance ratings to be compared across all criteria.

The result is that, if only considering two inputs with the same ratings and all other factors are equal, the model will tend to select for an area that is contained within the lower weighting rather than an area with a higher weighting. Another perspective is that those datasets that are considered more important have more of an influence on the model outcome, according to their assigned weighting.

The weightings applied to each of the criteria in this process are detailed in Appendix B. The result of this process enables the production of an overall constraints and opportunities map which broadly represents areas relatively suitable for the proposed future rail link.

2.6 Modelling result

2.6.1 Suitability map

The suitability surface map is a spatial representation of the overall constraints and opportunities in the area investigated for a rail corridor. The map indicating areas of relative suitability is provided at Figure 2. The dark green areas are those which offer a ‘path of least resistance’ and are areas of greater stability.

Initial review of the suitability surface showed that there were only small pockets of highly constrained land and the ‘suitability’ of the land in most of the area investigated area was relatively high.

However, the overall level of constraint is relatively high at the north and north-eastern end of the route driven by a number of factors including physical, environmental and social aspects. These include among others:

- Existing wetlands;
- Aquatic areas (fish habitat and turtle breeding areas); and
- Potential acid sulfate soils.

Along the same lines, the south-eastern section of the study extent presents an area highly constrained due to the presence of

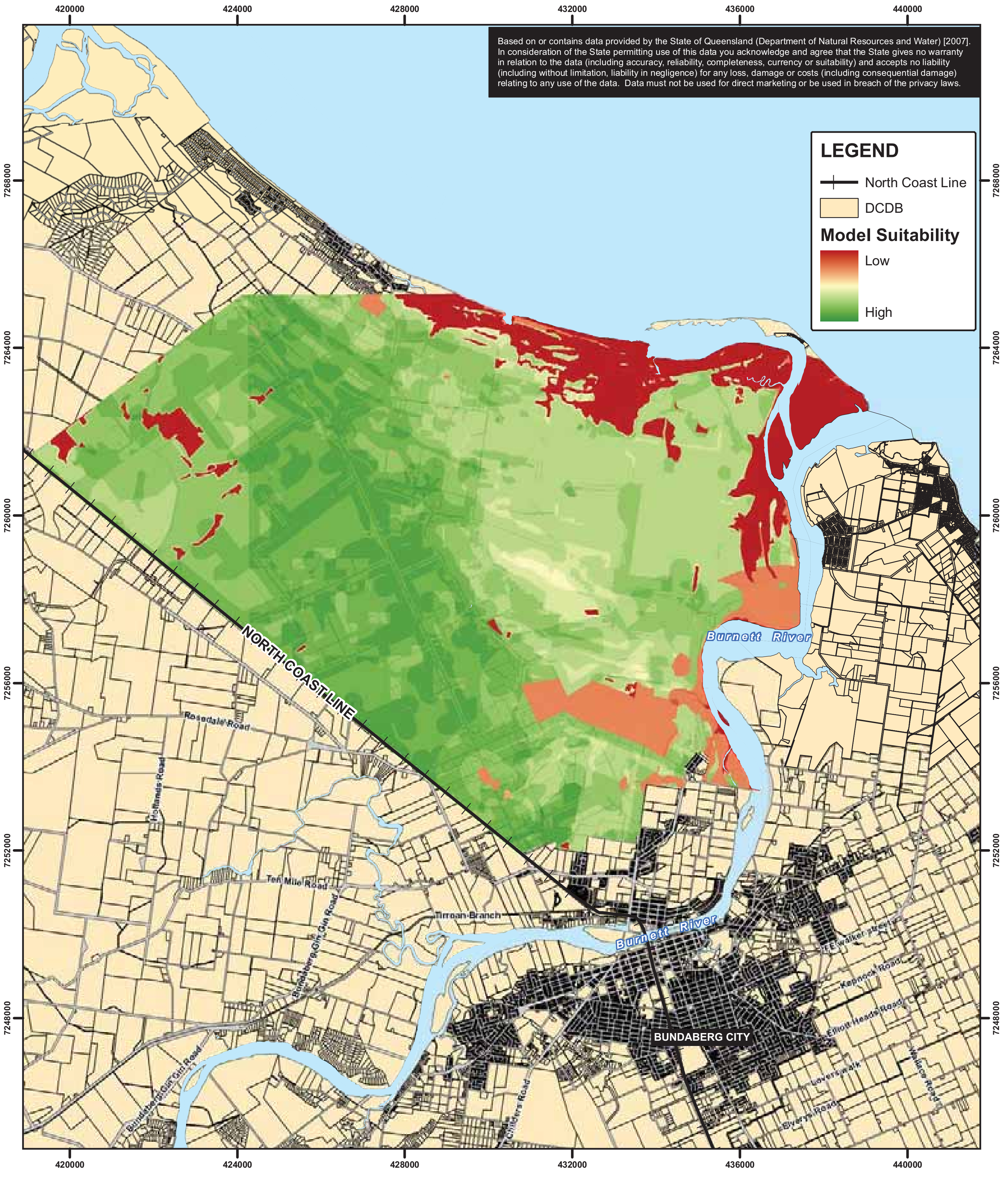
- Land zoned as hinterland residential; and
- Land identified as an extractive resource area (Bundaberg Clean Sands).

With the suitability surface defined, the corridor selection process seeks to find the shortest distance between the North Coast line and the Port whilst observing the constraints defined. For example, where the line is passing through ‘highly suitable’ areas that do not vary greatly then the model will use a straighter path to find the shortest distance. If, however, the model encounters less suitable areas then it will seek a route to avoid them which may not be the shortest distance. In this case, the high constraints detailed above are avoided in favour of a longer path. The outcome of this process is detailed below.

2.6.2 Preliminary model outcome

Accordingly, the modelling process established a 'path of least resistance' minimising the impact in the study area, in accordance with the modelling inputs. This model route, shown in Figure 3 was an important starting point for developing a corridor for further refinement.

Further analysis was completed on the draft model outcome to minimise the impact of any potential rail corridor on property, seeking to impact the least number of lots and avoid severance of access to existing roads where possible by utilising property boundaries. This was particularly important at the eastern and western extremities of the study corridor, where the lots included residential development.



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0 1 2 3 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Suitability Map

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Revision	D
Date	15 Oct 2008

Figure 2

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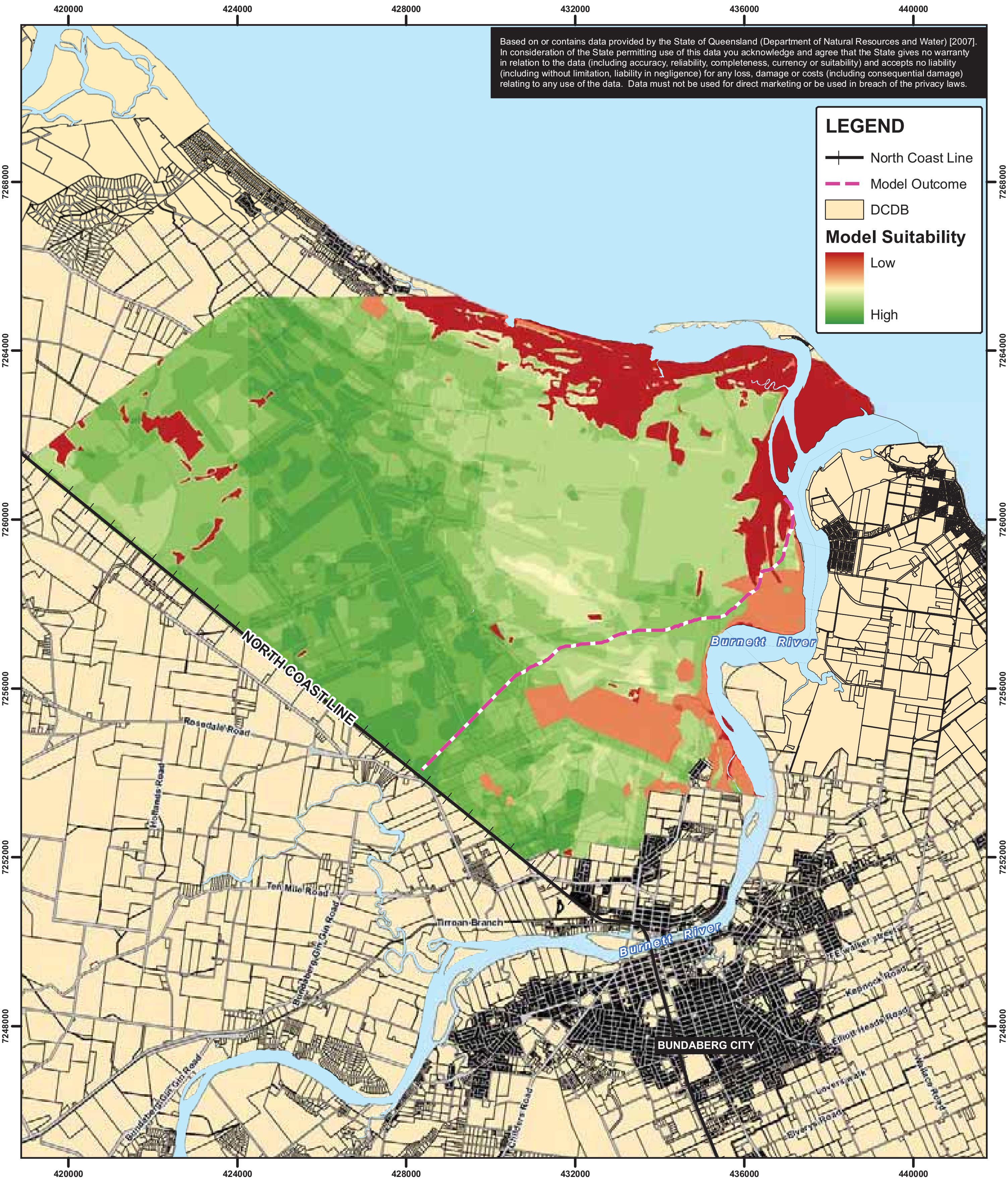
Data source: NRW - DCDB, 2007, GHD - Cost Surface/2007, GA - Railway/2007. Created by: DBoitshoko



1:120,000 (at A4)

0 1 2 3 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Bundaberg Port Rail Link Study

Suitability Map
and Model Outcome

Job Number	41-19291
Revision	D
Date	15 Oct 2008

Figure 3

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201 Charlotte Street Brisbane QLD 4000 T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com.au W www.ghd.com.au

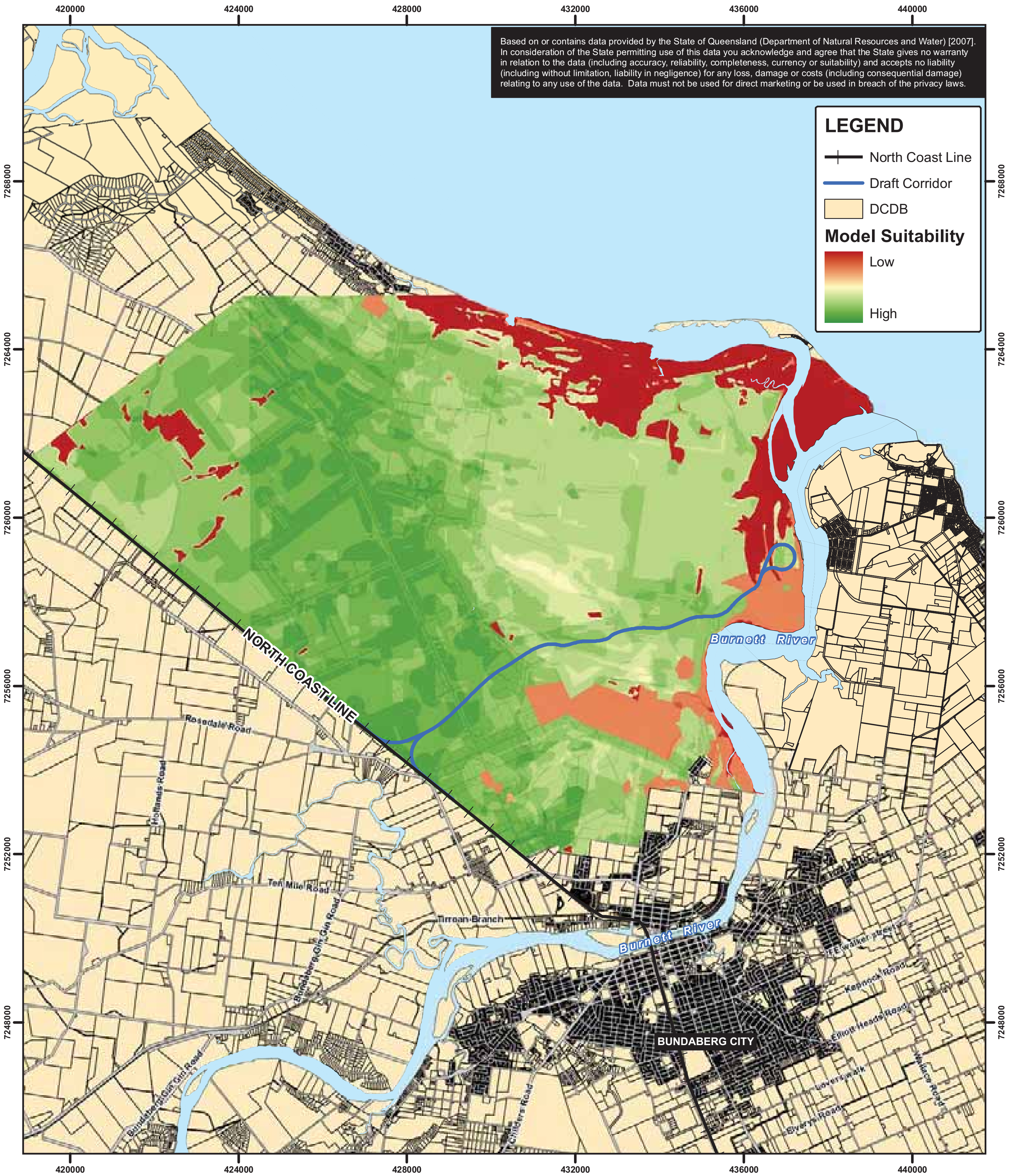
Data source: NRW - DCDB, 2007, GHD - Cost Surface/2007, GA - Railway/2007. Created by: DBoitshoko

2.6.3 Corridor selection outcome

Given deviations from the initial model outcome yielded a negligible loss of performance or increase in impact, it was therefore possible and appropriate to tailor the model outcome to seek optimised (least) impact on properties.

The outcome of this refinement process was the corridor alignment presented in Figure 4. This model outcome was then used as the basis for the preparation of an alignment that conformed to a considered engineering approach.

Figure 5 details the rail corridor following the completion of the engineering concept design described in section 4.



1:120,000 (at A4)

0 1 2 3 4

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Suitability Map and Draft Corridor

Job Number	41-19291
Revision	D
Date	15 Oct 2008

Figure 4

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201 Charlotte Street Brisbane QLD 4000 T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com.au W www.ghd.com.au

Data source: NRW - DCDB, 2007, GHD - Cost Surface/2007, GA - Railway/2007. Created by: DBoitshoko

Burnett River
River Road
Fairymead Road
Tantitha Road
Gooburrum Road
Moore Park Road
Pashleys Road
Hoods Road
North Coast Line
Patersons Road
426,000
428,000
430,000
432,000
434,000
436,000