Jemena Northern Gas Pipeline Pty Ltd

Northern Gas Pipeline

Draft Environmental Impact Statement

CHAPTER 7 - WATER

Public

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7. WATER

This chapter describes the surface and groundwater features that characterise the existing environment within and surrounding the NGP Project footprint, and assesses the potential impacts to water from Project activities. Risks associated with potential impacts to water are analysed and evaluated using the environmental risk assessment process described in Chapter 5 of this EIS. The controls are described that will minimise potential impacts on water and reduce residual risk to As Low As Reasonably Practicable (ALARP).

The purpose of this chapter is to demonstrate that Jemena has fully considered all risks to water and has effective management strategies in place to ensure that the control of these risks is properly addressed through each Project phase. The content of this chapter was developed specifically to address Section 5.5 of the Terms of Reference (ToR) for the preparation of an EIS for the Jemena NGP. Other water risks identified through the NGP environmental risk assessment process are also discussed.

The information presented in this chapter is informed by the technical content from the Watercourse Crossing Survey Report (Appendix K), Water Availability Study (Appendix N) and background research provided in Section 7.2 of this chapter. Other management plans are also referenced for specific controls where relevant to reducing water impacts.

The abbreviations, acronyms and terminology used throughout this chapter are defined in the Contents, Acronyms and Glossary component of this EIS.

7.1 TERMS OF REFERENCE

Section 5.5.2 of the EIS ToR requires identification and assessment of the following water-related risks:

- Impacts to existing surface and groundwater quality and quantity as a result of the Project, with specific reference to the Project components, including chemical and fuel storage on site, hydrostatic testing and gas processing
- potential uncontrolled release or passive discharge of contaminants, such as hydrocarbons, to surface and/or groundwater resources as a result of the Project components, including wash bays (if required)
- potential impacts to adjacent areas and vegetation, including surface watercourses, from the drawdown of groundwater, including the volume of groundwater expected to be intercepted and/or extracted during the Project
- disturbance of soils altering the hydrology and rates of erosion and sedimentation of watercourses
- any additional impacts to surface and/or groundwater resulting from changes to the Project.

Section 5.5.1 of the EIS ToR states the following environmental objectives relevant to water resource protection:

- ensure surface water and groundwater resources are protected both now and in the future, such that the ecological health and land uses, and the health, welfare and amenity of people are maintained.

- ensure available water supplies will be sufficient to fulfil the Project needs over the predicted life of Project, without causing environmental or social impacts.

7.2 EXISTING ENVIRONMENT

7.2.1 CLIMATE

The Project crosses two major climate classes: the summer dominant class of northern Australian and the arid class of the interior of Australia (as defined by BoM 2005 and see Figure 7-1). The summer dominant class of northern Australia is characterised by summer rainfall with a marked wet summer and dry winter, and the arid class of central Australia is generally drier with low rainfall. Tennant Creek is within the arid class while Mount Isa is within the summer dominant class, but both are within the 'hot dry summer, mild winter' climate zone, and the rainfall is summer dominant with occasional winter rain (Duguid et al. 2005). Evapo-transpiration is high, with annual averages far exceeding annual rainfall.

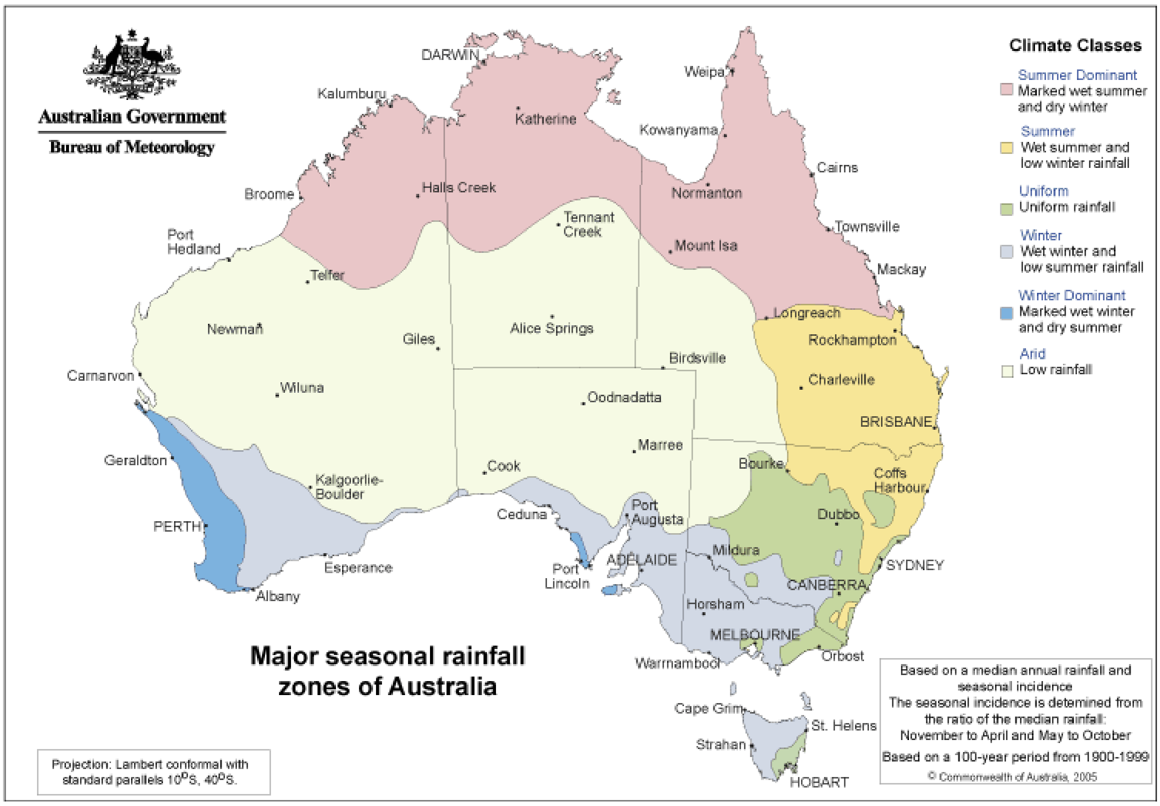


Figure 7-1. Climate zones in Australia; note Tennant Creek and Mount Isa locations

Note that although average climate data indicates a distinct seasonal pattern of rainfall, there is high variability in annual rainfall in the region (see Figure 7-2). The annual average rainfall in Mount Isa is highly variable, ranging from an minimum of 93 mm, recorded in 2013, to a maximum of 1,092 mm, recorded in 2011 (Mount Isa Water Board 2015). Despite the variation in volumes, the majority of rainfall (approximately 75 per cent) falls between December and March of each year.

The climate and arid zone divisions align with the surface water characteristics of the various regions traversed by the Project. In general, a number of small, disconnected and ephemeral drainage lines are located near the Tennant Creek end, while larger braided intermittent rivers are located near the Mount Isa end and in the eastern portion of the Northern Territory. There are very few drainage lines or surface water

features in the central section of the alignment (from approximately KP 100 to KP 375) where the alignment crosses the arid zones and grasslands of the Davenport Murchison Ranges and Tanami bioregions. The seasonality and volume of rainfall heavily influence the surface water flows and watercourse characteristics in the region. The majority of watercourses flowing only after rainfall, and the climate can be dry for a number of years immediately followed by a period of significant rainfall and flooding. Temperatures follow the seasonal patterns typical of northern Australia wet and dry seasons (see Figure 7-2), with the hottest average daily maximums occurring in December and January.

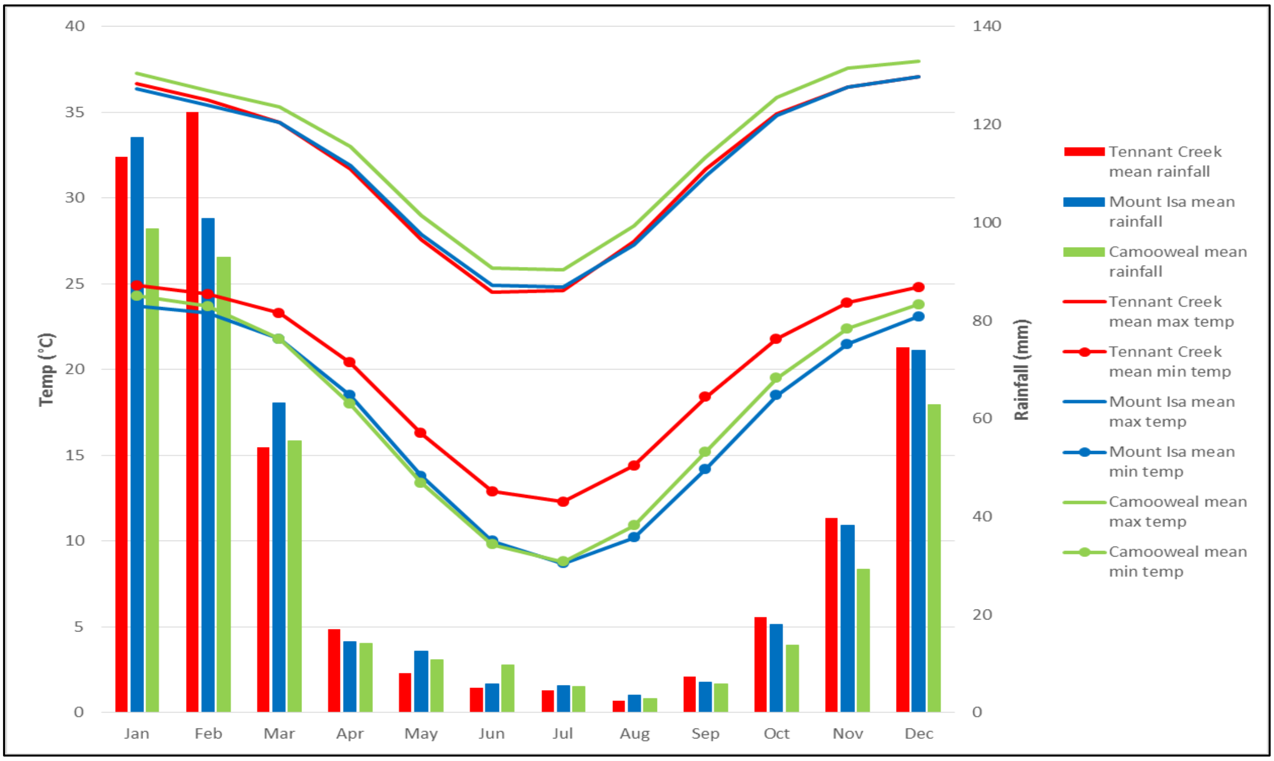


Figure 7-2. Average monthly rainfall and maximum and minimum temperatures recorded at Tennant Creek, Camooweal and Mount Isa (data sourced from BOM 2016a)

7.2.2 GEOLOGY AND SOILS

A hydrogeologist was contracted to undertake a review of the Project area and proposed works, and provide information on the hydrogeological context of the region outlined in this section, Section 7.2.4 and Section 7.2.5.

A geological region is a two-dimensional representation of the surface geology of the geological provinces of the Northern Territory (Ahmad & Munson 2013). A geological province is a body of rock with distinct geological characteristics and ages. The geological regions in which the construction footprint is located were determined from the Geological Regions of Australia 1:5,000,000 (Geoscience Australia 1998).

The Project is located within three geological regions, as shown in Figure 7-3. More detailed geological units are displayed in Figure 7-4.

Tennant Creek Region

The westernmost section of the Project area (KP 0-44.5) of the proposed pipeline route traverses Palaeoproterozoic rocks of the Warramunga Province (formerly known as the Tennant Creek Block or inlier). These broadly comprise of metamorphosed tuffaceous sandstones, siltstone and shale in addition

to granite and extrusive volcanics. A thin drape of Cainozoic sedimentary deposits overlie the Warramunga Province rocks where they are not exposed at the surface, these include silcrete and ferricrete duricrusts, colluvial and alluvial deposits, and aeolian sand dunes. The Warramunga Province forms a north-south aligned ridge separating the Cambrian Wiso and Georgina basins. The Proterozoic rocks extend to the east and form a basement to the overlying Georgina Basin sequence.

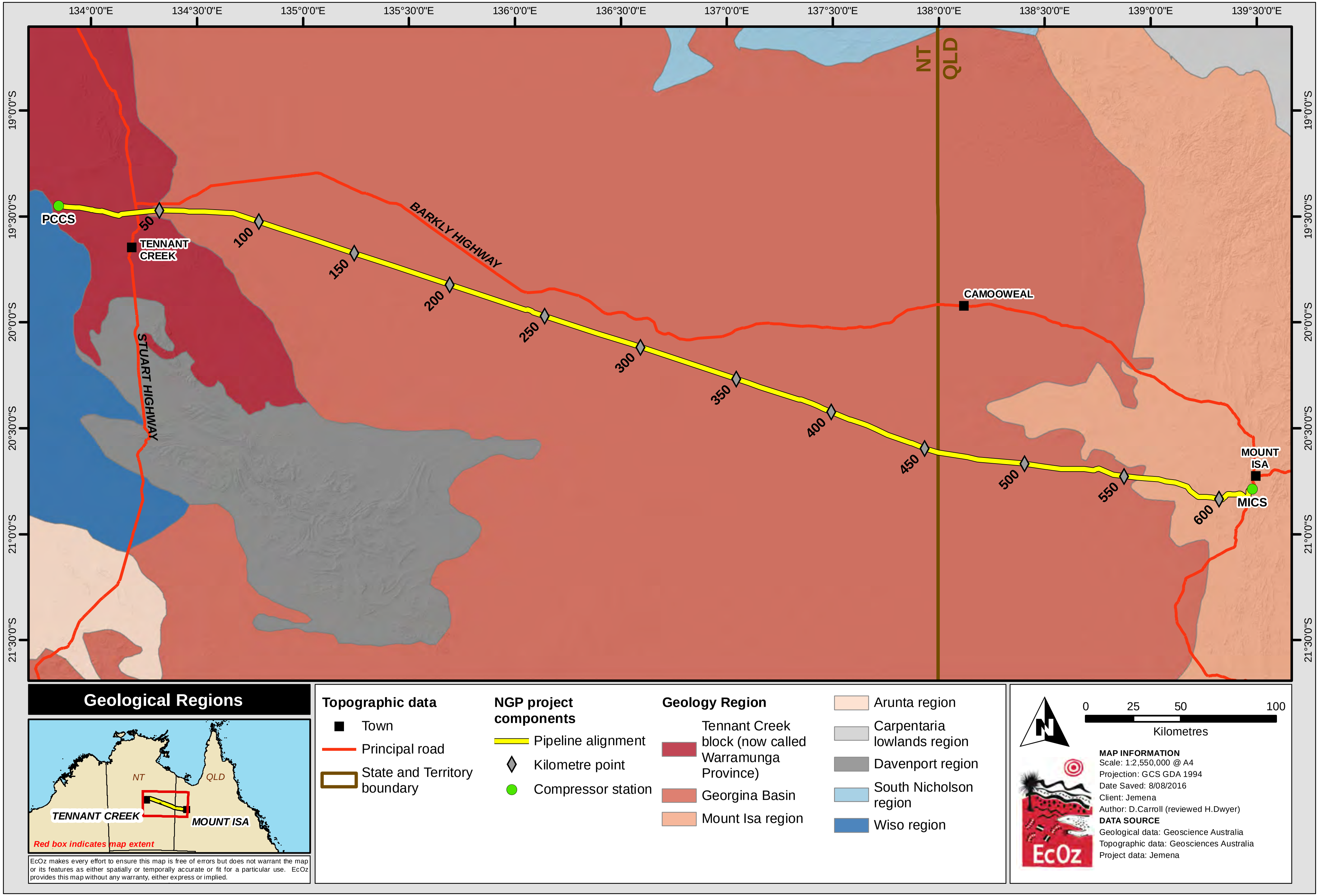
Georgina Basin

The central section of the pipeline alignment (KP 75-556) overlies the Georgina Basin, a regional sedimentary basin that covers over 330,000 km2 in the Northern Territory (Kruse et al. 2013). It extends beyond the Sandover Highway in the south and in the west is bounded by basement rocks of the Warrammunga and Tomkinson Provinces, which roughly align with the Stuart Highway. The basin extends into Queensland terminating just west of Mount Isa and in the north grades into the Daly Basin at Mataranka. Along the proposed pipeline alignment the central Georgina Basin is divided by the Wonarah basement high into the Barkly Sub-basin in the west and the Undilla Sub-basin in the Northern Territory/Queensland border region. The Georgina Basin sequence thins at the edge of the basin near Tennant Creek in the west, toward Mount Isa in the east and also over the Wonarah Basement High. Outside these areas a combined formation thickness of several hundred metres can be expected.

The generalised stratigraphy in the central Georgina Basin comprises a basal sequence of volcanics (Helen Springs Volcanics), which reach a recorded maximum thickness of around 150 m (Glass et al. 2013) and an overlying carbonate succession (Barkly Group). The Barkly Group consists of the Gum Ridge, Top Springs Limestone and Anthony Lagoon Beds in the Barkly Sub-basin and the Woonarah Formation, Ranken Limestone and Camooweal Dolostone in the Undilla Sub-basin. These formations comprise variously of limestone, dolomite, dolostone, siltstone, chert and sandstone. Disconnected outcrops of Gum Ridge and Woonarah Formation occur around the pipeline alignment in the west and central Georgina Basin respectively. Small surface exposures of the Camooweal Dolomite are recorded in the vicinity of the Ranken River and in the eastern Georgina Basin in Queensland. Elsewhere the Barkly Group is capped by a thin veneer of more recent Cainozoic formations. These include sand plains and alluvial deposits in the west of the Georgina Basin, sand dunes in the central basin and black soil plains around the Northern Territory/Queensland border. Surface exposures of the Austral Downs Limestone are also recorded along drainage lines in the border region.

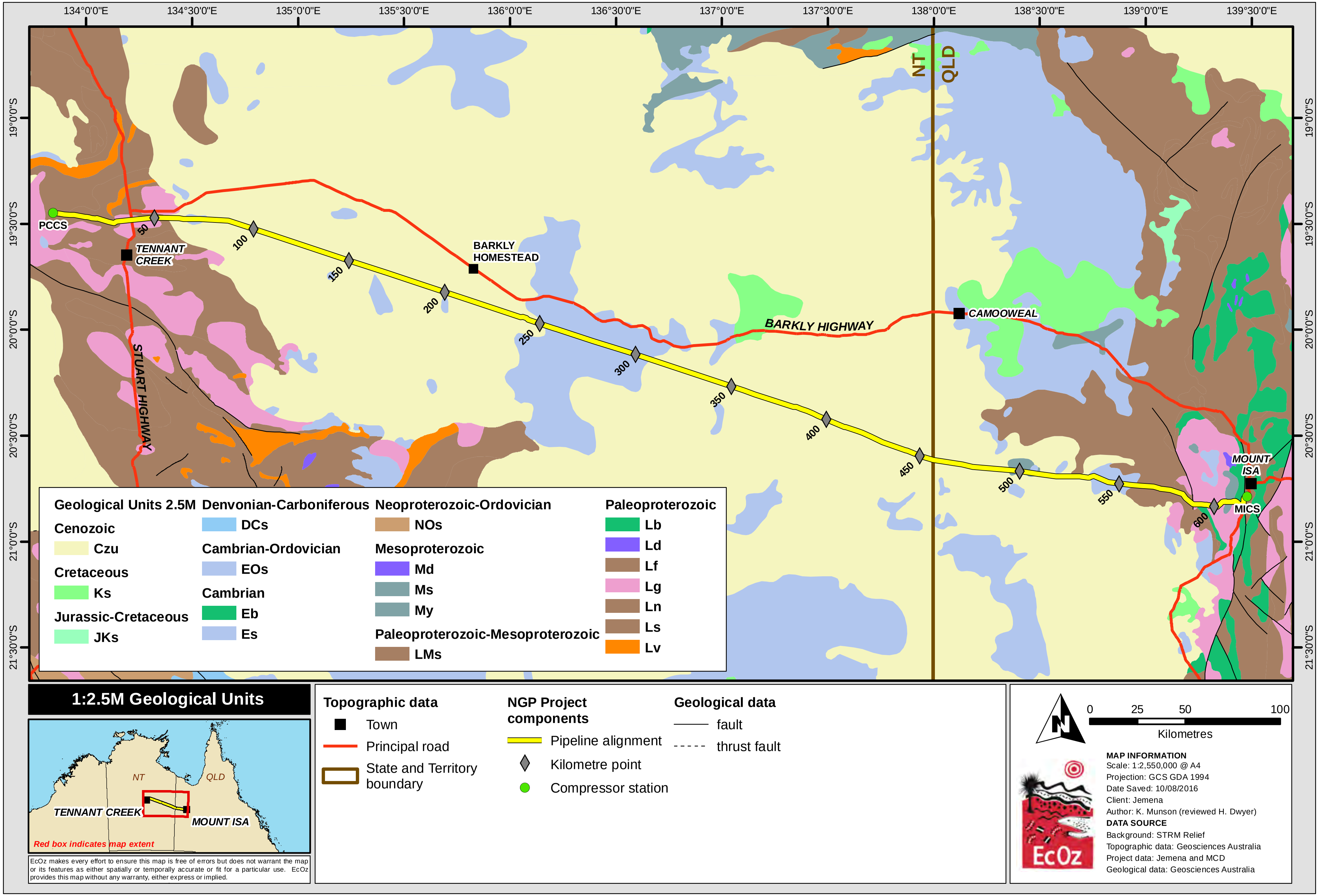
Mount Isa Region

The easternmost 65 km (KP 556-622) of the pipeline route overlies the Mount Isa Inlier, a suite of Proterozoic formations that have undergone extensive deformation (i.e. folding and faulting). The Mount Isa Inlier generally comprises metamorphosed sedimentary formations, dolomitised carbonates, volcanics and granite intrusions. For the purpose of this report no attempt has been made to distinguish individual formations and the basement rocks are referred to as undifferentiated Proterozoic rocks of the Mount Isa Inlier. Outcropping basement rocks are interspersed by Cainozoic sedimentary deposits, which include residual soils and alluvium.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-3. Map of the geological regions along the NGP construction footprint.mxd

Figure 7-3. Map of the geological regions along the construction footprint



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-4. Map of the geological regions along the NGP construction footprint.mxd

Figure 7-4. Map of the geological units along the construction footprint

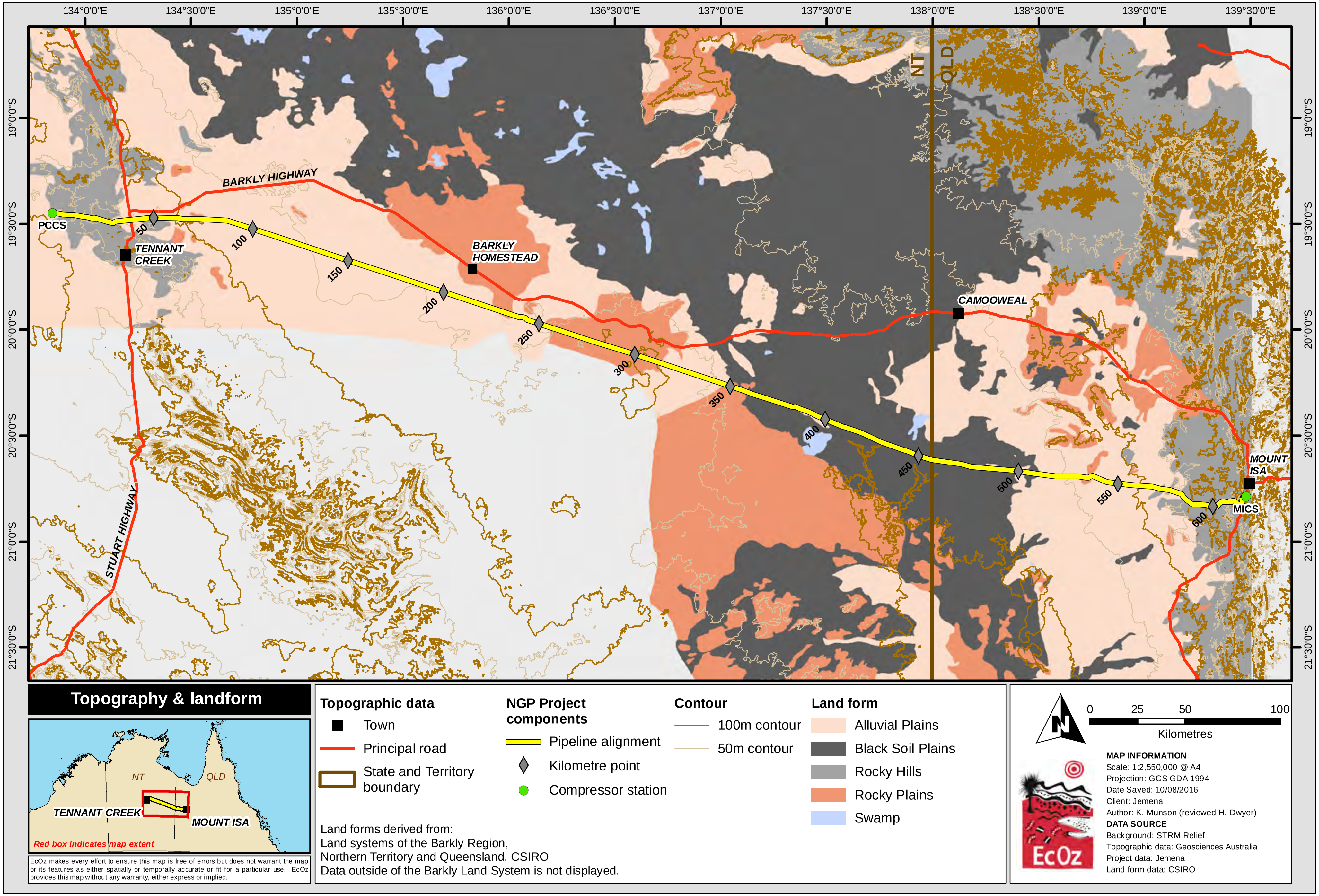
Topography and landform

Based on the Northern Territory 50 m contour intervals and Queensland 5 m contour intervals, the majority of the terrain through which the Project passes has gradual and small changes in elevation (see Figure 7-5). There are two sections of rocky hills which have a steeper gradient; near Tennant Creek and near Mount Isa.

A land system is “an area, or group of areas, throughout which there is a recurring pattern of topography, soils and vegetation” (Christian and Stewart 1953). Land systems can be combined to form land forms based on classification of geophysical properties. Land form allows the area through which the construction footprint passes to be described in terms of the substrate and topography. Generally, there are six land forms identified within and surrounding the Project: alluvial plains, black soil plains, rocky hills, rocky plains and swamp (CSIRO 2016). The location and description of the land forms along the construction ROW are summarised in Table 7-1 and shown in Figure 7-5.

Table 7-1. Land form description of area along the construction ROW

Location (KP)	Land form	Description
0 – 53	Rocky hills	Rocky hills land form which comprises flat-topped but often steep-sided hills and ranges on sandstones, siltstones, and shales. Many rock outcrops, some gently sloping areas and valleys.
53 – 352	Alluvial plains and rocky plains	Area is comprised of alluvial and rocky plains. The area experiences little elevation change and a generally flat slope, although there is a significant rise and fall in elevation immediately at the end of this section prior to change in land form.
352 – 518	Black soil plains	‘Channel country’; a large and low-lying floodplain with numerous braided streams and underlying deep grey and brown cracking clays.
518 – 584	Rocky plains	Gently undulating plains with occasional drainage depression. The area is characterised by generally gentle slopes of < 2%.
584 – 622	Rocky hills	The start of the Mount Isa Inlier Bioregion, an area of rockier and steeper terrain. Outcrops may have a steep gradient but adjacent land may be relatively flat.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-5. Map of the topography and landform along the construction ROW.mxd

Figure 7-5. Map of the topography and landform along the construction ROW

Soils

Broad soil mapping is available for the construction ROW from the Atlas of Australian Soils, as published by CSIRO (McKenzie and Hook 1992). This allows soils to be described according to the Australian Soil Classification soil orders. These were used to inform the ground-truthed mapping of the soil landscapes within the pipeline alignment, which was undertaken by a soil scientist during preliminary geotechnical investigations (Appendix L). Eight soil landscapes were mapped and described according to soil types, landform, and erosion risk.

The data is summarised in Table 7-2 and displayed in Figure 7-6. Note that soil landscape mapping has currently only occurred within the pipeline alignment and as such the soil landscape points are displayed over the existing landforms. It is evident from Figure 7-6 that the ground-truthed soil landscapes align approximately with the landforms.

The mapping of soil landscapes provides the basis for more detailed soil investigations to assess for erosion risk. The detailed soil investigations will be completed prior to construction and will inform the Erosion and Sediment Control Plans (ESCP) for the Project. Testing will be undertaken in accordance with the IECA (International Erosion Control Association) Guidelines for Erosion and Sediment Control ("IECA Guidelines", see IECA 2008). At least one soil sample will be obtained from each soil landscape and soils will be analysed for physical and chemical properties relevant to erodibility and structural stability.

Table 7-2. Soil landscapes as ground-truthed along the construction ROW

Soil landscape code	Relevant KP	Soil landscape summary	Erosion risk*
A	0 – 8	Red brown sandy clays and silty sands, with some gravel. Generally flat landform. Source geology is sand plain deposits flanking a north-west to south-east trending ridge of folded and faulted sedimentary greywacke, sandstone, siltstone and shale.	Low to moderate erosion risk based on gradient, vegetation cover and monthly erosivity, although clays may be dispersive. No existing erosion observed.
B	8 – 66	Red brown fine to coarse gravelly sand, and silty sand, with localised gravel. Depths range but soils are generally shallow and underlain by sedimentary limestone, siltstone, shale and sandstone. The landform is generally flat with undulating hills and ridges throughout. Source geology is sand plain deposits flanking a north-west to south-east trending ridge of folded and faulted sedimentary greywacke, sandstone, siltstone and shale.	
C	66 – 212	Red brown to light brown silty sand and silty clay with some gravelly sections. Landform is generally flat, with grasses and sparse to medium density tree cover. Source geology is sand plain deposits with some outcrops of limestone, chert and breccia.	
D	212 – 350	Red brown gravelly and silty sand soils with varying depths. Underlying rock is high strength silcrete, calcrete and conglomerate (as observed in outcrops). Landform is generally level to undulating ground with some rocky outcrops. Source geology is sand plain deposits with sand dunes, calcrete and outcrops of certified	Low to moderate erosion risk based on gradient, vegetation cover and monthly erosivity. Risk increases with increasing slope. Note that sinkholes may be present

Soil landscape code	Relevant KP	Soil landscape summary	Erosion risk*
		limestone, mudstone and dolostone. A sinkhole was observed during aerial surveys over this soil landscape.	in this soil landscape. No existing erosion observed.
E	350 – 500	Light grey brown to red brown silty clay soils with some local sandy patches and localised gravel. This landscape is the 'black soil plains' and the landform is a large floodplain of low relief. Source geology is chertified limestone and mudstone, with some areas of dolostone,	Low to moderate based on gradient, vegetation cover and monthly erosivity. Clay soils may be dispersive, and erosion was noted along the sides of river and watercourses.
F	500 – 563	Brown silty sands and clay soils. The landform is generally flat foothills with some gullies and creeks. Soils are anticipated to be relatively deep (< 1m). Source geology is characterised by alluvium and sheet wash deposits.	Moderate erosion risk based on silty and clay soils with frequent watercourses and varying slopes. Numerous washouts and erosion gullies were observed near watercourses.
G	563 – 612	Shallow silty sands over hard clay and low strength gravel and shale. The landform is generally undulating hills, with numerous creeks and gullies. Source geology is variable with folded and faulted sedimentary rocks interbedded and intruded by igneous strata.	Moderate erosion risk based on silty soils, slope and frequent watercourses. Vegetation is sparse in some areas, reducing ground cover. Clays at depth may be dispersive. No existing erosion was observed.
H	612 – 621	Shallow gravelly sand and gravel soils over shallow sedimentary siltstones and sandstones. The landform is rocky and gravelly hills of varying slope with depressions between crests. Depressions usually contain watercourses. Source geology is variable with folded and faulted sedimentary rocks interbedded and intruded by igneous strata	Moderate to high erosion risk based on slope. Low vegetation cover and frequent watercourses. Gully erosion was observed in the some depressions and along watercourses.

**Erosion risks are indicative based on slope, vegetation cover and monthly erosivity factors as per Appendix P of the IECA Guidelines (IECA 2008), noting that dispersion potential has not yet been assessed. Dispersion potential and soil structure will be investigated in future, pre-construction geotechnical studies and results incorporated into the ESCP. Preliminary geotechnical studies noted existing erosion within the construction ROW.*

Acid sulfate soils

Acid sulfate soils are soils or sediments that contain high levels of reduced inorganic sulfur (usually sulfides) which, when disturbed and exposed to oxygen, have the potential to oxidise and produce acid. Electronic mapping at 1:2,000,000 (Fitzpatrick et al. 2011) shows there is generally a low probability of acid sulfate soils (ASS) occurring within the Project area. There are some localised areas where there is a 'high probability of occurrence' of ASS. These areas are associated with inland lakes, watercourses, wetlands and riparian zones. The confidence associated with the data set is generally low, as probability of

occurrence of ASS within the construction footprint has been inferred from surrogate data without ground verification (CSIRO 2010).

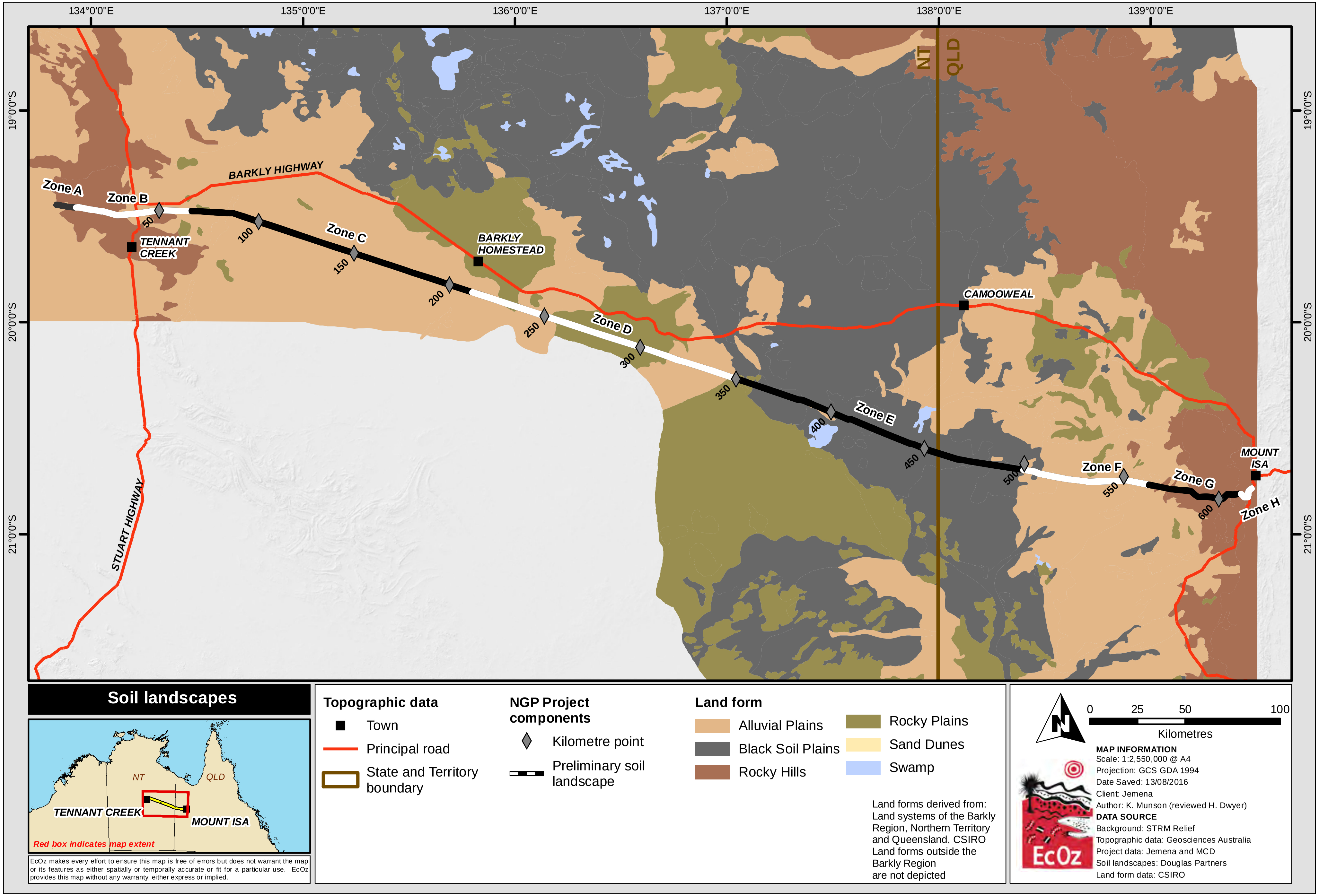
The location of the areas with a high or medium probability of occurrence as shown on the electronic mapping is shown in Table 7-3 and Figure 7-7.

Table 7-3. Areas of potential ASS

Location (KP)	Probability of ASS	Confidence	Area within 1 km corridor (km^2)	Notes*
383	High	Low	0.09	Watercourse running perpendicular to construction ROW.
486	High	Low	0.05	Edge of swamp area to the south of the construction ROW. Area will be avoided by construction ROW.
616 – 622	Medium	Low	5.82	Land adjacent to watercourse in an area of mapped sodosol soil.
601 – 610	Medium	Low	9.98	Area is in an area of sodosol soil; no major watercourses are associated with the area.

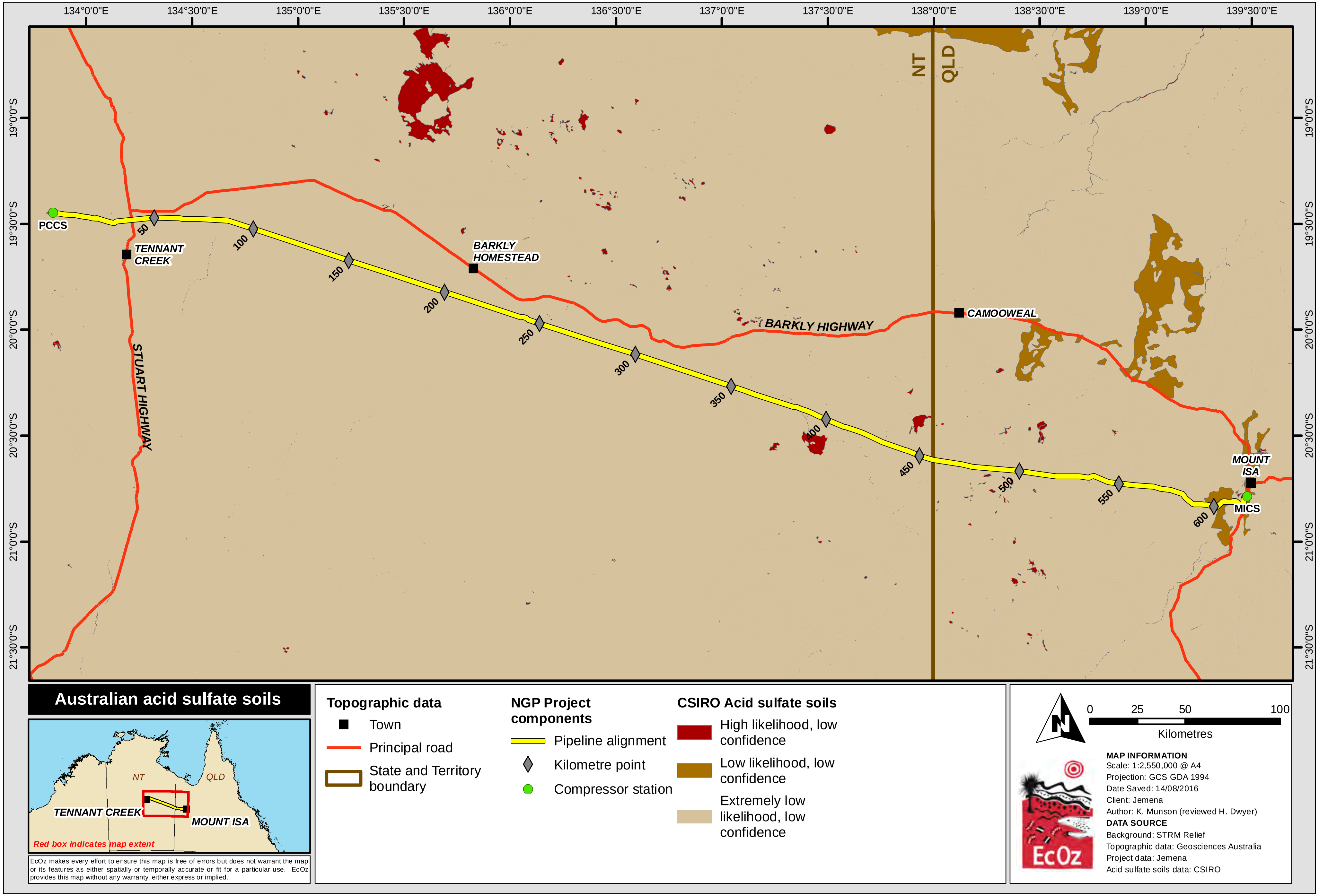
**Information derived from satellite imagery and ASS soil mapping*

Preliminary (non-intrusive) geotechnical assessment along the pipeline alignment included assessment for potential ASS areas. Field observations included signs of ASS, such as acid-tolerant plant species, vegetation die back, pooling water that is orange-brown or has oil like slicks, and signs of salinity or iron deposits on the surface of the soil and around the edge of waterbodies. None of these signs were observed by the soil scientist and geotechnical technician during the preliminary geotechnical assessment and the risk of ASS within the Project area is considered low. Soil sampling conducted for future geotechnical assessment (pre-construction) will include analysis for ASS if potential ASS soils are identified in test pits.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-6. Map of soil landscapes along the construction ROW.mxd

Figure 7-6. Map showing ground-truthed soil landscapes along construction ROW



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-7. Map of acid sulfate soil potential in relation to the construction ROW.mxd

Figure 7-7. Map showing ASS potential in relation to the construction ROW

7.2.3 SURFACE WATER

Regional catchment context

The Project traverses two major river basins entirely, and covers a small section of two other river basins at either end respectively (basins defined as per Geoscience Australia 1997). From west to east, the construction ROW commences in the eastern most section of the Wiso Basin, traverses the Barkly and Georgina basins and ends at the western most section of the Leichhardt basin (see Table 7-4 and Figure 7-8). These basins generally contain a number of smaller catchments. With the except for the Leichhardt Basin, which drains north toward the Gulf of Carpentaria, all of the watercourses within the basins drain inland.

Table 7-4. Drainage divisions and river basins along the construction ROW

Location	River basin	Drainage features
0 – 15	Wiso Basin	No major watercourses or drainage features crossed within this basin.
15 – 308	Barkly Basin	Within this basin the drainage features mostly commence in upland areas (to the north), forming defined channels and eventually draining into flood-out areas. The drainage lines are mostly disconnected and ephemeral to intermittent. During times of significant rainfall, the drainage lines feed flood-outs, wetlands, lakes and other broad systems which provide important habitat for a range of species (Duguid et al. 2005). A number of creeks form in the Davenport and Murchison Ranges and run northwards toward the pipeline. These dissipate into flood-outs south of the construction ROW and do not cross the construction footprint.
308 – 608	Georgina Basin	This basin contains the most significant watercourses traversed by the pipeline. Rivers through this 'channel country' drain south toward Lake Eyre. Watercourses are highly braided and flows are reliant on rainfall. While the system is usually dry, broad scale flooding of the braided watercourses and surrounding floodplains occurs in particularly wet years.
608 – 621	Leichhardt Basin	The ROW traverses this basin near the headwaters of the Leichhardt River, which drains north and eventually discharges into the Gulf of Carpentaria. The Leichhardt River feeds Lake Moondarra, the main water source for Mount Isa township. It is ephemeral and the headwaters usually retract to waterholes in the dry season. The construction ROW traverses Mica Creek, which joins the Leichhardt River immediately north-east of the end of the pipeline.

Only 15 km of the Project is within the Wiso Basin, and no major watercourses or drainage features are crossed in the segment.

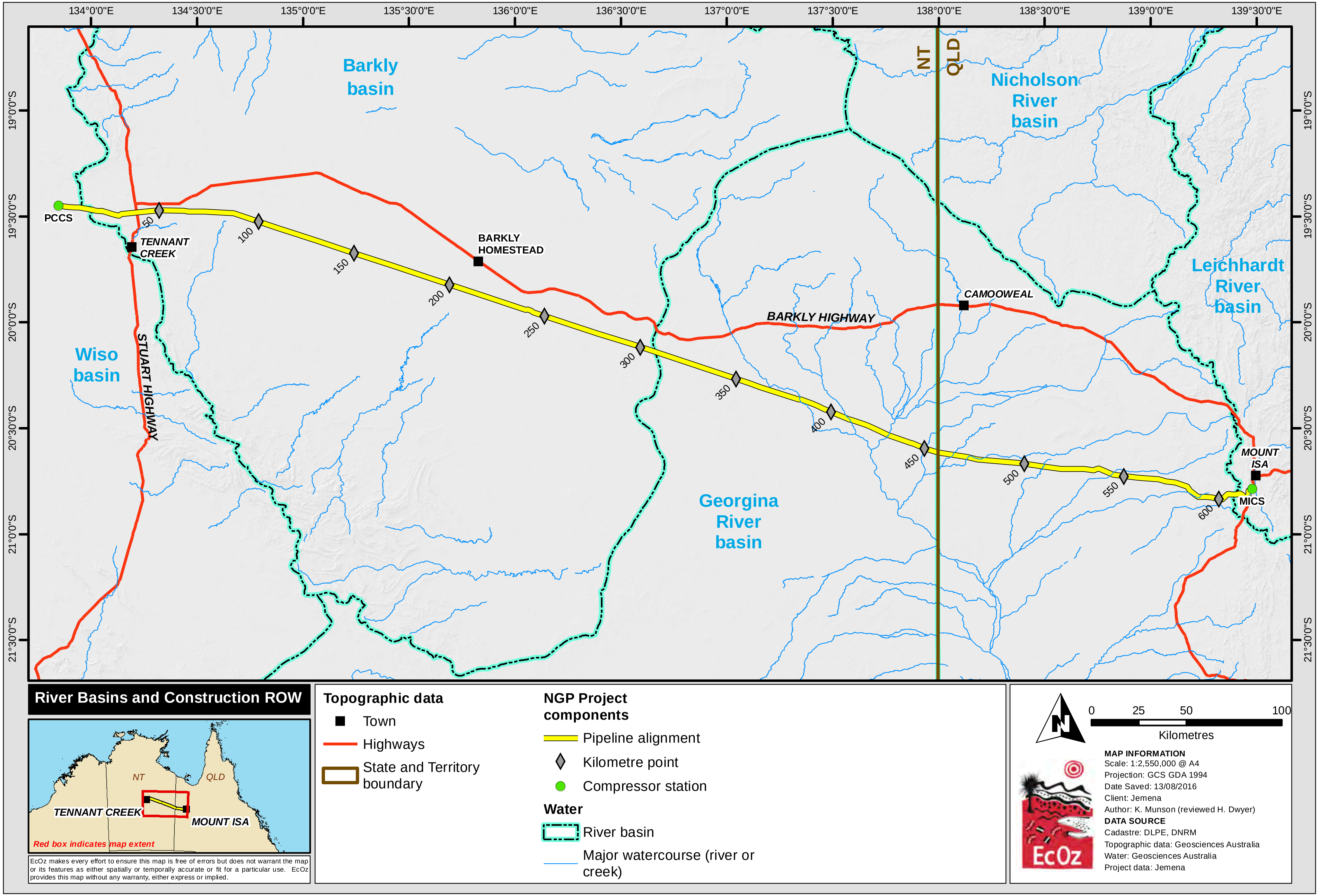
From KP 15 to KP 308 the Project traverses the Barkly Basin. The drainage features of the Barkly Basin mostly commence in upland areas, forming defined channels and eventually draining into floodout areas. The drainage lines are mostly disconnected and ephemeral to intermittent. During times of significant rainfall the drainage lines feed floodouts, wetlands, lakes and other broad systems which provide important habitat for a range of species (Duguid et al. 2005). South of the Project a number of creeks drain from the Davenport and Murchison Ranges north, but dissipate into floodouts south of the Project.

From KP 308 to KP 608 the Project traverses the Georgina Basin, which contains the most significant watercourses that are traversed by the Project. The basin contains major rivers which drain south toward Lake Eyre, and is the north-western most river basin in the 'Channel Country' of south-west Queensland. The watercourses within the basin are highly braided and flows are reliant on rainfall. While the system is usually dry, broad scale flooding of the braided watercourses and surrounding floodplains occurs in particularly wet years. Major rivers within the basin which will be traversed by the Project include the

Ranken River, James River and Georgina River, the headwaters for which commence in the Northern Territory.

The final segment of the Project (KP 608 – P 621) is within the Leichhardt River basin, traversing the basin near the headwaters of the Leichhardt River, which drains north and eventually discharges into the Gulf of Carpentaria. The Leichhardt River feeds Lake Moondarra, the main water source for Mount Isa. It is ephemeral and the headwaters usually retract to waterholes in the dry season. The Project also traverses Mica Creek, which joins the Leichhardt River just north-east of the end of the pipeline.

Surface water flows in the region are seasonal and dependent on rainfall, and all watercourses traversed by the Project are ephemeral or intermittent.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-8. With access tracks.mxd

Figure 7-8. Map of river basins and major watercourses in relation to the construction ROW

Watercourses

Within the two main river basins traversed by the Project (the Barkly and Georgina river basins) there are a number of water crossings (Figure 7-9 and Figure 7-10). The major watercourse crossings are within the Georgina River Basin, where the Project crosses the Ranken, James and Georgina rivers in the Northern Territory. These watercourse crossings include the only three watercourses that contain permanent waterholes: the Georgina, Ranken and James rivers (see Randal 1962).

In Queensland the Project crosses Redbank, Mingera, Polygonum and Yaringa creeks, plus the Templeton River. Of the eight named watercourse crossings in Queensland, only Mica Creek is within the Leichhardt River Basin; the remaining seven are within the Georgina River Basin.

Many of the watercourses in the eastern portion of the Northern Territory, and in Queensland, are braided and the Project crosses the same watercourses a number of times. A summary of watercourse crossings is provided in Table 7-5, including the stream order (as defined by Strahler and provided in the Northern Territory Land Clearing Guidelines – see NRETAS 2010) relevant basin, KP of crossing and number of crossings (for braided watercourses).

South of Tennant Creek, and 65 km south of the Project, is the Davenport and Murchinson Ranges. The headwaters of a number of watercourses are located within these ranges, including Jimmy Creek, Whistleduck Creek, Kurundi Creek and Gosse River. These watercourses drain toward the north and north-east where they floodout onto the plain country, and are not connected to other watercourses. None of these watercourses are traversed by the Project.

Some minor, unnamed drainage lines which are not connected to other major watercourses are traversed in the Barkly Basin.

Table 7-5. Summary of watercourses traversed by the pipeline alignment

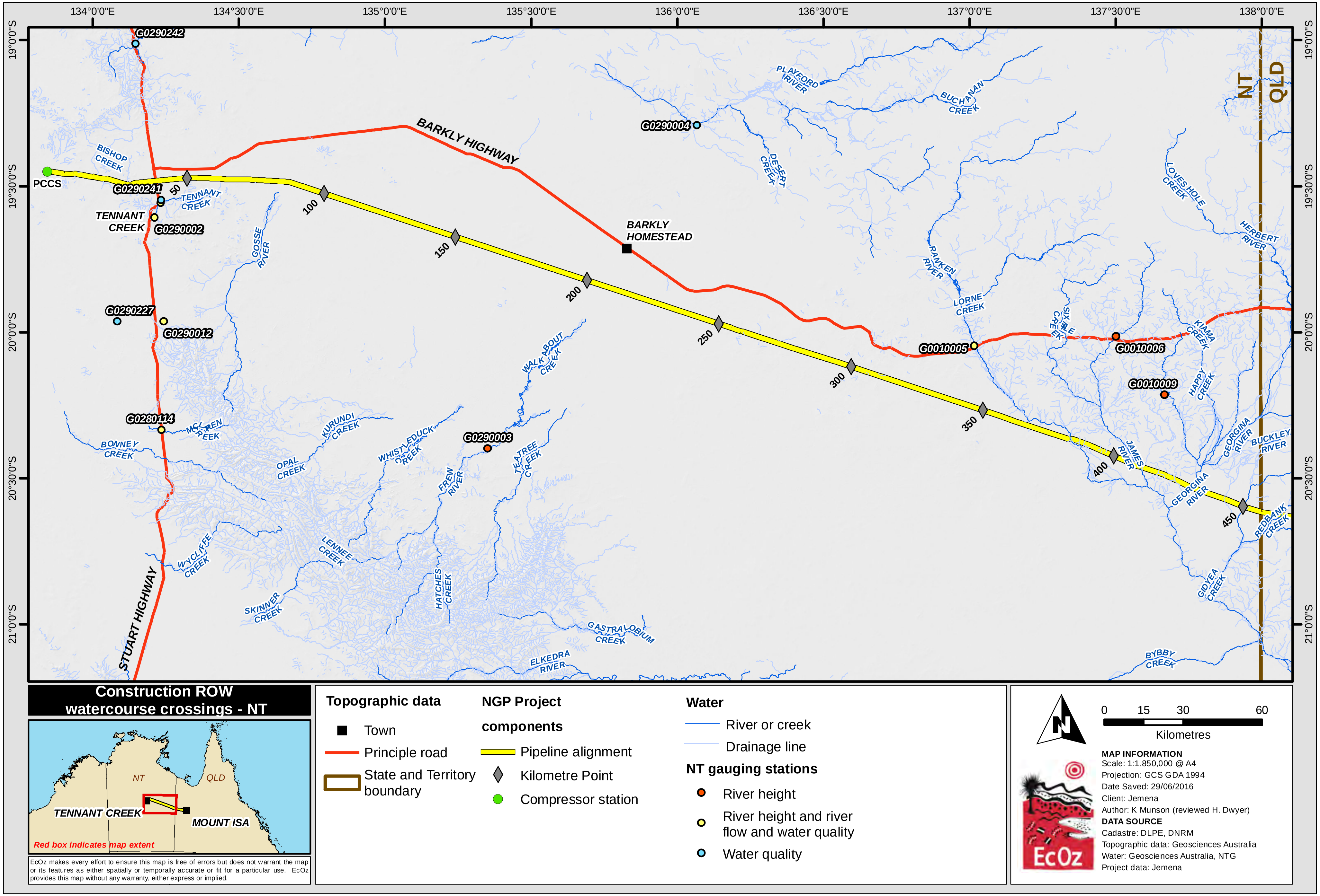
Name	Stream order*	Watercourse type	Basin	KP	Number of crossings
Northern Territory					
Bishop Creek	2	Drainage line	Barkly	18	1
Gosse River	Not applicable	Flood-out		87	1
Ranken River	5+	River	Georgina River	383	1
	1	Drainage line		383 – 396	5
James River	5+	River		410	1
	1 – 2	Drainage line		408 – 420	5
Georgina River	5+	River		431	1
	1 – 2	Drainage line		422-424	2
Blue Bush Creek	4	Creek		443 – 451	2
	1	Drainage line		448 – 453	4
Two additional unnamed drainage lines are crossed in the Barkly Tablelands, all stream order 1-2.					
Queensland					
Redbank Creek	3-4	Creek	Georgina River	464-465	2
Mingera Creek	5+	River		472	1
	1 – 2	Drainage line		472 – 498	3
Polygonum Creek	1 – 2	Drainage line		505 – 515	5
One Mile Creek	1	Drainage line		531	1
Lily Hole Creek	3	Creek		537	1
Templeton River	5+	River		544	1
	1 – 2	Drainage line		544 – 609	11
Yaringa Creek	5+	River		590	1
	3 – 4	Creek		585 – 601	3
	1-2	Drainage line		584 – 604	14
Mica Creek	3 – 4	Creek	Leichhardt River	611 – 619	4
	1 – 2	Drainage line		609 – 621	9
15 additional unnamed drainage lines are crossed; all stream order 1-2.					

**At point where construction ROW crosses watercourse*

The Northern Territory Water Data Portal (see DLRM 2016a) provides stream flow (water level and stream discharge) and water quality data for a number of monitoring stations around the Northern Territory. The Queensland Water Monitoring Information Portal (see DNRM 2016) provides similar data for watercourses in Queensland. Water level and/or stream discharge monitoring stations in proximity to the construction ROW are presented in Table 7-6, Figure 7-9 and Figure 7-10. Stream discharge and measured water level graphs are provided (graphed from all available data) for the Ranken River (G0010005) and James River (G0010006) stations in Figure 7-11 and Figure 7-12.

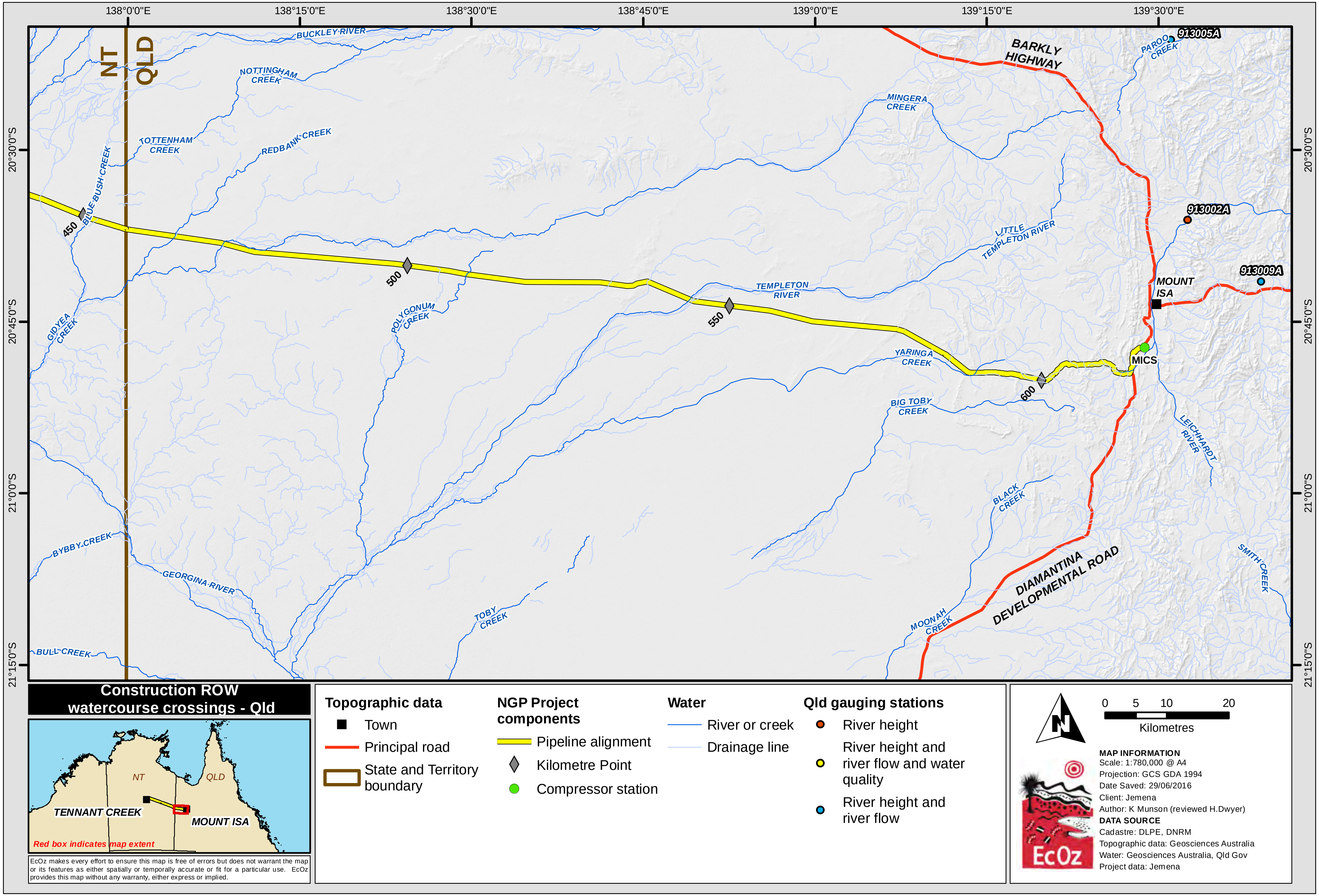
Table 7-6. Stream height and discharge monitoring stations in proximity to the construction footprint

Station number	Watercourse	River basin	Data dates	Proximity to ROW
NT stations				
G0290240	Tennant Creek	Barkly	1972 - 2011	7km south
G0290002	Maryann Dam	Barkly	1981 - 2011	13km south
G0290012	Kelly Creek	Barkly	1974 - 2012	53km south
G0290003	Frew River	Barkly	1968 - 1987	76km south
G0280114	McClaren Creek	Wiso	1964 - 2011	94km south
G0010005	Ranken River	Georgina River	1965 - 2011	24km north
G0010006	James River	Georgina River	1965 - 1987	46km north
G0010009	Shakespeare Creek	Georgina River	1969 - 1987	31km north
Qld stations				
001201A	Georgina River – Lake Nash	Georgina River	1948 - 1956	48km south
001203A	Georgina River – Roxborough Downs	Georgina River	1967 - now	195km south
001204A	Georgina River – Camooweal	Georgina River	1968 - 1998	81km north
913001A	Rifle Creek	Leichhardt River	1965 - 1988	20km south-east
913002A	Leichhardt River – Lake Moondarra	Leichhardt River	1977 - 1988	21km north-north-east
913005A	Paroo Creek	Leichhardt River	1968 - 1988	50km north
913009A	Gorge Creek	Leichhardt River	1970 - 1988	20km north-east
913014A	Leichhardt River – Doughboy Creek	Leichhardt River	1978 - now	59km north-east



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Biodiversity & Threat Species\Figure 7-9. Map of watercourses and monitoring stations in relation to the construction ROW - NT.mxd

Figure 7-9. Map of watercourses and monitoring stations in relation to the construction ROW - Northern Territory



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Biodiversity & Threat Species\Figure 7-10. Map of watercourses and monitoring stations in relation to the construction ROW - Qld.mxd

Figure 7-10. Map of watercourses and monitoring stations in relation to the construction ROW - Queensland

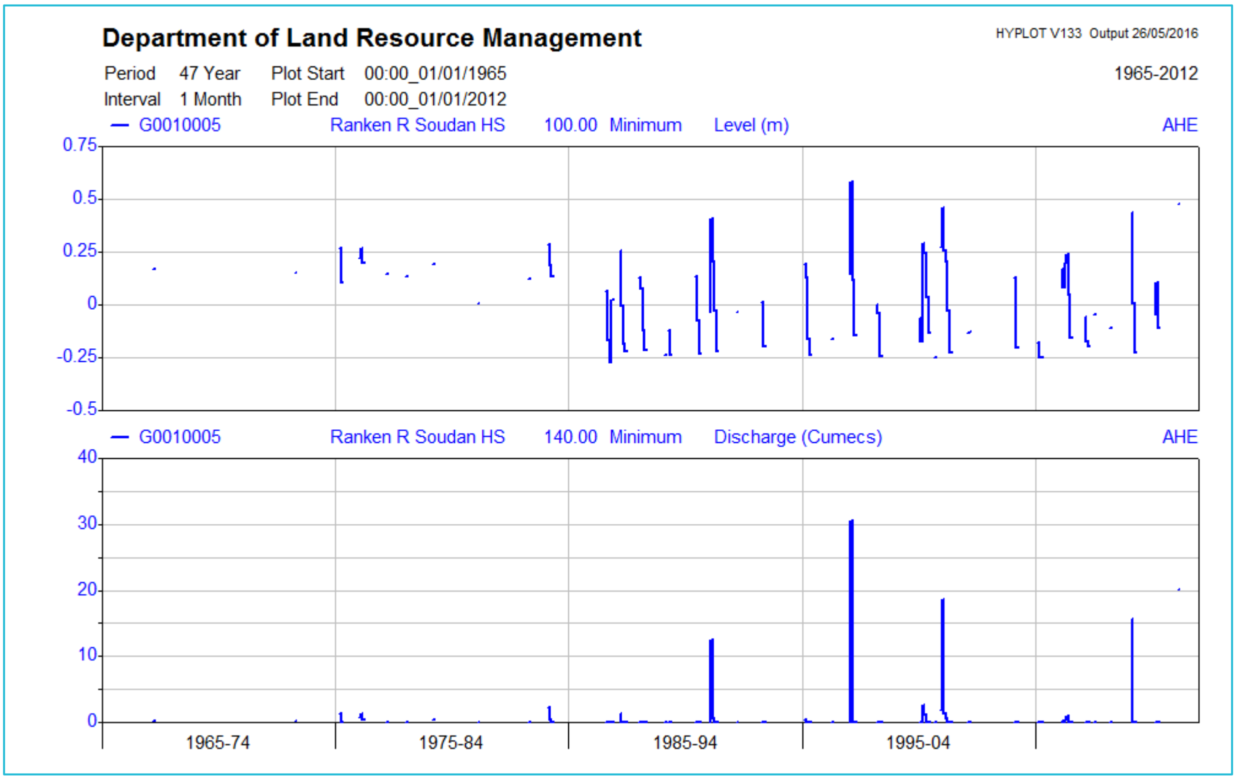


Figure 7-11. Stream discharge graph for the Ranken River station G0010005 (DLRM 2016a)

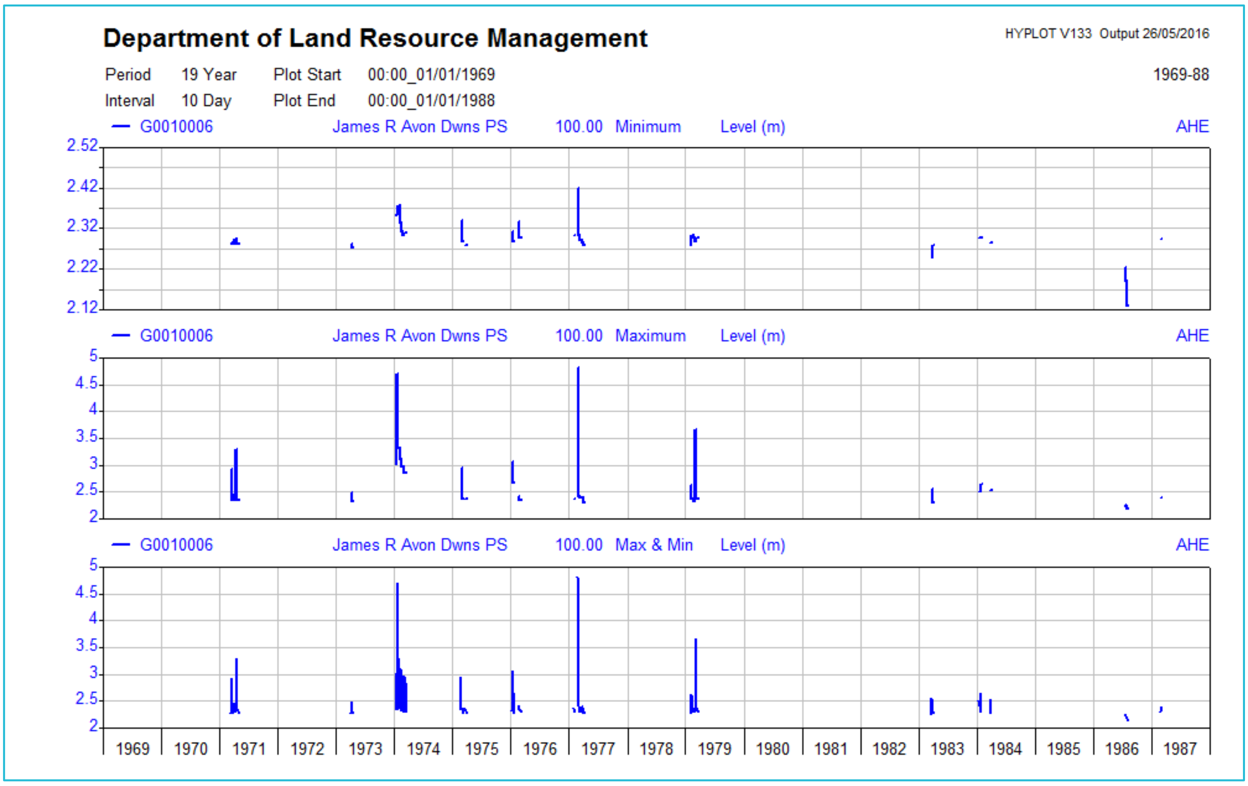


Figure 7-12. Measured water level graph for the James River station G0010006 (DLRM 2016a)

The stream flow data from these stations indicate that water levels and discharge rates are highly seasonal, with flows mostly recorded in February and April of each year (i.e. the later months of the wet season). Flow volumes fluctuate significantly depending on the seasonal rainfall volumes. The records indicate that 'cease to flow' conditions are experienced for the majority of the year (and often for several consecutive years), with some exceptions in particularly wet years. The gauging data confirms that watercourses within the construction ROW are highly seasonal, and intermittent to ephemeral. None are expected to be flowing or contain pools at the time of construction. If flows occur flow diversion (dam and pump method) will be implemented (refer to Section 7.6.7).

Gauging stations downstream in the catchment (e.g. 001203A) experience more regular flows, as the upstream catchments are significantly larger and therefore feed the watercourse for a longer period of time. Gauging data from these stations indicate a strong seasonality in water flows, with peak discharges and water levels consistently recorded during the wet season months. Refer to Northern Territory DLRM (2016a) and Queensland DNRM (2016) for detailed station data. Notably, none of the stations that experience more significant and regular flow are close to the construction footprint.

Watercourse crossings

A watercourse crossing assessment was undertaken for major watercourses (stream order 3+) intersected by the construction ROW as part of the threatened species surveys for the EIS (see Appendix G). In the Northern Territory, the assessment was undertaken from 2 May 2016 to 9 May 2016, and included an aerial survey of the crossings and stream sections immediately upstream and downstream, and on-ground assessment of the watercourse crossing to describe the beds, banks, riparian condition and bed and bank profiles. Signs of permanent pools, springs or groundwater dependent ecosystems were also assessed.

The major Northern Territory watercourse crossings are summarised below; namely the Ranken River, James River and Georgina River. Refer to Appendix K for all watercourse crossing data. All three watercourses were surveyed on 8 May and contained water at the time of the survey. A review of rainfall data from the Bureau of Meteorology indicates that a number of stations in the region recorded rainfall between the 3 May and 9 May 2016, with the majority recorded on 8-9 May (BoM 2016a). This indicates that the watercourse crossing survey correlated with a rainfall event, which resulted in water being present in the major watercourses (as depicted in Figure 7-13 to Figure 7-15).

Each watercourse crossing assessed was in the proximity of a narrow, naturally drier section of the river and the construction ROW will cross major watercourses at these points where possible to minimise impacts to larger sections of the river.

Although all three watercourses contained water at the time of the assessment there were no signs of natural large permanent pools or springs near the proposed pipeline alignment. However, the determination of this was limited by the presence of water, and further watercourse surveys will be conducted prior to construction to inform the erosion and sediment control plan and identify any permanent water near the construction ROW.

A description of the Ranken, James and Georgina watercourse crossings as described on 8 May 2016 is summarised below. Refer the Watercourse Crossing Survey Report (Appendix K) for all watercourse crossing data.

The main channel of the Ranken River is crossed at KP 383 (see Figure 7-13). The bed of the watercourse is 25-30 m at this junction with a bank height of approximately 2–3 m at a 2–3 per cent slope. Water was present in the main channel during the survey; however there were shallow, narrow sections (as depicted in the images) and water recedes after rainfall to predominantly dry beds. The banks are stepped clay with gravel; vegetation includes Coolabah and Mitchell grass. Erosion was observed in areas accessible by cattle.


Main channel with dry sections


River banks

Figure 7-13. Ranken River (May 2016), main channel (left) and banks (right)

The James River is crossed by the ROW at KP 410 (see Figure 7-14). At this point the river bed is approximately 10 m wide, banks have a 3 per cent slope, and are 1 m high on the western side and 2 m high on the eastern side. The river bed consists of clay and mud, while the banks are clay. Water was present in the main channel during the survey; however there were many shallow sections within the channel, and water recedes after rainfall to predominantly dry beds. Riparian vegetation includes Coolabah, apple bush and sedges. Erosion was observed in areas accessible by cattle.

Main channel


River banks

Figure 7-14. James River (May 2016), main channel (left) and banks (right)

The Georgina River is crossed by the ROW at KP 431 (Figure 7-15). At this point the river bed is approximately 16 m wide, banks have a 2 per cent slope, with a height of 2.5 – 3.0 m. The river bed consists of fine sands and clays and the banks are clay. Water was present in the main channel during the survey; however there were many shallow sections within the channel, and water recedes following rainfall to predominantly dry beds. Riparian vegetation includes Coolabah, apple bush and sedges. Erosion was observed in areas accessible by cattle.

Main channel | **River banks**

Figure 7-15. Georgina River (May 2016), main channel (left) and banks (right)

Wetlands

Although the region surrounding the Project is dry for much of the year and on the border of the arid environment there are a number of lakes, floodouts and waterholes (all referred to here as 'wetlands') which are important features in the landscape during wet periods (see Duguid et al. 2005 for detail). All significant wetlands are avoided and no Ramsar or nationally important listed wetlands are within, or near, the Project area.

The Northern Territory Government has identified Sites of Conservation Significance (SOCS) across the Territory for areas of important or unique habitat, or areas with significant biodiversity values. The closest SOCS to the Project is the Frew River floodout swamps, which is approximately 45 km south of KP 200 of the construction ROW.

SOCS to the north of the Project are Lake Sylvester, Tarrabool Lake and Eva Downs Swamp, which combined are referred to as the Barkly Lakes (DLRM 2016b). South of the pipeline the SOCS are Frew River floodout swamps, Davenport and Murchison Ranges and Elkedra River floodout swamps (Figure 7-16). With the exception of the Davenport and Murchison Ranges, all SOCS in the vicinity of the pipeline footprint are associated with wetlands, demonstrating the importance of water in the landscape. The Davenport and Murchison Ranges are low rugged rocky hills which provide diverse habitat and contain permanent and long-lasting waterholes in gorges. A number of the creeks and rivers which floodout to feed the wetlands have their headwaters in the ranges.

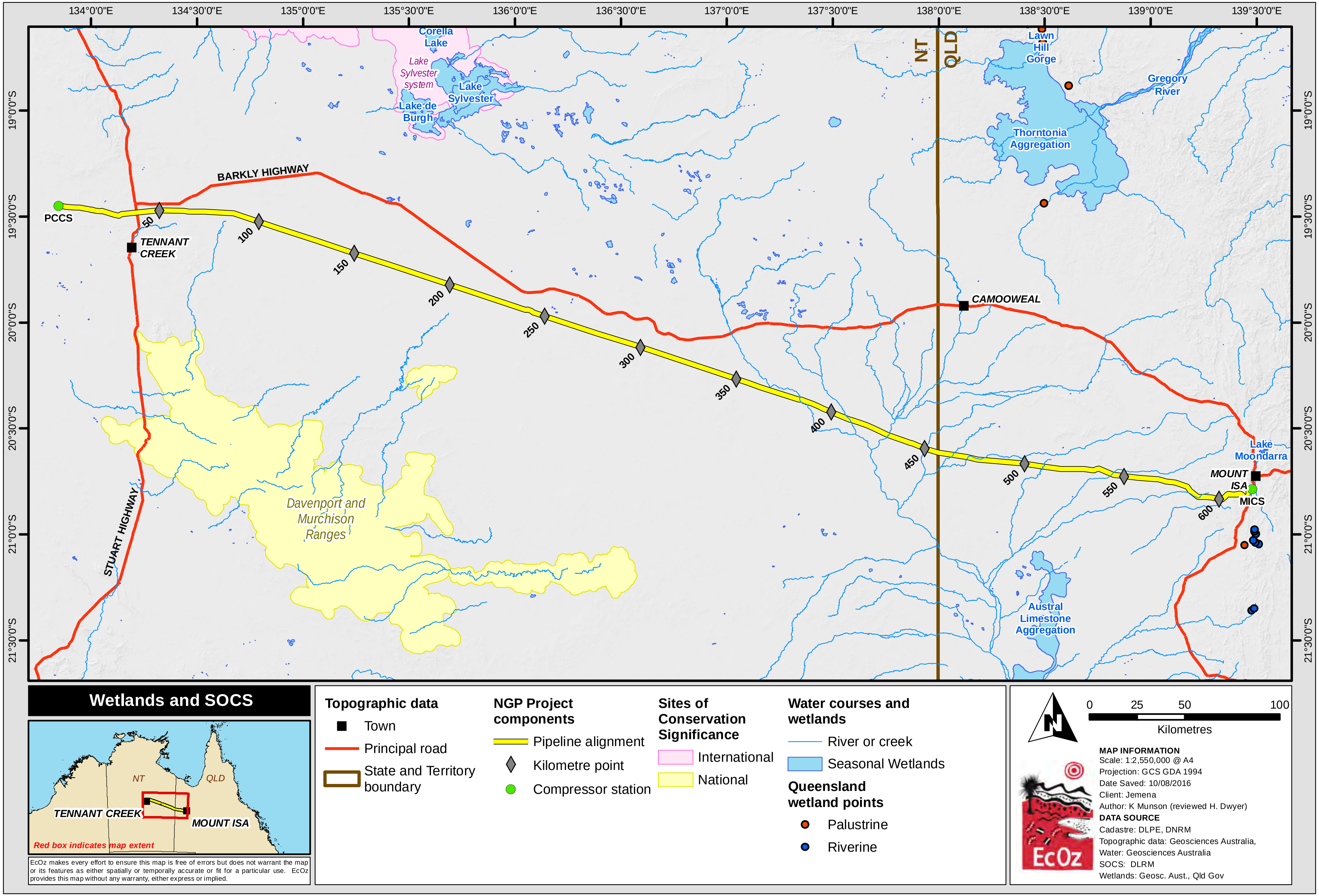
Although significant features in the landscape, the majority of wetlands in the Barkly Tablelands are highly seasonal, and water volumes and their extent vary significantly depending on rainfall (Duguid et al. 2005). With the exception of Lake Sylvester and some waterholes in the Davenport and Murchison Ranges, none of the systems discussed hold permanent water. During the wet season or periods of significant rainfall the wetlands fill (or, in the case of Lake Sylvester, increase in size) and become important habitats and breeding grounds for a wide range of species including waterbirds (DLRM 2016b).

The eastern end of the construction ROW is within the headwaters of the Lake Eyre Basin. The Lake Eyre Basin Intergovernmental Agreement was formulated between the Australian, Queensland, South Australian and Northern Territory governments to provide a framework for managing the basin (SEWPC 2013). A number of significant wetlands (e.g. Ramsar) are identified within the Lake Eyre Basin. None of these are near the construction footprint; however watercourses crossed by the construction ROW do discharge into the wetlands of Lake Eyre, particularly during periods of significant rainfall which result in flooding.

The Queensland Government has mapped wetlands and groundwater dependent ecosystems in the online resource Wetland Info (DEHP 2016). Additionally, Matters of State Environmental Significance (MSES), as regulated and defined under the Sustainable Planning Act 2009 (Qld), are mapped in the online resource SPP Interactive Mapping System (see MapData Services 2015). Although a number of wetlands are mapped in the region, no wetlands or watercourses are mapped as High Ecological Significance wetlands, high ecological value waters or declared fish habitat. The Camooweal Caves National Park is considered a MSES and the riparian vegetation associated with the watercourses traversed by the construction ROW are mapped as regulated vegetation.

The Camooweal Caves National Park is located over 70 km north of the construction ROW and therefore will not be impacted by the Project. Regulated vegetation will be cleared under an Environmental Authority administered by the Queensland Department of Environment and Heritage Protection (DEHP). The closest Strategic Environmental Area and High Ecological Significance Wetland to the construction ROW is approximately 60 km south and is associated with the Georgina River (at the confluence of the Templeton and Georgina rivers).

No impacts on significant wetlands or watercourses are expected as a result of the pipeline construction. Works will be undertaken during the dry period of the year and the alignment avoids all significant wetland systems.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-16. Map of SOCS and wetlands in relation to the construction ROW.mxd

Figure 7-16. Map of SOCS and wetlands in relation to the construction ROW

Water quality

Existing data for the watercourses in the region is limited. The Northern Territory Water Data Portal (see DLRM 2016a) provides online water quality data for monitoring stations around the Northern Territory. The stations in proximity to the construction ROW are summarised in Table 7-7. The dates and number of monitoring events range significantly between sites, and is generally sporadic as a result of the irregular flow conditions. There is very minimal data available for watercourses within the construction footprint; the closest station to the construction ROW is 7 km south (G0290240 - Tennant Creek).

A review and study of wetlands and watercourses in the arid Northern Territory (south of 20° of latitude) by Duguid et al. (2005) included collecting water quality samples from 124 sites. Analytes were limited, but electrical conductivity and pH were tested at most sites. In general the electrical conductivity (EC), which is an indication of salinity and total dissolved solids, varied across the sites from <100 µS/cm (i.e. fresh water) to >50 mS/cm (hyper-saline). EC varies depending on salinity, total dissolved solids and a variety of other factors such as anions, cations and metals. In general flowing watercourses, or recently filled wetlands, have relatively low EC, which increases as flows decrease. Once water is pooling evapo-concentration often results in the concentration of salts and total dissolved solids, which inherently increases EC. Randal 1962 states that the permanent pools of the Georgina, Ranken and James rivers often become milky as dry conditions persist, which indicates that EC and turbidity would increase throughout the dry season. Duguid et al. (2005) also state that many of the watercourses and wetlands are milky in colour which is likely attributable to the silt and clay soils suspended in the water column, and would be expected to result in high turbidity.

pH results from the samples collected by Duguid et al. (2005) indicated that the majority of watercourses and wetlands had circum-neutral pH, ranging from 6-8. Ten sites had alkaline pH (>8) which is often associated with springs fed by groundwater, which is naturally higher more alkaline.

The Queensland Water Quality Guidelines (QWQG) provide local guidelines for water quality based on regions and water types, and is the key guideline document for implementing the processes outlined in the Environmental Protection Policy (EPP) (Water) (DEHP 2009a). The QWQG outline environmental values for watercourses, and defines specific water quality objectives (WQOs) tailored to the environmental values. The Georgina and Leichhardt river basins are within the Lake Eyre and Gulf regions respectively and the QWQG state that there is very little or no water quality data for the watercourse in these regions. As such no WQOs are provided for these regions in the QWQG, and it is also stated that the ANZECC 2000 guidelines, which are the national default guidelines, may not be applicable due to the naturally high variation in the water quality of these watercourses. This proves limiting for establishing reference data for the watercourses which will be crossed by the construction ROW as there is little baseline data available.

Table 7-7. Water quality monitoring stations in proximity to the construction footprint

Station number	Watercourse	Basin	Data dates	Proximity to ROW	Number of monitoring events*
Northern Territory Stations					
G0280114	McLaren Creek	Wiso	1964 - 2011	94km south	1 - 2
G0290002	McClaren Creek	Barkly	1981 - 2011	13km south	1 - 24
G0290004	Playford River	Barkly	1966 - 2011	73km north	1 - 4
G0290012	Kelly Creek	Barkly	1974 - 2012	53km south	1 - 4
G0290227	Morphett Creek	Barkly	1993	53km south	1
G0290228	Morphett Creek	Barkly	2010 - 2011	67km north	3
G0290240	Tennant Creek	Barkly	1972 - 2011	7km south	1 - 3
G0290241	Tennant Creek – Old	Barkly	1965 - 1974	7km south	1 - 4
G0290242	Attack Creek	Barkly	1965 - 1987	53km north	1 - 14
G0010005	Ranken River	Georgina River	1965 - 2011	24km north	1 - 5
Queensland Stations					
001202A	Burke River – Boulia	Georgina River	1966 - now	234km south	1 - 18
001203A	Georgina River – Roxborough Downs	Georgina River	1967 - now	26km north	3 - 21
913014A	Leichhardt River – Doughboy Creek	Leichhardt River	1978 - now	59km north-east	1 - 42
913006A	Gunpowder Creek	Leichhardt River	1971 - now	125km north	1 - 94

**The number of monitoring events ranges for different parameters. At most sites calcium is the most frequently recorded analytes and other analytes (e.g. pH, EC, alkalinity) are recorded less frequently.*

7.2.4 GROUNDWATER

As aforementioned, this section has been completed by a hydrogeologist. Risks to groundwater and groundwater dependent ecosystems have been informed by the information provided in this section and Section 7.2.5.

The BoM national scale Geofabric identifies three broad groundwater provinces that underlie the construction ROW (see Figure 7-17): local scale aquifers associated with Proterozoic fractured rocks of the Tennant Creek Inlier, regional karstic and fractured rock aquifers of the Georgina Basin, and local fractured rock aquifers within the Proterozoic Mount Isa-Cloncurry Province.

Tennant Creek Province

In the Tennant Creek Province groundwater in the vicinity of the ROW mainly exists in fractured and weathered rock aquifers that occur in sandstone, conglomerate and minor volcanic rocks (DLRM 2016c). These are local scale aquifers with limited resource potential and an expected bore yield between 0.5 and 2.5 L/s. Felsic volcanic and mafic intrusive formations within the province form very marginal aquifers with a reported yield range of 0.05 – 0.5 L/s. Water quality ranges from fresh to relatively saline (Total Dissolved Solids [TDS] of <1 000 mg/L to > 3 000 mg/L - see DIPE 2002). Spatially water quality is highly variable which is characteristic of the local flow systems associated with the fractured rock aquifers. Reported groundwater levels in the fractured rock aquifers around the ROW range from 15 – 70 mBGL and exceed 25 mBGL in the majority of bores. Limited information exists regarding groundwater flow directions, recharge and discharge processes within these aquifers.

Twenty-five kilometres south of Tennant Creek are the Cabbage Gum and Kelly Well bore fields, which provide the municipal water supply for the town. These borefields tap a highly productive aquifers developed in Cainozoic silcrete deposits and in the weathered top of the underlying basement. These aquifers are distinct from the more marginal fractured rock aquifers within the Tennant Creek Province. Successful production bores have an average bore yield of 13 L/s with a yield range of 2 – 26 L/s. Groundwater flow direction within the aquifer is to the north-west and is coincident with the surface drainage pattern. Groundwater recharge to the Cainozoic aquifers occurs from a combination of diffuse recharge from the direct percolation of rainfall and indirect recharge from flood events (Verhoeven and Knott 1980). The aquifers targeted by the Kelly Well and Cabbage Gum bore fields contain water of potable quality with all parameters within Australian Drinking Water Quality Guideline values.

Georgina Basin

The Georgina Basin is a regional aquifer system that contains a significant but largely undeveloped groundwater resource with water availability estimated at 100,000 ML/year (NALWTF 2009). Along the pipeline alignment major aquifers are expected to occur in the Gum Ridge Formation in the west of the Georgina Basin, the Camooweal Dolomite in the east and potentially the Woonarah Formation in the central basin. At a regional level these aquifers are considered to form a single continuous carbonate aquifer which represents the principal resource for stock, domestic and community water supply within the Barkly region. The Gum Ridge Formation comprises massive grey limestone beds that are heavily fractured and commonly karstic. The Woonarah Formation comprises silty dolostone and mudstone interbeds, while the Camooweal Dolomite comprises dolostone, dolomitic limestone, minor marl and quartz sandstone. Both the Gum Ridge and Camooweal Dolomite are known to be cavernous and are associated with sinkhole development (Tickell, 2003). Aquifer depth (approximated by depth to the screen interval) in the limestone aquifers around the ROW is generally between 50 and 100 mBGL in the Northern Territory and 40 to 140 m in the Queensland portion of the Georgina Basin. Depth to groundwater commonly ranges from 30 – 100 mBGL (Tickell 2003) and is largely a function of surface elevation (i.e. deeper groundwater levels occur on elevated rises and shallow groundwater in lower lying areas). Bore yields for the carbonate aquifers typically range between 0.5 and 5 L/s (Tickell 2003). This range generally reflects the bore water requirement which being largely for stock watering is modest and in the vicinity of the pipeline yields of up to 18 L/s have been recorded in the Camooweal Dolomite (Read 2003). Drilling records commonly report “lost circulation” whilst drilling the carbonate aquifers. When this occurs below the regional watertable it often results from extensive fracturing and cavity development which is associated with significant groundwater resources. These are not often recorded on drilling records as air lift estimates of bore yield are not possible once circulation is lost.

Regional groundwater flow within the Georgina Basin is separated by a groundwater divide located in the vicinity of the Barkly Homestead. Groundwater to the north of this divide flows in a north-westerly direction toward Mataranka where springs in the Roper River form a major discharge for the Georgina Basin aquifer. South of this divide groundwater moves in an easterly direction toward springs draining into Lawn Hill Creek and the Gregory River in Queensland. Tickell (2003) also identifies an east-west oriented groundwater divide in the vicinity of Avon Downs and Austral Downs stations. North of this divide

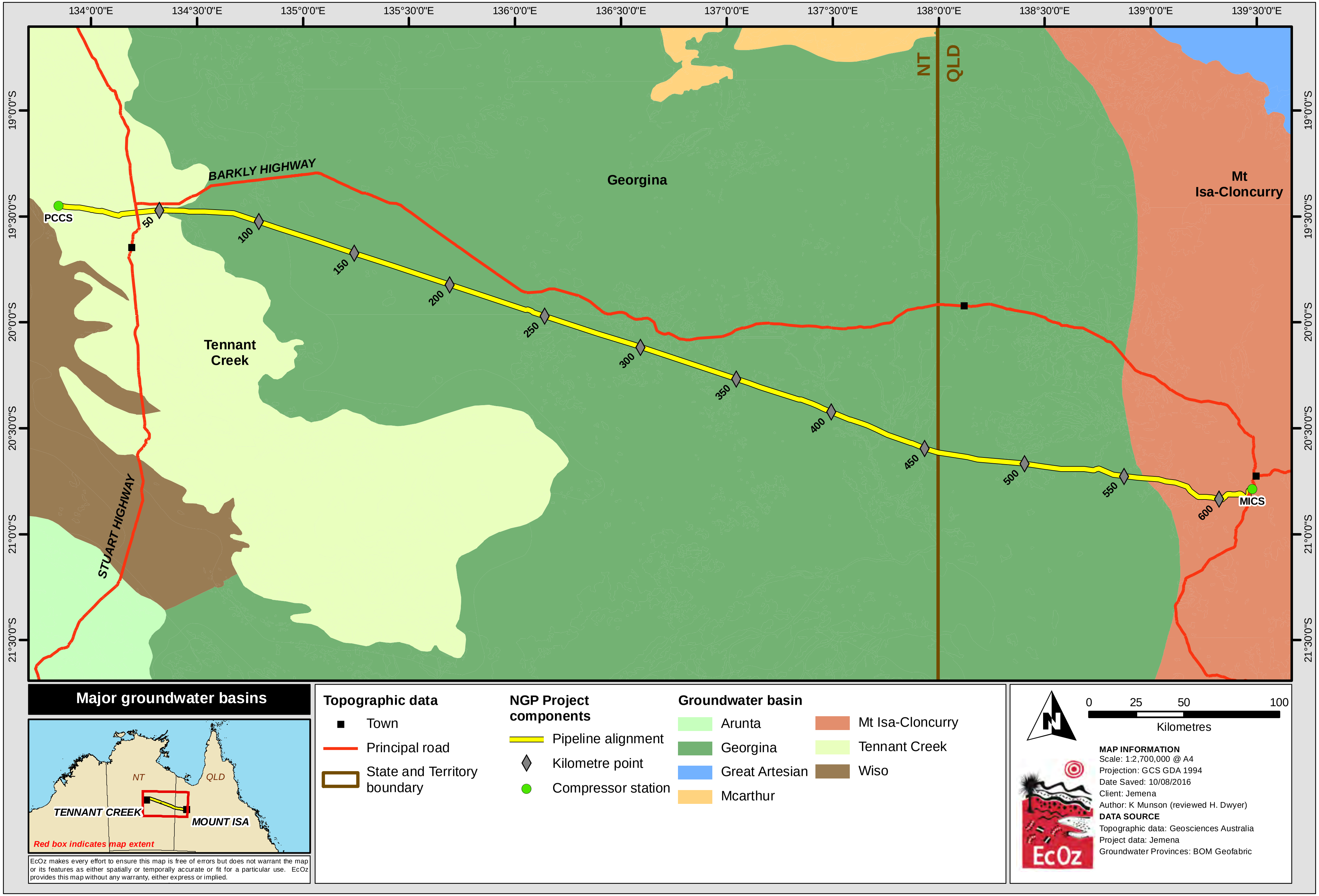
groundwater flows toward Lawn Hill Creek and the Gregory River. South of the divide groundwater flows in a southerly direction with a flow pattern that is coincident with the Georgina River drainage pattern (Randal 1967).

Recharge from the percolation of rainfall (diffuse recharge) is expected to occur where carbonate formations outcrop and where they underlie permeable surface formations, in particular, dune sands and the Austral Downs Limestone (Randal 1978). Indirect recharge is also expected where water courses cross outcropping limestone and dolomite. Noted recharge areas for the Georgina Basin include the north-east and south-west margin of the basin, around Tarrabool Lake and the area around Alexandria Station (Tickell 2003). A recharge zone is also postulated to occur between the Ranken River and the James River/Happy Creek near the Avon Downs homestead (Randal 1967).

Groundwater quality in the Georgina Basin ranges from fresh to saline, with a prominent area north of the Barkly Highway, and north-east of Tennant Creek containing a high number of saline bores (TDS 3,000 mg/L – 14,000 mg/L). This is attributed to the dissolution of gypsum and halite, which naturally occur in the Anthony Lagoon Beds in this region (see Tickell 2003). In the vicinity of the ROW, water quality in the Georgina Basin aquifers is generally of good quality with most bores reporting a TDS of less than 1,500 mg/L.

Mount Isa – Cloncurry Province

Marginal groundwater resources occur in the basement rocks of the Mount Isa Inlier. These formations have limited primary porosity and most bores source groundwater from fractured rock aquifers. Randal (1978) reports an average aquifer depth of around 30 m, a water level range of 5 – 56 mBGL (average of 18 mBGL). Bore yields are typically 1.8 L/s for volcanic aquifers and 0.6 L/s for granite aquifers. Higher yields are reported in localised areas such as fault planes in the Mount Isa Shale, which yields up to 10 L/s and has been used to augment surface water supplies for Mount Isa (Randal 1978). Groundwater flow paths within these aquifers are local but the broad gradient is to the west toward the Georgina Basin. Groundwater quality is the fractured rock aquifers is variable but is typically less than 1,500 mg/L TDS.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-17. Map of construction ROW and underlying groundwater basins.mxd

Figure 7-17. Map of construction ROW and underlying groundwater basins

7.2.5 GROUNDWATER – SURFACE WATER INTERACTION

Groundwater and surface water form part of a single connected water cycle. The points at which these systems interface are referred to as groundwater-surface water interactions and are key areas for understanding and sustainably managing water resources. Examples of groundwater-surface water interactions include groundwater discharge areas (e.g. springs, soaks, permanent pools, baseflow in rivers) and areas where surface water recharges the groundwater system (e.g. rivers which run over aquifer outcrop and sinkholes). Groundwater Dependent Ecosystems (GDE) refer to ecosystems which rely on access to groundwater (permanently or intermittently) for ecosystem processes and health (DEHP 2016). GDE include surface expressions of groundwater (such as springs and water dependent vegetation) and below ground systems (such as caves).

Northern Territory

In the Northern Territory, there are no known springs or permanent water bodies within the ROW construction footprint. The Atlas of Groundwater Dependent Ecosystems (BOM 2012) identifies GDE reliant on surface expression of groundwater along the Georgina River Basin watercourses. Consistent with this mapping, permanent pools have been recorded along the Ranken, Georgina and James rivers. The permanency of these pools in an arid environment suggests they are likely to be sustained by groundwater seepage. Water levels in the regional Georgina Basin aquifer are relatively deep in this area (approximately 50 mBGL), which suggests that the pools are more likely to be sustained by a local, perched watertable than the regional groundwater system. No such pools were identified within the construction footprint during the watercourse crossing assessment, however further surveys will be undertaken to assess watercourses and the presence of permanent pools during the detailed design phase of the Project.

A number of significant wetlands and floodout zones are located in the region surrounding the pipeline alignment (see Section 2.2.3) and those that hold permanent water may be sustained by groundwater. No such systems are in the direct vicinity of the construction ROW or ancillary infrastructure.

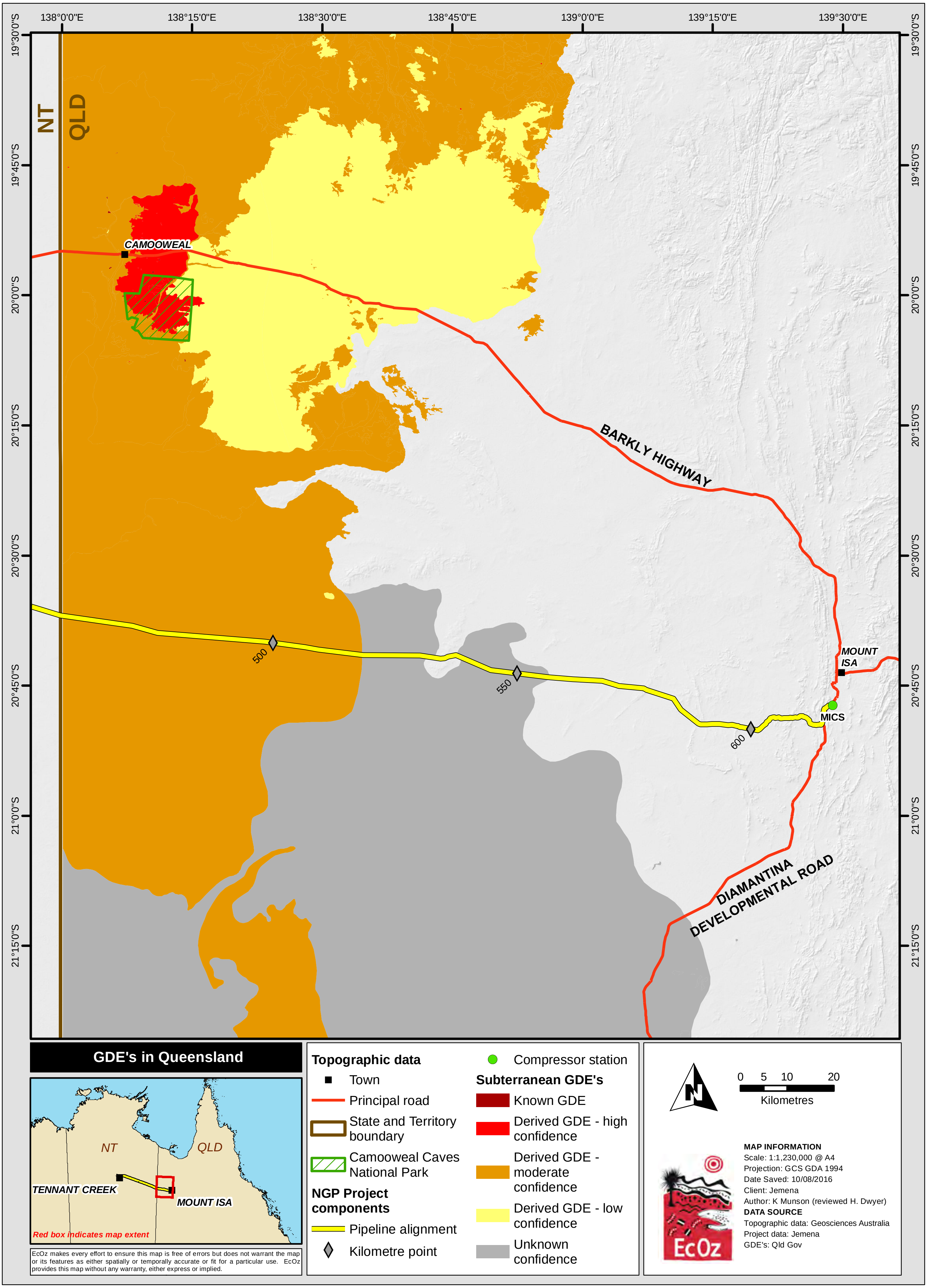
Queensland

The Queensland wetland mapping system (see DEHP 2016) provides online data for wetlands and GDE in Queensland. A review of available data for Queensland indicates that there are a number of riverine wetland systems mapped along the watercourses traversed by the construction ROW. These generally align with the RE mapping. A number of palustrine and lacustrine wetlands are also mapped. Note that the majority of the lacustrine systems are artificial (e.g. Lake Moondarra) and include a number of dams and weirs. The palustrine systems are arid and semiarid swamps, including tree swamps and lignum swamps (refer to DEHP 2016). None of the wetlands are considered significant (see Section 2.2.3) and the majority of them are ephemeral, with the exception of artificial and man-made dams and lakes. Several springs are mapped south and east of Mount Isa; the closest to the construction ROW is at Mount Guide Station and is approximately 25 km south of the ROW.

GDE are mapped around the Camooweal area and along the western boundary of Queensland where the construction ROW crosses from the Northern Territory (Figure 7-18). All are subterranean (i.e. below ground) and are associated with the caves of the Camooweal Dolomite aquifer system (DEHP 2016). It is noted that sinkholes may occur in this region and these features could potentially provide a high level of connection between surface water and the underlying aquifer and associated GDE. The location and extent of the Camooweal GDE are approximate and all mapped GDE underlying the construction footprint are 'derived' (i.e. versus known) with low to moderate confidence.

The Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems maps GDE surrounding Mount Isa as vegetation reliant on subsurface groundwater (BOM 2012). The areas within the construction footprint are mapped as having a low to moderate potential for groundwater interaction. Given the low

rainfall for much of each year, it would be expected that there would be some level of vegetation reliance on groundwater, although construction activities are not expected to have a significant impact on these interactions due to the shallow excavations and short construction period.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-18. Map of construction ROW and GDEs in Queensland.mxd

Figure 7-18. Map of construction ROW and GDEs in Queensland

Existing water users and beneficial uses

Aside from Mount Isa and the townships of Tennant Creek and Camooweal, the main land tenures are perpetual pastoral leases and Aboriginal Land Trust land with some freehold, vacant Crown land, perpetual crown leases and reserves throughout. Some Territory and Queensland government owned land also exists.

Figure 7-19 displays land tenure and populated places, including communities and homesteads, in relation to the construction footprint. Groundwater will be sourced from landholder bores where possible.

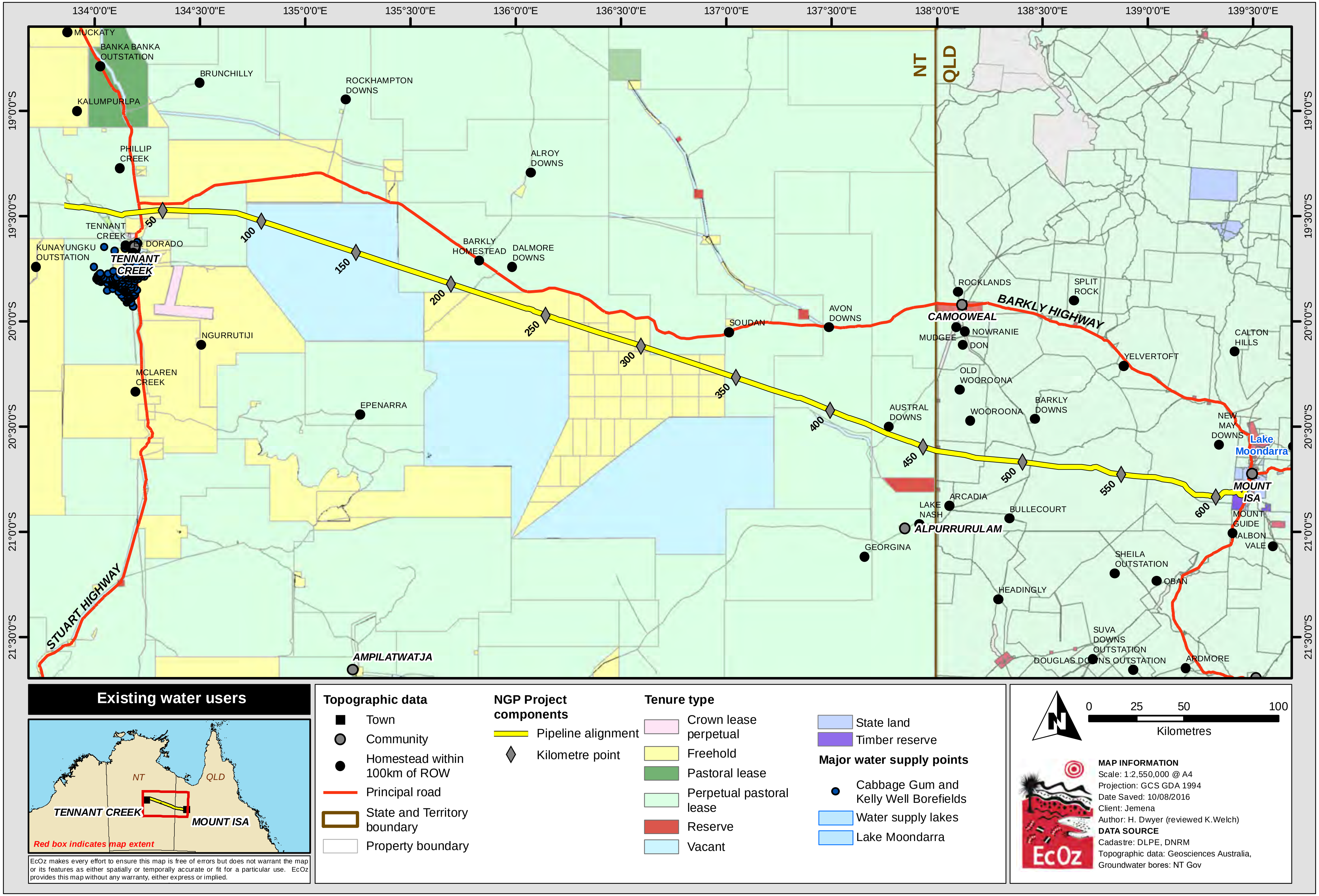
A number of mineral and petroleum leases are held by various parties within the Project area, many of which are not currently active. In Queensland, consultations have commenced with large water users and the Project is not expected to interact with, or impact on, these users.

Apart from Mount Isa, the majority of water sourced for the regions surrounding the Project is from groundwater as surface water flows are generally seasonal, and thus not a reliable water source. The main use for water in the region is for potable uses in towns and Aboriginal communities, and potable and pastoral uses on stations.

Water for Tennant Creek is sourced from the Cabbage Gum and Kelly Well bore fields, managed and operated by Power and Water Corporation (PowerWater 2016). The borefields are approximately 15 – 25 km south of Tennant Creek, and more than 30 km south of the NGP construction ROW. Similarly, water for Camooweal is sourced from groundwater by two sub-artesian bores (Viridis Consultants 2015).

In Mount Isa, water for potable consumption plus industrial uses including Mount Isa Mine is sourced from Lake Moondarra. Lake Moondarra is an artificial lake approximately 20 km north of Mount Isa that is supplied by the Leichhardt River. The water supply to the lake is dependent on rainfall and river flows in the Leichhardt, and the variability of seasonal rainfall necessitates water supply to be supplemented by Lake Julius in dry years.

In the Northern Territory, there are no declared beneficial uses for the watercourses traversed by, or within the vicinity of, the construction footprint. In Queensland, none of the watercourses within the construction footprint have declared environmental values or WQO, or are high ecological value waters.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\JEMENA\EIS (NT)\01 Project Files\Ch7-EMP\Water\Figure 7-19. Map of construction ROW and water users; towns, stations and communities.mxd

Figure 7-19. Map of construction ROW and water users; towns, stations and communities

7.3 WATER RISK ASSESSMENT

Risks associated with each potential impact were assessed using the procedures and criteria described in Chapter 5. The complete environmental risk register is documented in Appendix F1.

The likelihood and consequences of each potential impact to water were assessed in relation to the following objective defined by Section 5.5.1 of the EIS ToR:

"Ensure surface water and groundwater resources are protected both now and in the future, such that the ecological health and land uses, and the health, welfare and amenity of people are maintained. Available water supplies will be sufficient to fulfil the Project needs over the predicted life of Project, without causing environmental or social impacts."

For each potential impact to water identified in the risk register, the sections below provide a detailed discussion of risks structured as follows:

- **Context and assumptions:** a summary of the key aspects that influence the likelihood and consequence of impacts to the Project biodiversity objective
- **Inherent risk:** the likelihood and consequence of the impact occurring without additional controls
- **Controls:** the measures that will be taken to reduce inherent risk to ALARP
- **Assessment of effectiveness:** the anticipated effectiveness of the controls in reducing risk levels based on the experiences of Jemena, the Construction contractor and Environmental consultant, on other pipeline projects
- **Residual risk:** the risk level following risk treatment; assuming all controls are implemented.

7.4 POTENTIAL IMPACTS

Assessment of risks to water first involved identifying potential causes of impact associated with the Project activities described in Chapter 2, and subsequent impacts that could occur to surface and groundwater features in the context of the existing environment within the Project footprint and surrounds. The key references used were the EIS ToR (Appendix A), Project Description (Chapter 2) and the contextual information presented earlier in this chapter.

Construction of the pipeline and facilities will involve six river crossing (stream order five and above), 12 creek crossings (stream order three to four) and a number of minor drainage line crossings (stream order one and two). All watercourses crossed during construction are ephemeral to intermittent, and crossings will be constructed via open trench.

During the construction phase water will be required for construction purposes (i.e. dust suppression), potable water for the construction camps, and hydrostatic testing; a total volume of approximately 111 ML (refer to Section 7.6.6 for a further breakdown). Water will be sourced mainly from existing suppliers at Mount Isa and Tennant Creek, or from existing pastoral property groundwater bores.

Construction and hydrostatic test water will be stored in up to eight low consequence dams along the construction ROW, each with a capacity of 12 ML, which will be reinstated unless the landholder requests that they remain. Potable water will be stored in allocated potable water storage areas at each construction camp.

The following wastewater streams will be generated as a result of construction activities:

- the six construction camps will require on-site wastewater treatment and disposal via irrigation
- pre-fill and hydrostatic test water will require disposal to land; pre-fill water will be disposed to land at the end of each test section while hydrostatic test water will be stored in low consequence dams and reused for each test section. Hydrostatic test water will be discharged to land upon completion of the final test section
- should rainfall occur, or shallow groundwater be intercepted, during trenching the trench will require dewatering.

Construction will require land clearing and earthworks, which poses an erosion risk, particularly in high risk areas and where dispersive soils may be uncovered. Erosion within the construction footprint could result in sedimentation of the watercourses, although this would require a runoff event (i.e. rainfall), during which time the turbidity loads are naturally high in the watercourses traversed by the construction footprint. Nevertheless, erosion and sediment control plans will be developed for the various phases of the Project to manage drainage and minimise erosion and sedimentation within the Project footprint and receiving environment.

The majority of the construction footprint will be reinstated following construction, and water use will be minimal for the majority of operational activities. The exception to this is the PCCS, which will require approximately 4,800 L/day for use in gas processing. It will produce the same volume of wastewater (called produced water); up to 200 L/hour. This will be filtered and pumped to onsite evaporation ponds for disposal via evaporation.

Decommissioning water requirements are currently unknown, but it is assumed that they will be minimal as decommissioning will leave the pipe in situ (after it has been made safe), and remove above ground infrastructure, prior to rehabilitating the entire Project footprint. As such decommissioning risks are largely related to erosion and sedimentation risks and surface hydrology.

7.4.1 PLANNING

Activities during the planning phase, including early survey works, have potential to cause the following impacts to water:

- watercourse crossings not adequately assessed leading to insufficient detail for development of Progressive Erosion and Sediment Control Plans
- soils are not adequately mapped and problematic soils are not identified leading to inaccurate information for the development of specific management plans
- physical damage to watercourses when accessing survey activities.

7.4.2 CONSTRUCTION

Activities during the construction phase have potential to result in the following impacts to water:

- chemicals or hazardous substances entering groundwater or surface water due to a spill of chemicals or hazardous substances, and subsequent reduction in water quality
- sediment and/or vegetative material entering local watercourses, and subsequent reduction in water quality, due to:
    - ground disturbance
    - erosion of exposed soils
    - stockpiling of cleared vegetation and topsoil
    - trenching across watercourses
    - dewatering of water collected within the trench
    - uncontrolled release from low consequence dams
    - interception of shallow groundwater during trenching.
- sediment and/or vegetative material and/or contaminants entering groundwater aquifer due to the interception of shallow groundwater underneath watercourse crossings, and subsequent reduction in water quality
- reduced surface water flows due to the sourcing and extraction of water from watercourses, and subsequent impacts on downstream users and aquatic ecosystems
- alteration of surface water hydrology due to trenching across watercourses, via open cut, and subsequent impacts on downstream users and aquatic ecosystems
- exposure of problematic soils (e.g. dispersive, acid sulfate or contaminated) during surface and sub-surface excavations and subsequent reduction in water quality due to inadequate handling and/or treatment of problematic soils
- contaminated water entering watercourses or groundwater aquifers due to the generation and disposal of wastewater, and subsequent reduction in water quality
- drawdown of groundwater due to the sourcing and extraction of water for testing, and subsequent impacts on other groundwater users, groundwater dependent ecosystems and areas of ground-surface water interaction

7.4.3 OPERATIONS

Activities during the operations phase have potential to result in the following impacts to water:

- sediment entering local watercourses due to the erosion and scour of soils, and subsequent reduction in water quality
- chemicals or hazardous substances entering groundwater or surface water due to a failure of pipeline and release of contaminants, and subsequent reduction in water quality
- reduction in flows in watercourses due to the sourcing and extraction of water for operation of compressor stations, and subsequent impacts on downstream users and aquatic ecosystems
- drawdown of groundwater due to the sourcing and extraction of water for operation of compressor stations, and subsequent impacts on other groundwater users, groundwater dependent ecosystems and areas of ground-surface water interaction
- contaminated produced water from PCCS entering watercourses or groundwater aquifers due to uncontrolled release from evaporation ponds, and subsequent reduction in water quality.

7.4.4 DECOMMISSIONING

Activities during the decommissioning phase have potential to result in the following impacts to water:

- alteration of surface water flows associated with removal of infrastructure
- sediment entering local watercourses and reducing water quality associated with scour and erosion during removal of infrastructure.

These potential impacts are noted; however, no further assessment is undertaken in this chapter. Details of the decommissioning process and legislative requirements that will be applicable at the time (forecast to be in excess of 30 years from now) are not known with enough certainly to inform assessment of risk. Prior to decommissioning, a Decommissioning Management Plan will be that will include identification of risks and management measures to minimise impacts to water, to the satisfaction of the regulatory bodies at the time.

7.5 PLANNING PHASE RISKS

7.5.1 WATERCOURSE CROSSING ASSESSMENTS

Context and assumptions

Prior to construction a survey of all major watercourse crossings (stream order 3 and above) will be undertaken to inform the Progressive ESCP for watercourse crossings. This will be undertaken in conjunction with the soil mapping (see below). The survey of watercourse crossings will be timed for the dry season when the watercourses are dry, to enable assessment of the bed and bank profiles and provide a pre-disturbance assessment of the physical characteristics of each watercourse crossing. The survey will include identification of any permanent pools within the Ranken, Georgina and Templeton rivers in proximity to the construction footprint.

Inherent risk

There is a risk of the surveys not being conducted to a level that will provide sufficient information for the development of Progressive ESCP, resulting in inadequate or inaccurate ESCP and subsequent impacts on the level of disturbance and reinstatement of the watercourses. The consequence of this occurring is considered severe; as it could result in temporary harm to the environment and rectification requirements over the medium-term. However, as the survey data will be collected in a targeted manner during the soil survey program, the likelihood of this occurring is considered unlikely, resulting in an inherent risk of **MODERATE**.

Controls

In order to ensure that watercourse crossings are assessed to a level adequate for informing the Progressive ESCP surveys will be undertaken by a suitably qualified person (as identified in the IECA Guidelines). Surveys will be directed by the development of specific survey methods and field sheets to ensure all required information is captured consistently.

All major watercourses (stream order 3 and above) crossed by the construction ROW or new (proposed) access tracks will be surveyed and information used to develop Progressive ESCP, prior to construction.

Effectiveness

The development of, and adherence to, targeted survey methodology is an accepted method of ensuring consistent data collection. A suitably qualified person will develop the methodology as per the requirements of the Progressive ESCP. For land-based pipeline constructions, the IECA Guidelines define ‘suitably qualified person’ according to the width of the ROW and the erosion risk; at the bare minimum the person must have received advanced IECA training. The training and accreditation process through IECA is considered effective in ensuring that suitably qualified people develop Progressive ESCP and guide the required data collection.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface water as a result of inadequate surveys of watercourse crossings will be reduced to **LOW**.

7.5.2 SOIL MAPPING

Context and assumptions

Prior to construction a soil survey and soil landscape mapping will be conducted for the entire construction footprint. This will inform the Progressive ESCP, identify potentially problematic soils, and also provide geotechnical information for input into the construction and design process. The soil surveys will be undertaken by a suitably qualified soil scientist and will include field assessments and soil sampling.

Inherent risk

If the soil survey and soil landscape mapping is not undertaken, or not adequately assessed, there is a risk that problematic soils will not be identified, and Progressive ESCP will be inaccurate. The impacts of this include erosion and sedimentation of watercourses, and potential contamination issues related to inappropriate management of problematic soils (e.g. acidic leachate from acid sulfate soils). The consequence of inadequate soil sampling is considered severe; as it could result in temporary harm to the environment and rectification requirements over the medium-term. However, as the soil survey will be a

targeted exercise the likelihood of this occurring is considered unlikely, resulting in an inherent risk of **MODERATE**.

Controls

The soil sampling and soil landscape mapping will be conducted in accordance with the IECA guidelines. A soil scientist will develop the soil survey methodology and conduct the surveys. Any sampling will be undertaken in accordance with relevant standards and guidelines, and laboratory analysis will be conducted by a NATA accredited laboratory.

Effectiveness

The development of, and adherence to, targeted survey methodology is an accepted method of ensuring consistent data collection. A suitably qualified person will develop and undertake the soil landscape mapping and sampling in accordance with the IECA Guidelines.

The IECA Guidelines are the accepted Australian best practice guidelines for erosion and sediment control, and adherence to these guidelines is therefore considered to be a proven effective method for reducing risks associated with soil landscape mapping and identification of erosion risks.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface water as a result of inadequate soil landscape mapping will be reduced to **LOW**.

7.5.3 WATERCOURSE DAMAGE

Context and assumptions

During early survey works access to watercourses will be required to assess sections of the construction ROW and survey watercourses. It is assumed that no ground disturbance will occur within watercourses, and early survey works will only involve access by vehicles and foot.

The majority of watercourses traversed by the construction ROW will be dry during early survey works and are largely accessible by existing tracks. The watercourses are generally broad, with low banks, and braided, with relatively sparse riparian vegetation. Additionally, a number of the watercourses are within pastoral properties and show signs of physical damage due to cattle.

Inherent risk

Based on the above context and assumptions the consequence of damage to watercourses during early survey works is considered serious, with minimal damage that is recoverable through short-term remediation. The likelihood of this occurring is considered possible, resulting in an inherent risk of **MODERATE**.

Controls

During early survey works only existing tracks will be used for accessing the construction ROW and watercourses. Water course crossing will only occur at locations with minimum impact to watercourse banks. No ground disturbance within watercourses or adjacent riparian areas will occur.

Effectiveness

The risk is reduced through avoidance, which is considered an effective method of minimising impacts. This is consistent with the conditions of the Queensland pipeline survey permit, which is outcome-based and therefore considered proven effective.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface water as a result of inadequate soil landscape mapping will be reduced to **LOW**.

7.6 CONSTRUCTION PHASE RISKS

7.6.1 CHEMICALS OR HAZARDOUS SUBSTANCES ENTERING GROUNDWATER OR SURFACE WATER

Context and assumptions

Chemicals and other hazardous substances will be transported and stored onsite during construction. These will include diesel, lubricants, oils, paints and primers, chemicals, blasting materials and hydrostatic test chemicals.

Fuel will be transported to the construction camps where it will be stored in 110,000 L self-bunded tanks. Service trucks will refuel all machinery along the construction ROW, while all other vehicles will be refuelled at the camp in designated bunded areas.

Hazardous materials will be stored as required by their Safety Data Sheets (SDS), but generally in ventilated, self-bunded and secure shipping containers.

Blasting materials will be stored in secure areas by the blasting contractor in accordance with regulatory requirements.

For the purposes of the risk assessment it is assumed that volumes of chemicals and other hazardous substances will be relatively small, and that all chemicals and hazardous substances will be transported, stored and handled in accordance with relevant Australian standards and industry best practice.

Inherent risk

Based on the above context and assumptions, the consequence of a spill of chemical or hazardous substance is considered severe as it would be expected to result in temporary harm to the environment. In the context of the construction schedule and environment through which construction would occur it is reasonable to assume that runoff would be minor and spilt product would seep into the soil, providing opportunity for containment, clean-up and remediation. However, there is potential for spilt product to enter local watercourses and seep into groundwater, particularly in areas of ground-surface water interaction (e.g. shallow groundwater intercepted by trenching, or sinkholes). Without any mitigation measures, the likelihood of a spill is considered 'likely' due to the frequency of handling and transportation and the nature of the activity; spills are relatively common in construction and industrial environments.

The inherent risk to water associated with chemicals or hazardous substances is considered **HIGH**. Analysis of this risk indicated that further controls can be practicably implemented to reduce the likelihood of impacts to water occurring (see below).

Controls

Facilities for storage of hazardous materials will be designed in accordance with the requirements of the *Australian Dangerous Goods Code* and *Australian Standard (AS) 1940 Storage and handling of flammable and combustible liquids*. Storage and handling will comply with the requirements of the *National Standard NOHSC: 1015 (2001) Storage and Handling of Workplace Dangerous Goods* and all other industry accepted practices. The standards ensure that all practicable measures are in place to adequately contain substances and that handling is safe for all workers. Adherence to these codes will ensure that the likelihood of a spill is reduced (through appropriate storage for the substance) and also the consequence is reduced (e.g. through storage within bunding sized to contain 110 per cent of the volume of the storage).

No chemicals or hazardous substances will be stored near watercourses or sinkholes, and no refuelling will occur within 100 m of a watercourse or 200 m of a sinkhole (which is a pathway into the groundwater

aquifer). This will reduce the consequence of a spill, should one occur, through providing distance between the spill location and sensitive receiving environments. Containment and clean-up measures can then target the spill site, with little risk of off-site transport (e.g. in a watercourse).

Volumes of fuel will be logged to monitor for leaks and spills, which would be indicated by a pattern of loss or a large loss. This reduces the likelihood of a leak being undetected.

The Traffic Management Plan (refer Appendix E) details the traffic and transport considerations to ensure the safe passage of vehicular traffic, and also reduce the risk of vehicle accidents resulting in spills during transport. Adherence to the controls in the Traffic Management Plan will reduce the likelihood of a traffic accident resulting in a spill.

A Dangerous Goods and Hazardous Substance Management Procedure will be developed that will detail the types of materials stored, storage requirements for the chemicals and hazardous substances used for the Project, and specific spill response requirements for each substance. Standard spill response materials will be sourced for the Project and spill kits will be maintained onsite and with machinery on the construction ROW. Workers will be trained in spill response procedures. Storage requirements will reduce both the likelihood and consequence of a spill, through ensuring storage is appropriate for the substance and any spill is detected and contained. Spill response measures will reduce the consequence of a spill through containment, clean-up and remediation.

A Dangerous Goods and Hazardous Materials Register will be maintained, and all substances will stored and handled in accordance with Australian Standards and the SDS. This will allow tracking of all substances stored on-site and ensure that the above controls are implemented in accordance with the specific requirements of each substance, further reducing the consequence of any spill.

Effectiveness

The transport, storage and handling of fuels, chemicals and hazardous substances are prescribed by Australian Standards (AS1940:2004 in particular) and the *Code of Environmental Practice – Onshore Pipelines* (APIA 2013). These are considered best-practice for construction and pipeline projects in Australia and therefore when implemented are considered proven to be effective.

The NGP Construction Contractor has extensive experience in applying the controls for transport, storage and handling of fuels, chemicals and hazardous substance prescribed by the Code, including spill response measures. Additionally, SDS are developed for all hazardous substances and chemicals, which clearly outline the hazards associated with each product and the required storage, handling and spill responses as relevant. The development of a Dangerous Goods and Hazardous Substance Management Procedure will ensure that the required storage and handlings practices are captured for chemicals and hazardous substances that will be used for the construction phase of the Project.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface and groundwater as a result of the transport, storage and handling of chemicals and hazardous substances will be reduced to **LOW**.

7.6.2 SEDIMENTS AND/OR VEGETATIVE MATERIAL ENTERING SURFACE WATERCOURSES OR GROUNDWATER

Context and assumptions

Sediment and vegetation entering surface watercourses may occur as a result of clearing of vegetation and the exposure of soils, stockpiling of vegetation and soils, and dewatering of water accumulated in the trench (as a result of rainfall or groundwater interception during trenching). The impacts associated with these events are a reduction in water quality, particularly due to increased turbidity within the watercourse, and resultant impacts on aquatic ecosystem health.

Areas of highly erodible soils can contribute to higher sediment loads in watercourses, particularly if erosion is exacerbated due to soil disturbance. Preliminary soil landscape mapping has identified areas within the Project footprint where highly erodible soils may occur; these areas will be further investigated during a detailed soil survey undertaken prior to construction.

Preliminary hydrogeological assessment indicates that shallow groundwater may be intercepted by trenching activities in areas surrounding major watercourses. Sinkholes are also likely to occur in areas underlain by dolomite geological formations (e.g. Camooweal Dolostone). These provide potential pathways for groundwater contamination.

For the purposes of the risk assessment it was assumed that construction occurred without specific erosion and sediment controls in place. However, the risk was also assessed in the context of the semi-arid climate of the region (rainfall significantly increases erosion risk) and proposed construction schedule, and the existing geology and soils identified by desktop research.

It is not expected that significant volumes of water will be captured and dewatered from the trench, due to the climate (i.e. low rainfall for much of the year), construction schedule and depth of groundwater aquifers underlying the construction footprint. The risk has been assessed as a contingency should rainfall occur, or should shallow seasonal watertables be intercepted during trenching near major watercourses. The main potential impact of trench dewatering on water quality is increased sediment loads.

Inherent risk

Based on the above context and assumptions, construction activities have the potential to result in erosion and sedimentation of watercourses and groundwater aquifers, plus the deposition of vegetative material in watercourses. Any deposited material would potentially be released off-site due to the nature of watercourses and groundwater aquifers. Erosion can be notoriously difficult to rectify, and if watercourses are flowing removal and rectification of deposited sediment and vegetation would be difficult. Given the level of soil disturbance, it is likely that there would be some level of sedimentation and vegetation deposition in watercourses or groundwater aquifers if no controls are implemented.

The inherent risk to water associated with sediment or vegetative material entering surface water or groundwater is considered **HIGH**. Analysis of this risk indicated that further controls can be practicably implemented to reduce the likelihood of water impacts occurring (see below).

Controls

During construction, the area of exposed soils will be minimised through staged construction and progressive reinstatement of disturbed areas to reduce the likelihood of erosion. Stockpiles of soil and cleared vegetation will be located away from watercourses and drainage lines, and topsoil and subsoils will be stockpiled separately and reinstated in the order that they were removed in. Drainage controls will be installed to divert surface runoff around the trench and minimise the volume of water captured in trenches,

should rainfall occur. The trench will be progressively backfilled, which will also minimise the volume of water captured in the trench. Any dewatering required will occur to land, via erosion and sediment controls.

A two stage process will be implemented for erosion and sediment control planning, in accordance with the IECA Guidelines (IECA 2008). The ESCP will focus on reducing the likelihood of erosion (by providing drainage controls, ground cover, and minimising soil disturbance), and also include provision for reducing the consequence of erosion, sedimentation and vegetation removal (by containing it on-site and avoiding deposition in watercourses or groundwater aquifers).

A Primary ESCP has been developed as a supporting document for this EIS (see Appendix P); it provides an erosion risk assessment of the area and stipulates general management and risk minimisation measures for the entire Project. Standard drawings for applicable drainage, erosion and sediment controls are also provided, including those for watercourse crossings. Monitoring and reporting requirements are also outlined.

Following further, more detailed, soil and watercourse crossing assessments, Progressive ESCP will be developed that provide specific detail on high risk areas. As a minimum, these will cover major watercourse crossings, high erosion risk areas, gently sloped areas that may have dispersive soils, and the compressor stations, where both temporary and permanent controls will be required. The Progressive ESCP will be developed by a suitably qualified person in accordance with the IECA Guidelines. They will include contingencies for rainfall events and the specifications for watercourse crossings if water is present.

Effectiveness

The IECA Guidelines are the accepted Australian best practice guidelines for erosion and sediment control, and *Appendix P – Land Based Pipeline Construction* has been developed specifically for linear infrastructure developments such as the NGP pipeline. The development and implementation of erosion and sediment controls plans in accordance with these guidelines is therefore considered to be a proven effective method for reducing risks associated with erosion and sedimentation of watercourses. The IECA provides a mechanism for obtaining recognised qualifications in erosion and sediment management; a Certified Professional in Erosion and Sediment Control (CPESC). If required (as determined by the guidance on suitably qualified persons in the IECA guidelines) a CPESC will be engaged to complete the Progressive ESCP, which will ensure that the ESCP comply with best practice and the proposed mitigation measures would be effective, if implemented appropriately.

The *Code of Environmental Practice – Onshore Pipelines* (APIA 2013), which is considered best-practice for construction and pipeline projects in Australia, refers to the IECA Guidelines for best practice erosion and sediment control. Therefore, development and implementation of ESCP in accordance with the IECA Guidelines is considered proven to be effective.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to water as a result of sediment or vegetative material entering watercourses or groundwater aquifers will be reduced to **LOW**.

7.6.3 EXPOSURE OF PROBLEMATIC SOILS

Context and assumptions

The exposure of problematic soils, such as dispersive, acid sulfate or contaminated, may occur during the construction of the Project, primarily associated with the clearing of vegetation and trenching of the

pipeline. This activity can result in the release of sediments, acidic seepage or contaminants into watercourses.

The ROW crosses a complex mix of soil types, some of which could be dispersive. Disturbance of dispersive soils during construction could result in significant erosion issues if they are not treated or are poorly managed, as they have poor soil structure and tend to break up rapidly when exposed to water. The specific locations of dispersive soils within the construction footprint will be further investigated during detailed soil investigations (prior to construction).

No areas of potential contamination have been identified along the construction ROW.

Areas of potential acid sulfate soils (ASS) were mapped on Australia-wide ASS layers, which are very broad. The preliminary geotechnical investigations for the Project did not identify any areas of ASS, although intrusive investigations were limited. Further, more detailed soil sampling will be conducted prior to construction. Any potential ASS soils identified in the field will be sampled and analysed to confirm the location and acidity of the soils. An Acid Sulfate Soils Management Plan will be developed which will include identification, storage and handling, and treatment (i.e. neutralising) requirements if required.

Erosion and sediment control measures will be implemented though each phase of the Project to prevent run-off and problematic soils entering watercourses.

Inherent risk

Based on the above context and assumptions, construction activities have the potential to result in the exposure of problematic soils, which could then impact surface and ground water quality. The consequence of this occurring is severe, while the likelihood is possible, resulting in an inherent risk of **SIGNIFICANT**.

Controls

Prior to construction a detailed soil survey will be conducted of the entire Project footprint by a suitability qualified soil scientist. The survey will identify the location and extent of problematic soils within the Project footprint, and reduce the likelihood of unintentionally disturbing problematic soils. Subject to the results of this survey, specific management plans will be developed, for example:

- Acid Sulfate Soils Management Plan
- Progressive ESCP for dispersive soils
- Contaminated Soil Management Plan

The management plans will include maps that clearly illustrate the location of any problematic soils, which will be provided to the Construction Contractors for use during construction activities. The plans will also stipulate the required procedures for management, treatment, remediation and/or handling requirements of the soils, as appropriate to the nature of any problematic soils identified. The management plans will be developed in accordance with relevant guidelines, for example:

- The Queensland Acid Sulfate Soils Technical Manuals (Qld Government 2013)
- National Guidance for the Management of Acid Sulfate Soils in Inland Aquatic Ecosystems (EPHC and NRMMC 2011)
- IECA Best Practice Erosion and Sediment Control Guidelines (IECA 2008) – including specifically the addendum *Appendix P – Land Based Pipeline Construction.*

- National Environment Protection (Assessment of Site Contamination) Measure (NEPC 2013) – referred to as the NEPM Guidelines

Effectiveness

The treatment of problematic soils is guided by national standards and industry best practice guidelines, which stipulate their handling and treatment, and sampling and monitoring requirements to assess the success of management measures. Compliance with the relevant standards and guidelines through the development and implementation of specific management plans is proven effective in the management of problematic soils. If required, specific management plans will be developed by suitably qualified people, and assessed by independent third parties to ensure their adequacy for minimising impacts from problematic soils. This is an accepted method of ensuring management plans and their implementation strategies are effective on-ground.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to water as a result of exposure of problematic soils will be reduced to **LOW**.

7.6.4 CONSTRUCTION CAMP WASTEWATER ENTERING SURFACE WATERCOURSES OR GROUNDWATER AQUIFERS

Context and assumptions

The uncontrolled release of contaminated wastewater has the potential to enter surface watercourses or groundwater aquifers and reduce surface and groundwater quality within the locality.

Wastewater will be generated through the operation of the construction workers camps and also as a result of construction activities. The various wastewater generating activities are discussed below.

Five temporary construction camps will be used to accommodate the pipeline construction workforce along the ROW. Camps will be commissioned and decommissioned progressively with multiple camps in operation at one time. In addition to the pipeline construction camps, a construction camp will be located adjacent to the PCCS site to accommodate the PCCS construction workforce. Each camp will have capacity for up to 300 personnel and will have onsite wastewater management. The total volume of wastewater generated from all construction camps will be approximately 20 ML (this volume includes wastewater generated as a result of vehicle washdowns).

Each camp will have onsite wastewater management for the treatment of sewage and ablutions wastewater and camp kitchen waste. Treated wastewater will be irrigated in allocated areas at each camp.

Washdown bays will be located at each camp and along required sections of the ROW for washdown of vehicles and weed hygiene.

Wastewater, if inappropriately treated, stored or discharged, may enter surface watercourses and impact on water quality. Raw sewage, or poorly treated sewage, is high in nutrients, pathogens (e.g. Thermotolerant coliforms, *E.coli*), biological oxygen demand and suspended solids. The impact of these on water quality include nutrient spikes, algal blooms and eutrophication, which in turn can impact aquatic ecosystem health (e.g. fish kills). Additionally, the presence of pathogens in water poses a human health risk through interaction with water (e.g. swimming) and consumption of drinking water.

Wastewater from washdown bays is assumed to include weed seeds and vegetative material, sediment, and potential metals and hydrocarbons from vehicles (e.g. oil residue). The impact of these on water

quality include nutrient spikes (and associated algal blooms and eutrophication), sedimentation, and contamination with metals and hydrocarbons, and associated impacts on aquatic ecosystem processes.

Some areas within the construction footprint are underlain by highly porous and cavernous aquifers of limestone and dolomite formations. Outcropping of limestone or dolomite, or sinkholes, indicates potential for high connectivity with the underlying aquifer, and any contamination event could quickly mobilise large distances.

Upon completion of construction, all wastewater treatment, irrigation and washdown bay infrastructure will be removed and the areas will be reinstated (i.e. wastewater treatment will be temporary).

Inherent risk

Based on the above context and assumptions, the consequence of uncontrolled release of construction camp wastewater on surface or groundwater quality would be severe as it would result in temporary impacts on water quality, and the potential for temporary harm to the environment. Without any controls the risk of this occurring is considered possible, resulting in an inherent risk of **SIGNIFICANT**. Analysis of this risk indicated that further controls can be practicably implemented to reduce the likelihood of impacts to water occurring (see below).

Controls

No wastewater will be discharged to a watercourse.

Wastewater will be treated onsite and irrigated in accordance with applicable Australian standards, and will require approval from Northern Territory Department of Health (DoH). Irrigation systems for treated wastewater will be designed and operated in accordance with the *Guidelines for Wastewater Works Design Approval of Recycled Water Systems* (DoH 2013) including obtaining a *Wastewater Works Design Approval* from DoH prior to installation of the systems, undertaking a *Land Capability Assessment* for each site or assessing on-site soil characteristics, and obtaining Waste Discharge Licences where required. These measures will reduce both the likelihood and consequence of impacts to water quality from construction camp water as it will ensure that water is treated and disposed of appropriately. The Northern Territory *Guidelines for Wastewater Works Design Approval* (DoH 2013) stipulates the classes of wastewater management based on a risk assessment. The camp wastewater systems are categorised as a “Class C” system (medium risk) and appropriate end uses include irrigation with enhanced restricted access and application.

Irrigation areas will be located away from watercourses and application rates will be in accordance with accepted standards. Irrigation will be designed and managed such that no surface water runoff will occur. No irrigation of treated wastewater will occur in areas of limestone or dolomite outcrop, or sinkholes. This will reduce the consequence of any uncontrolled release of construction camp wastewater.

Washdown bays will be a closed loop, with water recycled through the system and then finally directed through the wastewater treatment system at the camps. No discharge from washdown bays will occur, eliminating the likelihood of impacts to water quality.

Effectiveness

Onsite treatment and disposal of wastewater is prescribed through Australian Standards and Northern Territory guidelines, and administered via approvals through the Department of Health. This includes water quality guidelines for treated effluent, specific controls for irrigation areas, and buffer distances to watercourses. Compliance with these approvals, standards and guidelines is considered proven to be effective.

Washdown bays will be designed and installed to be closed loop and have no discharge. This is considered to be effective as, through this design, risks to water quality have been avoided.

Monitoring and inspections of treated wastewater, irrigation areas and washdown bays will be undertaken as per the Water Management Plan (Construction) (Appendix O), which will provide an assessment of the effectiveness of the mitigation measures and ensure they are implemented in accordance with relevant approvals and management plans.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface and groundwater as a result of the treatment and disposal of construction camp wastewater will be reduced to **LOW**.

7.6.5 HYDROSTATIC TEST WASTEWATER ENTERING SURFACE WATERCOURSES OR GROUNDWATER AQUIFERS

Context and assumptions

The pipeline will be hydrostatically tested prior to operation to detect potential leaks and confirm the pipeline's capability to operate at the proposed operating pressure. Testing will be undertaken in accordance with AS2885.5. Sections of the pipeline will be tested as they are completed (referred to as 'test sections'). The number of test sections, and lengths, will be confirmed during detailed design.

Prior to hydrostatic testing, the test section will be cleaned with an absorbent pig and then flushed with approximately 0.02 ML of water (referred to as 'pre-fill') to remove any sediment that is sitting in the bottom of the pipe. The pipeline is internally coated and flushed during fabrication (prior to arrival at site), and any dirt, dust and debris in the pipe will only be from welding and installation in the trench.

Pre-fill water will be discharged to a bell hole, and then to land via sediment filtration at the end of each test section. Following pre-fill, the test section will be filled with hydrostatic test water.

A total of 22 ML of hydrostatic test water will be required (up to 8.5 ML per test section). This volume includes pre-fill water. Water is expected to be sourced from approved sources along the construction ROW.

Hydrostatic test source water will be tested prior to use to ensure that the quality is suitable for hydrostatic testing, primarily being fresh water. The requirement for oxygen scavenger and biocide additives, which may be added to the hydrostatic test water during testing, will be assessed following final determination and testing of source water, and will be detailed in the Hydrostatic Test Management Plan.

Hydrostatic test water will be stored in low consequence dams along the ROW and reused in subsequent test sections where practicable, to minimise the demand on water resources and the number of discharge sites. At the completion of testing hydrostatic test water will be discharged, subject to sampling of the water quality and compliance with relevant guideline values.

A study conducted on the quality of hydrostatic test water and impacts of discharge on receiving environments was undertaken by the CSIRO (see CSIRO 2005). The study found that the quality of hydrostatic discharge water was primarily a factor of the source water quality, and was also influenced by the additives used, and residue from pipe construction (e.g. sediment and metals). In the majority of cases, pre-cleaning of the pipe will reduce residue picked up during hydrostatic testing, and oxygen-scavengers can be readily broken down through aeration (e.g. spray irrigation).

In general, it was found that *"the quality of discharge water causes no increase in environmentally hazardous compounds derived from the pipe or any treatment made to the water"* (noting that none of the study pipelines used biocides; CSIRO 2005). *"Hydrostatic test water does no contribute to the concentration of nutrients… however the discharged water does contain increased turbidity…low levels of dissolved oxygen… and increased levels of sodium or ammonium sulphate"* (CSIRO 2005). Treatment of hydrostatic test water successfully reduced most contaminants to comply with guideline values, with the exception of biocides. Water treatment to remove residual concentrations of biocides can be undertaken, but to be successful it requires a specific treatment program to be developed, dependant on the biocide product used. This process can be time consuming and expensive, and as a result alternative methods of disposal are often sought (e.g. off-site disposal to a licenced facility or evaporation).

Construction and hydrostatic test water will be stored in temporary 12 ML low consequence dams constructed along the construction ROW. Current estimates are that eight dams will be required, but the location, sizing and number of dams will be confirmed during detail design, prior to construction.

Inherent risk

Uncontrolled release of hydrostatic test water (either from dams or directly at the test section site), or release without pre-treatment, is considered to have a severe consequence as it could result in temporary impacts on water quality and temporary harm to the environment. The likelihood of this occurring is considered possible, resulting in an inherent risk of **SIGNIFICANT**.

Note that this assumes that the water quality will be similar to that discussed in the CSIRO report; specifically it will not contain hazardous compounds from the pipe or biocide additives, but will be high in turbidity, low in dissolved oxygen, and may contain some levels of sodium, ammonium sulphate, and other minerals. It is also based on the assumption that source water quality will be good (i.e. low in nutrients, salinity, metals or other contaminants) as it will be sourced from existing suppliers.

The quality of source water, requirements for additives (i.e. biocides or oxygen scavengers), subsequent discharge water quality, and the discharge location, were not known at the time of this assessment. This has precluded robust quantification of the risks, and residual risks remain moderate in acknowledgment of the need for further work (see below). The general controls that can be practicably implemented to reduce the likelihood of impacts to water quality are outlined below, as are the specific requirements for further work.

At the time of writing the report there was limited information on the expected quality of pre-fill water, or treatment and discharge controls. For the purposes of risk rankings it is considered that pre-fill water will be of similar quality to hydrostatic test water and will not contain any additives.

Controls

Prior to flushing the test section with pre-fill water, an absorbent pig will be used to clean the pipe, removing construction debris from welding and dirt and dust. Once this is complete, a small volume of pre-fill water will be flushed through the test section; this will not fill the pipe but run along the bottom removing any sediment or dirt sitting in the bottom of the pipe. The pre-fill water will be discharged into a bell hole (a wider section of the trench). A volume of the pre-fill water is likely to seep into the surrounding soil; any remainder will be pumped out and discharged to ground at the end of the test section via sediment filtration (e.g. filter sock or sediment fences). Initial pigging reduces the likelihood of pre-fill and hydrostatic test water picking up contaminants such as metals, as the majority of construction residue will be removed. Filtering the pre-fill water via sediment controls reduces the consequence of discharging, as sediments and any residual construction debris will be removed.

Prior to discharging hydrostatic test water, the water will be sampled and analysed as per the Water Management Plan (Construction) (Appendix O). Where guideline values cannot be met, water will be treated to reduce the likelihood of impacts to water quality. If, following treatment, guideline values still are

not met, or if biocides are added to the water, then the water will be disposed of via alternative methods such as evaporation ponds, reducing the consequence of disposal. No discharge will occur unless guideline values are met, and discharge will only be to approved areas in accordance with environmental approvals and Waste Discharge Licence conditions. No discharge will occur near watercourses, in areas overlying highly porous aquifers, or near sinkholes, reducing the consequence of discharge on water quality.

For discharges in the Northern Territory a Waste Discharge Licence (WDL) will be sought from the NT EPA, the conditions of which will stipulate water quality and discharge requirements. Discharges in Queensland will be in accordance with conditions E8 and E9 of the Environmental Authority (EA).

A Hydrostatic Test Water Management Plan will be developed prior to commencing hydrostatic testing and will contain further detail on hydrostatic testing.

Dams used for storage of hydrostatic test water will be designed and constructed in accordance with accepted engineering standards, and will be monitored for early signs of loss of structural or hydraulic integrity, to reduce the likelihood of dam failure or leak. Dams will be engineered and sited to present a low risk of overtopping or uncontrolled release to surface watercourses, or seepage to groundwater aquifers, reducing the consequence to water quality should dam failure or leakage occur.

The consequence category of dams will be assessed in accordance with the Queensland *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DEHP 2013) prior to design and construction. Only low consequence dams will be constructed, which requires that they are:

- Designed such that the risk of failure (seepage or overtopping) or dam break is low
- The consequence of any failure would result in impacts to:
  - Locations where people are not routinely present in the failure path,
  - Locations where contamination of water used for human consumption could result in the health of <10 people being affected
  - Locations where contaminants[1]:
    - Are unlikely to be released to areas of Significant Values or Moderate Values
    - If released, would not cause impacts to environmental values of slightly to moderately disturbed waters, wetlands of ecological significance, riverine areas, springs or lakes.

A consequence assessment report will be prepared for each dam in Queensland and submitted to DEHP, and all structures will be certified as required under the guidelines. This will be completed by the Construction Contractor progressively throughout the construction phase.

Effectiveness

If implemented appropriately, the procedures for management of hydrostatic test water are expected to be effective as they are in accordance with the *Code of Environmental Practice – Onshore Pipelines* (APIA 2013), which is the established best-practice guidance relevant to managing the environmental impacts associated with hydrostatic testing on pipeline projects. However, there are uncertainties around the water quality of pre-fill and hydrostatic test discharge water, and the discharge locations. As such, further work is

[1] 'Contaminants' is the terminology used in the Qld Manual for assessing the consequence of dams (DEHP 2013), and is used to refer to dam water. It does not imply that all dam water is contaminated with hazardous substances, but rather any accidental release is a potential contamination event.

required to prove the effectiveness of the controls, and demonstrate how they will be implemented (refer below).

The process of assessing the consequence of dams and only constructing low consequence dams will ensure that all dams are designed such that the likelihood of failure is low. It also ensures that should failure occur, resulting consequences will not adversely impact watercourses or sensitive receiving environments. This is considered best practice and a regulatory requirement in Queensland, and is an outcome based process. Compliance with the *Manual for Assessing Hazard Categories and Hydraulic Performance of Dams* (DEHP 2013) is considered effective in reducing risks associated with water storage dams.

Residual risk

Due to uncertainties around the quality of pre-fill and hydrostatic testing discharge water, and the location of discharges, the precautionary principle has been used when assessing the residual risk of hydrostatic test wastewater impacts on surface and groundwater quality. As such the residual risk is **MODERATE**, and further work is required to reduce the residual risk to ALARP.

In order to further reduce the residual risk, the Hydrostatic Test Management Plan will need to include:

- source (s) of hydrostatic test water, and expected quality of source water
- required additives for hydrostatic test water
- expected water quality prior to discharge, of both pre-fill and hydrostatic test water
- required treatment regime, of both pre-fill and hydrostatic test water
- monitoring and reporting requirements for water quality
- specific details and designs for disposal.

The Hydrostatic Test Management Plan will be developed prior to the commencement of hydrostatic testing.

7.6.6 DRAWDOWN OF GROUNDWATER

Context and assumptions

Water use during the construction phase is estimated as (total volumes):

- 69 ML for construction purposes (e.g. dust suppression)
- 20 ML of potable water
- 22 ML of hydrostatic test water.

An initial assessment of water availability within the region indicates water can be sourced primarily from existing suppliers at Mount Isa and Tennant Creek.

Mount Isa is supplied raw water from both Lake Moondarra and Lake Julius, which have respective capacities of 106 – 800 ML and 107 – 500 ML. The dams have current supply levels of 68.5 per cent and

96 per cent respectively[2]. Mount Isa Water Board treats the water to potable standards, and distributes it through the town supply network in accordance with legislated allocations.

At Tennant Creek potable water is supplied from the Cabbage Gum / Kelly Well bore fields operated by the Power and Water Corporation. Water from the bore fields is chlorinated prior to distribution.

Consultations with Mount Isa Water Board (the water supplier for Mount Isa) and Power and Water Corporation (the water supplier for Tennant Creek) indicate that potable water can be sourced from existing supplies.

Construction and hydrostatic test water will be sourced from existing supplies at Mount Isa and Tennant Creek, and existing groundwater bores along the construction ROW as required. Hydrostatic test water and construction water will be stored in low consequence storage dams, and high evaporation rates may necessitate water volumes to be supplemented with groundwater from bores near the construction ROW.

Initial assessment of the groundwater resources along the construction ROW indicates that groundwater of varying flows and quality is available along the construction ROW. The variation is the result of the distance covered by the construction footprint, which traverses three groundwater provinces (as outlined in Section 7.2.4). Average daily water use for construction requirements is estimated at 0.35 ML/day, which could be supplied by three bores of an average flow rate of 1.5 L/s. This provides guidance on the target locations for groundwater extraction; refer to the Water Availability Study (Appendix N) for further information on groundwater sourcing.

Drawdown of groundwater beyond a sustainable yield could result in lack of groundwater resources for other users (i.e. pastoral properties), potential impacts on areas of ground-surface water interaction (i.e. springs where groundwater recharges surface water flows), and impacts on GDE.

Inherent risk

Based on the above context and assumptions, the consequence of groundwater drawdown is considered major, as it could have a major effect on water resources, other users, and GDE. Options for the rectification of groundwater drawdown are limited, and rely on natural recharge. An assessment of the hydrogeological context at a regional scale indicated that the likelihood of drawdown of groundwater resulting in major impacts was possible, given the relatively modest construction water volumes and short duration of extraction (i.e. the construction phase). The inherent risk of drawdown of groundwater is considered **HIGH**.

At the time of writing the report there was limited information on the specific locations and volumes of groundwater extraction, as water sourcing will be further defined during the detailed planning phase. This has precluded robust quantification of the risks to groundwater, and residual risks remain moderate in acknowledgment of the need for further work (see below).

The general controls that can be practicably implemented to reduce the likelihood of impacts to groundwater are outlined below, as are the specifics requirements for further work.

Controls

All water from existing bores will be extracted under landholder agreements and in accordance with any relevant water allocations. As much as possible, water will be sourced from existing suppliers at Mount Isa and Tennant Creek to reduce the demand on groundwater resources.

Prior to construction, the sustainable yields will be determined for proposed groundwater extraction bores to provide further information on the risk of groundwater drawdown and to reduce the likelihood of over-

[2] As at 5 May 2016.

extraction. Standing water levels will be measured prior to, during and immediately following extraction to provide insight into drawdown of groundwater. Groundwater drawdown will be assessed in the context of natural seasonal variation.

Information on the specific location and volumes of groundwater extraction for construction will be confirmed during the detailed design phase and detailed in the Construction Environmental Management Plan (CEMP) and Hydrostatic Test Management Plan.

If new groundwater bores are required they will be drilled by a driller licenced under the relevant legislation (e.g. NT Water Act). Any new bores will be pump tested to assess their sustainable yields and inform extraction rates. Licencing of water bore drillers by the Northern Territory Government means that the onus is on the driller to ensure that:

- drilling is undertaken legally
- bore design suits the hydrogeological conditions and protects the aquifer
- location of the bore is compliant with required setbacks and buffers
- bore is constructed appropriately (i.e. cutting are removed, the bore is cased and capped and no chemicals or toxic drilling fluids are used)
- bore information is supplied to Water Resources for registration of the bore, and maintenance of records on the hydrogeological conditions and water quality (where relevant).

Effectiveness

Landholders are generally familiar with the yields of groundwater bores on their properties, and the conditions or requirements of any water allocations. Development of, and compliance with, landholder agreements is expected to be effective in ensuring extraction volumes are in accordance with landholder expectations. However, this does not inherently mean that yields are sustainable for the aquifer. As such, further work is required to prove the effectiveness of the controls in reducing the risk of groundwater drawdown (refer below).

The Water Act (*NT*) (as in force from 1 July 2016) and supporting documents stipulate the process for driller licencing and the requirements of licenced drillers in the Northern Territory. It is expected that the use of a licenced driller will be effective in ensuring water bores drilled for the Project are legally constructed and tailored to the hydrogeological conditions. Pump testing will be undertaken by the licenced driller and is considered industry standard in assessment of the drawdown of groundwater. Compliance with current legislation and industry standards is considered to be proven effective in drilling groundwater bores to minimise impacts on groundwater aquifers.

Residual risk

Due to uncertainties around the location and volumes of groundwater extraction, the precautionary principle has been used when assessing the residual risk to groundwater extraction and impacts of drawdown and over-extraction. As such the residual risk is **MODERATE**, and further work is required to reduce the residual risk to ALARP.

In order to further reduce the residual risk, the following will need to occur:

- determine the locations of groundwater extraction
- determine the required volumes from each bore, and time of extraction

- determine the sustainable yields of proposed bores to be used for extraction, in relation to their hydrogeological context, and proximity to other users, GDE and watercourses
- confirm the requirement for additional bores, and if required, determine the location of, and volumes required from, new bores
- measure the standing water levels in groundwater bores used for extraction prior to extraction, during extraction, and immediately after extraction to assess groundwater drawdown.

Sustainable yield data is to inform groundwater extraction rates and specific mitigation measures for reducing the risk of groundwater drawdown. This information will be incorporated into the CEMP and Hydrostatic Test Management Plan, which will be developed prior to construction and the commencement of hydrostatic testing respectively.

7.6.7 ALTERATION OF SURFACE WATER FLOWS

Context and assumptions

The Construction ROW crosses six major watercourses (i.e. stream order five and above; rivers), 12 minor watercourses (stream order three and four; creeks) and numerous drainage lines, all of which are ephemeral. The creeks and drainage lines are generally part of much larger and wider floodplains which convey significant volumes of flow during flood events.

The Project has the potential to alter surface water flows as a result of the installation of the pipeline across watercourses, which may alter watercourse crossing profiles, impede water flows (if present) or intercept shallow groundwater. No water will be sourced from watercourses, and as such there will be no impacts to surface water flows as a result of water extraction. Any surface water used in the construction or operation of the pipeline will be from existing, approved suppliers in accordance with agreements developed between Jemena and the supplier.

The risk of impacting water flows or intercepting groundwater is higher following rainfall, at the end of the wet season, or when there are flows in watercourses. The risk assessment has been undertaken based on the assumption that watercourse crossings will be undertaken in times when there is no water present, or no flow. If watercourse crossings will be undertaken during times of flow, or when shallow groundwater tables are high (i.e. late in the wet season) then the risk assessment will require revision and mitigation measures will need to be developed accordingly. Content that informed the current risk assessment is detailed below.

Each watercourse crossing will be reinstated as soon as practicable after construction by backfilling excavated soils (in order – i.e. subsoils first, followed by topsoil) and re-contouring to match the original profile of the bed and bank. Preliminary watercourse crossing assessments undertaken for the EIS indicate that most major watercourses to be crossed during construction have wide and low profiles. This aids reinstatement of the bed and banks to the original landform, minimising the risk of long term alteration to the local hydrology.

Trenching across major watercourses may intercept shallow groundwater. In this event the trench will require dewatering. Assuming watercourse crossings will be conducted during times of no flow or low flow, and given the shallow depths of excavations, the volumes of groundwater intercepted are not expected to be large. Watercourse crossings will be constructed in the shortest practicable time to minimise the duration of open trenching across watercourses.

Surface flows may also be altered by long-term scour and erosion within the reinstated bed and banks of the watercourses. This could occur over time as a result of repeated high velocity flood events. The potential for scour is generally associated with the type of sediment occurring within the bed and banks.

The alteration of surface flows may result in impacts on water quality (i.e. due to sedimentation), downstream users, and aquatic ecosystems.

Inherent risk

Based on the above context and assumptions, the consequence of construction works altering surface flows is considered major as it could result in major impacts to aquatic ecosystems (i.e. through altered stream beds and flow regimes). Should reinstatement works be inadequate to avoid impacts to surface water flows, rectification will be difficult. This is especially true if issues with reinstatement (e.g. scour of reinstated bed and bank) are not identified until after a wet season, when the ROW and access tracks have been reinstated (impeding access for rectification works), and machinery is no longer on-site. Assuming rainfall will be minimal and there will be no significant flow in watercourses at the time of the pipeline installation, the likelihood of major impacts to surface flows is considered possible, resulting in an inherent risk of **HIGH**.

Controls

Only activities directly required for the construction of linear infrastructure will be undertaken within watercourses.

Watercourse crossings will be constructed in the following order of preference:

- firstly, in times when there is no water present
- secondly, in times of no flow
- thirdly, in times of flow, but in a way that does not impede low flow.

The design of watercourse crossings will be undertaken to minimise the potential for long-term alteration of hydrology. Open trenching is the preferred method of construction given the watercourses are ephemeral, and the trenched area will be backfilled to reinstate the original profile of bed and banks as far as possible. A Progressive ESCP will be developed prior to construction that will detail watercourse crossings, methods for backfill, reinstatement and stabilisation, and requirements for post-reinstatement monitoring. Examples of typical watercourse crossings (sourced from IECA 2008 and APIA 2013) are provided in Figure 7-20, for open trench construction across a dry watercourse, Figure 7-21 for watercourse crossings where low flows may occur or rainfall is predicted, and Figure 7-22 for watercourse crossings that are flowing and require a dam and pump system. Note that these are examples only, and actual watercourse crossings will be designed and detailed in the Progressive ESCP.

Information on the nature, location, extent and timing of watercourse crossings works in the Northern Territory will be submitted to the Department of Land Resource Management (DLRM) prior to works commencing. If watercourse flows commence during works in the Northern Territory a *Permit to Construct or Alter Works* will be sought from DLRM. All crossings in Queensland will be undertaken in accordance with the *Code for Temporary Waterway Barrier Works and the Activities in a watercourse, lake or spring associated with a resource activity or mining operation* guideline. Refer to Appendix O for further details.

During construction, bed and bank profiles will be surveyed prior to disturbance and immediately following bulk reinstatement to ensure reinstated watercourses match their pre-disturbance form. This will be informed by assessment and survey data of each watercourse crossing. It is proposed for major watercourses that an assessment of the potential scour, and need for scour protection, will be undertaken before construction, and scour protection will be implemented where necessary to avoid the likelihood of scour.

The Progressive ESCP will be developed by a suitably qualified person in accordance with the IECA Guidelines and, where relevant, the *Code of Environmental Practice - Onshore Pipelines* (APIA 2013). The Progressive ESCP will include contingency measures for inclement weather (i.e. rainfall), flows in watercourses, or measures to be implemented if shallow groundwater is intercepted during trenching across watercourses. The Progressive ESCP will reduce both the likelihood and consequence of alteration of surface flows through ensuring drainage is managed, erosion is minimised and reinstatement is as per best practice and industry standards, and also that sediment is captured and managed. Any temporary controls outlined in the Progressive ESCP will be implemented, maintained and monitored by the Construction Contractor, and will be removed once construction is complete and the area is stable.

Permanent controls (i.e. scour protection) may be required for larger watercourses, and the approaches to watercourses will require drainage diversion bunds to avoid creating a preferential flow path along the reinstated ROW and banks. The risk of scour along the reinstated ROW and watercourse crossings is generally higher during the first wet season following construction, where rehabilitation has had a limited time to establish. Watercourse crossing sites will be selected to target areas with stable banks to minimise the risk of scour and failure of rehabilitation (as informed by the watercourse crossing assessments discussed in Section 7.5.1). The requirements for monitoring and maintenance of permanent controls and reinstated watercourses will be outlined in the Progressive ESCP.

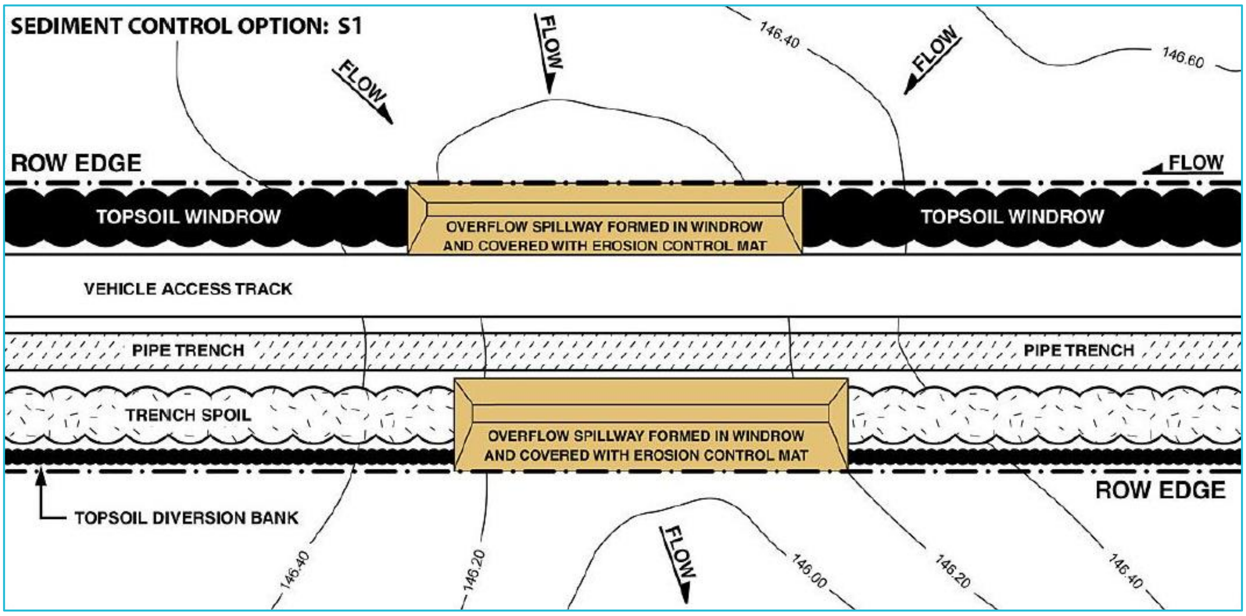


Figure 7-20. Example diagram of typical dry watercourse crossing (IECA 2008)

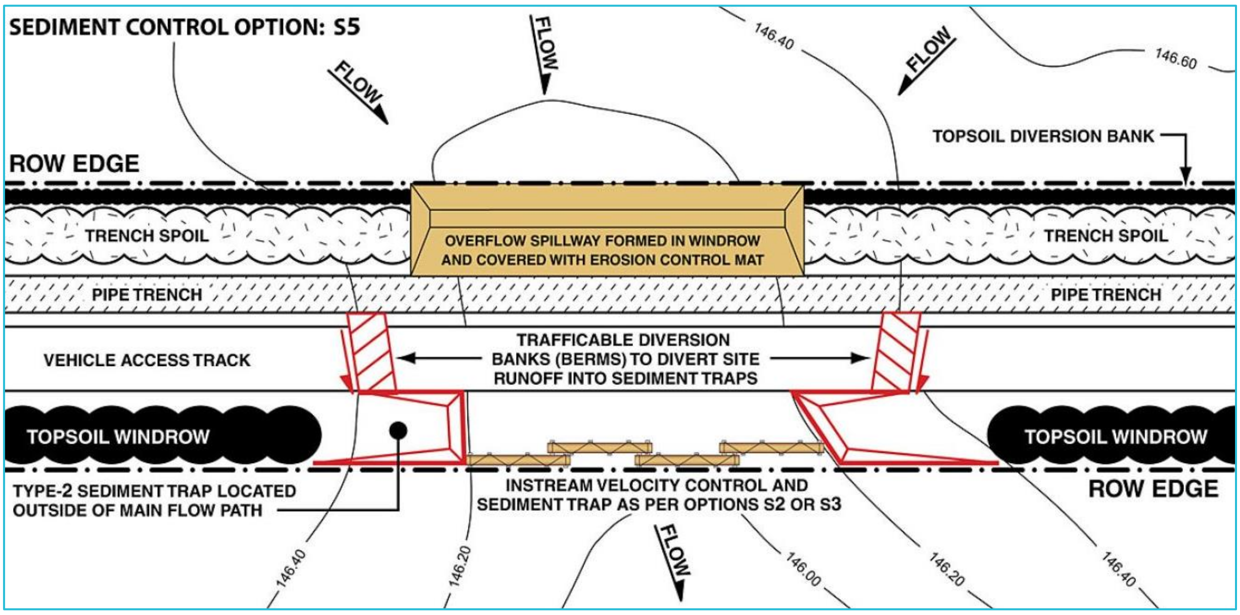


Figure 7-21. Example of watercourse crossing layout if rainfall is predicted (IECA 2008)

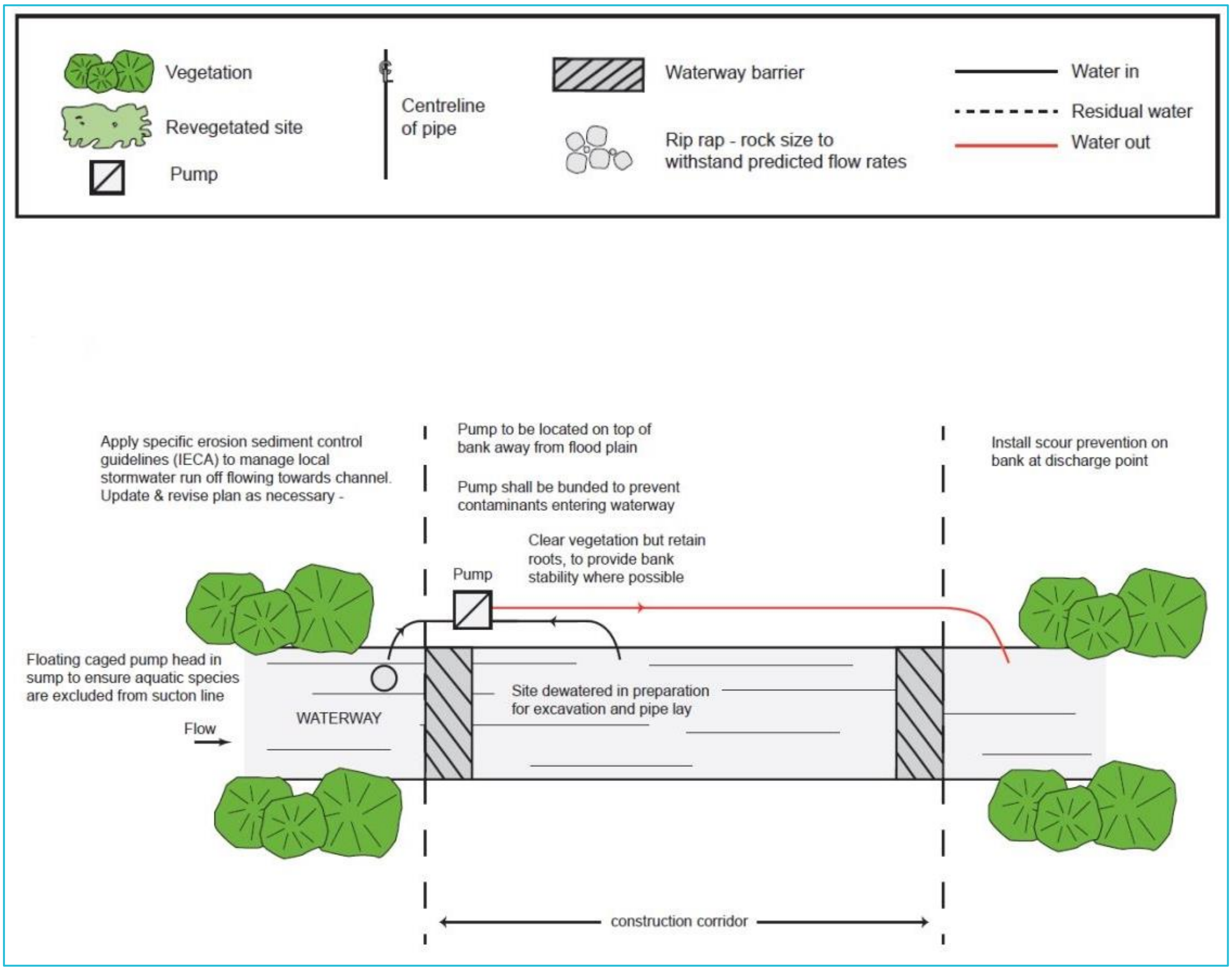


Figure 7-22. Example of a dam and pump watercourse crossing (APIA 2013)

Effectiveness

The *Code of Environmental Practice – Onshore Pipelines* (APIA 2013), which is considered best-practice for construction and pipeline projects in Australia, provides guidance on the construction and reinstatement of watercourse crossings, and standard drawings for a variety of watercourse crossings. The code of practice refers to the IECA Guidelines for erosion and sediment control.

The IECA Guidelines are the accepted Australian best practice guidelines for erosion and sediment control, and *Appendix P – Land Based Pipeline Construction* has been developed specifically for linear infrastructure developments such as the NGP. The guidelines provide specific guidance on watercourse crossings and reducing impacts associated with drainage, erosion and sedimentation which would result in alterations of surface flow. The development and implementation of specific erosion and sediment control plans for watercourse crossings, in accordance with these guidelines, is therefore considered to be a proven effective method for reducing the risk of altering surface flows from the trenching and installation of pipe across watercourses. The IECA provides a mechanism for obtaining recognised qualifications in erosion and sediment control; a Certified Professional in Erosion and Sediment Control (CPESC). If required (as determined by the guidance on suitably qualified persons in the IECA guidelines) a CPESC will be engaged to complete the watercourse crossing Progressive ESCP, which will ensure that the ESCP complies with best practice and the proposed mitigation measures would be effective, if implemented appropriately.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface flows as a result of the trenching and installation of the pipeline across watercourses will be reduced to **LOW**.

7.7 OPERATIONAL PHASE RISKS

7.7.1 CHEMICALS OR HAZARDOUS SUBSTANCES ENTERING GROUNDWATER OR SURFACE WATER

Context and assumptions

The storage and use of chemicals or hazardous substances will be restricted to the compressor stations, with the exception of minor volumes that may be used during maintenance of the pipeline and above ground facilities. These will include diesel, x-ray film chemicals, solvents, and rust proofing agents.

All chemicals and hazardous materials will be stored as required by Australian standards and their Safety Data Sheets (SDS), but generally in ventilated, self-bunded and secure shipping containers.

For the purposes of the risk assessment it is assumed that volumes of chemicals and other hazardous substances will be relatively small, and that all chemicals and hazardous substances will be stored and handled in accordance with relevant Australian standards and industry best practice.

The uncontrolled release (i.e. spill or leak) of chemicals or hazardous substances could result in contamination of groundwater and/or surface water, reduction in water quality, and subsequent impacts on aquatic ecosystem health.

There is a risk that failure of the pipeline could occur, resulting in a release of gas, although it is assumed that this would only occur in extenuating circumstances (e.g. third party interference). A failure of the pipeline would not be expected to impact on water quality as it would result in a release of gas that would be released into the atmosphere, rather than into water.

Inherent risk

Based on the context and assumptions outlined above, the consequence of a spill of chemical or hazardous substance is considered severe as it would be expected to result in temporary harm to the environment. During operations, chemicals and hazardous substances will only be stored at the compressor stations, reducing the area of potential impact. However, there is a risk that spilt product would enter local watercourses or seep into groundwater. Without any mitigation measures, the likelihood of a spill is considered possible due to the frequency of handling and use.

The inherent risk to water associated with chemicals or hazardous substances is considered **SIGNIFICANT**. Analysis of this risk indicated that further controls can be practicably implemented to reduce the likelihood of impacts to water occurring (see below).

Controls

Facilities for storage of hazardous materials will be designed in accordance with the requirements of the *Australian Dangerous Goods Code and Australian Standard (AS) 1940 Storage and handling of flammable and combustible liquids*. Storage and handling will comply with the requirements of the *National Standard NOHSC: 1015 (2001) Storage and Handling of Workplace Dangerous Goods* and all other industry accepted practices. Storage in accordance with these standards will reduce the likelihood of a spill.

Chemicals and hazardous substances will only be stored at compressor stations and will be stored over 100 m from major watercourses to reduce the consequence of a spill.

A Dangerous Goods and Hazardous Substance Management Procedure will be developed that will detail the types of materials stored, storage requirements for the chemicals and hazardous substances used for the Project, and specific spill response requirements for each substance. Standard spill response materials will be sourced for the Project, and spill kits will be maintained at compressor stations, and with maintenance crews working remotely along the pipeline. Operational and maintenance workers will be trained in spill response procedures. Should a spill occur, spill response will contain the spill and reduce the consequence of it.

A Dangerous Goods and Hazardous Materials Register will be maintained, and all substances will be stored and handled in accordance with Australian Standards and the SDS. The register will enable tracking of volumes of chemicals and hazardous substances, and reduce the likelihood of a spill or leak going unnoticed.

Effectiveness

The above controls are established in Australian Standards and are routine for industrial sites. Jemena have previous experience in the implementation of these measures on other similar projects, and the controls are proven to be effective in the management of chemicals and hazardous substance, and reduction of risks to surface and groundwater quality.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface and groundwater as a result of the storage and handling of chemicals and hazardous substances for operational purposes will be reduced to **LOW**.

7.7.2 SEDIMENT ENTERING SURFACE WATERCOURSES

Context and assumptions

The construction of the pipeline and ancillary infrastructure will result in the disturbance of soils, including potentially problematic soils (e.g. dispersive). Reinstatement of the pipeline will be undertaken progressively and rehabilitation monitoring and maintenance will be implemented during the operational phase. However, disturbance of soils and removal of groundcover increases the risk of erosion. The creation of a long, narrow disturbance corridor along the construction ROW has potential to provide a preferential flow pathway for surface water runoff following reinstatement, which can result in scour and erosion gullies forming along the ROW. There is also a risk of scour and erosion of reinstated watercourse bed and banks. These processes may result in the transport of sediment and deposition in watercourses, and subsequent impacts to water quality and aquatic ecosystems.

This potential impact is particularly high following the first wet season after reinstatement, when groundcover will be sparse and rehabilitation has not yet established.

For the purposes of assessing the risks of erosion and sedimentation of watercourses it is assumed that the ROW will be reinstated in accordance with ESCP developed for the construction phase, including the installation of any permanent controls such as drainage diversion bunds to divert runoff off the ROW at regular intervals, and on approaches to watercourses. Additionally it is assumed that cleared vegetation will be spread back across the ROW to provide some form of groundcover (groundcover is one of the most effective measures to reduce erosion).

Inherent risk

Based on the context and assumptions outlined above, the consequence of sedimentation of watercourses is considered to be serious as it will result in temporary and minor damage to water, and is recoverable through short-term remediation. The likelihood of erosion and sedimentation occurring is considered likely due to the area of the disturbance footprint and the fact that revegetation (to achieve ground cover) will rely on natural regeneration. This results in an inherent risk of **SIGNIFICANT**. Analysis of this risk indicated that further controls can be practicably implemented to reduce the likelihood of impacts to water occurring (see below).

Controls

A two stage process will be implemented for erosion and sediment control planning, in accordance with the *Appendix P – Land Based Pipeline Construction* of the IECA Guidelines (IECA 2008).

A Primary ESCP has been developed as a supporting document for this EIS (see Appendix P). The Primary ESCP provides an erosion risk assessment of the area and stipulates general management and risk minimisation measures for the entire Project. Following further, more detailed, soil and watercourse crossing assessments, Progressive ESCP will be developed that provide specific detail on high risk areas. As a minimum these will cover major watercourse crossings, high risk erosion areas, gently sloped areas that may have dispersive soils, and the compressor stations. The Progressive ESCP will be developed by a suitably qualified person as defined in the IECA Guidelines. They will include specifications for reinstatement and installation of permanent controls which will be installed at the completion of construction and remain in place during operations. Implementation of the ESCP will reduce the likelihood of erosion (through ensuring final landforms are stable) and the consequence (through providing for the capture of sediment).

During operations, regular inspections will be conducted along the reinstated ROW to identify areas of erosion and scour, particularly in relation to watercourse crossings. Remedial actions will be implemented as required and in accordance with an Operational Environmental Management Plan (OEMP) and Rehabilitation Management Plan. Remediation will likely include reinstatement works and installation of additional or revised permanent controls.

Effectiveness

The IECA Guidelines are the accepted Australian best practice guidelines for erosion and sediment control, and *Appendix P – Land Based Pipeline Construction* has been developed specifically for linear infrastructure developments such as the NGP pipeline. The development and implementation of erosion and sediment controls plans in accordance with these guidelines is therefore considered to be a proven effective method for reducing risks associated with erosion and sedimentation of watercourses.

The *Code of Environmental Practice – Onshore Pipelines* (APIA 2013), which is considered best-practice for construction and pipeline projects in Australia, refers to the IECA Guidelines for best practice erosion and sediment control. Therefore, development and implementation of ESCP in accordance with the IECA Guidelines is considered proven to be effective.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface water as a result of the erosion and sedimentation will be reduced to **LOW**.

7.7.3 ALTERATION OF SURFACE WATER FLOWS

Context and assumptions

The sourcing and extraction of water from surface water bodies could result in the alteration of surface flows, and subsequent impacts on downstream users and aquatic ecosystems.

During operations, water requirements will be negligible with the exception of those for PCCS (discussed in Section 7.7.4). Water for PCCS will be obtained from a groundwater bore. No water will be extracted from watercourses. Any operational water required for the MICS will be sourced from existing, approved sources, but will be minimal volumes (i.e. potable and amenity water requirements).

Inherent risk

Based on the above context and assumptions, the consequence of alteration of surface water flows is considered minor. The likelihood is considered rare, resulting in an inherent risk of **LOW**. As such, no specific mitigation measures are required.

7.7.4 DRAWDOWN OF GROUNDWATER

Context and assumptions

Operational water requirements will be negligible with the exception of PCCS, which will require 4,800 L/day for the nitrogen reduction process.

Water will be sourced from a new groundwater bore drilled near the PCCS site, or an existing nearby bore if available. Currently, there is limited information available on the likely location of this groundwater bore. This will be confirmed during the detailed design phase for the PCCS, and will be informed by an assessment of the flow rates and availability of groundwater in the vicinity of the PCCS.

The limited information currently available on the specific location and volumes of groundwater extraction has precluded robust quantification of the risks to groundwater, and residual risks remain moderate in acknowledgment of the need for further work (see below).

Analysis of this risk indicated that further controls can be practicably implemented to reduce the likelihood of impacts to water occurring (see below).

Inherent risk

Based on the above context and assumptions, the consequence of a drawdown of groundwater is considered severe, as it could result in localised impacts on water resources and other water users. Based on the assessment of the hydrogeological context at a regional scale, the likelihood of drawdown of groundwater resulting in severe impacts is considered possible, given the extraction will only be from one bore. The inherent risk of drawdown of groundwater is considered **SIGNIFICANT**.

Controls

The PCCS is within the Tennant Creek Water Control District. Petroleum activities are exempt from the requirement to obtain a water extraction licence, however the fact that the proposed groundwater extraction is within a water control district means that an assessment of sustainable yields will be required to demonstrate that proposed extraction will not result in impacts to the aquifer and other users.

Should a new bore be drilled, an assessment of the sustainability of groundwater resources will be required to assess the likely yields and impacts of proposed groundwater extraction on existing users and aquifer sustainability. This will be done in consultation with a hydrogeologist to inform the location and construction details of the groundwater bore and ensure that the bore is constructed in accordance with industry and Australian standards, and extraction volumes will not result in groundwater drawdown such that it impacts on existing users.

Consistent with Section 7.6.6, the groundwater bore will be drilled by a driller licenced under the Water Act (*NT*), and pump tested to assess the sustainable yields and inform extraction rates.

Effectiveness

The level of information currently available on groundwater extraction for the PCCS limits assessment of the effectiveness of specific mitigation measures. The effectiveness of general controls is discussed below, noting that further assessment of the effectiveness of controls will be required during the detailed design phase.

Hydrogeologists are experts in groundwater and assessing the potential impacts of groundwater extraction. Consultation with a suitably qualified hydrogeologist when locating the bore, and adherence to their recommendations, would be effective in siting the bore to provide maximum sustainable yields while minimising impacts to other users and GDE.

The Water Act (*NT*) (as in force from 1 July 2016) and supporting documents stipulate the process for driller licencing and the requirements of licenced drillers in the Northern Territory. The use of a licenced driller will ensure water bores drilled for the Project are legally constructed and tailored to the hydrogeological conditions. Pump testing will be undertaken by the licenced driller and is considered industry standard in assessment of the drawdown of groundwater. Compliance with current legislation and industry standards is considered to be proven effective in drilling groundwater bores to minimise impacts on groundwater aquifers.

Residual risk

Due to uncertainties around the location and volumes of groundwater extraction, the precautionary principle has been used when assessing the residual risk to groundwater extraction and impacts of drawdown and over-extraction. As such the residual risk is **MODERATE**, and further work is required to reduce the residual risk to ALARP.

In order to further reduce the residual risk, the following will need to occur:

- determine the locations of groundwater extraction
- determine the required volumes of extraction
- determine the sustainable yields of proposed target aquifers in relation to their hydrogeological context, and proximity to other users, GDE and watercourses
- engage a licenced driller to drill the groundwater bore in accordance with the Water Act (NT) and with reference to the hydrogeological setting

- seek advice from a hydrogeologist as required to ensure the location of the groundwater bore is suitable to provide required water volumes without
- measure the standing water levels in groundwater bores used for extraction prior to extraction, during extraction, and immediately after extraction to assess groundwater drawdown.

Sustainable yield data is to inform the location of groundwater extraction, extraction rates and specific mitigation measures for reducing the risk of groundwater drawdown. This information will be incorporated into the OEMP, which will be developed prior to the commencement of operations.

7.7.5 PRODUCED WATER ENTERING SURFACE WATERCOURSES OR GROUNDWATER AQUIFERS

Context and assumptions

Approximately 200 L/hr of water will be produced at the PCCS as part of the gas treatment process. Produced water will be filtered through an on-site waste water treatment package to remove minerals and trace chemicals such as amine and hydrocarbons. The treated water will then be directed to an on-site evaporation pond for disposal by evaporation.

At the time of writing this document there was limited information on the specific design of the evaporation ponds, or the expected quality of produced water. However, it is assumed that the quality of wastewater would result in detrimental impacts to water quality, and aquatic ecosystems.

The details of this will be further defined during the detailed design phase, and will inform construction of the evaporation ponds at the PCCS. However, it has been assumed that the evaporation ponds will be engineered and designed to contain expected wastewater volumes with no leakage to groundwater or uncontrolled release to surface water. The level of detail currently available is consistent with the staging of the Project and the design will inherently be confirmed as the Project commences. As such, controls are presented here to guide the design of the evaporation ponds, with the expectation that the ponds will be suitably engineered. Specific management and mitigation measures will be assigned as required during detailed design.

Inherent risk

Based on the context and assumptions outlined above, the consequence of an uncontrolled release of produced water is considered to be severe as it would result in temporary impacts to water quality and aquatic ecosystems, medium-term remediation works, and a breach of regulatory approvals. In the absence of specific mitigation measures and controls the likelihood of this occurring is considered likely, resulting in an inherent risk of **HIGH**.

Analysis of this risk indicated that further controls can be practicably implemented to reduce the likelihood of impacts to water occurring (see below).

Controls

Produced water will be filtered onsite and treated water will be directed to an onsite evaporation pond for disposal by evaporation. The details of the evaporation pond will be confirmed during detailed design, and operational management procedures will be developed for inclusion in the OEMP.

Current, general, mitigation measures require that the evaporation pond be engineered and designed to accommodate expected water volumes, with sufficient freeboard for anticipated rainfall volumes. The evaporation ponds will also be lined to prevent leakage, and regularly monitored leak detection systems

will be installed beneath them to alert Jemena of any potential leaks. This will reduce the likelihood of an uncontrolled release occurring.

Water quality will be monitored to assess the quality of water stored in the evaporation ponds. Residue will be pumped out of the pond as required, and disposed of at a licenced facility, which will reduce the consequence of an uncontrolled release by minimising the storage of large volumes of potential contaminants (i.e. that could be mobilised into the environment).

Effectiveness

In Australia, engineers are accredited by the Institute of Engineers Australia which ensures that engineers are suitably qualified to design structures in accordance with Australian and industry standards. The engineering of the evaporation ponds to contain expected volumes of produced water and expected rainfall, and incorporate leak detection, is considered effective if designed by an accredited engineer, and implemented and maintained as per the recommendations of the engineer.

The effectiveness of any additional specific mitigation measures will be assessed during detailed design, and these measures will be incorporated into the OEMP to ensure that there is a process for their implementation.

Residual risk

Subject to implementation of the above controls and ongoing monitoring and review in accordance with the environmental management framework described in Chapter 13, it is anticipated that the residual risk to surface and groundwater as a result of the production, storage and disposal (via evaporation) of produced water at the PCCS will be reduced to **LOW**.

7.8 MITIGATION AND MANAGEMENT

This section provides additional detail in relation to Jemena's approach to mitigation and management of risks to surface water and groundwater. Through implementation of the risk controls discussed in the sections above, most residual risks are expected to be reduced to levels that Jemena considers will be tolerable to Project stakeholders. Where further work is required to reduce residual risks, the required measures have been clearly outlined in each relevant section. Jemena's approach to mitigation and management of water risks across each Project phase is detailed in Section 13.6 of Chapter 13 Environmental Management Plan.

As requested in Section 5.5.3 of the EIS ToR, a Water Management Plan (WMP) (Appendix O) has been prepared to provide clear and concise methods to mitigate impacts to water. This plan applies to the construction phase of the Project, during which the majority of water risks will occur. The WMP was prepared by Environmental Consultants with demonstrated experience in the mitigation and monitoring of adverse impacts to surface water and groundwater, and incorporates advice received from a hydrogeologist who was engaged to assess the level of risk posed by the Project in relation to groundwater and the hydrogeological setting of the Project.

As the most significant potential impacts to water are associated with the Project construction phase, the WMP has been prepared specifically to provide the Construction Contractor with clear guidance in relation to appropriate risk controls and monitoring requirements. In addition to the WMP the following EIS documents provide for mitigation and management of water impacts:

- Primary Erosion and Sediment Control Plan (Appendix P)
- Traffic Management Plan (Appendix E)

The Construction Contractor will incorporate all controls relevant to water into the CEMP and associated procedures, which will be finalised prior to the commencement of construction activities. In addition to the CEMP, the following specific management plans will be developed for the construction phase to manage and mitigate potential impacts to water:

- Hydrostatic Test Management Plan
- Progressive Erosion and Sediment Control Plans (for various construction stages e.g. watercourse crossings, high erosion risk areas, and permanent infrastructure sites)
- Dangerous Goods and Hazardous Substance Management Procedures.

Operational water risks are less significant and do not require a stand-alone management plan. The mitigation and management requirements applicable to the Project operational phase are detailed in the Section 13.6 of Chapter 13 Environmental Management Plan. Jemena will incorporate these controls into the OEMP, which will be finalised prior to commencement of operations.

Decommissioning water risks were assessed as low based on the assumption that the pipeline is decommissioned in situ. Decommissioning risks will be re-assessed prior to that phase and any identified risks to water will be addressed by Jemena in an approved plan subject to the regulatory requirements applicable at that time.

7.9 SUMMARY AND RESIDUAL RISK

The NGP Project will involve activities which do have the potential to impact on surface and groundwater within the vicinity of the Project area. Each identified risk has been reduced to As Low As Reasonably Possible (ALARP) through the application of management and mitigation measures, many of which are standard practice for onshore pipeline projects. The mitigation measures prescribed in this chapter are expected to reduce most risks to low. For risks which cannot be reduced to low at this stage, the works and information required to further reduce residual risks have been outlined in the sections above, with the intention that this is addressed during the detailed design phase of the Project, and prior to implementation of the relevant phase.

The residual risk profile for water related risks is shown below.

PROJECT PHASE	Low	Moderate	Significant	High	Extreme
PLANNING	3	0	0	0	0
CONSTRUCTION	9	2	0	0	0
OPERATIONS	4	1	0	0	0

7.9.1 PLANNING PHASE RESIDUAL RISKS

During the planning phase soil and watercourse crossing surveys will be required to provide additional information for the development of specific erosion and sediment control plans. The risks related to this work are as follows;

- insufficient or inadequate detail will be provided, which limits the effectiveness and/or accuracy of the ESCP
- survey works may physically damage watercourses.

These risks have been reduced to low through ensuring that a suitably qualified person (as defined in the IECA Guidelines) is engaged to undertake the soil landscape surveys and mapping, and the watercourse crossing assessments. During survey works, existing tracks must be used and no driving along watercourses will be permitted, avoiding physical damage to watercourses.

7.9.2 CONSTRUCTION PHASE RISKS

The majority of risks to water are presented during the construction phase of the Project, when construction activities have the potential to impact on water quality (through contamination from chemicals or hazardous substances, wastewater, erosion and sedimentation, and deposition of vegetative material in watercourses), and water quantity (through sourcing and extraction of water for the construction phase, and potential impacts to surface water flows via alteration of the hydrology). Specific management and mitigation measures have been provided here to reduce all risks to ALARP. These have been incorporated into the detailed WMP (Construction) (Appendix O) and the Primary ESCP (Appendix P), which will be incorporated into the CEMP. The majority of residual risks have been mitigated to low with the application of management and mitigation measures required by legislation, Australian standards or industry standards, which are proven effective. Where further work is required, such as the development of Progressive ESCP, the steps required to address identified risks have been clearly outlined.

Two residual risks remain moderate: drawdown of groundwater, and disposal of hydrostatic test water. These remain moderate as the level of information currently available precludes robust assessment of the risks, however the nature of the Project necessitates that the information relevant to these risks is further

refined during the detailed design phase of the Project. The steps required to further reduce the residual risks to low have been clearly outlined for those risks and will be implemented as the Project is further refined. Specific management and mitigation measures to reduce these risks will be incorporated into relevant management plans (WMP, CEMP and Hydrostatic Test Management Plan) prior to the commencement of construction.

7.9.3 OPERATIONAL PHASE RISKS

Operational activities that have the potential to impact on water are related to water quality (through contamination from chemicals or hazardous substances, the management and disposal of produced water at the PCCS, and erosion along the reinstated construction ROW and subsequent deposition of sediment in watercourses), and water quantity (through the sourcing and extraction of water for the MICS and PCCS). The majority of these risks have been reduced to low through the application of management and mitigation measures required by legislation, Australian standards or industry standards, which are proven effective. The management and mitigation measures will be incorporated into the OEMP to ensure that they are implemented during the operational phase of the Project.

One residual risk remains moderate: the drawdown of groundwater due to sourcing water for the PCCS. This risk remains moderate as the level of information currently available precludes robust assessment of the risks, however the nature of the Project necessitates that this is further refined during the detailed design phase of the Project, and prior to the commencement of operations. The steps required to further reduce the residual risk to low have been clearly outlined for this risk and will be implemented as the Project is further refined. Specific management and mitigation measure for this risk will be incorporated into the OEMP prior to the commencement of operations.

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