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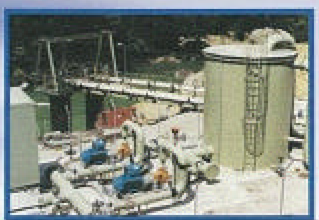
BHPBIO - RGP5 CHICHESTER DEVIATION & MAINLINE RAIL DUPLICATION SURFACE WATER MANAGEMENT



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BHPBIO - RGP5

CHICHESTER DEVIATION & MAINLINE

RAIL DUPLICATION

SURFACE WATER MANAGEMENT

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SECTION 1 - INTRODUCTION

1.1 GENERAL

BHP Billiton Iron Ore Pty Ltd (BHPBIO) conducts mining operations in the Newman area (including satellites), Yandi and Area C and transports ore by railway from these operations northwards to the port facilities at Port Hedland (Figure 1). With increased production, the need has arisen to duplicate the existing single track rail between the mine sites and the port. This duplicated track is generally proposed to be installed adjacent to the existing track, except for the section rising from the Fortescue Marsh through the Chichester Range, where the railway route will deviate westwards to create a reduced overall rising grade through the range.

Railway construction works for the proposed Chichester Rail Deviation and Mainline Duplication will potentially cause disturbance to the existing surface water flow regimes in the area, in particular, in those areas where the rail alignment passes through vegetation communities which may be partially dependent on runoff water, potentially blocked by the railway. The marsh rail crossing may impact on water resources and flow patterns in the marsh.

A surface water management study of the Chichester deviation and marsh crossing areas is required to assess the existing environment and the potential for impacts, and provide recommendations for managing identified impacts.

1.2 SCOPE OF WORK

The project study area includes the Chichester Rail Deviation and the Mainline Duplication between approximate BHPBIO railway chainages 222km and 255km.

The scope of works for this assessment comprises:

- Characterisation and description of baseline drainage conditions from both a regional and local project-area perspective (catchment area definitions; surface flow directions; flow characterisation).
- Assessment of potential project impacts on natural drainage systems (e.g. diversions, starvation, ponding, erosion, and siltation) and of the drainage systems impacts on the proposed project infrastructure (inundation, waterways).
- Develop strategies to minimise the impact of the project on the natural drainage systems (maintenance of drainage routes and environmental flows, diversion of drainage lines, erosion and sediment control works).
- Provide a study report suitable as a support document for the EIA application.

A site visit was undertaken on 6-7 August 2008, to view the surface hydrology along the proposed railway routes in the area of interest and to ground truth data obtained from published mapping and aerial photography.

SECTION 2 - HYDROLOGY

2.1 CLIMATE

WA has three broad climate divisions. The northern part is dry tropical and the south-west corner has a Mediterranean climate, with long hot summers and wet winters. The remainder is mostly arid land or desert climates.

The Pilbara Region is characterised by an arid climate resulting from the influence of tropical maritime and tropical continental air masses, receiving summer rainfall. Cyclones occur during this period, bringing heavy rain and causing potential destruction to inland and coastal towns.

2.2 TEMPERATURE

The Pilbara Region has an extreme temperature range, potentially rising to 50°C during the summer, and dropping to around 0°C in winter. Mean monthly maximum temperatures in Wittenoom (BOM) range from 39°C in January to 24°C in July, while mean monthly minimum temperatures range from 26°C in January to 11°C in July. High summer temperatures and humidity seldom occur together, given the Pilbara's very dry climate. Light frosts are occasionally experienced during the winter season.

2.3 RAINFALL AND EVAPORATION

The Pilbara Region has a highly variable rainfall, which is dominated by the occurrence of tropical cyclones mainly during the period January to March. The moist tropical storms from the north bring sporadic and drenching thunderstorms. With the exception of these large events, rainfall can be erratic, and localised, due to thunderstorm activity. Therefore, rainfall from a single site may not be representative of the spatial variability of rainfall over the entire catchment during an event. The driest months in the Pilbara are typically September to November.

During May and June, cold fronts move in an easterly direction across Western Australia and sometimes reach the Pilbara Region producing light winter rains.

The annual mean rainfall (Bureau of Meteorology) for Wittenoom is 458mm, which is notably higher than Newman with annual mean rainfall of 310mm. Rainfall variability across the region can be high.

The mean annual pan evaporation rate in the project area is around 3600mm (Dept. of Agriculture), which exceeds annual rainfall by over 3000mm. Average monthly pan evaporation rates vary between a minimum 180mm in June, and a maximum 420mm in December.

2.4 STREAMFLOW

Streamflow in the Pilbara Region is directly in response to rainfall, with the majority of the streamflow therefore occurring during the summer months of December through to March. Streamflow in the smaller flow channels is typically of short duration, and ceases soon after the rainfall passes. In the larger river channels which drain the larger catchments, runoff can persist for several weeks and possibly months following major rainfall events such as those resulting from tropical cyclones.

Streamflow gauging stations are widely spaced in the Pilbara Region, with none located near the immediate project area. Within the Fortescue Marsh catchment to the south of the project area, the nearest Department of Water (DoW) gauging station is at Waterloo Bore on Weeli Wolli Creek (DoW gauge S708013), located around 70km southeast from the Chichester deviation. This gauging station records streamflow from the approx 4,000km^2 Weeli Wolli Creek catchment (above the marsh), however due to relative catchment sizes streamflow data does not necessarily represent runoff within the project area.

Peak streamflow discharges from ungauged catchments in the Pilbara Region can be estimated using empirical techniques, such as those recommended in "Australian Rainfall and Runoff" (1987 and revised 1998) produced by the National Committee on Hydrology and Water Resources.

3.1 FORTESCUE MARSH

The proposed Chichester Deviation and Mainline Duplication are located in the Fortescue Marsh catchment, as shown in Figure 2. The marsh area is in the physiographic unit known as the Fortescue Valley, and occupies a trough between the Chichester and Hamersley Plateaux (Beard, 1975).

The Goodiadarrie Hills, located on the valley floor just west from the marsh rail crossing, effectively cuts the Fortescue River into two separate river systems. West from the Goodiadarrie Hills, the Lower Fortescue River Catchment drains in a general north-westerly direction to the coast, whereas east of the hills the Fortescue Marsh receives drainage from the Upper Fortescue River Catchment. Several large creek systems discharge to the Fortescue Marsh with a total catchment area of approx 31,000 km^2. These systems include the Fortescue River, Weeli Wolli Creek, Marillana Creek, Caramulla Creek, Jigalong Creek, Kondy Creek and Kulkinbah Creek (Figure 2). The alluvial outwash fan from the Weeli Wolli Creek and other smaller creek systems abutting the Goodiadarrie Hills is believed to be partially responsible for this obstruction to the Fortescue River and forming the Fortescue Marsh.

The Fortescue Marsh is an extensive intermittent wetland acting as a flood storage and occupying an area around 100km long by typically 10km wide, located on the floor of the Fortescue Valley. The marsh has an elevation around 400m AHD. To the north, the Chichester Plateau rises to over 500m AHD, whereas to the south the Hamersley Range rises to over 1000m AHD. Following significant rainfall events, runoff from the creeks drains to the marsh. For the smaller runoff events, isolated pools form on the marsh opposite the main drainage inlets, whereas for the larger events the whole marsh area has the potential to flood.

On the southern and northern flanks of the Fortescue Valley, numerous creeks discharge to the marsh. Runoff from rainfall on the valley sides initially drains down gradient as overland flow before concentrating in defined flow channels. In this process surface detention, vegetation, seepage and other mechanisms absorb water from the runoff stream. In steep areas, the runoff processes are faster with relatively low losses and defined drainage channels are typically in close proximity. In the lower slope areas, the runoff processes are slower with relatively higher losses and a greater distance between defined drainage channels.

Where defined drainage channels from the steeper slopes enter the lower slope areas, the channels typically have a reduced discharge capacity and in many instances become less well defined and braided or may even completely disperse in flat areas. In these reducing slope channels, runoff tends to over spill the main channel flow zones and spread over a wider front. In some of the lower slope areas, vegetation communities (scrub and mulga woodlands) have developed which may be partially dependent on seepage water provided by the overland flow process. In these flatter areas, the overland flow process has been termed sheetflow. In comparison, the Fortescue River, Weeli Wolli Creek and other main channels entering the marsh typically support eucalypt woodlands in their banks and floodplains.

Published topographical mapping indicates that the lower bed levels in the Fortescue Marsh predominantly lie between 400m and 405m AHD. Data provided by the DoW states that the flood level in the marsh would need to be marginally higher than 413m AHD to overspill westwards past the Goodiadarrie Hills. No published flood level data are available for the marsh. Enquires with BHPBIO indicate that flood levels have reached, but never overtopped their existing railway crossing over the marsh. Anecdotal data from BHPBIO (pers. comm. Gerry Gorman) recalls a large flood around 10 years ago (assumed Cyclone John, Dec. 1999) which reached the railway ballast level at the lowest section of the marsh crossing which equates to a flood level of approx 410m AHD. Anecdotal data indicates that a previous flood also reached a similar level (assumed Cyclone Joan, Dec. 1975).

Surface water runoff to the marsh is of low salinity and turbidity, though the runoff turbidity typically increases significantly during peak periods of flooding (WRC, 2000). Following a major flood event (that flooded the whole marsh area), anecdotal data indicates that the water could pond up to 10m depth in the lowest elevation marsh areas. Water stored on the marsh slowly dissipates through the processes of seepage and evaporation. During the evaporation process, the water salinity increases and as the flooded areas recede, traces of surface salt can be seen. During the seepage process, the increasingly more saline water is believed to seep into the valley floor alluvial deposits.

3.2 CHICHESTER RAIL DEVIATION AREA

The Chichester Deviation is located in the upper northwest sector of the Fortescue Marsh catchment with local runoff generally draining in a southerly direction towards the marsh. The local catchments and natural flowpaths around the proposed rail deviation area are shown in Figure 3. The proposed rail deviation route is approximate and may ultimately vary slightly from that shown. The Chichester Deviation diverges from the existing BHPBIO railway at approximate chainage 222km and rejoins again at approximate chainage 237km.

The drainages crossing the deviation route can be divided into three general areas:

3.2.1 Northern Deviation Section (D222km - D229km)

Drainages typically cross the rail alignment flowing in a general easterly direction and then flow southwards (Figure 3). The main south flowing creek runs semi parallel to the existing railway alignment. At the north end of this deviation area (near chainage D223km), a southerly flowing creek runs adjacent to the proposed deviation alignment for around 500m.

The creek lines crossing the northern section of the proposed deviation alignment have relatively small catchments with the largest at around 5km^2 crossing at approximately chainage D225km. Depending on the final deviation alignment, another creek with a combined catchment of around 5km^2 will cross and/or run adjacent to the deviation alignment near chainage D223km. In proximity to the deviation alignment, the creeks typically have flattish gradients.

The highest ridge crossed by the proposed rail deviation is near chainage D226km. This ridge area has a stony surface with relatively steep side slopes and is vegetated with scattered patches of mulga. Drainage in this area is directly down the ridge face which is approximately parallel to the proposed deviation alignment.

3.2.2 Western Deviation Section (D229km - D236km)

Drainages cross the rail alignment flowing in a general westerly direction and discharge into a well defined creek which flows southwards towards Fortescue Marsh. Although this creek runs semi-parallel to the proposed deviation alignment, the alignment has been located outside the main floodplain of the creek. The creek has a gravel bed with a 20 to 30m typical bed width and supports eucalypts along its channel.

The creek lines crossing the western section of the proposed rail deviation alignment have relatively small catchments with the largest at around 3km^2 crossing at approximately chainage D232km. These creeks typically have low/flat gradients where crossing the deviation alignment, with the larger creeks having gravel beds and scattered eucalyptus along the banks. Adjacent to the main drainage lines, thicker vegetation has generally developed, due to the better soil and moisture conditions. Mulga scrublands are located along the proposed alignment between chainages D235km and D236km (Ecologia, 2008).

3.2.3 Southern Deviation Section (D236km - D242km)

Drainages cross the rail alignment flowing in a general southerly direction towards the marsh with the largest creek draining a catchment area of approximate 57km^2, as outlined on Figure 3. More extensive scrublands and mulga woodlands are generally located through this section, except on the slightly higher elevation area between chainages D236km and D238km where vegetation is relatively sparse. The thicker vegetation areas along the deviation route are located adjacent to the main drainage crossings between approximate chainages D238km to D239km and between chainages D240.5km to D241.5km.

South of the proposed alignment, the topographic gradients flatten nearer to the marsh. Through this lower gradient zone, thicker vegetation zones have developed around the main drainage routes where moisture conditions are more favourable. Away from the main drainage routes, scrub and mulga woodland communities have developed, which are reported to be partially dependent on seepage water provided by the overland flow (sheetflow) process. Of particular note are extensive groved mulga communities which aerial photography indicates start a few hundred metres south from the proposed southern rail deviation section and extend southwards (down gradient) towards the marsh. The location of these groved mulga communities are shown in Figure 4. Groved mulga communities are reported to be dependent on both direct rainfall and sheetflow for providing soil moisture and nutrients for stability and productivity (Anderson and Hodgkinson, 1997).

Within the Chichester Deviation area, there are no known users of surface water, and beneficial use is understood to comprise in-stream support for native flora and fauna.

3.3 FORTESCUE MARSH RAIL CROSSING AREA

The proposed Mainline Duplication through the Fortescue Marsh crossing area will be located adjacent to, and on the west side of the existing BHPBIO railway (Figure 5). At this location, slightly elevated terrain locally reduces the width of the marshes from a typical width of 10km to less than 500m. Through the crossing zone between railway chainages 245km and 255km, no significant creeks cross the railway route, except for the actual main marsh waterway at around railway chainage 248.5km. Immediately to the west of the railway alignment (through this crossing zone), local drainage from the Goodiadarrie Hills flows generally to the east into the main marsh area. These small drainage lines cross the existing railway via appropriately located culverts. North from chainage 245km to the start of the Chichester Deviation, surface drainage is predominantly southwards draining semi parallel to the railway.

At the main crossing of the Fortescue Marsh (approximate chainage 248.5m), the local marsh bed level is approximately 407m AHD and the existing railway embankment is around 3m higher. Around 20 culverts of between 1.5m and 2.1m diameter have been installed at this Mainline crossing to allow water flow between the main eastern portion of the marsh and the smaller western portion of the marsh. Available topographic data indicates that the lowest marsh bed level in the western portion is around 408m AHD, whereas the lowest bed level in the eastern portion is around 400m AHD. Based on these levels, during a large flood event, as the marsh storage reached capacity in the western sector, flows would be expected to flow from west to east. However as anecdotally reported by BHPBIO, flood flows were observed to be from east to west (assumed Cyclone John, Dec. 1999). Hence flood flows through the culverts could possibly be in either direction, depending on relative flood levels within the marsh system.

Within the marsh crossing area, there are no known users of surface water, and beneficial use is understood to comprise support for native flora and fauna.

SECTION 4 - SURFACE WATER MANAGEMENT

4.1 GENERAL MANAGEMENT OBJECTIVES

General surface water management objectives for railway duplication comprise:

- Maintain the integrity, functions and environmental values of the downstream watercourses to prevent or minimise impacts on the quantity and quality of surface water resulting from activities.
- Maintain or improve the quality of surface water returned to local and regional surface water resources to ensure that existing and potential uses, including ecosystem maintenance are protected.

4.2 POTENTIAL IMAPCTS

The railway construction cut and fill earthworks could potentially interrupt the surface water drainage features that naturally cross the rail alignment. For the Chichester Deviation, these natural drainage features include creeks and some sheetflow areas; and at the Fortescue Marsh crossing, these include small flowpaths and the main marsh waterway.

Potential surface water impacts in the zone of influence along the proposed railway alignment include:

- Interruption to existing surface water flow patterns.
- Increased risk of erosion and sedimentation.
- Reduction of surface water runoff volume.
- Reduction of surface water runoff quality.
- Impact on downstream vegetation communities.
- Impact on downstream watercourse ecology.

4.3 GENERAL MANAGEMENT STRATEGIES

BHPBIO will install drainage culverts, erosion control works, flow dispersion works and minor diversions as required along the railway alignment to ensure that the engineering and the surface water management objectives of the project are achieved. Construction of the railway along the Chichester Deviation alignment will potentially have a localised effect on the surface water flow patterns, flowpath erosion and downstream vegetation communities. Installation of the railway duplication across the Fortescue Marsh will potentially not alter any existing surface water flow characteristics along the existing railway route if current practice of culvert installation is maintained.

Experience in the region has found that the following surface water management strategies effectively reduce the impact of construction works. BHPBIO will adopt these as good management practice:

- Limiting Clearing: Vegetation is the most effective method of minimising erosion and sedimentation. Initial clearing to be limited to areas of workable size actively being used for construction.
- Vehicle Movements: Keep vehicle movements to the minimum necessary and use existing tracks where possible.
- Buffer Zones: Adequate buffer zones to be provided between the areas of disturbance and the natural drainage lines where possible; to place a high priority on the protection of natural drainage lines from impacts resulting from construction activities.

- Dry Season Construction: Construction on or near natural flowpaths to be planned for the dry season where practicable. Temporary stabilisation measures to be used in high erosion risk zones.
- Separate Flowpaths: Flows from undisturbed areas to be kept separate from disturbed areas.
- Topsoil Storage: Topsoil to be stored such that it is protected from internal rainfall and runoff by temporary vegetation or mulching, and protected from external runoff by diversion banks/catch drains. Topsoil to be located away from drainage lines and any internal runoff water to be treated in sediment traps prior to discharge to the environment.
- Bunding: All borrow pits and stockpiles have the potential to generate sediment laden runoff and all internal runoff water requires treatment via sediment traps prior to discharge to the environment. Bunding to be provided as appropriate to contain internal surface water runoff for treatment, plus to divert external surface water runoff.
- Sediment Traps: Sediment traps to be designed and implemented as required, to catch sediments and limit their transportation downstream. They are to be located where required within drainage lines downstream of active stockpiles, dumps and other disturbance areas, and sized appropriately for the rainfall events and catchment area.
- Temporary Works: Surface runoff from disturbed areas will typically be sediment laden, and may also include pollutant loads such as oil and grease. Temporary erosion and sediment control structures to be provided such as diversion banks, drains and sediment traps.
- Hydrocarbon Management: Hydrocarbon storage areas to be bunded in accordance with Australian Standards. Potentially hydrocarbon polluted runoff to be directed to basins fitted with baffle mechanisms to trap possible pollutants before discharge to the downstream environment.

4.4 CHICHESTER RAIL DEVIATION

The Chichester Deviation typically crosses perpendicular to the natural surface water flowpaths. Most flowpaths crossing the alignment have relatively small catchments, except for the creek crossing at chainage D241km which has a significantly larger 57km^2 catchment. BHPBIO will install culverts at all flowpaths including sheetflow areas crossing the rail alignment. Installation of the railway embankment will not reduce the surface water runoff volumes from the upslope catchments draining to the downstream environment, due the culverts being provided. Erosion control works will be locally installed at the culvert crossings to protect against potentially erosive water velocities generated through the culverts.

During a flood event, upstream water levels at the culverts become elevated and pressurise the flow through the culverts generating a higher velocity discharge stream. Downstream from the culverts, the discharging water slows and reverts to natural flow conditions and pre-development water levels are not affected. In proximity to the culverts, localised higher flow velocities occur with the potential for scouring and appropriate erosion protection works are required. Methods to manage these potentially adverse factors to acceptable levels include limiting the upstream water levels, the provision of riprap or similar scour protection blankets and at some locations the provision of additional support earthworks. A reduction in the surface water runoff water quality or any impacts on the water course ecology are not anticipated downstream from the culvert crossings.

Where the railway formation is located such that topography would cause intercepted drainage pathways to flow along the upstream side of the formation for long distances, large and erosive drainage discharges could develop along the formation toe. In these areas, culverts will be installed under the railway formation at regular intervals together with small interceptor embankments to direct runoff into the culverts. Where natural drainage pathways flow adjacent to the railway formation, erosion protection works will be installed, as appropriate, to prevent potential erosion along the formation and to reduce the potential for an increased sediment content in the natural surface water runoff.

Along the flanks of the Chichester Ranges, the southern section of the Chichester Deviation passes through creek and sheetflow drainage zones where sheetflow dependent groved mulga communities are located in the downstream areas (Figure 4). It is generally reported by the Department of Environment and Conservation (DEC) and others that in groved mulga community areas the runoff shadowing effect caused by a linear structure, such as a road or railway, has a detrimental effect on the mulga communities. These linear structures cause an interruption to sheetflow through the area and a subsequent reduction in the potential for soil moisture replenishment in the mulga grove areas. Aerial photography indicates that the groved mulga communities start a few hundred metres south of the proposed southern rail deviation section and extend southwards (down gradient) towards the marsh but are not located in the immediate impact zone of the railway formation.

Where the alignment passes through the sheetflow areas, BHPBIO will install small diameter culverts under the railway formation at regular intervals. In these sheetflow areas, discharge, sediment and debris loadings are predicted to be relatively low and culverts with a minimum 300mm diameter will be used to redistribute the sheetflow. Where higher discharges are predicted, larger sized culverts will be installed to suit. To reduce the potential for impact through the more sensitive mulga areas, ground and vegetation conditions along the southern section of the Chichester Deviation route will be visually assessed to determine the required locations and spacings for the sheetflow culverts. In these more sensitive areas, the sheetflow culvert spacings could be at around 200m centres.

The access road adjacent to the railway needs to be considered in conjunction with the railway formation for its potential to block the sheetflow pathways and to introduce sediments into the surface water runoff. To maintain the access road, regular grading will be required which typically results in the formation of a loose earth windrow along the road edges. If the access road is located such that sheetflow collects against these windrows, this loose material will tend to be mobilised by the flows and redistributed downstream. Additionally, diverted water may pond over poorly graded sections in the road.

To reduce the potential for mobilising access road sediments through the southern sheetflow areas, BHPBIO will typically install the railway access road on the downslope side of the railway formation thus preventing sheetflow from impacting on the windrows and reducing the potential for sediment to block culverts. Where sheetflow culverts through the railway formation discharge across the access road, a shallow dip will be formed in the road and cement stabilised road base material (or similar) locally used for the road construction. This stabilised material will protect the road base from erosion and prevent it from becoming soft. Maintenance grading of the access road will be conducted such that windrows will not be formed in the culvert outlet flow zones.

On the downstream side of the railway sheetflow culverts and access road, BHPBIO will install works to redistribute the runoff, as appropriate. Where required, discharges from the culverts will be directed against a riprap pad where the flows will slow and disperse to the downstream environment. The conceptual layout for these redistribution works is shown in Figure 6. With the relatively low natural surface gradients in the sheetflow areas, runoff flows will tend to spread laterally as well as down gradient.

These provisions should ensure the re-establishment of the downstream sheetflow patterns. As such, the rail deviation should have negligible impact on the downstream water flow patterns, runoff water volumes and quality, or vegetation communities.

4.5 MAINLINE DUPLICATION

The Mainline duplication will be located adjacent to the existing BHPBIO railway in slightly elevated terrain. This elevated terrain locally reduces the actual marsh waterway crossing width to around 500m, as compared with the typical marsh width of 10km. The marsh bed at this crossing location is several metres higher than the lowest level in the marsh eastern storage area. Drainage culverts will be installed under the railway formation, sized to match those in the existing BHPBIO railway, both within the marsh crossing zone and on the approaches, so to not impact on the existing flow patterns or water quality in the marsh area.

Installation of the duplicate railway embankment will not reduce the volume of storage available in the marsh and will not affect the existing surface water drainage patterns. As such the duplicated railway crossing of the marsh will have a negligible effect on the surface water drainage system.

4.6 SPECIFIC SURFACE WATER MANAGEMENT MEASURES

BHPBIO commits to follow the management strategies to manage surface water during the construction phase, as detailed in Section 4.3 and commits to implement the following surface water management measures to reduce the potential for environmental impact from the installed works:

- Install culverts at all defined drainage crossings and with capacity to safely pass the design flood.
- Design culverts with limiting upstream water levels to control flow velocities and with riprap or similar scour protection blankets on the inlets and outlets.
- Install culverts with small interceptor embankments, where appropriate, to prevent long drainage pathways developing adjacent and parallel to the railway formation.
- Install small diameter culverts at regular intervals through sheetflow areas, with provision for larger sized culverts where higher discharges are predicted.
- Where sheetflow dependent groved mulga areas are located immediate downstream from the railway, sheetflow culvert locations shall be based on ground and vegetation conditions.
- In sheetflow areas, install the railway access road on the downslope side of the railway formation.
- Downstream from the sheetflow culverts, install a shallow dip in the railway access road using cement stabilised road base material and do not place graded windrow material in this flow zone.
- Downstream from the sheetflow culverts and railway access road, install riprap pads to slow and disperse culvert runoff to the downstream environment.

- Install culverts through the Mainline Duplication within the Fortescue Marsh zone to match culvert capacities within the existing railway alignment.

SECTION 5 - SUMMARY

With increased production, BHPBIO needs to duplicate their existing single track rail between the Pilbara mine sites and the port. This duplicated track is proposed to be installed adjacent to their existing track, except for the section rising from the Fortescue Marsh through the Chichester Range where the railway route will have a 20km length deviation loop to reduce overall rising grade through the range. This surface water management report covers the railway alignment for the Chichester Rail Deviation and the Mainline Duplication between approximate BHPBIO railway chainages 222km and 255km.

The railway construction works will potentially cause disturbance to the existing surface water flow regimes in the area. In particular, the rail deviation passes through vegetation communities which may be partially dependent on runoff water potentially blocked by the railway. The duplicated rail crossing through the marsh may impact on water resources and flow patterns in the marsh.

The Fortescue Marsh is an extensive intermittent wetland with a total catchment area of around 31,000km^2. It is located on the floor of the Fortescue Valley and occupies an area around 100km long by typically 10km wide. The Chichester Deviation is located around 15km north from the marsh in the Chichester Range, but still within the marsh catchment. South from the rail deviation, the topography more gradually slopes towards the marsh and thicker vegetation zones have developed around the main drainage routes. Away from the main drainage routes, scrub and mulga woodland communities have developed, which are reported to be partially dependent on water provided by sheetflow. Of particular note are extensive groved mulga communities which aerial photography indicates start a few hundred metres south from the proposed southern section of the rail deviation. Groved mulga communities are reported to be dependent on both direct rainfall and sheetflow for providing soil moisture and nutrients.

Along the Chichester Deviation natural drainages typically cross perpendicular to the alignment and drain relatively small catchments (up to 5km^2), except for the creek crossing at chainage D241km which has a catchment area of 57km^2. All drainages crossing through the rail deviation alignment flow into creek lines discharging southwards to the marsh.

The Mainline Duplication will be located adjacent to the existing BHPBIO railway in slightly elevated terrain which locally reduces the actual width of the marsh crossing to around 500m as compared with a typical marsh width of around 10km. The marsh bed at this crossing location is several metres higher than the lowest level in the main marsh storage area. Around 20 culverts of between 1.5m and 2.1m diameter have been installed at the existing BHPBIO crossing to allow water flow between the main eastern portion of the marsh and the smaller western portion. Flood flows through these culverts could be in either direction, depending on relative flood levels within the marsh system.

Potential surface water impacts in the zone of influence along the proposed railway alignment include interruption to existing surface water flow patterns, increased risk of erosion and sedimentation, reduction in surface water runoff volume and quality, and impact on downstream vegetation communities and watercourse ecology.

General surface water management objectives for railway duplication comprise:

- Maintain the integrity, functions and environmental values of the downstream watercourses to prevent or minimise impacts on the quantity and quality of surface water resulting from activities.
- Maintain or improve the quality of surface water returned to local and regional surface water resources to ensure that existing and potential uses, including ecosystem maintenance are protected.

To reduce the potential impacts from the railway construction works, BHPBIO will adopt surface water management strategies related to limiting clearing, limiting vehicle movements, providing drainage buffer zones, dry season construction, separating flowpaths, protecting topsoil stockpiles, bunding borrow pits and stockpiles, installing temporary erosion and sediment control structures, and management of hydrocarbons products.

To reduce the potential for environmental impact from the installed works, BHPBIO commits to implementing the following surface water management measures:

- Install culverts at all defined drainage crossings and with capacity to safely pass the design flood.
- Design culverts with limiting upstream water levels to control flow velocities and with riprap or similar scour protection blankets on the inlets and outlets.
- Install culverts with small interceptor embankments, where appropriate, to prevent long drainage pathways developing adjacent and parallel to the railway formation.
- Install small diameter culverts at regular intervals through sheetflow areas, with provision for larger sized culverts where higher discharges are predicted.
- Where sheetflow dependent groved mulga areas are located immediate downstream from the railway, sheetflow culvert locations will be based on ground and vegetation conditions.
- In sheetflow areas, install the railway access road on the downslope side of the railway formation.
- Downstream from the sheetflow culverts, install a shallow dip in the railway access road using cement stabilised road base material and do not place graded windrow material in this flow zone.
- Downstream from the sheetflow culverts and railway access road, install riprap pads to slow and disperse culvert runoff to the downstream environment.
- Install culverts through the Mainline Duplication within the Fortescue Marsh zone to match culvert capacities within the existing railway alignment.

Implementing the defined surface water management strategies should ensure the Chichester Deviation and Mainline Duplication will have negligible impact on the downstream water flow patterns, runoff water volumes, runoff water quality, vegetation communities or watercourse ecology.

SECTION 6 - REFERENCES

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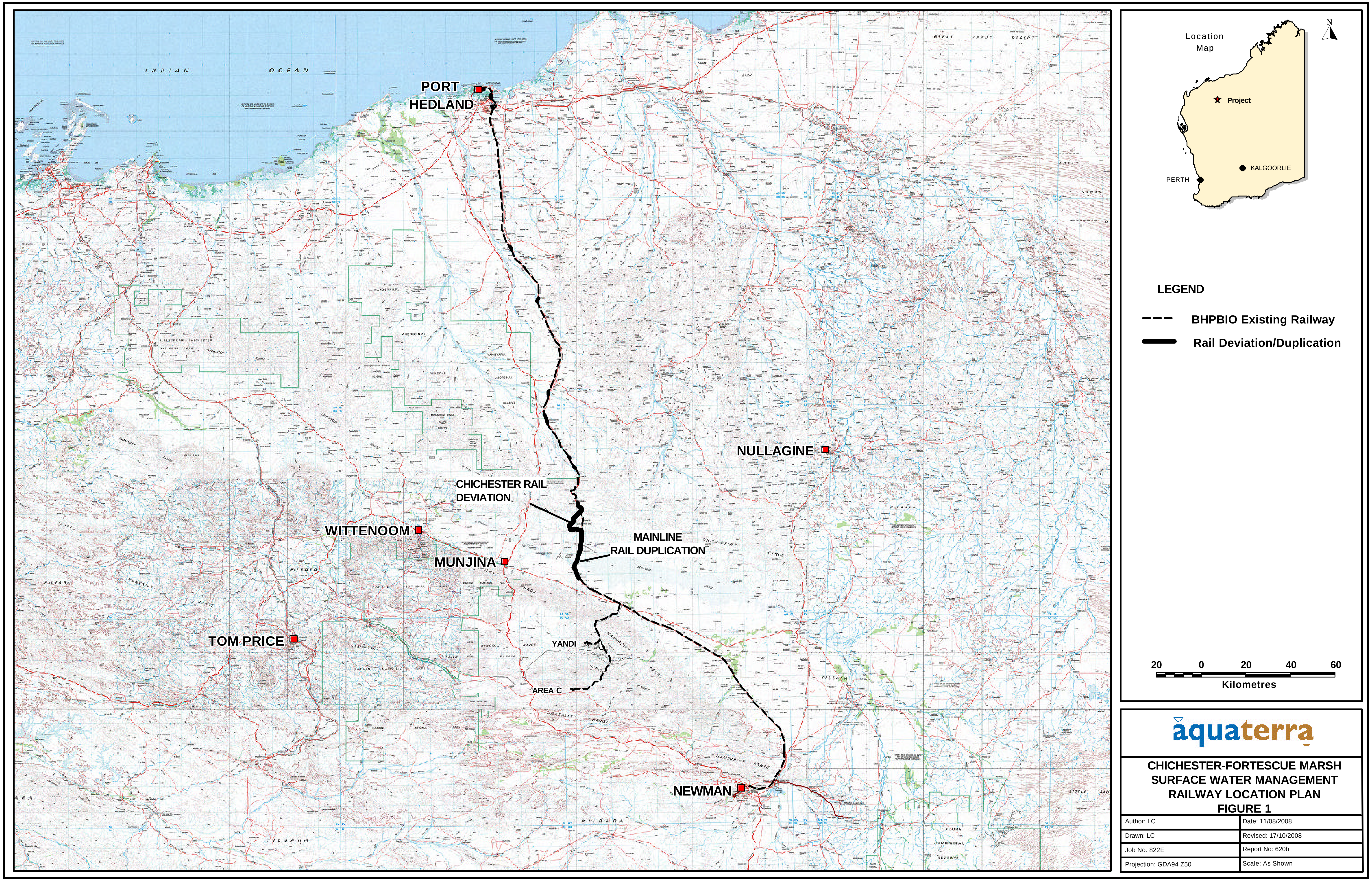
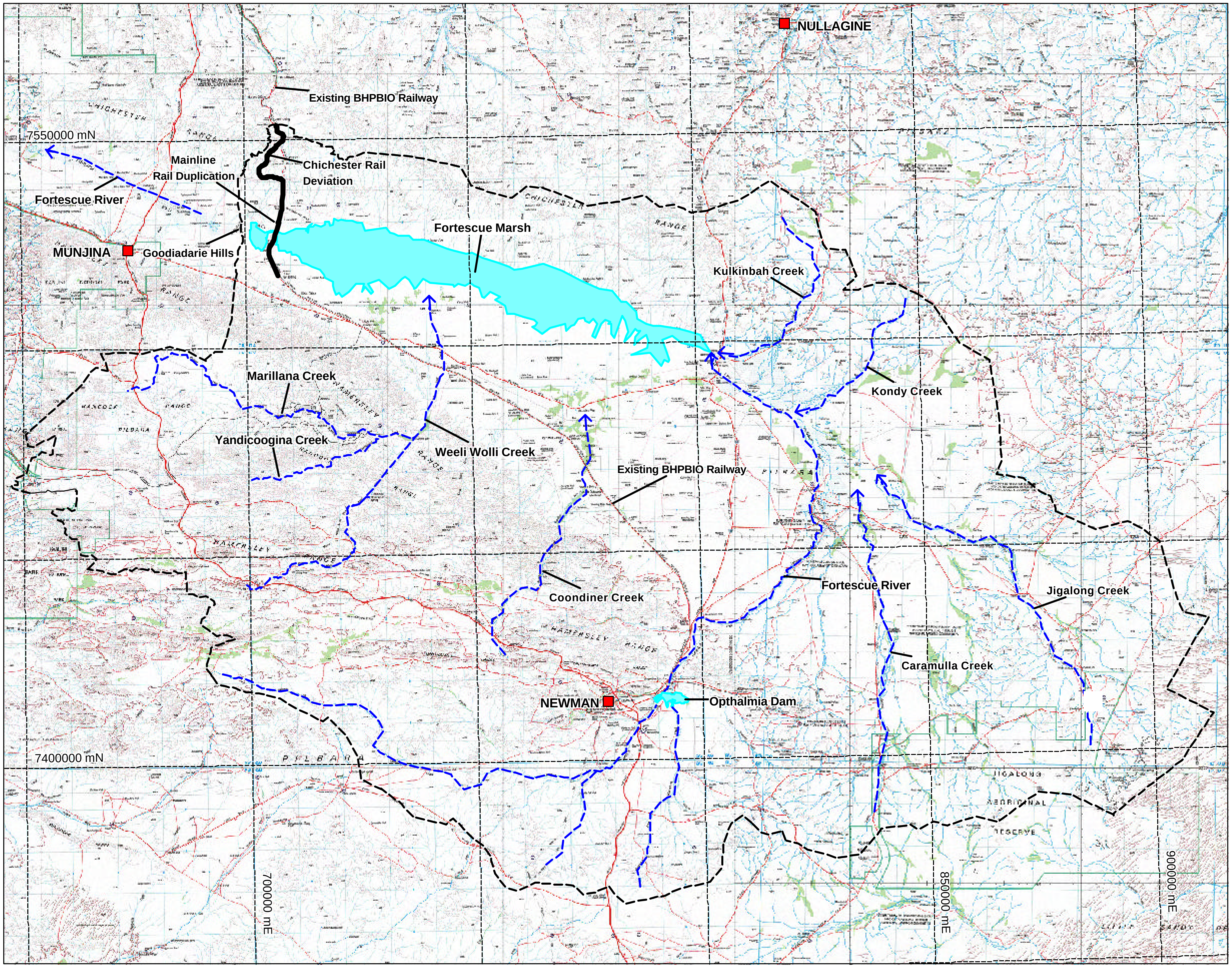
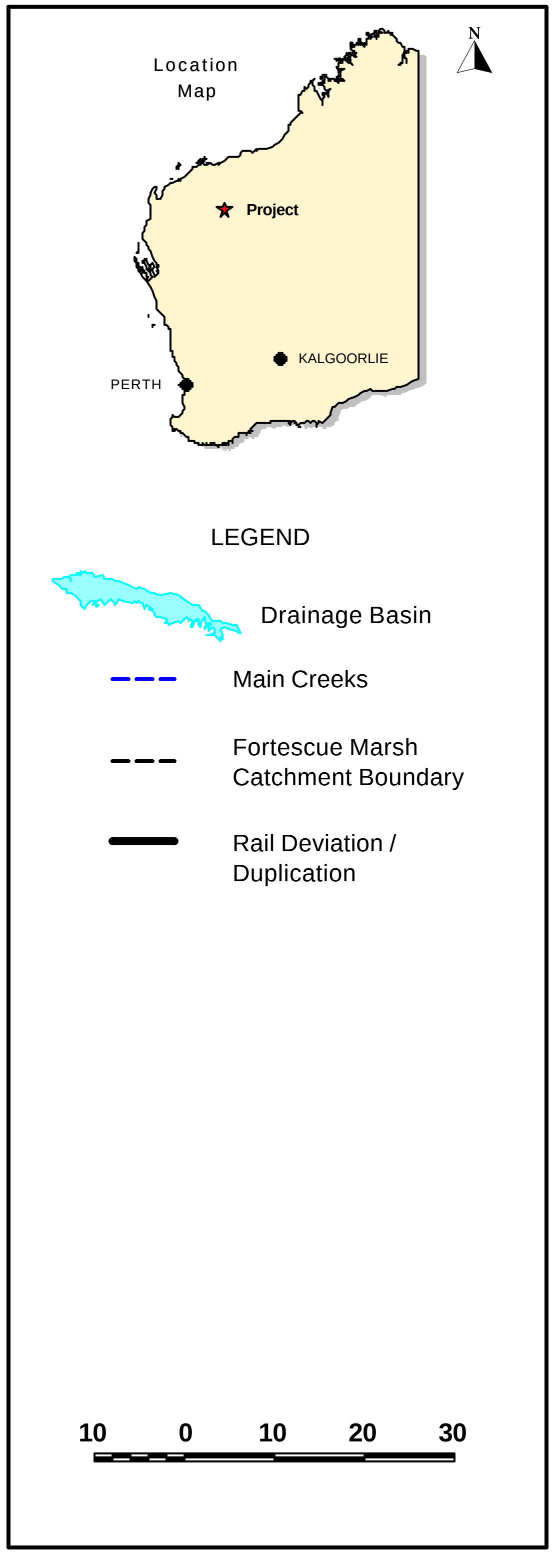
FIGURES



F:\Jobs\822\E Tasks\Report\620b Fig 1





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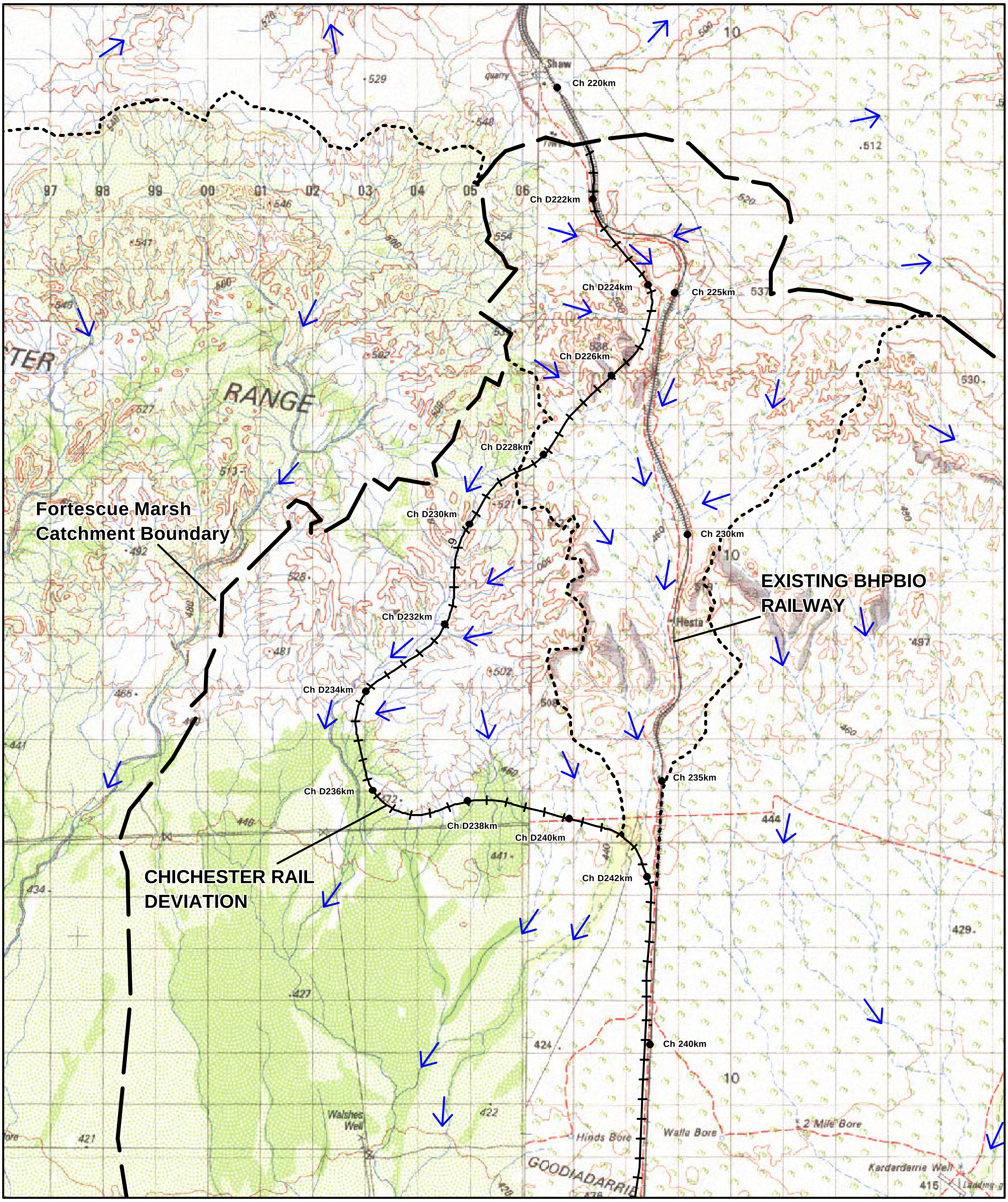
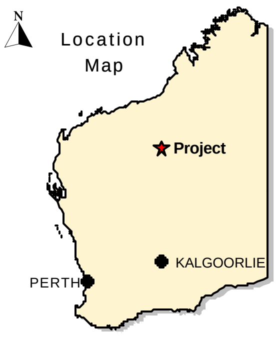
**CHICHESTER-FORTESCUE MARSH
SURFACE WATER MANAGEMENT
REGIONAL CATHMENT PLAN
FIGURE 2**

Author: VP	Date: 11/08/08
Drawn: LC	Revised: 17/10/2008
Job No: 822E	Report No: 620b
Projection: GDA94 Z50	Scale: As shown

F:\Jobs\822\E Tasks\Report\620b Fig 2





LEGEND

Fortescue Marsh Catchment Boundary

Sub-Catchment Boundary

Flow Direction

1 0 1 2 3

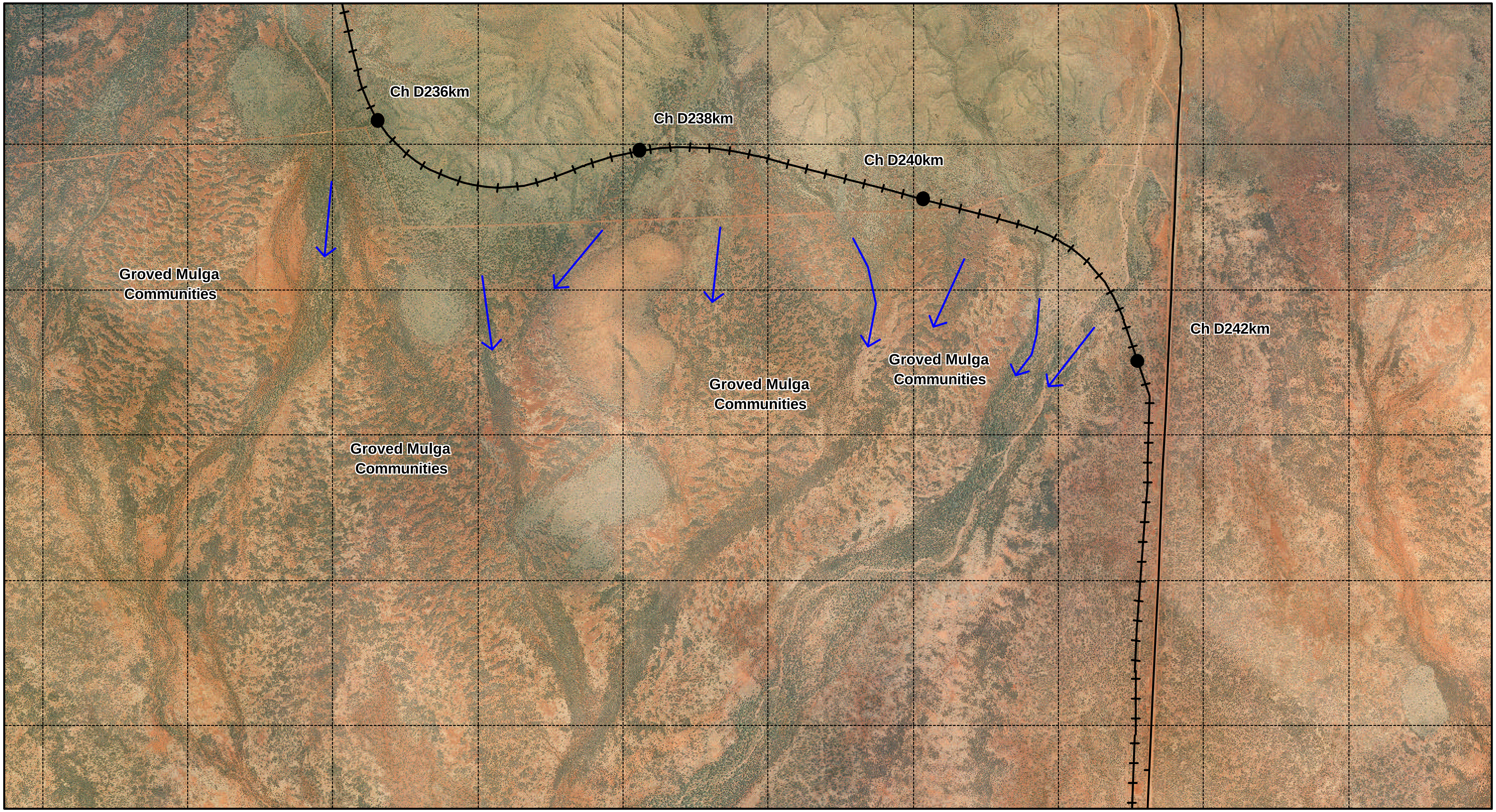
Kilometres

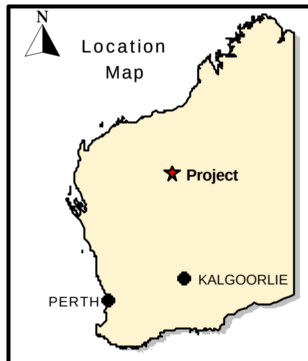
aquaterra

CHICHESTER RAIL DEVIATION
SURFACE WATER MANAGEMENT
CATCHMENTS AND FLOW PATHS
FIGURE 3

Author: LC	Date: 11/08/2008
Drawn: LC	Revised: 17/10/2008
Job No: 822E	Report No: 620b
Projection: GDA94 Z50	Scale: As shown

F:\Jobs\822\E Tasks\Report\620b Fig 3





LEGEND

Chichester Rail Deviation

Existing BHPBIO Railway

Flow Direction

0.5 0 0.5 1 1.5

Kilometres

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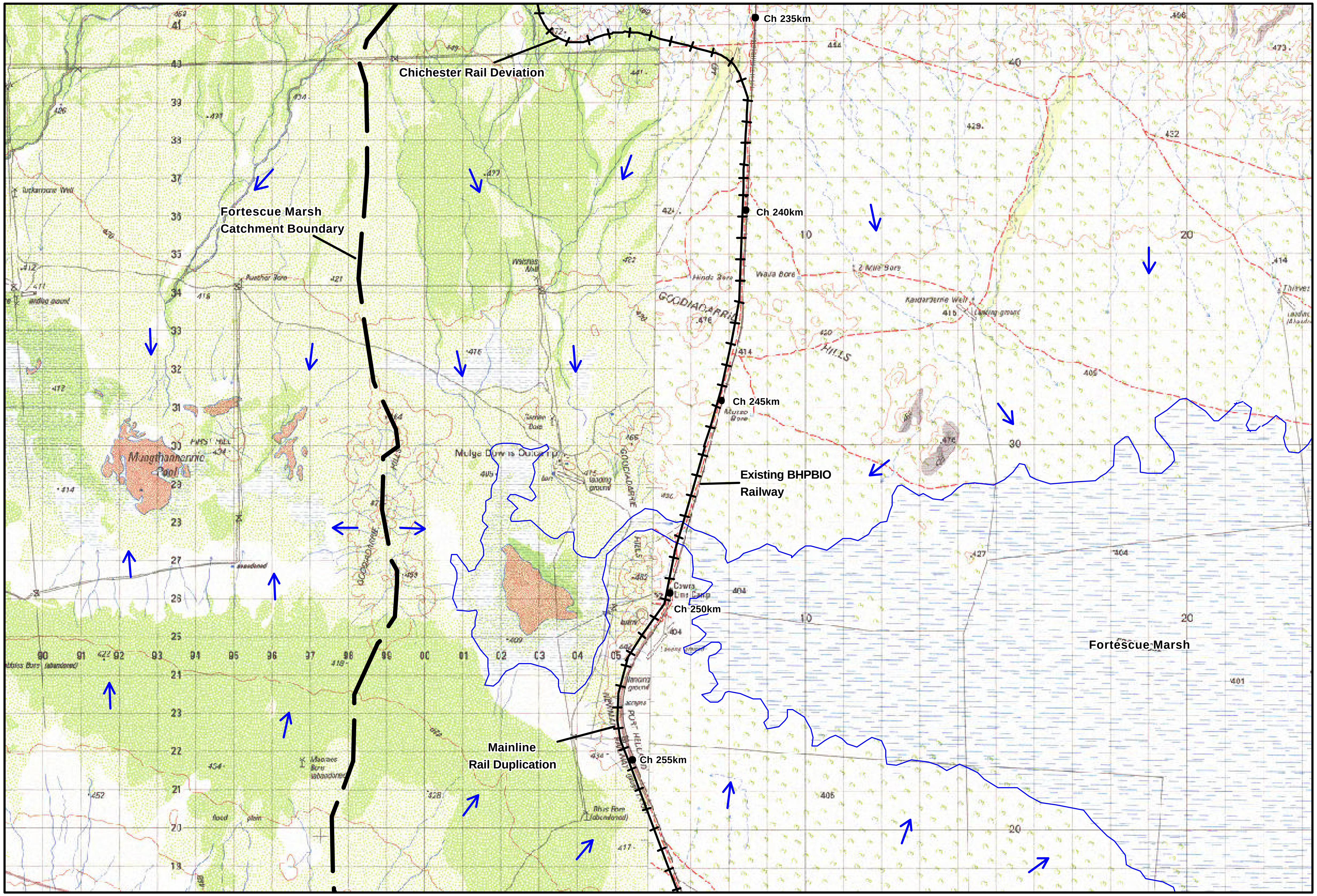
CHICHESTER RAIL DEVIATION
SURFACE WATER MANAGEMENT
GROVED MULGA COMMUNITIES LOCATION PLAN
FIGURE 4

Author: AC	Date: 26/08/08
Drawn: AC	Revised: 17/10/2008
Job No: 822E	Report No: 620b
GDA94 Z50	Scale: As shown

F:\Jobs\822\E Tasks\Report\620b Fig 4



Location Map

Project

KALGOORLIE

PERTH

LEGEND

- Fortescue Marsh Catchment Boundary
- Rail Deviation / Duplication
- Flow Direction

2 0 2 4

Kilometres

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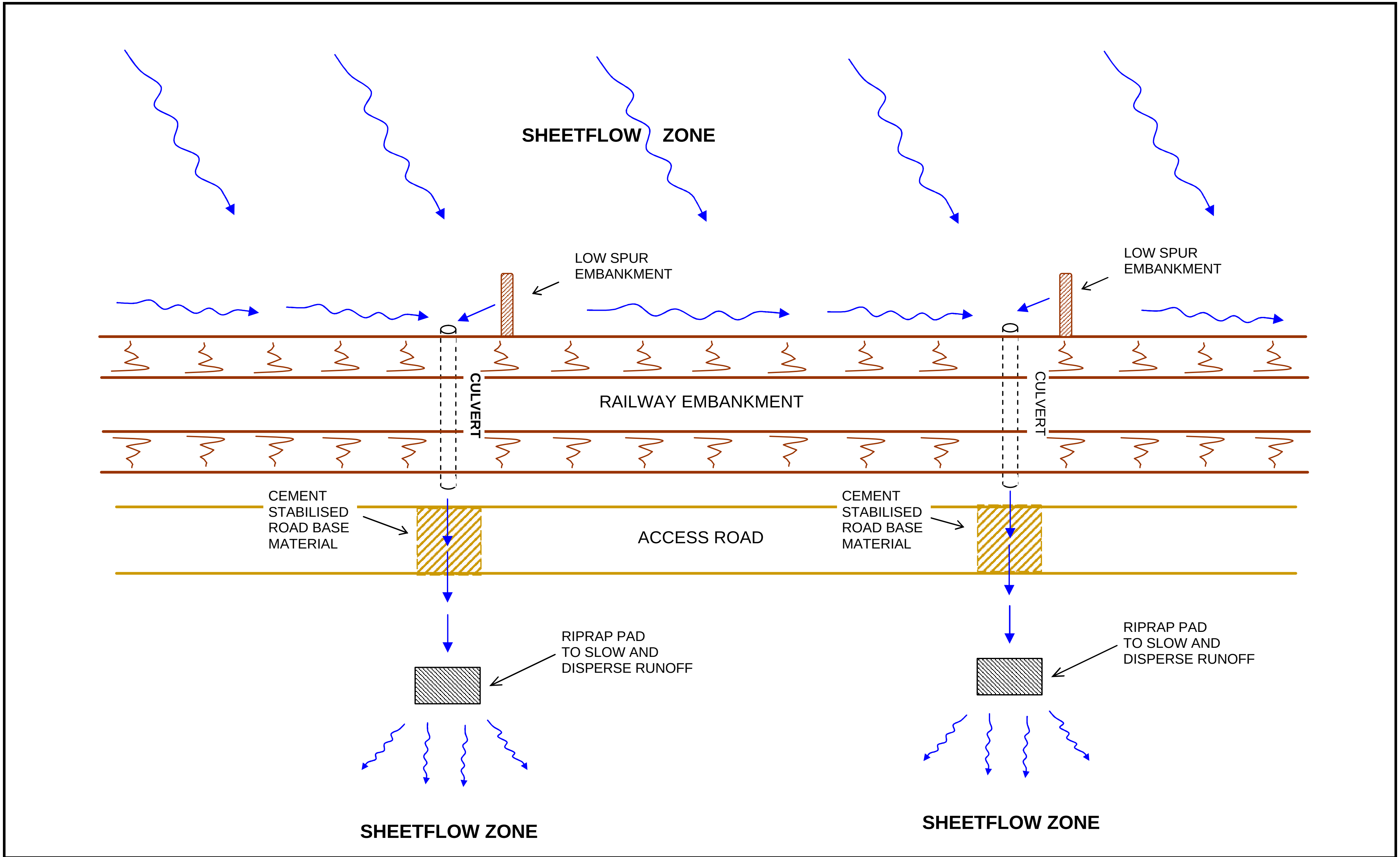
SURFACE WATER MANAGEMENT
MAINLINE RAIL DUPLICATION
CATCHMENTS AND FLOW PATHS
FIGURE 5

Author: AC	Date: 19/08/2008
Drawn: AC	Revised: 17/10/2008
Job No: 822E	Report No: 620b
Projection: GDA94 Z50	Scale: As shown

F:\Jobs\822\E Tasks\Report\620b Fig 5



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Railway Corridor Sheetflow Redistribution
Figure 6

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