Griffin Energy Saline Waste Disposal Proposed Pipeline Alignment
Acid Sulfate Soil Desktop Review

May 2008

Strategen

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1. Introduction

Construction of the Griffin Energy Saline Waste Disposal pipeline requires clearing and grading, excavation, pipe-laying, backfilling, rehabilitation and commissioning activities to be undertaken between Collie and Binningup (Figure 1). As part of the approvals process for the project, the proponent must demonstrate suitable knowledge and management of environmental issues associated with the proposed construction works.

Parsons Brinckerhoff (PB) was engaged by Strategen in January 2008 to undertake a desktop assessment to predict the likelihood of encountering acid sulfate soils, shallow groundwater, wetlands and river systems along the proposed pipeline alignment for Griffin Energy's Saline Waste Disposal. The results of this desktop assessment will be used to develop an investigation strategy along the pipeline route to enable preparation of suitable acid sulfate soil and dewatering management plans.

This desktop assessment encompasses the length of pipeline (63 km in total) running from the Bluewater PS Inlet, Collie Power Station, Collie to Buffalo Rd Beach, Binningup.

1.1 Distribution of acid sulfate soils in Western Australia

Acid sulfate soil is the common name for soil that contains iron sulfide or sulfide oxidation products. When acid sulfate soils are exposed to air and water, the iron sulfides can oxidise to produce sulfuric acid, iron precipitates and groundwater with elevated concentrations of dissolved metals such as aluminium, iron and arsenic. Although these materials are typically benign when undisturbed in their natural environment, the dewatering, excavation and/or stockpiling of acid sulfate soils may promote the occurrence of the aforementioned adverse environmental impacts.

Acid sulfate soils are widespread around coastal regions of Western Australia, and may also be locally associated with freshwater wetlands and saline sulfate rich groundwater in some agricultural areas. Through regional mapping projects, shallow acid sulfate soils are known to be present in the following general locations in Western Australia (DEC, 2006):

- Riverine, estuarine and coastal lowland areas such as mangroves, brackish lakes, tidal flats, salt marshes, salt pans, swamps and seasonally inundated plains;
- Wetland areas;
- Saline inland areas;
- Locally between the Moore River and Dunsborough on the Swan Coastal Plain; and
- On the Scott Coastal Plain at elevations up to 40 metres above sea level.

1.2 Project description

A 63 km trench will be excavated between Collie and Binningup. The trench depth will reach a nominal depth of 1.25 mBGL, and will be 800 mm wide. Excavation will take part in stages, with reburial within 48 hours where practical to do so. If reburial cannot be completed within this timeframe in medium to low and low risk areas, the pH of the stockpile will be monitored and if pH drops below threshold value (pH_{FOX}<4) then

stockpile is to be covered with a guard layer of AgLime. In medium and high risk areas where the excavation is to penetrate the watertable, the trench alignment will be covered with a layer of AgLime prior to excavation, so that the excavated soil will be neutralised when stockpiled. The amount of lime to be placed on the alignment will be based on treatment rates to be derived from the intrusive investigations proposed to be carried out to determine the acidity of soil in those specific locations (see Sections 3.6 and 4.6). The minimum length of trench excavated at any one time will likely be 1-2 km but will not exceed 10-15 km, therefore minimalising fauna entrapment.

Along specified lengths of pipeline construction through the coastal sand dunes will be undertaken using horizontal directional drilling techniques, and will not involve an open trench such that acid sulfate soil issues are not expected in this area.

Where the proposed pipeline route intersects rivers, pipe bridges will be used to negotiate river crossings. Where this is not possible, tunnelling excavation for the pipeline will commence approximately 50 m from the river bank, staying 2 m below the stable riverbed, and ascend 50 m from the opposite river bank. Where the proposed pipeline route intersects narrow creeks pipe bridges will be used to negotiate crossings. At larger river crossings adjacent to bridges, the pipeline could utilise the adjacent bridge as support. Where this is not possible, sub-bed river crossings will be required, by trenching across the river with the pipe encased in concrete. The point of descent and ascent of the pipe either side of the river would be dependant on local conditions (such as the height of bank, depth of water, and soil conditions), varying approximately between 2 m to 8 m in difficult conditions. The dimensions of pit excavations would have to be large enough to allow access to equipment for boring.

2. Assessment methodology

2.1 Desktop methodology

While mapping has been completed for much of the Swan Coastal Plain and coastal areas of regional Western Australia, limited inland risk mapping has been undertaken. The development of W.A. risk maps have primarily been based on existing geological mapping information and have given limited consideration to other risk factors such as depth to groundwater, local vegetation and wetlands.

Desktop assessment of regionally available information has been undertaken in this report, using key indicators of acid sulfate soils, to identify the likelihood of occurrence outside the regionally mapped areas.

2.2 Data sources

The following data sources were used as part of the desktop investigation:

- Department of Environment WIN Database for depth to groundwater;
- Department of Environment Statewide River Water Quality Assessment (2004) for surface water quality;
- Shuttle Radar Topography Mission (SRTM) for Digital Elevation Model (DEM) and water bodies;
- AGSO National Geoscience Dataset for regional regolith mapping;
- Integrated dataset of Agricultural Land Cover Change (ALCC95) (Barson *et al*. 2000), Forests of Australia 2003, 1996/97 Land Use of Australia, and the National Vegetation Information System 2000 (NVIS00) for regional vegetation cover; and
- Department of Water (DOW) database for depth to groundwater, hydrographic drainage, surface water management areas, metropolitan water supply and drainage.

2.3 Risk assignment

Data from each of the aforementioned sources was mapped along the proposed pipeline route. The potential for occurrence of acid sulfate soils occurring within the proposed excavation footprint was assessed through the use of key indicators such as geology, wetlands, depth to groundwater, and vegetation, and classified as HIGH (almost certain), MEDIUM (likely), MEDIUM TO LOW (possible in isolated circumstances), and LOW (unlikely).

The following general principles (DEC, 2006) regarding the occurrence of acid sulfate soil occurrence were used to rank the key indicators. Acid sulfate soils can be found in:

- Areas depicted on geology and/or geomorphological maps as geologically recent (e.g. shallow tidal flats or tidal lakes, coastal alluvial valleys, wetlands, floodplains, waterlogged areas, swamps);

- Areas identified in geological descriptions or maps as bearing acid sulfide minerals, former marine or estuarine shales and sediments, recent sand units, iron cemented organic rich sands (coffee rock), coal deposits, or mineral sand deposits;
- Areas known to contain peat or a build-up of organic material;
- Areas where the highest known watertable level is within 3 m of the surface; and
- Areas depicted in vegetation mapping as mangroves, wetland dependent vegetation (e.g. Melaleuca spp.), or salt/acid dependent vegetation (e.g. Casuarina spp.).

The risk ranking matrices used for soil along the proposed pipeline is summarised in Table 2.1 for regions along the pipeline route where ASS risk mapping has not been undertaken.

Table 2.1: Acid Sulfate Soil Risk Classification Criteria (specific to this investigation)

ASS RISK RANKING	GEOLOGY/LITHOLOGY			VEGETATION, WETLANDS AND WATER BODIES			DEPTH TO GROUNDWATER
	Regolith/Terrain	Geology	Soil Types	Vegetation	Wetlands and Water Bodies	Wetland Classification	mBGL
LOW	QUATERNARY SANDS, SOME LATERITE COASTAL PLAINS WITH DUNES UNDULATING PLAINS DISSECTED PLATEAUS MODERATELY/HEAVILY WEATHERED BEDROCK	QUATERNARY/PLEISTOCENE DEPOSITS GRANITE/SCHIST/GNEISS (ARCHEAN-PROTEROZOIC) TERRESTRIAL / ALLUVIAL/ AEOLIAN SEDIMENTS LATERITE	BLEACHED SANDS, SANDS WITH PANS, and LEACHED SANDS in low lying areas. IRONSTONE	CROPS NATIVE GRASSLANDS NATIVE SHRUBS AND HEATHS NATIVE FORESTS AND WOODLANDS	NONE > 500 m from CREEKS > 500 m from RIVERS > 500 m from WATER BODIES	NONE	>5
MEDIUM TO LOW	QUATERNARY SANDS, SOME LATERITE COASTAL PLAINS WITH DUNES UNDULATING PLAINS DISSECTED PLATEAUS MODERATELY/HEAVILY WEATHERED BEDROCK	QUATERNARY/ PLEISTOCENE DEPOSITS TERRESTRIAL / ALLUVIAL/ AEOLIAN SEDIMENTS LATERITE	BLEACHED SANDS, SANDS WITH PANS, and LEACHED SANDS in low lying areas. IRONSTONE	CROPS NATIVE GRASSLANDS NATIVE SHRUBS AND HEATHS NATIVE FORESTS AND WOODLANDS	> 500 m from SEASONAL/ PERMANENT WETLANDS <500 m from RIVERS <500 m from WATER BODIES	MULTIPLE USE	0-5
MEDIUM	QUATERNARY SANDS, SOME LATERITE COASTAL PLAINS WITH DUNES UNDULATING PLAINS DISSECTED PLATEAUS MODERATELY/HEAVILY WEATHERED BEDROCK	SWAMP AND LACUSTRINE SEDIMENTS QUATERNARY/ PLEISTOCENE DEPOSITS TERRESTRIAL / ALLUVIAL/ AEOLIAN SEDIMENTS LATERITE	BLEACHED SANDS, SANDS WITH PANS, and LEACHED SANDS in low lying areas. IRONSTONE	NATIVE FORESTS AND WOODLANDS NATIVE SHRUBS AND HEATHS CROPS	<500 m from SEASONAL/ PERMANENT WETLANDS	MULTIPLE USE	0-5

ASS RISK RANKING	GEOLOGY/LITHOLOGY			VEGETATION, WETLANDS AND WATER BODIES			DEPTH TO GROUNDWATER
	Regolith/Terrain	Geology	Soil Types	Vegetation	Wetlands and Water Bodies	Wetland Classification	mBGL
HIGH	QUATERNARY SANDS, SOME LATERITE COASTAL PLAINS WITH DUNES UNDULATING PLAINS DISSECTED PLATEAUS	SWAMP AND LACUSTRINE SEDIMENTS QUATERNARY/ PLEISTOCENE DEPOSITS in low-lying, wetland areas ALLUVIAL SEDIMENTS LATERITE	PEAT, ORGANIC RICH SEDIMENTS BLEACHED SANDS, SANDS WITH PANS, and LEACHED SANDS in low lying areas. IRONSTONE	MELALEUCA/ CASUARINA (not identified in this study) CROPS NATIVE FORESTS AND WOODLANDS NATIVE SHRUBS AND HEATHS	PERMANENT WETLANDS	RESOURCE ENHANCED or MULTIPLE USE	0-5

2.4 Proposed investigation methodology

Although this preliminary desktop investigation will allow areas of acid sulfate soils to be identified to a relatively high level of confidence, field sampling and validation are likely to be required by the Department of Environment and Conservation (DEC) to meet current guidelines in areas that are classified as having a medium to high risk of being characterised acid sulfate soils.

A level of intrusive investigation was assigned based on the risk of acid sulfate soils being present along the pipeline route. The level of intrusive investigation, based on the acid sulfate soil risk classification, for the preliminary acid sulfate soil investigation was defined as follows:

LOW: Site walkover at time of development. Where ground truthing indicates a deviation from the predicted occurrence, field analysis of pH_F and pH_{FOX} (pH after oxidation) at a rate of 1:200 m^3 will be undertaken.

LOW TO MEDIUM: Site walkover and minor field pH testing at time of development. Field analysis of pH_F and pH_{FOX} (pH after oxidation) at a rate of 1:200 m^3 of excavated soil will be undertaken at the time of investigation.

MEDIUM: Soil bores will be installed at a frequency of 1 soil bore per 200 m. Field analysis of pH_F and pH_{FOX} (pH after oxidation) at 0.25 m intervals will be undertaken. The highest risk soil sample from each bore will be sent for laboratory analysis for the Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) suite and 1 in every 10 bores will be laboratory analysed for SPOCAS at 0.5 m intervals through the bore profile.

If horizontal directional drilling techniques are employed in medium risk areas, then soil bore installation and analysis of pH_F and pH_{FOX} does not have to be employed as soil will not be exposed and consequently not subject to oxidation; therefore the area in question can be treated as a low risk area.

HIGH: Soil bores will be installed at a frequency of 1 soil bore per 100 m or one bore per area, whichever is greater. Field analysis of pH_F and pH_{FOX} (pH after oxidation) at 0.25 m intervals will be undertaken. The highest risk soil sample from each bore will be sent for laboratory analysis for SPOCAS and 1 in every 5 bores or a minimum of 1 bore per area will be laboratory analysed for SPOCAS at 0.5 m intervals through the bore profile.

If horizontal directional drilling techniques are employed in high risk areas, then soil bore installation and analysis of pH_F and pH_{FOX} does not have to be employed as soil will not be exposed and consequently not subject to oxidation; therefore the area in question can be treated as a low risk area.

3. Swan Coastal Plain

The western portion of the pipeline route runs along the Swan Coastal Plain from Buffalo Beach Rd, Binningup (from KP00 to KP23) and comprises 23 km of the 63 km pipeline. This portion of the pipeline route ranges in elevation from 0-1 mAHD (Kilometre of pipeline (KP) 01 to KP02) near the coast to 25 mAHD (KP05 to KP07) just inland where it passes through a region of sand dunes, although in general topography gradually increases to the east towards the Darling Scarp. More specific topographical information can be obtained during site walkover at time of development.

Appendix A depicts occurrence of the geological, wetland, vegetation and watertable characteristics encountered along the pipeline route and these parameters are tabulated in Appendix C.

3.1 Geological setting

The Swan Coastal Plain is characterised by a broad, level, alluvial belt with lines of Cenozoic sand dunes and limestone ridges on its seaward side, underlain by Mesozoic basalts and siltstones. This plain is interrupted by the Darling Scarp, running north-south along the coastal plain, bordering the Darling Plateau.

3.2 Vegetation

The vegetation of the Swan Coastal Plain consists mainly of a mosaic of Jarrah forest and native shrubs, with large areas cleared for cropping/grazing livestock. The first 3 km of pipeline run through native dune system shrubs and swamp vegetation. The pipeline route then passes through cropped areas and a mosaic of native Jarrah woodland. Towards the Darling Scarp, from KP15 to KP23, the vegetation is predominantly Jarrah woodland.

3.3 Groundwater

Information pertaining to the depth to groundwater in the area has been derived from data from groundwater monitor bores located predominantly within 1 km radius of each 1 km section of the pipeline; however information on depth to groundwater at a large number of proximal bores was not available.

Depth to groundwater along the pipeline route is expected to be very shallow (0-5 m BGL), and shallow (5-10 m BGL) in some portions.

3.4 Water bodies and wetlands

There are a number of water bodies and wetlands that the proposed pipeline route intersects. From KP00 to KP02 the pipeline runs adjacent to the Leschenault Estuary. At KP10, the pipeline intersects the Brunswick River and also runs through surrounding wetlands (seasonally waterlogged basins and flats). The pipeline also intersects the Collie River at KP21. The pipeline route continues through these wetlands until KP23.

Water quality information was obtained for the Leschenault Estuary, Collie River and Brunswick River from the DOW and McKenna (2007), with multiple data for the Collie River.

The Brunswick River has a high total nitrogen level (1.271 mg/L) and high turbidity (12.65 NTU), with marginal total dissolved salts (811.7 mg/L). Both the Brunswick and Collie Rivers have neutral pH (7.27 and 6.6-7.2 respectively), stained water with low dissolved oxygen (6.38 and 5.8-6.7 respectively). Further east along the Collie River, the water becomes less brackish (from 1696.5 to 860.3) and more turbid (from 3.8 to 8.3 NTU).

The Leschenault Estuary has varying salinity levels, ranging from fresh (0.4 ppt) to hypersaline (60 ppt), resultant from the estuaries permanent connection to the ocean. Hypersaline conditions have been reported annually for the northern end of the estuary; caused by the lack of strong tidal exchanges, shallow water depth and evaporation. The dissolved oxygen content varies throughout the water column from 0.1 to 12.5 mg/L. Turbidity for the estuary is classed as low.

These water bodies and wetlands can be considered sensitive receptors to any impacts resulting from the disturbance of acid sulfate soils.

3.5 Acid sulfate soil classification

Approximately 14 km of HIGH risk soils were identified in the first 2 km of pipeline and from KP10 to KP22. HIGH risk soils are generally associated with Quaternary lacustrine sediments in low-lying, wetland areas.

An additional 3 km of MEDIUM risk soils (KP02 to KP03, KP09 to KP10, and KP22 to KP23) were identified along the proposed pipeline route. MEDIUM risk soils are generally associated with Quaternary terrestrial or alluvial sediments or aeolian sands in seasonal wetlands (or lacustrine sediments less than 500 m from wetlands or seasonal wetlands).

A further 3 km of MEDIUM TO LOW risk soils (from KP03 to KP05, and KP08 to KP09) were identified, associated with Quaternary terrestrial or alluvial sediments, or aeolian sands, within native forests and woodlands and cropped areas greater than 500 m from water bodies or wetlands, with depth to groundwater less than 5 mBGL.

A further 3 km of LOW risk soils (from KP05 to KP08) were identified, associated with Quaternary terrestrial or alluvial sediments, or aeolian sands, within native forests and woodlands and cropped areas greater than 500 m from water bodies or wetlands, with depth to groundwater greater than 5 mBGL

The acid sulfate soil risk allocated along the pipeline route is illustrated in Appendix A.

3.6 Proposed ASS and hydrogeologic investigation

Table 3.1 summarises the proposed soil and groundwater sample and analysis plan for KP00 to KP23. A soil bore depth of 2.5 m has been assumed for all bores; however, soil bores will need to be installed to 1 m below the proposed depth of pipeline excavation of 1.25 m. Where the pipeline intersects the Collie River, it will descend approximately 50 m from the river bank, staying 2 m below the stable riverbed, and ascend 50 m from the opposite river bank. Groundwater monitor bores are proposed to be installed to a depth of 5 m at 2 km intervals in those areas where groundwater is encountered.

If horizontal directional drilling techniques are employed in medium or high risk areas, thus not exposing any ASS to oxidation, then the same intrusive investigation methodologies employed for low risk areas can be used.

Table 3.1: Summary Sampling and Analysis Plan – Swan Coastal Plain (depth of 2.5 m)

ASS Risk Ranking	No. Kilometres	No. Proposed Soil Bores	No. Proposed Monitor Bores	No. Proposed Field Tests[1]	No. Proposed SPOCAS Analysis
LOW	3	0	0	0	0
MEDIUM to LOW	3	0	0	0	0
MEDIUM	3	6	1	66	12
HIGH	14	140	7	1540	308

[1] Field tests to be conduicted at time of excavation

4. Darling Scarp and Darling Plateau

The eastern portion of the pipeline route runs from KP23 (at the edge of the Darling Scarp) to the end of the proposed pipeline route (at KP63), comprising 40 km of the 63 km pipeline. The pipeline route covers a range of elevations, increasing from approximately 20 mAHD to 255 mAHD over a 5 km distance east across the Darling Scarp (from KP23 to KP27). The elevation along the Darling Plateau varies from approximately 200 mAHD (KP47 to KP50, KP55 to KP58) to 255 mAHD (KP27 to KP28), with local highs and lows throughout.

Appendix B depicts occurrence of the geological, wetland, vegetation and watertable characteristics encountered along the pipeline route and these parameters are tabulated in Appendix C.

4.1 Geological setting

The Darling Plateau and bordering Darling Scarp lie east of the Swan Coastal Plain. Both the Darling Scarp and Darling Plateau consist of a thin layer of Tertiary laterites and conglomerates and Quaternary alluvium and colluvium sands, overlaying an Archean granitic/schist/gneissic basement. The plateau is heavily weathered and dissected, exposing the basement most commonly in river beds and valleys.

4.2 Vegetation

The vegetation of the Darling Scarp and Darling Plateau consists of Jarrah forest and native shrubs, with plantation forests from KP23 to KP29. The pipeline intersects Wellington National Park from KP33 to KP39 and KP40 to KP45, Collie State Forest from KP51 to KP52, and Harris River State Forest from KP51 to KP53 and KP58 to KP61.

4.3 Groundwater

Information pertaining to the depth to groundwater in the area has been derived from data from groundwater monitor bores located predominantly within 1 km radius of each 1 km segment of the pipeline; however information on depth to groundwater was not available for the majority of these bores.

Depth to groundwater along the pipeline route is predicted to vary from very shallow (0-5 m BGL) to shallow (5-10 m BGL) along sections proximal to river and lake systems and deep (>10 m BGL) as elevation and distance from water bodies increases.

4.4 Water bodies and wetlands

The proposed pipeline route intersects wetlands (swamp) at KP30 to KP31, Wellington Dam at KP44 to KP45, an unnamed watercourse from KP47 to KP48 and Harris River from KP55 to KP57. The Wellington Dam has 950 mg/L total dissolved salts in water, peaking to 1200 mg/L in dry periods; therefore is classed as having marginal to brackish water.

These can be considered sensitive receptors to any impacts resulting from the disturbance of acid sulfate soils

4.5 Acid sulfate soil classification

Approximately 1 km of HIGH risk soils were identified from KP30 to KP31. HIGH risk soils are generally associated with low-lying, wetland areas classified as resource enhancement or multiple use wetlands.

Approximately 7 km of MEDIUM risk soils were identified from KP28 to KP30, KP33 to KP34, KP37 to KP38, KP39 to KP40, KP44.5 to KP45, KP47.5 to KP48, and KP55.5 to KP56.5. MEDIUM risk soils are generally associated with water bodies, creeks or rivers, or areas less than 500 m from wetlands (swamp).

Approximately 11 km of MEDIUM TO LOW risk soils were identified from KP43 to KP44, KP44 to KP44.5, KP47 to KP47.5, KP48 to KP51, KP52 to KP55.5, KP56.5 to KP58, and KP59 to KP60. MEDIUM TO LOW risk soils are less than 500 m from water bodies, creeks, rivers (either fresh or brackish), and greater than 500 m from wetlands within native forests and woodlands, but exhibit a depth to ground water less than 5 mBGL.

Approximately 21 km of LOW risk soils were identified along the proposed pipeline route, from KP. LOW risk areas are generally associated with moderately weathered bedrock and Archean granitic rocks with native forest cover, greater than 500m from wetlands, water bodies, creeks, or rivers, with depth to groundwater greater than 5 mBGL.

The acid sulfate soil risk ranking is illustrated in Appendix B.

4.6 Proposed ASS and Hydrogeological Investigation

Table 4.1 summarises the proposed soil and groundwater sample and analysis plan for KP21 to KP63. A soil bore depth of 2.5 m has been assumed for all bores; however, soil bores will need to be installed to 1 m below the proposed depth of pipeline excavation of 1.25 m. Groundwater monitor bores are proposed to be installed to a depth of 5 m at 2 km intervals in those areas where groundwater is encountered.

If horizontal directional drilling techniques are employed in medium or high risk areas, thus not exposing any ASS to oxidation, then the same intrusive investigation methodologies employed for low risk areas can be used.

Table 4.1: Summary Sampling and Analysis Plan – Darling Scarp and Darling Plateau (depth of 2.5)

ASS Risk Ranking	No. Kilometres	No. Proposed Soil Bores	No. Proposed Monitor Bores	No. Proposed Field Tests[2]	No. Proposed SPOCAS Analysis
LOW	21	0	0	0	0
MEDIUM to LOW	11	0	0	0	0
MEDIUM	7	14	3	154	26
HIGH	1	10	1	110	22

[2] Field tests to be conducted at time of excavation

5. Conclusions

Based on the results of the desktop investigation, and within the limitations detailed in Section 7, the following conclusions have been drawn regarding the acid generating potential of near surface soils along the Griffin Energy Saline Waste Disposal proposed pipeline:

- Soils along KP00 to KP02, KP10 to KP22, have been ranked as HIGH risk in areas associated with Quaternary lacustrine sediments in low-lying permanent wetland areas classified as resource enhancement or multiple use wetlands, with depth to groundwater between 0-5 m BGL. Potentially HIGH risk soils have also been identified between KP30 to KP31 in association with low-lying permanent wetlands.
- Soils along KP02 to KP03, KP09 to KP10, KP22 to KP23, KP28 to KP30, KP33 to KP34, KP37 to KP38, KP39 to KP40, KP44.5 to KP45, KP47.5 to KP48, and KP55.5 to KP56.5 have been ranked as MEDIUM risk in areas associated with:
  - Quaternary terrestrial or alluvial sediments or aeolian sands that are also located less than 500 m from seasonal wetlands along the Swan Coastal Plain with depth to ground water less than 5 mBGL
  - Moderately to heavily weathered bedrock with water bodies, creeks or rivers (either fresh or brackish) within native forests and woodlands, or less than 500 m from wetlands along the Darling Scarp and Darling Plateau, with depth to ground water less than 5 mBGL
- Soils from KP03 to KP05, KP08 to KP09, KP43 to KP44, KP44 to KP44.5, KP47 to KP47.5, KP48 to KP51, KP52 to KP55.5, KP56.5 to KP58, and KP59 to KP60 have been ranked as MEDIUM TO LOW risk areas associated with:
  - Quaternary terrestrial or alluvial sediments, or aeolian sands, within native forests and woodlands and cropped areas, with depth to groundwater less than 5 m BGL along the Swan Coastal Plain,
  - On the Darling Scarp and Darling Plateau moderately to heavily weathered bedrock less than 500 m from water bodies, creeks or rivers (either fresh or brackish) and greater than 500 m from wetlands within native forests and woodlands, but exhibit a depth to ground water less than 5 mBGL.
- Soils along KP05 to KP08, KP23 to KP28, KP31 to KP33, KP34 to KP37, KP38 to KP39, KP40 to KP43, KP45 to KP47, KP51 to KP52, KP58 to KP59, and KP60 to KP63 have been ranked as LOW risk areas associated with:
  - Quaternary terrestrial or alluvial sediments, or aeolian sands, within native forests and woodlands and cropped areas with depth to groundwater greater than 5 mBGL along the Swan Coastal Plain,
  - Moderately weathered bedrock and Archean granitic rocks with native forest cover, greater than 500m from wetlands, water bodies, creeks, or rivers, with depth to groundwater greater than 5 mBGL along the Darling Scarp and Darling Plateau.

Where the proposed pipeline route intersects rivers, pipe bridges will be used to negotiate river crossings. This may not be possible where the proposed pipeline route intersects the Collie River between KP21 to KP22. In this case, tunnelling excavation for the pipeline will commence approximately 50 m from the river bank, staying 2 m below the stable riverbed, and ascend 50 m from the opposite river bank. The acid generating potential of subsurface soils at the site is considered to be high (the same risk ranking as for the near surface soils at KP21 to KP22).

If horizontal directional drilling techniques are employed in medium or high risk areas, thus not exposing any ASS to oxidation, then the same intrusive investigation methodologies employed for low risk areas can be used in place of soil bore installation and analysis of pH_F and pH_{FOX} as required for medium to high risk areas.

6. References

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7. Statement of Limitations

Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Parsons Brinckerhoff (PB) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

Environmental Conclusions

In accordance with the scope of services, PB has relied upon the data and has not conducted any environmental field monitoring or testing in the preparation of the report. The conclusions are based upon the data and visual observations and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Within the limitations imposed by the scope of services, the assessment of the site and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. PB assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of PB or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

PB will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

Appendix A

Swan Coastal Plain Maps

380000 390000 400000

6320000

PARKFIELD
BENGER
MARBALUP
WELLESLEY
BRUNSWICK
LESCHENAULT
BRUNSWICK JUNCTION
AUSTRALIND
ROELANDS
BUREKUP
EATON
WATERLOO

SOUTH WESTERN HWY
OLD COAST RD
AUSTRALIND BYPA
OMMANEY RD
RAYMOND RD
COALFIELDS RD

KP 1000
KP 3000
KP 5000
KP 7000
KP 9000
KP 11000
KP 13000
KP 15000
KP 17000
KP 19000
KP 21000
KP 23000
KP 25000
KP 27000
KP 29000
KP 31000
KP 33000
KP 35000

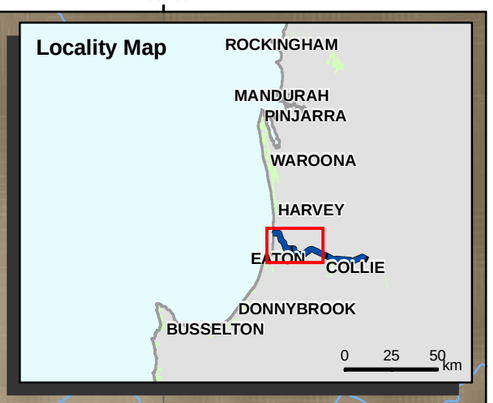
Lithology
Quaternary sands, swamps, some laterite

Regolith
Coastal plains with dunes, rising to undulating plains, Cape Naturaliste - Cape Leuwin granite with moderate relief

Lithology
Granite/Schist/Gneiss (Archean-Proterozoic)

Regolith
Deep weathering profile with mottled zones and ironstone. Erosional/Depositional: moderate to high rellief, variably weathered, stoney. Dissected plateaus, extensive blocky laterite, some swamps and old drainage lines

Locality Map



Legend

- KP points at 2km intervals KP37000 = Kilometre Pipe 37 (37km along pipeline)
- Proposed Pipeline
- Highway
- Watercourse
- Waterbody

Regolith - with descriptions

- Terrestrial sediments
- Very highly weathered bedrock

PB PARSONS BRINCKERHOFF

GRIFFIN ENERGY

0 1,250 2,500 m

Scale: 1:75,000 at A3

Coord. System.: MGA50 GDA94

N S

GDA

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.:	2145463A-GIS-F001		
Revision:	A	Date:	07/04/2008
Drawn By:	CT	Checked by:	BJW
Data Source: Landgate, Griffin Energy, DOW			

Griffin Energy

Acid Sulfate Soil Desktop Review

Saline Waste Disposal, Proposed Pipeline Alignment

Regolith and Lithology

Appendix A1

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F001.mxd

380000
390000
400000
6320000

PARKFIELD
BENGER
MARBALUP
WELLESLEY
SOUTH WESTERN HWY
BRUNSWICK
BEELA
BRUNSWICK JUNCTION
LESCHENAULT
AUSTRALIND BYPA
OMMANEY RD
AUSTRALIND
OLD COAST RD
RAYMOND RD
ROELANDS
COALFIELDS RD
BUREKUP
EATON
WATERLOO
SOUTH WESTERN HWY

1000
3000
5000
7000
9000
11000
13000
15000
17000
19000
21000
23000
25000
27000
29000
31000
33000
35000

3.68

Locality Map

ROCKINGHAM
MANDURAH
PINJARRA
WAROONA
HARVEY
EATON
COLLIE
DONNYBROOK
BUSSELTON
0 25 50 km

Legend

- KP points at 2km intervals
  KP37000 = Kilometre Pipe 37 (37km along pipeline)
- 3.0 DOW bore with water level data (mBGL)
- 3.0 Non-DOW bore with water level data (mBGL)
- Bore without water level data
- Watercourse
- Proposed Pipeline

Elevation (mAHD)
Value
High : 592
Low : 0

PARSONS BRINCKERHOFF

GRIFFIN ENERGY

0 1,250 2,500 m

Scale: 1:75,000 at A3

Coord. System.:MGA50 GDA94

N S

GDA

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.: 2145463A-GIS-F002			
Revision:	A	Date:	10/03/2008
Drawn By:	CT	Checked by:	BJW
Data Source: Landgate, Griffin Energy, DOW			

Griffin Energy
Acid Sulfate Soil Desktop Review
Saline Waste Disposal, Proposed Pipeline Alignment
Terrain and Depth to Groundwater (mBGL)
Appendix A2

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F002.mxd

380000 390000 400000

6320000

PARKFIELD
BENGER
BURRAGENUP
MARBALUP
WELLESLEY
SOUTH WESTERN HWY
BRUNSWICK
BEELA
Indian Ocean
OLD COAST RD
LESCHENAULT
AUSTRALIND BYPA
BRUNSWICK JUNCTION
OMMANEY RD
AUSTRALIND
RAYMOND RD
ROELANDS
COALFIELDS RD
BUREKUP
WATERLOO
SOUTH WESTERN HWY

KP 1000
KP 3000
KP 5000
KP 7000
KP 9000
KP 11000
KP 13000
KP 15000
KP 17000
KP 19000
KP 21000
KP 23000
KP 25000
KP 27000
KP 29000
KP 31000
KP 33000
KP 35000

Locality Map

ROCKINGHAM
MANDURAH
PINJARRA
WAROONA
HARVEY
EATON
COLLIE
DONNYBROOK
BUSSELTON
0 25 50 km

Legend

- KP points at 2km intervals
  KP37000 = Kilometre Pipe 37 (37km along pipeline)
- Highway
- Watercourse
- Proposed pipeline

Landcover

- Annual crops and highly modified pastures
- Bare
- Built-up
- Ephemeral and Permanent Water Features
- Native forests and woodlands
- Native grasslands and minimally modified pastu
- Plantation (hardwood)
- Plantation (softwood/mixed)
- Unknown/not reportable

380000 390000 400000

PB PARSONS BRINCKERHOFF

GRIFFIN ENERGY

0 1,250 2,500 m

Scale: 1:75,000 at A3

Coord. System.: MGA50 GDA94

N S

GDA

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.:	2145463A-GIS-F003		
Revision:	A	Date:	10/03/2008
Drawn By:	CT	Checked by:	CS/BJW
Source:	Landgate, Griffin Energy, DOW		

Griffin Energy

Acid Sulfate Soil Desktop Review

Saline Waste Disposal, Proposed Pipeline Alignment

Land Cover

Appendix A3

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F003.mxd

380000 390000 400000

6320000

PARKFIELD
BENGER
BURRAGENUP
WELLESLEY
MARBALUP
SOUTH WESTERN HWY
BRUNSWICK
Indian Ocean
BEELA
LESCHENAULT
OLD COAST RD
BRUNSWICK JUNCTION
AUSTRALIND
ROELANDS
RAYMOND RD
COALFIELDS RD
BUREKUP
EATON
WATERLOO
SOUTH WESTERN HWY

1000 3000 5000 7000 9000 11000 13000 15000 17000 19000 21000 23000 25000 27000 29000 31000 33000 35000

Locality Map
ARMADALE
ROCKINGHAM
MANDURAH
PINJARRA
WAROONA
HARVEY
EATON
COLLIE
DONNYBROOK
BUSSELTON
0 25 50 km

Legend

- KP points at 2km intervals
  KP37000 = Kilometre Pipe 37
  (37km along pipeline)
- Highway
- Watercourse
- Park/Reserves

Acid Sulfate Soil Risk

Risk level

- Low
- Medium - Low
- Medium
- High

PARSONS BRINCKERHOFF

GRIFFIN ENERGY

0 1,250 2,500 m

Scale: 1:75,000 at A3

Coord. System.:MGA50 GDA94

N S

GDA

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.: 2145463A-GIS-F004			
Revision:	A	Date:	10/04/2008
Drawn By:	CT	Checked by:	CS/BJW
Data Source: Landgate, Griffin Energy, DOW			

Griffin Energy

Acid Sulfate Soil Desktop Review

Saline Waste Disposal, Proposed Pipeline Alignment

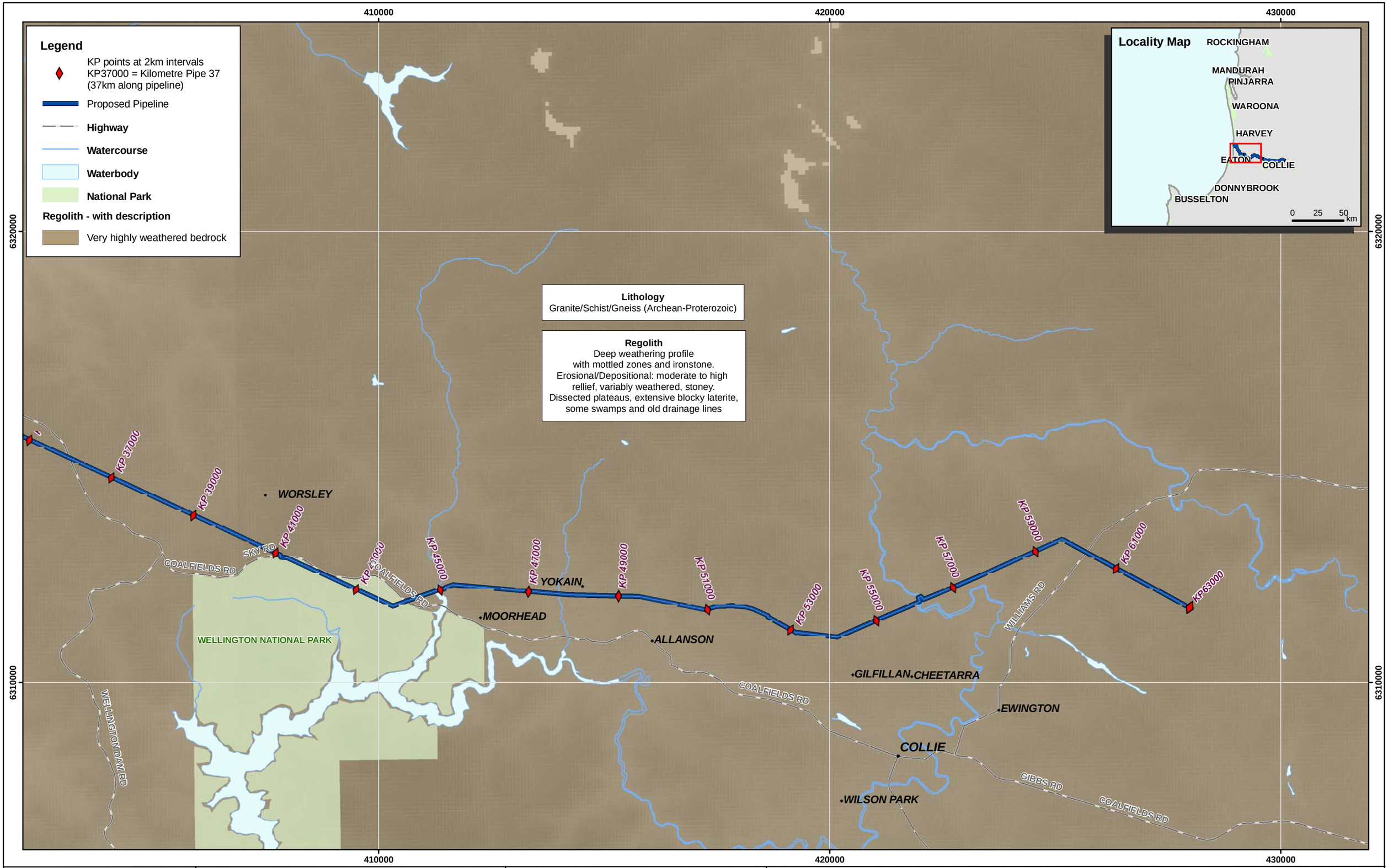
Acid Sulfate Soil Risk

Appendix A4

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F004.mxd

Appendix B

Darling Scarp and Darling Plateau Maps



PARSONS BRINCKERHOFF

GRIFFIN ENERGY

0 1,250 2,500 m

Scale: 1:75,000 at A3

Coord. System.:MGA50 GDA94

N

S

GDA

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.:	2145463A-GIS-F005		
Revision:	A	Date:	07/04/2008
Drawn By:	CT	Checked by:	BJW
Data Source: Landgate, Griffin Energy, DOW			

Griffin Energy

Acid Sulfate Soil Desktop Review

Saline Waste Disposal, Proposed Pipeline Alignment

Regolith and Lithology

Appendix B1

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F005.mxd

410000 420000 430000

6320000

6310000

Legend

- Non-DOW bore with water level data (mBGL)
- DOW bore with water level data (mBGL)
- Bore without water level data
- KP points at 2km intervals
  KP37000 = Kilometre Pipe 37 (37km along pipeline)
- Waterbody
- Highway
- Watercourse
- Proposed Pipeline

Elevation (mAHD)

Value

High : 451

Low : 0

Locality Map

ROCKINGHAM
MANDURAH
PINJARRA
WAROONA
HARVEY
EATON
COLLIE
DONNYBROOK
BUSSELTON
0 25 50 km

KP 37000
KP 39000
KP 41000
KP 43000
KP 45000
KP 47000
KP 49000
KP 51000
KP 53000
KP 55000
KP 57000
KP 59000
KP 61000
KP63000

COALFIELDS RD
WELLINGTON DAM RD
WILLIAMS RD
THROSSELL ST
GIBBS RD

WORSLEY
YOKAIN
ALLANSON
GILFILLAN
CHEETARRA
EWINGTON
COLLIE

3.4 1.93
7.72 5.86
9.44 6.25
8.36 6.04
15.859 14.509
4.42 3.15
11.12 5.3
9.69
14.43 10.3

0 1,250 2,500 m

N S

Scale: 1:75,000 at A3

Coord. System.: MGA50 GDA94

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.:	2145463A-GIS-F006		
Revision:	A	Date:	10/03/2008
Drawn By:	CT	Checked by:	BJW
Data Source; Landgate, Griffin Energy, DOW			

Griffin Energy

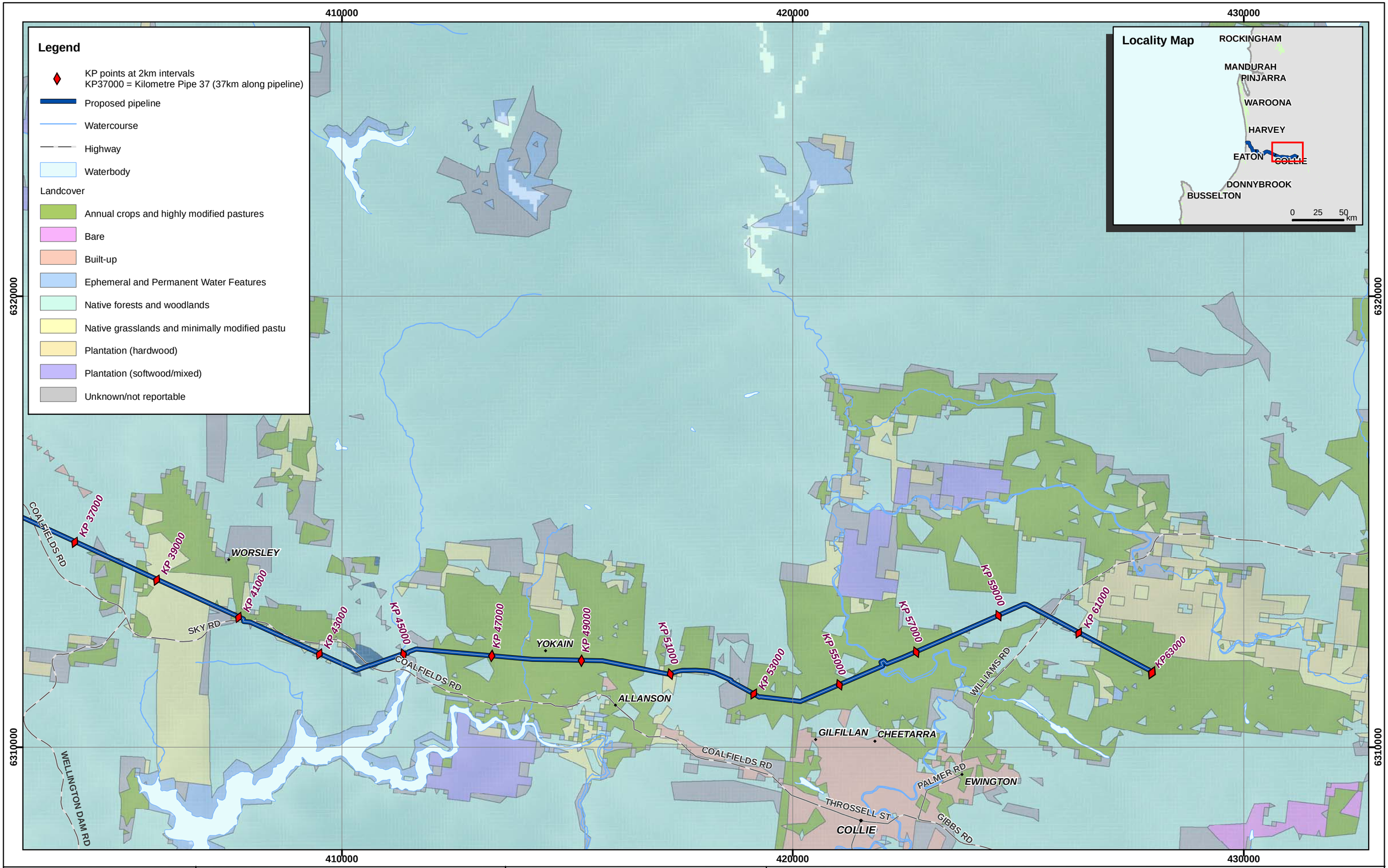
Acid Sulfate Soil Desktop Review

Saline Waste Disposal, Proposed Pipeline Alignment

Terrain and Depth to Groundwater (mBGL)

Appendix B2

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F006.mxd



PB PARSONS BRINCKERHOFF

GRIFFIN ENERGY

0 1,250 2,500 m

Scale: 1:75,000 at A3

Coord. System.: MGA50 GDA94

N S

GDA

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.: 2145463A-GIS-F007			
Revision:	A	Date:	10/03/2008
Drawn By:	CT	Checked by:	CS/BJW
Data Source: Landgate, Griffin Energy, DOW			

Griffin Energy

Acid Sulfate Soil Desktop Review

Saline Waste Disposal, Proposed Pipeline Alignment

Land Cover

Appendix B3

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F007.mxd

Legend

KP points at 2km intervals
KP37000 = Kilometre Pipe 37 (37km along pipeline)

Highway

Watercourse

Waterbody

Park/Reserves

Acid Sulfate Soil Risk

Risk level

Low

Medium - Low

Medium

High

Locality Map

ROCKINGHAM
MANDURAH
PINJARRA
WAROONA
HARVEY
EATON
COLLIE
DONNYBROOK
BUSSELTON
0 25 50 km

410000 420000 430000

6320000

6310000

37000 39000 41000 43000 45000 47000 49000 51000 53000 55000 57000 59000 61000 KP63000

WORSLEY
YOKAIN
MOORHEAD
ALLANSON
GILFILLAN
CHEETARRA
EWINGTON
COLLIE

COALFIELDS RD
SKY RD
WELLINGTON DAM RD
WILLIAMS RD
PALMER RD
THROSSELL ST
GIBBS RD

WELLINGTON NATIONAL PARK
PARK

PB PARSONS BRINCKERHOFF

GRIFFIN ENERGY

0 1,250 2,500 m

Scale: 1:75,000 at A3

Coord. System.:MGA50 GDA94

N S

GDA

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94).

Drawing No.:	2145463A-GIS-F008		
Revision:	A	Date:	22/05/2008
Drawn By:	CT	Checked by:	CS/BJW
Data Source: Landgate, Griffin Energy, DOW			

Griffin Energy

Acid Sulfate Soil Desktop Review
Saline Waste Disposal, Proposed Pipeline Alignment
Acid Sulfate Soil Risk
Appendix B4

GIS File: J:\A543 - ENV\PROJ\2145463A_Griffin_Energy\10_GIS\04 Output\MXD\2145463A-GIS-F008.mxd

Appendix C

ASS Risk Ranking Table

KP (Start)	KP (Finish)	Geology/ Lithology				Vegetation / Wetlands and Waterbodies					Depth to Groundwater	Ass Risk Ranking
Dist (km)	Dist (km)	Terrain	Regolith	Geology	Soil Types	Dist (km)	Vegetation	Wetlands	Wetland Classification	Waterbodies	mBGL	
KP23	KP24	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-mica-garnet-schist	Ironstone: gravelly yellow mottled soil	23 - 24	Jarrah Forest, shrubs, with highly modified pasture	NONE - 0.9 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.6 km north to unnamed water course	no info	Low
KP24	KP25	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-mica-garnet-schist	Ironstone: gravelly yellow mottled soil	24 - 25	Jarrah Forest, shrubs, with highly modified pasture	NONE - 1.1 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.1 km north to unnamed water course	no info	Low
KP25	KP26	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-mica-garnet-schist	Ironstone: gravelly yellow mottled soil	25 - 26	Jarrah Forest, shrubs, some plantations	NONE - 2.5 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.5 km north to unnamed water course	no info	Low
KP26	KP27	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	26 - 27	Jarrah Forest, shrubs, some plantations	NONE - 2.5 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.1 km north to unnamed watercoarse	no info	Low
KP27	KP28	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	27 - 28	Jarrah Forest, shrubs, some plantations	NONE - 1.5 km to nearest wetlands (sumpland)	Resource enhancement	NONE: 0.6 km north to unnamed watercoarse	18-19	Low
KP28	KP29	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	28 - 29	Jarrah Forest, shrubs, some plantations	NONE - 0.3 km to nearest wetlands (sumpland)	Resource enhancement	NONE: 0.6 km north to unnamed watercoarse	14-15	Medium
KP29	KP30	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	29 - 30	Jarrah Forest, shrubs, with highly modified pasture	NONE - 0.5 km to nearest wetlands (sumpland)	Resource enhancement	NONE: 1.1 km east to unnamed watercoarse	no info	Medium
KP30	KP31	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	30 - 31	Jarrah Forest, shrubs, with highly modified pasture	Wetlands (sumpland)	Resource enhancement	NONE: 2.1 km east to unnamed watercourse	no info	High
KP31	KP32	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	31 - 32	Jarrah Forest, shrubs, with highly modified pasture	NONE - 0.6 km to nearest wetlands (sumpland)	Resource enhancement	NONE: 3.1 km east to unnamed watercourse	no info	Low
KP32	KP33	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	32 - 33	Jarrah Forest, shrubs, with highly modified pasture	NONE - 1 km to nearest wetlands (sumpland)	Resource enhancement	NONE: 4 km east to unnamed watercoarse	no info	Low
KP33	KP34	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	33 - 34	Wellington National Park - Jarrah Forest, shrubs	NONE - 0.5 km to nearest wetlands (sumpland)	Multiple use	NONE: 4 km north to Lunenburgh River	no info	Medium

KP (Start)	KP (Finish)	Geology/ Lithology				Vegetation / Wetlands and Waterbodies					Depth to Groundwater	Ass Risk Ranking
Dist (km)	Dist (km)	Terrain	Regolith	Geology	Soil Types	Dist (km)	Vegetation	Wetlands	Wetland Classification	Waterbodies	mBGL	
KP34	KP35	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	34 - 35	Wellington National Park - Jarrah Forest, shrubs	NONE - 0.8 km to nearest wetlands (sumpland)	Multiple use	NONE: 4.6 km north to Lunenburgh River	no info	Low
KP35	KP36	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and sandy alluvium forming terraces to Nakina Formation, locally lateritized	Ironstone: gravelly yellow mottled soil	35 - 36	Wellington National Park - Jarrah Forest, shrubs	NONE - 0.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 4 km south east to unnamed watercoarse	no info	Low
KP36	KP37	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	36 - 37	Wellington National Park - Jarrah Forest, shrubs	NONE - 0.8 km to nearest wetlands (sumpland)	Multiple use	NONE: 3.3 km south east to unnamed watercoarse	no info	Low
KP37	KP38	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	37 - 38	Wellington National Park - Jarrah Forest, shrubs	NONE - 0.3 km to nearest wetlands (sumpland)	Multiple use	NONE: 2.5 km south east to unnamed watercoarse	no info	Medium
KP38	KP39	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and alluvial deposits strongly lateritized in parts	Ironstone: gravelly yellow mottled soil	38 - 39	Wellington National Park - Jarrah Forest, shrubs, some plantations	NONE - 0.7 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.9 km south to unnamed watercoarse	8-9	Low
KP39	KP40	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Quartz-feldspar-biotite (garnet) gneiss, and massive laterite with overlying pisolithic gravel and minor lateritized sand, and alluvial deposits strongly lateritized in parts, and colluvium	Ironstone: gravelly yellow mottled soil	39 - 40	Jarrah Forest, shrubs, some plantations	NONE - 0.5 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.3 km south to unnamed watercoarse	no info	Medium
KP40	KP41	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Porphyritic granite (medium to coarse grained) overlain in parts by massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	40 - 41	Wellington National Park - Jarrah Forest, shrubs	NONE - 1 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.2 km south to unnamed watercoarse	no info	Low
KP41	KP42	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Porphyritic granite (medium to coarse grained) overlain in parts by massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	41 - 42	Wellington National Park - Jarrah Forest, shrubs, some highly modified pastures	NONE - 1.8 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.6 km south to unnamed watercoarse	no info	Low
KP42	KP43	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Porphyritic granite (medium to coarse grained) overlain in parts by massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	42 - 43	Wellington National Park - Jarrah Forest, shrubs	NONE - 2.8 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.8 south km to Wellington Dam	no info	Low
KP43	KP44	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Porphyritic granite (medium to coarse grained) overlain in parts by massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	43 - 44	Wellington National Park - Jarrah Forest, shrubs	NONE - 3.8 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.2 km south to Wellington Dam	no info	Medium to Low
KP44	KP45	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Porphyritic granite (medium to coarse grained) overlain in parts by massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	44 - 44.5	Wellington National Park - Jarrah Forest, shrubs	NONE - 4.8 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.1 km east to Wellington Dam	no info	Medium to Low

KP (Start)	KP (Finish)	Geology/ Lithology				Vegetation / Wetlands and Waterbodies					Depth to Groundwater	Ass Risk Ranking
Dist (km)	Dist (km)	Terrain	Regolith	Geology	Soil Types	Dist (km)	Vegetation	Wetlands	Wetland Classification	Waterbodies	mBGL	
KP44	KP45	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Porphyritic granite (medium to coarse grained) overlain in parts by massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	44.5 - 45	Wellington National Park - Jarrah Forest, shrubs	NONE - 4.8 km to nearest wetlands (sumpland)	Multiple use	Wellington Dam	no info	Medium
KP45	KP46	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Fine to medium grained adamellite and granite, overlain in part by massive laterite with overlying pisolithic gravel and minor lateritized sand	Ironstone: gravelly yellow mottled soil	45 - 46	Jarrah Forest, shrubs	NONE - 5.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1 km south to Wellington Dam	no info	Low
KP46	KP47	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Fine to medium grained adamellite and granite, overlain in part by massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	46 - 47	Jarrah Forest, shrubs, highly modified pastures	NONE - 6.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.7 km east to unnamed watercoarse	no info	Low
KP47	KP48	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	47 - 47.5	Jarrah Forest, shrubs, highly modified pastures	NONE - 7.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.3 km east to unnamed watercoarse	0-1	Medium to Low
KP47	KP48	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	47.5 - 48	Jarrah Forest, shrubs, highly modified pastures	NONE - 7.6 km to nearest wetlands (sumpland)	Multiple use	Unnamed watercoarse	0-1	Medium
KP48	KP49	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	48 - 49	Jarrah Forest, shrubs, highly modified pastures	NONE - 8.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.2 km west to unnamed watercoarse	2-3	Medium to Low
KP49	KP50	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	49 - 50	Jarrah Forest, shrubs, highly modified pastures	NONE - 9.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.2 km west to unnamed watercoarse	3-4	Medium to Low
KP50	KP51	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	50 - 51	Jarrah Forest, shrubs	NONE - 10.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 2.2 km west to unnamed watercoarse	2-3	Medium to Low
KP51	KP52	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	51 - 52	Collie State Forest, Harris River State Forest, Jarrah Forest, shrubs, some highly modified pastures	NONE - 11.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 3.2 km west to unnamed watercoarse	5-6	Low
KP52	KP53	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	52 - 53	Harris River State Forest - Jarrah Forest, shrubs	NONE - 12.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 2.9 km east to Harris River	0-1	Medium to Low
KP53	KP54	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	53 - 54	Jarrah Forest, shrubs, highly modified pastures	NONE - 13.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.1 km east to Harris River	1-2	Medium to Low

KP (Start)	KP (Finish)	Geology/ Lithology				Vegetation / Wetlands and Waterbodies					Depth to Groundwater	Ass Risk Ranking
Dist (km)	Dist (km)	Terrain	Regolith	Geology	Soil Types	Dist (km)	Vegetation	Wetlands	Wetland Classification	Waterbodies	mBGL	
KP54	KP55	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	54 - 55	Jarrah Forest, shrubs, highly modified pastures	NONE - 14.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.2 km east to Harris River	3-4	Medium to Low
KP55	KP56	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	55 - 55.5	Jarrah Forest, shrubs, highly modified pastures	NONE - 15.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.1 km east to Harris River	3-4	Medium to Low
KP55	KP56	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	55.5 - 56	Jarrah Forest, shrubs, highly modified pastures	NONE - 15.6 km to nearest wetlands (sumpland)	Multiple use	Harris River	3-4	Medium
KP56	KP57	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Sandy alluvium forming terraces to Nakina Formation, locally lateritized, massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	56 - 56.5	Jarrah Forest, shrubs, highly modified pastures	NONE - 16.6 km to nearest wetlands (sumpland)	Multiple use	Harris River	no info	Medium
KP56	KP57	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Sandy alluvium forming terraces to Nakina Formation, locally lateritized, massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	56.5 - 57	Jarrah Forest, shrubs, highly modified pastures	NONE - 16.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.1 km west to Harris River	no info	Medium to Low
KP57	KP58	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Sandy alluvium forming terraces to Nakina Formation, locally lateritized, massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	57 - 58	Jarrah Forest, shrubs, highly modified pastures	NONE - 17.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.2 km west to Harris River	3-4	Medium to Low
KP58	KP59	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	58 - 59	Harris River State Forest - Jarrah Forest, shrubs	NONE - 18.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.2 km west to Harris River	no info	Low
KP59	KP60	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	59 - 60	Harris River State Forest - Jarrah Forest, shrubs	NONE - 19.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.4 km north to Collie River East	1-2	Medium to Low
KP60	KP61	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Sandy alluvium forming terraces to Nakina Formation, locally lateritized, massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	60 - 61	Harris River State Forest - Jarrah Forest, shrubs	NONE - 20.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.9 km north to Collie River East	no info	Low
KP61	KP62	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	61 - 62	Jarrah Forest, shrubs	NONE - 21.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.8 km north to Collie River East	10-11	Low
KP62	KP63	Dissected plateaus, extensive blocky laterites, some swamps and old drainage lines	Erosional/Depositional: moderate to high relief, variably weathered, stoney - deep weathering profile with mottled zones and ironstone	Massive laterite with overlying pisolithic gravel and minor lateritized sand, and colluvium	Ironstone: gravelly yellow mottled soil	62 - 63	Jarrah Forest, shrubs, highly modified pastures	NONE - 22.6 km to nearest wetlands (sumpland)	Multiple use	NONE: 1.6 km north east to Collie River East	11-12	Low

KP (Start)	KP (Finish)	Geology/ Lithology				Vegetation / Wetlands and Waterbodies					Depth to Groundwater	Ass Risk Ranking
Dist (km)	Dist (km)	Terrain	Regolith	Geology	Soil Types	Dist (km)	Vegetation	Wetlands	Wetland Classification	Waterbodies	mBGL	
KP00	KP01	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Quaternary Safety Bay sand, with estuarine, lagoonal and lacustrine deposits (clay, silt, marl with shell beds)	Bleached sands, sands with pans, leached sands	0 - 1	Leschenault Peninsula Conservation Park - Woodland - Other	Wetlands (Estuary - Peripheral)	Conservation	Leschenault Estuary	0-1	High
KP01	KP02	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Quaternary Estuarine, lagoonal and lacustrine deposits (clay, silt, marl with shell beds)	Bleached sands, sands with pans, leached sands	1 - 2	Leschenault Peninsula Conservation Park - Woodland - Other, shrubs	Wetlands (Estuary - Peripheral), Estuary-Waterbody	Conservation	Leschenault Estuary	0-1	High
KP02	KP03	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (calcretized and leached eolian calcarenite to quartz sand)	Bleached sands, sands with pans, leached sands	2 - 3	Woodland - Other	NONE - 0.3 km west to nearest wetlands (Estuary - Peripheral)	Multiple use	NONE: 0.3 km south west to Leschenault Estuary	1-2	Medium
KP03	KP04	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (calcretized and leached eolian calcarenite to quartz sand)	Bleached sands, sands with pans, leached sands	3 - 4	CALM land - Woodland - Other	NONE - 0.8 km west to nearest wetlands (sumpland, dampland)	Multiple use	NONE: 0.5 km west to Leschenault Estuary	1-2	Medium to Low
KP04	KP05	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (calcretized and leached eolian calcarenite to quartz sand)	Bleached sands, sands with pans, leached sands	4 - 5	CALM land - Woodland - Other, shrubs	NONE - 1 km west to nearest wetlands (sumpland)	Multiple use	NONE: 0.8 km west to Leschenault Estuary	1-2	Medium to Low
KP05	KP06	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (calcretized and leached eolian calcarenite to quartz sand)	Bleached sands, sands with pans, leached sands	5 - 6	CALM land - Forest or shrub	NONE - 1 km north west to nearest wetlands (sumpland)	Conservation	NONE: 0.9 km west to Leschenault Estuary	7-8	Low
KP06	KP07	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (predominantly quartz sand)	Bleached sands, sands with pans, leached sands	6 - 7	CALM land - Mosaic - Jarrah Woodland, shrubs, with highly modified pasture	NONE - 1.2 km north west to nearest wetlands (sumpland)	Conservation	NONE: 1.2 km west to Leschenault Estuary	7-8	Low
KP07	KP08	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (predominantly quartz sand)	Bleached sands, sands with pans, leached sands	7 - 8	CALM land - Mosaic - Jarrah Woodland, shrubs, with highly modified pasture	NONE - 1.3 km to nearest wetlands (sumpland)	Conservation	NONE: 1.3 km west to Leschenault Estuary	8-9	Low
KP08	KP09	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (predominantly quartz sand)	Bleached sands, sands with pans, leached sands	8 - 9	CALM land - Mosaic - Jarrah Woodland, shrubs, with highly modified pasture	NONE - 1.8 km to nearest wetlands (sumpland)	Conservation	NONE: 1.7 km south to Brunswick River	2-3	Medium to Low
KP09	KP10	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Tamala Limestone (predominantly quartz sand) with swamp and lacustrine deposits	Bleached sands, sands with pans, leached sands	9 - 10	Mosaic - Jarrah Woodland, shrubs, with highly modified pasture	NONE - 1 km to nearest wetlands (sumpland)	Conservation/Multiple use	NONE: 0.5 km south to Brunswick River	0-1	Medium
KP10	KP11	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Quaternary Swamp and lacustrine deposits, and alluvium	Bleached sands, sands with pans, leached sands	10 - 11	Mosaic - Jarrah Woodland, shrubs, with highly modified pasture	Wetlands (dampland and palusplain), Brunswick River: Lecshenault Estuary-Lower Collie Catchment	Conservation/Multiple use	Brunswick River	1-2	High
KP11	KP12	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Quaternary Swamp and lacustrine deposits, and alluvium	Bleached sands, sands with pans, leached sands	11 - 12	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain)	Conservation/Multiple use	NONE: 1 km north to Brunswick River	5-6	High
KP12	KP13	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Quaternary Swamp and lacustrine deposits	Bleached sands, sands with pans, leached sands	12 - 13	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain), and artifical lake	Conservation/Multiple use	NONE: 2 km north to Brunswick River	no info	High
KP13	KP14	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized	Bleached sands, sands with pans, leached sands	13 - 14	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain and dampland)	Conservation/Multiple use	NONE: 2.1 km north west to Brunswick River	3-4	High
KP14	KP15	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized	Bleached sands, sands with pans, leached sands	14 - 15	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain)	Multiple use	NONE: 1.6 km north west to Brunswick River	3-4	High
KP15	KP16	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized	Bleached sands, sands with pans, leached sands	15 - 16	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain)	Multiple use	NONE: 1.5 km north to Brunswick River	no info	High

KP (Start)	KP (Finish)	Geology/ Lithology				Vegetation / Wetlands and Waterbodies					Depth to Groundwater	Ass Risk Ranking
Dist (km)	Dist (km)	Terrain	Regolith	Geology	Soil Types	Dist (km)	Vegetation	Wetlands	Wetland Classification	Waterbodies	mBGL	
KP16	KP17	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized	Bleached sands, sands with pans, leached sands	16 - 17	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain)	Multiple use	NONE: 1.7 km north to Brunswick River	no info	High
KP17	KP18	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized	Bleached sands, sands with pans, leached sands	17 - 18	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain)	Multiple use	NONE: 2 km north to Brunswick River	1-2	High
KP18	KP19	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized	Bleached sands, sands with pans, leached sands	18 - 19	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain)	Multiple use	NONE: 1.5 km south to Collie River	1-2	High
KP19	KP20	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized	Bleached sands, sands with pans, leached sands	19 - 20	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain) Collie River: Leschenault Estuary-Lower Collie Catchment	Multiple use	NONE: 0.9 km south to Collie River	1-2	High
KP20	KP21	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized, and colluvium	Bleached sands, sands with pans, leached sands	20 - 21	Mosaic - Jarrah Woodland, with highly modified pasture	Wetlands (palusplain)	Multiple use	NONE: 0.2 km south to Collie River	1-2	High
KP21	KP22	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized, and colluvium	Bleached sands, sands with pans, leached sands	21 - 22	Jarrah Forest, shrubs, with highly modified pasture	Wetlands (palusplain)	Multiple use	Collie River	1-2	High
KP22	KP23	Coastal plains with dunes, rising to undulating plains	Quaternary sands, swamps, some laterite	Pleistocene Guildford Formation alluvium variably lateritized and podsolized, and colluvium	Bleached sands, sands with pans, leached sands	22 - 23	Jarrah Forest, shrubs, with highly modified pasture	NONE - 0.4 km to nearest wetlands (sumpland)	Multiple use	NONE: 0.7 km south to Collie River	no info	Medium