Contaminated Sites Desk Study

Calingiri Copper Project
Caravel Minerals

Revision No 1
May 2018

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Report

Title:	Contaminated Sites Desk Study Calingiri Copper Project
File:	PES18011
Author(s):	Taryn Wren
Client:	Caravel Minerals
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Synopsis:	This document details a contaminated sites desk study assessment of the tenements of the Calingiri Copper Project and the immediate surrounds. This assessment is intended to provide preliminary insight into existing potential sources of contamination which may impact human health and the environment.

Document Control

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1	10 May 2018	Taryn Wren	CvdW

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Executive Summary

Pendragon Environmental Solutions was engaged by Caravel Minerals to undertake a contaminated sites desk study assessment for the Calingiri Copper Project and its immediate surrounds. This assessment forms one component of the Pre-Feasibility Study (PFS) and is intended to provide preliminary insight into existing potential sources of contamination which may impact the environment within and/or adjacent to the mine tenements.

Objectives

The primary objective of this investigation is to assess the physical setting of the project, identify and characterise the nature and likely risk of contaminated sites within and surrounding the project and to identify data/knowledge gaps pertaining to the potential for contamination of land.

Scope of Work

The scope of works for this investigation entails:

- Search of the Contaminated Sites Database to identify known contaminated sites.
- Detailed assessment of all relevant regional, publicly available datasets with regard to potential sources for contamination.
- Identify and assess potential risks associated with mining and processing.
- Compile a report detailing the above including recommendations with regard to known and/or potential data gaps.

Desk Study Assessment

A desk study assessment was undertaken to identify potential existing and historic sources of contamination within and surrounding the project. Information has been derived from publicly available sources, primarily: published reports, information and data, detailed searches of several online databases and information and data provided by the client.

Most of the project area, which has known elevated soil and water salinities, supports rural agricultural activity which has been the dominant land use within the region for a period exceeding at least twenty years. There is thus a potential for prolonged agricultural operations to have impacted both soil and water quality by a wide range of contaminants/chemicals of concern including Total Petroleum Hydrocarbons from greases, oils and fuels, carbamates, pesticides, herbicides and insecticides, heavy metals and nutrients.

Potentially contaminating land uses have also been identified outside but in proximity to the project area. Owing to the geographical extent of the project and in the absence of reliable environmental data, contaminants of potential concern and the likelihood of the migration of contaminants cannot be commented upon.

Conclusions and Recommendations

This contaminated land desk study assessment found that whilst there are no registered potentially contaminating activities and/or land uses within the project area, there are:

- Two sites in Wongan Hills, some 60om from the nearest perimeter of the project, registered as Remediated for Restricted Use.

- Uncertainties with regard to long term agricultural activities and land uses within the project area that may impact future mining and infrastructure.

Consequently, owing to the scale of the project area and the general nature of information available at present, the likelihood of existing and/or potential contamination at any given location cannot be accurately derived.

Consideration should be given to:

- Developing a strategy for the localised assessment and management of land contamination as the project develops particularly across the areas where mining disturbances will take place (open pits) and where infrastructure (plant, waste rock dumps and tailings dams) is to be located.
- The collection of soil and water quality data to establish a baseline and screen for potential contamination of soil and water within the vicinity of the proposed mine infrastructure and disturbance areas.
- Phase I Preliminary Site Investigations where potentially contaminating land uses/activities (current or historic) take place near proposed mine disturbances/infrastructure.
- Using best practice during design and construction of potentially contaminating mine infrastructure such as waste rock dumps and tailings dams to prevent potential impacts to human life and the environment.
- Undertaking ethnographic and archaeological surveys over the mining area.
- Further sampling for acid sulfate soils should be undertaken during characterisation of soils and mine wastes required for managing acid mine drainage and mine closure and rehabilitation.

1. Introduction

Pendragon Environmental Solutions was engaged by Caravel Minerals to undertake a contaminated site desk study assessment for the Calingiri Copper Project and its immediate surrounds. This assessment forms one component of the Pre-Feasibility Study (PFS) and is intended to provide preliminary insight into existing potential sources of contamination which may impact the environment within and/or adjacent to the mine tenements.

1.1 Property Description, Location, and Access

The Calingiri Project is located 120km north-east of Perth, within the Wheatbelt of Western Australia (Figure 1) with access via the Great Northern Highway and the Calingiri-Wongon Hills Road or via the Great Eastern Highway and Goomalling Road. The project is accessible year-round via the sealed road network with local access via gazetted gravel roads (Caravel Minerals, 2016).

The project or area referred to throughout this report comprises the collective of tenements that make up the Calingiri Project (Figure 2). The project area extends from immediately south-west of the Wongon Hills townsite, to north-east of Bolgart.

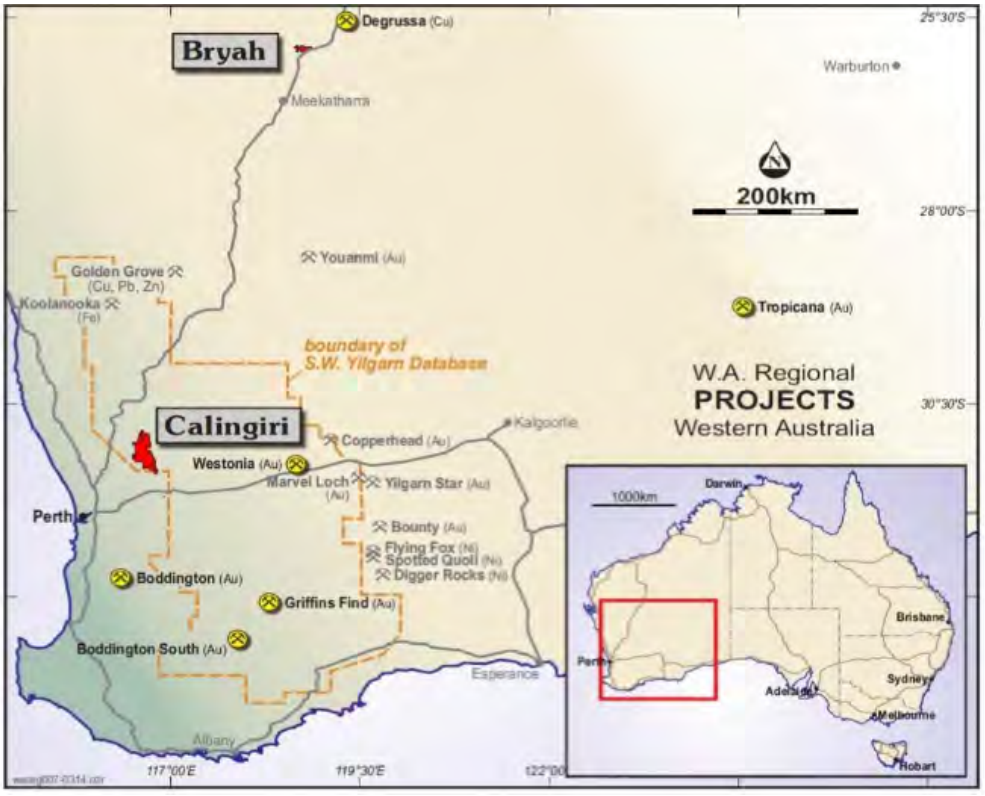
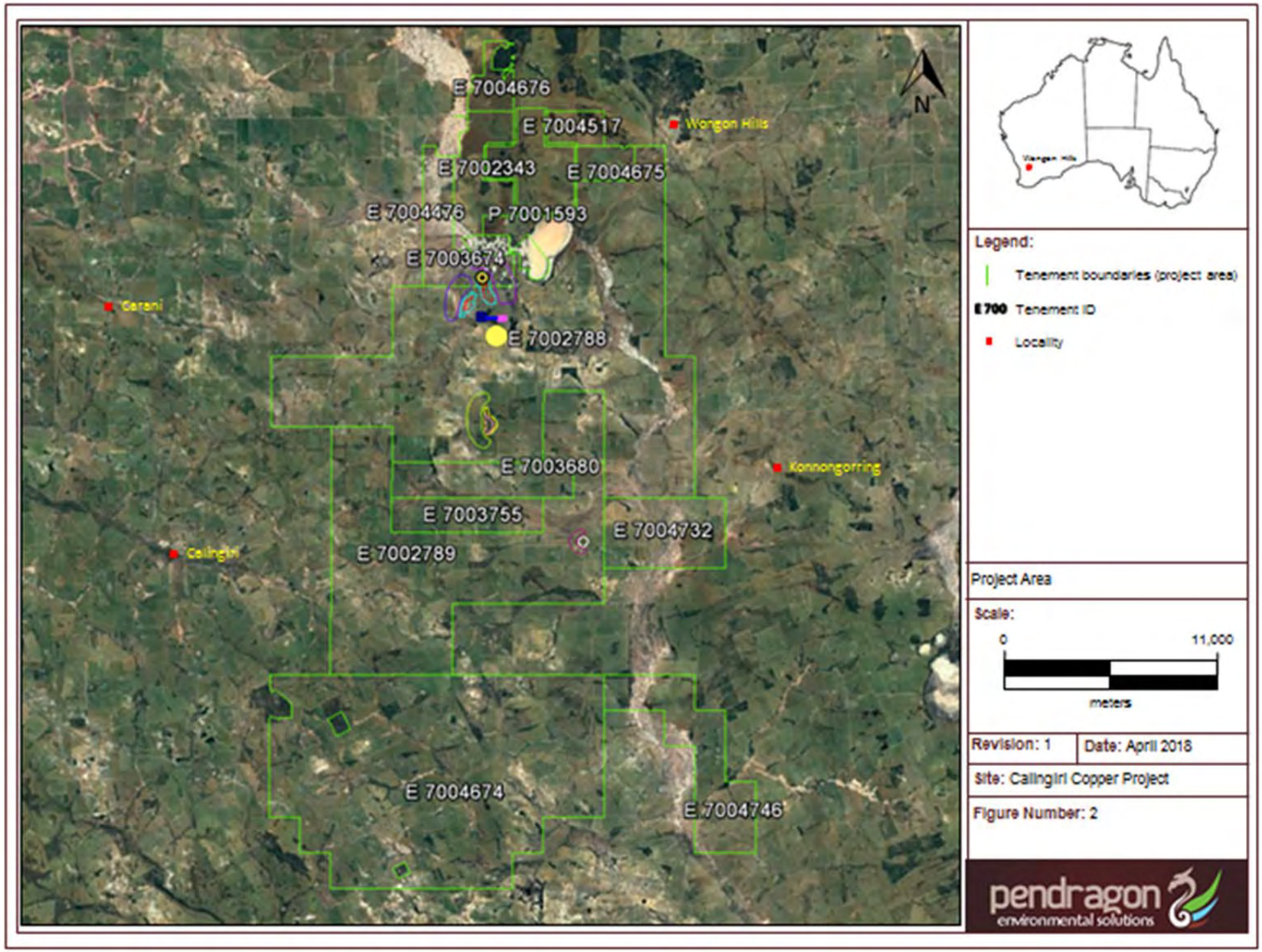


Figure 1: Location of the Calingiri Copper Project.

1.2 Objectives

The primary objective of this investigation is to assess the physical setting of the project area, identify and characterise the nature and likely risk of contaminated sites within/surrounding the project and to identify data/knowledge gaps pertaining to the potential for contamination of land.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Tenement boundaries (project area)
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Locality
Project Area
Scale:
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meters
Revision: 1
Date: April 2018
Site: Calingiri Copper Project
Figure Number: 2
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1.3 Scope of Work

The scope of works for this investigation entails:

- Search of the Contaminated Sites Database to identify known contaminated sites.
- Detailed assessment of all relevant regional, publicly available datasets with regard to potential sources for contamination.
- Identify and assess potential risks associated with mining and processing.
- Compile a report detailing the above including recommendations with regard to known and/or potential data gaps.

1.4 Legislative Framework

The following legislation, policy, and guidelines are relevant to identifying values and mitigating/ managing potential impacts associated with land contamination during exploration, construction, and operations/decommissioning of the project:

- Environmental Protection Act 1986.
- Contaminated Sites Act 2003.
- Contaminated Sites Regulations 2006.
- National Environmental Protection *(Assessment of Site Contamination)* Measure (NEPM), National Environmental Protection Council, 1999.
- Department of Water and Environment Regulation *Assessment and Management of Contaminated Sites*, 2014.

For the purposes of this assessment contamination will be defined as in the Contaminated Sites Act 2003: *contaminated, in relation to land, water or a site, means having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value*.

There are some situations listed in the Contaminated Sites Regulations 2006 where the definition does not apply, including:

- asbestos that is part of a structure or contained within a building;
- algal blooms from excess nutrients or land affected by salinity (where these are the only indications of contamination); and
- land where fertilisers, pesticides and herbicides were applied according to the laws of the day or manufacturer recommendations (only if land use has not changed).

Potentially contaminating activities (DWER, 2014) include land uses and activities that may cause contamination include (though are not limited to):

- fuel storage (including service stations);
- chemical manufacturing or storage; (including pesticide production);
- power stations;
- gasworks;
- agricultural use (including market gardens);

- landfill sites;
- large industrial facilities; and
- accepting fill from other sites that could be contaminated.

In addition to the above, there are many potential causes of contamination associated with rural activities including:

- poor storage of chemicals resulting in leaks to soil, surface water and/or groundwater;
- spills of hazardous chemicals or fuels;
- incorrect use of fertilisers, pesticides and herbicides resulting in elevated concentrations in soil;
- arsenic-based sheep or cattle dips, especially if they were unlined or where residue soaked into the ground or poured down a soakwell; and
- poor rubbish disposal practices.

When land contaminated by rural activities is changed to a more sensitive use, it may be necessary to determine the impacts to soil and/or groundwater and the risk to human health and/or the environment.

This investigation did not include a detailed assessment of these rural activities and also does not include dryland soil and water salinity; however, the latter aspects will be included in separate assessments for surface and ground water and materials characterisation.

2. Assessment Methodology

The assumptions, methods, and limitations relating to the contaminated land assessment are described below.

2.1 Study Area

Existing mine tenements occupy approximately 650km^2 (Figure 2) within the Shires of Victoria Plains, Wongan-Ballidu, and Goomalling. Owing to the extent of the project, investigation will focus on (but not limited to) areas intended for infrastructure (Figure 3). The town of Wongon Hills abuts the north-eastern boundary of the project and is the nearest substantially developed and populated region within proximity to the tenements and proposed infrastructure. General searches and broad scale investigations to identify potential off-site sources of contamination will therefore include Wongon Hills.

2.2 Desk Study

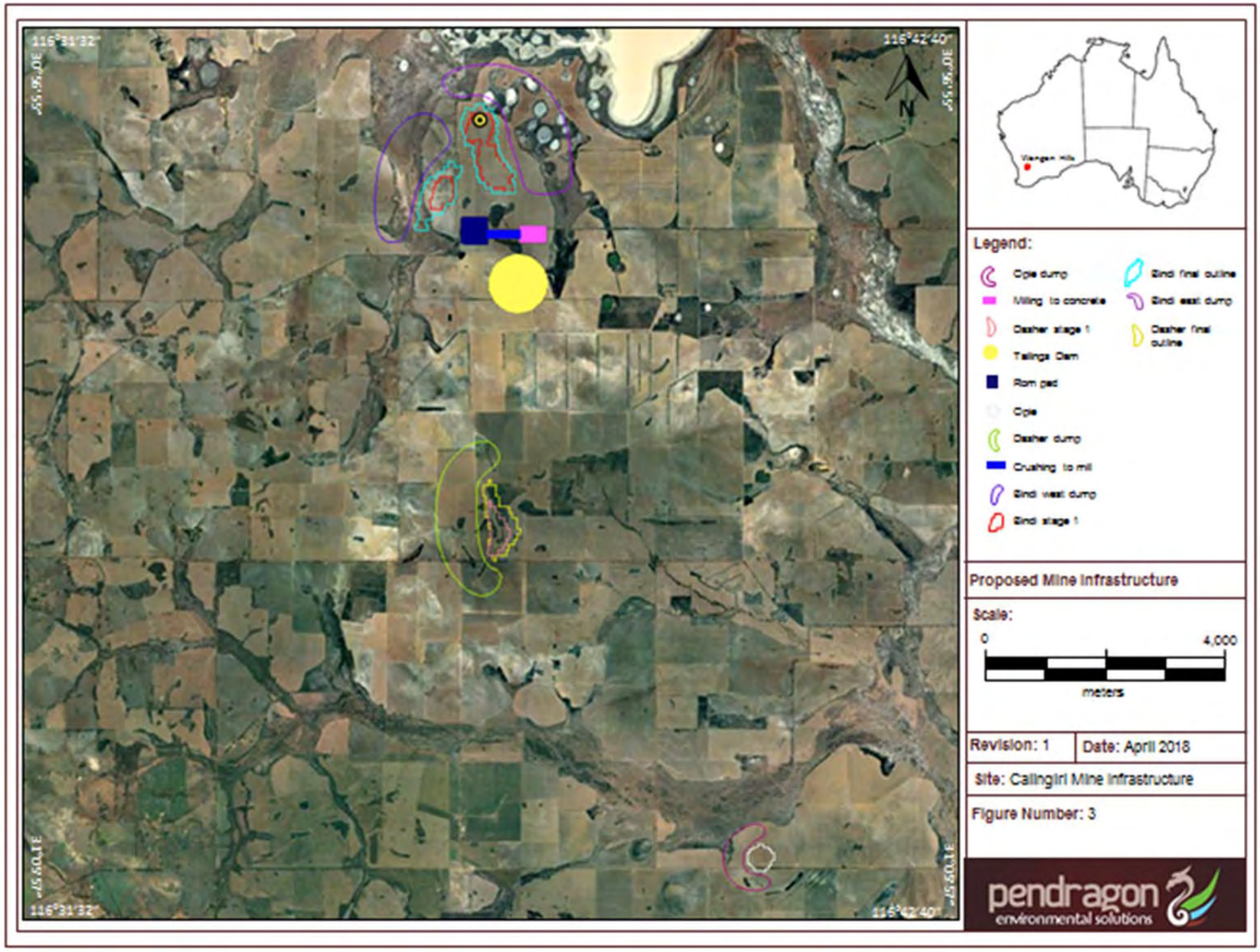
A preliminary desk study review was conducted to identify potential existing and historic sources of contamination within and surrounding the project. Information provided herein has been derived from publicly available sources, primarily: published reports, information and data, online databases and information and data provided by the client. Database searches have included the following:

- Department of Water and Environment Regulation (DWER): Contaminated Land Database.
- Landgate WA: Map Viewer and Historic Aerial Photograph Database.
- Heritage Council State Heritage Office: InHerit State Heritage Register.
- Department of Planning, Lands, and Heritage: Aboriginal Heritage Inquiry System and PlanWA Database.
- Shire of Wongon-Balidu: Town Planning Scheme No. 5.
- Shire of Goomaling: Town Planning Scheme No. 3.
- Shire of Victoria Plains: Town Planning Scheme No. 5.
- Landgate WA: V4 Index Topographic Map.
- CSIRO: Australian Soil Resource Information System (ASRIS) Database.
- Department of Water: Water Information Reporting Database.

The database searches generally require a real and single lot/property description. To overcome this limitation, searches were undertaken across the project area with an emphasis on areas with proposed mine infrastructure (Figure 3). The lateral extent of the searches was set at between 1km and 5km from the tenement and/or town, which is well beyond the 0.5km radius recommended for preliminary assessments in the *Contaminated Sites Guidelines* (DWER, 2014).

Several key constraints exist which may influence the certainty and completeness of information presented herein. Constraints include (but are not limited to):

- Publicly available information relating to contaminated land is not exhaustive. The DWER Contaminated Sites Database is limited to sites classified as *contaminated-remediation* required; *contaminated-restricted* use and *remediated for restricted* use. All other classifications and information related to sites not yet classified are excluded from the database. There is therefore a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Bindi east dump
Dasher final outline
Proposed Mine Infrastructure
Scale:
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4,000
meters
Revision: 1
Date: April 2018
Site: Calingiri Mine Infrastructure
Figure Number: 3
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potential that land within/in proximity to the project, which has been historically contaminated, may not be identified here.

- Owing to the extensive and generally rural nature of the project area, there will be expanses of land and/or specific locations that are likely to be impacted by potential sources of contamination but that has not been identified here. Furthermore, detailed information regarding specific operations undertaken within the project area (chemicals stored/used, agricultural practices, historic earthmoving activities, etc.) is unlikely to be available in the databases searched.
- Owing to the extent and location of the project area, the information obtained through aerial imagery and online sources are not exhaustive. As such, not all potentially contaminating land uses and activities were able to be identified and their locations ascertained.

Given the above constraints and in the absence of detailed site specific information regarding the extent of contaminated land (if present), the precautionary principle will be applied, whereby multiple-lines-of-evidence may be required to rule out potential contamination as the project progresses.

2.3 Limitations

This report has been prepared to provide preliminary insight into potential contamination which may exist within the project area, based upon a review of representative sites within the broader project bounds. Information provided herein is based upon what was publically available online at the time of undertaking this investigation and is not regarded as exhaustive but rather is intended to guide subsequent investigative stages for developing the project.

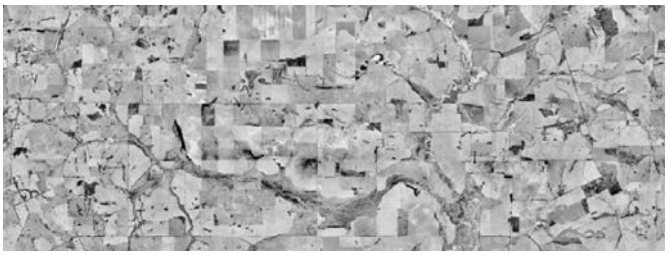
3. Site History

3.1 Historic Land Use

Historic aerial photographs of the area in its entirety are limited. The earliest available photographs are from 1999, at which point agricultural activity was already evident (Table 3.1). Online articles and reports indicate that historic land use within the region was agriculture, particularly grain and livestock Shire of Wongon-Balidu, n.d.). Land use appears to have been relatively consistent, with crop fields, rural properties and agriculture related infrastructure evident in aerial photographs (Table 3.1). Recent field observations confirm that the area remains dominated by agriculture, however it seems that a number of the farms have been abandoned.

The earliest reference to European development within proximity to the project is 1910 when Wongon Hills was established (Heritage Council WA, 2017). The railway to Wongon Hills opened in 1911 (Shire of Wongon-Balidu, n.d.). Since then Wongon Hills has grown to an established town site with a population nearing 1,000 (Australian Bureau of Statistics, 2016) comprising rural, residential, commercial and industrial properties.

Table 3.1: Historic Aerial Photographs.

Year: Observation	Image Location within Project	Image
1999: Land has been cleared and appears to be operating for agricultural purposes.		
2000: Crop fields can be identified. A rural property is positioned to the South of Lake Ninan.		
2006: Crop fields and agriculture related infurstrurture can be identified.		

Year: Observation	Image Location within Project	Image
2017: Land uses consistent with previous observations.		

3.2 Aboriginal Heritage

The Aboriginal Heritage Inquiry System (www.daa.wa.gov.au/AHIS/) of the Department of Planning, Lands and Heritage indicates that whilst there are numerous Registered Aboriginal and Other Heritage Places further afield, only one falls within 1km of the project area (Table 3.2).

Table 3.2: Registered Aboriginal Heritage Sites within 1 km of the Project.

ID	Name	Status	Type	MGA Coordinates (Zone 50)
5945	Wongon Hills: Craigs Farm	Registered Site	Man-Made Structure	472,640 mE; 6,573,650 mN

The project falls within the Indigenous Land Use Agreement (ILUA) of the Ballardong People (WAD6181/1998) and the Yued People (WAD6192/1998) two registered native title claimants over the tenement area. These ILUA's are two of six which were lodged on the 8th of June 2015 by the Western Australian Government and the Ballardon/Yued Peoples. The area is classified under the Single Noongar Claim (Area 1, WAD6006/2003).

The ILUAs bind the parties (including the State, which encompasses all State Government Departments and certain State Government agencies) to enter into a Noongar Standard Heritage Agreement (NSHA) when conducting Aboriginal Heritage Surveys in the ILUA areas, unless they have an existing heritage agreement. It is also intended that other State agencies and instrumentalities enter into the NSHA when conducting Aboriginal Heritage Surveys in the ILUA areas. It is recommended a NSHA is entered into, and an Activity Notice issued under the NSHA, if there is a risk that an activity will impact (i.e. by excavating, damaging, destroying or altering in any way) an Aboriginal heritage site. The Aboriginal Heritage Due Diligence Guidelines, which are referenced by the NSHA, provide guidance on how to assess the potential risk to Aboriginal heritage.

Likewise, from 8 June 2015 the Department of Mines, Industry Regulation and Safety (DMIRS) in granting Mineral, Petroleum and related Access Authority tenures within the South West Settlement ILUA areas, will place a condition on these tenures requiring a heritage agreement or a NSHA before any rights can be exercised (Native Title, 2014).

It is recommended that a suitably qualified heritage consultant be engaged to undertake ethnographic and archeological surveys over the mining area.

3.3 European Heritage

Review of Inherit, the Heritage Council of Western Australia's Cultural Heritage Database (inherit.stateheritage.wa.gov.au) indicates the following heritage within 1 km from the project area:

Table 3.3: Inherit Heritage Places within 1km of Project.

Place Number	Place	Heritage Record	Proximity to Project boundary
15857	18 Strickland St Wongon Hills	State Register Place	~1 km North
12470	Ackland's Place ("Osborne Hill", Moonagarrin) *Calingiri-Wongan Hills Rd Lake Ninan*		Within Project boundary
12524	Lake Ninan *Jctn Yerecoin South East/Wongan Calingiri Rds Lake Ninan*		Within Project boundary
2749	Wongon Hills Hospital (fmr) *82 Mitchell Street, Wongon Hills*		0.75 km East
12414	Railway Barracks		0.80 East
16644	Station Masters House *33 Fenton Street, Wongon Hills*		~0.9 km East
12462	Railway Houses *7 & 11 Ganzer Street, Wongon Hills*		~1 km East
2618	Benedictine Winery (fmr) *Behanging Rd, Wyening*	Child of State Register Place	Within Project boundary
2968	Wyening Mission Group (fmr) *1295 Behanging Rd, Wyening*	State Register Place	Within Project boundary
3522	Slater Homestead *Goomalling-Dowerin Rd, Goomalling*		0.70 km South

It appears that mining will not impact any of the Aboriginal and/or European Heritage sites/places.

4. Land Use

Land can become contaminated through a range of uses and activities. Owing to the large geographical extent of this assessment, investigation of land uses at/surrounding the project will be broad scale and focused on those land uses which are identified as potentially contaminating in the Guideline *Assessment and Management of Contaminated Sites* (DWER, 2014).

4.1 Land Zoning

The mine tenements extend into the Shire of Wongon-Balidu in the north and to the Shires of Goomalling and Victoria Plains in the south-east and south-west respectively.

The majority of the project area is zoned *Rural* under the respective Shire Town Planning Schemes, with properties occupied by Crown Reserves. Lake Ninan and surrounds (located toward the north of the project area) is zoned *Environmental Conservation Reserve* and *Public Open Space* under the Shire of Wongon-Balidu Local Planning Scheme No. 5. Wyening and Glendale Nature Reserves, toward the South-West of the Project area are zoned *Parks and Recreation* under the Shire of Victoria Plains Local Panning Scheme No. 5 (Appendix A). A number of *Primary Distributor Roads* also pass through the project area.

4.2 Current Land Use

Much of the project area supports low density agriculture, particularly harvesting of grain and livestock. Land uses which are known to occur within the project area include (but are not limited to):

- Roads.
- Rural residential and homesteads.
- Grazing and agriculture.
- Forestry.
- Parks and recreation.
- Silos and grain storage.

Wongon Hills town abuts the project in the north-east. The current town planning scheme is provided in Appendix A. Land uses within the town and project area which are most notably regarded as potentially contaminating and therefore pertinent to this investigation are summarised in Table 4.1.[1]

Table 4.1: Potentially Contaminating Activities and Land Uses.

Land Use/ Activity	Activity Details	Potential Sources of Contamination	Proximity to Project Area	Frequency within Project Area
Homestead complex/ Farming	General household/homestead buildings, including the potential for above/underground fuel storage tanks, chemical storage, sheds, machinery, etc.	▪ Spills and/or leaks from fuel/chemical storages and/or machinery. ▪ Waste disposal areas/practices	Likely to have occurred within project area	Infrequent

[1] Potentially contaminating land uses have been identified based upon available aerial photographs and therefore may not be exhaustive.

Land Use/ Activity	Activity Details	Potential Sources of Contamination	Proximity to Project Area	Frequency within Project Area
		▪ Use of uncontrolled fill. ▪ Use of pesticides, herbicides, and/or fertilizers.		
Crops and stockyards	Stockyards, holding yards, crop fields and stock dips, etc.	▪ Use of pesticides, herbicides, and/or fertilizers.	Likely to have occurred within Project area	Frequent
Tanks and Silos	Potential fuel/chemical above ground storage tanks, water tanks or silos.	▪ Fuel/Chemical storage, spills, and/or leaks	Likely to have occurred within Project area	Infrequent
Airport	Wongon Hills Airport located at north-eastern perimeter of townsite.	▪ Use/storage of fuel and machinery. ▪ Refuelling and vehicle servicing activities.	~2km	n/a
Workshops and service stations	Service station, vehicle/machinery repair workshops.	▪ Storage, spills, and/or leaks from fuel and chemical (including solvent and oils) storage and use.	~0.5km	n/a
Water/Waste water treatment plant	Wongon Hills wastewater treatment plant located at western extremity of townsite.	▪ Seepage/leachate from wastewater processing/treatment areas.	~0.6km	n/a
Landfill	Wongon Hills Landfill Site	▪ Leachate from waste disposal.	~1.6km	n/a

5. Environmental Setting

5.1 Topography

Topography and landform vary somewhat across the project area. Land in the vicinity of the proposed infrastructure is approximately 260mAHD (Figure 4). The landscape can be described as gently undulating and generally comprises fine grained sedimentary rocks, intersected by quaternary alluvium systems associated creek and river flats, floodplains and alluvial plains.

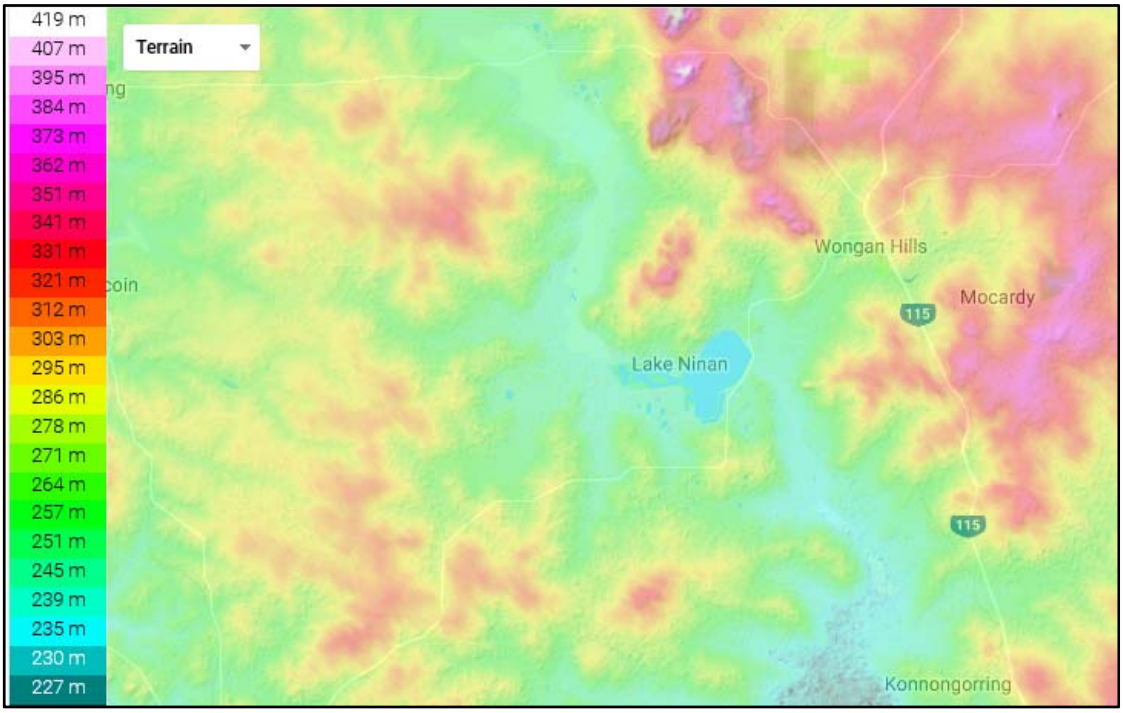


Figure 4: Regional Topography.

5.2 Regional Geology

The Calingiri Project is located in the south-western corner of the Archean Yilgard Craton. The granitic, volcanic and sedimentary rocks that comprise the craton can be divided into a number of distinct terranes and domains, based on strategic, structural, geochemical and geochronological constraints (Caravel Minerals, 2016).

5.3 Soil and Groundwater Quality

Owing to the geographical layout and extent, soil and groundwater quality, albeit saline, are likely to vary somewhat across the project area.

5.3.1 Soil Quality

There is limited information regarding soil quality. The ASRIS Acid Sulfate Soils (ASS) Risk Map indicates zones with a high probability of ASS occurring; however, confidence for the region is low (Figure 5). ASRIS indicates the Level 1 soil pH is primarily within the range of between 4.8 and 5.5 throughout the project area.

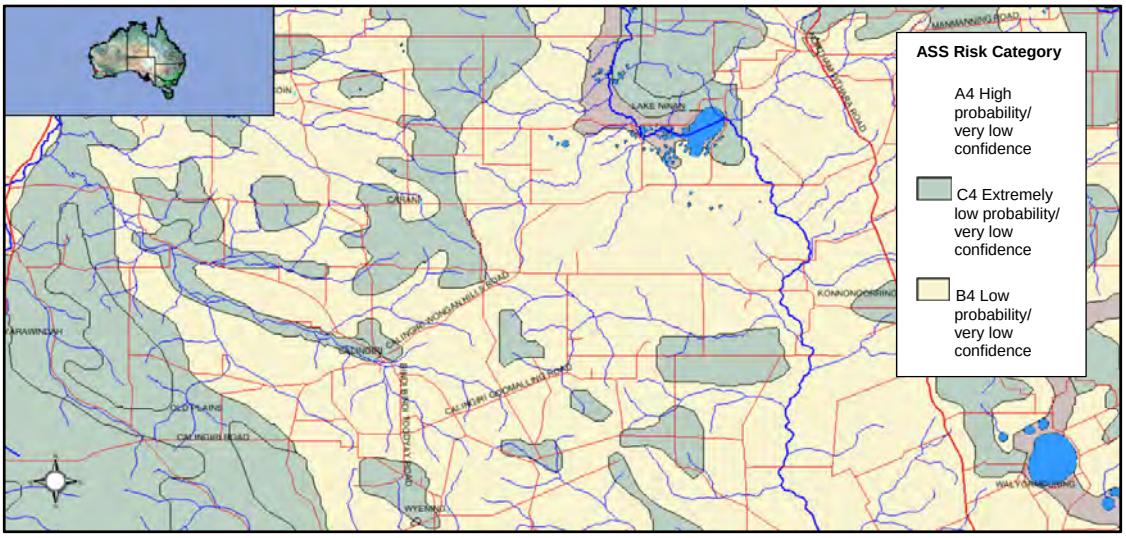


Figure 5: ASS Risk Map.

There are no mapped acid sulfate soils over the area but a review of the Technical Report 298 (Department of Agriculture, 2005) pertaining to susceptibility for subsurface acidification reveals that the area has a high (greater than 70%) risk of acidification.

5.3.2 Groundwater Quality

There is limited groundwater quality data (DWER, Water Information Reporting WIR Database). Search boundaries were based on the proposed infrastructure locations (Figure 3). Historic water quality data for these regions (although limited) is provided in Appendix B. Much of the data available is considered somewhat irrelevant due to their age; however, the data set indicates variability in Total Dissolved Solids concentrations throughout the project area.

Groundwater quality monitoring was undertaken between 2001 and 2009 for the Wongon Hills *Water Management Plan* (DWER, 2010). Samples were obtained from bores across the western portion of the town, with the nearest approximately 600m from the project. These investigations noted:

- There is some damage to infrastructure at Wongon Hills due to high (shallow) groundwater levels with elevated salinities and waterlogging.
- Trace element organics and microbiological qualities were found to be acceptable for groundwater recovery for non-potable use, such as irrigation, with only minor occurrences of organics and microbiological contamination.
- Total Dissolved Solids concentrations ranged between 400mg/L (below the Drinking Water guideline of 500mg/L) and 15,000mg/L.

5.4 Contaminated Sites Database

The Contaminated Sites Database (DWER) allows a maximum search radius of 10km. Several searches were undertaken to ensure coverage of the entire project area with the searches extended to 5km beyond the tenement boundaries (Figure 6). There are no sites with classifications:

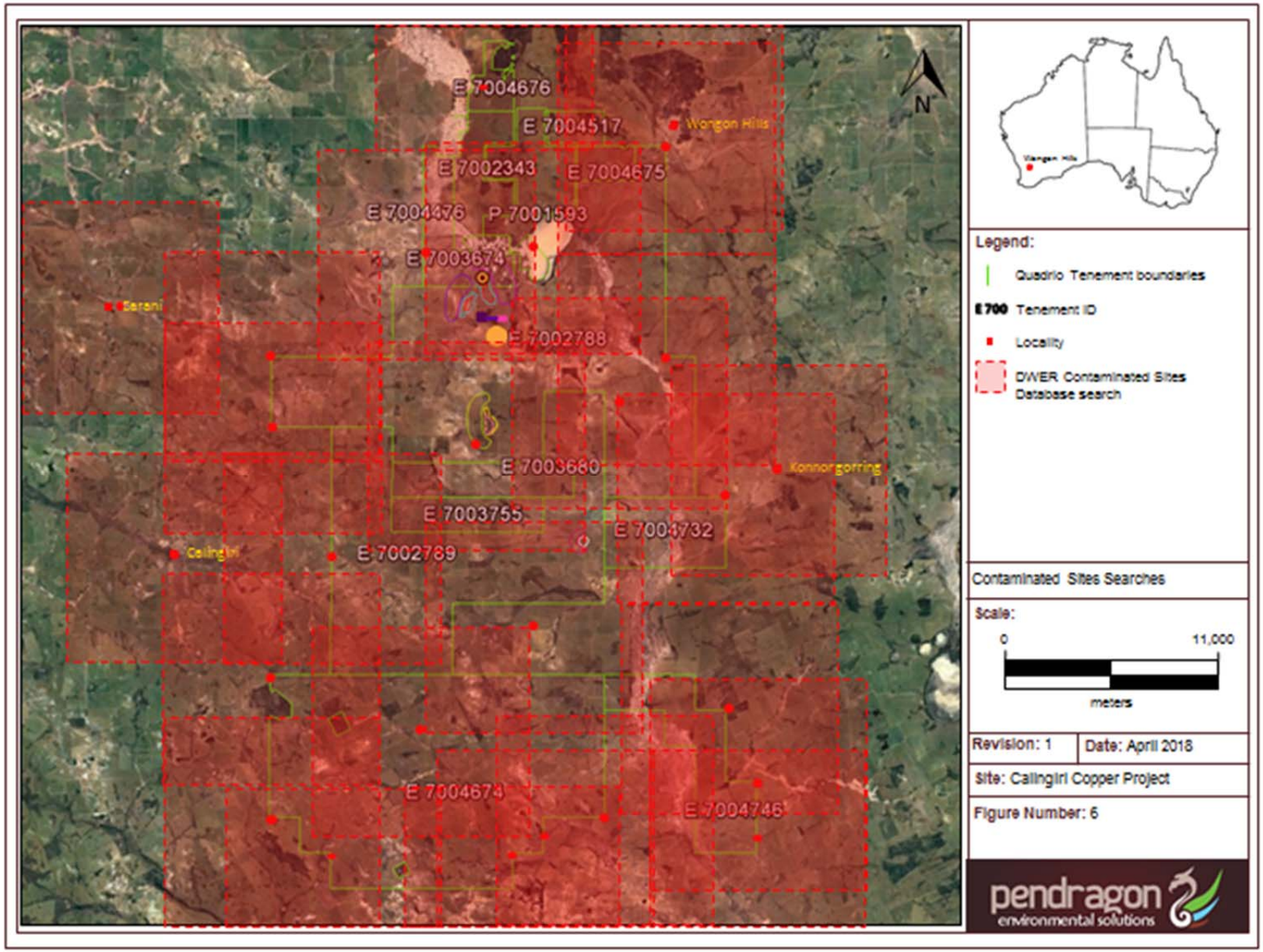
- contaminated-remediation required;
- contaminated-restricted use; and
- remediated for restricted use;

within the perimeters of the project.

The nearest known registered site is located in the Wongon Hills approximately 600m from the project (Appendix C). With the exception of the road reserve which abuts 4 Commercial Drive, Wongon Hills, the database did not contain any other registered sites within 5km of the tenement boundaries.

Table 5.1: Contaminated Sites within 5km of Project.

Address	Classification	Nature and Extent of Contamination	Proximity to Project Area
4 Commercial Rd Wongan Hills, WA 6603	02/01/2015 - *Remediated for restricted use*	Soil beneath the southern boundary of the site is impacted by hydrocarbons (such as from diesel and oil).	~0.6 km
Road reserve corner of Commercial Road and Ninan Street, Wongon Hills, WA 6603	02/01/2015 - *Remediated for restricted use*	Soil beneath the southern boundary of the site is impacted by hydrocarbons (such as from diesel and oil).	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Konnorgorring
E 7003755
E 7004732
Calingiri
E 7002789
E 7004674
E 7004746
N
Legend:
Quadrlo Tenement boundaries
E700 Tenement ID
Locality
DWER Contaminated Sites Database search
Contaminated Sites Searches
Scale:
0
11,000
meters
Revision: 1
Date: April 2018
Site: Calingiri Copper Project
Figure Number: 6
pendragon environmental solutions

6. Assessment

At the time of this report, most of the project area supports rural agricultural activity which has been the dominant land use within the region for a period exceeding at least twenty years. The area has known soil and water salinity.

There is a potential for prolonged agricultural operations to have impacted both soil and water quality. The primary contaminants/chemicals of concern include:

- Total Petroleum Hydrocarbons from greases, oils and fuels.
- Carbamates.
- Organochlorine and organophosphate pesticides containing amongst other chemicals, Aldrin and Dieldrin.
- Herbicides and insecticides containing amongst a host of other chemicals DDT, DDE and DDD and Bifenthrin.
- Heavy Metals.
- Nutrients.

Potentially contaminating land uses have also been identified further afield. Owing to the geographical extent of the project and in the absence of reliable environmental data, contaminants of potential concern and the likelihood of the migration of contaminants cannot be commented upon.

7. Conclusions and Recommendations

7.1 Conclusions

This contaminated land desk study assessment found that whilst there are no registered potentially contaminating activities and/or land uses within the project area, there are:

- Two sites in Wongan Hills, some 60om from the nearest perimeter of the project, registered as *Remediated for Restricted Use*.
- Uncertainties with regard to long term agricultural activities and land uses within the project area that may impact future mining and infrastructure.

Consequently, owing to the scale of the project area and the general nature of information available at present, the likelihood of existing and/or potential contamination at any given location cannot be accurately derived.

7.2 Recommendations

Consideration should be given to:

- Developing a strategy for the localised assessment and management of land contamination as the project develops particularly across the areas where mining disturbances will take place (open pits) and where infrastructure (plant, waste rock dumps and tailings dams) is to be located.

  The collection of soil and water quality data to establish a baseline and screen for potential contamination of soil and water within the vicinity of the proposed mine infrastructure and disturbance areas.

  Phase I Preliminary Site Investigations where potentially contaminating land uses/activities (current or historic) take place near proposed mine disturbances/infrastructure.
- Using best practice during design and construction of potentially contaminating mine infrastructure such as waste rock dumps and tailings dams to prevent potential impacts to human life and the environment.
- Undertaking ethnographic and archaeological surveys over the mining area.
- Further sampling for acid sulfate soils should be undertaken during characterisation of soils and mine wastes required for managing acid mine drainage and mine closure and rehabilitation.

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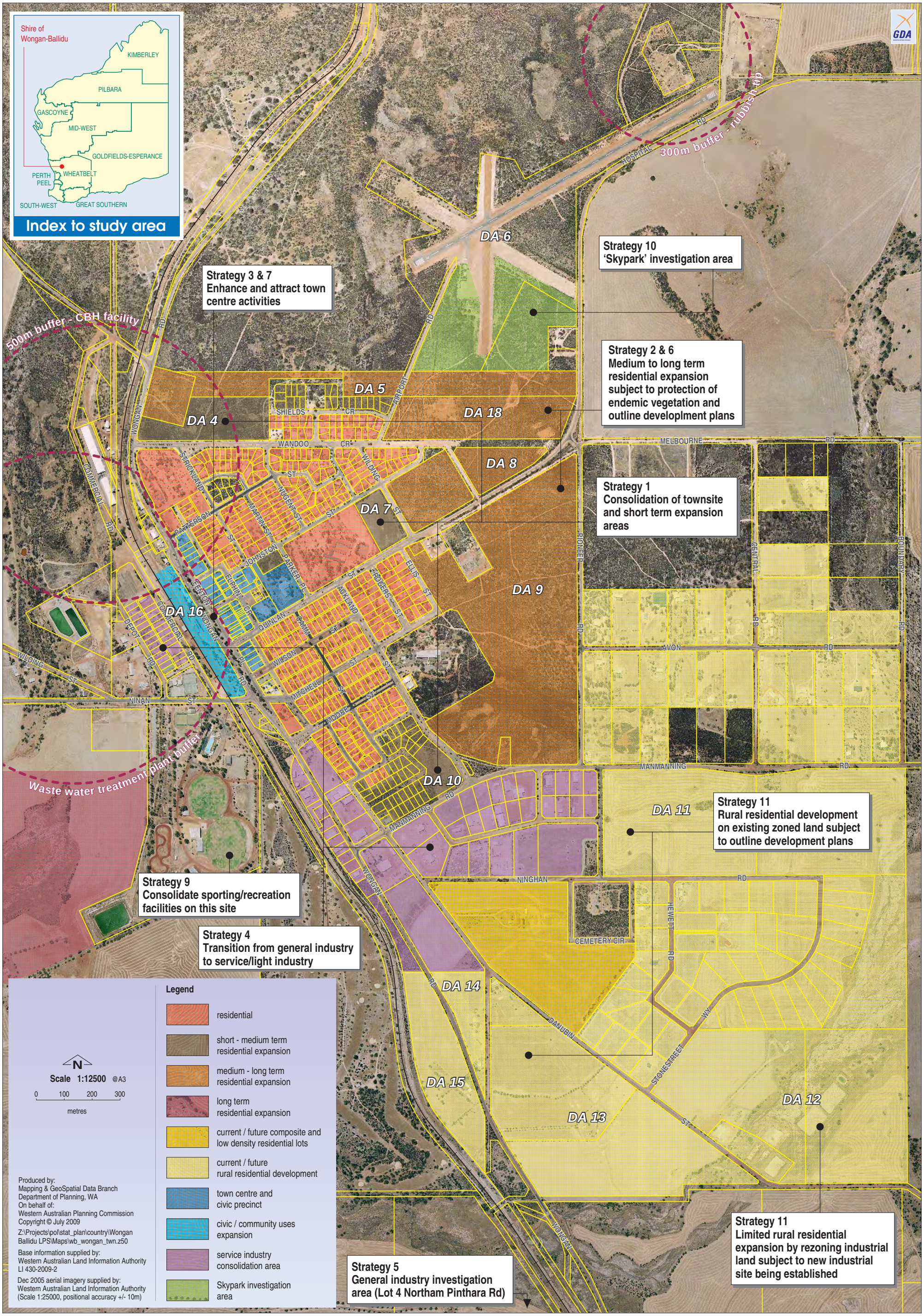
Appendices

Appendix A: Shire of Wongon Hills Town Planning Scheme Map.

Appendix B: Water Information Reporting Database Data.

Appendix C: DWER Contaminated Sites Reports.

Appendix A: Shire of Wongon Hills Town Planning Scheme Map.



Wongan-Ballidu local planning strategy

Wongan Hills townsite

Appendix B: Water Information Reporting Database Data.

						Borehole water supply | m3/day		TDSolids (in situ) | mg/L	
Site Ref	**Collect Date (Known Accuracy)**	**Project Code**	**Sample Number**	**Collection Method**	**Data Source**	**Reading Value**	**Quality**	**Reading Value**	**Quality**
61511445	30-JUN-1950 00:00:00 (unknown accuracy)	WA-G-<1996AQWADATA	Field	Unknown method	WIN	16		150	
61511447	30-JUN-1977 00:00:00 (unknown accuracy)	WA-G-<1996AQWADATA	Field	Unknown method	WIN	3		1270	
61511448	30-JUN-1977 00:00:00 (unknown accuracy)	WA-G-<1996AQWADATA	Field	Unknown method	WIN				
61513008	Date not known	WA-G-<1996AQWADATA	Field	Unknown method	WIN	2			
61513009	Date not known	WA-G-<1996AQWADATA	Field	Unknown method	WIN	2			
61513647	Date not known	WA-G-<1996AQWADATA	Field	Unknown method	WIN	2			
61513648	30-JUN-1977 00:00:00 (unknown accuracy)	WA-G-<1996AQWADATA	Field	Unknown method	WIN			7100	

Site Ref	Collect Date (Known Accuracy)	Sample Number	Collection Method	Sample Depths M	Collection Device	Collection Frequency	Data Source	Sample Comment	Security Level
61511244	30-JUN-1951 00:00:00 (unknown accuracy)	Field	Unknown method		Unknown	Unknown	WIN		Unrestricted
61511245	30-JUN-1950 00:00:00 (unknown accuracy)	Field	Unknown method		Unknown	Unknown	WIN		Unrestricted
61511253	30-JUN-1951 00:00:00 (unknown accuracy)	Field	Unknown method		Unknown	Unknown	WIN		Unrestricted
61511253	08-DEC-1981 (Known day)	70836	Grab sample	11	Bailer	Unknown	WIN	TURBIDITY: CLEAR WITH A SLIGHT BROWN DEPOSIT. Odour NIL	Unrestricted
61511305	30-JUN-1951 00:00:00 (unknown accuracy)	Field	Unknown method		Unknown	Unknown	WIN		Unrestricted

			Alkalinity (CO3-CO3) | mg/L		Alkalinity (HCO3-HCO3) | mg/L		Alkalinity (tot) (CaCO3) | mg/L		Borehole water supply |		Borehole water supply | no		Ca (sol) | mg/L		Cl (sol) | mg/L		Colour (TCU) | CU		Cond comp 25 deg C | uS/cm		F (sol) |
Lab Sample No	Field Sample Ref	COC No	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value
		No Batch 330							4.546												
		No Batch 330							4.546												
		No Batch 330							4.546												
8IW 7293		No Batch 163	<2		76		62						19		838		23		2830		0.1
		No Batch 330									(none)										

mg/L	Hardness (tot) (CaCO3)		K (sol) | mg/L		Mg (sol) | mg/L		Na (sol) | mg/L		NO3 (sol) | mg/L		pH | no units		SiO2 (sol react) | mg/L		SO4 (sol) | mg/L		TDSolids (calc @180°C)-HCO3		TDSolids (in situ) | mg/L		Temperature (lab test) | deg C	
Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality
																			1900			
																			2500			
																			1550			
	270		16		53		451		3		7.1		78		54		1550				25	
																			3000			

Site Ref	Collection Method	Sample Depths M	Collection Device	Collection Frequency	Data Source
61511248	Unknown method		Unknown	Unknown	WIN
61511248	Grab sample	14	Bailer	Unknown	WIN
61511249	Unknown method		Unknown	Unknown	WIN
61511250	Unknown method		Unknown	Unknown	WIN
61511252	Unknown method		Unknown	Unknown	WIN
6151335	Insitu		None	Once off	WIN
6151335	Insitu		None	Once off	WIN
6151335	Grab sample	0	Container	Once off	WIN
6151335	Insitu	0	None	Once off	WIN
6151335	Grab sample	0	Container	Irregular	WIN
6151336	Insitu		None	Once off	WIN
6151336	Insitu		None	Once off	WIN
6151336	Grab sample	0	Container	Once off	WIN
6151336	Insitu	0	None	Once off	WIN
6151336	Grab sample	0	Container	Once off	WIN
6151336	Insitu	0	None	Once off	WIN
6151525	Grab sample	0	Container	Regular	WIN
6151525	Grab sample	0	Container	Regular	WIN
6151525	Grab sample	0	Container	Regular	WIN

					Cond uncomp (in situ) | uS/cm		Discharge rate (estimated) |		N (sum sol ox) {NOx-N, TON} |	
Sample Comment	**Security Level**	**Lab Sample No**	**Field Sample Ref**	**COC No**	**Reading Value**	**Quality**	**Reading Value**	**Quality**	**Reading Value**	**Quality**
	Unrestricted			No Batch 330						
TURBIDITY: CLEAR WITH A BROWN DEPOSIT. Odour NIL	Unrestricted	82W 272		No Batch 163						
	Unrestricted			No Batch 330						
	Unrestricted			No Batch 330						
	Unrestricted			No Batch 330						
	Unrestricted			15628	56000					
	Unrestricted			24164						
	Unrestricted	W09/019926		43235						
4 x large box culvert	Unrestricted			43235	39900		0.112			
	Unrestricted	W09/019607		45373						
	Unrestricted			15628	90200					
	Unrestricted			24164						
	Unrestricted	W08/023602		44701						
	Unrestricted			44701	25600		0.00075			
	Unrestricted	W09/019927		43235						
Road culvert	Unrestricted			43235	29300		0.007			
From Edict {EdQA:Coll:2Stor:4Lab:4Data:3QR:B}	Unrestricted		9640020	1404					0.44	
From Edict {EdQA:Coll:4Stor:4Lab:4Data:4QR:A}	Unrestricted		9640078	2308					0.11	
From Edict {EdQA:Coll:4Stor:4Lab:4Data:4QR:A}	Unrestricted		9640136	2318					<0.01	

N (tot kjel) {TKN} | mg/L		N (tot) {TN, pTN} | mg/L		NH3-N/NH4-N (sol) | mg/L		P (tot) {TP, pTP} | mg/L		pH | no units		PO4-P (sol react) {SRP, FRP} |		TDSolids (in situ) | mg/L	
Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality	Reading Value	Quality
												5400	
								7.4					
												3550	
												1500	
												3200	
								8.3					
		2.8				0.23							
								8.05					
		1.7		<0.01		0.021				<0.005			
								8.2					
		1.2				0.015							
								8.64					
		1.9				0.033							
								8.24					
2.7		3.1		0.76		0.17				0.056			
1.4		1.6		0.14		0.034				0.009			
1.6		1.6		0.14		0.03				0.011			

Appendix C: DWER Contaminated Sites Reports.

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:42:55PM, 15/03/2018

Search Results

This response relates to a search request received for:

4 Commercial Rd
Wongan Hills WA 6603

This parcel belongs to a site that contains 2 parcel(s).

According to Department of Water and Environmental Regulation records, this land has been reported as a known or suspected contaminated site.

Address	4 Commercial Rd Wongan Hills WA 6603
Lot on Plan Address	Lot 4 On Plan 59376
Parcel Status	**Classification:** *02/01/2015 - Remediated for restricted use* **Nature and Extent of Contamination:** Soil beneath the southern boundary of the site is impacted by hydrocarbons (such as from diesel and oil). **Restrictions on Use:** The land use of the site is restricted to commercial/industrial use. The site should not be developed for a more sensitive use such as recreational open space; residential use or childcare centres without further contamination assessment and/or remediation. The construction of any buildings on the site is restricted to slab-on-grade buildings. A site-specific health and safety plan is developed and implemented to address the risks to the health of any workers undertaking intrusive works. **Reason for Classification:** This site was reported to the Department of Environment Regulation (DER) under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site classification is based on information submitted to DER by October 2014. This site was historically used as a service station and depot for at least 35 years, from 1969 to 2004. Activities at the site included the bulk storage of petroleum fuel, spray painting and miscellaneous chemical storage. These are activities which are consistent with activities that have the potential to cause contamination, as specified in the guideline

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:42:55PM, 15/03/2018

'Potentially Contaminating Activities, Industries and Landuses' (Department of Environment, 2004).

A contamination assessment was initially carried out in 1995 to assess the site's suitability for continued commercial/industrial use. Between 2003 and 2014, further contamination assessments were carried out for the same purpose.

Soil:

Soil investigations, carried out in 1995 and 2003, found that hydrocarbons (such as from petrol and diesel) were present in soils beneath the southern portion of the site at concentrations exceeding relevant ecological and health-based assessment criteria available at the time of the investigations.

In July 2004, the site was decommissioned and between July 2004 and November 2005, several rounds of soil remediation were undertaken. The soil remediation method implemented comprised of excavation, stockpiling, backfilling or off-site disposal depending on soil investigation results. Stockpiles that were found to be impacted with hydrocarbons were disposed off-site to a licenced landfill facility in July 2004. A validation sampling program, undertaken in July 2005 following several soil remediation attempts, found that hydrocarbons (such as from petrol and diesel) remain present in soil along the southern boundary of the site. Further remediation in this area was not possible without disrupting the structural integrity of the adjacent off-site footpath.

In November 2005, validated on-site stockpiles and approximately 440 cubic metres of validated clean imported fill was used to backfill the on-site excavated pits. In May 2006, another round of soil remedial works was undertaken involving excavation and stockpiling. Two impacted stockpiles from the excavation were disposed off-site and one validated clean stockpile, along with approximately 500 cubic metres of validated imported fill, was used to backfill the excavation pit.

A limited soil investigation, undertaken in October 2012, found no potential contaminants in soil beneath the site.

Groundwater:

Groundwater investigations were undertaken at the site between 2003 and 2013. The most recent groundwater investigation, undertaken in October 2013, found that hydrocarbons (such as from diesel and oil) were present in groundwater beneath the site. However, these hydrocarbon levels did not exceed any relevant assessment criteria.

Risk assessment and classification:

In 2014, a tier 2 human health risk assessment (HHRA) was undertaken to quantify the potential risk to human health posed by petroleum hydrocarbon impacts identified at the

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:42:55PM, 15/03/2018

site. Department of Health (DoH) reviewed the HHRA and stated that all parameters employed in the HHRA were appropriately conservative and there is sufficient confidence that receptors would be protected if there was any movement of hydrocarbons from pockets of impacted soils remaining. Furthermore, DoH concluded that the site is suitable for commercial use where a slab on grade type construction is used, as these limitations were used in the HHRA model. DER agrees with DoH's comments.

As the site is contaminated and has been remediated such that it is suitable for ongoing commercial/industrial land use, but may not be suitable for more sensitive land uses, the site is classified as 'remediated for restricted use'.

DER, in consultation with the DoH, has classified this site based on the information available to DER at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to DER, and as such, the usefulness of this information may be limited.

In accordance with DoH advice, if groundwater is being, or is proposed to be abstracted, DER recommends that analytical testing should be carried out to determine whether the groundwater is suitable for its intended use.

The site is subject to the following restrictions:

The site use is restricted to commercial/industrial use, excluding sensitive uses such as schools, childcare centres, kindergartens, public open space and residential use.

The construction of any buildings on the site is restricted to slab-on-grade buildings.

Due to the presence of hydrocarbon-impacted soils remaining beneath the southern boundary of the site, a site-specific health and safety plan is developed and implemented to address the risks to the health of any workers undertaking intrusive works.

Action required:

Owners, occupiers and developers of the site are required to comply with the specified restrictions on use.

No further management of the site in relation to contamination is required.

Certificate of Title Memorial

Under the Contaminated Sites Act 2003, this site has been classified as "remediated for restricted use". For further information on the contamination status of this site, please contact Contaminated Sites at the Department of Environment Regulation.

Current Regulatory Notice Issued

Type of Regulatory Notice: Nil

Date Issued: Nil

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:42:55PM, 15/03/2018

General

No other information relating to this parcel.

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:45:41PM, 15/03/2018

Search Results

This response relates to a search request received for:

Road Reserve
Wongan Hills WA 6603
Road reserve at corner of Commercial Rd and Ninan St, Wongan Hills, Landgate PIN 11873632

This parcel belongs to a site that contains 2 parcel(s).

According to Department of Water and Environmental Regulation records, this land has been reported as a known or suspected contaminated site.

Address	Road Reserve Wongan Hills WA 6603 Road reserve at corner of Commercial Rd and Ninan St, Wongan Hills, Landgate PIN 11873632
Lot on Plan Address	Road Reserve
Parcel Status	**Classification:** *02/01/2015 - Remediated for restricted use* **Nature and Extent of Contamination:** Soil beneath the southern boundary of the site is impacted by hydrocarbons (such as from diesel and oil). **Restrictions on Use:** The land use of the site is restricted to commercial/industrial use. The site should not be developed for a more sensitive use such as recreational open space; residential use or childcare centres without further contamination assessment and/or remediation. The construction of any buildings on the site is restricted to slab-on-grade buildings. A site-specific health and safety plan is developed and implemented to address the risks to the health of any workers undertaking intrusive works. **Reason for Classification:** This site was reported to the Department of Environment Regulation (DER) under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site classification is based on information submitted to DER by October 2014. This site was historically used as a service station and depot for at least 35 years, from 1969 to 2004. Activities at the site included the bulk storage of petroleum fuel, spray

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:45:41PM, 15/03/2018

painting and miscellaneous chemical storage. These are activities which are consistent with activities that have the potential to cause contamination, as specified in the guideline 'Potentially Contaminating Activities, Industries and Landuses' (Department of Environment, 2004).

A contamination assessment was initially carried out in 1995 to assess the site's suitability for continued commercial/industrial use. Between 2003 and 2014, further contamination assessments were carried out for the same purpose.

Soil:

Soil investigations, carried out in 1995 and 2003, found that hydrocarbons (such as from petrol and diesel) were present in soils beneath the southern portion of the site at concentrations exceeding relevant ecological and health-based assessment criteria available at the time of the investigations.

In July 2004, the site was decommissioned and between July 2004 and November 2005, several rounds of soil remediation were undertaken. The soil remediation method implemented comprised of excavation, stockpiling, backfilling or off-site disposal depending on soil investigation results. Stockpiles that were found to be impacted with hydrocarbons were disposed off-site to a licenced landfill facility in July 2004. A validation sampling program, undertaken in July 2005 following several soil remediation attempts, found that hydrocarbons (such as from petrol and diesel) remain present in soil along the southern boundary of the site. Further remediation in this area was not possible without disrupting the structural integrity of the adjacent off-site footpath.

In November 2005, validated on-site stockpiles and approximately 440 cubic metres of validated clean imported fill was used to backfill the on-site excavated pits. In May 2006, another round of soil remedial works was undertaken involving excavation and stockpiling. Two impacted stockpiles from the excavation were disposed off-site and one validated clean stockpile, along with approximately 500 cubic metres of validated imported fill, was used to backfill the excavation pit.

A limited soil investigation, undertaken in October 2012, found no potential contaminants in soil beneath the site.

Groundwater:

Groundwater investigations were undertaken at the site between 2003 and 2013. The most recent groundwater investigation, undertaken in October 2013, found that hydrocarbons (such as from diesel and oil) were present in groundwater beneath the site. However, these hydrocarbon levels did not exceed any relevant assessment criteria.

Risk assessment and classification:

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:45:41PM, 15/03/2018

Certificate of Title Memorial

In 2014, a tier 2 human health risk assessment (HHRA) was undertaken to quantify the potential risk to human health posed by petroleum hydrocarbon impacts identified at the site. Department of Health (DoH) reviewed the HHRA and stated that all parameters employed in the HHRA were appropriately conservative and there is sufficient confidence that receptors would be protected if there was any movement of hydrocarbons from pockets of impacted soils remaining. Furthermore, DoH concluded that the site is suitable for commercial use where a slab on grade type construction is used, as these limitations were used in the HHRA model. DER agrees with DoH's comments.

As the site is contaminated and has been remediated such that it is suitable for ongoing commercial/industrial land use, but may not be suitable for more sensitive land uses, the site is classified as 'remediated for restricted use'.

DER, in consultation with the DoH, has classified this site based on the information available to DER at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to DER, and as such, the usefulness of this information may be limited.

In accordance with DoH advice, if groundwater is being, or is proposed to be abstracted, DER recommends that analytical testing should be carried out to determine whether the groundwater is suitable for its intended use.

The site is subject to the following restrictions:

The site use is restricted to commercial/industrial use, excluding sensitive uses such as schools, childcare centres, kindergartens, public open space and residential use.

The construction of any buildings on the site is restricted to slab-on-grade buildings.

Due to the presence of hydrocarbon-impacted soils remaining beneath the southern boundary of the site, a site-specific health and safety plan is developed and implemented to address the risks to the health of any workers undertaking intrusive works.

Action required:

Owners, occupiers and developers of the site are required to comply with the specified restrictions on use.

No further management of the site in relation to contamination is required.

Under the Contaminated Sites Act 2003, this site has been classified as "remediated for restricted use". For further information on the contamination status of this site, please contact Contaminated Sites at the Department of Environment Regulation.

Government of Western Australia
Department of Water and Environmental Regulation

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 12:45:41PM, 15/03/2018

Current Regulatory Notice Issued	**Type of Regulatory Notice:** Nil **Date Issued:** Nil
General	No other information relating to this parcel.