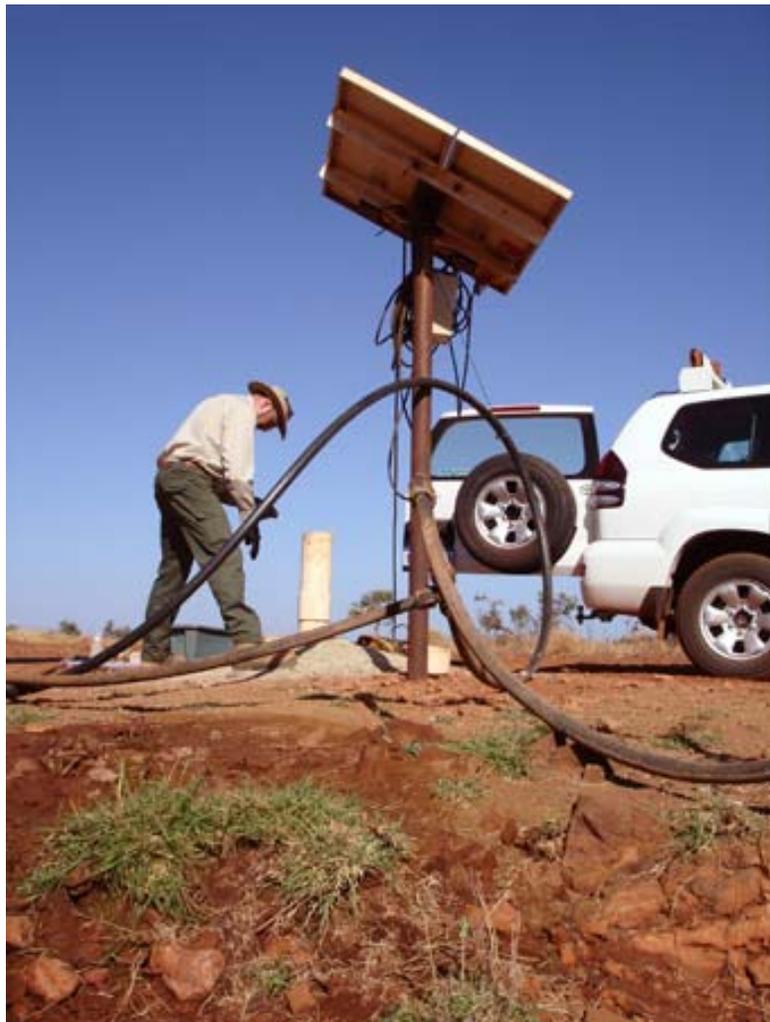




## **Stygofauna Sampling Results for the Devil Creek Development Project, Apache Energy Ltd, at 40 Mile Beach**



**Prepared for  
Apache Energy Ltd  
by Bennelongia Pty Ltd**

**December 2007**

**Report 2007/19**



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**Client – Apache Energy Ltd**

Report	Version	Prepared by	Checked by	Submitted to Client	
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## 1.0 Introduction

The Devil Creek Development Project is a new development in the Pilbara that will provide dry natural gas and petroleum condensate from an offshore gas field. The Project will consist of an offshore gas production platform, offshore gas pipeline, onshore gas pipeline, and onshore gas processing plant. The offshore pipeline will land in the vicinity of 40 Mile Beach, 45 km southwest of Dampier, and the gas processing plant will be located 10 km inland, adjacent to the North West Coastal Highway (Fig. 1.1). After compression and drying, gas will be transported via the Dampier to Bunbury Natural Gas Pipeline (DBNGP). Formation water from the gas will be disposed off in an evaporation pond. The proponent for the Project is Apache Energy Limited.

The onshore facility will consist of four major elements:

- A horizontally directionally drilled (HDD) shore crossing for the offshore pipeline in the vicinity of Gnoorea Point (to be installed from within the existing 5 ha shore-based marine facility)
- A buried pipeline to the processing plant in public road reserve (about 10 km long with an 18 ha envelope)
- A gas processing plant and ancillary area covering about 92 ha, a 24 ha borrow pit to supply material for infill and road construction, and worker accommodation in the vicinity of the Devil Creek Bore (approximately 8 ha)
- A groundwater bore(s) to supply water for construction and on-going processing. It is proposed to install a new bore adjacent to Devil Creek Bore as the principal source of water, although the recently installed production bore PB1 may be used to supply small quantities of water as well (Coffey 2007).

This report describes results of stygofaunal sampling undertaken at the Devil Creek Development Project site in accordance with the subterranean fauna sampling plan (Bennelongia 2007) agreed to by the Department of Environment and Conservation (DEC). It also assesses the level of risk that the Project may pose to subterranean species and communities.

## 2.0 Local geology

The geology of the area around the Devil Creek Development Project has been described by Coffey (2007). The proposed shore crossing area for the off shore pipeline is located in clayey sand and silty sand that extend to a depth of about 7 m and are underlain by weathered arkosic sandstone. The onshore pipeline route crosses silty sands underlain by calcarenite and basalt (only examined to 2 m bgl, depth to groundwater varies from 1.5-2 m to about 10 m). The proposed gas processing plant is located on sandy, clayey silt that extends to about 2.5 m depth, underlain by conglomerate and calcarenite. Depth to groundwater at the plant varies from about 6-10 m. Devil Creek Bore (near the accommodation area, Fig. 1.1) is in alluvium associated with the creek of the same name and has high yield (1 ML per day), indicating the existence of a relatively open underground structure, although it sits amongst outcropping Archean rock. Yield at the production bore PB1 within the proposed plant site (Fig. 1.1) was low at 15 KL per day, which suggests that subterranean habitat is not uniformly open and that the alluvial aquifer has patchy occurrence.

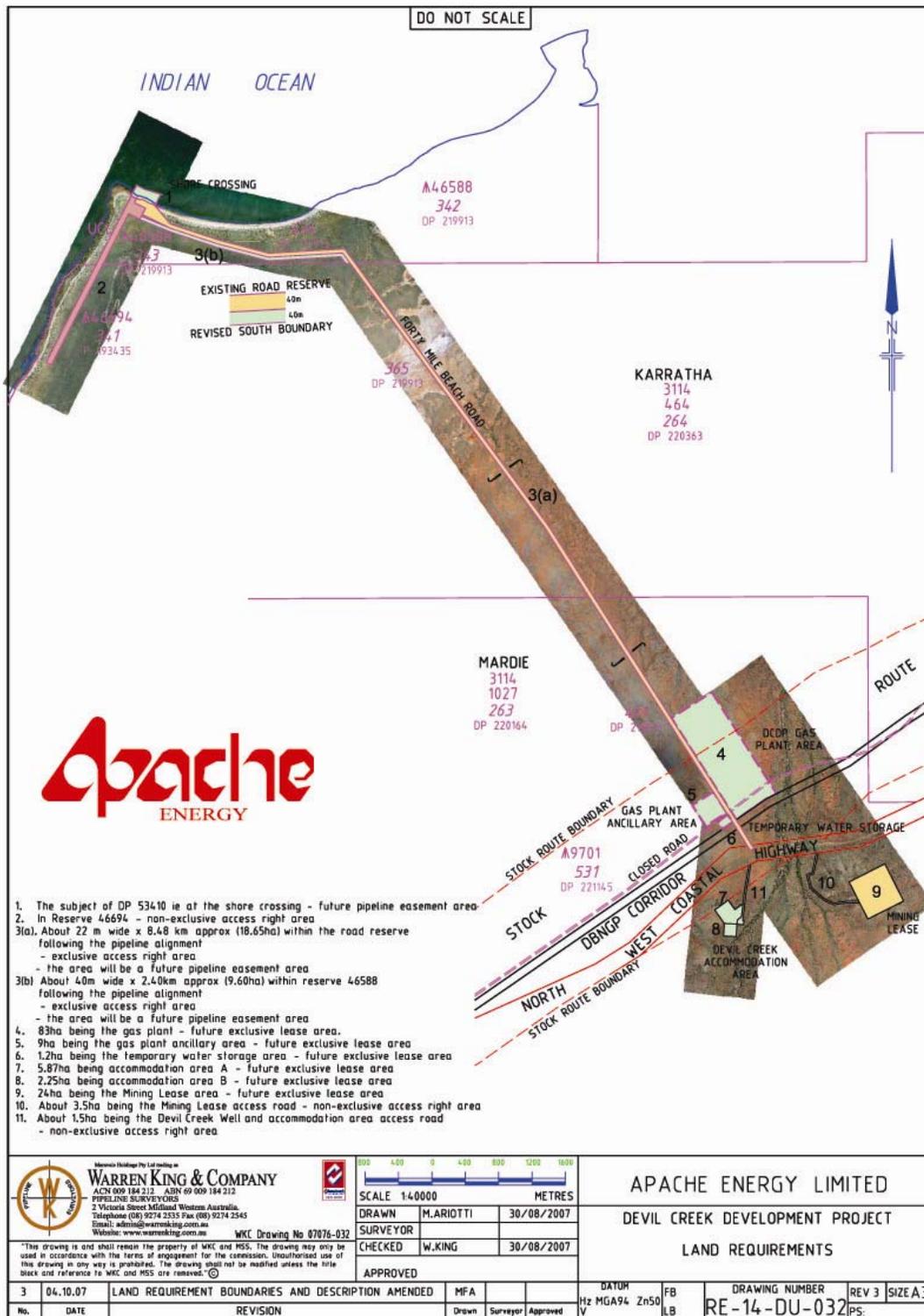


Fig. 1.1. Devil Creek Development Project facilities near 40 Mile Beach, southwest of Dampier, showing the major onshore elements of the Project

Table 3.1. Stygofaunal groups (46 species) collected from 25 bores in the coastal Pilbara between Fortescue River and Dampier outside the Devil Creek Development Project (Halse et al. in prep.; Bennelongia Pty Ltd, unpubl.). Restricted species have very localized distributions

Taxon	No of spp	% restricted	Taxon	No of spp	% restricted
Rotifers	1	0	Ostracods	13	0
Primitive worms	2	0	Copepods	11	0
Oligochaetes	10	0	Thermosbaenacids	1	0
Molluscs	2	0	Amphipods	4	0
Mites	2	0			

### 3.0 Subterranean fauna of the region

The Pilbara is a region with globally significant richness of stygofauna (Eberhard et al. 2008). It is also likely to harbor large numbers of troglifauna species (EPA 2007). There is no published information on the subterranean fauna on the coastal side of North-West Coastal Highway between the Fortescue River and Dampier (the area in which the Devil Creek Development Project is located) but the available unpublished information shows the area contains abundant assemblages of stygofauna (Table 3.1).

All 46 species known to be present between Fortescue River and Dampier have moderately wide distributions that cover significant proportions of one or more river basins. Species richness at sampled bores (based on one or two sampling events) varied from 0-12 species, with a mean of almost 5 species per bore. The fauna of the area is dominated by crustaceans (ostracods, copepods and amphipods), with a high number of oligochaete species also present (Table 3.1). Although the fauna in the vicinity of the Project is moderately rich, it is unlikely to represent an ancient resident subterranean fauna because the coastal plain where the Project is located would have been inundated by ocean within the past 130,000 years (much of it more recently) (see Allen 1993). The widespread occurrence of the species collected to date (Table 3.1) reflects this.

The extent of troglifauna occurrence in the vicinity of the Devil Creek Development Project is unknown but, based on current information about the habitats and occurrence of troglifauna, they are not expected to occur within the plant site. The only published records of troglifauna on the Pilbara coastal plain are from mesas in the Robe River basin. These elevated topographic features contain significant troglifauna assemblages within Channel Iron Deposit but the alluvium surrounding them does not contain troglifauna (Biota 2005).

### 4.0 Potential impacts of Devil Creek Development Project

It has been agreed that the potential impacts of the Project for subterranean fauna relate to stygofauna only and are likely to be associated with the gas processing plant and associated facilities (Bennelongia 2007). The primary potential impacting activity of the Project on subterranean fauna is groundwater drawdown around Devil Creek Well and other production bores. Modelling by Coffey (2007 and subsequent correspondence) has shown that this drawdown will be extremely limited, both vertically and horizontally. At the bore next to Devil Creek Bore it is expected to be 1.85 m at a 20 m radius from the bore and 1.2 m at 100 m. The thickness of the aquifer exceeds 20 m. At PB1, which will be used only as a supplementary supply, if at all, drawdown is expected to be < 0.5 m at a radius of 50 m. The thickness of the aquifer there exceeds 30 m.

A secondary potential impact is hydrocarbon-related groundwater contamination around the production bores and plant site. Potentially polluting equipment will be located on only about 20ha of the plant area, with engineering and management controls to ensure the containment of hydrocarbon products. Thus, any impacts are likely to be localized, although hydrocarbons may be transported westwards in narrow groundwater plume with decreasing hydrocarbon concentrations.

In summary, the scale of any impact to subterranean fauna is likely to be small and will be stygofauna-related. As a consequence, it was agreed with DEC that the sampling reported upon here would be restricted to stygofauna and occur at pilot-level intensity.

## 5.0 Objectives of sampling

The objective of sampling was to determine the risk to stygofauna posed by construction and operation of the Devil Creek Development Project facilities. The risk was investigated in the context of preliminary conclusions, based on desktop assessment and agreed to by DEC, that:

- The likelihood of troglifauna occurring is negligible. The humid, small voids that these animals require are very unlikely to occur within the Project area. The soil profile above watertable is sufficiently shallow (max. 10 m) that plant roots will be able to take up soil moisture through most of it. Furthermore, the clayey alluvial substrates are unlikely to contain large enough pore spaces for troglifauna
- The principal risks to stygofauna are associated with the gas processing plant and groundwater bore(s)
- The onshore pipeline, while it may involve some localized and temporary groundwater pumping during construction of parts of its length, is very unlikely to have significant effect on groundwater habitat and has an extremely small spatial extent (envelope of 18 ha)
- The offshore pipeline crossing will involve boring one or two incoming offshore pipeline holes approximately 18" diameter from the land near Gnoorea Point out under the beach and through the sea-bed for a distance of approximately 3 km. Drilling muds (water-based and bentonite) will be recovered during this process and are unlikely to cause significant contamination. There is no evidence that significant subterranean fauna habitat occurs near the beach. The Pilbara coast probably lacks the topographic relief, and has too wide a coastal plain, to support an anchialine system.

## 6.0 Methodology

### 6.1 Sampling effort

Three existing bores (age > 6 months) were sampled for stygofauna on 27 September and these, plus three bores installed in early November 2007, were re-sampled on 11 December 2007 (Table 6.1, Fig. 6.1). The new bores were pumped after installation to develop them (Coffey 2007). Note that all bores sampled are treated as being within the impact area for the purpose of assessment.

Sampling at the Devil Creek Development Project represented only a pilot-study level of effort (6-10 samples, see EPA 2007), which reflects that:

- The Project will have a very small footprint and is expected to have minimal impact on stygofauna habitat

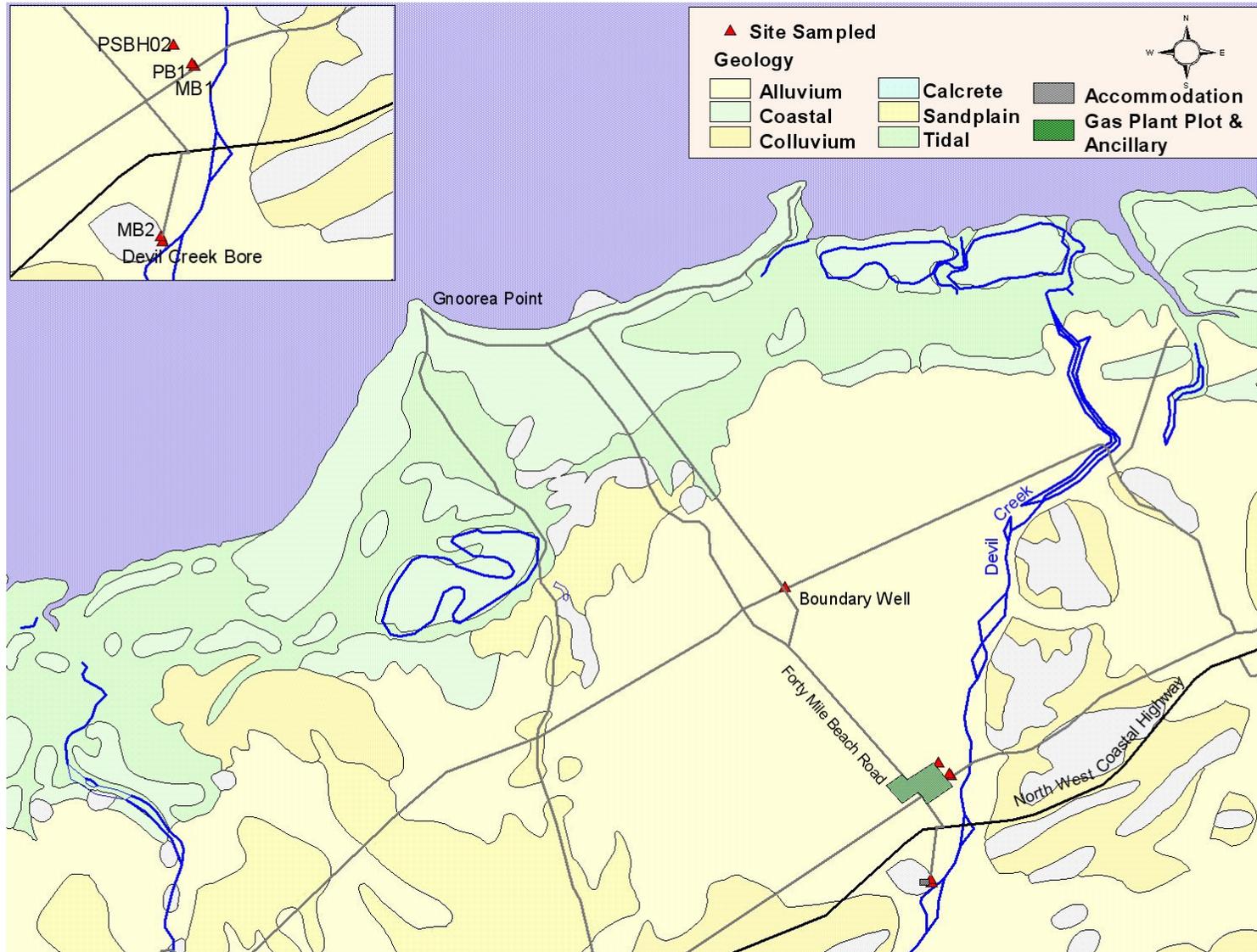


Fig. 6.1. Locations of the six bores sampled at the Devil Creek Development Project. Footprint of gas processing facility (north of Highway) and accommodation (south) are only indicative

Table 6.1. Bores sampled for stygofauna at the Devil Creek Development Project (all are regarded as being within impact area for purpose of assessment). Electrical conductivity (EC)  $\mu\text{S cm}^{-1}$  (based on September measurements except for PB1 in November)

Bore	Date sampled		Coordinates	Depth (m) to		EC
	27.ix.07	11.xii.07		Water	Bottom	
Boundary	Yes	Yes	20° 52' 41"S 116° 23' 49"E	7	11	3607
PSBH02	Yes	Yes	20° 54' 09"S 116° 25' 06"E	6-9	12	1498
Devil Creek	Yes	Yes	20° 55' 08"S 116° 25' 02"E	10	30	1695
MB2	No	Yes	20° 55' 07"S 116° 25' 02"E	10	18	-
PB1	No	Yes	20° 54' 15"S 116° 25' 12"E	10	36	1630
MB1	No	Yes	20° 54' 14"S 116° 24' 12"E	10	23	-

- Available evidence indicates that all stygofauna species present on the Pilbara coastal plain have ranges that are orders of magnitude greater than the likely impact zone of the Devil Creek Development Project (see Table 3.1, Eberhard et al. 2008).

The interval between sampling events was approximately 3 months.

## 6.2 Sampling methods

Sampling methods employed were those of the Pilbara Biological Survey (Eberhard et al. 2005), which are advocated for use in stygofauna assessment in Western Australia (EPA 2007). In summary, at each bore, six net hauls were collected using a weighted plankton net, which was lowered to the bottom of the bore, bounced up and down to stir up sediment, and then slowly retrieved so that it filtered both stirred up sediment and the water column. Contents of the net were transferred to a polycarbonate vial after each haul and then contents were preserved on-site in 100 % ethanol at the completion of sampling. Three net hauls were made with a 50  $\mu\text{m}$  mesh net and three with a 150  $\mu\text{m}$  mesh net.

At each bore, depths to water and the bottom of the bore were recorded and available information on geology was compiled. A field meter was used to measure electrical conductivity and pH in the bores sampled in September. Data collected in November (Coffey2007) were used to further characterize bore water chemistry.

Fieldwork in September was undertaken by Mike Scanlon and Jim Cocking; fieldwork in December was done by Stuart Halse and Grant Pearson.

## 6.3 Sampling sorting and species identification

Preserved samples were returned to the laboratory. They were then elutriated to separate out heavy sediment particles, and sieved into size fractions using 250, 90 and 53  $\mu\text{m}$  mesh sieves to improve searching efficiency during sorting, which was done under a dissecting microscope.

Animals picked out of the samples were identified to species or morpho-species level using appropriate published and unpublished keys, according to the specifications of EPA (2007) (unless damaged, juvenile or the wrong sex for identification). Many animals were dissected and examined under a compound microscope.

Sorting, and most identifications, were done by Jane McRae. Oligochaetes were identified by Mike Scanlon and ostracods by Stuart Halse.

## 7.0 Results

### 7.1 Water chemistry

Groundwater under the Devil Creek Development Project is fresh (Table 6.1, Coffey 2007), with a pH of 6.9-7.7. Closer to the coast at Boundary Well, groundwater is more saline (3607  $\mu\text{S cm}^{-1}$ ).

Table 7.1. Species of stygofauna collected within the Devil Creek Development Project area and their known distributions beyond the Project. Information about distributions is largely based on Halse et al. (in prep.), Harvey (unpubl.), Karanovic (2006, 2007) and Pinder (1994). s = September, d = December. PHC = Port Hedland Coast drainage basin

Species	Boundary s	Boundary d	PSBH02 s	PSBH02 d	Devil Crk s	Devil Crk d	MB2 d	PB1 d	MB1 d	Known distribution
No invertebrates			1					1	1	
<b>Protozoa</b>										
<i>Centropyxis</i> sp.		1								cosmopolitan
<b>Rotifera</b> (wheel animals)										
<i>Bdelloidea</i> sp. 2:2		1					1			surface Pilbara
<b>Platyhelminthes</b> (flat worms)										
<i>Turbellaria</i> sp.	1									cosmopolitan
<b>Nematoda</b> (round worms)										
<i>Nematoda</i> sp.		1					1			cosmopolitan
<b>Mollusca</b> (snails)										
<i>Hydrobiidae</i> sp. B1 (cf. <i>Gyalulus</i> )							1			Robe, Fortescue, PHC
<b>Oligochaeta</b> (aquatic earthworms)										
Phreodrilid with dissimilar ventral chaetae	1						1			Pilbara, South-West
<i>Pristina longiseta</i>	1	1								cosmopolitan
<b>Acarina</b> (mites)										
<i>Halacaridae</i> sp. 1 (PSS)	1	1								Pilbara
? <i>Arrenurus</i> sp. (damaged)							1			-
Oribatida group 1 (PSS)		1								WA (species complex)
<b>Crustacea</b>										
<b>Ostracoda</b> (seed shrimps)										
<i>Gomphodella hirsuta</i>							1			Fortescue, Robe, De Grey
<i>Humphreyscandona fovea</i>		1			1	1	1			lower Robe, Fortescue
<i>Arreacandona astrepte</i>							1			lower Robe, Ashburton?
<i>Cypretta seurati</i>	1	1								cosmopolitan
<i>Sarscypridopsis ochracea</i>	1									southern Africa, Pilbara
<b>Copepoda</b>										
<i>Stygioridgewayia westaustraliensis</i>					1		1			coastal Pilbara, Cape Range
<i>Microcyclops varicans</i>	1	1								cosmopolitan
<i>Diacyclops humphreysi unispinosus</i>				1			1			Barrow Is., coastal Pilbara
<i>Stygonitocrella unispinosa</i>				1						coastal Pilbara
<i>Elaphoidella humphreysi</i>							1			Pilbara
<b>Thermosbaenacea</b>										
<i>Halosbaena tulki</i>							1			Robe, Fortescue, Cape Range, Barrow Is.
<b>Amphipoda</b> (scuds)										
Paramelitidae cf. sp. 2 (PSS)				1						most of Pilbara
<i>Nedsia sculptilis</i> s.l.	1			1			1			Barrow Is., Fortescue, PHC
<i>Bogdiellidae</i> sp. 1 (PSS)							1			Robe, Fortescue
<b>No. of species</b>	<b>8</b>	<b>9</b>	<b>0</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>14</b>	<b>0</b>	<b>0</b>	

## 7.2 Stygofauna

A total of 24 species with potential groundwater affinities, including true stygobytes, were collected from the Project area (Table 7.1). Half the species could be assigned to named taxa. Although the community around Devil Creek Bore was quite rich (see results for Devil Creek and MB2), all the species present are widely distributed on the coastal plain of the Pilbara or beyond. Sampling supported the conclusion of initial desktop review (Table 3.1) that no species is likely to be restricted to the Project area and that the community present is a widespread one.

Comments about particular taxa are

- Protozoans sometimes occur in large numbers in boreholes. Whether such species are restricted to groundwater, or also occur at the surface, is unknown but protozoan species generally, including *Centropyxis*, are considered to be widespread (Paterson 1996)
- Existing taxonomic frameworks do not enable nematodes and turbellarians to be readily identified to species, so that species level distributions are poorly understood. Guidance Statement 54A does not expect that such taxa will be identified to species (EPA 2007)
- Phreodilid with dissimilar chaetae and Oribatida group 1 both represent widespread species complexes (Table 7.1); the former consists of juvenile animals that lack the sexual characters to enable species identification
- ? *Arrenurus* sp. was damaged and lacked the characters for species identification and was assigned to genus only tentatively. Several species of *Arrenurus* have been collected from Pilbara groundwater and are currently being described. They do not appear to have restricted distributions (M. Harvey, pers. comm.)
- Paramelitidae cf. sp. 2 is probably the same species as the more widely distributed Paramelitidae sp. 2 recognized in the Pilbara Biological Survey (Halse et al. in prep.). The variant is itself widespread (Table 7.1)
- All named species found within the Project area are known to be much more widely distributed (Table 7.1). Many of the species occur along the Pilbara coastal plain (e.g. *Stygonitocrella unispinosa*) and beyond (e.g. *Halosbaena tulki*), while according to current taxonomy a few are more-or-less cosmopolitan (e.g. *Microcyclops varicans*).

## 8.0 Discussion

### 8.1 Conservation significance of species collected

None of the species collected within the Devil Creek Development Project has high conservation significance in the context of its occurrence there. All species are likely to extend well beyond the Project area. The Project area community has a composition that matches the results of previous sampling between the Fortescue River and Dampier (Table 3.1) and, although the community is moderately speciose, it is not unusual in any way. This fits with the coastal plain having been inundated by ocean within the past 130,000 years, so that it does not support an ancient resident subterranean fauna in the way that is possible for much of the Pilbara Craton (see Humphreys 2001).

### 8.2 Risk to subterranean fauna associated with Project

The Devil Creek Development Project poses no risk to subterranean fauna for two reasons. Firstly, all species of subterranean fauna within the area appear to be widespread so that, even if local extinction occurred, overall species populations would not be affected. Secondly, the identified potential impacts of the Project are unlikely to affect local populations of subterranean species in a significant way. Groundwater drawdown near Devil Creek Bore will be extremely localized and will represent only about

5 % of aquifer thickness. It is also unlikely that the other potential impact, hydrocarbon contamination, will occur at a scale that will affect local populations significantly.

### 8.3 Limitations

This is not a report where limitations need to be highlighted. Results of the stygofauna surveys at the Devil Creek Development Project are clearcut and match the picture from wider survey on the Pilbara coastal plain. There can be a high degree of confidence in the validity of the results and conclusions drawn.

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