Annexure 2

Hydrogeology Report

HYDROGEOLOGY

Darwin
Beef Processing Facility

Prepared for

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1.0 REGIONAL GEOLOGY

The site of the proposed beef processing facility is located approximately eight (8) kilometres south of Noonamah adjacent to the Stuart Highway. It is near the eastern catchment boundary of part of the Berry Creek catchment, a tributary of the Blackmore River which drains into the Middle Arm of Darwin Harbour to the north west.

The geology of the region has been described by officers of the Department of Infrastructure, Planning and Environment in "*An understanding of the groundwater and surface water hydrology of the Darwin Harbour Plan of Management area"* (Haig and Townsend, 2003) and a brief summary is provided below.

The Darwin Harbour catchment is subdivided into the catchments of the Howard River, Elizabeth River, Blackmore River and the minor creeks and streams of the West Arm and Woods Inlet. Refer to Figure 1. (Haig and Townsend, 2003).

Elevation in the catchment ranges from about 140 metres in the south to sea level and the subject property ranges from ~28 – 54 metres ASL.

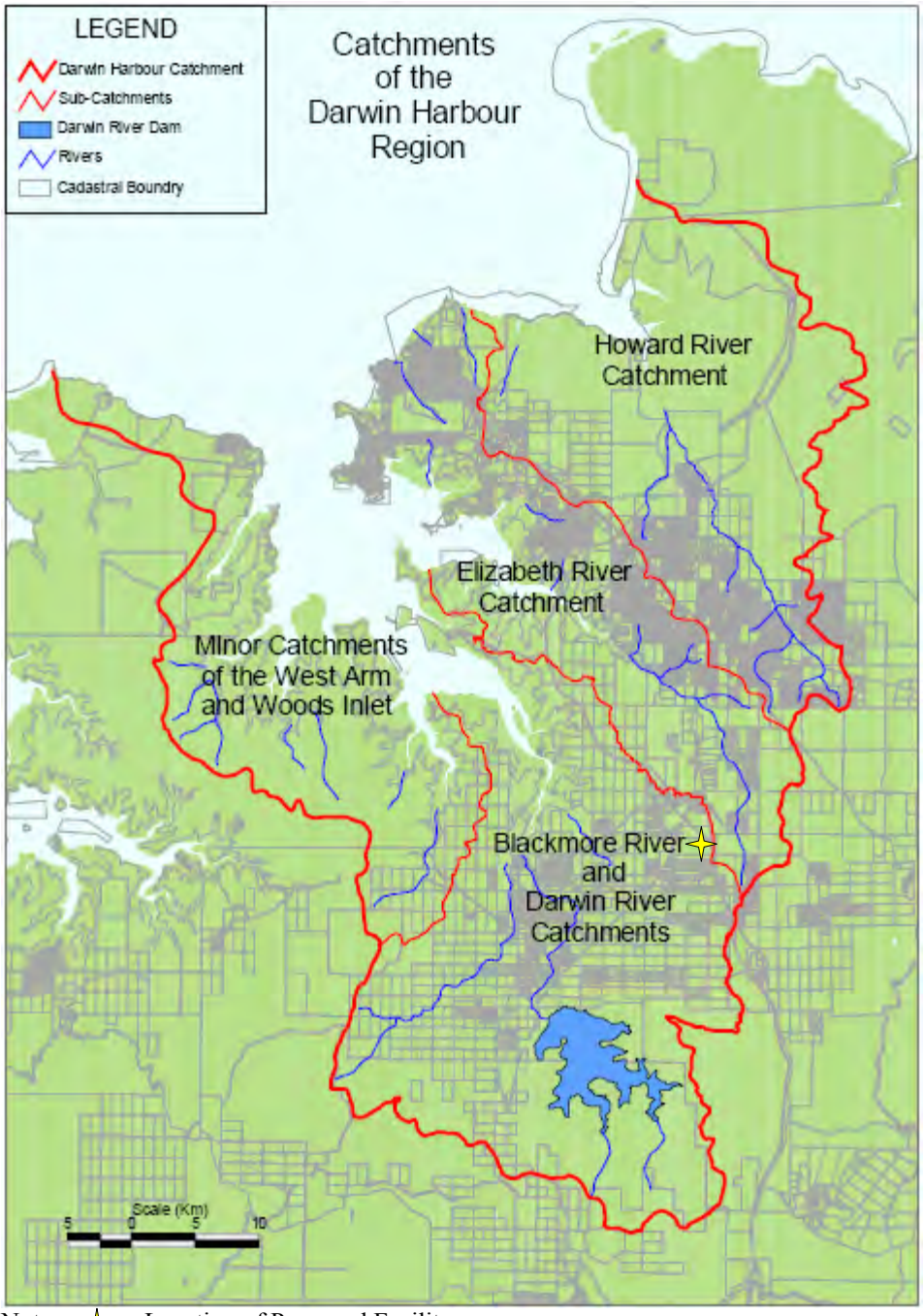
The following description of the geology of the area is a summary from the report by Haig and Townsend :-

> The bedrock geology consists of dolomite, carbonate rocks, sandstone, shale, siltstone, schist, granite and metamorphic rocks. The highest yielding bedrock aquifers are the dolomites and carbonate rocks. Lesser yielding aquifers are found in the fractured sandstones and siltstone. Schist, granite and metamorphic rocks are low yielding aquifers.
>
> Most of the region is covered with 20 to 50 metres of more recent sandstone, siltstone and claystone. There is a 5 to 10 metre thick layer of laterite ie. a residual clayey layer mainly consisting of hydroxides of iron and aluminium formed under tropical climatic conditions by the weathering of igneous rocks, that forms a capping layer over most of the area.
>
> Recharge to the regional aquifers is a result of direct infiltration of rain through the surface deposits. The average annual rainfall in the region is 1,700 mm, as much as 200 mm is recharged to some of the more transmissive areas in the catchment.
>
> Approximately 50% of the catchment area has moderately to severely water logged soils. Following the periods of high rainfall and runoff, the wetlands that form during the wet season will gradually dry up as shallow groundwater drains. Some wetlands which are "perched" above clay layers persist through the dry season.
>
> Perennially flowing springs, which are fed from deeper dolomite aquifers, are found at Howard Springs and Berry Springs.
>
> Compared to undeveloped areas, the groundwater levels at the end of the dry season in the developed rural area have lowered 6 to 10 metres over the last 20 years.

The additional lowering of water levels at the end of the dry season is due to water extraction associated with rural development.

Following the cycle of natural drainage and extraction of groundwater, the aquifer system is fully recharged each wet season.

Figure 1. Catchments of the Darwin Harbour Region.



Note: ✦ - Location of Proposed Facility

2.0 GROUNDWATER INFORMATION AND TRENDS

The Groundwater and Surface Water Hydrology Report (Haig and Townsend, 2003) provides a summary of groundwater usage and trends for the region. Key points from the report include :-

- Most of the Darwin Harbour region is covered by a 10m layer of Cainozoic aged laterite, below which there are about 30 to 60 metres of Cretaceous aged sandstones and claystone.

- The shallow sediments make up a regional unconfined aquifer system that is recharged by direct infiltration during the wet season. The cretaceous sediments act as a source of recharge and storage to the deeper bedrock aquifers.

- Groundwater discharge sourced predominantly from the lower dolomite aquifer occurs infrequently. Examples of this type of flow are seen at Howard Springs and Berry Springs.

- The Koolpinyah dolomite lies beneath most of the Howard River Catchment, and is the largest aquifer in the Darwin Harbour region with typical production rates of greater than 5 litres per second.

- Lower yielding groundwater supplies of 0.5 to 5 litres per second are found in the fractured and weathered siltstone, shale and schist.

- Most regional aquifers typically yield water of good quality.

- Regional depths to groundwater change annually from the wet season to the dry. Shallow groundwater drainage begins at the end of the wet season and the higher elevated land dries out earlier than lower areas.

- Groundwater flows are controlled by topography and by the ability of the aquifer to transmit water. In general, the direction of groundwater flow is from high to low areas of elevation.

- The groundwater in the Darwin region can be grouped into three main categories; fresh carbonate water, fresh non-carbonate water and saline water.

- Water quality is influenced by aquifer type, distance from the sea, time the water has spent in contact with aquifer material and distance from the recharge source.

- The fresh carbonate water tends to come from the deeper, dolomite aquifer and carbonate rocks. This water tends to be alkaline and hard.

- Fresh non-carbonate water is found in Cretaceous aged sandstones of the shallow aquifer or other non-carbonate rocks and tends to be slightly acidic and soft while saline water is found in coastal areas subject to tidal influence.

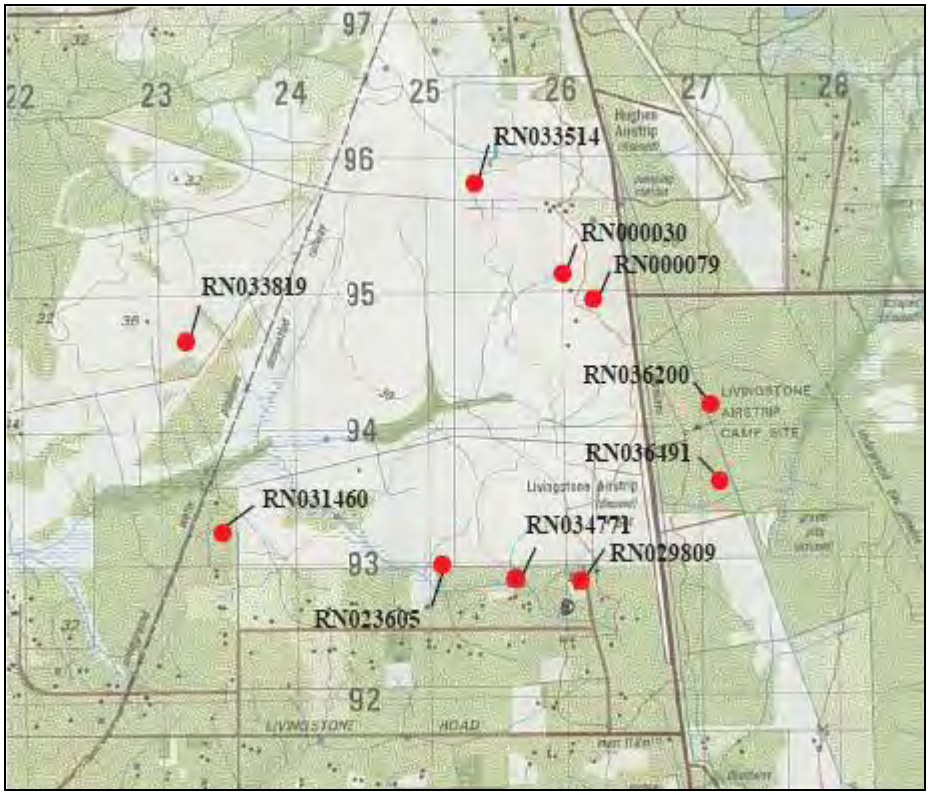
3.0 LOCAL HYDROGEOLOGY

A search of NT Land Information System, NRETA Maps on the Department of Natural Resources, Environment, The Arts and Sport (NRETAS) website identified a number of bores surrounding the proposed development site.

Of these, ten (10) bores were selected to give an adequate representation of groundwater trends in the local area. Refer to Figure 2.

Key information from the Departments' groundwater bore search is outlined in Table 1.

Figure 2. Goundwater Bores Map.



3.1 Local Bore Information

The majority of the existing registered bores in the locality were drilled and constructed between 1995 and 2009 for domestic and agricultural production purposes.

Records indicate that the majority of bores were drilled to depths ranging from 60 – 100 metres with standing water levels of 6 – 13 metres below ground level.

Yields were mostly sufficient for domestic and production bores ranging between 0.5 – 5 litres/second. The main water bearing zones are recorded as being from approximately 27 – 95 metres in depth.

Those bores with records of water quality all indicated good quality water.

Soil drill logs where recorded for the majority of these bores in the immediate vicinity of the proposed development. The majority of borehole/drill logs exhibited the following information :-

- topsoil to 0.5 – 1.0 metre depth
- sandy surface soil is underlain by sandy clay and clay layers to ~20 - 30 metres in depth providing a barrier to the groundwater aquifer
- deeper layers generally included yellow and grey clay, red and grey shale and siltstone with gravelly seams.

Two of these bores ie. Registration No. 031460 and Registration No. 023605 located near the southern boundary of the property, exhibit shale and quartz/siltstone, respectively, throughout the profile.

Table 1. Bore Records Sourced from NRETA Maps

RN Number	Name	Completed	Depth (m)	SWL (m)	WBZ (m)	Yield (L/s)	Quality	Use
023605	Bremner	1984	35	10	27 – 35	0.5	Good	Production
033514	Santavan	2002	43	2	-	-	-	Production
000079	Army	1943	64	18.3	2 – 5	0.9	-	Domestic / Production
033819	Bevan Nguyen	2003	79	13	64 – 75	-	-	Domestic / Irrigation
000030	Army	1943	79.3	21.3	30 – 33 60 – 70	1	-	Domestic
029809	Heriot	1995	95	6	81 – 89 89 – 95	2.5	-	Domestic / Irrigation
034771	Illingworth	2005	98	8	76 – 90	3.1	Good	Domestic / Production
036491	Fuller	2009	66	3	63 – 66	5.0	pH 7.8	Domestic
036200	Ruddick	2008	60	8	40 – 43	5.0	Good	Domestic
031460	Mottram	1997	35	9	33 – 34	5.0	Good	Domestic / Production

Hydrographs highlighting fluctuations in water levels for the abovementioned bores are not available but it is generally recognised that significant changes occur due to natural drainage and discharge of water out of the system between the wet season and the end of the dry season.

Implementation of an exploratory drilling program, including establishment of a network of monitoring bores (piezometers) on site, will provide useful hydrogeological information eg.

- benchmarking groundwater depth and quality
- siting and designing effluent treatment and storage ponds
- managing irrigation operations
- to help ensure local beneficial use of groundwater is not compromised.

Concluding comments :-

- Plans to undertake an exploratory drilling program should be implemented
- As long as works don't encroach onto the seasonally waterlogged areas in the lower terrain locations the available information indicates that there is an adequate buffer of clayey material between the proposed operations and the deeper water bearing sediments
- In addition to this buffer, groundwater will be protected and adverse environmental impacts minimised through suitably constructed and lined effluent treatment ponds, balanced manure application and effluent irrigation rates, and sealed cattle holding yards and manure composting pad.

4.0 REFERENCES

NT Land Information System , NRETA Maps, Department of Natural Resources and the Arts. http://www.nt.gov.au/nreta/nretasmaps/ [Accessed 9.11.2011].

T. Haig and S. Townsend (2003). "*An understanding of the groundwater and surface water hydrology of the Darwin Harbour Plan of Management area".* Department of Infrastructure, Planning and Environment, PO Box 30, Palmerston NT 0831.