SECTION 3

Alternatives

PowerWater

3 Alternatives

The Proponent considered and rejected several alternatives to manage sewerage generated with the Larrakeyah and Ludmilla sewage catchments. These are briefly described below with reasons for discounting these alternative scenarios.

3.1 Reasons for the Proposal

The projected increase in population of the Larrakeyah and Ludmilla sewage catchments, and associated industrial and commercial growth, presents the need for increased sewage treatment capacity for these catchments.

As described in **Section 2, Description of the Proposed Development**, the closure of the Larrakeyah sewage outfall and macerator are requirements of WDL 149 (see **Appendix D**). The current WDL requires the Proponent to undertake works to redirect Larrakeyah catchment sewage flows to an alternate facility, and closure of the Larrakeyah outfall. The Proposed Development is an integral element of the Larrakeyah Outfall Closure Plan (LOCP), and will provide the extra capacity at the Ludmilla WWTP necessary to allow closure of the Larrakeyah outfall and compliance with WDL 150 requirements.

3.2 Alternatives to the Proposed Development

The Guidelines require the Proponent to consider alternatives to constructing the duplicated effluent rising main, the Proposed Development. The alternative options to the Proposed Development are:

- Not to proceed with the Proposed Development.
- To redirect the effluent from Ludmilla WWTP to the Larrakeyah outfall.
- To redirect the additional flow to Ludmilla Creek.

3.2.1 Consequences of Not Proceeding

The consequences of not proceeding with the Proposed Development are as follows:

- Macerated sewage would continue to be discharged at Larrakeyah on a 365 days per year basis
- Overflows to Ludmilla Creek would continue to occur during the wet season.

In practice, under the ‘No Go’ option, treatment facilities and associated infrastructure at the Ludmilla WWTP would be expanded as necessary to handle increases in population in the Ludmilla WWTP catchment, and minor improvements may be made to the treatment and associated processes. However, the major improvements envisaged under the Proposed Development would not be implemented.

3.2.2 Alternatives to the Proposed Development

Alternatives to the ‘No Go’ option are:

- To transfer the effluent from Ludmilla WWTP to the Larrakeyah outfall
- To use the existing East Point effluent rising main.

3 Alternatives

Contemplated under the Ludmilla WWTP (Sinclair Knight Merz, 1998) the proposed alignment for the effluent pipeline to transfer secondary effluent from the Ludmilla WWTP to the Larrakeyah outfall involves a series of pipelines and pumping stations to transfer secondary effluent from the Ludmilla WWTP to Larrakeyah outfall, namely:

- A new effluent pumping station at Ludmilla WWTP to pump secondary effluent to Larrakeyah
- A rising main route ensuring the lowest impact to residents, recreational users and on valuable trees and landscaping
- The rising main joining the existing Larrakeyah outfall.

To return the effluent from Ludmilla WWTP to the existing Larrakeyah outfall does not comply with WDL 150 directive to redirect the Larrakeyah catchment sewage flows to an alternate facility and allow the closure of the Larrakeyah outfall.

To use the existing effluent rising main would not be practical, as the capacity of the existing infrastructure cannot handle the increased volume of effluent from Ludmilla WWTP. Furthermore, one of the factors limiting the sewage treatment capacity of the Ludmilla WWTP is the capacity of the existing effluent rising main. Hence, the frequency of overflow events, where sewage has to be discharged into Ludmilla Creek is expected to increase.

3.3 Alternative Outfall Locations and Configurations

Section 2.4, Related Actions describes the Proponents commitment to extending the existing EPO to deeper water. Extending the East Point outfall will be subject to environmental approval under the EA Act and EPBC Act.

The discharge alternatives for the secondary effluent at Ludmilla WWTP are redirecting the effluent from Ludmilla WWTP to:

- The existing Larrakeyah outfall.
- The existing East Point outfall.
- Ludmilla Creek.

To return the effluent to the existing Larrakeyah outfall does not comply with NRETAS WDL requirements to redirect the Larrakeyah catchment sewage flows to an alternate facility and allow the closure of the Larrakeyah outfall.

The existing East Point outfall is in shallow water and especially during low tide the mixing and dilution of discharge is minimal. Due to the increased organic load this can lead to algal blooms and have a negative effect on the natural environment.

There is an existing wet weather overflow beside the Ludmilla WWTP that leads to Ludmilla Creek. The existing overflow arrangement is a tidal channel which extends through the mangroves to the northern boundary of the WWTP.

Not proceeding with the Proposed Development, it is likely that the frequency of overflows will increase. That could lead to an increase in organic material, thus having a detrimental effect on the biological communities.

3 Alternatives

3.4 Alternative Pipeline Material and Installation Options

Other materials were considered for the construction of the duplicated effluent rising main. However, the longevity of the chosen material (see **Section 2.3.1, Design**) was proven over the lifetime of the current effluent rising main.

SECTION 4

Existing Environment

PowerWater

4 Existing Environment

This section describes the physical, biological and socio-economic aspects of the environment that will be affected by the Proposed Development. It is supported by field investigations undertaken to describe the existing environment as a baseline for assessing impacts, and including a terrestrial ecology survey, cultural heritage, geo-technical and ASS investigations.

A description of the potential impact is provided in **Section 5, Potential Impacts** and supported by proposed mitigation measures described under **Section 7, Mitigation, Management and Monitoring.**

4.1 Physical Environment

4.1.1 Climate

Darwin is located 12° south of the equator in the seasonally dry monsoon tropics. Rainfall seasonality and intense tropical storm activity are the most distinguishing features of the local and regional climatic pattern. The wet season, brought on by the northwest monsoon weather pattern, runs between September and May. The dry season, brought on by the south east trade weather pattern across the Australian continent, runs between June and August.

Localised thunderstorms occur during transitional periods at the start of the wet from September to November and the end of the wet from March to May. General monsoonal rain is the result of a monsoon trough (intertropical convergence zone) that falls across the Top End region between December and March. Large low pressure systems associated with the monsoon trough can produce severe tropical cyclones that lead to significant damage to above ground structures.

Climatic observations are made by the Bureau of Meteorology (BoM) at the Darwin Airport, site number 014015. Darwin Airport is located in close proximity to East Point and Ludmilla (approximately 2 km and 5 km, respectively). Long term averages for the period 1941 to 2011, based on observations made by BoM, are presented in **Table 4-1**. The major climatic observations include information on temperature, rainfall, humidity and wind speed.

Temperature

Ambient temperature at Darwin has an annual mean daily maximum of 32°C and daily minimum of 23.2°C. The mean annual temperatures for 9 am to 3 pm are 26.7°C and 30.8°C respectively. November is recorded as having the highest mean maximum temperature (33.3°C) and July the lowest mean minimum temperature (19.3°C).

Rainfall

Over 80% of the average annual rainfall occurs as general monsoon rain during the period from December to February. The mean annual rainfall is approximately 1,722.6 mm, with January statistically being the wettest month and July the driest. Relatively short duration, high intensity events, associated with afternoon and evening showers and thunderstorms dominate the rainfall pattern (BoM, 2011).

4 Existing Environment

Table 4-1 Long-Term Climate Data - Darwin Airport (1941 to 2011)

Statistic Element	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
TEMPERATURE													
Mean maximum temperature (°C)	31.8	31.4	31.9	32.7	32	30.6	30.5	31.3	32.6	33.2	33.3	32.6	32
Mean minimum temperature (°C)	24.8	24.7	24.5	24	22.1	20	19.3	20.4	23.1	24.9	25.3	25.3	23.2
RAINFALL													
Mean rainfall (mm)	426.2	366	319	100	21.1	1.9	1.2	5.1	15.8	70	140	252.4	1722.6
Decile 5 (median) monthly rainfall (mm)	411	358	286	74.1	4.3	0	0	0	6.4	52.8	140.5	227.4	1709.8
Mean number of days of rain >= 1 mm	18.9	18.3	16.7	7.1	1.7	0.3	0.2	0.4	1.6	4.9	9.9	14.1	94.1
OTHER DAILY ELEMENTS													
Mean daily sunshine (hours)	5.7	5.7	6.8	8.7	9.6	9.9	10.1	10.3	9.8	9.5	8.4	6.9	8.5
Mean number of clear days	0.6	0.7	1.9	6.2	12.1	16.3	17.6	19	15.1	9.2	3.6	0.9	103.2
Mean number of cloudy days	24.2	21.6	19.6	11.5	6.5	3.8	3.4	2.6	3.4	5.5	11.5	20.4	134
Mean daily evaporation (mm)	6	5.7	5.8	6.4	6.8	6.8	6.8	7.2	7.7	8	7.4	6.6	6.8
9am CONDITIONS													
Mean 9am temperature (°C)	28	27.7	27.6	27.4	25.6	23.3	22.8	24.4	27	28.7	29.2	28.8	26.7
Mean 9am relative humidity (%)	81	83	82	74	65	60	60	64	68	69	72	76	71
Mean 9am wind speed (km/h)	11.4	11.1	9	10.5	13.6	14.7	13	10.7	9	8.8	8.7	9.9	10.9
3pm CONDITIONS													
Mean 3pm temperature (°C)	30.2	30	30.5	31.7	31.2	29.9	29.6	30.2	31.2	32	31.9	31.2	30.8
Mean 3pm relative humidity (%)	70	72	67	52	43	38	37	40	47	52	58	65	54
Mean 3pm wind speed (km/h)	17.8	18.6	16.4	16.5	17	16.2	17.1	19	20.9	19.9	17.7	17.5	17.9

Source: BoM, 2011

4 Existing Environment

Humidity and Evaporation

Humidity is highest during February, when the mean 9 am value at Darwin Airport is 83% and the lowest mean humidity is in July at 37% at 3 pm. The annual mean daily evaporation for Darwin is indicated by BoM (2011) as 6.8 mm, with the monthly average daily evaporation ranging between 5.7 mm in February to 8.0 mm in October.

Wind Speed

Prevailing winds during the wet season (November to March) are light west to north-westerly, freshening in the afternoon due to sea breezes. During the day, the wind direction is variable, with a predominant easterly flow (BoM, 2011). The predominant winds during the dry season (April to October) are light to moderate and from the north-east to south-east quadrants. During the day, winds blow mainly from the south-east quadrant. At night the wind direction is mainly from the south south-east and north east.

4.1.2 Topography

The Proposed Development will be located on a narrow peninsula known as East Point, which extends north-westerly from the mainland north of Darwin and into Beagle Bay. The peninsula is bordered on the west and southwest by Fannie Bay and on the northeast by Ludmilla Creek. The topography of East Point is relatively flat to gently undulating except along the coastline, where the ground surface drops off as steep, rocky headlands (see **Figure 4-1**).

4.1.3 Geology

According to the Northern Territory Geological Survey[2] (NTGS) the Darwin member of the Bathurst Island Formation underlies the site. This member underlies most of Darwin and extensive areas to the north, due the very gradual dipping strata (0.1 degrees) to the north.

The horizontally bedded strata of the Bathurst Island formation consist predominantly of claystone, sandy claystone, glauconitic sandstone and a basal unit of conglomerate deposited in the Cretaceous Period under a shallow marine or paralic, low energy environment. These strata are overlain by a veneer of unconsolidated sand, clayey sand, soil and, in some places, artificial fill.

A geotechnical investigation along the alignment for the Proposed Development was completed by Cardno Ullman and Nolan in 2010 (see **Appendix D**). Boreholes along the alignment indicated that the unconsolidated sediments are in most cases less than 1 m in thickness.

Groundwater was encountered in 10 boreholes advanced by Cardno Ullman & Nolan (2010) at depths ranging from 0.4 to 2.5 m bgl. Groundwater levels, flow direction and vertical gradient are likely to be highly variable across the site and are expected to fluctuate both seasonally and with the tides (Cardno Ullman & Nolan, 2010).

During the Late Cretaceous Period and Early Tertiary Period, alteration of the original smectitic clays to kaolinite has occurred, along with redistribution of silica and iron oxides. This has resulted in the formation of a duricrust, common in the upper few meters, known locally as porcellanite. Rocky outcrops are generally scarce in the inland areas, often covered by a thin layer of Quaternary alluvium or colluvium or capped by laterite and saprolite soils, formed from the weathering of the bedrock (Cardno Ullman & Nolan, 2010).

[2] 1:100,000 Geological Map Series titled DARWIN and associated map, Sheet 5073

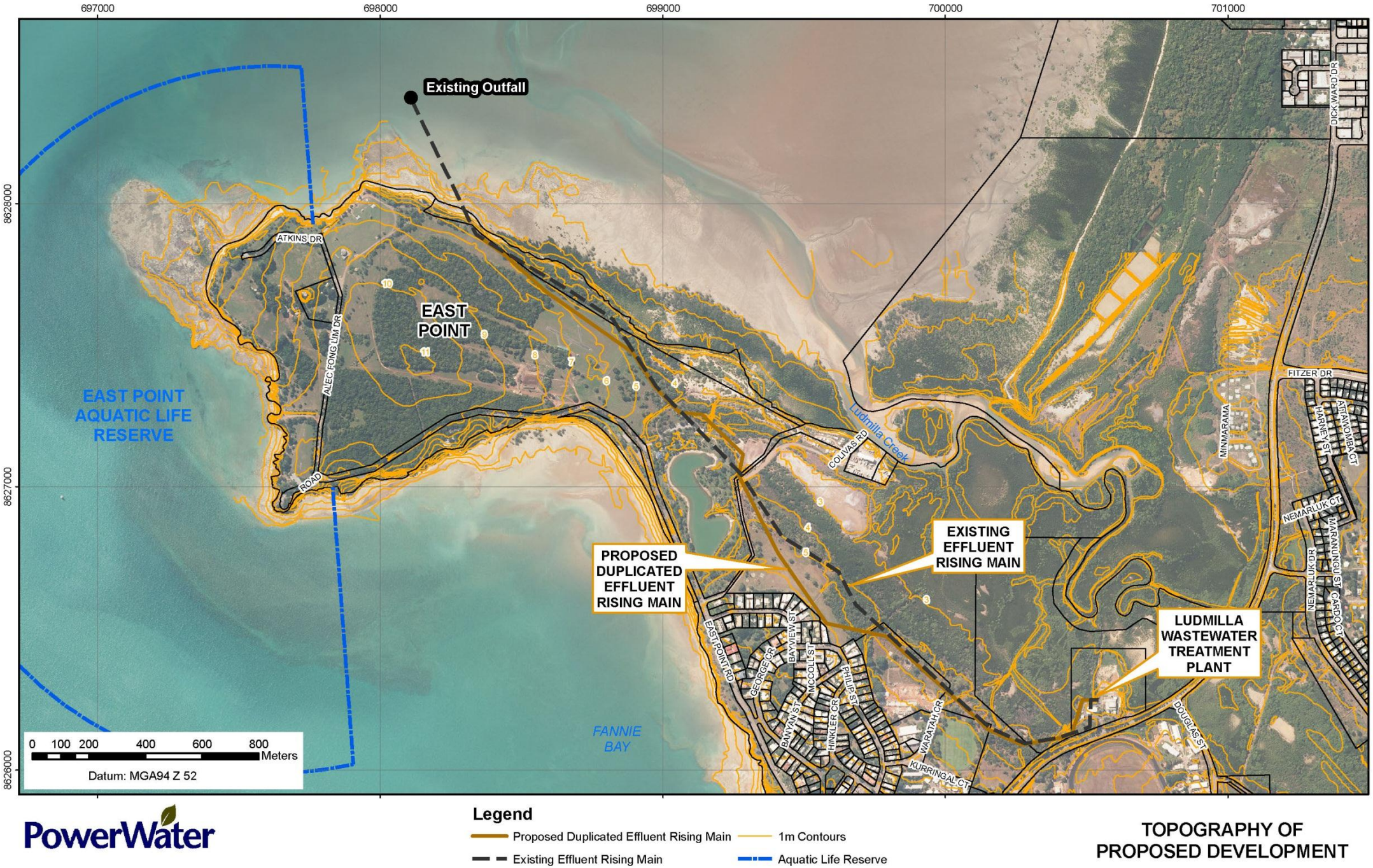


Figure 4-1 Contour Map of East Point and Ludmilla Area

4 Existing Environment

4.1.4 Soils

Soils of the East Point area typically consist of Tenosols, which are soils that do not fit the requirements of any other soil orders of the Australian Soil Classification (Northcote *et al.*, 1968). Soil and rock types vary in composition and strength along the project corridor, with four distinct subsurface materials identified. The general stratigraphic sequence is as follows (Cardno Ullman & Nolan, 2010):

- A surface layer of alluvium comprising loose to dense, gravels, silts and sands with thickness ranging from 0.2 to 0.5 m. Loose, clayey sand and soft clay deposited in a shallow marine or mangrove type environment was encountered in some locations at the Ludmilla WWTP end of the Proposed Development alignment.
- The underlying material was predominately a layer of laterite comprising medium dense to very dense, silty or clayey, sandy gravel. The thickness of the laterite varied from approximately 0.2 to 0.9 m.
- Underlying unit of residual soil / extremely weathered rock, varying in composition from soft–hard clay to loose–very dense sand and gravel.
- Underlying very low to moderate strength, highly weathered duricrust / porcellanite rock. The depth of the porcellanite layer was generally indicated borehole refusal.

Fill materials comprising loose to very dense, silty or clayey sandy gravel to depths ranging from 0.75 to 2.0 m have been identified at some locations along the Proposed Development alignment (Cardno Ullman & Nolan, 2010).

Soils within the project area include deep loamy massive earths, gravelly yellow massive earths, shallow very gravelly yellow massive earths and intertidal area characterised by loose silty and pebbly sand over soft mangrove clay (Douglas Partners, 1998).

Land Units (LU) associated with the project area are summarised in **Table 4-2**, which also include the capability constraints in terms of for each of the land units. **Figure 4-2** shows the Land Units in relation to the Proposed Development Corridor.

Table 4-2 Land Unit Properties

LU Code	Land Unit (LU) description	Erosion Risk
3b	Flat to gently undulating upland surface; slopes 0.5 – 2%; deep Loamy Massive Earths; Eucalypt Woodland and minor open woodland	Low
3c	Flat to gently undulating upland surface; slope 1 – 3%; shallow very gravelly yellow massive earths; Eucalypt woodland	Low
3d	Flat to gently undulating upland surface; slope 1 – 3%; shallow gravelly lithosols; Eucalypt open woodland	Low
4c	Gentle lower slopes' slope 0.5 – 1%; slow drainage; yellow massive earths; Eucalypt open forest with minor woodland	Low
9a	Estuarine fringes; slopes negligible with tidal inundation, with Saline muds and clays. Usually bare small areas of samphire and salt tolerant grasses.	Low

Source: After DCC 2009a and DCC 2009b

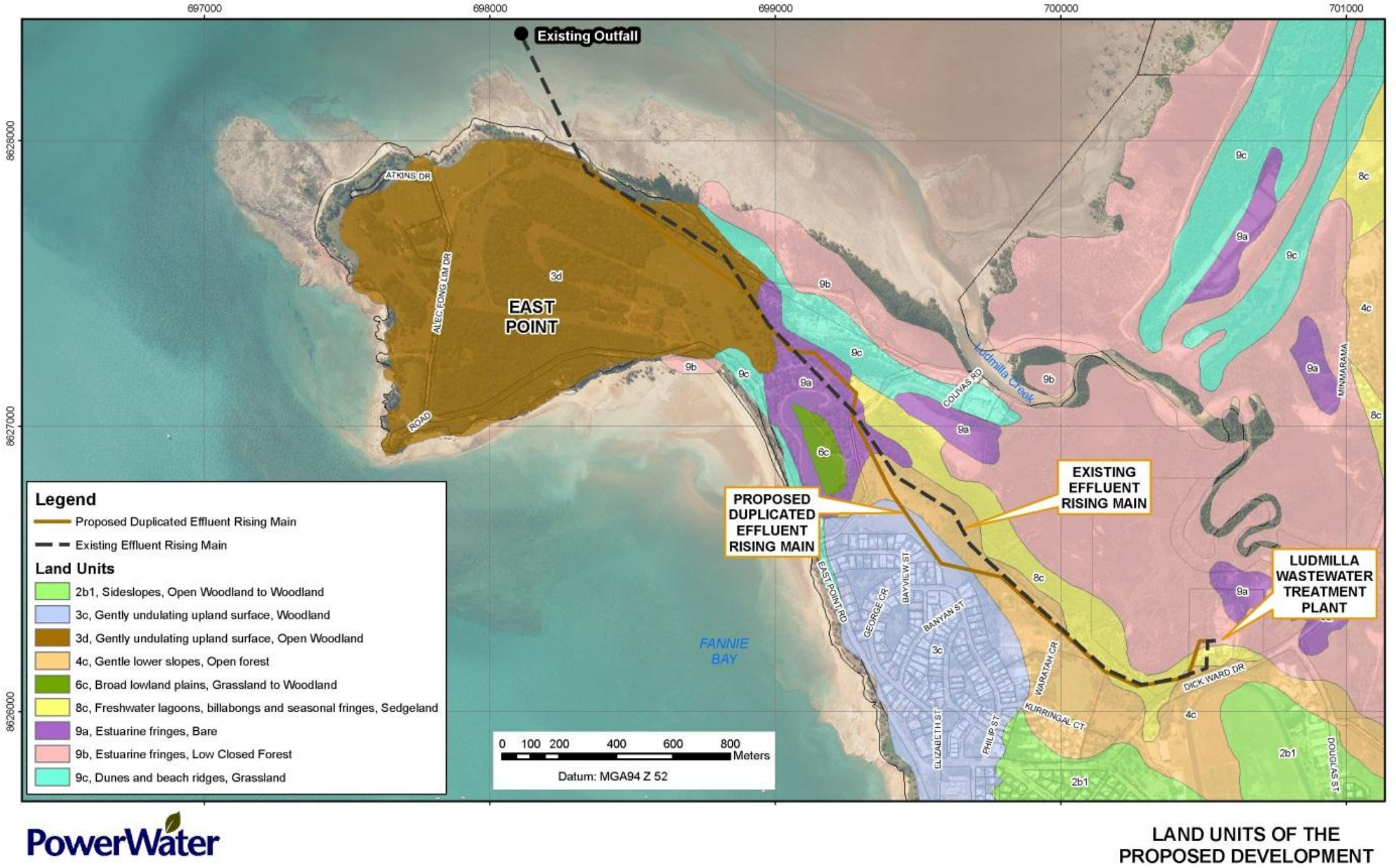


Figure 4-2 Land units at East Point

4 Existing Environment

Acid Sulphate Soils

Acid sulphate soil (ASS) and Potential Acid Sulphate Soils (PASS) is a common name given to a range of soil types containing iron sulfides, e.g. pyrite, and / or their oxidation products. In Australia, such soils are generally found in coastal and floodplain areas below 5 m Australian Height Datum (AHD). When exposed to air, the sulphides oxidise to produce salts and sulphuric acid. Oxidised acid sulphate soils generally have a pH of less than 4.0 and are termed Actual Acid Sulphate Soils (AASS). Sulphidic soils that have not been oxidised typically have a pH greater than 4.0 and are termed PASS.

Based upon a program of soil sampling and analysis, Hill and Edmeades (2008) concluded that the majority of soils in the intertidal areas of the Darwin Harbour region contain up to 10% Chromium Reducible Sulphur (CRS) and, therefore, potential acidity (see **Figure 4-3**). Mangrove soils in the mid-tidal level were found to have the highest potential acidity. Other zones within the intertidal area having high to moderate potential acidity included: the shoreline forest, closed forest, rocky shore woodlands and, to a lesser degree, samphire and salt-flat mangrove communities. High - and low - tidal flats were found to have lower acidity potential, while hinterland mangrove communities had the lowest potential.

As NRETAS identified the disturbance of ASS as a major risk for the Proposed Development, PWC commissioned an ASS and PASS study that evaluated the presence of ASS and PASS along the proposed East Point Rising Main corridor (Cardno Ullman & Nolan, 2011) (see **Appendix E**).

PASS and AASS were observed at two locations (BH28 and BH34) toward the Ludmilla WWTP end of the Proposed Development alignment, collected at depths of 1.75 - 2.25 m bgl and 0.3 - 0.4 m, respectively (Cardno Ullman & Nolan, 2010). This finding instigated further investigations to delineate the presence of potential and actual acid soils (BH1 to BH8).

Acid sulphate soils was observed at four test locations collected from BH1 at 0.0 - 0.25 m depth, BH6 (equivalent to BH34 in the 2010 study) at 1.75 - 2.00 and BH8 (equivalent to the BH28 in the 2010 study) at 1.25 - 1.50 and 1.75 - 2.00 m depth (see **Figure 4-4**) (Cardno Ullman & Nolan, 2011).

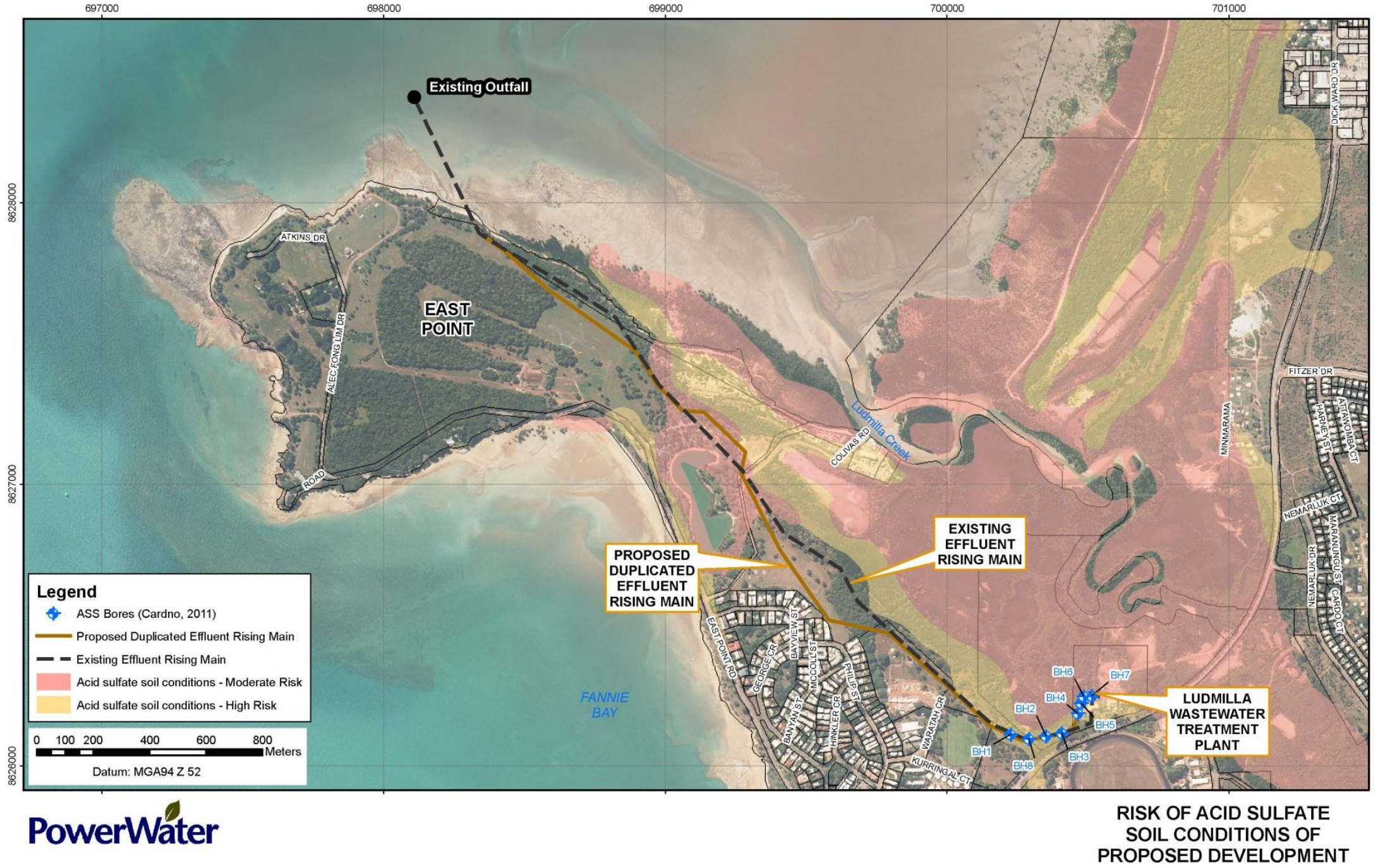
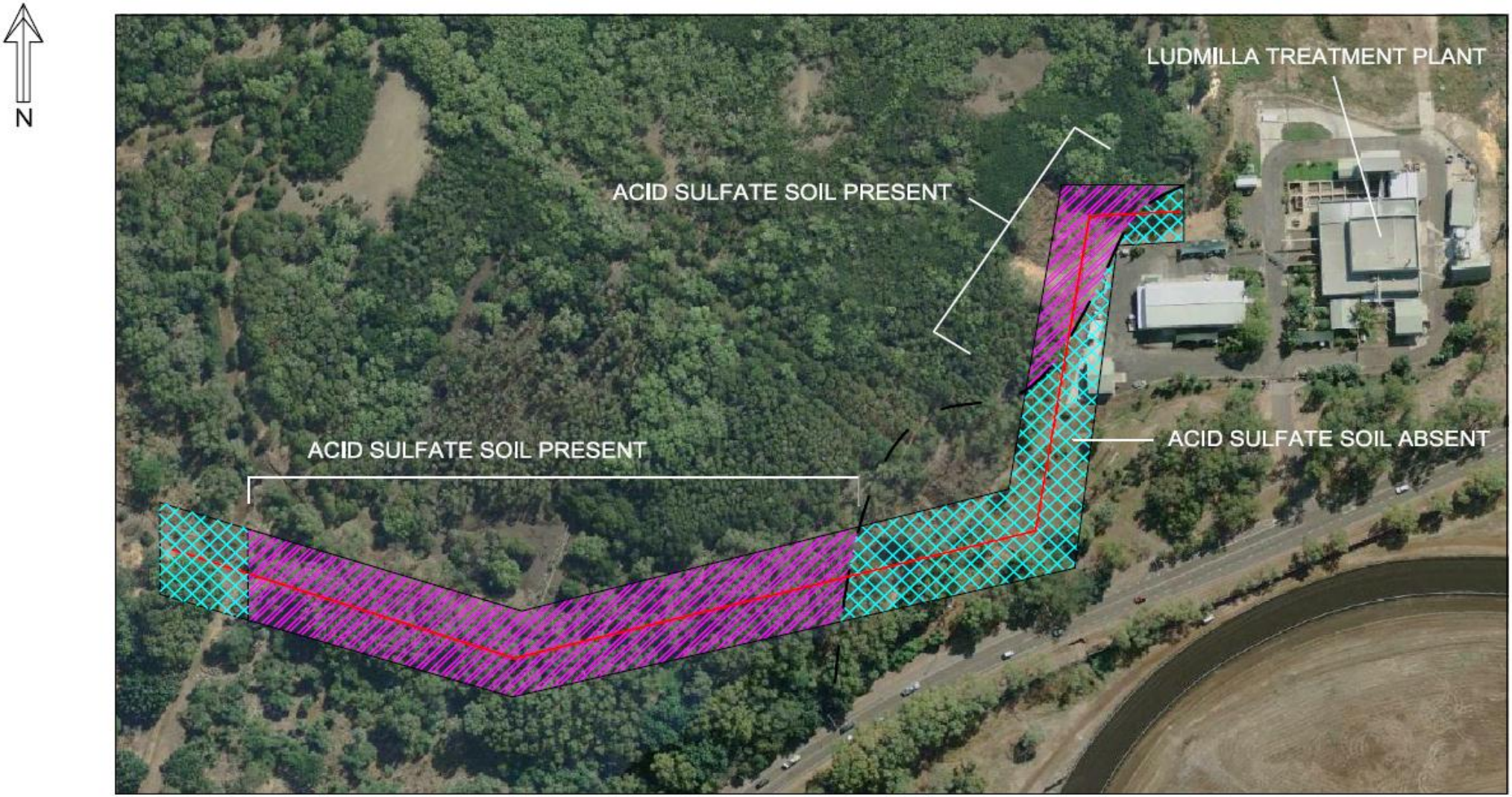


Figure 4-3 Potential occurrence Acid Sulphate Soil in and adjacent to the Project Area



- Acid sulfate soils (ASS) identified at south eastern end of alignment. See original geotechnical investigation by Cardno, dated December 20th 2010
- Acid sulfate investigation undertaken at south eastern end of alignment to determine vertical and lateral extent of ASS. low presence of ASS identified, however treatment will be required if soil disturbances occur. See ASS report by Cardno dated September 13th 2011 for recommendations and and suggested liming rates.
- Above map shows the presence and absence of ASS based on the above reports.

Figure 4-4 Potential occurrence Acid Sulphate Soil in and adjacent to the Project Area

Source: Cardno Ullman and Nolan, 2011

4 Existing Environment

4.2 Biological Environment

4.2.1 Terrestrial ecology

The existing population of flora and fauna was surveyed along Proposed Development corridor during the dry season involving general observational surveys of birds and mammals and the characteristics of the dominant vegetation communities and species. The fauna field surveys were conducted at various times (dawn, throughout the day and evening searches) using binoculars, spotlighting and subsequent identification. Surveys of shore birds focussed on a broader area to provide an assessment of adjacent terrestrial and mangrove habitats.

Full species lists and details of results from field surveys are included in **Appendix F**.

4.2.2 Terrestrial Flora

The vegetation along the Proposed Development corridor is dominated by urban parkland and road clearings. Regrowth vegetation along the Proposed Development corridor is made up of Mixed Species Open Woodlands and small patches and understorey of Coastal Monsoon Vine Forest.

In order to minimise environmental impacts the Proposed Development corridor has been designed to avoid most areas of remnant vegetation. However a small area of remnant vegetation along the alignment comprises Mangrove Forests. As discussed further below, the area of Mangrove Forests are not recognised as being significant and are not known to contain any listed species. The flora survey recorded a total of 76 flora species of which two sensitive / significant vegetation types (*Senna alata* [Candle bush] and *Senna obtusifolia* [Sicklepod]) were identified according to the *Northern Territory Land Clearing Guidelines* (NRETAS, 2010b).

Five terrestrial vegetation communities were identified including Coastal Monsoon Vine Forest, Low to Mid – Mixed Species Closed to Open Forest, Low to Mid – Mixed Species Open Woodland, Mangrove (Mangal) Forest and Urban (Parkland, Development Sites) as described in **Figure 4-5**. Only the Mangrove communities are recognised as sensitive, or significant vegetation, under the *Northern Territory Land Clearing Guidelines* (NRETAS, 2010b) and is not listed as threatened under the *EPBC Act 1999*.

Plate 4-1 to **Plate 4-5** shows examples of the typical vegetation communities encountered along the Proposed Development alignment.

Plate 4-1 Community 1: Coastal Monsoon Vine Forest

4 Existing Environment

Plate 4-2 Community 2: Low to Mid - Mixed Species Closed to Open Forest

Plate 4-3 Community 3: Low to Mid- Mixed Species Open Woodland

4 Existing Environment

Plate 4-4 Community 4: Mangrove (mangal) forest

Plate 4-5 Community 5: Urban (parkland; development sites)

4 Existing Environment

4.2.3 Terrestrial Fauna

The fauna assessment recorded a total of 45 species of native terrestrial bird, mammal and reptile species within the Proposed Development corridor including five mammal species, 36 bird species and four reptile species.

Of these 45 native faunal species, two species listed under the TPWC Act were recorded; *Varanus panoptes* (Yellow-spotted Monitor) and the *Burhinus grallarius* (Bush Stone Curlew) as depicted in **Table 4-3.** The Common Greenshank (*Tringa nubularia)* and the Rainbow Bee-eater, two migratory fauna (terrestrial and marine) species listed under the *EPBC Act 1999,* were recorded under the field surveys. Further, an additional three introduced species, the Cane Toad (*Rhinella marina*), Cat (*Felis catus*) and the Asian House Gecko (*Hemidactylus frenatus*), were recorded within the proposed pipeline area.

A full species list and details of the results of surveys are included in **Appendix F**.

Table 4-3 Listed Threatened Fauna Species / Site Records

Common Name	Scientific Name	*EPBC Act 1999*	*TPWC Act 2000*	Location
Yellow-spotted Monitor	*Varanus panoptes*		Vulnerable	Site 4; Darwin Harbour records from Acer Vaughn (1993).
Bush Stone-curlew	*Burhinus grallarius*		Near Threatened	Site 31 & 30; Darwin Harbour records from Acer Vaughn (1993) & EMS (2011).

Yellow-spotted monitor (Varanus panoptes) Vulnerable TPWC Act 2000

The Yellow-spotted Monitor (*Varanus panoptes*) is classified as vulnerable under the TPWC Act. Declines of this species have been associated with the invasion of the Cane Toad. This species has persisted in the Darwin region following the arrival of the Cane Toad (Smith and Firth, 2003); however it is likely to be present at lower population densities. One individual was recorded as deceased during surveys and located within the Mixed Species Closed Forest. This species has also been recorded in the broader Darwin region (Acer Vaughn, 1993).

Bush Stone-curlew (Burhinus grallarius) Near Threatened TPWC Act 2000

The Bush Stone-curlew (*Burhinus grallarius*) is listed as near threatened the under the TPWC Act. A species qualifies as near threatened when it has been evaluated against criteria but does not qualify as critically endangered, endangered or vulnerable at the time of assessment, but is close to qualifying for, or is likely to qualify for a threatened category in the near future (International Union for the Conservation of Nature [IUCN], 2001).

This species is relatively common in the Darwin region. Several pairs were recorded, however, they are unlikely to represent a significant population. The individuals observed within the bushland and regrowth remnants within the study area were also observed moving into adjacent areas of cleared land, railway yards and parkland (EMS, 2011).

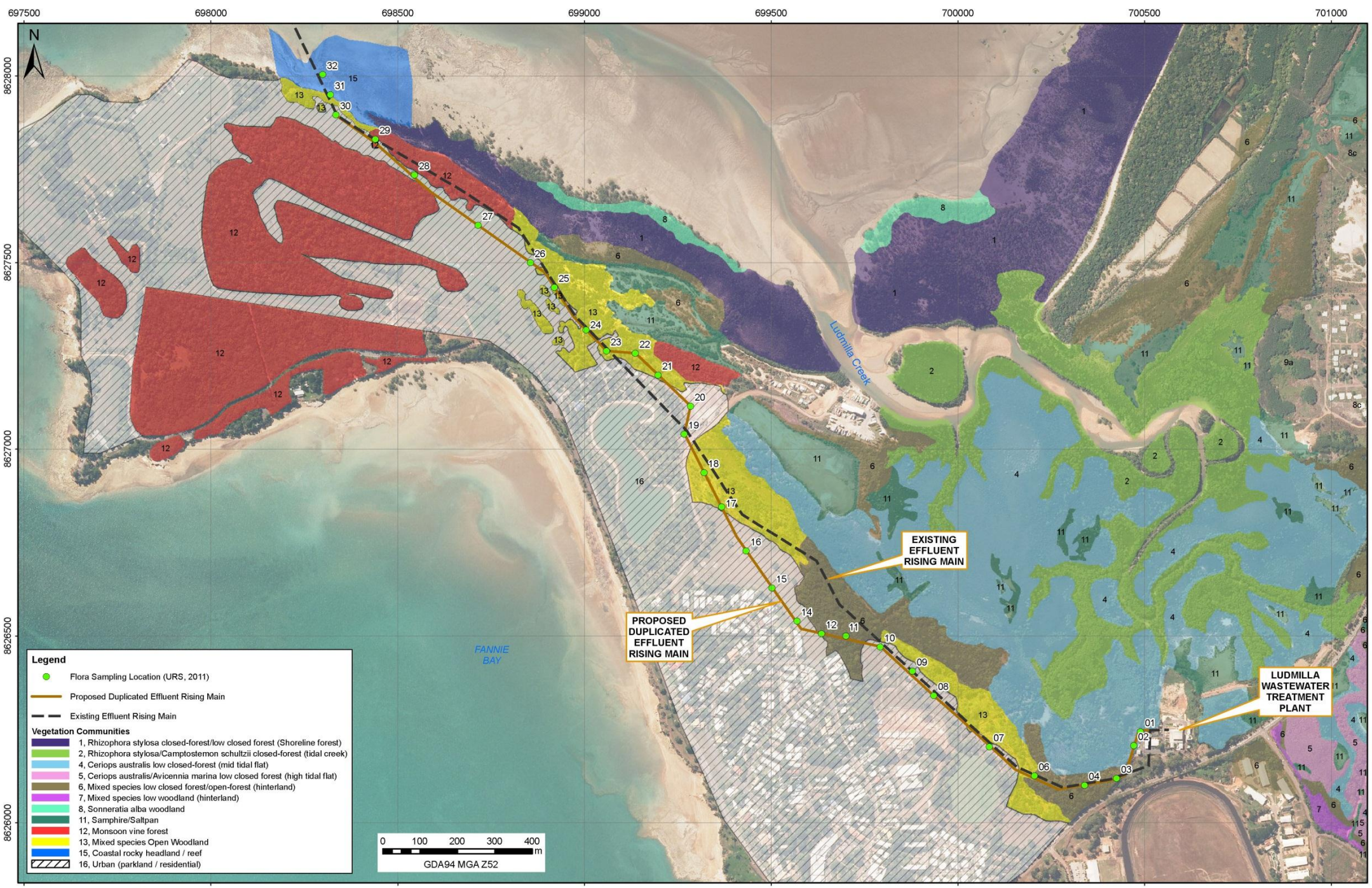


Figure 4-5 Extent of Vegetation Communities at East Point and Ludmilla Creek and the Location of the Proposed Pipeline Corridor

4 Existing Environment

4.2.4 Threatened Flora and Fauna Species Recorded in Surrounding Areas

Results of a review of existing databases and reports listing critically endangered, endangered and vulnerable flora and fauna species recorded in the surrounding areas are included in **Table 4-4**.

The search of the *EPBC Act 1999* protected matter databases for the East Point – Ludmilla Creek area lists eight threatened terrestrial / freshwater species that may occur or have been recorded in the area. In addition, the *EPBC Act 1999* protected matter search lists a range of listed migratory species that potentially occur in the East Point area (SEWPC, 2011). The search of the NTG databases for the area lists fifteen threatened terrestrial / freshwater species that may occur or have been recorded in the area. A copy of this database search is included in **Appendix G**. It is important to note that some of these records of threatened species are historical or are generated from data from the wider region.

In addition to the listed species recorded along the Proposed Development corridor, the Yellow-spotted Monitor and the Bush-stone Curlew, and based on existing data and known habitat preferences, nine threatened fauna species have been identified as potentially occurring in local habitats and are listed in **Table 4-4**.

Table 4-4 Listed Threatened Flora and Fauna Species Recorded in Surrounding Areas

Scientific / Common Name	*EPBC Act 1999*	*TPWC Act 2000*	Data Source	Habitat
Cycas armstrongii		V	1	Grassy Woodland on yellow and red earths, well drained sites
Merten's Water Monitor *Varanus mertensi*		V	1, 5	Swamp forest and riparian habitats
Atlas Moth *Attacus wardii*		E	1	Monsoon Vine Forests and riparian rainforest habitats
Masked Owl *Tyto novaehollandiae kimberli*	V	V	1, 3	Tall Open Forest, Monsoon Vine Forest
Northern Quoll *Dasyurus hallucatus*	E	CE	1, 2, 3, 4, 5	Open Forest and Woodlands
Northern Phascogale *Phascogale pirata*		V	1, 2, 3	Eucalypt Forest and Woodlands
Brush-tailed Rabbit-rat *Conilurus penicillatus*	V	V	2, 3	Open Forests and Woodlands
Bare-rumped Sheath-tailed Bat *Saccolaimus saccolaimus*	CE		1, 3	Tall Open Forest and Woodlands in the coastal lowlands
Water Mouse *Xeromys myoides*	V	DD	2, 3	Mangroves and adjacent vegetation, freshwater wetlands

Conservation Status: CE = Critically Endangered E = Endangered, V = Vulnerable, DD = Data Deficient

Data sources:
1 = NT Government Data/NT NRM Snapshot East Point Darwin, 2011
2 = East Point – Ludmilla Creek EPBC protected matters report, 2011
3 = Baker et al. (2005) Darwin Coastal Bioregional Assessment
4 = East Arm Wharf Precinct EIS (Acer Vaughn, 1993)
5 = Online Zoological Collections of Australian Museums (OZCAM) records

4 Existing Environment

Many of these species are also listed in existing data from the wider area (EMS, 2011; Acer Vaughan, 1993).

Field surveys undertaken in the Darwin region (specifically East Arm Wharf and Darwin Harbour) (Acer Vaughn, 1993; EMS, 2011) recorded additional species which could also potentially occur in the East Point area, including 31 species of birds listed as migratory wetland or migratory / marine species under the *EPBC Act 1999* and 59 bird species classified as marine species under the *EPBC Act 1999*.

None of the fauna species recorded, or likely to occur within the East Point – Ludmilla Creek area, are listed as endemic to the Darwin Coastal bioregion or to the NT in the *Northern Territory Assessment of Key Biodiversity Values and Threats for Bioregions* (Baker et al., 2005).

4.2.5 Migratory and Marine Species

A number of EPBC Act listed migratory species have been recorded within the broader Darwin area, predominantly within the mangroves, saline wetlands (including samphire and salt flat habitat), and the shoreline. The most significant habitats for listed migratory species within the East Point – Ludmilla Creek area are marine habitats and mangrove areas. For example, the Mangrove Forests of Darwin Harbour support highly specialised fauna populations including over 306 invertebrate species and 112 species of mammals, bats and birds (Metcalfe, 2007). Noske (1996) established that the north-western Australian Mangrove Forests have distinct faunal assemblages and support more mangrove-endemic bird species than any other region in the world.

Darwin Harbour has not been found to support nationally or internationally significant numbers of migratory shorebirds or wetland birds (Chatto, 2003; Harrison et al., 2009). However, the area does support locally significant numbers of some migratory shorebirds. Acer Vaughan (1993) reported that significant numbers of migratory birds were known to roost on off-shore islands, including South Shell Island. However, few birds were observed on these islands during the 2010 - 2011 surveys conducted by EMS in the same area (2011).

In addition, the *EPBC Act 1999* Protected Matters Report (June 2011) lists 52 migratory species that are known to occur or potentially occur in the East Point area (SEWPC, 2011). Presented in **Appendix F** are the migratory terrestrial, marine and wetland species for the East Point area and surrounding area. **Appendix F** also presents the maximum count of individuals recorded in the recent survey at East Arm Wharf (EMS, 2011).

Whilst small numbers of migratory terrestrial, marine and wetland species were recorded, populations are known to occur in the bioregion and make use of habitat through foraging, roosting and nesting. It is likely that EPBC Act listed migratory terrestrial, marine and wetland species utilise the East Point Peninsula, however the East Point area alone is unlikely to support significant numbers of populations and the area of disturbance is not considered likely to impact significantly on migratory and marine species habitats.

4 Existing Environment

4.2.6 Habitat Connectivity

The natural elements of the East Point Peninsula are isolated and are poorly connected to the broader region other than the coastal areas. Assessment of aerial photography found that:

- A narrow band of Monsoon Vine Forest is located adjacent to the proposed corridor. This area is within the vicinity of the significant remnant Monsoon Vine Forest at East Point but is bordered by urban parklands and tracks.
- The mangrove vegetation located on the northern side of the East Point Peninsula is connected to larger tracts of remnant mangrove habitat to the north east, and in particular the Ludmilla Creek area.
- The Mixed Species Closed Forest occurs in small isolated patches abutting Mangrove Forests and the urban (residential) areas.
- The Mixed Species Open Woodland area is made up of regrowth and revegetation and is patchily distributed throughout the area.

The vegetation communities of the East Point and Ludmilla Creek area are fragmented by managed urban parkland, roads and the residential area of Fannie Bay. Ecological corridors other than for mangrove forests are non-existent.

4.2.7 Significance of Vegetation Communities

None of the vegetation communities mapped in the study area are listed as threatened under the EPBC Act. However, two vegetation community types recorded in the study area are regarded as sensitive, or significant vegetation, according to the *Northern Territory Land Clearing Guidelines* (NRETAS, 2010b). These include the patches of Coastal Monsoon Vine Forest and the Mangrove Forest and are discussed further below. The habitat values of the Mixed Species Open Woodland and open woodland habitat are also discussed below.

Coastal Monsoon Vine Forest Habitat

The Proposed Development corridor will traverse very small areas of regrowth Coastal Monsoon Vine Forest covering approximately 0.632 ha. Franklin et al. (2010) identified the narrow band of Monsoon Vine Forest, located adjacent to the proposed pipeline corridor, as predominantly self-seeded regrowth with supplementary plantings at the eastern end. This area is within the vicinity of the significant remnant Monsoon Vine Forest at East Point however remains floristically simplified and has been contained by ongoing management of the East Point Reserve such as slashing. This vegetation community is a modified coastal rainforest community. Naturalised exotic trees are present with some enrichment planting of local native species.

The overall area of Monsoon Vine Forests located within or adjacent to the Proposed Development corridor is very small and the community is bordered by managed urban parkland, management tracks and the Model Aeroplane Club grounds. Whilst this vegetation community is unlikely to be providing significant habitat for wildlife, it is an important component of the East Point Reserve as a refuge for local fauna populations such as the Agile Wallaby and Rainbow Pitta *(Pitta iris)* in the greater landscape matrix (Franklin et al., 2010).

4 Existing Environment

The conservation status of the Agile Wallaby *(Macropus agilus)* under Commonwealth and NT legislation is 'Least Concern'. However, it is noted that DCC has been managing the Agile Wallaby population at East Point Reserve to ensure their long term conservation since 1989. The management program aims to maintain a viable population of Agile Wallabies at East Point by maintaining and enhancing the habitat, reducing threats to the population, monitoring the population and raising public awareness of the Agile Wallaby (DCC, undated).

Mangrove / Saline Wetland Habitats

Mangrove and salt marsh / saline wetland habitats within and surrounding the Proposed Development corridor support a number of listed migratory marine birds and shorebirds. Under EPBC significance criteria (SEWPAC[3], 2009) the larger Ludmilla Creek mangrove areas qualify as important habitat for migratory species listed under the *EPBC Act 1999*. These areas also support a range of other mangrove specialist fauna species (Noske, 1996; Clay and Andersen 1996).

A very small area of *Ceriops tagal* Mangrove Forest is likely to be impacted by the pipeline development and the area of impact will be limited to the edge of this vegetation community. The impacts on terrestrial vegetation and habitat are likely to be lessened because of this, as it is likely that core areas of Mangrove Forest that will not be impacted by the pipeline, are of greater significance for wildlife (Noske, 1996; Clay and Andersen, 1996).

Additionally the mangrove habitats directly adjacent to the existing sewage rising main, Ludmilla Waste Treatment Plant and urban areas are already impacted to some degree by edge effects associated with the land uses including drainage, sedimentation, noise and artificial light. Despite these impacts, the area continues to support a suite of mangrove and wetland specialist fauna species, including small numbers of listed migratory shorebirds (Noske 1996; Clay and Andersen, 1996; EMS, 2011).

Mixed Species Open Forest and Open Woodland Habitats

The Proposed Development corridor passes through an area of Mixed Species Open Forest and patches of Mixed Species Open Woodland regrowth and revegetation. These vegetation communities are in poor ecological condition. They are generally disturbed with evidence of weeds and impacts from adjacent urban land uses. Whilst these vegetation communities are unlikely to provide significant habitat for wildlife, the habitat value of these areas is similar to the Monsoon Vine Forest described above, that is, they are an important refuge for local fauna and threatened fauna such as the Yellow-spotted Monitor, to allow them to persist in the greater landscape matrix.

4.2.8 Declared Weeds and Other Naturalised Species

Fifteen naturalised flora species were recorded in the study area. Ten of these species are declared weeds listed in the *Weeds Management Act*, *2001*. Recorded naturalised and weed species are presented in **Table 4-5.**

It is noted that PWCs *Land Management Procedure* (2008) includes weed management strategies such as prevention of weed spread through weed hygiene practices, weed assessment and weed control. Additionally DCC have drafted an *East Point Reserve Weed Management Plan* (2010) to aid in the identification and prioritisation of weed management objectives. Weed treatment by DCC of *Pennisetum polystachion* (Mission Grass) was evident (herbicide spraying) along the proposed pipeline.

[3] Formally the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA).

4 Existing Environment

Table 4-5 Weed Species Recorded along the Proposed Development Corridor and their Classification under the *Weeds Management Act 2001* (NT)

Weed species	*Weeds Management Act 2001* (NT) Classification
Alternanthera sp. Alligator weed; Purple Alligator weed	Class A (to be eradicated) and Class C (not to be introduced to the NT)
Chloris barbata Purple-top Chloris	NA
Delonix regia Poinciana	NA
Hyptis suavelons Hyptis; Horehound	Class B (spread to be controlled) and Class C (not to be introduced to the NT)
Leucaena leucocephala Lead tree; Coffee bush; Leucaena	NA
Mimosa pigra Giant Sensitive Tree	Class B (spread to be controlled) and Class C (not to be introduced to the NT)
Passiflora foetida Stinking Passion Flower	NA
Pennisetum polystachion Mission Grass	Class B (spread to be controlled) and Class C (not to be introduced to the NT)
Senna alata Candlebush	Class B (spread to be controlled) and Class C (not to be introduced to the NT)
Senna obtusifolia Coffee Bush	Class B (spread to be controlled) and Class C (not to be introduced to the NT)
Senna occidentalis Coffee Senna	Class B (spread to be controlled) and Class C (not to be introduced to the NT)
Spathodea campanulata African Tulip Tree	NA
Tribulus terrestris Caltrop	Class B (spread to be controlled) and Class C (not to be introduced to the NT)
Ziziphus mauritiana Chinee Apple	Class B (spread to be controlled) and Class C (not to be introduced to the NT)

4 Existing Environment

4.3 Biting insects

4.3.1 Background

Mosquitoes are a serious potential public health issue in the NT, both as pest insects and as vectors of a number of human diseases including the potentially fatal disease Murray Valley encephalitis virus (MVEV) and a number of other diseases caused by Ross River Virus (RRV), Barmah Forest virus (BFV), and Kunjin virus (KUNV) (Warchot and Whelan, 2011).

Coastal areas, and especially Mangroves, provide attractive habitat for many species of biting insects. Construction activities in or adjacent to tidal areas can potentially increase the number of biting insect breeding sites (CMC, 1988).

Some ground depressions at East Point, including Lake Alexander, breed salt marsh mosquitoes (*Aedes vigilax*) and the common banded mosquito (*Culex annulirostris*) during the wet season. Biting midges (*Culicoides ornatus*) are also present at East Point. Almost all of the mosquito breeding sites in the East Point area are man-made.

Historic breeding sites are also associated with:

- Landscaping (filling, revegetation and associated mulching), vehicle activity and storage of mulch around East Point
- Poor profiling of land surrounding Lake Alexander during landscaping of the lake surrounds.
- The old East Point golf course.

Many mosquito breeding sites have been rectified over the years, but a large number still exist and nearby residents are subject to seasonal mosquito problems when control operations fail to target all sites.

Because of the potential for biting insect problems in the area, the NTG operates a biting insect control program at East Point and Ludmilla, targeting higher risk locations. The biting insect routine control sites in the vicinity of the Proposed Development corridor are shown in **Figure 4-6**.

The presence of existing productive mosquito breeding sites indicates future development has the potential to create new mosquito breeding sites. Development also has the opportunity to rectify existing mosquito breeding sites, however. Rectification of existing mosquito breeding sites will be of benefit to residents, workers, and other visitors to the East Point area, by reducing pest problems and the risk of mosquito borne disease transmission (Warchot and Whelan, 2011).

4.3.2 Potential Human Health Impacts from Biting Insects

Biting insects have the potential to affect the health of workers and members of the public through the transmission of Mosquito borne diseases or reactions to bites. The Proposed Development has the potential to create additional mosquito habitats and hence increase mosquito populations.

The mangrove biting midge *C. ornatus* breeds in mud adjacent to and under dense mangrove canopies (Warchot and Whelan, 2011). *Culicoides ornatus* is considered the most significant human pest biting midge species around coastal areas of the NT (Shivas, 1999; Shivas & Whelan, 2001), and is also the most common biting midge pest around coastal areas of the NT (Whelan, 2003).

Key midge breeding sites include the upper tidal tributaries of mangrove creeks around the mean high water neap tide mark, associated with pneumatophores of the mangrove species *Avicennia marina*, with highest productivity during the mid to late dry season (Shivas, 1999).

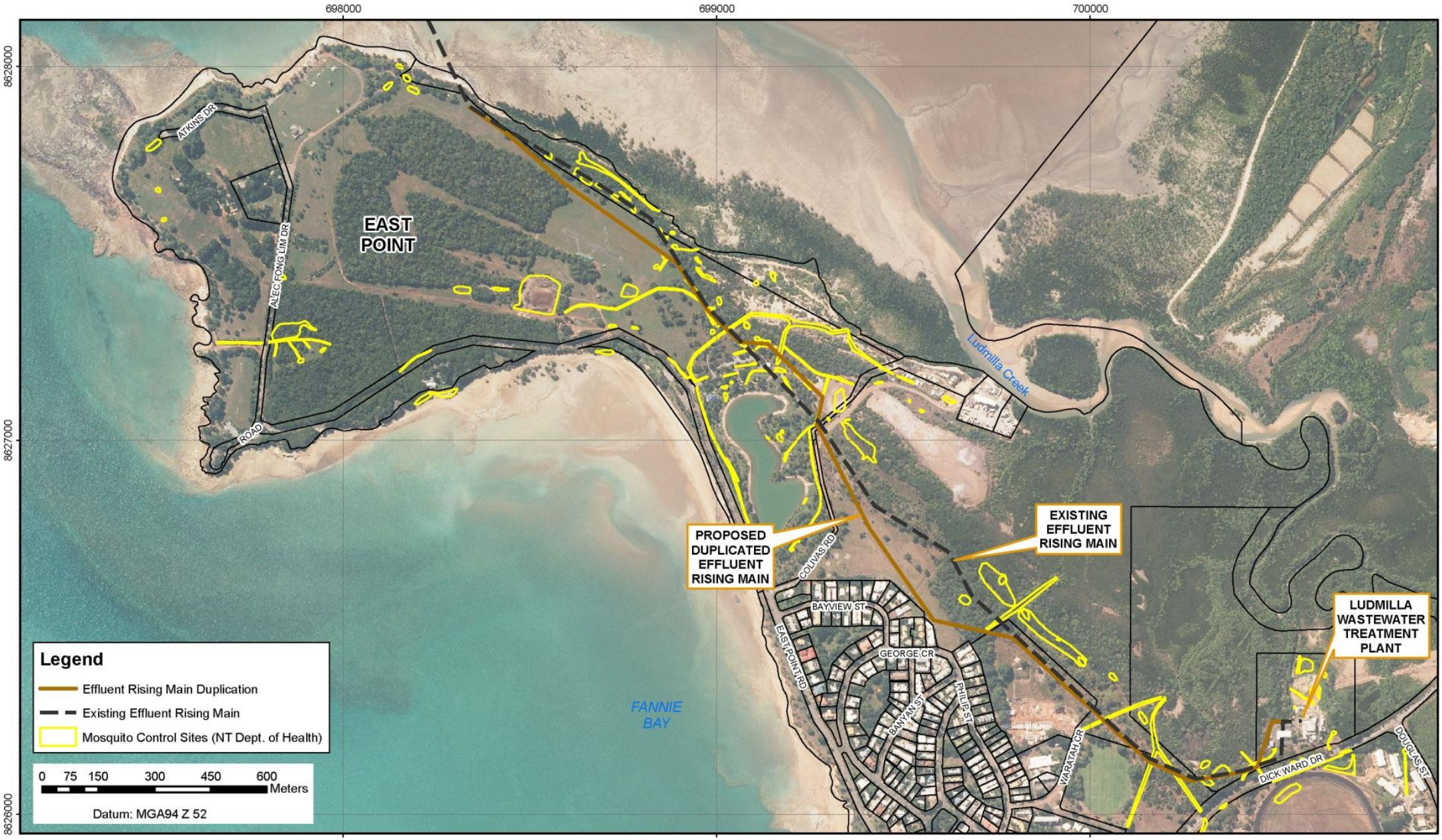


Figure 4-6 Routine Mosquito Control Sites at East Point / Ludmilla

Source: NTG, 2010

4 Existing Environment

Other breeding sites of low to medium productivity occur at the front edge of the mangrove forest in the *Sonneratia* or woodland mangrove zone facing open water (Shivas, 1999). These breeding sites are usually associated with mud substrates (Shivas, 1999). It is not envisaged that the Proposed Development will result in any increases in mangrove areas and therefore impacts associated with increased Biting Midge populations are not likely. The typical characteristics of the two major mosquito species at East Point, *Ae. vigilax* and *C. annulirostris*, are discussed below.

Aedes vigilax

Ae. vigilax, also known as the northern salt marsh mosquito, typical breeding sites include salt marshes, brackish water reed swamps, coastal inter-dune depressions, poorly draining upper tidal mangrove areas, tidally affected stormwater drains and disturbed upper tidal areas (Whelan, 1997a). Breeding sites at East Point include depressions on reclaimed and disturbed land, sediment ponds and shallow mud ponds, stormwater drains subject to tide influence and upper tidal depressions. *Ae. vigilax* is most abundant from September to January. It has a very long flight range, capable of flying up to 200 km, although highest numbers are usually encountered within 5 km of breeding sites (Whelan, 1997a). *Ae. vigilax* will be the most important pest mosquito affecting East Point as it is an aggressive biter and will bite during the daytime in shaded areas, as well as at night, and is usually the cause of most of the mosquito pest problems in Urban Darwin and Palmerston.

Culex annulirostris

C. annulirostris', also known as common banded mosquito, potential breeding areas include all shallow ponding areas with grass and/or semi-aquatic reeds, drains with semi-aquatic vegetation, and mud ponds and sediment ponds with semi-aquatic vegetation. *C. annulirostris* is most abundant from January to August, in which period there typically are two peaks in abundance, a short early/mid wet season peak and an extended late wet-mid dry season peak, depending on the characteristics of nearby breeding sites. At East Point, this species will be most common from January to April (Whelan, 1997). *C. annulirostris* can disperse up to 10 km from extensive breeding sites, although it is most common within 4 km of breeding sites (Whelan, 1997), and there is usually a significant drop in numbers 2 km away from significant breeding sites (Whelan, 2004). The species only bites after sundown at night, and is less aggressive than *Ae. vigilax*.

4.3.3 Vector Transmitted Arboviral Diseases

Viruses can be spread to people by arthropods, such as mosquitoes and ticks, and cause Arborviral (short for arthropod-borne) infections. The most common arboviral disease in Australia and the NT is RRV (Russell and Kay, 2004; Whelan et al., 2008). Symptoms of BFV are similar to RRV, but are generally milder and BFV is not as common as RRV (Centre for Disease Control (CDC), 2009). The principal vectors *Ae. vigilax*, *Cx. annulirostris* are present at East Point. Risk of RRV and BFV transmission associated with Ae. Vigilax is likely to be greatest in December and January. *Culex annulirostris* is likely to pose greatest risk during the wet season months of January to April (Warchot and Whelan, 2011). Main risk months for BFV transmission are likely October to July, with a peak in January to March, although transmission can occur during all months (Whelan, 1997b).

The principal potential vector of MVEV present at East Point is *Cx. annulirostris*. The highest risk months for MVEV transmission are January to July with a peak in March to May (Whelan, 1997b).

4 Existing Environment

Kunjin Virus (KUNV) can potentially cause a fatal inflammation of the brain, but is much rarer than with MVE disease, and has not been responsible for fatalities in the NT (Russell and Kay, 2004).

Endemic malaria is no longer present in the Northern Territory, but there is a risk of limited local transmission from people returning from overseas countries with malaria. It is highly unlikely that local malaria transmission will occur in the Proposed Development area, as long as prevention measures remain in place and new Anopheles species breeding sites are not created by development (Warchot and Whelan, 2011).

The highest pest problems will be encountered in areas within 1.5 km of the nearest mangrove margin. Peak season problems will occur from August to November, with lesser pest problems likely during all other months (Warchot and Whelan, 2011). Peak biting times for C. ornatus are in the two hours either side of sunset and sunrise (Whelan, 2003). This species also bites at relatively low numbers throughout the night (Logan et al., 1991).

4.4 Built Environment

Ludmilla WWTP is distant from residential areas with the closest dwellings some 400 m away to the southeast. The closest residential properties along the Proposed Development corridor are located within the suburb of Fannie Bay, on George Crescent, Phillip Street and Bayview Street, the latter 20 m southwest of the Proposed Development duplication corridor. The only dwelling in the East Point Recreational Reserve is the East Point Military Museum at the tip of the peninsula.

4.4.1 Existing Adjacent Land-uses

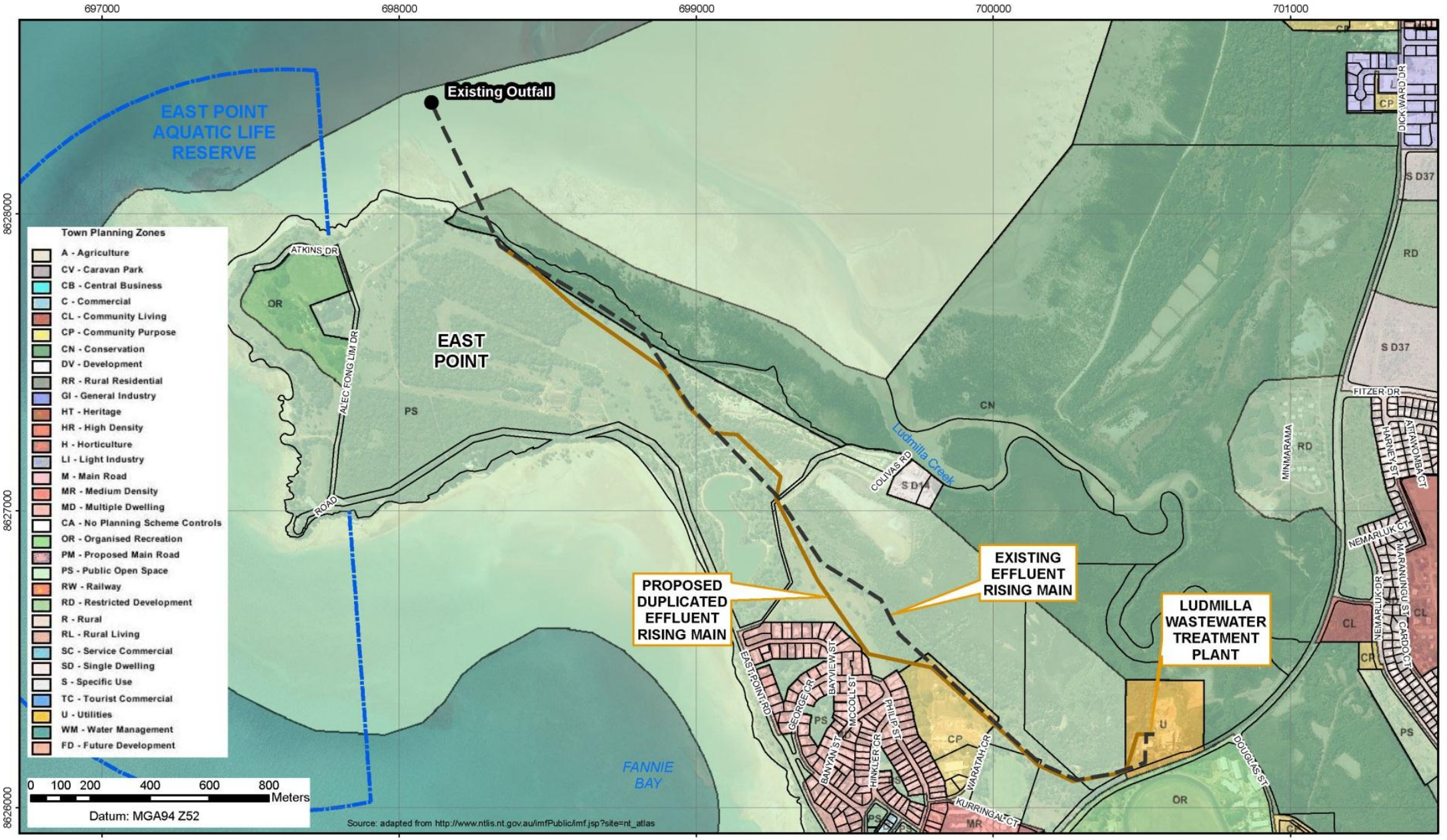
Land ownership rests to a large extent with DCC, a variety of stakeholders and leaseholders, including the Fannie Bay Equestrian Club, Larrakia Nation Aboriginal Corporation, Royal Australian Artillery Association, Pee Wee's at the Point, East Point Aero modellers Club and the NT Government. The northern coastal strip of mangrove habitat is vacant Crown land (DCC, 2009a, DCC 2009b). DCC divided the city into various Environmental Management Units (EMU). The proposed project will extend through EMU's 10 and 11, which are described as (DCC, 2009a, DCC 2009b):

- The East Point/Dudley Point Environmental Management Unit (EMU 10) are essentially dedicated to conservation and recreational activities. There is no residential or industrial estate within the boundaries of EMU 10 which includes the East Point recreation reserve, the military museum, Fannie Bay equestrian club and aero-modellers club.
- The Ludmilla Creek/ Fannie Bay North Environmental Management Unit (EMU 11) includes the suburbs of Fannie Bay, Parap, The Narrows and part of Ludmilla, the Fannie Bay Racecourse, the Darwin Turf Club, Lake Alexander and the Arafura Life Saving Club.

Land uses through which the Proposed Development will extend include:

- Public Space (PS) for recreational purposes, including the East Point Reserve
- Community Purpose (CP), an area used for sporting events including the Arafura Games
- Utilities (U) where the duplicate effluent rising main will connect to the Ludmilla WWTP.

Land-use in the vicinity of the Proposed Development is shown in **Figure 4-7**. The East Point reserve, Ludmilla Creek and Racecourse creek are popular fishing spots for Darwin residents. Depending on the time of year, pelagic fish and barramundi can be caught from the shore.



PowerWater

LANDUSE AT SITE OF PROPOSED DEVELOPMENT AND SURROUNDING AREA

Figure 4-7 Land-use Figure

4.4.2 Road Network and Traffic

Construction of the Proposed Development is expected to take approximately 12 weeks, during the dry season. Construction vehicles will likely access the development via Waratah Cres, George Cres, Colivas Road, Alex Fong Lim Drive and a service road of Alec Fong Lim Drive leading to the Darwin Model Flying Club (see **Figure 4-8**). The Proposed Development corridor also intersects Colivas Road (see **Plate 4-6**).

Plate 4-6 Colivas Road Interaction with the Proposed Development

DCC developed a bicycle track (a 4m wide bitumen track) along the East Point foreshore and within the East Point Reserve. The development corridor will require removal of sections along this track. **Plate 4-7** provides a typical section of the bicycle track.

Plate 4-7 East Point Reserve Bicycle Track

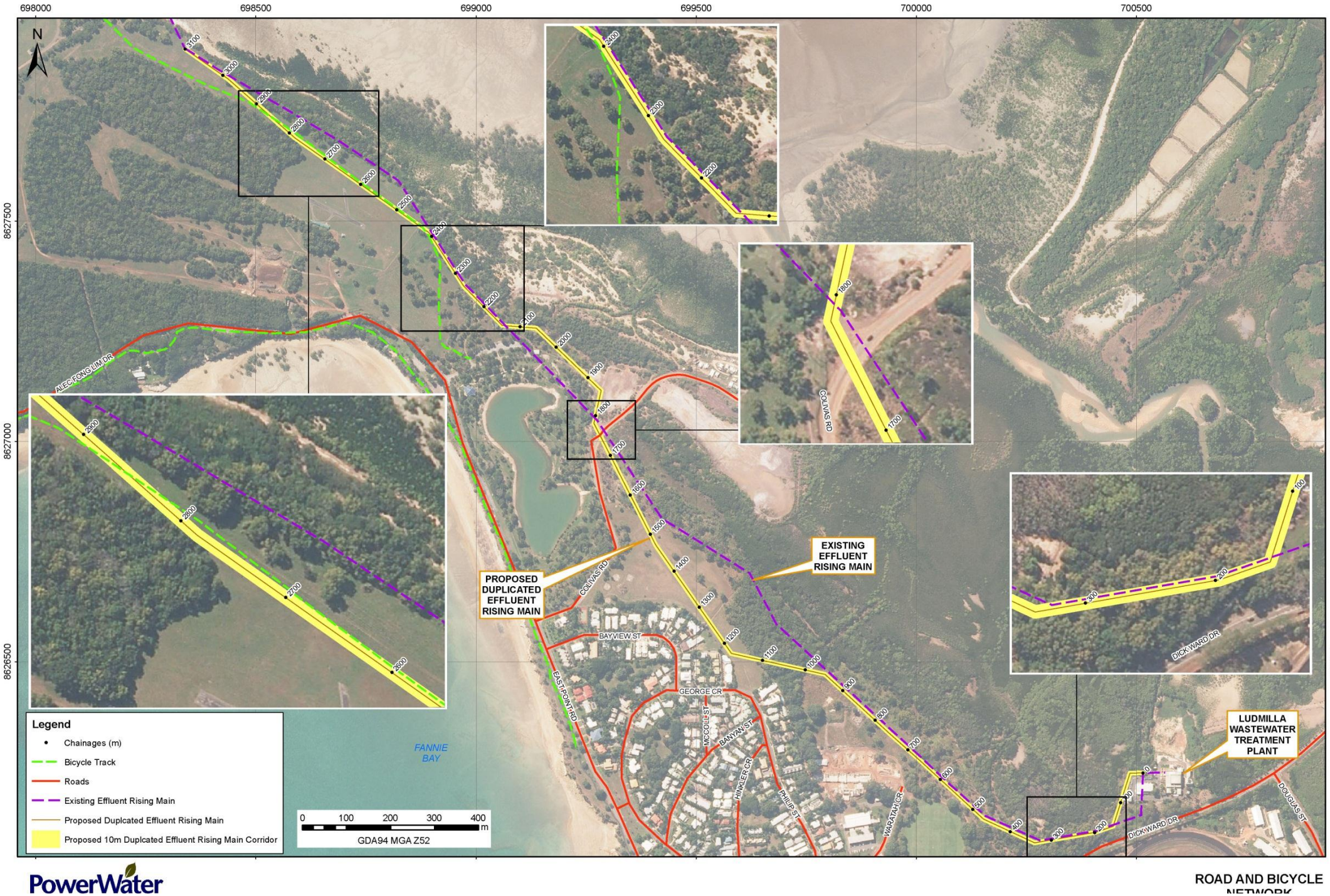


Figure 4-8 Road Network Supporting the Proposed Development

4.5 Socio-economic Environment

The Northern Territory's Gross State Product at around $9.1 billion accounts for around 1.3% of Australia's Gross Domestic Product. The economic structure of the Northern Territory economy is significantly different to that of Australia generally (URS, 2004a). Key points include:

- A higher proportion of public and defence spending.
- The significant contribution of the mining sector.
- The significance of tourism for the Darwin and Northern Territory economies, and to employment.
- The traditional role of construction as an important economic driver.
- The very small manufacturing sector compared with the rest of Australia.
- The higher proportion of public housing and private rented accommodation than the rest of Australia.
- Lower Consumer Price Index increases in Darwin over recent years than in other capital cities.

Tourism contributes an estimated 6.8% of the Northern Territory's Gross State Product, and more than 11% of wage and salary earners (compared with 7.1% nationally). In the longer-term, the Territory's economic development is likely to be influenced by the Timor Sea gas development and on-shore processing, by the development of Darwin's port and the operation of the recently-opened Adelaide to Darwin railway. These developments offer potential for significant economic stimulus through the establishment of new industries and improved communications with Asia and the rest of Australia.

4.5.1 Employment

The Northern Territory's workforce profile is significantly different to that of the national as a whole, being typically younger, more mobile and transient – and highly responsive to changes in economic conditions and employment opportunities. The dynamic nature of the Territory's labour force is reportedly reflected in high staff turnover and consequent significant costs to business in recruitment, training and the retention of valuable skills and expertise (URS, 2004a).

It is anticipated that construction of the Proposed Development will employ some ten people for a 12 week period, either directly involved in construction or auxiliary services. Once completed minimal labour will be required for maintenance and operation of the Proposed Development, which will likely be sourced from the Ludmilla WWTP operated by PWC.

4.5.2 Community Attitudes

Interviews with key local government, environmental and community stakeholders identified the following broad range of views on the Proposed Development.

- Closure of the Larrakeyah outfall were considered a priority for most stakeholders, citing a belief that closure of the Larrakeyah outfall would have a positive environmental outcome
- Construction may cause impacts from increased noise, traffic and disturbance
- The development corridor would impact on recently rehabilitated areas along Colivas Road
- A section of the East Point bicycle track would be removed and would impact on recreational activities at East Point
- Some scepticism was raised about proposed EPO extension project, with stakeholders inquiring on the Proponents commitment to proceeding with the project.

The stakeholder and community consultation program is further discussed under **Section 8, Public Involvement and Consultation**.

4 Existing Environment

4.5.3 Cultural Heritage

Archaeology and Aboriginal Cultural Heritage

A survey of the cultural environment was undertaken to evaluate the presence of archaeological significant sites, Aboriginal heritage sites and European heritage sites along the Proposed Development corridor (see **Appendix H**).

According to Sullivan and Bowdler (1984) archaeological significance means that it has scientific, archaeological or research value. That is, it has the potential to assist current or future research into problems of human history or other areas of enquiry.

The significance of a site is firstly related to the intactness or integrity of a site, hence the state of preservation, as well as the stratigraphic reliability of the cultural material. Secondly, the representativeness of a site is important either because a site is unusual, or because the site has research potential, when taken in conjunction with other sites. Thirdly, a site may provide chronology extending back into the past (Crassweller, 2009).

There are five types of Aboriginal cultural heritage sites previously recorded in this area of the Northern Territory and can broadly be defined as follows:

- Artefact scatters may contain flaked or ground artefacts and hearthstones. They occur as surface scatters of materials, or as stratified deposits, when there have been repeated occupations.
- Stone arrangements can range from simple cairn to more elaborate arrangements. These stone arrangements were used in ceremonial activities and represent sacred or totemic sites. Other stone arrangements were constructed for route or territory markers, the walls of huts, fish traps or small walls to stop water from entering a rock shelter or retain the floor.
- Rockshelter sites contain a deposit of cultural material that has built up over time and contain flaked or ground stone artefacts, faunal material and other Aboriginal cultural remains.
- Stone quarries are generally sites where stone for flaked or edge ground artefacts have been extracted from an outcropping source of rock.
- Knapping sites are discrete scatters of artefacts consisting of the remains of a single reduction event associated with the fabrication of implements. There are no archaeological sites listed for the survey area on the Archaeological Site Register at the Heritage Conservation Services. The nearest recorded site is a stone fish trap located approximately one kilometre northeast of the proposed rising main.

The survey of the corridor along the Proposed Development on land did not identify any archaeological material (Crassweller, 2009).

An application to the Aboriginal Area Protection Authority (AAPA) for authorisation of the expansion of the WWTP and sewage pumping station were obtained by PWC. The AAPA certificates are attached as **Appendix I**.

4 Existing Environment

European Cultural Heritage

The East Point peninsula contains the East Point Military Reserve, which was the first fixed defences of Darwin, built in 1932-34 to protect the naval oil depot. It is a declared heritage place listed on the Northern Territory Heritage register and is thus protected under the *NT Heritage Conservation Act* (1991).

The East Point Fortifications are valued for their social associations with the events of World War II in Northern Australia. The military facilities at East Point were further developed in the late 1930s as a response to the Japanese threat. They were one of the targets in Japanese air raids on Darwin (the first international armed conflict on Australian soil) which commenced on 19 February 1942 (NRETAS, 2011b).

The site has a variety of remains demonstrating the complexity of a defence installation of the WWII period. The closest World War II (WWII) feature of the Singapore Post located on a rocky ridge at the edge of the coast line and is approximately 50 m east of the proposed alignment. The next closest WWII feature is the remains of the Ack-ack Battery (see **Plate 4-6**) near Colivas Road. This is approximately 70 m west of the proposed alignment and has signage to draw attention to its presence. The area around the Radio Complex Precinct is protected by an existing fence (Crassweller, 2009).

Plate 4-8 Ack-Ack Battery

No archaeological sites, or objects, were located during the survey on land. None of the features in the East Point Military Precinct, which is a protected Registered Heritage Site, will be disturbed by the project. The features in proximity of the Proposed Development corridor are highly unlikely to be disturbed by the project as they are either behind an existing fence or are well signed and very visible. The closest WWII feature of the Singapore Post located on a rocky ridge at the edge of the coast line and is approximately 50 m east of the proposed alignment (Crassweller, 2009).

Figure 4-9 shows existing areas cultural heritage significance in relation to the Proposed Development Corridor.

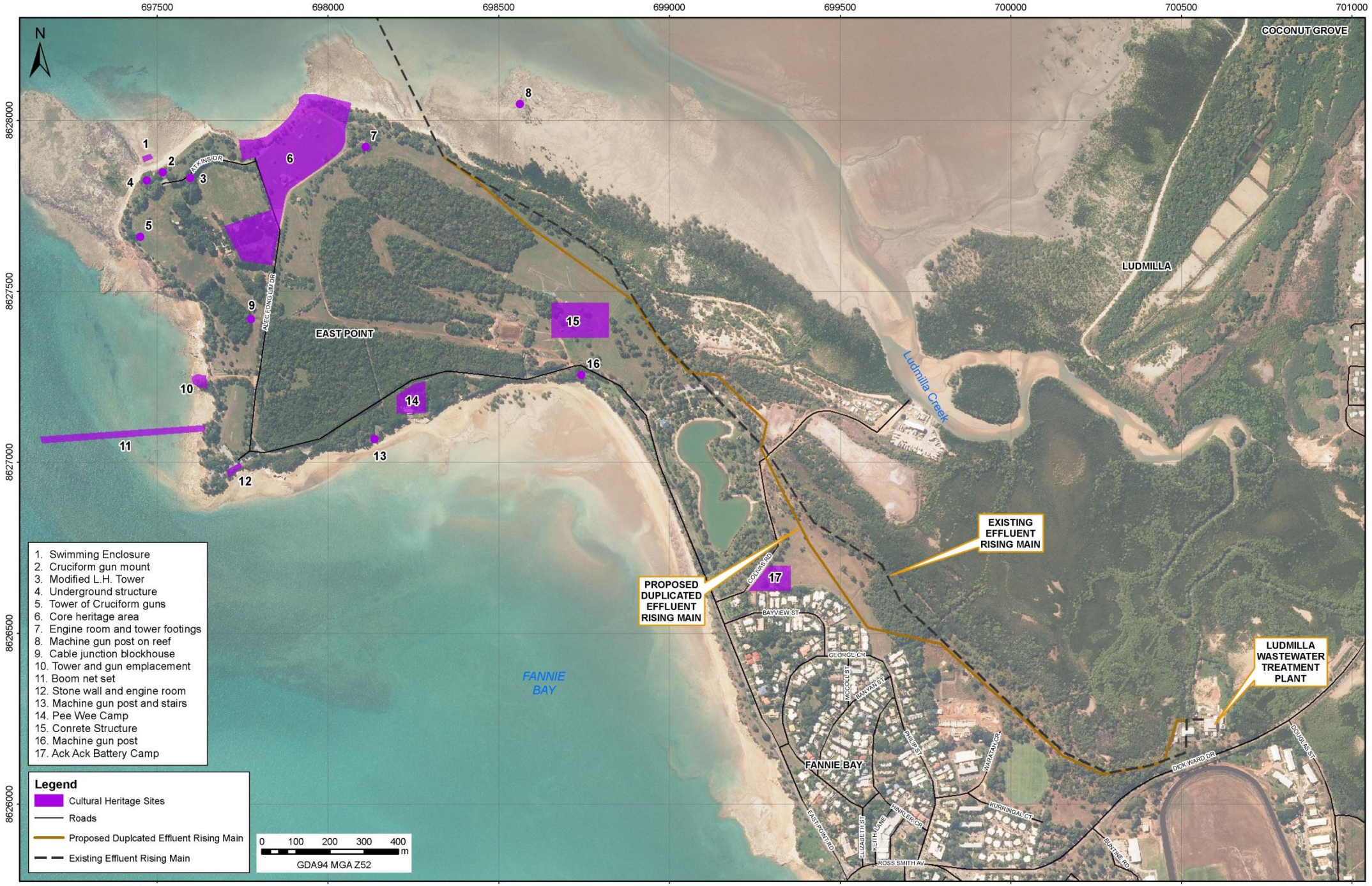


Figure 4-9 Areas of Cultural Heritage