Architecture
Interior Design
Landscape Architecture
Planning
Urban Design

Australia
China
Hong Kong SAR
Singapore
Thailand
United Kingdom

SOUTH FREMANTLE POWER STATION MASTER PLAN

APPENDICES

Prepared for LandCorp
10 July 2014

HASSELL

1/P17373	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	29/7/2006

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1878 FOLIO 135

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 1 ON PLAN 17373

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ELECTRICITY NETWORKS CORPORATION OF 363-365 WELLINGTON STREET, PERTH
(AN J789512) REGISTERED 16 JUNE 2006

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

--END OF CERTIFICATE OF TITLE--

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1878-135 (1/P17373).
PREVIOUS TITLE: 1878-134.
PROPERTY STREET ADDRESS: LOT 1 ROBB RD, NORTH COOGEE.
LOCAL GOVERNMENT AREA: CITY OF COCKBURN.
RESPONSIBLE AGENCY: ELECTRICITY NETWORKS CORPORATION.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Mar 14 07:57:06 2014 JOB 44169731

Landgate
www.landgate.wa.gov.au

2/P17373	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	15/2/2007

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1878 FOLIO 136

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

Subject to Dealing

LAND DESCRIPTION:

LOT 2 ON PLAN 17373

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ELECTRICITY GENERATION CORPORATION OF LEVEL 11, 15-17 WILLIAM STREET, PERTH
(AN K046057) REGISTERED 5 JANUARY 2007

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

--END OF CERTIFICATE OF TITLE--

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1878-136 (2/P17373).
PREVIOUS TITLE: 1878-134.
PROPERTY STREET ADDRESS: LOT 2 ROBB RD, NORTH COOGEE.
LOCAL GOVERNMENT AREA: CITY OF COCKBURN.
RESPONSIBLE AGENCY: ELECTRICITY GENERATION CORPORATION.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Mar 14 07:57:06 2014 JOB 44169731

*** SUBJECT TO DEALING *** *** SUBJECT TO DEALING ***

Landgate
www.landgate.wa.gov.au

3/P17373

DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	15/2/2007

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1878 FOLIO 137

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

Subject to Dealing

LAND DESCRIPTION:

LOT 3 ON PLAN 17373

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ELECTRICITY GENERATION CORPORATION OF LEVEL 11, 15-17 WILLIAM STREET, PERTH
(AN K046057) REGISTERED 5 JANUARY 2007

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. *I270505 MEMORIAL. HERITAGE OF WESTERN AUSTRALIA ACT 1990. LODGED 21.10.2002.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

--END OF CERTIFICATE OF TITLE--

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1878-137 (3/P17373).
PREVIOUS TITLE: 1878-134.
PROPERTY STREET ADDRESS: LOT 3 ROBB RD, NORTH COOGEE.
LOCAL GOVERNMENT AREA: CITY OF COCKBURN.
RESPONSIBLE AGENCY: ELECTRICITY GENERATION CORPORATION.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Mar 14 07:57:06 2014 JOB 44169731

*** SUBJECT TO DEALING *** *** SUBJECT TO DEALING ***

Landgate
www.landgate.wa.gov.au

2161/DP35641

DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

WESTERN AUSTRALIA

RECORD OF CERTIFICATE
OF
CROWN LAND TITLE
UNDER THE TRANSFER OF LAND ACT 1893
AND THE LAND ADMINISTRATION ACT 1997

VOLUME LR3130 FOLIO 821

NO DUPLICATE CREATED

The undermentioned land is Crown land in the name of the STATE of WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 2161 ON DEPOSITED PLAN 35641

STATUS ORDER AND PRIMARY INTEREST HOLDER:
(FIRST SCHEDULE)

STATUS ORDER/INTEREST: LEASEHOLD

PRIMARY INTEREST HOLDER: THE STATE ELECTRICITY COMMISSION OF WESTERN AUSTRALIA OF 321 MURRAY STREET, PERTH
(LC J012739) REGISTERED 7 SEPTEMBER 2004

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. J012739 LEASE. SUBJECT TO THE TERMS AND CONDITIONS AS SET OUT IN THE LEASE. REGISTERED 7.9.2004.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
Lot as described in the land description may be a lot or location.

--END OF CERTIFICATE OF CROWN LAND TITLE--

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: LR3130-821 (2161/DP35641).
PREVIOUS TITLE: This Title.
PROPERTY STREET ADDRESS: LOT 2161 MCTAGGART COVE, NORTH COOGEE.
LOCAL GOVERNMENT AREA: CITY OF COCKBURN.
RESPONSIBLE AGENCY: DEPARTMENT OF LANDS (SLSD).

NOTE 1: A000001A CORRESPONDENCE FILE 04433-1955-01RO.
NOTE 2: SUBJECT TO SURVEY - NOT FOR ALIENATION PURPOSES

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Mar 14 08:07:57 2014 JOB 44169982

Landgate
www.landgate.wa.gov.au

2167/DP37890	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF CROWN LAND TITLE

VOLUME LR3131 FOLIO 896

UNDER THE TRANSFER OF LAND ACT 1893
AND THE LAND ADMINISTRATION ACT 1997

NO DUPLICATE CREATED

The undermentioned land is Crown land in the name of the STATE of WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 2167 ON DEPOSITED PLAN 37890

STATUS ORDER AND PRIMARY INTEREST HOLDER:
(FIRST SCHEDULE)

STATUS ORDER/INTEREST: RESERVE UNDER MANAGEMENT ORDER

PRIMARY INTEREST HOLDER: CITY OF COCKBURN
(XE F935718) REGISTERED 25 JULY 1995

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. I726205 RESERVE 43701 FOR THE PURPOSE OF FORESHORE MANAGEMENT REGISTERED 11.12.2003.
   F935718 MANAGEMENT ORDER. CONTAINS CONDITIONS TO BE OBSERVED. REGISTERED 25.7.1995.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.

--END OF CERTIFICATE OF CROWN LAND TITLE--

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP37890.
PREVIOUS TITLE:	LR3105-804.
PROPERTY STREET ADDRESS:	LOT 2167 ROBB RD, NORTH COOGEE.
LOCAL GOVERNMENT AREA:	CITY OF COCKBURN.
RESPONSIBLE AGENCY:	DEPARTMENT OF LANDS (SLSD).

NOTE 1: A000001A CORRESPONDENCE FILE 01488-1995-01RO

LANDGATE COPY OF ORIGINAL NOT TO SCALE Fri Mar 14 07:57:06 2014 JOB 44169731

Landgate
www.landgate.wa.gov.au

Appendix B
Structural Inspection Report

CELEBRATING 50 YEARS
WOOD & GRIEVE ENGINEERS

SOUTH FREMANTLE POWER STATION
Structural Inspection Report

Sergio Femiano, Landcorp
October 2011

Prepared by Eric Le Meur Project Number: 20146-PER-S
Ground Floor, 226 Adelaide Terrace, Perth WA 6000
Phone (08) 6222 7000 **Fax** (08) 6222 7100 **Email** wge@wge.com.au **Web** www.wge.com.au

WGE - vital experience Albany Brisbane Busselton Darwin Gold Coast Melbourne Perth Shenzhen Sydney

Revision

REVISION	DATE	COMMENT	APPROVED BY
0	04/11/2011		EL

HASSELL
© 2014

Appendix B
Structural Inspection Report

Contents

1. Introduction

1.1 Scope

This report has been commissioned by s Mr. Sergio Famiano of Landcorp.

The aim of the report is as follows:

- To undertake a general structural condition survey of the existing building via visual inspection and material testing.
- To define a structural scope of remedial work to minimise the likelihood of significant structural deterioration occurring in the short term (5 to 10 years).
- To provide guidance on possible structural alterations and additions to enable long-term adaptive re-use of the existing building.

The qualifications applying to this report are as follows:

- Some areas of the building could not be visually examined and documentation may differ from the as-constructed building. As such, it is probable that our inspections cannot identify all potential defects or shortcomings of the building which may impact our structural assessment. It is our goal to maximise the extent of the inspection within the constraints of the available access.
- Inspections did not involve inspections of concealed spaces.
- All information provided by others, including verbal information and existing drawings has been accepted as correct and has not been separately verified.
- This report excludes all advice pertaining to compliance of the structure to statutory occupational health and safety requirements, including BCA compliance of balustrades, stairways, access platforms and roof anchor points.

1.2 Background

The South Fremantle Power Station was constructed in two stages between 1947 and 1951. It was decommissioned in 1985.

Since decommissioning, the Power Station's structural components have fallen into varying levels of dilapidation, with structural defects of varying severity being evident throughout.

The Power Station is divided into several areas, each of which relates to the station's original operational function. The largest area is the Boiler House, situated along the eastern edge of the station and the Turbine House on the western side of the building. The administrative block and transformer room is located to the north of the station.

2. Inspection and Findings

2.1 Overview

The Power Station is a steel-framed structure comprising of a regular grid of steel columns supporting steel roof trusses (in the Turbine House) and steel roof beams (in the Boiler House). Steel frames are generally arranged on a 5 to 6 metre grid.

A full height concrete wall full separates the Boiler House from the Turbine House.

The reinforced concrete roof slab spans between steel trusses in the Turbine House and between steel beams in the Boiler House. Within the Boiler House and Turbine House, there are several reinforced concrete mezzanine floors supported on steel beams which span between internal steel columns.

The external façade consists of concrete-encased steel columns, longitudinal concrete-encased steel beams and concrete upstand walls which extend along the entire length of the façade. Windows occur above all upstand walls. (Refer photographs in Appendix A)

Foundations could not be inspected however existing drawings indicate that the building is founded on concrete pilecaps and timber piles.

2.2 Visual Inspection

A general visual survey was undertaken by both WGE and Savcor to assess the level of structural degradation and to identify any signs of significant structural distress.

Safe access to the roof was not possible. The roof slab could only be sighted from a distance from a full height mobile access platform.

2.2.1 Steelwork

Internal steel columns were inspected to determine the general extent of corrosion and structural integrity. Generally, the original steelwork paint protection system has degraded throughout. Notwithstanding this, the majority of beams, columns and trusses appear to have experienced only minor levels of surface corrosion and are considered to be in sound structural condition with no apparent major loss of parent material or delamination. More severe degradation is apparent in a small number of localised areas, especially where water has been able to pond for extended periods of time.

The roof beams and roof trusses could only be inspected from ground level using binoculars since internal access could not be safely achieved via the mobile platform. The roof beams and trusses appear to be in sound condition generally. A detailed inspection of bolts and connection points of roof trusses and roof beams could not be undertaken due to access limitations. It is suggested that a detailed/close-up inspection of roof truss joints and roof beam connection points be undertaken to confirm the integrity of the connections.

Column base plates and stanchions generally appeared to be in moderate to poor condition with some signs of structural degradation being evident. Some baseplates could not be inspected and would require further exploratory work by breaking-out of localised areas of ground slab.

2.2.2 Roof Slab

The concrete roof slab is severely degraded and is indicating signs of concrete spalling and corrosion of exposed reinforcement. The roof down pipes which extend down the facade columns are blocked (as evidenced during site work by Savcor). The resulting water ponding combined with the absence of an effective waterproofing membrane is likely to have precipitated the advanced state of degradation evident on the roof slab.

2.2.3 Mezzanine Slabs

The surface and underside of the Turbine Room mezzanine slabs were inspected throughout.

The Internal suspended mezzanine concrete slab in the Boiler House and Turbine House were found to be in fair to sound condition with only localised areas of spalling, cracking and exposed corroded reinforcement being observed.

SOUTH FREMANTLE POWER STATION
STRUCTURAL INSPECTION REPORT

2.2.4 Internal Concrete Partition Wall

The internal concrete wall separating the Boiler Room and the Turbine Room was found to be in good to fair condition with no evident signs of significant structural distress.

2.2.5 Facade

Cracking is evident throughout the façade. Regular horizontal cracks can be observed over the height of the concrete encasement to the external steel columns. It is likely that such cracking will have facilitated the ingress of moisture and chloride to the load-bearing steel column contained within the casing, resulting in possible corrosion of the encased steel columns.

Localised areas of external concrete encasement were broken out to expose two external steel columns. The columns were found to be in sound condition with only surface corrosion and no major loss of parent material being evident. It should be noted that only two columns were inspected and that additional columns should be exposed to confirm whether these have been significantly degraded as a result of contained moisture within the concrete encasement elsewhere. This should be undertaken as part of any future investigative work, prior to any permanent/long-term remediation.

The trapped downpipe water could also present a higher risk of corrosion to encased steel columns elsewhere and needs to be drained.

Cracking was also noted along the length of the encased longitudinal steel façade beams. A similar regime of opening-up works to the longitudinal beam is recommended to assess the condition of the encased steel.

Concrete parapet walls (shown as “in-fill walls” in Appendix A) were found to be in fair condition with several localised areas of spalled concrete and exposed reinforcement being evident around window frames and at various locations along the length of the wall. It is envisaged that conventional and localised methods of reinforced concrete reinforcement (chase to sound substrate, prime reinforcement via zinc-rich primer and reinstate concrete via non-shrink cement mortar) would be sufficient in most areas.

Windows and window frames are generally degraded throughout and would require full replacement. Non-structural crazing of the render can be observed in several areas. Most embedded fixings and inserts have corroded and will require removal prior to localised remediation of concrete.

2.2.6 Foundations

Foundations could not be inspected, however existing drawings indicate that the building is founded on concrete pilecaps and timber piles. The condition of these piles could not be assessed as part of this report. The absence of settlement-related distress to the structure may suggest that the piles are performing as originally intended, however detailed testing of the existing timber piles should be undertaken prior to the commencement of any detailed adaptive re-use works.

2.2.7 Control Room and Transformer Room

The control room and transformer typically consists of suspended concrete slabs supported by steel beams and concrete-encased steel columns. Steel trusses support the concrete roof slab.

2.3 Materials Testing

Reinforcement corrosion in reinforced concrete and structural steelwork corrosion can have a long-term significant impact on the life expectancy of the structure. The level of existing and projected degradation will impact on the capital cost and ongoing costs of remedial and preventive measures required.

In order to accurately assess the level of degradation of existing structural components and to help predict the likely rate of ongoing degradation, a specialist material testing contractor (Savcor) was appointed to undertake the following material site and laboratory testing work:

2.3.1 Chloride Contents Analysis

Atmosphere-borne chlorides can, over time, ingress into concrete and progressively migrate to the reinforcement concrete. Once the chlorides reach the reinforcement, the protective layer of iron oxide surrounding the reinforcement bars is “de-passified” and the reinforcement begins to corrode.

© 2014

Appendix B
Structural Inspection Report

Over time this corrosion will cause the reinforcement to expand and crack the concrete. Subsequent spalling will expose the reinforcement bars to further atmospheric corrosion. From this point, the rate of reinforcement corrosion accelerates rapidly and the structural integrity of the concrete member becomes compromised as a result of the progressive loss of the reinforcement bars. This process is also commonly referred to as “Concrete Cancer”.

Detrimental chloride can be atmosphere-borne or may be present in the concrete from the day of construction. This can occur when chloride-rich beach sand is used in the concrete mix.

Cost-effective remedial surface treatments such as Silane coatings can be used to prevent chloride ingress or to stop the migration of chlorides to the reinforcement bars. This is only effective if the chlorides have not yet reached the reinforcement bars.

The purpose of chloride testing was to test various concrete elements (façade, slabs) to assess how far the chloride had ingressed and how close existing bars were to becoming de-passified.

The result of Savcor’s testing (Refer Savcor Report Appendix C) indicates that the concentration of detrimental chlorides found in the external columns and beam concrete encasement concrete, parapet wall concrete, roof slab concrete, and mezzanine floor concrete was low to very low. This would indicate that aside from some localised areas of deteriorated concrete (which would need localised repairs) there were no major issues with major chloride contamination in the structure.

2.3.2 Carbonation Testing of Concrete Elements

The steel in reinforced concrete is protected from corrosion by the alkalinity of the cement matrix.

Carbonation is the process whereby carbon Dioxide present in the atmosphere ingresses into the concrete to react with the alkaline components of the cement in concrete. Carbonation causes a reduction in the alkalinity responsible for the protection of steel corrosion. In the presence of moisture and oxygen, the reinforcement will corrode.

The depth of carbonation in the concrete can be measured by applying a PH indicator solution (Phenolphtalein). When sprayed onto freshly exposed concrete, the solution will turn a pink colour to indicate the extent of the carbonation front.

Carbonation testing was carried out over several concrete elements. The result of Savcor’s testing (Refer Savcor Report Appendix C) indicates that the risk of future carbonation-induced corrosion was ‘low” in the external column and beam concrete encasement concrete, “low” in the roof slab concrete, “moderate” in the parapet wall concrete and “considerable” in the Mezzanine floor concrete. This would indicate that the mezzanine slabs would likely require full replacement rather than remediation as part of any future adaptive re-use.

3. Recommendations

3.1 Overview

On the basis of visual assessment of structural elements and site/laboratory material testing, that the majority of the structural components that make up the Power Station are sound and generally appear to have withstood degradation relatively well despite the aggressive site environment. The findings below have been provided on the basis of two possible outcomes, namely short-term remediation to structurally stabilise ongoing structural degradation in the short-term (5 to 10 years) and long-term adaptive re-use with view to full, long-term remediation.

3.2 Short-Term Remediation and “Structural Stabilisation” of Structure

3.2.1 Steelwork

Although the general condition of the internal exposed steelwork members appear to be sound throughout, some localised degradation of roof-level welds and bolted connections may exist. The sudden failure of degraded welded or bolted connections presents a higher risk than the progressive corrosion of a steel member which can be more easily identified and pre-empted.

Short term recommendations are as follows:

- Annual structural inspections should be undertaken to ensure that the progressive degradation of severely corroded areas are not affecting the integrity or stability of the structure as a whole.
- A single detailed inspection of all roof-level truss and beam connections should be undertaken in the short-term to confirm the stability of overhead beams and trusses.
- Unblock roof down-pipes and re-direct drainage to prevent further corrosion of external concrete-encased steel columns.

3.2.2 Roof Slab

Large areas of spalling concrete are evident in both the roof slabs and mezzanine roof slabs. Although there is little evidence to suggest that concrete fragments are regularly detaching from the roof slab (general absence of concrete fragments on the Turbine House and Boiler House floor), the possibility of future spalling will increase with time. If the Power Station is likely to be occasionally accessed, consideration should be given to mitigating the overhead hazard from falling spalled concrete by way of a rock-fall wire-mesh protection system suspended from the existing roof trusse. As per recommendations made in section 3.2.1, alternative roof drainage should be provided to prevent ponding water and further corrosion damage to external steel columns as a result of water ingress from existing blocked drainage pipes.

Short term recommendations are as follows:

- Provide rock-fall wire mesh to guard against falling concrete debris.
- Provide alternative drainage path to roof and unblock existing drainage pipes.

3.2.3 Mezzanine Slabs

Mezzanine slabs are generally in sound condition and are not likely to require short term remediation work. Since the level of carbonation contamination in the mezzanine slabs is high and is likely to accelerate the rate of reinforcement degradation in the short to mid-term, it is likely that a full slab replacement will be required in the long term as part of any adaptive re-use work. Complete future replacement of the mezzanine concrete slab is likely to be more cost effective than providing ongoing preventative maintenance at this stage (through the application of a protective Silane treatment), however this should be confirmed by a Quantity Surveyor if necessary.

3.2.4 Internal Concrete Partition Wall

No major defects were observed in this wall and no short term stabilisation work is considered necessary at this stage.

3.2.5 Facade

Although the "low" levels of chloride and carbonation found in the concrete encasement would suggest a low risk of corrosion to the encased steel column, the presence of cracks at regular spacing will still provide a potential path of moisture ingress to the steel column over the coming years.

As such, it is recommended that moisture ingress through the façade encasement be minimised via the application of a suitable acrylic coating to all encased steel beams and columns.

This will serve to slow the rate of degradation to encased steelwork so that future remediation work undertaken as part of a more extensive adaptive re-use development is likely to be less extensive and onerous.

Short term recommendations are as follows:

- Apply acrylic coating to external concrete facade.

3.2.6 Foundations

Based on observations noted in section 2.0, there appears to be no signs of structural distress to the structure which could be associated with degradation/failure of the piling system.

No short term measures are recommended for foundations.

3.2.7 Control Room and Transformer Room

The support steelwork in both the control room and transformer room appears to be in sound condition with only surface corrosion being evident in the majority of cases. Existing concrete slabs appear to be in sound condition where visible.

No short term remediation measures are deemed necessary.

3.3 Long Term Remediation and Adaptive Re-use

3.3.1 Steelwork

Existing steel columns and beams in most instances, will have some capacity to accommodate minor amounts of additional loads (possibly in the order of one to two additional floor plates) resulting from redevelopment / adaptive re-use, however due consideration needs to be given to the capacity of existing timber piles which support the steelwork and which may limit the capacity of existing steelwork to accept additional loading from new construction.

In the majority of cases, the existing columns and foundations would have limited capacity to accommodate significant additional loading. It is envisaged that any new structure extending above the existing roof-line of the Power Station would need to be independently supported via newly-introduced columns and beams within the fabric of the existing building. This is indicated on proposed architectural drawings (Refer Appendix B)

Wind and Seismic stability to the increased building height would need to be provided by way of new lift cores introduced as part of any new development. These would serve to increase the seismic resistance of the existing building fabric to current earthquake codes.
Any new structural column grids should be located around existing foundations. Existing columns could be retained as necessary to express heritage interpretation requirements and be isolated from any additional loads if necessary through appropriate isolation detailing.

Based on preliminary calculations, the existing Turbine House steel roof trusses are not considered capable of supporting live load greater than what would be associated with a non-trafficable roof. Existing trusses could be retained and re-used (with minor remediation of deteriorated areas as required) where the proposed roof usage consisted of non-trafficable glazing, lightweight sheeting or replacement of existing concrete roof of similar thickness. Strengthening and modification of existing trusses would be required to accommodate public-use roof loads for residential, commercial or retail loading.

Any long-term adaptation of existing steelwork will require the application of a new paint protective system. It is expected that a suitable corrosion protection system can be applied following sandblasting of steelwork back to parent material. Where limited access prevents preparation work and re-coating (eg with encased steel columns) alternative forms of corrosion protection may required (eg: electrochemical corrosion prevention methods)

The condition of existing steelwork can be roughly categorised as follows:

- Little or no corrosion (typically exists over approximately 40% of existing steelwork) – Original protective coating system is mostly intact.
- Onset of Surface Corrosion (typically exists over approximately 30% of steelwork) – Original paint has been compromised with minor to moderate levels of surface corrosion.
- Formation of passivating layer over majority of steel member (typically exists over approximately 20% of existing steelwork) – Entire member is oxidised.
- Advanced corrosion – (typically exists over approximately 10% of existing steelwork) – Onset of delamination and loss of parent material cross section. Requires strengthening by welding of additional steelwork.

These stages of corrosion are illustrated in Appendix A.

3.3.2 Roof Slab

The extent of roof slab degradation indicates that it is beyond economical repair/reinstatement. It is expected that a replacement of the existing slab via a permanent formwork system ("Bondek" or similar) will be more cost-effective than full repair and remediation. Alternatively, lightweight sheeting or glazing could also be structurally accommodated by the existing trusses. It should be noted that existing trusses would require some modifications/alterations should the roof be required to accommodate live loading resulting from residential, commercial or retail loading.

3.3.3 Mezzanine Slabs

Mezzanine slab beams are capable of accommodating commercial and residential loads. Given the advanced state of ongoing, detrimental carbonation present in the slab, it is likely that the slab will require replacement in the long term as part of any adaptive re-use.

3.3.4 Internal Concrete Partition Wall

The internal concrete walls may be retained. The wall has limited axial capacity and is unlikely to offer significant support to any new-built form.

3.3.5 Façade

Long-term remedial work to the façade will include work to a number of non-structural components such as glazing, fixings and render. The majority of upstand parapet walls are expected to be suitable for adaptive re-use after extensive localised repair as noted in 2.2.5. Additional investigative work to confirm the condition of encased steel columns and beams will be required as noted in 2.2.5.

3.3.6 Foundations

The timber piled foundations present a significant level of uncertainty in terms of their ability to accommodate additional loading from new structure. It is recommended that integrity testing of timber piles be undertaken prior to permanent adaptive re-use development to assess existing condition and provide some guidance on likely rate of deterioration over the design life of the new structure.

3.3.7 Control Room and Transformer Room

Based on visual inspection alone, It is expected that both steel and concrete elements in the control room and transformer room will be suitable for adaptive re-use with levels of steelwork in the remainder of the Power Station.

HASSELL
© 2014

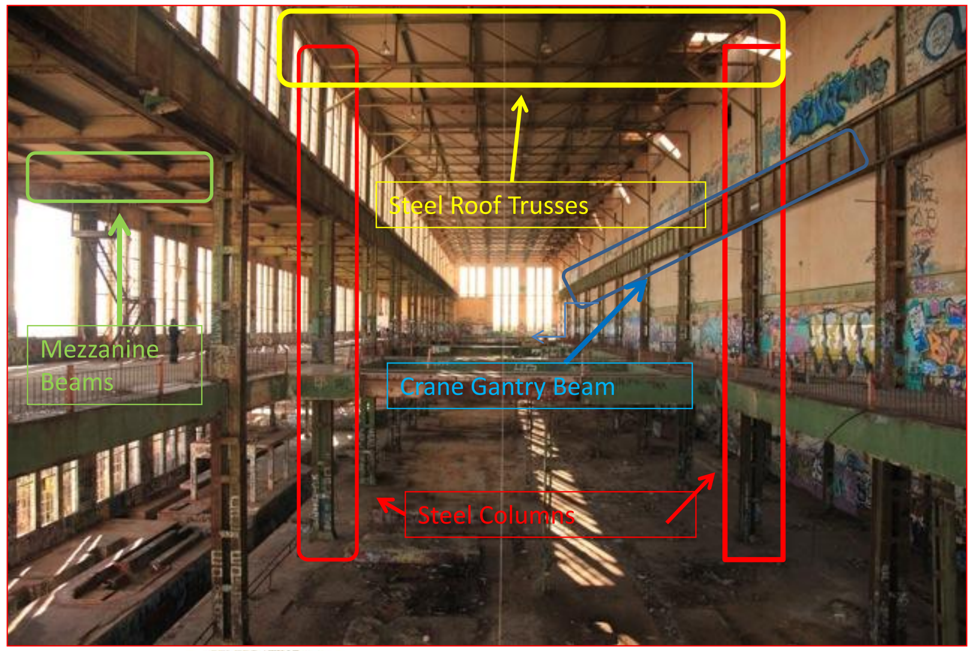
4. Conclusions

On the basis of our inspection, desktop analysis and materials testing the following points can be summarised:

- The existing structure is generally in sound structural condition and visible defects observed are commensurate with the age of the structure and with the coastal exposure conditions present.
- There appears to be no visual evidence to suggest that the structure is currently experiencing any severe signs of structural distress that could be indicative of an imminent risk of structural overstress.
- A large proportion of the existing structure is deemed suitable for adaptive re-use, subject to localised strengthening, remediation and protection of existing members against long-term corrosion and degradation. Steelwork would mostly require sand-blasting and re-coating with suitable steel protection system.
- The existing mezzanine floor beams are capable of accommodating residential and retail loading. Mezzanine slabs are likely to require replacement due to the advanced state of carbonation front in concrete.
- The existing roof may be replaced with glazing, lightweight or non-trafficable slab. The use of roof for public access would require strengthening of roof trusses.
- The current rate of structural degradation in the building may be retarded in the short term via appropriate remediation measures which may help to reduce the cost and extent of future permanent remediation work prior to future adaptive re-use.
- An annual structural condition inspection of the structure as a whole should be considered to confirm that the ongoing rate of degradation and deterioration is consistent with the expectations of this report.
- The existing structure has limited structural capacity to accomodate additional built-form. New structure will require new supports within the fabric of the existing building.
- Existing timber piles will require further integrity testing prior to commencement of any permanent adaptive re-use work.

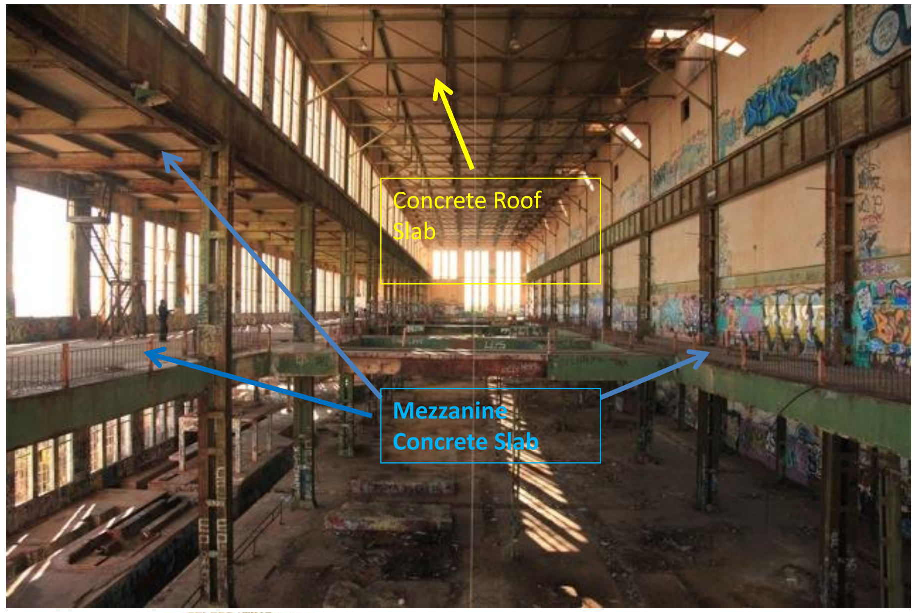
Appendix A – Photographs

Existing Structure – Steelwork (Turbine House)

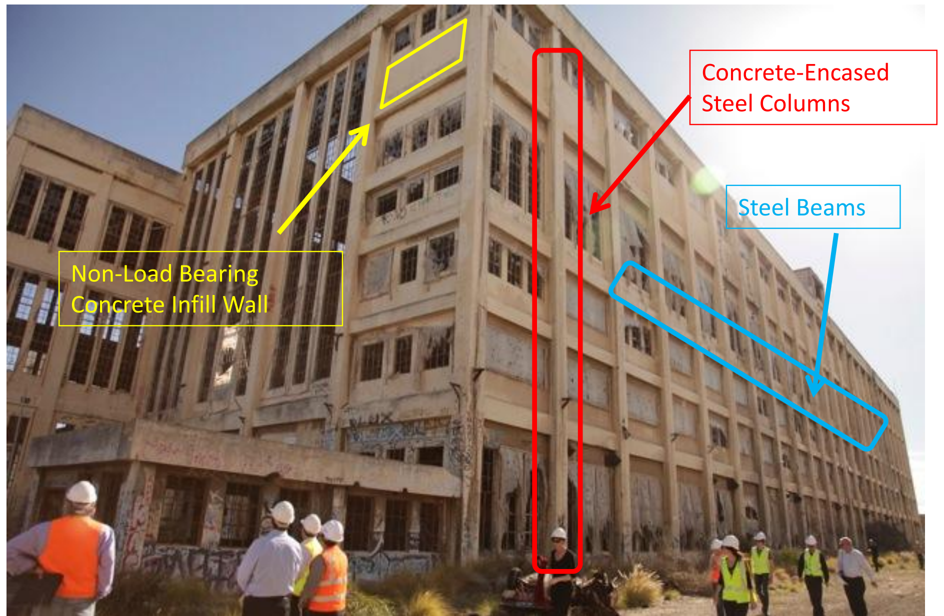


Existing Structure – Steel/Concrete (Boiler House)

Existing Structure – Concrete (Turbine House)



Existing Structure - External



Structural Condition - Steel

1) Little or no corrosion

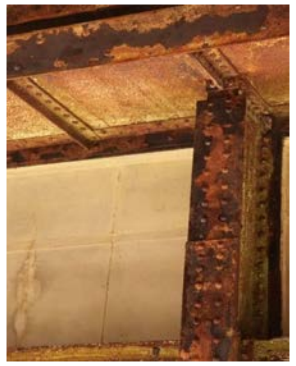
- Exists over approx. **40%** of building
- Original paint system mostly intact
- Minor amount of remediation required (Sand-blast and re-coat)

2) Onset of surface corrosion

- Exists over approx. **30%** of building
- Original paint compromised
- Minor to Moderate amount of remediation required (Sand-blast and re-coat)

3) Formation of passivating layer

- Exists over approx. **20%** of building
- Original Paint non-existent
- Moderate amount of remediation required (Sand blast and re-coat)



4) Onset of delamination, loss of parent material

- Exists over approx. **10%** of building
- Original paint non-existent
- Major level of remediation (sand blasting + strengthening by welding of additional steel plates)

LANDCORP HASSELL
CELEBRATING 50 YEARS WOOD & GRIEVE ENGINEERS

Structural Condition - Concrete

1) Little or no signs of deterioration

- Exists over approx. 20% of building
- No rust staining, cracking or concrete spalling
- Minor level of remediation required (apply a coating of transparent "Silane" to seal and protect slab)

2) Onset of deterioration

- Exists over approx. 60% of building
- Signs of rust staining, cracking and spalling
- Moderate amount of remediation required (Cut back concrete, check extent of corroded reinforcement, treat, install sacrificial anode and repair concrete)

3) Advanced stage of deterioration

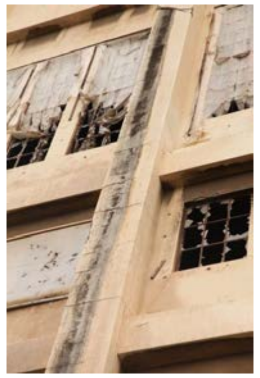
- Exists over approx. 20% of building, mostly on roof slabs
- Concrete has fallen away, reinforcement bars exposed and severely corroded
- Repair not cost-effective. Replace.

LANDCORP HASSELL
CELEBRATING 50 YEARS WOOD & GRIEVE ENGINEERS

Structural Condition – Other Elements

1) Handrails, inserts and fixings

- Corroded
- Unlikely to meet current code requirements
- Replace throughout



2) Windows and window frames

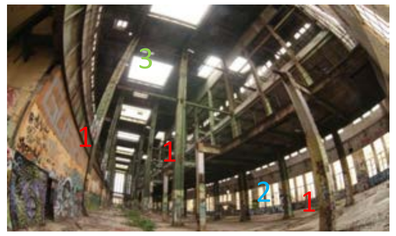
- Dilapidated/Damaged
- Replace throughout

3) Damaged columns

- Damaged most likely as a result of impact load (perhaps during removal of mechanical equipment)
- Only a few numbers of small columns affected
- Replace

LANDCORP HASSELL
CELEBRATING 50 YEARS WOOD & GRIEVE ENGINEERS

Adaptive Re-Use – Remediation



Suitability For Adaptive Re-use

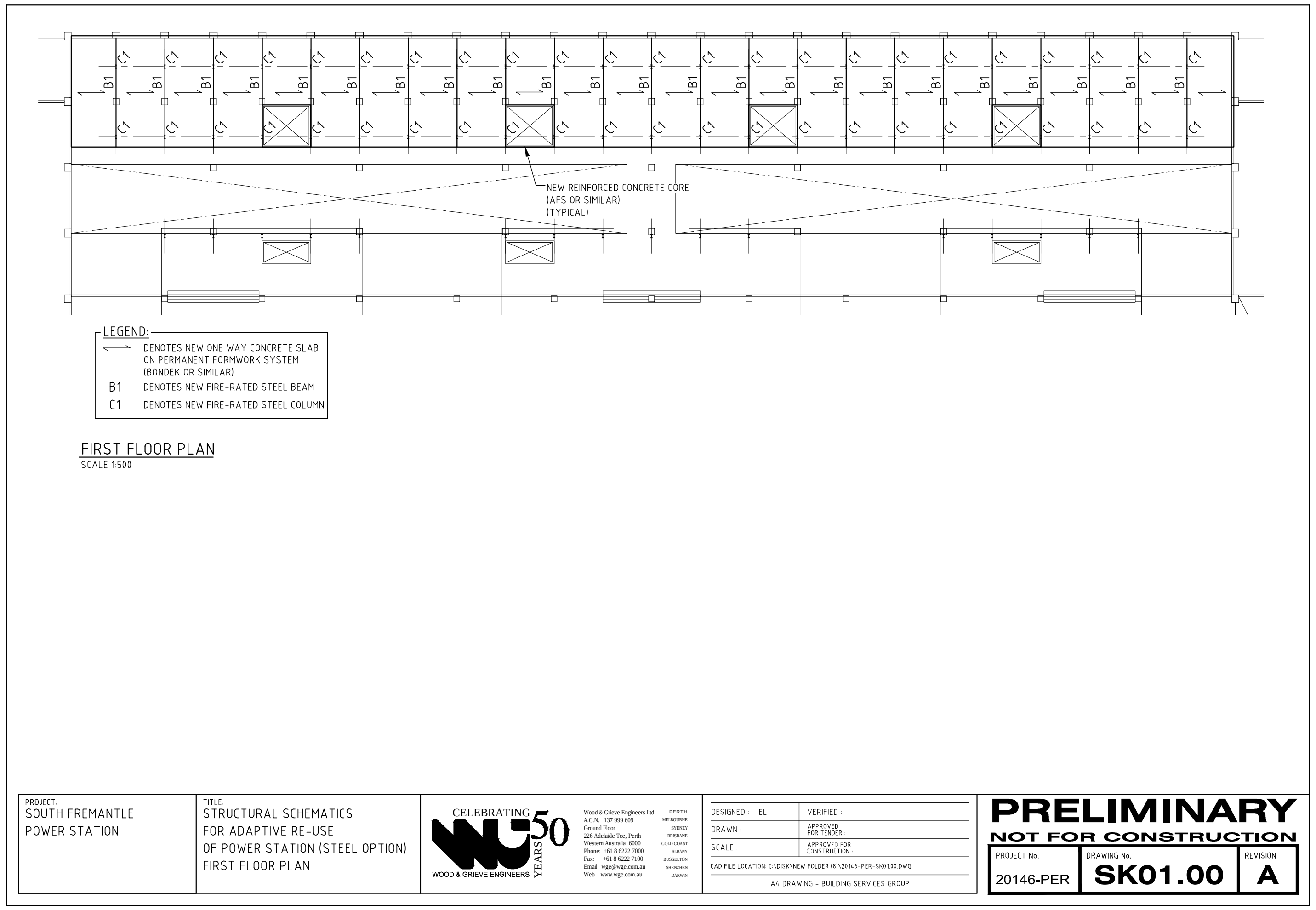
Number	Element	Excellent (No remediation Req'd)	Good (Minor Remediation Req'd)	Fair (Moderate Remediation Req'd)	Poor (Major Remediation Req'd or Replace)	Comments
1	Internal Steelwork		✓			Sand blast and paint
2	Internal Mezzanine Concrete Slab			✓		Repair or Replace
3	Roof Slab				✓	Replace
4	Foundations		(✓ – Expected)			No signs of distress – Further testing required
5	External Steel Columns			(✓ – Based on 2 columns inspections)		Additional testing recommended
6	External Concrete Infill Walls			✓		

LANDCORP HASSELL
CELEBRATING 50 YEARS WOOD & GRIEVE ENGINEERS

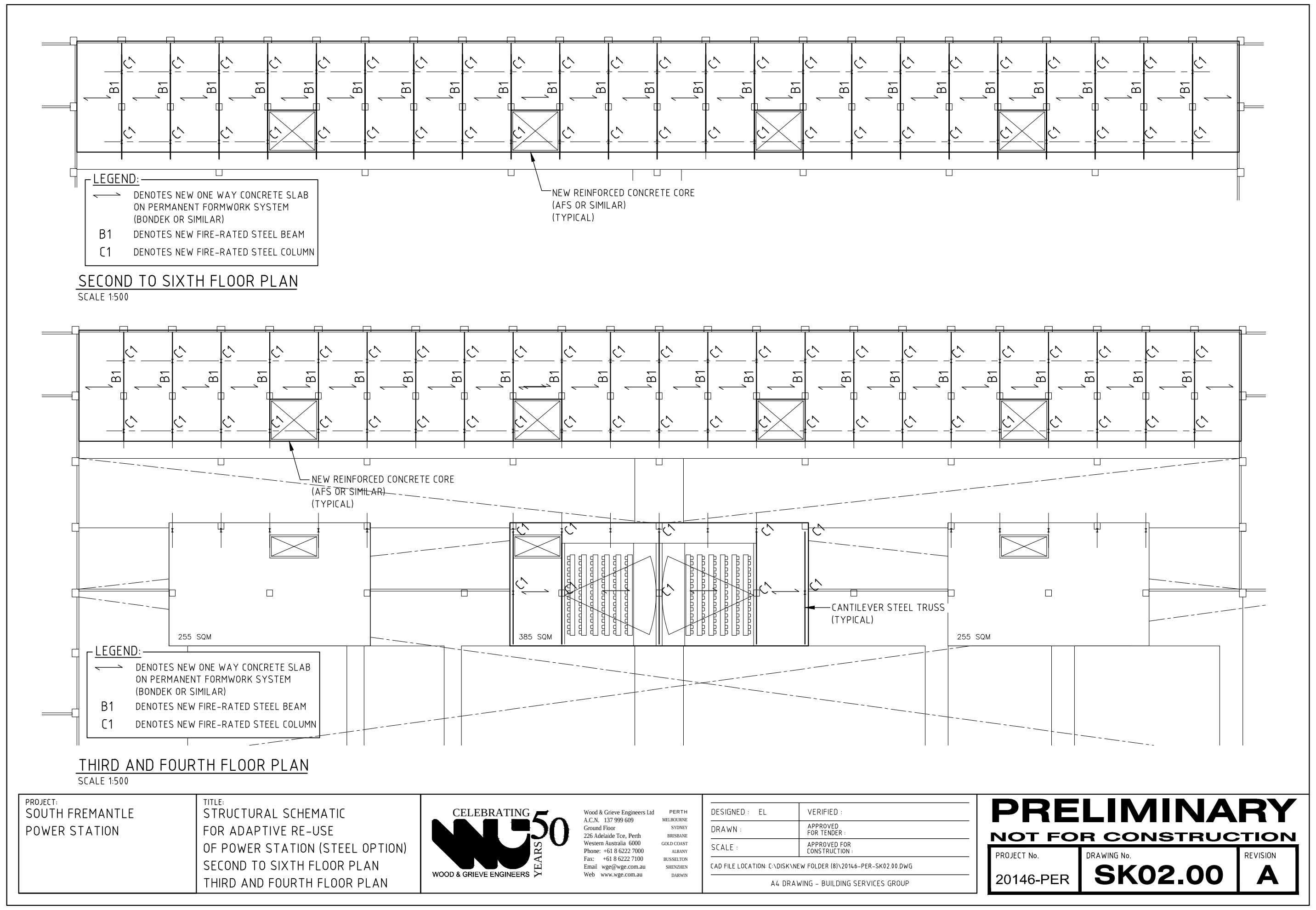
4. Conclusions

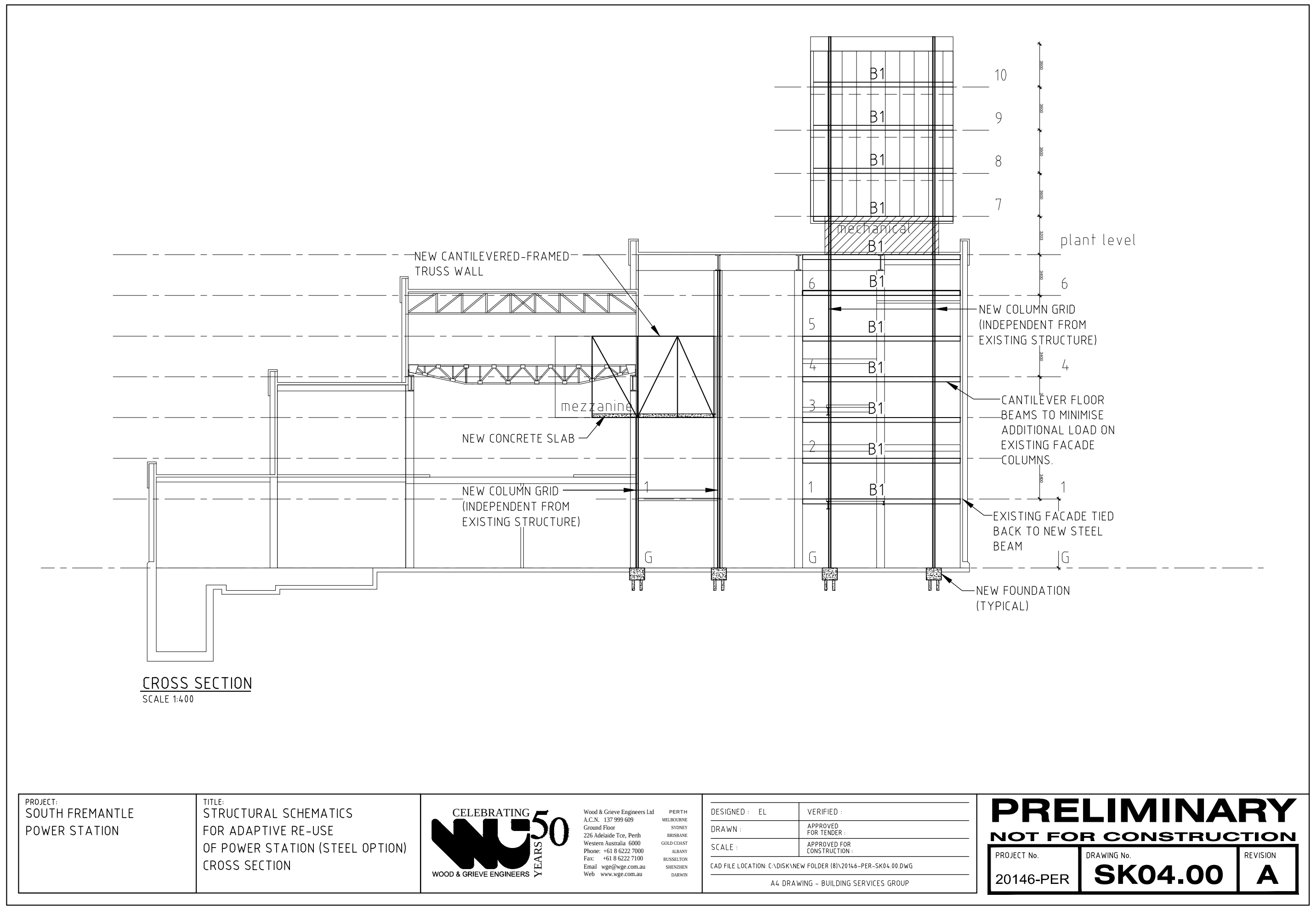
On the basis of our inspection, desktop analysis and materials testing the following points can be summarised:

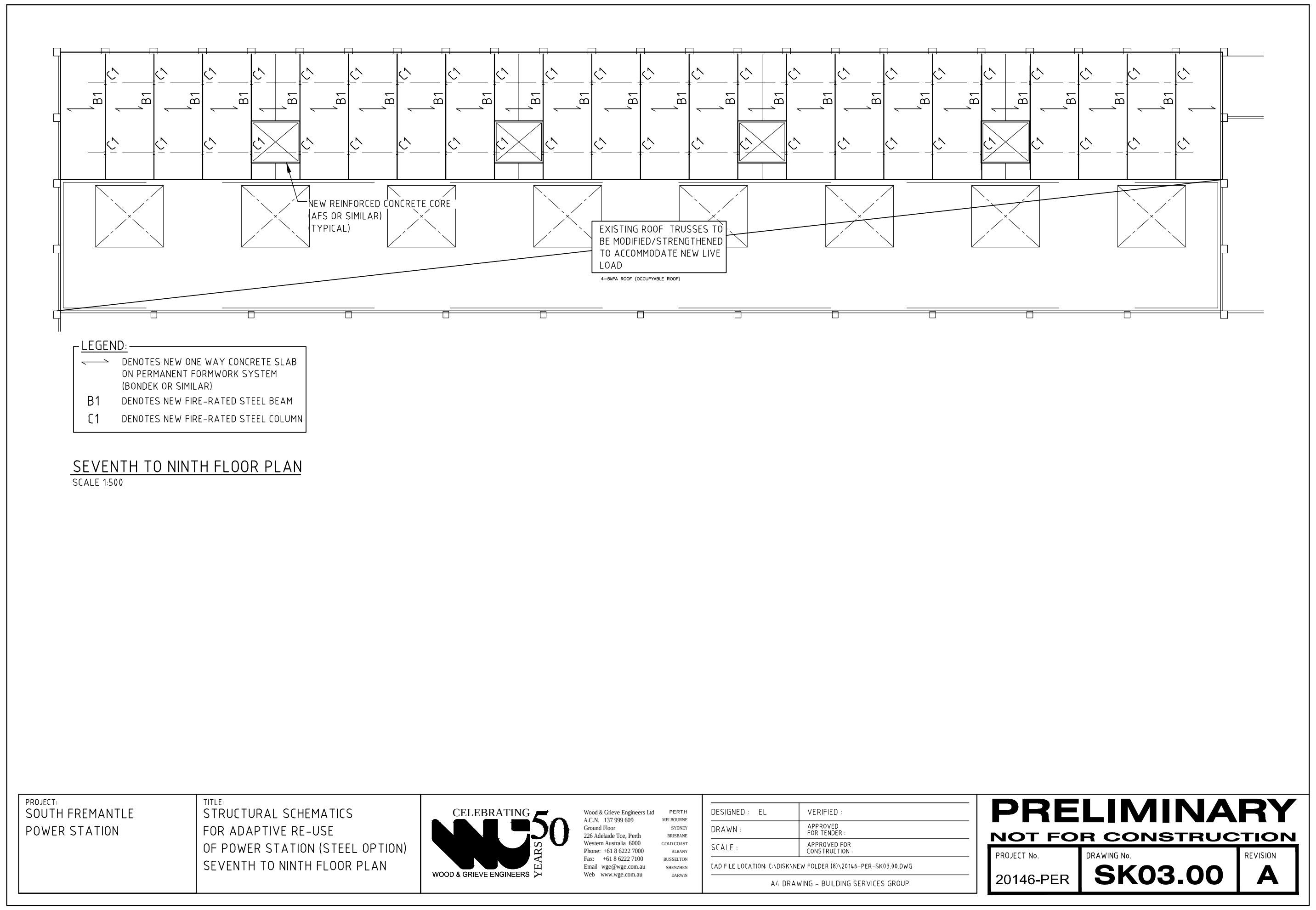
- The existing structure is generally in sound structural condition and visible defects observed are commensurate with the age of the structure and with the coastal exposure conditions present.
- There appears to be no visual evidence to suggest that the structure is currently experiencing any severe signs of structural distress that could be indicative of an imminent risk of structural overstress.
- A large proportion of the existing structure is deemed suitable for adaptive re-use, subject to localised strengthening, remediation and protection of existing members against long-term corrosion and degradation. Steelwork would mostly require sand-blasting and re-coating with suitable steel protection system.
- The existing mezzanine floor beams are capable of accommodating residential and retail loading. Mezzanine slabs are likely to require replacement due to the advanced state of carbonation front in concrete.
- The existing roof may be replaced with glazing, lightweight or non-trafficable slab. The use of roof for public access would require strengthening of roof trusses.
- The current rate of structural degradation in the building may be retarded in the short term via appropriate remediation measures which may help to reduce the cost and extent of future permanent remediation work prior to future adaptive re-use.
- An annual structural condition inspection of the structure as a whole should be considered to confirm that the ongoing rate of degradation and deterioration is consistent with the expectations of this report.
- The existing structure has limited structural capacity to accomodate additional built-form. New structure will require new supports within the fabric of the existing building.
- Existing timber piles will require further integrity testing prior to commencement of any permanent adaptive re-use work.



Appendix B
Structural Inspection Report







Appendix C – Savcor Condition Survey

Appendix B
Structural Inspection Report

SAVCOR

Advanced Rehabilitation Technology

Technical Report:

South Fremantle Power Station – Condition Survey

Report No.: T51256-01

Date: August 1, 2011

Revision: 0

Prepared For: Wood & Grieve Engineers
L3, Hyatt Centre, 3 Plain St
East Perth, WA 6004

Prepared By: Savcor Finn Pty Ltd
11 Juna Drive
Malaga, WA 6090

Savcor Group Limited

11 Juna Drive, Malaga 6090, Western Australia
Tel: +61 8 9248 8999 Fax: +61 8 9248 8933
Email: perth@savcor.com.au www.savcor.com

Technical Certification

TITLE:	**South Fremantle Power Station – Condition Survey**			
REPORT NO:	T51256-01	**DATE:** August 1, 2011	**REV:** 0	
AUTHOR(S):	Luke Evans Senior Technician			
TECHNICAL APPROVAL:	Liam Holloway BEng (Materials), PhD		**Date:** **Signature:**	
AUTHORISED FOR DISTRIBUTION:	Liam Holloway BEng (Materials), PhD		**Date:** **Signature:**	
DISTRIBUTION:	Wood & Grieve Engineers Savcor Finn Pty Ltd			

ABSTRACT:

Savcor were commissioned by Wood and Grieve Engineers to conduct a representative condition survey of the South Fremantle Power Station. The survey was primarily focused on the current condition and ongoing deterioration of the concrete elements of the building envelope. However, the general condition of the internal steel frame elements was also considered.

This report contains:

1. Findings from the representative condition survey
2. Results from concrete chloride content and carbonation depth testing
3. A discussion pertaining to the main risks to the long term durability and structural integrity of the building fabric
4. Recommendations for the interim and long term protection of the key structural elements of the building.

This report is copyright. Reproduction of the whole or any part thereof must not be made without the express permission of Savcor Finn Pty Ltd (i) This report and the results shown and any recommendation or advice made herein are based upon the information, drawings, samples and tests referred to in the report. (ii). Savcor Finn Pty Ltd accepts no liability for any damages, charges, costs (including, but not limited to legal costs) or expenses in respect of or in relation to any damage to any property or other loss (save for death or personal injury occasioned by reason of any negligence on the part of Savcor Finn Pty Ltd whatsoever) either directly or indirectly from the use of the report, the carrying out of any recommendations contained herein, the following of advice or the use of any goods or materials referred to in this report.

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

Savcor were commissioned by Wood and Grieve Engineers to conduct a representative condition survey of the South Fremantle Power Station. The survey was primarily focused on the current condition and ongoing deterioration of the concrete elements of the building envelope. However, the general condition of the internal steel frame elements was also considered.

1.2 Structure Description

The South Fremantle Power Station is located on Robb Road, Coogee. The construction of the power station was commenced in 1946 and began operations in 1951. The power station was eventually decommissioned in 1985. The building is currently listed on the register of Heritage Places.

The building envelope is understood to primarily consist of concrete encased steel beams and columns. The infill walls consist of reinforced concrete or concrete block work panels and large scale steel framed windows. The reinforced concrete elements of the facade have a painted render finish throughout. The roof structures are flat reinforced concrete slabs sealed with bituminous membranes. The internal framework of the structure consists of large painted steel columns and beams.

Figure 1 shows the layout of the site and its proximity to the coast.

Figure 1. South Fremantle Power Station

1.3 Scope of Works

The scope of work for the Condition Survey at South Fremantle Power Station included:

- Representative visual and delamination survey of the concrete facade elements
- Selective concrete cover survey
- Concrete core sampling
- Depth of concrete carbonation testing
- Concrete chloride content testing
- Exploratory breakout and inspection of steel elements embedded in concrete
- General visual survey of structural steel elements
- Consideration of future deterioration mechanisms and the relevant risk to the structural integrity of the building fabric
- General recommendations for the interim and future preservation of the building fabric

2 METHODOLOGY

2.1 Introduction

Each testing technique described below provides insight into some aspect of the structure/concrete condition. By combining the results of these tests an assessment of the state of the structure, and the deterioration mechanisms operating, can be determined. It is generally advised that no single test should be considered as a standalone or definite indicator of the structure's condition.

2.2 Exposure Condition Classification

When considering the deterioration of the building materials it is pertinent to develop an understanding of the exposure conditions with respect design standards for durability. To this end, the exposure classifications for the concrete and steel elements are assessed in accordance with the Australian Standards for Concrete structures AS3600-2009 and the Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings AS/NZS 2312-2002.

2.3 Visual and Delamination Survey

A representative visual survey of the structure was conducted to identify any significant defects, damage or deterioration that may present a risk to the durability or integrity of the structure. This survey included a reinforced concrete visual and delamination survey of cracks, delaminations, spalls and corrosion. This was conducted in accordance with Savcor Test Method Statement (TMS) 07 given in Appendix A.

2.4 Detailed Concrete Testing

At selected representative locations detailed concrete inspections were undertaken to determine the current condition and gather information for the purpose of predicting concrete deterioration into the future. The investigation techniques employed are briefly described below.

2.4.1 Reinforcement Concrete Cover Survey

Contaminants such as chloride ions and carbon dioxide can cause steel corrosion if they reach the level of the steel reinforcement, and subsequently cause deterioration of the structure. The concrete cover depth affects the time required for contaminants to penetrate to the depth of the steel reinforcement, and therefore affects the durability of the structure against contaminants.

A reinforcement concrete cover survey was completed using an electromagnetic covermeter.

2.4.2 Exploratory Breakout

At selected test locations, breakout of the cover concrete was carried out to inspect the condition of the embedded steel reinforcement and to test the depth of carbonation.

Concrete breakout out was also carried out in areas of advanced delamination, cracking and spalling as well as locations where there was not apparent signs of deterioration.

2.4.3 Carbonation Testing

In a high pH environment, such as that found in sound concrete, steel maintains a passivating iron oxide layer at its surface and negligible corrosion rates. The alkalinity of concrete may be reduced by carbonation, which is the reduction in alkalinity of pore water by the ingress of carbon dioxide. Carbon dioxide present in the atmosphere reacts with the calcium products that form from hydrated cement and neutralises the concrete, reducing the pH of the concrete.

The reduction in pH of the concrete can result in a breakdown of the passivating iron oxide layer of steel reinforcement, which may lead to active corrosion of the steel reinforcement.

The depth of carbonation was measured using Phenolphthalein solution, a pH indicator solution. The solution was sprayed over freshly broken concrete at breakout locations and the depth of carbonation was measured. This depth was then compared to the concrete cover depth to determine the potential for steel reinforcement corrosion due to carbonation.

2.4.4 Chloride Content Analysis

In sound chloride free concrete, steel reinforcement maintains a passivating iron oxide layer at its surface and negligible corrosion rates. Chloride contamination of concrete can occur by the use of contaminated aggregates or mix water at the time of construction or by the continued exposure to chloride rich marine environments. If the chloride concentration at the level of the reinforcing steel reaches a critical threshold it can cause breakdown of the passivating oxide layer and corrosion will persist. The concentration at which the breakdown of passivity occurs is dependent on many factors and can vary significantly. Nevertheless, the criteria presented in Table 1 provide some guidance on the risk of corrosion at different chloride contents. (Table 1 is based on the criteria presented in Broomfield, Corrosion of Steel in Concrete 2nd Ed. 2007).

Concrete samples for the purpose of chloride content analysis were secured as core samples or dusts collected from a series of drill holes. The chloride content analysis was carried out by a NATA registered laboratory in accordance with BS 1881: Part 124:1988 "Methods for Analysis of Hardened Concrete".

Table 1 Chloride content and relative corrosion risk

Chloride wt.% Cement	Chloride wt.% Concrete*	Corrosion Probability
<0.4	<0.05	Low
0.4 to 1.0	0.05 to 0.14	Medium
>1.0	>0.14	High
*Assuming concrete approximately 350kg/m^3 cement content, no cement replacement (i.e. blast furnace slag, fly ash or silica fume) and a density of 2500kg/m^3		

3 RESULTS

3.1 Exposure Classifications

The exposure classifications for the concrete and steel elements of the building fabric have been assessed. The following results should be considered in the context of the guidance provided in the relevant standards.

3.1.1 Concrete Structures

In accordance with Table 4.3 of AS3600-2009 the exposure classification of the external reinforced concrete elements of the structure is B2. AS/NZS 2312:2002.

3.1.2 Steel Structures

In AS/NZS 2312:2002 the "Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings" atmospheric environments are classified into the following five atmospheric corrosivity categories based on the corrosion rates of mild steel given in ISO 9223. Given the location of the power station it is considered that the atmospheric corrosivity category for the exposed steel elements is *between Category C: Medium* to *Category D: High*. In Appendix B of the standard advice is given on the atmospheric corrosion of steel in the Australian climate. This advice includes indicative general corrosion rates for steel. Based on the atmospheric corrosivity classifications expected corrosion rates (in terms of metal section loss) for mild steel in one year are given:

- *Category C: Medium*, 25-50 µm/year
- *Category D: High, 50-80* µm/year

In Table B2 from the same standard average one year corrosion rates determined at various locations around Australia are given. The most relevant site with respect to this investigation is Kwinana, where 29 µm/year.

It is important to note that these corrosion rates express rates for general corrosion and do not consider micro-environmental factors that may persist and localised corrosion rates. For example at a location where a crevice is formed between two elements that are joined together or where water is allowed accumulate for extended periods of time corrosion rates could be significantly higher.

3.2 Visual and Delamination Survey

Due to the size of the structure and available access a representative visual and delamination survey of the external reinforced concrete elements was carried out. The survey included sections of the Eastern, Southern and Northern Elevations. The defects identified during the survey are tabulated in Appendix B of this report along with marked up elevation photos showing the location of the defects and individual photographic records. It is important to note that this survey is not intended to be a comprehensive assessment of the overall condition or structural capacity of the building fabric.

The following points and figures summarise the typical types defects identified during the survey:

1. Cracking of the render finish and/or concrete cover on columns was recorded throughout the building. Figure 2 shows an example of a vertical crack running almost the entire length of the column on the Eastern elevation. It was also identified that vertical cracks on the sides for the columns follow the approximate location of the encased steel columns are closest to the surface. The survey found relatively few areas of delaminated concrete and or render on the columns.
2. On several of the columns surveyed horizontal cracking of the render finish was found. These cracks were often spaced at regular intervals up the face of the column. Figure 3 shows an example of horizontal cracking of the rendered finish on columns showing it to coincide with a cold joint in the underlying concrete.
3. Overall the width of the cracks identified on the beams and columns typically varied from approximately 0.2mm to 0.6mm.

Figure 2. Typical example of cracking on columns

Figure 3. Example of horizontal cracking of the rendered finish on columns showing it to coincide with cold joint in the underlying concrete

Figure 4. Concrete delamination and spalling along the bottom edge of a parapet wall exposing the corroding reinforcing steel

Figure 5. Example of cracking, delamination and spalling of the rendered finish on beams as well as the associated corroding metal elements embedded close to the surface

4. Delaminated and spalling concrete and render were recorded in isolated areas throughout the building. These areas were notably on the parapet walls, corners of the building and along the edges of beams. Figure 4 shows spalled areas on the parapet walls with exposed and corroded reinforcing bars. Figure 5 shows an

example of cracking, delamination and spalling of the rendered finish on beams as well as the associated corroding metal elements embedded close to the surface.

5. The visual survey identified water and rust staining emanating from various points on the columns around the building (Figure 6). Further inspection of these areas found this staining to be associated with internal downpipes that have failed and the cavities were holding water which would leak out at the location of cold joints and cracks in the concrete. Figure 7 shows an area where the cover concrete was broken out to reveal that the internal cavity was full of water.

Figure 6. Example of water and corrosion staining emanating from cracks in the column

Figure 7. Example of water and corrosion staining emanating from cracks in the column

Figure 8. Example of corroded fixings or reinforcing causing small areas of concrete and render cover to spall away

Figure 9. Example of cracking around window frames possible associated with corrosion of embedded frame fixings

6. Numerous small areas were found where the corrosion of small embedded steel elements (such as redundant fixings) or reinforcing steel close to the surface had cause the concrete and render to spall. Figure 8 shows and example of several such locations.
7. Cracking of the concrete and render cover around the window frames possibly associated with the corrosion of the embedded metal work was evident (Figure 9).
8. The flat concrete roof areas were covered by what appeared to be a bituminous type waterproofing membrane (Figure 10). Close inspection of the membrane revealed

that had sustained widespread deterioration and is not likely to be providing adequate waterproofing protection (Figure 11).

Figure 10. Typical waterproofing membrane on flat concrete roof areas

Figure 11. Typical condition of waterproofing membrane showing widespread cracking and deterioration

Figure 12. General view of concrete roof from the inside showing evidence of efflorescence, water ingress and areas of reinforcement corrosion and concrete spalling

Figure 13. General view of internal structural steel frame work

9. A general visual inspection of the reinforced concrete roof soffits revealed wide spread efflorescence, water ingress as well as some localised areas of reinforcement corrosion and concrete spalling (Figure 12). The water ingress and efflorescence appeared to coincide with cracking in the concrete. The areas where concrete cover had spalled exposing the corroded reinforcement appeared to typically be located near the edges of the roof or penetrations. It was also apparent that there were numerous areas of low concrete cover to the reinforcement.
10. A rudimentary inspection of the internal steel frame work was conducted. It was found the vast majority of the steel frame work was coated and exhibiting minimal corrosion (Figure 13). Some localised areas where more significant corrosion had occurred were identified, however, these were typically at locations where sections of the framework had been damaged, cut or water was allowed to accumulate at joints. It is important to note that it was not possible to provide a detailed investigation of the

steel frame work and especially the elements above ground level including the gantry crane and trusses at the roof.

3.3 Reinforcement Concrete Cover Survey

A representative survey of the reinforcing concrete cover was carried out at core sample locations and around the building. The relative location of the core samples and cover meter tests are provided in Appendix C and described in Table 2. The detailed cover survey results are presented in Appendix D. The following points summarise the key findings:

1. For the major columns and beams the cover the shallowest point of the steel beams ranged between 81 to 93mm.
2. At the locations tested for the reinforced concrete parapet walls the cover depth ranged from 36 to 63mm.
3. Testing on the internal floor returned cover values of 30-31mm.
4. The concrete cover for the internal wall between the boiler and turbine rooms was 96-101mm.
5. The cover from the top of the mezzanine floors in the turbine room were between 52-55mm.
6. The cover to the top layer of reinforcing steel of the roof levels tested was between 100-105mm.

3.4 Exploratory Breakout

Two exploratory breakouts were conducted on the concrete encased steel columns. The breakouts were conducted at one location where there was evidence of significant cracking and another location where the concrete cover appeared sound.

1. Figure 14 shows the condition of the steel beam flange at the location of the breakout where there was cracking in the concrete cover. The exposed edge of the steel beam had a build up of corrosion products on the surface. Figure 15 shows the same edge of the steel beam after the corrosion products were removed. The width of the flange after the removal of the corrosion products was approximately 14-15mm.
2. Figure 16 shows the condition of the steel beam flange at the location of the breakout where the concrete cover was sound. The exposed steel showed no signs of corrosion and the original coating on the steel was still evident. The width of the flange at this location was found to be approximately 15-16mm.
3. Based on the results from the two breakout inspections it appears that the steel at the location where the concrete covered had cracked the steel has loss approximately 1mm of section thickness due to corrosion.

Figure 14. As found condition of steel beam at the location of a breakout coinciding with a significant crack in the concrete cover

Figure 15. Width of steel flange after removal of corrosion product

Figure 16. Width of steel flange exposed at the location with sound concrete cover

HASSELL
© 2014

3.5 Carbonation Testing

The depth of concrete carbonation was tested for all of the core samples that were secured from the structure. The depth of carbonation was tested from both sides for the roof slabs and the internal wall. The results from the carbonation testing are presented in Table 2. Photographic records of the core samples and indicator tests are provided in Appendix C.

1. For the external concrete elements including the parapets and columns the average depth of carbonation was 37mm.
2. For the external surfaces of the concrete roof slabs the average depth of carbonation was 18mm.
3. For the internal concrete surfaces including the soffits of the concrete roof slabs and the mezzanine slabs the average depth of carbonation was 35mm.

Table 2 Carbonation Test Results

Core Sample	Location	Carbonation Depth Upper (mm)	Carbonation Depth Lower (mm)	Local Reinforcing /Beam Depth (mm)
FPS-1	North Elevation Ground Level	40	n/a	89
FPS-2	North Elevation at Height	35	n/a	42
FPS-3	East Elevation at Height	50	n/a	90
FPS-4	South Elevation at Height	50	n/a	92
FPS-5	South Elevation at Ground Level	35	n/a	82
FPS-6	Floor slab	20	n/a	30
FPS-7	Internal Wall Ground Level	50	25	99
FPS-8	Mezzanine Level West	40	45	52
FPS-9	Mezzanine Level East	40	40	54
FPS-10	West Elevation at Height	25	30	61
FPS-11	West Elevation Ground Level	30	n/a	91
FPS-12	Roof Slab	25	25	101
FPS-13	Roof Slab	10	30	105

3.6 Chloride Content Analysis

Chloride content analysis was conducted at various depths for several core samples taken from the structure. The results from the tests are presented in Table 3 and the test certificate is provided in Appendix E of this report.

Excluding the two out riding results for render layers of 0.14 and 0.2 wt.% concrete. The chloride contents were found to typically range between 0.01 and 0.08 wt.% concrete. The majority of the chloride content profiles within the concrete did not to follow the typical trend of decreasing chloride concentration with increasing depth. The average value of all of the chloride content results from the samples excluding the render was 0.03 wt.%.

Table 3 Concrete Chloride Content Test Results (Cl^- wt.% Concrete)

Core #	Location	0-10 (mm)	0-20 (mm)	10-20 (mm)	20-30 (mm)	70-80 (mm)	80-90 (mm)	Local Cover (mm)
Columns								
FPS1	North Elevation, Column, Ground Level	0.01*		0.03	0.04	0.04		89
FPS3	East Elevation, Column, At Height	0.07*		0.03	0.08			90
FPS4	South Elevation, Column, At Height	0.06*		0.05	0.05			92
FPS5	South Elevation, Column, Ground Level	0.14*		0.01	0.02			82
FPS11	West Elevation, Column, Ground Level	0.04*		0.03	0.05			91
Average	Columns	0.06*		0.03	0.05	0.04		91
Parapets								
FPS2	North Elevation, Parapet, At Height	0.05*		0.01	0.01			42
FPS10	West Elevation, Parapet, At Height	0.01*		0.01	0.03	0.04		61
Mezzanine								
FPS8a	Mezzanine Level Floor, top		0.2*	0.05	0.04			52
FPS8b	Mezzanine Level Floor, bottom	0.05		0.02	0.01			99
Roof Slab								
FPS13a	Roof Slab, Second Level top	0.01*		0.01	0.01		0.01	105
FPS13b	Roof Slab, Second Level bottom	0.04		0.01	0.01			105

*sample comprised of a render or screed layer.

4 DISCUSSION

Based on the findings from this investigation, consideration is given to the short and long term durability the key elements and the associated risk to the structural integrity.

4.1 Concrete Encased Steel Columns and Beams

The most significant risk to the short term durability and overall structural integrity of the columns was considered to be the water accumulating in the failed internal downpipes. Persistent water in the cavity of the columns containing downpipes may accelerate the corrosion of the steel columns and the internal downpipes. Without further investigation it was not possible to ascertain the extent of corrosion that had already occurred.

NB: It is important to note that the internal down pipes may contain asbestos. This is based on our experience with a similar site in WA (The East Perth Power Station).

The wider cracks in the columns and beams (>0.3mm) presented a risk to their medium to long term durability. Where these cracks extended through the concrete cover to the encased steel it was apparent that corrosion was occurring. The steel section loss at the location of the exploratory breakout was only approximately 1mm or less than 10% of the original thickness. Such cracks will allow rapid penetration of chlorides, oxygen and moisture to the encased steel, so that the extent of corrosion and potential for further cracking and delamination of the concrete cover will increase with time.

The risk for wide spread corrosion of the encased structural steel members due to carbonation and/or chloride contamination of the concrete was low. Overall the carbonation of cover concrete was found to penetrate to an average depth of 37mm. Even though this presented a risk for the corrosion of redundant fixings and areas where there was low cover to the steel, the main structural elements were found to have a cover depth typically between 80-90mm. Hence, the risk of significant deterioration due to carbonation was low.

The chloride contents measured for the samples from the columns varied somewhat and the profiles were found to be atypical for structures contaminated from airborne chlorides. Nevertheless, based on the average chloride values within the concrete and the typically high cover depths, it was considered that there was a low risk for widespread chloride induced corrosion of the main structural elements at the time of inspection.

4.2 Reinforced Concrete Parapet Walls

It was apparent that corrosion of the reinforcing steel in localized areas of the parapet walls had resulted in splaying of the concrete cover. However, the majority of the walls appeared to be of a sound condition. The cover meter survey revealed that the cover to the reinforcing steel varied considerably from 36-60mm. Carbonation of the external concrete elements ranged from 30-50mm. The chloride content within the concrete was less than 0.04 wt.% on average. Therefore, it was likely that carbonation of the concrete and localized areas of low concrete cover had been a significant contributor to the defects present at the time of inspection, and would present a moderate risk to the structural integrity of the parapets moving forward.

The current chloride levels presented a low risk of widespread chloride induced corrosion of the reinforcing steel within the parapets. If left unattended for an extended period of time (for example >10 years) the chloride levels may increase to a level that would present a more significant corrosion risk.

4.3 Reinforced Concrete Roof Slabs

It was not possible to complete a detailed inspection of the roof slabs. However, it was apparent the existing waterproofing membranes had suffered significant degradation and there was evidence of water ingress through cracks and joins in the slabs as well as localized areas of concrete spalling and reinforcement corrosion as viewed from the ground.

The depth of carbonation was found to range from 10-30mm and the chloride content levels were very low. At the locations where the concrete cover was measured it was found to be at a cover depth of approximately 100mm from the top of the slab. However, from the soffit of the slab the concrete cover was significantly less at approximately 15-20mm. Therefore, there was a considerable risk of wide spread carbonation induced corrosion of the reinforced concrete roof slabs. This risk will only be increased by the persistent wetting and drying of the concrete due to water penetration through the failed membrane.

4.4 Internal Reinforced Concrete Mezzanine Floors

A general inspection of the internal reinforced concrete mezzanine floors found them to be of a relatively sound condition with some areas of localized lower concrete cover at the soffits, concrete spalling and reinforcement corrosion.

The depth of carbonation was found to range from 40-45mm and the chloride content levels were very low. At the locations where the concrete cover was measured it was found to be at a cover depth of approximately 50 mm from the top of the slab. The cover depth was not measured from the soffit; however, it was expected to be at least similar to the cover to the top layer of reinforcing steel if not less. Based on these results there was a considerable risk of wide spread carbonation induced corrosion of the reinforced concrete mezzanine floor slabs.

4.5 Infill panel walls

No detailed investigation of the infill wall panels was conducted. It was also not certain if they were constructed of reinforced concrete or concrete block work. One typical type of defect that was identified was cracking around the window frames most likely related to corrosion of the embedded frame work.

4.6 Internal Structural Steel Frame

A general visual assessment revealed that the majority of the internal steel frame work was in a relatively good condition and either maintaining a protective coating or only sustaining minor general surface corrosion. Although there were areas where there was evidence of more accelerated localized corrosion, these areas were typically located at edges where elements had been cut or welded. Considering the exposure conditions at the time of inspection the general steel work was expected to corrode relatively slowly (Section 3.1.2).

HASSELL
© 2014

Despite general structural members being at a low risk of sustaining significant deterioration, there is always the risk of localized areas of accelerated corrosion occurring, especially at the location of joints and welds that may pose a more significant risk to the overall structural integrity of the steel frame work.

5 RECOMMENDATIONS

The following recommendations are made with respect to the protection of the primary elements of the building fabric for the interim period before any major redevelopment works are undertaken as well as their long term preservation as part of the redevelopment.

5.1 Interim protection and inspection recommendations

It is recommended that the following measures are undertaken as a minimum to reduce the risk of any significant structural deterioration occurring during the next 5-10 years. I would be prudent to implement these measures as soon as possible.

1. Install suitable temporary downpipes to effectively allow water captured on the roof tops to be transported away from the building.
2. Unblock existing down pipe cavities within columns, inspect for any significant damage using suitable pipe inspection video equipment, seal to minimize the risk of further water ingress. (it is important to note that the internal down pipes may contain asbestos)
3. Conduct an annual general visual inspection of the site to monitor the rate of deterioration and reassess the need for additional protection measures.
4. Within the next 5 years it would also be recommended to conduct a more specific assessment focused on the structural steel members. Especially the jointed sections of the roof trusses.

The following measures are recommended in addition to those above. They are aimed at reducing the rate of deterioration of some key structural elements over the next 5 -10years. If these measures are undertaken it is expected that they will reduce the extent of repair works that will eventually be requiered at the time of a major redevelopment.

5. Apply a temporary protective coating to the external surfaces of the concrete encased steel beams and columns to minimize the moisture, oxygen and chloride ingress at the location of significant cracks. A suitable acrylic coating system with the ability to bridge cracks would be sufficient.
6. Install a suitable water proofing membrane to the roof levels to minimise the risk of water penetration into the roof slabs.
7. Apply a suitable coating or sealant to all surfaces of the mezzanine slabs to reduce moisture ingress.

Should it be intended that the building will remain undeveloped for greater than ten years it would be necessary to reconsider the type and priority of the interim protection measures recommended.

5.2 Long term remediation and protection measures

Ultimately the recommended long term remediation and protection measures will need to consider the intended use and service life for the building. Nevertheless, the following preliminary recommendations are provided based on the structure being redeveloped within the next 5-10 years and being developed as a mixed commercial and residential site.

1. The external concrete elements have relatively low levels of chloride contamination and moderate levels of carbonation. Therefore, it is expected that following conventional repair of the current defects the long term durability of the reinforced concrete could be maintained by the application and upkeep of a suitable protective coating system to minimize the ingress of chlorides, carbon dioxide and moisture.
2. In addition to the conventional concrete repair, the reinforced concrete roof slabs will also require a suitable waterproofing membrane and drainage system to be installed to minimize the risk of water ingress.
3. The internal steel frame work may require some repairs be undertaken at any locations where there has been significant metal loss. For the purpose of the long term preservation the application and upkeep of a suitable coating system will be sufficient.

Prior to any major redevelopment works it is recommended that a comprehensive survey is conducted to allow the extent of repair works to be more accurately estimated as well as specific specification for the repair and protection works.

Appendix A: Test Method Statement

TEST METHOD STATEMENT

TMS 07	VISUAL INSPECTION AND DELAMINATION SURVEY OF CONCRETE STRUCTURES

Scope: To determine and record the condition of a structure by visual inspection and delamination testing.

Application: When reinforcement corrodes, the corrosion products cause tensile forces in the concrete due to an increase in volume over the original steel. The result is a crack, spall or delamination. These defects require investigation in a condition survey because it usually indicates high levels of corrosion activity and represents areas of unsound concrete.

References and Further Reading:

1) Taywood Engineering Ltd, Life Cycle Manual 1988.
2) Concrete Society Technical Report TR32, Section 5.
3) Guide to Concrete Repair and Protection HB 84-2006

Equipment: Concrete sounding hammer, crack width gauge, camera, making chalk/paint

Procedure:

1) List all elements of the structure under inspection in a logical testing sequence.
2) Inspect each element in detail and record all defects found. The defects should be categorised and identified in accordance with the "CONCRETE DEFECT CLASSIFICATION TABLE" attached.
3) The element should be tested for delamination by soundings carried out by tapping the survey area with a hammer to locate all drummy/delaminated concrete or render. The results should be included in the defect record list/drawing.
4) Defects and structural elements typical for the inspection area, or of particular interest, should be photographed and logged.

Skill/Qualification: Testing should be carried out by an engineer, corrosion technologist or supervisor experienced in concrete inspection work.

Records: All defects and photographs should be recorded in Pro Forma (RR07) and located on a suitable drawing or photograph of the structure using either the assigned symbol and/or reference #.

TEST METHOD STATEMENT

TMS 7	VISUAL INSPECTION AND DELAMINATION SURVEY OF CONCRETE STRUCTURES

CONCRETE DEFECT CLASSIFICATION TABLE

Code	Feature	Description	Cause	Details to be Recorded	Mark-up
A1	Cracking (General)	Jagged separations of concrete from no gap and greater	Overload, corrosion, shrinkage etc.	Width, Length	0.2
A2	Pattern cracking	As cracking but formed as pattern	Differential volume change between internal and external concrete	Area X and Y, Width	
B1	Exudation	Viscous gel like material exuding through a pore	Alkali aggregate reaction	Severity	AAR
B2	Incrustation Efflorescence	A crust (white) on the concrete surface	Leaching of lime from cement	Severity/ dampness	XXX
B3	Rust stains	Brown stains	Corrosion of rebar, tying wire or surface steelwork	Severity	R
B4	Dampness	The extent of water on the surface should be stated	Leakage, rundown	Severity	D
C1	Popout	Shallow, conical depression	Development of local internal pressure, it. expansion of aggregate particle	Surface area, depth	
C2	Spall	A fragment detached from a larger mass	Exertion of internal pressure due to corrosion of the reinforcement or exertion of external forces	Area X and Y, Depth	
C3	Delamination	A section of concrete	Exertion of internal pressure due to corrosion of the reinforcement	Area X and Y	
C4	Weathering or scouring	Loss of the concrete	Environmental action wears away the concrete or cement paste	Area X and Y, Depth	
C5	Exposed Aggregate or Etching	Loss of cement matrix	Chemical attach of the cement matrix, ie acid attack or sulphate attack	Area X and Y, Depth	
D1	Tearing	Similar to cracking	Adhesion to slipform shuttering	Area X and Y, Depth	0.2
D2	Honeycombing	Little or no cement matrix around aggregate	Lack of vibration, high placement height	Area, Depth, Severity	
E1	Construction Joint	Line on concrete surface, maybe feather edged or porous	Joint between two pours, with continuous reinforcement	Any associated deterioration	CJ
E2	Panel Joint	Ridge in the concrete surface	Mark formed by shutter joint	Any associated deterioration	
E3	Expansion Joint	Damaged edge/failed sealant	Joint between pours or panels, with discontinuous reinforcement	Any associated deterioration	EJ

RR07: Visual Survey

Reference Doc: TMS07

Job #: ____ Subject: ____ Survey By: ____ Date: ____
Client: ____ Conditions: ____ Checked By: ____ Date: ____
Project: ____ Temp: ____ Sheet: ____ of ____

Ref.#	Location	Defect	Photo #	width (mm)	length (mm)	Comment

Ref:RR07 Visual Survey LE 131108 Site Proforma 11/13/2008

Appendix B: Visual Survey Results

HASSELL
© 2014

RR07: Visual Survey

Reference Doc: TMS07

T51256 — **Subject:** Condition Survey — **Survey By:** LE — **Date:** 26/07/2011
Wood & Grieve Engineers — **Conditions:** Showers — **Checked By:** LH — **Date:** 29/07/2011
Fremantle Power Station — **Temp:**

Location	Defect	Photo #	Width (mm)	Length (mm)	Depth (mm)	Comment
East Elevation	Delamination		400	300		Southern face of column
	Delamination		400	500		Eastern face of column
	Crack	199	0.2+	10,000		Crack on column. Cover low point 56mm. Crack follows low cover point.
	Delamination	200	290	3000		Delaminated section beneath window
	Delamination	201	900	3000		Area of low cover and exposed bar ends.
	Spall	202	100	100		Bar end pop out. Low cover and corrosion on bar end.
	Delamination		290	3000		Delaminated section beneath window
	Delamination /Crack	203	500	1000		Delamination and cracking under beam
	Crack		0.2+	10,000		Crack on column
	Crack		0.2+	15,000		Crack on column
	Crack		0.2+	15,000		Crack on column
	Crack		0.2+	6,000		Crack on column
	Crack		0.2+	15,000		Crack on column
	Crack		0.2+	18,000		Crack on column
	Crack		0.2+	15,000		Crack on column
	Crack	205	0.2+	6,000		Crack on column

Ref:RR07 Visual Survey Fremantle Power Station 180711 — Page 1 of 2

RR07: Visual Survey

Reference Doc: TMS07

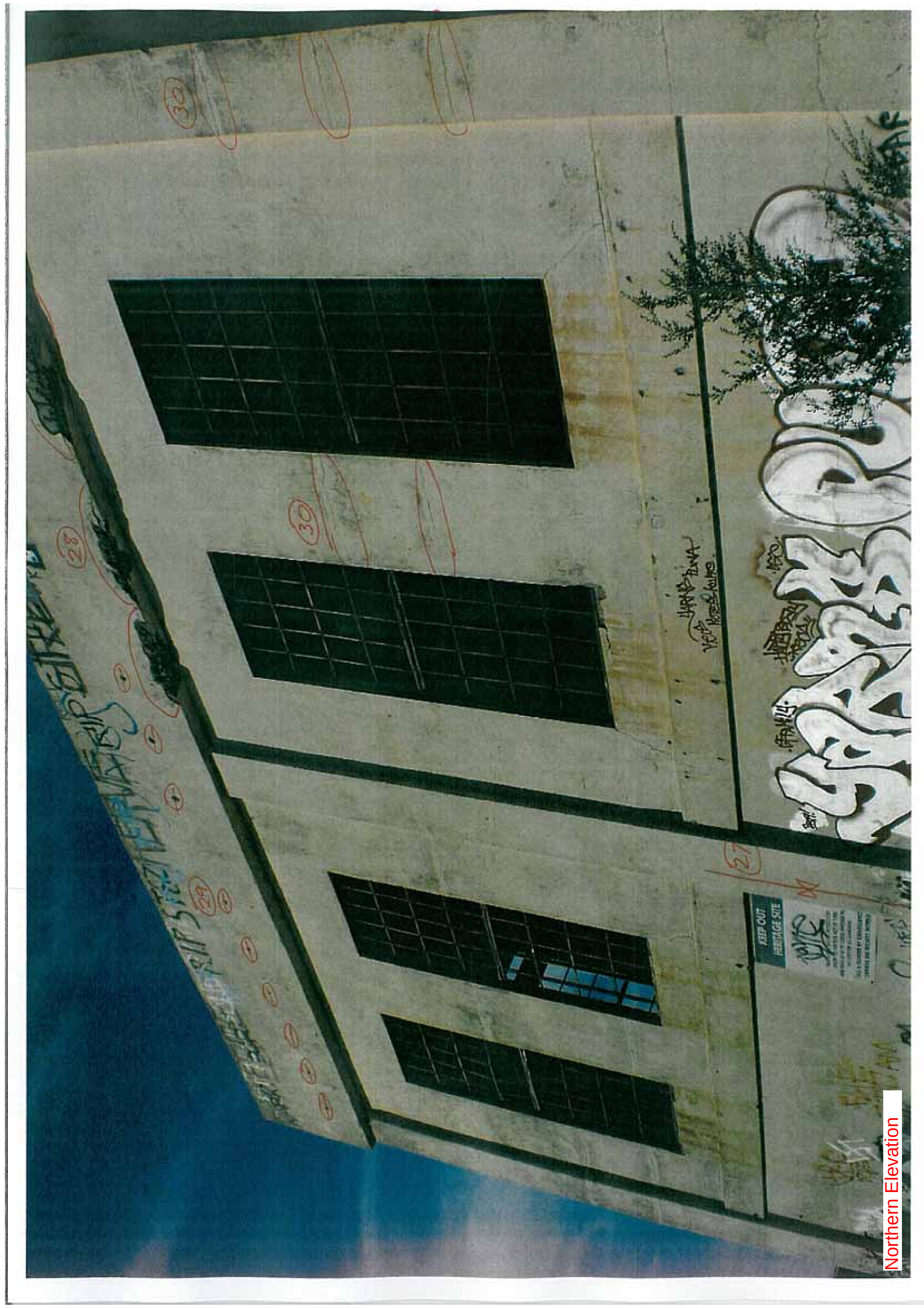
Job #: T51256 — **Subject:** Condition Survey — **Survey By:** LE — **Date:** 26/07/2011
Client: Wood & Grieve Engineers — **Conditions:** Showers — **Checked By:** LH — **Date:** 29/07/2011
Project: Fremantle Power Station — **Temp:**

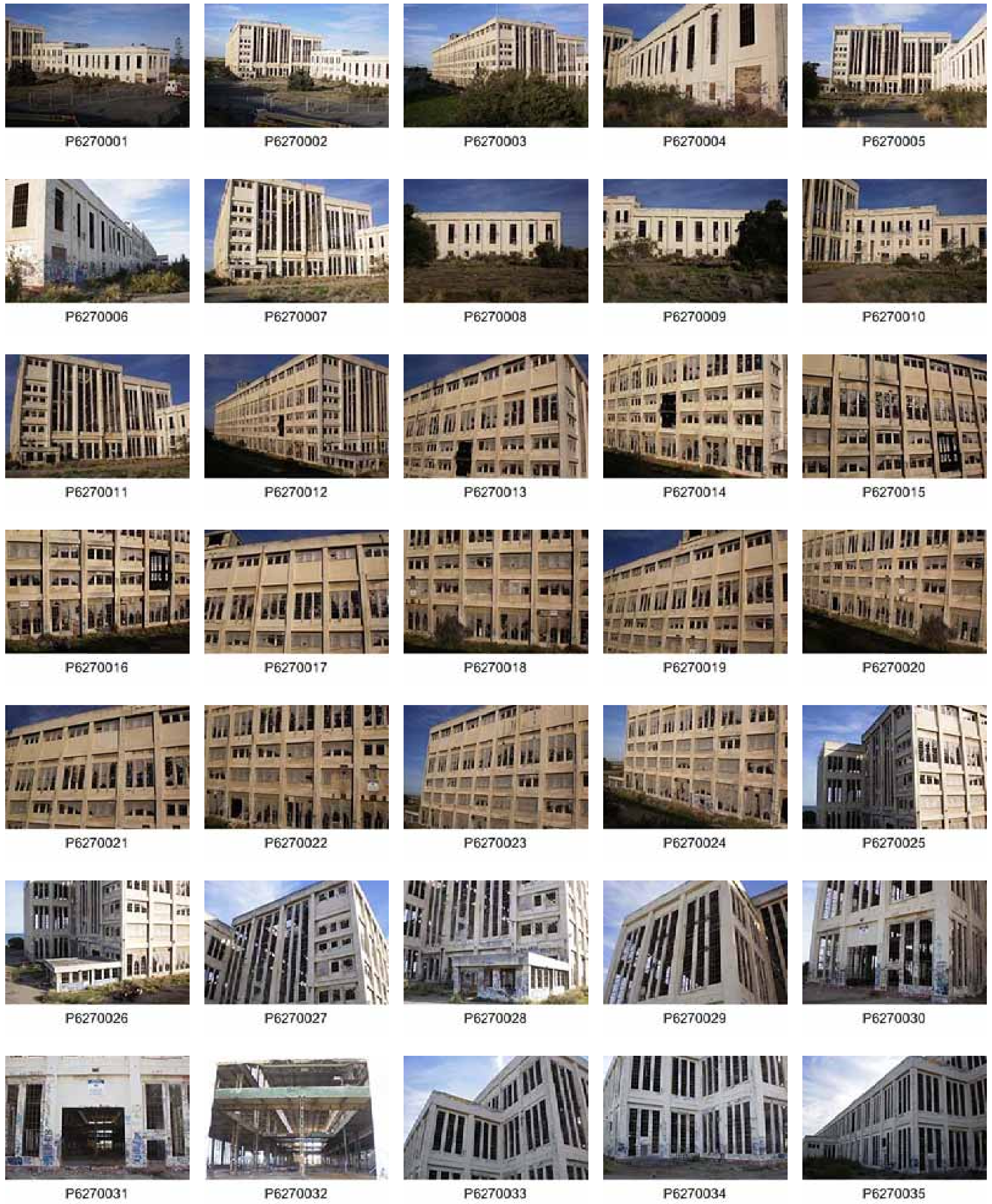
Ref.#	Location	Defect	Photo #	Width (mm)	Length (mm)	Depth (mm)	Comment
17			204				General photo. Blocked drains, slow leaks through cold joints.
18		Leak	206				Water leaking through crack
19		Crack					
20		Delamination		400	2000		Several delaminatied areas in column
21		Spall	207	400	1000		Render spall on horizontal column crack. Breakout showed crack and leaking on cold joint.
22	South Elevation	Crack	208	0.2	5000		Crack following beam on column
23	Inspection Point		209/11				Column broken out on crack. Corrosion present. 20mm before clean and 15mm after.
24	Inspection Point		213				Good area on column broken out. Clean steel with coating in good condition. 16mm beam
25		Crack	212	0.2+	600		
26		Delamination		400	800		
27	North Elevation	Crack	147	2	4500		Crack following beam in column. Break out found surface corrosion.
28		Spall	148	300	3000	45	3 spalls on parapet. 16mm rebar with corrosion and 2mm section loss.
29		Spall	149	600	600		Pop outs on bar ends with minimal cover.
30		Crack					Various horizontal cracks - assumed to be render cracks on cold joints.

Ref:RR07 Visual Survey Fremantle Power Station 180711 — Page 2 of 2


Eastern Elevation


Southern Elevation


Northern Elevation


P6270001
P6270002
P6270003
P6270004
P6270005
P6270006
P6270007
P6270008
P6270009
P6270010
P6270011
P6270012
P6270013
P6270014
P6270015
P6270016
P6270017
P6270018
P6270019
P6270020
P6270021
P6270022
P6270023
P6270024
P6270025
P6270026
P6270027
P6270028
P6270029
P6270030
P6270031
P6270032
P6270033
P6270034
P6270035

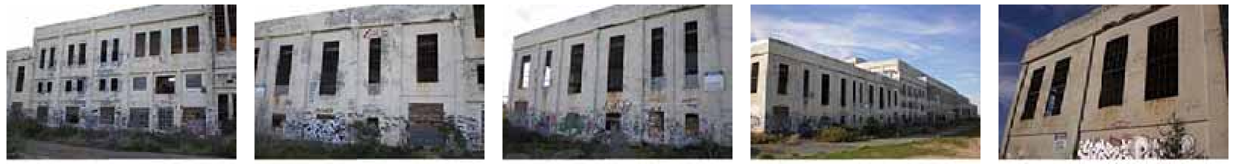
P6270036 P6270037 P6270038 P6270039 P6270040

P6270041 P6270042 P6270043 P6270044 P6270045

P6270046 P6270047 P6270048 P6270049 P6270050

P6270051 P6270052 P6270053 P6270054 P6270055

P6270056 P6270057 P6270058 P6270059 P6270060



P6270061 P6270062 P6270063 P6270064 P6270065

P6270066 P6270067 P6270068 P6270069 P6270070

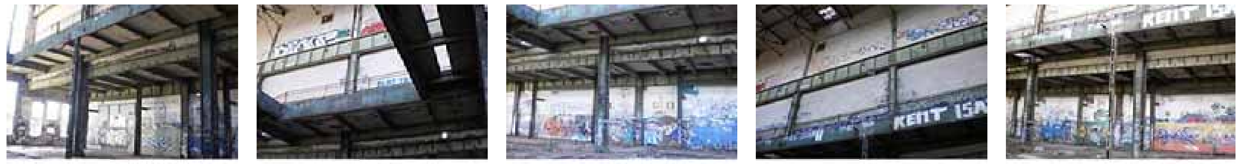
P6270071 P6270072 P6270073 P6270074 P6270075

P6270076 P6270077 P6270078 P6270079 P6270080

P6270081 P6270082 P6270083 P6270084 P6270085

P6270086 P6270087 P6270088 P6270089 P6270090

P6270091 P6270092 P6270093 P6270094 P6270095



P6270096 P6270097 P6270098 P6270099 P6270100

P6270101 P6270102 P6270103 P6270104 P6270105

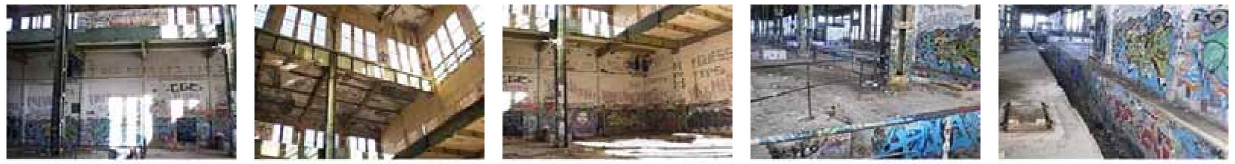
Appendix B
Structural Inspection Report

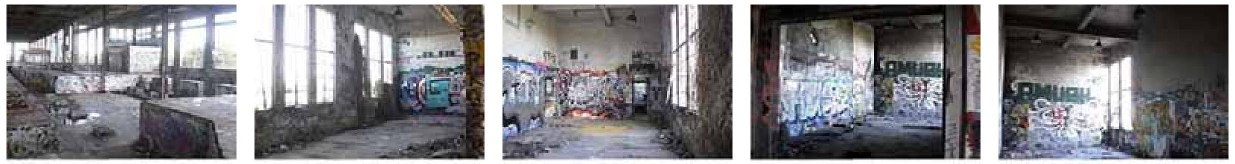

P6270106 P6270107 P6270108 P6270109 P6270110


P6270111 P6270112 P6270113 P6270114 P6270115


P6270116 P6270117 P6270118 P6270119 P6270120


P6270121 P6270122 P6270123 P6270124 P6270125


P6270126 P6270127 P6270128 P6270129 P6270130

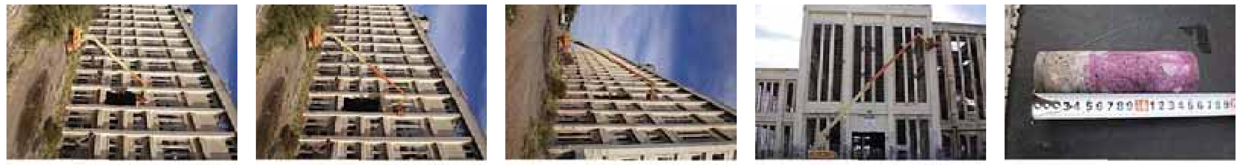

P6270131 P6270132 P6270133 P6270134 P6270135


P6270136 P6270137 P6270138 P6270139 P6270140


P6270141 P6270142 P6270143 P6270144 P6270145


P6270147 P6270148 P6270149 P6270150 P6270151


P6270152 P6270153 P6270154 P6270155 P6270156


P6270157 P6270158 P6270160 P6270163 P6270165

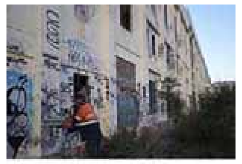

P6270166 P6290171 P6290173 P6290174 P6290175


P6290176 P6290177 P6290178 P6290179 P6290180

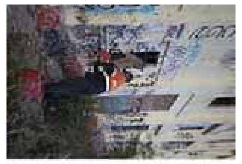

P6290181 P6290182 P6290183 P6290184 P6290185


P6290186


P6290189


P6290190


P6290191


P6290192


P6290193


P6290197


P6290198


P7010199

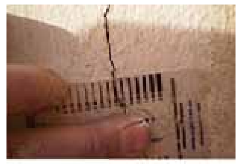

P7010200


P7010201


P7010202


P7010203


P7010204


P7010205


P7010206


P7010207


P7010208


P7010209


P7010211

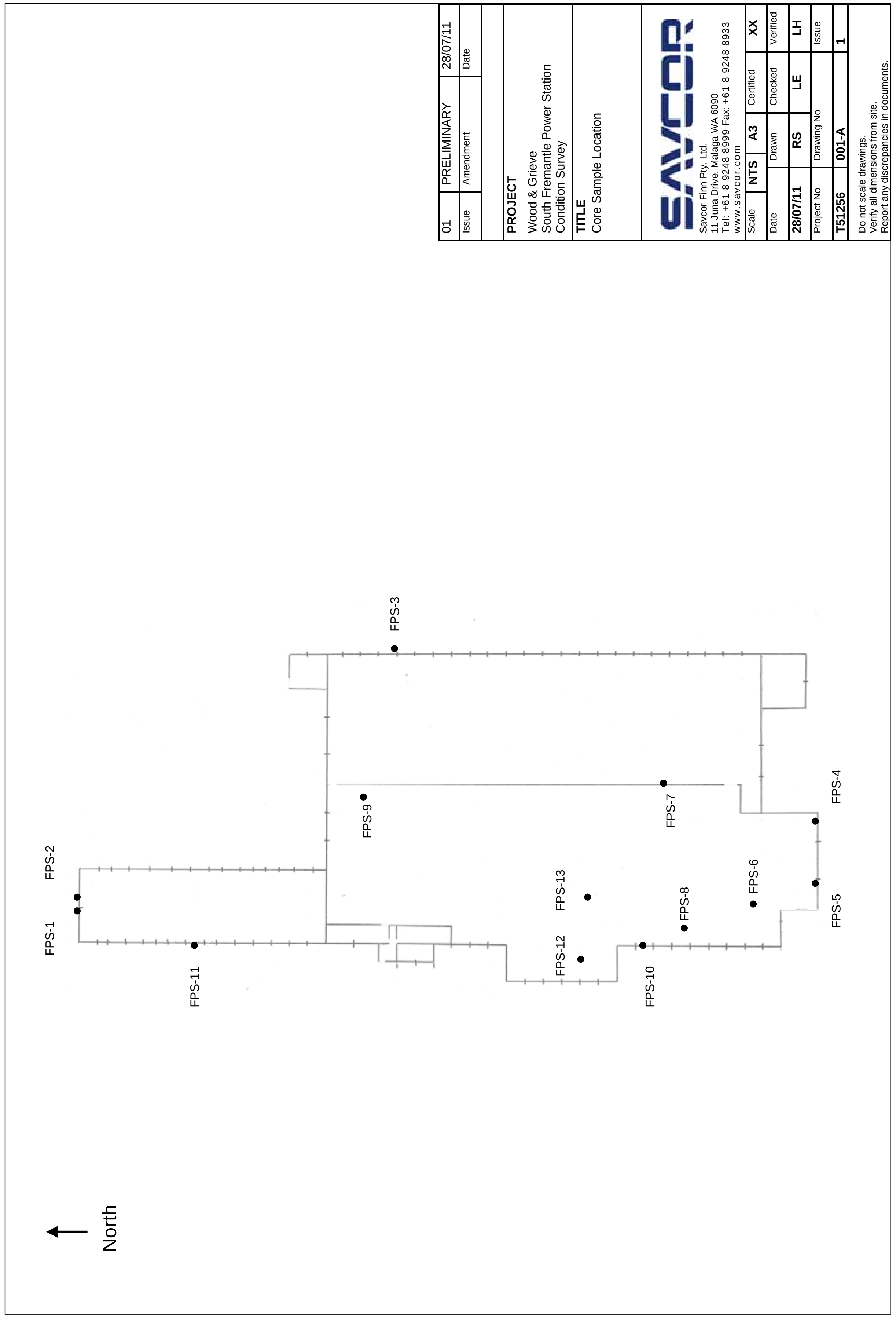

P7010212

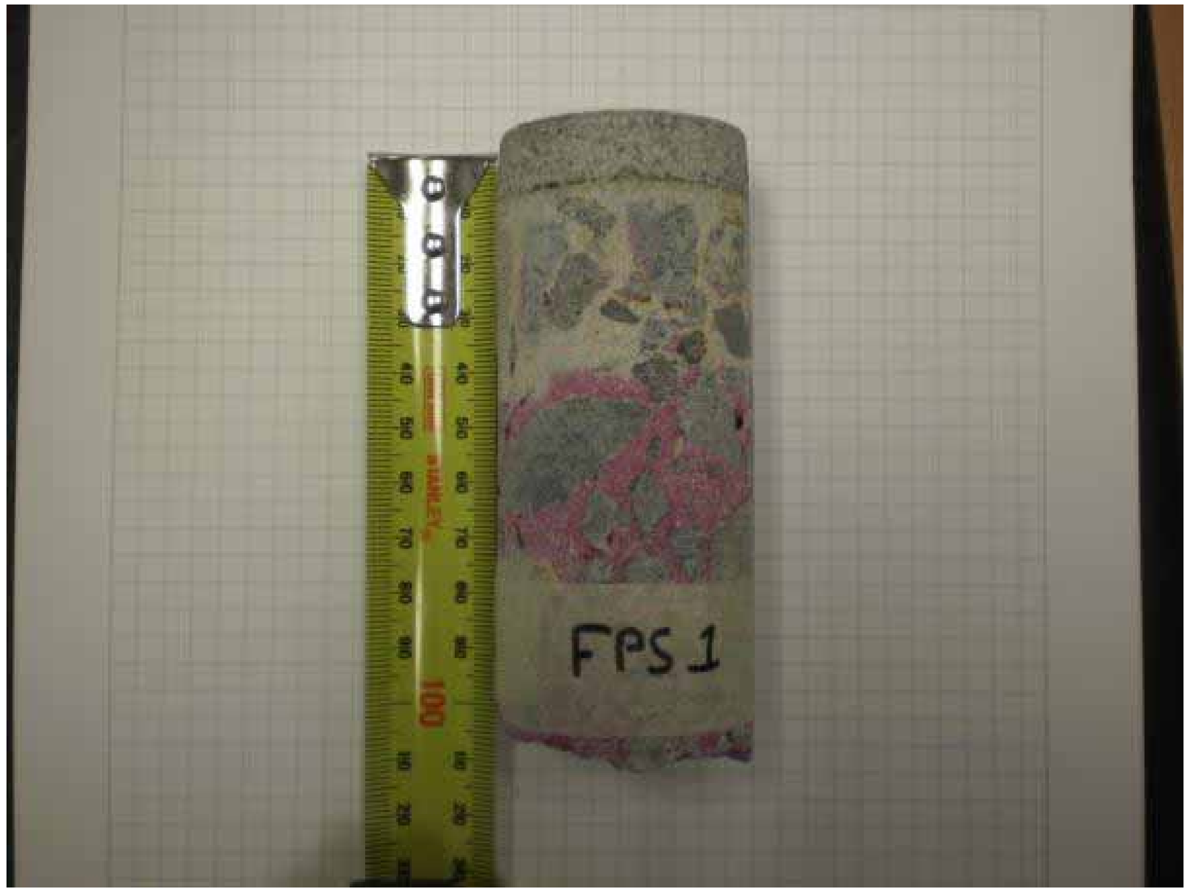

P7010213

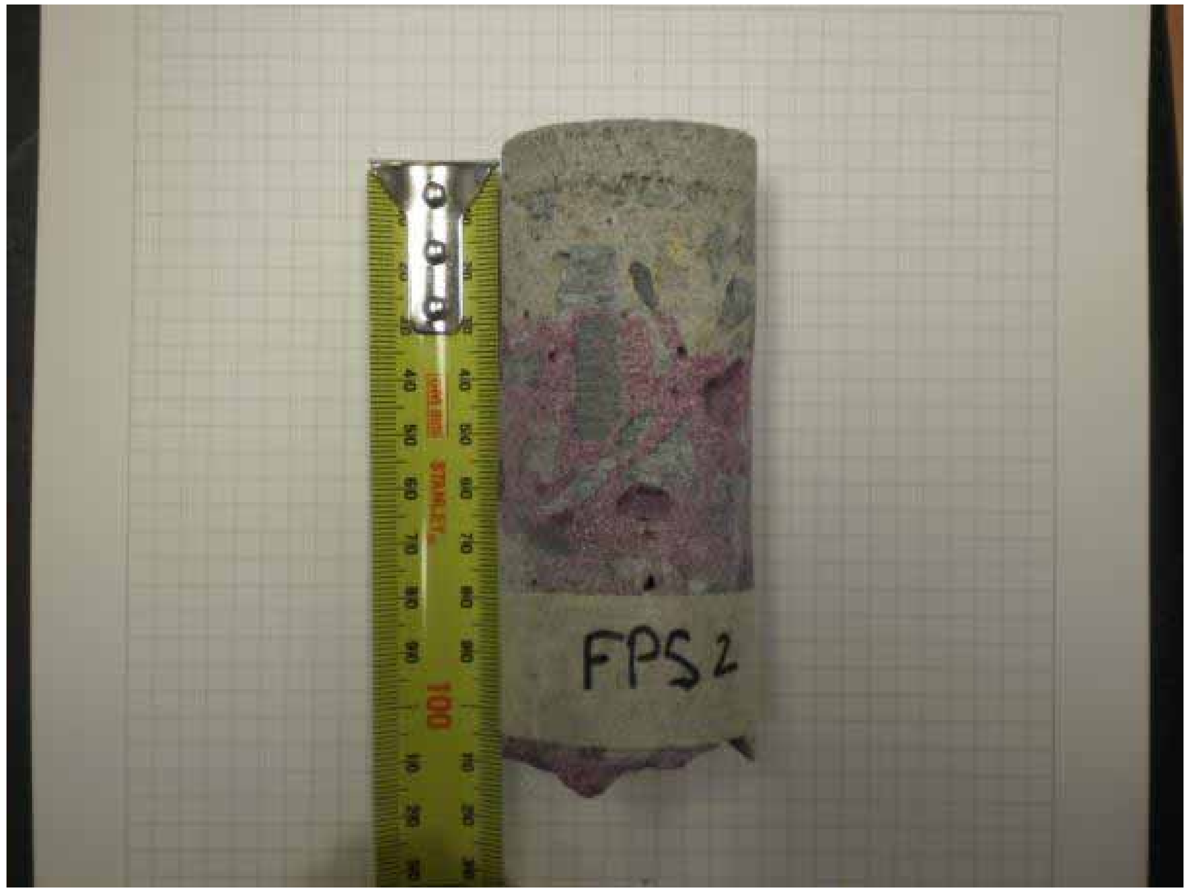
Appendix C: Core Sample Locations and Photographic Records

© 2014

Appendix B
Structural Inspection Report








Sketch Pad
Date:
FPS3


SAVCOR FINN Pty Ltd
Sketch Pad
Job Ref:
Date:
5
FPS 5


Sketch Pad
Date:
FPS 4

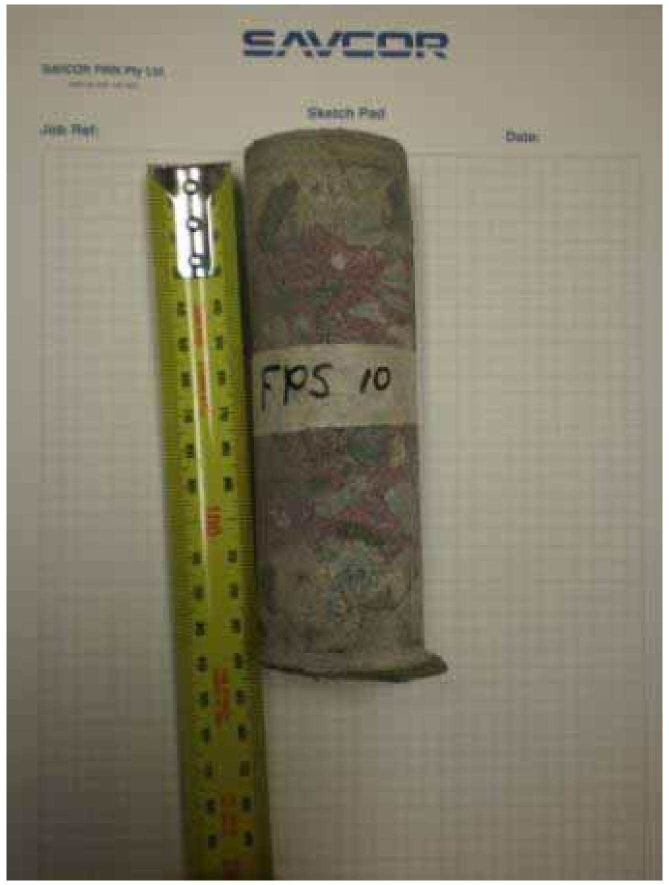

Job Ref:
Date:
FPS-6

© 2014


SAVCOR
FPS 7


Job Ref:
Date:
FPS 8


Job Ref:
Sketch Pad
Date:
FPS 9


SAVCOR
Job Ref:
Sketch Pad
Date:
FPS 10


SAVCOR
Sketch Pad
Job Ref:
Date:
FPS 11


SAVCOR
SAVCOR FINN Pty Ltd
Sketch Pad
Job Ref:
Date:
FPS 12


SAVCOR FINN Pty Ltd
Sketch Pad
Job Ref:
Date:
FPS 13

Appendix D: Cover Meter Survey Results

SAVCOR **RR05: Covermeter Survey**

Reference Doc: TMS05

Job #: T51256
Client: Wood & Grieve Engineers
Project: South Fremantle Power Station

Subject: -
Conditions: Showers
Temp: -

Survey By: Luke Evans **Date:** 27/07/2011
Checked By: Liam Holloway **Date:** 27/07/2011
Sheet: 1 **of** 1

Zone.#	Location	Ori	Dia. mm	Measurements (mm)								Min (mm)	Max (mm)	Ave (mm)
cov.	FPS-1		Beam	89	88	89	90	90	89	89	89	88	90	89
cov.	FPS-2		16	48	46	41	39	37	36	41	47	36	47	42
cov.	FPS-3		Beam	90	91	90	90	91	91	90	90	90	91	90
cov.	FPS-4		Beam	91	92	93	92	92	93	91	92	91	93	92
cov.	FPS-5		Beam	81	82	81	82	81	82	82	82	81	82	82
cov.	FPS-6		Mesh	30	31	30	31	30	30	30	30	30	31	30
cov.	FPS-7		16	100	98	99	98	99	99	101	101	98	101	99
cov.	FPS-8		16	52	52	53	52	53	52	52	53	52	53	52
cov.	FPS-9		16	55	54	52	53	55	54	55	53	52	55	54
cov.	FPS-10		16	60	62	62	61	62	63	60	61	60	63	61
cov.	FPS-11		Beam	90	91	91	90	92	90	91	89	89	92	91
cov.	FPS-12		16	102	100	100	101	101	100	102	101	100	102	101
cov.	FPS-13		16	105	104	105	105	104	105	104	105	104	105	105

Appendix E: Chloride Content Results

SGS

Client:	Savcor Finn Pty Ltd 11 Juna Drive Malaga WA 6090
Your Reference:	T51256 – Fremantle Power Station
Our Reference:	JN 11-06-143

Certificate of Test No. 7769

Sample:	Concrete Core Samples
Date Received:	15th July 2011
Date Tested:	27th-28th July 2011
From:	Fremantle Power Station
Description & Condition:	9 –off nominal 45 mm diameter concrete core samples

Test Description: **Acid Soluble Chloride Content**

Sample Preparation:

Sub-samples removed from cores by dry diamond saw, pulverised to pass 150 μm sieve prior to analysis.

Test Method:

Chloride content in accordance with BS 1881:Part 124:1988 "Methods for Analysis of Hardened Concrete" Section 10.2, except titration by potentiometric method.

28/07/11			28/07/11
Tested By F. Juwono, Technical Officer	Date	Approved Signatory N. Nguyen, Chemist	Date

NATA

NATA Accredited Laboratory No. 2418. **Page 1 of 3**
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced except in full.

SGS Australia Pty Ltd | Industrial Division, 36 Railway Parade, Welshpool WA 6106 t + 1300 781 744 f + 61 (8) 9458 3700 www.sgs.com

PF-(AU)-IND(MTE)-SC-029.B.08.09.2009

Certificate No. 7769

Test Results:

SGS Lab No.	Client No.	Sample Location	Depth (mm)	% Cl⁻ by Weight of Concrete
P34323	FPS-1	Front/Top	0-10 (render) 10-20 20-30 80-90	0.01 0.03 0.04 0.04
P34324	FPS-2	Front/Top	0-10 (render) 10-20 20-30	0.05 0.01 0.01
P34325	FPS-3	Front/Top	0-10 (render) 10-20 20-30	0.07 0.03 0.08
P34326	FPS-4	Front/Top	0-10 (render) 10-20 20-30	0.06 0.05 0.05
P34327	FPS-5	Front/Top	0-10 (render) 10-20 20-30	0.14 0.01 0.02
P34328	FPS-8	Front/Top	0-20 (screed) 20-30 30-40	0.20 0.05 0.04
		Back/Bottom	0-10 10-20 20-30	0.05 0.02 0.01
P34329	FPS-10	Front/Top	0-10 10-20 20-30 70-80	0.01 0.02 0.03 0.04
P34330	FPS-11	Front/Top	10-10 10-20 20-30	0.04 0.03 0.05

NATA Accredited Laboratory No. 2418.
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced except in full.

Page 2 of 3

PF-(AU)-IND(MTE)-SC-029.B.08.09.2009

Certificate No. 7769

Test Results:

SGS Lab No.	Client No.	Sample Location	Depth (mm)	% Cl⁻ by Weight of Concrete
P34331	FPS-13	Front/Top	0-10 10-20 20-30 70-80	0.01 0.01 0.01 0.01
		Back/Bottom	0-10 10-20 20-30	0.04 0.01 0.01

This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

NATA Accredited Laboratory No. 2418.
This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced except in full.

Page 3 of 3

PF-(AU)-IND(MTE)-SC-029.B.08.09.2009

Appendix B
Structural Inspection Report

Appendix D – General Information

WOOD & GRIEVE ENGINEERS — CELEBRATING 50 YEARS

ENQUIRIES: ERIC LE MEUR
PROJECT NO: 20146-PER-S

10 August 2011

LandCorp
Locked Bag 5, Perth Business Centre
PERTH WA 6849

Attention: Mr Sergio Famiano

Dear Sergio

**RE: SOUTH FREMANTLE POWER STATION
STRUCTURAL SCOPE OF WORK FOR TEMPORARY STABILISATION**

This interim report serves to define the structural scope of work required to reduce the risk of any significant structural deterioration occurring at the south Fremantle Power Station over the next 5 to 10 years. This information is suitable for order-of-magnitude "structural stabilisation" costing to be undertaken.

The recommendations made in this document are based on the results of material testing undertaken by Savcor in July 2011 and a visual inspection of the building undertaken by WGE at the same time.

The objective of the short-term stabilisation works is understood to be as follows:

1) To reduce the risk of significant structural deterioration occurring in the short term (5 to 10 years) prior to permanent/long term re-development.

2) To reduce the risk of failure of any critical structural component occurring in the short term (5 to 10 years).

3) To reduce the risk of structural degradation which may present a safety hazard to personnel accessing the building in the short term period.

The qualifications applying to the advice contained in this report are as follows:

1) Some areas of the building could not be safely inspected (e.g. roof slabs) and were only sighted via mobile access platforms. As such it is probable that our inspection cannot identify every potential defect of the building which may impact our structural assessment. It is our goal to maximise the extent of our inspection within the constraints of safe access available.

2) Inspections did not involve inspections of concealed spaces.

3) All information provided by others (laboratory reports, existing drawings) have been accepted as correct and has not been separately verified.

Level 3, 3 Plain Street, East Perth WA 6004
Phone +61 8 6222 7000 Fax +61 8 6222 7100 Email wge@wge.com.au Web www.wge.com.au
Wood & Grieve Engineers ABN 97 137 999 609 trading as Wood & Grieve Engineers Limited ACN 137 999 609
Albany Brisbane Busselton Darwin Gold Coast Melbourne Perth Shenzhen Sydney

DOCUMENT: M:\TECH\20100\46\STRUCTURAL\S_CL_001_SHORTTERMSTABILISATIONSCOPE.DOCX (NJ)
Certified System Quality ISO 9001

4) Short-term remediation of non-structural components (window frames, hand-railing and such) does not form part of this report.

5) Concrete test results are based on representative sampling only and may not identify all areas of localised defects.

The recommended measures for short-term structural stabilisation are as follows:

Remediation of Concrete-encased external steel columns and beams:

Defect: The external concrete-encased steel columns appear to have undergone minor levels of corrosion (approximately 10% loss of steel parent material) in the areas which were inspected. There is regular cracking present within the concrete which encases the steel columns. These cracks have facilitated the ingress of moisture, chlorides and oxygen through the concrete encasement to the steel columns and beams. As such the potential for further corrosion of the encased steel members will increase over time. It was also noted that roof drainage downpipes cast within the concrete at each column locations were blocked and were retaining water over the entire height of the downpipe. The entrapment of this water in the downpipe and possible leakage into the concrete and through to the steel column further increases the risk of moisture-induced corrosion in the steelwork.

Solution: In order to prevent further corrosion of the encased steel columns, any moisture ingress through cracks and failed downpipes must be prevented. The methodology is as follows:

Remedial Scope:

1) Core-drill through external concrete encasement at base of each external columns to allow water trapped in downpipes to drain out.

2) Provide an alternative temporary roof drainage path by installing new down-pipes to the face of the façade or alternatively by drilling through concrete parapet and allowing water to drain freely from the roof level.

3) Once empty, the inlet of the existing down-pipes are to be plugged/sealed at roof level.

4) Apply acrylic coating to external column and beam encasement as shown on attached photograph #1.

Savcor or any other suitably qualified materials repair contractor is able to provided cost estimates for this work.

Strengthening of Roof Truss Connections

Defect: Although the general condition of the internal, exposed steelwork truss members in the generator room appear to be generally sound throughout, some localised degradation of welds and bolted truss connections has taken place over time. In our experience, the degradation of steelwork connections is more likely to present a higher risk to the overall stability and structural integrity of the steelwork than the actual degradation/corrosion of the member itself. As such we consider that that preventative remediation of the roof truss connections via localised site welding where required is an important part of the short-term stabilisation process.

Solution: It is recommended that a cost provision be made for a strengthening of bolted and welded roof truss connections via site welding. At this stage, allowance should be made for this work to be undertaken on each truss. There may be scope to reduce the extent of strengthening if the remedial work is undertaken in conjunction with a detailed truss connection survey which may help identify areas which do not require strengthening. This survey would involve both visual of each bolt and non-destructive weld testing of welded connections.

Remedial Scope: (Note this scope is provisional only – In the absence of further detailed non-destructive testing and inspection of truss connections, an allowance has been made for strengthening by welding on all trusses)

1) Access roof trusses via EWP's (Elevated Word Platforms).

2) clean truss nodes (connection points of truss members – refer attached truss elevation) using mechanical power tools and provide 200mm long, 6mm fillet weld at each joint node. Allow for 14 weld locations per truss (14 truss node).

3) Reinstate weld areas via suitable surface tolerant epoxy.

Degradation and spalling of mezzanine concrete slabs and roof slab (Overhead Hazard)

Defect: Large areas of spalling concrete are evident in both the roof slabs and mezzanine roof slabs. This is caused by the long-term corrosion and expansion of reinforcement within the slabs which in turn has led to the cracking and spalling of concrete. The extent of this defect is more severe in the roof slab than in the mezzanine slabs. Although there is little evidence to suggest that concrete fragments are regularly detaching from the roof slab (general absence of concrete fragments on the turbine room and boiler room floor), the possibility of future concrete fragments falling in an area where personnel may occasionally access the site as part of any further investigative work. (e.g.: annual structural inspections/survey work/remediation work) should be given due consideration as part of any risk-management process. In this case we would consider the risk to be low but of high consequence (a small fragment falling over this height represents a high risk). To a lesser degree, this hazard exists also with the degradation and spalling of mezzanine slabs.

Solution: It is expected that the roof slab is beyond economical repair in the long term and would need to be replaced as part any long-term adaptive re-development. As such there appears to be no economical merit in undertaking detailed and costly concrete repair work to the roof slab to prevent further spalling. The risk of falling concrete fragments can be mitigated by way of a rock fall protection system. This would consist of suspending wire-meshing between roof trusses, slightly below the underside of the roof slab to prevent any concrete fragments falling from the roof from reaching the floor. The type of protection system is commonly used in dilapidated structures pending remediation.

Remedial Scope:

1) Undertake safety breakout (breakout of concrete which appears to be close to spalling) to turbine roof slab, boiler roof slab .and all mezzanine slabs via EWP.

2) Provide suspended meshing (chicken wire) to underside of turbine roof slab, boiler roof slab .and all mezzanine slabs.

Savcor or any other suitably qualified materials repair contractor is able to provided cost estimates for this work.

Annual Inspections

Defect: The short-term remediation measures detailed above are based on testing and observations recently undertaken. The projected deterioration rate of materials and structural components can reasonably be predicted o

Solution: Conduct an annual general visual inspection of the site to monitor the rate of deterioration and re-assess the need for additional protection measures

Remedial Scope:

1) Annual report by structural engineer.

Allow for approximately $5000 per annual inspection.

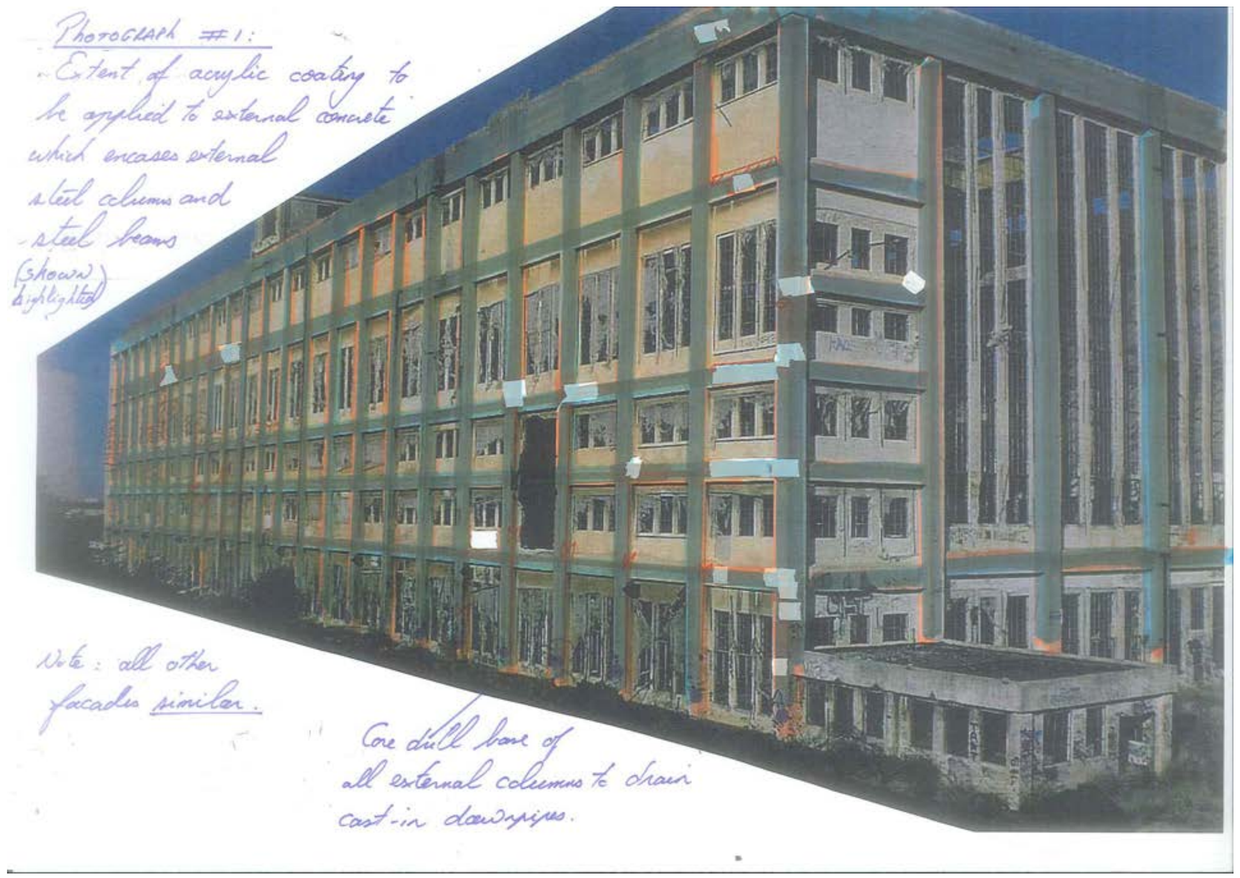
We trust the above suits your current requirements, please contact the undersigned should you have any queries.

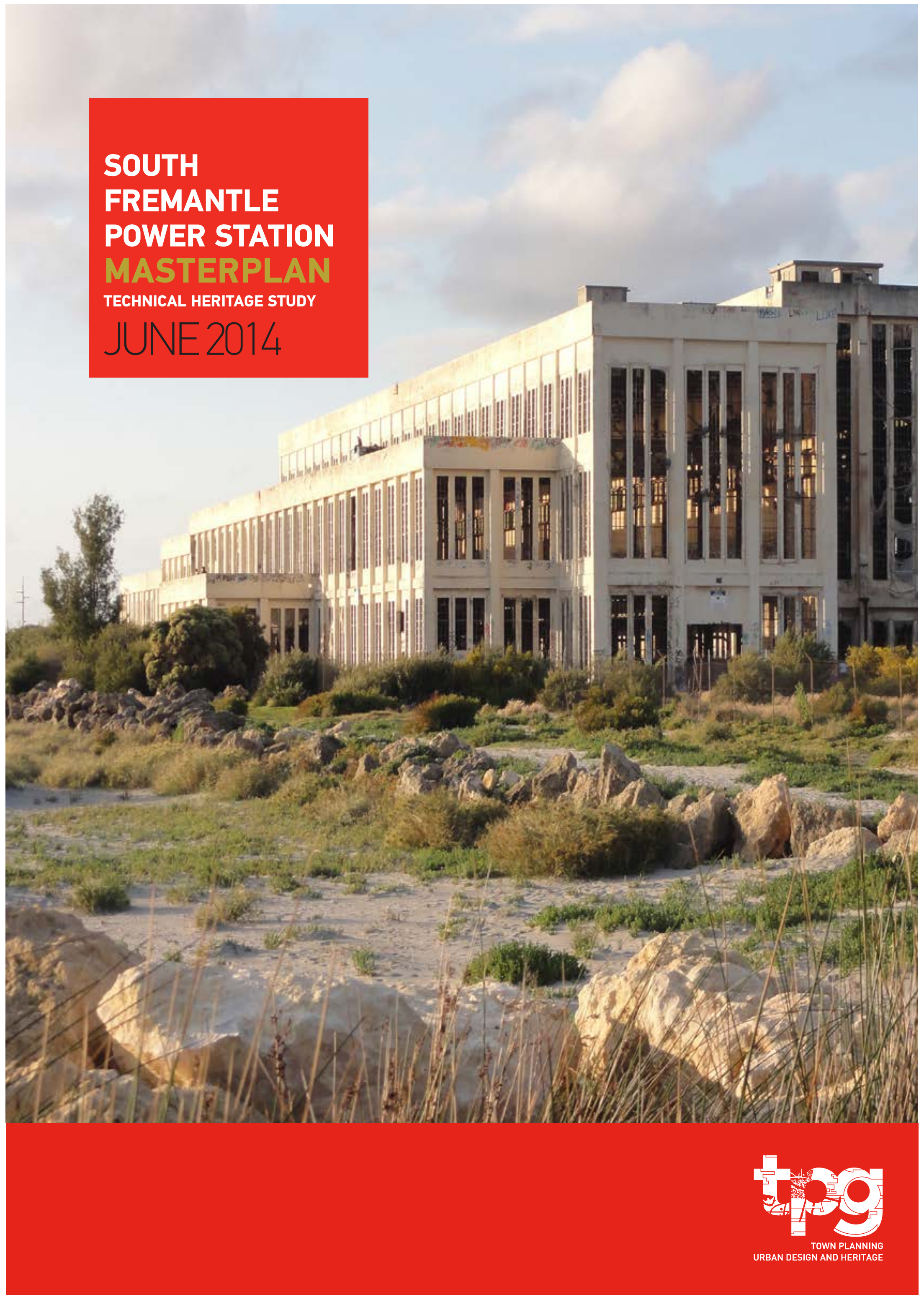
Yours faithfully

Eric Le Meur
for **Wood & Grieve Engineers**

Encl Photograph 1 notes.

DOCUMENT: M:\TECH\20100\46\STRUCTURAL\S_CL_001_SHORTTERMSTABILISATIONSCOPE.DOCX (NJ)





TOWN PLANNING
URBAN DESIGN AND HERITAGE

SOUTH FREMANTLE POWER STATION MASTERPLAN

Heritage Technical Study

711-310

JUNE 2014

© 2014

DOCUMENT CONTROL

Document ID: PLANNING/PG 2011/711-310 South Fremantle Power Station Masterplan/7 Final Documents/1 Lodged/711-310 Heritage Technical Report 16.04.14.indd						
Issue	Date	Status	Prepared by		Approved by	
			Name	Initials	Name	Initials
1	27.01.2012	Draft	Nerida Moredoundt, Susannah Kendall & Sian Morgan		Nerida Moredoundt	
2		Draft	Sian Morgan		Nerida Moredoundt	
3	17.01.14	Final	Sian Morgan		Nerida Moredoundt	
4	10.04.14	Rev1	Sian Morgan		Nerida Moredoundt	
5	16.04.14	Rev2	Sian Morgan		Nerida Moredoundt	
6	23.06.14	Rev3	Sian Morgan		Nerida Moredoundt	

This report has been prepared for the exclusive use of the Client, in accordance with the agreement between the Client and TPG ('Agreement').

TPG accepts no liability or responsibility whatsoever in respect of any use of or reliance upon this report by any person who is not a party to the Agreement or an intended recipient.

In particular, it should be noted that this report is a qualitative assessment only, based on the scope and timing of services defined by the Client and is based on information supplied by the Client and its agents.

TPG cannot be held accountable for information supplied by others and relied upon by TPG.

Copyright and any other Intellectual Property arising from the report and the provision of the services in accordance with the Agreement belongs exclusively to TPG unless otherwise agreed and may not be reproduced or disclosed to any person other than the Client without the express written authority of TPG.

CONTENTS

EXECUTIVE SUMMARY

TPG Heritage has been commissioned by LandCorp to prepare a Heritage Technical Study for the South Fremantle Power Station, to support the Master Plan being prepared for the site.

The Heritage Technical Study identifies the heritage significance of the Power Station building itself, as well as the other places of historic, Aboriginal and maritime significance in the vicinity of the Power Station.

The potential for adaptive reuse of the Power Station has been explored in the analysis of the site and the case studies that have been investigated in order to examine the extent of compatible and feasible options in developing a vision for the future of the site.

Opportunities and constraints arising from the current circumstances are then discussed. While the distinctive form, height and architectural design of the Power Station provide opportunities for new development in the vicinity, there are a number of challenges in realising the potential of the site, primarily in relation to the degraded condition of the vacant Power Station. Any future development of the precinct will also impact upon other sites of Historic, Aboriginal and Maritime significance, which must be treated sensitively.

Heritage management opportunities are then discussed. This is followed by an assessment of the proposed Master Plan in terms of its potential impacts upon the heritage significance of the Power Station and other heritage places in the vicinity.

It is concluded that the Master Plan is a positive step forward in the process toward realising the potential of the South Fremantle Power Station, and celebrating its heritage significance as the centrepiece of the broader Cockburn Coast redevelopment project.

Figure 1 - Location Plan

HASSELL
© 2014

1. INTRODUCTION

The Cockburn Coast District Structure Plan envisages that the South Fremantle Power Station site will be rejuvenated as a major activity node, forming the hub of the new community and a regional attractor.

The preparation of the Master Plan for the site (comprising Lots 2, 3 and 2167 Robb Road, North Coogee), of which this Heritage Technical Study is a component, is an important step in realising the potential of the site and is essential in progressing the zoning of the land from 'Urban Deferred' to 'Urban' under the Metropolitan Region Scheme.

Heritage analysis and input has been key in informing the preparation of the Master Plan. The current Heritage Technical Study addresses both the opportunities and challenges of the Power Station that have been explored in arriving at preferred options for the site. While the distinctive form, height and architectural design of the Power Station provide opportunities for new development in the vicinity, there are a number of challenges in realising the potential of the site. Any future development of the precinct will also impact upon other sites of historic, Aboriginal and maritime significance, which have also been considered in relation to the masterplanning. These opportunities and constraints are discussed further in Section 6.2 of this report.

The potential for adaptive reuse of the Power Station is a pivotal consideration for the Master Plan. This has been explored in the analysis of the heritage significance of the site captured in Section 4, and the case studies that have been identified and investigated in Section 6.1, in order to examine the extent of compatible and feasible options in developing a vision for the future of the site.

Section 7 outlines the heritage managment opportunities that are relevant to the adaptive reuse of the Power Station. This is followed by an assessment of the heritage implications of the proposed Master Plan.

Figure 2 - Heritage Places within the Cockburn Coast and immediate locality

2. BACKGROUND

The Metropolitan Region Scheme (MRS) Amendment stated that a detailed Master Plan is required for Lots 2, 3 and 2167 Robb Road (the Power Station Master Plan Precinct) and must demonstrate the following heritage considerations:

> *Heritage assessment and demonstration of adaptive reuse of the South Fremantle Power Station to a detailed standard in relation to State Planning Policy 3.5 - Historic Heritage Conservation [Section 6], planning Bulletin 88 - Historic Heritage Conservation and the Cockburn Coast District Structure Plan [Section 2.5].*

The primary objectives of State Plannning Policy 3.5 - Historic Heritage Conservation (SPP3.5) and the associated Bulletin are as follows:

- To conserve places and areas of historic heritage significance
- To ensure that development does not adversely affect the significance of heritage places and areas
- To ensure that heritage significance at both the State and local levels is given due weight in planning decision-making
- To provide improved certainty to landowners and the community about the planning processes for heritage identification, conservation and protection

These objectives and the detailed policy measures outlined in SPP3.5 Section 6 provide the basis for the methodology and scope of the Heritage Technical Study.

2.1 Background Documents

Conservation Plan (2003)

- The Conservation Plan is very thorough in terms of its assessment and analysis of the Power Station, however, the policies may require review in light of the changing circumstances.

State Register of Heritage Places Documentation (1997)

- The Register has not been updated since the Conservation Plan was completed.

Cockburn Coast District Structure Plan: Historic Sites Report (2008)

Cockburn Coast District Structure Plan: Preliminary Investigation of Aboriginal Heritage (2008)

Cockburn Coast Cultural Heritage Strategy (2012)

2.2 Study Area

The South Fremantle Power Station is located approximately 5 kilometres south of central Fremantle and 18 kilometres south of the Perth CBD, in the City of Cockburn. The Power Station is within the Cockburn Coast District Structure Plan area.

Refer to Figure 1 - Location Plan

The Power Station Master Plan Precinct, which forms the study area for the Heritage Technical Study, involves the land surrounding the Power Station generally bound by McTaggart Cover to the north, the freight railway line to the east, Caledonia Loop (Port Coogee) to the south and the Indian Ocean to the west. Options for the future development in the study area may propose a marina extending into the ocean. This will potentially require a revised heritage technical study at the time.

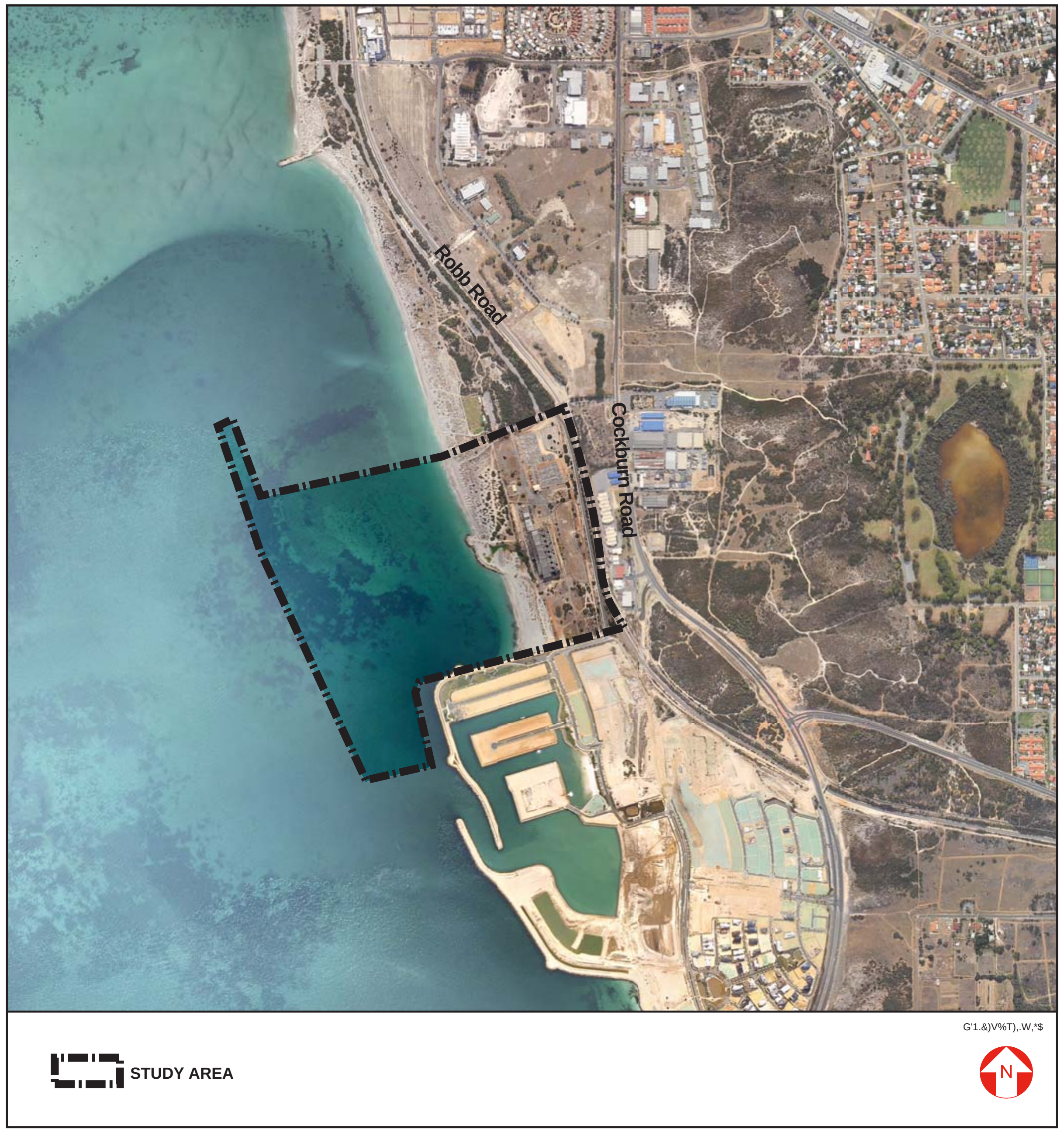


Figure 3 - Aerial Plan showing the study area

HASSELL
© 2014

The study area currently involves the South Fremantle Power Station and surrounding sites of associated buildings no longer extant; groynes, ponds and foreshore area; the switchyard (still operational); and the area immediately east of the Power Station building, previously used for coal storage.

Refer to Figure 3 - Aerial Plan showing the study area

2.3 Study Team

The research and documentation for the Heritage Technical Study has been undertaken by:

TPG Heritage:

Nerida Moredoundt	Principal Heritage Architect
Susannah Kendall	Senior Heritage Planner
Siân Morgan	Heritage Planner

Yates Heritage Consultants:

Dr Amanda Yates	Archaeologist

> *"Adaptation of buildings for new uses will often be the key to conservation of heritage places that no longer serve their original function, and will often require imagination and flexibility.* (SPP3.5 pp. 2479)*"*

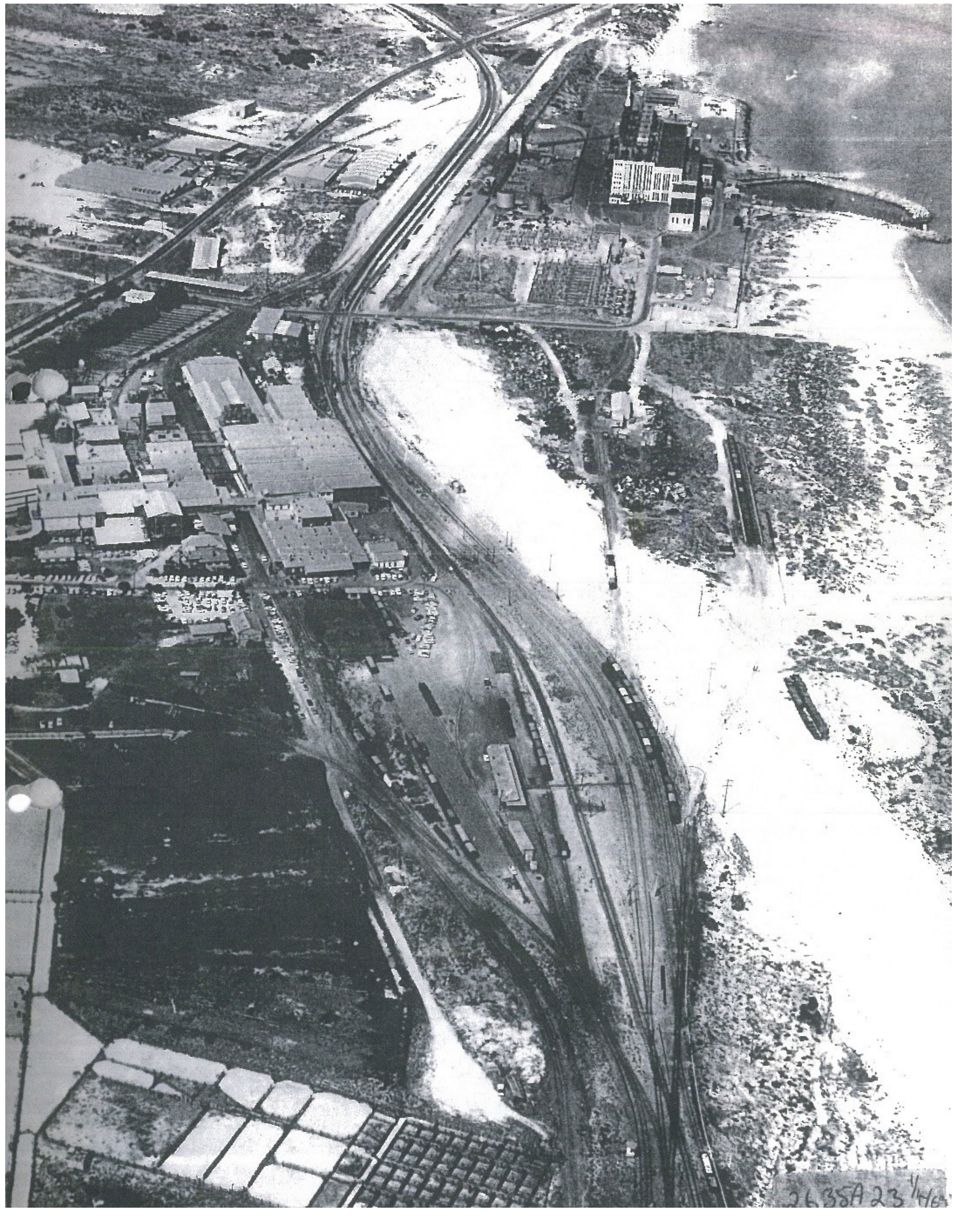


Figure 4 - Archival Aerial view of Robb Freight Terminal with South Fremantle Power Station in background (top right) c1970s Source: Maunsell Collection State Library of Western Australia

3. DESCRIPTION OF THE PLACE

The South Fremantle Power Station currently survives as a building shell stripped of all plant and machinery (except for the original overhead crane in the Turbine Room) and external elements including smoke stacks, coal conveyors and subsidiary buildings.

The registered curtilage also includes the Generating Station, Coal Storage Area, groynes and Water Basin on Cockburn Sounds and the sites of the former auxiliary buildings to the north and south of the station building, generally contained within the current boundary fencing.

Construction of the Power Station began in 1946 and continued until the official opening of the Station in 1951. The building is constructed of steel and reinforced concrete with extensive areas of clear glazing in steel frames to the external walls. The building remains structurally sound, however some spalling of the external concrete has occurred and much of the glazing has deteriorated significantly with little remaining intact (Refer to Structural Engineer's detailed report).

The Power Station building generally consists of the Turbine Room (west) and Boiler House (east) in the main portion of the building, with the Entrance and Control Room and Switch House adjoining the northern end of the Turbine Room.

Two groynes projected into Cockburn Sound to contain the water basin for intake of circulating seawater used in the process of steam and power generation. The groynes are still extant, and within the registered curtilage of the place, however they are no longer within the existing boundary fence. The coal storage area, serviced by the railway line to the east of the site, was located on the high ground east of the Power Station building, and supplied coal to the Boiler House by a system of elevated coal conveyors (no longer extant).

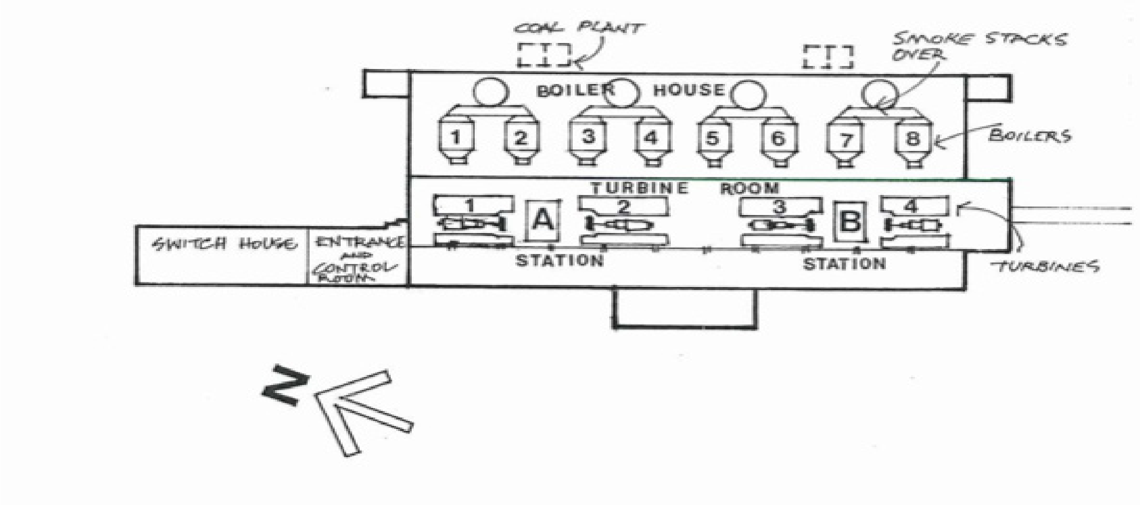


Figure 5 - Diagrammatic Floor Plan of the South Fremantle Power Station Source: South Fremantle Conservation Plan (Ronald Bodycoat, 2003)

The switchyard is located to the north-east of the power station and is still operational. The relocation of the switchyard is being investigated by the agencies involved.

In the vicinity of the Power Station are a number of other places of historic, Aboriginal and maritime significance. These include:

- South Beach Horse Exercise Area
- James and Diana shipwrecks
- Robb Jetty Camp Site
- Indian Ocean Site

These places are described with reference to their respective heritage significance in the section to follow.

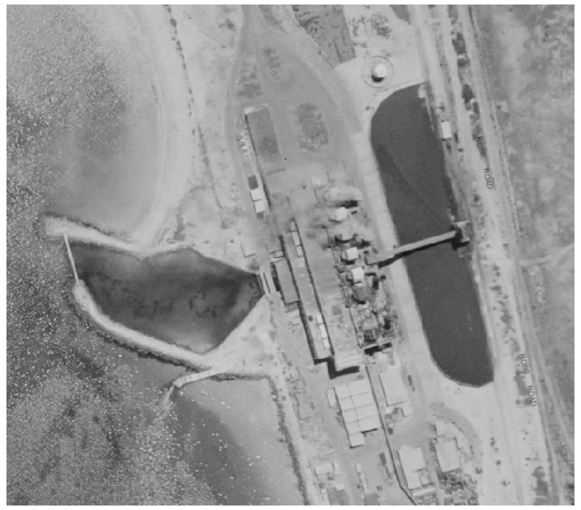


Figure 6 - South Fremantle Power Station (1952) Source: Landgate

Figure 7 - South Fremantle Power Station (1981) Source: Landgate

Figure 8 - South Fremantle Power Station (2010) Source: Nearmaps

HASSELL
© 2014

4. HERITAGE SIGNIFICANCE

4.1 Heritage Listings

A number of significant places of Aboriginal, historic and maritime history are located within the Study Area. These include the following:

- South Fremantle Power Station
- South Beach Horse Exercise Area
- James and Diana shipwrecks
- Robb Jetty Camp Site
- Indian Ocean Site

Heritage Site	Type	Heritage List	Status
South Fremantle Power Station	Historic	State Register of Heritage Places	Interim Listed
		City of Cockburn Heritage list	Category A
		National Trust Register of Classified Places*	Classified
South Beach Horse Exercise Area	Historic	State Register of Heritage Places	Permanent Listed
		City of Cockburn Heritage list	Category A
James and Diana shipwrecks	Maritime	Register of Historic Shipwrecks	Sailing Vessel
		Register of the National Estate*	Historic
Robb Jetty Camp Site	Aboriginal	Register of Aboriginal Sites	Registered Site Open No Restriction
Indian Ocean Site	Aboriginal	Register of Aboriginal sites	Stored Data Open No Restriction

* The National Trust Register of Classified Places and the Register of the National Estate each recognise places of cultural heritage value but have no statutory implications.

Each of these places and their current heritage status under the statutory provisions afforded to heritage places in Western Australia are outlined on the following pages.

Figure 9 - Aerial Plan Showing Extent of Heritage Curtilage of the South Fremantle Power Station and the South Beach Horse Exercise Area

4.2 South Fremantle Power Station

The South Fremantle Power Station is constructed on coastal dunes on the foreshore of Cockburn Sound. The main Power Station building is a high volume, industrial building designed specifically for the function of power generation. By virtue of its size and form in a sparse coastal landscape it is a landmark building and is recognised for its important contribution in the development of power generation in the State. The place has significant cultural heritage values and has been listed on a number of important registers as follows.

4.2.1 State Register of Heritage Places

The Power Station was listed on the State Register of Heritage Places on an interim basis on 28 October 1997 (HCWA Database Number 0338).

The Heritage Council of Western Australia Registration Documentation sets out the following Statement of Significance for the South Fremantle Power Station:

- *the surviving Main Building, now stripped of all plant, equipment and services, remains aesthetically significant; the building demonstrates the strong expression of a structure specifically designed for an industrial process;*
- *the internal areas of the cleared building are impressive in the former Boiler House and Turbine Room, where the structural elements are of striking dominance, the vistas through the building are significant and the transparency of the external walls is uncompromisingly apparent in the empty building;*
- *the place is a good example of an Art Deco Industrial structure, being the largest one to be built in Western Australia, and,the building and site housed the first major power generating equipment in the State specifically designed to generate alternating current at the Australian and British Standard Frequency of 50 Hertz. It therefore enabled the initial changeover of the Metropolitan Area Power Supply from 40 Hertz to 50 Hertz operation.*

4.2.2 The National Trust Register of Classified Places

The Power Station was listed on the Trust's Register on 9 March 1998. This Register is intended to perform an advisory and educational role.

The Power Station was identified on the National Trust's 2010 Heritage At Risk Register. The Register is a national program intended to raise awareness of heritage issues in Australia, by identifying those places and objects valued by the community, which are at risk. It is coordinated by the Australian Council of National Trusts.

Figure 10 - South Fremantle Power Station (undated) Source: Battye Library

4.2.3 Local Government Inventory

The South Fremantle Power Station is listed on the City of Cockburn Inventory of Heritage Places, which was first adopted in 1998 and reviewed most recently in 2014. The place is allocated a Management Category A listing ('exceptional significance').

The Statement of Significance for the South Fremantle Power Station, as identified in the Local Government Inventory, is as follows:

- *South Fremantle Power Station demonstrates the strong expression of a structure specifically designed for an industrial process.*
- *South Fremantle Power Station is a good example of an Art Deco industrial structure, being the largest one to be built in Western Australia.*
- *South Fremantle Power Station housed the first major power generating equipment in the State specifically designed to generate alternating current at the Australian and British Standard Frequency of 50 Hz.*

Figure 11 - South Fremantle Power Station (1964) Source: Fremantle City Library Local History Collection

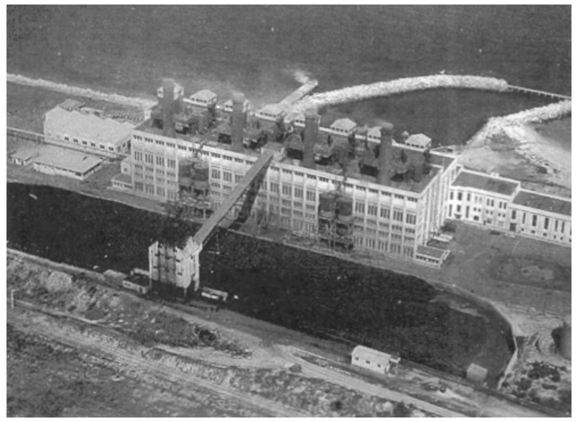


Figure 12 - South Fremantle Power Station (1955) Source: Edmonds, L; Cathedrals of Power pg 39

Figure 13 - South Fremantle Power Station (1954) Source: Still Image from Postcard from Perth, Australian National Film Board.

Figure 14 - South Fremantle Power Station (2011)

Figure 15 - South Fremantle Power Station (2011)

Figure 16 - South Fremantle Power Station and Coal Store (2011)

Figure 17 - Turbine Hall of the South Fremantle Power Station (2011)

Figure 18 - Urban Art within South Fremantle Power Station (2011)

Figure 19 - Internal Staircase within South Fremantle Power Station (2011)

4.3 South Beach Horse Exercise Area

The South Beach Horse Exercise Area is the portion of South Beach extending south past Catherine Point to McTaggart Cove. It includes the southern portion of South Beach south of Ocean Road and the whole of CY O'Connor Reserve. Since 1833 this area has been used for the exercising and training of horses.

South Beach Horse Exercise Area consists of a managed coastal landscape of parks, beach facilities, groynes, public art, fenced an unfenced tracks, dune vegetation and re-vegetation, and a beach with archaeological remains.

Although the registered curtilage of the South Beach Horse Exercise Area currently only extends as far as McTaggart Cove, it should be noted that the horse training did extend much further south of the Power Station site prior to the construction of the Groynes and Water Basin.

The Horse Exercise Area continues to be regularly used, attracting trainers and owners from across the metropolitan area, given that it is one of only two horse beaches in the metropolitan area. It is a significant example of living history.

4.3.1 State Register of Heritage Places

The South Beach Horse Exercise Area has been listed on the State Register of Heritage Places since 9 May 2006, and on a Permanent basis since 30 March 2007 (HCWA Database Number 16120).

The Heritage Council of Western Australia Registration Documentation sets out the following Statement of Significance for the South Beach Horse Exercise Area:

- *the place was the site of the first official horse race in Western Australia in October 1833 and has been used for exercise and training of horses, both recreational and sporting, in particular horse racing from that time to the present;*
- *the place was used regularly for horse training by C.Y. O'Connor, Engineer-in-Chief, who died there in 1902, and by the 10th Light Horse Regiment during Worl War I in preparation for services overseas;*
- *the place has associations with numerous champion horses and outstandingly successful trainers and jockeys;*
- *the place has played an integral part in the history of the horse racing industry in Western Australia, in particular in the 1830s, and in the period from c1900 to the mid-1970s, when the industry thrived in Fremantle;*
- *the place includes sites of Aboriginal heritage significance, including mythological sites pre-dating European settlement, and the site of the Aboriginal stockmen's camp at Robb Jetty;*
- *the place is valued by the horse racing community for the integral role it played and continues to play in the lives of many involved in the State's horse racing industry, as commemorated in the public artworks erected at the place in the late 20th century, and by the wider community who value its recreational use as a beach and park; and,*
- *the place is an attractive managed coastal landscape with views to Garden, Carnac and Rottnest Islands, together with vistas to Woodman Point and Fremantle.*

4.3.2 Local Government Inventory

The South Beach Horse Exercise Area is listed on the City of Cockburn Inventory of Heritage Places (adopted August 2004 and reviewed in 2014) as Place No. 82. The place is allocated a Management Category A listing ('exceptional significance').

The Statement of Significance for the South Beach Horse Exercise Area, as identified in the Local Government Inventory, is as follows:

- *The beach remains as an important part of the natural coastline surrounding Cockburn Sound.*
- *This particular stretch of beach has many associations with the horse racing community and represents a continuous link with the past. The beach is still used as a horse beach as horses from Randwick Stables are still walked to the beach along the same routes they have taken since the 1920s.*
- *The memorials were erected to commemorate the historical significance of South Beach ot emphasise the links with CY O'Connor and the horse racing industry. The beach is a representative of a unique aspect of the history of the Cockburn and Fremantle area.*

Figure 20 - Horse on South Beach Source: Fremantle City Library Local History Section

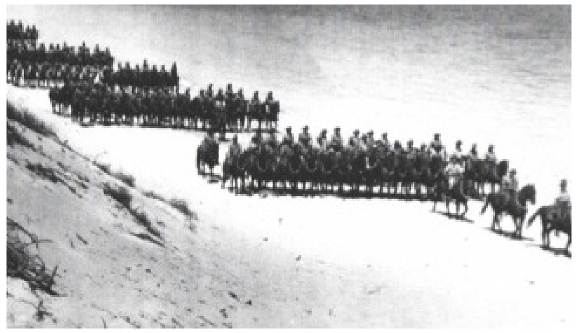


Figure 21 - The 10th Light Horsemen trained on the beach Source: Fremantle City Library Local History Collection

Figure 22 - Horses On the South Beach Horse Exercise Area Source: Yates Heritage Consulting

4.4 James Shipwreck

Australia's historic shipwrecks and their associated relics are protected by the *Commonwealth Historic Shipwrecks Act 1976*. This Act protects all shipwrecks older than 75 years in Australian waters, extending from the low tide mark to the edge of the continental shelf (at the time when they are registered). The Commonwealth Historic Shipwrecks Act also protects all relics on land directly associated with a Commonwealth historic shipwreck, such as survivor camps, and relics held in private hands. The WA Museum is the delegated authority for management of Commonwealth historic shipwrecks and relics in Western Australia.

The state of Western Australia has its own legislation, the *Maritime Archaeology Act 1973*, which protects maritime archaeological sites on land and in state waters, such as bays, harbours and rivers. In addition to shipwrecks the Act also protects relics, such as an anchors, and land sites associated with historic ships.

The James is the earliest post-settlement wreck of a merchant ship found in Western Australia. It was driven ashore on 21 May 1830. The wreckage site lies south west of the South Fremantle Power Station. It is currently covered with sand. A cannon associated with the wreckage was found recently and more artefacts may still exist.

4.4.1 Historic Shipwrecks Act

The James is listed on the Register of the National Estate (No. 10440) and the National Shipwreck Data Base (No. 4271), and is protected under the provisions of the *Historic Shipwrecks Act 1976*.

4.5 Diana Shipwreck

The Diana was wrecked on 16 July 1878, after parting a mooring during a storm. It is an example of a typical three masted schooner employed in coastal trade. The wreckage lies south west of the South Fremantle Power Station, just north of the James.

4.5.1 Historic Shipwrecks Act

The Diana is listed on the Register of the National Estate (No. 10430) and the National Shipwreck Data Base (No. 3951), and is protected under the provisions of the *Historic Shipwrecks Act 1976*.

Figure 23 - The locations of the James and Diana Shipwrecks under the sand on the foreshore adjacent to the Power Station

4.6 Robb Jetty Camp Site

This site was originally recorded by O'Connor in 1985[1] as a camping area located in the sand hills of South Beach, in the vicinity of Catherine Point that was still being used as a fringe camp at the time of recording. O'Connor noted that it is known to have been used since early twentieth century and is linked with the Robb Jetty Abattoir and associated shipping activity. The camping area was estimated to extend about 1.2 km north west between the Iron Foundry and Robb Jetty.

Robb Jetty Camp Site represents a place of economic interaction between the Aboriginal population and the Robb Jetty site, with a number of Aboriginal people being employed at Robb Jetty Abattoir.

The extent of Robb Jetty Camping area has been subject of a number of Archaeological Surveys over the last few years as part of heritage feasibility studies for nearby developments. All of these archaeological surveys were unable to find any physical evidence of past camping activity, but all noted that such evidence would have since been consumed by the mobile coastal sand dunes. Indeed, the original recorder of the camp site noted:

> *though the sands driven by winter winds cover most evidence of human occupation, making individual camps hard to distinguish, in the interdunal swales, camp fire ashes, domestic refuse and the remnants of temporary shelters have been observed.*[2]

4.6.1 Register of Aboriginal Sites

DIA Site ID 3707

This Site has been assessed as meeting the terms of Section 5 and Section 39(2) of the in regard to its importance and significance. Sites on the Permanent Register are places to which the *Aboriginal Heritage Act* applies.

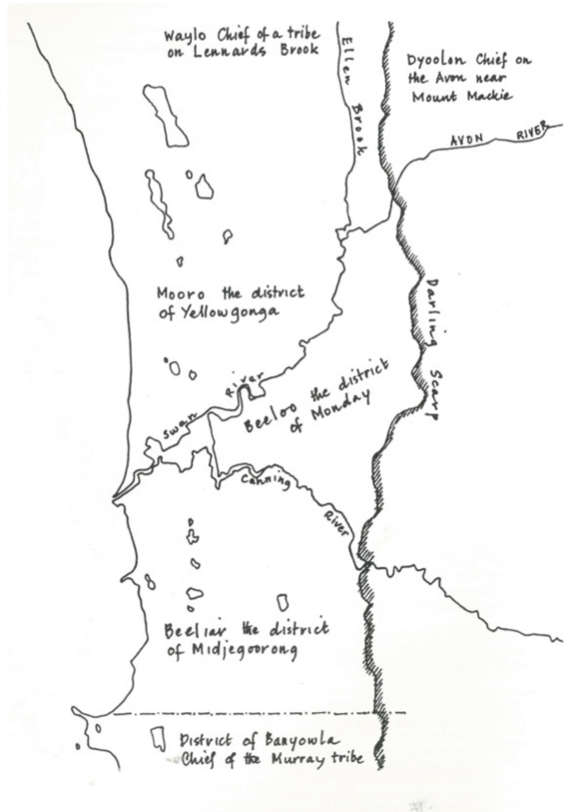


Figure 24 - Aboriginal Family Groups around Perth according to R M Lyon (1833). Source: Canning River Regional Park – Historical Survey

1 O'Connor, R. Bodney, C. and Little, L. (1985) Preliminary report on the survey of Aboriginal areas of significance in the Perth Metropolitan and the Murray River Regions. Perth: Aboriginal Sites Department pp 83
2 O'Connor, R. Bodney, C. and Little, L. (1985) Preliminary report pp 83

4.7 Indian Ocean Site

This mythological site covers the large area of water between the mainland and the three islands (Rottnest, Carnac & Garden) and relates to mythological narratives concerning the creation of Cockburn Sound and the offshore islands, especially Rottnest.

One of the narratives was recorded by early colonist, George Fletcher Moore, as follows:

> *The natives have a tradition that Rottnest, Carnac, and Garden Island, once formed part of the mainland, and that the intervening ground was thickly covered with trees; which took fire in some unaccountable way, and burned with such intensity that the ground split asunder with a great noise, and the sea rushed in between, cutting off those islands from the mainland. This is a savage's description of an eruption of subterranean fire; and although there are not many indications of volcanic action in the neighborhood, yet some recent observations of the officers of H. M. S. Beagle, during an examination of that part of the coast, and of the group of the Abrolhos Islands, would rather tend to confirm than to overthrow this opinion.*[3]

4.7.1 Register of Aboriginal Sites

DIA Site ID 3776

This site has been assessed as stored data, which indicates that it has been assessed as not meeting the terms of Section 5 of the Aboriginal Heritage Act. The provisions of the Act do not apply to these places unless further information is lodged with the Registrar requiring a reassessment of the place.

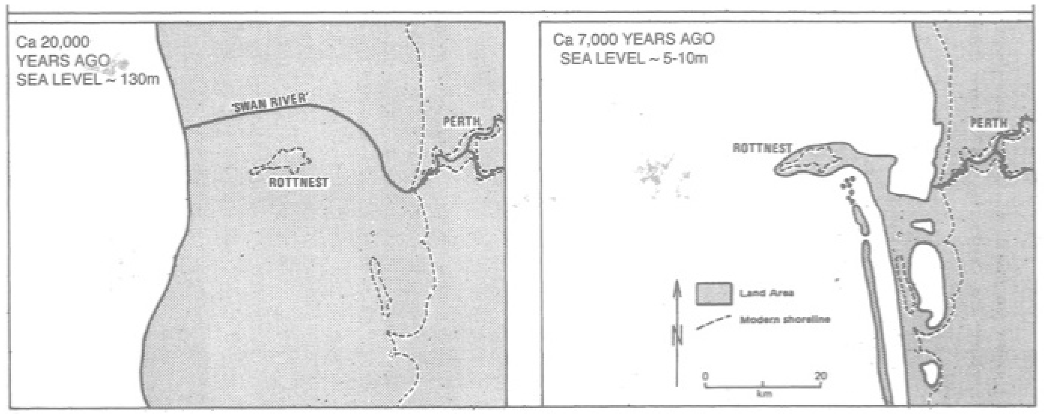


Figure 25 - Alterations in the landscape with sea level changes. (source: Ernest Hodgkin's, Swanland 2005)

3 Moore, George Fletcher (1884). Diary of Ten Years, University of Western Australia Press, Nedlands, Western Australia

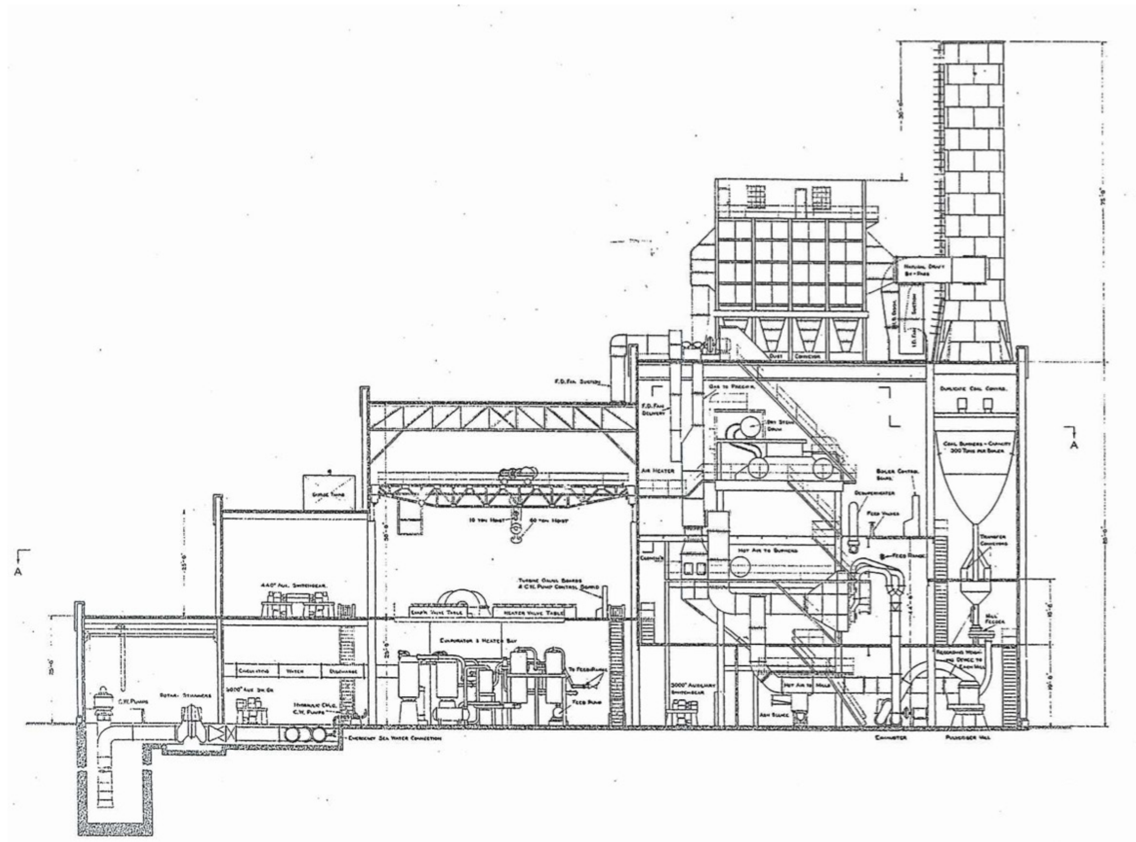


Figure 26 - Archival Plan showing Cross-Section source: South Fremantle Conservation Plan (Ronald Bodycoat, 2003)

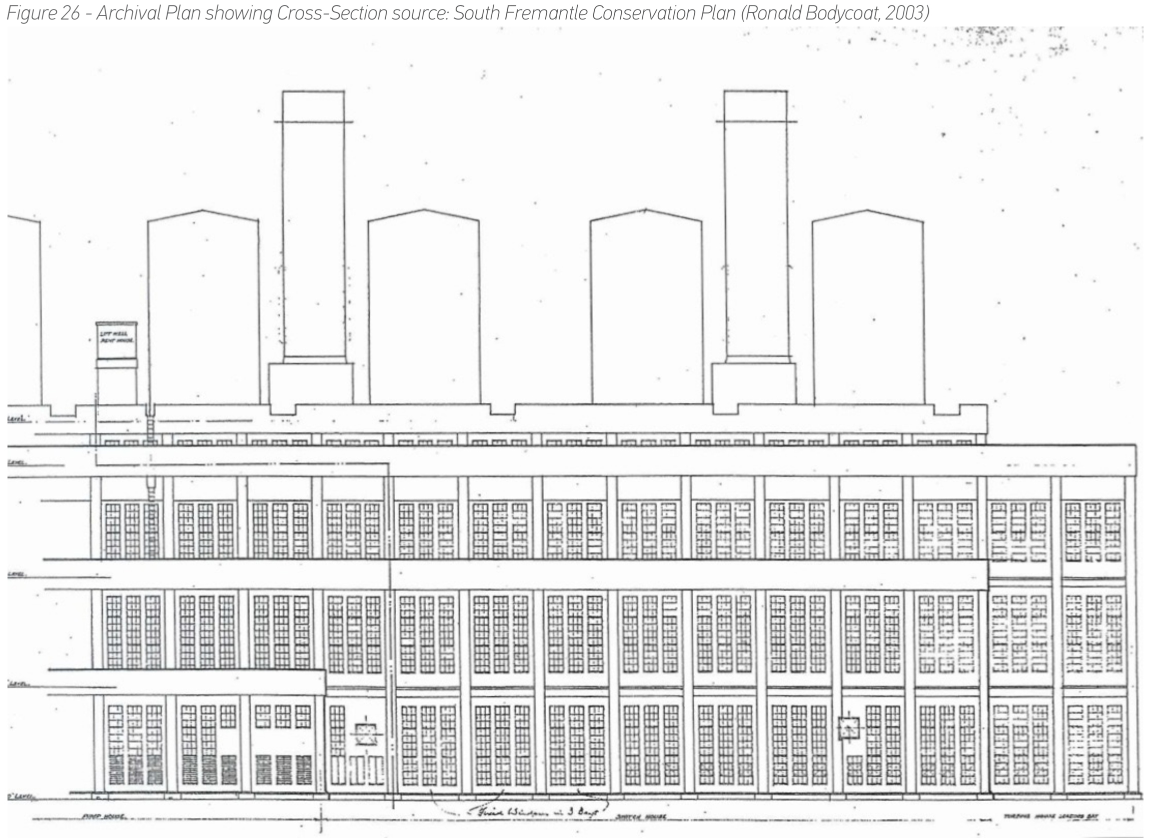


Figure 27 - Archival Plan showing Part of West Elevatioin source: South Fremantle Conservation Plan (Ronald Bodycoat, 2003)

5. OTHER STUDIES

5.1 Conservation Plan

The Conservation Plan for the South Fremantle Power Station (R. Bodycoat, 2003) was commissioned by Western Power and prepared to fulfil the requirements of the Government Heritage Property Disposal Process.

The Conservation Plan Study Area comprises the whole of the registered curtilage of the place, including the Power Station, Coal Storage Area and the sites of the former auxiliary buildings to the north and south of the station building, generally contained within the present boundary fence line as well as the groynes and Water Basin on Cockburn Sound, which are outside of the boundary fence.

The Statement of Significance for the South Fremantle Power Station, which is contained within the Conservation Plan, is as follows:

- *The surviving Station Building, now stripped of all plant, equipment and services, remains aesthetically significant as a building which demonstrates the strong expression of the functionalist style and has landmark qualities due to its prominent and exposed location*
- *The internal areas of the Boiler House and Turbine Room, now cleared of all plant and equipment, demonstrate impressive spaces, structural strength and a transparency which derives from the extensive glazed wall areas*
- *The place demonstrates some Art Deco stylistic elements in vogue at the time of design and construction*
- *The overhead crane in the Turbine Room, the two groynes which form the Water Basin with the entry screens, remain as elements to express the former working functions of the Power StationThe place, as a purpose-built power generating installation, was an important element of the interconnected power grid distributing power to the metropolitan region and the south-west of the State; South Fremantle facilitated replacement of the initial 40 cycle current generated at East Perth with 50 cycle current throughout the entire grid; as a further consequence, the place contributed to the subsequent takeover of regional supply by SECWA*
- *The place demonstrates the influence of W. H. Taylor, General Manager of the Western Australian Government Electricity Supply, and his contribution to the design of the Station building and the generating plant which it housed*
- *The engineers, plant manufacturers and the workmen who built and operated the Power Station contribute to the social significance of the place*
- *The place is rare as one of only two Power Stations in Western Australia designed and built in a strong architectural style, known as 'Cathedrals of Power', which satisfied the requirement at the time to demonstrate the importance of power generation to the State*

5.1.1 Levels of Significance

The surviving elements of the Power Station are identified in the Conservation Plan as having the following degrees of significance (reflected in the Graded Zones of Significance plan, to follow):

Considerable Significance – conservation of these elements is essential:

- the steel framed and concrete clad form and fabric of the main Station building formerly housing the Boiler House and Turbine Room, and the wing extending north from the main building and constructed for Entrance Hall, Laboratories, Control Centre, Administration offices and Switch House;
- the steel framing exposed internally;
- the overhead crane in the Turbine Room and all associated support framing and plant;
- the steel-framed glazed walling throughout;
- the staircase and balustrade in the Entrance Hall to the Administration Wing;
- the two stone groynes and the Water Basin;
- the open spaces between the main Station building and the bank to the Coal Storage Area, and between the main building and the Water Basin.

Some Significance – conservation of these elements is recommended:

- surviving railway lines east and south of the main building;
- original ceramic wall tiling in the Turbine Room.

Little Significance – conservation of these elements is optional:

- the Coal Storage Area and structural elements such as retaining walls associated with the area
- floor finishes; floor channels; openings in the upper floor level of the Turbine Room (Turbine machinery level) together with associated steel beams and intermediate light steel columns;
- wrought iron balustrading in the Boiler House and Turbine Room; steel stairways

No Significance – conservation of these elements is not recommended from the viewpoint of heritage significance:

- the sites of removed auxiliary buildings, viz. Workshops, Stores, Amenities, Canteen and Gatehouse to the north and south of the main Station building
- perimeter fencing.

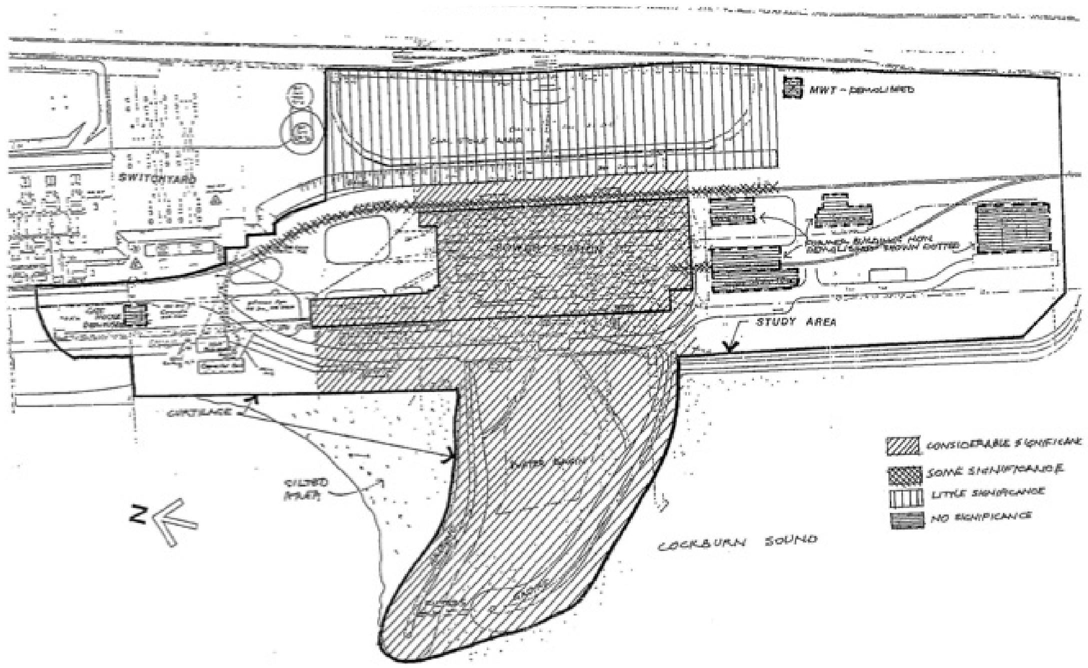


Figure 28 - Graded Zones of Significance source: South Fremantle Conservation Plan (Ronald Bodycoat, 2003)

5.1.2 Conservation Plan Policies

The Conservation Plan policies outline that elements identified as being of Considerable Significance should be conserved and promoted for their high cultural value within the process of adaption for new uses. Retention, reasonable expression and conservation of these elements arises out of the recognition of cultural significance; these elements are crucial to an appropriate interpretation of the place as a former Power Station.

Elements identified as being of Some Significance should be preserved, restored or reconstructed as appropriate within the context of the conservation policy and the adaption to new uses.

Elements identified as having Little or No Significance should be carefully considered for their impact on the interpretation and evaluation of the place, and may be enhanced or changed within the context of the conservation policy and the adaption for new uses.

Figure 29 - Aerial Plan Showing The Key Elements of the Conservation Policy in regards to Future Development

5.2 Cockburn Coast District Structure Plan (Part 1)

The Cockburn Coast District Structure Plan (Part 1) (CCDSP1) was endorsed by the Western Australian Planning Commission (WAPC) in August 2009. This was the first step in establishing a detailed land use framework, guiding and informing the future development of the Cockburn Coast area, which covers more than 331 hectares. The area is bound by the Indian Ocean to the west and Beeliar Regional Park to the east, South Beach to the north and Port Coogee to the south.

The CCDSP 1 duly recognises the South Fremantle Power Station building as a significant component of Cockburn area, owing to its physical dominance and uniqueness. The Plan sets out a suite of heritage principles identified through the district structure planning process, in conjunction with a heritage architect, to ensure that the heritage values of the site are retained and the significance of the place interpreted appropriately in the evolution of the building:

- *Retention of the existing façades and windows of the original (current) building structure – it may be possible to modify retained steel window frames.*
- *Retention of the link between the building and the foreshore, lagoon and ocean.*
- *Retention of the relationship and curtilage between the power station and existing coal storage area and open area to the north-east of the building (partly enclosed by the control room wing).*
- *Retention of the remaining original structure and expose this where possible.*
- *Develop a large internal central space in any redevelopment (up to the current roof level) to interpret the internal size and scale of the original building. This would also provide the necessary light and ventilation to internal areas. It is recommended that this space extend to an existing external wall.*
- *Retain and expose where possible the vertical wall separating the boiler hall from the turbine hall – this should form part of the large internal central space in any redevelopment.*
- *New development should be constructed of new material that is contemporary and not identical, but complementary to the rendered façade of the original building. The additional elements should continue the planar cubic form of the existing building and not extend beyond the vertical plane of the façade below it.*
- *Climate control should be designed on the inside of existing or new window openings and not protrude outside the plane of the new façade. It is recommended that an indoor-outdoor zone around the inside perimeter of the existing building be developed to provide sheltered outdoor space and a zone of climate control. External projections, screens and other structures beyond the plane of the external surface of the building are not recommended.*
- *There is a possibility to add additional space to the top of the building and the opportunity to interpret the four original steel smoke stacks should be encouraged. New towers should be four in number with massing that is similar to the original towers and no higher than the original towers (approximately 20 metres above the roof slab), should this concept be explored further.*
- *Use of the large roof area and top of the perimeter wall to install solar PC collectors and wind turbines to produce renewable energy for the building and electrical grid is strongly recommended, as it interprets and continues the original purpose and use of the power station.*
- *It is recommended that the roof be developed with a sod topping and grass with a stormwater collection system to filter and recycle possible salt and pollution-laden rain and recycling this for use in the building (toilet/secondary water supply). The grass area can also be used as a rooftop common recreation space for occupants and visitors.*

HASSELL
© 2014

5.3 Cockburn Coast District Structure Plan (Part 2)

The Cockburn Coast District Structure Plan (Part 2) builds on the CCDSP 1, providing further detailed guidance on elements that span the whole project area, but are too detailed to be explored within Part 1. A Cultural Heritage Strategy has been prepared as one of a suite of guiding documents accompanying CCDSP 2 to assist in the planning and ongoing management of the area. Strategies are provided to guide management decisions and actions in relation to the various heritage sites within the Cockburn Coast area, including those located within the Power Station Master Plan Precinct.

Those strategies relevant to the Power Station Master Plan Precinct are outlined as follows:

South Fremantle Power Station

- Retain, conserve and adapt the South Fremantle Power Station for new uses
- Any future conservation, management and/or adaption works to the place are to be undertaken in accordance with State and local policies and procedures
- Maintain the visual setting of, and interrelationship between, the significant contributory elements of the South Fremantle Power Station
- Ensure all opportunities to generate awareness and public interest in the building are capitalised upon
- Acknowledge the significance of high quality urban art, which has been informally applied on the walls of the Power Station since its closure
- Integrate interpretation of the site in the Cockburn Coast project to communicate the tangible and intangible values and history of the place to the community

The Diana Shipwreck

- Retain in situ and do not disturb
- Any future conservation, management and/ or adaptation works to the place are to be undertaken in accordance with Commonwealth and state legislation, policies and procedures
- Integrate interpretation of the site in the Cockburn Coast project to communicate the tangible and intangible values and history of the wreck to the community

The James Shipwreck

- Retain in situ and do not disturb
- Any future conservation, management and/ or adaptation works to the place are to be undertaken in accordance with Commonwealth and State legislation, policies and procedures
- Integrate interpretation of the site in the Cockburn Coast project to communicate the tangible and intangible values and history of the wreck to the community

Indian Ocean Site

- Any future conservation, management and/ or adaptation works to the place are to be undertaken in accordance with State and local policies and procedures
- Integrate interpretation of the mythological story of the site into the Cockburn Coast project to communicate the tangible and intangible values of the site

Robb Jetty Camp

- Any future conservation, management and/ or adaptation works to the place are to be undertaken in accordance with State and local policies and procedures
- Integrate interpretation of the site in the Cockburn Coast project to communicate the tangible and intangible values and history of the place to the community
- Record and preserve important aspects of a human experience that would otherwise go undocumented

South Beach Horse Exercise Area

- South Beach should continue to be used for the horse training, a use with which it has had a long association
- Any future conservation, management and/ or adaptation works to the place are to be undertaken in accordance with State and local policies and procedures
- Integrate interpretation of the site in the Cockburn Coast project to communicate the tangible and intangible values and history of the place to the community

5.4 South Fremantle Power Station – Structural Condition Report (2002)

This report was prepared in 2002 for Western Power by BG+E to assess the structural condition of the Power Station building. The report provides an indication of the condition of the building elements, and their suitability for adaptive reuse.

The report is based upon information obtained from a selection of existing drawings and a visual inspection of the majority of the building. It does not assess structural stability or capacity through calculation.

The overall assessment of the structural elements comprising the Power Station building is that they are generally sound. The report notes, however, that the Power Station is exposed to an extremely corrosive environment by virtue of its location on the coast. The building façade is no longer sealed from the elements, which has lead to accelerated internal structural deterioration. The report advises that if the deterioration continues on the present basis, the structural condition will be significantly worse within several years. An updated structural report has been prepared as part of the Master Plan process.

5.5 South Fremantle Power Station – Cooling Water Lagoon Study (1995)

This report was prepared in 1995 by M P Rogers & Associates Pty Ltd for Western Power, to investigate three options for the removal of the Cooling Water Lagoon in front of the Power Station, being:

- Repair of the groynes and filling the lagoon
- Removal of the southern groyne that partly forms the lagoon
- Partial removal of the southern groyne and formation of a beach between the southern and northern groynes

The objective was to eliminate the enclosed body of water and create an area that is satisfactory from engineering and environmental points of view.

The report recommends the third option – modifying the southern groyne and creating a pocket beach – as it was found to have to lowest estimated cost of construction, no significant environmental impacts and provides a number of opportunities for the Department of Commerce & Trade to improve the recreational use of the area.

A portion of the southern groyne has since been breached and the basin part filled.

6. VISIONING

6.1 Case Studies

The case studies that have been analysed as part of the current investigations fall into one of three categories:

- Smaller, municipal power stations usually associated with tramways
- Larger 'cathedral-style' power stations, like the South Fremantle Power Station
- Other industrial buildings that have been adapted for new uses

Almost all case studies have required the injection of public funds for successful adaptive reuse.

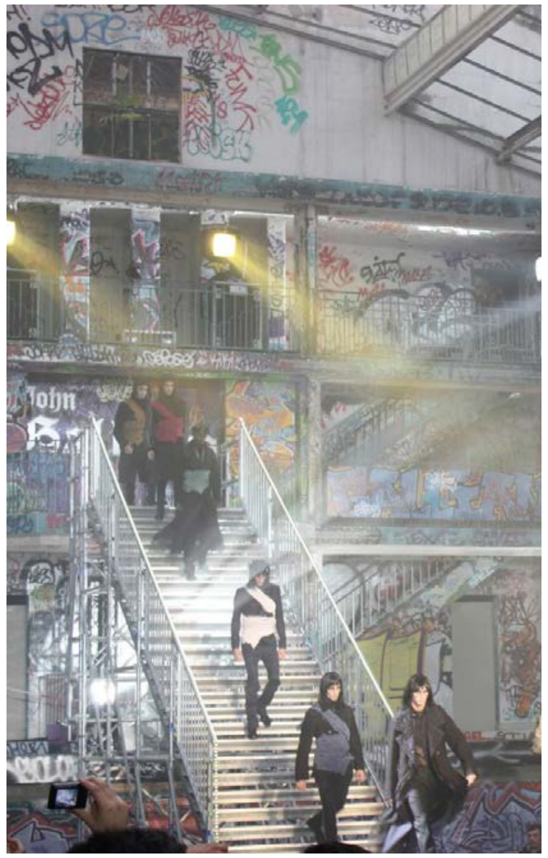


Figure 30 - Paris Swimming Pool (Piscine Molitor) (2009) source: http://thefactualist.blogspot.com:

6.1.1 Municipal Power Stations

The Brisbane Powerhouse, QLD (former New Farm Powerhouse)

The Brisbane City Council New Farm Powerhouse was designed by Brisbane City Council tramway architect, Roy Rusden Ogg and constructed in stages between 1928 and 1940. The Powerhouse was operational from 1928 until it was officially decommissioned in 1971.

Most of the original equipment had been removed when the plant was decommissioned, with only two of the original pieces remaining. The first is a switch, which is situated near the new bar. The second is a gantry crane positioned high above the Turbine Platform.

After two decades of neglect the building was reacquired by the Brisbane City Council in 1989. Now the Brisbane Powerhouse is a multi-purpose arts centre, which includes the apex of the Turbine Hall, gallery walls, and an outdoor plaza with green spaces.

The design philosophy of the redevelopment aimed to preserve the twin histories of the old powerhouse; as an industrial site generating coal-powered electricity; and from 1971 as a derelict building where people found refuge, staged partied and left their marks.

Figure 31 - Brisbane Powerhouse source: www.brisbanepowerhouse.org

The Wapping Project, UK (former Wapping Hydraulic Power Station)

The Wapping Hydraulic Power Station, built in 1890 and operational from 1893 until it closed in 1977, has been adapted to its current use as an art space and restaurant. The architectural aim of the adaption of the building was to keep as much of the existing building structure and machinery as possible, and to maintain the atmosphere of the power station's industrial past.

Exhibition and performance spaces have been created from the Boiler and Filter Houses, which have both been stripped back to their 1890 form, and designed for the greatest possible flexibility (including for the opening installation, flooding of the floor). The architectural additions have been designed to reflect contemporary technology, and make a subtle but clear delineation between the original fabric and new additions.

Figure 32 - The Wapping Project (2011) source: Kristin H, http://artecony.blogspot.com

Figure 33 - Canberra Glassworks (2007) source: Gary Sauer-Thompson, www.sauer-thompson.com

Canberra Glassworks (former Kingston Powerhouse), ACT

Designed in 1911, the Kingston Powerhouse was operational from 1915 to 1927, however the plant was used sporadically as needed in the years 1936-42 and 1948-57. The main block has two gabled halls – the boiler and engine bays – each over three storeys high, with single and two storey annexes. The walls are concrete infill between encased structural steel columns and beams.

The Canberra Glassworks now occupies the building – providing opportunities for visitors to interact with and learn about glassmaking. Visitors can meet artists, see glassmaking as it happens, view exhibitions, take tours and have hands-on experience working with glass.

A number of windows between the ground and first floor have been in-filled with brickwork and all boilers, generating units and condensers have been removed from the building. The chimney has been demolished, apart from its base. A two storey addition has been built on the eastern end of the north wall of the engine bay and a single story addition has been built on the eastern side of the annexe.

The adaption of the building has been mindful of energy efficiency and sustainability principles. The condensing pits below ground are now reused for rainwater storage and water used for washing down the workshops; timber planks from the condensing pit walkways were reused in new seats in the Hotshop viewing area; heat from glass furnaces is reclaimed for heating water for in-slab heating; natural ventilation is optimised and windows automated.

HASSELL
© 2014

Powerhouse Museum, NSW (former Ultimo Power Station)

The Ultimo Power Station was built between 1899 and 1902 to provide power for Sydney's new electric tram system. After the last tram stopped in 1961, the building lay derelict until 1979, when the New South Wales government announced that the building would house the Powerhouse Museum, the flagship of the Museum of Applied Arts and Sciences.

Government architect Lionel Glendenning redesigned the old interior spaces of the power station and added a new building that complemented the old but also added a new contemporary style. It was inspired by the grand railway stations and exhibition halls of the 19th century. The old tram depot adjacent to the power station, later to become offices, workshops, laboratories and storage, opened as Stage One in 1981. The Powerhouse Museum opened to the public in March 1988.

The main museum building encloses a space larger than that of the Sydney Opera House, and now contains five floors, three courtyards, a basement and storage building.

The installation of a cogeneration system is currently proposed for the Museum that will deliver electricity to the Museum and waste heat to the adjacent Aquatic Centre for water and space heating. The project has received funding assistance of $461,000 from the NSW Government's Public Facilities Program to help ensure it meets economic hurdles.

Figure 34 - Powerhouse Museum, Sydney source: http://genc6003.unsw.wikispaces.net/builtenv

Figure 35 - Canberra Glassworks source: www.mbt3th.us

Figure 36 - TATE Modern source: http://nemehill.blogspot.com/

Figure 37 - TATE Modern source: www.tate.org.uk

Figure 38 - TATE Modern source: Hayes Davidson and Herzog & de Meuron, www.tate.org.uk

6.1.2 'Cathedral-Style' Power Stations

The Tate Modern (former Bankside Power Station), UK

Bankside Power Station was designed by Sir Giles Gilbert Scott and built in two phases between 1947 and 1963. The power station, located on a 3.43 hectare site, consisted of a huge turbine hall, thirty-five metres high and 152 metres long, with, parallel to it, the boiler house. The northern frontage of the building is over 200 metres long and the chimney is 99 metres high, specifically built to be lower than the dome of St Paul's Cathedral at 114 metres, which is opposite the site, on the north side of the River Thames.

Bankside Power Station now houses the Tate Modern museum, which has a total internal floor area of 34,500m2, including:

- Gallery suites for display and exhibition of 7,827m^2,
- The former Turbine Hall as a 'covered street' of 3,300m^2, where works of art may also be shown,
- A special exhibition suite of 1,300m^2,
- A 240 street auditorium
- Two cafés to seat 240 and 170 people, respectively, plus 30 in the bar area
- An educational area
- A Members Room
- 1350m^2 of offices
- A support services/art handling area
- 9 passenger lifts of which 4 are for public use
- 6 escalators

An international architectural competition was held, to find the architect for the adaptive reuse, attracting entries from practices all over the world. The final choice was Herzog and De Meuron, a relatively small and then little known Swiss firm. A key factor in this choice was that their proposal retained much of the essential character of the building.

The turbine hall became a dramatic entrance area, with ramped access, as well as a display space for very large sculptural projects. The boiler house became the galleries. These are on three levels running the full length of the building. The galleries are disposed in separate but linked blocks, known as suites, on either side of the central escalators.

Above the original roofline of the power station Herzog and De Meuron added a two-storey glass penthouse, known as the lightbeam. The top level of this houses a café-restaurant with stunning views of the river and the City, and the lower a members room with terraces on both sides of the building, the river side one offering the same stunning views as the restaurant. The chimney was capped by a coloured light feature designed by the artist Michael Craig-Martin, known as the Swiss Light. At night, the penthouse lightbeam and the Swiss Light mark the presence of Tate Modern from a great distance.

Construction began in January 2010 on 'The Tate Modern Project' – a new iconic building being added to the south of the existing gallery. The building will provide more spaces for displaying the collection, performance and installation art and learning, as well creating more social spaces for visitors. Like the original adaption of the Tate Modern, the new building is designed by Herzog and de Meuron. The façade will use brick to match the surface of the existing structure, while creating unique new effect – a perforated brick lattice through which the interior lights will be visible in the evening. The height of the building will respond to the iconic chimney of Giles Gilbert Scott's power station, rising 64.5 metres above ground in 11 levels.

Battersea Power Station

The Battersea Power Station was one of the first in a series of large coal-fired electrical generating stations set up in London in the 1930s. Battersea came on stream in 1933 with a second phase completed in 1957. It stopped producing power in 1983. It was heritage listed in 1980, preventing any calls for its wholesale demolition.

Designed by Sir Giles Gilbert Scott (also the architect of the Bankside Power Station), Battersea is the biggest brick building in Europe, featuring an Art Deco interior and fittings.

Two previous owners have tried unsuccessfully over the years to regenerate the Battersea Power Station site. The first demolished the roof and west wall to remove the giant turbines as part of plans to create a massive theme park, scheduled to open in 1990. Nothing more was done and the Power Station was left open to the elements. Three years later, Parkview International took possession of the site. Parkview gained planning permission to develop restaurants, retail, cinemas and other cultural and commercial offerings within the existing building, along with significant new development on the site. This did not go ahead.

The current masterplan for the existing Power Station building includes:

- Preserved space immediately around the Power Station maintaining the setting and character of the building
- An urban square at the entrance to the Power Station, intended as an event space and connection with a new transport interchange
- The first zero carbon office space in Central London
- A 6 acre (2.4 hectare) riverside park to the north of the Power Station
- Turbine Halls A and B, each a similar size to the Turbine Hall in the Tate Modern, will become new event areas giving public access to the many different uses in the building
- A conference centre with the largest ballroom in London
- A green energy plant at foundation level, used to power the rest of the site.

Development of the proposal as a whole is expected to be phased over a 14 year period, with the Power Station work occurring from 2012 to 2019.

Figure 39 - Battersea Power Station
source: industri management, www.industry.uk.com

Figure 40 - Battersea Power Station
source: industri management, www.industry.uk.com

Figure 41 - Battersea Power Station
source: industri management, www.industry.uk.com

HASSELL
© 2014

6.1.3 Other Industrial Buildings

The Ruhr Valley, Germany

The Ruhr Valley in western Germany was once the country's industrial heartland. The coal mines and iron and steel mills power the military and industrial works during the two World Wars, and was the engine for the rapid reconstruction and development of the West German economy in the 1950s and '60s. However, by the 1970s, the industries began to decline.

The Oberhausen Gasometer, which had been used to store gas produced by nearby blast furnaces, closed in 1988. At over 385 feet (117 metres) high and 220 feet (67 metres) in diameter, it has become Europe's largest exhibition space. An internal elevator allows visitors to see the interior of the space as they ascend to the roof, from which they have a sweeping view of the entire area.

The Zollverein Colliery has been called the 'Cathedral of Labour' or 'Cologne Cathedral of the Ruhr' – a famous symbol of the German mining industry. It closed in 1986. The Bauhaus-inspired buildings have been adapted for a number of new cultural uses including a museum of coal production, a centre that features exhibitions of the best industrial design, a citizens' centre and a restaurant. A solar-powered Ferris wheel takes visitors through and above the plant to capitalise on the views. Hiking trails connect the Colliery to the nearby community.

The Duisburg-Nord Industrial Landscape Park contains well over 550 acres (202 hectares), most of which is open space. Visitors can explore a blast furnace and appreciate the skill and strength of workers who once produced iron and steel there. Imaginative steps have been taken to provide recreational uses that would entice visitors – walls are used for rock-climbing lessons; a large metal tube out, down and back through a wall forming a slide for children.

The multi-coloured night lighting is an interpretation of the lights associated with the plants' historic 24 hour operations. This new lighting, created as a result of an international design competition, was not intended to replicate the old but helps bring the past through the present into the future.

St Louis Union Station, US

The St Louis Union Station opened in 1894 and was once the world's largest and busiest train station. The station complex includes The Grand Hall, The Headhouse, The Midway and Train Shed, totalling more than 11 acres (4.45 hectares).

In August 1985, after a $150 million renovation, Union Station was reopened with a 539-room hotel, shopping mall, restaurants and food court, and still serves local rail transit passengers. The train shed also includes an internal lake. Federal historic rehabilitation tax credits were used to transform Union Station into one of the city's most visited attractions. The station rehabilitation byConrad Schmitt Studios is one of the largest adaptive re-use projects in the United States.

In January 2010, St. Louis Union Station is under major redevelopment with the expansion of the station's Marriott Hotel in the main terminal building. The hotel will take over the Midway area of the station and all stores have been relocated to the train shed shopping arcade.

Seattle Gas Works Park, US

Gas Works Park is 7.7 hectare park on the site of the former Seattle Gas Light Company gasification plant. The gas plant began manufacturing synthetic gas on the north shore of Lake Union in 1906. The gas plant closed in 1956, when natural gas replaced manufactured gas as Seattle's primary energy source. The plant was left derelict until the 1970s when plan emerged for a unique park, after being purchased by the City of Seattle in 1962.

Gas Works Park was designed by Seattle landscape architect Richard Haag, who won the American Society of Landscape Architects Presidents Award of Design Excellence for the project. The park incorporates numerous pieces of the old plant. Some are left as ruins, while others have been reconditioned, brightly painted, and incorporated into a children's "play barn" structure, constructed in part from what was the plant's exhauster-compressor building. The boiler house has been converted to a picnic shelter with tables, barbeques and an open area, and a hill constructed out of thousands of cubic metres of rubble from building foundations covered with fresh topsoil. A sundial at the top of the hill was created by two local artists, formed out of concrete and delineated with rocks, shells, glass, bronze and other materials. The sundial tells time by using the body of the visitor as the gnomon.

Figure 42 - St Louis Union Station (2007) source: William Wesen

Figure 43 - Seattle Gas Works Park source: Ben O'Connor, http://urbanresearch.files.wordpress.com

Figure 44 - Zollverein Colliery, Ruhr Valley (2008) source: Lynn Salmon, www.thesalmons.org

Figure 45 - Oberhausen Gasometer Ruhr Valley source: www.fotocommunity.com, User JR46119

6.2 Opportunities and Constraints

The following table outlines the key opportunities and constraints arising from the current circumstances at the South Fremantle Power Station. In most cases, the issues identified are both opportunities and constraints.

Issue	Opportunity	Constraint
Condition	Some of the vandalism may be seen as skilled graffiti art, which provides the opportunity for elements to be incorporated into the future use.	The on-going structural integrity of the Power Station is a key concern. The excessive vandalism is impacting on the heritage fabric, and also contributes to the cost of future use.
Scale	The scale of the building contributes to its landmark quality and provides opportunity for new similarly scaled buildings in close proximity.	The cost of redeveloping such a large building may be a key inhibiter to future development.
Location	The location of the Power Station abutting the coast provides significant amenity in terms of views, as well as recreational amenity. The Power Station also forms part of the broader Cockburn Coast area and the associated history and historical landmarks.	The location of the site both adjacent to the coast and in proximity to other heritage places requires careful consideration of potential direct and indirect effects.
Industrial aesthetic	Opportunity to inform design of new buildings in the locality.	May limit protruding elements on the elevations.
Equipment/ machinery	The majority of the plant and equipment has been removed from the Power Station, opening up the large internal spaces for greater development potential. The crane is the only remaining piece of equipment, which has the potential to be incorporated into adaptive reuse strategy.	Some interpretation value was arguably lost with the removal of the majority of the equipment, which could have been utilised as a feature of a future use, as has been the case in other power station adaptions.
Transparency of external walls	The large expanses of steel framed glazing (though much of the glass has been vandalised) permit natural light to infiltrate the building.	The amount of light entering the building through the external walls will need to be carefully considered to ensure any future uses that require highly controlled environments do not impact on the spatial qualities of the building.
History	The history of the site provides fertile ground for interpretation.	The past industrial use of the site has contributed to contamination.

Issue	Opportunity	Constraint
Aboriginal sites	Interpretation and story-telling potential.	According to the DIA Spatial Data System, DIA 3707 Rob Jetty extend south along the coast to the South Fremantle Power Station Water Basin and Groynes. An archaeological field survey of this area will be required to establish if any extant artefactual material is present and assess subsurface artefactual potential
Maritime sites	Interpretation, tourism and recreational potential.	There are a number or maritime heritage sites in Owens Anchorage. Any development proposals must take into consideration any direct or indirect impacts on maritime heritage, such as damage, movement and interment from construction, shifting sands, dredging and siltation. The James and Diana shipwrecks should remain in-situ and undisturbed.
Foreshore heritage	The foreshore area was once part of the heritage horse training area prior to the foreshore being obstructed by the groynes and Water Basin. There is an opportunity to interpret this past usage of the foreshore.	The horse training will need to be considered when planning for foreshore uses.
Switch yard	Part of the story of power generation.	The switch yard is a significant constraint to residential or commercial development of the power station, given the unattractive visual qualities and proximity to the Power Station impeding the provision of visual buffers.
Smoke Stacks	There is a possibility to add additional height to the top of the building and the opportunity to interpret the four original steel smoke stacks (no longer extant) is encouraged by the Cockburn Coast District Structure Plan.	The chimney stacks themselves are no longer extant, which may result in difficulty in having any additional proposed height approved in accordance with Coastal Height Policy.
Groynes and Water Basin	Opportunity to interpret a feature unique to South Fremantle Power Station.	Retention and/or interpretation of the groynes and Water Basin may limit development on waterfront if marina options are pursued.
Adaptive reuse potential	Large unimpeded spaces Large range of potential adaptive reuse.	Cost implications of restoring the building to allow new uses to be introduced.

HASSELL
© 2014

Figure 46 - South Fremantle Power Station (South Elevation)

Figure 47 - Cooling Ponds and Groyne at South Fremantle Power Station

6.2.1 Built Form Opportunities and Constraints

The sheer scale of the Power Station building presents both difficulties and opportunities in terms of potential uses and tenure. A comprehensive planning and feasibility assessment will be required to be undertaken for the site to provide an appropriate use or mix of uses and form which will reflect the importance and iconic nature of the building.

Preliminary investigations undertaken as a part of the district structure plans show the area is too large for any one particular use, and suggests that the development capacity could provide for a mixture of the following uses:

- A range of community uses;
- A mix of residential and commercial uses, along with a boutique hotel or short-stay apartment component; and
- Cafés, restaurants and bar, tourist and festival retail and a small element of convenience retail on the ground floor and a mezzanine level of the main building.

The preliminary investigations have identified the key issues and considerations that will need to be addressed in the comprehensive planning for the site. Ideally a significant portion of the building would be occupied by a civic, cultural or community use which would utilise the unique space of the building, however there are no current apparent users of such a scale. The restoration of the building will also require a significant investment.

The building's location on the coast means that the default position for use is residential apartments, however this use would result in limiting public access to the area and potential conflict with the entertainment and hotel activities. It is considered that at a minimum the ground level and administration wing of the building should be established as uses which enable and encourage public access.

On this basis it is recommended that planning and feasibility assessments are undertaken for the site, with the following key principles applied to the planning and development of the Power Station building to assist in maintaining its heritage values:

- Provision of ground floor activity and retention of public access to this level, including the western forecourt of the power station;
- A balance between commercially driven and community uses;
- Facilitate and promote access to the coast;
- Retain the landmark status of the building;
- Recognise the building's former use, through inclusion of visible green power generation (wind and solar); and
- Provide a suitable interface and relationship to enable creation of a quality pedestrian environment linking the surrounding development, the Power Station, and the coast.

The electrical switchyard adjacent to the Power Station site and associated distribution lines are a significant challenge. Options have been investigated as to the viability of relocation or rationalisation of the switchyard site, with substantial costs involved. It is understood that the relocation of the switchyard has a ten-year plus timeframe.

Figure 48 - Switch Yards at South Fremantle Power Station

6.2.2 Archaeological Opportunities and Constraints

Indigenous Archaeology

The Robb Jetty Camp Site (DIA 3707) extends to the northern foreshore reserve of the South Fremantle Power Station Precinct. Any proposed ground disturbance impinging on this site will require a Section 18 application to disturb the site under the Aboriginal Heritage Act.

The foreshore reserve area is considered to be an area of high archaeological potential, because the mobility of the dunes may have served to preserve artefactual material in its original context. Sand dunes typically provide a potential for stratified deposit in a dateable context. The coastal dunes of the Swan Coastal Plain are also considered to be favoured areas for prehistoric burials as the soils are easy to dig by hand. A number of Aboriginal burials have been found along the coastal sand dunes. Resultantly the Aboriginal community typically request that these coastal landscapes be monitored during any groundwork activity.

A significant issue that has implications for any archaeological assessment of the Cockburn Coast is the high degree of disturbance and modification to the original prehistoric and even historical landscape. In particular, the industrial usage and subsequent environmental remediation would have either removed, destroyed or re-deposited any archaeological material, so even if artefacts are found in this area it would not be in a recordable derivation or context. Moreover, the soil contamination by industrial agents would skew the results of any radiocarbon dates, in the unlikely event that the site contains material in a datable context, rendering the area ineffectual for any further archaeological research. As such, any artefacts found in the Robb Jetty Abattoir and surrounding area will tend to be a reflection of survival rates of artefactual material rather than an accurate reflection of the pattern of past Aboriginal occupation of the area.

Maritime Archaeology

Whilst the James and Diana shipwrecks have been located within the subject area, other ships are known to have been lost near Catherine Point, however these are yet to be discoverd. There may therefore be other as yet unknown shipwrecks off the coast of the Power Station or in the adjacent foreshore, which could potentially be impacted by the future development of the precinct.

It is therefore a requirement that the subject area be subject to a Maritime Archaeological Survey. Maritime Archaeology is a specialist area of expertise, which is provided by the Western Australian Maritime Museum. An investigation of this type was undertaken by the Maritime Museum for the neighbouring Port Coogee Development.[4]

There is some evidence that burials, survivor camps and structures associated with the wreck of the James were located along the beach in the vicinity of the James wreck. This will need to be investigated through further archival and archaeological research. Given that these features associated with the wreck of the James, the identification and preservation of these sites are also provided for under the provisions of the Maritime Archaeology Act 1973, so any further research will need to be done in association with the WA Maritime Museum. In the meantime, both the James and Diana shipwrecks should remain undisturbed in-situ.

4 Green, J 2006 Survey of the Port Coogee Development Area. Report to the Department of Maritime Archaeology. WAM No 213.

7. HERITAGE MANAGEMENT OPPORTUNITIES

7.1 Historic Heritage

7.1.1 Themes and Opportunities from Case Studies

The investigation of case studies of the adaptive-reuse of industrial buildings has illuminated a number of common themes and opportunities/possibilities relevant to the adaptive reuse of the South Fremantle Power Station.

Large Internal Spaces

The most remarkable quality of many industrial buildings is the scale of internal spaces, which remain as a reminder of the enormous machinery that previously filled the voids.

Utilising the large internal spaces of such buildings through open halls, enabling appreciation of the internal scale of the industrial buildings.

The Tate Modern's largely empty turbine hall permits a direct appreciation of the scale of the building, and also enables large temporary exhibitions to exhibit there, reminiscent of the huge industrial machinery that previously occupied the space.

Lighting

Lighting has been utilised in a number of cases of heritage buildings and specifically the adaptive re-use of industrial buildings, as a means of interpreting historic features and building on iconic qualities. Lighting can be used to raise awareness of historic sites by actively promoting them and drawing attention to their importance as community assets.

The Tate Modern's penthouse 'lightbeam' and Swiss Light - above the original roofline of the power station Herzog and De Meuron added a two-storey glass penthouse, known as the lightbeam. The chimney was capped by a coloured light feature designed by the artist Michael Craig-Martin, known as the Swiss Light. At night, the penthouse lightbeam and the Swiss Light mark the presence of Tate Modern for many miles.

The Ruhr Valley's Duisburg-Nord Industrial's multi-coloured night lighting – an interpretation of the plants' historic 24 hour operations. This new lighting, created as a result of an international design competition, was not intended to replicate the old but helps bring the past through the present into the future.

Heritage Perth has developed a project to create an imaginative and sustainable façade lighting scheme for significant buildings within the Perth City. The 'Light Up the City' project is providing a lighting show that highlights important buildings at night, with the aim of reaffirming Perth's title of 'City of Light', encouraging reactivation of the city centre and drawing increased numbers of visitors back into the city in the evening. In order to gain maximum support from the community, the project has been designed to minimise the environmental impact of the lighting, using energy efficient equipment. Heritage buildings in the City of Perth that have been lit under this scheme include Wesley Church and Council House.

A similar project to light the heritage buildings of Liverpool, UK, is now complete and an independent audit suggests that the lighting has numerous benefits, both economic and intangible or strategic benefits. The audit found that the lighting generated additional night time spending within the city centre of £3.2 million per annum and that 50% of visitors are making a special trip into the city to see the illuminations.[5]

'Green' Energy

Several examples of the adaptive re-use of power stations have reintroduced power generation to the sites, primarily utilising sustainable energy generation.

Battersea Power Station incorporated a green energy plant at foundation level, used to power the rest of the site, and Tate Modern continues to supply some electrical power services.

5 Heritage Perth Inc. [ONLINE] http://heritageperth.com.au/about-us/projects/light-up-the-city

HASSELL
© 2014

Civic/Cultural Use

Civic and cultural uses, including galleries and parklands are common uses introduced in the adaptive re-use of industrial buildings. Such uses enable equitable and broad-reaching access to buildings that often have strong ties to the history of the locality and shared narrative of the community. However, the propensity for such uses to be introduced into these buildings may be due to often high cost of adaptive re-use requiring the injection of public funding.

Link between Power Station and Water

The intake of cooling water from a water body is an integral part of the functioning of power stations. As a result, most are located on the banks of a river such at Battersea Power Station, Bankside Power Station (the Tate Modern), the New Farm Powerhouse (Brisbane Powerhouse) and the East Perth Power Station. Uniquely, the South Fremantle Power Station drew cooling water from the ocean through the use of two groynes and the ponds created between them. As identified in the Conservation Plan, this area providing the direct linkage from the Power Station to the ocean is equally significant as the Power Station building itself (recognised as being of 'Considerable Significance').

7.1.2 Built Form

Under the Conservation Plan it is necessary to retain the elements classified as being of Considerable Significance, namely:

- the steel framed and concrete clad form and fabric of the main Station building formerly housing the Boiler House and Turbine Room, and the wing extending north from the main building and constructed for Entrance Hall, Laboratories, Control Centre, Administration offices and Switch House;
- the steel framing exposed internally;
- the overhead crane in the Turbine Room and all associated support framing and plant;
- the steel-framed glazed walling throughout;
- the staircase and balustrade in the Entrance Hall to the Administration Wing;
- the two stone groynes and the Water Basin;
- the open spaces between the main Station building and the bank to the Coal Storage Area, and between the main building and the Water Basin.

Any proposal to demolish or modify the elements above would be required to have strong justification to be accepted by the Heritage Council of Western Australia.

Figure 49 - Urban Art within South Fremantle Power Station (2011)

7.1.3 Urban Art

Since the decommissioning of the Power Station in 1985, the building has lain vacant, which has lead to vandalism, squatting, 'underground' gatherings and concerts, and unauthorised yet highly skilled Urban Art becoming prolific in the building. These activities have been present for over 25 years, forming a substantial period in the history of the place. Despite this being subversive in nature, it forms a legitimate layer of use and meaning associated with the Power Station.

Given the skill and quality of much of the artwork, an opportunity is presented to retain and preserve some portions, which would add an additional layer of meaning and interpretation to the future adaptive reuse. This would also likely serve to involve and attract different parts of the local community in any new development and would help avoid alienating the local youth culture that has utilised the space in recent years.

Urban Art has been maintained and successfully incorporated in the adaptive reuse of other Power Stations and industrial buildings, including the Brisbane Powerhouse.

7.1.4 Shipwrecks

The James and Diana shipwrecks are both located beneath the sand on the foreshore immediately southwest of the Power Station (adjacent to the groynes). Opportunity to interpret the shipwrecks to communicate the tangible and intangible values and history of the wreck should be explored through public art installations and interpretive signage. The shipwrecks should remain in-situ and undisturbed for their protection

7.2 Archaeological

7.2.1 Indigenous Heritage Survey

Given that Aboriginal Site DIA 3707 Robb Jetty Camp impinges on the northern foreshore reserve of the South Fremantle Power Station Precinct, a Section 18 application to disturb the site under the Aboriginal Heritage Act will be required.

The area of Robb Jetty Camping area has been subject of a number of Archaeological Surveys over the last few years as part of heritage feasibility studies for nearby developments. All of these archaeological surveys were unable to find any physical evidence of past camping activity, but all noted that such evidence would have since been consumed by the mobile coastal sand dunes. Therefore, taking issues of high degree of landscape disturbance and negative results of previous archaeological surveys it has been recommended that the most viable archaeological survey sampling strategy is a Purposive design that is based on information from Aboriginal Informants.

In accordance with this strategy, Aboriginal Informants identify target areas for inspection based on ethnographic and historical knowledge and reading country. Some of the local Aboriginal Informants once camped and worked at Robb Jetty, so they are able to take the archaeologist to the specific location of past activities. This strategy will require that the Archaeological and Ethnographic field surveys be conducted concurrently, which is the most preferable scenario for the Aboriginal Community who like to have an input into archaeological investigations.

7.2.2 Further Archaeological Research of the South Fremantle Power Station

The 2003 South Fremantle Power Station Conservation Plan has made the following recommendations in regards to archaeological aspects of the Power Station site:

> *Archaeological investigation will confirm the existence of buildings and structures previously documented and photographed and now removed from site. In specific areas, further archaeological evidence may determine the construction process and areas of waste disposal on site.*

This type of archaeological research only has purpose if the proponent decides to precisely reconstruct and/or interpret the now removed features of the site, which is not envisaged by the Power Station Master Plan. This would require archaeological excavation and or probing to find the original location and extent of the various buildings and features. This can be a timely and costly exercise that is probably not warranted if there is clear photographic evidence, and architectural plans of the buildings and features.

Perhaps the most significant archaeological feature that remains is the Power Station groynes and Water Basin. The significance of the form and function of these features need to be further assessed in terms of current global debates on sustainable power generation. These features also provide a significant coastal landmark.

7.2.3 Further Maritime Research

Given there is archival evidence that burials, survivor camps and structures associated with the wreck of the were located along the beach in the vicinity of the James wreck, further archival and archaeological research is required to substantiate the precise locations of these potentially important sites.

The preservation of these sites is also provided for under the provisions of the Maritime Archaeology Act 1973, so any further research will need to be done in association with the W.A Maritime Museum.

7.2.4 Archaeological Monitoring

Given the high potential for undiscovered Aboriginal and historical archaeological material, particularly skeletal material, it is recommended that any ground works in the Foreshore area be monitored.

Archaeological and Aboriginal monitoring involves on-site monitoring of earthworks by an archaeologist and/or Traditional Owners to ensure that no significant cultural material or sites are destroyed without record.

HASSELL
© 2014

Figure 50 - Concept Master Plan (HASSELL, 2014)

8. PROPOSED MASTER PLAN

As outlined in the introductory section of this report, the preparation of the Master Plan for the Power Station site is an important step in realising the potential of the site and is essential in progressing the rezoning of the land from 'Urban Deferred' to 'Urban' under the Metropolitan Region Scheme.

The proposed Master Plan has been prepared by lead consultants HASSELL with input from a range of specialised consultants, including TPG Heritage. The Master Plan has been adapted and developed as the project has progressed, with input from a range of key stakeholders.

The proposed Master Plan looks at both the proposed development of the precinct surrounding the Power Station, and the future adaption of the Power Station building itself.

With regard to the Power Station building itself, the Master Plan proposes the following:

- Retention and conservation of the built fabric, including those elements identified as being of 'considerable significance' in the Conservation Plan
- Maintenance of the large open 'cathedral like' space of the Turbine Hall
- Utilisation of the western portions of the Power Station buildings for commercial and community uses, as well as internal open space and thoroughfare
- Construction of apartments within and above the eastern portion of the Power Station building (the Boiler House)
- Interpretation of the former smoke stacks (no longer extant) with the development of apartments above the Boiler House

With regard to the area surrounding the Power Station Building, the Master Plan generally proposes:

- Conservation and restoration of the groynes, with safe access permitted via a boardwalk above the groynes, and a jetty extending into the ocean
- Interpretation of the Water Basin with a water feature (detailed design to be confirmed at future planning stages)
- Retention of the James and Diana Shipwrecks beneath public open space
- Utilisation of the area northeast of the Power Station building for a public square/plaza
- Development of a series of residential and mixed use buildings to the north, south and east of the Power Station building, ranging in height between 2 and 6 storeys
- Provision of a range of pubic open space areas, disbursed throughout the precinct
- A u-shaped bridge to providing pedestrian and vehicular access across the freight rail line

Whilst the development of a marina in front of the Power Station has been considered as an option for the redevelopment of the precinct, at this stage it has been decided to progress without the inclusion of a marina in the Master Plan. It is understood that the development of a Marina has not necessarily been precluded from further investigation at future stages of planning. The marina has not, however, been included in the assessment of the current Master Plan.

Figure 51 - Concept Master Plan - Building Heights Plan (HASSELL, 2014)

Figure 52 - Concept Master Plan - Land Use Plan (HASSELL, 2014)

HASSELL
© 2014

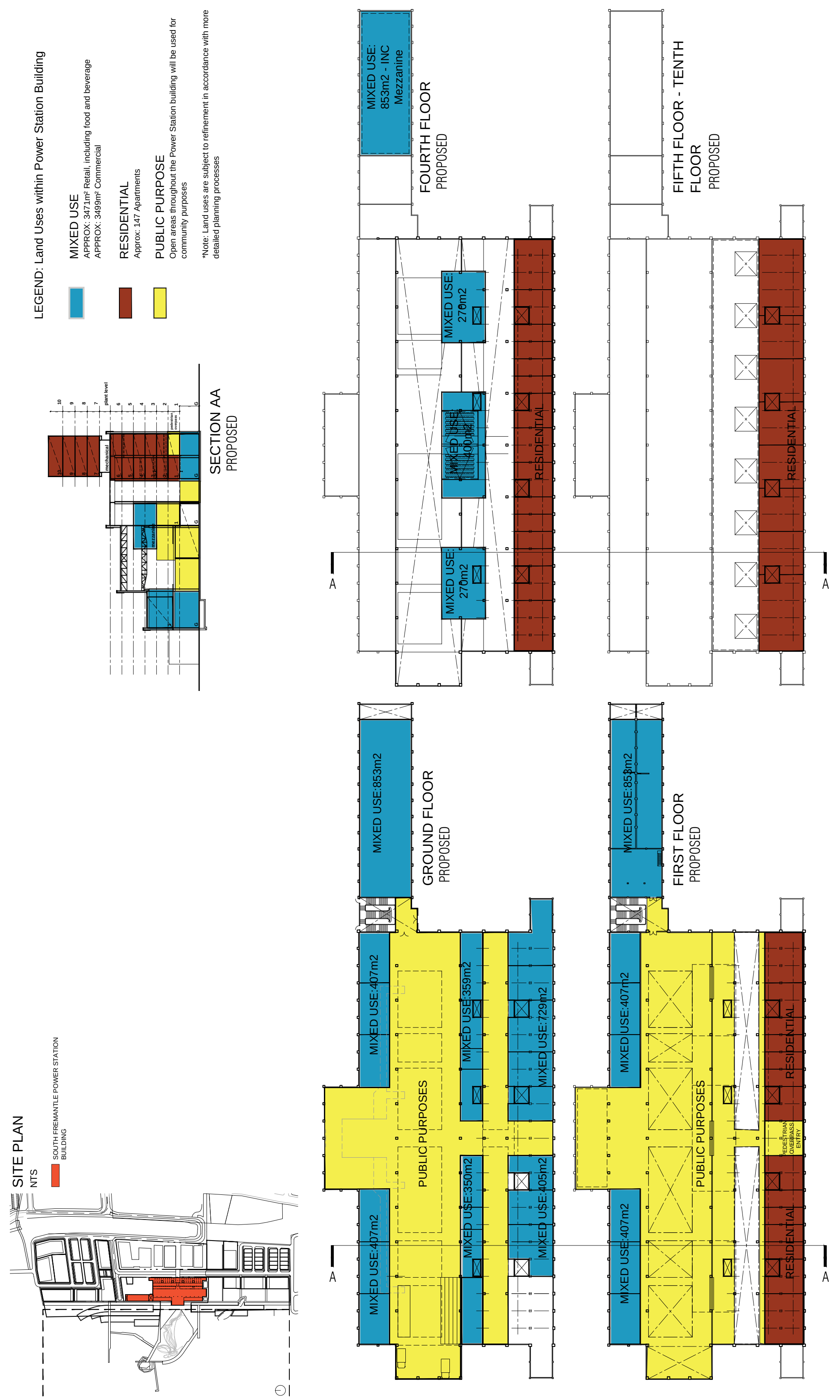


Figure 53 - Concept Master Plan - Power Station Summary Drawings (HASSELL, 2014)

9. ASSESSMENT OF PROPOSED MASTER PLAN

The proposed Master Plan has been assessed against the State Register Statement of Significance, Conservation Plan Statement of Significance and Conservation Policy, State Planning Policy 3.5 – Historic Heritage Conservation (SPP 3.5), the heritage requirements in the District Structure Plan (Part 1) and the principles of the ICOMOS Burra Charter.

The positive and potential negative impacts of the Master Plan, with regard to both the Power Station building and its setting have been explored below.

9.1 Potential Impact on Power Station Building

The South Fremantle Power Station is recognised as an important place of cultural heritage significance, at both a State and local level. It is also recognised as a critical component of the Cockburn Coast project as the landmark feature of the redevelopment area and as a regionally significant coastal node for Perth's southern suburbs. The Master Plan represents a commitment to the retention, conservation and adaptive reuse of the building.

1. The proposal has sought to retain the existing heritagefabric and also those elements identified as of Considerable Significance in the Conservation Plan, including:

- The steel-framed and concrete clad form and fabric of the main Station building formerly housing the Boiler Room and Turbine Hall, the wing extending from the north of the main building (constructed for the Entrance Hall, Laboratories, Control Centre, Administration offices and Switch House).
- All glazed walling.
- Steel framing internally.
- The overhead crane in the Turbine Hall and all associated support framing and plant.
- The staircase and balustrade in the Entrance Hall to the Administration Wing.

2. The Burra Charter states that the conservation of a place should take into consideration all aspects of cultural significance without unwarranted emphasis on any one value at the expense of others (Article 5.1). Since its closure urban art has been informally applied onto the walls of the Power Station. This art demonstrates that a period of abandonment and neglect has been a significant part of the history and evolution of the building over the past 25 years.

Retention of the building will enable opportunities to retain some of the high quality urban art.

3. After the closure of the Power Station four smoke stacks, which had been visually prominent elements above the roof-line of the Power Station building were removed. It is proposed that these smoke stacks be interpreted through new development. Interpretation of these stacks will provide an understanding of the sheer size and scale of the Power Station when it was functioning.

4. SPP 3.5 recognises that the adaptation of buildings for new uses will often require imagination and flexibility and is often the key to the conservation of heritage places that no longer serve their original function. Given the large scale of the building, a variety of new uses have been proposed, which will seek to ensure the place is continued to be used and maintained, including:

- Introduction of both public uses and residential development to activate the building
- Enabling a variety of temporary changing uses to utilise the Turbine Room space
- Internal spaces and uses will maintain vistas through the building
- Enabling year-round activation through internal spaces protected from the weather.

9.2 Impact on Setting

1. The South Fremantle Power Station remains as a prominent element on the shoreline in the coastal sand dunes south of Fremantle; it will be clearly visible from the north and south for some distance along the coast and from Owen Anchorage seawards. Policy 3 of the Conservation Plan states that the landmark values of the building should be preserved and not obscured. This option has been designed to accord with Policy 3, as outlined below:

- No new development has been positioned west of the Power Station building enabling clear sight-lines to the building from the foreshore/coast and Owen Anchorage.
- The lower scale of the proposed 2 - 6 floor development positioned to the north, south and east of the Power Station will assist in retaining the physical dominance and landmark qualities of the existing building. The new buildings will sit below the height of the Power Station, which has a height equivalent of an 8 storey building.
- Leveraging off the uniqueness of the Power Station, these new buildings will assist in creating a coastal residential, tourist and visitor node unlike any other in Perth as envisaged in the District Structure Plan (Part 1).
- All new development is setback and will not be an appendage to the Power Station building (with minimal links to aid adaptive re-use).
- As required by the District Structure Plan (Part 1), the proposed new buildings will continue the planar cubic form of the Power Station building and will be sympathetic to its aesthetic qualities.
- A jetty, which is proposed to extend from the timber boardwalk, will provide increased opportunities to view the Power Station from Owen Anchorage.
- The Public Open Space link in front of the Power Station facilitates continuity of views and public access to the Power Station.
- An open thoroughfare on the eastern side of the Power Station building has been retained, as requested in the Conservation Plan, enabling future interpretation of the Coal Storage Area.

2. The distinctive Water Basin, which was constructed behind stone groynes, on the western side of the Power Station, utilised sea water for use in the boilers and for cooling the turbines. The Conservation Plan identifies the two groynes and the Water Basin as items of 'Considerable Significance' and advocates their conservation.

The Master Plan seeks to retain and interpret these elements by:

- Constructing a boardwalk on top of the existing groyne structures (provided they can be made structurally stable).
- Installing an interactive water canal mapping the historic layers of the cooling pond.

The interpretation of these elements will ensure an appropriate context for the Power Station is maintained and to assist in an understanding of how the place operated.

3. The Diana and James wreck sites are located south west of the Power Station. Leaving the wrecks beneath the public open space will ensure that they are not further degraded or intruded on by footings of any new buildings, and can be excavated in the future if necessary. The shipwrecks will be interpreted in the public open space.

9.3 Potential Negative Impacts

At this stage no negative impacts on the setting of the Power Station, nor the Power Station building have been identified. This is because the proposal has been informed by and responds to an understanding and respect of the place's cultural heritage value.

10. SUMMARY AND CONCLUSIONS

The Cockburn Coast District Structure Plan envisages that the South Fremantle Power Station site will be rejuvenated as a major activity node, forming the hub of the new community and a regional attractor.

This Heritage Technical Study has identified that the significance of the Power Station – the attributes that make the place unique and special – is encapsulated not just in its built form, but also in the voluminous spaces within, the setting around and the story that is told collectively by these elements.

While the distinctive form, height and architectural design of the Power Station provide opportunities for new development in the vicinity, there are a number of challenges in realising the potential of the site. Any future development of the precinct will impact upon sites of historic, Aboriginal and maritime significance, which has been taken into account in the masterplanning for the site.

The analysis of the heritage significance of the place, identification of case studies and development of opportunities and constraints has identified opportunities in terms of built form, land use and setting that can facilitate the adaptive reuse of the building, whilst being sympathetic to the heritage significance of the Power Station and other places of significance in the vicinity.

An assessment of the Master Plan with regard to its potential impacts upon the heritage significance of the Power Station and other heritage places in the vicinity, has identified many positive impacts on both the building and the setting.

It is concluded that the Master Plan is a positive step forward in the process toward realising the potential of the South Fremantle Power Station, and celebrating its heritage significance as the centrepiece of the broader Cockburn Coast redevelopment project.

HASSELL
© 2014

eco logical AUSTRALIA

South Fremantle Power Station Site

Desktop Flora and Fauna Assessment

Prepared for
LandCorp

September 2013

DOCUMENT TRACKING

Item	Detail
Project Name	Cockburn Power Station Site Desktop Flora and Fauna Assessment
Project Number	13PERECO-0036
Project Manager	Phillipa Tompson (08) 9 227 1070 Suites 1&2 49 Ord St West Perth 6005
Prepared by	Sarah Dalgleish, Phillipa Tompson
Reviewed by	Joel Collins, Warren McGrath
Approved by	Warren McGrath
Status	FINAL
Version Number	2
Last saved on	6 September 2013
Cover photo	South Fremantle Power Station © Eco Logical Australia 2011

This report should be cited as 'Eco Logical Australia September 2013. *South Fremantle Power Station Flora and Fauna Assessment*. Prepared for LandCorp.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Matthew Pears of LandCorp.

Disclaimer
This document may only be used for the purpose for which it was commissioned and in accordance with the contract between Eco Logical Australia Pty Ltd and LandCorp. The scope of services was defined in consultation with LandCorp, by time and budgetary constraints imposed by the client, and the availability of reports and other data on the subject area. Changes to available information, legislation and schedules are made on an ongoing basis and readers should obtain up to date information.

Eco Logical Australia Pty Ltd accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report and its supporting material by any third party. Information provided is not intended to be a substitute for site specific assessment or legal advice in relation to any matter. Unauthorised use of this report in any form is prohibited.

Template 22/08/13

Contents

© ECO LOGICAL AUSTRALIA PTY LTD

List of figures

Abbreviations

Abbreviation	Description
DPaW	Department of Parks and Wildlife
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Areas
IBRA	Interim Biogeographic Regionalisation for Australia
TEC/PEC	Threatened or Priority Ecological communities
WC Act	*Wildlife Conservation Act 1950*

© ECO LOGICAL AUSTRALIA PTY LTD

1 Introduction

Eco Logical Australia (ELA) was engaged by LandCorp to conduct a desktop flora and fauna assessment for the land surrounding the South Fremantle Power Station (herein 'the study area') (**Figure 1**).

1.1 Background

A master plan is currently being prepared to facilitate redevelopment of the South Fremantle Power Station and surrounding land. The master plan is required to address the 12 points raised by the Western Australian Planning Commission's Metropolitan Region Scheme (MRS) Amendment 1180/41 to lift the 'Urban deferred' status over Lots 2, 3, and 2167 Robb Road (including the study area). This flora and fauna assessment report is intended to fulfil the requirement for an "Environmental Assessment" in these 12 points, and will be used as a supporting document for the South Fremantle Power Station master plan. Any recommendations for further survey presented in this document are understood to be likely to be carried out at the local structure plan stage.

1.2 Approach and methodology

The desktop flora and fauna assessment was undertaken through:

- Database searches for previous recordings of significant flora and fauna values
- Literature review of previous site surveys
- Aerial photo analysis
- Extrapolation of above information to describe general vegetation and habitat types and condition
- Professional preliminary assessment of any key values based on the above.

2 Database search and literature review findings

2.1 Database searches

The following databases were searched to determine a potential list of conservation significant flora, fauna, ecological communities, and Environmentally Sensitive Areas (ESAs) that may occur in the study area:

- Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters search tool (SEWPaC 2013a);
- Department of Parks and Wildlife (DPaW) [formerly Department of Environment and Conservation (DEC)] and Western Australian Museum's NatureMap online database (DPaW 2013a); and
- DPaW Environmentally Sensitive Areas database (DPaW 2013b).

2.2 IBRA and regional vegetation descriptions

The Interim Biogeographic Regionalisation for Australia (IBRA) Version 7 recognises 89 large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. The 89 bioregions are further refined into 419 subregions which are more localised and homogenous geomorphological units in each bioregion (SEWPaC 2013b).

The study area lies within the Perth sub-region of the Swan Coastal Plain IBRA region. The Perth sub-region mainly comprises woodlands of Banksia and tuart on sandy soils with sheoak on outwash plains and paperbark in swampy areas (Kendrick and McKenzie 2002).

2.3 Soil type and topography

The study area lies in the Quindalup Dunes in the Safety Bay Sand soil type. This soil type is characterised as calcareous deep sand with white, medium-grained, rounded quartz and shell debris which is well sorted and of eolian origin (Gozzard 1983).

2.4 Environmentally sensitive areas

ESAs are areas of high conservation value as defined within the WA *Environmental Protection Act 1986* (EP Act) and include the presence of, or habitat for, threatened species and communities. There are no terrestrial ESAs located within the study area. The closest ESA is approximately 1.8 km south of the study area; the Threatened Ecological Community (TEC) SCP30a - *Callitris preissii* or *Melaleuca lanceolata* forests and woodlands, which is discussed further in Section 2.6.

2.5 Conservation significant flora

According to NatureMap there are no Threatened flora species listed under the *Wildlife Conservation Act 1950* (WC Act) or Priority flora (listed by DPaW) records within the study area and no records within a one kilometre radius of the study area.

The EPBC Act protected matters search tool identified five federally listed Threatened flora species within a one kilometre search radius, however these species are considered unlikely to occur in the study area due to lack of specific habitat.

2.6 Threatened and priority ecological communities

There are no TECs or Priority Ecological communities (PECs) listed under the EPBC Act or by DPaW present within study area.

The closest TEC/PEC is the TEC SCP30a - *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain which is located approximately 1.8 km kilometres south of the study area at Woodman Point.

2.7 Conservation significant fauna

The database searches identified that there are no Threatened or Priority fauna records from within the study area, however 11 conservation significant fauna species may potentially occur. Most of these species are migratory birds and if present in the study area, would likely only be passing through as the study area doesn't contain any habitat that would be significant for breeding or foraging for these species. It is however likely that the DPaW Priority 3 species *Lerista lineata* (Perth Slider, Lined Skink) would occur within the study area as it has been recorded from two locations within one kilometre of the study area.

2.8 Previous ecological surveys

Three ecological studies have been conducted in the South Fremantle (Cockburn) Foreshore area to support various planning activities. Two studies were conducted to support the Cockburn Coast District Structure Plan; a Vegetation Spring Survey and Level 2 Fauna Survey of the Cockburn Coast and surrounding areas conducted by GHD in 2009 (GHD 2009), and a vegetation desktop study conducted by ENV in 2007 (ENV 2007). Most recently, ELA conducted a ground-truthing survey of the Cockburn Foreshore area (immediately to the north of the study area) and prepared a summary of environmental values of the Foreshore for inclusion in the Cockburn Coast Foreshore Management Plan (Hassell 2012). This included a summary of the results of the two previous surveys, some of which covered portions of the study area.

The vegetation mapping from the ELA ground-truthing survey (in Hassell 2012) has been used to describe, and further extrapolate, the vegetation types and condition of the study area.

3 Preliminary site assessment

3.1 Vegetation type

The study area is highly disturbed, containing large patches of cleared land. Vegetation types likely to be present within the study area were extrapolated from vegetation mapping conducted previously within parts of the study area and nearby. The small portion of the study area containing remnant native vegetation, is in the north-east corner along the coastal dune system. This vegetation type is described as:

- Open Grassland of *Spinifex longifolius* over weed dominated herb layer with areas of rehabilitation on the dunes. Associated species include *Olearia axillaris, Atriplex sp, *Asphodelus fistulosus, *Pelargonium capitatum* and **Tetragonia decumbens.*

The remaining areas have been previously cleared and contain areas of introduced species. These areas include:

- Cleared areas now dominated by weed grassland
- Open Shrubland of **Leptospermum laevigatum*, over weed dominated herb layer

As no vegetation mapping has taken place in the part of the study area that includes the power station and its immediate surrounds, this area has been interpreted through a review of aerial imagery and the existing vegetation mapping nearby. Based on this approach it is likely this area comprises:

- Cleared area now dominated by scattered shrubs (likely to be **Leptospermum laevigatum*) and weed grassland

The known and suspected vegetation types within the study area are presented in **Figure 1**.

3.2 Vegetation condition

Vegetation condition in the previously described portion of the study area is in a degraded to completely degraded condition (Hassell 2012); (GHD 2009). Based on a review of aerial imagery, it is apparent that vegetation in the unmapped areas is also likely to be in a degraded to completely degraded condition. The unmapped parts of the study area appear to have been subject to significant

disturbances including clearing and the development infrastructure associated with the power station (**Figure 1**).

The degraded vegetation is heavily infested with introduced flora species.

3.3 Conservation significant ecological communities and flora

It is highly unlikely that the study area supports any listed Threatened flora under the *Wildlife Conservation Act 1950* or the EPBC Act because of the degraded condition of the remaining vegetation and the lack of records of such species in the area.

The remnant vegetation of the study area is highly unlikely to be representative of a TEC or PEC listed under the EPBC Act or by DPaW because of the degraded condition and generally highly modified nature of the environment.

3.4 Likely fauna values

The Priority 3 species *Lerista lineata* (Perth Slider, Lined Skink) is likely to occur in the study area. This species is found in pale sands that support heathlands and shrublands in southern suburbs and dunes of the Swan Coastal Plain (Bush et al 1995). It is also known to occur in disturbed areas such as backyards, which comprise much of its remaining habitat (Bush et al 1995). It is recommended that an on-ground assessment be carried out within the study area to evaluate what areas are likely to be of value to the species such that further advice in regards to management of this issue during site development can be provided.

The inlet and dune area containing remnant vegetation within the study area, do not constitute high-value habitat for migratory bird species as the dune vegetation is degraded and partially cleared, and the inlet west of the power station is likely to be polluted.

The study area is unlikely to support any other potentially significant fauna values.

4 Conclusion

The historical clearing and activity associated with construction and operation of the power station have left the study area highly disturbed with little remaining native vegetation and widespread introduced flora species. In combination with its small size, the study area offers no substantial habitat for conservation significant flora species or conservation significant fauna species, with one potential exception.

It is recommended that an on-ground assessment of the study area for the DPaW Priority 3 species *Lerista lineata* (Perth Slider, Lined Skink) be conducted at the local structure plan stage, as it has been known to occur in disturbed areas and has been recorded nearby. The information gained from this assessment can be used to inform future detailed site planning and development.

© ECO LOGICAL AUSTRALIA PTY LTD

HASSELL
© 2014

References

Bush, B, Maryan, B, Browne – Cooper, R and Robinson, D. 1995. *Reptile and Frogs of the Perth Region*. University of Western Australia Press.

Department of Parks and Wildlife. (DPaW) 2013a. *NatureMap: Mapping Western Australia's Biodiversity*. Available: http://naturemap.dec.wa.gov.au/default.aspx

Department of Parks and Wildlife. (DPaW) 2013b. *Native Vegetation Map Viewer.* Available: http://maps.dec.wa.gov.au/idelve/nv/index.jsp

Department of Sustainability, Environment, Water, Populations and Communities. (SEWPaC) 2013a. *EPBC Protected Matters Search Tool*. Available: http://www.environment.gov.au/epbc/pmst/index.html

Department of Sustainability, Environment, Water, Population and Communities (SEWPaCa). 2013b. Australia's Bioregions. Available: http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html

ENV (2007). Environmental assessment, Cockburn Coast District Structure Plan Prepared for Department for Planning and Infrastructure, July 2007.

GHD (2009). Report for Cockburn Coast, Supplementary Flora and Fauna Assessment. Preparedfor the Western Australian Planning Commission, December 2009.

Gozzard J.R. 1983. *Fremantle Part Sheets 2033 I & 2033 IV, Perth Metropolitan Region, Environmental Geology Series*, Geological Survey of Western Australia.

Hassell (2012). *Cockburn Coast Foreshore Management Plan*. Prepared for LandCorp

Kendrick, P. and McKenzie, N. 2002. *Bioregional Summary of the 2002 Biodiversity Audit for Western Australia*, pp. 93-98. Department of Conservation and Land Management, Perth, Western Australia.

eco logical AUSTRALIA

HEAD OFFICE
Suite 4, Level 1
2-4 Merton Street
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

SYDNEY
Level 6
299 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9264 0717

ST GEORGES BASIN
8/128 Island Point Road
St Georges Basin NSW 2540
T 02 4443 5555
F 02 4443 6655

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 6103 0148

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 4910 0126

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4476 1151
F 02 4476 1161

COFFS HARBOUR
35 Orlando Street
Coffs Harbour Jetty NSW 2450
T 02 6651 5484
F 02 6651 6890

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2681
F 02 6772 1279

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1230
F 02 6372 9230

PERTH
Suite 1 & 2
49 Ord Street
West Perth WA 6005
T 08 9227 1070
F 08 9322 1358

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 4268 4361

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1220
F 02 4322 2897

DARWIN
16/56 Marina Boulevard
Cullen Bay NT 0820
T 08 8989 5601

BRISBANE
51 Amelia Street
Fortitude Valley QLD 4006
T 07 3503 7193

1300 646 131
www.ecoaus.com.au

Appendix E
Cockburn Coast Coastal Vulnerability Report

m p rogers & associates pl ABN 14 062 681 252
creating better coasts and ports

R466 Rev 2

14 March 2014

LandCorp

Cockburn Coast
Coastal Vulnerability to 2013 SCPP

marinas
boat harbours
canals
breakwaters
jetties
seawalls
dredging
reclamation
climate change
waves
currents
tides
flood levels
water quality
siltation
erosion
rivers
beaches
estuaries

www.coastsandports.com.au

m p rogers & associates pl
creating better coasts and ports

Suite 1, 128 Main Street, Osborne Park, WA 6017
p: +618 9254 6600
e: admin@coastsandports.com.au
w: www.coastsandports.com.au

K1132, Report R466 Rev 2
Record of Document Revisions

Rev	Purpose of Document	Prepared	Reviewed	Approved	Date
A	Draft for MRA review	M Rogers	C Doak	M Rogers	17/01/14
0	Issued for Client use	M Rogers	C Doak	M Rogers	17/01/14
1	Minor edits & reissued for Client use	M Rogers	C Doak	M Rogers	29/01/14
2	Minor edits & reissued for Client use	D Hamilton	M Rogers	M Rogers	14/03/14

Form 035 18/06/2013

Limitations of this Document

This document has been prepared for use by the Client in accordance with the agreement between the Client and M P Rogers & Associates Pty Ltd. This agreement includes constraints on the scope, budget and time available for the services. The consulting services and this document have been completed with the degree of skill, care and diligence normally exercised by members of the engineering profession performing services of a similar nature. No other warranty, expressed or implied, is made as to the accuracy of the data and professional advice included. This document has not been prepared for use by parties other than the Client and its consulting advisers. It may not contain sufficient information for the purposes of other parties or for other uses.

M P Rogers & Associates takes no responsibility for the completeness or form of any subsequent copies of this document. Copying this document without the permission of the Client or M P Rogers & Associates Pty Ltd is not permitted.

Table of Contents

Table of Figures

Table of Tables

HASSELL
© 2014

1. Introduction

1.1 General

LandCorp has been investigating the development of the coastal land from just north of Rollinson Road, South Beach to Port Coogee. A District Structure Plan was prepared for the proposed development in 2008 and is shown in Figure 1.1.

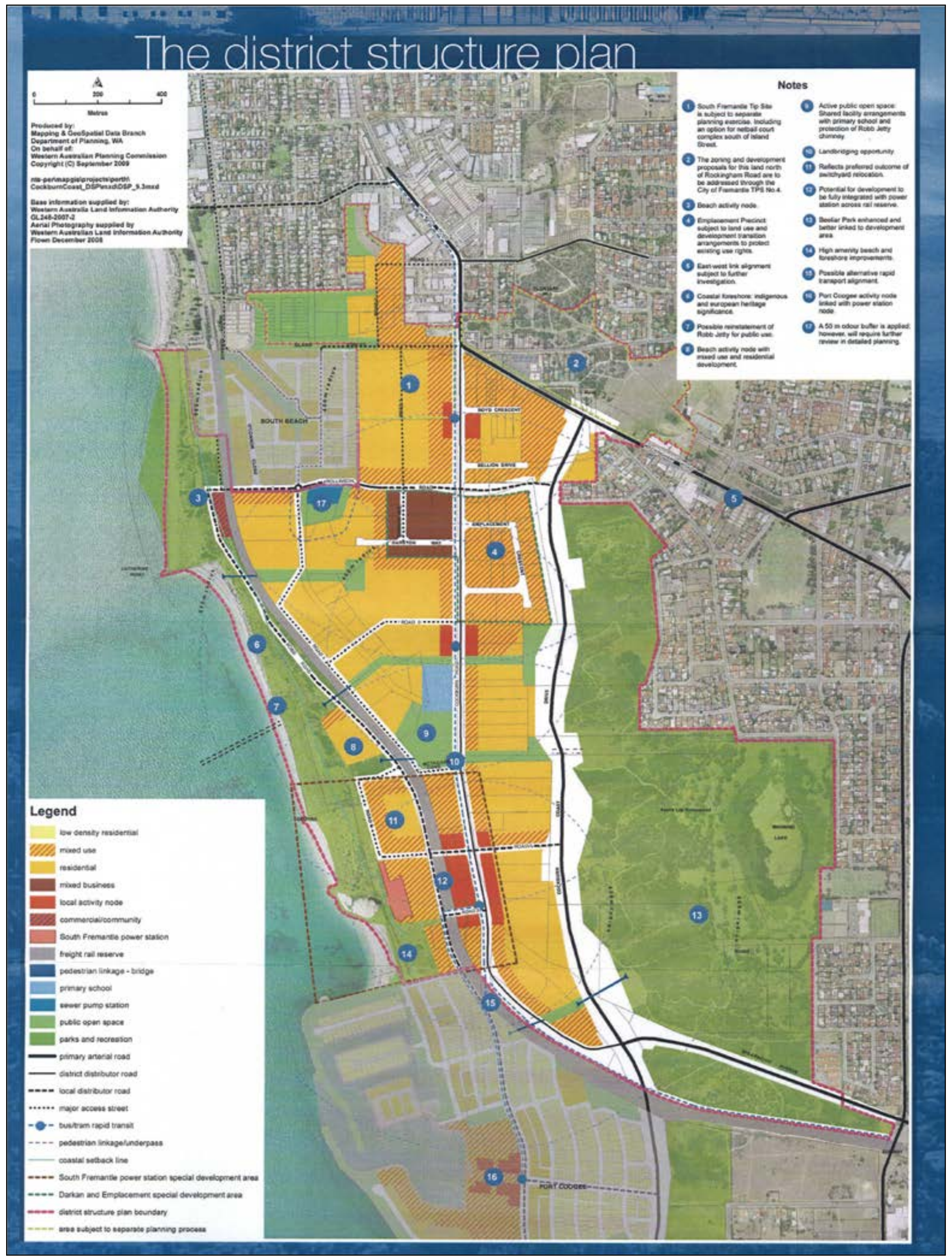


Figure 1.1 District Structure Plan

The District Structure Plan shown in Figure 1.1 was based on setbacks calculated by Oceanica in 2007 to the then current State Coastal Planning Policy (SCPP). It was accepted by the City of Cockburn and the Department of Planning.

In 2010 LandCorp engaged Wood & Grieve Engineers (WGE) to assist with the civil, structural, servicing and coastal / maritime engineering. WGE engaged specialist coastal and port engineers, M P Rogers & Associate Pty Ltd (MRA) to complete the coastal / maritime engineering investigations for the project. This included a coastal vulnerability assessment to then current Statement of Planning Policy 2.6 – State Coastal Planning Policy (WAPC 2003) together with the Position Statement released in 2010 (WAPC 2010). The MRA report R301 Rev 0 of July 2011 presented that work. That assessment and report utilised the results of Oceanica's 2007 assessment of coastal processes for the development of the District Structure Plan (Oceanica 2007).

In July 2013, the State Coastal Planning Policy was revised (WAPC 2013). LandCorp has engaged MRA to complete an assessment to the requirements of this new policy in order to confirm that the proposed development would be safe from potential coastal erosion.

This policy provides a methodology for completing an assessment of the potential impacts of coastal processes over the planning timeframe that can be used to inform the planning process. This methodology requires consideration of the potential effects of:

- severe storm erosion (termed the S1 allowance);
- future long term changes to the shoreline position (termed the S2 allowance);
- climate change induced sea level rise (termed the S3 allowance); and
- storm surge inundation (termed the S4 allowance).

1.2 Background & Setting

The shoreline in this area has a long history of development since European settlement in the 1800's. The area has been used for horse racing, recreation, a variety of industrial and port uses, power generation, and more recently for urban development. There are several ship wrecks in the area that are of historical significance.

The natural coastal processes have been interrupted for about half a century by the groynes at Island Street, Catherine Point, Robb Road and the South Fremantle Power Station. The South Fremantle Power Station was constructed on the shoreline in the 1940's and included seawalls to protect the facilities. Over the last 70 years there has been significant accretion of the coast due to the sand feed from Success Bank being trapped by the various coastal structures. The seawalls both north and south of the cooling water pond area have been covered by sand accumulation. The shoreline to the north of the cooling water pond has prograded more than 120 m since 1942.

In 2006 the main breakwaters at Port Coogee were constructed. These also changed the coastal processes. The Waterway Manager of Port Coogee is responsible for ongoing beach monitoring and management to mitigate the impacts of the development on coastal processes and maintain Coogee Beach. The management has included bypassing sand from the northern side of Port Coogee to the beaches to the south. Since the Port Coogee breakwaters were constructed, bypassing has been carried out in 2009 when approximately 15,000 m³ was bypassed (Rogers & Associates 2009) and subsequently in 2012 when approximately 15,000 m^3 was bypassed.

The bypassing is completed to maintain the beaches to the south. However, to maintain the beaches to the south requires less sand to be moved than the quantity arriving to the north of Port Coogee. The net result has been accretion on the beaches immediately north of Port Coogee. Since 2006 the beach between the cooling water pond and Port Coogee has prograded some 50 m. In future decades, the area of accretion will extend to the north and the beaches north of the cooling water pond will also accrete. This was identified in the coastal process studies completed as part of the environmental approvals for Port Coogee and confirmed by the extensive beach monitoring program.

2. Severe Storm Erosion (S1)

Severe storm events have the potential to cause increased erosion to a shoreline, through the combination of higher, steeper waves generated by sustained strong winds, and increased water levels. These two factors acting in concert allow waves to erode the upper parts of the beach not normally vulnerable to wave attack.

If the initial width of the surf zone is insufficient to dissipate the increased wave energy, this energy is often spent eroding the beach face, beach berm and sometimes the dunes. The eroded sand is transported offshore with the return water flow to form offshore bars. As these bars grow, they can cause incoming waves to break further offshore, decreasing the wave energy available to attack the beach. This is shown diagrammatically in Figure 2.1.

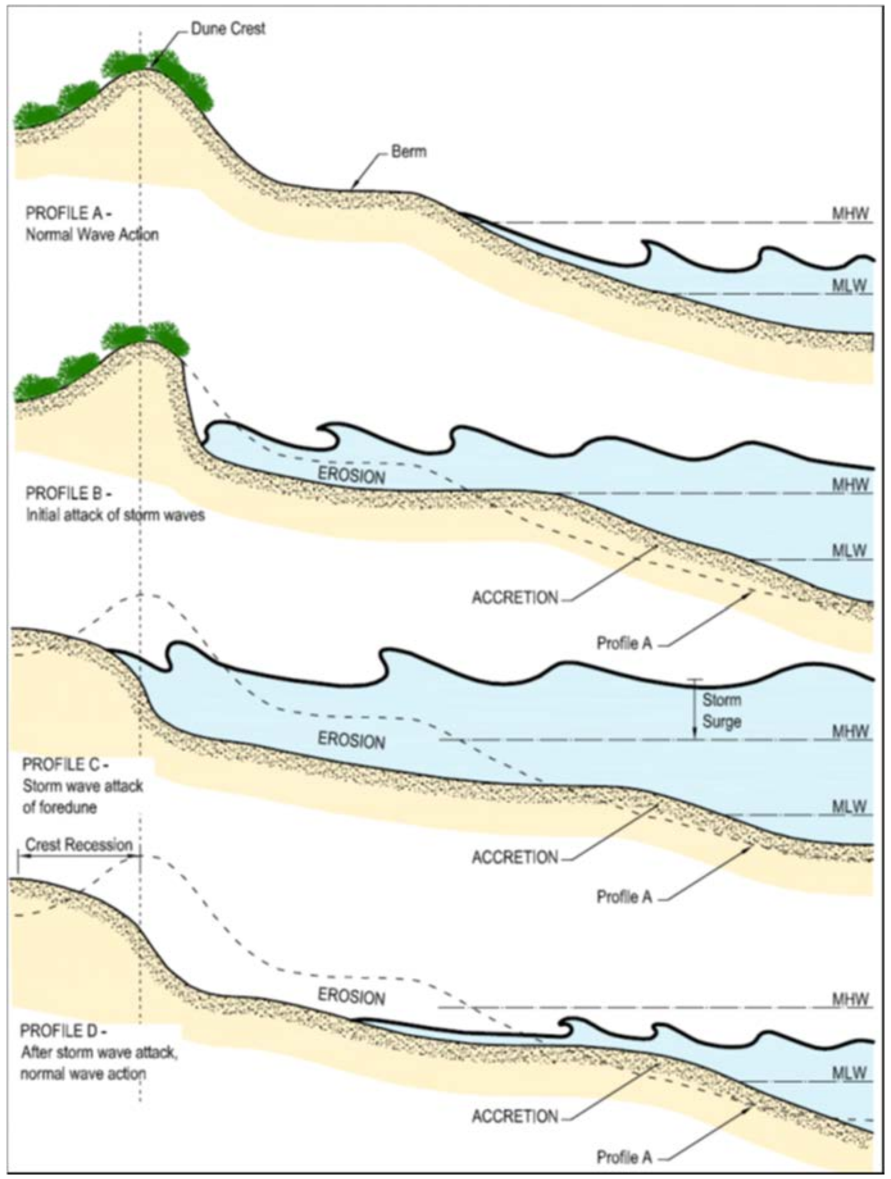


Figure 2.1 Storm Erosion Process (source: CERC 1984)

HASSELL
© 2014

The SBEACH computer model was developed by the Coastal Engineering Research Centre (CERC) to simulate beach profile evolution in response to storm events. It is described in detail by Larson & Kraus (1989). Since this time the model has been further developed, updated and verified based on field measurements (Wise et al 1996, Larson & Kraus 1998, Larson et al 2004).

SBEACH has also been validated locally by MRA (Rogers et al 2005). This local validation has shown that SBEACH can provide useful and relevant predictions of the storm induced erosion provided the inputs, which include time histories of wave height, period and water elevation, as well as pre-storm beach profile and median sediment grain size, are correctly applied; and care is taken to ensure that the model is accurately reproducing the recorded wave heights and water levels.

SPP2.6 recommends that the allowance for absorbing acute erosion consider both the effects of longshore and cross shore sediment transport processes. It is recommended that potential cross shore erosion be determined by modelling the impact of an appropriate storm sequence using acceptable models such as SBEACH (WAPC 2013). It is also specified that the modelled storm should have an annual exceedance probability (AEP) of 1% with regard to beach erosion. This is equivalent to a storm with an average recurrence interval (ARI) of 100 years.

It is widely accepted that simulating 3 repeats of a severe storm sequence that effected south west Western Australia in July 1996 provides a conservative representation of the 100 year beach erosion event. This storm sequence had elevated water levels for a period of approximately 111 hours and caused coastal erosion at a number of locations in Western Australia. Modelling three consecutive repeats of this storm therefore simulates the effects of over 330 hours of storm conditions on the shoreline.

Previously the SBEACH model was used by Oceanica (2007) to predict the response of the shoreline to the designated storm sequence for the following coastal sectors.

- Sector 1 = 110 m north of Rollinson Road to Catherine Point Groyne.
- Sector 2 = Catherine Point Groyne to Robb Jetty remains.
- Sector 3 = Robb Jetty remains to Robb Road Groyne.
- Sector 4 = Robb Road Groyne to the Power Station Cooling Water Pond.
- Sector 5 = Power Station Cooling Water Pond to Port Coogee Northern Breakwater.

These sectors and the main coastal features are shown on Figure 2.2.

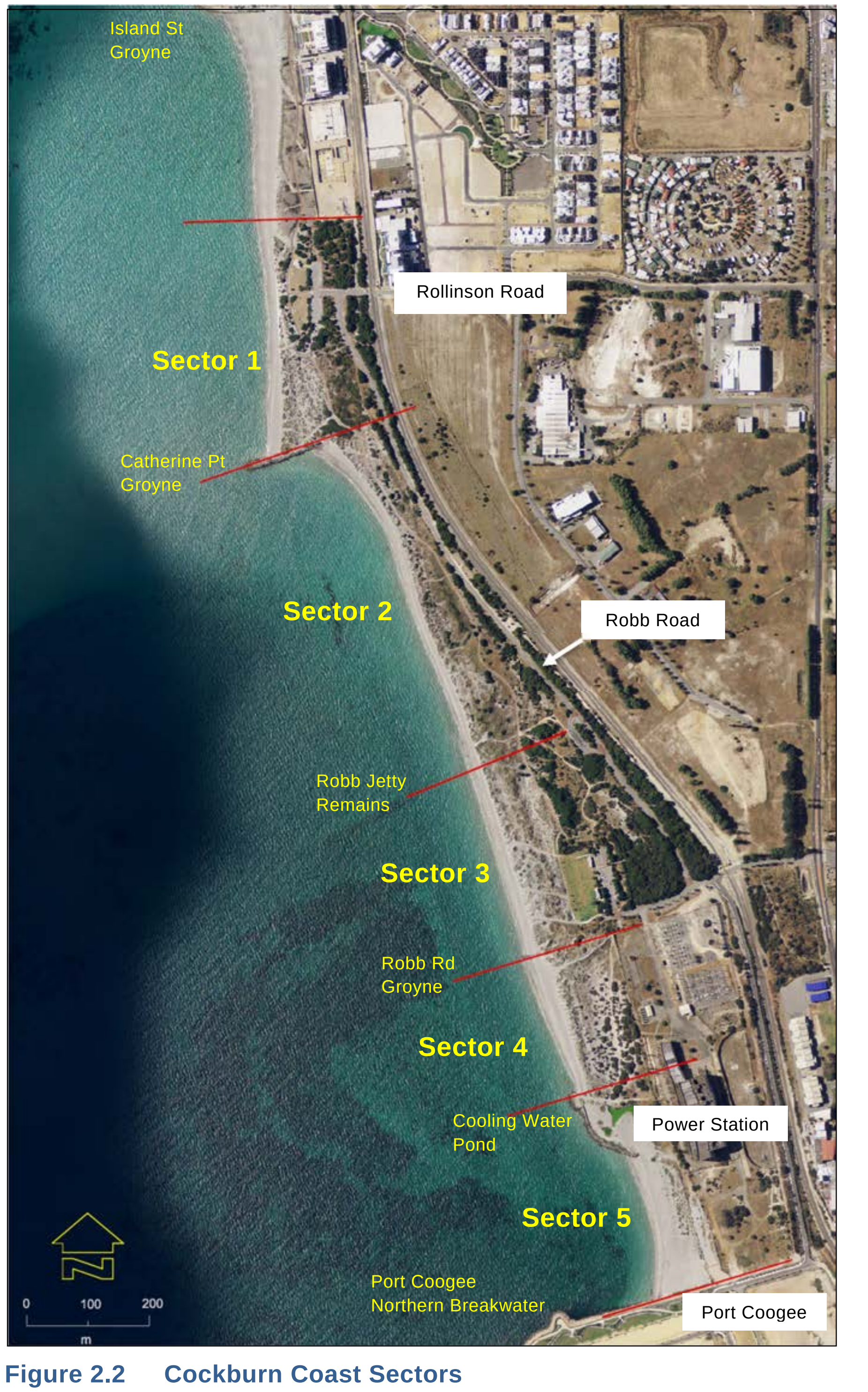


Figure 2.2 Cockburn Coast Sectors

The SBeach modelling for these various sectors has been completed to the requirements of the 2013 State Coastal Planning Policy. This modelling work provided the position of the Horizontal Shoreline Datum (HSD) and the S1 value to allow for storm erosion behind the HSD.

The results for the SBeach modelling for each of the sectors is shown in the figures below and the summary table that follows.

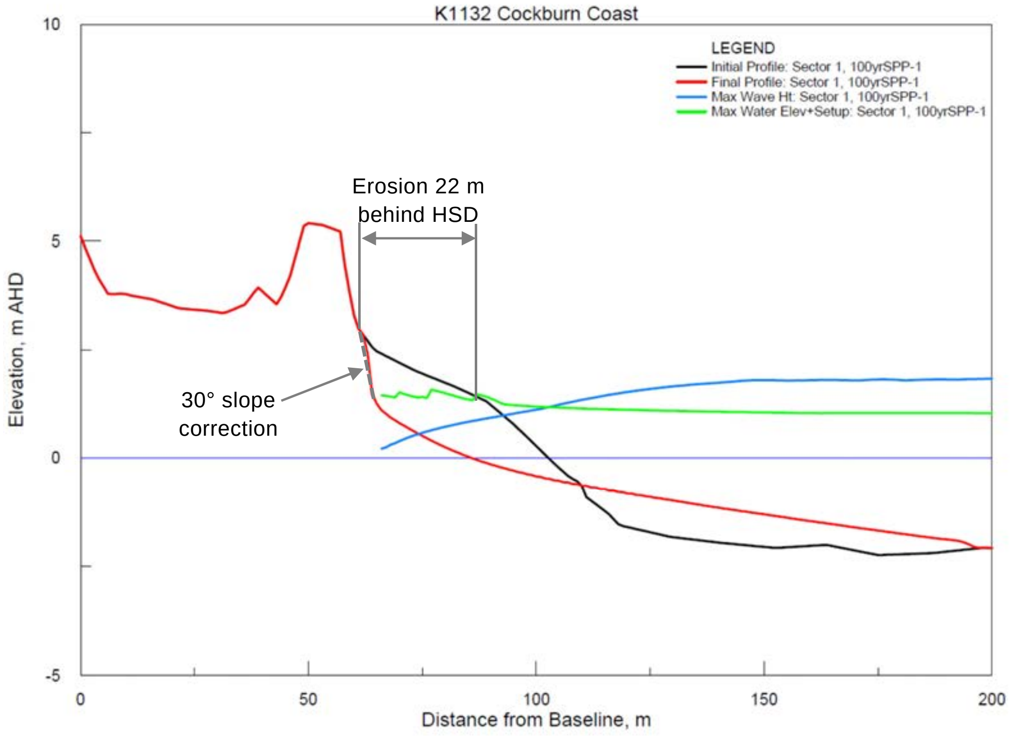


Figure 2.3 Sector 1 SBeach Results

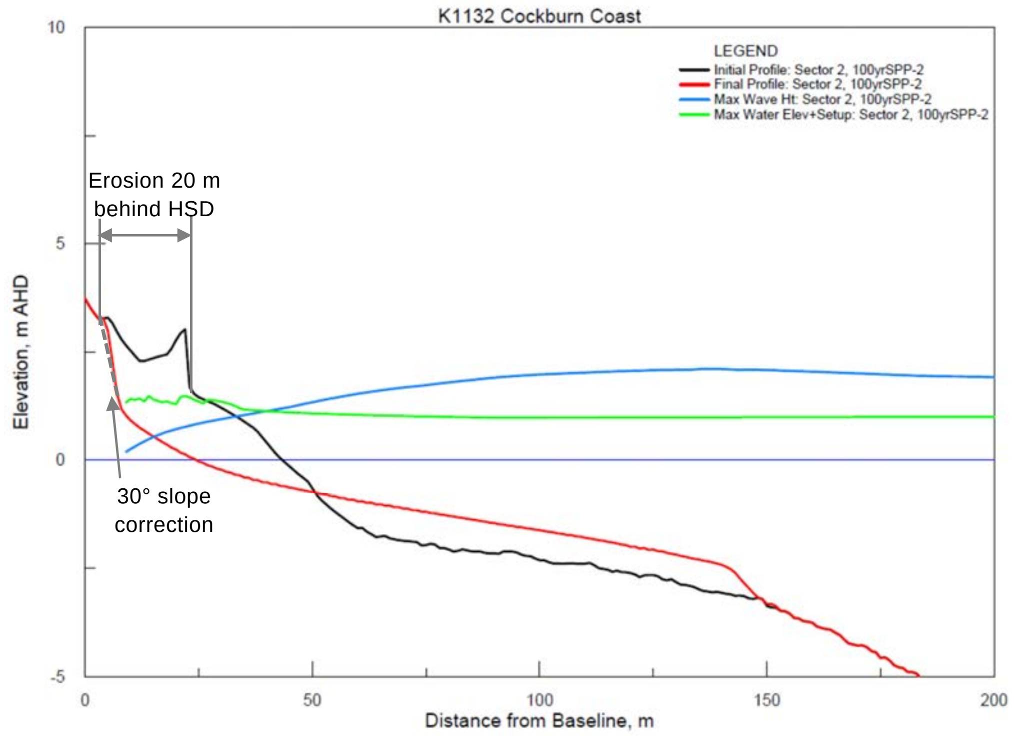


Figure 2.4 Sector 2 SBeach Results

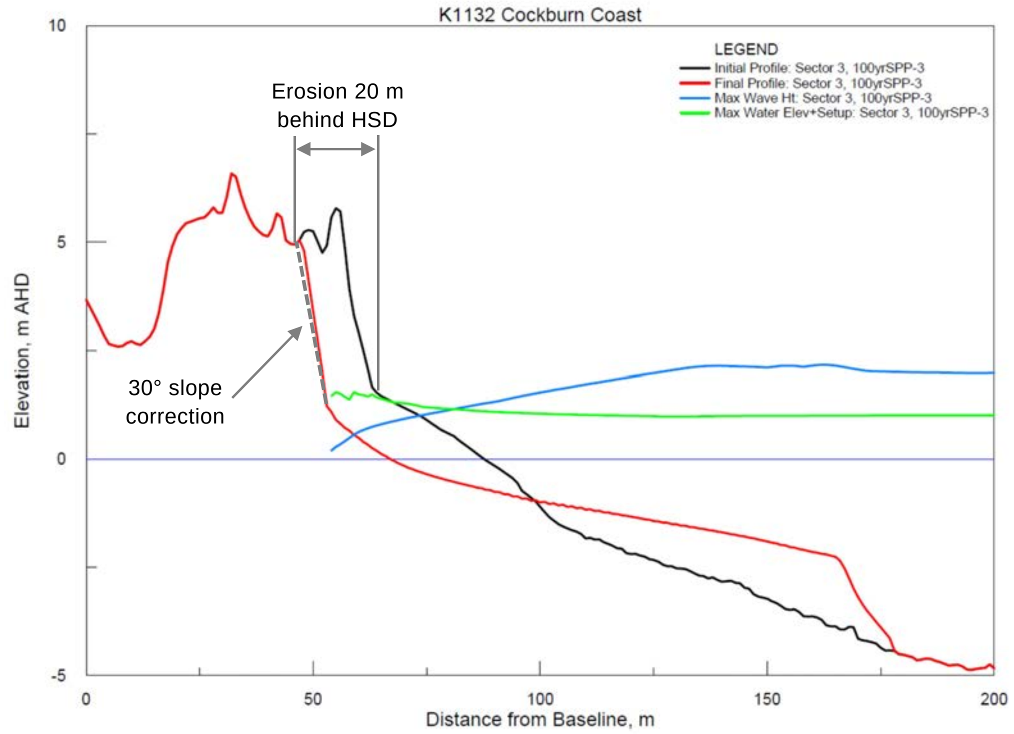


Figure 2.5 Sector 3 SBeach Results

HASSELL
© 2014

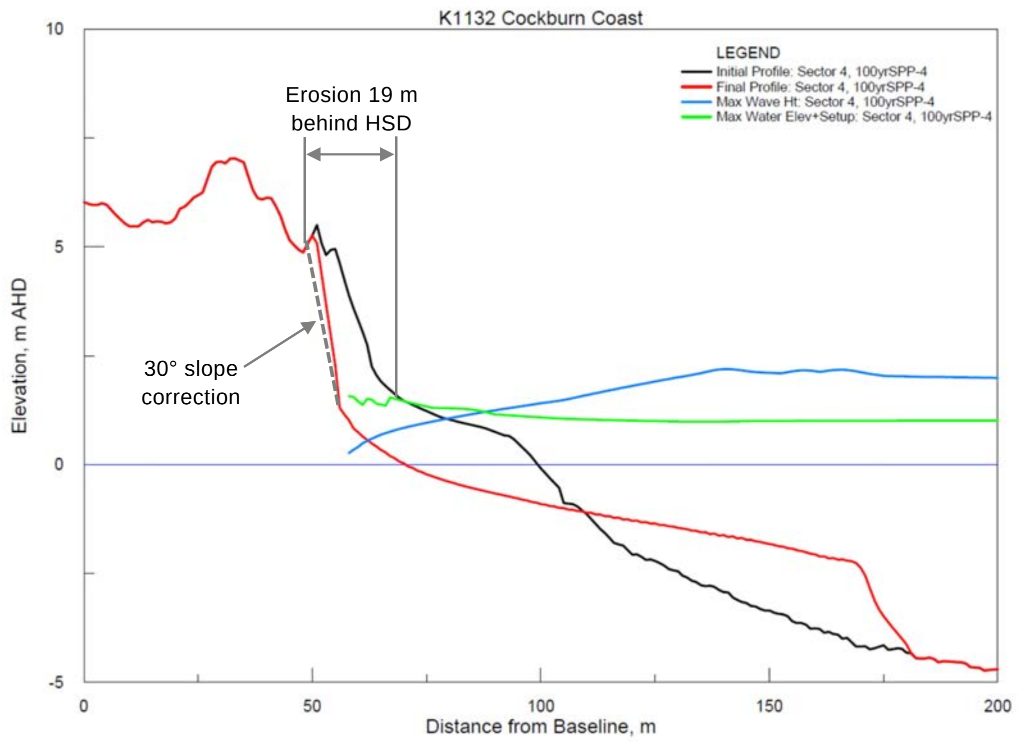


Figure 2.6 Sector 4 SBeach Results

Sector 5 is protected by the seawall that forms the cooling water pond and the seawall that is buried in the newly formed beach between the cooling water pond and Port Coogee. These seawalls will be upgraded as part of the proposed development and it is recommended that all freehold development be set 50 m behind the crests of the upgraded seawalls. Consequently, a SBeach simulation of potential storm erosion is not required for Sector 5.

The results of the work are summarised in the table below. The new policy also requires an assessment of possible changes due to gradients in longshore transport. This has also been completed and is included in the table showing the S1 value for each sector.

Table 2.1 S1 Severe Storm Erosion Allowance

Coastal Sector	SBeach behind HSD	Longshore Drift Factor	S1
1 – North of Catherine Point Groyne	22 m	5 m	27 m
2 – Catherine Point Groyne to Robb Rd Jetty	20 m	5 m	25 m
3 – Robb Rd Jetty to Robb Rd Groyne	20 m	0 m	20 m
4 – Robb Rd Groyne to Power Station	19 m	0 m	19 m
5 – Power Station to Port Coogee	NA	NA	NA

Note: 1. Sector 5 is protected by the existing seawalls and the S1 factor is not applicable.

3. Historic Shoreline Movement Trends (S2)

Physical coastal process act on wide ranging time scales, from storm to post storm, seasonal and longer term. The continual action of these processes helps to shape the shoreline.

Short term changes to the coast are captured by the S1 component. The S2 component in the 2013 State Coastal Planning Policy seeks to capture the longer term changes to the shoreline that are likely to occur in the future.

By monitoring changes in the shoreline over time, information can be obtained regarding the net dynamics of an area. Historical aerial photography has therefore used to plot the movement of the shoreline through recent history.

Rogers & Associates (2005) and Oceanica (2007) both collated and reviewed a large amount of historical information for the coastline of the sediment cell extending from Fremantle Harbour to Woodman Point. This information indicates that the foreshore in front of the site has been influenced by the various groynes, seawalls and breakwaters. The dynamics of Success Bank has also influenced the coast. In general there has been net accretion due to the onshore feed of sand from Success Bank and the trapping action of the various groynes and breakwaters. There has been significant accretion of the shoreline with the beach prograding about 120 m near the Power Station since the 1940s. This accretion is anticipated to continue in the coming century.

In the last few decades there has been some erosion of the beach north of Catherine Point Groyne. This was caused by the movement of the crest of Success Bank and reduction in the rate of sand feed from Success Bank. The area has stabilised in recent years and is still seaward of its position in 1942. The beach immediately south of Catherine Point Groyne has also experienced erosion due to the changes in the position and sand feed from Success Bank.

Sector 1 has a long term history of accretion, a short period of realignment due to the movement of Success Bank, and in recent years has been stable. Given this history and the likely future changes it is anticipated that there will not be a long term erosion trend. Consequently, S2 has been assessed as 0 m.

Sector 2 also has a long term history of accretion but has suffered erosion in the last two decades. The erosion immediately south of Catherine Point Groyne is expected to continue for a decade or two and then the realigned beach would be dynamically stable and may even have periods of accretion. The recession of the shoreline in the two decades is expected to be about 10 to 20 m with no further recession in the subsequent decades. The southern area of this sector (near Robb Road Jetty ruins) has not suffered the same erosion. It is anticipated that this area will recede about 5 m in the coming two decades and then accrete in subsequent decades. In view of this assessment of the future dynamics it is recommended that the allowance for S2 be 20 m at the northern end of Sector 2 and 5 m at the southern end.

Sectors 3, 4 and 5 are expected to continue the long term accretion trend. A conservative assessment of the likely future accretion trend was made using a sand feed from Success Bank that is greatly reduced from the historical rate (15,000 to 40,000 m^3/year). This conservative assessment was made on the basis of about 7,500 m^3/year of sand arriving south of Catherine Point Groyne and moving to the south where it would accrete due to the presence of Port Coogee. The sand bypassing operations would remove about 5,000 m^3/year leaving about 2,500 m^3/year. This would cause the shoreline to accrete and prograde about 0.2 m/year on average. The 2013 SCPP requires that half of the long term accretion rate be taken for S2. Consequently, for Sectors 3, 4 and 5 the recommended value for S2 is -10 m.

Based on these thorough investigations of the historical and a detailed assessment of the future beach and sand bank dynamics the following allowances for S2 are recommended.

Table 3.1 S2 Ongoing Trends

Coastal Sector	S2
1 – North of Catherine Point Groyne	0 m
2 – Catherine Point Groyne to Robb Rd Jetty Northern End	20 m
2 – Catherine Point Groyne to Robb Rd Jetty Southern End	5 m
3 – Robb Rd Jetty to Robb Rd Groyne	-10 m
4 – Robb Rd Groyne to Power Station	-10 m
5 – Power Station to Port Coogee	-10 m

4. Future Sea Level Rise (S3)

The 2013 State Coastal Planning Policy requires that for sandy beaches the S3 allowance be taken as 100 times a sea level rise of 0.9 m. This gives S3 as 90 m for a sandy beach. This factor has been used in this assessment of the Physical Processes Setback Distance.

HASSELL
© 2014

5. Recommended Physical Processes Setback

A thorough assessment of the Physical Processes Setback has been complete to the full requirements of the 2013 State Coastal Planning Policy. The recommended setbacks are shown in the table below.

Table 5.1 Recommended Physical Processes Setback Distances to 2013 SCPP

Coastal Sector	S1	S2	S3	FOS	Total
1 – North of Catherine Point Groyne	27 m	0 m	90 m	20 m	**137 m**
2 – Catherine Point Groyne to Robb Rd Jetty Northern End	25 m	20 m	90 m	20 m	**155 m**
2 – Catherine Point Groyne to Robb Rd Jetty Southern End	20 m	5 m	90 m	20 m	**135 m**
3 – Robb Rd Jetty to Robb Rd Groyne	20 m	-10 m	90 m	20 m	**120 m**
4 – Robb Rd Groyne to Power Station	19 m	-10 m	90 m	20 m	**119 m**
5 – Power Station to Port Coogee	0 m	0 m	0 m	50 m	**50 m**

Note: 1. Sector 5 is protected by the seawalls that will be upgraded as part of the development.

These setback distances should be measured from the Horizontal Shoreline Datum as defined in the 2013 State Coastal Planning Policy. The HSD is taken from the extent of ocean action in the design storm and has been determined from the various SBeach runs presented previously in this report.

The physical processes setbacks to the requirements of the 2013 State Coastal Planning Policy have been plotted on a composite plan showing the proposed areas of freehold development on the Local Structure Plan for the northern portion of the subject land and the Master Plan for the southern portion of the subject land. This is presented in the Figure 5.1 below.

The setback buffers for Sectors 1 and 2 extend to the eastern side of Robb Road and the freight rail corridor. Robb Road is vested in the City of Cockburn and the freight rail corridor is owned by the Public Transport Authority (PTA). PTA has entered into a long term lease of the freight rail infrastructure to Brookfield Rail. The freight rail infrastructure is a vital asset of strategic importance to the State of Western Australia. It is an essential element of Fremantle Ports' infrastructure. The efficient port operation is important to the economy of Western Australia. It is not conceivable that the Government of Western Australia would not protect this essential infrastructure should it become threatened by coastal erosion in the coming century. The freight rail corridor would be protected and such coastal protection measures would also protect the proposed development of freehold land immediately east of the freight rail corridor. Consequently, the proposed freehold development on the eastern side of the rail corridor in Sectors 1 and 2 would be adequately protected from future coastal erosion and thus the proposed development meets the intent of the 2013 State Coastal Planning Policy.

LandCorp engaged MRA to develop some initial concepts that could be used to stabilise Sector 2 and address the erosion threat to Robb Road and the freight rail corridor. These are presented in

MRA report R314 Rev 4 of March 2014. These concepts can be considered by the City and the PTA to determine their approach to the erosion threat over the coming decades.

The setback buffer for Sectors 3 and 4 are 120 m and 119 m respectively and all proposed freehold development is located behind the recommended setback line. There is a small section of WAPC land in Sector 3 that extends about 20 m seaward of the recommended Physical Processes Setback Line. It is proposed to excise this 900 m^2 area from the WAPC landholding and transfer it to the foreshore reserve. This is also shown on Figure 5.1 below.

Sector 5 between the Power Station Cooling Water Pond and Port Coogee is protected by existing seawalls. These seawalls walls will be upgraded as part of the proposed development and it is proposed that all freehold development will be at least 50 m behind the these upgraded seawalls. The buffer of 50 m behind the upgraded seawalls is quite generous and was suggested by Oceanica in the initial work for the District Structure Plan in 2007. Should it be required, further technical studies could be completed to examine the suitability of a smaller buffer behind the upgraded seawalls. Nevertheless, at this stage all freehold development is proposed to be 50 m behind the upgraded seawalls.

It is not proposed to create any freehold land seaward of the setback line shown for Sectors 3, 4 and 5.

LandCorp has developed a comprehensive Foreshore Management Plan for the subject land area that provides suitable foreshore amenities and access to the beaches throughout the planning period to 2110. The risk of future coastal erosion has been evaluated and fully avoided as required by the 2013 State Coastal Planning Policy.

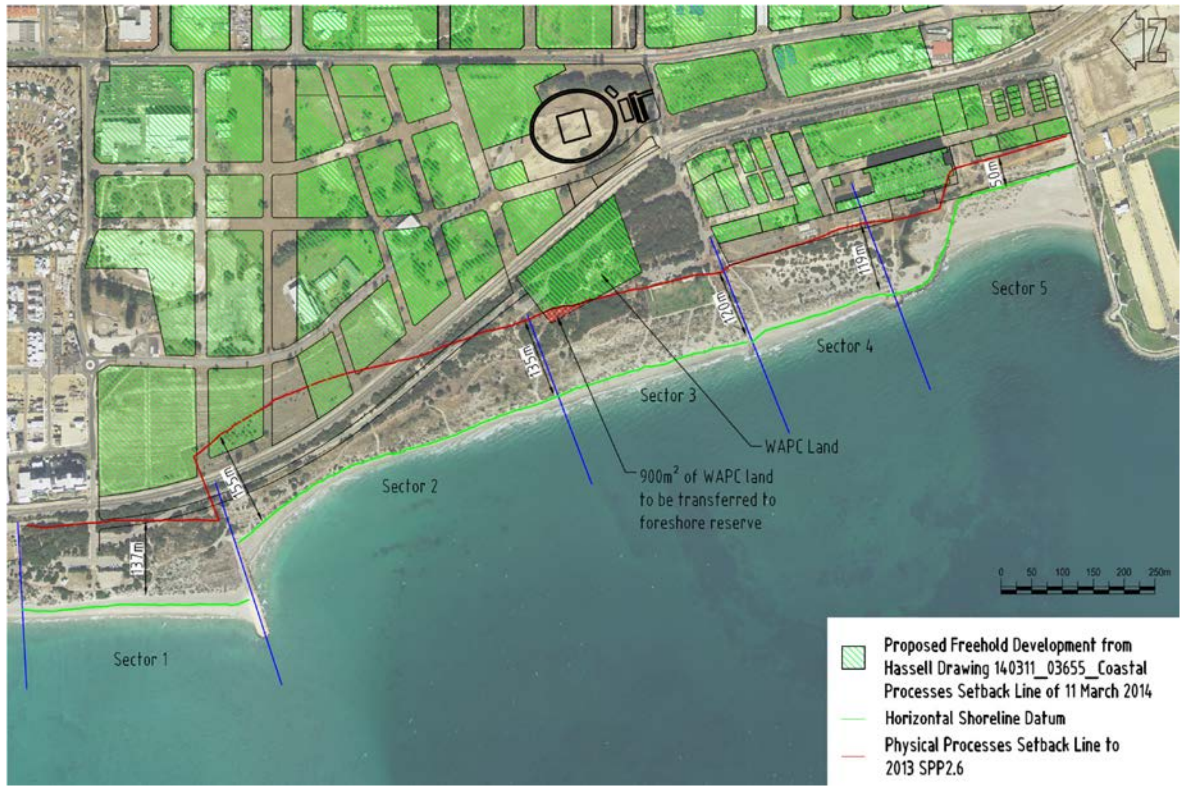


Figure 5.1 2013 SCPP Physical Processes Setback and the Proposed Development

6. Inundation (S4)

The 2013 State Coastal Planning Policy requires that the development be above a very rare ocean storm surge level to avoid flooding. The new policy states "*the storm event for storm surge inundation should be based on ocean forces and coastal processes that have a 0.2 percent or one-in-five hundred probability of being equalled or exceeded in any given year over the planning time frame.*"

During severe storms the ocean water level can be higher than the normal astronomical tidal levels. The combined action of low atmospheric pressure, strong onshore winds and waves breaking onto reefs and the shore can create significant storm surge above the normal tidal levels.

There have been ocean water level measurements taken at Fremantle Harbour since 1897. Since World War II the reliability of these records has improved. An analysis of the water level records at Fremantle since the 1950s indicates that the 500 year Average Recurrence Interval steady water level in about 6 m of water is approximately +1.4 mAHD.

Strong onshore winds that would accompany the design storm could cause further water level set up between water 6 m deep and the shore. It was estimated that this setup would be about 1.2 m.

At the end of the century long planning period the 2013 SCPP requires that a sea level rise of 0.9 m be used in order to account for the possible impacts of Climate Change.

Using all of these factors the assessment of the S4 Inundation level was completed and is summarised below.

- 500 year ARI ocean water level in 6 m of water +1.4 mAHD
- Local set up between 6 m of water and the shore +1.2 m
- Allowance for Sea Level Rise to 2110 +0.9 m
- **S4 RECOMMENDED MINIMUM FINISHED FLOOR LEVEL +3.5 mAHD**

This recommended Finished Floor Level is for new freehold development located behind the recommended setback line. All of the proposed freehold development will be required to have development levels of 3.5 mAHD or higher.

HASSELL
© 2014

7. Summary

In 2008 LandCorp developed a District Structure Plan for the land between Rollinson Road and Port Coogee. The supporting work included an assessment of the coastal dynamics and recommended setback distances by Oceanica in 2007. The Oceanica work was based on the 2003 State Coastal Planning Policy.

In 2010 the WAPC released a Position Statement for the State Coastal Planning Policy. LandCorp had the setback distances re-evaluated to the new guidelines and adjusted the development plans accordingly (Rogers & Associates 2011). The planning work continued and between 2010 and 2014 LandCorp developed Local Structure Plans for the northern part of the subject land and a Master Plan for the Power Station Precinct.

In July 2013 a new version of the State Coastal Planning Policy was released. This new policy is quite different in several areas to the previous versions. LandCorp has had the physical processes setback distances and inundation factor assessed to the full requirements of the 2013 State Coastal Planning Policy.

This report provides the results of the assessment to the new policy. The proposed development by LandCorp shown in the development plans has all proposed freehold land behind the freight rail corridor or the Physical Processes Setback line calculated to the 2013 State Coastal Planning Policy. Consequently, the proposed development meets the requirements of the new 2013 State Coastal Planning Policy and no freehold land would be under threat from future coastal erosion.

In addition, all freehold properties will be founded above 3.5 mAHD and avoid inundation from ocean storm surge as required by the 2013 State Coastal Planning Policy.

LandCorp has developed a comprehensive Foreshore Management Plan that provides suitable access to the beaches and foreshore amenities throughout the planning period to 2110.

8. References

Department of Transport, 2009. Coastal Demarcation Lines for Administrative & Engineering Purposes: Delineation Methodology & Specification. Government of Western Australia.

IPCC 2001. Summary for Policy Makers, Climate Change 2001: Impacts, Adaptation and Vulnerability. Published by the IPCC and Approved by the IPCC Working Group II in Geneva.

IPCC 2007. Summary for Policymakers. In: Climate Change 2007 – The Physical Science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [S Solomon, D Qin, M Manning, Z Chen, M Marquis, K B Averyt, M Tignor and H L Miller (eds)]. Cambridge University Press, Cambridge UK.

Komar, P D 1998. Beach Processes and Sedimentation (2nd Edition). Prentice Hall Inc, New Jersey, USA.

Larson, M & Kraus, N C 1989. SBEACH: Numerical Model for Simulating Storm-Induced Beach Change. Report 1: Empirical foundation and model development. Technical Report CERC-89-9. Coastal Engineering Research Centre, Vicksburg, MS.

Larson, M & Kraus, N C 1998. SBEACH: Numerical Model for Simulating Storm-Induced Brach Change. Report 5: Representation of Non-erodible (Hard) Bottoms. Technical Report CERC-89-9, Coastal Engineering Research Centre, Vicksburg, MS.

Larson, M, Wise, R A & Kraus, N C 2004. Coastal Over-wash Part 2: Upgrade to SBEACH. ERDC/CHL RSMP CHETN-IV-XXI, US Army Corps pf Engineers.

Oceanica 2007. Cockburn Coast District Structure Plan, Coastal Processes Assessment. Oceanica Consulting Pty Ltd, Perth Report No 524/1 prepared for the WAPC in June 2007.

Rogers & Associates 2005. Southern Perth Metropolitan Coast – Coastal Setback Study. M P Rogers & Associates Pty Ltd report R156 Rev 0 prepared for the Department for Planning & Infrastructure, Perth WA in August 2005.

Rogers & Associates 2009. Port Coogee Sand Bypassing – Completion Report. M P Rogers & Associates Pty Ltd letter report 09258 Rev 0 prepared for the Port Catherine Development, Perth WA in December 2009.

Rogers & Associates 2011. Cockburn Coast – Coastal Vulnerability Assessment. M P Rogers & Associates Pty Ltd report R301 Rev 0 prepared for LandCorp, Perth.

Rogers & Associate 2014. Cockburn Coast – Foreshore Management Plan, Coastal Vulnerability Assessment & Adaptation. M P Rogers & Associates Pty Ltd report R314 Rev 4. Prepared for LandCorp, Perth.

Rogers, M. P., Saunders, B. S. & Hunt, T. S. 2005. Living on the Coast – But How Close is Safe? Proceedings of the Coasts and Ports 2005 Conference, Adelaide, Australia.

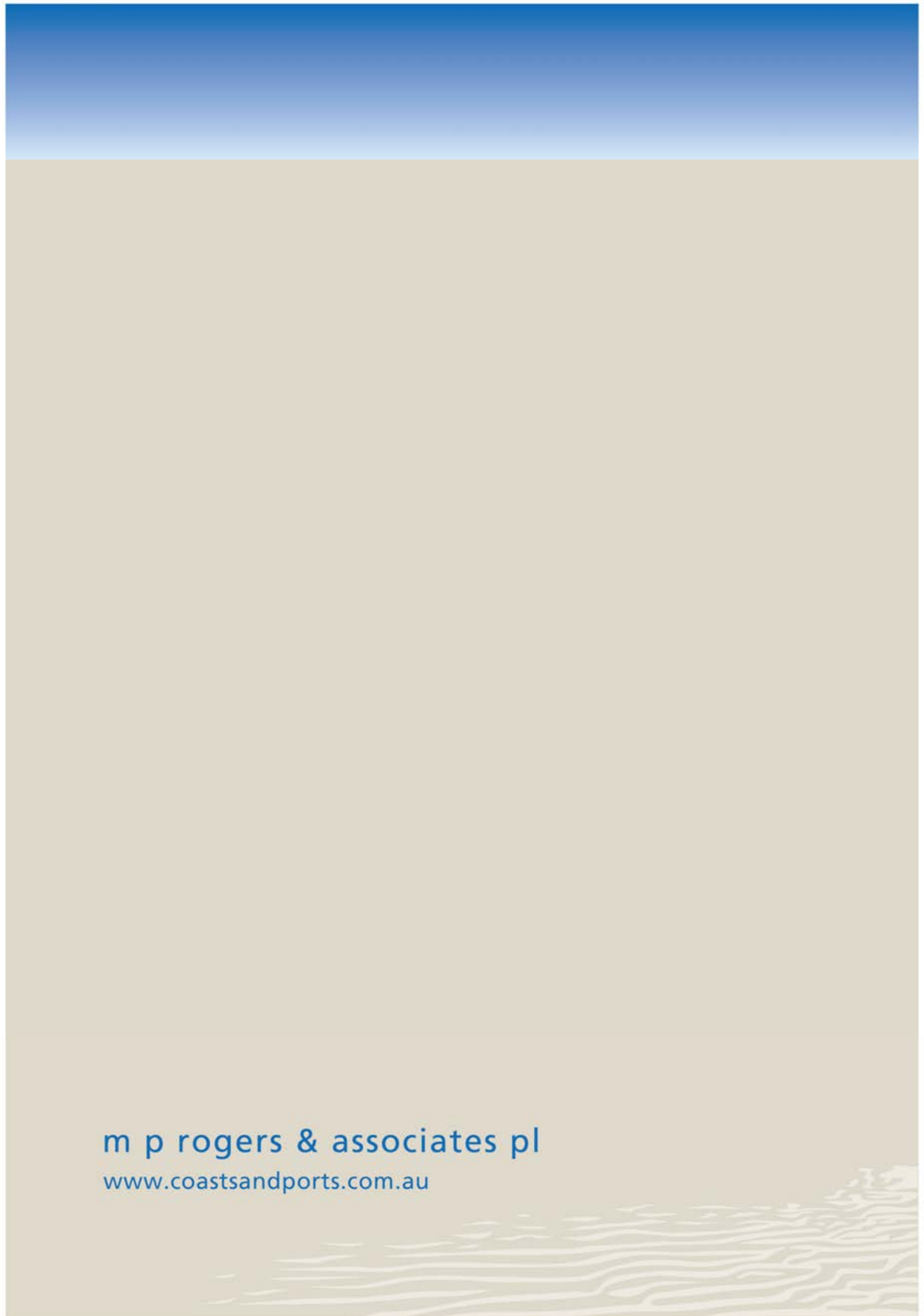
Short, A. 2006. Beaches of the Western Australian Coast: Eucla to Roebuck Bay. A guide to their nature, characteristics, surf and safety, Sydney University Press.

WAPC 2003. Statement of Planning Policy No. 2.6 – State Coastal Planning Policy. Western Australian State Government, Perth.

WAPC 2010. Position Statement - State Planning Policy No. 2.6 - State Coastal Planning Policy Schedule 1 Sea Level Rise. Western Australian State Government, Perth.

WAPC 2013. Statement of Planning Policy No. 2.6 – State Coastal Planning Policy. Western Australian State Government, Perth.

Wise, R A, Smith, S J & Larson, M 1996. SBEACH: Numerical Model for Simulating Storm-Induced Beach Change. Report 4, Cross-shore transport under random waves and model validation with SUPERTANK and field data. Technical Report CERC-89-9 rept. 4. Coastal Engineering Research Centre, Vicksburg, MS.



© 2014

Appendix F
Infrastructure Servicing Report

Infrastructure Servicing Report South Fremantle Power Station Master Plan Area Cockburn Coast Development

for

LandCorp
Attention: Sergio Famiano

11 March 2014

Revision No. 1

Prepared by Michael Del Borrello Project Number: 20146-PER-C-LSP

Ground Floor, 226 Adelaide Terrace, Perth WA 6000

Phone (08) 6222 7000 Fax (08) 6222 7100 Email wge@wge.com.au Web www.wge.com.au

Albany Brisbane Busselton Darwin Gold Coast Melbourne Perth Shenzhen Sydney WGE - vital experience

Contents

HASSELL
© 2014

1 Introduction

Wood & Grieve Engineers (WGE) have been commissioned by LandCorp to provide an Infrastructure Servicing Report in support of the South Fremantle Power Station Master Plan.

This report discusses existing infrastructure in the area, upgrades, relocations and likely timing of these works.

2 Earthworks

2.1 Geotechnical

We anticipate that the site is of a predominantly sandy/limestone nature. Techniques used to achieve acceptable foundation strengths may include in-situ earthworks and compaction, together with associated testing.

Formal assessment of subsurface geotechnical nature of the site will be required to guide the ultimate earthworks design and feasibility of the project.

2.2 Earthworks

Onsite cut to fill and importation of sandy fill will be required to create generally flat lots that provide adequate clearance to stormwater drainage systems and overland stormwater flood routing in accordance with City of Cockburn requirements.

Existing levels across the site produce a height differential of up to 7m in some areas. Retaining structures along lot boundaries may be required for ultimate development to produce level pads.

3 Wastewater and Effluent Disposal

3.1 Existing Sewer Infrastructure

The existing sewer system in this area consists of the following infrastructure:

- DN200 pressure main within Robb Road which conveys wastewater from the Coromandel Approach WWPS north to the Bennett Avenue WWPS.
- DN480 steel pressure main through Cockburn Road and land to the immediate west.
- DN150/DN225 gravity reticulation sewer serving the neighbouring Port Coogee development to the south.

There is currently no reticulated sewer to service parent title lots within the South Fremantle Power Station Master Plan Precinct development area.

3.2 Wastewater Infrastructure Upgrades

Water Corporation wastewater planning over the Cockburn Coast development area is included in Appendix 1. The regional planning gives an indication of the wastewater infrastructure required with development of the site. Wastewater servicing to the South Fremantle Power Station Master Plan Precinct can be achieved through extension of existing gravity reticulation sewers.

Future development of land parcels between existing railway line and Cockburn Road may require a developer funded relocation of the existing DN480 steel main into Cockburn Road. Indicative location for this is shown on sewer concept plan in Appendix 2 (SK18).

3.3 Gravity Sewer Reticulation

The attached plan in Appendix 2 (SK18) shows the extent of existing and proposed gravity sewer reticulation over (and beyond) the Power Station Master Plan Precinct.

Water Corporation sewer planning indicates that the site may be served by extension of the sewer system from the Port Coogee development to the south. A DN225 gravity reticulation sewer extending north from Caledonia Loop through to MacTaggart Cove will provide serviceability across the development site.

This strategy remains subject to the timing of the development and Water Corporation approval.

SOUTH FREMANTLE POWER STATION SITE – MASTER PLAN AREA
COCKBURN COAST DEVELOPMENT

4 Water Supply

4.1 Existing Water Infrastructure

The existing water system in this area consists of the following infrastructure:

- DN305/DN255 steel water distribution main within Cockburn Road
- DN150 steel water reticulation main in MacTaggart Cove
- DN150 PVC water reticulation main within Caledonia Loop serving the neighbouring Port Coogee development to the south.

Water supply is served from the Hamilton Hill high level tank and supply area. All water supply assets are owned and operated by the Water Corporation.

4.2 Water Supply Planning

The Water Corporation has completed a review of water infrastructure planning for the Hamilton Hill Gravity Supply Scheme. This planning review incorporates the anticipated dwelling/service yields from the full development of the Cockburn Coast land. The attached plan in Appendix 3 illustrates the upgrades for the water servicing of the Cockburn Coast development, which are summarised as follows:

i) Approximately 760m DN375 water distribution main from Bellion Drive intersection heading southwards along Cockburn Road (this could be done in stages depending on demand, spatial staging of land development, and having regard to any Council plans to reconstruct/upgrade this section of Cockburn Road).

   The final pipe route and sizing will be refined based on the spatial pattern of the development in Cockburn Coast. It may be possible for equivalent pipe volumes to be constructed as two separate feeds in other roads through the development area parallel to Cockburn Road.

ii) Approximately 1,430m DN500 distribution main from the end of the existing Forrest Road DN610 (coming out of the Hamilton Hill Reservoir) heading westwards as indicated on the attached plan to link into the Cockburn Road DN300-375 at Bellion Drive.

   At planning level, it is estimated that this DN500 main will be required around 2016 depending on the pattern and rate of development of the Cockburn Coast land. The operational trigger for the DN500 is when the peak day demands in the Cockburn Coast development area exceed 1.6ML/day (the equivalent of approximately 1,000 services) and/or the HGL at the intersection of the proposed DN500 with the DN300-375 main at Bellion Drive approaches RL53m AHD.

4.3 Water Supply Reticulation

Potable water servicing within the Power Station Master Plan Precinct can be achieved using a conventional piped network reticulation system.

The attached plan in Appendix 4 (SK19) shows potential locations for proposed water reticulation mains and link-ins with existing mains. Connections to existing mains within MacTaggart Cove to the north and Caledonia Loop to the south facilitate water serviceability across the site.

This strategy remains subject to the timing of the development and Water Corporation approval.

HASSELL
© 2014

5 Port Coogee Groundwater Pipeline

A subsurface groundwater pipeline exists within Robb Road, originating from the Port Coogee development to the south. The purpose of the pipeline is to extract groundwater from Port Coogee and inject at various borehole locations within Robb Road to the north of the Power Station Master Plan Precinct. Refer plan in Appendix 9.

At this stage, management and/or protection of this asset will potentially be a requirement of the future detailed planning process, during the preparation of the Power Station local structure planning process.

6 Roadworks

6.1 Existing Roadworks

Existing parent title lots within this development area are fronted by sealed and kerbed road pavement. Cockburn Road is the current north-south artery adjacent the development and serves as the main freight route for existing commercial business in the area. Multiple services exist within the Cockburn Road road reserve.

The Integrated Transport Plan report and further traffic studies being undertaken by others will provide information on roads and transportation issues.

6.2 Roadworks Upgrades

Roadworks infrastructure consists of two main elements for the Power Station Master Plan Precinct:

- Internal Roads - Vehicular access to the site will be from MacTaggart Cove to the north, Caledonia Loop to the south, and Cockburn Road to the east. A traffic bridge has been proposed over the existing railway line, linking South Fremantle Power Station Master Plan Precinct with the Cockburn Road intersection. Internal pavement design profiles and carriageway widths will be in general accord with City of Cockburn design requirements.

- Cockburn Road - It is a likely requirement that Cockburn Road will be upgraded as part of the development process. The extent of upgrade will depend on the final configuration of the Integrated Transportation Plan, existing road user requirements and City of Cockburn requirements. Upgrading of Cockburn Road may also include the relocation of multiple existing services within the existing and/or future reserve boundaries.

  It is envisaged that transportation studies will inform of future road widths for Cockburn Road. Consideration must also be given to the existing services within the road reserve, with the intent of minimizing service relocations. Future road widths should be sized accordingly.

7 Drainage

Stormwater attenuated within the South Fremantle Power Station Master Plan Precinct development area will be infiltrated on site. The area is underlain by permeable sandy soils, providing good opportunities for management of drainage by on-site infiltration. Landscaping and engineering design will be critical to creating infiltration areas within public open space. This approach supports the best of Water Sensitive Urban Design principles.

Proposed lots would be required to infiltrate their rainfall runoff on site up to a return period stipulated by the Local Authority. We understand that the City of Cockburn requires a 10 year ARI to be retained within lots.

To attenuate flows from larger storm events, pit and pipe infrastructure installed within road reserves will direct flows to regional infiltration areas. A Local Water Management Strategy and Urban Water Management Plan will document the relevant design parameters that will guide ultimate drainage and earthworks design at the structure planning and development application stage of the planning process.

8 Power Supply

8.1 Power Supply Upgrading

The Western Power Feasibility Study in Appendix 5 confirms that initial stages of development may be able to be serviced by the existing AMT507 Orsino Boulevard feeder located in Cockburn Road. This is dependent upon the development rate of Port Coogee, as the feeder was installed to primarily supply the Port Coogee development.

Geographically, SF505 is an ideal feeder to supply the initial stages of development. However, this feeder has high fault ratings and is not recommended due to its poor reliability. It is noted that the South Fremantle sub-station may be relocated in future and it is planned not to have any distribution feeders from this sub-station. As a result, SF505 may not exist in the future.

Ultimately a new HV feeder is likely to be required to be installed from the Amherst sub-station to the development area (approx. 3km length HV infrastructure). It is also likely that major upgrade will be required for both transmission and distribution assets to increase capacity.

Further discussion with Western Power following their feasibility study indicates a sub-station may be required within the Cockburn Coast area. A sub-station typically requires a land area of 1 hectare and hence has land planning implications. Western Power is addressing this possible requirement in conjunction with the Terminal Substation relocation. The likely substation area is shown on the attached plan in Appendix 6 (SK15).

Due to the dynamic nature of Western Power's network, infrastructure capacity and connection points may differ at the time when the subdivision proceeds and a Design Information Package is requested.

8.2 Transmission Line Relocation

Within the South Fremantle Power Station Master Plan Precinct, a section of existing aerial power transmission lines run from the Terminal Sub-Station area southward along Robb Road. As part of the overall development it is proposed to relocate the zone substation currently adjacent to the old South Fremantle Power Station to an area on the eastern side of Cockburn Road. This will therefore underground a portion of the transmission lines. The overhead aerials running within Cockburn Road are proposed to remain. Refer to Appendix 6 for proposed route.

HASSELL
© 2014

9 Telecommunications

The current extent of telecommunications infrastructure is shown on plan in Appendix 7 (SK 21). Relocation and upgrade of existing services will be required. Early liaison with Telstra will minimise cost and timing of this process.

National Broadband Network (NBN) will likely be the service provider for the development area. Current policy is that for developments greater than 100 dwellings the NBN will provide optic fibre to each dwelling. The developer will be required to provide pipe and pit for each stage of development in accordance with NBN specifications. This will be confirmed upon formal design application to NBN.

SOUTH FREMANTLE POWER STATION SITE – MASTER PLAN AREA
COCKBURN COAST DEVELOPMENT

10 Gas Supply

A high pressure gas main exists within Cockburn Road, as shown on plan in Appendix 8 (SK20). There are currently no other mains that exist within existing or proposed road reserves.

Supply to the South Fremantle Power Station Master Plan Precinct could be provided by an extension of the gas main from Cockburn Road down MacTaggart Cove and Robb Road. This can only be confirmed by ATCO Gas upon formal design application.

11 Conclusion

The South Fremantle Power Station Master Plan Precinct is well serviced by existing infrastructure and/or upgrade and extension of infrastructure adjacent the site.

On development some of the existing infrastructure will require upgrading, relocation or extension to service new subdivisional cadastral boundaries.

Liaison with relevant statutory service authorities and project stakeholders is recommended to achieve timely provision of adequate service infrastructure.

SOUTH FREMANTLE POWER STATION SITE – MASTER PLAN AREA
COCKBURN COAST DEVELOPMENT

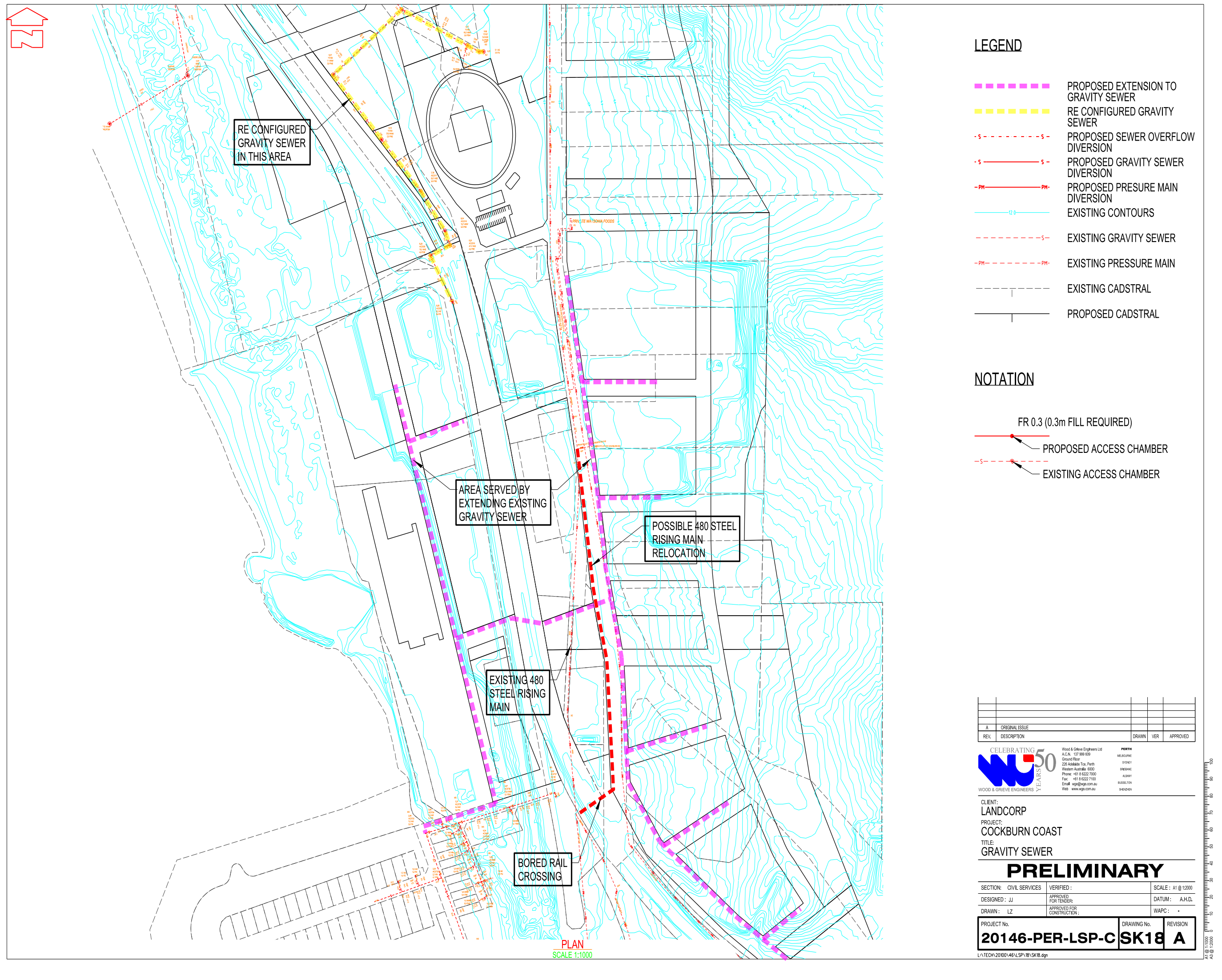
Appendix 1

Water Corporation Sewer Strategy

HASSELL
© 2014

Appendix 2

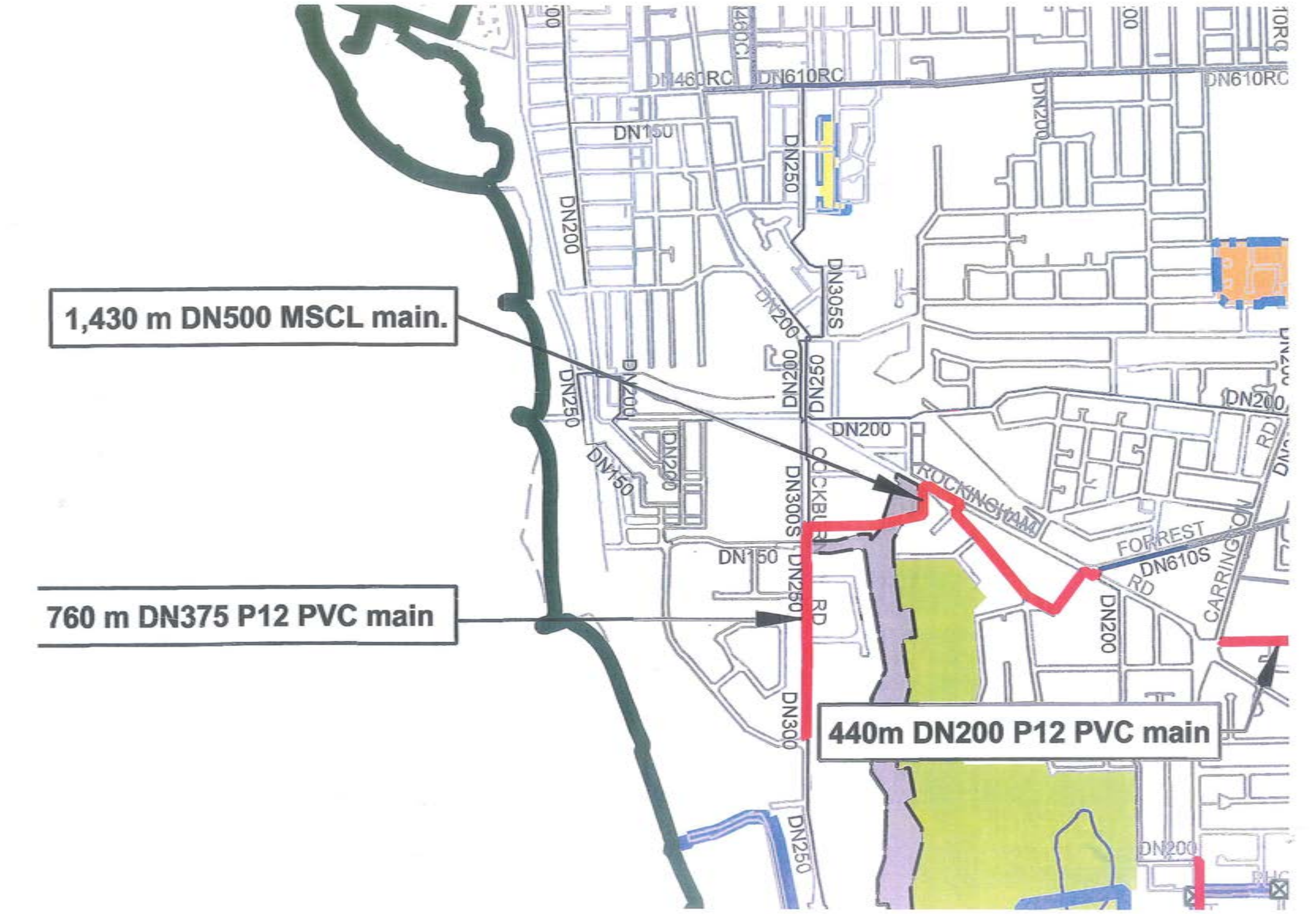
Sewer Sketch Plans Showing Extent of Existing Gravity Sewer Reticulation



Appendix 3

Water Corporation
Proposed Water Supply Upgrade Works

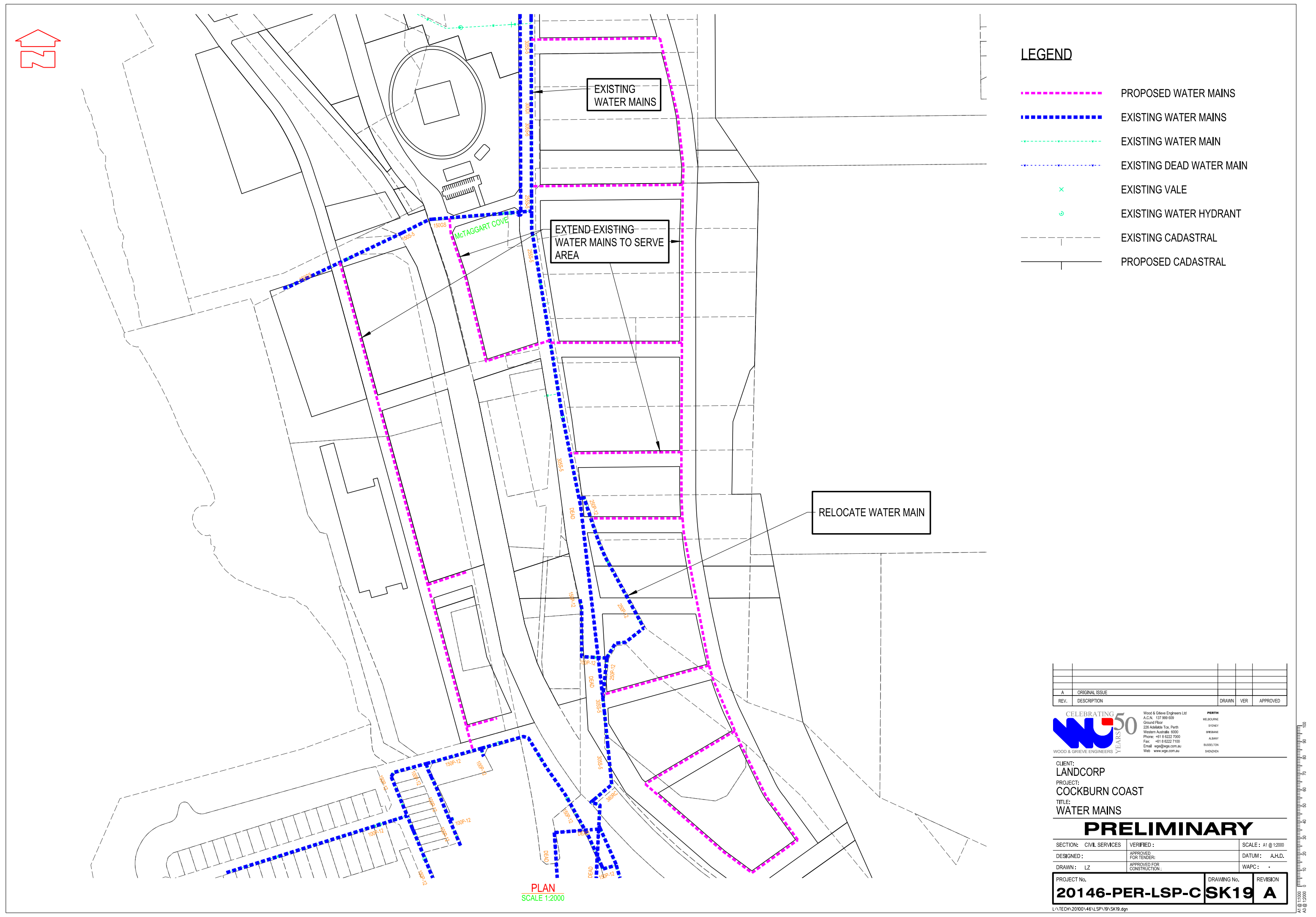
HASSELL
© 2014



SOUTH FREMANTLE POWER STATION SITE – MASTER PLAN AREA
COCKBURN COAST DEVELOPMENT

Appendix 4

Water Supply Existing Services and Proposed Relocations



Appendix 5

Western Power Feasibility Study

© 2014

20146 -Per-C

westernpower networks today & tomorrow

Feasibility Study

Project Name:	Cockburn Coast
Customer Ref:	20146 – PER – U
Number of lots:	4850 Lots
Project Number:	MF010044

1. INTRODUCTION

Landcorp has requested a Feasibility Study in South Fremantle. The project name is Cockburn Coast. The following information was provided for us to conduct this study:

Number of lots	4860
Number of stages	20
Number of lots per stage	243
Construction to begin	July 2011
Rate of development	one stage per year

Based on the customer request of 9kVA per lot, the total load required therefore is approximately 43.74 MVA. Please refer to **Appendix 1** for details.

2. EXISTING INFRASTRUCTURE

The location of Cockburn Coast and existing infrastructure of HV distribution network supplying the surrounding area are as shown in Figure 1 and Figure 2. There are three 22 kV feeders within the vicinity of the development, *AMT512 Lefroy Rd (yellow)*, *AMT507 346 Orsino Bvd 1 (pink)* which are from Amherst zone Substation, and *SF505 Cockburn Rd North (blue)* which is from South Fremantle substation.

The majority of this development is within the Amherst zone substation's catchment area.

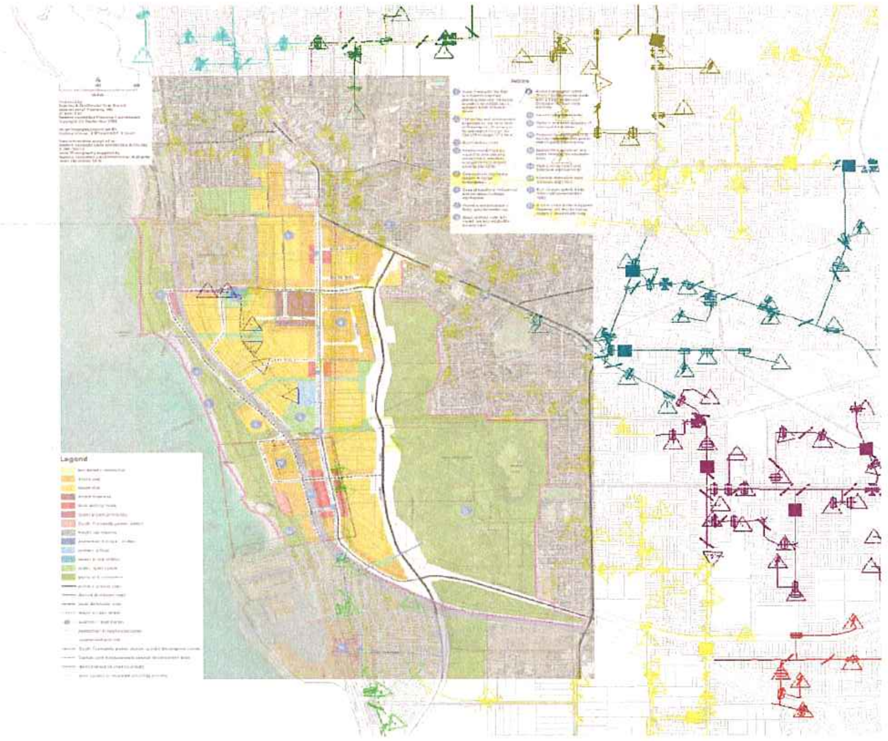


Figure 1: Location of Cockburn Coast

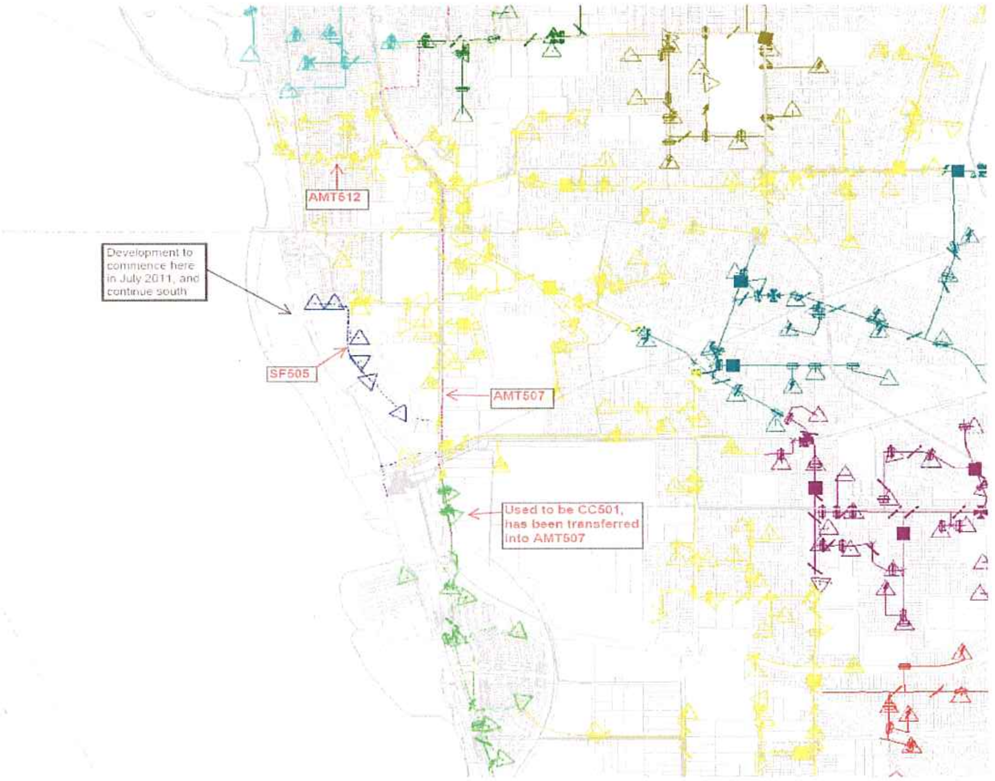


Figure 2: Existing Infrastructure – Distribution

DM#: 7148990v1 Page 3 of 9

3. STUDY DETAILS

The initial analysis revealed that the existing network infrastructure does not have capacity to supply the new load requested as a whole (43.65MVA) due to the large size of the development.

As shown on **Appendix 1**, the initial stages are to commence around 'area 3' of the structure plan and will continue south. Please see **Appendix 2** for structure plan. Geographically, SF505 is an ideal feeder to supply the initial stages. However, this feeder has high fault ratings and not recommended due to its poor reliability. South Fremantle substation maybe relocated in the future and it is planned not to have any distribution feeders from this substation. As a result, SF 505 may not exist in the future.

AMT507 L346 Orsino Bvd 1 runs through Cockburn Coast south along Cockburn Rd, and it is currently lightly loaded. It may be utilised to supply the initial stages. However, AMT507 was installed to primarily supply Port Coogee and if the load on Port Coogee increases in the near future, this feeder may not have enough capacity to cater for this load take up at Cockburn Coast, particularly at 'area 3'.

AMT512 Lefroy Rd feeder is considered as one of the critical feeders due to limited capacity and the various reliability issues with it. There is a project planned to install a new feeder to transfer some of the loads from AMT 512 feeder but it may be implemented beyond July 2011.

In summary, planning study reveals that the existing feeders within the vicinity of this development are not able to supply the total load request. AMT 507 maybe possible to supply the initial stages but it is highly dependent on the load take up timing at Port Coogee development.

DM#: 7148990v1 Page 4 of 9

© 2014

4. REINFORCEMENT REQUIREMENTS

Based on the study details above, the estimated scope of works required is listed below:

- New feeders from Amherst substation
- Major reinforcement required for both Transmission and distribution assets to increase the capacity

The timing of the above reinforcements is highly dependent on the rate of this development and future load growth in the area surrounding.

5. CONCLUSION/ GENERAL ASSESSMENT

Based on the study, the existing HV distribution network infrastructure surrounding the areas of the development may not be able to support this new load. A new feeder is highly recommended to connect the initial loads for this development. The timing of this is best to be evaluated when the formal application for load connection has been received. It may be possible to connect the initial load of approximately 2 MVA on to AMT 507 while it is lightly load at the moment. However, this is not a guaranteed approval as the large amount of load is expected on AMT 507. Due to the large load take up area, major reinforcements for both Transmission and Distribution assets are necessary to cater for this development.

The details in this feasibility enquiry report are only indicative. Further in-depth study and analysis will be required to determine the exact requirement of the reinforcement works once a formal application to Western Power has been lodged. It would be appreciated that at the time of the initial application, a staging plan with expected takeoff dates be provided to Western Power.

Western Power can neither reserve capacity nor guarantee supply to this development without a formal request being lodged. In order to provide a firm connection proposal and cost, a formal application to Western Power will have to be made, in accordance with our connection policies.

6. LAND DEVELOPMENT COMMENTS

Unless the Port Coogee development utilises the spare capacity on the AMT 507 feeder, the current network should be able to supply the first stage of this development.

The following stages will need to be supplied from a new HV feeder from Amherst Zone substation. The approximate cost of direct drilling a 400mm HV cable over 3 kilometres is **$1.4 million (unbinding).**

This new feeder should be able to supply the development for the next 4 to 5 stages, depending on uptake from other projects in the area.

The above estimation is based on but not limited to the aforementioned assumptions and design variables. Normal Subdivision Policy applies.

Appendix 1

westernpower

Electricity Networks Corporation ABN 18 540 492 861

Part A - Application type

☐ Feasibility Enquiry ☑ Feasibility Study

Applicant details - for tax invoice

Title (e.g. Mr, Mrs)	Mr
Surname	Hazelden
Given name(s)	Glenn
Company or business name	Landcorp C/o Wood and Grieve Engineers
ABN	
Postal address	Level 3, 3 Plain street
Suburb or town	East Perth
Post code	6004
Email (optional)	
Mobile (optional)	
Telephone	(08) 6222 7000
Fax (optional)	( )
Western Power reference number (if applicable)	

Part B - Land use

☐ Residential ☐ Commercial/Industrial ☐ Special Rural

Other (please describe)	
Number of lots	4850
Number of stages	
Number of lots per stage	
Approximate commencement date for each stage	Stage 1 to commence in July 2011, subsequent stages (243 lots per annum) each year after that. Staging to commence around 'area 3' of the structure plan and will continue south, the last area of development to be 'area 1' (south Fremantle tip site).
Comments	This project is on the WAPC planning website and includes the relocation of the Western Power South Fremantle switchyard.

Part C - Project details

Please attached Stage Plan with this document.

Project name	Cockburn Coast
Your project reference number	20146-PER-U

westernpower

Electricity Networks Corporation ABN 18 540 492 861

Part D - Site address/location plan

Please attach a location plan or concept plan with this document.

Site address	Cockburn Coast
Suburb or town	Cockburn
Post code	
Nearest cross street	Cockburn Coast Drive
Map number	
Grid reference	
From street directory	

Part E - Proposed loading

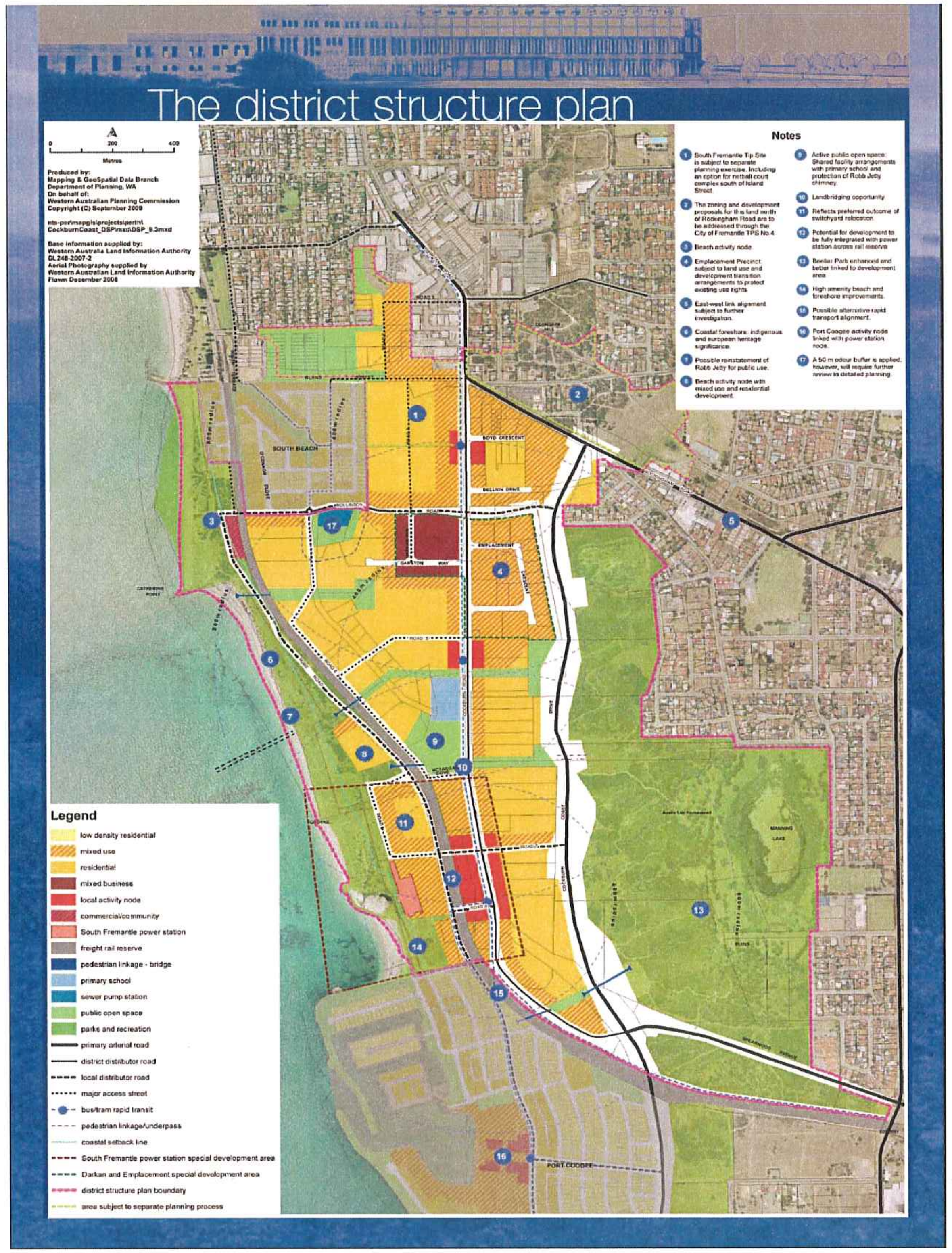
ADMD per lot	9kVA
Comments	

Part F - Approval

On signing this form as the duly authorised representative, the signatory accepts liability for payment of $315.00 (inc GST) for a Feasibility Enquiry or $775.00 (inc GST) for a Feasibility Study. Please refer to 'Terms & Conditions'.

Name	Glenn Hazelden
Mobile (optional)	
Telephone	(08) 6222 7000
Signature	G. Hazelden
Date	20 / 4 / 2010

Appendix 2



DM#: 7148990v1 Page 9 of 9

westernpower

Your Ref: 20146-PER-U
Our Ref: MF010044
Enquiries: Customer Contact Centre
Telephone 13 10 87
Fax: 9225 2073

Western Power
Connections Manager
Locked Bag 2520
PERTH, WA 6001
Electricity Networks Corporation
ABN 18 540 492 861

25 June 2010

Wood & Grieve Engineers
Unit 3, 3 Plain Street
EAST PERTH WA 6004

Attention: Mr Glenn Hazelden

Dear Sir/Madam,

COCKBURN COAST
WESTERN POWER REF: MF010044, WAPC No: N/A

In response to your request for a Feasibility Study, 21 April 2010, I am pleased to provide you with the attached report.

Our Tax Invoice will be sent to you in due course. The amount due includes the standard fee of $775.00.

The following is an estimated cost of the high voltage distribution works to provide electricity distribution capacity to your proposed development. This estimate is based on a desktop review of your requirements and the existing electrical network.

FEASIBILITY ESTIMATE

The estimated cost of the reinforcement works to your proposed development is $1,394,627.00, including GST.

Please note the following important information about this estimated cost:

- It is an indicative figure only, to assist you to plan and make decisions about your project.
- The final quoted cost may be higher or lower than this estimate. In some cases, final quotes are significantly higher than estimates, because of ground conditions and other impediments identified during the site visit and / or fluctuations in the cost of materials and labour etc.
- This estimated cost is non-binding.

DISCLAIMER

- This information is based on information available today.
- Western Power cannot reserve any capacity to accommodate the proposed development unless a quotation is offered and accepted.

- Western Power accepts no responsibility for any consequences resulting from decisions made on the basis of information provided in this response.

ANY QUESTIONS?

If you have any questions, please telephone our Customer Contact Centre on 13 10 87 during business hours.

Yours faithfully,

Customer Services Officer
for
Connections Manager
Customer Assist

enc: Terms and Conditions

westernpower
networks today & tomorrow

Electricity Networks Corporation
ABN 18 540 492 861

FEASIBILITY STUDY TERMS AND CONDITIONS

1. **Terms and Conditions**
These terms and conditions shall form part of the contract unless specifically excluded in writing by an authorised representative of Western Power.

2. **Consequential Loss**
Damages shall be limited to damages for direct and foreseeable loss attributable to breach or default under this Agreement. The rights of either party to damages for indirect or consequential loss are hereby excluded. Neither party shall be liable to the other for any loss of profit suffered by a party to this Agreement or any other person.

3. **Modification**
A purported modification, variation or amendment of this Agreement including the scope of works or any waiver of any rights of any party or any approval or consent shall have no effect unless in writing and signed by the party to be charged, and may attract a subsequent fee.

4. **Application of Acts and By-Law**
Nothing contained in these Terms and Conditions shall in any way limit the operation or effect of the Electricity Corporation Act 1994, Energy Corporations (Powers) Act 1994, Energy Corporations (Transitional and Consequential Provisions) Act 1994, or any Regulations, By-Laws or Orders made pursuant thereto.

5. **Ownership of Works**
The whole of the electricity extension that forms the works carried out in accordance with the proposal is the property of Western Power and Western Power has the right to connect additional customers to any part of the extension.

6. **Indicative Estimate**
This indicative estimate of the cost of electrical distribution [and transmission] works is ONLY AN INDICATIVE ESTIMATE.

7. **Assumptions**
Western Power has calculated the indicative estimate on the basis of a "desktop study" only which includes information readily available at the time and certain assumptions regarding the project and costs. The information and assumptions may turn out to be incorrect or incomplete.

8. **Fluctuations**
Construction costs, including materials and labour, are subject to fluctuation and may change significantly over time. The final quoted cost may be higher or lower. In some cases final quoted costs are SIGNIFICANTLY HIGHER than indicative estimates.

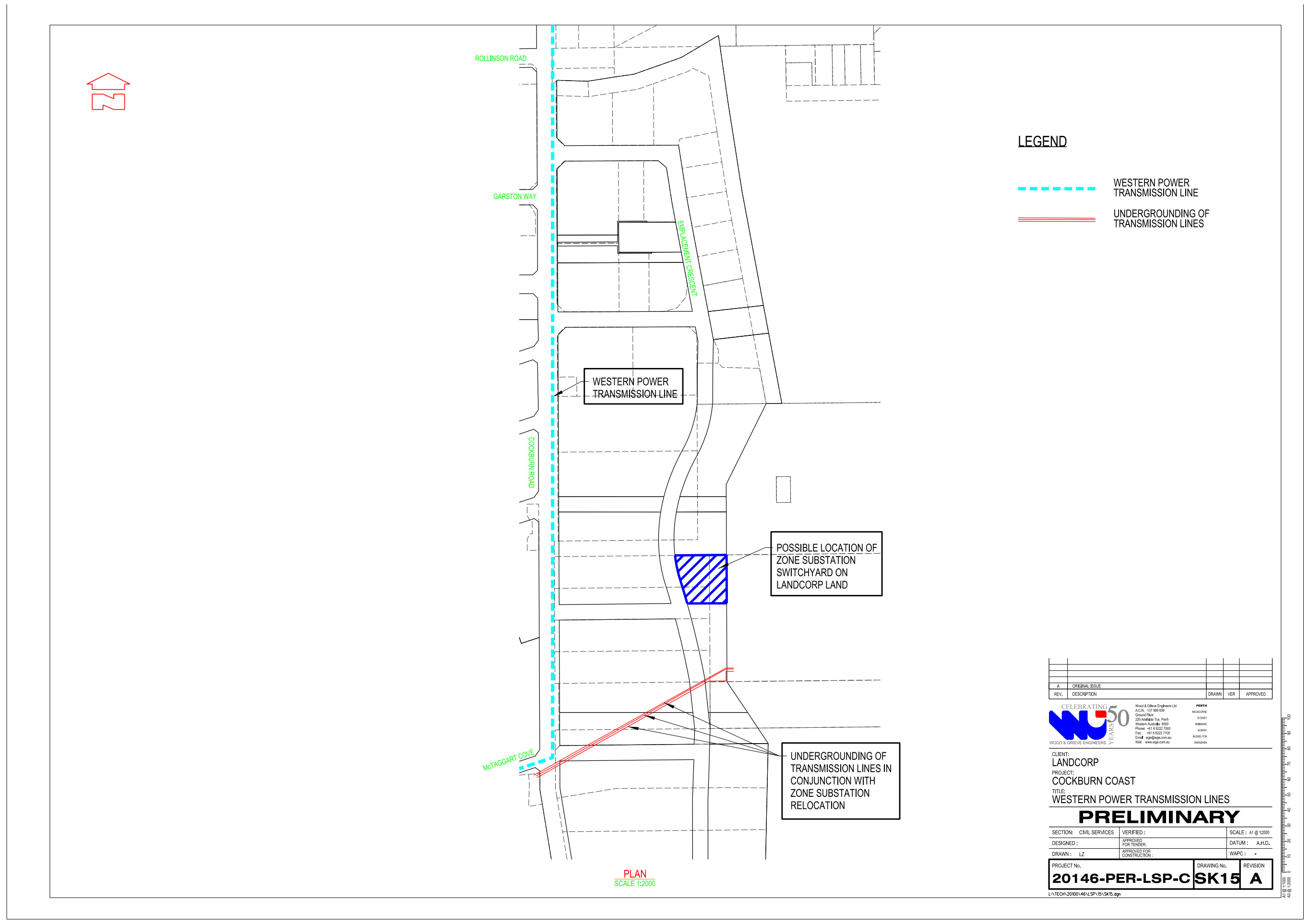
9. **Liability**
Western Power has calculated the indicative estimate in good faith however Western Power, to the extent permitted by law, accepts no liability for any errors or omissions or for any discrepancy between the indicative estimate and the final quoted cost, if any.

© 2014

SOUTH FREMANTLE POWER STATION SITE – MASTER PLAN AREA
COCKBURN COAST DEVELOPMENT

Appendix 6

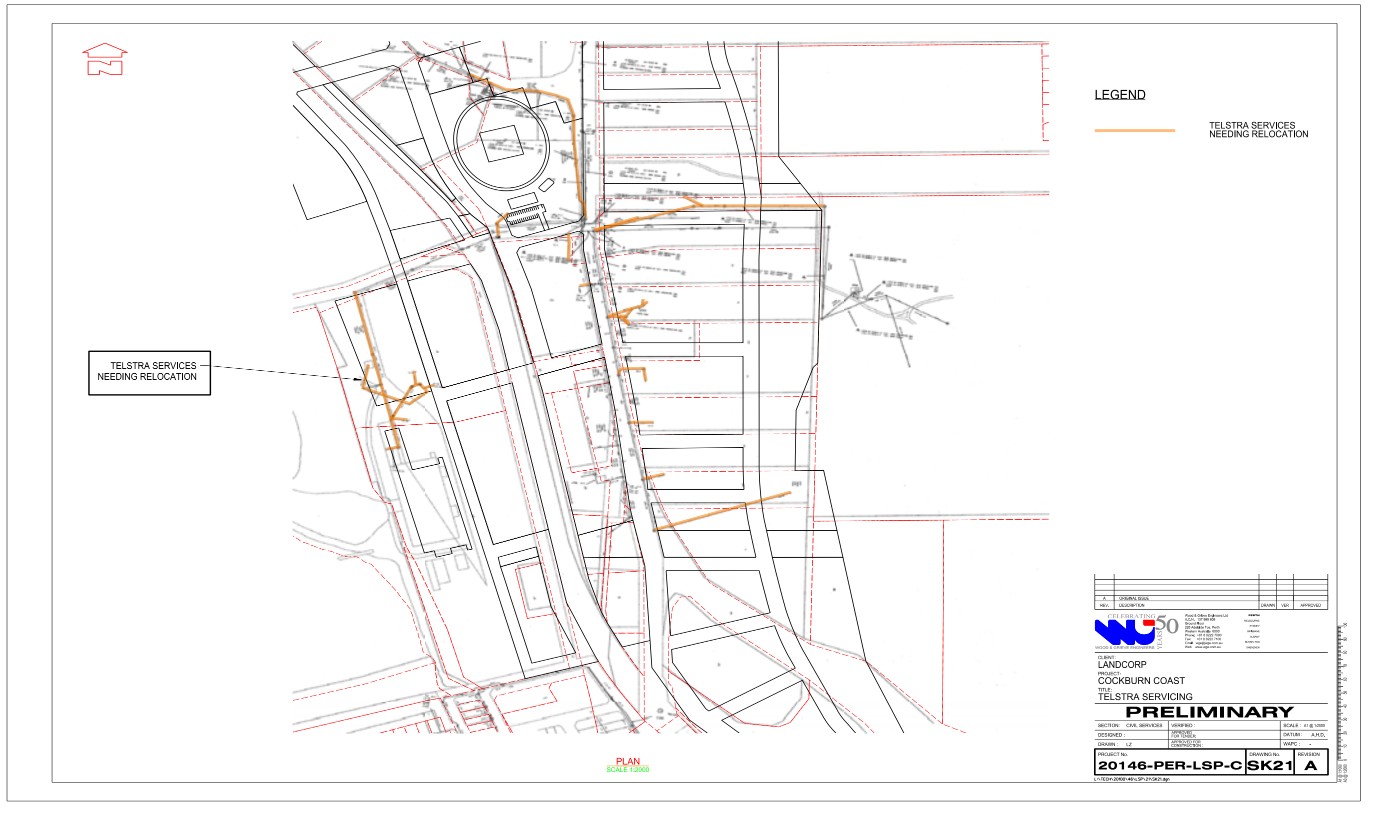
Western Power Transmission Lines and Substation Site



SOUTH FREMANTLE POWER STATION SITE – MASTER PLAN AREA
COCKBURN COAST DEVELOPMENT

Appendix 7

Existing Telstra Cabling and Required Relocations



HASSELL
© 2014

Appendix 8

Existing Gas Mains

Appendix 9

Existing Port Coogee Groundwater Pipeline Plan

HASSELL
© 2014

LANDCORP

POWER STATION MASTER PLAN PRECINCT

ECONOMIC REPORT

March 2014

Disclaimer

This report has been prepared for **LandCorp.** The information contained in this report has been prepared with care by the authors and includes information from apparently reliable secondary data sources which the authors have relied on for completeness and accuracy. However, the authors do not guarantee the information, nor is it intended to form part of any contract. Accordingly all interested parties should make their own inquiries to verify the information and it is the responsibility of interested parties to satisfy themselves in all respects.

This report is only for the use of the party to whom it is addressed and the authors disclaim any responsibility to any third party acting upon or using the whole or part of its contents.

HASSELL
© 2014

Contents

1 Executive Summary

The revitalisation of Cockburn Coast has sought to recognise its unique location within Perth's value chains, whilst envisaging a more urban context for the site. The Power Station Master Plan Precinct will be a major employment centre and driver for the identity, investment and attraction of a wider range of users to the site by improving the value proposition of Cockburn Coast and creating a sustainable competitive advantage for the area. The refurbishment of the Power Station structure is a catalyst for investment as it provides the greater project area with a major piece of infrastructure to act as an anchor for activity.

This report focuses on an economic assessment of the Power Station Master Plan Precinct.

1.1 Floorspace Demand

The findings of the population-driven demand analysis suggest that Cockburn Coast Redevelopment project area could support a total of approximately 15,800m^2 of net leasable retail floorspace. It is expected that the Robb Jetty Local Structure Plan Area will provide most of the convenience retail required by users within the Cockburn Coast catchment whereas the Power Station Master Plan Precinct will largely cater for the comparison and entertainment retail needs of users.

The estimated floorspace demand figures for Cockburn Coast have been further refined to demonstrate a more accurate breakdown of the demand focused in the Power Station Master Plan Precinct. The results indicate that the Power Station Master Plan Precinct could support approximately 7,300m^2 of net leasable retail and entertainment floorspace, which accounts for approximately 46% of the total retail and entertainment floorspace in Cockburn Coast. These findings are considered appropriate for the Master Plan.

1.2 Employment

The findings of the employment analysis suggest that the Power Station Master Plan Precinct could support approximately 820 centre-based jobs, accounting for approximately 30% of the total centralised employment target for the Cockburn Coast Redevelopment area (2,750 jobs). In the short-term the majority of jobs in the Power Station Master Plan Precinct will be population-driven. Strategic jobs will eventually make up a greater share of the total jobs if the employment target for Cockburn Coast is to be met.

The Power Station Master Plan employment figures are considered an appropriate contribution toward the DSP2 employment target of at least 2,750 jobs in Cockburn Coast. Additional commercial activity is to be incorporated in the wider Cockburn Coast area including Robb Jetty Local Structure Plan Area and the broader district centre.

1.3 Economic Activation

The Power Station Master Plan Precinct takes into account economic activation principles, linking residents and visitors to core activity precincts; concentrating retail tenancies to encourage life and vibrancy;

maximising possible modes of transport for easy access; and minimising access routes to channel traffic past shop fronts.

1.4 Conclusion

The economic assessment indicates that the Power Station Master Plan design and yields are appropriate in helping to build a value proposition that encourages strong visitation from local, regional, state and national users. The Master Plan also encourages pedestrian flows into the most intense and vibrant nodes within the development and provides for sufficient, but not excessive, commercial floorspace to meet projected demand and employment requirements.

The importance of the Power Station Master Plan Precinct to the broader Cockburn Coast Redevelopment project cannot be overstated. The Precinct is a critical component of the overall vision for Cockburn Coast, accounting for approximately 30% of the total centralised employment target for Cockburn Coast and providing the area with an anchor off which a future resilient and vibrant local economy can grow and develop.

2 Introduction

Cockburn Coast has sought to recognise its unique location within Perth's value chains, whilst envisaging a more urban context for the Power Station. The Power Station Master Plan Precinct will create employment opportunities, provide a strong identity to Cockburn Coast, and attract investment and a wide range of users. It will do this by complementing the value proposition of Cockburn Coast and creating a sustainable competitive advantage for the area. The refurbishment of the Power Station Structure itself is a catalyst for investment as it provides the greater project area with a major piece of infrastructure to act as an anchor for activity.

The economic assessment for the Power Station Master Plan Precinct needs to be considered in the greater Cockburn Coast Redevelopment project context. It draws upon a comprehensive planning and development framework for Cockburn Coast including:

- District Structure Plan (DSP)
- DSP 2
- Cockburn Coast Economic and Employment Strategy

The analysis in this report is informed by the documents above and seeks to expand upon them by focusing on the floorspace demand, employment potential and economic activation of the Precinct for the Power Station Master Plan.

HASSELL
© 2014

3 Site Context

The Power Station Master Plan Precinct is focussed on the redevelopment of the Power Station Master Plan Site. This report is an economic assessment of the proposed redevelopment of the Power Station Master Plan Precinct, which includes the Power Station and surrounding land.

It is envisioned that the Power Station Master Plan Precinct will revitalise a piece of iconic but unutilised and rundown infrastructure into an intense, active and inviting destination that attracts a variety of users and provides a varied mix of uses including entertainment, retail and commercial. The Power Station Master Plan Precinct is has the potential to be a major driver of employment and investment in the area.

The Power Station Master Plan is to be prepared to address the requirements of the Western Australian Planning Commission, prior to the lifting of 'Urban Deferment' in the area. The Master Plan will be prepared in a similar fashion as preceding district structure plans, with input from key stakeholders helping to ensure the current and future needs of the Cockburn community are met. The Master Plan will inform the preparation of a Power Station Local Structure Plan, thus establishing an appropriate planning framework for implementation.

4 Floorspace Demand

The Cockburn Coast Economic Development Strategy established the population-driven demand for retail and commercial floorspace across the Cockburn Coast Redevelopment Project area. Some minor changes have been made in this report to reflect recent changes in floorspace and dwelling yields throughout Cockburn Coast. This section of the report refines the findings from the Strategy into floorspace demand estimates for the Power Station Master Plan Precinct to assist planning across commercial land uses.

Refer to Appendix 1 for a detailed description of the data and assumptions used to calculate the demand for retail floorspace in Cockburn Coast.

4.1 Cockburn Coast Floorspace

Floorspace demand estimates are derived by modelling the expenditure pools of local users and applying productivity targets for the different floorspace types. The Cockburn Coast model assumed that productivity across all areas will improve over time, indicating that businesses within the project area will become more productive per square metre of floorspace as the local economy matures and user population expands. This reflects activity centres with higher levels of activation that effectively capture greater levels of expenditure within the same provision of floorspace.

Figure 1 outlines the floorspace requirements for Cockburn Coast across the key retail categories of convenience, comparison and entertainment floorspace.

Figure 1. Cockburn Coast Total Floorspace Demand

Retail Category	Floorspace Demand
Convenience floor space	8,700 m^2
Comparison floor space	4,100 m^2
Entertainment floor space	3,000 m^2
Total Retail floor space	15,800 m^2

Source: Pracsys 2013

The findings of the population-driven demand analysis suggest that Cockburn Coast could support a total 15,800m^2 of net leasable retail floorspace.

4.2 Power Station Master Plan Precinct Floorspace

When assessing floorspace demand for Cockburn Coast it is important to consider the future roles of the Power Station Master Plan and Robb Jetty Local Structure Plan Area. It is expected that the Robb Jetty Local Structure Plan Area will provide most of the convenience retail required by users within the Cockburn Coast catchment, whereas the Power Station Master Plan Precinct will largely cater for the comparison retail and entertainment needs of users.

In recognition of this, the estimated floorspace demand figures for Cockburn Coast have been further refined to demonstrate a more accurate breakdown of the demand focused in the Power Station Master Plan Precinct.

4.2.1 Assumptions

The assumptions in Figure 2 have been used to suggest what proportion of the overall floorspace for Cockburn Coast will be focused within the Power Station Master Plan Precinct.

Figure 2. Power Station Master Plan Precinct Floorspace Assumptions

Retail Category	% Of Total Cockburn Coast Floorspace
Convenience floor space	20%
Comparison floor space	80%
Entertainment floor space	80%

Source: Pracsys 2013

4.2.2 Outcome

The assumptions in Figure 2 were applied to the total floorspace demand figures for Cockburn Coast to produce refined estimates for the Power Station Master Plan Precinct, shown in Figure 3.

Figure 3. Power Station Master Plan Precinct Floorspace Demand

Retail Category	Floorspace Demand
Convenience floor space	1,700 m^2
Comparison floor space	3,200 m^2
Entertainment floor space	2,400 m^2
Retail Floor space	7,300 m^2

Source: Pracsys 2013

Population-driven demand analysis suggests that the Power Station Master Plan Precinct could support up to 7,300m^2 of net leasable retail and entertainment floorspace, which accounts for approximately 46% of the total retail and entertainment floorspace demand in Cockburn Coast.

These findings are considered appropriate for the Power Station Master Plan Precinct. The population-driven retail floorspace will be accompanied by additional demand for non-retail uses catering for strategic employment, increasing the consumption of floorspace across the Power Station Master Plan Precinct. Activities within the Power Station building itself (e.g. hotel, retail and office activities) would also consume approximately 27% of the unused floorspace within Cockburn Coast.

Master Plan Precinct. In the short-term any potential oversupply of floorspace should be managed by controlling the release and use of strategic sites.

4.2.3 Commercial Floorspace

Demand for commercial floorspace is not typically calculated in the same way as retail, this is because commercial spending patterns do not tend to be as defined. As a result, the viability of the proposed commercial floorspace has been assessed by obtaining the average ratio of population driven workforce to population in the Greater Perth area. This has then been applied to the Power Station Master Plan Precinct Area. This calculation can be seen in Figure 4.

Figure 4. Commercial Population Driven Employment

Category	Metric
Commercial floorspace	5,765 m^2
Commercial floorspace (Population Driven)	4,324 m^2
Commercial population driven employment	144
Population to population driven employment ratio	2.9
Required population	418

Source: Pracsys 2013

Commercial floorspace has been assumed to be 25% strategic and 75% population driven, given this, population driven employment is expected to be approximately 144 persons (Figure 4).

As retail and other uses also form a component of the population driven workforce we must examine how this portion of population driven workforce fits into the overall demand, this can be seen in Figure 5. Total population driven job calculations can be found in Appendix 2 – Employment Analysis.

Figure 5. Non Commercial Population Driven Employment

Category	Metric
Total population driven jobs	565
Population driven jobs less commercial	373
Population to population driven employment ratio	2.9
Required population	1081

Source: Pracsys 2013

As a result the required population to service the Power Station Master Plan Precinct is expected to be 1,600, this can be seen in Figure 6.

Figure 6. Population Required

Category	Metric
Commercial floorspace population needed	557

© 2014

Other floorspace population needed	1081
Required population	1600

Source: Pracsys 2013

Given that the Master Plan currently has capacity for the required population to support the proposed population driven floorspace (including population driven commercial), the proposed levels are not expected to exceed demand.

5 Employment

Achieving the employment goals for Cockburn Coast Redevelopment project area requires the development of a unique local economy that meets the needs of a range of users and markets. The following section expands upon analysis previously completed for Cockburn Coast by considering the quality of employment within the Power Station Master Plan Precinct.

5.1 Cockburn Coast Employment Targets

The Cockburn Coast District Structure Plan (DSP) and DSP2 have produced a range of employment targets based on differing assumptions.

Figure 7. DSP and DSP2 Employment Targets for Cockburn Coast

Planning Document	Employment Target
District Structure Plan (DSP)	4,080
DSP2	2,750

Source: Pracsys 2013

The Cockburn Coast Economic Development Strategy (2012) recognises the ranges in these targets, with the DSP being considered an optimal employment outcome, and the DSP2 target being considered a minimal achievement. As such the employment analysis is seeking to achieve a total employment outcome of at least 2,750 jobs in Cockburn Coast.

The employment profile for the Power Station Master Plan establishes the Precinct's contribution toward the DSP2 employment target and discusses the role the area plays in the broader context of the Cockburn Coast development. The planning implications of potential gaps in the employment estimates and the DSP/DSP2 targets are also discussed.

5.2 Employment Analysis

A key target for employment within Cockburn Coast is centre-based employment. The aim is for employment to be increasingly centralised within the development's two centres, with activities being integrated into Robb Jetty Main Street and Power Station Master Plan Precinct rather than dispersed throughout the broader Cockburn Coast area.

The following analysis estimates the number and types of jobs that may be centralised within the Power Station Master Plan Precinct. The analysis draws upon the projected yields for the Master Plan Precinct and the retail floorspace demand assumptions from Section 4 of this report to help describe potential employment scenarios for the Precinct.

Refer to Appendix 2 for a detailed description of the data and assumptions used to calculate employment in the Power Station Master Plan Precinct.

5.2.1 Outcome

Figure 8 estimates the number of jobs and different employment types required to achieve the centre-based employment target for Cockburn Coast.

Figure 8. Indicative employment based upon Power Station Master Plan Precinct yields

Employment Type	Number of Jobs
Strategic[1]	255
KICS[2]	90
CS/PS[3]	475
Total Jobs	820
Projected centralised employment target (DSP2)	2,750
% Of provision of total centralised employment	30%

Source: Pracsys 2013

The findings of the employment analysis suggest that the Power Station Master Plan Precinct could support 820 centre-based jobs, accounting for approximately 30% of the total centralised employment for the Cockburn Coast development.

In the short-term the majority of jobs in the Power Station Master Plan Precinct will be population-driven[4]. To reach projected employment targets, strategic jobs will eventually need to make up a greater share of the total jobs if the employment target for Cockburn Coast is to be met.

The employment figures for the Power Station Master Plan Precinct are considered to be appropriate. As mentioned in Section 4, additional commercial activity is to be incorporated in the wider Cockburn Coast area including in the Robb Jetty Main Local Structure Plan area and the broader district centre.

5.3 Implications for Planning

5.3.1 DSP and DSP2 Employment Scenarios

The Cockburn Coast Economic Development Strategy establishes two scenarios under which the development may achieve the employment targets set by the DSP and DSP2.

The original District Structure Plan's stated goal of 4,080 jobs is aspirational for a development with the locational, infrastructure and existing economic characteristics of Cockburn Coast. This scenario assumes a significant restructure in the immediate economy of the Western Trade Coast, along with Perth as a whole, with the function of the planned district centre evolving over time to be more like that envisioned for a secondary centre in within State Planning Policy 4.2 Activity Centres for Perth and Peel.

[1] Strategic jobs result from economic activity focused on the creation and transfer of goods and services to an external market.
[2] Knowledge Intensive Consumer Services (KICS) includes activities such as education, healthcare, aged care, personal finance, architecture, construction, accountancy and real estate.
[3] Consumer services (CS) include activities such as retail and hospitality. Producer services (PS) include activities such as basic trades and administration support.
[4] Consumer Services, Producer Services or Knowledge Intensive Consumer Services.

The DSP2's refined employment goal of 2,750 jobs is aspirational for a development with limited potential for continued retail expansion and development due to limitations in its available catchment. In this scenario Cockburn Coast is a high quality mixed-use urban development project that attracts a high level of regional visitation to a vibrant redeveloped Power Station Master Plan Precinct recognised throughout the metropolitan area as a destination of choice for families, events and a range of experiences. High-density residential areas host a diverse and vibrant local community that successfully integrates the provision of affordable housing.

5.3.2 Bridging the Employment Gap

The divergence of the DSP and DSP2 employment targets is a product of these two possible scenarios for Cockburn Coast. Achieving the refined employment target of DSP2, and indeed exceeding this to produce an outcome closer to the DSP target, relies on several factors discussed in the Cockburn Coast Economic Development Strategy:

- Cockburn Coast needs to use its proximity to major export value chains to develop strategic relationships with surrounding logistics and industrial infrastructure and other activity centres
- The local structure planning areas, particularly Robb Jetty and Power Station, need to ensure that the configuration of population-driven activities maximises the quantity and quality of transactions critical to the development of urbanisation economies[5]
- Over time strategic activities may overflow from surrounding areas, such as Fremantle, into Cockburn Coast. The location of the development in relation to major infrastructure, value chains and activity centres may allow for leverage of a significant amount of effective density
- The development of a competitive advantage[6] can provide the anchor around which a strong localisation economy[7] can grow, increasing the level of strategic economic activity in the area. Localisation economies are the result of a number of firms and enterprises in complementary industries and supply chains locating in the same area
- Cockburn Coast will need to mature from a population-driven centre servicing basic consumer needs to a centre that services the higher order needs of the population while attracting some strategic industry

[5] Urbanisation agglomeration of activities result from the general benefits that a firm will gain from locating in a particular urban environment. This includes access to general labour pools, access to financial and commercial services and proximity to transport and communication networks.
[6] Competitive advantage is defined as the strategic advantage one business entity has over its rival entities within its competitive industry. Achieving competitive advantage strengthens and positions a business better within the business environment.
[7] Localisation economies are the result of a number of firms and enterprises (including research institutions, not-for-profit organisations and government departments) in complementary industries and supply chains locating in the same area.

HASSELL
© 2014

5.3.3 Importance of the Power Station Master Plan Precinct

The importance of Power Station Master Plan Precinct cannot be overstated if Cockburn Coast is to achieve the employment targets set by DSP2 or even the DSP. The Power Station structure is a catalyst for investment as it provides Cockburn Coast with a major piece of infrastructure to act as an anchor for activity.

The Refurbishment of the iconic Power Station Structure would be a driver for identity, investment and attraction of a wider range of users to the site by improving the value proposition of Cockburn Coast and creating a sustainable competitive advantage for the area. The increased attraction of residents, visitors, workers and enterprises and associated transactions can also create the activity needed for the development of urbanisation and localisation economies in Cockburn Coast.

6 Economic Activation

From a centre design and ongoing management perspective, there are certain economic activation principles that can be implemented to ensure the Power Station Master Plan Precinct is as user friendly as possible to maximise the number and length of visits, and the quality of transactions that occur on each visit.

Economic activation is defined as the frequency and concentration of social and economic transactions carried out by the diverse user groups of a place. A successful place must understand what its users need and want and provide an environment that both attracts and retains people.

This report identifies the user mix for the Power Station Master Plan Precinct as being residents, workers and visitors. The population and expenditure of each group forms the Precinct's economic base and drives the commercial vitality of office and retail tenancies.

Through the redevelopment process, and with ongoing management, there is the potential for the revitalisation of a unique state asset in the Power Station. Activating the Power Station Master Plan Precinct will involve:

- Linking the residents and visitors to core activity precincts
- Concentrating retail tenancies to encourage life and vibrancy
- Maximising possible modes of transport for easy access
- Minimising access routes to channel traffic past shop fronts

There are six principles of economic activation that have been developed into a coherent framework to apply to urban renewal projects. These principles are outlined in Figure 9 below.

Figure 9. Six Principles of Economic Activation

Principles	Description
1. Purpose of Place	• Address the question – what does the Power Station Master Plan Precinct represent to its target user population (residents, workers, visitors)? • Enhance land economics by using design to maximise frequency and concentration of transactions
2. Access – Arrival Points	• Decisions about access begin 5km away from the place • Do not allow transport networks to bypass the place – does the design funnel people and traffic into the core? • Congestion and mix of transport nodes is good • Arrive at the 'front door' of the place and not around the back

Principles	Description

3. Origins – Car Parking and Transport Nodes	• Parking is the driver of pedestrian movement
	• Strategic distribution of origin points will maximise pedestrian movement
	  o Location is more important than numbers
	  o Space the origin points around the centre
	• Street parking is important for commercial areas
	  o Charge no fees
	  o Relax time limits

4. Exposure – Pedestrian Movement	• Economic activation is driven by frequency and concentration of transactions
	• Channel pedestrian movements
	  o Concentrate transactions by pushing people past as many shop windows as possible
	  o Rents and sales are directly related to pedestrian traffic (e.g. Corner locations are generally more desirable due to extra traffic flow)
	• Minimise possible routes from origin to destination points (e.g. Bus stop to main attraction) as architectural 'permeability' is not always a good thing

5. Destinations – Major attractions	• Identify main destination – what will bring users into the core?
	• Assess user behaviour
	  o Number of visits
	  o Timing of visits (time of day, seasonality)
	• Give major destinations special treatment
	  o Understand what they need
	  o Build centre around them
	• Amplify the impact of attractions by creating support amenity and infrastructure to maximise frequency, length of stay and expenditure

6. Control – Strategic Sites	• Tenure control is vital for overall development success – which sites (supporting what uses) must stay in public ownership? • Identify active frontages and take control of key sites • Corner sites drive uses on either side • Not all areas in a place need to be active – be selective

Source: Pracsys 2013

The following section evaluates the redevelopment of the Power Station Master Plan Precinct in relation to these principles of economic activation.

6.1 Assessment of Options

Figure 10 highlights the key considerations when assessing the economic activation potential for the Power Station Master Plan Precinct.

Figure 10. Power Station Master Plan Precinct - Key Areas for Economic Activation

Source: Hassell 2013 and Pracsys 2013

6.1.1 Purpose of Place

The Power Station Master Plan Precinct will be a unique place within the urban fabric of Perth with higher density residences integrated into a historical coastal environment characterised by a vibrant, diverse range of activities. It will be a high amenity sub-regional attractor and a regularly visited destination along the Fremantle/Cockburn coastal journey for leisure, events and recreation for users primarily from south of Perth.

The focus of the Precinct will predominantly be servicing the local catchment and incidental visitors from the Fremantle/Cockburn coastal journey. The Power Station is expected to be the major attractor in the Cockburn Coast Redevelopment Project Area with the retail component being the major driver of activity in the precinct.

The Power Station Master Plan Precinct creates an immediate residential catchment encouraging local expenditure, minimal car-based activities, and a local focus on meeting lifestyle needs while the Power Station structure will provide a driver for identity, investment and attraction of a wider range of users to the Precinct.

In the short-term the primary function of the Power Station Master Plan Precinct will be as a local high-density population centre. As the development matures there is potential for the Precinct to develop a significant workforce population providing effective density for a knowledge intensive consumer services employment function.

6.1.2 Access/Arrival Points

It is important to understand how user groups will access the Power Station Master Plan Precinct and how they will move around internally after they arrive. User groups will access the Precinct at various arrival points shown in Figure 10.

Entrances and footpath access, especially to and from car parks, should be positioned so that users naturally remain within the Precinct for as long as possible and carry out multiple transactions.

A large number of users will arrive at Access Point A4 and A5 from public transport and parking outside the Precinct. The benefit of this access point is that it enables people arriving to be efficiently disseminated to an active civic space. The purpose of place for the Power Station Master Plan Precinct should be obvious to users arriving at this critical point as it facilitates easy entry for the greatest number of users

Users can also arrive via Access Points A1 and A2 by foot or bike. These alternative access point are intended to connect the seaside bike and pedestrian path to the activity centre predominantly within the Power Station structure.

6.1.3 Origins – Car Parking and Transport Nodes

Once users move into an area (via private motor vehicles, public transport or bicycling) it is important to consider where foot-traffic will originate as this is where users commence their interaction with the centre.

Power Station Master Plan Economic Report

The major points of origin identified for the Power Station Master Plan Precinct is the car park adjacent to the Power Station (O1) and the bus stations located nearby (O2a, O2b), and the residential units within the Precinct.

6.1.4 Exposure – Pedestrian Movement

Likely movement to and within the Power Station Master Plan Precinct is shown in Figure 10. Pedestrian movement that maximises intensity, connectivity and user interactions is crucial to any precinct. Placing retail tenancies in close proximity to one another concentrates users within a tight walkable catchment and creates a vibrant and active feel. It also improves the commercial viability of the retailers by maximising passing traffic, raising awareness and potentially enticing expenditure. Whenever possible, line-of-sight views to other sites should be maintained to encourage pedestrian movement within the Precinct and multi-purpose visits.

6.1.5 Destinations – Major attractions

The major destinations within the Master Plan Precinct are the Power Station itself and the civic piazza. Major destinations and attractors are sites that draw a significant number of users to the Power Station Master Plan Precinct by offering unique value propositions. It is essential to identify and position major attractions so that they are easily accessible, have a clear relationship to each other and provide a focal point for activity.

Choosing a point of focus for the site around which activity can be centred is an important factor in the successful activation of an area. Successfully activated sites identify these attractions and utilise them as a focal point for the remainder of development in such a way to promote interaction and encourage diverse uses. Such focal points can be public open space, urban squares, public art or major attractions.

6.1.6 Control – Strategic Sites

The key strategic sites for the Power Station Master Plan Precinct are shown in Figure 10. Long-term economic vitality often depends on locating the right uses in the right locations at the right time. Maintaining control over key sites will ensure that the target business types locate there for the long-term benefit. The sites will vary based upon decisions made in regards to the location of major attractions and points of focus, however there are obvious sites of importance due to the quantity of passing traffic and the presence of public transport infrastructure. The selected sites have been chosen because of their proximity to major destinations and access points.

A site may be important to the activation of the area as a whole due to its proximity to pedestrian and vehicle traffic flow, potential as a corner 'showpiece', or due to its proximity to a potential major point of focus such as a hotel, tourist destination or piece of community infrastructure. These sites should be managed to promote uses that best represent the value offering of the site and encourage traffic that will flow onto other adjacent sites.

Staging of development is also essential. Identifying and staging strategic sites may require caveats to be placed on sites, allowing them to initially be used for community and economic development activity, before converting to commercial and business activity in the longer-term when amenity and market conditions make such uses desirable.

7 Conclusion

Cockburn Coast has the potential to be a unique place within the urban fabric of Perth, with high amenity, higher density residences integrated into a historic coastal environment characterised by a vibrant, diverse range of activities.

The successful redevelopment of the Power Station Master Plan Precinct is critical to the achievement of the overall vision for Cockburn Coast, with it being a driver for identity, investment and attraction of a wide range of users to the Power Station. It is therefore essential to plan the appropriate scale and configuration of the Precinct.

The economic assessment indicates that the Power Station Master Plan design and yields are appropriate in helping to build a value proposition that encourages strong visitation from local, regional, state and national users. The Master Plan also encourages pedestrian flows into the most intense and vibrant nodes within the development and provides for sufficient but not excessive commercial floorspace to meet projected demand and employment requirements.

The importance of the Power Station Master Plan Precinct to the broader Cockburn Coast development cannot be overstated. The Precinct is a critical component of the overall vision for Cockburn Coast, accounting for the majority of the total centralised employment target for Cockburn Coast and providing the area with an anchor off which a future resilient and vibrant local economy can grow and develop.

8 Appendix 1 – User Mix Profile and Floorspace Demand

The following analysis describes the estimated future demand for floorspace across Cockburn Coast. The demand estimates are derived by modelling the expenditure pools of local users and applying productivity targets for the different floorspace types.

8.1 User Mix Profile

An understanding of retail floorspace demand needs to begin with an analysis of the future users of the retail offerings within Cockburn Coast. Key user groups for the area's commercial and retail offerings will be:

- Local Residents
- Local Workers
- Visitors (day and night)

8.1.1 Residents

The first user mix category is local residents within Cockburn Coast. Relatively undeveloped suburban areas surround the Power Station Master Plan Precinct. These areas will experience significant residential development over the coming years, progressively increasing the number of people residing in the area. Local residents contribute the most expenditure across all user groups as they spend the greatest amount of time in the area.

8.1.2 Workers

The second category contributing to the Cockburn Coast user mix are the workers that will be servicing the area's main industries. These are broadly split into the two worker sub-types of commercial (e.g. office, manufacturing etc.) and retail (e.g. fast food, fashion etc.). Full-time workers make a significant contribution toward weekday expenditure in an area, with part-time and casual workers also adding to this.

8.1.3 Visitors

The third user mix category is visitors to Cockburn Coast. Visitors can be broken down into the timing of visits (day or night), points of origin, and purpose. Visitors are also an important source of expenditure, particularly during weekends and nights.

8.1.4 User Mix Summary

Figure 11 provides a summary of the estimated number of users in Cockburn Coast across the three groups described above. For the purpose of this analysis the residents user group is defined by the number of residential dwellings anticipated for Cockburn Coast.

Figure 11. Cockburn Coast User Mix Summary

User Group	Number of Users
Total Dwellings	5,200
Total Workers	3,500
Total Visitors	418,700

Source: Hassell 2013 and Pracsys 2013

One significant limiting factor for the Cockburn Coast development is its isolation from surrounding population or industrial centres. When combined with its coastal location, this results in a very limited catchment area from which to draw users from. In addition to its limited catchment, Cockburn Coast's relative proximity to the major retail precinct of Fremantle also creates the potential for significant expenditure leakage.

8.2 Expenditure

The annual expenditure of each user group is calculated using ABS data and divided across the three retail categories of convenience (e.g. groceries), comparison (e.g. clothing) and entertainment (e.g. restaurants). These retail categories form the expenditure pools from which future demand for each type of floorspace is calculated.

Figure 12. Cockburn Coast Expenditure Pools

Retail Category	Annual Expenditure
Total Convenience Expenditure	$65,830,300
Total Comparison Expenditure	$24,401,200
Total Entertainment Expenditure	$18,455,100

Source: ABS Household Expenditure Survey 2009-10 and Pracsys 2013

8.3 Floorspace Demand

Floorspace productivity is the mechanism by which expenditure is related back to floorspace demand. Productivity is defined as the turnover per square meter of floorspace, per year. The greater the productivity, the more efficiently the floorspace is being used to create revenue.

The assumptions in Figure 13 have been used when calculating retail floorspace productivity for Cockburn Coast.

Figure 13. Cockburn Coast Floorspace Productivity Assumptions

Retail Category	Productivity Assumption
Convenience	$7,500
Comparison	$6,000
Entertainment	$6,000

Source: Pracsys 2013

Floorspace demand is derived by dividing the sum of expenditure by the floorspace productivity for each retail category. The following analysis was undertaken using Pracsys modelling of Cockburn Coast's expenditure pools and floorspace productivity.

Figure 14. Cockburn Coast Total Floorspace Demand

Retail Category	Floorspace Demand
Convenience floor space	8,700 m^2
Comparison floor space	4,100 m^2
Entertainment floor space	3,000 m^2
Total Retail Floor space	15,800 m^2

Source: Pracsys 2013

The population-driven demand analysis findings suggest that Cockburn Coast could support a total of 15,800 m^2 of net leasable retail floorspace across convenience, comparison and entertainment uses.

9 Appendix 2 – Employment Analysis

The following analysis provides an estimate of the number and type of jobs that may be centralised within the Power Station Master Plan Precinct. The analysis draws upon the projected yields for the Power Station Master Plan Precinct and the retail floorspace demand assumptions from Section 4 of this report to produce employment scenarios.

Figure 15 contains the floorspace estimates across the whole of Cockburn Coast, the broader Power Station Master Plan Precinct, and within the Power Station building itself. These estimates, described below, form the basis of the employment analysis.

Figure 15. Floorspace Across the Power Station Master Plan Precinct

Location Description	Floorspace
Power Station Master Plan Precinct – Convenience	1,755 m^2
Power Station Master Plan Precinct – Comparison	3,250 m^2
Power Station Master Plan Precinct – Entertainment	2,460 m^2
Commercial Inside of Power Station Building	5,765 m^2

Source: Pracsys 2013

9.1 Assumptions

In order to produce indicative employment figures, a series of assumptions were applied to the floorspace estimates. The assumptions in Figure 16 suggest an average amount of floorspace required per employee over different land uses.

Figure 16. Floorspace Required Per Employee

Floorspace Type	Floorspace Required Per Employee
Retail	30 m^2
Entertainment	15 m^2
Non-retail (including Power Station)	30 m^2

Source: Pracsys 2013

Dividing the floorspace estimates by the appropriate assumption according to their floorspace type provides an estimate of the total number of employees that can be accommodated within the Power Station Master Plan Precinct.

In order to derive a full employment profile for the Precinct it was also necessary to make assumptions regarding the general employment types to be accommodated within the Power Station building itself. Figure 17 describes the assumed breakdown of employment quality across the Power Station site only.

HASSELL
© 2014

Figure 17. Power Station Master Plan Precinct Floorspace by Employment Type

Employment Type	Proportion of Total Floorspace Occupied
CS/PS[8]	75%
KICS/Strategic[9]	25%

Source: Pracsys 2013

Applying these assumptions to the Power Station site provides an estimate of the amount and types of employment that will be generated by the site itself. This employment will be in addition to that which is created across the broader Power Station Master Plan Precinct.

9.2 Outcome

The following employment estimates were produced using the assumptions and floorspace estimates described above.

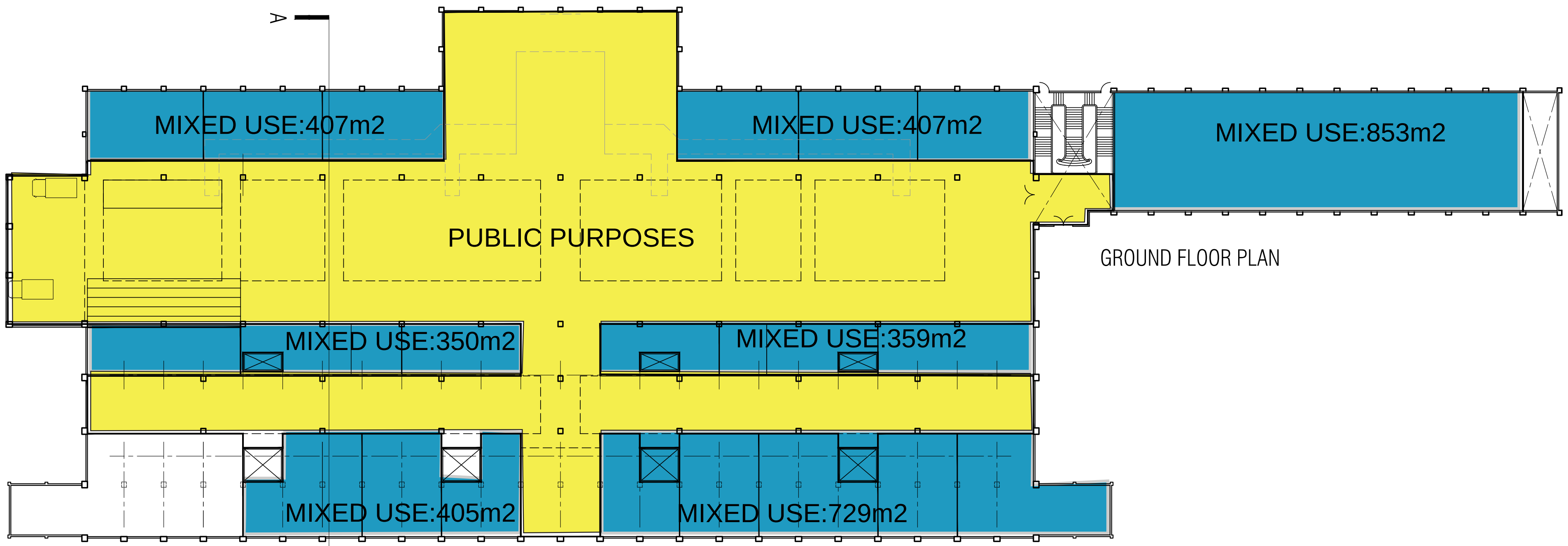
Figure 18. Indicative Power Station Master Plan Master Plan Precinct Employment

Employment Type	Number of Jobs
Strategic	255
KICS	90
CS/PS	475
Total Jobs	820

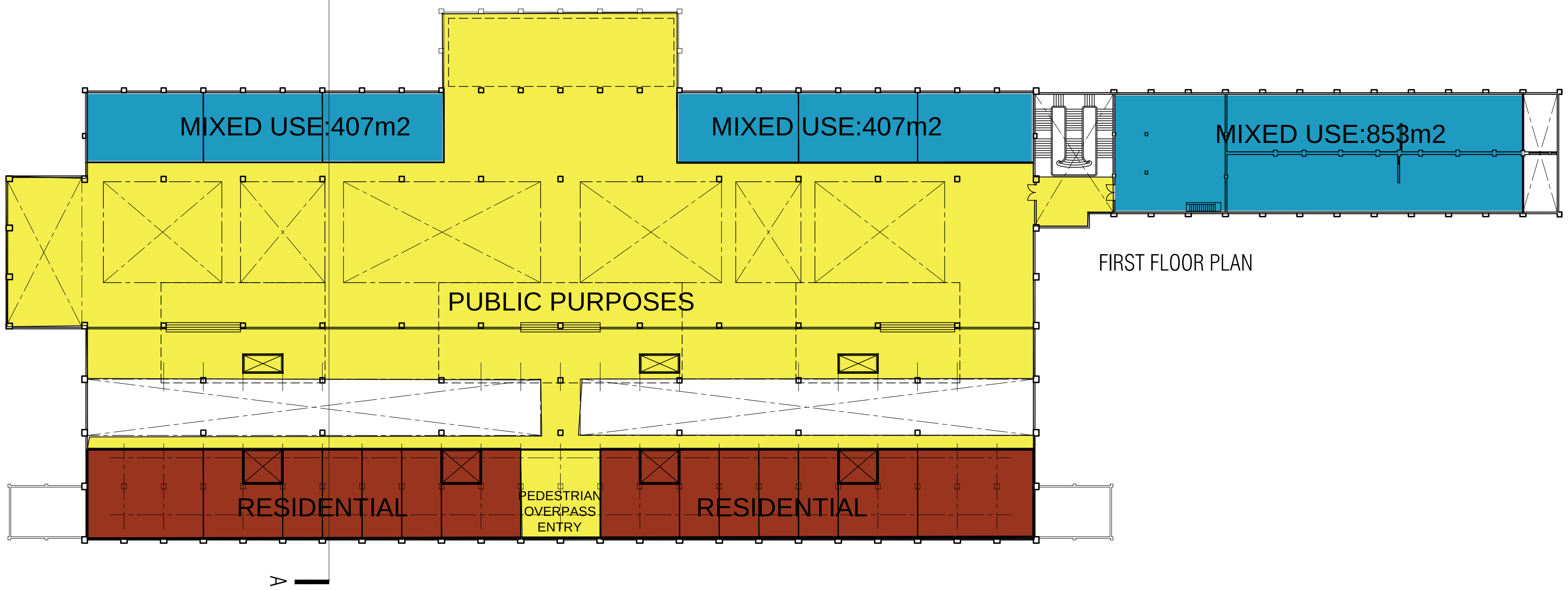
Source: Pracsys 2013

The employment analysis suggests that the Power Station Master Plan Precinct could support 820 centre-based jobs within Cockburn Coast.

[8] Consumer services (CS) include activities such as retail and hospitality. Producer services (PS) include activities such as basic trades and administration support.
[9] Knowledge Intensive Consumer Services (KICS) includes activities such as education, healthcare, aged care, personal finance, architecture, construction, accountancy and real estate. Strategic jobs result from economic activity focused on the creation and transfer of goods and services to an external market.



GROUND FLOOR PLAN



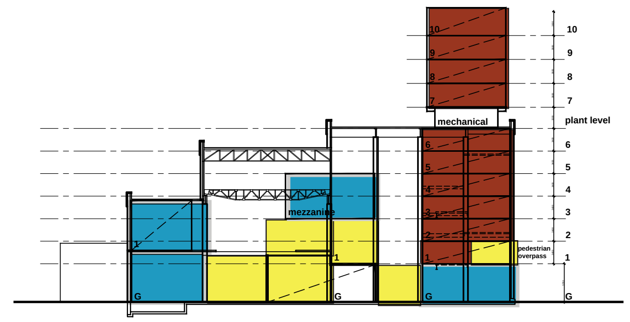
FIRST FLOOR PLAN

MIXED USE
APPROX: 3471m² Retail, including food and beverage
APPROX: 3499m² Commercial

RESIDENTIAL
Approx: 147 Apartments

PUBLIC PURPOSE
Open areas throughout the Power Station building will be used for community purposes

*Note: Land uses are subject to refinement in accordance with more detailed planning processes



SECTION AA
PROPOSED

GROUND AND FIRST FLOOR PLANS
POWER STATION

HASSELL

Revision	Date	Scale		Client	Project Name	Drawing
6	16th April 2014	1:350	@ A1	LANDCORP	South Fremantle Power Station	140416_03655_Power Station Drawings_Ground + First Floor Plan_Rev 6

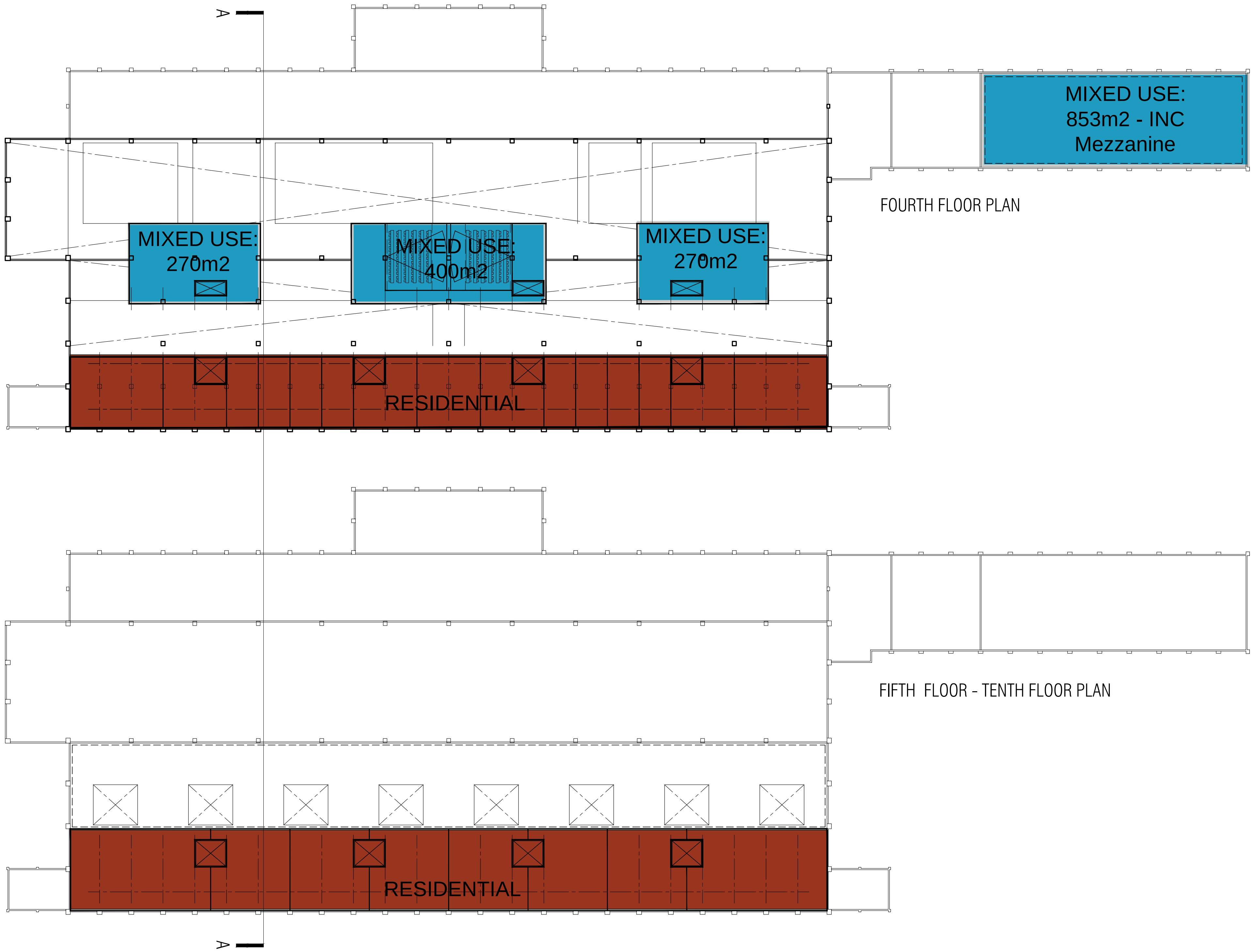
File Location:: \\per.work.hassell.info\sites\Projects\003655\Models\AutoCAD\Work\CAD files\131120_003655_POWERSTATION_PLANS_SUMMARY.dwg
File Location:: \\per.work.hassell.info\sites\Projects\003655\Drawings\130924_Power Station_Proposed_Summary\140416_03655_Issue 06_Powe Station Summary Drawings

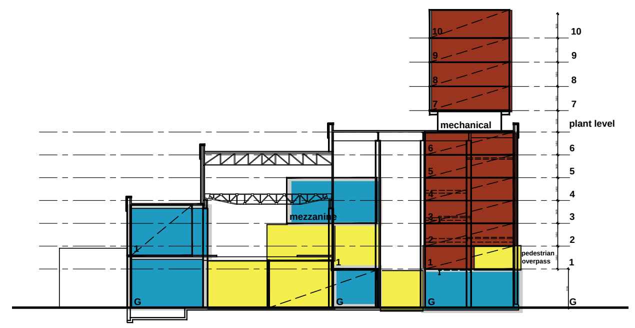
MIXED USE
APPROX: 3471m² Retail, including food and beverage
APPROX: 3499m² Commercial

RESIDENTIAL
Approx: 147 Apartments

PUBLIC PURPOSE
Open areas throughout the Power Station building will be used for community purposes

*Note: Land uses are subject to refinement in accordance with more detailed planning processes





SECTION AA
PROPOSED

FOURTH AND FIFTH FLOOR PLANS
POWER STATION

HASSELL

Revision	Date	Scale		Client	Project Name	Drawing
6	16th April 2014	1:350	@ A1	LANDCORP	South Fremantle Power Station	140416_03655_Power Station Drawings_Fourth and Fifth Floor Plan_Rev 6

File Location:: \\per.work.hassell.info\sites\Projects\003655\Models\AutoCAD\Work\CAD files\131120_003655_POWERSTATION_PLANS_SUMMARY.dwg
File Location:: \\per.work.hassell.info\sites\Projects\003655\Drawings\130924_Power Station_Proposed_Summary\140416_03655_Issue 06_Powe Station Summary Drawings

HASSELL
© 2014

Landcorp

South Fremantle Power Station Master Plan

Traffic and parking report

14 March 2014

PARSONS BRINCKERHOFF

Document information
Client: Landcorp Title: South Fremantle Power Station Master Plan Subtitle: Traffic and parking report Document No: 2174970A-TPT-RPT-001 RevA Date: 14 March 2014

Rev	Date	Details
A	17/02/2014	Draft
B	14/03/2014	Draft – land use amended

Author, Reviewer and Approver details			
Prepared by:	Kate McDonald	Date: 14/03/2014	Signature:
Reviewed by:	Andrew Leedham	Date: 17/03/2014	Signature:
Approved by:		Date: 17/03/2014	Signature:

Distribution
Landcorp, Parsons Brinckerhoff file, Parsons Brinckerhoff Library

©Parsons Brinckerhoff Australia Pty Limited 2014

Copyright in the drawings, information and data recorded in this document (the information) is the property of Parsons Brinckerhoff. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by Parsons Brinckerhoff. Parsons Brinckerhoff makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information.

Document owner

Parsons Brinckerhoff Australia Pty Limited

ABN 80 078 004 798

Level 5 503 Murray Street
Perth WA 6000
PO Box 7181
Cloisters Square WA 6850
Australia
Tel: +61 8 9489 9700
Fax: +61 8 9489 9777
Email: perth@pb.com.au
www.pbworld.com

Certified to ISO 9001, ISO 14001, AS/NZS 4801
A GRI Rating: Sustainability Report 2011

Contents

Landcorp South Fremantle Power Station Master Plan
- Traffic and parking report

List of tables

List of figures

1. Introduction

Parsons Brinckerhoff has been commissioned by Landcorp to carry out a traffic and parking assessment to inform the Concept Master Plan for the South Fremantle Power Station. The disused Power Station is located in the Power Station precinct which is the southern portion of the Cockburn Coast District Structure Plan area within the City of Cockburn.

The Cockburn Coast Integrated Transport Plan (ITP) was produced in 2011 to support the Cockburn Coast District Structure Plan No. 2 (DSP No.2) and the subsequent Local Structure Plans (LSPs). The ITP refined the development of transport infrastructure required for development in the DSP area. It sets out generally the networks for all modes and outlines a number of principles for the implementation of a sustainable transport system including the development of a Bus Rapid Transit corridor, and traffic reduction principles including maximum parking rates. The Cockburn Coast Local Transport and Traffic Management Strategy provided an assessment of the transport and traffic impacts of the development in accordance with the WAPC guidelines.

The overarching premise of the ITP was the need to shift transport reliance from the private vehicle to other non-car modes including public transport, walking and cycling to ensure that use of the land could be maximised with the creation of vibrant, active spaces.

The area surrounding the Power Station has historically been used for industrial purposes with some businesses currently operating although the land is currently underutilised.

This report discusses the transport system in relation to the ultimate development of the Master Plan and assumes that the existing industrial businesses will no longer operate in their present form.

1.1 Location

The Cockburn Coast Redevelopment project area is located approximately 4km to the south of Fremantle and 18km southwest of the Perth CBD. The development area is approximately 330 hectares and is abutted to the north and south by the South Beach and Port Coogee urban renewal projects.

Landcorp South Fremantle Power Station Master Plan
- Traffic and parking report

2. The proposal

2.1 Regional Context

Cockburn Coast is well located between economically significant centres, namely Fremantle, Rockingham, Kwinana and Henderson. It is also well connected to other major employment areas at Cockburn Central and Spearwood Industrial area. Within the South-West Sub-region, Rockingham is the principal centre of mixed use activity and is classified under Directions 2031 as a Primary Centre; Kwinana and Henderson are strategic industrial centres with a major focus on heavy industrial and export-oriented industry, employing over 10,000 workers. According to the employment targets set within Directions 2031, the south-west sub-region is expected to increase its employment self-sufficiency rate to 70% by 2031, requiring the creation of 41,000 new jobs, an increase from the already existing 52,000 in 2008.

The Power Station building is located approximately 700 m south of the future Main Street of the Robb Jetty precinct and just north of the Coogee Marina.

2.2 Proposed land uses

The Concept Master Plan proposes 5,765 m^2 commercial space, 6,672 m^2 retail space and 147 dwellings within the Power Station building with an additional 692 dwellings in the remaining Master Plan Precinct. The arrangement of the apartment and other dwellings is shown in the Master Plan Concept Heights plan attached in Appendix A and in Figure 2.1 overleaf.

HASSELL
© 2014

Figure 2.1 Proposed land use and building heights

2.3 Major attractors / generators

Cockburn Coast has a limited economic catchment due to its location between the ocean to the west and Manning Reserve to the east. The proposed dwellings within the Master Plan Precinct will generate a number of work trips with destinations including Fremantle, Cockburn Central and the industrial areas to the south. Robb Jetty Main Street will be an attractor for some retail, commercial and school trips while the redeveloped Power Station will be an attractor for business and leisure trips from the remainder of the Structure Plan area and the Coogee Marina to the south.

In terms of the Transport assessment, the Power Station as proposed is not a major regional attractor as it only has about 12,000 sqm GFA. The peak hour trip generation rates are applicable to retail and employment floor space. If successful, the Power Station may attract more visitors but it is expect this to be related to the retail / commercial offerings, and to be spread throughout the day. We have identified a site for a potential additional parking station should this be the case.

3. Existing conditions

3.1 Existing land use

The Master Plan Precinct is a former industrial area, housing the South Fremantle Power Station and switchyard. A small number of industrial uses are still in operation to the east of the precinct.

Although the Cockburn Coast area is mainly industrial, the surrounding areas are predominantly urban residential. South of the Power Station is the Port Coogee of South Fremantle, Coogee, Hamilton Hill and Spearwood are existing residential suburbs. The surrounding land use is illustrated on Figure 3.1.

3.2 Existing road network

The existing road network around the site is limited with the main access to the Power Station from McTaggart Cove from Cockburn Road. Access is also provided via Robb Road from Rollinson Road and to the north. Cockburn Road (State Route 12) connects destinations in the south such as Coogee, the Australian Marine Complex at Henderson, the Kwinana Industrial area and Rockingham with Fremantle to the north. Cockburn Road is the primary north – south route for freight and regional traffic. It has a speed limit of 60kph at the northern end and 70kph at the southern end with the transition point located south of the intersection with Emplacement Crescent.

Robb Road runs to the west of the East Fremantle to North Cockburn freight rail line (the freight rail line) from Rollinson Road in the north to Caledonia Loop, intersecting with McTaggart Cove just north of the Power Station. Robb Road provides access to several beach areas, Catherine Point and the CY O'Connor Reserve.

The Power Station is on the western side of the East Fremantle to North Cockburn Freight rail line which has approximately eight trains per day all running outside the peak hours. There are three rail level crossing providing access for vehicles and pedestrians across the freight rail line. Formal at-grade crossings with lights and boom barriers are provided at McTaggart Cove and Rollinson Road. A third temporary crossing has been provided at Old Cockburn Road however this is presently fenced off.

The existing road network is shown in Figure 3.2 which also indicates the location of the two permanent crossings.

Landcorp South Fremantle Power Station Master Plan
- Traffic and parking report

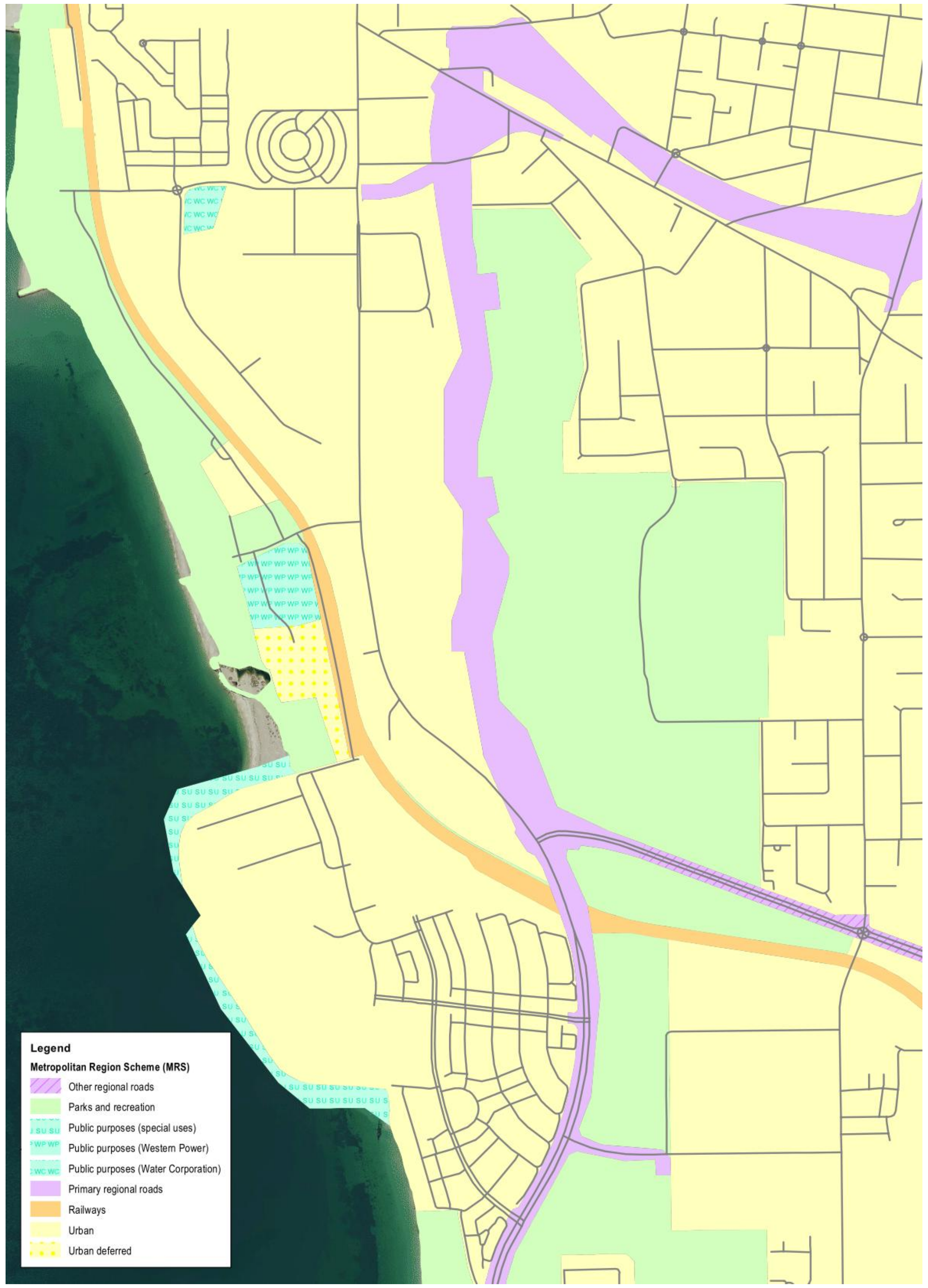


Figure 3.1 Surrounding land use *(Source: Landgate (SLIP, 2014))*

HASSELL
© 2014

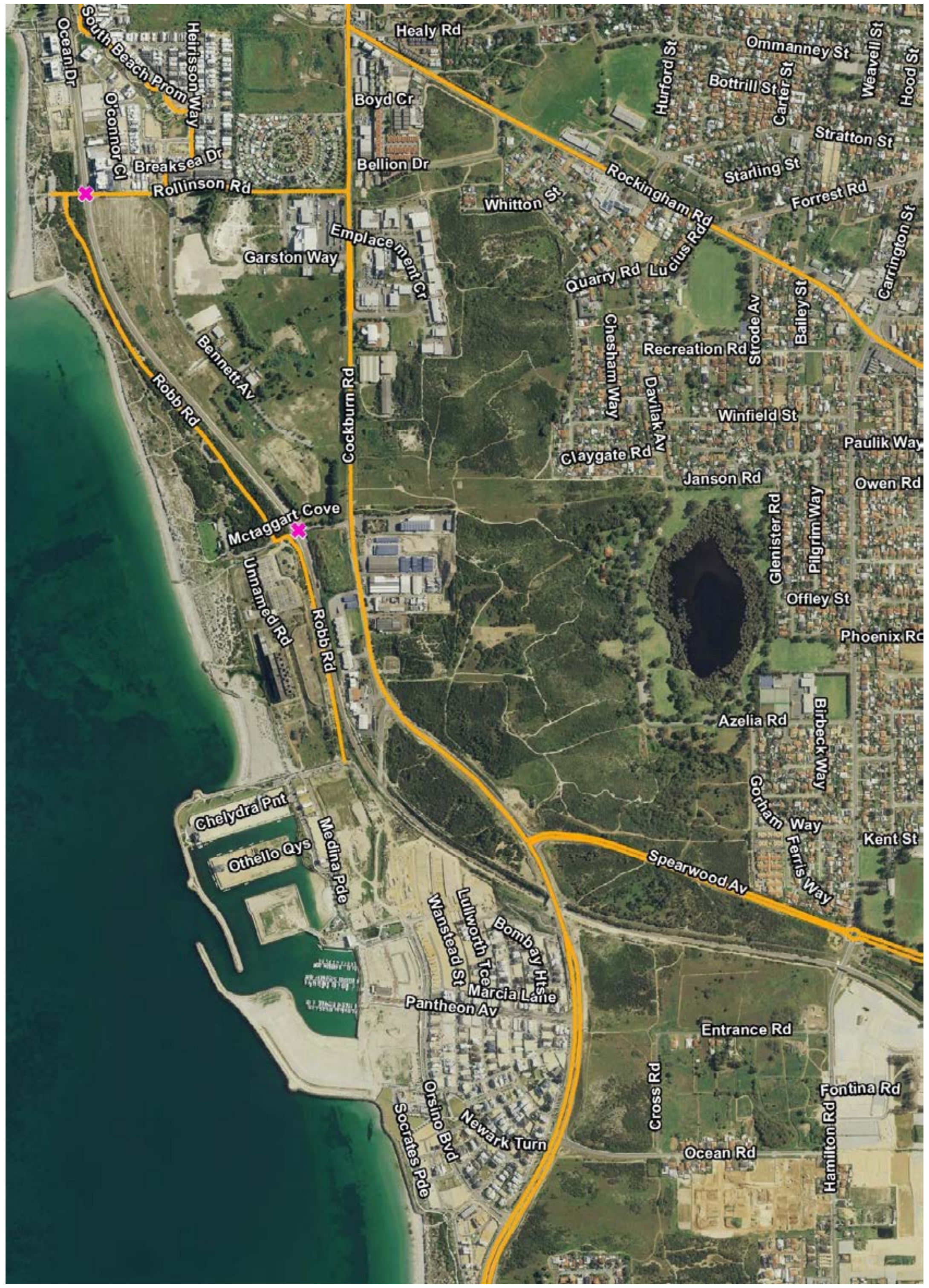


Figure 3.2 Existing road network *(Source: Landgate (SLIP, 2014))*

3.3 Existing pedestrian and cycle networks

The existing pedestrian and cycle facilities within and surrounding the Master Plan Precinct are shown in Figure 3.3. There is a pathway along the western side of Robb Road which extends into the Coogee Marina area via Caledonia Loop. There is also pedestrian access along the beachfront and several formal and informal paths back to Robb Road. McTaggart Cove is the only location where the railway line can be crossed (at-grade) and there is a path to Cockburn Road along the northern side of McTaggart Cove. A pedestrian refuge is provided to allow crossing of Cockburn Road on the north side of the McTaggart Cove intersection.

There is a sealed shoulder on both sides of Cockburn Road to the southern end of the study area whilst a shared pedestrian / cycle path also runs from the south east of the study area along the coast to the northwest. Route SW10 which forms part of the Perth Bicycle Network enters the Cockburn Coast Redevelopment area at Rockingham Road.

Source: *Department of Transport, Perth Bike Map Series, Cockburn*

Figure 3.3 Existing cycle routes and facilities

Landcorp South Fremantle Power Station Master Plan
- Traffic and parking report

3.4 Existing public transport services

The bus services currently operating in the vicinity of the Power Station Master Plan Precinct are illustrated on Figure 3.4 and listed in Table 3.1. The 825 service provides the most convenient transport to / from the Power Station area running north – south along Cockburn Road just to the east of the Master Plan Precinct. This service operates between Fremantle Station and Rockingham Station at a frequency of 2 – 3 buses per hour in each direction. A number of other services operate between Fremantle Station and Cockburn Central Station, or Rockingham Station. These can be accessed by taking the 825 bus north.

Table 3.1 Existing bus frequencies

Service	Route	Frequency
825	Fremantle Station - Hampton Rd. - Cockburn Rd. – Cockburn Rd/Magazine Ct - Rockingham Rd./Macedonia St. - Rockingham Station	Every 20-30 mins
520	Fremantle Station - Hampton Rd.- Rockingham Rd./Carrington St. - Lakes shopping centre - Cockburn Central Station	Every 15-20mins
530/531/ 533	Fremantle Station - Hampton Rd. - Rockingham Rd./ Carrington St.- Marvell Av - Rockingham Rd. - Beeliar Dr/Durnin Av. - Emmanuel Catholic College - Cockburn Central Station	Every 10-15 mins
920	Fremantle Station - South St./Hampton Rd. - Rockingham Rd./Carrington St.- Kwinana Hub Bus Station - Rockingham Station	Every 15-30mins (every 10 mins in the peak)

The 13 minute bus trip makes Fremantle Station the closest rail station to the Power Station area. From Fremantle, Perth Rail station is a 23 minute trip. The overall journey time between the Power Station and the Perth CBD is just over an hour during the peak hours.

Figure 3.4 Bus services and stops (Source: *Transperth*)

HASSELL
© 2014

4. Proposed transport networks

4.1 Proposed road network

The proposed road network was outlined in the ITP and further developed in the Cockburn Coast Local Transport and Traffic Management Strategy to support the DSP No.2. Since finalisation of that report and adoption of the DSP No.2 by the Department of Planning, LandCorp, the Public Transport Authority and Main Roads Western Australia have reached an agreement on the provision of road crossings over the East Fremantle to North Cockburn Freight rail line that requires the McTaggart Cove level crossing to be closed. The removal of the at-grade crossing at McTaggart Cove is required as one of the conditions for the installation of an at–grade crossing at Main Street in the Robb Jetty precinct. The road network proposed in the ITP has been amended to include a horseshoe shaped bridge over the Freight rail line just east of the Master Plan Precinct. It was necessary to incorporate the Power Station bridge to provide suitable access to the Master Plan Precinct. The Power Station bridge will form the main eastern access to the Master Plan Precinct from Cockburn Road.

From the north, the Master Plan Precinct will be accessed via Robb Road which in turn will provide access across the Freight rail at both Main Street and Rollinson Road. Robb Road continues around the east of the Master Plan Precinct and west of the Freight Rail line.

To the south, local traffic access is provided from the Power Station main street to the Port Coogee area via Caledonia Loop.

4.2 Road cross sections

The proposed road cross sections for the Master Plan Precinct are derived from those proposed in the ITP and the Cockburn Coast Local Transport and Traffic Management Strategy. Indicative cross sections for the road network are shown in Figure 4.1 below and the road hierarchy is shown in Figure 4.2. Parking is proposed on one side of the main street and local street cross sections to provide street level activation without an oversupply of parking. The ITP proposed many shared streets throughout the Structure Plan area to ensure good pedestrian and cyclist permeability and to reinforce the sense that this is not a place dominated by cars. Within the Master Plan Precinct, the Main Street to the east of the Power Station is proposed as a shared street as well as the local street leading towards it.

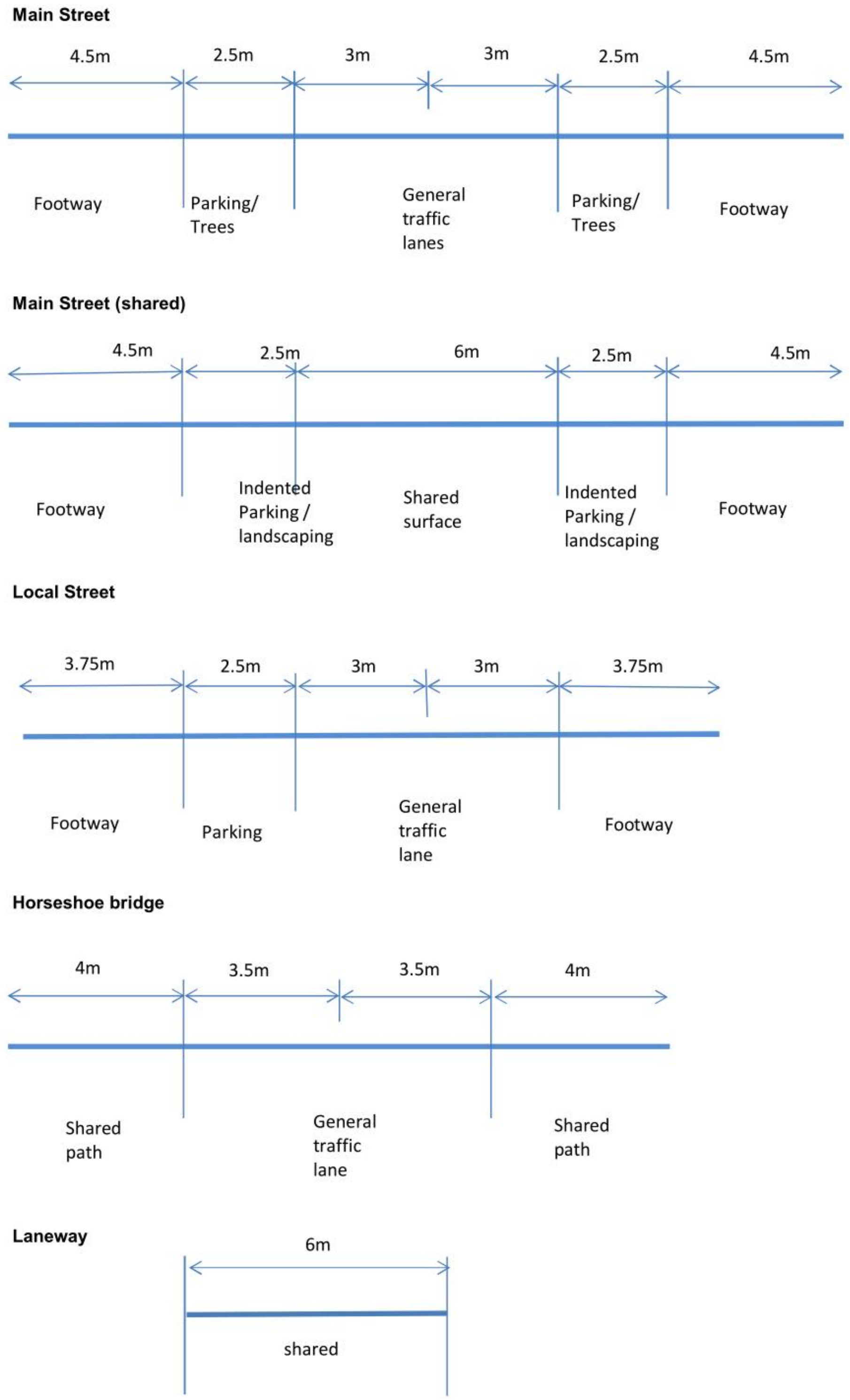


Figure 4.1 Typical cross sections

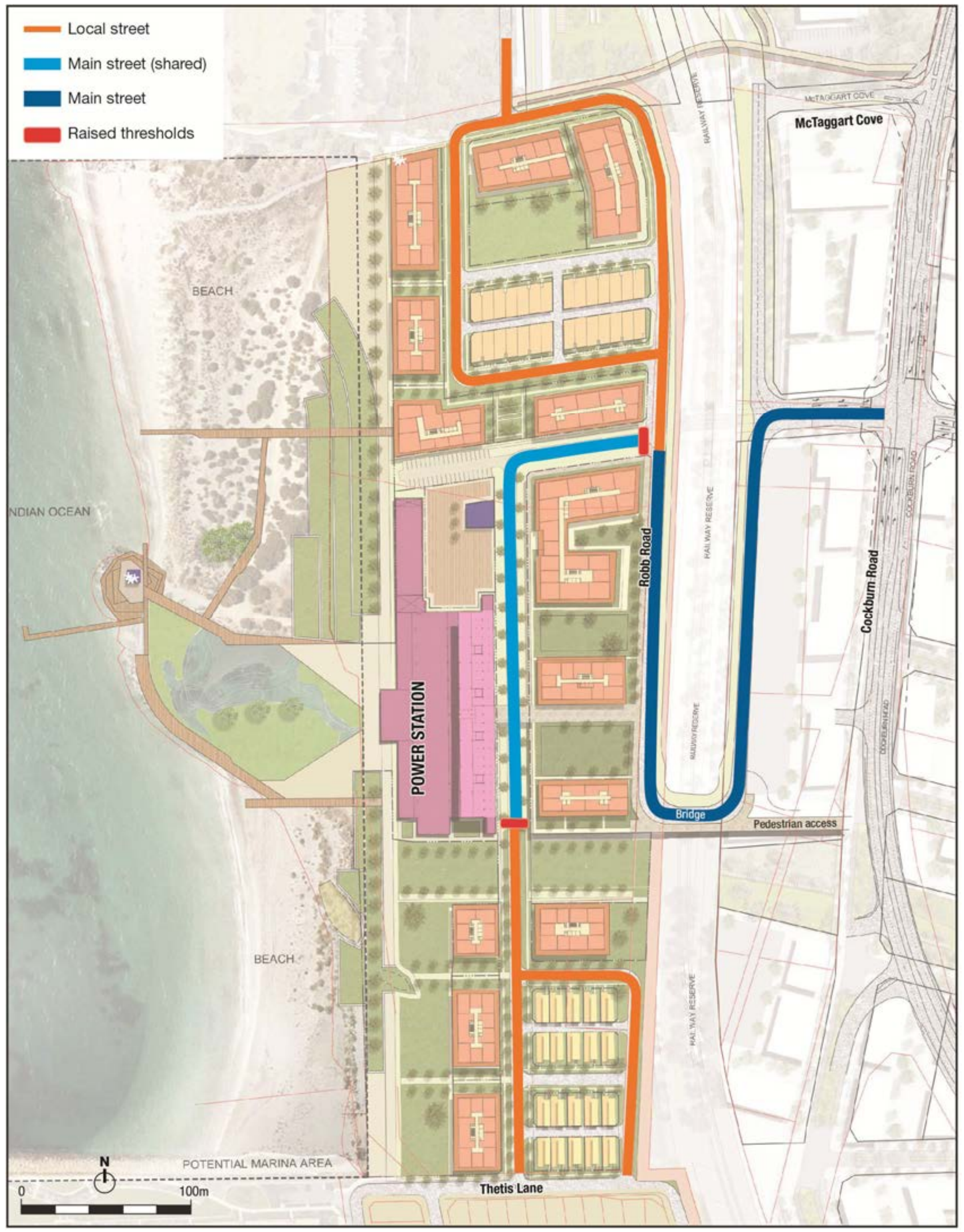


Figure 4.2 Proposed Road Hierarchy

Landcorp South Fremantle Power Station Master Plan
- Traffic and parking report

4.3 Intersections

As can be seen from Figure 4.2, all intersections within the Master Plan Precinct will be T-intersections with Give-way controls. With the relatively low traffic projections for this area, this is a safe and appropriate intersection control.

4.4 Pedestrian and cycle networks

As detailed in the ITP, pedestrian and cycling facilities will be provided within Cockburn Coast to ensure the site is accessible for non-motorised users, whilst helping to minimise traffic flows in the area.

The ITP recommended that priority be given to pedestrians at key street crossings and in the overall design speeds of the streets. A hierarchy for pedestrian movement has been developed to ensure safe and direct access for pedestrians throughout Cockburn Coast. The network will consist of informal tracks to the beach, shared paths, shared streets and piazza spaces for pedestrians.

Within the Master Plan Precinct, the key elements of the active transport network will be the pedestrian promenade along the front of the Power Station building and a shared path from Cockburn Road to the Power Station building with grade separated crossings of the Freight Rail line and the Master Plan Main Street. All streets within the master plan area will have low speed limits (30kph or 10kph) to improve pedestrian safety and reinforce the priority toward pedestrians and cyclists. The pedestrian / cycle network is shown in Figure 4.3 overleaf.

HASSELL
© 2014

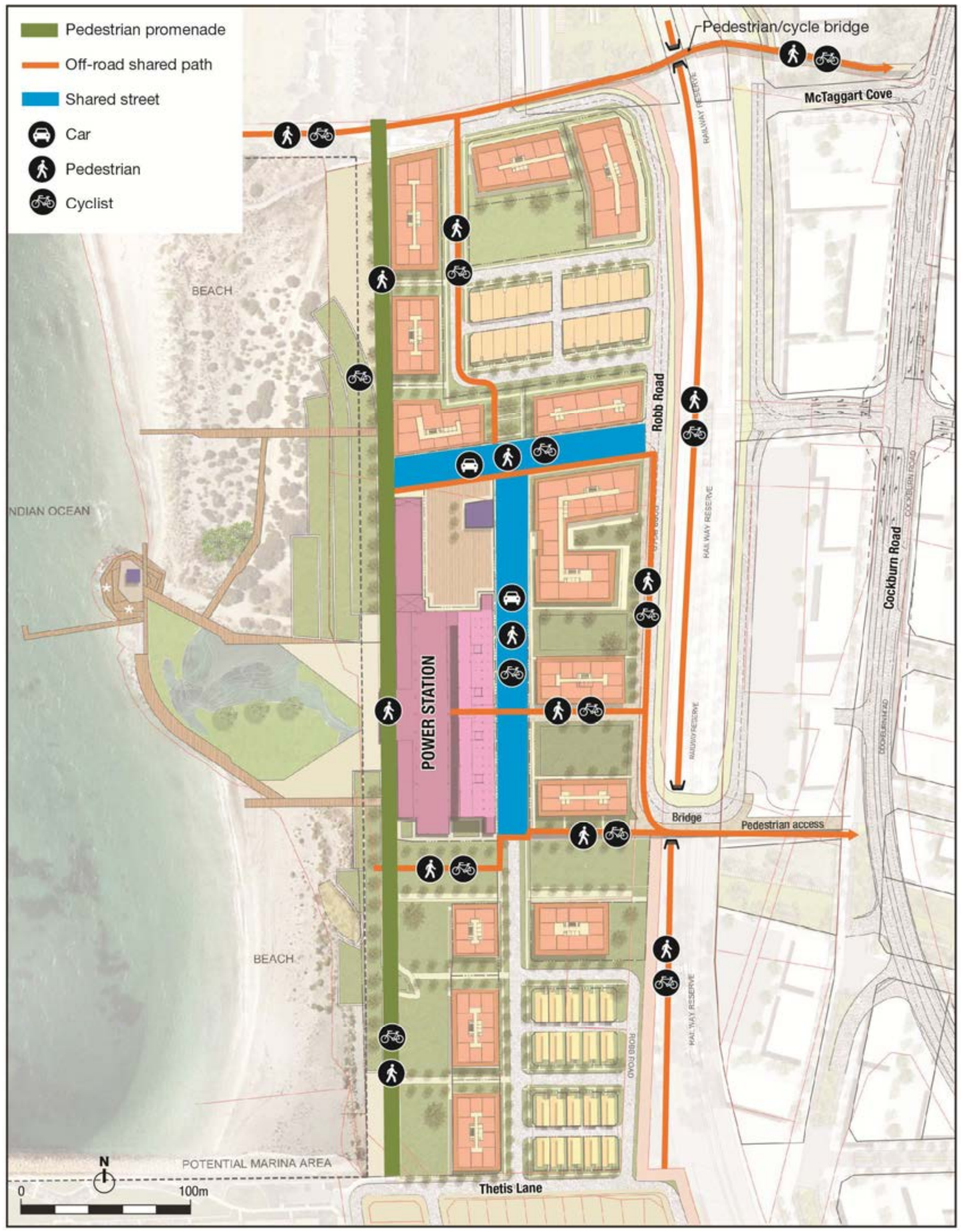


Figure 4.3 Proposed pedestrian and cycle network for the development

4.5 Public transport routes

There will be no scheduled public transport services through the Master Plan Precinct however a Bus Rapid Transit (BRT) corridor will be created along Cockburn Road and through Cockburn Coast, connecting Fremantle to Rockingham. BRT stops will be located close to the two pedestrian bridges across the Freight Rail line to provide good access for public transport trips to and from the Power Station. The proposed BRT is included in the Department of Transport's Draft Public Transport Network Plan and is expected to be constructed in 2016. It will not only provide an excellent level of service towards Fremantle but will also link into other elements of the Department of Transport's draft Public Transport Network Plan (PTNP) to be constructed by 2031 providing and excellent range of public transport trips. Figure 4.4 shows the proposed route and associated bus stops. The closest BRT stop is shown in Figure 4.4 and is approximately within 400-600 metres of the Power Station and will therefore be within walking distance for the majority of the development.

The proposed horseshoe bridge across the Freight Rail line has been designed to accommodate buses passing on the curves so there will be provision for ad hoc bus or coach trips to the Power Station should there be a demand. The bridge and the road network are suitable to support buses should a future local bus service be required.

The local, district and regional services that currently operate in the vicinity will continue to operate.

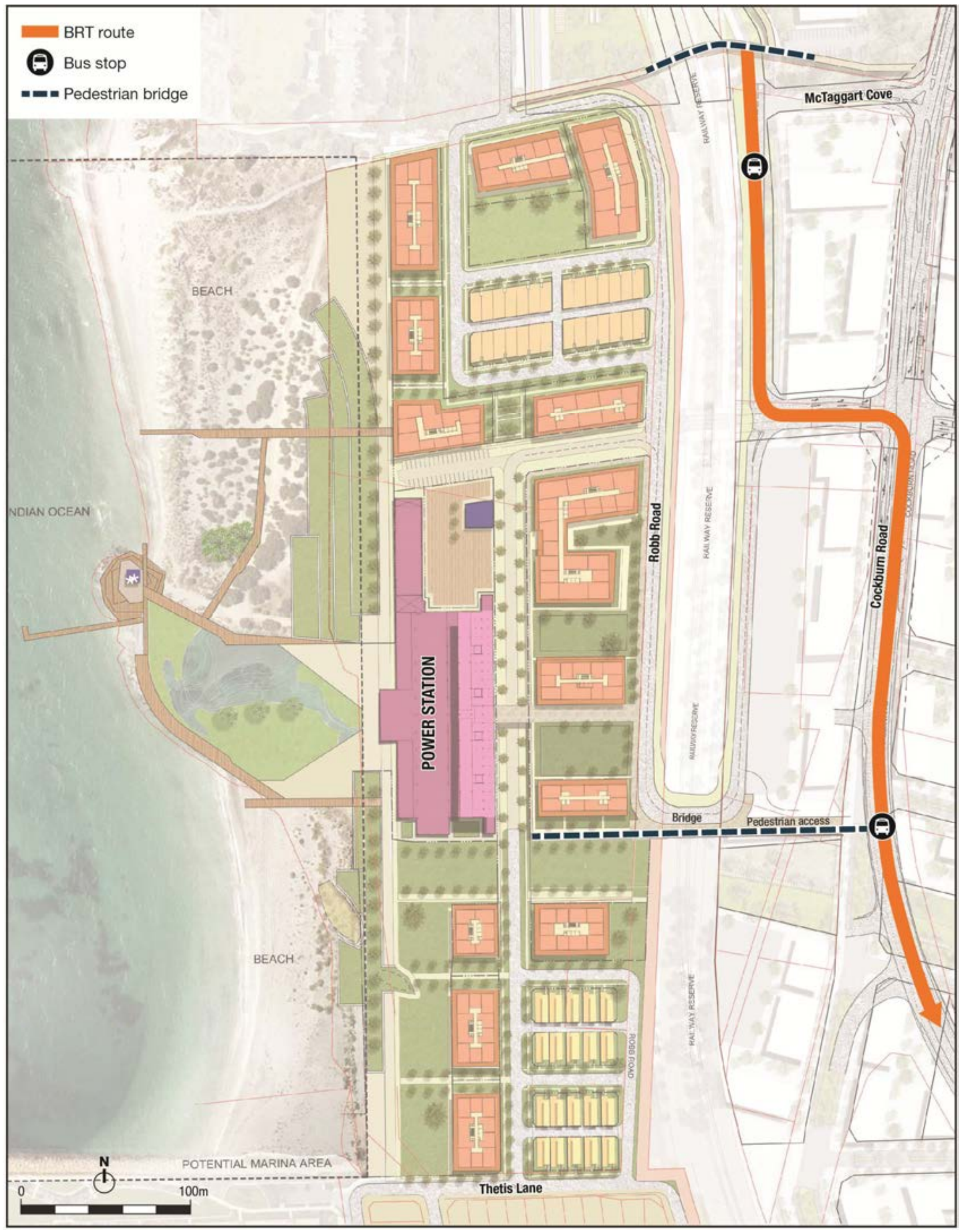


Figure 4.4 Proposed BRT route

Landcorp South Fremantle Power Station Master Plan
- Traffic and parking report

4.6 Changes to existing road network

The proposed road network is an essentially new network to cater for an entirely different land use than occurs at present. The most significant change will be the relocation of the existing McTaggart Cove rail level crossing to the new Robb Jetty Main Street and the introduction of a new bridge access to the Power Station.

South of McTaggart Cove, Robb Road will be elevated to form the western ramp approach to the new bridge rather than continuing through to Thetis Lane. Through traffic between the Robb Jetty precinct and Port Coogee will travel via the new Power Station Main Street although the network will be designed to discourage rat-running.

A preliminary concept drawing has been prepared for the Power Station Access Bridge and is attached in Appendix A.

4.7 Proposed speed limits

In order to achieve the “Foot Power” outcomes described in the ITP, the design speed for streets throughout Cockburn Coast were set at 30 kph or less. All streets within the Master Plan Precinct will have speed limits of 30 kph with the exception of the Shared Main Streets at 10 kph. The 30 kph speed limit will also apply to the Power Station Bridge which has been designed using a design speed of 40 kph.

The proposed speed limits are shown in Figure 4.5 overleaf:

HASSELL
© 2014

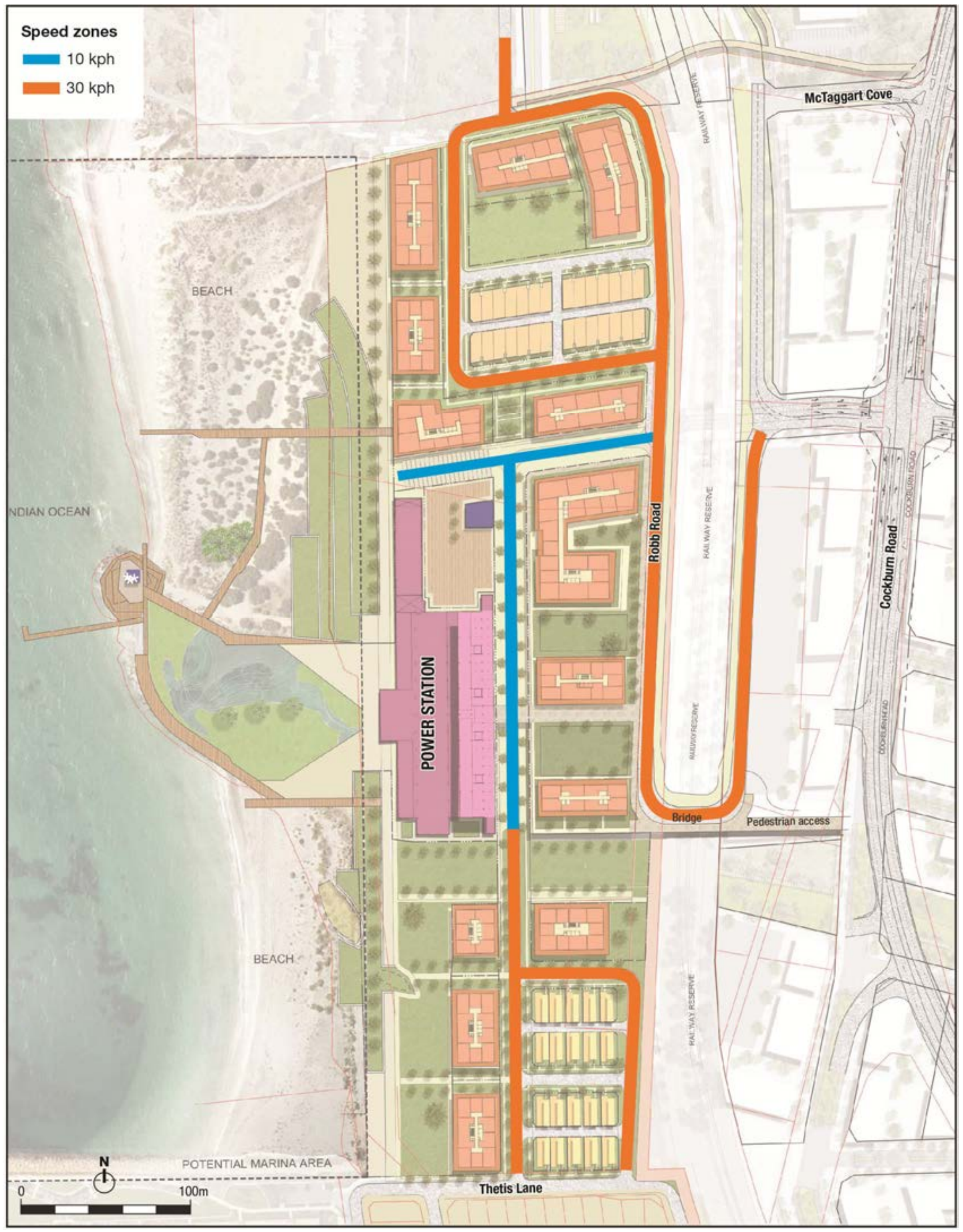


Figure 4.5 Proposed speed limits

5. Integration with surrounding area

5.1 Surrounding attractors / generators

Figure 5.1 indicates the 800 metre catchment from the boundary of the Master Plan Precinct. The major trip attractors and generators are also shown and will include the Main Street of the Robb Jetty precinct, the beach front, the Port Coogee area and the surrounding residential areas. There is also a primary school proposed within the Robb Jetty precinct just to the north of the site, and on the eastern side of the Freight Rail line.

The proposed land uses for the Master Plan Precinct have a larger residential component than was envisaged when the DSP No.2 was assessed and this could impact on employment self-sufficiency resulting in the need for residents to travel further afield for work. Likely destinations for work trips include Fremantle, Murdoch, Perth (via Fremantle), the Australian Marine Complex and Latitude 32. All of these destinations will be accessible via public transport with an excellent service proposed on completion of the BRT.

The residential areas within the 800m perimeter that would be classed as major generators include the Robb Jetty, Port Coogee and the Emplacement precinct. People from these residential areas would be attracted to the beach front, and the commercial / retail uses within the Power Station. The Power Station is expected to attract some visitors from further afield although with the currently proposed land use this would be less than was envisaged when the ITP and DSP No.2 were prepared as there is less commercial floorspace proposed. Visitor trips from further afield (outside the local area) would be expected to be at different times to the commuter peak hours i.e. in the middle of the day or in the evening. If the Power Station Precinct evolves into an Activity Centre in the future leading to an increase in visitors, it is expected that it will be in the off-peak periods that trip generation increases.

Figure 5.1 Key attractors and generators external to the Master Plan Precinct

Landcorp South Fremantle Power Station Master Plan
- Traffic and parking report

5.2 Proposed changes to surrounding land uses

The Master Plan Precinct is within the Cockburn Coast DSP No.2 area which has been assessed in the ITP and the subsequent Traffic and Parking assessment. The traffic flows used for the intersection analyses include the forecast demand based on the DSPNo.2 area including the parts of the Power Station Local Structure Plan outside the Master Plan Precinct.

5.3 Travel desire lines from Cockburn Coast to these attractors / generators

The travel desire lines between each of the attractors and generators are illustrated on Figure 5.2. This illustrates east-west and north-south movements to and from the development. The transport network has been designed to cater for these desirable movements. Trips to/ from Robb Jetty can be made via Robb Road or via the pedestrian overpass and the path network. Trips to / from Port Coogee can be made via the Master Plan Main Street connection to Thetis Ave. Trips via Cockburn Road will use the new Horse Shoe bridge.

5.4 Adequacy of existing transport networks and remedial measures

The existing transport network in the immediate area is not supportive for a development of the scale proposed for the Master Plan Precinct and the impending removal of the existing McTaggart Cove rail level crossing will remove the major point of access. The two lane Robb Road will provide sufficient local road access from the north to the Power Station Precinct and the road network through the Port Coogee precinct provides sufficient local access however the major access will be via Cockburn Road and this will require increased capacity before development in the Power Station Precinct can commence.

The DSP No.2 and the Local Transport and Traffic Management Strategy proposed that Cockburn Road be upgraded to two lanes in each direction with the addition of several new signalised intersections. Analysis showed that the external network would then operate satisfactorily at 2031 with staged development of Cockburn Coast Redevelopment project area

Figure 5.2 Travel desire lines between the Master Plan Precinct and external attractors and generators

6. Transport networks

6.1 Assessment years and time periods

The assessment for this Master Plan Precinct is consistent with the analysis for the DSP No.2 area and is for 2031 with the AM and PM peak hours of 7 – 8 AM, and 5PM – 5PM. Although full completion of the entire Cockburn Coast is unlikely by the year 2031, this is the horizon for which there is available traffic data and details regarding infrastructure provision. Extending the analysis beyond this period would require consideration of a wide range of factors that are not possible to quantify at this time.

6.2 Trip generation

When Master Plan proposed land uses are compared with that used in the DSP No.2 assessment, there is an overall increase in dwellings and retail floor space and a fall in commercial floor space. The change in yield has been used to calculate the change in trip generation over that used in the Cockburn Coast Traffic and Parking assessment. Table 6.1 shows that the Master Plan proposal under consideration results in increased peak hour trips.

Table 6.1 Peak hour trip generation change from Cockburn Coast Transport ASsessment

Land use type	Change in Yield	AM		PM	
	Quantity	in	out	in	out
Dwellings	579	79	236	197	118
Commercial	-4032	-44	-11	-11	-44
Retail	6672	45	11	91	91
		80	**237**	**277**	**165**

6.3 Trip distribution

The trip distribution assumed for the Master Plan Precinct is shown in Table 6.2. This is based on an assessment that the Cockburn Road intersection and bridge overpass will be by far the most attractive route into the site. There are relatively low levels of employment generating uses in both the Master Plan Precinct and the Robb Jetty precinct compared to other destinations across the Perth Metropolitan Area. It is therefore likely that the level of peak hour trips generated to the north and south will be relatively low although there may be some school trips towards Robb Jetty (even though walking will be much more attractive and driving discouraged).

Table 6.2 Peak hour trip distribution

Destination		AM	PM	AM	PM
Robb Jetty	15%	12	35	41	25
Port Coogee	10%	8	24	28	16
Cockburn Road	75%	60	177	207	124

6.4 Assumptions for trip generation of surrounding areas.

The traffic assessment was carried out using the traffic network forecasts outlined in the Local Transport and Traffic Management Strategy. This assumed 85% of the potential yield for the DSP No.2 area would be present upon completion. of the development

An estimate was also made of the likely level of development that would have occurred by 2031 assuming that a large percentage of the Robb Jetty LSP would be developed, while the Emplacement and Power Station LSPs would not be as progressed. The yield projection made the following assumptions on the staging of development by 2031:

- 50% of the Power Station LSP (external to Master Plan Precinct),
- 60% of the Emplacement LSP will be developed,
- 90% of the Robb Jetty LSP will be developed.

For this study, it has been assumed that the Power Station Master Plan Precinct will be fully developed and the resultant additional trips have been added onto the base traffic flows from the earlier study.

6.5 Network traffic flows

The estimated 2031 AM and PM peak hour vehicle trips are shown in Figure 6.1. These have been determined by adding the trip generation increases identified above, to the network traffic flows shown in the Local Transport and Traffic Management Strategy.

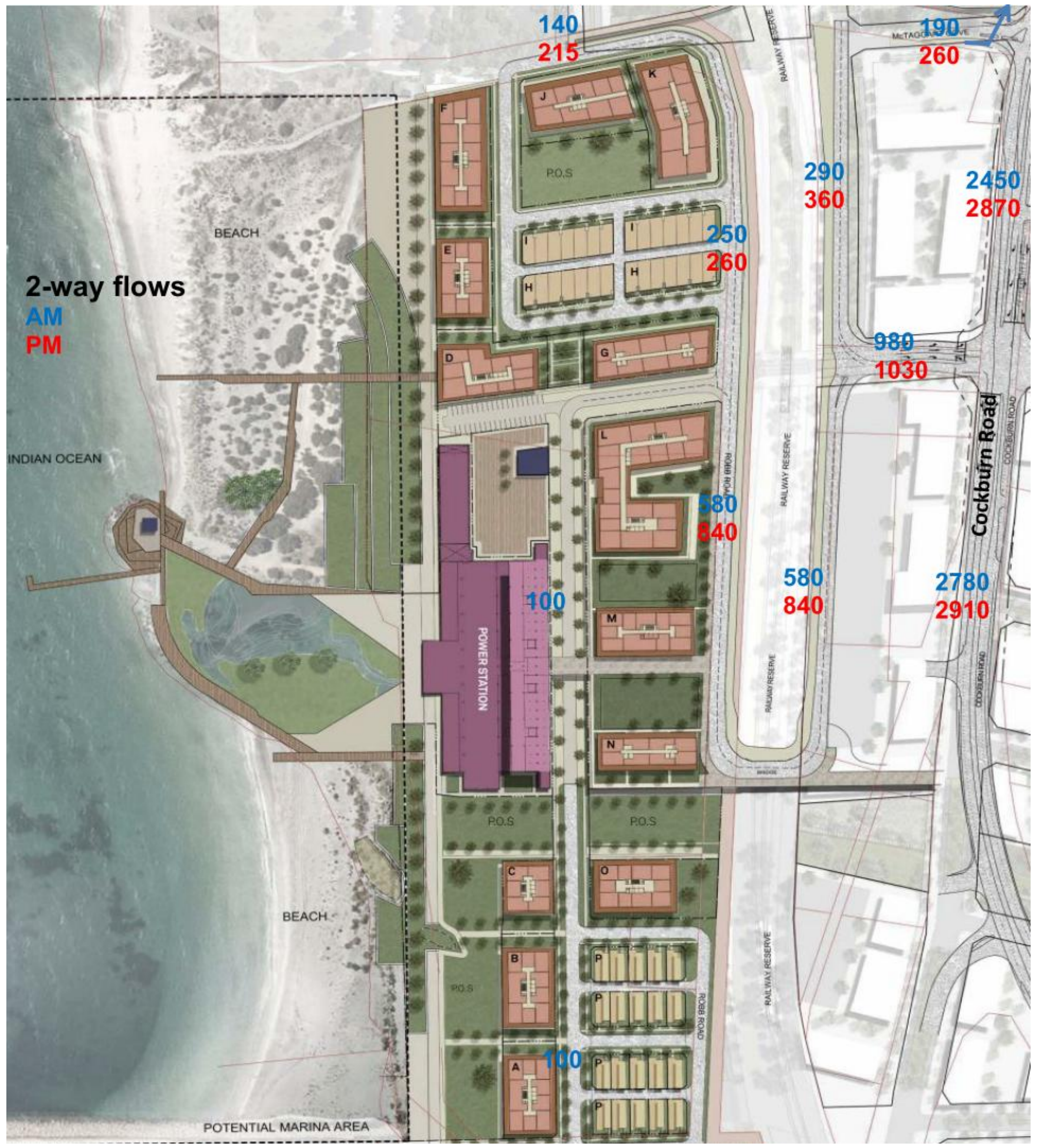


Figure 6.1 Forecast 2031 peak hour flows

6.6 Intersection operation

6.6.1 Cockburn Road / Power Station access

The intersection of Cockburn Road and the Power Station access was previously assessed in the Local Transport and Traffic Management Strategy and found to operate satisfactorily but with minimal spare capacity. Given the slight increase in trip generation identified in 6.2 above, it was necessary to reassess this intersection. The SIDRA intersection program was used to analyse the intersection for the AM and PM peak hours at the planning year of 2031 assuming full development of the Master Plan Precinct. Figures 6.2 and 6.3 provide a summary of the SIDRA analysis with full movement summaries provided in Appendix A.

HASSELL
© 2014

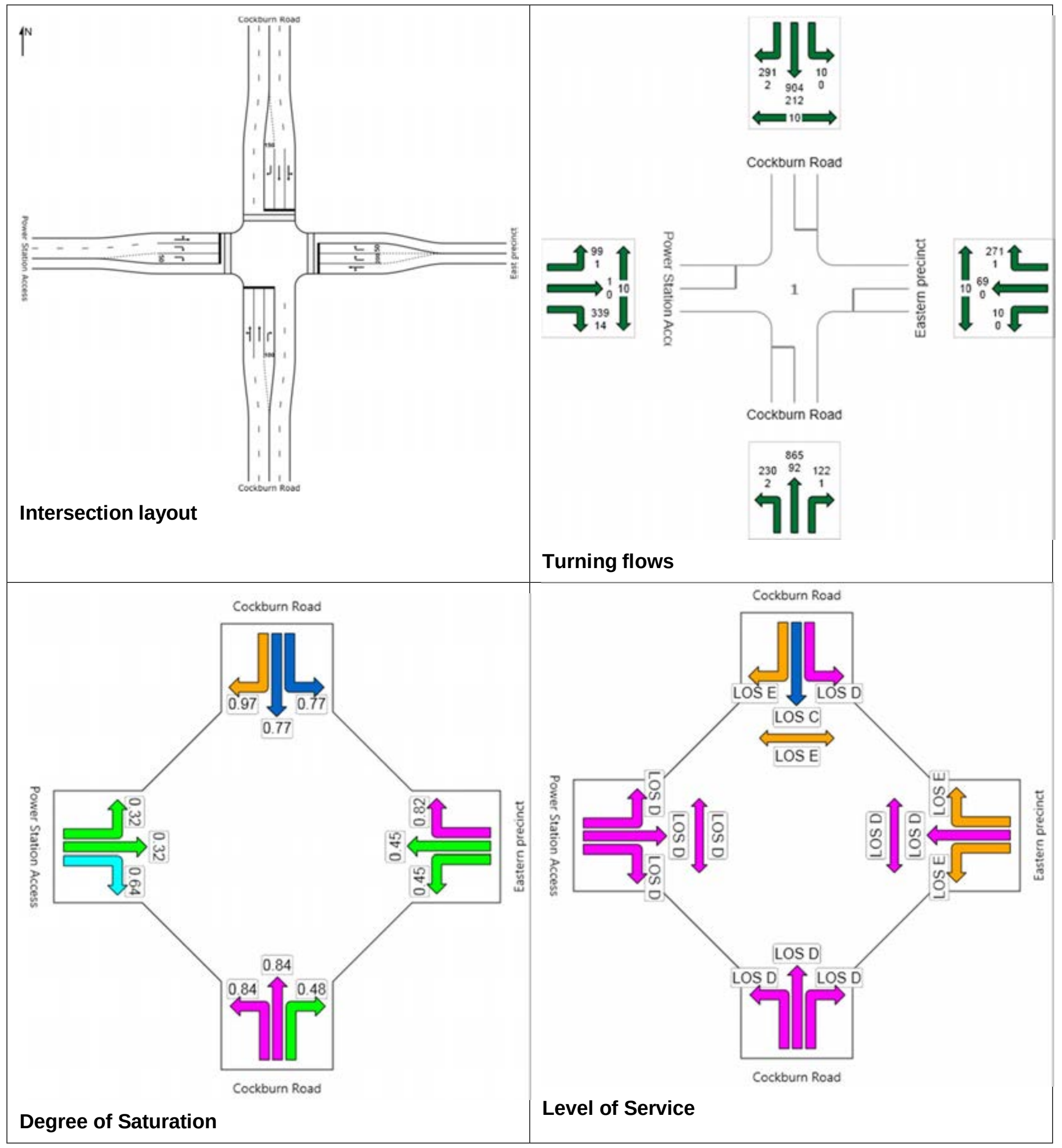


Figure 6.2 Cockburn Rd intersection performance 2031 AM peak, ultimate Master Plan

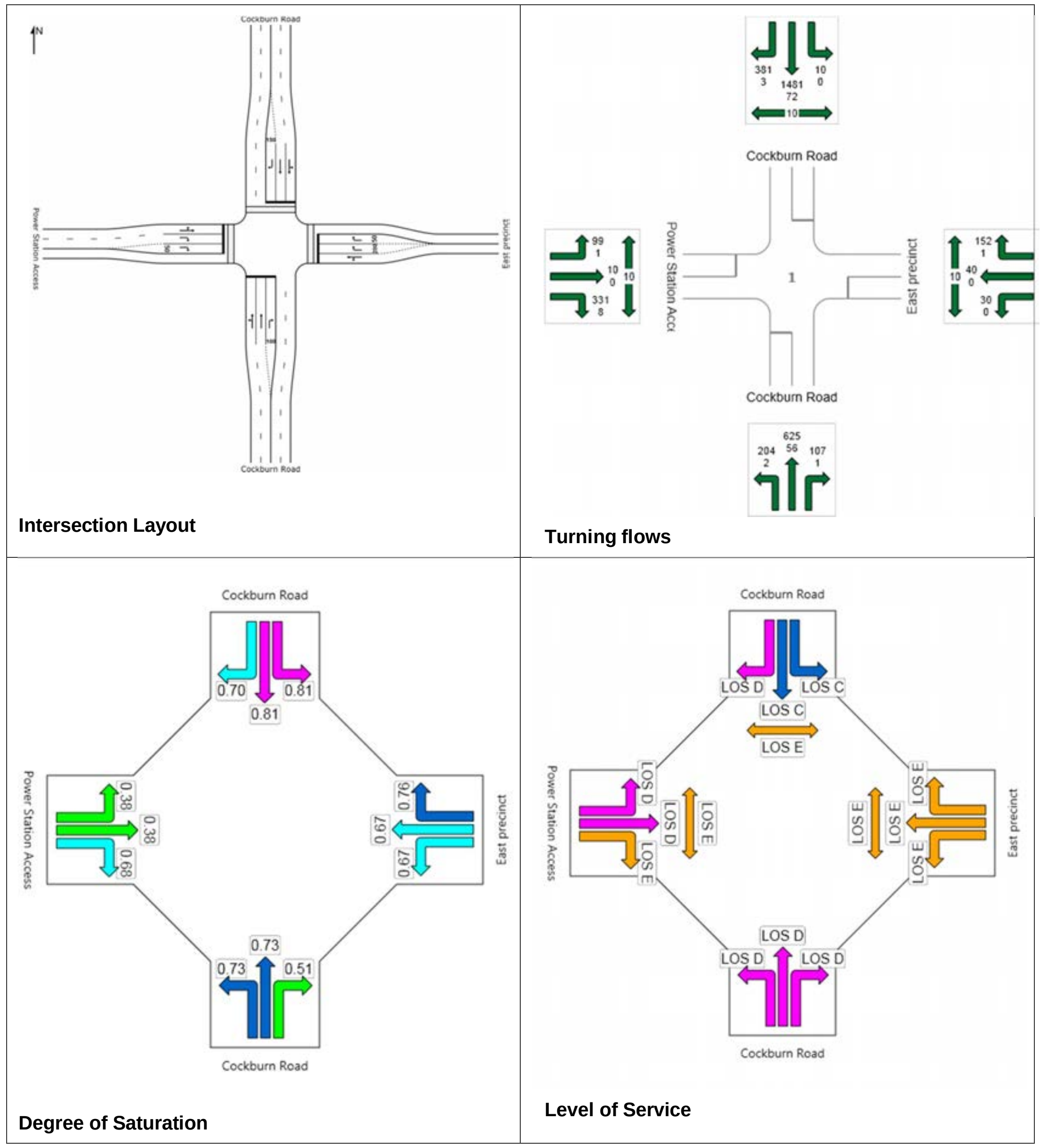


Figure 6.3 Cockburn Road intersection performance 2031 PM peak – ultimate development of Master Plan Precinct

The initial analysis was performed on the intersection layout recommended in the Local Transport and Traffic Management Strategy however SIDRA showed that with the additional traffic identified in Table 6.1 the Power Station Access approach became overloaded. By providing a second right turn lane out from the Power Station and diverting some of the northbound traffic to McTaggart Cove, the overall performance of the intersection became satisfactory in both peak hours. The major strategic movements on Cockburn Road continue to operate at Level of Service D or better which is consistent with the traffic carrying function of the road. The turning movements operate at Level of Service D or E which is reasonable in a busy congested environment. These results are considered appropriate as they indicate that the strategic network will continue to operate whilst not providing so much capacity that car travel becomes the most attractive mode of transport to the Cockburn Coast area.

Due to its proximity to the signalised intersection, an assessment was also made of the T-intersection where the bridge ramp commences east of the freight rail line. This was also carried out in SIDRA and the movement displays are shown in Figures 6.4 and 6.5 below. At the level of traffic expected to be generated by the development in the Master Plan Precinct, the operation of this intersection is excellent with minimal delays and considerable additional capacity available.

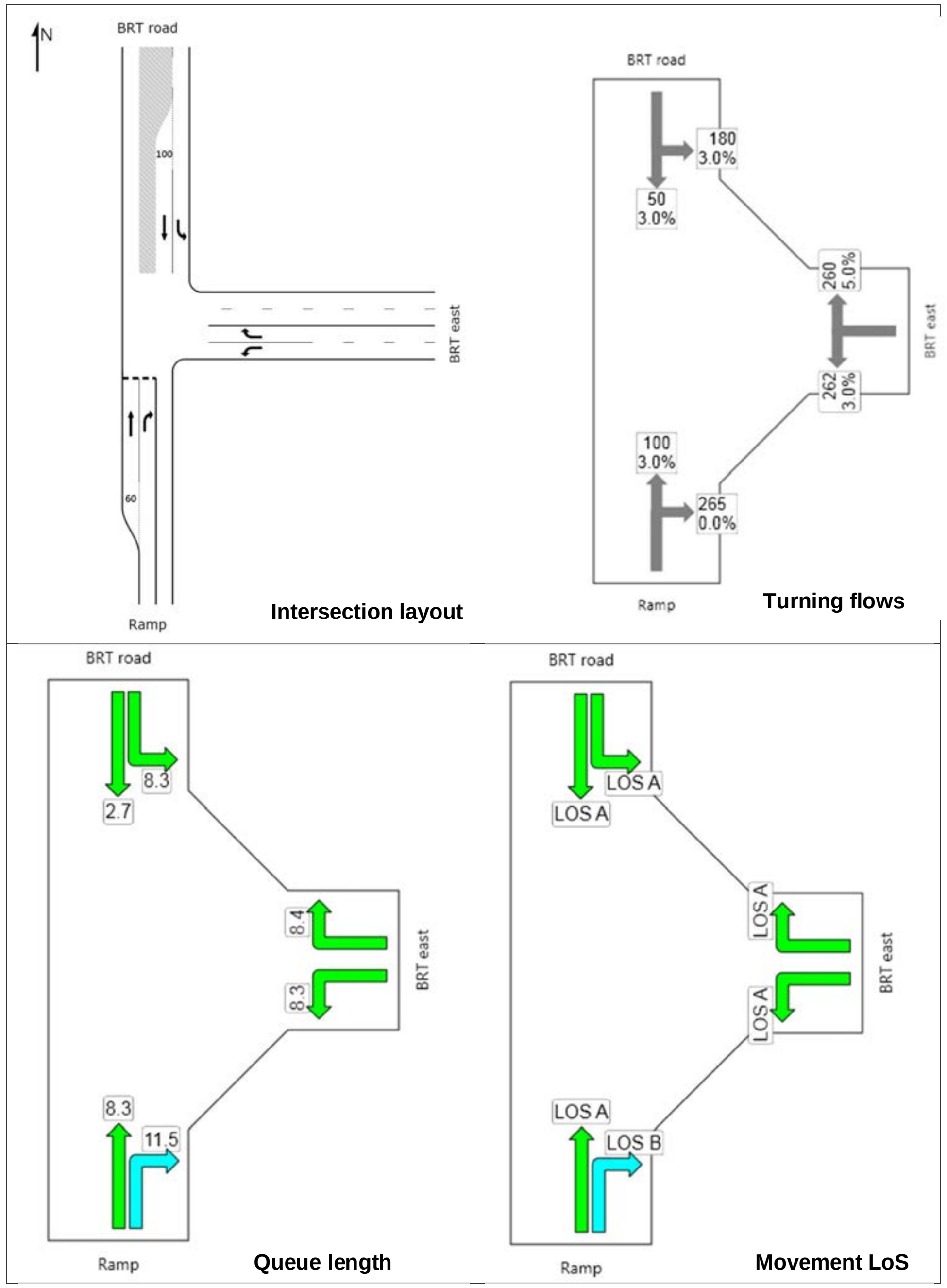


Figure 6.4 Eastern bridge ramp intersection performance 2031 full development AM peak

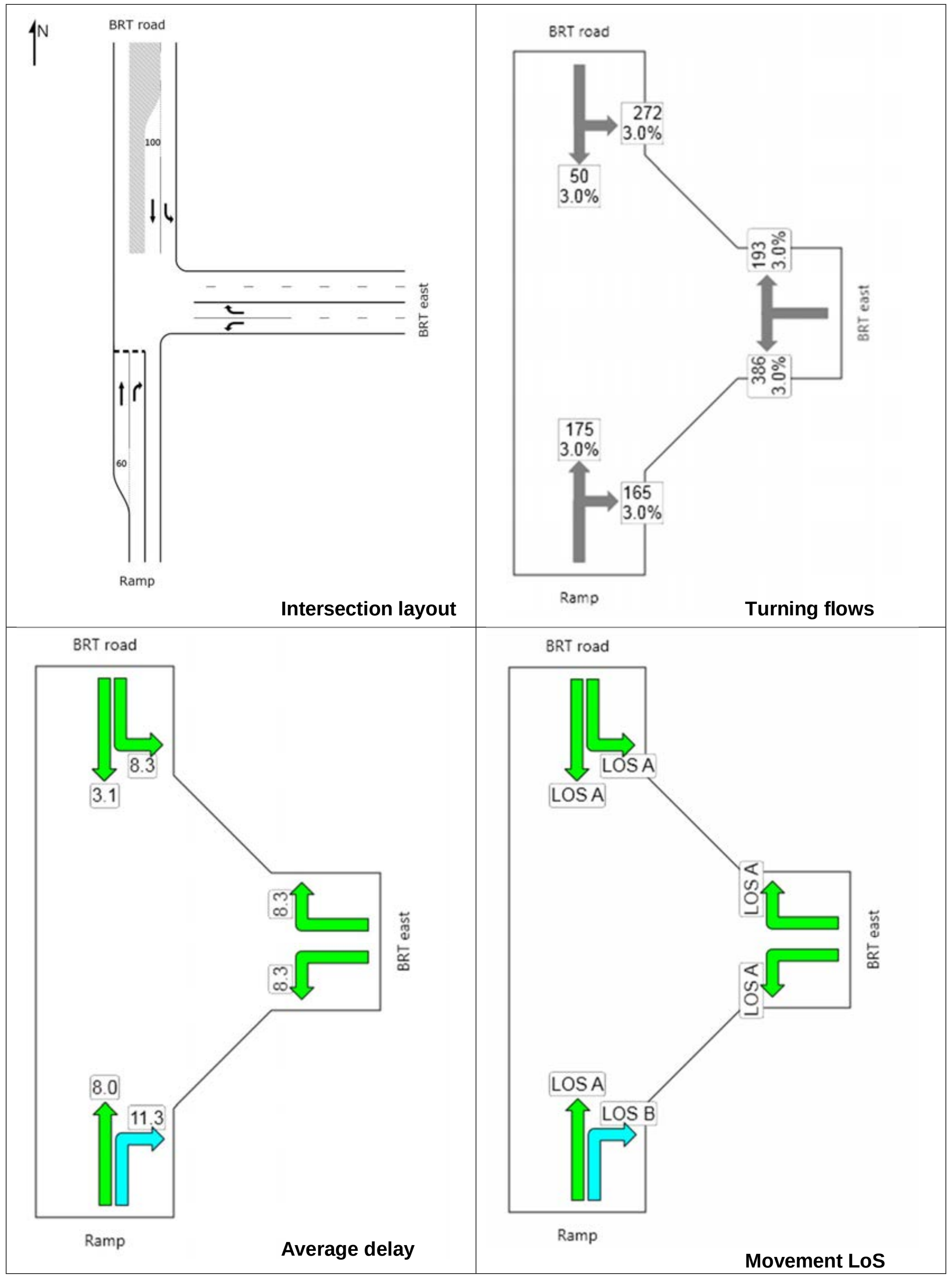


Figure 6.5 Eastern bridge ramp intersection performance 2031 full development PM peak

HASSELL
© 2014

6.7 Frontage access strategy

The only road in the Master Plan Precinct requiring a controlled access strategy is the ramp approach to the Power Station Bridge to the west of the freight rail line. The concept design for the bridge has considered the possible future provision of access to parking stations on both the east and west side of the Freight Rail line. Access to the podium parking station on the western side should be provided closer to the northern end of the podium in the vicinity of building L.

A minor car park access is also proposed on the western side of building L, at the north end of the shared Main Street. It is recommended that no further direct access be proposed off the shared portion of this Main Street as this would detract from the high level of pedestrian amenity that is desirable here.

6.8 Safe walk / cycle to school

The nearest proposed primary school is located to the north of the Master Plan Precinct in the Robb Jetty LSP. Children will be able to use the network of paths and shared streets described above to travel to the north eastern corner of the Master Plan Precinct to access a pedestrian bridge across the Freight Rail line. From here a safe path will be available via the recreation reserve to the school. Figure 6.6 indicates the walk to school from the centre of the Master Plan Precinct.

Figure 6.6 Safe route to school

6.9 Pedestrian permeability

The proposed Master Plan will provide excellent pedestrian permeability within the site. The traditional street layout allows pedestrians many choices and allows the most direct route to be chosen in most cases. Although the Power Station building could have presented a long north south barrier, pedestrian access will be provided through the building to maintain the east –west links right across the Structure Plan area.

6.10 Access to public transport

Access to public transport services is provided via two pedestrian bridges across the Freight Rail line the proposed BRT via the stop at the sports ground; or in Cockburn Road near the end of the pedestrian walkway. The entire Master Plan Precinct is within 400 m of one or other of these stops providing excellent access not only to the BRT but to the future Public Transport Network.

7. Parking

A fundamental strategy within the ITP is to minimise the amount of parking to promote the use of public and active transport. The ITP set out the following rates to be applied throughout Cockburn Coast:

Table 7.1 ITP Maximum parking rates

	Within 400 m Public Transport	Greater than 400 m Public Transport
Residential	1 per dwelling (regardless of size)	1 per dwelling (regardless of size) plus 1 visitor bay per 4 units
Retail / Commercial	1:75 m^2 GFA	1:50 m^2 GFA

It is noted that the DSP No.2 specifies the use of the R-Code Multi Unit Housing Code as the standard for parking for the first 5 years of development. It is expected that development in the Power Station Master Plan Precinct will not commence within the first five years of development within the Cockburn Coast Redevelopment project area and therefore parking rates shown in Table 8.1 will be the applicable rates in this area. The Government's draft Public Transport Network Plan proposes that the Fremantle to Rockingham BRT be operational before 2020 which will mean that the entire Master Plan Precinct will be within 400 m of a high quality public transport route and therefore the first column of Table 7.1 above is applicable. The resulting demand for parking is shown in Tables 7.2 and 7.3 below. Table 7.2 shows the number of spaces to be provided within development lots while Table 7.3 shows the number of spaces that will be provided in the podium car park under lots L, M and N.

Table 7.2 Parking spaces required – located with dwelling

Lot	Dwellings	Rate	Total spaces
A	34	1	34
B	43	1	43
C	22	1	22
D	53	1	53
E	43	1	43
F	58	1	58
G	48	1	48
H	42	1	42
I	42	1	42
J	34	1	34
K	38	1	38
O	48	1	48
P	20	1	20
		TOTAL	525

Table 7.3 Parking spaces required – parking station

Lot	Number	Rate	Total spaces
L	76	1	76
M	53	1	53
N	38	1	38
Power Station			
Dwellings	147	1	147
Commercial (m^2)	5765	1:75	77
Retail (m^2)	6672	1:75	89
		TOTAL	480

HASSELL has undertaken a conceptual review of the available floor space within the podium level of lots L,M and N. Based on an average provision of 30 m^2 per parking space to include manoevering areas and aisles, approximately 535 spaces can be accommodated within two levels of a multi-level parking facility east of the existing Power Station. It is recommended that the access points be provided at the northern end of the car park with the main access from the bridge ramp and a secondary access from the Main Street. This would keep the majority of vehicle turning movements away from the pedestrianized areas closer to the Power Station.

With the level of development proposed, all of the required parking spaces can be provided within the Master Plan Precinct on the west side of the Freight Rail line providing convenient access to destinations. There would remain an opportunity to provide additional parking within a parking station on the east side of the Freight Rail line which could be accessed from the Power Station Bridge. This was originally identified in the Local Transport and Traffic Management Strategy and could be used to provide additional parking if more intense uses are planned in the future as the Master Plan area evolves into an acitivity centre. It is important to limit the parking provision to the maximum rates specified in the ITP to ensure that car trip demand can be minimised and the priority towards active transport maintained.

The proposed parking strategy is shown in Figure 7.1.

HASSELL
© 2014

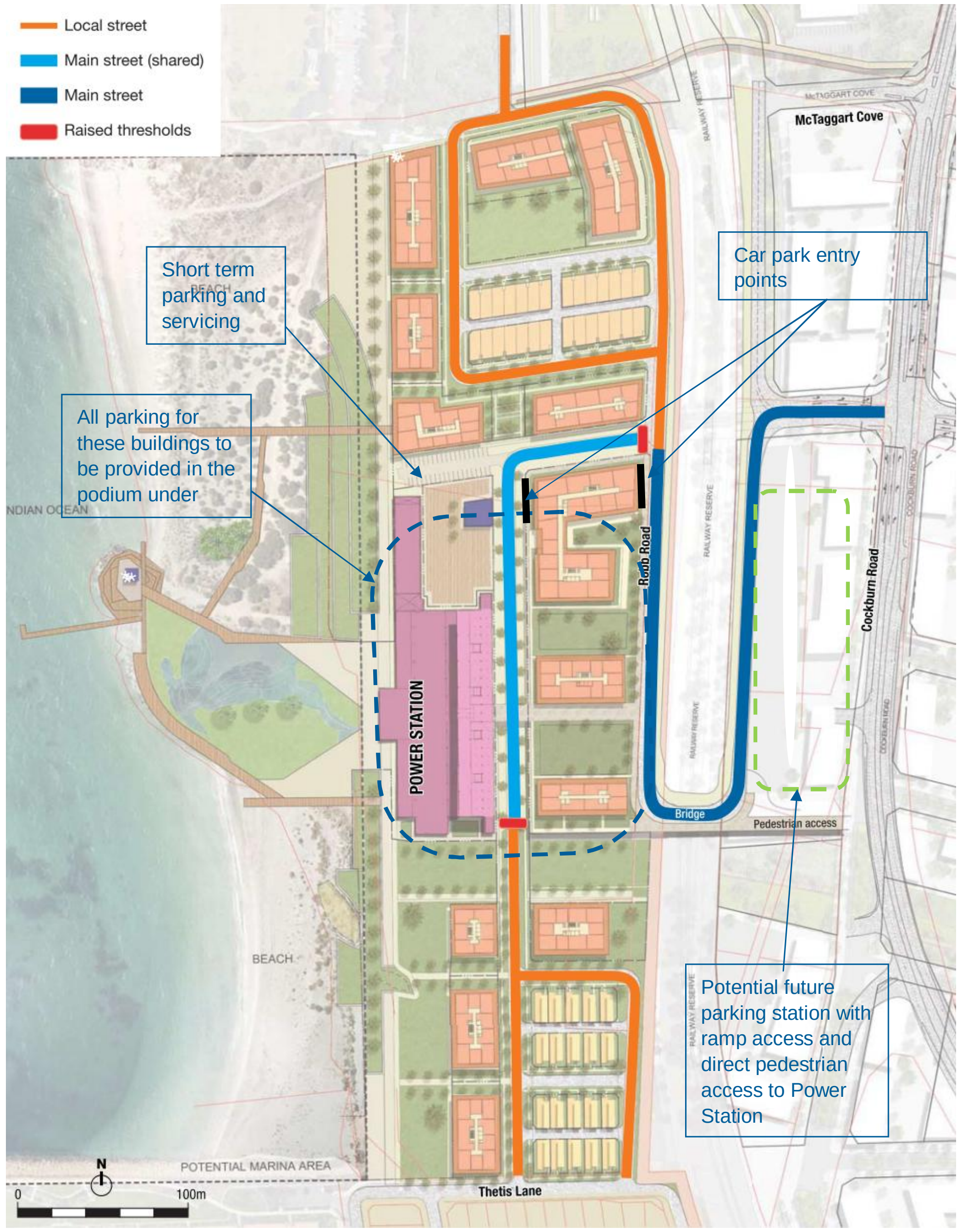


Figure 7.1 Proposed parking locations - Power Station Master Plan

8. Conclusion

This report has considered the transport implications for the proposed South Fremantle Master Plan in the context of the wider Cockburn Coast area and the principles set out in the ITP.

Consistent with the findings of the Local Transport and Traffic Management Strategy, there is congestion in the vicinity of the site and limited road capacity however at the assessment horizon of 2031 it is likely that there will be congestion throughout much of the metropolitan area. It is recommended that a second right turn lane be provided on the western approach to the intersection of the Power Station access with Cockburn Road. The main intersection providing access to the site would operate at a satisfactory level of service and would not unduly impact Cockburn Road.

The proposed active and public transport networks will ensure that the Master Plan Precinct is easily accessible and a desirable place for walking and cycling with the use of cars minimised. An important part of this strategy is the limitation of parking availability, and appropriate rates of parking have been provided.

Appendix A

Development yields plan

	Ground Floor Storeys		Total Dwellings
A	9 dwellings - 4 storeys	=	34
B	9 dwellings - 5 storeys	=	43
C	6 dwellings - 4 storeys	=	22
D	11 dwellings - 5 storeys	=	53
E	9 dwellings - 5 storeys	=	43
F	12 dwellings - 5 storeys	=	58
G	10 dwellings - 5 storeys	=	48
H	14 dwellings - 3 storeys	=	42
I	14 dwellings - 3 storeys	=	42
J	9 dwellings - 4 storeys	=	34
K	10 dwellings - 4 storeys	=	38
L	20 dwellings - 4 storeys	=	76
M	11 dwellings - 5 storeys	=	53
N	8 dwellings - 5 storeys	=	38
O	10 dwellings - 5 storeys	=	48
P	20 single dwelling lots	=	20
Power Station	Mixed Use ground floor 147 apartments - 11 storeys	=	147
	Total Dwellings	=	839

MASTER PLAN CONCEPT_ DWELLING YIELDS

Revision	Date	Scale	Client	Project Name	Drawing
7	7th March 2014	1:1000@A1 1:2000@A3	Landcorp	South Fremantle Power Station, Perth, Australia	140307_3655_Masterplan Concept_ Rendered_Rev 7_ Dwelling Yields

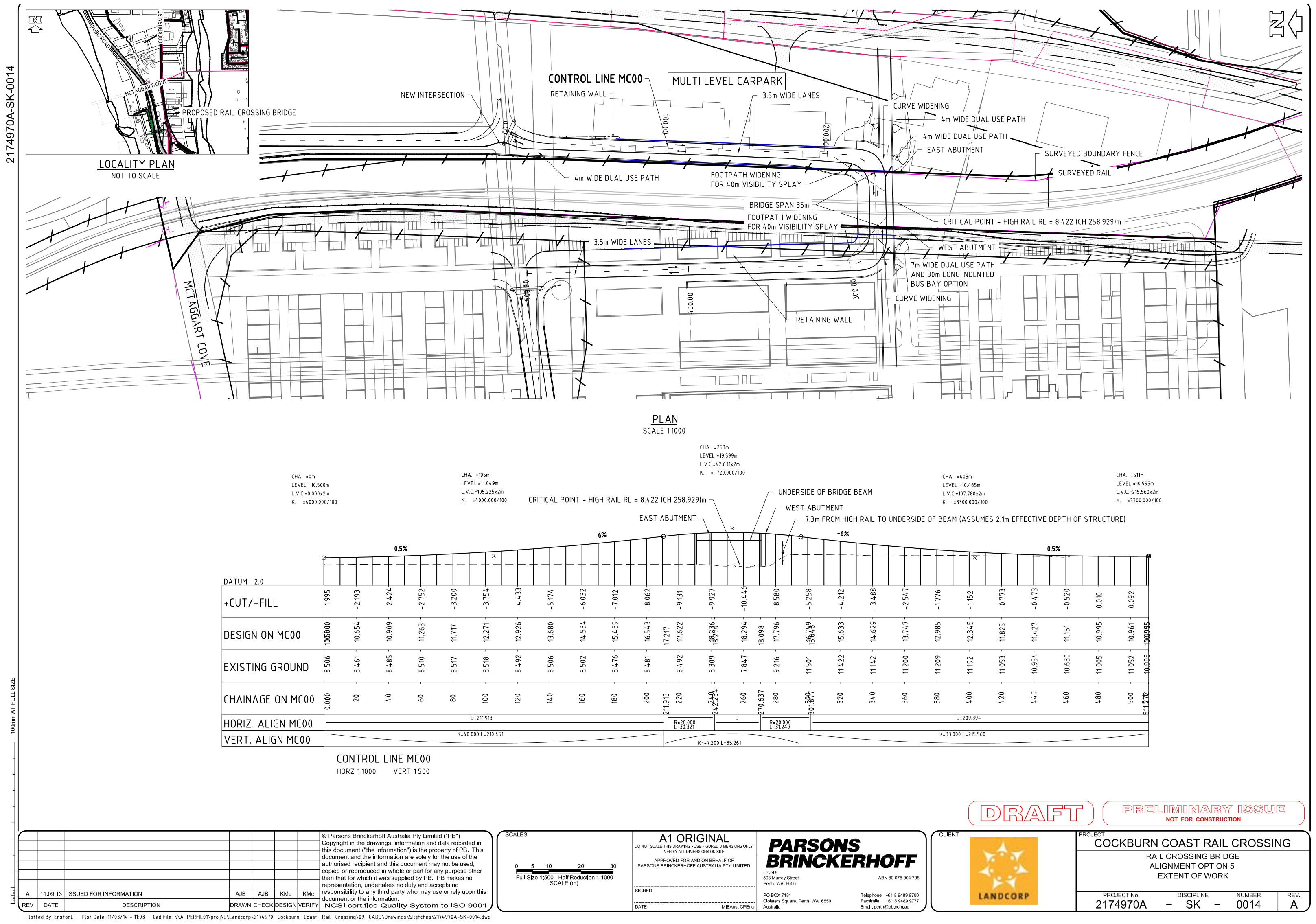
HASSELL

File Path: \\per.work.hassell.info\sites\Projects\003655\Drawings\130924_Revised Masterplan Concept 2_including bridge\Masterplan Concept\Issue 5

HASSELL
© 2014

Appendix B

Power Station access bridge



Appendix C

SIDRA summaries

MOVEMENT SUMMARY

Site: AM 2031 Power Station -2RT Feb25

Power Station Access / Cockburn Road
Signals - Fixed Time   Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Cockburn Road											
1	L	232	0.7	0.838	43.3	LOS D	29.7	218.9	0.97	0.97	28.3
2	T	958	9.7	0.838	35.8	LOS D	29.7	219.1	0.98	0.96	28.6
3	R	123	0.8	0.478	44.4	LOS D	5.7	40.0	0.97	0.82	27.0
Approach		1313	7.3	0.838	38.0	LOS D	29.7	219.1	0.97	0.95	28.4
East: Eastern precinct											
4	L	10	0.0	0.453	57.0	LOS E	3.8	26.9	0.99	0.77	24.3
5	T	69	0.0	0.453	48.9	LOS D	3.8	26.9	0.99	0.76	24.4
6	R	272	0.4	0.816	63.3	LOS E	7.3	51.3	1.00	0.93	21.9
Approach		351	0.3	0.816	60.3	LOS E	7.3	51.3	1.00	0.89	22.4
North: Cockburn Road											
7	L	10	0.0	0.772	36.0	LOS D	24.3	197.5	0.92	0.94	31.9
8	T	1116	19.0	0.772	28.1	LOS C	24.4	198.6	0.92	0.85	32.2
9	R	293	0.8	0.974	74.9	LOS E	17.2	120.9	1.00	1.19	19.6
Approach		1419	15.1	0.974	37.8	LOS D	24.4	198.6	0.94	0.92	28.4
West: Power Station Access											
10	L	100	1.4	0.323	48.4	LOS D	4.4	31.4	0.92	0.78	25.7
11	T	1	0.0	0.323	40.1	LOS D	4.4	31.4	0.92	0.73	26.0
12	R	353	3.9	0.651	51.2	LOS D	9.5	68.4	0.97	0.83	24.9
Approach		454	3.4	0.651	50.6	LOS D	9.5	68.4	0.96	0.82	25.1
All Vehicles		3537	9.2	0.974	41.7	LOS D	29.7	219.1	0.96	0.91	27.2

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P3	Across E approach	11	33.6	LOS D	0.0	0.0	0.82	0.82
P5	Across N approach	11	44.2	LOS E	0.0	0.0	0.94	0.94
P7	Across W approach	11	33.6	LOS D	0.0	0.0	0.82	0.82
All Pedestrians		33	37.1	LOS D			0.86	0.86

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Tuesday, 25 February 2014 11:51:08 AM
SIDRA INTERSECTION 5.1.9.2068
Project: C:\Users\mcdonaldka\Desktop\McTaggart Cove - Cockburn Rd.sip
8000926, PARSONS BRINCKERHOFF AUSTRALIA, ENTERPRISE

Copyright © 2000-2011 Akcelik and Associates Pty Ltd
www.sidrasolutions.com

© 2014

MOVEMENT SUMMARY

Site: PM 2031 Power Station - 2RT
Feb25

Power Station access / Cockburn Road
Signals - Fixed Time Cycle Time = 110 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Cockburn Road											
1	L	206	1.1	0.737	43.5	LOS D	21.7	158.7	0.94	0.88	28.0
2	T	681	8.2	0.737	36.2	LOS D	21.7	158.7	0.95	0.84	28.5
3	R	108	0.9	0.512	49.9	LOS D	5.7	40.3	0.99	0.83	25.3
Approach		995	6.0	0.737	39.2	LOS D	21.7	158.7	0.95	0.85	28.0
East: East precinct											
4	L	30	0.8	0.674	68.3	LOS E	4.0	28.3	1.00	0.81	21.3
5	T	40	0.0	0.674	60.1	LOS E	4.0	28.3	1.00	0.81	21.4
6	R	153	0.5	0.758	69.9	LOS E	4.5	31.6	1.00	0.86	20.5
Approach		223	0.5	0.758	68.0	LOS E	4.5	31.6	1.00	0.84	20.8
North: Cockburn Road											
7	L	10	0.0	0.811	33.1	LOS C	35.6	259.2	0.90	0.95	33.2
8	T	1554	4.7	0.811	25.2	LOS C	35.8	260.6	0.90	0.84	33.7
9	R	384	0.8	0.708	35.6	LOS D	14.8	104.0	0.95	0.87	30.3
Approach		1948	3.9	0.811	27.3	LOS C	35.8	260.6	0.91	0.85	33.0
West: Power Station Access											
10	L	100	1.0	0.384	54.3	LOS D	5.4	38.3	0.94	0.79	24.1
11	T	10	0.0	0.384	46.1	LOS D	5.4	38.3	0.94	0.75	24.4
12	R	339	2.3	0.680	57.2	LOS E	10.2	72.5	0.98	0.84	23.3
Approach		449	2.0	0.680	56.3	LOS E	10.2	72.5	0.97	0.82	23.5
All Vehicles		3615	4.0	0.811	36.7	LOS D	35.8	260.6	0.94	0.84	29.0

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P3	Across E approach	11	40.2	LOS E	0.0	0.0	0.85	0.85
P5	Across N approach	11	49.2	LOS E	0.0	0.0	0.95	0.95
P7	Across W approach	11	40.2	LOS E	0.0	0.0	0.85	0.85
All Pedestrians		33	43.2	LOS E			0.88	0.88

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Tuesday, 25 February 2014 11:52:44 AM
SIDRA INTERSECTION 5.1.9.2068
Project: C:\Users\mcdonaldka\Desktop\McTaggart Cove - Cockburn Rd.sip
8000926, PARSONS BRINCKERHOFF AUSTRALIA, ENTERPRISE

Copyright © 2000-2011 Akcelik and Associates Pty Ltd
www.sidrasolutions.com

SIDRA INTERSECTION

Australia

Adelaide
HASSELL
Level 5
70 Hindmarsh Square
Adelaide SA
Australia 5000
T +61 8 8220 5000
E adelaide@hassellstudio.com

Brisbane
HASSELL
36 Warry Street
Fortitude Valley QLD
Australia 4006
T +61 7 3914 4000
E brisbane@hassellstudio.com

Melbourne
HASSELL
61 Little Collins Street
Melbourne VIC
Australia 3000
T +61 3 8102 3000
E melbourne@hassellstudio.com

Perth
HASSELL
Podium Level, Central Park
152 – 158 St Georges Terrace
Perth WA
Australia 6000
T +61 8 6477 6000
E perth@hassellstudio.com

Sydney
HASSELL
Level 2
Pier 8/9, 23 Hickson Road
Sydney NSW
Australia 2000
T +61 2 9101 2000
E sydney@hassellstudio.com

China

Beijing
HASSELL
Building A7
50 Anjialou
ChaoYang District
Beijing 100125 China
T +8610 5126 6908
E beijing@hassellstudio.com

Hong Kong SAR
HASSELL
22F, 169 Electric Road
North Point Hong Kong SAR
T +852 2552 9098
E hongkong@hassellstudio.com

Shanghai
HASSELL
Building 8 Xing Fu Ma Tou
1029 South Zhongshan Road
Huangpu District
Shanghai 200011 China
T +8621 6887 8777
E shanghai@hassellstudio.com

Shenzhen
HASSELL
1212, Landmark
4028 Jintian Road
Futian District
Shenzhen 518035 China
T +86755 2381 1838
E shenzhen@hassellstudio.com

South East Asia

Bangkok
HASSELL
Unit 4A 17F Paso Tower
88 Silom Road
Suriyawongse Bangrak
Bangkok 10500 Thailand
T +66 2231 6399
E bangkok@hassellstudio.com

Singapore
HASSELL
17A Stanley Street
068736 Singapore
T +65 6224 4688
E singapore@hassellstudio.com

United Kingdom

Cardiff
HASSELL
4th Floor, James William House
9 Museum Place
Cardiff CF10 3BD United Kingdom
T +44 29 2072 9071
E cardiff@hassellstudio.com

London
HASSELL
Level 2, Morelands
17 – 21 Old Street
Clerkenwell
London EC1V 9HL United Kingdom
T +44 20 7490 7669
E london@hassellstudio.com

\\per.work.hassell.info\sites\Projects\003655\Reports\140609_003655_South_Fremantle_Power_Station_City_Changes\140618_South Fremantle Power Station Master Plan_Including_city_changes.indd