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Carnarvon Fascine Wall Independent Review

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R972 Rev 1

December 2017

Department of Primary Industries and Regional Development

Carnarvon Fascine Wall Independent Review

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1. Introduction

The Shire of Carnarvon has recently completed several projects to revitalise the Carnarvon Fascine and the Town Centre. These projects were funded by the Royalties for Regions program. A major component of this work was the redevelopment of the foreshore along the Carnarvon Fascine including the installation of a new steel sheet pile wall to provide coastal protection to the development. The location of this wall is shown in the following aerial photograph.

Figure 1.1 Location Diagram

The sheet pile wall was installed in two separate stages. The first stage was approximately 90m at the northern end of the site and the second stage was approximately 700m extending to the south. Photographs showing the wall in October 2017 are provided in the following figures.

Figure 1.2 Photographs of the Fascine Wall (October 2017)

Since construction, the wall has experienced significant corrosion of the steel sheet piles, which has raised concerns over the durability of the structure. To address these concerns the Western Australian State Government, through the Department of Primary Industries and Regional Development (DPIRD) sought an independent structural engineering assessment of the Royalties for Regions funded wall. This assessment will be used to assist in planning maintenance, future works and informing the community.

To carry out the independent assessment DPIRD engaged specialist coastal engineers, M P Rogers & Associates Pty Ltd (MRA).

The objectives of the assessment were to confirm:

- The current condition of the steel sheet pile system based on above and below water inspection and physical thickness testing.
- The useful life of the structure if no maintenance is carried out.
- A 10 and 20 year maintenance strategy, program and cost estimate including the maintenance and repair strategy for the current structure. The program shall include individual cost estimates for executing the maintenance for the asset. The program shall identify the future and estimated reactive maintenance requirements and inspections required to ensure that the asset remain well maintained, safe and operational for the purpose for which it is intended. It is also a requirement that an overall program shall be produced, which clearly summarises on an annual and cumulative basis the overall maintenance requirements and total cost estimate for maintaining the asset over a ten-year and twenty-year period.

In addition, DPIRD sought an independent opinion on:

- The assessment of the suitability of the material used in the current steel sheet pile system.
- A comparative assessment of currently used or appropriate alternative (which could have been used) material. The specifications of appropriate steelwork (and associated treatments) that could have been used in the construction of the Carnarvon Fascine Wall. eg steel work could be XXmm rather than YYmm as optimal design thickness.
- The maintenance strategy (for 10 and 20 years), program and estimated cost and life expectancy on the appropriate steelworks (and associated treatments).
- The specifications for appropriate structural material, design and maintenance strategy for the Carnarvon Fascine Wall.

This report presents the findings from the independent structural assessment.

2. Sheet Pile Wall Design & Background Information

Despite several attempts only limited information was able to be obtained regarding the design, procurement and construction of the Carnarvon Fascine Wall. The following documents were provided to MRA from the Shire of Carnarvon:

- Design drawings prepared by Cardno dated February 2013.
- Photographs of the sheet pile wall construction from July to November 2013.
- Architectural drawings prepared by Alexander Planning Consultants dated March and July 2015.

A list of the drawings is provided in the following tables and copies are included in Appendix A.

Table 2.1 Cardno Design Drawings

Drawing No.	Rev	Date	Drawing Title
E12002-001-CV1	0	7/2/13	Fascine Wall – Cover Sheet and Drawing List
E12002-001-FW01	0	7/2/13	Fascine Wall – Proposed Alignment – Plan Chn. -18.5 – 200m Sheet 1 of 4
E12002-001-FW02	0	7/2/13	Fascine Wall – Proposed Alignment – Plan Chn. 220 – 430m Sheet 2 of 4
E12002-001-FW03	0	7/2/13	Fascine Wall – Proposed Alignment – Plan Chn. 430 – 640m Sheet 3 of 4
E12002-001-FW04	0	7/2/13	Fascine Wall – Proposed Alignment – Plan Chn. 640 – 900m Sheet 4 of 4
E12002-001-FW05	0	7/2/13	Fascine Wall – Proposed Alignment – Longitudinal Profile
E12002-001-FW06	0	7/2/13	Fascine Wall – Proposed Alignment – Cross Sections Chn. -18.5 – 300m Sheet 1 of 3
E12002-001-FW07	0	7/2/13	Fascine Wall – Proposed Alignment – Cross Sections Chn. 320 – 620m Sheet 2 of 3
E12002-001-FW08	0	7/2/13	Fascine Wall – Proposed Alignment – Cross Sections Chn. 640 – 680m Sheet 3 of 3
E12002-001-M1	1	12/2/13	Fascine Wall – Sheet Piling – Cross Section and Typical Details
E12002-001-SD1	0	7/2/13	Fascine Wall – Standard Details Sheet 1 of 2
E12002-001-SD1	0	7/2/13	Fascine Wall – Standard Details Sheet 2 of 2

Table 2.2 Alexander Planning Consultants – Architectural Drawings

Drawing No.	Rev	Date	Drawing Title
A00	D	8/7/15	Title Drawing and Key Plan
A01	D	8/7/15	Plan of Fascine Walk
A02	H	29/7/15	Plan of Fascine Walk / Jetty 1
A03	D	8/7/15	Plan of Fascine Walk
A04	G	23/7/15	Plan of Fascine Walk / Jetty 2
A05	D	8/7/15	Plan of Fascine Walk
A06	D	8/7/15	Plan of Fascine Walk
A07	D	8/7/15	Plan of Fascine Walk
A08	D	8/7/15	Plan of Fascine Walk
A09	D	8/7/15	Plan of Fascine Walk / Jetty 3
A010	H	29/7/15	Plan of Fascine Walk
A011	D	8/7/15	Plan of Fascine Walk
A012	A	30/3/15	Jetty 2 & Ramps – Plan and Elevations
A013	A	30/3/15	Jetty 2 & Ramps – Plan and Sections
A014	A	30/3/15	Jetty 2 & Ramps – Elevation and Sections

Note: 1. There were a number of other drawings (A015 – A022, L01 – L11) which were provided to MRA but are not relevant to the sheet pile wall review.

From this information, and advice provided by David Neilson at the Shire of Carnarvon, it appears that the construction of the wall occurred in the following stages.

- Stage 1 was approximately 90m at the northern end of the site which was constructed by Curnow Group Pty Ltd. No design drawings were available for this section of wall.
- Stage 2 was the remainder of the wall which was constructed by In Situ Construction & Maintenance Pty Ltd. This work appears to have been completed in mid to late 2013.
- The landscaping works and jetty structures were also constructed by In Situ Construction & Maintenance under a design and construction contract which appears to have been completed in 2015.

From the Cardno design drawings the steel sheet piles were specified as AZ14-770 sheets. The design dimensions of these sheets are shown in the following figure.

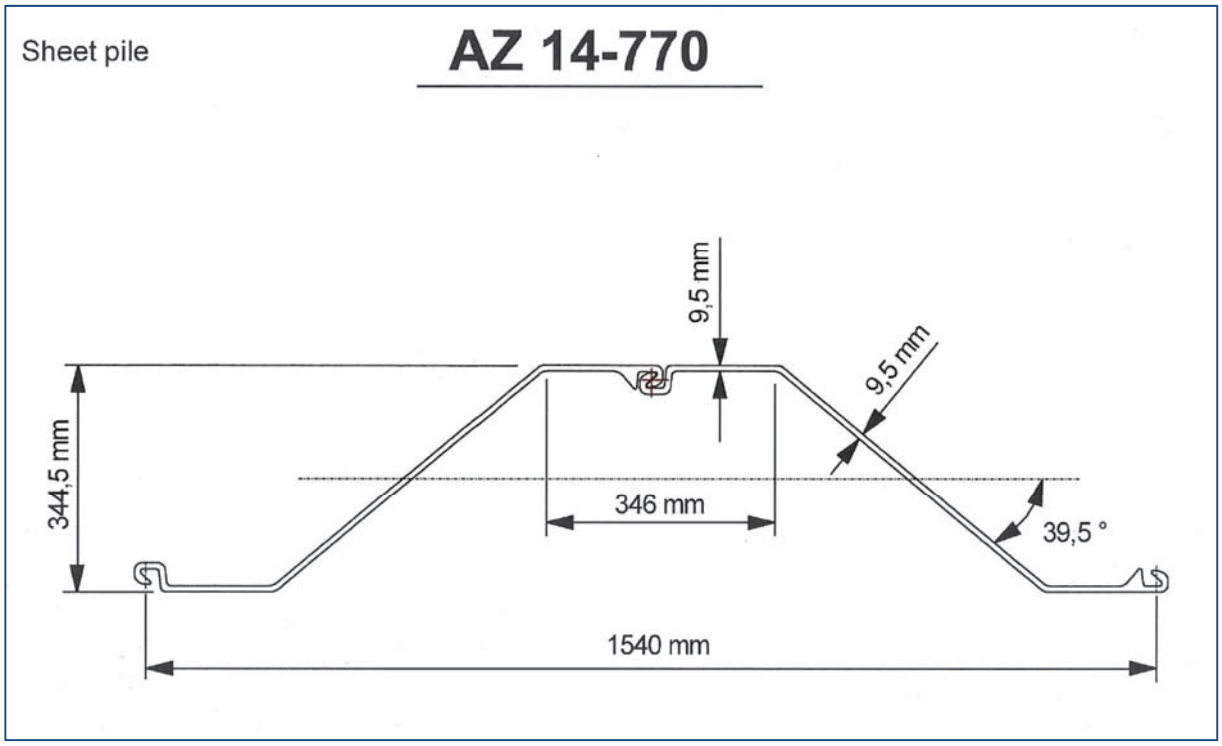

Figure 2.1 Sheet Pile Design Dimensions

The following background reports were also provided to MRA to assist in the assessment of the wall.

- Carnarvon Sheet Piling Report: Metal loss inspection report and inspection findings (Hudson, 2016).
- Fascine Steel Sheet Pile Investigation: Inspection and Interpretive Report (BGI Group, 2016).
- Metallurgical Test Report No.22508 CARN (MTS, 2015).
- Fascine Steel Sheet Pile Coating Closeout Report (BGI Group, 2017)

No information was provided in the design documentation regarding the steel grade used in the sheet piles. However, Hudson (2016) refers to steel grade S355GP and this is confirmed by the MTS (2015) report showing compliance with the equivalent American steel grade ASTM A328. No reference is made to the equivalent steel grade from the Australian Standards.

Advice from the Shire was that the sheet piles were supplied by Curnow Group Pty Ltd.

The following figures show the design details for the sheet pile wall.

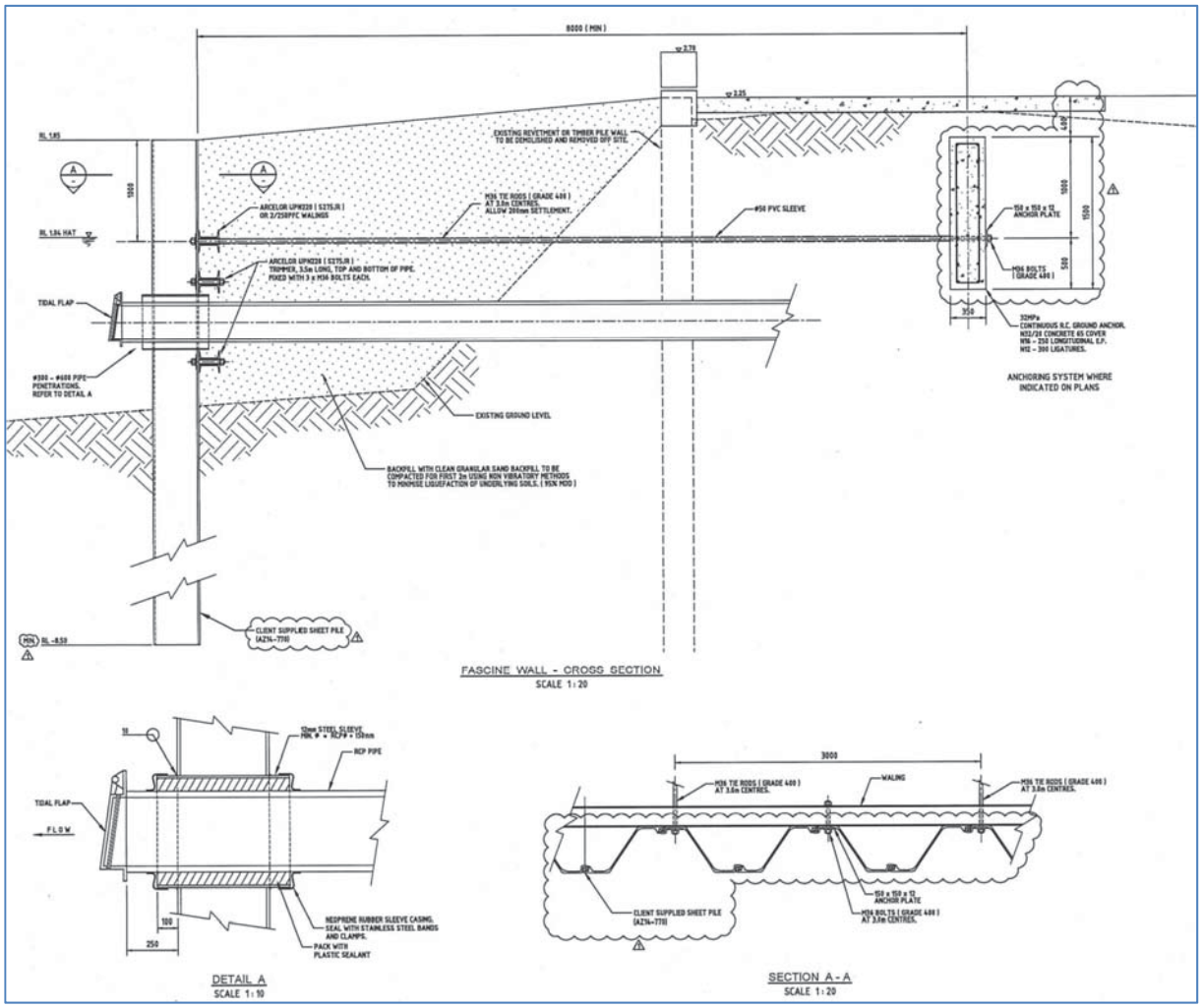

Figure 2.2 Sheet Pile Design Section (Taken from Cardno Drawing E12002-001-M1 Rev 1)

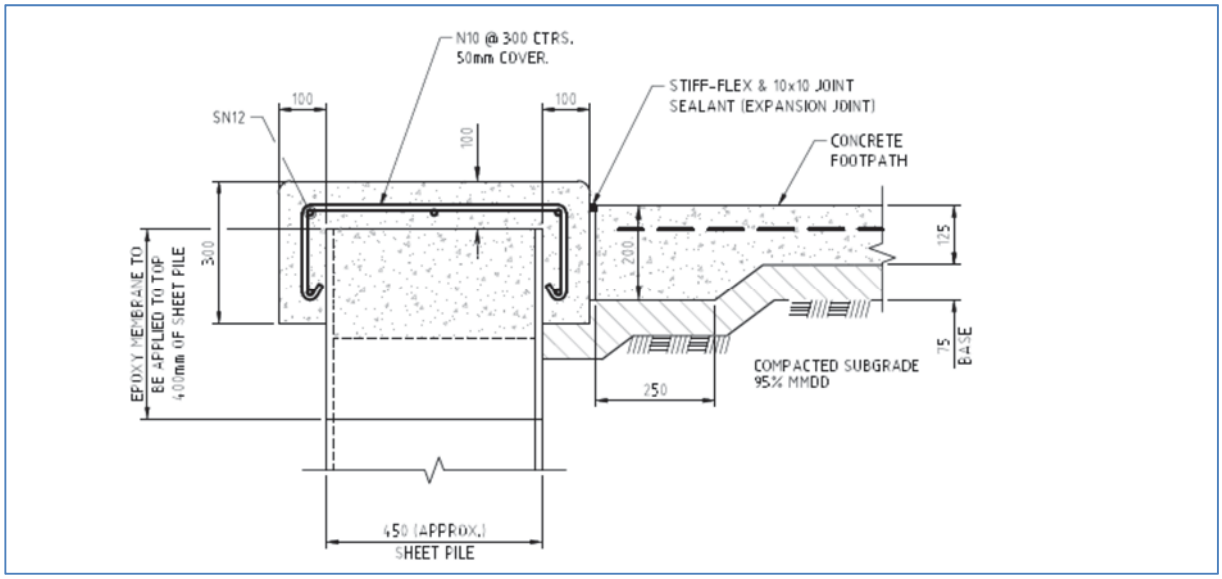

Figure 2.3 Wall Capping Detail (Taken from Cardno Drawing E12002-001-SD1 Rev 0)

From the design drawings provided the following items were noted in relation to the design of the sheet pile wall:

- The specified sheet piles were AZ14-770 to be installed to a minimum depth of -8.5mAHD.
- M36 tie rods were to be installed for the wall sections adjacent to the jetty structures and drainage outlets. The drawing states that the tie rods were to be hot dipped galvanised or appropriately protected against corrosion. A 50mm PVC sleeve was shown on the drawings to encase the tie rods. Minimum steel grade 400 MPa was specified for the tie rods.
- A steel waling was included on the landward side of the wall. The drawings specified an Arcellor UPN220 or 2 250PFC members.
- A concrete capping was included on top of the sheet pile wall. The design included steel reinforcing with 50mm cover and 32 MPa concrete.

A selection of the Shire's photographs taken during the construction of the wall are provided below.

Figure 2.4 Sheet Pile Wall Construction (July 2013)

Figure 2.5 Sheet Pile Wall Construction (October 2013)

Given the high level of corrosion experience on the sheet piles following the construction the Shire has recently engaged a contractor to paint the exposed face of the sheet piles. The protective

coating specification was developed by BGI Group Pty Ltd for the Shire of Carnarvon (RFT 05/2017). The work was advertised for tender and awarded to Saunders International Limited (Saunders) in July 2017 for $611,628 (excl. GST).

The specified coating works involved:

- Clean and abrasive blast the splash zone of the sheet piles.
- Apply a marine coating system to protect the piles.

The chosen coating system was PPG Sigmashield 880, which is a two-component, high-build, polyamine adduct-cured epoxy coating.

David Nielson at the Shire of Carnarvon advised that an alternative tender was accepted from Saunders with the following changes.

- The basis of the alternative was that the blast work would be carried out by ultra-high pressure water rather than abrasive garnet.
- During the initial couple of hundred metres of coating works it became apparent that the methodology being used by Saunders was not providing acceptable coating coverage.
- This was partly to do with the pitted texture of the wall face. The single coat 500 micron spraying operation they were applying was leaving too many “holidays” in the coating.
- Saunders came back with an amended proposal to provide a second coating with minimum DFT of 300 microns i.e. total minimum DFT of 800 microns.
- They revised the application methodology of the first coat to roll and brush in the heavily pitted areas to improve penetration to the pits.

The coating system was applied from the pile cap down to approximately the low tide level or the bed level where above low tide. The remainder of the sheet pile was left uncoated. The work was completed in October 2017.

3. Condition Assessment

To assess the current condition of the steel sheet pile system a detailed inspection and testing of the wall was completed. The inspection was undertaken by Senior Coastal Engineer, Peter Doust, together with divers from Shorewater Marine who were engaged as a subcontractor to MRA. The inspection was completed on the 24th and 25th October 2017 during low tides.

The scope of work for the Condition Inspection included:

- Visual inspection of 800 meters of sheet wall piling, above and below water noting the corrosion, defects, irregularity and general condition.
- Cleaning marine growth & removing corrosion to check the condition of steelwork & conduct thickness measurements with Ultrasonic Thickness (UT) testing equipment on a selection of sheet piles to confirm the typical condition of the piles at the pile cap, highest astronomical tide level, intertidal column/MSL and at lowest astronomical tide level or seabed level if it is found to be higher than LAT.
- Testing of anodes if installed (Note: There was no evidence of anodes during the inspection).
- Photographs of the above.
- Inspection report on the above.

A detailed inspection report has been prepared by Shorewater Marine and is included in Appendix B.

Figure 3.1 Thickness Testing by Shorewater Marine

Results from the condition inspection are summarised below and a selection of photographs are provided in Figures 3.2 to 3.8.

- The wall at the time of inspection had recently being painted from the top of the sheet pile down to around the low tide level. A large amount of corrosion products were left on the seabed likely from when the wall was blasted prior to painting.

Figure 3.2 Paint Coating and Corrosion Products

- Where there was scour protection rock at the base of the sheet pile wall there were sections that were not painted.

Figure 3.3 Incomplete Paint Coating

- The condition along the length of the wall was fairly uniform with the highest levels of corrosion typically in about a 1.5m strip covering the intertidal zone. This was evidenced by the rough texture on the front of the wall where steel had been lost.

Figure 3.4 Loss of Thickness in Intertidal Zone

- There were a number of holes through the wall which were taped off to enable future patch repairs. These were generally found at the northern end (Stage 1 section) of the wall, however there were 4 holes found in the Stage 2 section of wall. The paint coating may also have covered over a number of small holes that are now unable to be detected from a visual inspection.

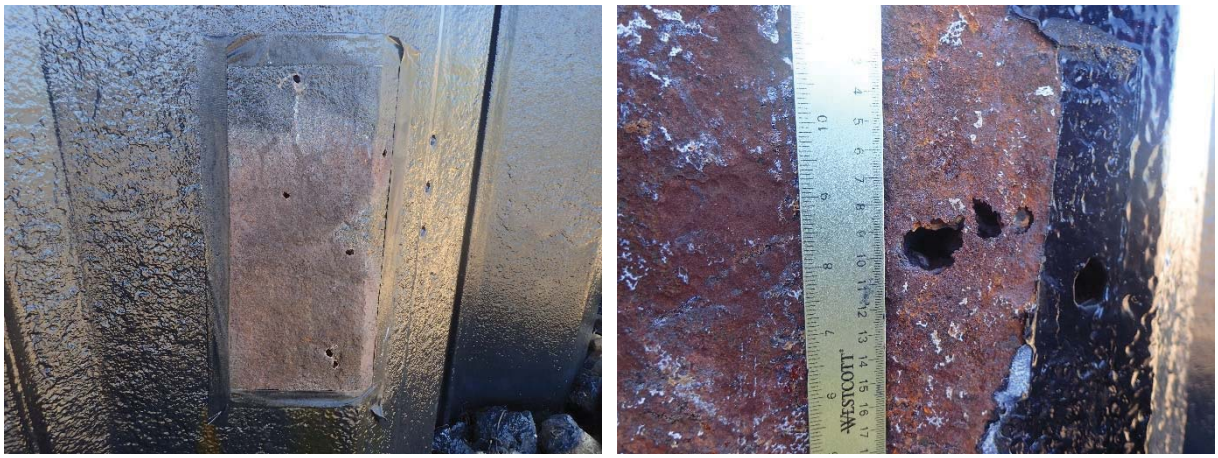

Figure 3.5 Holes in Wall

- The concrete capping had extensive cracking due to corrosion of the reinforcing steel and concrete spalling. In some locations it appeared that the concrete cover was less than 10mm, which was much less than the 50mm specified on the design drawings. It is not clear what concrete mix was used, however the design drawings suggest 32MPa concrete. For marine structures the Australian Standard AS4997-2005 recommends structural concrete to have:

  - Minimum characteristic strength (*f'c*) of 40 MPa (refer clause 6.3.3).
  - Minimum cover to reinforcing steel of 75mm where in the splash zone (ie exposed soffits of structures) or 70mm for the spray zone, unless higher strength concretes are used (refer clause 6.3.7).

  The design and installation of the concrete did not meet these requirements.

Figure 3.6 Concrete Capping Failure

- A number of the drainage outlets were inadequately sealed enabling material to be washed out from behind the wall.

Figure 3.7 Drainage Outlets

- At the northern end of the wall (Stage 1 section) there appeared to be some subsidence of the pavement behind the wall. This may be due to loss of backfill material through the wall. The pavement behind the wall was approximately 30mm lower than the capping beam.

Figure 3.8 Paving Subsidence

In addition to the inspection undertaken by MRA and its subcontractors, the Shire of Carnarvon has also carried out their own investigations on the wall including extracting sections of the wall for more detailed assessment. This is shown in the following photographs provided by the Shire.

Figure 3.9 Removal of Sections by Shire

The following points summarise the findings from the sections removed from the wall:

- The section of pile removed from the mid tide level showed severe corrosion on both the front and rear of the sheet pile. Deep pitting corrosion was found on the landward side of the sheet pile as shown in the photograph below.

Figure 3.10 Condition of Removed Steel Section

- The Shire advised that there was a large amount of retained water behind the wall which flowed out when the section of wall was removed.

As shown from the Shire's investigation there appears to be a high level of corrosion on the rear face of the sheet pile. To better understand the cause of this corrosion, testing of the soil is recommended. It is understood that the Shire is currently arranging for this soil testing to be carried out, however the results were not available at the time of writing this report.

4. Sheet Pile Wall Analysis

4.1 Wall Thickness / Section Loss

The results from the thickness measurements taken on site are summarised in the following charts. Figure 4.1 shows the wall thickness measurements for different levels on the wall. As shown the thinnest sections of steel were found around the high tide line.

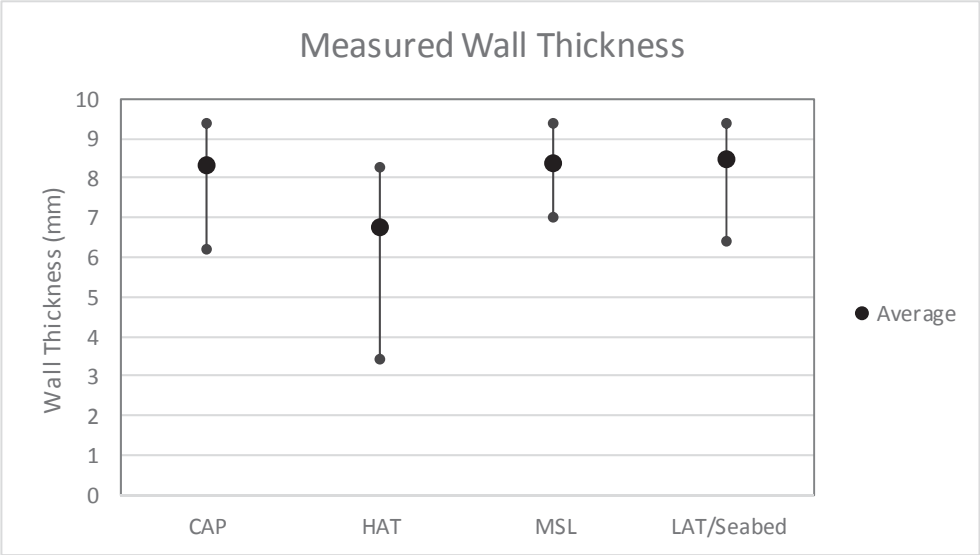

Figure 4.1 Measured Sheet Pile Wall Thickness

The measurements represented in the above chart do not include the isolated holes that were found where the wall thickness had been completely corroded.

The section loss is represented in the following chart.

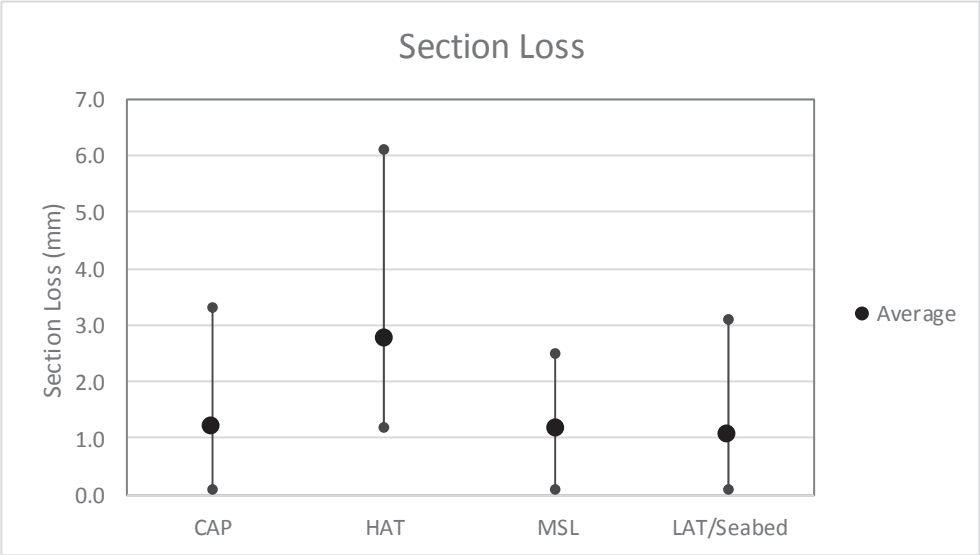

Figure 4.2 Section Loss

Within the splash zone the average section loss varied from about 1 to 3 mm.

4.2 Corrosion Rates

It is not clear the exact dates that the wall was installed, however from the information provided it appears that the majority of the wall was installed around mid to late 2013. This means that at the time of inspection the wall was around 4 years old.

Based on the measured section loss the typical corrosion rates were around **0.25 to 0.75 mm/yr**. However for the localised pitting that has resulting in holes in the sheet pile wall the corrosion rates are in the order of 2 to 3 mm/yr.

Corrosion can occur on both faces of the sheet pile wall being the landside and the waterside. Each side of the wall has a different exposure environment which can affect the rate of corrosion. The corrosion rates specified above do not distinguish between the front and rear of the wall and are therefore a combined corrosion rate including corrosion on both the front and rear of the wall.

As a comparison, published corrosion rates are provided in several Australian Standards and are summarised in the following table. Their applicability to the Carnarvon Fascine Wall is also provided in the table.

Table 4.1 Published Corrosion Rates

Exposure Zone	Standard / Reference	Exposure Description	Corrosion Allowance (mm/yr)	Applicability to Carnarvon Fascine Wall
Permanently Submerged in Seawater	AS4997-2005 (Cl. 6.4.4.7)	Permanently Submerged – Tropical/Subtropical (North of 30°S)	0.1	This is for submerged steel only. The standard outlines that higher corrosion rates can occur due to microbiologically induced corrosion or accelerated low water corrosion.
	AS2159-2009 (Cl. 6.5.3)	Seawater – Submerged	0.04 – 0.1	This is for submerged steel only. These are averaged rates for generalised corrosion. Higher rates can occur for localised pitting or accelerated low water corrosion.
	AS2312.1-2014 (Appendix B4)	Mild Steel in Seawater	Short Term Mean 0.13 Long Term Mean 0.05	These are typical corrosion rates across Australia. Higher rates are expected in the tropics. The standard states that localised pitting can be 3 to 4 times these mean rates.
Tidal / Splash Zone	AS2159-2009 (Cl. 6.5.3)	Seawater – Tidal/Splash Zone – Tropical/Subtropical (North of 30°S)	>0.1	The standard classifies the tidal / splash zone as very severe conditions and recommends a site-specific assessment should be sought. The rates provided are uniform corrosion rates and higher localised rates can be experienced.
	AS2312.1-2014 (Cl. 2.4)	C4: High (Seashore – Calm) C5-M: (Seashore – Surf) CX: (Shoreline – severe surf)	0.05 to 0.08 0.08 to 0.2 0.2 to 0.7	These are for atmospheric corrosion and don't apply directly to the severe exposure in the tidal zone. Therefore it would be expected that corrosion rates would be similar to the extreme category of 0.2 to 0.7mm/year for the tidal/splash zone.
Buried	AS2159-2009 (Cl. 6.5.3)	Depends on Soil pH and chloride concentrations	Varies from <0.01 for non-aggressive soils to 0.1 for severe soils	The soil conditions at the site are unknown. It is understood that the Shire is currently undertaking soil testing to confirm the soils conditions.
	AS4997-2005 (Cl. 6.4.4.7)	Permanently buried in the seabed	0.01	Doesn't account for microbiologically induced corrosion which can produce higher corrosion rates.
	AS2312.1-2014 (Appendix B5)	Buried	Short Term 0.1 to 0.3 Long Term ~0.1	This is for typical soils without a marine influence. Higher corrosion rates can occur in marine soils.

The corrosion rates presented in the Australian Standards are generally applicable to uniform corrosion rates and it is reasonable to expect higher localised rates of corrosion particularly for the very severe tidal / splash zone. The corrosion rates experienced at the Carnarvon Fascine Wall are not dissimilar to those expected when reviewing the Australian Standards.

Based on the environmental exposure outlined in the Australian Standards the most severe corrosion zone would be expected to occur in the tidal/splash zone. As outlined in AS2159-2009

the corrosion rate in the splash/tidal zone is likely to be greater than 0.1mm/year and a site specific assessment is recommended due to the very severe corrosive environment. AS2312-2014 provides corrosion rates of 0.2 to 0.7mm/year for the CX:Extreme category. This category applies to areas at surf beach shorelines where there is very high salt deposition. The Carnarvon Fascine Wall is located directly adjacent to the Fascine waterway, which is tidally influenced and can also experience locally generated wind waves. These processes lead to high levels of salt deposition on the face of the Fascine Wall. Based on this, it is expected that corrosion rates would be similar to the CX:Extreme category presented in AS2312:2014.

It should be noted that the corrosion rate on new steel is generally more rapid initially and will then slow due to the build-up of corrosion products on the face of the steel. The presence of marine growth can also affect the corrosion rates.

4.3 Useful Life

DPIRD have requested an assessment of the useful life of the asset if no maintenance is carried out. The useful life of the sheet pile wall is dependent on a number of failure modes. The end of useful life is considered to be when the sheet pile has reached a stage that further deterioration of the structure would lead to loss of service. The different failure modes are discussed below.

Corrosion of Sheet Piles

The corrosion of the steel can lead to inadequate structural capacity to withstand loading on the wall. The wall requires adequate thickness to withstand bending and axial forces. From the information provided it is not clear how much reserve capacity is included in the design of the sheet piles or if a corrosion allowance was included in the design. Therefore, it is difficult to determine the useful life of the structure based on the corrosion experienced without more detailed structural analysis which is beyond the scope of this assessment.

It should be noted that the location of the maximum bending moment for typical cantilever sheet pile walls is generally below the seabed level and some loss of section can occur at higher levels without affecting the overall capacity of the structure.

However, given the corrosion rates experienced it is expected that the structural capacity of the wall without any paint coating would have become inadequate within the coming 5 to 10 years. Localised areas were there has been higher corrosion rates may have inadequate capacity sooner and within 5 years.

The recently applied protective paint coating will limit corrosion on the seaward face. However this paint coating has a limited life and maintenance of this coating is required to ensure further corrosion does not occur once the coating breaks down. The coating provided also doesn't address the issues of corrosion on the rear face of the wall or corrosion of the submerged unpainted section. If no further maintenance is carried out the useful life of the structure is expected to be around 5 to 15 years, including benefits of the existing paint coating.

Corrosion of Tie Rods & Waling

The corrosion of the tie rods and waling members behind the wall can also lead to failure of the wall. These items were unable to be inspected during this assessment and therefore their condition is unknown.

From the information provided it appeared that corrosion protection of the tie rods was achieved by galvanising the rods. It is not clear if any other corrosion protection measures were applied. If the tie rods are only galvanised their durability will be dependent on the life of the galvanised

coating. This depends on the coating thickness and the severity of the environment. In severe corrosive environments the galvanised coatings can be lost in less than 10 years. Further information regarding the current condition of the tie rods and the type of soil they are installed in is required to better understand the likely life of the tie rods.

Loss of Backfill

Corrosion holes through the wall can lead to loss of backfill and subsidence of the pavements behind the wall. During the site inspection a number of holes were found which enabled the washout of backfill through the wall. The inadequate sealing around the drainage pipes is also likely to be contributing to this issue. With no maintenance it is expected that these holes will get larger and more holes will form. This could result in major loss of material potentially in the coming 5 to 10 years.

Concrete Failure

Deterioration of the concrete capping beam can result in loss of large sections of concrete, making it unsafe to walk along the top edge of the wall. It is not clear from the design information provided but the concrete capping beam may also be acting as a waling beam to share loads along the sheet pile wall. Therefore, failure of this beam could result in structural failure of the wall.

Given the current poor condition of the capping beam and the large cracks and spalling evident, it is likely that with no maintenance the capping beam would experience major failure in the coming 5 to 10 years.

4.4 Suitability of Steel Used

Carbon steel such as that used for the Carnarvon Fascine Wall is commonly used for sheet piled waterfront structures. The service life for sheet piles structures in the marine environment is typically around 50 years provided appropriate durability measures are included in the design. The durability can be achieved through a variety of ways including:

- A suitable corrosion allowance so that the structure has sacrificial steel that can be lost prior to the structural capacity being affected.
- Coating systems to prevent the steel from corroding.
- Cathodic protection systems including sacrificial anodes or impressed current systems to protect the steel.

From the information provided the wall was installed without a coating system or cathodic protection system. It is not clear if a corrosion allowance was included, but based on the exposure of the wall and the likely corrosion rates it is unlikely that the unprotected steel would have sufficient thickness to achieve the required durability, even if a thicker sheet pile was used.

4.5 Comparison to Alternative Materials

Alternative sheet pile wall options using different materials are discussed below.

AMLoCor

AMLoCor is Arcelor Mittal's 'low corrosion' steel grade. This steel has a slightly different chemical composition to carbon steel which reduces its corrosion rate. The supplier has completed tests which show the rate of corrosion is reduced by a factor of 3 to 5 depending on the exposure zone (Arcelor Mittal, 2017). The main benefits of AMLoCor is a reduction in the corrosion rate at the

Low Water Zone and in the Permanent Immersion Zone. There does not appear to be any significant reduction in corrosion rates in the upper tidal zone and splash zone.

The use of AMLoCor steel adds about 10% to the supply cost of the steel. For this project it is expected that it could have cost and additional $180,000 to $200,000 to specify AMLoCor steel over the carbon steel.

Given the highest levels of corrosion are in the upper tidal zone and splash zone, the use of this steel on its own would not solve the corrosion issues experienced and other corrosion protection measures would still be required.

Maintenance costs would therefore also be similar to those if carbon steel is used.

Non-Ferrous Sheet Piles

Alternative non-ferrous sheet piles include Vinyl, Fibre Reinforced Polymers (FRP), and Aluminium. These products are less widely used than steel piles but are increasingly being installed in corrosive environments where the strength of steel is not required. An example is shown in the photograph below.

Figure 4.3 Non-Ferrous Sheet Piles

The main difference with the design of sheet pile structures using these alternative products is a reduced capacity in bending compared to steel sheet piles. Therefore, thicker sheets with a higher section modulus are generally required to provide a similar level of capacity. Larger deflections and creep can also cause issues which require careful design consideration. The retained heights at the Carnarvon Fascine Wall reached greater than 3.5m in some sections of the wall. This is likely to be at the limit of the non-ferrous sheet piles and the use of additional tie backs is likely to be required. Further structural analysis is required to confirm if the use of non-ferrous sheet would have been a cost effective or viable solution for the Carnarvon Fascine Wall.

There can also be an additional cost when installing these sheet piles. If hard ground conditions are encountered there may be a requirement to predrill the ground and use a mandrill when installing the piles. If the ground conditions are relatively soft then the installation procedure is similar to steel piles.

Maintenance costs for these alternative non-ferrous sheet piles are likely to be lower than carbon steel. However, these material are still relatively new and there is limited information on the long term performance and maintenance requirements.

Encasement

Another method for protecting sheet piles against corrosion is to encase the steel with a protective barrier. Concrete has often being used to encase steel sheet piles, particularly in the highly corrosive tidal / splash zone. Concrete is cast around the pile which prevents oxygen from reaching the steel and corroding the pile.

This encasement using concrete is estimated to cost in the order of $3,000 to $5,000 /m of wall. Therefore for the full length of wall it could be in the order of $2.5M to $4M additional cost.

Other methods of encasement could also be used but would require careful design to ensure protection to the sheet pile is maintained throughout the life of the structure. Any encasement materials need to be suited to exposure in the harsh marine environment.

Maintenance would still be required to ensure the encasing material maintains the protection to the underlying sheet piles.

4.6 Comparison to Other Wall Types

As an alternative to a vertical sheet pile wall other edge treatments could have also been considered such as those discussed below.

Rock Revetment

Rock revetments are commonly used as an edge treatment to protect shorelines from erosion and wave overtopping. They are generally constructed by placing armour rock over underlayers of smaller rocks and usually a geotextile filter fabric to prevent fines from being washed out through the revetment. An example is shown in the following photograph and sketch.

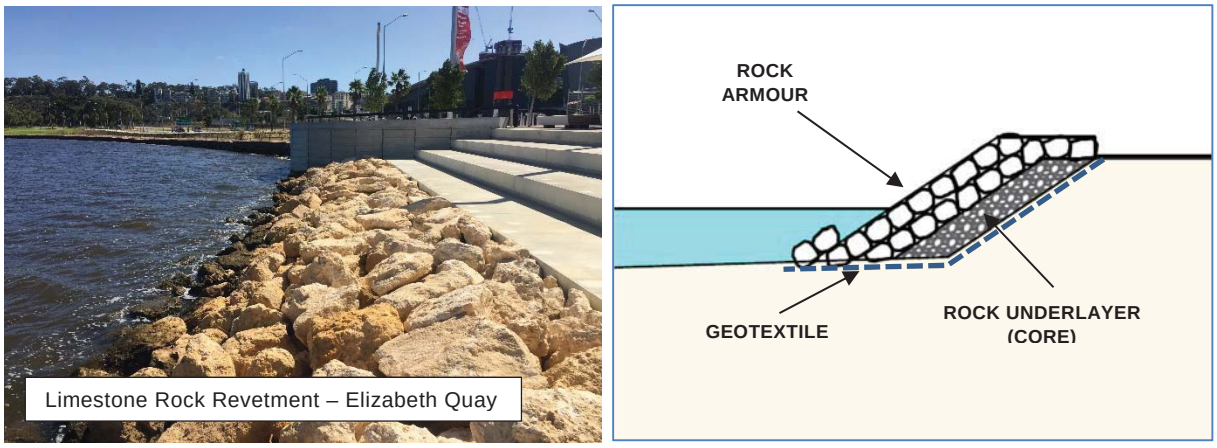

Figure 4.4 Example Rock Revetment

The costs for these type of edge treatment depends on the availability of durable rock and the distance to the supply quarries.

Typical rates for this type of edge protection are in the order of $3,000 to $4,000 per m in Perth. In Carnarvon the costs are expected to be higher as rock is likely to be harder to source. A concept estimate for this type of wall in Carnarvon is expected to be in the range of $4,000 to

$6,000 per m. This will depend on the final design details such as crest levels, layer thicknesses and rock sizes.

Ongoing maintenance costs for rock revetments are generally around 1-2% per annum of the capital cost, on average. This maintenance involves inspections and repairs to any damage such as slumping or settlement of rocks. This maintenance work is unlikely to be completed each year and will be programmed to occur when it makes economical sense to do so. Therefore there might be major maintenance works every 10 years or so.

Concrete Diaphragm Wall

A concrete diaphragm wall involves the excavation of a trench using specialised equipment which is then filled with a reinforcing cage and pumped concrete. The result is a reinforced panel which retains the soils behind it. Following installation the material from in front of the wall is then excavated to the required depth. An example is shown in the photograph and sketch below.

Figure 4.5 Example Concrete Diaphragm Wall

Scour protection is generally installed in front of the wall to limit scouring of the bed along the face of the wall.

The cost for this type of structure depends on the availability of the specialist equipment and expertise required to construct the wall. This specialist equipment would need to be mobilised to Carnarvon to complete the works. The availability of good quality concrete suitable for the marine environment will also influence the cost. For the relatively simple wall design such as that at the Carnarvon Fascine it is likely that steel sheet piles would be a more cost effective option.

Ongoing maintenance costs are likely to be lower than a steel sheet pile wall, but this is likely to be outweighed by a higher capital cost. Further engineering design and investigation would be required to confirm the viability of this option.

Precast Concrete “L” Walls

Precast concrete “L” walls involve the placement of large precast wall segments which are joined together and then backfilled. The durability of the concrete can be achieved through careful specification of concrete mix and construction requirements. The design details such as cover, stresses within the reinforcing, and bar sizes also influence the durability.

It is likely that the site would need to be bunded, excavated and dewatered prior to the installation of the precast elements.

An example of this type of wall is shown in the following photograph and sketch.

Figure 4.6 Example Concrete “L” Wall

The cost of this type of wall is likely to be significantly higher than a steel sheet pile wall as it involves a more difficult construction methodology (eg. excavation & dewatering) and high cost precast concrete to achieve the required durability. The bearing capacity would also require detailed assessment to ensure there were no settlement issues following construction. The final costs will depend on detailed engineering assessment and further investigations, however it is expected that cost would be 1.5 to 2 times that of the sheet pile wall option.

Ongoing maintenance costs are likely to be less than a steel sheet pile and would involve inspections and repairs to any damage (eg damge from boat impact, cracks etc).

4.7 Summary of Alternative Options

The alternative options presented have different pros and cons and a detailed assessment of these options would require detailed engineering analysis and further investigations, which is beyond the scope of this study. However, a high level review of these options has been completed and is summarised in the following table. An indication of the capital cost and ongoing maintenance costs in comparison to the steel sheet pile option are provided.

Table 4.2 Summary of Alternative Options

Option	Description	Concept Capital Cost Estimate Comparison	Ongoing Maintenance Cost Estimate
AMLoCor	AMLoCor steel used instead of normal carbon steel.	Supply cost 10% greater than steel used. ~$180 to $200k extra.	Similar to carbon steel option, as it doesn't address corrosion in upper tidal zone.
Non-Ferrous Sheet Piles	Vinyl, FRP or Aluminium sheet piles instead of carbon steel. Likely that additional tie backs required to achieve required strength.	Likely to be more expensive than carbon steel as additional tie backs likely to be required. Further design required to confirm costs.	Likely to be less than carbon steel, but not much information available on long term performance.
Encasement	Encasement of steel sheet piles with concrete through the splash & intertidal zone.	~$3k to $5k per lineal m additional for concrete encasement.	Likely to be much less than option without protection. Concrete encasement will still require maintenance.
Rock Revetment	Use a rock revetment instead of a vertical edge wall.	Depends on availability of rock. ~$4k to $6k per lineal m.	1 - 2% of capital cost per annum over life of structure. Therefore less than steel sheet pile.
Concrete Diaphragm	Concrete diaphragm wall with marine grade concrete.	Likely to be more expensive than steel sheet pile wall. High cost for mobilising specialist equipment.	Likely to be lower than carbon steel.
Concrete "L" Walls	Precast concrete "L" wall.	Likely to be significantly more expensive (1.5 to 2 times) than sheet pile wall option. Further design required to confirm costs.	Likely to be lower than carbon steel.

Note: 1. The costs provided above are at a concept level only. Additional investigations and engineering design is required to confirm these costs.

5. Maintenance Strategy & Recommendations

Based on the current condition of the sheet pile wall the following maintenance strategy and recommendations have been developed.

A maintenance plan, program and cost estimate is included in Appendix C.

5.1 Further Investigations

To provide further clarity on the current condition of the structure and to better understand the required maintenance it is recommended that the following further investigations are carried out.

Soil Testing

Given the high level of corrosion on the rear side of the sheet pile wall where the sections were removed by the Shire, it is recommended that the soil in the backfill is tested to determine its corrosive nature. If the soil is a major contributor to the corrosion of the sheet piles then corrosion protection of the back of the wall will be required.

It is understood that the Shire is currently getting the soil tested, however the results were not available at the time of writing this report.

Inspection of Buried Tie Rods and Waling

The buried tie rods and waling member was buried at the time of inspection and its condition was therefore unable to be determined. Therefore it is recommended that sections of the tie rods and waling are exposed to enable their condition and corrosion protection measures to be determined. It is recommended that this occurs at several locations along the wall alignment to give confidence in the performance of these items.

This inspection will result in some damage to the landscaping behind the wall which will need to be reinstated following the investigation.

It is expected that the investigation could cost in the order of $15,000 to $20,000.

Structural Analysis of Sheet Pile Wall

Given the limited available design information regarding the sheet pile wall it is recommended that additional structural analysis is completed to confirm how much reserve capacity is in the sheet piles and when strengthening of sheet piles is required. This will involve structural analysis of the wall under different design loading scenarios with consideration of different corrosion loss on the sheets. This analysis is expected to cost in the order of $20,000.

The results from this analysis will enable optimisation of the timing of strengthening repairs and a better understanding of the wall capacity and the level of corrosion that is acceptable.

5.2 Repairs

From the results of the condition inspection it is recommended that the following repairs are completed.

5.2.1 Repairs for Section Loss

Where the corrosion and section loss of the steel has resulted in the requirement to strengthen the sheet pile or where holes need to be sealed to prevent loss of backfill it is recommended that repairs are carried out using steel plates welded to the face of the sheet pile.

As outlined in Section 5.1 above, further analysis is required to determine the minimum thickness that is acceptable before there is a need to strengthen the sheet pile.

The methodology for this type of repair would involve the following.

- Cleaning back the existing sheet pile to bare metal to enable welding of the new steel to the existing sheet pile.
- Installing a new plate of steel over the thin section of sheet pile to strengthen the structure. This will need a full seal weld around the perimeter of the plate.
- Reinstating the paint coating over the repaired section to prevent further corrosion.

An example is shown in the figure below. The works would need to be carried out during low tides.

Figure 5.1 Example Steel Plate Repair

The costs associated with this type of repair will depend on the extent that needs to be strengthened and the number of repairs to be completed. Works will need to be completed using a dive team. Typical rates for a dive team with the required welding equipment and consumables are around $2,500 per day. It is envisaged that several patch repairs could be completed each day. There would be additional mobilisation and demobilisation costs.

Once repaired and recoated, the repair is likely to achieve the design life of the structure, provided the corrosion protection measures and coatings are maintained.

5.2.2 Resealing Stormwater Outlets

To prevent the loss of backfill from behind the wall there were 4 stormwater outlets that required resealing. A flexible sealant shall be used with appropriate durability to last in the marine environment. An indicative cost of $5,000 is considered appropriate to complete these repairs.

5.2.3 Repairs / Replacement of the Concrete Capping

The cracking and spalling of the concrete capping beam needs to be addressed. This can be achieved by carrying out repairs to the existing capping or full replacement of the capping.

The recommended repair methodology would involve the following:

- Break off any spalling concrete or cracked concrete to expose the corroding steel.
- Clean back and coat the reinforcing steel with a zinc-rich epoxy resin primer. An example product is Nitoprime-Zincrich.
- Reinstate concrete with appropriate epoxy repair mortar such as Xypex Megamix.
- Seal the remainder of the concrete capping beam to limit further corrosion of the reinforcing steel. An example product is Parchem Emer-Stop S100N.

Based on the condition inspection, this repair is currently required to approximately 80% of the length of the capping beam. It is likely that further repairs will be required in the future as further deterioration of the concrete occurs.

Alternatively the whole capping beam could be removed and reinstated with a new beam which is properly designed and constructed for the marine environment. This is estimated to cost around $250,000 to $300,000.

Given the condition of the beam and the likely inconvenience associated with ongoing repairs it is MRA's recommendation that the full capping beam is replaced. This does not need to occur immediately, but should be completed in the coming few years, depending on how quickly its condition deteriorates.

5.3 Ongoing Monitoring & Inspections

Ongoing monitoring and inspections of the sheet pile wall is recommended to enable early detection of any defects and to prioritise any maintenance works. The following inspections are recommended:

- Annual Visual Inspection
  This is to checks for any damage to the protective paint coating or any other damage to the structure. Any holes in the wall or leakage of material from around the stormwater outlets should be checked during these inspections. The condition and evidence of any further cracking of the concrete capping beam should also be checked during these inspections.
- 5 Yearly Detailed Condition Inspection
  These more detailed inspections should be completed to assess deterioration of the sheet pile wall that is not picked up during the annual visual inspections. This will include diver inspection to check the underwater portions of the structure, thickness measurements of the steel and testing of anodes (if installed).

- Inspection after Severe Events
  It is also recommended to inspect the structure for any damage following severe events such as major floods or storm surge events.

5.4 Coating Maintenance

To ensure the continued protection to the steel the paint coating will require regular maintenance. As outlined in AS2312.1:2014 a very high build epoxy paint coating is likely to last between 5 and 15 years in the marine environment until major maintenance or recoating is required.

In between these major maintenance episodes, minor repairs are likely to be required to require to address any localised damage to the coating or areas were corrosion is evident. The need for these minor repairs and confirmation of the preferred timing for major maintenance works will be determined from the ongoing annual inspections of the coating.

The cost for minor repairs to the coating is expected to be around $10,000 per year initially following recoating and increasing to around $20,000 per year as the coating deteriorates.

The major recoating is expected to be required approximately every 10 years and is expected to cost in the order of $400,000, however this will depend on the level of deterioration of the coating and the require preparation works.

5.5 Upgrades & Additional Protection

As there is currently no additional corrosion protection to the immersed or buried portions of the sheet pile it is recommended that a Cathodic Protection (CP) system is designed and installed on the structure to limit any further corrosion. The need for a CP system for the rear of the wall should be confirmed following the additional investigation into the corrosive nature of the backfill material as outlined in Section 5.1.

If the additional investigations show the need for corrosion protection on the rear of the wall the recommended system is likely to involve an Impressed Current Cathodic Protection (ICCP) for the rear of wall and a Sacrificial Anode Cathodic Protection (SACP) for the front of wall. The ICCP system is likely to provide some protection to the front of the wall depending on the conductivity of the soil beneath the wall. The need for sacrificial anodes along the front of the wall should be determined following the installation of the ICCP and testing to confirm the effectiveness of that system.

The final design of such a system would be subject to the detailed design by a corrosion expert.

The cathodic protection system will generally only provide protection up to around the mid tide level and maintenance of the paint coating for the sheet above the level will still be required.

5.6 Cost Estimates

A detailed maintenance plan including estimated costs is provided in Appendix C. As outlined in the plan the following maintenance costs are expected to be required on the structure over the next 20 years.

Table 5.1 Summary of Maintenance Plan Costs

Item	Immediate (Year 1)	Medium Term (Years 2 – 10)	Long Term (Years 11 – 20)
Investigations & Monitoring	$45,000	$105,000	$110,000
Repairs & Maintenance	$115,000	$805,000	$540,000
Upgrades & Additional Protection	$525,000	$100,000	$250,000
Total	**$685,000**	**$1,010,000**	**$900,000**

Note: 1. A detailed breakdown of these costs is provided in Appendix C.

The annual average maintenance costs for steel sheet pile marine structures are typically in the order of 1-2% of the new costs or replacement value of the structure (Thoresen 2003). The above maintenance costs are within this range.

6. Summary & Conclusions

The following points provide a summary of the independent assessment for the Carnarvon Fascine Sheet Pile Wall.

- The condition inspection confirmed the high levels of corrosion experienced around the tidal / splash zone of the wall.
- Corrosion rates were typically in the range of 0.25 to 0.75mm/year with higher localised rates where the deep pitting and corrosion holes had formed.
- The corrosion rates were similar to those described in the Australian Standards for the very severe marine environment.
- If the wall was not painted and without any maintenance it is estimated that the wall will last 5 to 10 years before reaching the end of its useful life. Some areas with higher localised corrosion rates may reach the end of their useful life before this time. With the recently applied paint coating it is estimated that the wall will last 5 to 15 years as there are other issues which need to be addressed other than the corrosion in the upper tidal zone. Further investigations are required to confirm this.
- An assessment of the suitability of the steel that was used was carried out together with comparisons to alternative material. The steel was found to be acceptable provided additional corrosion protection measures were included such as paint coatings or cathodic protection. Other materials could have also been used, but further design and analysis is required to confirm how effective these alternative materials would be.
- The concrete capping beam design did not meet the requirements of the relevant Australian Standards (eg insufficient strength and cover) and was also found to be poorly constructed (eg concrete cover much less than design). MRA's recommendation is that the capping beam is replaced with a new concrete capping designed and constructed in accordance with the relevant Australian Standards.
- A detailed maintenance strategy, with costings, was prepared for the coming 20 years. Significant maintenance works are required to ensure the continued performance of the sheet pile wall. Further investigations are also recommended to gain a better understanding of the condition of the soil behind the wall, the condition of the tie rod and waling, and the amount of reserve capacity in the wall. It is expected that approximately $2.6M will need to be spent on the wall in the coming 2 decades.

7. References

Arcelor Mittal, 2017. *AMLoCor Steel Grade Brochure*.

Hudson M, 2016. *Report: Carnarvon Fascine Sheet Piling*.

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BGI Group Pty Ltd, 2017. *Fascine Steel Sheet Pile Coating Closeout Report*. Report No. BGI-WA-201710. Prepared for the Shire of Carnarvon.

MTS (Metallurgical testing services), 2015. *Report No.22508 CARN*.

Thoresen, C.A., 2003. *Port Designer's Handbook: Recommendations and Guidelines*. Thomas Telford, London.

8. Appendices

Appendix A **Design Drawings**

Appendix B **Shorewater Marine – Diver Inspection Report**

Appendix C **Maintenance Plan**

Appendix A Design Drawings

CARNARVON - FASCINE WALL WORKS

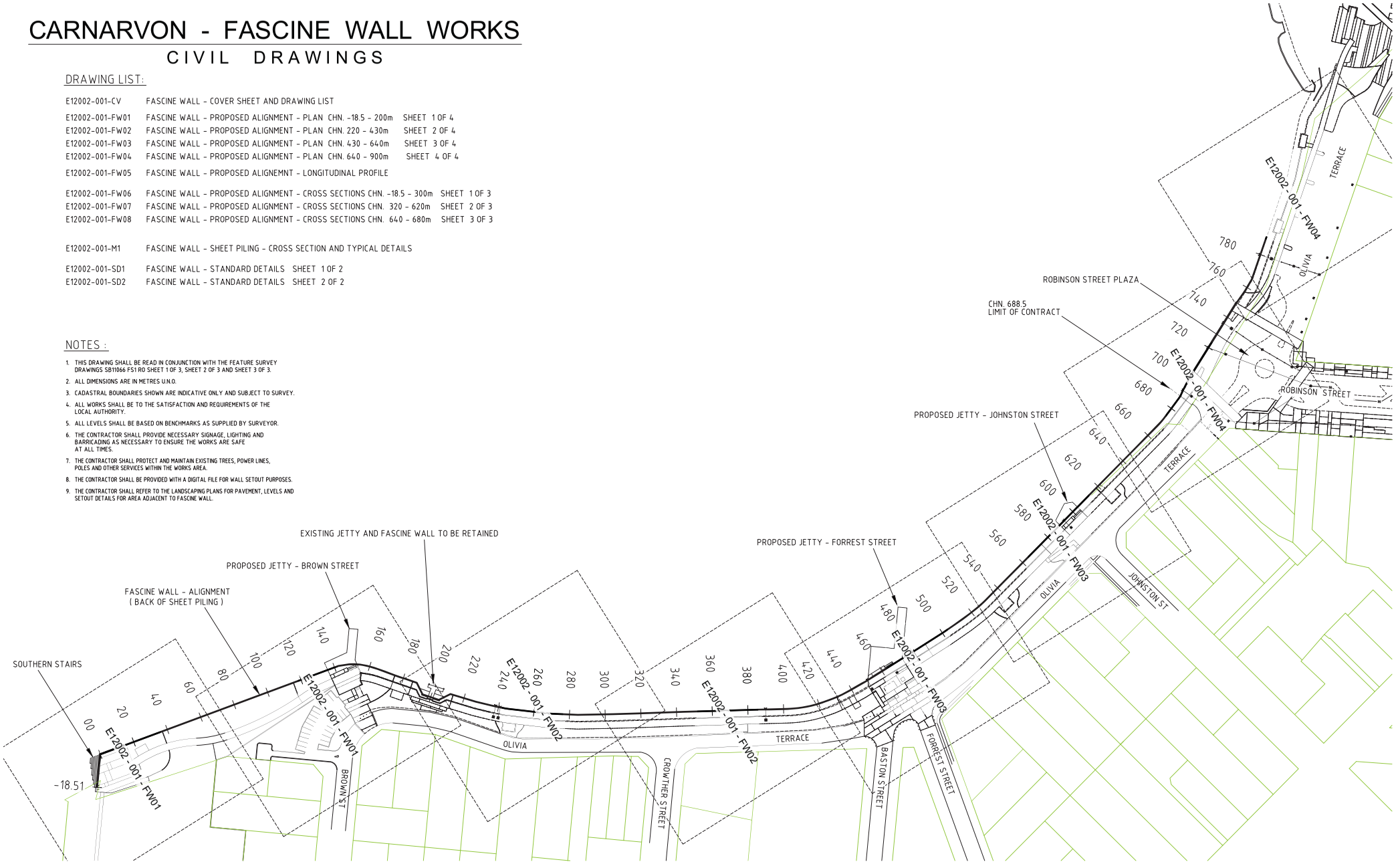
CIVIL DRAWINGS

DRAWING LIST:

E12002-001-CV	FASCINE WALL - COVER SHEET AND DRAWING LIST	
E12002-001-FW01	FASCINE WALL - PROPOSED ALIGNMENT - PLAN CHN. -18.5 - 200m	SHEET 1 OF 4
E12002-001-FW02	FASCINE WALL - PROPOSED ALIGNMENT - PLAN CHN. 220 - 430m	SHEET 2 OF 4
E12002-001-FW03	FASCINE WALL - PROPOSED ALIGNMENT - PLAN CHN. 430 - 640m	SHEET 3 OF 4
E12002-001-FW04	FASCINE WALL - PROPOSED ALIGNMENT - PLAN CHN. 640 - 900m	SHEET 4 OF 4
E12002-001-FW05	FASCINE WALL - PROPOSED ALIGNEMNT - LONGITUDINAL PROFILE	
E12002-001-FW06	FASCINE WALL - PROPOSED ALIGNMENT - CROSS SECTIONS CHN. -18.5 - 300m	SHEET 1 OF 3
E12002-001-FW07	FASCINE WALL - PROPOSED ALIGNMENT - CROSS SECTIONS CHN. 320 - 620m	SHEET 2 OF 3
E12002-001-FW08	FASCINE WALL - PROPOSED ALIGNMENT - CROSS SECTIONS CHN. 640 - 680m	SHEET 3 OF 3
E12002-001-M1	FASCINE WALL - SHEET PILING - CROSS SECTION AND TYPICAL DETAILS	
E12002-001-SD1	FASCINE WALL - STANDARD DETAILS	SHEET 1 OF 2
E12002-001-SD2	FASCINE WALL - STANDARD DETAILS	SHEET 2 OF 2

NOTES :

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE FEATURE SURVEY DRAWINGS SB11066 FS1 R0 SHEET 1 OF 3, SHEET 2 OF 3 AND SHEET 3 OF 3.
2. ALL DIMENSIONS ARE IN METRES U.N.O.
3. CADASTRAL BOUNDARIES SHOWN ARE INDICATIVE ONLY AND SUBJECT TO SURVEY.
4. ALL WORKS SHALL BE TO THE SATISFACTION AND REQUIREMENTS OF THE LOCAL AUTHORITY.
5. ALL LEVELS SHALL BE BASED ON BENCHMARKS AS SUPPLIED BY SURVEYOR.
6. THE CONTRACTOR SHALL PROVIDE NECESSARY SIGNAGE, LIGHTING AND BARRICADING AS NECESSARY TO ENSURE THE WORKS ARE SAFE AT ALL TIMES.
7. THE CONTRACTOR SHALL PROTECT AND MAINTAIN EXISTING TREES, POWER LINES, POLES AND OTHER SERVICES WITHIN THE WORKS AREA.
8. THE CONTRACTOR SHALL BE PROVIDED WITH A DIGITAL FILE FOR WALL SETOUT PURPOSES.
9. THE CONTRACTOR SHALL REFER TO THE LANDSCAPING PLANS FOR PAVEMENT, LEVELS AND SETOUT DETAILS FOR AREA ADJACENT TO FASCINE WALL.



FASCINE WALL - PLAN
SCALE : 1:1000

Rev	Date	Description	Drawn	Appr.
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B	24.07.2012	DRAWING LIST UPDATED	DLC	NTT
A	06.06.2012	IISSUED FOR TENDER	JPK	NTT

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	JPK	Date 27.03.2012
Designed		Date
Checked	NTT	Date 30.05.2012
Reviewed		Date
Approved		Date

Client: SHIRE OF CARNARVON
Project: SHIRE OF CARNARVON FASCINE WALL REDEVELOPMENT
Status: FOR CONSTRUCTION
Date: 30.05.2012 | Datum: A.H.D | Scale: AS SHOWN | Size: A1
Title: FASCINE WALL COVER SHEET AND DRAWING LIST
Drawing Number: E12002-001-CV1 | Revision: 0

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DATE PLOTTED: 07 February, 2013 - 4:16pm
XREFs: xr-fs, xr-FW
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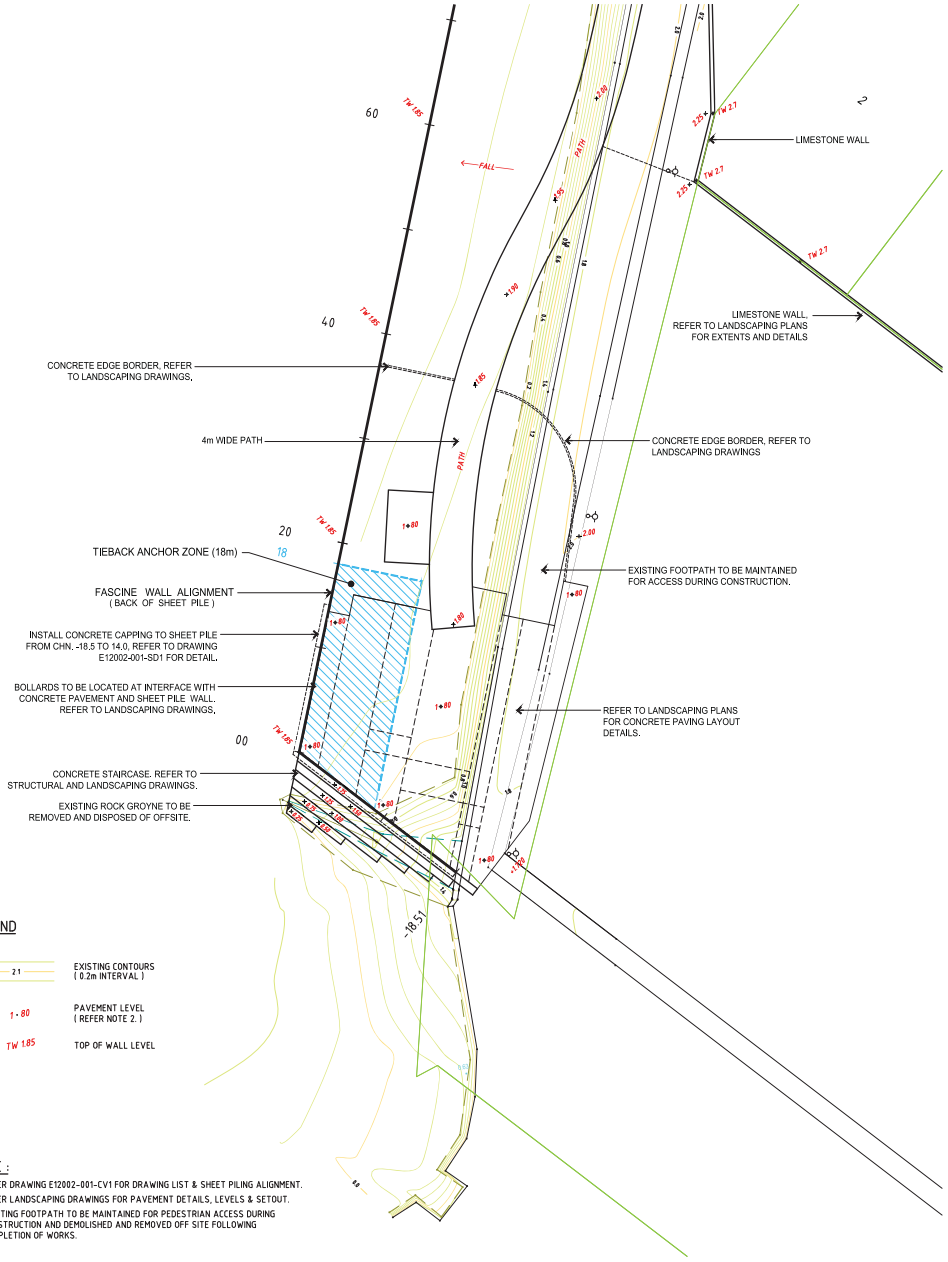
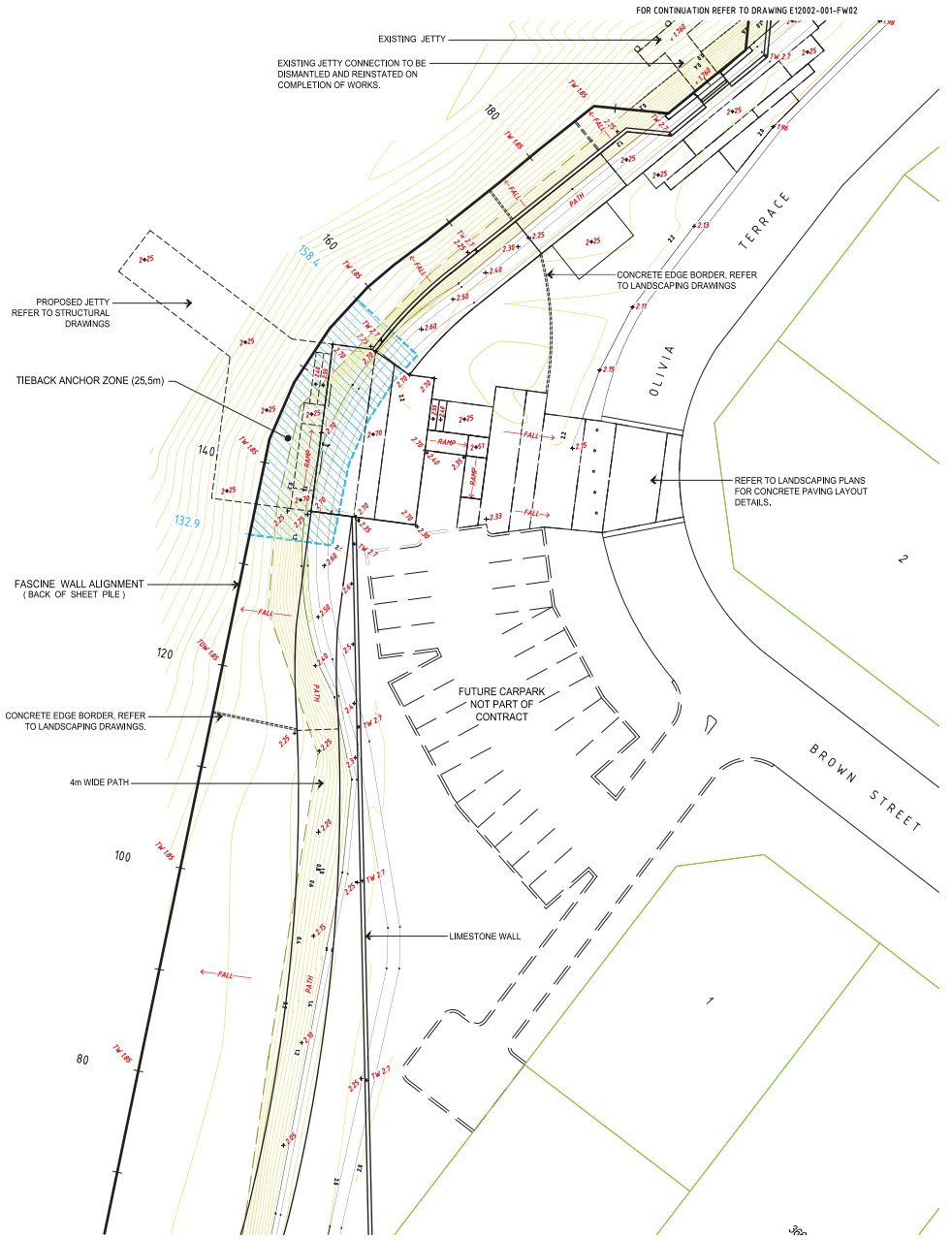


PLAN CHN. -18.5 - 70m

1:250



PLAN CHN. 70 - 200m

1:250

1:250

NOTE :

1. REFER DRAWING E12002-001-CV1 FOR DRAWING LIST & SHEET PILING ALIGNMENT.
2. REFER LANDSCAPING DRAWINGS FOR PAVEMENT DETAILS, LEVELS & SETOUT.
3. EXISTING FOOTPATH TO BE MAINTAINED FOR PEDESTRIAN ACCESS DURING CONSTRUCTION AND DEMOLISHED AND REMOVED OFF SITE FOLLOWING COMPLETION OF WORKS.

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	IISSUED FOR TENDER	JPK	NTT

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TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	JPK	Date	27.03.2012
Designed		Date	
Checked	NTT	Date	30.05.2012
Reviewed		Date	
Approved		Date	

Client: SHIRE OF CARNARVON

Project: SHIRE OF CARNARVON
FASCINE WALL REDEVELOPMENT

Status: FOR CONSTRUCTION

Date	Datum	Scale	Size
30.05.2012	A.H.D	AS SHOWN	A1

Title: FASCINE WALL
PROPOSED ALIGNMENT PLAN CHN. -18.50 - 200m
SHEET 1 OF 4

Drawing Number: E12002-001-FW01

Revision: 0

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DATE PLOTTED: 07 February, 2013 - 4.16pm

XREFs: xr-ca; xr-Splat; xr-FS; x-FW
CAD FILE: L:\20\EE12002 - Fascine Eng Des\Drawings\CAD\E12002-001-FW01-FW04.dwg

LEGEND

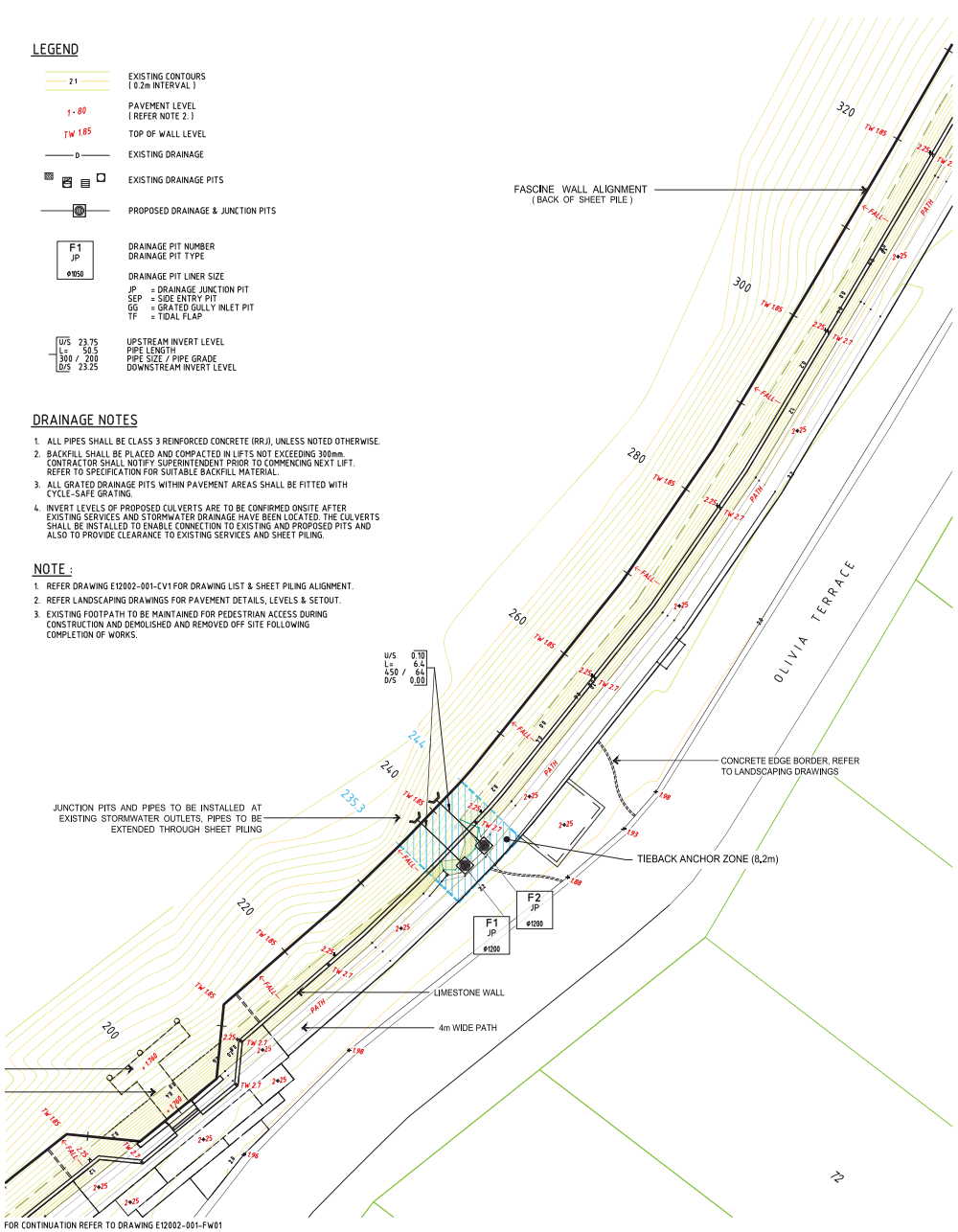
- EXISTING CONTOURS (0.2m INTERVAL)
- 1 - 80 — PAVEMENT LEVEL (REFER NOTE 2.)
- TW 1.85 — TOP OF WALL LEVEL
- EXISTING DRAINAGE
- EXISTING DRAINAGE PITS
- PROPOSED DRAINAGE & JUNCTION PITS
- F1 / JP / ϕ1050 — DRAINAGE PIT NUMBER / DRAINAGE PIT TYPE / DRAINAGE PIT LINER SIZE
  - JP = DRAINAGE JUNCTION PIT
  - SEP = SIDE ENTRY PIT
  - GG = GRATED GULLY INLET PIT
  - TF = TIDAL FLAP
- U/S 23.75 / L= 50.5 / 300 / 200 / D/S 23.25 — UPSTREAM INVERT LEVEL / PIPE LENGTH / PIPE SIZE / PIPE GRADE / DOWNSTREAM INVERT LEVEL

DRAINAGE NOTES

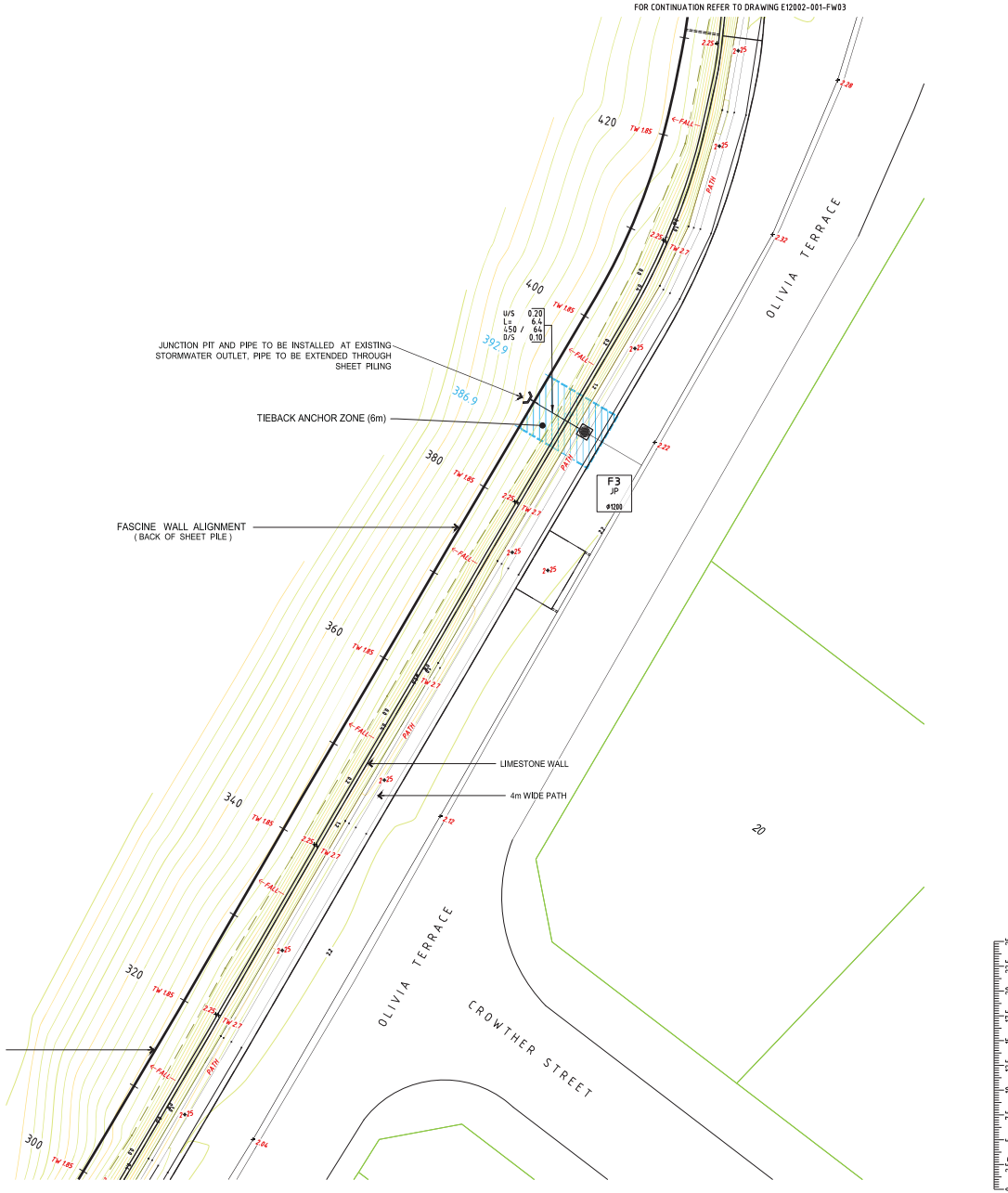
1. ALL PIPES SHALL BE CLASS 3 REINFORCED CONCRETE (RRJ), UNLESS NOTED OTHERWISE.
2. BACKFILL SHALL BE PLACED AND COMPACTED IN LIFTS NOT EXCEEDING 300mm. CONTRACTOR SHALL NOTIFY SUPERINTENDENT PRIOR TO COMMENCING NEXT LIFT. REFER TO SPECIFICATION FOR SUITABLE BACKFILL MATERIAL.
3. ALL GRATED DRAINAGE PITS WITHIN PAVEMENT AREAS SHALL BE FITTED WITH CYCLE-SAFE GRATING.
4. INVERT LEVELS OF PROPOSED CULVERTS ARE TO BE CONFIRMED ONSITE AFTER EXISTING SERVICES AND STORMWATER DRAINAGE HAVE BEEN LOCATED. THE CULVERTS SHALL BE INSTALLED TO ENABLE CONNECTION TO EXISTING AND PROPOSED PITS AND ALSO TO PROVIDE CLEARANCE TO EXISTING SERVICES AND SHEET PILING.

NOTE :

1. REFER DRAWING E12002-001-CV1 FOR DRAWING LIST & SHEET PILING ALIGNMENT.
2. REFER LANDSCAPING DRAWINGS FOR PAVEMENT DETAILS, LEVELS & SETOUT.
3. EXISTING FOOTPATH TO BE MAINTAINED FOR PEDESTRIAN ACCESS DURING CONSTRUCTION AND DEMOLISHED AND REMOVED OFF SITE FOLLOWING COMPLETION OF WORKS.



PLAN CHN. 200 - 310m
1:250



PLAN CHN. 310 - 430m
1:250

1:250

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	IISSUED FOR TENDER	JPK	NTT

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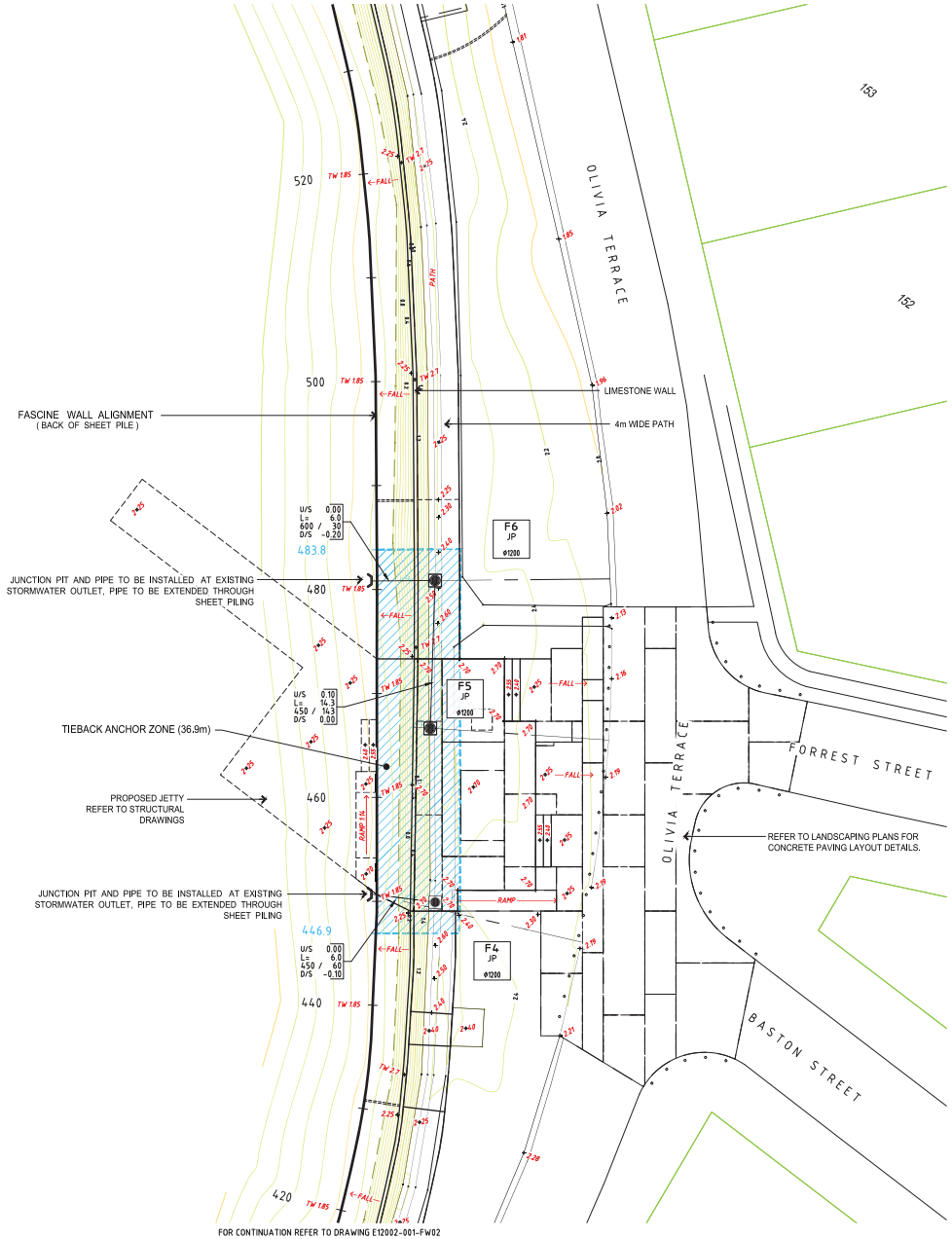
CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	JPK	Date	27.03.2012
Designed		Date	
Checked	NTT	Date	30.05.2012
Reviewed		Date	
Approved		Date	

Client: SHIRE OF CARNARVON
Project: SHIRE OF CARNARVON
FASCINE WALL REDEVELOPMENT
Status: FOR CONSTRUCTION
Date: 30.05.2012 | Datum: A.H.D | Scale: AS SHOWN | Size: A1
Title: FASCINE WALL
PROPOSED ALIGNMENT - PLAN CHN. 200 - 430m
SHEET 2 OF 4
Drawing Number: E12002-001-FW02 | Revision: 0

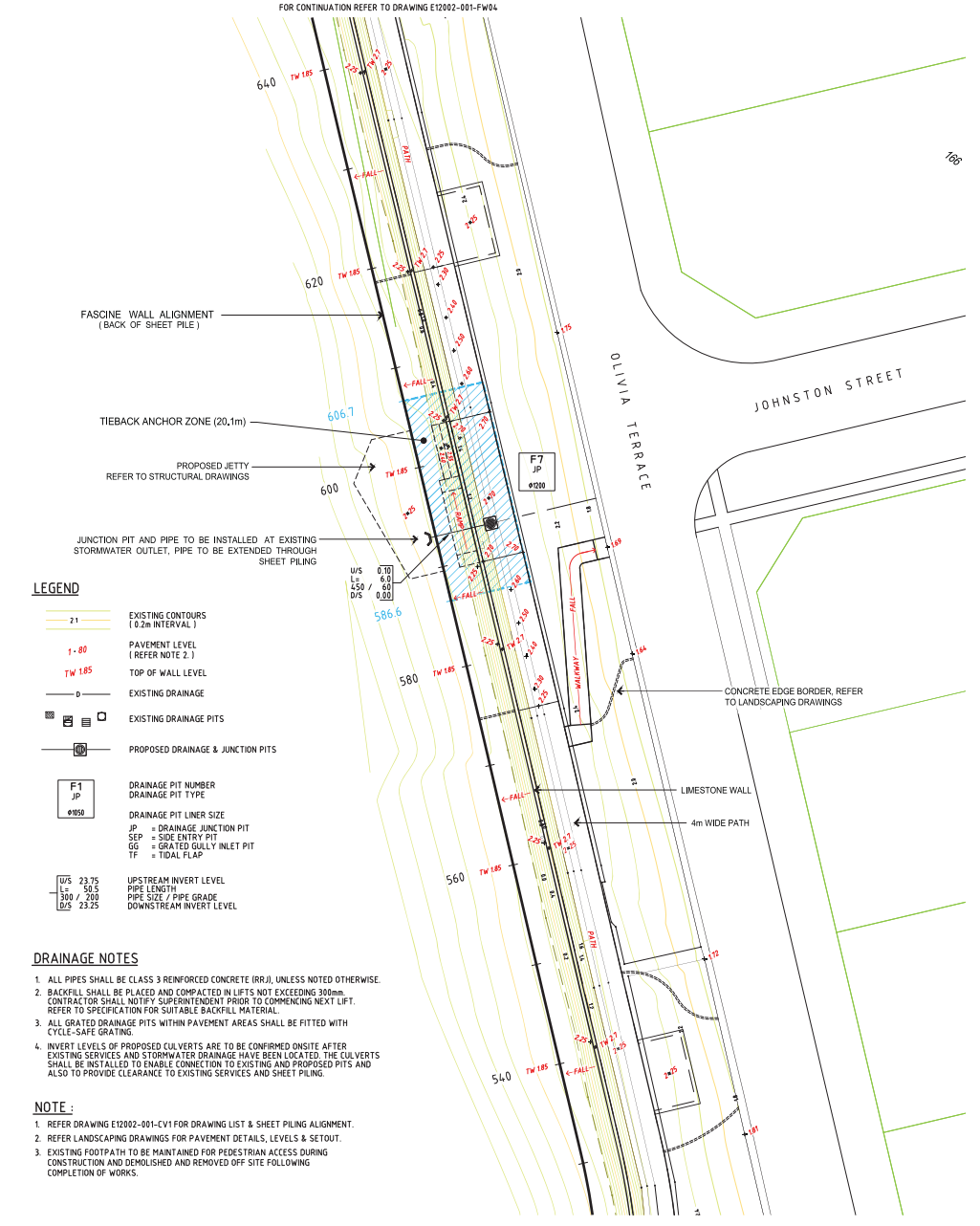
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm ON A1 ORIGINAL

DATE PLOTTED: 07 February, 2013 - 4:17pm
XREFs: xr-da; xr-Splat; xr-FS; x-FW
CAD FILE: L:\2012\E12002 - Fascine Eng Des\Drawings\CAD\E12002-001-FW01-FW04.dwg



PLAN CHN. 430 - 530m

1:250



PLAN CHN. 530 - 640m

1:250

LEGEND

- EXISTING CONTOURS (0.2m INTERVAL)
- PAVEMENT LEVEL (REFER NOTE 2.)
- TOP OF WALL LEVEL
- EXISTING DRAINAGE
- EXISTING DRAINAGE PITS
- PROPOSED DRAINAGE & JUNCTION PITS
- DRAINAGE PIT NUMBER / DRAINAGE PIT TYPE (e.g. F1 JP Ø1050)
- DRAINAGE PIT LINER SIZE
  - JP = DRAINAGE JUNCTION PIT
  - SEP = SIDE ENTRY PIT
  - GG = GRATED GULLY INLET PIT
  - TF = TIDAL FLAP
- UPSTREAM INVERT LEVEL / PIPE LENGTH / PIPE SIZE / PIPE GRADE / DOWNSTREAM INVERT LEVEL (e.g. U/S 23.75, L= 50.5, 300 / 200, D/S 23.25)

DRAINAGE NOTES

1. ALL PIPES SHALL BE CLASS 3 REINFORCED CONCRETE (RRJ), UNLESS NOTED OTHERWISE.
2. BACKFILL SHALL BE PLACED AND COMPACTED IN LIFTS NOT EXCEEDING 300mm. CONTRACTOR SHALL NOTIFY SUPERINTENDENT PRIOR TO COMMENCING NEXT LIFT. REFER TO SPECIFICATION FOR SUITABLE BACKFILL MATERIAL.
3. ALL GRATED DRAINAGE PITS WITHIN PAVEMENT AREAS SHALL BE FITTED WITH CYCLE-SAFE GRATING.
4. INVERT LEVELS OF PROPOSED CULVERTS ARE TO BE CONFIRMED ONSITE AFTER EXISTING SERVICES AND STORMWATER DRAINAGE HAVE BEEN LOCATED. THE CULVERTS SHALL BE INSTALLED TO ENABLE CONNECTION TO EXISTING AND PROPOSED PITS AND ALSO TO PROVIDE CLEARANCE TO EXISTING SERVICES AND SHEET PILING.

NOTE :

1. REFER DRAWING E12002-001-CV1 FOR DRAWING LIST & SHEET PILING ALIGNMENT.
2. REFER LANDSCAPING DRAWINGS FOR PAVEMENT DETAILS, LEVELS & SETOUT.
3. EXISTING FOOTPATH TO BE MAINTAINED FOR PEDESTRIAN ACCESS DURING CONSTRUCTION AND DEMOLISHED AND REMOVED OFF SITE FOLLOWING COMPLETION OF WORKS.

1:250

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	IISSUED FOR TENDER	JPK	NTT

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

		Date
Drawn	JPK	27.03.2012
Designed		Date
Checked	NTT	30.05.2012
Reviewed		Date
Approved		Date

Client: SHIRE OF CARNARVON

Project: SHIRE OF CARNARVON
FASCINE WALL REDEVELOPMENT

Status: FOR CONSTRUCTION

Date	Datum	Scale	Size
30.05.2012	A.H.D	AS SHOWN	A1

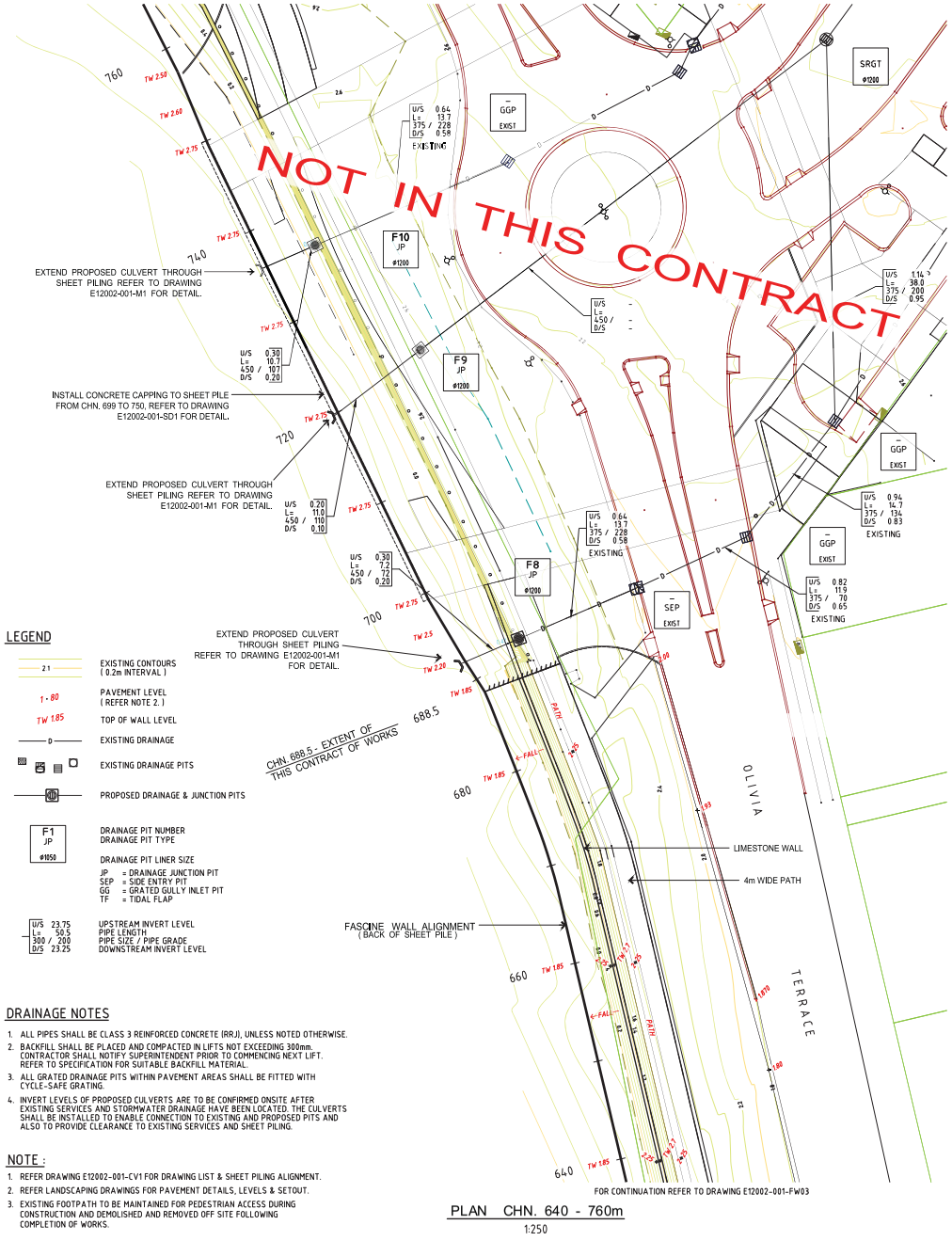
Title: FASCINE WALL
PROPOSED ALIGNMENT - PLAN CHN. 430 - 640m
SHEET 3 OF 4

Drawing Number: E12002-001-FW03 | Revision: 0

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm ON A1 ORIGINAL

DATE PLOTTED: 07 February, 2013 - 4:17pm

XREFs: xr-da, xr-Splat; xr-FS, x-FW
CAD FILE: L:\2012\E12002 - Fascine Eng Des\Drawings\CAD\E12002-001-FW01-FW04.dwg



LEGEND

- EXISTING CONTOURS (0.2m INTERVAL)
- PAVEMENT LEVEL (REFER NOTE 2.1)
- TOP OF WALL LEVEL
- EXISTING DRAINAGE
- EXISTING DRAINAGE PITS
- PROPOSED DRAINAGE & JUNCTION PITS
- F1 JP ø1050 — DRAINAGE PIT NUMBER, DRAINAGE PIT TYPE, DRAINAGE PIT LINER SIZE
  - JP = DRAINAGE JUNCTION PIT
  - SEP = SIDE ENTRY PIT
  - GG = GRATED GULLY INLET PIT
  - TF = TIDAL FLAP
- U/S 23.75 L= 50.5 300 / 200 D/S 23.25 — UPSTREAM INVERT LEVEL, PIPE LENGTH, PIPE SIZE / PIPE GRADE, DOWNSTREAM INVERT LEVEL

DRAINAGE NOTES

1. ALL PIPES SHALL BE CLASS 3 REINFORCED CONCRETE (RRJ), UNLESS NOTED OTHERWISE.
2. BACKFILL SHALL BE PLACED AND COMPACTED IN LIFTS NOT EXCEEDING 300mm. CONTRACTOR SHALL NOTIFY SUPERINTENDENT PRIOR TO COMMENCING NEXT LIFT. REFER TO SPECIFICATION FOR SUITABLE BACKFILL MATERIAL.
3. ALL GRATED DRAINAGE PITS WITHIN PAVEMENT AREAS SHALL BE FITTED WITH CYCLE-SAFE GRATING.
4. INVERT LEVELS OF PROPOSED CULVERTS ARE TO BE CONFIRMED ONSITE AFTER EXISTING SERVICES AND STORMWATER DRAINAGE HAVE BEEN LOCATED. THE CULVERTS SHALL BE INSTALLED TO ENABLE CONNECTION TO EXISTING AND PROPOSED PITS AND ALSO TO PROVIDE CLEARANCE TO EXISTING SERVICES AND SHEET PILING.

NOTE :

1. REFER DRAWING E12002-001-CV1 FOR DRAWING LIST & SHEET PILING ALIGNMENT.
2. REFER LANDSCAPING DRAWINGS FOR PAVEMENT DETAILS, LEVELS & SETOUT.
3. EXISTING FOOTPATH TO BE MAINTAINED FOR PEDESTRIAN ACCESS DURING CONSTRUCTION AND DEMOLISHED AND REMOVED OFF SITE FOLLOWING COMPLETION OF WORKS.

PLAN CHN. 640 - 760m

1:250

1:250

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	IISSUED FOR TENDER	JPK	NTT

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ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

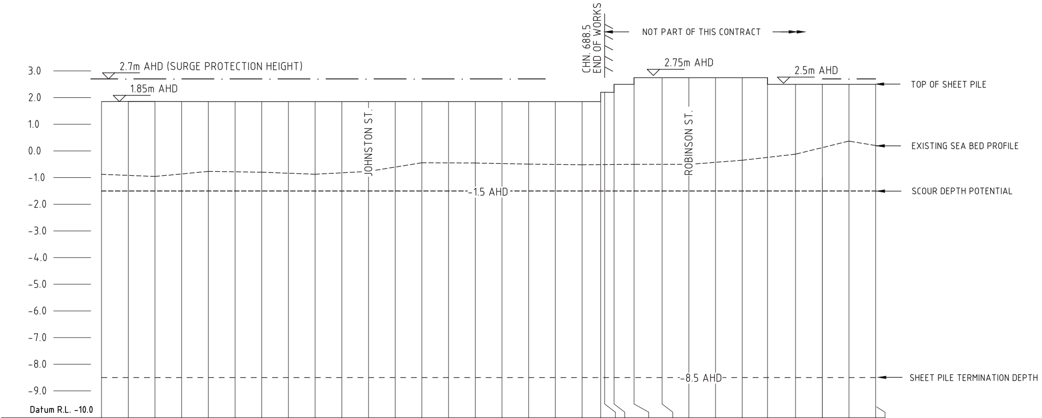
Drawn	JPK	Date	27.03.2012
Designed		Date	
Checked	NTT	Date	30.05.2012
Reviewed		Date	
Approved		Date	

Client: SHIRE OF CARNARVON
Project: SHIRE OF CARNARVON FASCINE WALL REDEVELOPMENT
Status: FOR CONSTRUCTION
Date: 30.05.2012 | Datum: A.H.D | Scale: AS SHOWN | Size: A1
Title: FASCINE WALL PROPOSED ALIGNMENT - PLAN CHN. 640 - 760m SHEET 4 OF 4
Drawing Number: E12002-001-FW04 | Revision: 0

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm ON A1 ORIGINAL

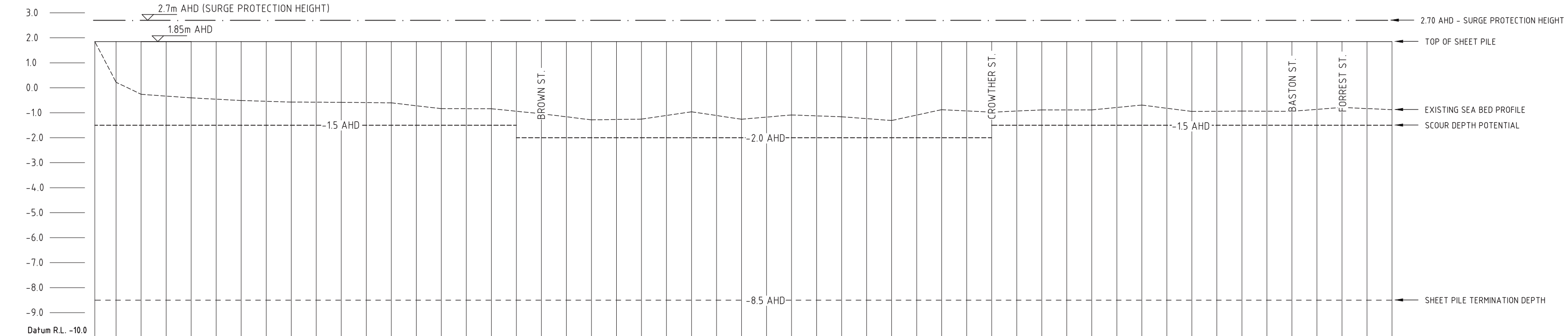
DATE PLOTTED: 07 February, 2013 - 4:17pm

XREFs: xr-da, xr-Splat, xr-FS, x-FW
CAD FILE: L:\2012\E12002 - Fascine Eng Des\Drawings\CAD\E12002-001-FW01-FW04.dwg



Chainage	Top of Wall Level	SeaBed Level	Wall Top to Seabed
500.00	1.850	-0.876	+2.73
510.00	1.856	—	—
520.00	1.850	-0.957	+2.81
530.00	1.853	—	—
540.00	1.850	-0.768	+2.62
550.00	1.850	—	—
560.00	1.850	-0.797	+2.65
570.00	1.850	—	—
580.00	1.850	-0.874	+2.72
590.00	1.850	—	—
600.00	1.850	-0.767	+2.62
610.00	1.850	—	—
620.00	1.850	-0.443	+2.29
630.00	1.850	—	—
640.00	1.850	-0.454	+2.30
650.00	1.850	—	—
660.00	1.850	-0.494	+2.34
670.00	1.850	—	—
680.00	1.850	-0.519	+2.37
687.00	1.850	—	—
688.50	2.200	—	—
692.00	2.200 / 2.500	—	—
699.50	2.500 / 2.750	—	—
710.00	2.750	—	—
720.00	2.750	-0.505	+3.25
730.00	2.750	—	—
740.00	2.750	-0.350	+3.10
749.50	2.750 / 2.500	—	—
760.00	2.500	-0.122	+2.62
770.00	2.500	—	—
780.00	2.500	0.369	+2.13
790.00	2.500	—	—
790.31	—	0.196	—

FASCINE WALL - PROFILE CHN. 500 - 800m
HORIZONTAL SCALE : 1:1000 VERTICAL SCALE 1:100



Chainage	Top of Wall Level	SeaBed Level	Wall Top to Seabed
-18.5	1.850	1.760	—
-10.00	1.850	0.221	—
0.00	1.850	-0.260	+2.11
10.00	1.850	—	—
20.00	1.850	-0.404	+2.25
30.00	1.850	—	—
40.00	1.850	-0.509	+2.36
50.00	1.850	—	—
60.00	1.850	-0.572	+2.42
70.00	1.850	—	—
80.00	1.850	-0.581	+2.43
90.00	1.850	—	—
100.00	1.850	-0.603	+2.45
110.00	1.850	—	—
120.00	1.850	-0.835	+2.69
130.00	1.850	—	—
140.00	1.850	-0.839	+2.69
150.00	1.850	—	—
160.00	1.850	-1.039	+2.89
170.00	1.850	—	—
180.00	1.850	-1.284	+3.13
190.00	1.850	—	—
200.00	1.850	-1.280	+3.13
210.00	1.850	—	—
220.00	1.850	-0.960	+2.81
230.00	1.851	—	—
240.00	1.850	-1.259	+3.11
250.00	1.850	—	—
260.00	1.850	-1.087	+2.94
270.00	1.850	—	—
280.00	1.850	-1.160	+3.01
290.00	1.850	—	—
300.00	1.850	-1.310	+3.16
310.00	1.850	—	—
320.00	1.850	-0.876	+2.73
330.00	1.850	—	—
340.00	1.850	-0.977	+2.83
350.00	1.850	—	—
360.00	1.850	-0.885	+2.74
370.00	1.850	—	—
380.00	1.850	-0.887	+2.74
390.00	1.850	—	—
400.00	1.850	-0.690	+2.54
410.00	1.854	—	—
420.00	1.852	-0.947	+2.80
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440.00	1.850	-0.932	+2.78
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460.00	1.850	-0.941	+2.79
470.00	1.850	—	—
480.00	1.850	-0.786	+2.64
490.00	1.850	—	—
500.00	1.850	-0.876	+2.73

FASCINE WALL - PROFILE CHN. -18.50 - 500m
HORIZONTAL SCALE : 1:1000 VERTICAL SCALE 1:100

1:100 (0 – 1m – 10m)
1:1000 (0 – 10m – 100)

NOTE :
1. REFER TO DRAWING E12002-001-CV1 FOR DRAWING LIST AND SHEET PILING ALIGNMENT.
2. REFER TO DRAWINGS E12002-001-FW06 TO FW08 FOR CROSS SECTIONS.

Rev	Date	Description	Drawn	Appr
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	ISSUED FOR TENDER	JPK	NTT

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PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn: JPK	Date: 28.05.2012	
Designed	Date	
Checked: NTT	Date: 30.05.2012	
Reviewed	Date	
Approved	Date	

Client: SHIRE OF CARNARVON
Project: SHIRE OF CARNARVON
FASCINE WALL REDEVELOPMENT
Title: FASCINE WALL
PROPOSED ALIGNMENT
LONGITUDINAL PROFILE
Status: FOR CONSTRUCTION

Date	Datum	Scale	Size
30.05.2012	A.H.D	AS SHOWN	A1

Drawing Number: E12002-001-FW05
Revision: 0

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DATE PLOTTED: 07 February, 2013 - 4:18pm
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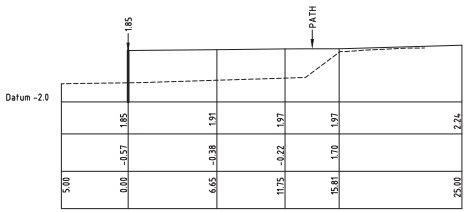

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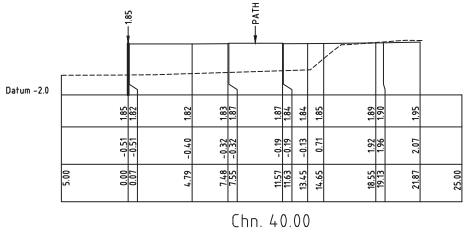

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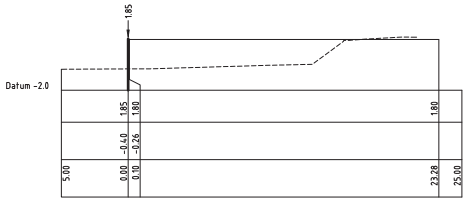

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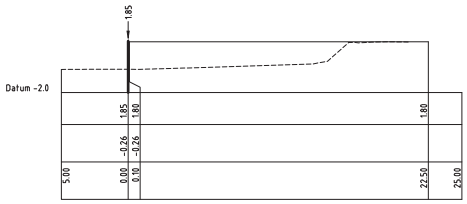

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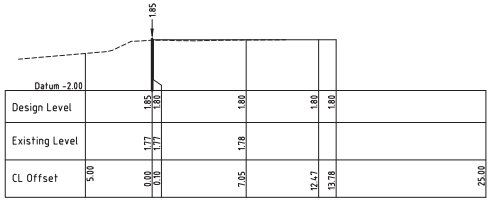

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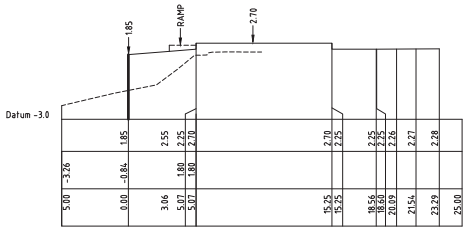

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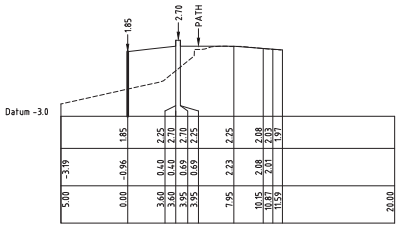

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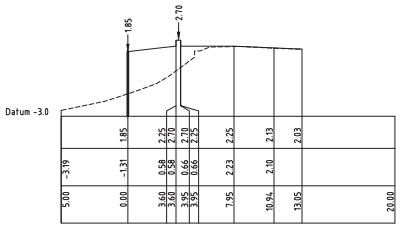

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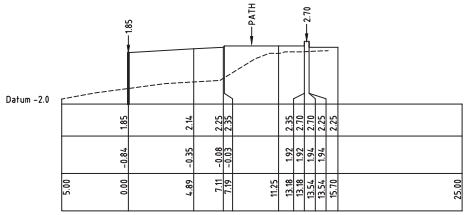

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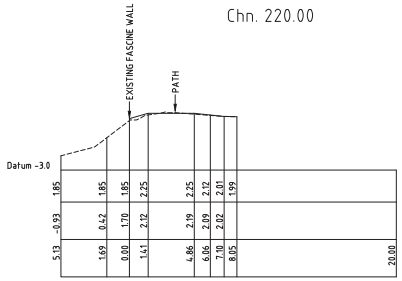

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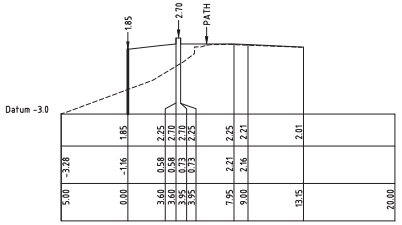

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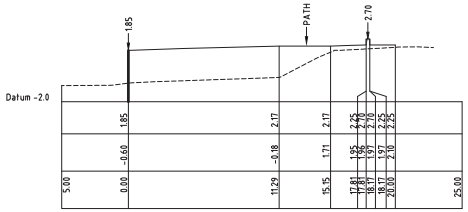

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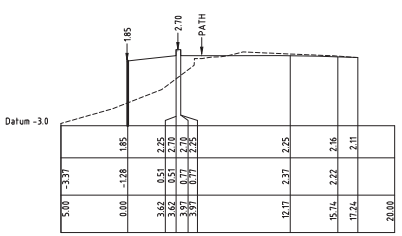

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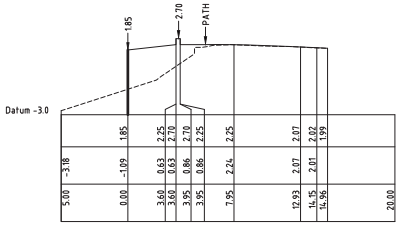

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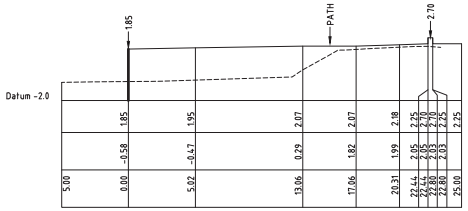
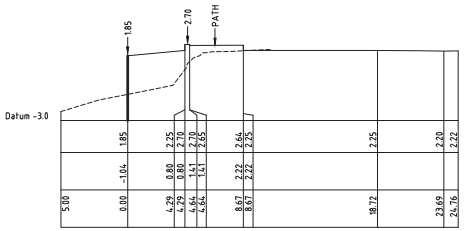


Chn. 80.00



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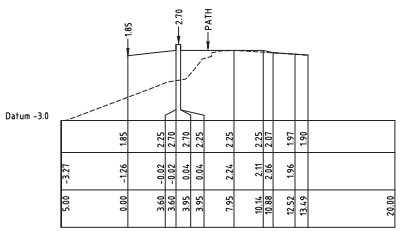

Chn. 240.00

FASCINE WALL - CROSS SECTIONS CHN. -18.5 - 300m

SCALE 1:200

NOTE :

1. REFER TO DRAWING E12002-001-CV1 FOR COVER SHEET AND DRAWING LIST AND CHAINAGE LOCATIONS.
2. REFER TO DRAWING E12002-001-FW05 FOR SHEET PILING LONGITUDINAL PROFILE.
3. THE CROSS SECTIONS ARE A GUIDE. REFER TO THE LANDSCAPING DRAWINGS FOR PAVEMENT LEVELS AND SETOUT.

1:200

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	ISSUED FOR TENDER	JPK	

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	JPK	Date	28.05.2012
Designed		Date	
Checked	NTT	Date	30.05.2012
Reviewed		Date	
Approved		Date	

Client: SHIRE OF CARNARVON

Project: SHIRE OF CARNARVON
FASCINE WALL REDEVELOPMENT

Status: FOR CONSTRUCTION

Date	Datum	Scale	Size
30.05.2012	A.H.D	AS SHOWN	A1

Title: FASCINE WALL
PROPOSED ALIGNMENT
CROSS SECTIONS CHN. -18.5 - 300m SHEET 1 OF 3

Drawing Number: E12002-001-FW06

Revision: 0

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DATE PLOTTED: 07 February, 2013 - 4:19pm

XREF's
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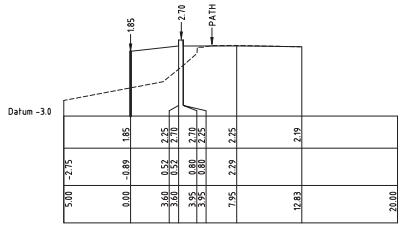

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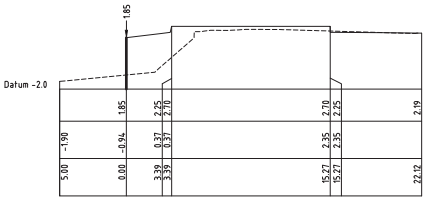

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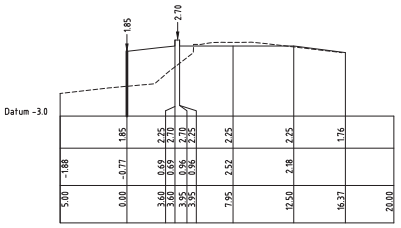

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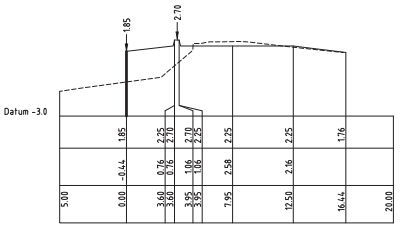

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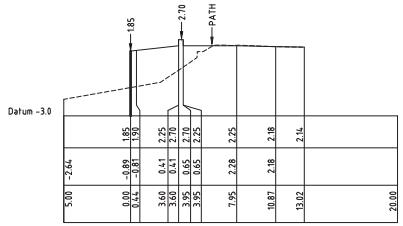

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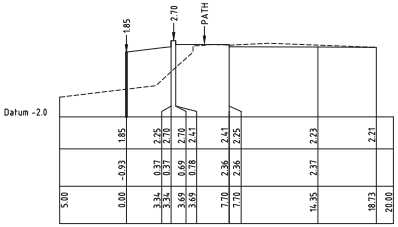

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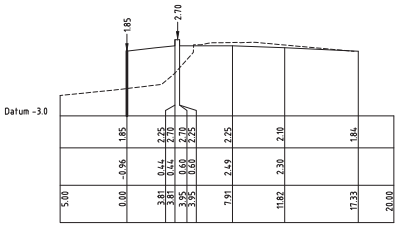

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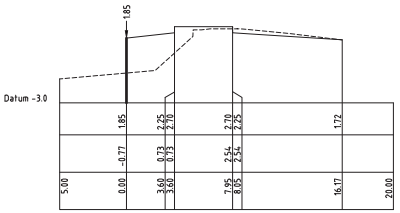

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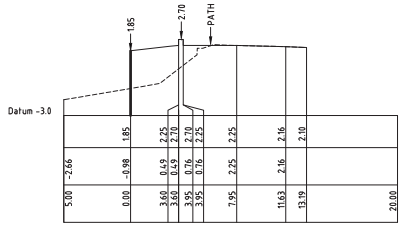

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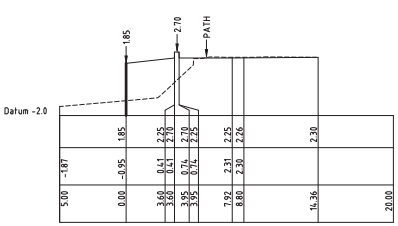

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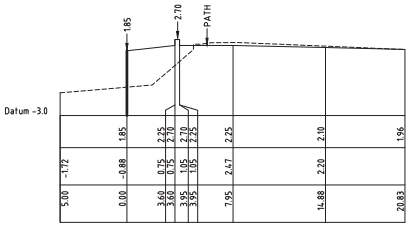

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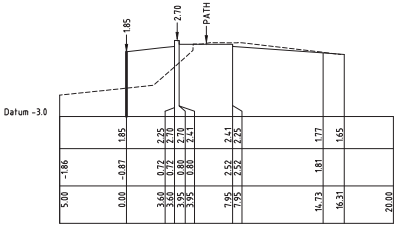

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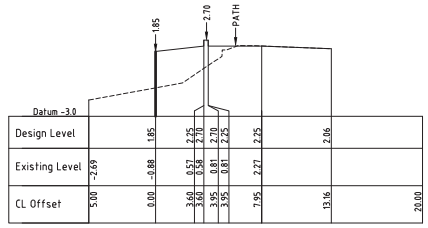

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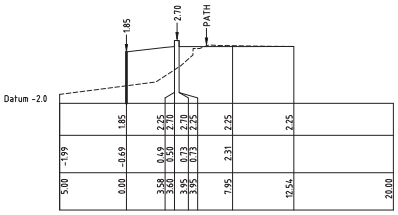

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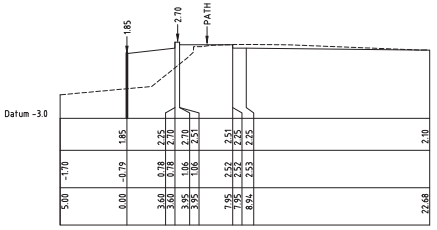

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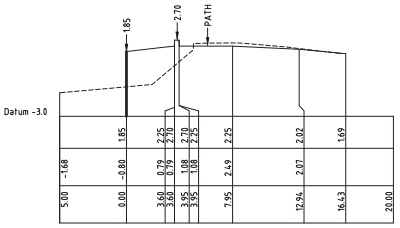

Chn. 560.00

FASCINE WALL - CROSS SECTIONS CHN. 320 - 620m

SCALE 1:200

NOTE :

1. REFER TO DRAWING E12002-001-CV1 FOR COVER SHEET AND DRAWING LIST AND CHAINAGE LOCATIONS.
2. REFER TO DRAWING E12002-001-FW05 FOR SHEET PILING LONGITUDINAL PROFILE.
3. THE CROSS SECTIONS ARE A GUIDE. REFER TO THE LANDSCAPING DRAWINGS FOR PAVEMENT LEVELS AND SETOUT.

1:200

0 2m 4 6 8 10 12 14 16 18 20m

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	ISSUED FOR TENDER	JPK	

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	JPK	Date 28.05.2012
Designed		Date
Checked	NTT	Date 30.05.2012
Reviewed		Date
Approved		Date

Client: SHIRE OF CARNARVON

Project: SHIRE OF CARNARVON
FASCINE WALL REDEVELOPMENT

Status: FOR CONSTRUCTION

Date	Datum	Scale	Size
30.05.2012	A.H.D	AS SHOWN	A1

Title: FASCINE WALL
PROPOSED ALIGNMENT
CROSS SECTIONS CHN. 320 - 620m SHEET 2 OF 3

Drawing Number: E12002-001-FW07

Revision: 0

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DATE PLOTTED: 07 February, 2013 - 4:19pm

XREF's
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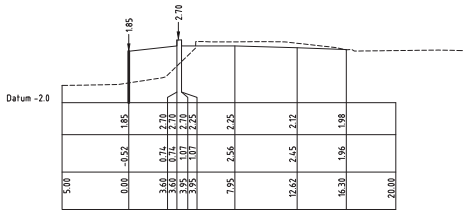
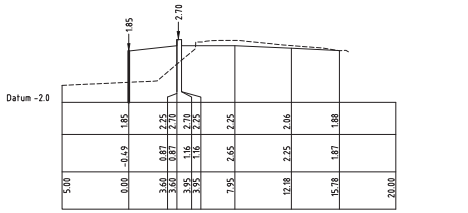


Chn. 680.00



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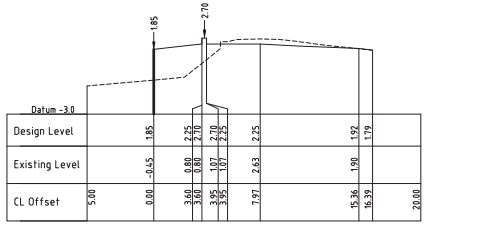

Chn. 640.00

FASCINE WALL - CROSS SECTIONS CHN. 640 - 680m
SCALE 1:200

NOTE :
1. REFER TO DRAWING E12002-001-CV1 FOR COVER SHEET AND DRAWING LIST AND CHAINAGE LOCATIONS.
2. REFER TO DRAWING E12002-001-FW05 FOR SHEET PILING LONGITUDINAL PROFILE.
3. THE CROSS SECTIONS ARE A GUIDE. REFER TO THE LANDSCAPING DRAWINGS FOR PAVEMENT LEVELS AND SETOUT.

1:200 0 2m 4 6 8 10 12 14 16 18 20m

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	IISSUED FOR TENDER	JPK	

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	JPK	Date 28.05.2012
Designed		Date
Checked	NTT	Date 30.05.2012
Reviewed		Date
Approved		Date

Client: SHIRE OF CARNARVON
Project: SHIRE OF CARNARVON
FASCINE WALL REDEVELOPMENT
Status: FOR CONSTRUCTION
Date: 30.05.2012 | Datum: A.H.D | Scale: AS SHOWN | Size: A1
Title: FASCINE WALL
PROPOSED ALIGNMENT
CROSS SECTIONS CHN. 640 - 680m SHEET 3 OF 3
Drawing Number: E12002-001-FW08 | Revision: 0

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DATE PLOTTED: 07 February, 2013 - 4:20pm
XREF's
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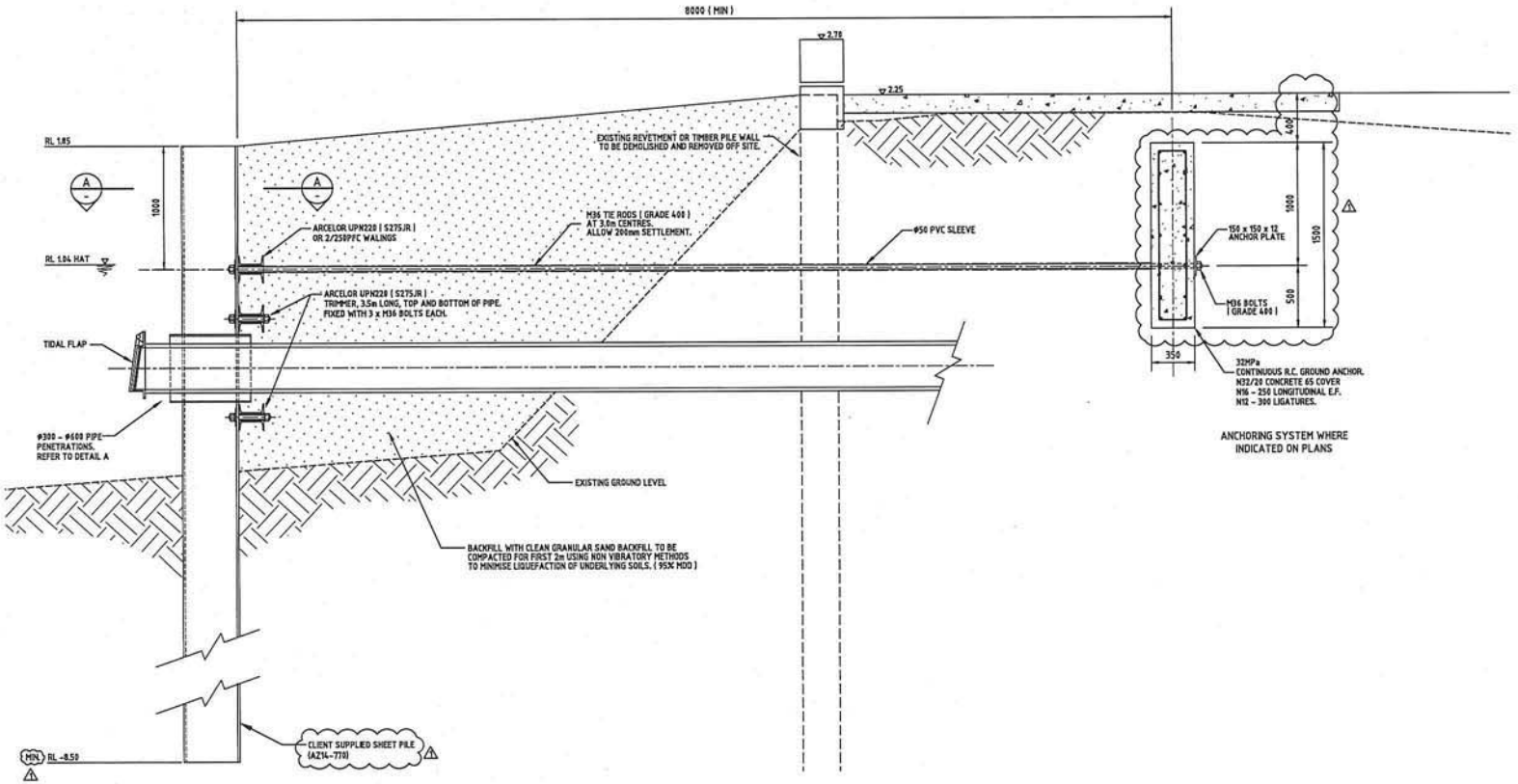
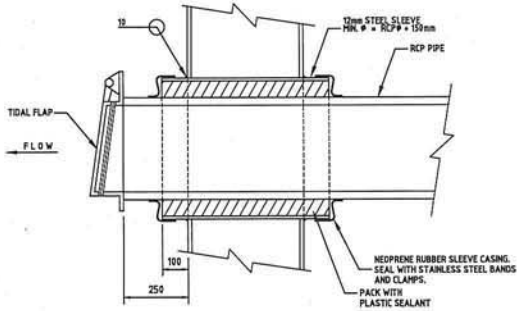


ANCHORING SYSTEM WHERE INDICATED ON PLANS

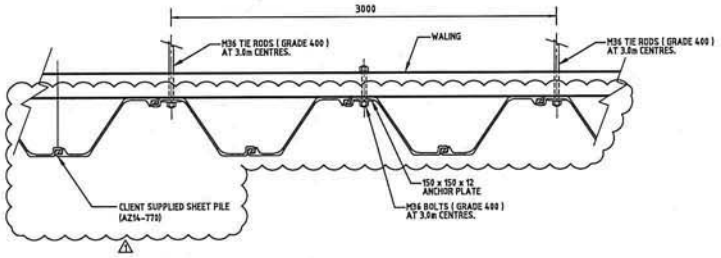
FASCINE WALL - CROSS SECTION
SCALE 1 : 20

NOTES :

1. ALL TIE RODS, BEARING PLATES WASHERS AND NUTS TO BE HOT DIP GALVANISED OR APPROPRIATELY PROTECTED AGAINST CORROSION.
2. MINIMUM STEEL GRADE FOR TIE RODS 400mpa.
3. CONTRACTOR TO PROVIDE SHOP DRAWINGS FOR APPROVAL PRIOR TO CONSTRUCTION.
4. DESIGN LOADS ALLOWED FOR :
   a.) SHEET PILES $m_* = 385kNm/m$
   $V_* = 1355kN/m$
   b.) ANCHOR FORCE @ 3.0m crs
   $N_* = 145$ N
5. REFER TO WALL SECTION DRAWINGS FOR PILING AND ANCHORING DEPTHS.



DETAIL A
SCALE 1 : 10



SECTION A-A
SCALE 1 : 20

REFER DRAWING E12002-001-CV1 FOR DRAWING LIST & SHEET PILING ALIGNMENT.

Rev	Date	Description	Drawn	Appr.
1	12.02.2013	SHEET PILE NOTES & ANCHOR BLOCK CHANGE	JYY	
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
A	06.06.2012	ISSUED FOR TENDER	JPK	NTT

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	JPK	08.03.2012
Designed	NTT	08.03.2012
Checked	NTT	30.05.2012
Reviewed		
Approved		

Client: SHIRE OF CARNARVON
Project: CARNARVON FORESHORE FASCINE WALL
Title: FASCINE WALL SHEET PILING CROSS SECTION AND TYPICAL DETAILS

Status: FOR CONSTRUCTION
Date: 30.05.2012 | Datum: A.H.D | Scale: AS SHOWN | Size: A1
Drawing Number: E12002-001-M1 | Revision: 1

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DATE PLOTTED: 12 February, 2013 - 3:25pm
XREF's
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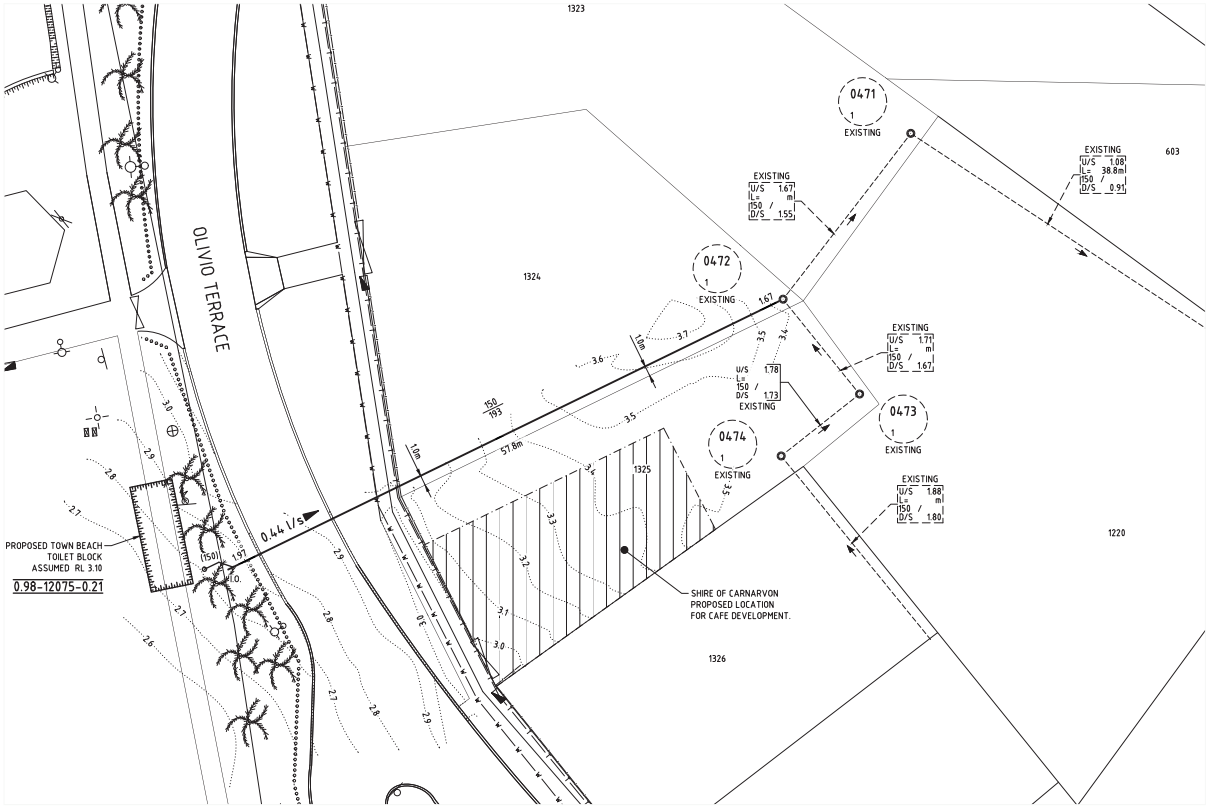
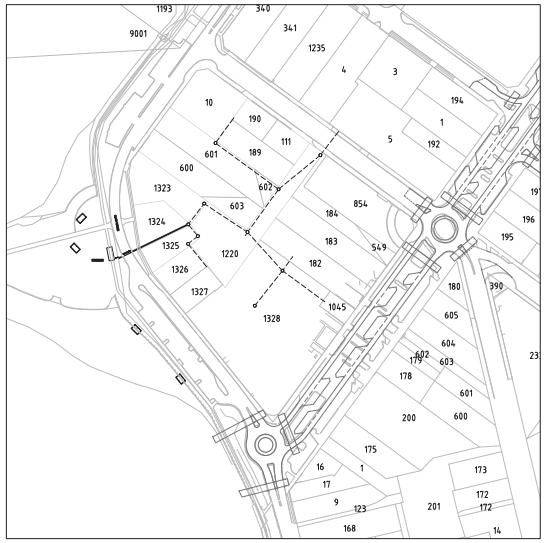


SEWER RETICULATION PLAN

SCALE 1: 250



LOCATION PLAN

SCALE 1: 2000

DESIGN DATA NOTES

NET AREA FOR AREA SERVICED – 0.98 Ha
PEAK FLOW FOR AREA SERVICED – 0.21 L/sec

SITE NOTES

LOCAL AUTHORITY: = SHIRE OF CARNARVON
ESTIMATED MAX. G.W.L. = VARIES
ENTIRE AREA CONSIDERED AS DRY DESIGN. UNLESS SHOWN OTHERWISE.

No. OF LOTS SERVICED = 1

LOTS TO BE RELEASED:
WITHIN THIS STAGE.
(incl. # excl. *) = 0

LOTS TO BE RELEASED:
(PREVIOUSLY SERVED: #) = 0

LOTS NOT TO BE RELEASED:
(SERVED THIS STAGE: *) = 0

No. OF ACCESS CHAMBERS = 0
No. OF MAINTENANCE SHAFTS = 0

LENGTH OF SEWERS (m)
150 DIAMETER = 57.8m

NO BACKFILLING OF SEWER TRENCHES SHALL OCCUR UNTIL CERTIFICATION IS OBTAINED FROM THE PROJECT SURVEYOR THAT THE AS CONSTRUCTED SURVEY COMPLIES WITH THE DESIGN LEVELS.
IT IS THE CONTRACTORS RESPONSIBILITY TO CO-ORDINATE AND LIAISE WITH THE SURVEYOR AT THE APPROPRIATE TIME.

NOTATION

NON RESIDENTIAL

NET AREA(ha) — 0.86-12075-0.18 — DESIGN FLOW (l/s)
l/NET HECTARE/DAY

LEGEND

- PROPOSED GRAVITY SEWER
- EXISTING SEWER
- PROPOSED SEWER EASMENT
- AC C 0.0 1 D — TRAFFICABLE: (CAST / DUCTILE IRON) ACCESS CHAMBER No. CLASS OF COVER & DEPTH (APPROX) CHAMBER TYPE AND DROP NOTATION
- 90°/180° — ANGLE OF INLETS
- U/S L= m 150 / D/S — UPSTREAM INVERT LEVEL, PIPE LENGTH, PIPE SIZE / PIPE GRADE, DOWNSTREAM INVERT LEVEL
- 150 / 200 — PIPE DIAMETER, PIPE GRADE
- 00.00 00.00 — INVERT LEVELS
- FLOW DIRECTION 100.0m — PIPE LENGTH
- 0.55 l/s — DIRECTION OF FLOW

SEWER NOTES

1. THE DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE NOTES AND STANDARD DRAWINGS LISTED ON WATER CORPORATION DWG AA01-3-1.
2. ALL PIPE SIZES IN MILLIMETERS (DIA 150 U.O.N.). ALL DISTANCES AND LEVELS IN METERS.
3. DISTANCES GIVEN ARE AT THE INTERSECTION OF SEWERS.
4. THE CONTRACTOR SHALL ENSURE THAT ALL STRATA LOTS ARE SERVED WITH HOUSE CONNECTIONS.
5. EARTHWORKS TO BE PLACED AND COMPACTED PRIOR TO CONSTRUCTION OF SEWERS.
6. ALL CONNECTIONS TO LIVE SEWERS TO BE BY THE WATER CORPORATION AT THE CONTRACTORS EXPENSE.
7. ACCESS CHAMBER DEPTHS ARE SHOWN FOR WATER CORPORATION INFORMATION ONLY.
8. BASE INFORMATION
   - 8.1. LEVELS ARE REDUCED FROM AUSTRALIAN HEIGHT DATUM.
   - 8.2. CONTRACTOR TO MAKE THEIR OWN ASSESSMENT OF GROUNDWATER LEVELS AND MAKE ALL DUE ALLOWANCES IN THEIR LUMP SUM TENDER.
9. CENTERLINES OF ACCESS CHAMBERS, SEWER PIPES AND END OF I.O. LINES ARE TO BE ON ALIGNMENTS OF 3.2m IN ROAD RESERVES AND 0.7m INSIDE LOTS U.O.N.
10. SEWER PIPES TO BE UPVC CLASS "SN8" SOLVENT CEMENT JOINT U.O.N.
11. ALL HOUSE CONNECTIONS DEEPER THAN 1.5m ARE TO BE BROUGHT UP TO 0.5m BELOW FINISHED SURFACE LEVEL. ALL HOUSE CONNECTIONS UNDER RETAINING WALLS ARE TO BE BROUGHT IN A MINIMUM DISTANCE OF 1.5m.
12. MINIMUM COVER OF SEWERS TO BE 1.0m IN ROAD CROSSINGS AND 0.75m IN LOTS AND ROAD VERGE.
13. CONCRETE ENCASEMENT SHALL BE PROVIDED ALONG SIDE BOUNDARIES AS SHOWN FROM THE FRONT BOUNDARY TO THE REAR BOUNDARY.
14. ACCESS CHAMBERS LESS THAN 6m DEEP SHALL BE PRECAST CONCRETE, OR STANDARD BRICK CONSTRUCTION UNLESS NOTED OTHERWISE.
15. TRAFFICABLE ACCESS CHAMBER COVERS TO BE GATIC TWO PART HEAVY DUTY (B2931) OR SIMILAR APPROVED. ALL OTHER COVERS WITHIN ROAD RESERVE SHALL BE TYPE D.
16. CONTRACTOR SHALL ONLY CLEAR THE MINIMUM WIDTH REQUIRED TO EXCAVATE TRENCHES FOR SEWER LINES WITHIN PUBLIC OPEN SPACE. ALL OTHER VEGETATION SHALL BE PRESERVED UNLESS OTHERWISE DIRECTED BY THE SUPERINTENDENT. TRAFFIC SHALL BE CONFINED TO THESE SEWER LINES.
17. SERVICES, SUCH AS WATER, GAS, TELEPHONE, ELECTRICITY AND DRAINAGE MAY BE ENCOUNTERED DURING CONSTRUCTION OF THE WORKS. SERVICES INFORMATION SHOWN ON DRAWINGS IS INDICATIVE ONLY AND MAY NOT BE COMPLETE. BEFORE EXCAVATION COMMENCES THE LOCATION OF ALL SUCH SERVICES SHALL BE OBTAINED FROM THE RELEVANT AUTHORITIES.
18. THE LOCATION AND LEVEL OF POINTS OF CONNECTION TO EXISTING SCHEMES SHALL BE VERIFIED BY A SURVEYOR BEFORE COMMENCING CONSTRUCTION.
19. LOCAL AUTHORITY: CITY OF ARMADALE
20. EASEMENTS TO RUN PARALLEL TO SEWER LINES & ARE AT NO COST TO WATER CORPORATION.
21. THE CONTRACTOR SHALL VERIFY / CONFIRM THE EXISTING SEWER PIPE INVERT LEVELS TO THE SUPERINTENDENT PRIOR TO EXTENDING THE NEW SEWER MAIN. ANY DISCREPANCIES SHALL BE REPORTED TO THE SUPERINTENDENT IMMEDIATELY.
22. THE CONTRACTOR SHALL SUBMIT COPIES OF SEWER ISOLATING PLUG, CONTRACTOR'S PIPE LAYING CERTIFICATION, CERTIFICATION OF TESTING EQUIPMENT AND ALL ACCREDITATION CERTIFICATES AS APPROPRIATE TO THE SUPERINTENDENT INCLUDING ANY PAYMENT TO WATER CORPORATION PRIOR TO COMMENCEMENT OF ANY WORK ON SITE.
23. THE CONTRACTOR SHALL SUBMIT TO THE SUPERINTENDENT COPIES OF SEWER AS CONSTRUCTED FLIMSIES IN COMPLIANCE WITH WATER CORPORATION'S REQUIREMENTS WITHIN 7 DAYS AFTER COMPLETION OF SEWER INSTALLATION. IN THE EVENT THIS INFORMATION IS NOT SUBMITTED AS INDICATED THE SUPERINTENDENT WILL POSTPONE THE PROCESSING OF PROGRESS CLAIM SUBMITTED BY THE CONTRACTOR UNTIL SUCH A TIME THE REQUIRED SEWER AS CONSTRUCTED INFORMATION IS SUBMITTED TO THE SUPERINTENDENT.

THIS PLAN IS ACCEPTED AS COMPLYING WITH OVERALL SCHEME PLANNING. COMPLIANCE WITH RELEVANT MANUALS REMAINS THE RESPONSIBILITY OF THE CONSULTING ENGINEER.
NO WORKS ARE TO COMMENCE ON SITE UNTIL STARTUP ARRANGEMENTS HAVE BEEN MADE WITH THE RELEVANT WORKS INSPECTOR.
SEE DEVELOPER'S MANUAL FOR CONTACT DETAILS.

Nick McLachlan
FOR MANAGER LAND SERVICING

18 / 12 / 2012
DATE

KZ82-001-001-01A

FILE No.: JT1 2012 11016 V01

RETICULATION AREA: CARNARVON

Rev	Date	Description	Drawn	Appr.
0	25.01.2013	ISSUED FOR CONSTRUCTION	DLC	NC

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		Date
Drawn	DLC	15.10.2012
Designed	DLC	15.10.2012
Checked	NC	15.10.2012
Reviewed	NC	15.10.2012
Approved	NC	15.10.2012

Client: SHIRE OF CARNARVON
Project: SHIRE OF CARNARVON FASCINE WALL REDEVELOPMENT
Title: SEWER RETICULATION PLAN TOWN BEACH

Status: FOR CONSTRUCTION
Date: 15.10.2012 | Datum: A.H.D. | Scale: AS SHOWN | Size: A1
Drawing Number: E12002-001-S1 | Revision: 0

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1:250 0 2.5m 5 7.5 10 12.5 15 17.5 20 22.5 25

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm ON A1 ORIGINAL

DATE PLOTTED: 25 January, 2013 - 11:28am
XREFs: X-OA, X-SPLAT
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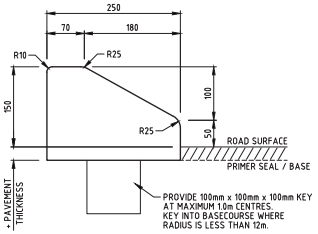
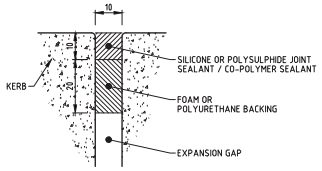


SEMI-MOUNTABLE KERB - TYPE 1 (SMK-1)

SCALE 1 : 5

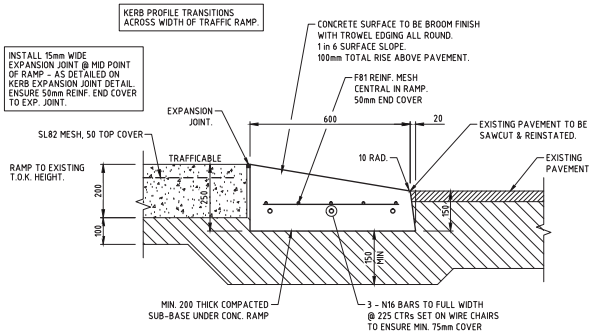
KERB NOTES:

1. CONCRETE FOR USE IN EXTRUDED KERBING SHALL BE READY MIXED CONCRETE CONFORMING WITH ALL THE REQUIREMENTS OF AS 1379.
2. EXPANSION JOINTS: PLACE AT 5m INTERVALS FOR ALL KERBS. EXPANSION JOINTS: PLACE AT 10m INTERVALS FOR ALL REINFORCED FLUSH BEAMS. - ENSURE REINF COVER.
3. REINFORCED FLUSH EDGE BEAM NOT TO BE CUT.
4. REINFORCEMENT TO BE STRUCTURAL GRADE STEEL COMPLYING WITH AS1302 GRADE 410Y.
5. TRANSITION OF KERB TYPES TO BE OVER 2.0m LENGTH UNLESS NOTED OTHERWISE.
6. THE CONCRETE CYLINDER COMPRESSIVE STRENGTH AT 28 DAYS SHALL BE NO LESS THAN 32MPa.
7. AGGREGATE SIZE SHALL BE 10mm NOMINAL.
8. CONCRETE SHALL HAVE A MAXIMUM SLUMP OF 50mm.



KERB EXPANSION JOINT DETAIL

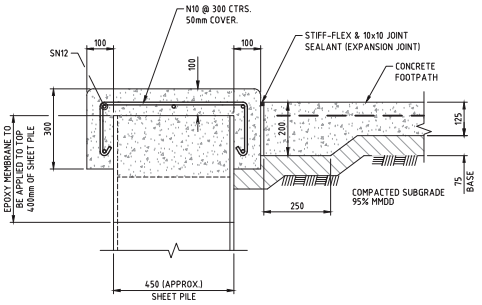
DIAGRAMMATIC



MOUNTABLE TRAFFIC RAMP DETAIL

LOCATED AT PLAZA TREATMENT AREAS

SCALE 1 : 10

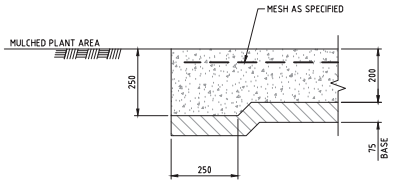


PILE CAP DETAILS

SCALE 1 : 10

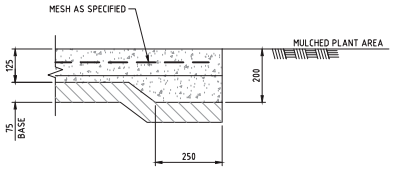
NOTES

1. EXPANSION JOINTS FOR PILE CAPS TO BE EVERY 2.5m.
2. CONCRETE TO BE BROOMED FINISH Fc'28 32MPa.



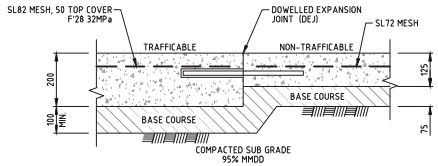
TRAFFICABLE CONCRETE & PLANT AREA INTERFACE

SCALE 1 : 10



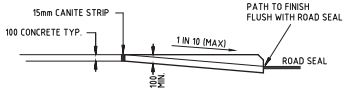
NON-TRAFFICABLE CONCRETE & PLANT AREA INTERFACE

SCALE 1 : 10



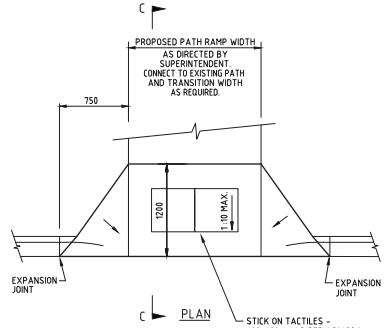
CONCRETE CROSSINGS - TRAFFICABLE & NON-TRAFFICABLE INTERFACE

SCALE 1 : 10



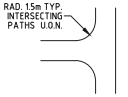
SECTION C-C

FRONT ELEVATION



CONCRETE PATH RAMP DETAILS

N.T.S.



RAMP NOTES:

1. EDGE OF RAMP SHALL BE FLUSH WITH ROAD PAVEMENT.
2. ALL EDGES OF DUAL USE PATHWAYS, INCLUDING TRANSVERSE JOINTS ARE TO BE FINISHED USING A BULL NOSED TROWEL.
3. GENERALLY, PATHS & RAMPS TO BE CONCRETE FINISH.
4. COMPACTION UNDER PATHS TO BE 95% MDD.

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
B	24.07.2012	IISSUED FOR TENDER	DCL	NTT
A	13.06.2012	IISSUED FOR COMMENT	DCL	NTT

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

		Date
Drawn	DLC	13.06.2012
Designed	NTT	13.06.2012
Checked		
Reviewed		
Approved		

Client: SHIRE OF CARNARVON
Project: CARNARVON FORESHORE FASCINE WALL
Title: STANDARD DETAILS SHEET 1 OF 2
Status: FOR CONSTRUCTION
Date: 13.06.2021 | Datum: A.H.D | Scale: AS SHOWN | Size: A1
Drawing Number: E12002-001-SD1 | Revision: 0

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1:10 0 0.1m 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
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DATE PLOTTED: 07 February, 2013 - 4:29pm
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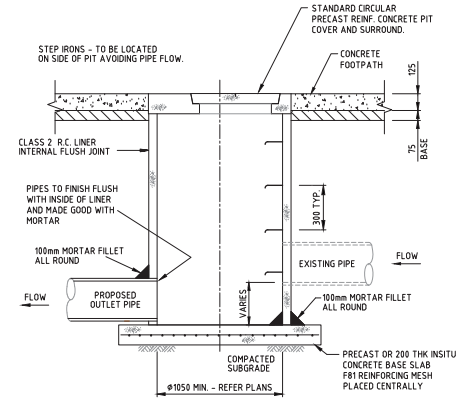
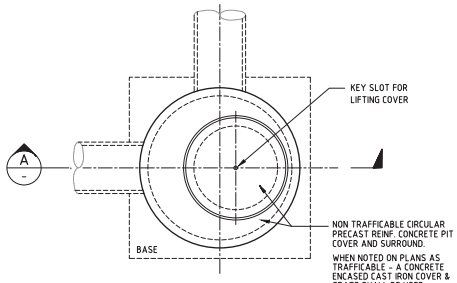


SECTION A–A

SCALE: 1 : 20



PLAN

JUNCTION PIT (TYPE: JUNC)

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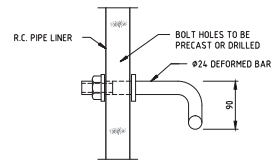

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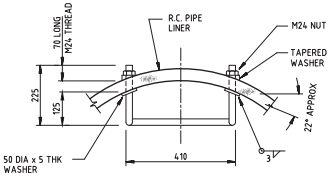
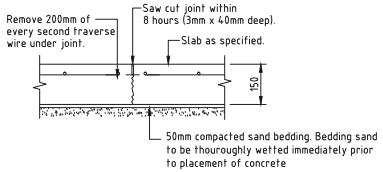


PLAN

STEP IRON DETAILS

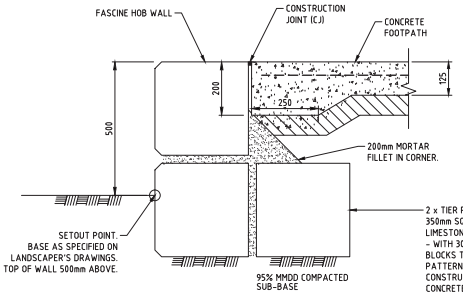
N.T.S.

- ALL ITEMS SHALL BE HOT DIPPED GALVANISED.
- STEP IRONS AT 300 CENTRES.
- TOP STEP IRON SHALL BE LOCATED 500 MAX. BELOW TOP OF LID.



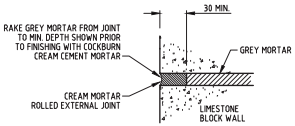
TYPICAL SAW-CUT JOINT (SCJ)

1:10 at A1
1:20 at A3



TYP. RETAINING WALL & PLAZA DETAIL

SCALE 1 : 10



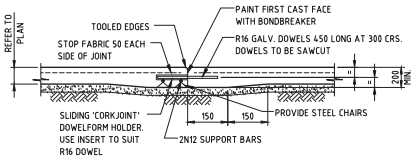
BLOCK WALL MORTAR JOINT DETAIL.

TYPICAL MORTAR DETAIL - FINAL JOINT FINISH TO BE AS SPECIFIED ON PROJECT PLANS

SCALE N.T.S.

STANDARD NOTES

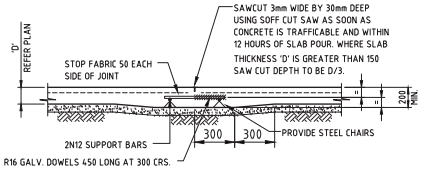
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN
2. CONCRETE SHALL BE 20mm NOM. AGGREGATE AND HAVE A MINIMUM STRENGTH AT 28 DAYS OF:
   INSITU BASE - 20 MPa
   PRECAST UNIT - 40 MPa
3. MORTAR SHALL BE 3 SAND : 1 CEMENT.
4. ALL PRECAST CONCRETE COMPONENTS SHALL BE OF APPROVED MANUFACTURE.
5. SUBGRADE TO BASE SHALL BE COMPACTED TO 95% M.M.D.D. BEFORE PLACING BASE.
6. BACKFILL AROUND PIT SHALL BE COMPACTED TO 95% M.M.D.D.
7. ALL WORKS SHALL BE TO REQUIREMENTS AND APPROVAL OF THE LOCAL AUTHORITY.
8. BOLT ON GALVANISED STEP IRONS AT 300 CTRS SHALL BE INSTALLED IN ALL DRAINAGE PITS DEEPER THAN 1.0m FROM TOP OF COVER TO TOP OF BASE.
9. ALL DRAINAGE PITS (EXCEPT LOT DRAINAGE) SHALL BE CONCRETE BENCHED TO A MINIMUM DEPTH OF 50mm, UNLESS SPECIFIED AS A TRAPPED PIT ON THE DRAINAGE PLANS. WHERE THE PIT SHALL BE 600mm MIN. DEPTH BELOW THE LOWEST I.L. A TRAPPED PIT SHALL HAVE A Φ230mm SEEPAGE HOLE CENTRAL IN PIT BASE AND FILLED WITH 32mm MIN. AGGREGATE. U.O.N.
10. ALL PIPEWORK SHALL HAVE 100mm MORTAR FILLET ALL ROUND TO PIT WALLS.
11. PIT LINER SIZES SHALL BE AS SPECIFIED ON THE PROJECT DRAINAGE PLANS UNLESS DISCUSSED OTHERWISE. OTHER PIT SIZES OR TYPES SHALL BE DISCUSSED WITH THE SUPERINTENDENT.
    PIT LINERS SHALL BE INTERLOCKING JOINT, SPUN REINFORCED CONCRETE - EQUIVALENT TO CLASS 2 PIPE. BASES TO BE SET ON BEDDED COMPACTED SAND.



TYPICAL DOWELLED EXPANSION JOINT (DEJ)

WHERE SLAB THICKNESS IS GREATER THAN 150 NO THICKENING REQUIRED

N.T.S



TYPICAL SAWN DOWELLED JOINT (S.D.J.)

WHERE SLAB THICKNESS IS GREATER THAN 150 NO THICKENING REQUIRED

N.T.S

GENERAL NOTES

1. DO NOT SCALE FROM DRAWINGS.
2. CHECK DRAWING AND SITE DIMENSIONS BEFORE COMMENCING WORK. REPORT DISCREPANCIES TO THE ENGINEER AND OBTAIN A DIRECTION.
3. SPECIFICATIONS OR INSTRUCTIONS ON DRAWINGS TAKE PRECEDENCE OVER THESE NOTES.
4. WALLS HAVE BEEN DESIGNED FOR SURCHARGE LOADS < 5kPa. APPROVAL FROM AN INDEPENDENT PRACTICING STRUCTURAL ENGINEER MUST BE OBTAINED BEFORE ANY ALTERATIONS OR ADDITIONS ARE MADE TO THE WALL OR ANY CHANGES TO GROUND LEVELS IN THE VICINITY OF THE WALL.
5. WALLS HAVE BEEN DESIGNED FOR STABLE (CLASS 'A' OR 'S' TO AS2870) FOUNDATION CONDITIONS. FOR SAND BACKFILL (MAX. 5% FINES SMALLER THAN 75 MICRONS) AND FOR A WATER TABLE WHICH WILL NOT RISE ABOVE A LEVEL 600mm BELOW THE BASE OF THE WALL. THE ENGINEER MUST BE CONSULTED PRIOR TO COMMENCING CONSTRUCTION IF ANY OF THESE CONDITIONS CAN NOT BE SATISFIED.

PREPARATION

1. REMOVE UNSUITABLE SILT, CLAY, ORGANIC AND DELETERIOUS MATERIALS FROM AREAS TO BE EXCAVATED OR OCCUPIED BY STRUCTURES, PAVEMENTS, EMBANKMENTS AND THE LIKE.
2. COMPACT SOIL BASE UNDER RETAINING WALL TO AT LEAST 95% MODIFIED MAXIMUM DRY DENSITY. CONTRACTOR SHALL PROVIDE INDEPENDENT COMPACTION TEST RESULTS BY A NATA REGISTERED TESTING AUTHORITY.

LIMESTONE WALL CONSTRUCTION

1. WALL FACES SHALL BE CONSTRUCTED USING COURSED LIMESTONE BLOCKS AS SPECIFIED ON MAIN SECTION OF THIS DRAWING. RUBBLE SHALL NOT BE USED TO FILL VOIDS. ALL BACK-BLOCKS SHALL BE SQUARE EDGE AND LAID IN STRETCHER BOND PATTERN.
2. VOIDS AT WEEP HOLE LOCATIONS - SHALL BE FILLED WITH CONCRETE AS REQUIRED.
3. ALL JOINTS TO BE MORTARED WITH 1 : 1 : 6 (CEMENT:LIME:SAND) 30mm THICK MORTAR U.O.N. - RUBBLE NOT TO BE USED TO FILL VOIDS. FACE OF MORTAR MIX SHALL MATCH LIMESTONE. REFER JOINT DETAIL. MORTAR THICKNESS SPECIFIED ON LAYOUT.
4. RECONSTITUTED BLOCK MATERIAL SHALL HAVE A DRY DENSITY OF AT LEAST 1750kg/m³ AND CRUSHING STRENGTH OF AT LEAST 2MPa. CONCRETE BACKER BLOCKS SHALL HAVE A DRY DENSITY OF AT LEAST 1950kg/m³ AND CRUSHING STRENGTH OF AT LEAST 5MPa.
5. THE CONTRACTOR SHALL INCLUDE CONTRACTION JOINTS WITHIN THE RETAINING WALL AS INDICATED ON PROJECT PLANS (C.J.) OR AT A MAXIMUM SPACING OF 20m ALONG ANY STRAIGHT RUN. WHERE THE WALL CHANGES DIRECTION, A CONTRACTION JOINT SHALL BE INSTALLED AT A DISTANCE 'd' FROM THAT CORNER ALONG ONE OF THE WALL FACES. 'd' = 1.0m (RW2-RW4), 'd' = 2.0m (RW5-RW8), 'd' = 3.0m (RW9-RW12). CONTRACTION JOINTS SHALL BE 15mm WIDE AND FILLED WITH EXPANDED POLYETHYLENE (100mm DEEP) COVERED WITH A 25mm DEEP MASTIC WITH COLOUR TO MATCH WALL MORTAR.
6. THE CONTRACTOR SHALL PROVIDE CERTIFICATION AT PRACTICAL COMPLETION THAT THE WALL CONSTRUCTION AND COMPACTION HAS BEEN CARRIED OUT IN ACCORDANCE WITH THESE DETAILS AND SPECIFIED REQUIREMENTS. THE CERTIFICATION SHALL BE BY A PRACTICING STRUCTURAL ENGINEER NOMINATED BY SUPERINTENDENT.
7. 3 COATS OF NON-SACRIFICIAL ANTI-GRAFFITI COATING SHALL BE APPLIED TO ANY WALLS EXPOSED TO ROAD FRONTAGE, P.O.S. OR SCHOOL. CONTRACTOR SHALL PROVIDE CERTIFICATION THAT COATING HAS BEEN APPLIED AND ISSUE CLEANING SPECIFICATION TO SUPERINTENDENT FOR LODGEMENT WITH COUNCIL PRIOR TO PRACTICAL COMPLETION.

BACKFILL

1. PROVIDE APPROVED WELL GRADED AND CLEAN FILL MATERIAL WHERE REQUIRED. PLACE FILL IN LAYERS OF 300mm MAXIMUM, ADJUSTING MOISTURE CONTENT IF NECESSARY PRIOR TO COMPACTION.
2. NO BACKFILL TO BE PLACED UNTIL WALL HAS BEEN CONSTRUCTED FOR A MINIMUM OF 7 DAYS. COMPACT SELECT GRANULAR SAND BACKFILL BEHIND WALLS IN 300mm MAXIMUM LAYERS ENSURING NO TILT. BACKFILLING SHALL BE CARRIED OUT IN LAYERS OF NOT MORE THAN 300mm AND COMPACTION SHALL BE TESTED AT NO GREATER THAN 900mm FILL INCREMENTS. COMPACTION OF BACKFILL MATERIAL SHALL BE NOT LESS THAN 95% MMDD. CONTRACTOR SHALL PROVIDE INDEPENDENT COMPACTION TEST RESULTS FOR VARIOUS STAGES OF CONSTRUCTION AND BACKFILLING BY A NATA, REGISTERED TESTING AUTHORITY.
3. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO USE APPROPRIATE COMPACTING MACHINERY TO COMPACT THE BACKFILL MATERIAL BEHIND THE WALL.

1:20 0 0.2m 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0

1:10 0 0.1m 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Rev	Date	Description	Drawn	Appr.
0	07.02.2013	ISSUED FOR CONSTRUCTION	JYY	
B	24.07.2012	IISSUED FOR TENDER	DCL	NTT
A	13.06.2012	IISSUED FOR COMMENT	DCL	NTT

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CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS
BUILDING DESIGN

Drawn	DLC 13.06.2012
Designed	NTT 13.06.2012
Checked	Date
Reviewed	Date
Approved	Date

Client: SHIRE OF CARNARVON

Project: CARNARVON FORESHORE FASCINE WALL

Title: STANDARD DETAILS SHEET 2 OF 2

Status: FOR CONSTRUCTION

Date	Datum	Scale	Size
13.06.2021	A.H.D	AS SHOWN	A1

Drawing Number: E12002-001-SD2

Revision: 0

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm ON A1 ORIGINAL

DATE PLOTTED: 07 February, 2013 - 4:20pm

XREF's
CAD FILE: L:\2012\E12002 - Fascine Eng Docs\Drawings\CAD\E12002-001-SD1-SD3.dwg

DRAWING LIST/PAGE

A00	TITLE DRAWING AND KEY PLAN	1:1000
A01	PLAN OF FASCINE WALK	1:100
A02	PLAN OF FASCINE WALK / JETTY 1	1:100
A03	PLAN OF FASCINE WALK	1:100
A04	PLAN OF FASCINE WALK / JETTY 2	1:100
A05	PLAN OF FASCINE WALK	1:100
A06	PLAN OF FASCINE WALK	1:100
A07	PLAN OF FASCINE WALK	1:100
A08	PLAN OF FASCINE WALK	1:100
A09	PLAN OF FASCINE WALK / JETTY 3	1:100
A010	PLAN OF FASCINE WALK	1:100
A011	PLAN OF FASCINE WALK	1:100
A012	JETTY 2 & RAMPS - PLAN AND ELEVATIONS	1:50
A013	JETTY 2 & RAMPS - PLAN AND SECTIONS	1:50
A014	JETTY 2 & RAMPS - ELEVATIONS AND SECTIONS	1:50
A015	JETTY 1 & SURROUNDS PLAN	1:50
A016	JETTY 3 & SURROUNDS PLAN	1:50
A017	JETTY 1 & 3 - SECTIONS	1:50
A018	SHELTER 2 - PLAN, ELEVATION AND DETAILS	1:50 / 1:25
A019	3D JETTY AND STRUCTURAL DETAILS	1:10 / 1:5
A020	FISHING AND SEATING NODE - DETAILS AND FURNITURE LAYOUT	1:50 / 1:25 / 1:10
A021	DETAILS JETTY	1:10 / 1:5
A022	DETAILS BALUSTRADES	1:25
L01 TO L11	SOFT LANDSCAPING PLANS HARD LANDSCAPING DETAILS PLANTING SCHEDULES FURNITURE DETAILS FURNITURE LAYOUTS	1:100

GENERAL NOTES

READ ALL DRAWINGS IN CONJUNCTION WITH OTHER ARCHITECTURAL DRAWINGS, OTHER CONSULTANT DRAWINGS AND ANY OTHER WRITTEN SPECIFICATIONS AND DOCUMENTS.

THE BUILDER IS RESPONSIBLE FOR VERIFYING ALL DIMENSIONS RELEVANT TO SETTING OUT AND OFF-SITE WORKS BEFORE CONSTRUCTION AND FABRICATION IS COMMENCED.

ANY DISCREPANCIES ARE TO BE NOTIFIED AND ATTENTED TO IMMEDIATELY.

THE BUILDER IS REPONSIBLE TO APPLY FOR ALL NECESSARY STATUTORY APPROVALS AND COMPLYING TO RELEVANT CURRENT NCC CODES AND THE LOCAL STATUTORY AUTHORITIES REGULATIONS.

ALL WORKMANSHIP IS TO BE IN ACCORDANCE WITH ANY RELEVANT AUSTRALIAN STANDARDS.

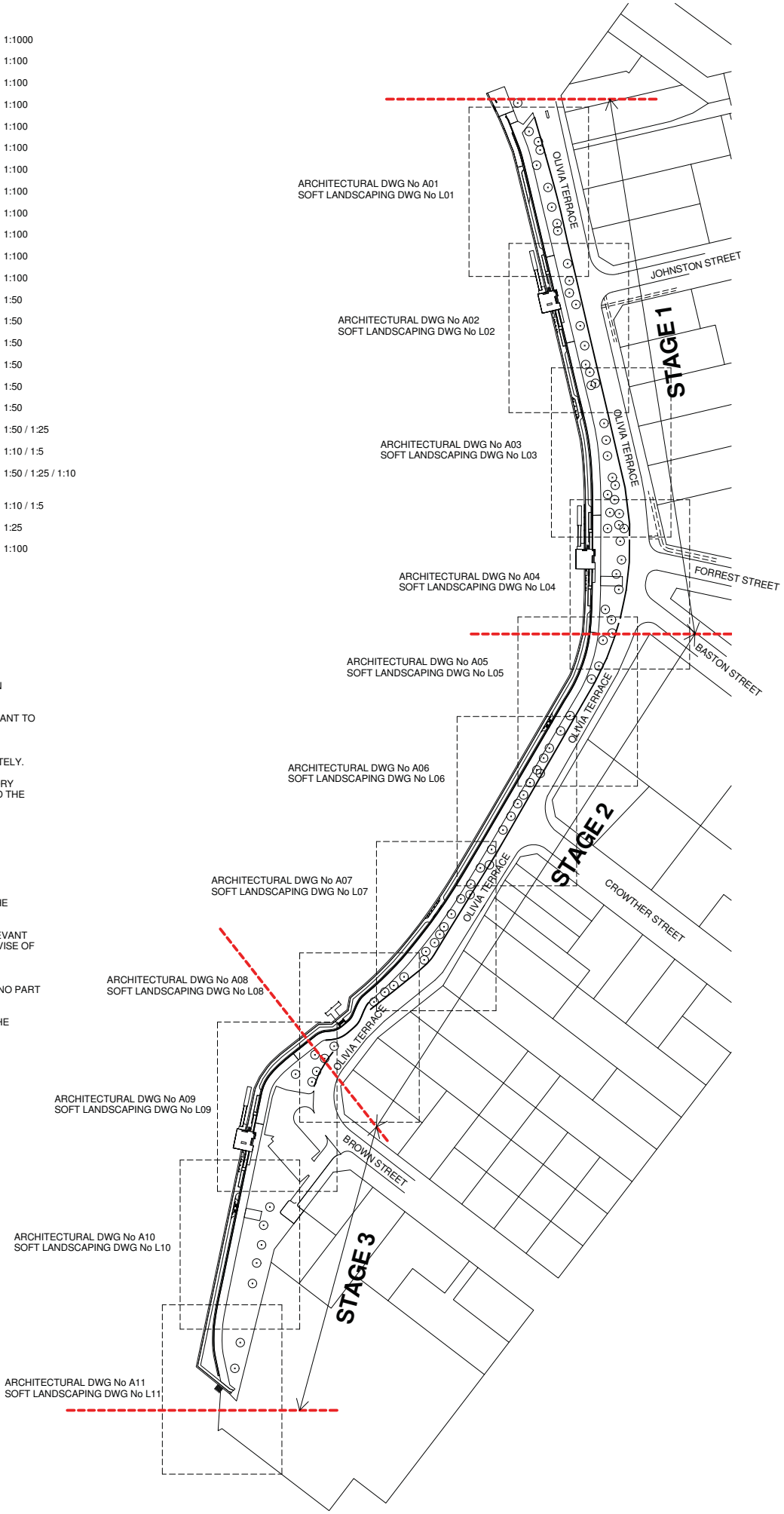
ALL DIMENSIONS ARE IN MILLIMETERS. ALL LEVELS ARE EXPRESSED IN METERS AND ARE RELATED TO AHD.

DRAWINGS ARE PRODUCED FROM THE BEST INFORMATION AVAILABLE. NO RESPONSIBILITY IS TAKEN FOR ACCURACY AND COMPLETION OF THE INFORMATION SHOWN.

THE BUILDER IS TO ESTABLISH, ON SITE, THE EXACT POSITION OF RELEVANT ELEMENTS, SERVICES, ETC. THAT AFFECT THE PROPOSED WORKS. ADVISE OF ANY DISCREPANCIES.

THE BUILDER IS REPONSIBLE FOR:
MAINTAINING ALL STRUCTURES IN STABLE CONDITION AND ENSURING NO PART SHALL BE OVERSTRESSED DURING CONSTRUCTION ACTIVITIES.

THE BUILDING ACTIVITY AREA IS TO BE FENCED OFF AND SAFETY OF THE PUBLIC IS TO BE ENSURED AT ALL TIMES.



No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	11/06/15	ISSUED FOR STRUCTURAL SIZING	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

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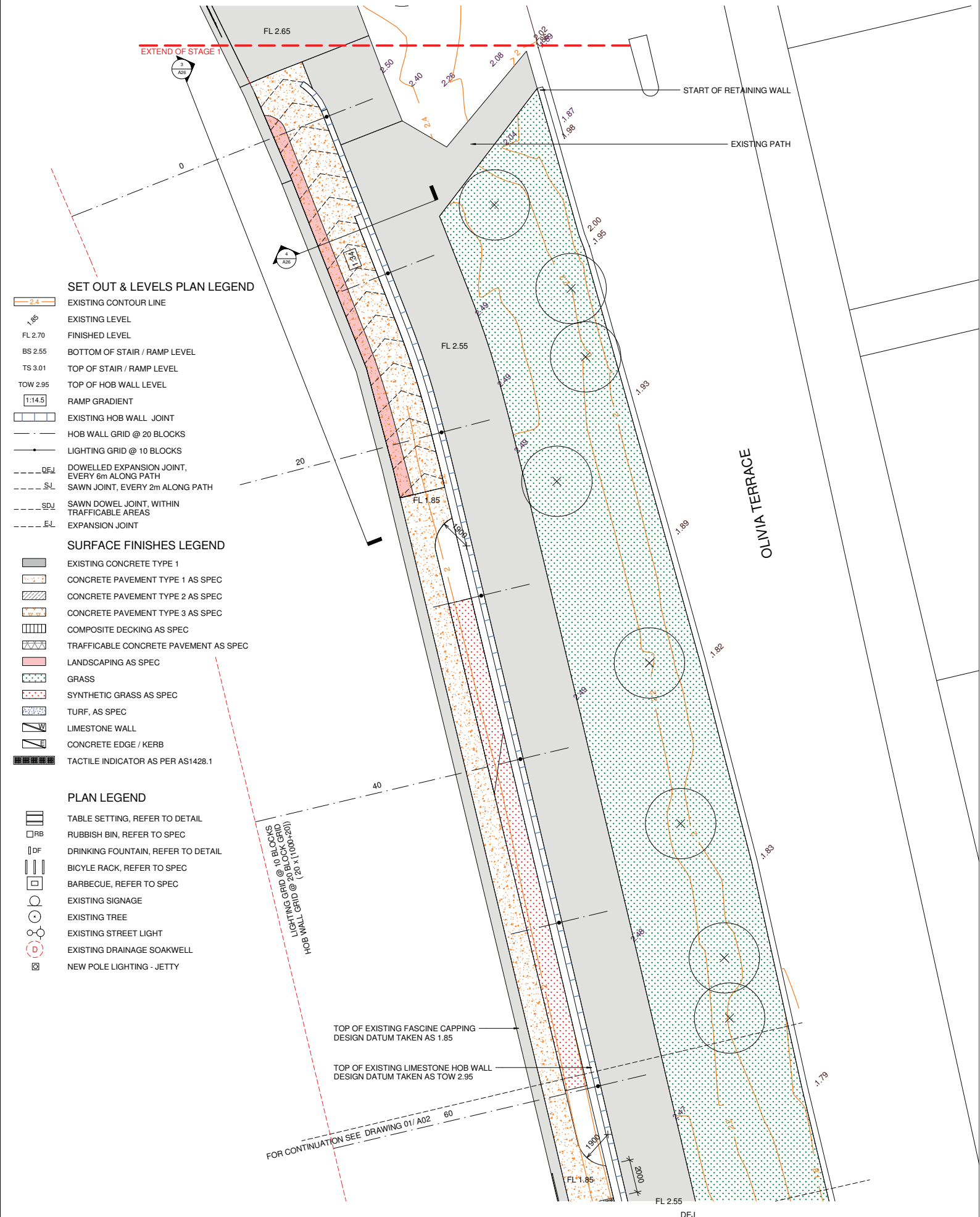
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: TITLE PAGE AND KEY PLAN

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: As indicated @ A1
DATE: 08/07/15
DRAWN: LW
CHECKED: JA
JOB NO: 1502
DWG NUMBER: A00
REV: D



SET OUT & LEVELS PLAN LEGEND

- EXISTING CONTOUR LINE
- EXISTING LEVEL
- FL 2.70 — FINISHED LEVEL
- BS 2.55 — BOTTOM OF STAIR / RAMP LEVEL
- TS 3.01 — TOP OF STAIR / RAMP LEVEL
- TOW 2.95 — TOP OF HOB WALL LEVEL
- 1:14.5 — RAMP GRADIENT
- EXISTING HOB WALL JOINT
- HOB WALL GRID @ 20 BLOCKS
- LIGHTING GRID @ 10 BLOCKS
- DEJ — DOWELLED EXPANSION JOINT, EVERY 6m ALONG PATH
- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	11/06/15	~~ISSUED FOR STRUCTURAL SIZING~~	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

CONTRACTOR: IN SITU

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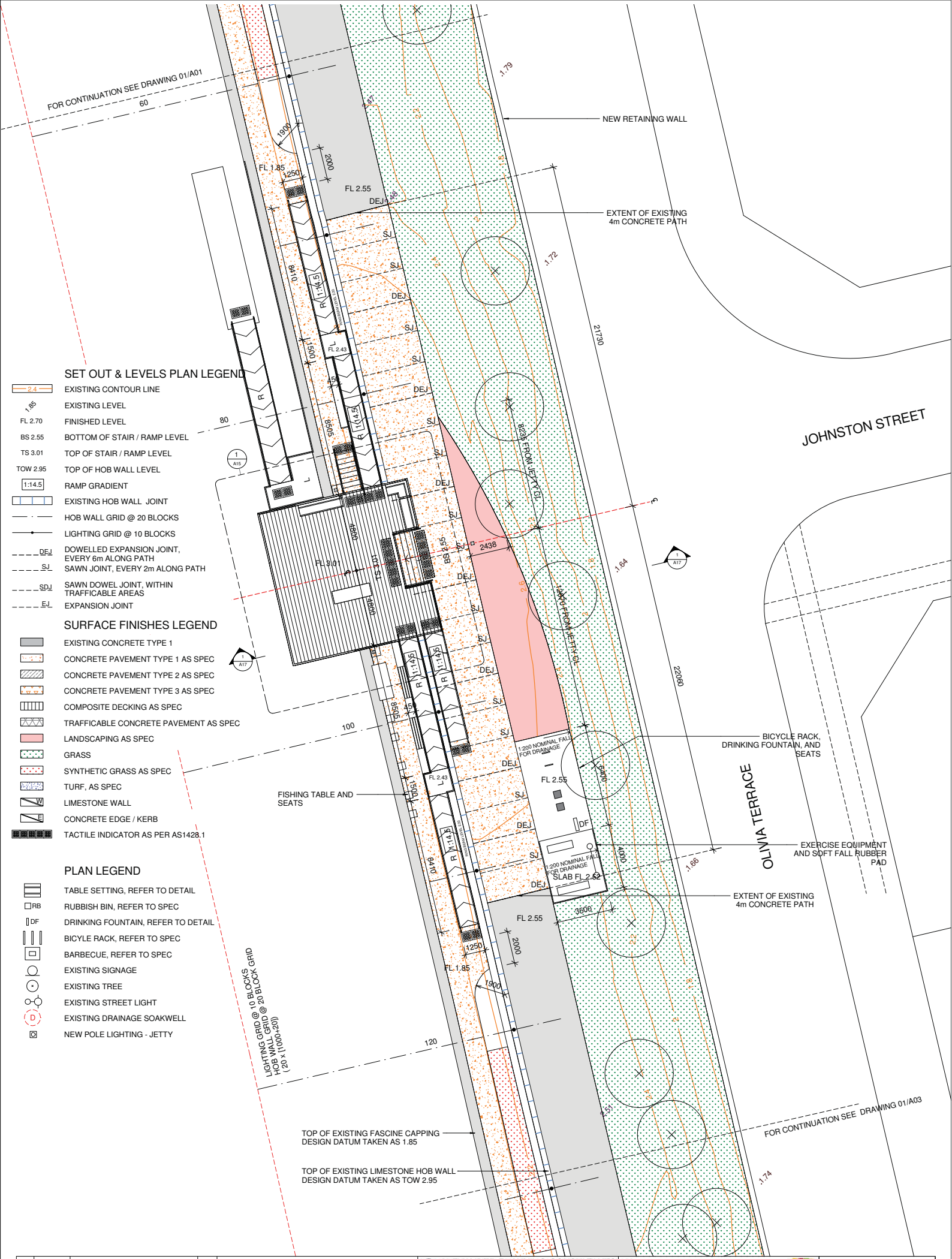
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1
DATE: 08/07/15
JOB NO: 1502
DRAWN: LW
CHECKED: JA
DWG NUMBER: A01
REV: D



SET OUT & LEVELS PLAN LEGEND

- EXISTING CONTOUR LINE
- EXISTING LEVEL
- FL 2.70 — FINISHED LEVEL
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- TS 3.01 — TOP OF STAIR / RAMP LEVEL
- TOW 2.95 — TOP OF HOB WALL LEVEL
- 1:14.5 — RAMP GRADIENT
- EXISTING HOB WALL JOINT
- HOB WALL GRID @ 20 BLOCKS
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- DEJ — DOWELLED EXPANSION JOINT, EVERY 6m ALONG PATH
- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APP.	
B	11/06/15	ISSUED FOR STRUCTURAL SIZING	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	
E	15/07/15	RUBBER SOFTFALL DETAIL ADDED	
F	17/07/15	SHELTER AND FURNITURE UPDATED	
G	23/07/15	JETTY 2 LANDSCAPE MODIFIED	
H	29/07/15	EXERCISE AREAS MODIFIED	

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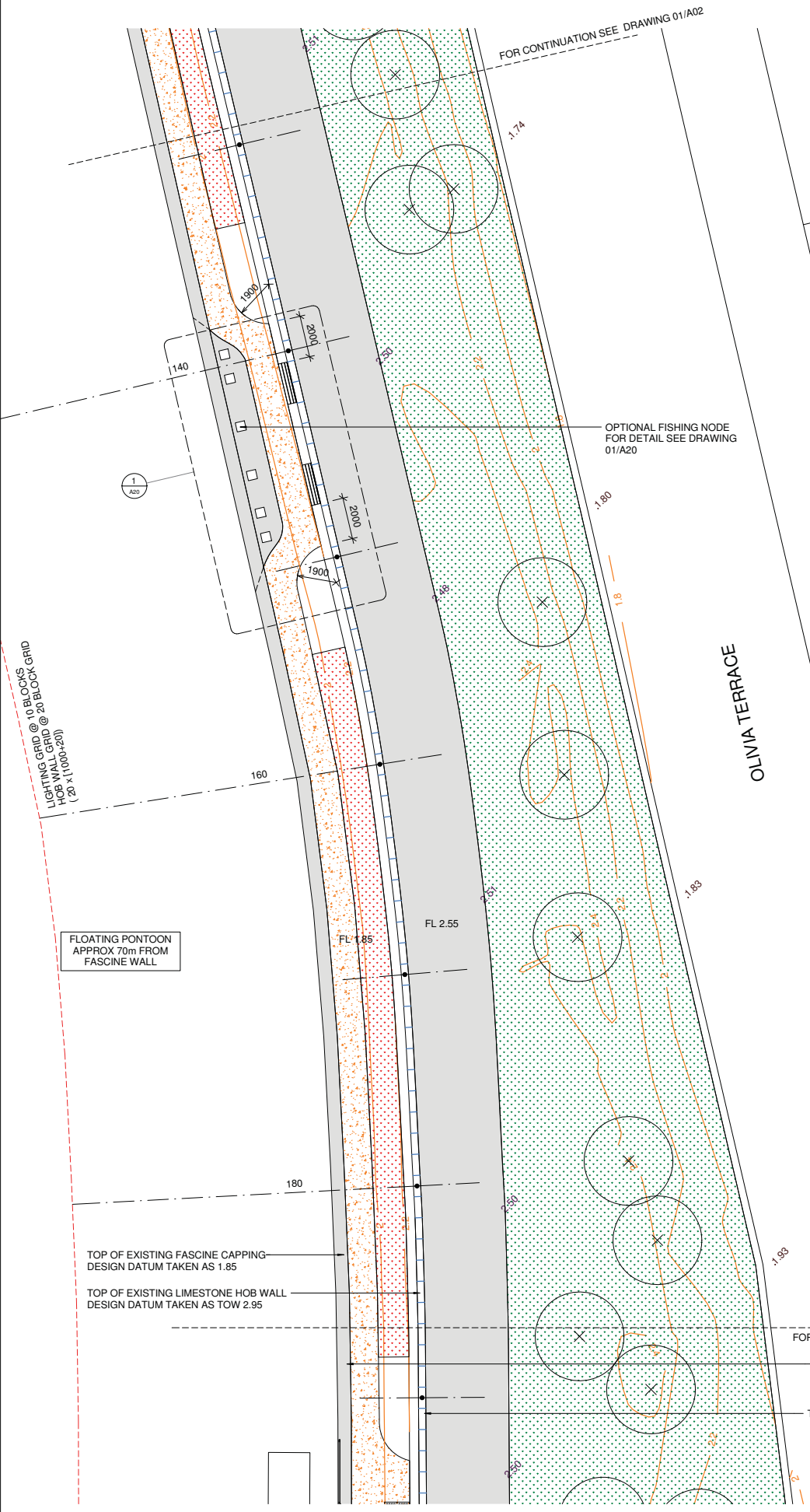
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK / JETTY 1

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1
DATE: 29/07/15
DRAWN: LW
CHECKED: JA
JOB NO: 1502
DWG NUMBER: A02
REV: H



SET OUT & LEVELS PLAN LEGEND

- EXISTING CONTOUR LINE
- EXISTING LEVEL
- FL 2.70 — FINISHED LEVEL
- BS 2.55 — BOTTOM OF STAIR / RAMP LEVEL
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- TOW 2.95 — TOP OF HOB WALL LEVEL
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- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	11/06/15	~~ISSUED FOR STRUCTURAL SIZING~~	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

CONTRACTOR: IN SITU

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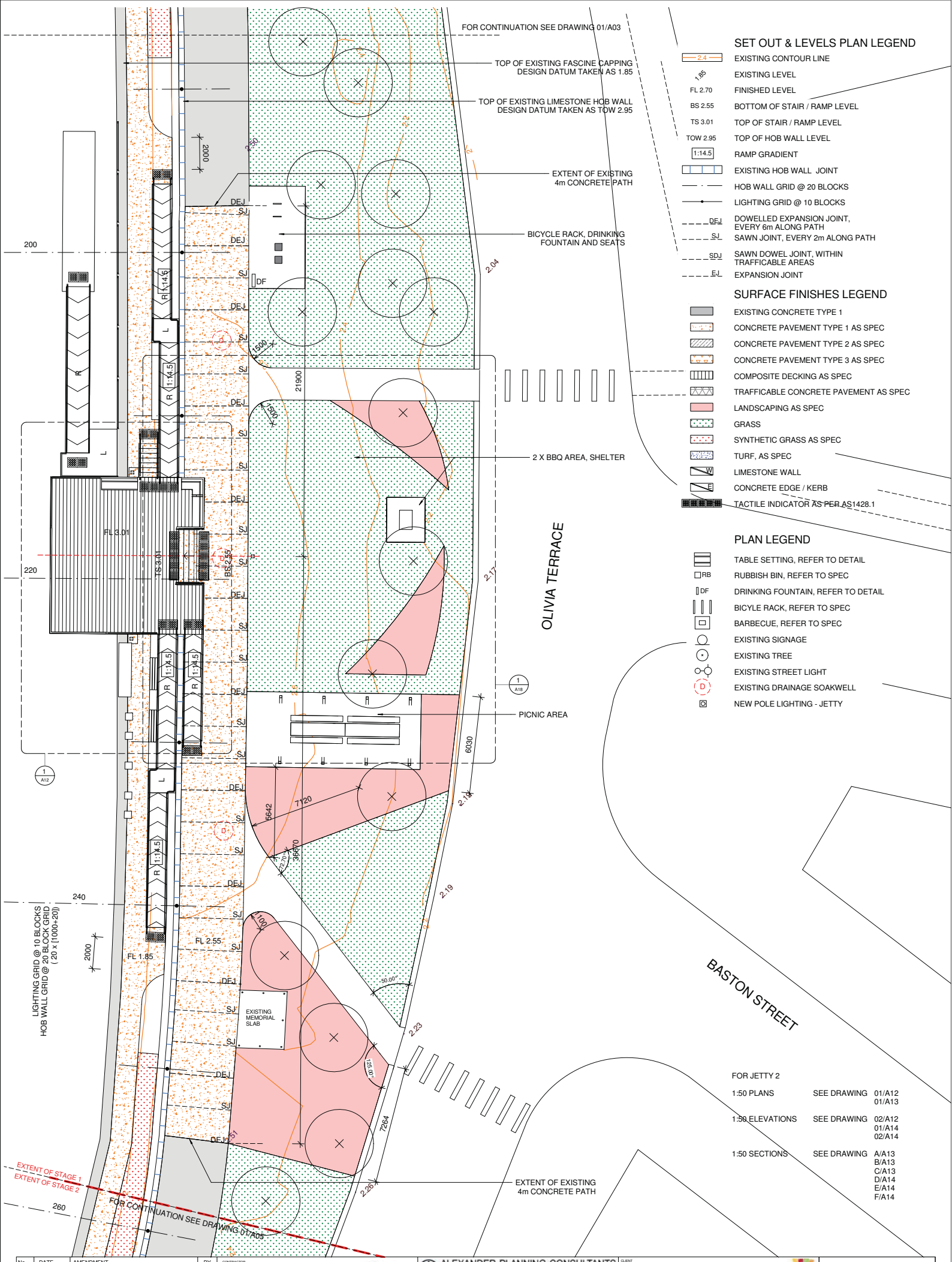
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1
DATE: 08/07/15
DRAWN: LW
CHECKED: JA
JOB NO: 1502
DWG NUMBER: A03
REV: D



No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APP.	
B	11/06/15	ISSUED FOR STRUCTURAL SIZING	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	
E	15/07/15	RUBBER SOFTFALL DETAIL ADDED	
F	17/07/15	SHELTER AND FURNITURE UPDATED	
G	23/07/15	JETTY 2 LANDSCAPE MODIFIED	

CONTRACTOR: IN SITU

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CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK / JETTY 2

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1

DATE: 23/07/15

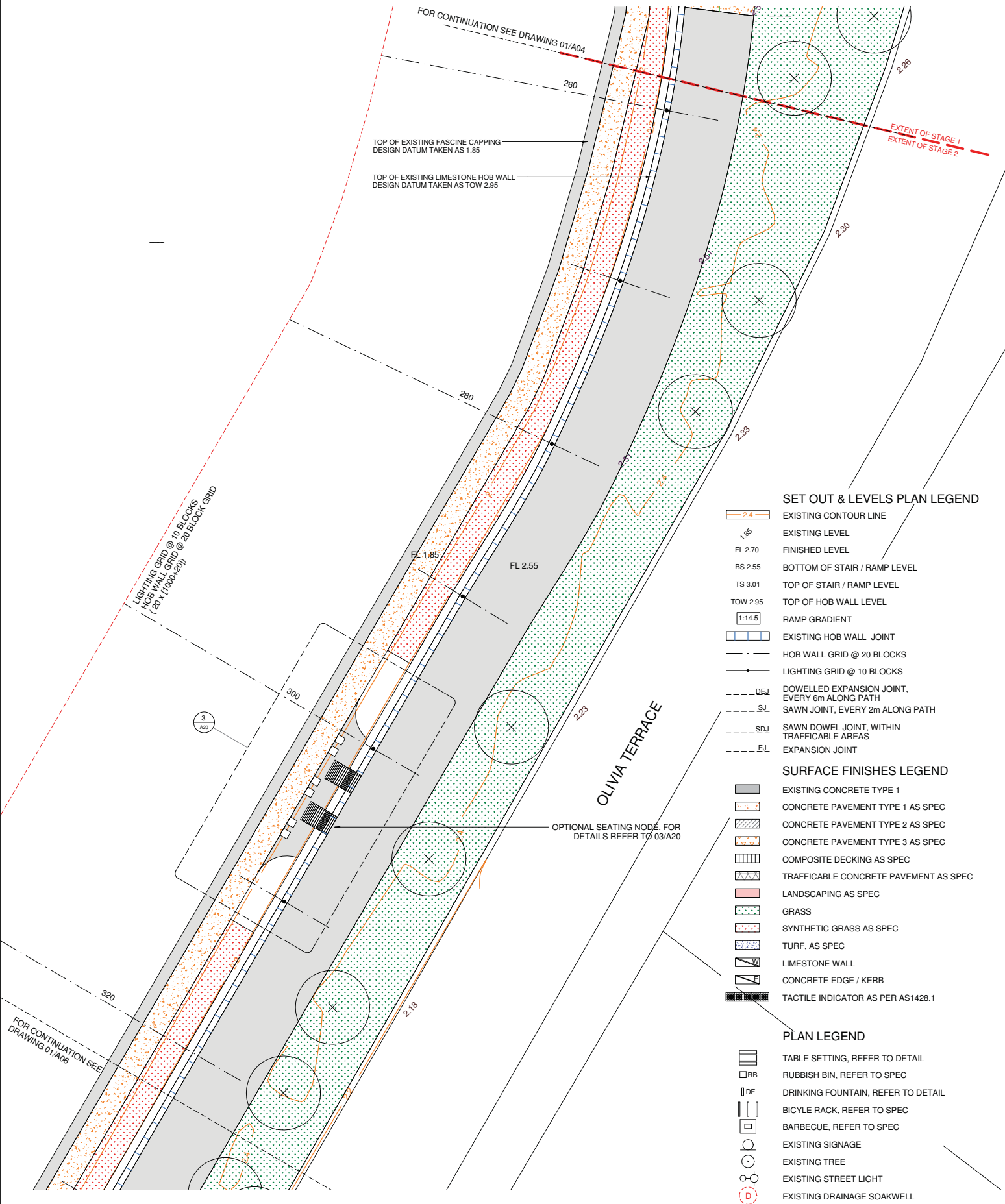
DRAWN: EA

CHECKED: JA

JOB NO: 1502

DWG NUMBER: A04

REV: G



SET OUT & LEVELS PLAN LEGEND

- 2.4 — EXISTING CONTOUR LINE
- 1.85 — EXISTING LEVEL
- FL 2.70 — FINISHED LEVEL
- BS 2.55 — BOTTOM OF STAIR / RAMP LEVEL
- TS 3.01 — TOP OF STAIR / RAMP LEVEL
- TOW 2.95 — TOP OF HOB WALL LEVEL
- 1:14.5 — RAMP GRADIENT
- EXISTING HOB WALL JOINT
- HOB WALL GRID @ 20 BLOCKS
- LIGHTING GRID @ 10 BLOCKS
- DFJ — DOWELLED EXPANSION JOINT, EVERY 6m ALONG PATH
- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	~~11/06/15~~	~~ISSUED FOR STRUCTURAL SIZING~~	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

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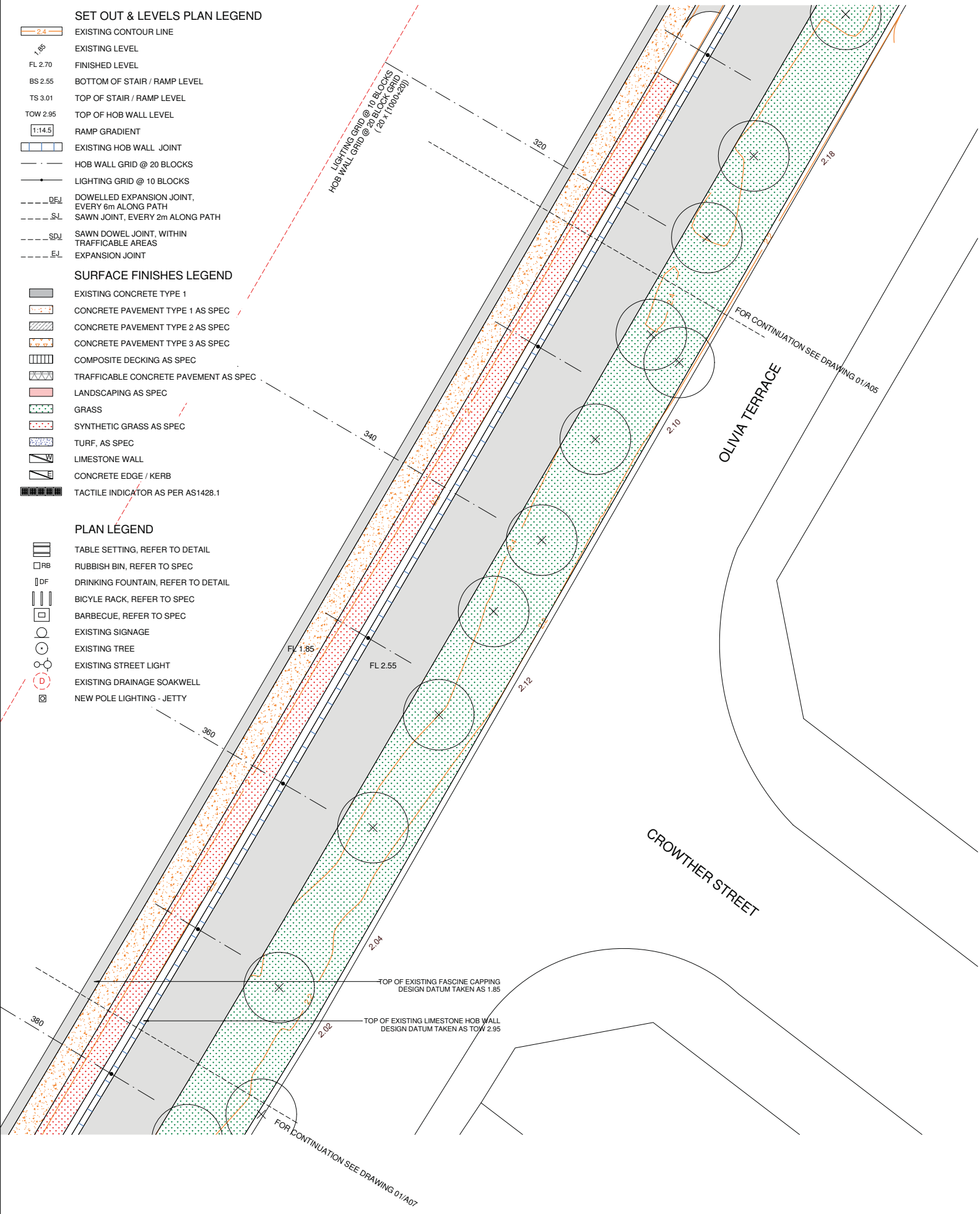
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1
DATE: 08/07/15
DRAWN: LW
CHECKED: JA
JOB NO: 1502
DWG NUMBER: A05
REV: D



No.	DATE	AMENDMENT	BY
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C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

CONTRACTOR: IN SITU

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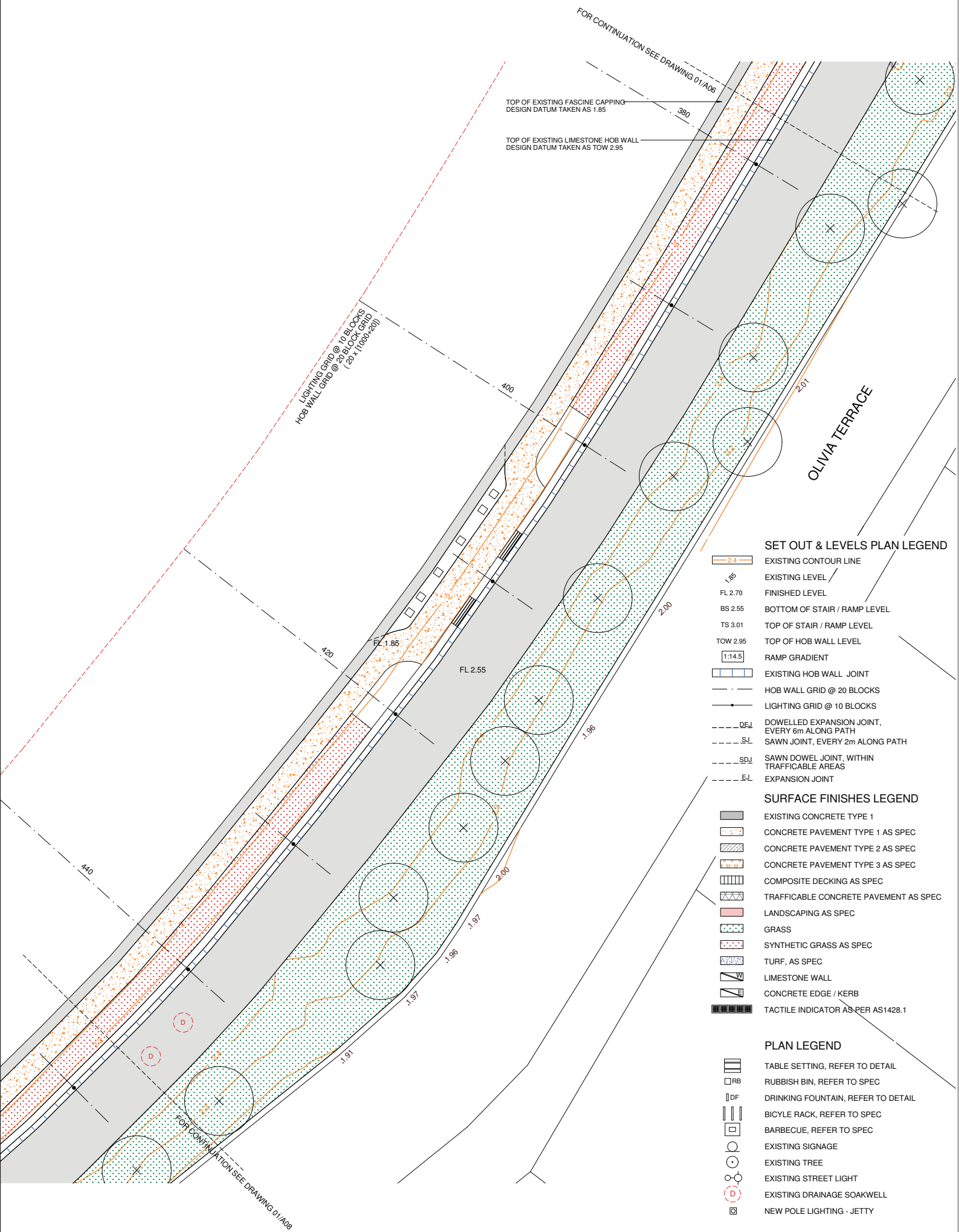
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1
DATE: 08/07/15
DRAWN: LW
CHECKED: JA
JOB NO: 1502
DWG NUMBER: A06
REV: D



SET OUT & LEVELS PLAN LEGEND

- 2.4 — EXISTING CONTOUR LINE
- 1.85 — EXISTING LEVEL
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- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	~~11/06/15~~	~~ISSUED FOR STRUCTURAL SIZING~~	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

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CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

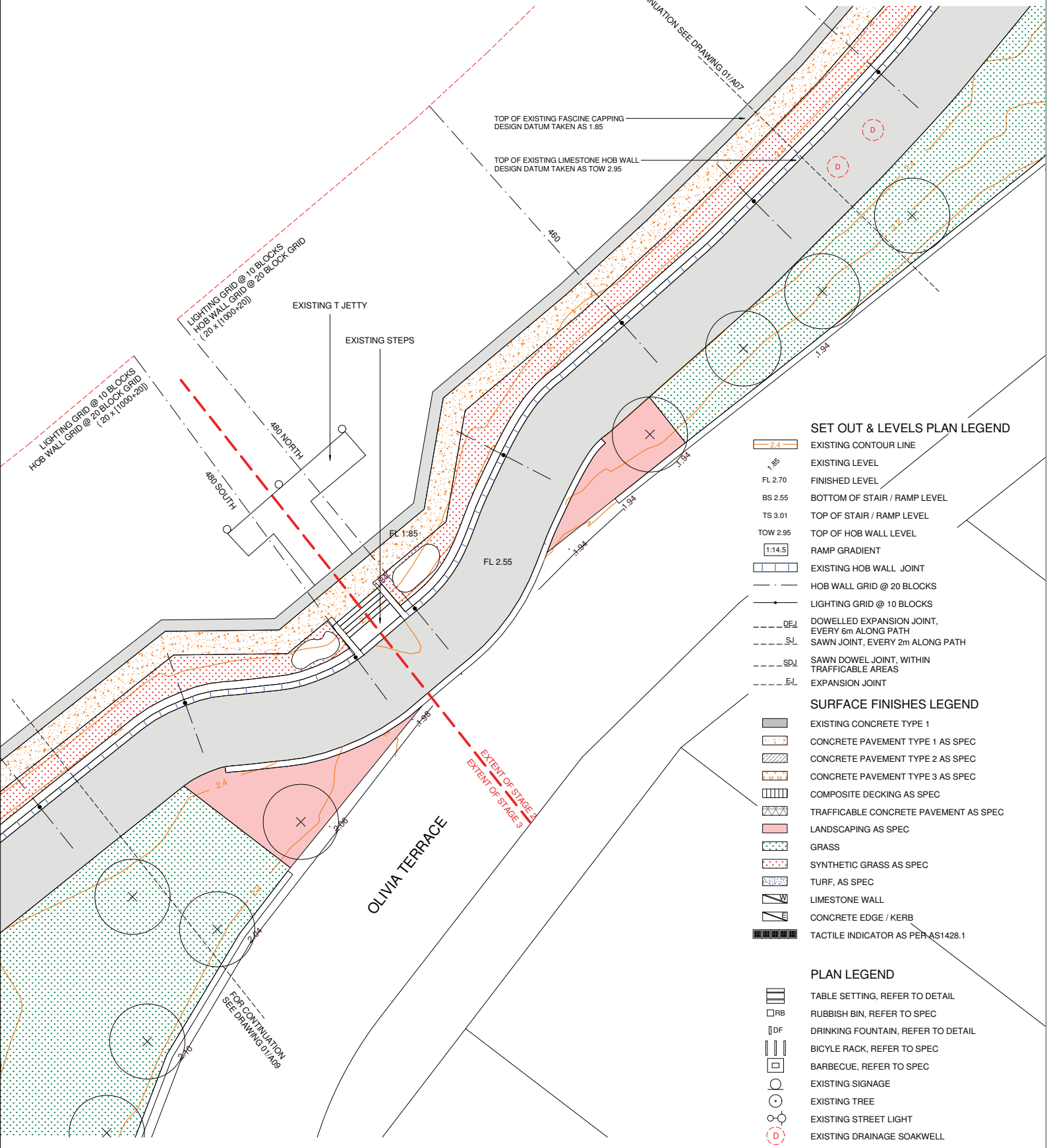
SCALE: 1 : 100 @ A1 | JOB NO: 1502

DATE: 08/07/15

DRAWN: LW

CHECKED: JA

DWG NUMBER: A07 | REV: D



SET OUT & LEVELS PLAN LEGEND

- 2.4 — EXISTING CONTOUR LINE
- 1.85 — EXISTING LEVEL
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- DFJ — DOWELLED EXPANSION JOINT, EVERY 6m ALONG PATH
- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	~~11/06/15~~	~~ISSUED FOR STRUCTURAL SIZING~~	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

CONTRACTOR: IN SITU

0 1m 3m 5m 10m

N

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CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1
DATE: 08/07/15
DRAWN: LW
CHECKED: JA
JOB NO: 1502
DWG NUMBER: A08
REV: D

SET OUT & LEVELS PLAN LEGEND

- 2.4 — EXISTING CONTOUR LINE
- 1.85 — EXISTING LEVEL
- FL 2.70 — FINISHED LEVEL
- BS 2.55 — BOTTOM OF STAIR / RAMP LEVEL
- TS 3.01 — TOP OF STAIR / RAMP LEVEL
- TOW 2.95 — TOP OF HOB WALL LEVEL
- 1:14.5 — RAMP GRADIENT
- EXISTING HOB WALL JOINT
- HOB WALL GRID @ 20 BLOCKS
- LIGHTING GRID @ 10 BLOCKS
- DEJ — DOWELLED EXPANSION JOINT, EVERY 6m ALONG PATH
- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

TOP OF EXISTING FASCINE CAPPING DESIGN DATUM TAKEN AS 1.85

TOP OF EXISTING LIMESTONE HOB WALL DESIGN DATUM TAKEN AS TOW 2.95

FOR CONTINUATION SEE DRAWING 01/A08

EXTENT OF EXISTING 4m CONCRETE PATH

EXTENT OF EXISTING 4m CONCRETE PATH

LIGHTING GRID @ 10 BLOCKS
HOB WALL GRID @ 20 BLOCK GRID
(20 x (1000+20))

OLIVIA TERRACE

BROWN ST CAR PARK
23 BAYS

BOLLARD

DIS SHARED BAY

8 - DIS

PATH SLOPE NOT TO BE GREATER THAN 1:30

BICYCLE RACK, SEATS AND DRINK FOUNTAIN

EXERCISE EQUIPMENT AREA

FOR CONTINUATION SEE DRAWING 01/A10

FL 1.85
FL 2.55
FL 3.01
TS 3.01
BS 2.55

520 540 560 580

9570 4790 12460 6400 4040 4475

6500 5500 2700 2400 1500

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	11/06/15	ISSUED FOR STRUCTURAL SIZING	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

CONTRACTOR: IN SITU

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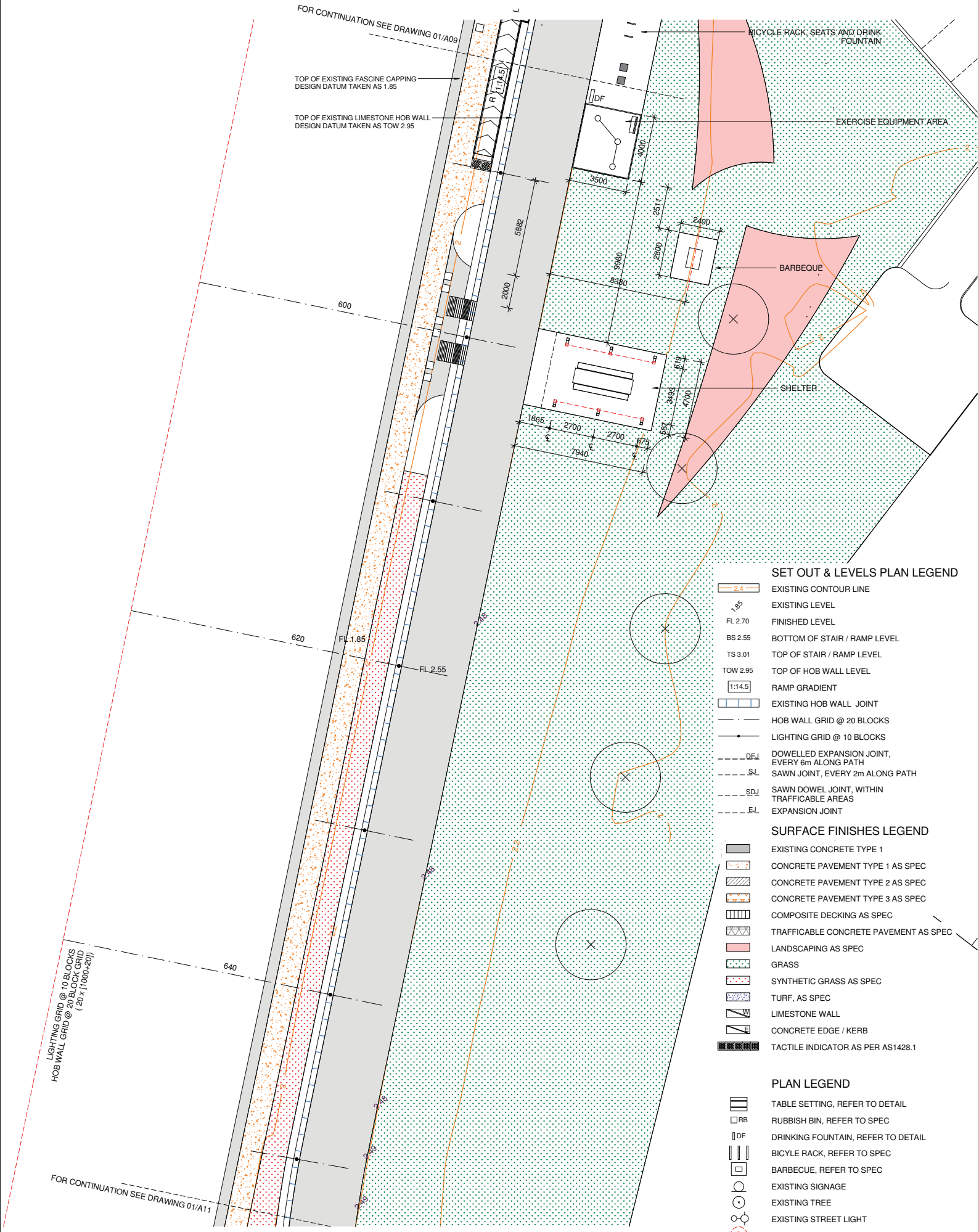
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK / JETTY 3

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1
DATE: 08/07/15
DRAWN: LW
CHECKED: JA
JOB NO: 1502
DWG NUMBER: A09
REV: D



SET OUT & LEVELS PLAN LEGEND

- 2.4 — EXISTING CONTOUR LINE
- 1.85 — EXISTING LEVEL
- FL 2.70 — FINISHED LEVEL
- BS 2.55 — BOTTOM OF STAIR / RAMP LEVEL
- TS 3.01 — TOP OF STAIR / RAMP LEVEL
- TOW 2.95 — TOP OF HOB WALL LEVEL
- 1:14.5 — RAMP GRADIENT
- EXISTING HOB WALL JOINT
- HOB WALL GRID @ 20 BLOCKS
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- DEJ — DOWELLED EXPANSION JOINT, EVERY 6m ALONG PATH
- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APP.	
B	11/06/15	ISSUED FOR STRUCTURAL SIZING	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	
E	15/07/15	RUBBER SOFTFALL DETAIL ADDED	
F	17/07/15	SHELTER AND FURNITURE UPDATED	
G	23/07/15	JETTY 2 LANDSCAPE MODIFIED	
H	29/07/15	EXERCISE AREAS MODIFIED	

CONTRACTOR: IN SITU

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CLIENT: SHIRE OF CARNARVON

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

SCALE: 1 : 100 @ A1

JOB NO: 1502

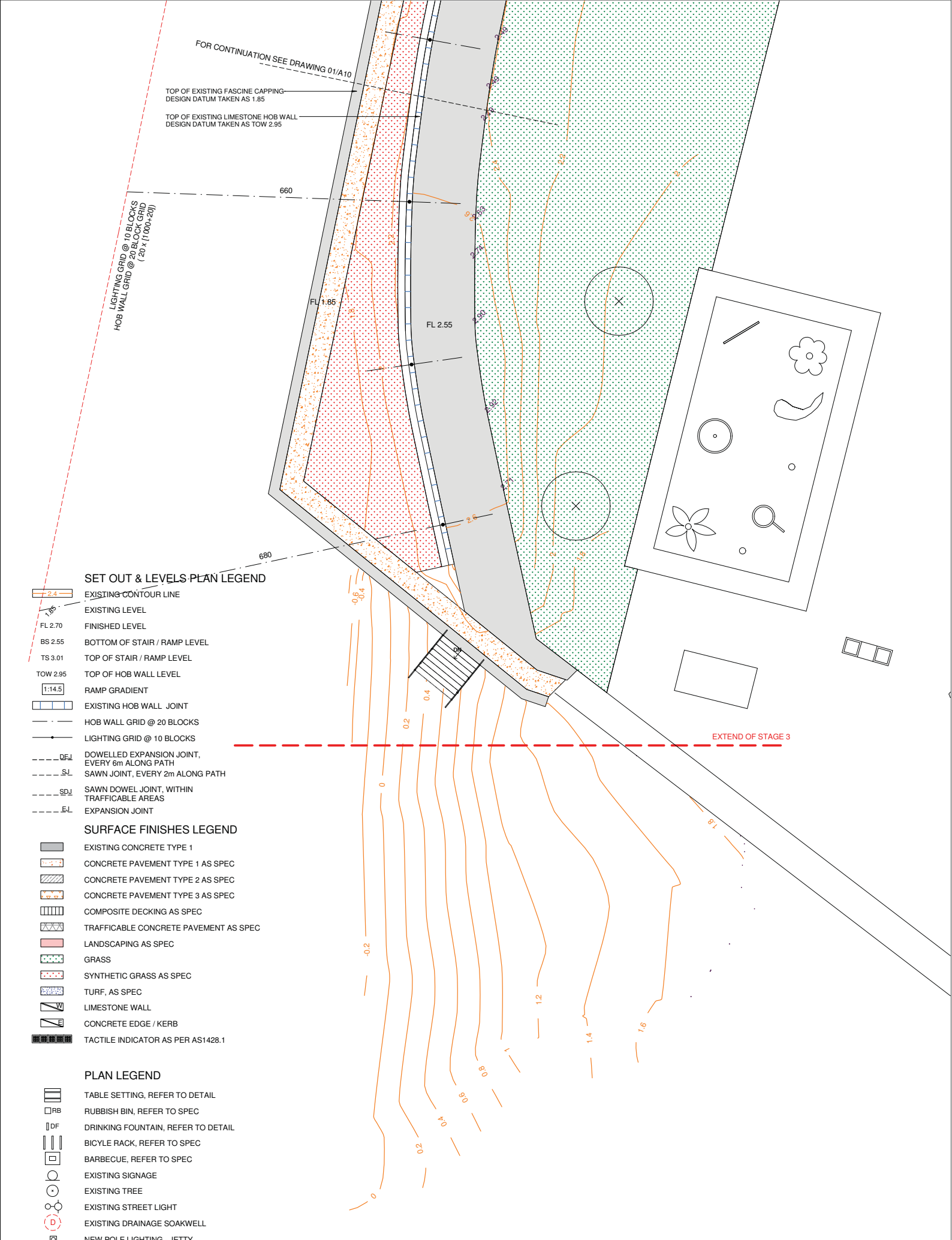
DATE: 29/07/15

DRAWN: EA

CHECKED: JA

DWG NUMBER: A10

REV: H



SET OUT & LEVELS PLAN LEGEND

- 2.4 — EXISTING CONTOUR LINE
- 1.85 — EXISTING LEVEL
- FL 2.70 — FINISHED LEVEL
- BS 2.55 — BOTTOM OF STAIR / RAMP LEVEL
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- EXISTING HOB WALL JOINT
- HOB WALL GRID @ 20 BLOCKS
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- DFJ — DOWELLED EXPANSION JOINT, EVERY 6m ALONG PATH
- SJ — SAWN JOINT, EVERY 2m ALONG PATH
- SDJ — SAWN DOWEL JOINT, WITHIN TRAFFICABLE AREAS
- EJ — EXPANSION JOINT

SURFACE FINISHES LEGEND

- EXISTING CONCRETE TYPE 1
- CONCRETE PAVEMENT TYPE 1 AS SPEC
- CONCRETE PAVEMENT TYPE 2 AS SPEC
- CONCRETE PAVEMENT TYPE 3 AS SPEC
- COMPOSITE DECKING AS SPEC
- TRAFFICABLE CONCRETE PAVEMENT AS SPEC
- LANDSCAPING AS SPEC
- GRASS
- SYNTHETIC GRASS AS SPEC
- TURF, AS SPEC
- W — LIMESTONE WALL
- E — CONCRETE EDGE / KERB
- TACTILE INDICATOR AS PER AS1428.1

PLAN LEGEND

- TABLE SETTING, REFER TO DETAIL
- RB — RUBBISH BIN, REFER TO SPEC
- DF — DRINKING FOUNTAIN, REFER TO DETAIL
- BICYLE RACK, REFER TO SPEC
- BARBECUE, REFER TO SPEC
- EXISTING SIGNAGE
- EXISTING TREE
- EXISTING STREET LIGHT
- D — EXISTING DRAINAGE SOAKWELL
- NEW POLE LIGHTING - JETTY

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	
B	11/06/15	~~ISSUED FOR STRUCTURAL SIZING~~	
C	30/06/15	PRELIMINARY ISSUE	
D	08/07/15	ISSUED FOR CONSTRUCTION	

CONTRACTOR: IN SITU

0 1m 3m 5m 10m

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CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: PLAN OF FASCINE WALK

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE: 1 : 100 @ A1

DATE: 08/07/15

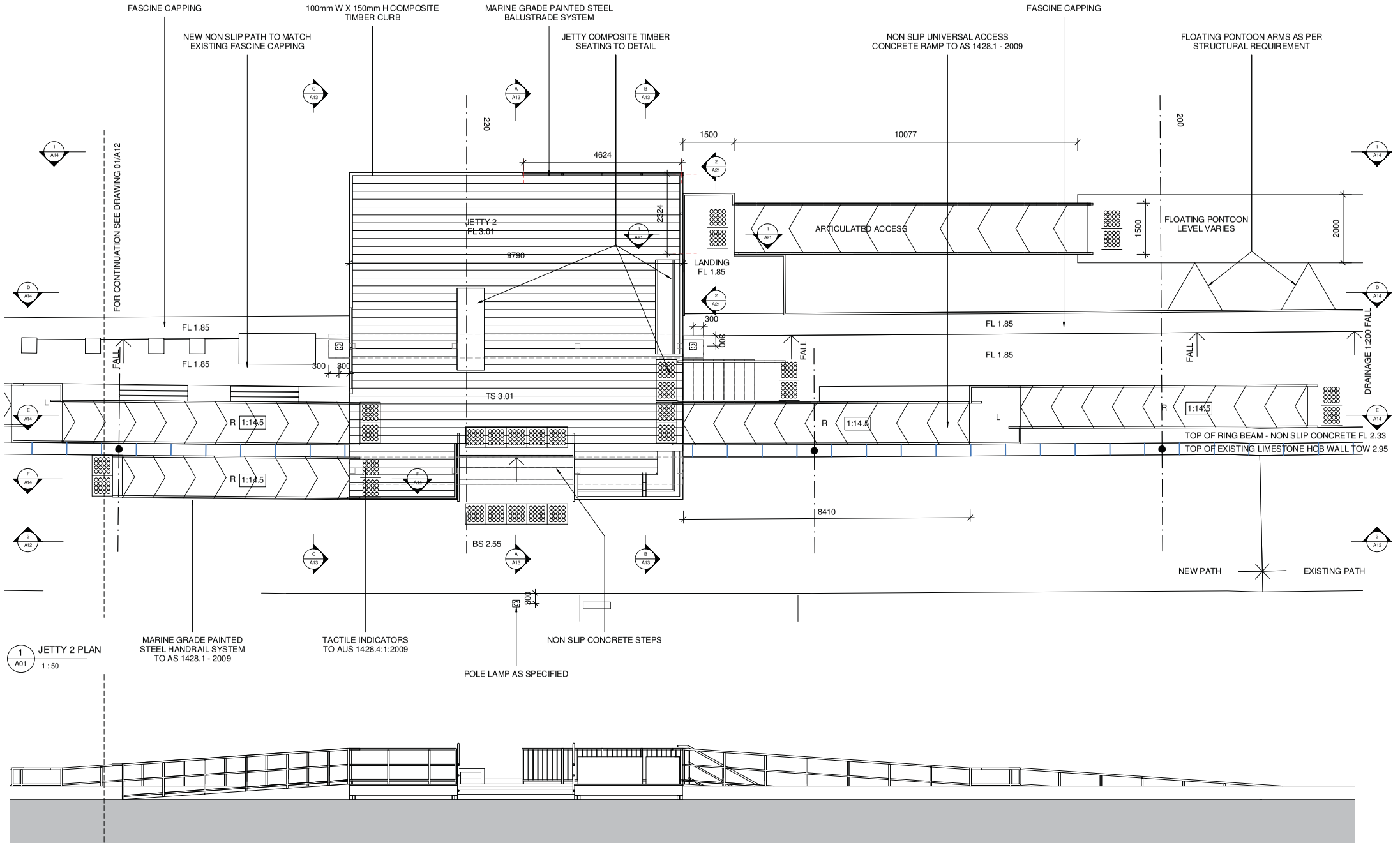
JOB NO: 1502

DRAWN: LW

CHECKED: JA

DWG NUMBER: A11

REV: D



1 A01 JETTY 2 PLAN
1 : 50

2 A12 JETTY 2 ELEVATION
1 : 50

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	

CONTRACTOR: IN SITU

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0 1m 3m 5m

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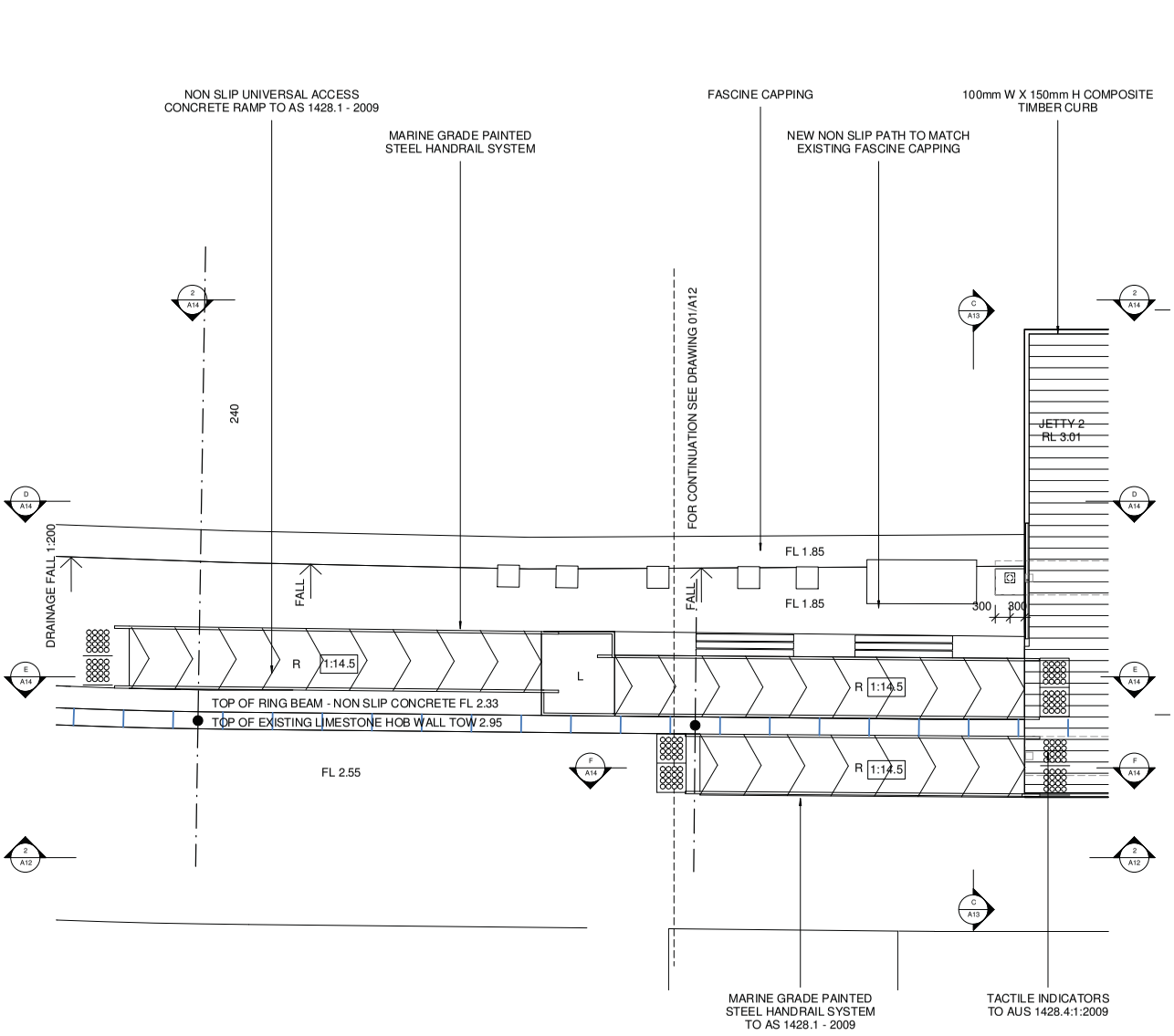
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

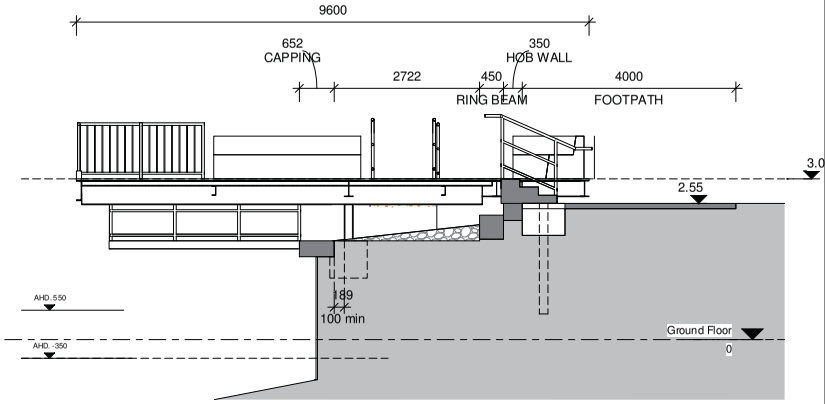
TITLE: JETTY 2 & RAMPS - PLAN AND ELEVATIONS

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

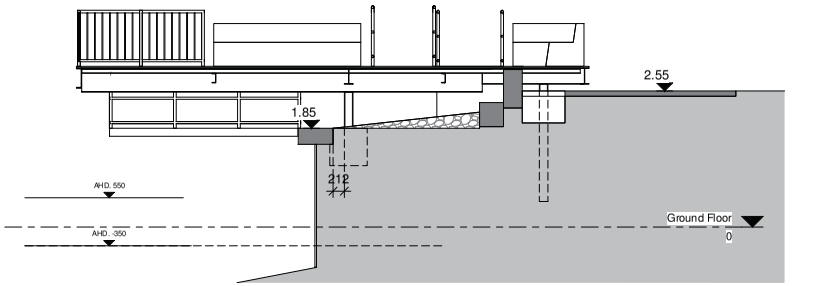
SCALE	1 : 50 @ A1
DATE	25/03/15
DRAWN	LW
CHECKED	JA
JOB NO.	1502
DWG NUMBER	A12
REV.	A



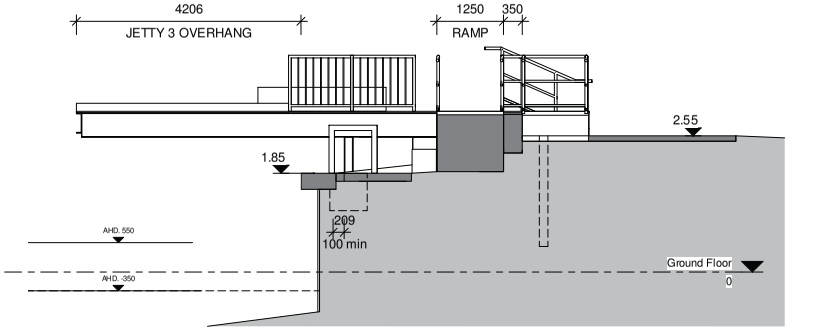
1 A13 JETTY 2 PLAN - PART 2
1 : 50



A A12 JETTY 2 SECTION A
1 : 50



B A12 JETTY 2 SECTION B
1 : 50



C A12 JETTY 2 SECTION C
1 : 50

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	

CONTRACTOR: IN SITU

0 1m 3m 5m

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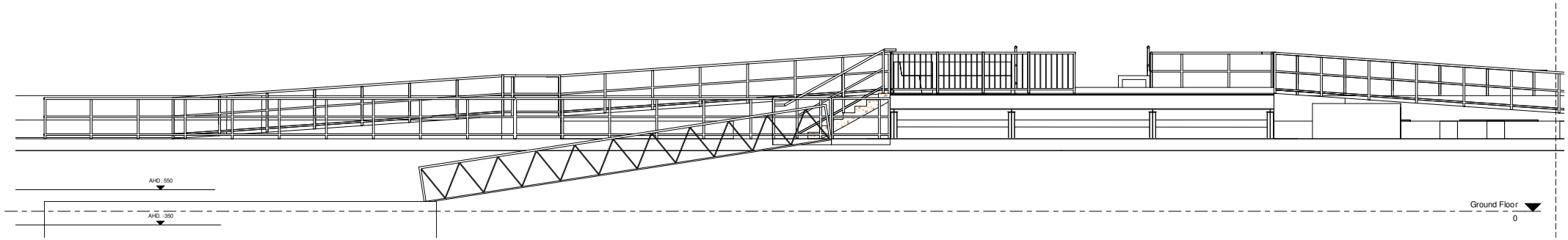
CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

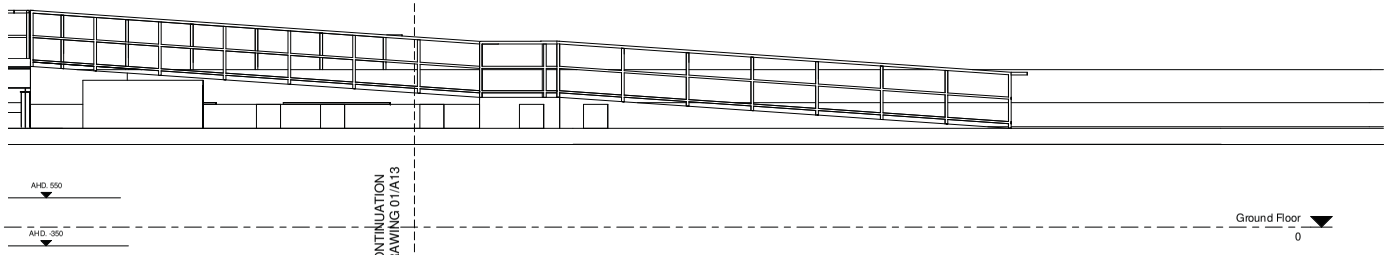
TITLE: JETTY 2 & RAMPS - PLAN AND SECTIONS

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

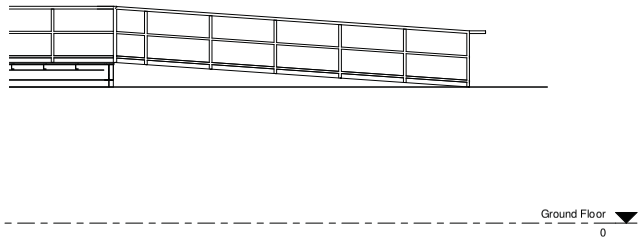
SCALE	1 : 50 @ A1
DATE	25/03/15
DRAWN	LW
CHECKED	JA
JOB NO.	1502
DWG NUMBER	A13
REV.	A



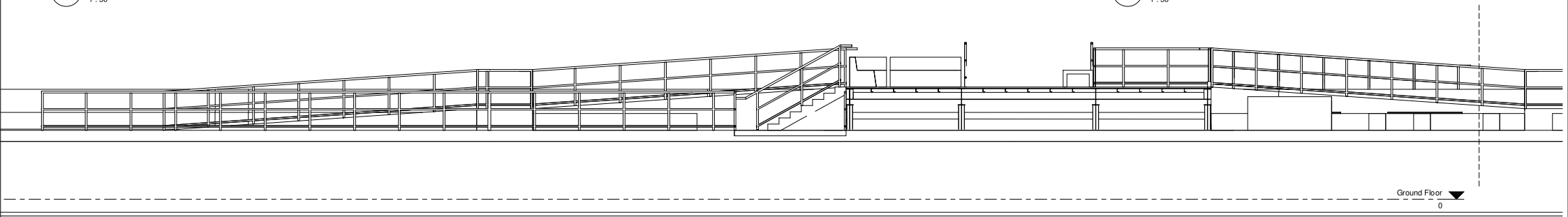
1 / A12 JETTY 2 ELEVATION 2 PART 1
1 : 50



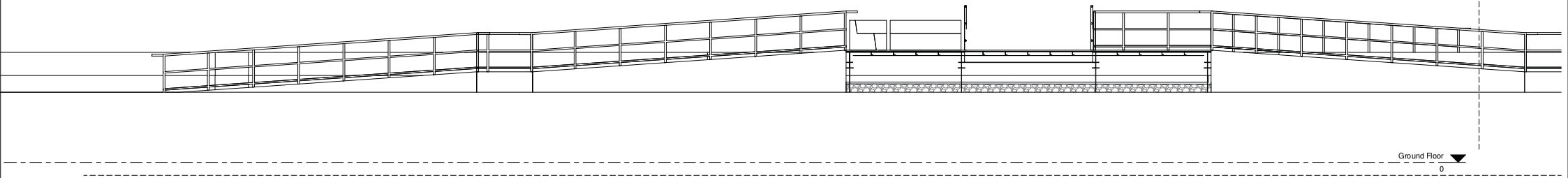
2 / A13 JETTY 2 ELEVATION 2 PART 2
1 : 50



F / A12 JETTY 2 SECTION F
1 : 50



D / A12 JETTY 2 SECTION D
1 : 50



E / A12 JETTY 2 SECTION E
1 : 50

No.	DATE	AMENDMENT	BY
A	30/03/15	ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL	

CONTRACTOR: IN SITU

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CLIENT: SHIRE OF CARNARVON

PROJECT: CARNARVON FASCINE FORESHORE REVITALISATION

TITLE: JETTY 2 & RAMPS - ELEVATIONS AND SECTIONS

ISSUED FOR CONSTRUCTION SUBJECT TO CLIENT APPROVAL

SCALE	1 : 50 @ A1
DATE	25/03/15
DRAWN	LW
CHECKED	JA
JOB NO.	1502
DWG NUMBER	A14
REV.	A

Appendix B Shorewater Marine – Diver Inspection Report

SHOREWATER MARINE PTY LTD

COMMERCIAL DIVING & MARINE MAINTENANCE

M P Rogers & Associates

Carnarvon Fascine Sheet Wall Piling Inspection

Completion Report October 2017-Report ID 0686

SWM0686

SHOREWATER MARINE PTY LTD

WORKS COMPLETION DATE

M P Rogers & Associates
1/128 Main Street
Osborne Park, WA 6017

SUBJECT: Carnarvon Fascine Sheet Wall Inspection

INTRODUCTION:

Shorewater Marine Pty Ltd was engaged by Peter Doust on behalf of M P Rogers & Associates to provide commercial diving services to conduct an above and below water assessment on the sheet wall piling fascine wall, located at Carnarvon, Western Australia

All work was accomplished as per SWM-0686 quotation document and structured on the Department of Primary Industries RFQ Document DPIRD – IM001. Supplied by M P Rogers & Associates.

All enquiries while on site were directed to Peter Doust of M P Rogers & Associates.

Shorewater Marine has provided the following report on all works completed. The report submission includes, executive summary, methodology for works completed, general observations and table of findings, summary, and recommendations for future maintenance.

REPORT INFORMATION	NAME	TITLE	COMPANY	SIGNATURE	DATE
Prepared	S. Williamson	Project Manager Dive Supervisor Director	SWM		14/11/17
Reviewed	H. Hill	Operations Manager	SWM		14/11/17
Approved	S. Williamson	Project Manager Dive Supervisor Director	SWM		15/11/17

Diver name	Position	ADAS Qualification number
S. Williamson	Dive Supervisor	03943
M. Hunt	Lead Supervisor	11658
B. Schutte	Diver	11559

TABLE OF CONTENTS

EXECUTIVE SUMMARY:

Shorewater Marine Pty Ltd (SWM) attended Carnarvon, Western Australia from the 23rd to the 26th of October 2017 to conduct an above and below water assessment on the sheet wall piling fascine wall, located at Carnarvon, Western Australia.

The sheet wall piling had recently been blasted and painted, making it difficult to conduct a visual inspection above tidal level due to the thickness of the paint coating applied. However, SWM's divers did provide a detailed visual inspection; commenting on several corrosion holes/areas of section-loss observed on sheet wall piles throughout the length of the fascine wall. Ultrasonic Thickness Testing (UTT) was also completed to confirm section loss within the allocated test locations, all findings are tabled within this report.

It was also noted by the divers that the sheet wall piles have no cathodic protection and the submerged in-water pile sections are freely corroding. Cathodic protection potential testing was carried out concurrently with UTT testing to confirm that at present no sacrificial anodes, or impressed current cathodic protection systems are present on the fascine wall, findings are tabled within this report.

Additionally, SWM divers completed a visual inspection on the fascine walls concrete capping, finding concrete spalling and cracking within approximately 80% of the sheet wall piling concrete capping. It was also observed that there was little concrete cover over the rebar, resulting in sections of concrete blowing out, exposing the rebar.

To complete the inspection works SWM's divers conducted an extensive walk through and dive inspection covering the entire 800 lineal metres of the sheet wall piling from seabed to concrete capping level, with SWM divers continuously commenting on any defects, this included but was not limited to; outflow pipes, sheet wall pile clutches, retainment rods and nuts, areas of subsidence, paint coating defects and corrosion formation.

The works were completed on time and with no incidents or injuries, all work was undertaken in accordance with the relevant AS/NZ Standards. SWM's team documented all the required information on a site template, for the purpose of reporting.

TERMS AND ABBREVIATIONS:

Abbreviation	Written in Full
ADAS	Australian Diving Accreditation Scheme
AS/NZS	Australian/New Zealand Standards
HAT	Highest Astronomical Tide
MSL	Mean Sea Level – referring to the Intertidal Column
CD	Chart Datum
CP	Cathodic Potential
LAT	Lowest Astronomical Tide
N/A	Not Accessible or Not Required
CC	Concrete Capping
DP	Depth of Protective Paint Coating
PC	Paint Coating
SB	Sea Bed
SWM	Shorewater Marine Pty Ltd
QHSE	Quality, Health, Safety and Environment
UTT	Ultrasonic Thickness Testing

TIME LINE OF WORKS:

Date	Works achieved
20th	SWM dive team completed all equipment checks required to complete the works and loaded onto the work ute ready for departure.
23rd	SWM Dive team departed Perth, bound for Carnarvon
24th	SWM Arrive on site and complete Shorewaters site set up and all necessary documentation including Shorewater site specific inductions, Job Safety Analysis (JSA) and Safe Work Method Statement (SWMS). Start inspection
25th	SWM Continue inspection.
26th	SWM Departed Carnarvon for Perth

DETAILED WORK DESCRIPTION:

1. Upon arrival at site Shorewater Marine Pty Ltd completed Shorewaters site set up and all necessary documentation including Shorewater site specific inductions, Job Safety Analysis (JSA) and Safe Work Method Statement (SWMS). Shorewater Marine Pty Ltd used a commercial dive team to AS/NSZ:2299.1 to complete the required works.
2. Completed visual inspection of 800 lineal meters of sheet wall piling, above and below water. Noting the condition of paint coatings, corrosion, defects, irregularity and general condition. Including comments on the condition of the concrete capping beam.
3. Cleaning of the sheet wall/removal of marine growth & corrosion to check the condition of steelwork & conduct thickness measurements with Ultrasonic Thickness Testing (UTT) equipment on a selection of sheet piles to confirm the typical condition of the piles at the pile cap, highest astronomical tide level, intertidal level and at lowest astronomical tide level or seabed level if it was found to be higher than LAT.
4. Completed UTT testing on the sheet wall structure at 40.0m intervals in 21 locations on a convex and concave face and a minimum of 1 diagonal face, at each location, at the above nominated levels (Pile Cap, HAT, MSL/Intertidal Column & LAT)
5. Visual inspection for anodes and cathodic potential meter testing.
6. Measurements of unprotected steel or freely corroding steel.
7. Visual inspection of all outflow pipes
8. Photographs and videos of the above.
9. Inspection report on the above with recommendations for repair.

TOOLS UTILISED:

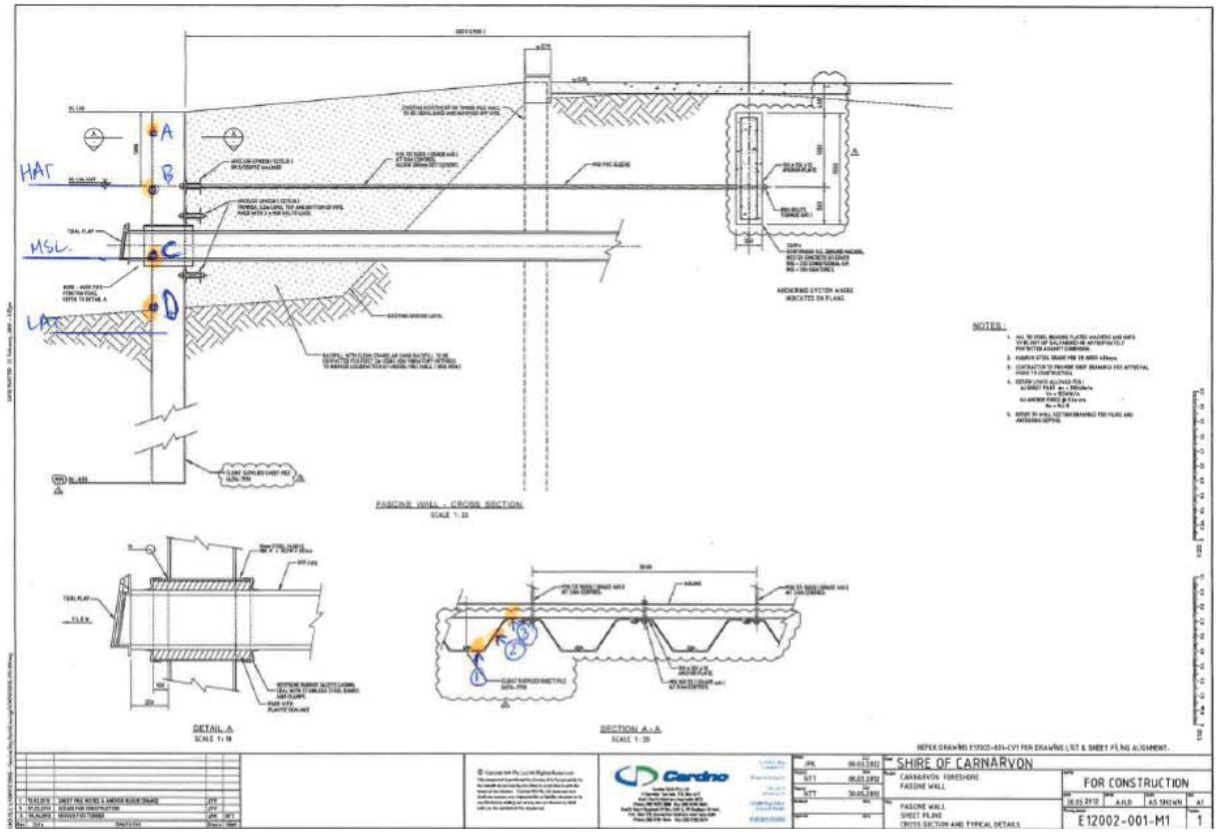
The following specialized equipment was utilised to gather the required information.

- Ultrasonic Thickness Testing Equipment – Shorewater Marine Pty Ltd, utilised a Tritex Multi Gauge 3000 underwater thickness tester to conduct all UTT measurements, on assembly, prior to use, the thickness testing unit was calibrated utilising 2 test pieces of steel, included within the Thickness Testing unit's assembly kit, these pieces of steel are 10 and 15 mm precisely in diameter. Each is tested to ensure the unit is providing accurate measurements prior to use.

- A MPS anode meter was utilised for the Cathodic Protection Potential readings and the following statement was adhered to: As stated within AS 2832.3-2005 Cathodic protection of metals Part 3: Fixed immersed structures a safe range for protection of a Steel structure is between **-800 to -1050mV**. If a steel structure is **under protected** it is either freely corroding or prone to corrosion.

- An Olympus Stylus TG-4 was utilised for under water and above water photos.

DRAWINGS UTILISED FOR UTT TEST LOCATIONS:



K1488 Carnarvon Fascine Wall - Chainage Plan LOCATION = 1-21 MARK = X

m p rogers & associates pl

K1488 Carnarvon Fascine Wall - Chainage Plan

0 10 20 30 40 50 m

m p rogers & associates pl

UTT TABLE OF FINDINGS:

UTT meter results, CP meter results, Diver Comments and photos for each individual test location are itemised in the following table of findings.

LOCATION 1:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
1	Convex	8.2	N/A	8.2	8.4	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, No exposed unprotected steel.
1	Concave	8.5	N/A	8.2	8.0	N/A	
1	East Sidewall	8.4	N/A	8.2	8.2	N/A	

CP Meter	N/A	Depth of paint – CC to DP	800mm	Depth of Unprotected steel - PC to SB	N/A

LOCATION 2:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
2	Convex	8.3	7.7	N/A	9	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, exposed unprotected steel 90mm to seabed.
2	Concave	8.4	7.7	N/A	9.1	N/A	
2	East Sidewall	8.0	7.9	N/A	8.8	N/A	

CP Meter	N/A	Depth of paint – CC to DP	1750mm	Depth of Unprotected steel - PC to SB	100mm

LOCATION 3:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE% WORN	DIVER COMMENTS
3	Convex	7.8	8.2	9.0	8.2	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Minor Paint loss on corners of sheet wall pile clutches, Surface corrosion on unprotected steel.
3	Concave	7.9	7.0	8.4	8.3	N/A	
3	East Sidewall	7.9	7.7	8.7	8.7	N/A	

CP Meter	-665mV	Depth of paint – CC to DP	1770mm	Depth of Unprotected steel - PC to SB	480mm

LOCATION 4:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
4	Convex	8.0	7.5	7.8	8.9	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Minor Paint loss in intertidal area, Surface corrosion on unprotected steel.
4	Concave	8.2	7.8	8.4	8.9	N/A	
4	East Sidewall	8.3	7.7	8.7	8.8	N/A	

CP Meter	-665mV	Depth of paint – CC to DP	1650mm	Depth of unprotected steel - PC to SB	550mm

LOCATION 5:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
5	Convex	7.9	7.2	8.3	9.0	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Minor Paint loss in intertidal area, Surface corrosion on unprotected steel.
5	Concave	8.3	4.2	8.4	8.9	N/A	
5	East Sidewall	8.1	5.2	8.2	8.5	N/A	

CP Meter	-660mV	Depth of paint – CC to DP	1720mm	Depth of Unprotected steel - PC to SB	680mm

LOCATION 6:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
6	Convex	9.0	7.7	8.2	8.6	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Minor Paint loss in intertidal area, Surface corrosion on unprotected steel.
6	Concave	8.9	7.0	8.1	8.5	N/A	
6	East Sidewall	9.0	8.0	8.3	8.3	N/A	

CP Meter	-610mV	Depth of paint – CC to DP	1800mm	Depth of Unprotected steel - PC to SB	930mm

LOCATION 7:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
7	Convex	9.1	8.1	8.3	7.2	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Minor Paint loss in intertidal area, Surface corrosion on unprotected steel.
7	Concave	9.2	8.2	8.4	7.3	N/A	
7	East Sidewall	8.7	8.0	8.2	7.8	N/A	
7	West Sidewall	9.0	8.3	8.6	7.8	N/A	

CP Meter	-665mV	Depth of paint – CC to DP	1810mm	Depth of Unprotected steel - PC to SB	1090mm

LOCATION 8:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
8	Convex	8.8	7.9	7.9	8.1	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area, Surface corrosion on unprotected steel. (Paint may have been affected by incoming tide at time of application)
8	Concave	8.1	8.0	8.2	8.3	N/A	
8	East Sidewall	8.7	6.9	8.3	8.1	N/A	
8	West Sidewall	8.4	5.6	8.4	8.2	N/A	

CP Meter	-678mV	Depth of paint – CC to DP	1810mm	Depth of Unprotected steel - PC to SB	1140mm

LOCATION 9:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
9	Convex	9.1	7.6	8.8	8.3	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area, Surface corrosion on unprotected steel. (Paint may have been affected by incoming tide at time of application)
9	Concave	9.1	7.9	8.5	8.2	N/A	
9	East Sidewall	9.3	7.4	8.5	8.6	N/A	
9	West Sidewall	8.3	7.2	8.3	8.8	N/A	

CP Meter	-680mV	Depth of paint – CC to DP	1830mm	Depth of Unprotected steel - PC to SB	1630mm

LOCATION 10:



LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
10	Convex	9.4	6.3	8.2	8.9	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area, Surface corrosion on unprotected steel. (Paint may have been affected by incoming tide at time of application)
10	Concave	9.1	7.6	8.7	8.2	N/A	
10	East Sidewall	9.4	6.5	8.3	8.5	N/A	
10	West Sidewall	9.0	7.0	8.6	7.8	N/A	

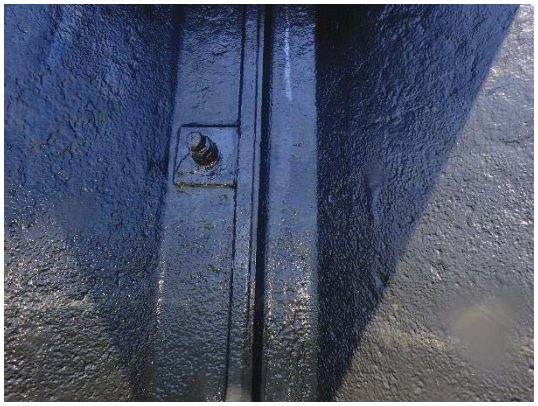
CP Meter	-678mV	Depth of paint – CC to DP	1810mm	Depth of Unprotected steel - PC to SB	1590mm

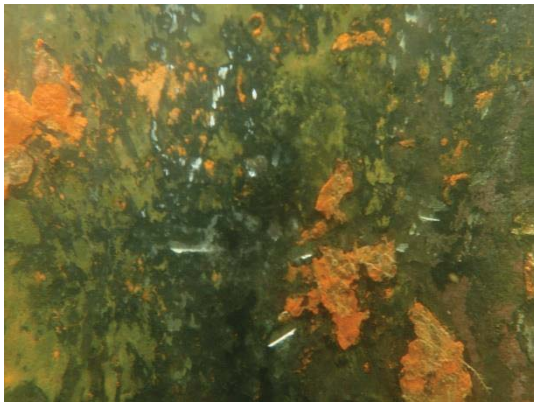
LOCATION 11:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
11	Convex	9.0	7.0	8.4	7.3	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area, Surface corrosion on unprotected steel. (Paint may have been affected by incoming tide at time of application)
11	Concave	8.9	5.8	8.3	7.1	N/A	
11	East Sidewall	8.5	4.9	8.2	6.4	N/A	
11	West Sidewall	8.3	5.0	8.7	8.3	N/A	

CP Meter	-655mV	Depth of paint – CC to DP	1880mm	Depth of Unprotected steel - PC to SB	1420mm

LOCATION 12:





LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
12	Convex	9.2	7.0	8.1	8.5	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area. (Paint may have been affected by incoming tide at time of application) Surface corrosion on unprotected steel below water line was more evident within this Location
12	Concave	9.2	7.5	8.4	7.9	N/A	
12	East Sidewall	8.4	6.8	8.5	8.1	N/A	
12	West Sidewall	7.9	5.7	8.3	7.4	N/A	

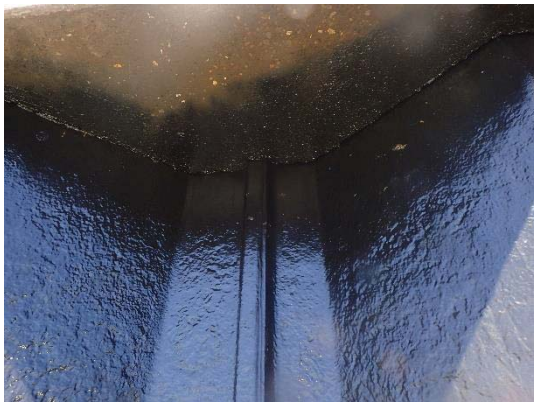
CP Meter	-690mV	Depth of paint – CC to DP	1800mm	Depth of Unprotected steel - PC to SB	1260mm

LOCATION 13:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
13	Convex	7.9	6.4	9.4	8.6	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area, Surface corrosion on unprotected steel. (Paint may have been affected by incoming tide at time of application)
13	Concave	8.3	6.5	8.8	8.7	N/A	
13	East Sidewall	7.1	7.8	9.0	8.6	N/A	
13	West Sidewall	8.5	7.2	8.5	6.8	N/A	

CP Meter	-680mV	Depth of paint – CC to DP	1800mm	Depth of Unprotected steel - PC to SB	1850mm

LOCATION 14:



LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
14	Convex	9.1	7.1	7.9	8.2	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area, Surface corrosion on unprotected steel. (Paint may have been affected by incoming tide at time of application)
14	Concave	8.7	6.7	8.5	8.4	N/A	
14	East Sidewall	8.7	6.1	8.1	8.5	N/A	
14	West Sidewall	8.4	7.0	7.6	8.7	N/A	

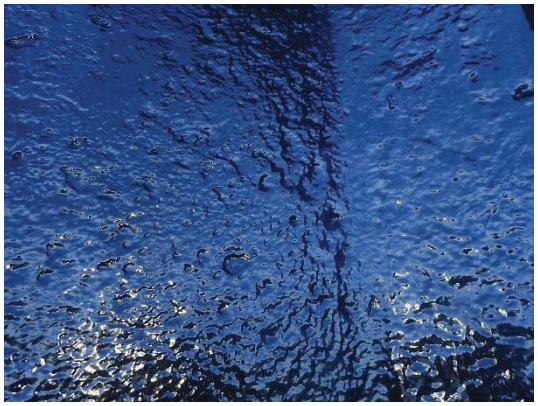
CP Meter	-680mV	Depth of paint – CC to DP	1800mm	Depth of Unprotected steel - PC to SB	970mm

LOCATION 15:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
15	Convex	8.3	6.9	7.0	8.4	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area, Surface corrosion on unprotected steel. (Paint may have been affected by incoming tide at time of application)
15	Concave	8.0	8.0	8.2	8.0	N/A	
15	East Sidewall	6.5	6.7	7.8	7.8	N/A	
15	West Sidewall	6.5	6.6	7.8	8.8	N/A	

CP Meter	-687mV	Depth of paint – CC to DP	1800mm	Depth of Unprotected steel - PC to SB	1070mm

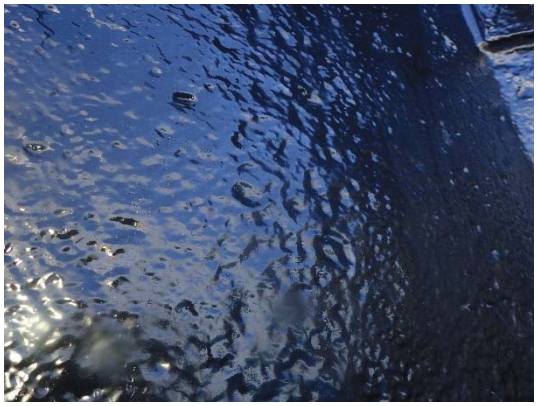
LOCATION 16:



LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
16	Convex	7.9	6.6	8.3	9.0	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area. (Paint may have been affected by incoming tide at time of application). Surface corrosion on unprotected steel below and above water line was more evident within this Location
16	Concave	7.6	6.2	8.2	9.2	N/A	
16	East Sidewall	7.5	6.0	8.4	9.0	N/A	
16	West Sidewall	7.7	6.3	8.2	8.9	N/A	

CP Meter	-687mV	Depth of paint – CC to DP	1910mm	Depth of Unprotected steel - PC to SB	930mm

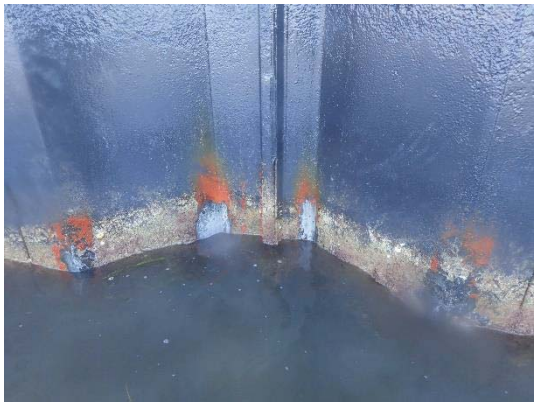
LOCATION 17:



LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
17	Convex	7.7	5.5	9.1	9.3	N/A	Recently heavy protective paint coating applied, heaver pitting observed under paint coating within this location, Paint loss in intertidal area. Surface corrosion on unprotected steel below water line was more evident within this Location
17	Concave	6.4	6.3	8.6	8.8	N/A	
17	East Sidewall	8.2	6.6	8.5	9.0	N/A	
17	West Sidewall	7.0	6.5	8.2	8.8	N/A	

CP Meter	-687mV	Depth of paint – CC to DP	1870mm	Depth of Unprotected steel - PC to SB	940mm

LOCATION 18:



LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
18	Convex	7.6	5.4	8.2	8.6	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Paint loss in intertidal area. (Paint may have been affected by incoming tide at time of application) Surface corrosion on unprotected steel below water line was more evident within this Location
18	Concave	6.4	5.7	8.3	8.5	N/A	
18	East Sidewall	6.2	5.5	7.9	8.6	N/A	
18	West Sidewall	6.5	3.4	8.2	8.2	N/A	

CP Meter	-671mV	Depth of paint – CC to DP	1920mm	Depth of Unprotected steel - PC to SB	830mm

LOCATION 19:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
19	Convex	9.0	3.7	N/A	9.2	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Holes within sheet piling observed, Paint loss in intertidal area. Surface corrosion on unprotected.
19	Concave	8.5	6.2	N/A	8.8	N/A	
19	East Sidewall	7.7	6.6	N/A	9.0	N/A	
19	West Sidewall	7.6	6.4	N/A	8.7	N/A	

CP Meter	N/A	Depth of paint – CC to DP	2430mm	Depth of Unprotected steel - PC to SB	80mm

LOCATION 20:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
20	Convex	9.0	6.6	N/A	9.3	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, Holes have been patch welded in this location, Bolt threaded into sheet wall piling is causing paint failure.
20	Concave	8.9	6.4	N/A	9.4	N/A	
20	East Sidewall	8.8	6.2	N/A	9.3	N/A	
20	West Sidewall	8.0	5.8	N/A	9.2	N/A	

CP Meter	N/A	Depth of paint – CC to DP	2650mm	Depth of Unprotected steel - PC to SB	50mm and around rocks

LOCATION 21:

LOCATION #	CONVEX/ CONCAVE/SIDEWALL	CAP LEVEL	HAT	MSL/ INTERTIDAL	LAT OR SEABED	ANODE % WORN	DIVER COMMENTS
21	Convex	9.0	7.2	N/A	8.2	N/A	Recently heavy protective paint coating applied, Pitting observed under paint coating, paint coating not applied around rocks and base of sheet wall.
21	Concave	8.8	5.5	N/A	8.8	N/A	
21	East Sidewall	8.8	7.0	N/A	8.5	N/A	
21	West Sidewall	8.6	7.0	N/A	9.3	N/A	

CP Meter	N/A	Depth of paint – CC to DP	2350mm	Depth of Unprotected steel - PC to SB	80mm and around rocks

VISUAL INSPECTION FINDINGS: SHEET WALL PILES

A protective paint coating had recently been applied to the sheet wall piles (application date unknown). The paint coating was overall in a good condition, however divers noted that typically the lowest 100-200mm of the paint coating, within areas subject to water fluctuation, may have been affected by the rising tide during the coatings application, with visible distortion of the coating observed in these areas. In other areas, divers observed “holidays” in the paint coating at seabed level, where rocks sat against the face of the sheet wall piling, with the painting application completed without the removal of the obstruction.

Pitting and scalloping of the steel was observed under the paint coating in all areas, however it was most prominent in intertidal areas.

During the painting process localised corrosion holes had been identified by the painting contractor and covered over with duct tape, presumably for future patch welding repairs, these patches were most prominent between chainage areas 710 - 800.

SWM divers also noted additional corrosion holes that were not patched over, but had received application of a new paint coating in the following chainage areas:

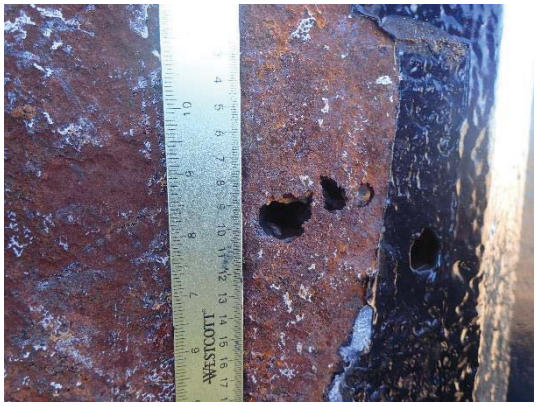
- Chainage - 710 to 800 number of corrosion holes ranging from 5 - 30mm in dia. In addition to those noted above that had been covered for later repair.
- Chainage - 590 at 450mm below capping level 15mm in dia.
- Chainage - 590 at 200mm below capping level 10mm in dia.
- Chainage - 160 at 420mm below capping level 20mm in dia.
- Chainage - 161 at 410mm below capping level 25mm in dia.

Sheet wall piling below LAT, in subsea areas had a consistent layer of surface corrosion with no localised scalloping or corrosion holes observed. All sheet wall piles below LAT are bare steel and are freely corroding. Calculated on the average uncoated depth of 0.738m multiplied by the 800 lineal meters of sheet wall piling, 590.4m2 would require cathodic protection.

Note: The visibility during the project below the water line was poor, limiting the divers vision, it is possible that due to the minimal thickness of the paint coating in intertidal areas, smaller corrosion holes may have been covered over by the paint coating, making them impossible to identify during a visual inspection.

SHEET WALL PILE PHOTOS: TYPICAL DEFECTS

1.1



1.2

1.3

1.4

1.5

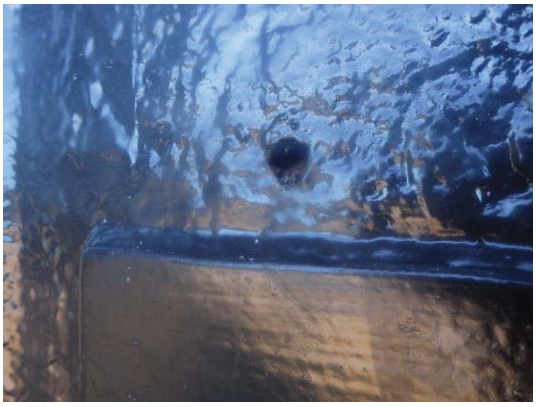
1.6

1.1 – Example of paint coating not applied due to the presence of rocks on the seabed.
1.2 – Example of corrosion holes observed that had not been painted or prepared for repair.
1.3 – Example of corrosion holes observed that had been patched, presumably in preparation for repair.
1.4 – Example of corrosion holes observed that had been painted over.
1.5 – Example of corrosion holes observed that had been painted over.
1.6 – Typical corrosion observed on the bare steel in subsea areas.

VISUAL INSPECTION FINDINGS: AREAS OF COMPLETED PATCH WELDING

Within chainage areas 725 to 800 a number of patch welded plates covering corrosion holes have been installed. All patches are in good condition, however some do not cover all of the corrosion holes in that area, as seen in the below photos.

2.1



2.2

2.1 – Example of completed patch welding repairs.
2.2 – Example of corrosion holes observed in the sheet wall piling, outside of the coverage of the completed patch welding repairs.

VISUAL INSPECTION FINDINGS: CONCRETE CAPPING

The concrete capping within chainage areas 709-800 is in a good condition with only a single small crack found between chainage 709 -710.

The concrete capping within chainage areas 0-709 has cracking forming in approximately 80% of the length of the concrete with a number of areas suffering concrete spalling and exposure of reinforcement, divers observed that there was very minimal coverage of concrete between the rebar and the outside edge of the concrete, resulting in spalling corrosion, exposure of the reinforcement and cracking.

Chainage area 325 has concrete section loss with exposed rebar the rebar showing the effects of accelerated corrosion.

Chainage area 130 has concrete section loss with concrete spalling exposing the rebar, divers also noted that the concrete breaks away easily in hand with little to no force required.

Typically, the presence of cracking, spalling and rebar exposure is isolated to the underside of the capping beam and the seaward face across the 800 lineal metres.

CONCRETE CAPPING PHOTOS: TYPICAL DEFECTS

3.1

3.2

3.3

3.4

3.5

3.6

3.1, 3.2 & 3.3 – Typical concrete spalling, leading to exposure of the rebar observed on the underside of the concrete capping. Photos also identify the minimal thickness of concrete between the rebar and bottom face

3.4, 3.5 & 3.6 – Typical concrete cracking observed on the underside of the concrete capping beam.

VISUAL INSPECTION FINDINGS: OUT FLOW PIPES

In addition to the quoted work scope divers visually inspected all drainage out flow pipes and tide flaps, all findings are tabled below.

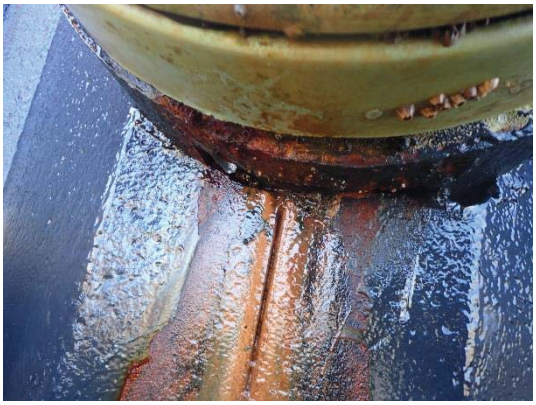
CHAINAGE	DIVER COMMENTS - OUT FLOW PIPES
800	Tide flap and hinge in good condition, gap between pipe and sheet wall pile has been sealed with hessian bags and seal has failed causing subsidence, recommend resealing pipe
730	Tide flap and hinge in good condition, gap between pipe and sheet wall pile has been sealed with tyre tube, tube is in poor condition. Water is evident behind sheet wall; pipe needs to be resealed ASAP to stop subsidence.
710	Tide flap and hinge in good condition, pipe extrudes out through steel ring. Hole at base of ring which is allowing water ingress, recommend sealing at the earliest opportunity.
615	Tide flap and hinge in good condition. Gap between pipe and sheet wall pile sealed with tyre tube and held with hose clamp. Recommend sealing.
500	Tide flap and hinge in good condition, pipe protrudes through steel ring Pipe is sealed to ring and is in good condition.
460	Tide flap and hinge in good condition, pipe protrudes through steel ring Pipe is sealed to ring and is in good condition.
400	Tide flap and hinge in good condition, pipe protrudes through steel ring Pipe is sealed to ring and is in good condition.

OUT FLOW PIPE PHOTOS: TYPICAL DEFECTS

4.1

4.2

4.3

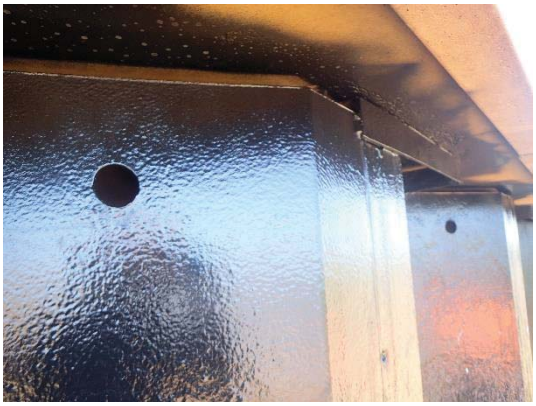


4.4

4.1 – Overview drainage outflow pipe and tide flap configuration. Seal between the sheet wall piling and outflow pipe is in a good condition.
4.2 – Example gap between sheet wall piling and outflow pipe sealed with a hessian bag, causing subsidence.
4.3 – Example gap between sheet wall piling and outflow pipe sealed with a tyre tube, causing subsidence.
4.4 – Example hole at the base of the ring at chainage 730, with water evident behind sheet wall piling.

VISUAL INSPECTION FINDINGS: PILE LIFTING POINTS

Within chainage areas 710 to 800 sheet wall piles have open holes, presumed lifting points during fabrication, that may lead to corrosion or back full material subsidence. As seen in the below photos.



5.1

5.2

5.1 & 5.2 – Example presumed lifting points.

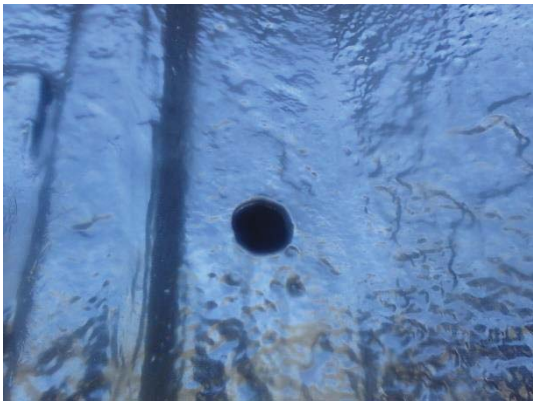
VISUAL INSPECTION FINDINGS: RETAINMENT RODS, NUTS & WASHERS

The retainment rod system was in good condition with no rod, nut or washer defects noted. However, it was observed by the divers that in chainage areas 685 and 675 that open tie-rod holes had been left un-capped, this may lead to back fill material subsidence.

6.1

6.2

6.3



6.4

6.1 & 6.2 – Examples of retainment rod system in good condition, with no observed defects.
6.3 & 6.4 – Example of open retainment rod holes that are unsealed, that may lead to back fill material subsidence.

VISUAL INSPECTION FINDINGS: ENTRY/EXIT LADDERS

All ladders were observed to be visually in a good condition with only minor painting coating defects.

7.1

7.2

7.3

7.4

7.1 & 7.2 – Examples of entry/exit ladders with no observed defects.
7.3 & 7.4 – Examples of entry/exit ladders with minor paint coating defects on rebar edges.

RECOMMENDATIONS:

Shorewater Marine would recommend conducting the following remedial repair works on the Carnarvon Fascine Wall to assist with the longevity of the structure.

CATHODIC PROTECTION:

Designing a sacrificial anode Cathodic Protection system to sufficiently protect the submerged steel structure, within the recommended range of protection, for fixed immersed structures. Continuity welding of the Sheet Wall Pile clutches is recommended, for optimum performance of the sacrificial anode system.

SHEET WALL PILING:

Patch welding of corrosion holes, lifting points and retainment rod holes is recommended to prevent possible subsidence of back fill materials, and assist with the longevity of the structure.

CONCRETE CAPPING BEAMS:

Repair of spalling corrosion, concrete section loss and concrete cracking is recommended to prevent further spalling and/or section loss. Products such as Xypex Megamix are capable of providing a sufficient repair.

OUTFLOW PIPES:

Repair of the damaged seals between the outflow pipes and the sheet wall piling is recommended at the earliest convenience to prevent further subsidence.

PROTECTIVE PAINT COATING:

Continued annual maintenance of the protective paint coating is recommended to ensure areas above the low water mark, particularly through the intertidal column, remain sufficiently protected from the harsh marine environment, Shorewater Marine would also recommend addressing areas of the sheet wall piling, left unprotected, due to the presence of rocks or other obstructions on the seabed.

SUMMARY:

Shorewater Marine has provided these findings & recommendations, based on industry experience and works completed similar in nature to the Carnarvon Fascine Wall. We do recommend that M P Rogers review all findings and recommendations.

Shorewater Marine can provide many repair methodologies for consideration, with budget quotations on all recommended repairs.

Shorewater Marine PTY LTD would like to thank M P Rogers & Associates for providing us with the opportunity to complete the above and below water assessment of the sheet wall piling fascine wall, located at Carnarvon, Western Australia.

We hope the information provided in this report is written in a clear and detailed manner, we are available on the numbers listed should you have any questions or queries regarding this report or any future works we can assist you with.

Kind Regards

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Appendix C Maintenance Plan

Maintenance Plan

The following maintenance plan has been prepared to assist in planning and programming future maintenance works on the Carnarvon Fascine Sheet Pile Wall over the coming 2 decades. This plan shall be reviewed and updated as required during the life of the wall.

Further Investigations

In order to confirm the current condition of the wall and to gain a better understanding of the reserve capacity of the wall the following investigations shall be completed as a high priority and before committing to any costly repairs.

Soil Testing

The backfill material shall be sampled and tested by an experienced geotechnical consultant to confirm the corrosivity of the soil. The presence of organics, high acidity or contaminants in the soil can lead to corrosive conditions. The composition of any retained water behind the wall can also create corrosive conditions. Therefore the testing shall confirm the composition of the soil and water retained behind the wall. The consultant shall provide comment on the likely extent that the backfill and retained water is contributing to corrosion of the sheet pile wall including the tie rods and waling.

The soil samples shall be taken from a minimum of 5 locations along the length of the wall.

A description of the geotechnical conditions shall also be provided which will be used in the structural analysis of the sheet pile wall.

The results from the soil sampling and testing shall be summarised in a brief geotechnical report.

Inspection of Buried Tie Rods & Waling

To ascertain the condition and existing corrosion protection measures for the tie rods and waling members a selection of tie rods and waling shall be exposed and inspected.

As a minimum it is recommended that the tie rods are exposed and inspected at 3 locations along the length of the wall. Locations shall be determined in consultation with the Shire to ensure disruptions are kept to the minimum.

The results from the inspection shall be documented in a brief report including a description of the findings and photographs. If the members are found to be corroding an assessment of the loss of section shall be provided.

Following the inspection the landscaping shall be reinstated to the condition prior to the inspection works.

Structural Analysis of Sheet Pile Wall

To confirm the reserve capacity of the sheet pile wall and to assist in determining the requirements for strengthening repairs, structural analysis of the wall shall be completed by a Structural Engineer with experience in the design of marine sheet pile walls.

Appropriate design criteria for the analysis shall be determined by the consultant in consultation with the Shire (eg. design life, surcharge loads etc).

The analysis shall include an assessment of distribution of design actions for a section through the wall. The amount of reserve capacity in the sheet piles shall be assessed for different levels

of corrosion applied at various heights on the sheet pile. The outcomes of this analysis shall enable the Shire to confirm what level of corrosion is acceptable and when strengthening of the sheet piles is required to achieve the required design capacity.

The results of the analysis shall be summarised in brief report.

Repairs

The following repairs shall be completed to extend the useful life of the structure. All repairs shall be undertaken by a Marine Contractor with experience in marine maintenance works.

Plate Repairs to Strengthen Wall and Seal Holes

The extent and timing of plate repairs shall be determined following the results of the additional investigations outlined above.

Plate repairs (if required) shall involve the following.

- Cleaning back the existing sheet pile to bare metal to enable welding of the new steel to the existing sheet pile.
- Installing a new plate of steel over the thin section of sheet pile to strengthen the structure. This will need a full seal weld around the perimeter of the plate. The thickness of the plate and the weld size will depend on the results of the structural analysis above.
- Reinstating the paint coating over the repaired section to prevent further corrosion.

Sealing Stormwater Outlets

To prevent loss of backfill material from around the drainage outlets the gap between the pipe and the sheet pile wall shall be resealed. There are 4 outlets to be sealed at approximate chainages 615, 710, 730, and 800 as outlined in the Shorewater Marine report.

Concrete Capping Replacement

The existing concrete capping shall be demolished and replaced with a new reinforced concrete capping beam. The new concrete capping beam shall be designed by a qualified structural engineer with experience in the design of marine structures. The design shall comply with the strength and durability requirements of AS4997-2005 and AS3600-2009.

Demolition and disposal of existing capping shall be undertaken carefully to ensure there is no damage to the existing pavements and sheet pile wall. Any damage shall be made good by the Contractor at no additional expense to the Shire.

Construction of the new capping shall be undertaken in accordance with AS4997-2005 and AS3600-2009. The concrete shall have a minimum strength of 32MPa prior to stripping forms and shall be continuously water cured for a period of 7 days.

Ongoing Inspections & Monitoring

Annual Visual Inspections

A visual inspection of the wall shall be carried out on an annual basis. This shall be carried out during low tides. The following shall be checked and documented.

- Any damage to the wall or the protective paint coating.
- Any leakage of backfill material from around drainage outlets.

- Condition of the concrete capping beam.
- Evidence of any subsidence.
- Photographs showing the general condition and any defects or damage.

The results shall be summarised in a brief report.

5 Yearly Detailed Condition Inspection

A detailed condition inspection shall be undertaken every 5 years. This shall be completed by an experienced coastal engineer together with divers. The following shall be recorded:

- Detailed visual inspection of the above and below water portions of the wall noting any damage or defect.
- Clean back and completed Ultrasonic Thickness (UT) testing to confirm the thickness of the steel. This shall include tests at 20 locations along the length of the wall. At each location there shall be tests at 4 levels on the sheet pile (ie. Cap, HAT, MSL, LAT/Seabed).
- Photographs showing the general condition and any defects or damage.
- Recommended maintenance works.

The results shall be summarised in a brief report.

Inspection Following Severe Events

The wall shall be inspected for damage or movement following any severe events including:

- Major flooding events.
- Storm surge events.
- Overloading of the wall.

Coating Maintenance

Minor Repairs

Following the annual inspections, any defects in the paint coating shall be repaired to ensure protection to the steel. The repairs shall be completed in accordance with the requirements of AS2312.1-2014 and to the paint manufacturer's recommendations. The paint used shall be a high build epoxy and shall be compatible with the existing paint coating (Sigmashield 880).

Recoating

The paint coating is likely to deteriorate over time and reach a stage where it requires recoating. The timing of recoating will be determined from the results of the annual inspections.

The recoating works shall include blast cleaning the sheet piles to Class Sa2 ½ in accordance with AS1627.4-2005 then coating with a high-build epoxy paint coating. The painting shall be completed in accordance with the requirements of AS2312.1-2014 and to the paint manufacturer's recommendations. The paint shall be applied in a minimum of 2 coats.

Upgrades & Additional Protection

Depending on the results of the further investigations outlined above additional corrosion protection may be required to extend the life of the sheet pile wall. This protection shall be achieved by installing an appropriate cathodic protection system as outlined below.

Cathodic Protection

The cathodic protection system shall be designed by personnel with experience and qualifications in the design of cathodic protection.

Two types of cathodic protection systems are available including sacrificial anodes and impressed current systems. To offer the best level of protection a combination of the two systems shall be considered (eg impressed current for the rear of the wall, sacrificial anodes for the front of the wall).

To ensure electrical continuity between each of the sheet piles a 75mm continuity weld shall be applied between the clutches at the top of each sheet pile. Any damage to the paint coating shall be reinstated.

The installation of the cathodic protection system shall be completed by an experienced contractor to the requirements of the cathodic protection design developed above.

Carnarvon Fascine Wall – Maintenance Plan

	Item	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Investigations & Monitoring	General Visual Inspections	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
	Detailed Condition Inspeciton with Divers including UTT and sacrificial anode testing					$ 30,000					$ 30,000					$ 30,000					$ 30,000
	Soil Testing to Assess Corrosive Nature of Backfill	*Being undertaken by Shire*																			
	Expose and check condition of tie rods and waling.	$ 20,000																			
	Structural analysis of wall to confirm requirement for wall strengthening repairs	$ 20,000																			
Repairs & Maintenance	Ongoing Patch Repairs to Paint Coating	$ 10,000	$ 10,000	$ 10,000	$ 15,000	$ 15,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000		$ 10,000	$ 10,000	$ 10,000	$ 15,000	$ 15,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	
	Reinstatement of New Paint Coating										$ 400,000										$ 400,000
	Steel Patch Repairs to cover holes and repair thin sections.	*$ 100,000*	*(depends on results from structural analysis above)*																		
	Sealing around Stormwater Outlets	$ 5,000																			
	Replacement of concrete capping beam			$ 275,000																	
Upgrade & Additional Protection	Design and installation of Sacrificial Anodes to Protect Submerged Portion of Seaward side of wall.	$ 250,000																			
	Repairs or Replacement of Anodes						$ 10,000					$ 50,000					$ 100,000				
	Design and installation of Impressed Current Cathodic Protection System to protect landward face of sheet piles.	*$ 275,000*	*(depends on results from soil testing above)*																		
	Monitoring and management of CP system		*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*	*$ 10,000*
	Total Annual Cost	**$ 685,000**	**$ 25,000**	**$ 300,000**	**$ 30,000**	**$ 60,000**	**$ 45,000**	**$ 35,000**	**$ 35,000**	**$ 35,000**	**$ 445,000**	**$ 75,000**	**$ 25,000**	**$ 25,000**	**$ 30,000**	**$ 60,000**	**$ 135,000**	**$ 35,000**	**$ 35,000**	**$ 35,000**	**$ 445,000**
	Total Cumulative Cost	**$ 685,000**	**$ 710,000**	**$ 1,010,000**	**$ 1,040,000**	**$ 1,100,000**	**$ 1,145,000**	**$ 1,180,000**	**$ 1,215,000**	**$ 1,250,000**	**$ 1,695,000**	**$ 1,770,000**	**$ 1,795,000**	**$ 1,820,000**	**$ 1,850,000**	**$ 1,910,000**	**$ 2,045,000**	**$ 2,080,000**	**$ 2,115,000**	**$ 2,150,000**	**$ 2,595,000**

Note:
1. The costs provided are based on 2017 rates and no allowance is included for depreciation or inflation.
2. All costs are exclusive of GST.
3. The costs are preliminary only and are subject to further investigation and detailed design of the repairs and upgrade works.
4. The costs are based on the works being packaged and completed in a cost effective manner.
5. The steel patch repairs will depend on the results from the structural analysis of the wall.
6. The need for a CP system to protect the rear of the wall will depend on the results of the soil testing.

m p rogers & associates pl

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