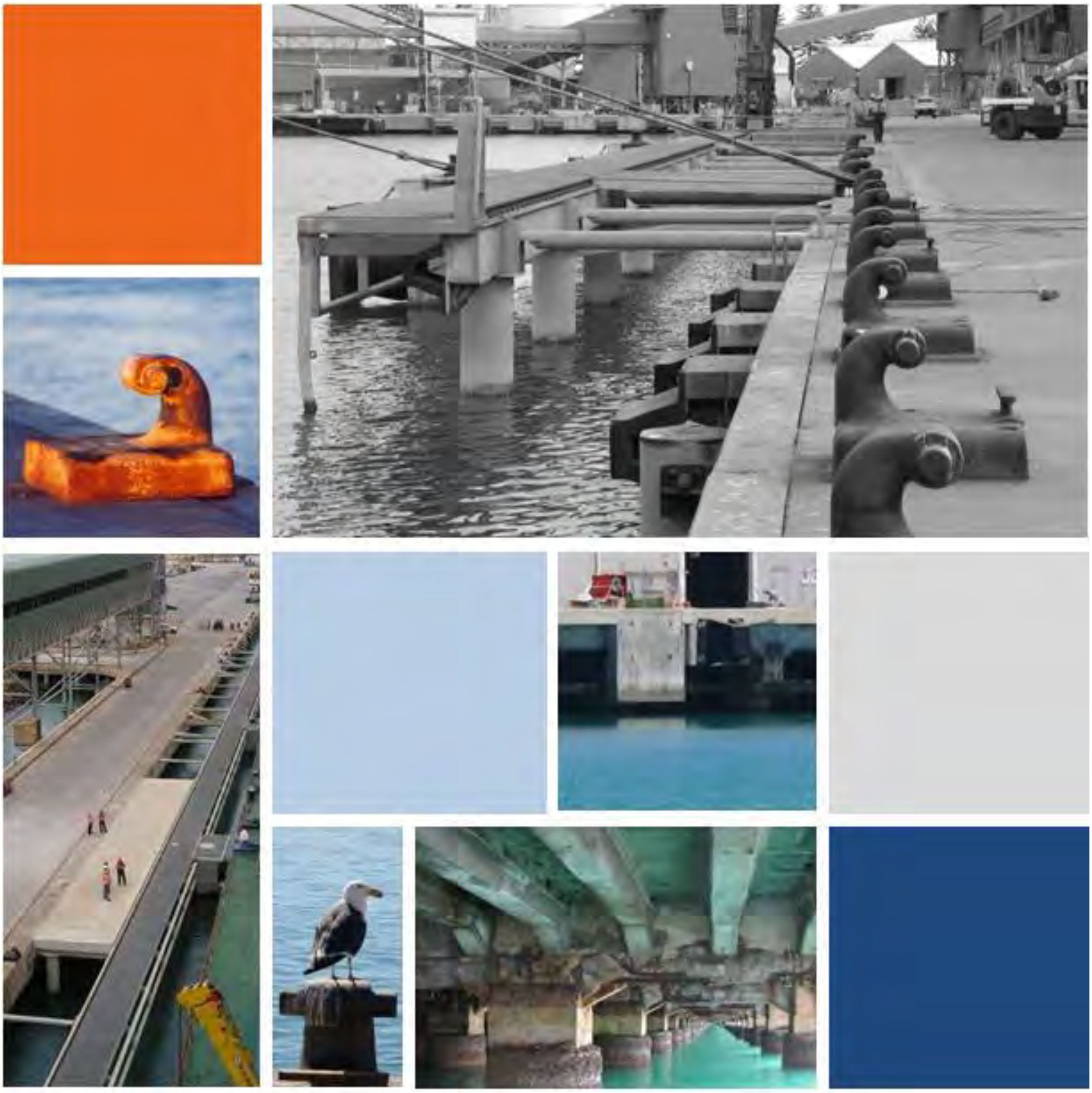
MID WEST PORTS

TECHNICAL GUIDELINE

MWPA400 – MARITIME STRUCTURES GUIDELINE



UNCONTROLLED WHEN PRINTED

Version	Revision Date	Details	Prepared By	Authorised By
Rev A	09/04/2014	Complete	SMEC	
Rev B	04/06/2014	Formatted to MWPA	S. Good	P. Blundell
Rev C	14/09/2015	Formatted	I. McLeod	P. Blundell

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APPENDICES

1. PREFACE

This document has been compiled for the Mid West Ports Authority (MWPA) to provide developers, designers, contractors and inspectors guidance on MWPA's maritime structures. It does not replace bespoke project basis of design, design criteria or specifications, but it is intended to provide a benchmark for the minimum technical requirements for new construction, refurbishment and repair of maritime structures within Geraldton Port.

The chapters of this Guideline include guidance and statutory requirements and Geraldton Port-specific design and construction requirements for maritime structures projects.

This Guideline will be used as a basis for identifying any shortcomings in the technical content, and ultimately accepting or rejecting proposed, underway or complete projects.

2. SCOPE

2.1. GENERAL

This Guideline defines the minimum requirements for design, construction and maintenance projects that include the following types of maritime structure:

- Berths
- Jetties
- Wharfs
- Pens
- Shipping guidance infrastructure (navigation buoys and beacons)
- Berth Furniture (bollards, fenders, capstans, etc.)
- Fixed Access Structures
- Seawalls

Where documents are referred to in this Guideline, the reference shall be taken to mean the most recent revision, unless noted otherwise.

2.2. EXCLUSIONS

The following are excluded from this Guideline:

- Protective Coatings – **Refer to MWPA401**
- Rock Structures (including breakwaters, rock walls, revetments, concrete armour units and slope protection mattresses) – **Refer to MWPA402**
- Cathodic Protection – **Refer to MWPA404**
- Rock anchors
- Dredging

2.3. PRECEDENCE

As a general guide, where particular aspects are not covered in the MWPA Technical Guidelines or where conflict between documents exists, the following precedence for standards applies:

1. Statutory Regulations
2. Design Codes and Standards
3. Project Specific Specification
4. MWPA Technical Guidelines; and
5. Other References (e.g. Recognised Industry Best Practice)

Regardless of the general order of precedence, if there is a conflict between documents the clause presenting the more conservative and pragmatic guidance will govern. If in doubt, or in all cases where noncompliance is anticipated, clarification shall be sought from MWPA.

3. GLOSSARY

For the purposes of this Guideline the following particular definitions apply:

Table 1: Glossary of Terms

Term	Definition
Bathymetry	Underwater Topography of Seabed.
Belting	Refer Sponson.
Bollard	A post to which vessel mooring lines are attached.
Buckling	A mode of failure of a structural member in compression.
Chart Datum	Datum used in navigational charts equal to LAT.
Composite Member	Two different materials bound together so they structurally act as one.
Datum	Any permanent line, plane or surface used as a reference to which elevations are referred.
Deadweight Tonnage	Total mass of cargo, stores, fuels, crew and reserves with which a vessel is laden when submerged to the summer loading line.
Design Life	The period a structural member remains fit for use for its intended purpose with appropriate maintenance.
Design Wave	Highest 1% of waves in any given time interval.
Displacement	Total mass of a vessel and its contents.
Drawings	Engineering plans and drawings provided by the designer as part of a proposed project's documentation package.
Fender	Units formed from rubber that absorb berthing energy.
Fender Blocks	Concrete blocks forming part of maritime structure for attaching fenders.
Fender Panels	Panels attached to the front of fenders to reduce berthing pressures.
Highest Astronomical Tide	The highest level of water which can be predicted to occur under any combination of astronomical conditions. This level may not be reached every year.
Jacketed	A protective concrete outer casing or encapsulation.
Keel	Lowest external part of a vessel.
Liquefaction	Shaking by earthquakes causing sands to behave like a liquid.
Lowest Astronomical Tide	The lowest level of water which can be predicted to occur under any combination of astronomical conditions. This level may not be reached every year.

Term	Definition
Mean Sea Level	The average height of the sea for all stages of the tide over a 19 year period, usually determined from hourly height readings.
Overtopping	Water passing over the top of a structure.
Precast	To cast concrete in a place other than where it is to be installed in a structure.
Raking	Inclined.
Significant Wave Height	Average height of the highest one third of the waves in a given sea state.
Soffit	Underside of a structural member.
Sponson	Rubbing strip, generally at main deck level, to strengthen and protect a vessel from berthing impacts.
Swell waves	Wind-generated waves that have travelled out of their generating area. Swell waves characteristically exhibit a more regular and longer period and have flatter crests than waves within their fetch.
Vessel	A ship or boat.
Vessel wash	Waves formed by passage of a vessel.
Wave height	Height of a wave crest above the proceeding wave trough.

For the purposes of this Guideline the following particular abbreviations apply:

Table 2: Abbreviations

Abbreviation	Meaning
CD	Port of Geraldton Chart Datum
AHD	Australian Height Datum
AS	Australian Standard
AS/NZS	Australian/New Zealand Standards
MWPA	Mid West Ports Authority
QRH	Quick Release Hook
GA	General Arrangement
MSL	Mean Sea Level
LAT	Lowest Astronomical Tide
HAT	Highest Astronomical Tide
SOLAS	International Convention for the Safety of Life at Sea

Abbreviation	Meaning
ARI	Average Recurrence Interval
DWT	Dead Weight Tonnage
PDA	Pile Driving Analyser

4. RELEVANT DOCUMENTATION

4.1. GUIDELINE SERIES

This guideline should be read in conjunction with other parts of the MWPA Technical Guideline series, where relevant, as listed below:

- MWPA 000 Series – Port Development Guidelines;
- MWPA 100 Series – General Guidelines;
- MWPA 200 Series – Drafting and Surveying Guidelines;
- MWPA 300 Series – Mechanical Guidelines;
- MWPA 400 Series – Guidelines for Maritime Structures;
- MWPA 500 Series – Civil Engineering Guidelines;
- MWPA 600 Series – Buildings and Structures Guidelines;
- MWPA 700 Series – Electrical and Instrumentation Guidelines;
- MWPA 800 Series – Guidelines for Rail; and
- MWPA 900 Series – Additional Guidelines.

Where the referenced MWPA guidelines do not yet exist, the relevant Australian Standards and industry best practice shall apply.

4.2. MID WEST PORTS AUTHORITY POLICIES AND PROCEDURES

All parties involved in a maritime structures project should be aware of and comply with MWPA policies and procedures. A full list of MWPA's policies and procedures can be found in **MWPA100** and obtained either from the MWPA website *www.midwestports.com.au* or requested from the MWPA Project Coordinator or Owner's Engineer.

4.3. LOCAL, STATE AND FEDERAL STATUTORY REQUIREMENTS

In addition to the requirements of this part of the MWPA Technical Guidelines, all Projects shall meet the requirements of Local, State and Federal statutory, health, safety and environmental requirements and regulations and include, but not be limited to, the following:

- Western Australian Environmental Protection
- Western Australian Occupational Safety and Health Act (1984) and Regulations (1996)
- Western Australian Marine (Certificates of Competency and Safety Manning) Regulations (1983)
- Western Australian Mines Safety and Inspection Act (1994)
- Western Australian Mines Safety and Inspection Regulations (1995)
- Dangerous Goods Safety Act (2004)
- Port Authorities Act (1999)
- Maritime Transport and Offshore Facilities Security Act (MTOFSA) (2003)
- Environmental Protection Act and Regulations (1986)

4.4. AUSTRALIAN STANDARDS AND DESIGN CODES

The latest version of the following standards and documents should be adopted for works covered by this Guideline:

Table 3: Relevant Australian Standards and Design Codes

No.	Title
AS 1012	Methods of testing concrete
AS/NZS 1050	Methods for analysis of iron and steel
AS 1074	Steel tubes and tubulars for ordinary service
AS 1085	Railway track materials
AS/NZS 1111	ISO metric hexagon bolts and screws
AS/NZS 1112	ISO metric hexagon nuts
AS/NZS 1163	Cold-formed structural steel hollow sections
AS/NZS 1170.0	Structural design actions – General principles
AS/NZS 1170.1	Structural design actions – Permanent, imposed and other actions
AS/NZS 1170.2	Structural design actions – Wind actions
AS 1170.4	Structural design actions – Earthquake actions in Australia
AS 1199	Sampling procedures for inspection by attributes
AS 1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS 1379	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout
AS/NZS 1554	Structural steel welding
AS/NZS 1594	Hot-rolled steel flat products
AS 1604.1	Specification for preservative treatment – Sawn and round timber
AS 1657	Fixed platforms, walkways, stairways and ladders – Design, construction and installation
AS/NZS 1664	Aluminium structures
AS/NZS 1665	Welding of aluminium structures
AS 1720.1	Timber Structures – Design methods
AS 1726	Geotechnical site investigations
AS 2159	Piling – Design and installation

No.	Title
AS 2177	Non-destructive testing – Radiography of welded butt joints in metal
AS 2207	Non-destructive testing – Ultrasonic testing of fusion welded joints in carbon and low alloy steel
AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings
AS 2327.1	Composite structures – Simply supported beams
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates
AS 2832	Cathodic protection of metals
AS 3582	Supplementary cementitious materials for use with Portland and blended cement
AS 3600	Concrete structures
AS 3610	Formwork for concrete
AS/NZS 3678	Structural steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679.1	Structural steel - Hot-rolled bars and sections
AS/NZS 3679.2	Structural steel – Welded I sections
AS 3962	Guidelines for design of marinas
AS 3972	General purpose and blended cements
AS 4100	Steel structures
AS/NZS 4600	Cold-formed steel structures
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4672	Steel prestressing materials
AS/NZS 4673	Cold-formed stainless steel structures
AS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS 4997	Guidelines for the design of marine structures
AS 5100	Bridge design
AS 5604	Timber – Natural durability ratings

4.5. INTERNATIONAL STANDARDS AND DESIGN CODES

In the absence of suitable Australian Standards, the latest version of the following international standards and design codes may be adopted for works covered by this Guideline:

Table 4: International Standards and Codes

Section	Title
BS6349: Part 1	Maritime structures. Code of practice for general criteria
BS6349: Part 2	Maritime works. Code of practice for the design of quay walls, jetties and dolphins
BS6349: Part 4	Maritime works. Code of practice for design of fendering and mooring systems

4.6. ADDITIONAL REFERENCES

The following references have been used in the production of this guideline:

Table 5: Additional References

Item No.	Reference
1	*www.transport.wa.gov.au*
2	*www.midwestports.com.au*
3	*www.planning.wa.gov.au*
4	Guidelines for the Design of Fenders Systems (PIANC)
5	Port Designer's Handbook – Recommendations and Guidelines (Carl A Thoresen)
6	MWPA Wharf Specification Booklet

4.7. EXISTING DATA

Appendix A contains a list of reports and drawings held by MWPA which may be of use in the application of this Guideline.

5. GENERAL AND MWPA SPECIFIC REQUIREMENTS

Developers, designers, contractors and inspectors should familiarise themselves with relevant MWPA marine operations, permits, access and HSEQ requirements. General guidance on these can be found in **MWPA100**, the MWPA Contractor Handbook and on the MWPA website.

5.1. LEVELS AND SURVEYING

All surveying should be undertaken using horizontal survey datum Geraldton Coastal Grid 95 (GCG-95) unless otherwise noted on construction drawings. Vertical levels for marine structures and hydrographic surveys should be relative to Chart Datum (CD) which is equal to LAT.

Although it is recognized that onshore levels are relative to AHD, it is preferable to show land levels relative to CD on maritime structures drawings to maintain a single datum. The AHD datum is 0.547m above CD at Geraldton Port, which should be clearly presented on drawings.

Levels shown on drawings should be checked prior to commencement of design or construction works. It is the Contractor's responsibility to:

- Ensure that all survey controls that are installed remain visible and undisturbed.
- Establish and maintain coordinate reference points and level control on site.
- Notify MWPA in the event of any disturbance of survey controls.

For further information on levels and surveying refer to **MWPA100 Section 11.5.1** and **MWPA201** respectively.

5.2. HEALTH AND SAFETY

For general safety requirements and documentation to be submitted prior to commencement of any work, refer to **MWPA100 Section 6**.

5.2.1. SAFETY IN DESIGN

A Safety in Design risk review, considering all stages of the asset's life, should be undertaken for all maritime structure projects.

The safety in design items which should be considered during the design of maritime structures include, but are not limited to, the following:

- Reduced manual handling of materials.
- Reduced working at height or over water by use of prefabricated materials.
- Safe access for inspection or repair.
- Specification of non-hazardous materials or substances.
- Stability and capacity of existing or new structures for temporary construction loads.
- Ground stability during construction.
- Effects of new or upgraded structures on existing structures.
- Details for safe lifting of members or fall prevention.

For further information on Safety in Design, refer to **MWPA100 Section 11.3**.

5.2.2. SAFETY DURING CONSTRUCTION

Remedial or construction works to maritime structures require management of numerous safety risks. The safety during construction items which should be considered include, but are not limited to, the following:

- Existing vessel movements and operations.
- Snapping of existing mooring lines.
- Stability and load carrying capacity of existing or new structures.
- Methods and capacity of cranes to lift loads.
- Ground stability.
- Existing services.
- Hazardous substances and materials.
- Weather and sea conditions.
- Condition of equipment.
- Plant clearance requirements.
- Flying debris and manual handling.
- Working over or under water.
- Working at height.

5.2.3. PERSONAL PROTECTIVE EQUIPMENT

MWPA's mandatory Personal Protective Equipment (PPE) for work performed within the Port is detailed in **MWPA100 Section 6.5.1** and includes high visibility long sleeved shirts with reflective strips, long pants with reflective strips, safety footwear, safety glasses, gloves and helmets.

As detailed in **MWPA100 Section 6.6.2**, Personal Flotation Devices (PFD's) are to be worn when working near or above water.

5.2.4. NAVIGATIONAL REQUIREMENTS

All parties should observe the regulations and requirements of MWPA and other government agencies which apply to navigation and obtain all necessary permits.

Contractors should make all necessary arrangements with MWPA for temporary removal and replacement of any shipping guidance infrastructure (lights, buoys, markers, etc.) that may obstruct the works. In addition, any lighting required as part of the works should be in accordance with MWPA requirements.

Floating plant and equipment used by Contractors should display the correct navigation signals and should be clearly marked and lit at night to the satisfaction of MWPA. Floating plant and equipment should be positioned in such a manner that it minimises interference with other waterway users.

Contractors must seek the approval of the Duty Pilot before entering the harbour, before moving any floating plant and equipment within the harbour and before exiting the harbour.

Contractors must adhere to any instructions issued by the Duty Pilot, which may include exiting the harbour during ship movements. Contractors should allow for attending daily site operations meetings with MWPA personnel.

5.2.5. PLANT AND EQUIPMENT

Contractors are responsible for ensuring that all plant and equipment is suitable for the intended purpose. Contractors must familiarise themselves with the works required, lifting capabilities, load limits, access restrictions, existing operations and environmental site conditions. Contractors are expected to visit the site to assess the suitability of their proposed plant and equipment and to confirm their construction methodology.

Contractor's plant and equipment should be maintained in a good and serviceable condition and must comply with all Workcover and MWPA requirements throughout the works.

MWPA has the right to carry out inspections of all equipment prior to its mobilisation and during the works. During such inspections, the Contractor should extend full co-operation to MWPA and should allow access to any dismantled items of equipment. The inspections may include, but need not be limited to, the checking and calibration of equipment, including inspection and certification documentation. If an inspection reveals that equipment provided is not in a condition acceptable to MWPA, the Contractor should carry out the necessary repairs or replacements.

5.2.6. ACCESS AND CLEARANCES

Access requirements for maritime structures should comply with Clause 3.4 of AS 4997 and the following clearance requirements:

- A minimum clear width of 750mm for walkways and catwalks to dolphins.
- A minimum of 900mm clear space around mooring bollards or quick release hooks for inspection and maintenance.
- 750mm minimum clearance around all other equipment.

The design of maritime structures should consider providing adequate clearance below the structure to allow safe inspection and maintenance by boat. Several existing structures have low clearances and therefore safe access is limited to periods of low tide or by diving personnel. The clearance below the soffit of new or upgraded maritime structures should be discussed with MWPA since factors such as deck level, form of construction, tide levels, wave clearance, safe access to vessels and fender design will influence the design and construction process.

For safety ladder and services access requirements, refer to **Sections 8.19.7** and **5.2.7** respectively.

5.2.7. SERVICES AND UTILITIES

Developers, Designers and Contractors should locate existing services and utilities to limit their disturbance and reduce the risk of incidents occurring during construction or maintenance works. Access for maintenance of services may be provided by manholes built into the maritime structure. Services which are underslung below the deck of structures should be provided with sufficient clearance from waves or the appropriate protection.

For further details on services, refer to the **Buried Services Guideline MWPA502**.

5.3. ENVIRONMENT

The environmental consequences of the works and means of reducing environmental impacts should be considered at each stage of a maritime structure project.

An example of environmental considerations may include providing precast concrete elements below water to minimise underwater concreting and hydrocarbon interceptors to treat surface runoff prior to discharge.

Details on environmental requirements for construction works are provided in **MWPA100 Section 6.3**.

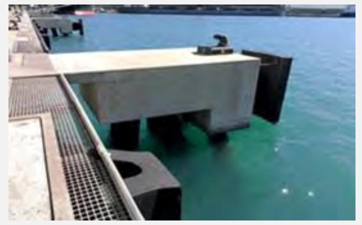
6. EXISTING MARITIME STRUCTURES

Geraldton Port has seven berths within its Main Harbour and three jetties within its Tug Boat Harbour. Several jetties and boat pens are located in the north and south areas of the Fishing Boat Harbour respectively. A plan showing the locations of MWPA maritime structures is provided in Figure 1.

Descriptions, key modifications and photos of the maritime structures within Geraldton Port are provided in **Table 6**. The latest information regarding the structures can be found in MWPA's Asset Maintenance software.

Information on the load capacities of Berths 1 to 6 within the Main Harbour is provided in **MWPA's Wharf Specification Booklet** (Reference No.6).

Table 6: Description of Maritime Structures within Geraldton Port

Location	Asset Name	Construction Year	Description	Key Modifications	Photos
Main Harbour – South East corner	Berths 1 & 2	1928	Berths 1 and 2 have a combined length of 275m and handle general cargo and multi-purpose vessels. Each berth comprises a suspended concrete deck supported on concrete piles. At their rear is a concrete piled sea wall, and below deck a rock wall that slopes down from the seawall to the berthing channel. A GA Plan of Berths 1 and 2 is provided in Figure 2.	In 1999, Berths 1 and 2 had a new concrete deck of 320mm to 600mm varying thickness constructed on top of their original decks. The new deck was connected to existing piles by drilling dowel bars into the tops of piles.	   
Main Harbour – South Side	Berth 3	1928	Berth 3 is 228m long and supports a ship loader that handles grain. Its original construction comprised concrete piles supporting a suspended concrete deck. At the rear of the structure is a concrete piled sea wall. Below the deck is a rock wall that slopes down from the sea wall to the berthing channel. A GA of Berth 3 is provided in Figure 3 and Archive Drawings MP4102-03, MP4102-05, 44915-URS-DPE-353 and 44915-URS-DPE-354.	In 1996, a new 510mm thick concrete deck was constructed on top the existing deck and supported on new steel piles. Strengthening works were also undertaken below the ship loader rails through installation of steel beams. Construction works in 1996 also included a 29m extension of the original structure (known as Berth 3 extension), which consisted of a concrete deck supported on a two-way steel beam frame and piles. In 2003, five dolphins were constructed in front of the berth, moving the berthing line approximately 7m seawards.	   
Main Harbour – South West Corner	Berth 4	1965	Berth 4 is 280m long and primarily handles minerals, concentrates, talc and fertilizers. The berth comprises steel piles supporting a two-way steel beam frame below a 350m thick concrete deck. A steel sheet pile wall runs along the rear of the structure and below the deck, a rock wall slopes down to the berthing channel. A GA of Berth 4 is provided in Figure 4 and Archive Drawings 39195, 10765C and 44915-URS-DPE-356.	In 1986, the berth was extended 100m to the west, which comprised a similar form of construction to the original structure. In 2003, five dolphins were constructed in front of the berth, moving the berthing line approximately 7m seawards.	 

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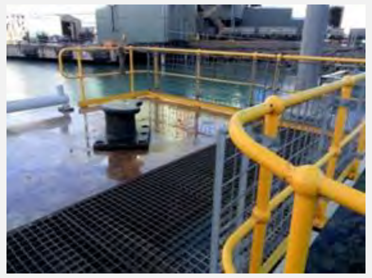
Location	Asset Name	Construction Year	Description	Key Modifications	Photos
Main Harbour – South West Corner	Berth 5	1977	Berth 5 is 213m long and supports a rail mounted ship loader handling iron ore. The berth comprises a suspended concrete deck on steel piles, the tops of which are encased in concrete. At the centre and ends of the berth the deck extends to form access bridges to the land. Sheet pile abutment walls are located at the landside ends of the access bridges. Mooring dolphins with access walkways are located at each end of the berth. A rockwall is located landward of the main deck. A GA of Berth 5 is provided in Figure 5 and Archive Drawings 50020-6-1, 50020-3-1, 75309405-3545 and 75309405-3547.	In 2006, the front of the berth was extended approximately 10m seaward through construction of five dolphins and a steel grated deck supported on steel piles and beams.	   
Main Harbour – North West Corner	Berth 6	1995	Berth 6 is 246m long and handles general cargo, livestock, minerals, fertilizer and fuel. Its structure comprises a concrete deck supported on steel beams and piles. There is a steel sheet pile wall beneath the landward side of the wharf. A rock wall is located beneath the deck, which is overlaid with grout filled mattresses up to low water and includes toe stabilization piles at the edge of the berthing channel. A GA of Berth 6 is provided in Figures 6 and 7.	In 2005, revetment toe stabilisation piles and fender piles were installed along the berth face.	 
Main Harbour – North Side	Berth 7	2006	Berth 7 is a newly built structure which handles iron ore. The facility is operated and maintained by Karara Mining.	None to date.	Photograph to be obtained
Tug Boat Harbour – North Side	Tug Boat Jetty	1988	The Tug Boat Jetty is 60m long and handles up to two tug boats, one on each side. The structure comprises steel grated flooring supported on steel beams and piles.	No major modifications identified.	 

Location	Asset Name	Construction Year	Description	Key Modifications	Photos
Tug Boat Harbour – South Side	Pilot Boat Jetty	TBC	The Pilot Boat Jetty is approximately 100m long and comprises a single row of timber piles supporting timber headstocks, joists and decking. A GA of the jetty is provided in Figures 8 and 9.	No major modifications identified.	 
Tug Boat Harbour – West Side	Small Boat Jetty	TBC	The Small Boat Jetty is approximately 100m long and constructed on two rows of timber piles. The piles support timber headstocks, stringer beams and deck planks. A GA of the jetty is provided in Figures 8 and 9.	No major modifications identified.	
Fishing Boat Harbour	Main Fisherman's Wharf	TBC	The Fishermen's Wharf consists of a sheet piled main wharf approximately 98 metres in length, a fuel berth of approximately 55 metres in length. A GA of the wharf is provided in Figure 10.	No major modifications identified.	Photo to be added
Fishing Boat Harbour	Short & Long Service Jetties	TBC	The Long Service Jetty comprises concrete panel decking supported on steel piles. The Short Service Jetty comprises timber decking supported on timber piles with steel casing. A GA of the jetties is provided in Figure 11.	No major modifications identified.	Photo to be added
Fishing Boat Harbour	Trawler Jetty	TBC	The Trawler Jetty comprises concrete decking supported on two rows of steel piles. A GA of the jetty is provided in Figure 12.	No major modifications identified.	Photo to be added
Fishing Boat Harbour	GFC Jetty	TBC	The GFC Jetty comprises timber decking supported on steel piles. A GA of the jetty is provided in Figure 13.	No major modifications identified.	Photo to be added
Fishing Boat Harbour	East Jetties	TBC	The East Jetties comprise concrete panel decking supported on steel piles. A GA of the jetties is provided in Figure 13.	No major modifications identified.	Photo to be added

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Location	Asset Name	Construction Year	Description	Key Modifications	Photos
Fishing Boat Harbour	North Pens & Access Walkway	TBC	The North Pens and Access Walkway timber decking supported on timber piles with steel casing. A GA of the pens and walkway is provided in Figure 11.	No major modifications identified.	Photo to be added
Fishing Boat Harbour	South Pens & Access Walkway	TBC	The South Pens Access Walkway comprises timber and fibreglass decks supported on timber piles South Pen 1 comprises a timber deck supported on timber piles. South Pen 2 comprises a timber and galvanised steel mesh deck supported on timber piles. South Pens 3 and 4 comprises a galvanised steel mesh deck supported on steel piles. A GA of the pens and walkway is provided in Figures 14, 15 and 16.	No major modifications identified.	Photo to be added
Fishing Boat Harbour	Fisheries Pens	TBC	The Fisheries Pens comprise galvanised steel mesh decking supported on steel piles. A GA of the pens is provided in Figure 10.	No major modifications identified.	Photo to be added
Fishing Boat Harbour	Live Cray Saltwater Supply Jetty	TBC	The Live Cray Saltwater Supply Jetty comprises galvanised steel mesh decking supported on steel piles. A GA of the jetty is provided in Figure 11.	No major modifications identified.	Photo to be added
Shipping guidance infrastructure	Buoys Beacons	TBC	The Shipping Guidance Infrastructure comprises 18 mono-piled beacons, one three-pile beacon, four Sirus Towers and 11 buoys located in the North Channel, South (Main) Channel, offshore and at the entrance to the Fishing Boat Harbour.	No major modifications identified.	Photo to be added

7. SITE CONDITIONS

7.1. TIDAL

The tidal planes for Geraldton Port are provided in **MWPA100 Section 10.3.1**.

7.2. WIND

The Geraldton Port area is exposed to strong winds, which have the potential to disrupt remedial or construction works. For planning and operations, contractors should familiarise themselves with the local wind conditions, giving consideration to potential operational downtime and safety issues.

Local monthly wind speed data is provided in **MWPA100 Section 10.2**. Wind data can also be obtained from ***www.bom.gov.au***

7.3. WAVES

The offshore wave climate in Geraldton is described in **MWPA100 Section 10.3** and **MWPA402 Section 7.3**. Wave heights within and outside Geraldton harbour, based on a study undertaken in 2001, are presented in **Table 7** below.

Table 7: Wave heights Developed by Coastal Engineering Solutions (2001)

Location	Estimated Significant Wave Height (Hs) (M)		
	25 year ARI*	**50 year ARI ***	**100 year ARI***
Outer structures	2.6	2.8	3.0
Inner structures (inside harbours)	0.8	0.8	0.85

Occasionally long period swell waves enter the Main Harbour and Tug Boat Harbour, which can lead to peak loadings on mooring lines and subsequent line breakages.

The Fishing Boat Harbour is well protected. In this area of the Port vessel wash generally produces the more dominant waves.

Existing wave data for Geraldton Port is listed in **MWPA402 Table A1.2**.

7.4. CURRENTS

There is limited data currently available relating to currents within the port. Strong localised currents can be generated by the propellers of tugs and other vessels operating within the harbour, as described in **MWPA402 Section 7.3.2**.

7.5. BATHYMETRY

Seabed levels around the Port of Geraldton can be sourced from various charts and hydrographic surveys, as listed in **MWPA402 Table A1.1**.

Water depths alongside berths are provided in **MWPA100 Section 9.1**.

7.6. TOPOGRAPHY

Land levels at the interfaces of maritime structures can be sourced from surveys listed in **Table A1.2** of **Appendix A**.

7.7. GEOLOGY

Geraldton Port is located within an area comprising dune and beach sands overlying coastal limestone. A large portion of the land is reclaimed, which generally consists of granular fill material overlying recent coastal sand sediments and limestone below. There is a possibility that caverns may exist within the limestone rock. Previous geotechnical investigation reports conducted at Geraldton Port are listed in **Table A1.1** of **Appendix A**.

Further information on the geology at Geraldton Port is provided in **MWPA100 Section 10.4**.

7.8. SEISMICITY

Seismic parameters specific to Geraldton Port are provided in **MWPA100 Section 10.5**.

7.9. TEMPERATURE

Temperatures at Geraldton Port generally average around 20^{o}C in the winter and 32^{o}C in the summer months. The highest and lowest recorded temperatures recorded at Geraldton are 47.7^{o}C and -0.4^{o}C respectively.

Monthly temperatures are presented in **MWPA100 Table 14**.

7.10. RAINFALL

Most of the yearly rainfall occurs during the winter months at Geraldton Port. The highest recorded amount of rainfall is 286.4mm, which occurred during the month of June. Monthly rainfall data is presented in **MWPA100 Table 14**.

8. GUIDELINES FOR DESIGNERS

8.1. SITE INVESTIGATION

Site investigations that may be required for maritime structures projects include:

- Geotechnical investigation to determine:
  - Soil properties for the design of foundations and earth retaining walls.
  - Materials types to be dredged.
  - Predicted settlement of soils.
- Wave and current studies.
- Bathymetric and topographic level surveys.
- Environmental surveys such as water quality sampling.
- Surveys to verify the information presented on existing drawings for the design of repairs or upgrades. These may include:
  - Dimension and level survey.
  - Material strength testing.
  - Intrusive investigation to confirm concrete reinforcement details and cover depths.
  - Survey of utilities and services.

Accurate details of existing structures will be required in order to assess the structural capacity to carry temporary and permanent loads resulting from new construction or repair works. A condition survey may need to be undertaken to account for material section losses when assessing the load capacities of structural members, or to establish the extent and form of rehabilitation works.

Prior to planning site investigation works, information on the site conditions at Geraldton Port (refer to Section 7) should be studied to identify any missing data. The level of detail presented in the existing data should also be assessed to determine whether it is appropriate for the proposed design. Where insufficient data or detail is available, appropriate project risk mitigation measures should be identified and presented to MWPA.

8.2. GROUND CONDITIONS

Ground conditions need to be established at an early stage of a project to determine the foundation type and appropriate form of maritime structure. The type and extent of geotechnical investigation should be appropriate for the level of design to be undertaken. Test locations should be spaced in a manner to accurately establish the ground conditions. Reduced test location spacing may be necessary where ground conditions are highly variable. Ground investigations need to be of sufficient depth for the anticipated type of foundation to be designed and cover all soil layers that may have an impact on the design.

The short and long term settlement of shallow foundations, due to the properties of founding material or deeper underlying layers, needs to be considered. In cases where excessive settlement is expected, ground improvement techniques could be undertaken or the foundation design amended to reduce the settlement.

The type of structural member can dictate the allowable settlement of material. For example, tie rods need to be installed in material that will experience minimal settlement. Alternatively, tie rods can be placed in large rigid tubes to avoid contact with soil before or after settlement. In general, differential settlement should be kept to a minimum to avoid excessive stresses on structural members.

8.3. STRUCTURAL LEVELS

The design elevation of the marine structure should be derived from the 1 in 100 year ARI design water level, including the effects of waves and future sea level rise and mitigate overtopping on the operating areas (e.g. deck or walkways) to minimise operational and health and safety risk. In general, overtopping should not occur, unless otherwise agreed by MWPA.

The soffit level of maritime structures should be above the design wave crest at HAT to maintain an air gap. Soffit levels are often governed by the depth of deck beams which can be reduced by considering a reduced spacing of beams, an increased width of beams, provision of additional beam reinforcement or in some instances excluding beams entirely and proving a single deck slab.

It is beneficial for the gap between sea level and the soffit level of maritime structures to be maximised to reduce rates of deterioration caused by splashing of structural members with seawater and to provide safe access below the deck for inspections and maintenance. Deck levels should, however, enable fenders to be designed to accommodate the range of design vessel sizes.

Where it is not possible to provide an air gap between sea level and soffit level, then the provision of vents to relieve hydrodynamic uplift pressures may be considered. The deck will need to be designed to withstand such uplift pressures.

8.4. SERVICEABILITY CRITERIA

Design for serviceability of maritime structures includes the following:

- Concrete cover – refer to Section 8.15.4.
- Crack control of concrete – refer to Section 8.15.5.
- Deflection limits.

Information on deflection limits and load combinations for serviceability design are provided in Section 4.2.4 of AS 4997.

8.5. LAYOUT OF STRUCTURES

The layout of maritime structures should consider the following:

- Safe berthing and mooring of vessels, taking into account interaction effects of passing vessels.
- Potential future expansion.
- Sufficient space for safe operations such as turning of vehicles, cargo handling and placement of ship hatch covers.
- Safe access to the structure.
- Environmental effects on adjacent areas.
- Impact on existing structures such as load transfer or increased wave effects.

8.6. DESIGN LIFE

Unless otherwise approved by MWPA, the design life for maritime structures at Geraldton Port should be in accordance with **Table 8** below.

Table 8: Design Life of Maritime Structures

Item	Design Life (Years)
Permanent Structures	50
Cathodic Protection	30
Wharf Furniture	30
Rehabilitation Works on Existing Structures	30
Temporary Structures	Equal or greater than the number of years in service

8.7. DESIGN FOR DURABILITY

Design for durability should be undertaken in order to meet the design life requirements for maritime structures listed in **Table 8**. Access for inspection and rehabilitation during and beyond the design life should be considered in the design of the structure.

At the end of the design life, structural members should have adequate strength to resist ultimate loads and remain serviceable for repair or strengthening to prolong their operational use. Design for durability includes, but is not limited to, the following:

- Increased thickness of steel elements to account for corrosion losses.
- Limiting crack widths of concrete under service loads.
- Providing sufficient concrete cover to steel reinforcement.
- Providing protective paint systems to steelwork or protective waterproof coatings to concrete.
- Providing free draining steelwork to prevent accelerated corrosion due to ponding of water.
- Sealing hollow steel members to prevent water ingress and internal corrosion.
- Providing protective wrapping or jacketing systems to structural members.
- Installation of cathodic protection systems to prevent corrosion to steelwork or steel reinforcement of concrete.
- Galvanize or use stainless steel reinforcement at exposed parts of concrete members or joints.
- Limit the number of joints in the structure and ensure they are appropriately protected.

8.8. DESIGN VESSEL SIZES

Design vessel sizes need to be agreed with MWPA at an early stage of the design in order to determine the following:

- Length of structure and mooring arrangement.
- Berthing and mooring forces on the structure.
- Positions, spacing and types of fenders and bollards.
- Details of wharf furniture such as the required length of crane rail.
- Channel depth and extent of dredging that may be required for safe passage of vessels to and from the structure.

- Form of maritime structure appropriate for the required depth of channel and vessel types.
- Geometric requirements of the harbour and channels to accommodate the safe passage of vessels to and from the structure with consideration to vessels operating at other berths.

The range of vessel sizes should consider future operational requirements. The design should consider opportunities for the structure to be constructed in phases to initially meet current operational requirements, but with capacity for expansion. In this case, the initial structure should be designed to accommodate future berthing and mooring operational loads, including future dredging depths.

Information on vessels operating at existing berths at Geraldton Port and restrictions on vessel sizes can be obtained from the MWPA website or requested from MWPA. Restrictions are based on factors such as channel depths, length of berths, structural load capacities and existing loading equipment.

Tables providing dimensions for a range of vessel types and sizes can be found in Appendix C of PIANC Guidelines (Reference No. 4).

8.9. DESIGN LOADS

Loads acting on maritime structures include the following:

- Permanent.
- Imposed (includes berthing and mooring).
- Berthing.
- Mooring.
- Wind.
- Wave.
- Current.
- Propeller wash.
- Earth pressure.
- Hydrostatic.
- Seismic.
- Construction and maintenance loads.
- Movement induced loads.

Design loads, load factors and combinations should be in accordance with AS 4997 and AS/NZS 1170. The following sections describe the loads listed above.

8.9.1. PERMANENT

Permanent loads include the self-weight of the maritime structure, deck surfacing, wharf furniture, equipment or any other long term load being supported.

8.9.2. IMPOSED

Imposed loading includes loads from vessels, vehicles, forklifts, ship loaders, products, cranes, conveyors and pedestrians.

Rail mounted crane or ship loader loads should be obtained from the crane or ship loader supplier with wheel loading provided for operational, storm (tied-down) and seismic conditions specific for the environmental conditions at Geraldton Port referred to in Sections 7.2 and 7.8. Conveyor loads should also be advised by the supplier.

Deck loading may be obtained from Table 5.1 of AS 4997. Product loads placed near the edges of berths prior to transport or loading should be considered in designs. Dynamic impact factors should be applied to the wheel loads of vehicles, ship loaders and cranes, including those which are rail mounted.

The walkways or catwalks providing access to maritime structures should be designed for a distributed load of 2.5kPa or a point live load of 1.1kN in accordance with AS 1657.

For all imposed loads, a summary of the loading adopted for design should be presented in the 'General Notes' of drawings under the heading 'Design Criteria' with full details be presented in the design report for the structure.

8.9.3. BERTHING

Berthing loads should be determined in accordance with PIANC Guidelines and BS 6349 Part 4.

Berthing loads will depend on the specific fender type selected which is capable of absorbing the required abnormal berthing energy. The formula for calculating abnormal energy is:

EA = FS x 0.5 x M x VB2 x CM x CE x CC x CS

Where,

E_A = Abnormal berthing energy
F_S = Factor of Safety for abnormal berthing
M = Vessel mass
V_B = Approach velocity
C_M = Added mass coefficient
C_E = Eccentricity coefficient
C_C = Berth configuration coefficient
C_S = Softness coefficient
In summary, the berthing energy calculation considers the following:

- Vessel type, size and shape.
- Berthing velocity.
- Under keel clearance.
- Type of berthing.
- Berthing angle and point of impact.
- Berth configuration.

Berthing loads are to be calculated for a vessel size range confirmed by MWPA. Factors of safety for abnormal berthing, which are dependent on the type and size of vessels, should not be less than 2.0 for vessels less than 5,000 DWT.

In addition to normal berthing reactions, fenders and their support structure need to be designed to resist lateral and vertical berthing loads due to friction between fender and vessel using friction factors obtained from Table 4 of BS 6349 Part4. Suitable low friction facings on fender panels should be considered in designs to minimise loads.

8.9.4. MOORING

Mooring loads occur due to wind, current and wave forces acting on vessels, and in some cases manoeuvring forces when vessels use bollards to slow down or assist in turning.

Wave forces should include long period waves that are referred to in Section 7.3 and those created by passing vessels. Consideration may be given, through consultation with MWPA, to achieving a more economical design by assuming that large vessels leave the port during the periods when there are strong winds or large waves in Geraldton Port.

Due to the sea state at Geraldton Port, loads on mooring points and required bollard and quick release hook (QRH) capacities should be determined by dynamic mooring analysis for vessels greater than 20,000t displacement, unless agreed otherwise with MWPA. Methods to calculate wind and current loads on vessels are provided in Section 5 of AS 4997 and Clause 42 of BS 6349 Part1.

In all cases, notwithstanding the conclusions of a mooring analysis, bollards and QRHs should have capacities of not less than those given in Table C1 of AS 4997.

Mooring line angles and associated loads should cover horizontal angles of ±90^{o} and vertical angles +75^{o} and -30^{o} unless mooring assessments dictate otherwise.

8.9.5. WIND

Wind loads on maritime structures are to be determined in accordance with AS 1170 Part2. Geraldton Port is located within Region B. A Terrain Category 2 may be assumed for wind approaching from open sea due to sea surface roughness.

Methods to calculate wind loads on vessels are provided in Clause 42 of BS 6349 Part1 and Section 5 of AS 4997. A wind pressure based on a 30 second gust should be applied to vessels due to their delayed response to wind loads. A factor of 0.87 is provided in AS 4997 to convert basic three second gust to 30 second gust wind speeds.

The operational wind speed for cranes or ship loaders operating on maritime structures should be provided by crane or ship loader suppliers when assessing wind load combinations. In general, operational speeds of cranes or ship loaders should not exceed 20m/s for a three second gust, unless advised otherwise by MWPA or by crane or ship loader suppliers.

8.9.6. WAVE

Wave loads on maritime structures may be calculated using recognized wave formula or from hydraulic modelling. Current velocities are to be included within wave velocity profiles.

Wave loads should be based on a significant wave height associated with a peak storm event that occurs during the design life of the structure, and with an annual probability of exceedance based on the structure's function category. A Function Category 3 given in Table 5.4 of AS 4997 should be adopted for MWPA maritime structures unless a Function Category 2 can be justified.

Waves uplift loads should be considered when there is limited soffit clearance and waves can travel below the deck of a maritime structure. Uplift loads may be calculated and applied in accordance with Section 5.9 of AS 4997. Loads may be reduced by providing pressure relief openings or vents through the deck of structures or avoiding details which attract high pressures such as corners between deck slabs, seawalls and beams.

8.9.7. CURRENT

Current loads on the underwater foundations of maritime structures and on the sides of vessels which contribute to mooring loads should be calculated in accordance with Section 5 of AS 4997 for vessels up to 10,000t displacement and Clause 38 of BS 6349 Part1 for vessels greater than 10,000t displacement.

Areas of piles exposed to current loads may assume a 50mm thick marine growth around piles from seabed up to MSL.

8.9.8. PROPELLER WASH

Maritime structure components that are located underwater may be subject to strong current loads from propellers of passing vessels, in particular tugs. Propeller induced currents are more likely to have a significant effect on lighter maritime structures designed to service only small vessels.

For the design of maritime structures in the Main Harbour, it is recommended that the designer consults with the MWPA Harbour Master to verify the normal and extreme propeller wash design parameters.

8.9.9. EARTH PRESSURE

Earth pressure loads on earth retaining structures such as steel sheet pile walls or concrete seawalls should be calculated using soil properties determined by soil investigation, or otherwise known properties of imported fill material. Earth pressures need to be assessed at each stage of construction. Temporary supports to reduce the sizing of structural members may be beneficial in relation to construction time and cost. Methods to improve lateral stability or reduce lateral loading on maritime structures may include the following:

- Installation of tie rods or rock anchors.
- Providing raking pile braces.
- Providing relieving platforms.
- Ground improvement works, including compaction of material.
- Increasing the dead weight of the structure.
- Reducing surcharge loads by providing means to increase the spread of load or restrict operational area of crane, ship loader or vehicle loads.
- Addition of earth material or struts in front of walls.
- Increase the size and depth of walls.

In addition to wall stability, it is necessary to consider undertaking slope stability analysis to assess possible slip plane failure below the structure which should include earth quake conditions (see Section 8.9.11).

8.9.10. HYDROSTATIC

Hydrostatic loads on maritime structures and associated lateral and uplift pressures should be calculated by considering the highest or lowest possible water levels to give the worst case loading and stability cases.

Hydrostatic loads may be reduced by installing drainage systems to reduce ground water levels, in which case systems should be well maintained and free from blockages.

Designers need to consider the effects of tidal lag and wave backpressure described in Section 5 of AS 4997. Tidal lag is caused by a slower rate of drainage and lowering of water levels behind a wall compared to tidal water level fluctuations.

Wave backpressure occurs due to overtopping or penetration though openings causing temporary increased water levels and pressures behind walls.

8.9.11. SEISMIC

Seismic loads should be determined in accordance with AS 1170 Part 4. The seismic load calculations should include allowances for future permanent and imposed loading.

The liquefaction potential of soils should be assessed and, if required, the maritime structure should be designed to accommodate the effects of liquefaction. Slope failures during seismic events also need to be assessed and, if necessary, structures should be designed to accommodate such failures. Alternatively, measures should be designed to improve the stability of slopes.

8.9.12. CONSTRUCTION AND MAINTENANCE LOADS

In addition to operational loads, maritime structures should be designed to handle loads during construction and maintenance. The following should be considered:

- Capacity of members during lifting and handling (e.g. consider the number and locations of lifting points and resultant stresses on members).
- Capacity of members during installation (e.g. stresses induced during pile driving).
- Temporary crane or equipment loads on existing or new members (Reference No.6 provides load capacities on Berths 1 to 6).
- Member capacity during the curing of concrete (e.g. precast beam with in-situ concrete fill or steel beam with in-situ slab needs to support the weight of wet concrete prior to becoming a composite member).
- Lateral support (e.g. a structural member may be more unstable or prone to buckling during certain stages of construction).
- Exposure to environmental loads (e.g. increased exposure to wind or waves during construction).

8.9.13. MOVEMENT INDUCED LOADS

Movement induced loads include those caused by thermal expansion and contraction, or the deflection of members transferring load to adjacent members. A sufficient number of joints with sufficient gaps are required to accommodate such movements. Alternatively, structures can be designed to accommodate movement induced loads in order to limit the number of joints.

8.10. SEA LEVEL RISE

Maritime structures are to be designed to cater for an increase in sea level due to climate change. A sea level rise determined from Figure 11 of **MWPA100 Section 10.3.2** should be adopted for the design life of the maritime structure.

Allowances for sea level rise may include:

- Increasing the platform level of the maritime structure.
- Providing sufficient structural capacity for future deck surfacing or concrete topping in order to increase deck levels.

Water levels should include an allowance for sea level rise, when its inclusion in load combinations for structural analysis yields a more critical result.

8.11. CONSTRUCTABILITY

Constructability needs to be assessed at an early stage of planning in order to produce a design that can be constructed in a safe, timely and cost effective manner.

Designs may be dictated by the method of construction, which should consider the following:

- Safety in design - refer to Section 5.2.1.
- Safety in construction - refer to Section 5.2.2.
- Construction and maintenance loads - refer to Section 8.9.12.
- Port operations – refer to Section 9.1.

8.12. SCOUR POTENTIAL

The potential lowering of seabed levels due to scour should be assessed. Maritime structures should be designed to accommodate the effects of scour protection measures where appropriate. Examples where scour may be significant are areas affected by the propeller action of vessels or waves acting at the base of seawalls. Consideration should be given to the geotechnical data for the Main Harbour and the level of the existing limestone bedrock in relation to existing or proposed maritime structures.

8.13. REMEDIAL WORKS

Remedial works may include the repair of cracks and spalled areas of concrete, including the cleaning of existing reinforcement and the addition of new bars. Repair design details, in particular the specification of materials, can differ greatly to new construction works. Concrete repair materials may need to be thin layered, self-consolidating and applied through pressure inlets within formwork. Designers should discuss with Contractor's experienced in the repair of steel and concrete members of maritime structures to determine the most effective repair methods in terms of cost and added design life.

8.14. PILING

The choice of material for piling is dependent on factors such as the required load capacity, soil conditions, driveability, pile length, noise restrictions and availability of materials. The benefits of steel piles are that they can be easily spliced, extended or cut, and can provide significant added skin friction when driven open ended, depending on the properties of soil layers.

The benefits of concrete piles are that are that there is no requirement for a protective paint system and there is generally a faster procurement time.

There are existing timber piles within the Tug Boat Harbour and Fishing Boat Harbour. Where these piles are to be replaced, the current MWPA policy is to use steel piles where possible and appropriate.

Prior to undertaking the design of piles, the ground conditions of the site should be established as described in Section 8.2. After assessing the ground conditions and establishing design parameters, the design of geotechnical and structural design of piles should be undertaken in accordance with AS 2159.

8.14.1. GEOTECHNICAL DESIGN

The ultimate geotechnical design strength should be calculated in accordance with Section 4 of AS 2159 using the appropriate strength reduction factors. The requirement to calculate ultimate compression and tension capacities is dependent on whether the pile will be subject to compressive loads, tension loads or both.

8.14.2. STRUCTURAL DESIGN

The structural capacity of piles should be assessed under combined axial bending loads and include additional loading due to the fabrication and construction tolerances listed in **Table 15** and **Table 16**.

Concrete piles are to be designed in accordance with AS 3600 using the appropriate concrete placement factor from Table 5.3.2 of AS 2159. Steel reinforcement should comply with AS/NZS 4671.

Steel piles should be designed in accordance with AS 4100 using reduced sections to account for the corrosion allowances listed in **Table 15**.

The concrete plugs within tubular piles for connections to concrete decks or anchorage at bases should have sufficient contact area between concrete and steel for the transfer of load, taking into account shrinkage. Bearing or shear connectors may be added to the insides of steel piles to increase the capacity for load transfer and reduce plug lengths. Reinforcement within plugs should be designed accordingly to carry design loads.

8.14.3. CORROSION PROTECTION

Steel piles require a protective paint system down to seabed level, below which the rate of corrosion is sufficiently low. Paint systems suitable for a marine environment such as high build epoxy should be used. The paintwork on piles needs to extend a minimum distance of 3.0m below seabed level. A polyethylene coating system on piles may be used as an alternative to paint.

Structural members in the splash zone are at most risk to deterioration, therefore additional protection in this area should be considered such as petroleum tape wrapping and concrete jacketing. Splash zone protection should end a minimum distance of 1.0m below LAT level.

Additional protection may also cover the submerged zone to a distance 500mm below seabed level, extending deeper to account for scour potential.

Guidelines for protective coatings are provided in **MWPA401**.

A cathodic protection system may be provided to reduce the corrosion of steel. A cathodic protection system on steel piles is, however, only effective for those parts permanently submerged below seawater. Designers should ensure that when catholic protection is used, the paintwork of steel is compatible.

The corrosion allowances for steel piles provided in **Table 15** may be reduced when additional corrosion protection or cathodic systems are provided. Any reductions need to be agreed with MWPA at an early stage of design and should consider the level of maintenance required for the proposed system.

Guidelines for cathodic protection are provided in **MWPA403**.

8.15. CONCRETE

Concrete members in maritime structures should be designed in accordance with AS 4997 and AS 3600. Where there is conflict between standards, AS 4997 should take precedence.

Further information is provided in Reinforced Concrete Guidelines **MWPA601**.

8.15.1. EXPOSURE CLASSIFICATIONS

Exposure classifications for the design of concrete members in maritime structures are provided in **Table 9**.

Table 9: Exposure Classification for Maritime Structures

Location	Definition	Exposure Classification
Members permanently below seabed	500mm or more below seabed level	A2
Members permanently submerged below seawater	500mm below seabed to 1.0m below LAT	B2
Splash Zone	1.0m below LAT to 1m above wave crest levels or deck soffit	C2
Spray Zone	1.0m or more above wave crest levels or deck soffit	C1

Exposure classifications not covered in the above table, such as members in contact with aggressive soils, should be classified in accordance with Table 4.3 of AS 3600.

8.15.2. MATERIAL STRENGTH

The minimum concrete strength requirements for the design of in-situ or precast reinforced concrete members of maritime structures are provided in **Table 10**.

Table 10: Concrete Material Strengths for Maritime Structures

Exposure Classification	Minimum Characteristic Compressive Strength (Mpa)
A2	40
B2	40
C1	50
C2	50

Concrete material strengths for exposure classifications not covered in the above table are provided in Table 4.4 of AS 3600. The concrete strength for all structural members of maritime structures should not however be less than 40MPa.

The minimum yield strength of steel reinforcement for the design of concrete members of maritime structures is provided in **Table 11**.

Table 11: Yield Strength of Steel Reinforcement for Maritime Structures

Bar Type	Minimum Characteristic Yield Strength (Mpa)
Deformed	500
Round	250

8.15.3. REINFORCEMENT BAR DIAMETER

The minimum bar diameter requirements for the design of concrete members of maritime structures are provided in **Table 12**.

Table 12: Steel Reinforcement Bar Diameters for Maritime Structures

Location	Minimum Diameter (Mm)
Slabs	16
Beams with depth ≥500mm	24
Beams with depth <500mm	28
Ties and ligatures	12

8.15.4. COVER TO REINFORCEMENT

The minimum concrete cover requirements to reinforcing steel for the design of concrete members forming maritime structures are provided in **Table 13**:

Table 13: Concrete Cover for Maritime Structures

Exposure Classification	Minimum Cover (Mm) for Standard Compaction	Minimum Cover (Mm) for Intense Compaction
A2	40	35
B2	50	40
C1	50	45
C2	65	60

The concrete cover for concrete members with exposure classifications A2 and B2 may be reduced in accordance with Tables 6.4 and 6.5 of AS 4997 if designed for concrete strengths of 50MPa or above.

Concrete cover requirements for exposure classifications not covered in the above table are provided in Tables 4.10.3.2 and 4.10.3.3 of AS 3600.

The cover for all structural members of maritime structures should not, however, be less than 40mm for standard compaction and 35mm for intense compacted concrete.

8.15.5. CRACK CONTROL

To limit crack widths for durability, concrete members of maritime structures should be designed to meet the serviceability stress limits for steel reinforcement provided in **Table 14**.

Table 14: Steel Reinforcement Stress Limits for Maritime Structures

Exposure Classification	Bar Diameter (Mm)	Bar Stress (Mpa)
C1, C2	≤12	185
	16	175
	20	160
	≥24	150

The serviceability steel reinforcement bar stress limits for concrete members under exposure classifications A2 and B2 may be increased to the limits provided in AS 3600.

8.16. STRUCTURAL STEELWORK

Structural steelwork and connections should be designed in accordance with AS 4100, taking into account the corrosion allowances listed in **Table 15**.

Further information is provided in **Structural Steelwork Guidelines MWPA602**.

8.17. PROTECTIVE TREATMENT

Structural steelwork in maritime structures requires a protective paint system suitable for splash, spray or permanently submerged zones which are defined in **Table 9**. Guidelines to Protective Coatings are provided in **MWPA401**.

In addition to paintwork, steelwork may be wrapped with petrolatum tape such as around the bottom flanges of beams which are in close contact with seawater. Tubular sections may be fully wrapped and provided with a polyethylene coating system rather than paint.

8.18. CORROSION ALLOWANCES

Corrosion allowances at Geraldton Port may be calculated using the corrosion rates provided in **Table 15** for the appropriate design life of the steel member. The rates are based on unprotected steelwork, therefore the design life of protective coatings needs to be considered when determining allowances.

Allowances may be reduced with MWPA's approval, when additional corrosion protection or cathodic systems are provided as described in **Section 8.14.3**.

Table 15: Corrosion Allowances for Steel Members of Maritime Structures

Location	Definition	Annual Corrosion Rate (Mm/Year)
Members permanently below seabed	500mm or more below seabed level	0.01
Members permanently submerged below seawater	500mm below seabed to 1.0m below LAT	0.08
Splash Zone	1.0m below LAT to 1m above wave crest levels or deck soffit	0.12
Spray Zone	1.0m or more above wave crest levels or deck soffit	0.08

Corrosion rates may be higher than those listed in **Table 15** due to concentrated corrosion which is described in Section 59 of BS 6349 Part 1.

8.19. WHARF FURNITURE

8.19.1. BOLLARDS

Bollards and QRHs are to have sufficient capacity for the design mooring loads described in **Section 8.9.4**. Suitable protection such as rope guards should be provided along the edge of structures at bollards or QRH locations to prevent damage to mooring lines.

The positioning and spacing of bollards depends on the layout of mooring lines. In general, a suitable spacing of bollards for continuous berths is 30m for vessels greater than 20,000t displacement and 15m to 30m for smaller vessels.

Where bollards are installed in concrete, the structural member needs to be designed to account for the layout and forces on bolts under the design mooring load. Consideration should also be given to edge distance, concrete pull out or shear failure and the positioning of reinforcement to avoid clashing with bolt installation. Bolts placed in sleeves and penetrating the full depth of the structural member can enable bolts to be more easily replaced. Bolts should be tightly fitted into sleeves to limit movement.

Bollards and QRHs should be designed so that the fixings fail first during excessive loading and therefore reducing the likelihood of damage to the maritime structure. This may be achieved by using holding down bolts with waisted tops to facilitate breakoff.

Kerbs along the edges of maritime structures need to be discontinued at bollard or QRH locations to prevent obstruction to mooring lines.

8.19.2. FENDERS

Fenders should have sufficient capacity for the required energy absorption described in **Section 8.9.3**.

Fenders or fender panels are to be designed so that the permissible hull pressures presented in Table 4.4.1 of PIANC Guidelines (Reference No.4) are not exceeded.

Fender panels may require weight, shear or tension chains. Weight chains are used to avoid deformation of fenders under their self-weight and to resist vertical berthing loads. Shear chains are used to resist lateral loads acting on fenders, and tension chains are used to resist tension loads resulting from eccentricity between the berthing reaction and centre of panels.

The spacing of fenders should be such that the stern or bow of vessels, including belting or sponsons, cannot strike the berth structure and sufficient fenders are mobilized for the required energy absorption. The spacing of fenders should not be less than the smallest design vessel length multiplied by 1.15, as recommended in BS 6349 Part 4. As much as practically possible, fenders should be positioned to avoid mooring lines catching on them during operations.

Precast concrete fender blocks with cast in threaded anchors may be considered for attachment of fenders to maritime structures to facilitate installation and provide greater accuracy in positioning of the anchors.

8.19.3. RAILS

Crane rails will require rail troughs, fixings and holding down bolts incorporated within the deck of maritime structures. Future extension of rails or widening of gauge should be considered and, if necessary, supporting structures provided to carry future loads. Alternatively, designs may allow for future modifications. Rail lengths and gauges should be confirmed with MWPA at an early stage of design.

8.19.4. BUFFER STOPS

Buffer stops for rail mounted cranes are to be designed to accommodate horizontal crane loads applied at the level of hydraulic stoppers. Buffer stops may be required to accommodate more than one crane type, in which case they need to be designed to accommodate stopper loads applied at varying levels.

Supporting members of buffer stops should be designed to accommodate the layout and forces acting on holding down bolts.

8.19.5. CRANE TIE DOWNS, STOW PINS AND JACKING PLATES

Positions of crane tie downs, stow pins and jacking plates should be agreed with MWPA, but in general they should be positioned at the ends of rails to avoid obstructing operations when cranes are being maintained. Parts of crane rail beams may require widening for the installation of tie downs and jacking plates.

Maritime structures are required to have sufficient capacity to accommodate uplift forces acting on tie-downs, compressive loads on jacking plates and longitudinal loads on stow pins.

8.19.6. MANHOLES AND CABLE PITS

Electrical and drainage manholes or cable pits may need to be incorporated within the deck of maritime structures. The sizes of chambers need to be sufficiently sized for safe access of personnel with sloped flooring and drainage outlets. Covers are to be designed to accommodate deck loading which may include wheel loading from vehicles or cranes. Designers may consider providing covers in smaller sections for manual lifting depending on MWPA requirements.

8.19.7. LADDERS AND LIFE BUOYS

Ladders are required at dolphins and at 60m maximum spacing along berths. They should be located clear of mooring and berthing furniture to avoid obstructing operations.

The bottom rungs of ladders should be located at least 300mm below LAT, and safety rails extending out at least 250mm are required to prevent small vessels accidently striking personnel. Alternatively, ladders may be recessed into the face maritime structures. All ladders should be designed in accordance with AS 1657.

In general, lifebuoys meeting the requirements of SOLAS should be provided where ladders are located, however should be positioned so to not hamper operations.

8.20. DRAINAGE

Maritime structures are required to have minimum surface gradients of 2% for drainage. Surface water may be channelled into crane rail troughs or cable slots and, where practical, water should be channelled away from the sea and collected in landside drainage. Ponding of water such as around bollards or other wharf furniture should be avoided.

Design parameters for the sizing of channels and requirements for the treatment of surface run off pollutants are provided in MWPA100 Section 11.5.3.

9. CONSTRUCTION GUIDELINES

9.1. PORT OPERATIONS

MWPA conducts operations on a 24 hour basis. In most cases port operations, in particular shipping movements and activities including the loading and unloading of vessels, will take priority over Contractor's work activities. Port operations should therefore be taken into account in all stages of a maritime structures project.

Depending on location, work may be scheduled during MWPA nominated maintenance shutdown periods to avoid hampering operations.

For more details on Port Operations refer to **MWPA100 Section 9**.

9.2. MONITORING, REPAIR AND MAINTENANCE WORKS

Regular condition monitoring of maritime structures is recommended by undertaking both above and below water inspections. Identifying and repairing minor damage such as small areas of spalling or narrow cracks in concrete may avoid the need for major repair works in the future. Inspection works should be well documented for MWPA recording purposes. The design of repairs works is described in **Section 8.13.**

Maintenance works on maritime structures may include the following:

- Cleaning and repainting of steelwork.
- Repair of cracked or spalled concrete including cleaning and replacement of existing steel reinforcement.
- Replacement of protective wrappings.
- Application of concrete waterproof coatings.
- Strengthening of corroded steel section.
- Unblocking of drainage pipes or channels.

9.3. DIVING OPERATIONS

For guidance on diving operations refer to **MWPA402 Section 9.3**.

9.4. CONSTRUCTION METHODOLOGY

9.4.1. CONSTRUCTION PLANT

The type of plant used for the construction of maritime structures depends on the scale, type and location of the works. The choice of plant and whether it is land or marine based, may depend on the following:

- Load carrying capacity of existing or newly built structures.
- Access restrictions.
- Existing port operations.

9.4.2. CONSTRUCTION LOADS

Construction loads need to be considered during all phases of a maritime structure project. Designers should consult with experienced contractors to ensure that construction loads described in **Section 8.9.12** are considered in designs.

Contractors are required to have an appropriate construction methodology to meet the construction load limits at each stage of construction or repair.

9.4.3. DAMAGE DURING CONSTRUCTION

Contractors need to consider the possibility of extreme weather events occurring during construction and plan their methodology or program to minimise the potential for damage and loss of materials.

9.5. FABRICATION

Structural steelwork, fabricated piles and precast concrete elements are required to be finished free of surface flaws, cracks, laminations and any other defects which may adversely affect their structural performance and the performance of protective coating systems.

Fabrication tolerances for precast concrete members including steel reinforcement should be in accordance with Sections 17.5 of AS 3600 and AS 3610.

Fabrication tolerances for structural steelwork should be in accordance with Section 14 of AS 4100. Piles should be manufactured to the tolerances in **Table 16** below:

Table 16: Pile Fabrication Tolerances

Dimension	Tolerance
Length	-0 / +20mm
Diameter	-5 / +10mm
Straightness	Length / 1000
Circumference	± 10 mm
Wall thickness	-0 / +1mm
Difference between maximum and minimum diameters at any particular cross section	±5 mm
Deviation from a circular arc with chord length of 300mm	±3 mm
Pile ends out of square inclination	1/50 max

The lengths of pile should not be modified without approval by MWPA.

9.6. CONSTRUCTION TOLERANCES

Construction tolerances for concrete members including steel reinforcement should be in accordance with Sections 17.5 of AS 3600 and AS 3610. Construction tolerances for structural steelwork should be in accordance with Section 14 of AS 4100.

The positions of piles at cut-off level and their inclinations are to be within the tolerances provided in **Table 17**.

Table 17: Pile Construction Tolerances

Description	Dimension	Tolerance
Piles installed from land with cut-off level no greater than 2m below piling platform level	Plan position	75mm
	Inclination for vertical piles	4%
	Inclination for raked piles	7%
Piles installed from land with cut-off level greater than 2m below piling platform level	Plan position	75 + 20(h-2)mm in plan position where h is cut-off depth in metres
	Inclination for vertical piles	4%
	Inclination for raked piles	7%
Piles installed from floating plant	Plan position	150mm
	Inclination for vertical piles	4%
	Inclination for raked piles	7%
Non-circular piles	Rotational position	10^{o}

Construction tolerances for the installation of cast in places piles are provided in Sections 7.4 to 7.6 of AS 2159.

Piles which exceed the specified tolerances in Table 17 may be accepted by MWPA if proven to be structurally sound with sufficient capacity, otherwise contractors are required to undertake remedial measures for MWPA approval such as:

- Withdraw or cut-off the misplaced pile at seabed level, and install the pile or a new pile at the correct location.
- Modify the design of the maritime structure to accommodate the misplaced pile position.

9.7. HANDLING AND SUPPORT

Handling, stacking, transportation and installation should be undertaken using methods which are safe and which do not cause damage to structural members. Contractors are required to repair any damages which may occur.

Lifting arrangements are required to be submitted to MWPA for approval. Fittings for lifting should be removed from structural members after their use and areas repaired. Lifting fittings of piles should be removed and repaired prior to installation into the ground.

The capacity of structural members should be considered during handling, lifting and at each stage of construction, as described in Section 8.9.12.

Piles should be provided with adequate support to ensure they are held firmly in their correct position and alignment, and accurate hammer to pile alignment is maintained. Piles are required to be supported by a minimum of two gates to ensure accurate alignment during pitching and driving.

Gates should incorporate suitable soft faced rollers to prevent damage to protective coatings. Piles should continue to be supported to ensure stability throughout construction.

9.8. MARKINGS

Structural members need to be clearly marked for identification during transit and on site. Piles should be numbered in accordance with the piling schedule. Piles should also be marked with transverse lines and distances at intervals of one metre from the pile tip, subdivided in intervals of 250mm over the portion of the pile exposed above water.

9.9. PILE INSTALLATION

MWPA requires 24 hour notice prior to the installation of piles to arrange attendance. An installation procedure is required by MWPA at least six weeks prior to the commencement of piling. Procedures should include the following information:

- Proposed equipment specification including:
  - Hammer type, energy rating, year of manufacture and calibration certification.
  - Crane capacity to handle the piles and hammer.
  - Ancillary equipment details including proposed backup or standby equipment.
  - Past history of equipment performance in similar conditions.
- Control of pile position including:
  - Survey and setting out details.
  - Installation tolerance control methods.
  - Procedures for correction of positional errors.
- Driving of piles including:
  - Methods for pile driving and monitoring.
  - Pile driving criteria including embedment and final set.
  - Drivability analysis including GRLWEAP or another approved wave equation analysis.
  - PDA testing program and details.
  - Proposed equations to calculate pile capacities and procedures for correlation with pile dynamic testing results.
  - Temporary works details.
  - Weld testing details
- Quality assurance and quality control including:
  - Inspection procedures.
  - Verification methods for pile acceptance.

Piles are required to be driven by approved proprietary hydraulic pile driving hammers to be used within the operating conditions recommended by the manufacturer. The installation of piles by jetting is not permitted. Driving hammers are to have sufficient energy to drive piles to the required depth and geotechnical capacity. Pile refusal is defined as the point where the blow count exceeds 250 blows over 250 mm penetration, for a hammer operating at full capacity.

Piles should not be stressed beyond 90% of the yield stress during driving. Contractors are required to strengthen the head of piles as necessary to resist driving stresses and if needed provide suitable helmet or anvil. Additional toe strengthening of piles may are also be required to achieve the required penetration. Should pile damage occur during installation then MWPA should be notified immediately.

Pile driving records for submission to MWPA should include the following information:

- Pile reference number.
- Date and time of driving.
- Weather conditions.
- Seabed, top of pile, splice and toe levels.
- Positional survey.
- Length of pile cut-off.
- Hammer type and energy.
- Cushion type.
- Number of blows for each 250mm penetration.
- Hammer blow rate and final set.
- Comments including records of delays.

9.10. MATERIALS, INSPECTION, TESTING & QUALITY CONTROL

9.10.1. GENERAL

Contractors are responsible for achieving the specified standards and demonstrating such achievement through inspections, testing and measurement in accordance with MWPA and contractual requirements. Documentation should cover all work under the Contract, both onsite and offsite, including the activities of Subcontractors and Suppliers.

MWPA should at all times be provided access to facilities where work, inspections or testing associated with the Contract is being performed, including the facilities of Subcontractors or Suppliers either onsite or elsewhere. All inspections and tests should be conducted within normal office hours, unless otherwise authorised by MWPA.

Surveying processes to verify conformance should be conducted by personnel with a minimum qualification for acceptance to the Surveying and Spatial Sciences Institute.

9.10.2. PILING

Materials for piles should comply with the standards referenced in Sections 9.10.2 and 9.10.3 for steel and concrete. In general, all welds of steel piles should be 100% ultrasonically tested unless specified otherwise in the contractual requirements.

The first three piles of maritime structures are required to undergo PDA testing to prove their geotechnical capacity before the installation of other piles. Piles not PDA tested are accepted as having sufficient capacity if pile driving formulae which has been correlated to the PDA test results shows a pile capacity equal to or greater than the closest PDA tested pile.

In general, the percentage of piles to undergo PDA testing should be at least 10% of the total number of piles to be installed or as otherwise stated in the contractual requirements. Testing requirements are provided in Section 8 of AS 2159. Piles which are selected for PDA testing are to be agreed with MWPA and represent an even randomly distributed spread. Additional piles may be selected for PDA testing during the installation program in the event of piles having low blow counts, do not reach required toe levels, or are damaged during installation.

9.10.3. CONCRETE

Concrete for use in marine structures is required to be special class. The supply, workmanship, materials and testing requirements should conform to AS 3600, AS 1379 and the recommendations provided in AS 4997. Steel reinforcement should comply with the requirements of AS/NZS 4671.

Further concrete guidelines are provided in **MWPA601**.

9.10.4. STRUCTURAL STEELWORK

Structural steelwork should comply with the requirements of AS 4100 and the relevant standards relating to manufacture and fabrication listed in AS 4100. Welding requirements for structural steelwork should in accordance with AS/NZS 1554.

All butt welds should be 100% ultrasonic tested and all fillet welds at least 10% magnetic particle tested with 100% visual inspection, unless stated otherwise in the contractual requirements.

Further structural steelwork guidelines are provided in **MWPA602**.

9.10.5. NOTIFICATION

Contractors should notify MWPA at least seven days in advance of the date, time and place where inspections or tests will be carried out and provide a detailed test plan. MWPA may, at its discretion, nominate a representative who will witness all or part of the inspections or testing. If a MWPA representative attends an inspection or test the contractor should ensure that all inspection and test sheets that were witnessed are appropriately annotated and signed by the MWPA representative.

If a MWPA representative is not nominated or does not attend, the contractor should proceed with all inspections and tests on the date and time proposed, and submit inspection and test sheets to the MWPA representative.

9.11. DOCUMENTS TO BE SUBMITTED

Details of documents required to be submitted by Contractors before, during and after construction are provided in **MWPA100 Sections 5.3, 5.4, 6.1, 6.2, 6.3** and **12.1**.

APPENDIX A

EXISTING DATA

ITEM A1 – LISTS OF EXISTING DATA

A1.1 REPORTS

NO.	TITLE
1	Wharf Specification Booklet (Connell Wagner, 2002)
2	Concrete Condition Survey – Geraldton Port – Berths 4&5 (Savcor, 2009)
3	MWPA Tug Pen Structural Assessment (URS, 2012)
4	MWPA Asset Condition Assessment - Technical Report - Volume 1 (SMEC, 2013)
5	MWPA Asset Condition Assessment - Technical Report - Volume 2 (SMEC, 2013)
6	MWPA Asset Condition Assessment - Project Report - Volume 3 (SMEC, 2013)
7	Geraldton Port: Berth 4 Remedial Works (KBR, 2011)
8	Mid West Ports Authority - Structural Review of Berth 1 & 2 (AECOM, 2009)
9	Trawler Jetty Structural Assessment (Aurecon, 2013)
10	Long Service Jetty Minor Assessment (GHD, 2001)

A1.2 DRAWINGS

SERIES	TITLE
MP4-102-00 to 17	Mid West Ports Authority Reconstruction of Berth 3 (Halpern Glick Maunsell, 1996)
14649-S1 to S4	Mid West Ports Authority Trawler & Lobster Jetty (Wood & Grieve, 1995)
11674C-S1 to S2	Mid West Ports Authority North Pens Fishing Boat Harbour Trawler Jetties (Wood & Grieve, 1990)
25711-1A to 20	Geraldton Harbour Works – Repairs to Wharf 1, 2 & 3 (Public Works Department)
5579-1B to 6A	Mid West Ports Authority South Pens Finger 3 Corrosion & Cathodic Protection (John McCoy, 2000)

APPENDIX B

FIGURES

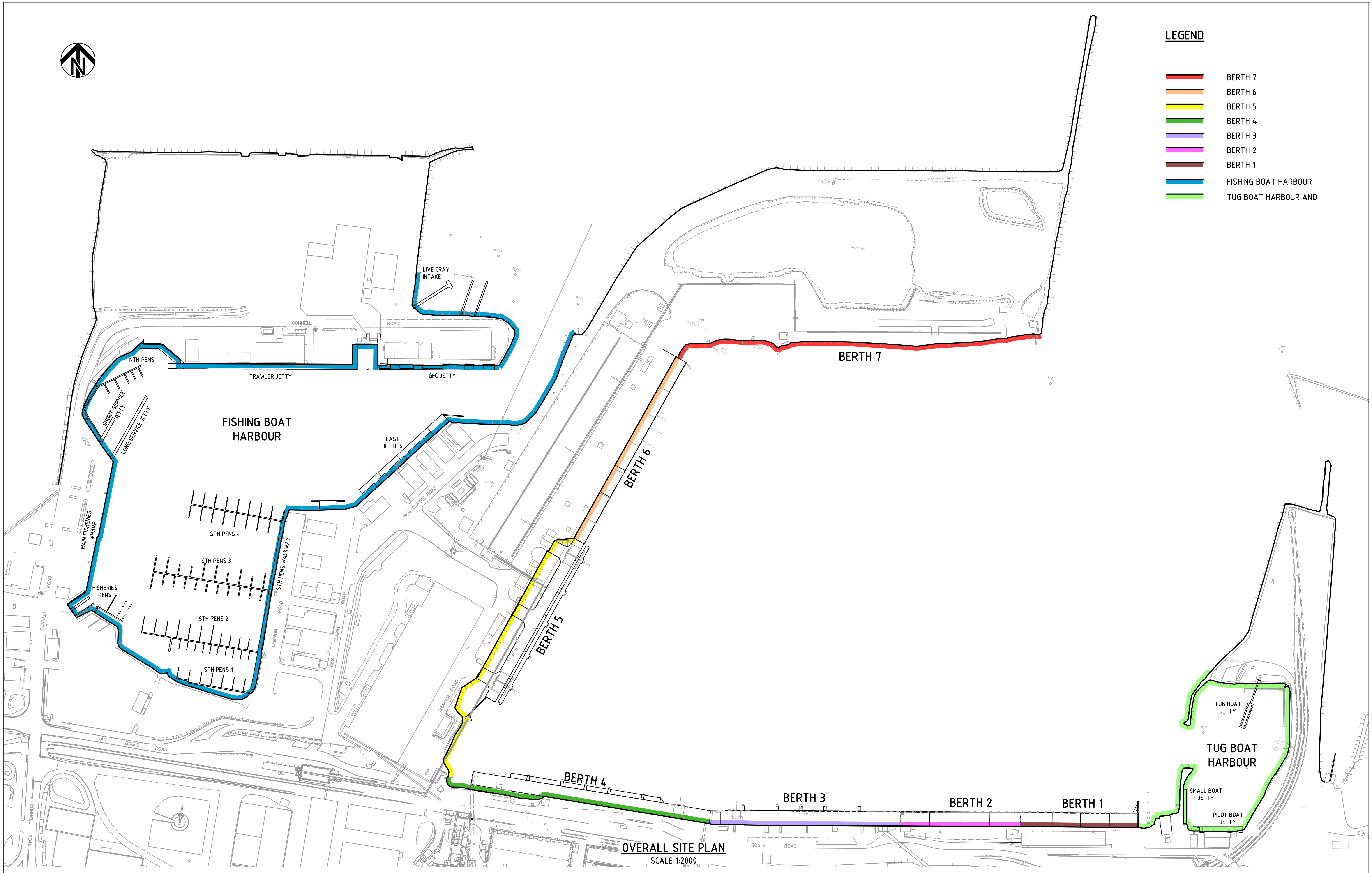

FIG NO. 1	FIGURE TITLE MARITIME STRUCTURES LOCATION PLAN	DATE 09.04.2014 SCALE 1:2000 20 0 20 40 60 80 100	PAGE SIZE A3	COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -	

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T:\Projects\30012249\CAD\Sketches\FIG 1.dwg

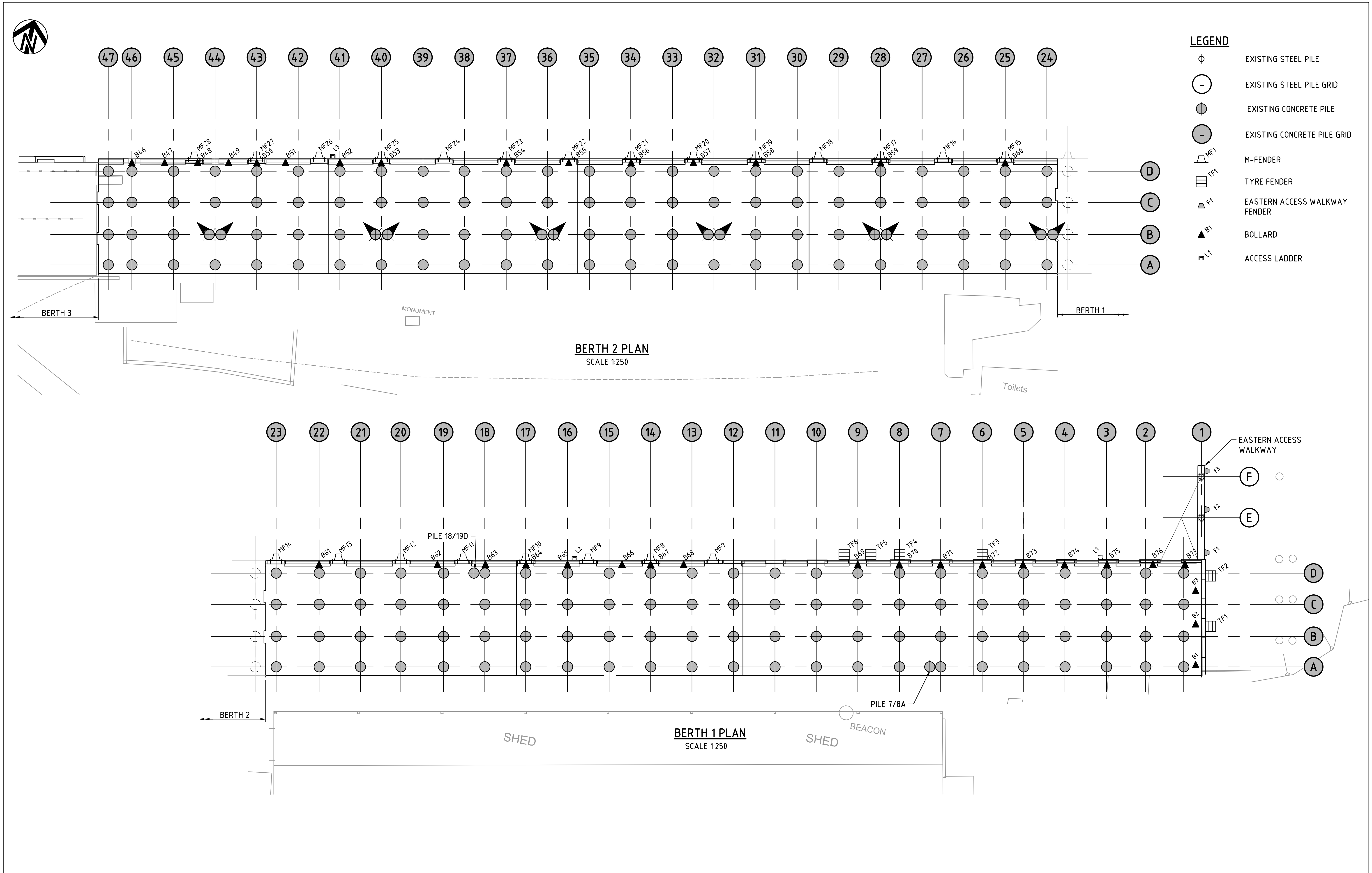

FIG NO. 2 FIGURE TITLE BERTH 1 AND 2

DATE 09.04.2014

SCALE 1:125

PAGE SIZE A3

COORDINATE SYSTEM -

PROJECT NO. 3006198 PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE

CREATED BY S.DRUERY

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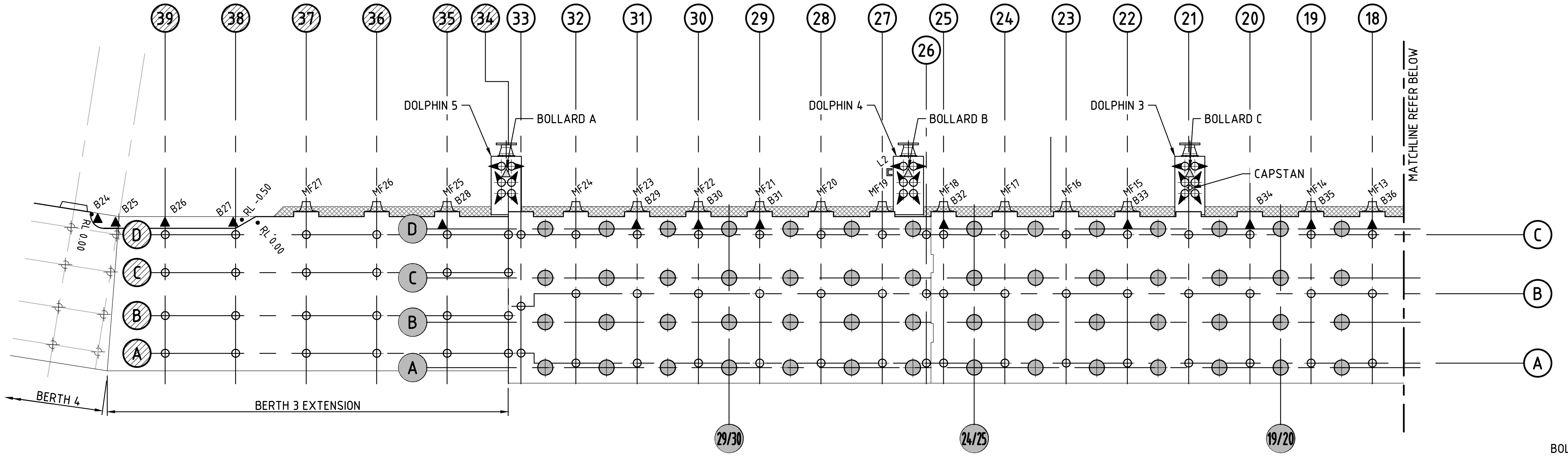
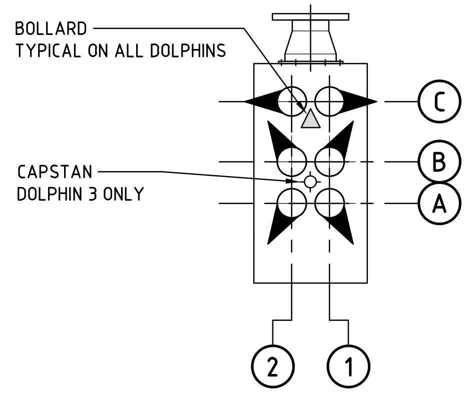
T:\Projects\30012249\CAD\Sketches\FIG 2.dwg



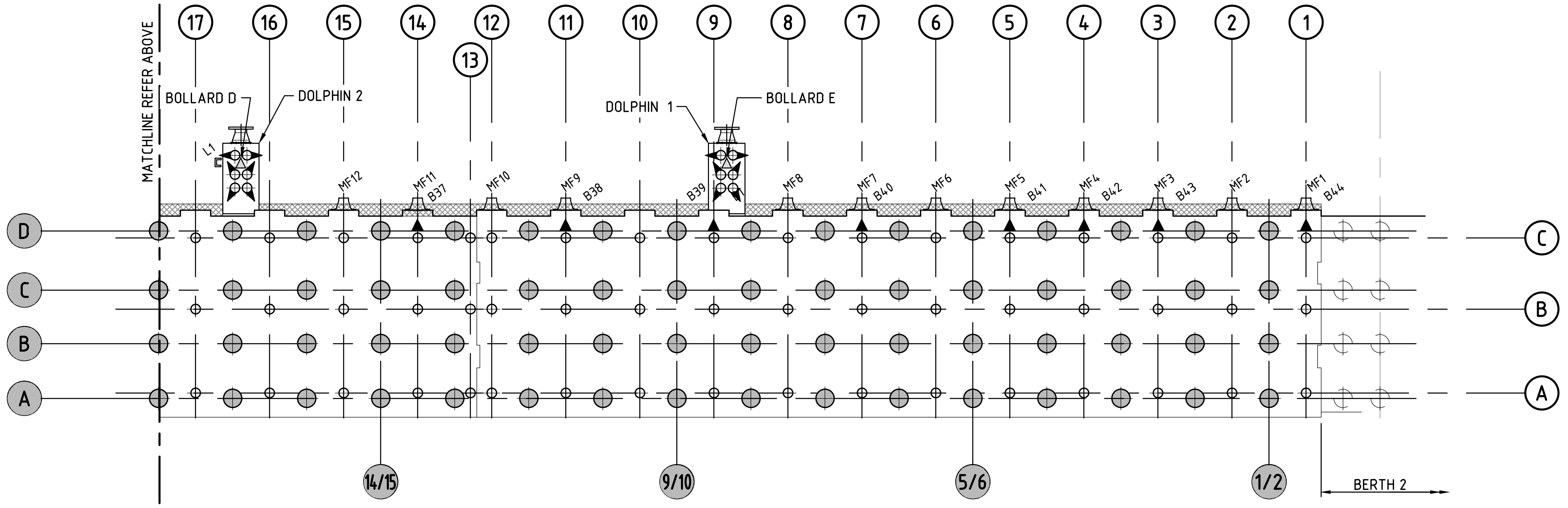
BERTH 3 PLAN
SCALE 1:250



TYPICAL DOLPHIN PLAN
SCALE 1:100

LEGEND

- EXISTING STEEL PILE
- EXISTING CONCRETE PILE
- EXISTING STEEL PILE GRID
- BERTH 3 EXTENSION EXISTING STEEL PILE GRID
- EXISTING CONCRETE PILE GRID
- GRATING
- BOLLARD
- DOLPHIN BOLLARD
- CAPSTAN
- M-FENDER
- ACCESS LADDER



BERTH 3 PLAN
SCALE 1:250

FIG NO. 3	FIGURE TITLE BERTH 3	DATE 09.04.2014	PAGE SIZE A3 / COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -

SCALE 1:100
SCALE 1:250

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T:\Projects\30012249\CAD\Sketches\FIG 3.dwg

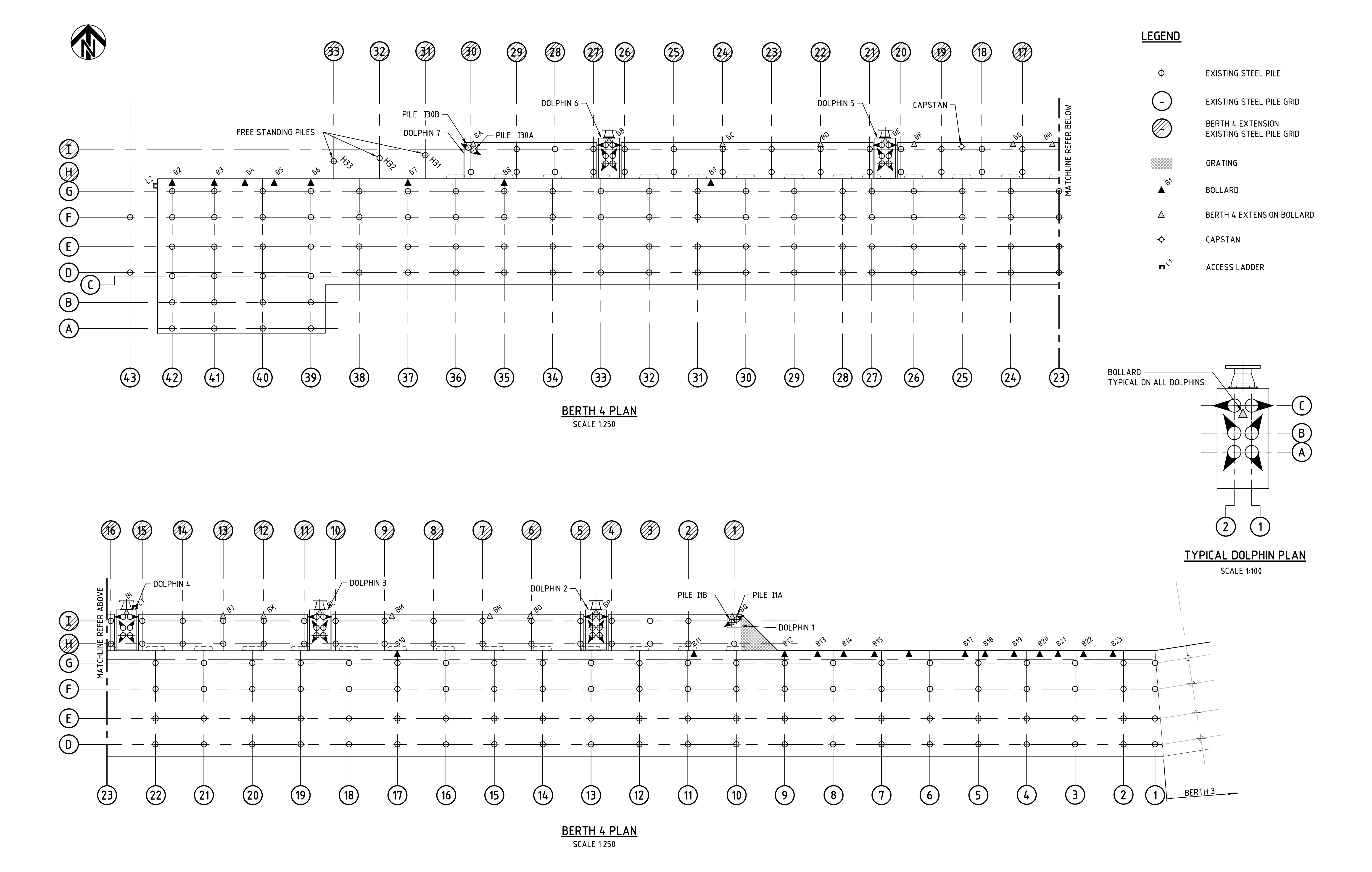

FIG NO. 4	FIGURE TITLE BERTH 4	DATE 09.04.2014	PAGE SIZE A3	COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -	

SCALE 1:100
SCALE 1:250

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T:\Projects\30012249\CAD\Sketches\FIG 4.dwg

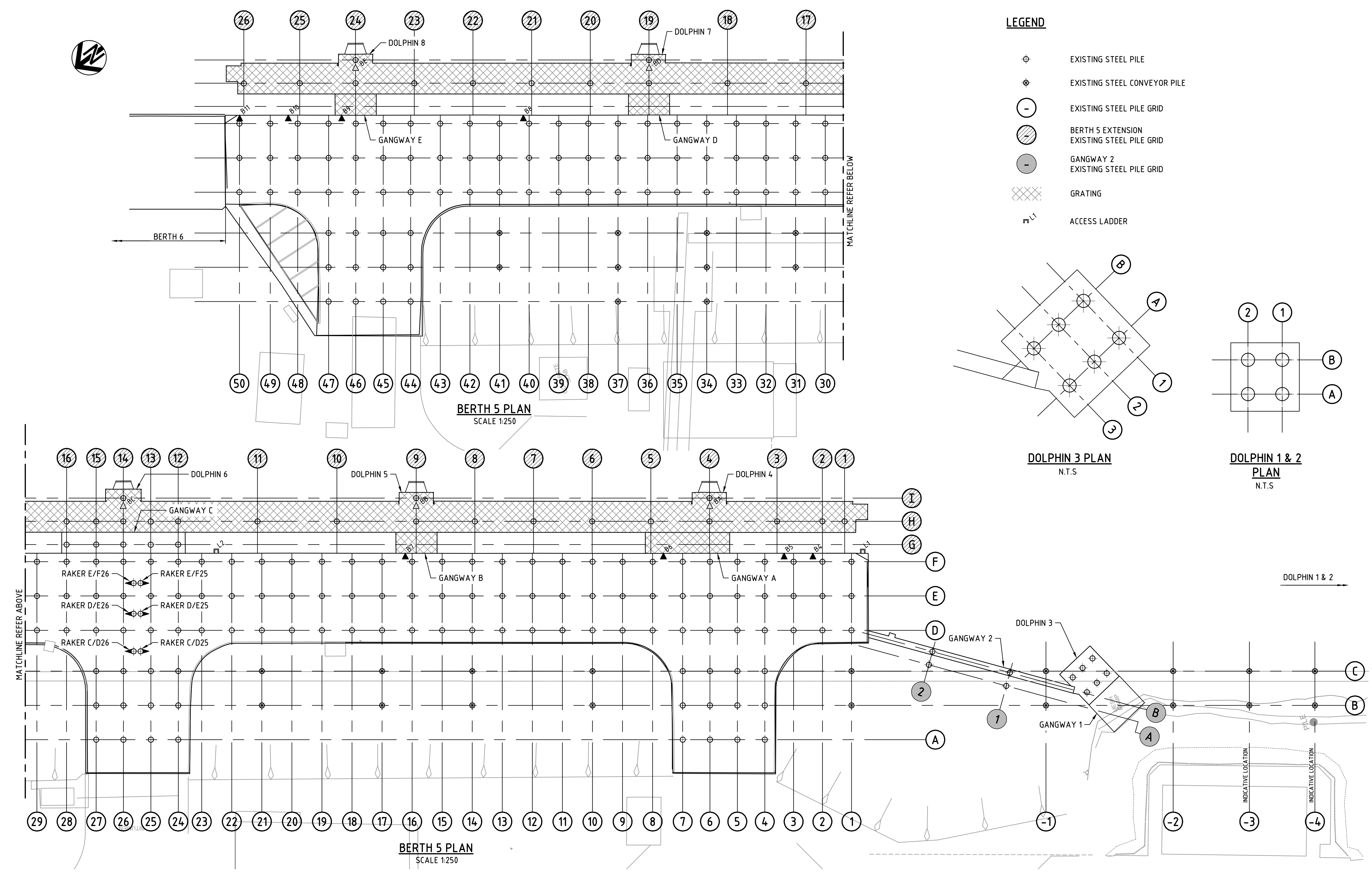

FIG NO. 5 FIGURE TITLE BERTH 5

DATE 09.04.2014

SCALE 1:100

SCALE 1:250

PAGE SIZE A3

COORDINATE SYSTEM -

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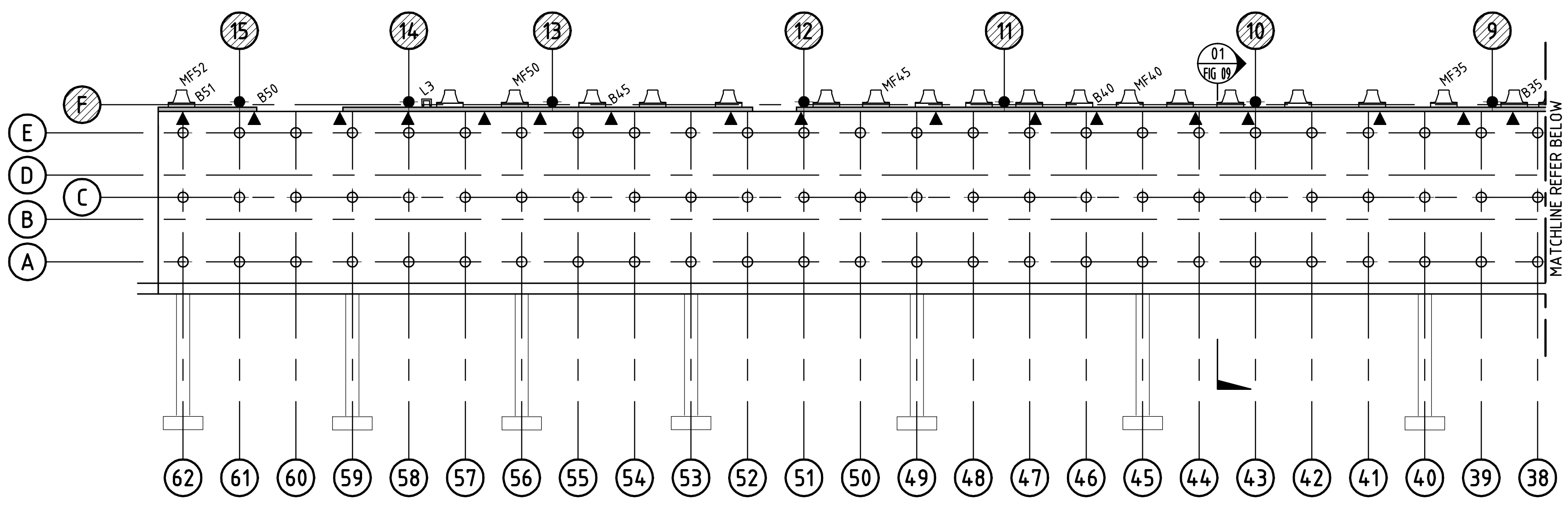
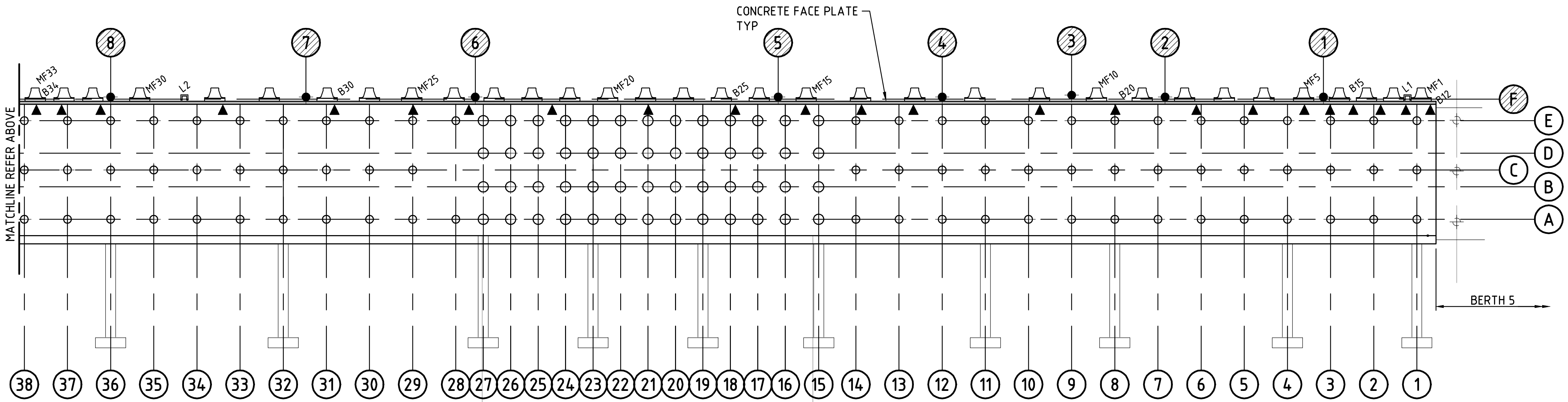
PROJECT NO. 3006198 PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE

CREATED BY S.DRUERY SOURCES -

T:\Projects\30012249\CAD\Sketches\FIG 5.dwg



BERTH 6 PLAN
SCALE 1:250



BERTH 6 PLAN
SCALE 1:250

LEGEND

- EXISTING STEEL PILE
- EXISTING STEEL FENDER PILE
- EXISTING STEEL PILE GRID
- EXISTING STEEL FENDER PILE GRID
- M-FENDER
- BOLLARD
- ACCESS LADDER

FIG NO. 6	FIGURE TITLE BERTH 6	DATE 09.04.2014	PAGE SIZE A3
		SCALE 1:100 / SCALE 1:250	COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -

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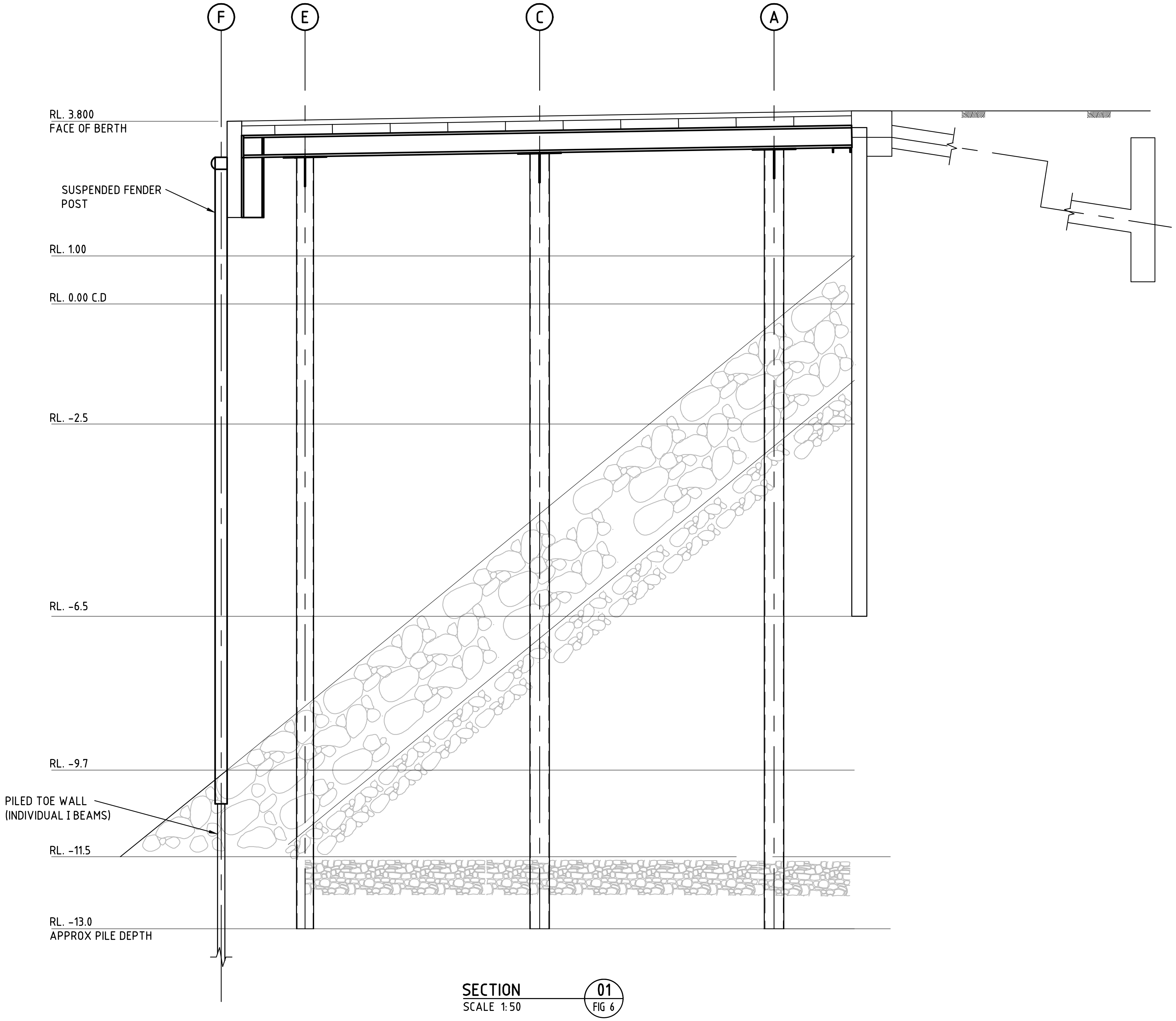
T:\Projects\30012249\CAD\Sketches\FIG 6.dwg



SECTION 01
SCALE 1:50
FIG 6

FIG NO. 7	FIGURE TITLE BERTH 6 SECTION	DATE 09.04.2014 SCALE 1:100 SCALE 1:250	PAGE SIZE A3	COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -

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T:\Projects\30012249\CAD\Sketches\FIG 7.dwg

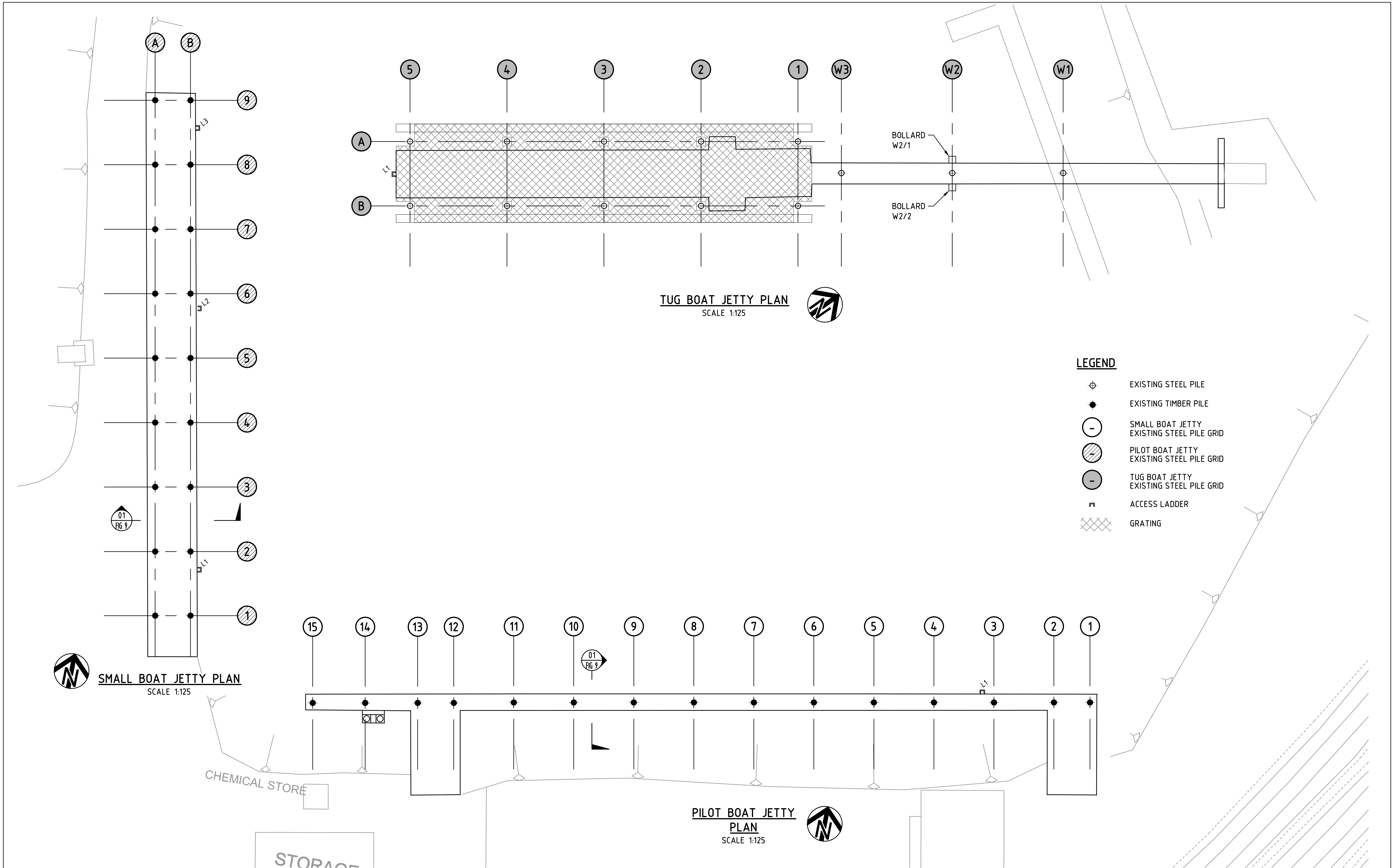

FIG NO. 8	FIGURE TITLE TUG BOAT HARBOUR	DATE 09.04.2014 SCALE 1:125	PAGE SIZE A3 · COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -

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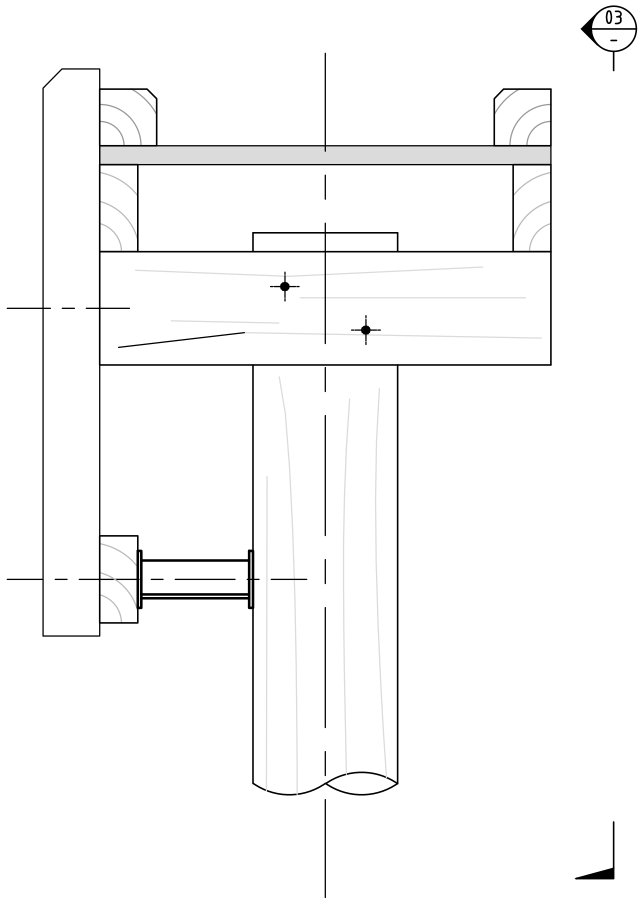
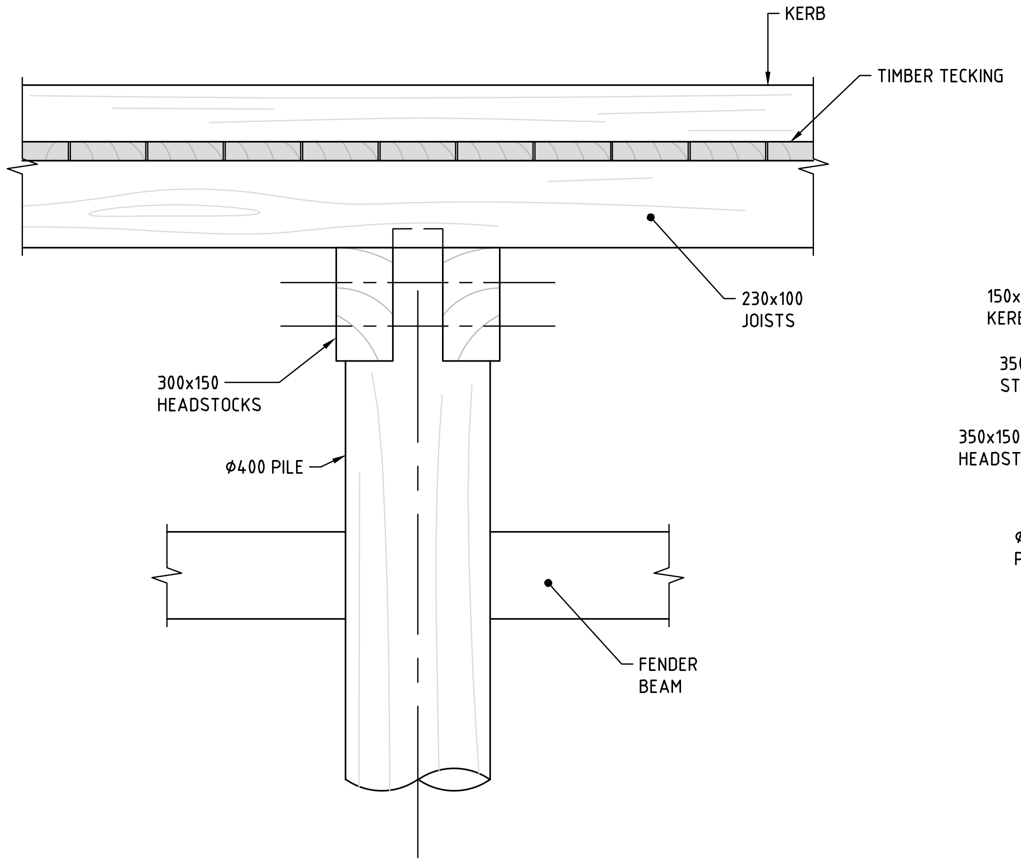
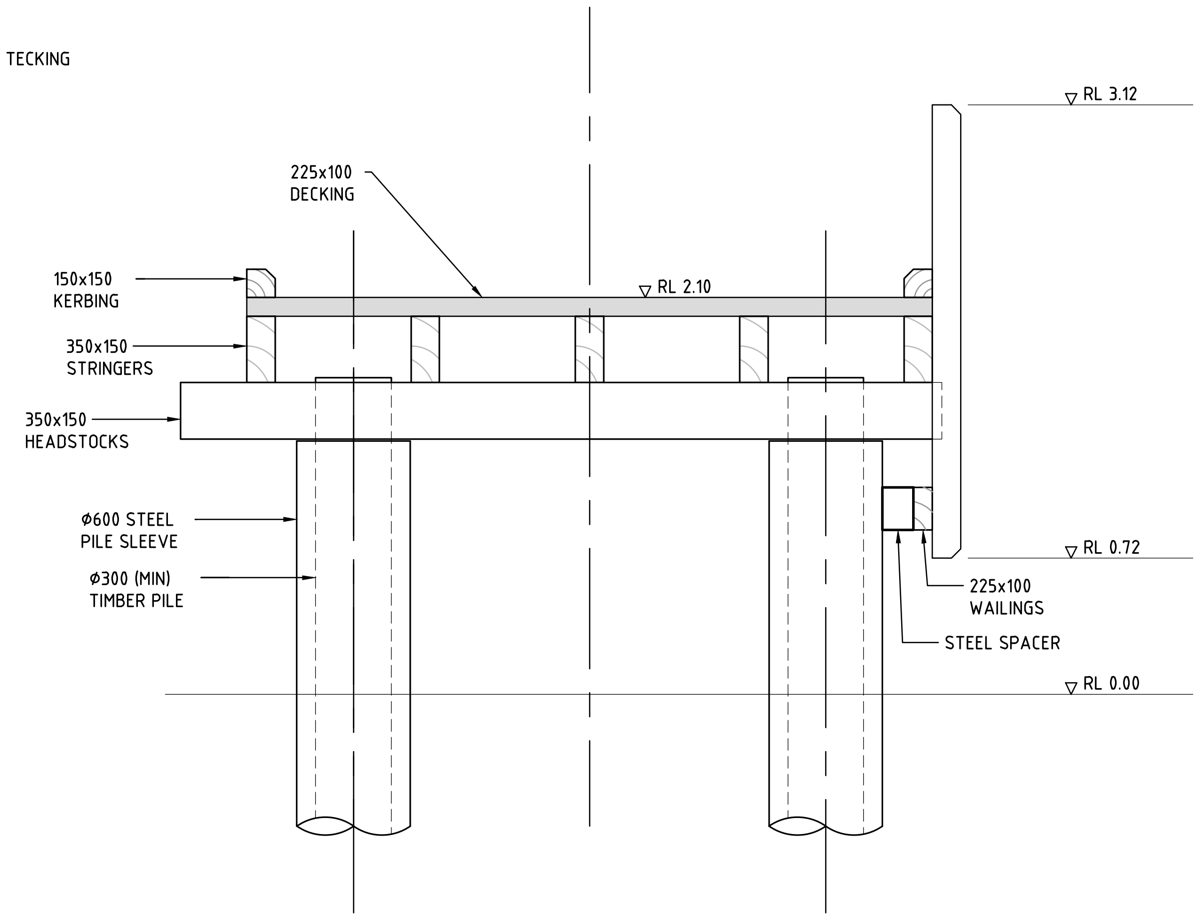
T:\Projects\30012249\CAD\Sketches\FIG 8.dwg



SECTION 01
SCALE 1:10 FIG 8



ELEVATION 03
SCALE 1:10 -



SECTION 02
SCALE 1:20 FIG 8

FIG NO. 9	FIGURE TITLE TUG BOAT HARBOUR SECTIONS	DATE 09.04.2014	PAGE SIZE A3	COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -	

SCALE 1:10 0.1 0 0.1 0.2 0.3 0.4 0.5
SCALE 1:20 0.2 0 0.2 0.4 0.6 0.8 1.0

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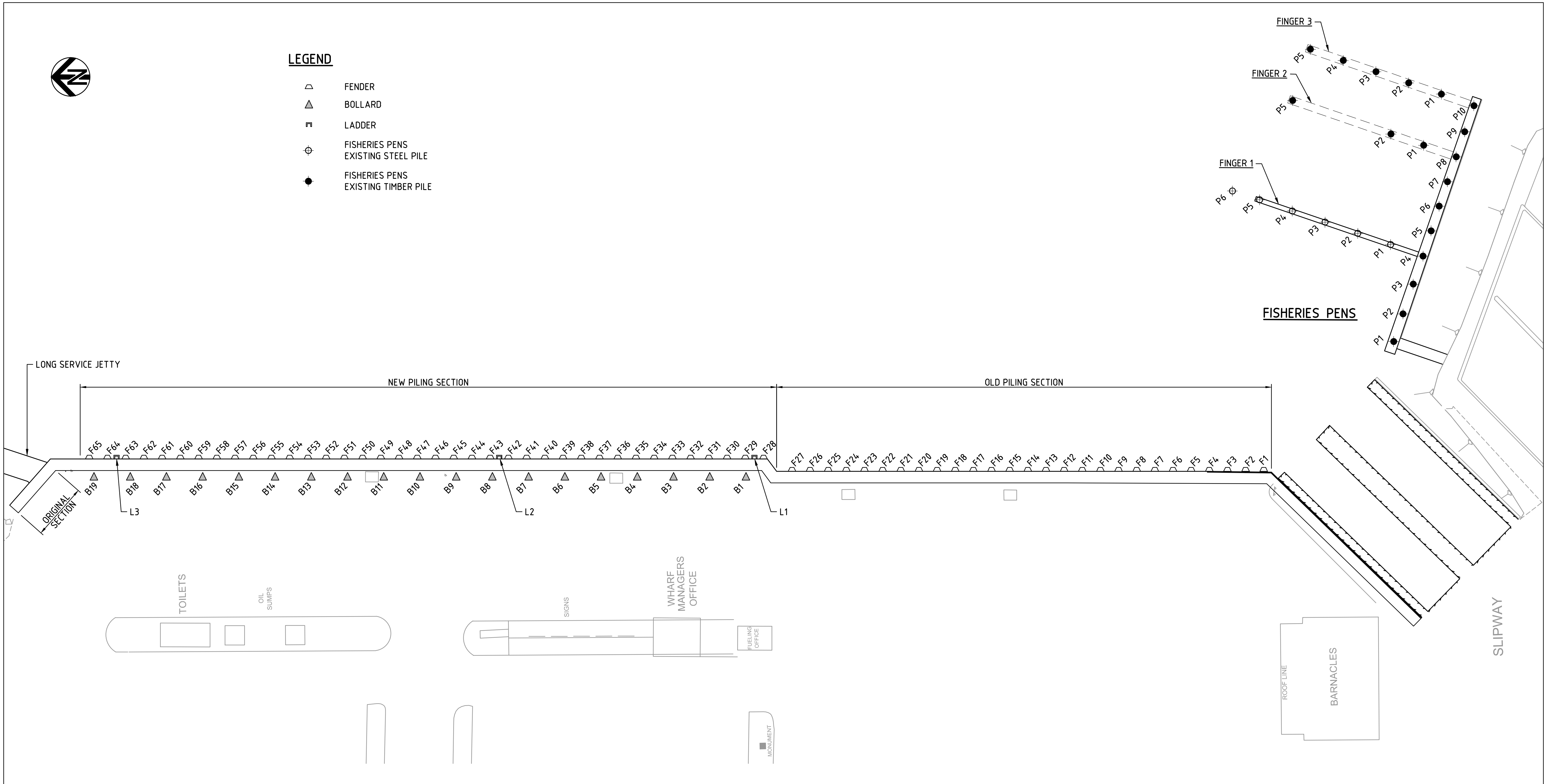
T:\Projects\30012249\CAD\Sketches\FIG 9.dwg



MAIN FISHERMAN'S WHARF PLAN

SCALE 1:250

FIG NO. 10	FIGURE TITLE FISHERMAN'S WHARF	DATE 09.04.2014 SCALE 1:1250 12.5 0 25 50	PAGE SIZE A3 COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -

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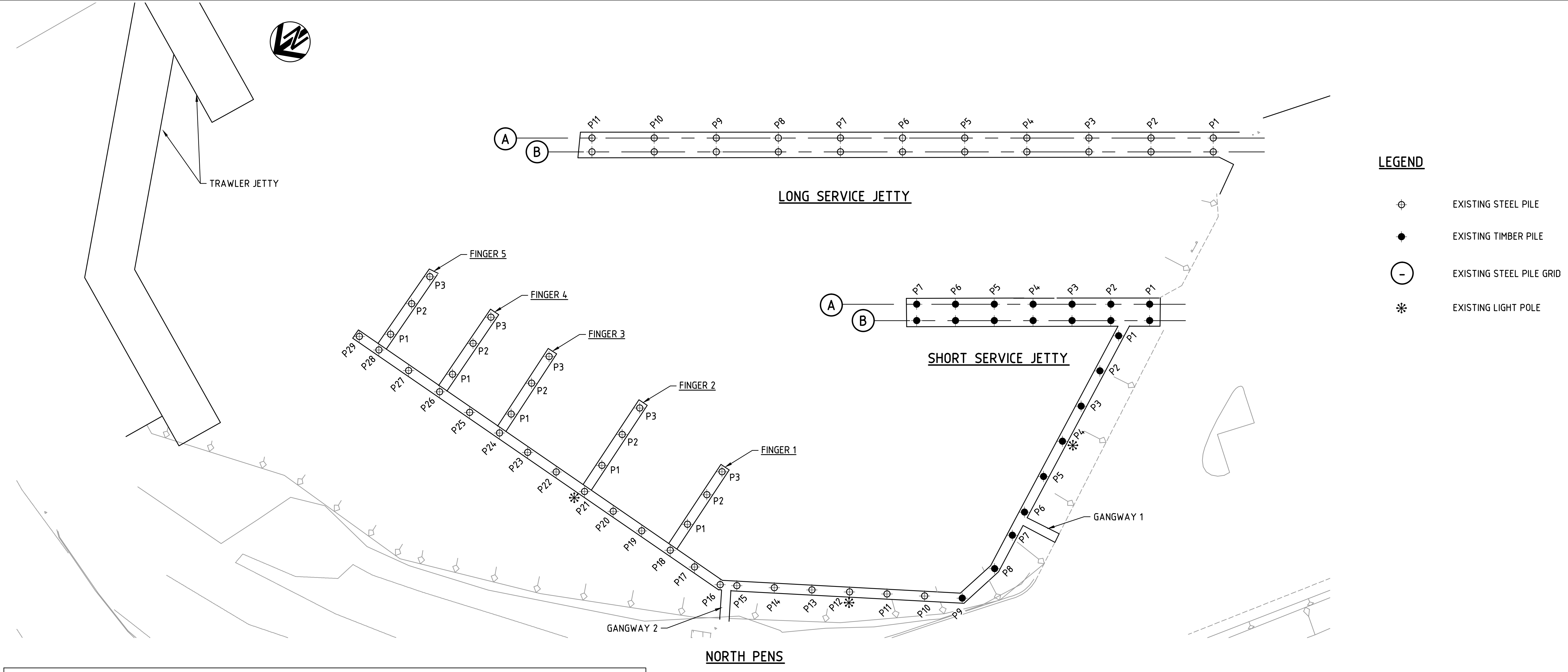
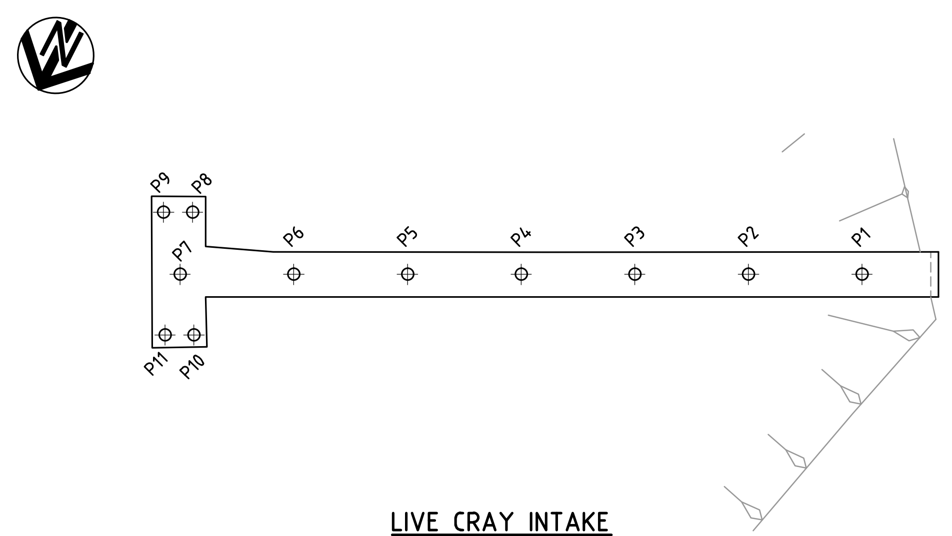
T:\Projects\30012249\CAD\Sketches\FIG 10.dwg



PLAN
SCALE 1:250



LIVE CRAY INTAKE
PLAN
SCALE 1:250

FIG NO. 11	FIGURE TITLE FISHING BOAT HARBOUR	DATE 09.04.2014 SCALE 1:1250	PAGE SIZE A3 / COORDINATE SYSTEM -
PROJECT NO. -	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -

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T:\Projects\30012249\CAD\Sketches\FIG 11.dwg

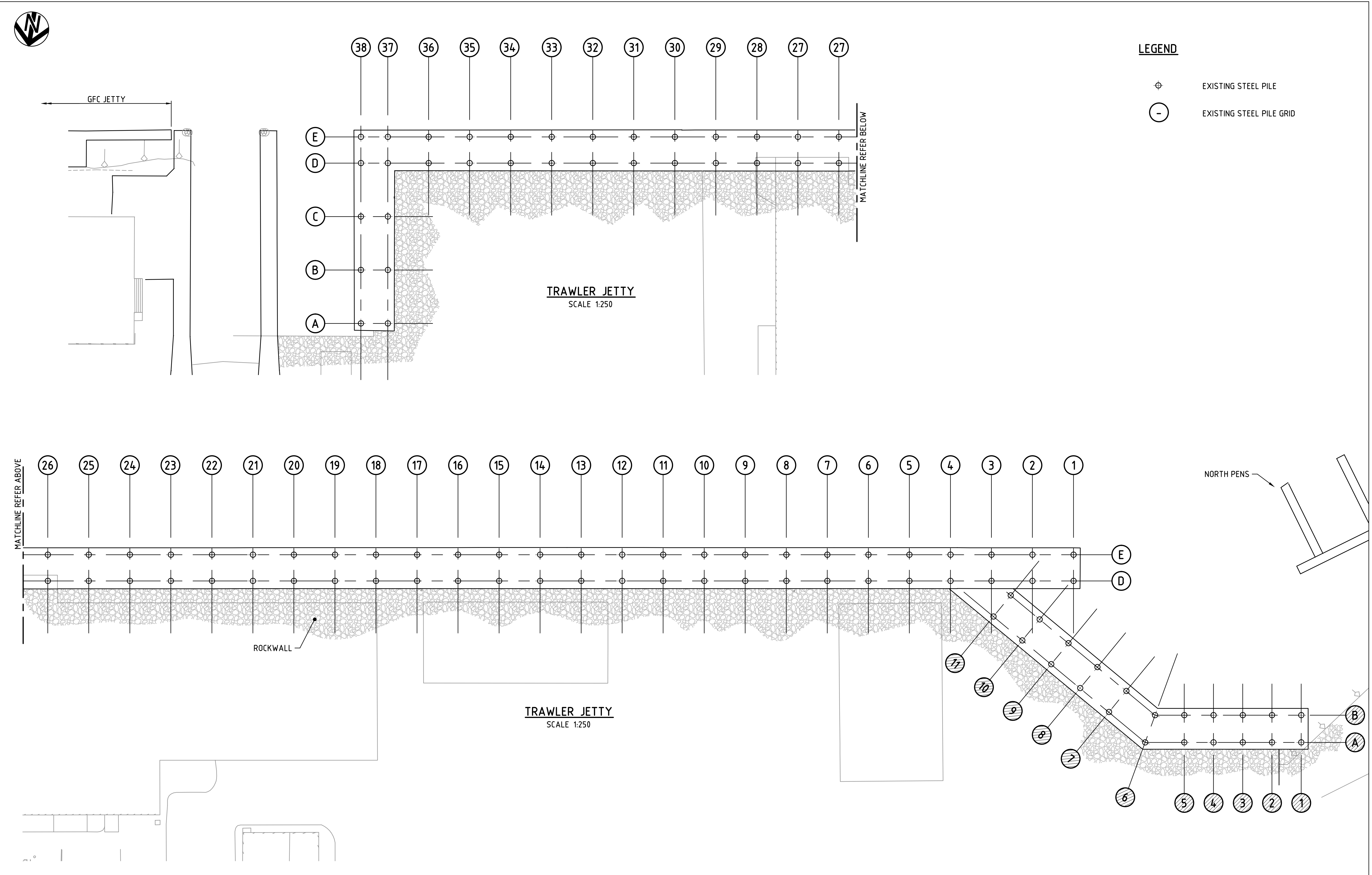

FIG NO. 12	FIGURE TITLE TRAWLER JETTY	DATE 09.04.2014	SCALE 1:250	PAGE SIZE A3	COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY		SOURCES -	

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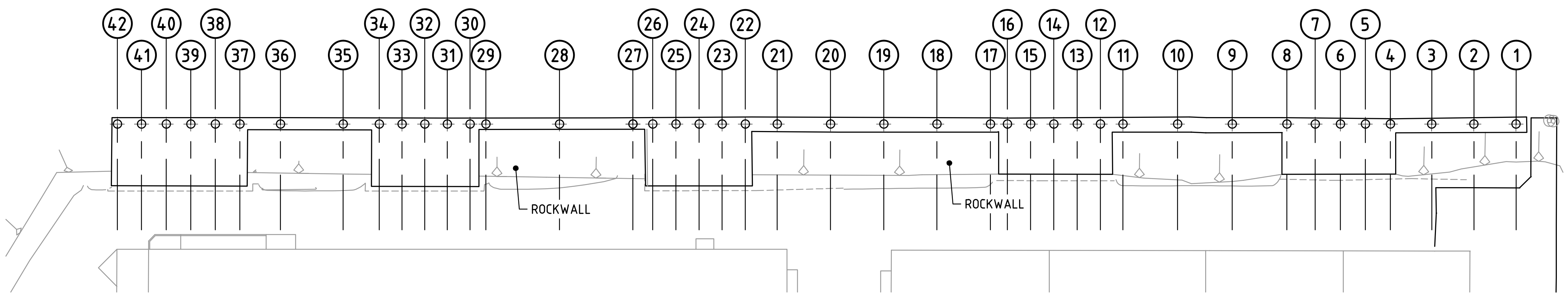
T:\Projects\30012249\CAD\Sketches\FIG 12.dwg

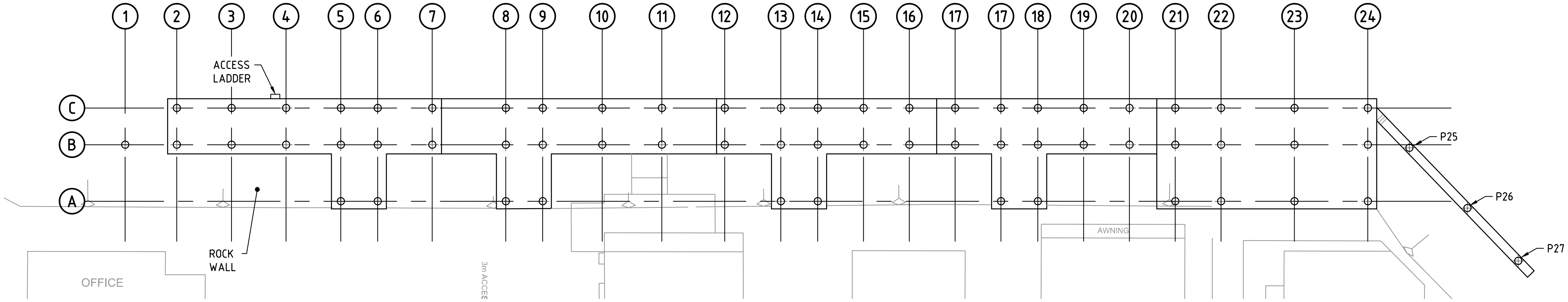
LEGEND

EXISTING STEEL PILE

EXISTING STEEL PILE GRID



GFC PLAN
SCALE 1:125



EAST JETTIES PLAN
SCALE 1:250

FIG NO. 13	FIGURE TITLE GFC AND EAST JETTIES	DATE 09.04.2014 SCALE 1:250	PAGE SIZE A3	COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -	

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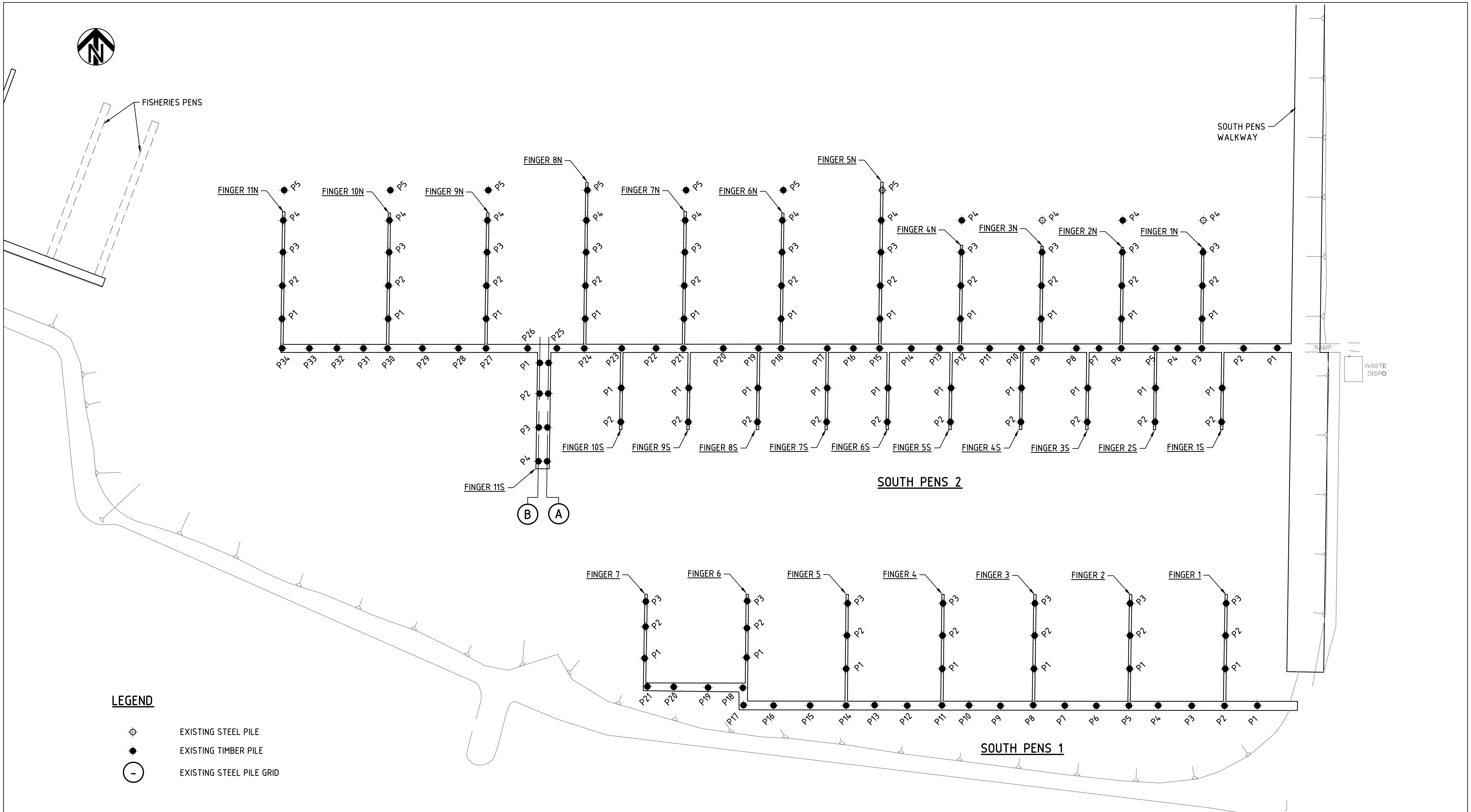
T:\Projects\30012249\CAD\Sketches\FIG 13.dwg



PLAN

SCALE 1:250

FIG NO. 14	FIGURE TITLE SOUTH PENS 1 & 2	DATE 09.04.2014 SCALE 1:1250	PAGE SIZE A3 / COORDINATE SYSTEM -
PROJECT NO. 3006198	PROJECT TITLE GERALDTON PORT AUTHORITY MARITIME STRUCTURES GUIDELINE	CREATED BY S.DRUERY	SOURCES -

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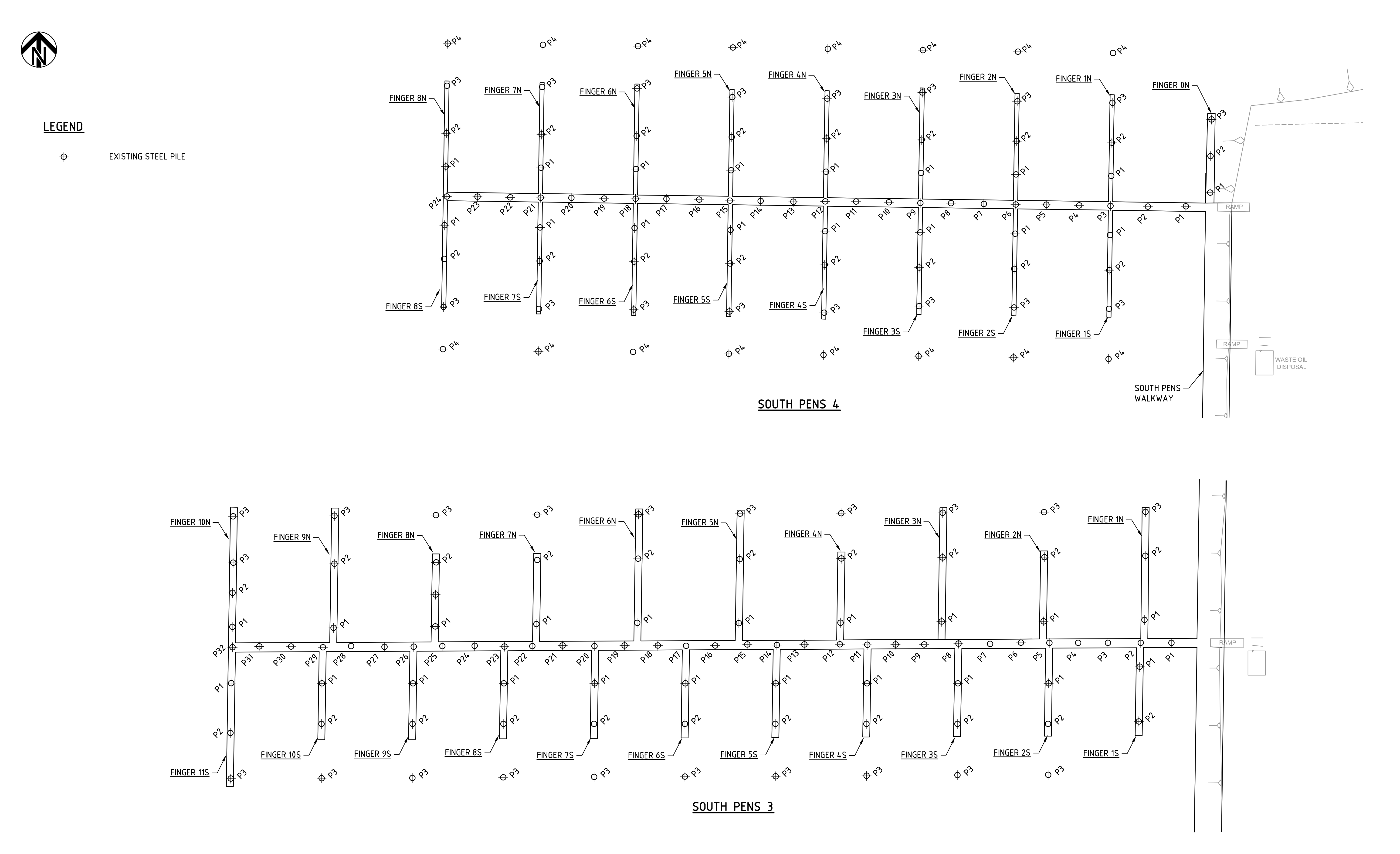
T:\Projects\30012249\CAD\Sketches\FIG 14.dwg



PLAN
SCALE 1:250

FIG NO. 15 FIGURE TITLE SOUTH PENS 3 & 4

DATE 09.04.2014 SCALE 1:1250 12.5 0 25 50

PAGE SIZE A3

COORDINATE SYSTEM -

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T:\Projects\30012249\CAD\Sketches\FIG 15.dwg

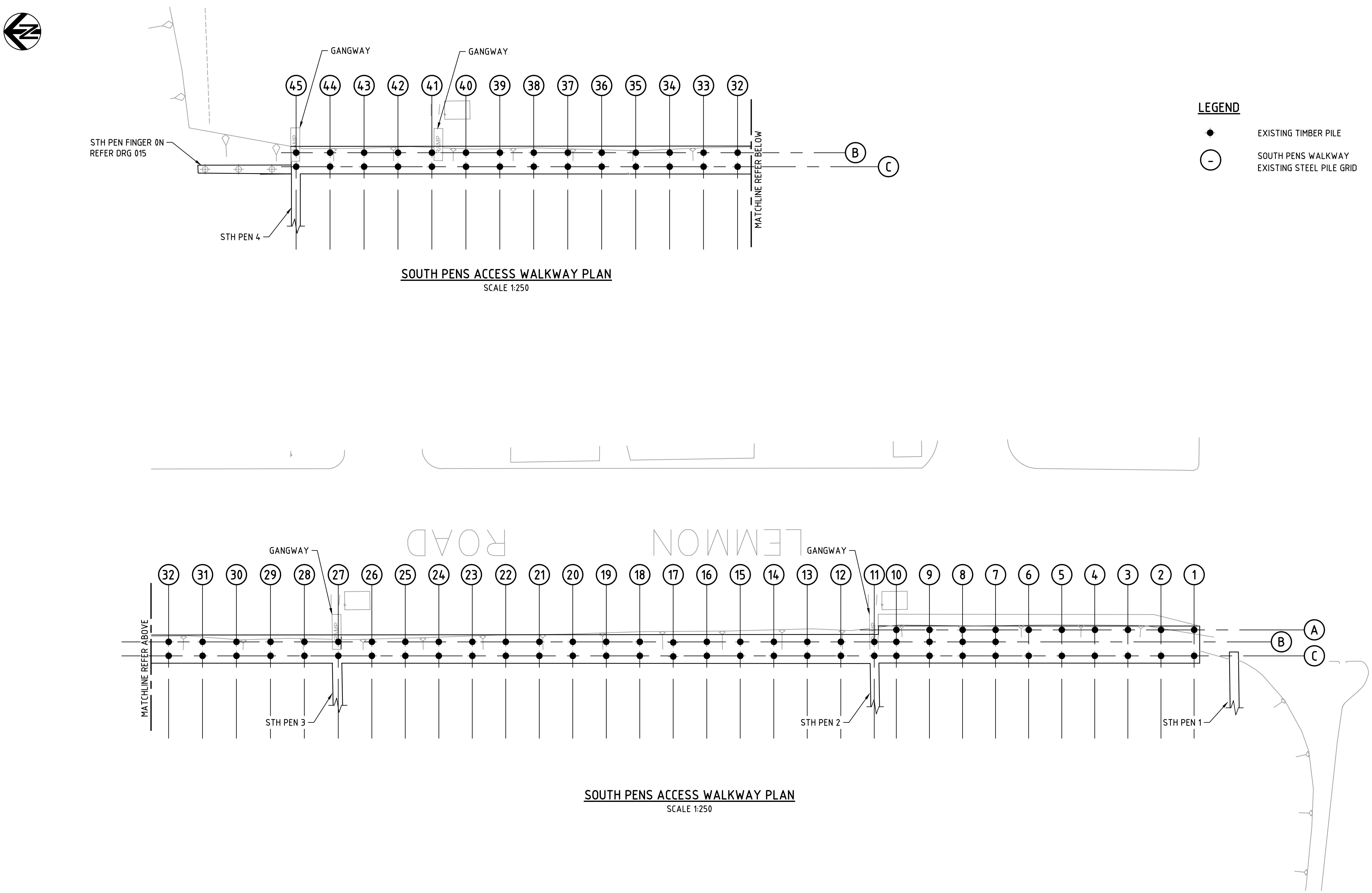

FIG NO. 16 | FIGURE TITLE SOUTH PENS ACCESS WALKWAY

DATE 09.04.2014 | SCALE 1:1250 | 12.5 0 25 50

PAGE SIZE A3 | COORDINATE SYSTEM -

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T:\Projects\30012249\CAD\Sketches\FIG 16.dwg