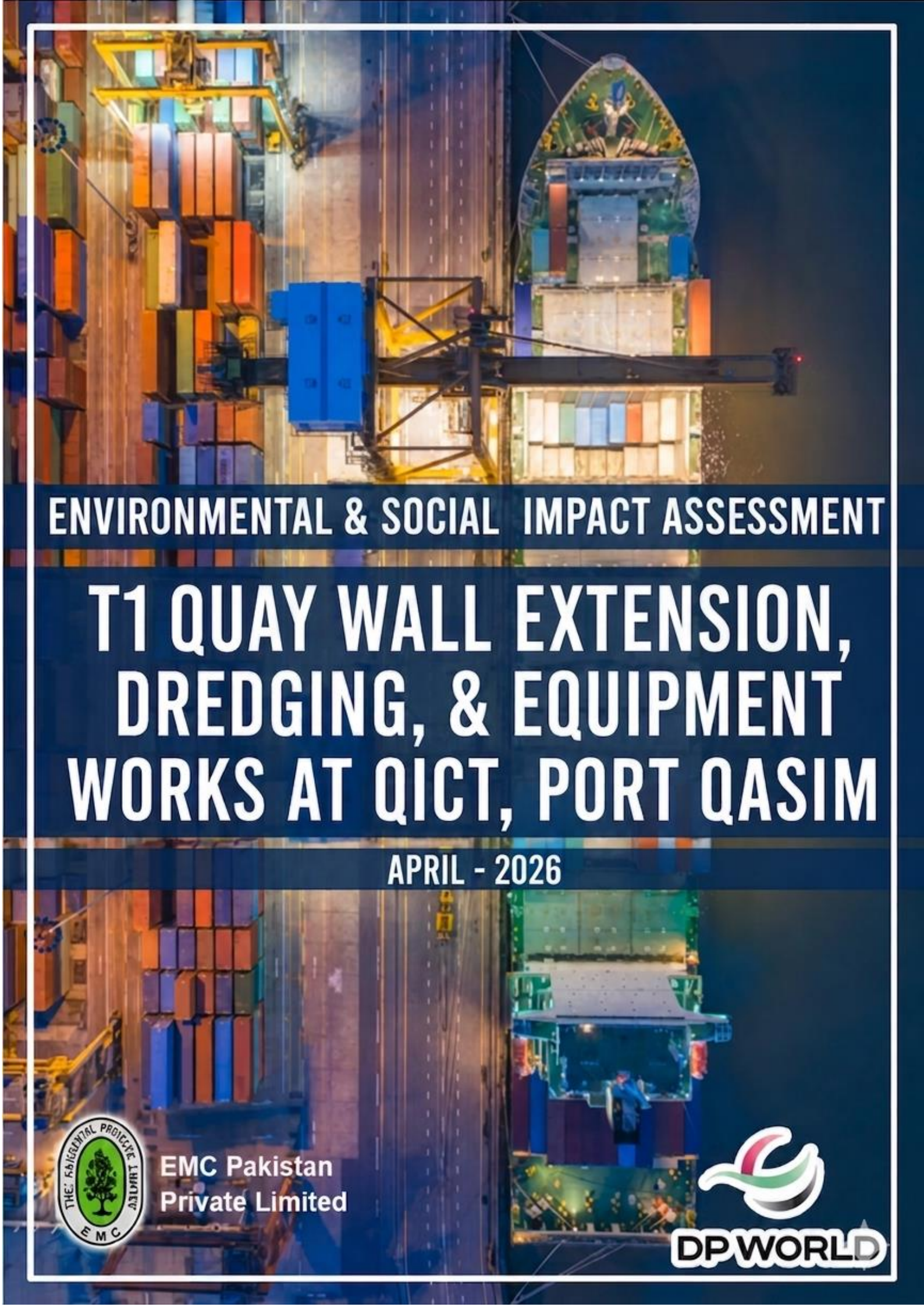

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

T1 QUAY WALL EXTENSION, DREDGING, & EQUIPMENT WORKS AT QICT, PORT QASIM

APRIL - 2026

EMC Pakistan
Private Limited

DP WORLD

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1 Introduction

EMC Pakistan (Private) Limited has been commissioned by Qasim International Container Terminal (QICT), for conducting the Environmental & Social Impact Assessment (ESIA) for the proposed quay wall extension, dredging, and equipment works project at QICT, Port Qasim, Karachi. The project involves the extension of the existing quay wall at Terminal 1, dredging of deeper berth pockets to achieve the required navigational depth, and installation of associated equipment and infrastructure to enhance the terminal's operational efficiency and container handling capacity. To address the potential environmental and social impacts from the development of this project, this Environmental and Social Impact Assessment (ESIA) has been prepared in accordance with the Guidelines of the Sindh Environmental Protection Agency (SEPA) for their scrutiny and approval.

1.1 Background – Port Qasim & QICT

Pakistan's economic growth, industrial development, and international competitiveness are heavily dependent upon the efficiency of its maritime sector. As a trade-oriented economy, Pakistan relies on seaborne transportation for the movement of the overwhelming majority of its international cargo. Nationally, approximately 95% of Pakistan's trade by volume and a significant portion of its trade by value has been handled through its seaports, making maritime infrastructure a critical component of the country's economic framework. Among these facilities, Port Qasim has emerged as one of the most important gateways for international trade, industrial development, and energy security[1].

Port Qasim, located along the Arabian Sea within the Indus Delta region, is one of Pakistan's principal deep-sea ports and serves as a major gateway for the country's maritime trade. The port is situated approximately 35 km southeast of Karachi and was developed to supplement Karachi Port and to handle bulk and industrial cargo associated with the country's expanding industrial base.[2] The selection of the site was based on the natural shelter and navigational advantages offered by the Phitti Creek channel system, which provides access from the open sea to the inner harbour.[3]

The modern development of Port Qasim began in the 1970s with the establishment of the Port Qasim Authority (PQA) through an Act of Parliament in 1973 to plan, develop, and manage port operations. The port commenced commercial operations in 1980 with the commissioning of the Iron Ore and Coal Berth to serve Pakistan Steel Mills. Since then, it has evolved into a multi-purpose deep-sea port with specialized terminals for containers, liquid bulk, LNG, coal, edible oil, chemicals, and general cargo. Over time, Port Qasim has developed into a major industrial and logistics hub with an extensive industrial zone accommodating power plants, steel manufacturing, automotive assembly, and chemical industries, thereby playing a critical role in Pakistan's energy security and economic development.[4]

Today, Port Qasim handles a substantial share of the country's seaborne trade and operates on a 24-hour basis with modern navigational aids, pilotage services, and channel management systems. The port is connected to the national highway and railway network, enabling efficient cargo movement to inland commercial and industrial centres. Within the port, DP World's Qasim

[1] Sardar, T. (2025, June 2). Pakistan's ports: A Modernization Drive for global trade. Freyt Consol. https://freytconsol.com/news/pakistans-ports-a-modernization-drive-for-global-trade/?utm_source=chatgpt.com
[2] Port Qasim Authority
[3] Port Qasim Authority
[4] Port Qasim Authority

International Container Terminal (QICT) operates as one of the leading container handling facilities under a concession agreement with PQA and contributes significantly to containerized trade.[5]

Despite ongoing development and infrastructure expansion, Port Qasim continues to face operational and environmental challenges associated with increasing cargo volumes and the global trend toward larger container vessels. Sedimentation within the navigation channel and berth pockets requires periodic dredging to maintain the necessary draft for safe vessel navigation and berthing operations. Furthermore, given the date of establishment, certain existing terminal infrastructure was not originally designed to accommodate modern large container vessels or high-capacity quay cranes, which can limit operational efficiency during periods of high traffic. Marine construction and dredging activities within the port area also require careful environmental management to control turbidity, protect marine water quality, and minimize potential impacts on benthic habitats and the mangrove ecosystems associated with the Indus Delta. Furthermore, the presence of extensive industrial activities within the port area necessitates strict environmental management to address issues related to air emissions, wastewater discharge, waste handling, and occupational health and safety.

In response to these operational challenges and the increasing demand for efficient container handling infrastructure, infrastructure enhancement initiatives are being planned within the port area. Alongside the detailed capital dredging project proposed by Port Qasim Authority, small scale initiatives are also being undertaken by different operators, where one such initiative is the QICT T1 Quay Wall, Dredging & Equipment Works Project, which aims to upgrade the existing Terminal 1 infrastructure at Qasim International Container Terminal.

1.2 Project Overview

The primary objective of the proposed development at Qasim International Container Terminal (QICT) Terminal 1 is to modernize and strengthen the existing marine infrastructure to ensure safe, sustainable, and future-ready port operations under the jurisdiction of Port Qasim Authority. The proposed interventions involved here include:

- Construction of a new quay wall, 6 m seawards in front of the existing quay wall (spanning the width of the existing quay wall, i.e., 712 m)
- Dredging of berth pockets to approximately 16 m depth
- Installation of scour protection
- Ground improvement works, excavation, and backfilling
- Construction of apron roads, walkways, lighting, and fencing
- Construction and installation of utilities and infrastructure services systems, including but not limited to water supply, firefighting, stormwater drainage, electrical, sewerage, surface drainage
- Installation of 6 new high-capacity Ship to Shore (STS) cranes suitable for modern large container vessels, along with the safe commissioning and disposal of 6 existing cranes.
- Modernization of quay side infrastructure, including crane rails, bollards, fenders, safety ladders, and associated utilities (electrical, MEP, and firefighting supply lines) to meet current operational and safety requirements.

Whilst the interventions proposed are localized and relatively small in comparison to other activities taking place in the navigational channel, the project is proposed to significantly enhance berth capability, improve crane productivity, reduce operational and structural risks, and ensure alignment with international standards for marine terminal design and operation.

A map of the project area, along with an overview of the proposed interventions area is provided below:

[5] Qasim Port: Port Operations: DP World (https://www.dpworld.com/en/ports-terminals/pakistan/qasim)

Figure 1.1 – Project Location

Figure 1.2 – Project Area Map

1.3 Project Proponent[6]

DP World is a leading global provider of integrated logistics and supply chain solutions headquartered in Dubai, United Arab Emirates. The company specializes in port terminal operations, logistics services, maritime services, and free trade zone development. Established in 2005, DP World operates a global network of ports, terminals, logistics parks, and economic zones across multiple regions including Asia-Pacific, the Middle East, Europe, Africa, and the Americas. Through its extensive logistics network, the company facilitates international trade by enabling the efficient movement of cargo between global markets.

DP World operates a wide portfolio of container terminals and logistics infrastructure, handling millions of containers annually and serving global shipping lines through advanced port operations and modern cargo-handling systems. The company emphasizes operational efficiency, safety, and sustainable development by integrating advanced technologies, modern infrastructure, and environmentally responsible practices into its global operations.

In Pakistan, DP World operates the Qasim International Container Terminal (QICT) located at Port Qasim, Karachi, under a concession agreement with the Port Qasim Authority (PQA). QICT is one of Pakistan's major container handling terminals and plays a critical role in facilitating the country's containerized trade. The terminal provides container handling services for international shipping lines and supports Pakistan's import and export activities by connecting the country to global maritime trade routes.

QICT operates multiple container berths equipped with modern cargo-handling equipment, yard management systems, and terminal operating systems designed to ensure efficient container handling and vessel turnaround. The terminal is strategically located within the Port Qasim industrial and logistics hub, which hosts a wide range of industrial facilities including power plants, steel manufacturing units, and other industrial developments. This location enables efficient connectivity between maritime transport and inland transportation networks serving major commercial and industrial centres across Pakistan.

Over the years, QICT has contributed significantly to improving Pakistan's container handling capacity and port efficiency through investments in infrastructure development, operational modernization, and adoption of advanced port technologies. With the increasing growth of containerized trade and the global trend toward larger container vessels, continuous modernization of terminal infrastructure has become necessary to maintain operational efficiency and competitiveness.

1.4 Project Objectives

The primary objective of the proposed development at Qasim International Container Terminal 1 is to modernize and strengthen the existing marine infrastructure to ensure safe, sustainable, and future-ready port operations under the jurisdiction of Port Qasim Authority.

The project aims to enhance the structural integrity of the quay wall through a seaward extension to strengthen the structure and enable deeper water access. It also includes dredging of berth pockets up to 92 meters from the new quay edge to increase draft capability and accommodate larger, deeper-draft container vessels in line with evolving global shipping trends.

A key component of the redevelopment is the installation of six (6) new high-capacity Ship-to-Shore (STS) cranes suitable for modern large container vessels, along with the safe decommissioning and disposal of six existing cranes. The project further includes modernization of quay-side

[6] DP World

infrastructure, including crane rails, bollards, fenders, safety ladders, and associated utilities (Electrical, MEP and Firefighting supply line) to meet current operational and safety requirements.

Overall, the proposed scope will significantly enhance berth capability, improve crane productivity, reduce operational and structural risks, and ensure alignment with international standards for marine terminal design and operation.

1.5 Need for ESIA

The Sindh Environmental Protection Act -2014 is the governing environmental law for the proposed project, with the Sindh Environmental Protection Agency (SEPA) as the governing authority for environmental matters pertaining to the project.

The need for this ESIA is warranted as per Section 17 of the Sindh Environmental Protection Act, 2014, which states:

"No proponent of a project shall commence construction or operation unless he has filed with the Agency an Initial Environmental Examination or Environmental Impact Assessment and has obtained from the Agency approval in respect thereof."

Furthermore, the Review of Environmental Assessment Regulations 2021 of SEPA also provides the necessary details pertaining to the preparation, submission, and review of different environmental assessments, including ESIA reports. The categorization of the proposed project falls under the following category defined in the regulations:

Schedule III – Projects Requiring an EIA
Category E – Transport
Sub-Category (3) - Ports & Harbor Development

1.6 Objective of ESIA

The prime objective of the ESIA study is to identify and assess the anticipated impacts and risks of the proposed project, and to accordingly recommend adequate mitigation measures to prevent/ minimize the identified impacts on the surrounding physical, biological, and social environment. This is done through adopting changes and practices, which ameliorate the environmental and social performance of a project during its different stages (pre-construction, construction, and operation).

More specifically, other associated objectives of this ESIA are to:

- Facilitate QICT in ensuring the environmental and social sustainability of the project.
- Establish a baseline of the existing environmental and social conditions in the project area prior to project initiation, by collecting secondary and primary data/ information on physical, biological, and socio-economic conditions.
- Identify potentially significant environmental and social impacts (positive and negative) during the different stages of the project.
- Conduct, record, and report public consultations and participation with major stakeholders; and
- Devise an Environmental and Social Management Plan (ESMP) for all stages of the project as a tool for the implementation of the suggested measures, along with a monitoring and evaluation mechanism with adequate resources including capacity building of the implementing agencies.

1.7 Approach & Methodology

The detailed approach & methodology used for this ESIA is given below:

1.7.1 Literature Review

Before mobilization, a desktop study was conducted, involving the collection and review of guidelines, data, and reports relevant to the project. This included: (a) an examination of applicable environmental legislation (b) analysis of Google Earth satellite imagery; (c) relevant design information provided by the client and design consultant; and (e) references to ESIA documents from similar projects.

This review encompasses various aspects, including previous studies, regional environmental data, socio-economic analyses, and documentation of similar projects in Pakistan and internationally.

1.7.2 Review of Environmental Laws & Institutional Requirements

A thorough review of environmental laws and institutional requirements is essential to ensure compliance with legal frameworks governing environmental and social impacts in Pakistan. This review includes national, provincial, and local regulations that pertain to the proposed expansion activities. All such laws and legislations related to the proposed project have been discussed in detail in chapter 3 of this ESIA.

1.7.3 Analysis of Alternatives

The analysis of alternatives is an important component of the ESIA process, undertaken to evaluate different project options, and identify the most feasible and environmentally acceptable solution. This analysis included the consideration of the “No Project” alternative, as well as alternative designs, technologies, and operational approaches where applicable. The purpose of this exercise is to compare potential environmental and social implications of each option and to support the selection of a preferred alternative that minimizes adverse impacts while meeting project objectives. Details of the alternatives considered are discussed in Chapter 4 of this ESIA report.

1.7.4 Area of Influence (AOI)

For conducting the Environmental & Social baseline surveys and for defining the boundaries within which project related impacts are anticipated, the Area of Influence of the project has been defined as:

A radius of 500 meters from the boundaries of the proposed project interventions, including on shoare and off shore interventions.

This AOI has been selected based on the nature of the proposed interventions, and the foreseeable impacts that would arise from these interventions on the Valued Environmental Components (VECs) in the area. A visual depiction of this is also provided below:

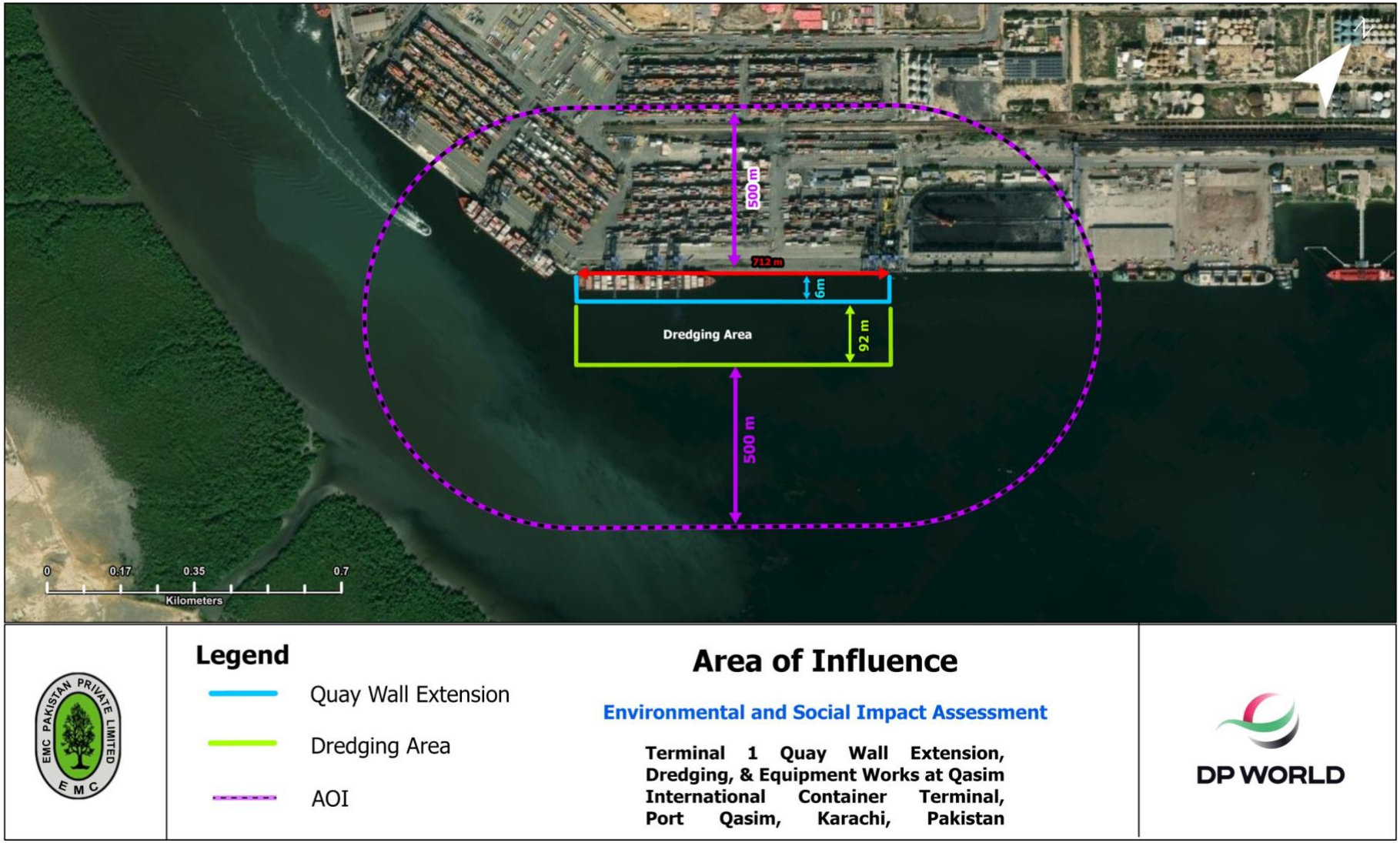


Figure 1.3 - Area of Influence

1.7.5 Environmental & Social Baseline Surveys for the Project

Baseline surveys are essential for establishing the current environmental and social conditions within the project area. These surveys provide a reference point against which potential impacts can be assessed, enabling the identification of significant changes resulting from project activities. Prior to the start of field activities, comprehensive checklists, proformas, and maps were developed covering the following main parameters:

A) Physical Environment

The information required for the establishment of the physical baseline included the following parameters:

- Land Resources (including land use pattern, soil composition, soil erosion, etc.)
- Bathymetry
- Sub-soil investigations within the sea
- Climate data (including temperature, rainfall, humidity, wind speed, and direction, etc.)
- Ambient air quality and noise levels monitoring data

C) Socio-Economic Environment

- Identifying significant cultural and historical sites within the project area, ensuring that potential impacts on heritage are recognized and addressed (if any)
- Mapping existing land uses within the project area, including agriculture, residential areas, and natural habitats, to assess potential conflicts with project activities.
- Identifying key stakeholders, including community leaders, local organizations, and government authorities, to facilitate effective engagement throughout the ESIA process.

1.7.6 Stakeholder Consultation

Extensive stakeholder identification and consultations were also conducted for the project. The project stakeholders were identified during the inception/ scoping stage and meetings were conducted with them to receive feedback on the anticipated environmental and social issues related to the project impacts and suggested mitigation measures. Meetings were carried out with relevant departments to discuss the issues/ constraints and get their views and feedback to mitigate the potential environmental and social impacts associated with the implementation and operation of the project. Letters were also written to the concerned departments through the clients for communication and feedback on the project.

1.7.7 Impact Assessment & Mitigation Measures

The impact assessment process for the subject project involved evaluating potential environmental and social impacts, identifying both negative and positive effects to develop appropriate mitigation measures aimed at minimizing adverse outcomes. Baseline data, stakeholder consultations, and expert input were analyzed to identify impacts associated with project activities such as construction, operation, and decommissioning. Each identified impact was assessed for significance, considering factors like magnitude, duration, and likelihood of occurrence, which helped prioritize the impacts requiring mitigation.

The assessment also included a detailed evaluation of the nature, extent, location, timing, and duration of potential impacts. Severity was determined by correlating the impacts to the project's location, design, construction, and operational stages, taking into account the sensitivity of the receptor. Based on predictions and public consultations, the ESIA team screened adverse

environmental and social impacts for inclusion in mitigation measures and the Environmental and Social Management Plan (ESMP).

1.7.8 Environmental & Social Management Plan

An ESMP has also been prepared to ensure the adequacy and effectiveness of the proposed measures by clearly identifying the roles and responsibilities of the agencies responsible for implementation, monitoring, and auditing of ESMP activities, existing and suggested framework, necessary approvals, training needs and the required further studies. It includes an organizational setup, a monitoring mechanism, monitoring plan along with frequency of monitoring activities, and method for data collection and environmental monitoring, ecological and social component/ social mitigation measures were introduced as part of the ESMP.

1.8 Report Organization

This report contains nine chapters, where the contents of each chapter are described as follows:

Table 1.1 - Report Organization

Chapter No.	Title	Description
1.	Introduction	Provides an introduction to the project and the assessment; the underlying objectives, the need, and the methodology followed.
2.	Project Description	Furnishes an overall description of the project, including its background, features, key components, and anticipated timelines.
3.	Review of Pertinent Legislations	Elaborates upon the current applicable legal framework on the project with respect to environment and sustainable development, including national and provincial requirements
4.	Analysis of Alternatives	Presents the evaluation of potential feasible alternatives, including the “No Project” option and other possible design or technological alternatives
5.	Description of Baseline Conditions	Details the existing conditions with respect to physical, ecological, and socio-economic baseline within the project area
6.	Anticipated Impacts & Mitigation Measures	Elaborates upon the likely impacts of the project on the physical, biological, and socio-economic environemnt during the construction and operational stages of the project, along with the proposed mitigation measures to mitigate potentially adverse impacts
7.	Stakeholder Consultations	Provides a summary of the consultations carried out with relevant stakeholders for the project, along with their suggestions and observations on the project
8.	Environmental & Social Management Plan	Outlines the framework for the adoption and implementation of the identified mitigation measures, along with the responsibilities of the different parties involved
9.	Conclusion & Recommendations	Summarizes the findings of the assessment and provides recommendations accordingly

2 Project Description

This chapter provides further details on the project, including the interventions planned, their sequencing for implementation, and the overall objectives.

2.1 Project Overview

The proposed project involves the extension and modernization of Terminal 1 at Qasim International Container Terminal (QICT), located within Port Qasim, Karachi. The project is being undertaken by QICT to enhance the operational capacity of the terminal and accommodate larger container vessels in response to increasing containerized trade.

As can be seen from Figure 2.2, the project involves a 6 m seaward extension of the existing quay wall for the development of a new quay wall (with a width of 712 m), dredging of berth pockets up to 16 m next to the new quay wall, and installation of 6 new high-capacity ship-to-shore (STS) cranes, and associated infrastructure works. These upgrades will improve cargo-handling efficiency, reduce vessel turnaround time, and allow the terminal to handle larger vessels. Upon completion, the container handling capacity of Terminal 1 is expected to increase from approximately 730,000 Twenty-Foot Equivalent Units (TEUs) to about 1.2 million TEUs annually.

2.2 Need for Project

Currently, the existing infrastructure at Terminal 1 of Qasim International Container Terminal (QICT) faces operational, structural, and capacity-related constraints. Although the terminal continues to function, the proposed project has become necessary due to the following reasons:

1. **Lack of Available Draft**: The lack of available draft at Terminal 1 (which is currently approximately 12.5 m), limits the terminal's ability to handle modern deep-draft container vessels which now require 14-16 m draft. Along with restricting vessel size and cargo intake, the shallower draft also adversely affects safety margins, particularly for navigation in silt-prone zones, manoeuvring during berthing, tug operations, and adverse weather conditions.
2. **Global Trends & Maintaining Competitiveness**: Given that larger vessels requiring deeper drafts are now becoming the industry standard, maintaining a shallower draft is inconsistent with the needs of modern container shipping. Coupling this with the availabiity of deeper drafts across neighboring regional ports, without any depth enhancement, Port Qasim risks the loss of declining competitiveness amongst regional trade networks.
3. **Improvements in Safety**: Improving safety conditions at Terminal 1 is one of the major drivers for the proposed interventions, where this is incorporated in different aspects of the project accordingly:
    - The proposed seaward extension of the quay wall aims at improving overall structural integrity, supporting wider crane rail gauges, accomodating heavier modern cranes, and improving berth alignment.
    - Deeper berth pockets, as proposed in the project, provides adequate Under-keel clearance, supports larger berthing forces, ensures safety in shallow water hydrodynamics, and improves tug manoeuverability
    - Dredging the area next to the new proposed quay edge ensures adequate water depth for vessel hull dimensions, alignment with berthing envelopes, and reduced risk of propeller wash impacts on quay infrastructure
4. **Operational Improvements**: The project through its proposed interventions is anticipated to:
    - Increase productivity where larger vessels with higher TEUs can be accomodated, reducing the number of overall vessels required, reducing yard congestion, and minimizing anchorage delays.

- With the increased depths, vessels can operate independent of tidal constraints resulting in increased turnaround times, improved scheduling, and reduced congestion at acnhorage points

5. **Aged Infrastructure:** With Terminal 1 built in 1981, the infrastructure is aged and unsuited to cater to modern demands, including crane rail deflections and alignment inconsistencies caused by settlement and aging foundations, ground settlement and reduced structural resilience, limiting load bearing performance, and operational risks associated with aging crane assets.
6. **Improved Financial Synergies:** With the advent of the proposed interventions, QICT and Port Qasim can attract modern, higher capacity vessels, alonside lowering logistics costs (through reducing transshipment dependency, feeder costs, and transit times for exporters and importers), overall improving Pakistan's competitiveness in global trade.
7. **Improved Energy Efficiency & Reduced Emissions**: Potentially handling larger vessels at the berths would improve fuel efficiency per TEU, and result in lower emissions per container moved.

As Pakistan's trade volumes grow and global shipping trends move towards larger, deeper draft vessels, Port Qasim's competitiveness is increasingly dependent on its ability to support modern ship sizes and technologies. Terminal 1, designed in 1981, was not originally designed to handle modern super-post-panamax vessels or heavier, higher-capacity quay cranes required for them. The quay structure, foundations, and rail systems are approaching the end of their serviceable life, resulting in operational constraints and safety concerns.

Upgrading Terminal 1 is therefore essential not only for QICT but also for the wider Pakistan logistics corridor, which depends heavily on Port Qasim for import and export flows.

2.3 Project Location

Port Qasim lies approximately 35–50 km southeast of Karachi and serves as one of Pakistan's principal deep-sea ports, facilitating a substantial share of the country's maritime trade. The port provides access to international shipping routes through a navigation channel connecting the inner harbor with the Arabian Sea and supports a wide range of cargo handling activities including containers, bulk cargo, and liquid cargo. QICT is situated within the Port Qasim industrial and logistics complex, which is located along the Phitti Creek channel system in the Indus Delta region on the Arabian Sea coast.

The proposed project will be implemented specifically within the existing operational area of QICT Terminal 1, where container berthing and cargo-handling activities are already established. The development works—including quay wall extension, berth pocket dredging, and installation of new Ship-to-Shore (STS) cranes—will be carried out within the existing terminal boundary and the adjacent marine area along the berth line.

The location of the proposed project within Port Qasim and the Terminal 1 operational area is illustrated in Figure 2.1 below.

Figure 2.1 - Project Location Map

Figure 2.2 - Project Area Map

Figure 2.3 - Project Schematic Map

2.4 Existing Terminal Infrastructure

Established in the 1980s, Terminal 1 of the Qasim International Container Terminal (QICT) forms one of the main container handling berths within Port Qasim and is equipped with the necessary marine and cargo-handling infrastructure required for container terminal operations. The terminal includes quay-side structures, berthing facilities, cargo-handling equipment, and associated operational infrastructure that support vessel berthing and container handling activities.

The existing quay wall at Terminal 1 serves as one of two primary marine structures for container vessel berthing. This structure provides the operational interface between vessels and quay-side cargo-handling equipment. The berth area includes mooring facilities such as bollards, fender systems, and access ladders, which support safe vessel berthing and personnel access.

The current berth pocket depth at Terminal 1 is approximately 12.5 meters, which defines the navigational depth available for vessels calling at the berth. The berth area is supported by associated quay-side infrastructure, including crane rail systems, service corridors, and operational access areas.

Cargo-handling operations at Terminal 1 are supported by six (6) Ship-to-Shore (STS) cranes, which are used for loading and unloading containerized cargo from vessels. In addition to quay-side equipment, the terminal also includes container storage yards, internal road networks, and supporting operational facilities required for container handling and movement within the terminal. The terminal currently has an estimated container handling capacity of approximately 730,000 TEUs per year, supported by the existing quay infrastructure, cargo-handling equipment, and terminal operational systems.

2.5 Project Components

The components involved under the proposed project are defined below:

2.5.1 Quay Wall Extension

The proposed project includes the construction of a new quay wall, 6 m into the sea from the existing quay wall extension seawards of approximately 6 m with an approximate length of 712 meters at Terminal 1 of the Qasim International Container Terminal (QICT). The extension will be constructed seaward of the existing quay wall and will be structurally integrated with the current terminal infrastructure. This development is intended to strengthen the berth structure and enhance its capacity to support modern container terminal operations.

The new quay wall will be designed and constructed in accordance with international marine engineering standards and will incorporate structural elements such as marine piles, coping beams, anchor systems, and backfilling to ensure long-term stability and operational safety. The extension will increase the structural load-bearing capacity of the berth and enable the installation and operation of modern Ship-to-Shore (STS) cranes, which require wider crane rail gauge and stronger quay foundations.

The quay wall extension will be implemented in two construction phases to maintain operational continuity at the terminal. Phase 1 will involve construction of approximately 364 meters of the new quay wall, while Phase 2 will complete the remaining 364 meters, resulting in the total extension length of 712 meters. The phasing of project works has been depicted in Figure 2.3, and an overall outlook on the quay wall extension is provided below in Figure 2.4.

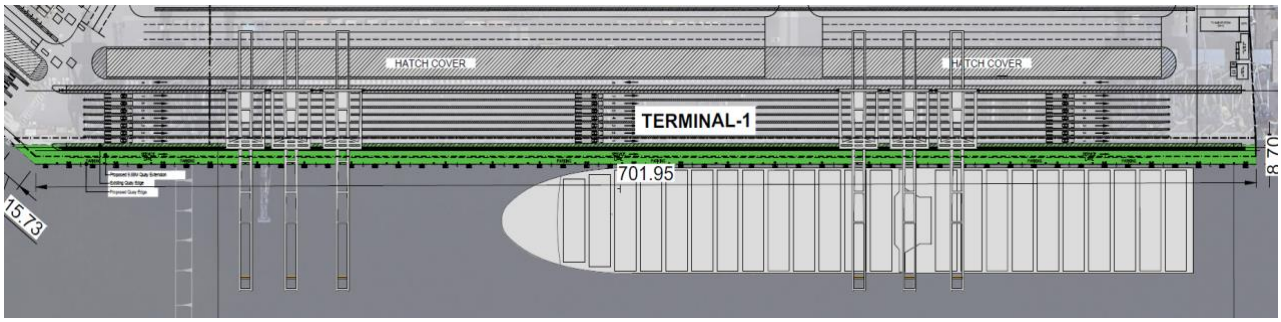


Figure 2.4 - Schematic Representation of Project

Further details on the sub-components involved under the quay wall extension works are highlighted below:

2.5.1.1 Structural Works

The quay wall extension will include several structural components designed to ensure long-term stability, durability, and operational safety. These works typically involve a combination of marine piling, structural reinforcement, and foundation stabilization measures.

Key structural components include:

1. **Pile Foundations**

Installation of marine piles driven into the seabed to provide structural support to the quay wall structure.

2. **Coping Beams**

Construction of reinforced concrete coping beams along the quay edge to provide structural continuity and support for crane rails and quay fixtures.

3. **Tie Rods and Anchor Systems**

Installation of tie rods and anchoring systems to stabilize the quay wall and resist lateral loads generated by soil pressure and vessel berthing forces.

4. **Backfilling and Ground Improvement Works**

Backfilling operations will be carried out behind the quay wall structure using suitable fill materials. Ground improvement measures

2.5.1.2 Quay-Side Infrastructure

Additional infrastructure will be installed along the quay edge to support safe vessel berthing and cargo operations. These components are essential for ensuring safe mooring of vessels and efficient terminal operations.

These infrastructure elements include:

- Bollards for securing mooring lines of vessels
- Fender systems to absorb berthing impact energy
- Mooring accessories and safety fittings
- Access ladders and safety chains for safe personnel access
- Crane rail systems for the movement of Ship-to-Shore cranes

2.5.2 Berth Pocket Dredging

Dredging works will be undertaken within the berth pocket area adjacent to the proposed quay wall extension in order to accommodate modern container vessels with deeper draft requirements. The dredging activities will increase the existing berth pocket depth of approximately 12.5 meters to an operational depth of approximately 16 meters, allowing safe berthing and maneuvering of larger vessels calling at Terminal 1.

The dredging operations will involve removal of seabed sediments within the designated berth pocket area located seaward of the new quay wall alignment. This deepening will provide adequate under-keel clearance (UKC) for vessels during berthing and departure, thereby improving navigational safety and operational efficiency at the terminal.

As illustrated in Figure 2.4, the dredging footprint extends along the full length of the proposed quay wall extension and approximately 50–100 meters seaward from the quay edge. The estimated volume of dredged material is approximately 200,000–300,000 cubic meters, which will be removed using appropriate marine dredging equipment and disposed of at Port Qasim Authority (PQA) approved offshore disposal sites in accordance with regulatory requirements.

2.5.3 Ship to Shore (STS) Crane Installation

The proposed project includes the procurement and installation of six (6) new high-capacity Ship-to-Shore (STS) cranes at Terminal 1 of Qasim International Container Terminal (QICT). These cranes are designed to accommodate modern large container vessels and improve cargo-handling efficiency through increased lifting capacity, extended outreach, and enhanced operational performance. Prior to installation, the existing six STS cranes will be safely decommissioned, dismantled, and removed using specialized lifting equipment and in accordance with established safety procedures. Following this, the new, wider crane rails will be installed, following which, the new STS cranes will be installed along the quay wall. Following installation, the cranes will undergo testing and commissioning to ensure operational safety, performance reliability, and proper integration with the terminal operating system, thereby improving berth productivity and reducing vessel turnaround time.

A picture of how these cranes will look like is provided below:

Figure 2.5 - Typical STS Cranes

2.5.4 Supporting Infrastructure Works

In addition to the primary marine construction works, the project will include several supporting infrastructure improvements within the terminal area where these are described below:

2.5.4.1 Ground Improvement & Backfilling

Ground improvement measures, excavation, and backfilling activities will be carried out to ensure structural stability of the quay wall extension and supporting infrastructure. These works will improve the bearing capacity of the soil and ensure long-term durability of the quay structure.

2.5.4.2 Apron Roads & Walkways

Construction of apron roads, operational walkways, and access areas will be carried out along the quay wall. These facilities will enable safe movement of personnel, operational vehicles, and maintenance equipment within the terminal.

2.5.4.3 Utilities & Services

The layout of utilities and service infrastructure associated with Terminal-1 is presented in Figure 2.6. The layout illustrates the arrangement of electrical supply lines, fire-fighting pipelines, drainage systems, communication cables, and other supporting services required for safe and efficient terminal operations.

2.6 Development Methodology

The construction of the proposed Terminal 1 quay wall extension, dredging works, and installation of new Ship-to-Shore (STS) cranes will be carried out using standard marine construction practices under the supervision of qualified engineers and contractors. The works will be implemented in a phased manner to ensure continuity of terminal operations and to minimize disruption to vessel traffic and cargo handling activities at QICT.

The development process will begin with site mobilization and marine piling works, where pile foundations will be installed using specialized marine piling equipment to provide structural support for the new quay wall extension. Following pile installation, quay wall construction activities will be undertaken, including installation of coping beams, tie rods, anchor systems, and backfilling to form the structural framework of the quay wall. Concurrently or subsequently, dredging operations will be carried out within the berth pocket area to increase the existing depth to the required operational level. Dredging will be conducted using suitable marine dredging equipment, and the dredged material will be transported to designated offshore disposal sites approved by Port Qasim Authority.

After completion of the quay wall structural works and installation of crane rails and marine fixtures, the project will proceed with the removal of existing STS cranes and installation of six new high-capacity cranes. The cranes will be installed on the newly constructed rail system and will undergo testing and commissioning before becoming fully operational. The overall construction activities will be executed in two major phases, allowing portions of the upgraded berth to become operational while the remaining works are completed, thereby maintaining operational continuity at the terminal.

2.6.1 Marine Traffic & Navigation Management During Development Works

Marine construction and dredging activities associated with the proposed quay wall extension will be undertaken within an active port environment where continuous vessel movement occurs. Therefore, effective marine traffic and navigation management will be essential to ensure safe and uninterrupted port operations throughout the construction phase.

All marine works will be carried out in close coordination with the Port Qasim Authority (PQA) Marine Department. Daily coordination will be maintained through established port communication channels to align construction activities with vessel traffic schedules and operational requirements. Designated navigation routes, turning basins, and berth access areas will remain unobstructed at all times. Temporary construction zones will be clearly defined, marked, and communicated to relevant port authorities and vessel operators. Safety buffers will be maintained around dredging equipment, barges, and other marine construction assets to minimize the risk of interference with vessel movement.

All dredgers, barges, and support vessels will be equipped with appropriate navigation lights, signals, and communication systems in accordance with port and international maritime safety requirements. Real-time communication will be maintained between construction teams, port control, and vessel pilots to ensure safe maneuvering within the project area.

Where feasible, development activities—particularly dredging operations—will be scheduled to avoid peak vessel traffic periods in order to reduce congestion and navigational risks. In addition, a detailed Navigation and Vessel Traffic Management Plan will be developed in coordination with PQA prior to the commencement of marine works.

2.7 Project Implementation Schedule & Timeline

The implementation of the proposed Terminal 1 Quay Wall Extension, Dredging, and Equipment Works Project at Qasim International Container Terminal (QICT) will be carried out in a phased manner to ensure that terminal operations continue with minimal disruption during construction activities. The project will involve mobilization of construction equipment and personnel, marine civil works, dredging of the berth pocket, installation of cargo-handling equipment, and final testing and commissioning of the upgraded infrastructure.

To maintain operational continuity at the terminal, the construction works will be executed in two main phases, allowing portions of the upgraded berth to become operational while the remaining works are completed. As illustrated in Figure 2.3 the new quay wall extension will be constructed progressively along the existing Terminal 1 berth, where the phasing of project works is described below:

Phase 1 – Initial Quay Wall Extension and Equipment Installation (0–364 m)

The first phase will involve the construction of the initial section of the quay wall extension along approximately 0–364 meters of the berth line. The key activities during this phase will include:

- Construction of approximately 50% of the new quay wall extension
- Installation of crane rails and associated quay-side infrastructure
- Installation of four (4) new Ship-to-Shore (STS) cranes
- Localized dredging works adjacent to the completed quay wall section
- Removal and decommissioning of corresponding existing cranes
- Completion of this phase will allow part of the upgraded berth to become operational while construction continues along the remaining section.

Phase 2 – Completion of Quay Wall and Remaining Equipment Installation (364–712 m)

The second phase will involve the construction of the remaining 364–712 meters of the quay wall extension and installation of the remaining equipment. Major activities during this phase will include:

- Construction of the remaining section of the quay wall extension
- Installation of the remaining two (2) Ship-to-Shore (STS) cranes
- Completion of berth pocket dredging along the full quay wall length
- Installation of remaining marine fixtures and quay-side infrastructure
- Removal of the remaining existing cranes

Following completion of the construction activities, the project will proceed with testing, commissioning, and operational handover to ensure that the upgraded terminal infrastructure and cargo-handling equipment meet the required operational, engineering, and safety standards before full-scale terminal operations commence. The physical interventions associated with the development works are anticipated to be completed by July 2029.

2.8 Project Construction Workforce & Contractor Camps

2.8.1 Project Workforce

The construction and implementation of the proposed project will require skilled and semi-skilled manpower for civil works, marine construction, dredging operations, crane installation, and project supervision. The manpower requirement will vary depending on the project phase and construction activities being undertaken. Workforce deployment will be phased according to the two main construction stages and adjusted based on operational conditions and peak activity periods.

Table 2.1 Estimated manpower requirements

Activity	Estimated Personnel	Description
Civil & Marine Construction	100–200	Engineers, supervisors, skilled laborers, and marine crew for quay wall piling, structural works, backfilling, and marine construction support
Dredging Operations	30–40	Dredger operators, marine engineers, surveyors, and bathymetric monitoring staff
STS Crane Installation & Commissioning	40–60	Crane specialists, riggers, electricians, mechanical engineers, and commissioning technicians
Support Services	15–30	HSE officers, QA/QC personnel, logistics staff, and site management

The workforce will be managed by the appointed contractor, while a QICT supervisory team will monitor construction progress and ensure compliance with safety, environmental, and operational requirements. For the purposes of the project, it is estimated that an average of 80 persons will be required for the implementation works of the project.

2.8.2 Contractor Camps

Whilst it is not anticipated that contractor camps will be established under this project due to the availability of labor to Port Qasim. Neevrtheless, guidelines for the establishment of camp sites are provided below to ensure that the selection, establishment, and operation of these camps minimize negative impacts on the surrounding environment and communities. The contractor is responsible for identifying suitable construction camp sites, guided by the following criteria:

Land Acquisition & Resettlement

- Establishing contractor camps will not involve land acquisition or potential resettlement issues. If land needs to be rented, the contractor will negotiate terms directly with landowners, ensuring a written rental agreement is signed by both parties.

Distance from Settlements

- Camp sites should be located away from existing residential areas (if any) to minimize disturbances.
- A considerable buffer zone should also be maintained.

Proximity to Project Site

- Camp sites should be chosen close to the project area to ensure convenient access to main roads, facilitating efficient transportation of materials, machinery, and personnel.

Workforce Management

- Camp sites must not pose a threat to domestic or public water supplies, and care should be taken to prevent drainage from the camps from contaminating local water sources.
- The size of each camp site should be adequate to prevent overcrowding and ensure the availability of necessary facilities.
- Precautions should be taken to avoid damage to property, vegetation, irrigation systems, and drinking water supplies.
- Camp sites should be located in areas that are not prone to flooding and away from ecologically sensitive areas, such as wildlife habitats or protected lands.

Approval of Camp Sites

- The contractor, in consultation with the QICT Team, will select the final locations of the contractor camps, where the same will be communicated to PQA also.

2.9 Utilities Requirements

It is pertinent to understand that the utility requirements reported below are in line with the assumption that camps are established. Should camps not be established, then the following utility requirements will not be applicable (barring electricity).

2.9.1 Water Demand & Source

In this section, the water demand for construction stage is assessed and reported, along with the potential source for this water, where potable water will be required for consumption purposes at the camp site. Dedicated water supplies will be stored for firefighting purposes and emergency response needs adequately in line with the fire risk at the site during construction.

The source of water during the **construction** phase will be from water tankers. The WHO defines between 50 and 100 litres of water per person per day[7] are needed to ensure that the most basic needs are met, and no health concerns arise. In this case, considering the higher end of the spectrum for the project, where each worker will require 100 litres/day, the water consumption is estimated to be over 8,000 litres /day for 80 construction workers.

2.9.2 Wastewater Generation

[7] UN – Water Decade Programme on Advocacy and Communication and Water Supply and Sanitation Collaborative Council

The estimated wastewater generation during the **construction phase** for 80 workers is estimated at 6,400 litres/day[8] from the construction camps. Septic tanks will be constructed to provide primary treatment after which the wastewater will be discharged from the site.

2.9.3 Solid Waste Generation

Due to the construction activities, waste will be generated at the construction sites and contractor camps. The excavated materials will be reused where applicable for construction purposes. Solid waste generated during construction and camp operations shall be safely disposed of in the operating landfill site. Considering 0.5 kg/capita/day of solid waste generated, the estimated solid waste generation is considered to be 40 kg/day for 80 workers during the construction phase.

2.9.4 Electricity

To fulfill the electricity requirement at the project site the following sources are used, where the estimated consumption is also reported:

Phases of the project	Electricity Source
Construction Phase	two kVA Diesel generator sets and 03 X15 kW Portable generators

[8] Design criteria of Public Health Engineering for Water Supply, Sewerage, and Stormwater Drainage (Domestic sewage generation = 80% of water consumed/ day)

3 Policy, Legal, & Regulatory Framework

This chapter provides an overview of the policy framework and legislation that presents requirements with respect to the environmental and social aspects of the proposed project's implementation. The project needs to comply with all the applicable environmental policies, laws, guidelines, and acts of the Government of Pakistan and the Government of Sindh and international best practices.

3.1 Environmental & Social Regulatory Authorities in Sindh

The key provincial regulatory authorities that are tasked with implementing the applicable environmental and social policies are listed below:

Table 3.1 - Functions of Sindh's Environmental and Social Regulatory Authorities

Organization	Functions/ Role
Sindh Environmental Protection Agency (SEPA)	• Regulating environmental issues • Reviewing and checking environmental assessment reports prepared as per the legal requirements • Environmental approvals of the project • Ensuring compliance and reviewing the performance of environmental management plans implementation
Sindh Labor & Human Resources Department	Guaranteeing the rights of workers like the right to organize, the right to collective bargaining, participation in the affiars of the implementing agency, health & safety, minimum wags, compensation, etc. are followed in the project
Sindh Social Welfare Department & Women Development Department	• Transformation of the government into an organization that actively practices and promotes gender equality and women empowerment • Mainstreaming gender equality perspectives across public policies, laws, programs, and projects by departments and agencies of the government with a focus on women empowerment • Looking after various margnizalized segments of population such as persons living below the poverty line, people with disabilities, orphans, victims of violence (specially women) to ensure their welfare and support

3.2 Summary of Relevant Strategies, Policies, Acts, & Legislations

A summary of the major relevant strategies, policies, Acts, and legislation pertinent to the project with respect to environment and social aspects are highlighted below:

Table 3.2 - National Laws & Legislations

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
1.	**National Conservation Strategy, 1993**	Under this strategy, the project requires to be executed in such a way that it has approach towards promoting sustainable development, conserving and managing natural resources.	The proponent of this project will protect, conserve, and restore the environment along the project area by providing mitigation/ compensation measures	
2.	**National Environmental Policy,2005**	The National Environmental Policy aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life for the citizens through sustainable development.	The proponent of this project will protect, conserve and restore environment at the project site by providing mitigation / compensation measures.	
3.	**National Climate Change Policy, 2021**	Pakistan developed its first National Climate Change Policy (NCCP) in 2012, which was updated in 2021. The focus of the NCCP-2021 is on adaptation and mitigation, with a major emphasis on nature-based solutions.	Relevant as it defines the different ways projects must inbuild sustainability into their design and development	Ensure that the project includes precursors for sustainability and sustainable development
4.	**National Climate Change Policy, 2021**	The policy highlights the vulnerabilities of various sectors to climate change and outlines appropriate adaptation measures. These measures cover sectors such as water, agriculture, forestry, coastal areas, biodiversity, and other vulnerable ecosystems. Despite Pakistan's small contribution to global greenhouse gas (GHG) emissions, its role as a responsible member of the global community in combating climate change is emphasized, particularly through mitigation efforts in energy, transport, forestry, and agriculture. Additionally, the policy incorporates disaster preparedness, capacity building, institutional strengthening, technology transfer, and international cooperation as important components.	Focuses on reducing GHG emissions, particularly in the energy and transport sectors, contributing to Pakistan's climate change commitments.	Ensure that the project is developed, prioritizing minimal GHG emissions and employing methods to reduce these to the extent possible. The objectives of this policy are being met under this project, as the cranes being replaced are being replaced with more carbon friendly equipment.
5.	**National Gender Policy Framework, 2022**	Ministry of planning, development and special initiatives, Government of Pakistan has launched National Gender Policy Framework on 8th March 2022 with an objective for year 2022-25 to accelerate progress towards equality between women and men by bringing gender equality goals and women's perspectives to the center of policy related decision making in all sectors. The Government of Pakistan aims to achieve a gender-responsive society where women and men equally contribute to, and benefit from development, and this shall be done through promotion of gender perspective in all	The policy is applicable to the project to ensure and encourage inclusion of all genders in all stages of the project and eliminate, discrimination, violence against women and girls in all its manifestations and removal of socio-cultural impediments that hinder travelling to desired places.	Ensure no discrimination is carried out in the employment of persons for the project

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		policies and programs, understanding the prospective impact on women and men respectively, before rolling out the programs.		
6.	**Pakistan Climate Change Act, 2016**	The Prime Minister of Pakistan established Pakistan Climate Change Council which coordinates and supervises the enforcement of the provisions of the Act, monitor implementation of the international agreements relating to climate change, approve and monitor implementation of comprehensive adaptation and mitigation policies, strategies, plans, programs, projects and other measures formulated by the authority to meet Pakistan's international obligations, monitor the implementation of National Adaptation Plan and its constituent provincial and local adaptation action plans, approves guidelines for the protection and conservation of renewable and non-renewable resources, species, habitats and biodiversity adversely affected or threatened by climate change.	The Act is applicable to proposed project as the proposed project involves the solid waste management activities that may contribute to generation of greenhouse gases.	Requires compliance with local EPA and its requirements
7.	**Antiquities Act, 1975**	The Antiquities Act, 1975 (amended in 1990) states the following: "Ancient" is any object that is at least 75 years old. All accidental discoveries of artefacts must be reported to the Federal Department of Archaeology. The Government is the owner of all buried antiquities discovered on any site, whether protected or otherwise. All new construction within a distance of 200 feet from protected antiquities is forbidden. No changes or repairs can be made to a protected monument, even if it is owned privately, without approval of the responsible authorities; and The cultural heritage laws of Pakistan are uniformly applicable to all categories of sites regardless of their state of preservation and classification as monuments of national or world heritage.	Although no antiquity site has been identified within the proposed AoI. However, the law will be applicable to the Project mainly due to its two provisions: According to the law, any construction activity within 61 m or 200 ft. of protected antiquities, are prohibited. The provisions of this Act would also be applicable, if any accidental archaeological discoveries may occur during the excavation works for the construction of proposed Project.	Should there be an identified antiquity lying within 200 feet of one of the project sites, then approval must be obtained from the culture and heritage department. Further during project execution, on account of discovery of any archaeological remains, antiquities department to be intimated promptly.

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
8.	**Pakistan Penal Code, 1860**	The Code deals with the offences where public or private property or human lives are affected due to intentional or accidental misconduct of an individual or organization. The Code also addresses control of noise, noxious emissions, and disposal of effluents.	The provisions of the Penal Code, 1860 are applicable to the Project in terms of penalties for effecting human lives and public property. It also addresses the control of noise, air emissions and effluent disposal.	Requires adherence to the law of the land, where it defines the need to comply with aspects affecting the environment and other humans.
9.	**Protection against Harassment of women at the workplace Act, 2010**	The Protection Against Harassment of Women at the Workplace Act (2010) refers to sexual harassment at the workplace.	This Act will be applicable to the Project if women are employed for the construction of the proposed Project.	Ensure that women are not harassed at workplaces.
10.	**Labor Laws as part of Constitution of Pakistan, 1973**	The Constitution of Pakistan contains a range of provisions with regards to labor rights, in particular: Article 11 of the Constitution prohibits all forms of slavery, forced labor and child labor. Article 17 provides a fundamental right to exercise the freedom of association and the right to form unions. Article 18 proscribes the right of its citizens to enter upon any lawful profession or occupation and to conduct any lawful trade or business. Article 25 lays down the right to equality before the law and prohibition of discrimination on the grounds of sex alone; and Article 37(e) makes provision for securing just and human conditions of work, ensuring that children and women are not employed in vocations unsuited to their age or sex, and for maternity benefits for women in employment. Labor law is controlled at both provincial and national levels with compulsory employment agreements containing the terms set out by the labor laws. The labor laws are a comprehensive set of laws in Pakistan dealing with the following aspects:	The labor laws are relevant as it would deal with employment of labor for the construction of proposed Project. Following are the major labor laws which are applicable to the Project: Sindh Workers Compensation Act 2015 Sindh Minimum Wage Act 2015 Sindh Terms of Employment (Standing Orders) Act 2015 Sindh Bonded Labor System (Abolition) Act 2015 Sindh Payment of Wages Act 2015 Sindh Occupational Safety & Health Act 2017 Sindh Factories Act 2021	Requires that the labor regulations defined therein are complied with during project implementation.

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		Contract of Employment. Termination of Contract. Working Time and Rest Time. Working hours. Paid Leave. Maternity Leave and Maternity Protection. Other Leave Entitlements. Minimum Age and Protection of Young Workers. Equality Pay Issues. Workers' Representation in the Enterprise. Trade Union and Employers Association Regulation; and Other Laws.		
11.	**National Disaster Management Act, 2010**	National Disaster Management Act, 2010 was passed by Parliament of Pakistan in 2010. The Act applies to whole Pakistan. The Act was passed in backdrop of 2010 Floods in Pakistan and strengthens Disaster Management system.	This Act is applicable as proper mitigation measure will be adopted by technical consultant during design stage to offset any chances of disaster to existing project area, including quay wall along the East Wharf	Requires that the project design take into account the previous intake and data on any national disasters.
12.	**Building Code of Pakistan, 2007**	The provision of Building Code of Pakistan shall apply for engineering design of building like structure and related components. The construction in violation of the building code shall be deemed as violation of professional engineering work. Moreover, a certificate for the proposed action will be obtained from Provincial Building Control Authority.	These codes shall be used in structural design of building area components constructed under this proposed Project.	Requires that the codes defined therein are used in the construction of any buildings constructed for the project.
13.	**The Criminal Law (Third Amendment Act, 2011)**	The Criminal Law (Third Amendment) Act 2011 was passed by the Parliament in 2011 and assented by the President on 16th December 2011. The Act amended relevant sections in the Pakistan Penal Code and Code of Criminal Procedures. The Amendment criminalized a number of customary practices such as giving women or girls in marriage for settling a dispute), forced marriage, marriage with the Holy Quran and depriving women of inheriting	This Act is applicable as the proposed project may involve the numbers of staff/worker having different religion, political affiliation, sect, colour, caste, creed, ethnic background.	Requires that workers of all different backgrounds, religions, cultures are treated the same without any discrimination.

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		property. All these offences are made non-compoundable and non-bailable under this Act.		
14.	**Gender Equality as part of the Constitution of Pakistan, 1973**	The Constitution of Pakistan contains a range of provisions regarding gender equality, in particular, provides the principle of equal rights and equal treatment to all citizens/ persons, without any distinction including on the basis of sex: Article 3 calls upon the State to eliminate all forms of exploitation. Article 4 provides for the right of individual to enjoy the protection of law and to be treated in accordance with the law. This applies to the citizens as well as "to every other person for the time being within Pakistan" without distinction. This article also clearly states that certain rights cannot be suspended. Article 25 ensures equality before the law and equal protection of the law and states that there shall be no discrimination on the basis of sex alone. Articles 25(3) and 26(2) allow the state to make special provisions for the protection of women and children. Articles 26 & 27 provide for equal access to public places and equality of employment in the public and private sector. Articles 11 & 37 (g) prohibit trafficking in human beings as well as prostitution. Article 32 makes special provisions for the representation of women in local Government. Article 34 directs the state to take appropriate measures to enable women to participate in all spheres of life and social activities. Article 35 asks the state to protect the marriage, the family, the mother, and the child.	The articles of laws Constitution of Pakistan are relevant as it would deal with employment of male and female labor having different religion, political affiliation, sect, colour, caste, creed, ethnic background for the construction of proposed Project.	Requires that women are not discriminated against for jobs during project implementation.

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		Article 37 (e) directs the state to make provisions for securing just and humane conditions of work ensuring that children and women are not employed in vocations unsuited to their age or sex, and for ensuring maternity benefits for women in employment. Articles 51 & 106 provide for the reservation of seats for women in the legislatures.		

Table 3.3 - Provincial Laws & Legislations

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
1.	**Sindh Strategy for Sustainable Development, 2007**	The Sindh Strategy for Sustainable Development (SSSD) proposes a ten- year sustainable development agenda for Sindh. Its purpose is to highlight the ecological, economic and social issues of the province and to provide recommendations and strategic actions to address them. The strategy promotes the sustainable use of natural resources to achieve the objectives of poverty alleviation and social development through the participation of the people of Sindh. It is a live document, which should evolve with the changing scenario. The strategy would be reviewed and revised every three years, incorporating lessons learned during implementation.	The project supports sustainable development by addressing the need for carrying out activities needed to cater for the increasing demand and supply of the country by making infrastructural interventions as necessary.	Ensure that development carried out includes incorporation of sustainability to the extent possible
2.	**Sindh Drinking Water Policy, 2017**	This policy is to provide safely managed drinking water whose supply is adequate, well maintained and sustainable; and to enhance public awareness about health, nutrition and hygiene related to safe drinking water. The basic objective of this policy is to introduce legislative measures and regulations to create an enabling framework for safely managed drinking water supply, regulation of water usage, extraction, treatment transportation and distribution.	There will be numerous workers working under the project, both during the construction and the operation stage, along with living at the site, where it will need to be ensured that people	Requires that people employed under the project are provided with clean drinking water for safe consumption
3.	**Sindh Water Policy 2023**	The Sindh Water Policy outlines a comprehensive strategy aimed at addressing the pressing challenges	Ensures the project's water usage is efficient and aligned with policy goals.	Ensures the project's water usage is efficient and aligned with policy goals.

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		surrounding water resources and their sustainable use. With increasing concerns over water scarcity, pollution, and climate change, this policy document seeks to establish a forward- looking framework that promotes efficient water management, conservation, and equitable distribution. The overarching goal of this policy is to ensure a secure water supply for present and future generations while preserving aquatic ecosystems and fostering socio-economic development.		
4.	**1st Sindh Labour Policy, 2018**	1St Sindh Labour Policy was introduced in 2018. The Major focus of the 1st Sindh labour policy, 2018 is to ensure the health and safety of workers at work place with guaranteeing living wages for all. As labour laws are mostly male centric, but this policy will address women labour issues, which include equal opportunities and equal remuneration in line with the International Labour Organization (ILO) conventions.	The policy is applicable to the project since labor will be employed for the project at various stages.	Ensure that labor dealing and handling is in line with the requirements of the policy.
5.	**Sindh Environmental Protection Act, 2014**	Sindh Environmental Protection Agency as a part of Sindh Act No. VIII of 2014 prepared Sindh Environmental Protection Act (SEPA), 2014 which was passed by the provincial assembly of Sindh on 24th February 2014 and asserted by the Governor of Sindh on 19th March 2014 and notified on 20th March 2014. It is a fairly comprehensive legislation and provides legislative framework for protection, conservation, rehabilitation, and improvement of the environment. It contains concrete action plans and programs for the prevention of pollution and promotes sustainable development. Act has 11 parts with 37 Sections followed by sub-sections and clauses. Part VI is related to the environmental examinations and assessments while part X is related to the public participation.	The proposed Project is located in Sindh so it falls under the jurisdiction of the SEPA that will be the responsible authority for governing the environmental compliance of the project with local guidelines.	Prior to project construction, an Environmental Impact Assessment must be conducted against which an approval has to be obtained from the department.
6.	**Sindh Environmental Assessment Regulations, 2021**	These regulations set out: • Key policy and procedural requirements for filing an EIA. • The purpose of environmental assessment. • The goals of sustainable development.	Defines the categories for different projects, where the type of study/ assessment required (Checklist, IEE, EIA) against each category of project is defined to fulfil local environmental compliance.	As per the categories defined, the following project falls into the category of an EIA based on: **Schedule III – Projects Requiring an EIA**

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		• The requirement that environmental assessment be integrated with feasibility studies. • The jurisdiction of the Provincial EPA and Planning & Development (P&D) Departments. • The responsibilities of proponents. • Duties of responsible authorities. • Provides schedules of proposals that the Project requires either EC, IEE, or an EIA. • The environmental screening process of the projects under schedule I, II and III; and The procedure for the environmental approval for filing the case with the Sindh EPA for the granting of the NOC.		*Category (D) – Transport* Port & Harbor Development
7.	**Sindh Environmental Quality Standards, 2016**	SEPA has formulated the Sindh Environmental Quality Standards (SEQS) as per Clause (g) of sub-section (1) of Section 6 of SEPA Act 2014. The SEQS were promulgated in 2016 which includes standards for liquid effluent, industrial gaseous emissions, ambient air, drinking water quality, noise levels and standards for motor vehicle exhaust, diesel vehicle, and petrol vehicles.	Defines acceptable standards for the construction and operation of different projects in Sindh with respect to ambient air quality, vehicular and exhaust emissions, drinking water quality, and effluent quality.	All projects to be implemented in Sindh must conform to SEQS during all the phases i.e., construction and operation.
8.	**Sindh Solid Waste Management Act, 2021**	The Sindh Solid Waste Management Act, 2021 enacted to establish a board for collection and disposal of all solid waste, to arrange effective delivery of sanitation services, to provide pollution free environment and to deal with other relevant matters. The Board established under the Act headed by the Chief Minister or his nominee and constitutes of thirteen other ex-officio members of other relevant departments.	This Act is applicable as the main Act of the implementing agency of the project. It will define the boundaries in which the project must take place, and continue operations in.	No requirements, only defines the ambit of SSWMB's operations.
9.	**Sindh Cultural Heritage (Preservation) Act, 1994**	This provincial Act empowers the Government of Sindh to preserve and protect any premises or objects of archaeological, architectural, historical, cultural, or national interest in Sindh by declaring them protected. Karachi alone has over 200 buildings declared as "Protected Heritage" by the Government of Sindh.	If a site is declared as a protected heritage, then no work may take place within 200 feet of that area.	None of the sites protected under this law has been identified within the RoW/ZoI of the proposed Project. Proponent will get NOC from Department of Culture, Tourism and Antiquities if any protected site is identified along the project.
10.	**Sindh Wildlife Protection, Preservation, Conservation and**	The Sindh Wildlife Protection, Preservation, Conservation & Management Act was enacted in September, 2020. The Act was passed to make provisions for protection, conservation, preservation, and sustainable use of wildlife	The project falls within the Port Qasim Area, in the area where QICT already carries out its operations.	The project is not located in any wildlife protected area therefore the contraventions of the act, other than ensuring no disproportionate impact

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
	Management Act, 2020	for establishment, management and maintenance of protected areas in the Province of Sindh. The Act introduces the establishment of a Council for protection and the Conservation of Wildlife, and other measures which guarantee and protect the rights and ensure safety of wildlife in the Province of Sindh.		falls on wildlife, will not be applicable to the project.
11.	**The Sindh Prohibition of Employment of Child Act, 2017**	Article 11(3) of the Constitution of Pakistan prohibits employment of children below the age of 14 years in any factory, mines, or any other hazardous employment. In accordance with this Article, the Prohibition of Child Employment Act (PCEA) 2017 disallow child labor in Sindh. The PCEA defines a child as a person who has not completed his/her fourteenth years of age, and an adolescent means a person who has completed fourteenth year of age but has not completed eighteenth years of his age. No child shall be employed or permitted to work in any establishment including construction, but an adolescent can be employed or permitted to work under strict guidelines provided in the PCEA and rules. An adolescent shall not be employed in any hazardous work included in the schedule to the PCEA.	The relevance of this Act to the Project will be to prohibit child employment for construction of the proposed Project.	Does not permit child labour during project construction or operation.
12.	**Sindh Factories Act, 2021**	The Act deals with regulations related to Project Area workers and workplace EHS requirements. The Factories Act also provides regulations with provision for general health and safety of the work force in their work area. Conditions are specified for clean workplace, toilets, waste handling, provision of drinking water quality, worker health and hygiene etc. Under the Act, no occupier of a factory shall be allowed to start manufacturing process unless he has obtained factory registration certificate from the Directorate of Labor. The Act does not allow a child below the age of 14 years to work in a factory in any case. The new Law restricts the employment of contractual labor in manufacturing process. The amendment 2021 is specifically related to the provision of safe transportation facility to women workers,	This Act is applicable for the Project workers as well as belonging community including men, adults, women, adolescent working in and near the construction industry (during construction phase).	Requires that the occupational health and safety, along with labor regulations defined therein are complied with during project implementation.

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		working hours and working periods of seasonal and whole year factories.		
13.	**Sindh Fisheries Ordinance, 1980**	This ordinance mainly regulates fishing in any public waters for any purpose. The regulated waters include the coastal areas and rivers. The section 8 of this ordinance specifically prohibits the dumping of untreated industrial or domestic sewage waste into a water body in Sindh, unless treated and made harmless for fish and other aquatic life	Ensure no disproportionate impact on the fisheries in the area, specially not through the use of any untreated sewage	Do not release any harmful or untreated effluent in any water body in the area
14.	**Sindh EPA Hazardous Substances Rules, 2014**	The rule describes the procedure of handling, transportation and disposal of hazardous substances and hazardous waste. General safety precautions for handling hazardous substances as well as safety precautions for workers, and notification requirements in the event of an accident are also described in these rules.	This rule is applicable to the proposed Project due to involvement of hazardous waste handling, use and disposal during different construction activities at the construction stage.	A separate approval must be obtained from the Sindh EPA if there is any permanent use of any of the hazardous substances that are listed in the Rules.
15.	**Sindh Minimum Wages Act, 2015**	To provide the regulation of minimum rates of wages and various allowances for different categories of workers employed in certain industrial and commercial undertakings and establishments.	This Act will be applicable to the Project to ensure that the minimum wages and allowances should be given to the Project labor (skill and unskilled employed for the construction of the proposed Project.	Requires that the project ensure that workers are not paid below the defined minimum wage.
16.	**Sindh Occupational Health & Safety Act, 2017**	The Act makes provisions for occupational safety and health conditions at all workplaces in the province for the protection of workers during work. Under the Act, an Occupational Safety and Health Council will be established in Sindh with secretary of Sindh government's Labor and Human Resources Department as its chairperson. The proposed council lays down penalties in case of death and injury due to violation. In case of death sub-section 01 of section 38 will accord 2 years' imprisonment or a fine of PKR 100,000 or both. Similarly, in case of injury the imprisonment may extend to six months or a fine up to PKR 20,000 or both.	The Act applies in any Project situation where worker's rights and protections are enforced. This law is applicable to construction and Project workers and will be complied during construction and operation phases.	Requires that the occupational health & safety regulations defined therein are complied with during project implementation.
17.	**Sindh Bonded Labour System**	The Act is gender sensitive; an anti-discrimination clause is added to each new proposed Law in accordance with ILO requirement viz: "No discrimination shall be made on	This Act is applicable as the proposed project may involve the numbers of staff/worker having different religion,	Bonded labour will not be allowed or utilized for the project

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
	(Abolition) Act, 2015	the basis of sex, religion, political affiliation, sect, colour, caste, creed, ethnic background in considering and disposing of issues relating to the enforcement of this Act". In all proposed Laws the cognizance has been changed from that of the Judicial Magistrate to the Presiding Officer Labor Courts who is a Session Judge.	political affiliation, sect, colour, caste, creed, ethnic background.	
18.	**Sindh Transparency and Right to Information Act, 2016**	The purpose of this Act to provide transparency and freedom of information to ensure that all citizens have better access to public information, to make the government more accountable to citizens, to enforce the fundamental right to information in all matters of public importance, to ensure transparency in all Government matters. Transparency and access to information are essential principles of democracy which not only enable the citizens to hold the Government and their institutions accountable but also help in improving the system of governance.	This Act is applicable as the proposed Project is the public sector Project and shall be transparent for public.	Defines how the project must operate in a transparent manner to the public.
19.	**Sindh Differently Abled Persons (Employment, Rehabilitation and Welfare) (Amendment) Act, 2017**	The Act provides for the employment, rehabilitation, and welfare of differently able persons. The definition of "differently able" is any persons who on account of injury, disease, or congenital deformity, is challenged for undertaking any gainful profession or employment in order to earn his livelihood and includes a person who is blind, deaf, physically challenged or mentally challenged. In the Sindh Differently Able Persons (Employment, Rehabilitation and Welfare) Act, 2014 was amended and job quota was increased from two percent to five percent. The Act also waived admission fees at public educational institutions for people with disabilities as well as 75% of tuition fee, along with establishing reserved seats. Pakistan is a signatory of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD).	This Act is applicable as the proposed project will involve serious occupation health and safety issues during construction phase and may cause serious injury to worker/staff causing permanent disability and differently able.	Requires differently abled persons are not discriminated against during project implementation for jobs.
20.	**Sindh Commission on the Status of Women Act, 2015**	The Act has enabled the government to constitute a Commission to be known as the Sindh Commission on the Status of Women, to exercise the powers to examine the policy, programs and other measures taken or to be taken by Government for gender equality, women's	This Act is applicable as the proposed project may involve the numbers of female staff/worker as well as local resident women along the project corridor which are directly or indirectly	Requires that women are not discriminated against for jobs during project implementation.

Sr. No	Policy/Plan	Description	Relevance to Project	Regulatory Requirement from Project
		empowerment, political participation, representation, assess, implementation and make suitable recommendations to the concerned authorities. In addition, the Commission will be responsible to review all provincial laws, rules, and regulations prejudicial to the legitimate interest and rights of women and suggest accordingly.	linked with project activities.	

4 Analysis of Alternatives

This chapter provides a detailed examination of the alternatives considered for the proposed project, along with the proposed option for implementation moving ahead. The "No Project" Alternative was also studied to understand fully the need of the project and future scenarios if the project is not implemented. Similarly, different location, design, and implementation alternatives were studied for the project also.

4.1 No-Project Alternative

The "No-Project" alternative considers future scenarios where the proposed project has not been implemented. Under this option, the terminal would continue to operate using the existing infrastructure, avoiding the short term environmental impacts associated with the proposed development activities. This, however, would leave the terminal vulnerable to the issues which the project has been proposed to counter, including:

8. **Lack of Available Draft**: The lack of available draft at Terminal 1 (which is currently approximately 12.5 m), limits the terminal's ability to handle modern deep-draft container vessels which now require 14-16 m draft. Along with restricting vessel size and cargo intake, the shallower draft also adversely affects safety margins, particularly for navigation in silt-prone zones, manoeuvring during berthing, tug operations, and adverse weather conditions.
9. **Global Trends & Maintaining Competitiveness**: Given that larger vessels requiring deeper drafts are now becoming the industry standard, maintaining a shallower draft is inconsistent with the needs of modern container shipping. Coupling this with the availabiity of deeper drafts across neighboring regional ports, without any depth enhancement, Port Qasim risks the loss of declining competitiveness amongst regional trade networks.
10. **Improvements in Safety**: Improving safety conditions at Terminal 1 is one of the major drivers for the proposed interventions, where this is incorporated in different aspects of the project accordingly:
    - The proposed seaward extension of the quay wall aims at improving overall structural integrity, supporting wider crane rail gauges, accomodating heavier modern cranes, and improving berth alignment.
    - Deeper berth pockets, as proposed in the project, provides adequate Under-keel clearance, supports larger berthing forces, ensures safety in shallow water hydrodynamics, and improves tug manoeuverability
    - Dredging the area next to the new proposed quay edge ensures adequat water depth for vessel hull dimensions, alignment with berthing envelopes, and reduced risk of propeller wash impacts on quay infrastructure
11. **Operational Improvements**: The project through its proposed interventions is anticipated to:
    - Increase productivity where larger vessels with higher TEUs can be accomodated, reducing the number of overall vessels required, reducing yard congestion, and minimizing anchorage delays.
    - With the increased depths, vessels can operate independent of tidal constraints resulting in increased turnaround times, improved scheduling, and reduced congestion at acnhorage points
12. **Aged Infrastructure:** With Terminal 1 built in 1981, the infrastructure is aged and unsuited to cater to modern demands, including crane rail deflections and alignment inconsistencies caused by settlement and aging foundations, ground settlement and reduced structural resilience, limiting load bearing performance, and operational risks associated with aging crane assets.
13. **Improved Financial Synergies:** With the advent of the proposed interventions, QICT and Port Qasim can attract modern, higher capacity vessels, alonside lowering logistics costs (through reducing transshipment dependency, feeder costs, and transit times for exporters

and importers), overall improving Pakistan's competitiveness in global trade.

14. **Improved Energy Efficiency & Reduced Emissions**: Potentially handling larger vessels at the berths would improve fuel efficiency per TEU, and result in lower emissions per container moved.

As Pakistan's trade volumes grow and global shipping trends move towards larger, deeper draft vessels, Port Qasim's competitiveness is increasingly dependent on its ability to support modern ship sizes and technologies. Terminal 1, designed in 1981, was not originally designed to handle modern super-post-panamax vessels or heavier, higher-capacity quay cranes required for them. The quay structure, foundations, and rail systems are approaching the end of their serviceable life, resulting in operational constraints and safety concerns.

Upgrading Terminal 1 is therefore essential not only for QICT but also for the wider Pakistan logistics corridor, which depends heavily on Port Qasim for import and export flows. Therefore, the No-Project alternative is not considered a long term viable option.

4.2 Design Alternatives

The design alternative evaluates different engineering approaches for addressing the structural limitations of the existing quay wall and improving berth capacity at Terminal 1 of the Qasim International Container Terminal (QICT). The analysis considered whether the required operational improvements could be achieved through rehabilitation of the existing quay wall structure or through the construction of a new quay wall extension integrated with modern port infrastructure.

One potential option involves rehabilitation or strengthening of the existing quay wall without constructing a new extension. Under this approach, structural repairs, reinforcement of deteriorated sections, and localized improvements to crane rails and quay fixtures could be undertaken to improve the condition and load-bearing capacity of the existing structure. Such measures could temporarily extend the operational life of the quay wall and address certain maintenance-related issues.

However, rehabilitation alone would not fully resolve the structural and operational limitations associated with the existing facility. The current quay wall was constructed several decades ago and was not originally designed to accommodate modern large container vessels or the heavier loads imposed by high-capacity ship-to-shore (STS) cranes. In addition, the existing structural configuration and crane rail gauge may not meet the technical requirements necessary for the installation and safe operation of modern container handling equipment. Consequently, relying solely on rehabilitation measures would provide only a short-term solution and may not support the long-term operational requirements of the terminal.

The selected design alternative involves the construction of a new quay wall extension seaward of the existing structure, combined with the modernization of quay-side infrastructure and installation of new cargo-handling equipment. This engineering approach allows for improved structural stability, increased load-bearing capacity, and compatibility with modern STS cranes designed for larger container vessels. The extension also allows for better integration with berth deepening works and provides adequate space for installation of upgraded marine fixtures such as bollards, fenders, and crane rails.

Furthermore, constructing a new quay wall extension enables the project to incorporate modern marine engineering standards and design practices, thereby improving long-term durability and operational reliability. This approach also minimizes operational risks associated with aging infrastructure and provides a more sustainable solution for accommodating future growth in containerized trade.

Considering the structural, operational, and long-term performance requirements of the terminal, the quay wall extension design was selected as the preferred alternative, as it provides a technically robust, efficient, and long-term solution for upgrading Terminal 1 and enhancing overall terminal productivity.

4.3 Dredging Options Alternatives

This section looks into the potential dredging alternatives available, and the most suitable option proposed moving ahead for the subject project, given the existing conditions at the Terminal and the channel.

4.3.1 Categories

Dredging methods can broadly be categorized into:

- **Mechanical Dredging** – Excavation-based methods using buckets or grabs.
- **Hydraulic Dredging** – Using suction to transport material in slurry form.

Each method offers different advantages and is suited to specific dredging environments, as detailed below.

4.3.2 Mechanical Dredging Methods

4.3.2.1 Clamshell Dredging

Mechanism: A clamshell bucket attached to a crane or derrick dredger scoops sediment from the seabed and deposits it into barges or hoppers.

Advantages:
- High precision.
- Operable in confined spaces.
- Easy handling of debris or mixed material.
- Effective near quay walls.

Limitations:
- Slower production rates than hydraulic dredgers.
- Potential for sediment resuspension and turbidity.

Suitability:
Suitable as a supplementary method for soft sediment removal, trimming, debris clearance, and localized works, but not preferred as the main dredging method for the full berth pocket.

An image of a clamshell dredger is also provided below:

Figure 4.1 - Clamshell Dredging

4.3.2.2 Backhoe Dredging

Mechanism: An excavator mounted on a pontoon dredges material with a bucket arm and places it into waiting barges.

Advantages:

- High excavation force.
- Controlled sediment removal with low turbidity.
- High precision near quay walls and berth structures
- More suitable for staged works in an operational terminal

Limitations:

- Limited reach and lower efficiency for larger areas.
- Requires stable weather and calm waters.
- Lower production rate compares with large hydraulic dredgers
- Requires barges for material transport

Suitability:
This is the most suited method for near-quay dredging and berth pocket formation, especially where control, accuracy, and reduced disturbance to terminal operations are required.

An image of a backhoe dredger is also provided below:

Figure 4.2 - Backhoe Dredging

4.3.3 Hydraulic Dredging Methods

4.3.3.1 Cutter Suction Dredging (CSD)

Mechanism: A rotating cutter head loosens the seabed while a suction pipe draws the sediment as a slurry and transports it via pipeline to disposal or reclamation sites.

Advantages:
- High efficiency in soft to medium cohesive soils.
- Continuous dredging and pumping capacity.
- Useful when larger dredging volumes are required

Limitations:
- Not ideal in areas with debris or very hard material.
- Requires extensive pipe network and disposal planning.
- Higher turbidity compared to mechanical dredging methods
- May disrupt live port operations
- Less flexible in confined areas

Suitability:
This method is not as suitable for the project, given that it will take place next to live berth operations, and will also require greater turbidity controls and port traffic coordination.

An image of a Cutter Suction Dredger is provided below:

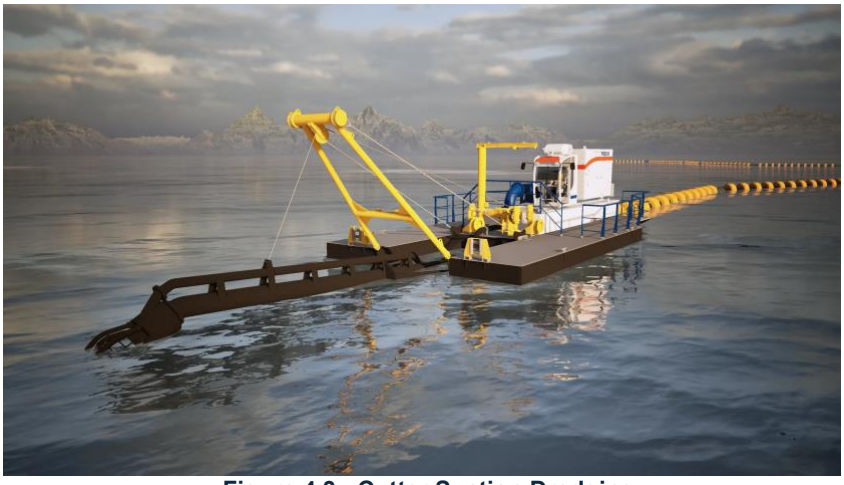


Figure 4.3 - Cutter Suction Dredging

4.3.3.2 Trailing Suction Hopper Dredger (TSHD)

Mechanism: A TSHD uses suction pipes dragged along the seabed to remove loose sediments and store the dredged material in an onboard hopper.

Advantages:
- High mobility and efficient large-scale sediment removal.
- Can discharge at sea or via pump ashore.

Limitations:
- Less effective in confined or shallow inner-harbor spaces.
- Requires periodic sailing away to disposal sites, increasing downtime.
- Poor precision near quay structures

- Not as effective in hard strata
- May generate turbidity during overflow
- Requires maneuvering space

Suitability:
This method is not proposed as the primary dredging method and instead may be considered for removal of loose surficial sediments in open areas away from the quay wall.

An image of a Trailing Suction Hopper Dredger is provided below:

Figure 4.4 - Trailing Suction Hopper Dredging

4.3.4 Preferred Alternative

Based on the available bathymetric, sub-bottom profiling, and geotechnical information, the preferred dredging approach is a controlled mechanical dredging strategy, using a backhoe dredger, supported by grab dredging for trimming, debris removal, and localized soft sediment removal. This is preferred as the dredging site is located immediately adjacent to an existing operational quay wall and within a live port environment. The seabed conditions are variable, with soft, silty clay at the surface, very dense sandy gravel below, and localized/ harder shale/ sandstone layers further below.

4.4 Conclusion

Based on the analysis of the various alternatives considered, the proposed Terminal 1 Quay Wall, Dredging, and Equipment Works Project at Qasim International Container Terminal (QICT) represents the most technically feasible, operationally effective, and environmentally acceptable option. While alternatives such as maintaining existing conditions, employing carious design changes, and understanding the different modalities for implementation were evaluated, the proposed project interventions still remain the most feasible option.

The proposed project provides a comprehensive solution by improving berth infrastructure, increasing navigational depth, and upgrading cargo-handling equipment to support modern container vessels and growing trade demands. Therefore, implementation of the proposed project is considered necessary to enhance operational efficiency, ensure safe vessel handling, and support the long-term sustainability and competitiveness of QICT, and through it, Port Qasim.

5 Description of Baseline Conditions

5.1 General

This section provides baseline data (physical, biological, and socio-economic conditions) related to the project area information provided is both quantitative and qualitative, and obtained using primary and secondary data sources.

The baseline information, along with relevant stakeholder consultations, is required for scoping of potential environmental and social impacts associated with the implementation of the project. On the basis of the baseline information, proposed interventions are assessed and mitigation measures are proposed. The baseline information also aids in indicating specific issues and areas to be monitored during project execution.

Figure 5.1 - Project Location Map

The project is located within the vicinity of the Port Qasim area, specifically in the area where QICT operates their terminal (terminal 1), along the Phitti Creek.

Port Qasim, itself, is situated in the Bin Qasim sub-division of district Malir, which is one of the most strategically important industrial and maritime areas in Pakistan. The sub-division comprising derives its name from Muhammad Bin Qasim and encompasses the Port Qasim industrial complex, Bin Qasim Industrial Zone, Pakistan Steel Mills area, Steel Town, Gulshan-e-Hadeed, Shah Town, and several coastal and industrial settlements. The sub-division is spread over an area of approximately 447 km^2 and supports a population of approximately 323,000 persons (as per the 2023 census).

The sub-division is bound by the Arabian Sea to the South, Thatta District and the Indus Delta to the East, the Gadap sub-division to the North, and the urban-industrial areas of Malir and Korangi to the West. Due to the presence of Port Qasim, and its associated industrial estate, Bin Qasim serves as a critical economic node supporting Pakistan's international trade, industrial production, energy security, and employment generation. The proposed QICT Terminal 1 Quay extension is

therefore situated in an area of national economic importance where the maritime infrastructure, industrial development, and logistics activities form the dominant land use characteristics.

5.2 Physical Environment

An overview of the existing physical environment in the area is described below:

5.2.1 Topography

The project area is located within the coastal zone of Port Qasim, Karachi (District Malir), forming part of the southeastern low-lying coastal plain of Karachi. Regionally, Karachi's topography transitions from the elevated and rugged terrain of the Kirthar Range in the north and west to flat and gently undulating coastal and deltaic environments in the south and southeast.

The immediate project site, encompassing the QICT Terminal 1 Quay Wall and associated dredging areas, is characterized by flat to very gently sloping terrain. Elevations within the site generally range from approximately -4 m to +5 m above mean sea level, based on available elevation data. The area exhibits a very low surface gradient (approximately 1:50), typical of deltaic and coastal depositional environments.

The coastal morphology is dominated by intertidal and subtidal mudflats, influenced by the hydrodynamics of Korangi Creek and associated tidal channels. These features result in periodic tidal inundation and contribute to ongoing sediment deposition and redistribution. The presence of adjacent mangrove habitats further reflects the low-energy, sediment-rich coastal setting.

Unlike the more rugged coastal features observed along other parts of Karachi's coastline (e.g., cliffs and rocky headlands), the project area is largely engineered and modified, with extensive land reclamation, dredging, and port infrastructure development. As a result, the natural topographic profile has been significantly altered to support port operations.

Despite these modifications, the site remains inherently low-lying and tidally influenced, making it potentially susceptible to coastal flooding, storm surges, and sea-level rise. No significant natural elevation barriers are present within the immediate project footprint.

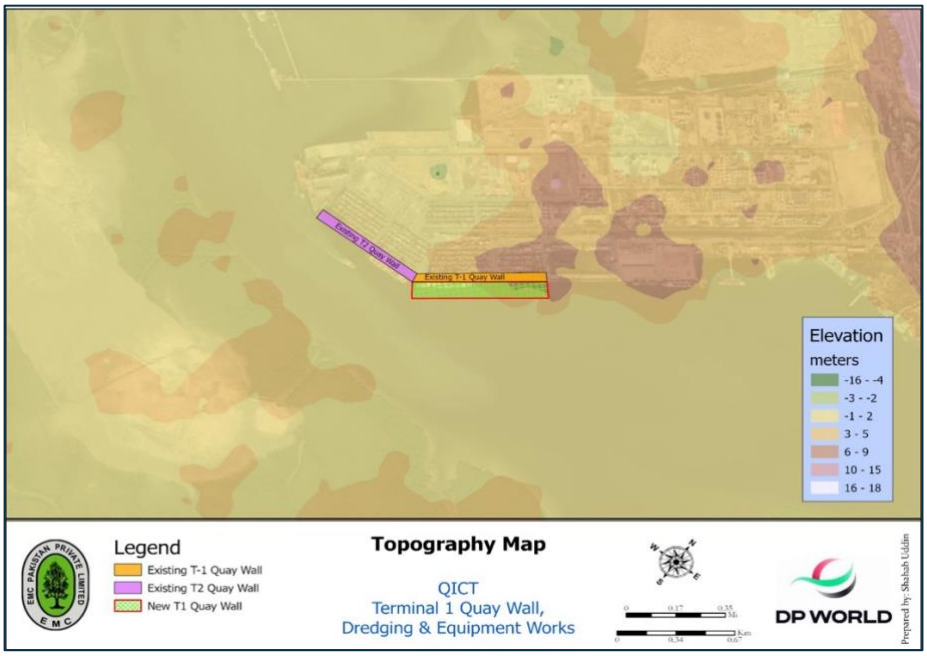


Figure 5.2 - Topography

5.2.2 Soil & Geology (Terrestrial)

The project area is situated within the Indus Deltaic region, which is characterized by thick sequences of sedimentary deposits overlying older geological formations. Regionally, the geology of Karachi comprises sedimentary rocks of Paleogene age, including limestone, sandstone, shale, and claystone, formed in marine and deltaic depositional environments.

Based on the project-specific geology map, the site and its immediate surroundings are underlain predominantly by Paleogene rock formations, which represent consolidated sedimentary strata forming the geological foundation of the coastal belt. These formations are typically composed of interbedded sandstone, shale, and limestone, reflecting variations in depositional conditions over geological time.

Overlying these consolidated formations, particularly in the coastal and creek areas of Port Qasim, are recent unconsolidated alluvial and marine sediments associated with the Indus Delta system. These sediments have been deposited through fluvial, tidal, and marine processes, resulting in a complex stratigraphy of silts, clays, and sands in the near-surface layers.

The geological setting of the area is further influenced by its location within a tectonically active margin, where regional structures such as faults and folds associated with plate interactions have shaped the subsurface geology. However, no major surface expressions of geological structures are observed within the immediate project footprint.

Overall, the geology of the project area is characterized by Paleogene sedimentary bedrock overlain by recent deltaic deposits, which has implications for ground stability, sediment behavior, and engineering characteristics of the site.

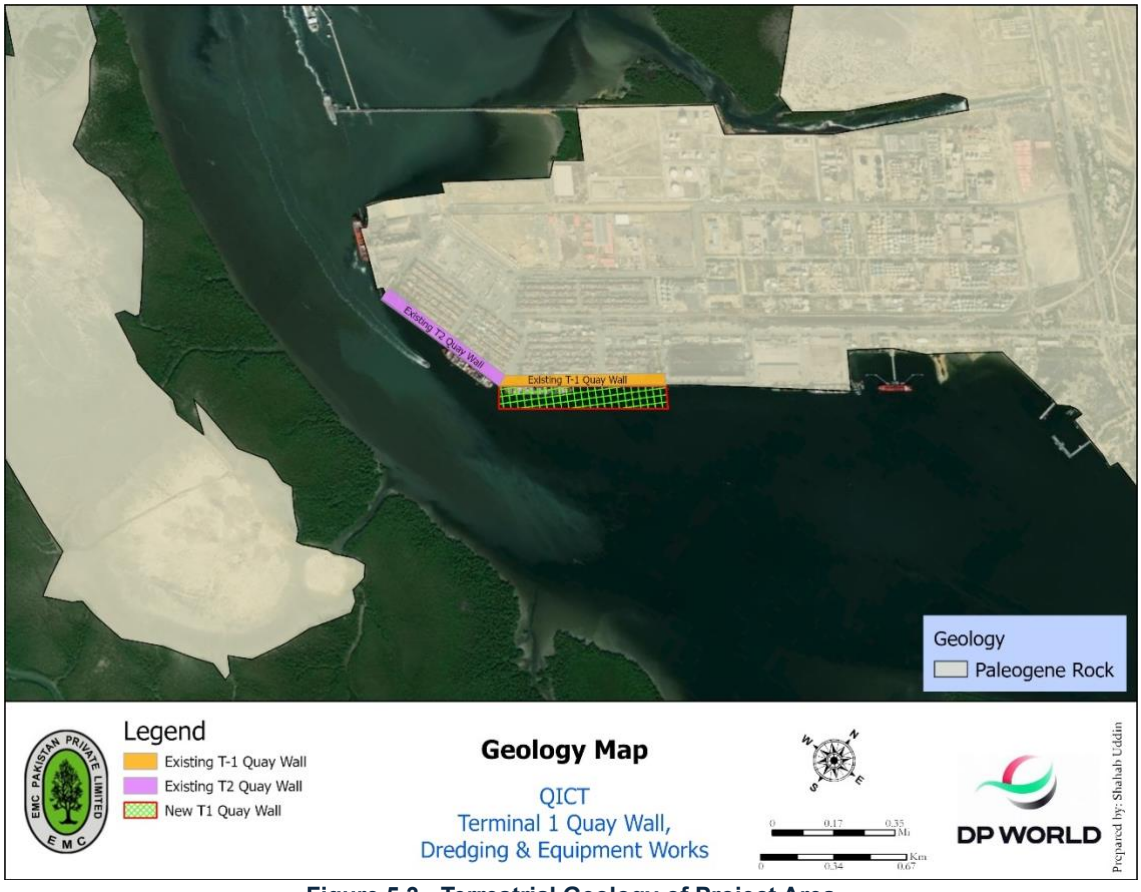


Figure 5.3 - Terrestrial Geology of Project Area

The soils within the project area at QICT, Port Qasim are characteristic of a coastal deltaic environment, influenced by fluvial, tidal, and marine depositional processes associated with the Indus Delta system. According to the soil map, the area is predominantly classified as lithosols, which generally represent shallow soils overlying consolidated material; however, in the coastal setting of Port Qasim, these are overlain by recent unconsolidated marine and alluvial sediments.

The near-surface soils in the project area typically consist of soft to firm silty clay and clayey silt, commonly referred to as marine mud or slush, particularly within intertidal zones and adjacent creek areas. These soils are characterized by high moisture content, low shear strength, and high compressibility, reflecting their depositional origin in low-energy tidal environments.

Beneath the upper cohesive layer, the soil profile generally transitions into dense sand and gravel deposits, indicating periods of higher energy deposition. These granular layers exhibit relatively higher strength and permeability compared to the overlying clayey strata. At greater depths, the subsurface conditions grade into more consolidated sedimentary formations, consistent with the regional geology of the area.

The soil conditions in the project area are further influenced by tidal inundation, sediment transport, and anthropogenic modifications, including land reclamation and port development activities. As a result, the soils exhibit spatial variability in terms of composition and engineering properties.

Overall, the soils in the project area are characterized by soft, compressible upper layers underlain by denser granular deposits, which are typical of coastal and deltaic environments and are important considerations for dredging, foundation design, and ground stability.

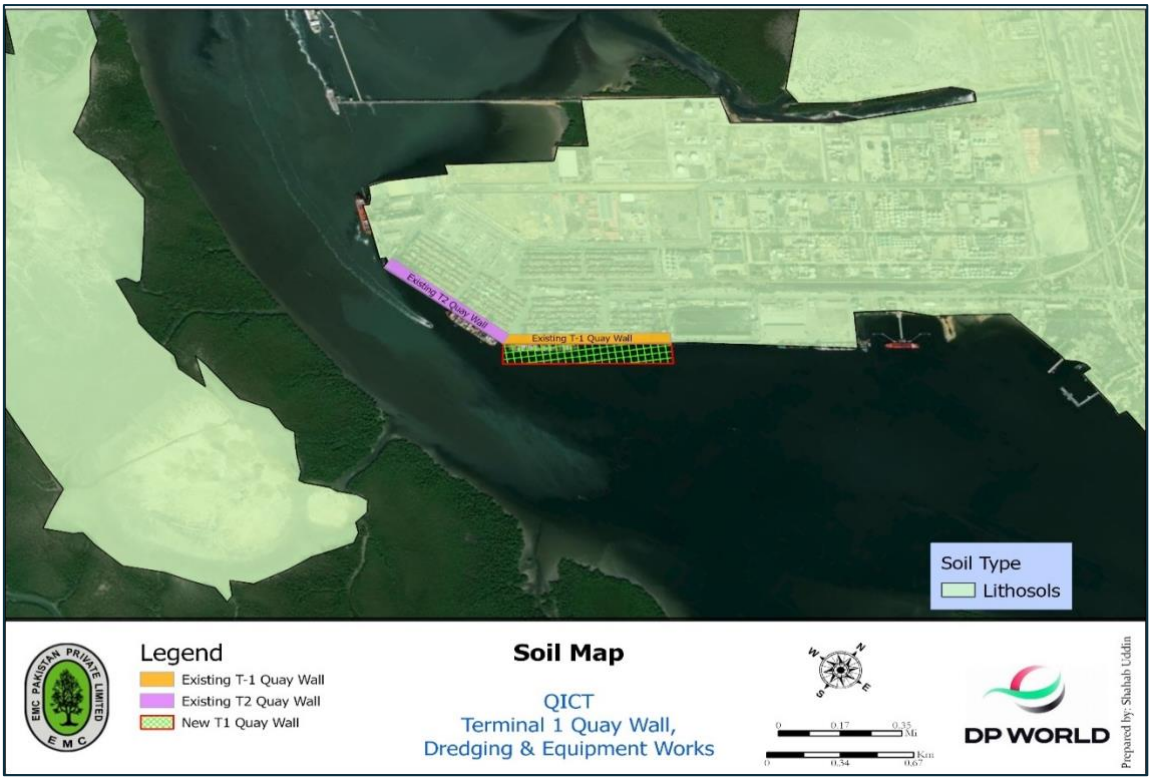


Figure 5.4 – Soil of Project Area

5.2.3 Geology (Aquatic)

A geotechnical investigation was conducted along Terminal-1 Berths 5 to 7 at Qasim International Container Terminal (QICT), Port Qasim to determine the subsurface soil conditions and

engineering properties of the seabed sediments in the project area. The investigation was carried out by drilling five boreholes up to a depth of approximately 30 m below the seabed level, followed by laboratory testing of collected soil samples to evaluate the physical and engineering characteristics of the subsurface materials.

The drilling operations were performed using a rotary drilling rig mounted on a temporary platform installed along the berth edge. Standard Penetration Tests (SPT), coring, and laboratory testing were carried out in accordance with ASTM and BS standards to determine the soil stratigraphy and engineering parameters required for foundation design.

The generalized subsurface profile indicates that the seabed in the project area is characterized by soft silty clay (slush) in the upper layer, followed by dense sand and gravel deposits. At greater depths, the soil profile transitions into shale, conglomerate, sandstone, and siltstone formations, which are typical geological formations of the coastal belt of Karachi and the Indus Delta region.

The summarized subsurface stratigraphy encountered during the geotechnical investigation is presented in Table 5.1, while the generalized subsoil profile derived from the borehole logs is illustrated in Figure 5.4. Detailed borehole logs and laboratory test results are provided in the Annexures attached to this report.

Table 5.1 - Summary of Sub-Surface Stratigraphy

Layer	Soil Description	General Characteristics
I	Silty Clay (Slush)	Very soft to firm marine clay
II	Sand / Gravel Deposits	Very dense sand with gravel
III	Shale	Medium hard shale with embedded gravels
IV	Conglomerate / Sandstone	Loosely cemented sedimentary formation
V	Shale / Siltstone / Claystone	Medium to hard sedimentary rock layers

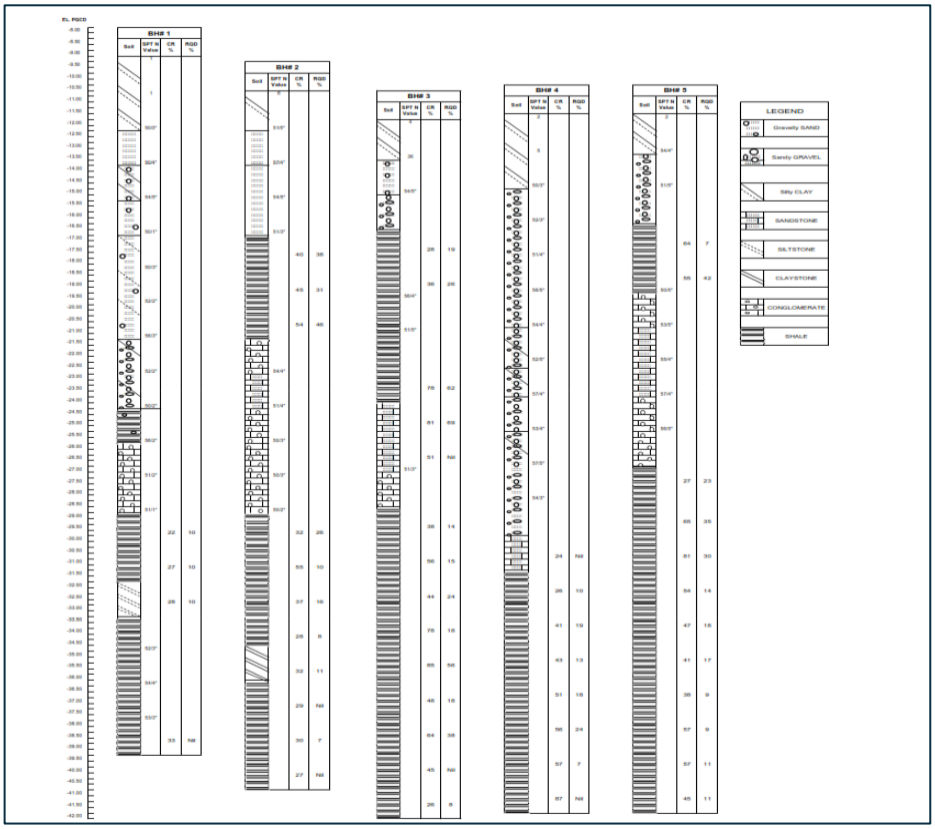


Figure 5.5 - Subsoil Profile Derived from Boreholes BH-1 to BH-5

The generalized subsoil profile derived from boreholes BH-1 to BH-5 illustrates the variation of subsurface soil layers encountered along Terminal-1 Berths 5 to 7. The borehole logs indicate an upper layer of soft silty clay, underlain by dense sand and gravel deposits, followed by deeper sedimentary formations including shale, conglomerate, sandstone, siltstone, and claystone. The profile also presents SPT values and core recovery data, which help evaluate the strength and engineering characteristics of the subsurface strata for foundation design.

5.2.4 Bathymetry

Bathymetric conditions within the study area indicate that the seabed in front of Qasim International Container Terminal (QICT) Terminal-1 exhibits gradual depth variation along the berth pocket and surrounding marine area. Bathymetry provides important information regarding the existing seabed morphology, depth distribution, and features relevant to navigation and dredging activities.

The bathymetric survey indicates that the seabed depths within the project area generally range between approximately 7.7 m and 17.9 m below chart datum. The most common depth range observed along the Terminal-1 frontage lies between 12 m and 14.9 m, representing the operational berth pocket area. Deeper zones reaching approximately 15.9 m to 17.9 m are observed toward the western section of the survey area closer to Terminal-2. In contrast, relatively shallow areas ranging between 7.7 m and 9 m occur toward the eastern portion of the terminal.

Figure 5.6 - Bathymetric Survey Coverage Area

Analysis of the bathymetric digital elevation model indicates that seabed depth generally increases gradually from east to west along the terminal frontage. The seabed morphology appears relatively smooth with gentle slopes typical of maintained port environments where periodic dredging operations are conducted to maintain navigational depths.

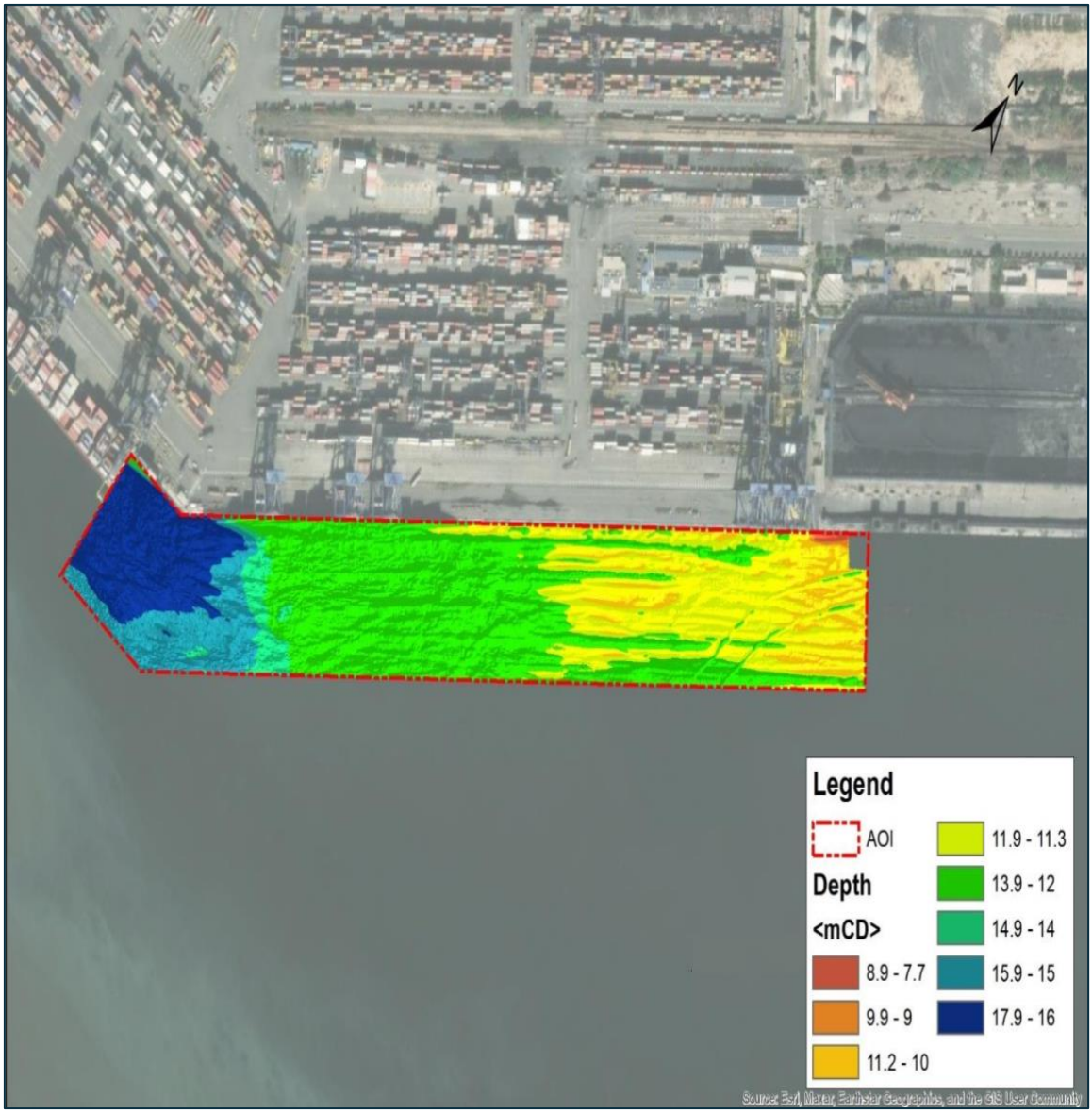


Figure 5.7 - Digital Elevation Model showing Seabed Depth Distribution

Distinct linear seabed features visible within the bathymetric dataset indicate previous dredging activities, which are common within operational port basins where maintenance dredging is carried out to maintain safe berthing and vessel maneuvering conditions. These dredging marks appear as elongated linear depressions along the seabed aligned with the berth pocket.

Multibeam imagery also indicates the presence of submerged quay wall structures and jetty piles associated with existing terminal infrastructure. Additionally, localized seabed irregularities and potential debris areas were observed within the survey area.

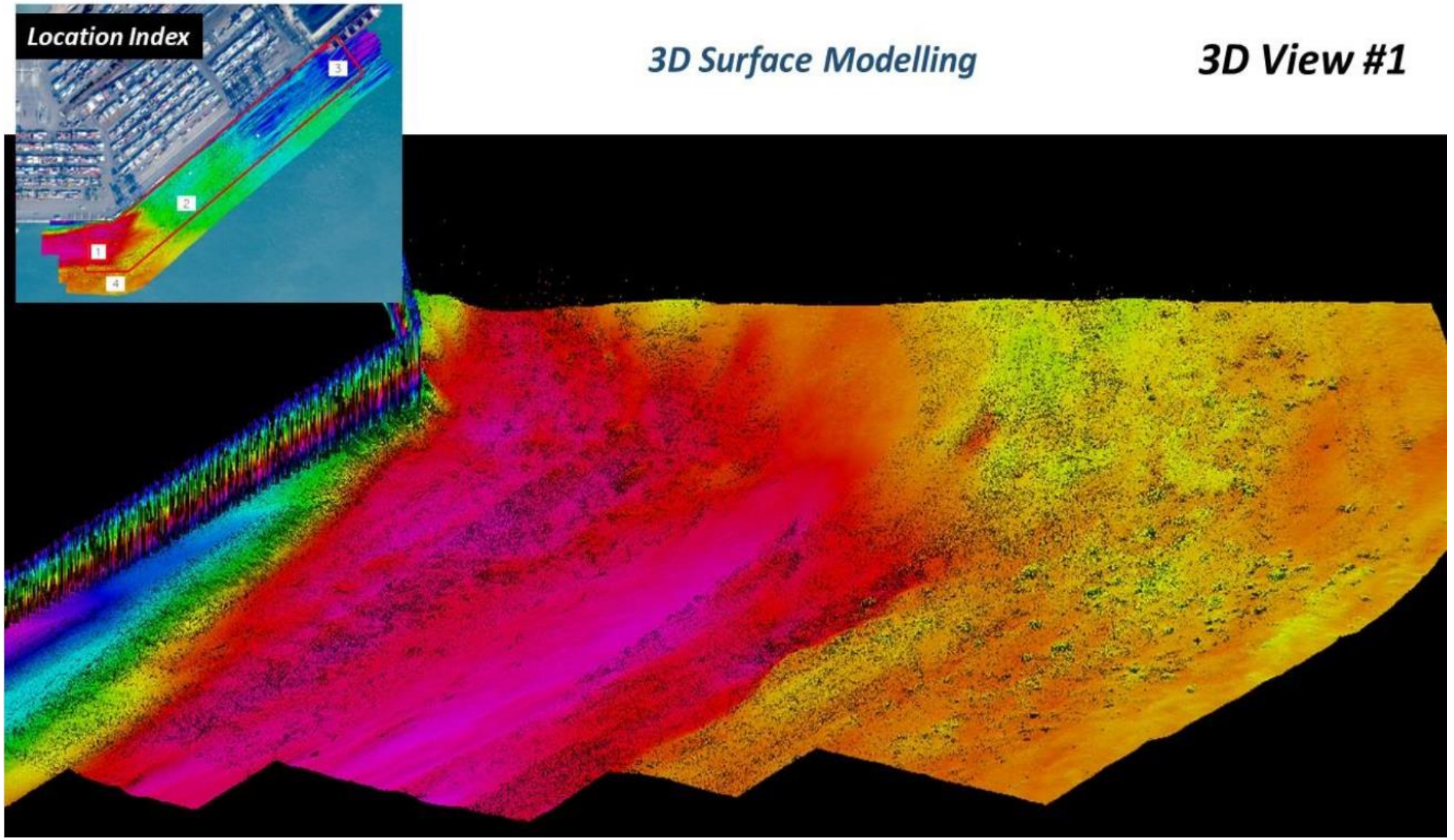


Figure 5.8 - Three Dimensional Seabed Model of the Survey Area (View 1)

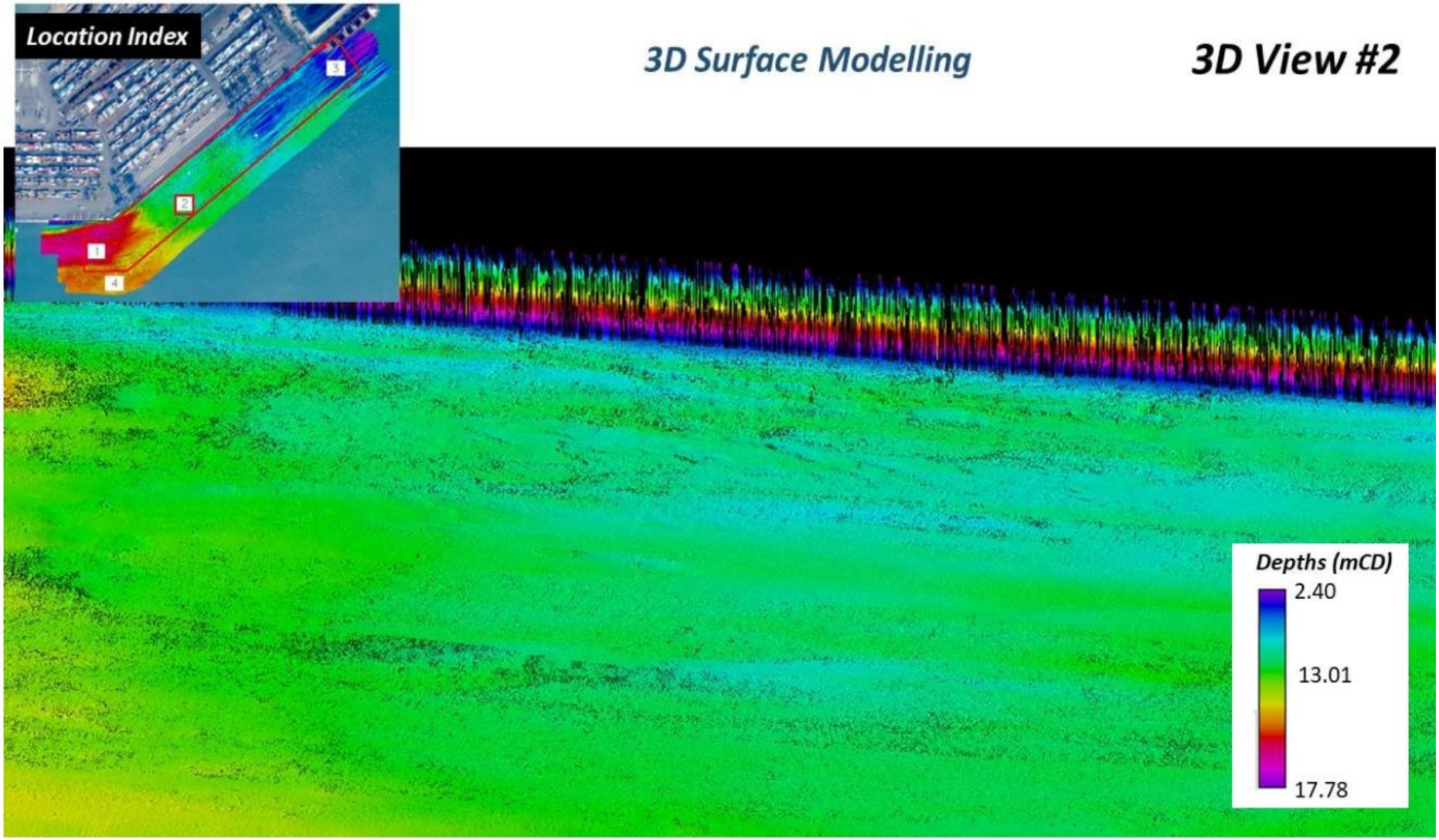


Figure 5.9 - Three Dimensional Seabed Model of the Survey Area (Vieew-2)

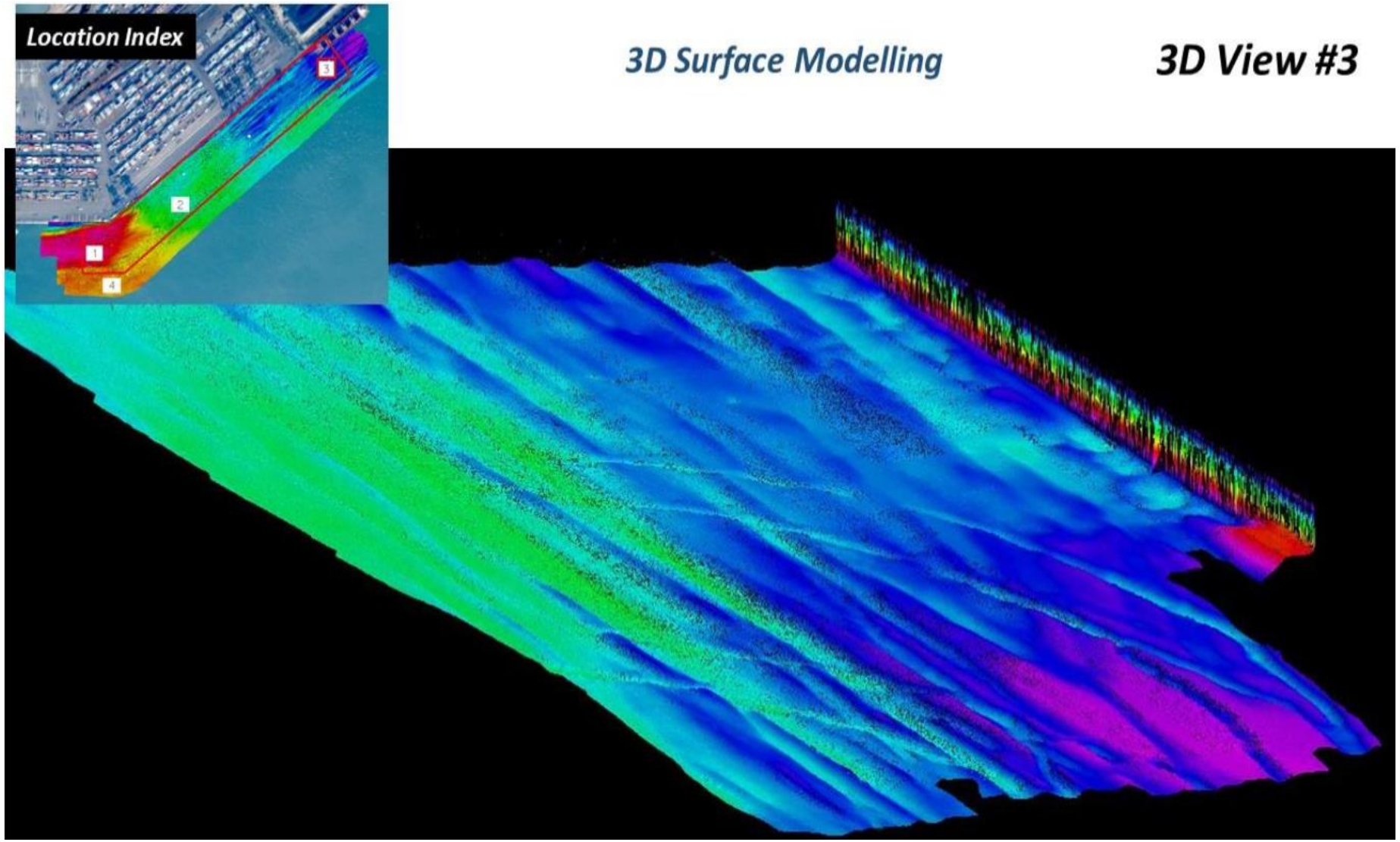


Figure 5.10 - Model depicting Dredging Marks (View-3)

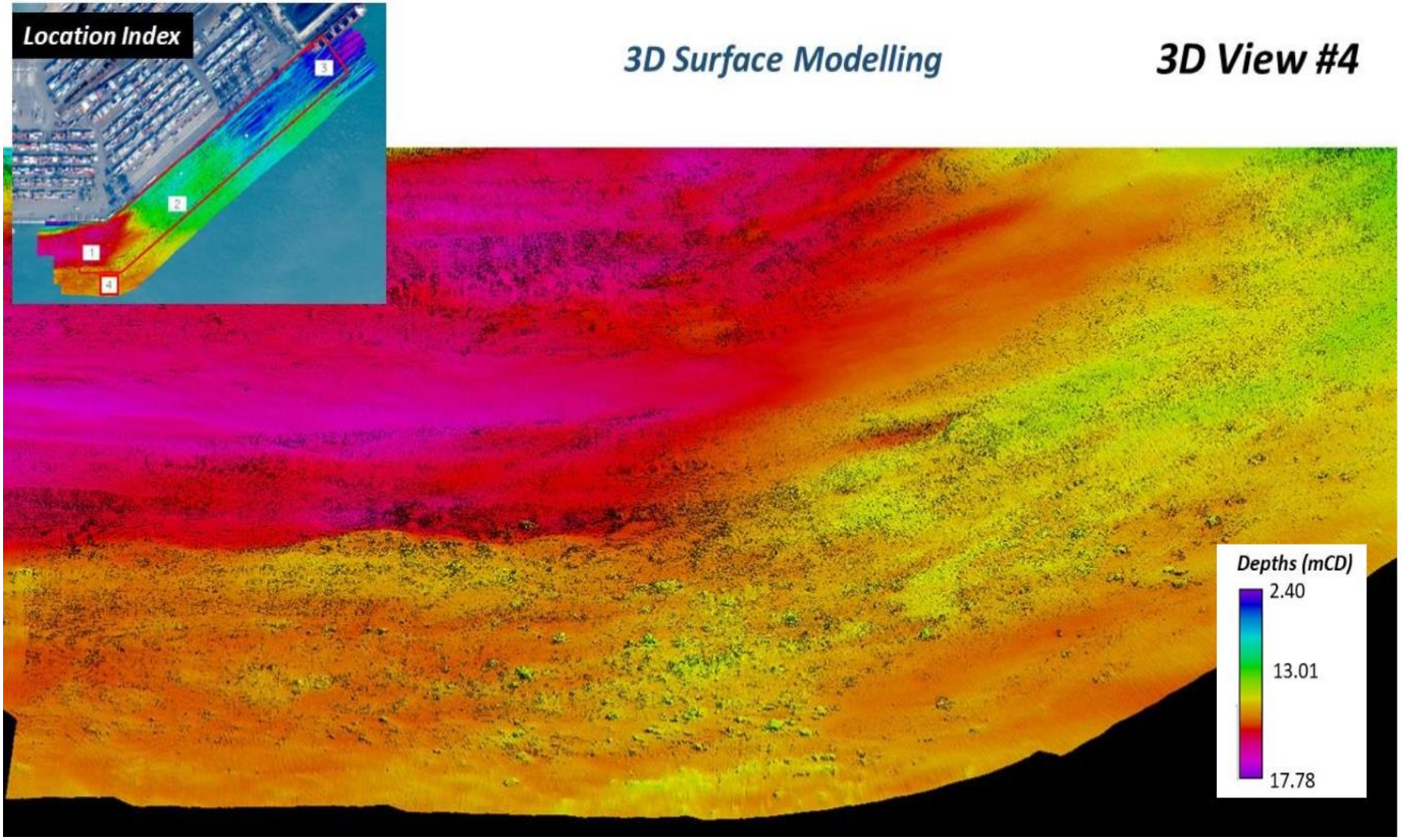


Figure 5.11 - Model depicting Potential debris Area (View-4)

Overall, the seabed conditions within the study area are consistent with the maintained port basin morphology, characterized by controlled depths, and localized dredging featrues associated with routine port operations.

5.2.5 Marine Sediment Characteristics

Sub-bottom profiling surveys were conducted to investigate the shallow subsurface sediment layers beneath the seabed within the project area at Qasim International Container Terminal (QICT) Terminal-1. While the bathymetric survey provided information on seabed depths and morphology, the sub-bottom profiler survey enabled interpretation of the subsurface geological stratigraphy and sediment composition, which are important for dredging and marine construction activities.

The survey was carried out within the same footprint as the bathymetric investigation, covering an area of approximately 108,000 m² along the Terminal-1 quay wall. Acoustic data were collected using a parametric sub-bottom profiling system (SES2000 Light) capable of penetrating up to approximately 40 m below the seabed under favorable sediment conditions.

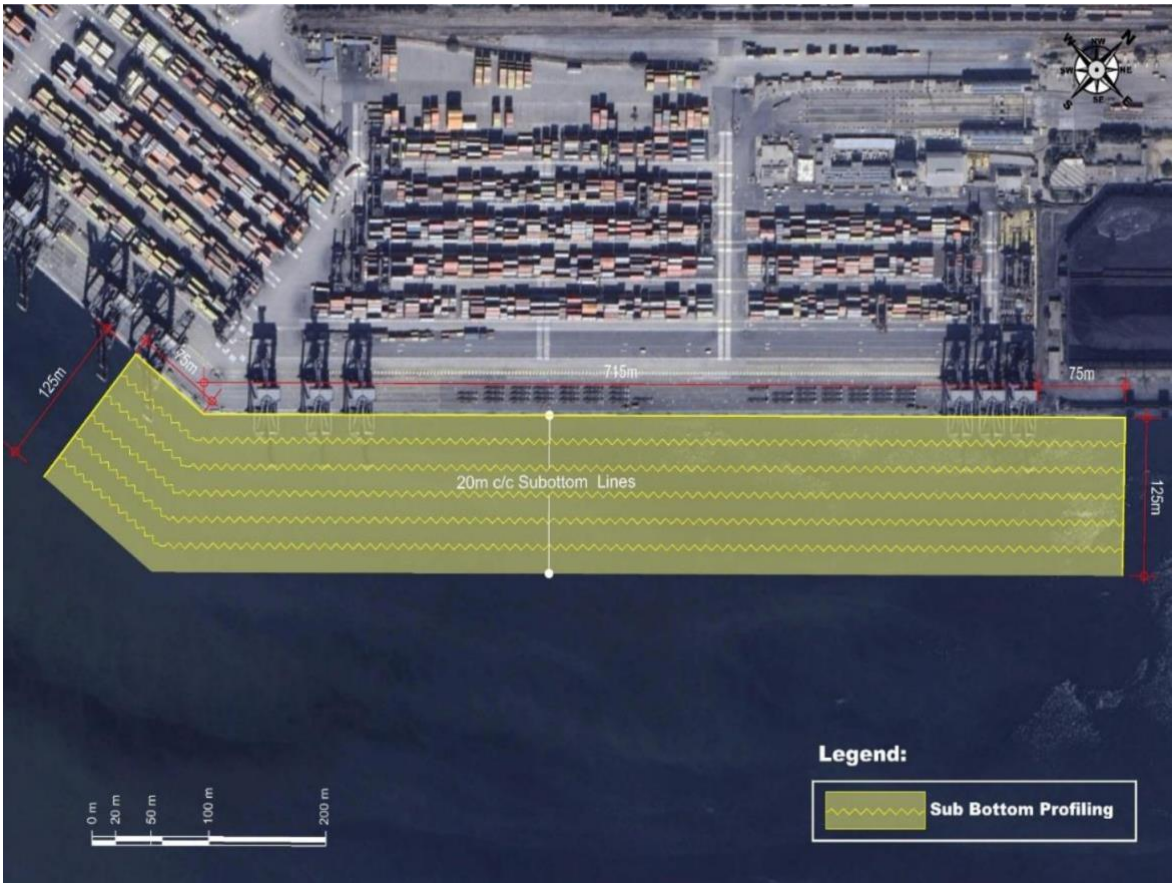


Figure 5.12 - Sub-Bottom Profiler Survey Coverage Area

The sub-bottom profiler records acoustic reflections from different sediment layers beneath the seabed. These reflections allow identification of distinct subsurface strata and interpretation of the sedimentary structure within the project area.

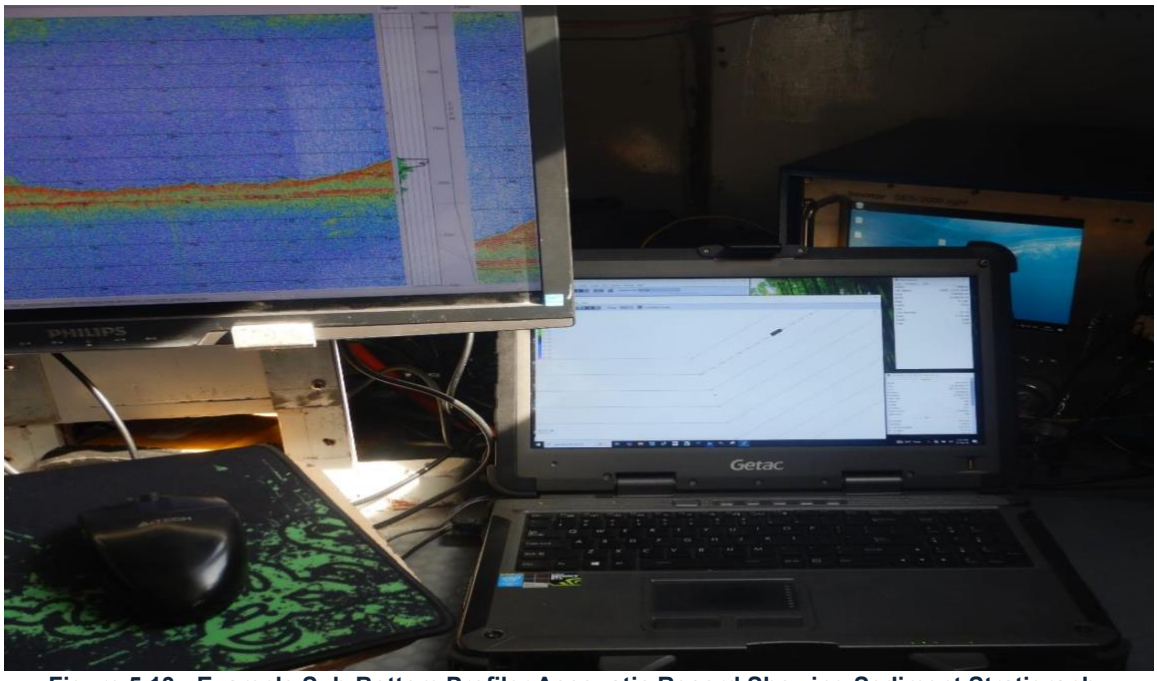


Figure 5.13 - Example Sub-Bottom Profiler Accoustic Record Showing Sediment Stratigraphy

Interpretation of the acoustic profiles, supported by available geotechnical borehole information, indicates that the seabed in the study area consists of several sediment layers typical of deltaic marine depositional environments associated with the Indus Delta.

Borehole investigations provided by the client were integrated with the acoustic data to improve stratigraphic interpretation. Four boreholes located within the survey area extend to depths of approximately 30 m below the seabed, providing reliable information on soil composition and strength characteristics.

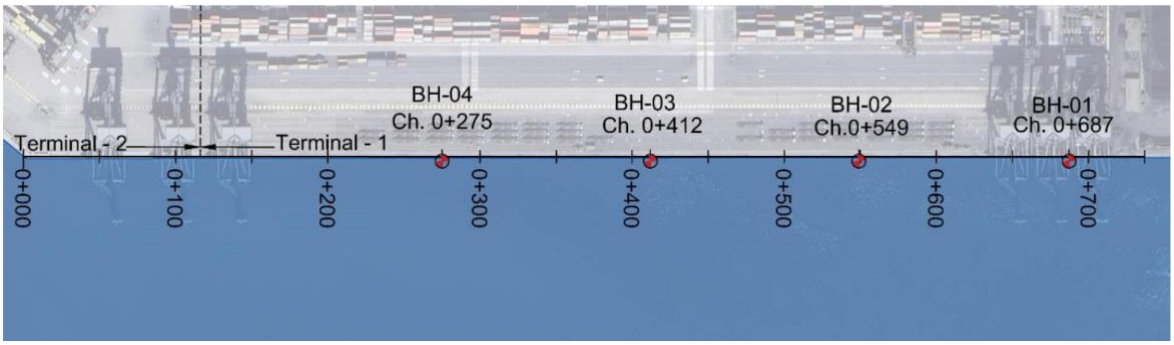


Figure 5.14 - Location of Boreholes within the Survey Area

The borehole logs indicate that the upper seabed layer consists predominantly of soft silty clay, characterized by relatively low Standard Penetration Test (SPT) values (N < 10). This layer occurs immediately below the seabed surface and typically extends to a thickness of approximately 2 m across most of the survey area.

Below the silty clay layer, a sandy gravel layer is present, representing relatively more consolidated sediment deposits. At greater depths, the geological sequence consists of shale and sandstone formations, which represent more competent underlying geological materials.

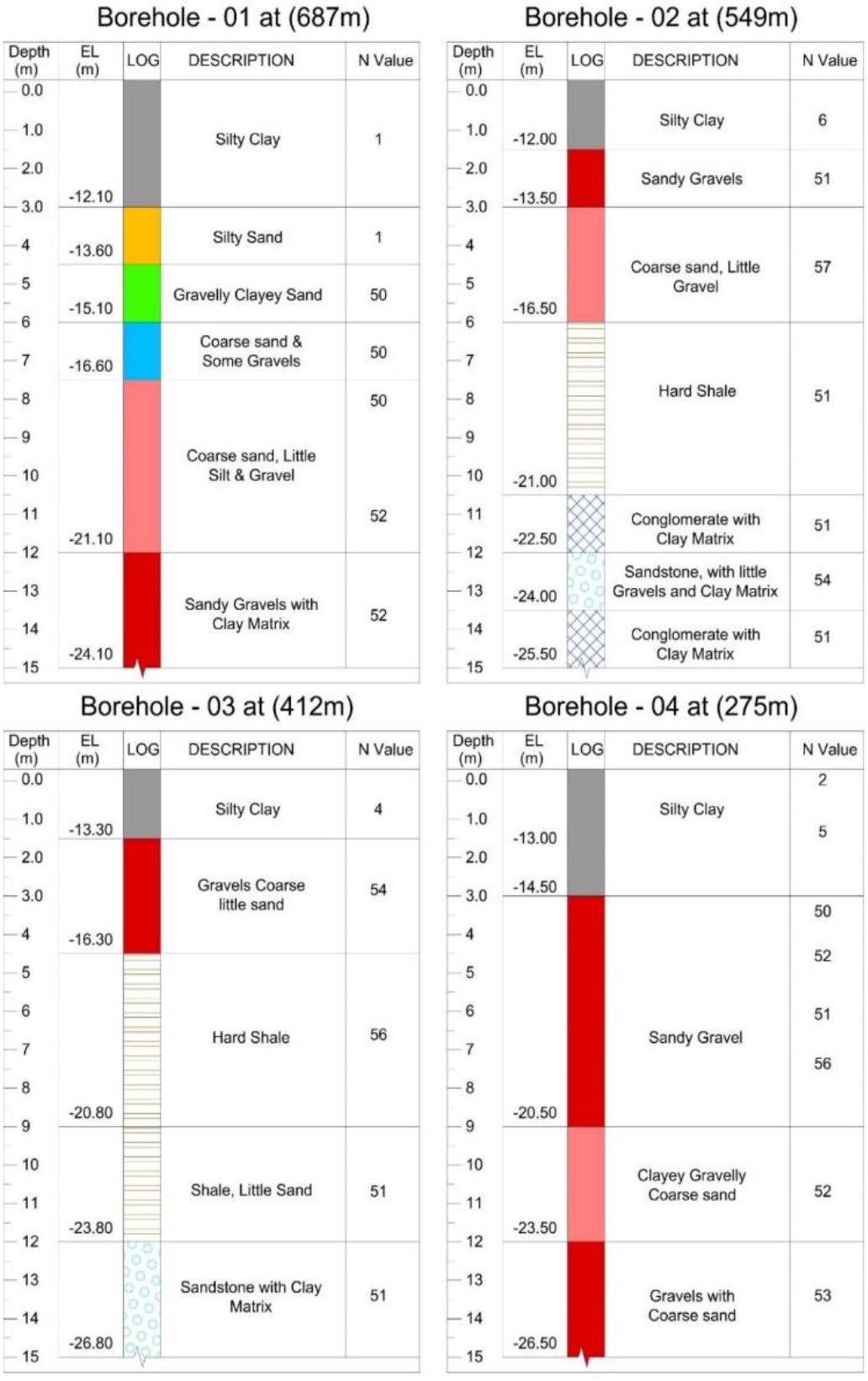


Figure 5.15 - Borehole Log Summary and Stratigraphic Information

Sediment contour maps derived from the sub-bottom profiler interpretation further illustrate the spatial distribution of these sediment layers across the survey area.

Figure 5.16 - Sediment Contour Map - Sandy Gravel Layer

Figure 5.17 - Sediment Contour Map - Shale Layer

Figure 5.18 - Sediment Contour Map - Sandstone Layer

Overall, the subsurface conditions within the study area are characterized by soft unconsolidated marine sediments overlying more consolidated geological formations, which is typical for port environments located within the Indus deltaic sedimentary system. The presence of soft surface sediments suggests that dredging operations in the project area will primarily involve unconsolidated materials, which are generally favorable for dredging activities associated with berth deepening and marine infrastructure development.

5.2.6 Seismicity

The project site at QICT, Port Qasim, Karachi is located within a tectonically active region influenced by the interaction of the Indian, Arabian, and Eurasian plates, with regional seismicity associated with major structural features such as the Makran Subduction Zone, Owen Fracture Zone, and Ornach-Nal fault system. According to the Uniform Building Code (1997), Karachi falls within Seismic Zone 2B, indicating a moderate level of seismic risk. Based on the project-specific seismicity map, the site lies predominantly within Zone 2B, with nearby areas extending into Zone 2A, reflecting minor spatial variation in seismic hazard across the coastal region. The area forms part of the Indus deltaic synclinorium, characterized by sedimentary deposits and the presence of active fault systems, although seismic activity is generally of low to moderate magnitude. Due to the low-lying, reclaimed, and unconsolidated nature of the site soils, there is potential for secondary seismic effects such as soil liquefaction and ground settlement. Overall, the seismic risk is considered moderate, and appropriate design and construction practices in accordance with applicable standards are required.

Seismicity of Site: According to the Uniform Building Code (1997), Karachi and its adjoining areas fall in Seismic Zone-2B.

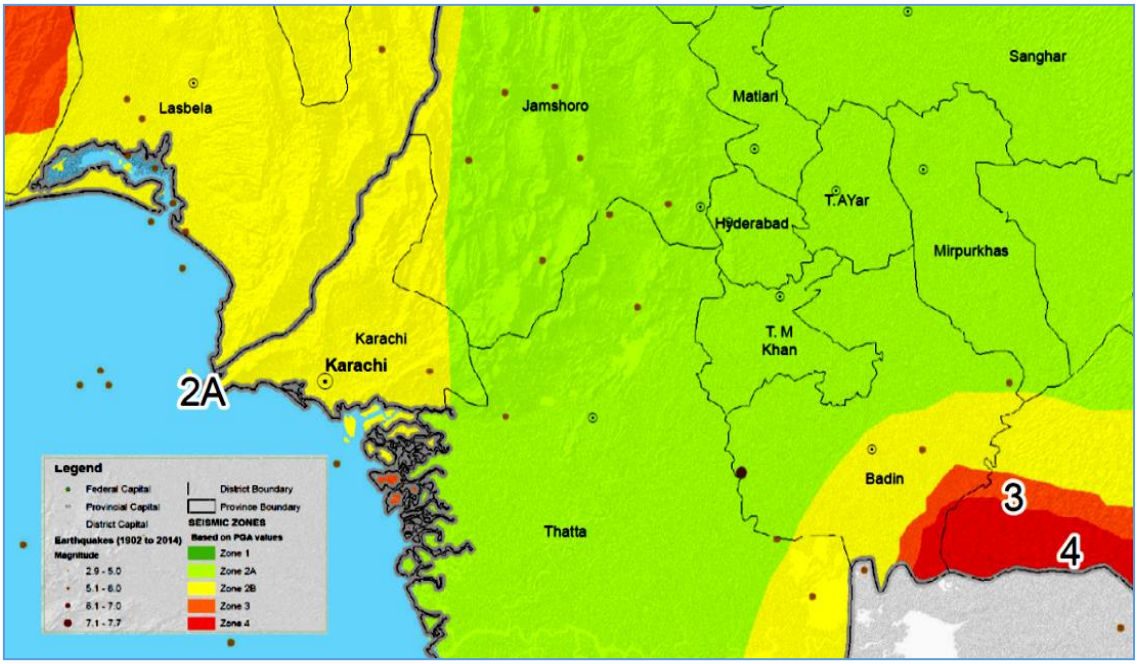


Figure 5.19 - Seismic Zones of Karachi
(PMD, GSP, Pakistan Engineering Council)

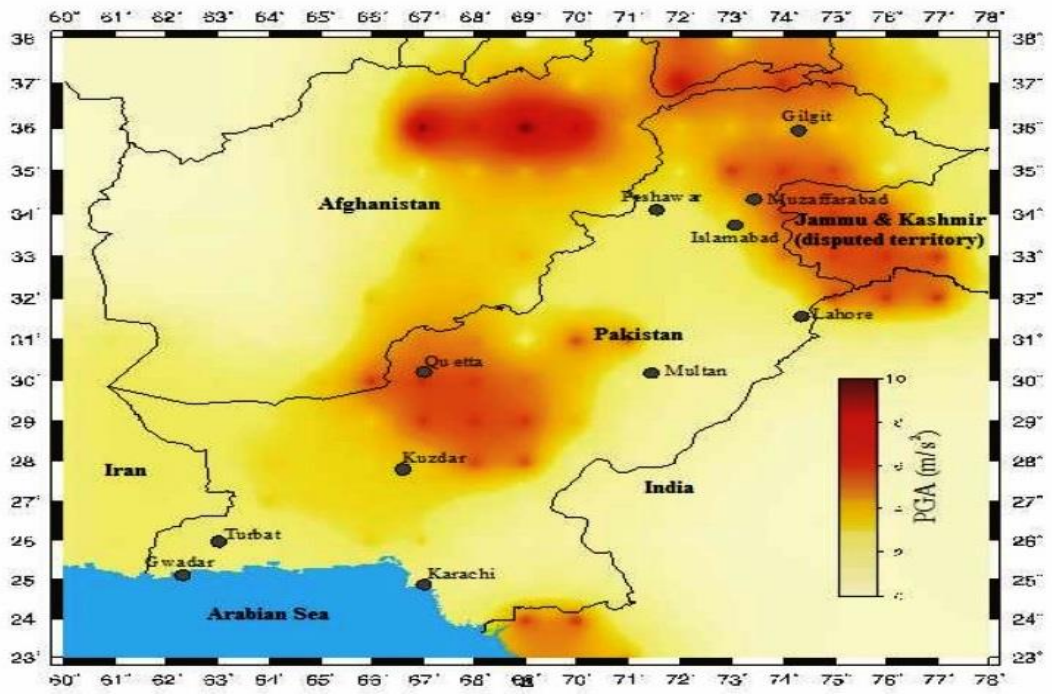


Figure 5.20 - Seismic Hazards for Pakistan in terms of Peak Ground Acceleration

Seismic activity in the region is the result of the triple junction as well as the Karachi Arc, located in southeastern Pakistan, as a large fold and thrust belt that shows Neogene thin-skinned eastward movement (Sarwar and DeJong, 1979; Schelling, 1999). Seismic activity in and around the region shows that the Karachi Arc has been active since long in prompting the eastward movement of the delta. It is possible that the movement is related to the rebound that takes place after mass shift. Sarwar has suggested that the eastward creep of Karachi Arc is directly related to active subsidence of the Hyderabad graben that underlies it and also defines the northern and southern limits of the Karachi Arc.[9]

It may be added that subsidence such as that on Southern coast of Sindh, occurs naturally as a result of plate tectonic activity above active faults, and in places where fluid is expelled from underlying sediments and is common at river deltas that may have receded. Earthquakes arise and result from the release of the force along the growth fault plane. As a result, many different growth faults are created as sediment loads shift basin ward and landward.

Liquefaction Potential

The seismicity in Karachi and at the project site is considered to be low. According to the published data, the project area lies in a zone of low seismic activity, with acceleration ranging from 1.6 to 2.8 m/sec². A factor of 2.8 m/sec², on the other hand, has to be taken for a maximum credible earthquake (MCE).

Seismically induced soil liquefaction potential has to be evaluated against a peak horizontal acceleration of 0.2 g for an earthquake of magnitude 6.5 (Richter scale).

[9] (Sarwar, G., 2004. Earthquakes and the Neo-Tectonic Framework of the Kutch-Hyderabad-Karachi Triple Junction Area, Indo-Pakistan. Pakistan Journal of Hydrocarbon Research, 14, 35-40).

5.2.7 Tsunamis

Major damages done by Tsunamis, the impulsively generated seawater waves that are a result of underwater earthquakes, have not been recorded for the coastal area south of Karachi. There are, however, evidences of a 1.2 m tsunami generated by an offshore earthquake of intensity 8 M in 1945, which caused only minor damages in Port Qasim and surrounding areas. This event was followed by another Tidal wave that was recorded in 1953. The Tsunami of December 26, 2004 had no impact on the macroenvironment of the project area.

At Karachi, the tsunami arrived from the direction of Clifton and Gizri. It ran along the oil installations at Keamari and flooded a few compounds. The waves were 6.5 feet or 2.0 meter high when they reached Karachi. There was a delay of more than one hour between the main shock and arrival of the damaging tsunami at Karachi.

According to a PAEC report, Tsunami threat along the Karachi Coast is meager. No tsunamigenic earthquake is recorded in the historic or modern time along Karachi Coast. The tsunami waves generated by the tsunamigenic sources present in the Indonesian Sea will also be obstructed by the Indian and Sri Lankan land masses therefore the coast of Karachi in particular will not be affected.

5.2.8 Hydrology

There is no inland surface water body in project area except the mudflat lying between the 9-meter contour and the coastline of Arabian Sea. The Kadiro Creek area, which forms the macroenvironment of the Project, is the only water body in study area. The complex creek system southeast of Karachi is part of the Indus Delta. The Delta presents a major case study of adverse impact of the progressive reduction in fresh water discharge over a period of time. Whereas construction of dams and barrages has reduced the flow of freshwater into the Arabian Sea. The creeks are hyposaline with salinity in the 27 to 29 ppt range.

The ground water table lies at 2.3-5 meters depth in the study area. The ground water quality is very saline having total dissolved solids about 20,000 mg/l. It is therefore, very poor-quality ground water and unsafe for human consumption.

The coastal belt has been used to dispose of sewage from adjacent coastal areas and industries located in Korangi Industrial Area, Landhi Industrial Trading Estate and Bin Qasim Industrial Area. There are several open drains carrying untreated raw sewage discharge in to the Korangi and Gharo Creek. However, the Kadiro Creek at which the PQA is developed, is considerably less polluted in terms of sewage and industrial effluents.

The constant inflow of untreated effluent into the coastal waters has led to marine pollution which, by various accounts, has reduced the quality of water and led to loss of habitat for flora and fauna, reduced species diversity, smothering by high suspended solids and oils, accumulation of toxins in marine organisms especially in the larval stages of commercial species, tar balls on beaches, and reduction in amenities, and the eventual loss of marine living resources in the polluted areas.

5.2.9 Sea Level Rise, Sindh Coast

A tide gauge station is installed in Karachi which observes the mean sea levels along the coast. Mean sea level (MSL) observations from 1916 to 2,000 were studied and the rate of rise of MSL was measured as 1.1 millimeters per year (Quraishee 1988, ((NOAA), 2000) during that period, which coincided with global MSLR within that time period, i.e., 1-2 millimeters per year (IPCC TAR 2001 & IPCC AR4 2007).

Due to limited data, the impact of SLR is difficult to model till the end of 21st century for Pakistan. However, global and regional data of SLR projections can be used to estimate the degree of hazard to be faced by Pakistan in the future. IPCC AR5, 2014 references global mean SLR of 0.2 to 0.6 meters by the end of 2100, whereas for South Asia including Pakistan coast, projected SLR is 0.7 m by 2100 on average (with range between 0.42-1.12 meters and a 90% level of confidence) (see Figure 5.21) (ADB, 201710).

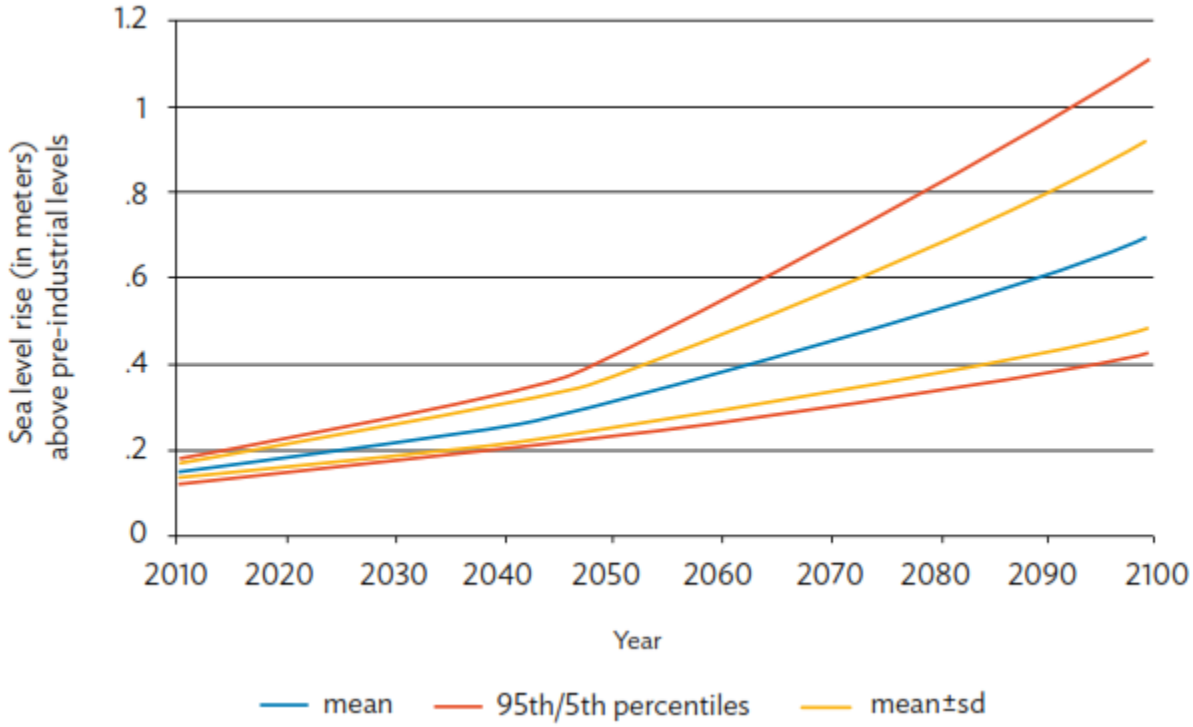


Figure 5.21 - Modelled Mean SLR till 2100 in South Asia Region (Suphachalasai, 2014[11])

5.3 Climate & Meteorology

The climate of the macroenvironment can be characterized by dry, hot and humid conditions and in general terms it is moderate, sunny and humid. There is a minor seasonal intervention of a mild winter from mid-December to mid-February followed by a long hot and humid summer extending from April to September, with monsoon rains from July to mid-September. The characteristic climatic feature of the four seasons of Karachi is presented in table below.

Table 5.2: Seasonal Characteristics of the Climate of Karachi

Season	Temperature	Rainfall	Wind
Summer (Mid-March to Mid-June)	The summer is hot with temperature increasing from 26.2 °C in March, rising up to 40 °C in June.	There are less frequent rain showers in summer with no more than 1 or 2 rainy days in summer.	The wind speed in summer is variable. It is around 2.5 m/s in March and rises up to 18 m/s in April and drops to 4 m/s for the rest of the season.
Monsoon (Mid-June to mid-September)	The temperature in monsoon remains high but relatively lower than	Almost 80 % of the yearly rain occurs in the monsoon with July and	The wind direction in the monsoon is mostly blowing from East.

[10] ADB. (2017). Climate Change Profile of Pakistan. Asian Development Bank

[11] Suphachalasai, A. A. (2014). Assessing the Costs of Climate Change and Adaptation in South Asia. Asian Development Bank

	summer and oscillates around 32°C.	August being the wettest month.	
Post-Monsoon Summer (Mid-September to November)	The average temperature post monsoon drops and average min temperature may reach 12 °C in November.	The post-monsoon period remains mostly dry and rainfall in November is around 1.8 mm.	The wind speed in September is around 3.7 m/s and drops to 1.4 m/s in November.
Winter (December to mid-March)	The winter is mild with January being the coolest month where average minimum temperature falls to 6 °C.	Like the other seasons, except monsoon, there is little occasional rainfall. The rainfall in winter is less than 50 mm.	The wind speed in the winter season increases from 1.4 m/s in December to 2.6 m/s in March. The wind direction for most part winter season is blowing from NE and changes its course to blowing from West in early March

Climate data for the project area has been obtained from the Pakistan Meteorological Department (PMD) Station No. 41780 located at Karachi Airport, which represents the regional climatic conditions for the study area. The dataset used in this assessment comprises five years of meteorological records, including temperature, rainfall, humidity, and wind parameters.

5.3.1 Temperature

The air temperature in Karachi Division and its coastal areas are generally moderate throughout the year due to presence of sea. Climate data generated by the meteorological station at Karachi Airport represents climatic conditions for the region. The mean monthly maximum and minimum temperatures, recorded during 2001-2025 in Karachi to describe the weather conditions are shown in Table 5.3 and 5.4 respectively. The Tables indicate that the mean monthly maximum temperature in Karachi ranged between 26.8°C and 36.8°C during the 2001-2020 periods, while the mean monthly minimum temperature ranged between 12.9ºC and 29.8°C. The annual mean maximum and mean minimum temperatures during 2001-19 periods were 33.0°C and 21.0°C respectively, which indicates that there has been a slight but significant rise in the mean minimum temperature during the last 23 years.

Table 5.3 - Mean Monthly Maximum Temperature °C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	27.2	29.6	33.1	34.6	35.1	34.9	32.2	32.3	33.1	36.0	33.5	30.4	32.7
2002	27.0	28.2	33.3	35.4	35.6	35.1	32.2	31.6	31.4	36.5	32.7	28.1	32.3
2003	27.6	28.5	32.4	36.6	35.7	34.9	34.1	32.6	32.5	37.0	32.2	28.3	32.7
2004	26.6	29.9	36.2	35.4	36.8	35.6	33.8	32.7	32.8	33.7	33.1	29.4	33.0
2005	24.9	26.3	31.5	35.3	35.4	36.0	33.2	32.2	34.2	35.2	33.1	28.4	32.1
2006	26.0	31.3	31.8	34.0	34.6	35.3	33.8	31.0	34.2	35.0	33.4	26.3	32.2
2007	26.9	29.4	31.4	37.7	36.0	36.4	N/A	N/A	N/A	N/A	N/A	N/A	33.0
2008	24.4	26.9	34.3	34.4	33.9	35.1	33.5	31.9	34.7	35.5	32.5	27.2	32.0
2009	26.2	29.8	33.0	36.0	36.8	35.7	34.5	33.0	32.8	35.9	33.0	28.6	32.9
2010	27.5	29.2	34	35.7	36.5	34.7	34.6	33.2	34.5	35.9	32.7	28	33.0
2011	26.9	28.5	33.2	35.8	35.3	35.3	34.2	32.8	32.9	N/A	N/A	N/A	N/A
2012	25.7	26.9	31.7	35.1	35.5	34.6	33.2	32.7	33.2	35.0	32.7	28.2	32.0
2013	26.7	28.0	33.3	34.0	35.1	36.5	33.8	32.1	33.0	35.7	32.3	28.3	32.4
2014	25.5	28.0	31.7	35.1	35.9	36.5	34.0	33.7	33.8	36.3	32.9	28.7	32.7
2015	26.3	28.9	31.5	35.9	36.0	37.7	34.1	32.3	34.6	35.8	33.0	28.6	32.9
2016	27.8	30.3	33.3	34.7	35.7	36.1	33.6	33.0	32.9	34.0	33.3	31.0	33.0
2017	25.4	30.2	32.8	35.5	36.2	36.3	33.1	33.8	33.4	36.6	32.3	28.2	32.8
2018	28.5	30.4	34.4	36.2	38.7	35.4	33.8	31.9	32.6	36.8	33.8	28.2	33.4

2019	26.3	26.8	31.3	35.4	36.0	37.2	34.7	32.5	35.7	35.8	31.5	27.1	32.5
2020	24.3	30.1	31.2	36.2	36.6	37.3	36.7	34.6	35.0	36.2	31.4	28.1	33.1
2021	26.6	31.3	34.6	37.3	37.5	36.1	34.5	32.6	36.3	34.8	34.0	27.6	33.6
2022	24.6	30.1	35.2	37.4	36.8	35.7	33.3	32.1	33.7	35.7	32.9	29.6	33.1
2023	25.6	30.9	33.3	34.5	35.5	35.9	35.0	31.4	34.4	35.1	33.0	29.4	32.8
2024	27.3	28.6	31.9	34.5	37.3	37.1	36.5	32.5	33.4	37.3	33.8	27.6	33.1
2025	27.2	30.4	34.7	37.2	36.5	35.6	34.3	33.0	32.4	35.3	31.8	29.2	33.1
Source: Pakistan Meteorological Department													

Table 5.4 - Mean Monthly Minimum Temperature °C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	11.5	14.9	19.6	23.8	28.1	29.0	27.1	26.5	25.9	24.4	18.6	15.8	22.1
2002	12.8	13.8	19.5	23.9	27.0	28.2	29.6	25.6	24.8	22.5	17.7	14.9	21.7
2003	12.7	16.9	19.8	24.2	26.5	28.2	23.6	27.0	25.3	20.9	15.2	12.0	21.0
2004	12.9	14.5	19.1	24.8	27.3	28.8	27.5	26.3	25.3	22.4	18.0	15.4	21.9
2005	12.3	11.3	20.3	23.0	26.4	28.3	27.2	26.6	26.6	22.9	18.9	13.0	21.4
2006	11.7	18.1	19.6	24.5	27.5	28.5	28.3	26.3	26.8	25.7	19.4	14.0	22.5
2007	13.0	17.3	19.7	24.7	27.6	28.6	N/A	N/A	N/A	N/A	N/A	N/A	21.8
2008	10.1	11.1	19.6	24.0	27.3	29.1	27.9	26.8	26.6	23.8	17.6	14.9	21.6
2009	14.7	16.5	20.8	23.8	27.6	28.7	28.1	27.5	26.5	22.6	17.0	13.9	22.3
2010	12.2	14.7	21.3	25.1	28	28.2	28.3	27.2	25.8	23.9	17.4	11.1	21.9
2011	11	14.5	19.7	23.1	27.1	28.8	27.8	28.6	26.5	N/A	N/A	N/A	N/A
2012	11.2	11.9	19.1	24.5	27.2	28.0	27.9	26.9	26.4	22.7	18.6	14.2	21.5
2013	11.6	15.1	19.2	24.2	27.1	29.3	28.0	26.6	25.5	25.4	18.1	13.0	21.9
2014	9.9	13.1	18.9	24.4	27.0	29.2	28.3	27.1	26.8	23.3	19.5	13.1	21.7
2015	12.6	16.4	19.2	25.7	27.7	29.8	28.4	26.9	26.3	24.9	18.6	12.6	22.4
2016	14.8	14.9	21.7	24.6	27.9	27.9	28.1	27.1	26.4	24.0	17.1	15.5	22.5
2017	12.5	18.2	20.3	24.4	27.8	29.2	27.7	27.0	26.2	23.5	16.8	13.0	22.2
2018	12.9	15.8	20.9	25.3	27.7	28.8	28.1	26.3	25.5	23.0	19.3	13.1	22.2
2019	13.3	15.3	19.0	24.0	26.6	28.9	28.1	26.8	27.2	24.0	19.4	13.7	22.2
2020	10.8	15.3	19.1	24.7	27.7	29.7	29.4	28.1	27.3	22.7	16.0	12.5	21.9
2021	9.2	15.0	21.6	25.1	28.9	29.6	28.5	27.4	28.0	23.1	17.6	13.9	22.3
2022	12.8	15.9	21.6	25.5	28.1	28.6	27.4	27.1	26.8	22.7	19.3	13.2	22.4
2023	10.6	15.4	20.9	24.3	27.5	29.3	28.9	27.0	27.1	25.7	20.0	14.8	22.6
2024	13.6	16.8	19.7	24.8	28.1	30.0	30.3	27.5	27.0	26.3	21.9	12.6	23.2
2025	11.5	16.5	20.6	25.2	28.6	29.1	28.9	27.3	26.6	24.1	16.9	13.5	22.4
Source: Pakistan Meteorological Department													

5.3.2 Precipitation

The main source of precipitation is rainfall which is received mostly in the months of July to September during SW Monsoon winds. It is very erratic as some years are very dry and there is no rain. The average rainfall is 217 mm and most of it is received in the month of July.

Occasional winter rains are also received in the months of December – February as result of NE winds which count 15-25% of total rainfall. A summary of the precipitation amount the city of Karachi has seen over the years is provided below:

Table 5.5 - Monthly Amount of Precipitation (mm) at Karachi Airport

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	0	0	0	0	0	10.6	73.6	16.2	N/A	0	0	0	100.4
2002	0	2.4	0	0	0	N/A	N/A	52.2	N/A	0	0.5	0.4	55.5
2003	6.4	21.8	0	0	0	16.3	270.4	9.8	N/A	0	0.2	0	324.9
2004	13.7	0	0	0	0	N/A	3	5.6	N/A	39.3	0	4.3	65.9
2005	6.6	12.8	N/A	0	0	N/A	N/A	0.3	54.9	0	0	17.1	91.7

2006	N/A	0	N/A	0	0	0	66.2	148.6	21.9	0	3.1	61.3	301.1
2007	0	13.2	33.4	0	0	110.2	N/A	N/A	N/A	N/A	N/A	N/A	156.8
2008	8	Trace	1.1	0	0	0	54	37.5	Trace	0	0	21	121.6
2009	3	Trace	0	Trace	0	2.6	159.9	44	68.9	0	0	1.5	279.9
2012	0.2	0	0	0	0	Trace	Trace	8.1	121	0	0	22.8	152.1
2013	Trace	20	2.8	30	0	Trace	5.5	105.4	4	1.2	0	0	168.9
2014	Trace	0	12.4	0	1.3	Trace	1.1	9.9	1.4	0	4.6	0	30.7
2015	0.3	2.1	2.8	0	0	Trace	46.6	1.4	Trace	0	0	0	53.2
2016	3.1	0	Trace	0	0	65.8	1.9	96.9	Trace	0	0	0	167.7
2017	41.5	Trace	0	0	0	58.8	33.3	65.6	26.4	0	0	6.6	232.2
2018	Trace	Trace	0	0	0	Trace	Trace	0.8	Trace	0	0	Trace	0.8
2019	39.4	Trace	2.2	0	0	1.6	66.3	204	51.7	1.2	Trace	Trace	367.3
2020	Trace	2.6	0.5	0	0	Trace	101.2	366.8	Trace	0	3.1	0	474.2
2021	0	0	0	0	0	Trace	45.4	Trace	88.3	17.2	0.0	16.9	167.8
2022	28.5	0.4	0	0	0	21.6	348.3	127.9	43.4	0	2.6	0	572.7
2023	0.0	0.0	5.7	2.2	14.9	4.0	40.4	Trace	4.6	0.0	5.5	0.0	77.3
2024	2.2	60.6	12.3	15.1	0.0	0.5	67.1	159.4	0.6	12.0	0.0	0.0	329.8
2025	0.0	Trace	0.0	0.0	0.0	29.7	2.0	205.1	72.3	33.7	0.0	1.2	344.0
Source: Pakistan Meteorological Department													

5.3.3 Humidity

The relative humidity typically ranges from 25% (dry) to 70% (humid) over the course of a year, rarely dropping below 20% (very dry) and reaching as high as 90% (very humid). A summary of the relative humidity in Karachi across the years is provided below:

Table 5.6 - Mean Monthly Relative Humidity (Mean) at 1200 UTC (%)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2014	25.0	27.0	35.0	47.0	57.0	61.0	64.0	61.0	60.0	36.0	36.0	31.0	45.0
2015	38.0	41.0	37.0	45.0	60.0	56.0	69.0	67.0	56.0	47.0	28.0	31.0	47.9
2016	46.0	25.0	41.0	47.0	60.0	60.0	68.0	70.0	63.0	57.0	34.0	38.0	50.8
2017	38.0	25.0	36.0	44.0	59.0	62.0	70.0	67.0	63.0	44.0	29.0	20.0	46.4
2018	36.0	37.0	33.0	45.0	46.0	65.0	65.0	68.0	63.0	40.0	32.0	30.0	46.7
2019	40.4	33.9	36.6	48.0	55.6	58.8	64.8	72.6	67.6	41.1	34.6	29.7	48.6
2020	29.9	28.1	34.2	44.4	57.1	56.8	65.0	74.8	62.4	38.1	32.9	29.1	46.1
2021	31.3	34.1	41.2	43.3	54.3	60.3	67.5	64.5	63.0	46.5	27.6	38.7	47.7
2022	40.5	39.1	37.7	47.1	55.3	62.1	74.7	79.1	66.3	42.0	49.4	36.5	52.5
2023	25.5	42.2	39.3	46.7	57.7	62.4	67.8	71.0	59.5	54.9	32.5	28.7	49.0
2024	42.8	35.1	34.6	48.7	52.3	57.8	69.6	73.7	66.4	50.1	47.2	22.1	50.0
2025	26.8	33.6	27.9	44.2	58.6	63.3	64.2	68.0	68.2	33.5	31.2	30.2	45.8
Source: Pakistan Meteorological Department													

5.3.4 Wind Speed & Direction

The wind direction and speed between the summer and winter monsoon seasons are rather unsettled and large variations are noted both with respect to speed and direction.

The twenty five years' wind velocity record (2001-2025) indicates that the velocity varies and ranges between 1.0 m/s to 13.7 m/s. The Tables 5.7 and 5.8 show the wind speed and direction respectively in Karachi.

Table 5.7 – Mean Monthly Wind Speed at 1200 UTC (knots)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	2.6	3.4	4.3	5.6	7.5	8.1	6.8	7.3	5.5	3.7	2.0	2.4	4.9
2002	3.6	3.9	4.0	6.5	8.5	8.2	9.8	7.3	7.7	3.3	2.9	3.2	5.7

2003	4.0	5.0	5.4	5.2	7.7	8.8	6.7	7.1	6.0	3.2	3.1	3.0	5.4
2004	3.4	3.7	4.0	6.0	8.0	9.0	10.0	9.5	7.3	3.8	1.0	2.5	5.7
2005	3.6	4.2	4.8	5.1	7.1	7.5	9.0	6.9	6.4	3.9	2.0	1.5	5.2
2006	2.0	3.0	3.0	6.2	8.0	7.7	8.3	6.2	4.7	4.2	2.2	3.0	4.9
2007	2.0	3.7	4.0	4.0	6.0	6.3	N/A	N/A	N/A	N/A	N/A	N/A	4.3
2008	4.3	7.6	8.2	10.5	12.6	7.6	11.0	9.3	8.7	6.6	5.1	3.9	7.9
2009	7.0	7.2	7.9	9.3	9.8	9.7	9.5	9.3	9.1	6.1	5.0	3.9	7.8
2012	5.8	6.6	9.3	9.8	12.3	12.8	13.1	11.2	8.4	7.1	5.7	5.8	9.0
2013	5.2	6.9	9.0	10.3	11.5	10.8	12.0	11.2	10.3	7.7	5.1	4.5	8.7
2014	5.9	8.9	8.6	11.5	12.4	13.4	12.8	11.6	11.7	8.3	6.0	4.5	9.6
2015	6.9	10.3	10.1	11.5	12.8	12.3	13.7	12.3	10.5	8.7	5.6	5.8	10.0
2016	7.5	8.7	4.8	1.1	13.0	11.7	11.8	10.5	12.1	9.2	5.5	5.2	8.4
2017	7.0	8.0	10.8	12.1	12.8	11.5	12.1	10.3	8.7	8.5	5.4	7.4	6.9
2018	6.3	7.0	9.5	10.2	10.8	11.1	12.3	12.4	12.2	8.7	6.1	6.8	9.4
2019	6.7	8.9	10.2	11.7	12.1	11.7	13.7	9.1	8.5	8.0	6.9	7.4	9.6
2020	9.0	9.4	9.0	10.5	13.3	10.9	10.1	8.9	9.4	7.3	6.2	5.5	9.1
2021	6.1	7.6	9.7	8.5	11.7	12.7	12.6	11.1	8.8	8.1	6.7	6.6	9.2
2022	6.8	7.9	8.9	9.9	12.5	12.5	9.5	7.0	8.8	7.0	6.1	4.8	8.5
2023	7.0	7.7	9.2	10.1	11.7	11.5	11.3	12.3	9.1	7.9	6.9	6.6	9.3
2024	7.1	7.1	8.1	9.9	10.1	11.3	10.0	10.2	9.5	7.2	6.8	6.3	8.6
2025	6.7	7.7	9.4	10.5	10.6	11.6	10.6	9.7	8.9	8.5	6.2	5.5	8.8
Source: Pakistan Meteorological Department													

Table 5.8 - Mean Monthly Wind Direction at 1200 UTC

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	S54W	S43W	S42W	S45W	S46W	S45W	N52W	S59W	S44W	N56W	S45W	S06W
2002	S67W	S52W	S51W	S55W	S51W	S42W	S54W	S45W	S48W	S56W	N54W	S41W
2003	S60W	N50W	S45W	S48W	S45W	S68W	S60W	S47W	S43W	S54W	S50W	S27W
2004	N27E	S46W	S53W	S49W	S52W	S54W	S54W	S62W	S56W	S47W	S45W	N86E
2005	N63E	S51W	S50W	S52W	S63W	S48W	S54W	S49W	S87W	S54W	S52W	N23W
2006	S48W	S62W	S50W	S57W	S64W	S60W	S67W	S78W	S51W	S53W	S49W	N79E
2007	S30W	S62W	S47W	S55W	S58W	S47W	S41W	S55W	S60W	S48W	S48W	N45E
2008	N45E	S47W	S54W	S51W	S52W	S39W	S50W	S52W	S46W	S39W	S38W	N
2009	N45E	S45W	S41W	S58W	S46W	S46W	S56W	S49W	S56W	S42W	S39W	S45E
2012	S3E	N56E	S62W	S46W	S61W	S51W	S66W	S51W	S53W	S41W	S41W	N9W
2013	N39W	S54W	S56W	S54W	S61W	S40W	S53W	S52W	S55W	S47W	S17W	N50W
2014	S72E	S54W	S43W	S46W	S46W	S45W	S54W	S48W	S85W	S45W	S49W	S45E
2015	S72E	S54W	S43W	S48W	S50W	S40W	S54W	S55W	S50W	S41W	S	S58W
2016	S43W	S36W	S48W	S54W	S54W	S45W	S48W	S36W	S51W	S45W	S43W	S36W
2017	S83E	S56W	S51W	S45W	S45W	S44W	S66W	S57W	S48W	S51W	S59W	N45E
2018	S39W	S39W	S46W	S51W	S50W	S45W	S45W	S48W	S46W	S46W	S42W	S18W
2019	S24W	S65W	S45W	S44W	S42W	S37W	S48W	S46W	S53W	S35W	N59E	N55E
2020	N31E	S12W	S52W	S55W	S49W	S44W	S47W	S55W	S47W	S38W	S4E	N35E
2021	S21W	S38W	S44W	S42W	S52W	S53W	S55W	S48W	S40W	S41W	S22E	S40E
2022	N45E	S54W	S57W	S59W	S57W	S56W	S62W	S59W	S60W	S48W	S32W	S32W
2023	S22E	S45W	S40W	S58W	S65W	S38W	S56W	S74W	S57W	S53W	S40E	S84E
2024	S3E	S8E	S50W	S51W	S41W	S45W	S54W	S72W	S57W	S27W	S40W	N41E
2025	S4E	S38W	S30W	S33W	S32W	S36W	S34W	S40W	S42W	S5E	S16W	S5W
Source: Pakistan Meteorological Department												

5.3.5 Tropical Cyclones

Though cyclones are rare in the Arabian sea which is a part of North Indian Ocean, cyclones that form in this sea mostly move towards Western India rather than Pakistan.[12] Cyclones in the Arabian

[12] http://www.imd.gov.in/section/nhac/static/cyclone-history-as.htm

sea form mostly from May till June and then from September till October, monsoon season plays a vital role for the formation of cyclone in this basin.[13]

Each year before the onset of monsoon that is 15 April to 15 July and also after its withdrawal that is 15 September to 15 December, there is always a distinct possibility of the cyclonic storm to develop in the north Arabian Sea. There is a 98 per cent chance of cyclones to turn towards the Indian state of Gujarat, one per cent chance of moving towards the Gulf and one per cent chance of moving towards the Pakistani coast.[14] There is only one tropical cyclone warning center in Pakistan, which is in Karachi in Sindh province.[15]

Cyclones mostly hit the Sindh coast than the Balochistan coast in Pakistan. During the last 125 years a number of cyclonic storms have struck Pakistan's coastal areas. The years involved were 1895, 1902, 1907, 1944, 1948, 1964, 1985, 1999, 2007 and 2010. Other cyclones that are listed below caused rains as remnants.[16]

Cyclone Storm Categories

a) Category 1. Depression/ Deep Depression with wind speeds between 31 – 61 kmh.
b) Category II. Cyclonic Storm with wind speed between 62 – 88 kmh.
c) Category III. Severe Cyclonic Storm with wind speeds between 89 – 118 kmh.
d) Category IV. Very Severe Cyclonic Storm with wind speeds between 119 -221 kmh.
e) Category V. Super Cyclonic Storm with wind speeds above 221 kmh.

Cyclone Occurrences in Pakistan

Over the past year's cyclones tend to recur frequently though, most did not seriously impact Pakistan's coast. However, cyclone of 1999 seriously impacted Thatta and Badin districts of Sindh and affected 0.6 million people and caused loss of 202 lives.

Table 5.9: History of cyclone occurrence along and on the Pakistan coast

Name / Year	Impact	Attributes	Affected Region
Asna: August 30 to September 2, 2024	Region: Arabian Sea Saffir-Simpson scale: tropical storm	Wind speed: max. 83 km/h on land: max. 69 km/h	Sindh
Biparjoy: June 6-16, 2023	Region: Arabian Sea	Wind speed: max. 165 km/h Diameter: max. 567 km	Sindh
Gulab: September 24 to October 4, 2021	Region: Arabian Sea	Wind speed: max. 130 km/h on land: max. 46 km/h	Sindh
Gulab: September 23 to October 4, 2021	Region: Arabian Sea	Wind speed: max. 111 km/h Diameter: max. 556 km	Sindh Balochistan
Tauktae: May 13-19, 2021	Region: Arabian Sea	Wind speed: max. 185 km/h	Sindh

[13] http://www.associatepublisher.com/e/t/tr/tropical_cyclone.htm
[14] http://www.reliefweb.int/rw/rwb.nsf/db900sid/MYAI-86495X?OpenDocument
[15] http://www.pakmet.com.pk/
[16] http://indianweatherman.blogspot.com/2010/06/cyclone-history-for-karachi.html

Name / Year	Impact	Attributes	Affected Region
		on land: max. 46 km/h	
Source: https://www.worlddata.info/asia/pakistan/cyclones.php			

The Mangroves and the deltaic islands provide a buffer in case of storm surges, cyclones and Tsunamis.

5.4 Environmental Monitoring

Environmental monitoring was carried out in the project area to obtain primary data for the further robust development of the baseline conditions of the project area. The monitoring carried out included ambient air monitoring, noise monitoring, and sea water quality assessments in the area where works are proposed.

The results from the monitoring carried out along with the analysis of these results is provided below:

5.4.1 Ambient Air Quality

Baseline ambient air quality monitoring was conducted to determine the concentration of major atmospheric pollutants in the project area. Air quality monitoring was carried out at seleted locations within the terminal area over an eight hour moniotring period.

Table 5.10 - Results from Ambient Air Quality Monitoring

Location	Parameter	Unit	Monitoring Duration	Average Obtained Concentration	SEQS	LDL-Limits	Methodology
QICT Project Area (Berth no. 1)	**Carbon Monoxide (CO)**	**mg/m^3**	**08 Hours**	**0.40**	**5.0**	**0.01**	Non-Dispersive Intra Red (NDIR)
	Nitrogen oxide (NO)	**µg/m^3**	**08 Hours**	**21.3**	**40.0**	**0.0**	Chemiluminescence
	Nitrogen Dioxide (NO_2)	**µg/m^3**	**08 Hours**	**19.7**	**80.0**	**0.0**	
	Sulphur Dioxide (SO_2)	**µg/m^3**	**08 Hours**	**25.3**	**120.0**	**0.0**	Ultraviolet Fluorescence Method
	Ozone (O_3)	**µg/m^3**	**01 Hour**	**21.1**	**130.0**	**0.0**	Non-Dispersive UV Absorption Method
	Particulate Matter (PM_{10})	**µg/m^3**	**08 Hours**	**109.1**	**150.0**	**10.0**	β Ray Absorption Method
	Particular Matter ($PM_{2.5}$)	**µg/m^3**	**08 Hours**	**32**	**75.0**	**2.5**	
	Suspended Particulate Matter (SPM)	**µg/m^3**	**08 Hours**	**270.6**	**500.0**	**1.0**	
	Lead (Pb)	**µg/m^3**	**08 Hours**	**ND**	**1.5**	**0.01**	ASS Method
QICT Project	**Carbon Monoxide (CO)**	**mg/m^3**	**08 Hours**	**0.47**	**5.0**	**0.01**	Non-Dispersive Intra Red (NDIR)

Location	Parameter	Unit	Monitoring Duration	Average Obtained Concentration	SEQS	LDL-Limits	Methodology
Area (Berth no. 2)	**Nitrogen oxide (NO)**	**µg/m³**	**08 Hours**	**25.4**	**40.0**	**0.0**	Chemiluminescence
	Nitrogen Dioxide (NO_2)	**µg/m³**	**08 Hours**	**23.4**	**80.0**	**0.0**	
	Sulphur Dioxide (SO_2)	**µg/m³**	**08 Hours**	**27.4**	**120.0**	**0.0**	Ultraviolet Fluorescence Method
	Ozone (O_3)	**µg/m³**	**01 Hour**	**19.5**	**130.0**	**0.0**	Non-Dispersive UV Absorption Method
	Particulate Matter (PM_{10})	**µg/m³**	**08 Hours**	**120.5**	**150.0**	**10.0**	β Ray Absorption Method
	Particular Matter ($PM_{2.5}$)	**µg/m³**	**08 Hours**	**36.9**	**75.0**	**2.5**	
	Suspended Particulate Matter (SPM)	**µg/m³**	**08 Hours**	**283.4**	**500.0**	**1.0**	
	Lead (Pb)	**µg/m³**	**08 Hours**	**ND**	**1.5**	**0.01**	ASS Method

The monitoring results indicated that the concentrations of all measured parameters were within the limits prescribed by the Sindh Environmental Quality Standards (SEQS) for ambient air quality.

5.4.2 Noise

Baseline noise monitoring was conducted to assess the existing noise environment within the project area. Noise measurements were taken at representative locations within the terminal area, including operational berth locations.

Noise levels were measured using calibrated sound level meters, and the results were recorded in decibels [dB(A)] as equivalent continuous sound levels (Leq).

Table 5.11 - Noise Testing Results

S. #.	LOCATION/SOURCE	SEQS Limits: 75dB(A) *Leq		
		Noise Level Readings		
		Minimum	Maximum	Average
1	Berth No 1	65.9	66.8	66.3
2	Berth No 2	69.4	70.5	69.9
SEQS=Sindh Environmental Quality Standard. *dB (A) Leq: Time weighted average of the level of sound in decibel on scale which is relatable to human hearing.				

The monitoring results indicated average noise levels of approximately 66-70 dB(A), which are within the applicable SEQS limit of 75 dB(A) for industrial areas.

5.4.3 Sea Water Quality

Baseline marine water quality monitoring was conducted to assess the existing seawater conditions in the vicinity of the proposed project site at Qasim International Container Terminal (QICT), Port Qasim. Seawater samples were collected from representative locations using

standard grab sampling methods and analyzed at a SEPA-certified laboratory following recognized analytical procedures. The results provide baseline environmental conditions for comparison with future monitoring during project implementation and are presented in the table below.

Table 5.12 - Sea Water Quality Testing Results

S.No	PARAMETERS TO BE ANALYZED	LDL	UNITS	RESULTS	TEST METHOD
1	Temperature	1.0	^{0}C	29	Thermometer
2	pH value	0.01	-	8.33	USEPA 150.1
3	Biochemical Oxygen Demand $(BOD)_5$ at 20^0C	0.1	mg/L	44	Hach 8043
4	Chemical Oxygen Demand (COD)	1.0	mg/L	78	ASTM D1252
5	Total Suspended Solids (TSS)	1.0	mg/L	12	Hach 8006
6	Total Dissolved Solids (TDS)	1.0	mg/L	31,800	Hach 8160
7	Total Hardness as $CaCO_3$	0.1	mg/L	14,322	EDTA Titration.Hach-8213
8	Ammonia (NH_3)	0.1	mg/L	0.36	Hach 10031
9	Nitrate (NO_3)	0.01	mg/L	14	Hach -8039
10	Cyanide (as CN-) total	0.001	mg/L	0.042	Hach 8027
11	DO	1.0	mg/L	1.26	ASTM D888
12	Mercury		mg/L	0.12	ASTM D-3223
13	Total Petroleum Hydrocarbon (TPH)	0.1	mg/L	0.28	ASTM D3921
14	Lead	0.1	mg/L	101	ASTM D3559
15	Oil and grease	0.1	mg/L	0.77	ASTM D3921
16	Coliforms	-	cfu	>1000	APHA-SM9221B

SEQS=Sindh Environmental Quality Standards
USEPA=United State Environmental Protection Agency method
Hach USA, method
BDL=Below Detection Limit
APHA-SM = American Public Health Association- Standard Methods for Water & Wastewater Examination
LDL= Least Detectable Value
NoGL=No Guideline Limits Available

5.5 Ecology

5.5.1 Indus Delta

The Indus Delta contains the world's largest area of arid climate mangroves, with the Indus Delta comprising of 17 major creeks, numerous minor creeks and extensive areas of mangrove forests and tidal wetlands. The dense mangrove forests are mainly located in the pockets created by the creeks. The dense mangrove forests are primarily found in creek-formed pockets. About 667,209 ha in size, the delta is a significant ecosystem in this region. It relies almost entirely on freshwater discharges from the Indus River and a small amount of freshwater from Karachi's domestic and industrial effluents.

5.5.2 Climate

Tropical climate prevails in the Indus Delta region. While the monsoon regime dominates the eastern portion of the country, coastal regions receive minimal precipitation. The average annual rainfall along the coast of Sindh is approximately 200 mm. April and October are transitional

months between the southwest and northeast monsoon seasons, which last from May to September and November to March, respectively. Wind speeds during SW monsoons are approximately 25-30 Knots and during NE monsoons they are 5-10 Knots. Therefore, atmospheric and oceanic circulation is more vigorous during the SW monsoon than during the NE monsoon. The circulation of the southwest monsoon appears to penetrate deeper, influencing the movement of water masses below the thermocline, whereas the drift during the northeast monsoon is relatively shallow. The tides are of the mixed semidiurnal type, with two high tides and two low tides each day, with the highest tide reaching a height of 2.60 m.

5.5.3 Historical Freshwater & Sediment Supply Into the Indus Delta area

The fertile high-lying deltaic areas, mainly at the interface of the Indus River and away from the coast, were cultivated on fresh water from the river, or a mixture of saline and fresh water having very low salinity levels. During that era, the communities of Kharo Chan, Keti Bundar and Shah Bundar had very good agrarian economy and these areas would produce red rice in abundance on fresh water, as reported in gazetteers and revenue records (Hague, 1894).

The increase in salinity due to depleting freshwater has reduced the suitability of the delta for the cultivation of agricultural and horticultural crops, and raising of livestock due to loss of grazing lands. The mangrove ecosystem has also been degraded due to a combination of water flow reductions and direct human destruction and overuse (Inam et al., 2006)[17].

The Project Zone is located in the Indus Ecoregion, a biodiversity hotspot identified by the WWF's Global 20018. The Ecoregion consists of riverine forests along the Indus River, mangrove forests and tidal wetlands in the coastal areas, and desert ecosystems on the periphery. The area, which covers around 65% of the Sindh Province, is regarded as the 40 most biologically rich in the Asia-Pacific region.

The fan-shaped Indus Delta is the fifth largest delta in the world and is located south of the Indus Ecoregion. It is a vast complex of multiple tidal river channels and 17 major creeks, low-lying sandy islands, mangrove forests, and intertidal lands extending from Korangi Creek in the west to Sir Creek near the Indian border in the east. In November 2002, the Indus Delta was designated a Ramsar Site.

5.5.4 Biodiversity

The dominating flora of the overall macroenvironment is mainly dominated by mangroves in the intertidal zone. The following floristic list represents a few of the dominant life forms in the macroenvironment. Algal blooms can also be seen in the post-monsoon and early winter seasons. They often restrict mangrove growth by entangling them with their thallus.

Table 5.13: Floral diversity of Janghi Sur downstream Indus River to Arabian sea.

Mangroves				
1	*Avicennia marina*	Timer	Least Concern	The mangroves of provide the habitat for fish, birds, reptiles, mammals, amphibians and crustaceans.
2	*Rhizophora mucronata*	Kumri	Least Concern	
3	*Aegiceras corniculatum*	Chaunr	Least Concern	
4	*Ceriops tagal*	Kiriri	Least Concern	
Algae				

[17] Inam, Asif, Peter D. Clift, Liviu Giosan, Ali Rashid Tabrez, Muhammad Tahir, Muhammad Moazam Rabbani and Muhammad Danish, 2007. The Geographic, Geological and Oceanographic Setting of the Indus River. *In Large Rivers: Geomorphology and Management, Edited by A. Gupta © 2007 John Wiley & Sons, Ltd.*

[18] Olsen, D.M. and E. Dinerstein. 2002. The Global 200: Priority Ecoregions for global conservation. Annals of the Missouri Botanical Garden 199-224

5	*Cyanophyta*	Not Available	Common	• Food chain • Fish culture • Sewage treatment
6	*Chlorophyta*	Not Available	Common	
7	*Bacillariophyta*	Not Available	Common	
8	*Euglenophyta*	Not Available	Common	

Note*: The conservation status vegetation has been assessed through IUCN red list of species.

Coastal Biodiversity

The main vegetation type in the Indus Delta is the mangrove forest. Eight species of mangroves have been reported historically along the Sindh Coast i.e., *Avicennia marina, Rhizophora mucronata*, *Ceriops tagal, Aegiceras corniculatum, Ceriops roxburgiana, Burguiera conguga, Rhizophora apiculate and Sonneratia caseoiaris*. At present, only four survive. *Avicennia marina* is the most common mangrove species found in the area. Avicennia marina can attain heights up to 9 m and girth of 50 cm^2. The other species found are *Rhizophora mucronata*, *Ceriops tagal* and *Aegiceras corniculatum*.

Figure 5.22: Mature Mangrove Plantation Observed outside the AOI

Within the Delta, there are two distinct types of mangrove forest, as depicted in the figure below. In addition, planting activities are planned for a land cover type classified as highly degraded mangrove areas in order to increase and improve forest cover through reforestation and assisted natural regeneration.

Figure 5.23: Dense Mangrove Forest type in the Project Zone on the left and Sparse Mangrove on the right

Dense mangroves are typically found in narrow stretches along creeks and are dominated by *Avicennia marina*, *Rhizophora mucronata*, and *Ceriops tagal*, among others. *Avicennia marina* can

grow as tall as 9 m and as wide as 50 cm^2. There has been some growth of *Tamarix spp*, *Acacia nilotica*, and *Prosopis juliflora*. Undergrowth may include small bushes of *Calotropis procera*, *Atriplex griffithii*, *Aerva javanica*, and *Polycarpaea corymbosa*. The forest class of Sparse Mangroves is most prevalent in sandy, dry areas, such as coastal dunes. *Suaeda fruticosa*, *Salsola barysoma*, *Abutilon indicum*, *Sericostoma pauciflorum*, *Cressa cretica*, *Heliotropium undulatum*, *H. curassavicum*, *Solanum surattense*, *Cyperus conglomeratus*, and various grasses make up the majority of the vegetation.

A salient feature of arid mangroves in the Delta is that there is no understorey of shrubs, herbs and grasses mainly due to high saline conditions and lack of fresh water. However, the natural regeneration of *Avicennia marina* does occupy the gaps found in between other species like *Rhizophora mucronata* and *Ceriops tagal*. Vertically, the three major strata observed along the tidal creeks are: supratidal, intertidal, and subtidal. In each of these three vertical strata, there is a distinct community of species connected with mangrove vegetative structures.

The arboreal sections of mangrove forests comprise the supratidal or uppermost layer. Birds, reptiles, crabs, snails, insects, and spiders inhabit this layer. The intermediate or intertidal layer ranges from high to low water tidal heights and contains the mangroves' aerial root systems. The tides periodically submerge the major inhabitants of this zone (algae, barnacles, isopods, snails, crabs, amphipods and oysters). The lower or subtidal layer exists under the mean low water mark, where mangrove roots provide as a substrate for creatures accustomed to persistent submersion (anemones, tunicates, octocorals, nudibranchs, polychaetes, algae, sponges, brittlestars, shrimp and jellyfish).

Terrestrial and supratidal biodiversity

WWF 2007-08 have reported that 75 bird species including 28 resident and 47 migratory species, 21 species of reptiles, two species of amphibians, 63 species of fish and 24 species of shellfish in the region.

The Indus River, which runs through the heart of the Delta is the main migration route called Indus Flyway is the famous International Migratory Bird Route Number 4. The migratory birds from Siberia followed this route till they reach the mudflats in the Indus Delta. The small Dhands (lakes) formed in the delta provide an excellent breeding and foraging grounds.

Termites and ants (Formicidae) are pervasive and are clearly the most abundant terrestrial animals in these mangroves. It is estimated that may species of ants live in direct association with the mangroves, utilizing hollow twigs and branches as nest sites[19].

Among mammals, wild boar, the Indian jackal, the Bengal fox, the fishing cat, cetaceans (humpback dolphin and bottle-nosed dolphin) and the endangered Indian Pangolin were recorded. Sea snakes are the most common reptiles in the creeks and deltaic plains.

Intertidal and subtidal biodiversity

In addition to the mangrove trees, other primary producers in mangrove communities and adjacent areas include microscopic and macroscopic algae. Microscopic algae are found in the plankton (phytoplankton), on mangrove roots (periphyton) and other substrates (epibenthic), and within the tissues of sea anemones, ascidians, sponges, and other animals (endobionts).

A total of 38 finfish species, 21 shellfish (shrimps, gastropods and bivalves) were identified at different locations in the Delta. *Liza subviridis* of the family Mugilidae, was found to be the dominant

[19] Feller, I.C. and M. Sitnik, 1996. Mangrove Ecology Workshop Manual. Smithsonian Institution, Washington, D.C

species making 14.36% of the total, whereas two other species of the family Sciaenidae, *Johnius carouna* and *Otolithes ruber*, were at 9.41% and 9.94%, respectively[20].

A mudskipper prevalent in the area

Indian Pond Heron

Slug shells also prevalent in low-lying areas

Leptocephalus spp. often observed in low-lying mudflats where marine water reaches

Camel grazing is also prevalent in the area

Some parts of the mudflats are degraded due to unavailability of fresh water, usually they are high-lying areas

5.5.5 Terrestrial Ecosystems

5.5.5.1 Flora

Pakistan is divided into four phyto-geographical regions based on similarity of natural flora. Karachi falls in the Saharo-Sindian region. Floristically this region is considered very poor as represented by the fact that despite its size, only 9.1% of the known 4,940 floral species of Pakistan are found

[20] Project Document - Delta Blue Carbon – 1, March 2021

in this region. However, the project is located close to the coast therefore, marine phytoplankton and mangrove forests are in relative abundance in the coastal areas.

In the study area, empty land in the east of the site comprises natural vegetation with no species of ecological importance. Native Shrubs has grown there due to the natural drainage of stormwater. *Prosopis juliflora* and Tall Reed (*Phragmites karka)* are observed to be in abundance. *Phragmites karka* occurs in swamps and beside streams. It is said to be poisonous to cattle (Duthie) but in any case, it is far too course for fodder. For most of their range these two species of Phragmites are allopatric and *Phragmites karka* is tropical. While *Prosopis juliflora* is a large shrub indigenous to West Indies and Mexico, widely naturalized in Sind and Punjab. It is good firewood and excellent for making charcoal. It is also used for fence posts. The Phragmite is grown due to the natural drainage, however, Prosopis is found as invasive species, common in dry and stony lands of Karachi and Sindh.

Mangrove forest is located quite far away about 2.75 km in the creeks. *Avicennia marina* is the dominant species of the mangroves in the Indus Delta and creek ecosystem. Since the seeds of *Avicennia marina* floats along the water, it can reach miles and find a suitable soil with intertidal condition to grow. The intake channel of PSML also comprises *Avicennia marina* along its length. This is the only plant species which is protected by the Forest Act 1927; however, it is quite far away from the project site.

A list of plants found within the macro-environment, their local and scientific names, distribution, and status are given in the table below.

Table 5.14: Vegetation of the Microenvironment (within 5.0 km radius)

S#	Local Name	Scientific Name	Local Status	Local Distribution
Trees				
1.	Devi	*Prosopis juliflora*	Very common	Karachi region
2.	Kandi Kheji	*Prosopis cineraria*	Common	Lyari, and Gond Pass
3.	Jungali Ber	*Zyziphus nummularia*	Common	Coastal area
4.	Neem	*Azadirachta indica*	Common	Karachi region
5.	Cono	*Conocarpus Erectus*	Common	Planted in Urban area
Shrubs				
6.	Aak	*Calotropis procera*	Common	Saline and Coastal Area
7.		*Salsola foetida*	Common	Saline and Coastal Area
8.		*Salsola bryosoma*	Common	Saline and Coastal Area
9.		*Haloxylon recurvum*	Common	Saline and Coastal Area
10.		*Suaeda nudiflora*	Common	Saline and Coastal Area
11.		*Suaeda fruticose*	Scarce	Saline and Coastal Area
12.		*Salicornia indicum*	Common	Saline and Coastal Area
Reed and Sedges				
13.	Cane Grass-Munj	*Phragmites karka*	Very common	Fresh water and along the Sea coast
14.	Grass-Deer	*Typha angustata*	Scarce	Fresh water and along the Sea coast
15.		*Festuca idahoensis*	Common	Saline and Coastal Area
Herb				
16.	Kapok	*Aerva javanica*	Common	Tharparkar, Sea coast

Coastal Belt: The natural setting of creek coastal ecosystem of the project area has been characterized as (Saifullah et al.):

Dwarf common plants: *Prosopis juliflora*, *Salvadora persica, Cressa cretica*.

Grasses: *Suaeda nudiflora, Cenchrus bliflora, Sporobolus tremulus and Juncellus laerigatis*.

5.5.5.2 Fauna

The faunal density is increased in intertidal channel and mangrove ecosystem located inside the study area of 5 km. The below description provides the reported species found in the macroenvironment and mainly in mangrove ecosystem which is located farther outside the AOI.

Supra-tidal Community: Part of the coastal belt beyond tidal influence is dry and deserted and includes characteristic xerophytic plantation. Through this part, land fauna enters the system for food and sometimes for shelter also. Land vertebrates constitute the major part of the community. Rodents, hares, squirrels and wild boars are herbivores, whereas snakes, lizards, cats, jackals and foxes are omnivores. Water and land birds are also found here which are to some extent omnivores, as also is the case with jackals and foxes.

Table 5.15: List of Mammals reported / recorded in the Macroenvironment

S#	Order	Family	Scientific Name	Common Name	IUCN Status
1.	Rodentia	Muridae	*Rattus rattus*	Common Rat	LC
2.	Rodentia	Sciuridae	*Funambulus pennantii*	Northern Palm Squirrel	LC
3.	Eulipotyphyla	Soricidae	*Suncus murinus*	Asian House Shrew	LC
4.	Carnivora	Felidae	*Felis chaus*	Jungle Cat	LC
5.	Carnivora	Herpestidae	*Herpestes javanicus*	Small Indian Mongoose	LC
6.	Carnivora	Herpestidae	*Herpestes edwardsii*	Indian Grey Mongoose	LC
7.	Artiodactyla	Suidae	*Sus scrofa*	Indian Wild Boar	LC
LC – Least Concern					

Table 5.16: List of Reptiles reported in the Study Area

S#	Order	Family	Scientific Name	Common Name	IUCN Status
1.	Squamata	Agamidae	*Calotes versicolor*	Common Tree Lizard	LC
2.	Squamata	Gekkonidae	*Hemidactylus brookii*	Spotted Barn Gecko	LC
3.	Squamata	Gekkonidae	*Hemidactylus flaviviridis*	Yellow-belly Gecko	LC
4.	Squamata	Gekkonidae	*Hemidactylus persicus*	Persian House Gecko	LC
5.	Squamata	Lacertidae	*Agamura persica*	Blunt-tailed spider Gecko	LC
6.	Squamata	Lacertidae	*Crossobamon orientalis*	Sindh Gecko	LC
7.	Squamata	Lacertidae	*Acanthodactylus cantoris*	Blue-tail Sand Lizard	LC
8.	Squamata	Lacertidae	*Mesalina watsonana*	Spotted Lacerta	LC
9.	Squamata	Scincidae	*Ophiomorus raithmati*	Three-finger Sand Swimmer	LC
10.	Squamata	Colubridae	*Platyceps rhodorachis*	Cliff Racer	LC
11.	Squamata	Colubridae	*Spalerosophis diadema*	Blotched Diadem Snake	LC
12.	Squamata	Colubridae	*Ptyas mucosus*	Indian Rat Snake	LC
13.	Squamata	Colubridae	*Xenochrophis cerasogaster*	Red-belly Marsh Snake	VU
14.	Squamata	Colubridae	*Naja naja*	Black Cobra	LC
15.	Squamata	Viperidae	*Echis carinatus*	Saw-scaled Viper	LC
16.	Squamata	Hydrophidae	*Hydrophis spiralis*	Yellow Sea Snake	LC
LC – Least Concern *VU - Vulnerable*					

Endemic birds: A total of 62 bird species have been reported from the macroenvironment (M Zaheer Khan *et. al* 2018[21]) (Table 5.17). Of these birds, three are included in the IUCN Red List 2012 and listed as Endangered, Vulnerable and Near Threatened. These are Egyptian Vulture, Common Pochard and Black Tailed Godwit respectively.

The intertidal areas of the Indus Deltaic Creeks also provide food and shelter to a number of endemic species of birds. Almost all the species in the above table are found in the Mangrove ecosystem and Kadiro Creek environment. Few of the common species which are commonly found in the built environment, were reported near the industrial areas. Some of these birds are also migratory. The more common among these are Oystercatcher, Lesser Sand Plover, Greater Sand Plover, Grey Plover, Golden Plover, Little Ringed Plover, Kentish Plover, Sanderling, Dunlin, Curlew, Whimbrel, Marsh Sandpiper and Common Sandpiper.

Breeding activities of a number of endemic birds have been reported in the coastal wetlands the Delta particularly of the Little Tern, Common Tern, Gullbilled Tern, Yellow legged Herring, Lesser Black backed Gull and Great Black headed Gull.

The diversity of bird fauna is indicative of food availability, different bird has a range of benthic animals to feed on. The birds feed on a range of organisms from plankton to polychaete worms, crabs and mud skipper.

Table 5.17: List of Birds Reported

S#	Order	Family	Scientific Name	Common Name	IUCN Status
1.	Accipitriformes	Accipitridae	*Milvus migrans*	Black Kite	LC
2.	Accipitriformes	Accipitridae	*Elanus caeruleus*	Black-shouldered Kite	LC
3.	Accipitriformes	Accipitridae	*Haliastur Indus*	Brahminy Kite	LC
4.	Accipitriformes	Accipitridae	*Buteo buteo*	Common Buzzard	LC
5.	Accipitriformes	Accipitridae	*Accipiter badius*	Central Asian Shikra	LC
6.	Accipitriformes	Accipitridae	*Circus aeruginosus*	Marsh Harrier	LC
7.	Accipitriformes	Accipitridae	*Neophron percnopterus*	Egyptian Vulture	EN
8.	Accipitriformes	Pandionidae	*Pandion haliaetus*	Osprey	LC
9.	Falconiformes	Falconidae	*Falco tinnunculus*	Kestrel	LC
10.	Anseriformes	Anatidae	*Anas crecca*	Common Teal	LC
11.	Anseriformes	Anatidae	*Anas clypeata*	Shoveller	LC
12.	Anseriformes	Anatidae	*Anas Penelope*	Wigeon	LC
13.	Anseriformes	Anatidae	*Anas platyrhynchos*	Mallard	LC
14.	Anseriformes	Anatidae	*Anas strepera*	Gadwall	LC
15.	Anseriformes	Anatidae	*Aythya ferina*	Common Pochard	VU
16.	Pelecaniformes	Phalacrocoracidae	*Phalacrocorax fuscicollis*	Indian Shag	LC
17.	Pelecaniformes	Phalacrocoracidae	*Phalacrocorax carbo*	Large Cormorant	LC
18.	Pelecaniformes	Phalacrocoracidae	*Phalacrocorax niger*	Little Cormorant	LC
19.	Ciconiiformes	Ardeidae	*Ardea cinerea*	Grey heron	LC
20.	Ciconiiformes	Ardeidae	*Ardea purpurea*	Purple Heron	LC
21.	Ciconiiformes	Ardeidae	*Ardeola grayii*	Indian Pond Heron	LC
22.	Ciconiiformes	Ardeidae	*Bubulcus ibis*	Cattle Egret	LC
23.	Ciconiiformes	Ardeidae	*Egretta alba*	Large or Great white Egret	LC

[21] M Zaheer Khan *et. al*, Distribution and Status of the Vertebrate Biodiversity of Korangi and Phitti Creeks, Karachi Coast, Sindh, Pakistan, 2018, *International Journal of Biology and Biotechnology,* 15 (4): 751-764.

S#	Order	Family	Scientific Name	Common Name	IUCN Status
24.	Ciconiiformes	Ardeidae	*Egretta garzetta*	Little Egret	LC
25.	Ciconiiformes	Ardeidae	*Butorides striatus*	Little Green Heron	LC
26.	Ciconiiformes	Ardeidae	*Egretta gularis*	Indian Reef Heron	LC
27.	Ciconiiformes	Ardeidae	*Egretta intermedia*	Intermediate Egret	LC
28.	Ciconiiformes	Ardeidae	*Nycticorax nycticorax*	Night Heron	LC
29.	Phoenicopteriformes	Phoenicopteridae	*Phoenicopterus roseus*	Greater Flamingo	LC
30.	Charadriiformes	Burhinidae	*Esacus recurvirostris*	Great Stone Plover/Great Thick-Knee	LC
31.	Charadriiformes	Rostratuliidae	*Rostratula benghalensis*	Painted Snipe	LC
32.	Charadriiformes	Dromadidae	*Dromas ardeola*	Crab Plover	LC
33.	Charadriiformes	Recuvirostridae	*Himantopus himantopus*	Black-winged Stilt	LC
34.	Charadriiformes	Recuvirostridae	*Recurvirostra avosetta*	Pied Avocet	LC
35.	Charadriiformes	Charadriidae	*Vanellus malabaricus*	Yellow-wattled Lapwing	LC
36.	Charadriiformes	Charadriidae	*Vanellus indicus*	Red-wattled Lapwing	LC
37.	Charadriiformes	Charadriidae	*Vanellus leucurus*	White-tailed Lapwing	LC
38.	Charadriiformes	Charadriidae	*Pluvialis squatarola*	Grey Plover	LC
39.	Charadriiformes	Charadriidae	*Charadrius hiaticula*	Ringed Plover	LC
40.	Charadriiformes	Charadriidae	*Charadrius dubius*	Little-ringed Plover	LC
41.	Charadriiformes	Charadriidae	*Charadrius mongolus*	Lesser Sand Plover	LC
42.	Charadriiformes	Scolopacidae	*Limosa limosa*	Black-tailed Godwit	NT
43.	Charadriiformes	Scolopacidae	*Numenius phaeopus*	Whimbrel	LC
44.	Charadriiformes	Scolopacidae	*Tringa erythropus*	Spotted Redshank	LC
45.	Charadriiformes	Scolopacidae	*Tringa nebularia*	Green Shank	LC
46.	Charadriiformes	Scolopacidae	*Tringa ochropus*	Green Sandpiper	LC
47.	Charadriiformes	Scolopacidae	*Tringa stagnatilis*	Marsh Sandpiper	LC
48.	Charadriiformes	Scolopacidae	*Xenus cinereus*	Terek Sandpiper	LC
49.	Charadriiformes	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	LC
50.	Charadriiformes	Scolopacidae	*Limicola falcinellus*	Broad-billed Sandpiper	LC
51.	Charadriiformes	Scolopacidae	*Calidris alba*	Sanderling	LC
52.	Charadriiformes	Scolopacidae	*Calidris temminckii*	Temminck's Stint	LC
53.	Charadriiformes	Laridae	*Larus argentatus*	Herring Gull	LC
54.	Charadriiformes	Laridae	*Larus hemprichii*	Sooty Gull	LC
55.	Charadriiformes	Laridae	*Larus ichthyaetus*	Great Black-headed or Pallas Gull	LC
56.	Charadriiformes	Laridae	*Larus genei*	Slender-billed Gull	LC
57.	Charadriiformes	Sternidae	*Gelochelidon nilotica*	Gull-billed Tern	LC
58.	Charadriiformes	Sternidae	*Sterna caspia*	Caspian Tern	LC
59.	Charadriiformes	Sternidae	*Sterna hirundo*	Common Tern	LC
60.	Charadriiformes	Sternidae	*Sterna repressa*	White-cheeked Tern	LC
61.	Charadriiformes	Sternidae	*Sterna albifrons*	Little Tern	LC
62.	Charadriiformes	Sternidae	*Sterna bergii*	Great Crested Tern	LC

LC – Least Concern
VU – Vulnerable
EN – Endangered
NT – Near Threatened

Sand Plover

Curlew bird

Stork

Coots and Seagull

Figure 5.24: Endemic species of birds

Benthic Community: This community includes the microbes: detritus feeders, small and large herbivores, and small and large carnivores. In the mangrove ecosystem, the benthic community of the adjacent shallow water is a subject of interest. Here, the microbes decompose the plant litter into organic detritus - a fundamental commodity of system energy. This detrital matter is picked up by the detritus feeders over the bottom, such as fishes, shrimps and shellfish, and then carried to the littoral zone by wave action, shared by the intertidal fauna such as crabs, shrimps, mudskippers, invertebrates and waders. At low tide, when a large part of muddy bottom is exposed, crabs, mudskippers and" waders are seen in large numbers picking up their food which includes worms and different animals left behind by the receding tide.

Benthic Fish Community: Benthic fish community includes detritus feeders, small and large herbivores, and small and large carnivores. In the mangrove ecosystem, the benthic community of the adjacent shallow water is a subject of interest. Here, the microbes decompose the plant litter into organic detritus - a fundamental commodity of system energy. This detritus matter is picked up by the detritus feeders over the bottom, such as fishes, shrimps and shellfish, and then carried to the littoral zone by wave action, shared by the intertidal fauna such as crabs, shrimps, mudskippers, and other invertebrates. Grey mullets, gizzard shads, flat fishes, many skates and rays are some of the fish which prefer to live on soft bottom and feed on bottom detritus. At low tide, when a large part of muddy bottom is exposed, crabs, mudskippers and birds are seen in large numbers picking up their food which includes worms and different animals left behind by the receding tide.

Pelagic Fish Community: This community includes powerful swimmers, which are exclusively carnivore in nature like predaceous fishes, mullets, croakers, snappers, carangids breams, perches, and sea snakes. In the mangrove ecosystem the predaceous forms are often small in size and easily wander among the mangroves at high tide (Bianchi, 1985). The local fisher folk use small gill set nets across small tidal creeks to trap between 2-10 kg of fish in a day mostly mullets (*Mugil cephalus*) during ebb and flow tides (Figure 4-11[22])

[22] EIA of Bin Qasim Coal Conversion Project – BQPS-I – 2014 (EMC Pakistan Archives)

Artisanal Crab Fishery: Local fishing community members fish for mud crabs Scylla serrata (Figure 4-12) during low tide. The mud crab, burrows in mudflats in close proximity to the mangrove plantation. The locals excavate the soft mud with bare hands or a hooked iron rod is used which is inserted into the mud crab dwelling during the exposed mud flats at low tide.

The crabs are caught from their habitats and kept alive in moist gunny bags. The locals earn their livelihood through the capture and sale of mud crabs. The local fishermen are also engaged in catching undersize juveniles of fish that is converted into trash fish, swimming crabs (*Portunus pelagicus*) and juvenile shrimps (*Metapenaeus spp*) from the area.

According to (UNESCAP, 1996), as many as 148 species of fingerlings or young stages and juveniles have been reported from the mangrove of Indus Delta. More common larvae of fishes described for Korangi Creek and adjoining creeks in Indus Delta belong to the families *Mugilidae*, *Gerreidae*, *Clupeidae*, *Nemipteridae*, *Gobiidae*, *Sciaenidae*, *Engraulidae*, *Sillaginidae* and *Lutjanidae*. Their abundance from season to season varies. There are a number of settlements of fishermen along the creeks of Indus Delta which depend on the fisheries resources of these creeks.

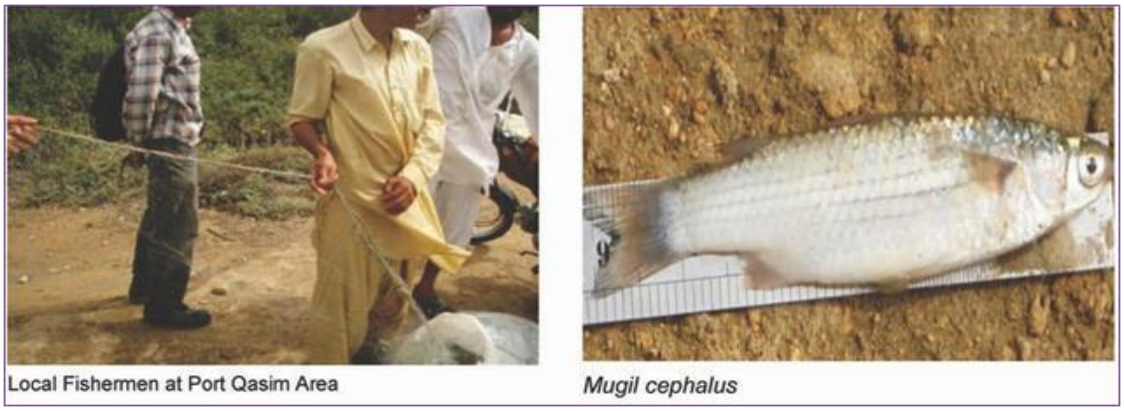


Figure 5.25: Local Fishing Enthusiasts Trap Mullets with Gill Set Net at Ebb and Flow Tides at Port Qasim Area

Figure 5.26: Local Fisherman Collects Mud Crabs Scylla serrata at Low Tide in Port Qasim Area

5.6 Socio-Economic Baseline

The socio-economic baseline cprovides a comprehensive review of the socio-economic conditions of the project area, where this socio-economic profile is based on a literature review and several primary data gathering activities including site visits, socio-economic surveys of stakeholders in the area and consultations with primary and secondary stakeholders. This social baseline provides an overview of the socio-economic conditions of the people who reside and work in the project

vicinity. It also includes an assessment of public utilities and social services (education and health facilities) in the area.

The social baseline is divided into the macro and micro environments of the project area. The macro- environment encompasses the entire Malir District of Karachi under which project area is falling. The discussion on macro environment covers the administrative setup, demography, education, health and utilities profile of the area. The project will be constructed in district Malir and its sub-division Bin Qasim town, the project area is considered to be the micro-environment, encompassing key aspects such as education, healthcare, transportation, and utility infrastructure.

The proposed quay wall extension and capacity enhancement at DP World's Qasim International Container Terminal aligns with SDG 9 (Industry, Innovation and Infrastructure) by strengthening resilient port infrastructure and improving logistics efficiency. The project supports sustainable industrial development by modernizing critical maritime facilities that enable trade connectivity and economic activity, while integrating environmental and social safeguards through the ESIA process.

5.6.1 Project Macroenvironment

5.6.1.1 Administrative Context

Karachi, the capital of Sindh province, is the country's largest city and the main seaport. Located along the Arabian Sea, northwest of the Indus River delta, Karachi is an important economic and cultural center. Historically, it has been known by names like Caranjee, Currachee, and Kalachi-jo-Goth, meaning "the village of Kalachi. Over time, Karachi has grown into Pakistan's industrial, commercial, and financial hub, serving as a trade gateway to Afghanistan. The sprawling division of Karachi covers an area of 3,527 sq.km with the city's seven districts, namely, Karachi: Central, West, South, East, Keamari, Korangi and Malir. The Sindh Local Government Act (2013)[23] establishes a framework for organizing local governance by dividing Local Councils in rural and urban areas. The rural areas have District Councils with Union Councils (with a population between 10,000 to 25,000) as their constituting units. Whereas the urban areas are divided into the local councils based on their population.

The proposed project falls under District Malir. A total of 6 subdivisions falls under District Malir Karachi which include Airport Sub Division, Bin Qasim Sub Division, Gadap Sub Division, Ibrahim Hyderi Sub Division, Murad Memon Sub Division and Shah Murad Sub Division.

According to (KaKmc) Katchi Abadi Karachi Metropolitan Corporation district Malir was created in 1996 by bifurcation of district East and had a population of 2.4 million in 2023. Before the creation of Pakistan there were small villages of Sindhi and Kalmati Baloch in Gadap and Malir town of modern Karachi, now both have developed as the suburbs of the city because of the urban sprawl. Malir has been regarded in history as the countryside of Karachi City due to its open atmosphere and green farms. [24]

[23] Government of Sindh. (2013). *The Sindh Local Government Act, 2013* (Sindh Act No. XLII of 2013). Provincial Assembly of Sindh. https://www.pas.gov.pk/index.php/acts/details/en/31/218
[24] https://kakmc.com/district-malir/

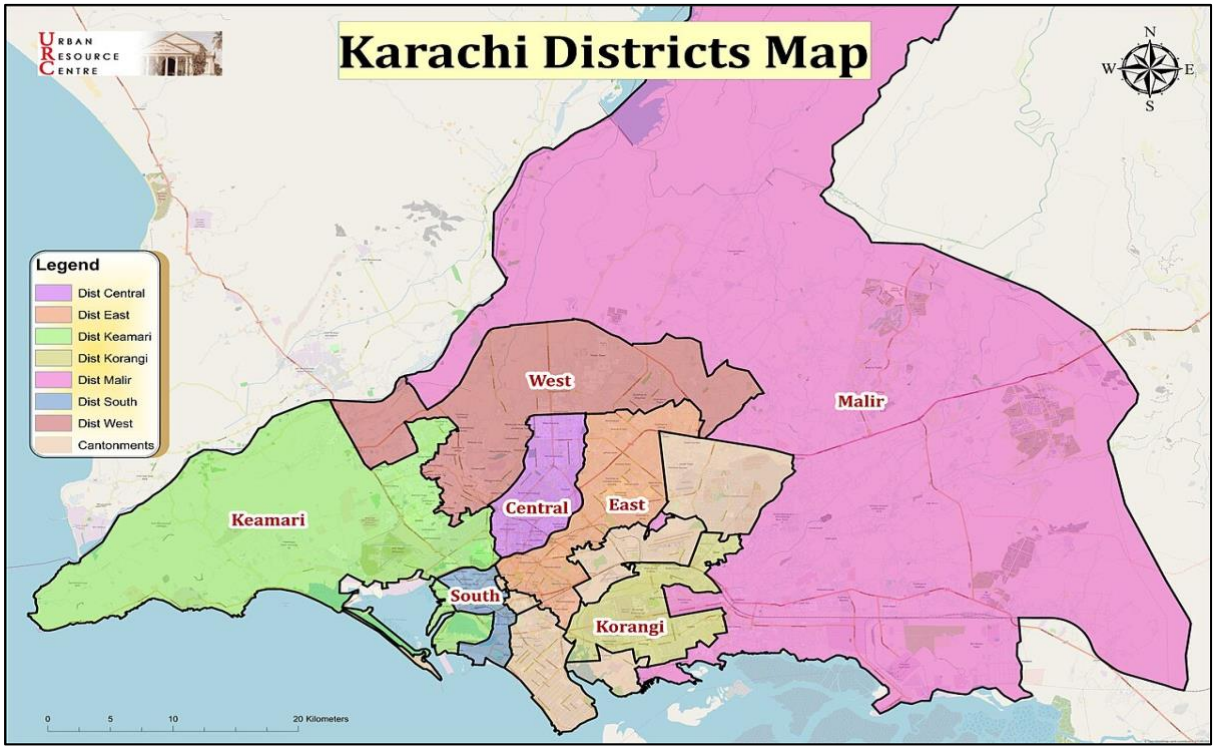


Figure 5.27 - Districts of Karachi

5.6.1.2 Demography

Karachi is ranked as the 12th most populous urban center in the world. The city witnessed rapid urbanization over the past few 17 decades, with the urban population growing from 5 million in 1998 to 20.35 million in 2023. The population is highly diverse, 18 comprising various ethnicities, languages, and religious communities, contributing to the city's rich cultural landscape.

Table 5.18 - Population of Karachi Division & Districts

Name of Administrative Unit	Area S.Q Kilometres	Population Density Per S.Q Kilometres	Total Population of the Area	2017- 2023 Average Annual Growth rate
Karachi Division	3,527	5779.10	20,382,881	4.10
District Central	69	55,396.01	3,822,325	4.30
District East	139	28,213.97	3,921,742	5.32
District South	122	19,096.43	2,329,764	4.71
District West	370	7,241.57	2,679,380	4.35
District Keamari	559	3,700.27	2,068,451	2.07
District Korangi	108	28,971.95	3,128,971	3.29
District Malir	2,160	1,126.04	2,432,248	3.99
Bin Qasim town	447	722.40	322,915	4.50
Source: Pakistan Bureau of Statistics (2023)				

According to the data from PBS 2023, Karachi Division has a population of 20 million, with an annual growth rate of 4.10%. Karachi covers a total area of 3,527 square kilometers. District Malir has the largest area among all districts, covering 2,160 square kilometers, and has a population of 2,432,248 with an average annual growth rate of 3.99%, showing gradual change over time. Among the districts, District Malir covers the largest area at 2,160 sq. km, but has a relatively low density of 1,126.04 people per sq. km, reflecting its semi-urban and rural characteristics its population is 2,432,248, with a steady growth rate of 3.99%. Bin Qasim Town, a sub-division of Malir District, spans 447 sq. km, with a low density of 722.40 but a significant growth rate of 4.50%, suggesting ongoing development and migration trends.

Table 5.19 - Population of Religious Groups

District	Total Population	Muslim	Christian	Hindu	Ahmedi	Castes	Sikh	Parsi	Other
Central	3,822,325	3,756,578	48,464	12,084	1,556	100	159	53	1,394
East	3,921,742	3,719,921	121,401	61,184	2,819	406	441	328	7,156
South	2,329,764	2,186,415	38,342	96,486	349	2,286	651	952	4,283
West	2,679,380	2,619,785	50,192	7,744	361	105	603	222	368
Keamari	2,068,451	2,028,420	26,199	9,701	152	507	123	46	1,426
Korangi	3,128,971	3,003,914	107,008	13,579	2,406	317	180	50	522
Malir	2,432,248	2,333,721	44,015	38,028	617	2,162	439	5	749
Bin Qasim town	322,915	312,547	3,513	6,083	142	466	31	2	131

Source: Pakistan Bureau of Statistic 2023

The table presents demographic data from the Pakistan Bureau of Statistics (2023) for various districts of Karachi, detailing the religious composition of each area's population. It includes the total population and a breakdown by religious affiliation: Muslim, Christian, Hindu, Ahmedi, Castes (likely referring to Scheduled Castes), Sikh, Parsi, and Other. Central, East, and Korangi districts have the highest populations, with Muslims forming the overwhelming majority in all districts. Christians and Hindus are the largest minority groups, particularly concentrated in East, South, and Malir. Smaller communities of Ahmedis, Castes, Sikhs, Parsis, and others are also present, with noticeable representation in districts like South and Malir.

Table 5.20 - Language Distribution of District Malir

Category	Population
Total	2,419,736
Urdu	382,091
Punjabi	240,591
Sindhi	846,492
Pushto	428,486
Balochi	190,579
Kashmiri	7,067
Saraiki	77,895
Hindko	137,791
Brahvi	22,841
Shina	4,218
Balti	1,710
Mewati	1,842
Kalasha	58
Kohistani	1,358
Others	7,671

Source: PBS Census (2023)

According to the Pakistan Bureau of Statistics (PBS) census (2023), District Malir has a total population of 2,419,736, reflecting a highly diverse linguistic composition. Sindhi is the most widely spoken language, with 846,492 speakers, followed by Pushto (428,486) and Urdu (382,091). Other significant linguistic groups include Punjabi (240,591), Balochi (190,579), and Hindko (137,791), indicating strong internal migration patterns within the district. Smaller language groups such as Saraiki (77,895), Brahvi

(22,841), Kashmiri (7,067), Shina (4,218), Balti (1,710), Mewati (1,842), Kohistani (1,358), Kalasha (58), and others (7,671) further highlight the multicultural and multi-ethnic nature of the area.

5.6.1.3 Education

Education in Karachi reflects its status as Pakistan's largest urban and economic hub. The region is home to a wide range of educational institutions, catering to various levels of education from primary to higher education. For higher education, Karachi boasts prestigious universities such as the University of Karachi, Aga Khan University, and Dow University of Health Sciences, which attracts students from across the country.

Table 5.21 - District Summary: School, Enrollment, Teacher Wise

District Name	No. of Schools				Enrolment			Teacher		
	Boys	Girls	Mixed	Total	Boys	Girls	Total	Male	Female	Total
Central	145	80	102	327	39,984	48,391	88,375	1,559	3,453	5,012
East	89	43	48	180	25,528	28,135	53,663	957	2,301	3,261
South	21	38	79	138	22,193	31,137	53,330	792	1,940	2,732
West	25	16	138	179	20,403	22,676	43,079	599	871	1,470
Korangi	91	44	82	217	40,156	47,042	87,198	1,162	2,885	4,047
Keamari	25	22	155	202	21,946	22,573	44,519	758	859	1,617
Malir	133	80	320	533	36,832	33,477	70,309	1,462	1,479	2,941
Sub-Division/Taluka Wise Student Enrollment										
Bin Qasim								11,440		
Source: Sindh Education Management Information System (2023-2024)										

The table, sourced from the Sindh Education Management Information System (2023–2024), provides an overview of the educational infrastructure and staffing across various districts of Karachi. It outlines the number of boys', girls', and mixed schools, total student enrollment by gender, and the distribution of male and female teachers. Malir district hosts the highest number of schools (533), while Central and Korangi districts show the highest student enrollments, exceeding 87,000 each. Central also leads in teacher count with over 5,000 staff. Districts like South and East have fewer schools but maintain substantial enrollment figures. Additionally, the Bin Qasim sub-division recorded a student enrollment of 11,440.

5.6.1.4 Health

Karachi is home to a wide range of health facilities, offering both public and private healthcare services to meet the needs of its large population. Leading public hospitals such as the Civil Hospital Karachi and Jinnah Postgraduate Medical Centre provide comprehensive medical services. Private hospitals like Aga Khan University Hospital, Liaquat National Hospital, and Ziauddin Hospital are known for their advanced facilities and quality care

Table 5.22 - Health Facilities

District	Teaching Hospitals		Civil, Major, Specialized, Taluka, Hospital		Dispensarie s		Rural Health centers		T.B Clinics		Basic Health Unit		MCHC	
Karachi	3	4,200	12	2,307	45	-	5	38	43	350	35	78	23	23
Source: Sindh Bureau of Statistic 2024														

The table, sourced from the Sindh Bureau of Statistics (2024), presents an overview of healthcare infrastructure across Karachi. It lists the number of various types of healthcare facilities and their available beds. Karachi has 3 teaching hospitals with a total of 4,200 beds, and 12 civil, major, specialized, and taluka hospitals offering 2,307 beds. In addition, the city hosts 45 dispensaries, 5 rural

health centers with 38 beds, 43 tuberculosis (T.B) clinics with 350 beds, 35 Basic Health Units (BHUs) providing 78 beds, and 23 Maternal and Child Health Centers (MCHCs) with 23 beds. This data reflects a diverse yet uneven distribution of healthcare services, indicating the city's reliance on high-capacity teaching and specialized hospitals while smaller units like BHUs and MCHCs remain limited in bed capacity.

5.6.1.5 Utilities

In Karachi, the water supply is managed by the Karachi Water and Sewerage Corporation (KWSC). Additionally, the following entities 30 play roles in special aspects of water and sanitation: Sindh Local Government Department oversees municipal services, including water supply and sanitation in collaboration with KWSC and local 31 government bodies, while the Sindh Solid Waste Management Board (SSWMB) manages solid waste collection and disposal. According to the 2023 Census, 97% of households in Karachi have access to improved drinking water. The gas supply is managed by the Sui Southern Gas Company (SSGC) and the electricity supply is provided by the K-Electric (KE). 89% of the households in Karachi use Sui Gas as fuel for 33 cooking, 6% use firewood, 4% use LPG/LNG cylinders and 1% use other sources.

5.6.1.6 Transport

As urban centers expand, the demand for civic facilities, including transport infrastructure and services, increases significantly, requiring continuous development, technological advancement, and efficient management. Karachi, being one of the fastest-growing mega port cities in the region, is experiencing a very high rate of urbanization. Consequently, the need for improved transport infrastructure and mobility services is rising rapidly. Severe traffic congestion has become a common feature across Karachi, and the situation continues to deteriorate due to increasing population, vehicle growth, and expanding commercial activities.

Within this urban context, District Malir holds strategic importance due to its extensive transport infrastructure and regional connectivity. The district hosts Jinnah International Airport, Pakistan's largest international and domestic airport, which provides connectivity to all provincial capitals, Islamabad, and major international destinations. The presence of the airport significantly enhances mobility, trade, cargo movement, and employment opportunities within the district, while also contributing to increased traffic volumes on major connecting corridors.

Malir is well connected through the national road network. The National Highway (N-5), located approximately 18 km north of Malir city, links Karachi with Hyderabad and onward to other parts of the country. The Karachi–Hyderabad Motorway (M-9) further strengthens intercity connectivity. Major arterial roads, including Shahrah-e-Faisal and other link roads within the district, facilitate access between Malir and central Karachi. However, increasing vehicular load and urban expansion have placed considerable pressure on these road networks, contributing to congestion and travel delays.
The district is also served by Pakistan Railways through Malir Railway Station and several associated stations, including Malir Halt, Malir Cantt, Malir Colony, Airport Station, Model Colony Stations, and Malir Garrison Station. The railway network connects Malir to Karachi and major cities across Pakistan, supporting passenger movement and economic linkages at regional and national levels.

Public and local transportation services operate extensively throughout the district. Taxis, ride-hailing services, intercity coaches, buses, minibuses, and para-transit modes such as Suzukis provide 24-hour connectivity within Karachi and to other districts of Sindh, including Hyderabad, Thatta, Sujawal, Badin, Tando Allahyar, Tando Muhammad Khan, Mirpur Khas, Umerkot, and Tharparkar. Due to the presence of the airport and associated commercial activity, Malir experiences a diverse and mobile population, further increasing transport demand.

Overall, while District Malir benefits from multi-modal connectivity through air, road, rail, and public transport systems, rapid urbanization and rising traffic volumes continue to exert pressure on existing infrastructure.

Table 5.23 - Motor Vehicles "On Road"

District	Motor cars, Jeeps and station wagons	Motor cycles	Taxies	Rikshaws	Buses/Mini buses	Trucks	Tractors	Others	Total
Karachi	464,162	227,534	1,943	16,489	5,477	27,700	457	116,432	860,194
Source: Sindh Bureau of Statistics 2024									

The table presents data on motor vehicles “on road” in the Karachi district, as reported by the Sindh Bureau of Statistics (2024). It categorizes vehicles into motor cars, jeeps and station wagons; motorcycles; taxies; rickshaws; buses/mini buses; trucks; tractors; and others, with a total of 860,194 vehicles recorded. Among these, motor cars, jeeps and station wagons make up the largest share (464,162), followed by motorcycles (227,534). The remaining categories include rickshaws (16,489), taxies (1,943), buses/mini buses (5,477), trucks (27,700), tractors (457), and others (116,432). The data indicates that private vehicles and two-wheelers dominate Karachi’s vehicular composition, reflecting a heavy reliance on personal modes of transportation within the city.

5.6.2 Project Microenvironment

5.6.2.1 Adminsitrative Context

The proposed project, involving the extension and modernization of Terminal 1 quay wall at DP World’s Qasim International Container Terminal (QICT), is located within the Port Muhammad Bin Qasim area, Karachi. The project site falls within the administrative boundaries of District Malir and is situated inside the operational limits of Port Qasim. The development is confined to the existing terminal footprint and adjoining marine area, encompassing the proposed quay wall extension and associated dredging works within the navigational and berthing zone of Terminal 1. Notable nearby landmarks include FAP (Fauji Akbar Portia) Terminal, EVTL, IFFCO Pakistan (Pvt), Pardhan Oil Industries (Pvt) Ltd, Khadija Edible Oil & Ghee (Pvt) Ltd, and MM Ghee Mill (Pvt) Ltd.

5.6.2.2 Overview of Port Qasim

Port Qasim is Pakistan’s second-largest seaport and serves as a major maritime gateway for national and international trade. Located approximately 35 km east of Karachi city center in District Malir, the port plays a strategic role in supporting Pakistan’s industrial and commercial activities. The port was established in the 1970s to complement the capacity of Karachi Port and to facilitate the growing demand for maritime trade and industrial development.

Port Qasim covers an area of approximately 12,000 acres and includes a large industrial zone known as the Port Qasim Industrial Zone (PQIZ). The industrial zone hosts a wide range of industries including edible oil processing, chemicals, steel, energy, fertilizer production, and logistics operations. Major industrial and terminal operators located within the port area include Pakistan International Bulk Terminal (PIBT), Engro Vopak Terminal Limited (EVTL), Fauji Akbar Portia Marine Terminal (FAP), and Qasim International Container Terminal (QICT), among others.

The port consists of multiple specialized terminals handling a variety of cargo types such as containers, coal, LNG, petroleum products, chemicals, and bulk commodities. Collectively, these terminals handle a substantial portion of Pakistan’s seaborne trade and contribute significantly to national import and export activities.

Port Qasim operates through a navigational channel approximately 45 kilometers in length, connecting the Arabian Sea to the port terminals. The port infrastructure includes multiple berths, cargo handling facilities, storage areas, and supporting logistics infrastructure designed to accommodate large commercial vessels and facilitate efficient cargo movement. Due to its strategic location and integrated

industrial infrastructure, Port Qasim continues to play a critical role in supporting Pakistan's trade, industrial development, and economic growth. [25]

5.6.2.3 Education

There are many private and government schools imparting education in Bin Qasim Town, which is outside the premises of the Port Qasim Industrial Zone. Most of the schools in the area cater to the needs of the children of the local population, some of the institutions outside the industrial area include The Smart School [Gulshan e Hadeed] (11km), Government Boys Secondary School Ghaghar Phatak Town (13 km) and Elysium School System [Gulshan e Hadeed] (11km).

5.6.2.4 Health Facilities

The majority of government and private medical facilities are located outside the Port Qasim Industrial Zone. The nearest healthcare centers include Madina Medical Center, Razia Medical Complex and AMJ Pipri Clinic, located around 8.68 kilometers from the project area. These facilities provide medical services to the surrounding industrial and residential communities.

5.6.2.5 Utilities

Bin Qasim Town is well-connected to Karachi's main service networks. Electricity is supplied by K-Electric (KE), ensuring power to both industrial and residential areas. Natural gas is provided by the Sui Southern Gas Company Limited (SSGC), catering to domestic, commercial, and industrial needs. Water supply and sewerage services are managed by the Karachi Water and Sewerage Corporation (KWSC), although water availability can fluctuate in some localities. The area also has access to telecommunication and internet services through various public and private operators.

5.6.2.6 Traffic

The traffic conditions in the project area, located within the Port Qasim Industrial Zone, are generally characterized by moderate to heavy vehicular movement, primarily due to the concentration of industrial and port-related activities. The main access routes, such as the Port Qasim Road, National Highway (N-5) connecting internal industrial roads, experience frequent movement of heavy vehicles including trucks, trailers, and container carriers transporting goods to and from the port and industrial units.

[25] Port Qasim Authority. (2026). *Port Qasim Authority*. https://www.pqa.gov.pk/en

6 Anticipated Impacts & Mitigation Measures

Presented in this section is a screening of the potential, environmental, social, and ecological impacts associated with the proposed interventions, along with an assessment of their severity based on professional judgement, the proposed interventions, stakeholder perceptions, and the baseline data obtained. The assessment has been organized according to the different environmental, social, and ecological receptors with a discussion on potential impacts across the project's siting/design, construction, and operational phases.

6.1 Methodology

A risk based approach has been utilized for the assessment, where each impact has been assessed by combining likelihood of occurrence with the severity of possible impacts, prior to the application of any mitigation measures. This allows for the determination of inherent risk, and following the appliaction of mitigation measures, the residual risk. A breakdown of how the terms utilized in this chapter are defined is provided below:

Table 6.1 - Breakdown of Impact Assessment Terms

Score	Likelihood (L)	Definition
1	Rare	May occur only in exceptional circumstances; not expected under normal works.
2	Unlikely	Could occur but is not expected if standard controls are present.
3	Possible	Could occur during the activity, particularly if controls are weak or weather/operational conditions change.
4	Likely	Expected to occur at some stage without targeted management controls.
5	Almost Certain	Expected to occur repeatedly or continuously without targeted controls.
Score	**Severity (S)**	**Definition**
1	Minor	Localized, short-term, readily reversible; no material non-compliance or safety consequence.
2	Moderate	Localized to site/AOI but noticeable; requires management and monitoring; minor injury or limited exceedance possible.
3	Major	Significant effect on sensitive receptor, port operations, compliance, or worker/community safety; may require corrective action and reporting.
4	Severe	Major safety, environmental, operational, or compliance event; difficult to reverse; high reputational/regulatory consequence.
5	Critical	Fatality, major collision, major spill, structural failure, or widespread irreversible damage.

Furthermore, the scale utilized to categgorize impacts in line with the likelihood of occurance and severity of impacts is also provided below:

Table 6.2 - Likelihood v Severity Risk Matrix

Likelihood / Severity	1 Minor	2 Moderate	3 Major	4 Severe	5 Critical
5 Almost Certain	5 - Medium	10 - High	15 - High	20 - Very High	25 - Very High
4 Likely	4 - Low	8 - Medium	12 - High	16 - High	20 - Very High
3 Possible	3 - Low	6 - Medium	9 - Medium	12 - High	15 - High
2 Unlikely	2 - Low	4 - Low	6 - Medium	8 - Medium	10 - High
1 Rare	1 - Low	2 - Low	3 - Low	4 - Low	5 - Medium

6.2 Risk Assessment

The risk assessment for the different stages of the project, with respect to the above methodology is presented below:

Table 6.3 - Risk Assessment

Potential Impact / Risk	L	S	Inherent Risk	Mitigation / Management Measures	Residual L x S	Residual Risk
Pre-Construction/Design Stage						
Use of sub-optimal dredging methodology which may lead to unnecessary turbidiy and over-dredging	4	3	High (12)	This has already been addressed in the Analysis of Alternatives Section of this ESIA report, where, utilizing the various surveys carried out (including the subsea geotechnical investigation, the bethymetry, and the side scan profile) the different dredging methods available are discussed and their suitability for the site reviewed. Moving ahead, once the dredging contractor is brought onboard, then the contractor will also carry out their own surveys and prior to deployment, prepare and submit a Dredging Management Plan, which will define the approved footprint and depths, equipment type, dredging windows, tidal/weather constraints, barge freeboard, anti-overflow controls, water quality thresholds, receptor monitoring points, stop-work triggers, and responsibilities for real-time supervision.	2 x 3 = 6	Medium (6)
Unapproved or unsuitable dredged material disposal route or location	3	4	High (12)	QICT has already, in consultation with PQA, identified a designated disposal site for the dredged material. The point highlighted is a point in the deep sea, outside of the current Port Qasim Navigational Channel, where PQA has highlighted QICT may dispose of the dredged material. This point is far out from any mangroves or any navigational area. Prior to dredging activities commencement, the dredging contractor and QICT to confirm route, restrictions, and documentation. Alongside this, the contractor and QICT are to maintain disposal logs, barge tracking records, and daily reconciliation of dredged/disposed quantities.	2 x 3 = 6	Medium (6)
Unidentified contaminated sediment before dredging	3	4	High (12)	The Proponent through the contractor is to conduct pre-dredge sediment characterization for grain size, metals, hydrocarbons, oil and grease, and other contaminants of concern. Once the results are obtained, proponent is to divide the sediments into contaminated or non-contaminated. If contaminated sediments are identified then discuss the methodology for disposal with SEPA prior to disposing. Ensure contamianted and non-contaminated sediments are kept separately and only non-contaminated sediment is disposed off in the PQA approved site.	2 x 3 = 6	Medium (6)
Marine navigation conflict due to inadequate interface planning	3	5	High (15)	Prior to initiation of works, the contractor is to prepare a Navigation and Vessel Traffic Management Plan in coordination with PQA Marine Department, with a complete navigation risk review carried out. Define exclusion zones, temporary restrictions, VHF/AIS requirements, lighting, buoyage/signage, notices to port users, emergency towage, rescue routes, and daily marine coordination meetings. Furthermore, ensuring coordination with PQA during the implementation of works.	2 x 3 = 6	Medium (6)
Insufficient ecological, mangrove, and fisheries protection planning	3	3	Medium (9)	Given that the channel is an active channel with the ingress and egress of container vessels, there is no major faunal species anticipated to be impacted from this project and its localized interventions. Furthermore, the nearest	2 x 2 = 4	Low (4)

Potential Impact / Risk	L	S	Inherent Risk	Mitigation / Management Measures	Residual L x S	Residual Risk
				mangroves to the project site lie outside of the Area of Influence of the project, approximately 650 m away from the project site. Furthermore, given that no onshore disposal of dredged material is anticipated under the project, no major impacts on mangroves are foreseen under the project.		
Weak emergency and spill preparedness before marine works	3	5	High (15)	The contractor is to prepare and test Emergency Preparedness and Spill Response Plan before mobilization in the supervision of QICT. Provide spill kits, booms, extinguishers, first aid, rescue arrangements, life buoys, emergency communications, muster points, and drills for spill, fire, man-overboard, collision, severe weather, and crane/lifting incidents.	2 x 3 = 6	Medium (6)
Improved operational readiness and safety through design modernization	-	-	Positive	Embed international terminal design and safety requirements into the final design. Confirm maintainability, access, firefighting supply, electrical safety, stormwater segregation, emergency access, and future vessel/crane requirements.	Positive	Positive
Construction/ Development Works Stage						
Increased turbidity and suspended sediments in water during dredging events	4	3	High (12)	Implement the Dredging Management Plan developed prior to implementation of works, and limit dredging to approved footprint and depth. Avoid over-dredging, bucket overflow, uncontrolled barge loading, and dredging during unsafe weather/tide conditions. Monitor turbidity/TSS at upstream, downstream, near-field, and receptor points; implement stop-work/corrective actions when thresholds are exceeded.	2 x 3 = 6	Medium (6)
Deterioration of marine water quality	4	3	High (12)	Prohibit untreated discharges from the quay wall works into marine water. Bund fuel/chemical storage, inspect equipment for leaks, provide spill kits on quay/barges/dredgers, control concrete washout, maintain sanitation systems, and monitor pH, DO, TSS, turbidity, oil and grease, hydrocarbons, BOD/COD, and visual sheen during active marine works.	2 x 2 = 4	Low (4)
Adverse effects from dredged material transport and disposal	3	4	High (12)	Dispose only at approved offshore site after material classification. Track each barge trip, disposal volume, coordinates, and time. Maintain adequate freeboard and prevent overflow/leakage. Avoid disposal in unsafe sea conditions or near mangroves, islands, mudflats, creek mouths, or fishing areas and document disposal conditions.	2 x 3 = 6	Medium (6)
Sedimentation or indirect stress on mangrove habitats	3	3	Medium (9)	Establish mangrove no-go zones and protect natural tidal exchange. Monitor turbidity and visible sedimentation near mangrove edges where relevant. Avoid disposal routes and placement near mangrove creeks. Train workforce on mangrove protection and prepare restoration/compensation actions for accidental damage.	2 x 2 = 4	Low (4)
Underwater noise and vibration impacts	3	4	High (12)	Use soft-start/ramp-up piling procedures, maintain engines/mufflers, avoid unnecessary simultaneous high-noise marine activities, establish observation zones where practicable, and pause high-noise activities if sensitive fauna are observed in the immediate work zone. Conduct monioring, and consider additional controls if monitoring indicates unacceptable levels.	2 x 3 = 6	Medium (6)

Potential Impact / Risk	L	S	Inherent Risk	Mitigation / Management Measures	Residual L x S	Residual Risk
Air emissions and dust	3	2	Medium (6)	Use maintained equipment and compliant fuel. Prohibit excessive idling. Cover dusty material, wet down dust-prone areas, control vehicle speeds, maintain generators/engines, and monitor PM10, PM2.5, NOx, SO2, CO, and visible emissions as per ESMP.	2 x 2 = 4	Low (4)
Construction noise and vibration	3	2	Medium (6)	Schedule high-noise works with port coordination. Provide hearing protection to workers and demarcate high-noise zones. Monitor noise at work fronts and terminal boundaries and investigate complaints/exceedances.	2 x 1 = 2	Low (2)
Marine navigation and collision risk	3	5	High (15)	Coordinate daily with PQA Marine Department and Port Control. Maintain AIS, navigation lights, VHF communication, exclusion zone markers, notices to port users, emergency towage and rescue procedures, and clear navigation/turning routes. Given that PQA tugboats lead any incoming and outgoing container vessels, coordiantion with PQA will serve to avoid any major incidents of risks associated with this impact.	2 x 3 = 6	Medium (6)
Interference with QICT and neighboring terminal operations	4	3	High (12)	Communicate daily work schedules with adjoining stakeholders, maintain emergency access, berth access, internal roads, and utility continuity, and apply permit-to-work controls at operational interfaces.	2 x 3 = 6	Medium (6)
Major OHS risks from marine construction	4	5	Very High (20)	Develop and Implement a project and site specific OHS Plan and Marine Works Safety Plan. Require method statements, job safety analyses, permit-to-work, fall protection, life jackets near water, rescue equipment, first aid, competent supervisors, toolbox talks, weather monitoring, incident reporting, and stop-work authority.	2 x 3 = 6	Medium (6)
Heavy lifting and STS crane decommissioning/installation risk	4	5	Very High (20)	Use specialist contractors and engineered lifting plans. Verify ground bearing capacity, crane pad design, lifting gear certification, exclusion zones, wind-speed limits, lift supervision, trained riggers/banksmen, and lock-out/tag-out for electrical/mechanical isolation.	2 x 3 = 6	Medium (6)
Fire, explosion, and emergency event	3	5	High (15)	Apply hot work permits, fire watch, gas testing where needed, extinguishers, firefighting water, emergency drills, fuel controls, electrical inspection, and coordination with QICT/PQA emergency response. Maintain clear access for emergency vehicles and marine response.	2 x 3 = 6	Medium (6)
Solid and hazardous waste generation	3	2	Medium (6)	Implement Waste Management Plan. Segregate hazardous/non-hazardous waste, reuse suitable fill, recycle scrap steel from decommissioned cranes where feasible, use licensed waste contractors, maintain manifests, and prohibit dumping into marine waters/drains/unused port areas.	2 x 1 = 2	Low (2)
Sanitary wastewater and worker welfare impacts	3	2	Medium (6)	Provide adequate toilets, washing facilities, potable water, drainage, housekeeping, medical access, and worker welfare. Use septic tanks, holding tanks, or approved treatment systems; prohibit direct discharge and use licensed SEPA contractors for waste disposal.	2 x 1 = 2	Low (2)

Potential Impact / Risk	L	S	Inherent Risk	Mitigation / Management Measures	Residual L x S	Residual Risk
Stormwater runoff, erosion, and monsoon flooding	3	2	Medium (6)	Maintain temporary drainage, sediment traps where feasible, stockpile protection, covered storage, drain clearance, post-rain inspections, and segregation of contaminated runoff from clean stormwater.	2 x 1 = 2	Low (2)
Land-side traffic and community health and safety risks	3	2	Medium (6)	Implement Traffic Management Plan with haul routes, speed limits, delivery timings, signage, flagmen, pedestrian segregation, vehicle fitness checks, driver training, emergency access, and coordination of abnormal loads with PQA/QICT.	2 x 1 = 2	Low (2)
Labor management, worker rights, and grievance risks	3	2	Medium (6)	Provide written contracts, legal wages, working hour controls, PPE, accommodation standards, non-discrimination, prohibition of child/forced labor, worker grievance mechanism, code of conduct, training records, and contractor labor audits.	2 x 1 = 2	Low (2)
Employment and local procurement benefits	-	-	Positive	Prioritize local hiring and procurement where skills and quality are available. Provide HSE induction and skills training. Ensure fair labor terms, safe working conditions, and transparent contractor recruitment.	Positive	Positive
Operational Stage						
Improved berth safety and structural reliability	-	-	Positive	Implement preventive maintenance and structural inspection for fenders, bollards, ladders, crane rails, quay edge, scour protection, utilities, settlement markers, and emergency systems. Maintain records and corrective actions.	Positive	Positive
Improved terminal capacity and reduced vessel turnaround time	-	-	Positive	Optimize berth planning, crane deployment, equipment maintenance, and terminal operating systems. Monitor productivity, vessel waiting time, and capacity utilization after commissioning.	Positive	Positive
Potential reduction in emissions per TEU	-	-	Positive	Use efficient berth scheduling, minimize vessel waiting/idling, maintain cargo-handling equipment, and consider future readiness for low-emission equipment and shore-power compatibility where feasible.	Positive	Positive
Altered sedimentation, scour, or seabed instability	3	4	High (12)	Install and maintain scour protection. Conduct regular bathymetric surveys and structural inspections. Monitor berth pocket condition and under-keel clearance. Repair scour protection and undertake targeted maintenance dredging where required.	2 x 3 = 6	Medium (6)
Operational marine pollution	3	2	Medium (6)	Enforce no-discharge rules and port waste reception requirements. Maintain spill kits/booms, inspect crane hydraulic systems and vessel interfaces, train staff in spill prevention/response, and record spills and corrective actions.	2 x 1 = 2	Low (2)
Stormwater contamination from terminal surfaces	3	2	Medium (6)	Maintain surface drainage, silt traps, oil-water separation where installed, spill cleanup, housekeeping, drain desilting, waste storage controls, and monsoon inspections.	2 x 1 = 2	Low (2)
OHS risks during terminal operations	3	4	High (12)	With the advent of larger cranes and more containers through the expansion of the terminal, OHS risks may increase. To counteract this, maintain operational OHS Management System including crane procedures, traffic segregation, safe mooring, lock-out/tag-out, work-at-height controls, competency requirements, maintenance permits, emergency drills, and incident investigation.	2 x 2 = 4	Low (4)

Potential Impact / Risk	L	S	Inherent Risk	Mitigation / Management Measures	Residual L x S	Residual Risk
Navigational incident due to larger vessels	3	4	High (12)	Coordinate with PQA pilotage/traffic control, maintain berth operating limits, tug requirements, under-keel clearance procedures, berth occupancy planning, weather restrictions, fender/bollard inspections, and emergency response readiness.	2 x 2 = 4	Low (4)
Fire, collision, severe weather, or emergency event	3	5	High (15)	Maintain Emergency Preparedness and Response Plan, firefighting systems, drills, severe weather procedures, spill response equipment, incident command arrangements, emergency access, and coordination with PQA/QICT response teams.	2 x 3 = 6	Medium (6)
Hazardous and non-hazardous operational waste	3	2	Medium (6)	Maintain waste segregation, hazardous waste storage, licensed waste disposal, records/manifests, spill residue handling, recycling of suitable materials, and periodic waste audits.	2 x 1 = 2	Low (2)
Climate resilience and sea level/monsoon risks	2	4	Medium (8)	Integrate design freeboard, drainage capacity, structural inspection, scour protection, emergency shutdown, severe weather alerts, asset maintenance, and periodic climate resilience reviews into operations.	2 x 2 = 4	Low (4)

6.3 Design/ Pre-Construction Stage - Assessment of Potential Impacts & Mitigation Measures

6.3.1 Design Considerations

The proposed works involve structural modification of the existing operational quay wall in soft deltaic and marine sediment conditions. Should the proposed development not take into account the existing conditions accordingly, the new quay wall and associated infrastructure's integrity may be at risk. Factors such as geotechnical assumptions, scour allowance, berthing energy, lateral loads, settlement, crane rail loads, sesimicity, or long term maintenance requirements, all need to be sufficiently evaluated and incorporated into the deisgn.

Since the new quay wall is expected to support high capacity STS cranes and deeper vessel operations, design margins must be robust, where failure of the structural integrity or excessive deformation could cause serviceability loss, rail mismanagement, operational interruption, damage to vessels or cranes, worker safety hazards, accelerated maintenance requirements, and potentials for major incidents.

The inherent risk associated with this impact is High adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Complete independent design review for geotechnical parameters, pile capacity, lateral loading, settlement, liquefaction potential, seismicity, berthing forces, mooring loads, crane wheel loads, scour and sea level/monsoon conditions.
- Confirm the design basis for the 16 m berth pocket, propeller wash exposure, scour protection sizing and long-term bathymetric stability.
- Define construction hold points for pile installation, reinforcement, concrete works, tie systems, backfilling, ground improvement and crane rail installation.
- Carry out pile integrity testing, material testing, compaction verification and survey control during construction.
- Install or define settlement markers, rail alignment checks, bathymetric checks and post-construction structural monitoring requirements.
- Carry out periodic monitoring of the above highlighted items and maintenance works as and where necessary.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.3.2 Choice of Dredging Method

As highlighted above in Chapter 4, the choice of dredging method employed here will dictate the sort of environmental impacts that will arise, along with the protective measures that will have to be inbuilt into the dredging methodology by the contractor. Poor selection of equipment or weak controls can increase turbidity, lead to over-dredging beyond the approved berth pocket area, increase the volume of material requiring disposal and extend the duration of the impacts. Alongside this, potential impacts may also include avoidable deterioration of marine water quality, disturbance to benthic habitats, and increased sediment deposition along the peripheries of the creek.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Contractor to prepare a project-specific Dredging Environmental Management Plan before mobilization and obtain approval from QICT against it. A guideline Dredging Management Plan has been prepared and is attached to this report as an Annex.
- Define the approved dredging footprint, target depth, allowable tolerances, plant type, sequencing, tidal/weather constraints and barge loading controls.
- Use controlled dredging techniques appropriate for near-quay precision dredging and avoid unnecessary seabed disturbance outside the approved area.
- Set turbidity/TSS monitoring locations, alert levels, action levels, stop-work triggers and corrective action requirements before dredging starts.
- Assign real-time environmental supervision responsibilities for dredging, barge loading, freeboard checks and disposal documentation.
- Conduct monitoring during dredging works to ensure that dredging works are being carried out in the manner anticipated, and detrimental impacts are being curtailed accordingly.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.3.3 Disposal of Dredged Material

The inadequate disposal of dredged material may create significant secondary impacts if the disposal route, location, timing, or placement is not taken into consideration beforehand. Disposal near shallow habitats, mangrove creeks, fishing areas, mudflats, or navigation sensitive areas may lead to increased sedimentation, turbidity plumes, and conflicts with other marine users and navigation.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- QICT has already, in consultation with PQA, identified a designated disposal site for the dredged material. The point highlighted is a point in the deep sea, outside of the current Port Qasim Navigational Channel, where PQA has highlighted QICT may dispose of the dredged material. This point is far out from any mangroves or any navigational area. The amount of dredged material anticipated for disposal under the project is between 200,000-300,000 tons, where this will be disposed of in the appointed disposal area.
- Prior to dredging activities commencement, the dredging contractor and QICT to confirm route, restrictions, and documentation.
- Alongside this, the contractor and QICT are to maintain disposal logs, barge tracking records, and daily reconciliation of dredged/disposed quantities.
- Avoid disposal during rough sea conditions or where barge control, containment, or visibility are compromised.

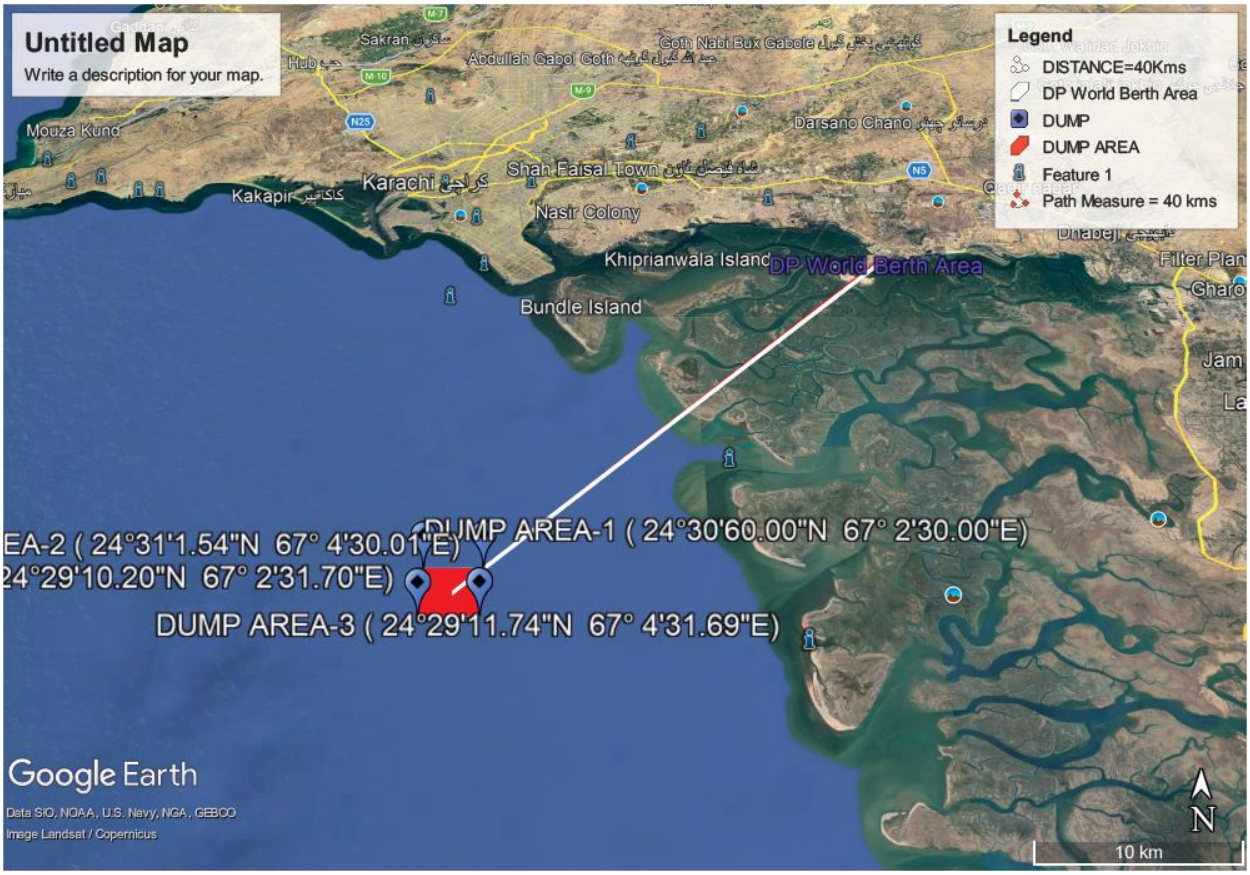


Figure 6.1 - PQA Appointed Disposal Site for Dredged Material

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.3.4 Re-Suspension of Potentially Contaminated Sediments

The proposed dredging activities may lead to the dredging of potentially contaminated sediments also, where these sediments may have accumulated over time from historical vessel activity, runoff, spills, antifouling residues, industrial discharges and overall port operations. Should dredging take place without proper testing and characterization first, contaminants may be resuspended in the water column or transported to an unsuitable disposal area.

Potential re-suspension of contaminated sediments may lead to increased toxicity in benthic organisms, deterioriation in marine water quality, exposure to workers, and potential contamination of disposal grounds.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- The Proponent through the contractor is to conduct pre-dredge sediment characterization for grain size, metals, hydrocarbons, oil and grease, and other contaminants of concern.

- Once the results are obtained, proponent is to divide the sediments into contaminated or non-contaminated. If contaminated sediments are identified then dispose of the contaminated sediments through a SEPA certified hazardous waste contractor.
- Ensure contamianted and non-contaminated sediments are kept separately and only non-contaminated sediment is disposed off in the PQA approved site.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.3.5 Marine Navigation

With the movement of the dredger, and the development of the new quay wall, the project will place temporary exclusion zones in the channel, where without a proper marine interface system conflicts may arise with vessel berthing, tug operations, pilotage, emergency routes, and adjacent terminal operations.

Potential impacts here include vessel collision, interruption to port operations, spill events, injury, and emergency access obstruction.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Prior to initiation of works, the contractor is to prepare a Navigation and Vessel Traffic Management Plan in coordination with PQA Marine Department, with a complete navigation risk review carried out.
- Define exclusion zones, temporary restrictions, lighting, buoyage/signage, notices to port users, emergency towage, rescue routes, and daily marine coordination meetings.
- Ensure coordination with PQA during the implementation of works.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.3.6 Impacts on Ecology

Despite works taking place in a developed, active terminal, the broader environmental setting is the Indus Delta creek system where mangroves and mangrove associated habitats are present, including birds, fish, and crabs are present. Poor pre-construction planning can often overlook indirect impact pathways such as turbidity movement, worker access into sensitive areas, vessel route effects, and perceieved impacts on fisheries users.

Potential impacts may include avoidable disturbance to ecoloigcal receptors, stakeholder complaints, accidental mangrove damage, failure to identify sensitive periods and weak integration of ecology into dredging and construction supervision.

The inherent risk associated with this impact is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Given that the channel is an active channel with the ingress and egress of container vessels, there is no major faunal species anticipated to be impacted from this project and its localized interventions.
- Furthermore, the nearest mangroves to the project site lie outside of the Area of Influence of the project, approximately 650 m away from the project site.
- Consultations with forest and wildlife department also did not highlight any particular sensitivies in the area that must be conisdered during the assessment and then implementation process
- Furthermore, given that no onshore disposal of dredged material is anticipated under the project, no major impacts on mangroves are foreseen under the project
- Independent monitoring to be carried out prior to, during, and after development works to ascertain the existing ecological conditions and whether these are being impacted during the project implementation works.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.3.7 Emergency Preparedness & Response

The marine construction interventions under the project will introduce high-consequence emergency scenarios, including spills, fires, vessel collision, lifting failure, and electrical incidents amongst many others. If emergency arrangements are not established before mobilization, response delays can turn a controllable incident into major environmental or safety events.

A lack of proper emergency preparedness and response planning may also result in injury, fatality, hydrocarbon release to marine water, fire spread, loss of equipment, disruption to terminal operations, and escalation to emergency services.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- The contractor is to prepare and test Emergency Preparedness and Spill Response Plan before mobilization in the supervision of QICT. A guide emergency preparedness and response plan is attached to this report as an annex.
- Provide spill kits, booms, extinguishers, first aid, rescue arrangements, life buoys, emergency communications, muster points, and drills for spill, fire, man-overboard, collision, severe weather, and crane/lifting incidents.
- Define muster points, emergency contacts, notification chains, response roles, and coordination with QICT and PQA.
- Conduct drills for spill, fires, man overboard, collision, severe weather, and crane/ lifting incidents.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.3.8 Improved Operational Readiness & Safety

The proposed interventions under the project are expected to improve operational readiness and overall safety conditions by upgrading aged terminal infrastructure and aligning the berth with modern vessel and crane requirements. A strengthened quay edge, improved fendering, modern rails, safer access systems and upgraded utilities improve operational readiness and reduce structural and safety constraints associated with older infrastructure.

This impact is considered to be overall positive.

6.4 Construction Stage - Assessment of Potential Impacts & Mitigation Measures

The construction stage of this project is anticipated to be the most environmentally and socially sensitive phase of the project as it involves seabed disturbance, marine piling, dredged material handling, crane decommissioning, heavy lifting, and working within an operational terminal.

6.4.1 Turbidity & Sedimentation

Dredging and near-quay marine works will result in disturbance to seabed sediments and may result in an increase in turbidity and susepended sediments. Fine particles involved in this may remain suspended for longer periods of time and also move with tidal currents, while coarser material may resettle closer to the work area. This impact will be most significant during dredging works, barge loading, seabed levelling, pile installation, and backfilling activities near the marine edge.

As a result of increased turbidity, overall light peentration in the water may be reduced, affecting primary productivity, interfering with fish feeding and respiration, disturb benthic organisms, and may lead to sediment deposition in sensitive creek margins.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Implement the Dredging Management Plan developed prior to implementation of works, and limit dredging to approved footprint, depth, and allowable tolerance.
- Avoid over-dredging, bucket overflow, uncontrolled barge loading, and dredging during unsafe weather/tide conditions.
- Monitor turbidity/TSS at upstream, downstream, near-field, and receptor points; implement stop-work/corrective actions when thresholds are exceeded.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.2 Deterioration of Marine Water Quality

Marine water quality may be deteriorated through physical, chemical, and biological pathways during construction. Sediment resuspension may also increase turbidity and oxygen demand, while spills of fuel, hydraulic oil or lubricants can create surface sheen and hydrocarbon contamination.

Uncontrolled wastewater, wash water, or contaminated stormwater can alter pH, introduce suspended solids and degrade nearshore water quality.

After effects from the deterioration of marine water quality may include disturbance to aquatic organisms, visual pollution, exceedance of water quality, damage to mangrove associaed recepors.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Prohibit untreated wastewater, wash water, concrete washout or contaminated runoff discharge to marine waters.
- Store fuels, oils and chemicals in bunded areas with secondary containment and away from drains/marine edges.
- Inspect dredgers, barges, cranes, generators and hydraulic equipment for leaks before use.
- Provide spill kits on the quay, barges, dredgers and fuel handling areas.
- Control concrete washout using designated lined or contained areas.
- Monitor pH, dissolved oxygen, TSS, turbidity, oil and grease, hydrocarbons, BOD/COD and visual sheen during active marine works internally, and through an Independent Monitoring Agency.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.3 Transport & Disposal of Dredged Material

Whilst QICT has already finalized a disposal point with PQA for the dredged material, the transport of the dredged material to and from the project site and the disposal site, and vice versa, may also contribute to potential environmental impacts, including the likes of turbidity plumes, localized seabed smothering, accidental loss and spill of dredged material during transport. Further risks associated with imporper transport and disposal of dredged material include disturbance to benthic organisms, sediment plume formation, and interference to navigating ships.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Dispose only at the approved offshore disposal site and only after sediment classification.
- Track each barge trip, disposal volume, time and coordinates.
- Maintain adequate barge freeboard and prevent overflow, leakage or side casting during transit.
- Avoid disposal during unsafe sea states or where vessel control is reduced.
- Prohibit disposal near mangroves, islands, mudflats, creek mouths, fishing grounds or navigation-sensitive areas.
- Reconcile dredged and disposed quantities daily and keep records

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.4 Impacts on Mangroves

No direct mangrove removal is anticipated under the defined works, but mangrove-associated habitats in the wider creek system are sensitive to indirect impacts. Excessive suspended sediment may settle on root zones, while altered tidal exchange, runoff or inappropriate vessel routes could create localized stress.

Potential impacts on mangroves may include reduced gas exchange at root structures, reduced seedling health, localized sediment smothering, and habitat disturbance for birds and crabs.

The inherent risk associated with this impact is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Establish and communicate mangrove no-go zones for workers, vessels and equipment.
- Avoid disposal routes, anchoring, mooring or material placement near mangrove creeks and edges.
- Maintain natural tidal exchange and do not block drainage pathways to mangrove areas.
- Monitor turbidity and visible sediment deposition near mangrove edges where relevant.
- Train workers on mangrove protection requirements and prohibit cutting, trampling, waste disposal or fuel handling near mangroves.
- Coordinate and carry out independent monitoring with officials from Sindh Forest Department

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.5 Underwater Noise & Vibration

Marine piling and dredging can generate underwater noise and vibration that propagate through the water column and seabed. Fish and other aquatic organisms can respond through avoidance, startle response or temporary behavioral change. The intensity depends on piling method, equipment condition, water depth, substrate and duration of exposure. Potential consequences include temporary displacement of fish, stress to aquatic fauna, masking of natural cues and disturbance to benthic organisms. Although the area is already an active port, additional construction noise may still be significant during peak activities.

The inherent risk associated with this impact is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Use soft-start or ramp-up procedures for piling and other high-noise activities.
- Maintain engines, mufflers and rotating equipment to reduce unnecessary noise and vibration.

- Avoid simultaneous high-noise marine activities where practicable.
- Establish observation zones where practicable and pause high-noise works if sensitive fauna are observed in the immediate work zone.
- Consider additional controls if monitoring or observations indicate unacceptable disturbance.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.6 Air Emissions & Dust

Construction emissions will arise mainly from diesel combustion in dredgers, support vessels, cranes, generators, trucks and construction plant. Dust may be generated by stockpiles, exposed surfaces, material handling and vehicle movement. In the port setting, this adds to existing industrial and traffic emissions but is expected to be temporary and localized.

Potential impacts from this include localized increases in particulate matter, NOx, SO2, CO and nuisance dust exposure for workers and adjacent terminal users. Poorly maintained engines can also increase black smoke and fuel consumption.

The Inherent Risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Use maintained equipment, compliant fuel and manufacturer-recommended maintenance schedules.
- Prohibit excessive idling of trucks, generators, dredgers and plant.
- Cover dusty material and wet down dust-prone areas where practicable.
- Control vehicle speeds on unpaved or dusty surfaces.
- Monitor PM10, PM2.5, NOx, SO2, CO and visible emissions as required by the ESMP.
- Investigate visible smoke, complaints or exceedances and implement corrective actions.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.7 Construction Noise & Vibration

Construction noise will occur from piling, lifting, cutting, vehicle movement, generator operation and crane dismantling. Vibration may occur during piling and heavy equipment movement. In an operational port, background noise is already elevated; however, additional high-intensity or impulsive noise may affect workers and nearby terminal users.

Potential Impacts from this include worker hearing risk, communication interference, nuisance to adjacent operations, fatigue and temporary disturbance to fauna. The effect is expected to be manageable with scheduling and occupational controls.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Use silencers, mufflers and acoustic enclosures where feasible.
- Schedule high-noise works in coordination with QICT and adjacent terminal operations.
- Provide hearing protection and demarcate high-noise zones.
- Maintain equipment to prevent abnormal noise.
- Monitor noise at representative work fronts and terminal boundaries.
- Investigate complaints or exceedances and adjust work methods where needed.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.8 Marine Navigation & Collision Risk

The exclusion zone established under the project for dredging and construction may reduce maneuvering space, create temporary obstructions and increase navigational complexity. The risk is particularly important during barge movements, dredger positioning, piling platform operation, night works, restricted visibility and adverse weather.

Consequences can include collision, allision with the quay or plant, vessel delays, spill events, injury, damage to equipment and disruption of port operations. Because of the severity of possible outcomes, navigation management must be continuous rather than occasional.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Coordinate daily with PQA Marine Department and Port Control.
- Maintain AIS, navigation lights, VHF communication and exclusion zone markers on relevant marine plant.
- Issue notices to port users and update them when work fronts or restrictions change.
- Keep navigation routes, turning areas and emergency routes clear.
- Define emergency towage, rescue, spill response and severe weather procedures.
- Suspend or modify marine works if visibility, tide, wind or port traffic conditions exceed safe operating limits.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.9 Interference with Neighboring Terminal Operations

The works will occur within an operational container terminal and may interact with berthing, yard circulation, utility systems, emergency access, cargo handling and adjacent terminal activity. Poorly planned phasing can cause congestion, unsafe interface between construction and operations, utility disruptions and delays to vessels or terminal users.

Consequences include operational delays, increased safety risk at live interfaces, loss of emergency access, conflicts with neighboring terminals and reduced productivity during construction.

The inherent risk associated with this is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Implement the two-phase construction strategy to maintain terminal continuity.
- Prepare an interface management plan covering live operations, adjacent terminal coordination, utilities, roads, emergency access and berth access.
- Communicate daily and weekly work schedules to QICT operations and relevant port users.
- Maintain emergency access, internal road continuity and utility protection.
- Use permit-to-work and isolation controls at all operational interfaces.
- Review interface risks during daily coordination meetings and update controls as work fronts shift.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.10 Occupational Health & Safety

Marine construction creates critical occupational hazards due to work over water, moving vessels, heavy equipment, hot works, lifting, electrical isolation, confined spaces, unstable surfaces and changing weather conditions. Potential consequences include drowning, falls from height, struck-by incidents, electrocution, burns, crushing, confined-space injury, heat stress and delayed rescue. The risk is intensified by simultaneous port operations and the need for multiple contractors to work in constrained areas.

The inherent risk associated with this is Very High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Implement a project-specific OHS Plan.
- Require method statements, job safety analyses and permit-to-work controls for high-risk activities.
- Use fall protection, edge protection, life jackets and rescue equipment for work near or over water.
- Provide trained supervisors, competent operators, banksmen, riggers, welders and rescue personnel.
- Conduct toolbox talks, safety inductions, emergency drills and weather monitoring.
- Maintain incident/near-miss reporting, corrective action tracking and stop-work authority.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.11 Decommissioning & Installation of New Cranes

Crane dismantling and installation involve complex heavy lifts, high centers of gravity, large components, wind sensitivity, electrical and mechanical isolation, and interaction with live terminal infrastructure. Failure of a lift or inadequate ground bearing verification could have catastrophic safety and asset consequences.Potential impacts may include fatality, dropped loads, structural collapse, crane damage, electrical incidents, fire, prolonged terminal shutdown and damage to quay infrastructure.

The inherent risk associated with this is Very High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Use specialist crane decommissioning and installation contractors with verified competence.
- Prepare engineered lifting plans, lift studies and critical lift permits.
- Verify ground bearing capacity, crane pad design, travel paths and exclusion zones before lifting.
- Inspect and certify lifting gear, cranes, slings, shackles, spreader beams and rigging equipment.
- Define wind-speed limits and stop lifting when limits are exceeded.
- Use trained lifting supervisors, riggers, banksmen and operators.
- Apply lock-out/tag-out for electrical and mechanical isolation during decommissioning and commissioning.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.12 Fire, Explosion, & Emergency Risk

Construction activities at the site will involve hot works, fuel storage, hydraulic systems, electrical installations, generators and vessel operations. These sources can create fire or explosion risk if ignition control, isolation, housekeeping or emergency readiness are weak. Hydrocarbon fires near marine water also create spill and contaminated runoff pathways. Consequences from such events may include injury, equipment loss, vessel or terminal damage, marine pollution from firefighting runoff or fuel release, operational disruption and escalation to port emergency response.

The inherent risk associated with this is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Apply hot work permits, fire watch and gas testing where required.
- Maintain extinguishers, firefighting water, alarms and emergency access at work fronts.
- Control fuel storage, transfer and hydraulic systems through bunding, inspection and spill readiness.
- Inspect temporary electrical systems and prohibit unsafe connections.
- Conduct emergency drills and coordinate with QICT/PQA emergency response teams.
- Maintain clear access for emergency vehicles and marine response craft.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.4.13 Solid & Hazardous Waste Generation

Construction and crane replacement will generate non-hazardous and hazardous wastes, including scrap metal, packaging, used oils, oily filters, contaminated rags, domestic waste and construction debris. If not segregated and documented, wastes can contaminate drains, create housekeeping hazards and be disposed through unsuitable routes.

Consequences include littering, marine debris, unsafe storage, occupational exposure, fire risk, regulatory non-compliance and loss of opportunities for reuse or recycling, especially for scrap steel from decommissioned cranes.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Implement a Waste Management Plan before construction begins.
- Segregate hazardous and non-hazardous waste at source using labelled containers.
- Reuse suitable fill and recycle scrap steel where feasible.
- Store hazardous waste in bunded, covered and labelled areas.
- Use licensed waste contractors and maintain manifests/disposal records.
- Prohibit dumping into marine waters, drains or unused port areas.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.14 Wastewater & Worker Welfare

Worker welfare impacts can arise if sanitation, potable water, hygiene, rest areas or medical access are inadequate. Uncontrolled sanitary wastewater can also contaminate work areas, drainage systems and marine waters. Welfare quality is directly linked to worker health, dignity, productivity and labor compliance. Consequences include worker illness, unhygienic work fronts, odor, vector attraction, marine pollution, complaints and non-compliance with labor and HSE requirements.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Provide adequate toilets, handwashing, washing facilities, drinking water, rest areas and housekeeping.
- Use septic tanks, holding tanks or approved treatment systems for sanitary wastewater.
- Prohibit direct discharge of wastewater to drains, soil or marine water.
- Use licensed contractors for desludging and maintain records.
- Provide medical access and worker welfare arrangements appropriate to workforce size.

- Inspect welfare facilities regularly and correct deficiencies promptly.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.15 Community Health & Safety

Construction deliveries and worker transport may increase traffic on internal terminal roads and port access routes. Heavy vehicles, abnormal loads and pedestrian interactions can create safety hazards if routes, timing and segregation are not controlled. Consequences include traffic congestion, vehicle collisions, pedestrian injury, blocked emergency access, damage to port infrastructure and conflict with adjacent terminal operations.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Implement a Traffic Management Plan with approved haul routes and delivery timing.
- Set speed limits, signage, barriers and flagman requirements where needed.
- Segregate pedestrians from vehicle routes at work fronts and access points.
- Check vehicle fitness and driver competence.
- Coordinate abnormal loads with PQA and QICT operations.
- Maintain emergency access at all times.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.16 Labor

Labor risks may arise if contractor workers do not receive clear employment terms, fair wages, safe working conditions, working hour controls, grievance channels or protection from discrimination. Subcontracting can increase the risk of inconsistent implementation unless labor controls are contractually required and audited. Consequences include labor disputes, low morale, unsafe work behavior, regulatory concern, reputational risk and unresolved grievances.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Provide written contracts and comply with legal wage and working hour requirements.
- Prohibit child labor, forced labor and discriminatory practices.
- Provide induction, PPE, task-specific training and safe accommodation where relevant.
- Establish a confidential worker grievance mechanism and code of conduct.
- Maintain attendance, training, wage and grievance records.
- Conduct contractor and subcontractor labor compliance audits.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.4.17 Employment

Construction will generate temporary employment and procurement opportunities across marine works, civil works, supervision, HSE, transport, equipment support and services. The benefit is enhanced when local workers and suppliers are used where capability, safety and quality requirements can be met.

Positive outcomes include income generation, skills development, local service demand and improved contractor capacity.

6.5 Operations Stage - Assessment of Potential Impacts & Mitigation Measures

6.5.1 Improved Berth Safety & Structural Reliability

The upgraded quay wall and associated berth infrastructure are expected to improve structural reliability and operational safety compared with the aging terminal configuration. Stronger foundations, modern fenders, bollards, rails, ladders and utilities will better accommodate deeper-draft vessels and modern STS cranes. Positive effects include improved berthing safety, reduced structural risk, improved inspection access, reduced equipment downtime and better resilience of critical berth assets.

6.5.2 Improved Terminal Capacity

The deeper berth pocket and higher-capacity STS cranes will improve terminal productivity and allow handling of larger container vessels. Capacity improvement is expected to reduce operational constraints associated with shallow draft and aged equipment. Positive outcomes include higher berth productivity, reduced vessel waiting time, improved schedule reliability, improved competitiveness and improved logistics performance.

6.5.3 Potential Reduction in Emissions per TEU

By accommodating larger vessels and improving crane productivity, the project can reduce emissions intensity per container handled, particularly where vessel waiting time, anchorage delays and tidal constraints are reduced. The effect depends on operational efficiency and continued equipment maintenance. Potential benefits include lower fuel use per TEU transported, fewer delays, reduced auxiliary engine running time and improved logistics efficiency.

6.5.4 Altered Sedimentation, Scour, or Seabed Instability

Deepening the berth pocket and accommodating larger vessels can change local hydrodynamic and sediment behavior near the quay. Propeller wash, tug maneuvering and tidal currents may increase scour at the quay edge or cause localized sediment deposition in the berth pocket.

Consequences include reduced under-keel clearance, local seabed instability, exposure or damage to scour protection, increased maintenance dredging and potential structural stress if scour is not detected early.

The inherent risk associated with this is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Install and maintain appropriately designed scour protection.
- Conduct regular bathymetric surveys to monitor berth pocket levels and seabed change.
- Inspect quay structures, fenders, bollards and scour protection after commissioning and after extreme events.
- Monitor under-keel clearance and berth pocket condition.
- Repair scour protection and undertake targeted maintenance dredging where required.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.5.5 Operational Marine Pollution

Operational marine pollution may arise from vessel interface activities, bilge or waste mismanagement, hydraulic leaks from cranes, fuel handling, maintenance spills or poor housekeeping. Although port controls already exist, increased terminal activity may increase the number of interfaces requiring supervision. Potential impacts include surface sheen, localized hydrocarbon contamination, aquatic toxicity, visual pollution, regulatory reporting and damage to ecological receptors if spills reach creek waters.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Enforce no-discharge rules and port waste reception requirements.
- Maintain spill kits, booms and trained response personnel at relevant locations.
- Inspect crane hydraulic systems and vessel interface areas regularly.
- Train staff in spill prevention, reporting and response.
- Record spills, investigate root causes and implement corrective actions.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.5.6 Stormwater Management & Contamination

Stormwater can collect oil residues, sediment, litter, cargo residues and other contaminants from paved terminal surfaces before entering the drainage system. During monsoon rainfall, pollutant loads may increase if housekeeping and drain maintenance are weak. Potential impacts may include contaminated runoff to marine waters, blocked drains, localized flooding, sheen formation and regulatory concern if drainage controls are not maintained.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Maintain surface drainage, silt traps and oil-water separation systems where installed.
- Clean spills immediately and prevent waste storage near drains.
- Conduct regular housekeeping and drain desilting.
- Inspect stormwater systems before and during monsoon periods.
- Maintain records of inspections, cleaning and corrective actions.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.5.7 Occupational Health & Safety

Terminal operations involve high-energy equipment, moving vehicles, suspended loads, mooring lines, vessel interface, electrical systems and maintenance at height. New cranes and improved infrastructure reduce some risks, but safe operation requires formal procedures and competent personnel.Consequences include struck-by injuries, falls, crush injuries, electrocution, mooring line snap-back incidents, vehicle collisions and maintenance accidents.

The inherent risk associated with this is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Maintain the operational OHS Management System.
- Use crane operating procedures, traffic segregation and safe mooring procedures.
- Apply lock-out/tag-out for electrical and mechanical maintenance.
- Use work-at-height permits, fall protection and rescue arrangements.
- Define competency requirements for crane operators, riggers, maintenance teams and supervisors.
- Conduct emergency drills, incident investigations and corrective action tracking.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.5.8 Navigational Incidents due to Large Vessels

The upgraded berth will accommodate larger and deeper-draft vessels. While this is a beneficial operational objective, it also requires disciplined navigation procedures, tug support, under-keel clearance control, weather restrictions and coordination with PQA pilotage and traffic systems. Consequences of a navigational incident include contact with quay infrastructure, vessel collision, fender/bollard damage, spill, injury, cargo delay and disruption to port operations.

The inherent risk associated with this is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Coordinate all larger vessel movements with PQA pilotage and traffic control.
- Maintain berth operating limits, tug requirements and weather restrictions.
- Apply under-keel clearance procedures and berth occupancy planning.
- Inspect fenders and bollards and maintain defect correction records.
- Maintain emergency response readiness for collision, spill and rescue scenarios.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.5.9 Emergency Preparedness & Response

Major operational emergencies may arise from vessel collision, fire, crane malfunction, electrical failure, fuel/hydraulic release, severe weather, cyclones or monsoon flooding. These events are low-frequency but high-consequence and require continuous preparedness. Consequences can include injury, fatality, major asset damage, marine pollution, prolonged operational shutdown, emergency evacuation and regulatory reporting.

The inherent risk associated with this is High Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Maintain and periodically drill the Emergency Preparedness and Response Plan.
- Maintain firefighting systems, spill response equipment and emergency access.
- Define incident command arrangements and communication chains.
- Coordinate with PQA and QICT response teams.
- Implement severe weather procedures, shutdown protocols and evacuation arrangements.
- Review lessons learned after drills, incidents and near misses.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.

6.5.10 Hazardous & Non-Hazardous Waste Management

Routine operations and maintenance will generate waste streams including packaging, domestic waste, used oils, filters, oily rags, spill residues and equipment maintenance materials. Poor storage or disposal can cause contamination, fire risk and housekeeping issues. Consequences include unsafe storage, littering, drain contamination, worker exposure, regulatory non-compliance and unnecessary landfill disposal of recyclable materials.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Maintain waste segregation at source.

- Store hazardous waste in labelled, bunded and covered areas.
- Use licensed contractors for waste collection and disposal.
- Maintain waste manifests and disposal records.
- Recycle suitable materials where feasible.
- Conduct periodic waste audits and correct non-compliances.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

6.5.11 Climate Resilience

The coastal port setting is exposed to monsoon rainfall, high tide, storm surge, cyclonic conditions, sea level rise and heat stress. These hazards can affect drainage capacity, structural durability, emergency access, worker safety and continuity of operations over the design life of the asset. Poor Plannnig and inclusion of climate change can result in flooding, drainage surcharge, scour, asset deterioration, heat-related illness, operational shutdown and post-event repair requirements.

The inherent risk associated with this is Medium Adverse.

Mitigation Measures

Mitigation measures proposed to reduce the severity of this impact include:

- Integrate design freeboard, drainage capacity and scour protection into operations and maintenance.
- Monitor severe weather alerts and implement shutdown procedures when thresholds are reached.
- Inspect structures, drainage and scour protection after extreme events.
- Maintain heat stress controls for workers during high-temperature periods.
- Conduct periodic climate resilience reviews as part of asset management.

Residual Risk

Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.

7 Stakeholder Consultations

7.1 Overview

Public consultation and information disclosure is an essential component of the Environmental & Social Impact Assessment process, recognized by development agencies and national governments alike. Similarly, to incorporate the views, concerns, and suggestions of project stakeholders and to provide them with sufficient opportunity to become part and parcel of the development process, the importance of stakeholder engagement throughout the project life cycle cannot be dismissed.

Stakeholder consultation presents an opportunity for mutual information-sharing and dialogue between the project proponent and stakeholders. An effective public consultation provides concrete suggestions that can help improve project design, resolve conflicts at an early stage, identify management solutions to mitigate potentially adverse consequences and enhance perceived positive impacts.

7.2 Consultation Objectives

Effective stakeholder engagement enhances project beneficiaries' role from "participants" to "enabling agents" that proactively provide insights to project planning and implementation. The stakeholder consultation process for this project has been designed to enhance the role of stakeholders and thereby contribute towards project success and sustainability. Specific tasks and purposes of consultations with stakeholders have been given in the table below.

Table 7.1 - Tasks & Purpose of Consultation

Task	Purpose of Consultation with Stakeholders
Need for consultation with the stakeholders	• To build trust to ensure sustained support for the proposed project and build resilience during the times of crisis. • To learn about public concerns that need to be addressed and considered in designing of the project concept and preparing mitigation measures and programs. • To learn about the strengths, skills, and organizational support that the stakeholders can bring to support project planning and implementation. • To introduce the project and obtained their views and feedback on it, along with measures to incorporate to improve the project
Modes and benefits of consultation	• Listening and creating dialogue with stakeholders to keep the project tuned to public concerns early, to pre-empt breakdowns, and avoid mistrust in public confidence. • Engaging the public as advocates for the project construction and to support the implementation of social, resettlement, and environment and health programs.

The specific objectives of the stakeholder engagement exercise carried out for the project includes:

- Ensure all stakeholders are informed about the project's objectives, context, and scope, including the design features and other potential environmental and social implications.
- Promote active engagement with project-affected parties, beneficiaries, and other stakeholders to foster acceptance, ownership, and sustainability of the project. Ensure participation from diverse groups, irrespective of gender, ethnicity, income level, or ability, in an inclusive, transparent manner.

- Gather community feedback on potential impacts, such as environmental changes or livelihood disruptions, and develop practical solutions to address these concerns while enhancing project outcomes.

7.3 Stakeholder Identification & Analysis

The two categories of stakeholders are outlined below:

- **Primary Stakeholders** – Primary stakeholders are those who are directly involved in or affected by the project within the Port Qasim operational area. This includes the project proponent, terminal operators, and industrial entities located in close proximity to the project site, whose operations may be influenced by construction activities, dredging works, and associated marine traffic.
- **Secondary Stakeholders** – Secondary stakeholders are those who are indirectly impacted by the project, such as government agencies and other regulatory bodies responsible for overseeing environmental, social, and economic aspects.

Details regarding Primary stakeholders and their roles and responsibilities are represented in Table below:

Table 7.2 - Roles & Responsibilities of Primary Stakeholders

Project Stakeholder	Roles and Responsibilities
QICT	• Responsible for overall development and implementation of the proposed project, along with the measures provided in this report • Ensure compliance with environmental and regulatory requirements • Coordinate with relevant authorities and stakeholders during project planning and execution
Port Qasim Authority	• Acts as the regulatory authority for the project location within Port Qasim. • Oversees port operations, navigational safety, and marine activities. • Provides necessary approvals, permissions, and coordination for works within port limits.
FAP Terminals (Pvt.) Limited	• Functions as a neighboring port/industrial operator within the project vicinity. • Coordinate with project activities to ensure minimal disruption to marine and logistics operations. • Share operational insights relevant to traffic, navigation, and safety during project implementation.
Huaneng Fuyun Port & Shipping (Pvt.) Limited	• Functions as a neighboring port/industrial operator within the project vicinity. • Coordinate with project activities to ensure minimal disruption to marine and logistics operations. • Share operational insights relevant to traffic, navigation, and safety during project implementation.

Details regarding secondary stakeholders and their roles and responsibilities are provided in the table below:

Table 7.3 - Roles & Responsibilities of Secondary Stakeholders

Project Stakeholder	Roles and Responsibilities
Sindh Environmental Protection Agency (SEPA)	SEPA is the regulatory authority and mainly responsible for the development and implementation of the environmental policies and strategies in order to integrate the environmental issues and sustainable development approaches into the legal and regulatory frameworks as per Sindh Environmental Protection Act, 2014. EPA Sindh is responsible for the approval of the proposed project prior to implementation.
Marine Fisheries Department, GoP	Regulates and manages fisheries resources in coastal and marine areas. Provides guidance on potential impacts of dredging and marine works on fish habitats, breeding grounds, and fisheries productivity. Recommends mitigation measures to protect fisheries and associated livelihoods.
Sindh Forest Department	Enforces relevant forestry laws and regulations to mitigate ecological damage. Prevents deforestation and degradation of natural ecosystems, including mangroves.
International Union for Conservation of Nature (IUCN)	Provides technical expertise on biodiversity conservation and sustainable natural resource management. Advises on potential ecological impacts, particularly on coastal and marine ecosystems. Recommends best practices for environmental protection and sustainability.
World Wildlife Fund (WWF)	Works on conservation of biodiversity, including marine and coastal ecosystems. Provides input on protection of mangroves, marine habitats, and endangered species. Recommends mitigation measures and monitoring strategies for environmental sustainability.

7.4 Consultation & Participation Process

The project utilizes various methods of engagement that were employed as part of its continuous interaction with project stakeholders. For the engagement process to be effective and meaningful, a range of various techniques were applied that were specifically tailored to the identified stakeholder groups. For ascertaining the perceptions of different stakeholders about the project consultations/meetings were carried out at following two levels:

- Consultations with Primary Stakeholders
- Consultations with Secondary Stakeholders

7.4.1 Consultations with Primary Stakeholders

The main purpose of the consultation exercise was to disseminate project information to relevant stakeholders and solicit their feedback received at an early stage regarding potential issues and concerns based on the current project concept and design features.

Identification of stakeholders is one of the major steps for designing an effective consultation process. For this purpose, several site visits were carried out by the E&S team to identify the relevant stakeholders for consultation. Consultation meetings were conducted with the identified stakeholders. The stakeholders were briefed about the background and scope of the project at the beginning of the meeting sessions. Concerns and suggestions of the respondents were noted down by the team and pictures of the session were taken with the consent of the stakeholders. If the interviewees had any queries regarding the project, the team responded to their queries during the session. Key Informant Interviews (KIIs) were conducted with project stakeholders to gather their perspectives on project implementation, and their feedback was formally documented.

7.4.2 Consultations with Secondary Stakeholders

Other interested parties, such as nongovernmental organizations and government departments were identified as key stakeholders and approached individually for consultations. These consultations were conducted through Key Informant Interviews (KIIs), allowing each department to provide detailed feedback and share their perspectives on various aspects of the project. This approach ensured that the views of all relevant stakeholders were considered in the project planning and implementation process creating a comprehensive understanding of their concerns, expectations, and recommendations.

7.5 Consultation Feedback & Analysis

Timeline of all stakeholder consultations carried out are presented below:

Table 7.4 - Consultations Conducted

S#	Types of Consultation/ Meeting	Dates
a)	Sindh Forest Department	8th March 2026
b)	International Union for Conservation of Nature (IUCN)	11th March 2026
c)	Port Qasim Authority	7th April 2026
d)	Sindh Wildlife Department	23rd April 2026
e)	Marine Fisheries Department	23rd April 2026
f)	SEPA	23rd April 2026
g)	Huaneng Fuyun Port & Shipping (Pvt.) Limited	14th April 2026
h)	FAP Terminals Pvt Ltd	14th April 2026
i)	QICT	24th February 2026

7.5.1 Primary Stakeholders

The comments, concerns, and suggestions received from the primary stakeholders during the survey have been collated in this section. The comments solicited from the primary stakeholders were helpful in the screening of the potential environmental and social aspects of the project.

Details regarding Primary stakeholder's feedback and suggestions are represented in the Table below:

Table 7.5 - Stakeholder Feedback from Primary Stakeholders

S#	Name	Occupation	Comments/Feedback
a)	QICT	Written Response provided by team	• The proposed quay wall extension is generally aligned with Port Qasim's development strategy and complements planned capital dredging activities aimed at increasing cargo and container throughput. • The project is currently under review by the Port Qasim Authority (PQA), and formal approvals are required prior to implementation. This includes approval through the PQA Planning & Development (P&D) Department, with final authorization issued by the PQA Secretary. • Additional approvals may be required from the Sindh Environmental Protection Agency (SEPA) and other relevant stakeholders operating within the port premises. • It is not yet confirmed whether dredging activities fall under the scope of National Dredging & Marine Services (NDMS). If applicable, necessary coordination and consent from NDMS will be required. • Continuous coordination with the PQA Marine Department is essential during the construction phase to ensure that navigational safety, vessel traffic management, and channel operations are not adversely affected. • All marine and dredging activities must be conducted in accordance with PQA guidelines and subject to prior approvals from relevant authorities. • A navigational study has been proposed by QICT and submitted to PQA for concurrence. This study will assess vessel maneuverability, navigation safety, and channel operations, and will inform appropriate mitigation measures. • Designated navigational routes, safety buffers, and restricted zones (including turning basins and berth approach areas) must be strictly maintained during construction. • Temporary construction zones (e.g., dredgers, barges, cranes) should be clearly demarcated and communicated to port authorities and vessel operators. • Safety buffers must be maintained around active construction and dredging equipment to prevent interference with vessel movement. • Coordination regarding vessel movements and construction activities should be maintained through existing daily shipping affairs communication channels with PQA. • A major cumulative activity identified is the planned capital dredging of the navigational channel by PQA, which may overlap with the proposed project and requires coordination. • No specific additional external agencies have been identified at this stage; however, all relevant port

S#	Name	Occupation	Comments/Feedback
			authorities and agencies will be engaged as required, with primary coordination through PQA for navigational, operational, and security clearances. • Environmental monitoring during dredging should be conducted in accordance with Sindh EPA guidelines, as advised by PQA's hydrographic and channel dredging department. • Operational disruption can be minimized through: ❖ A phased construction approach to maintain partial terminal functionality ❖ Use of existing marine communication channels for coordination ❖ Implementation of traffic and access management plans ❖ Clear demarcation of construction zones and safety buffers ❖ Environmental and safety measures should include: ❖ Continuous environmental monitoring ❖ Strict adherence to Health, Safety, and Environment (HSE) protocols ❖ Use of appropriate Personal Protective Equipment (PPE) ❖ Installation of safety signage ❖ Implementation of emergency preparedness plans ❖ General project management measures should include: ❖ Regular stakeholder engagement ❖ Continuous monitoring and reporting to PQA ❖ Ensuring uninterrupted supply of utilities (electricity, water) during construction and operations • At this stage, no major concerns have been raised; however, continuous coordination with PQA departments is strongly recommended to ensure compliance with port regulations and safe operations throughout the project lifecycle.
b)	Mr. Shahid Hafeez, Port Qasim Authority	Director (Dredging)	• The Private Sector Projects Department within PQA is responsible for handling project-related matters; however, initial awareness of the project exists at a preliminary level. • Detailed review and alignment with the Port Qasim Master Plan will be undertaken after completion of the ESIA and feasibility study, once potential impacts are clearly identified. • A formal No Objection Certificate (NOC) from Port Qasim Authority is required prior to commencement of project activities. • The project proponent is not obligated to utilize National Dredging Marine Services and may engage any qualified third-party contractor or undertake dredging independently.

S#	Name	Occupation	Comments/Feedback

			• The project proponent must coordinate with the PQA Operations Department and provide detailed information, including:
			  ○ Dredging methodology and type
			  ○ Equipment and machinery specifications
			  ○ Dredging team and operational setup
			  ○ Project layout and design specifications
			  ○ Proposed working hours and schedule
			• The location and methodology of dredged material disposal must be clearly defined and submitted for approval.
			• Approval to commence dredging activities will only be granted after submission and review of all required technical and operational details.
			• PQA will monitor project activities through its Automatic Identification System (AIS), along with on-site monitoring by dredging inspectors.
			• The PQA Environmental and Safety Department will also be involved in overseeing compliance and monitoring environmental performance.
			• The project proponent must ensure that turbidity levels are controlled, and dredging activities should be halted if unacceptable increases in turbidity are observed.
			• A detailed soil and sediment testing program should be conducted prior to dredging activities.
			• The dredged material disposal site must be located away from mangrove areas to avoid ecological impacts.
			• Care must be taken to ensure that dredged volumes are managed appropriately at the disposal site to prevent adverse impacts on marine flora and fauna.
			• A qualitative risk assessment and hydraulic study should be conducted prior to project implementation and shared with PQA for review.
			• It was noted that PQA has upcoming capital dredging activities; therefore, coordination should be ensured to avoid overlap or operational conflicts.
			• No additional external consultations are required from PQA's side; however, formal approval must be obtained from the Director Marine Operations.

c)	Mr. Abdul Waheed, General Manager	FAP Marine Terminals Pvt Ltd	• Mr. Abdul Waheed, General Manager at FAP Marine Terminal, expressed overall support for the proposed project and highlighted the importance of maintaining good neighboring relations, noting that there have been no previous or ongoing issues with QICT projects. • During the discussion, he inquired about the project location, type of dredging to be undertaken, and associated methodologies. He emphasized that dredging activities should be carried out responsibly to avoid any adverse impacts on surrounding areas, particularly in terms of sediment dispersion and potential disruption to local hydraulics. He

S#	Name	Occupation	Comments/Feedback
			specifically noted that dumping of dredged material should be conducted at a suitable distance to ensure that waste or sediments do not affect their operational area, especially considering that Berth 2 is already maintained at a depth of approximately 16 meters. • He further highlighted the importance of ensuring that transportation of dredged material is conducted without leakage, to prevent environmental contamination. While no specific time restrictions were suggested due to continuous vessel activity in the area, he stressed the need for clear communication regarding dredging equipment, methodology, and disposal practices. • As a recommendation, he suggested that a formal meeting be conducted with their team prior to the commencement of works to provide detailed information and ensure coordination. He also emphasized the importance of engaging with other neighboring industries to obtain their input and facilitate smooth project implementation.
d)	Huaneng Fuyun Port & Shipping (Pvt.) Limited	-	A letter was written to the ownership of the company, along with emails shared on the proposed interventions under the project, and requested feedback. No response was receieved from them however.

Pictures from the consultations carried out are provided below:

Port Qasim Authority

FAP Marine Terminals Pvt Ltd

7.5.2 Secondary Stakeholders

The comments, concerns, and suggestions received from the secondary stakeholders during the survey have been collated in this section. The comments solicited from the secondary stakeholders were helpful in the screening of the potential environmental and social aspects of the project.

Details regarding Secondary stakeholder's feedback and suggestions are represented in in the table below:

Table 7.6 - Stakeholder Feedback from Secondary Stakeholders

Stakeholder	Feedback & Suggestions
1. Sindh Environmental Protection Agency (SEPA)	Respondent: Imran Sabir, Director • SEPA is the primary regulatory authority responsible for ensuring that development projects comply with environmental laws and regulations in Sindh. It reviews ESIA reports to evaluate environmental and social impacts and ensures that appropriate mitigation measures are incorporated into the ESMP prior to granting environmental approval/NOC. • The proposed quay wall extension and dredging project requires the preparation and submission of an ESIA in accordance with the Sindh Environmental Protection Agency (Environmental Assessment) Regulations, 2021, as such activities are environmentally sensitive and may impact marine ecosystems, coastal hydrodynamics, and water quality. • The project is considered to fall under Schedule III, Section E (Transport), Sub-section (Ports and Harbour Development) of the Environmental Assessment Regulations due to its components, including quay wall construction, dredging, ground improvement works, and installation of associated infrastructure and utilities. • The presence of mangroves in the project vicinity necessitates additional environmental assessment and possible regulatory clearances. The ESIA should include: ❖ Mangrove mapping and ecological surveys ❖ Assessment of indirect impacts such as sedimentation, turbidity, and hydrological changes ❖ Buffer zone evaluation

Stakeholder	Feedback & Suggestions
	❖ Consideration of mangrove conservation or offset measures, if required ❖ Coordination with the Sindh Forest Department and relevant coastal authorities • Marine water quality monitoring should be incorporated into the ESIA using recognized standards. Key parameters to be monitored include: ❖ Turbidity ❖ Total Suspended Solids (TSS) ❖ Dissolved Oxygen (DO) ❖ Salinity ❖ pH ❖ Heavy metals ❖ Hydrocarbons and oil & grease Monitoring stations should be established upstream and downstream of dredging locations to ensure compliance with acceptable limits. • Dredged material must be assessed for contamination prior to disposal. If hazardous substances are present, separate approval will be required. Disposal options may include: ❖ Offshore dumping at approved sites ❖ Beneficial reuse (e.g., land reclamation or beach nourishment) ❖ Confined disposal facilities for contaminated material • SEPA recommends consultation with relevant stakeholders and authorities, including: ❖ Port Qasim Authority (PQA) ❖ Sindh Forest and Wildlife Department ❖ Pakistan Maritime Security Agency ❖ Fisheries Department ❖ Karachi Port Trust ❖ National Institute of Oceanography ❖ Local fishing communities and coastal stakeholders • Key environmental concerns identified from similar projects include: ❖ Increased turbidity during dredging ❖ Sediment dispersion affecting marine habitats ❖ Potential impacts on mangroves ❖ Dredged material disposal issues ❖ Navigation and safety concerns ❖ Disturbance to fisheries and local livelihoods • To minimize environmental impacts and ensure compliance, SEPA recommends: ❖ Implementation of turbidity control measures ❖ Use of silt curtains where feasible ❖ Scheduling dredging activities to avoid fish breeding seasons ❖ Continuous marine water quality monitoring ❖ Proper dredged material management and disposal ❖ Mangrove protection measures ❖ Spill prevention and oil management plans ❖ Environmental monitoring during construction and operation phases ❖ Ongoing stakeholder engagement • The ESIA should address key marine environmental impacts, including turbidity increase, disturbance of benthic habitats, sediment dispersion, water quality degradation, hydrodynamic changes, and marine noise and vibration.

Stakeholder	Feedback & Suggestions
	• The ESIA should include: ❖ Comprehensive marine ecological surveys ❖ Hydrodynamic and sediment transport modelling ❖ Cumulative impact assessment considering other port activities ❖ Climate resilience considerations (e.g., sea level rise and extreme weather) ❖ Detailed Environmental and Social Management Plan (ESMP) ❖ Emergency response and pollution prevention plans • The ESIA process should ensure transparency through stakeholder consultation and public disclosure in accordance with SEPA regulations and international best practices. • It was also suggested that a site visit may be arranged for SEPA staff at a mutually convenient time to facilitate better understanding of the project.
2. Forest Department, Government of Sindh	<u>Respondent: Shahzad Gill, Divisional Forest Officer</u> • The proposed dredging and quay wall extension activities may potentially impact nearby mangrove ecosystems; therefore, careful planning and implementation are required to minimize ecological disturbance. • It was advised that formal approval / No Objection Certificate (NOC) must be obtained from the Sindh Forest Department prior to commencement of project activities. • The project proponent should formally communicate with the Sindh Forest Department through an official letter detailing the scope of works, including construction methodology, dredging activities, and associated timelines. • Clarification is required regarding key project parameters, including the width and extent of the proposed quay wall expansion, which are currently not specified. • Details regarding the designated disposal site for dredged material must be provided, including handling, transportation, and disposal methods. • Adequate measures should be implemented to control pollution and sediment dispersion during dredging activities to ensure that impacts do not extend to adjacent mangrove habitats. • The potential impacts on aquatic life and sediment dynamics should be carefully assessed, and mitigation measures should be incorporated to minimize disturbance to marine ecology. • It was recommended to consult the Sindh Wildlife Department to assess the presence of migratory birds and other wildlife species in the project area. • Prior to initiation of construction activities, the Sindh Forest Department should be formally informed through a detailed submission outlining all proposed activities, and necessary approvals should be secured.
3. IUCN	<u>Respondent: Dr. Babar Hussain</u> • Dr. Babar Hussain highlighted that dredging activities have the potential to disturb biodiversity, mangrove ecosystems, and aquatic life. He emphasized that such operations are often carried out without adequate safeguards, which can lead to environmental damage. As a reputable and globally recognized company, QICT should ensure that appropriate environmental protection measures and continuous monitoring are

Stakeholder	Feedback & Suggestions
	implemented during dredging activities to prevent any harm to mangroves and biodiversity. • Dr. Babar Hussain further pointed out that the disposal location for the dredged material has not been specified. He emphasized that the exact site for dumping the dredging waste should be clearly identified and mentioned in the report before granting approval for the activity. It should also be ensured that the dredged material is not disposed of near nearby islands or creeks, as this could potentially damage mangrove ecosystems and disrupt the movement and livelihoods of the local coastal community. • He also noted that a large number of migratory birds visit this area. He suggested that their presence should be taken into consideration and that dredging activities should preferably be scheduled during specific months to minimize disturbance to these migratory bird populations.
4. Sindh Wildlife Department	<u>Respondent: Mumtaz Ali Soomro, Deputy Conservator</u> • He stated that the Wildlife Department is responsible for the conservation of wildlife across Sindh and also conducts technical surveys in relevant areas. • He emphasized the importance of protecting mangroves and the surrounding flora and fauna within the project site. If dredging is expected to impact these ecosystems, necessary precautions must be taken. • He further stressed that the natural habitats of all living organisms should remain undisturbed throughout the project's implementation.
5. Marine Fisheries Department	<u>Respondent: Kashifa Zohra, Deputy Director</u> • The project area may support marine habitats and aquatic species, and therefore potential impacts on marine ecology should be assessed and monitored during dredging and associated activities. • Measures should be implemented to control underwater noise and vibration levels, as these may affect marine life in the vicinity of the project area. • Adequate precautions should be taken to prevent the release of hydrocarbons, sediments, or other pollutants into the marine environment during construction and dredging works. • Coordination with relevant maritime and security agencies is important to ensure that project activities are conducted in a safe and compliant manner within the port environment. • Necessary approvals and clearances from relevant authorities should be obtained prior to commencement of marine and dredging activities. • Where required, technical expertise may be sought to support environmental management and monitoring during project implementation. • Appropriate mitigation measures should be implemented to minimize any residual impacts on water quality and marine fauna resulting from project activities.

Pictures from the secondary stakeholder consultations carried out are proivded below:

Sindh Wildlife Department	Marine Fisheries Department
IUCN	Sindh Forest Department

8 Environmental & Social Management Plan

8.1 General

This section discusses the implementation and management of mitigation measures that are required for the proposed project which include progressive report and techniques to ensure that all necessary environmental protection measures are carried out in the future as planned and to reduce residual impact to acceptable levels and achieve the expected outcomes of the project. The Environmental and Social Management Plan (ESMP) is based on the type, extent and duration of the identified environmental impacts.

Environmental management and monitoring are mandatory activities to be undertaken by the project administration over the entire project cycle showing its commitment towards meeting environmental regulations/standards as well as maintaining health and safety standards.

The ESMP is implemented from the very early stages of the planning and execution phases of the project. The authorization of the project is the point of initiation of the environmental management plan. The monitoring data, observations recorded and test results/ analyses are vital for the formulation of legal documents. All the data and legal documents are kept in safe custody and may be provided to the competent authority in accordance with the Sindh Environmental Protection Act 2014 when required.

ESMP stands for Environmental and Social Management Plan, which is a strategic framework used to identify, assess, and mitigate the environmental and social impacts of projects. It ensures compliance with environmental regulations and promotes sustainable practices.

The Proponent will be responsible for implementing the ESMP and ensuring that all personnel management are informed about the ESMP and the requirement to implement the procedures it contains. The ESMP is intended as a quick reference for Project personnel and regulators to monitor compliance.

8.2 Structure of ESMP

The environmental and social management plan is divided into the following core components:

- Organizational Structure and Roles and responsibilities;
- Implementation of Environmental & Social Management Plan
- Mitigation matrix for each project phase;
- Monitoring plan for the project;
- Worker's Health and Safety Plan
- Equipment Maintenance
- Emergency Response Plan

8.3 Objectives of ESMP

The ESMP will serve as a principal execution module of the project that would not only mitigate adverse environmental impacts during the designing, construction, operational and maintenance phase of the project but also ensures that environmental standards and good housekeeping is

maintained. Continuous environmental monitoring is exercised to ensure that preventive measures are in place and are effective; to sustain environmental integrity. Some of the key objectives of the ESMP are to:

Outline mitigation measures recommended in the ESIA and define the responsibility and implementation of these measures;

- To outline functions and responsibilities of personnel;
- To state and implement environmental standards, guidelines and legislations relevant to the project;
- To facilitate the implementation of mitigation measures according to the project details and proposed mitigation measures;
- To develop a monitoring mechanism for the identification of whether the monitoring parameters are being implemented completely and effectively
- To identify training requirements at various levels and provide a plan for the implementation of training sessions. It is important that the recommendations and mitigation measures are carried out according to the spirit of the environmental assessment process and in line with the guidelines. The ESMP are presented in Table 7.1 and Table 7.2. Screening of potential environmental and social impacts has played a vital role in reconfirming typical mitigation measures and in identifying any different approaches based on the feasibility and detailed design assumptions and any alternatives available at this stage.

8.4 Coverage of ESMP

This ESMP covers all activities ordained under the different stages of this project (design, and implementation), which will be controlled and monitored as per the guidelines of the ESMP. Aspects not explicitly covered in the ESMP will be managed through separate plans.

8.5 Legislation and Guidelines

Legislation and guidelines pertaining to this project have been discussed at length in chapter 03 of this ESIA study. It shall ensure that the project activities during designing, construction and operation phases of the project would follow the relevant environmental legislations and guidelines. The staff of the proponent and contractor should also be aware of these laws.

8.6 Environmental & Social Management Plan

The impacts and their mitigation measures have been classified into those relevant to the design and implementation phase. The matrix provides details of the mitigation measures recommended for each of the identified impacts, time span of the implementation of mitigation measures, and the responsibility of the institution. The institutional responsibility has been specified for the purpose of the implementation and the supervision. The matrix is supplemented with a monitoring plan.

The monitoring plan is designed based on the project cycle. During the designing period, the monitoring activities will focus on;

- checking contractor's bidding documents to ensure that all necessary environmental requirements have been included,
- checking that the contract documents' references to environmental mitigation measures requirements have been incorporated as part of contractor's assignment and,
- making sure that any advance works are carried out in good time i.e., to ensure that the inclusion and checking of designs must be carried out where detailed design is required

(e.g., for power distribution lines and avoidance of other resources).

During the implementation period, the monitoring activities will focus on;

- ensuring that environmental and social mitigation measures are implemented,
- remedial actions are provided

8.7 Institutional Requirements

The institutional requirements for the design and implementation phases of the project are elaborated upon the following sections:

8.7.1 ESMP Implementation During Design

The project is to be executed by QICT through a project manager. In the organizational hierarchy of the company, the CEO will be overall responsible for the overall project. The Project Manager of the proposed project along with the subject matter specialists from the company will be responisble for monitoring and complying with the guidelines laid down in the ESMP. The responsibilities fo the staff include the following:

- Engaging in collaborative efforts to monitor the environmental and social compliance in the pre-construction phase
- Providing regular reprots on the status of the environmental and social compliance
- Conducting assessments and implementing measures to address the long-term environmental and social impacts of the proposed project
- Maintaining a productive partnership among relevant agencies and departments to ensure ongoing collaboration

8.7.2 ESMP Implementation During Implementation

The key stakeholders during the implementation of the proposed project are QICT, SEPA, the Contractor (C), and the Third Party Monitoring Consultant. The roles and responsibilities of these parties are defined below:

QICT will bound contractors through clauses in their contracts to implement the ESMP, and other terms and conditions of the Environmental approval issued by SEPA. The whole ESMP will be included as a clause in the contractor’s documents. The organizational setup of the ESMP during implementation is provided below:

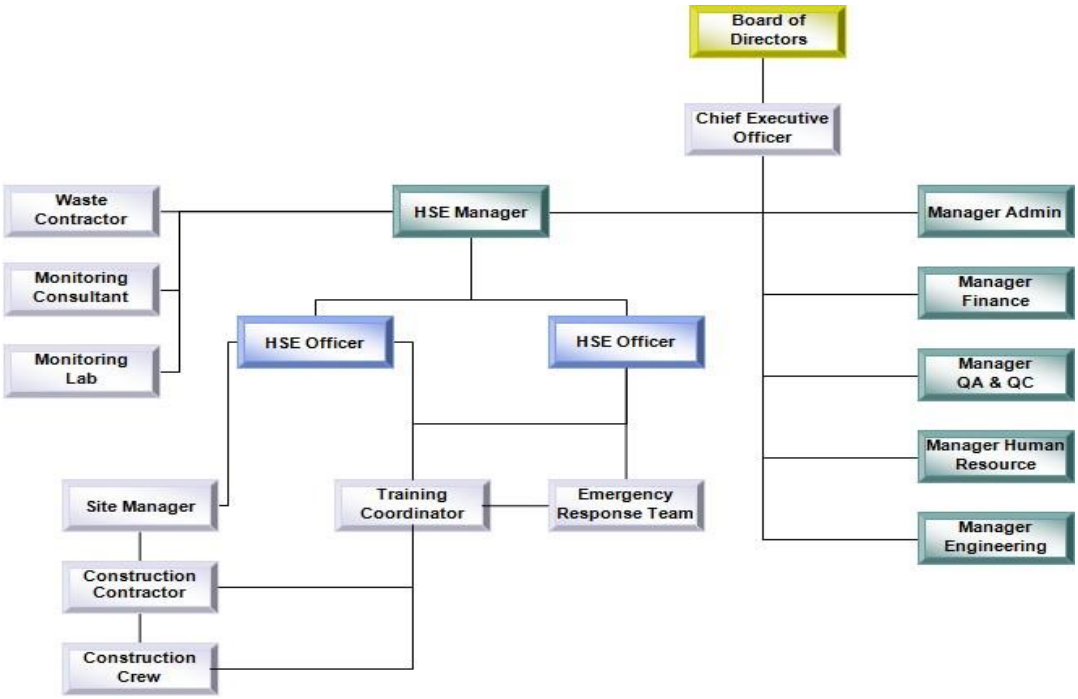


Figure 8.1 - Institutional Setup for Implementation of ESMP during Implementation

8.7.3 Roles & Responsibilities

a) Sindh Environmental Protection Agency

In accordance with the Sindh Environmental Protection Act of 2014, the responsibility for environmental protection and pollution control lies with SEPA (Sindh Environmental Protection Agency). SEPA is tasked with approving the Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) for all development projects falling under their jurisdiction. Additionally, SEPA will conduct audits of the proposed sub-project activities as and when necessary, ensuring adherence to the protocols outlined in the Environmental and Social Management Plan (ESMP) and obtaining environmental approval.

b) Chief Executive Officer (QICT)

The CEO of QICT will serve as the principal authority overseeing the project. As the head, the CEO assumes the responsibility for making crucial policy, administrative, and financial decisions to ensure the efficient and timely execution of the project in accordance with the approved framework and implementation schedules. In addition, the CEO bears the overall responsibility for project implementation, including environmental and social management aspects, as well as the selection and engagement of consultants and contractors.

c) HSE Manager & Team

The HSE Team (Manager & Officers) will be responsible for the overall implementation of the ESMP. They will be responsible for ensuring the ESMPs are included in the contractors' bidding documents, along with the implementation supervision. This team will manage environmental and social aspects of the project activities, including arranging for environmental and social monitoring and preparing compliance reports for submission to the SEPA. The team will be responsible to ensure compliance of the ESMP during the implementation phase, and will also hire the services of an independent environmental and social consultancy firm as Third Party for Third Part Monitoring (TPM).

Furthermore, they shall be responsible for:

- Ensuring the provision of necessary environmental and social training to relevant personnel.
- Ensuring compliance with all contractual obligations pertaining to environmental and social standards.
- Conducting regular site visits to construction sites to assess the environmental and social performance of the Contractor(s).
- Regularly checking the proper implementation of the Environmental and Social Management Plan (ESMP) during the construction phase.
- Reviewing monitoring reports on the progress of environmental and social activities.
- Documenting and disclosing monitoring results, identifying corrective and preventive actions in periodic reports, and monitoring the progress of these actions towards desired outcomes.
- Assisting the Contractor in ensuring timely payments of negotiated prices.
- Providing assistance to the Contractor in obtaining necessary approvals from relevant departments.
- Overseeing compliance with all monitoring programs outlined in the ESMP.
- Maintaining effective communication with other relevant departments and stakeholders.
- Reporting the status of ESMP implementation to the Sindh Environmental Protection Agency (SEPA).

d) Third Party Monitoring Agency

The Third-Party Monitoring (TPM) process will involve the engagement of independent Environmental and Social (E&S) Specialists. These specialists will be responsible for monitoring environmental and social factors and conducting field surveys at the implementation sites to assess the level of compliance with the project documents. Their role will entail conducting external and independent monitoring of the ESMP implementation. The external monitoring agency will perform biannual, annual, and final evaluations of the ESMP implementation and provide recommendations for necessary changes to the Environmental and Social Committee (ESC).

Roles and responsibilities of the third-party consultant will include:

- Conduct autonomous monitoring at crucial sites throughout the implemenetation phase and oversee the implementation of the Environmental and Social Management Plan (ESMP) within the project area.
- Promptly notify the client of any significant impacts that arise during the implementation process.
- Observe and revise or prepare corrective action plans as necessary.
- Monitor the implementation of the plans in collaboration with the Project Implementation Consultant.

e) Contractor

Contractors will be obligated to hire on-site Environmental and Social Experts who possess appropriate education and experience for the dredging site. It will be the responsibility of the contractors to execute measures that prevent or minimize any negative environmental and social effects during the implementation phase. Prior to commencing work, contractors must develop a site-specific Environmental and Social Management Plan (SSESMP) that outlines their approach to meeting the ESMP requirements for each site. This plan must be submitted for approval to the client. The Environmental and Social Experts employed by the contractors will be responsible for undertaking the following activities:

- Develop the Site-Specific Environmental and Social Management Plan (SSESMP) and secure approval from the client.
- Implement the mitigation measures outlined in the ESMP and SSESMP at the site.
- Contractors are contractually obligated to comply with all the specific and general provisions stated in the contract document.
- Provide appropriate Personal Protective Equipment (PPE) to workers and train them on its proper usage.
- Prepare and submit monthly, quarterly, biannual, annual, and final progress reports to the client.
- Immediately report any accidents, incidents, including environmental and social incidents, to the client.
- Conduct environmental and health and safety training for workers and laborers.
- Coordinate with the client on E&S measures

Regardless of the number of contractors, each contractor will be mandated to have adequately qualified and experienced persons to function as environmental, social, and OHS specialists to work in close liaison with the client and its HSE team.

8.8 Environmental & Social Mitigation & Management Matrix

The Environmental and Social Mitigation and Management Matrix is one of the central elements of the ESMP, where it will be used as the management tool for implementation of the above-mentioned mitigation measures. The plan includes the following:

- Envisaged impacts as identified in the ESMP and their recommended mitigation measures.
- The person/ organization directly responsible for adhering to or executing the required mitigation measures.

Regardless of different organizations being delegated responsibilities for execution and monitoring of the project, the HSE team at QICT will be the primary party responsible for ensuring the complete implementation of the ESMP. The following table provides information about all impacts to be raised due to project activities due to the project activities during different phases of the project. (refer Table 7.1). The Contractor(s) will be responsible for the preparation of the Site Specific Environmental and Social Management Plan (SSEMP) on the same format of this ESMP along with the site-specific plans based on the guidelines provided in the annexures.

Table 8.1 - Environmental & Social Mitigation Matrix

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
Pre-Construction Phase				
1.	**Design Considerations** The proposed works involve structural modification of the existing operational quay wall in soft deltaic and marine sediment conditions. Should the proposed development not take into account the existing conditions accordingly, the new quay wall and associated infrastructure's integrity may be at risk. Factors such as geotechnical assumptions, scour allowance, berthing energy, lateral loads, settlement, crane rail loads, sesimicity, or long term maintenance requirements, all need to be sufficiently evaluated and incorporated into the deisgn. Since the new quay wall is expected to support high capacity STS cranes and deeper vessel operations, design margins must be robust, where failure of the structural integrity or excessive deformation could cause serviceability loss, rail mismanagement, operational interruption, damage to vessels or cranes, worker safety hazards, accelerated maintenance requirements, and potentials for major incidents. The inherent risk associated with this impact is High adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Complete independent design review for geotechnical parameters, pile capacity, lateral loading, settlement, liquefaction potential, seismicity, berthing forces, mooring loads, crane wheel loads, scour and sea level/monsoon conditions. • Confirm the design basis for the 16 m berth pocket, propeller wash exposure, scour protection sizing and long-term bathymetric stability. • Define construction hold points for pile installation, reinforcement, concrete works, tie systems, backfilling, ground improvement and crane rail installation. • Carry out pile integrity testing, material testing, compaction verification and survey control during construction. • Install or define settlement markers, rail alignment checks, bathymetric checks and post-construction structural monitoring requirements. • Carry out periodic monitoring of the above highlighted items and maintenance works as and where necessary. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.	Design Consultant and QICT	QICT
2.	**Choice of Dredging Method**	Mitigation measures proposed to reduce the severity of this impact include:	Design Consultant and QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring

	As highlighted above in Chapter 4, the choice of dredging method employed here will dictate the sort of environmental impacts that will arise, along with the protective measures that will have to be inbuilt into the dredging methodology by the contractor. Poor selection of equipment or weak controls can increase turbidity, lead to over-dredging beyond the approved berth pocket area, increase the volume of material requiring disposal and extend the duration of the impacts. Alongside this, potential impacts may also include avoidable deterioration of marine water quality, disturbance to benthic habitats, and increased sediment deposition along the peripheries of the creek.
	
	The inherent risk associated with this impact is High Adverse.
		• Contractor to prepare a project-specific Dredging Environmental Management Plan before mobilization and obtain approval from QICT against it. A guideline Dredging Management Plan has been prepared and is attached to this report as an Annex.
		  • Define the approved dredging footprint, target depth, allowable tolerances, plant type, sequencing, tidal/weather constraints and barge loading controls.
		  • Use controlled dredging techniques appropriate for near-quay precision dredging and avoid unnecessary seabed disturbance outside the approved area.
		  • Set turbidity/TSS monitoring locations, alert levels, action levels, stop-work triggers and corrective action requirements before dredging starts.
		  • Assign real-time environmental supervision responsibilities for dredging, barge loading, freeboard checks and disposal documentation.
		  • Conduct monitoring during dredging works to ensure that dredging works are being carried out in the manner anticipated, and detrimental impacts are being curtailed accordingly.
		
		Residual Risk
		
		Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		

3.	**Disposal of Dredged Material** The inadequate disposal of dredged material may create significant secondary impacts if the disposal route, location, timing, or placement is not taken into consideration beforehand.	Mitigation measures proposed to reduce the severity of this impact include: • QICT has already, in consultation with PQA, identified a designated disposal site for the dredged material. The point highlighted is a point in the deep sea, outside of the	Design Consultant and QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	Disposal near shallow habitats, mangrove creeks, fishing areas, mudflats, or navigation sensitive areas may lead to increased sedimentation, turbidity plumes, and conflicts with other marine users and navigation. The inherent risk associated with this impact is High Adverse.	current Port Qasim Navigational Channel, where PQA has highlighted QICT may dispose of the dredged material. This point is far out from any mangroves or any navigational area. The amount of dredged material anticipated for disposal under the project is between 200,000-300,000 tons, where this will be disposed of in the appointed disposal area. • Prior to dredging activities commencement, the dredging contractor and QICT to confirm route, restrictions, and documentation. • Alongside this, the contractor and QICT are to maintain disposal logs, barge tracking records, and daily reconciliation of dredged/disposed quantities. • Avoid disposal during rough sea conditions or where barge control, containment, or visibility are compromised. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
4.	**Re-Suspension of Contaminated Sediments** The proposed dredging activities may lead to the dredging of potentially contaminated sediments also, where these sediments may have accumulated over time from historical vessel activity, runoff, spills, antifouling residues, industrial discharges and overall port operations. Should dredging take place without proper testing and characterization first, contaminants may be resuspended in the water column or transported to an unsuitable disposal area.	Mitigation measures proposed to reduce the severity of this impact include: • The Proponent through the contractor is to conduct pre-dredge sediment characterization for grain size, metals, hydrocarbons, oil and grease, and other contaminants of concern. • Once the results are obtained, proponent is to divide the sediments into contaminated or non-contaminated. If contaminated sediments are identified then dispose of the contaminated sediments through a SEPA certified hazardous waste contractor.	Design Consultant and QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	Potential re-suspension of contaminated sediments may lead to increased toxicity in benthic organisms, deterioriation in marine water quality, exposure to workers, and potential contamination of disposal grounds. The inherent risk associated with this impact is High Adverse.	• Ensure contamianted and non-contaminated sediments are kept separately and only non-contaminated sediment is disposed off in the PQA approved site. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
5.	**Marine Navigation** With the movement of the dredger, and the development of the new quay wall, the project will place temporary exclusion zones in the channel, where without a proper marine interface system conflicts may arise with vessel berthing, tug operations, pilotage, emergency routes, and adjacent terminal operations. Potential impacts here include vessel collision, interruption to port operations, spill events, injury, and emergency access obstruction. The inherent risk associated with this impact is High Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Prior to initiation of works, the contractor is to prepare a Navigation and Vessel Traffic Management Plan in coordination with PQA Marine Department, with a complete navigation risk review carried out. • Define exclusion zones, temporary restrictions, lighting, buoyage/signage, notices to port users, emergency towage, rescue routes, and daily marine coordination meetings. • Ensure coordination with PQA during the implementation of works. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.	Design Consultant and QICT	QICT
6.	**Impacts on Ecology** Despite works taking place in a developed, active terminal, the broader environmental	Mitigation measures proposed to reduce the severity of this impact include:	Design Consultant and QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	setting is the Indus Delta creek system where mangroves and mangrove associated habitats are present, including birds, fish, and crabs are present. Poor pre-construction planning can often overlook indirect impact pathways such as turbidity movement, worker access into sensitive areas, vessel route effects, and perceieved impacts on fisheries users. Potential impacts may include avoidable disturbance to ecoloigcal receptors, stakeholder complaints, accidental mangrove damage, failure to identify sensitive periods and weak integration of ecology into dredging and construction supervision. The inherent risk associated with this impact is Medium Adverse.	• Given that the channel is an active channel with the ingress and egress of container vessels, there is no major faunal species anticipated to be impacted from this project and its localized interventions. • Furthermore, the nearest mangroves to the project site lie outside of the Area of Influence of the project, approximately 650 m away from the project site. • Consultations with forest and wildlife department also did not highlight any particular sensitivies in the area that must be conisdered during the assessment and then implementation process • Furthermore, given that no onshore disposal of dredged material is anticipated under the project, no major impacts on mangroves are foreseen under the project • Independent monitoring to be carried out prior to, during, and after development works to ascertain the existing ecological conditions and whether these are being impacted during the project implementation works. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
7.	**Emergency Preparedness & Response** The marine construction interventions under the project will introduce high-consequence emergency scenarios, including spills, fires, vessel collision, lifting failure, and electrical incidents amongst many others. If emergency arrangements are not established before mobilization, response delays can turn a	Mitigation measures proposed to reduce the severity of this impact include: • The contractor is to prepare and test Emergency Preparedness and Spill Response Plan before mobilization in the supervision of QICT. A guide emergency preparedness and response plan is attached to this report as an annex. • Provide spill kits, booms, extinguishers, first aid, rescue arrangements, life buoys, emergency communications,	Design Consultant and QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	controllable incident into major environmental or safety events. A lack of proper emergency preparedness and response planning may also result in injury, fatality, hydrocarbon release to marine water, fire spread, loss of equipment, disruption to terminal operations, and escalation to emergency services. The inherent risk associated with this impact is High Adverse.	muster points, and drills for spill, fire, man-overboard, collision, severe weather, and crane/lifting incidents. • Define muster points, emergency contacts, notification chains, response roles, and coordination with QICT and PQA. • Conduct drills for spill, fires, man overboard, collision, severe weather, and crane/ lifting incidents. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
8.	**Improved Operational Readiness & Safety** The proposed interventions under the project are expected to improve operational readiness and overall safety conditions by upgrading aged terminal infrastructure and aligning the berth with modern vessel and crane requirements. A strengthened quay edge, improved fendering, modern rails, safer access systems and upgraded utilities improve operational readiness and reduce structural and safety constraints associated with older infrastructure.	This impact is considered to be overall positive.	Design Consultant and QICT	QICT
	Construction Phase			
9.	**Turbidity & Sedimentation** Dredging and near-quay marine works will result in disturbance to seabed sediments and may result in an increase in turbidity and susepended sediments. Fine particles involved in this may remain suspended for longer	Mitigation measures proposed to reduce the severity of this impact include: • Implement the Dredging Management Plan developed prior to implementation of works, and limit dredging to approved footprint, depth, and allowable tolerance.	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	periods of time and also move with tidal currents, while coarser material may resettle closer to the work area. This impact will be most significant during dredging works, barge loading, seabed levelling, pile installation, and backfilling activities near the marine edge. As a result of increased turbidity, overall light peentration in the water may be reduced, affecting primary productivity, interfering with fish feeding and respiration, disturb benthic organisms, and may lead to sediment deposition in sensitive creek margins. The inherent risk associated with this impact is High Adverse.	• Avoid over-dredging, bucket overflow, uncontrolled barge loading, and dredging during unsafe weather/tide conditions. • Monitor turbidity/TSS at upstream, downstream, near-field, and receptor points; implement stop-work/corrective actions when thresholds are exceeded. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
10.	**Deterioration of Marine Water Quality** Marine water quality may be deteriorated through physical, chemical, and biological pathways during construction. Sediment resuspension may also increase turbidity and oxygen demand, while spills of fuel, hydraulic oil or lubricants can create surface sheen and hydrocarbon contamination. Uncontrolled wastewater, wash water, or contaminated stormwater can alter pH, introduce suspended solids and degrade nearshore water quality. After effects from the deterioration of marine water quality may include disturbance to aquatic organisms, visual pollution, exceedance of water quality, damage to mangrove associaed recepors.	Mitigation measures proposed to reduce the severity of this impact include: • Prohibit untreated wastewater, wash water, concrete washout or contaminated runoff discharge to marine waters. • Store fuels, oils and chemicals in bunded areas with secondary containment and away from drains/marine edges. • Inspect dredgers, barges, cranes, generators and hydraulic equipment for leaks before use. • Provide spill kits on the quay, barges, dredgers and fuel handling areas. • Control concrete washout using designated lined or contained areas. • Monitor pH, dissolved oxygen, TSS, turbidity, oil and grease, hydrocarbons, BOD/COD and visual sheen during	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	The inherent risk associated with this impact is High Adverse.	active marine works internally, and through an Independent Monitoring Agency. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
11.	**Transport & Disposal of Dredged Material** Whilst QICT has already finalized a disposal point with PQA for the dredged material, the transport of the dredged material to and from the project site and the disposal site, and vice versa, may also contribute to potential environmental impacts, including the likes of turbidity plumes, localized seabed smothering, accidental loss and spill of dredged material during transport. Further risks associated with imporper transport and disposal of dredged material include disturbance to benthic organisms, sediment plume formation, and interference to navigating ships. The inherent risk associated with this impact is High Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Dispose only at the approved offshore disposal site and only after sediment classification. • Track each barge trip, disposal volume, time and coordinates. • Maintain adequate barge freeboard and prevent overflow, leakage or side casting during transit. • Avoid disposal during unsafe sea states or where vessel control is reduced. • Prohibit disposal near mangroves, islands, mudflats, creek mouths, fishing grounds or navigation-sensitive areas. • Reconcile dredged and disposed quantities daily and keep records **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.	Dredging & Construction Contractor	QICT
12.	**Impacts on Mangroves** No direct mangrove removal is anticipated under the defined works, but mangrove-associated habitats in the wider creek system	Mitigation measures proposed to reduce the severity of this impact include: • Establish and communicate mangrove no-go zones for workers, vessels and equipment.	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	are sensitive to indirect impacts. Excessive suspended sediment may settle on root zones, while altered tidal exchange, runoff or inappropriate vessel routes could create localized stress. Potential impacts on mangroves may include reduced gas exchange at root structures, reduced seedling health, localized sediment smothering, and habitat disturbance for birds and crabs. The inherent risk associated with this impact is Medium Adverse.	• Avoid disposal routes, anchoring, mooring or material placement near mangrove creeks and edges. • Maintain natural tidal exchange and do not block drainage pathways to mangrove areas. • Monitor turbidity and visible sediment deposition near mangrove edges where relevant. • Train workers on mangrove protection requirements and prohibit cutting, trampling, waste disposal or fuel handling near mangroves. • Coordinate and carry out independent monitoring with officials from Sindh Forest Department **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
13.	**Underwater Noise & Vibration** Marine piling and dredging can generate underwater noise and vibration that propagate through the water column and seabed. Fish and other aquatic organisms can respond through avoidance, startle response or temporary behavioral change. The intensity depends on piling method, equipment condition, water depth, substrate and duration of exposure. Potential consequences include temporary displacement of fish, stress to aquatic fauna, masking of natural cues and disturbance to benthic organisms. Although the area is already an active port, additional construction noise may still be significant during peak activities.	Mitigation measures proposed to reduce the severity of this impact include: • Use soft-start or ramp-up procedures for piling and other high-noise activities. • Maintain engines, mufflers and rotating equipment to reduce unnecessary noise and vibration. • Avoid simultaneous high-noise marine activities where practicable. • Establish observation zones where practicable and pause high-noise works if sensitive fauna are observed in the immediate work zone. • Consider additional controls if monitoring or observations indicate unacceptable disturbance. **Residual Risk**	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	The inherent risk associated with this impact is High Adverse.	Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
14.	**Air Emissions & Dust** Construction emissions will arise mainly from diesel combustion in dredgers, support vessels, cranes, generators, trucks and construction plant. Dust may be generated by stockpiles, exposed surfaces, material handling and vehicle movement. In the port setting, this adds to existing industrial and traffic emissions but is expected to be temporary and localized. Potential impacts from this include localized increases in particulate matter, NOx, SO2, CO and nuisance dust exposure for workers and adjacent terminal users. Poorly maintained engines can also increase black smoke and fuel consumption. The Inherent Risk associated with this is Medium Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Use maintained equipment, compliant fuel and manufacturer-recommended maintenance schedules. • Prohibit excessive idling of trucks, generators, dredgers and plant. • Cover dusty material and wet down dust-prone areas where practicable. • Control vehicle speeds on unpaved or dusty surfaces. • Monitor PM10, PM2.5, NOx, SO2, CO and visible emissions as required by the ESMP. • Investigate visible smoke, complaints or exceedances and implement corrective actions. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.	Dredging & Construction Contractor	QICT
15.	**Construction Noise & Vibration** Construction noise will occur from piling, lifting, cutting, vehicle movement, generator operation and crane dismantling. Vibration may occur during piling and heavy equipment movement. In an operational port, background noise is already elevated; however, additional high-intensity or impulsive noise may affect workers and nearby terminal users.	Mitigation measures proposed to reduce the severity of this impact include: • Use silencers, mufflers and acoustic enclosures where feasible. • Schedule high-noise works in coordination with QICT and adjacent terminal operations. • Provide hearing protection and demarcate high-noise zones. • Maintain equipment to prevent abnormal noise.	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	Potential Impacts from this include worker hearing risk, communication interference, nuisance to adjacent operations, fatigue and temporary disturbance to fauna. The effect is expected to be manageable with scheduling and occupational controls. The inherent risk associated with this is Medium Adverse.	• Monitor noise at representative work fronts and terminal boundaries. • Investigate complaints or exceedances and adjust work methods where needed. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
16.	**Marine Navigation & Collision Risk** The exclusion zone established under the project for dredging and construction may reduce maneuvering space, create temporary obstructions and increase navigational complexity. The risk is particularly important during barge movements, dredger positioning, piling platform operation, night works, restricted visibility and adverse weather. Consequences can include collision, allision with the quay or plant, vessel delays, spill events, injury, damage to equipment and disruption of port operations. Because of the severity of possible outcomes, navigation management must be continuous rather than occasional. The inherent risk associated with this is Medium Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Coordinate daily with PQA Marine Department and Port Control. • Maintain AIS, navigation lights, VHF communication and exclusion zone markers on relevant marine plant. • Issue notices to port users and update them when work fronts or restrictions change. • Keep navigation routes, turning areas and emergency routes clear. • Define emergency towage, rescue, spill response and severe weather procedures. • Suspend or modify marine works if visibility, tide, wind or port traffic conditions exceed safe operating limits. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.	Dredging & Construction Contractor	QICT
17.	**Interference with Neighboring Terminal Operations**	Mitigation measures proposed to reduce the severity of this impact include:	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	The works will occur within an operational container terminal and may interact with berthing, yard circulation, utility systems, emergency access, cargo handling and adjacent terminal activity. Poorly planned phasing can cause congestion, unsafe interface between construction and operations, utility disruptions and delays to vessels or terminal users. Consequences include operational delays, increased safety risk at live interfaces, loss of emergency access, conflicts with neighboring terminals and reduced productivity during construction. The inherent risk associated with this is High Adverse.	• Implement the two-phase construction strategy to maintain terminal continuity. • Prepare an interface management plan covering live operations, adjacent terminal coordination, utilities, roads, emergency access and berth access. • Communicate daily and weekly work schedules to QICT operations and relevant port users. • Maintain emergency access, internal road continuity and utility protection. • Use permit-to-work and isolation controls at all operational interfaces. • Review interface risks during daily coordination meetings and update controls as work fronts shift. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
18.	**Occupational Health & Safety** Marine construction creates critical occupational hazards due to work over water, moving vessels, heavy equipment, hot works, lifting, electrical isolation, confined spaces, unstable surfaces and changing weather conditions. Potential consequences include drowning, falls from height, struck-by incidents, electrocution, burns, crushing, confined-space injury, heat stress and delayed rescue. The risk is intensified by simultaneous port operations and the need for multiple contractors to work in constrained areas.	Mitigation measures proposed to reduce the severity of this impact include: • Implement a project-specific OHS Plan. • Require method statements, job safety analyses and permit-to-work controls for high-risk activities. • Use fall protection, edge protection, life jackets and rescue equipment for work near or over water. • Provide trained supervisors, competent operators, banksmen, riggers, welders and rescue personnel. • Conduct toolbox talks, safety inductions, emergency drills and weather monitoring. • Maintain incident/near-miss reporting, corrective action tracking and stop-work authority.	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	The inherent risk associated with this is Very High Adverse.	**Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
19.	**Decommissioning & Installation of New Cranes** Crane dismantling and installation involve complex heavy lifts, high centers of gravity, large components, wind sensitivity, electrical and mechanical isolation, and interaction with live terminal infrastructure. Failure of a lift or inadequate ground bearing verification could have catastrophic safety and asset consequences.Potential impacts may include fatality, dropped loads, structural collapse, crane damage, electrical incidents, fire, prolonged terminal shutdown and damage to quay infrastructure. The inherent risk associated with this is Very High Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Use specialist crane decommissioning and installation contractors with verified competence. • Prepare engineered lifting plans, lift studies and critical lift permits. • Verify ground bearing capacity, crane pad design, travel paths and exclusion zones before lifting. • Inspect and certify lifting gear, cranes, slings, shackles, spreader beams and rigging equipment. • Define wind-speed limits and stop lifting when limits are exceeded. • Use trained lifting supervisors, riggers, banksmen and operators. • Apply lock-out/tag-out for electrical and mechanical isolation during decommissioning and commissioning. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.	Dredging & Construction Contractor	QICT
20.	**Fire, Explosion, & Emergency Risk** Construction activities at the site will involve hot works, fuel storage, hydraulic systems, electrical installations, generators and vessel operations. These sources can create fire or	Mitigation measures proposed to reduce the severity of this impact include: • Apply hot work permits, fire watch and gas testing where required.	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	explosion risk if ignition control, isolation, housekeeping or emergency readiness are weak. Hydrocarbon fires near marine water also create spill and contaminated runoff pathways. Consequences from such events may include injury, equipment loss, vessel or terminal damage, marine pollution from firefighting runoff or fuel release, operational disruption and escalation to port emergency response. The inherent risk associated with this is High Adverse.	• Maintain extinguishers, firefighting water, alarms and emergency access at work fronts. • Control fuel storage, transfer and hydraulic systems through bunding, inspection and spill readiness. • Inspect temporary electrical systems and prohibit unsafe connections. • Conduct emergency drills and coordinate with QICT/PQA emergency response teams. • Maintain clear access for emergency vehicles and marine response craft. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
21.	**Solid & Hazardous Waste Generation** Construction and crane replacement will generate non-hazardous and hazardous wastes, including scrap metal, packaging, used oils, oily filters, contaminated rags, domestic waste and construction debris. If not segregated and documented, wastes can contaminate drains, create housekeeping hazards and be disposed through unsuitable routes. Consequences include littering, marine debris, unsafe storage, occupational exposure, fire risk, regulatory non-compliance and loss of opportunities for reuse or recycling, especially for scrap steel from decommissioned cranes.	Mitigation measures proposed to reduce the severity of this impact include: • Implement a Waste Management Plan before construction begins. • Segregate hazardous and non-hazardous waste at source using labelled containers. • Reuse suitable fill and recycle scrap steel where feasible. • Store hazardous waste in bunded, covered and labelled areas. • Use licensed waste contractors and maintain manifests/disposal records. • Prohibit dumping into marine waters, drains or unused port areas. **Residual Risk**	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	The inherent risk associated with this is Medium Adverse.	Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
22.	**Wastewater & Worker Welfare** Worker welfare impacts can arise if sanitation, potable water, hygiene, rest areas or medical access are inadequate. Uncontrolled sanitary wastewater can also contaminate work areas, drainage systems and marine waters. Welfare quality is directly linked to worker health, dignity, productivity and labor compliance. Consequences include worker illness, unhygienic work fronts, odor, vector attraction, marine pollution, complaints and non-compliance with labor and HSE requirements. The inherent risk associated with this is Medium Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Provide adequate toilets, handwashing, washing facilities, drinking water, rest areas and housekeeping. • Use septic tanks, holding tanks or approved treatment systems for sanitary wastewater. • Prohibit direct discharge of wastewater to drains, soil or marine water. • Use licensed contractors for desludging and maintain records. • Provide medical access and worker welfare arrangements appropriate to workforce size. • Inspect welfare facilities regularly and correct deficiencies promptly. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
23.	**Community Health & Safety** Construction deliveries and worker transport may increase traffic on internal terminal roads and port access routes. Heavy vehicles, abnormal loads and pedestrian interactions can create safety hazards if routes, timing and segregation are not controlled. Consequences include traffic congestion, vehicle collisions, pedestrian injury, blocked emergency access,	Mitigation measures proposed to reduce the severity of this impact include: • Implement a Traffic Management Plan with approved haul routes and delivery timing. • Set speed limits, signage, barriers and flagman requirements where needed. • Segregate pedestrians from vehicle routes at work fronts and access points. • Check vehicle fitness and driver competence.	Dredging & Construction Contractor	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	damage to port infrastructure and conflict with adjacent terminal operations. The inherent risk associated with this is Medium Adverse.	• Coordinate abnormal loads with PQA and QICT operations. • Maintain emergency access at all times. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
24.	**Labor** Labor risks may arise if contractor workers do not receive clear employment terms, fair wages, safe working conditions, working hour controls, grievance channels or protection from discrimination. Subcontracting can increase the risk of inconsistent implementation unless labor controls are contractually required and audited. Consequences include labor disputes, low morale, unsafe work behavior, regulatory concern, reputational risk and unresolved grievances. The inherent risk associated with this is Medium Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Provide written contracts and comply with legal wage and working hour requirements. • Prohibit child labor, forced labor and discriminatory practices. • Provide induction, PPE, task-specific training and safe accommodation where relevant. • Establish a confidential worker grievance mechanism and code of conduct. • Maintain attendance, training, wage and grievance records. • Conduct contractor and subcontractor labor compliance audits. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.	Dredging & Construction Contractor	QICT
Operational Phase				
25.	**Altered Sedimentation, Scour, or Seabed Instability**	Mitigation measures proposed to reduce the severity of this impact include:	QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	Deepening the berth pocket and accommodating larger vessels can change local hydrodynamic and sediment behavior near the quay. Propeller wash, tug maneuvering and tidal currents may increase scour at the quay edge or cause localized sediment deposition in the berth pocket. Consequences include reduced under-keel clearance, local seabed instability, exposure or damage to scour protection, increased maintenance dredging and potential structural stress if scour is not detected early. The inherent risk associated with this is High Adverse.	• Install and maintain appropriately designed scour protection. • Conduct regular bathymetric surveys to monitor berth pocket levels and seabed change. • Inspect quay structures, fenders, bollards and scour protection after commissioning and after extreme events. • Monitor under-keel clearance and berth pocket condition. • Repair scour protection and undertake targeted maintenance dredging where required. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
26.	**Operational Marine Pollution** Operational marine pollution may arise from vessel interface activities, bilge or waste mismanagement, hydraulic leaks from cranes, fuel handling, maintenance spills or poor housekeeping. Although port controls already exist, increased terminal activity may increase the number of interfaces requiring supervision. Potential impacts include surface sheen, localized hydrocarbon contamination, aquatic toxicity, visual pollution, regulatory reporting and damage to ecological receptors if spills reach creek waters. The inherent risk associated with this is Medium Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Enforce no-discharge rules and port waste reception requirements. • Maintain spill kits, booms and trained response personnel at relevant locations. • Inspect crane hydraulic systems and vessel interface areas regularly. • Train staff in spill prevention, reporting and response. • Record spills, investigate root causes and implement corrective actions. **Residual Risk**	QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
		Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
27.	**Stormwater Management & Containment** Stormwater can collect oil residues, sediment, litter, cargo residues and other contaminants from paved terminal surfaces before entering the drainage system. During monsoon rainfall, pollutant loads may increase if housekeeping and drain maintenance are weak. Potential impacts may include contaminated runoff to marine waters, blocked drains, localized flooding, sheen formation and regulatory concern if drainage controls are not maintained. The inherent risk associated with this is Medium Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Maintain surface drainage, silt traps and oil-water separation systems where installed. • Clean spills immediately and prevent waste storage near drains. • Conduct regular housekeeping and drain desilting. • Inspect stormwater systems before and during monsoon periods. • Maintain records of inspections, cleaning and corrective actions. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.	QICT	QICT
28.	**Occupational Health & Safety** Terminal operations involve high-energy equipment, moving vehicles, suspended loads, mooring lines, vessel interface, electrical systems and maintenance at height. New cranes and improved infrastructure reduce some risks, but safe operation requires formal procedures and competent personnel.Consequences include struck-by injuries, falls, crush injuries, electrocution, mooring line snap-back incidents, vehicle collisions and maintenance accidents.	Mitigation measures proposed to reduce the severity of this impact include: • Maintain the operational OHS Management System. • Use crane operating procedures, traffic segregation and safe mooring procedures. • Apply lock-out/tag-out for electrical and mechanical maintenance. • Use work-at-height permits, fall protection and rescue arrangements. • Define competency requirements for crane operators, riggers, maintenance teams and supervisors.		

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	The inherent risk associated with this is High Adverse.	• Conduct emergency drills, incident investigations and corrective action tracking. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		
29.	**Navigational Incidents due to Large Vessels** The upgraded berth will accommodate larger and deeper-draft vessels. While this is a beneficial operational objective, it also requires disciplined navigation procedures, tug support, under-keel clearance control, weather restrictions and coordination with PQA pilotage and traffic systems. Consequences of a navigational incident include contact with quay infrastructure, vessel collision, fender/bollard damage, spill, injury, cargo delay and disruption to port operations. The inherent risk associated with this is High Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Coordinate all larger vessel movements with PQA pilotage and traffic control. • Maintain berth operating limits, tug requirements and weather restrictions. • Apply under-keel clearance procedures and berth occupancy planning. • Inspect fenders and bollards and maintain defect correction records. • Maintain emergency response readiness for collision, spill and rescue scenarios. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.	QICT	QICT
30.	**Emergency Preparedness & Response** Major operational emergencies may arise from vessel collision, fire, crane malfunction, electrical failure, fuel/hydraulic release, severe weather, cyclones or monsoon flooding. These events are low-frequency but high-	Mitigation measures proposed to reduce the severity of this impact include: • Maintain and periodically drill the Emergency Preparedness and Response Plan. • Maintain firefighting systems, spill response equipment and emergency access.	QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	consequence and require continuous preparedness. Consequences can include injury, fatality, major asset damage, marine pollution, prolonged operational shutdown, emergency evacuation and regulatory reporting. The inherent risk associated with this is High Adverse.	• Define incident command arrangements and communication chains. • Coordinate with PQA and QICT response teams. • Implement severe weather procedures, shutdown protocols and evacuation arrangements. • Review lessons learned after drills, incidents and near misses. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Medium Adverse.		
31.	**Hazardous & Non-Hazardous Waste Management** Routine operations and maintenance will generate waste streams including packaging, domestic waste, used oils, filters, oily rags, spill residues and equipment maintenance materials. Poor storage or disposal can cause contamination, fire risk and housekeeping issues. Consequences include unsafe storage, littering, drain contamination, worker exposure, regulatory non-compliance and unnecessary landfill disposal of recyclable materials. The inherent risk associated with this is Medium Adverse.	Mitigation measures proposed to reduce the severity of this impact include: • Maintain waste segregation at source. • Store hazardous waste in labelled, bunded and covered areas. • Use licensed contractors for waste collection and disposal. • Maintain waste manifests and disposal records. • Recycle suitable materials where feasible. • Conduct periodic waste audits and correct non-compliances. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.	QICT	QICT
32.	**Climate Resilience**	Mitigation measures proposed to reduce the severity of this impact include:	QICT	QICT

S. No.	Impacts	Mitigation Measures	Responsibility	
			Implementation	Monitoring
	The coastal port setting is exposed to monsoon rainfall, high tide, storm surge, cyclonic conditions, sea level rise and heat stress. These hazards can affect drainage capacity, structural durability, emergency access, worker safety and continuity of operations over the design life of the asset. Poor Plannnig and inclusion of climate change can result in flooding, drainage surcharge, scour, asset deterioration, heat-related illness, operational shutdown and post-event repair requirements. The inherent risk associated with this is Medium Adverse.	• Integrate design freeboard, drainage capacity and scour protection into operations and maintenance. • Monitor severe weather alerts and implement shutdown procedures when thresholds are reached. • Inspect structures, drainage and scour protection after extreme events. • Maintain heat stress controls for workers during high-temperature periods. • Conduct periodic climate resilience reviews as part of asset management. **Residual Risk** Following the implementation of the above defined mitigation measures, it is anticipated that the residual risk will be Low Adverse.		

8.9 Environmental & Social Monitoring Plan

Environmental and social monitoring plays a crucial role in providing timely and valuable information to project management and implementation agencies. In essence, monitoring involves regularly checking and balancing the progress of project activities and the achievement of developmental targets during construction and operation. It aids in promptly identifying, analyzing, and addressing any obstacles that may arise. Specific environmental parameters, encompassing physical, ecological, and social aspects, are carefully selected, and subjected to quantitative analysis. The results of this analysis are then compared against established guidelines, standards, and pre-project conditions to assess the effectiveness of the Environmental and Social Management Plan (ESMP) and its implementation in mitigating impacts. The objectives of the environmental and social monitoring plan throughout the construction and operation phases are as follows:

- Monitor the actual impacts of the project on physical, ecological, and socio-economic receptors.
- Provide recommendations for mitigation measures in case of unforeseen impacts or when the impact level exceeds the anticipated level stated in the Environmental and Social Management Plan (ESMP).
- Ensure compliance with legal and community obligations, including safety measures during the construction and operation phases.
- Ensure the proper disposal of excess construction materials, solid waste, water, wastewater, and gaseous emissions.
- Evaluate the adequacy of the ESMP in relation to the project's predicted long-term impacts on the physical, ecological, and socio-economic environment of the area.
- Assess the effectiveness of the mitigation measures proposed in the Environmental and Social Management Plan (ESMP) and recommend improvements if necessary.
- Compile data on periodic incidents and accidents to support analyses aimed at minimizing future risks.

QICT will hold responsibility for all monitoring activities to be conducted (compliance and effects monitoring). All findings and results will form part of the monitoring report to be shared with SEPA.

8.9.1 Compliance Monitoring

Compliance monitoring is primarily aimed at ensuring that the environmental control measures outlined in the ESIA are strictly followed throughout the project's implementation. It will be the responsibility of all organizations involved in field activities, including QICT and the contractors. The compliance monitoring process will include:

- Systematic observation of activities carried out by contractors, subcontractors, or any other project personnel.
- Verification that all activities comply with the ESIA and Environmental and Social Management Plan (ESMP).
- Documentation of observations and communication of any discrepancies to the relevant personnel at the contractor and QICT, enabling prompt corrective action.
- Recording and tracking of all significant environmental and social incidents, including any corrective measures taken.
- Regular engagement with stakeholders to gather feedback and address concerns during meetings.
- Preparation of periodic reports on environmental, health, and safety performance.

The monitoring plan detailed in Tables 7.2 (a) and (b) will serve as a tool for compliance monitoring. Inspections will be conducted using checklists prepared by the respective contractors, based on these tables, throughout the construction phase.

8.9.2 Effects Monitoring

The Environmental and Social Management Plan (ESMP) takes into account the projected impacts of the proposed project using available information and the interconnectedness of various environmental and social factors. Mitigation measures are incorporated based on this assessment to ensure that the expected residual effects remain within acceptable thresholds. However, it is important to recognize that despite full implementation of mitigation measures, there is a possibility that the project's negative impacts may exceed predicted levels or acceptable limits. To address these concerns, an effects monitoring program will be implemented during the project activities, aiming to effectively manage environmental and social risks and uncertainties. The objectives of the effects monitoring program can be outlined as follows:

- To ensure that the impacts of the proposed project remain within acceptable thresholds, thereby establishing trust and confidence among the public.
- To promptly alert the client about any unforeseen adverse impacts or sudden changes in impact trends, enabling swift corrective actions such as modifications to project activities or the implementation of additional mitigation measures.
- To provide information that assists in planning and controlling the timing, location, and intensity of specific project activities, with the aim of minimizing their effects.
- To support research and development efforts by documenting the effects of the proposed project, which can be used to validate impact prediction methods and enhance the accuracy of future project assessments.

The contractor(s) holds the primary responsibility for conducting effect monitoring under the supervision of the client at the site, covering the entire project. The effect monitoring program has been meticulously developed, taking into account the identified impacts outlined in Chapter-5. Some adjustments may be made to this program, including potential changes in frequency, based on insights gained from the project's one-year operation, documented in the Change Record Register. Table 7.3 presents the schedule for environmental and social effect monitoring during the design and implementation phase of the project.

Table 8.2 - Environmental & Social Monitoring Plan (Dredging)

Stage	Monitoring Component	Parameters	Location	Monitoring frequency	Standard	Responsibility	Supervision
Dredging and associated works	Marine Flora and Fauna	Biodiversity monitoring (Mortality of marine fauna and mangrove growth) should be undertaken by marine ecologist keeping in view the baseline condition on other intertidal zones other than project area.	Mangroves across from terminal	Monthly	N.A	Independent Ecologist	IMC
	Air Emissions from Dredging Vessel	CO, SOx, NOx, PM	At Dredging vessel	Quarterly	SEQS	IMC	QICT
	Sea Water Quality	SSC, turbidity, and dissolved oxygen (DO)	Upstream, downstream, and at project site	Fortnightly	Proposed threshold limits	IMC	QICT
	Dredging Spoil Contamination	29 Items (heavy metals, BTEX, VOCs, PCBs)	Dredging site	Monthly	Japan Ministry of Environment[26]	IMC	QICT
	Health Safety ofworkers	Accidents PPEs Annoyance Visual checks to assess the situation.	At Dredging vessel	Weekly	Monitoring of the health & safety of workers	QICT	IMC
	Fire & Safety	Fire Hazards & Safety Protocols	All Operational Areas	Continuous	N.A	QICT	IMC
	Hazardous spill	Spill on Water	At Dredging vessel	Continuous	MARPOL regulations and SEQS	IMC	QICT

[26] https://www.env.go.jp/en/water/soil/sp.html

Table 8.3 - Environmental & Social Monitoring Plan (On Shore Works)

Stage	*Monitoring Component*	*Parameters*	*Location*	*Monitoring frequency*	*Standard*	*Responsibility*	*Supervision*
On Shore Works	Air Emissions	CO, SOx, NOx, PM, Smoke	Gensets and vehicles	Quarterly	SEQS	IMC	QICT
	Solid Waste	Solid waste quality and quantity and disposal, Visual checks to assess the situation.	At campsite	Continuous	N.A	QICT	IMC
	Wastewater	Primary Pollutants of SEQS	At sewerage discharge points	Quarterly	SEQS	IMC	QICT
	Health Safety of workers	Accidents PPEs, Annoyance Visual checks to assess the situation.	At campsite	Continuous	Monitoring of the health & safety of workers	QICT	IMC
	Fire & Safety	Fire Hazards & Safety Protocols	At campsite	Continuous	N.A	QICT	IMC

8.10 Communication & Documentation

Communication and documentation are essential features of the ESMP, where the key features are:

8.10.1 Data Recording & Maintenance

Standardized formats will be used for documenting information during environmental and social monitoring, ensuring consistency and compatibility with the designated database. To streamline data entry, check boxes will be incorporated wherever applicable. Additionally, a tracking system will be established for each form to facilitate efficient management and organization of the collected data.

8.10.2 Database

The database may include the following information:

- Training Programs.
- Staff Deployment
- Non-Compliances
- Corrective Actions
- List of Environmental & Social Data on pollution
  - Disposal of waste
  - Water resources
  - Fuel oil and chemical spills
  - Noise pollution
  - Air and dust pollution
  - Socio-economic data

8.10.3 Meetings & Reporting

During the implementation phase, the client will convene monthly site meetings to address regular activities, non-compliance issues, and their corresponding corrective actions. Periodic reports, as outlined in the table below, will be generate specifying the responsible individuals for report preparation and review. Furthermore, meeting minutes will be included in routine environmental and social reports to ensure comprehensive documentation.

S. No	Report Category	Prepared by	Submitted To
1.	Monthly	Contractors' environmental and social staff	QICT
2.	Quarterly	Contractors' environmental and social staff	QICT & SEPA
3.	Quarterly Environmental and Social Monitoring Report	Contractor	QICT
4.	Semi-Annual External Environmental and Social Monitoring Report (SAEESMR)	Third Party Monitoring and Evaluation Consultant	QICT
5.	Annual Report	Contractors' environmental and social staff	QICT
6.	Completion Report	Contractors' environmental and social staff	QICT

8.10.4 Photogrpahic Records

Contractors will be required ot maintain photogrpahic documentation throughout the implementation of the project. this photographic record should encompass essential elements such as site photographs, road infrastructure, camp sites, monitoring activities, and more.

8.10.5 Non-Compliance of the ESMP

The successful implementation of the proposed ESMP relies on the collaboration of various stakeholders. The Contractor holds primary responsibility for ensuring the execution of the mitigation measures outlined in the ESMP, which will be included in the contractual agreements. The environmental mitigation costs will be factored into the overall project budget, and the Contractor will receive payment based on monthly compliance reports. However, failure to comply with the ESMP implementation and timely submission of compliance reports may result in deductions from the Contractor's payments allocated for environmental and social components. The compliance status of the ESMP will also be periodically submitted to SEPA for review, as mandated by their environmental approval requirements. Non-compliance may lead to the withdrawal of the environmental approval where the proponent may also withhold a percentage of the funds if non-compliance with E&S clauses and measures is observed through withholding part of the performance guarantee (up to 2%) submitted at the start of the works. In this regard, the contractor will be given two verbal warnings, followed by 2 written warnings, after which it will be deducted the project amount.

8.10.6 Review of Recorded Data

The client will periodicaly review and examinae all the data and communications documented and maintained by the Contractor. Based on their assessment, appropriate actions and recommendations will be proivded to the Contractor to enhance the quality of recording and documentation practices.

8.11 Contractor's Obligation & Management

The Contractor will bear primary responsibility for ensuring the effective implementation of the proposed mitigation measures outlined in the ESMP. The necessary details of the ESMP will be included in the bidding document and subsequently incorporated into the contract documents of the Contractor. The costs associated with environmental and social mitigation will be included in the overall project budget, and payments to the Contractor will be based on monthly compliance reports, actual work completed on-site, and resource allocation. Additionally, the Contractor will be accountable for developing and executing a site-specific ESMP, also known as the Contractor-ESMP, in accordance with the guidelines specified in the ESMP. Prior approval from the client will be required for the Contractor's ESMP and all associated sub-plans. Furthermore, the Contractor will ensure the presence of an Environmental and Social (E&S) staff on-site from the project's commencement, and the proposed organizational structure will be subject to approval from the client.

9 Conclusion & Recommendations

The Environmental and Social Impact Assessment (ESIA) has been undertaken to evaluate the potential environmental and social implications associated with the proposed **Quay Wall Extension Project at Terminal-1, Qasim International Container Terminal (QICT), Port Qasim, Karachi**, and to identify appropriate measures for avoiding, minimizing, mitigating, and managing adverse impacts throughout the project lifecycle.

The proposed project constitutes a strategic investment in Pakistan's maritime infrastructure and is intended to enhance the operational efficiency, safety, and long-term competitiveness of QICT by extending the existing quay wall, increasing berth depth, facilitating the accommodation of larger container vessels, and supporting the installation of modern Ship-to-Shore (STS) cranes. These improvements are expected to strengthen national trade logistics, improve cargo handling capacity, reduce vessel turnaround times, and contribute positively to Pakistan's economic development while supporting the long-term growth objectives of Port Qasim.

The baseline investigations undertaken for the ESIA demonstrate that the project is situated within an existing operational industrial port environment where marine shipping, cargo handling, dredging activities, and associated industrial operations already constitute the dominant land use. Although the surrounding Port Qasim area contains ecologically important resources, including mangrove ecosystems, tidal creeks, fisheries resources, and migratory bird habitats within the wider Indus Delta, the assessment indicates that the immediate project footprint is located within a highly modified marine environment that has experienced long-term industrial disturbance. Furthermore, the nearest sensitive ecological receptors, including mangrove forests, are located outside the project's direct Area of Influence, thereby substantially reducing the likelihood of significant direct ecological impacts.

The impact assessment identified that the most significant environmental risks associated with the project will occur during the construction phase, particularly those associated with dredging, marine construction, crane replacement, heavy lifting operations, vessel movements, and the management and offshore disposal of dredged material. Without appropriate environmental controls, these activities have the potential to generate increased turbidity, deterioration of marine water quality, localized disturbance to benthic habitats, underwater noise, temporary disruption to marine navigation, occupational health and safety hazards, and potential pollution arising from accidental spills or inappropriate waste management practices. Similarly, operational risks include localized scour around the extended quay wall, operational spills, increased navigation demands associated with larger vessels, and long-term infrastructure maintenance requirements.

However, the assessment demonstrates that these impacts are **largely temporary, localized, predictable, and readily manageable** through the implementation of internationally accepted engineering controls, environmental management measures, and monitoring programmes. The mitigation hierarchy adopted throughout this ESIA emphasizes impact avoidance wherever practicable, followed by minimization, restoration, and compensation where necessary. The proposed Environmental and Social Management Plan (ESMP), together with the supporting Dredging Environmental Management Plan, Waste Management Plan, Emergency Preparedness and Response Plan, Occupational Health and Safety Plan, Marine Traffic Management Plan, Spill Prevention and Response Procedures, and other contractor-specific management plans, provides a comprehensive framework for managing project-related risks throughout all phases of implementation.

The assessment further concludes that the proposed dredging methodology, combined with the use of an approved offshore disposal location designated by the Port Qasim Authority, significantly reduces the potential for adverse impacts on sensitive marine habitats. Similarly, implementation

of continuous marine water quality monitoring, sediment characterization prior to dredging, controlled dredging techniques, navigation management procedures, spill prevention measures, and independent environmental monitoring will further ensure that project activities remain within acceptable environmental limits. Residual environmental impacts following implementation of mitigation measures are generally assessed as **Low to Medium Adverse**, with no residual impacts considered to be of major significance or irreversible in nature.

From a social perspective, the project is not expected to require permanent land acquisition, physical displacement, or economic displacement of surrounding communities. Construction activities will occur entirely within the operational boundaries of QICT and existing Port Qasim infrastructure. Potential temporary impacts associated with traffic management, occupational health and safety, labor management, worker welfare, and stakeholder communication have been identified and adequately addressed through the proposed mitigation measures, contractor management plans, grievance redress mechanisms, and monitoring arrangements. The implementation of these measures will ensure that project activities are undertaken in accordance with applicable national labor legislation and international good practice.

The project is also anticipated to generate substantial long-term positive impacts. These include increased container handling capacity, improved operational efficiency, enhanced navigational safety, modernization of terminal infrastructure, improved structural resilience of port facilities, increased employment opportunities during construction, strengthened national trade logistics, and improved economic competitiveness of Pakistan's maritime sector. The replacement of aging infrastructure with modern engineering systems will also improve operational safety, reduce maintenance requirements, and enhance the resilience of the terminal against future operational demands and climate-related stresses.

The environmental and social monitoring programme developed as part of this ESIA establishes a comprehensive framework for verifying the effectiveness of mitigation measures throughout the pre-construction, construction, and operational phases of the project. Routine monitoring of marine water quality, sediment quality, dredging activities, disposal operations, ecological receptors, air quality, noise, occupational health and safety performance, waste management, labor compliance, community health and safety, and emergency preparedness will enable early identification of any emerging issues and facilitate adaptive management where necessary. Independent environmental monitoring and periodic compliance auditing will provide additional assurance that project implementation remains consistent with both regulatory requirements and international lender expectations.

Overall, the findings of this ESIA indicate that the proposed Quay Wall Extension Project is **environmentally and socially feasible**, provided that all mitigation measures, environmental management plans, and monitoring requirements identified within this ESIA are fully implemented throughout the project lifecycle. The project is not expected to result in significant irreversible environmental degradation, unacceptable impacts on surrounding communities, or substantial adverse effects on ecologically sensitive receptors. With appropriate environmental management, engineering controls, institutional oversight, and commitment from QICT and its contractors, the residual impacts associated with the project remain within acceptable limits and are considered consistent with the principles of sustainable development and Good International Industry Practice.

Accordingly, it is concluded that the proposed Quay Wall Extension Project may proceed from an environmental and social perspective, subject to obtaining the necessary regulatory approvals and ensuring the effective implementation, monitoring, and continual improvement of the Environmental and Social Management Plan and associated management programmes throughout the life of the project. This will ensure that the project's significant economic and operational benefits are realized while maintaining a high standard of environmental stewardship, occupational safety, and social responsibility.

Annex I - Environmental Monitoring Reports

Lab Report Ref. No.: QTS/DP/26/5086 Reporting Date: 04/03/2026
Report to: DP World T 1 Quay Wall Extension

SAMPLE DESCRIPTION

Sample ID: Noise Level Test
Sample Description: Ambient *Noise*
No. of samples: 02
Sample Collected/Submitted by: QTS Representative
Sampling Date: 19/02/2026
Sample Receipt at QTS - Date: 19/02/2026

NOISE LEVEL REPORT

S. #.	LOCATION/SOURCE	SEQS Limits: 75dB(A) *Leq		
		Noise Level Readings		
		Minimum	Maximum	Average
1	Berth No 5	65.9	66.8	66.3
2	Berth No 9	69.4	70.5	69.9

SEQS=Sindh Environmental Quality Standard.
***dB (A) Leq: Time weighted average of the level of sound in decibel on scale which is relatable to human hearing.**

Terms & Conditions:

- This report is not valid for any negotiations
- Report is valid for current batch(sample)
- This report is intended only for your guidance & not for legal purpose or for advertisement.

Remarks: The Average concentration of Noise Level within SEQS Limits.

Sample Analyzed by: Hassan Ali	**Signature of Laboratory In charge:** **Name: Haseeb Arshad**

Quality Testing Services Karachi Q.T.S

Ambient Air Quality Test Report

Project Name:	DP World T 1 Quay Wall Extension	Test Report No:	QTS/DP/26/5087-A
Sample Description:	Ambient Air Quality Test	Sample Duration:	08hrs
Location	Berth No 5		

SEQS-PARAMETERS									
Date	Time	NO ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	CO (mg/m^3)	PM 10 ($\mu g/m^3$)	PM 2.5 ($\mu g/m^3$)	SPM ($\mu g/m^3$)	Lead ($\mu g/m3$)
19/02/2026	08:00	19.3	18.1	23.4	0.30	101	25	261	ND
	09:00	19.6	18.6	23.1	0.33	103	26	265	
	10:00	19.1	18.3	23.6	0.35	105	28	266	
	11:00	21.0	19.4	25.3	0.38	107	30	268	
	12:00	21.9	19.4	25.0	0.40	108	32	270	
	13:00	21.8	19.8	25.7	0.44	110	33	273	
	14:00	23.4	21.2	27.4	0.45	113	35	275	
	15:00	23.2	21.2	27.1	0.49	115	38	278	
	16:00	23.2	21.3	27.5	0.52	119	40	280	
MIN		19.1	18.1	23.1	0.30	101	25	261	
MAX		23.4	21.3	27.5	0.52	119	40	280	
AVG		21.3	19.7	25.3	0.40	109.1	32	270.6	
SEQS		40	80	120	5	150	75	500	1.5
LDL-Limits		0.0	0.0	0.0	0.0	10	2.5	1.0	-

Ambient Air Quality Test Report

Project Name:	DP World T 1 Quay Wall Extension	**Test Report No:**	QTS/DP/26/5087-A
		Sample Duration:	08hrs
Sample Description:	Ambient Air Quality Test	**Sampling Date:**	19-02-2026
		Location	Berth No 5

Parameter	Unit	Monitoring Duration	Average Obtained Concentration	SEQS	LDL-Limits	Methodology
Carbon Monoxide (CO)	mg/m³	08 Hours	0.40	5.0	0.01	Non Dispersive Intra Red (NDIR)
Nitrogen oxide (NO)	µg/m³	08 Hours	21.3	40.0	0.0	Chemiluminescence
Nitrogen Dioxide (NO_2)	µg/m³	08 Hours	19.7	80.0	0.0	
Sulphur Dioxide (SO_2)	µg/m³	08 Hours	25.3	120.0	0.0	Ultraviolet Fluorescence Method
Ozone (O_3)	µg/m³	01 Hour	21.1	130.0	0.0	Non Dispersive UV Absorption Method
Particulate Matter (PM_{10})	µg/m³	08 Hours	109.1	150.0	10.0	β Ray Absorption Method
Particular Matter ($PM_{2.5}$)	µg/m³	08 Hours	32	75.0	2.5	
Suspended Particulate Matter (SPM)	µg/m³	08 Hours	270.6	500.0	1.0	
Lead (Pb)	µg/m³	08 Hours	ND	1.5	0.01	ASS Method

SEQS= Sindh Environmental Quality Standards.
(24 Hours Standard for all the parameters Except O3 and CO),
µg/m3= Micrograms per Cubic Meter
mg/m3= Milligrams per Cubic Meter
ND= Not Detected
LDL=Least Detection Limit
BDL=Below Detection Limits

Comments:
The Average concentration of Ambient Air Level is within SEQS Limits.

Sample Analyzed By: Hassan Ali	**Signature of Laboratory In charge:** **Name:** Haseeb Arshad

Ambient Air Quality Test Report

Project Name:	DP World T 1 Quay Wall Extension	Test Report No:	QTS/DP/26/5087-B
Sample Description:	Ambient Air Quality Test	Sample Duration:	08hrs
Location	Berth No 9		

SEQS-PARAMETERS									
Date	Time	NO (µg/m³)	NO_2 (µg/m³)	SO_2 (µg/m³)	CO (mg/m³)	PM 10 (µg/m³)	PM 2.5 (µg/m³)	SPM (µg/m³)	Lead (µg/m3)
19/02/2026 20/02/2026	17:00	23.1	21.6	25.8	0.41	112	30	275	ND
	18:00	23.9	21.3	25.7	0.42	115	32	277	
	19:00	23.8	21.4	25.4	0.43	117	33	279	
	20:00	25.7	23.2	27.0	0.45	119	35	281	
	21:00	25.4	23.8	27.1	0.47	121	36	283	
	22:00	25.0	23.9	27.6	0.49	123	38	285	
	23:00	27.3	25.6	29.5	0.51	125	41	289	
	24:00	27.5	25.1	29.2	0.52	126	43	290	
	01:00	27.1	25.5	29.3	0.53	128	44	292	
MIN		23.1	21.3	25.4	0.41	112	30	275	
MAX		27.5	25.6	29.5	0.53	128	44	292	
AVG		25.4	23.4	27.4	0.47	120.5	36.9	283.4	
SEQS		40	80	120	5	150	75	500	1.5
LDL-Limits		0.0	0.0	0.0	0.0	10	2.5	1.0	-

Ambient Air Quality Test Report

Project Name:	DP World T 1 Quay Wall Extension	**Test Report No:**	QTS/DP/26/5087-B
		Sample Duration:	08hrs
Sample Description:	Ambient Air Quality Test	**Sampling Date:**	19-20/02/2026
		Location	Berth No 9

Parameter	Unit	Monitoring Duration	Average Obtained Concentration	SEQS	LDL-Limits	Methodology
Carbon Monoxide (CO)	mg/m³	08 Hours	0.47	5.0	0.01	Non Dispersive Intra Red (NDIR)
Nitrogen oxide (NO)	µg/m³	08 Hours	25.4	40.0	0.0	Chemiluminescence
Nitrogen Dioxide (NO_2)	µg/m³	08 Hours	23.4	80.0	0.0	
Sulphur Dioxide (SO_2)	µg/m³	08 Hours	27.4	120.0	0.0	Ultraviolet Fluorescence Method
Ozone (O_3)	µg/m³	01 Hour	19.5	130.0	0.0	Non Dispersive UV Absorption Method
Particulate Matter (PM_{10})	µg/m³	08 Hours	120.5	150.0	10.0	β Ray Absorption Method
Particular Matter ($PM_{2.5}$)	µg/m³	08 Hours	36.9	75.0	2.5	
Suspended Particulate Matter (SPM)	µg/m³	08 Hours	283.4	500.0	1.0	
Lead (Pb)	µg/m³	08 Hours	ND	1.5	0.01	ASS Method

SEQS= Sindh Environmental Quality Standards.
(24 Hours Standard for all the parameters Except O3 and CO),
µg/m3= Micrograms per Cubic Meter
mg/m3= Milligrams per Cubic Meter
ND= Not Detected
LDL=Least Detection Limit
BDL=Below Detection Limits

Comments:
The Average concentration of Ambient Air Level is within SEQS Limits.

Sample Analyzed By: Hassan Ali	**Signature of Laboratory In charge:** **Name:** Haseeb Arshad

Lab Report Ref. No.: QTS/DP/26/5088 Reporting Date: 04/03/2026

Project: DP World T 1 Quay Wall Extension

SAMPLE DESCRIPTION

Sample ID: Sea water- 01 (Low Tide)
Sampling Method: APHA 1060-A & B
Sample Type: Grab Sample
Sample Collected/Submitted by: EMC Representative
Sampling Date: 20/02/2026

ANALYTICAL TEST REP0ORT

S.NO.	PARAMETERS TO BE ANALYZED	LDL	UNITS	RESULTS	TEST METHOD
1	Temperature	1.0	^0C	29	Thermometer
2	pH value	0.01	-	8.33	USEPA 150.1
3	Biochemical Oxygen Demand $(BOD)_5$ at 20^0C	0.1	mg/L	44	Hach 8043
4	Chemical Oxygen Demand (COD)	1.0	mg/L	78	ASTM D1252
5	Total Suspended Solids (TSS)	1.0	mg/L	12	Hach 8006
6	Total Dissolved Solids (TDS)	1.0	mg/L	31,800	Hach 8160
7	Total Hardness as $CaCO_3$	0.1	mg/L	14,322	EDTA Titration.Hach-8213
8	Ammonia (NH_3)	0.1	mg/L	0.36	Hach 10031
9	Nitrate (NO_3)	0.01	mg/L	14	Hach -8039
10	Cyanide (as CN-) total	0.001	mg/L	0.042	Hach 8027
11	DO	1.0	mg/L	1.26	ASTM D888
12	Mercury		mg/L	0.12	ASTM D-3223
13	Total Petroleum Hydrocarbon (TPH)	0.1	mg/L	0.28	ASTM D3921
14	Lead	0.1	mg/L	101	ASTM D3559
15	Oil and grease	0.1	mg/L	0.77	ASTM D3921
16	Coliforms	-	cfu	>1000	APHA-SM9221B

SEQS=Sindh Environmental Quality Standards
USEPA=United State Environmental Protection Agency method
Hach USA, method
BDL=Below Detection Limit
APHA-SM = American Public Health Association- Standard Methods for Water & Waste water Examination
LDL= Least Detectable Value
NoGL=No Guideline Limits Available

Terms & Conditions:

- This report is not valid for any negotiations
- Report is valid for current batch(sample)
- The remaining portion of the sample will be discarded after 07 days unless otherwise instructed

Sample Analyzed by: AFAQ AHMED

Signature of Laboratory In charge:_____
Name: Haseeb Arshad

Quality Testing Services Karachi Q.T.S

Annex II - Guide Waste Management Plan

CONSTRUCTION WASTE MANAGEMENT PLAN

Construction waste material consists mainly of concrete, masonry, limestone, sandstone, metal, and wood, depending on the construction type. In building waste, a larger percentage of paper, plastic, etc. is expected due to packaging materials and the wood retired from formwork and scaffolding. This is in addition to significant amounts of concrete, masonry and metal materials.

1.0 Origins and Causes of Construction Waste

Origins of waste	Causes of waste
Contractual	▪ Errors in contract documents ▪ Contract documents incomplete at commencement of construction
Design	▪ Design changes ▪ Design and detailing complexity ▪ Design and construction detail errors ▪ Unclear/unsuitable specification ▪ Poor coordination and communication (late information, last minute client requirements, slow drawing revision and distribution)
Procurement	▪ Ordering errors (i.e., ordering items not in compliance with specification) ▪ Over allowances (i.e., difficulties to order small quantities) ▪ Supplier errors
Transportation	▪ Damage during transportation ▪ Difficulties for delivery vehicles accessing construction sites ▪ Insufficient protection during unloading ▪ Inefficient methods of unloading
On-site Management and Planning	▪ Lack of on-site waste management plans ▪ Improper planning for required quantities ▪ Delays in passing information on types and sizes of materials and components to be used ▪ Lack of on-site material control ▪ Lack of supervision
Material storage	▪ Inappropriate site storage space leading to damage or deterioration ▪ Improper storing methods ▪ Materials stored far away from point of application
Material handling	▪ Materials supplied in loose form ▪ On-site transportation methods from storage to the point of application ▪ Inadequate material handling
Site operation	▪ Accidents due to negligence ▪ Unused materials and products ▪ Equipment malfunction ▪ Poor craftsmanship

Origins of waste	Causes of waste
	▪ Use of wrong materials resulting in their disposal ▪ Time pressure ▪ Poor work ethics
Residual	▪ Waste from application processes (i.e., over preparation of mortar) ▪ Off-cuts from cutting materials to length ▪ Waste from cutting uneconomical shapes ▪ Packaging
Other	▪ Weather ▪ Vandalism ▪ Theft

2.0 Construction Waste Management Plan

1) Waste Management Goals

To establish that this project shall generate at least 50% less waste into landfills and the processes shall be employed to ensure that this goal is met. These shall include prevention of damage to materials to be incorporated into the work due to mishandling, improper storage, contamination, inadequate protection or other factors as well as minimizing poor quantity estimation, as well as through building design.

2) Responsibility

- The Project Director shall be responsible for the implementation of the administrative portions of this program, including the notification of subcontractor management, the training of the site supervisor and the onsite posting of this plan.
- The site supervisor will be responsible for the implementation of the onsite portions of this program including the training of subcontractor personnel.

3) Waste Prevention Planning

- In addition to other requirements specified herein it is a requirement for the work of this project that the contractor comply with the applicable city waste disposal requirements.
- Of the inevitable waste that is generated, the waste materials designated in this specification shall be salvaged for reuse and or recycling where practical and possible.
- Project Construction Documents: The General Contractor will contractually require all subcontractors to comply with these recycling guidelines. A copy of this “Construction Waste Management Plan” will accompany all subcontractor agreements and require subcontractor participation.
- The “Construction Waste Management Plan” shall be implemented and executed as follows and as on the chart:
  - Salvageable materials will be diverted from disposal where feasible.
  - There will be a designated area on the construction site reserved for materials that can be recycled.
  - Areas shall be marked to designate what recycle materials are to be stored there.
  - Hazardous waste will be managed by a licensed hazardous waste vendor.

4) Communication & Education Plan

- This Construction Waste Management Plan will be posted onsite.

- Each subcontractor will be made aware of the intent of this project with respect to reduction of waste and recycling.
- Onsite recycling containers and/or areas will be plainly marked.
- The subcontractor will be expected to make sure all their crews comply with the Waste Management Plan.
- All recycling containers/areas will be clearly marked.
- Lists of acceptable/unacceptable materials will be posted at the site.
- All subcontractors will be informed in writing of the importance of non-contamination with other materials or trash.

5) Motivation Plan

The General Contractor will conduct a pre-award meeting for subcontractors. Subcontractors under consideration will be required to attend the meeting to review project goals and requirements with the project team. Attendance will be a prerequisite for award of subcontracts. This document will be an attachment to every subcontract. Copies of the attachment will be posted prominently at the job site.

6) Expected Project Waste, Disposal, and Handling

The following chart identifies waste materials expected on this project, their expected disposal methods and handling procedures. New items may be added as needed.

Material	Quantity	Disposal Method	Handling Procedure
Land clearing debris		Keep separate for reuse and or wood sale. Separate topsoil and rock for future landscaping use.	Keep separated in designated areas onsite.
Clean dimensional wood and palette wood		Keep separate for reuse by on-site construction or by site employees for either heating stoves or reuse in home projects. May be offered to public.	Keep separated in designated areas onsite.
Plywood, OSB, particle board		Reuse onsite when possible, landfill or recycle off site.	Keep separated in designated areas onsite. Place in “Trash” container.
Painted or treated wood		Reuse, off site recycle, landfill.	Keep separated in designated areas onsite. Place in “Trash” container.
Concrete		Recycle when possible.	
Concrete Masonry Units		Keep separate for re-use by on-site construction or by site employees.	Keep separated in designated areas onsite.

Material	Quantity	Disposal Method	Handling Procedure
Metals		Recycle off site when possible. Separate copper wire when possible.	Keep separated in designated areas onsite. Place in "Metals" container.
Paint		Reuse onsite.	Keep separated in designated areas onsite
Insulation		Reuse, landfill.	
Flooring		Reuse, landfill.	
Carpet and pad		Reuse or recycle with carpet manufacturer	
Glass		Glass Bottles: recycle locally.	Keep separated in designated areas onsite.
Plastics		Plastic Bottles: recycle locally; be aware of plastics that are acceptable to recycle facility.	Keep separated in designated areas onsite.
Beverage		Recycle locally	Keep separated in designated areas onsite.
Cardboard		Recycle locally	Keep separated in designated areas onsite.
Paper and newsprint		Recycle locally	Keep separated in designated areas onsite.

7) Waste Disposal Company

To be determined

a) Contact:

8) Recycle Hauler

To be determined

b) Contact:

c) Some or all recycle may be hauled by the builder.

9) Possible Recycle Locations and Acceptable Materials

i) Coordinate with companies which are registered with local Municipality that accept materials for recycle; and

ii) Using the above as a resource, a list will be kept indicating local opportunities for recycle of expected materials. New locations should be added as needed.

Annex III - Guide Water & Wastewater Management Plan

GUIDELINE WATER & WASTEWATER MANAGEMENT PLAN

INTRODUCTION

This plan outlines the measures that can improve conditions of sanitation at construction sites during construction phase.

1. PURPOSE OF THE PLAN

The plan intends to ensure sanitation including the control of water supplies, excrete and wastewater disposal, refuse disposal, vectors of diseases, housing conditions, food supplies and handling, atmospheric conditions, and the safety of the working environment.

2. MANAGEMENT OF SANITATION DURING CONSTRUCTION PHASE

i) Responsibility

The Health and Safety Inspector designated by construction contractor shall also inspect sanitation conditions and ensure safe working environment for workers.

ii) Location of Camp Sites

The accommodation and ancillary facilities for labor shall be constructed and maintained to standards and scales approved by the Resident Engineer.

The camps must be located such that the drainage from and through the camps shall not endanger any domestic or public water supply.

All sites must be managed to avoid ditches and depressions to minimize nuisance due to stagnant water.

iii) Water Supply

An adequate and convenient water supply, approved by the appropriate health authority, must be provided in each camp for drinking, cooking, bathing and laundry purposes.

Potable water supply systems for labor camps occupants shall meet the drinking water quality standards of SEQS, 2016. In addition, the design of water system facilities shall be based on the suppliers Engineer's estimates of water demands. The drinking water must be monitored regularly for drinking water quality parameters.

At all construction camps and other workplaces, good and sufficient water supply shall be provided and maintained to eliminate chances of waterborne diseases to ensure the health and hygiene of the workers.

iv) Toilet Facilities and Hygiene

According to health and safety guidelines OR-OSHA number of toilets required at construction site is as one toilet for 20 workers. **Table 1** shows the number of toilets required in accordance with the number of employees at construction site. The total numbers of employees at construction site are estimated to be 220 persons.

Table 1: Number of Toilets Required for Employees at Construction Site

No. of Employees	No. of Toilets and Urinals by OSHA	Total No. Toilets and Urinals Required at Construction Site
Up to 20 Employees	1 Toilet	5 Toilets
Up to 40 Employees	1 Urinal	2 Urinals

Within the premises of every workplace, toilets and urinals shall be provided in an accessible place, and the accommodation, separately for each of these, as per standards prevailing in the province and country.

Toilet facilities adequate for the capacity of the camp must be provided. Each toilet room must be located, so as to be accessible.

A toilet room must be located within 200 feet of the camp. No toilet may be closer than 100 feet to kitchen and sleeping area.

These toilets must be distinctly marked by signs printed in native language of the persons occupying the camp, or marked with easily understood pictures or symbols.

Urinals troughs in privies must drain freely into the pit or vault, and the construction of this drain must be such as to exclude flies and rodents from the pit.

Proper facility for hand washing and other cleaning activities to be provided as follows:

- Provide individual hand towels from a sanitary dispenser and receptacles for disposing of waste towels;
- Providing hand soap and industrial hand cleaner for removing paints and other contaminants;
- Prohibited use of gasoline or solvent for hand washing; and
- Keep the floor of facilities dry to prevent spills and falls.

v) Waste Disposal

The sewage system for the camp must be designed, built and operated in compliance with the relevant legislation so that no health hazard occurs and no pollution to the air, ground or adjacent watercourse takes place.

Garbage bins must be provided in the camps and regularly emptied and the garbage disposed of in a hygienic manner.

Unless otherwise arranged for by the local sanitary authority, arrangement for disposal of excreta should be done in the already existing sewerage system in the area.

On completion of the works, all such temporary structures shall be cleared away, all rubbish burnt, excreta tank and other disposal pits or trenches filled in and effectively sealed off and the outline site left clean and tidy, at the Contractor's expense, to the entire satisfaction of the engineer.

vi) Maintenance of Sanitary Facility

Proper maintenance of toilets and other sanitary facilities should assure by health and safety inspector. Toilets and other sanitary facilities shall be cleaned at least four times daily and at least twice during working hours and kept in a strict sanitary condition. Receptacles shall be tarred inside and outside at least once a year.

All buildings, rooms and equipment and the grounds surrounding them shall be maintained in a clean and operable condition, and be protected from rubbish accumulation.

All necessary means shall be employed to eliminate and control any infestations of insects and rodents within all parts of any labor camp.

3. Management of Sanitation During Operational Phase:

A proper sanitation plan is to be adopted for maintaining the hygienic conditions during the operational phase of the project. These includes

- Site Clearance;
- Sewage Pipe Clearing, and
- Solid Waste Management.

i) Site Clearance

The construction contractor shall assure the clearance of construction machinery, vehicle and other equipment used during the construction period after the completion of the project.

ii) Solid Waste Management

Municipal solid waste and medical waste produced along the road should be collected and managed properly by the concerned department. Waste bins should be placed along the road side; regular cleaning of the road should be carried out using mechanical sweepers and at least two to four sweepers should be deputed for the whole proposed road to assure regular cleaning.

iii) Awareness and Training

A training and awareness sessions shall be conducted for workers before commencement of the Project. The implementation of sanitation plan would be more effective if the importance of hygiene; sanitation and safety are known to the workers.

Annex IV - Guide OHS Plan

GUIDELINE OCCUPATIONAL HEALTH AND SAFETY PLAN

Occupational Health and Safety covers all personnel working under the project and will be in line with the World Bank EHS guidelines on health and safety.

The Occupational Health and Safety program will aim to ensure that the workplace is safe and healthy by: addressing the hazards and risks at the workplace; outlining the procedures and responsibilities for preventing, eliminating and minimizing the effects of those hazards and risks; identifying the emergency management plans for the workplace or workplaces; and, specifying how consultation, training and information are to be provided to employees at various workplaces.

Some of the risks/hazards associated with workplaces are due to working close to or at sites associated with the various project construction activities. Other risks associated with the project construction phase include risk of increase of vector borne and other different diseases.

The following sections will be implemented during the construction phase to address and ensure workers' health and safety.

1.1 SCREENING AND REGULAR UNANNOUNCED CHECKING OF WORKERS

As per the procedure for hiring workers, all contractors and labor agencies are required to make all prospective workers undergo medical tests to screen for diseases and sicknesses, prior to selection and employment of any worker. The contractor is also responsible for ensuring that no worker who has a criminal record is employed at the project site. It will be ensured that all workers undergo medical tests to screen diseases at source and at sites in consultation with the designated Health Officer.

In addition to this, the Project Management will also undertake sudden, unannounced checks on workers to look for diseases such as COVID-19, HIV, STDs, and hepatitis and take necessary steps as mandated by the Contractual agreement between the Contractor and the Worker(s).

1.2 MINIMIZING HAZARDS AND RISKS AT THE WORKPLACE

To ensure safety at all work sites, the following will be carried out:

i. Installation of signboards and symbols in risky and hazardous areas, to inform workers to be careful.
ii. Construction of barricades around construction sites and deep excavated pits, to cordon off and deter entry of unauthorized personnel and workers into these areas.
iii. Providing a safe storage site/area for large equipment such as power tools and chains, to prevent misuse and loss.
iv. Proper Housekeeping: Ensuring that materials are all stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse. Brick stacks will not be more than 7 feet in height and for concrete blocks they will not be more than 6 feet high.
v. Removing all scrap timber, waste material and rubbish from the immediate work area as the work progresses.
vi. Where scaffolds are required, ensuring that each scaffold or its components shall be capable of supporting its own weight and at least 4 times the maximum intended load applied or transmitted to it. The platform/scaffold plank shall be at least 15 inches wide and 1.5 inches thick. The rope should be capable of supporting at least 6 times the maximum intended load applied or transmitted to that rope. Pole scaffolds over 60 feet in height shall be designed by a registered professional engineer and shall be

constructed and loaded in accordance with that design. Where scaffolds are not provided, safety belts/safety nets shall be provided;

vii. Ensure that all ramps or walkways are at least 6 feet wide, having slip resistance threads and not inclined at more than a slope of 1 vertical and 3 horizontal.

viii. Stacking away all excavated earth at least 2 feet from the pit to avoid material such as loose rocks from falling back into the excavated area and injuring those working inside excavated sites.

ix. Constructing support systems, such as bracing to adjoining structures that may be endangered by excavation works nearby.

x. Only a trained electrician to construct, install and repair all electrical equipment to prevent risks of electrical shocks and electrocution.

xi. Install fire extinguishers and/or other fire-fighting equipment at every work site to prepare for any accidental fire hazards.

1.3 PROVISION OF PERSONAL PROTECTIVE EQUIPMENT

Risks to the health and safety of workers can be prevented by provision of Personal Protective Equipment (PPEs) to all workers. This will be included in the construction cost for each Contractor. Depending on the nature of work and the risks involved, contractors must provide without any cost to the workers, the following protective equipment:

i. High visibility clothing for all personnel during road works must be mandatory.

ii. Helmet shall be provided to all workers, or visitors visiting the site, for protection of the head against impact or penetration of falling or flying objects.

iii. Safety belt shall be provided to workers working at heights (more than 20 ft) such as roofing, painting, and plastering.

iv. Safety boots shall be provided to all workers for protection of feet from impact or penetration of falling objects on feet.

v. Ear protecting devices shall be provided to all workers and will be used during the occurrence of extensive noise.

vi. Eye and face protection equipment shall be provided to all welders to protect against sparks.

vii. Respiratory protection devices shall be provided to all workers during occurrence of fumes, dusts, or toxic gas/vapor.

viii. Safety nets shall be provided when workplaces are more than 25 feet (7.5 m) above the ground or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors or safety belts is impractical.

The specific PPE requirements for each type of work are summarized below.

Table 1: PPE Requirement List

Type of Work	PPE
Elevated work	Safety helmet, safety belt (height greater than 20 ft), footwear for elevated work.
Handling work safety	Helmet, leather safety shoes, work gloves.
Welding and cutting work	Eye protectors, shield and helmet, protective gloves.
Grinding work	Dust respirator, earplugs, eye protectors.
Work involving handling of chemical substances	Dust respirator, gas mask, chemical-proof gloves. Chemical proof clothing, air-lined mask, eye protectors.
Wood working	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Blasting	Hard hat, eye and hearing protection.
Concrete and masonry work	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Excavation, heavy equipment, motor graders, and bulldozer operation	Hard hat, safety boots, gloves, hearing protection.
Quarries	Hard hat, eye protectors, hearing protection, safety footwear, leather

Type of Work	PPE
	gloves and dust respirator.

1.4 PROCEDURES TO DEAL WITH EMERGENCIES SUCH AS ACCIDENTS, SUDDEN ILLNESS AND DEATH OF WORKERS

First aid kits will be made available at all times throughout the entire construction period by the respective contractors. This is very important, because most work sites will be at some distance from the nearest hospital. In addition to the first aid kits, the following measures should be in place:

i. Provision of dispensaries by the individual EPC contractor.
ii. A vehicle shall be on standby from the Project Office so that emergency transportation can be arranged to take severely injured/sick workers to the nearest hospital for immediate medical attention.
iii. A designated Health Officer/worker for the Project will be identified as a focal person to attend to all health and safety related issues. This employee's contact number will be posted at all work sites for speedy delivery of emergency services. The focal person shall be well versed with the medical system and facilities available at the hospital.
iv. Communication arrangements, such a provision of radios or mobile communication for all work sites, for efficient handling of emergencies, will be made.

1.5 RECORD MAINTENANCE AND REMEDIAL ACTION

The Project Management will maintain a record of all accidents and injuries that occur at the work site. This work will be delegated by the contractor to the site supervisor and regularly reviewed every quarter by project management. Reports prepared by the contractor shall include information on the place, date and time of the incident, name of persons involved, cause of incident, witnesses present and their statements. Based on such reports, the management can jointly identify any unsafe conditions, acts or procedures and recommend for the contractor to undertake certain mitigative actions to change any unsafe or harmful conditions.

1.6 COMPENSATION FOR INJURIES AND DEATH

Any casualty or injury resulting from occupational activities should be compensated as per the local labor laws of Pakistan. Where compensation is sought by the injured party, proper procedures for documentation of the case will be followed, including a detailed report on the accident, written reports from witnesses, report of the examining doctor and his/her recommendation for treatment. Each individual contractor will be responsible for ensuring compensation for the respective workers.

1.7 AWARENESS PROGRAMS

The Project management will undertake awareness programs through posters, talks, and meetings with the contractors to undertake the following activities:

i. Dissemination sessions will clarify the rights and responsibilities of the workers regarding interactions with local people (including communicable disease risks, such as HIV/AIDS, COVID-19), work site health and safety, waste management (waste separation, recycling, and composting), and the illegality of poaching.
ii. Make workers aware of procedures to be followed in case of emergencies such as informing the focal health person who in turn will arrange the necessary emergency transportation or treatment.

1.8 NOMINATION OF A HEALTH AND SAFETY FOCAL PERSON

Within each site (especially if different sites are being implemented by different contractors), a Health and Safety Focal Person will be appointed. The Terms of Reference for the focal person will mainly be as follows:

i. Function as the focal person/representative for all health and safety matters at the workplace;
ii. Responsible for maintaining records of all accidents and all health and safety issues at each site, the number of accidents and its cause, actions taken and remedial measures undertaken in case of safety issues;
iii. Be the link between the contractor and all workers and submit grievances of the workers to the contractor and instructions/directives on proper health care and safety from the contractors back to the workers;
iv. Ensure that all workers are adequately informed on the requirement to use Personal Protective Equipment and its correct use;
v. Also responsible for the first aid kit and making sure that the basic immediate medicines are readily available.

1.9 SUGGESTED CONTENTS OF OCCUPATIONAL HEALTH AND SAFETY PLAN

The suggested contents of Occupational Health and Safety Plan to be developed by the Contractor(s) are described below:

a Purpose
b Scope of Application
c Complying Basis
d Occupational Health and Safety Objectives
e Organization and Responsibility
  - Contractor's Project Manager
  - HSE Management Department of the Contractor(s)
  - Medical Treatment Room of the Contractor(s)
  - Subcontractor's Project Manager
  - Subcontractor's HSE Managers
  - Occupational Health and Safety
  - Community Health and Safety
f Health Plan
  - Labour Protection
  - Sanitary Epidemic Prevention
g Safety Plan
  - Summary
  - Qualification Review
  - Safety Training
  - Construction Plans and Documents
  - Control Measures
  - Monitoring Measures
  - Management of the Key Safety Accidents
h Public Security Plan
i Local Community Health and Safety

Annex V - Guide Emergency Preparedness & Response Plan

GUIDELINE EMERGENCY PREPAREDNESS AND RESPONSE PLAN

1.1 PURPOSE

The purpose of this Emergency Response Procedure is to provide measures and guidance for the establishment and implementation of emergency preparedness plans for the project. The aim of the Emergency Response Procedure is to:

i. Ensure all personnel and visitors to the office/job sites are given the maximum protection from unforeseen events.
ii. Ensure all personnel are aware of the importance of this procedure to protection of life and property.

1.2 EMERGENCY PREPARATION AND RESPONSE MEASURE SCOPE

The emergency management program is applied to all Project elements and intended for use throughout the Project life cycle. The following are some emergencies that may require coordinated response.

i. Construction Accident
ii. Road & Traffic Accident
iii. Hazardous material spills
iv. Structure collapse or failure
v. Trauma or serious illness
vi. Sabotage
vii. Fire
viii. Environmental Pollution
ix. Loss of person
x. Community Accident

1.3 RESPONSIBILITIES

The detailed roles and responsibilities of certain key members of the Emergency Response team available to assist in emergency are provided in **Table 1** below.

Table 1: Emergency Response Team

Action Group	Responsibility
Emergency Coordinator	▪ Overall control of personnel and resources. ▪ The Emergency Coordinator will support and advise the Site Safety Supervision as necessary. ▪ Serves as public relations spokes persons, or delegates to some staff member the responsibility for working with news media regarding any disaster or emergency. Also assure proper coordination of news release with appropriate corporate staff or other designated people.
Site Safety Supervision (Emergency Commander)	▪ Overall responsibility for activating emergency plan and for terminating emergency actions. ▪ Be alternative of emergency response chairpersons. ▪ Disseminates warnings and information as required to ensure all people in the immediate area have been warned and evacuated either by alarms or by word of mouth. ▪ Supervise the actions of the Emergency Response Team to ensure all persons are safe from the danger. ▪ Notify outside authorities if assistance is required. ▪ Carries the responsibility for coordinating actions including other organizations in accordance with the needs of the situation.

Action Group	Responsibility
	▪ Ensure maximum co-operation and assistance is provided to any outside groups called to respond to an emergency. ▪ Establish and appoint all emergency organization structure and team. ▪ Assures adequate delegation of responsibilities for all key positions of assistants on the Project to assist with any foreseeable emergency. ▪ Ensure resources available to purchase needed emergency response equipment and supplies. ▪ Assures that all persons on the Emergency Response Team aware and fully understand their individual responsibilities for implementing and supporting the emergency plan. ▪ Establish the emergency drill schedule of all identified emergency scenarios, track the status and evaluate the emergency. ▪ The Emergency Commander shall ensure that senior management personnel have been reported of the emergency as soon as practical after the event.
Security Team	▪ Ensure that the exit route is regularly tested and maintained in good working order. ▪ Maintain station at the security gate or most suitable location to secure the area during any emergency such that only authorized personnel and equipment may enter, prevent access to the site of unauthorized personnel. ▪ Assist with strong/activation of services during an emergency. ▪ Ensure vehicles and obstructions are moved to give incoming emergency vehicles access to the scene, if ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct any incoming emergency service to the site of emergency.
Rescue & Medical Team	▪ Protect the injured from further danger and weather. ▪ Provide treatment to the victim(s) to the best of their ability by first aid and then transfer to hospital. ▪ Remain familiar with the rescue activities and rescue apparatus. ▪ Assist outside medical services personnel when they arrive
General Administration Team	Response to support any requested general facilities for assisting Emergency Response Team in their work.
Government Relation Team	▪ Coordinate with local government on a matter of concerned in the emergency response plan to liaise with local officers in their affair for support Emergency Response Team. ▪ Coordinate emergency plan with the government authorities, local community.
Environment Team	In case of emergency related to the environmental pollution such as the chemical spill, oil spill into the ambient, the environment team will support the technical advice to control and mitigate the pollution until return to the normal situation.
Department Heads	▪ Call up of personnel into the safe location for protective life and property. ▪ Take immediate and appropriate action while Emergency Response Team is being mobilized. ▪ Keep in touch with the Emergency Commander ▪ Control and supervise operators and contractors on the implementation of this procedure, with consultation with Safety Team as necessary. ▪ Provide and maintain emergency equipment of their responsible areas.

Action Group	Responsibility
Other Staff and Employees	▪ All other staff and employees will remain at their workstations or assembly point unless directed otherwise from Emergency Response Team. ▪ Each supervisor will ensure that all members of his work group are accounted for and keep in touch with each of their Department Head.

1.4 PROCEDURE

Emergency situation and injuries to person can occur at any time or place either on Project site or elsewhere. The most two common types of emergencies on site are fire and serious accident.

Figure 3.1 Emergency Procedures for Fire

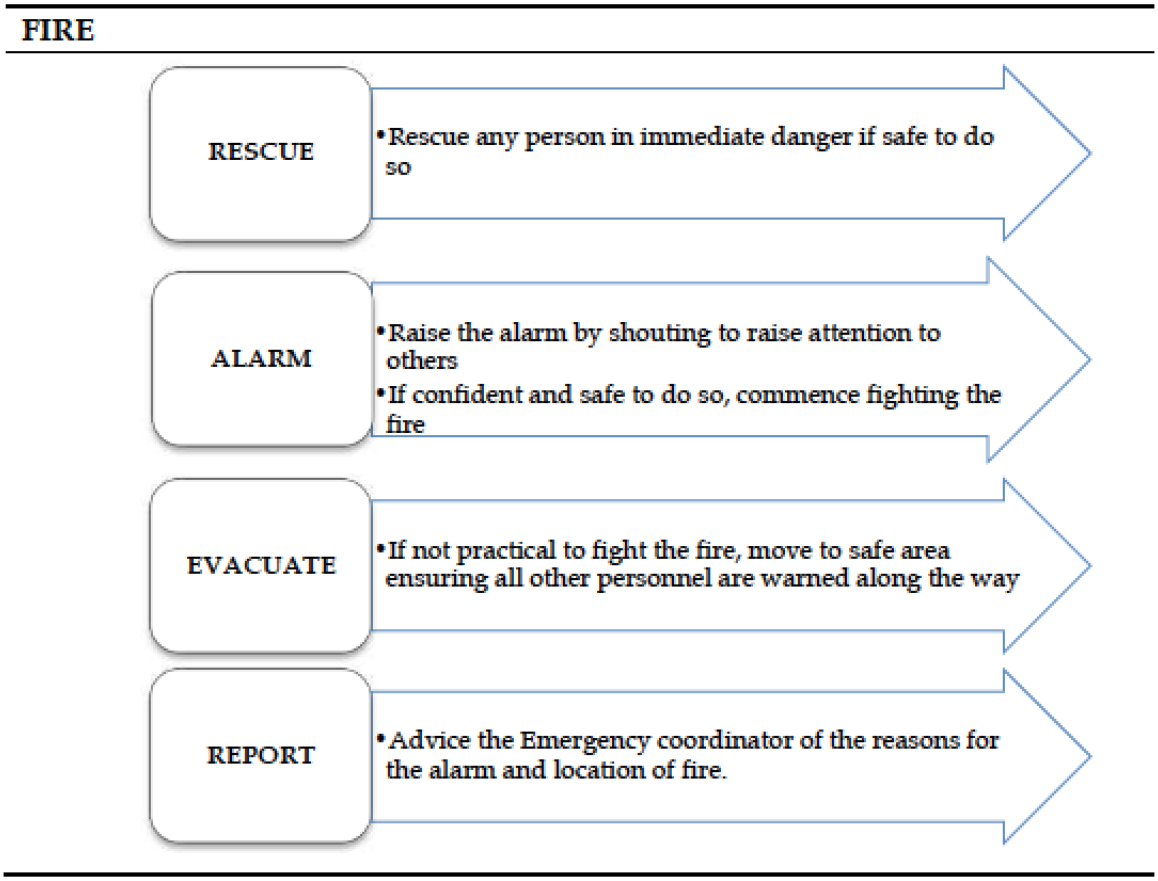
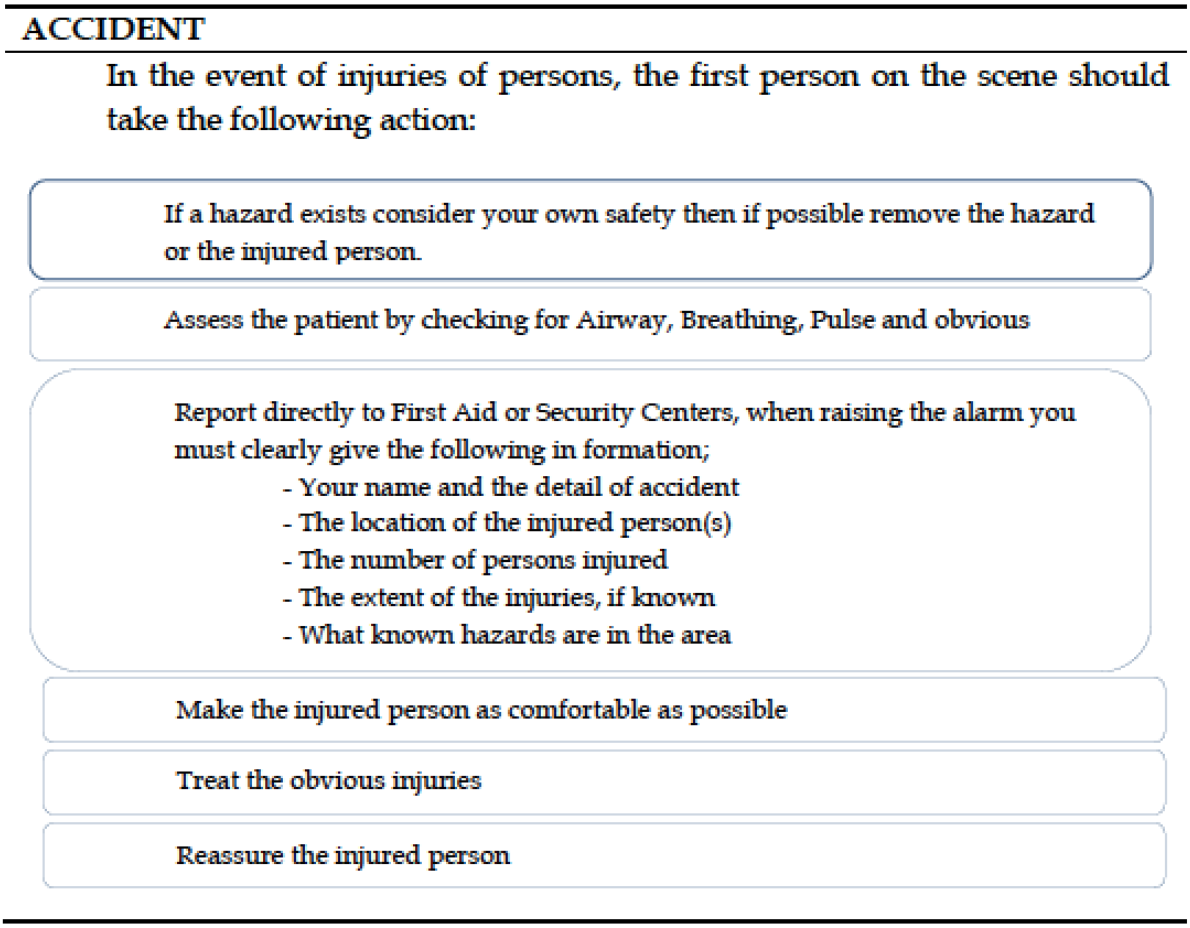


Figure 3.2 Emergency Procedures for Serious Accident



3.5 COMMUNICATION WITH AUTHORITIES / PRESS AT SITE

In the event of an accident or incident, only senior staff is permitted to give factual information to the authorities for resource of liability exposure. The press must be avoiding politely, at all costs, with the terse comment that “the matter is under investigation and relevant information when available will be provided by our Head Office” Do not ever give your opinion or story.

1.5 FIRST AID PERSONS

Upon advice of medical emergency, make immediate assessment to response required and if necessary, advise security to summon ambulance or medical assistance, the qualified first aid attendant should also,

- Provide treatment to the victim(s) to the best of his/her ability.
- Ensure the safety of victims by ceasing any work activity in the area.
- Protect the injured from further danger and weather.
- Assist medical services personnel when they arrive.

1.6 GENERAL ADMINISTRATION TEAM

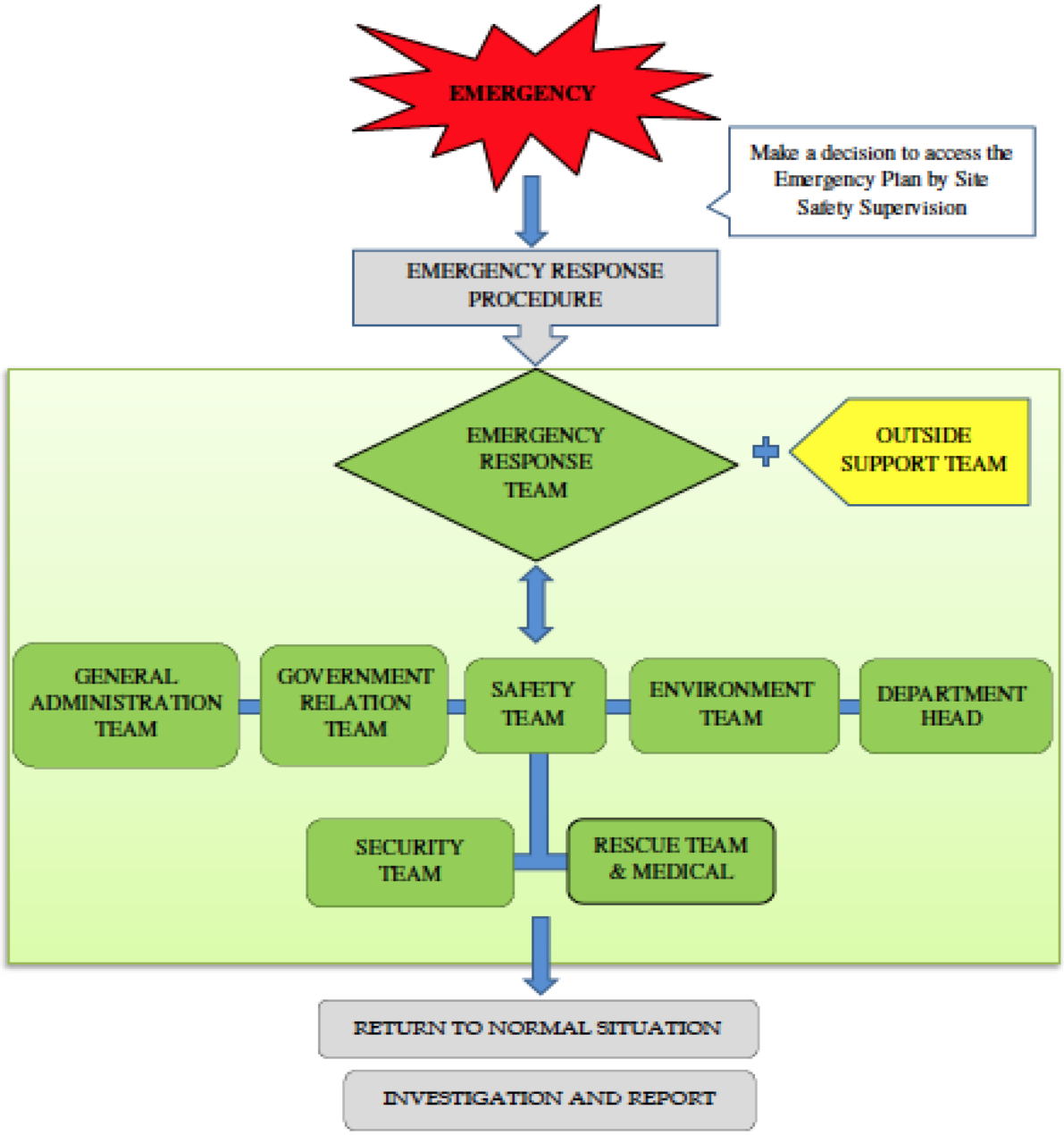
Upon advice of medical emergency, maintain contact with first aid personnel and summon ambulance if required.

1.7 SECURITY TEAM

- If ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct vehicle closest to the scene.
- Prevent access to the site of unauthorized personnel (press, etc.).

1.8 EMERGENCY COORDINATOR

- The Emergency Coordinator shall assist emergency personnel at the scene as required through allocation of company resources.
- The Emergency Coordinator shall ensure next-of-kin are properly notified as soon as possible and give whatever company support and assistance is necessary to assist them bundle the situation
- The Emergency Coordinator shall ensure that senior management personnel are advised of the emergency as soon as practical after the event.



Note: Name of contact person and call number from Owner/Contractor to be determined.

1.9 INCIDENT AND ACCIDENT REPORT

Section A: Identification Data

Report No:	Date of Reported:	Reporter:	Sign:
Job Title:		Company Name:	

Section B: Violence Rate

Accident Violence: ☐ 01-Death ☐ 02-Serious Injury ☐ 03-Lost Time Injury ☐ 04-First Aid ☐ 05- Not Injury ☐ 06-Near Miss

Property Damage Cost: ☐ 1-2,000 USD ☐ 2,001-10,000 USD ☐ 10,001-50,000 ☐ > 50,001

Section C: Environmental Impact

Affected area	☐ Construction area	☐ Public area	
Receptor	☐ None	☐ Workers	☐ Community
Type of pollution	☐ Physical	☐ Chemical	☐ Biological
Toxicity	☐ Non-toxic	☐ Low - toxic	☐ High - toxic
Return to Normal	☐ 1 day	☐ 1 day to 1 week	☐ ≥ 1 week
Cumulative impact	☐ Non-cumulative	☐ Cumulative	

Section D: Injured/Illness Employee

1.Name:	Sex:	Date of Birth: Month	Day	Year	Age:	Regular Job Title:	Experience: In this job title Years	Weeks	In this Project Years	Weeks
	☐ Male ☐ Female									

Site:	Company:	Reference:	Phone No:	Social Security Numbe

Part of Body Injured or Affected:

☐ Head	☐ Hands	☐ Face	☐ Nose
☐ Eyes	☐ Legs	☐ Teeth	☐ Neck
☐ Trunk	☐ Toes	☐ Elbow	☐ Shoulder
☐ Back	☐ Ankle	☐ Wrist	☐ Foot
☐ Arms	☐ Thump	☐ Fingers	☐ Internal

Remark: .....

Nature of Injury or Illness:

☐ Laceration	☐ Amputation	☐ Puncture	☐ Fracture
☐ Strain & Sprain	☐ Burns	☐ Contusion	☐ Dry Heat Friction
☐ Hernia	☐ Foreign Body	☐ Chemical	☐ Contamination
☐ Skin (Occupationnel)	☐ Rash	☐ Irritation	

Remark: .....

2.Name:	Sex:	Date of Birth: Month	Day	Year	Age:	Regular Job Title:	Experience: In this job title Years	Weeks	In this Project Years	Weeks
	☐ Male ☐ Female									

Site:	Company:	Reference:	Phone No:	Social Security Numbe

Part of Body Injured or Affected:

☐ Head	☐ Hands	☐ Face	☐ Nose
☐ Eyes	☐ Legs	☐ Teeth	☐ Neck
☐ Trunk	☐ Toes	☐ Elbow	☐ Shoulder
☐ Back	☐ Ankle	☐ Wrist	☐ Foot
☐ Arms	☐ Thump	☐ Fingers	☐ Internal

Remark: .....

Nature of Injury or Illness:

☐ Laceration	☐ Amputation	☐ Puncture	☐ Fracture
☐ Strain & Sprain	☐ Burns	☐ Contusion	☐ Dry Heat Friction
☐ Hernia	☐ Foreign Body	☐ Contamination	☐ Chemical
☐ Skin (Occupationnel)	☐ Rash	☐ Irritation	

Remark: .....

Section E: Accidents/incident Details

Date Accident/Incident Occurred:	Time Accident/Incident Occurred:	Exact Location of the Accident / Incident:

Details of the actual Job Being done at the time:

Details of Accident / Incident / What actually happened?

Section F: Accident Cause (Basic cause mark X / Contributing cause, if any mark O)

UNSAFE CONDITIONS		UNSAFE ACTS	
1	☐ Inadequately Guarded	1	☐ Operating Without Authority / Training
2	☐ Unguarded	2	☐ Operating at Unsafe Speed
3	☐ Defective Tools, Equipment, or Subetance	3	☐ Marking SHE Device Inoperative
4	☐ Unsafe Design or Construction	4	☐ Using Unsafe Equipment or Equipment Unsafely
5	☐ Hazardous Arrangement	5	☐ Unsafe Loading, Placing, Mixing
6	☐ Unsafe Illumination	6	☐ Taking Unsafe Position
7	☐ Unsafe Ventilation	7	☐ Working on Moving or Dangerous Equipment
8	☐ Unsafe Clothing	8	☐ Distraction, Teasing, Horse Play
9	☐ Insufficient Instruction	9	☐ Failure to use Personal Protective Devices
10	☐ Lack of system of work	10	☐ Lack of effective instruction or supervision

Why was the unsafe act committed? _____ Why did the unsafe condition exist? _____

Section G: Guide to Corrective Action (Base on the cause checked above, I am taking the following corrective action)

UNSAFE ACT	UNSAFE CONDITION	If Supervisor can't handle, then recommend to
☐ Stop the Behaviour	☐ Remove	☐ Site Engineer, or
☐ Study the job	☐ Guard	☐ Site Manager, or
☐ Instruct (tell-show-try-check)	☐ Warn	☐ Project Manager, or
☐ Follow Up	☐ Supervisory Training	☐ Safety Committee
☐ Enforce		

Detail below any immediate remedial actions that have been taken:

Detail below any corrective and preventative actions that could be taken to prevent future re-occurrence:	Responsible	Completion Date

Section H: Witness Statement	
Witness Name	**Interviewer Name**

Section I: Reviewed & Recommend by			
Recommendation:			
Reviewed By:	Position:	Signature:	Date:

Remarks : If Accident or Incident happened with lost time injury and affected to the publicity must further report to Safety Department;
: First Aid Cases will not applicable to this form;
: The accident report shall submit to Safety Department within 3 days
: Attached the photograph or sketch the location of accident / incident;

1.10 SUGGESTED CONTENTS OF EPRP

The Contractor should prepare the EPRP based on the guidelines provided in the above sections. The suggested structure of the EPRP is listed below:

1. Purpose
2. Applicable Scope
3. Preparation Basis
4. Emergency Response System
   - 4.1 Generals
   - 4.2 Emergency Response System
   - 4.3 Responsibilities
5. Major Safety Risks
6. Precautionary Measures
   - 6.1 Training and Exercise
   - 6.2 Hazard Source Monitor
   - 6.3 Alert Action
   - 6.4 Management Measures
7. Control Measures
   - 7.1 Response
   - 7.2 Response Procedures
   - 7.3 Emergency Response
   - 7.4 Emergency Completion and Restoration
8. Emergency Response Report and Settlement
9. Supporting Measures
   - 9.1 Communication
   - 9.2 Emergency Team
   - 9.3 Funding for Emergency
   - 9.4 Provisions and Resources
10. Records

Annex VI - Guide Traffic Management Plan

GUIDELINE TRAFFIC MANAGEMENT PLAN

1. Need for Plan

During the construction period of the project, considerable vehicular movement carrying large amounts of material and machinery is expected. This will definitely interrupt the local traffic and is therefore important to manage the traffic to avoid the nuisance to local residents in terms of noise, dust, congestion and inconvenience.

2. The plan

The objective of Traffic Management Plan (TMP) is to define the requirements that should be implemented to mitigate any potential negative risks to the environment, workers or the community resulting from construction traffic.

The TMP will advise and inform site Contractors and external suppliers of equipment and materials of access and entry points along with other key information such tipping areas and wash-out areas. It is intended to compliment and work alongside relevant EMP. The TMP will be classed as “live” and therefore be subjected to updates as required.

The Contractor, at the time of the execution of the project, will prepare a comprehensive TMP in coordination with local authorities, QICT, emergency services and local administrative department. QICT and SC will review and approve the Contractor’s TMP. The Contractor’s TMP shall include following mitigation measures during its preparation:

- Undertake a road conditions assessment prior to and following the peak construction period, to assess any damage to road infrastructure that can be attributed to Project development.
- Repair damage as appropriate or enter into a voluntary agreement with the relevant roads authority to reimburse the cost of any repairs required to the public road network as a result of the Project.
- Spoil dumpsites located close to project site to minimize journey distance and limit movements to site access roads.
- Construction of worker accommodation on site to reduce light vehicle movements relating to travel to/ from the site.
- Provision of bus/minibus services for personnel living in nearby settlements.
- Movements of construction workers will be planned to avoid the busiest roads and times of day when traffic is at its greatest.
- Schedule deliveries and road movements to avoid peak periods.
- Driver training for HGV drivers and refresher course every six months for project drivers.
- Run a safety campaign to improve the people’s knowledge of the traffic hazard on their roads, public information and other activities to address the issues.
- Run a pedestrian awareness programme.
- Temporary signage

The traffic management plan for the project corridor is provided below.

3. Other Recommendations

It is important to manage public access routes during construction because it can cause delay to local traffic and create a safety hazard both on and offsite. People working and living near the tower sites would be annoyed by the emissions, noise and visual intrusion of queuing vehicles. Some important factors involved in access routes and site traffic are as follows:

3.1. Public Access Routes

The use of public road for site access may be restricted in terms of:

- Vehicle size, width and type of load
- Time limits
- Parking
- Pedestrian conflicts

Contractor should have consultation with the local police or local authority to address these issues and to effectively manage them before the beginning of the construction.

3.2. Site Workers Traffic

Site personnel should not be permitted to park vehicles right on the road; this will lead to disruption in material deliveries. Designated parking areas with appropriate parking space will be needed for this purpose; any plain area near construction site can be used for this purpose.

3.3. Site Rules

- Access to and from the site must be only via the specified entrance.
- On leaving the site, vehicles must be directed to follow the directions given.
- Drivers must adhere to the site speed limits.
- All material deliveries to site must keep allocated time limits.
- No material or rubbish should be left in the loading-unloading area.
- Develop a map for alternate routes showing material delivery services.
- Assign designated personnel on site to receive deliveries and to direct the vehicles.
- Monitor vehicle movement to reduce the likelihood of queuing or causing congestion in and around the area.
- Project vehicles should have a unanimous badge or logo on windscreen displaying that they belong to the project.

4. Contractor’s Obligation

The traffic management plan of the Contractor should be safe enough and widening of any access roads and construction of the detours (as applicable and practical) must be completed prior to start of project construction activities so that heavy vehicular transportation for construction activities do not hinder the normal course of traffic lanes. Contractor must ensure

that road closures are carried out by a competent person. The Contractor obligation must include the display of traffic signs according to the need to divert the traffic volume and to guide the road users in advance. The traffic sign, traffic light should be placed from any diverting route or road marking.

The Contractor should consider the environmental and social impacts of the traffic during construction. It will be sole responsibility of the Contractor to implement a plan which produces minimum nuisance to the local people and to the environment. Safety of the people should be given due importance. It will be under Contractor obligation to notify the traffic management plan and its later changes to SC, QICT, emergency services and Traffic Police, and also publish weekly programme in the local newspaper.

Annex VII - Guide Resource Conservation & Pollution Prevention Plan

Guideline Resource Conservation & Pollution Prevention Plan

1. Introduction:

Sustainable development calls for the need to conserve resources, especially the non-renewable resources.

2. Objective of the plan:

The Resource Conservation Plan is intended to make an effort towards achieving sustainable development. The objective of the resource conservation plan is to:

- Minimize the use of natural resources; and
- Mitigate/ prevent pollution contaminating the natural resources.

3. Planning:

Careful estimations of quantities of material, fuel, water and energy required directly or indirectly shall be done to avoid excessive or unnecessary wastage of these materials. In addition to this, pollution prevention strategies shall also be devised to prevent contamination of resources.

- The estimations include the following:
    1. Estimation of construction material required for the project
    2. Estimation of fuel consumption for construction machinery, construction vehicles and generators etc.
    3. Estimations of the energy requirements during all the stages of the project
    4. Estimations of water consumption for construction activities and construction camp sites.
- Strategies shall be planned to reduce loads on the identified resources to be consumed;
- Best management practices shall be devised to control or reduce pollution resulting from the activities during different stages of the project; and
- An inspector shall be assigned responsibility to oversee the ongoing activities to check the compliance of the planned strategies.

4. Execution of the plan:

The planned strategies shall be implemented to conserve the natural resources including but not limited to the following:

Material

- Material supplied shall be in conformance with the estimated quantities and excess material shall be returned to the supplier;
- Material wastage shall be avoided by using best management practices;
- Waste produced during the project execution shall be disposed off safely to the designated disposal sites through approved contractors; and
- Reuse of the materials shall be appreciated.

Fuel/Energy

- Reduce trips and optimize routes to and from the construction site for all kinds of activities;
- Regular maintenance of equipment and vehicles to avoid leaks and sustain efficient fuel consumption;
- Switch off/plug off idle equipment and vehicles to avoid wastage of fuel;
- Minimize warm up time, unnecessary acceleration and deceleration of the construction equipment and vehicles;
- Avoid unnecessary burning of fuel for cooking in construction camps;
- Avoid unnecessary heating/cooling systems during extreme weathers;
- Construction shall start in early hours of the day to avoid heat in summers and utilization of day light; and
- Alternate energy sources shall be considered for electricity generations during construction and operation to conserve fossil fuel as it is non-renewable resource.

Water

- Avoid using potable water for sprinkling, curing and washing of equipment/vehicles. Surface water or treated effluent can be used instead;
- Wastage of water should be controlled through providing proper valves and through controlling pressure of the water;
- Unnecessary equipment washings should be avoided;
- Awareness amongst workers shall be raised to conserve water and immediately report for any leaks detected; and
- Ensure protection of canal water from contamination resulting from construction activities.

Pollution:

- Emissions shall be reduced/controlled as far as possible and direct discharges to air shall be avoided by strictly adhering to the mitigation measures outlined in ESIA report;
- Waste water shall not be discharged directly into the canal and must be managed as per the recommendations presented in ESIA; and
- Construction & demolition waste and municipal solid waste shall not be dumped/ burnt openly and shall be handled according to the preventative measure given in ESIA study.

5. Checking and Corrective Actions

The proponent shall bind the construction contractor through contract agreement to comply with the strategies outlined in the Resource Conservation Plan. The proponent shall also appoint an Inspector who shall monitor the daily onsite activities and shall report any issues/ concerns raised in relation to Resource Conservation Plan. The inspector shall recommend adequate corrective actions to mitigate the issues raised.

Annex VIII - Aquatic Geotechnical Investigation

Report on
Geotechnical Investigation
Alongside of QICT, Terminal 1 Berth No.5 to 7
DP world, Karachi

Project #	:	CES-16650
Client	:	QASIM INTERNATIONAL CONTAINER TERMINAL (QICT)
Date	:	Dec 26, 2016

Report on
Geotechnical Investigation
Alongside of QICT, Terminal 1 Berth No.5 to 7
DP world, Karachi

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2. GEOLOGY OF THE AREA 1

3. PROGRAM OF INVESTIGATIONS 2

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   3.2 Lab Testing 2

4. RESULTS OF INVESTIGATION 2

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   4.2 Laboratory Test Results 3
   4.3 Soil Parameters 5

EXHIBIT-1: THE PLATFORM SETUP AT BOREHOLE LOCATION

FIG-1: SUBSOIL PROFILE

BOREHOLE LOGS

SUMMARY OF LABORATORY TEST RESULTS

LABORATORY TEST RESULTS

Report on
Geotechnical Investigation
Alongside of QICT, Terminal 1 Berth No.5 to 7
DP World, Karachi

1. INTRODUCTION:

A program of Soil Investigation was undertaken to determine Subsoil conditions at Berth # 5, 6, & 7, Qasim International Container Terminal, DP World, Karachi.

Consolidated Engineering Services (Pvt.) Ltd. Karachi carried out the program of soil investigation.

The program of investigation included drilling of five boreholes in front of Existing Berths upto depth of 30.0m from Seabed level, at specified locations, collection of representative soil samples and conducting laboratory tests. The scope of work also included preparation of factual report giving results of Investigation.

The fieldwork was carried out from Nov9, 2016 to Dec 09, 2016. The soil samples collected during field investigations were tested in the laboratory, the results were compiled and analysis was made for the foundations design.

The soil stratigraphy is presented as shown in Borehole logs while laboratory test results are also included with the report.

This report presents the results of the investigations and recommendations for soil parameters for design of foundations.

2. Geology of the area:

The geological formations in Port Qasim and its adjoining areas belong to the Middle and upper Tertiaries Periods. The soil formations found in the area are fresh and slightly weathered, recent and sub recent shoreline deposits. These deposits are derived from Gaj/Manchhar formations of Lower Miocene to Middle Miocene/Upper Miocene to Pliocene age. Similar deposits are found all along the coastal belt of Karachi and adjoining areas.

The Gaj formation consists of mostly limestone with subordinate Shales and Sandstones. The limestone is hard, sandy and extremely fossiliferous. This formation overlies Nari formation, which consists of harder Limestone and Shales.

Conformably overlying Gaj formation is Manchhar formation. The type section of Manchhar formation is exposed west of Manchhar Lake (26^{o} 8' N and 67^{o} 34' E) near Sehwan Sherief in Dadu District. The formation is composed of Sandstone, Clay beds, cemented Sand and Gravel (Pseudo Conglomerate). Sandstone is thick, porous and grey in color. It is friable and also consists bands of Conglomerate. The Clay are of various colors e.g. grey, brown, chocolate and orange, however the most widely occurring Clays are of light brown (khaki) and dark grey in color. The Clay has shades of green and brown. Sandy layers are also found interbedded with Clay and Gravel. Conglomerates are mostly composed of sand, gravels and fragments of shells and highly calcareous.

3. PROGRAM OF INVESTIGATIONS:

3.1 Drilling of Boreholes:

Total five boreholes were drilled upto 30.0m depth from existing seabed level at under water locations. The Boreholes were drilled in front of existing berths by using projected platform. The platform was placed on top of berth projecting out (cantilever) about 3m from edge of berth. The drilling Rig was setup on the platform while cantilever of the platform was countered by placing concrete blocks on rear part of the platform. Exhibit-1 shows the platform setup at borehole location.

The location of the boreholes was marked by the Client.

The Elevation of each borehole, drilled underwater, was established by measuring the seabed level at each borehole location from top of existing berth and correlate with Elevation of top of berth and Port Qasim Chart Datum.

Rotary drilling method was used to advance the borehole to the required depth. Standard Penetration Tests (SPT) were conducted as per ASTM Designation D-1586 while Cone Penetration Test (CPT) were conducted in Gravelly strata as per BS-1377-7. Coring was adopted for drilling and sampling through hard cohesive Shale and Cemented/ Rock formation as per ASTM Designation D-2113. Representative samples of subsoil materials were preserved for further testing.

3.2 Lab Testing:

A program of laboratory tests was conducted and selected representative samples were tested to determine physical and engineering characteristics of various subsoil materials encountered at the site.

The tests were conducted in accordance with Standard Procedure as given in relevant ASTM/BS standards.

4. RESULTS OF INVESTIGATION:

4.1 Subsoil Stratigraphy

Five boreholes were drilled in front of existing Berths at specified locations. The subsoil materials as encountered at the site have been described in detail in Borehole Logs included in Annex-1 and subsoil profile is presented in Fig-1. The stratigraphy at site is summarized hereunder:

		BH#1	BH#2	BH#3	BH#4	BH#5
Seabed level, EL. m		-9.10	-10.50	-11.80	-11.50	-11.60
Layer #	Subsoil Description	Extent of layer, EL. m				
I	Slush (very soft to firm Silty CLAY)	-12.10	-12.0	-13.30	-14.5	-13.10
II	Very dense, Gravelly SAND/ Sandy GRAVELS/ Clayey GRAVELS	-24.10	-16.50	-16.30	-29.50	-16.10
III	Medium hard SHALE with embeded Gravels	-25.6	-21.0	-23.80	Not Encountered	-19.10
IV	Loosely cemented CONGLOMERATE with Clay matrix / SANDSTONE	-28.6	-28.5	-28.3	-31.0	-26.6
V	Medium hard Sandy SHALE interlayered SILTSTONE/ CLAYSTONE	-39.10 *	-40.50 *	-41.80 *	-41.50 *	-41.60 *

* Maximum Investigated depth.

4.2 Laboratory Test Results:

The Laboratory Test Results are presented in Annex-2 of this report. These results have been considered while preparing Borehole Logs and giving recommendations for soil parameters. Following is the summary of test results:

Grain Size Analysis

Grain size analysis was conducted on a total of 57 samples. Particles finer than # 200 sieve (75 microns) vary from 07 to 48% in cohesion less soil and 56 to 99 % in cohesive soils.

Plasticity Index

Plasticity index was determined on 44 samples of fine grained soils. The Liquid Limit varies from a value of 30 to 49% and Plasticity Index ranges between 8 to 28%, while one sample was found to be *Non Plastic*.

Unconfined Compression Tests

Unconfined Compressive Strength was determined on 26 Core sample. The Unconfined Compressive Strength values range between 2.56 kg/cm^{2}to 12.01 kg/cm^2 (251 kPa to 1177 kPa), while strain ranges from 2.6% to 8.0%

Direct Shear Tests

A total of 06 Direct Shear Tests were performed on remolded SPT samples. The results indicate that the angle of internal friction of SAND ranges between 31^o to 32^o.

Moisture Content

Moisture Content was determined on 26 Core Samples. Moisture Content varies from 8.3% to 22.9%.

Bulk Density

The value of Bulk Density for 26 Core Samples ranges between 2.027 gm/cc to 2.465 gm/cc (20.3 kN/m^{3}to 22.8 kN/m^3).

Chemical Tests

Chemical tests were performed on 15 Soil Samples to determine Chloride Content, Sulphate Content, pH value, TDS and Organic content.

The values of chemical properties of Soil samples tested in the laboratory are as under:

Sulphate Content %	Chloride Content %	TDS %	pH Value	Organic Matter %
0.106 to 0.243	0.107 to 0.236	0.54 to 1.61	7.5	1.17 to 3.45

4.3 Soil Parameters:

Based on investigated data and test results presented here above, subsoil parameters are evaluated as presented hereunder:

Layer	Subsoil	SPT N Value	γ_t kN/m^3	Cohesion C kPa	ϕ^o	Unconfined Compressive Strength 'qu' kPa
I	Slush (Silty CLAY)	2-5	19	25	-	-
II	SAND/ GRAVELS	Refusal	20	-	32	-
III	SHALE	Refusal	20	125	-	250-300
IV	CONGLOMERATE/ SANDSTONE	Refusal	22	-	32	
V	SHALE	-	20	200	-	300-500
	SILTSTONE/ CLAYSTONE	-	20	400		1009 & 1177

EXHIBIT-1

THE PLATFORM SETUP AT BOREHOLE LOCATION

EXHIBIT-1: PLATFORM SETUP AT BOREHOLE LOCATION

FIG-1: SUBSOIL PROFILE

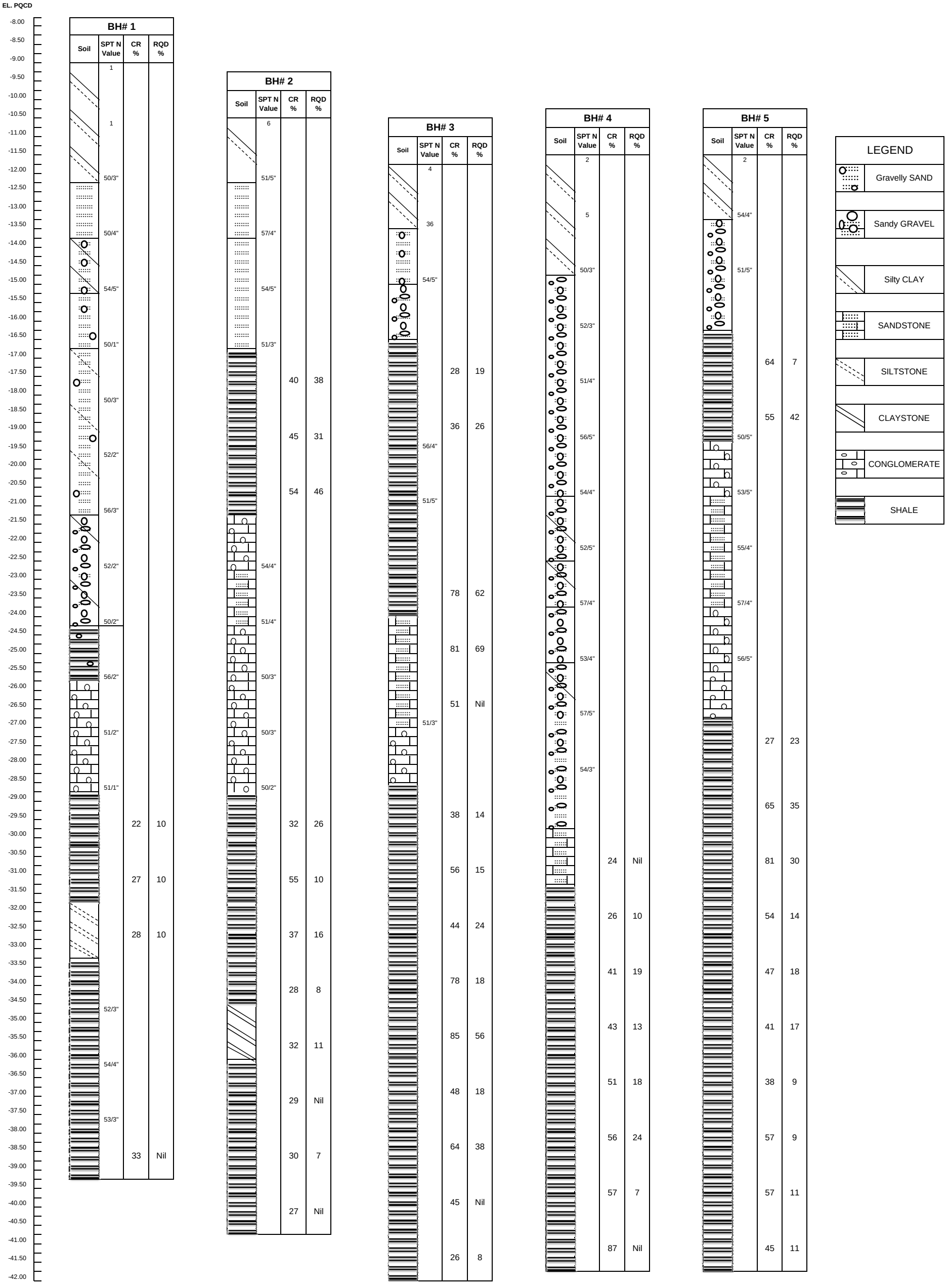


FIG-1: Subsoil Profile through BH-1 to BH-5

ANNEA-1

BOREHOLE LOGS

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP World, Karachi.		BOREHOLE# : 01	Sheet: 1 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		PROJECT # :	CES-16650
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel		Sea Bed Level: -9.1 m
BOREHOLE DIA : 100mm	Casing dia: 3"	DATE STARTED:	9/11/2016
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 23.0m	DATE COMPLETED:	12/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 687, between Bollards 28 - 29	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(9.10)			SPT-01						1			
			Greyish black, very soft, Silty CLAY (Slush)	0.0 m									
1.0													
				SPT-2						1			
				1.50m									
2.0													
3.0	-12.10			SPT-3						50/3"			Refusal
				3.0m									
			Greyish black, very denes, Silty SAND, with little Gravels.										
4.0													
	-13.60			SPT-4						50/4"			Refusal
				4.50m									
5.0			Yellowish brown, very hard, Gravelly Clayey SAND										
6.0	-15.10			SPT-5						54/5"			Refusal
				6..0m									
			Yellowish brown, very dense, Coarse SAND, some Gravels										
7.0													
	-16.60			CPT-1						50/1"			Refusal
				DS-1									
8.0			Yellowish brown, very dense, Coarse SAND,little Silt & Gravels	(7.50 - 9.0 m)									
9.0				CPT-2						50/3"			Refusal
				DS-2									
				(9.0 - 10.5 m)									
10.0													
				CPT-3						52/2"			Refusal
				DS-3									
11.0				(10.5 - 12.0 m)									
12.0	-21.10			CPT-4						56/3"			Refusal
				DS-4									
			Yellowish Brown, very dense, loosely cemented, Sandy GRAVELS, with Clay matrix	(12.0 - 13.5 m)									
13.0													
				CPT-5						52/2"			Refusal
				DS-5									
14.0				(13.5 - 15.0 m)									
15.0	-24.10												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 01	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-24.10			CPT-6						50/2"			
			Brown, very hard, Sandy SHALE, embeded Gravels	DS-6 (15.0 - 16.5 m)									
16.0													
	-25.60			CPT-7						56/2"			Refusal
				DS-7									
17.0			Brown, very dense, loosely cemented, CONGLOMERATE, with Clay matrix	(16.5 - 18.0 m)									
18.0				CPT-8						51/2"			Refusal
				DS-8 (18.0 - 19.5 m)									
19.0													
	-28.60			CPT-9						51/1"			Refusal
20.0			Brown, medium-hard, Sandy SHALE	CRS - 01 (19.5 - 21.0 m)							22	10	CW-1 S.L = 16 cm
21.0													
22.0				CRS - 02 (21.0 - 22.5 m)							27	10	CW-2 S.L = 16 cm
	-31.60												
23.0			Brown, hard, SILTSTONE	CRS - 03 (22.5 - 24.0 m)							28	10	CW-3 S.L = 16 cm
24.0	-33.10												
			Brown, medium-hard, SHALE	DS-10 (24.0 - 25.5 m)									
25.0				CPT-10						52/3"			Refusal
				DS -11 (25.5 - 27.0 m)									
26.0													
27.0				CPT-11						54/4"			Refusal
				DS-12 (27.0 - 28.5 m)									
28.0													
				CPT-12						53/3"			Refusal
29.0				CRS- 04 (28.5 - 30.0 m)							33	Nil	CW-4 S.L = 11cm
30.0	-39.10												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP World, Karachi.		BOREHOLE# : 02	Sheet: 1 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		PROJECT # :	CES-16650
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel		Sea Bed Level: -10.5m
BOREHOLE DIA : 100mm	Casing dia: 6" & 3"	DATE STARTED:	15/11/2016
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 20.0m, 21.0m	DATE COMPLETED:	18/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 549, between Bollards 23 - 24	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(10.50)		Greyish black, firm, Silty CLAY (Slush)	SPT-01 0.0 m						6			
1.0													
	-12.00			CPT-1						51/5"			Refusal
2.0			Brown, very dense, Sandy GRAVELS little Clay	DS-1 (1.50 - 3.0 m)									
3.0	-13.50			CPT-2						57/4"			Refusal
4.0			Brown, very dense, medium to Coarse SAND, trace to little Gravels	DS-2 (3.0 - 4.50 m)									
				CPT-3						54/5"			Refusal
5.0				DS-3 (4.50 - 6.0 m)									
6.0	-16.50			CPT-4/DS-4	(6.0 - 6.10m)					51/3"			Refusal
7.0			Brown, medium-hard, SHALE	CRS - 01 (6.10 - 7.50 m)							40	38	CW-1 S.L = 13cm
8.0				CRS - 02 (7.50 - 9.0 m)							45	31	CW-2 S.L = 20 cm
9.0													
10.0				CRS - 03 (9.0 - 10.5 m)							54	46	CW-3 S.L = 21 cm
	-21.00												
11.0			Yellowish Brown, loosely cemented CONGLOMERATE with Clay matrix	DS- 5 (10.5 - 12.0 m)									
12.0	-22.50			CPT-5						54/4"			Refusal
13.0			Yellowish Brown, , loosely cemented medium to coarse grained SANDSTONE, with little Gravels and Clay matrix	DS-6 (12.0 - 13.5 m)									
	-24.00			CPT-6						51/4"			Refusal
14.0			Yellowish Brown, loosely cemented CONGLOMERATE with Clay matrix	DS-7 (13.5 - 15.0 m)									
15.0	-25.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 02	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-25.50			CPT-7						50/3"			Refusal
			Brown, very dense, loosely cemented, CONGLOMERATE, with Clay matrix	DS-8 (15.0 - 16.5 m)									
16.0				CPT-8						50/3"			Refusal
				DS-9 (16.5 - 18.0 m)									
17.0													
18.0	-28.50			CPT-9						50/2"			Refusal
			Brown, medium-hard, SHALE										
				CRS - 04 (18.0 - 19.5 m)							32	26	CW-4 S.L = 13 cm
19.0													
20.0				CRS - 05 (19.5 - 21.0 m)							55	10	CW-5 S.L = 16 cm
21.0													
				CRS - 06 (21.0 - 22.5 m)							37	16	CW-6 S.L = 10 cm
22.0													
23.0				CRS - 07 (22.5 - 24.0 m)							28	8	CW-7 S.L = 14 cm
24.0													
			Brown, hard, CLAYSTONE	CRS - 08 (24.0 - 25.5m)							32	11	CW-8 S.L = 17cm
25.0													
26.0			Brown, medium-hard, SHALE	CRS - 09 (25.5 - 27.0m)							29	Nil	
27.0	-37.50												
			Reddish Brown, medium-hard, SHALE										
				CRS - 10 (27.0 - 28.5 m)							30	7	CW-9 S.L = 12cm
28.0													
29.0				CRS - 11 (28.5 - 30.0 m)							27	Nil	
30.0	-40.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		BOREHOLE# : 03	Sheet: 1 of 2
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel	PROJECT # :	CES-16650
BOREHOLE DIA : 100mm	Casing dia: 6" & 4"	DATE STARTED:	Sea Bed Level: -11.80m
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 19.5m, 21.0m	DATE COMPLETED:	6/12/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 412, between Bollards 17-18	9/12/2016

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(11.80)		Greyish black, very soft, Silty CLAY (Slush)	SPT-01 0.0 m						4			
1.0													
	-13.30			SPT-02						36			Refusal
2.0			Brown, dense, Gravelly coarse SAND,	1.50 m									
3.0	-14.80			SPT-03						54/5"			Refusal
			Brown, very dense, GRAVELS little Sand	DS-1 (3.0 - 4.50 m)									Shoe Sample CW-1
4.0													S.L = 13 cm
	-16.30												
5.0			Brown to Brownish Grey, medium hard, SHALE	CRS - 01 (4.50 - 6.0 m)							28	19	CW-2 S.L = 18 cm
6.0													
7.0				CRS -02 (6.0 - 7.50m)							36	26	CW-3 S.L = 13 cm
	-19.30			CPT-1						56/4"			Refusal
8.0			Brown, very hard, SHALE, embeded Gravels	DS-2 (7.50 - 9.0 m)									
9.0	-20.80			CPT-2						51/5"			Refusal
10.0			Yellowish Brown, medium-hard, SHALE, little Sand	DS-3 (9.0 - 10.50m)									
11.0				CRS -03 (10.5 - 12.0 m)							78	62	CW-4 S.L = 17 cm
12.0	-23.80												
13.0			Yellowish Brown, very dense, loosely cemented, medium to coarse grained SANDSTONE, with Clay matrix	CRS -04 (12.0 - 13.5 m)							81	69	CW-5 S.L = 17 cm
14.0				CRS -05 (13.5 - 15.0 m)							51	Nil	CW-6 S.L = 8 cm
15.0	-26.80												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 03	Sheet: 2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :	CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-26.80			CPT-3						51/3"			Refusal
			Brown, loosely cemented CONGLOMERATE with Clay matrix	DS-4 (15.0 - 16.5 m)									
16.0													
	-28.30												
17.0			Brown, medium hard, SHALE										
				CRS -06 (16.5 - 18.0 m)							38	14	CW-7 S.L = 22 cm
18.0													
				CRS - 07 (18.0 - 19.5 m)							56	15	CW-8 S.L = 17 cm
19.0													
20.0													
				CRS - 08 (19.5 - 21.0 m)							44	24	CW-9 S.L = 24 cm
21.0													
				CRS - 09 (21.0 - 22.5 m)							78	18	CW-10 S.L = 25 cm
22.0													
23.0													
				CRS - 10 (22.5 - 24.0 m)							85	56	CW-11 S.L = 13 cm
24.0	-35.80												
			Greyish Brown to Brown, medium hard, SHALE	CRS - 11 (24.0 - 25.5m)							48	18	CW-12 S.L = 19 cm
25.0													
	-37.30												
26.0			Dark Brown, medium hard, SHALE interlayered Siltstone										
				CRS - 12 (25.5 - 27.0m)							64	38	CW-13 S.L = 18 cm
27.0													
				CRS - 13 (27.0 - 28.5 m)							45	Nil	CW-14 S.L = 6 cm
28.0													
29.0													
				CRS - 14 (28.5 - 30.0 m)							26	8	CW-15 S.L = 13 cm
30.0	-41.80												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP World, Karachi.		BOREHOLE# : 04	Sheet: 1 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		PROJECT # :	CES-16650
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel		Sea Bed Level: -11.50m
BOREHOLE DIA : 100mm	Casing dia: 6" & 3"	DATE STARTED:	22/11/2016
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 21.0m, 23.0m	DATE COMPLETED:	25/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 275, between Bollards 12 - 13	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(11.50)		Greyish black, very soft to firm, Silty CLAY (Slush)	SPT-01 0.0 m						2			
1.0													
	-13.00			SPT-02						5			
2.0				1.50 m									
3.0	-14.50			CPT-1						50/3"			Refusal
			Brown, very dense, Sandy GRAVEL	DS-1 (3.0 - 4.50 m)									
4.0				CPT-2						52/3"			Refusal
				DS-2 (4.50 - 6.0 m)									
5.0													
6.0				CPT-3						51/4"			Refusal
				DS-3 (6.0 - 7.50m)									
7.0													
				CPT-4						56/5"			Refusal
8.0				DS-4 (7.50 - 9.0 m)									
9.0	-20.50			CPT-5						54/4"			Refusal
				DS-5 (9.0 - 10.50m)									
10.0			Brown, very dense, Clayey Gravelly Coarse SAND										
				CPT-6						52/5"			Refusal
11.0				DS-6 (10.5 - 12.0 m)									
12.0	-23.50			CPT-7						57/4"			Refusal
			Brown, very dense, GRAVELS with Coarse SAND	DS-7 (12.0 - 13.5 m)									
13.0													
	-25.00			CPT-8						53/4"			Refusal
14.0			Brown, very dense, Clayey Gravelly Coarse SAND	DS-8 (13.5 - 15.0 m)									
15.0	-26.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 04	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-26.50			CPT-9						57/5"			Refusal
			Brown, very dense, Gravelly coarse SAND, trace Clay	DS-9 (15.0 - 16.5 m)									
16.0													
				CPT-10						54/3"			Refusal
				DS-10 (16.5 - 18.0 m)									
17.0													
18.0	-29.50												
			Yellowish Brown, very dense, loosely cemented, medium to coarse grained SANDSTONE, with some Gravels and Clay matrix	CRS - 01 (18.0 - 19.5 m)							24	Nil	
	-31.00												
20.0			Brown, medium hard, SHALE	CRS - 02 (19.5 - 21.0 m)							26	10	CW-1 S.L = 16 cm
21.0													
22.0				CRS - 03 (21.0 - 22.5 m)							41	19	CW-2 S.L = 14 cm
23.0				CRS - 04 (22.5 - 24.0 m)							43	13	CW-3 S.L = 20 cm
24.0													
25.0				CRS - 05 (24.0 - 25.5m)							51	18	CW-4 S.L = 13cm
26.0				CRS - 06 (25.5 - 27.0m)							56	24	CW-5 S.L = 16cm
27.0													
28.0				CRS - 07 (27.0 - 28.5 m)							57	7	CW-6 S.L = 11cm
29.0				CRS - 08 (28.5 - 30.0 m)							87	Nil	CW-7 S.L = 6 cm
30.0	-41.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		BOREHOLE# : 05	Sheet: 1 of 2
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel	PROJECT # :	CES-16650
BOREHOLE DIA : 100mm	Casing dia: 6" & 4"		Sea Bed Level: -11.60m
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 19.5m, 21.5m	DATE STARTED:	29/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	DATE COMPLETED:	2/12/2016
		Location: Berthing Mark 687, between Bollards 28 - 29	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(11.60)		Greyish black, very soft, Silty CLAY (Slush)	SPT-01 0.0 m						2			
1.0													
	-13.10			CPT-01						54/4"			Refusal
2.0			Brown, very dense, Sandy GRAVELS	DS-1 (1.50 - 3.0 m)									
3.0				CPT-2						51/5"			Refusal
				DS-2 (3.0 - 4.50 m)									
4.0													
	-16.10												
5.0			Brown, medium hard, SHALE	CRS - 01 (4.50 - 6.0 m)							64	7	CW-1 S.L = 13 cm
6.0													
7.0				CRS -02 (6.0 - 7.50m)							55	42	CW-2 S.L = 15 cm
	-19.10			CPT-3						50/5"			Refusal
8.0			Yellowish Brown, very dense, loosely cemented, CONGLOMERATE with Clay matrix	DS-3 (7.50 - 9.0 m)									
9.0				CPT-4						53/5"			Refusal
10.0			Yellowish Brown, very dense, loosely cemented, coarse grained SANDSTONE, with Clay matrix	DS-4 (9.0 - 10.50m)									
				CPT-5						55/4"			Refusal
				DS-5 (10.5 - 12.0 m)									
11.0													
12.0				CPT-6						57/4"			Refusal
13.0			Yellowish Brown, very dense, loosely cemented, CONGLOMERATE with Clay matrix	DS-6 (12.0 - 13.5 m)									
				CPT-7						56/5"			Refusal
				DS-7 (13.5 - 15.0 m)									
14.0													
15.0	-26.60												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 05	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-26.60		Brown, medium hard, SHALE intermix Gravels at places	CRS -03 (15.0 - 16.5 m)							27	23	CW-3 S.L = 18 cm
16.0	-28.10												
17.0			Brown, medium hard, SHALE	CRS -04 (16.5 - 18.0 m)							65	35	CW-4 S.L = 18 cm
18.0				CRS - 05 (18.0 - 19.5 m)							81	30	CW-5 S.L = 18 cm
19.0													
20.0				CRS - 06 (19.5 - 21.0 m)							54	14	CW-6 S.L = 21 cm
21.0													
22.0				CRS - 07 (21.0 - 22.5 m)							47	18	CW-7 S.L = 13 cm
23.0				CRS - 08 (22.5 - 24.0 m)							41	17	CW-8 S.L = 13 cm
24.0													
25.0				CRS - 09 (24.0 - 25.5m)							38	9	CW-9 S.L = 14 cm
26.0				CRS - 10 (25.5 - 27.0m)							57	9	CW-10 S.L = 14 cm
27.0													
28.0				CRS - 11 (27.0 - 28.5 m)							57	11	CW-11 S.L = 16 cm
29.0				CRS - 12 (28.5 - 30.0 m)							45	11	CW-12 S.L = 16 cm
30.0	-41.60												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

ANNEX-2

SUMMARY OF LABORATORY TEST RESULTS

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

SUMMARY OF TEST RESULTS

Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation CD PQA	Passing #200	Atterberg Limit		Unconfined Compression			Bulk Density (gm/cc)	Moisture (%)	Dry Density (gm/cc)	Direct Shear		Specific Gravity	Chemical Test				
						LL	PI	qu (kg/ cm^2)	qu (kPa)	Strain (%)				c (Kg/cm^2)	ϕ (deg)		pH	Sulphate Content	Chloride Content	Total Disolve Salt	Organic Matter (%)
Barthing mark 687, Between 28-29, Bollards	BH-01	SPT-1	0.0	-9.1	94	37	10														
	BH-01	UDS-1	1.0	-10.1												2.572					
	BH-01	SPT-3	3.0	-12.1	37									0	32		7.5	0.243	0.193	1.29	3.45
	BH-01	SPT-4	4.5	-13.6	30											2.585					
	BH-01	DS-1	7.5	-16.6	28																
	BH-01	DS-4	12.0	-21.1	25	30	9														
	BH-01	DS-6	15.0	-24.1	79	30	8														
	BH-01	CRS-1	19.5	-28.6	90	41	14										7.5	0.194	0.236	1.08	-
	BH-01	CRS-2	21.0	-30.1	88	40	13	3.65	358	6.66	2.064	18.9	1.736								
	BH-01	CRS-3	22.5	-31.6	96	41	13	10.29	1009	5.4	2.218	10.8	2.001								
	BH-01	DS-10	24.0	-33.1	94	42	14														
	BH-01	DS-12	27.0	-36.1	86	37	12														
Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5	93	34	12									2.626	7.5	0.150	0.129	0.54	1.40
	BH-02	DS-1	1.5	-12.0	13																
	BH-02	DS-3	4.5	-15.0	7									0.0	32	2.668					
	BH-02	CRS-1	6.1	-16.6	85	49	21	2.75	269	5.28	2.027	18.1	1.716				7.5	0.172	0.150	0.65	1.18
	BH-02	CRS-2	7.5	-18.0				5.24	514	5.11	2.076	17.8	1.762								
	BH-02	CRS-3	9.0	-19.5	75	30	11	2.97	291	5.14	2.065	16.5	1.773								
	BH-02	DS-5	10.5	-21.0	20												7.5	0.106	0.107	0.65	
	BH-02	DS-7	13.5	-24.0	24																
	BH-02	CRS-4	18.0	-28.5	97	48	19														
	BH-02	CRS-5	19.5	-30.0				3.29	323	3.00	2.256	12.5	2.006								
	BH-02	CRS-7	22.5	-33.0	95	42	18	5.99	587	6.52	2.196	17.4	1.870								
	BH-02	CRS-8	24.0	-34.5				12.01	1177	8.00	2.151	10.4	1.949								
	BH-02	CRS-9	25.5	-36.0	93	39	14														
	BH-02	CRS-10	27.0	-37.5	97	39	15														
Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3		Non-Plastic								0.0	31		7.5	0.164	0.140	0.86	1.17
	BH-03	SPT-3	3.0	-14.8		48	20														
	BH-03	CRS-1	4.5	-16.3	87	49	23	2.56	251	5.49	2.465	8.3	2.275				7.5	0.150	0.161	0.97	2.35
	BH-03	DS-2	7.5	-19.3	48	34	16									2.657	7.5	0.142	0.130	0.86	1.99
	BH-03	DS-3	9.0	-20.8	82	36	14														
	BH-03	CRS-1	4.5	-16.3																	
	BH-03	CRS-3	10.5	-22.3	62	38	17	4.04	396	7.05	2.061	17.4	1.756								
	BH-03	CRS-4	12.0	-23.8				3.64	357	6.3	2.280	12.6	2.025								
	BH-03	CRS-6	16.5	-28.3	80	38	18	3.14	308	4.66	2.186	16.6	1.874								
	BH-03	CRS-7	18.0	-29.8	71	47	21	3.78	370	5.21	2.207	20.5	1.832								
	BH-03	CRS-8	19.5	-31.3				3.71	364	4.93	2.092	22.9	1.702								
	BH-03	CRS-9	21.0	-32.8	85	48	22	4.43	435	6.04	2.208	21.8	1.813								
	BH-03	CRS-10	22.5	-34.3	88	49	28														
	BH-03	CRS-11	24.0	-35.8				3.47	340	5.04	2.171	16.2	1.869								
	BH-03	CRS-12	25.5	-37.3	82	40	18	3.72	365	5.33	2.151	21.2	1.775								
	BH-03	CRS-13	27.0	-38.8	78	41	17														

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

SUMMARY OF TEST RESULTS

Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation CD PQA	Passing #200	Atterberg Limit		Unconfined Compression			Bulk Density (gm/cc)	Moisture (%)	Dry Density (gm/cc)	Direct Shear		Specific Gravity	Chemical Test				
						LL	PI	qu (kg/ cm^2)	qu (kPa)	Strain (%)				c (Kg/cm^2)	ϕ (deg)		pH	Sulphate Content	Chloride Content	Total Disolve Salt	Organic Matter (%)
Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5	89	33	12									2.659					
	BH-04	SPT-2	1.5	-13.0	94	36	13										7.5	0.195	0.140	1.40	2.11
	BH-04	DS-1	3.0	-14.5	10									0.0	32						
	BH-04	DS-5	9.0	-20.5	19												7.5	0.164	0.129	1.61	0.84
	BH-04	DS-6	10.5	-22.0	32									0.0	32	2.612					
	BH-04	DS-8	13.5	-25.0	35												7.5	0.177	0.107	0.97	-
	BH-04	DS-10	16.5	-28.0	7																
	BH-04	CRS-2	19.5	-31.0	92	32	10	3.54	347	6.66	2.243	9.9	2.041								
	BH-04	CRS-3	21.0	-32.5	87	35	13														
	BH-04	CRS-4	22.5	-34.0				4.79	469	6.66	2.165	22.1	1.773								
	BH-04	CRS-5	24.0	-35.5	92	49	19														
	BH-04	CRS-6	25.5	-37.0				4.34	425	6.66	2.17	18.8	1.826								
	BH-04	CRS-7	27.0	-38.5	99	34	11														
	BH-04	CRS-8	28.5	-40.0	89	36	13														
Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1		30	9							0.0	32		7.5	0.137	0.107	0.97	2.27
	BH-05	DS-2	3.0	-14.6																	
	BH-05	CRS-1	4.5	-16.1	72	46	15									2.624	7.5	0.208	0.150	1.18	2.26
	BH-05	DS-3	7.5	-19.1		30	10														
	BH-05	DS-6	12.0	-23.6		38	12										7.5	0.155	0.129	0.97	2.29
	BH-05	CRS-3	15.0	-26.6	56	49	18	3.07	301	5.75	2.070	16.2	1.782								
	BH-05	CRS-4	16.5	-28.1	70	45	13	5.78	566	6.66	2.160	14.0	1.895								
	BH-05	CRS-5	18.0	-29.6				3.96	388	6.76	2.103	14.4	1.838								
	BH-05	CRS-6	19.5	-31.1	75	44	13	5.00	491	5.5	2.113	15.1	1.836								
	BH-05	CRS-8	22.5	-34.1	85	48	24														
	BH-05	CRS-10	25.5	-37.1	76	44	17														
	BH-05	CRS-11	27.0	-38.6				4.15	407	4.73	2.237	13.6	1.969								
	BH-05	CRS-12	28.5	-40.1	75	42	12	3.57	350	2.6	2.200	15.3	1.908								

LABORATORY TEST RESULTS

L.R # 63/ 16

Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.

Client: Qasim International Container Terminal Port(QICT), DP WORLD

GRAIN SIZE ANALYSIS (PER CENT FINER BY WEIGHT)
SIEVE ANALYSIS

S.No.	Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation (m)	3"	1.5"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	0.05	0.01	0.002	0.001
						75 mm	38 mm	19 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	0.05 mm	0.010 mm	0.002 mm	0.001 mm
1	Barthing mark 687, Between 28-29, Bollards	BH-01	SPT-1	0.0	-9.1								100	98	96	94	72	61	54	24
2		BH-01	SPT-3	3.0	-12.1				100	93	89	85	82	80	65	37				
3		BH-01	SPT-4	4.5	-13.6			100	88	67	62	58	55	53	43	30				
4		BH-01	DS-1	7.5	-16.6				100	89	76	58	49	47	35	28				
5		BH-01	DS-4	12.0	-21.1		100	76	66	58	54	42	36	33	28	25				
6		BH-01	DS-6	15.0	-24.1					100	96	91	88	86	83	79	71	62	57	26
7		BH-01	CRS-1	19.5	-28.6					100	99	98	97	96	94	90	80	73	62	24
8		BH-01	CRS-2	21.0	-30.1						100	97	96	96	93	88	70	60	52	23
9		BH-01	CRS-3	22.5	-31.6									100	98	96	83	75	64	24
10		BH-01	DS-10	24.0	-33.1								100	99	97	94	82	74	63	23
11		BH-01	DS-12	27.0	-36.1						100	97	95	94	91	86	80	72	60	26
12	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5								100	98	96	93	85	76	65	29
13		BH-02	DS-1	1.5	-12.0			100	75	36	25	20	18	16	14	13				
14		BH-02	DS-3	4.5	-15.0			100	94	82	69	39	22	19	10	7				
15		BH-02	CRS-1	6.1	-16.6						100	95	92	91	87	85	76	67	58	25
16		BH-02	CRS-3	9.0	-19.5						100	91	86	84	79	75	70	62	57	26
17		BH-02	DS-5	10.5	-21.0		100	62	37	33	31	27	24	23	21	20				
18		BH-02	DS-7	13.5	-24.0		100	82	64	57	52	45	39	36	28	24				
19		BH-02	CRS-4	18.0	-28.5									100	98	97	76	68	55	24
20		BH-02	CRS-7	22.5	-33.0								100	98	96	95	88	77	68	29
21		BH-02	CRS-9	25.5	-36.0								100	97	95	93	82	73	62	28
22		BH-02	CRS-10	27.0	-37.5									100	98	97	85	76	69	29

L.R # 63/ 16

Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.

Client: Qasim International Container Terminal Port(QICT), DP WORLD

GRAIN SIZE ANALYSIS (PER CENT FINER BY WEIGHT)
SIEVE ANALYSIS

S.No.	Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation (m)	3"	1.5"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	0.05	0.01	0.002	0.001
						75 mm	38 mm	19 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	0.05 mm	0.010 mm	0.002 mm	0.001 mm
23	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3			100	71	44	19	11	8	3	1					
24		BH-03	SPT-3	3.0	-14.8	61	25	20	19	19	19	19	19	18	18					
25		BH-03	CRS-1	4.5	-16.3								100	98	97	87	76	65	30	
26		BH-03	DS-2	7.5	-19.3	100	86	76	75	73	67	63	61	55	51	48	42	38	20	
27		BH-03	DS-3	9.0	-20.8							100	99	97	96	82	74	63	29	
28		BH-03	CRS-3	10.5	-22.3				100	99	95	92	89	77	69	62	57	47	21	
29		BH-03	CRS-6	16.5	-28.3				100	95	92	91	90	88	86	80	73	60	26	
30		BH-03	CRS-7	18.0	-29.8								100	98	97	71	60	52	23	
31		BH-03	CRS-9	21.0	-32.8								100	98	97	85	74	63	28	
32		BH-03	CRS-10	22.5	-34.3							100	99	97	95	88	79	67	31	
33		BH-03	CRS-12	25.5	-37.3								100	99	98	82	74	61	28	
34		BH-03	CRS-13	27.0	-38.8				100	93	90	89	88	86	85	78	65	58	27	

L.R # 63/ 16

Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.

Client: Qasim International Container Terminal Port(QICT), DP WORLD

GRAIN SIZE ANALYSIS (PER CENT FINER BY WEIGHT)
SIEVE ANALYSIS

S.No.	Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation (m)	3"	1.5"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	0.05	0.01	0.002	0.001
						75 mm	38 mm	19 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	0.05 mm	0.010 mm	0.002 mm	0.001 mm
35	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5						100	96	94	93	91	89	81	72	61	28
36		BH-04	SPT-2	1.5	-13.0							100	98	97	95	94	85	74	63	27
37		BH-04	DS-1	3.0	-14.5		100	53	33	26	21	17	13	12	10	10				
38		BH-04	DS-5	9.0	-20.5		100	91	76	66	55	40	32	28	22	19				
39		BH-04	DS-6	10.5	-22.0			100	91	84	76	60	49	43	35	32				
40		BH-04	DS-8	13.5	-25.0			100	86	83	81	77	70	62	45	35				
41		BH-04	DS-10	16.5	-28.0		100	72	65	50	31	15	10	9	8	7				
42		BH-04	CRS-2	19.5	-31.0							100	99	98	95	92	82	71	60	26
43		BH-04	CRS-3	21.0	-32.5							100	96	95	93	87	76	63	57	25
44		BH-04	CRS-5	24.0	-35.5							100	99	98	94	92	72	61	55	24
45		BH-04	CRS-7	27.0	-38.5									100	99	99	86	74	64	27
46		BH-04	CRS-8	28.5	-40.0							100	98	97	93	89	83	73	61	26
47	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1		100	75	75	28	15	6	6	5	5					
48		BH-05	DS-2	3.0	-14.6		100	76	74	38	8	4	4	3	3					
49		BH-05	CRS-1	4.5	-16.1								100	99	98	72	61	51	23	
50		BH-05	DS-3	7.5	-19.1	100	85	71	69	64	54	50	46	40	36					
51		BH-05	DS-6	12.0	-23.6	100	85	71	68	58	42	36	33	28	26					
52		BH-05	CRS-3	15.0	-26.6		100	90	88	85	77	74	72	69	68	56	47	38	18	
53		BH-05	CRS-4	16.5	-28.1						100	95	94	86	82	70	61	52	22	
54		BH-05	CRS-6	19.5	-31.1							100	99	95	92	75	62	55	24	
55		BH-05	CRS-8	22.5	-34.1							100	99	95	94	85	77	64	28	
56		BH-05	CRS-10	25.5	-37.1								100	99	98	76	65	56	25	
57		BH-05	CRS-12	28.5	-40.1								100	96	95	75	62	53	23	

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

ATTERBERG LIMITS

S. No.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	Liquid Limit	Placticity Index
1	Barthing mark 687, Between 28-29, Bollards	BH-01	SPT-1	0.0	-9.1	37	10
2		BH-01	DS-4	12.0	-21.1	30	9
3		BH-01	DS-6	15.0	-24.1	30	8
4		BH-01	CRS-1	19.5	-28.6	41	14
5		BH-01	CRS-2	21.0	-30.1	40	13
6		BH-01	CRS-3	22.5	-31.6	41	13
7		BH-01	DS-10	24.0	-33.1	42	14
8		BH-01	DS-12	27.0	-36.1	37	12
9	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5	34	12
10		BH-02	CRS-1	6.1	-16.6	49	21
11		BH-02	CRS-3	9.0	-19.5	30	11
12		BH-02	CRS-4	18.0	-28.5	48	19
13		BH-02	CRS-7	22.5	-33.0	42	18
14		BH-02	CRS-9	25.5	-36.0	39	14
15		BH-02	CRS-10	27.0	-37.5	39	15

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

ATTERBERG LIMITS

S. No.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	Liquid Limit	Placticity Index
16	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3	Non-Plastic	Non-Plastic
17		BH-03	SPT-3	3.0	-14.8	48	20
18		BH-03	CRS-1	4.5	-16.3	49	23
19		BH-03	DS-2	7.5	-19.3	34	16
20		BH-03	DS-3	9.0	-20.8	36	14
21		BH-03	CRS-3	10.5	-22.3	38	17
22		BH-03	CRS-6	16.5	-28.3	38	18
23		BH-03	CRS-7	18.0	-29.8	47	21
24		BH-03	CRS-9	21.0	-32.8	48	22
25		BH-03	CRS-10	22.5	-34.3	49	28
26		BH-03	CRS-12	25.5	-37.3	40	18
27		BH-03	CRS-13	27.0	-38.8	41	17
28	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5	33	12
29		BH-04	SPT-2	1.5	-13.0	36	13
30		BH-04	CRS-2	19.5	-31.0	32	10
31		BH-04	CRS-3	21.0	-32.5	35	13
32		BH-04	CRS-5	24.0	-35.5	49	19
33		BH-04	CRS-7	27.0	-38.5	34	11
34		BH-04	CRS-8	28.5	-40.0	36	13

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

ATTERBERG LIMITS

S. No.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	Liquid Limit	Placticity Index
35	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1	30	9
36		BH-05	CRS-1	4.5	-16.1	46	15
37		BH-05	DS-3	7.5	-19.1	30	10
38		BH-05	DS-6	12.0	-23.6	38	12
39		BH-05	CRS-3	15.0	-26.6	49	18
40		BH-05	CRS-4	16.5	-28.1	45	13
41		BH-05	CRS-6	19.5	-31.1	44	13
42		BH-05	CRS-8	22.5	-34.1	48	24
43		BH-05	CRS-10	25.5	-37.1	44	17
44		BH-05	CRS-12	28.5	-40.1	42	12

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

UNCONFINED COMPRESSION TEST

S. NO.		BORING NO.	SAMPLE	Depth BelowSeabed(m)	Elevation (m)	Unconfined Compression			Bulk Density (gm/cc)	Moisture (%)	Dry Density (gm/cc)
						qu (kg/ cm^2)	qu (kPa)	STRAIN (%)			
1	Barthing mark 687, Between 28-	BH-01	CRS-2	21.0	-30.1	3.65	358	6.66	2.064	18.9	1.736
2		BH-01	CRS-3	22.5	-31.6	10.29	1009	5.4	2.218	10.8	2.001
3	Barthing mark 549, Between 23-24, Bollards	BH-02	CRS-1	6.1	-16.6	2.75	269	5.28	2.027	18.1	1.716
4		BH-02	CRS-2	7.5	-18.0	5.24	514	5.11	2.076	17.8	1.762
5		BH-02	CRS-3	9.0	-19.5	2.97	291	5.14	2.065	16.5	1.773
6		BH-02	CRS-5	19.5	-30.0	3.29	323	3.00	2.256	12.5	2.006
7		BH-02	CRS-7	22.5	-33.0	5.99	587	6.52	2.196	17.4	1.870
8		BH-02	CRS-8	24.0	-34.5	12.01	1177	8.00	2.151	10.4	1.949
9	Barthing mark 412, Bollards Between 17-18,	BH-03	CRS-1	4.5	-16.3	2.56	251	5.49	2.465	8.3	2.275
10		BH-03	CRS-3	10.5	-22.3	4.04	396	7.05	2.061	17.4	1.756
11		BH-03	CRS-4	12.0	-23.8	3.64	357	6.3	2.280	12.6	2.025
12		BH-03	CRS-6	16.5	-28.3	3.14	308	4.66	2.186	16.6	1.874
13		BH-03	CRS-7	18.0	-29.8	3.78	370	5.21	2.207	20.5	1.832
14		BH-03	CRS-8	19.5	-31.3	3.71	364	4.93	2.092	22.9	1.702
15		BH-03	CRS-9	21.0	-32.8	4.43	435	6.04	2.208	21.8	1.813
16		BH-03	CRS-11	24.0	-35.8	3.47	340	5.04	2.171	16.2	1.869
17		BH-03	CRS-12	25.5	-37.3	3.72	365	5.33	2.151	21.2	1.775
18	Barthing mark 275, Between 12-13, Bollards	BH-04	CRS-2	19.5	-31.0	3.54	347	6.66	2.243	9.9	2.041
19		BH-04	CRS-4	22.5	-34.0	4.79	469	6.66	2.165	22.1	1.773
20		BH-04	CRS-6	25.5	-37.0	4.34	425	6.66	2.17	18.8	1.826
21	Barthing mark 137, Between 6 - 7, Bollards	BH-05	CRS-3	15.0	-26.6	3.07	301	5.75	2.070	16.2	1.782
22		BH-05	CRS-4	16.5	-28.1	5.78	566	6.66	2.160	14.0	1.895
23		BH-05	CRS-5	18.0	-29.6	3.96	388	6.76	2.103	14.4	1.838
24		BH-05	CRS-6	19.5	-31.1	5.00	491	5.5	2.113	15.1	1.836
25		BH-05	CRS-11	27.0	-38.6	4.15	407	4.73	2.237	13.6	1.969
26		BH-05	CRS-12	28.5	-40.1	3.57	350	2.6	2.200	15.3	1.908

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--1 **SAMPLE :** CRS-2 **DEPTH (m):** 21.0 - 22.5

Diameter (cm)	5.41	Area A_0 (cm^2)	22.990	Ht,L_0 (cm)	10.510	LRC kg/div	4.3
Volume (cm^3)	241.63	Correction Factor of Height	1.00				
weight	498.8		Moisture	18.9			
Bulk Density	2.064	Dry Density	1.736				

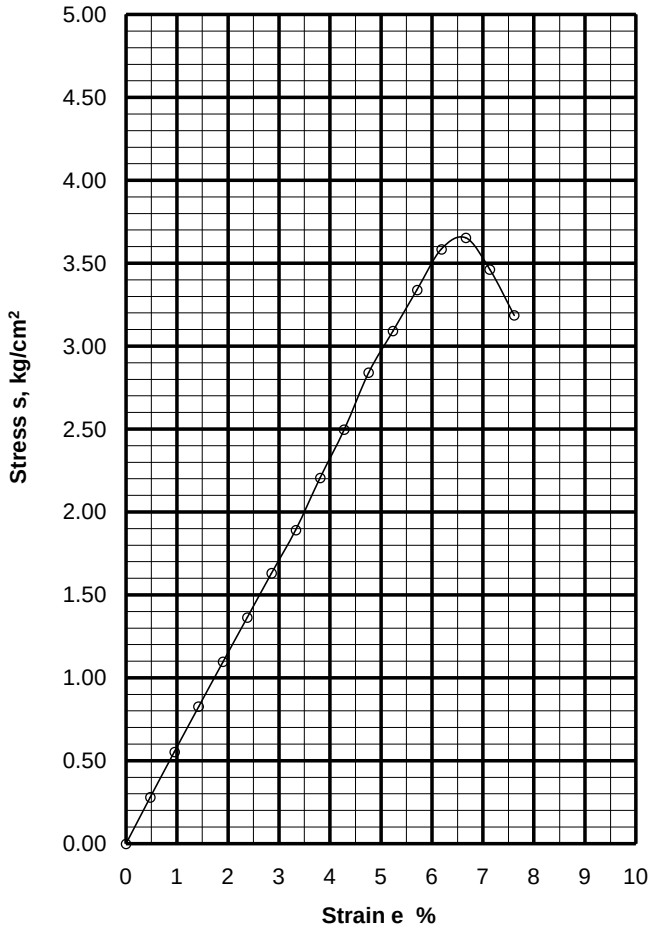
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	22.99	0	0	0
50	1.5	0.05	0.48	0.9952	23.10	6.45	0.279	0.28
100	3	0.1	0.95	0.9905	23.21	12.9	0.556	0.55
150	4.5	0.15	1.43	0.9857	23.32	19.35	0.830	0.83
200	6	0.2	1.90	0.9810	23.44	25.8	1.101	1.10
250	7.5	0.25	2.38	0.9762	23.55	32.25	1.369	1.36
300	9	0.3	2.85	0.9715	23.67	38.7	1.635	1.63
350	10.5	0.35	3.33	0.9667	23.78	45.15	1.898	1.89
400	12.3	0.4	3.81	0.9619	23.90	52.89	2.213	2.21
450	14	0.45	4.28	0.9572	24.02	60.2	2.506	2.50
500	16	0.5	4.76	0.9524	24.14	68.8	2.850	2.84
550	17.5	0.55	5.23	0.9477	24.26	75.25	3.102	3.09
600	19	0.6	5.71	0.9429	24.38	81.7	3.351	3.34
650	20.5	0.65	6.18	0.9382	24.51	88.15	3.597	3.58
700	21	0.7	6.66	0.9334	24.63	90.3	3.666	3.65
750	20	0.75	7.14	0.9286	24.76	86	3.474	3.46
800	18.5	0.8	7.61	0.9239	24.88	79.55	3.197	3.19

RESULT	
Stress	3.65
Strain	6.66

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim) L.R # 63/ 16
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--1

SAMPLE : CRS-2

DEPTH(m): 21.0 - 22.5

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--1 **SAMPLE :** CRS-3 **DEPTH (m):** 22.5 - 24.0

Diameter (cm)	5.71	Area A_0 (cm^2)	25.611	Ht,L_0 (cm)	11.110	LRC kg/div	4.3
Volume (cm^3)	284.53	Correction Factor of Height	1.00				
weight	631		Moisture	10.84			
Bulk Density	2.218	Dry Density	2.001				

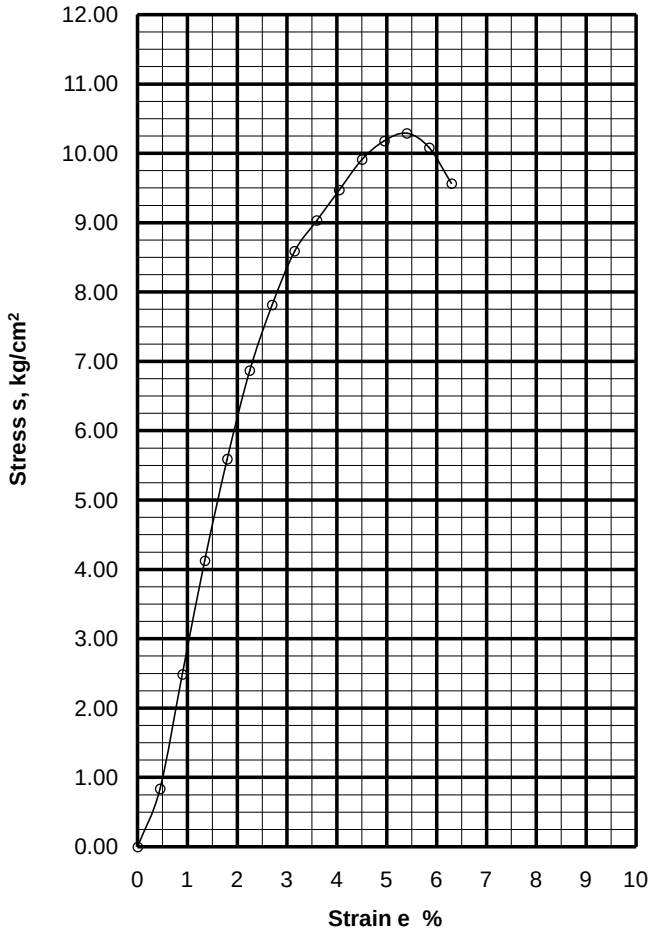
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	25.61	0	0	0
50	5	0.05	0.45	0.9955	25.73	21.5	0.836	0.833
100	15	0.1	0.90	0.9910	25.84	64.5	2.496	2.487
150	25	0.15	1.35	0.9865	25.96	107.5	4.141	4.127
200	34	0.2	1.80	0.9820	26.08	146.2	5.606	5.587
250	42	0.25	2.25	0.9775	26.20	180.6	6.893	6.870
300	48	0.3	2.70	0.9730	26.32	206.4	7.842	7.815
350	53	0.35	3.15	0.9685	26.44	227.9	8.618	8.590
400	56	0.4	3.60	0.9640	26.57	240.8	9.064	9.034
450	59	0.45	4.05	0.9595	26.69	253.7	9.505	9.473
500	62	0.5	4.50	0.9550	26.82	266.6	9.941	9.908
550	64	0.55	4.95	0.9505	26.94	275.2	10.214	10.180
600	65	0.6	5.40	0.9460	27.07	279.5	10.324	10.290
650	64	0.65	5.85	0.9415	27.20	275.2	10.117	10.083
700	61	0.7	6.30	0.9370	27.33	262.3	9.597	9.565

RESULT	
Stress	10.290
Strain	5.40

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--1

SAMPLE : CRS-3

DEPTH(m): 22.5 - 24.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-1 **DEPTH (m):** 6.10 - 7.50

Diameter (cm)	6.01	Area A_0 (cm^2)	28.372	Ht,L_0 (cm)	10.410	LRC kg/div	4.3
Volume (cm^3)	295.36	Correction Factor of Height	1.02				
weight	598.7		Moisture	18.11			
Bulk Density	2.027	Dry Density	1.716				

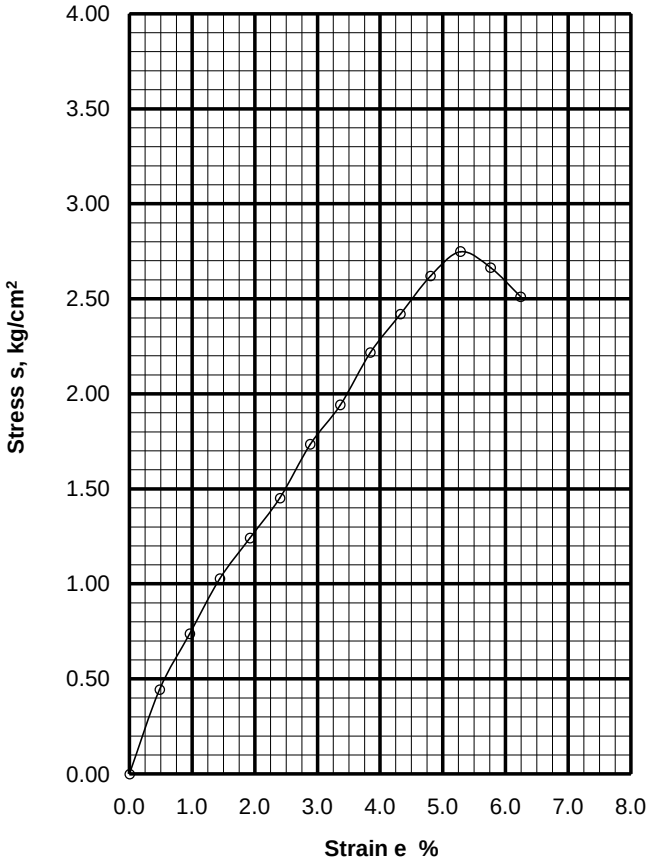
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	28.37	0	0	0
50	3	0.05	0.48	0.9952	28.51	12.9	0.452	0.444
100	5	0.1	0.96	0.9904	28.65	21.5	0.751	0.737
150	7	0.15	1.44	0.9856	28.79	30.1	1.046	1.027
200	8.5	0.2	1.92	0.9808	28.93	36.55	1.263	1.240
250	10	0.25	2.40	0.9760	29.07	43	1.479	1.452
300	12	0.3	2.88	0.9712	29.21	51.6	1.766	1.734
350	13.5	0.35	3.36	0.9664	29.36	58.05	1.977	1.941
400	15.5	0.4	3.84	0.9616	29.51	66.65	2.259	2.218
450	17	0.45	4.32	0.9568	29.65	73.1	2.465	2.420
500	18.5	0.5	4.80	0.9520	29.80	79.55	2.669	2.620
550	19.5	0.55	5.28	0.9472	29.95	83.85	2.799	2.748
600	19	0.6	5.76	0.9424	30.11	81.7	2.714	2.664
650	18	0.65	6.24	0.9376	30.26	77.4	2.558	2.511

RESULT	
Stress	2.748
Strain	5.28

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-1

DEPTH(m): 6.10 - 7.50

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-2 **DEPTH (m):** 7.5 - 9.0

Diameter (cm)	4.73	Area A_0 (cm^2)	17.574	Ht,L_0 (cm)	9.780	LRC kg/div	4.3
Volume (cm^3)	171.87	Correction Factor of Height	1.00				
weight	356.8		Moisture	17.8			
Bulk Density	2.076	Dry Density	1.762				

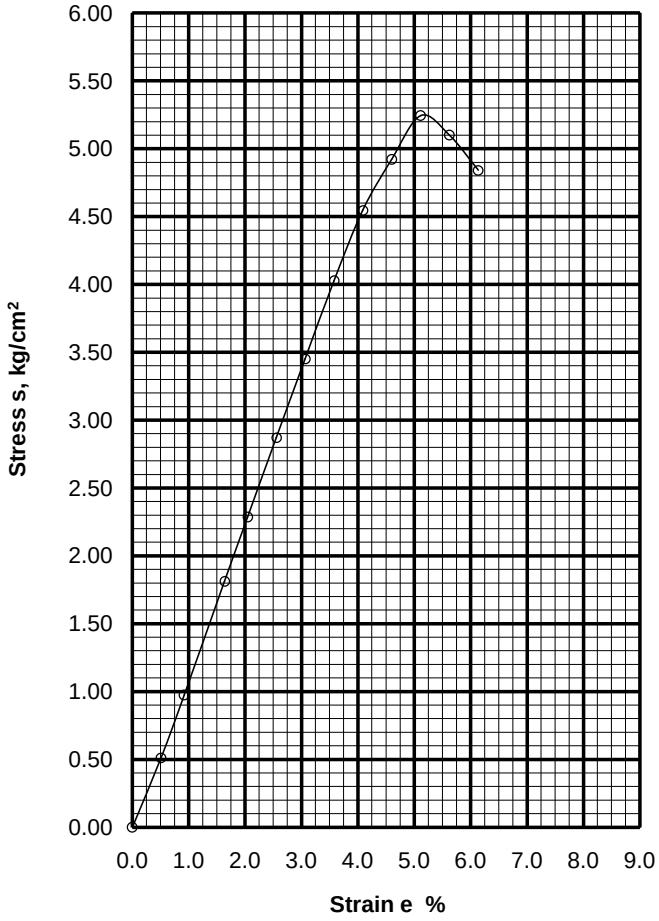
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	17.57	0	0	0
50	2.1	0.05	0.51	0.9949	17.66	9.03	0.511	0.513
90	4	0.09	0.92	0.9908	17.74	17.2	0.970	0.974
150	7.5	0.16	1.64	0.9836	17.87	32.25	1.805	1.812
200	9.5	0.2	2.04	0.9796	17.94	40.85	2.277	2.286
250	12	0.25	2.56	0.9744	18.03	51.6	2.861	2.872
300	14.5	0.3	3.07	0.9693	18.13	62.35	3.439	3.453
350	17	0.35	3.58	0.9642	18.23	73.1	4.011	4.027
400	19.3	0.4	4.09	0.9591	18.32	82.99	4.529	4.547
450	21	0.45	4.60	0.9540	18.42	90.3	4.902	4.921
500	22.5	0.5	5.11	0.9489	18.52	96.75	5.224	5.244
550	22	0.55	5.62	0.9438	18.62	94.6	5.080	5.100
600	21	0.6	6.13	0.9387	18.72	90.3	4.823	4.842

RESULT	
Stress	5.244
Strain	5.11

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-2

DEPTH(m): 7.5 - 9.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-3 **DEPTH (m):** 9.0 - 10.5

Diameter (cm)	4.71	Area A_0 (cm^2)	17.426	Ht,L_0 (cm)	10.710	LRC kg/div	4.3
Volume (cm^3)	186.63	Correction Factor of Height	0.99				
weight	385.3		Moisture	16.48			
Bulk Density	2.065	Dry Density	1.772				

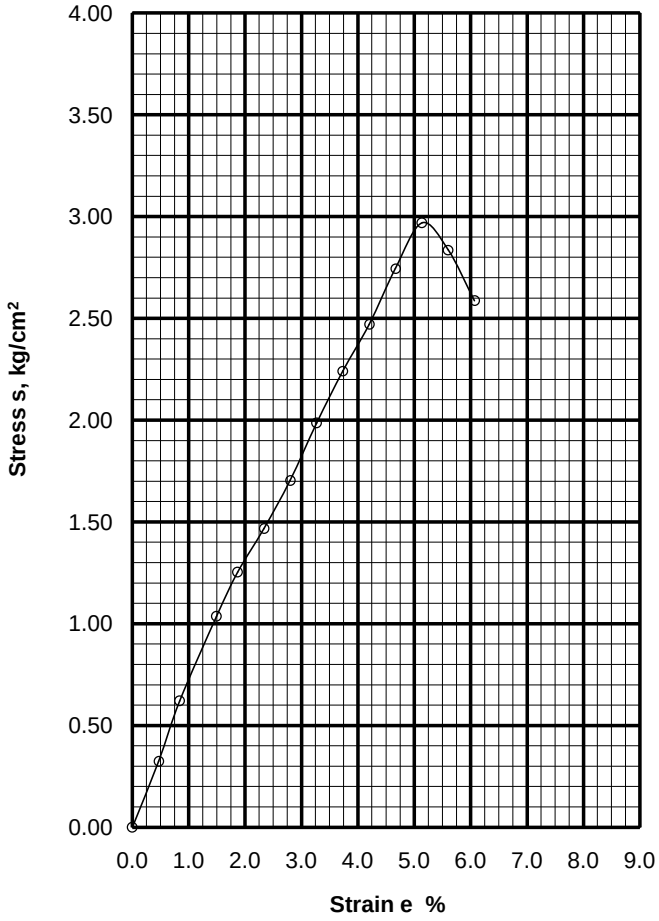
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	17.43	0	0	0
50	1.3	0.05	0.47	0.9953	17.51	5.59	0.319	0.324
90	2.5	0.09	0.84	0.9916	17.57	10.75	0.612	0.621
150	4.2	0.16	1.49	0.9851	17.69	18.06	1.021	1.036
200	5.1	0.2	1.87	0.9813	17.76	21.93	1.235	1.253
250	6	0.25	2.33	0.9767	17.84	25.8	1.446	1.467
300	7	0.3	2.80	0.9720	17.93	30.1	1.679	1.704
350	8.2	0.35	3.27	0.9673	18.01	35.26	1.957	1.986
400	9.3	0.4	3.73	0.9627	18.10	39.99	2.209	2.242
450	10.3	0.45	4.20	0.9580	18.19	44.29	2.435	2.471
500	11.5	0.5	4.67	0.9533	18.28	49.45	2.705	2.745
550	12.5	0.55	5.14	0.9486	18.37	53.75	2.926	2.969
600	12	0.6	5.60	0.9440	18.46	51.6	2.795	2.836
650	11	0.65	6.07	0.9393	18.55	47.3	2.550	2.587

RESULT	
Stress	2.969
Strain	5.14

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-3

DEPTH(m): 9.0 - 10.5

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-5 **DEPTH (m):** 19.50 - 21.0

Diameter (cm)	5.52	Area A_0 (cm^2)	23.934	Ht,L_0 (cm)	10.000	LRC kg/div	4.3
Volume (cm^3)	239.34	Correction Factor of Height	1.01				
weight	539.9		Moisture	12.48			
Bulk Density	2.256	Dry Density	2.005				

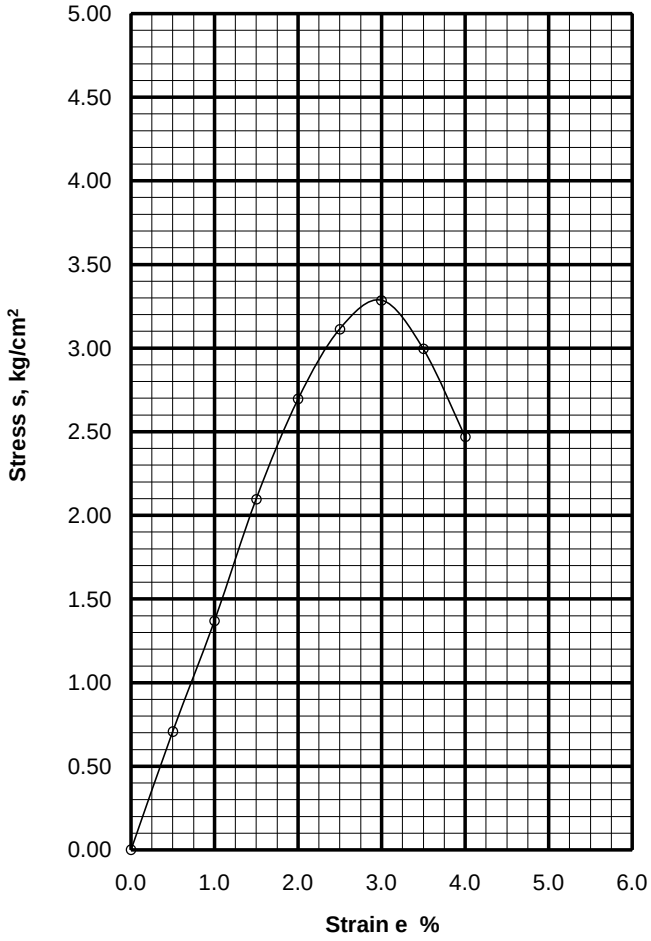
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	23.93	0	0	0
50	4.0	0.05	0.50	0.9950	24.05	17.2	0.715	0.71
100	7.8	0.1	1.00	0.9900	24.18	33.54	1.387	1.37
150	12.0	0.15	1.50	0.9850	24.30	51.6	2.124	2.10
200	15.5	0.2	2.00	0.9800	24.42	66.65	2.729	2.70
250	18.0	0.25	2.50	0.9750	24.55	77.4	3.153	3.11
300	19.1	0.3	3.00	0.9700	24.67	82.087	3.327	3.29
350	17.5	0.35	3.50	0.9650	24.80	75.25	3.034	3.00
400	14.5	0.4	4.00	0.9600	24.93	62.35	2.501	2.47

RESULT	
Stress	3.29
Strain	3.00

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-5

DEPTH(m): 19.50 - 21.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-7 **DEPTH (m):** 22.5 - 24.0

Diameter (cm)	5.91	Area A_0 (cm^2)	27.436	Ht,L_0 (cm)	11.510	LRC kg/div	4.3
Volume (cm^3)	315.79	Correction Factor of Height	1.00				
weight	693.4		Moisture	17.42			
Bulk Density	2.196	Dry Density	1.870				

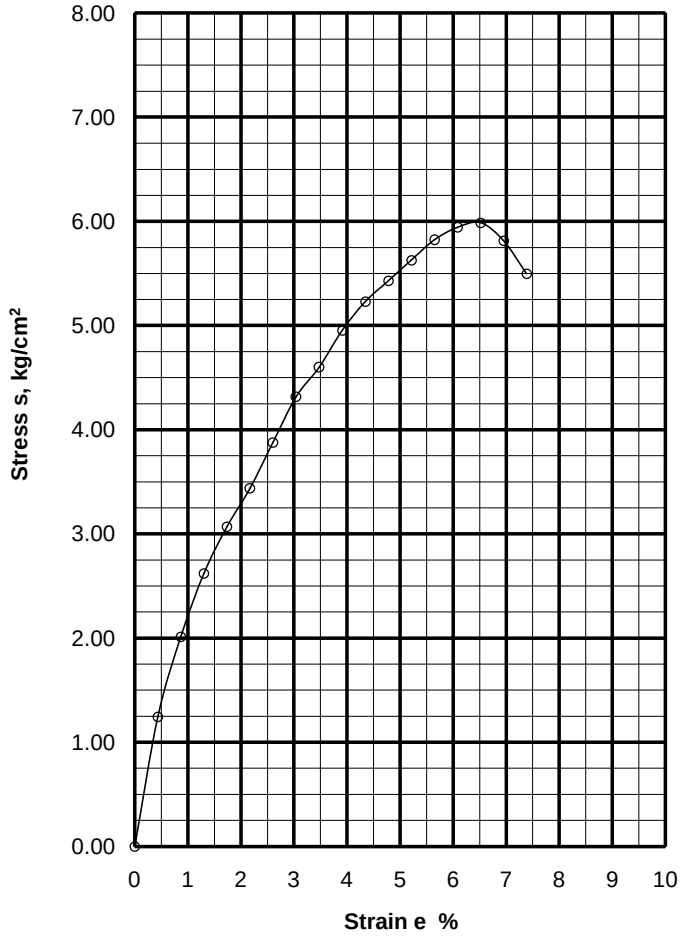
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.44	0	0	0
50	8	0.05	0.43	0.9957	27.56	34.4	1.248	1.244
100	13	0.1	0.87	0.9913	27.68	55.9	2.020	2.013
150	17	0.15	1.30	0.9870	27.80	73.1	2.630	2.621
200	20	0.2	1.74	0.9826	27.92	86	3.080	3.070
250	22.5	0.25	2.17	0.9783	28.05	96.75	3.450	3.439
300	25.5	0.3	2.61	0.9739	28.17	109.65	3.892	3.880
350	28.5	0.35	3.04	0.9696	28.30	122.55	4.331	4.317
400	30.5	0.4	3.48	0.9652	28.42	131.15	4.614	4.599
450	33	0.45	3.91	0.9609	28.55	141.9	4.970	4.954
500	35	0.5	4.34	0.9566	28.68	150.5	5.247	5.230
550	36.5	0.55	4.78	0.9522	28.81	156.95	5.447	5.430
600	38	0.6	5.21	0.9479	28.94	163.4	5.645	5.627
650	39.5	0.65	5.65	0.9435	29.08	169.85	5.841	5.822
700	40.5	0.7	6.08	0.9392	29.21	174.15	5.961	5.942
750	41	0.75	6.52	0.9348	29.35	176.3	6.007	5.988
800	40	0.8	6.95	0.9305	29.49	172	5.833	5.815
850	38	0.85	7.38	0.9262	29.6	163.4	5.516	5.498

RESULT	
Stress	5.988

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-7

DEPTH(m): 22.5 - 24.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-8 **DEPTH (m):** 24.0 - 25.50

Diameter (cm)	5.94	Area A_0 (cm^2)	27.715	Ht,L_0 (cm)	10.000	LRC kg/div	4.3
Volume (cm^3)	277.15	Correction Factor of Height	1.02				
weight	596.1		Moisture	10.39			
Bulk Density	2.151	Dry Density	1.948				

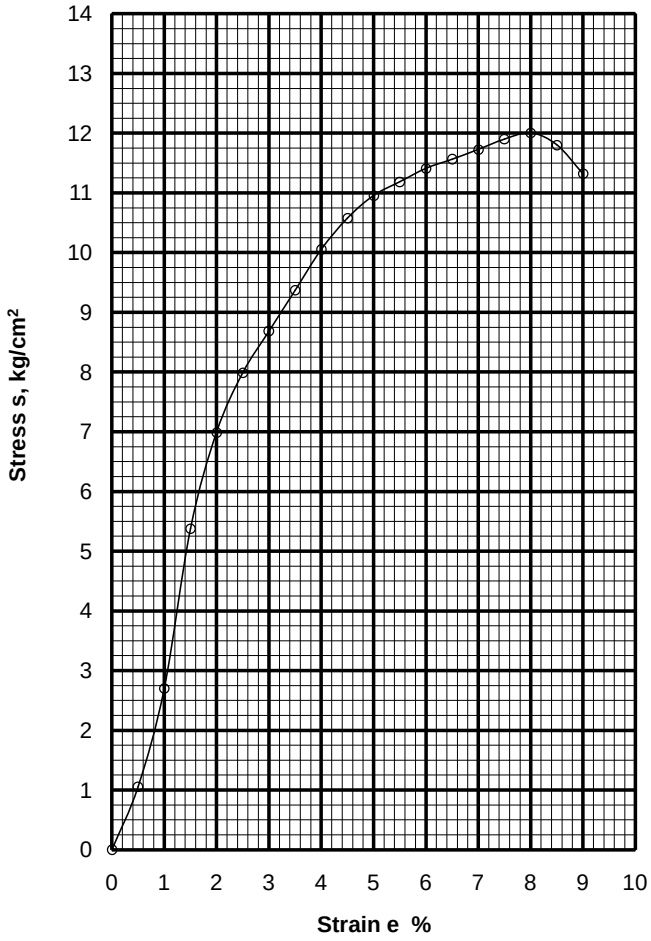
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.72	0	0	0
50	7	0.05	0.50	0.9950	27.85	30.1	1.081	1.057
100	18	0.1	1.00	0.9900	28.00	77.4	2.765	2.704
150	36	0.15	1.50	0.9850	28.14	154.8	5.502	5.380
200	47	0.2	2.00	0.9800	28.28	202.1	7.146	6.989
250	54	0.25	2.50	0.9750	28.43	232.2	8.169	7.988
300	59	0.3	3.00	0.9700	28.57	253.7	8.879	8.683
350	64	0.35	3.50	0.9650	28.72	275.2	9.582	9.371
400	69	0.4	4.00	0.9600	28.87	296.7	10.277	10.050
450	73	0.45	4.50	0.9550	29.02	313.9	10.816	10.578
500	76	0.5	5.00	0.9500	29.17	326.8	11.202	10.955
550	78	0.55	5.50	0.9450	29.33	335.4	11.436	11.184
600	80	0.6	6.00	0.9400	29.48	344	11.667	11.410
650	81.5	0.65	6.50	0.9350	29.64	350.45	11.823	11.562
700	83.1	0.7	7.00	0.9300	29.80	357.33	11.990	11.726
750	84.8	0.75	7.50	0.9250	29.96	364.64	12.170	11.901
800	86	0.8	8.00	0.9200	30.13	369.8	12.275	12.005
850	85	0.85	8.5	0.915	30.3	365.5	12.067	11.801
900	82	0.9	9.00	0.9100	30.46	352.6	11.577	11.322

RESULT	
Stress	12.005
Strain	8.00

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-8

DEPTH(m): 24.0 - 25.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-1 **DEPTH (m):** 4.50 - 6.0

Diameter (cm)	5.61	Area A_0 (cm^2)	24.721	Ht,L_0 (cm)	9.110	LRC kg/div	4.3
Volume (cm^3)	225.21	Correction Factor	1.03				
weight	555.2	of Height	Moisture	8.33			
Bulk Density	2.465	Dry Density	2.276				

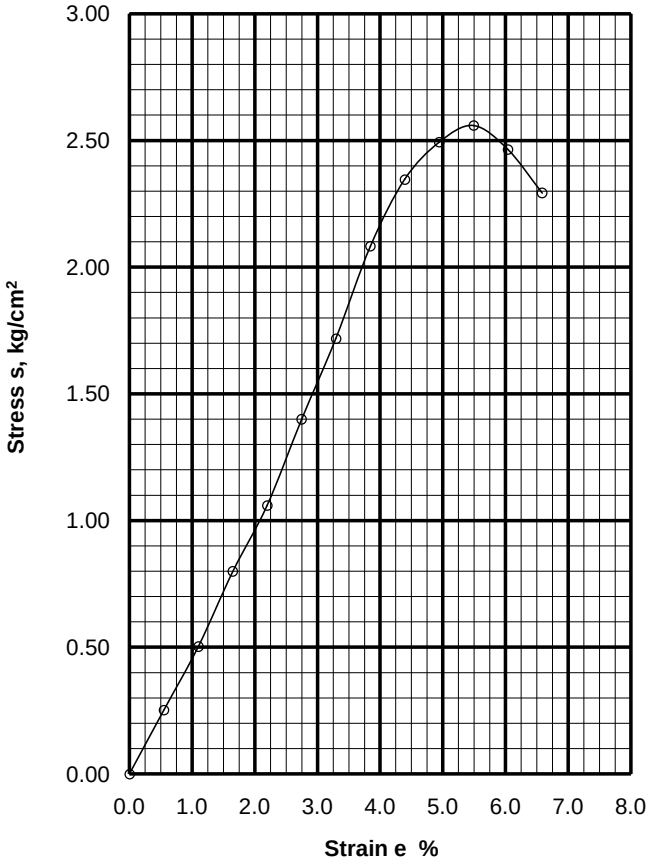
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	24.72	0	0	0
50	1.5	0.05	0.55	0.9945	24.86	6.45	0.259	0.252
100	3	0.1	1.10	0.9890	25.00	12.9	0.516	0.502
150	4.8	0.15	1.65	0.9835	25.14	20.64	0.821	0.799
200	6.4	0.2	2.20	0.9780	25.28	27.52	1.089	1.059
250	8.5	0.25	2.74	0.9726	25.42	36.55	1.438	1.399
300	10.5	0.3	3.29	0.9671	25.56	45.15	1.766	1.718
350	12.8	0.35	3.84	0.9616	25.71	55.04	2.141	2.083
400	14.5	0.4	4.39	0.9561	25.86	62.35	2.411	2.346
450	15.5	0.45	4.94	0.9506	26.01	66.65	2.563	2.494
500	16	0.5	5.49	0.9451	26.16	68.8	2.630	2.559
550	15.5	0.55	6.04	0.9396	26.31	66.65	2.533	2.465
600	14.5	0.6	6.59	0.9341	26.46	62.35	2.356	2.292

RESULT	
Stress	2.559
Strain	5.49

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-1

DEPTH(m): 4.50 - 6.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-3 **DEPTH (m):** 10.50 - 12.0

Diameter (cm)	4.41	Area A_0 (cm^2)	15.276	Ht,L_0 (cm)	8.510	LRC kg/div	4.3
Volume (cm^3)	130.00	Correction Factor of Height	1.00				
weight	267.9		Moisture	17.4			
Bulk Density	2.061	Dry Density	1.755				

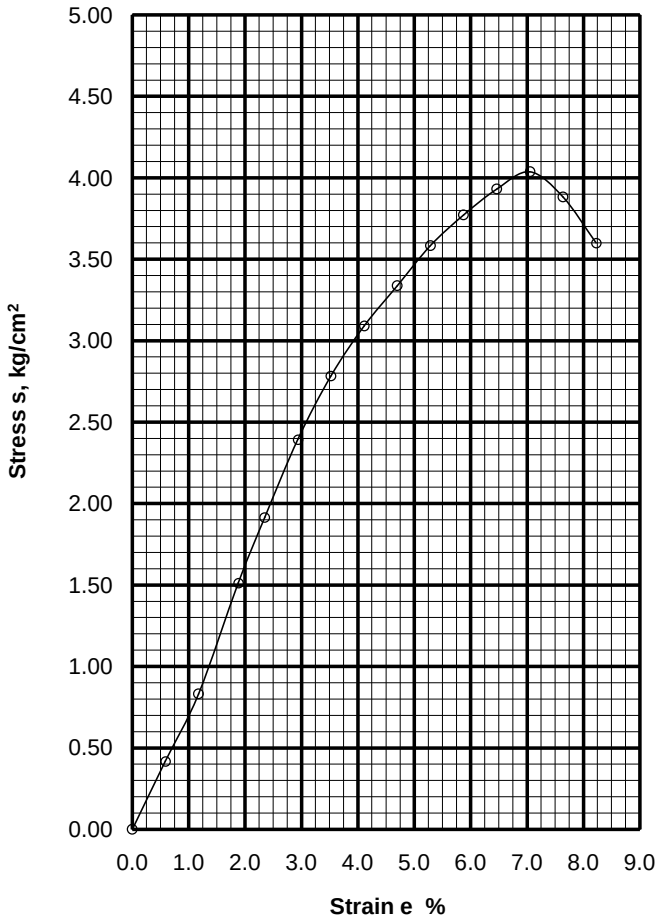
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	15.28	0	0	0
50	1.5	0.05	0.59	0.9941	15.37	6.45	0.420	0.418
100	3	0.1	1.18	0.9882	15.46	12.9	0.835	0.831
150	5.5	0.16	1.88	0.9812	15.57	23.65	1.519	1.512
200	7	0.2	2.35	0.9765	15.64	30.1	1.924	1.916
250	8.8	0.25	2.94	0.9706	15.74	37.84	2.404	2.394
300	10.3	0.3	3.53	0.9647	15.83	44.29	2.797	2.785
350	11.5	0.35	4.11	0.9589	15.93	49.45	3.104	3.090
400	12.5	0.4	4.70	0.9530	16.03	53.75	3.353	3.339
450	13.5	0.45	5.29	0.9471	16.13	58.05	3.599	3.583
500	14.3	0.5	5.88	0.9412	16.23	61.49	3.789	3.772
550	15	0.55	6.46	0.9354	16.33	64.5	3.949	3.932
600	15.5	0.6	7.05	0.9295	16.44	66.65	4.055	4.038
650	15	0.65	7.64	0.9236	16.54	64.5	3.900	3.883
700	14	0.7	8.23	0.9177	16.65	60.2	3.617	3.601

RESULT	
Stress	4.038
Strain	7.05

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-3

DEPTH(m): 10.50 - 12.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-4 **DEPTH (m):** 12.0 - 13.50

Diameter (cm)	5.11	Area A_0 (cm^2)	20.511	Ht,L_0 (cm)	10.310	LRC kg/div	4.3
Volume (cm^3)	211.47	Correction	1.00				
weight	482.2	Factor of Height	Moisture	12.58			
Bulk Density	2.280	Dry Density	2.025				

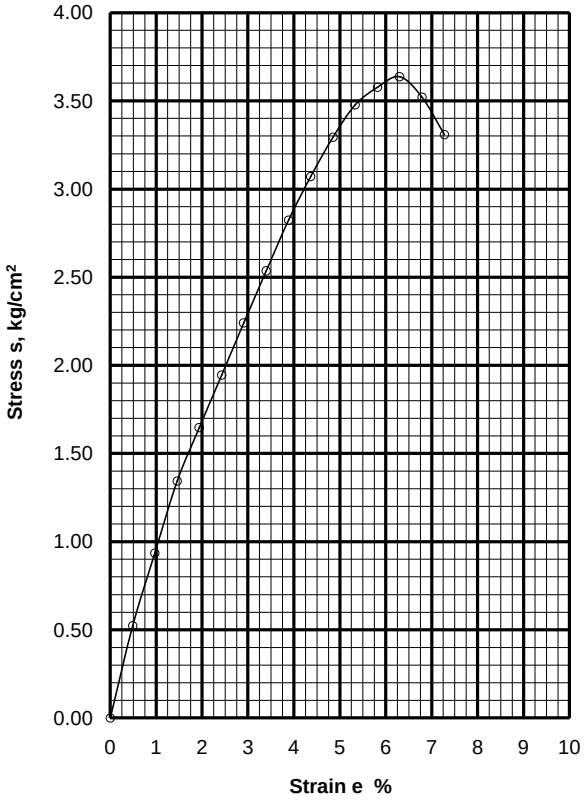
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	20.51	0	0	0
50	2.5	0.05	0.48	0.9952	20.61	10.75	0.522	0.522
100	4.5	0.1	0.97	0.9903	20.71	19.35	0.934	0.935
150	6.5	0.15	1.45	0.9855	20.81	27.95	1.343	1.344
200	8	0.2	1.94	0.9806	20.92	34.4	1.645	1.646
250	9.5	0.25	2.42	0.9758	21.02	40.85	1.943	1.945
300	11	0.3	2.91	0.9709	21.13	47.3	2.239	2.241
350	12.5	0.35	3.39	0.9661	21.23	53.75	2.532	2.534
400	14	0.4	3.88	0.9612	21.34	60.2	2.821	2.824
450	15.3	0.45	4.36	0.9564	21.45	65.79	3.068	3.071
500	16.5	0.5	4.85	0.9515	21.56	70.95	3.291	3.295
550	17.5	0.55	5.33	0.9467	21.67	75.25	3.473	3.477
600	18.1	0.6	5.82	0.9418	21.78	77.83	3.574	3.577
650	18.5	0.65	6.30	0.9370	21.89	79.55	3.634	3.638
700	18	0.7	6.79	0.9321	22.01	77.4	3.517	3.521
750	17	0.75	7.27	0.93	22.12	73.1	3.305	3.308

RESULT	
Stress	3.638
Strain	6.30

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-4

DEPTH(m): 12.0 - 13.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-6 **DEPTH (m):** 16.5 - 18.0

Diameter (cm)	5.91	Area A_0 (cm^2)	27.436	Ht,L_0 (cm)	11.810	LRC kg/div	4.3
Volume (cm^3)	324.02	Correction Factor	1.00				
weight	708.3	of Height	Moisture	16.63			
Bulk Density	2.186	Dry Density	1.874				

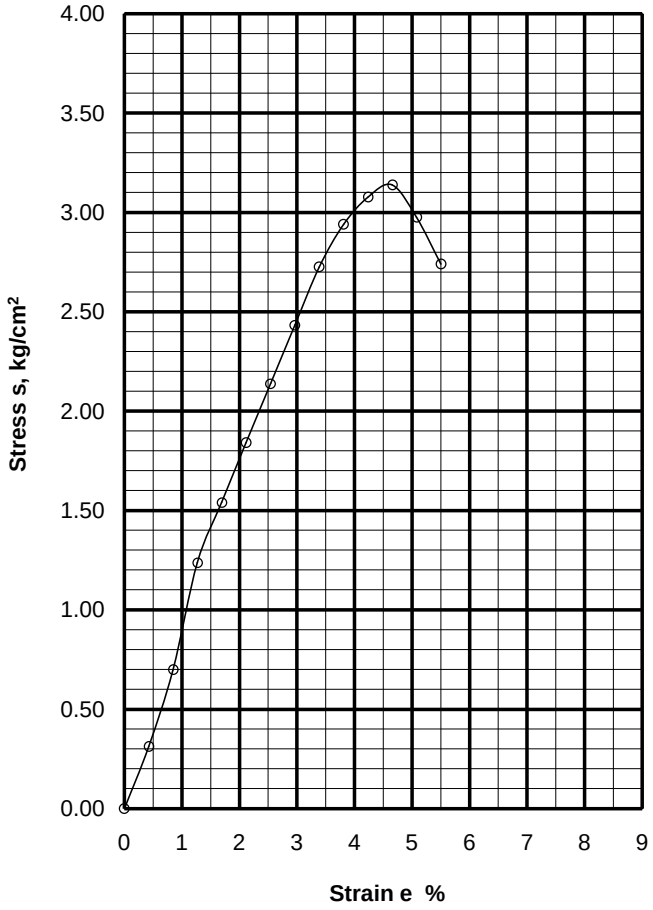
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.44	0	0	0
50	2	0.05	0.42	0.9958	27.55	8.6	0.312	0.312
100	4.5	0.1	0.85	0.9915	27.67	19.35	0.699	0.699
150	8	0.15	1.27	0.9873	27.79	34.4	1.238	1.238
200	10	0.2	1.69	0.9831	27.91	43	1.541	1.541
250	12	0.25	2.12	0.9788	28.03	51.6	1.841	1.841
300	14	0.3	2.54	0.9746	28.15	60.2	2.138	2.138
350	16	0.35	2.96	0.9704	28.27	68.8	2.433	2.433
400	18	0.4	3.39	0.9661	28.40	77.4	2.726	2.725
450	19.5	0.45	3.81	0.9619	28.52	83.85	2.940	2.939
500	20.5	0.5	4.23	0.9577	28.65	88.15	3.077	3.077
550	21	0.55	4.66	0.9534	28.78	90.3	3.138	3.138
600	20	0.6	5.08	0.9492	28.90	86	2.975	2.975
650	18.5	0.65	5.50	0.9450	29.03	79.55	2.740	2.740

RESULT	
Stress	3.138
Strain	4.66

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-6

DEPTH(m): 16.5 - 18.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-7 **DEPTH (m):** 18.0 - 19.50

Diameter (cm)	5.91	Area A_0 (cm^2)	27.436	Ht,L_0 (cm)	11.510	LRC kg/div	4.3
Volume (cm^3)	315.79	Correction Factor of Height	1.00				
weight	696.8		Moisture	20.49			
Bulk Density	2.207	Dry Density	1.831				

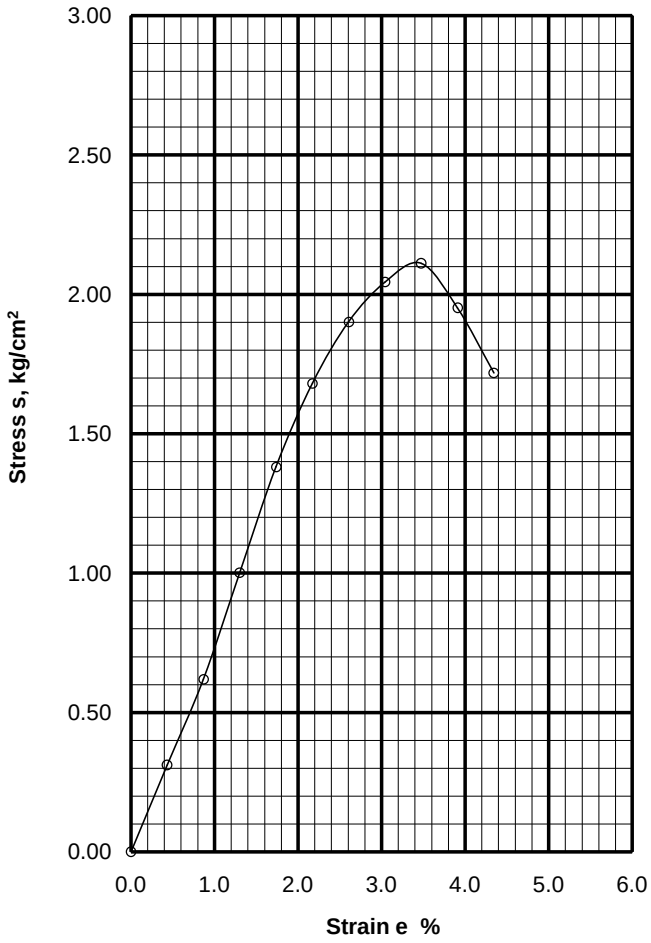
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.44	0	0	0
50	2	0.05	0.43	0.9957	27.56	8.6	0.312	0.311
100	4	0.1	0.87	0.9913	27.68	17.2	0.621	0.619
150	6.5	0.15	1.30	0.9870	27.80	27.95	1.005	1.002
200	9	0.2	1.74	0.9826	27.92	38.7	1.386	1.382
250	11	0.25	2.17	0.9783	28.05	47.3	1.687	1.681
300	12.5	0.3	2.61	0.9739	28.17	53.75	1.908	1.902
350	13.5	0.35	3.04	0.9696	28.30	58.05	2.051	2.045
400	14	0.4	3.48	0.9652	28.42	60.2	2.118	2.111
450	13	0.45	3.91	0.9609	28.55	55.9	1.958	1.952
500	11.5	0.5	4.34	0.9566	28.68	49.45	1.724	1.719

RESULT	
Stress	2.111
Strain	3.48

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-7

DEPTH(m): 18.0 - 19.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-8 **DEPTH (m):** 19.5 - 21.0

Diameter (cm)	4.41	Area A_0 (cm^2)	15.276	Ht,L_0 (cm)	8.110	LRC kg/div	4.3
Volume (cm^3)	123.89	Correction	1.01				
weight	259.2	Factor of Height	Moisture	22.94			
Bulk Density	2.092	Dry Density	1.702				

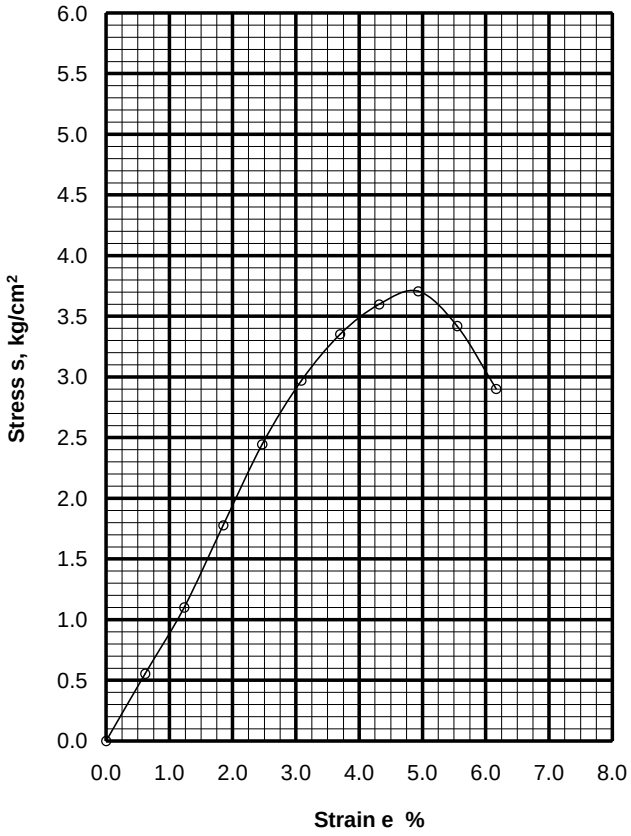
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	0	3	4	5	6	7	8	9
0	0	0	0	1.0000	15.28	0	0	0
50	2	0.05	0.62	0.9938	15.37	8.6	0.559	0.554
100	4	0.1	1.23	0.9877	15.47	17.2	1.112	1.100
150	6.5	0.15	1.85	0.9815	15.56	27.95	1.796	1.777
200	9	0.2	2.47	0.9753	15.66	38.7	2.471	2.445
250	11	0.25	3.08	0.9692	15.76	47.3	3.001	2.970
300	12.5	0.3	3.70	0.9630	15.86	53.75	3.388	3.353
350	13.5	0.35	4.32	0.9568	15.97	58.05	3.636	3.598
400	14	0.4	4.93	0.9507	16.07	60.2	3.746	3.707
450	13	0.45	5.55	0.9445	16.17	55.9	3.456	3.420
500	11.1	0.5	6.17	0.9383	16.28	47.73	2.932	2.901

RESULT	
Stress	3.707
Strain	4.93

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-8

DEPTH(m): 19.5 - 21.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-9 **DEPTH (m):** 21.0 - 22.5

Diameter (cm)	6.01	Area A_0 (cm^2)	28.372	Ht,L_0 (cm)	12.410	LRC kg/div	4.3
Volume (cm^3)	352.10	Correction Factor	1.00				
weight	777.3	of Height	Moisture	21.8			
Bulk Density	2.208	Dry Density	1.812				

UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	28.37	0	0	0
50	5	0.05	0.40	0.9960	28.49	21.5	0.755	0.758
100	8	0.1	0.81	0.9919	28.60	34.4	1.203	1.207
150	11	0.15	1.21	0.9879	28.72	47.3	1.647	1.653
200	13.5	0.2	1.61	0.9839	28.84	58.05	2.013	2.021
250	15	0.25	2.01	0.9799	28.96	64.5	2.228	2.236
300	17.0	0.3	2.42	0.9758	29.08	73.1	2.514	2.524
350	19.2	0.35	2.82	0.9718	29.20	82.56	2.828	2.839
400	20.5	0.4	3.22	0.9678	29.32	88.15	3.007	3.018
450	22	0.45	3.63	0.9637	29.44	94.6	3.213	3.225
500	23.8	0.5	4.03	0.9597	29.56	102.34	3.462	3.475
550	25.3	0.55	4.43	0.9557	29.69	108.79	3.664	3.678
600	26.8	0.6	4.83	0.9517	29.81	115.24	3.865	3.880
650	28.5	0.65	5.24	0.9476	29.94	122.55	4.093	4.109
700	30	0.7	5.64	0.9436	30.07	129	4.290	4.306
750	31	0.75	6.04	0.9396	30.20	133.3	4.414	4.431
800	30	0.8	6.45	0.9355	30.33	129	4.254	4.270
850	28	0.85	6.85	0.9315	30.46	120.4	3.953	3.968

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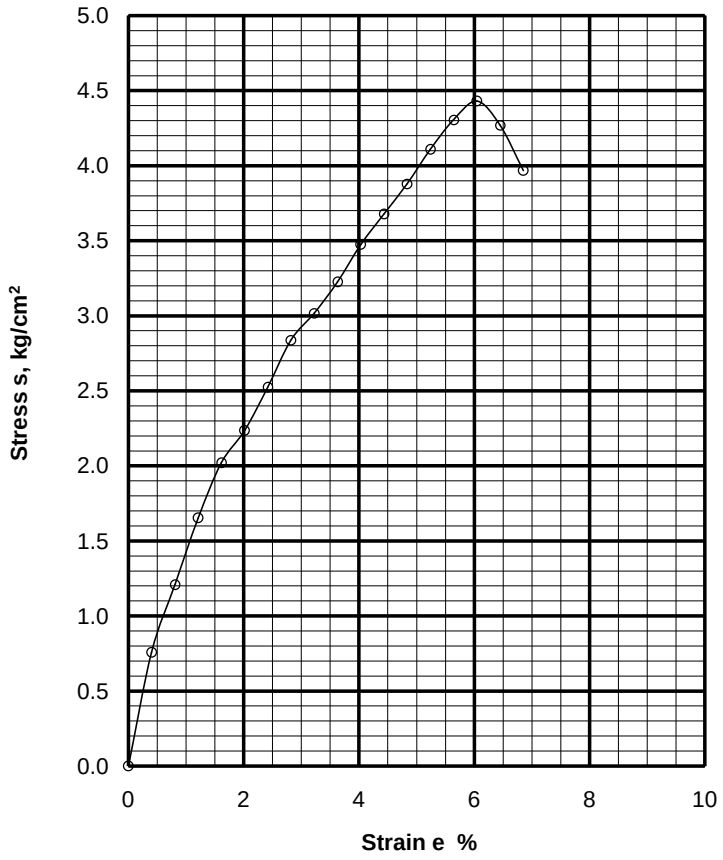
RESULT	
Stress	4.431
Strain	6.04

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-9

DEPTH(m): 21.0 - 22.5

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-11 **DEPTH (m):** 24.0 - 25.50

Diameter (cm)	6.11	Area A_0 (cm^2)	29.324	Ht,L_0 (cm)	10.910	LRC kg/div	4.3
Volume (cm^3)	319.93	Correction	1.01				
weight	694.5	Factor of Height	Moisture	16.16			
Bulk Density	2.171	Dry Density	1.869				

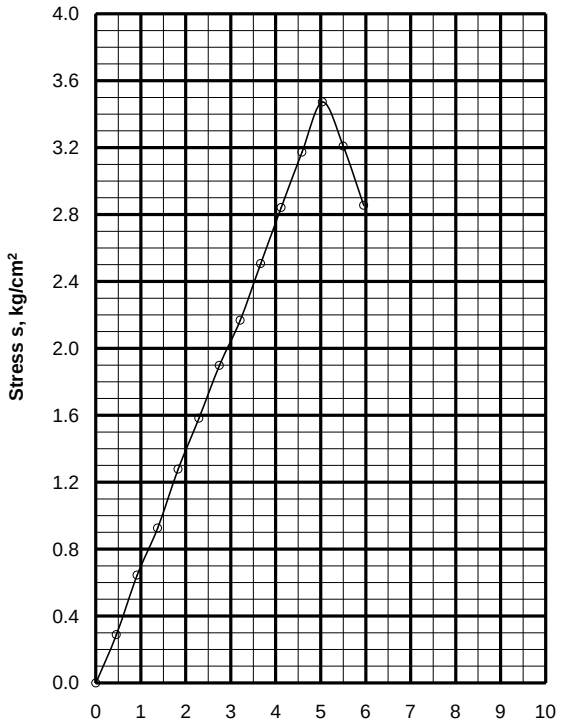
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	29.32	0	0	0
50	2	0.05	0.46	0.9954	29.46	8.6	0.292	0.29
100	4.5	0.1	0.92	0.9908	29.60	19.35	0.654	0.64
150	6.5	0.15	1.37	0.9863	29.73	27.95	0.940	0.93
200	9	0.2	1.83	0.9817	29.87	38.7	1.296	1.28
250	11.2	0.25	2.29	0.9771	30.01	48.16	1.605	1.58
300	13.5	0.3	2.75	0.9725	30.15	58.05	1.925	1.90
350	15.5	0.35	3.21	0.9679	30.30	66.65	2.200	2.17
400	18	0.4	3.67	0.9633	30.44	77.4	2.543	2.51
450	20.5	0.45	4.12	0.9588	30.59	88.15	2.882	2.84
500	23	0.5	4.58	0.9542	30.73	98.9	3.218	3.17
550	25.3	0.55	5.04	0.9496	30.88	108.79	3.523	3.47
600	23.5	0.6	5.50	0.9450	31.03	101.05	3.256	3.21
650	21	0.65	5.96	0.9404	31.18	90.3	2.896	2.85

RESULT	
Stress	3.47
Strain	5.04

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-11

DEPTH(m): 24.0 - 25.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-12 **DEPTH (m):** 25.50 - 27.0

Diameter (cm)	5.21	Area A_0 (cm^2)	21.322	Ht,L_0 (cm)	10.310	LRC kg/div	4.3
Volume (cm^3)	219.83	Correction Factor of Height	1.00				
weight	472.8		Moisture	21.8			
Bulk Density	2.151	Dry Density	1.766				

UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	0	3	4	5	6	7	8	9
0	0	0	0	1.0000	21.32	0	0	0
50	3	0.05	0.48	0.9952	21.43	12.9	0.602	0.601
100	6	0.1	0.97	0.9903	21.53	25.8	1.198	1.197
150	8.5	0.15	1.45	0.9855	21.64	36.55	1.689	1.687
200	10	0.2	1.94	0.9806	21.74	43	1.978	1.975
250	12	0.25	2.42	0.9758	21.85	51.6	2.361	2.358
300	13.5	0.3	2.91	0.9709	21.96	58.05	2.643	2.640
350	15	0.35	3.39	0.9661	22.07	64.5	2.922	2.919
400	16	0.4	3.88	0.9612	22.18	68.8	3.102	3.098
450	17.5	0.45	4.36	0.9564	22.29	75.25	3.375	3.371
500	18.5	0.5	4.85	0.9515	22.41	79.55	3.550	3.545
550	19.5	0.55	5.33	0.9467	22.52	83.85	3.723	3.718
600	19	0.6	5.82	0.9418	22.64	81.7	3.609	3.604
650	18	0.65	6.30	0.9370	22.76	77.4	3.401	3.397

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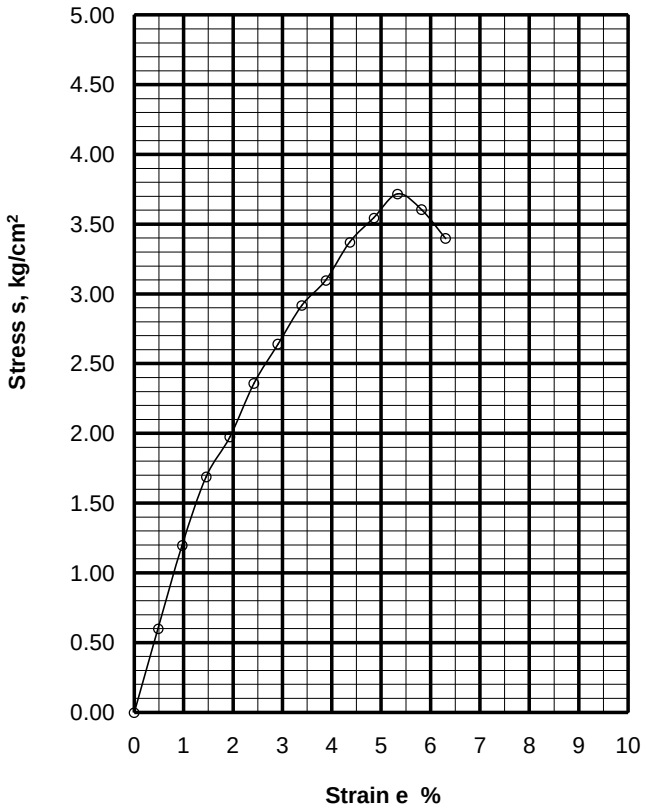
RESULT	
Stress	3.718
Strain	5.33

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-12

DEPTH(m): 25.50 - 27.0

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--4 **SAMPLE :** CRS-2 **DEPTH (m):** 19.50 - 21.0

Diameter (cm)	5.71	Area A_0 (cm^2)	25.611	Ht,L_0 (cm)	7.510	LRC kg/div	4.3
Volume (cm^3)	192.34	Correction Factor	1.06				
weight	431.5	of Height	Moisture	9.88			
Bulk Density	2.243	Dry Density	2.042				

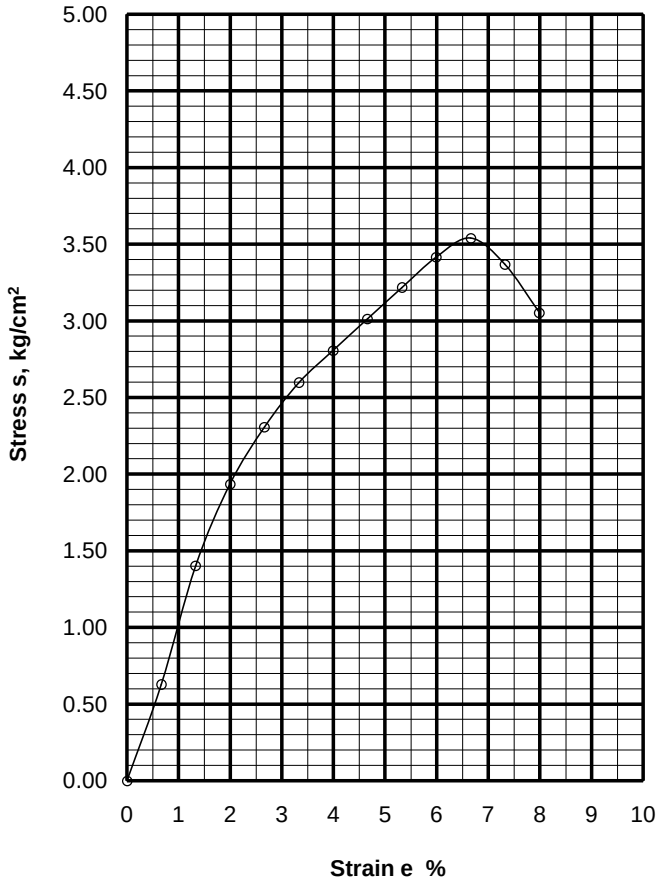
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	25.61	0	0	0
50	4	0.05	0.67	0.9933	25.78	17.2	0.667	0.628
100	9	0.1	1.33	0.9867	25.96	38.7	1.491	1.403
150	12.5	0.15	2.00	0.9800	26.13	53.75	2.057	1.936
200	15	0.2	2.66	0.9734	26.31	64.5	2.451	2.307
250	17	0.25	3.33	0.9667	26.49	73.1	2.759	2.597
300	18.5	0.3	3.99	0.9601	26.68	79.55	2.982	2.807
350	20.0	0.35	4.66	0.9534	26.86	86	3.201	3.013
400	21.5	0.4	5.33	0.9467	27.05	92.45	3.418	3.217
450	23	0.45	5.99	0.9401	27.24	98.9	3.630	3.417
500	24	0.5	6.66	0.9334	27.44	103.2	3.761	3.540
550	23	0.55	7.32	0.9268	27.63	98.9	3.579	3.368
600	21	0.6	7.99	0.9201	27.83	90.3	3.244	3.053

RESULT	
Stress	3.540
Strain	6.66

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--4

SAMPLE : CRS-2

DEPTH(m): 19.50 - 21.0

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--4 **SAMPLE :** CRS-4 **DEPTH (m):** 22.5 - 24.0

Diameter (cm)	5.81	Area A_0 (cm^2)	26.515	Ht,L_0 (cm)	12.010	LRC kg/div	4.3
Volume (cm^3)	318.45	Correction	1.00				
weight	689.3	Factor of Height	Moisture	22.12			
Bulk Density	2.165	Dry Density	1.772				

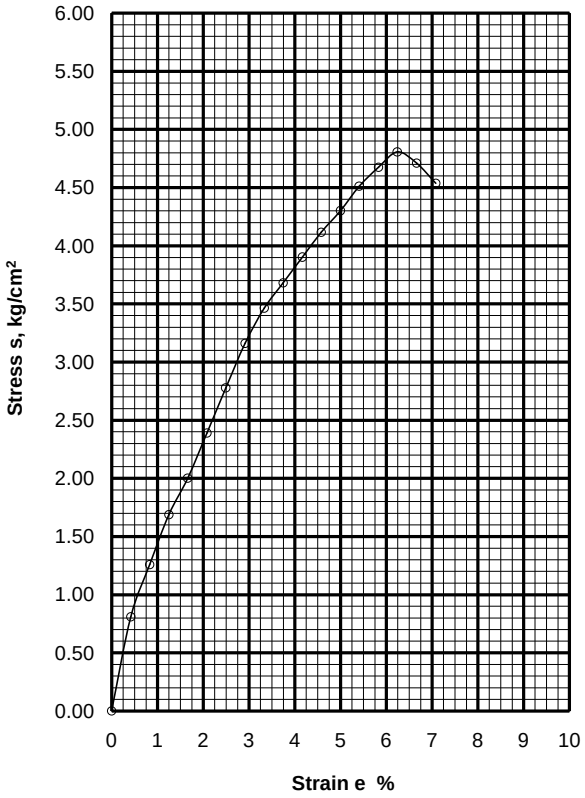
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.52	0	0	0
50	5	0.05	0.42	0.9958	26.63	21.5	0.807	0.811
100	7.8	0.1	0.83	0.9917	26.74	33.54	1.254	1.259
150	10.5	0.15	1.25	0.9875	26.85	45.15	1.682	1.688
200	12.5	0.2	1.67	0.9833	26.96	53.75	1.993	2.001
250	15	0.25	2.08	0.9792	27.08	64.5	2.382	2.391
300	17.5	0.3	2.50	0.9750	27.19	75.25	2.767	2.778
350	20	0.35	2.91	0.9709	27.31	86	3.149	3.161
400	22	0.4	3.33	0.9667	27.43	94.6	3.449	3.462
450	23.5	0.45	3.75	0.9625	27.55	101.05	3.668	3.683
500	25	0.5	4.16	0.9584	27.67	107.5	3.885	3.901
550	26.5	0.55	4.58	0.9542	27.79	113.95	4.101	4.117
600	27.8	0.6	5.00	0.9500	27.91	119.54	4.283	4.300
650	29.3	0.65	5.41	0.9459	28.03	125.99	4.494	4.512
700	30.5	0.7	5.83	0.9417	28.16	131.15	4.658	4.676
750	31.5	0.75	6.24	0.9376	28.28	135.45	4.789	4.808
800	31	0.8	6.66	0.9334	28.41	133.30	4.692	4.711
850	30	0.85	7.08	0.9292	28.53	129.00	4.521	4.538

RESULT	
Stress	4.808

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--4

SAMPLE : CRS-4

DEPTH(m): 22.5 - 24.0

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--4 **SAMPLE :** CRS-6 **DEPTH (m):** 25.5 - 27.0

Diameter (cm)	5.81	Area A_0 (cm^2)	26.515	Ht,L_0 (cm)	10.510	LRC kg/div	4.3
Volume (cm^3)	278.68	Correction Factor of Height	1.01				
weight	604.8		Moisture	18.81			
Bulk Density	2.170	Dry Density	1.827				

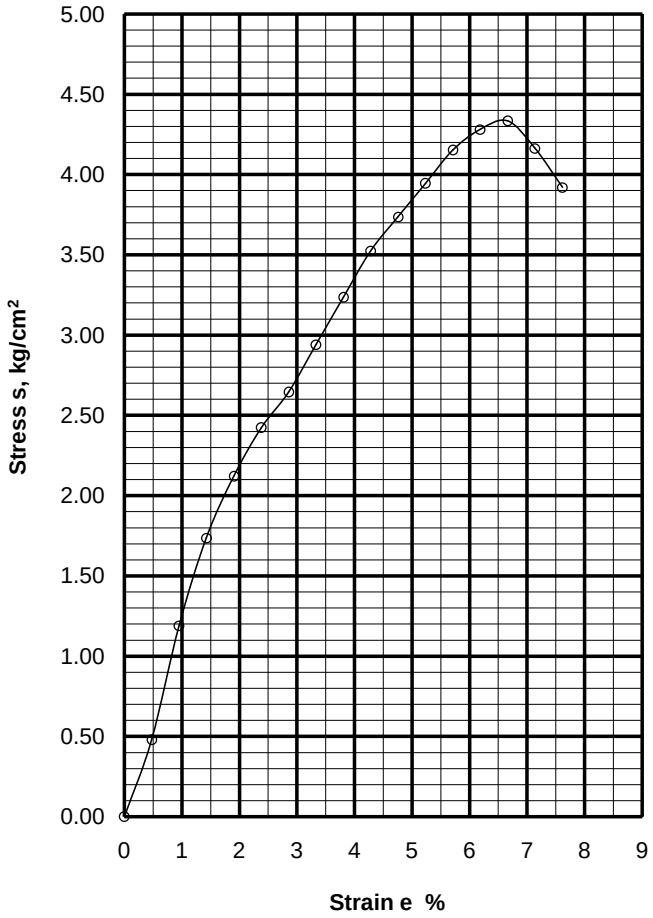
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.52	0	0	0
50	3	0.05	0.48	0.9952	26.64	12.9	0.484	0.478
100	7.5	0.1	0.95	0.9905	26.77	32.25	1.205	1.190
150	11	0.15	1.43	0.9857	26.90	47.3	1.758	1.736
200	13.5	0.2	1.90	0.9810	27.03	58.05	2.148	2.121
250	15.5	0.25	2.38	0.9762	27.16	66.65	2.454	2.423
300	17	0.3	2.85	0.9715	27.29	73.1	2.678	2.645
350	19	0.35	3.33	0.9667	27.43	81.7	2.979	2.941
400	21	0.4	3.81	0.9619	27.56	90.3	3.276	3.235
450	23	0.45	4.28	0.9572	27.70	98.9	3.570	3.526
500	24.5	0.5	4.76	0.9524	27.84	105.35	3.784	3.737
550	26	0.55	5.23	0.9477	27.98	111.8	3.996	3.946
600	27.5	0.6	5.71	0.9429	28.12	118.25	4.205	4.152
650	28.5	0.65	6.18	0.9382	28.26	122.55	4.336	4.282
700	29	0.7	6.66	0.9334	28.41	124.7	4.390	4.335
750	28	0.75	7.14	0.9286	28.55	120.4	4.217	4.164
800	26.5	0.8	7.61	0.9239	28.70	113.95	3.970	3.921

RESULT	
Stress	4.335

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--4

SAMPLE : CRS-6

DEPTH(m): 25.5 - 27.0

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH-5 **SAMPLE :** CRS-3 **DEPTH (m):** 15.0 - 16.50

Diameter (cm)	5.79	Area A_0 (cm^2)	26.333	Ht,L_0 (cm)	11.300	LRC kg/div	4.3
Volume (cm^3)	297.56	Correction Factor of Height	1.00				
weight	616		Moisture	16.19			
Bulk Density	2.070	Dry Density	1.782				

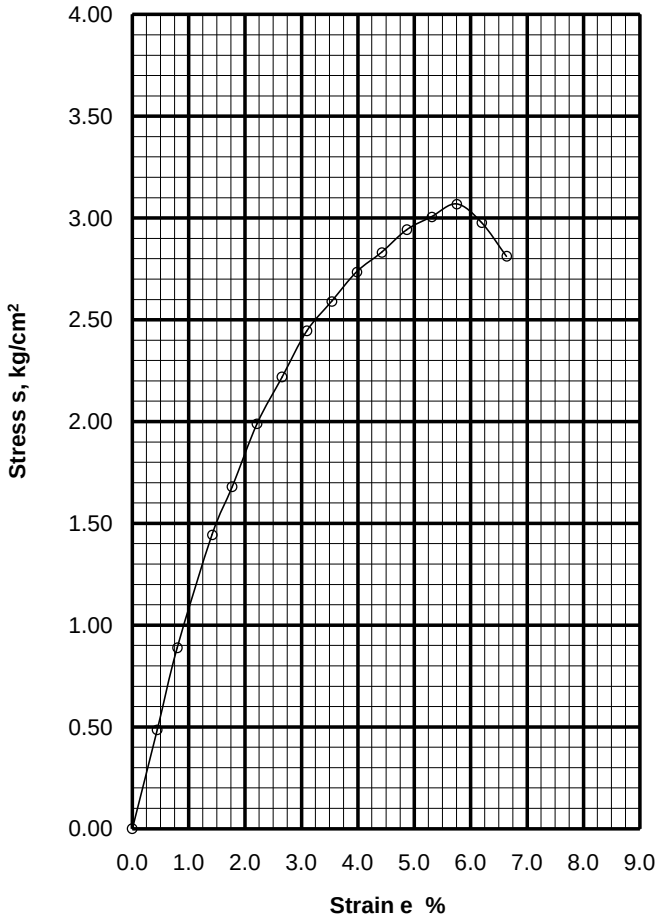
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.33	0	0	0
50	3	0.05	0.44	0.9956	26.45	12.9	0.488	0.486
90	5.5	0.09	0.80	0.9920	26.54	23.65	0.891	0.888
150	9	0.16	1.42	0.9858	26.71	38.7	1.449	1.445
200	10.5	0.2	1.77	0.9823	26.81	45.15	1.684	1.679
250	12.5	0.25	2.21	0.9779	26.93	53.75	1.996	1.990
300	14	0.3	2.65	0.9735	27.05	60.2	2.225	2.219
350	15.5	0.35	3.10	0.9690	27.17	66.65	2.453	2.445
400	16.5	0.4	3.54	0.9646	27.30	70.95	2.599	2.591
450	17.5	0.45	3.98	0.9602	27.43	75.25	2.744	2.736
500	18.2	0.5	4.42	0.9558	27.55	78.26	2.840	2.832
550	19	0.55	4.87	0.9513	27.68	81.7	2.952	2.943
600	19.5	0.6	5.31	0.9469	27.81	83.85	3.015	3.006
650	20	0.65	5.75	0.9425	27.94	86	3.078	3.069
700	19.5	0.7	6.19	0.9381	28.07	83.85	2.987	2.978
750	18.5	0.75	6.64	0.9336	28.21	79.55	2.820	2.812

RESULT	
Stress	3.069
Strain	5.75

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH-5

SAMPLE : CRS-3

DEPTH(m): 15.0 - 16.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--5 **SAMPLE :** CRS-4 **DEPTH (m):** 16.50 - 18.0

Diameter (cm)	5.93	Area A_0 (cm^2)	27.622	Ht,L_0 (cm)	11.260	LRC kg/div	4.3
Volume (cm^3)	311.02	Correction Factor	1.01				
weight	671.7	of Height	Moisture	13.99			
Bulk Density	2.160	Dry Density	1.895				

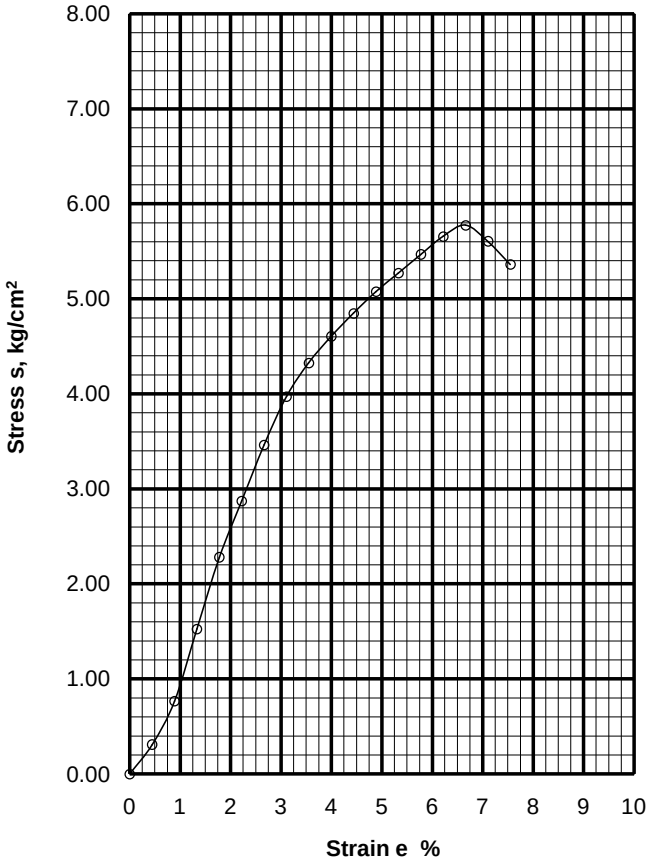
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.62	0	0	0
50	2	0.05	0.44	0.9956	27.75	8.6	0.310	0.308
100	5	0.1	0.89	0.9911	27.87	21.5	0.771	0.767
150	10	0.15	1.33	0.9867	27.99	43	1.536	1.526
200	15	0.2	1.78	0.9822	28.12	64.5	2.294	2.279
250	19	0.25	2.22	0.9778	28.25	81.7	2.892	2.874
300	23	0.3	2.66	0.9734	28.38	98.9	3.485	3.463
350	26.5	0.35	3.11	0.9689	28.51	113.95	3.997	3.972
400	29	0.4	3.55	0.9645	28.64	124.7	4.354	4.326
450	31	0.45	4.00	0.9600	28.77	133.3	4.633	4.604
500	32.8	0.5	4.44	0.9556	28.91	141.04	4.879	4.848
550	34.5	0.55	4.88	0.9512	29.04	148.35	5.108	5.076
600	36	0.6	5.33	0.9467	29.18	154.8	5.306	5.272
650	37.5	0.65	5.77	0.9423	29.31	161.25	5.501	5.466
700	39	0.7	6.22	0.9378	29.45	167.7	5.694	5.658
750	40	0.75	6.66	0.9334	29.59	172	5.812	5.775
800	39	0.8	7.10	0.9290	29.7	167.7	5.640	5.604
850	37.5	0.85	7.55	0.9245	29.88	161.25	5.397	5.363

RESULT	
Stress	5.775
Strain	6.66

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-4

DEPTH(m): 16.50 - 18.0

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--5 **SAMPLE :** CRS-5 **DEPTH (m):** 18.0 - 19.50

Diameter (cm)	5.88	Area A_0 (cm^2)	27.158	Ht,L_0 (cm)	11.100	LRC kg/div	4.3
Volume (cm^3)	301.46	Correction Factor of Height	1.01				
weight	634.1		Moisture	14.44			
Bulk Density	2.103	Dry Density	1.838				

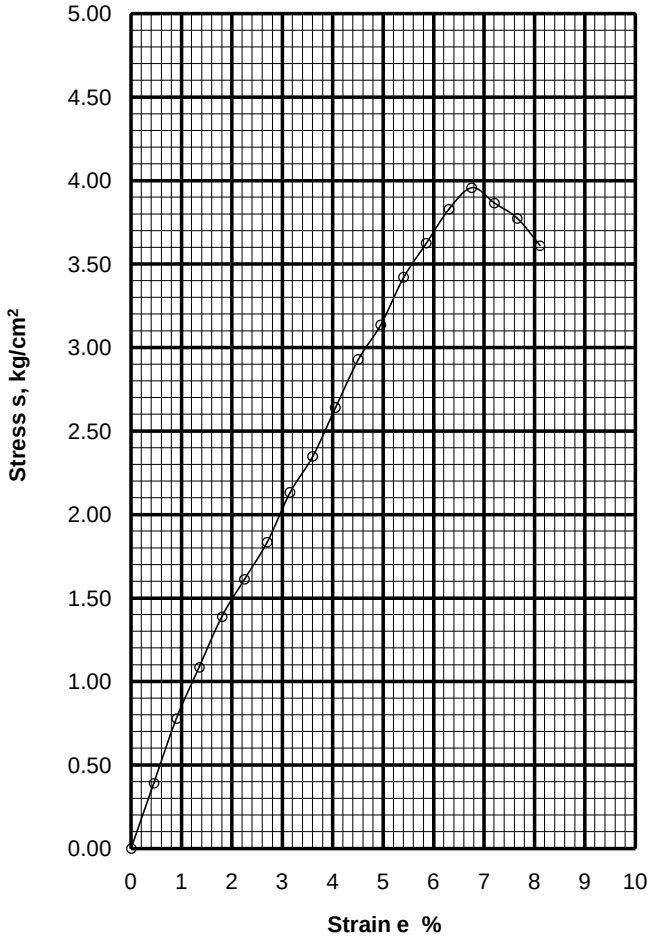
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.16	0	0	0
50	2.5	0.05	0.45	0.9955	27.28	10.75	0.394	0.391
100	5	0.1	0.90	0.9910	27.41	21.5	0.785	0.779
150	7	0.15	1.35	0.9865	27.53	30.1	1.093	1.086
200	9	0.2	1.80	0.9820	27.66	38.7	1.399	1.389
250	10.5	0.25	2.25	0.9775	27.78	45.15	1.625	1.614
300	12	0.3	2.70	0.9730	27.91	51.6	1.849	1.836
350	14	0.35	3.15	0.9685	28.04	60.2	2.147	2.132
400	15.5	0.4	3.60	0.9640	28.17	66.65	2.366	2.349
450	17.5	0.45	4.05	0.9595	28.31	75.25	2.658	2.640
500	19.5	0.5	4.50	0.9550	28.44	83.85	2.948	2.928
550	21	0.55	4.95	0.9505	28.57	90.3	3.160	3.138
600	23	0.6	5.41	0.9459	28.71	98.9	3.445	3.420
650	24.5	0.65	5.86	0.9414	28.85	105.35	3.652	3.626
700	26	0.7	6.31	0.9369	28.99	111.8	3.857	3.830
750	27	0.75	6.76	0.9324	29.13	116.1	3.986	3.958
800	26.5	0.8	7.21	0.9279	29.27	113.95	3.893	3.866
850	26	0.85	7.66	0.9234	29.4	111.8	3.801	3.774
900	25	0.9	8.11	0.9189	29.55	107.5	3.637	3.612

RESULT	
Stress	3.958
Strain	6.76

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-5

DEPTH(m): 18.0 - 19.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH-5 **SAMPLE :** CRS-6 **DEPTH (m):** 19.50 - 21.0

Diameter (cm)	5.9	Area A_0 (cm^2)	27.343	Ht,L_0 (cm)	10.910	LRC kg/div	4.3
Volume (cm^3)	298.31	Correction Factor of Height	1.01				
weight	630.2		Moisture	15.06			
Bulk Density	2.113	Dry Density	1.836				

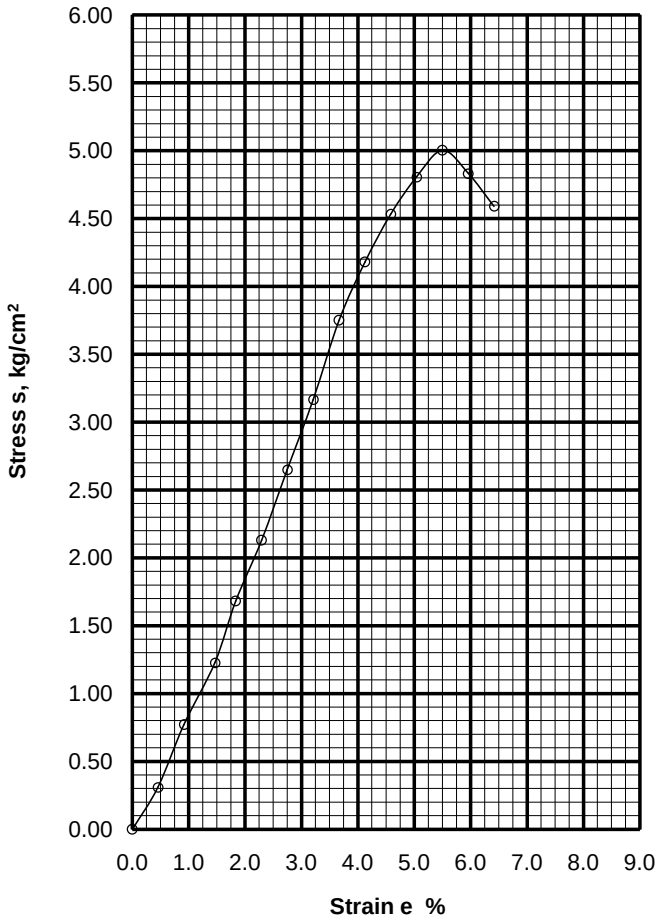
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.34	0	0	0
50	2	0.05	0.46	0.9954	27.47	8.6	0.313	0.310
100	5	0.1	0.92	0.9908	27.60	21.5	0.779	0.772
150	8	0.16	1.47	0.9853	27.75	34.4	1.240	1.228
200	11	0.2	1.83	0.9817	27.85	47.3	1.698	1.682
250	14	0.25	2.29	0.9771	27.98	60.2	2.151	2.130
300	17.5	0.3	2.75	0.9725	28.12	75.25	2.676	2.650
350	21	0.35	3.21	0.9679	28.25	90.3	3.197	3.166
400	25	0.4	3.67	0.9633	28.38	107.5	3.787	3.751
450	28	0.45	4.12	0.9588	28.52	120.4	4.222	4.181
500	30.5	0.5	4.58	0.9542	28.66	131.15	4.577	4.532
550	32.5	0.55	5.04	0.9496	28.79	139.75	4.853	4.806
600	34	0.6	5.50	0.9450	28.93	146.2	5.053	5.004
650	33	0.65	5.96	0.9404	29.08	141.9	4.880	4.833
700	31.5	0.7	6.42	0.9358	29.22	135.45	4.636	4.591

RESULT	
Stress	5.004
Strain	5.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH-5

SAMPLE : CRS-6

DEPTH(m): 19.50 - 21.0

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--5 **SAMPLE :** CRS-11 **DEPTH (m):** 27.0 - 28.50

Diameter (cm)	5.79	Area A_0 (cm^2)	26.333	Ht,L_0 (cm)	10.510	LRC kg/div	4.3
Volume (cm^3)	276.76	Correction Factor of Height	1.01				
weight	622.6		Moisture	13.63			
Bulk Density	2.250	Dry Density	1.980				

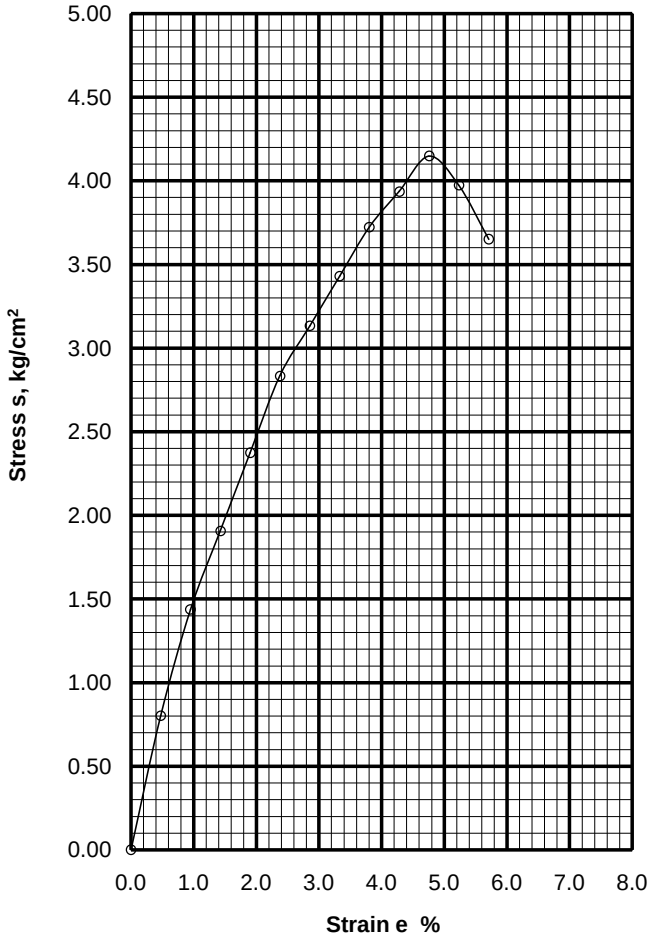
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.33	0	0	0
50	5	0.05	0.48	0.9952	26.46	21.5	0.813	0.803
100	9	0.1	0.95	0.9905	26.59	38.7	1.456	1.438
150	12	0.15	1.43	0.9857	26.71	51.6	1.932	1.908
200	15	0.2	1.90	0.9810	26.84	64.5	2.403	2.374
250	18	0.25	2.38	0.9762	26.97	77.4	2.869	2.835
300	20	0.3	2.85	0.9715	27.11	86	3.173	3.134
350	22	0.35	3.33	0.9667	27.24	94.6	3.473	3.431
400	24	0.4	3.81	0.9619	27.38	103.2	3.770	3.724
450	25.5	0.45	4.28	0.9572	27.51	109.65	3.986	3.938
500	27	0.5	4.76	0.9524	27.65	116.1	4.199	4.148
550	26	0.55	5.23	0.9477	27.79	111.8	4.023	3.975
600	24	0.6	5.71	0.9429	27.93	103.2	3.695	3.651

RESULT	
Stress	4.148
Strain	4.76

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-11

DEPTH(m): 27.0 - 28.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--5 **SAMPLE :** CRS-12 **DEPTH (m):** 28.50 - 30.0

Diameter (cm)	7.35	Area A_0 (cm^2)	42.435	Ht,L_0 (cm)	9.450	LRC kg/div	4.3
Volume (cm^3)	401.01	Correction Factor of Height	1.07				
weight	1008.3		Moisture	8.09			
Bulk Density	2.514	Dry Density	2.326				

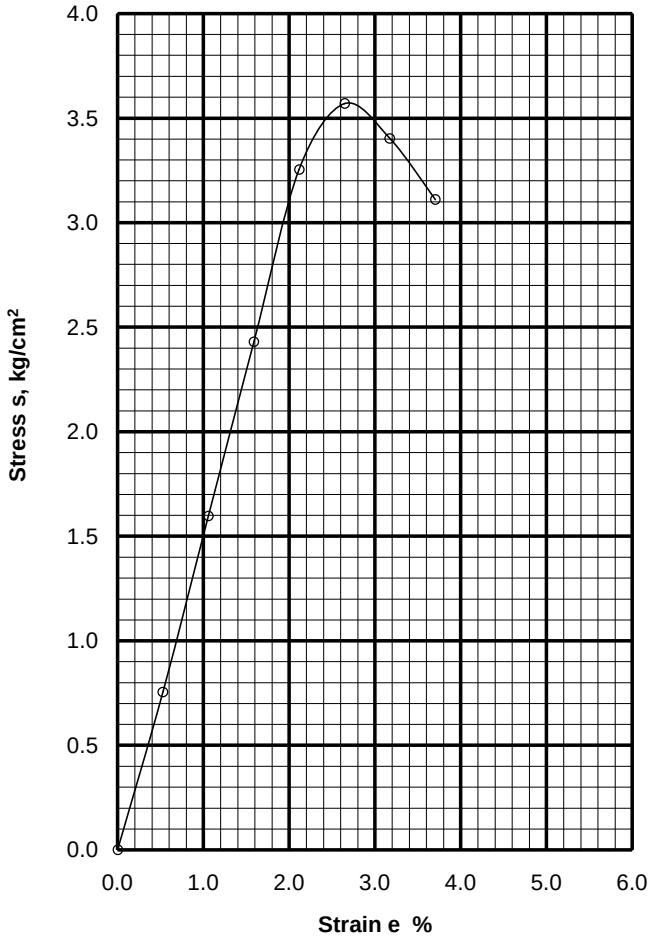
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	42.43	0	0	0
50	8	0.05	0.53	0.9947	42.66	34.4	0.806	0.756
100	17	0.1	1.06	0.9894	42.89	73.1	1.704	1.598
150	26	0.15	1.59	0.9841	43.12	111.8	2.593	2.431
200	35	0.2	2.12	0.9788	43.35	150.5	3.472	3.255
250	38.6	0.25	2.65	0.9735	43.59	165.98	3.808	3.570
300	37	0.3	3.17	0.9683	43.83	159.1	3.630	3.403
350	34	0.35	3.70	0.9630	44.07	146.2	3.318	3.110

RESULT	
Stress	3.57
Strain	2.65

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-12

DEPTH(m): 28.50 - 30.0

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

DIRECT SHEAR TEST AND SPECIFIC GRAVITY

S. NO.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	c (Kg/cm^2)	ϕ (deg)	Specific Gravity
1	Barthing mark 687, Between 28-29, Bollards	BH-01	UDS-1	1.0	-10.1			2.572
2		BH-01	SPT-3	3.0	-12.1	0.0	32	
3		BH-01	SPT-4	4.5	-13.6			2.585
4	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5			2.626
5		BH-02	DS-3	4.5	-15.0	0.0	32	2.668
6	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3	0.0	31	
7		BH-03	DS-2	7.5	-19.3			2.657
8	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5			2.6585
9		BH-04	DS-1	3.0	-14.5	0.0	32	
10		BH-04	DS-6	10.5	-22.0	0.0	32	2.612
11	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1	0.0	32	
12		BH-05	CRS-1	4.5	-16.1			2.624

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

CHEMICAL TEST

S. NO.	Location	Borehole#	Sample	Depth BelowSea bed(m)	Elevation (m)	pH	Sulphate Content (%)	Chloride Content (%)	Total Disolve Salt (%)	Organic Matter (%)
1	Barthing mark 687,Between 28-29, Bollards	BH-01	SPT-3	3.0	-12.1	7.5	0.243	0.193	1.29	3.45
2		BH-01	CRS-1	19.5	-28.6	7.5	0.194	0.236	1.08	-
3	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5	7.5	0.150	0.129	0.54	1.40
4		BH-02	CRS-1	6.1	-16.6	7.5	0.172	0.150	0.65	1.18
5		BH-02	DS-5	10.5	-21.0	7.5	0.106	0.107	0.65	
6	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3	7.5	0.164	0.140	0.86	1.17
7		BH-03	CRS-1	4.5	-16.3	7.5	0.150	0.161	0.97	2.35
8		BH-03	DS-2	7.5	-19.3	7.5	0.142	0.130	0.86	1.99

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

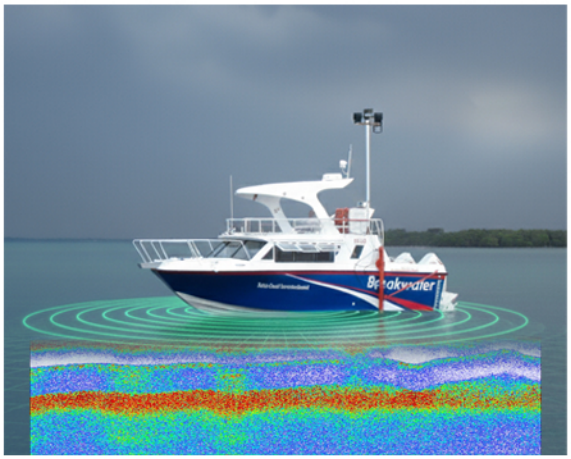
CHEMICAL TEST

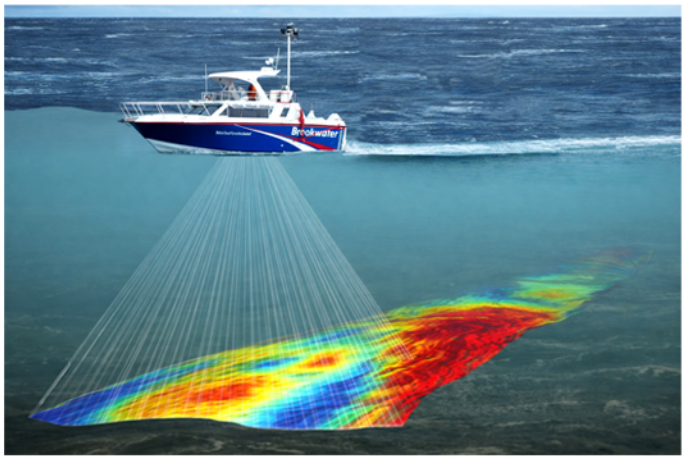
S. NO.	Location	Borehole#	Sample	Depth BelowSea bed(m)	Elevation (m)	pH	Sulphate Content (%)	Chloride Content (%)	Total Disolve Salt (%)	Organic Matter (%)
9	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-2	1.5	-13.0	7.5	0.195	0.140	1.40	2.11
10		BH-04	DS-5	7.5	-19.0	7.5	0.164	0.129	1.61	0.84
11		BH-04	DS-8	13.5	-25.0	7.5	0.177	0.107	0.97	-
12	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1	7.5	0.137	0.107	0.97	2.27
13		BH-05	CRS-1	4.5	-16.1	7.5	0.208	0.150	1.18	2.26
14		BH-05	DS-6	12.0	-23.6	7.5	0.155	0.129	0.97	2.29

Annex IX - Bathymetry Report

DP WORLD

Bathymetric and Subbottom Survey for QICT Terminal 1





Survey Report March 2026

Techno-Consult International (Pvt.) Ltd.
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- Appendix-B: Sub-Bottom Layer Stratigraphy & Previous Geotechnical Report
- Appendix-C: Survey Log
- Appendix-D: Survey Equipment Specifications

1 Introduction

This survey report has been prepared by Techno-Consult International Private Limited (TCI), hereafter referred to as the consultant, in response to the RFP document received from DP World / QICT, the client, pertaining to detailed survey works. The primary objective of the survey(s) is to facilitate in subsequent construction of a new quay wall and dredging works to upgrade terminal infrastructure and future proof QICT as one key players in the region.

- **Project Title**: QICT.NG.25.17056 - Bathymetric Survey Works, Container Terminal-1, QICT
- **Location**: Port Qasim, QICT
- **Client**: DP World / QICT
- **Point of Contact**: Saad Ahmed - Deputy Manager Procurement

Figure 1. Qasim International Container Terminal (QICT) -Port Qasim.

Outlined in this report is the methodology and results of the surveys undertaken as per the project scope of work. Additionally, the following information is provided:

- Appendix-A: Bathymetric Charts
- Appendix-B: Sub-Bottom Layer Stratigraphy & Previous Geotechnical Report
- Appendix-C: Survey Log
- Appendix-D: Survey Equipment Specifications

2 Objective

The objective of the project is to undertake detailed bathymetric and sub-bottom profiling surveys to obtain high-resolution seabed and shallow subsurface data at Container Terminal-1, Qasim International Container Terminal (QICT), Port Qasim, in support of the engineering design of the quay wall and associated dredging works.

The surveys will provide a reliable basis to:

- Define the existing seabed profile and water depths referenced to the local Chart Datum.
- Seabed features, irregularities, and potential obstructions relevant to dredging and construction planning identified by sub-bottom and multibeam survey.
- Distinguish different seabed layers based upon reflectivity through high-resolution sub-bottom profiling.
- Supply survey datasets compliant with IHO S-44 standards, as required by detailed engineering design and risk assessment by DP World.

2.1 Scope of Work

The surveys are to be performed alongside the quay wall of the existing QICT Terminal-1 as indicated in Figure 2 – as taken from the RFP document.

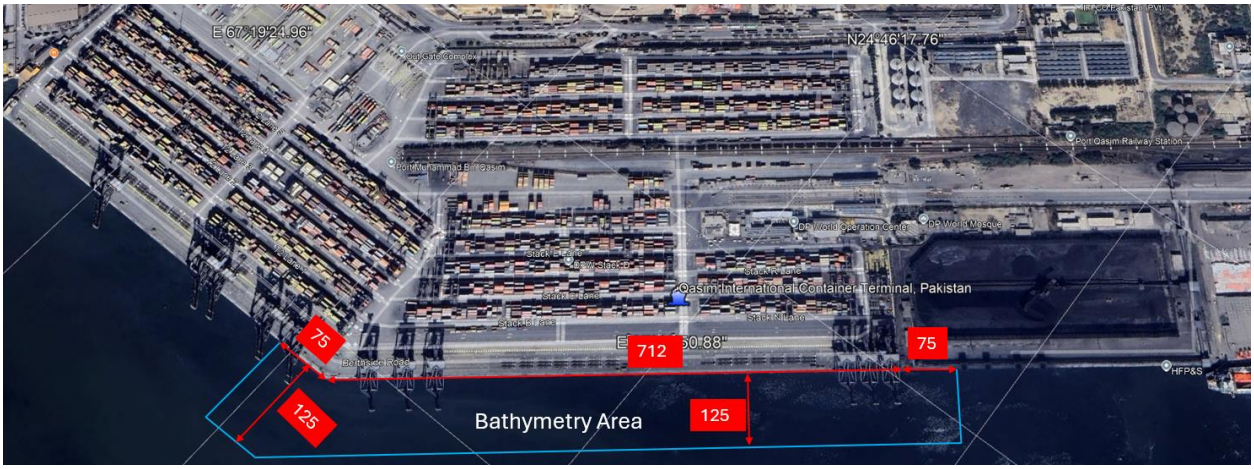


Figure 2. Area for bathymetric and sub-bottom profiling survey(s).

Inline with the RFP document, the project scope entails the following:

1. **Mobilization and Survey Setup**

   Mobilization of survey vessel(s), qualified personnel, calibrated equipment, positioning and motion sensors, and establishment of tidal referencing to Chart Datum.

2. **Multibeam Bathymetric Survey**

   - Full coverage multibeam echosounder survey of the defined area in front of the quay wall.
   - Acquisition of high-density bathymetric data with real-time positioning, motion compensation, sound velocity profiling, and system calibration.
   - Quality control and data acquisition in accordance with IHO S-44 requirements.

3. **Sub-Bottom Profiling / Shallow Seismic Survey**

   - High-resolution shallow seismic reflection survey using a sub-bottom profiler instrument to delineate seabed sediments and shallow geological layers.

- Georeference the profile data suitable for interpretation of sediment thickness and subsurface interfaces relevant to dredging and quay wall design.

4. Data Processing and Deliverables

- Processing, validation, and interpretation of bathymetric and geophysical data using industry-standard software.
- Preparation of bathymetric charts, contours, digital terrain models, seismic profiles, and interpretative drawings.
- Submission of a consolidated technical report and all digital datasets in formats compatible with engineering design and construction planning.

All survey activities were executed with due consideration of **live port operations**, ensuring minimal disruption and full compliance with DP World Pakistan's safety, operational, and permitting requirements.

3 Team Mobilization

On 28th January 2026, key members of the TCI field team mobilized to site following the issuance of the work order by DP World, marking the commencement of the assigned works. Pursuant to this authorization, the necessary clearances and No-Objection Certificate (NOC) were obtained from the Port Qasim Authority (PQA) Harbour Master for the sailing and operation of TCI's survey vessel "Breakwater", together with its crew, as detailed in Table 1.

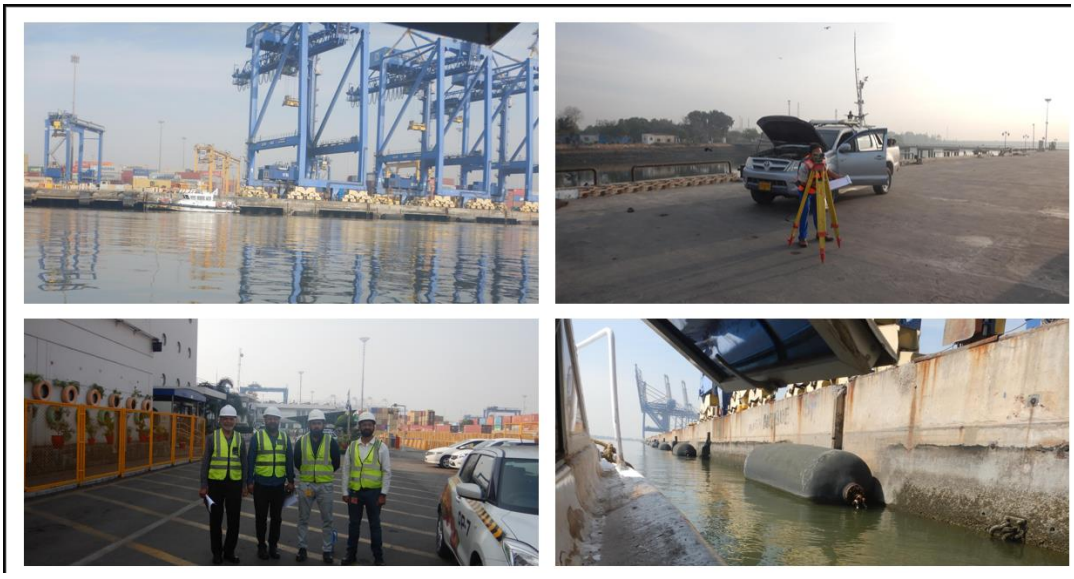
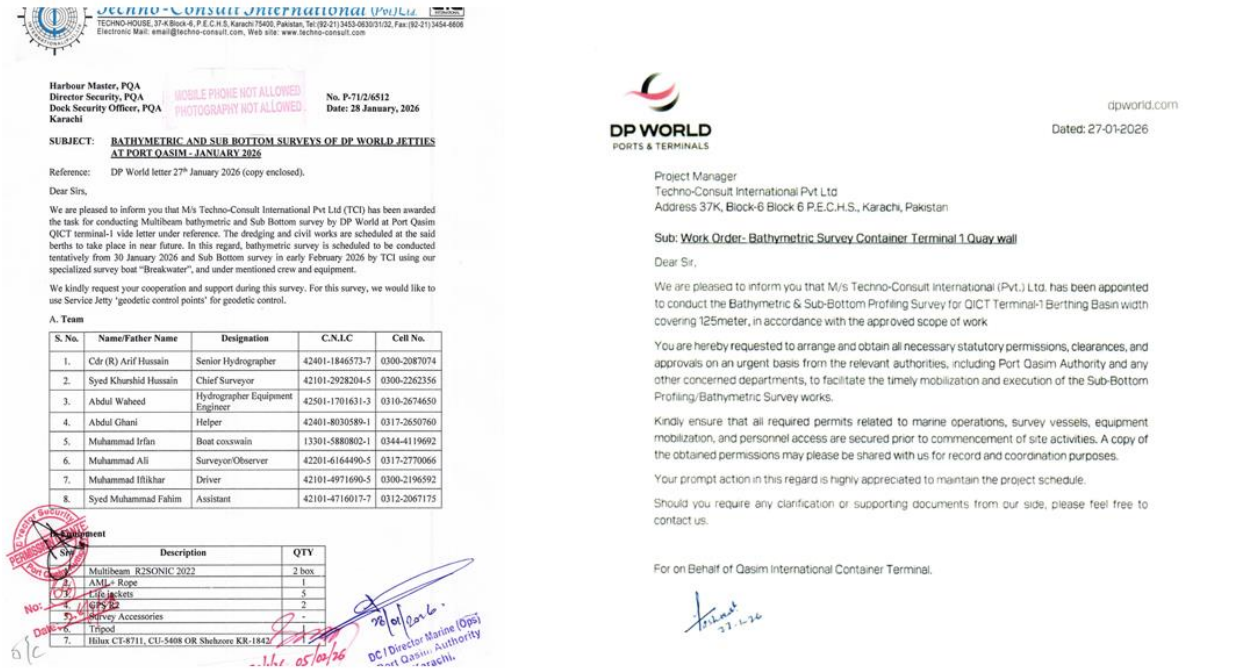


Figure 3. TCI field mobilization



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Harbour Master, PQA
Director Security, PQA
Dock Security Officer, PQA
Karachi

MOBILE PHONE NOT ALLOWED
PHOTOGRAPHY NOT ALLOWED

No. P-71/2/6512
Date: 28 January, 2026

SUBJECT: BATHYMETRIC AND SUB BOTTOM SURVEYS OF DP WORLD JETTIES AT PORT QASIM - JANUARY 2026

Reference: DP World letter 27th January 2026 (copy enclosed).

Dear Sirs,

We are pleased to inform you that M/s Techno-Consult International Pvt Ltd (TCI) has been awarded the task for conducting Multibeam bathymetric and Sub Bottom survey by DP World at Port Qasim QICT terminal-1 vide letter under reference. The dredging and civil works are scheduled at the said berths to take place in near future. In this regard, bathymetric survey is scheduled to be conducted tentatively from 30 January 2026 and Sub Bottom survey in early February 2026 by TCI using our specialized survey boat "Breakwater", and under mentioned crew and equipment.

We kindly request your cooperation and support during this survey. For this survey, we would like to use Service Jetty 'geodetic control points' for geodetic control.

A. Team

S. No.	Name/Father Name	Designation	C.N.I.C	Cell No.
1.	Cdr (R) Arif Hussain	Senior Hydrographer	42401-1846573-7	0300-2087074
2.	Syed Khurshid Hussain	Chief Surveyor	42101-2928204-5	0300-2262356
3.	Abdul Waheed	Hydrographer Equipment Engineer	42501-1701631-3	0310-2674650
4.	Abdul Ghani	Helper	42401-8030589-1	0317-2650760
5.	Muhammad Irfan	Boat coxswain	13301-5880802-1	0344-4119692
6.	Muhammad Ali	Surveyor/Observer	42201-6164490-5	0317-2770066
7.	Muhammad Iftikhar	Driver	42101-4971690-5	0300-2196592
8.	Syed Muhammad Fahim	Assistant	42101-4716017-7	0312-2067175

B. Equipment

S/No	Description	QTY
1.	Multibeam R2SONIC 2022	2 box
2.	AML+ Rope	1
3.	Life jackets	5
4.	GPS 72	2
5.	Survey Accessories	-
6.	Tripod	1
7.	Hilux CT-8711, CU-5408 OR Shehzore KR-1842	1

DC / Director Marine (Ops)
Port Qasim Authority
Karachi.

DP WORLD
PORTS & TERMINALS

dpworld.com

Dated: 27-01-2026

Project Manager
Techno-Consult International Pvt Ltd
Address 37K, Block-6 Block 6 P.E.C.H.S., Karachi, Pakistan

Sub: Work Order- Bathymetric Survey Container Terminal 1 Quay wall

Dear Sir,

We are pleased to inform you that M/s Techno-Consult International (Pvt.) Ltd. has been appointed to conduct the Bathymetric & Sub-Bottom Profiling Survey for QICT Terminal-1 Berthing Basin width covering 125meter, in accordance with the approved scope of work

You are hereby requested to arrange and obtain all necessary statutory permissions, clearances, and approvals on an urgent basis from the relevant authorities, including Port Qasim Authority and any other concerned departments, to facilitate the timely mobilization and execution of the Sub-Bottom Profiling/Bathymetric Survey works.

Kindly ensure that all required permits related to marine operations, survey vessels, equipment mobilization, and personnel access are secured prior to commencement of site activities. A copy of the obtained permissions may please be shared with us for record and coordination purposes.

Your prompt action in this regard is highly appreciated to maintain the project schedule.

Should you require any clarification or supporting documents from our side, please feel free to contact us.

For on Behalf of Qasim International Container Terminal.

Figure 4. Letter of award and NOC issuance - PQA.

S. No	Name	Designation
1	Crd R Arif Hussain	Senior Hydrographer / Geologist
2	Syed Khursheed Hussain	Chief Surveyor
3	Abdul Waheed	Hydrographer / Equipment Engineer
4	Mohammad Irfan	Boat coxswain
5	Muhammad Ali	Assistant Surveyor
6	Muhammad Iftikar	Vehicle Driver
7	Syed Mohammad Fahim	Assistant

Table 1. TCI field team mobilization.

In addition to the field team, TCIs in-house office team working on this assignment responsible for planning, processing, and reporting of all collected field data are listed below in Table 2.

Name	**Position**	**Education**	**Experience Summary**
Azeem Ahmed	Project Manager	MSc Coastal Engineering / Ports & Waterways Design – TU Delft, Netherlands BASc Civil Engineering – University of Toronto, Canada	7+ years' experience in large-scale marine & coastal infrastructure projects; expertise in marine field investigations, technical reporting, numerical modelling support; strong communication & stakeholder management capabilities.

Name	Position	Education	Experience Summary
Cdr. (Rtd.) Muhammad Ashraf	Senior Hydrographer / Dredging Specialist	MSc Oceanography – University of Southampton, UK	40+ years of hydrographic, oceanographic, and dredging supervision experience with Pakistan Navy & Karachi Port Trust; Former Chief Hydrographer KPT; supervised major capital dredging works including PDWCP.
Cdr. (Rtd.) Arif Hussain	Senior Hydrographer & Geophysical/Geotechnical Specialist	MSc Geology – University of Karachi • Advanced Hydrography Certification – Canada – H1 / CAT-B • Marine Geophysics Training – ISA/UN	35+ years' experience in hydrographic surveys, marine geophysics, geotechnical assessments, dredging studies; extensive port & coastal project involvement across Pakistan and region.
Shafat Ahmed	Principal Port Engineer / Marine Structures Specialist	MEng Structural Engineering –SEATO Graduate School of Engineering, Bangkok • BEng Civil Engineering – N.E.D. College, University of Karachi	20+ years' experience in port planning, jetty & quay wall design, structural engineering of marine facilities; specialist in BS 6349–compliant marine structures.
Faisal Aziz	Data Processing expert	MSc Computer Science (Software Engineering) – PAF KIET	20+ years' experience in GIS, remote sensing, and spatial data management; supported hydrographic, port, coastal, and infrastructure projects experienced in geodatabase development, satellite imagery analysis, and GIS support for marine and dredging projects.
Muhammad Qasim	Data Processing operator	Electronic Engineer / Data Processing & GIS Specialist B.Eng Electronics – PAF Karachi Institute of	7+ years' experience in electronic engineering, GIS, and data analysis; skilled in QGIS, AutoCAD, MATLAB, and Python. Worked on

Name	Position	Education	Experience Summary
		Economics & Technology, Karachi	Port Qasim, BYCO, CPHGC, and Engro marine projects.
Momin Khan	Data Processing operator	B.S. Computer Science • Intermediate (Pre-Engineering) –	7+ years' experience in marine surveying, GIS, bathymetry, and topographical data analysis; skilled in QGIS, AutoCAD, Python, MATLAB, and hydrographic survey systems.

Table 2. TCI in-house office team deputed for this assignment.

4 Vertical Datum and Horizontal Control

For all survey activities, the local Port Qasim Chart Datum, established at control point S040 at the Service Jetty, was adopted as the vertical reference. All measured depths were reduced to Chart Datum using the (K–N) tidal correction value of **46.03m**, which represents the vertical offset between the WGS-84 ellipsoid and the local Chart Datum. The adopted chart datum definition and associated reduction methodology were confirmed with the Client prior to commencement of the survey. An illustration of the datum reduction procedure using the (K–N) value is presented in Figure 5.

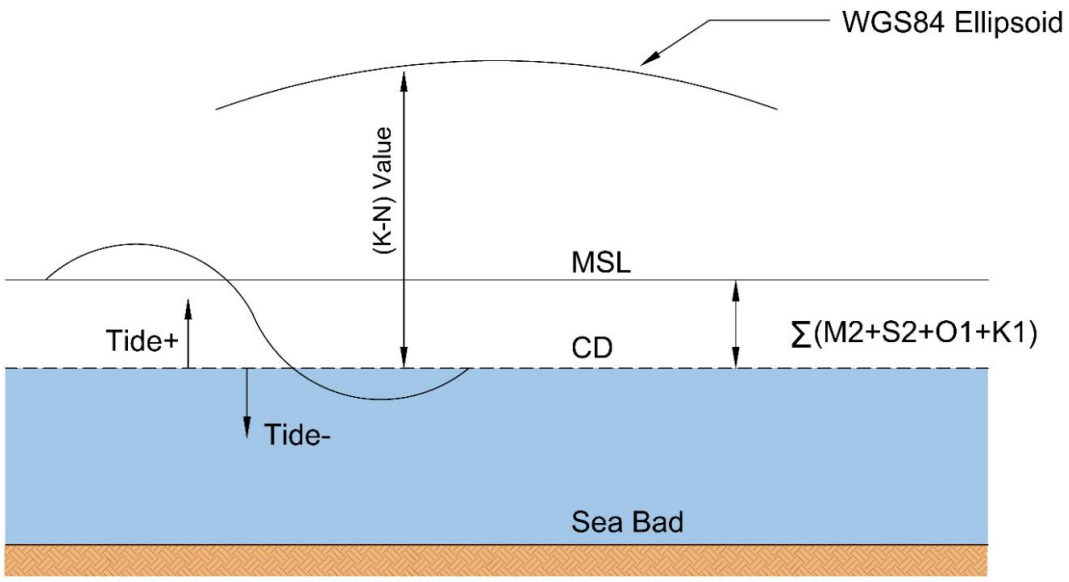

Figure 5. Local chart datum, (K-N) value schematic.

Horizontally, all survey data were referenced to the World Geodetic System 1984 (WGS-84). Positioning was recorded in geographic coordinates (latitude and longitude, decimal degrees) and subsequently projected to the Universal Transverse Mercator (UTM) coordinate system, Zone 42R, to support accurate spatial analysis, mapping, and seamless integration with downstream engineering design outputs.

4.1 Base Station and Tide Gauge

As depicted in Figure 6, a GNSS base station was established at a known control point at the Port Qasim Service Jetty, where the Chart Datum level is defined, to resolve the (K–N) value. The base station was operated in conjunction with the Post-Processed Kinematic (PPK) and Real Time Kinematic (RTK) positioning technique(s), described in the following sections, to derive precise vessel trajectory and positioning solutions during bathymetric and sub-bottom surveys.

In addition, a tide gauge (RBR Duet instrument) was deployed at the same location (Figure 7) for the full duration of the survey works to enable independent verification of tidal reductions applied to the bathymetric datasets. All tidal records, calibration details, and verification plots were compiled and submitted to the Client as part of the survey deliverables.

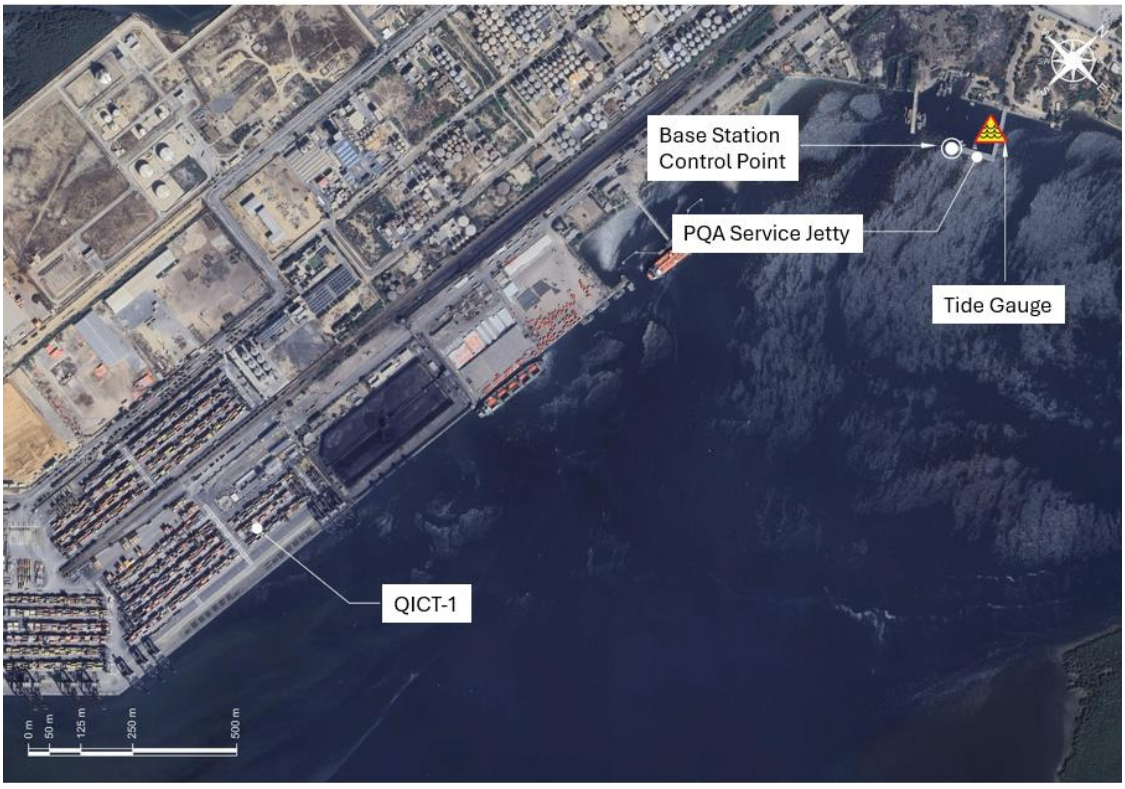

Figure 6. GNSS base station and tide gauge installation location - PQA Service Jetty.

Figure 7. RBR Duet pressure sensor tide gauge installation at PQA Service Jetty.

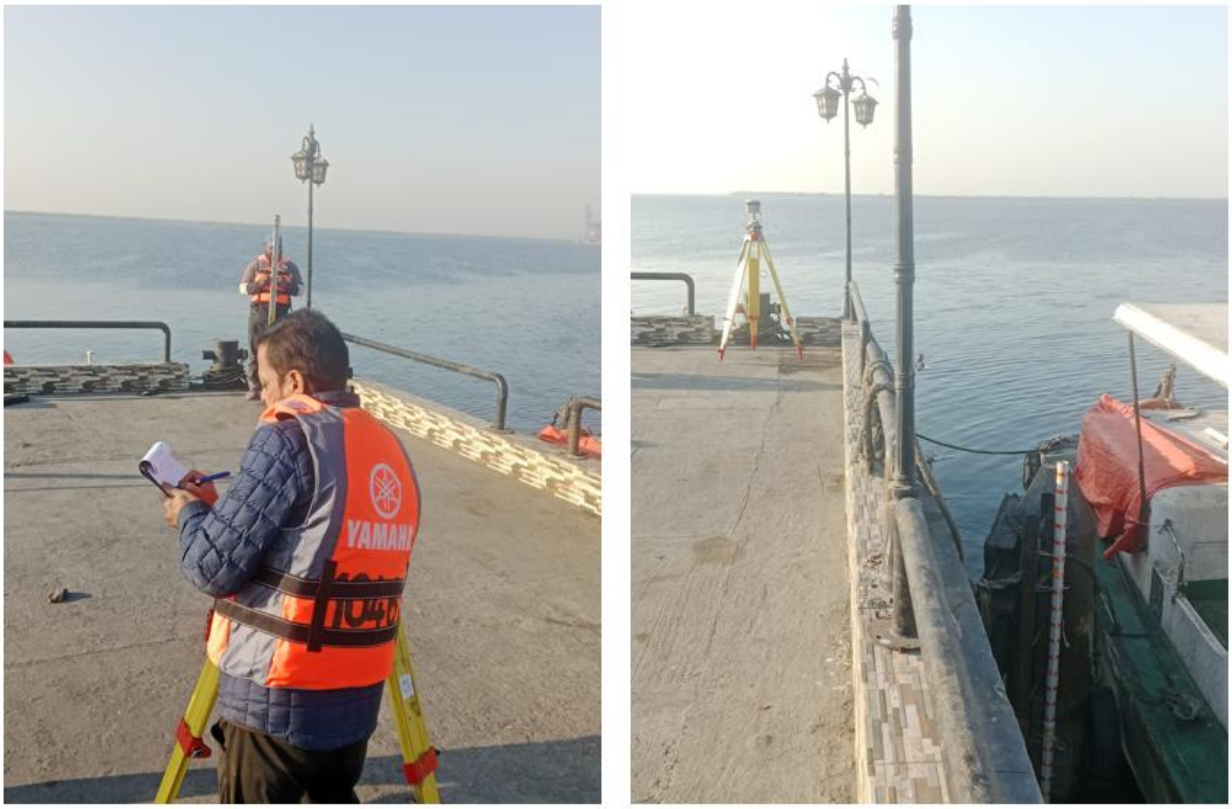

Figure 8. GNSS base station at control point S040, PQA Service Jetty.

5 Survey Execution Methodology

Outlined in Figure 9 below is the flow chart depicting the general execution methodology for both bathymetric and sub-bottom profiling survey(s). Specific details for each survey are described in the proceeding sections.

Figure 9. Survey execution methodology - general flow chart.

6 Multibeam Bathymetry

A multibeam bathymetric survey of the area depicted in Figure 10, covering approximately 108,000 m², was successfully undertaken by TCI on 30th January 2026.

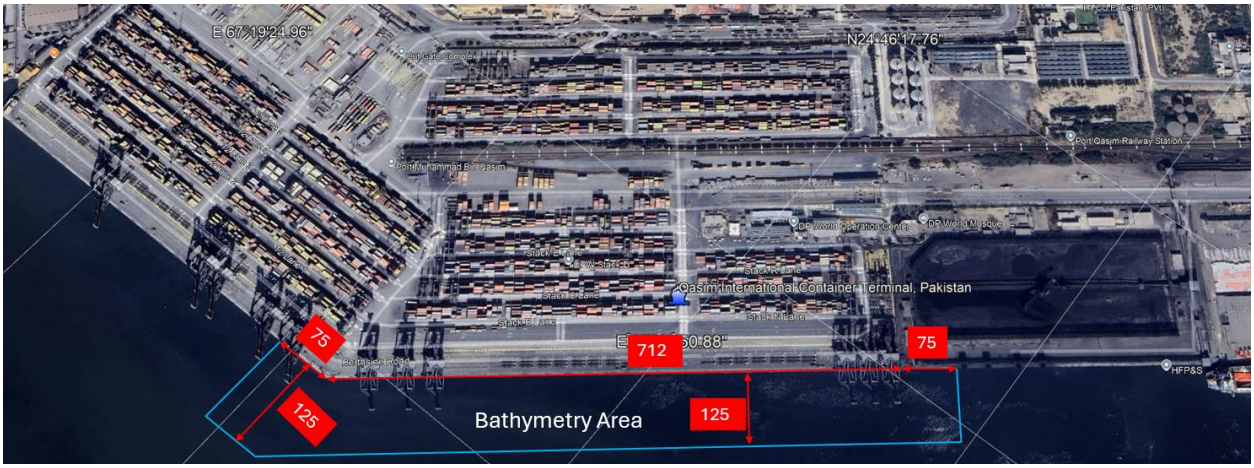

Figure 10. Bathymetry area extents.

The survey was carried out using an industry-leading R2 Sonic 2022 multibeam echosounder, integrated with a Surf-Master inertial measurement unit (IMU) and a Valeport sound velocity probe rigidly mounted at the transducer head to enable continuous, real-time sound velocity monitoring. Detailed equipment specifications are provided in Appendix D (Figure 11).

Figure 11 TCI R2 Sonic Multibeam instrument.

In addition to real-time sound velocity measurements, independent sound velocity casts were conducted at regular intervals and at key stages of the tidal cycle to ensure the highest sounding accuracy. These casts were acquired using an AML Base X2 sound velocity profiler - Figure 12

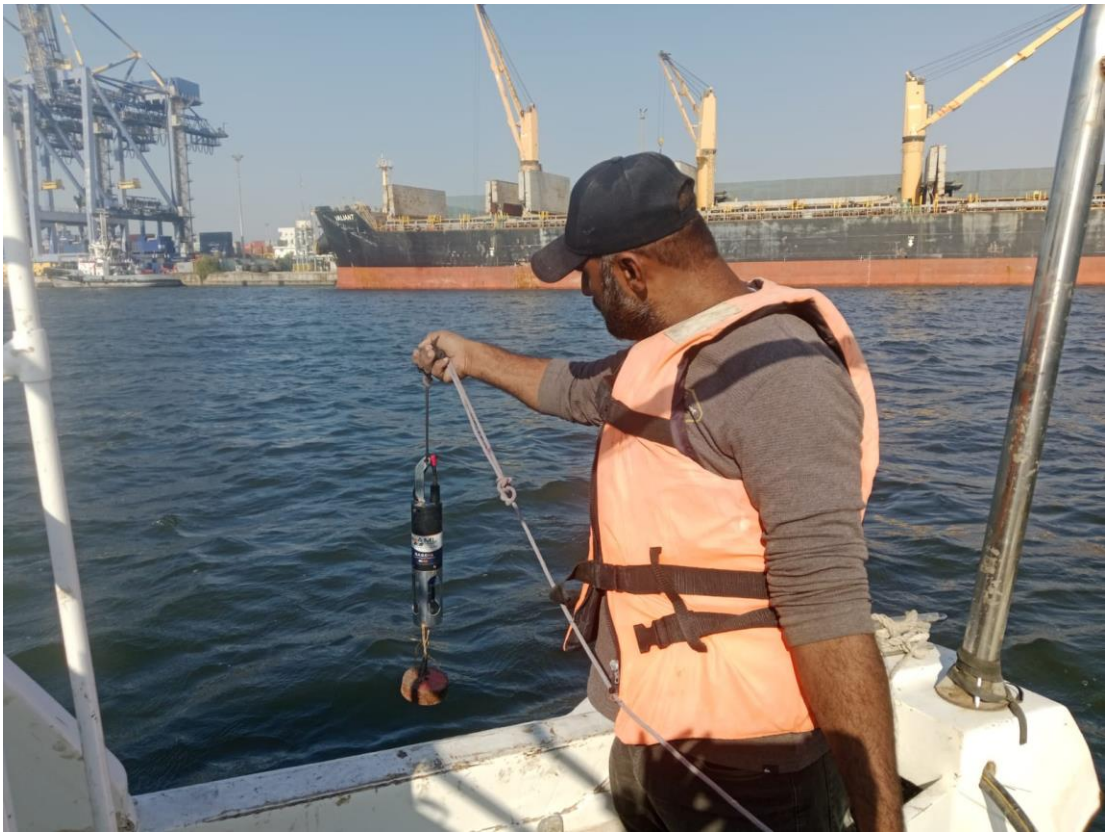

Figure 12. Sound velocity casting at regular intervals using AML Base X2 instrument.

Vessel positioning and trajectory solutions were resolved using the Post-Processed Kinematic (PPK) GNSS technique, providing high-accuracy horizontal and vertical positioning throughout the survey. A GNSS base receiver was established at a known control point at the Port Qasim Service Jetty to support subsequent trajectory processing.

All required system calibration and verification tests, including patch tests, latency checks, and sensor alignment verification, were completed in accordance with internationally recognized best practices, as described in the preceding section.

The multibeam survey was executed using TCI's self-owned survey vessel "Breakwater". The multibeam system was pole-mounted to the vessel to ensure positional stability and consistent transducer geometry throughout data acquisition – Figure 13. A representative from the client was also present during survey operations- Figure 14

Figure 13. TCI survey vessel "Breakwater" with pole mounted multibeam system.

Figure 14. Representative from the client (DP world) present during data acquisition.

During survey operations, vessel speed was strictly controlled and did not exceed 5 knots, minimizing the risk of air entrainment and bubble sweep-down near the transducer that could otherwise introduce noise artifacts into the dataset. –Figure 15

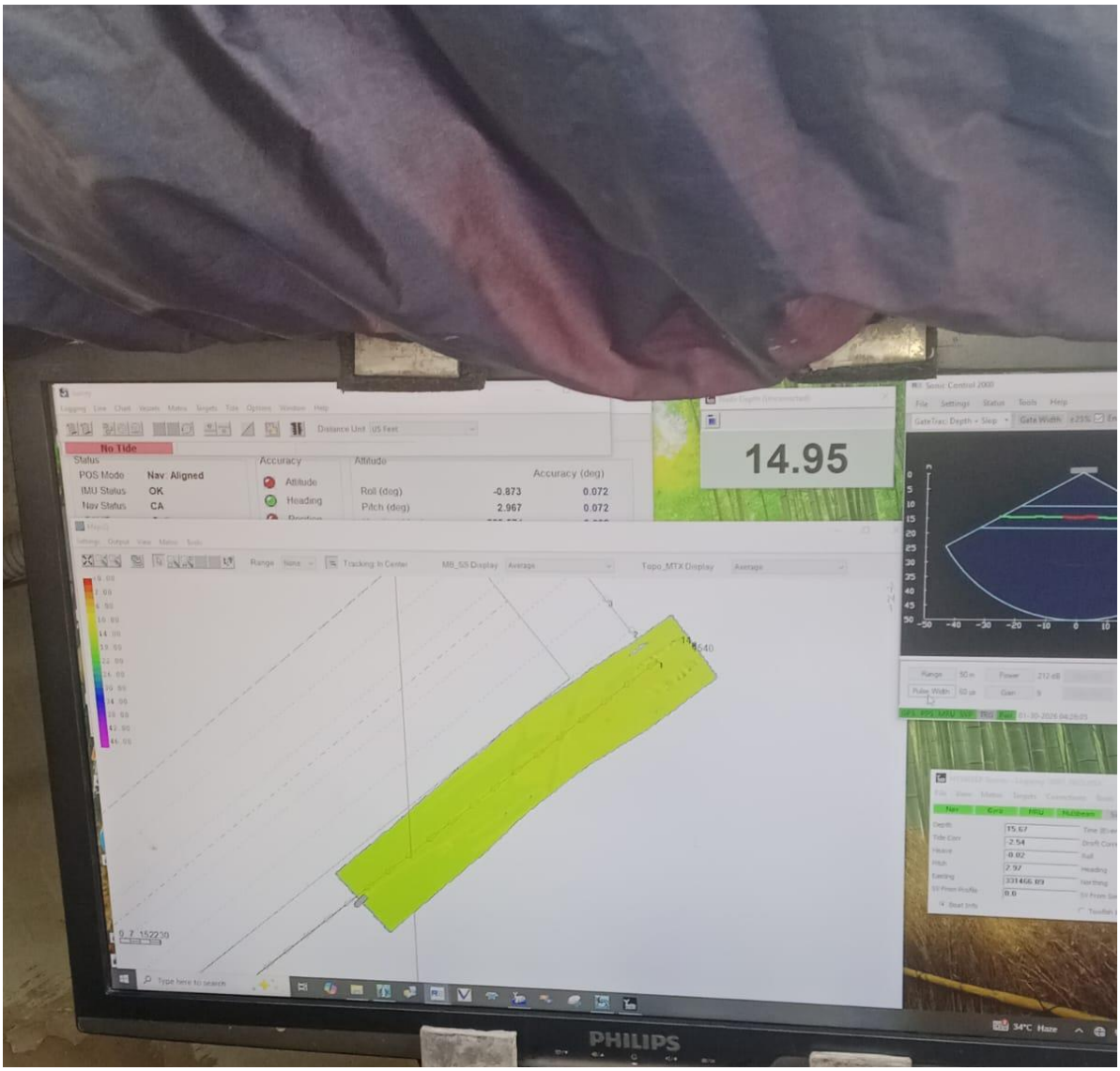

Figure 15 Real time data acquisition- Multibeam.

For tidal referencing and depth reduction, a duly calibrated independent water level sensor (pressure gauge) was installed at the Port Qasim Service Jetty, located within approximately 5 km of the survey site. Recorded water level data were used to independently verify the tidal corrections applied to the bathymetric dataset- reference to section 4.1 above.

The R2 Sonic system's user-adjustable swath angle and operating frequency were configured in accordance with the RFP requirements. A swath width of approximately 100 degrees, with a minimum overlap of 20%, was employed to ensure full coverage of the approximately 108,000 m² survey area (Figure 16).

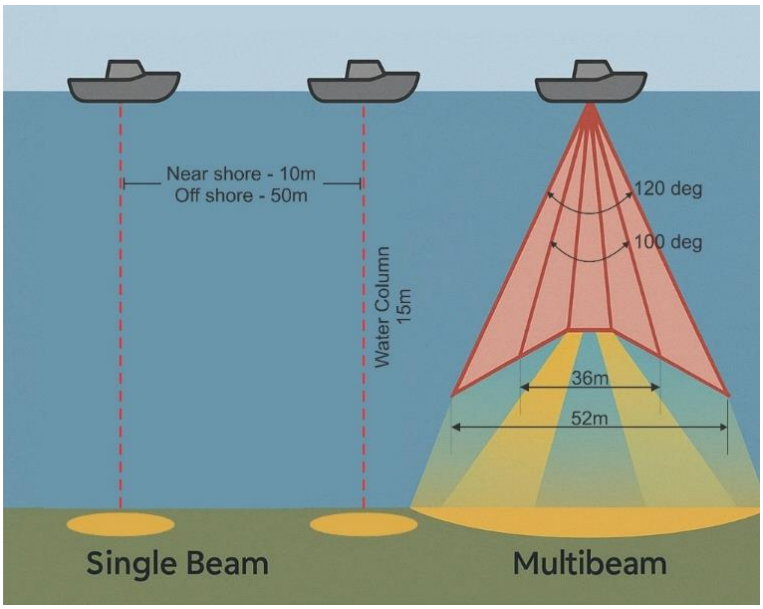

Figure 16. Multibeam area insonified, and user adjustable swath width.

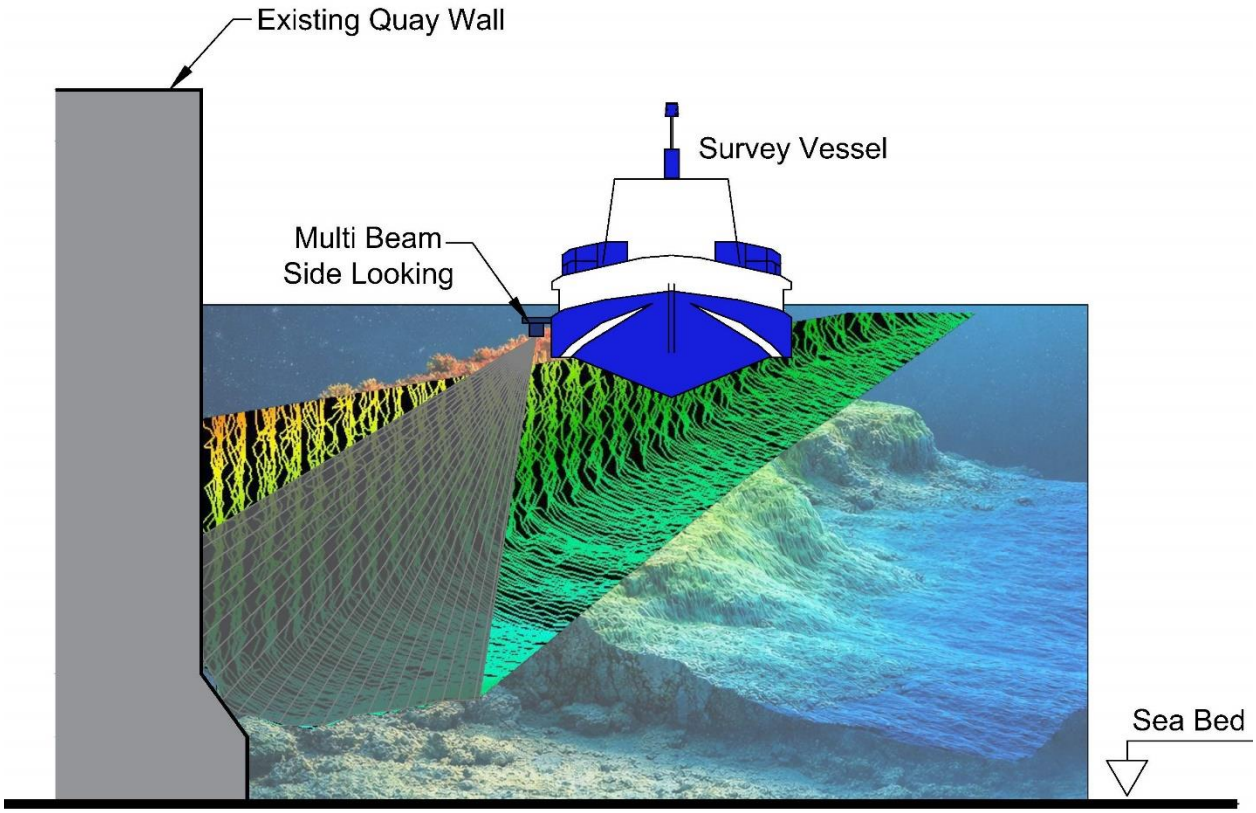

Figure 17. Multibeam "beam steering" to capture quay wall in greater detail.

HYPACK / HYSWEEP software was used for survey line planning, real-time data acquisition, and post-processing. Survey lines were oriented longitudinally along the existing quay wall, with a nominal line spacing of 20 m, to optimize coverage and data density in areas critical to quay wall

assessment and design - Figure 18. In addition, the system's beam-steering capability was utilized to enhance data quality along the quay wall toe and seabed interface, enabling detailed assessment of localized seabed conditions and potential scour features (Figure 17) – results depicted in section 6.4.2 below.

Figure 18. Planned survey lines - multibeam bathymetry.

6.1 PPK Positioning – Multibeam Bathymetry

TCI employed the PPK GNSS positioning technique, recognized as one of the most accurate and robust methods for bathymetric surveying. Unlike real-time kinematic techniques, PPK eliminates line-of-sight and telemetry constraints while providing centimetric accuracy in both horizontal and vertical positioning.

PPK Workflow Summary (Executed):

- A GNSS base receiver was established onshore at a known control point and recorded raw satellite and ephemeris data.
- A GNSS rover installed on the survey vessel logged synchronized positional data.
- The multibeam IMU continuously recorded vessel attitude parameters (roll, pitch, heave, and yaw).
- Base and rover GNSS data were processed using Applanix POSPac software to generate an optimized vessel trajectory solution.

- The processed trajectory was imported into HYPACK, where positional and attitude corrections were applied to all depth soundings.

6.2 Bathymetric Survey Area Coverage

Presented in Figure 19 is the actual area coverage of the multibeam survey, of approximately 113,000 m2, over and above the area limits prescribed in the RFP (red box, Figure 19). Along the T1 and T2 quay wall, no gaps in data were present and sufficient overlap was maintained throughout to ensure seamless coverage.

Figure 19. Bathymetric area coverage.

However, the minor area portion of about 25x44m towards the east of the survey limits, encroached upon the China Coal Terminal (Berth number 4), where a coal bulk vessel was moored. Given the unknown operational vacancy status of this berth, and it falling outside of DP World jurisdiction warranting separate permission and NOC clearance, this area has been omitted for the time being.

Note: *TCI remains committed to completing the full survey coverage. Coordination is ongoing with the China Coal Terminal operator and the PQA Harbour Master to obtain the necessary permissions and confirm berth vacancy so that the small remaining area can be surveyed. However, as this portion lies within another terminal's operational zone, berth availability and access are subject to the terminal operator's schedule and operational constraints, and therefore cannot be confirmed at present. TCI continues to liaise with the terminal's operations planning focal person to facilitate access at the earliest possible opportunity.*

6.3 Multibeam System Calibration Tests & Validation

Prior to commencement of data acquisition, the multibeam system was fully calibrated in accordance with recognized international hydrographic standards. All required calibration and verification tests were completed during the survey mobilization and acquisition window.

Multibeam Calibration and Validation Tests Completed:

- Offset measurements from the vessel reference point
- Latency testing
- Patch testing (roll, pitch, and yaw alignment)
- GAMMS testing
- Tide verification checks
- Sound velocity casting at appropriate intervals during the survey
- Cross line depth matching

6.3.1 Patch Test Results

The patch test determines the offset or angular misalignment between the sonar transducer head and the IMU. It is performed only after the multibeam system has been mounted on a specific vessel. These calibration procedures are therefore specific to a particular equipment setup and/or vessel, and not to a project or client.

- **Pitch Error:**

  Data collection was carried out over a steep slope to determine pitch misalignment. One survey line was run twice in reciprocal directions at a survey speed of approximately 6 knots. The resulting datasets were analysed in HYPACK HYSWEEP and overlaid to determine the angular error–induced spatial shift. **Pitch test result = 3.20 degrees**

- **Roll Error:**

  Data collection was conducted over an identifiable seabed object, followed by a reciprocal survey line over the same object. The datasets were analysed in HYPACK HYSWEEP and overlaid to determine the angular error–induced spatial shift. **Roll test result = 0.35 degrees**

- **Yaw Error:**

  Data collection was carried out over two parallel survey lines run in the same direction on either side of a seabed feature, spaced approximately two to three times the water depth apart. The datasets were analysed in HYPACK HYSWEEP and overlaid to determine the angular error–induced spatial shift.

  Yaw test result = 0.00 degrees

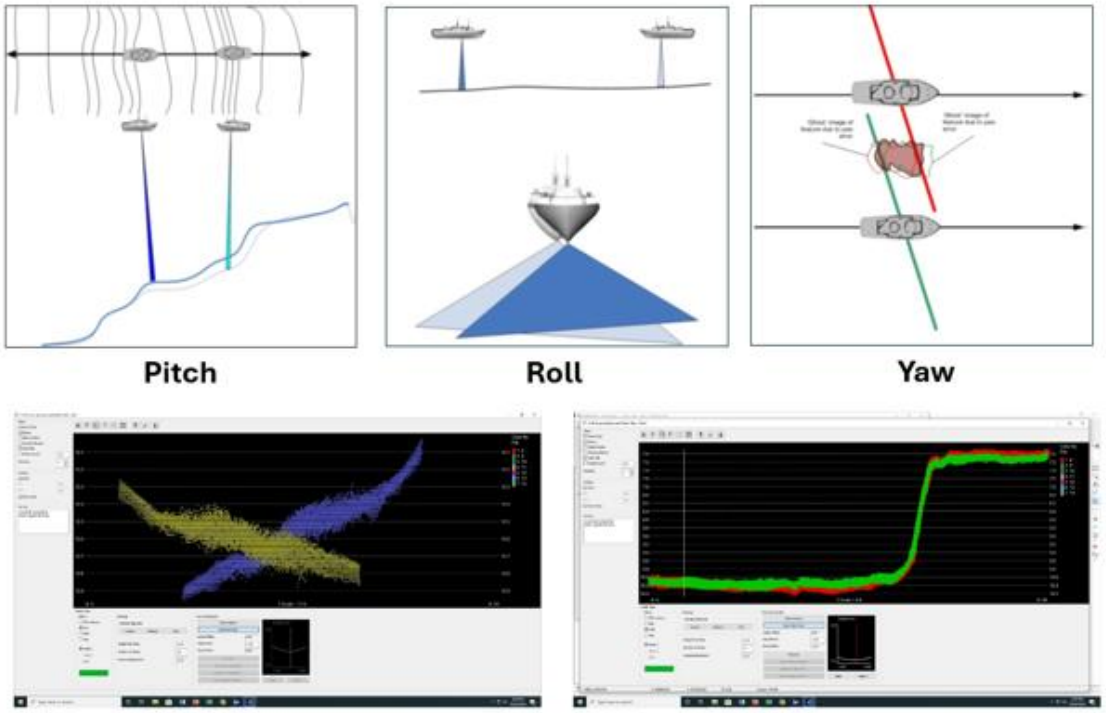

Figure 20. Depiction of patch test to correct for roll, pitch, and yaw, between transducer and IMU.

6.3.2 Tide Verification

The tide reduced by the multibeam system leveraging on the PPK technique and (K-N) value (reference to section 4) was verified against an installed tide gauge at service jetty and manual water level measurement. Figure 21 is proof of this, as can be seen the tidal data is well within acceptable tolerance.

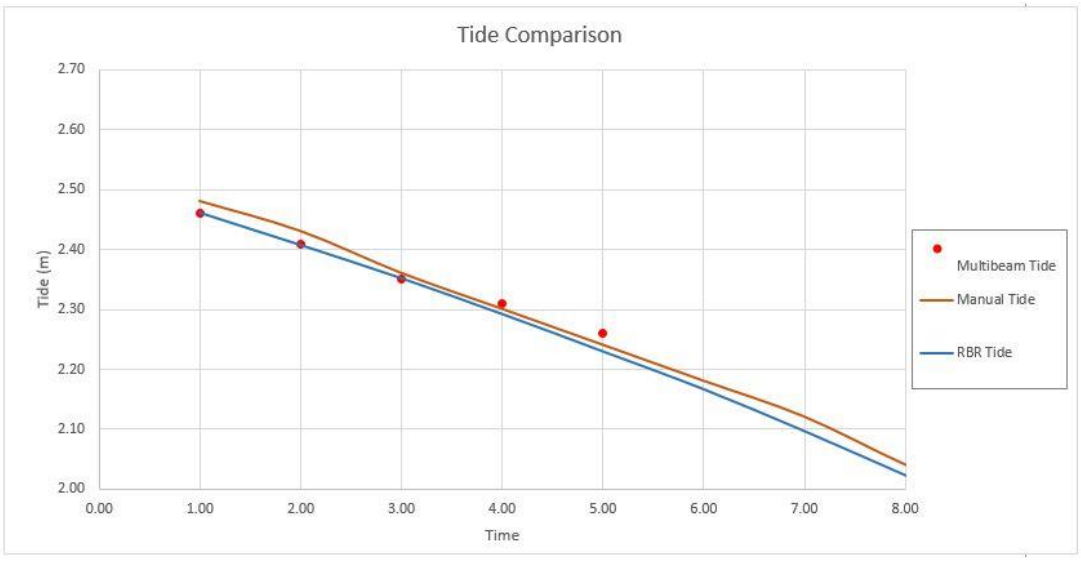

Figure 21. Tidal reduction verification, multibeam vs. tide gauge, vs. manual readings.

6.3.3 Sound Velocity Casting

Using and AML Base X2 instrument sound velocity casting was conducted to supplement the continuous real time sound velocity probe on the multibeam system. Casts were conducted throughout the survey at regular intervals (changing tidal stages) to capture the variation of sound velocity across the depth profile. Figure 22 depicts the various cast profiles.

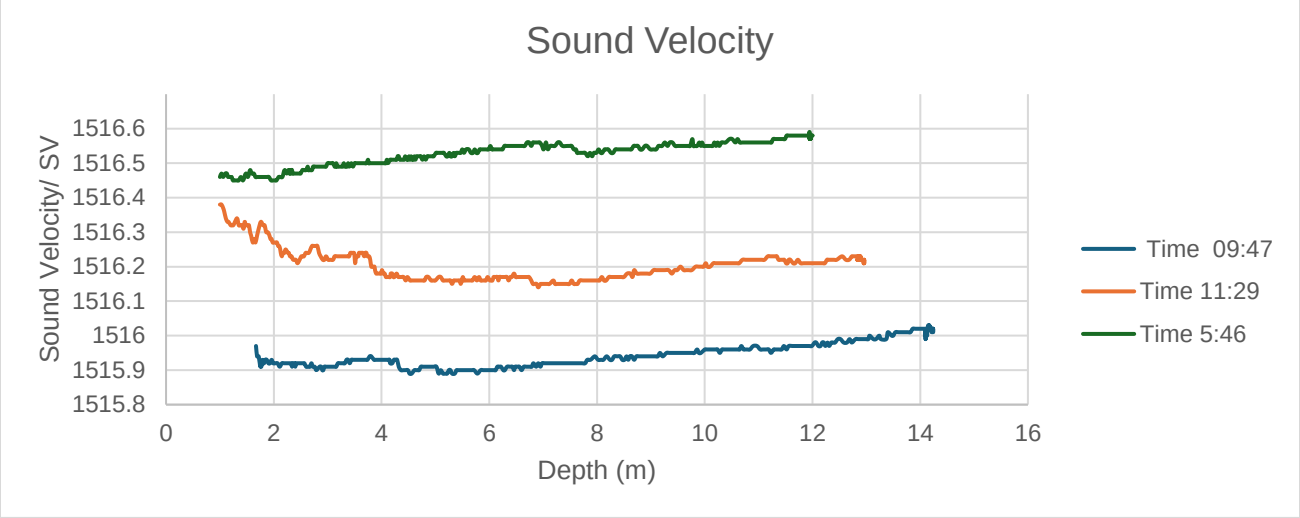

Figure 22. Sound velocity casting profiles – at various times.

6.3.4 Cross line Depth Matching

As a final data validation exercise for the multibeam system and the PPK GNSS positioning technique, selected test lines acquired under differing tidal conditions within the same survey period were compared to confirm depth matching within acceptable tolerances. Data points from different cross lines were visualized in 3D to ensure consistency and repeatability of the multibeam system – depicted in Figure 23.

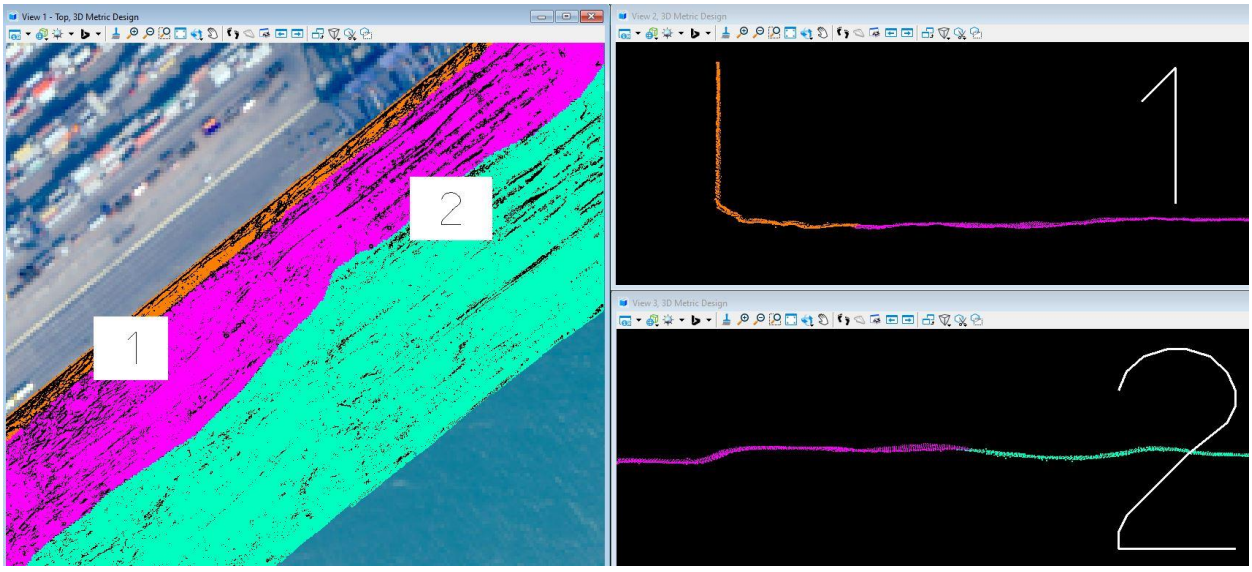

Figure 23. Overlapped / Crossline depth matching – assessment.

6.4 Bathymetric Survey Results

The full bathymetric chart is attached in Appendix A. The bathymetric data has been processing to create a digital elevation model with 3d renderings in Terra Modeller Software. The following sections depict the results and various 3D views of the seabed and submerged quay wall structure. Furthermore, bathymetric data is also provided in electronic format containing raw files, processed files, XYZ points, DWG, and DEM (Geo-tiff) files – see Section 9.

Based on Figure 24 below, the following salient features are identified:

- In general depths increases from the east towards the west along T1 going towards T2
- The most common depth range along T1 falls within the 12-14.9m class.
- Relatively shallow depths are found towards the eastern sector of T1, with patches ranging from 7.7-9m depth.
- The greatest depths are found alongside T2 with a range of 15.9 – 17.9m.
- Visible dredging marks (slashes) are present on the seabed alongside T1 & T2.

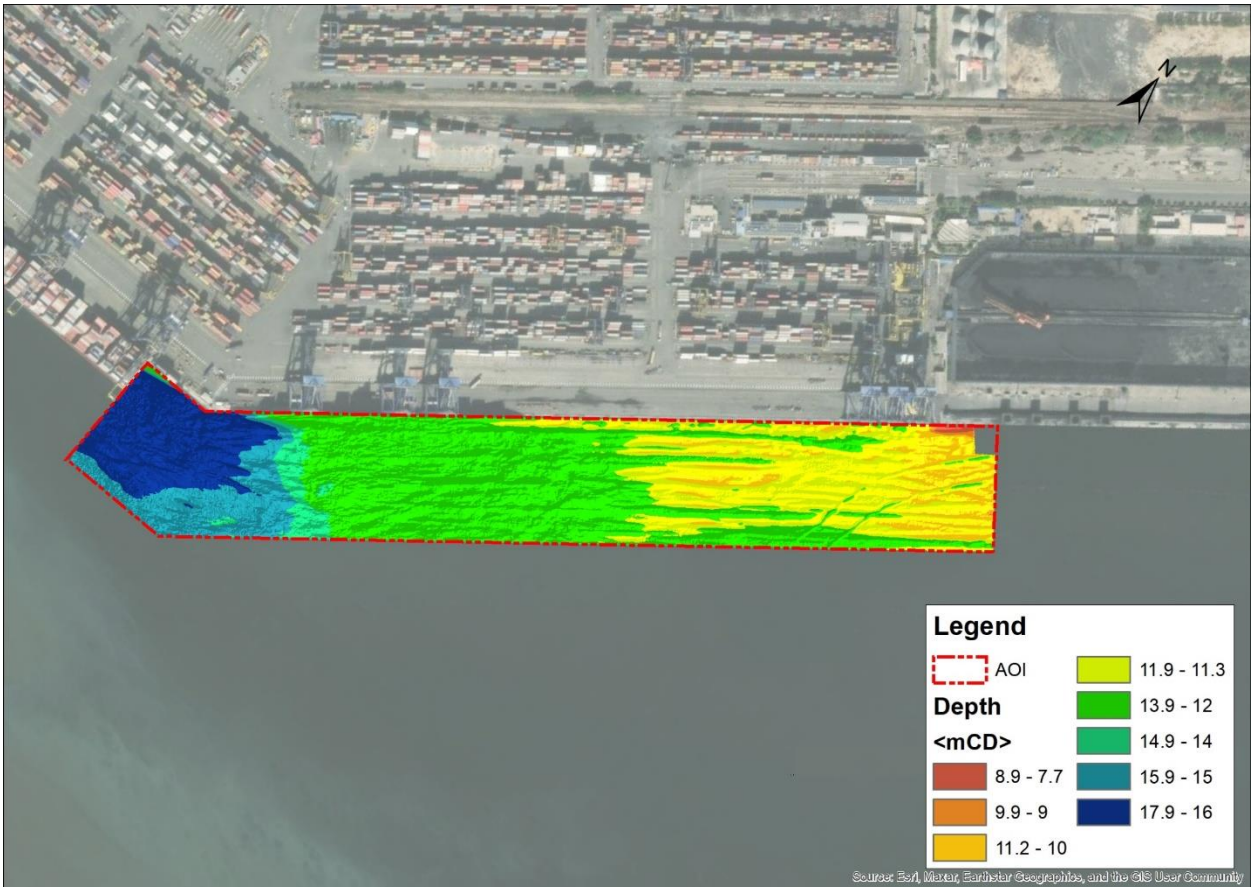

Figure 24. Digital Elevation Model (DEM) of acquired multibeam bathymetry – color coded depth measured from chart datum.

6.4.1 3D Surace Model Views

Figure 25 and Figure 26 depict 3D view(s) of the seabed digital terrain model created in Terra Modeller Software.

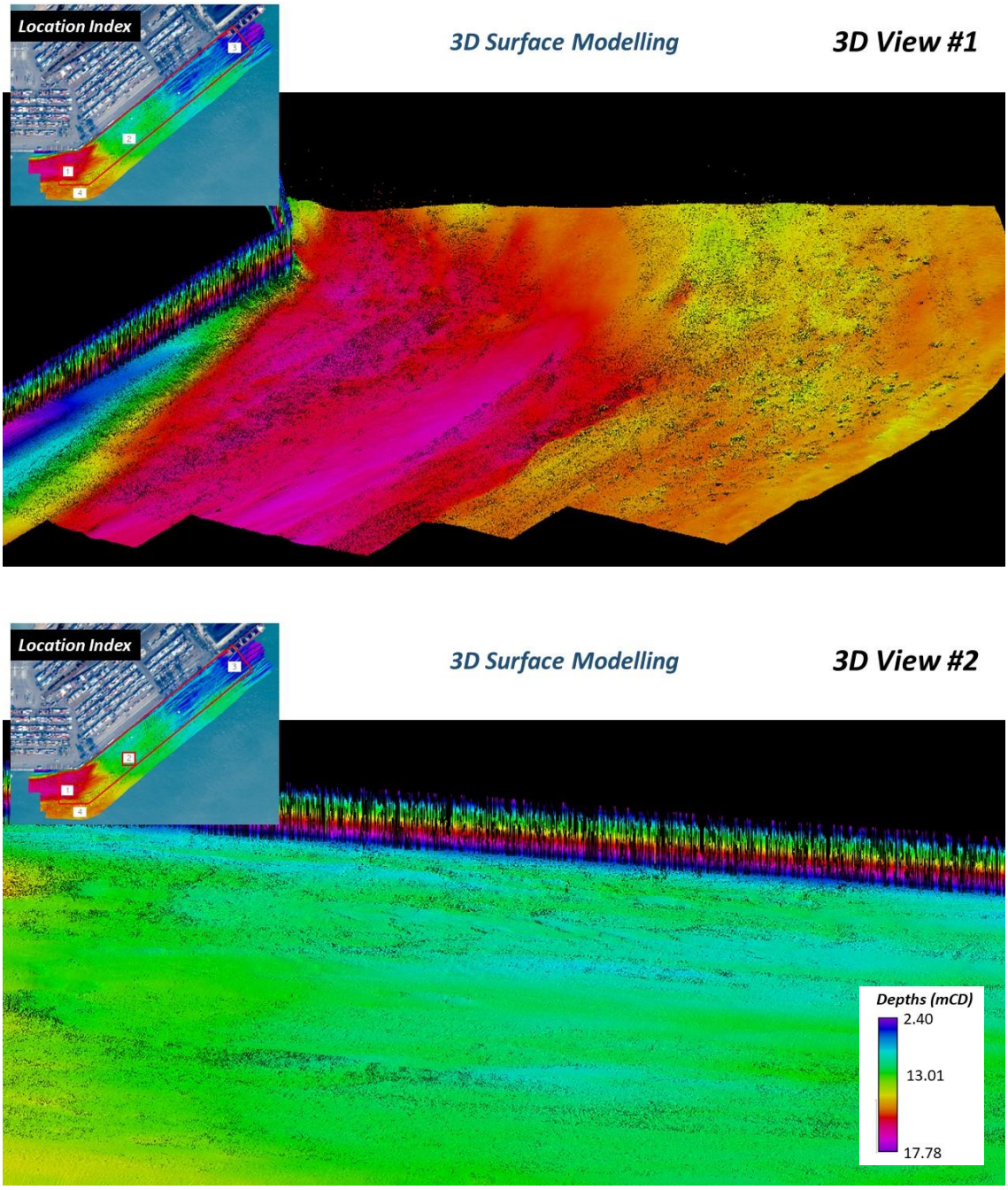

Figure 25 - View 1 & 2 of 3D model generated from Point Cloud Data

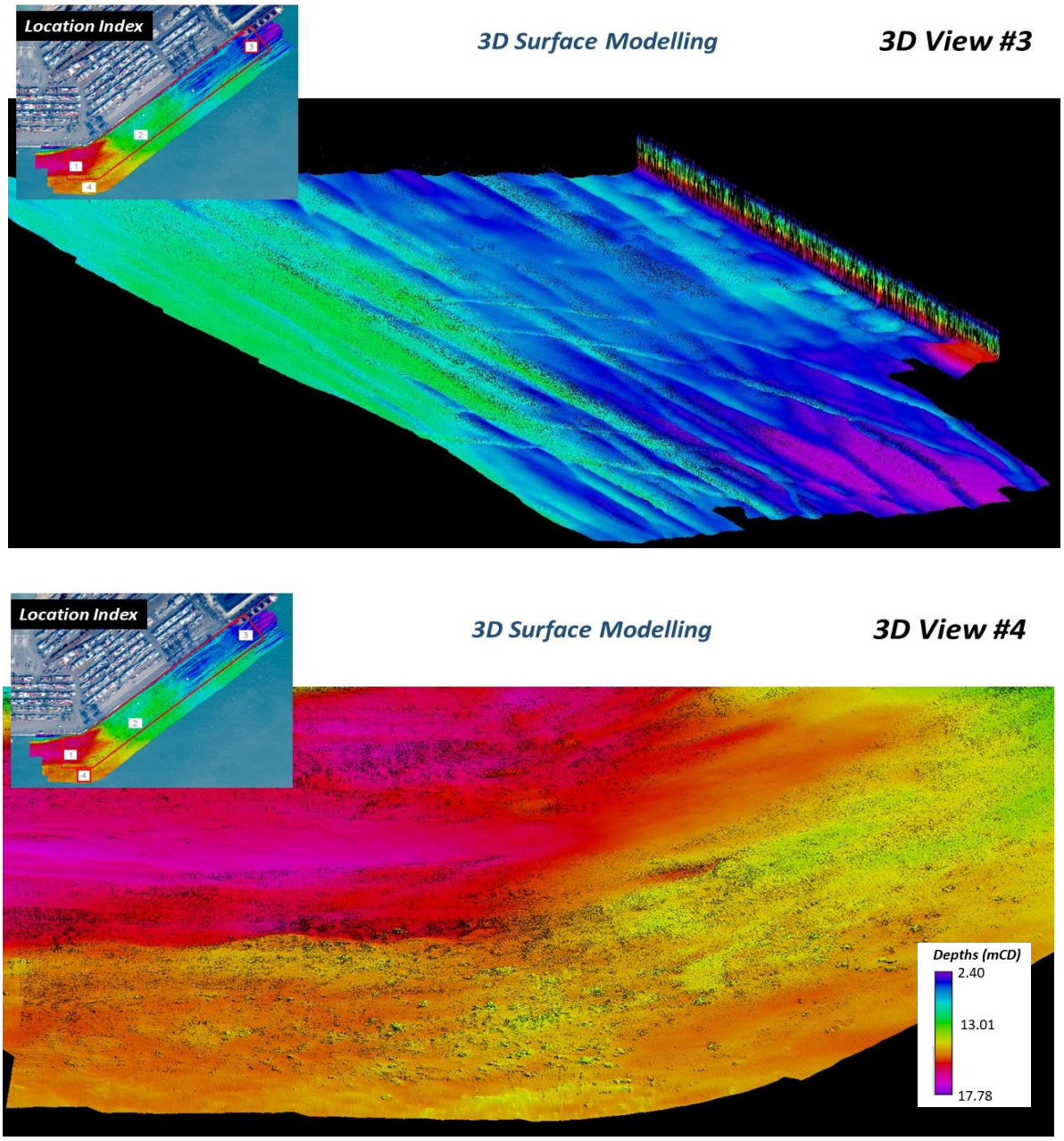

Figure 26 - 3D Model depicting dredging marks (View 3) and potential debris area (View 4)

6.4.2 Beam Steering – 3D Visualization

Figure 27 - Figure 29, show 3D visualization images of Quay wall sections acquired via MB Beam Steering technique.

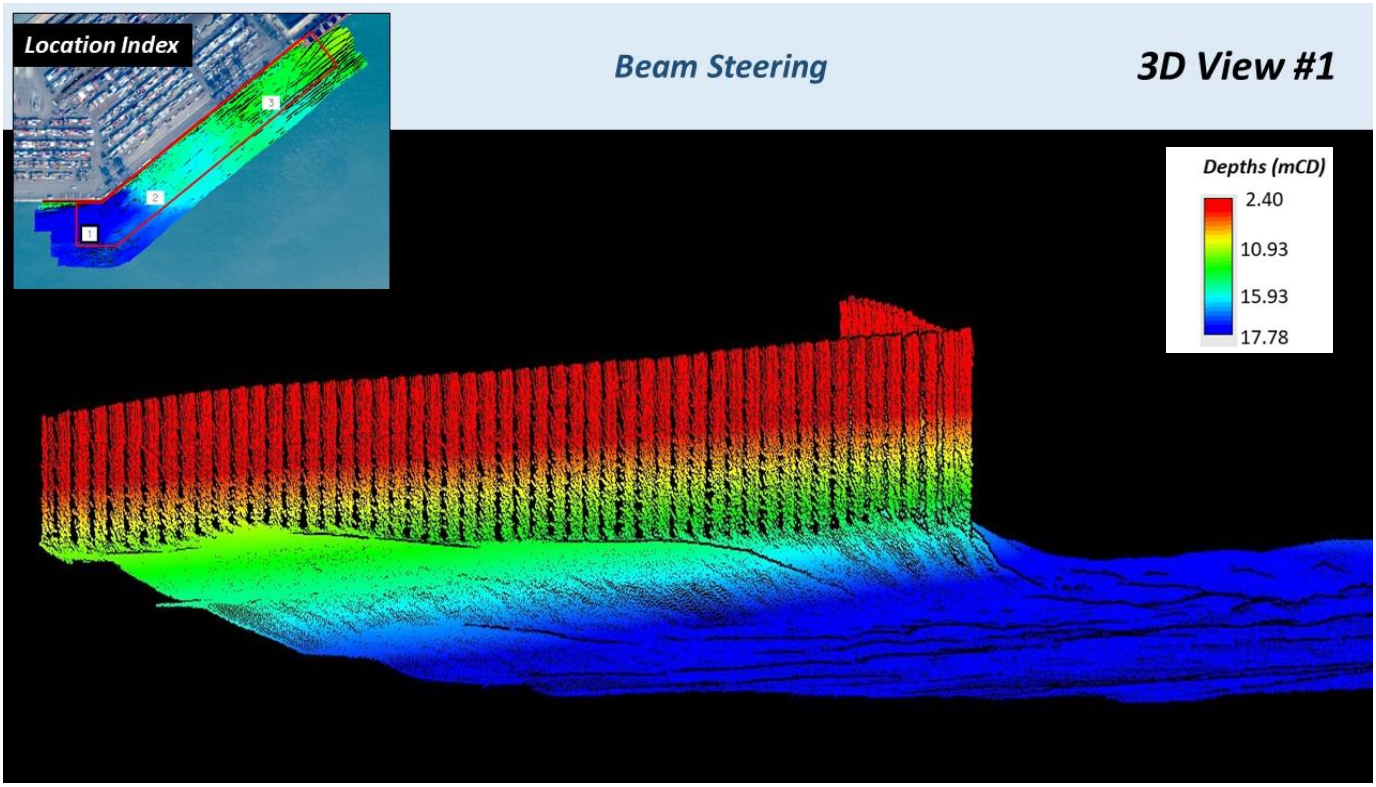

Figure 27 showing 3D visualization of subsea jetty piles structure (location 1)

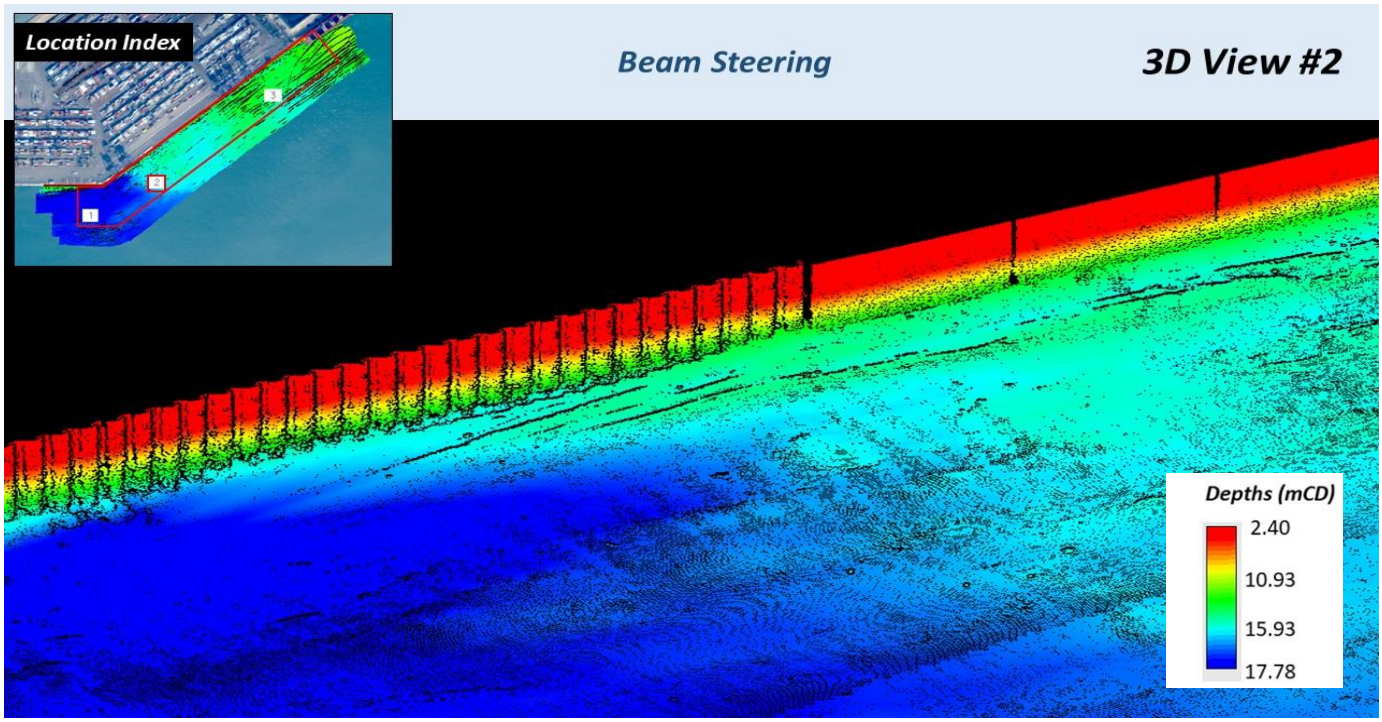

Figure 28 showing 3D visualization of sheet pile and pile structures (location 2)

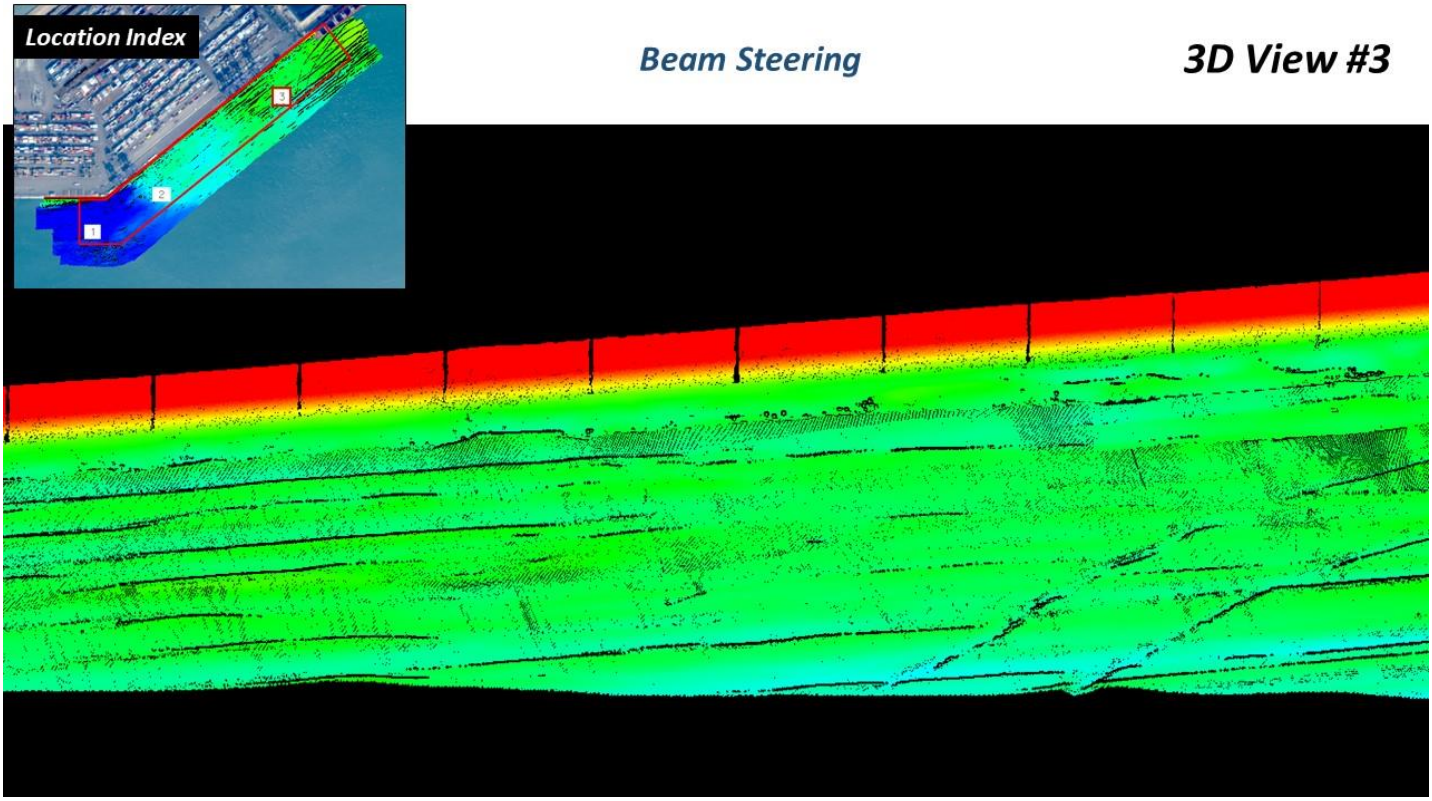

Figure 29 3D visualization of sheet pile structure (location 3)

7 Sub-Bottom Profiling

The sub-bottom profiling surveys were carried out by Techno Consult International on February 7th 2026. While the bathymetric survey provided detailed information on seabed levels, the sub-bottom profiling survey supplemented this by providing continuous insight into shallow subsurface conditions that cannot be reliably inferred from discrete geotechnical investigations alone.

The bathymetric and sub-bottom profiling surveys were undertaken within the same survey footprint along QICT Terminal-1, covering an approximate area of 108,000 m², as illustrated in the survey layout presented in Figure 30.

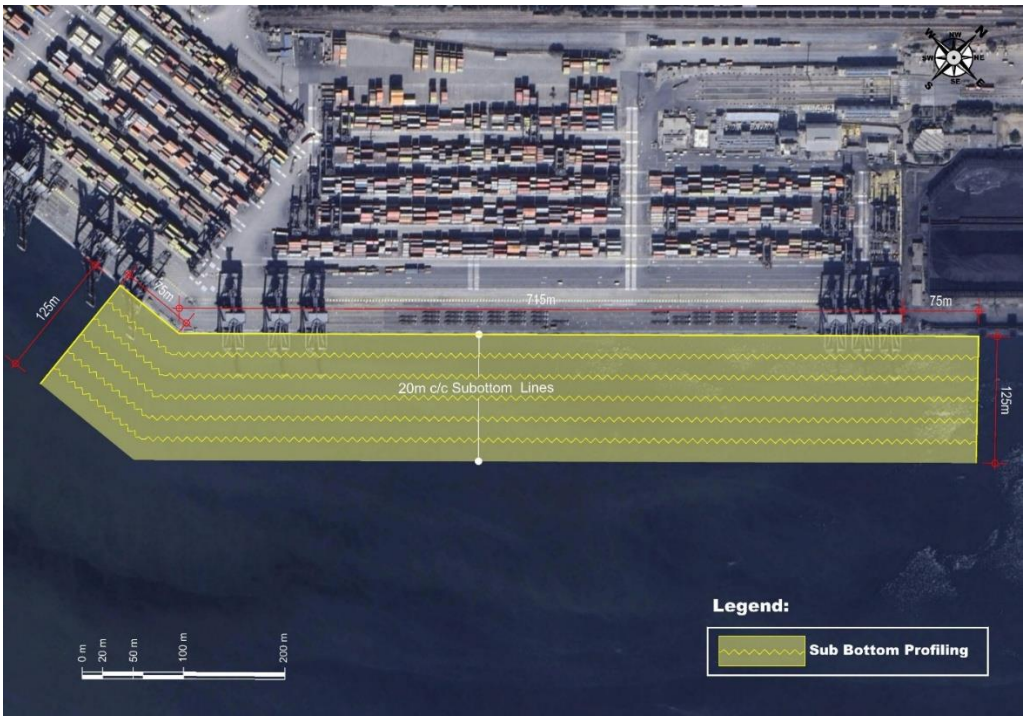

Figure 30. Sub bottom survey area.

To map the 108,000km2 area the survey utilized a state-of-the-art high-resolution Parametric sub-bottom profiling system called 'SES2000 Light' by Innomar, Germany, which claims an acoustic signal penetration of up to 40 meters in favourable muddy sediments. This is a parametric sub-bottom profiler for use in shallow water, and it is owned by TCI, Figure 31 & Figure 32 show the real time data acquisition - *(Detailed equipment specifications in Appendix D).*

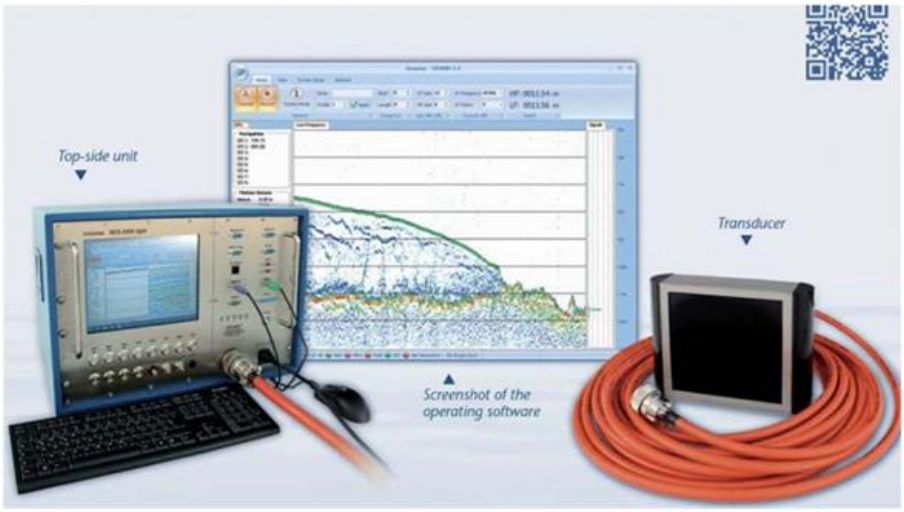

Figure 31 TCI owned Innomar sub-bottom profiler.

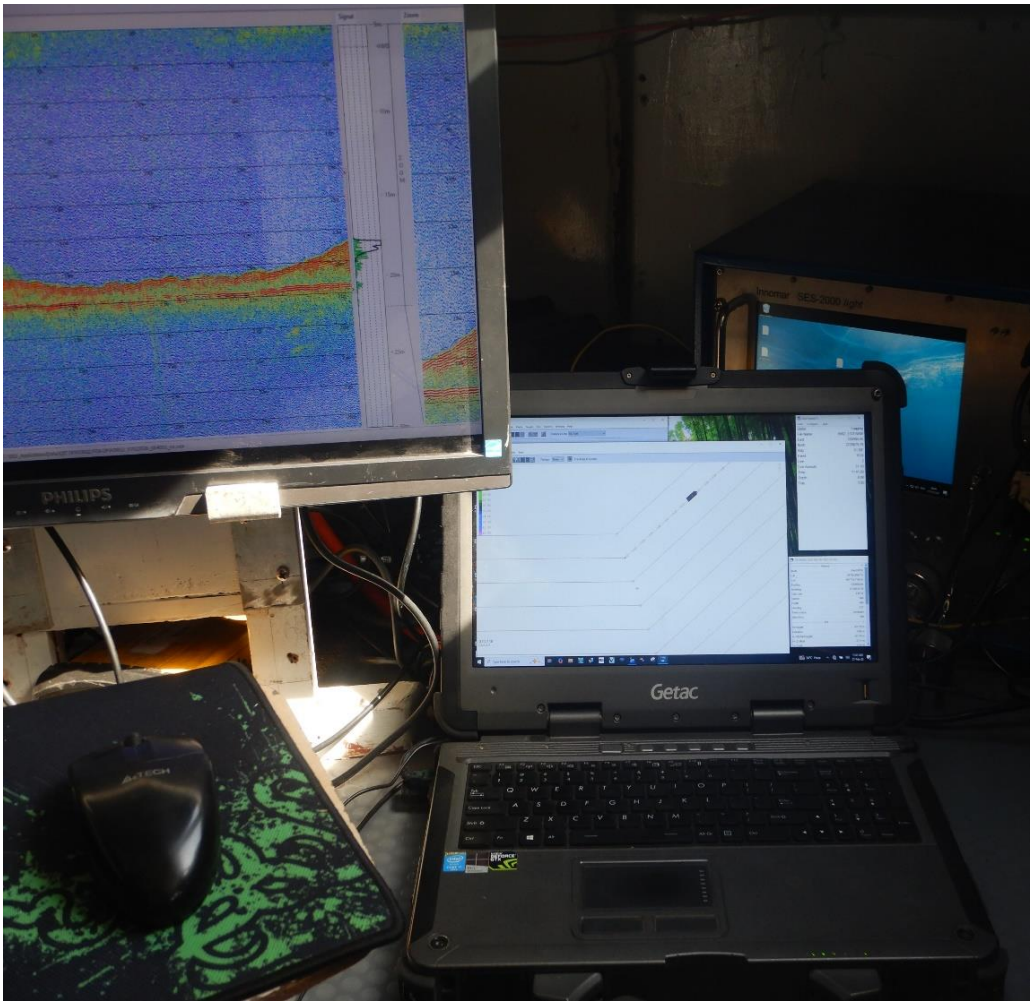

Figure 32 Real time data acquisition of Innomar SES2000 Light, showing soil stratigraphy and line spacing.

Figure 33 below provides a simplified visual depiction of how a sub-bottom profiler works

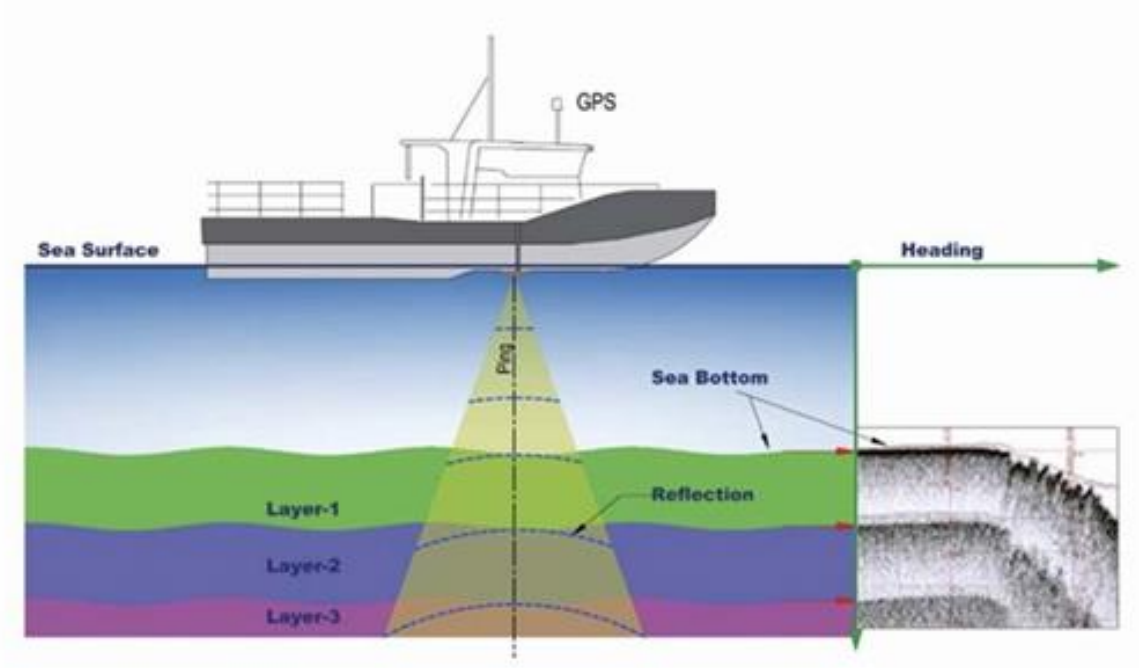

Figure 33. Schematic overview of how sub-bottom profiler works.

The main parameters controlled by the operator were:
- Frequency
- Pulse length
- Range
- Gain

These parameters affect the achievable resolution (i.e. vertical layer to layer resolution), the penetration (i.e. how deep can we look into the sediments), the ping rate (i.e. how many pings are generated per time unit and distance travelled) and the signal to noise ratio of the received echo signals (i.e. what is the weakest detectable reflector).

Prior to survey commencement, test lines were performed to determine optimal values for the above parameters. It was determined through trail and error of the sample area, that a frequency setting of 6 kHz delivered the best results.

Upon completion of survey, all acquired field data was processed using Innomar's ISE 2.93 software. Raw data was acquired via Innomar's proprietary SESWIN software. Detailed results are provided in Annexure-B. The raw data was acquired in native innomar format which we converted to SEG-Y to allow for data exchange to other systems – further processing details are provided in the sections below.

7.1 Sub-Bottom Profiling Survey Area Coverage

The parametric sub-bottom transducer was affixed to a survey vessel (“Breakwater”, Figure 13) by means of an external pole, to cover over the area of interest the survey lines traversed by the vessel were spaced at a centre-to-centre distance of 20 m (Figure 34), starting at 3 m from the quay wall to traverse over the borehole locations line and keeping in mind safety considerations.

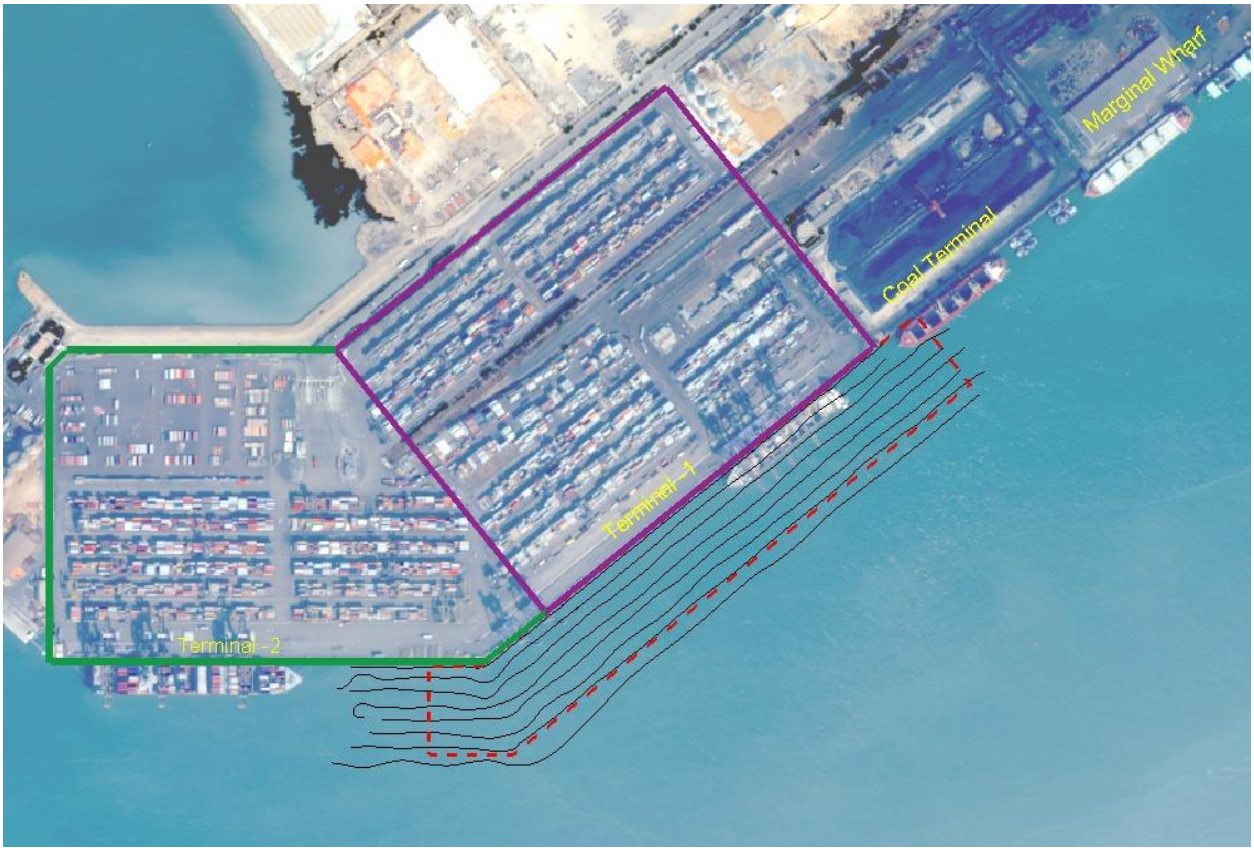

Figure 34 Sub-bottom profiling survey plan lines traversed by vessel.

7.2 RTK Positioning- Sub-Bottom Profiling

The trajectory solution of the vessel was acquired by means of two GNSS receivers configured in base and rover mode using RTK positioning – base established at benchmark S040-Figure 35. The sub-bottom transducer was coupled with an inertia measurement unit (IMU) to record the vessel attitude and correct for roll, pitch, yaw, and heave for best accuracy.

Figure 35 RTK positioning with base established

7.3 Calibration Tests and Procedures

The following calibration tests were carried out prior to commencement of survey.

- Transducer alignment with IMU
- Beam width and beam pattern
- Sensitivity and gain calibration
- Time delay calibration
- Velocity calibration
- Noise and interference assessment
- Navigation systems and positioning check

7.4 Sub-Bottom Profiler Results

Sub-bottom profiler (SBP) data were processed and interpreted using ISE2 software. The raw SBP files were first imported into the software environment for detailed review and analysis. Processing parameters were configured according to the acquisition settings, with the low-frequency channel set to 6 Hz to achieve greater sub-seafloor penetration. Appropriate signal-processing filters were applied to enhance reflector continuity, suppress background noise, and improve the overall clarity of the acoustic records.

Interpretation began with the digitization of the primary reflector corresponding to the seabed along each survey line. Following seabed identification, additional sub-seabed reflectors were interpreted and digitized sequentially based on the number of distinguishable acoustic horizons observed within the profiles. Each interpreted layer was carefully tracked across the survey lines to maintain reflector consistency and geological continuity.

Available borehole data were integrated into the interpretation to support stratigraphic correlation. Borehole lithological information was entered by depth, categorized according to sediment type, and assigned standardized colour coding for clear visualization. The borehole logs were displayed alongside the interpreted SBP reflectors to facilitate correlation between geophysical signatures and ground-truth geotechnical data Figure 38.

Final interpreted profiles were exported in DXF format for CAD integration and in JPEG and PDF formats for reporting purposes (Appendix B). Two interpretation datasets were maintained:

1. Low-frequency dataset – used for deeper stratigraphic interpretation and full layer digitization.
2. High-frequency dataset – optimized for accurate seabed definition, where only the seabed reflector was digitized following application of appropriate high-frequency processing parameters and filters.

All raw and processed data files have been electronically provided, as referenced in Section 9.

7.4.1 Prior Geotechnical Investigation & Boreholes

To support layer digitization and quantitative interpretation of the sub-bottom profiling data, the Client provided a geotechnical investigation report prepared by CES (2016). The report includes four boreholes located within the survey area, as shown in Figure 36.

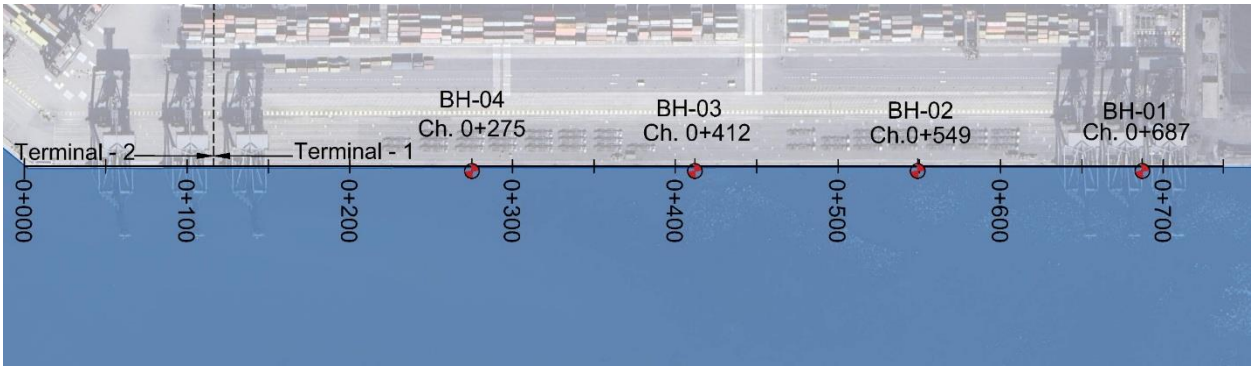

Figure 36. Borehole location(s), plan map.

The borehole logs provide soil classification data together with Standard Penetration Test (SPT) values, which further facilitate in interpretation of acoustic reflectors. The boreholes extend to depths of approximately 30 m below the seabed, significantly deeper than both the anticipated dredging envelope associated with the planned terminal deepening and new quay wall development and the effective penetration depth of the sub-bottom profiler. This depth coverage allows reliable correlation between geophysical and geotechnical datasets.

A summary of the stratigraphy derived from the borehole logs is presented in Figure 37, while the complete CES geotechnical report is included in Appendix B.

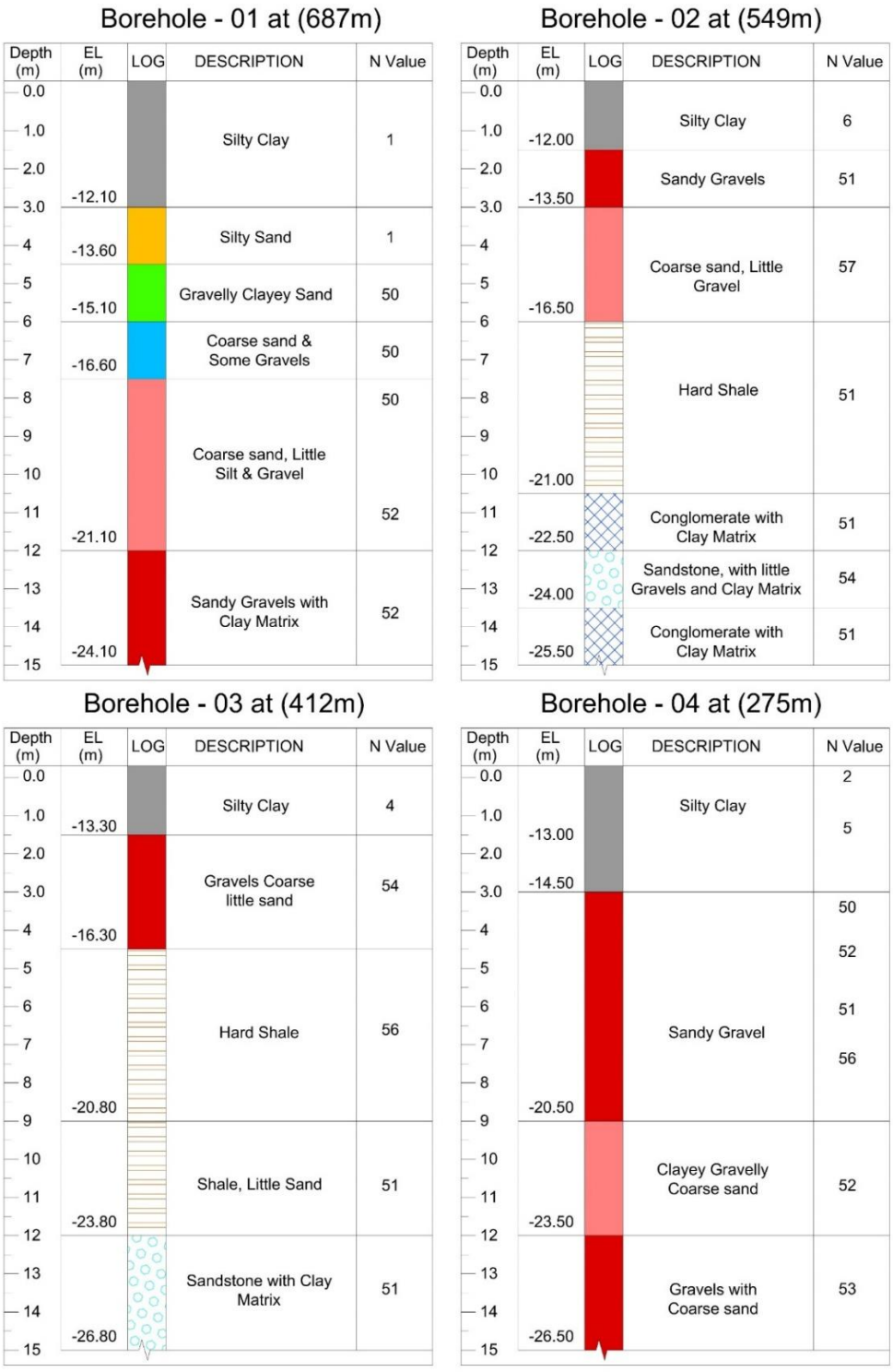

Figure 37. Borehole log(s) summary as derived from CES Report, 2016.

7.4.2 Geotechnical Interpretation and Dredge-ability

Based on the borehole logs and correlation with sub-bottom profiler data, the following soil layers are identified - Figure 38, with contour maps provided in section 7.5:

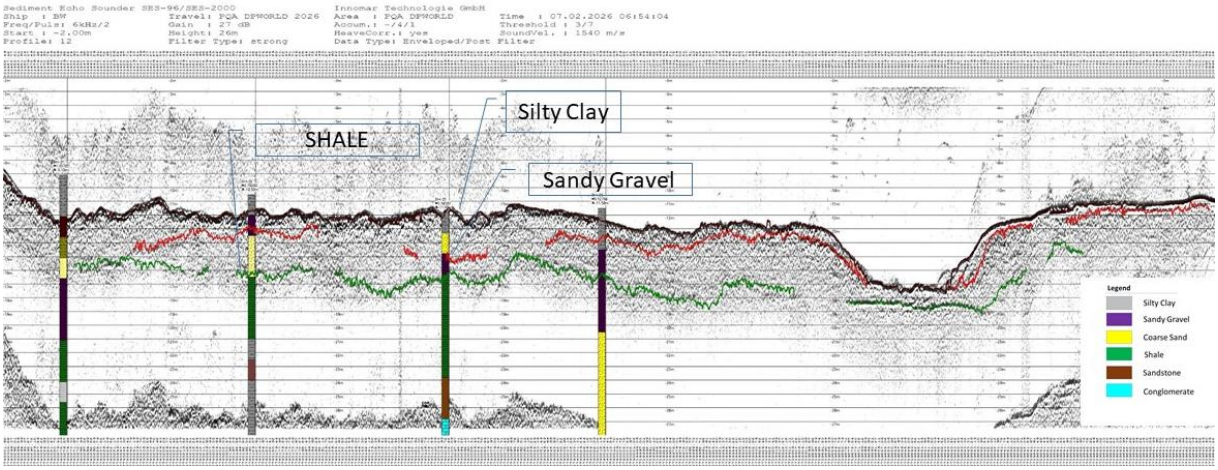

Figure 38. borehole plotting in Innomar SES software for stratigraphic correlation.

- **Silty Clay:** The uppermost layer across the survey area consists predominantly of **silty clay** with **low SPT N-values (N < 10)**, indicating soft material. This layer is encountered immediately below the seabed and extends across most of the survey area with an average thickness of **less than approximately 2 m**.
- **Sandy Gravel:** The second layer identified is **sandy gravel**, which is present across the survey area. **SPT refusal conditions (N > 50)** were encountered within this layer in the boreholes. The thickness of this unit varies spatially, as does the depth at which it is encountered, as illustrated in Figure 40.
- **Shale:** Below the sandy gravel layer, **hard shale** is encountered with **SPT N-values exceeding 50**, indicating very stiff to hard material. The depth to this layer varies across the area, and its presence is not continuous throughout the entire **Area of Interest (AOI)** (Figure 41).
- **Sandstone:** The deepest identifiable unit consists of **sandstone**, also characterized by **SPT N-values exceeding 50**. This layer is present only locally within the AOI, with depth variations shown in Figure 42.

The primary objective of the sub-bottom profiling survey, in conjunction with the geotechnical investigation, is to provide an assessment of the dredge-ability of the subsurface sediments. At present, average seabed depths along the T1 quay wall range between 11 m and 13 m, with anticipated capital dredging depths of approximately 5–8 m below the existing seabed.

To support the dredge-ability assessment, the CES geotechnical report includes results of unconfined compression tests conducted on selected cohesive soil samples collected from the four boreholes. These tests determine the unconfined compressive strength (qu) of the soil, which provides an indication of soil consistency and resistance to excavation.

Most of the test samples were obtained from depths greater than 10 m below the seabed, which extends beyond the anticipated dredging envelope. However, the available qu values within 10 m of the seabed are summarized below:

- **Borehole-1:** No unconfined compression test sample collected for depth less than 10m beneath seabed.
- **Borehole-2:**
  - CRS-1 (sample collected at **6.1m** beneath seabed), qu = 269 kPa
  - CRS-2 (sample collected at **7.5m** beneath seabed), qu = 514 kPa
  - CRS-3 (sample collected at **9.0m** beneath seabed), qu = 291 kPa
- **Borehole-3:**
  - CRS-1 (sample collected at **4.5m** beneath seabed), qu = 251 kPa
  - CRS-2 (sample collected at **10.5m** beneath seabed), qu = 396 kPa
- **Borehole-4**: No unconfined compression test sample collected for depth less than 10m beneath seabed.

To aid interpretation of the measured qu values, Table 3 provides an indicative dredge-ability classification based on commonly accepted engineering practice and typical soil consistency ranges.

Based on the CES geotechnical data and the stratigraphic interpretation derived from the SBP survey, the upper silty clay layer is expected to be readily dredgeable, whereas the underlying layers exhibit high strength characteristics (qu > 200 kPa) from depths of approximately 4.5 m below the seabed and deeper.

Accordingly, it is anticipated that high-power cutter suction dredgers (CSD) would be required for efficient execution of the capital dredging works. If dredging depths extend beyond approximately 6.5 m below the seabed, mechanical excavation methods such as backhoe dredging or ripping may be required due to the increasing soil strength with depth.

qu (kPa)	Soil Consistency (BS 5930 / common practice)	Indicative Dredge-ability	Typical Dredging Method
< 25	Very soft clay	Very easy	TSHD / Plain suction
25 – 50	Soft clay	Easy	TSHD / Small CSD
50 – 100	Firm clay	Moderate	Medium CSD
100 – 200	Stiff clay	Difficult	High-power CSD
200 – 350	Very stiff clay	Very difficult	Heavy CSD / Ripper head
> 350	Hard / Cemented clay	Borderline excavation	Backhoe dredger / Ripping

Table 3. Indicative dredge-ability assessment based on qu values inline with industry norms.

7.5 Sediment Contour Maps

Sediment contour maps derived from the sub-bottom profiler interpretation and borehole correlations are presented below. The following notes apply to the figures:

- The depth shown in each figure represents the top elevation of the respective layer.
- A given layer may not extend across the entire Area of Interest (AOI).
- Layer thickness varies spatially as interpreted from the SBP data; therefore, in some locations two stratigraphic layers may appear within a similar depth class, although they remain distinct geological units.
- Profile cross-sections illustrating the digitized layers are provided in Appendix B.

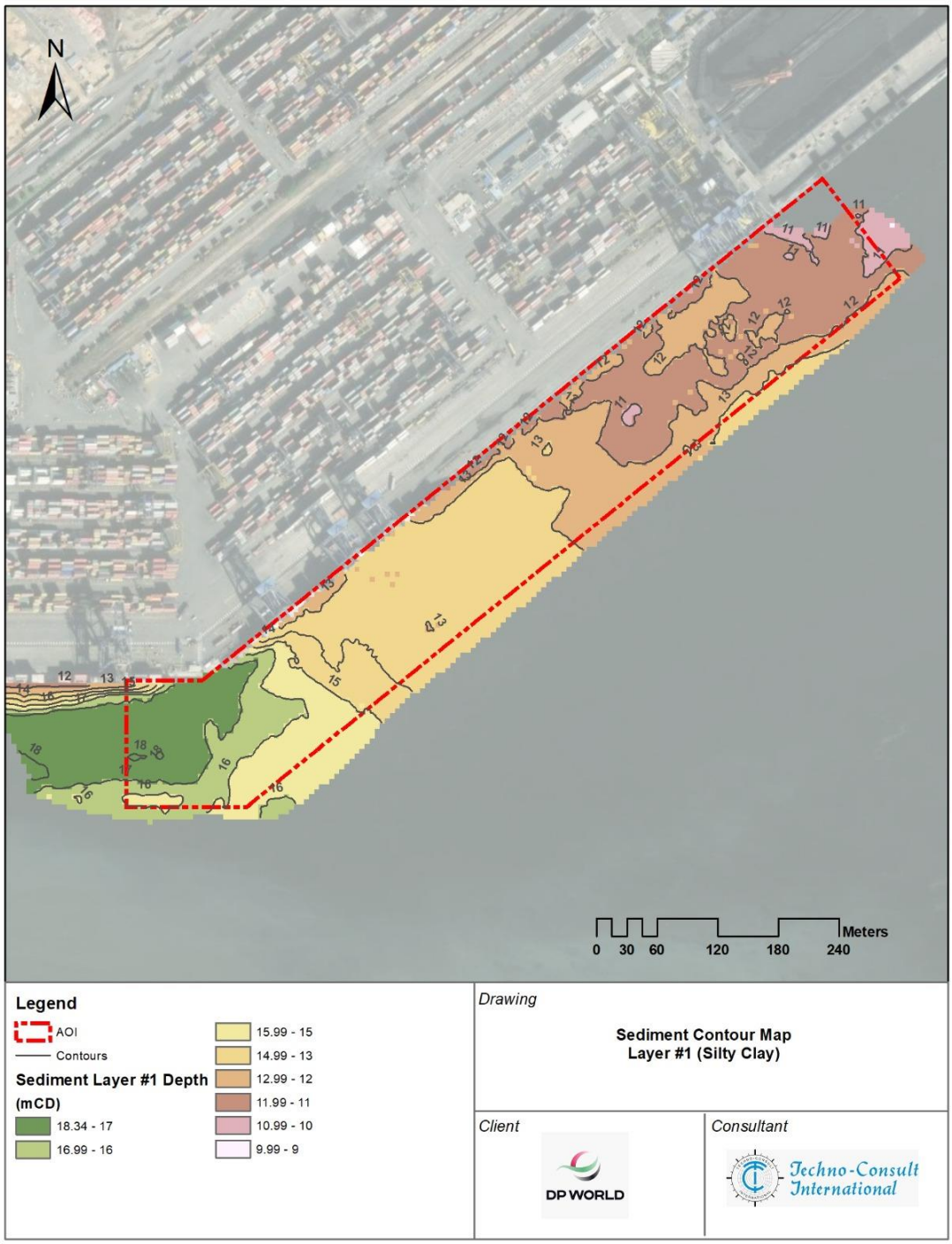

Figure 39. Sediment contour map, layer-1, silty clay.

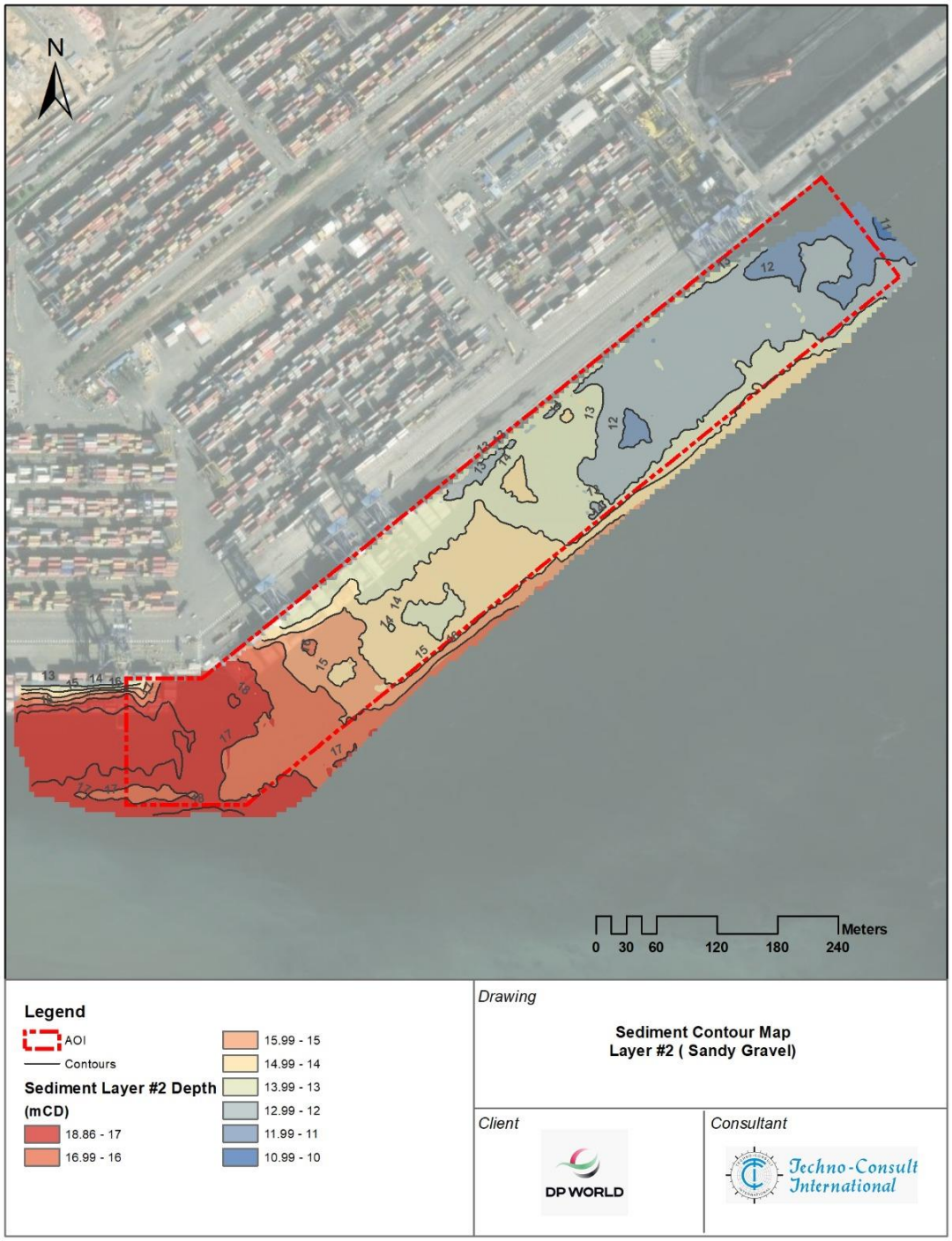

Figure 40. Sediment contour map, layer-2, sandy gravel.

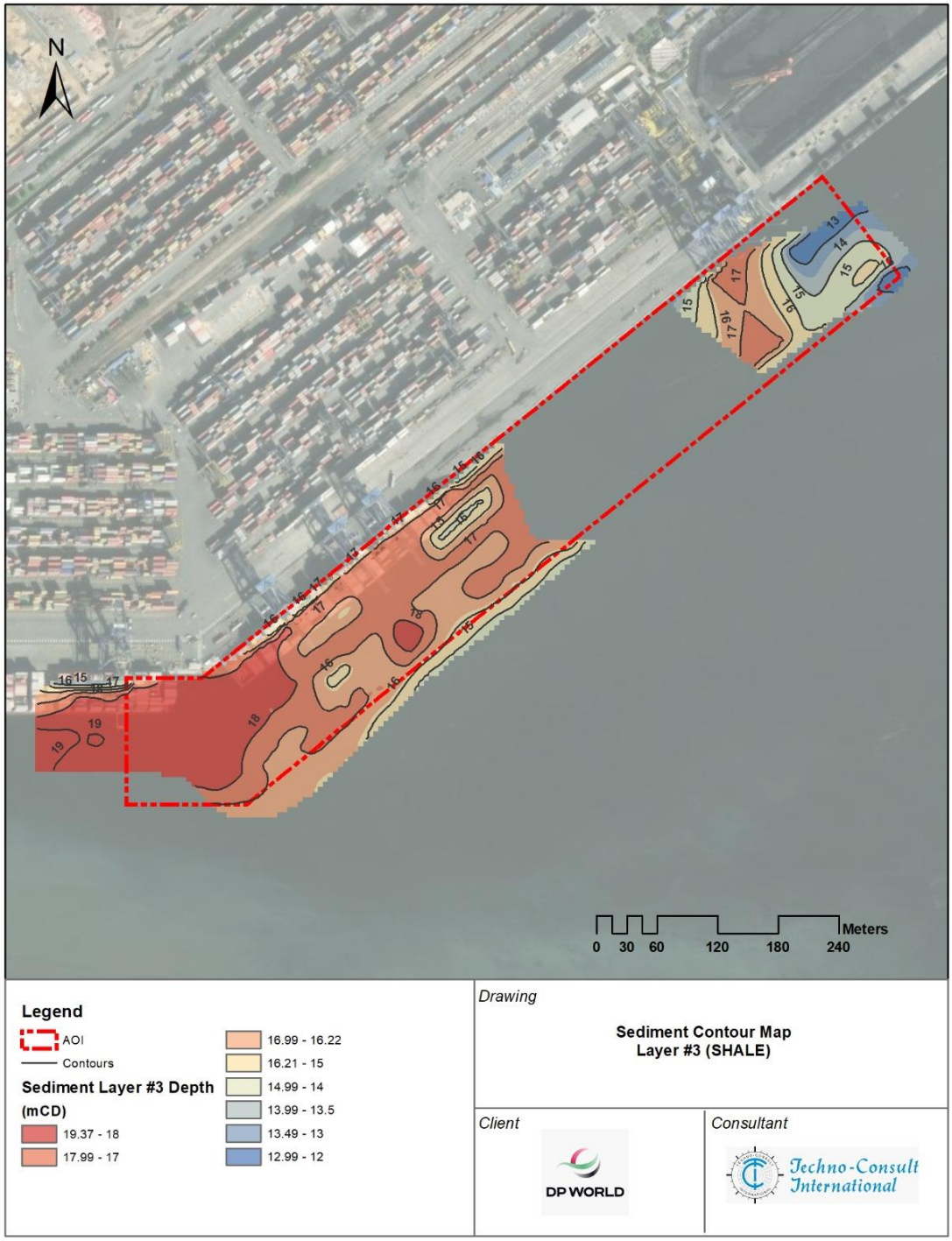

Figure 41.Sediment contour map, layer-3, shale.

Figure 42. Sediment contour map, layer-4, sandstone.

8 HSSE and Quality Assurance

8.1 HSSE Policy Statement

Techno-Consult International (TCI) executed all bathymetric and sub-bottom profiling survey works at Container Terminal-1, Qasim International Container Terminal (QICT), in strict compliance with DP World Karachi's Quality, Health, Safety, Security and Environment (QHSSE) requirements, applicable Pakistani regulations, and internationally recognized marine survey practices.

TCI follows a **Zero Harm philosophy**, under which safety, environmental protection, and operational discipline are treated as core project priorities. All survey activities were planned and executed to ensure:

- Protection of personnel and port users
- Safe operation alongside active quay infrastructure
- Protection of port assets and environment
- Full compliance with DP World's permit and operational systems

As stated in the project scope, all survey works were carried out with due consideration of live port operations and client safety requirements.

- Internal consistency across datasets
- Absence of gaps or artifacts
- Compliance with required formats

Daily survey activity logs were also maintained and attached in Appendix-C.

9 List of Data Provided (Electronically)

9.1 Bathymetric Data

- DEM File
- DWG
- Process Data
- XYZ Output
- Raw Data

9.2 Sub-Bottom Data

- DXF
- PDF
- Raw Data
- SGY

CES Report

Report on
Geotechnical Investigation
Alongside of QICT, Terminal 1 Berth No.5 to 7
DP world, Karachi

Project #	:	CES-16650
Client	:	QASIM INTERNATIONAL CONTAINER TERMINAL (QICT)
Date	:	Dec 26, 2016

Report on
Geotechnical Investigation
Alongside of QICT, Terminal 1 Berth No.5 to 7
DP world, Karachi

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SUMMARY OF LABORATORY TEST RESULTS

LABORATORY TEST RESULTS

Report on
Geotechnical Investigation
Alongside of QICT, Terminal 1 Berth No.5 to 7
DP World, Karachi

1. INTRODUCTION:

A program of Soil Investigation was undertaken to determine Subsoil conditions at Berth # 5, 6, & 7, Qasim International Container Terminal, DP World, Karachi.

Consolidated Engineering Services (Pvt.) Ltd. Karachi carried out the program of soil investigation.

The program of investigation included drilling of five boreholes in front of Existing Berths upto depth of 30.0m from Seabed level, at specified locations, collection of representative soil samples and conducting laboratory tests. The scope of work also included preparation of factual report giving results of Investigation.

The fieldwork was carried out from Nov9, 2016 to Dec 09, 2016. The soil samples collected during field investigations were tested in the laboratory, the results were compiled and analysis was made for the foundations design.

The soil stratigraphy is presented as shown in Borehole logs while laboratory test results are also included with the report.

This report presents the results of the investigations and recommendations for soil parameters for design of foundations.

2. Geology of the area:

The geological formations in Port Qasim and its adjoining areas belong to the Middle and upper Tertiaries Periods. The soil formations found in the area are fresh and slightly weathered, recent and sub recent shoreline deposits. These deposits are derived from Gaj/Manchhar formations of Lower Miocene to Middle Miocene/Upper Miocene to Pliocene age. Similar deposits are found all along the coastal belt of Karachi and adjoining areas.

The Gaj formation consists of mostly limestone with subordinate Shales and Sandstones. The limestone is hard, sandy and extremely fossiliferous. This formation overlies Nari formation, which consists of harder Limestone and Shales.

Conformably overlying Gaj formation is Manchhar formation. The type section of Manchhar formation is exposed west of Manchhar Lake (26^{o} 8' N and 67^{o} 34' E) near Sehwan Sherief in Dadu District. The formation is composed of Sandstone, Clay beds, cemented Sand and Gravel (Pseudo Conglomerate). Sandstone is thick, porous and grey in color. It is friable and also consists bands of Conglomerate. The Clay are of various colors e.g. grey, brown, chocolate and orange, however the most widely occurring Clays are of light brown (khaki) and dark grey in color. The Clay has shades of green and brown. Sandy layers are also found interbedded with Clay and Gravel. Conglomerates are mostly composed of sand, gravels and fragments of shells and highly calcareous.

3. PROGRAM OF INVESTIGATIONS:

3.1 Drilling of Boreholes:

Total five boreholes were drilled upto 30.0m depth from existing seabed level at under water locations. The Boreholes were drilled in front of existing berths by using projected platform. The platform was placed on top of berth projecting out (cantilever) about 3m from edge of berth. The drilling Rig was setup on the platform while cantilever of the platform was countered by placing concrete blocks on rear part of the platform. Exhibit-1 shows the platform setup at borehole location.

The location of the boreholes was marked by the Client.

The Elevation of each borehole, drilled underwater, was established by measuring the seabed level at each borehole location from top of existing berth and correlate with Elevation of top of berth and Port Qasim Chart Datum.

Rotary drilling method was used to advance the borehole to the required depth. Standard Penetration Tests (SPT) were conducted as per ASTM Designation D-1586 while Cone Penetration Test (CPT) were conducted in Gravelly strata as per BS-1377-7. Coring was adopted for drilling and sampling through hard cohesive Shale and Cemented/ Rock formation as per ASTM Designation D-2113. Representative samples of subsoil materials were preserved for further testing.

3.2 Lab Testing:

A program of laboratory tests was conducted and selected representative samples were tested to determine physical and engineering characteristics of various subsoil materials encountered at the site.

The tests were conducted in accordance with Standard Procedure as given in relevant ASTM/BS standards.

4. RESULTS OF INVESTIGATION:

4.1 Subsoil Stratigraphy

Five boreholes were drilled in front of existing Berths at specified locations. The subsoil materials as encountered at the site have been described in detail in Borehole Logs included in Annex-1 and subsoil profile is presented in Fig-1. The stratigraphy at site is summarized hereunder:

		BH#1	BH#2	BH#3	BH#4	BH#5
Seabed level, EL. m		-9.10	-10.50	-11.80	-11.50	-11.60
Layer #	Subsoil Description	Extent of layer, EL. m				
I	Slush (very soft to firm Silty CLAY)	-12.10	-12.0	-13.30	-14.5	-13.10
II	Very dense, Gravelly SAND/ Sandy GRAVELS/ Clayey GRAVELS	-24.10	-16.50	-16.30	-29.50	-16.10
III	Medium hard SHALE with embeded Gravels	-25.6	-21.0	-23.80	Not Encountered	-19.10
IV	Loosely cemented CONGLOMERATE with Clay matrix / SANDSTONE	-28.6	-28.5	-28.3	-31.0	-26.6
V	Medium hard Sandy SHALE interlayered SILTSTONE/ CLAYSTONE	-39.10 *	-40.50 *	-41.80 *	-41.50 *	-41.60 *

* Maximum Investigated depth.

4.2 Laboratory Test Results:

The Laboratory Test Results are presented in Annex-2 of this report. These results have been considered while preparing Borehole Logs and giving recommendations for soil parameters. Following is the summary of test results:

Grain Size Analysis

Grain size analysis was conducted on a total of 57 samples. Particles finer than # 200 sieve (75 microns) vary from 07 to 48% in cohesion less soil and 56 to 99 % in cohesive soils.

Plasticity Index

Plasticity index was determined on 44 samples of fine grained soils. The Liquid Limit varies from a value of 30 to 49% and Plasticity Index ranges between 8 to 28%, while one sample was found to be *Non Plastic*.

Unconfined Compression Tests

Unconfined Compressive Strength was determined on 26 Core sample. The Unconfined Compressive Strength values range between 2.56 kg/cm^{2}to 12.01 kg/cm^2 (251 kPa to 1177 kPa), while strain ranges from 2.6% to 8.0%

Direct Shear Tests

A total of 06 Direct Shear Tests were performed on remolded SPT samples. The results indicate that the angle of internal friction of SAND ranges between 31^o to 32^o.

Moisture Content

Moisture Content was determined on 26 Core Samples. Moisture Content varies from 8.3% to 22.9%.

Bulk Density

The value of Bulk Density for 26 Core Samples ranges between 2.027 gm/cc to 2.465 gm/cc (20.3 kN/m^{3}to 22.8 kN/m^3).

Chemical Tests

Chemical tests were performed on 15 Soil Samples to determine Chloride Content, Sulphate Content, pH value, TDS and Organic content.

The values of chemical properties of Soil samples tested in the laboratory are as under:

Sulphate Content %	Chloride Content %	TDS %	pH Value	Organic Matter %
0.106 to 0.243	0.107 to 0.236	0.54 to 1.61	7.5	1.17 to 3.45

4.3 Soil Parameters:

Based on investigated data and test results presented here above, subsoil parameters are evaluated as presented hereunder:

Layer	Subsoil	SPT N Value	γ_t kN/m^3	Cohesion C kPa	ϕ^o	Unconfined Compressive Strength 'qu' kPa
I	Slush (Silty CLAY)	2-5	19	25	-	-
II	SAND/ GRAVELS	Refusal	20	-	32	-
III	SHALE	Refusal	20	125	-	250-300
IV	CONGLOMERATE/ SANDSTONE	Refusal	22	-	32	
V	SHALE	-	20	200	-	300-500
	SILTSTONE/ CLAYSTONE	-	20	400		1009 & 1177

EXHIBIT-1

THE PLATFORM SETUP AT BOREHOLE LOCATION

EXHIBIT-1: PLATFORM SETUP AT BOREHOLE LOCATION

FIG-1: SUBSOIL PROFILE

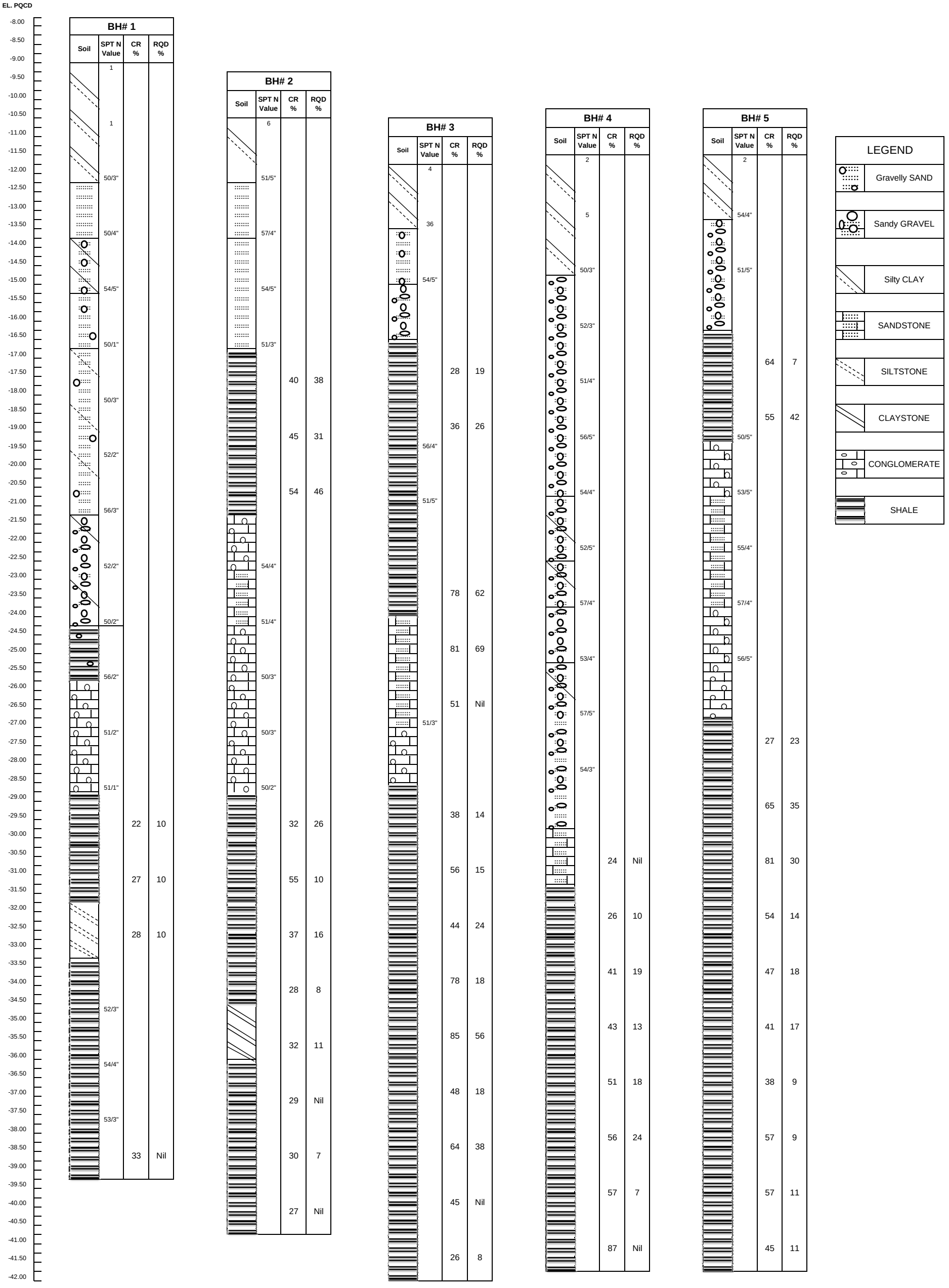


FIG-1: Subsoil Profile through BH-1 to BH-5

ANNEA-1

BOREHOLE LOGS

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP World, Karachi.		BOREHOLE# : 01	Sheet: 1 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		PROJECT # :	CES-16650
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel		Sea Bed Level: -9.1 m
BOREHOLE DIA : 100mm	Casing dia: 3"	DATE STARTED:	9/11/2016
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 23.0m	DATE COMPLETED:	12/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 687, between Bollards 28 - 29	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(9.10)			SPT-01						1			
			Greyish black, very soft, Silty CLAY (Slush)	0.0 m									
1.0													
				SPT-2						1			
				1.50m									
2.0													
3.0	-12.10			SPT-3						50/3"			Refusal
				3.0m									
			Greyish black, very denes, Silty SAND, with little Gravels.										
4.0													
	-13.60			SPT-4						50/4"			Refusal
				4.50m									
5.0			Yellowish brown, very hard, Gravelly Clayey SAND										
6.0	-15.10			SPT-5						54/5"			Refusal
				6..0m									
			Yellowish brown, very dense, Coarse SAND, some Gravels										
7.0													
	-16.60			CPT-1						50/1"			Refusal
				DS-1									
8.0			Yellowish brown, very dense, Coarse SAND,little Silt & Gravels	(7.50 - 9.0 m)									
9.0				CPT-2						50/3"			Refusal
				DS-2									
				(9.0 - 10.5 m)									
10.0													
				CPT-3						52/2"			Refusal
				DS-3									
11.0				(10.5 - 12.0 m)									
12.0	-21.10			CPT-4						56/3"			Refusal
				DS-4									
			Yellowish Brown, very dense, loosely cemented, Sandy GRAVELS, with Clay matrix	(12.0 - 13.5 m)									
13.0													
				CPT-5						52/2"			Refusal
				DS-5									
14.0				(13.5 - 15.0 m)									
15.0	-24.10												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 01	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-24.10			CPT-6						50/2"			
			Brown, very hard, Sandy SHALE, embeded Gravels	DS-6 (15.0 - 16.5 m)									
16.0													
	-25.60			CPT-7						56/2"			Refusal
				DS-7									
17.0			Brown, very dense, loosely cemented, CONGLOMERATE, with Clay matrix	(16.5 - 18.0 m)									
18.0				CPT-8						51/2"			Refusal
				DS-8 (18.0 - 19.5 m)									
19.0													
	-28.60			CPT-9						51/1"			Refusal
20.0			Brown, medium-hard, Sandy SHALE	CRS - 01 (19.5 - 21.0 m)							22	10	CW-1 S.L = 16 cm
21.0													
22.0				CRS - 02 (21.0 - 22.5 m)							27	10	CW-2 S.L = 16 cm
	-31.60												
23.0			Brown, hard, SILTSTONE	CRS - 03 (22.5 - 24.0 m)							28	10	CW-3 S.L = 16 cm
24.0	-33.10												
			Brown, medium-hard, SHALE	DS-10 (24.0 - 25.5 m)									
25.0				CPT-10						52/3"			Refusal
				DS -11 (25.5 - 27.0 m)									
26.0													
27.0				CPT-11						54/4"			Refusal
				DS-12 (27.0 - 28.5 m)									
28.0													
				CPT-12						53/3"			Refusal
29.0				CRS- 04 (28.5 - 30.0 m)							33	Nil	CW-4 S.L = 11cm
30.0	-39.10												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP World, Karachi.		BOREHOLE# : 02	Sheet: 1 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		PROJECT # :	CES-16650
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel		Sea Bed Level: -10.5m
BOREHOLE DIA : 100mm	Casing dia: 6" & 3"	DATE STARTED:	15/11/2016
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 20.0m, 21.0m	DATE COMPLETED:	18/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 549, between Bollards 23 - 24	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(10.50)		Greyish black, firm, Silty CLAY (Slush)	SPT-01 0.0 m						6			
1.0													
	-12.00			CPT-1						51/5"			Refusal
2.0			Brown, very dense, Sandy GRAVELS little Clay	DS-1 (1.50 - 3.0 m)									
3.0	-13.50			CPT-2						57/4"			Refusal
4.0			Brown, very dense, medium to Coarse SAND, trace to little Gravels	DS-2 (3.0 - 4.50 m)									
				CPT-3						54/5"			Refusal
5.0				DS-3 (4.50 - 6.0 m)									
6.0	-16.50			CPT-4/DS-4	(6.0 - 6.10m)					51/3"			Refusal
7.0			Brown, medium-hard, SHALE	CRS - 01 (6.10 - 7.50 m)							40	38	CW-1 S.L = 13cm
8.0				CRS - 02 (7.50 - 9.0 m)							45	31	CW-2 S.L = 20 cm
9.0													
10.0				CRS - 03 (9.0 - 10.5 m)							54	46	CW-3 S.L = 21 cm
	-21.00												
11.0			Yellowish Brown, loosely cemented CONGLOMERATE with Clay matrix	DS- 5 (10.5 - 12.0 m)									
12.0	-22.50			CPT-5						54/4"			Refusal
13.0			Yellowish Brown, , loosely cemented medium to coarse grained SANDSTONE, with little Gravels and Clay matrix	DS-6 (12.0 - 13.5 m)									
	-24.00			CPT-6						51/4"			Refusal
14.0			Yellowish Brown, loosely cemented CONGLOMERATE with Clay matrix	DS-7 (13.5 - 15.0 m)									
15.0	-25.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 02	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-25.50			CPT-7						50/3"			Refusal
			Brown, very dense, loosely cemented, CONGLOMERATE, with Clay matrix	DS-8 (15.0 - 16.5 m)									
16.0				CPT-8						50/3"			Refusal
				DS-9 (16.5 - 18.0 m)									
17.0													
18.0	-28.50			CPT-9						50/2"			Refusal
			Brown, medium-hard, SHALE										
				CRS - 04 (18.0 - 19.5 m)							32	26	CW-4 S.L = 13 cm
19.0													
20.0				CRS - 05 (19.5 - 21.0 m)							55	10	CW-5 S.L = 16 cm
21.0													
				CRS - 06 (21.0 - 22.5 m)							37	16	CW-6 S.L = 10 cm
22.0													
23.0				CRS - 07 (22.5 - 24.0 m)							28	8	CW-7 S.L = 14 cm
24.0													
			Brown, hard, CLAYSTONE	CRS - 08 (24.0 - 25.5m)							32	11	CW-8 S.L = 17cm
25.0													
26.0			Brown, medium-hard, SHALE	CRS - 09 (25.5 - 27.0m)							29	Nil	
27.0	-37.50												
			Reddish Brown, medium-hard, SHALE										
				CRS - 10 (27.0 - 28.5 m)							30	7	CW-9 S.L = 12cm
28.0													
29.0				CRS - 11 (28.5 - 30.0 m)							27	Nil	
30.0	-40.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		BOREHOLE# : 03	Sheet: 1 of 2
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel	PROJECT # :	CES-16650
BOREHOLE DIA : 100mm	Casing dia: 6" & 4"	DATE STARTED:	Sea Bed Level: -11.80m
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 19.5m, 21.0m	DATE COMPLETED:	6/12/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 412, between Bollards 17-18	9/12/2016

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(11.80)		Greyish black, very soft, Silty CLAY (Slush)	SPT-01 0.0 m						4			
1.0													
	-13.30			SPT-02						36			Refusal
2.0			Brown, dense, Gravelly coarse SAND,	1.50 m									
3.0	-14.80			SPT-03						54/5"			Refusal
			Brown, very dense, GRAVELS little Sand	DS-1 (3.0 - 4.50 m)									Shoe Sample CW-1
4.0													S.L = 13 cm
	-16.30												
5.0			Brown to Brownish Grey, medium hard, SHALE	CRS - 01 (4.50 - 6.0 m)							28	19	CW-2 S.L = 18 cm
6.0													
7.0				CRS -02 (6.0 - 7.50m)							36	26	CW-3 S.L = 13 cm
	-19.30			CPT-1						56/4"			Refusal
8.0			Brown, very hard, SHALE, embeded Gravels	DS-2 (7.50 - 9.0 m)									
9.0	-20.80			CPT-2						51/5"			Refusal
10.0			Yellowish Brown, medium-hard, SHALE, little Sand	DS-3 (9.0 - 10.50m)									
11.0				CRS -03 (10.5 - 12.0 m)							78	62	CW-4 S.L = 17 cm
12.0	-23.80												
13.0			Yellowish Brown, very dense, loosely cemented, medium to coarse grained SANDSTONE, with Clay matrix	CRS -04 (12.0 - 13.5 m)							81	69	CW-5 S.L = 17 cm
14.0				CRS -05 (13.5 - 15.0 m)							51	Nil	CW-6 S.L = 8 cm
15.0	-26.80												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 03	Sheet: 2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :	CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-26.80			CPT-3						51/3"			Refusal
			Brown, loosely cemented CONGLOMERATE with Clay matrix	DS-4 (15.0 - 16.5 m)									
16.0													
	-28.30												
17.0			Brown, medium hard, SHALE										
				CRS -06 (16.5 - 18.0 m)							38	14	CW-7 S.L = 22 cm
18.0													
				CRS - 07 (18.0 - 19.5 m)							56	15	CW-8 S.L = 17 cm
19.0													
20.0													
				CRS - 08 (19.5 - 21.0 m)							44	24	CW-9 S.L = 24 cm
21.0													
				CRS - 09 (21.0 - 22.5 m)							78	18	CW-10 S.L = 25 cm
22.0													
23.0													
				CRS - 10 (22.5 - 24.0 m)							85	56	CW-11 S.L = 13 cm
24.0	-35.80												
			Greyish Brown to Brown, medium hard, SHALE	CRS - 11 (24.0 - 25.5m)							48	18	CW-12 S.L = 19 cm
25.0													
	-37.30												
26.0			Dark Brown, medium hard, SHALE interlayered Siltstone										
				CRS - 12 (25.5 - 27.0m)							64	38	CW-13 S.L = 18 cm
27.0													
				CRS - 13 (27.0 - 28.5 m)							45	Nil	CW-14 S.L = 6 cm
28.0													
29.0													
				CRS - 14 (28.5 - 30.0 m)							26	8	CW-15 S.L = 13 cm
30.0	-41.80												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP World, Karachi.		BOREHOLE# : 04	Sheet: 1 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		PROJECT # :	CES-16650
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel		Sea Bed Level: -11.50m
BOREHOLE DIA : 100mm	Casing dia: 6" & 3"	DATE STARTED:	22/11/2016
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 21.0m, 23.0m	DATE COMPLETED:	25/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	Location: Berthing Mark 275, between Bollards 12 - 13	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(11.50)		Greyish black, very soft to firm, Silty CLAY (Slush)	SPT-01 0.0 m						2			
1.0													
	-13.00			SPT-02						5			
2.0				1.50 m									
3.0	-14.50			CPT-1						50/3"			Refusal
			Brown, very dense, Sandy GRAVEL	DS-1 (3.0 - 4.50 m)									
4.0				CPT-2						52/3"			Refusal
				DS-2 (4.50 - 6.0 m)									
5.0													
6.0				CPT-3						51/4"			Refusal
				DS-3 (6.0 - 7.50m)									
7.0													
				CPT-4						56/5"			Refusal
8.0				DS-4 (7.50 - 9.0 m)									
9.0	-20.50			CPT-5						54/4"			Refusal
				DS-5 (9.0 - 10.50m)									
10.0			Brown, very dense, Clayey Gravelly Coarse SAND										
				CPT-6						52/5"			Refusal
11.0				DS-6 (10.5 - 12.0 m)									
12.0	-23.50			CPT-7						57/4"			Refusal
			Brown, very dense, GRAVELS with Coarse SAND	DS-7 (12.0 - 13.5 m)									
13.0													
	-25.00			CPT-8						53/4"			Refusal
14.0			Brown, very dense, Clayey Gravelly Coarse SAND	DS-8 (13.5 - 15.0 m)									
15.0	-26.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 04	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-26.50			CPT-9						57/5"			Refusal
			Brown, very dense, Gravelly coarse SAND, trace Clay	DS-9 (15.0 - 16.5 m)									
16.0													
				CPT-10						54/3"			Refusal
				DS-10 (16.5 - 18.0 m)									
17.0													
18.0	-29.50												
			Yellowish Brown, very dense, loosely cemented, medium to coarse grained SANDSTONE, with some Gravels and Clay matrix	CRS - 01 (18.0 - 19.5 m)							24	Nil	
	-31.00												
20.0			Brown, medium hard, SHALE	CRS - 02 (19.5 - 21.0 m)							26	10	CW-1 S.L = 16 cm
21.0													
22.0				CRS - 03 (21.0 - 22.5 m)							41	19	CW-2 S.L = 14 cm
23.0				CRS - 04 (22.5 - 24.0 m)							43	13	CW-3 S.L = 20 cm
24.0													
25.0				CRS - 05 (24.0 - 25.5m)							51	18	CW-4 S.L = 13cm
26.0				CRS - 06 (25.5 - 27.0m)							56	24	CW-5 S.L = 16cm
27.0													
28.0				CRS - 07 (27.0 - 28.5 m)							57	7	CW-6 S.L = 11cm
29.0				CRS - 08 (28.5 - 30.0 m)							87	Nil	CW-7 S.L = 6 cm
30.0	-41.50												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

BOREHOLE LOG

CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD		BOREHOLE# : 05	Sheet: 1 of 2
DRILLING EQUIPMENT : Stright Rotary	SAMPLER : SPT/Core Barel	PROJECT # :	CES-16650
BOREHOLE DIA : 100mm	Casing dia: 6" & 4"		Sea Bed Level: -11.60m
SPT HAMMER WEIGHT : 63.5 kg Drop: 76 cm	Casing Length: 19.5m, 21.5m	DATE STARTED:	29/11/2016
GEOLOGIST: Wajid Syfi	DRILLER : Qaim-ud-din	DATE COMPLETED:	2/12/2016
		Location: Berthing Mark 687, between Bollards 28 - 29	

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
0.0	(11.60)		Greyish black, very soft, Silty CLAY (Slush)	SPT-01 0.0 m						2			
1.0													
	-13.10			CPT-01						54/4"			Refusal
2.0			Brown, very dense, Sandy GRAVELS	DS-1 (1.50 - 3.0 m)									
3.0				CPT-2						51/5"			Refusal
				DS-2 (3.0 - 4.50 m)									
4.0													
	-16.10												
5.0			Brown, medium hard, SHALE	CRS - 01 (4.50 - 6.0 m)							64	7	CW-1 S.L = 13 cm
6.0													
7.0				CRS -02 (6.0 - 7.50m)							55	42	CW-2 S.L = 15 cm
	-19.10			CPT-3						50/5"			Refusal
8.0			Yellowish Brown, very dense, loosely cemented, CONGLOMERATE with Clay matrix	DS-3 (7.50 - 9.0 m)									
9.0				CPT-4						53/5"			Refusal
10.0			Yellowish Brown, very dense, loosely cemented, coarse grained SANDSTONE, with Clay matrix	DS-4 (9.0 - 10.50m)									
				CPT-5						55/4"			Refusal
				DS-5 (10.5 - 12.0 m)									
11.0													
12.0				CPT-6						57/4"			Refusal
13.0			Yellowish Brown, very dense, loosely cemented, CONGLOMERATE with Clay matrix	DS-6 (12.0 - 13.5 m)									
				CPT-7						56/5"			Refusal
				DS-7 (13.5 - 15.0 m)									
14.0													
15.0	-26.60												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

BOREHOLE LOG

PROJECT: Geotechnical Investigation Alongside of QICT, Terminal 1 Berth No.5 to 7, DP W	BOREHOLE# : 05	Sheet:	2 of 2
CLIENT: Qasim International Container Terminal Port(QICT), DP WORLD	PROJECT # :		CES-16650

DEPTH (m)	EL m	LOG	DESCRIPTION	SAMPLE/ TEST #	SPT BLOWS, N/30 cm 10	20	30	40	50	N Value	CORING CR%	RQD%	Remarks
15.0	-26.60		Brown, medium hard, SHALE intermix Gravels at places	CRS -03 (15.0 - 16.5 m)							27	23	CW-3 S.L = 18 cm
16.0	-28.10												
17.0			Brown, medium hard, SHALE	CRS -04 (16.5 - 18.0 m)							65	35	CW-4 S.L = 18 cm
18.0				CRS - 05 (18.0 - 19.5 m)							81	30	CW-5 S.L = 18 cm
19.0													
20.0				CRS - 06 (19.5 - 21.0 m)							54	14	CW-6 S.L = 21 cm
21.0													
22.0				CRS - 07 (21.0 - 22.5 m)							47	18	CW-7 S.L = 13 cm
23.0				CRS - 08 (22.5 - 24.0 m)							41	17	CW-8 S.L = 13 cm
24.0													
25.0				CRS - 09 (24.0 - 25.5m)							38	9	CW-9 S.L = 14 cm
26.0				CRS - 10 (25.5 - 27.0m)							57	9	CW-10 S.L = 14 cm
27.0													
28.0				CRS - 11 (27.0 - 28.5 m)							57	11	CW-11 S.L = 16 cm
29.0				CRS - 12 (28.5 - 30.0 m)							45	11	CW-12 S.L = 16 cm
30.0	-41.60												

SPT: Standard Penetration Test CRS : Core Sample CR:Core Recovery RQD:Rock Quality Designation

Elevation of Boreholes is given with reference to top of wharf at + 5.2m (PQCD)

ANNEX-2

SUMMARY OF LABORATORY TEST RESULTS

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

SUMMARY OF TEST RESULTS

Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation CD PQA	Passing #200	Atterberg Limit		Unconfined Compression			Bulk Density (gm/cc)	Moisture (%)	Dry Density (gm/cc)	Direct Shear		Specific Gravity	Chemical Test				
						LL	PI	qu (kg/ cm^2)	qu (kPa)	Strain (%)				c (Kg/cm^2)	ϕ (deg)		pH	Sulphate Content	Chloride Content	Total Disolve Salt	Organic Matter (%)
Barthing mark 687, Between 28-29, Bollards	BH-01	SPT-1	0.0	-9.1	94	37	10														
	BH-01	UDS-1	1.0	-10.1												2.572					
	BH-01	SPT-3	3.0	-12.1	37									0	32		7.5	0.243	0.193	1.29	3.45
	BH-01	SPT-4	4.5	-13.6	30											2.585					
	BH-01	DS-1	7.5	-16.6	28																
	BH-01	DS-4	12.0	-21.1	25	30	9														
	BH-01	DS-6	15.0	-24.1	79	30	8														
	BH-01	CRS-1	19.5	-28.6	90	41	14										7.5	0.194	0.236	1.08	-
	BH-01	CRS-2	21.0	-30.1	88	40	13	3.65	358	6.66	2.064	18.9	1.736								
	BH-01	CRS-3	22.5	-31.6	96	41	13	10.29	1009	5.4	2.218	10.8	2.001								
	BH-01	DS-10	24.0	-33.1	94	42	14														
	BH-01	DS-12	27.0	-36.1	86	37	12														
Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5	93	34	12									2.626	7.5	0.150	0.129	0.54	1.40
	BH-02	DS-1	1.5	-12.0	13																
	BH-02	DS-3	4.5	-15.0	7									0.0	32	2.668					
	BH-02	CRS-1	6.1	-16.6	85	49	21	2.75	269	5.28	2.027	18.1	1.716				7.5	0.172	0.150	0.65	1.18
	BH-02	CRS-2	7.5	-18.0				5.24	514	5.11	2.076	17.8	1.762								
	BH-02	CRS-3	9.0	-19.5	75	30	11	2.97	291	5.14	2.065	16.5	1.773								
	BH-02	DS-5	10.5	-21.0	20												7.5	0.106	0.107	0.65	
	BH-02	DS-7	13.5	-24.0	24																
	BH-02	CRS-4	18.0	-28.5	97	48	19														
	BH-02	CRS-5	19.5	-30.0				3.29	323	3.00	2.256	12.5	2.006								
	BH-02	CRS-7	22.5	-33.0	95	42	18	5.99	587	6.52	2.196	17.4	1.870								
	BH-02	CRS-8	24.0	-34.5				12.01	1177	8.00	2.151	10.4	1.949								
	BH-02	CRS-9	25.5	-36.0	93	39	14														
	BH-02	CRS-10	27.0	-37.5	97	39	15														
Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3		Non-Plastic								0.0	31		7.5	0.164	0.140	0.86	1.17
	BH-03	SPT-3	3.0	-14.8		48	20														
	BH-03	CRS-1	4.5	-16.3	87	49	23	2.56	251	5.49	2.465	8.3	2.275				7.5	0.150	0.161	0.97	2.35
	BH-03	DS-2	7.5	-19.3	48	34	16									2.657	7.5	0.142	0.130	0.86	1.99
	BH-03	DS-3	9.0	-20.8	82	36	14														
	BH-03	CRS-1	4.5	-16.3																	
	BH-03	CRS-3	10.5	-22.3	62	38	17	4.04	396	7.05	2.061	17.4	1.756								
	BH-03	CRS-4	12.0	-23.8				3.64	357	6.3	2.280	12.6	2.025								
	BH-03	CRS-6	16.5	-28.3	80	38	18	3.14	308	4.66	2.186	16.6	1.874								
	BH-03	CRS-7	18.0	-29.8	71	47	21	3.78	370	5.21	2.207	20.5	1.832								
	BH-03	CRS-8	19.5	-31.3				3.71	364	4.93	2.092	22.9	1.702								
	BH-03	CRS-9	21.0	-32.8	85	48	22	4.43	435	6.04	2.208	21.8	1.813								
	BH-03	CRS-10	22.5	-34.3	88	49	28														
	BH-03	CRS-11	24.0	-35.8				3.47	340	5.04	2.171	16.2	1.869								
	BH-03	CRS-12	25.5	-37.3	82	40	18	3.72	365	5.33	2.151	21.2	1.775								
	BH-03	CRS-13	27.0	-38.8	78	41	17														

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

SUMMARY OF TEST RESULTS

Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation CD PQA	Passing #200	Atterberg Limit		Unconfined Compression			Bulk Density (gm/cc)	Moisture (%)	Dry Density (gm/cc)	Direct Shear		Specific Gravity	Chemical Test				
						LL	PI	qu (kg/ cm^2)	qu (kPa)	Strain (%)				c (Kg/cm^2)	ϕ (deg)		pH	Sulphate Content	Chloride Content	Total Disolve Salt	Organic Matter (%)
Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5	89	33	12									2.659					
	BH-04	SPT-2	1.5	-13.0	94	36	13										7.5	0.195	0.140	1.40	2.11
	BH-04	DS-1	3.0	-14.5	10									0.0	32						
	BH-04	DS-5	9.0	-20.5	19												7.5	0.164	0.129	1.61	0.84
	BH-04	DS-6	10.5	-22.0	32									0.0	32	2.612					
	BH-04	DS-8	13.5	-25.0	35												7.5	0.177	0.107	0.97	-
	BH-04	DS-10	16.5	-28.0	7																
	BH-04	CRS-2	19.5	-31.0	92	32	10	3.54	347	6.66	2.243	9.9	2.041								
	BH-04	CRS-3	21.0	-32.5	87	35	13														
	BH-04	CRS-4	22.5	-34.0				4.79	469	6.66	2.165	22.1	1.773								
	BH-04	CRS-5	24.0	-35.5	92	49	19														
	BH-04	CRS-6	25.5	-37.0				4.34	425	6.66	2.17	18.8	1.826								
	BH-04	CRS-7	27.0	-38.5	99	34	11														
	BH-04	CRS-8	28.5	-40.0	89	36	13														
Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1		30	9							0.0	32		7.5	0.137	0.107	0.97	2.27
	BH-05	DS-2	3.0	-14.6																	
	BH-05	CRS-1	4.5	-16.1	72	46	15									2.624	7.5	0.208	0.150	1.18	2.26
	BH-05	DS-3	7.5	-19.1		30	10														
	BH-05	DS-6	12.0	-23.6		38	12										7.5	0.155	0.129	0.97	2.29
	BH-05	CRS-3	15.0	-26.6	56	49	18	3.07	301	5.75	2.070	16.2	1.782								
	BH-05	CRS-4	16.5	-28.1	70	45	13	5.78	566	6.66	2.160	14.0	1.895								
	BH-05	CRS-5	18.0	-29.6				3.96	388	6.76	2.103	14.4	1.838								
	BH-05	CRS-6	19.5	-31.1	75	44	13	5.00	491	5.5	2.113	15.1	1.836								
	BH-05	CRS-8	22.5	-34.1	85	48	24														
	BH-05	CRS-10	25.5	-37.1	76	44	17														
	BH-05	CRS-11	27.0	-38.6				4.15	407	4.73	2.237	13.6	1.969								
	BH-05	CRS-12	28.5	-40.1	75	42	12	3.57	350	2.6	2.200	15.3	1.908								

LABORATORY TEST RESULTS

L.R # 63/ 16

Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.

Client: Qasim International Container Terminal Port(QICT), DP WORLD

GRAIN SIZE ANALYSIS (PER CENT FINER BY WEIGHT)
SIEVE ANALYSIS

S.No.	Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation (m)	3"	1.5"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	0.05	0.01	0.002	0.001
						75 mm	38 mm	19 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	0.05 mm	0.010 mm	0.002 mm	0.001 mm
1	Barthing mark 687, Between 28-29, Bollards	BH-01	SPT-1	0.0	-9.1								100	98	96	94	72	61	54	24
2		BH-01	SPT-3	3.0	-12.1				100	93	89	85	82	80	65	37				
3		BH-01	SPT-4	4.5	-13.6			100	88	67	62	58	55	53	43	30				
4		BH-01	DS-1	7.5	-16.6				100	89	76	58	49	47	35	28				
5		BH-01	DS-4	12.0	-21.1		100	76	66	58	54	42	36	33	28	25				
6		BH-01	DS-6	15.0	-24.1					100	96	91	88	86	83	79	71	62	57	26
7		BH-01	CRS-1	19.5	-28.6					100	99	98	97	96	94	90	80	73	62	24
8		BH-01	CRS-2	21.0	-30.1						100	97	96	96	93	88	70	60	52	23
9		BH-01	CRS-3	22.5	-31.6									100	98	96	83	75	64	24
10		BH-01	DS-10	24.0	-33.1								100	99	97	94	82	74	63	23
11		BH-01	DS-12	27.0	-36.1						100	97	95	94	91	86	80	72	60	26
12	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5								100	98	96	93	85	76	65	29
13		BH-02	DS-1	1.5	-12.0			100	75	36	25	20	18	16	14	13				
14		BH-02	DS-3	4.5	-15.0			100	94	82	69	39	22	19	10	7				
15		BH-02	CRS-1	6.1	-16.6						100	95	92	91	87	85	76	67	58	25
16		BH-02	CRS-3	9.0	-19.5						100	91	86	84	79	75	70	62	57	26
17		BH-02	DS-5	10.5	-21.0		100	62	37	33	31	27	24	23	21	20				
18		BH-02	DS-7	13.5	-24.0		100	82	64	57	52	45	39	36	28	24				
19		BH-02	CRS-4	18.0	-28.5									100	98	97	76	68	55	24
20		BH-02	CRS-7	22.5	-33.0								100	98	96	95	88	77	68	29
21		BH-02	CRS-9	25.5	-36.0								100	97	95	93	82	73	62	28
22		BH-02	CRS-10	27.0	-37.5									100	98	97	85	76	69	29

L.R # 63/ 16

Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.

Client: Qasim International Container Terminal Port(QICT), DP WORLD

GRAIN SIZE ANALYSIS (PER CENT FINER BY WEIGHT)
SIEVE ANALYSIS

S.No.	Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation (m)	3"	1.5"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	0.05	0.01	0.002	0.001
						75 mm	38 mm	19 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	0.05 mm	0.010 mm	0.002 mm	0.001 mm
23	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3			100	71	44	19	11	8	3	1					
24		BH-03	SPT-3	3.0	-14.8	61	25	20	19	19	19	19	19	18	18					
25		BH-03	CRS-1	4.5	-16.3								100	98	97	87	76	65	30	
26		BH-03	DS-2	7.5	-19.3	100	86	76	75	73	67	63	61	55	51	48	42	38	20	
27		BH-03	DS-3	9.0	-20.8							100	99	97	96	82	74	63	29	
28		BH-03	CRS-3	10.5	-22.3				100	99	95	92	89	77	69	62	57	47	21	
29		BH-03	CRS-6	16.5	-28.3				100	95	92	91	90	88	86	80	73	60	26	
30		BH-03	CRS-7	18.0	-29.8								100	98	97	71	60	52	23	
31		BH-03	CRS-9	21.0	-32.8								100	98	97	85	74	63	28	
32		BH-03	CRS-10	22.5	-34.3							100	99	97	95	88	79	67	31	
33		BH-03	CRS-12	25.5	-37.3								100	99	98	82	74	61	28	
34		BH-03	CRS-13	27.0	-38.8				100	93	90	89	88	86	85	78	65	58	27	

L.R # 63/ 16

Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.

Client: Qasim International Container Terminal Port(QICT), DP WORLD

GRAIN SIZE ANALYSIS (PER CENT FINER BY WEIGHT)
SIEVE ANALYSIS

S.No.	Location	Borehole#	Sample	Depth Below Seabed (m)	Elevation (m)	3"	1.5"	3/4"	3/8"	#4	#8	#16	#30	#50	#100	#200	0.05	0.01	0.002	0.001
						75 mm	38 mm	19 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	0.05 mm	0.010 mm	0.002 mm	0.001 mm
35	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5						100	96	94	93	91	89	81	72	61	28
36		BH-04	SPT-2	1.5	-13.0							100	98	97	95	94	85	74	63	27
37		BH-04	DS-1	3.0	-14.5		100	53	33	26	21	17	13	12	10	10				
38		BH-04	DS-5	9.0	-20.5		100	91	76	66	55	40	32	28	22	19				
39		BH-04	DS-6	10.5	-22.0			100	91	84	76	60	49	43	35	32				
40		BH-04	DS-8	13.5	-25.0			100	86	83	81	77	70	62	45	35				
41		BH-04	DS-10	16.5	-28.0		100	72	65	50	31	15	10	9	8	7				
42		BH-04	CRS-2	19.5	-31.0							100	99	98	95	92	82	71	60	26
43		BH-04	CRS-3	21.0	-32.5							100	96	95	93	87	76	63	57	25
44		BH-04	CRS-5	24.0	-35.5							100	99	98	94	92	72	61	55	24
45		BH-04	CRS-7	27.0	-38.5									100	99	99	86	74	64	27
46		BH-04	CRS-8	28.5	-40.0							100	98	97	93	89	83	73	61	26
47	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1		100	75	75	28	15	6	6	5	5					
48		BH-05	DS-2	3.0	-14.6		100	76	74	38	8	4	4	3	3					
49		BH-05	CRS-1	4.5	-16.1								100	99	98	72	61	51	23	
50		BH-05	DS-3	7.5	-19.1	100	85	71	69	64	54	50	46	40	36					
51		BH-05	DS-6	12.0	-23.6	100	85	71	68	58	42	36	33	28	26					
52		BH-05	CRS-3	15.0	-26.6		100	90	88	85	77	74	72	69	68	56	47	38	18	
53		BH-05	CRS-4	16.5	-28.1						100	95	94	86	82	70	61	52	22	
54		BH-05	CRS-6	19.5	-31.1							100	99	95	92	75	62	55	24	
55		BH-05	CRS-8	22.5	-34.1							100	99	95	94	85	77	64	28	
56		BH-05	CRS-10	25.5	-37.1								100	99	98	76	65	56	25	
57		BH-05	CRS-12	28.5	-40.1								100	96	95	75	62	53	23	

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

ATTERBERG LIMITS

S. No.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	Liquid Limit	Placticity Index
1	Barthing mark 687, Between 28-29, Bollards	BH-01	SPT-1	0.0	-9.1	37	10
2		BH-01	DS-4	12.0	-21.1	30	9
3		BH-01	DS-6	15.0	-24.1	30	8
4		BH-01	CRS-1	19.5	-28.6	41	14
5		BH-01	CRS-2	21.0	-30.1	40	13
6		BH-01	CRS-3	22.5	-31.6	41	13
7		BH-01	DS-10	24.0	-33.1	42	14
8		BH-01	DS-12	27.0	-36.1	37	12
9	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5	34	12
10		BH-02	CRS-1	6.1	-16.6	49	21
11		BH-02	CRS-3	9.0	-19.5	30	11
12		BH-02	CRS-4	18.0	-28.5	48	19
13		BH-02	CRS-7	22.5	-33.0	42	18
14		BH-02	CRS-9	25.5	-36.0	39	14
15		BH-02	CRS-10	27.0	-37.5	39	15

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

ATTERBERG LIMITS

S. No.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	Liquid Limit	Placticity Index
16	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3	Non-Plastic	Non-Plastic
17		BH-03	SPT-3	3.0	-14.8	48	20
18		BH-03	CRS-1	4.5	-16.3	49	23
19		BH-03	DS-2	7.5	-19.3	34	16
20		BH-03	DS-3	9.0	-20.8	36	14
21		BH-03	CRS-3	10.5	-22.3	38	17
22		BH-03	CRS-6	16.5	-28.3	38	18
23		BH-03	CRS-7	18.0	-29.8	47	21
24		BH-03	CRS-9	21.0	-32.8	48	22
25		BH-03	CRS-10	22.5	-34.3	49	28
26		BH-03	CRS-12	25.5	-37.3	40	18
27		BH-03	CRS-13	27.0	-38.8	41	17
28	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5	33	12
29		BH-04	SPT-2	1.5	-13.0	36	13
30		BH-04	CRS-2	19.5	-31.0	32	10
31		BH-04	CRS-3	21.0	-32.5	35	13
32		BH-04	CRS-5	24.0	-35.5	49	19
33		BH-04	CRS-7	27.0	-38.5	34	11
34		BH-04	CRS-8	28.5	-40.0	36	13

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

ATTERBERG LIMITS

S. No.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	Liquid Limit	Placticity Index
35	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1	30	9
36		BH-05	CRS-1	4.5	-16.1	46	15
37		BH-05	DS-3	7.5	-19.1	30	10
38		BH-05	DS-6	12.0	-23.6	38	12
39		BH-05	CRS-3	15.0	-26.6	49	18
40		BH-05	CRS-4	16.5	-28.1	45	13
41		BH-05	CRS-6	19.5	-31.1	44	13
42		BH-05	CRS-8	22.5	-34.1	48	24
43		BH-05	CRS-10	25.5	-37.1	44	17
44		BH-05	CRS-12	28.5	-40.1	42	12

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

UNCONFINED COMPRESSION TEST

S. NO.		BORING NO.	SAMPLE	Depth BelowSeabed(m)	Elevation (m)	Unconfined Compression			Bulk Density (gm/cc)	Moisture (%)	Dry Density (gm/cc)
						qu (kg/ cm^2)	qu (kPa)	STRAIN (%)			
1	Barthing mark 687, Between 28-	BH-01	CRS-2	21.0	-30.1	3.65	358	6.66	2.064	18.9	1.736
2		BH-01	CRS-3	22.5	-31.6	10.29	1009	5.4	2.218	10.8	2.001
3	Barthing mark 549, Between 23-24, Bollards	BH-02	CRS-1	6.1	-16.6	2.75	269	5.28	2.027	18.1	1.716
4		BH-02	CRS-2	7.5	-18.0	5.24	514	5.11	2.076	17.8	1.762
5		BH-02	CRS-3	9.0	-19.5	2.97	291	5.14	2.065	16.5	1.773
6		BH-02	CRS-5	19.5	-30.0	3.29	323	3.00	2.256	12.5	2.006
7		BH-02	CRS-7	22.5	-33.0	5.99	587	6.52	2.196	17.4	1.870
8		BH-02	CRS-8	24.0	-34.5	12.01	1177	8.00	2.151	10.4	1.949
9	Barthing mark 412, Bollards Between 17-18,	BH-03	CRS-1	4.5	-16.3	2.56	251	5.49	2.465	8.3	2.275
10		BH-03	CRS-3	10.5	-22.3	4.04	396	7.05	2.061	17.4	1.756
11		BH-03	CRS-4	12.0	-23.8	3.64	357	6.3	2.280	12.6	2.025
12		BH-03	CRS-6	16.5	-28.3	3.14	308	4.66	2.186	16.6	1.874
13		BH-03	CRS-7	18.0	-29.8	3.78	370	5.21	2.207	20.5	1.832
14		BH-03	CRS-8	19.5	-31.3	3.71	364	4.93	2.092	22.9	1.702
15		BH-03	CRS-9	21.0	-32.8	4.43	435	6.04	2.208	21.8	1.813
16		BH-03	CRS-11	24.0	-35.8	3.47	340	5.04	2.171	16.2	1.869
17		BH-03	CRS-12	25.5	-37.3	3.72	365	5.33	2.151	21.2	1.775
18	Barthing mark 275, Between 12-13, Bollards	BH-04	CRS-2	19.5	-31.0	3.54	347	6.66	2.243	9.9	2.041
19		BH-04	CRS-4	22.5	-34.0	4.79	469	6.66	2.165	22.1	1.773
20		BH-04	CRS-6	25.5	-37.0	4.34	425	6.66	2.17	18.8	1.826
21	Barthing mark 137, Between 6 - 7, Bollards	BH-05	CRS-3	15.0	-26.6	3.07	301	5.75	2.070	16.2	1.782
22		BH-05	CRS-4	16.5	-28.1	5.78	566	6.66	2.160	14.0	1.895
23		BH-05	CRS-5	18.0	-29.6	3.96	388	6.76	2.103	14.4	1.838
24		BH-05	CRS-6	19.5	-31.1	5.00	491	5.5	2.113	15.1	1.836
25		BH-05	CRS-11	27.0	-38.6	4.15	407	4.73	2.237	13.6	1.969
26		BH-05	CRS-12	28.5	-40.1	3.57	350	2.6	2.200	15.3	1.908

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--1 **SAMPLE :** CRS-2 **DEPTH (m):** 21.0 - 22.5

Diameter (cm)	5.41	Area A_0 (cm^2)	22.990	Ht,L_0 (cm)	10.510	LRC kg/div	4.3
Volume (cm^3)	241.63	Correction Factor of Height	1.00				
weight	498.8		Moisture	18.9			
Bulk Density	2.064	Dry Density	1.736				

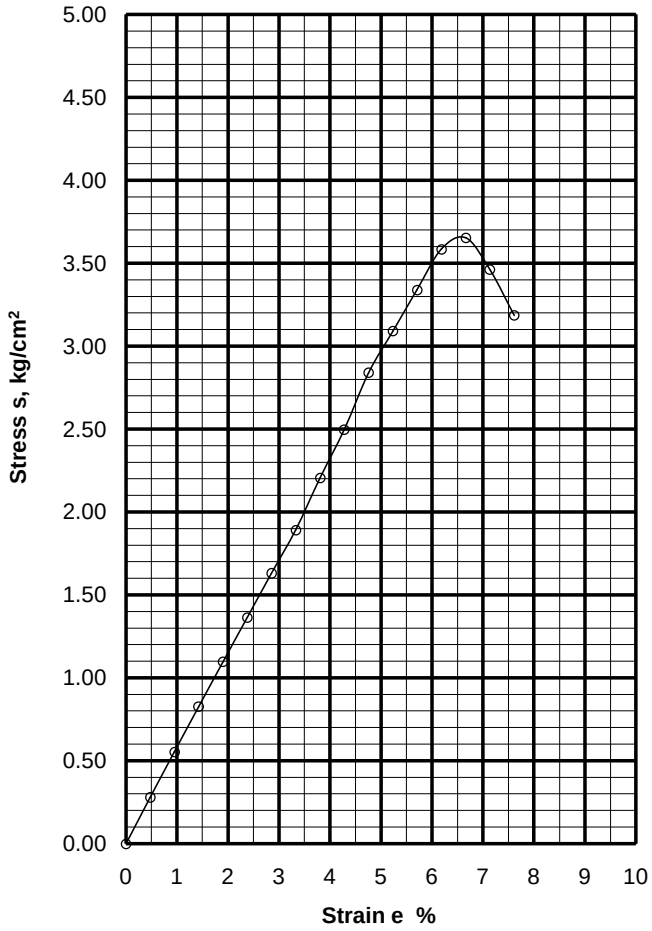
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	22.99	0	0	0
50	1.5	0.05	0.48	0.9952	23.10	6.45	0.279	0.28
100	3	0.1	0.95	0.9905	23.21	12.9	0.556	0.55
150	4.5	0.15	1.43	0.9857	23.32	19.35	0.830	0.83
200	6	0.2	1.90	0.9810	23.44	25.8	1.101	1.10
250	7.5	0.25	2.38	0.9762	23.55	32.25	1.369	1.36
300	9	0.3	2.85	0.9715	23.67	38.7	1.635	1.63
350	10.5	0.35	3.33	0.9667	23.78	45.15	1.898	1.89
400	12.3	0.4	3.81	0.9619	23.90	52.89	2.213	2.21
450	14	0.45	4.28	0.9572	24.02	60.2	2.506	2.50
500	16	0.5	4.76	0.9524	24.14	68.8	2.850	2.84
550	17.5	0.55	5.23	0.9477	24.26	75.25	3.102	3.09
600	19	0.6	5.71	0.9429	24.38	81.7	3.351	3.34
650	20.5	0.65	6.18	0.9382	24.51	88.15	3.597	3.58
700	21	0.7	6.66	0.9334	24.63	90.3	3.666	3.65
750	20	0.75	7.14	0.9286	24.76	86	3.474	3.46
800	18.5	0.8	7.61	0.9239	24.88	79.55	3.197	3.19

RESULT	
Stress	3.65
Strain	6.66

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim) L.R # 63/ 16
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--1

SAMPLE : CRS-2

DEPTH(m): 21.0 - 22.5

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--1 **SAMPLE :** CRS-3 **DEPTH (m):** 22.5 - 24.0

Diameter (cm)	5.71	Area A_0 (cm^2)	25.611	Ht,L_0 (cm)	11.110	LRC kg/div	4.3
Volume (cm^3)	284.53	Correction Factor of Height	1.00				
weight	631		Moisture	10.84			
Bulk Density	2.218	Dry Density	2.001				

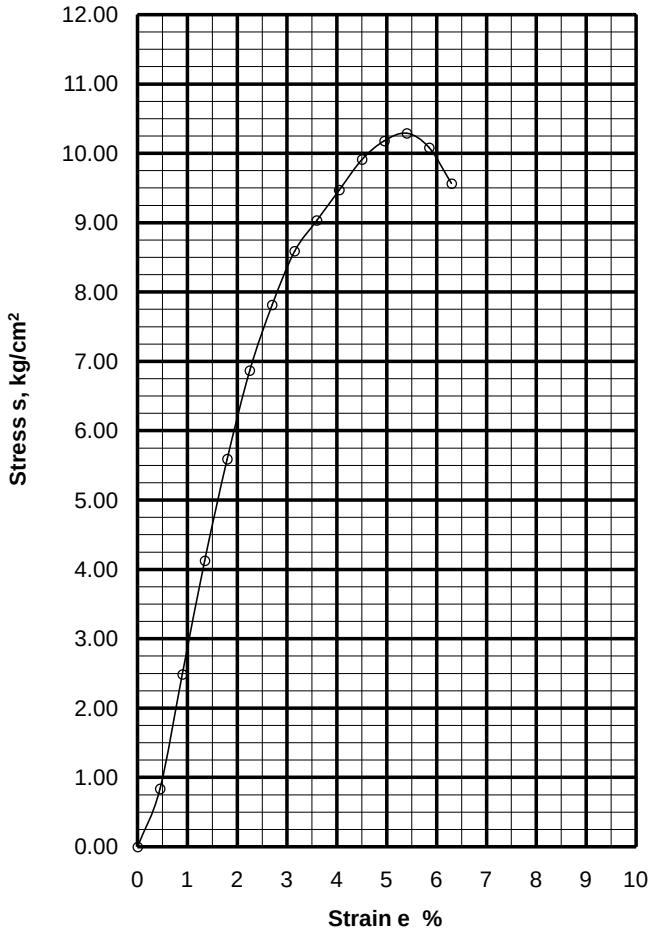
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	25.61	0	0	0
50	5	0.05	0.45	0.9955	25.73	21.5	0.836	0.833
100	15	0.1	0.90	0.9910	25.84	64.5	2.496	2.487
150	25	0.15	1.35	0.9865	25.96	107.5	4.141	4.127
200	34	0.2	1.80	0.9820	26.08	146.2	5.606	5.587
250	42	0.25	2.25	0.9775	26.20	180.6	6.893	6.870
300	48	0.3	2.70	0.9730	26.32	206.4	7.842	7.815
350	53	0.35	3.15	0.9685	26.44	227.9	8.618	8.590
400	56	0.4	3.60	0.9640	26.57	240.8	9.064	9.034
450	59	0.45	4.05	0.9595	26.69	253.7	9.505	9.473
500	62	0.5	4.50	0.9550	26.82	266.6	9.941	9.908
550	64	0.55	4.95	0.9505	26.94	275.2	10.214	10.180
600	65	0.6	5.40	0.9460	27.07	279.5	10.324	10.290
650	64	0.65	5.85	0.9415	27.20	275.2	10.117	10.083
700	61	0.7	6.30	0.9370	27.33	262.3	9.597	9.565

RESULT	
Stress	10.290
Strain	5.40

PROJECT: Barthing mark 687, Between 28-29, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--1

SAMPLE : CRS-3

DEPTH(m): 22.5 - 24.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-1 **DEPTH (m):** 6.10 - 7.50

Diameter (cm)	6.01	Area A_0 (cm^2)	28.372	Ht,L_0 (cm)	10.410	LRC kg/div	4.3
Volume (cm^3)	295.36	Correction Factor of Height	1.02				
weight	598.7		Moisture	18.11			
Bulk Density	2.027	Dry Density	1.716				

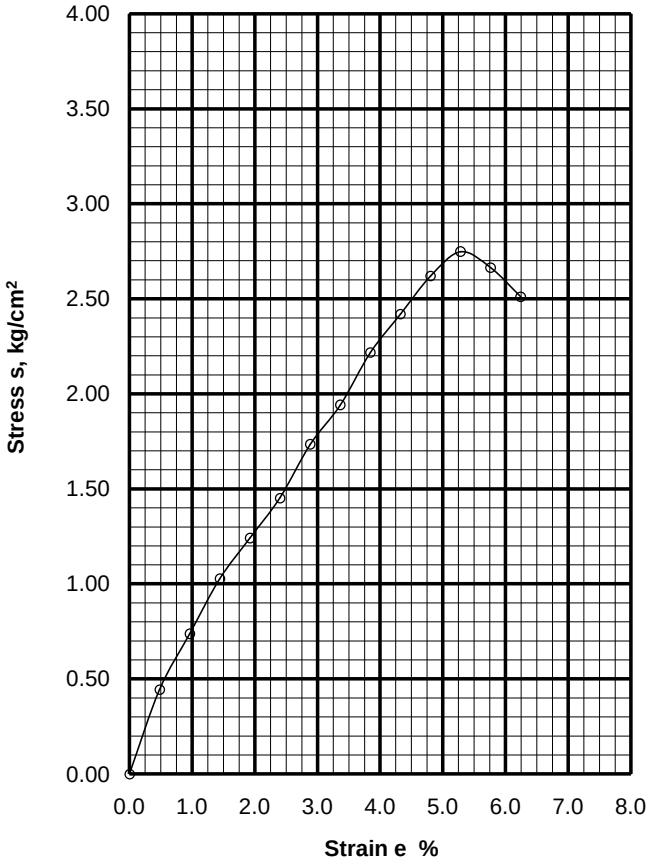
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	28.37	0	0	0
50	3	0.05	0.48	0.9952	28.51	12.9	0.452	0.444
100	5	0.1	0.96	0.9904	28.65	21.5	0.751	0.737
150	7	0.15	1.44	0.9856	28.79	30.1	1.046	1.027
200	8.5	0.2	1.92	0.9808	28.93	36.55	1.263	1.240
250	10	0.25	2.40	0.9760	29.07	43	1.479	1.452
300	12	0.3	2.88	0.9712	29.21	51.6	1.766	1.734
350	13.5	0.35	3.36	0.9664	29.36	58.05	1.977	1.941
400	15.5	0.4	3.84	0.9616	29.51	66.65	2.259	2.218
450	17	0.45	4.32	0.9568	29.65	73.1	2.465	2.420
500	18.5	0.5	4.80	0.9520	29.80	79.55	2.669	2.620
550	19.5	0.55	5.28	0.9472	29.95	83.85	2.799	2.748
600	19	0.6	5.76	0.9424	30.11	81.7	2.714	2.664
650	18	0.65	6.24	0.9376	30.26	77.4	2.558	2.511

RESULT	
Stress	2.748
Strain	5.28

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-1

DEPTH(m): 6.10 - 7.50

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-2 **DEPTH (m):** 7.5 - 9.0

Diameter (cm)	4.73	Area A_0 (cm^2)	17.574	Ht,L_0 (cm)	9.780	LRC kg/div	4.3
Volume (cm^3)	171.87	Correction Factor of Height	1.00				
weight	356.8		Moisture	17.8			
Bulk Density	2.076	Dry Density	1.762				

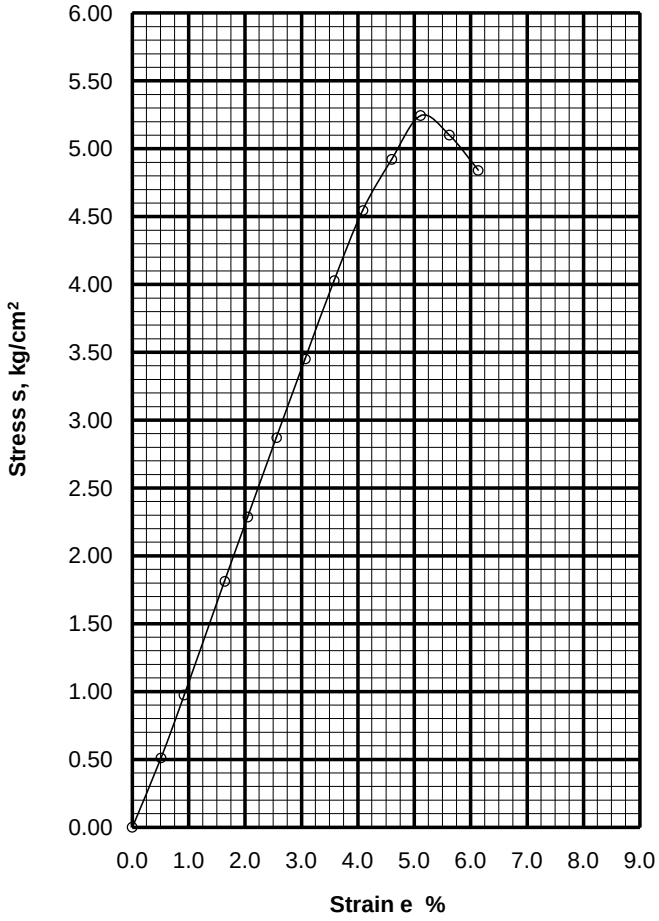
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	17.57	0	0	0
50	2.1	0.05	0.51	0.9949	17.66	9.03	0.511	0.513
90	4	0.09	0.92	0.9908	17.74	17.2	0.970	0.974
150	7.5	0.16	1.64	0.9836	17.87	32.25	1.805	1.812
200	9.5	0.2	2.04	0.9796	17.94	40.85	2.277	2.286
250	12	0.25	2.56	0.9744	18.03	51.6	2.861	2.872
300	14.5	0.3	3.07	0.9693	18.13	62.35	3.439	3.453
350	17	0.35	3.58	0.9642	18.23	73.1	4.011	4.027
400	19.3	0.4	4.09	0.9591	18.32	82.99	4.529	4.547
450	21	0.45	4.60	0.9540	18.42	90.3	4.902	4.921
500	22.5	0.5	5.11	0.9489	18.52	96.75	5.224	5.244
550	22	0.55	5.62	0.9438	18.62	94.6	5.080	5.100
600	21	0.6	6.13	0.9387	18.72	90.3	4.823	4.842

RESULT	
Stress	5.244
Strain	5.11

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-2

DEPTH(m): 7.5 - 9.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-3 **DEPTH (m):** 9.0 - 10.5

Diameter (cm)	4.71	Area A_0 (cm^2)	17.426	Ht,L_0 (cm)	10.710	LRC kg/div	4.3
Volume (cm^3)	186.63	Correction Factor of Height	0.99				
weight	385.3		Moisture	16.48			
Bulk Density	2.065	Dry Density	1.772				

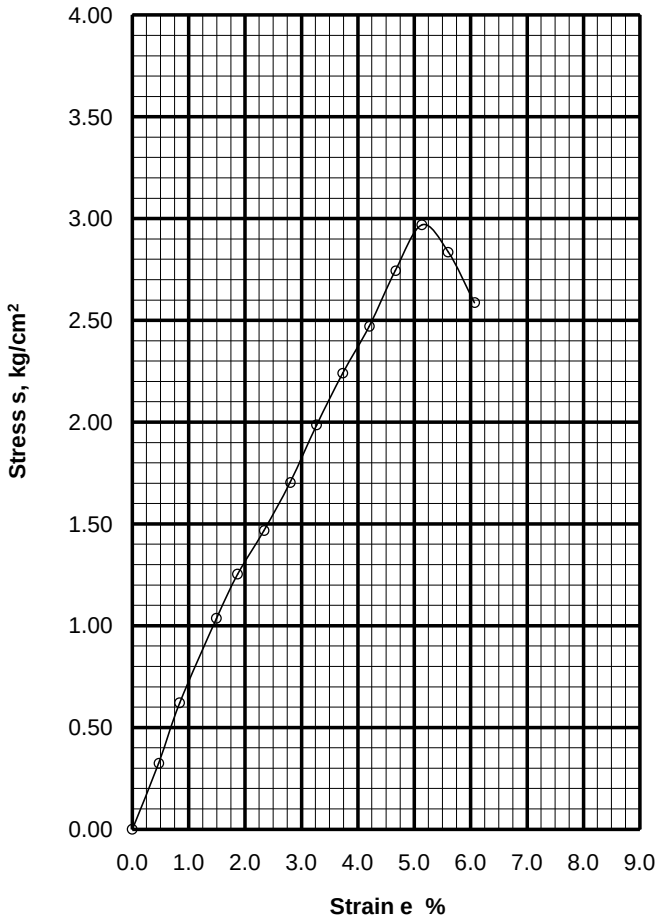
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	17.43	0	0	0
50	1.3	0.05	0.47	0.9953	17.51	5.59	0.319	0.324
90	2.5	0.09	0.84	0.9916	17.57	10.75	0.612	0.621
150	4.2	0.16	1.49	0.9851	17.69	18.06	1.021	1.036
200	5.1	0.2	1.87	0.9813	17.76	21.93	1.235	1.253
250	6	0.25	2.33	0.9767	17.84	25.8	1.446	1.467
300	7	0.3	2.80	0.9720	17.93	30.1	1.679	1.704
350	8.2	0.35	3.27	0.9673	18.01	35.26	1.957	1.986
400	9.3	0.4	3.73	0.9627	18.10	39.99	2.209	2.242
450	10.3	0.45	4.20	0.9580	18.19	44.29	2.435	2.471
500	11.5	0.5	4.67	0.9533	18.28	49.45	2.705	2.745
550	12.5	0.55	5.14	0.9486	18.37	53.75	2.926	2.969
600	12	0.6	5.60	0.9440	18.46	51.6	2.795	2.836
650	11	0.65	6.07	0.9393	18.55	47.3	2.550	2.587

RESULT	
Stress	2.969
Strain	5.14

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-3

DEPTH(m): 9.0 - 10.5

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-5 **DEPTH (m):** 19.50 - 21.0

Diameter (cm)	5.52	Area A_0 (cm^2)	23.934	Ht,L_0 (cm)	10.000	LRC kg/div	4.3
Volume (cm^3)	239.34	Correction Factor of Height	1.01				
weight	539.9		Moisture	12.48			
Bulk Density	2.256	Dry Density	2.005				

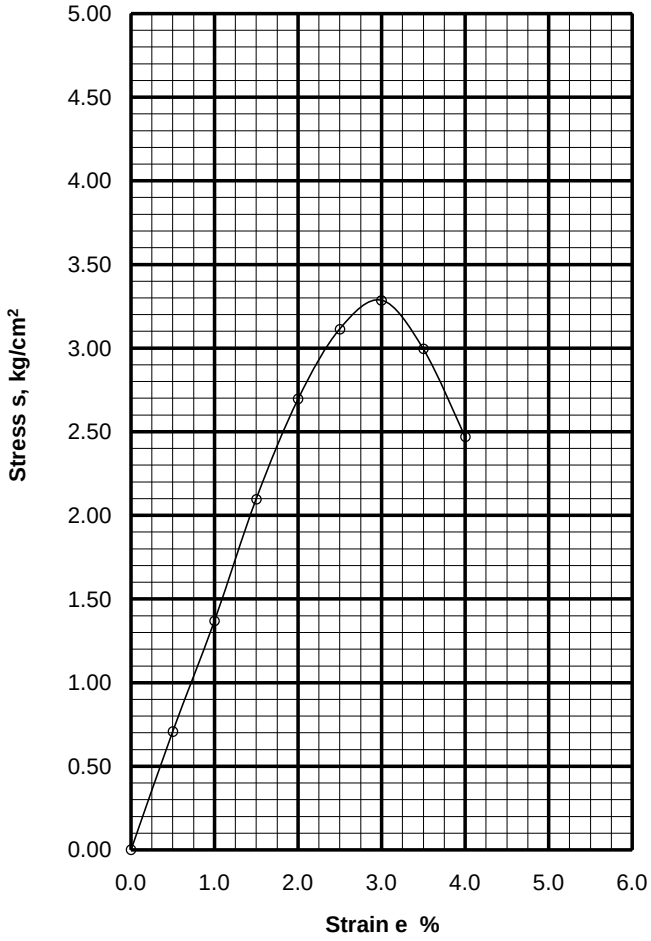
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	23.93	0	0	0
50	4.0	0.05	0.50	0.9950	24.05	17.2	0.715	0.71
100	7.8	0.1	1.00	0.9900	24.18	33.54	1.387	1.37
150	12.0	0.15	1.50	0.9850	24.30	51.6	2.124	2.10
200	15.5	0.2	2.00	0.9800	24.42	66.65	2.729	2.70
250	18.0	0.25	2.50	0.9750	24.55	77.4	3.153	3.11
300	19.1	0.3	3.00	0.9700	24.67	82.087	3.327	3.29
350	17.5	0.35	3.50	0.9650	24.80	75.25	3.034	3.00
400	14.5	0.4	4.00	0.9600	24.93	62.35	2.501	2.47

RESULT	
Stress	3.29
Strain	3.00

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-5

DEPTH(m): 19.50 - 21.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-7 **DEPTH (m):** 22.5 - 24.0

Diameter (cm)	5.91	Area A_0 (cm^2)	27.436	Ht,L_0 (cm)	11.510	LRC kg/div	4.3
Volume (cm^3)	315.79	Correction Factor of Height	1.00				
weight	693.4		Moisture	17.42			
Bulk Density	2.196	Dry Density	1.870				

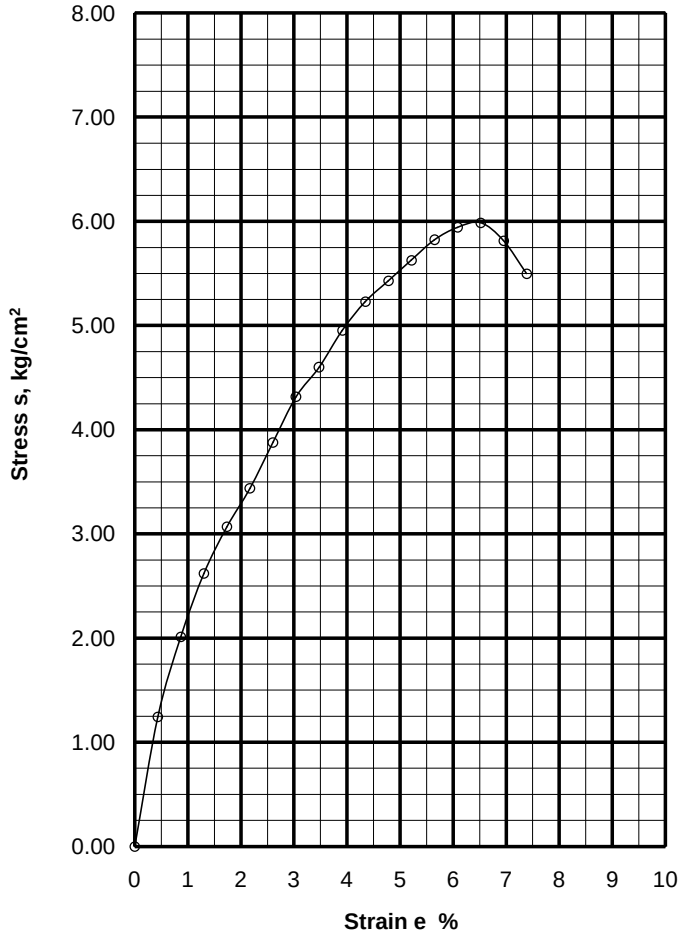
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.44	0	0	0
50	8	0.05	0.43	0.9957	27.56	34.4	1.248	1.244
100	13	0.1	0.87	0.9913	27.68	55.9	2.020	2.013
150	17	0.15	1.30	0.9870	27.80	73.1	2.630	2.621
200	20	0.2	1.74	0.9826	27.92	86	3.080	3.070
250	22.5	0.25	2.17	0.9783	28.05	96.75	3.450	3.439
300	25.5	0.3	2.61	0.9739	28.17	109.65	3.892	3.880
350	28.5	0.35	3.04	0.9696	28.30	122.55	4.331	4.317
400	30.5	0.4	3.48	0.9652	28.42	131.15	4.614	4.599
450	33	0.45	3.91	0.9609	28.55	141.9	4.970	4.954
500	35	0.5	4.34	0.9566	28.68	150.5	5.247	5.230
550	36.5	0.55	4.78	0.9522	28.81	156.95	5.447	5.430
600	38	0.6	5.21	0.9479	28.94	163.4	5.645	5.627
650	39.5	0.65	5.65	0.9435	29.08	169.85	5.841	5.822
700	40.5	0.7	6.08	0.9392	29.21	174.15	5.961	5.942
750	41	0.75	6.52	0.9348	29.35	176.3	6.007	5.988
800	40	0.8	6.95	0.9305	29.49	172	5.833	5.815
850	38	0.85	7.38	0.9262	29.6	163.4	5.516	5.498

RESULT	
Stress	5.988

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-7

DEPTH(m): 22.5 - 24.0

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--2 **SAMPLE :** CRS-8 **DEPTH (m):** 24.0 - 25.50

Diameter (cm)	5.94	Area A_0 (cm^2)	27.715	Ht,L_0 (cm)	10.000	LRC kg/div	4.3
Volume (cm^3)	277.15	Correction Factor of Height	1.02				
weight	596.1		Moisture	10.39			
Bulk Density	2.151	Dry Density	1.948				

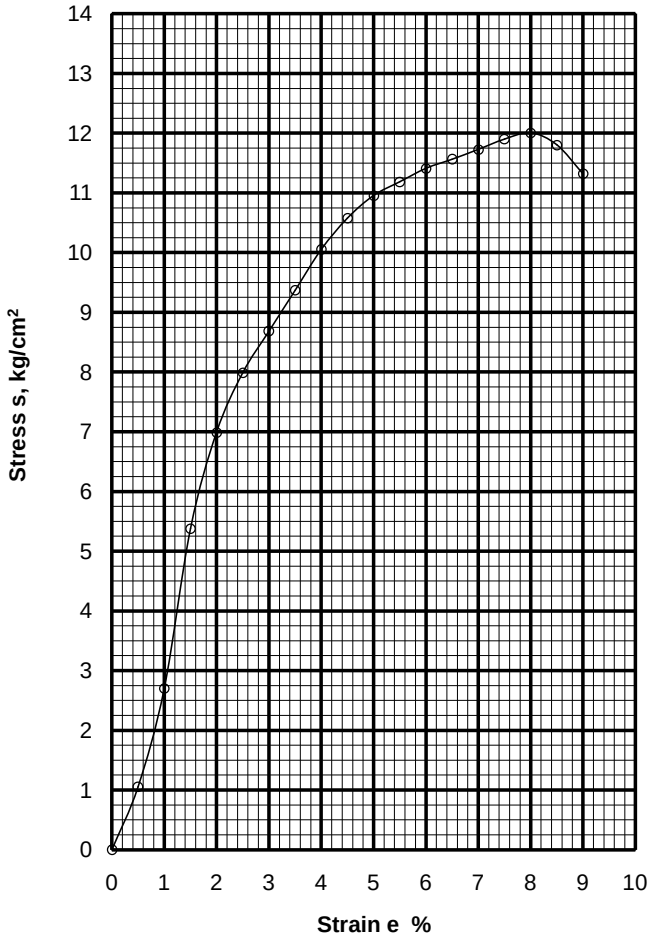
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.72	0	0	0
50	7	0.05	0.50	0.9950	27.85	30.1	1.081	1.057
100	18	0.1	1.00	0.9900	28.00	77.4	2.765	2.704
150	36	0.15	1.50	0.9850	28.14	154.8	5.502	5.380
200	47	0.2	2.00	0.9800	28.28	202.1	7.146	6.989
250	54	0.25	2.50	0.9750	28.43	232.2	8.169	7.988
300	59	0.3	3.00	0.9700	28.57	253.7	8.879	8.683
350	64	0.35	3.50	0.9650	28.72	275.2	9.582	9.371
400	69	0.4	4.00	0.9600	28.87	296.7	10.277	10.050
450	73	0.45	4.50	0.9550	29.02	313.9	10.816	10.578
500	76	0.5	5.00	0.9500	29.17	326.8	11.202	10.955
550	78	0.55	5.50	0.9450	29.33	335.4	11.436	11.184
600	80	0.6	6.00	0.9400	29.48	344	11.667	11.410
650	81.5	0.65	6.50	0.9350	29.64	350.45	11.823	11.562
700	83.1	0.7	7.00	0.9300	29.80	357.33	11.990	11.726
750	84.8	0.75	7.50	0.9250	29.96	364.64	12.170	11.901
800	86	0.8	8.00	0.9200	30.13	369.8	12.275	12.005
850	85	0.85	8.5	0.915	30.3	365.5	12.067	11.801
900	82	0.9	9.00	0.9100	30.46	352.6	11.577	11.322

RESULT	
Stress	12.005
Strain	8.00

PROJECT: Barthing mark 549, Between 23-24, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--2

SAMPLE : CRS-8

DEPTH(m): 24.0 - 25.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-1 **DEPTH (m):** 4.50 - 6.0

Diameter (cm)	5.61	Area A_0 (cm^2)	24.721	Ht,L_0 (cm)	9.110	LRC kg/div	4.3
Volume (cm^3)	225.21	Correction Factor	1.03				
weight	555.2	of Height	Moisture	8.33			
Bulk Density	2.465	Dry Density	2.276				

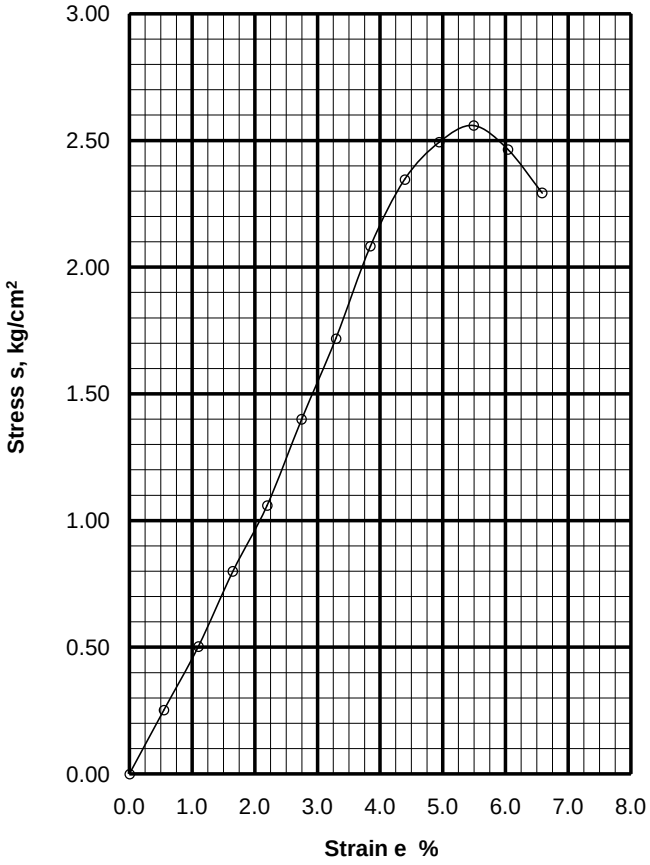
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	24.72	0	0	0
50	1.5	0.05	0.55	0.9945	24.86	6.45	0.259	0.252
100	3	0.1	1.10	0.9890	25.00	12.9	0.516	0.502
150	4.8	0.15	1.65	0.9835	25.14	20.64	0.821	0.799
200	6.4	0.2	2.20	0.9780	25.28	27.52	1.089	1.059
250	8.5	0.25	2.74	0.9726	25.42	36.55	1.438	1.399
300	10.5	0.3	3.29	0.9671	25.56	45.15	1.766	1.718
350	12.8	0.35	3.84	0.9616	25.71	55.04	2.141	2.083
400	14.5	0.4	4.39	0.9561	25.86	62.35	2.411	2.346
450	15.5	0.45	4.94	0.9506	26.01	66.65	2.563	2.494
500	16	0.5	5.49	0.9451	26.16	68.8	2.630	2.559
550	15.5	0.55	6.04	0.9396	26.31	66.65	2.533	2.465
600	14.5	0.6	6.59	0.9341	26.46	62.35	2.356	2.292

RESULT	
Stress	2.559
Strain	5.49

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-1

DEPTH(m): 4.50 - 6.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-3 **DEPTH (m):** 10.50 - 12.0

Diameter (cm)	4.41	Area A_0 (cm^2)	15.276	Ht,L_0 (cm)	8.510	LRC kg/div	4.3
Volume (cm^3)	130.00	Correction Factor of Height	1.00				
weight	267.9		Moisture	17.4			
Bulk Density	2.061	Dry Density	1.755				

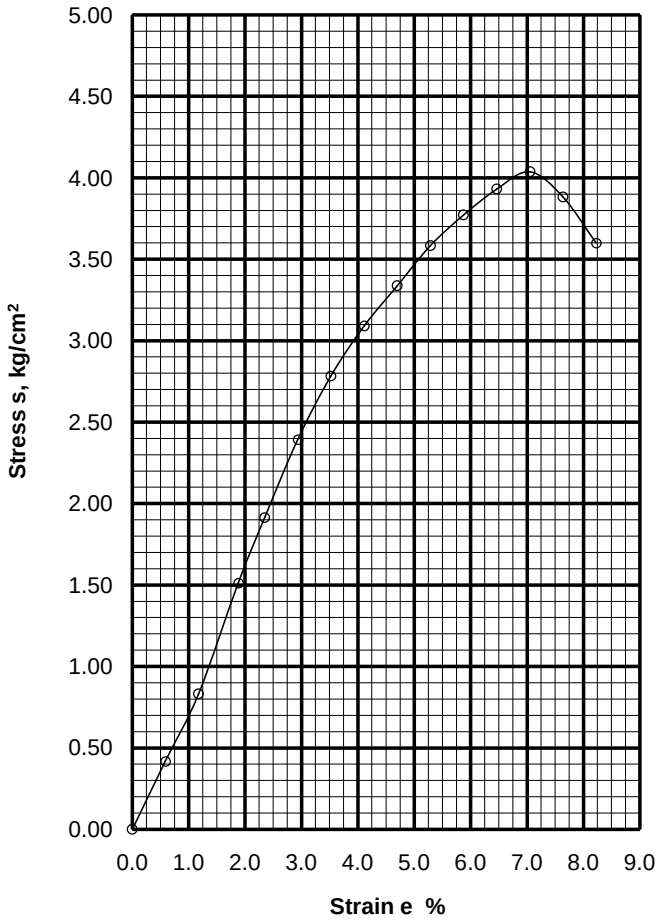
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	15.28	0	0	0
50	1.5	0.05	0.59	0.9941	15.37	6.45	0.420	0.418
100	3	0.1	1.18	0.9882	15.46	12.9	0.835	0.831
150	5.5	0.16	1.88	0.9812	15.57	23.65	1.519	1.512
200	7	0.2	2.35	0.9765	15.64	30.1	1.924	1.916
250	8.8	0.25	2.94	0.9706	15.74	37.84	2.404	2.394
300	10.3	0.3	3.53	0.9647	15.83	44.29	2.797	2.785
350	11.5	0.35	4.11	0.9589	15.93	49.45	3.104	3.090
400	12.5	0.4	4.70	0.9530	16.03	53.75	3.353	3.339
450	13.5	0.45	5.29	0.9471	16.13	58.05	3.599	3.583
500	14.3	0.5	5.88	0.9412	16.23	61.49	3.789	3.772
550	15	0.55	6.46	0.9354	16.33	64.5	3.949	3.932
600	15.5	0.6	7.05	0.9295	16.44	66.65	4.055	4.038
650	15	0.65	7.64	0.9236	16.54	64.5	3.900	3.883
700	14	0.7	8.23	0.9177	16.65	60.2	3.617	3.601

RESULT	
Stress	4.038
Strain	7.05

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-3

DEPTH(m): 10.50 - 12.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-4 **DEPTH (m):** 12.0 - 13.50

Diameter (cm)	5.11	Area A_0 (cm^2)	20.511	Ht,L_0 (cm)	10.310	LRC kg/div	4.3
Volume (cm^3)	211.47	Correction	1.00				
weight	482.2	Factor of Height	Moisture	12.58			
Bulk Density	2.280	Dry Density	2.025				

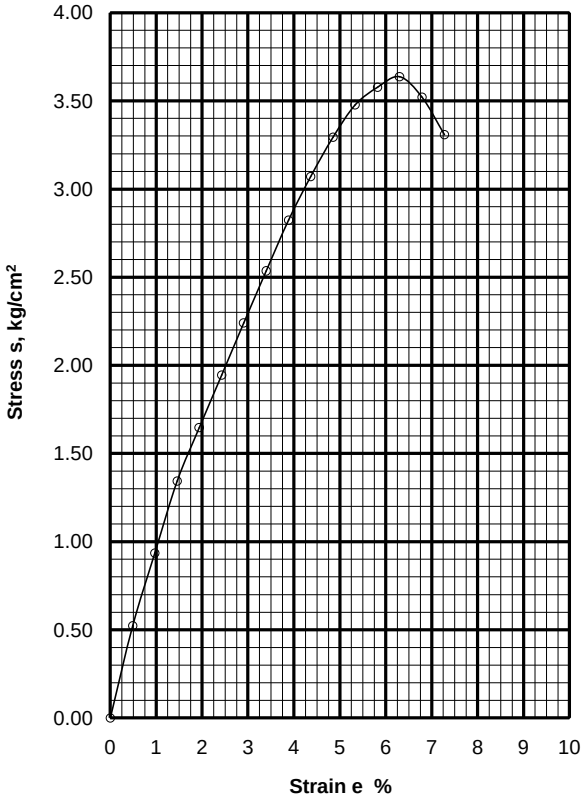
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	20.51	0	0	0
50	2.5	0.05	0.48	0.9952	20.61	10.75	0.522	0.522
100	4.5	0.1	0.97	0.9903	20.71	19.35	0.934	0.935
150	6.5	0.15	1.45	0.9855	20.81	27.95	1.343	1.344
200	8	0.2	1.94	0.9806	20.92	34.4	1.645	1.646
250	9.5	0.25	2.42	0.9758	21.02	40.85	1.943	1.945
300	11	0.3	2.91	0.9709	21.13	47.3	2.239	2.241
350	12.5	0.35	3.39	0.9661	21.23	53.75	2.532	2.534
400	14	0.4	3.88	0.9612	21.34	60.2	2.821	2.824
450	15.3	0.45	4.36	0.9564	21.45	65.79	3.068	3.071
500	16.5	0.5	4.85	0.9515	21.56	70.95	3.291	3.295
550	17.5	0.55	5.33	0.9467	21.67	75.25	3.473	3.477
600	18.1	0.6	5.82	0.9418	21.78	77.83	3.574	3.577
650	18.5	0.65	6.30	0.9370	21.89	79.55	3.634	3.638
700	18	0.7	6.79	0.9321	22.01	77.4	3.517	3.521
750	17	0.75	7.27	0.93	22.12	73.1	3.305	3.308

RESULT	
Stress	3.638
Strain	6.30

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-4

DEPTH(m): 12.0 - 13.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-6 **DEPTH (m):** 16.5 - 18.0

Diameter (cm)	5.91	Area A_0 (cm^2)	27.436	Ht,L_0 (cm)	11.810	LRC kg/div	4.3
Volume (cm^3)	324.02	Correction Factor	1.00				
weight	708.3	of Height	Moisture	16.63			
Bulk Density	2.186	Dry Density	1.874				

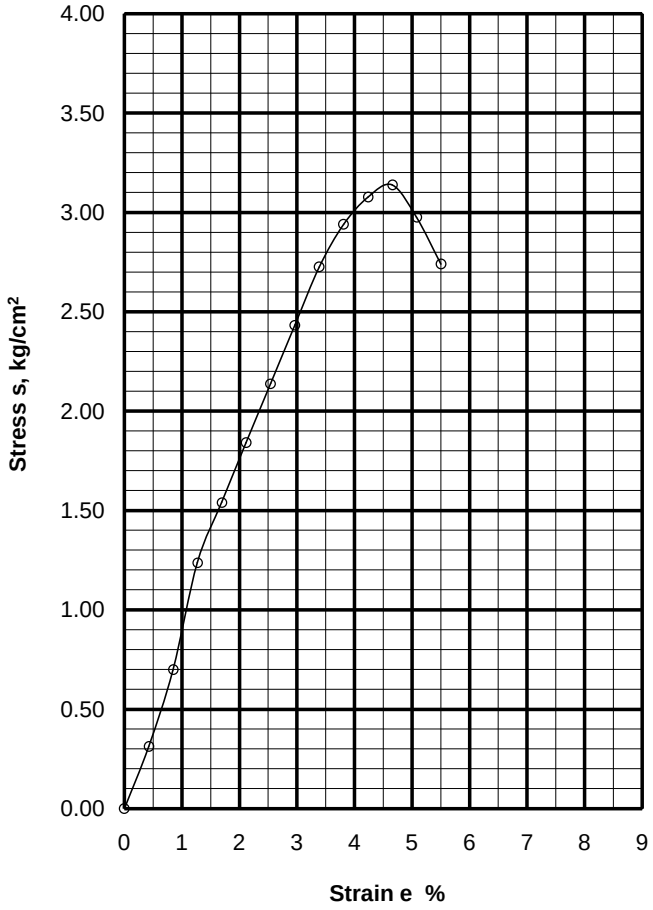
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.44	0	0	0
50	2	0.05	0.42	0.9958	27.55	8.6	0.312	0.312
100	4.5	0.1	0.85	0.9915	27.67	19.35	0.699	0.699
150	8	0.15	1.27	0.9873	27.79	34.4	1.238	1.238
200	10	0.2	1.69	0.9831	27.91	43	1.541	1.541
250	12	0.25	2.12	0.9788	28.03	51.6	1.841	1.841
300	14	0.3	2.54	0.9746	28.15	60.2	2.138	2.138
350	16	0.35	2.96	0.9704	28.27	68.8	2.433	2.433
400	18	0.4	3.39	0.9661	28.40	77.4	2.726	2.725
450	19.5	0.45	3.81	0.9619	28.52	83.85	2.940	2.939
500	20.5	0.5	4.23	0.9577	28.65	88.15	3.077	3.077
550	21	0.55	4.66	0.9534	28.78	90.3	3.138	3.138
600	20	0.6	5.08	0.9492	28.90	86	2.975	2.975
650	18.5	0.65	5.50	0.9450	29.03	79.55	2.740	2.740

RESULT	
Stress	3.138
Strain	4.66

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-6

DEPTH(m): 16.5 - 18.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-7 **DEPTH (m):** 18.0 - 19.50

Diameter (cm)	5.91	Area A_0 (cm^2)	27.436	Ht,L_0 (cm)	11.510	LRC kg/div	4.3
Volume (cm^3)	315.79	Correction Factor of Height	1.00				
weight	696.8		Moisture	20.49			
Bulk Density	2.207	Dry Density	1.831				

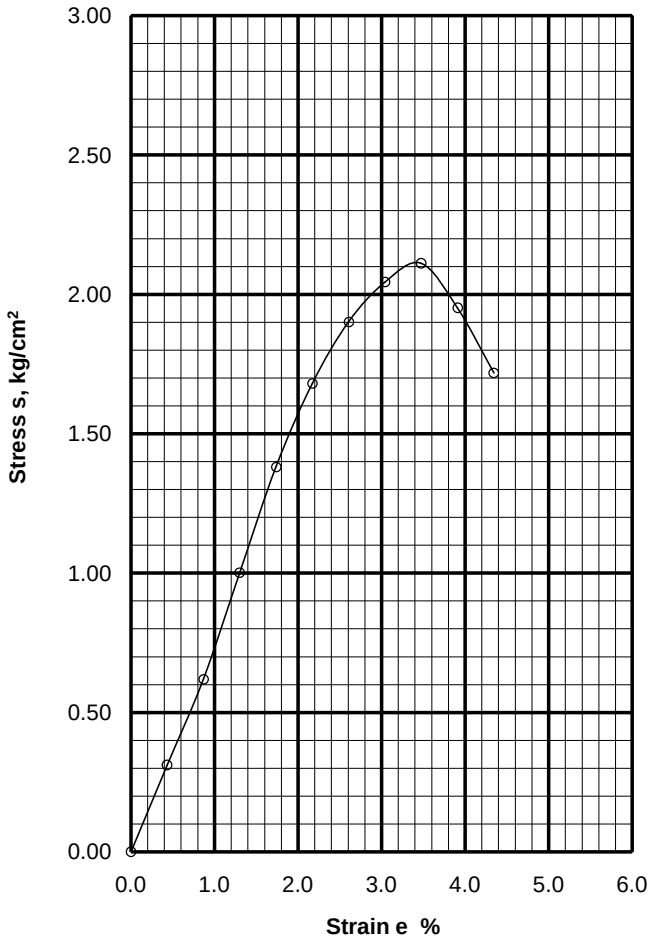
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.44	0	0	0
50	2	0.05	0.43	0.9957	27.56	8.6	0.312	0.311
100	4	0.1	0.87	0.9913	27.68	17.2	0.621	0.619
150	6.5	0.15	1.30	0.9870	27.80	27.95	1.005	1.002
200	9	0.2	1.74	0.9826	27.92	38.7	1.386	1.382
250	11	0.25	2.17	0.9783	28.05	47.3	1.687	1.681
300	12.5	0.3	2.61	0.9739	28.17	53.75	1.908	1.902
350	13.5	0.35	3.04	0.9696	28.30	58.05	2.051	2.045
400	14	0.4	3.48	0.9652	28.42	60.2	2.118	2.111
450	13	0.45	3.91	0.9609	28.55	55.9	1.958	1.952
500	11.5	0.5	4.34	0.9566	28.68	49.45	1.724	1.719

RESULT	
Stress	2.111
Strain	3.48

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-7

DEPTH(m): 18.0 - 19.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-8 **DEPTH (m):** 19.5 - 21.0

Diameter (cm)	4.41	Area A_0 (cm^2)	15.276	Ht,L_0 (cm)	8.110	LRC kg/div	4.3
Volume (cm^3)	123.89	Correction	1.01				
weight	259.2	Factor of Height	Moisture	22.94			
Bulk Density	2.092	Dry Density	1.702				

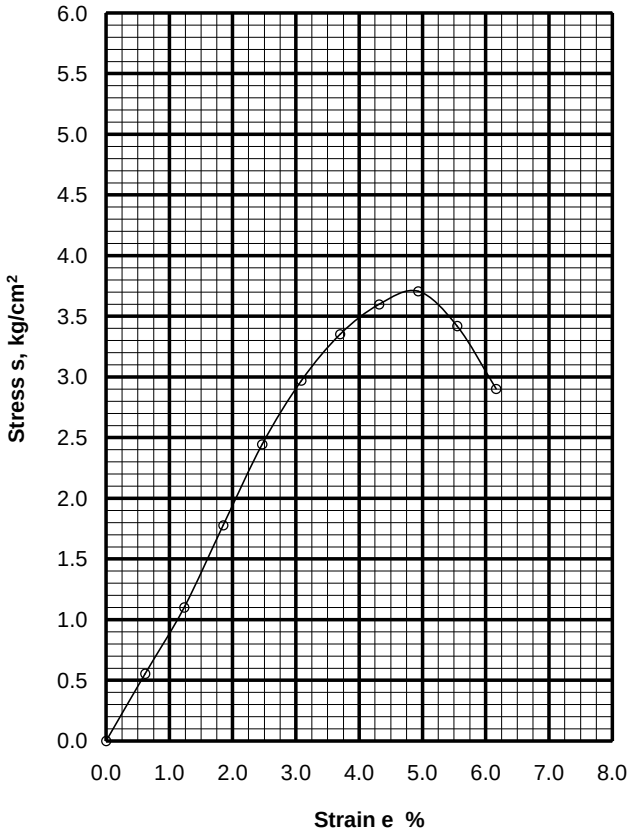
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	0	3	4	5	6	7	8	9
0	0	0	0	1.0000	15.28	0	0	0
50	2	0.05	0.62	0.9938	15.37	8.6	0.559	0.554
100	4	0.1	1.23	0.9877	15.47	17.2	1.112	1.100
150	6.5	0.15	1.85	0.9815	15.56	27.95	1.796	1.777
200	9	0.2	2.47	0.9753	15.66	38.7	2.471	2.445
250	11	0.25	3.08	0.9692	15.76	47.3	3.001	2.970
300	12.5	0.3	3.70	0.9630	15.86	53.75	3.388	3.353
350	13.5	0.35	4.32	0.9568	15.97	58.05	3.636	3.598
400	14	0.4	4.93	0.9507	16.07	60.2	3.746	3.707
450	13	0.45	5.55	0.9445	16.17	55.9	3.456	3.420
500	11.1	0.5	6.17	0.9383	16.28	47.73	2.932	2.901

RESULT	
Stress	3.707
Strain	4.93

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-8

DEPTH(m): 19.5 - 21.0

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-9 **DEPTH (m):** 21.0 - 22.5

Diameter (cm)	6.01	Area A_0 (cm^2)	28.372	Ht,L_0 (cm)	12.410	LRC kg/div	4.3
Volume (cm^3)	352.10	Correction Factor	1.00				
weight	777.3	of Height	Moisture	21.8			
Bulk Density	2.208	Dry Density	1.812				

UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	28.37	0	0	0
50	5	0.05	0.40	0.9960	28.49	21.5	0.755	0.758
100	8	0.1	0.81	0.9919	28.60	34.4	1.203	1.207
150	11	0.15	1.21	0.9879	28.72	47.3	1.647	1.653
200	13.5	0.2	1.61	0.9839	28.84	58.05	2.013	2.021
250	15	0.25	2.01	0.9799	28.96	64.5	2.228	2.236
300	17.0	0.3	2.42	0.9758	29.08	73.1	2.514	2.524
350	19.2	0.35	2.82	0.9718	29.20	82.56	2.828	2.839
400	20.5	0.4	3.22	0.9678	29.32	88.15	3.007	3.018
450	22	0.45	3.63	0.9637	29.44	94.6	3.213	3.225
500	23.8	0.5	4.03	0.9597	29.56	102.34	3.462	3.475
550	25.3	0.55	4.43	0.9557	29.69	108.79	3.664	3.678
600	26.8	0.6	4.83	0.9517	29.81	115.24	3.865	3.880
650	28.5	0.65	5.24	0.9476	29.94	122.55	4.093	4.109
700	30	0.7	5.64	0.9436	30.07	129	4.290	4.306
750	31	0.75	6.04	0.9396	30.20	133.3	4.414	4.431
800	30	0.8	6.45	0.9355	30.33	129	4.254	4.270
850	28	0.85	6.85	0.9315	30.46	120.4	3.953	3.968

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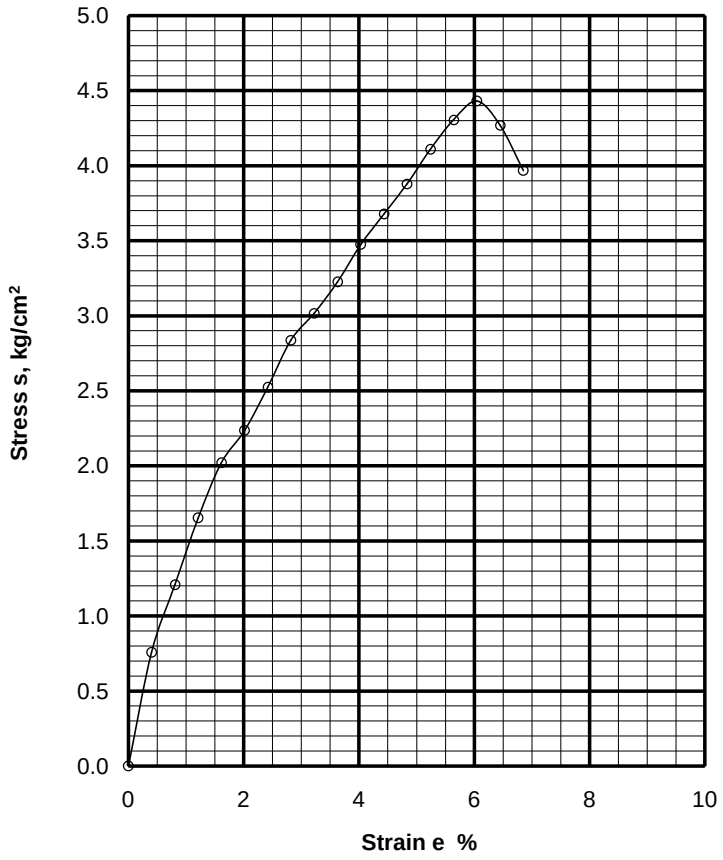
RESULT	
Stress	4.431
Strain	6.04

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-9

DEPTH(m): 21.0 - 22.5

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--3 **SAMPLE :** CRS-11 **DEPTH (m):** 24.0 - 25.50

Diameter (cm)	6.11	Area A_0 (cm^2)	29.324	Ht,L_0 (cm)	10.910	LRC kg/div	4.3
Volume (cm^3)	319.93	Correction	1.01				
weight	694.5	Factor of Height	Moisture	16.16			
Bulk Density	2.171	Dry Density	1.869				

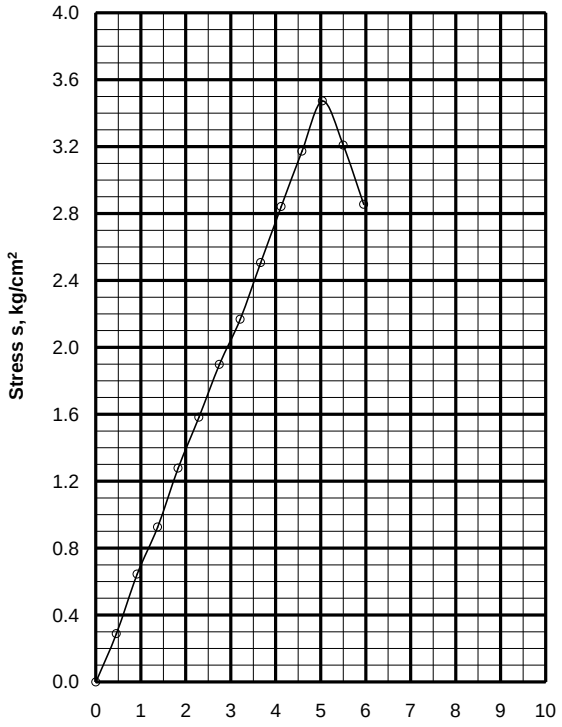
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	29.32	0	0	0
50	2	0.05	0.46	0.9954	29.46	8.6	0.292	0.29
100	4.5	0.1	0.92	0.9908	29.60	19.35	0.654	0.64
150	6.5	0.15	1.37	0.9863	29.73	27.95	0.940	0.93
200	9	0.2	1.83	0.9817	29.87	38.7	1.296	1.28
250	11.2	0.25	2.29	0.9771	30.01	48.16	1.605	1.58
300	13.5	0.3	2.75	0.9725	30.15	58.05	1.925	1.90
350	15.5	0.35	3.21	0.9679	30.30	66.65	2.200	2.17
400	18	0.4	3.67	0.9633	30.44	77.4	2.543	2.51
450	20.5	0.45	4.12	0.9588	30.59	88.15	2.882	2.84
500	23	0.5	4.58	0.9542	30.73	98.9	3.218	3.17
550	25.3	0.55	5.04	0.9496	30.88	108.79	3.523	3.47
600	23.5	0.6	5.50	0.9450	31.03	101.05	3.256	3.21
650	21	0.65	5.96	0.9404	31.18	90.3	2.896	2.85

RESULT	
Stress	3.47
Strain	5.04

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-11

DEPTH(m): 24.0 - 25.50

PROJECT: Barthing mark 412, Bollards Between 17-18, L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--3 **SAMPLE :** CRS-12 **DEPTH (m):** 25.50 - 27.0

Diameter (cm)	5.21	Area A_0 (cm^2)	21.322	Ht,L_0 (cm)	10.310	LRC kg/div	4.3
Volume (cm^3)	219.83	Correction Factor of Height	1.00				
weight	472.8		Moisture	21.8			
Bulk Density	2.151	Dry Density	1.766				

UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	0	3	4	5	6	7	8	9
0	0	0	0	1.0000	21.32	0	0	0
50	3	0.05	0.48	0.9952	21.43	12.9	0.602	0.601
100	6	0.1	0.97	0.9903	21.53	25.8	1.198	1.197
150	8.5	0.15	1.45	0.9855	21.64	36.55	1.689	1.687
200	10	0.2	1.94	0.9806	21.74	43	1.978	1.975
250	12	0.25	2.42	0.9758	21.85	51.6	2.361	2.358
300	13.5	0.3	2.91	0.9709	21.96	58.05	2.643	2.640
350	15	0.35	3.39	0.9661	22.07	64.5	2.922	2.919
400	16	0.4	3.88	0.9612	22.18	68.8	3.102	3.098
450	17.5	0.45	4.36	0.9564	22.29	75.25	3.375	3.371
500	18.5	0.5	4.85	0.9515	22.41	79.55	3.550	3.545
550	19.5	0.55	5.33	0.9467	22.52	83.85	3.723	3.718
600	19	0.6	5.82	0.9418	22.64	81.7	3.609	3.604
650	18	0.65	6.30	0.9370	22.76	77.4	3.401	3.397

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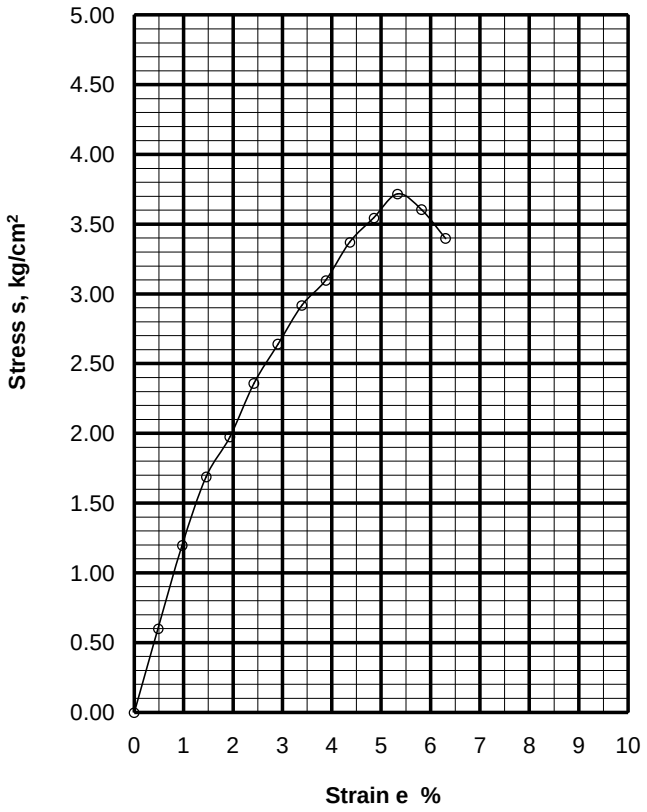
RESULT	
Stress	3.718
Strain	5.33

PROJECT: Barthing mark 412, Bollards Between 17-18,
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--3

SAMPLE : CRS-12

DEPTH(m): 25.50 - 27.0

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--4 **SAMPLE :** CRS-2 **DEPTH (m):** 19.50 - 21.0

Diameter (cm)	5.71	Area A_0 (cm^2)	25.611	Ht,L_0 (cm)	7.510	LRC kg/div	4.3
Volume (cm^3)	192.34	Correction Factor	1.06				
weight	431.5	of Height	Moisture	9.88			
Bulk Density	2.243	Dry Density	2.042				

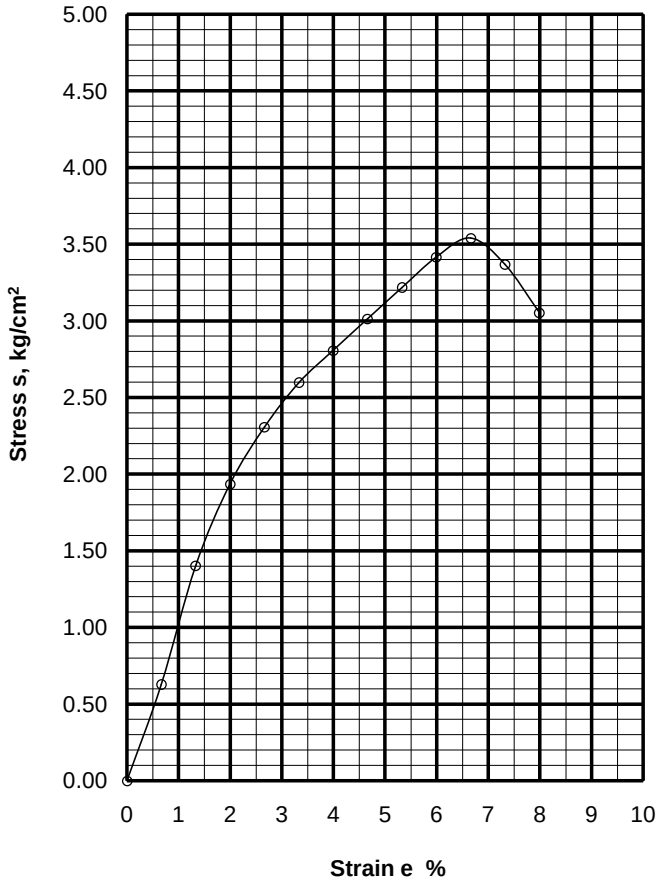
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	25.61	0	0	0
50	4	0.05	0.67	0.9933	25.78	17.2	0.667	0.628
100	9	0.1	1.33	0.9867	25.96	38.7	1.491	1.403
150	12.5	0.15	2.00	0.9800	26.13	53.75	2.057	1.936
200	15	0.2	2.66	0.9734	26.31	64.5	2.451	2.307
250	17	0.25	3.33	0.9667	26.49	73.1	2.759	2.597
300	18.5	0.3	3.99	0.9601	26.68	79.55	2.982	2.807
350	20.0	0.35	4.66	0.9534	26.86	86	3.201	3.013
400	21.5	0.4	5.33	0.9467	27.05	92.45	3.418	3.217
450	23	0.45	5.99	0.9401	27.24	98.9	3.630	3.417
500	24	0.5	6.66	0.9334	27.44	103.2	3.761	3.540
550	23	0.55	7.32	0.9268	27.63	98.9	3.579	3.368
600	21	0.6	7.99	0.9201	27.83	90.3	3.244	3.053

RESULT	
Stress	3.540
Strain	6.66

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--4

SAMPLE : CRS-2

DEPTH(m): 19.50 - 21.0

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--4 **SAMPLE :** CRS-4 **DEPTH (m):** 22.5 - 24.0

Diameter (cm)	5.81	Area A_0 (cm^2)	26.515	Ht,L_0 (cm)	12.010	LRC kg/div	4.3
Volume (cm^3)	318.45	Correction	1.00				
weight	689.3	Factor of Height	Moisture	22.12			
Bulk Density	2.165	Dry Density	1.772				

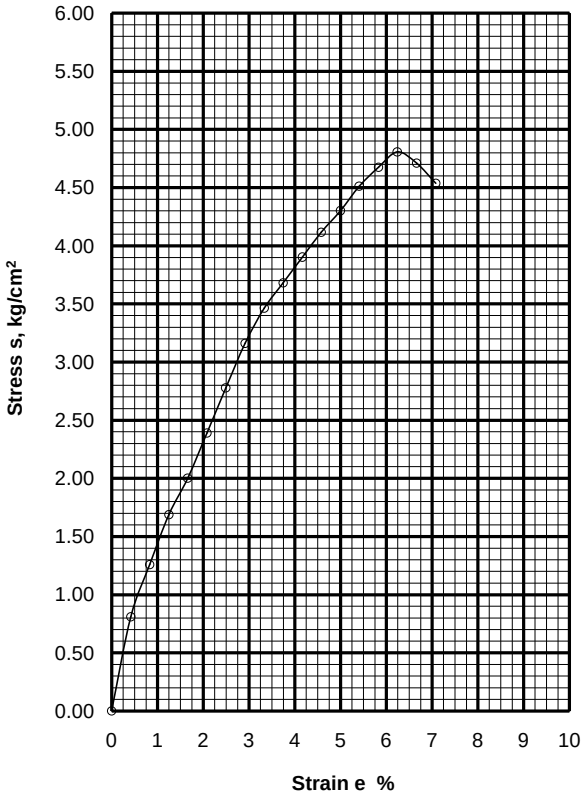
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.52	0	0	0
50	5	0.05	0.42	0.9958	26.63	21.5	0.807	0.811
100	7.8	0.1	0.83	0.9917	26.74	33.54	1.254	1.259
150	10.5	0.15	1.25	0.9875	26.85	45.15	1.682	1.688
200	12.5	0.2	1.67	0.9833	26.96	53.75	1.993	2.001
250	15	0.25	2.08	0.9792	27.08	64.5	2.382	2.391
300	17.5	0.3	2.50	0.9750	27.19	75.25	2.767	2.778
350	20	0.35	2.91	0.9709	27.31	86	3.149	3.161
400	22	0.4	3.33	0.9667	27.43	94.6	3.449	3.462
450	23.5	0.45	3.75	0.9625	27.55	101.05	3.668	3.683
500	25	0.5	4.16	0.9584	27.67	107.5	3.885	3.901
550	26.5	0.55	4.58	0.9542	27.79	113.95	4.101	4.117
600	27.8	0.6	5.00	0.9500	27.91	119.54	4.283	4.300
650	29.3	0.65	5.41	0.9459	28.03	125.99	4.494	4.512
700	30.5	0.7	5.83	0.9417	28.16	131.15	4.658	4.676
750	31.5	0.75	6.24	0.9376	28.28	135.45	4.789	4.808
800	31	0.8	6.66	0.9334	28.41	133.30	4.692	4.711
850	30	0.85	7.08	0.9292	28.53	129.00	4.521	4.538

RESULT	
Stress	4.808

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--4

SAMPLE : CRS-4

DEPTH(m): 22.5 - 24.0

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim) L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--4 **SAMPLE :** CRS-6 **DEPTH (m):** 25.5 - 27.0

Diameter (cm)	5.81	Area A_0 (cm^2)	26.515	Ht,L_0 (cm)	10.510	LRC kg/div	4.3
Volume (cm^3)	278.68	Correction Factor of Height	1.01				
weight	604.8		Moisture	18.81			
Bulk Density	2.170	Dry Density	1.827				

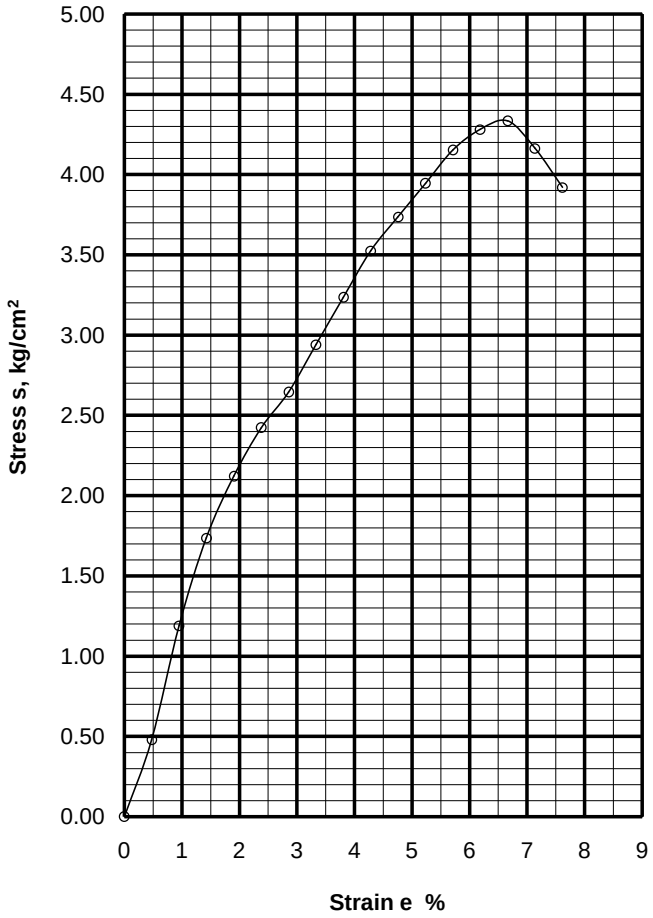
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.52	0	0	0
50	3	0.05	0.48	0.9952	26.64	12.9	0.484	0.478
100	7.5	0.1	0.95	0.9905	26.77	32.25	1.205	1.190
150	11	0.15	1.43	0.9857	26.90	47.3	1.758	1.736
200	13.5	0.2	1.90	0.9810	27.03	58.05	2.148	2.121
250	15.5	0.25	2.38	0.9762	27.16	66.65	2.454	2.423
300	17	0.3	2.85	0.9715	27.29	73.1	2.678	2.645
350	19	0.35	3.33	0.9667	27.43	81.7	2.979	2.941
400	21	0.4	3.81	0.9619	27.56	90.3	3.276	3.235
450	23	0.45	4.28	0.9572	27.70	98.9	3.570	3.526
500	24.5	0.5	4.76	0.9524	27.84	105.35	3.784	3.737
550	26	0.55	5.23	0.9477	27.98	111.8	3.996	3.946
600	27.5	0.6	5.71	0.9429	28.12	118.25	4.205	4.152
650	28.5	0.65	6.18	0.9382	28.26	122.55	4.336	4.282
700	29	0.7	6.66	0.9334	28.41	124.7	4.390	4.335
750	28	0.75	7.14	0.9286	28.55	120.4	4.217	4.164
800	26.5	0.8	7.61	0.9239	28.70	113.95	3.970	3.921

RESULT	
Stress	4.335

PROJECT: Barthing mark 275, Between 12-13, Bollards (Port Qasim)
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--4

SAMPLE : CRS-6

DEPTH(m): 25.5 - 27.0

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH-5 **SAMPLE :** CRS-3 **DEPTH (m):** 15.0 - 16.50

Diameter (cm)	5.79	Area A_0 (cm^2)	26.333	Ht,L_0 (cm)	11.300	LRC kg/div	4.3
Volume (cm^3)	297.56	Correction Factor of Height	1.00				
weight	616		Moisture	16.19			
Bulk Density	2.070	Dry Density	1.782				

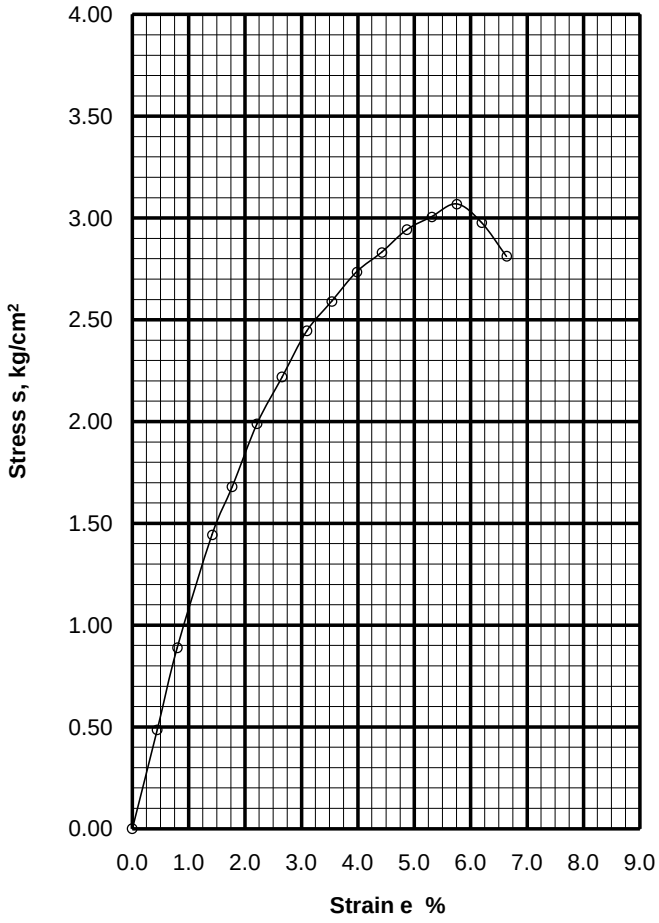
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $\times 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.33	0	0	0
50	3	0.05	0.44	0.9956	26.45	12.9	0.488	0.486
90	5.5	0.09	0.80	0.9920	26.54	23.65	0.891	0.888
150	9	0.16	1.42	0.9858	26.71	38.7	1.449	1.445
200	10.5	0.2	1.77	0.9823	26.81	45.15	1.684	1.679
250	12.5	0.25	2.21	0.9779	26.93	53.75	1.996	1.990
300	14	0.3	2.65	0.9735	27.05	60.2	2.225	2.219
350	15.5	0.35	3.10	0.9690	27.17	66.65	2.453	2.445
400	16.5	0.4	3.54	0.9646	27.30	70.95	2.599	2.591
450	17.5	0.45	3.98	0.9602	27.43	75.25	2.744	2.736
500	18.2	0.5	4.42	0.9558	27.55	78.26	2.840	2.832
550	19	0.55	4.87	0.9513	27.68	81.7	2.952	2.943
600	19.5	0.6	5.31	0.9469	27.81	83.85	3.015	3.006
650	20	0.65	5.75	0.9425	27.94	86	3.078	3.069
700	19.5	0.7	6.19	0.9381	28.07	83.85	2.987	2.978
750	18.5	0.75	6.64	0.9336	28.21	79.55	2.820	2.812

RESULT	
Stress	3.069
Strain	5.75

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH-5

SAMPLE : CRS-3

DEPTH(m): 15.0 - 16.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--5 **SAMPLE :** CRS-4 **DEPTH (m):** 16.50 - 18.0

Diameter (cm)	5.93	Area A_0 (cm^2)	27.622	Ht,L_0 (cm)	11.260	LRC kg/div	4.3
Volume (cm^3)	311.02	Correction Factor	1.01				
weight	671.7	of Height	Moisture	13.99			
Bulk Density	2.160	Dry Density	1.895				

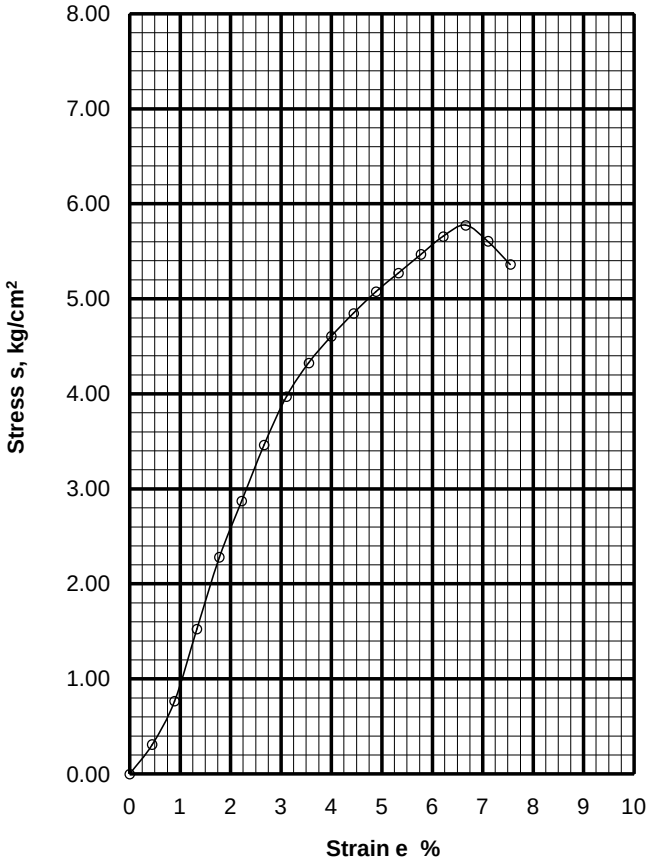
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.62	0	0	0
50	2	0.05	0.44	0.9956	27.75	8.6	0.310	0.308
100	5	0.1	0.89	0.9911	27.87	21.5	0.771	0.767
150	10	0.15	1.33	0.9867	27.99	43	1.536	1.526
200	15	0.2	1.78	0.9822	28.12	64.5	2.294	2.279
250	19	0.25	2.22	0.9778	28.25	81.7	2.892	2.874
300	23	0.3	2.66	0.9734	28.38	98.9	3.485	3.463
350	26.5	0.35	3.11	0.9689	28.51	113.95	3.997	3.972
400	29	0.4	3.55	0.9645	28.64	124.7	4.354	4.326
450	31	0.45	4.00	0.9600	28.77	133.3	4.633	4.604
500	32.8	0.5	4.44	0.9556	28.91	141.04	4.879	4.848
550	34.5	0.55	4.88	0.9512	29.04	148.35	5.108	5.076
600	36	0.6	5.33	0.9467	29.18	154.8	5.306	5.272
650	37.5	0.65	5.77	0.9423	29.31	161.25	5.501	5.466
700	39	0.7	6.22	0.9378	29.45	167.7	5.694	5.658
750	40	0.75	6.66	0.9334	29.59	172	5.812	5.775
800	39	0.8	7.10	0.9290	29.7	167.7	5.640	5.604
850	37.5	0.85	7.55	0.9245	29.88	161.25	5.397	5.363

RESULT	
Stress	5.775
Strain	6.66

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-4

DEPTH(m): 16.50 - 18.0

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH--5 **SAMPLE :** CRS-5 **DEPTH (m):** 18.0 - 19.50

Diameter (cm)	5.88	Area A_0 (cm^2)	27.158	Ht,L_0 (cm)	11.100	LRC kg/div	4.3
Volume (cm^3)	301.46	Correction Factor of Height	1.01				
weight	634.1		Moisture	14.44			
Bulk Density	2.103	Dry Density	1.838				

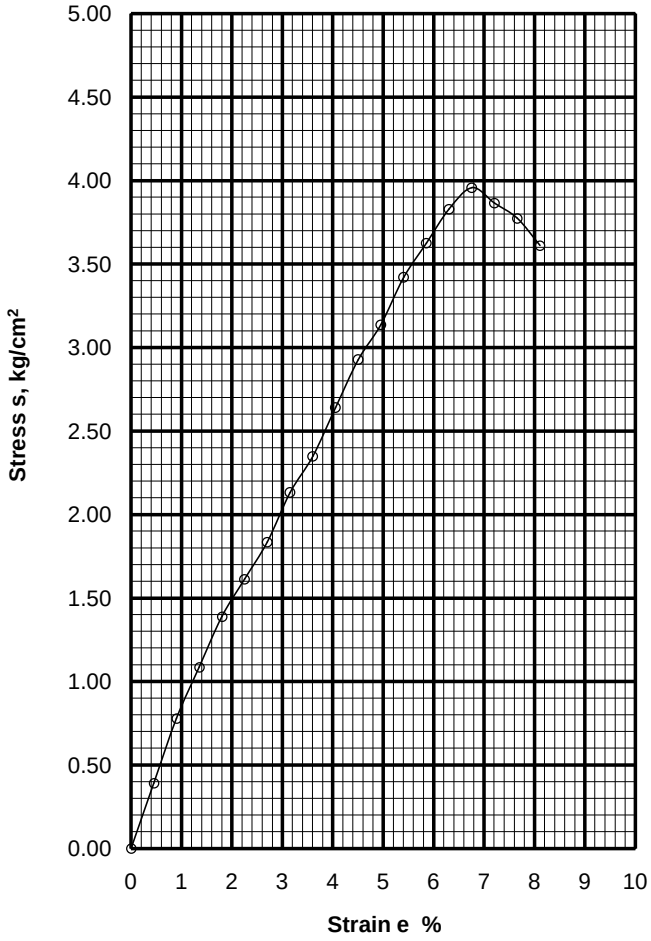
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.16	0	0	0
50	2.5	0.05	0.45	0.9955	27.28	10.75	0.394	0.391
100	5	0.1	0.90	0.9910	27.41	21.5	0.785	0.779
150	7	0.15	1.35	0.9865	27.53	30.1	1.093	1.086
200	9	0.2	1.80	0.9820	27.66	38.7	1.399	1.389
250	10.5	0.25	2.25	0.9775	27.78	45.15	1.625	1.614
300	12	0.3	2.70	0.9730	27.91	51.6	1.849	1.836
350	14	0.35	3.15	0.9685	28.04	60.2	2.147	2.132
400	15.5	0.4	3.60	0.9640	28.17	66.65	2.366	2.349
450	17.5	0.45	4.05	0.9595	28.31	75.25	2.658	2.640
500	19.5	0.5	4.50	0.9550	28.44	83.85	2.948	2.928
550	21	0.55	4.95	0.9505	28.57	90.3	3.160	3.138
600	23	0.6	5.41	0.9459	28.71	98.9	3.445	3.420
650	24.5	0.65	5.86	0.9414	28.85	105.35	3.652	3.626
700	26	0.7	6.31	0.9369	28.99	111.8	3.857	3.830
750	27	0.75	6.76	0.9324	29.13	116.1	3.986	3.958
800	26.5	0.8	7.21	0.9279	29.27	113.95	3.893	3.866
850	26	0.85	7.66	0.9234	29.4	111.8	3.801	3.774
900	25	0.9	8.11	0.9189	29.55	107.5	3.637	3.612

RESULT	
Stress	3.958
Strain	6.76

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-5

DEPTH(m): 18.0 - 19.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16

CLIENT: D.P World

BORE HOLE NO. BH-5 **SAMPLE :** CRS-6 **DEPTH (m):** 19.50 - 21.0

Diameter (cm)	5.9	Area A_0 (cm^2)	27.343	Ht,L_0 (cm)	10.910	LRC kg/div	4.3
Volume (cm^3)	298.31	Correction Factor of Height	1.01				
weight	630.2		Moisture	15.06			
Bulk Density	2.113	Dry Density	1.836				

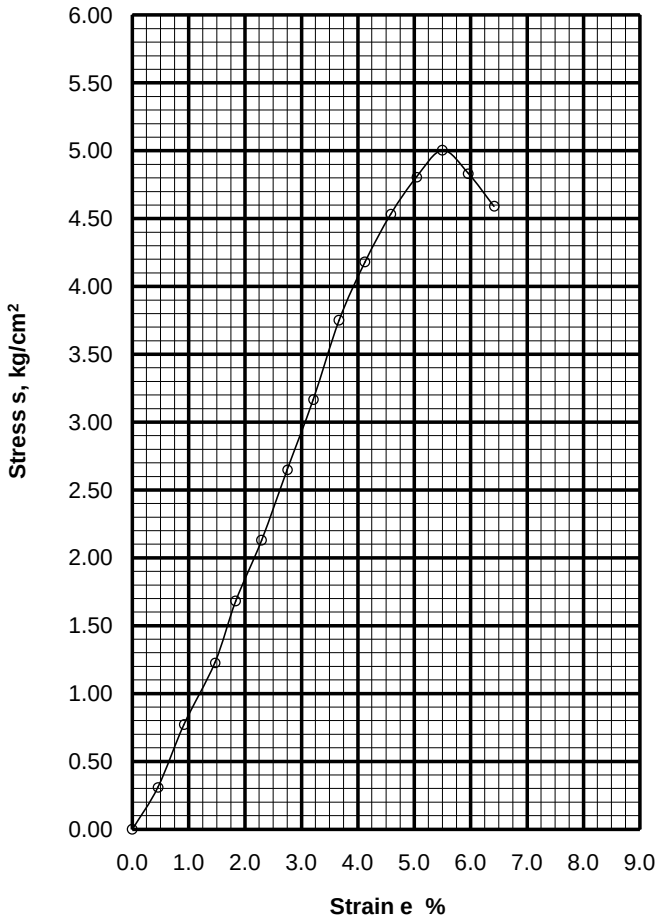
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 $X\ 10^{-2}$	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	27.34	0	0	0
50	2	0.05	0.46	0.9954	27.47	8.6	0.313	0.310
100	5	0.1	0.92	0.9908	27.60	21.5	0.779	0.772
150	8	0.16	1.47	0.9853	27.75	34.4	1.240	1.228
200	11	0.2	1.83	0.9817	27.85	47.3	1.698	1.682
250	14	0.25	2.29	0.9771	27.98	60.2	2.151	2.130
300	17.5	0.3	2.75	0.9725	28.12	75.25	2.676	2.650
350	21	0.35	3.21	0.9679	28.25	90.3	3.197	3.166
400	25	0.4	3.67	0.9633	28.38	107.5	3.787	3.751
450	28	0.45	4.12	0.9588	28.52	120.4	4.222	4.181
500	30.5	0.5	4.58	0.9542	28.66	131.15	4.577	4.532
550	32.5	0.55	5.04	0.9496	28.79	139.75	4.853	4.806
600	34	0.6	5.50	0.9450	28.93	146.2	5.053	5.004
650	33	0.65	5.96	0.9404	29.08	141.9	4.880	4.833
700	31.5	0.7	6.42	0.9358	29.22	135.45	4.636	4.591

RESULT	
Stress	5.004
Strain	5.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH-5

SAMPLE : CRS-6

DEPTH(m): 19.50 - 21.0

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--5 **SAMPLE :** CRS-11 **DEPTH (m):** 27.0 - 28.50

Diameter (cm)	5.79	Area A_0 (cm^2)	26.333	Ht,L_0 (cm)	10.510	LRC kg/div	4.3
Volume (cm^3)	276.76	Correction Factor of Height	1.01				
weight	622.6		Moisture	13.63			
Bulk Density	2.250	Dry Density	1.980				

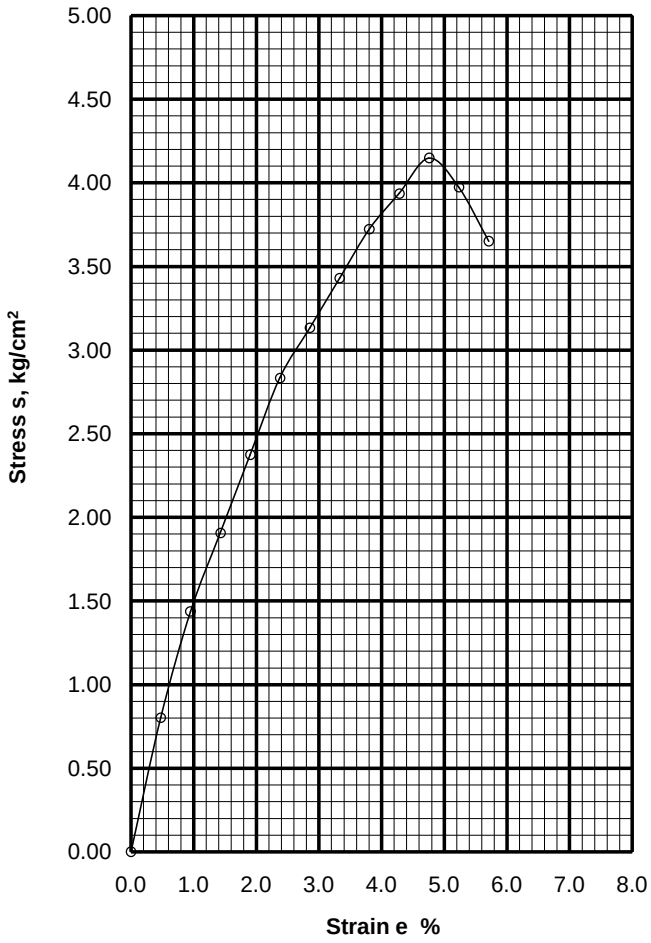
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	26.33	0	0	0
50	5	0.05	0.48	0.9952	26.46	21.5	0.813	0.803
100	9	0.1	0.95	0.9905	26.59	38.7	1.456	1.438
150	12	0.15	1.43	0.9857	26.71	51.6	1.932	1.908
200	15	0.2	1.90	0.9810	26.84	64.5	2.403	2.374
250	18	0.25	2.38	0.9762	26.97	77.4	2.869	2.835
300	20	0.3	2.85	0.9715	27.11	86	3.173	3.134
350	22	0.35	3.33	0.9667	27.24	94.6	3.473	3.431
400	24	0.4	3.81	0.9619	27.38	103.2	3.770	3.724
450	25.5	0.45	4.28	0.9572	27.51	109.65	3.986	3.938
500	27	0.5	4.76	0.9524	27.65	116.1	4.199	4.148
550	26	0.55	5.23	0.9477	27.79	111.8	4.023	3.975
600	24	0.6	5.71	0.9429	27.93	103.2	3.695	3.651

RESULT	
Stress	4.148
Strain	4.76

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-11

DEPTH(m): 27.0 - 28.50

PROJECT: Barthing mark 137, Between 6 - 7, Bollards L.R # 63/ 16
CLIENT: D.P World
BORE HOLE NO. BH--5 **SAMPLE :** CRS-12 **DEPTH (m):** 28.50 - 30.0

Diameter (cm)	7.35	Area A_0 (cm^2)	42.435	Ht,L_0 (cm)	9.450	LRC kg/div	4.3
Volume (cm^3)	401.01	Correction Factor of Height	1.07				
weight	1008.3		Moisture	8.09			
Bulk Density	2.514	Dry Density	2.326				

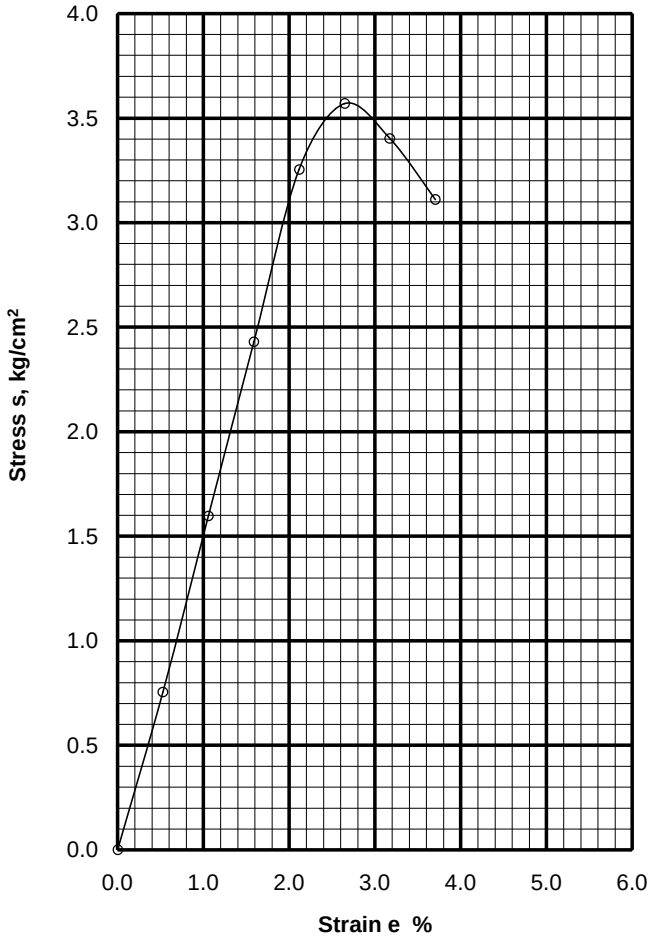
UNCONFINED COMPRESSION TEST

Deformation dial[1] reading (0.01mm)	Load dial[1] (units)	Sample deformation DL, (mm)	Unit strian,e DL/L_0 X 10^{-2}	Area CF 1-e	Corrected area A' (cm^2)	Total load on sample[2] (col.2XLCR) kg	Sample stress, s_1 kg/cm^2	Corrected stress, s_1 kg/cm^2
1	2	3	4	5	6	7	8	9
0	0	0	0	1.0000	42.43	0	0	0
50	8	0.05	0.53	0.9947	42.66	34.4	0.806	0.756
100	17	0.1	1.06	0.9894	42.89	73.1	1.704	1.598
150	26	0.15	1.59	0.9841	43.12	111.8	2.593	2.431
200	35	0.2	2.12	0.9788	43.35	150.5	3.472	3.255
250	38.6	0.25	2.65	0.9735	43.59	165.98	3.808	3.570
300	37	0.3	3.17	0.9683	43.83	159.1	3.630	3.403
350	34	0.35	3.70	0.9630	44.07	146.2	3.318	3.110

RESULT	
Stress	3.57
Strain	2.65

PROJECT: Barthing mark 137, Between 6 - 7, Bollards
CLIENT: D.P World

UNCONFINED COMPRESSION TEST



BORE HOLE #: BH--5

SAMPLE : CRS-12

DEPTH(m): 28.50 - 30.0

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

DIRECT SHEAR TEST AND SPECIFIC GRAVITY

S. NO.	Location	Borehole#	Sample	Depth BelowSeabed(m)	Elevation (m)	c (Kg/cm^2)	ϕ (deg)	Specific Gravity
1	Barthing mark 687, Between 28-29, Bollards	BH-01	UDS-1	1.0	-10.1			2.572
2		BH-01	SPT-3	3.0	-12.1	0.0	32	
3		BH-01	SPT-4	4.5	-13.6			2.585
4	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5			2.626
5		BH-02	DS-3	4.5	-15.0	0.0	32	2.668
6	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3	0.0	31	
7		BH-03	DS-2	7.5	-19.3			2.657
8	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-1	0.0	-11.5			2.6585
9		BH-04	DS-1	3.0	-14.5	0.0	32	
10		BH-04	DS-6	10.5	-22.0	0.0	32	2.612
11	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1	0.0	32	
12		BH-05	CRS-1	4.5	-16.1			2.624

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

CHEMICAL TEST

S. NO.	Location	Borehole#	Sample	Depth BelowSea bed(m)	Elevation (m)	pH	Sulphate Content (%)	Chloride Content (%)	Total Disolve Salt (%)	Organic Matter (%)
1	Barthing mark 687,Between 28-29, Bollards	BH-01	SPT-3	3.0	-12.1	7.5	0.243	0.193	1.29	3.45
2		BH-01	CRS-1	19.5	-28.6	7.5	0.194	0.236	1.08	-
3	Barthing mark 549, Between 23-24, Bollards	BH-02	SPT-1	0.0	-10.5	7.5	0.150	0.129	0.54	1.40
4		BH-02	CRS-1	6.1	-16.6	7.5	0.172	0.150	0.65	1.18
5		BH-02	DS-5	10.5	-21.0	7.5	0.106	0.107	0.65	
6	Barthing mark 412, Bollards Between 17-18,	BH-03	SPT-2	1.5	-13.3	7.5	0.164	0.140	0.86	1.17
7		BH-03	CRS-1	4.5	-16.3	7.5	0.150	0.161	0.97	2.35
8		BH-03	DS-2	7.5	-19.3	7.5	0.142	0.130	0.86	1.99

L.R # 63/ 16
Date: 16-12-2016

Project: Geotechnical investigation at Berth # 5, 6 & 7.
Client: Qasim International Container Terminal Port(QICT), DP WORLD

CHEMICAL TEST

S. NO.	Location	Borehole#	Sample	Depth BelowSea bed(m)	Elevation (m)	pH	Sulphate Content (%)	Chloride Content (%)	Total Disolve Salt (%)	Organic Matter (%)
9	Barthing mark 275, Between 12-13, Bollards	BH-04	SPT-2	1.5	-13.0	7.5	0.195	0.140	1.40	2.11
10		BH-04	DS-5	7.5	-19.0	7.5	0.164	0.129	1.61	0.84
11		BH-04	DS-8	13.5	-25.0	7.5	0.177	0.107	0.97	-
12	Barthing mark 137, Between 6 - 7, Bollards	BH-05	DS-1	1.5	-13.1	7.5	0.137	0.107	0.97	2.27
13		BH-05	CRS-1	4.5	-16.1	7.5	0.208	0.150	1.18	2.26
14		BH-05	DS-6	12.0	-23.6	7.5	0.155	0.129	0.97	2.29

Appendix - A
(Bathymetry Chart)

330800 330900 331000 331100 331200 331300 331400 331500 331600

2740300 2740200 2740100 2740000 2739900 2739800 2739700

TERMINAL-1

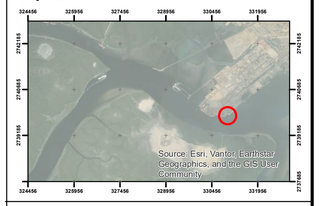
TERMINAL-2

N

S

0 12.5 25 50 75 100 Meters

Key Plan



NOTE:
* Depths are shown as positive.

Legend

- AOI
- Contours

Depth (mCD)

- 8.9 - 7.7
- 9.9 - 9
- 11.2 - 10
- 11.9 - 11.3
- 13.9 - 12
- 14.9 - 14
- 15.9 - 15
- 17.9 - 16

Date of Survey

Date of Survey
30 Jan 2026

Datum Projection Parameters

Datum Name: WGS - 84
Ellipsoid: 6378137.00m
Ellipsoid: 1/F 298.2572235630
Projection : UTM Zone 42N
False Easting : 500,000

Horizontal Control: IGS
Vertical Control: Bench Mark S040 at PQA Service Jetty

Equipement Details

Multibeam R2Sonic 2022 / Applanix - BM

Data Processing

Multibeam 100% Coverage
Trajectory Calculation: PosPac MMs8
Data Cleaning: Hyweep / Hypack Max
Data Presentation: Terra Solid Suite / ArcGIS

NOTE: NOT TO BE USED FOR NAVIGATION

Rev.	Description	DRW	CHK	APP	DD.MM.YYYY
0	First issue	NR	FA	AH	16 Feb 2026

Consultants:

Techno-Consult International

Client:

DP WORLD

Project:

Bathymatric Survey - Container Terminal-1
Quay Wall, QICT, Karachi, Pakistan

Description

MULTIBEAM BATHYMETRIC SURVEY

Size	Scale	Project number	Drawing No.	Rev.
A1	1:1250	ED-GIS-279	B-100	0

Appendix - B

SUB-BOTTOM LAYER STRATIGRAPHY – DIGITIZATION

330800 331000 331200 331400 331600

2740300 2740100 2739900 2739700

N W E S

Line No. 8
"PQA DPWORLD_07022026_065404"

Line No. 6
"PQA DPWORLD_07022026_062001"

Line No. 4
"PQA DPWORLD_07022026_060740"

Line No. 2
"PQA DPWORLD_07022026_052200"

Terminal - 1

Terminal - 2

BH-01

BH-02

Line No. 9
"PQA DPWORLD_07022026_070654"

Line No. 7
"PQA DPWORLD_07022026_064201"

Line No. 5
"PQA DPWORLD_07022026_062001"

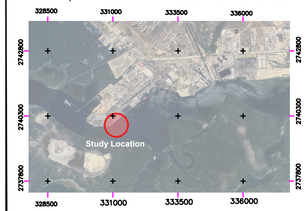
Line No. 3
"PQA DPWORLD_07022026_055656"

Line No. 1
"PQA DWORLD_07022026_050955"

0 10 25 50 100

Annexure-B

Index Map



Projection: UTM Zone 42N, WGS 84

Legend:

- Line No. 1
- Line No. 2
- Line No. 3
- Line No. 4
- Line No. 5
- Line No. 6
- Line No. 7
- Line No. 8
- Line No. 9
- Borehole

Date of Survey

Date of Survey
Subbottom : 07 February 2026

Datum Projection Parameters

Datum Name: WGS - 84
Ellipsoid: 6378137.00m
Ellipsoid: 1/F 298.2572235630
Projection : UTM Zone 42N
False Easting : 500,000

Horizontal Control: IGS
Vertical Control: Bench Mark S040 at PQA Service Jetty

Equipement Details

Innomar SES2000

Data Processing

Innomar ISE2.93
Seswin, HyPack

revision	description	drawn	checked	approved	date
B					
A	First issue	NR	FA	WA	16.FEB.2026

consultants

TECHNO-HOUSE, 37-K
Karachi 75400, Pakistan.
(92-21) 3453-9630/31/32 Telephone
(92-21) 3454-6606 Fax
email@techno-consult.com E-mail
www.techno-consult.com Web site:

Techno-Consult International

client

DP WORLD

project

Bathymatric Survey - Container Terminal-1
Quay Wall, QUICT, Karachi, Pakistan

area: Port Qasim | plot no.: -

description

SUBBOTTOM TRACK LINES LAYOUT

size	scale	phase
A1	1:1250	-

project number	drawing number	revision
ED-GIS-279	/ B-300	/ 0

File name: E:\ED-GIS-279\Phase-01\Bathymetry\Survey Tracklines\ED-GIS-279-SUBB - Subbottom Lines.dwg

Sediment Echo Sounder SES-96/SES-2000 | Innomar Technologie GmbH

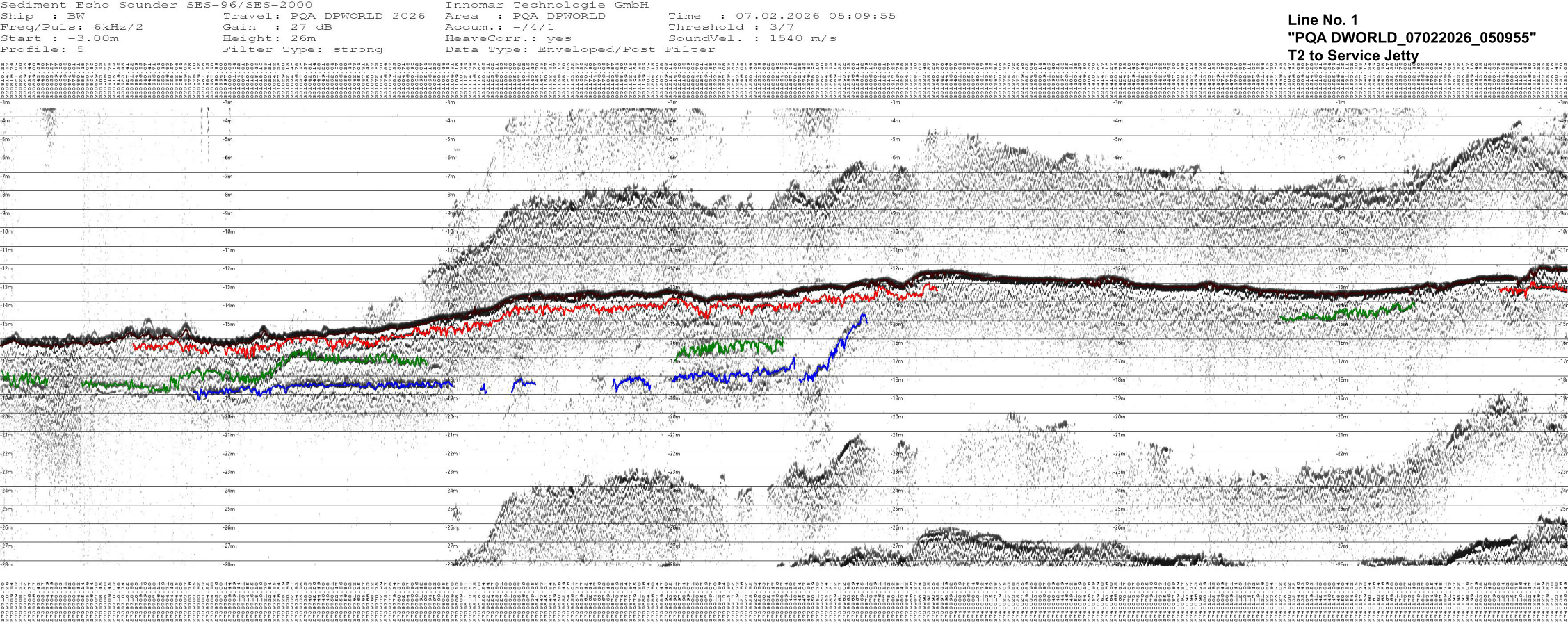
Ship : BW | Travel: PQA DPWORLD 2026 | Area : PQA DPWORLD | Time : 07.02.2026 05:09:55

Freq/Puls: 6kHz/2 | Gain : 27 dB | Accum.: -/4/1 | Threshold : 3/7

Start : -3.00m | Height: 26m | HeaveCorr.: yes | SoundVel. : 1540 m/s

Profile: 5 | Filter Type: strong | Data Type: Enveloped/Post Filter

Line No. 1
"PQA DWORLD_07022026_050955"
T2 to Service Jetty



Sediment Echo Sounder SES-96/SES-2000 Innomar Technologie GmbH

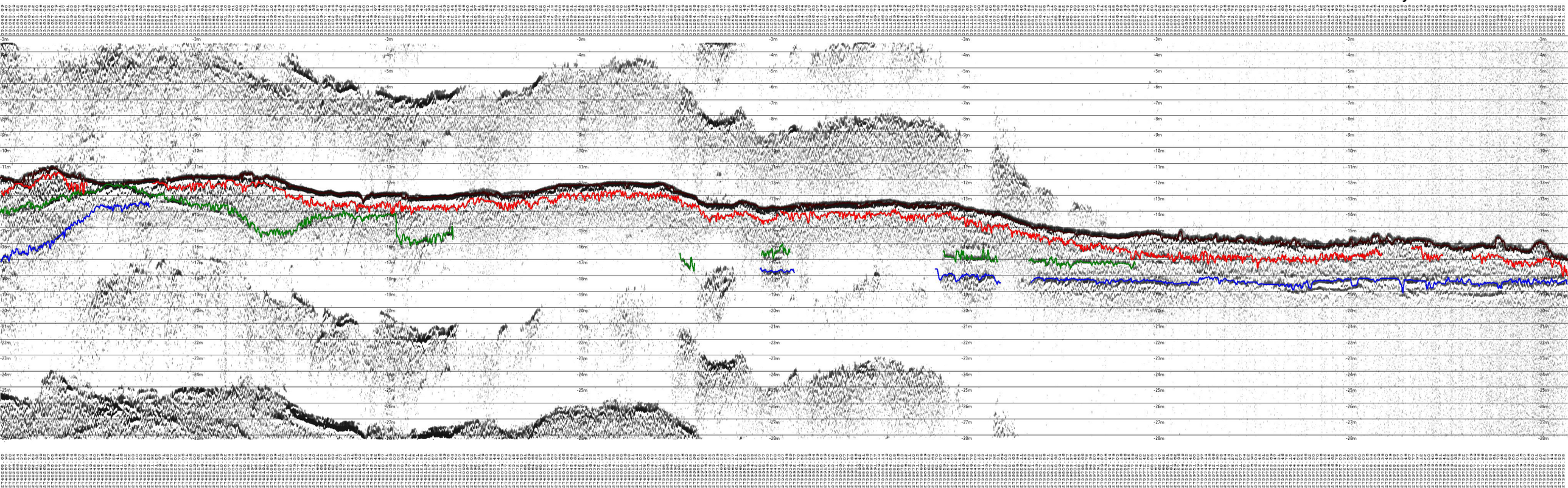
Ship : BW Travel: PQA DPWORLD 2026 Area : PQA DPWORLD Time : 07.02.2026 05:22:08

Freq/Puls: 6kHz/2 Gain : 29 dB Accum.: -/4/1 Threshold : 3/7

Start : -3.00m Height: 26m HeaveCorr.: yes SoundVel. : 1540 m/s

Profile: 6 Filter Type: strong Data Type: Enveloped/Post Filter

Line No. 2
"PQA DPWORLD_07022026_052208"
Service Jetty to T2



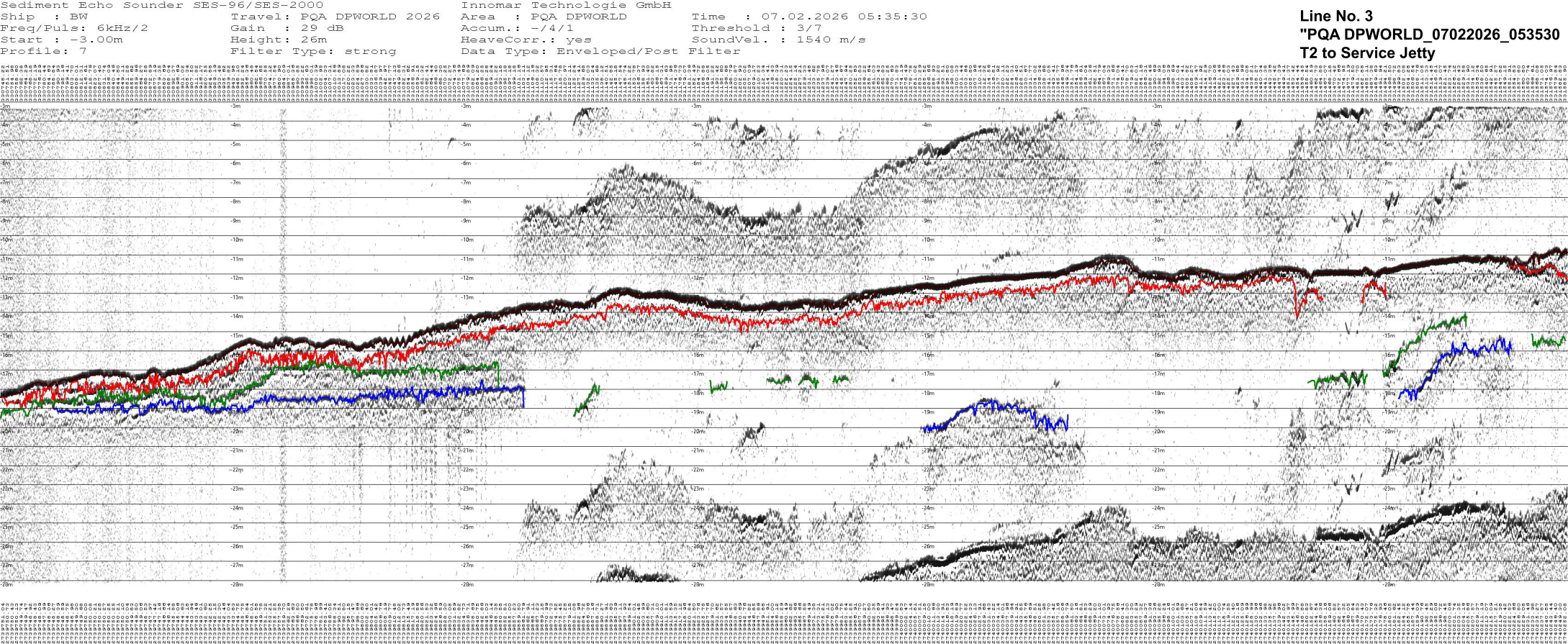
Sediment Echo Sounder SES-96/SES-2000
Ship : BW
Freq/Puls: 6kHz/2
Start : -3.00m
Profile: 7

Innomar Technologie GmbH
Travel: PQA DPWORLD 2026
Gain : 29 dB
Height: 26m
Filter Type: strong

Area : PQA DPWORLD
Accum.: -/4/1
HeaveCorr.: yes
Data Type: Enveloped/Post Filter

Time : 07.02.2026 05:35:30
Threshold : 3/7
SoundVel. : 1540 m/s

Line No. 3
"PQA DPWORLD_07022026_053530
T2 to Service Jetty



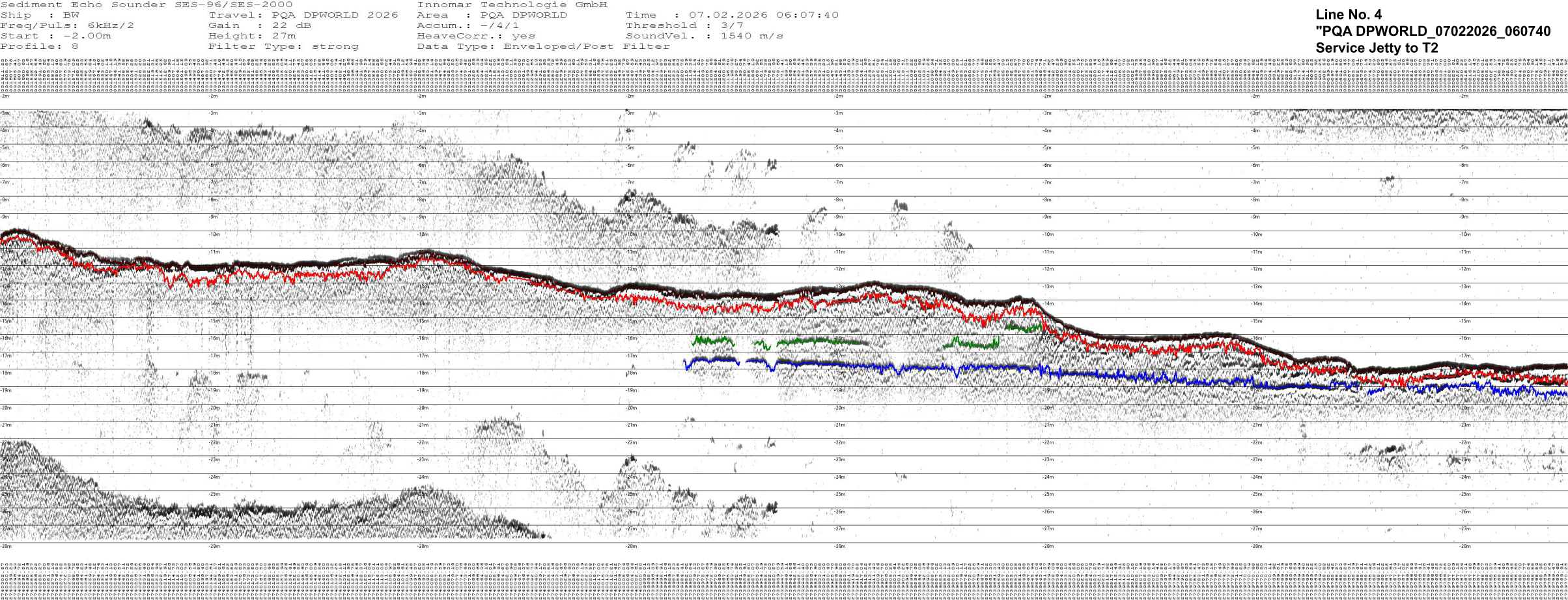
Sediment Echo Sounder SES-96/SES-2000
Ship : BW
Freq/Puls: 6kHz/2
Start : -2.00m
Profile: 8

Innomar Technologie GmbH
Travel: PQA DPWORLD 2026
Gain : 22 dB
Height: 27m
Filter Type: strong

Area : PQA DPWORLD
Accum.: -/4/1
HeaveCorr.: yes
Data Type: Enveloped/Post Filter

Time : 07.02.2026 06:07:40
Threshold : 3/7
SoundVel. : 1540 m/s

Line No. 4
"PQA DPWORLD_07022026_060740
Service Jetty to T2



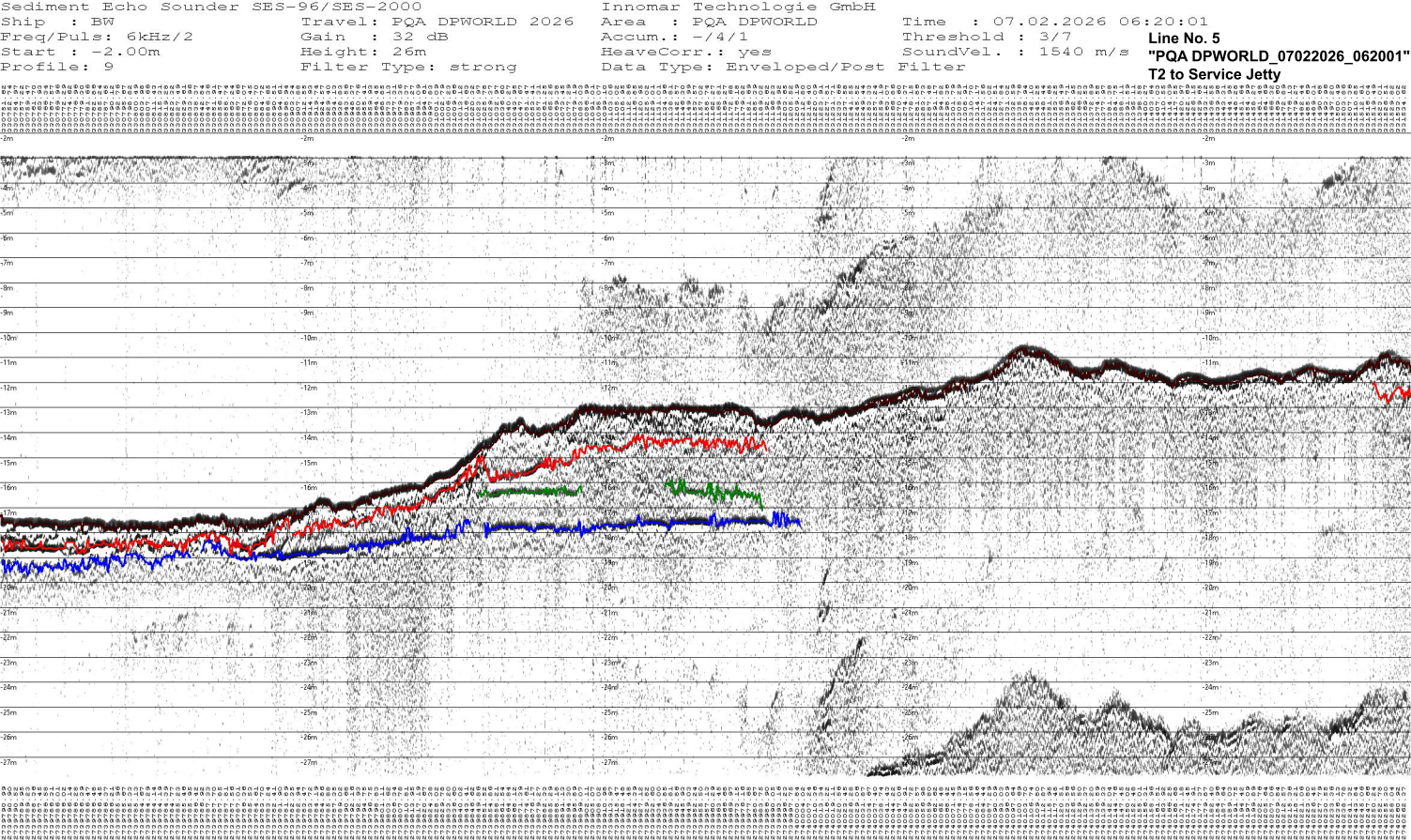
Sediment Echo Sounder SES-96/SES-2000
Ship : BW
Freq/Puls: 6kHz/2
Start : -2.00m
Profile: 9

Travel: PQA DPWORLD 2026
Gain : 32 dB
Height: 26m
Filter Type: strong

Innomar Technologie GmbH
Area : PQA DPWORLD
Accum.: -/4/1
HeaveCorr.: yes
Data Type: Enveloped/Post Filter

Time : 07.02.2026 06:20:01
Threshold : 3/7
SoundVel. : 1540 m/s

Line No. 5
"PQA DPWORLD_07022026_062001"
T2 to Service Jetty



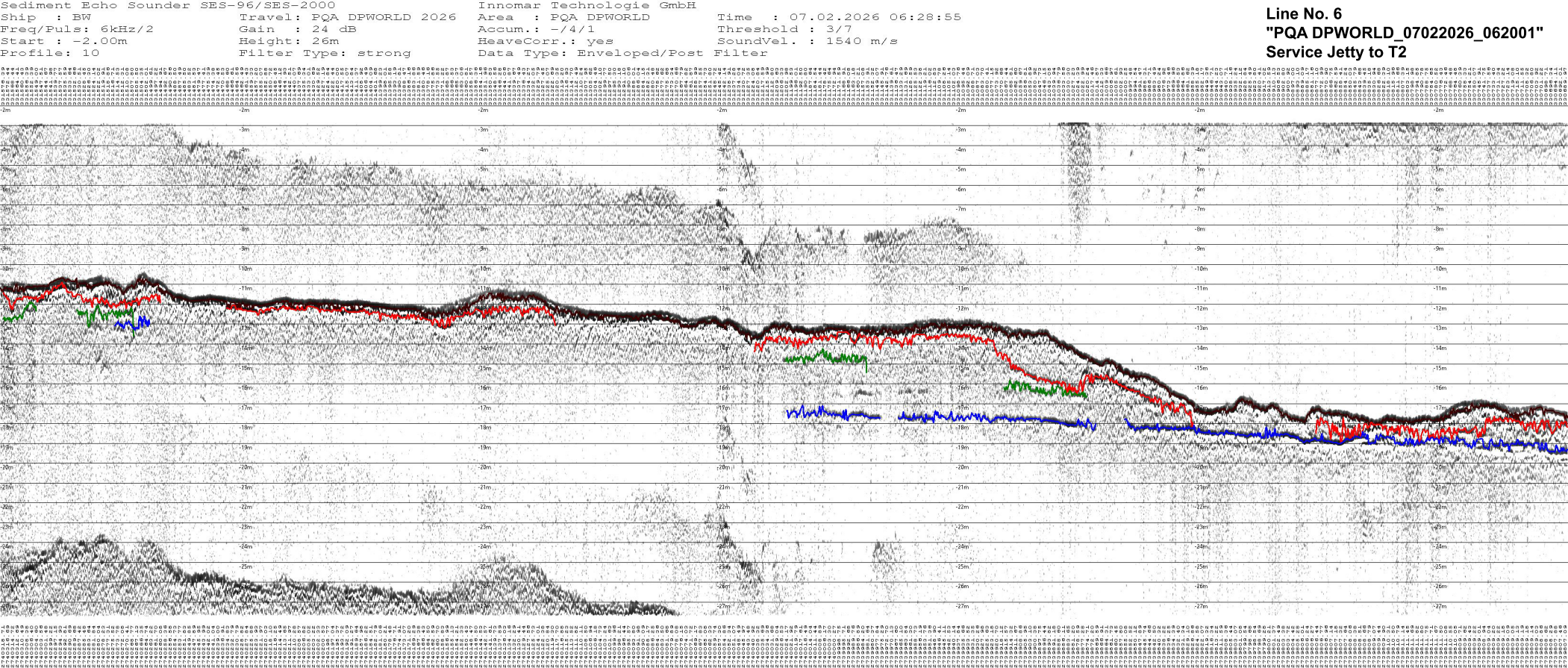
Sediment Echo Sounder SES-96/SES-2000
Ship : BW
Freq/Puls: 6kHz/2
Start : -2.00m
Profile: 10

Innomar Technologie GmbH
Travel: PQA DPWORLD 2026
Gain : 24 dB
Height: 26m
Filter Type: strong

Area : PQA DPWORLD
Accum.: -/4/1
HeaveCorr.: yes
Data Type: Enveloped/Post Filter

Time : 07.02.2026 06:28:55
Threshold : 3/7
SoundVel. : 1540 m/s

Line No. 6
"PQA DPWORLD_07022026_062001"
Service Jetty to T2



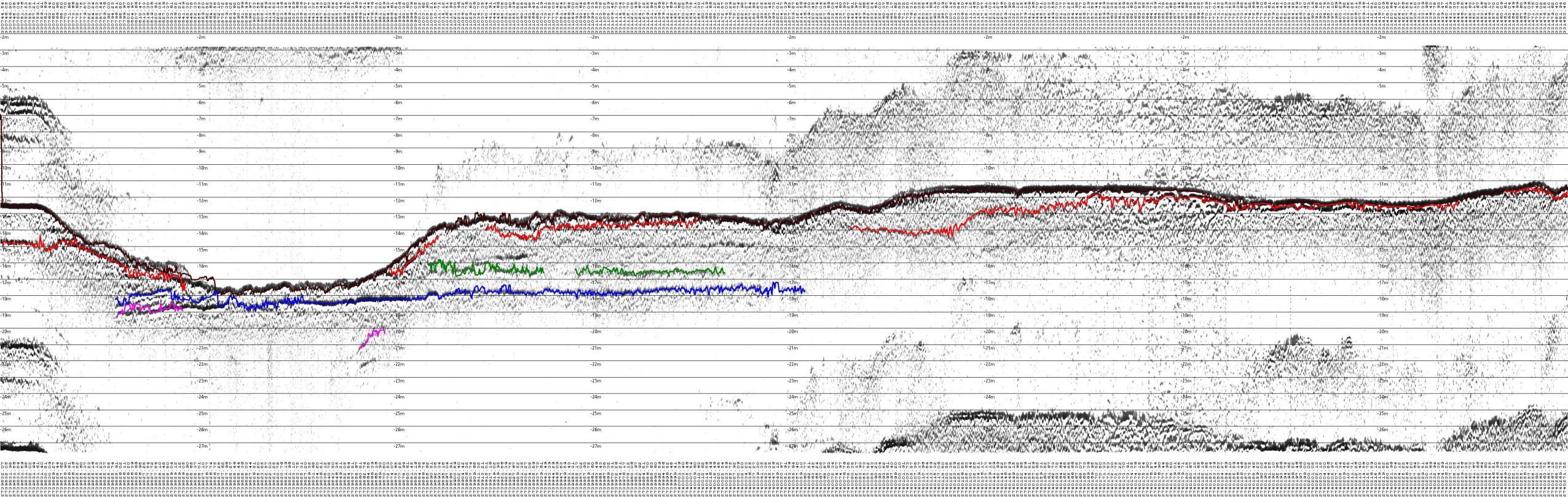
Sediment Echo Sounder SES-96/SES-2000
Ship : BW
Freq/Puls: 6kHz/2
Start : -2.00m
Profile: 11

Travel: PQA DPWORLD 2026
Gain : 26 dB
Height: 26m
Filter Type: strong

Innomar Technologie GmbH
Area : PQA DPWORLD
Accum.: -/4/1
HeaveCorr.: yes
Data Type: Enveloped/Post Filter

Time : 07.02.2026 06:40:51
Threshold : 3/7
SoundVel. : 1540 m/s

Line No. 7
"PQA DPWORLD_07022026_064051"
T2 to Service Jetty



Sediment Echo Sounder SES-96/SES-2000
Ship : BW
Freq/Puls: 6kHz/2
Start : -2.00m
Profile: 12

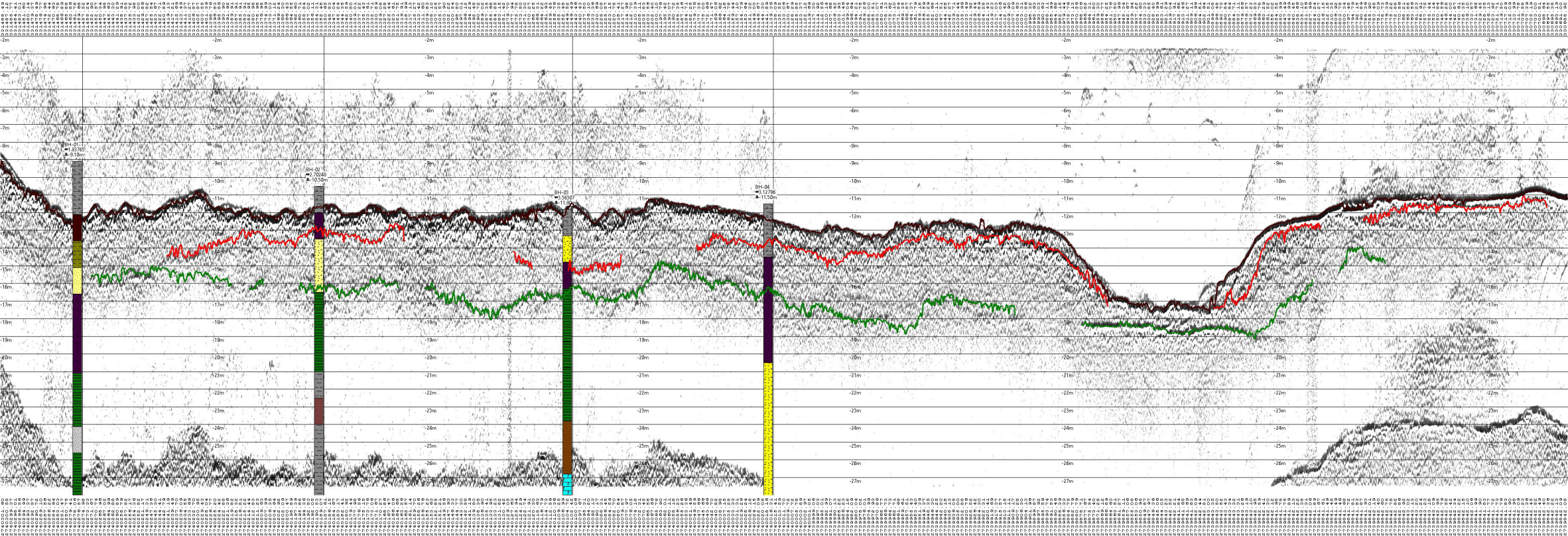
Travel: PQA DPWORLD 2026
Gain : 27 dB
Height: 26m
Filter Type: strong

Innomar Technologie GmbH
Area : PQA DPWORLD
Accum.: -/4/1
HeaveCorr.: yes
Data Type: Enveloped/Post Filter

Time : 07.02.2026 06:54:04
Threshold : 3/7
SoundVel. : 1540 m/s

Legend
- Silty Clay
- Sandy Gravel
- Coarse Sand
- Shale
- Sandstone
- Conglomerate

Line No. 8
"PQA DPWORLD_07022026_065404"
Service Jetty to T2



Sediment Echo Sounder SES-96/SES-2000
Ship : BW
Freq/Puls: 8kHz/2
Start : -2.00m
Profile: 13

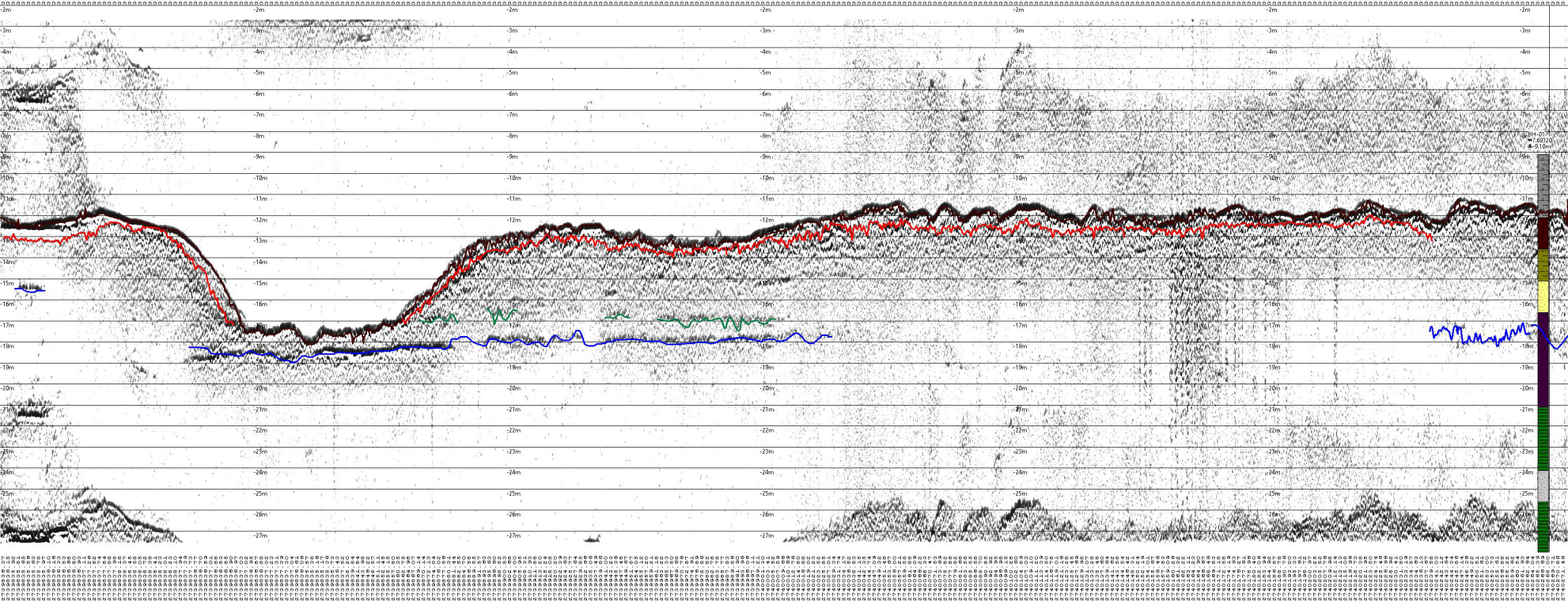
Travel: PQA DPWORLD 2026
Gain : 24 dB
Height: 26m
Filter Type: strong

Innomar Technologie GmbH
Area : PQA DPWORLD
Accum.: -/4/1
HeaveCorr.: yes
Data Type: Enveloped/Post Filter

Time : 07.02.2026 07:06:54
Threshold : 3/7
SoundVel. : 1540 m/s

Legend
- Silty Clay
- Sandy Gravel
- Coarse Sand
- Shale
- Sandstone
- Conglomerate

Line No. 9
"PQA DPWORLD_07022026_070654"
T2 to Service Jetty



Appendix - C
(Survey Log)

Techno-Consult International (Pvt.) Ltd.
TECHNO-HOUSE, 37-K Block-6, P.E.C.H.S, Karachi 75400, Pakistan, Tel: (92-21) 3453-0630/31/32, Fax: (92-21) 3454-6606
Electronic Mail: email@techno-consult.com, Web site: www.techno-consult.com

MARINE SURVEY LOG BOOK

1. Surveyor and Crew Information

Project Name	QICT	Surveyor Name	Abdul Waheed/Khursheed
Crew Names	Irfan , Ghani		

2. General Information

Location of Survey	Port Qasim Karachi
Type of Survey	Bathymetric Survey
Weather Conditions	Normal

3. Boat Information

Boat Name	Break Water	Registration No.	481
Fuel (Liters)	270		
Boat Operator	Irfan		

4. Equipment Condition

Equipment Condition & Remarks
"All bathymetric survey equipment was inspected and confirmed to be fully operational and in satisfactory working condition, with no deficiencies observed."

5. Daily Survey Record

S.No	Date	Start Time	End Time	Remarks
1	30-jan-2026	9:00 am	6:00 pm	successfully conducted Bathymetric survey.

7. Signatures

Chief surveyor		Signature	S. Khurshid

ANNEXURE - D

SURVEY EQUIPMENT SPECIFICATIONS

Instrument	Usage
Trimble SPS855	GNSS receiver – static observation and control point establishment
Trimble R2	GNSS receiver – Base/Rover for bathymetry
Teledyne ECHOTRAC E20	High precision single beam echosounder – usage in depth less than 3m.
Innomar SES200 Light Sub-bottom Profiler	High resolution single beam echosounder
AML Base X2	Industry leading sound velocity probe for continuous water column profiling
R2 Sonic 2022 Multibeam	High-resolution multibeam echosounder with SurfMaster IMU and integrated sound velocity probe
RBR Duet 2 (tide gauge)	Self-contained water level sensor
TCI Survey Vessel (Breakwater)	Fiber glass survey vessel, LOA = 28ft, Beam = 7ft, and Draft = 0.4m with 2 x 175HP Engines

Software	Usage
Trimble Business Center	GNSS baseline processing for control point establishment. PPK trajectory solution
Auto CAD	Creation of planning and layout drawings / georeferencing
HYPACK/ HYSWEEP	Bathymetric (multibeam) data acquisition & processing
Terra Scan / Terra Modeler	Creation of digital terrain and 3D seabed models from point cloud data
ARC GIS/ QGIS	Charting, data visualization, and map production
Applanix POSPac	Post-processing of multibeam IMU and GNSS data
Innomar SES /SWIN	SESWIN propriety software to process sub-bottom profiler data

Annex X - Guideline Dredging Management Plan

1. Purpose and Status of this Guideline DEMP

This Guideline Dredging Environmental Management Plan (DEMP) provides the minimum environmental, social, health, safety, navigation, and monitoring requirements that shall be built upon by the dredging contractor for the Terminal 1 quay wall extension and berth pocket dredging works at QICT, Port Qasim. It translates the mitigation measures identified in the ESIA impact assessment into practical controls, hold points, inspection requirements, monitoring commitments, and response procedures for the dredging phase.

The document is intentionally written as a guideline. It does not replace the contractor method statement, construction ESMP, navigation plan, emergency plan, spill response plan, PQA approvals, or any conditions imposed by SEPA, PQA, Sindh Forest Department, Sindh Wildlife Department, Marine Fisheries Department, or other relevant authorities. Instead, it establishes the framework and minimum requirements that the contractor shall develop into a complete project-specific DEMP before mobilization.

- Prevent uncontrolled sediment dispersion and water quality deterioration during dredging, marine piling, barge loading, transport, and disposal.
- Protect marine water quality, seabed sediments, benthic communities, fish, crabs, birds, mangrove-associated receptors, and fisheries-related users in the wider Port Qasim creek system.
- Ensure that dredging proceeds only within the approved footprint, depth, timing, methodology, monitoring regime, and disposal arrangements.
- Provide clear responsibilities, environmental hold points, stop-work triggers, corrective actions, documentation, and reporting requirements.
- Support contractor compliance with ESIA/ESMP requirements, regulatory conditions, and PQA marine operational controls.

2. Project Context and Dredging Scope

The proposed project involves modernization of QICT Terminal 1 within the existing Port Qasim operational area. The marine works include extension of the existing quay wall, berth pocket deepening to accommodate larger vessels, scour protection, and associated works connected with ground improvement, backfilling, crane rail works, utilities, apron roads, lighting, and installation of six new high-capacity STS cranes. The dredging works are therefore closely linked to marine construction and the operational interface with an active container terminal.

Parameter	Guideline requirement
Location	Existing QICT Terminal 1 operational area and adjoining marine berth area within Port Qasim, Karachi.
Main dredging purpose	Deepening of berth pockets next to the new quay wall to provide safe navigational and berthing depth for larger container vessels.
Target depth	Approximately 16 m, subject to final design drawings, approved dredging plans, and PQA requirements.
Existing depth context	The terminal currently has draft limitations of approximately 12.5 m, requiring berth pocket deepening for modern deep-draft container vessels.
Dredging footprint	Along the Terminal 1 quay frontage and seaward berth pocket area. The contractor shall confirm the approved footprint using issued-for-construction drawings and PQA-approved coordinates.
Estimated dredged volume	To be confirmed by final design and hydrographic pre-dredge survey. The ESIA impact chapter refers to an estimated volume of approximately 200,000 to 300,000 m3 in earlier assessment material; the contractor shall verify and update this figure before works.
Likely dredging approach	Precision near-quay dredging using mechanical methods such as backhoe dredging or controlled clamshell dredging, unless an alternative method is approved by QICT, PQA, and relevant regulators.
Disposal requirement	Use only PQA-approved dredged material disposal sites and routes. No disposal shall occur near mangroves, mudflats, creek mouths, fishing grounds, shallow sensitive habitats, or navigation-sensitive areas.
Operational setting	Active port environment requiring daily coordination with PQA Marine Department, Port Control, QICT operations, neighboring terminals, pilots, tug operators, and other marine users.

3. Environmental and Social Context

The project is located within a heavily modified and operational port environment, but it is also part of the wider Indus Delta creek system. For this reason, the dredging footprint is localized, while the potential influence of suspended sediment plumes, dredged material transport, disposal, spills, and marine traffic can extend beyond the immediate work front if poorly managed.

Receptor / issue	Management implication for dredging
Marine water quality	Sensitive to suspended sediment, turbidity, oil and grease, hydrocarbons, wastewater, concrete washout, and construction runoff. Monitoring is required before, during, and after dredging.
Seabed sediments and benthos	Direct disturbance will occur within the approved dredging footprint. Disturbance shall be minimized through accurate positioning, controlled excavation, and prevention of material loss during handling and transport.
Mangrove-associated habitat	Mangrove stands occur in the wider creek system. No direct damage, cutting, smothering, sedimentation, or disturbance shall be permitted without separate approval. Disposal routes and sites shall avoid mangrove creeks and edges.
Fish, crabs, and fisheries-related users	Temporary disturbance may arise from dredging, underwater noise, exclusion zones, barge movement, and disposal. Works shall remain inside approved port limits and safety zones, with grievance recording for fisheries-related concerns.
Birds	Resident and migratory birds may use nearby mudflat and mangrove habitats. Lighting, noise, and worker access shall be controlled to avoid unnecessary disturbance.
Navigation and port operations	Dredging shall be coordinated with PQA and QICT operations to avoid conflicts with active vessel movements, adjacent terminals, tug operations, pilotage, and emergency routes.
Cumulative port-level impacts	The contractor shall coordinate with PQA regarding other dredging, construction, navigation restrictions, and disposal activities to avoid overlapping high-turbidity or high-traffic periods where feasible.

4. Objectives and Performance Requirements

The contractor shall develop the DEMP to achieve the following performance requirements:

- No dredging before all approvals, method statements, marine notices, disposal arrangements, emergency arrangements, monitoring stations, and hold-point sign-offs are complete.
- No dredging outside the approved footprint, depth, working corridor, disposal route, or disposal site.
- No deliberate discharge of untreated wastewater, oil, chemicals, concrete washout, garbage, or contaminated runoff to the sea.
- No dredged material overflow, leakage, dumping, or placement outside approved areas.
- No direct or indirect damage to mangroves, mudflats, creek mouths, or other ecological no-go areas.
- No marine works without PQA coordination, communication controls, navigation lighting, vessel identification, exclusion zones, and emergency response arrangements.
- No continuation of dredging where monitoring confirms threshold exceedances until corrective action has been implemented and accepted.
- Complete traceability of dredged quantities, barge trips, disposal coordinates, weather/tide conditions, water quality monitoring, inspections, non-conformances, incidents, and corrective actions.

5. Applicable Approvals and Interface Requirements

The contractor shall identify all approvals and permits required for dredging, disposal, marine traffic management, environmental monitoring, and emergency response. At minimum, the following shall be addressed before mobilization or commencement of marine works.

Approval / interface item	Minimum requirement	Hold point
SEPA approval / ESIA conditions	QICT / Contractor to integrate all approval conditions into the C-ESMP, DEMP, monitoring plan, and method statements.	Before mobilization
PQA dredging and marine operations approval	Submit final dredging methodology, equipment specifications, dredging extent, disposal site, barge routes, navigation controls, schedule, and emergency	Before dredging

Approval / interface item	Minimum requirement	Hold point
	arrangements.	
PQA-approved disposal site	Confirm coordinates, depth, allowable volume, restrictions, access route, tracking, and documentation procedures.	Before dredging
Hydrographic survey approval	Submit pre-dredge survey methodology, survey grid, benchmarks, volume calculations, and post-dredge survey method.	Before dredging
Sediment characterization results	Submit sampling locations, laboratory results, classification, and material management recommendations.	Before dredging
Marine traffic / navigation interface plan	Coordinate with PQA Marine Department, Port Control, pilots, tugs, and adjacent terminals. Issue notices where required.	Before marine works
Ecological safeguards	Confirm mangrove no-go areas, ecological monitoring points, bird/mangrove observations, and agency consultation requirements.	Before dredging
Emergency and spill response arrangements	Complete drills, equipment staging, contact lists, rescue arrangements, spill kits, booms, and notification procedures.	Before mobilization

6. Roles, Responsibilities, and Competency Requirements

The contractor shall nominate competent personnel for the implementation of this DEMP and shall include a detailed organization chart, names, contact details, deputies, and 24-hour emergency contacts. Minimum role expectations are summarized below.

Role	Core responsibilities	Minimum competency / authority
QICT Project Manager	Overall owner of project environmental compliance; ensure approvals, contractor resources, coordination with PQA and regulators, and corrective action closure.	Authority to suspend works where compliance or safety risks are unacceptable.
QICT HSE / Environmental Representative	Review and monitor contractor DEMP implementation, inspection records, water quality results, incident reports, and corrective actions.	Interface with regulators, PQA, and contractor environmental team.
Contractor Project Manager	Ensure the DEMP is developed, resourced, communicated, and implemented across dredging, marine vessels, barges, subcontractors, and disposal operations.	Accountable for compliance with approved method statements and conditions.
Contractor Environmental Manager	Prepare and implement DEMP, monitoring plan, environmental inspections, ecological controls, reporting, and corrective actions.	Must have marine construction/dredging environmental management experience.
Dredging Superintendent / Master	Control dredging execution, positioning, depths, bucket controls, barge loading, tide/weather restrictions, and communication with Port Control.	Competent in marine dredging in active port environments.
Hydrographic Surveyor	Undertake pre-, interim, and post-dredge surveys, volume calculations, and as-built dredging verification.	Qualified surveyor with calibrated equipment and accepted survey methodology.
Water Quality Monitoring Team	Collect field and laboratory samples, operate calibrated instruments, maintain chain of custody, and report exceedances immediately.	Trained in marine water quality sampling and QA/QC.
Barge / Tug Masters	Follow approved routes, maintain freeboard, prevent overflow/leakage, track trips, and confirm disposal coordinates.	Licensed and familiar with PQA marine requirements.
Emergency Response / Spill Team	Maintain spill kits, booms, PPE, rescue equipment, drills, spill containment, reporting, and cleanup.	Trained in spill response, man-overboard, fire, and first aid procedures.

7. Contractor Submittals and Hold Points

No dredging shall begin until the following submittals have been prepared by the contractor, reviewed by QICT, and accepted by PQA and other relevant authorities where required. The contractor shall maintain a live submittal register and hold-point sign-off sheet.

Submittal	Content to be developed by contractor	Review / acceptance
Detailed DEMP	This guideline converted into a project-specific plan with final methodology, monitoring stations, thresholds, responsibilities, templates, reporting, and maps.	QICT / PQA / as required by SEPA conditions
Dredging Method Statement	Dredger type, production rate, sequence, bucket controls, positioning, over-dredge tolerance, hydrographic survey integration, and QA/QC.	QICT / Engineer / PQA
Dredged Material Management Plan	Material classification, barge loading, freeboard, disposal site, transport route, disposal method, tracking, and contingency measures.	QICT / PQA
Sediment Sampling Plan and Results	Sampling locations, lab parameters, chain of custody, classification criteria, contamination response, and approval pathway.	QICT / PQA / SEPA as required
Water Quality Monitoring Plan	Baseline data, monitoring stations, frequency, parameters, thresholds, trigger levels, QA/QC, reporting, and stop-work process.	QICT / PQA / SEPA as required

Submittal	Content to be developed by contractor	Review / acceptance
Ecological Protection Plan	Mangrove no-go zones, bird/fisheries considerations, ecological walkover, monitoring and restoration triggers.	QICT / relevant agencies as required
Navigation and Vessel Traffic Management Plan	Exclusion zones, routes, AIS/VHF, lighting, signals, notices, emergency towage, daily marine meetings.	PQA Marine / QICT
Emergency Preparedness and Spill Response Plan	Scenarios, contacts, spill response equipment, drills, training, response times, notifications, and records.	QICT / PQA
Training and Competency Matrix	Required training, induction, toolbox talks, environmental training, dredger/barge competence, spill drills, and records.	QICT / Contractor

8. Dredging Methodology Guidelines

The contractor shall select and justify a dredging methodology appropriate for precision berth pocket deepening in a live terminal environment. Based on the ESIA alternatives assessment, controlled mechanical dredging, particularly backhoe dredging or controlled clamshell dredging, is generally suitable for near-quay work because it allows precision, reduces unnecessary disturbance, and can be phased around terminal operations. Any hydraulic dredging approach shall be justified by sediment type, navigation space, plume control, operational constraints, and approval requirements.

Control area	Guideline requirement
Approved footprint	Upload approved dredge footprint and design depths into dredger positioning system. Display no-go boundaries. Use daily survey checks.
Depth control	Define target dredge level, tolerance, over-dredge limit, and verification method. Over-dredging shall be minimized and reported.
Dredging sequence	Sequence works by sections to reduce concurrent disturbance and maintain operational continuity. Interface with quay wall works and berth operations.
Bucket / excavation control	Use closed or controlled bucket operation where feasible. Avoid rapid hoisting, excessive swing, seabed dragging, and uncontrolled sediment loss.
Barge loading	Load slowly and evenly. Maintain minimum freeboard. Do not allow overflow, wash-over, or leakage. Stop loading if freeboard is inadequate.
Weather and tide controls	Set criteria for suspension during high winds, unsafe waves, poor visibility, cyclonic warnings, extreme tidal currents, or storm warnings.
Equipment maintenance	Inspect dredger, grabs, hydraulic lines, engines, barges, tugs, and bilges daily. Repair leaks before work resumes.
Work hours and lighting	Define daytime and night-time work procedures. Use shielded lighting to reduce spill toward creeks and mangroves.
Cumulative activity control	Coordinate with PQA and adjacent terminals to avoid overlapping high-turbidity activities or congested barge movements where feasible.

9. Pre-Dredge Surveys and Baseline Requirements

Pre-dredge surveys establish the baseline against which dredging accuracy, water quality change, sediment classification, and environmental performance will be assessed. The contractor shall complete the following before dredging.

Pre-dredge requirement	Minimum content
Hydrographic / bathymetric survey	Conduct pre-dredge bathymetric survey of the berth pocket, approaches, and obstruction/debris areas. Use calibrated equipment and accepted benchmarks. Prepare volume estimate and dredge grid.
Obstruction and debris survey	Identify debris, abandoned equipment, hard spots, pipelines, cables, or unknown obstructions. Mark and remove obstructions through approved methods.
Sediment characterization	Sample sediment within dredging footprint and, where relevant, representative depth intervals. Analyze physical and chemical quality before disposal decisions.
Marine water baseline	Measure pH, temperature, salinity/conductivity, dissolved oxygen, turbidity, TSS, oil and grease, TPH, BOD/COD, visual sheen, and any additional parameters required by approvals.
Ecological walkover	Map nearby mangrove edges, mudflats, bird activity zones, fisheries-related use points, and sensitive receptors relative to dredging and disposal routes.
Navigation baseline	Confirm normal vessel movements, tug routes, pilot boarding/operational requirements, adjacent terminal interfaces, and emergency access needs.
Photographic baseline	Take dated photographs of work fronts, quay edge, water surface, nearby sensitive receptors, fuel/chemical storage, spill equipment, and barge loading points.

10. Sediment Characterization and Classification

Sediment characterization is a mandatory environmental hold point because dredging in an industrial port can mobilize sediment-bound contaminants. The contractor shall submit a sediment sampling and analysis plan before sampling and shall not dredge until the results have been reviewed and the material management route has been approved.

- Sampling locations shall cover the full dredging footprint, including near-quay zones, deeper berth pocket zones, areas of visible debris, and representative sediment types/depths.
- Parameters shall include, at minimum, grain size, moisture content, organic matter where relevant, metals, hydrocarbons/TPH, oil and grease, and other contaminants of concern identified by QICT, PQA, SEPA, or prior site information.
- The sampling plan shall include sampling method, depth intervals, sample preservation, chain of custody, laboratory accreditation, QA/QC samples, and reporting format.
- Sediments shall be classified before disposal. Suitable uncontaminated material may follow approved marine disposal arrangements. Contaminated or suspect material shall be segregated and managed through regulator-approved treatment, containment, or disposal routes.
- Unexpected odour, sheen, discoloration, waste, drums, oily sediment, medical waste, or other suspect material encountered during dredging shall trigger immediate stop-work in the affected area and notification to QICT and PQA.

Sediment category	Required contractor action
Clean / acceptable for approved marine disposal	Laboratory results and visual checks do not indicate contamination above applicable criteria. Material may be dredged, transported, and disposed at PQA-approved site with standard controls.
Suspect material	Visual sheen, unusual odour, discoloration, debris, or uncertain lab results. Isolate area, sample further, hold material, and obtain approval before disposal.
Contaminated material	Laboratory results or observations confirm contamination requiring special handling. Segregate, prevent marine disposal unless approved, and use treatment/containment/licensed disposal.
Debris / obstruction material	Scrap, metal, timber, ropes, concrete, waste, or other debris. Remove by controlled lifting and manage through approved waste routes, not marine dumping.

11. Turbidity, TSS, and Marine Water Quality Controls

The main environmental risk during dredging is increased turbidity and suspended sediment. The contractor shall develop a monitoring program with baseline values, action thresholds, stop-work thresholds, station coordinates, monitoring methods, calibration records, and reporting lines. Thresholds shall be approved by QICT and, where required, PQA/SEPA before dredging.

- Maintain dredging within approved limits and avoid unnecessary seabed disturbance.
- Avoid overfilling buckets and barges; maintain adequate freeboard at all times.
- Avoid dredging during conditions likely to cause excessive plume dispersion, including unsafe weather, extreme tidal currents, or storm warnings.
- Use precision positioning and controlled bucket operation to reduce repeated passes and unnecessary resuspension.
- Where feasible and safe in the port setting, consider localized silt control measures or operational controls around particularly sensitive activities. Use of silt curtains shall be subject to marine safety review because strong currents and active navigation may make them unsuitable.
- Monitor turbidity and TSS at background/up-current, near-field, down-current, and receptor points. Include visual plume observations with photographs.
- Apply trigger-action-response procedures if thresholds are exceeded, including slowing work, changing bucket cycle, reducing loading rate, pausing during peak currents, inspecting equipment, increasing monitoring, or stopping works.

Monitoring component	Guideline requirement
Field parameters	Turbidity, pH, dissolved oxygen, temperature, salinity/conductivity, visual sheen, visible plume extent.
Laboratory parameters	TSS, oil and grease, TPH, BOD/COD, metals where required by approvals or sediment results.
Minimum monitoring locations	Up-current/background station, near-field station close to dredger, down-current station,

Monitoring component	Guideline requirement
	receptor station toward mangroves/creeks where relevant, and disposal site plume station during disposal.
Minimum frequency	Baseline before dredging; daily during active dredging as a minimum; increased frequency during exceedances, complaints, unusual plume formation, or sensitive activities.
QA/QC	Calibrate instruments daily, record tide/weather, use chain of custody for lab samples, retain field sheets, and submit results with interpretation.
Response timeline	Immediate verbal notification for exceedance; written corrective action record within 24 hours; follow-up monitoring to verify recovery.

12. Dredged Material Transport and Disposal Controls

Dredged material shall be transported and disposed only through approved routes and at PQA-approved disposal sites. The contractor shall prepare a Dredged Material Management Plan and include a map of dredging areas, barge routes, no-go areas, disposal coordinates, emergency refuge areas, and spill response locations.

Control requirement	Guideline action
Barge integrity	Inspect hull, hatches, hopper, scuppers, bilges, and freeboard before loading. Defective barges shall not be used.
Loading control	Load within safe capacity, maintain freeboard, prevent overflow, and avoid wash-over during transit.
Route control	Use only approved routes. Avoid mangrove creeks, shallow sensitive habitats, mudflats, fishing areas, and navigation-restricted areas.
Tracking	Record dredger ID, barge ID, loading time, departure time, route, AIS/GPS track, disposal time, disposal coordinates, material volume, weather, tide, and operator.
Disposal control	Dispose only within approved coordinates and conditions. No side-dumping, leakage, trial dumping, or disposal outside approved limits.
Weather restrictions	Suspend barge transport/disposal during unsafe sea conditions, poor visibility, storm warnings, or conditions that could cause uncontrolled loss of material.
Record keeping	Maintain disposal logs, trip tickets, GPS/AIS tracks, photographs where relevant, and daily reconciliation of dredged vs disposed volumes.

13. Ecological and Mangrove Protection Measures

The contractor shall treat mangroves, mudflats, creek mouths, aquatic fauna, bird habitats, and fisheries-related receptors as environmental no-go or controlled-access areas. No worker, vessel, barge, spoil disposal, laydown, waste storage, fueling, or maintenance activity shall occur in such areas unless explicitly approved.

Ecological issue	Guideline control
Mangrove no-go zones	Map mangrove edges and buffers before works. Brief all marine crews. Do not cut, damage, smother, anchor in, or dispose near mangroves.
Sedimentation control	Monitor visible sedimentation and turbidity near mangrove edges where relevant. Adjust or stop work if sediment plumes are moving toward sensitive receptors.
Bird disturbance	Avoid unnecessary night lighting toward creeks and mangroves. Use shielded downward lighting. Restrict worker access to mudflats and mangrove areas.
Fish and crab resources	Avoid unnecessary vessel idling, propeller wash, or anchoring in shallow habitat. Maintain grievance mechanism for fisheries-related concerns.
Ecological observations	Record fish kills, unusual fauna behavior, oiled birds, distressed fauna, or mangrove damage. Notify QICT immediately and implement corrective action.
Restoration contingency	Prepare a procedure for assessment and compensatory restoration if accidental mangrove or habitat damage occurs, subject to agency requirements.

14. Navigation, Marine Safety, and Operational Interface Controls

Dredging will occur in an active port environment. Environmental controls must therefore be implemented together with marine safety and navigation controls. The contractor shall prepare a Navigation and Vessel Traffic Management Plan in coordination with PQA Marine Department and QICT operations.

Marine safety issue	Guideline control
Daily marine coordination	Hold daily coordination meetings with PQA, Port Control, QICT operations, dredging superintendent, tug/barge masters, and affected terminal representatives as needed.
Exclusion zones	Define and mark marine work zones, no-entry zones, barge loading areas, turning areas, and

Marine safety issue	Guideline control
	emergency access routes.
Communication	Maintain VHF communication, AIS, navigation lights, day shapes/signals, contact lists, and emergency communication protocols.
Notices to port users	Issue notices or work schedules as required by PQA, including changes in route, restrictions, or high-risk activities.
Vessel traffic interface	Coordinate dredger/barges with pilotage, tug movements, berthing/unberthing, adjacent terminal operations, and emergency routes.
Night and poor visibility	Use approved lighting, reflective markers, AIS, and restricted operations during poor visibility. Suspend work if safe navigation cannot be maintained.
Incident response	Define response for collision, grounding, loss of tow, man-overboard, spill, fire, severe weather, or dredger breakdown.

15. Pollution Prevention, Waste, Wastewater, and Spill Response

The contractor shall prevent pollution from dredgers, barges, tugs, work platforms, workshops, fuel storage, chemicals, sanitation facilities, and maintenance activities. No direct discharge to marine waters, stormwater drains, quay edge, or unprotected ground shall be allowed.

- All fuel, oils, chemicals, lubricants, paints, and hazardous substances shall be stored in bunded areas with secondary containment and spill kits.
- Fuel transfer over water shall be minimized and, where unavoidable, shall occur under permit-to-work with drip trays, absorbents, spill booms, trained personnel, and weather restrictions.
- Dredgers and barges shall have spill kits, drip trays, waste bins, firefighting equipment, and bilge controls.
- Concrete washout, wastewater, sewage, bilge water, oily rags, filters, used oil, garbage, and food waste shall be collected and disposed through approved routes.
- Maintenance shall occur only in designated areas where spill containment is available. Emergency repairs over water shall use drip trays and absorbents.
- All spills, even minor spills, shall be reported, recorded, contained, cleaned, and investigated. Recovered contaminated material shall be treated as hazardous waste.

16. Emergency Preparedness and Severe Weather Controls

The contractor shall integrate dredging-specific emergency procedures into the project Emergency Preparedness and Spill Response Plan. Emergency arrangements shall be tested before dredging starts and periodically during works.

Scenario	Minimum response
Spill to marine water	Stop source, deploy booms/absorbents, notify QICT/PQA, protect drains and water, recover material, record incident, monitor water quality, dispose contaminated waste properly.
Man-overboard	Stop work, raise alarm, deploy rescue equipment/rescue boat, notify Port Control, provide first aid, record and investigate.
Collision / grounding	Notify Port Control and QICT, secure vessels, assess spill risk, activate spill response, maintain exclusion zone, investigate.
Fire / explosion	Stop work, isolate fuel/electrical sources, raise alarm, deploy trained response, notify QICT/PQA, evacuate as required.
Severe weather / cyclone warning	Monitor weather daily, define trigger levels, secure dredger/barges/materials, suspend works, move to safe berth/anchorage as directed by PQA.
Unacceptable turbidity or fish/fauna distress	Stop or modify works, inform QICT, increase monitoring, investigate source, implement corrective action, restart only after approval.

17. Monitoring, Inspection, and Corrective Action Program

The contractor shall submit a monitoring program before works. The program shall include environmental performance monitoring, compliance inspections, hydrographic verification, ecological observations, disposal tracking, and emergency equipment checks.

Monitoring item	Parameters / indicators	Minimum frequency	Responsible party
Water quality monitoring	Turbidity, TSS, pH, DO, temperature, salinity/conductivity, oil and grease, TPH, BOD/COD, visual sheen	Baseline; daily during dredging as minimum; increased during	Contractor Environmental Manager / monitoring team

Monitoring item	Parameters / indicators	Minimum frequency	Responsible party
		exceedances	
Visual plume monitoring	Plume direction, length, color, persistence, tide/wind, photographs	Continuous visual observation and at least twice daily record	Dredging supervisor / environmental team
Hydrographic survey	Pre-dredge, interim, and post-dredge bathymetry; volume calculations; over-dredge checks	Before, during by section, and after completion	Hydrographic surveyor
Barge and disposal tracking	Barge ID, volume, route, AIS/GPS, disposal coordinates, time, freeboard, weather/tide	Each trip	Barge master / dredging superintendent
Sediment quality	Grain size, metals, hydrocarbons, oil and grease, contaminants of concern	Before dredging and if suspect material encountered	Contractor / approved laboratory
Ecological observations	Mangrove edge condition, sedimentation, birds, fish kills, oiled fauna, unusual conditions	Weekly and during high-risk activities; immediately after incidents	Environmental team / ecologist as required
Spill prevention inspection	Fuel/chemical storage, spill kits, booms, hydraulic leaks, waste storage, housekeeping	Daily at active work fronts and vessels	HSE / Environmental team
Navigation compliance	AIS, lights, signals, VHF, exclusion zones, notices, marine coordination records	Daily during marine works	Dredging superintendent / marine coordinator
Training and toolbox talks	DEMP induction, spill response, no-go zones, waste, marine fauna, emergency response	Before start and weekly / activity-specific	Contractor HSE / Environmental Manager

18. Trigger Action Response Plan

The contractor shall finalize numeric trigger levels before dredging based on baseline data, applicable standards, regulator/PQA requirements, and site-specific receptor sensitivity. Until project-specific values are approved, the following trigger-action framework shall be used.

Trigger level	Indicative condition	Required action
Green - normal	Monitoring within baseline-adjusted limits; plume remains localized and short-lived; no sheen, no complaints, no ecological distress.	Continue works. Maintain routine monitoring and records.
Amber - early warning	Turbidity/TSS rising above normal trend; plume moving toward sensitive receptor; minor sheen; repeated visual plume persistence; minor complaint.	Notify supervisor and environmental manager. Check equipment, bucket control, barge loading, freeboard, tide/weather. Increase monitoring and modify work rate or sequence.
Red - exceedance / unacceptable condition	Approved threshold exceeded; visible plume reaching sensitive receptor; oil sheen from project source; fish kill/fauna distress; disposal outside approved area; barge leakage/overflow.	Stop relevant activity. Notify QICT and PQA. Implement corrective action, investigate cause, monitor recovery, document incident/non-conformance. Restart only after approval.
Black - emergency	Major spill, collision, sinking, fire, uncontrolled release, severe weather emergency, major navigation incident, or confirmed serious ecological harm.	Activate Emergency Response Plan. Stop works. Notify all required parties. Secure site, protect receptors, investigate, and implement recovery/remediation plan.

19. Reporting, Records, Audits, and Close-out

The contractor shall maintain a complete environmental record for dredging works. Records shall be available for review by QICT, PQA, SEPA, and other relevant authorities.

Record / report	Minimum content
Daily dredging report	Work area, dredger/barge IDs, quantities, position, weather, tide, operating hours, delays, incidents, environmental observations.
Water quality report	Monitoring results, station coordinates, field sheets, instrument calibration, photographs, interpretation, exceedances, corrective actions.
Disposal log	Barge trip records, loading/disposal time, volume, disposal coordinates, route, AIS/GPS evidence, freeboard checks.
Inspection checklist	Vessel inspections, spill kits, waste storage, fuel/chemical storage, housekeeping, no-go zones, navigation controls.
Non-conformance report	Incident/exceedance description, immediate action, root cause, corrective/preventive action, responsible party, close-out evidence.
Weekly environmental summary	Progress, monitoring trends, issues, complaints, stakeholder interfaces, upcoming risks, and action register.
Completion report	Final bathymetry, total dredged/disposed volume, monitoring summary, incident summary, corrective actions, lessons learned, and close-out statement.