Specified Engineering Works

Terminal 4 Temporary Bund

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1 Introduction

1.1 Project Overview

RBK have been commissioned by Dublin Port to undertake dredging and treatment of contaminated sediments within the Alexandra Basin of Dublin Port. The contaminated status of dredged sediments has restricted the potential for disposal at sea and as a result sediment stabilisation is considered as the primary treatment option for the reuse of sediments. The treated sediments are intended to be used as engineering fill for future construction works at Graving Dock 2 and Berth 52/53. The legacy contamination within dredged sediments relates to historical ship building and maintenance activities associated with the Alexandra Port Facility. The presence of metals and organo-tin compounds within the dredged sediments are considered the main risk drivers governing the suitability of materials for reuse. The Environmental Protection Agency (EPA) have granted an Industrial Emissions License (Ref P1022-02) for the proposed treatment works.

Submission LR041556 "Submission of SEW for Treatment and Infilling Works Rev 03" detailed how RBK will dredge, treat and place as fill, the contaminated sediments into Graving Dock 2. This is part of Phase 1A works.

Submission LR043760 "Berth 52/53 Shallow Fill" detailed how RBK will place as fill treated dredge sediment on the existing Berth 52/53 area. This is part of Phase 1B – Part 1 works.

SEW Phase 1B – Part 2 provided engineering drawings and information for the construction of a temporary dredge containment bund at Berth 52/53. The containment bund will be utilised to temporarily store additional non-hazardous material dredged from Alexandra Basin.

This SEW will provide engineering drawings and information for a dredge containment bund located inside the IED redline boundary at Terminal 4, Dublin Port. This dredge containment bund was constructed to store hazardous dredge material intended for export. This dredge material originated within Alexandra Basin in the vicinity of Berth 28. The material has not dried sufficiently to facilitate export and it is now proposed to stabilise and utilise this material within the IED Boundary.

The bund was constructed in July 2019 and filling of the bund commenced in August 2019. It currently stores material dredged from Alexandra Basin.

Approval is now sought for processing and treating the dredge material stored within this bund in existing and currently operational Berth 27 treatment plant.

Approval is also sought to utilise the bund for future storage of dredge material prior to treatment in the Berth 27 treatment plant. It has been identified that a bund would have benefits for the dredge programme by providing resilience to issues such as mechanical breakdown of the treatment plant for example.

1.2 Proposed Works

In accordance with the licensed activities at the site the following works are proposed: -

- Excavate and remove existing dredge material stored within the bund
- Transport of dredge material to the Berth 27 treatment plant
- Screening of dredge material to remove oversize stone at the Berth 27 treatment plant
- Treatment of dredge material in the Berth 27 treatment plant
- Storage of future hazardous dredge material from Alexandra Basin prior to treatment in the Berth 27 treatment plant
- Deconstruction of Terminal 4 bund

1.3 Proposed Operational Hours

A submission has been made to the Agency to extend the operational hours of the dredge treatment plant. The Agency has reviewed submission LR044138, requesting approval for the alteration of hours of operation in accordance with Condition 1.8 of IE licence register no. P1022-02. The Agency approved the request, contingent on the appropriate planning derogation having been granted by Dublin City Council prior to the commencement of the altered hours of operation.

Application No: PARTX/0015 was submitted to Dublin City Council for the extension of working hours. The following date(s) & time(s) were approved.

Monday 27th January, 3rd, 10th, 17th, 24th February from 06:00-08:00 and 18:00-22:00

Tuesday 28th January, 4th, 11th, 18th, 25th February from 06:00-08:00 and 18:00-22:00

Wednesday 29th January, 5th, 12th, 19th, 26th February from 06:00-08:00 and 18:00-22:00

Thursday 30th January, 6th, 13th, 20th, 27th February from 06:00-08:00 and 18:00-22:00

Friday 31st January, 7th, 14th, 21st, 28th February from 06:00-08:00 and 18:00-22:00

Saturday 1st, 8th, 15th, 22nd, 29th February from 07:00-08:00 & 13:00 - 22:00

Sunday 2nd, 9th, 16th, 23rd February, 1st March from 07:00 -19:00

Additional applications will be made monthly to Dublin City Council for the extension of working hours.

RBK propose to operate the dredge treatment plant during the times listed below.

March 2020 to December 2020

Monday – Friday 06:00 – 22:00

Saturday 07:00 – 22:00

Sunday 07:00 – 19:00

2 Terminal 4 Bund

2.1 Location of the Bund

The location of the temporary containment bund is shown in Figure 2-1 below.

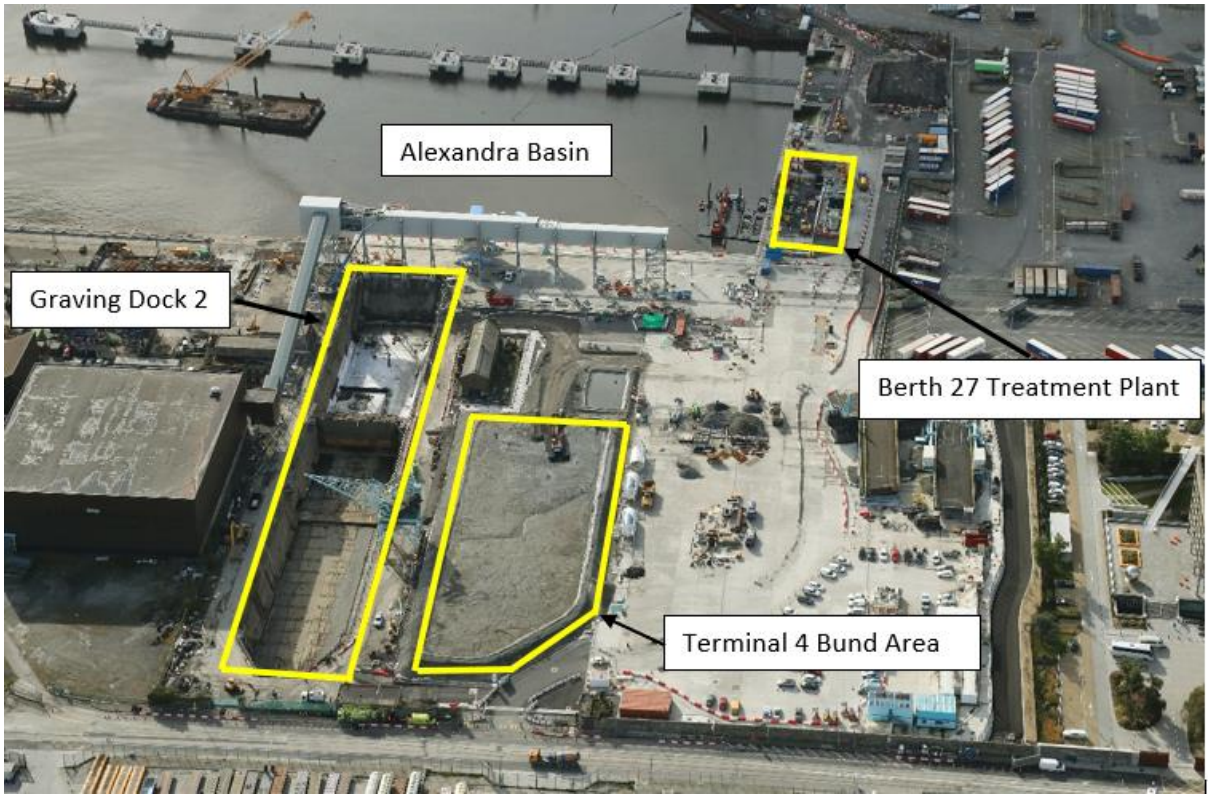


Figure 2-1: Location of Terminal 4 Bund

3 Design of Bund

3.1 Design Codes

The following is a list of recognised engineering standards that have been adhered to in designing the storage bund:

- The EPA's IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities (Document No. 010607-22-RP-001 B) dated 11th June 2004, and
- CIRIA Report C736: Containment Systems for the Prevention of Pollution dated 2014. Note C736: Containment Systems for the Prevention of Pollution: Secondary, Tertiary and other Measures for Industrial and Commercial Premises (C736; 2014) now supersedes the Design of Containment Systems for the Prevention of Water Pollution from Industrial Incidents (R164) referenced throughout the aforementioned EPA IPC Guidance note.

Due to the nature of the dredged materials it has been decided that design of the bund be made to meet a "Class 2, i.e. intermediate degree of integrity".

3.2 Bund Construction

The bund has been constructed on the newly constructed Terminal 4. This area has been paved with flexible impermeable paving. The bund is located within the IED red line boundary. The makeup of the flexible paving is: 150mm unbound sub-base (R_USB 1). 250mm base course (R_BAS 1). 60mm binder/regulating course (R_BIN 1). 40mm surface course (R_SUR 3).

There are a number of existing underground services in the area that have been covered by the bund, see below. The drainage channels under the bund are protected with plywood strips, and the manholes have been covered using steel plates. See Drawing 648-SK051 for underground services.

As noted in Drawing 648-SK051, bungs have been placed on all surface channels as a secondary protective measure downstream of the bund.

The bund has been constructed to cater for 5550m^3 of storage, with a freeboard height of 400mm. The bund walls have been constructed using 6F2 material. In order to mitigate against the risk of puncture, sand was used to smooth the bund walls before the HDPE liner was applied. The bund is lined with a 2mm thick HDPE liner. To provide added robustness, the liner on the base of the bund has

been covered with SECUTEX R301 Geotextile and then capped and protected with 100mm of sand and 300mm of drainage stone. Please refer to Detail 2 on Drawing 648-SK036.

An access ramp into the bund has been created at the south end of the bund. This access ramp has a 1:8 slope. The access ramp has been constructed using 6F2 material. The crest of the bund and inner bund liner have been protected with a 400mm layer of fine dust.

A leak detection system comprising of a perforated pipe placed outside the liner on the inner perimeter of the bund walls has been installed. This falls to a purpose-built manhole outside the bund perimeter.

The integrity of the bund liner was tested before filling commenced. A dielectric porosity test was conducted in accordance with international standard ASTM D4787-13. There were 8 defects identified during the dielectric porosity test which are detailed in section 3.1 of the report. These were repaired by applying patches of geomembrane over the defects, extrusion welding to the existing and retesting. The retests confirmed that the repairs were successful, and this is shown in section 3.2 of the report.

Please refer to Geomembrane Leak Detection Survey Report in Appendix C.

Please refer to Drawing 648-SK036 - T4 Mitigation Bund 2.5M for construction details.

3.3 Screening of Dredge Material Within the Bund

RBK propose to carry out primary screening of the dredge material currently stored within the bund and any future dredge material placed within the bund. This will involve turning the dredge material within the bund using excavators and mechanical screening plant to remove any oversize stone.

The HDPE liner on the base of the bund is protected with 400mm of crushed stone. The excavator and screening plant will stay above this buffer level while screening the material. The excavator driver will be instructed to only excavate material directly above the base of the bund. A one metre buffer zone will be maintained around the inner perimeter wall of the bund in order to prevent the excavator bucket puncturing the liner. The remaining dredge material may then slump into the base of the bund under gravity. This can be aided with the use of a high-pressure water hose as required.

The oversize stone will be retained within the bund where it will be washed prior to removal. The wastewater generated from washing the oversize material will be removed from site by licensed tanker until such time as the wastewater treatment plant is operational and meeting threshold discharge limits.

Waste characterisation testing will be carried out on the screened-out material before reuse or disposal off-site.

3.4 Transport of Material to Berth 27 Treatment Plant

Dredge material will be transported to the Berth 27 treatment plant using tractors and trailers. The trailers will have hydraulic tailboards to minimise the risk of spillage. Tractors and trailers may need to be washed at the Terminal 4 bund prior to departing to the Berth 27 treatment plant. A power washer will be provided for this task. The washings will drain back into the Terminal 4 bund.

A road vacuum sweeper will operate continuously on site in order to sweep the transit route from the Terminal 4 bund to the Berth 27 treatment plant.

The tractors and trailers will travel to the Berth 27 treatment plant and deposit the dredge material into the bunded area. A raised platform has been constructed consisting of concrete walls with a concrete base. This will allow the tractors and trailers to tip safely into the bunded area. A fall on the ramp will direct any runoff back into the bunded treatment area.

3.5 Treatment of Dredge Material

It is proposed to treat existing dredge material and future dredged material within the existing Berth 27 treatment plant and utilise as fill in Graving Dock 2 and Berth 52/53. Please refer to Submission LR041556 “Submission of SEW for Treatment and Infilling Works Rev 03” for details of the Berth 27 dredge treatment plant and dredge treatment process.

3.6 Future Use of Bund

Approval is also sought to utilise the bund for future storage of dredge material prior to treatment in the Berth 27 treatment plant. It has been identified that a bund would have benefits for the dredge programme by providing resilience to issues such as mechanical breakdown of the treatment plant for example.

Material dredged from Alexandra Basin will be loaded into tractors and trailers at the Berth 27 treatment plant. A raised platform has been constructed consisting of concrete walls with a concrete base. This will allow the tractors and trailers to loaded in a contained area. A fall on the ramp will direct any runoff back into the bunded treatment area.

The tractors and trailers will transport the dredge material to the Terminal 4 bund and deposit the dredge material within. The trailers will have hydraulic tailboards to minimise the risk of spillage. A road vacuum sweeper will operate continuously on site in order to sweep the transit route from the Terminal 4 bund to the Berth 27 treatment plant.

An amphibious excavator will be positioned in the bund to move the dredge material to the required location.

A power washer will be provided at the Terminal 4 bund to wash the tractors and trailers before they proceed back to the Berth 27 treatment plant.

4 Environmental Considerations

4.1 Sampling of Untreated Dredge Stored Within the Bund

Samples have been taken of the dredged material stored within the bund. This has demonstrated the level of contamination of the dredge within the bund and as such has informed the mix design to be used to treat the dredge material to achieve the leachate limits.

The dredge material within the bund has been tested for the following parameters.

Frequency	Parameters
Every 1,000 m^3	*Arsenic, Cadmium, Chromium, Chromium IV, Copper, Iron, Mercury, Nickel, Lead, Mercury, Nickel, Zinc, TBT, DBT, Hydrocarbon,* *TPH >C5-C6,* *TPH >C6-C7,* *TPH >C7-C8,* *TPH >C8-C10,* *TPH >C10-C12,* *TPH >C12-C16,* *TPH >C16-C21,* *TPH > C21-C35* *Total TPH > C5-C35* *Naphthalene, Acenaphtylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo[b]fluoranthene, Chrysene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1,2,3-c,d)Pyrene* *Dienz(a,h)Anthracene* *Benzo[g,h,i]perylene* *Total of 16 PAH's* *PCBs*

4.2 Monitoring of Treated Dredge

RBK will take samples every 1,000m^3 of treated dredge material to ensure that all treated dredge material complies with the leaching limits specified in Schedule B.6.

Table 4-1: Waste Monitoring

Waste Class	Frequency	Parameters	Leachate Limit (mg/l)
Treated dredge sediment *(leachate test)*	*After each change to the recipe for the treatment mix* *And* *Every 1,000 m^3* *Leachate samples will be tested at 1, 2, 4 and 9 days*	*TBT* *Nickel*	*1.42 x 10^{-4}* *6.09*

5 Compliance with License Conditions

An installation noticeboard has previously been installed at the entrance to the Berth 27 treatment plant, along Alexandra Road in order to comply with Condition 3.5 of the IED licence. The board is 1200 mm by 750 mm and contains the following information:

- the name and telephone number of the installation;
- the normal hours of operation;
- the name of the licence holder;
- an emergency out of hours contact telephone number;
- the licence reference number; and
- where environmental information relating to the installation can be obtained.

A plan of the installation has also been included on the noticeboard.

A windsock has previously been installed at the entrance to the Berth 27 treatment plant as per Condition 3.15 of the IED licence.

Security fencing and security gates will be installed around the perimeter of the dredge treatment plant as per Condition 3.17.1 of the IED licence. This can be removed and reused following decommissioning of the facility. A CCTV system has been installed to monitor the waste storage areas on a 24-hour basis. The CCTV will be operated at all times and copies of recordings kept on site and made available on request as per Condition 3.17.2 of the IED licence.

Site offices and welfare units have been installed in close proximity to the bund and wastewater treatment plant as per Condition 3.19 of the IED licence. This allows the processing and storage of plans and data relating to the operation of the facility. Weighbridge dockets will be entered onto an electronic spreadsheet and kept on record along with any other documentation and licences relating to the operation of the site. All data received from the environmental monitoring being carried out on site will be stored electronically and easily accessed on request.

Adequate lighting has been installed around the dredge treatment plant and Graving Dock 2, as per Condition 3.20.1 of the IED licence.

No smoking is allowed on site. A designated smoking area is available in the site compound as per Condition 3.20.2 of the IED licence.

A weighbridge has been installed at the Berth 27 loading area as per Condition 3.21 of the IED licence. It has been calibrated, with calibration certs being kept on record in the site office. The dredge treatment plant infrastructure has the capability to weigh all inputs and outputs from the dredge treatment plant. The weighbridge is utilised to weigh the oversize screenings and wastewater.

An odour assessment has been carried out on the dredge material and treatment process. Odour samples have been taken by a professional odour consultant. Modelling was undertaken on these samples and no issues were identified that required mitigation.

6 Water Management

6.1 Wastewater Management

A wastewater storage lagoon has been constructed on the south west corner of the bund, outside the bund wall. The lagoon walls have been constructed using 6F2 material.

The lagoon is lined with a 2mm HDPE liner and has a capacity of 180m^3. There is a freeboard of 250mm.

The integrity of the lagoon liner was tested before filling commenced. A dielectric porosity test was conducted in accordance with international standard ASTM D4787-13. Please refer to Geomembrane Leak Detection Survey Report in Appendix C.

There is a sump located in the south west corner of the dredge containment bund. Located in this sump is a submersible pump. Wastewater from the untreated dredge material drains to the south west corner of the bund and is pumped up and over the bund wall to the wastewater storage lagoon. From here the wastewater is transported by tanker to the on-site wastewater treatment plant infrastructure currently in use at the Berth 27 treatment plant. In the event that we cannot discharge water from the wastewater treatment plant, excess wastewater will be removed from site using a licensed vacuum tanker.

7 Water Monitoring

7.1 Wastewater Monitoring

Monitoring is being carried out as per Condition 6 – Control and Monitoring and Schedule C of the IED licence. The wastewater treatment plant outfall is located at:

WW2 E318401; N234634

Table 7-1: Monitoring of Emissions to Water

Requirements	Monitoring Locations	Parameters
Schedule C: Control & Monitoring C.2.2. Monitoring of Emissions to Water	*WW2*	*Flow, temperature, pH, TOC, Suspended solids, Total Dissolved Solids* *Ammonia (as N) Total Phosphorus (as P),* *Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Zinc, TBT* *Phenols, PAHs, PCBs, Petroleum Hydrocarbons, Organic Compounds, Toxicity*

7.2 Surface Water Monitoring

A boat is used to access monitoring points SW1 to SW3 as listed in the licence.

SW1 E318004; N234301

SW2 E320683; N233872

SW3 E321313; N234225

Monitoring was carried out monthly prior to construction of the treatment plant and is currently being carried out daily throughout the construction and operating life of the plant. Please refer to Table 2 Programme of Works. The frequency of sampling is as per Schedule C of the IED licence. A Van Dorn Beta Horizontal sampler which is specifically designed for sampling in open water is being utilsed. Sample bottles provided by the laboratory are filled from one of the sampling taps from the Van Dorn sampler. The device provides a sufficient water sample size to allow the flushing out (i.e. in triplicate) of each laboratory container and accompanying caps prior to the taking of each sample. Each surface water sample is taken from the bow of the boat while it is facing upstream into the flow of the river (i.e. facing west).

Table 7-2: Water Monitoring in the Liffey Estuary

Requirements	Monitoring Locations	Parameters
Schedule C: Control & Monitoring C.2.3. Marine Water Monitoring in the Liffey Estuary	*SW1 to SW3*	*Suspended solids, Turbidity Temperature, Dissolved Oxygen* *Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Zinc, TBT, PAHs, PCBs, Petroleum Hydrocarbons*

7.3 Storm Water Monitoring

Storm water samples are currently being taken at Emission Point SW01

SW01 E318404; N234637

Table 7-3: Monitoring of Storm Water Emissions

Requirements	Monitoring Locations	Parameters
Schedule C: Control & Monitoring *C2.4 Monitoring of Storm Water Emissions*	*SW01*	*Visual, pH, Temperature, Suspended Solids, Arsenic, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Zinc, TBT, PAHs, PCBs, Petroleum Hydrocarbons*

7.4 Groundwater Monitoring

Groundwater monitoring is carried out monthly prior to construction of the treatment plant and monthly throughout the operating life of the plant. The existing borehole monitoring results along with the monitoring carried out before construction works informed the baseline study.

Prior to sampling, each of the nine groundwater wells is dipped with a Geotechnical Instrument Interface Probe to determine firstly if any groundwater was present, and if so, the depth of standing water level, total well depth and to determine if any floating free-phase product (i.e. Light Non-aqueous Phase Liquid (LNAPL)) or (i.e. Nonaqueous Phase Liquid (DNAPL)) are present within the aquifer on site. Monitoring well sampling logs are produced for each borehole on each sampling occasion.

Dedicated Waterra inertial lift pumps are installed in each of the nine groundwater boreholes for sample extraction. Prior to each sampling round, three well volumes are removed as recommended by British Standard BS 6068-6.11:1993 (ISO 5667-11:1993) Part 6: Section 6.11 Guidance on Sampling of Groundwater. This standard provides recommendations regarding the number of well volumes and subsequently the amount of time required to purge a borehole prior to taking a water sample for laboratory analysis. The purpose of this procedure is to remove stagnant groundwater (i.e. where the

well has not been sampled for an extended period and/or groundwater that may have been contaminated by the drilling process (i.e. in order to give a representative groundwater sample). The purge water is visually examined during the purging process in a dedicated bucket for physical evidence of contamination in the form of floating product or emulsified product (i.e. sheen, droplets, etc) and/or sheen and/or taint or discoloration. The purged water is also inspected for olfactory evidence of contamination (i.e. odour). All observations are logged in the field in an All-Weather Notebook. Geotagged and time-stamped digital photographs are taken of purge water taken from each borehole.

Sample bottles are filled directly from the waterra outlet. Unfiltered samples are taken for each laboratory analyte with the exception of the sample taken for heavy metals analysis. A disposable 0.5um mesh waterra inline filter is employed to remove suspended solids from the groundwater samples.

Table 7-4: Groundwater Monitoring

Requirements	Monitoring Locations	Parameters
Schedule C: Control & Monitoring *C.7 Groundwater Monitoring*	*GW1, GW2, GW4, GW5, GW6, GW7, GW8, GW10, GW12*	*pH, COD, Nitrate, Total Ammonia, Total Nitrogen, Conductivity, Chloride, Fluoride, Cadmium, Chromium, Chromium VI, Copper, Lead, Mercury, Nickel, Zinc, TBT, PAHs, PCBs, Petroleum Hydrocarbons*

8 Decommissioning and Deconstruction

December 2020 is the programmed date for deconstruction of the containment bund and lagoon.

Following emptying, the bund and lagoon will be washed down and the wastewater will be drawn off by tanker to the wastewater treatment plant. The HDPE liner will be removed and disposed of to an appropriate waste facility pending acceptance.

The stone aggregate will be stockpiled on site for future use.

Appendix A: Drawing List

Drawing Number	Title
648-SK036	T4 MITIGATION BUND 2.5M
648-SK051	T4 MITIGATION BUND INCLUDING SERVICES

Appendix B: Environmental Risk Assessment

In each case where a Risk is relevant to the task the relevant word should be placed into the box adjacent to the risk. The 1st box is for "Likelihood of it happening" is it "Certain, Likely, Possible or Unlikely". As can be seen in the table the "Result" is the "Likelihood x Risk". After the controls are put in place the same process should be completed to get the "Revised Result".	Likelihood of it happening	Outcome of Risk			
		No Risk	Low Risk	Medium Risk	Serious Event
	Certain	Medium	Medium	High	High
	Likely	Low	Medium	Medium	High
	Possible	Controlled	Low	Medium	Medium
	Unlikely	Controlled	Controlled	Low	Medium

ID	Hazard	Likelihood of it happening	Outcome of Risk	Result	Risk Reduction Methods	Revised Likelihood of it happening	Revised Outcome of Risk	Revised Result
	Spillage of material from vehicles during transport to Berth 27 treatment plant	Possible	Contamination entering surface water drainage system	High	• Sealed trucks to be used for transporting dredge material to Berth 27. • Daily inspections of truck tailboards • Road sweeper available on site for use if required	Possible	Reduced risk of contamination on public roads or surface water	Controlled
	Truck wheels carrying dredge sediments onto public roads	Likely	Contamination of the public road network	High	• Trucks will be washed before leaving the Berth 27 loading area	Possible	Reduced risk of dredge sediments	Controlled

							being deposited onto public roads	
	Failure of containment bund	Possible	Leakage of contaminated dredge run-off entering the water course	High	• The bund has been constructed in accordance with the EPA 'Guidance Note on Storage and Transfer of Materials for Scheduled Activities'. • Bund has been tested be tested to agreed standards. • Leak detection system	Unlikely	Reduced risk of leakage of hazardous materials once bunds are constructed to the agreed standards set out and that the bunds are regularly monitored.	Controlled
	Failure of water treatment plant	Possible	Contaminated effluent being discharged into water course	High	• Continuous and daily monitoring of water treatment plant to alert of any high readings. • SCADA system. • Ability to shut down water treatment plant and close off effluent pipe. • Adequate storage provided in attenuation tanks once dredging operations cease on discovery of a problem.	Possible	The risk of contaminated effluent entering the watercourse is lowered with continuous and daily monitoring of water being carried out.	Controlled

	Odour production	Possible	Release of hydrogen sulphide contained within the dredged material leading to odour complaints	Medium	• Odour assessment has been carried out with no odour nuisance identified • Little to no untreated dredge will be stored on site. A continuous process of treatment will be employed • Wind direction in the Dublin area is predominately westerly-south westerly (circa 60% of the year) which will direct odours away from residential areas to the south.	Unlikely	No odour complaints envisaged	Controlled
	Noise production	Possible	Noise nuisance complaints	Medium	• Low Noise Emitting Machinery chosen for use. • Noise monitoring throughout the project.	Unlikely	Noise production within limits	Controlled
	Dust production	Possible	Dust nuisance complaints	Medium	• Dredge material to be treated will be wet so dust production is not envisaged. • Dust suppression will be provided during dry conditions to dampen down haul roads	Possible	Dust production within limits	Controlled

Appendix C: Geomembrane Leak Detection Survey Report

GEOMEMBRANE LEAK DETECTION SURVEY REPORT

DUBLIN PORT

MITIGATION BUND AND LAGOON

AUGUST 2019

Prepared For

KEATING CONSTRUCTION

KEATING
Marine · Civil Engineering · Building

Prepared By

GEOTECT LTD

Geotect
Geophysical Detection Surveys

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1.0 INTRODUCTION

Geotect Ltd was invited by Keating Construction to undertake a Geophysical Leak Detection Survey (LDS) over a Mitigation Bund and small lagoon at Dublin Port, Dublin.

The LDS was performed by Geotect staff on 2 August 2019.

The purpose of the LDS was to locate any damage to the placed geomembrane liner. The dielectric porosity testing method was used throughout the LDS and was conducted on the Mitigation Bund base and walls, and smaller lagoon, directly on the clean and dry exposed geomembrane.

This report describes the methodology used throughout the survey and presents the results.

2.0 DIELECTRIC POROSITY TESTING METHODOLOGY

2.1 Dielectric Porosity Testing Principle

The dielectric porosity test method was used on the base and side slopes of the bund and lagoon. It was developed specially for the testing of exposed geomembrane and the test was carried out in accordance with international standard ASTM D4787-13. Since the dielectric porosity testing method is not dependent on water making good contact through the leak, it is more sensitive than other, water-based methods, and will locate any holes that electrons can pass through.

A voltage is introduced above the geomembrane and grounded to the material directly beneath the geomembrane. In the presence of a hole, an electrical spark is formed along with an audible alarm.

Data cannot be collected during the test, as a result contour plots cannot be produced. The tester is alerted to the presence of a hole by an audible alarm. The hole is precisely located and repaired by the geomembrane welding technician. The repair is then retested until no audible alarm is heard.

2.2 Test Hole

To ensure the survey was working correctly a test hole was made in the geomembrane liner. The test hole was placed on the bund base and was introduced by the geomembrane lining team. Prior to the commencement of the main survey the section was surveyed by Geotect's survey team. The test hole was accurately located to confirm the survey was working correctly.

3.0 SURVEY RESULTS

3.1 Dielectric Porosity Test Results

A total of eight defects were located during the Dielectric Porosity Test over the Mitigation Bund and lagoon at Dublin Port.

- Defect 1 was located on the base of the Mitigation Bund. It was the test hole.
- Defect 2 was located on the base of the Mitigation Bund. It was a puncture in the liner, approximately 1mm in diameter.
- Defect 3 was located on the base of the Mitigation Bund. It was a puncture in the liner, less than 1mm in diameter.
- Defect 4 was located on the base of the Mitigation Bund. It was a puncture in the liner, approximately 1mm in diameter.
- Defect 5 was located on the base of the Mitigation Bund. It was a puncture in the liner, approximately 1mm in diameter.
- Defect 6 was located on the base of the Mitigation Bund. It was a puncture in the liner, less than 1mm in diameter.
- Defect 7 was located on the top of the wall of the Mitigation Bund. It was a puncture in the liner, approximately 3mm in diameter.
- Defect 8 was located on the small lagoon. It was a puncture in the liner, less than 1mm in diameter.

Photographs of the defects are included in Appendix A.

3.2 Retests

Retests were conducted following the repair of the defects. The retests confirmed the repairs were successfully completed.

4.0 CONCLUSIONS

The LDS undertaken over the Mitigation Bund and lagoon at Dublin Port identified a total of eight defects in the liner system. Following the repair of the defects retests were undertaken, which confirmed the repairs were effective.

To confirm the survey was working correctly a test hole was made in the liner. The test hole was located accurately.

5.0 CLOSURE

The information contained in this report is based on the interpretation of the data collected during the survey. The ability of the leak detection survey technique to detect defects in the geomembrane liner is dependent on those defects having a configuration which allows electrical current to flow through the defects.

This report does not, therefore, offer a guarantee that the geomembrane liner of the Mitigation Bund and lagoon at Dublin Port is defect free. Best practises have however been adopted to give the highest possible confidence in the results of the survey.

This report is for the exclusive use of Keating Construction and its agents. No warranties or guarantees should be assumed by any third parties.

APPENDIX A

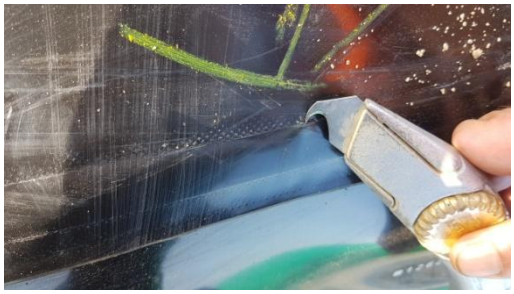
Photographs



DEFECT 2



DEFECT 3



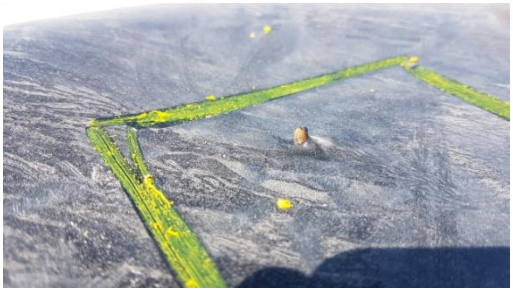
DEFECT 4



DEFECT 5



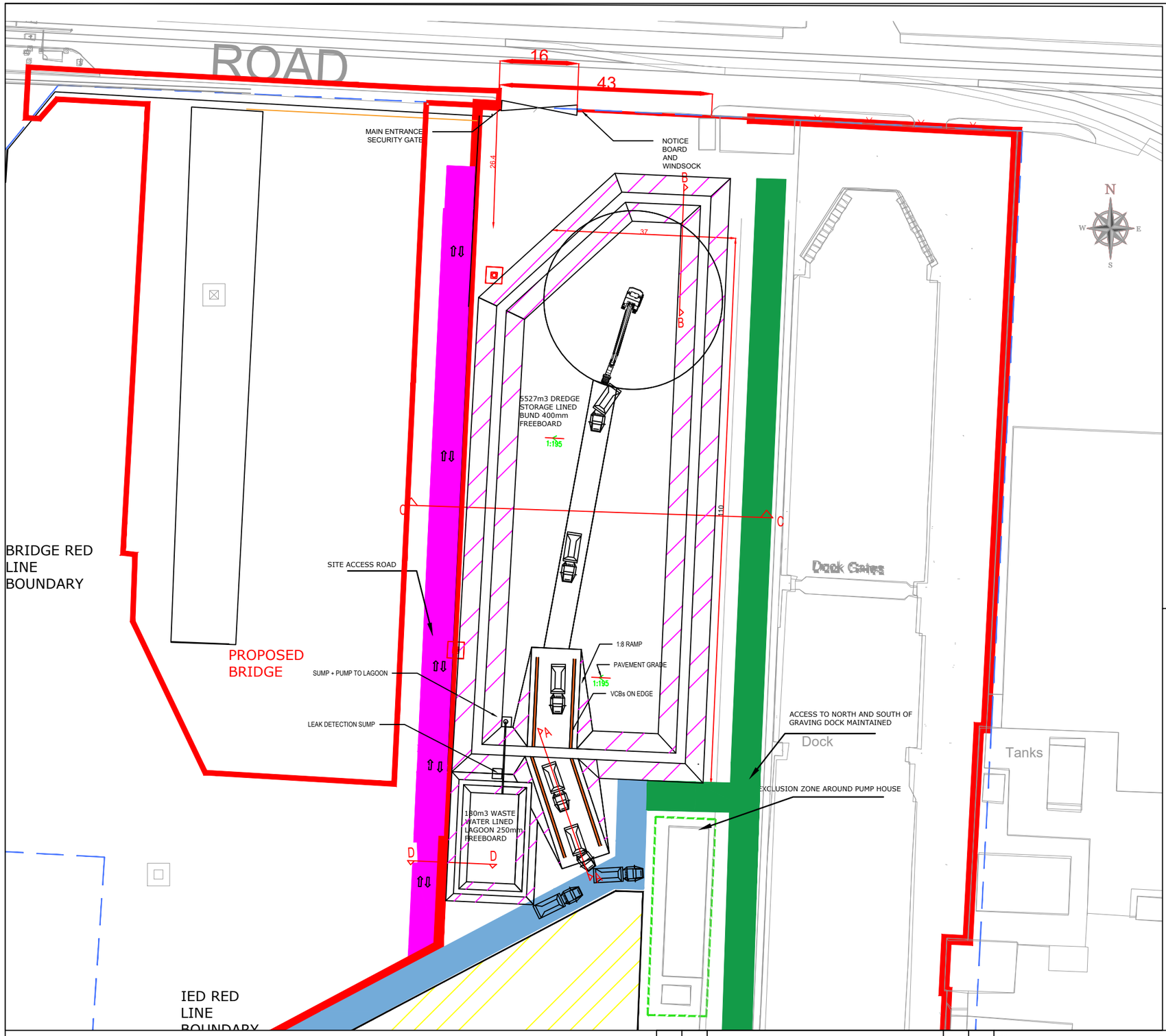
DEFECT 6



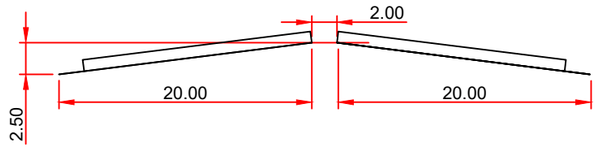
DEFECT 7



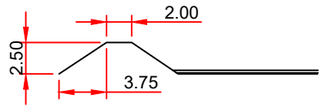
DEFECT 8



SECTION A-A

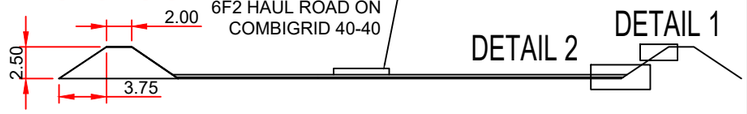


SECTION B-B

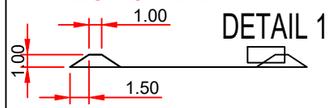


SECTION C-C

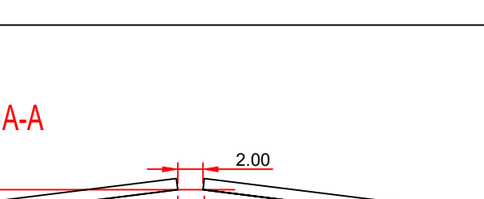
5m WIDE, 400MM HIGH 6F2 HAUL ROAD ON COMBIGRID 40-40



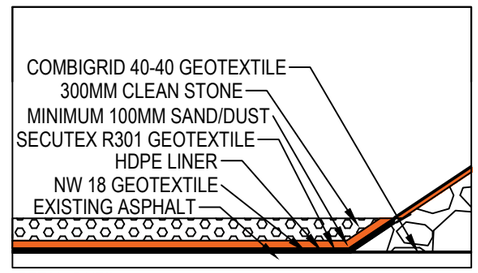
SECTION D-D



NTS



DETAIL 1 NTS



DETAIL 2 NTS

ENGINEERS IRELAND cpd ACCREDITED EMPLOYER
QUALITY ISO 9001:2015 NSAI Certified
ENVIRONMENT ISO 14001:2015 NSAI Certified

COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Rev:	Date:	Description:	Drw:	Chk:
10	07/02/20	LEAK DETECTION SUMP ADDED	MB	EC
9	04/07/19	Bund outline revised	CW	EC
8	03/07/19	HML Protection, bund outline revised	CW	EC
7	27/06/19	Ramp, haul road and shape revised	CW	EC
6	19/06/19	Revised for HML Protection	CW	EC

Client: DPC

Project: 648 IED

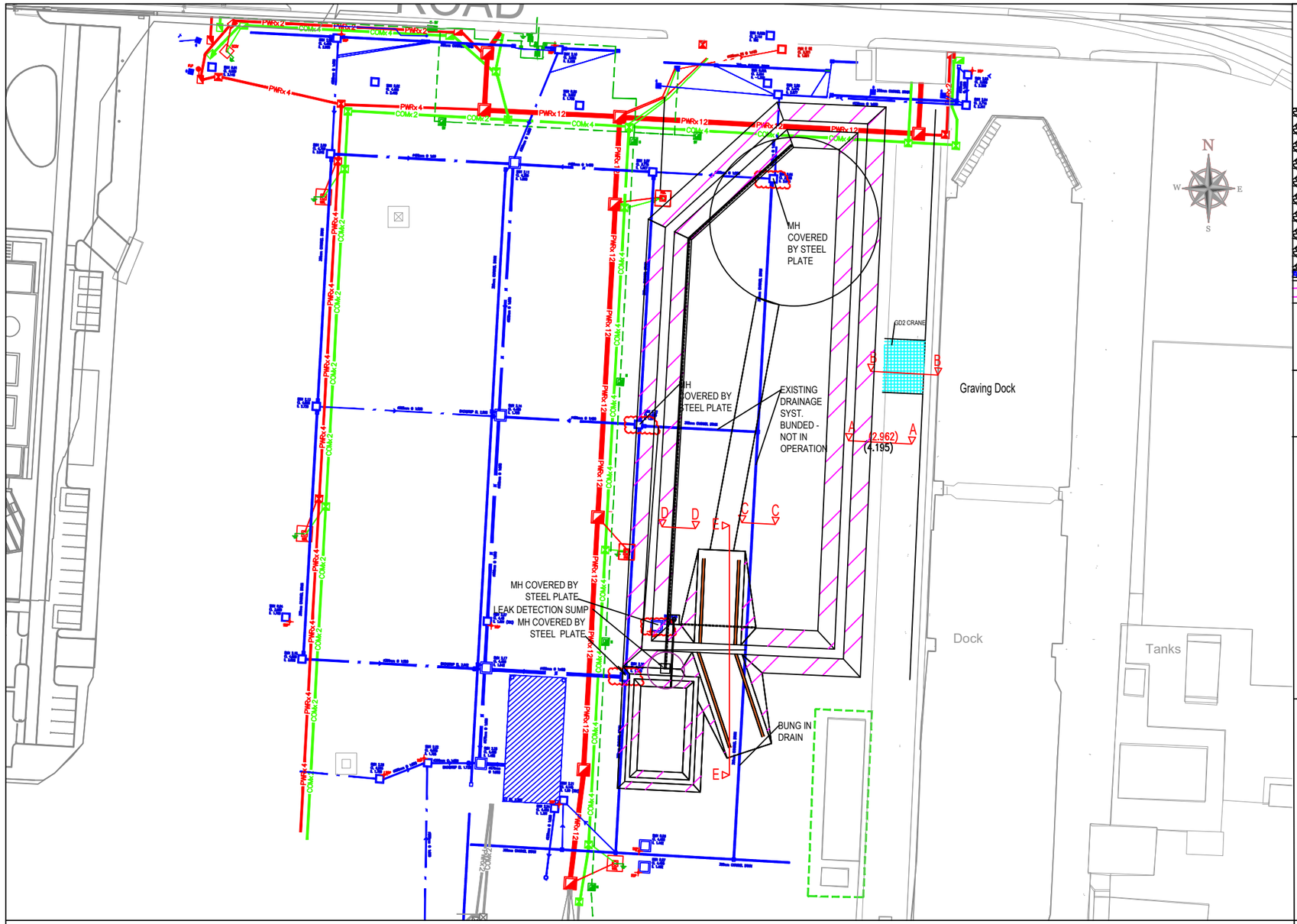
Drawing title: T4 MITIGATION BUND 2.5M

Roadbridge - Keating JV
Roadbridge
KEATING Marine-Civil Engineering-Building

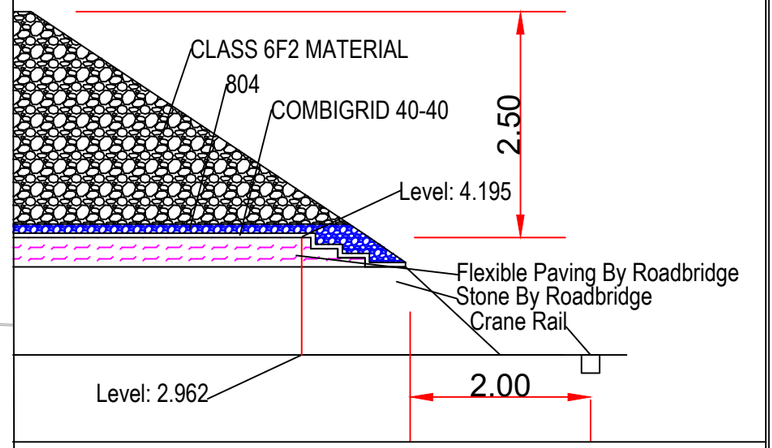
Drw by:	CW	Scale (s):	1:1000
Eng app:	CW	Date:	04/07/19
App by:	EC	Status:	CONSTRUCTION

Drawing No: 648-SK036

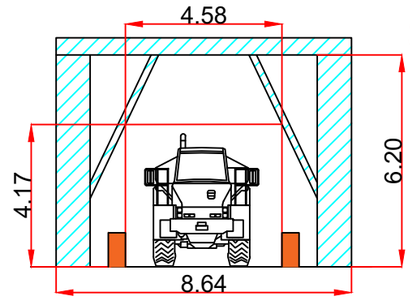
Rev: 10



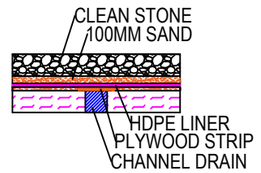
SECTION A-A



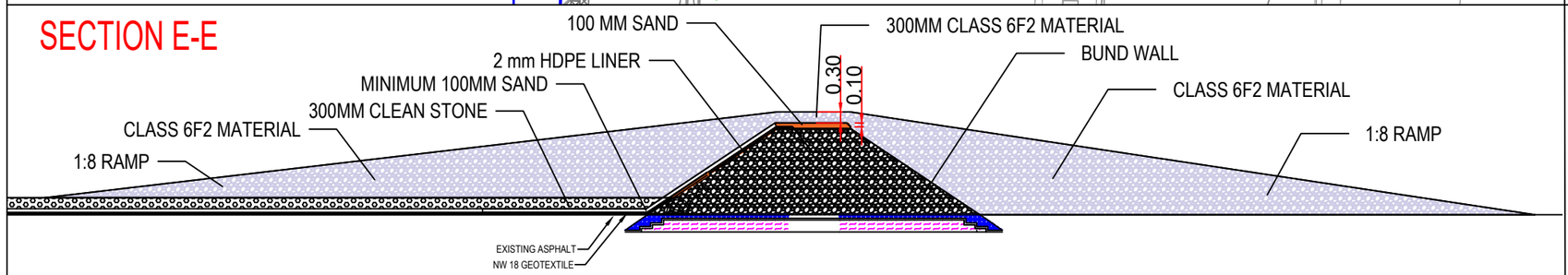
SECTION B-B



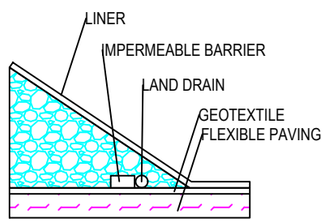
SECTION C-C



SECTION E-E



SECTION D-D



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ENVIRONMENT ISO 14001:2015 NSAI Certified

COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Rev:	Date:	Description:	Drw:	Chk:
7	07/02/19	RAMP DETAIL ADDED	MB	EC
6	04/07/19	BOUNDARY REVISED + LAND DRAIN ADDED	CW	EC
5	03/07/19	BOUNDARY REVISED, HML PROTECTION REMOVED	CW	EC
4	27/06/19	Ramp, Haul road + bund shape revised	CW	EC
3	19/06/19	HML Protection Revised	CW	EC

Client: DPC

Project: 648 IED

Drawing title: T4 Bund incl Services Drawing

Roadbridge - Keating JV
Roadbridge KEATING Marine-Civil Engineering-Building

Drw by:	CW	Scale (s):	1:1000	Drawing No:	Rev:
Eng app:	CW	Date:	07/02/20	648-SK051	7
App by:	EC	Status:	CONSTRUCTION		