Appendix 4.2

DOCK INFILL METHODOLOGY FOR PLANNING

BUROHAPPOLD ENGINEERING

Project	The People's Project
Subject	Dock Infill Methodology for Planning Documentation
Project no	0040026
Date	21 August 2020

This ES technical appendix relating to the Dock Infill Methodology has been reviewed against the following aspects and for each it has been confirmed that there are no amendments required to the content of the appendix:

- Baseline data validity: there have been no relevant changes to the baseline data, and it remains valid;
- Legislation/policy revisions: there have been no related updates to legislation/policy that have affected either the methodology or findings of this assessment;

However, due to the proposed development design changes, specifically omission of the geotechnical membrane during the dock infill, the information presented in this report varies from that submitted as part of the original application submission principally in Section 2.5.

A planning application (LPA ref. 20F/0001) for the proposed scheme was submitted to Liverpool City Council (LCC) in December 2019 and has been subject to statutory consultation. There were limited statutory consultee comments received in relation to the information presented in this appendix that required a response.

1 Introduction

The applicant's Design Team have undertaken research to establish a dock filling strategy that removes the need to dredge the deposits that were encountered at the bottom of the dock basin during the Phase 1 and Phase 2 site specific ground investigation.

In addition to programme savings, by not dredging, the dock deposits will not require off-site disposal (excluding pile spoil) which is evidently more sustainable. There are also subsequent reductions in the volume of imported material as Bramley-Moore Dock (BMD) is effectively partially filled.

2 Methodology

The proposed development at BMD requires the dock to be infilled for the purposes of:

- Providing a construction working platform (above existing dock wall level of approximately +6.6mOD);
- Infilling the western water channel from the dock basin level (approximately -4.5mOD) to the top of the western water channel bed (+2.9mOD);
- Providing external zones including the western plaza and eastern fan zone.

The following sections outline the proposed methodology to be adopted for the dock infilling procedure. Detailed construction method statements and necessary permits will be prepared and obtained by the specialist marine contractor and submitted to the relevant authorities for approval when required.

2.1 Early Operations

Following recommendation and advice from the appropriate relevant authorities (including, but not limited to, the Environment Agency (EA)) marine life will be removed, in line with the Fish Rescue Plan that will be produced and agreed with the EA prior to any works taking place.

To ensure the marine life does not re-enter through the northern entrance to BMD in advance of the infilling procedure, a bubble curtain will temporarily be installed. The northern isolation structure will be the method of ensuring marine life does not re-enter the dock during the infilling procedure.

2.2 Raking of the Dock Deposits

It is necessary to rake the dock deposits in advance of the dock infilling (but after the first fish removal has been undertaken). The raking procedure will aim to recover metallic objects or obstructions that would otherwise disrupt the piling operations.

The rake will be dragged from the back of a purpose built boat and will systematically track across the dock, moving objects towards the western wharf of BMD.

The recovered objects will be lifted ashore, documented and appropriately disposed of depending on what is encountered. If debris is encountered that cannot be moved by the raking procedure, these will be marked for removal with other equipment.

Enough time should be allowed between the raking and infilling phase. This period is currently assumed to be 2 months to allow the dock deposits to settle out following disturbance from the raking procedure. This period of time is necessary to ensure the infill material that is placed on top of the dock deposits will not mix up with any loose deposits still settling through the water, resulting in a change in geotechnical properties.

2.3 Undertaking a UXO Risk Mitigation Survey

A desk top site specific Explosive Ordnance Threat Assessment has been undertaken for the dry and wet areas of Bramley-Moore Dock. The results of this Threat Assessment concluded the requirement of a UXO Risk Mitigation Survey to reduce the risk of unexploded ordnance to the substructure works of the proposed development.

Examples of a Risk Mitigation Survey techniques include:

- Non-intrusive magnetometer;
- Side scan sonar survey;
- Sub bottom imaging survey.

Following the Risk Mitigation Survey, the results will be interpreted to identify anomalies in the data which could be the presence of potential unexploded ordnance.

Any anomalies will be visually inspected, and if required, will be disposed of by the relevant authorities. Following any necessary disposal, or confirmation that no anomalies were encountered, an Unexploded Ordnance ALARP Certificate will be issued.

Owing to the anticipated large amount of ferrous objects at the bottom of the dock which could be incorrectly identified as unexploded ordnance, the Risk Mitigation Survey should be undertaken post dock raking to reduce the number of potential anomalies.

2.4 BMD Wall Remedial Works

Remedial works to the BMD walls above and below the current dock water level are required to preserve the condition of the dock walls. The remedial works (to be subject to separate Listed Building Consent 'LBC' submission) will reflect the proposed future use of the dock wall.

In some areas, the BMD walls will continue to perform as a functional wall, retaining the earth behind (such as the western side of the western water channel). In other locations, the BMD walls will be completely buried (such as under the proposed structure) and will no longer act as a retaining wall as it will be fully confined by the earth behind and the new dock infill in front.

2.5 Membrane

A geotechnical membrane was previously proposed for the following purposes:

- Confining the dock deposits and subsequently control the infilling process leading to more confidence and certainty in the calculated settlement magnitude and rate;
- Prevention of mixing of the dock deposits and infilled sand and thus limiting the uncertainty concerning the long term mixing with loss of sand particles into the soft silt;
- Reducing the risk of uncontrolled mud wave generation by limiting lateral displacement of the dock deposits.

The above points were considered, and the following key mitigation measure proposed to confirm the acceptance of the membrane omission whilst still achieving the above requirements:

- Careful placement and specific construction methodology of the imported dock fill by the dock infill contractor to reduce the risk of mud waves and mixing of deposits. This will form part of the Performance Specification for the dock infill contractor to adhere to.

2.6 Dock Isolation Structure (South) Remedial Works

The existing southern isolation structure is constructed out of two sheet piles with two horizontal ties at -1.5mOD and +2.5mOD. Eight pipes with a crown at +4.05mOD and bottom level at +3.45mOD provide the method of connection with the two docks, controlled by sluice gates.

If required, remedial works will be undertaken to strengthen the southern isolation structure to ensure that it is structurally stable during and after the infilling procedure.

2.7 Dock Isolation Structure (North) Construction

A dock isolation structure is required in the north of BMD to retain the dock fill. In the temporary situation (during infill), this is proposed to be constructed from 6F2 material and or aggregate located within the existing channel between BMD and Sandon Half-Tide Dock to the north in order to form a temporary bund.

To reduce noise impact, the permanent northern isolation structure is proposed to be a secant piled wall, bored into the underlying Sandstone once the dock is infilled, thus dry construction methods can be adopted. The permanent dock isolation structure will provide a retaining wall for the western water channel fill and to support the road for the northern circulation route around the site.

Similar to the existing southern isolation structure, horizontal ties will be required. Pipes will be cast in between the two rows of piles at identical levels to the existing southern isolation structure to enable the exchange of dock water to the north and south.

During construction, whilst the dock is infilled and the isolation structure in place, there is no quantifiable way of determining the impact of any hydrological disconnection with the southern dock. It is likely that salinity and dissolved oxygen levels may fluctuate over time. Baseline monitoring will therefore be undertaken of the southern water body prior to construction to indicate the natural variation in salinity and dissolved oxygen. Monitoring would then continue through the construction period. If the salinity and / or dissolved oxygen of the southern water body falls below a historic minimum, then over pumping from north to south may be undertaken to address the reductions.

In the permanent case, the water channel bed will be designed to 0.5m below the bottom of the pipes (+2.9mOD) to ensure any silt build up does not restrict the flow of dock water through the pipes at the north and south.

2.8 Displacement Monitoring of the Dock Walls

The BMD walls are Grade II listed, and due to their historical importance, preservation and protection is imperative for the proposed development.

The dock infilling procedure will confine the dock walls in the permanent state and increase its current stability. However, the infilling process of the dock (hydraulically placed sand and subsequent compaction), may result in unacceptable wall movement.

As such, installation of displacement monitoring equipment to the dock walls is proposed. A baseline survey (for the purpose of asset protection) will be undertaken a minimum of 2 days in advance of the dock infilling works and will end the same day compaction is complete.

2.9 Dock Infill

Before infilling the dock, a further attempt to remove marine life will be undertaken.

The proposed material to infill the dock is anticipated to be dredged approximately 25 nautical miles BMD and transferred using a trailer dredger. The location is shown in Figure 1. The infill material will have the following geotechnical properties which will be outlined in the engineering specification for the infilling works. It is anticipated that approximately 400,000m^3 of material will be dredged.

Grading:	Cobbles	0%
	Gravel maximum	10%
	Sand minimum	90%
	Silt & Clay maximum	1%
Uniformity coefficient:	Cu	> 1.7
Relative density:	Dry compacted fill	60%
	Saturated compacted fill	75%
	Saturated loose fill	50%
Angularity:	Rounded to sub rounded	

Once loaded, the trailer dredger will moor in an agreed point in the River Mersey. The trailer dredger has an overall capacity of 4,500m^3 with approximate dimensions of 100m x 19m x 8m. The mooring location will be approximately 300 - 400m from BMD in sufficient water depth that allows the operation of discharging sand not to be affected by the tide. The location will therefore be close to the Mersey navigation channel and will be agreed with Peel Ports.

Once moored, the trailer dredger will connect to a temporary discharge pipeline network that is floating on the surface of the shore. The dredged material will be fluidised in a hopper and hydraulically pumped via the pipeline over the River Mersey wall to a spreader pontoon within BMD, and hydraulically placed into the dock.

The layers will be placed systematically to avoid 'mud waves' of the dock deposits using winches to move the spreader pontoon in the appropriate direction to achieve this.

As the dredged material is fluidised, the impact with regards to pressure on the Existing Lock Gates will be negligible during the infilling procedure. The infilling method adopted by the Contractor will also ensure that there is no direct pumping onto the Existing Lock Gates.

As the dock is progressively filled, the existing dock water and the water used for the infilling process will require displacing. The methodology of displacing the water will be natural displacement into the dock network which will be outlined on the site specific discharge consent. It is anticipated that there will be approximately 56,000m^3 of discharged water every day based on four separate pumping cycles.

The following considerations have been made to prevent pollution to the SPAs during the infilling works:

- The vessels used will be sea certified;
- Method statements and plans will be in place by the appointed contractor to prevent a pollution incident from occurring;
- The pipeline will be secure to ensure there are no spillages during pumping;
- The dredged material will be fluidised with water from the River Mersey, rather than water from the dredge location;

- The dock infilling construction methodology if laying sand in thin targeted layers effectively caps the dock deposits so that there is no mixing between the material and the water;

- At the displacement location (adjacent to the isolation structure), a stilling pond will be created to slow down the water flow, which will in turn allow any fines to settle out before the water is displaced. This will be created by shaping the infilled sand once it is filled to the existing dock water level.

Once reclamation is above the existing dock water level, the remainder of the material will be placed by land plant, with the final finished level of +5.0mOD being achieved. This level has been adopted as it is the formation level of the underside of the 0.5m thick piling platform.

2.10 Post Filling Operations

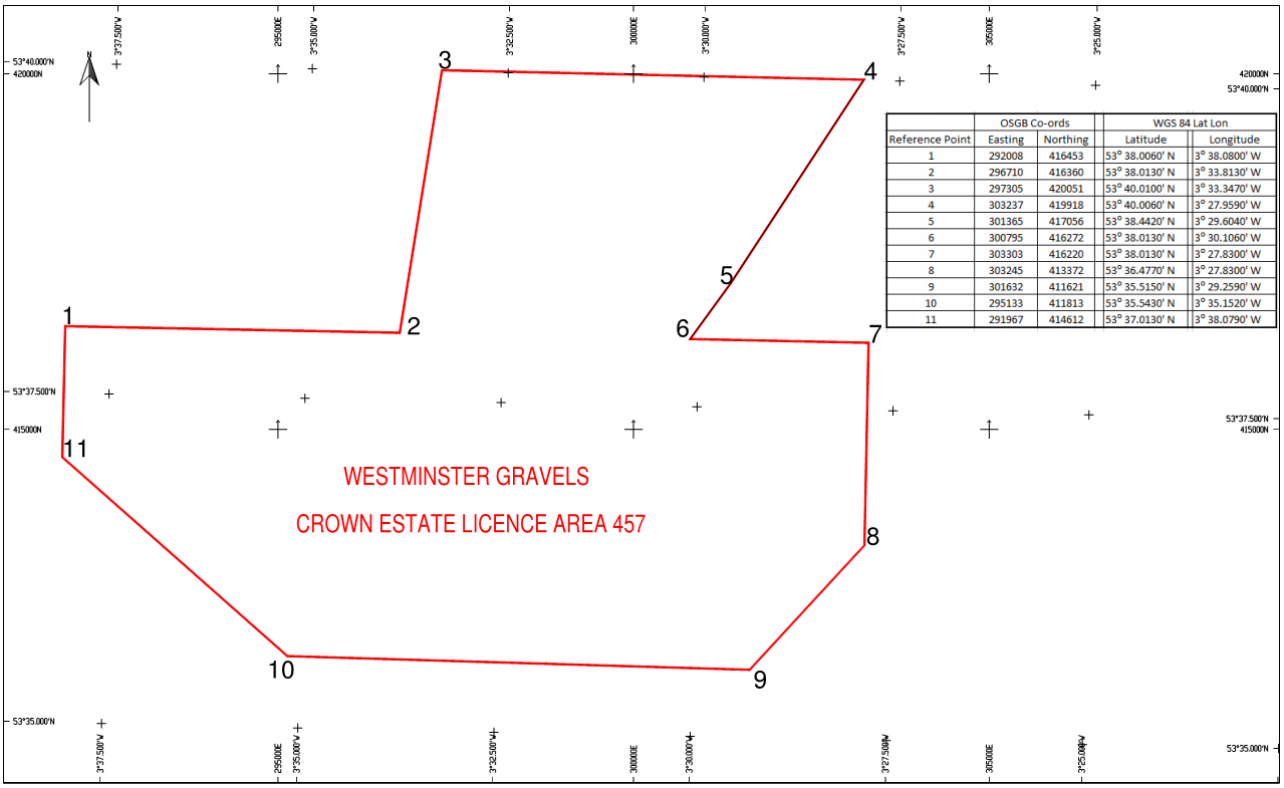
To ensure the settlement of the dock infill is controlled and measurable, the following post fill operations will be undertaken:

- Rapid dynamic compaction of the dock infill followed by land roller compaction to the performance stated in the engineering specification. Rapid dynamic compaction is to be adopted as it is deemed the most suitable technique owing to the minimal lateral impact (which is an important consideration owing to the BMD Walls and Existing Dock Gates) and noise, when compared to standard dynamic compaction;

- Post compaction cone penetration tests undertaken to confirm the suitability and performance of the compaction for material placed under the piling platform.

3 Conclusion

The methodology above has been proposed following dialogue with a specialist marine contractor. Although every major step has been identified, there may be intermediate steps, changes in the order, or adjustments to the process if site specific requirements are needed following a detailed review by the appointed contractor.



Reference Point	OSGB Co-ords Easting	OSGB Co-ords Northing	WGS 84 Lat Lon Latitude	WGS 84 Lat Lon Longitude
1	292008	416453	53° 38.0060' N	3° 38.0800' W
2	296710	416360	53° 38.0130' N	3° 33.8130' W
3	297305	420051	53° 40.0100' N	3° 33.3470' W
4	303237	419918	53° 40.0060' N	3° 27.9590' W
5	301365	417056	53° 38.4420' N	3° 29.6040' W
6	300795	416272	53° 38.0130' N	3° 30.1060' W
7	303303	416220	53° 38.0130' N	3° 27.8300' W
8	303245	413372	53° 36.4770' N	3° 27.8300' W
9	301632	411621	53° 35.5150' N	3° 29.2590' W
10	295133	411813	53° 35.5430' N	3° 35.1520' W
11	291967	414612	53° 37.0130' N	3° 38.0790' W

Figure 1: Boskalis Westminster Sand Winning Area. Drawing No. F_Area457_19-10-04a_001. October 2019.