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Our Reference: BFK/log/DS/001

Dear Sir,

10 May 2011

For the attention of Mr Graham King

Transportation of Tunnel Ring Segments Contract No. C300/410 – Western Running Tunnels & Station Tunnels

Please find the attached report which explains the reasons for selecting road as the means for transporting tunnel ring segments from Old Oak Common to Westbourne Park.

We trust that this satisfies your requirements but if you require any further information please do not hesitate to contact the undersigned.

Yours Faithfully,
For and on behalf of
BAM Ferrovial Kier JV

David Court
Project Director

Encl.

Transportation of Tunnel Ring Segments

Transportation of Tunnel Ring Segments

Introduction

BFK's tender submission was based on the intention of moving the tunnel segments from Old Oak Common (OOC) to Westbourne Park (WBP) by rail. Since being appointed by Crossrail, BFK have identified technical difficulties regarding rail transport and have carried out more detailed studies and, together with a Brett report commissioned by Crossrail, have come up with a more feasible way of moving the segments which is described in this report.

Old Oak Common

The OOC site is situated on part of the footprint of disused Network Rail sidings in Hammersmith & Fulham and is where the segment manufacturing plant will be situated. Each month 761 complete tunnel rings will be manufactured and each ring contains 8 segments. These need to be moved to WBP in Westminster and so BFK have looked into three different modes of transport:

Transport by Canal Barge

The segment manufacturing plant will be located adjacent to the Grand Union Canal and this waterway also runs adjacent to our site at WBP where the segments are to be delivered. It therefore made sense to carry out a feasibility study to move the segments by barge.
It was found that in both locations the canal is considerably higher than the sites and so complex sloping gantry cranes will be needed to lift the segments into barges from the stockpiles. The segments will have to be lifted over the towpath which will cause disruption to pedestrians and the presence of 400kv cables in the towpath is an additional risk.
The gantries will be substantial structures at both sites and little can be done to mitigate any noise from their operation due to the proximity of the water. The double handling of the segments that this method entails will take extra time and adds to the risk of damaging the segments.

A scheduling exercise was carried out to see how many rings could be delivered in a day. Each barge would take two hours to complete the 1.1 mile journey and with allowing one hour to load or offload gives a round trip of 6 hours. A tug can only take two barges safely on the canal and with every trip taking 6 hours each barge could manage two round trips in a day. Assuming that one set of barges will be loading while another set is travelling and a third set is unloading, we can run six barges a day.

Each barge is 3.7m wide and can carry 16 segments, or two rings, and with six barges completing two trips means that 24 rings can be delivered to WBP each day. However, the Tunnel Boring Machine (TBM) will require an average of 34 rings a day which the barges alone cannot deliver.
Working 24 hours a day was considered but it would require additional crews for the barges and gantry cranes, and it would not allow time for maintenance of the tugs and other infrastructure. The noise and the wash moving the houseboats would be unacceptable at night.

The depth of the canal is currently only 1.2m which is not deep enough for the use of barges and would need to be dredged to 1.65m for over a mile. This has environmental knock-on effects in that it would create a lot of silt in the water that will affect the fish and most of the wild life.

Transport by Rail

A full railhead would need to be set up at OOC to allow for the delivery of tunnel rings to WBP. This would have to be operated by Rail Freight Logistics contractors with a dedicated staff. The sidings within the available footprint of OOC, after setting up the segment manufacturing plant, will not be capable of taking a full length train. More sidings would have to be constructed at OOC to accommodate a split train and this would increase the turn-round time required. Extra and more flexible plant would be required to service this option. A train consisting of 8 wagons could carry 16 rings and it would be 172m long plus the length of the engine. This means that at least two trains would be needed per day to sustain the tunneling operation.

At WBP we need two sidings to remove the huge quantities of tunnel spoil by rail to Kent and this takes priority over any other rail traffic. BFK looked into the construction of a third siding which could be used to deliver tunnel rings but it was found that a Network Rail signal gantry was in the way and this could not be removed in time for the start of tunneling. There is a sixth line at WBP that appears to be available but this is a back-up line for all the other lines and cannot be used under any circumstances.

Delivery by rail would also pose the problem of available train paths. There is no guarantee that the necessary paths would be available to deliver the rings which adds further risks to the tunneling programme.

Transport by Road

The two modes of transport investigated so far have thrown up serious problems that would be extremely difficult to overcome and so although movement by road is not BFK's first choice it is the only available option.
The concrete segments that make up the rings are precast within very high tolerance and so it is important that they are handled as few times as possible to prevent damage.

The mode of transport should also be as gentle as possible and this is where a road trailer has an advantage over a railway wagon.

The delivery programme of tunnel rings to WBP has to be carefully controlled and may need to be varied at short notice due to perhaps delays in manufacturing or tunnel boring. This requires a flexible mode of transport that can be increased or decreased at will. Road transport provides this as well as reliability as there are fewer risks than with a large train that may be affected by strikes, availability of train paths or breakdowns.

Loading segments onto vehicle trailers is quick and does not require double handling thus reducing potential damage. Each vehicle will be able to carry eight segments i.e. one complete ring and so approximately 34 lorries will be required each day to feed the TBM with segments.
To reduce impact on the local community, BFK also propose transporting segments out of peak and school hours where children are being picked up or dropped off.

Carbon Footprint Comparison

		Transport Method		
		Water	**Rail**	**Road**
No Rings (8 Segments per Ring)	9132			
No Rings per round Trip		4	44	1
Conversion Factor (kgCO2/ltr)		2.76	2.77	2.64
Round Trip Time Hrs (running time)		3	8	1
Idling time		1	1.5	0
Round Trip Miles		5.2	3	6.4
Litres per Mile		3.17	7.06	0.54
Fuel per Hr (Ltrs)		5.49	2.65	3.42
$KgCO^2$ per Round Trip		**50.99**	**62.64**	**9.04**
$KgCO^2$ per Complete Contract		**116,411**	**13,001**	**82,547**

NOTE: Idling time for water and rail is assumed to consume the same volume of fuel as running time during normal operations.

Summary

Tunneling is a continuous process which has to be maintained to minimize settlement risks and although rail transportation is to be used for the removal of large quantities of excavated material to Kent, it does not provide the flexibility to deliver just the right number of rings to WBP in line with the progress of the TBM. Clearly it would be very inefficient to deliver only partially loaded trains.

In the event of a rail strike, mechanical problems or lack of train paths, the spoil trains would be stuck at WBP taking up all the available sidings, and so, even if we were to use a private line, there would be no room to accommodate the segment trains. There are too many outside variables not under BFK's control using the rail option and we need the confidence that tunnel segments can be delivered under any circumstances.

One of the biggest obstacles to using rail transport is the signal gantry (No 5) which cannot be removed in time to construct additional sidings for a segment train.

Whilst the canal appears to be capable of carrying some of the tunnel rings, the impact and disruption to the local environment, both ecologically and strategically is prohibitive. This is due to the necessary infrastructure, dredging operations and overall speed limitations which effectively rules out this option. This is borne out by the contents of the Crossrail Grand Union Canal Feasibility Study by Brett Consulting.

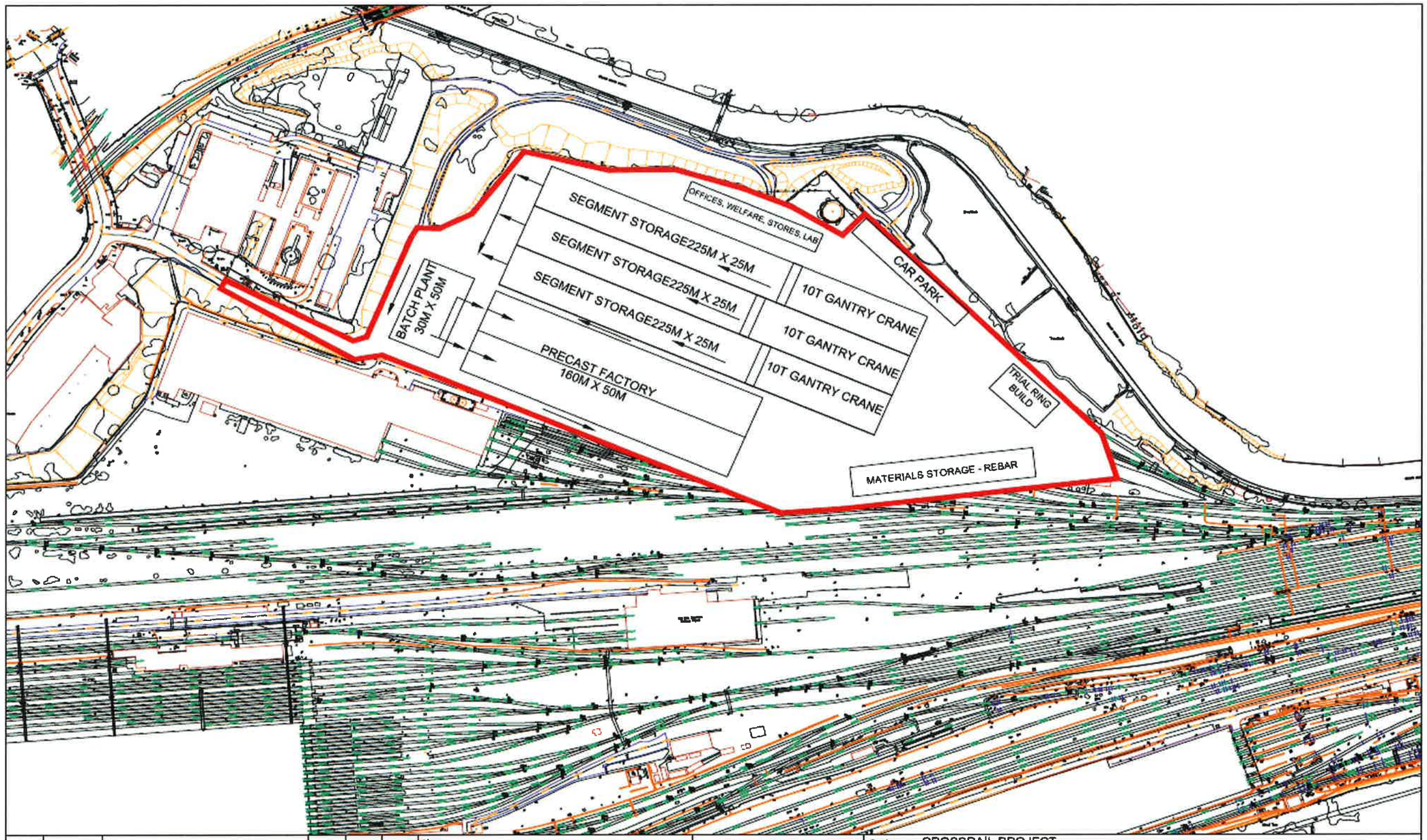
Strategically, the impact of lorries on the local network was reviewed when determining alternate solutions to rail haulage. This review has lead to the development of lorry routes that reduce journey times and utilize roads as directed by Crossrail

Analysis has shown lorries to be more sustainable than using the canal but only because the barges cannot move the required quantities. Rail transport would be the most sustainable option but this is not feasible without a third siding at WBP. Each lorry load would be guaranteed to be full and deliveries could still be made to replenish the segment stockpile in line with the rate of tunneling. Road movement allows complete flexibility for both the delivery rate and alternating routes if required. It minimizes the risks and so for these reasons we would recommend that taking the tunnel rings by road is the best option in the circumstances.

Appendices

A. OOC Detailed Layout

B. WBP Detailed Layout



Rev.	Date	Description	By	Chkd	App

Notes:

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Contract :	CROSSRAIL PROJECT
Originator :	BFK
Location :	OLD OAK COMMON
Title :	PROPOSED SITE LAYOUT
By :	MF
Chk :	RM
App :	BW
Scale :	1:1000@ A3
Drawing No :	OOC-SK001
Rev :	1.0
Suitability :	

WESTBOURNE PARK TEMPORARY SIDINGS - OPTION 3
TWO ROADS - CONVEYOR FEED FROM SPOIL SIDINGS 1 NORTH OF GANTRY No 5

LOCATION PLAN

CROSS SECTION AT SIDING GANTRY No 5

WESTBOURNE PARK - CONTRACT 300