Crossrail Water Freight

Grand Union Canal Feasibility Study

Phase 1 Report: Draft

Project Ref: 23086/001

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1 Introduction

Crossrail has commissioned Brett Consulting to carry out a study to assess the use of canal transportation to support the construction of railway tunnels accessing London from the west; in particular, the supply of materials from a proposed manufacturing location at Northfields to the Westbourne Park tunnelling worksite.

The work programme to complete the study will need to align with the date for the issue of ITTs for tunnelling contract C300. The timeframe for the study is from the end of September to the end of November.

1.1 Scope of work

The scope of the feasibility work addresses a range of key issues in order to provide an understanding as to whether the use of the Grand Union Canal offers a viable supply chain solution to support the tunnelling work. These are:

- Identify the requirements for gaining access and controlling the section of the Grand Union Canal, between Northfields and Westbourne Park
- Identify existing operators, private users and respective infrastructure owners
- Assess the availability of existing commercial fleets of self-propelled barges, dumb barges, tugboats and other support vessels such as dredgers
- Provide a recommendation for new fleet items to be procured along with a schedule for manufacture
- Assess the condition of the existing wharf and berthing facility at Northfields, and the level of upgrade required
- Report on the proposed location for off loading at Westbourne Park and recommend the facility required to be established for servicing the tunnelling operation; with a key emphasis on protecting the public using the canal towpath
- Identify the key risks to the operation
- Provide a budget cost for the necessary licenses to operate the fleet, other equipment and carry out construction. Including identification of any grants or funding which may be available
- Identify the necessary planning consents required and a programme for the same
- Summarise the potential for other opportunities via the Grand Union and Regents canal; particularly to access opportunities in the West London area for removal of excavated material

This stage 1 report address operational, commercial and design issues. The stage 2 report will address wider opportunities and remaining aspects not fully covered in this report.

1.2 This report

The remainder of this draft report is structural as follows:

- Chapter 2: Crossrail sites and loads to be transported
- Chapter 3: Navigation review
- Chapter4: Barge transport
- Chapter 5: Delivery of materials
- Chapter 6: Crossrail wharf and load handling requirements
- Chapter 7: Excavation material from Westbourne Park
- Chapter 8: Operational Costs
- Chapter 9: Planning considerations

2 Crossrail sites and loads to be transported

Crossrail have indicated three locations which need to be considered in order to provide a canal solution for the western tunnel portal. These are:

- Westbourne Park – the most suitable location to access the construction site
- Northfields Industrial Estate – the preferred location for a tunnel segment factory
- Old Oak Common – an alternative location for the tunnel segment factory.

This section provides a basic description of each location.

2.1 Westbourne Park, London, W11

2.1.1 Location, description and current use

The location being proposed for a wharf on the Paddington Arm of the Grand Union Canal is approximate 1.6 miles west of Paddington Waterside (Basin), 4.5 miles via the canal from Northfields Industrial Estate and lies at the apex of a bend where the A40 West Way projects over the canal. The wharf would be located on the towpath side (i.e. south bank) of the canal in order to access the Crossrail construction site, which is adjacent to the canal on the towpath side at this point.

The length available for a potential wharf is approximately 200m. Along the available length, the bank consists of steel piling with concrete capping. The towpath surface is made up of concrete segments that sit on top of a duct for HV cables, and an earth strip behind this.

The distance between the canal surface and the back of the towpath is 6.5m (3.45m concrete slab, 3.05m earth), while the vertical height difference from the path surface to the underside of the A40 flyover is approximately 4.5m. At the apex of the bend on the canal the A 40 flyover is over the back of the towpath, elsewhere the land has fallen away and the clearance between the surface and the underside of the A40 is greater as the structure is not over the towpath itself. The height difference between the towpath and the A40 remains constant.

It is currently not practical to moor at this location due to the hard bank and there being no rings fitted. The canal is wide enough (i.e. over 15m) for other vessels to pass if barges were moored at this location. Mooring rings or bollards for commercial traffic would be required.

It is estimated that the depth of water by the wharf wall is no more than 30cm. However this increases rapidly as distance from the canal bank increases.

2.1.2 Access from the Grand Union Canal to the site

The Crossrail site is adjacent to the towpath at this location, but at a much lower level. Any cargo would have to be handled over the towpath. This will necessitate gaining permission from BW and from the owners of services buried in the towpath. Vehicles are able to get within approximately 10m of the wharf (if sited on the apex of the bend in the canal), but they would be at a level of about 9m below the towpath.

Easier access to the canal bank is possible at approximately 75m east of the bend apex, where an incline is indicated on Crossrail drawings as a 1:20 gradient on a ramp.

2.2 Northfields Industrial Estate, Wembley, HA0

2.2.1 Location, description and current use

The site being proposed for the wharf lies in an area bounded by the A406 North Circular Road and Beresford Avenue. Parts of the industrial estate have been cleared in preparation of setting up the Crossrail tunnel segment manufacturing plant.

This site is on the non-towpath side of the canal, and the presence of mooring rings in places suggests it may have been used as a wharf in the past. Being on the non-towpath side adjacent to a private site there is no mooring on this side of the canal at this location. Only casual mooring could occur on the towpath side, and there is no evidence that this happens on a regular basis. In any event the canal is wide enough (17m) for boats to moor on both sides without creating an obstruction.

The length available for a potential wharf is approximately 200m. The campshot (canal bank) is steel piling with concrete capping. The wharf wall is straight and offers mooring for at least 6 barges. Approximately 100m further west, there is a retaining wall at the water's edge with mooring rings that could provide additional moorings for waiting barges.

It is estimated that the depth of water by the wharf wall is no more than 30cm, increasing rapidly away from the bank.

2.2.2 Access to the Grand Union Canal

The site is immediately adjacent to the canal and suitable internal configuration would enable loading into barges to be very straightforward, as vehicles and other materials handling equipment would be able to gain complete access to the canal edge for the entire length of the wharf.

2.3 Old Oak Common

2.3.1 Location, description and current use

Old Oak Common is currently used as a rail depot for a variety of train operators. While the depot is adjacent to the canal, it is much lower, with the canal retained by a high wall. It is not clear whether the Crossrail construction site is alongside the canal. The location is some 3.5 miles (5.6km) from Westbourne Park.

Old Oak Common depot is on the towpath side of the canal. Permission would be needed from BW to load over the towpath, and also from any service providers who have cables or pipes in the towpath. The depth of water against the towpath is not known here but is expected to be around 30cm as elsewhere, deepening rapidly towards the centre of the canal.

Nearby is Powerday's *Old Oak Wharf*, on the non-towpath side, capable of handling 90 tonne Olympic Class barges.

2.3.2 Access to the Grand Union Canal

Access to the canal from Old Oak Common is over the towpath. No site visit or assessment has been made as part of this study.

2.4 Crossrail loads

If the canal were to be used by Crossrail a range of construction materials could be considered for transport. However, the primary opportunity is likely to be for tunnel lining components that will be manufactured at either Northfields or Old Oak Common.

2.4.1 Tunnel lining description

The tunnel linings are the concrete segments put in place as the boring machines excavates the route of Crossrail between Westbourne Park and Stratford and Custom House. A complete ring comprises seven lining segments and a keystone. The size of each segment is:

Width 1.5m x length 2.85m x arc depth 0.8m; weight 3.1 tonnes (t)

2.4.2 Other construction materials

It is our understanding that it is the aim of Crossrail to move other materials from the Northfields site. No details have been provided to us about the nature and quantities of these materials, or when they will required. This will be considered during a later phase of this study.

2.4.3 Excavation arisings

Spoil from the tunnelling will be temporarily stored at Westbourne Park, with the bulk being transported from the site by rail. It is planned that this operation will comprise three trainloads of 1600t per day to remove the 4800t that is excavated by the tunnel boring machines. However, as a backup to this operation Crossrail may use canal transport as a partial contingency along with road. The quantities are unknown, but it is assumed to be up to 1600t should a trainload service fail to arrive or is late for loading.

3 Navigation review

3.1 Waterway infrastructure

There is no physical restriction on the maximum length of boat that may navigate the canal between Northfields and Westbourne Park, since it is lock free. This means there is no reason why the maximum practical length of vessel could not be about 30 metres without encountering difficulties at bends and bridges. Importantly, such a vessel is significantly longer than the maximum length of 72 feet (21 metres) that BW state is able to use the Paddington Arm.

However, if a 30m vessel were to be used it would have to be capable of travelling in both directions without being turned round (i.e. bows at both ends of the barge) as the winding holes (i.e. turning points) are only designed to accommodate 21-metre long boats. Since a 30m vessel would only be capable of operating on the lock free section of the Grand Union Canal there is limited opportunity to utilise this size vessel for other cargoes, as it would not be able to pass through locks onto other sections of the canal.

Although BW state the maximum length of boat to be 21m in practice the two locks on the Harleyford Aggregates traffic are being used by boats 23.8m (78 feet) long and locks on the Regents Canal are actually 24.3m (80 feet long). Thus, boats up to 23.8m long could reach Denham on the Grand Union or the River Thames via the Regents Canal. However, they could not travel down the Grand Union Canal to Brentford via the Hanwell Locks, as this route will only accommodate barges up to 21m long. Barges could be self-propelled or push/pulled by tugs.

Assuming 21m vessels were used, in order to achieve quicker delivery and turn round rates it would be sensible if turning boats around could be avoided in any event, because at Westbourne Park it would be necessary to proceed to Little Venice to turn, and at Northfield it vessels would have to travel to at least Alperton. Little Venice is approximately 700m beyond Westbourne Park and Alperton nearly two kilometres beyond Northfield. Thus vessels would travel a total of 5.4 km extra just to turn round.

Given these factors and since a self-propelled barge has to turn around, it is more appropriate to use dumb barges with bow ends to carry the segments, and a tug to haul the barges, although using 21m self-propelled barges should not be ruled out for moving other or supplementary cargoes. A tug with two 21m barges would have a combined tow length of 52m including the tug. Using a push tug to push one barge and tow a second one would allow safe handling of this length of tow. However, the bulk of this arrangement through the water may make it more effective to push a single barge. A longer tow, while physically possible (say, three 21m barges) would be difficult to control.

The historical depth of water in the canal as stated in *Bradshaw's Canals and Navigable Rivers 1904* [(1)] is 4 feet, which converts to 1.2m. However the canal was constructed to a much greater depth, which means that a barge today should be able to draw up to 1.5m with suitable dredging. A depth survey of the stretch between Northfields and Paddington is advisable to ensure that this can be achieved for Crossrail operations.

BW have stated that the dredged depth of the Paddington branch is 1.65m below surface level. It should be noted that this depth is the depth the canal will be dredged to when routine dredging occurs, not the depth that is always available. For this traffic it would be beneficial to dredge the canal to 1.65m immediately prior to the traffic commencing. BW would need to be commissioned (and paid) to do this unless it coincided with their own dredging programme.

3.1.1 Embankment and bridges

Between Northfields and Westbourne Park numerous bridges cross the canal and immediately east of Northfields the Canal crosses the North Circular Road on a double-channelled aqueduct, which carries

[1] Bradshaw's Canals and Navigable Rivers of England and Wales, 1904, (Rodolph De Salis,1969 reprint, David and Charles)

the canal in two parallel channels approximately 15 feet (4.5 metres) wide. This is the narrowest structure on the route and while it accommodates a standard Grand Union beam of 14 feet (4.2 metres) it does not allow any significant increase over this for a local traffic**.** Although barges can be longer than the normal maximum permitted length for the Grand Union Canal, they cannot be any wider, which restricts opportunity to increase payload**.**

There are two other structures that restrict beam in this way. The railway bridge at Powerday (Old Oak Wharf) appears to have clearance of approximately 17 feet (5 metres) and one bridge at Ladbroke Grove has been narrowed to about this width to allow stop gates to be installed. This would have occurred during the Second World War and these could now be removed.

All other bridges span the canal at full width and therefore do not constrain barge size in any way

Between Westbourne Park and Paddington there are several bridges that narrow the canal to about 15 feet (4.5 metres). On the approach to Paddington are official residential moorings on the off-side and long term leisure moorings on the near side, many of which are in practice used as unofficial residential moorings. The Little Venice area (the junction of the Paddington Branch with the Regents Canal) can be very busy in summer with leisure boats and at least three commercial passenger boats active.

The maximum size of barge that could be used for this traffic would be 30m long by 4.5m beam and a loaded draught of 1.5 metres. A barge of these dimensions would have a maximum payload of around 105 tonnes. A barge this long would be constrained to working on the level of canal between Camden lock (beyond Little Venice) and Slough, which would reduce flexibility as the barge could not pass through the locks at Camden, Norwood or Uxbridge. The locks at Uxbridge would prevent a 30m long barge from reaching the Harleyford Aggregates Quarry on the Grand Union Canal.

A 21m barge could carry approximately 70 tonnes with a 4.5m beam and a 1.5 m draught, but would be able to pass through locks if required. They would also be useable on other traffics once this work has finished, and present less of a risk to the operator as a result. Thus barges longer then 21m should only be used if projected loads demonstrate that 21m barges have insufficient capacity.

3.1.2 Moorings

There are no official residential moorings on the length between Northfields and Westbourne Park. It is likely that some of the boats moored offside are in residential use but they will not have planning permission for this. On the towpath side, the only moorings are standard leisure moorings restricted to 14 days or less. Some of these are used as winter moorings. Again there should be no residential use of these moorings officially, although in practice there is some abuse of the 14 day restriction and a number of those boats moored on winter moorings will be unofficially used as residences.

It is worth noting that on a midweek day in October, seven boats were observed moving in a few hours. This suggests this section of the canal has the potential to get quite busy at peak periods, but the lack of locks means that capacity will not be an issue, since no waiting delays should occur.

Leisure navigation is permitted 24 hours a day, although night time traffic is limited. There is a need to address the impact of night time working for Crossrail if it is felt necessary to keep this option open. The impact is likely to be limited: barges are quiet compared to lorries and passage would be infrequent, but it will be necessary to demonstrate that the impact is acceptable to canal side residents. There are also safety issues to night time working, which are related to fatigue as well as darkness. In practice, it may be advisable to keep night time working as an option to overcome lost time but not to make general use of it.

It is not anticipated that the barges will moor anywhere other than at the two ends of the route.

3.1.3 Canal Channel

Away from structures the canal is generally around 15-18 metres wide and thus has plenty of room for two barges, or trains of barges that meet each other. Travel may need to be undertaken with a degree of caution if there are boats moored in the vicinity. At present, however, the proposals do not require barges to be moving in opposite directions at the same time. The primary issue will be passing leisure traffic. As there will be no leisure boats larger than the proposed barges, and the barges could pass each other if required, we do not believe this will be an issue.

It should also be noted that laden barges 4.5m in beam and loaded to 1.5m used this route until the early 1970's. On this basis we are of the opinion that there will not be any fundamental constraints to using boats of this cross section - again subject to adequate dredging.

3.2 Transit times

The transit times for a barge to shuttle between Northfields Industrial Estate and Westbourne Park and Paddington are shown in Table 1.

Table 1: Canal route distances and times between loading and unloading points

Canal route	Distance - miles	Transit time
Northfields / Westbourne Park	4.5	1 hr 25 mins
Northfields / Paddington	5.6	1 hr 40 mins
Old Oak Common / Westbourne Park	2.6	1 hr 15 mins
Old Oak Common / Paddington	3.7	1 hr 10 mins
Westbourne Park / Powerday (Old oak Wharf)	2.8	1 hr 25 mins
Westbourne Park / Harleyford Pit	18.8	9 hr 50 mins

The option for hauling tunnelling materials from these locations can be accomplished by using dumb barges and tugs, where a tug would drop off a barge (or possibly a chain of barges) and pick up another to return. The tug would make the round trip, including dropping and picking up tows, in around 3 hours for Northfields. Travel onwards to Paddington would add around another twenty minutes in each direction, while Old Oak Common trips would reduce return trips by about 45 minutes.

If self-propelled vessels were used, an extra hour would be required in the round trip to allow time for travelling to and from turning points, plus load and unload times. Thus more motive power is needed in total.

In summary, we would recommend the use of dumb barges that do not need to be turned at the end of the route. These barges should be 21m long with a 4.2m beam and designed to operate at a loaded depth of 1.5m. Operations are considered separately, but at this stage it appears that two barges per trip (that is, one tug with two barges) would be the most practical operation.

4 Barge transport

4.1 Operators

London's canals currently carry a small amount of freight and the only regular traffic of up to 60,000t per year is moved out to the west between Denham and West Drayton (aggregates for Hanson). The small amount of freight moved on the is reflected by the low number of operators working the waters, namely:

- Wood, Hall & Heward
- Land and Water
- SmartBarge
- Other small lifestyle operators

4.1.1 Wood, Hall & Heward

This operator has been established for many years and operates a variety of barges and tugs which have been used for many canalside construction projects in London.

4.1.2 Land and Water

Land and Water is a major waterways contractor who originally used canal transport as an ancillary activity in support of their own contracts. More recently they have developed water transport as an operation in its own right.

Land and Water has the contract to transport aggregate between Denham and West Drayton for Hanson Aggregates using two motor barges (supplemented with dumb barges and narrow boats). Land and Water has recently introduced a new dumb barge called an Olympic Class hopper barge for moving other bulks such as secondary aggregates and construction waste. These new barges can carry in excess of 85t on an operating draft of less than 1.37m.

4.1.3 SmartBarge

SmartBarge is part of the Doyle Group and has designed and trialled a new barging technology called SmartBarge that can carry cargoes using a flexible modular system.

The system is based around a modular design that uses polypropylene buoyancy sections which are fixed to a frame made from heavy duty square metal tube. Within each module, platforms, containers and skips can be carried. The use of the polypropylene buoyancy sections removes the need for floatation chambers within the modules. The SmartBarge modules are secured to each other using a standard maritime twist lock, which permits any number of modules to be fixed together to form a barge like configuration. The carrying units are not permanently attached to the module frame, meaning they can be lifted in and out of the module if laden or empty, or cargo can be loaded into them while they are in place in the module.

The assembled barge is square ended rather than the conventional shape, giving greater capacity within the same length and beam. SmartBarge state that the modules can be built to any specification needed. Thus, if the overall length of the module is 19m and the hold is 18m long by 3.7m wide, it is theoretically possible to load 7 segments across the module and 6 along the length, giving a total of 42 segments carried. However, this would give a payload weight of 130t that is significantly higher than a conventional barge and we are not confident that this is a plausible load for SmartBarge which is as yet an unproven technology for this type of load.

4.1.4 Other lifestyle operators

Around the London Canals are a number of lifestyle operators, so named because the operate to enjoy a boating lifestyle on the modest returns available rather than seeking maximum income, an income not likely to be found on the canals. These operators tend to service leisure craft or undertake occasional cargoes for construction work. They are not well equipped for a two year bulk carriage operation and the Crossrail proposal is not the sort of traffic they would be seeking.

4.2 Available vessels

There are generally two types of vessel used to transport goods on canals:

- Dumb barges pushed or pulled by a tug
- Self-propelled barges where the barge, engine, and wheelhouse are all on the same vessel

Generally a dumb barge operation is likely to be most practical for the Crossrail operation. The advantages are that the tugs do not need a special area to turn around in, and the tug can immediately collect an empty barge after delivering a loaded barge, maximising utilisation of the expensive powered unit.

It is our view that in order to ensure a reliable water transport service for Crossrail, it will be necessary that the appointed barge operator has access to relatively new barges and tugs. There are several reasons for this: the traffic will be very demanding compared to other London canal traffics, and there is a need to keep downtime to the absolute minimum. Much of the barge stock in London is over 30 years old. Even the tugs are often of this sort of age, with the exception of Land and Water's barges on the Harleyford gravel traffic, their new Olympic Class barge and the SmartBarge equipment.

Elsewhere in this report it is highlighted that the traffic is expected to run for up to sixteen hours a day, six days a week, and that servicing should routinely take place during non-traffic hours. This is a demanding schedule for the tug boat engines and thus newer stock with readily available spares and filters would be advisable, This concern doesn't apply as much to the barges, but new barges would be less at risk of springing a weld on impact with the wharf or another barge and could be designed to suit the traffic in terms of hold length and shape.

Our conclusion is that there are insufficient 'new' craft to carry the Crossrail traffic at present and any operator would have to procure a fleet of new barges to provide the delivery service level that will be required. However, at this moment there are twelve dumb vessels 18.5m by 3.6m available due to a cancelled order. These barges are slightly small for this traffic but could handle the loads.

4.3 Type and number of vessels to serve Crossrail traffic

4.3.1 Introduction

Given that there are potentially three different Crossrail traffics, this section discusses the vessel requirements for each as separate entities:

- Barges for tunnel linings
- Barges for other materials
- Barges for excavation arisings

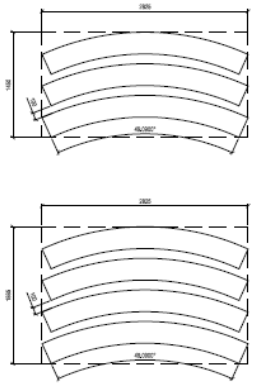
4.3.2 Barges for tunnel linings

In Section 2.4.1, the size and weight of the individual segments was provided. In terms of determining how many segments will be carried in a single trip and handling these on and off barges, the weight

and arc depth are key figures. As noted, the weight per segment is 3.1 tonnes. However, the segments will be handled in batches of 3 or 4 segments forming one block. A block will comprise the segments and soft spacers that prevent segments touching and could be secured by an adjustable webbing strap around the outside of the segments or by using a form of lifting harness. This permits the segments to be carried on their side and would give a total weight of 9.3 or 12.4 tonnes per block.

The dimensions of a block would be approximately 3m wide; 1.5m or 1.9m depth (assumes a space pad 10cm thick); and 1.5m high.

Figure 1: Possible segment configuration for carriage by water



Conventional barges and tugs

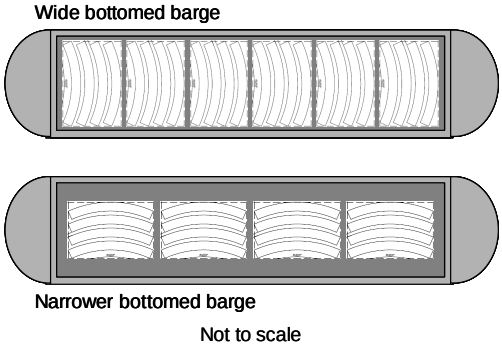
Assuming all dumb barges will be new vessels, it is suggested that they should be designed double ended to avoid the need to turn. The dimensions would have to be in the region of 20m long and 4.2m wide, with a maximum draught of 1.5m. This would provide a hold of around 15/18m long by 3.5m wide; the vessel would have a carrying capacity in the region of 75/85t.

In practice the barges will reach their maximum payload weight before the full 15m of hold has been used, but the length of barge is required for displacement to maximise the weight payload, even though the load would physically fit in a slightly smaller barge.

Increasing barge length to 23.5m (the maximum that will fit through Uxbridge and Denham Locks) would increase payload by 15.5 tonnes, enough to carry an extra 5 segments.

The practicalities of carrying the segments will depend on the internal shape of the barge - i.e. are its side's upright or does it have sloping sides. Figure 2 illustrates the principle of loading the barge depending on the width of the hold floor.

Figure 2: Possible loading configuration of segments in a barge



In the case of the new Olympic Class barges, which have sloping hold sides (2.1m at the bottom and 3.5m at the opening), the holds are design such that steel frames or platforms can be placed in them to provide at alternative floor height that mitigates the incursion of the slope. Land and Water believe this option would enable more segments to be carried since the raised floor would be wider point in the barge.

The tugs used would be push-tugs similar to the now discontinued Bantam Class craft and should be capable of moving two barges in one train (i.e. pushing and pulling two barges at the same time as one unit). This will be a useful contingency although in practice normal operation will be to push one barge only.

SmartBarge

The overall length of a SmartBarge train is expected to be at least same as a conventional barge - 21m by 4.2m wide. Its draught will be a maximum of 1.5m, but since the amount of buoyancy can be adjusted to carry heavier loads, its floating height might be more than that of conventional barges.

Propulsion would be provided by ex-NATO barges, or SmartBarge propulsion modules.

4.3.3 Barges for other materials

Depending on the demand and nature of the materials will govern the type of barge used - e.g. dumb barge with tug, SmartBarge or self propelled barges.

It is not envisaged that there would be an absolute need to use new barges for these traffics as they will be less demanding and potentially less time sensitive, and thus older stock would probably suffice. The range of vessel sizes currently available means that ones of suitable size for these traffics can be found.

Self-propelled barges might be able to play a role for other materials if they can be unloaded at Westbourne Park without too much delay (e.g. queuing for space on the wharf), since the crew remain with the load. These craft typically have large single holds and would be capable of carrying a variety of cargoes. The barges used on the Harleyford Aggregates traffic, and other models such as the Leeds and Liverpool boats, are examples of this.

4.3.4 Barges for excavation arisings

In principle these would be similar to the barges proposed for tunnel segments and with some design details could be the same fleet of barges used interchangeably between the traffics. The most important design detail is that the hold should ideally have curved corners at the bottom to make for ease of removal of the last bit of spoil. This design detail would not impact on the ability of the barge to carry tunnel segments.

It should also be noted that unloading of spoil would probably be by grab unless some kind of container system is used. The grab will inevitably impact on the barge on occasion and the barge will need to be strong enough to take this impact without causing serious damage. This differs from carrying tunnel segments in that the tunnel segments are sufficiently delicate as to require careful handling and thus the barge will not suffer impacts from them.

In the event that spoil is regularly and systematically removed by barge it is likely that new barges providing a high payload capacity would be most suitable - e.g. 23.5m long barge carrying 90t. This length would allow passage of Denham and Uxbridge Locks on the Grand Union, and of all the locks on the Regents Canal.

Where they are used to provide assistance in an emergency or used to complement rail and in both cases delivering to a relatively close destination (e.g. Powerday), older stock will probably by sufficient, although the carry capacity of such craft can be as low as 60t.

The barges used for the tunnel lining segments could also be used and it was suggested by Land and Water that it might be plausible to devise an integrated segment and spoil traffic schedule, whereby better utilisation was obtained from the barges.

Self-propelled barges could be considered for excavated materials, but existing vessels only have a capacity of 60t. Larger vessels of up to 24m long could be introduced but these would be new builds.

4.3.5 Number of barges and tugs required

The number of barges needed to comfortably allow deliveries to be made without interruption will depend on:

- The size and format of the barge
- If tugs are hauling one or two barges on each outbound and inbound trip
- If spoil is carried on the outbound trip from Westbourne Park

To meet the peak demand of 210 segments per day, it is estimated that at least 12 barges and three tugs would be required - comprising 9 barges working (three per tug) and 3 barges as back up or short-term wharf-side storage (see section 5.2).

For the transport of spoil to Powerday, it is estimated that 5 or 6 barges (carrying 75t payload) being moved by 2 tugs could move around 1,000t per day.

4.3.6 Summary

The use of barges that can be left at the wharves while tugs continue to haul other loaded or empty barges will offer the most effective solution for the delivery of the tunnel segments. Self-propelled barges could perform other deliveries where turnaround times are not so crucial or supplement dumb barge traffic if there was a particular need.

5 Delivery of materials

5.1 Daily demand

The daily demand for tunnel lining segments will be as follows [(2)]:

- July 2011 - Oct 2011 build up 4 day stockpile at WBP portal east say delivery of 120 rings based on 2 TBM's in full production using 15 rings = 840 segments - no daily delivery schedule for stockholding build up
- Oct 2011 - Jan 2012 WB TBM only requires 15 rings per day = 105 segments per day
- Jan 2012 - Jan 2013 EB and WB TBM require 15 rings each per day = 15 x 2 x 7= 210 segments per day
- Jan 2012 - April 2013 EB TBM only requires 15 rings per day = 105 segments per day

This equates to a weekly rate of 735 segments per TBM. In the period Jan 2012 - Jan 2013, weekly rate will equal 1,470 for segments.

In addition, to the segment traffic there is every probability that other materials would be hauled by barge in consolidated loads from Northfields or Old Oak Common, although quantities for this transport are as yet undetermined.

5.2 Delivery scheduling

A tug pushing one barge can deliver 6 blocks, or 24 segments in a single trip. This is sufficient to build three tunnel rings. Using a push tug with a single barge, a delivery can arrive at Westbourne Park every three hours, assuming that there is always an empty barge and a loaded barge ready for collection at the respective ends of the trip.

As the round trip takes three hours it makes sense for the length of operation to be a multiple of three hours, say 9,12 or 15 hours. In practice minor delays will result in this moving towards 10, 13 and 16 hours. A notional 16 hour day would be from 6am to 10pm. A notional 10 hour day would be from 8 am to 6pm.

A single tug can manage 3 round trips in a 9-10 hour day and 5 in a 15-16 hour day. This would result in delivery of 72-120 segments in a day with one barge.

The consumption rate is 735 segments per week per tunnel boring machine, making a maximum consumption rate of 1,470 segments a week, which averages 210 per day. A single barge operating 24 hours a day, 7 days a week would not be adequate to cover this, and would also represent a delivery system at full stretch.

Working 6 days a week would require delivery of 245 segments a day, and would allow one day to catch up in the event of downtime during the week. To deliver 245 segments in one day requires eleven barge loads. Assuming one tug per barge the most comfortable way of achieving this would be for three tugs working approximately 12 hours a day for 6 days a week.

This system would allow a lot of flexibility ensuring a reliable delivery pattern. With three tugs working twelve hours, if one tug fails then the other two can work extended hours, or one tug can take two barges. Working six days for a 12 hour day allows one day a week and six nights to catch up in the event of failure reducing the delivery rate. Three tugs is also a lot less vulnerable than one.

[2] Information on number of segments require per day was supplied by Crossrail

For practical reasons the tugs should not leave together but should be staggered over an hour, otherwise they will get in each other's way on first arrival at Westbourne park. For example, a schedule could run as follows:

Crews arrive at 7am:

7:30am: first tug and barge depart from Northfield, followed at 8am and 8:30 by tugs 2 and 3

9am, first tug arrives at Westbourne Park, drops loaded barge and collects empty barge. Tugs 2 and 3 follow at 9:30 and 10.

10:30 first tug back at Northfield, drops empty and collects loaded barge

And so on until the first tug departs Northfields at 4:30pm to take its last load of the day. Assuming the operation has gone smoothly for the day, the third tug may not need to make a fourth trip. The first tug will return to Northfields at 7:30pm.

During the winter, part of the day's operation will be during the hours of darkness. For this reason the front of the tow (not just the tug) should carry lights and the loading and unloading areas should be lit. The tug should also have lights to illuminate the deck and wheelhouse, but these need to be controlled by the steerer as they should not be turned on unless the steerer needs to leave the wheelhouse.

5.3 Handling Barges at the Westbourne Park

The optimal span of the crane is 15m as this will enable the barge to be unloaded without having to be moved along the wharf and the crane has access to all of the hold as segment blocks are lifted off the vessel. However, if a narrower span it opted for, ideally this should be 7.5m or 5m which will limit the number of moves to one or two. Shifting the barges could be achieved by the installation of powered capstans or winches on the bank in front and/or behind the barge.

Empty barges would be moved outwards the Paddington direction where they will be moored awaiting return to Northfields, while full barges will be fed from the Northfield side. This flow pattern will avoid any need to turn barges and tugs on the canal.

6 Crossrail wharf and load handling requirements

6.1 Introduction

In this section we consider the best location for the wharves and the equipment and handling requirements need to lift segments in and out of barges.

6.2 Northfields

The wharf at this location is large enough to permit a variety of cranes to operate on it, although a structural survey would be required to verify its condition (e.g. load bearing capacity) to support crane operations.

Ideally a mobile crane such as a Terex Fuchs Loading Machine (e.g. MHL 360D) or similar should be used, as this will be able to move along the wharf to load waiting barges, rather than having to manoeuvre barges on the wharf. Furthermore, this type of machine can be fitted with a range of handling heads and could be utilised in other parts of the site when not required for loading barges.

6.2.1 Wharf and pavement specification

Specification to be provided

6.3 Westbourne Park

The purpose of the wharf at this location is to transfer tunnelling and other materials from barges to the works site and storage areas. As noted in Section 2 the wharf is on the towpath side of the canal. As a result consideration will have to be given to pedestrians and cyclist using this part of the canal, ensuring they are able to have safe passage past the site. In addition, running beneath the towpath there are cables within a 3.5m concrete conduit and we understand, fibre optic cables in the earth area of the path.

6.3.1 Potential unloading locations

Three locations at the site have been considered:

- At the apex of the bend on the canal
- Approximately 75m east of the apex
- Approximately 95m west of the apex

6.3.2 Apex of bend

The canal edge is 6.5m from the existing boundary wall at this location and is the closest point to the main site when the internal site measurements are taken into account. However, this is in the proximity of a bridge support for the A40 flyover and behind the existing wall the ground falls away to a level that is approximately 9m below elevation of the towpath. Furthermore, the overhead clearance to the A40 flyover, which is directly over the canal bank at this point, is approximately 4.5m, which constrains available height.

6.3.3 East of the apex

Approximately 75m east of the bend apex the towpath adjoins a small piece of land offering about 157m^2 between the relocated Design/Art Studios and edge of the A40 flyover, a perpendicular depth from the canal edge of around 13m. Behind the towpath boundary wall at this point the drop in the ground level is not so severe and slope off into the site. Measuring the clearance from drawing (INSERT DRAWING REF) at this point it is estimated that there is 5.9m to the underside of the A40 flyover. The combination of the towpath, the additional land and superior clearance makes this location more attractive than at the apex of the canal bend.

6.3.4 West of the apex

Approximately 95m west of the bend apex the towpath adjoins another small triangular piece of land offering around 140m^2 between the bus garage building and edge of the A40 flyover, a perpendicular depth from the edge of the A40 flyover of around 16m. The overhead clearance at this point is unknown. On the site side of this land the ground drops away about 9m from the level of the towpath. In the vicinity of the drop there is also an entrance to an underground car par at this lower level and it is not clear whether this will be accessible during the Crossrail works. The end of the site will also be the main road access for London Buses and Tarmac [*clarification required*]. While the area offers more space than at the apex, the steep drop and other factors make it unsuited for the delivery of the tunnel linings and other materials.

6.3.5 Summary of potential wharf locations

The location at the apex of the bend on the canal has limited headroom and does not offer an option to install a pedestrian walkway that is off the existing alignment of the towpath in order to not disturb underground cables.

The location to the west of bend apex appears to have sufficient room to install a pedestrian walkway that is off the existing alignment of the towpath in order to not disturb underground cables. However, the location is a poor position in respect to the entrance of the Crossrail site, London Buses and Tarmac.

The location to the east of the bend apex has better overhead clearance and sufficient space to install a pedestrian walkway that is off the existing alignment of the towpath in order to not disturb underground cables. There is also less of an incline into the Crossrail site and available space for accommodating transfer of loads to site vehicles. Given these advantages over the other two locations we would recommend that the Westbourne Park wharf be located to the east of the canal bend apex.

It should be noted that all locations involve handling over the towpath, and this will require not only BW approval but also approval from National Grid and Easynet who have cables in the towpath at this location. This approval will only be forthcoming if these bodies are satisfied that there cables will not be at risk from the operation.

6.4 Loading handling equipment at Westbourne Park

The equipment considered in the section is based on the assumption that the recommended wharf location is used. The space constraints at this location, the weight of the loads, the position of the towpath and cable conduit and the importance not to damage tunnel lining segments, limit the choice of lifting gear that can be used. In addition, the need to transfer loads to a suitable transfer point beyond the wharf adds a further constraint to the choice of techniques that minimise multiple handling of the segments.

The choices we have consider for craneage are:

- Jib crane
- Mobile crane / Loading machine
- Overhead beam / gantry crane

6.4.1 Jib crane

A jib crane is a simple arm crane that will lift and rotate loads through 360˚. Heavy-duty versions are available that would be suitable for lifting loads at the Westbourne Park wharf. In terms of its ground footprint, this type of equipment would fit within the space available and would need to be positioned on the earth portion of the towpath. The height and reach of the equipment could be specified such that it would be a solution to lifting loads over the protective pedestrian walkway. Its position away from the A40 flyover would eliminate overhead clearance problems and since its hoists are electric

powered, removing noise disturbance. However, a crane of this size would require a substantial foundation close to the canal bank and concrete HV cable conduit and it unlikely there is insufficient support in the ground to a structure of this size. Moreover, there is a need for a secondary conveying system to transfer loads to waiting delivery vehicles further within the site, which will also slow the unloading operation. In addition, since the lift will have to pass over the protective pedestrian footway the operator would require the aid of CCTV in order to place loads in the correction position when depositing on the transfer system.

6.4.2 Mobile crane / loading machine

There are a significant number of mobile cranes that would be able to perform the unloading of barges at the Westbourne Park wharf. The front of equipment will have to be positioned on the earth portion towpath, in order to ensure its arm is at a distance that will enable it to lift 12.4t loads. To make certain that the operator has full vision of lifting and lowering of loads, a model with hydraulic elevating cab should be used, as this will be able to rise above the height of the protective pedestrian walkway. This machinery should be able to drive to the location under the A40 flyover if a ramp is installed. To ensure the crane is stable over a long period it will be necessary to install a concrete base, which is likely to require the disturbance of the fibre optic cables under this section of the towpath. As with the jib crane, there is a need for a secondary conveying system to transfer loads to waiting delivery vehicles further within the site, which will also slow the unloading operation. In addition, this equipment would be powered by a diesel motor which could present a noise and emissions problem for residents in the vicinity.

6.4.3 Overhead beam / gantry crane

This type of lifting equipment comprises an elevated frame that provides a track along which a crossbeam and hoist travel; the track can be built to any length and can include bends. An important advantage of this equipment is the removal of the need to transfer loads to a secondary conveying system, which means operation is quicker, safer, and the potential to damage loads is lower as they are only handled twice. The track supports (stanchions) have to be built such that the beam/hoist travels over the lifting point, which in the case of Westbourne Park does present some challenges. In particularly, it will be necessary to place at least two stanchions into the canal. The site also presents difficulties in that the overhead clearance under the A40 flyover limits the elevation of the crane's frame to approximately 5.75m. If there were no obstacles at ground level this would not be a problem for moving loads, but in this case a protective pedestrian walkway will have to be installed which effectively means the operating space in which loads have to "slung and carried" is 2m.

However, the main advantage this system has over the jib and mobile cranes is it removes the need to disturb the underground cables (HV and fibre optic), as the stanchions' foundations could be positioned away from these services. Furthermore the gantry crane has another advantage in that, by design, it cannot strike the A40 flyover, whereas the other two are reliant on the operator to ensure the flyover is not struck.

Since its traction and hoists are electric powered, noise disturbance is removed from its operation.

6.4.4 Handling the segments

It was mentioned at a meeting with Crossrail that segments can be blocked together using an adjustable webbing strap and lifted using chains attached to the individual segments. It is our view that the restricted lifting clearance of about 2m (from top of pedestrian tunnel to hoist hook) will not provide sufficient room for the segments, chains and hoist to pass under the A40 flyover. Furthermore, we also learned that it is most important that the edges of the segments are protected during handling operations, since damaged edges cause significant problems when grouting the in place segment. This was a recurring difficulty in the construction of the underground section of the CTRL. Thus for the reasons of minimising the overall height of the segment and lifting attachments and the protect of segment edges it is felt that more compact options should be considered. For example:

- a metal lifting frame (with a close coupled eye) that would secure the segments in place and protect their edges when lifted in and out of the barge, or

- a specially designed spreader beam (with a close coupled eye) and lifting slings (e.g. Dyneema slings), which would still include forming a block using an adjustable webbing strap.

6.4.5 Load handling equipment summary

The presence of the HV cable conduit located within 3m of the canal edge, the limited space around and accessibility to the preferred wharf site, and the weight of the loads does present a number of constraints, which it turn affect the choice of crane.

In considering the crane options we have regarded minimising potential damage to the segments as being the most important. Two of the options discussed above will require double handling of loads, which raises the probability of damage to segments occurring. All will require a level of engineering to install the equipment (e.g. concrete bases, foundations), although the overhead beam crane is the most challenging. However, taking that into consideration it is our opinion that the beam crane would be the most effective and therefore recommend that this option be pursued.

6.5 Engineering considerations

The use of a mobile crane at Northfields and the installation of a beam/gantry crane will both require an engineering review of the ground conditions in order to assess what work has to be carried out to bring the sites up to a standard that will prevent any collapse of canal edges, embankments or other features.

6.5.1 Northfields

The site has a steel piled wharf with concrete capping and a concrete surfaced apron behind this. The standard of this surface is not known and will need further investigation to establish its state.

6.5.2 Westbourne Park

As noted previously, the site at Westbourne Park, whilst very convenient for the delivery of tunnel segments and materials, does have some engineering challenges in terms of installing a suitable crane for unloading the barges. The difficulties related to the site are:

- Location of high voltage (HV) cables set in a concrete conduit that runs directly next to the canal and forms part of the towpath.
- The presence of a fibre optic cable which is part of the national network set below the earth portion of the towpath
- The proximity of the A40 Westway flyover which restricts headroom clearance.
- The need to install a protective pedestrian walkway, since the towpath must remain open during the use of the wharf.
- The distance and gradient that loads have to travel before they can be released onto another transfer vehicle.

The combination of these factors supports a very strong case for the installation of a beam/gantry crane, since this option will mitigate the handling required if other crane and transfer methods were used.

6.5.3 Structural specification for a beam crane

Three design options for a beam crane are considered (Drawings 23086_001_101.pdf and 23086_001_102.pdf) as follows:

- a crane that has two sets of stanchions in the canal - a set next to the towpath campshot and a set approximately 6m out from the towpath campshot (Options 1 & 2);
- a crane that has two sets of stanchions in the canal - a set next to the towpath campshot and a set next to the off-side campshot (Option 3);
- a crane that has one set of stanchions in the canal next to the towpath campshot and a set on the off-side embankment (Option 4).

British Waterways have commented as follows on these proposals. Placing stanchions in the canal is acceptable but BW would need to be assured that this would not cause problems for the canal lining, especially when these are later removed. It may be possible to leave stanchions at the edge of the canal when the operation ceases. However a stanchion part way across the canal would have to be removed.

In practice as well as needing technical approval, BW are likely to require Crossrail to indemnify them against any damage to the canal structure.

Lifting loads of up to 12.4t out of barges will require sufficient support on the towpath side and it is felt that this can only be achieved in all options if a set of stanchions is placed next to the towpath campshot. These stanchions would be set within a dry bank extension that would be contained by concrete formwork.

Details of how the stanchion foundations should be set on the canal floor will be confirmed by BW engineers, but it is anticipated that the preferred option will require the use of steel sheet laid on the puddle clay and the foundation set onto this.

All options assume a maximum overhead clearance of 5.9m[(3)] under the A40 flyover, permitting a crane with a maximum height of 5.75m from the towpath level.

For the first crane option with a second set of stanchions located about 6m for the towpath side campshot, the foundations will have to be constructed similar to the towpath side pair. To improve protection from collision with a barge fenders will be required or an artificial island built in which the stanchions would sit. Drawing 23086_001_101.pdf shows the same crane option, but illustrates the pedestrian tunnel in a position on the earth portion of the towpath and south of the towpath.

For the second crane option the illustration shows a second set of stanchions located next to the offside campshot, the foundation arrangement will emulate the towpath side.

For the third crane option the illustration shows a second set of stanchions located on offside embankment the foundations will have to set at a depth that does not pace pressure of the campshot. BW state they do not own the land on the off-side between the waters edge and the fencing for the properties, and thus negotiations with the land owner would be required. We have not ascertained who the land owner is, but if it is not BW it is likely to be the owner of the development.

The second and third option both have the pedestrian tunnel located south of the towpath.

For all three crane options the separation of the overhead beams needs to be considered, as the hoist can only operate between them. The hold of the barges will be approximately fifteen metres long, and thus a separation of 15m would allow the barge to be unloaded without moving. A 5m separation would require the barge to be moved twice and a 7.5m separation would allow half the hold to be unloaded and the barge then moved to unload the other half

[3] The ground to flyover sofit clearance has been obtained from the Crossrail site plan drawing x

In the case where the stanchions are set on the offside, a protection barrier might be required in the middle of the canal (e.g. about 6m from the towpath side) to segregate moored Crossrail barges from other moving craft. Whether such a barrier would be required is a point that BW will need to clarify.

6.6 Towpath and pedestrian access

BW will require the towpath to be open to pedestrians while the wharf is being used. However, since loads will be moved above them it is necessary to provide overhead protection against possible falling items.

The simplest option is to install a prefabricated tunnel built to a standard that can withstand the impact of a 12.4t block of segments dropping from approximately 500mm. For the purpose of this study we have assumed a concrete tunnel can meet this criteria.

The best position for the protective walkway would be around 1.5m south of the earth portion of the towpath, in order not disturb the fibre optic cables. The Crossrail ground plans indicate there is sufficient space to accommodate the walkway, but to ensure that the required clearance for slung segments to pass is available, the tunnel will have to be sunk into the ground to a depth of 500mm.

The length of the walk way will be governed by the span of the crane (e.g. 5m, 7.5, or 15m wide), but is expected to extend by about 1m past each track.

No cycling would be permitted through the walkway and therefore the installation of restrictive barriers would be required at each end. Although BW's preference is for the structure to be cycle friendly there are other locations on the canal where cyclists are asked to dismount and some instances where cycling is physically impossible. Any changes in the towpath will require BW technical approval.

The towpath is not a right of way at this point, but it is both a permissive recreational path and a permissive cycle route. These uses are marked on OS maps of the area and will need to be accommodated.

7 Excavation material from Westbourne Park

It is our understanding that excavation material will not be moved by barge from Westbourne Park on a regular basis. The main method of transport will be rail, but there might be occasions when barge could be used to play a complementary role - e.g. if there is a problem fulfilling a 3-train service per day.

7.1 The handling requirements at Westbourne Park

It will not be possible to use the location of the unloading wharf for loading outbound barges with excavation material; this would have to take place at a separate wharf adjacent to the spoil storage point (i.e. west of the canal bend apex). The only practical method to move and load barges at the Westbourne Park location is the use of a conveyor. However, the critical issue with this solution is presence of two obstacles which the conveyor will have to clear:

- the London Buses / Tarmac / site access road requiring a clearance height of approximately 5m
- a second protective pedestrian walkway at a height of approximately 2.5m above the towpath

The specification of the conveyor is dependent upon the characteristics of the excavation materials to be handled and has not been considered in detail for this report. However it can be said that at the wharf, a hopper attachment is advisable to guide material into the barge. Since the hopper will be in a fixed position, the loading process will require the barge to be moved along the wharf such that an even distribution of the load in the hold is achieved. Uneven loads will cause the barge to list or pitch, which could result in the barge scraping the canal bottom or being unstable.

If barges were to be used for spoil transfer, currently there are two primary destinations that can be considered; the Powerday recycling facility and siding, and Lea Gravel Pit (Harleyford) at Denham.

7.2 Powerday

Powderday operate a construction materials recycling centre and two years ago installed a wharf (*Old Oak Wharf)* on the GUC, which their site borders. Barges can unload demolition waste and other waste materials and be loaded with secondary product or other cargoes. The site also incorporates a rail freight siding which could potentially offer an alternative loading point for rail transfer of arisings if moved initially be barge.

Powderday is about 1hr sailing time from Westbourne Park, which means that a tug could make a round trip in around 2-2/12 hours including dropping and collecting barges. This gives an individual tug a capacity of four round trips in a ten hour day or six in a 15 hour day. At 75 tonnes per trip this equates to 300-450 trips. If the fleet of three tugs proposed elsewhere were pressed into action for 15 hour days this would equate to 1350 tonnes in one day. Assuming there were enough barges to allow for round the clock loading and unloading (leaving six empty barges for loading and six full ones for unloading overnight) each barge would need to be loaded in 90 minutes, and each unload would also need to be completed in 90 minutes. It is the unloading that is likely to be slow and the use of two grabs to unload two barges simultaneously would help.

7.3 Lea Gravel Pit (Harleyford)

Harleyford pit is just inside the M25 motorway and a sailing distance of about 19 miles from Westbourne Park. This location is in the process of making a planning application to open up a new pit next to the existing one which is close to becoming exhausted. A condition of the current planning

permission for the existing pit is the need to backfill once it is no longer in use, thus providing a potential destination for Crossrail excavation material.

The delivery of spoil by barge is probably not viable if journeys are made direct from Westbourne Park, since the journey time is nearly 10 hours - i.e. a day there and a day back. Land and Water feel that there might be some potential to move a quantity of Crossrail material to this site as they already haul the aggregate to West Drayton. They envisage a journey that would involve barges from Westbourne Park travelling to West Drayton and swapping load spoil barges with empty aggregate barges that would be taken back to Northfields for loading with segments

8 Operational Costs

8.1 Introduction

In this section we examine the operational costs once the barges have been purchased (the capital cost of barge purchase will be considered elsewhere). These costs have been built up from first principles and developed specifically for the tunnel segment traffic. Overall the costs relate to three factors, staff time, fuel and craft maintenance

8.2 Staff Time

Assuming a push/pull tug arrangement then the barges can be operated by one crew member assuming that only two barges are used (one pushed, one pulled). If more than one is towed a second operative on each subsequent barge is needed to control the barges further back in the tow.

Steering two barges is a relatively skilled job and would require the steerer to hold the appropriate Boat Masters Certificate. Since this is commercial carrying, the market for crewmembers is very different to the leisure market where skippers are often earn a little better than the minimum wage. A skipper working a 40-hour week might reasonably expect an annual salary of £25,000, comparable to a highway maintenance engineer. This cost therefore comes in at £12.50 an hour plus on-costs. Even for an outdoors job such as this, the on-costs will be of the order of 25% after national insurance contributions (24% has been added for national insurance, making a crew cost of approximately £20 per hour).

In addition staff will be needed at loading and unloading. It is likely that three staff will be needed, one to drive the crane and two to handle the loading/unloading process. The crane drivers job is more specialist and advertised rates at present are around the £12-£15 per hour range. Taking the top end of this range equates to £23 an hour salary cost. The other operatives would be paid around £11 per hour, which works out at £17 an hour.

Overall staff costs with 3 staff at each end and one skipper will come to £134 an hour

8.3 Fuel Costs

The tug will operate on gas oil, commonly known as red diesel. Since this is a commercial operation no propulsion tax is paid and the operator would pay around 40p per litre for fuel. With loaded barges the tug will use 5-6 litres an hour, rather less than when returning with the empty barges. Even at this rate of consumption fuel prices are around £2.50 per hour, and even a doubling of fuel consumption would make fuel a cost that is hardly noticeable in the bottom line.

8.4 Vessel Maintenance

The biggest cost in vessel maintenance will be engine and transmission train servicing. The tugs will work hard, possibly running for nearly 100 hours a week, and engine servicing (oil change etc) will be required more or less weekly. A basic service by an external mechanic would cost between £150 and £200, plus any parts necessary due to wear and tear. The engine would be out of action for around 4 hours and if possible servicing should be undertaken when the boat would normally be off duty, for example on a Sunday, or at night. These costs are still insignificant when compared to staffing costs however.

8.5 Barge costs for segment deliveries

The cost of providing a dumb barge is about £400 per week. Assuming that 12 barges were used for the segment deliveries the total cost would be in the region of £4,800 per week.

8.6 Barge and tug costs for other commodities

If other cargoes such as spoil and other construction materials are taken into account a further six to eight barge might be needed

8.7 Licensing Costs

As this is a leisure waterway BW would normally issue boats with a trade licence rather than charge a toll per tonne. In addition, BW have charges for access to the canal in terms of cranes oversailing the canal and towpath, and also charge a mooring fee.

These costs are as yet undetermined and care will be needed in negotiations with BW to ensure that these costs reflect the reality of the trade being conducted. In particular, leisure moorings are at a premium in London and thus very expensive. However, the moorings for these barges (which would notionally be off-side at Northfield) are not available for leisure users and thus should not be charged at rates to reflect this. In addition, Crossrail will already be paying directly for increased costs to accommodate the traffic in the form of paying for dredging and any other improvements that may be required. BW will continue to benefit from this after the traffic has ceased.

9 Planning considerations

9.1 Introduction

Water Transport is promoted in principle through national policy, outlined in PPG13 and other supporting documents such as “Planning for Freight on Inland Waterways” (AINA). The use of water transport is promoted through TfL and in local and regional planning guidance, While much of this is targeted at the Thames it is equally applicable on the canal system where suitable cargoes can be found.

In addition to policy considerations the development of facilities for carriage by water is normally subject to planning permission under the Town and Country Planning Act 1990 as amended. This act defines development and under normal circumstances the erection of cranes and other wharf facilities in isolation would constitute a development requiring planning permission. So long as loading and unloading are taking place within a site compound these uses would not constitute development, as they would be ancillary to the main use of the site for construction.

Although British Waterways have certain statutory privileges relating to their operations, they do not have a blanket exemption from the need for planning permission.

In considering the planning requirements for the canal operation, it should be noted that Crossrail also have powers under their enabling legislation. Nothing in the powers that BW has can affect Crossrail’s powers, and vice versa.

9.1.1 Permitted Development Rights

The only permitted development rights that are relevant to this proposal are Part 17, Class D. Thes provide additional permitted development rights for the disposal of dredgings as follows.

Class D Dredgings
Permitted development

The use of any land by statutory undertakers in respect of dock, pier, harbour, water transport, canal or inland navigation undertakings for the spreading of any dredged material.”
Althoughp roposals for the Prescott Lock and weir to control water levels in the Bow Back Rivers and provide access for 350 tonne barges to the Olympic Park site were brought forward as permitted development under the GDPO by British Waterways as these waterways were remainder waterways, under which BW have such powers. For Commercial Waterways under the 1968 Transport Act BW will have similar powers under their own enabling legislation. For Cruiseway, which the Grand Union is, BW’s statutory powers are limited to the leisure role of the waterway

Part 11, Class A of the GPDO provides permitted development rights for development authorised by a local or private Act of Parliament, or by certain Parliamentary Orders which designates specifically the nature of the development authorised and the land on which it may be carried out. As with Part 17 there are certain exceptions to the permitted development rights and prior approval of the local planning authority is required that can only be refused in limited circumstances.

The GPDO does not give a right to undertake maintenance without planning permission, except of remainder waterways. This is because BW has a statutory duty to maintain the commercial and cruising waterways and this duty over-rides the need for planning permission (but not for listed building consent or scheduled ancient monument consent)

9.1.2 The operation of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 in relation to the GPDO

Permitted development rights do not apply to projects that fall within Schedule 1 of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (the 'Regulations) or within Schedule 2 of the Regulations and is likely to have significant effects on the environment by virtue of its nature, size or location (Regulation 2(1)).

A formal determination as to whether Environmental Impact Assessment is required can be obtained by the submission of a request for a screening opinion to the local planning authority (Regulation 5).

Where wharf proposals form part of a larger development that requires Environmental Impact Assessment (for example a wharf to be used for construction materials) there will be a need to include the wharf in the Environment Impact Assessment. This was the case in the planning application submitted by TfL for temporary wharves at Becton and Thamesmead to be used for the construction of Thames Gateway Bridge.

9.1.3 Consideration of environmental issues

In addition to planning consent other consents will be needed, for example the wharves may require an environmental statement or an environmental impact assessment. The possible consents and issues are:

- the management of noise and dust to protect the amenity of neighbours
- the management of freight operations to avoid the spillage of materials into the watercourse
- the management of drainage of the wharf site to avoid pollution of the watercourse
- nature conservation considerations in relation to dredging and wharf operations
- the protection of historic structures such as quay walls and dry docks that may have listed building status.

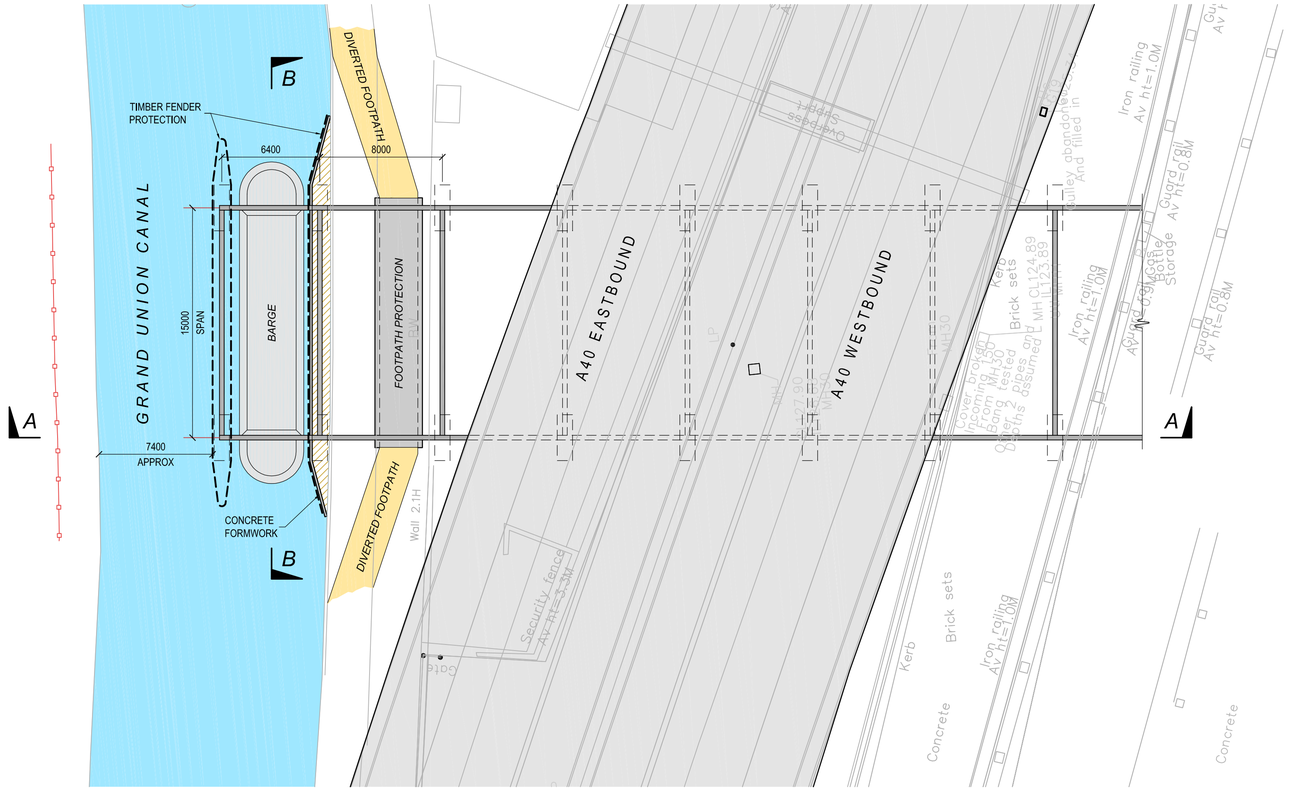
9.2 Summary

It must be assumed that development of wharf facilities at both Northfields and Westbourne Park will require planning permission. As part of this permission it will be necessary to submit details regarding the impact of the operation on residents and neighbours to the site and the canal, and to negotiate the most favourable conditions regarding hours of operation. Detailed preparation of a planning consent in discussions with City of Westminster (For Westbourne Park) and London Borough of Brent (For Northfields) will expedite the grant of planning permission, as will early preparation of relevant environmental statements and we would be able to support this effort if so required.

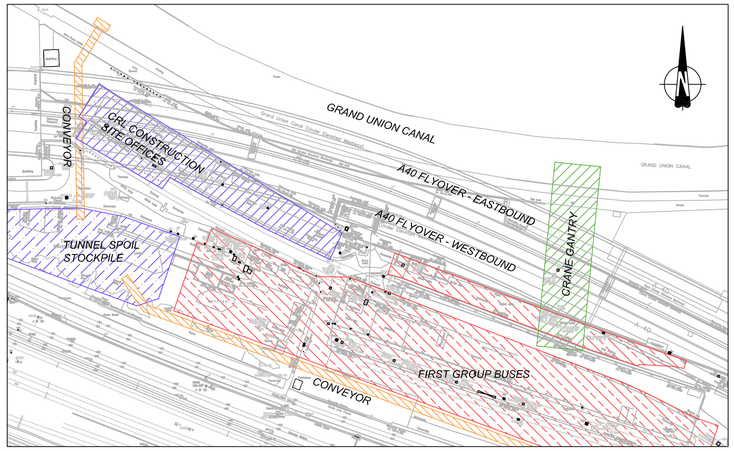
Appendix 1 - Barge Operators Contacted

Person contacted	Company	Contact details
Gerry Heward	Wood, Hall & Heward Ltd	Springwell Farm, Springwell Lane, Harefield, Middx, UB9 6PG Tel: 01895 820203 Mob: 07951 026174 (Gerry Heward) Email: info@whhbarges.co.uk
Ian Wallace	SmartBarge Ltd	John Doyle House, Little Burrow, Welwyn Garden City, AL7 4SP Tel: 01707 364500 Mob: 07944 757519 (Ian Wallace) Email: IanWll@aol.com
James Maclean	Land & Water services Ltd	Weston Yard, Albury, Guildford, Surrey, GU5 9AF Tel: 01483 202733 Mob: 07967 461002 Email: james.maclean@land-water.co.uk

Appendix 2 - Westbourne Park gantry crane options

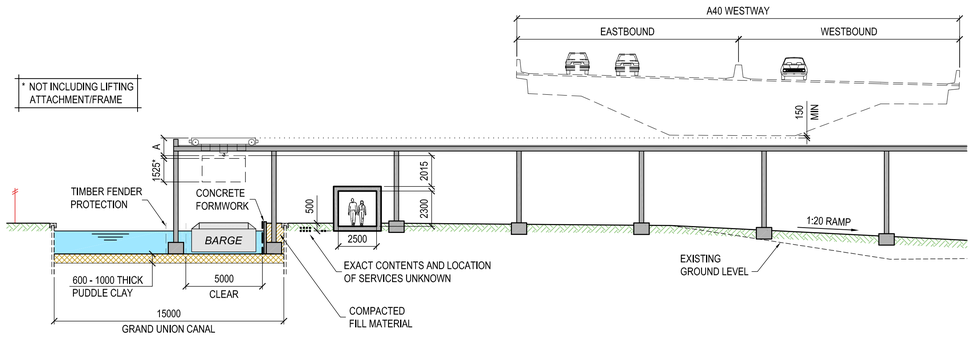


PLAN ON CRANE GANTRY LAYOUT
Scale 1:200

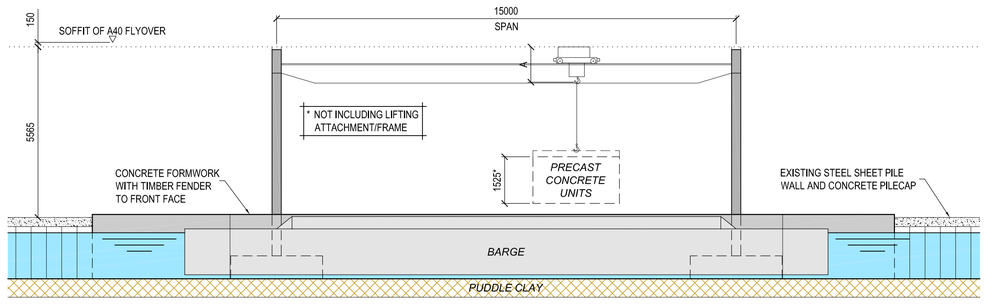


LOCATION PLAN
Scale 1:1000

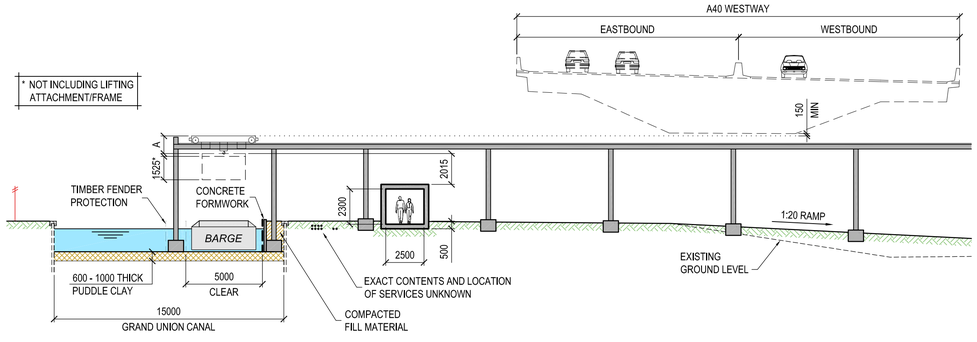
ALL LEVELS AND DIMENSIONS ARE INDICATIVE FOR SCHEMATIC OPTIONS ONLY, TO BE CONFIRMED SUBJECT TO DESIGN AND CONFIRMATION OF SITE GROUND CONDITIONS.



SECTION A-A - OPTION 1
Scale 1:200



SECTION B-B
Scale 1:100



SECTION A-A - OPTION 2
Scale 1:200

GANTRY CRANE SETTING OUT CRITERIA		
SPAN (m)	DOUBLE GIRDER CRANE 16t MAX LIFT, A (mm)	SINGLE GIRDER CRANE 10t MAX LIFT, A (mm)
15	1150	1320
10	1090	1120
7.5	-	1120
5	-	1120

DIMENSIONS BASED UPON ABUS OVERHEAD TRAVELLING CRANE SYSTEMS.

Mark	Revision	Drawn	Date	Chkd

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake his own investigation where the presence of any existing sewers, services, plant or apparatus may affect his operations.

Drawing Issue Status

DISCUSSION

CROSS RAIL
GRAND UNION CANAL FEASIBILITY
SCHEMATIC CRANE GANTRY
GENERAL ARRANGEMENT - SHEET 1 OF 2

Client

Date of 1st Issue: 13.11.2009	Drawn by: LH
A1 Scale: AS SHOWN	Checked by: SA
Drawing Number: 23086/001/101	Revision: -

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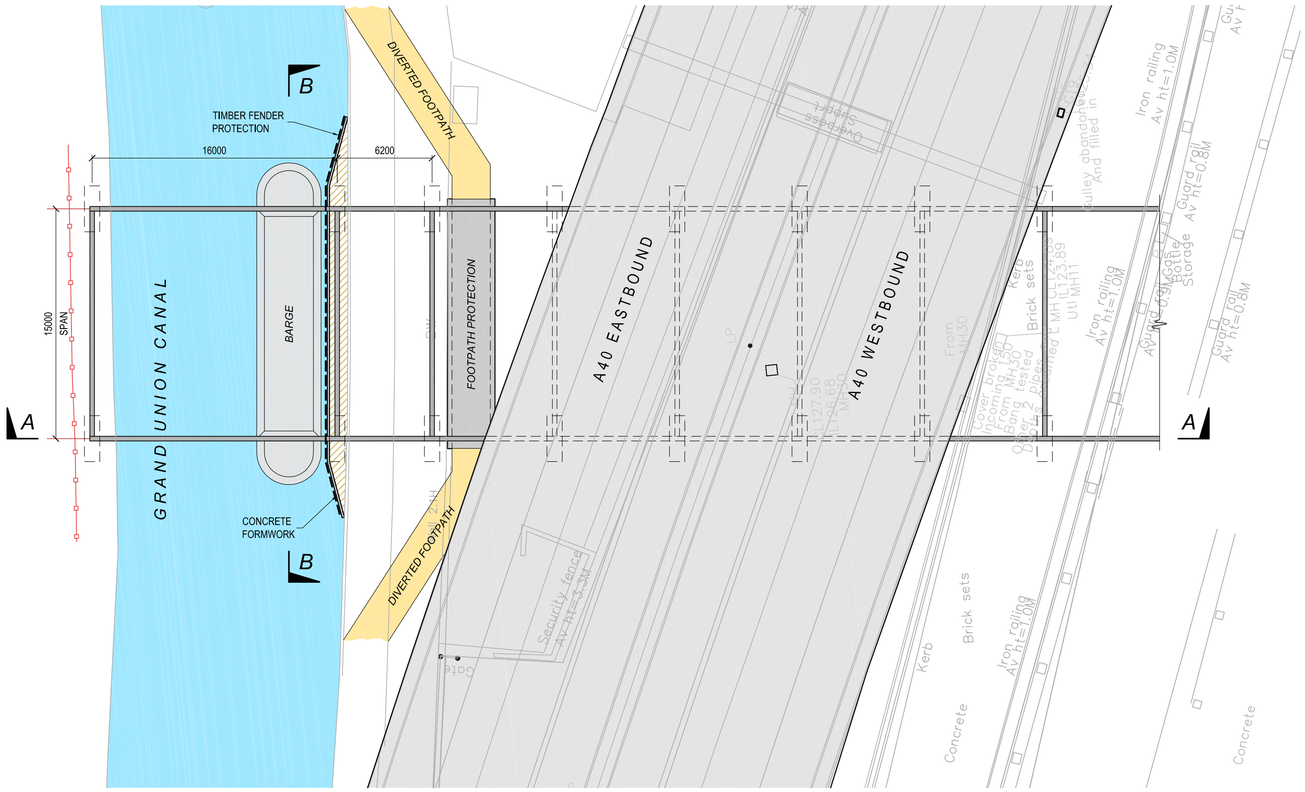
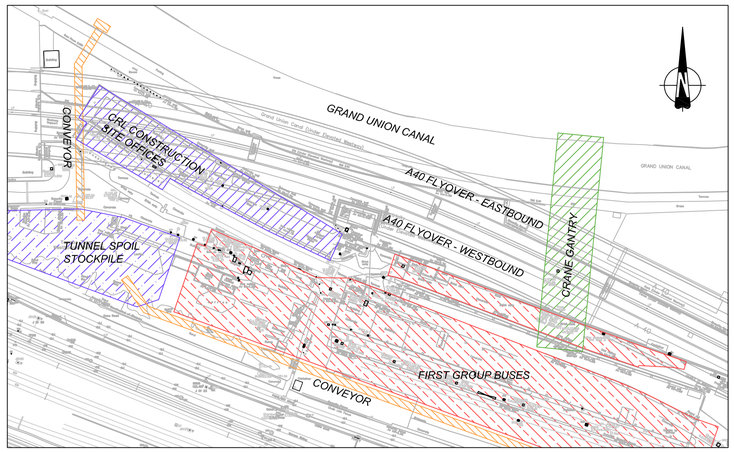
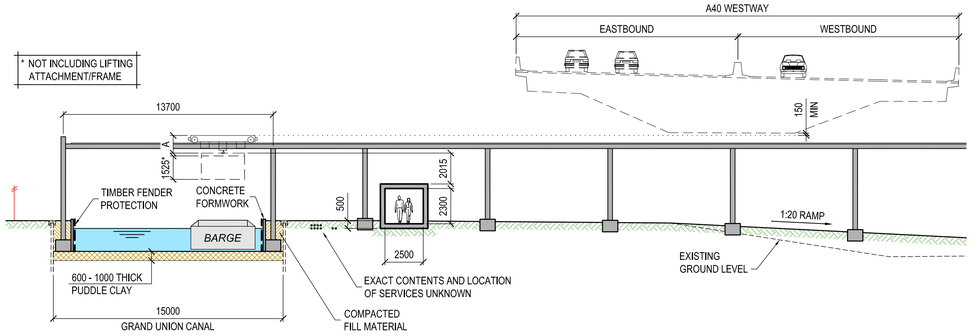


PLAN ON CRANE GANTRY LAYOUT
Scale 1:200

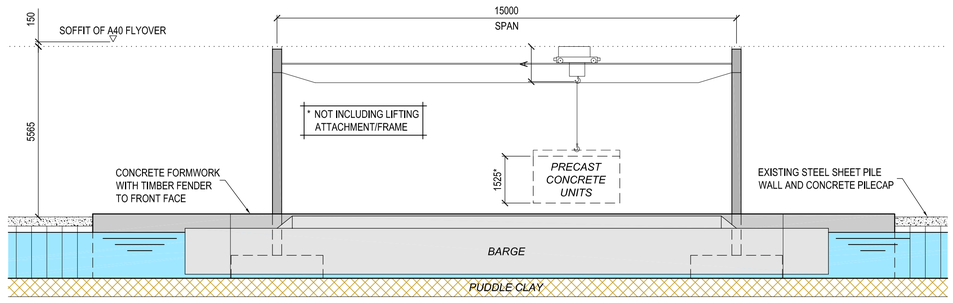


LOCATION PLAN
Scale 1:1000

ALL LEVELS AND DIMENSIONS ARE INDICATIVE FOR SCHEMATIC OPTIONS ONLY, TO BE CONFIRMED SUBJECT TO DESIGN AND CONFIRMATION OF SITE GROUND CONDITIONS.



SECTION A-A - OPTION 3
Scale 1:200



SECTION B-B
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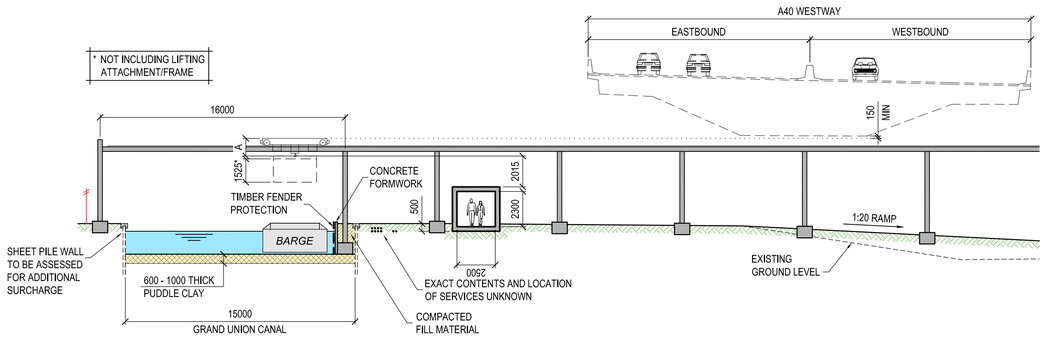

SECTION A-A - OPTION 4
Scale 1:200

GANTRY CRANE SETTING OUT CRITERIA		
SPAN (m)	DOUBLE GIRDER CRANE 16t MAX LIFT, A (mm)	SINGLE GIRDER CRANE 10t MAX LIFT, A (mm)
15	1150	1320
10	1090	1120
7.5	-	1120
5	-	1120
DIMENSIONS BASED UPON ABUS OVERHEAD TRAVELLING CRANE SYSTEMS.		

Mark	Revision	Drawn	Date	Chkd

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Drawing Issue Status

DISCUSSION

CROSS RAIL
GRAND UNION CANAL FEASIBILITY
SCHEMATIC CRANE GANTRY
GENERAL ARRANGEMENT - SHEET 2 OF 2

Client

Date of 1st Issue: 13.11.2009	Drawn by: LH
A1 Scale: AS SHOWN	Checked by: SA
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