WATER | ENVIRONMENT

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Our Ref: 20123/CB
15th January 2021

The London Borough of Richmond
Civic Centre
44 York Street
Twickenham
TW1 3BZ

Dear Sir or Madam,

HARRODS WHARF, BARNES
FLOOD RISK STATEMENT

This Flood Risk Statement (FRS) assesses the flood risk from all sources relating to the proposed redevelopment of Harrods Wharf.

The property is located within Flood Zone 3 of the River Thames. This assessment has been prepared with due consideration of the National Planning Policy Framework[1] (NPPF), the latest Planning Practice Guidance for Flood Risk and Coastal Change[2] and Flood Risk Standing Advice (FRSA) for 'Vulnerable' developments in Flood Zone 3[3]. In addition, this letter complies to the London Borough of Richmond upon Thames (LBR) local policy LP11 and LP21 in terms of flood risk and sustainable drainage.

ASSESSMENT OF EXISTING SITE

The wharf site is located adjacent to the Grade II listed Harrods Furniture Depository, in Barnes (as shown in Figure 1), with the River Thames on its eastern side. The site lies within the London Borough of Richmond upon Thames.

The site consists of the existing wharf, which is 92m in length and between 7-8m wide resulting in an area of approximately 690m^2. The development site boundary also contains the public footpath to the north and south.

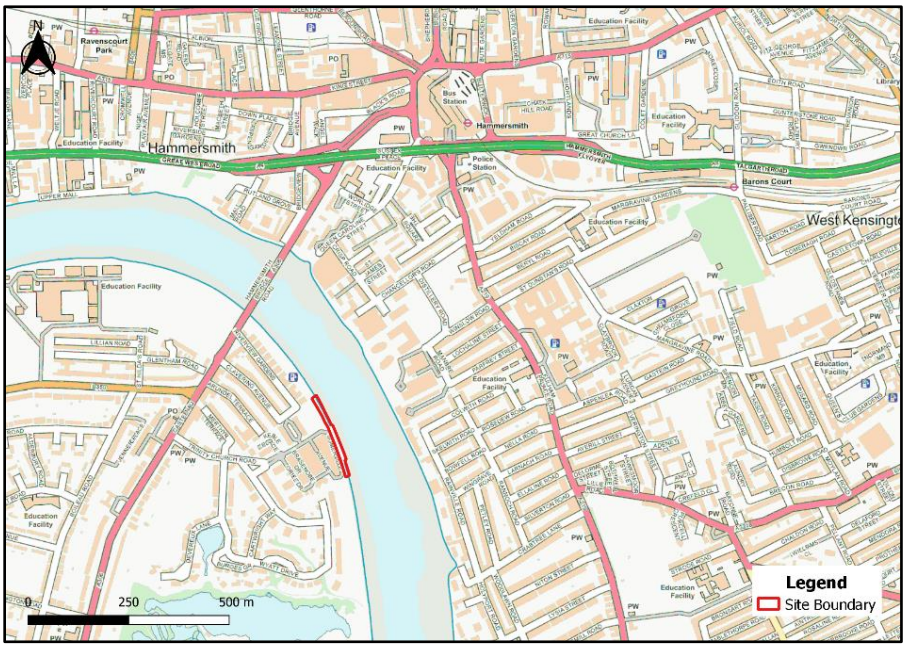


Figure 1[4] - Site Location

Cont…/

[1] Communities and Local Government, Updated National Planning Policy Framework, 2019
[2] Communities and Local Government, Planning Practice Guidance, 2014
http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/ Accessed 05/01/2021
[3] https://www.gov.uk/flood-risk-assessment-local-planning-authorities Accessed 05/01/2021
[4] Ordnance Survey 2020

The site levels show the existing wharf to have a ground level of 4.90m AOD. The concrete flood defence wall, which also marks the Harrods village area, is set at 5.94m AOD – the statutory flood defence level – according to the Environment Agency (EA). A site visit to the area in December 2020 confirms that the flood defence is uniform in level and approximately 1m above the existing wharf level.

ASSESSMENT OF PROPOSED DEVELOPMENT

The proposed development is for two single storey pavilions connected by a covered area and to reinstate the ferry terminal. One pavilion will house the ticket office with staff amenities, while the other pavilion will include a café and WCs. The linked covered area between the pavilions will be to be used for queuing and cycle storage.

ASSESSMENT OF FLOOD RISK

In assessing the risk of flooding to the site, data from; the EA, Richmond upon Thames Preliminary Flood Risk Assessment[5] (PFRA), Surface Water Management Plan[6] (SWMP), and Strategic Flood Risk Assessment[7] (SFRA) have been reviewed and used as appropriate.

Historic Flood Records

A number of sources of flood risk were investigated to determine if the site and surrounding area have been affected by floods in the past. It was found that the EA does not hold any record of the site or surrounding area flooding specifically. Although not formally documented as a historical flood event, the wharf is located below of the extreme tidal level and would therefore experience flooding in high or spring tides.

We are not currently aware of any other history of flooding at the site, or of any records of flooding from any other source close to the site.

Risk of Flooding from Rivers and the Sea

The dominant source of flood risk to the site is tidal in nature from the River Thames. The GOV.UK internet Flood Zone maps show that the site lies within 'Flood Zone 3' ('high risk', which for tidal sources equates to a greater than 0.5% annual exceedance probability) as shown in Figure 2.

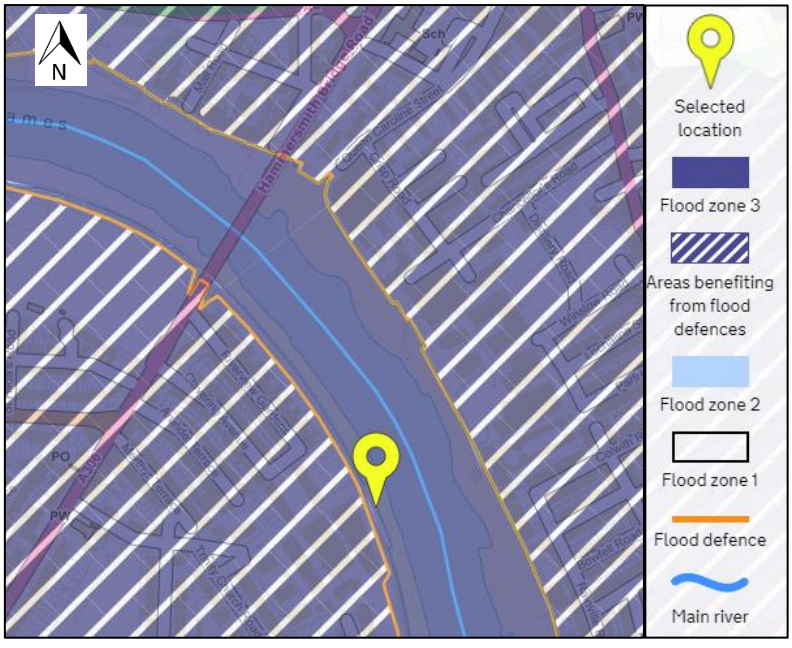


Figure 2[8] – GOV.UK Flood Map for Planning

[5] Drain London, London Borough of Richmond Upon Thames Preliminary Flood Risk Assessment, 2011

[6] Drain London, London Borough of Richmond Upon Thames Surface Water Management Plan, 2011

[7] Metis, Richmond Upon Thames Strategic Flood Risk Assessment, September 2020

[8] https://flood-map-for-planning.service.gov.uk/summary?easting=523145&northing=177695 - Retrieved 05/01/2021

The SFRA and PFRA show that the site is not affected by fluvial flooding from the nearby Beverley Brook, and therefore the only risk to the site is from the tidal Thames.

Due to the nature the site, the wharf lies directly in front of the flood defences on the river side and is therefore not defended by the raised flood defences during a fluvial or tidal flooding event. The site is defended from large tidal events by the presence of the Thames Barrier; however, this is dependent on the barrier being closed. There is no set trigger level for closure of the Thames Barrier, which is primarily designed to protect central London from tidal surges, and this is based on a combination of three major factors; the height of the tide in the Thames Estuary, the height of the tidal surge, and the river flow entering the tidal Thames over the weir at Teddington.

The current TE2100 Extreme Water Level for this stretch of the River Thames (Node 2.20) is 5.01m AOD, which rises with climate change to 5.48m AOD in 2065, and 5.92m AOD in 2100. This node is located approximately 300m upstream of Harrods Wharf, at Hammersmith Bridge. The operation is the responsibility of the staff at the Thames Barrier and if levels and flows are forecast to increase any further, the Thames Barrier would shut, ensuring that the tide is blocked and the river maintained to a low level. As such, the extreme water levels presented are considered the maximum allowable through closure of the Thames Barrier as required.

The Port of London Authority (PLA) Tide Tables and Port Information for 2021[9] provides the level of tides at key locations on the River Thames. The closest location to the site is Hammersmith Bridge, which has a level of 1.68m based on Chart Datum below Ordnance Newlyn Datum. Chart Datum is approximately the level of the Lowest Astronomical Tide. The Mean High Water Springs (MHWS) is 5.8m and the Highest Astronomical Tide (HAT) is 6.4m. This converts to 4.12m AOD and 4.72m AOD respectively.

The existing wharf is set at 4.90m AOD, and therefore is not expected to flood in the MHWS and the HAT. However, the EA modelled levels show the wharf could experience flooding in an extreme tidal event. At present levels, this would result in 110mm depth of flooding on the wharf, but this would be expected to increase in the future to in excess of 500mm depth by 2065.

Risk of Flooding from Land

Flooding from surface water arises during intense rainfall events when flood waters are unable to infiltrate into the ground or discharge into local ditches or artificial drainage infrastructure. In an urban environment, the risk of flooding from surface water and from overloaded sewers is closely related, and both are included in the relevant surface water flooding datasets. Flooding events are typically of short duration (unless there is a drainage system blockage) but can be severe.

The GOV.UK Flood Long Term Flood Risk Maps cover the risks of flooding from surface water. These maps are a useful tool in assessing the extent and frequency of flooding in a general area but do come with a caveat that they should not be relied upon for site specific development or property level assessment. Engineering judgement is therefore required when considering the flood risk information presented. The GOV.UK maps showing the risk of flooding from surface water map, applicable to the site, is shown in Figure 3.

The dark blue shaded areas are areas of 'High' surface water flood risk which have a 3.3% (1 in 30 year event) chance of flooding. While the lighter blue areas are of 'Medium' risk of surface water flooding which have a 1% (1 in 100 year event) chance and the pale blue areas are of 'Low' risk of surface water flooding has a 0.1% to 1% (between a 1 in 1000 year and 1 in 100 year event) chance of occurring. Areas not highlighted in blue are classed at 'Very Low' risk of surface water flooding with less than 0.1% (1 in 1000 year event) chance of occurring.

[9] https://www.pla.co.uk/assets/platidetables2021webversion.pdf Retrieved 13/01/2021

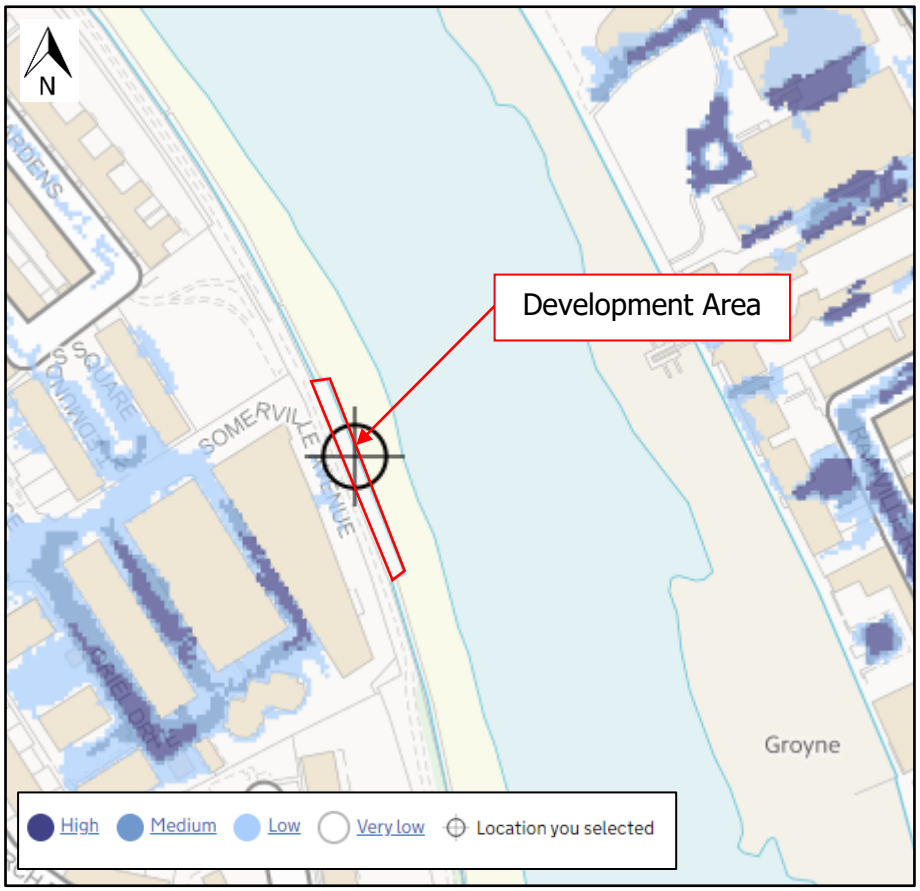


Figure 3[10] - GOV.UK Long Term Flood Risk, Surface Water Extents Risk Map

Figure 3 shows the site to lie in the area to an area defined at 'Very Low' risk. As such, the site is at low risk of surface water flooding in the 1 in 100 year plus climate change event.

Risk of Flooding from Sewers

Sewer flooding generally results in localised short-term flooding caused by intense rainfall events overloading the capacity of sewers. There are a number of sewers running close to the site including a 150mm diameter foul sewer which runs along the eastern side of the Harrods Furniture Depository building and then turns west around the building. A surface water sewer is located adjacent to the foul sewer. The surface water sewer is 225mm diameter and then merges into a sewer 300mm diameter in size.

The Richmond-upon-Thames PFRA and SWMP has collated data from the DG5 register from Thames Water which indicates that there were no records of sewer flooding between 2000 to 2010 for postcode SW13 8. The SFRA notes there were between one and five sewer flooding events between 2010 and 2020 with the same postcode area however no exact locations of these incidents are provided.

Risk of Flooding from Groundwater

The DEFRA's Magic Maps show that the site is not located in a groundwater Source Protection Zone (SPZ), but the superficial deposits are classified as a 'Secondary Undifferentiated' aquifer and Groundwater Vulnerability shown to be 'Minor Aquifer' low. This means the site could support groundwater at a local level rather than a strategic scale.

The British Geologic Survey (BGS) 1:50,000 scale mapping classifies the superficial geology underlying the site to be Alluvium. The bedrock geology is impermeable London Clay. Any groundwater would therefore be expected perched within the superficial deposits rather than the bedrock geology.

[10] © Crown Copyright and database right 2019 OS 100024198. Retrieved 05/01/2020

The Intermediate Assessment of Groundwater Flooding Susceptibility[11], which informs the SWMP, shows that the EA has no records of groundwater flood incidents in the Castelnau area, close to Harrods Wharf.

The site and surrounding area are predominantly hard paved, which reduces the emergence of groundwater at the surface. Groundwater emergence elsewhere in the area would follow localised flow paths, any flooding would flow into the River Thames or into the local surface water drainage network. As the site is located adjacent to the River Thames, it is assumed the groundwater level is intrinsically linked to the baseflow level of the River Thames.

The data for the site suggests that the site is at a low risk of flooding from groundwater sources.

Risk of Flooding from Artificial Sources

The GOV.UK Long Term Flood Risk from Artificial Sources show that the site could be affected by reservoir flooding. The Environment Agency are the enforcement authority for the Reservoirs Act 1975 in England, they ensure that reservoirs are inspected regularly, and essential safety work is carried out. All reservoirs must be inspected and supervised by reservoir panel engineers. There has been no loss of life in the UK from reservoir flooding since 1925.

The Thames Water asset search also provides the location of the potable (clean water) infrastructure. The asset plans shows that there is a private unknown diameter pipe which crosses the site and the River Thames. The pathway of this potable water main clips the southern corner of the wharf. There should be no risk of flooding from this source as the pipe is well maintained by the operator. Before construction begins it is recommended that the operator of the pipe is determined, and exact details of the pipe (location, depth, diameter, and material) is discovered to inform the Construction Management Plan to avoid any damage to the asset.

The site is therefore not considered to be at risk of reservoir flooding and there are no further artificial waterbodies in the area that would constitute a significant risk of flooding to the site.

Summary of Sources of Flood Risk

This assessment concludes that the site is at risk of flooding from the tidal River Thames. The wharf is in front of the raised tidal defences; therefore, it is not protected and would experience tidal flooding. The PLA tide levels have been converted to Ordnance Datum and show the MHWS to be 4.12m AOD and the HAT to be 4.72m AOD. Both these levels are below the level of the wharf (4.90m AOD). However, the EA hydraulic model confirms that the current flood water for the tidal River Thames is 5.01m AOD and the future 2065 flood water level is 5.48m AOD. This means the wharf is not expected to flood during a high tide according to the PLA information but in the event of an extreme tidal flood, the wharf could be affected by tidal flooding.

The is also at risk of flooding from reservoir flooding but as mentioned due the Reservoirs Act 1975 and regular inspections of reservoirs, this source of flood risk is not considered a significant risk to the development.

The site is considered to be a low risk of flooding from other sources.

DESIGN RESPONSE TO FLOOD RISK

Threshold Levels

The EA standing advice for 'Vulnerable' development located in areas of flood risk should have ground floor levels set a minimum of whichever is higher: 600mm above the minimum estimated flood water level or 300mm above the general ground levels. If this is not possible flood mitigation measures, as in accordance with the government guidance document "Improving the Flood Performance of New Buildings: Flood Resilient Construction"[12] ,should be implemented within the design.

The wharf is located above the MHWS and the HAT by 0.78m and 0.18m retrospectively, and the proposed redevelopment of the wharf would not be expected to flood during normal hide tide events. However, the wharf level is 110mm below the present EA extreme TE2100 tidal levels, increasing to 580mm below in 2065.

[11] URS Scott Wilson, March 2011, Intermediate Assessment of Groundwater Flooding Susceptibility

[12] Communities and Local Government (2007), Improving the Flood Performance of New Buildings: Flood Resilient Construction

Given the nature of the development being located on the existing wharf, the wharf will be retained at existing levels and the pavilions raised. The pavilions will have a finished floor level (FFL) of 5.60m AOD.

The FFL of 5.60m AOD is above the PLA MHWS and AHT levels, and the EA current and future extreme TE2100 tidal levels. The pavilions' FFLs are 590mm above the current TE2100 extreme tidal level and 120mm above the 2065 extreme tidal levels.

The pavilions have been designed in respect to the EA guidance for current extreme tidal levels. The development may need to consider implementing flood protection measures on both pavilions to protect against internal during an extreme tidal event after 2065. Future flood protection measures should be in the form of the flood "exclusion" strategy via the use of flood boards and flood resistant construction techniques to prevent the ingress of flood water to the buildings as per published guidance.

However, given the type of development it is considered that the current proposed pavilions would be at minimum refurbished in 50 years' time, therefore no addition measures need to be considered at this time.

Safe Access and Egress

The site is at risk of tidal flooding from the River Thames. The Harrods Wharf management team should sign up to the EA Flood Warning Service to ensure that any flood mitigation measures as outlined in each warning on the GOV.UK website can be implemented in good time.

Should a significant tidal flood event occur, due to the location of the site, occupants would be able to visually see water levels rising and thus be able to implement the flood evacuation plan. The proposed redevelopment does not include any residential development or sleeping accommodation, and therefore there will be no permanent residents nor members of public present on site when the wharf is closed.

In terms of flood evacuation routes, at present there is a level-access route through "metropolitan open land" (north of the Harrods Furniture Depository) from the public footpath along the River Thames bankside. This route would lead to the Riverview Gardens. This would be the quickest viable route to reach the safety of land protected by tidal defences. The Design and Access Statement suggests this route as one of the main access routes to the wharf.

Sustainable Drainage Systems

The existing wharf has formal surface water drainage with outfalls to the River Thames. A site visit in December 2020, showed the wharf to have a gully system down the centre of the site with a series of outfalls at the base of the wharf. A CCTV survey is suggested to confirm that the wharf gullies do outfall to the River Thames.

At present, the wharf free drains (unrestricted flow) to the River Thames. It is proposed that the development continue to discharge to the River Thames, in line with the Drainage Hierarchy.

Detailed runoff calculations have been undertaken for solely the wharf in its existing and post-development state. The existing wharf (690m^2) produces a runoff rate of 19.73 l/s in the 100-year, 6-hour storm event. Post development as per the NPPF, an uplift for climate change is required and the site runoff rate increases to 27.6 l/s for the 1% AEP event plus 40% climate change (with no mitigation measures).

To reduce the surface water rates, post development, green roofs have been proposed across the pavilions. Green roofs are considered amongst the most sustainable of all the SuDS techniques, providing similar benefits as greenfield land such as:

- reduced rainwater runoff;
- enhanced roof insulation properties;
- attractive visual appearance;
- reduction in urban heat island effect;
- enhanced roof lifespan by protecting underlying waterproofing system; and
- provision of green space in urban areas and encouragement of biodiversity.

It should be noted that green roofs are suitable for use with photovoltaics. The presence of a green roof beneath photovoltaic cells has been shown to cool the ambient air temperature around the photovoltaic cells making them more efficient.

Due to the nature of the development there are no other SuDS options which could be incorporated on the wharf and pavilions. Swales and ponds are not suitable due to a lack of open space. Bio-retention area, infiltration and below ground cellular tanks are not feasible as the wharf is concrete. Rainwater harvesting is potentially a solution, but the associated storage tank would need to be place above the structure and as such the shipping containers do not have suitable structural integrity for this loading, alongside the green roof. This is the same conclusion with a blue roof. Green roofs are the only viable option for the site to reduce surface water rates.

The inclusion of 100-150mm deep substate green roofs on the pavilions reduces the post development rate to 21.22 l/s. This green roof SuDS feature reduce rates by 23% in the 1 in 100 year plus 40% climate event. This is a vast improvement on the existing unrestricted rates which discharge to the River Thames.

The remainder of the development site is soft permeable landscaping and the public footpath. The soft landscaping is remaining unchanged and the public footpath drains naturally to the permeable areas. The public footpath will remain unchanged.

Design of the green roof and other SuDS element can be determined at the detailed design stages. Management and maintenance of the chosen SuDS elements should follow manufacturer's specifications. Both can be conditioned as part of the planning permission.

The proposed development does not increase surface water runoff rates and volumes off the site post development and therefore would be compliant with the NPPF.

Summary

This letter has outlined the risk of flooding from all sources and the required mitigation measures. The site is at risk of tidal flooding and it is proposed to raise the pavilions above the EA TE2100 current extreme tidal levels. Given the type of development it is considered that the current proposed pavilions would be at minimum refurbished in 50 years' time, therefore no addition measures need to be considered at this time.

The development will be maintaining its surface water connection to the River Thames and the development is seeking to reduce surface water runoff rates. The pavilions will be introducing green roofs with a subbase of at least 100-150mm which reduces surface water rates by 23%.

Please feel free to contact me if you have any queries.

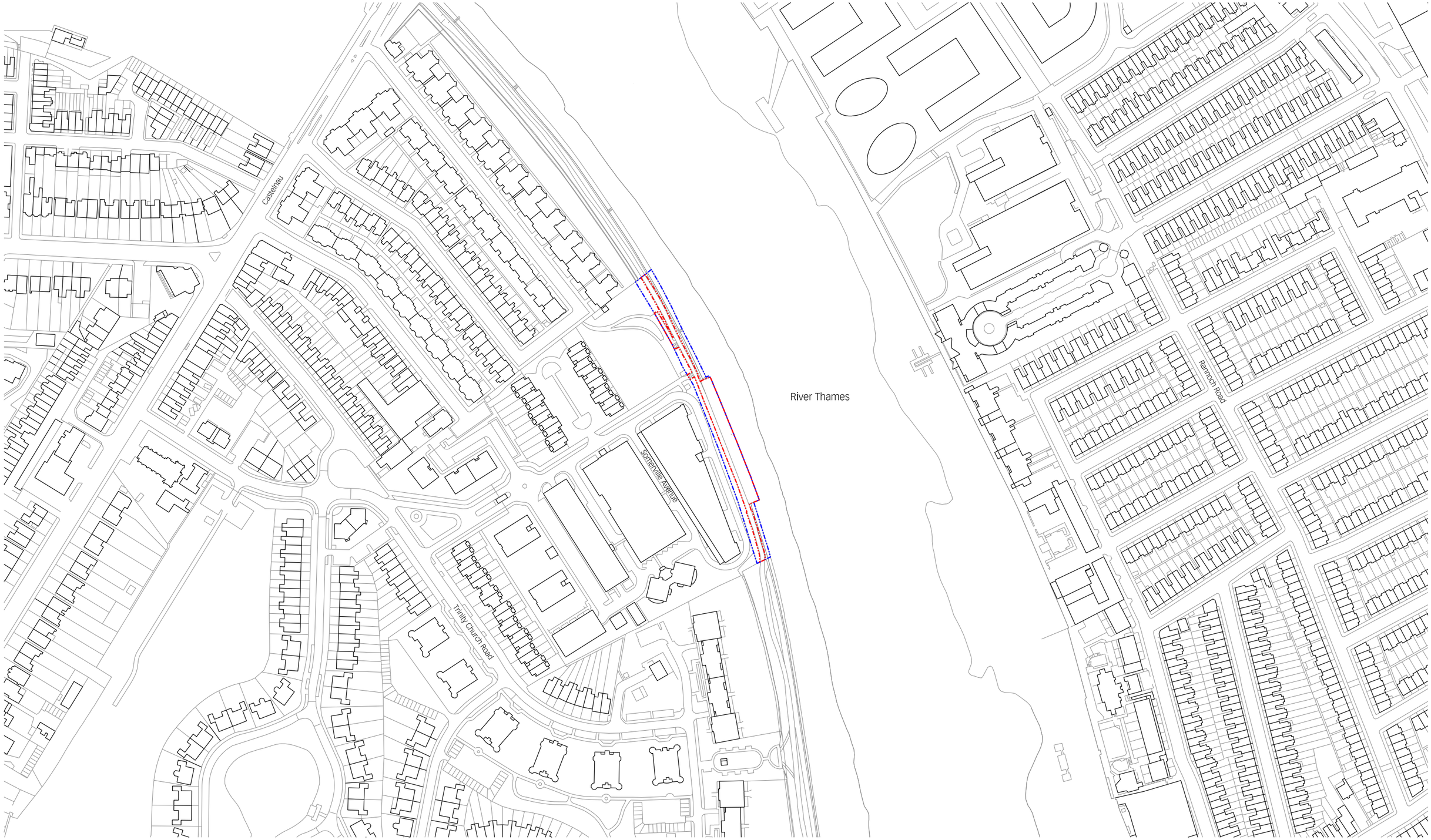
Yours faithfully,

Claire Burroughs
MSc DIC MEng (Hons) Civil
MCIWEM
Senior Environmental Engineer

Enclosures:

- Existing plans
- Proposed plans
- Thames Water Asset Plans
- Surface water calculations

A1/A3



rev date by revisions

key plan

notes

Ownership boundary
Development boundary

0 10 20 30 40 50 100m

architect
Lifschutz Davidson Sandilands
Island Studios, 22 St. Peter's Square, London W6 9NW T +44 (0)20 8600 4800 mail@lds-uk.com

project
Harrods Wharf

Application site and location plan

client
Jamie Waller

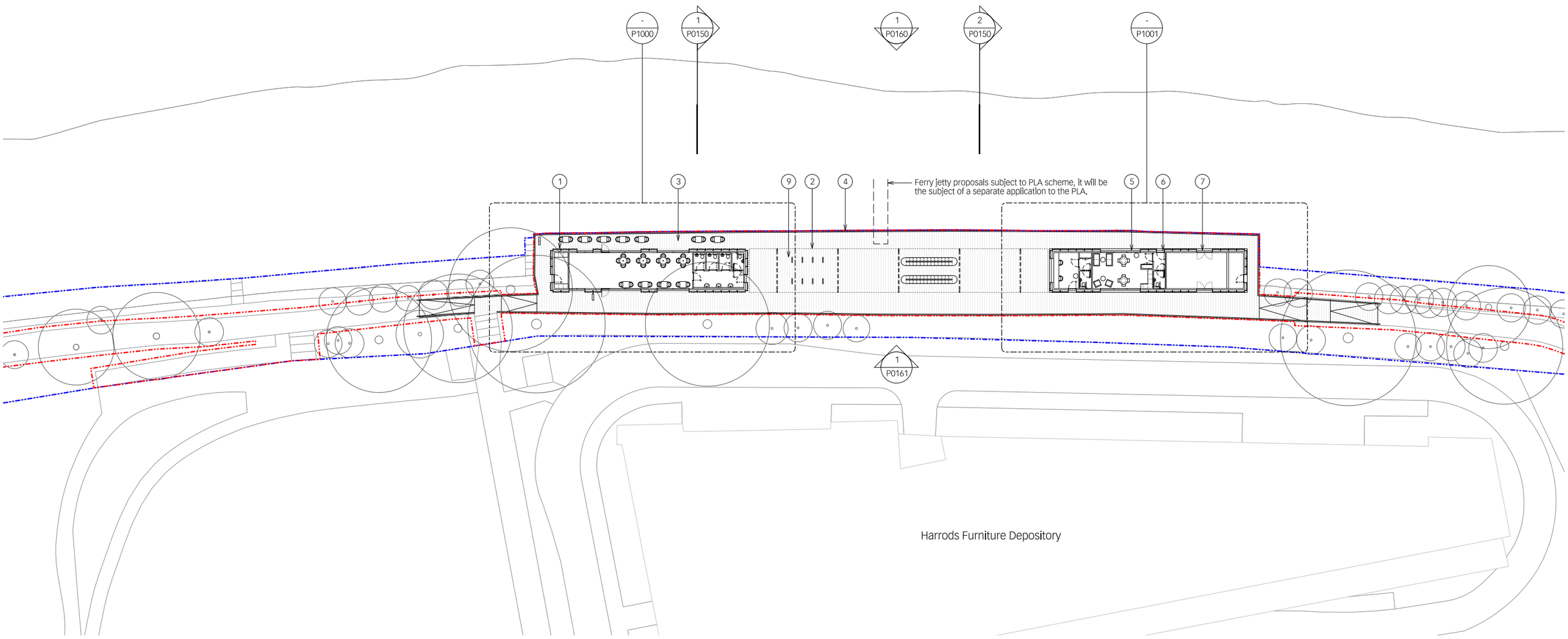
scale at A1	scale at A3	drawn	date
1:1250	1:2500	RF	10.20

job no.	drawing	rev.
1178	X0001	-

A1/A3

material key:

1. metal framed cladding panel with back-illuminated tensile fabric
2. metal framed canopy with back-illuminated tensile fabric
3. recycled composite decking
4. painted metal railing to match existing
5. metal framed glazing
6. metal framed glazed door
7. metal faced door
8. PV panels
9. metal sheffield stand
10. 4m high lamp post
11. low level lighting bollard



rev	date	by	revisions
A	21.12.20	PF	Access ramps updated. Plant room added
B	15.01.21	PF	Access ramps updated.
C	18.01.21	PF	Material key updated
D	22.01.21	PF	Minor amendment on internal layout

key plan

notes

Ownership boundary
Development boundary

0 2 4 6 8 10 20m

architect

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project

Harrods Wharf

Proposed site plan

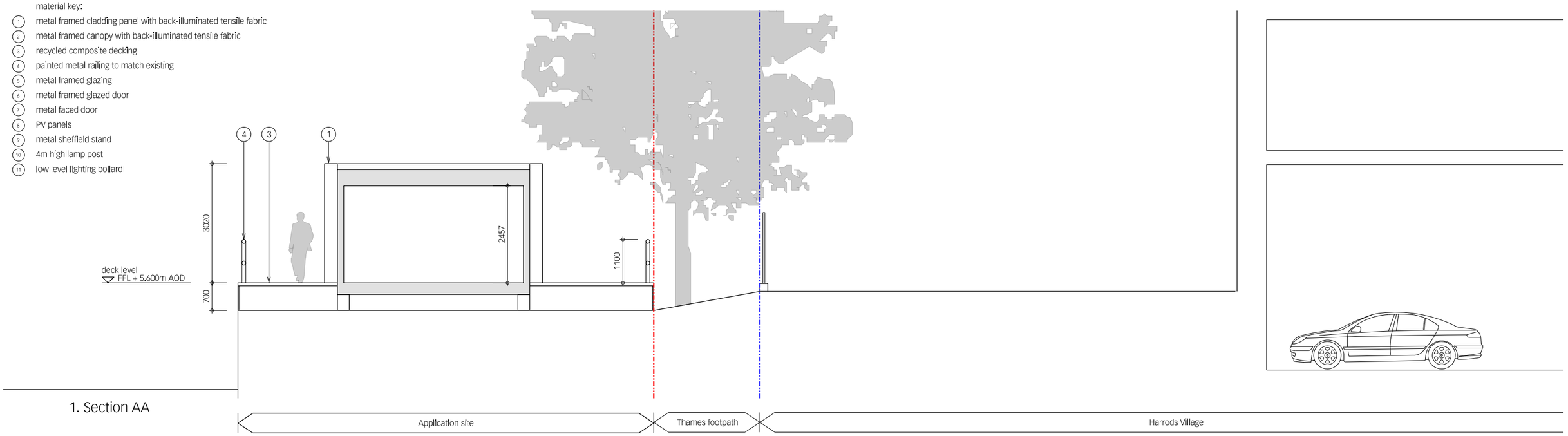
client	scale at A1	scale at A3	drawn	date
Jamie Waller	1:250	1:500	RF	10.20

job no.	drawing	rev.
1178	P0100	D

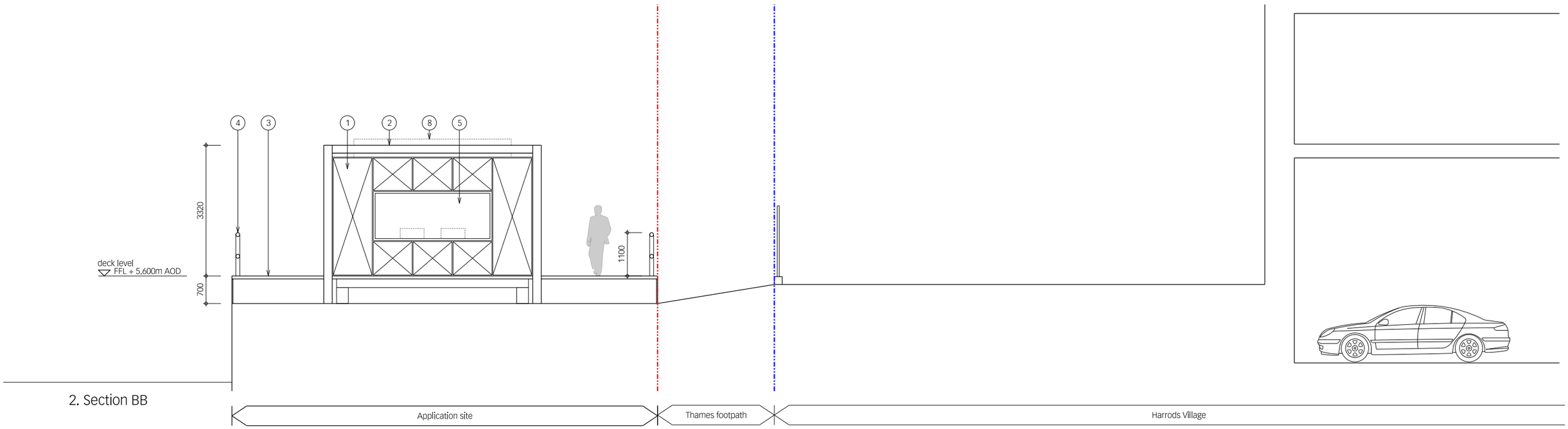
A1/A3

material key:

1. metal framed cladding panel with back-illuminated tensile fabric
2. metal framed canopy with back-illuminated tensile fabric
3. recycled composite decking
4. painted metal railing to match existing
5. metal framed glazing
6. metal framed glazed door
7. metal faced door
8. PV panels
9. metal sheffield stand
10. 4m high lamp post
11. low level lighting bollard



1. Section AA



2. Section BB

rev	date	by	revisions
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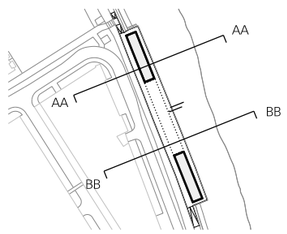
B	15.01.21	PF	Deck level updated
C	18.01.21	PF	Material key updated

key plan



notes

Ownership boundary
Development boundary

0 1 2 3 5m

architect

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project

Harrods Wharf

Proposed pavilion sections

client	scale at A1	scale at A3	drawn	date
Jamie Waller	1:50	1:100	RF	10.20

job no.	drawing	rev.
1178	P0150	C

A1/A3

material key:

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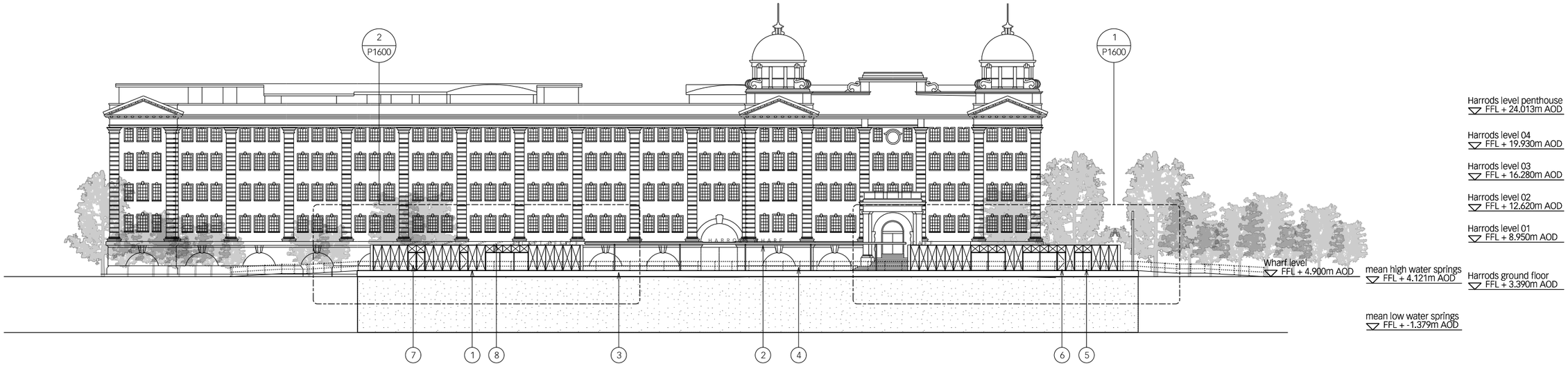
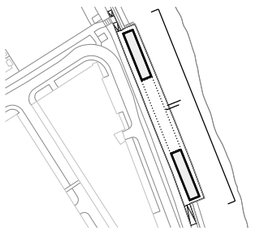
2. metal framed canopy with back-illuminated tensile fabric
3. recycled composite decking
4. painted metal railing to match existing
5. metal framed glazing
6. metal framed glazed door
7. metal faced door
8. PV panels
9. metal sheffield stand
10. 4m high lamp post
11. low level lighting bollard



rev	date	by	revisions
A	21.12.20	PF	Deck level updated to accommodate foundations
B	15.01.21	PF	Deck level and access ramps updated
C	18.01.21	PF	Material key updated

key plan



notes

0 2 4 6 8 10 20m

architect

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project

Harrods Wharf

Proposed east elevation

client	scale at A1	scale at A3	drawn	date
Jamie Waller	1:250	1:500	RF	10.20

job no.	drawing	rev.
1178	P0160	C

A1/A3

material key:

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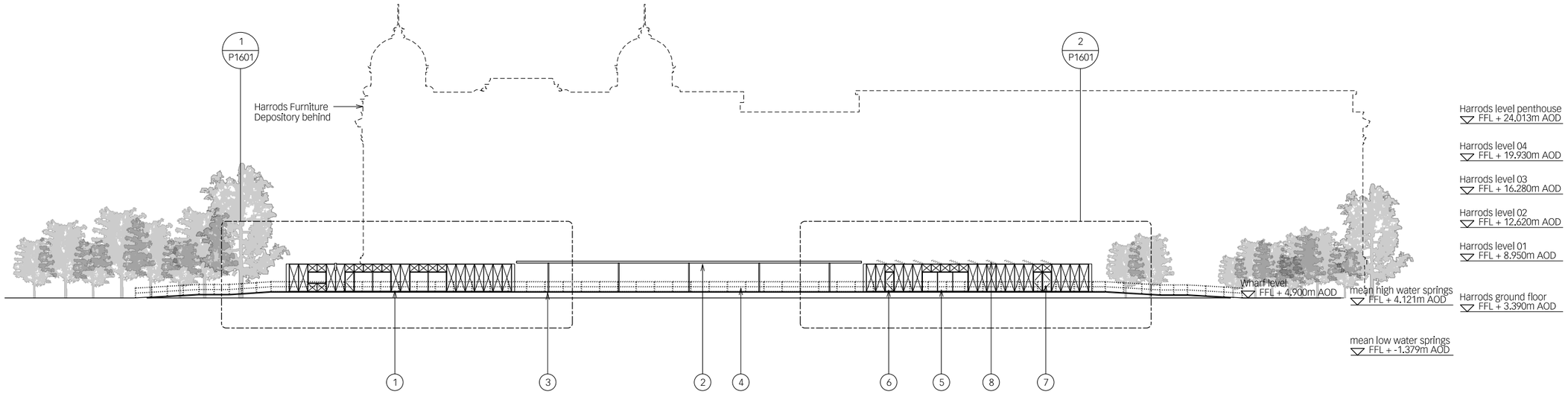
2. metal framed canopy with back-illuminated tensile fabric
3. recycled composite decking
4. painted metal railing to match existing
5. metal framed glazing
6. metal framed glazed door
7. metal faced door
8. PV panels
9. metal sheffield stand
10. 4m high lamp post
11. low level lighting bollard



rev	date	by	revisions
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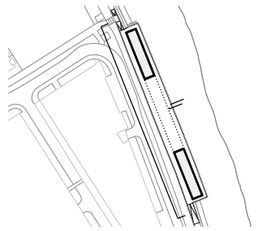
B	15.01.21	PF	Deck level and access ramps updated
C	18.01.21	PF	Material key updated

key plan



notes

0 2 4 6 8 10 20m

architect

Lifschutz Davidson Sandilands

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project

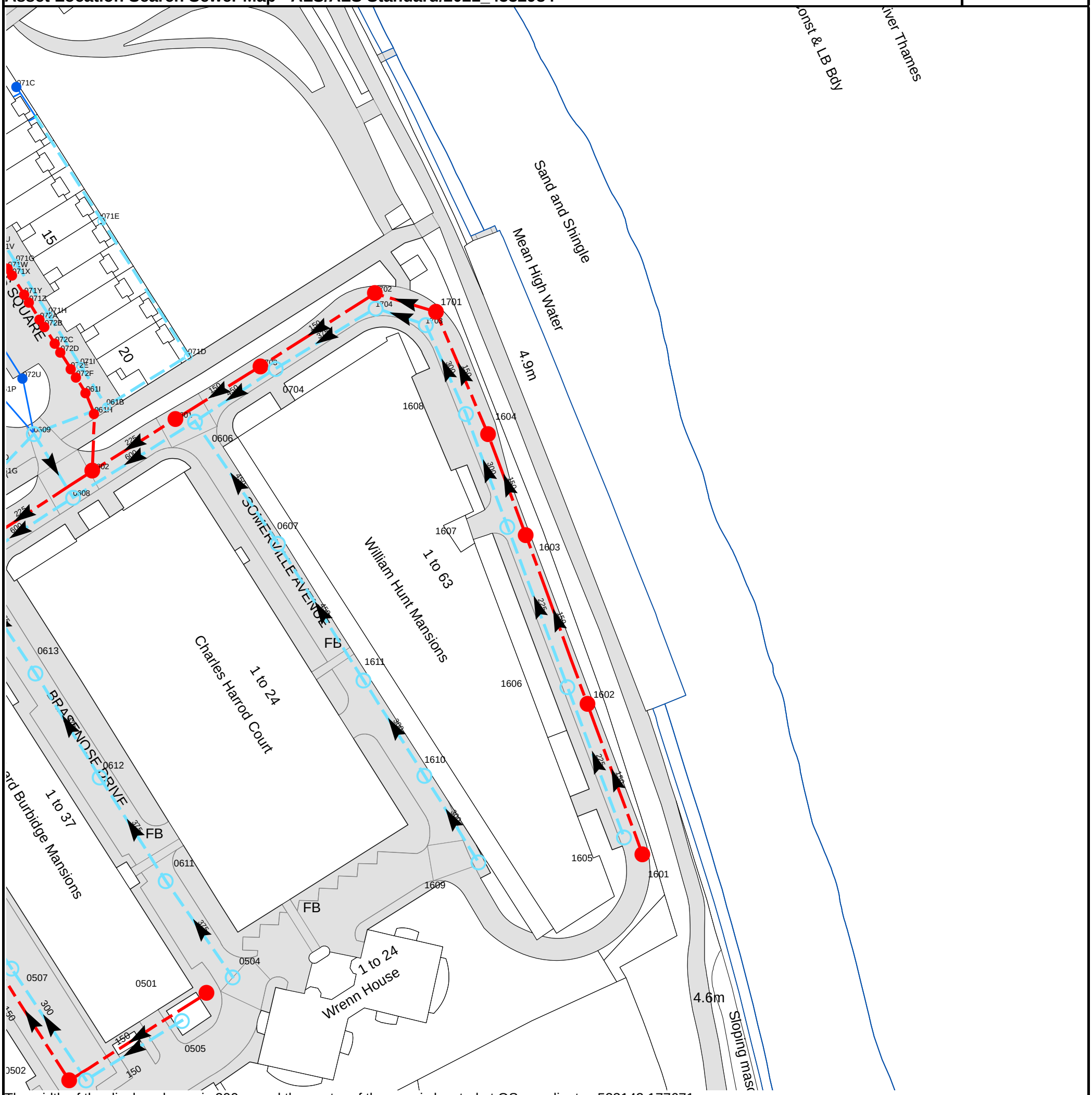
Harrods Wharf

Proposed west elevation

client	scale at A1	scale at A3	drawn	date
Jamie Waller	1:250	1:500	RF	10.20

job no.	drawing	rev.
1178	P0161	C

Asset Location Search Sewer Map - ALS/ALS Standard/2021_4332984



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 523142,177671

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
0606	3.443	1.749
0703	4.175	2.449
0704	4.219	1.947
0607	3.16	1.938
1611	3.008	1.984
1702	4.929	2.612
1704	4.864	2.062
1703	5.031	3.084
1701	5.09	2.685
1608	5.022	3.2
1604	5.044	2.862
1607	4.918	3.248
1603	4.979	3.015
1606	5.062	3.432
1602	5.099	3.249
1610	3.025	2.185
1609	3.361	2.225
1605	4.827	3.525
1601	4.825	3.475
071W	n/a	n/a
071X	n/a	n/a
072U	n/a	n/a
071Y	n/a	n/a
071Z	n/a	n/a
0609	3.317	2.055
0613	3.04	1.972
072A	n/a	n/a
072B	n/a	n/a
071H	n/a	n/a
072C	n/a	n/a
072D	n/a	n/a
072E	n/a	n/a
0608	3.205	1.715
072F	n/a	n/a
071I	n/a	n/a
061I	n/a	n/a
0602	3.259	1.377
061H	n/a	n/a
061B	n/a	n/a
0601	3.95	2.071
071D	n/a	n/a
0507	2.83	1.54
0502	2.83	.29
0506	2.83	1.6
0612	2.973	2.012
0611	3.04	2.076
0505	3	2.07
0501	3	1.13
0504	3.159	2.134
071G	n/a	n/a
071E	n/a	n/a
071C	n/a	n/a

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

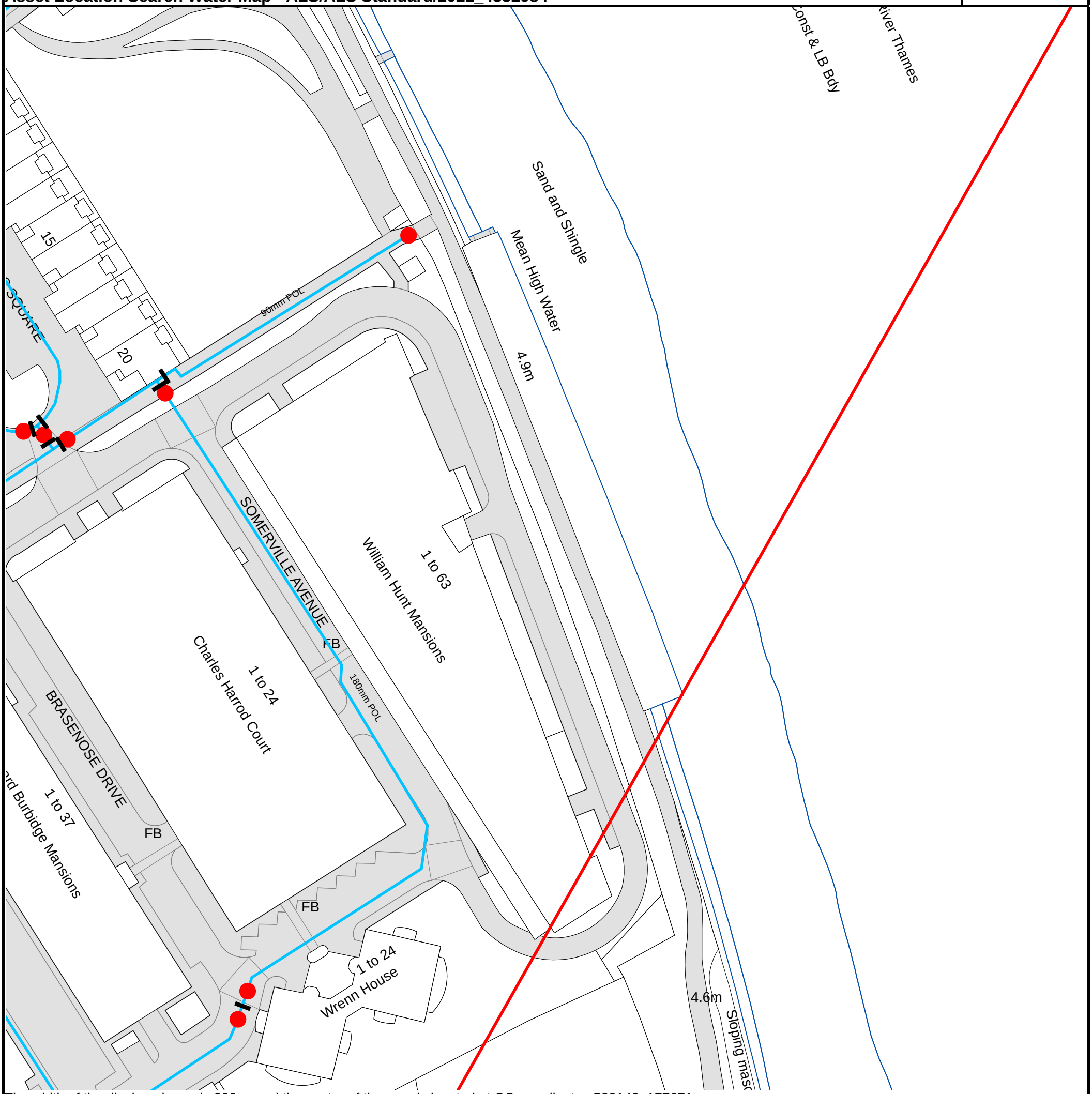
Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2021_4332984



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 523142, 177671.

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16"

Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY

Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE

Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED

Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

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D21 RUNOFF CALCULATIONS | COVER SHEET

Job No.	20123	
Job Name	Harrods Wharf	
Engineer	Claire Burroughs	CB
Checked By	Tony Clothier	TC
Date	08.01.21	

Site Characteristics

Site Area (ha): 0.069

	Overall		Discharging from site		
Existing Pervious Surfaces (ha)	0	0%	0	β	0%
Existing Impervious Surfaces (ha)	0.069	100%	0.069	α	100%
Total:	0.069	Total:	0.069		

	Overall		Discharging from site		
Proposed Pervious Surfaces (ha)	0	0%	0	β	0%
Proposed Impervious Surfaces (ha)	0.0414	60%	0.0414	α	100%
Proposed Green Roof	0.0276	40%	0.0276	γ	100%
Total:	0.069	Total:	0.069		

Green Roof Type: sedum-herbaceius-grass plants >10-15 cm Course Depth
Construction Depth: 100-150mm Gradient: of up to 15°,

Peak Rate of Runoff

Existing Site	BROWNFIELD
Detailed Modelling Used?	No e.g. Microdrainage, HydroCAD, Multiple Catchments
Runoff Calculation Method (Existing)	Wallingford/Modified Rational Calculation Sheets Attached
Runoff Calculation Method (Proposed)	Wallingford/Modified Rational Calculation Sheets Attached
Allowance for Future Climate Change	To 2115 UE 40%
Surface Water Management Strategy	Attenuated on Site

	1yr	30yr	100yr		
Existing Discharge Rate	**6.3**	**15.4**	**19.7**	l/s	
IoH Greenfield Discharge Rate (full site)	**0.1**	**0.2**	**0.3**	l/s	
Detailed modelling output/FEH:				l/s	
Limiting Discharge Rate	6.3	15.4	19.7	l/s	
Post-Development Discharge Rate	4.8	11.8	15.2	l/s	
Detailed modelling output:				l/s	
including allowance for climate change	**6.8**	**16.6**	**21.2**	l/s	
Proposed Discharge Rate	6.3	15.4	19.7	l/s	
Bespoke Limiting Discharge Rate	4.4	10.5	13.4		
Design discharge rate:	**4.4**	**10.5**	**13.4**	l/s	Bespoke Rate
Minimum Storage Required	**0.6**	**1.5**	**2.1**	m^3	

Volume of Runoff

Additional Volume (above Greenfield) of Runoff Generated

Existing Site	21.1	m^3
Proposed Site (unmitigated)	29.6	m^3
Rainwater retained on-site for re-use (where limited)	0.0	m^3
Long Term Storage Required	8.4	m^3
Proposed Site (including soakaways/infiltration SUDS)	#DIV/0!	m^3

Off-site discharge must be restricted and storage provided
Justification for not using infiltration or preventing discharge: Ground conditions not suitable

	1yr	Qbar	2 l/s/ha	Min Flow*
Limiting discharge rates:	6.3	0.10	0.138	2 (l/s)

Preferred Limiting Discharge Rate: 2.0 l/s Design and model outputs attached

Date Printed: 14/01/2021

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IH124 : Greenfield Peak Runoff

20123	Harrods Wharf	
Calculations By: CB	Checked By: TC	Date: 08.01.21

Catchment Area	AREA	ha	0.069
Standard average annual rainfall 1941 - 1970	SAAR	mm	600
Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL		0.3

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1A_{SOIL1} + 0.3A_{SOIL2} + 0.37A_{SOIL3} + 0.47A_{SOIL4} + 0.53A_{SOIL5}}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5
AREA	0	0.069	0	0	0
SPR	0.1	0.3	0.37	0.47	0.53

SOIL: 0.3

$QBAR = 0.00108 . (0.01AREA)^{0.89}. SAAR^{1.17}. SOIL^{2.17}$

* The site area is less than 50ha. Since the IoH124 methodology is not calibrated for sites less than 50ha in area, the calculation should be undertaken based on a 50ha site area and proportionately adjusted based on the ratio of the site size to 50ha.

$QBAR_{50ha}$	l/s	76.08
QBAR/ha	l/s/ha	1.52
$QBAR_{site}$	l/s	**0.10**

Hydrological Area	fig 4.2	6

Return Period (years)	Growth Factor (table 4.3)	Discharge rate l/s
1	0.85	**0.09**
2	0.88	0.09
10	1.62	0.17
30	2.3	**0.24**
50	2.62	0.28
100	3.19	**0.33**

Figures and table references from CIRIA C753 The SUDS Manual © CIRIA 2015

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Wallingford Procedure : Existing Peak Runoff

20123	Harrods Wharf	
Calculations By: CB	Checked By: TC	Date: 08.01.21

Site Characteristics

Site Area	AREA	ha	0.069
Drained Catchment Area	AREA	ha	0.069
Approximate Longest Drainage Path	L	m	100
Difference in Ground Levels	ΔH	m	1
Slope	Slope (S)		1: 100
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	0%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	100%
Area Weighted Rational Method Runoff Coefficient			0.950

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Time of Concentration

Recommended Tc Method: SCS: Sheet Flow
Tc Method Choice: SCS: Sheet Flow

Sheet Flow

Surface Description			Concrete (coarse)
Slope			Shallow
Roughness Coefficient	(Manning's n)		0.024
Flow Length, L		m	100
M2-24hr		mm	37.70
Land Slope		m/m	0.01000
Tc		hr	0.19

Time of Concentration	T_c	min	11.3
Critical Storm Duration (minimum 5min)	T_{crit}	min	11.3

Critical Storm Rainfall and Runoff

$Z1_{TC}$	0.54	*Wallingford Procedure Figure 3.6
M5-T_{crit}	10.7	
C	0.950	

Discharge Rate
Q = 2.78CiA

Return Period (years)	Z2*	Depth (mm)	Intensity (mm/hr)	Discharge Rate l/s
1	0.61	6.5	34.6	**6.30**
2	0.79	8.5	44.8	8.16
10	1.22	13.1	69.1	12.60
30	1.49	16.0	84.4	**15.39**
50	1.65	17.7	93.5	17.04
100	1.91	20.5	108.3	**19.73**

*Wallingford Procedure Table 3.2

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Wallingford Procedure : Developed Peak Runoff

20123	Harrods Wharf	
Calculations By: CB	Checked By: TC	Date: 08.01.21

Site Characteristics

Site Area	AREA	ha	0.069
Drained Catchment Area	AREA	ha	0.069
Approximate Longest Drainage Path	L	m	100
Difference in Ground Levels	ΔH	m	1
Slope	Slope (S)		1: 100

Permeable Surfaces (Rational Method runoff coefficient = 0.4)	ha	0%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)	ha	60%
Green Roof of gradient of up to 15°, and depth of 100-150mm , c=	0.4 *	40%
Area Weighted Rational Method Runoff Coefficient		0.73

*in line with Table 10.1 of CIRIA C644

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Time of Concentration

Recommended Tc Method: SCS: Sheet Flow
Tc Method Choice: SCS: Sheet Flow

Sheet Flow

Surface Description			Concrete (coarse)
Slope			Shallow
Roughness Coefficient	(Manning's n)		0.024
Flow Length, L		m	100
M2-24hr		mm	37.70
Land Slope		m/m	0.01000
Tc		hr	0.19

Time of Concentration	T_c	min	11.3
Critical Storm Duration (minimum 5min)	T_{crit}	min	11.3

Critical Storm Rainfall and Runoff

$Z1_{TC}$ 0.54 *Wallingford Procedure Figure 3.6
$M5\text{-}T_{crit}$ 10.7
C 0.730

Discharge Rate
Q = 2.78CiA

Return Period (years)	Z2*	Depth (mm)	Intensity (mm/hr)	Discharge Rate l/s	Future Rate l/s
1	0.61	6.5	34.6	**4.84**	**6.78**
2	0.79	8.5	44.8	**6.27**	8.78
10	1.22	13.1	69.1	**9.68**	13.56
30	1.49	16.0	84.4	**11.83**	**16.56**
50	1.65	17.7	93.5	**13.09**	18.33
100	1.91	20.5	108.3	**15.16**	**21.22**

*Wallingford Procedure Table 3.2

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SUDS Manual Volume Calculation (Existing)

20123	Harrods Wharf	
Calculations By: CB	Checked By: TC	Date: 08.01.21

Site Characteristics

Site Area	AREA	ha	0.069
Permeable Surfaces (Existing Case)			0%
Proportion discharging to sewer network or local watercourses	β		0%
*zero if all runoff collected from unpaved surfaces is retained on site or discharged to ground			
Impermeable Surfaces (Existing Case)	PIMP		100%
Proportion discharging to sewer network or local watercourses	α		100%
*zero if all runoff from paved surfaces remains on site or is collected and discharged to ground			
Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL		0.3

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1A_{SOIL1} + 0.3A_{SOIL2} + 0.37A_{SOIL3} + 0.47A_{SOIL4} + 0.53A_{SOIL5}}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5	
AREA	0	0.069	0	0	0	**SOIL:**
SPR	0.1	0.3	0.37	0.47	0.53	**0.3**

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Volume Calculation for the 100 year return period 6hr storm

$Z1_{6hr}$	1.55	*Wallingford Procedure Figure 3.6
M5-6hr	31.1	
$Z2_{100yr}$	1.97	*Wallingford Procedure Table 3.2
M100-6hr	61.2	

Additional volume (m^3) of existing site runoff over Greenfield runoff:

$$Vol = \text{"M100-6hr"}.AREA.10[PIMP/100\ (0.8\alpha)+(1-PIMP/100)SOIL\ .\ \beta-SOIL]$$

* EQ24.10 CIRIA C753 The SUDS Manual © CIRIA 2015

Additional Volume of Runoff (above Greenfield state):	**m^3**	**21.1**

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SUDS Manual Volume Calculation (Proposed)

20123	Harrods Wharf	
Calculations By: CB	Checked By: TC	Date: 08.01.21

Site Characteristics

Site Area	AREA	ha	0.069
Permeable Surfaces (Proposed Case)			0%
Proportion discharging to sewer network or local watercourses	β		0%
*zero if all runoff collected from unpaved surfaces is retained on site or discharged to ground			
Impermeable Surfaces (Proposed Case)	PIMP		100%
Proportion discharging to sewer network or local watercourses	α		100%
*zero if all runoff from paved surfaces remains on site or is collected and discharged to ground			
Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL		0.3

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1A_{SOIL1} + 0.3A_{SOIL2} + 0.37A_{SOIL3} + 0.47A_{SOIL4} + 0.53A_{SOIL5}}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5	
AREA	0	0.069	0	0	0	**SOIL:**
SPR	0.1	0.3	0.37	0.47	0.53	**0.3**

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Volume Calculation for the 100 year return period 6hr storm

$Z1_{6hr}$	1.55	*Wallingford Procedure Figure 3.6
M5-6hr	31.1	
$Z2_{100yr}$	1.97	*Wallingford Procedure Table 3.2
M100-6hr	61.2	
With Climate Change	85.7	40%

Additional volume (m^3) of development runoff over Greenfield runoff:

$$Vol = \mathrm{M100{-}6hr}.AREA.10\left[\frac{PIMP}{100}(0.8\alpha) + \left(1 - \frac{PIMP}{100}\right)SOIL.\beta - SOIL\right]$$

* EQ24.10 CIRIA C753 The SUDS Manual © CIRIA 2015

Additional Rainfall Volume (above Greenfield state) for the developed site: **m^3** **29.6**

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D21 RUNOFF CALCULATIONS | COVER SHEET

Job No.	20123	
Job Name	Harrods Wharf	
Engineer	Claire Burroughs	CB
Checked By	Tony Clothier	TC
Date	08.01.21	

Site Characteristics

Site Area (ha) 0.069

	Overall		Discharging from site		
Existing Pervious Surfaces (ha)	0	0%	0	β	0%
Existing Impervious Surfaces (ha)	0.069	100%	0.069	α	100%
Total:	0.069	Total:	0.069		

	Overall		Discharging from site		
Proposed Pervious Surfaces (ha)	0	0%	0	β	0%
Proposed Impervious Surfaces (ha)	0.069	100%	0.069	α	100%
Proposed Green Roof	0	0%	0	γ	0%
Total:	0.069	Total:	0.069		

Green Roof Type: sedum-herbaceius-grass plants >10-15 cm Course Depth
Construction Depth: 100-150mm Gradient: of up to 15°,

Peak Rate of Runoff

Existing Site	BROWNFIELD	
Detailed Modelling Used?	No	e.g. Microdrainage, HydroCAD, Multiple Catchments
Runoff Calculation Method (Existing)	Wallingford/Modified Rational	Calculation Sheets Attached
Runoff Calculation Method (Proposed)	Wallingford/Modified Rational	Calculation Sheets Attached
Allowance for Future Climate Change	To 2115 UE 40%	
Surface Water Management Strategy	Attenuated on Site	

	1yr	30yr	100yr		
Existing Discharge Rate	**6.3**	**15.4**	**19.7**	l/s	
IoH Greenfield Discharge Rate (full site)	**0.1**	**0.2**	**0.3**	l/s	
Detailed modelling output/FEH:				l/s	
Limiting Discharge Rate	6.3	15.4	19.7	l/s	
Post-Development Discharge Rate	6.3	15.4	19.7	l/s	
Detailed modelling output:				l/s	
including allowance for climate change	**8.8**	**21.5**	**27.6**	l/s	
Proposed Discharge Rate	6.3	15.4	19.7	l/s	
Bespoke Limiting Discharge Rate	4.4	10.5	13.4		
Design discharge rate:	**4.4**	**10.5**	**13.4**	l/s	Bespoke Rate
Minimum Storage Required	**1.7**	**4.4**	**6.0**	m^3	

Volume of Runoff

Additional Volume (above Greenfield) of Runoff Generated

Existing Site	21.1	m^3
Proposed Site (unmitigated)	29.6	m^3
Rainwater retained on-site for re-use (where limited)	0.0	m^3
Long Term Storage Required	8.4	m^3
Proposed Site (including soakaways/infiltration SUDS)	#DIV/0!	m^3

Off-site discharge must be restricted and storage provided
Justification for not using infiltration or preventing discharge: Ground conditions not suitable

	1yr	Qbar	2 l/s/ha	Min Flow*
Limiting discharge rates:	6.3	0.10	0.138	2 (l/s)

Preferred Limiting Discharge Rate: 2.0 l/s Design and model outputs attached

Date Printed: 15/01/2021

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Wallingford Procedure : Developed Peak Runoff

20123	Harrods Wharf	
Calculations By: CB	Checked By: TC	Date: 08.01.21

Site Characteristics

Site Area	AREA	ha	0.069
Drained Catchment Area	AREA	ha	0.069
Approximate Longest Drainage Path	L	m	100
Difference in Ground Levels	ΔH	m	1
Slope	Slope (S)		1: 100

Permeable Surfaces (Rational Method runoff coefficient = 0.4)	ha	0%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)	ha	100%
Green Roof of gradient of up to 15°, and depth of 100-150mm , c=	0.4 *	0%
Area Weighted Rational Method Runoff Coefficient		0.95

*in line with Table 10.1 of CIRIA C644

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Time of Concentration

Recommended Tc Method: SCS: Sheet Flow
Tc Method Choice: SCS: Sheet Flow

Sheet Flow

Surface Description			Concrete (coarse)
Slope			Shallow
Roughness Coefficient	(Manning's n)		0.024
Flow Length, L		m	100
M2-24hr		mm	37.70
Land Slope		m/m	0.01000
Tc		hr	0.19

Time of Concentration	T_c	min	11.3
Critical Storm Duration (minimum 5min)	T_{crit}	min	11.3

Critical Storm Rainfall and Runoff

$Z1_{TC}$ 0.54 *Wallingford Procedure Figure 3.6
$M5\text{-}T_{crit}$ 10.7
C 0.950

Discharge Rate
Q = 2.78CiA

Return Period (years)	Z2*	Depth (mm)	Intensity (mm/hr)	Discharge Rate l/s	Future Rate l/s
1	0.61	6.5	34.6	**6.30**	**8.82**
2	0.79	8.5	44.8	**8.16**	11.42
10	1.22	13.1	69.1	**12.60**	17.64
30	1.49	16.0	84.4	**15.39**	**21.54**
50	1.65	17.7	93.5	**17.04**	23.86
100	1.91	20.5	108.3	**19.73**	**27.62**

*Wallingford Procedure Table 3.2