

Manchester City Council

Victoria North Infrastructure Works

Drainage Strategy

Reference: VNIF-ARP-ZZ-YYY-RP-CD-0003

P05 | 03 October 2022

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 282022

Arup Limited
6th Floor 3 Piccadilly Place
Manchester
M1 3BN
United Kingdom
arup.com

Document Verification

Project title Victoria North HIF
Document title Drainage Strategy
Job number 282022
Document ref VNIF-ARP-ZZ-YYY-RP-CD-0003
File reference

Revision	Date	Filename	VNIF-ARP-ZZ-YYY-RP-CD-0003 - Drainage Strategy		
P01	20 Oct 2021	Description	First Draft		
			Prepared by	Checked by	Approved by
		Name	Drew Hunter/Emily Stoddart	Ryan Griffiths	Melanie Edwards
		Signature			
P02	28 Jan 2022	Filename	VNIF-ARP-ZZ-YYY-RP-CD-0003 - Drainage Strategy		
		Description	Issued for planning		
			Prepared by	Checked by	Approved by
		Name	Drew Hunter/Emily Stoddart	Ryan Griffiths	Michael Wilton
		Signature			
P03	18 Feb 2022	Filename	VNIF-ARP-ZZ-YYY-RP-CD-0003 - Drainage Strategy		
		Description	Updated for planning		
			Prepared by	Checked by	Approved by
		Name	Emily Stoddart/Drew Hunter	Ryan Griffiths	Michael Wilton
		Signature			
P04	02 Sept 2022	Filename	VNIF-ARP-ZZ-YYY-RP-CD-0003 - Drainage Strategy		
		Description	Updated for WS4		

	Prepared by	Checked by	Approved by
Name	Emily Stoddart	Ryan Griffiths	Michael Wilton
Signature			

P05	03 Oct 2022	Filename	VNIF-ARP-ZZ-YYY-RP-CD-0003 - Drainage Strategy
		Description	Updated to TA comments
		Prepared by	Checked by
		Approved by	
		Name	Emily Stoddart/Drew Hunter
		Signature	

Issue Document Verification with Document ☒

Contents

1.	Introduction	1
2.	Site overview	1
2.1	Site description	1
2.2	Scope of works	2
3.	Existing Drainage	3
3.1	Combined sewer network	3
3.2	Surface water drainage regime	5
4.	Geotechnics and Geo-Environmental	6
4.1	Topography overview of the site	6
4.2	Overview of Groundwater conditions	6
4.3	Potential for contamination	6
5.	Surface water hierarchy	7
6.	Flood Risk Assessment	7
7.	Proposed drainage strategy	8
7.1	Discharge restrictions	8
7.2	Climate change	9
7.3	Surface water strategy	9
7.4	Foul water strategy	11
8.	Sustainable drainage systems (SuDS)	12
8.1	Plateau Road	13
8.2	Detention basin	13
8.3	Geocelular Tanks	13
8.4	Oversized Pipes	13
8.5	Water treatment capabilities and the Simple Index Approach	13
9.	Phased development and maintenance	15
9.1	Interim construction phase maintenance regime	15
9.2	Post site completion maintenance regime	16
10.	Conclusions	20

Tables

Table 1 Flood Risk Assessment Summary	7
Table 2 Network restrictions summary	10
Table 3 Foul Generation per plot	11
Table 4 Land Use Pollution Hazard Indices	14
Table 5 Proposed SuDS Pollution Mitigation Indices	14
Table 6 Operation and maintenance requirements for detention basins	16
Table 7 Operation and maintenance requirements for Permeable Paving	17
Table 8 Operation and maintenance requirements for an Attenuation Tank	18
Table 9 Typical maintenance requirements of pipe network	19
Table 10 Operation and maintenance requirements for channel drains, slot drains and gullies	19

Figures

Figure 1 Proposed Victoria North Masterplan	1
Figure 2 Victoria North site location and boundary	2
Figure 3 River Works scope as defined by the HIF river works package	3
Figure 4 Existing combined drainage network	4
Figure 5 Historic site profile (note: plan shows outdated site boundary)	5
Figure 6 Drainage zones	9
Figure 7 SuDS suitability matrix for Victoria North	12

Drawings

No table of figures entries found.

Pictures

No table of figures entries found.

Photographs

No table of figures entries found.

Attachments

No table of figures entries found.

Appendices

A.1	Appendix A Existing Surface Water Catchment Plan	22
A.2	Appendix B Detention Basin Design Checklist	23
A.3	Appendix C Detention Basin Health and Safety Risk Assessment	24
A.4	Appendix D Detention Basin Riprap Size Calculation	25
A.5	Appendix E Detention Basin Maintenance Inspection Plan	26

1. Introduction

Arup have been commissioned by BAM on behalf of Manchester City Council (MCC) to provide design services for the 'Design and Build' Infrastructure Works for the Victoria North HIF¹ masterplan (see Figure 1). This is funded under Homes England for the development of a 14ha site within the Lower Irk Valley in Manchester. Infrastructure works are being carried out to support a subsequent residential led development being planned for Victoria North by a Joint Venture of MCC and FEC. This development is part of a wider Victoria North masterplan redevelopment to the North of Manchester centre. This report provides an overview to the Drainage Strategy as it stands during the Work Stage 4 delivery of the scheme.



Figure 1 Proposed Victoria North Masterplan

2. Site overview

2.1 Site description

The Site comprises an area of circa 14 hectares within the Lower Irk Valley, predominately within the Red Bank and New Town neighbourhoods, which form part of the extended Manchester City Centre. The Site location and proposed redline boundary is provided in Figure 2.

¹ Housing Infrastructure Funding



Figure 2 Victoria North site location and boundary

The site comprises features that represent more than 150 years of industrial history and infrastructure. Features include modified waterways, significant operational and redundant rail infrastructure, utilities infrastructure and contaminated sites associated with textile manufacturing and other heavy industries. These features may present constraints and influence future development proposals.

2.2 Scope of works

2.2.1 Victoria North HIF infrastructure works

The masterplan for the Victoria North Works RIBA Stage 4 review is presented in Figure 1. The Infrastructure works comprise preparation of the existing landscape for the development of new plots, to be accessed by new and existing highways. Existing access points will be maintained across the River Irk. The works also include development of a central park area.

The proposed drainage strategy for the Infrastructure Works will take account of connections and diversions of utilities required for the future development of the plots within the site.

The joint venture (MCC/FEC) have stated an aspiration for a net zero carbon development for the Victoria North masterplan in line with MCC strategy on sustainable development and carbon management. It should be noted that the HIF Victoria North Infrastructure Works delivery will be carbon positive due to the nature of the work and will only be ‘part’ of the wider environmental strategy of the Victoria North Masterplan (an overall net zero carbon target).

2.2.2 River works

As part of the HIF scheme, there is a separate commission which includes works to the River Irk with the aim of reducing flood risk and increasing the water quality of the river. These works are being delivered under a separate project and are not covered in this report. However, there are multiple interfaces between this project and the infrastructure scheme, as all surface water is proposed to drain directly to the River Irk. Coordination with the river works team is ongoing to ensure that an integrated drainage strategy is achieved between both work packages. The extent of the river works scheme is shown in Figure 3.

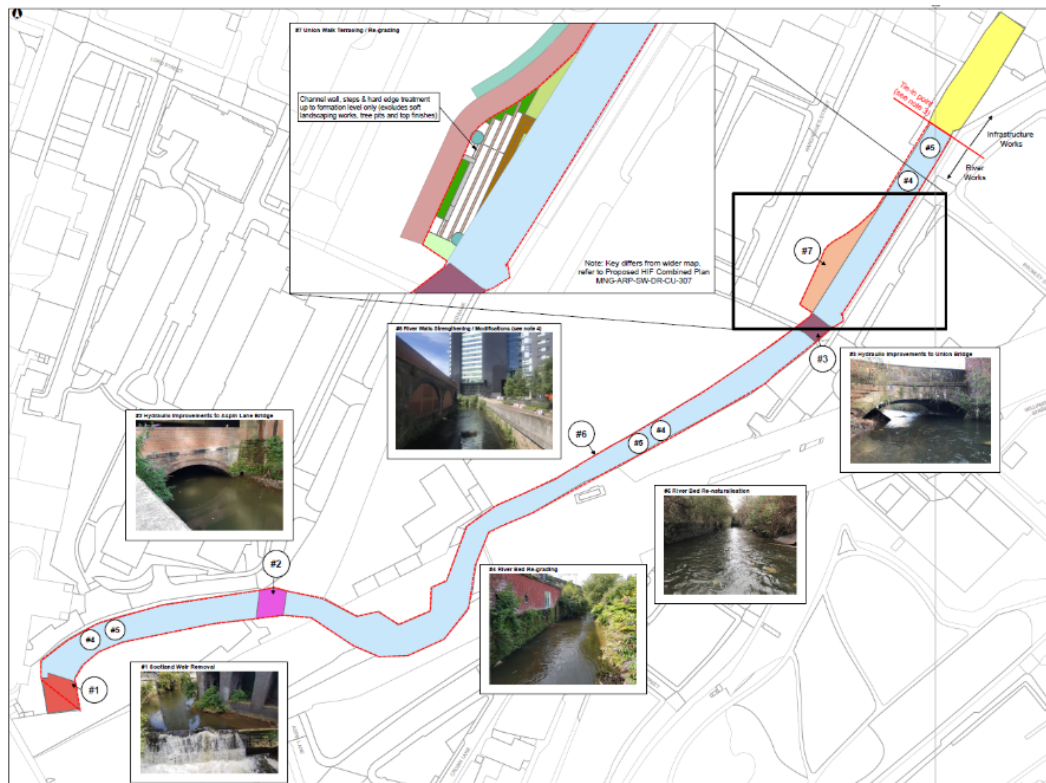


Figure 3 River Works scope as defined by the HIF river works package

3. Existing Drainage

3.1 Combined sewer network

The existing network within the HIF Red Bank area consists of combined sewers with overflows into the River Irk. The site sits within multiple existing drainage catchments as identified in the site wide drainage strategy. Drawing VNIF-ARP-ZZ-YYY-DR-CD-0001 in Appendix A shows the existing catchments.

The existing drainage network on site consists of combined public sewers, owned by United Utilities who are the statutory undertaker. The features of the existing network have been identified from statutory records provided by United Utilities, these are summarised below and shown on Figure 4:

- 380x480mm box culvert, circa 5m deep and flowing South beneath Red Bank at the North of site

- 1500mm diameter sewer pipe, circa 5m deep and flowing South beneath Dantzic street at the South of site
- 550mmx640mm box culvert, circa 5m deep, flowing South running through the centre of the site, with an overflow into, and passage under the River Irk
- A small network of sub-carriageway box culverts between Brighton street and Hargreaves street, circa 3m deep, ranging from 375mmx500mm to 550mmx750mm in cross section
- A single pipe flowing into Dantzic Street beneath the waste processing facility

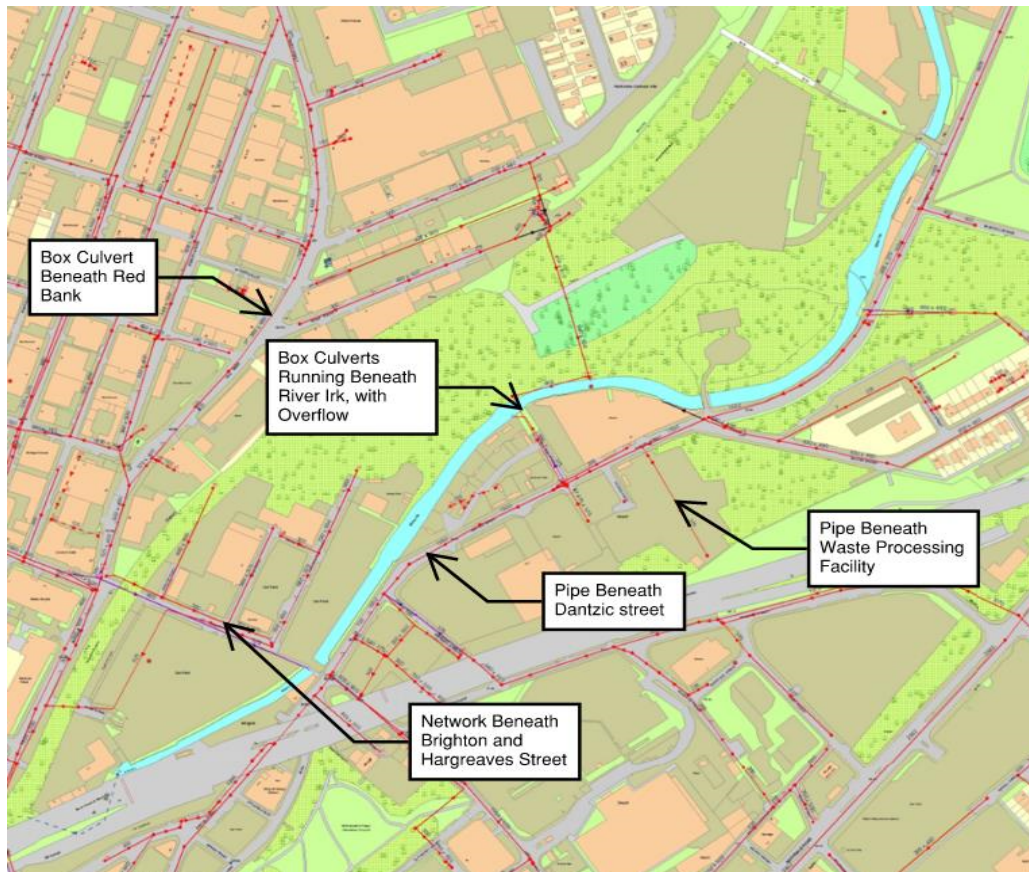


Figure 4 Existing combined drainage network

There are several Combined Sewer Overflows (CSOs) to the river within the site boundary, these act as strategic contingency overflows when the capacity of the connected sewer is surcharged in periods of extreme precipitation or due to back-up from blockages. These prevent flooding from sewers in populated areas and can prevent damage to the sewer network and allow efficient design of sewers. The CSOs on the Victoria North site outfall into the River Irk. The details of the CSOs are as follows:

- 2 overflows which outfall on opposite riverbanks, North of Warford Street;
- an overflow from Roger Street, which outfalls on the North bank of the River Irk;
- an overflow perpendicular to Dantzic Street, from underneath the proposed NT01 plot, which outfalls from the South bank of the River Irk.

In 2020 the CSOs within the site boundary spilled a total of 108 times for a total of 660 hours², with the most spills occurring at the Dantzic Street/Warford Street CSO. This indicates that there may be reduced capacity in the combined sewers as a result of blockages.

Passing through the centre of site is an existing watercourse called the River Irk. Historic records indicate that an old mill run comes off the River Irk to the North East of site and re-connects to the River Irk towards the South West of the site. Records show that this channel has been infilled since decommissioned. This can be seen in the Figure 5 below in light blue.

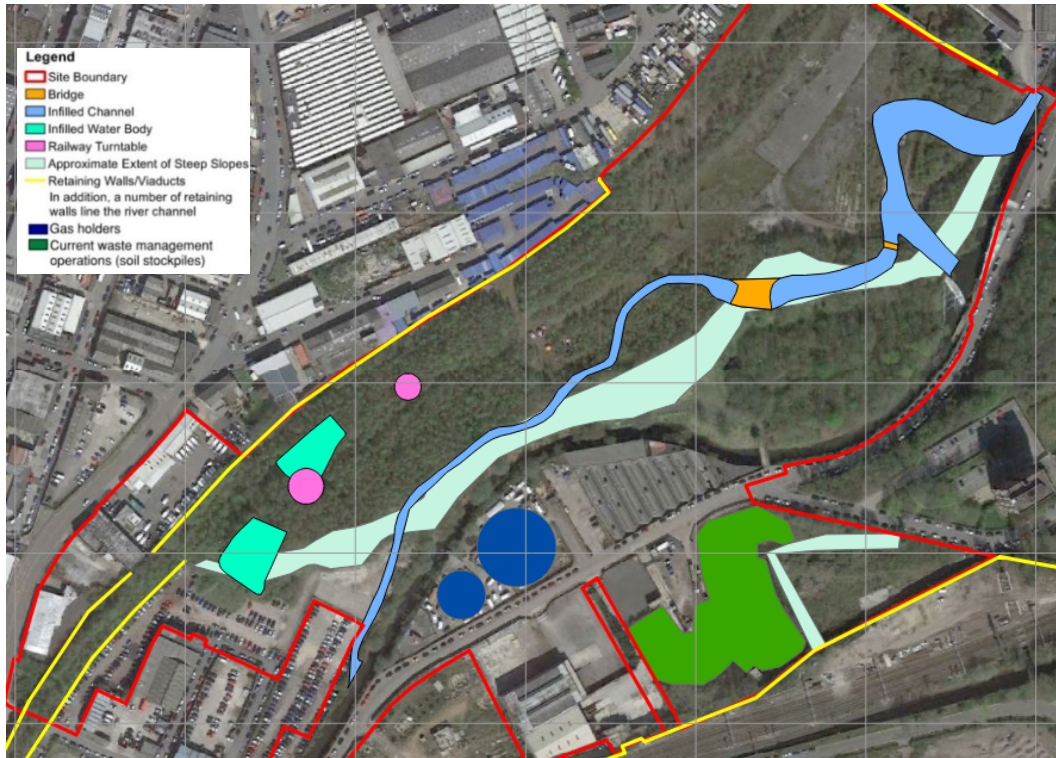


Figure 5 Historic site profile (note: plan shows outdated site boundary)

3.2 Surface water drainage regime

There are no existing surface water drains in or around the site. All surface water is assumed to either infiltrate, drain to the River Irk or to the combined sewer network. There are three surface water catchments within the site boundary, these are indicated on Drawing VNIF-ARP-ZZ-YYY-DR-CD-0001 in Appendix A.

Based on the site topography and location of existing sewers, it is likely that catchment 4 (Plateau East and St Catherine's Wood) does not drain to the combined sewer and instead is drained through infiltration or directly to the river. Catchment 1 (Plateau West down to Satnam) is likely to be at least partially drained by the combined sewers in Roger Street and Red Bank, infiltration is also likely in some areas of catchment 1.

² The Rivers Trust: <https://www.riverstrust.org/key-issues/sewage-in-rivers>

4. Geotechnics and Geo-Environmental

This section presents a high-level review of the key geotechnical and geo-environmental considerations relating to the Victoria North Infrastructure Works site.

The Ground Investigation Interpretive Report VNIF-ARO-ZZ-YYY_RP-CG-0012 gives detail of the ground conditions on the site.

4.1 Topography overview of the site

The site occupies the north-east/south-west orientated valley of the River Irk. Areas of the site are characterised by steep slopes. North of the river, ground levels fall from approximately 50m AOD in the north to approximately 30m AOD along the river channel. South of the river, ground levels rise from river level to approximately 40m AOD at the southern site boundary. Levels are based off a Topographical Survey received 29-09-21.

4.2 Overview of Groundwater conditions

The main aquifers beneath the site are the Chester Pebble Beds and Collyhurst formations (Principal Aquifers) with the Manchester Marl a Secondary B Aquifer. Available GI data suggests groundwater is present at between 40m AOD in the NE and 28m AOD in the SW of the site and appears to be associated with both Made Ground and Glacial Till, though groundwater is also likely to be encountered in alluvial deposits. The principal groundwater level is anticipated as being below most proposed structures and excavations (except for piled foundations). However, localised perched groundwater is anticipated within the Made Ground (along with the relatively high water table to the NE of site) and this may limit the potential for infiltration to be used in certain areas within site.

4.3 Potential for contamination

Ground investigation has identified contamination from the following sources on site:

- Around the former gasworks in St Catherine's Wood which may pose a risk to human health and controlled waters.
- Around the former carriage shed on Red Bank Plateau which may pose a risk to human health and controlled waters.
- Oils may be encountered during excavation, which may present a risk to groundwater and may impact the potential for reuse of site-won soil. If identified during the works, additional localised remediation and validation may be required.
- Hazards associated with the presence of asbestos fibres and asbestos containing materials in made ground, which will require mitigation during construction and operation of the site.
- Contaminants including metals, hydrocarbons and PAH within the made ground, which Will require mitigation during construction and operation, including during any interim periods between the completion of remediation and the beginning of plot development;
- Potential contaminant linkages relating to impact on the River Irk and bedrock aquifers have been identified in the DQRA_ Remediation works are required 10 the former gas works and former carriage shed areas to address these issues.

Due to the above factors, infiltration is not proposed as a drainage mechanism across any of the site with the exception of St Catherine's Wood which will be actively drained.

5. Surface water hierarchy

The surface water hierarchy is summarised below, discharge mechanisms should be prioritised with 1 being most favourable to 4 being least favourable.

- (1) Infiltration > (2) Discharge to surface water body > (3) Discharge to surface water sewer > (4) Discharge to combined sewer

Following the discharge hierarchy, infiltration will not be possible due to the issues presented in section 4. Discharge to surface water is therefore the preferred mechanism for this site.

Where land is currently parkland and will remain as parkland, infiltration will remain the drainage mechanism and it is not proposed that these areas are actively drained.

All surface water will be discharged to the River Irk which passes through the site. Discharge restrictions have been agreed with the LLFA (MCC) and the EA. This strategy will prevent the new outfalls to the River Irk from worsening fluvial flood risk.

6. Flood Risk Assessment

Arup have produced a Site Specific Flood Risk Assessment (SSFRA) VNIF-ARP-ZZ-YYY-RP-CD-0002. The SSFRA shall be referred to for the full report/context, but a summary of the report is shown in the table below.

Table 1 Flood Risk Assessment Summary

Site Area	Flood zone(s)	Potential impacts of HIF Infrastructure works	Mitigation measures required assuming removal of river wall upstream of Union Bridge
Upper Plateau	Flood zone 1 for whole area	No anticipated impact on flood risk	Maintain existing flow regime Adopt a suitable drainage strategy including 40% allowance for climate change
South of river & Dantzic Street	Flood zone 1 along West edge of Travis Island Flood zone 2 in majority of area Flood zone 3 on Dantzic Street	Negligible impact on flood risk	Within all flood zones: - Maintain existing flow regime - Adopt a suitable drainage strategy including 40% allowance for climate change Within flood zone 2: - Development to follow Environment Agency Standing Advice - On-plot building levels and evacuation routes designed to appropriate levels Within flood zone 3: - Surface water management on Dantzic Street to consider water levels in drainage design Note: Dantzic Street strategy is not included in the stage 4 design
North of river (west)	Flood zone 1 at proposed red bank terraces	Increase flood depth >0.1m upstream and downstream of Union	Within all flood zones; - Maintain existing flow regime

	Flood zone 2 in majority of area Flood zone 3 immediately north of Union Bridge	Bridge for 100-year event, and upstream of Union Bridge only for 1000-year event Flood extents likely increased South of Roger Street for 100-year event and North of Roger Street for 1000-year event	- Adopt a suitable drainage strategy including 40% allowance for climate change Within flood zone 2: - Development to follow Environment Agency Standing Advice - On-plot building levels and evacuation routes designed to appropriate levels - Drainage design and building levels both on and off plot should consider increased flood depths resulting from the removal of the river wall upstream of Union Bridge Within flood zone 3: - Surface water management to be designed considering flood depths and extents - On-plot land used to be designed to prioritise less vulnerable building types within flood zone 3 Mitigation measures due to impact of works: - Drainage design and building levels both on and off plot should consider increase flood depths resulting from the removal of the river wall upstream of Union Bridge for all flood zones - Temporary bunding may be used to replicate the function of the existing river wall and avoid worsening flood risk - Phasing of the river wall removal shall be developed in coordination with confirmation of the river works design solution to ensure flood risk is not worsened as a result of the scheme without permanent mitigation which may be achieved through the river works
Off site (along Scotland Street)	N/A	Increase flood depth of approximately 0.02m due to additional fluvial flooding originating from out of channel flows enabled by removal of river wall upstream of Union Bridge.	Temporary bunding may be used to replicate the function of the existing river wall upstream of Union Bridge and avoid worsening flood risk off site. Phasing of the river wall removal shall be developed in coordination with the confirmation of the river works design solution to ensure flood risk is not worsened as a result of the scheme without permanent mitigation which may be achieved through the river works.

7. Proposed drainage strategy

7.1 Discharge restrictions

The drainage strategy will discharge all surface runoff directly to the River Irk. As all connections to the river will be considered new connections, greenfield restrictions have been specified by the LLFA in line with ambitions set out in the Manchester, Salford and Trafford SFRA.

Surface water restrictions are based on the existing catchments shown in Appendix A. This excludes the park area which will continue to drain through infiltration as it does currently.

Discharge restrictions have been agreed with the LLFA (MCC), the Environment Agency and the on-plot developer. As all outfalls are new connections to the River Irk, a greenfield (Qbar)

restriction is applied up to the 30-year event and a 100-year greenfield restriction is applied for the 100-year event. The resulting discharge restrictions are as follows:

- 30-year storm = **14 l/s/ha** (catchments 1, 3 and 4)
- 30-year storm = **13.3 l/s/ha** (catchment 5)
- 100-year storm = **22 l/s/ha** (all catchments)

These restrictions will also be applied to all plot connections into the network.

7.2 Climate change

In accordance with NPPF, runoff for the 100-year storm will include a 40% allowance for climate change.

7.3 Surface water strategy

Three surface water networks are included in the design with three outfalls. There is a separate network which supplies a small wet play area within the proposed park. Flow controls are included at various points in the networks to achieve a varied restriction between the 30-year and 100-year events. The outline of the three drainage zones are shown in Figure 6.



Figure 6 Drainage zones

7.3.1 Development Plots

The general arrangement of the surface water network is shown on VNIF-ARP-00-YYY-DR-CD-0002. Drainage pipes for the surface water network have been modelled with a depth of 2.0-2.5m below cover level. Plots will be drained through connections to carrier pipes within the highway and public realm; one connection will be allowed per plot. Surface water connections from the plots will have flow restrictions in line with the site wide discharge restrictions and the management of this will be the responsibility of the plot developer.

7.3.2 Infrastructure Strategy

The carrier drain network downstream of plot connections are to be adopted by United Utilities. Flow control devices will be applied at the outfall to the river Irk for each catchment, which will restrict flows to the following:

Table 2 Network restrictions summary

Outfall	Impermeable Area (ha)	30-year restriction (l/s)	30-year modelled peak flow (l/s)	100-year restriction (l/s)	100-year modelled peak flow (l/s)
1 (Union Walk)	0.486	6.8	5.9	10.7	10.4
2 (Plateau West)	4.420	60.9	59.6	97.2	95.9
3 (Plateau East)	1.817	24.2	23.9	40.0	34.2

All calculations for the surface water networks are given in VNIF-ARP-ZZ-YYY-CS-CD-0001 and indicate that all discharge restrictions are met, and that flooding does not occur up to the 30-year event. Any flooding in the 100-year event will be maintained on site as shown on exceedance route drawings VNIF-ARP-00-YYY-DR-CD-0018 AND 0019. For detailed drawings of network elements, refer to drawings VNIF-ARP-00-YYY-DR-CD-0002-0063.

The Union Walk and Plateau West networks have been tested under surcharged conditions for the 30-year event, Plateau East outfalls at a higher level than the 30-year peak river level and so the surcharged case is not tested. See VNIF-ARP-00-YYY-FN-CD-0001 for details of how the networks have been surcharged, surcharged results are also given in VNIF-ARP-ZZ-YYY-CS-CD-0001.

7.3.3 Plateau East

The Plateau Road will be drained through permeable paving which stores runoff before discharging to carrier pipes within the carriageway. The permeable layer will be lined to prevent infiltration. Orifice flow controls at the inlet to carrier drains will allow water to be stored in the permeable road layer in order to achieve the proposed discharge restriction. This system is not to be adopted by United Utilities.

The carrier system then joins the sewers carrying the outfall from the plots. A Hydro-Brake flow control restricts the flow at the top of the plateau to utilise all available storage before discharging down the hillside through a series of backdropped pipes, a complex control at the outfall allows for the varied discharge restrictions to be met. The outfall for Plateau East consists of a core through an existing river wall.

7.3.4 Plateau West

The drainage mechanism for Plateau west mirrors the mechanism for Plateau east. Highway runoff will be captured and stored in permeable paving and discharged to carrier pipes within the highway. This system is lined to prevent infiltration and orifice flow controls restrict flow to allow water to be stored within the permeable layer. Plots will be drained into the carrier system further downstream.

A complex flow control restricts flow at the top of the plateau to utilise all available storage. A series of backdrops then carries the flow down the hillside and through a detention basin.

A second branch drains Red Bank Terraces and public realm, storage is provided by 2 n.o. attenuation tanks with flow controls. This branch connects downstream of the detention basin before outfalling through a headwall structure to the River Irk.

7.3.5 Union Walk

Union Walk public realm is drained through 2n.o. attenuation tanks with flow controls, these connect with the plot drainage for plot RB07 before discharging to the Irk through a headwall structure.

7.3.6 River Park

The Park area replaces an existing area with no active drainage mechanism; therefore, this area will continue to naturally drain, and no drainage infrastructure is proposed within the park. A wet play area is proposed within the park, this is drained through a series of filter drains with an outfall through the retaining wall to the River Irk.

7.4 Foul water strategy

Foul water from the plots will be collected in new foul water sewers, which will discharge to the existing combined sewer network which surrounds the site. The connection depth from plots has been agreed with the on-plot developers as 1.5m minimum depth to cover.

The expected foul peak flows are shown in Table 3. In line with the Sewers Design and Construction Guidance, these are calculated based on a peak rate of 4000l/s/day per dwelling and 0.6l/s/ha for non-residential land uses. Two scenarios are tested for plots RB05a and RB05c, refer to VNIF-ARP-ZZ-YYY-CS-CD-0001 for further detail.

Table 3 Foul Generation per plot

Plot	Housing units	Commercial sqm	Clubhouse sqm	School/GP sqm	Total non-resi sqm	Foul generation l/s
RB01	239	1132	0	0	1132	12.02
RB02	176	679	0	0	679	8.84
RB03	189	0	0	0	0	9.45
RB04	203	0	0	0	0	10.15
RB05a (1)	416	0	1335	0	1335	20.88
RB05a (2)	214	0	0	0	0	10.70
RB05b	0	0	0	1824	1824	0.11
RB05c (1)	0	0	0	0	0	0.00
RB05c (2)	202	0	0	0	0	10.10
RB06	285	0	1824	0	1824	14.36
RB07	Drained to separate network					
RB08	Drained to separate network					

RB09	Drained to separate network					
RB10	Drained to separate network					
RB11	Drained to separate network					
RB12a	Drained to separate network					
RB12b	134	0	0	0	0	6.70

Plots outside the HIF boundary in immediate proximity to the existing combined system are assumed to connect into the existing system directly and do not connect to the proposed foul network.

Consultation is ongoing with United Utilities to understand the capacity of the existing sewers. A CCTV survey of the sewers has also been commissioned to advise on their current condition. Existing surface water connections from the site to the combined sewer will be re-routed directly to the river, so the overall flow rate to the combined sewer will be reduced. Collaboration with United Utilities will continue to achieve a design which is adoptable by them.

Phasing of the development will be considered to ensure that self-cleansing velocities are achieved within the foul system at all stages of development.

8. Sustainable drainage systems (SuDS)

An initial investigation of the potential SuDS for use within the Victoria North site was undertaken at an early design stage, an overview of the results of this is shown in Figure 7.

Suitability:  High (+)  Medium  Low (-)	Blue Roof	Green Roof	Grey Water Recycling	Rain Water Harvesting	Kerb Drain, Rills and Channels	Bio-Retention	Hydro-Dynamic Separators (HDS)	Detention Basins	Ponds / Wetlands	Storage Tank	Geocellular Tank	Rain Gardens	Bioswale	Porous Pavements	Infiltration Trenches	Oversized Pipes	Dry Swales
	Suitability for Victoria North (Off-Plot)																
	Suitability for Victoria North (On-Plot)																
	Cost																
Limited Space																	
Water Quality																	
Reduce Runoff																	
Storage																	
Maintenance																	
Aesthetic Value	/		/	/			/			/	/					/	

Figure 7 SuDS suitability matrix for Victoria North

All suitable off plot SuDS were considered during the design. Through design development the most suitable SuDS systems to tie into the wider masterplan were decided for each of the site areas as summarised in the sections below.

8.1 Plateau Road

Permeable Paving will be utilised for the Plateau road and areas of public realm within the masterplan, including on-street car parking spaces and footways. Permeable paving provides a large area for storage of storm water to reduce the risk of flooding. Pollutants in the water will be trapped by the permeable layer through adsorption and settlement and broken down by natural processes. Additional benefits will include the prevention of surface water pooling as well as potential evapotranspiration due to the shallow depth of storage.

Water infiltrates through voids in the paving, and is stored in the voids in the sub-base. Additional gullies have been included in areas where the calculated runoff from the catchment served by a paving section exceeds the available infiltration in the 100yr + climate change event. Paving will only be porous to the surface course within the areas of the parking bays. The area of permeable surface has been calculated as sufficient to drain the catchment for each sections, however the ratio of impermeable: permeable surface for some sections of paving is greater than 2:1, presenting a residual risk of clogging of the permeable layer; the maintenance regime should make particular consideration of this, as presented in section 9.2.2. The sub-base will be lined to ensure there is no infiltration to the ground. The surface water will exit through a filter pipe at the bottom of the sub-base to drain to the carrier system. A typical section of the permeable paving is shown in VNIF-ARP-00-YYY-DR-CD-0013.

8.2 Detention basin

The detention basin will store up to 120m³ of water during storm events and will sit dry during prolonged periods of dry weather, providing an area of amenity. This will store runoff collected in the Plateau West network and a complex control will restrict outflow from the basin to provide the required storage for the 30 and 100-year storms. The basin is proposed for adoption by UU, the Ciria design checklist for the basin is given in Appendix B and the health and safety assessment for the basin is given in Appendix C. Maintenance considerations for the basin are covered in section 9.2.1 of this document.

The maximum velocity during the 30 minute 1-year storm event is shown in Appendix D to be 0.035m/s when accounting for the influence of the rip rap stone apron at the inlet of the basin.

The basin will be vegetated with grass, this which will provide some filtration along the base, settling of particulate pollutants within the basin will also provide water treatment. The outfall will be designed to prevent the resuspension of solids before water outfalls to the river.

8.3 Geocelular Tanks

Geocelular tanks are used within the Red Bank Terrace and Union Walk areas of the site. These are considered the most suitable SuDS to achieve the required storage volumes in areas of flood zones 2 and 3 to reduce the risk of storage systems being carried away in potential flood events.

8.4 Oversized Pipes

1 n.o. oversized pipe (750mm dia) is used within the Plateau East network, this is needed to meet the storage requirement for the 100-year event and to fit into the spatial constraints of the site.

8.5 Water treatment capabilities and the Simple Index Approach

The Simple Index Approach (SIA) has been used to determine the treatment efficiency of the proposed Sustainable drainage systems across the site.

Under the SIA, the site use has been designated as ‘low traffic roads’ which is the site use with the highest Pollution Hazard Index of all proposed land uses within the development. The Pollution Hazard Indices for this land use are shown in Table 4.

Table 4 Land Use Pollution Hazard Indices

<i>Pollution Hazard Indices</i>				
<i>Runoff Area Land Use Description</i>	<i>Pollution Hazard Level</i>	<i>Total Suspended Solids</i>	<i>Metals</i>	<i>Hydrocarbons</i>
Low traffic roads (e.g. residential roads and general access roads, < 300 traffic movements/day)	Low	0.5	0.4	0.4

The Pollution Mitigation Indices of the proposed SuDS features are shown in Table 5.

Table 5 Proposed SuDS Pollution Mitigation Indices

<i>Pollution Mitigation Indices</i>			
	Total Suspended Solids	Metals	Hydrocarbons
Detention basin	0.5	0.5	0.6
Bioretention system (where the system is not designed as an infiltration component)	0.8	0.8	0.8
Pervious pavement (where the pavement is not designed as an infiltration component)	0.7	0.6	0.7

Groundwater protection will be provided for all SuDS features through the use of lining to prevent infiltration to the ground.

As the pollution mitigation indices for each of the proposed SuDS elements are greater than the pollution hazard index, the proposed components are considered sufficient to provide pollution risk mitigation in isolation. Additionally, the SuDS features have been designed so that most of the surface water flows will pass through multiple SuDS elements before they are discharged. This will provide a robust treatment train and treat a broad range of pollutants; the proposed features will provide interception, primary and secondary treatment to most of the surface water flows as defined by the Ciria SuDS Manual 2015.

Some areas of the site are drained through attenuation tanks only, these are in areas of lower hazard potential (pedestrian and soft landscaping zones). Siltation will be reduced in these areas using silt traps and sumps at collection points and prior to outfalls.

9. Phased development and maintenance

The Victoria North site is to be developed in multiple phases. The infrastructure works will form part of the first stage of development, on-plot development will be undertaken in subsequent phases. The construction phase will therefore continue after the completion of the HIF works, with the last plot being completed in approximately 2032 according to the current phasing plan.

For both the surface and foul water networks, construction and associated traffic could also cause increased amounts of debris to enter the system which may also cause blockages. Blockages and sedimentation within the SuDS systems will reduce their storage and treatment capabilities which could lead to increased flood risk and pollution of surface water or other environmental receptors. Similarly, sedimentation within the foul network could exacerbate current capacity issues downstream in the combined sewer network, likely leading to increased CSO spill rates and potential flooding. Construction debris may also cause erosion to pipe networks, particularly where backdrops are included due to steep slopes. Temporary construction traffic routes should be developed with consideration of the cover depths and load classes of the drainage network to prevent damage.

As the drainage networks will be installed prior to plots connecting to the system, self-cleansing velocities may not be achieved during all phases of the development. The current proposed phasing plan indicates a seven-year gap between the completion of the first plot and the last. Assuming that occupancy of the plots will follow a similar timeline to their completion, flow rates may be lower than the designed full flow rate for a number of years before all plots come online and an interim increased maintenance regime is required, as discussed in section 9.1.

9.1 Interim construction phase maintenance regime

A maintenance plan is outlined in section 9.2 in line with Ciria 753. The frequency of maintenance activities should be increased during construction phases to prevent the need for remedial actions. Additional maintenance requirements of the system during the interim period between HIF Infrastructure completion and plot occupation will include:

- Visual inspection of all networks quarterly and following large storms,
- Camera surveys prior to plot build outs to ensure the system is clear of debris and construction waste,
- Rodding and jetting of drainage pipes and regular inspection/sediment removal from chambers as needed following inspection,
- Sweeping of permeable paving using a brush and suction cleaner twice yearly, after leaf fall and as required following inspection,
- Monthly inspection and sediment removal from flow controls, inlets and outlets,
- Mowing, vegetation management and debris removal in detention basin monthly or as required (less frequent during winter), regular inspection should inform the need for sediment excavation during subsequent construction and use phases.

United Utilities will adopt the drainage mentioned above formally once the Section 104 has been agreed and the occupancy of the plots is above 51% of the final occupation levels. Before this point, the whole drainage system will need to be maintained privately by the Developer. The Developer should consider separate S104 applications in order to achieve adoption status sooner.

9.2 Post site completion maintenance regime

Upon completion of the wider site, the maintenance of drainage systems will be the responsibility of the asset owners. It is anticipated that once the whole site has been developed, the whole foul water network as well as the surface water network put forward for adoption will be adopted by United Utilities; this also includes the online detention basin. The highway will be unadopted and so maintenance of the highway drainage up to the connection with the proposed adopted carrier drain will be the responsibility of the private owner. The maintenance regime once the site is completed should align with CIRIA 753.

9.2.1 Detention basin maintenance plan

Detention basins require ongoing regular maintenance to ensure continuing operation to design performance standards. Adequate access has been provided in the design and must be maintained to all of the detention basin area for inspection and maintenance, including access for appropriate equipment and vehicles. Litter and debris removal is to be undertaken as part of general landscape maintenance for the site and before any other SuDS management task.

The basin is planted with grass only, vegetation management will therefore include mowing and removal of any weeds within the basin. Regular mowing in and around the detention basin is required along maintenance access routes, footpaths and across the main storage area. Mowing should retain grass lengths of 75-150mm across the main basin surface to assist in filtering pollutants and retaining sediments and reduce the risk of flattening during runoff events.

Table 6 provides guidance on the operational and maintenance requirements of the detention basin. The frequency of activities is also listed. A maintenance inspection plan for the basin is provided in Appendix E.

Table 6 Operation and maintenance requirements for detention basins

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly
	Cut grass- for access routes	As required
	Cut grass- meadow grass in and around basin	Twice a year (spring- before nesting season and autumn)
	Manage other vegetation and remove nuisance plants	Monthly
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year) then as required
	Visually inspect flow control chamber to check for damages and blockages	Monthly
	Remove sediment from inlets, outlet and forebay	As required

Maintenance Schedule	Required Action	Typical Frequency
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years or as required
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

9.2.2 Permeable paving maintenance plan

Before handover, the paving should be inspected for clogging, litter, weeds and water ponding, and all failures should be rectified. After handover, the paving should be inspected regularly, preferably during and after heavy rainfall to check effective operation and to identify any areas of ponding.

The permeable paving needs to be regularly cleaned of silt and other sediments to preserve the infiltration capacity at the inlets (parking bays). A brush and suction cleaner should be used for regular sweeping. Care should be taken in adjusting vacuuming equipment to avoid removal of jointing material. Any lost material should be replaced. It is also possible to clean the surface using lightweight rotating brush cleaners combined with power spraying using hot water.

If the permeable paving were to clog, a more specialist sweeper with water jetting and oscillating and rotating brushes may be required, to restore the surface infiltration rate to an acceptable level. The specialist equipment should be adjusted so that it does not strip binder from the aggregate in the asphalt.

Table 7 provides guidance on the operational and maintenance requirements of permeable paving. The frequency of activities is also listed.

Table 7 Operation and maintenance requirements for Permeable Paving

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations
Occasional Maintenance	Removal of weeds or management using glyphosate applied direction into the weeds by an applicator rather than spraying	As required; once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks	As required

Maintenance Schedule	Required Action	Typical Frequency
	considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three monthly, 48 hours after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

9.2.3 Attenuation tank maintenance plan

Regular inspection and maintenance is important to ensure the effective long-term operation of below-ground storage systems. Table 8 provides guidance on the operational and maintenance requirements of attenuation tanks. The frequency of activities is also listed.

Table 8 Operation and maintenance requirements for an Attenuation Tank

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risk to performance)	Monthly
	Check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration as necessary	Annually
	Remove sediment from pre-treatment structures and/or chambers	Annually or as required
Remedial Actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually

Maintenance Schedule	Required Action	Typical Frequency
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

9.2.4 Pipe network maintenance plan

Regular inspection and maintenance of the surface water and foul water pipe networks is important to ensure effective long-term operation. Table 9 provides guidance for a typical maintenance regime for a pipe network.

Table 9 Typical maintenance requirements of pipe network

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Visually inspect access covers for structural damage and remove litter or debris	Monthly
	Lift access covers to visually inspect condition of access chambers and presence of silt or debris, remove as necessary	Annually
	Visually inspect flow control chambers remove sediment. Maintain flow controls in accordance with manufacturers' recommendations	Biannually

Maintenance for channel drains, slot drains and gullies can be seen in Table 10 below.

Table 10 Operation and maintenance requirements for channel drains, slot drains and gullies

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	All above ground elements should be visually inspected for broken or displaced elements	Monthly
	Inlets should be inspected to determine the depth of sediment and debris accumulation and cleared where necessary	Monthly
	Gratings shall be inspected and cleared of any accumulation of sediment or vegetation that may impeded the flow of water	Monthly
Occasional Maintenance	All grates should be inspected to ensure they are secure and that no elements of the locking system are broken	Annually
	Grates should be lifted according to manufacturer's instructions and channels cleared of any obstructions	Annually

Maintenance Schedule	Required Action	Typical Frequency
	Access drains through access chambers to introduce jet house and a suction hose.	Annually
Remedial Actions	If any drains become blocked, drain rods or high-pressure jets should be used to clear the obstruction	As required
	Broken elements should be safely removed and repaired if possible or replaced	As required

Maintenance for flow control chambers can be seen in Table 11 below.

Table 11 Operation and maintenance requirements for flow control chambers

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove any litter or debris	Quarterly
Occasional Maintenance	Visually inspect and remove any sediment where necessary.	Biannually
Remedial Actions	Remove blockages identified during visual inspections	As required
	Damage caused as a result of vandalism, tampering or accidental damage which could pose a risk to H&S or hydraulic performance should be repaired in accordance with manufacture's specification.	As required

10. Conclusions

The Victoria North development will include the provision of drainage and utilities infrastructure as well as highways and ground remediation to enable the development of multiple high density residential units. The site sits to the North of Manchester City Centre and previous site use has been mostly industrial. The River Irk is a main river which passes directly through the site. As a result of the site's history, areas of potential contamination have been identified, the topography has also been shaped by this industrial past which has resulted in areas of very steep slopes between flatter areas. Groundwater is considered to be at a depth which won't be affected by the proposed development.

The existing drainage on and around site consists only of combined sewers. In line with the drainage hierarchy, and with consideration of the potential for contamination, the proposed surface water drainage strategy will discharge to surface water as the primary discharge mechanism. The sitewide strategy will discharge all surface water to the River Irk.

Discharge restrictions have been agreed with the LLFA and the EA. The site will be restricted to Qbar up to the 30-year event and will be restricted to the 100-year storm for the 100 year + climate change event. To achieve these restrictions, SuDS have been proposed across the site, these will

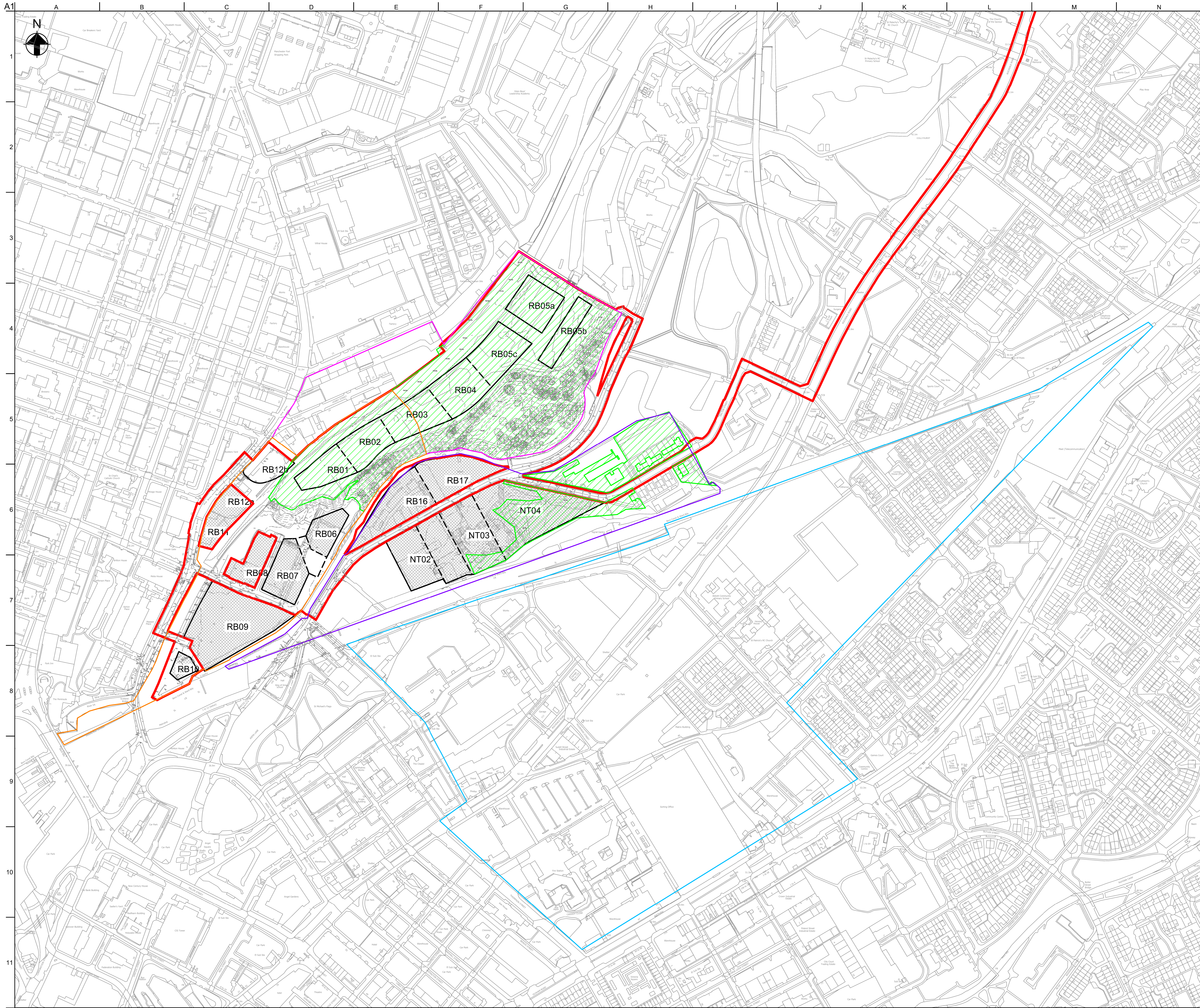
include: permeable paving, geocellular tanks and a detention basin. All attenuation features will have impermeable lining to prevent infiltration. Under the Simple Index Approach, the proposed SuDS are shown to be sufficient to mitigate pollution potential of the highest hazard potential zones. Where storm water does not pass through a treatment SuDS prior to outfall, sediment traps will instead be utilised to prevent pollution of the watercourse, this is only the case in zones of lower hazard potential under the simple Index Approach. The sitewide SuDS will drain highways and public realm only, attenuation for the plots will be achieved on-plot.

The SuDS features will drain to a carrier pipe system, which will also connect with the plot surface water drainage. The carrier drains will convey all surface water to 3n.o. outfalls to the River Irk. There is also a 4th small outfall from a wet play area within the proposed park. Complex flow controls will be installed within each surface water network to control the discharge in line with the sitewide restriction.

A new foul network will be installed to drain the plots, this will connect to the existing combined sewers in and around the site. Foul water generation has been calculated based on the proposed building uses. Consultation with United utilities is ongoing to understand the capacity of existing sewers which are to be discharged to.

Maintenance of the proposed drainage systems should be prioritised during all phases to prevent blockages which could lead to the system not functioning as designed, causing flooding and pollution. This should particularly be considered during the construction of plots which are due to progress after the infrastructure works delivery.

A.1 Appendix A Existing Surface Water Catchment Plan



- Notes**
1. All dimensions are in mm, all levels in mAOD, unless specified otherwise.
 2. This map is reproduced from Ordnance Survey Material with the permission of the Ordnance Survey on behalf of the Controller of Her Majesty's Stationary Office (c) Crown Copyright. License Number 100019568 (2021).
 3. Layout is based on:
 - Topographical Survey drawing PS-2158-TS by Paragon Surveys dated September 2021.
 4. No guarantee is given for the accuracy of the information contained herein, which is provided for general guidance only and must not be relied upon for excavation or detailed design until apparatus locations are verified / validated through further site investigation works.
 5. This drawing should be read with reference to VNIF-ARP-ZZ-YYY-CS-CD-0001 drainage calculations
 6. Greenfield assumed as areas which are not positively drained.
 7. Greenfield extents are shown to catchment boundaries only.

- Key**
- HIF Site Boundary
 - Plot Boundary
 - Greenfield Extents
 - Drainage Catchment 1
 - Drainage Catchment 3
 - Drainage Catchment 4
 - Drainage Catchment 5

P01	26/08/21		AS	AS	AS	---
P02	17/02/22	Amended for Planning Comments	DH	DH	RG	---
P03.01	21/04/22		---	---	---	---
Rev	Date	Description	By	Chkd	Appd	Auth

ARUP

6th Floor 3 Piccadilly Place
Manchester M1 3BN
Tel +44 161 228 2331 Fax +44 161 228 8879
www.arup.com

Client



Project Title
Victoria North HIF Infrastructure & Enabling Works

Drawing Title
HIF Existing Surface Water Catchments

Scale at A1 1:2500		Anup Job No 282022-00	
Role Civil - Drainage			
Suitability S0 - Initial Status or WIP			
Rev	By	Chkd	Appd
P03.01	---	---	---
	Date	Date	Date
	---	---	---
Name			
VNIF - ARP- 00 - YYY- DR - CD - 0001			
Project	Originatur	Volume	Location
		Type	Role
			Number

A.2 Appendix B Detention Basin Design Checklist

	Summary details	Acceptable (Y/N) (UU)	Comments/remedial actions
Dimensions			
Length (m)	10.5m (at base)		
Width - at top and base (m)	13.4m (at base) 17.2m (at top)		
Top surface area (m ²)	247.8		
Side Slope (1 in x)	1:3 (1:5 at inlet/outlet)		
Depth - max and min	0.66m (+freeboard)		
Freeboard (m)	0.3m		
Longitudinal slope (1 in x)	1:400		
Inflows			
Provide a description of the contributing catchment land use and its size (m ²)	Mixed use 33,240m ²		
Does the design include suitable silt interception upstream of the system, where required?	Sumps at collection points. Source control through permeable paving or on-plot to provide suitable silt management		
Where required, does the design include			
- suitable flow spreading	Low flow channel and riprap		
- appropriate energy dissipation	included at inlet		
Outfall arrangements			
Provide details of any flow control systems. Overflow arrangements and limiting discharge rate from the basin	Complex flow at outlet (Hydro-Brake and weir, refer to VNIF-ARP-00-YYY-DR-CD-0057) Restrictions: 45.5l/s (30-year storm) 72.9l/s (100-year storm)		
Is the basin designed to allow infiltration?	No		
Does the design include infiltration trenches or blankets beneath the base to promote improved infiltration?	No		
Is a geomembrane required to prevent infiltration? If yes, give a reason	Yes, contamination potential		
Depth to maximum likely groundwater level (m)	Approx. 3.0m		
Is topsoil of sufficient permeability to allow infiltration or underdrainage (where required?)	N/A		
Storage			
Design return period(s) (years)	30, 100		
Maximum design water depth(s) and level(s)	100 yr Depth: 0.534m level: 31.374m 30 .yr surcharged Depth: 0.318m level: 31.158m		
Maximum design storage volume(s) (m ³)	120.8 m ³		
Levels around the edge of pond/wetland appropriate to contain design depths of water?	Yes		
Water quality treatment			

For the 1 year, 30 minute event confirm:

Average residence time in detention basin is acceptable for effective treatment

Low flow channel to achieve minimum 9 min retention time

Or

Maximum velocity is acceptable for effective treatment

Velocity of 0.035m/s achieved by riprap apron at inlet

Landscape/biodiversity

Does the proposed planting have potential to create biodiverse habitats?

Limited, grass planting only

Have native plant species been used?

Yes

Is the proposed planting appropriate to the location, visually, relative to gradient, water depths etc. and with respect to access and maintenance?

Yes, grass planting to maximise volume and reduce maintenance requirements

Where relevant, confirm planting design does not adversely impact highway visibility and safety requirements

N/A

Is the proposed subsoil profile suitable to sustain the proposed plant species and as permeable as the filter bed?

Yes, refer to landscape specification

Critical materials and product specification

Geomembrane

N/A

Geotextile (non-woven)

Terram Rootguard Plus or similar approved

Topsoil

Imported topsoil to BS3882

Other (including proprietary systems)

Althon SFA10C headwalls or similar approved

Constructability

Are there any identifiable construction risks? If yes state and confirm acceptable risk management measures are proposed

Yes, construction hazard and risk assessment has been developed with contractor

Maintenance

Confirm that access for maintenance is acceptable and summarise details

Yes, footpaths in close proximity, access routes to basin at 1:5 slope

Are there specific features that are likely to pose maintenance difficulties?

If yes, identify mitigation measures required

Refer to maintenance plan and inspection plan

Basin design acceptability (UU)

Summary details and any changes required

Acceptable (Y/N)

Date changes made

Acceptable:

Minor changes required:

Major changes required/redesign:

A.3 Appendix C Detention Basin Health and Safety Risk Assessment

Victoria North
Basin health and safety risk assessment
checklist

C753 SuDS Manual Table B.5

Site/System overview	
Site ID	Victoria North
Asset ID	Detention Basin
Location	E: 384521.025, N: 399494.116
Assessment date	26.08.22
General description of component and its operation	Dry detention basin to provide attenuation
Identify potential hazards	
Drowning or falling through ice in winter	Yes
Slips, trips and falls	Yes
Entry into pipes or confined spaces (for public access)	Yes
Water quality - health risk	Yes

Drowning or falling through ice in winter		
	Summary of influence of factor on likelihood of entry/access, including justification	Summary of influence of factor on consequence of entry/access, including justification
Environmental factors		
Proximity to populated areas, especially attractive features likely to be visited	Proximity to public footpath and park/ play area, Likely entry by all age groups. Basin forms part of landscaped area within park	Potential access by members of public, major consequence of drowning for young children, moderate consequence for adults. Basin cannot be moved out of public access area.
Features allowing or encouraging access (e.g. paths)	Proximity to public footpath, likely entry by all age groups. Basin forms part of landscaped area within park	Potential access by members of public, major consequence of drowning for young children, moderate consequence for adults. Basin cannot be moved out of public access area.
Physical accessibility of proposed drainage feature: consider intended use and inadvertent access	Railings proposed around headwalls to reduce risk of falling/ inadvertent access, Boulders to indicate edge of basin. Possible entry	Potential access by members of public, major consequence of drowning for young children, moderate consequence for adults. Basin cannot be moved out of public access area.
Visibility and natural surveillance of proposed drainage features	Close proximity to proposed housing and public footpaths, natural surveillance reduces likelihood of entry to possible	High visibility of basin reduces consequences of accidental entry to moderate for children, minor for adults
Behavioural factors		
Category and volume of expected users; swimmers, anglers, walkers, drivers, specialist water users, general public, dog walkers, teenagers, accompanied/ unaccompanied children	Low volume of expected users. No permanent body of water. possible for access by general public, rare access for water related activities due to size and depth	Access only expected when basin is dry and for low risk activities, minor consequences under basin's intended use
Nature of development (housing, commercial, industrial etc.)	Housing, public park. Likely to be accessed by general public	High visibility of basin reduces consequence of accidental entry to moderate for children, minor for adults

Any existing known risks (e.g. records of accidents) posed by water/ drainage features at or close to the site?	None known	
Design factors - water's edge		
Type and nature of water-edge planting	No planting proposed other than grass, access not restricted so remains likely	No influence
Definition of water edge and nature of ground (e.g. hard/soft)	Footpath and landscaping around basin edge. Boulders to indicate basin edge make accidental access unlikely	No influence
Natural obstacles, barriers/fencing	Railings around headwalls make accidental access unlikely	No influence
Height above edge of water	0.3m - 0.96m	No influence
Gradient and extent of slopes above, at and below water level	1:3 - 1:5, extent of slopes under water varies depending on how full the basin is, accidental access unlikely when basin is full	Side slopes provides safe exit route and reduces consequence to moderate
Design factors - water body		
Water depth profile	0.00 - 0.66m	No influence
Water surface area	0.0m2 - 247.8m2	No influence
Clarity	Likely to be clear water	No influence
Underwater obstacles or traps	No planting or features other than grass	Low risk of trapping, moderate consequence of entry
Potential currents, velocities	No currents, low velocities (max modelled velocity 1.1m/s)	Means of exit is accessible, moderate consequence of entry
Potential increase in depth of water and rate of rise	Potential increase of 0.534m across critical 1:100 year storm. Flow control restricts outflow so rate of water rise is slow	No fast rising water and accessible exit routes, minor consequence of access during dry periods
Potential for ice formation and significant depth of water below in winter	Max depth below ice 0.534 in modelled storms	Shallow depths of water below ice so moderate consequence of entry during winter
Public education		
Signage	None proposed, UU to advise	No influence
Community engagement strategies	None proposed	No influence
Local education strategies (e.g. schools)	None proposed	No influence

Summary of risk assessment for drowning or falling through ice

Group	Likelihood of entry to water	Likely consequence of entry to water	Overall level of risk posed by the design	further mitigation measures required
Children < 5 years	Possible	Moderate	Medium	
Children > 5 years	Probable	Moderate	High	
Adults	Unlikely	Minor	Low	

Slips, trips and falls

	Summary of influence of factor on likelihood of slip/trip/fall, including justification	Summary of influence of factor on consequence of slip/trip/fall, including justification
Design factors - inlets and outlets or channels		
Headwall or channel location	1 n.o. headwall at inlet, 1 n.o. headwall at outlet. Possible slips/trips	Consequence of fall moderate (due to concrete/stone below). Headwalls and stone required for basin design
Headwall height or channel depth and width	Height of headwall and potential fall height 0.96m (on basin side) Railings provided to make falls unlikely	Potential moderate consequence of fall from this height
Slope of headwall or channel profile	Ground to be at 1:5 slope around headwall, likelihood of fall possible for all age groups	Potential moderate consequence of fall from this height
Channels - profile and risk of freezing water	N/A	
Design factors - surfaces		
Level changes	Side slopes 1:3 or shallower. Unlikely to cause slips/trips	Consequence of fall on side slope of basin considered minor due to fall height and sloped edges
Surfacing materials	Grass planting only. Boulders to indicate edge of basin, unlikely to cause trips	Consequence of fall on side slope of basin considered minor due to fall height and sloped edges

Summary of risk assessment for slips/trips/falls

Group	Likelihood of slips/trips/falls	Likely consequence of slips/trips/falls	Overall level of risk posed by the design	further mitigation measures required
Children < 5 years	Possible	Moderate	Medium	
Children > 5 years	Possible	Moderate	Medium	
Adults	Possible	Moderate	Medium	

Entry into pipes or confined spaces (Note: This risk assessment covers inadvertent access by the public. Where specific access is required by workers the requirements of relevant health and safety legislation and guidance should be followed)

	Summary of influence of factor on likelihood of entry to confined spaces, including justification	Summary of influence of factor on consequence of entry to confined spaces, including justification
Design factors - inlets and outlets		
Pipe diameter	Inlet 375mm, outlet 450mm. Possible access for children, rare access from adults	Major consequence of entry, risk of drowning
Are grilles provided?	Yes, access rare for all groups	Consequence of accidental entry not reduced by grilles
Design factors - chambers		
Depth of chamber	Inlet 0.968m, outlet 2.091. Entry unlikely	Consequence of entry high due to fall/drowning risk
Is access possible?	No, chambers to be sealed. Grilles on inlet and outlet	Consequence of accidental entry not reduced

Summary of risk assessment for entry into pipes/confined spaces

Group	Likelihood of entry into confined spaces	Likely consequence of entry into confined spaces	Overall level of risk posed by the design	further mitigation measures required
Children < 5 years	Rare	Major	Medium	
Children > 5 years	Rare	Major	Medium	
Adults	Rare	Major	Medium	

Health Issues		
	Summary of influence of factor on likelihood of poor health, including justification	Summary of influence of factor on consequence of poor health, including justification
Pollution treatment strategy		
Level of contamination of publically accessible water	Contamination low (storm water only), unlikely to have adverse health effects	Consequence considered insignificant as no pollution present
Likely contamination from rat urine	Rats may be present in/around sewer so possible contamination	Potential moderate consequence of weill's disease for children (if sediment/water is ingested), minor consequence for adults
Likely contamination from dog or bird fouling	Potential contamination in basin, no intended access to water so likelihood of poor health rare	Potential for moderate consequence to health for all age groups
Likelihood of toxic algal blooms	Risk of algae build up unlikely, conditions not considered optimal to cause toxic algae blooms	Consequence insignificant as algae not expected to be present
Likelihood of vectors (organism which carries disease - causing microorganisms from one host to another)	Likely presence of vectors such as flies, rats. No intended access to water so unlikely to cause ill health	Potential for moderate consequence to health for all age groups
Public accessibility to any sediment accumulation zones	Likely access to sedimentation at base and in low flow channel	Volume of sediment expected to be low, therefore consequence considered minor
Public education and risk management		
Signs	None proposed, UU to advise	No influence
Community engagement strategies	None proposed	No influence
Local education strategies (e.g. schools)	None proposed	No influence
Litter management and control	Refer to maintenance strategy and inspection plan	Proper maintenance makes consequence of exposure minor
Dog fouling management and control	Refer to maintenance strategy and inspection plan	Proper maintenance makes consequence of exposure minor

Summary of risk assessment for health issues

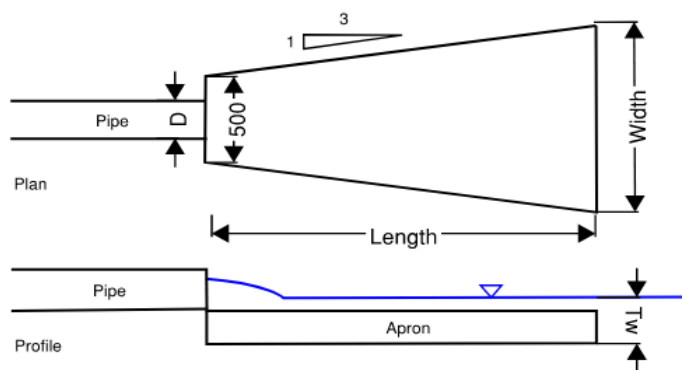
Group	Likelihood of ill health	Likely consequence of ill health	Overall level of risk posed by the design	further mitigation measures required
Children < 5 years	Possible	Minor	Medium	
Children > 5 years	Possible	Minor	Medium	
Adults	Possible	Minor	Low	

A.4 Appendix D Detention Basin Riprap Size Calculation

ARUP		Job No.	Sheet No.	Rev.
		282022	1	1
Job Title		Member/Location		
Victoria North Infrastructure Works		Drg. Ref.		
Calculation		Made by	Date	Chd.
Basin riprap calculation		ES	24/08/2022	RG

The following calculation determines the riprap stone size and show that water flow into the basin is <0.3m/s as per UU's recommendations

The riprap apron design is calculated using FHWA HEC-14 Third edition



D_{50} = required riprap rock size (m)

Q = discharge (m^3/s)

D = pipe rise (diameter) (m)

T_w = tailwater depth (m)

g = acceleration due to gravity

$Q = 0.0314 \text{ m}^3/\text{s}$ (from modelled basin inflow - pipe 1.017 in attached model report)

$D = 0.375\text{m}$

$T_w = 0.4D$ (worst case) = 0.15

$$D_{50} = 0.2D \left(\frac{Q}{\sqrt{g}D^{2.5}} \right)^{\frac{4}{3}} \left(\frac{D}{T_w} \right)$$

Apron rock size, $D_{50} = 0.037\text{m}$

Inlet velocity calculation:

Apron length = $4D = 1.8\text{m}$

Apron width = $0.5 + (1.8/3) + (1.8/3) = 1.7\text{m}$

Apron depth = $3.5 \times D_{50} = 0.525\text{m}$

Critical depth of water = Apron depth = 0.525m (worst case)

Area = depth x width = $0.525 \times 1.7 = 0.84\text{m}^2$

$$v = Q/A$$

$$v = \frac{0.0314}{0.89} = 0.035\text{m/s}$$

Length of low flow channel for 9min retention time:

$$L = vt = 0.035 \cdot (9 \cdot 60) = 18.9\text{m min}$$

Ove Arup & Partners International Ltd		Page 1
The Arup Campus Blyth Gate Solihull B90 8AE		
Date 24/08/2022 13:57 File Plateau West 30min 1 ye...		
Designed by Emily.Stoddart Checked by		
XP Solutions		Network 2020.1.3

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	26
Number of Online Controls	28	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.357		

©1982-2020 Innovyze

Ove Arup & Partners International Ltd								Page 2	
The Arup Campus Blyth Gate Solihull B90 8AE									
Date 24/08/2022 13:57				Designed by Emily.Stoddart					
File Plateau West 30min 1 ye...				Checked by					
XP Solutions				Network 2020.1.3					
Summary of Results for 30 minute 1 year Winter (Storm) Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF Analysis Timestep Fine Inertia Status OFF DTS Status ON									
PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	DUMMY01	43.227	0.023	0.000	0.95		24	0.7	SURCHARGED
1.001	S1W	43.112	0.077	0.000	0.02			0.2	SURCHARGED
1.002	S2W	41.825	-0.140	0.000	0.01			0.2	OK
2.000	DUMMY02	42.928	0.069	0.000	0.95			0.7	SURCHARGED
2.001	S3W	42.718	0.101	0.000	0.03			0.8	SURCHARGED
1.003	J1	41.652	-0.202	0.000	0.02			1.0	OK*
3.000	DUMMY03	42.517	0.058	0.000	0.94			0.7	SURCHARGED
3.001	S4W	42.352	0.089	0.000	0.03			0.8	SURCHARGED
1.004	S5W	41.329	-0.195	0.000	0.04			1.8	OK
4.000	DUMMY04	42.118	0.052	0.000	1.00			0.7	SURCHARGED
4.001	S6W	41.985	0.079	0.000	0.01			0.2	SURCHARGED
1.005	J2	41.004	-0.194	0.000	0.05			2.0	OK*
5.000	DUMMY05	41.782	0.078	0.000	1.03			0.8	SURCHARGED
5.001	S7W	41.577	0.078	0.000	0.02			0.5	SURCHARGED
1.006	S8W	40.663	-0.189	0.000	0.06			2.5	OK
6.000	DUMMY06	41.361	0.047	0.000	0.93			0.7	SURCHARGED
6.001	S9W	41.213	0.086	0.000	0.03			0.5	SURCHARGED
1.007	J3	40.339	-0.185	0.000	0.07			3.0	OK*
7.000	DUMMY07	40.961	0.022	0.000	0.92			0.5	SURCHARGED
7.001	S11W	40.906	0.043	0.000	0.01			0.3	SURCHARGED
1.008	S12W	40.037	-0.193	0.000	0.05			3.3	OK
8.000	S13W	41.484	-0.176	0.000	0.11			8.5	OK
9.000	DUMMY08	40.877	-0.117	0.000	0.47			15.4	OK
9.001	PLOT_RB12b	40.806	-0.134	0.000	0.06			2.8	OK
9.002	S36W	40.661	-0.185	0.000	0.07			2.8	OK
8.001	S14W	40.634	-0.143	0.000	0.29			13.7	OK
1.009	S15W	39.684	-0.153	0.000	0.22			20.8	OK
10.000	DUMMY09	38.027	-0.142	0.000	0.29			10.2	OK
10.001	PLOT_RB_11	37.975	-0.133	0.000	0.07			2.1	OK
10.002	DUMMY10	37.866	-0.188	0.000	0.07			2.1	OK*
10.003	S16W	37.818	-0.182	0.000	0.08			3.0	OK
11.000	DUMMY11	37.817	-0.150	0.000	0.24			10.7	OK
11.001	PLOT_RB_12a	37.762	-0.108	0.000	0.08			2.3	OK
11.002	DUMMY12	37.644	-0.184	0.000	0.08			2.3	OK*
10.004	S17W	37.633	-0.161	0.000	0.18			6.7	OK
10.005	S18W	37.522	-0.160	0.000	0.18			6.7	OK
10.006	S19W	37.408	-0.162	0.000	0.17			6.7	OK
1.010	S20W	37.082	-0.166	0.000	0.41			31.9	OK
12.000	DUMMY19	37.897	-0.103	0.000	0.58			18.8	OK
12.001	PLOT_RB_01	37.847	-0.099	0.000	0.17			2.9	OK
12.002	DUMMY20	37.761	-0.162	0.000	0.17			2.9	OK
1.011	S21W	36.801	-0.261	0.000	0.20			32.6	OK
13.000	DUMMY15	36.137	-0.163	0.000	0.43			26.5	OK
13.001	PLOT_RB_03	36.080	-0.182	0.000	0.00			0.2	OK
13.002	DYMMY16	36.078	-0.157	0.000	0.00			0.0	OK*
©1982-2020 Innovzye									

Ove Arup & Partners International Ltd								Page 3	
The Arup Campus Blyth Gate Solihull B90 8AE									
Date 24/08/2022 13:57 File Plateau West 30min 1 ye...				Designed by Emily.Stoddart Checked by					
XP Solutions				Network 2020.1.3					
<u>Summary of Results for 30 minute 1 year Winter (Storm)</u>									
PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
14.000	DUMMY13	40.032	0.807	0.000	0.89			26.7	SURCHARGED
14.001	PLOTRB_04	40.025	0.840	0.000	0.18			5.5	SURCHARGED
14.002	DUMMY14	38.998	-0.160	0.000	0.18			5.5	OK*
14.003	S22W	38.954	-0.177	0.000	0.11			9.3	OK
14.004	S23W	38.170	-0.175	0.000	0.11			9.3	OK
13.003	S24W	36.665	0.457	0.000	0.23			12.5	SURCHARGED
13.004	S25W	36.655	0.560	0.000	0.20			11.4	SURCHARGED
13.005	S26W	36.644	0.679	0.000	0.17			8.6	SURCHARGED
15.000	DUMMY17	36.531	-0.093	0.000	0.65			21.4	OK
15.001	PLOTRB_02	36.465	-0.104	0.000	0.04			1.0	OK
15.002	DUMMY18	36.463	-0.065	0.000	0.04			0.7	OK*
13.006	S27W	36.634	0.761	0.000	0.11			8.4	SURCHARGED
13.007	S28W	36.625	0.863	0.000	0.12			8.5	SURCHARGED
1.012	S29W	36.617	0.959	0.000	0.30			31.5	SURCHARGED
1.013	S30W	35.169	-0.213	0.000	0.19			31.5	OK
1.014	S31W	32.631	-0.187	0.000	0.31			31.4	OK
1.015	S32W	31.333	-0.186	0.000	0.31			31.4	OK
1.016	S33W	31.099	-0.161	0.000	0.62			31.4	OK
1.017	63	31.045	-0.267	0.000	0.35			31.4	OK*
1.018	DUMMY08	30.915	-0.292	0.000	0.27			31.3	OK*
1.019	S34W	29.555	0.047	0.000	0.69			30.4	SURCHARGED*
16.000	S37W	36.764	-0.129	0.000	0.05			2.5	OK
16.001	S38W	34.482	-0.118	0.000	0.10			4.6	OK
16.002	S39W	32.499	-0.098	0.000	0.26			9.6	OK
16.003	S40W	31.347	-0.149	0.000	0.25			13.5	OK
16.004	S41W	31.144	-0.081	0.000	0.29		24	4.6	OK
16.005	S42W	31.013	-0.192	0.000	0.05			4.6	OK
16.006	S43W	29.765	-0.171	0.000	0.13			4.6	OK
17.000	DUMMY21	28.840	-0.152	0.000	0.49			30.0	OK
17.001	PLOTRB_08	28.786	-0.162	0.000	0.10			5.5	OK
17.002	S47W	28.667	-0.242	0.000	0.08			5.5	OK
18.000	S50W	28.950	-0.025	0.000	1.00			6.6	OK
18.001	S51W	28.924	-0.095	0.000	0.11		18	6.4	OK
17.003	S48W	28.556	-0.219	0.000	0.16			10.3	OK
19.000	DUMMY22W	29.781	-0.085	0.000	0.71			22.8	OK
19.001	PLOTRB_06	29.696	-0.118	0.000	0.07			4.2	OK
17.004	S49W	28.485	-0.199	0.000	0.25			14.2	OK
16.007	S44W	28.441	-0.192	0.000	0.28			18.6	OK
16.008	S45W	28.307	-0.170	0.000	0.30			18.6	OK
16.009	S46W	28.271	-0.126	0.000	0.34			19.0	OK
1.020	S35W	28.258	-0.098	0.000	0.79			48.6	OK
©1982-2020 Innovyze									

A.5 Appendix E Detention Basin Maintenance Inspection Plan

Maintenance Inspection Plan

Site ID	Victoria North
Asset Description	Detention Basin
Inspection frequency	Monthly
Reference Drawings	VNIF-ARP-00-YYY-DR-CD-0020 VNIF-ARP-00-YYY-DR-CD-0021
Purpose of asset	Attenuation

[illegible]