B&NES Hicks Gate Improvements
Level 1 Flood Risk Assessment

Prepared for

Bath and North East Somerset Council

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ch2m:

Burderop Park

Swindon

SN4 0QD

Document history

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Level 1 Flood Risk Assessment Report

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Contents

Tables

Figures

Acronyms and Abbreviations

P&Rs	Park and Ride sites
NPPF	National Planning Policy Framework
EA	Environment Agency
FRA	Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment
SUDS	Sustainable drainage systems
B&NES	Bath and North East Somerset

1 Introduction

1.1 Purpose of the report

CH2M, now part of Jacobs, has been commissioned to examine the options at Hicks Gate Roundabout to accommodate an A4-A37 Link Road to the south and relocate the Brislington Park and Ride (P&R) to land southwest of the roundabout and south of the A4 Bath Road. A Constraints Plan showing local physical and environmental constraints in the vicinity of Hicks Gate is included in **Appendix A**.

Two options for the Hicks Gate Roundabout amendment are being considered. Both options place the relocated P&R south of the A4 and connect the Link Road from the A4 to the A37. The two options (Option 2 and Option 3) have different highway configurations. Plans are provided in **Appendix B**.

As a component of the project, a Level 1 (Screening) Flood Risk Assessment (FRA) of the two proposed 'short-list' options are presented in this report. Interim options excluding the P&R relocation have not been considered.

1.2 Requirements for flood risk assessment

The National Planning Policy Framework (NPPF) (DCLG 2012) and National Planning Practice Guidance (NPPG) set out the Government's planning policies for England and how these are to be applied. As described in the NPPF, inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. Where development is necessary, it should be made safe without increasing flood risk elsewhere.

The NPPF uses a risk-based approach to identify suitable locations for development and to aid decisions on development control through a Sequential Test. The flood zones are the starting point for this sequential approach.

Flood zones (described in **Table 1**) provide an indication of the likelihood of flooding from the sea and rivers only. Local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses, which are classified in **Table 2**, assessed against the flood zones (see **Table 3**) to consider when an Exception Test is required.

A new development should be steered towards Flood Zone 1 areas, where there is a low risk of flooding and no Exception Test is required for any classified land use level of vulnerability. If this is not possible, then locating development in Flood Zone 2 can be considered. However, it may require an accompanying Exception Test. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 be considered, again taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

As set out in the NPPF, the Exception Test allows the wider sustainability benefits of a development to be considered to justify its location in a high-risk flood zone, as long as the development is not considered vulnerable to flooding. The Exception Test requires that a proposed development provides wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible, reducing flood risk overall.

This report forms the first stage of an FRA (Level 1 - Screening), providing an initial indication of the potential flood risk to the site and identifying whether there are any flooding or surface water management issues that may warrant further consideration, or that may affect the feasibility of a development. More detailed studies may then be required to complete the FRA process.

Table 1: Flood Zones (Source: DCLG 2012)

Flood Zone	Definition	Flood Risk Assessment Requirement
1	This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).	For development proposals on sites comprising one hectare or above, the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment. This need only be brief unless the factors above or other local considerations require particular attention.
2	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.	All development proposals in this zone should be accompanied by a flood risk assessment.
3a	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.	All development proposals in this zone should be accompanied by a flood risk assessment.
3b	This zone comprises land where water has to flow or be stored in times of flood.	All development proposals in this zone should be accompanied by a flood risk assessment.

Table 2: Flood risk vulnerability classification (Source: DCLG 2012)

Classification	Example
Essential infrastructure	• Essential transport links (including mass evacuation routes) • Essential utility infrastructure (including electricity generating power stations, and water treatments works)
High vulnerability	• Police stations, ambulance stations, fire stations, command centres and telecommunications installations required to be operational during a flood • Emergency dispersal points • Basement dwellings • Caravans, mobile homes and park homes for permanent residential use • Installations requiring hazardous substances consent
More vulnerable	• Hospitals • Residential institutions (including care homes, children's homes, social service homes, prisons and hostels) • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels • Non-residential uses for health services, nurseries and educational establishments

Classification	Example
	• Landfill and hazardous waste management facilities • Sites used for holiday or short-let caravans and camping
Less vulnerable	• Police, ambulance and fire station not required to be operational during a flood • Buildings used for shops, financial, professional and other services, restaurants, cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable", and assembly and leisure • Land and buildings used for agriculture and forestry • Minerals working and processing • Waste treatment • Sewage treatment works, and water treatment works that do not need to stay operational during a flood
Water compatible development	• Flood control infrastructure • Water and sewage transmission infrastructure and pumping stations • Sand and gravel working • Docks, marinas and wharves • Navigation facilities • Ministry of Defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 3: Flood Risk Vulnerability (Source: DCLG 2012)

Flood Zone	Vulnerability				
	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
1	✓	✓	✓	✓	✓
2	✓	✓	Exception Test required	✓	✓
3a	Exception Test required	✓	✗	Exception Test required	✓
3b	Exception Test required	✓	✗	✗	✗

Note ✓ Development is appropriate. ✗ Development should not be permitted.

2 Site Description

The drawn plans of the two options for changes to the Hicks Gate roundabout and relocation of the P&R are presented in Appendix B. **Table 4** describes the location and changes that Option 2 and Option 3 propose.

Table 4: Description of Hicks Gate Roundabout location and proposed changes

	Option 2	Option 3
Location	Hicks Gate Roundabout, northwest of Keynsham.	Same as Option 2.
Roundabout changes	Expanded roundabout/gyratory layout with a 'cut through' from the A4 Keynsham Bypass to the northbound A4174. New road junction connecting to the new A4-A37 link road.	Expanded roundabout/gyratory layout with a 'cut through' from the A4175 Spur to the northbound A4174. New road junction connecting to the new A4-A37 link road.
Size of relocated P&R	0.09km^2	0.09km^2
Existing land use	Located in green belt.	Same as Option 2.
Main Rivers	The Main River, a small tributary of the Avon, runs north of the site, diverted through a culvert under the existing A4 and A4174 roads	Same as Option 2.
Ordinary and manmade watercourses	No Ordinary or manmade watercourses crossing site	Same as Option 2.

2.1 Flood risk vulnerability classification

Review of the flood risk vulnerability classification in Table 2, sourced from Technical Guidance to the NPPF, indicates that the proposed road extensions are Essential Infrastructure. P&Rs are not specifically listed within the classification.

In light of the lack of specific guidance for the P&R, and reflecting the non-residential use of the facility, the flood risk vulnerability of the development is considered low (i.e. 'Less Vulnerable'). This assessment assumes that there is no requirement for the P&R to remain operational during times of flood.

Referring to Table 3, sourced from Technical Guidance to NPPF, Less Vulnerable development is permitted within Flood Zones 1, 2 and 3a, without requiring the application of an Exception Test. Essential Infrastructure development is permitted within Flood Zones 1 and 2, but requires an application of an Exception Test for Flood Zones 3a and 3b.

It is recommended that subsequent, more detailed phases of this FRA include consultation with the Environment Agency to confirm the development vulnerability classification.

3 Flood Risk

3.1 Sources of flood risk

Potential sources of flood risk are from the Main River to the north of the roundabout and increased surface runoff from the hard-standing areas of the P&R into the river. This Level 1 FRA has referenced the following information:

- Strategic Flood Risk Assessment (SFRA) for Bath and North East Somerset (Source: Capita Symonds, 2008);
- Environment Agency online 'Flood Map For Planning' (Source: https://flood-map-for-planning.service.gov.uk/ ; and
- Environment Agency online Flood Map for 'Long Term Flood Risk' (Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map).

3.2 Fluvial flood risk

Based on the obtained information from the Environment Agency 'Flood Map For Planning', **Figure 1** shows that the western approach of the A4 Bath Road to the Hicks Gate Roundabout lies within Flood Zone 1.

The majority of the sites of the two proposed options, in particular the relocated P&R and the new link road, lie within Flood Zone 1. This means that the majority of the site has less than 1 in 1,000 annual probability of river flooding. **Figure 1** also illustrates that the only section of the site in Flood Zone 2 or Flood Zone 3 is the far north and far northwestern extremity of the site, where existing essential infrastructure, including the A4, is located. This area is subject to a 1 in 100 or greater annual probability of river flooding in any year.

The cut through road in Option 3 (the additional infrastructure over and above that included in Option 2) lies primarily in Flood Zone 1. Its northern limit is adjacent to Flood Zone 3. The majority of the extended roundabout loop proposed in both Option 2 and Option 3 is in Flood Zone 1.

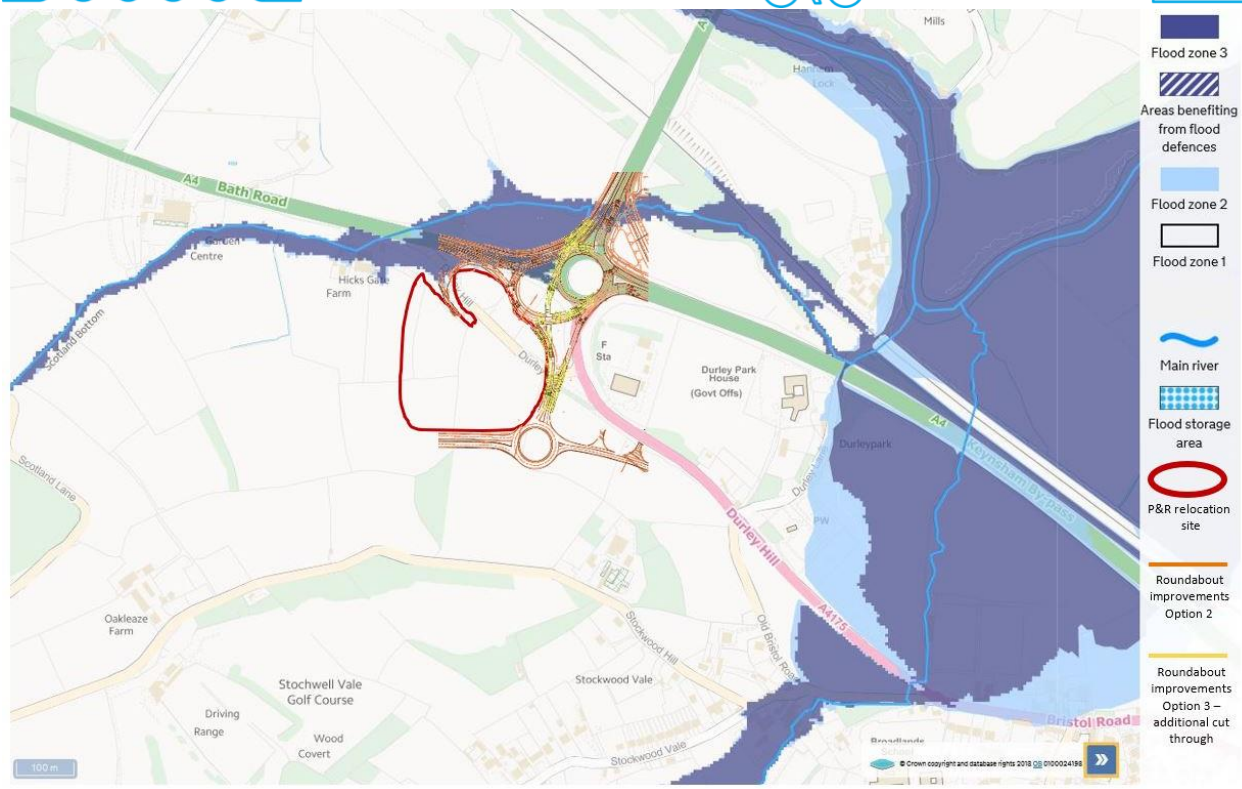


Figure 1: Environment Agency map of flooding from rivers and sea at Hicks Gate Roundabout with overlaid option plans

3.3 Surface water flood risk

The Environment Agency's online map showing the long-term flood risk was used to assess the risk of flooding from surface water within the site area. In the subsequent figures, the darker blue shading represents areas with a high likelihood of surface water flooding which corresponds to 1 in 30 (3.3%) or greater annual probability. The mid-blue represents areas with a medium likelihood, which corresponds to less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) annual probability of surface water flooding, whilst the lighter shading indicates areas where the likelihood of flooding is considered to be low which is described as less than 1 in 100 (1%) but greater than or equal to 1 in 1,000 (0.1%) annual probability. The remaining area is considered as having very low likelihood which corresponds to 1 in 1,000 years or lower annual probability of surface water flooding.**Figure 2** indicates that there is high likelihood of surface water flooding on the A4 westbound approach to the existing roundabout, which is a 1 in 30 or greater annual probability of surface water flooding. This surface water flooding could have a potential impact on new road surfaces built around this approach. The remainder of the site either has a low (1 in 100 to 1 in 1,000 probability) or very low (1 in 1,000 or lower probability) likelihood of surface water flooding.

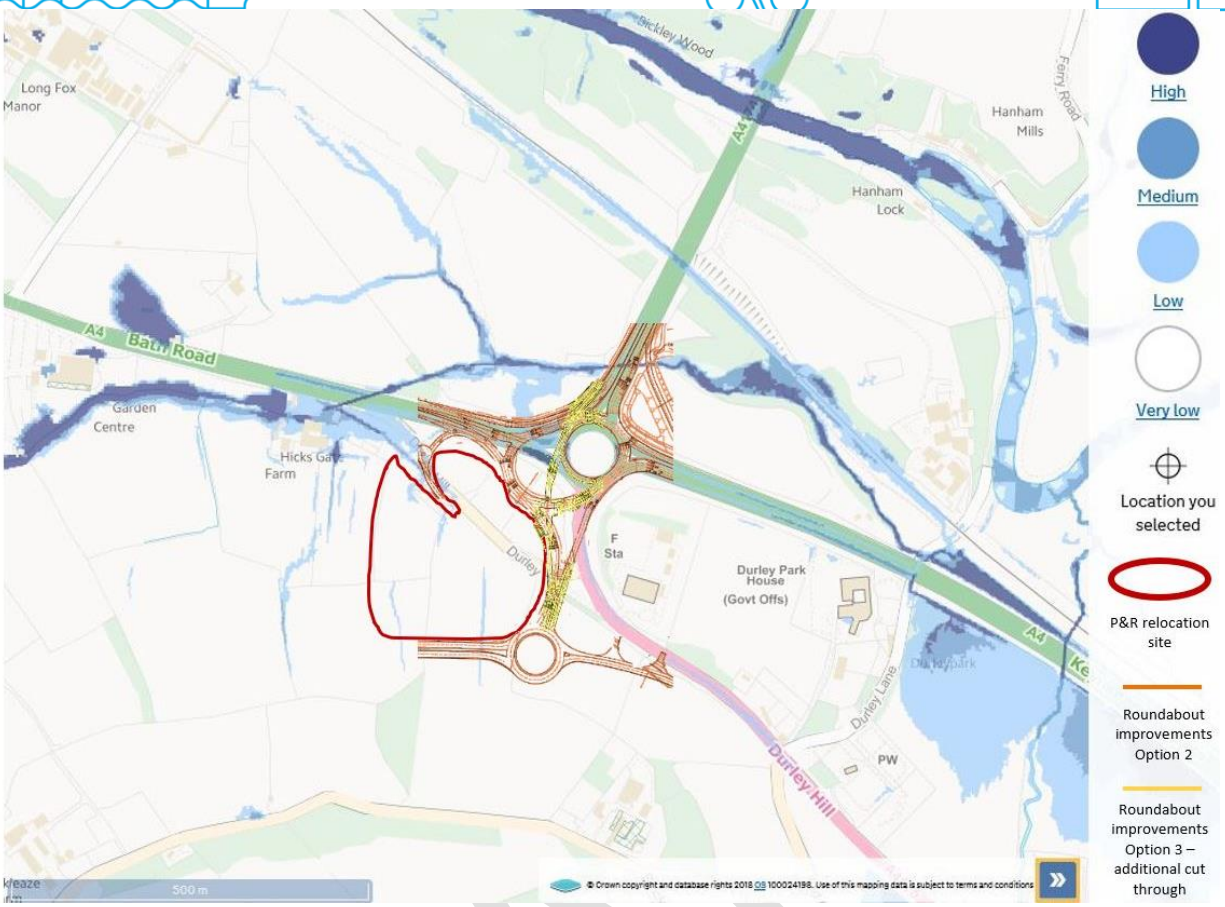


Figure 2: Environment Agency flood risk from surface water at Hicks Gate Roundabout with overlaid option plans

3.4 Reservoir flood risk

Figure 3, produced using the Environment Agency's Long-Term Flood Risk online map, shows the flood risk from reservoirs. **Figure 3** shows that Hicks Gate Roundabout and the proposed improvements in both Option 2 and Option 3, along with the P&R relocation site, lie outside the maximum extent of flooding associated with reservoir failure.

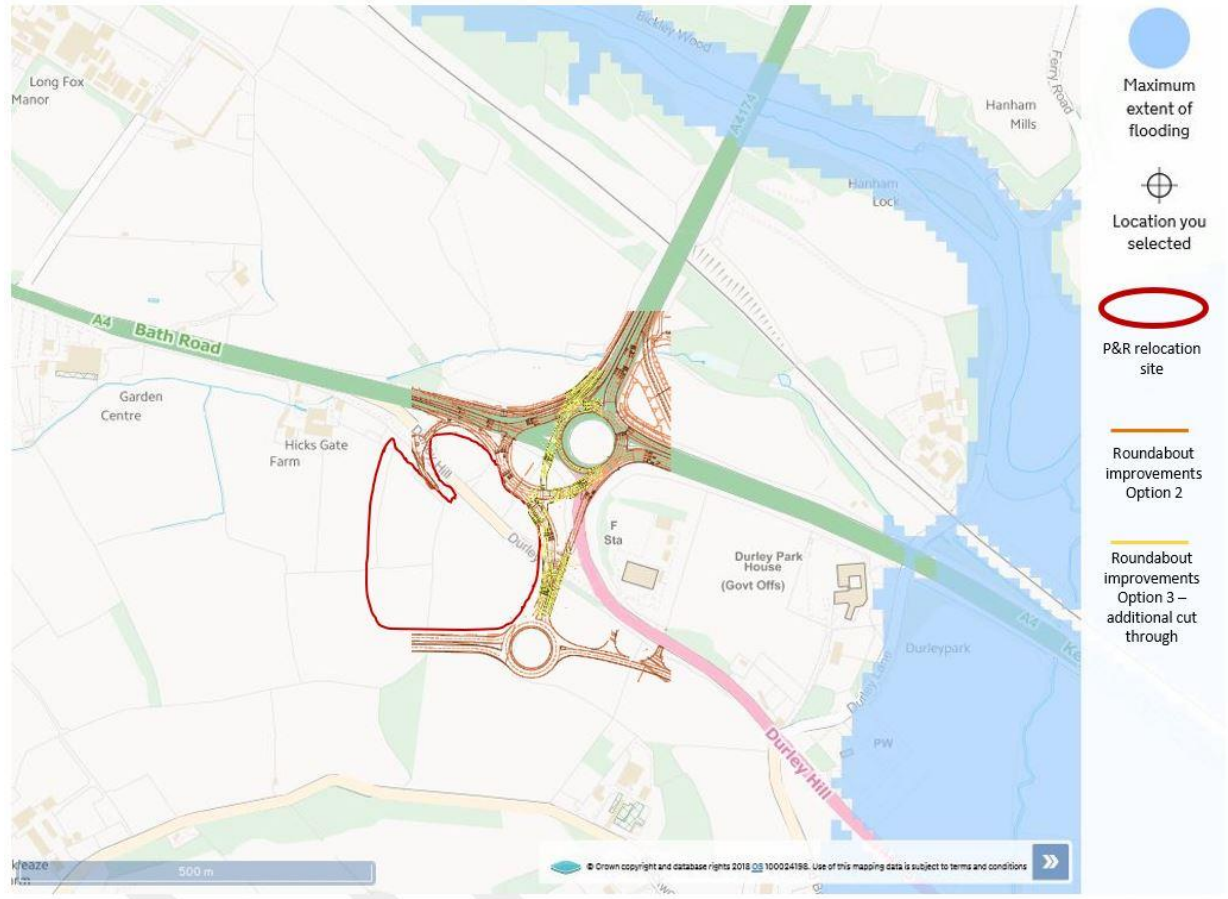


Figure 3: Environment Agency map of flood risk from reservoirs at Hicks Gate Roundabout with overlaid option plans

3.5 Other flood risks

3.5.1 Flood risk from groundwater

Groundwater flooding is usually the result of a sustained period of rainfall causing the water table to rise above ground level. Local geology also influences susceptibility to groundwater flooding. The geology underlying the north of Bath and North East Somerset (B&NES), in which the site is located, are Triassic mudstones (including Keaper Marl, Dolomitic Conglomerate and Rhaetic) and Upper Westphalian Limestone (and coal beds), which have low permeability (B&NES SFRA, 2008).

The existing Environment Agency flood maps, which indicate fluvial, pluvial and reservoir failure flood risk, do not show the likelihood of groundwater flooding.

The B&NES SRFA concludes that groundwater flooding is not considered a significant issue in B&NES. It states that 0% of the total B&NES area is prone to flooding from groundwater.

3.5.2 Flood risk from the sea

Reflecting the location of the site, an assessment of flood risk from the sea can be considered as not applicable.

3.5.3 Flood risk from sewers and other constructed drainage systems

The proposed development and relocation of the P&R is taking place in a green belt area. The B&NES SRFA states that the sewers and constructed drainage systems in the area are serviced by Wessex Water. If further investigation into flood risk posed by sewers and other constructed drainage systems is required, contacting Wessex Water would be the appropriate course of action.

4 Sequential Test

The NPPF Sequential Test requires that a sequential approach is followed to steer new development to areas with the lowest probability of flooding (i.e. Flood Zone 1, then 2, then 3).

This Level 1 FRA has assessed the proposed Option 2 and Option 3, in terms of flood risk. **Table 5** summarises the likelihood of flooding for the different sources present at Hicks Gate Roundabout and the area proposed for the P&R.

The P&R site has the same design under Option 2 and Option 3 and lies within Flood Zone 1. No Exception Test for this portion of the design is required. The P&R site contains small areas at low risk of surface water flooding.

The new road to be built to link the P&R to the highway junction and form the start of the A4-A37 link road, present in both Option 2 and Option 3 plans, also lies within Flood Zone 1. No Exception test is required for this portion of the design.

The proposed highway amendments to the existing roundabout under Option 2 and 3 lie within Flood Zone 1, but adjacent to Flood Zone 3. As Essential Infrastructure, works would be permitted in Flood Zone 3, providing an Exception Test is passed. It is recommended that the Environment Agency is consulted to confirm if further investigation is required.

The proposed highway amendments under Option 2 and 3 lie adjacent to areas at risk of surface water flooding. The extent of proposed works adjacent to areas at risk of surface water flooding is greater under Option 3 than Option 2. It is noted that the existing roundabout has an area of medium risk of surface water flooding and that this stretch of highway is proposed to be removed in Option 2 and 3.

Table 5: Summary of flood risk

Planned improvements		Source of Flooding		
		Fluvial	**Pluvial**	**Reservoir Failure**
Option 2	**Highway works**	Flood Zone 1 (small portion of new road infrastructure within and adjacent to Flood Zone 3)	Majority of site: Low Small portion of new road infrastructure adjacent to Medium and High risk	No
	P&R relocation	Flood Zone 1	Majority of site: Very Low Restricted areas of Low risk	No
Option 3	**Highway works**	Flood Zone 1 (small portion of new road infrastructure in the northwest within and adjacent to Flood Zone 3)	Majority of site: Low Small portion of new road infrastructure adjacent to Medium and High risk	No
	P&R relocation	Flood Zone 1	Majority of site: Very Low Restricted areas of Low risk	No

5 Surface Water Management

The P&R relocation site and the area to which the roundabout improvements will extend lie in currently undeveloped green belt land. The development of the P&R facility and additional road surfaces will necessitate an increase in impermeable area, thereby increasing rates of runoff.

In accordance with current guidance, the expected drainage approach is to manage surface water at source and to mitigate for additional run-off generated by development, taking pollution control into account. It is proposed that the drainage design of the proposed schemes will seek to reduce the risk of flooding elsewhere. The adverse effects of stormwater runoff should be controlled through appropriate drainage design, including the deployment of sustainable drainage systems (SUDS), to reinforce and where possible, follow the natural pattern of drainage.

SUDS are surface water drainage solutions designed to manage surface water runoff and mitigate the adverse effects of urban storm water runoff by reducing flood risk and controlling pollution. SUDS techniques allow surface water runoff from development to be controlled in ways that imitate natural drainage by controlling the rate of discharge to a receiving watercourse. SUDS may also provide valuable habitat and amenity value when carefully planned.

Drainage design should be integrated with the site characteristics taking into account constraints resulting from ground conditions and the topography of the site. Where possible, runoff should be limited to greenfield rates, following the SUDS standard hierarchy:

- Infiltration to the ground - ground investigations are necessary to determine suitability for infiltration;
- Discharge to a surface water body;
- Discharge to a surface water sewer; and
- Discharge to a combined sewer.

SUDS comprise a variety of means to reduce runoff rates and volumes, as well as providing varying degrees of treatment using natural processes (sedimentation, filtration, adsorption and biological degradation). The five general methods of control are:

- Filter strips and swales;
- Permeable surfaces and filter drains;
- Infiltration devices;
- Basins and ponds; and
- Attenuation storage in oversized pipes and underground tanks.

Environment Agency (2015) provides indicative costs for SUDS options and these are presented in **Table 6**. Construction of SUDS is highly variable and depends on the proposed design and construction methods. Solutions are site-specific and heavily dependent on the size of the associated catchment area. The costs of SUDS associated with any specific site will depend on a number of factors as follows:

- Scale and size of development;
- Hydraulic design criteria (design event, volume of storage required and impermeable catchment area);
- Inlet/outlet infrastructure design (volume and velocity of anticipated flows and the capacity of drainage system beyond site boundary);
- Water quality design criteria;
- Soil types (permeability and depth of water table), porosity and load bearing capacity;
- Materials availability;
- Density of planting;
- Specific Utilities requirements;
- Proximity to receiving watercourse; and
- Amenity / public education / safety requirements.

Capital cost estimates will require consideration of the following:

- Site investigation costs;
- Design costs;
- Project management, planning and supervision costs;
- Clearance and land preparation costs;

- Materials;
- Construction costs;
- Design and planning of subsequent maintenance responsibility; and
- Landscaping and planting costs (post construction).

Costs associated with the planning and design of SUDS are typically 15% of the capital costs (CIRIA 2007, in Environment Agency 2015).

Table 6: Typical SUDS options and indicative costs (Environment Agency 2015)

Option	Description	Unit Cost	Source (quoted by Environment Agency 2015)
Permeable paving	Surfaces, such as car parks, designed to allow rainwater to infiltrate into the underlying ground.	£30-£40 per m^2 of permeable surface. £27 per m^2 of replacement surface. £54 per m^2.	CIRIA, 2007. Stovin & Swan 2007. Environment Agency, 2007.
Filter drain / perforated pipes	Trenches filled with permeable material to collected and convey runoff from the edge of paved areas. A perforated pipe may be built into the base of the trench to convey the water to other parts of a site.	£100 - £140 per m^3 stored volume £61 per m £120 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Swales	Broad, shallow grass channels designed to convey and attenuate runoff as well as to allow infiltration into the ground.	£10-£15 per m^2 swale area £18-£20 per m length using an excavator £12.5 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Infiltration basin	Depressions and basins that store runoff and allow infiltration into the ground. They may be landscaped to provide habitat and amenity value.	£10-£15 per m^3 stored volume	CIRIA, 2007
Soakaways	Underground structures or excavations filled with granular material designed to store rapid runoff from a single or multiple properties and to allow efficient infiltration into the surrounding soil.	>£100 per m^3 stored volume £454 -£552 per soakaway	CIRIA, 2007 Stovin & Swan 2007
Infiltration trench	Linear soakaways that allow water to infiltrate into the ground.	£55-£65 per m^3 stored volume £74-£99 per m length £60 per m^2	CIRIA, 2007 Stovin & Swan 2007 Environment Agency, 2007
Filter strip	Wide gently sloping grass verges that treat runoff from adjacent impermeable areas.	£2-£4 per m^2 filter strip area	CIRIA, 2007

Option	Description	Unit Cost	Source (quoted by Environment Agency 2015)
Constructed wetland	Ponds with shallow areas and wetland vegetation to improve the removal of pollutants and enhance wildlife value. Wetlands also provide additional flood storage capacity and attenuation.	£25-£30 per m^3 treated volume	CIRIA, 2007
Retention (wet) pond	Basins that provide temporary storage for storm runoff above a permanent water level used for water quality treatment. This technique may also provide improved habitat and amenity value.	£15-£25 per m^3 treated volume £80,000 per 5,000 m^3 pond (£16 per m^3)	CIRIA, 2007 SNIFFER, 2007
Detention basin	Normally dry basins but may have permanent pools at the inlet or outlet. Designed to detain a defined volume of runoff and may provide water quality treatment.	£15-£20 per m^3 detention volume £35-£55 per m^3 stored volume £18 per m^3	CIRIA, 2007 Stovin & Swan 2007 SNIFFER, 2007
Attenuation and storage	Oversized pipes and tanks to attenuate flows.	£449-£518 per m^3 for reinforced concrete storage tank. No data available for oversized pipes	Stovin & Swan 2007

6 Conclusions

This report represents a Level 1 FRA in compliance with the requirements set out in National Planning Policy Framework, Planning Practice Guidance. This FRA has been produced to accompany a study of two potential options for the Hicks Gate Roundabout improvements, including constructing a new link road between the A4 and A37, and the relocation of the Brislington P&R.

In accordance with the NPPF, development should be directed to area of low flood risk (i.e. Flood Zone 1). Existing flood risk information (sourced from the Environment Agency and existing reports, including the B&NES SFRA) indicates that the majority of both Option 2 and Option 3 is located in Flood Zone 1, indicating a low risk of fluvial flooding. The north part of the site lies adjacent to Flood Zone 3 and appears to be proposed to be protected by an embankment and flood storage cells, potentially mitigating any effect fluvial flooding would have on the road. The likelihood of surface water flood risk is Very Low or Low across most of the site. Option 2 and Option 3 do propose portions of highway works adjacent to areas of Medium and High surface water flood risk and this extent is greater for Option 3. The site (both Option 2 and 3) is absent of reservoir flood risk and there is no evidence to suggest issues of groundwater or sewer flooding.

As the proposed highway works associated with Option 2 and 3 involve works immediately adjacent to Flood Zone 3, and areas of Medium and High surface water flood risk, it is recommended that the Environment Agency is consulted to confirm if further investigations are required.

Surface water drainage, especially on the relocated P&R, the new link road and cut through roads, must also be carefully designed to minimise flood risk impact. Indicative costs of potential options have been sourced from existing reports and should be investigated further during more detailed phases of future flood risk studies (Level 2 or Level 3 FRAs).

7 References

DCLG 2012 (National Planning Policy Framework)

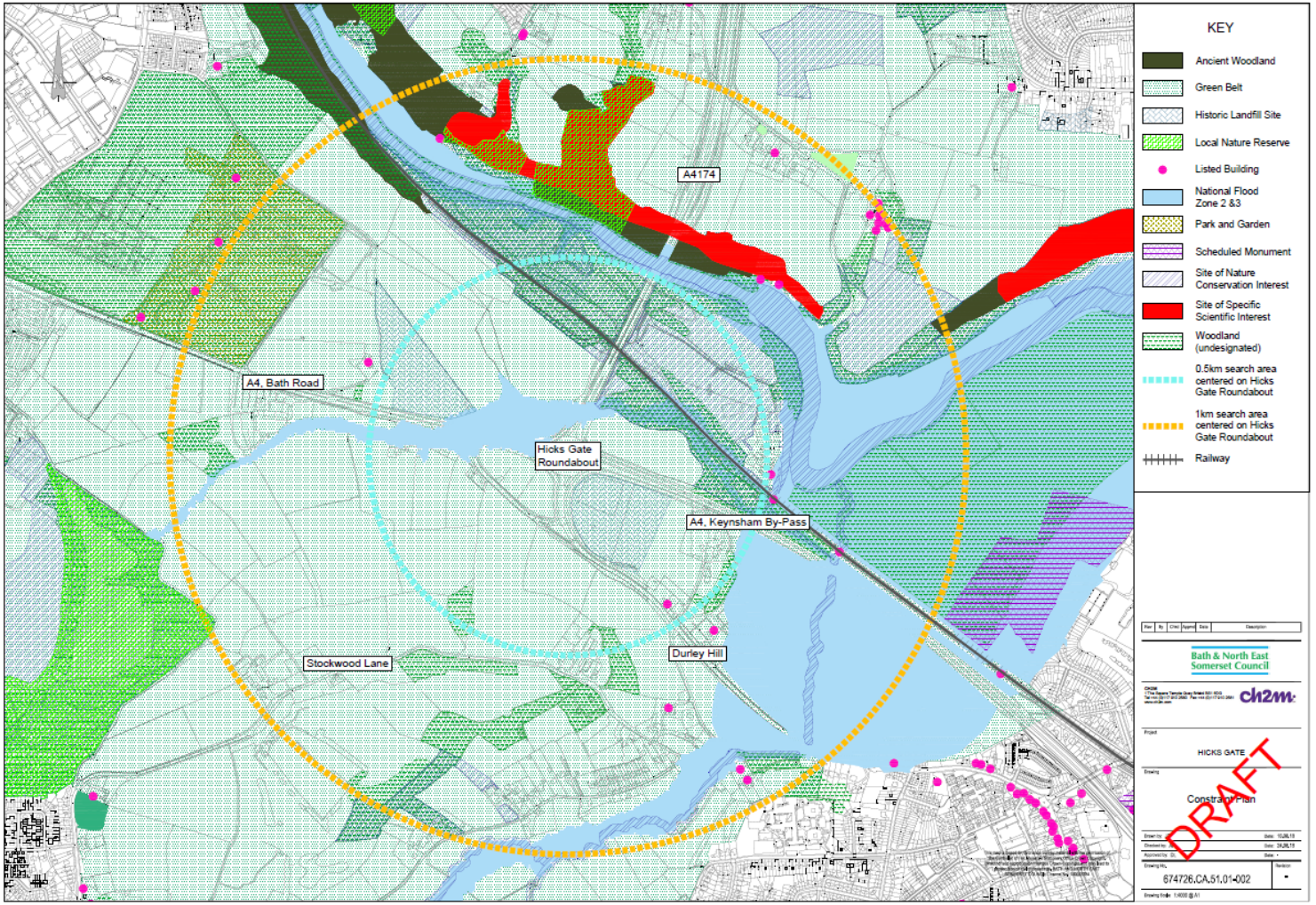
Capita Symonds , Strategic Flood Risk Assessment of Bath and North East Somerset; Volume 1 Technical report; Bath and North East Somerset Council, April 2008

Environment Agency, 2015. 'Cost Estimation for SUDS – summary of evidence (SC080039/R9)' Available: http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/SC080039_cost_SUDS.sflb.ashx

Environment Agency (EA) online 'Flood Map For Planning' (Source: https://flood-map-for-planning.service.gov.uk/

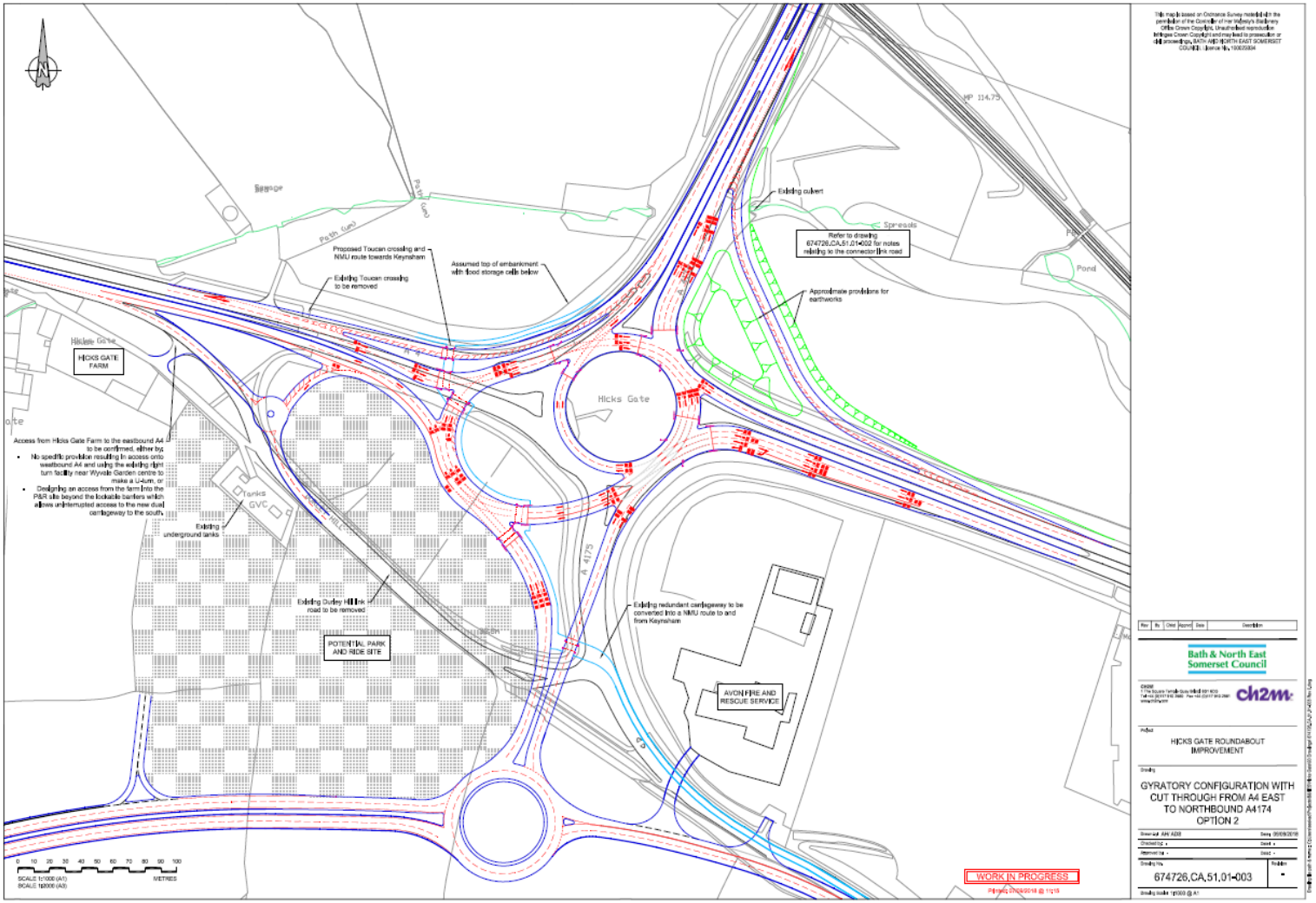
Environment Agency (EA) online Flood Map for 'Long Term Flood Risk' (Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk/m

Appendix A – Constraints Plans

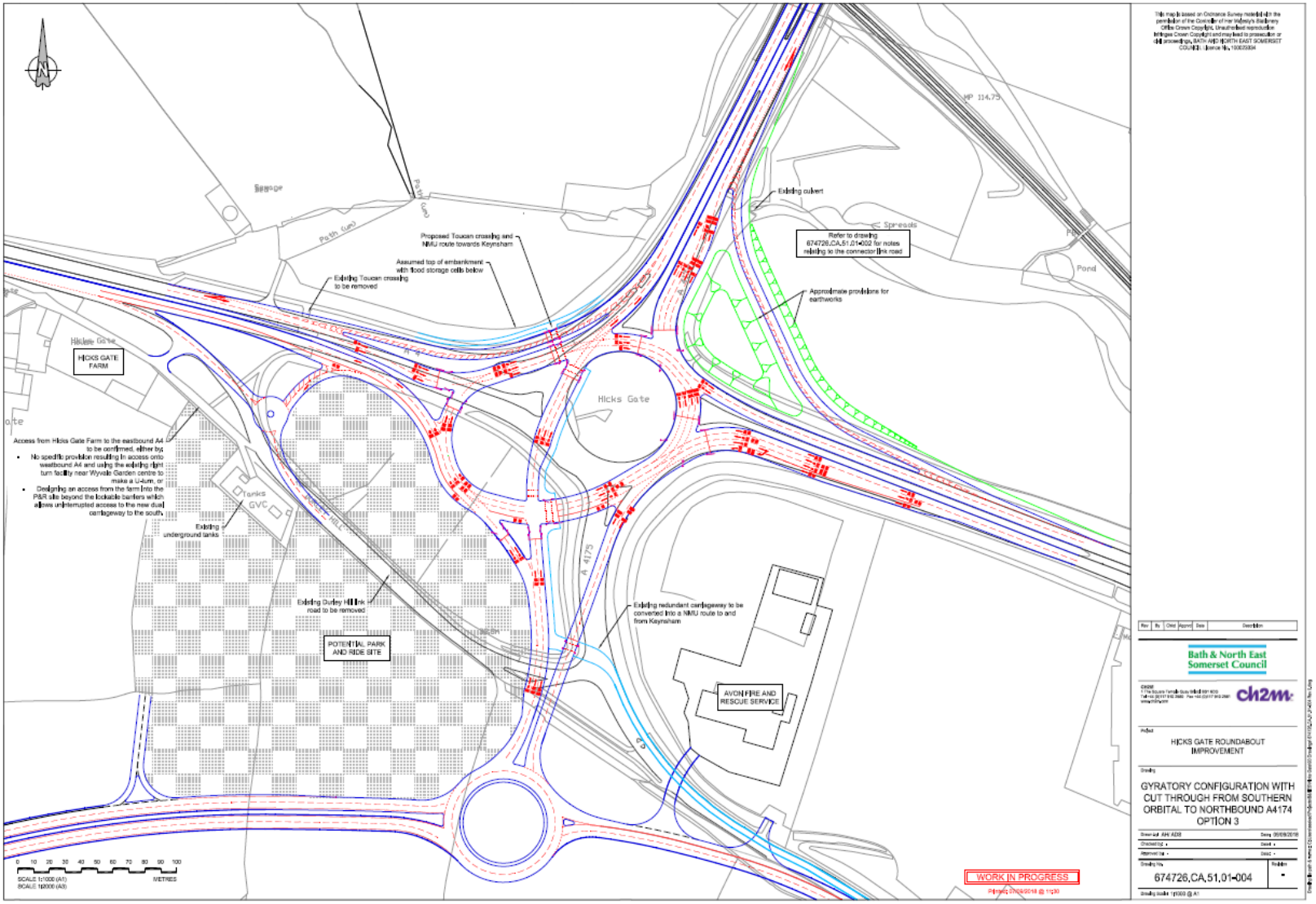


Constraints Map

Appendix B – Drawn Plans



Option 2: Layout Plan



Option 3: Layout Plan