

AMBER PLANNING
Flood Risk & Hydrology

Old Passage Inn
Arlingham
Gloucestershire
GL2 7JR

Flood Risk & Drainage Assessment
October 2023
Version 1



Quality Inns

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EXECUTIVE SUMMARY

Site Area	Built Elements: 58m ² (extension areas only) Car Park: c.790m ²
Existing / Historic Use	Commercial Property (Public House)
Proposed Use	Refurbishment of existing Public House and input of new rear carpark.
Flood Zone	<p><u>Indicative Risk:</u> Tidal: Flood Zone 3a (High Risk) Fluvial: Flood Zone 3a (High Risk)</p> <p><u>Assessed Risk:</u> Tidal: Flood Zone 3a (High Risk) Fluvial: Flood Zone 3a (Low to Moderate Risk)</p> <p><u>Residual Risk (accounting for mitigation):</u> Tidal: Practicably Low Fluvial: Low to Moderate</p>
Groundwater Flooding	Low
Infrastructure Failure	<p><u>Indicative Risk:</u> Raised Waterways: Not at Risk Reservoir Failure: Not at Risk Flood Defence Breach / Failure: At Risk (Significant hazard).</p> <p><u>Residual Risk (inc. Flood Mitigation / Management):</u> Practicably Low</p>
Overland Flow - Flooding	Low – Very Low
Sewer Flooding	Very Low
Change to Site Surface Finishings (Y/N)	Yes (new car park). Surface water management is proposed in line with best practice for new development.
Infiltration Potential?	No. Precluded by low permeability soils (Clay).
Attenuation Storage Proposed	Unlimited discharge to tidal receiving waters. Outfall to be situated above MHWS water level. Where outfall is located below MHWS water levels, minor SW storage would be provided to account for periods of tide locking.
Potential Receptor for Surface Water Discharges	Tidal receiving waters following upstream water quality treatment.
Climate Change Allowance	<p>Tidal Flooding: Incorporated within EA modelling.</p> <p>Fluvial Flooding: 37% to 2070, based on a 50 year development lifetime (<i>non-residential</i>).</p> <p>Rainfall Intensity: 25% based on a 50 year development lifetime (<i>non-residential</i>).</p>

1.0 INTRODUCTION

1.1 Background

- 1.1.1 Amber Planning Ltd. has been appointed by Quality Inns of Gloucestershire Ltd. to prepare a Flood Risk Assessment in support of an application for the proposed refurbishment of a commercial property (Public House) at the Old Passage Inn, Arlingham, Gloucestershire, GL2 7JR. Proposals include the input of a new rear carpark. Arlingham falls within the administrative remit of Stroud District Council and Gloucestershire County Council, with the latter comprising the Lead Local Flood Authority.
- 1.1.2 Reference to Environment Agency (EA) online Flood Maps indicates the Old Passage Inn to be situated within Flood Zone 3a (High Risk) for the adjacent tidal River Severn, Figure 001. The property is indicated to be unaffected by surface water or reservoir flooding and to be external to Groundwater Source Protection Zones.
- 1.1.3 A Flood Risk Assessment is therefore required to inform the development design, with flood resilience and management measures outlined to ensure that the property and its users / occupants remain protected from flooding throughout the anticipated development lifetime. Consideration of the impacts of proposals on surface water drainage is also required.
- 1.1.4 This Flood Risk Assessment report has been prepared in accordance with the National Planning Policy Framework (NPPF) and its Planning Practice Guidance (PPG). The requirements of the Environment Agency, Stroud District Council and Gloucestershire County Council have also been accounted for within this study.

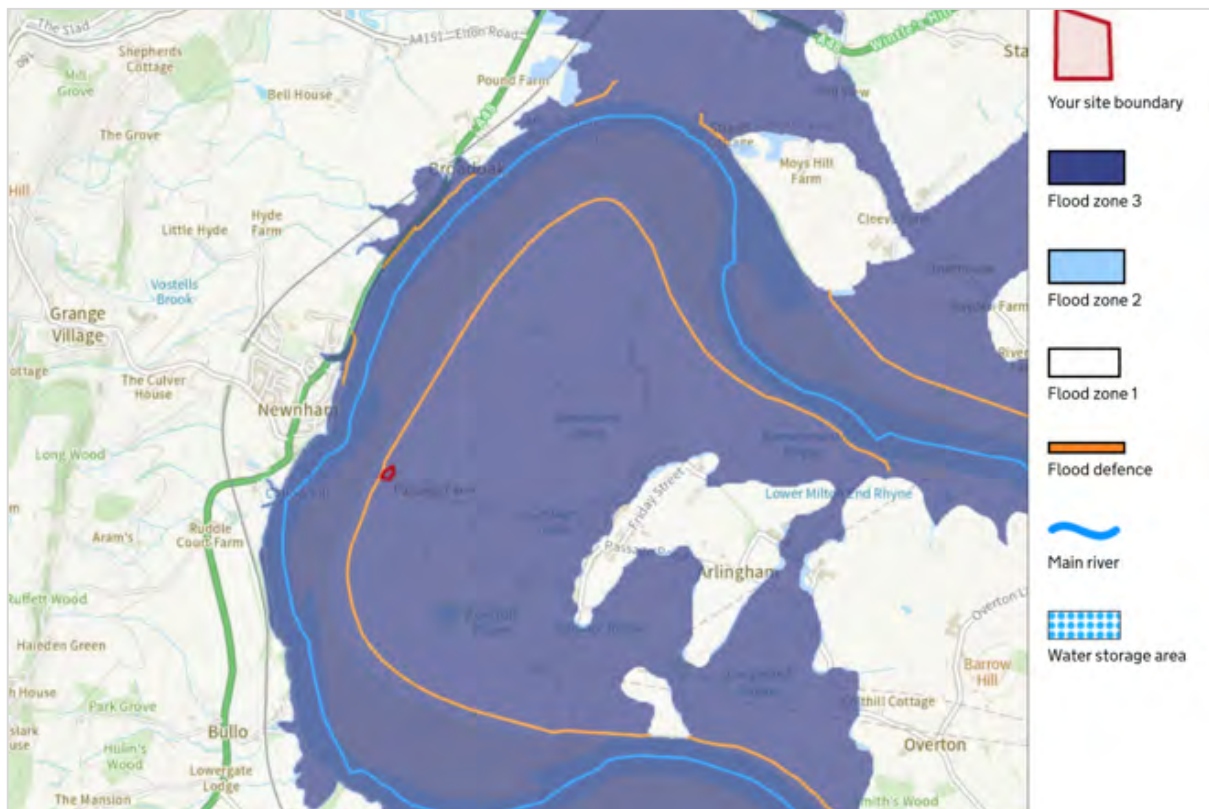


Figure 001: Environment Agency Indicative Flood Map

1.2 Objectives

1.2.1 The objectives of the Flood Risk Assessment are to:

- Review national and local planning policy documents and identify any issues they raise, and which need to be addressed in relation to flooding and hydrology;
- Review readily available information on flooding using data provided by the EA and, where available, the Strategic Flood Risk Assessment (SFRA);
- Evaluate the background hydrology;
- Assess the risks from all sources of flooding, including tidal and fluvial;
- Consider the surface water drainage requirement(s) accounting for potential impacts on pre-developed rates and volumes of surface water runoff;
- Identify opportunities for the incorporation of Sustainable Drainage Systems (SuDS); and
- Recommend mitigation and / or management measures required to prevent detrimental impacts to flooding or hydrology at the site or within downstream receptors. This includes the design of a surface water management scheme which accounts for the requirements of the Environment Agency and the Lead Local Flood Authority.

1.2.2 Local development framework documents, as well as strategic policy and technical studies, have been reviewed as part of this study.

1.3 Confidentiality

1.3.1 Amber Planning has prepared this report solely for the use of The Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from Amber Planning; a charge may be levied against such approval.

2.0 SOURCES OF INFORMATION

2.1 General

2.1.1 In preparing this assessment background information has been sought from the following sources:

- Communities and Local Government (July 2021). National Planning Policy Framework;
- Communities and Local Government (*Living Document*). Planning Practice Guidance;
- UK Government Guidance (May 2022). Flood Risk Assessments: Climate Change Allowances¹;
- CIRIA (2015). C753: The SUDS Manual V.6;
- Stroud District Council website, Planning Strategy page²;
- Stroud District Council Local Plan (2015);
- Stroud District Council (2008). Level 1 Strategic Flood Risk Assessment³;
- Stroud District Council (2019). Level 2 Strategic Flood Risk Assessment;
- Gloucestershire County Council LLFA: Local Flood Risk Management Strategy (2014);
- Severn Estuary Coastal Group (2010). Severn Estuary Shoreline Management Plan Review;
- Environment Agency Flood Mapping⁴ and Site-specific data request (Jul. 2023);
- British Geological Survey online mapping⁵;
- Centre for Ecology and Hydrology Flood Estimation Handbook (FEH) Web Service, hydrometric data⁶;
- OS Mapping data⁷; and
- Site-specific Topographical Survey.

2.2 Planning Context - National Planning Policy

National Planning Policy Framework

2.2.1 The National Planning Policy Framework (NPPF) Section 14: Meeting the Challenge of Climate Change, Flooding and Coastal Change, and its Planning Policy Guidance (PPG) document, provide guidance on the consideration of flood risk, drainage and water quality within development design.

2.3 Planning Context - Local Planning Policy

Stroud District Council Local Plan 2015

2.3.1 Stroud District Council Local Plan provides a Development Strategy and overview for the evolution of the District up until 2031. Policies relevant to the consideration of Flood Risk and Drainage are as follows:

- SO5: Climate change and environmental limits
- CP5: Environmental development principles for strategic sites
- CP6: Infrastructure and developer contributions
- CP14: High quality sustainable development
- ES2: Renewable or low carbon energy generation

¹ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-2>

² <https://www.stroud.gov.uk/environment/planning-and-building-control/planning-strategy>

³ https://www.gloucestershire.gov.uk/media/8040/stroud_district_council_level_1_sfra_final-28385.pdf

⁴ <http://www.Gov.uk>

⁵ <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

⁶ <https://fehweb.ceh.ac.uk/GB/map>

⁷ www.promap.co.uk

- ES3: Maintaining quality of life within our environmental limits
- ES4: Water resources, quality and flood risk

Strategic Flood Risk Assessment

2.3.2 The Strategic Flood Risk Assessment (SFRA) reports evaluate the extent and nature of flooding in the district. They also consider the implications for land use planning and set out the criteria for submitting future planning applications and guiding development control decisions.

2.3.3 These documents have been reviewed as input to this study.

Severn Estuary Shoreline Management Plan Review

2.3.4 Developed in partnership by local authorities, regulators and other stakeholders, a Shoreline Management Plan (SMP) is a high level non-statutory policy document designed to assist coastal flood and erosion risk management planning. It provides a large-scale assessment of the risks (to people, property, the natural and historic environment) associated with coastal erosion and flooding at the coast over the long-term.

2.3.5 The SMP enables planners and regulators to plan for and manage the way that the coast will change. This could be by maintaining or improving defences, by enabling the natural processes to play a greater role, creating new natural habitat, or by helping areas that are at risk of flooding at some point in the future to cope with and limit the impact of flooding events.

2.3.6 The SMP2 for the Severn Estuary updates an earlier document (SMP1: 2000). It aims to provide greater certainty for landowners, residents and businesses as to how the coast will be managed by regulators during the next 100 years, so that they can plan ahead and make decisions about investments, homes, development and the management of their resources. The Shoreline Management Plan 2 received final sign-off from Defra and the Welsh Government in February 2017.

2.3.7 Review of this document indicates the property to be situated in Policy Unit SHAR 4 (Gloucester to Sharpness), Figure 002. The Shoreline Management Plan (SMP) policy for this area is 'Hold the Line' in the short term (0-20 years, 2025), with 'Managed Realignment' proposed over the medium (20 – 50 years, 2055) to long term (50 – 100 years, 2105).

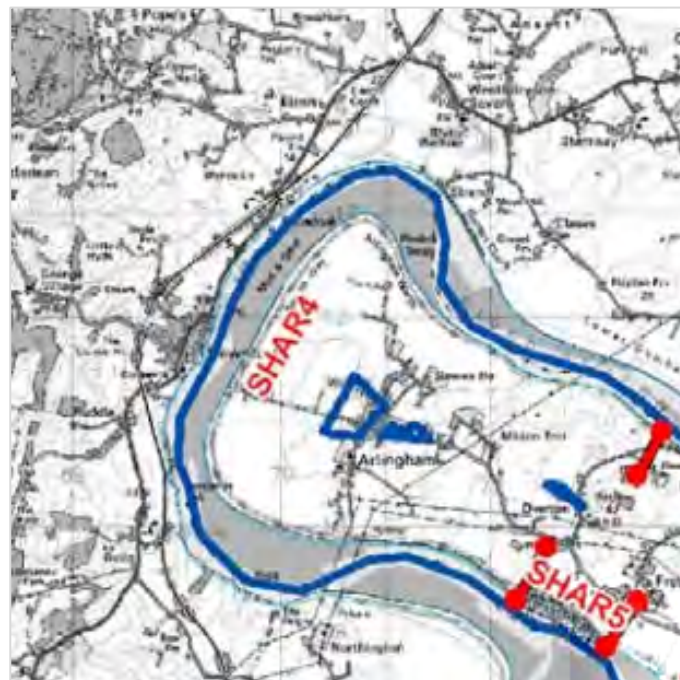


Figure 002: Shoreline Management Plan Policy Unit Map

3.0 BACKGROUND AND DATA REVIEW

3.1 Site Setting

Property Address	Old Passage Inn, Arlingham, Gloucestershire, GL2 7JR
National Grid Reference	369570, 211330
Area	Built Elements: 58m ² (extension areas only) Car Park: 790m ²

Table 001: Site Setting

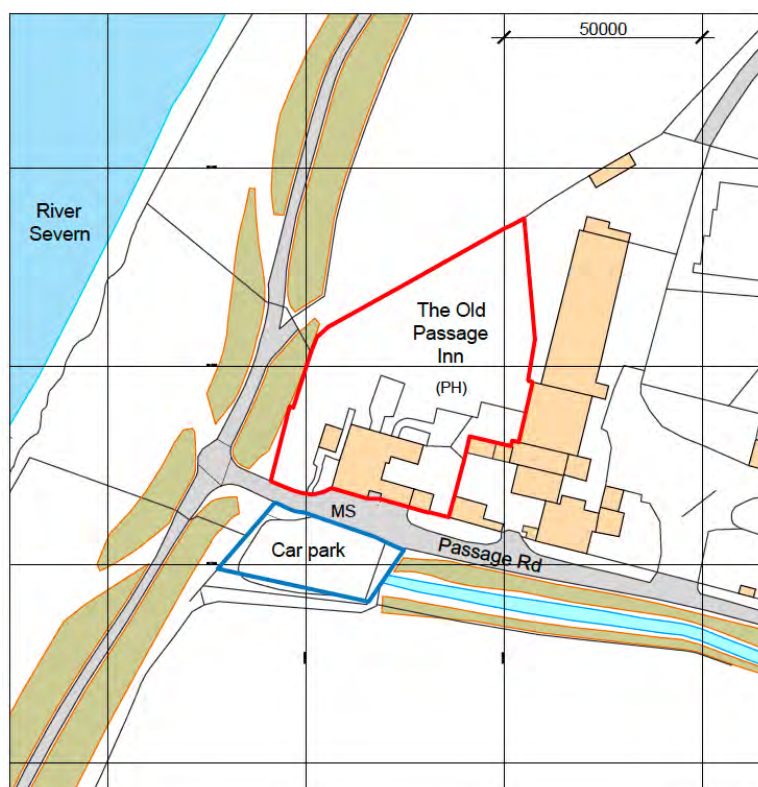


Figure 003: Site Location Plan

3.2 Current Layout

- 3.2.1 The Old Passage Inn is a detached Public House located on the eastern banks of the River Sever (horseshoe loop) 1.3km west of the village of Arlingham. The property is accessed via Passage Road. The Inn itself is located on the point of an historic ferry crossing and dates back to the 16th Century. It was traditionally a public house but in recent years has evolved to become a tea rooms / café by day and a restaurant during the evening, with Bed and Breakfast accommodation also present.
- 3.2.2 The ground floor comprises an open plan restaurant and ice cream parlour, with a catering kitchen present which is set on a split level. Owners accommodation is understood to be present at lower ground floor level which includes a kitchen / diner and pantry, with separate double bedroom and living room.
- 3.2.3 A large rear compound / yard is situated in the eastern section of the plot off which a block-built outbuilding is located. This is understood to be of considerable size and to be split into in two sections which are used for storage. A lower ground floor level is also understood to be present beneath the bar and restaurant which houses a toilet block, beer cellar, 2 no. storage rooms.
- 3.2.4 At first floor level are 3 no. double sized letting bedrooms, each set within a full bedroom suite with accompanying en-suite bathroom.

- 3.2.5 The grounds of the Inn comprise a large, landscaped garden with a children's play area, which extend north and west towards the River Sever. A further parcel of land is present on the southern side of Passage Road which is understood to be used as a car park, the surface finish of which comprises gravel. A further parcel of land, located between the western property boundary and the River Sever, is understood to be leased from a local landowner.
- 3.2.6 The Inn is located c.75m from the River Sever, with the continuation of Passage Road and a field separating the property and the River, Figures 003-005.



Figure 004: Existing Site Layout – Aerial Photo

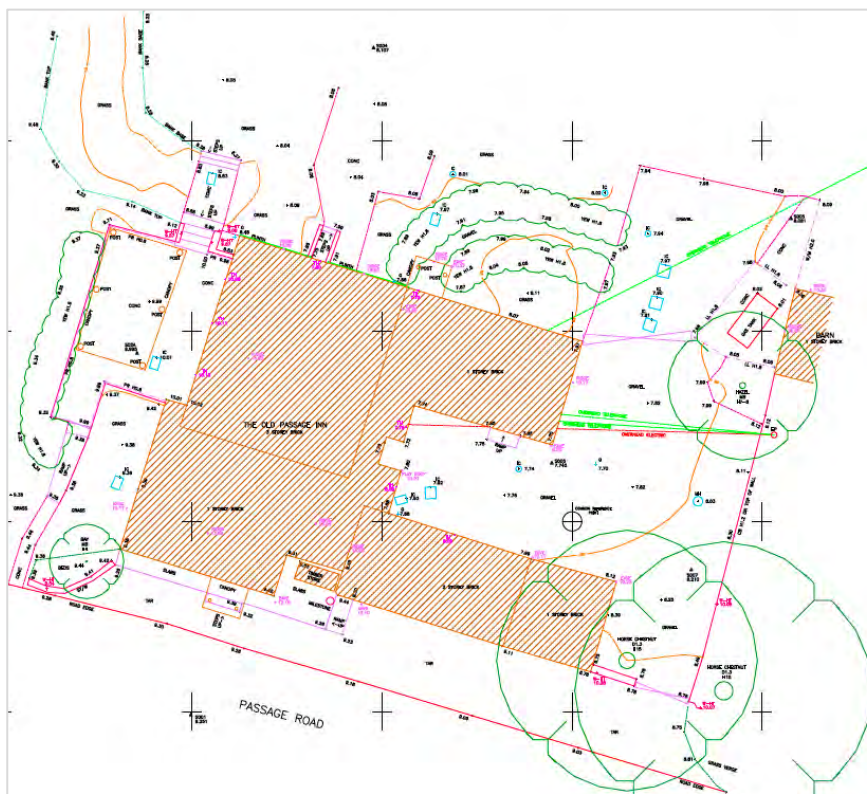


Figure 005: Existing Site Plan

3.3 Surrounding Area

- 3.3.1 The Old Passage Inn is situated within a rural setting c.1.0km west of the village of Arlingham and 75m east of the tidal River Severn. The River surrounds the Arlingham Parish on three sides, passing within 2km of the northern boundary of the subject property and heading south where it passes within 75m of the western boundary. To the south of the Passage Inn, the River Severn continues in a southerly direction for c.800m before heading east.
- 3.3.2 The town of Newnham is present c.400m west on the western banks of the River Severn. The Passage Inn marks the spot of a historic ferry crossing between Arlingham on the eastern banks of the Severn and Newnham in the west. Access to the property is via Passage Road to the south.

3.4 Proposed Development

- 3.4.1 Refurbishment of the Passage Inn is proposed, with this including the following elements:
- Demolition of an existing single storey extension measuring c. 42m² on the eastern elevation. This will be replaced with a 2 storey extension on the same footprint.
 - Roof raising above the existing kitchen.
 - Patio style roof extension over a c.16m² area on the western elevation to provide a covered seating area (not enclosed).
 - Change of use of lower ground floor to provide staff accommodation / holiday let(s).
 - New 790m² car park to the rear of the property.
- 3.4.2 It is understood that no increase in the built footprint, nor in the amount of sleeping accommodation located at ground or lower ground floor levels, will arise from development proposals.



Figure 006: Proposed Site Layout

3.5 Topographical Survey

- 3.5.1 Topographical survey data for the building and immediate surrounds has been supplied, refer to Drawing 6983-14FEB23-01: *Topographic Survey*, a copy of which is located to the rear of this report. This indicates surface elevations within the property boundary of between 7.70m AOD and 10.02m AOD, increasing in a westerly direction, with moderately low topographical relief. Ground levels undulate, with the lowest elevations in the rear courtyard on the eastern part of the plot and the most elevated ground present on the north western corner of the western elevation.
- 3.5.2 Building threshold levels are recorded between 7.75m AOD (northern elevation) and 10.12m AOD (north western elevation). The main entrance to the Inn is present on the southern elevation; ground levels of 9.39m AOD are noted in this area.

3.6 Hydrogeology

- 3.6.1 Regional geological mapping indicates the bedrock geology to comprise the Mercia Mudstone Group – Mudstone, overlain by Tidal Flats Deposits (Clay, Silt and Sand).
- 3.6.2 BGS borehole data is available for the area, which dates from July 1987, and which is noted to be associated with the local flood defences: SO61SE60, 0.19km north; SO61SE59, 0.22km south west and SO61SE66, 0.22km east, (Figure 007). These record superficial tidal deposits to depths of 3.30m bgl, 4.10m bgl and 3.90m bgl, respectively. Groundwater is noted to be absent.
- 3.6.3 Mapping data downloaded from Defra's Magic website⁸ indicates the property to be external to Groundwater Source Protection Zones.
- 3.6.4 Accounting for the above data, the risk of groundwater flooding is considered to be **Low**. This risk is further reduced by the impermeable underlying geology, which would prevent the upward migration of groundwater, with no further assessment proposed.



Figure 007: British Geological Survey Borehole Location Map

⁸ <https://magic.defra.gov.uk/MagicMap.aspx>

3.7 Flood Defences

- 3.7.1 The area is indicated to benefit from the presence of flood defences. Environment Agency flood defence asset records indicate earth embankments to be present on the eastern banks of the River Severn in this locale. These defences are noted to be 59.5m in length with a crest level of 10.35m AOD.
- 3.7.2 The Shoreline Management Plan (SMP) policy for this area is 'Hold the Line' in the short term (0-20 years, 2025), with 'Managed Realignment' for the medium (20 – 50 years, 2055) to long term (50 – 100 years, 2105).

3.8 Tidal River Severn

General Tidal Levels

- 3.8.1 The property is located c.75m east of the tidal River Severn which represents the principal flood risk to the Arlingham area.
- 3.8.2 National Tidal and Sea Level Facility (NTSLF)⁹ Tide Tables have been reviewed to ascertain the general tidal levels for the nearest tidal node on the Bristol Channel in this locale (Avonmouth), the results of which are summarised in Table 002. This data has been corrected to account for chart datum, with all levels converted to m AOD also using data downloaded from the NTSLF¹⁰ for Avonmouth.

Location	MHWS*	MLWS*	Range (m)	MHWN*	MLWN*	Range
Avonmouth	6.83	-5.44	12.27	3.49	-2.72	6.21

Table 002: River Severn Tide Data

*All levels in m AOD

- 3.8.3 A standard rule of twelfths approximation has been applied to the calculated tidal ranges to derive basic tidal curves, which are summarised in Figures 008a and 008b.

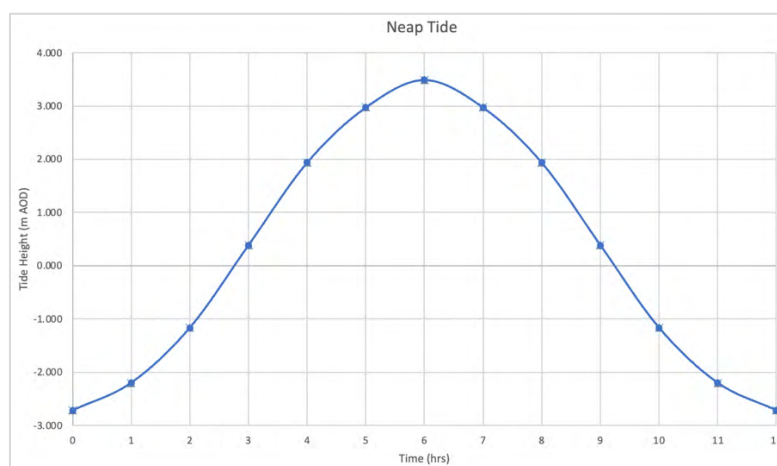


Figure 008a: Tidal Curve - Neap Tide

⁹ <https://ntslf.org/tides/hilo>

¹⁰ <https://ntslf.org/tides/datum>

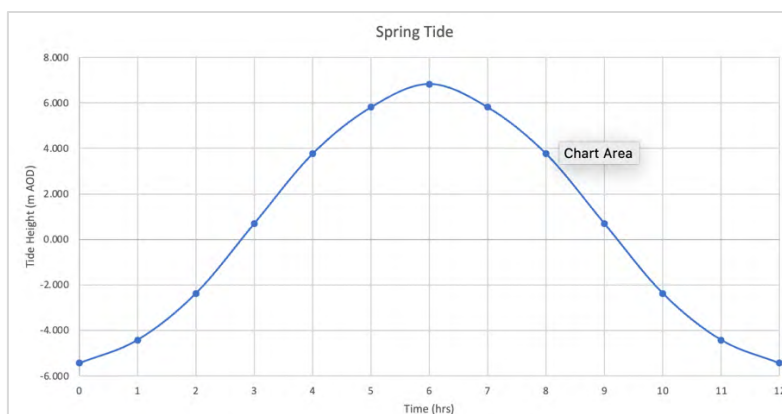


Figure 008b: Tidal Curve - Spring Tide

Tidal Flooding

Date	2020		2070	
	200	1000*	200	1000
Higher Central Flood Level (m AOD)	10.52	10.59	10.68	-
Upper End Flood Level (m AOD)	10.53	-	10.71	-

Table 003: River Severn Defended Tidal Flood Levels *Includes 5 year fluvial flood (joint probability)

3.8.4 Environment Agency detailed tidal flood data is available for this locale which has been extracted from the 2020 (re-run) River Severn Hydraulic Model and which includes revised estimations of climate change to 2070. A summary of this data is presented in Table 003.

3.8.5 Review of this data confirms the Old Passage Inn to be potentially affected by tidal flooding with further consideration required.

3.9 Fluvial Flooding and Hydrology

3.9.1 Arlingham lies at the western end of the horseshoe loop of the River Severn, known as the "Horseshoe Bend", looking across the water to Newnham on Severn and the Forest of Dean. Access to the village is via Fretherne bridge over the Gloucester and Sharpness Canal, or Sandfield Bridge at Saul Junction.

3.9.2 The Old Passage Inn is located c.75m east of the tidal River Severn which represents the principal flood risk. The wider area is crossed by a series of ditches, including the Cottage, Passage and Westmarsh Ditches. A pond is also present at Passage Farm, c.0.20km east.

Fluvial Flooding

3.9.3 Environment Agency detailed fluvial flood data is available for this locale which has been extracted from the River Severn Model (2020 re-run) and which includes revised estimation of climate change to 2125. A summary of this data is presented in Table 004. Review of this data confirms the property to be potentially affected by fluvial flooding with further consideration required.

Date	2020		2070	
	100	1000	100	1000
Higher Central Flood Level (m AOD)	10.11	10.25*	10.15	-
Upper End Flood Level (m AOD)	10.14	-	10.17	-

Table 003: River Severn Defended Fluvial Flood Levels *Includes 2 year tidal flood (joint probability)

Hydrological Data

- 3.9.4 Catchment descriptor information has been downloaded from the CEH Flood Estimation Handbook Web Service which is summarised in Table 004. Owing to the tidal nature of the Severn catchment, the nearest node for data extraction is situated at Maisemore some 30km upstream of Arlingham. Nevertheless, given the significant catchment area (9,970km²), this data will still be representative of the flood mechanism(s) at Arlingham.
- 3.9.5 This indicates a large, *slightly urbanised*, catchment with elevated topographical relief, permeable geology and moderate average annual rainfall.

Catchment Descriptor	River Severn	Site Catchment
Area	9,971km ²	0.58km ²
River Baseflow Index (BFIHOST 19)	0.495	0.667
Standard Percentage Runoff (SPRHOST)	35.93%	31.00%
Drainage Path Length (DPLBAR)	143.46km	0.90km
Drainage Path Slope (DPSBAR)	73.00m/km	5.400m/km
Flood Attenuation by Rivers and Lakes (FARL)	0.979	1.000
Proportion of time soils are wet (PROPWET)	0.32	0.33
Standard Annual Average Rainfall (SAAR)	814mm	796mm
Urban Extent (URBEXT: 2000)	0.0351	0.0451

Table 004: FEH Catchment Descriptor Information

- 3.9.6 Fluvial flows within the River Severn are likely to be marginally predominated by subterranean flow (BFIHOST) with more modest contributions via overland flow (SPRHOST) and with a low to moderate catchment response to incident rainfall anticipated. A low FARL value (Flood Attenuation by Rivers and Lakes) indicates attenuation to be present within the upper catchment which may depress the response to incident rainfall. The catchment response to rainfall may however be elevated by local factors, e.g. urban runoff and impermeable overlying soils.
- 3.9.7 An indicative time to peak of 28.50hrs has been calculated for the River Severn at Maisemore using catchment descriptor information downloaded from the CEH website as input to the following Equation taken from FEH Volume 1 , p.21:

$$T_p = 1.56 \text{ PROPWET} - 1.09 \times \text{DPLBAR}^{0.60} \times (1 + \text{URBEXT}) - 3.34 \times \text{DPSBAR}^{0.28}$$

- 3.9.8 Furthermore, a design storm duration of 51.7 hrs is estimated, with a baseflow lag (time for peak baseflow contribution) calculated at 85.7hrs. It is therefore considered that significant warning would be available in the event of fluvial flooding arising from the River Severn.

3.10 Climate Change

Tidal Allowance

- 3.10.1 Current UK Government Guidance on Climate Change states that both the *Higher Central* and *Upper End* climate change allowance should be applied to tidal flood level when considering the potential risk to development within Flood Zones 2 & 3a.
- 3.10.2 The flood data supplied by the Environment Agency for this locale has been prepared using detailed hydrodynamic modelling which incorporates climate change allowances for both fluvial and tidal inputs for the next 100 years, and which includes joint probability analysis for tidal and fluvial inputs. This data has been used to inform this study.

Fluvial Allowance

- 3.10.3 Current UK Government Guidance on Climate Change states that the *Central* climate change allowance should be applied to fluvial flows when considering the potential risk to 'More Vulnerable' development within Flood Zones 2 & 3a. This requires application of climate change factors of up to 37% to 2070, based on a development lifetime of 50 years (*non-residential use*).
- 3.10.4 The flood data supplied by the Environment Agency for this locale has been prepared using detailed hydrodynamic modelling (Tidal Severn Climate Change Re-Run 2020 model) which includes climate change allowances for fluvial inputs for the next 100 years, as well as consideration of joint (fluvial and tidal) probability analysis. This data has been used as input to this study.

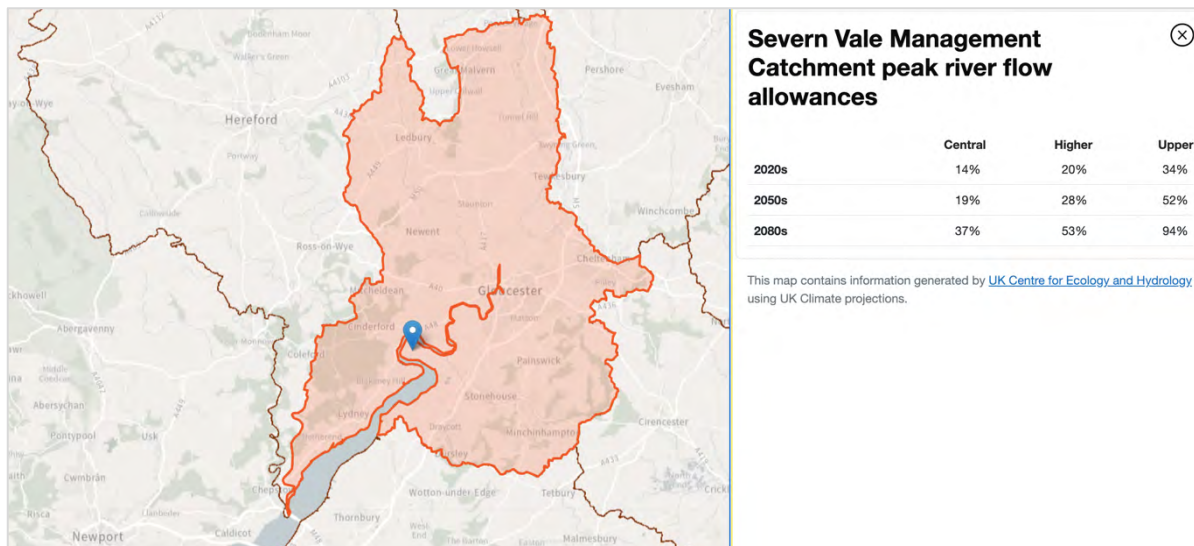


Figure 009: Climate Change Allowance – Fluvial Flow

Rainfall Allowance

- 3.10.5 Government Guidance on Climate Change Allowances to Peak Rainfall Intensity (Table 2), requires application of climate change factors of up to 25% (*Central Allowance*) for both the 2050s epoch (2022-2060) and the 2070s epoch, based on development with a lifetime between 2061 and 2100 (*non-residential use*).

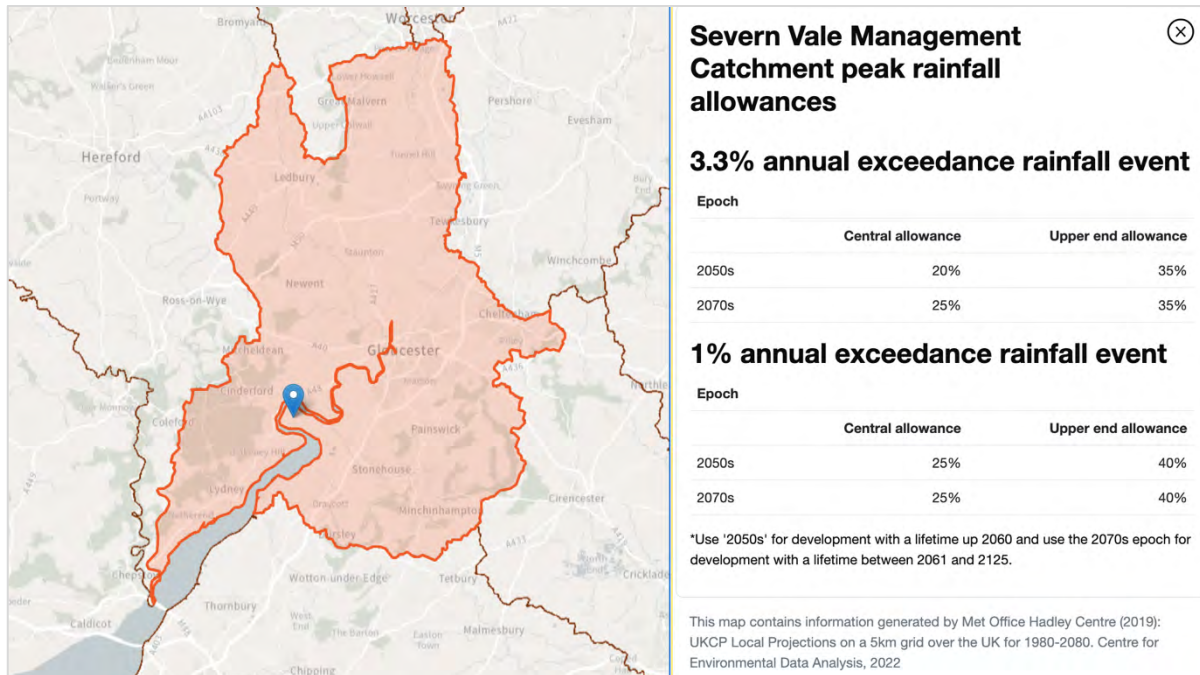


Figure 010: Climate Change Allowance – Rainfall Intensity

3.11 Flood Warning

3.11.1 The Old Passage Inn is situated within the Environment Agency Flood Alert Area for 'Severn Estuary from Gloucester to Sharpness'.¹¹

3.12 Historic Flooding



Figure 011: Defra Historic Flood Map

¹¹ <https://check-for-flooding.service.gov.uk/target-area/031WAT217>

- 3.12.1 Desk based investigation, including review of the Strategic Flood Risk Assessment and Defra Historic Flood Maps¹², reveals evidence of historic flooding in this locale, Figure 011. There is also evidence of an 'Arlingham Great Flood' from the 17th century, which was thought to be associated with a high tide and tidal surge, pre-dating defences.
- 3.12.2 EA supplied data also indicates historic flooding in this locale in December 1981 with this noted to arise from exceedance of the channel capacity.
- 3.12.3 Caution should be exercised when reviewing historic flood records. This information is largely anecdotal and does not always include record of either the antecedent conditions giving rise to flooding (e.g. flood source), or reference to a flood return period. Furthermore, a lack of recorded incidents is no guarantee that an area has never flooded.

3.13 Flood Zone Classification

- 3.13.1 The Old Passage Inn is situated within defended Flood Zone 3a (High Risk) for the tidal River Severn.

3.14 Flood Risk Vulnerability

- 3.14.1 A planning application is to be submitted for the refurbishment of The Old Passage Inn, Arlingham, Gloucestershire, GL2 7JR. This includes:
- Demolition of an existing single storey extension which is to be replaced with a two storey extension;
 - Minor roof extension to create a covered area (not enclosed);
 - An area of roof raising; and
 - A new carpark.
- 3.14.2 All building work will be within the existing built footprint with no sleeping accommodation proposed at ground floor level.
- 3.14.3 Table 2 of the PPG defines *hotel* and *drinking establishment* uses as 'More Vulnerable'. Table 3 of the PPG considers this an appropriate use within Flood Zone 3a subject to application of the Exception Test.

	Flood Risk Vulnerability Class'n (PPG Table 2)	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone (PPG Table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	Exception Test Required	✓	✓	✓
	Zone 3a	Exception Test Required	x	Exception Test Required	✓	✓
	Zone 3b (Functional Floodplain)	Exception Test Required	x	x	x	✓

Key:

✓ Development is appropriate x Development should not be permitted

Table 005: PPG Table 3 – Flood Risk Vulnerability and Flood Zone Compatibility

¹² <https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/HistoricFloodMap&Mode=spatial>

3.15 NPPF Sequential and Exception Tests

- 3.15.1 The Sequential Test steers development preferentially towards Flood Zone 1 (Low Risk), considering Flood Zone 2 (Medium Risk) and then Flood Zone 3 (High Risk) only if land cannot be identified as available for development in zones at lower risk from flooding.
- 3.15.2 The Sequential Test is generally carried out at a strategic level by the Local Planning Authority with input from the Environment Agency, as part of the Local Plan process and should be informed by a Strategic Flood Risk Assessment.
- 3.15.3 According to the NPPF paragraph 168 and footnote 56:

'Applications for some minor development and changes of use should not be subject to the Sequential or Exception Tests but should still meet the requirements for site-specific Flood Risk Assessments.'

- 3.15.4 The current Change of Use application is therefore exempt from consideration under the NPPF Sequential and Exception Tests. Nevertheless, a Flood Risk Assessment must still be provided in accordance with footnote NPPF 55. This must consider the risks arising from all potential forms of flooding and ensure the safety of the property and its users throughout the development lifetime, without increasing flood risk elsewhere.

3.16 Infrastructure Failure

- 3.16.1 Flooding from artificial sources occurs when man made infrastructure, e.g. flood defences, raised channels or surface water storage features (e.g. reservoirs), becomes overwhelmed leading to breach or failure of the dam, banks or control structures. The probability of failure is low owing to regular inspection and maintenance regimes. However, in the event of a breach occurring, the consequences can be significant.
- 3.16.2 The application area is remote from raised waterways the failure of which could lead to flooding. The flood risk posed by this form of infrastructure failure is therefore considered to be **Low** with no further assessment required.
- 3.16.3 Review of National Reservoir Flood Maps indicates the Old Passage Inn to be unaffected by reservoir flooding under both normal and extreme river water level scenarios, with no further assessment required.
- 3.16.4 The Arlingham area benefits from the presence of flood defence infrastructure the breach or failure of which could lead to flooding, with a potentially **Significant** associated risk and with further assessment therefore required.

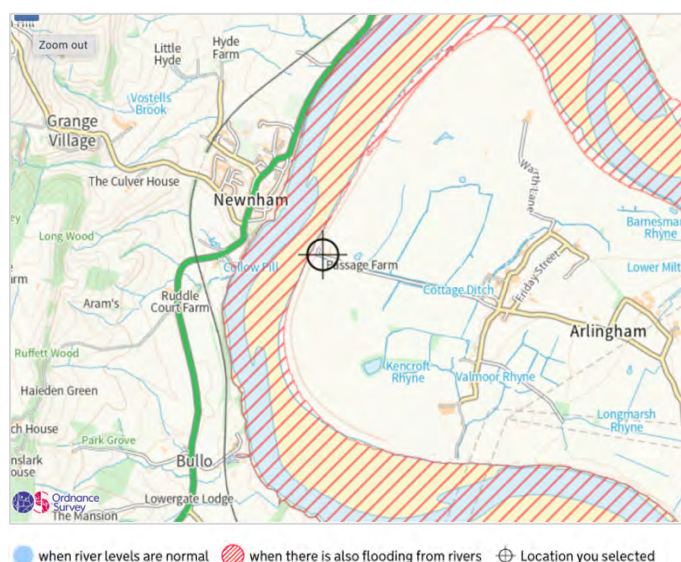


Figure 012: Environment Reservoir Flood Map

3.17 Surface Water Flooding

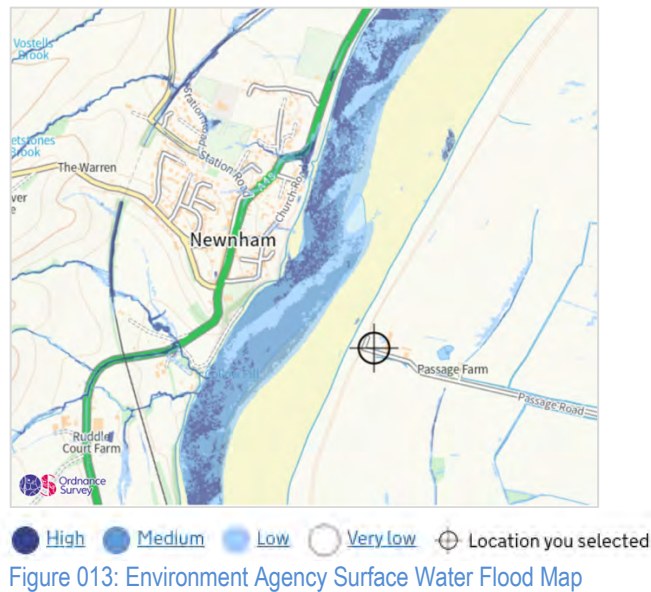


Figure 013: Environment Agency Surface Water Flood Map

- 3.17.1 Detailed EA pluvial mapping downloaded from the EA website, assesses three main scenarios, Low Risk (0.1%-1% probability of flooding annually), Medium Risk (3.3% - 1%) and High Risk (>3.3%). The findings of this assessment are summarised in Figure 013.
- 3.17.2 This data indicates the application area to be at generally **Very Low** risk of surface water flooding. Some minor discrete areas of **Low** risk flooding are indicated on the western elevation of the property, likely associated with the ponding of runoff in low points within the garden, with no inundation of the building anticipated and with no further assessment proposed.

3.18 Sewer Flooding

- 3.18.1 Whilst the Arlingham area is served by a network of public sewers which is maintained by Severn Trent Water, the property itself is indicated to be remote from these, being served by a septic tank.
- 3.18.2 The SFRA sewer flood data provided by Severn Trent Water and Wessex Water indicates the GL2 7 area to be at **Medium Risk** from sewer flooding, with 6 properties likely to be affected. Given the property's remote location relative to public sewers, it is considered that it would be unaffected by this form of flooding with no further assessment proposed.

4.0 FLOOD RISK ASSESSMENT

4.1 Flood Risk Screening Opinion

- 4.1.1 In accordance with the NPPF Section 14 it is necessary to consider all forms of flood risk. A flood risk scoping exercise has therefore been completed, the results of which are outlined in Table 006.

Nature of Flood Risk	Flood Risk to Site?
Groundwater	No. Main groundwater is indicated to be located at depth. Underlying Clay geology further reduces this risk.
Tidal	Yes. The property is located entirely within (defended) Flood Zone 3a for the tidal River Severn and associated tributaries.
Fluvial	Yes. Plot within Flood Zone 3a for the adjacent River Severn.
Infrastructure Failure (Reservoirs, Canals and Other Artificial Sources)	Raised Waterways: Not at risk.
	Reservoir Failure: Not at risk.
	Flood Defence Breach / Failure: At risk. The property is within an area benefitting from the presence of flood defences, the breach or failure of which could lead to flooding, with further assessment proposed.
Overland Flow (surface water from off-site sources)	No. EA Flood Maps indicate the property to be at Very Low risk from pluvial flooding, with no further assessment required.
Sewers	No. The property is considered to be unaffected by sewer flooding with no further assessment proposed.
Surface Water Drainage (on-site)	No. A minor uplift in impermeable surface will arise from development proposals with consideration of surface water management required.

Table 006: Flood Risk Screening Opinion

- 4.1.2 Flood screening indicates the principal flood risk to arise from fluvial and tidal sources, with these duly assessed. Residual risks associated with extreme tidal flooding (1000 years) and flood defence breach / failure have also been considered. The results are summarised below.

4.2 Tidal Flooding

Flood Zone 3a - 200 Year Tidal Flood (Design Event)

- 4.2.1 Detailed flood data has been data supplied by the Environment Agency with maximum flood levels of 10.53m AOD estimated under an existing 200 year tidal flood (2020), increasing to 10.71m AOD accounting for climate change to 2070.
- 4.2.2 Inundation of the property is anticipated despite the presence of flood defences. This owing to the minimum crest level on the defences (10.35m AOD) being located between c.0.18m and c.0.36m below the anticipated flood levels now and in the future, respectively.
- 4.2.3 Topographical analysis indicates flood depths of up to 2.83m at the property during an existing tidal flood event, increasing to 3.01m for a future (2070) tidal flood with a **Significant** associated flood risk.
- 4.2.4 Minimum threshold levels in the existing Inn are indicated at 7.75m AOD with maximum water depths in the building estimated at between 2.78m (2020) and 2.96m (2070), also with a **Significant** associated flood risk.
- 4.2.5 The principal flood mechanism would be overtopping of the flood defences, with available flood storage present within the flood cell area between the defences and the Inn which would flood first and which would afford a degree of flood warning time.

- 4.2.6 A standard rule of twelfths approximation has been applied to the calculated Mean High Water Springs and Mean High Water Neaps tidal range for the nearest tidal node (Avonmouth). This to derive a basic tidal curve (Figure 014) onto which the future 200 year tidal storm surge level within the River Severn has been superimposed for *Upper End* estimations of climate change to 2070. This is considered representative of the flood levels which would be experienced at the defences throughout the course of a future 200 year storm surge.
- 4.2.7 The flood defence crest level has been projected onto this tidal curve to evaluate the likely period of overtopping. The results are summarised in figure 014 with inundation of the property indicated for a period of up to 1hr around high water on a Spring Tide and 1.5hrs on a Neap Tide.
- 4.2.8 Flooding could continue across at least 2 tidal cycles before the storm surge abates, although it is likely that the majority of overtopped water would discharge back into the estuary during the low tide via local land drains and outfalls / sluices.

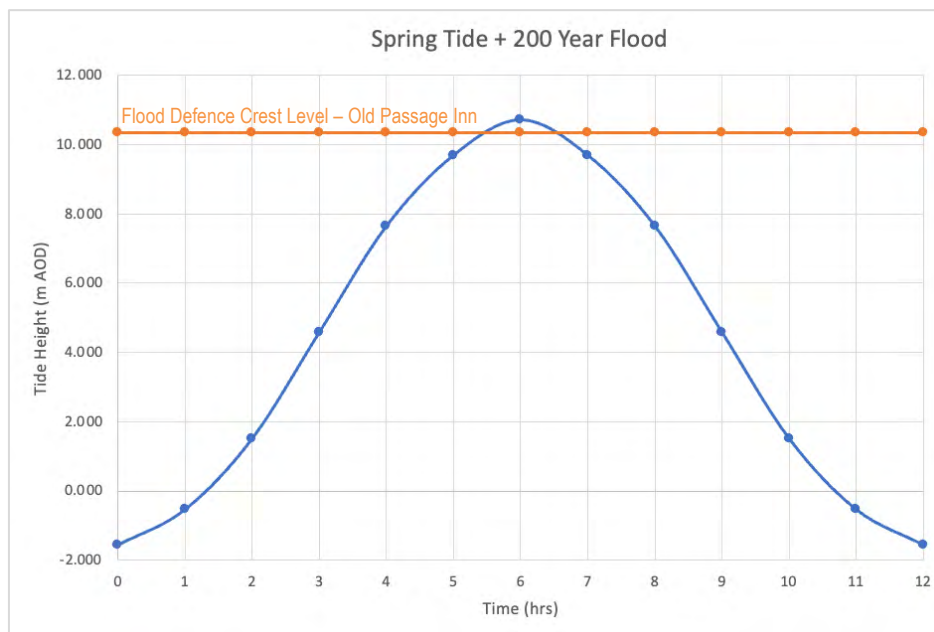


Figure 014a: 200 Year (2125) Tidal Flood Curve – Spring Tide

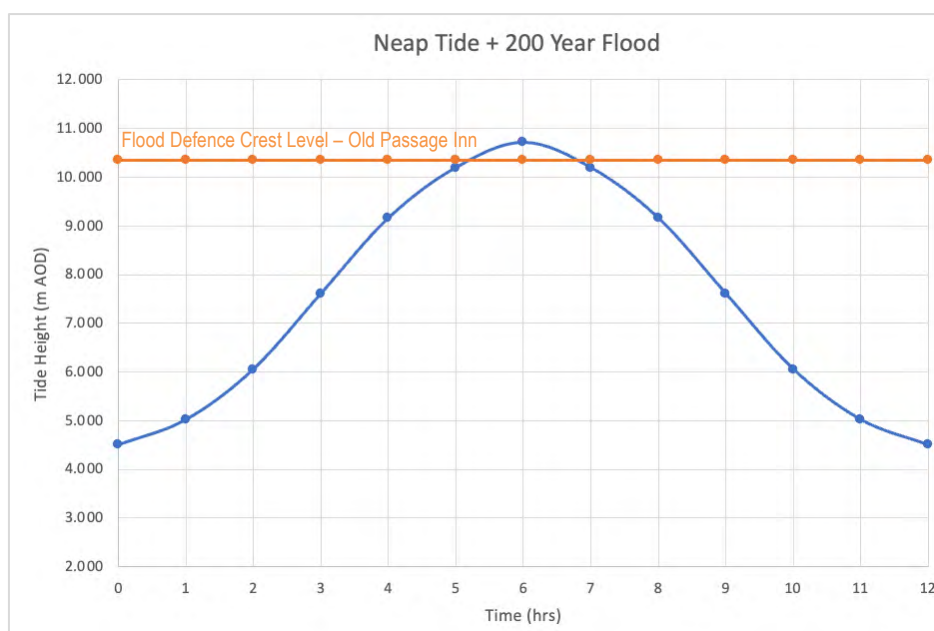


Figure 014b: 200 Year (2125) Tidal Flood Curve – Neap Tide

- 4.2.9 The following factors serve to increase the lead time for flood warning and to reduce the flood hazard:
- The tidal nature of flooding provides an element of predictability;
 - Wave action within the River Severn itself would be limited owing to the presence of topographical barriers (Meanders) and the restricted fetch over which wind generated waves could be set up;
 - The tidal R. Severn is highly managed, with a substantial monitoring regime in place, which would likely strengthen the passage of information via the flood warning system in this locale;
 - The Arlingham area benefits from the presence of flood defences with the principal flood mechanism indicated to be overtopping. These reduce the risk to the property for tidal flood levels up to and including 10.05m AOD (accounting for freeboard consideration) and increase the lead time for evacuation ahead of flooding;
 - The volume of water entering the floodplain via overtopping of the defences is dependent on:
 - Length of defence overtopped;
 - Eustatic head of water experienced at the crest (up to 0.47m indicated);
 - Period of overtopping, with this is indicated to be restricted to a c.1.5hr. period about high tide, and with flood water likely to recede quickly in the period between high waters; and
 - Flood storage available within lower ground present between the property and flood defences which would flood first.
 - Given the tidal influence on flooding, it is anticipated that maximum water levels would be restricted to the peak around the high tide, with flood water receding quickly in the period between high waters;
 - The application represents a continuation of an existing and established use and would not increase the hazard to which occupants are currently exposed;
 - Absence of sleeping accommodation at ground floor level;
 - Flood mitigation is incorporated within the design of the proposed extensions;
 - Flood management measures are proposed to reduce residual risks which cannot be borne out through design;
 - The property benefits from flood warning which would alert the owners and guests to the potential for elevated water levels in the River Severn which may lead to flooding or a breach of the flood defences; and
 - Emergency access / egress is available via Passage Road to the east, which is indicated to be unaffected by flooding to the west of the junction between Church Road and Arlingham High Street (1.25km east).
- 4.2.10 The above factors, coupled with the proposed flood resilience and management measures, would ensure that the flood risk to the Inn and its occupants arising from design return period tidal flood events can be reduced to a **Practically Low** level, now and in the future.
- Flood Zone 3a - 100 Year Fluvial Flood (Design Event)**
- 4.2.11 Detailed flood data has been data supplied by the Environment Agency with maximum flood levels of 10.11m AOD estimated under an existing 100 year fluvial flood (2020), increasing to 10.15m AOD accounting for climate change to 2125. No inundation of the property is anticipated owing to the presence of flood defences the crest levels of which are located at 10.35m AOD.
- 4.2.12 Nevertheless, the freeboard between the maximum flood level and the crest level of the adjacent flood defences is noted to be below the standard 300mm recommended to account for storms in excess of those assessed, successive storm events or bank settlement. It is therefore considered that the flood defences offer below a 100 year standard of protection from flooding both now and in the future.
- 4.2.13 The flood risk to site users is further reduced by the following factors which increase the lead time for flood warning:
- Size of the upstream R. Severn catchment (9,971km²) which has an estimated 'Time to Peak' of 28.5hrs, with Critical Storm Duration of 51.7hrs and Baseflow Lag of 85.7hrs;
 - Elevated water levels in the R. Severn are likely to be limited to the period around peak flows, with these receding quickly once downstream water levels subside;

- Wave action within the River Severn itself would be limited owing to the presence of topographical barriers (Meanders) and the restricted fetch over which wind generated waves could be set up;
- The R. Severn is subject to tidal influence at its downstream extent with elevated water levels in the River and its tributaries likely subject to a degree of predictability, particularly where fluvial and tidal surge events coincide;
- The R. Severn is a highly managed catchment, which is subject to significant artificial control by pumps and sluices and with a substantial monitoring regime in place, which would likely strengthen the passage of information via the flood warning system in this locale;
- The flood mechanism is anticipated to be overtopping of the eastern banks of the R. Severn, with low associated flow velocities and a significant lead time for flood warning.;
- The application represents a continuation of an existing and established use and would not increase the hazard to which occupants are currently exposed;
- Absence of sleeping accommodation at ground floor level;
- Flood mitigation is incorporated within the design of the proposed extensions;
- Flood management measures are proposed to reduce residual risks which cannot be borne out through design;
- The property benefits from flood warning which would alert the owners and guests to the potential for elevated water levels in the River Severn which may lead to flooding or a breach of the flood defences;
- The building itself will act as a point of safe refuge should flooding occur, with this capable of accommodating site users for an extended period; and
- Emergency access / egress is available via Passage Road to the east, which is indicated to be unaffected by flooding to the west of the junction between Church Road and Arlingham High Street (1.25km east).

4.2.14 The above factors, coupled with the proposed flood resilience and management measures, would ensure that the flood risk to the Inn and its occupants arising from design return period fluvial flood events can be reduced to a **Practically Low** level, now and in the future.

4.3 Flood Mitigation and Management

Flood Mitigation

- 4.3.1 The Old Passage Inn is situated on the eastern banks of the River Severn and is indicated to be affected by flooding for design return period tidal storm events (up to and including 200 years), with a **Significant** associated flood risk.
- 4.3.2 Given the depth of flooding anticipated and that the proposals relate to a change of use of an old building which is considered a heritage asset within a Conservation Area, it is not practicable to raise existing / proposed floor levels or to make substantial structural alterations.
- 4.3.3 Furthermore, it is important to ensure that an appropriate balance is struck between the provision of flood risk mitigation and good place making. In order to fulfil disabled access requirements it will be necessary to provide entrances which are flush with the external ground levels. The proposed use at ground floor level is commercial with operation likely to conform to standard restaurant hours, with a manager present at all times and with no ground floor sleeping accommodation proposed.
- 4.3.4 Taking account of the above factors, the following flood resilience measures are proposed to increase the lead time for flood warning and ensure the safety of the occupants in the event of flooding (until such time as an evacuation could be effected):
- Location of all residential / guest accommodation elements at first floor level or above;
 - Raising of entry points for all services to a minimum of 600mm above the surrounding ground level to ensure an emergency level of service is retained in the event of flooding, e.g. until such time as the Flood Management Plan can be executed and / or an evacuation be effected;
 - Flood doors / windows to be fitted to all new entry points / windows which are situated at ground floor level;
 - Flood resilient design should be incorporated within all ground floor extension areas. This to include:
 - Screed / tiled floors and tanking of walls to minimise the impact of flooding and to ensure the property can be quickly brought back into use without significant refurbishment;

- Consideration should also be given to retrofitting flood resilient design to existing ground floor walls and floors, e.g. screed / tiled floors, tanking of walls to prevent secondary ingress via brickwork in the event of flooding;
- Temporary demountable barriers on doors / windows which can be installed in the event of flood warning being received;
- Flood proof air bricks; and
- Non-return valves to be fitted on all ground floor toilets, sinks and waste outfalls to prevent backflow / ingress pathways in the event of flooding.

4.3.5 Input from a structural engineer should be sought to ensure that the built fabric of the property (extension) can withstand the pressures and forces (hydrostatic and hydrodynamic) associated with maximum anticipated flood water levels accounting for climate change.

Flood Management

4.3.6 The Old Passage Inn is considered to be affected by flooding under both design and extreme return period fluvial and tidal flood events. Flood management measures are therefore proposed to reduce the residual risk to site users. The Local Plan documents and the SFRA have been referred to when specifying these measures, which include the following:

- No sleeping accommodation to be provided at ground floor level;
- Sign up to the EA flood warning system¹³. This provides advance warning of flooding and would advise occupants of the potential need to evacuate;
- Preparation of a Flood Management Plan, alerting site users to the risks posed to the properties by flooding and outlining the measures to be taken should flooding occur. This to include designation of points of safe refuge and means of safe access / egress for site users and the Emergency Services.
- Given the maximum anticipated depths of flooding (>3m), where flooding occurs, the building should be evacuated as soon as safe to do so. In the event flooding occurs without warning (unlikely), the upper floor(s) should be used as a point of safe refuge until evacuation can be executed safely;
- The property owner(s) and any overnight guests are advised to familiarise themselves with the measures to be undertaken in the event of flooding, e.g. points of safe refuge, evacuation routes and isolation of services; and
- A flood alarm system should be fitted to the building which can be used to alert occupants to the requirement for evacuation. This could have 2 sound levels, one to alert site users to be prepared to evacuate and a second to evacuate immediately. This should have remote capability, e.g. via a mobile application, to allow it to be triggered by a designated safety officer who may be located in an off-site location.

Safe Refuge and Access

4.3.7 The property is indicated to be currently defended from fluvial flooding for existing design return period events, although the freeboard on the flood defences is below the required 300mm standard. However, inundation is indicated under both existing future design return period tidal flood events, with a **Significant** associated flood hazard.

4.3.8 Where flooding is anticipated but has not yet occurred, site users should evacuate east along Passage Road, where safe refuge is available beyond the junction with Church Road and Arlington High Street (1.25km east) and which connects into the main arterial road networks serving the area.

4.3.9 Site users should be aware that flooding of the road networks beyond Arlingham may occur and are advised to check for flooding to the east of Arlingham ahead of accessing the road networks beyond the village. Where flooding of the wider road network has occurred, people should remain in Arlingham and await instruction from the Emergency Services.

4.3.10 Where flooding has already occurred, occupants should remain inside the property, evacuating to first floor level and follow flood management procedures, e.g. isolation of power and services, and await further instruction from the Environment Agency and Emergency Services.

¹³ <https://www.gov.uk/sign-up-for-flood-warnings>

- 4.3.11 Given the tidal nature of the flooding, it is anticipated that water would recede quickly, with evacuation possible in the period between high tides. Nevertheless, site users should prepare for flooding across a minimum of two tidal cycles (24 hrs).
- 4.3.12 Based on the above factors it is concluded that safe access / egress routes and safe refuge are available in the event of flooding during design return period flood events, now and in the future.
- 4.3.13 It is recommended that a Flood Management Plan be produced, which outlines the flood risks at the Old Passage Inn and the procedures to be followed in the event of flooding.

4.4 Residual Flood Risk

Flood Zone 2: 1000 Year Flood Outline - Fluvial

- 4.4.1 In accordance with the requirements of the NPPF, it is necessary to assess the risks associated with more extreme flooding in order to inform the flood management measures required. The NPPF regards the 1000 year storm to be representative of an extreme event and this has been duly assessed. The probability of extreme flooding occurring is considered to be low, which reduces the flood risk.
- 4.4.2 The Old Passage Inn is situated adjacent to the tidal River Severn. Environment Agency detailed flood data indicates the property to be affected by a 1000 year return period flood with flood depths up to 10.25m AOD (2020).
- 4.4.3 Inundation of the property is unlikely since the crest level of the flood defence (10.35m AOD) is located above the flood level. However, the water levels in the River would be close to continuity with the crest of the flood defences, with very little freeboard available, with minor overtopping likely. Flood depths and flow velocities are likely to be low with a **Low to Moderate** associated flood hazard.
- 4.4.4 Flood resilience measures are specified for incorporation within the design of the new property elements, with flood management proposed to alert site users to the risks posed by flooding and the actions to be taken should this occur.
- 4.4.5 The factors outlined within Section 4.2 serve equally to reduce the potential flood hazard to the properties in the event of extreme fluvial flooding. These, coupled with the proposed flood resilience and management measures, would ensure that the residual flood risk to the Inn and its occupants arising from extreme fluvial flooding can be reduced to a **Practicably Low** level, now and in the future.

Flood Zone 2: 1000 Year Flood Outline - Tidal

- 4.4.6 Detailed flood data has been data supplied by the Environment Agency with maximum flood levels of 10.59m AOD estimated under an existing 1000 year tidal flood (2020).
- 4.4.7 Inundation of the property is anticipated despite the presence of flood defences. This owing to the crest level on the defences (10.35m AOD) being located c.0.24m below the anticipated flood level. Topographical analysis indicates flood depths of up to 2.89m at the property during an extreme tidal flood with a **Significant** associated flood hazard.
- 4.4.8 Flood resilience measures are specified for incorporation within the design of the new built elements, with flood management proposed to alert site users to the risks posed by flooding and the actions to be taken should this occur.
- 4.4.9 The factors outlined within Section 4.2 serve equally to reduce the potential flood hazard to the properties in the event of extreme tidal flooding. These, coupled with the proposed flood resilience and management measures, would ensure that the residual flood risk to the Inn and its occupants arising from extreme fluvial flooding can be reduced to a **Practicably Low** level, now and in the future.

Infrastructure Failure - Breach of Flood Defences

- 4.4.10 The development is located within an area which benefits from the presence of flood defences, the breach / failure of which could lead to flooding. Although the likelihood of this is low, the potential hazard would be **Significant** and must be fully scrutinised to inform the management measures required to ensure the safety of site users in this event.
- 4.4.11 In the event of a breach of the flood defences, there would be little or no flood warning, with a sudden onset of flooding and a **Significant** associated hazard. Greatest depths and velocities would be seen immediately adjacent to the defences, reducing

as water spreads across the floodplain (spreading loss). The Old Passage Inn is located some 75m from the defences and is therefore likely to experience elevated flow velocities and flood depths.

- 4.4.12 Ingress of the building is highly probably with a **Significant** associated flood risk.
- 4.4.13 The tidal nature of the adjacent River Severn increases the likely flood warning time for those extreme storm events which may precipitate a breach of the flood defences. Further, it is anticipated that water levels would recede quickly, with emergency repairs / evacuation possible in the period between high tides. Nevertheless, site users should prepare for flooding across a minimum of two tidal cycles (24 hours).
- 4.4.14 The flood defences are subject to ongoing inspection, management and maintenance, to ensure their continued integrity, which further reduces the risk of a breach.
- 4.4.15 The factors outlined within Section 4.2 serve equally to reduce the potential flood hazard to the properties in the event of a flood defence breach. These, coupled with the proposed flood resilience and management measures, would ensure that the residual flood risk to the Inn and its occupants arising from a breach of the estuary defences can be reduced to a **Practicably Low** level.

4.5 Summary of Flood Risk

- 4.5.1 In accordance with the requirements of the NPPF and local planning policy documents, all potential flood risks posed to / by the Old Passage Inn have been assessed, with the principal hazards identified to arise from fluvial and tidal sources, which have been duly assessed.
- 4.5.2 The property is currently indicated to be defended from flooding for design return period fluvial flood events to 2070 although the freeboard on the adjacent flood defences is below the statutory requirements with minor overtopping likely and with a **Low to Moderate** associated flood hazard.
- 4.5.3 The Old Passage Inn is indicated to be affected by tidal flooding now and in the future with inundation likely and with a **Significant** associated flood hazard.
- 4.5.4 Flood resilience measures are specified to reduce identified risks to a practicably low level accounting for both the development lifetime and flood risk vulnerability. Flood management is also proposed to alert site users to the risks posed by flooding and the actions to be taken should this occur. This includes consideration of flood warning and designation of points of safe refuge, as well as safe access / egress routes.
- 4.5.5 Residual risks associated with extreme flooding and potential flood defence breach / failure have also been considered and concluded to be **Practicably Low** accounting for the proposed flood mitigation and management measures.
- 4.5.6 It is duly presented that the risks posed to the Old Passage Inn and its users by fluvial and tidal flooding can be reduced to a **Practicably Low** level throughout its lifetime, ensuring the safety of its occupants throughout all periods of flooding, and with no detrimental impact on flood risk elsewhere.
- 4.5.7 The proposals are therefore considered appropriate within the context of the Local Planning Policy documents and paragraph 167 of the NPPF:
- *Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
 - *The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;*
 - *It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
 - *Any residual risk can be safely managed; and*
 - *Safe access and escape routes are included, where appropriate, as part of an agreed emergency plan.*
- 4.5.8 Potential impacts to flood risk arising from surface water generated by the development are addressed in Section 5.0.

5.0 SURFACE WATER

5.1 Introduction

- 5.1.1 Amber Planning Ltd. has been appointed by Quality Inns of Gloucestershire Ltd. to prepare a Flood Risk Assessment in support of an application for the proposed refurbishment of a commercial property (Public House) at the Old Passage Inn, Arlingham, Gloucestershire, GL2 7JR. Proposals include the input of a new rear carpark.
- 5.1.2 The property currently drains unattenuated via infiltration into the underlying soils, with excess runoff discharged to local drainage networks and watercourses via overland flow.
- 5.1.3 The NPPF and its PPG require that existing runoff rates be maintained, taking account of climate change and that, wherever possible, a degree of betterment is provided. An uplift in the runoff coefficient will arise from development proposals which, without mitigation, would have a consequent detrimental impact on the rate and volume of surface water runoff generated. This would be further compounded by climate change impacts over time.
- 5.1.4 In accordance with the NPPF, new development must incorporate flood attenuation measures sized to accommodate flows from impervious surfaces for return period pluvial flood events up to and including 100 years, taking account of climate change and with discharges restricted to existing (*greenfield*) rates. Water quality treatment is also required to mitigate potential detrimental impacts to downstream receptors, e.g. groundwater and local watercourses. Sustainable Drainage Systems (SuDS) must be incorporated within the design, wherever practicable.

5.2 Land Use

Land Use	Existing		Proposed	
	Area (m ²)	Runoff Coefficient	Area (m ²)	Runoff Coefficient
Built / Impervious	42*	0.90	58*	0.90
Permeable Paving / Driveway	0	0.70	790	0.70
Soft Landscaping	806	0.40	0	0.40
Total	848	0.42	848	0.71

Table 007: Summary of Land Use

* Extension areas only

5.3 SuDS Options for Surface Water Disposal

- 5.3.1 Desk based investigation indicates the presence of underlying clay bedrock geology, overlain by soils with limited infiltration potential.
- 5.3.2 A network of land drainage channels is present in this locale into which a gravitational connection could be established for the disposal of surface runoff. The nearest is the Cottage Ditch, on the southern side of Passage Road immediately adjacent to the Old Passage Inn. This drainage channel is laterally extensive discharging into the River Severn c.75m west.
- 5.3.3 Discharge to local watercourse is the preferred method of surface water discharge. This will be supplemented by SuDS measures (where practicable) to maximise infiltration at source and limit off site discharges during minor rainfall events. This is in accordance with the SuDS hierarchy as outlined within Section 3.2.3 of the SuDS Manual, and summarised below:

SuDS Discharge Hierarchy:

- Infiltration
- Discharge to surface waters
- Discharge to surface water sewer
- Discharge to combined sewer (Last Resort)

5.4 Surface Water Discharge Rates

5.4.1 Given the location of the property adjacent to the tidal reaches of the River Severn, it is considered that an unlimited discharge to this watercourse would be acceptable.

Tide Locking

5.4.2 Investigation has been undertaken to establish the Mean High Water Springs level, with this set at 6.83m AOD and with the outfall at the River Severn understood to be set above this level thus avoiding tide locking under standard flow conditions. It is recommended that the site side discharge point include a flap valve at the outfall to prevent ingress in the event of elevated water levels downstream.

5.5 Network Capacity

5.5.1 The car park will be served by a drainage blanket comprising a permeable geotextile membrane located beneath the gravel surface and designed to promote infiltration at source. The drainage blanket will incorporate a fall of 1:250 towards a perimeter filter drain present on the eastern boundary which will activate once the capacity of the subsoil beneath the carpark is reached and which will convey runoff to an outfall into the Cottage Ditch on the southern side of Passage Road.

5.5.2 It is recommended that all filter drains / permeable pipes be lined / sleeved with a geotextile membrane to reduce sediment ingress / clogging, with a silt trap fitted at the downstream end to prevent sedimentation.

5.5.3 Pipework within the filter drain will be permeable to promote infiltration at source and sized to convey runoff for return period storms up to and including 100 years, accounting for climate change, without surcharge, with capacity present for short duration rainfall (high intensity) rainfall events, e.g. the 15 minute storm.

5.5.4 To this end, the following pipe diameter and fall is recommended:

- 200mm / 1:250. Total flow = 23.882 l/s

Max. Required flow (Q100_{15mins} +25%CC): 18.627 l/s

5.5.5 Exceedance pathways are incorporated within the design to direct floodwater water to the outfall via overland flowpaths, using surface contouring to prevent on-site / off-site flooding in the event of blockage / surcharge or flows in excess of design. To this end, it is recommended that the porous medium (stone / gravel), within which the filter drain sits, be increased to 500mm wide and deep (inc. pipework) to convey runoff to the outfall and into the Cottage Ditch via overland flows in the event of pipe surcharge.

5.6 Water Quality

5.6.1 Surface water runoff will be conveyed to the outfall via a combination of permeable piped networks situated within filter drains and overland flowpaths, each of which will serve to promote water quality.

5.6.2 Silt traps / baffles will be fitted at the base of all roof gulleys and on the pipework immediately upstream of the outfall to prevent the discharge of sediment and suspended solids to receiving waters and to ensure that only clean water is discharged.

5.6.3 The above water quality treatment measures account for the Pollution Hazard and Mitigation Indices outlined within Tables 26.2 and 26.3 of the SuDS Manual, respectively; with these summarised in Tables 008 and 009 of this report.

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Non-residential car parking with <300 traffic movements / day	Low	0.5	0.4	0.4

Table 008: Excerpt from CIRIA 753 Table 26.2 Pollution Hazard Indices for Different Land Use Classifications

SuDS Mitigation Indices			
SuDS Component	Total Suspended Solids	Metals	Hydrocarbons
Filter Strip	0.4	0.4	0.5
Filter Drain	0.4	0.4	0.4
Permeable Paviments / Gravel Surface	0.7	0.6	0.7
Adjusted SuDS Mitigation Index¹	0.60-0.95	0.60-0.90	0.70-1.05

¹Applies where the Mitigation Index of individual SuDS component is insufficient to treat runoff in isolation and where 2 SuDS components (or more) are required in series

Table 009: Excerpt from CIRIA 753 Table 26.3 SuDS Mitigation Indices for Discharges to Surface Waters

5.6.4 Review of the SuDS Manual Table 26.2 indicates the property to be considered Non-Residential in nature with a **Low** associated hazard to water quality.

5.6.5 Examination of the above data indicates the Pollution Hazard Indices for all identified contaminants to be lower than the Mitigation Indices for at least one of the individual SuDS components, refer to Tables 008 & 009. It is therefore concluded that the proposed SuDS Mitigation measures outlined in Table 009, and expanded on below, are sufficient to mitigate potential contaminants present within site generated runoff.

Water Quality Treatment

5.6.6 Based on the above analysis, the following water quality treatment measures will be interspersed throughout the development and will service the different built elements as follows:

- Roof drainage to pass to the outfall via piped networks / filter drains with no further treatment aside from silt traps located at the upstream end of all pipe runs to remove silts and sediments upstream of the storage area(s);
- Potentially contaminated runoff from the property, roads and hardstanding will discharge to the attenuation facility(ies) via the following water quality treatment, designed in accordance with the requirements of the SuDS Manual section 4 (Table 4.3) and Section 26 (Tables 26.2 and 26.3):
 - **Permeable Paviments / Gravel Surface:** Runoff would be intercepted at source and directed via porous sub-base and underlying drainage blanket into the filter drains located at the car park perimeter. The porous surfaces will slow runoff and encourage sediment deposition upstream of the outfall. Hydrocarbons present will be removed through adsorption, adhesion and microbial processes within the paviments and / or underlying sub-base;
 - **Filter Strips:** 0.5m-1.0m wide grass / crushed stone strips present between the property / car parks / roads / filter drains to slow runoff and encourage sediment deposition; and
 - **Filter Drains:** Situated at the property perimeter and designed to convey runoff to the outfall via an underlying permeable pipe. Permeable pipework to be wrapped in membrane to prevent sediment ingress.

5.6.7 The inclusion of the above measures will encourage the settlement and retention of sediments, preventing blockage of the inlet(s) / outfall(s) and the discharge of sediment laden water to local watercourses, with associated scour, and ensuring that only clean water is discharged.

5.7 Water Re-Use / Discharge Reduction

5.7.1 In line with best practise, first flush storage is required to accept the first 5mm of rainfall from impervious surfaces and infiltrate it into the surrounding topsoil. This to reduce off-site surface water discharges during minor rainfall events.

5.7.2 A total first flush storage requirement of 3.06m³ is estimated based on an effective impermeable area of 611m². It is anticipated that this would be easily accommodated by the on-site SUDS measures which include permeable surfaces and filter drains, and which would promote the interception and infiltration of surface water at source and limit off-site discharges under general

/ low flow conditions.

- 5.7.3 This will be further bolstered through the provision of water butts to collect rainwater for re-use in watering gardens and reduce reliance on the potable supply for non-potable uses. Typical water butts store between 100-200 litres, it is therefore recommended that a minimum of 2 water butts be installed, with these ideally >150 litres volume. Whilst for flood attenuation purposes it must be assumed that the butts are full, this would nevertheless reduce the rate and volume of runoff for minor rainfall events.

5.8 Management and Maintenance Responsibility

- 5.8.1 **Quality Inns of Gloucestershire Ltd.** will be responsible for ensuring the ongoing management and maintenance of the surface water management systems serving the cottage, either directly or via an appointed contractor / managing agent. Where the property(ies) is / are sold this responsibility will be transferred to the purchaser or their appointed managing agent.

Element	Frequency	Notes
Gulleys / Gulley Pots / Drainage grates	Twice annually / following storm activity	<ul style="list-style-type: none"> Remove grill and check for debris / blockage. Remove accumulated debris to prevent blockage of pipework. Rod / jet where required. Silt traps to be cleansed before and after rodding.
Manholes / Inspection Covers / pipework	Twice annually / following storm activity	<ul style="list-style-type: none"> Visual inspection – remove cover, shine torch into manhole. Check every orifice for blockage / siltation. Pour water into each to verify through flow. Remove debris /silt and rod / jet where required. Silt traps to be cleansed before and after rodding.
Filter Strips	Quarterly / following storm activity	<ul style="list-style-type: none"> Regular mowing and maintenance will be key to ensuring the continued efficiency of the filter strips. Reseeding or turfing should be undertaken where bald patches or die back occur.
Silt Traps	Twice annually / following storm activity	<ul style="list-style-type: none"> Visual inspection, removal of accumulated silt. Where rodding of manholes is proposed silt traps should be cleansed before and after to prevent silt bypassing the traps.
Permeable surfaces / Filter Drains	Twice annually / following storm activity	<ul style="list-style-type: none"> Visual inspection for accumulated silt / vegetation (at surface). Check for surface clogging / ponding. Remove vegetation / silt. Remove siltation / blockage from the stone sub-base and/or underlying pipework serving the drainage blanket.
Inlets / Outfalls	Twice annually / following storm activity	<ul style="list-style-type: none"> Visual inspection for accumulated debris or blockage, at both upstream and downstream faces. Check every orifice / inlet / outlet / structure for blockage or siltation, pour water into each to verify through flow. Remove debris and rod where required.
Vegetation	Quarterly (ensure cutting / strimming is undertaken at least twice during peak growing seasons e.g. Mar. / Sept.)	<ul style="list-style-type: none"> Regular grass cutting and maintenance of shrubs / trees will be key in reducing the presence of debris which could block the drainage network or cause eutrophication of water bodies. Grass should be cut quarterly, with focus on the growing season (Mar. – Oct.) and leaves / debris cleared from landscaped areas. During the winter shrubs and trees should be pruned to reduce accumulated vegetation within the site / surface water features. All mowings / cuttings to be removed from vicinity of lagoons / swales to prevent eutrophication.

Table 010: Drainage Inspection and Maintenance Schedule

Inspection and Maintenance Schedule

- 5.8.2 It is proposed that a programme of inspection and maintenance be executed for the surface water management systems by the property owner / managing agent, or their appointed drainage contractor. This should be undertaken in accordance with the schedule outlined in Table 010 and following significant rainfall events and / or storm activity.
- 5.8.3 A photographic record of inspections should be undertaken to pick up long term changes that may not be apparent within a single visit. Inspections should comply with all relevant Health and Safety legislation.
- 5.8.4 This maintenance schedule applies for the lifetime of the development.

Notes

- 5.8.5 All waste arisings should be collected by an approved contractor and should be subject to appropriate treatment and disposal (where applicable). The property owner or managing agent should be contacted where blockages are identified.

6.0 CONCLUSIONS

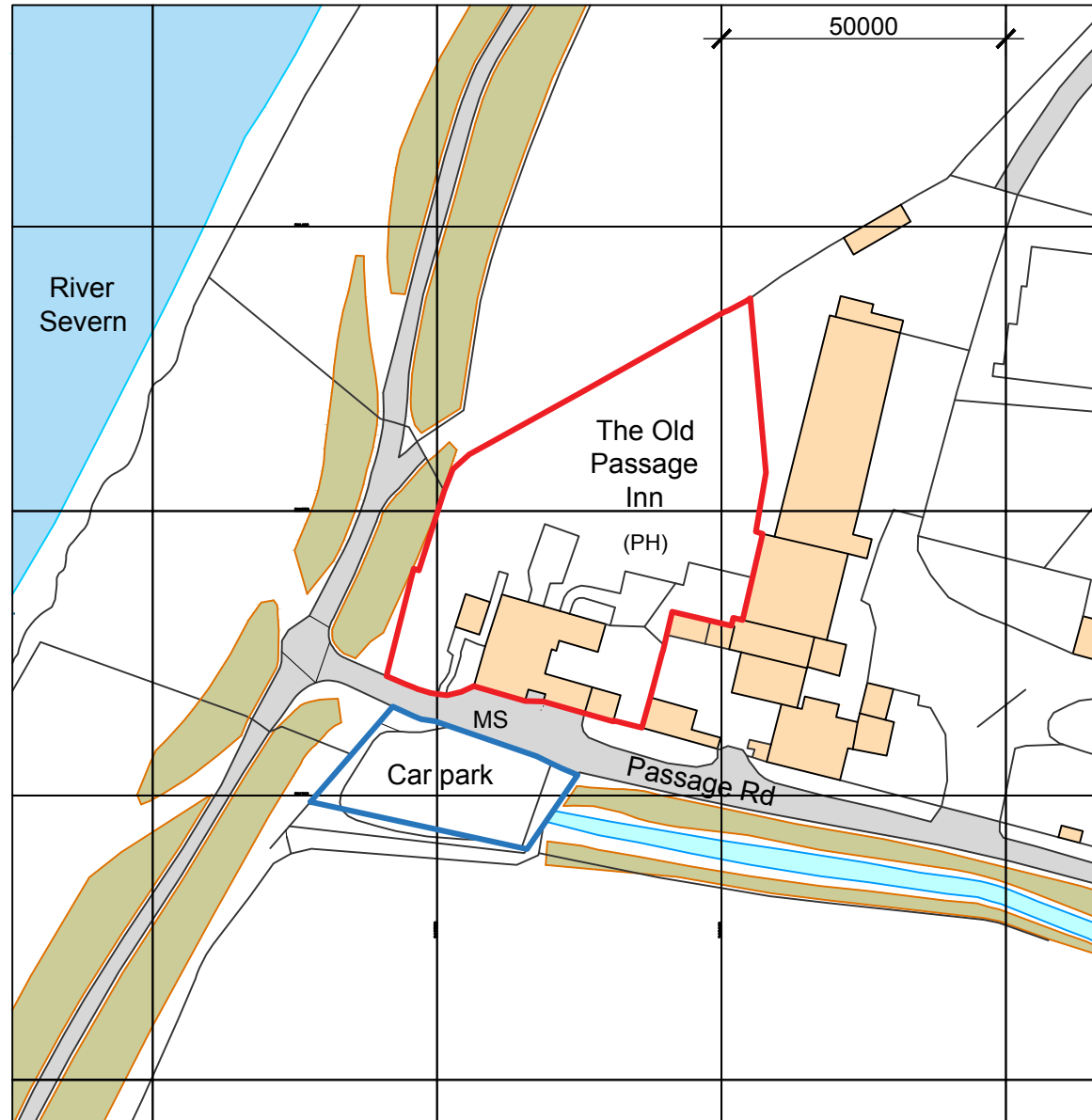
- 6.0.1 A planning application is to be submitted for the refurbishment of a commercial property (Public House) and installation of a rear car park at the Old Passage Inn, Arlingham, Gloucestershire, GL2 7JR. No increase in the building footprint will arise from development proposals.
- 6.0.2 The Arlingham area falls within the administrative remit of Stroud District Council and Gloucestershire County Council, with the latter comprising the Lead Local Flood Authority.
- 6.0.3 This Flood Risk Assessment has been completed in accordance with the guidance set out in the NPPF, Section 14, and its accompanying PPG, for 'More Vulnerable' development within Defended Flood Zone 3a. The requirements of Local Planning Policy, including the SFRA, have also been accounted for within this assessment.
- 6.0.4 A scoping exercise has been completed which considers all potential flood risks, each of which have been fully assessed as part of this study, taking account of the development lifetime and climate change predictions, and with the principal flood risks identified to arise from fluvial and tidal sources, both being associated with the adjacent tidal River Severn.
- 6.0.5 The Old Passage Inn is demonstrated to be defended from fluvial flooding for existing design return period events now and in the future. However, the freeboard on the flood defences is below the required standard.
- 6.0.6 The property is indicated to be at risk from tidal flooding with inundation of the Arlingham area and the Old Passage Inn considered likely.
- 6.0.7 Flood resilience measures have been incorporated within the design and flood management measures specified to reduce identified flood risks to a practicably low level accounting for the vulnerability of the proposed use and the anticipated development lifetime accounting for climate change predictions.
- 6.0.8 Consideration has also been given to the residual risks associated with extreme flooding and flood defence breach, with flood management measures specified to reduce those risks which cannot be borne out through design to an acceptable level. This includes consideration of flood warning and designation of points of safe refuge, access and egress.
- 6.0.9 Given that the property will discharge to tidal waters no attenuation is proposed. Nevertheless, the outfall should be set to discharge above the Mean High Water Springs level to avoid surcharge in the event of downstream tide locking. Where this cannot be achieved, surface water storage would be required with this accounting for the period of tide locking. All drainage networks have been designed to account for industry best practice with regards system capacity.
- 6.0.10 Sustainable Drainage (SuDS) measures are incorporated within the design of the surface water management systems to reduce the rate and volume of runoff for more minor rainfall events. These will be supplemented with water re-use measures including tanks / water butts for use in watering gardens. This to reduce over reliance on potable supply for non-potable uses.
- 6.0.11 It is anticipated that the provision of a formal surface water management system will ensure that potential detrimental impacts on pluvial flooding are suitably mitigated throughout the anticipated development lifetime, in accordance with the National Planning Policy Framework and its accompanying Planning Practice Guidance.
- 6.0.12 **Quality Inns of Gloucestershire Ltd.** or an appointed agent will be responsible for the management and maintenance of the surface water management systems, throughout the development lifetime. The responsibility for management and maintenance will pass to the lessee, where the property is subject to lease by a third party, and to the purchaser where the property is subject to sale.
- 6.0.13 The mitigation solutions noted within this report are subject to agreement with the Environment Agency, Stroud District Council and Gloucestershire County Council in their respective capacities within the Lead Local Flood Authority and as part of the application process.
- 6.0.14 It is duly presented that the development proposals are appropriate within the context of the NPPF and Local Planning Policy.

7.0 CLOSURE

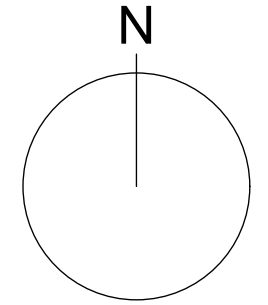
- 7.0.1 This report has been prepared by Amber Planning Ltd. with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with The Client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.
- 7.0.2 Reliance has been placed on factual and anecdotal data obtained from the sources identified. Amber Planning Ltd. cannot be held responsible for the scope of work, or any omissions, misrepresentation, errors or inaccuracies within the supplied information. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part in the event of delay between the writing of the report and its consideration by The Client, with particular regard to submission of a planning application.
- 7.0.3 This report is for the exclusive use of The Client; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from Amber Planning.
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Revision Schedule		
Rev	Description	Date



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Drawing Status:
PLANNING

Client:
QUALITY INNS OF GLOUCESTERSHIRE

Project:
THE PASSAGE INN, ARLINGHAM

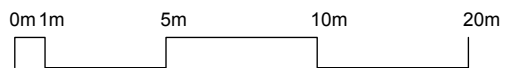
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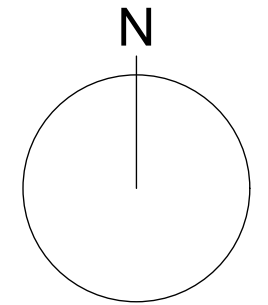
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Revision Schedule		
Rev	Description	Date



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QUALITY INNS OF GLOUCESTERSHIRE

Project:
THE PASSAGE INN, ARLINGHAM

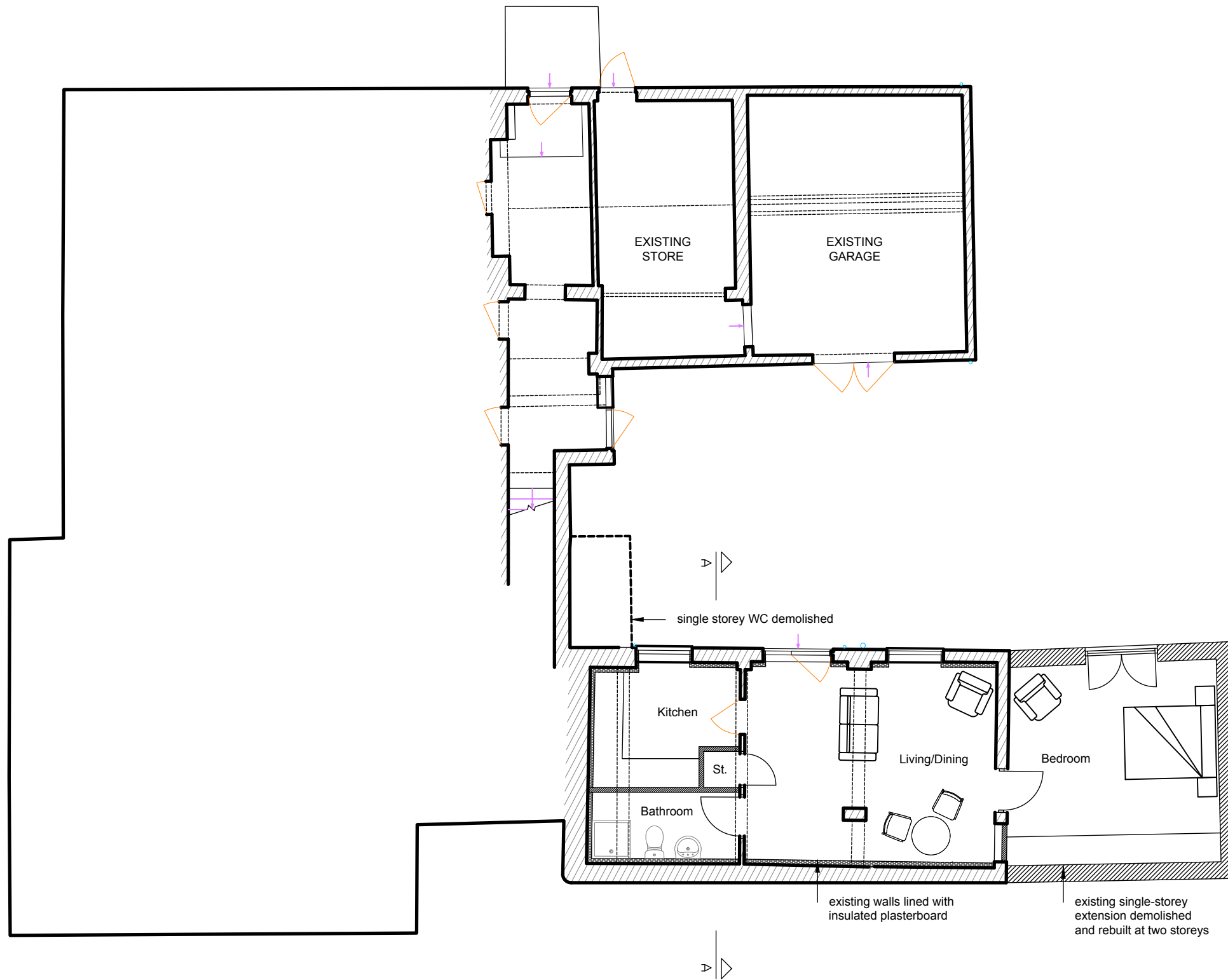
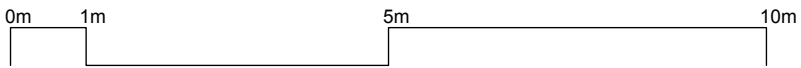
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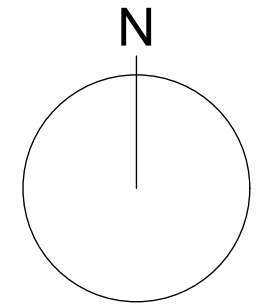
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LOWER GROUND FLOOR

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Revision Schedule		
Rev	Description	Date



Drawing Status:
PLANNING

Client:
QUALITY INNS OF GLOUCESTERSHIRE

Project:
THE PASSAGE INN, ARLINGHAM

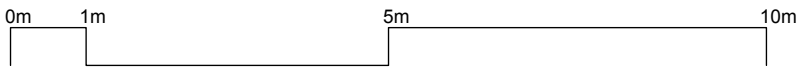
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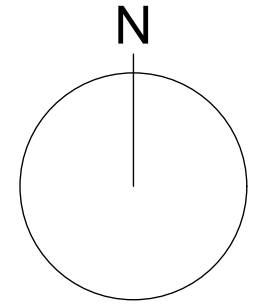
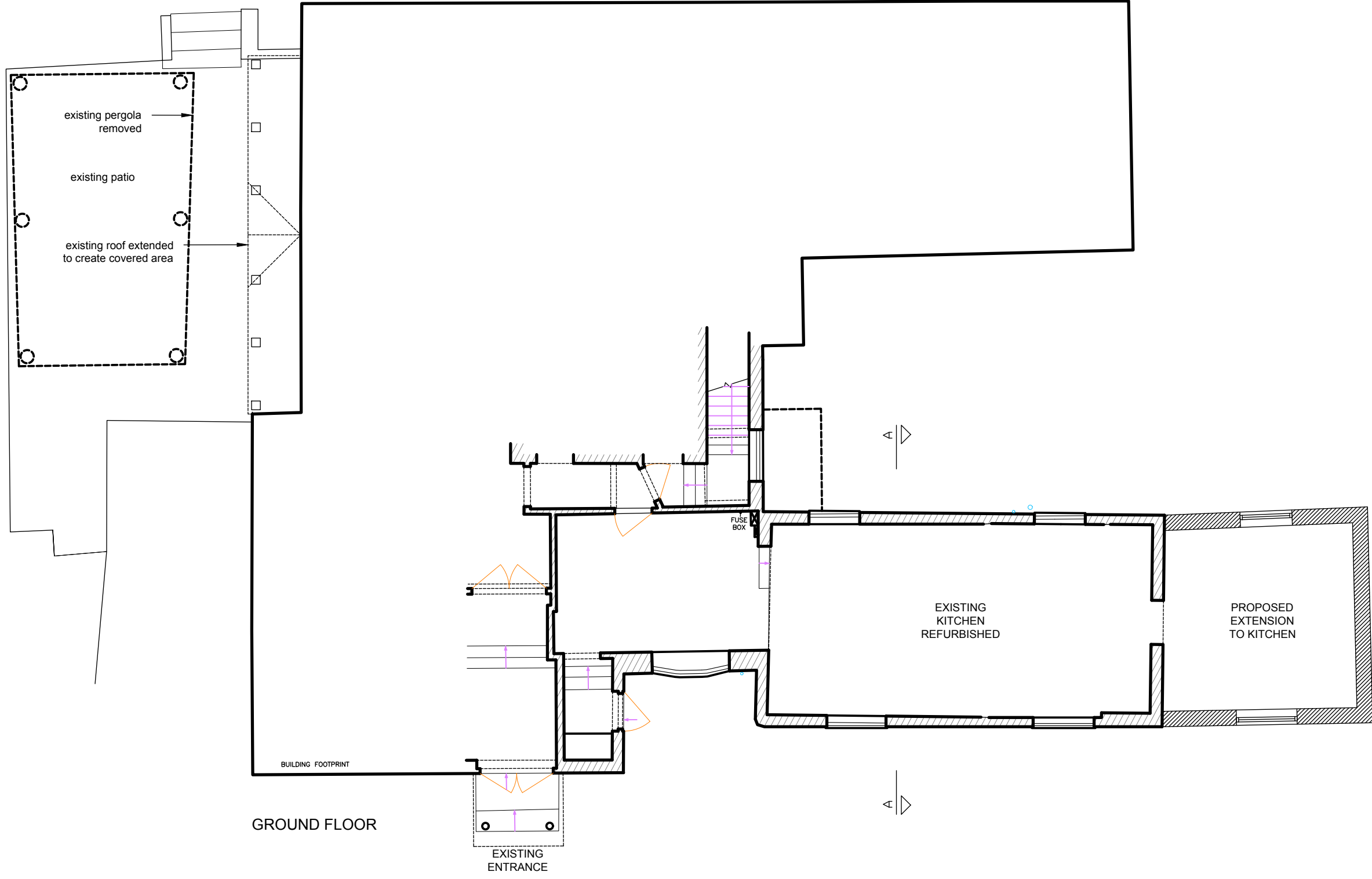
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Revision Schedule		
Rev	Description	Date



Drawing Status:
PLANNING

Client:
QUALITY INNS OF GLOUCESTERSHIRE

Project:
THE PASSAGE INN, ARLINGHAM

Drawing Description:
PROPOSED GROUND FLOOR

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Job No: 22089	Drawing No: 04	Revision: P0
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Norwest Holst Soil Engineering Ltd.

Trial Pit No.

HPB4

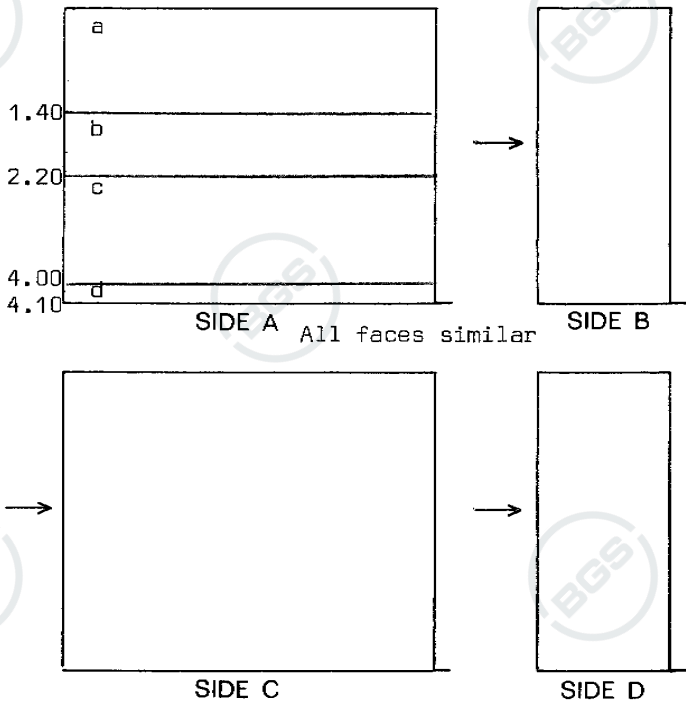
Contract No. F7510
Location Severn Tidal Defences
Client Severn-Trent Water Authority
Excavation Plant JCB C III
Dimensions (l x b x h) 1.90 x 0.75 x 4.10 m

TRIAL PIT LOG

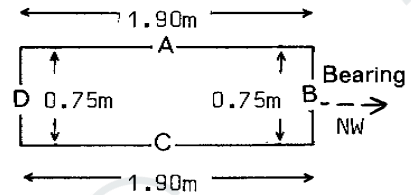
SO 61 SE

Co-ords: E6943...N.1115...
Ground Level 8.90 m.A.O.D.
Date 23/7/87

ELEVATIONS:—



PLAN (Not to scale)



SAMPLES

No. & Type	Depth m.
1B	1.00
2B	2.50

No.	Depth m.	STRATA DESCRIPTION	Cv/Cp kN/m ²
a	GL- 1.40	TOPSOIL - firm, grey brown, very clayey SILT numerous rootlets.	
b	1.40- 2.20	Firm to soft, grey brown, thickly spaced, sandy partings, very clayey SILT, slightly sandy CLAY, occasional rootlets.	
c	2.20- 4.00	Soft, dark grey, thinly to thickly spaced sandy partings, very clayey SILT occasional organic material.	
d	4.00- 4.10	Grey brown, slightly silty, fine to medium SAND.	

NOTES Cv/Cp: Approximate value of undrained shear strength from hand vane/penetrometer
Groundwater: None
Pumping: None
No Supports/Stability: Good



Norwest Holst Soil Engineering Ltd.

Trial Pit No.

HPB5

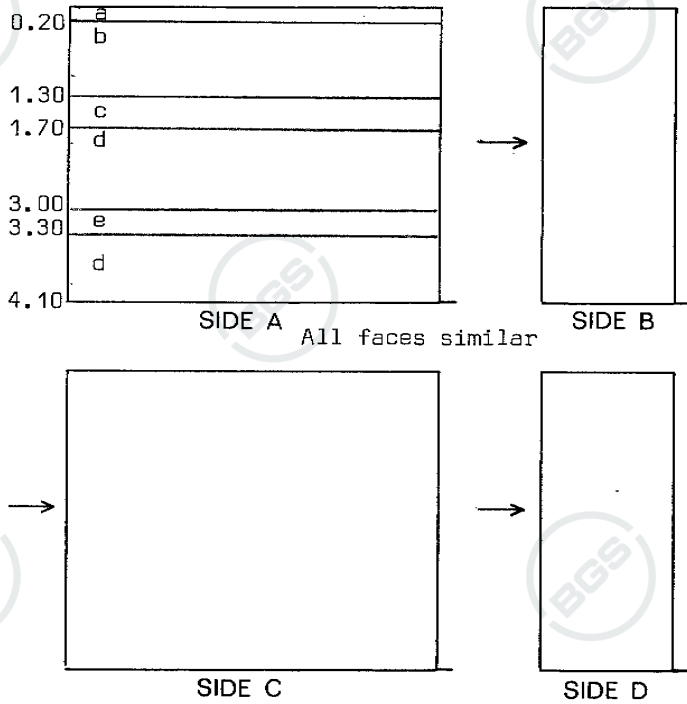
Contract No. F7510
Location Severn Tidal Defences
Client Severn-Trent Water Authority
Excavation Plant JCB C III
Dimensions (l x b x h) 1.80 x 0.75 x 4.10 m

TRIAL PIT LOG

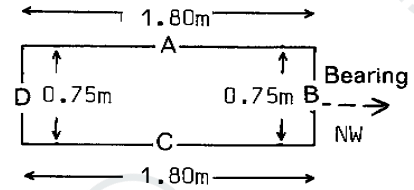
SO 61 SE
60

Co-ords E6960 N 1151
Ground Level 8.90 m.A.O.D.
Date 23/7/87

ELEVATIONS:—



PLAN (Not to scale)



SAMPLES

No. & Type	Depth m.
1B	1.00
2B	2.00
3B	3.00 - 3.30

No.	Depth m.	STRATA DESCRIPTION	Cv/Cp kN/m ²
a	GL- 0.20	TOPSOIL - firm, dark brown, very clayey SILT numerous rootlets.	
b	0.20- 1.30	Firm, grey, very clayey slightly sandy SILT, occasional rootlets.	
c	1.30- 1.70	Soft, brown grey, thickly to thinly spaced sandy partings, very clayey SILT	
d	1.70- 3.00 3.30- 4.10	Soft, dark grey, thickly to thinly spaced sandy partings, very clayey SILT occasional organic content.	
e	3.00- 3.30	Grey brown, slightly silty, fine to medium SAND.	

NOTES Cv/Cp: Approximate value of undrained shear strength from hand vane/penetrometer
Groundwater: None
Pumping: None
No Supports/Stability: Good



Norwest Holst Soil Engineering Ltd.

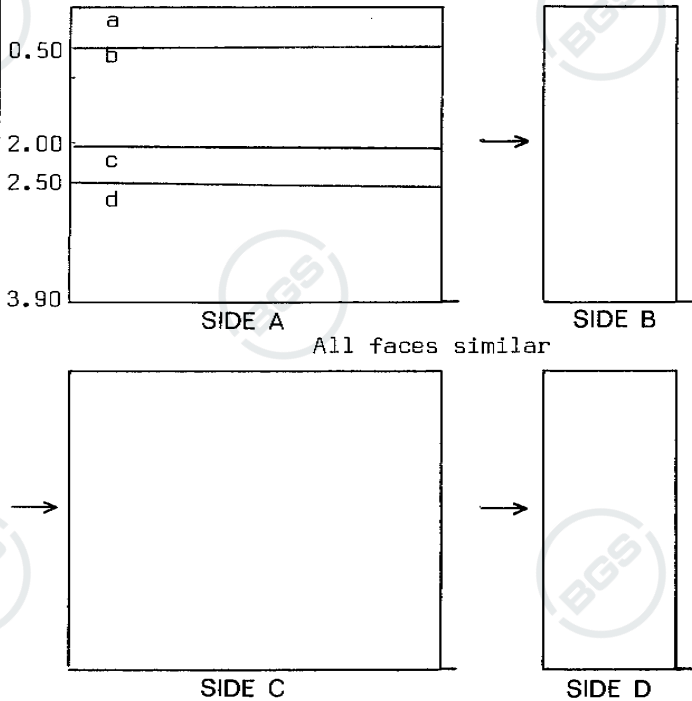
Trial Pit No.
HPB18

Contract No. F7510
Location Severn Tidal Defences
Client Severn-Trent Water Authority SO 61 SE
Excavation Plant JCB C III
Dimensions (l x b x h) 1.80 x 0.75 x 3.90m 66

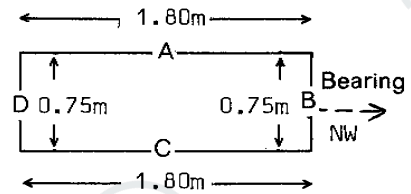
TRIAL PIT LOG

Co-ords ..E.6984...N.1132.....
Ground Level8.80... m.A.O.D.
Date23/7/87.....

ELEVATIONS:—



PLAN (Not to scale)



SAMPLES

No. & Type	Depth m.
1J	0.20
2B	GL - 0.50
3J	0.60
4B	1.00 - 1.50
5J	2.00
6B	2.00 - 2.50
7J	2.60
8B	3.00 - 3.50

No.	Depth m.	STRATA DESCRIPTION	Cv/Cp kN/m ²
a	GL-0.50	TOPSOIL - soft to firm, dark brown, very clayey slightly sandy SILT, numerous rootlets.	
b	0.50-2.00	Soft, light brown grey mottled orange, very clayey SILT	
c	2.00-2.50	Firm, light brown grey mottled orange, thickly spaced sandy partings, laminated, very clayey SILT	
d	2.50-3.90	Soft, blue grey, very clayey SILT with occasional sandy partings.	

NOTES Cv/Cp: Approximate value of undrained shear strength from hand vane/penetrometer
Groundwater: None
Pumping: None
No Supports/Stability: Good