The Old Garage Site
Flood Risk Assessment

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Revision History

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1.0 Introduction

RAB Consultants has prepared this Flood Risk Assessment (FRA) in support of the proposed development at The Old Garage Site, Dunsop Bridge, Lancashire.

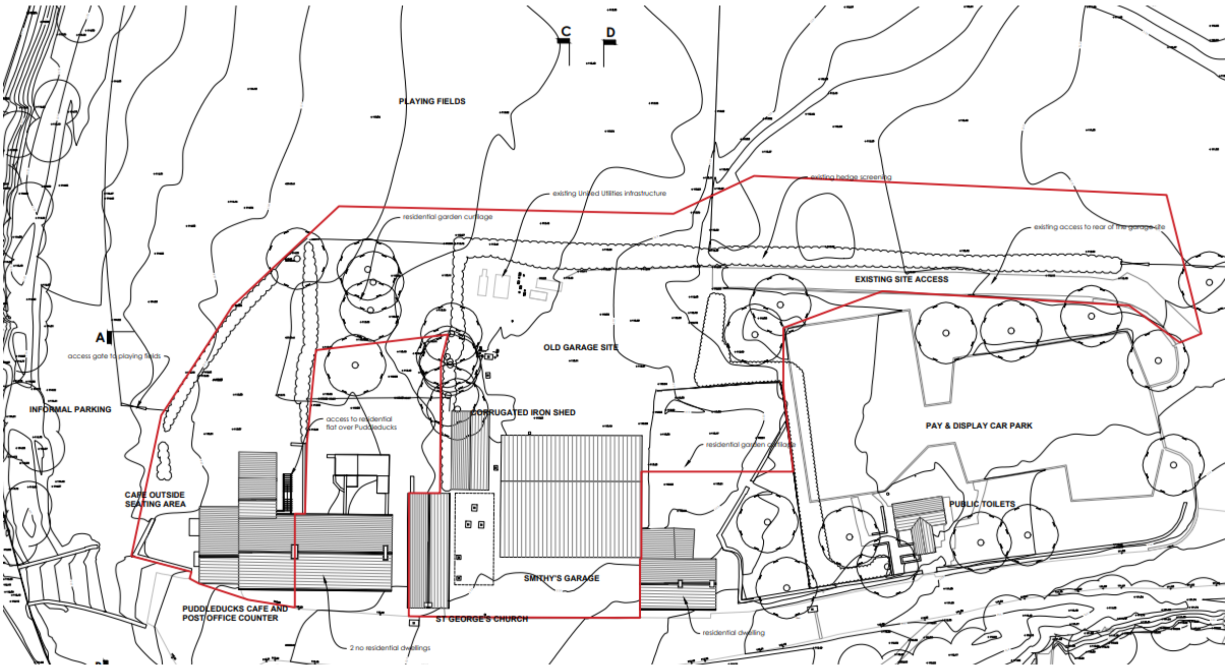
The development site is located partially in Flood Zone 2 and 3 according to the Environment Agency's Flood Map for Planning (Rivers and Sea). A Flood Risk Assessment for this site is required under the Planning Practice Guidance for the National Planning Policy Framework (NPPF) which requires a site-specific FRA to be carried out for developments located in Flood Zones 2 and 3 and for those designated a major development. The site-specific FRA is required to ensure that the development is safe from flooding and will not increase the risk of flooding elsewhere of flooding elsewhere.

2.0 Site details

2.1 Site location

TABLE 1: SITE LOCATION

Site address:	The Old Garage Site, Dunsop Bridge, Clitheroe, Lancashire
Site area:	Approximately 0.4 ha
Existing land use:	Temporary E-bike hire store (old garage building), unused shed, St George's Church, post office and Puddleducks Tea Room café with a first floor residential flat
OS NGR:	SD 66005 50095
Local Planning Authority:	Ribble Valley Borough Council



2.2 Site description

The site is located in Dunsop Bridge, a village in the Borough of Ribble Valley, Lancashire.

The existing site comprises an unused corrugated iron shed to the southwest of the site, a 1950's garage occupied on a temporary basis by a e-bike hire store to the southeast, St George's Church, a post office and Puddleducks Tea Room café with a first floor residential flat.

The surrounding environment is predominantly rural with a few residential buildings. To the southeast and east is Forge House and a car park with a public toilet and finally to the north is playing field. The River Dunsop flows to the south of the site.

Access to the front of the site is direct from the B6478. Access to the rear is from an unnamed track via Dunsop Bridge car park to the east.

2.3 Development proposal

It is proposed to:

1. Demolish the existing unused shed and old garage building currently occupied by the existing e-bike store and construct a single storey community hub with a community café, community grocery shop, two community information areas, a retail unit, an admin office, a post office counter with a shop and café, kitchen, storeroom, three toilets and an area for bins/recycling. The proposed community café will include an outdoor covered seating area adjoining the northeast of the proposed community hub building.
2. Construct a roof connecting the community hub to the existing St George's Church.
3. Change the use from the St George's Church into two community use / therapy rooms and a space for a variety of community uses.
4. Change the use from the post office and Puddleducks Tea Room café into two residential flats (there is currently one upper floor flat). A kitchen / living room, entrance hall, three bedrooms including the master with an ensuite, a bathroom and a storeroom is proposed for the ground floor residential flat and a kitchen, lounge, bathroom and two bedrooms including the master with an ensuite is proposed for the first floor flat. The existing upper residential flat will be retained.
5. Construct three disabled parking bays, a drop off point and electric car charging point to the northeast of the community hub building.
6. Construct a bike storage area with e-bike storage charging points to the northwest of the community hub building.
7. Remove the existing fuel tanks and clean up the site.
8. Install a plant / store room with district wide ground source heat system and communal waste treatment area to the north of the site.
9. Improve the north access route to the northeast of the proposed community hub.
10. Extend the car parking area.

Access will remain from the B6478 to the south and from the unnamed track to the east of the Dunsop Bridge car park. In addition, a new pedestrian access will be created at the north-west of the site.

The proposed drawings can be found in Appendix A.

3.0 Flood Risk

3.1 Sequential test

According to the Environment Agency's Flood Map for Planning the site lies in partially in Flood Zone 2, which is described in the NPPF as land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (between 1% AEP and 0.1% AEP) and partially in Flood Zone 1, which is described in the NPPF as land having a less than 1 in 1,000 annual probability of river or sea flooding (less than 0.1% AEP).

The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. NPPF Planning Practice Guidance (PPG) Table 2 confirms the 'Flood risk vulnerability classification' of a site, depending upon the proposed usage. This classification is subsequently applied to Table 3 'Flood risk vulnerability and flood zone compatibility' to determine whether:

- The proposed development is suitable for the flood zone in which it is located; and
- Whether an Exception Test is required for the proposed development.

The proposed mixed-use development includes 'more vulnerable' residential use, in accordance with NPPF PPG. The development is therefore appropriate for the Flood Zone. Both a Sequential and Exception Test are required in accordance with Table 3 of the NPPF, PPG.

The proposed new building is simply a replacement for an existing building, which will maintain a 'less vulnerable' use for this part of the development. There is already a residential flat on the first floor of the Puddleducks Tea Room with a change of use planned to expand residential usage to the ground floor as well. Other changes within the proposal are effectively a reconfiguration of the site.

The case for sustainable mixed-use at the proposed site has been proven through experience with the existing arrangement. The development will provide an opportunity for betterment by improving flood risk management through design.

The requirements of the Sequential Test and Exception Test are therefore met.

3.2 Flood History

Ribble Valley Borough Council published a Level 1 Strategic Flood Risk Assessment (SFRA) in May 2010 which includes a map indicating that there are no records of historical flooding at or around the site. The 2010 SFRA and the Ribble Valley Borough Council April 2017 Level 1 Strategic Flood Risk Assessment (SFRA) state that there is a record of numerous major flood events affecting the Ribble catchment since 1600, however there is no indication of the proposed site being affected by the major floods listed in the report.

The Environment Agency's online recorded flood outline map shows no records of flooding affecting the proposed site.

The site has been owned by the planning applicant for decades with knowledge of the site and community going back to the 1940s. The applicant reports that flooding affected the site and the entire valley in 1967. A section of the B6478 access road to the south typically experiences flooding three times a year. It is understood that neither the site nor the properties to the east and west of the site have flooded since the 1967 event.

3.3 Fluvial (Rivers)

The site is located partially in Flood Zone 3 and 2 according to the Environment Agency's Flood Map for Planning (Figure 1).

The nearest watercourse and main source of flooding to the site is the River Dunsop located approximately 35m to the south (Figure 1). The River Dunsop flows into the larger River Hodder 200m downstream (south-west) of the site.

Black Brook flows into the River Hodder 475m to the southeast of the site and the Rough Skye flows into the River Hodder approximately 1km to the southeast of the site. Langden Brook flows into the River Hodder 865m to the east of the site (Figure 2).

A topographic survey has been provided for the site (Appendix A) which shows ground levels in the range 112.06mAOD to 113.96mAOD. The ground levels fall from north to south and west to east.

The typical ground level where the old garage building (e-bike store) and proposed community hub building will be located is 113.0mAOD. The client has confirmed that the finished floor level of the existing old garage building and unused shed is 113.0mAOD. The ground floor finished floor level of the existing post office / Puddleducks Tea Room café is 113.84mAOD and the finished floor level of St George's Church is 113.37mAOD. The typical ground level where the proposed plant room will be located is 113.45mAOD.

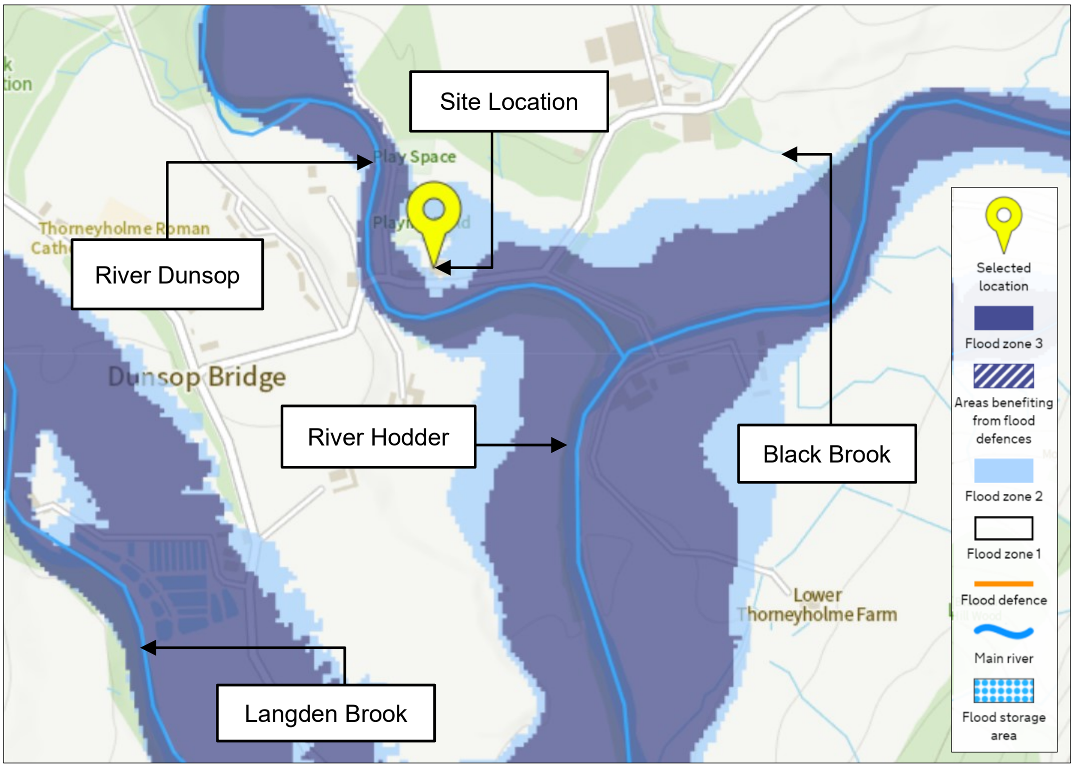


FIGURE 1: SCREEN SHOT OF THE ENVIRONMENT AGENCY'S FLOOD MAP FOR PLANNING ON 28.10.2021

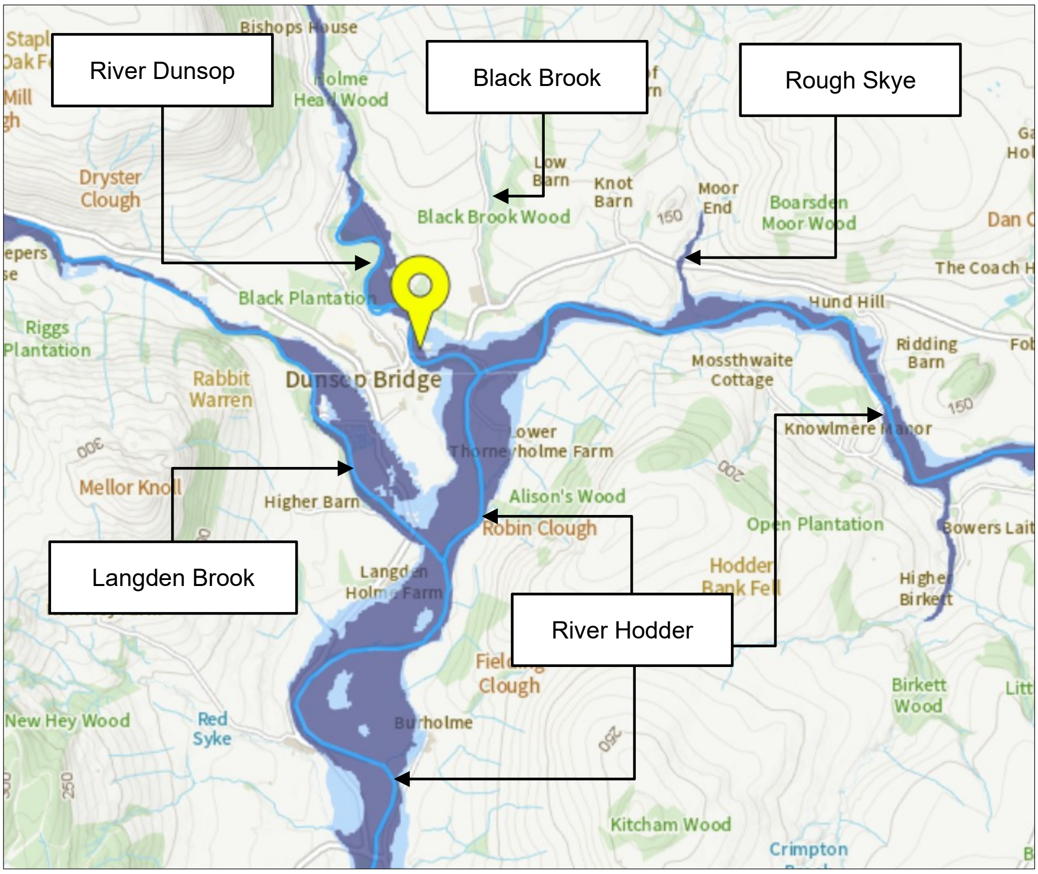


FIGURE 2: OVERVIEW SCREEN SHOT OF THE ENVIRONMENT AGENCY'S FLOOD MAP FOR PLANNING ON 28.10.2021

The Environment Agency have no modelled flood data for the River Dunsop, therefore a 1D-2D linked Flood Modeller Pro / TUFLOW model was developed to assess fluvial risk at the proposed development site.

The modelled flood extents and levels are shown in the figures below with the full hydrology and hydraulic report included in Appendix B.

The hydraulic model not only provides a flood extent and level, but also reveals the mechanism of flooding for this location. The model indicates that the channel capacity south of the site is exceeded in the 1% AEP plus 36% climate change design event with flood water flowing north/northeast, first flooding the road and then flooding the south and central part of the site. The channel capacity is also exceeded upstream of the site (130m to the northwest) resulting in the flood water travelling south/southeast, out of bank, combining with the flood water from the south. The buildings to the west of the site including the post office / Puddleducks Tea Room café will mostly remain dry during this scenario. During this baseline scenario the road bridge to the west does not appear to create a flow constriction. The flood mechanism is summarised in Figure 3.

Most of the site is predicted to flood during the 1% AEP plus 36% climate change design event, with flood levels being the highest to the west of the site. Peak flood levels are shown in Figure 4.

FIGURE 3: FLOOD MECHANISM DURING THE 1% AEP PLUS 36% CLIMATE CHANGE BASELINE SCENARIO

The steep nature of the floodplain means there is no single design flood level relevant to the whole site.

In the case of the proposed community hub building, a design flood level of 113.39mAOD gives a typical flood depth of 0.39m when compared to the typical ground level of 113.0mAOD.

A typical flood depth of 0.02m is expected in St George's Church when comparing the design flood level of 113.39mAOD to the buildings existing finished floor level of 113.37mAOD.

Comparing the design modelled flood level of 113.49mAOD where the proposed plant / store room will be located gives a flood depth of 0.04m when compared to the typical ground level of 113.45mAOD.

The existing finished floor level (113.84mAOD) of the post office / Puddleducks Tea Room café is 0.25m higher to the design flood level of 113.59mAOD.

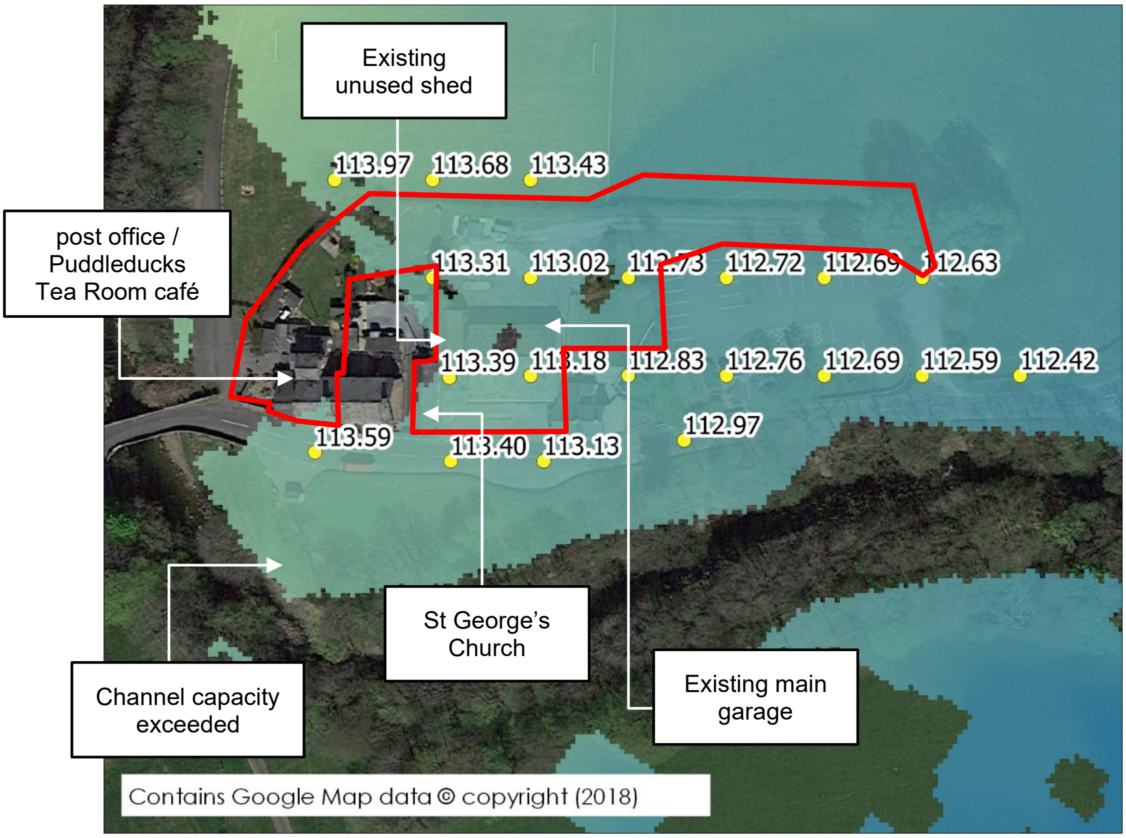


FIGURE 4: MODELLED FLOOD EXTENT AND LEVELS FOR 1% AEP PLUS 36% CC DESIGN EVENT

A 50% blockage scenario was also tested of the road bridge to the west of the site. The results are summarised in Figure 5 which shows an increase in the flood levels compared to the baseline scenario due to the constriction effect.

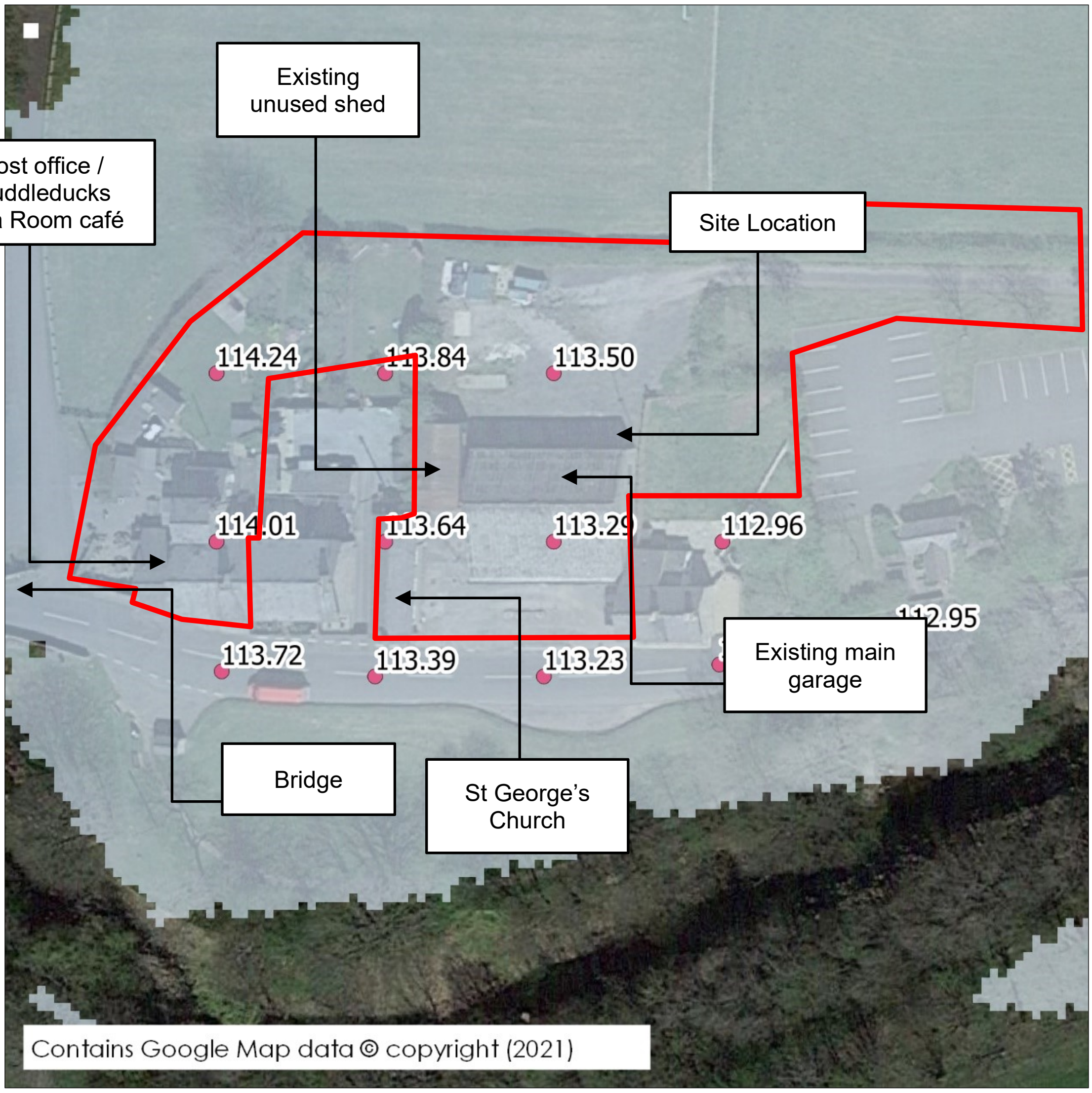


Figure 5: Modelled flood extent and levels during a 1% AEP plus 36% CC and 50% blockage scenario

3.3.1 Climate Change Impact on Fluvial Risk

The Environment Agency guidance document 'Flood risk assessments: climate change allowances' was released in February 2016 and updated in July 2021. It includes statistical increases on peak fluvial flows by Management Catchment and allowance categories based on epochs and development vulnerability classification. Referring to the NPPF PPG, the development is classified as 'less vulnerable' and has an expected lifetime of 50 years therefore the 'central' allowance category applies for development in Flood Zone 2. This equates to an increase of 36% on modelled flow for the Ribble Management Catchment in the 2080s.

The latest climate change allowance of 36% has been incorporated into the model used to access risk at the site.

3.4 Flood defence breach or overtopping

3.4.1 Breach Risk

The site does not benefit from raised flood defences, so there is no breach risk for the site.

3.4.2 Overtopping Risk

The site does not benefit from raised flood defences, so there is no risk of overtopping at the site.

3.5 Coastal/Tidal

The site is not affected by coastal or tidal flood risk.

3.6 Pluvial (Surface water)

The Environment Agency Surface Water Flood Map (Figure 6) identifies the site to be at a combination of 'very low' (a chance of flooding of less than 0.1%) risk and 'low' (between 0.1% AEP and 1% AEP) risk from surface water flooding. A maximum flood depth of 0.9m and a velocity over 0.25m/s is predicted.

This risk is associated with the natural flow route of the River Dunsop which is principally a fluvial risk and has already been assessed in Section 3.3.

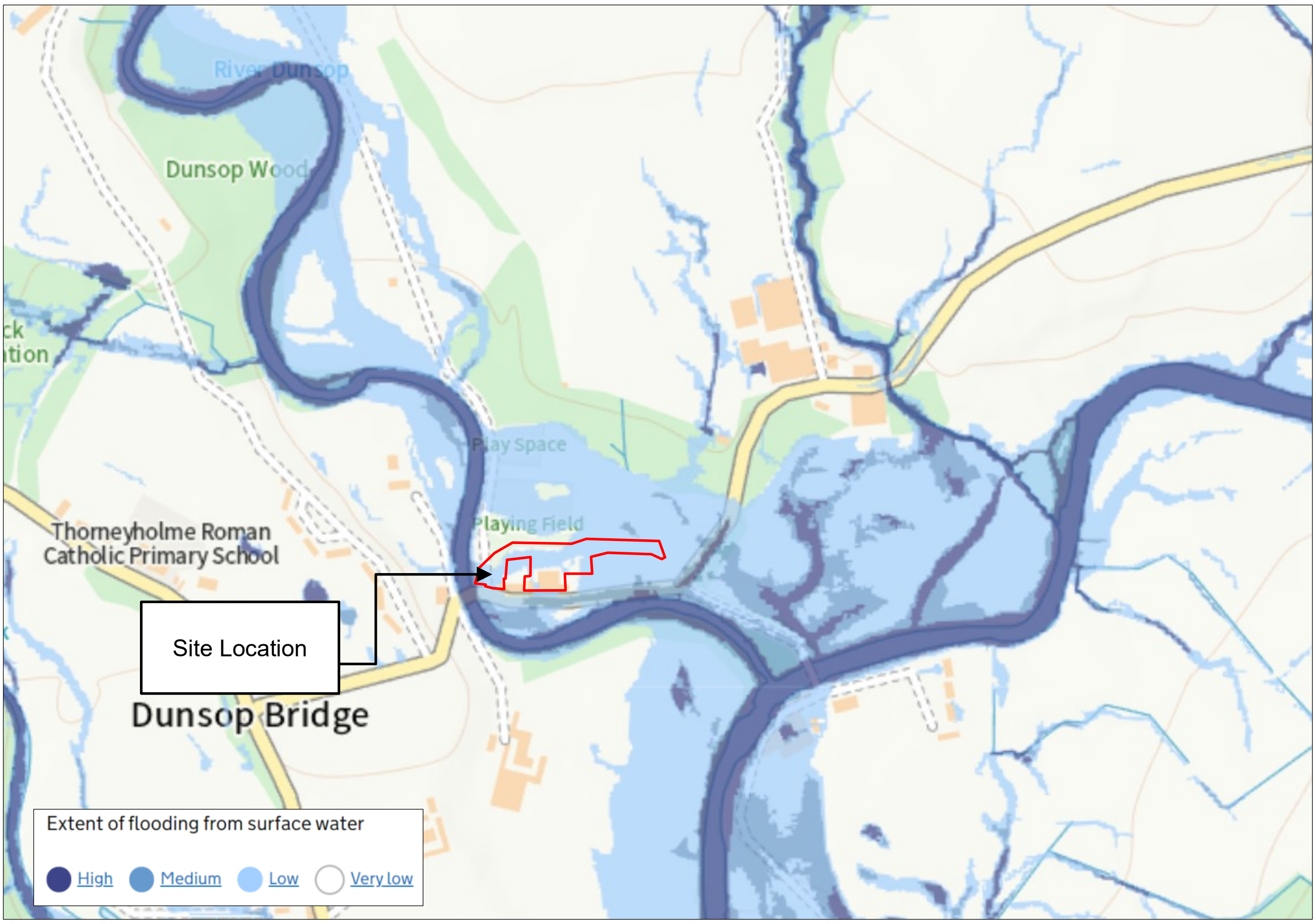


FIGURE 6: SCREEN SHOT OF THE ENVIRONMENT AGENCY'S RISK OF FLOODING FROM SURFACE WATER ON 15.12.2021

TABLE 2: ENVIRONMENT AGENCY SURFACE WATER RISK CATEGORIES

Surface Water Risk Category	Surface water flooding Annual Exceedance Probability
Very Low	< 0.1%
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	> 3.3% (1 in 30 years)

3.7 Artificial water bodies

The Environment Agency Reservoir flood map (Figure 7) identifies that the site is at risk of flooding from a dam break at Stocks Reservoir.

Reservoir flooding is extremely unlikely to happen. The Environment Agency as the enforcement authority for the Reservoirs Act 1975, ensures that reservoirs are inspected regularly, and essential safety work is carried out. The risk of flooding reservoirs is therefore considered to be lower than fluvial risk which has been assessed in Section 3.3.

There are no canals near the proposed site that could pose a risk to the site should a failure or breach occur.

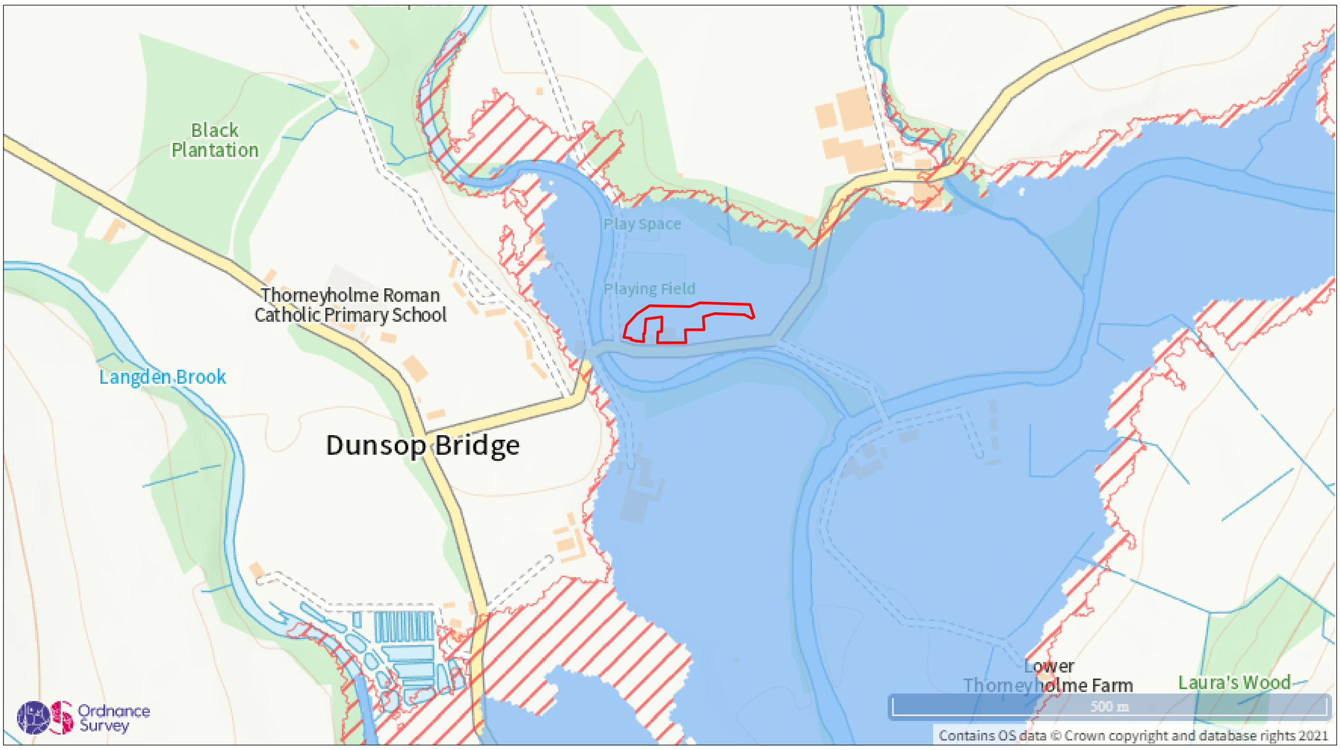


FIGURE 7: SCREENSHOT OF THE ENVIRONMENT AGENCY'S RESERVOIR FLOOD RISK MAP 15.11.2021

3.8 Groundwater

The 2010 and 2017 SFRAs state that there is no evidence of groundwater flooding in the area.

With the River Hodder and River Dunsop being at close proximity to the site, groundwater will be closely linked to fluvial water. Any groundwater is expected to essentially match fluvial levels; fluvial risk has been assessed in Section 3.3.

Based on this information, a further assessment of groundwater flooding is not appropriate.

3.9 Sewers

No information has been provided in the 2010 and 2017 SFRAs with regards to historical sewer flood events affecting the site. As the site is shown to be within the flood risk extent of the River Hodder and River Dunsop, direct flooding from the rivers is considered to be the primary source of risk and will be used to judge risk in this report.

Based on this information a further assessment of sewer flooding is not appropriate.

4.0 Mitigation Methods

4.1 Risk to buildings

4.1.1 Finished floor levels

In order to afford a level of protection against flooding it is normally recommended that finished floor levels are set 0.6m above the modelled 1% AEP plus climate change design flood level.

The finished floor level of the proposed plant / store room is 114.20mAOD, 0.71m above the 1% AEP +CC design flood level of 113.49mAOD.

The proposed finished flood level of the Puddleducks Tea Room café ground floor residential flat will be raised to 114.19mAOD, 0.6m above the 1% AEP +CC design flood level of 113.59mAOD.

The existing finished floor level of St George' Church is 113.37mAOD, 0.02m below the 1% AEP +CC design flood level of 113.39mAOD. There is no scope to raise the finished floor level of the St George's Church, therefore additional mitigation measures should be considered.

The proposed finished floor level of the community hub building is 113.20mAOD, 0.19m lower than the 1% AEP +CC design flood level of 113.39mAOD. It is not possible to raise the finished floor level higher than this as disabled access is a fundamental requirement of the scheme, therefore additional mitigation measures are required.

4.1.2 Flood resistance

Flood resistance is a strategy of temporary or permanent measures taken to reduce the amount of flood water that will enter buildings. A strategy of water exclusion could be considered as part of the proposed building design however, given the assessed flood risk, flood resistance may not be the most appropriate long-term solution.

4.1.3 Flood resilience

Flood resilience measures are intended reduce damage to a building such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment.

Flood resilience should be incorporated into the design of the community hub and to any refit of St George' Church to mitigate the residual risk. The following flood resilience measures should be considered:

- Water-compatible final coating on floors (e.g. resin surface or specialised treated wood or tiles)
- Raised electrics.
- Water-compatible plaster (e.g. lime-based) in conjunction with masonry internal wall construction (if appropriate).
- Water-compatible internal wall insulation (closed-cell insulation) to internal lining of external walls and party wall partitions (if appropriate).
- Store high-value water sensitive items above the flood level.
- Utilising water compatible fixtures, fittings and furnishings.
- Arranging items so they can be reactively moved to higher levels (such as high shelves, stands or plinths) should flooding threaten the building.

More detailed information about flood resilience can be found in the following documents:

- Environment Agency publication: 'Prepare your property for flooding' https://www.gov.uk/government/publications/prepare-your-property-for-flooding
- RAB Consultants publication: 'Homeowners guide to flood resilience' http://www.knowyourfloodrisk.co.uk/sites/default/files/FloodGuide_ForHomeowners.pdf
- Improving the Flood Performance of New Buildings: Flood Resilient Construction

  https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

4.2 Risk to occupiers

4.2.1 Safe access/egress

The modelled flood risk undertaken to support this assessment shows the most appropriate access, in the event of a flood, to be from the rear heading west, and then south onto the road.

The maximum flood depth and velocity on this route is 0.15m and 0.5m/s respectively in the modelled 1% AEP +CC design event, which represents a very low flood hazard (Table 13.1 of the Flood Risk Assessment Guidance for New Development – R&D Technical Report FD2320/TR2).

4.2.2 Flood warning and evacuation plan

The Environment Agency does not provide a Flood Warning for the site. However, the site is included in the Environment Agency Flood Alert area '*Upper River Ribble, Hodder*' which would provide useful information about local flood conditions.

The free service offers a minimum 2 hours lead time before the onset of flooding at the site. The site manager, staff and residents should register to receive a Flood Alert for this area from the Environment Agency by the channels identified in Table 3. A choice is given on how they are to be contacted by the Environment Agency in the event of a flood, such as an automated telephone call, fax or email.

Table 3: Flood Alert Information

Channel	Details
Register for Flood Warnings / Alerts	https://www.gov.uk/sign-up-for-flood-warnings
Floodline	0345 988 1188 **(Quick Dial Code: 202038)** **Dialling Floodline:** After a receipt of a alert, you are recommended to call the Environment Agency Floodline 'dial and listen' service to hear further information. After dialling Floodline you will be given the option of entering a quick dial code for the flood alert area that relates to you. The quick dial code that relates to you is **202038**. This will give you an automated response regarding any flood alerts that have been issued for this area. If you wish to speak to someone about flooding in relation to this area you need to state that it is the **Upper River Ribble, Hodder**.
Typetalk	0845 602 6340
Live Flood Alert information	https://flood-warning-information.service.gov.uk/

In addition, the site manager, staff and residents will have the option to monitor the Met Office Severe Weather Warnings and the 5-day flood risk. This will enable them to make appropriate decisions to safeguard the health and safety of staff and visitors.

Table 4 includes a list of useful links the site manager and staff can use to monitor flood risk and weather warnings.

The site manager and staff should be aware of water levels near Dunsop Bridge and adjacent roads and maintain visual observations of the surroundings to check for flooding.

TABLE 4: USEFUL WEBSITE LINKS

USEFUL WEBSITE LINKS	
Description	**Website Link**
Weather Warning Guide	https://www.metoffice.gov.uk/weather/guides/warnings
EA Live Flood Alert information	https://flood-warning-information.service.gov.uk/
Flood Guidance Statement User Guide	http://www.ffc-environment-agency.metoffice.gov.uk/services/FGS_User_Guide.pdf
Guide to email alert service	https://www.metoffice.gov.uk/about-us/guide-to-emails
5-day flood risk for England and Wales	https://flood-warning-information.service.gov.uk/5-day-flood-risk
5-day flood risk for England and Wales – What the Risk Types Mean	https://flood-warning-information.service.gov.uk/5-day-flood-risk/things-you-should-do
Severe Weather Warning Service including weather warning impacts and what they mean	https://www.metoffice.gov.uk/weather/guides/severe-weather-advice
Met Office Live Severe Weather Warnings	https://www.metoffice.gov.uk/weather/warnings-and-advice/uk-warnings#?date=2020-10-02
BBC Weather	https://www.bbc.co.uk/weather

4.3 Risk to others

4.3.1 Floodplain compensation

Environment Agency guidance states there must be no loss of flood storage capacity up to the 1% AEP plus climate change event.

The project team confirms that the total existing enclosed built footprint is 649.32m^2. This will increase slightly to 661.32m^2 post-development, principally arising from the creation of a small plant / store room to the north. The change equates to a 12m^2 increase of built footprint. Any impact from this change is expected to be small and localised within the redline site area to the north, away from the more vulnerable uses.

4.3.2 Surface water run-off

The proposed development is on land that is already impermeable and will therefore not create additional surface water runoff compared with existing. The proposal does however provide an opportunity for betterment, in line with SuDS.

The SuDS Manual (2015), discusses the SuDS approach to managing surface water runoff which is intended to mimic the natural catchment process as closely as is possible. The approach sets out the design objectives in respect of SuDS:

- Use of surface water runoff as a resource;
- Manage rainwater close to where it falls (at source);
- Manage runoff on the surface (above ground);
- Allow rainwater to soak into the ground (infiltration);
- Promote evapotranspiration;
- Slow and store runoff to mimic natural runoff rates and volumes;
- Reduce contamination of runoff through pollution prevention and by controlling the runoff at source; and
- Treat runoff to reduce the risk of urban contaminants causing environmental pollution.

Depending on the characteristics of the site and local requirements, these may be used in conjunction and to varying degrees. Table 5 presents the functions of the SuDS components (from which a management train can be created) and their feasibility in respect of the site.

TABLE 5: FEASIBILITY OF SUDS TECHNIQUES AT THE DEVELOPMENT SITE

Technique	Description	Feasibility Y / N / M (Maybe)
Good building design and rainwater harvesting	Components that capture rainwater and facilitate its use within the building or local environment.	Y – It is feasible to include water butts on downpipes for water reuse.
Porous and pervious surface materials	Structural surfaces that allow water to penetrate, thus reducing the proportion of runoff that is conveyed to the drainage system (green roofs, pervious paving).	Y – Any new driveways, parking areas and hardstanding areas could be made permeable (e.g. gravel). This would provide space for water storage and treatment.
Infiltration Systems	Components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil.	N – Infiltration is unlikely to be appropriate given the close proximity of the Riven Dunsop / River Hodder.

Conveyance Systems	Components that convey flows to downstream storage systems (e.g. swales, watercourses).	N – SuDS conveyance is beyond the small scale of this development.
Storage Systems	Components that control the flows and, where possible, volumes of runoff being discharged from the site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff (eg ponds, wetlands, and detention basins).	Y – It may be feasible to include a small interception feature such as a rain garden.
Treatment Systems	Components that remove or facilitate the degradation of contaminants present in the runoff.	Y – A small interception feature, such as a rain garden, would provide a degree of water treatment.

Given the proposed development is for the replacement of an existing building with other minor reconfiguration of the site, there are no major upgrades planned to the surface water drainage system within the site.

There are opportunities to manage run-off in such a way as to provide downstream betterment: - the use of water-butts on downpipes; permeable surfaces on any new driveways / parking area / footpaths / hardstanding surround and draining the rooftop via a small online rain garden feature prior to discharge into the existing drainage system.

5.0 Conclusion

Planning permission is sought for the replacement of an existing building, creation of an additional residential flat and reconfiguration of the existing mixed-use site at The Old Garage Site, Dunsop Bridge, Lancashire.

The site is identified as being partially in Flood Zone 3 and 2 according to the Environment Agency's Flood Map for Planning due to the River Dunsop.

An assessment of flood risk to the site from all sources has been made from available data. Flood modelling was undertaken to assess the site-specific flood risk from River Dunsop, which shows that the proposed site is expected to be affected by flooding. Flood risk to the buildings will be managed by raising floor levels with residual risk mitigated through the use of flood resilience.

The access is predicted to flood in the modelled design flood event however the hazard is appropriate for the proposed use. Residual risk to people can be managed by the implementation of a Flood Plan in line with guidance given in Section 4.2.2 of this report.

The overall built footprint will increase slightly from existing. Given the small increase proposed and it being located away from the majority of the site, any impact is expected to be small and localised within the redline site area to the north, away from the more vulnerable uses.

The proposed development will have no impact on surface water runoff and local flood risk. There is however scope within the proposed development to incorporate SuDS components to provide betterment to downstream receptors.

It is concluded that the proposed development is appropriate for the flood risk and is not expected to increase the risk of flooding elsewhere.

6.0 Recommendations

- The finished floor level of the proposed community hub building should be set no lower than 113.20mAOD.
- The finished floor level of the proposed ground floor residential flat should be set no lower than 114.19mAOD.
- The finished floor level of the plant / store room should be set no lower than 114.20mAOD.
- The finished floor level of St George's Church should maintained at (or if possible raised above) 113.37mAOD.
- Incorporate flood resilience measures within the proposed community hub building and to any refit of St George' Church (in line with Section 4.1.3 of this report).
- The site manager, staff and residents should register to receive Environment Agency Flood Alerts and implement a Flood Plan in line with guidance given in Section 4.2.2 of this report.
- Review the use of small SuDS components as part of the surface water drainage arrangement for the replacement building (in line with Section 4.3.2 of this report).
- *Construction (Design and Management) Regulations 2015*
    - *The revised CDM Regulations came into force in April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the Designer's responsibilities is to ensure that the Client organisation, in this instance The Duchy of Lancaster, is made aware of their duties under the CDM Regulations.*

Appendix A – Proposed Drawings and Topographical Survey

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REVISONS

Original Drawn By	Date
EW	December 2021

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Client
The Duchy of Lancaster

Contract
OLD GARAGE SITE
Dunsop Bridge

Drawing title
EXISTING SITE LAYOUT

Scale	Job No.	Drg No.
1:250	KL2887	101


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REVISONS
EXISTING SITE ACCESS
existing extended residential gardens to be reduced
existing United Utilities infrastructure to be retained
OLD GARAGE SITE
PAY & DISPLAY CAR PARK
CORRUGATED IRON SHED
shed to be removed
access to residential flat over Puddleducks to be retained
CAFE OUTSIDE SEATING AREA
residential garden curtilage area to be reduced
NOTE:
ALL BUILDINGS INDICATED ON THE SITE ARE WITHIN THE OWNERSHIP OF THE DUCHY OF LANCASTER
N
0m 1m 2m 4m 6m 8m 10m 20m
1 : 200
SMITHY'S GARAGE
hatching indicates area of below ground petrol tanks to be removed
existing building to be retained
existing building to be removed
PUDDLEDUCKS CAFE AND POST OFFICE COUNTER
ST GEORGE'S CHURCH
VILLAGE GREEN
450130mN
450120mN
450080mN
Original Drawn By: EW
Date: December 2021
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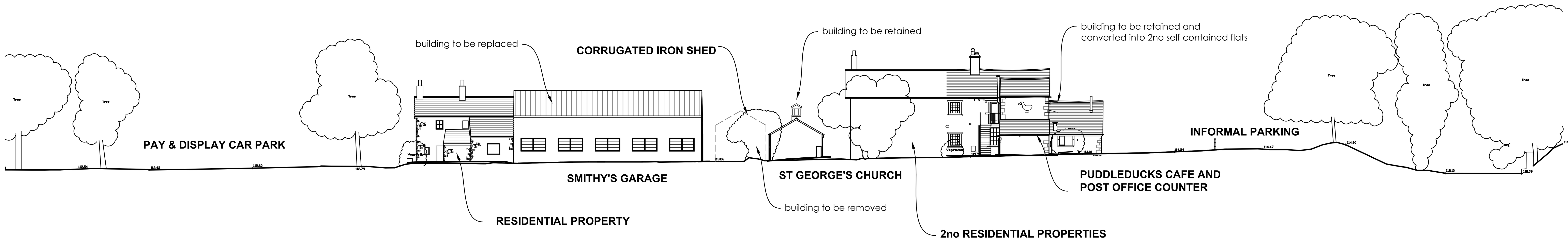
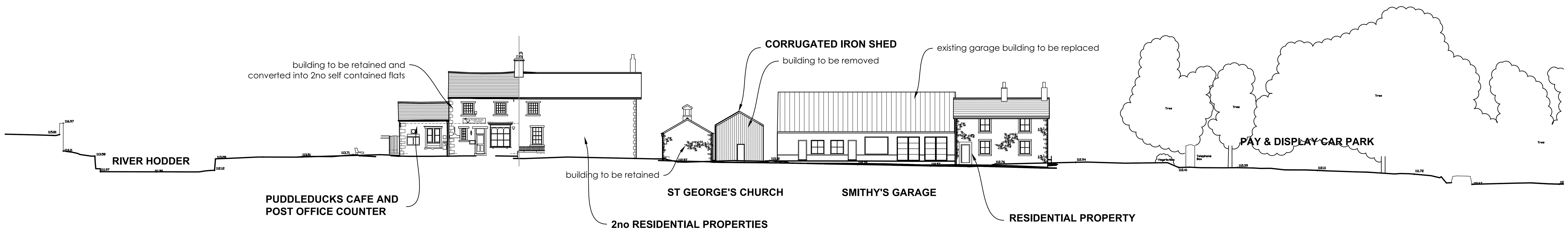
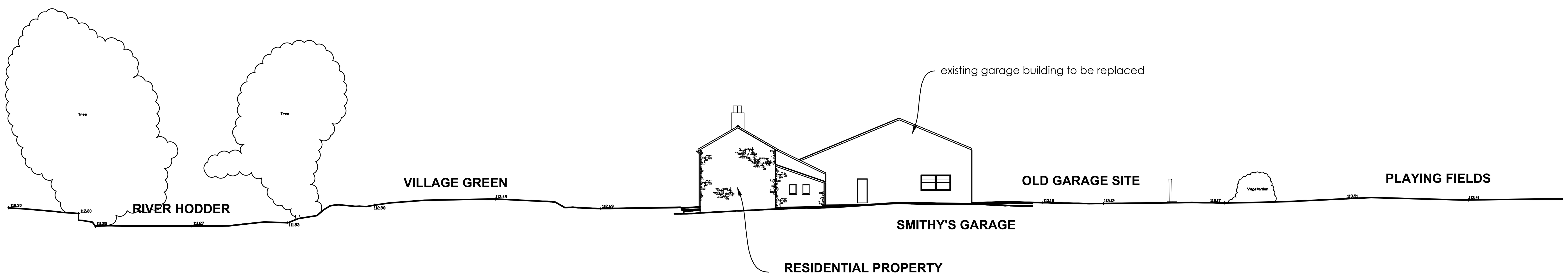
tel / 015242 71697 email / mail@wdparchitects.co.uk
Client: The Duchy of Lancaster
Contract: OLD GARAGE SITE Dunsop Bridge
Drawing title: EXISTING PLANS
Scale: 1:100
Job No.: KL2887
Drg No.: 102



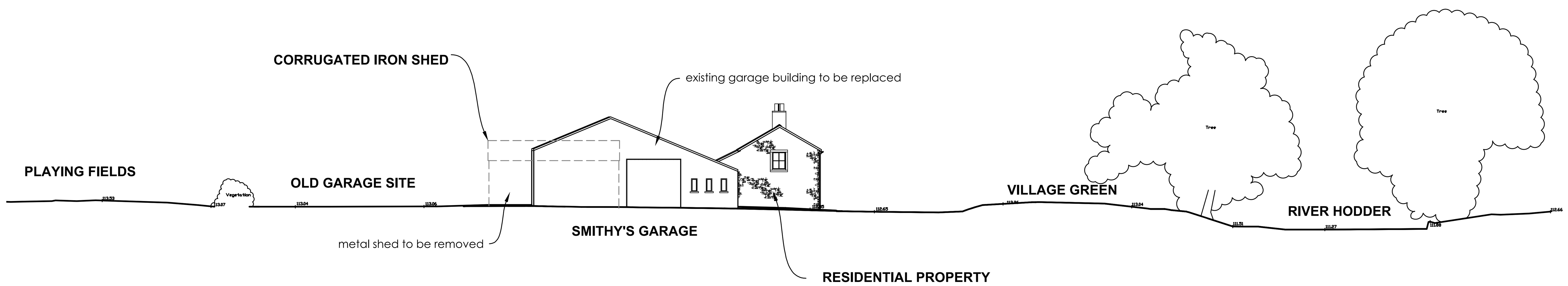
ELEVATION A - A



ELEVATION B - B



ELEVATION C - C



ELEVATION D - D

REVISONS

NOTE:
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N

0m 1m 2m 4m 6m 8m 10m 20m

1 : 200

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Client: The Duchy of Lancaster

Contract: OLD GARAGE SITE, Dunsop Bridge

Drawing title: EXISTING ELEVATIONS

Scale	Job No.	Drg No.
1:200	KL2887	103

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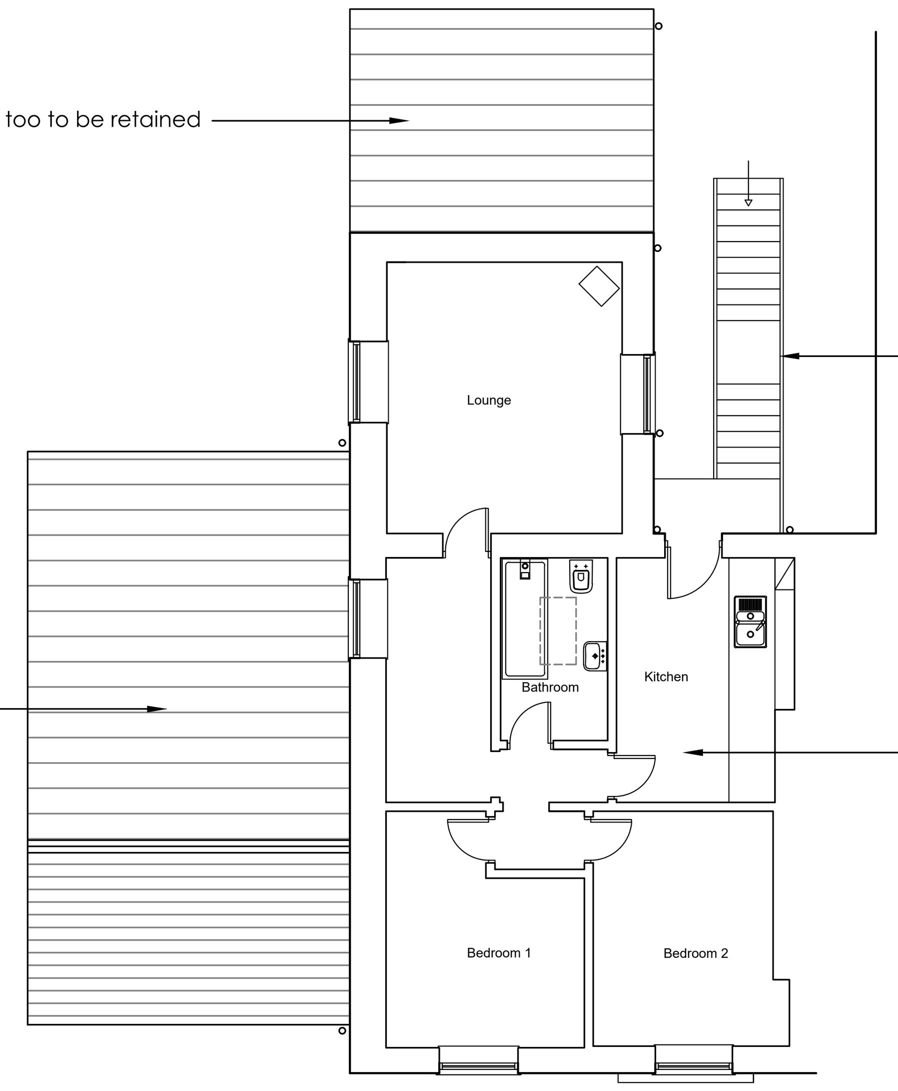
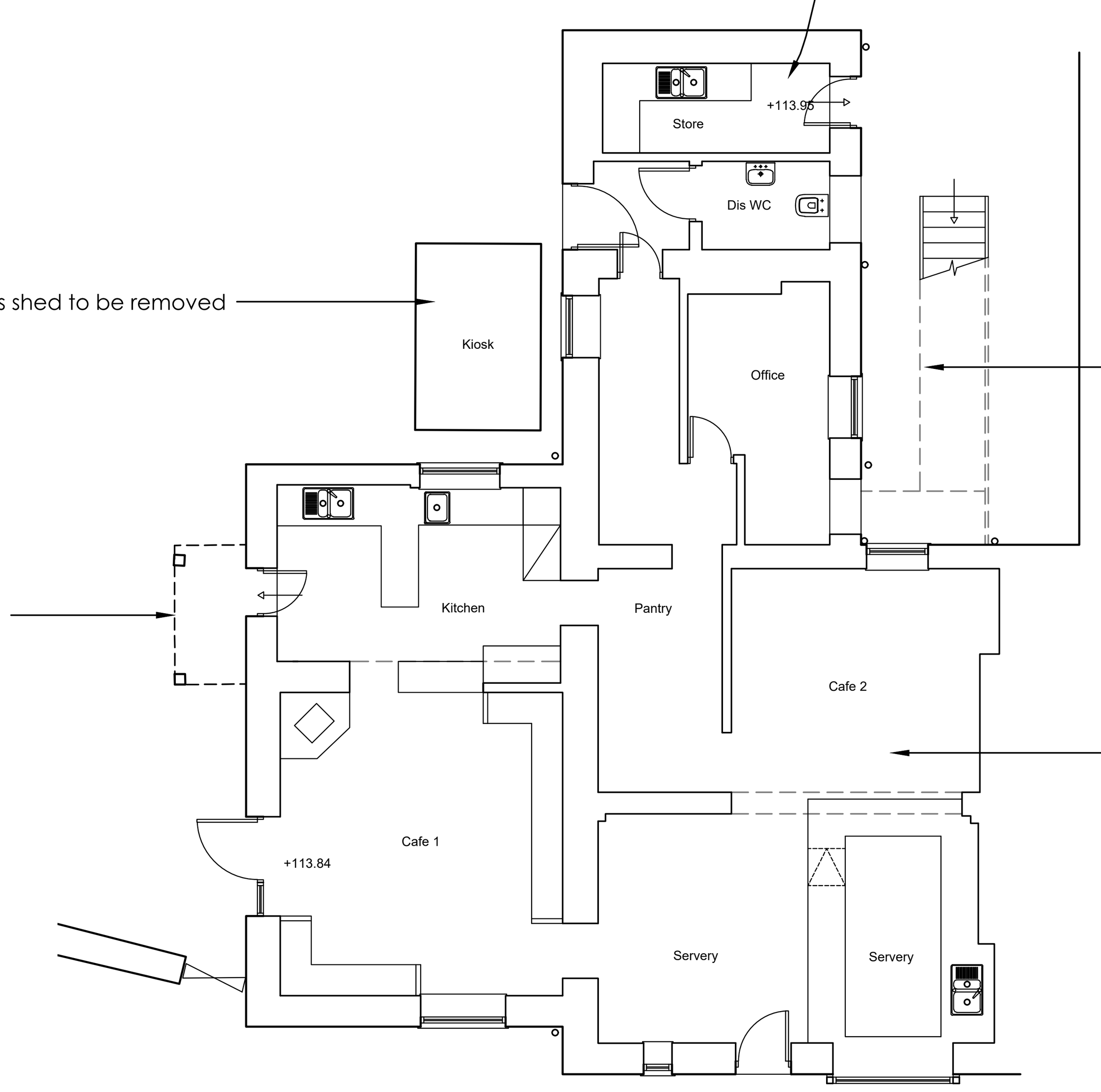
REVISONS



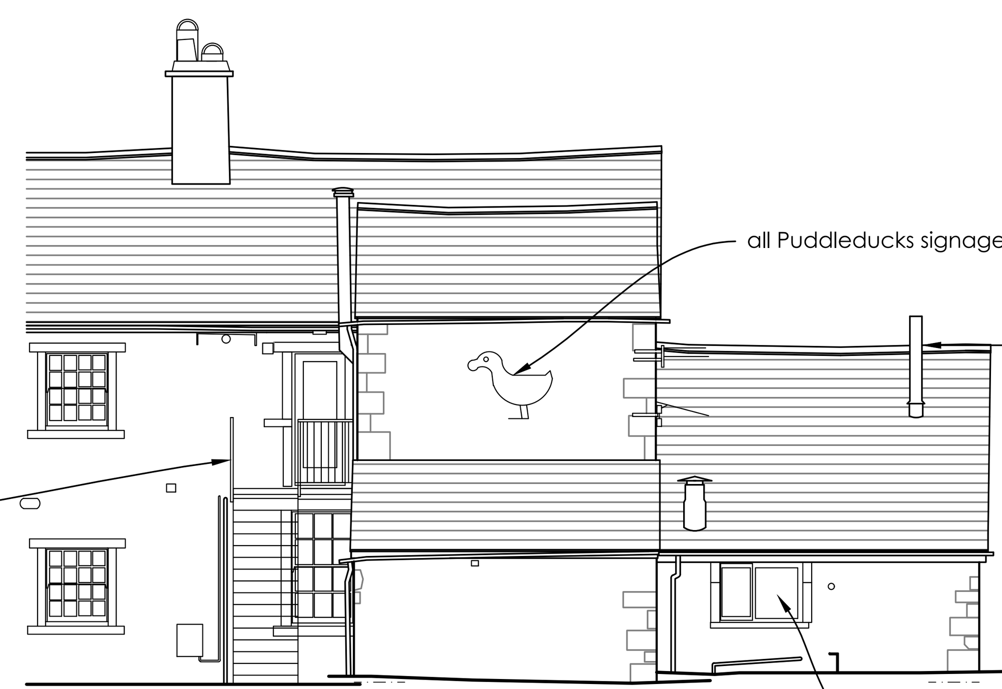
FIRST FLOOR PLAN



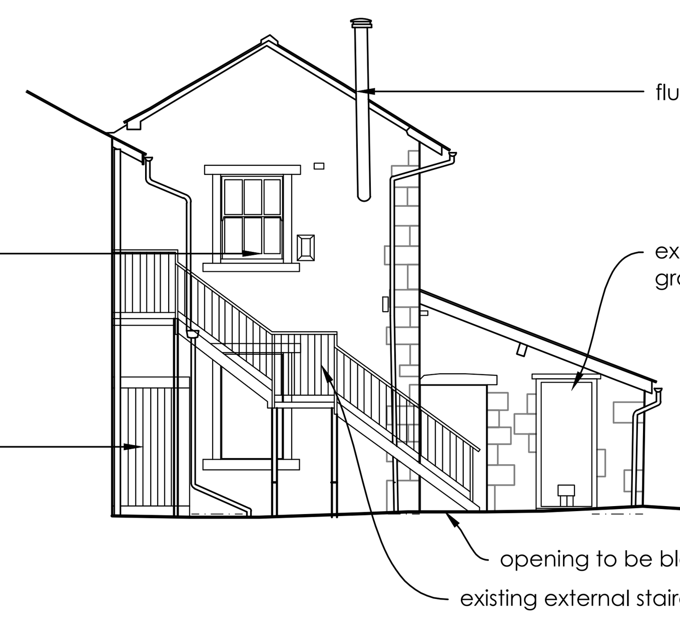
GROUND FLOOR PLAN

SOUTH ELEVATION

WEST ELEVATION



NORTH ELEVATION



EAST ELEVATION

0m 1m 2m 3m 4m 5m 10m

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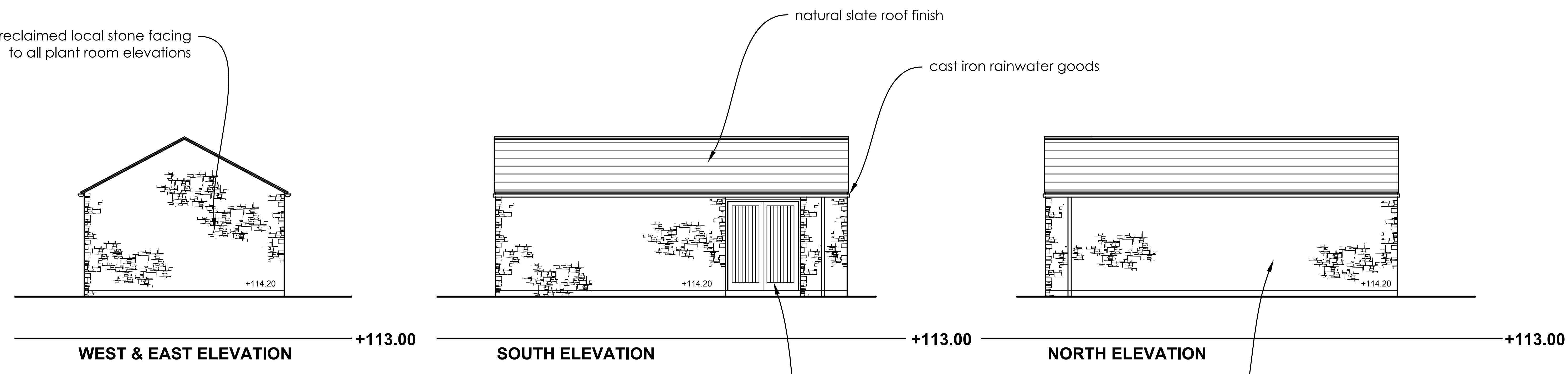
Client
Duchy of Lancaster

Contract
OLD GARAGE SITE
Dunsop Bridge,
Conversion of Puddleducks
to form 2no residential flats.

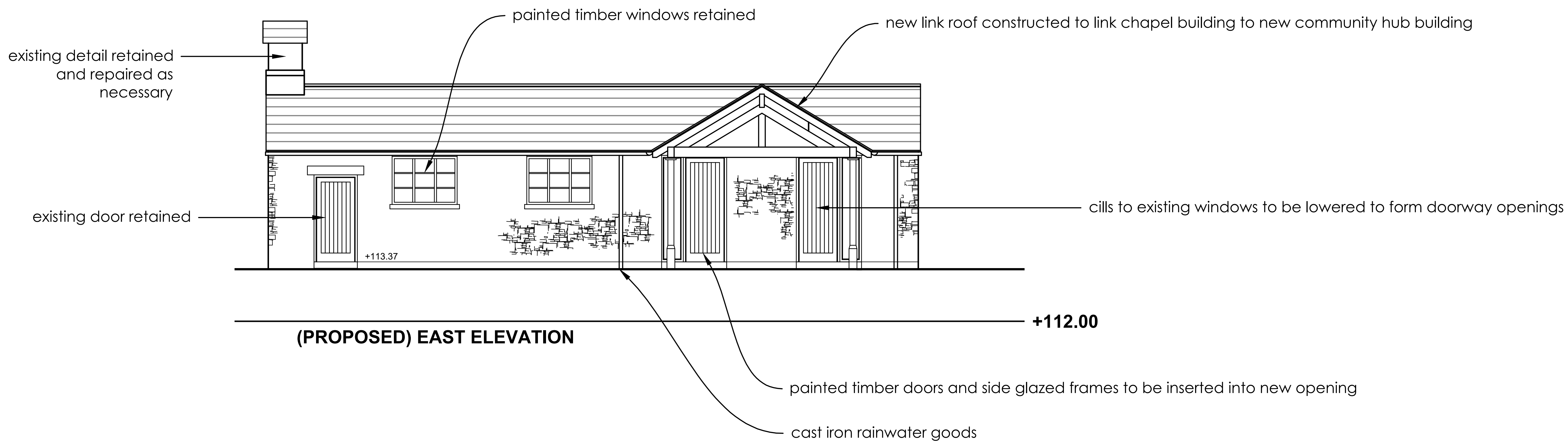
Drawing title
EXISTING PLAN &
ELEVATION DETAILS

Scale	Job No.	Drg No.
1:100	KL2887	104

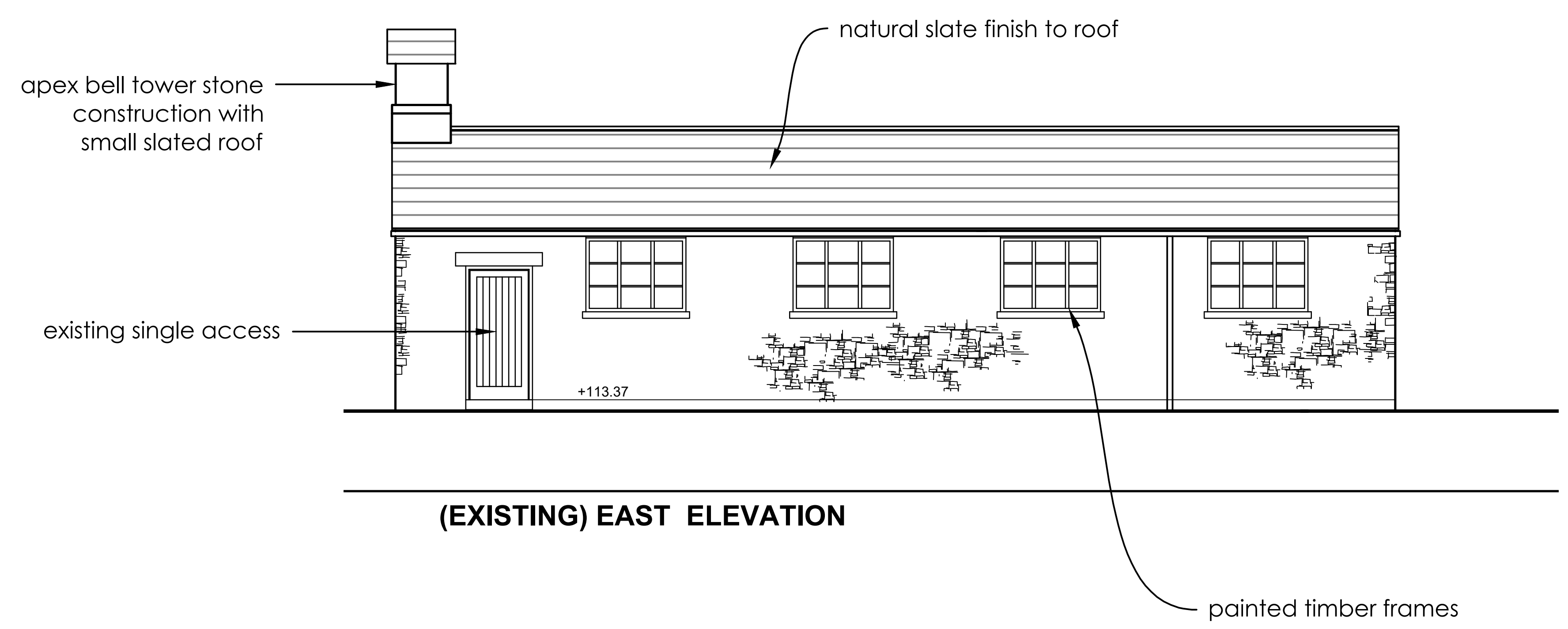
REVISONS



PROPOSED ELEVATIONS TO PLANT / STORE



EXISTING & PROPOSED ELEVATIONS TO ST GEORGE'S CHAPEL



0m 1m 2m 3m 4m 5m 10m
1 : 100

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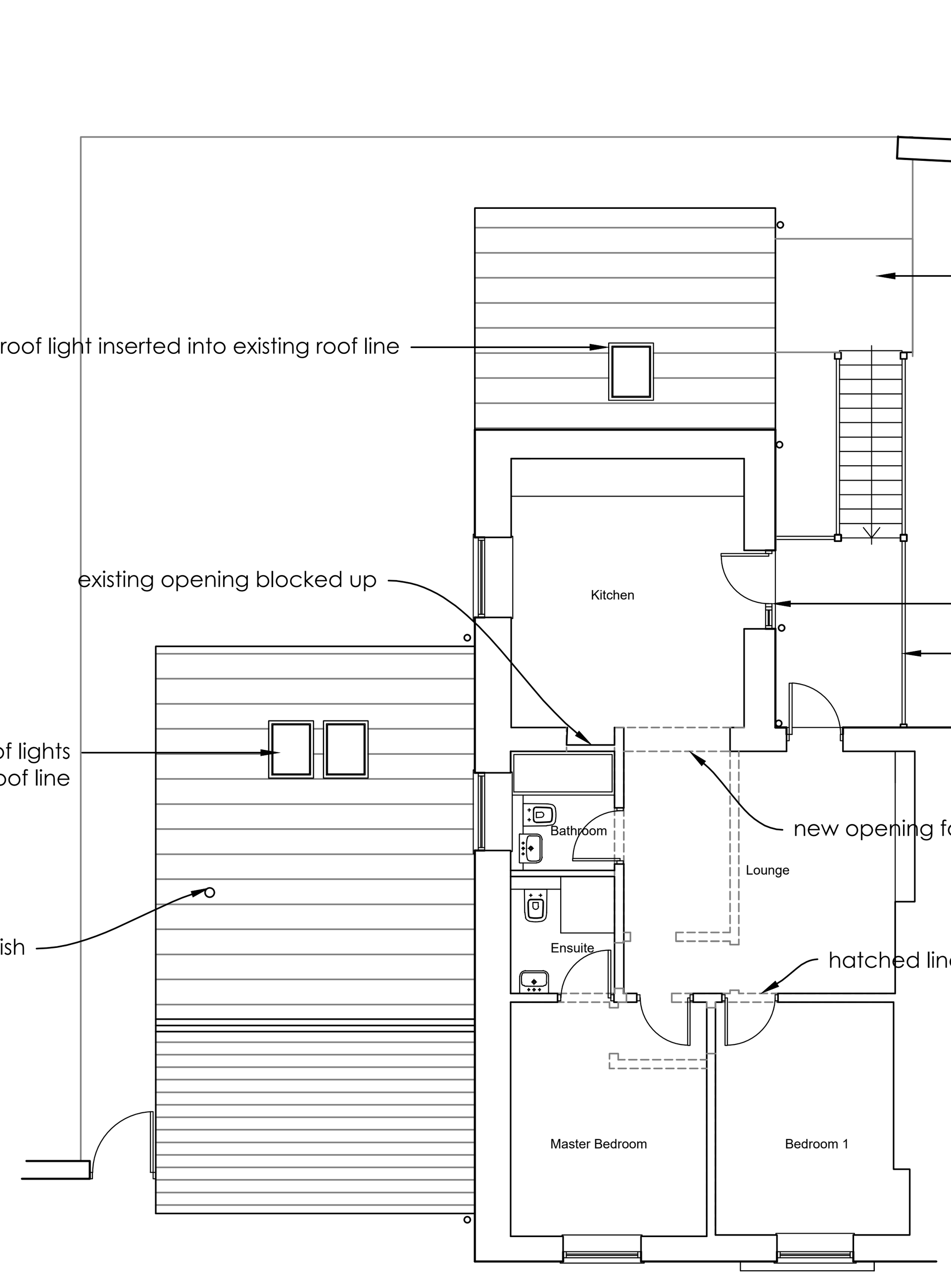
Client
The Duchy of Lancaster

Contract
OLD GARAGE SITE
Dunsop Bridge

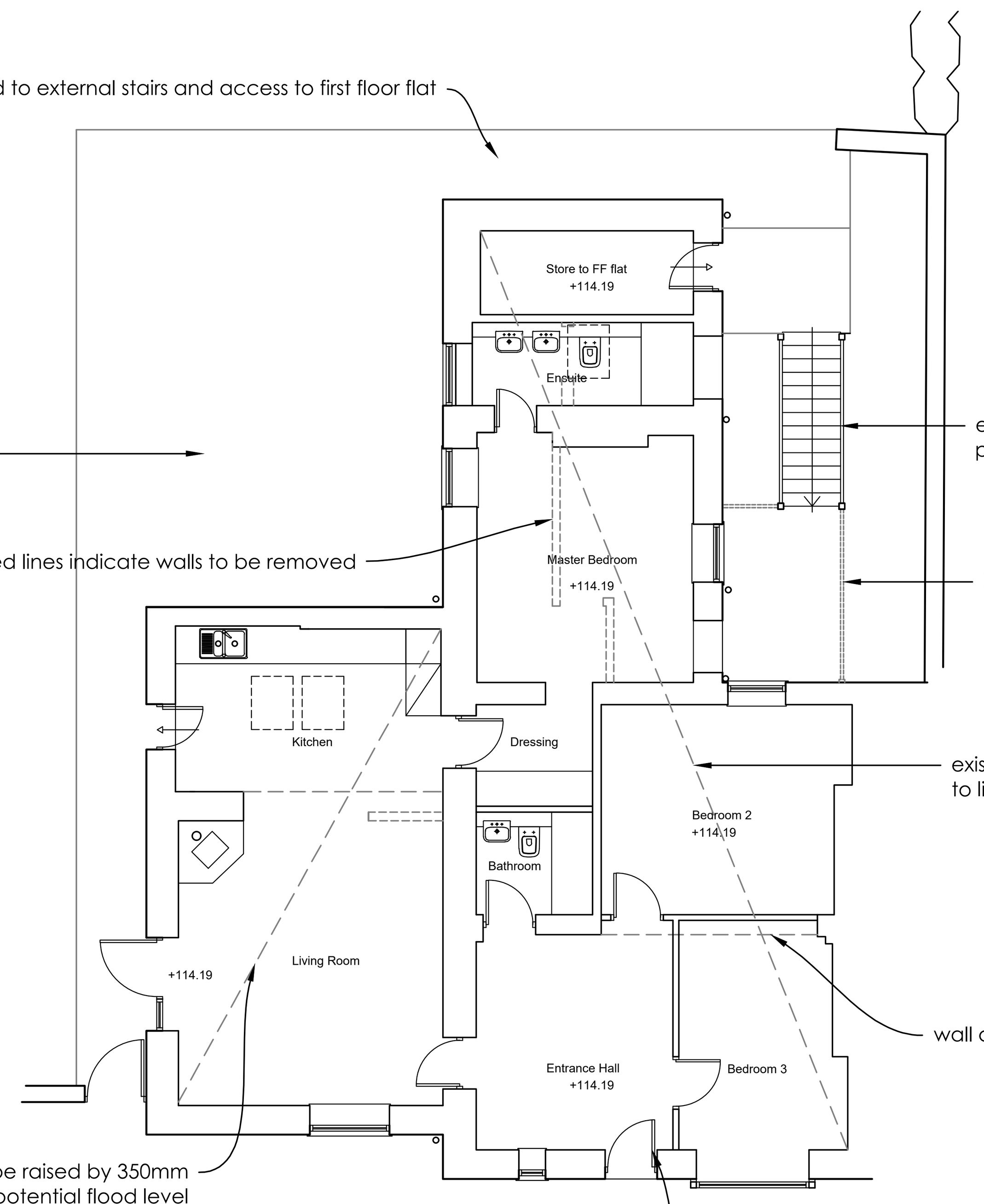
Drawing title
EXISTING & PROPOSED ELEVATION
DETAIL TO PLANT / STORE & CHAPEL

Scale	Job No.	Drg No.
1:100	KL2887	109

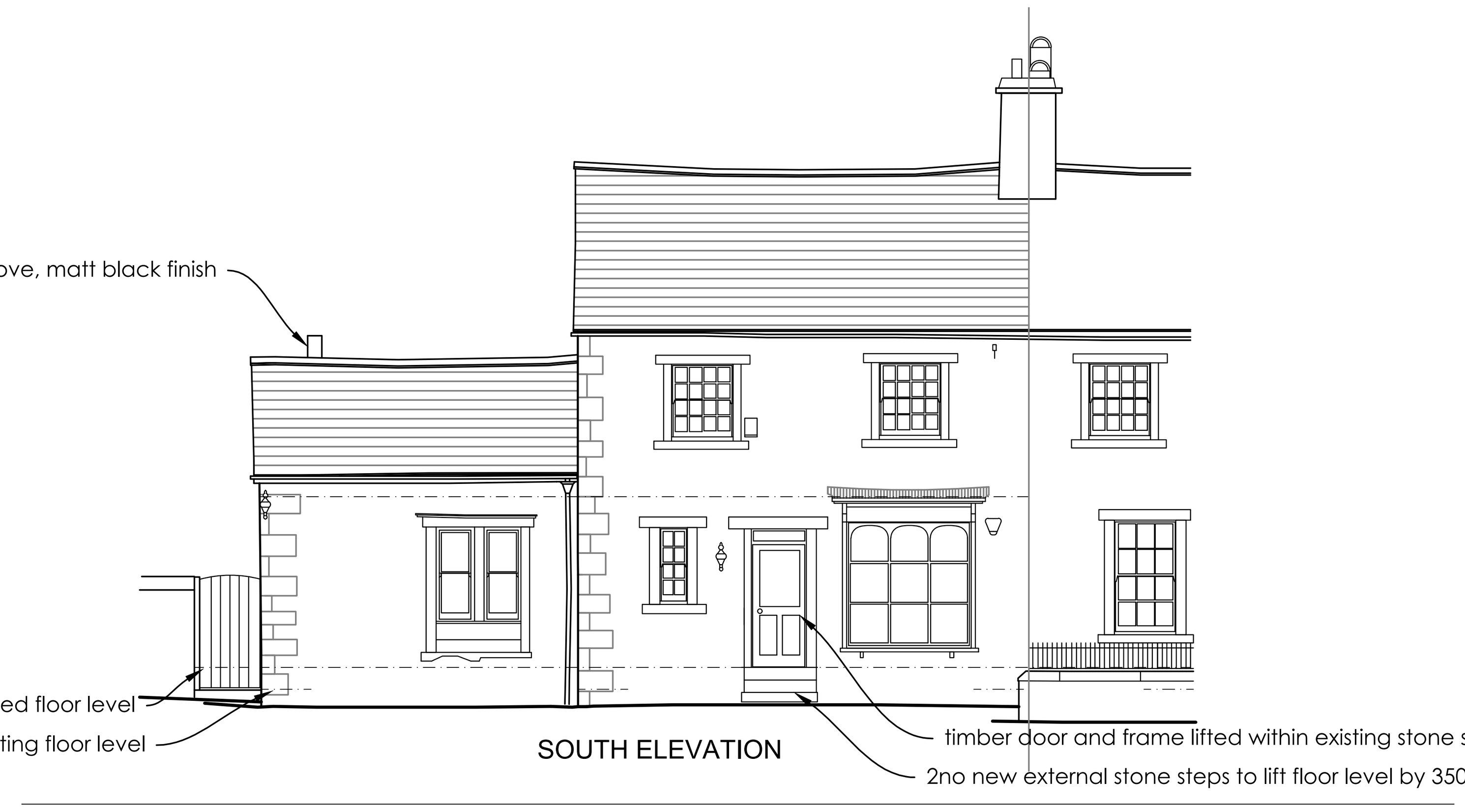
REVISONS



FIRST FLOOR LAYOUT

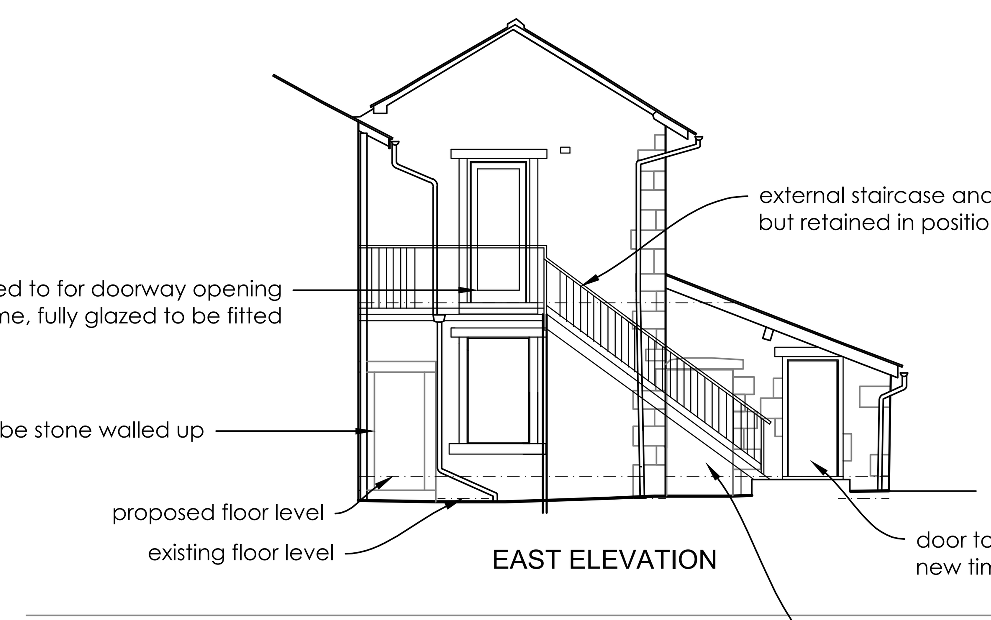


GROUND FLOOR LAYOUT



SOUTH ELEVATION

WEST ELEVATION



EAST ELEVATION

0m 1m 2m 3m 4m 5m
1 : 50

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Client
Duchy of Lancaster

Contract
OLD GARAGE SITE
Dunsop Bridge,
Conversion of Puddleducks
to form 2no residential flats.

Drawing title
PROPOSED PLAN &
ELEVATION DETAILS

Scale	Job No.	Drg No.
1:100	KL2887	108

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SOUTH ELEVATION (A - A)

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Client
The Duchy of Lancaster

Contract
OLD GARAGE SITE
Dunsop Bridge

Drawing title
PROPOSED SITE PLAN

Scale	Job No.	Drg No.
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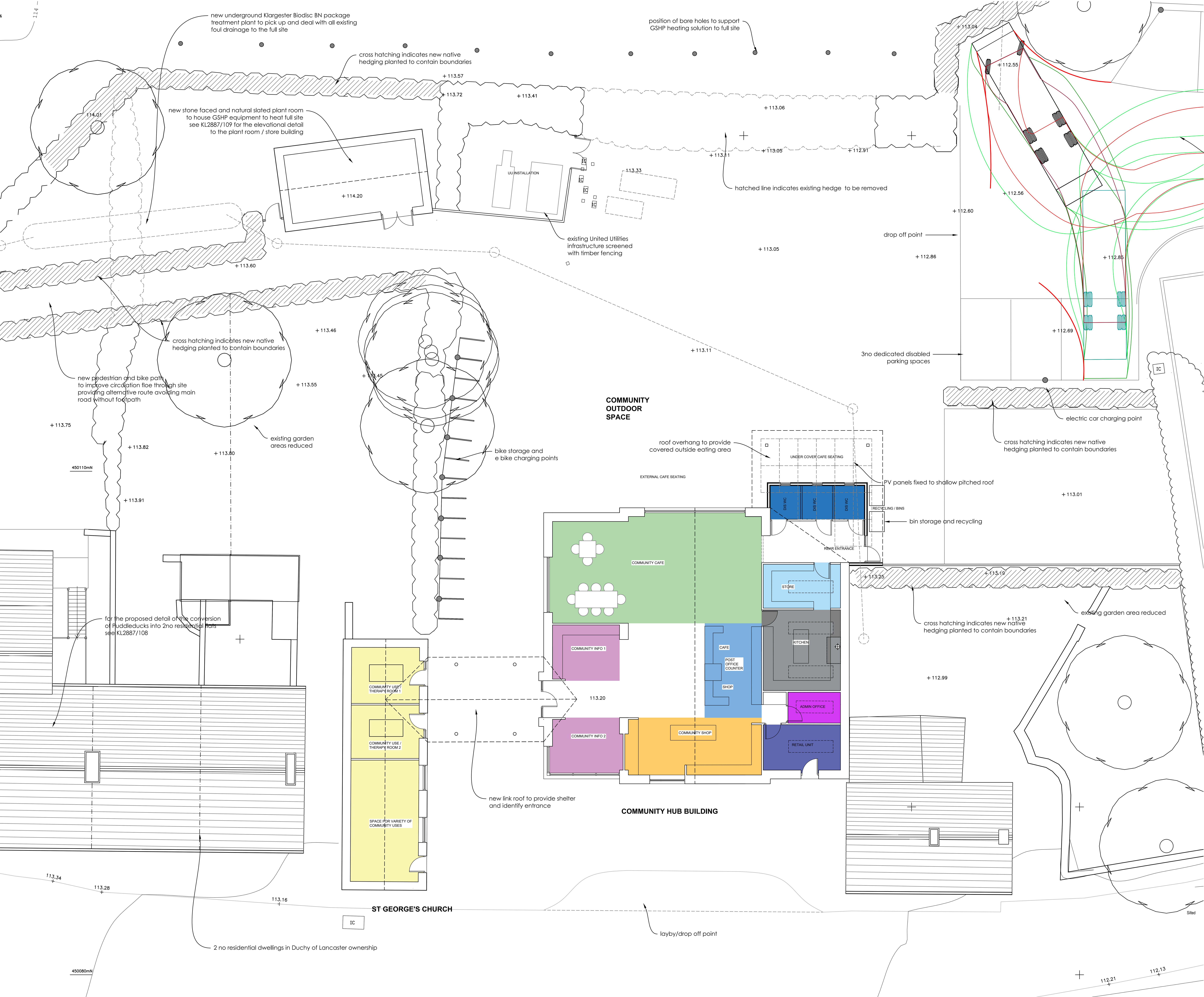

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REVISONS

N

0m 1m 2m 3m 4m 5m 10m

1 : 100

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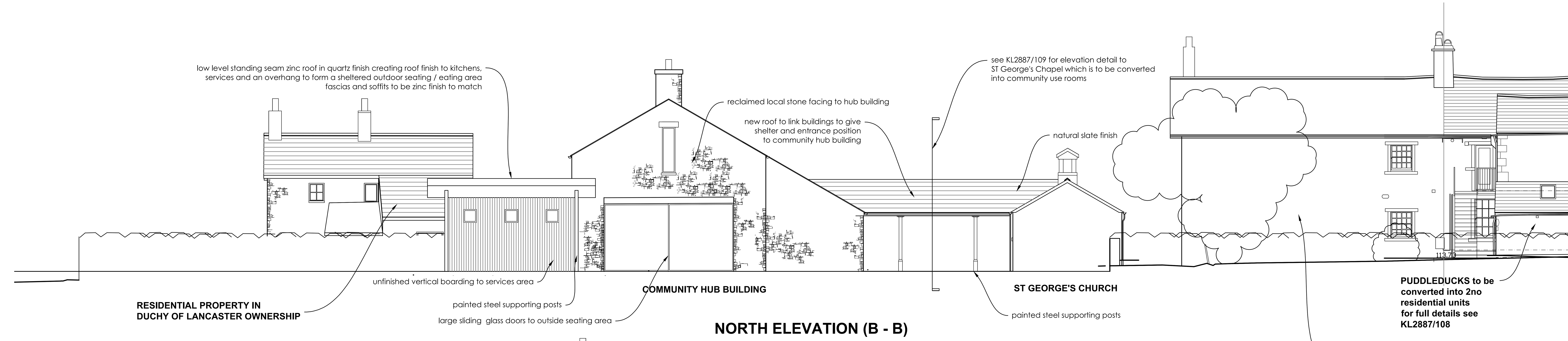
Client: The Duchy of Lancaster

Contract: OLD GARAGE SITE Dunsop Bridge

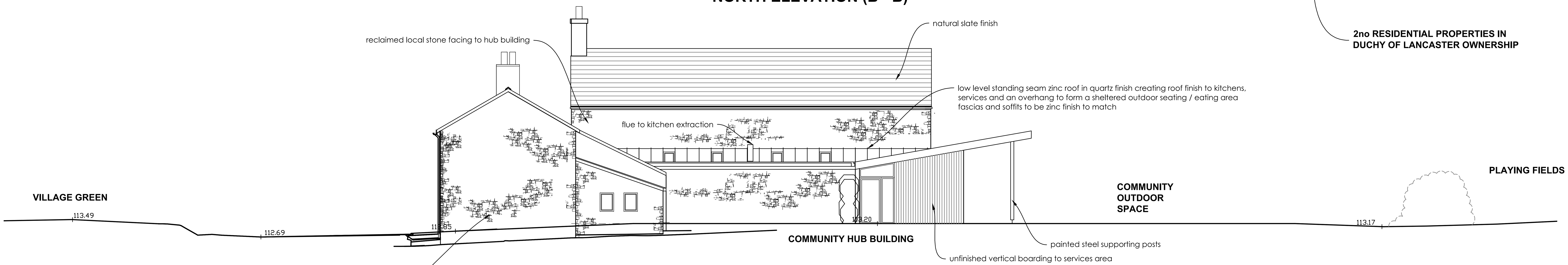
Drawing title: PROPOSED PLANS

Scale	Job No.	Drg No.
1:100	KL2887	106

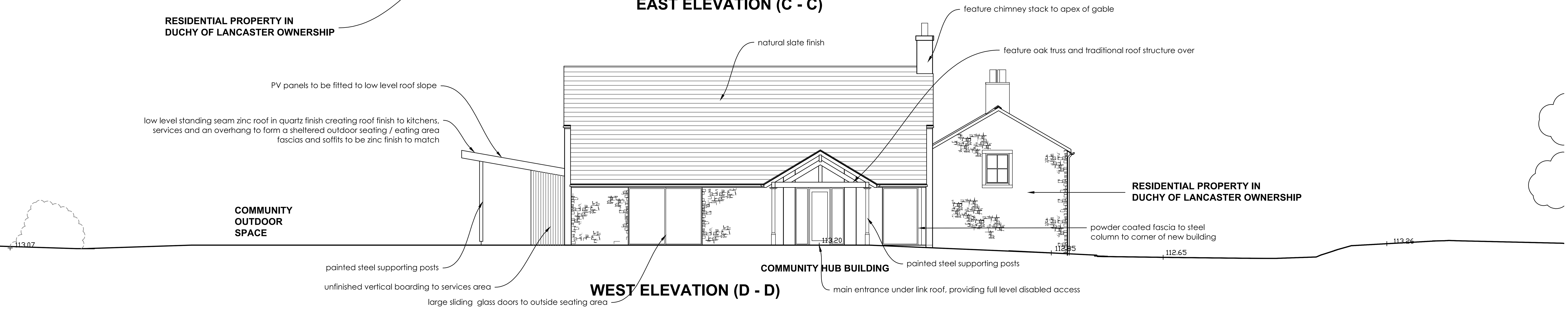
SOUTH ELEVATION (A - A)



NORTH ELEVATION (B - B)



EAST ELEVATION (C - C)



WEST ELEVATION (D - D)

REVISONS

0m 1m 2m 3m 4m 5m 10m

1 : 100

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EW	December 2021

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Client: The Duchy of Lancaster

Contract: OLD GARAGE SITE
Dunsop Bridge

Drawing title: PROPOSED ELEVATIONS

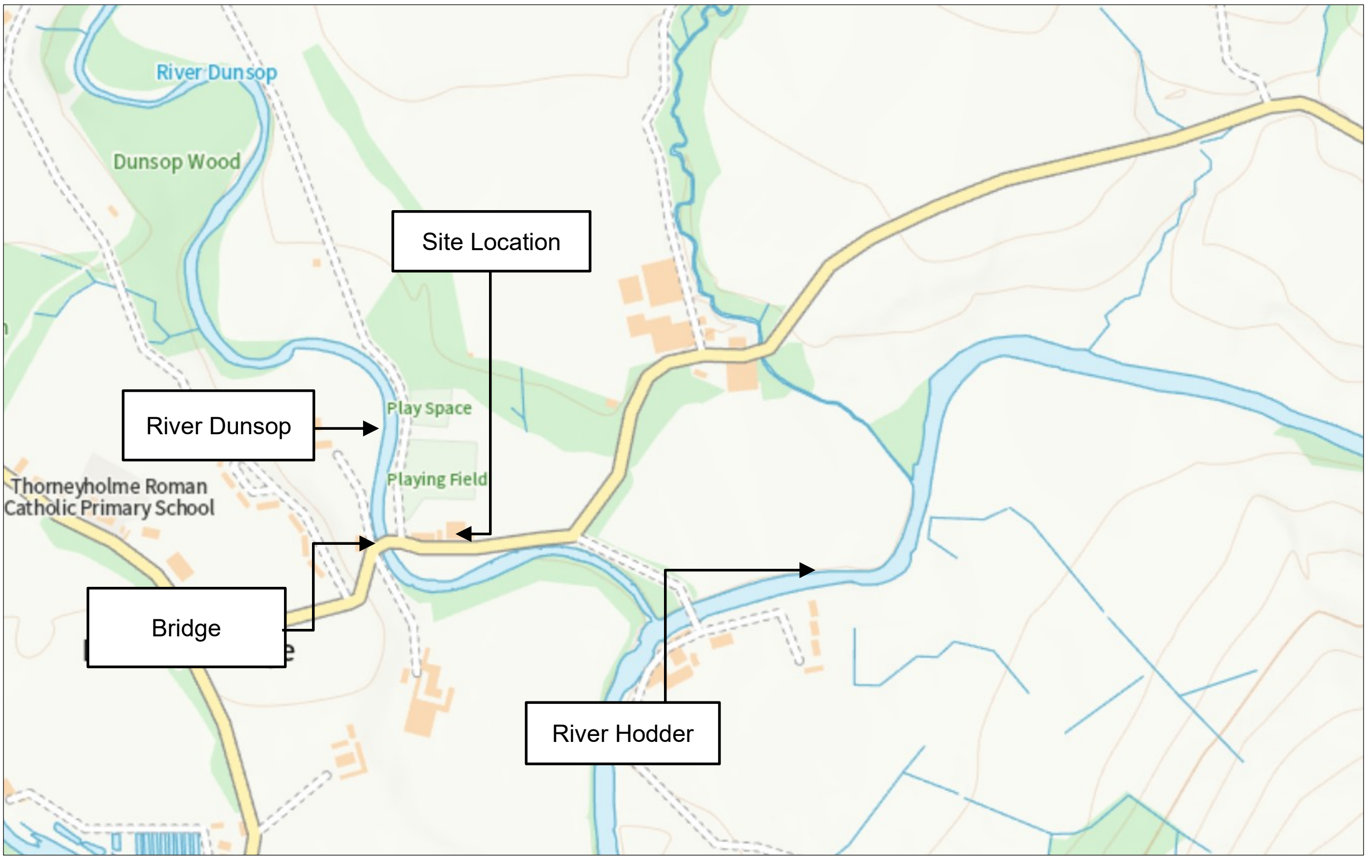
Scale	Job No.	Drg No.
1:100	KL2887	107

Appendix B – Model Report

Hydrological Assessment

The River Dunsop flows around the west and south of the proposed site (approximately 35m at closest approach) before discharging into the River Hodder 200m to the south-east. The River Dunsop is a small watercourse with a catchment area of approximately 30km^2 within the Forest of Bowland. The Forest of Bowland is almost entirely rural, generally comprising gritstone fells with peat moorland and blanket bog. The underlying geology is generally characterised as sandstones, mudstones and siltstones. The catchment falls from around 500mAOD at the highest point down to 113mAOD at Dunsop Bridge over a straight-line distance of approx. 8.3km. The watercourse therefore falls quite steeply with an average gradient of 1 in 25 from highest point down to Dunsop Bridge. There are no upstream reservoirs and no major structures that would affect the natural catchment.

The River Hodder catchment, as it approaches Dunsop Bridge, is also contained within the Forest of Bowland. This catchment is larger than the River Dunsop, spanning approx. 110km^2. The upstream flow of the Hodder will be attenuated to some degree by Stocks Reservoir.



FEH Statistical Method

A catchment area for the River Dunsop and its associated descriptors were obtained from the FEH Web Service for a location on the downstream side of the site shown below in Figure 8 and Figure 9.

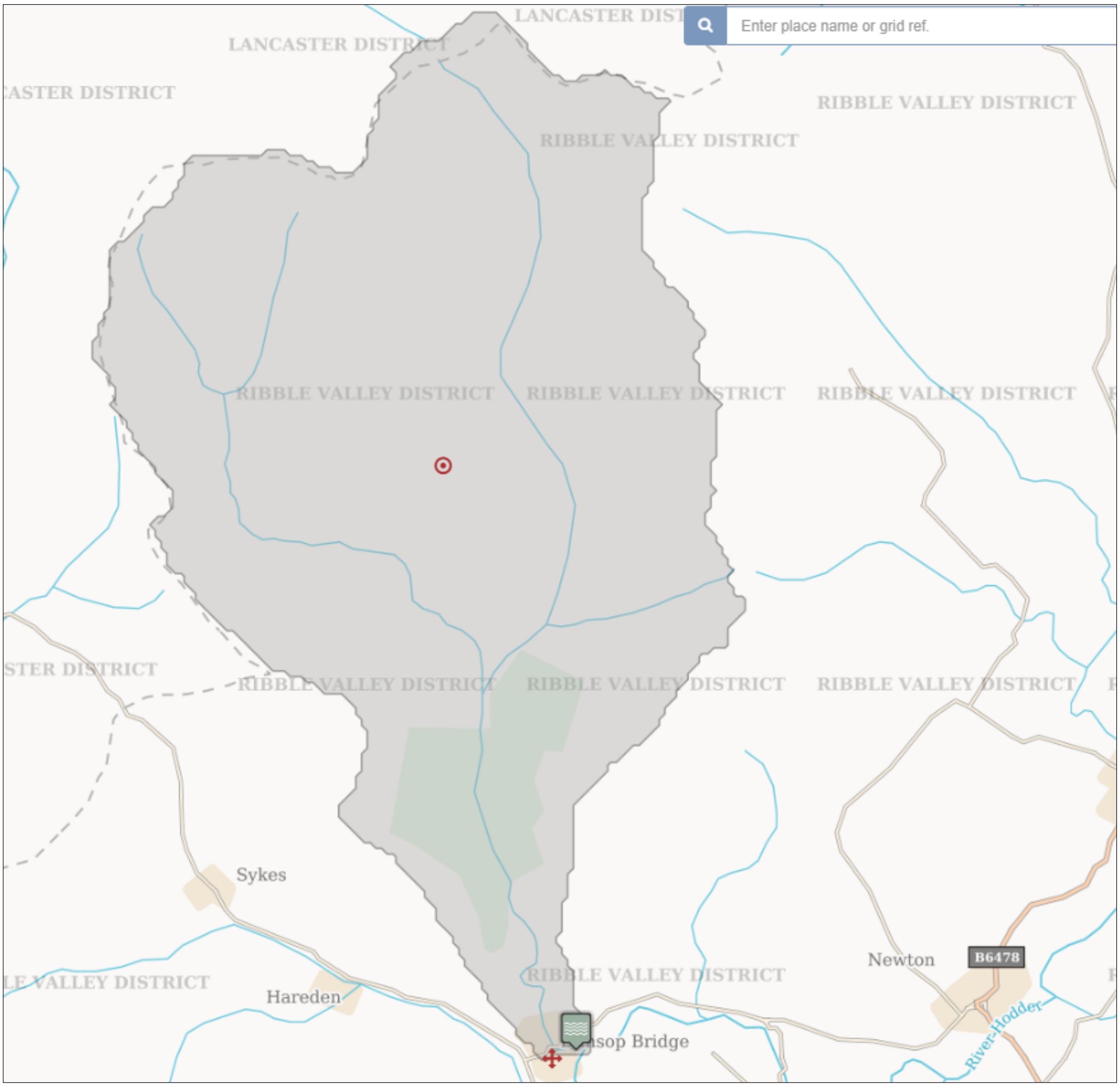


FIGURE 8: FEH WEB SERVICE, CATCHMENT AREA

Outlet	366200, 450050
NGR	SD 66200 50050
Area	28.95 km²
Altbar	347 m
Aspbar	197 degrees
Aspvar	0.21
Bfihost	0.308
Bfihost19	0.293
CentroidEasting	365,040 m
CentroidNorthing	455,170 m
Dplbar	7.59 km
Dpsbar	184.50 m/km
Farl	0.9990
Fpext	0.0270
Fpdbar	0.796 cm
Fploc	0.681
Ldp	12.94 km
Propwet	0.600
Rmed1H	12.4 mm
Rmed1D	59.1 mm
Rmed2D	81.3 mm
Saar6190	1,894 mm
Saar4170	1,845 mm
Sprhost	52.59 %
Urbconc1990	
Urbext1990	0.0001
Urbloc1990	
Urbconc2000	
Urbext2000	0.0001

Figure 9: Catchment descriptors

The software package WINFAP-5 (Version 5.0.7947) with Version 10 of the NRFA peak flow dataset was used to process the FEH Statistical Method. There is no flow gauge relevant to the site and so a QMED value could not be determined by the single site / enhanced single site method. An estimate of QMED was therefore derived from the catchment descriptor equation embedded within WINFAP-5. This value was then adjusted using the latest donor site procedure (using the top 6 donor sites identified with WINFAP 5).

A pooling group was created with in excess of 500 years of records by normal practice searching from all available gauging stations omitting those tagged as unsuitable for QMED and pooling.

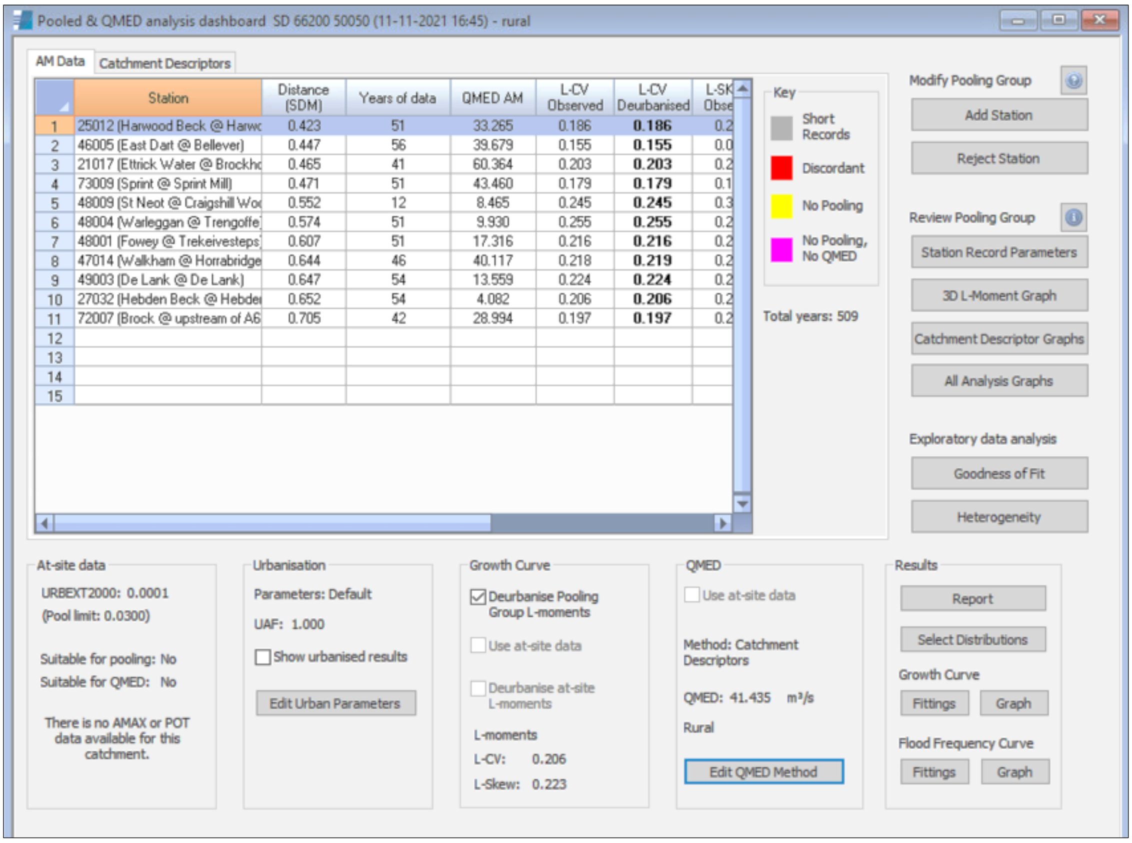


FIGURE 10: POOLING GROUP

A growth curve was produced from the pooling group using a Generalised Logistical distribution and applied to QMED to give a flood frequency curve, given in Table 6.

TABLE 6: FEH STATISTICAL METHOD FREQUENCY CURVES

Annual exceedance probability (AEP)	Peak flood flow rate (m^3/s)			
	Stat method (derived from catchment descriptors)		Stat method (donor adjusted)	
	No urban adjustment	With urban adjustment	No urban adjustment	With urban adjustment
50%	41.44	41.44	41.86	41.86
10%	65.48	65.48	66.15	66.15
5%	76.73	76.73	77.52	77.52
2%	93.98	93.98	94.95	94.95
1%	109.36	109.37	110.49	110.49
1 % AEP + 36% CC	148.72	148.74	150.27	150.27

Revitalised FSR/FEH rainfall runoff method

The catchment descriptors were also entered into the FEH ReFH2 software package (Version 3.2.7650), using the default model parameters. The default 30 min timestep and 6.5-hour rainfall duration were used. The flood frequency curve from the ReFH2 method is given in Table 7 below.

TABLE 7: REFH2 FLOOD FREQUENCY CURVES

Annual exceedance probability (AEP)	Peak flood flow rate (m^3/s) ReFH2 method -Rural
50%	44.13
10%	70.25
5%	82.41
2%	101.30
1%	118.89
1% AEP + 36% CC	161.69

Assessment of data

The statistical method is generally the preferred approach for estimating flood frequency curves as it is based on a much larger dataset of flood events compared to the other methods. There are no particular catchment characteristics or data use requirements that warrants deviating from normal guidance in this case. Therefore, the peak flows generated from the donor adjusted statistical method will be taken forward for the model study. The inflow hydrograph shape will be based on the ReFH2 hydrograph but scaled to the FEH peak flows.

Hydraulic Modelling

Ground levels by the River Hodder at the confluence with the Dunsop are approximately 4m lower than the proposed development site, consequently it is not expected that the Hodder would pose a direct flood risk to the site. This assumption is consistent with the shape of the indicative flood zones on the Environment Agency's Flood Map for Planning. In addition, given the size difference between the Hodder and the Dunsop catchments (~110km^2 vs ~30km^2), peak flows on the two watercourses are not expected to coincide. A hydraulic model was therefore developed of just the River Dunsop from 950m north-west of the site down to the confluence with the River Hodder. The potential influence of the River Hodder was investigated as a downstream boundary test on the River Dunsop model by judging and applying a reasonably high water level as a stage-time boundary.

Flood Modeller Pro was used to represent the Dunsop in the 1D domain. Floodplain flows were modelled using TUFLOW, creating a 1D-2D model, to consider the potential for upstream flood water to 'short-circuit' the meanders to flow through the proposed development site.

Given the small scale of development, no formal river survey was undertaken. Both the cross-section data for the 1D watercourse and the topography of the 2D floodplain was represented by 2m resolution LiDAR data. The channel is well defined within the LiDAR data. The dimensions of the road bridge included within the modelled were taken from photographs and simple measurements provided by the site owner. Figure 11 below shows the model schematisation.

The river channel and floodplain were assigned a roughness value with reference to standard values given in Chow, V.T, 1959, Open-Channel hydraulics, New York: McGraw-Hill. Manning's 'n' values were assigned for the channel and floodplain based on local conditions. In-channel sections of the watercourse were assigned a Manning's value of 0.045 (clean, straight, full stage, no rifts or deep pools, with stones and weeds), whilst a value of 0.015 was used for bridge. Manning's n value for the floodplain was set to a universal value of 0.040 given the rural pastureland nature of the area.

A model grid size of 2m was selected to provide adequate representation of all flow paths. Link lines were used to connect the 1D and 2D elements. The link lines were set along the bank tops using data extracted from LiDAR. 2D flow boundaries were used at the edge of the active area, to allow water to leave the model, set at 1:80 gradient to match the gradient of the local landscape. Inflow to the model was provided by a flow time boundary at the start of the model.

The downstream 1D boundary was represented by a Normal Depth boundary unit for most tests although a stage-time boundary was used to test the potential influence of the Hodder. The time-steps for the linked model runs were set at 1D = 0.5s and 2D = 1s. The bridge opening area was assumed to be 100% available in the baseline scenario. Model sensitivity and blockage testing was undertaken, in line with best industry practice guidelines.

A hydraulic model review checklist is included at the end of this section which summarises key parameters and choices made within the model.

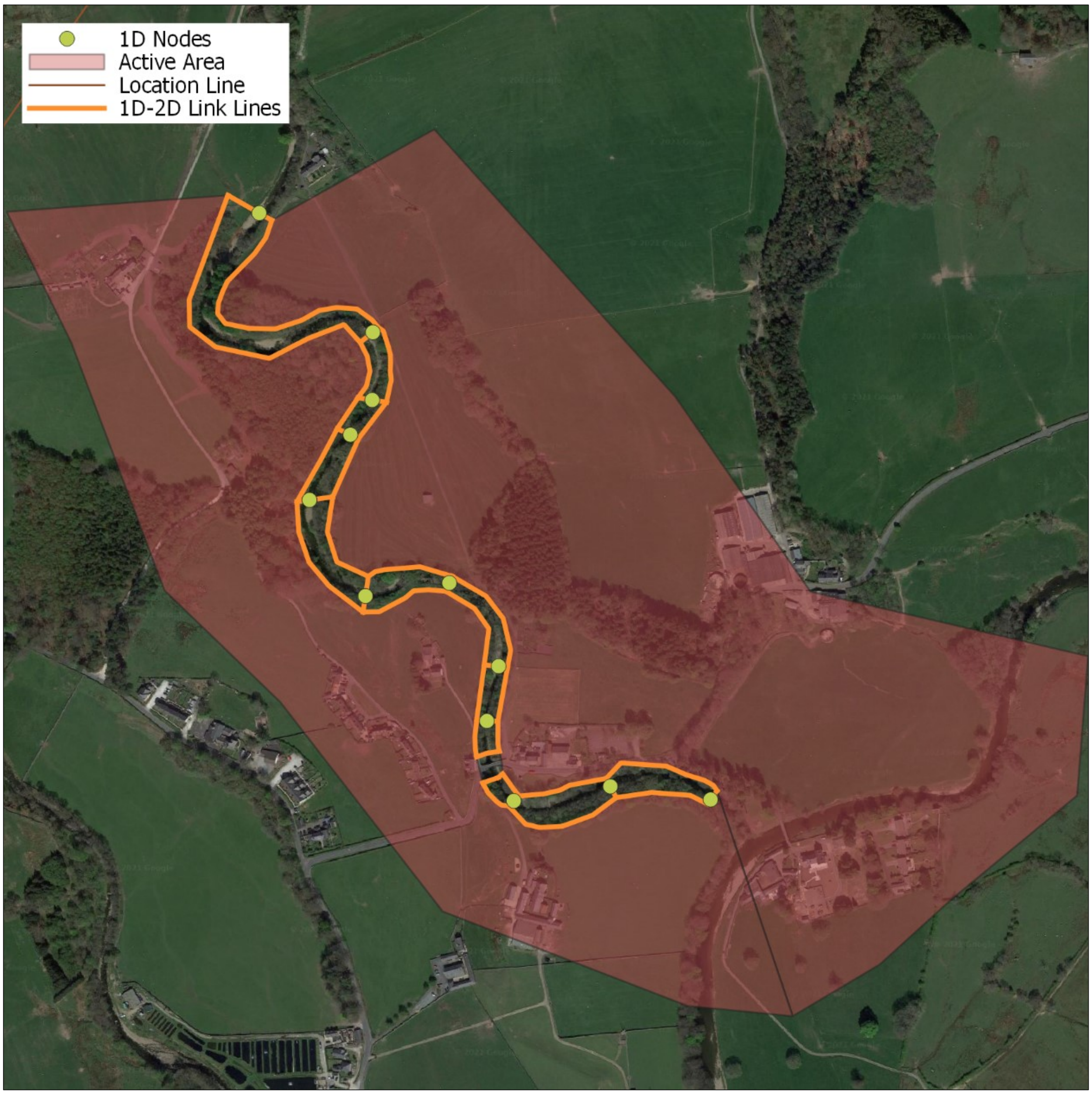


Figure 11: Model schematisation

Model Results Analysis:

The modelled flood extents and levels are shown in the figures below.

The hydraulic model not only provides a flood extent and level, but also reveals the mechanism of flooding for this location. The model indicates that the channel capacity south of the site is exceeded in the 1% AEP plus 36% climate change design event with flood water flowing north/northeast, first flooding the road and then flooding the south and central part of the site. The channel capacity is also exceeded upstream of the site (130m to the northwest) resulting in the flood water travelling south/southeast, out of bank, combining with the flood water from the south. The buildings to the west of the site including the post office and Puddleducks Tea Room café mostly remain dry during this scenario. During this baseline scenario the road bridge to the west does not appear to create a flow constriction. The flood mechanism is summarised in Figure 12.

Most of the site is predicted to flood during the 1% AEP plus 36% climate change design event, with flood levels being highest to the west of the site. Peak flood levels are summarised in Figure 13.

FIGURE 12: FLOOD MECHANISM DURING THE 1% AEP PLUS 36% CLIMATE CHANGE BASELINE SCENARIO

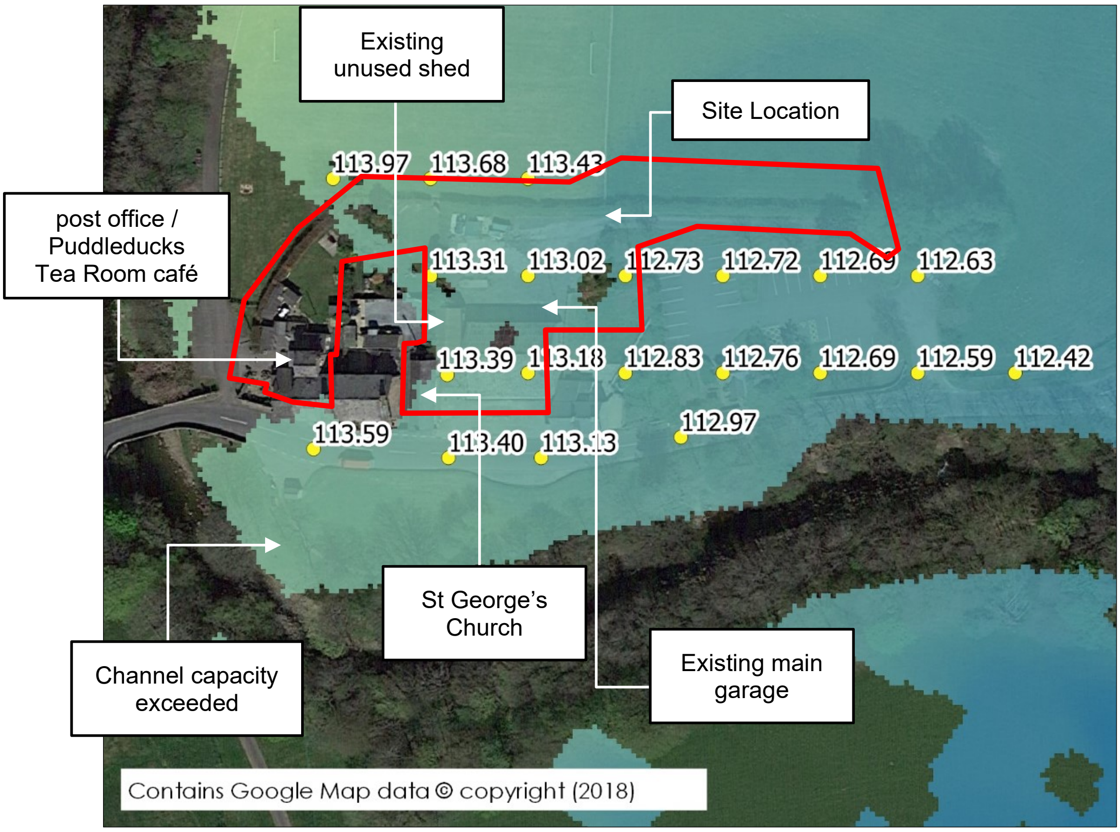


FIGURE 13: MODELLED FLOOD EXTENT AND LEVELS FOR 1% AEP PLUS 36% CC DESIGN EVENT

A 50% blockage scenario was also tested of the road bridge to the west of the site. The results are summarised in Figure 14 which shows an increase in the flood levels compared to the baseline scenario due to the constriction effect driving a greater upstream out of bank flow.

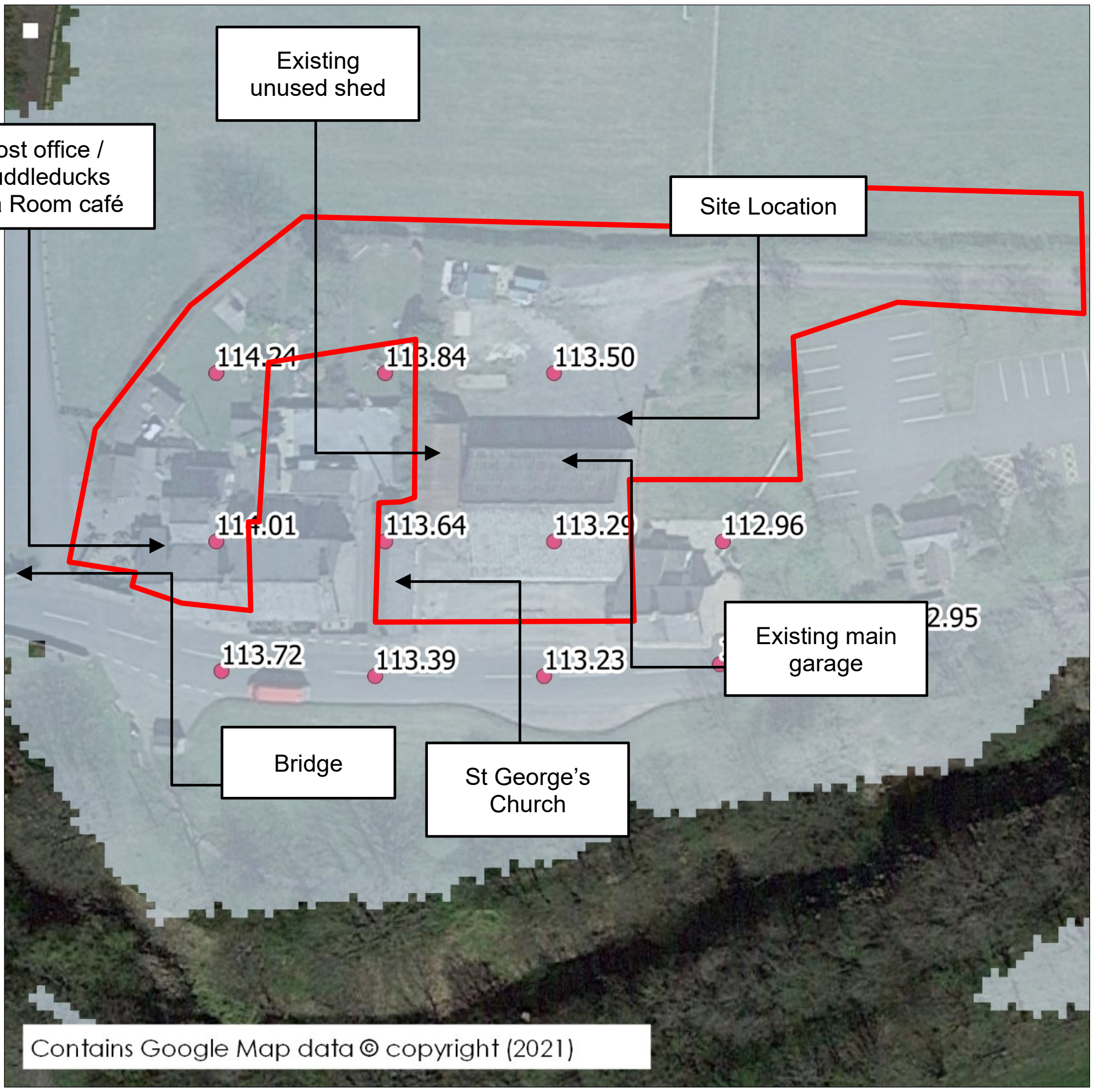


FIGURE 14: MODELLED FLOOD EXTENT AND LEVELS DURING A 1% AEP PLUS 36% CC AND 50% BLOCKAGE SCENARIO

Model Calibration:

There is no flow / level gauge at Dunsop Bridge and therefore no quantitative data to calibrate / validate the model.

The modelled results indicate out of bank flood water regularly affecting the road through Dunsop Bridge, with a depth of 0.6m in the design 1% AEP +CC event and 0.15m even in a 20% AEP event. The model predicts flood water only starting to significantly affect the site with the 1% AEP event.

These results are comparable with local experience where the planning applicant reports:

'The only knowledge of flooding effecting the site dates back to an incident in 1967 that effected the entire valley. A section of the B6478 road to the south of the site is known to flood periodically circa 3 times a year. Neither the site nor the properties to the east and west of the site have ever flooded save for the incident in 1967. This is based on local knowledge and information dating back to the 1940's.'

Model Sensitivity:

In the absence of formal calibration, the model performance will also be assessed by sensitivity testing. Sensitivity testing is the process of adjusting key parameters within the hydraulic model to assess the impact on the modelled outcome.

The main parameters tested are:

- Manning's 'n' increased by 20% globally.
- Manning's 'n' decreased by 20% globally.
- Downstream boundary gradient decreased.
- Downstream boundary gradient increased.
- Downstream accounting for the River Hodder.

All sensitivity tests were run with the 1% AEP + CC (36%) scenario.

Table 8: Model Sensitivity Results

Modelled Scenario	Flood level at 2D point (mAOD)
1 % AEP + 36% CC	113.39
1% AEP + CC (36%) & downstream boundary gradient decreased (20%)	113.39
1% AEP + CC (36%) & downstream boundary gradient increased (20%)	113.39
1% AEP + CC (36%) & manning's decreased (20%)	113.35
1% AEP + CC (36%) & manning's increased (20%)	113.44
1% AEP + CC (36%) & 50% blockage of bridge	113.64
1% AEP + CC (36%) & out of bank flooding at the River Hodder	113.39

FIGURE 15: LOCATION AT WHICH LEVEL OF WATER WAS ANALYSED DURING SENSITIVITY TESTING

Manning's n

As a result of both increasing and decreasing Manning's 'n' by 20%, there was a small change in the peak water level. An increase in roughness resulted in a 0.05m peak flood level increase, whilst a decrease in roughness reduced the peak flood level by 0.04m. Minor changes in level are expected when modifying the Manning's 'n', as this influences the flow profile of the channel and overland flows. The results show the model is not particularly sensitive to choices relating to Manning's n roughness.

Downstream Boundary adjustments

Normal depth is the depth of flow in a channel or culvert when the slope of the water surface and channel bottom is the same and the water depth remains constant. In Flood Modeller, the Normal Depth Boundary (NCDBDY) unit is a downstream boundary which automatically generates a flow-head relationship based on section data; it applies a normal depth from the Manning's equation. Both decreasing and increasing the gradient made no change to the modelled flood levels.

As discussed earlier in this report, it was assumed that the downstream River Hodder would have no direct impact on flood risk at the site, given the magnitude of fall, down to the confluence. This assumption was tested by setting a downstream water level of 111.20mAOD in the model which, when compared with typical river bank levels of 110.80mAOD – 111.00mAOD at the confluence, would represent an out of bank situation for the Hodder. Given the size difference between the Hodder and the Dunsop catchments (~110km^2 vs ~30km^2), peak flows on the two watercourses are not expected to coincide. The results of the test show no difference at the site of interest suggesting the assumption regarding influence of the Hodder to be reasonable.

Hydraulic Model Review Checklist:

General Information and Modelling Approach	
Item	**Comments**
General Information & Modelling Approach	
Software choice?	Flood Modeller Pro / TUFLOW
Modelling Approach?	1D-2D linked
Modelling Scenarios Used?	• 1% AEP + 36% CC • 1% AEP + 36% CC & 50% blockage of the bridge • 1% AEP + CC (36%) & downstream boundary decreased (20%) • 1% AEP + CC (36%) & downstream boundary increased (20%) • 1% AEP + CC (36%) & manning's decreased (20%) • 1% AEP + CC (36%) & manning's increased (20%) • 1% AEP + CC (36%) & out of bank flooding at the River Hodder
1D Model / Network	
How have roughness values been determined?	Roughness values have been chosen based on visual inspection from web searches.
Are all structures included or exclusions documented?	Yes – estimated from provided images
Are spill units included?	Yes
Is the model geo-references?	Yes
Have bank / bed markers been used?	Yes
1D Boundary Conditions	
What 1D Boundaries have been applied?	Flow Time Boundary & Normal Downstream Boundary
Has an appropriate location been chosen for the downstream model extents?	Yes. The downstream boundary is 250m southeast of the site, which is far enough away to have minimal impact. (As verified by the sensitivity results).
1D structures	
Are all structures included or exclusions documented?	Yes – In line with provided survey information and supplied imagines

1D Run Parameters	
What time step has been used for the 1D model?	0.5 seconds
What initial conditions have been used?	Time 0, Steady State.
Have any of the parameters and advanced parameters been changed from the default. If so, has it been justified?	No changes to default parameters made
2D Model Build	
Number of domains?	One
What dataset has been used to define the DTM elevations?	2m LiDAR
What grid resolution has been used?	2m
How have buildings been represented within the DTM?	Buildings on site represented in the pre and post development comparison using 2D elevation shape files.
2D Boundary and Roughness	
Have any boundaries been used in the 2D domain?	Yes – a 2D normal depth boundary outflow
Is the model boundary suitably large?	Yes - the 2D area is large enough to prevent glass walling
What manning's n values have been used to define floodplain roughness?	A default roughness has been applied within the 2D, chosen to best represent the pastureland.
2D Run Parameters	
What time step has been used for the 2D model?	1 seconds
Have initial water levels been applied?	No
What initial conditions have been used?	Time 0, Steady State
Are the other 2D model parameters reasonable	Default setting
1D/2D model Links	
How have the 1D/2D models been coupled?	Using 2D HX / CN link lines.
Have any default link parameters been changed?	No
Model Stability	
What warnings / errors are present on the logs?	No errors or warning that would affect results
Is mass balance within tolerable limits?	Yes, mass below 0.5%. error is shown to peak at 1.5% but is typically
Does a basic check of animations and graphed outputs give an indication of good model stability?	Yes, animations show no oscillation.
Do the 2D extents / outputs look sensible?	Yes, although no flood history to calibrate results.
Model Sensitivity	
Have appropriate model parameters been chosen for sensitivity testing?	• 1% AEP + CC (36%) & downstream boundary decreased (20%) • 1% AEP + CC (36%) & downstream boundary increased (20%)

	• 1% AEP + CC (36%) & manning's decreased (20%) • 1% AEP + CC (36%) & manning's increased (20%)
Do the results of the tests show the models to be particularly sensitive to certain parameters?	No