Appendix B - Data sources used in the SFRA

1 Historical Flooding

North Yorkshire County Council Cumbria County Council provided Section 19 reports in the area. Lancashire County Council did not have any Section 19 reports which include records of flooding within the area covered by the National Park. North Yorkshire County Council also provided a list of locations where they have investigated flooding in the National Park. North Yorkshire Fire and Rescue Service and Lancashire County Council provided records of historic flooding incidents in the National Park. The Environment Agency's Historic Flood Map is also presented in Appendix A: GeoPDF Mapping.

Section 5.1 documents historic flooding records obtained.

2 Fluvial flooding

2.1 Flood Zones 2 and 3a

Flood Zones 2 and 3a, as shown in the Appendix A mapping, show the same extent as the online Environment Agency's Flood Map for Planning (which incorporates latest modelled data) as all modelled data used in this SFRA has been fully incorporated into the EA Flood Zones.

Over time, the online mapping is likely to be updated more often than the SFRA, so SFRA users should check there are no major changes in their area.

2.2 Flood Zone 3b (the Functional Floodplain)

Flood Zone 3b, as shown in Appendix A mapping, has been compiled for the study area as part of this SFRA and is based on the 5% AEP (1 in 20-year chance of flooding in any given year) or 4% AEP (1 in 25-year chance of flooding in any given year) extents produced from Environment Agency detailed hydraulic models where outputs were available and impacted upon land within the Yorkshire Dales National Park (see Figure B-1 for model coverage).

The Kettlewell Beck model did not have a suitable output available for Flood Zone 3b and could not be run to produce an output.

For areas not covered by detailed EA models (or where suitable outputs were not available), a precautionary approach should be adopted for Flood Zone 3b with the assumption that the extent of Flood Zone 3b would be equal to Flood Zone 3a. If development is shown to be in Flood Zone 3a (or Flood Zone 3b derived from 2D generalised modelling), further work should be undertaken as part of a detailed site-specific Flood Risk Assessment to define the extent of Flood Zone 3b.

If the area of interest is in an area that has seen some major changes to the extent of the Flood Zones, having checked the online mapping, developers will also need to remap Flood Zone 3b as part of a detailed site-specific Flood Risk Assessment.

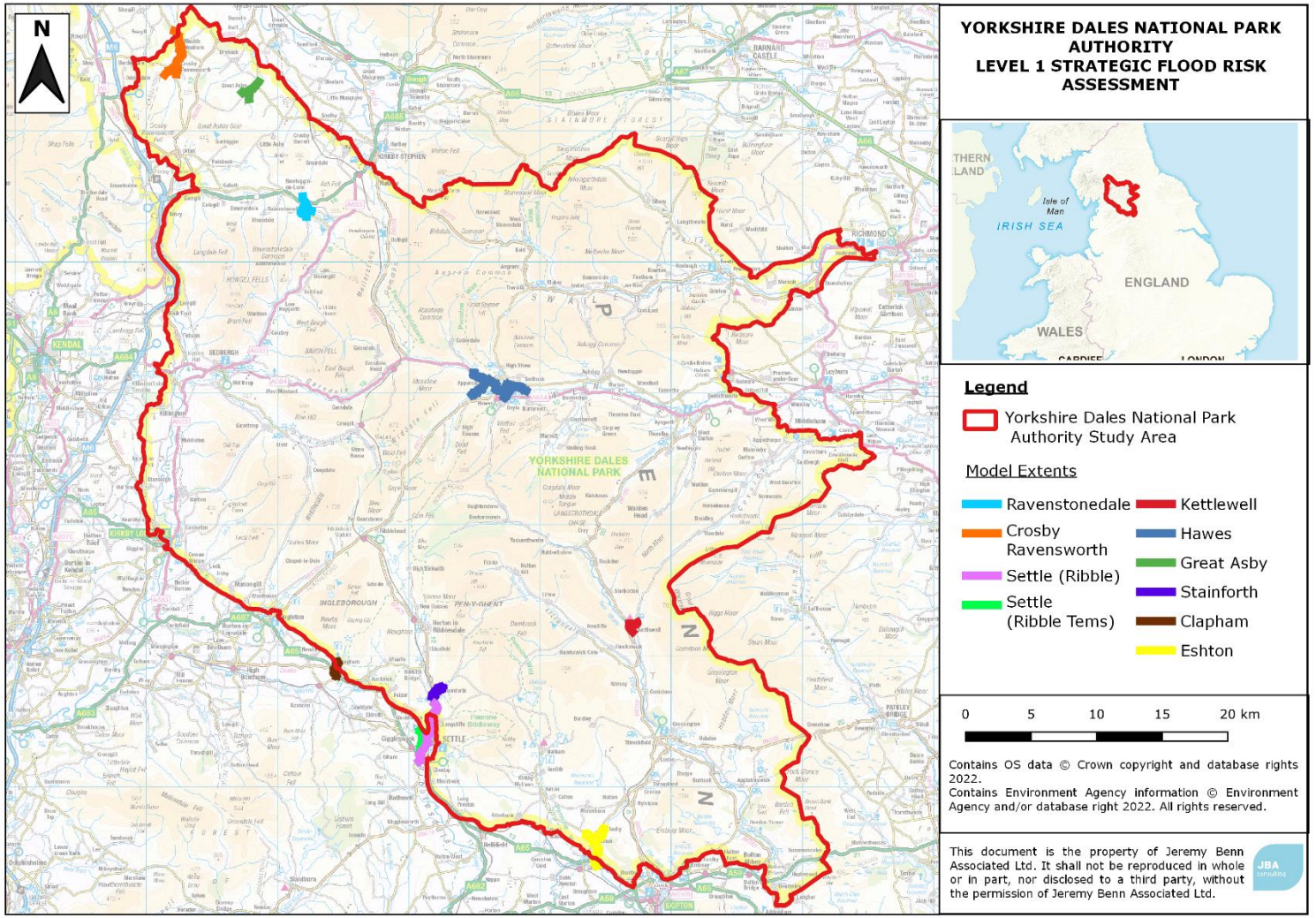

Figure B-1: Existing hydraulic modelling coverage

3 Climate change

Detailed Environment Agency hydraulic models were obtained under licence for the SFRA. Where climate change simulations undertaken for the past projects were within +/- 10% of the updated climate change allowances, these were deemed suitable to use following discussions with the EA. This was the case for the Eshton Beck model. Where previous climate change runs were not suitable these models were re-run with the latest 2021 climate change allowances for the 2080's central and/or high central estimates as required. It should be noted that the EA climate change guidance was further updated in May 2022, but no changes were made to the peak river flow allowances. The following sections provide details of the models which were re-run.

For Kettlewell Beck, no hydraulic model was produced for this flood risk mapping study, therefore, no climate change runs could be produced here. The flood maps in the original study were revisions of the Environment Agency Flood Maps based on hydraulic capacity estimates, questionnaire data, visual inspections from a walkover survey and OS Profile Data.

For the Ravenstonedale model, the HEC-RAS model was produced in 2010 using an older version of the modelling software with only a +20% climate change uplift run, considerably lower than the updated guidance (+47% and +61%). In the original version of HEC-RAS there was no RAS Mapper and no functionality to load LIDAR data into the model. Running this model in the updated software did not produce appropriate results. This is because previously flood maps were created by first running the 1D model and then extracting the results into MapInfo. Cross sections and the LIDAR were used in MapInfo to apply the water levels and produce approximate flood outlines which were then manually digitised to create the flood outlines for each simulation. Producing new results from this model would have required large updates to the model which are beyond the scope of this SFRA. Therefore, no climate change runs could be produced here.

Where there were no detailed models available, or the existing models could not be re-run with the updated climate change guidance, Flood Zone 2 has been used as an indication of climate change.

Please refer to Chapter 4 for information on the approach to climate change in this SFRA.

3.1 Clapham Beck

Clapham Beck, flowing through Clapham, is represented by the Environment Agency's 1D-2D ESTRY-TUFLOW hydraulic model (2011). This model was re-run with the updated climate change guidance released by the Environment Agency in July 2021 for the central and higher central estimates (+49% and +61% for the Lune Management Catchment).

It was noted that the 100-year and 100-year plus climate change scenarios do not produce significant flood extents. Whilst this could be representative of the area given the impact of catchment permeability and

lake attenuation, it may also be indicative of uncertainties within the original hydrology analysis. Given this uncertainty and the age of the model, should development be planned within this area it is recommended that a full technical review of the 2011 hydrology and hydraulic model is undertaken, with updates applied accordingly.

3.2 Crosby Ravensworth

Lyvennet Beck, flowing through Crosby Ravensworth, is represented by the Environment Agency's 1D-2D Flood Modeller-TUFLOW hydraulic model (2017). This model was re-run with the updated climate change guidance released by the Environment Agency in July 2021 for the central and higher central estimates (+47% and +61% for the Eden and Esk Management Catchment).

3.3 Great Asby

Asby Beck through Great Asby is represented by the Environment Agency's 1D-2D Flood Modeller-TUFLOW hydraulic model (2017). This model was re-run with the updated climate change guidance released by the Environment Agency in July 2021 for the central and higher central estimates (+47% and +61% for the Eden and Esk Management Catchment).

It was noted that the 100-year and 100-year plus climate change scenarios do not produce significant flood extents, potentially due to catchment permeability. Hydrological analysis was conducted using ReFH1, which provides flow estimates that are associated with a high level of uncertainty on permeable catchments. The FEH Guidelines state that ReFH2 results on highly permeable catchments are "greatly improved compared with those from ReFH1". Therefore, if development is planned in this area, it is recommended that the hydrology is updated accordingly.

The TUFLOW stability for the 61% climate change uplift showed values that were slightly beyond typical acceptable thresholds with a cumulative mass error (%) between -1% and -2% from 2.75 hours onwards. As the stability values shown are not far beyond the typically accepted range the model was not updated to remove these.

It was noted that the original 100-year climate changes uplifts (+30%, +35% and +70%) appear to have been run incorrectly. They use the hydrograph scaling that would be expected for the 100-year uplifts but use the 1000-year design rainfall, so produce much greater flood extents than expected. The lower uplift (+20%) appears to have been correctly run as an uplift on both the 100-year and 1000-year return periods. Should these runs be required in the future then these should be re-run.

3.4 Hawes

Widdale Beck and the River Ure flow through Hawes and are represented by the Environment Agency's 1D-2D Flood Modeller-TUFLOW hydraulic model (2019). This model was re-run with the updated climate change guidance released by the Environment Agency in July 2021 for the central and higher central estimates (+25% and +34% for the Swale, Ure, Nidd and Upper Ouse Management Catchment).

3.5 Settle

For Settle, Flood Modeller-TUFLOW models were provided for the River Ribble and its tributary of Tems Beck. The River Ribble model included the lower section of the Tems Beck and was originally run for the critical storm duration for the River Ribble (13.25 hours). The Tems Beck Model included the River Ribble and extended the Tems Beck further upstream and was originally run for the critical storm duration for the Tems Beck (5.25 hours). The original results were then produced by combining the results from the two models to give a worst-case scenario using the critical storm durations for both watercourses. However, the model files provided for the Tems Beck were unable to be run, despite changes made to fix the start-up errors and different software versions used. Therefore, the updated climate change run could only be run for the River Ribble. The 100-year, 1,000-year and 100-year plus 35% climate change uplift available from the original model runs include both the River Ribble and Tems Beck.

The River Ribble through Settle is represented by the Environment Agency's 1D-2D Flood Modeller-TUFLOW hydraulic model (2017). This model was re-run with the updated climate change guidance released by the Environment Agency in July 2021 for the higher central estimate (+46% for the Ribble Management Catchment).

It was noted that the 2D downstream boundary in the model is not snapped to the 2D extent which does not follow best practice and should be addressed when the model is next updated.

3.6 Stainforth

Stainforth Beck, flowing through Stainforth, is represented by the Environment Agency's 1D-2D Flood Modeller-TUFLOW hydraulic model (2019). This model was re-run with the updated climate change guidance released by the Environment Agency in July 2021 for the higher central estimate (+46% for the Ribble Management Catchment).

This downstream boundary is represented with a single value stage hydrograph for this model, thus the levels at and close to the downstream boundary are identical for both the 100-year scenario and the climate change uplift scenarios (and throughout the simulations). As the watercourse is steep, this effect is isolated to approximately the lower 200m, however, the results in this lower reach should be ignored, with the model updated if any development is planned along this lower reach.

The TUFLOW stability for the 46% climate change uplift showed values that were beyond typical acceptable thresholds with a cumulative mass error (%) between 1% and 3% within the first two hours of the model run however, this then returned to between +/- 1% for the remainder of the model run. A similar error is shown in the provided model results for the larger return periods. These large values at the start can occur if there are 2D cells rapidly wetting and the flow through the model is relatively small, which is particularly characteristic of steep 2D domains. As the stability values shown are not far outside the acceptable range the model was not updated to remove these.

4 Surface water flooding

Mapping of surface water flood risk in the study area has been taken primarily from the Risk of Flooding from Surface Water (RoFfSW) maps published online by the Environment Agency. These maps are intended to provide a consistent standard of assessment for surface water flood risk across England and Wales in order to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk.

The RoFfSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water (Table B-1).

Table B-1: RoFfSW risk categories

Category	Definition
High	Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year (annual probability of flooding 3.3%).
Medium	Flooding occurring as a result of rainfall of between 1 in 100 (1%) and 1 in 30 (3.3%) chance in any given year.
Low	Flooding occurring as a result of rainfall of between 1 in 1,000 (0.1%) and 1 in 100 (1%) chance in any given year.

Although the RoFfSW offers improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high level assessments such as SFRAs for local authorities. If a site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be considered to illustrate the flood risk more accurately at a site-specific scale. The 1 in 1000 surface water flood extent has been used to define surface water Zone "B" for the purpose of performing the Sequential Test.

5 Groundwater

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater Flooding 2010 (AStGWF) dataset and the JBA Groundwater Flood Risk map.

The AStGWF dataset is a strategic-scale map showing groundwater flood areas on a 1km square grid. It shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring and does not take account of the chance of flooding from groundwater rebound (e.g. following cessation of mining or industrial activity). This dataset covers a large area of land, and only isolated locations within the overall susceptible area are likely to suffer the consequences of groundwater flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale.

The JBA Groundwater Flood Risk map shows groundwater flood risk on a 5m square grid. For each grid cell, a depth range is given for modelled groundwater levels in the 100-year return period flood event. It takes into account factors including topography, groundwater recharge volumes and spatial variations in aquifer storage and transmission properties.

Section 5.7 of the Main Report explains groundwater flooding.

6 Sewers

Historical incidents of flooding are detailed by Yorkshire Water through their Hydraulic Flood Risk Register (HFRR). The HFRR database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. The HFRR database from Yorkshire Water was provided with flooding incidents from 2008 – 2022. For confidentiality, this data was supplied on a 5-digit postcode basis.

United Utilities provided records of internal and external drainage incidents from 2009 – 2022.

Section 5.6 of the Main Report presents this data.

7 Reservoirs

The risk of inundation because of reservoir breach or failure of reservoirs within the area has been mapped using the outlines produced as part of the National Reservoir Flood Mapping (RFM) study, and are shown online on the **Long-Term Risk of Flooding website** (https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=504825&northing=249317&address=100081210838&map=RiversOrSea) at the time of publication.

The Environment Agency provide two flooding scenarios for the reservoir flood maps: a 'dry-day' and a 'wet-day'. The 'dry-day' scenario shows the predicted flooding which would occur if the dam or reservoir fails when rivers are at normal levels. The 'wet-day' scenario shows the predicted worsening of the flooding which would be expected if a river is already experiencing an extreme natural flood.

Section 5.9 of the Main Report presents the reservoirs affecting the Yorkshire Dales National Park.

8 Flood Defences

The Environment Agency supplied the location of all flood defences within the district in their AIMS database, including information relating to the type of flood defence and their standard of protection. The Areas Benefitting from Defences shapefile was also considered. Chapter 6 of the Main Report provides information on flood defences and schemes.

9 Overview of supplied data

Overview of supplied data for the Yorkshire Dales National Park SFRA from stakeholders is as follows:

Source of flood risk	Data used to inform the assessment	Data supplied by
Historic (all sources)	Historic Flood Map Recorded Flood Outlines Hydraulic Modelling Reports	Environment Agency
	Section 19 Reports	North Yorkshire County Council Cumbria County Council
	Historic flooding incident records	North Yorkshire Fire and Rescue Service Lancashire County Council
Fluvial (including climate change)	Clapham Beck (2011) 1D-2D ESTRY-TUFLOW Hydraulic Model Crosby Ravensworth (2017) 1D-2D FM-TUFLOW Hydraulic Model Eshton Beck (2021) 1D-2D FM-TUFLOW Hydraulic Model Great Asby (2017) 1D-2D FM-TUFLOW Hydraulic Model Hawes (Widdale Beck, Gayle Back and the River Ure) (2019) 1D-2D FM-TUFLOW Hydraulic Model Kettlewell Beck (2006) Flood Risk Mapping Study Ravenstonedale (Stone Gill and Scandal Beck) (2010) 1D HEC-RAS Hydraulic Model Settle (River Ribble and Tems Beck) (2017) 1D-2D FM-TUFLOW Hydraulic Model Stainforth (2019) 1D-2D FM-TUFLOW Hydraulic Model	Environment Agency
	Flood Map for Planning Flood Zones	Environment Agency
Surface Water	Risk of Flooding from Surface Water dataset	Environment Agency
Sewers	Internal and external historic drainage records	United Utilities Yorkshire Water
Groundwater	Areas Susceptible to Groundwater Flooding dataset Bedrock geology/superficial deposits datasets (online dataset)	Environment Agency
	Groundwater Flood Risk Map	JBA
Reservoir	National Inundation Reservoir Mapping (Long term flood risk map)	Environment Agency

Flood Defences	Location and description of flood defences	Environment Agency
Cross-boundary impacts	Neighbouring authority sites and Local Plan information, to help assess cross-boundary impacts and the cumulative impact assessment	Craven District Council Eden District Council Lancaster District Council Richmondshire District Council South Lakeland District
Other datasets	Partner Data Catalogue: - Source Protection Zones - Aquifer Designation Maps - Areas Susceptible to Groundwater Flooding - Detailed River Network - Flood Alert Areas - Flood Warning Areas - Flood Maps for Planning - Groundwater Vulnerability - Historic Flood Map - Risk of Flooding from Rivers and Sea	Environment Agency (via YNDPA)