

ENVIRONMENTAL STATEMENT (VOLUME III)

Appendix 18.5 Flood Consequence Assessment

HyNet Carbon Dioxide Pipeline DCO

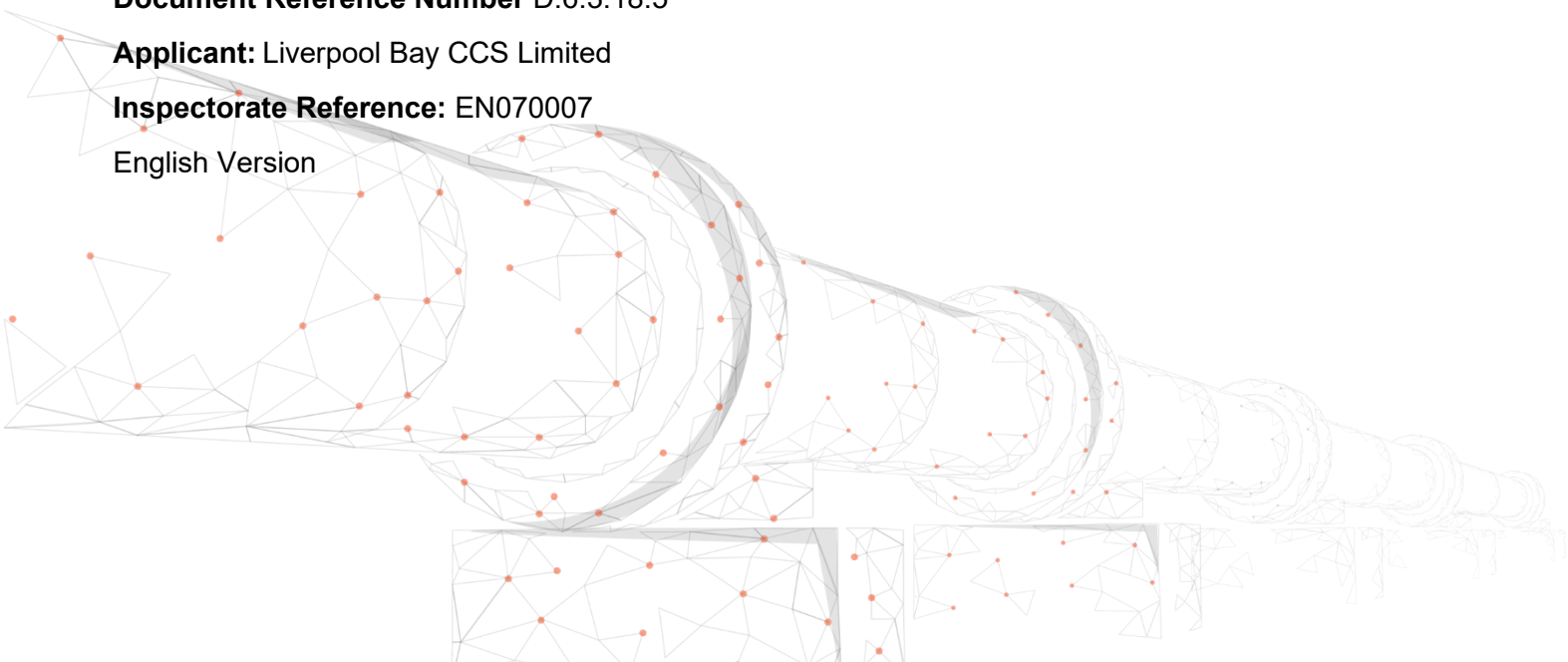
Planning Act 2008

Document Reference Number D.6.3.18.5

Applicant: Liverpool Bay CCS Limited

Inspectorate Reference: EN070007

English Version



REVISION: 01

DATE: September 2022

DOCUMENT OWNER: WSP UK Limited

PUBLIC

QUALITY CONTROL

Issue/Revision	First Issue	Revision 1	Revision 2	Revision 3
Document Reference	D.6.3.18.5			
Revision	Rev A			
Author Name and Sign	FM			
Approver Name and Sign	EI			
Document Owner	WSP			

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION.....	1
1.1. Appointment and Brief.....	1
1.2. Limitations.....	1
1.3. Objective of the Study and Methodology.....	3
1.4. Planning Policy Wales Vulnerability and Technical Advice Note 15.....	4
2. BASELINE DESCRIPTION.....	6
2.2. Location of the DCO Proposed Development	6
2.3. Site Topography.....	8
2.4. Geology and Hydrogeology.....	11
2.5. Existing Waterbodies	16
2.6. Existing Sewer and Drainage Infrastructure	18
2.7. Existing Flood Defences	20
3. STAKEHOLDER ENGAGEMENT	21
3.1. Natural Resources Wales (NRW).....	21
3.2. Flintshire County Council (LLFA)	21
3.3. DWR Cymru Welsh Water (DCWW)	21
4. CLIMATE CHANGE.....	23
5. DEFINITION OF FLOOD HAZARD	24
5.1. Overview	24
5.2. Flooding History	24
5.3. Flooding from Coastal Sources	25
5.4. Flooding from Fluvial Sources.....	26
5.5. Flooding from Pluvial Sources.....	27
5.6. Flooding from Groundwater Sources	29
5.7. Flooding from Sewer and Drainage Infrastructure.....	31
5.8. Flooding from Artificial Sources.....	32
6. ASSESSMENT OF ACCEPTABILITY CRITERIA	34
6.2. TAN15 – Section 9	34
6.3. Development Type & Vulnerability Classification	37
6.4. Flood resistant design	38
6.5. Loss of floodplain	39
6.6. No Increase in Flood Risk Elsewhere	39
6.7. Acceptable Consequences for Nature of Use	40

6.8. Awareness of Flood Risk and Flood Warning Systems.....	40
7. CONCLUSIONS AND RECOMMENDATIONS.....	42
7.1. Conclusions.....	42
7.2. Recommendations	44
8. REFERENCES.....	45

FIGURES

Insert 1 - Pipe Reach 4b Long Section	8
Insert 2 - Pipe Reach 5 Long Section	9
Insert 3 - Pipe Reach 6 Long Section	9

TABLES

Table 1 - Watercourse Crossings.....	17
Table 2 - TAN15 Section 9 Summary of Policy Requirements.....	35

EXECUTIVE SUMMARY

This Flood Consequence Assessment (FCA) was developed to support the Development Consent Order (DCO) Application covering the proposed Above Ground Installations (AGI) and Block Valve Stations (BVS) and the Newbuild Carbon Dioxide Pipeline in Wales.

As part of this FCA, the following proposals were assessed:

- Newbuild Carbon Dioxide Pipeline
- Aston Hill (BVS)
- Northop Hall (AGI)
- Flint (AGI)
- Cornist Lane (BVS)
- Pentre Halkyn (BVS)
- Babell (BVS)
- Cathodic Protection (CP)
- Marker Posts
- Fibre Optic Cable (FOC); and
- Electricity Connections

This assessment has been undertaken in accordance with the requirements of the Technical Advice Note 15 (TAN15, 2004). Engagement was undertaken with various Consultees, including the Natural Resources Wales, Flintshire County Council's Lead Local Flood Authority and Dwr Cymru Welsh Water.

NEWBUILD CARBON DIOXIDE PIPELINE

The assessment has found that, although the Newbuild Carbon Dioxide Pipeline crosses a number of watercourses and Flood Zones A, B and C along its alignment, the risk of flooding to the buried pipeline from various sources is between negligible and low.

The Newbuild Carbon Dioxide Pipeline complies with the requirements of TAN15 as “*Less Vulnerable Development*”. Residual risk associated to potential formation of preferential groundwater flow pathways (and subsequent local rises in groundwater level) along the Newbuild Carbon Dioxide Pipeline will require the implementation of mitigation measures, namely, trench breakers (clay plugs) placed in the trench.

ABOVE GROUND INSTALLATIONS AND BLOCK VALVE STATIONS

The proposed AGIs and BVSs are all located on land classified as Flood Zone A which are defined by NRW as “Areas at little or no risk of flooding from rivers and the sea”. The AGIs and BVSs are not shown to be at risk of flooding from fluvial or tidal water sources. Each AGI and BVS is classed as “less vulnerable development” and, in accordance with the requirements of TAN15, they are therefore suitable for development in Flood Zone A.

The Flint AGI has an existing overland runoff route that flows from the southwestern boundary of the Site towards an ordinary watercourse located north of the Site. The Flint AGI will need to ensure that the overland runoff route is not affected by the development so that it does not increase the risk of flooding elsewhere.

HyNet CO₂ PIPELINE

The AGIs and BVSs will also require suitable drainage on Site to manage the surface water generated at the Sites due to the increase in impermeable areas.

An **Outline Surface Water Drainage Strategy Report (Ref. D.6.5.13)** has been developed alongside this FCA for all the proposed AGIs and BVSs to demonstrate how surface water drainage will be managed in accordance with the requirements of the LLFA and SAB, taking into account the impacts of increased rainfall intensity due to climate change predictions.

The FCA has assessed that the AGIs and the BVSs can be defined as “*Less Vulnerable Development*”. Mitigation measures have been proposed that will ensure that the risk of flooding to the DCO Proposed Development is minimised and there is no increase in the risk of flooding elsewhere.

The FCA concludes that the Newbuild Carbon Dioxide Pipeline, AGIs and BVSs within Wales are in compliance with the requirements of the TAN15 (2004) for development within Flood Zones A, B and C.

1. INTRODUCTION

1.1. APPOINTMENT AND BRIEF

- 1.1.1. This Flood Consequence Assessment (FCA) reports on the DCO Proposed Development Newbuild Infrastructure located from the England/Wales border to the Babell Block Valve Station (BVS) in Wales. A separate **Flood Risk Assessment (FRA) (Appendix 18-4, Volume III)** reports on the DCO Proposed Development from Ince AGI in England to the England/Wales border.
- 1.1.2. The DCO Proposed Development in Wales includes the installation of the Newbuild Carbon Dioxide Pipeline as well as the installation of two Above Ground Installations (AGIs) and four BVSs at:
- Aston Hill BVS;
 - Northop Hall AGI;
 - Flint AGI;
 - Cornist Lane BVS;
 - Pentre Halkyn BVS;
 - Babell BVS;
- 1.1.3. Other infrastructure includes:
- Cathodic Protection (CP) transformer rectifier cabinets, CP test posts and pipeline marker posts;
 - Utility Connection's infrastructure: including power utilities and Fibre Optic Cable (FOC);
 - Permanent access road to the AGIs and BVs; and
 - Temporary ancillary works integral to the construction of the Carbon Dioxide Pipeline, including Construction Compounds and temporary access tracks. However, these have not been assessed in this FCA as only permanent measures will be taken into consideration.
- 1.1.4. For the purpose of this FCA, the Newbuild Carbon Dioxide Pipeline has been separated into AGIs, BVSs and Pipe Reaches of which Pipe Reach 4b, 5 and 6 will be referred to (see **Figure 18.5.1, Annex A**). Pipe Reaches 4b, 5 and 6 are the interconnecting pipes between the AGIs and BVSs and this naming system has been adopted in this report to aid the assessment individual parts of the schemes (i.e pipe reaches and AGIs/BVSs) in accordance with requirements of TAN15. This subdivision is slightly different from the named sections proposed in **Chapter 18 – Water Environment and Flood Risk (Volume II)**.

1.2. LIMITATIONS

- 1.2.1. This FCA focuses solely on the permanent works proposed as part of the DCO Proposed Development in Wales, as named above. Flood risk for the temporary works and during the Construction Stage of the DCO Proposed Development is

not included in this report as they are documented within the **Outline Construction Environmental Management Plan (OCEMP)** (Document reference: **D.6.5.4**) and **Chapter 18 – Water Environment and Flood Risk (Volume II)** of the Environmental Statement (ES).

- 1.2.2. The surface water management and drainage proposals for the DCO Proposed Development are outside of the scope of this FCA report and are addressed and included in the **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)**.
- 1.2.3. The **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** needs to be referred to in conjunction with this FCA report. This is in order to understand the surface water management proposals which have been prepared to prevent impact of surface water flood risk to the DCO Proposed Development and elsewhere.
- 1.2.4. At the time of writing, the GI had limited spatial coverage of groundwater monitoring points. Therefore, information on groundwater levels is limited in sections across the DCO Proposed Development.
- 1.2.5. This FCA has been prepared using readily available information including strategic studies (e.g. SFRAs), through consultation with key stakeholders. No hydraulic modelling has been undertaken to inform this assessment.
- 1.3. OBJECTIVE OF THE STUDY AND METHODOLOGY**
- 1.3.1. This FCA investigates the potential sources of flooding in the area and the potential impact of flood risk on the DCO Proposed Development together with any potential effects on flood risk caused by the DCO Proposed Development elsewhere. It also identifies any necessary mitigation measures to manage such risk in line with policy and best practice.
- 1.3.2. As part of the preparation of this FCA, the following have been undertaken:
- Engagement with Natural Resources Wales (NRW), Flintshire County Council (FCC) and Dwr Cymru Welsh Water (DCWW) to obtain information relating to local flood risk issues for the DCO Proposed Development.
 - Review of the water related information contained in the utility search report undertaken by a third party on behalf of the Client in 2021 (**Ref. 21**).
 - Identification of all potential sources of flooding within the Newbuild Infrastructure Boundary (i.e. fluvial, surface water, tidal, highways, groundwater, reservoir, sewers, and canal) using publicly available information, including a review of the Flintshire County Council Strategic Flood Consequence Assessment, 2018 (**Ref. 3**).
 - Consideration of the flood consequence implications, taking into account the allowance for climate change over the lifetime of the DCO Proposed Development and the identification of the areas requiring flood risk mitigation measures, where applicable.
- 1.3.3. This FCA has been prepared in accordance with the relevant national, regional, and local requirements and guidance of the following publications and organisations:

- Technical Advice Note (TAN) 15: Development and Flood Risk dated October 2004, issued by the Welsh Government (**Ref. 1**); and
- Planning Policy Wales (Edition 9, November 2016) issued by the Welsh Government (**Ref. 14**).

1.3.4. This FCA has been undertaken is based on datasets licensed from Natural Resource Wales (NRW).

1.3.5. To complete this FCA, the following consultees have been engaged:

- Natural Resources Wales (NRW);
- Flintshire County Council (FCC) as Lead Local Flood Authority (LLFA) and SuDS Approval Body (SAB); and
- Dwr Cymru Welsh Water (DCW) as Statutory Water Authority in Wales.

1.4. **PLANNING POLICY WALES VULNERABILITY AND TECHNICAL ADVICE NOTE 15**

1.4.1. The general approach of the Planning Policy Wales (PPW), supported by the Technical Advice Note 15 (TAN15, 2004) (**Ref. 1**) is to follow a precautionary framework approach when determining the suitability of land for development in flood risk areas, with the intention of steering development away from areas of high risk of flooding to the lowest flood risk areas.

1.4.2. When development has to be considered in high-risk areas (Zone C) only those developments which can be justified on the basis of the tests outlined in Section 6 and Section 7 of the TAN15 guidance are to be located within such areas.

1.4.3. Table 2 of TAN15 guidance confirms the 'Flood Risk Vulnerability Classification' of a Site, depending on the proposed usage. This classification is subsequently applied to the Development Advice Map (DAM) containing three zones (A, B and C with subdivision into C1 and C2) to determine whether:

- The DCO Proposed Development is suitable for the zone in which it is located; and
- The appropriate planning tests that need to be demonstrated in relation to the DCO Proposed Development.

- 1.4.4. TAN15 framework defines the flood risk zones according to their use, this is discussed in more detail within **Section 7**.
- 1.4.5. Some flooding consequences may not be acceptable for certain types of developments. The precautionary framework within TAN15 identifies the vulnerability of different development types according to the proposed Site use.

2. BASELINE DESCRIPTION

- 2.1.1. This FCA assesses the Newbuild Carbon Dioxide Pipeline (split into three pipe reaches named as Pipe Reach 4b, Pipe Reach 5 and Pipe Reach 6), two AGIs and four BVSs which form the DCO Proposed Development located in Wales. Each of the AGIs and BVSs are assessed individually. Additional information on the layout of the Above Ground Structures can be found in **Annex A**.
- 2.1.2. A summary of the specifics of the AGIs and BVSs is provided below, as those are the parts of the scheme which are more relevant for a flood risk assessment. However, a more detailed description of the DCO Proposed Development can be found in **Chapter 3 – Description of the DCO Proposed Development (Volume II)**:
- **Above Ground Installations:** Securely fenced compounds which provide the transition between the Carbon Dioxide Pipeline system and the industrial emitters. The AGIs will house facilities for inspecting the Carbon Dioxide Pipeline (called Pipeline Inspection Gauges), electrical and instrumentation kiosks, lighting, parking provisions, and other associated infrastructure. The compounds will also include security lighting.
 - **Block Valve Stations:** Block valves are used to isolate sections of the Carbon Dioxide Pipeline for maintenance purposes or in case of emergency. The block valves will be installed below ground level, with only limited above ground visible elements, including secure chamber access covers and a containerised electrical and instrumentation kiosk. The block valves will be housed within Block Valve Station compounds, which will also include security lighting.
- 2.1.3. In addition, and as mentioned in the introduction, some additional assets are present along the pipeline and include:
- **Cathodic Protection (CP)**
 - **CP Test Posts**
 - **Marker Posts**
 - **Fibre Optic Cable and connection (FOC)**
 - **Electricity Connections**
- 2.1.4. Additional detail of the items above is found in **Chapter 3 – Description of the DCO Proposed Development (Volume II)**. .

2.2. LOCATION OF THE DCO PROPOSED DEVELOPMENT

- 2.2.1. A description of the site location and surrounding areas for the DCO Proposed Development is provided in **Sections 3.3 to 3.5 of Chapter 3 – Description of the DCO Proposed Development (Volume II)**. A general description of the Newbuild Carbon Dioxide Pipeline location is included below. The location of

the DCO Proposed Development can be seen in **Figures 3-1 and 3-2 (Volume IV)** of the ES.

NEWBUILD CARBON DIOXIDE PIPELINE

- 2.2.2. For the purpose of this FCA, we have subdivided the Newbuild Carbon Dioxide Pipeline in Pipe Reach 4b, Pipe Reach 5, and Pipe Reach 6. Please note that this subdivision is different from the sections proposed in **Chapter 18** and it has been done to assess individually the AGIs/BVSs and consequently analysing the proposed DCO Carbon Dioxide Pipeline connecting these infrastructures. These pipe reaches are located between the proposed AGIs/BVSs respectively, commencing at the England/Wales border and ending at the Babell BVS, as can be seen in the Site location plans in **Figure 18.5.1 – Pipe Reaches Wales (Sheet 1) (Annex A)**.

Pipe Reach 4b

- 2.2.3. The proposed alignment of Pipe Reach 4b is located from the England/Wales border at National Grid Reference SJ 363 689 (E: 336312, N: 368946) to the Aston Hill BVS at National Grid Reference SJ 31137 66907 (E: 331137, N: 366907). The approximate pipe length is 7.8km and it crosses numerous agricultural fields, roads and watercourses.

Pipe Reach 5

- 2.2.4. The proposed alignment of Pipe Reach 5 is located from the Aston Hill BVS at National Grid Reference SJ 31137 66907 (E: 331137, N: 366907) to the Northop Hall AGI at National Grid Reference SJ 259 677 (E: 325981, N: 367799). The approximate pipe length is 6.1km and it crosses numerous agricultural fields, roads and watercourses.

Pipe Reach 6

- 2.2.5. The proposed alignment of Pipe Reach 6 is located from the Northop Hall AGI at National Grid Reference SJ 259 677 (E: 325981, N: 367799) to the Flint AGI at National Grid Reference SJ 25129 70800 (E: 325129, N: 370800). The approximate pipe length is 3.3km and it crosses numerous agricultural fields, roads, and watercourses.
- 2.2.6. For the proposed AGIs and BVS details please refer to **Chapter 3 – Description of the DCO Proposed Development (Volume II)**

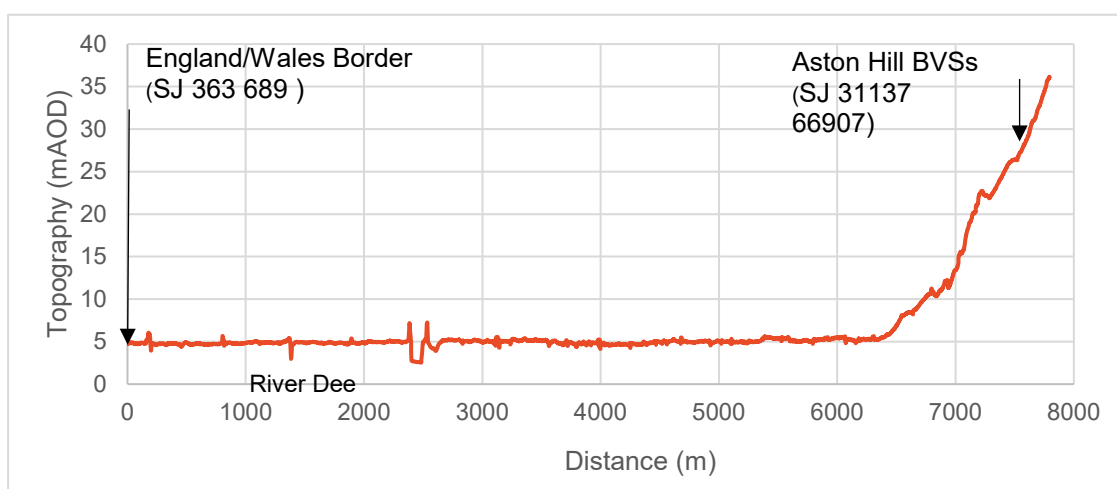
2.3. SITE TOPOGRAPHY

- 2.3.1. A general description of the local topography at the Newbuild Carbon Dioxide Pipeline, BVSs and AGIs is provided below.

NEWBUILD CARBON DIOXIDE PIPELINE

Pipe Reach 4b

- 2.3.2. The existing elevation of the ground level along Pipe Reach 4b ranges from approximately 5mAOD at the England/Wales border at SJ 363 689 to around 36.6mAOD at the proposed Aston Hill BVS Site. A long section of Pipe Reach 4b is shown in **Insert 1** below.

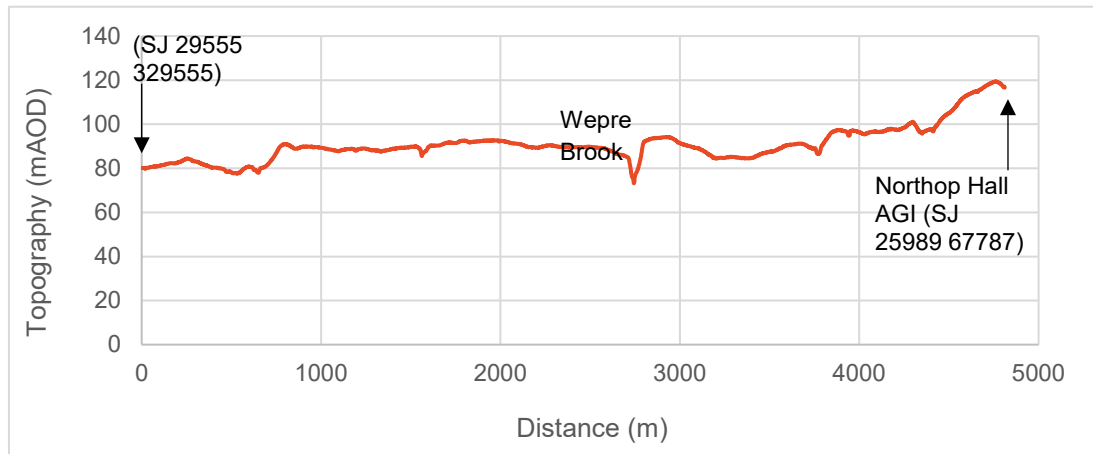


Insert 1 - Pipe Reach 4b Long Section

- 2.3.3. The general topography of the ground along Pipe Reach 4b is low lying ground surrounding the tidal floodplain of the River Dee. The ground elevation increases significantly at the proposed Aston Hill BVS.

Pipe Reach 5

- 2.3.4. The existing elevation of Pipe Reach 5 ranges from approximately 36mAOD at the proposed Aston Hill BVS Site to around 111.7mAOD at the proposed Northop Hall AGI Site. A long section of Pipe Reach 5 is shown in **Insert 2** below.

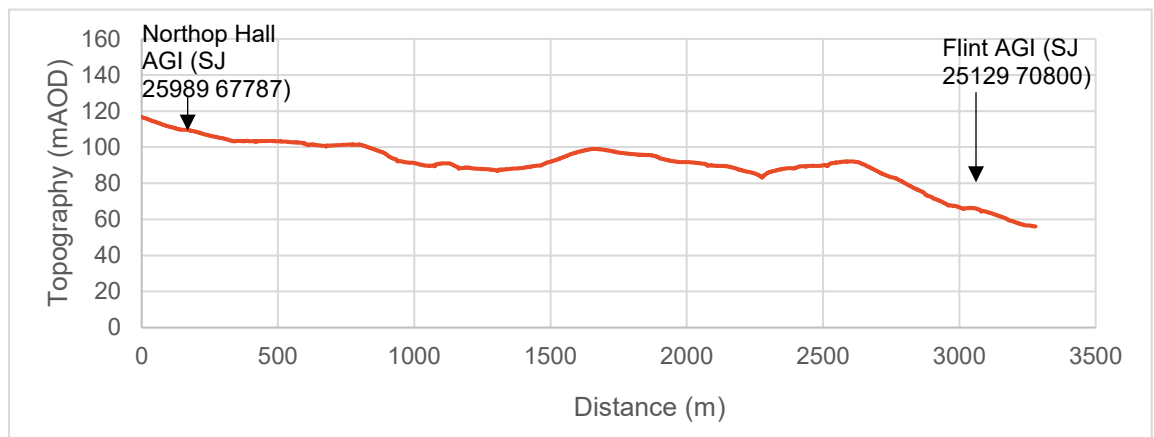


Insert 2 - Pipe Reach 5 Long Section

- 2.3.5. Due to an area of missing LiDAR data in the immediate west of the proposed Aston Hill BVS, the long section above has been taken at National Grid Reference SJ 29555 67359 (E: 329555, N: 367359) approximately 1km from Aston Hill BVS. The general topography of Pipe Reach 5 is high variable ground.

Pipe Reach 6

- 2.3.6. The existing elevation of the ground along Pipe Reach 6 ranges from approximately 111.73mAOD at the proposed Northop Hall AGI Site to around 51.9mAOD at the proposed Flint AGI Site. A long section of Pipe Reach 6 is shown in **Insert 3** below.



Insert 3 - Pipe Reach 6 Long Section

- 2.3.7. The general topography of the pipe along Pipe Reach 6 is high variable ground which decreases towards the proposed Flint AGI.

NORTHOP HALL AGI

- 2.3.8. The existing elevation of the proposed Northop Hall AGI Site ranges from approximately 119mAOD in the northeast to around 113mAOD in the southwest. The nearest access road to the Site is the B5125 Village Road and the levels range from approximately 119.1mAOD to 118.4mAOD. The existing farm track leading to the Site rises towards the northeast from an elevation of 118.2mAOD to approximately 119.1mAOD where it joins the B5125 Village Road.

FLINT AGI

- 2.3.9. The existing elevation of the proposed Flint AGI Site ranges from approximately 53.4mAOD in the northeast to around 58.4mAOD in the southwest. The nearest access road to the Site is called Allt Goch Lane and the levels range approximately from 58.6mAOD to 56.9mAOD.

ASTON HILL BVS

- 2.3.10. The existing elevation of the proposed Aston Hill BVS Site ranges from approximately 35.4mAOD in the northwest to around 37.1mAOD in the southeast. The nearest access road to the Site is Upper Aston Hill Lane and the levels range approximately from 41.8mAOD to 42.8mAOD.

CORNIST LANE BVS

- 2.3.11. The existing topography at the Cornist Lane BVS Site falls from east to west, from an elevation of approximately 143.5m AOD to approximately 137.5m AOD. The existing farm track leading to the Site slopes towards the northwest from an elevation of approximately 137m AOD to approximately 130m AOD where it joins Cornist Lane.

PENTRE HALKYN BVS

- 2.3.12. The existing topography of the Pentre Halkyn BVS Site ranges approximately between 213.5m AOD and 212m AOD. The existing access farm track sits slightly lower at approximately 210m AOD and merges with the existing B5121 road at an elevation of approximately 206m AOD.

BABELL BVS

- 2.3.13. The existing elevation of the Babell BVS Site ranges from approximately 174m AOD in the northeast to around 172m AOD in the southwest. The existing access road to the Site ranges approximately from 175.5m AOD to 173.75m AOD in elevation. The existing farm track crossing the Site has an elevation of approximately 174m AOD.

2.4. GEOLOGY AND HYDROGEOLOGY

- 2.4.1. A general description of the Site geology and hydrogeology is included below for the Newbuild Carbon Dioxide Pipeline, BVSs and Above AGIs.
- 2.4.2. No continuous groundwater monitoring (long-term or otherwise) has to date been undertaken at the proposed locations of any of the BVSs or AGIs. Instead, to inform groundwater levels and likely groundwater interaction/groundwater flood risk at these locations, all relevant information from the GI (such as water strikes recorded in trial pits and boreholes) as well as publicly available information (e.g. BGS GeoIndex) has been utilised wherever possible. Site-specific groundwater monitoring may be undertaken in subsequent phases of GI at certain locations where significant uncertainty regarding shallow groundwater/increased groundwater flood risk remains.

NEWBUILD CARBON DIOXIDE PIPELINE

- 2.4.3. Further information on the underlying geology including full geological descriptions and recorded depths and the general hydrogeology along the Newbuild Carbon Dioxide Pipeline can be found in **Chapter 18 – Water Resources and Flood Risk (Volume II)**.

Pipe Reach 4b

- 2.4.4. The superficial geology beneath Pipe Reach 4b consisting of the following (from east to West):
- Tidal flat deposits – clay, silt and sand;
 - Glacial Devensian till – Diamicton; and
 - Glaciofluvial deposits – sand and gravel.
- 2.4.5. A Ground Investigation (GI) was undertaken (**Appendix 11-x (Volume III)**.) across the Newbuild Infrastructure Boundary from November 2021 through to March 2022. The GI involved trial pits, boreholes, CPT tests and groundwater monitoring between the Ince AGI and Flint AGI, while at the Cornist Lane BVS, Pentre Halkyn BVS and Babel BVS only trial pits were completed. Borehole logs from the GI indicate that the glacial Devensian till and tidal flat deposits to the east of the River Dee are proven to 15 – 20 mbgl. From the western side of the River Dee to Sandycroft, the GI has recorded the tidal flat deposits to a depth of 12 - 18 mbgl, underlain by glacial till. The glacial till deposits west of Chester Road have been proven to a depth of 10 mbgl. At the Aston Hill BVS superficial deposits are thinner, with the glacial till and glaciofluvial deposits 5 – 10 m thick. The tidal flat deposits and glacial Devensian till are categorised by the BGS GeoIndex (**Ref. 20**) as Secondary (undifferentiated) aquifers. While the glaciofluvial deposits have been categorised as a Secondary A aquifer.

- 2.4.6. The existing bedrock geology beneath Pipe Reach 4b consists of the following (from east to west):
- Kinnerton Sandstone Formation – aeolian sandstone;
 - Etruria Formation – mudstone, sandstone and conglomerate;
 - Pennine Coal Measures Group – mudstone, siltstone and sandstone; and
 - Millstone Grit Group– sandstone and argillaceous rocks.
- 2.4.7. The GI did not encounter bedrock from the Welsh-English border to Sandycroft, with the superficial deposits proven to a depth of 18 mbgl. However, BGS historic borehole SJ36NW8 has recorded the coal measures at 50 mbgl in Sandycroft. Towards Aston Hill BVS the GI has recorded the Pennine Coal Measures Group at a depth of 5 – 10 mbgl. The Kinnerton Sandstone is categorised by the BGS GeoIndex (**Ref. 20**) as a Principal aquifer as part of the wider Sherwood Sandstone Group aquifer. The Etruria Formation, Pennine Coal Measures Group and Millstone Grit Group have been categorised as Secondary A aquifers (**Ref. 20**).
- 2.4.8. Groundwater levels have been recorded in a monitoring borehole (LB_21_44) on the north-eastern bank of the River Dee between 2.2 – 3.6 mbgl between November 2021 and January 2022. At Chester Road East, north of Sandycroft groundwater levels were recorded at a groundwater monitoring borehole (LB_21_55) between 0.16 and 1.33 mbgl 1.1 from November 2021 to February 2022. A groundwater monitoring borehole 0.45 km northeast of Aston Hill BVS has recorded groundwater levels between 1.5 – 2.3 mbgl during December 2021.
- 2.4.9. Further information on the underlying geology and hydrogeology of the pipeline can be found in **Chapter 18 – Water Environment and Flood Risk (Volume II)**.

Pipe Reach 5

- 2.4.10. The existing superficial geology beneath Pipe Reach 5 consists of the following (from east to west):
- Glacial Devensian till – Diamicton;
 - Glaciofluvial deposits – sand and gravel; and
 - Head deposits.
- 2.4.11. At Aston Hill BVS the GI has recorded the superficial deposits between 5 - 10 mbgl with small pockets of glacial till that reach a depth of 20 mbgl. West of Aston Hill the remainder of Pipe Reach 5 is underlain by glacial till which has been recorded by the GI to a depth of 5 – 10 mbgl before it meets bedrock. The head deposits have been categorised by the BGS GeoIndex (**Ref. 20**) as a Secondary A aquifer.

- 2.4.12. The existing bedrock geology beneath Pipe Reach 5 consists of the following (from east to west):
- Pennine Coal Measures Group – mudstone, siltstone and sandstone;
 - Millstone Grit Group– sandstone and argillaceous rocks; and
 - Bowland Shale Formation – mudstone.
- 2.4.13. The GI has indicated that bedrock is between 5-10 mbgl between Aston Hill BVS and Northop Hall AGI with smaller pockets where bedrock is deeper due to thicker superficial cover (15 m). The Bowland Shale Formation has been categorised by the BGS GeoIndex (**Ref. 20**) as a Secondary (undifferentiated) aquifer.
- 2.4.14. GI groundwater level monitoring locations are sparsely spaced across Pipe Reach 5 and 6. However, BGS records generally indicate that there is a lack of groundwater within the glacial till (**Ref. 20**). Where groundwater is present, levels are deeper (6 mbgl south of Northop Hall) compared to those recorded around the River Dee estuary.
- 2.4.15. Further information on the underlying geology and hydrogeology of the pipeline can be found in **Chapter 18 – Water Environment and Flood Risk (Volume II)**.

Pipe Reach 6

- 2.4.16. The existing bedrock geology beneath Pipe Reach 6 (east to west) consists of the following:
- Hollin Rock – Sandstone;
 - Pennine Middle Coal Measures Formation – Mudstone, Siltstone and Sandstone;
 - Pennine Lower Coal Measures Formation – Mudstone, Siltstone and Sandstone; and
 - Gwespyr Sandstone – Sandstone and Argillaceous Rocks.
- 2.4.17. The existing superficial geology beneath Pipe Reach 6 consists of the following (from east to west):
- Glacial Devensian till – Diamicton.
- 2.4.18. The GI has proven the glacial deposits across Pipe Reach 6 to a depth of 14 mbgl.
- 2.4.19. The existing bedrock geology beneath Pipe Reach 6 consists of the following (from east to west):
- Pennine Coal Measures Group – mudstone, siltstone and sandstone; and
 - Millstone Grit Group – sandstone and argillaceous rocks.

- 2.4.20. The bedrock formations were not proven by the GI in Pipe Reach 6, with the superficial deposits proven to over 14 mbgl. However, BGS historic borehole SJ26NE1635 has recorded the coal measures at 50 mbgl to the north of Northop Brook (**Ref. 20**).
- 2.4.21. Further information on the underlying geology and hydrogeology of the pipeline can be found in **Chapter 18 – Water Environment and Flood Risk (Volume II)**.

NORTHOP HALL AGI

- 2.4.22. The superficial deposits beneath the Northop Hall AGI site consists of glacial Devensian till. The GI has described the glacial till as sandy/gravelly clay and has recorded the deposit to approximately 1 – 3 mbgl before meeting bedrock.
- 2.4.23. The bedrock geology beneath the Northop Hall AGI site consists of sandstone beds of the Pennine Coal Measures Group. The GI has recorded the bedrock below the superficial deposits at the Northop Hall AGI site at approximately 1 – 3 mbgl, proven to a depth of 8 mbgl.
- 2.4.24. The NRW geological data mapping (**Ref. 17**) indicates that the Site does not lie within a groundwater protection zone. In addition, the map indicates that the Site lies within an area with medium to low groundwater vulnerability.
- 2.4.25. Groundwater was not encountered by the GI at the Northop Hall AGI site (**Appendix 11-x – Ground Investigation, Volume III**). The BGS historic borehole SJ26NE27 (REF) approximately 400 m southeast of the Northop Hall AGI has recorded a groundwater level of 6 mbgl.

FLINT AGI

- 2.4.26. The superficial deposits beneath the Flint AGI site consists of glacial Devensian till. The GI has described the glacial till as sandy/gravelly clay and has proven the superficial deposit to a depth of 14 mbgl without meeting bedrock.
- 2.4.27. The bedrock geology beneath the Flint AGI site consists of Pennine Coal Measures Group. The GI did not encounter bedrock at the Flint AGI, with the superficial deposits proven to 14 mbgl. 1.3 km southeast of the Flint AGI site, BGS historic borehole SJ26NE1635 (**Ref. 20**) has recorded the coal measures at 50 mbgl.
- 2.4.28. The Natural Resources Wales (NRW) geological data mapping indicates that the Site does not lie within a groundwater source protection zone. In addition, the map indicates that the Site is within an area of high risk of groundwater vulnerability.
- 2.4.29. Groundwater was not encountered by the GI at the Flint AGI.

ASTON HILL BVS

- 2.4.30. The superficial deposits below the Aston Hill BVS consist of glaciofluvial deposits and glacial Devensian till. The GI has recorded the superficial deposits to a depth of 7.5 mbgl at the Aston Hill BVS before they meet bedrock.
- 2.4.31. The bedrock geology beneath the Aston Hill BVS site consists of Pennine Coal Measures Group. The Pennine Coal Measures Group has been recorded by the GI at the Aston Hill BVS from 7.5 mbgl, proven to 10.5 mbgl.
- 2.4.32. The NRW geological data mapping indicates that the Site does not lie within a groundwater source protection zone. Furthermore, the map indicates that the Site lies within an area with medium to low groundwater vulnerability.
- 2.4.33. Water seepage was observed by the GI at the base of the inspection pit of LB_21_95_BH however no groundwater level was recorded. Approximately 450 m northeast of the Aston Hill BVS a groundwater monitoring borehole (Location ID: LB_21_109_BH) recorded groundwater levels between 1.5 mbgl and 2.3 mbgl during December 2021.

CORNIST LANE BVS

- 2.4.34. The BGS GeoIndex (REF 20) indicates that superficial deposits are not present beneath the Cornist Lane BVS site, however the GI has identified sand and clay deposits, proven to a depth of 2.7 mbgl.
- 2.4.35. The bedrock geology beneath the Cornist Lane BVS site consist of the Bowland Shale Formation, described by the BGS GeoIndex (REF) as a mainly dark grey fissile and blocky mudstone, weakly calcareous, with subordinate sequences of interbedded limestone and sandstone, fossiliferous in more-or-less discrete bands. The GI trial pits at the Cornist Lane BVS did not encounter bedrock.
- 2.4.36. The Site is not located within a groundwater source protection zone and no groundwater was encountered in any of the trial pits at the Cornist Lane BVS.

PENTRE HALKYN BVS

- 2.4.37. The superficial deposits beneath the Pentre Halkyn BVS site consist of the glacial Devensian till and glaciofluvial deposits. The GI has identified layers of sand, gravel, silt and clay within the trial pits at the Pentre Halkyn BVS, proven to a depth of 2.1 mbgl.
- 2.4.38. The bedrock geology beneath the Pentre Halkyn BVS site consists of the Clwyd Limestone Group. The BGS GeoIndex (**Ref. 20**) has described the Clwyd Limestone Group as a diverse range of limestone facies with subordinate sandstone and mudstone units and exhibit local dolomitization. The GI trial pits at the Pentre Halkyn BVS did not encounter bedrock.
- 2.4.39. The Site is not located within a groundwater source protection zone and no groundwater was encountered in any of the trial pits at the Pentre Halkyn BVS.

BABELL BVS

- 2.4.40. The superficial deposits beneath the Babell BVS site consists of glacial Devensian till, glaciofluvial deposits and head deposits. Head deposits have been described by the BGS GeoIndex (**Ref. 20**) as poorly sorted and poorly stratified, angular rock debris and/or clayey hillwash and soil creep, mantling a hillslope and deposited by solifluction and gelifluction processes. The GI has recorded sand and clay deposits within the trial pits at the Babell BVS, proven to a depth of 2.3 mbgl.
- 2.4.41. The bedrock geology beneath the Babell BVS site consist of the Clwyd Limestone Group. The GI trial pits at the Pentre Halkyn BVS did not encounter bedrock. BGS borehole SJ17SE124 (**Ref. 20**), 0.5 km to the south-east of the Babell BVS encountered limestone at 3.5 mbgl.
- 2.4.42. A review of the Flintshire County Council Strategic Flood Consequence Assessment (2018) (**Ref. 1**) indicates that the Site is not within a groundwater source protection zone. In addition, the Natural Resources Wales Geological Data Mapping (**Ref. 17**) indicates that the Site has 'Medium to High' groundwater vulnerability.
- 2.4.43. Groundwater seepage was observed at the base of the inspection pit of LB_21_309_BH however no groundwater level was recorded. BGS borehole SJ17SE124 (**Ref. 20**) has recorded a groundwater level at 62 mbgl .
- 2.4.44. For further detail on the underlying geology and hydrogeology of the AGIs and BVSs refer to **Chapter 18 – Water Environment and Flood Risk (Volume II)**.

2.5. EXISTING WATERBODIES

- 2.5.1. This section provides a summary of all the watercourses that the Newbuild Carbon Dioxide Pipeline is crossing. In addition, this section reports on all known watercourses within 500m of the AGI and BVS Sites.
- 2.5.2. The DCO Proposed Development has a total of 18 watercourse crossings consisting of 6 ordinary watercourses and 12 main rivers in Wales. These are presented in **Table 1** below and **Figure 18.5.1 – Watercourse Crossings (Sheet 1)**.

Table 1 - Watercourse Crossings

Watercourse	Designation	Proposed Crossing Type
Sealand Main Drain	Main	OC
River Dee	Main	TC
Railway Ditch 2	Ordinary	TC
Railway Ditch 3	Ordinary	TC
Broughton Brook	Main	TC
Sandycroft Drain 1	Main	TC
Sandycroft Drain 2	Main	OC
Sandycroft Tributary	Ordinary	OC
Mancot Brook 1	Ordinary	OC
Mancot Brook 2	Ordinary	OC
Mancot Brook 3	Ordinary	OC
Chester Road Brook	Main	TC
Willow Park Brook	Ordinary	OC
New Inn Brook	Ordinary	OC
Alltami Brook	Ordinary	OC
Wepre Brook	Ordinary	OC
Northop Hall Brook	Ordinary	TC
Northop Hall Brook Tributary	Ordinary	OC

OC – Open Cut Crossing

TC – Trenchless Crossing

NORTHOP HALL AGI

2.5.3.

A review of OS Mapping (2022) (**Ref. 18**) has been undertaken to identify watercourses within 500m of the Site. The closest watercourse to the proposed Northop Hall AGI Site is Wepre Brook located approximately 350m to the southeast of the Site. The watercourse is culverted beneath the A55 dual carriageway and flows east towards Northop Hall where it joins Altami Brook. In addition, there is an unnamed pond located approximately 100m west of the Site.

FLINT AGI

- 2.5.4. A review of OS Mapping (2022) (**Ref. 18**) has been undertaken to identify watercourses within 500m of the Site. The closest open watercourse to the Flint AGI is Little Lead Brook located approximately 50m northeast of the Site boundary. The watercourse flows north towards Flint where it is culverted beneath the A548 Chester Road before joining Pentre Brook in the Dee Estuary.

ASTON HILL BVS

- 2.5.5. A review of OS Mapping (2022) (**Ref. 18**) has been undertaken to identify watercourses within 500m of the Site. The closest watercourse to the proposed Aston Hill BVS Site is Aston Hill Brook Trib located approximately 340m to the west of the Site adjacent to Aston Hill. The watercourse flows northeast through Queensferry where it is culverted beneath the A494 before joining the River Dee.

CORNIST LANE BVS

- 2.5.6. The Afon Nant-y-Fflint is located approximately to the 100m west of the Cornist Lane BVS at its closest point. This is shown in **Figure 18.5.22 – Cornist Lane Development Advice Map (Sheet 5) (Annex G)** of the ES. The catchment of Afon Nant-y-Fflint extends approximately 2km northwest and is predominantly rural.

PENTRE HALKYN BVS

- 2.5.7. The closest watercourse to the Pentre Halkyn BVS, the Afon Pant-Gwyn, is located approximately 1.4km west of the Newbuild Infrastructure Boundary. This is shown in **Figure 18.5.23 – Pentre Halkyn Development Advice Map (Sheet 6) (Annex G)**.

BABELL BVS

- 2.5.8. The closest open watercourse, to the Babell BVS is the Afon Wys. This is located approximately 400m southwest of the Newbuild Infrastructure Boundary. This is shown in **Figure 18.5.24 – Babell Development Advice Map (Sheet 7) (Annex G)** of the ES.

2.6. EXISTING SEWER AND DRAINAGE INFRASTRUCTURE

NEWBUILD CARBON DIOXIDE PIPELINE

- 2.6.1. DCWW has been contacted requesting their asset information, and they provided an indicative location of assets near the Newbuild Carbon Dioxide Pipeline. In addition, a utilities search carried out in 2021 (**Ref. 21**) indicates that there are various DCWW assets located within the Newbuild Infrastructure Boundary. This asset information will be taken into consideration for the Detailed Design of the Newbuild Carbon Dioxide Pipeline.

NORTHOP HALL AGI

- 2.6.2. Given that the current Site use at the proposed Northop Hall AGI Site is greenfield (agricultural), it is assumed that the Site is not served by any sewer infrastructure.
- 2.6.3. DCWW asset information has been obtained and there are no known DCWW assets that have been identified to be within the Site.

FLINT AGI

- 2.6.4. Given that the current use of the proposed Flint AGI Site is greenfield (agricultural), it is assumed that the Site is not served by any sewer infrastructure.
- 2.6.5. DCWW asset information has been obtained and there are no known DCWW assets that have been identified to be within the Site.

ASTON HILL BVS

- 2.6.6. Given that the current Site use at the proposed Aston Hill BVS Site is greenfield (agricultural), it is assumed that the Site is not served by any sewer infrastructure.
- 2.6.7. DCWW assets information has been obtained and there are no DCWW assets that have been identified to be within the Site.
- 2.6.8. DCWW have indicated that Blackburn Avenue (approximately 150m east of the Site) has a sewer system that is over capacity and therefore could be a cause for concern. However, a review of the location of the DCWW asset indicates that it does not fall within the Newbuild Infrastructure Boundary and Newbuild Carbon Dioxide Pipeline (indicative location). In addition, Blackburn Avenue is located 5m AOD below the Site and any risk of sewer flooding from this area onto the Newbuild Infrastructure Boundary is therefore considered to be negligible.

CORNIST LANE BVS

- 2.6.9. Given the current Site use at the Cornist Lane BVS Site is greenfield – agricultural, it is unlikely that the Site benefits from any sewer infrastructure.

PENTRE HALKYN BVS

- 2.6.10. Given the current use of the Pentre Halkyn BVS Site is greenfield – agricultural, it is unlikely that the Site benefits from any sewer infrastructure. The Site is crossed by a 63mm watermain, which is a DCWW asset. As DCWW only provided point location data for the watermain, its alignment is unknown.

BABELL BVS

- 2.6.11. Given the current use of the proposed Babell BVS Site is greenfield (agricultural) it is unlikely that the Site benefits from any sewer infrastructure.

2.7. EXISTING FLOOD DEFENCES

- 2.7.1. The Newbuild Carbon Dioxide Pipeline will be crossing the River Dee which is a defended tidally influenced river. The River Dee flood defence consists of flood embankments.
- 2.7.2. There are no known flood defences serving the four BVSs and the two AGIs. This is expected given their distance from any major waterbodies and location away from any known fluvial/tidal/coastal floodplains.
- 2.7.3. A description of the DCO Proposed Development including the Newbuild Carbon Dioxide Pipeline, AGIS and BVSs is provided in **Chapter 3 – Description of the DCO Proposed Development (Volume II)** of the ES.

3. STAKEHOLDER ENGAGEMENT

3.1. NATURAL RESOURCES WALES (NRW)

- 3.1.1. A meeting between NRW and the Applicant on 14 March 2022 did not raise any significant issues relating to the flood risk associated with the Newbuild Carbon Dioxide Pipeline, two AGIs and the four BVSs. The following key items were noted:
- Open cut crossings on all main rivers will require flood risk activity permits (FRAP);
 - The FCA needs to acknowledge the need for generic mitigation measures for managing flows during the construction stage and further detail will be required as part of the **Outline Construction Environment Management Plan (OCEMP) (Document reference: D.6.5.4)**;
 - It is acceptable for this FCA to report on the permanent works only, not on the temporary works (Construction Stage);
 - For the purposes of this FCA, it is acceptable to refer to the **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** that has been prepared as a separate document to support the DCO Application; and
 - As the Newbuild Carbon Dioxide Pipeline will be crossing the River Dee a marine license will be required.
- 3.1.2. A request was made for Site specific information from the NRW Planning Department and NRW Asset Management Department. Correspondence received to date from NRW can be seen in **Annex B**.

3.2. FLINTSHIRE COUNTY COUNCIL (LLFA)

- 3.2.1. Engagement has been attempted with Flintshire County Council in their role as LLFA however no info has been provided. A meeting between FCC and the Applicant was arranged on the 5th August 2022 where the DCO proposed development was presented to the LLFA

3.3. DWR CYMRU WELSH WATER (DCWW)

- 3.3.1. During the Statutory Consultation phase, DCWW provided a response on the 26 April 2022.
- 3.3.2. DCWW have advised the following:
- “As no proposals are made to connect to the public sewerage system or potable water network, Dwr Cymru Welsh Water has no objections in principle to the development. Should circumstances change, Dwr Cymru Welsh Water will need to be re-consulted with on this application”.*

3.3.3. DCWW have advised that

“A minimum exclusion zone is required by Dwr Cymru Welsh Water for their assets impacted by the development. No part of any building will be permitted within the exclusion zone of Dwr Cymru Welsh Water assets. The exclusion zone distance is calculated either side from the centre line of the impacted asset”.

3.3.4. DCWW have further stated the following:

- Any known surface water or foul sewer flooding issues in this area?
“We have traced the pipeline route, and largely it skirts our infrastructures so there are only a couple of locations we should highlight in terms of sewer flooding issues. The first is around Chester Road, Pentre and Leaches Lane, Mancot where we have a number of locations of both internal and external sewer flood risks due to hydraulic incapacity. The second is postcode areas CH5 3HJ (Blackbrook Avenue, Hawarden). We have a number of risks of external flooding in this vicinity”.
- Are there any properties within this area on the DG5 flooding register?
“We do have properties within this area on our Flooding Register, specifically at Pentre and Hawarden. There are properties on our Register at Pentre (at varying levels of risk but including some properties at risk of internal flooding). There are 9 properties on our Register at Blackbrook Avenue, Hawarden, although these are external flood risks only”.
- Are there any plans for the construction of new foul and/ or surface water sewers in this area for flood risk management purposes?
“This area is not currently in our investment programme to resolve flood risk”.
- Is there any ongoing Section 104 adoptions or Section 185 sewer diversions currently being undertaken in the area?
“There are no live S104/S185 applications along the proposed work extent route”.

3.3.5. DCWW have stated specific exclusion zones for each noted asset along the Newbuild Carbon Dioxide Pipeline. In addition, a utilities search carried out in 2021 (**Ref. 21**) indicates that there are various DCWW assets located within the Newbuild Infrastructure Boundary. These will be taken into consideration at detail design to ensure no impacts on third party assets.

3.3.6. Correspondence received to date from DCWW can be seen in **Annex B**.

4. CLIMATE CHANGE

- 4.1.1. Welsh Government guidance “Flood Consequences Assessments: Climate change allowances” (**Ref. 8**) issued in 2016 and most recently updated in March 2022 provides up to date information on expected changes in rainfall, river flows and sea level rise as a consequence of climate change to take into consideration as part of flood risk assessments.
- 4.1.2. A key change from the previous guidance is that the climate change allowances for peak river flows now are shown as variable on a regional basis; allowances are also now based on percentiles, whereby a percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level (e.g., a 50% percentile means that the allowance has 50% chances of not being exceeded). The peak river flow allowances for the River Dee range between 5% (Lower end estimate - 2050s) and 40% (Upper end estimate – 2050s).
- 4.1.3. UKCP18 presents sea level rise allowances as regionalised data, with the impact of climate change dependent on location. This guidance has also been updated to indicate projected increases in sea level rise for each local authority administrative area. These regional allowances replace the single allowance for Wales previously provided. For Flintshire, mean sea level is expected to rise by the year 2100 between 0.76m (70th percentile) and 1.03m (95th percentile). Refer to **Chapter 7 – Climate Resilience (Volume II)** for further information.
- 4.1.4. Climate change will increase rainfall intensity in the future which can lead to an increase in associated flood risk in the absence of appropriate drainage solutions. Typical rainfall intensity allowances in Wales range between +20% and +40% and appropriate allowances should be included in the Drainage Strategy (see the **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** given the increase in impermeable areas for DCO Proposed Development.
- 4.1.5. The potential increase in pluvial flood risk as a consequence of climate change is recognised by Flintshire County Council. The surface water drainage strategy has therefore taken into account the effect of climate change as part of the solutions proposed by considering a suitable climate change allowance . **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13).**
- 4.1.6. The **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** will be in compliance with the requirements of the SAB, incorporating the required allowances for climate change for surface water management, ensuring that there is no increase in flood risk elsewhere throughout the lifetime of the DCO Proposed Development. The lifetime of the Newbuild Carbon Dioxide Pipeline is 40 years, and 25 years for both AGIs and BVSs.

5. DEFINITION OF FLOOD HAZARD

5.1. OVERVIEW

- 5.1.1. This Section provides an overview of the present-day and future baseline flood risk at the Site and surrounding areas.
- 5.1.2. This Section should be read in conjunction with **Chapter 18 – Water Resources and Flood Risk (Volume II)**, paragraphs 18.5.19 to 18.5.22, which provide an overview of the flood zone classifications within the Indicative Newbuild Infrastructure Boundary.
- 5.1.3. This assessment considers flood risk profile, sources, and mechanisms of flooding during the current day scenario and taking into account climate change information where available, in association to construction of the Newbuild Carbon Dioxide Pipeline, the BVs and AGIs.
- 5.1.4. Please note that the following assessment in regards of the proposed Newbuild Carbon Dioxide Pipeline, it is also valid for the FOC as this will be installed along the length of the Newbuild Carbon Dioxide Pipeline .
- 5.1.5. Marker posts and CP posts along the proposed Newbuild Carbon Dioxide Pipeline are subject to the same flood hazard; however, they are considered to be negligible from a flood risk prospective as these are simple posts on a concrete base. Same applies for the CP cabinet at the River Dee.
- 5.1.6. TAN15 framework (**Ref. 1**) defines the flood risk zones according to their use within the precautionary framework, these are as follows:
- Zone A – Considered to be at little or no risk of fluvial or tidal/coastal flooding;
 - Zone B – Areas known to have been flooded in the past evidenced by sedimentary deposits;
 - Zone C – Based on Natural Resources Wales extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal);
 - Zone C1 – Areas of the floodplain which are developed and served by significant infrastructure, including flood defences; and
 - Zone C2 – Areas of the floodplain without significant flood defence infrastructure.

5.2. FLOODING HISTORY

- 5.2.1. Historic flood records available on NRW's website (**Ref. 7**) indicate that they hold one record of a past flood event along the Newbuild Carbon Dioxide Pipeline (Pipe Reach 4b). The incident occurred along the B5129 Chester Road which is located adjacent to Broughton Brook. There is no information when the event occurred or how severe the flooding event was.

- 5.2.2. The historic flood records available on NRW's website indicate that they do not hold records of historic flooding at the proposed Aston Hill BVS, Babell BVS, Pentre Halkyn, Cornist Lane BVS, Northop Hall AGI and Flint AGI Sites.
- 5.2.3. A review of Flintshire County Council's Strategic Flood Consequence Assessment (2018) (**Ref. 1**) further indicates that the B5129 Chester Road has had an incidence of historic fluvial flooding. There is currently no information regarding the timeline of this historic flood.
- 5.2.4. The Flintshire County Council's Strategic Flood Consequence Assessment (2018) (**Ref. 1**) indicates that there are no records of incidents of historic flooding within the proposed Aston Hill BVS, Babell BVS, Pentre Halkyn BVS, Cornist Lane BVS, Northop Hall AGI and Flint AGI Sites.
- 5.2.5. Engagement with DCWW has indicated that there has been no historical flooding from sewers within the proposed Aston Hill BVS, Babell BVS, Pentre Halkyn BVS, Cornist Lane BVS, Northop Hall AGI and Flint AGI Sites. However, DCWW have stated that parts of the Newbuild Carbon Dioxide Pipeline (Pipe Reach 4b) are located within areas that have previously been flooded from sewers and drainage infrastructure.

5.3. FLOODING FROM COASTAL SOURCES

NEWBUILD CARBON DIOXIDE PIPELINE

- 5.3.1. The Newbuild Carbon Dioxide Pipeline is sub-divided in Pipe Reaches 4b, 5 and 6 within this report and relates to the Welsh section of the pipeline.
- 5.3.2. Based on NRW's Development Advice Maps (**Ref. 7**), Pipe Reach 4b lies within Flood Zone A, Flood Zone B and Flood Zone C1. Flood Zone C1 is an area which benefits from significant flood defences. Pipe Reach 4b is located within Flood Zone C1 and within an area of "low" risk of coastal flooding (areas of land with between 0.5% and 0.1% chance of flooding each year from the sea), as shown on the Flood Risk Assessment Wales Map (**Ref. 7**).
- 5.3.3. The "low" likelihood of flooding is due to the area being currently served by flood defences protecting the surrounding residential area and B5129 Chester Road against flooding from the River Dee. This is shown in **Figure 18.5.2 – DCO Newbuild Carbon Dioxide Pipeline Flood Defence Map (Annex C)**.
- 5.3.4. Therefore, the likelihood of coastal flooding along the route of the Newbuild Carbon Dioxide Pipeline varies from negligible to low.

NORTHOP HALL AGI

- 5.3.5. The proposed Northop Hall AGI Site lies within Flood Zone A, an area which is considered to be at "little or no risk of tidal/coastal flooding".

FLINT AGI

- 5.3.6. The proposed Flint AGI Site lies within Flood Zone A, an area which is considered to be at “little or no risk of tidal/coastal flooding”.

ASTON HILL BVS

- 5.3.7. The proposed Aston Hill BVS Site lies within Flood Zone A, an area which is considered to be at “little or no risk of tidal/coastal flooding”.

CORNIST LANE BVS

- 5.3.8. The proposed Cornist Lane BVS Site lies within Flood Zone A, an area which is considered to be at “little or no risk of tidal/coastal flooding”.

PENTRE HALKYN BVS

- 5.3.9. The proposed Pentre Halkyn BVS Site lies within Flood Zone A, an area which is considered to be at “little or no risk of tidal/coastal flooding”.

BABELL BVS

- 5.3.10. The proposed Babell BVS Site lies within Flood Zone A, an area which is considered to be at “little or no risk of tidal/coastal flooding”.

5.4. FLOODING FROM FLUVIAL SOURCES

NEWBUILD CARBON DIOXIDE PIPELINE

- 5.4.1. The Newbuild Carbon Dioxide Pipeline crosses 18 open watercourses. A review of the NRW mapping (**Ref. 7**) indicates that the following 11 watercourse crossings are within Flood Zone C1 (an area which benefits from significant flood defences):
- Sealand Main Drain;
 - River Dee;
 - Railway Ditch 3;
 - Broughton Brook;
 - Sandycroft Drain 1 and 2;
 - Sandycroft Tributary;
 - Mancot Brook 1 and 2;
 - Chester Road Brook;
 - Alltami Brook;
 - Wepre Brook; and
 - Northop Hall Brook.
- 5.4.2. A further review indicates that the other 7 watercourse crossings are within Flood Zones B and C.

- 5.4.3. Therefore, the likelihood of fluvial flooding along the route of the Newbuild Carbon Dioxide Pipeline varies from negligible to high.

NORTHOP HALL AGI

- 5.4.4. The NRW's Development Advice Maps (**Ref. 7**), indicate that the proposed Northop Hall AGI Site lies within Flood Zone A – “Considered to be at little or no risk of fluvial flooding”. This is shown in **Figure 18.5.4 – Northop Hall AGI Fluvial Flood Map (Sheet 2) (Annex D)**.

FLINT AGI

- 5.4.5. The NRW's Development Advice Maps (**Ref. 7**), indicate that the proposed Flint AGI Site lies within Flood Zone A – “Considered to be at little or no risk of fluvial flooding”. This is shown in **Figure 18.5.5 - Flint AGI Fluvial Flood Map (Sheet 3) (Annex D)**.

ASTON HILL BVS

- 5.4.6. The NRW's Development Advice Maps (**Ref. 7**), indicate that the proposed Aston Hill BVS Site lies within Flood Zone A – “Considered to be at little or no risk of fluvial flooding”. This is shown in **Figure 18.5.6– Aston Hill BVS Fluvial Flood Map (Sheet 4) (Annex D)**.

CORNIST LANE BVS

- 5.4.7. The NRW's Development Advice Maps (**Ref. 7**), indicate that the proposed Cornist Lane BVS Site lies within Flood Zone A – “Considered to be at little or no risk of fluvial flooding”. This is shown in **Figure 18.5.7 – Cornist Lane BVS Fluvial Flood Map (Sheet 5) (Annex D)**.

PENTRE HALKYN BVS

- 5.4.8. The NRW's Development Advice Maps (**Ref. 7**), indicate that the proposed Pentre Halkyn BVS Site lies within Flood Zone A – “Considered to be at little or no risk of fluvial flooding”. This is shown in **Figure 18.5.8– Pentre Halkyn BVS Fluvial Flood Map (Sheet 6) (Annex D)**.

BABELL BVS

- 5.4.9. The NRW's Development Advice Maps (**Ref. 7**), indicate that the proposed Babell BVS Site lies within Flood Zone A – “Considered to be at little or no risk of fluvial flooding”. This is shown in **Figure 18.5.9– Babell BVS Fluvial Flood Map (Sheet 7) (Annex D)**.

5.5. FLOODING FROM PLUVIAL SOURCES

NEWBUILD CARBON DIOXIDE PIPELINE

- 5.5.1. The NRW mapping indicates that the Newbuild Carbon Dioxide Pipeline lies within areas that are at risk of Negligible, low, medium and high surface water flooding.

- 5.5.2. Current surface water mapping shows that the surface water flooding along the pipeline is mainly associated with existing open watercourse channels and overland runoff. This is shown in **Figure 18.5.10 – DCO 36 inch Proposed Pipeline Surface Water Flood Map (Sheet 1) (Annex E)**.

NORTHOP HALL AGI

- 5.5.3. Information reviewed from the NRW Mapping (**Ref. 7**) shows that the Northop Hall AGI area has a “Negligible” risk of surface water flooding and there are no overland flow routes traversing the Site. This is shown in **Figure 18.5.11– Northop Hall AGI Surface Water Flood Map (Sheet 2) (Annex E)**.
- 5.5.4. On this basis the likelihood of surface water flooding within the area is considered to be negligible.

FLINT AGI

- 5.5.5. Information reviewed from the NRW Flood Mapping (**Ref. 7**) shows that the Flint AGI is generally at ‘negligible’ risk of surface water flooding; however, an area within the Site is classified as having a “low” risk of surface water flooding which, based on the NRW mapping, is attributed to an overland flow path traversing the southwestern extent of the Site before discharging into the ordinary unnamed watercourse 50m to the east of the Site.
- 5.5.6. A review of local topography based on LiDAR data (**Ref. 19**) confirms the location of such potential runoff route; in storm conditions, any excess runoff would naturally flow towards the unnamed watercourse following the local topography. This is shown in **Figure 18.5.12– Flint AGI Surface Water Flood Map (Sheet 3) (Annex E)**.
- 5.5.7. On this basis the likelihood of surface water flooding within the area is considered to be mainly negligible and low along the potential flow path.

ASTON HILL BVS

- 5.5.8. Information reviewed from the NRW website (**Ref. 7**) shows that the Aston Hill BVS has a “Negligible” risk of surface water flooding and there are no overland flow routes traversing the Site. This is shown in **Figure 18.5.13– Aston Hill BVS Surface Water Flood Map (Sheet 4) (Annex E)**.

CORNIST LANE BVS

- 5.5.9. The NRW surface water flood risk map (**Ref. 7**) shows that the Cornist Lane BVS is at negligible risk of flooding from pluvial sources. Currently, the surface water mapping shows that there are no off-Site surface water flow routes traversing the Site. This is shown in **Figure 18.5.14– Cornist Lane BVS Surface Water Flood Map (Sheet 5) (Annex E)**.

PENTRE HALKYN BVS

- 5.5.10. The NRW website (**Ref. 7**) shows that the Pentre Halkyn BVS Site is at “Negligible” risk of flooding from pluvial sources.
- 5.5.11. Current NRW surface water mapping shows that there are no off-Site surface water flow routes traversing the Site. This is shown in **Figure 18.5.15– Pentre Halkyn BVS Surface Water Flood Map (Sheet 6) (Annex E)**.

BABELL BVS

- 5.5.12. Information reviewed from the NRW website (**Ref. 5**) shows that the Babell BVS Site has a “Negligible” to “Low” risk of surface water flooding and there are no overland flow routes traversing the Site.
- 5.5.13. The NRW surface water flood risk mapping shows that the “Low” surface water flooding is associated with small puddles forming in existing localised depressions on the Site. This is shown in **Figure 18.5.16– Babell BVS Surface Water Flood Map (Sheet 7) (Annex E)**.

5.6. FLOODING FROM GROUNDWATER SOURCES

- 5.6.1. Groundwater flooding is caused by high/emerging groundwater levels. It occurs as excess water emerging at the ground surface or within manmade structures such as basements. Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months, and can result in significant damage to property. The risk of groundwater flooding depends on the nature of the geological strata underlying the Site, as well as on local topography.

NEWBUILD CARBON DIOXIDE PIPELINE

- 5.6.2. The buried depth of the Newbuild Carbon Dioxide Pipeline would be a minimum of 1.2m to the crown of the pipe in open cut sections and deeper for trenchless crossings to avoid existing services and physical obstructions. The open cut trench will be between approximately 2.5m and 6m deep to enable pipeline installation. A review of the Flintshire County Council’s Strategic Flood Consequence Assessment (2018) (**Ref. 3**) shows that the pipeline crosses areas that are within low, medium, and high risk of groundwater emergence and flooding.
- 5.6.3. During a review of groundwater level data from the GI and BGS GeoIndex (**Ref. 20**) it has been identified that groundwater levels are at their shallowest (0.16 – 1.33 mbgl) between the River Dee and Sandycroft on the Welsh side of the DCO Proposed Development. This area is the most at risk from groundwater flooding. West of Pentre, groundwater levels deepen to 6 – 8 mbgl at Aston Hill and down to 11 mbgl west of Northop Hall. There are a number of monitoring locations with telemetry data loggers along the Newbuild Carbon Dioxide Pipeline route. However, the data is limited for understanding the seasonal

variation in groundwater levels due to the groundwater monitoring regime commencing less than a year ago at time of writing.

NORTHOP HALL AGI

- 5.6.4. A review of the 2018 Flintshire Strategic Flood Consequence Assessment (**Ref. 3**) shows the Northop Hall AGI to be in an area where there is “no risk” of flooding from groundwater sources.
- 5.6.5. The GI undertaken at the Northop Hall AGI did not encounter groundwater, however from the BGS record 400 m southeast groundwater may be between 2 – 8 mbgl.

FLINT AGI

- 5.6.6. A review of the 2018 Flintshire Strategic Flood Consequence Assessment (**Ref. 3**) shows the Northop Hall AGI to be in an area where there is “no risk” of flooding from groundwater sources. an area where there is “no risk” of flooding from groundwater sources.
- 5.6.7. The GI undertaken at the Flint AGI did not encounter any groundwater.

ASTON HILL BVS

- 5.6.8. A review of the 2018 Flintshire Strategic Flood Consequence Assessment (**Ref. 3**) shows the Aston Hill BVS to be in an area where there is “no risk” of flooding from groundwater sources.
- 5.6.9. The GI has not recorded a groundwater level at the Aston Hill BVS, however from the monitoring borehole 450 m north east groundwater levels may be between 1 – 4 mbgl.

CORNIST LANE BVS

- 5.6.10. A review of the 2018 Flintshire Strategic Flood Consequence Assessment (**Ref. 3**) shows the Cornist Lane BVS to be in an area where there is “No Risk” of flooding from groundwater sources.
- 5.6.11. A GI undertaken by WSP at the site identified a mixture of clay with sporadic elements of sand and gravel. The deepest trial pit (TP305) was dug to a depth of 2.7m. Groundwater was not encountered in any of the trial pits.
- 5.6.12. Site specific groundwater levels (seasonal variations) are currently unavailable at the site.

PENTRE HALKYN BVS

- 5.6.13. A review of the 2018 Flintshire Strategic Flood Consequence Assessment (**Ref. 3**) shows the Pentre Halkyn BVS to be in an area where there is a “Risk of flooding to subsurface assets but risk to surface assets is unlikely”.

- 5.6.14. A GI undertaken by WSP at the site, identified a mixture of clay with sporadic elements of sand and gravel. The deepest trial pit (TP307) was dug to a depth of 2.1m. Groundwater was not encountered in any of the trials pits.
- 5.6.15. Site specific groundwater levels (seasonal variations) are currently unavailable at the site, however groundwater levels are expected to sit below the excavation depth.

BABELL BVS

- 5.6.16. A review of the 2018 Flintshire Strategic Flood Consequence Assessment (**Ref. 3**) shows the Babell BVS to be in an area there is a “Risk of flooding to subsurface assets but risk to surface assets is unlikely”.
- 5.6.17. A GI at the site identified a mixture of sandy clay with elements of gravel at the site, consistent with glacial till. The deepest trial pit (TP309) was dug to a depth of 2.3m and encountered some seepage of water at 1.3m below ground level.
- 5.6.18. Site specific groundwater levels (seasonal variations) are currently unavailable at the site, however, groundwater levels are expected to sit below the excavation depth.

5.7. FLOODING FROM SEWER AND DRAINAGE INFRASTRUCTURE NEWBUILD CARBON DIOXIDE PIPELINE

- 5.7.1. Information on existing sewers and the risk of sewer flooding to the Newbuild Carbon Dioxide Pipeline was provided as part of engagement with DCWW. There have been no instances of flooding within the proposed AGI and BVS Sites.
- 5.7.2. DCWW have indicated that there are known instances of flooding along Chester Road, Pentre Leaches Lane and Mancot as a result of hydraulic incapacity. The Newbuild Carbon Dioxide Pipeline is in the vicinity of Chester Road, however the Newbuild Carbon Dioxide Pipeline will be a subsurface structure which limits any potential risk from existing sewers. The risk of flooding from existing sewer and drainage infrastructure is considered to be low.
- 5.7.3. For more information refer to DCWW correspondence in **Annex B**.

NORTHOP HALL AGI

- 5.7.4. Correspondence from DCWW (**Annex B**) and a review of the utilities search asset information (**Ref. 21**) has indicated that there are no assets within the Newbuild Infrastructure Boundary. Given this information and location of the DCO Proposed Development, the risk of flooding from existing sewer and drainage infrastructure is considered to be low.

FLINT AGI

- 5.7.5. Correspondence from DCWW (**Annex B**) and a review of the utilities search asset information (**Ref. 21**) has indicated that there are no assets within the

Newbuild Infrastructure Boundary. Given this information and location of the DCO Proposed Development, the risk of flooding from existing sewer and drainage infrastructure is considered to be low.

ASTON HILL BVS

- 5.7.6. Correspondence from DCWW (**Annex B**) and a review of the utilities search asset information (**Ref. 21**) has indicated that there are no assets within the Newbuild Infrastructure Boundary. Given this information and location of the DCO Proposed Development, the risk of flooding from existing sewer and drainage infrastructure is considered to be low.

CORNIST LANE BVS

- 5.7.7. Correspondence from DCWW (**Annex B**) and a review of the utilities search asset information (**Ref. 21**) has indicated that there are no assets within the Newbuild Infrastructure Boundary. Given this information and location of the DCO Proposed Development, the risk of flooding from existing sewer and drainage infrastructure is considered to be low.

PENTRE HALKYN BVS

- 5.7.8. Correspondence with DCWW (**Annex B**) and a review of the utility search (**Ref. 21**) asset information has indicated that the only asset within the site was a 63mm watermain. Given this information and location of the DCO Proposed Development, the risk of flooding from existing sewer and drainage infrastructure is considered to be low.

BABELL BVS

- 5.7.9. Correspondence from DCWW (**Annex B**) and a review of the utility search (**Ref. 21**) asset information has indicated that there are no assets within the Newbuild Infrastructure Boundary. Given this information and location of the DCO Proposed Development, the risk of flooding from existing sewer and drainage infrastructure is considered to be low.

5.8. FLOODING FROM ARTIFICIAL SOURCES

NEWBUILD CARBON DIOXIDE PIPELINE

Reservoirs

- 5.8.1. The NRW reservoir flooding map (**Ref. 7**) indicated that Pipe Reach 4b lies within a reservoir flood outline.

Canals

- 5.8.2. There are no embanked or at grade canal sections within the vicinity of the Newbuild Carbon Dioxide Pipeline, therefore the risk of flooding from this source is considered to be negligible.

AGIs

Reservoirs

- 5.8.3. The NRW reservoir flooding map (**Ref. 7**) indicated that the Northop Hall AGI and Flint AGI Sites do not lie within a reservoir flood outline. On this basis, the risk of reservoir flooding to these AGI Sites is considered to be negligible.

Canals

- 5.8.4. There are no embanked or at grade canal sections within the vicinity of the Northop Hall AGI and Flint AGI Sites, therefore the risk of flooding from this source to the AGI Sites is considered to be negligible.

BVSs

Reservoirs

- 5.8.5. The NRW reservoir flooding map (**Ref. 7**) indicated that the Aston Hill BVS, Cornist Lane BVS, Pentre Halkyn BVS and Babell BVS Sites do not lie within a reservoir flood outline. On this basis, the risk of reservoir flooding to the BVSs is considered to be negligible. is considered to be negligible.

Canals

- 5.8.6. There are no embanked or at grade canal sections within the vicinity of the Aston Hill BVS, Cornist Lane BVS, Pentre Halkyn BVS and Babell BVS Sites, therefore the risk of flooding from this source to the BVSs is considered to be negligible.

6. ASSESSMENT OF ACCEPTABILITY CRITERIA

- 6.1.1. The aim of this section is to provide an assessment of the suitability of the DCO Proposed Development against the requirements of TAN15, 2004 (**Ref. 1**).
- 6.1.2. The objective of the assessment is to develop a full appreciation of the consequences of flooding on the development and elsewhere within the catchment as well as establish appropriate mitigation measures, where required.
- 6.1.3. This FCA focuses on the assessment of flooding and mitigation measures for the permanent works and the operational stage only.
- 6.1.4. Flood risk will be managed during the Construction Stage through appropriate mitigation measures proposed as part of the **OCEMP (Document reference: D.6.5.4)**.

6.2. TAN15 – SECTION 9

- 6.2.1. **Table 2** provides a summary of the policy requirements from Section 9 of TAN15 for developments in Flood Zones A, B, C (C1).

Table 2 - TAN15 Section 9 Summary of Policy Requirements

DAM	Development Type (Section 5)	Planning Requirements (Section 4)	Acceptability Criteria (Section 7 & Appendix 1)	Development Advice (Section 5, 6, 7 & Appendix 1)
A	<ul style="list-style-type: none"> Emergency services; Highly vulnerable development; Less vulnerable development; and Other. 	<ul style="list-style-type: none"> Justification test not applicable; and Refer to surface water requirements. 	<ul style="list-style-type: none"> No increase in flooding elsewhere. 	No constraints relating to river or coastal flooding, other than to avoid increasing risk elsewhere.
B	<ul style="list-style-type: none"> Emergency services; Highly vulnerable development; Less vulnerable development; and Other. 	<ul style="list-style-type: none"> If Site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further; and Refer to surface water requirements. 	<ul style="list-style-type: none"> Acceptable consequences for nature of use; Agreement for construction and maintenance costs secured; Occupiers aware of flood risk; Escape/evacuation routes present • Effective flood warning provided; Flood emergency plans and procedures; Flood resistant design; and No increase in flooding elsewhere. 	Generally suitable for most forms of development. Assessments, where required, are unlikely to identify consequences that cannot be overcome or managed to an acceptable level. It is unlikely, therefore, that these would result in a refusal of planning consent on the grounds of flooding.

DAM	Development Type (Section 5)	Planning Requirements (Section 4)	Acceptability Criteria (Section 7 & Appendix 1)	Development Advice (Section 5, 6, 7 & Appendix 1)
C1	<ul style="list-style-type: none"> • Emergency services • Highly vulnerable development • Less vulnerable development 	<ul style="list-style-type: none"> • Application of justification test (section 6), including acceptability of consequences (section 7 and appendix 1); and • Refer to surface water requirements. 	<ul style="list-style-type: none"> • Acceptable consequences for nature of use; • Flood defences adequate; • Agreement for construction and maintenance costs secured; • Occupiers aware of flood risk; • Escape / evacuation routes present • Effective flood warning provided; • Flood emergency plans and procedures; • Flood resistant design; and • No increase in flooding elsewhere 	Plan allocations and applications for all development can only proceed subject to justification in accordance with section 6 and acceptability of consequences in accordance with section 7 and Appendix 1.

- 6.2.2. Appendix 1 of TAN15 also provides a more detailed list of requirements of an FCA for new developments. A checklist of TAN15 requirements is included in **Annex H**.

6.3. DEVELOPMENT TYPE & VULNERABILITY CLASSIFICATION

NEWBUILD CARBON DIOXIDE PIPELINE

- 6.3.1. In accordance with the information available within Figure 2 in TAN15, the Newbuild Carbon Dioxide Pipeline is classed under the “less vulnerable developments” category and these types of general industrial developments are acceptable in Flood Zone A and B. They are also acceptable within Flood Zone C1 providing that the requirements of TAN15 are met.
- 6.3.2. According to Chapter 6 of TAN15, less vulnerable development, including transport infrastructure will only be justified if it can be demonstrated that:
- Location in Zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement;
 - Its location in Zone C is necessary to contribute to key employment objectives supported by the local authority, and other key partners, to sustain an existing settlement or region;
 - It concurs with the aims of PPW and meets the definition of previously developed land (PPW fig 2.1); and
 - the potential consequences of a flooding event for the particular type of development have been considered, and in terms of the criteria contained in sections 5 and 7 and appendix 1 found to be acceptable.
- 6.3.3. This FCA investigated the potential sources of flooding and demonstrates that consequences of flooding have been considered and mitigated as appropriate. Further reference of mitigation measures are within the **Outline Surface Water Drainage Strategy Report (Document reference: D.6.5.13)**.
- 6.3.4. The Newbuild Carbon Dioxide Pipeline meets the required conditions to be deemed appropriate within Flood Zone A, B, C (C1).
- #### **ABOVE GROUND INSTALLATIONS AND BLOCK VALVE STATIONS**
- 6.3.5. The two AGIs and four BVS are considered “less vulnerable developments”. They are all located within Flood Zone A (areas considered to be at little or no risk of fluvial/coastal flooding).
- 6.3.6. The two AGIs and four BVSs also meet the requirements of Section 9 of TAN15 (**Ref. 1**) and are deemed appropriate within Flood Zone A.

6.4. FLOOD RESISTANT DESIGN

- 6.4.1. As discussed in **Section 5**, the review of the potential sources of flooding in the areas of the DCO Proposed Development shows that flood risk is not a major constraint to the proposals as the majority of the DCO Proposed Development in Wales is in areas at low risk of flooding.
- 6.4.2. The Newbuild Carbon Dioxide Pipeline will be underground. Therefore, during operation it is not expected to be at risk in case of flooding. The same is applicable for the Fibre Optic Cable and the electricity connections. Marker posts along the proposed Newbuild Carbon Dioxide Pipeline are subject to the same flood hazard; however, they are considered to be negligible from a flood risk prospective as these are simple posts on a concrete base.
- 6.4.3. In areas where there is risk of ground water emergence, the risk of buoyancy of the Newbuild Carbon Dioxide Pipeline structures will need to be mitigated by the provision of anchorage measures (in such locations the pipeline will be coated in concrete or installed with concrete ballast) to prevent buoyancy and damage to the proposed buried infrastructure (D-WR-039 of the REAC, Document Reference: D.6.5.1). Groundwater monitoring might be required at specific locations to inform the Detailed Design. AGIs and BVSs are generally at low risk of flooding. Nevertheless, as discussed in **Section 5** a potential surface water runoff route has been identified within the proposed Flint AGI Site. The AGI will not be affected as the flow path is located south of the proposed AGI. It should be added that the proposed embankment would slightly encroach on the flow path however it would not impact on direction and flow due to local topography. Any potential water flowing through the Site will need to be managed through the proposed drainage system if required and as appropriate (see the **Outline Surface Water Drainage Strategy, Ref.D.6.5.13**) which should be reviewed at Detailed Design.
- 6.4.4. Any proposed surface water drainage measures, e.g SuDS or other features would need to take into account the existing surface water flow paths on this Site as part of their drainage design development.
- 6.4.5. The AGIs and BVSs will require surface water management measures to manage the increase in hardstanding areas as a consequence of the development. An **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** has been produced and demonstrates that surface water will be managed in line with policy and best practice and allowing for the effects of climate change.
- 6.4.6. Although no significant surface water runoff routes have been identified as potentially affecting the Aston Hill BVS, Cornist Lane BVS, Pentre Halkyn BVS, Babell BVS and Northop Hall AGI, any potential overland runoff flowing through the Sites and accumulating within the developed structures will need to be controlled and managed through the proposed surface water drainage system;

this should be investigated at Detailed Design (D-WR-061 of the REAC, Document Reference: D.6.5.1).

- 6.4.7. The Cornist Lane BVS is excavated to a depth of 4.95m. No information on groundwater is provided to this depth and as such, uncertainties on the likelihood of intercepting the groundwater table are unknown.
- 6.4.8. Consideration of depth to groundwater (e.g., through groundwater monitoring) might be required to inform the detailed design stage for preventing impacts on the proposed infrastructure from rising groundwater table e.g., at Cornist Lane BVS.
- 6.4.9. Outdoor equipment in the proposed AGIs and BVSs will be designed to be water-resistant, but not to operate under water. In order to mitigate any potential flood risk from the various sources of flooding, the equipment and kiosk will be standing on plinths, raised a minimum of 200mm above proposed working platform elevation which further reduces the likelihood of flooding. Additional associated infrastructure is going to be raised above ground...
- 6.4.10. A combination of the measures proposed above will ensure that the DCO Proposed Development is in a suitable location within the Newbuild Infrastructure Boundary.

6.5. LOSS OF FLOODPLAIN

- 6.5.1. The Newbuild Carbon Dioxide Pipeline (Pipe Reach 4b) is located within the River Dee Tidal floodplain. However, as this will be a buried subsurface asset, no loss of floodplain will be anticipated.
- 6.5.2. The Aston Hill BVS, Cornist Lane BVS, Pentre Halkyn BVS, Babell BVS, Northop Hall AGI and Flint AGI are located within Flood Zone A (outside designated floodplains) and therefore will not result in the loss of a floodplain.

6.6. NO INCREASE IN FLOOD RISK ELSEWHERE

- 6.6.1. An **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** has been prepared for the DCO Proposed Development in accordance with the requirements of the LLFA (D-WR-043 of the **REAC**, **Document Reference: D.6.5.1**) and the SAB to ensure that there is no increase in the risk of surface water flooding at the Site or elsewhere. The drainage strategy has been prepared to take into account guidance which include, but not limited to the following:
- Technical Advice Note (TAN 15: Development and Flood Risk dated October 2004 issued by Welsh Government) (**Ref. 1**);
 - Welsh Government Guidance – Statutory standards for sustainable drainage systems (designing, constructing, operating and maintaining surface water drainage systems) – 2018; (**Ref. 10**);

- Guidance for Pre-Application Approval and Full Application Approval of SuDS on new developments in accordance with The Sustainable Drainage (Approval and Adoption Procedure (Wales) Regulations 2018 (**Ref. 11**);
- Building Regulations 2010 (2015 Edition) (**Ref. 12**);
- Sewers for Adoption 7th Edition (**Ref. 13**);
- Planning Policy Wales Edition 11 (December 2018) issued by Welsh Government (**Ref. 14**);
- Welsh Ministers Standards for Foul Sewers and Lateral Drains (**Ref. 15**); and
- Sustainable Drainage Systems (SuDS) Manual C753, CIRIA (**Ref. 16**);

6.6.2. During the Operational Stage, trench breakers (clay bunds) will prevent the formation of preferential groundwater flow pathways as a consequence of the Newbuild Carbon Dioxide Pipeline being constructed. Note, groundwater flood risk will not be affected from pre to post-construction stage. The excavated trenches will be generally filled with the same material previously removed, with the exception of sand being used for bedding and pipe surround (which will have quite a high permeability in any case), and therefore hydraulic properties will be very similar to pre-construction conditions.

6.7. ACCEPTABLE CONSEQUENCES FOR NATURE OF USE

NEWBUILD CARBON DIOXIDE PIPELINE

6.7.1. Whilst the Newbuild Carbon Dioxide Pipeline crosses Flood Zones A, B, and C1 it is a buried subsurface asset and therefore will satisfy the criteria of Section A1.14 of Appendix 1 of TAN15 (**Ref. 1**).

ABOVE GROUND INSTALLATIONS AND BLOCK VALVE STATIONS

6.7.2. The Northop Hall AGI, Flint AGI, Aston Hill BVS, Cornist Lane BVS, Pentre Halkyn BVS and Babell BVS Sites satisfy the criteria of section A1.14 of Appendix 1 of TAN15 (**Ref. 1**) as they are all located within Flood Zone A.

6.8. AWARENESS OF FLOOD RISK AND FLOOD WARNING SYSTEMS

6.8.1. Due to the nature of the Newbuild Carbon Dioxide Pipeline (buried structure) it will not be subject to ongoing manned access. Given the location of the proposed pipelines within Flood Zones B, C and C1, any planned inspections will need to take into account the risk of flooding in the area and any flood alerts/warnings issued by the NRW.

6.8.2. Given that the AGI's and BVS Sites are located within Flood Zone A, there is no requirement for emergency flood access/egress routes, although these are recommended as good practice as part of the general Site operational plans.

- 6.8.3. A Flood Action Plan will be put in place for all AGIs and BVSs for the operational phase (D-WR-040 of the **REAC, Document Reference: D.6.5.1**). The Flood Action Plan will identify roles and responsibilities and emergency procedures including, where applicable, closure of the premises and evacuation in case of expected flooding/during a flood emergency. The Flood Action Plan will be informed by subscription to the Flood Warning Service where available. The level of detail of the Flood Action Plan will reflect the level of flood risk at each location.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. CONCLUSIONS

- 7.1.1. This FCA was developed to support the DCO Application covering the DCO Proposed Development in Wales.
- 7.1.2. This Section should be read in conjunction with **Chapter 18 – Water Resources and Flood Risk (Volume II)**, paragraphs 18.5.19 to 18.5.22, which provide an overview of the flood zone classifications within the Indicative Newbuild Infrastructure Boundary.

NEWBUILD CARBON DIOXIDE PIPELINE

- 7.1.3. The Newbuild Carbon Dioxide Pipeline crosses Flood Zones A, B, C1 and C2 within Wales. In particular, NRW's Development Advice Maps (**Ref. 7**) show that Pipe Reach 4b lies within Flood Zone A, Flood Zone B and Flood Zone C1 (an area which benefits from significant flood defences).
- 7.1.4. As the Newbuild Carbon Dioxide Pipeline is a linear scheme, it is required to cross through various flood zones throughout its alignment. Given that the Newbuild Carbon Dioxide Pipeline is classed as 'less vulnerable development', it therefore complies with the requirements of TAN15 for this type of development.
- 7.1.5. The Newbuild Carbon Dioxide Pipeline is a buried structure and will remain unaffected from sources of flooding on the ground surface.
- 7.1.6. The Newbuild Carbon Dioxide Pipeline crosses areas with low, medium, and high risk of groundwater emergence and risk of flooding. The two main potential impacts of groundwater emergence are the formation of preferential groundwater flow pathways through the pipe bed and surrounding material of the proposed pipeline (after the construction) and also the risk of buoyancy of the proposed buried pipework. These risks will be mitigated by the implementation of measures to prevent groundwater migration e.g. clay plugs as part of the reinstatement of the proposed trenches and designing out the risk of buoyancy in key areas of concern for groundwater emergence.
- 7.1.7. Although the Newbuild Carbon Dioxide Pipeline crosses 18 open watercourses and some parts of the Newbuild Carbon Dioxide Pipeline are proposed within Flood Zone C1, with the Newbuild Carbon Dioxide Pipeline being a subsurface structure, during operational stage the pipeline is unlikely to be affected by fluvial flooding from these watercourses.

ABOVE GROUND INSTALLATIONS

- 7.1.8. The proposed Flint AGI and Northop Hall AGI are both located on land classified as Flood Zone A which are defined by NRW as “Areas at little or no risk of flooding from rivers and the sea”. The AGIs are not shown to be at risk of flooding from fluvial or tidal water sources.
- 7.1.9. Each AGI is classed as “less vulnerable development” and, in accordance with the requirements of TAN15, they are therefore suitable for development in Flood Zone A.
- 7.1.10. The AGI developments will require suitable drainage onsite to manage the surface water generated at the Site due to the increase in impermeable areas and flowing into the site as a consequence of the proposed levels where applicable.
- 7.1.11. The Flint AGI Site has an existing overland runoff route that flows from the southwestern boundary of the Site towards an ordinary watercourse located north of the Site. However local topography indicates that the proposals would not negatively affect the flow path impacting on flood risk elsewhere. The overland runoff route will be protected or managed as part of the development so that it does not negatively affect the risk of flooding elsewhere.
- 7.1.12. An **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** has been developed alongside this FCA for all the proposed AGIs to demonstrate how surface water drainage will be managed in accordance with the requirements of the LLFA and SAB, taking into account the impacts of increased rainfall intensity due to climate change predictions.

BLOCK VALVE STATIONS

- 7.1.13. The proposed Aston Hill BVS, Cornist Lane BVS, Pentre Halkyn BVS and Babell BVS are all located on land classified as Flood Zone A which are defined by NRW as “*Areas at little or no risk of flooding from rivers and the sea*”. The proposed BVSs are not shown to be at risk of flooding from fluvial or tidal water sources.
- 7.1.14. Each BVS is classed as “less vulnerable development” and, in accordance with the requirements of TAN15, each Site is therefore suitable for development in Flood Zone A. The proposed BVSs will require suitable drainage onsite to manage the surface water generated at the Sites due to the increase in impermeable areas.

- 7.1.15. An **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** has been developed alongside this FCA for all the BVSs to demonstrate how surface water drainage at the proposed BVSs will be managed in accordance with the requirements of the LLFA and SAB, taking into account the impacts of increased rainfall intensity due to climate change predictions.

7.2. RECOMMENDATIONS

- 7.2.1. At this stage there is limited information on the groundwater levels at each proposed BVS and AGI Sites. If appropriate and depending on location it is therefore recommended to further assess the option of undertaking groundwater monitoring to understand any potential risk of groundwater flooding to inform the Detailed Design
- 7.2.2. It is also recommended, as part of the development of the detailed drainage strategy and detailed drainage design to liaise further with the LLFA and SAB at Flintshire County Council, to ensure the all the stages of the SAB approval process are complied with.
- 7.2.3. Where applicable and where there are modifications in the proposed ground levels, for e.g. proposed cut and fill operations, the surface water drainage design systems will be required to taken into consideration the contribution of adjacent catchments to prevent the risk of overland surface water runoff. See **Outline Surface Water Drainage Strategy (Document reference: D.6.5.13)** for additional detail.
- 7.2.4. It is recommended to liaise further with NRW and the LLFA to discuss and agree the mitigation measures required to be in place for temporary and permanent works through, near, beneath or on floodplains and flood defences. This will be required to be part of the Flood Risk Activity Permit (FRAP) application and **OCEMP (Document reference: D.6.5.4)** to be submitted for temporary and permanent works consent from the relevant Statutory Authorities (NRW/LLFA).

- **Ref. 1:** *Welsh Government 2004*. Technical Advice Note (TAN) 15: Development and Flood Risk. Retrieved from <https://gov.wales/Sites/default/files/publications/2018-09/tan15-development-flood-risk.pdf>.
- **Ref. 2:** Flintshire County Council 2011. Preliminary Flood Consequences Assessment Flintshire. [Online]. Retrieved from [https://www.flintshire.gov.uk/en/PDFFiles/Land-and-Property/Preliminary-Flood-Risk-Assessment-June-2011-\(PDF-1MB-new-window\).pdf](https://www.flintshire.gov.uk/en/PDFFiles/Land-and-Property/Preliminary-Flood-Risk-Assessment-June-2011-(PDF-1MB-new-window).pdf).
- **Ref. 3:** Flintshire County Council 2018. Strategic Flood Consequence Assessment Flintshire. [Online]. Retrieved from <https://www.flintshire.gov.uk/en/PDFFiles/Planning/Evidence-Base-Documents/Natural-Built-Environment/LDP-EBD-EN1-Strategic-Flood-Consequences-Assessment-Final-Report-2018.pdf>.
- **Ref. 4:** Flintshire County Council 2013. Local Flood Risk Management Strategy. [Online]. Retrieved from <https://www.flintshire.gov.uk/en/PDFFiles/Flooding-and-Drainage/Flintshire-Local-Flood-Risk-Management-Strategy.pdf>.
- **Ref. 5:** North West and NorthWales Coastal Group. 2011. *North West England and North Wales Shoreline Management Plan SMP2*. [Online].
[REDACTED]
- **Ref. 6:** *Natural Resources Wales, JBA 2017*. Point of Ayr to Pensarn Tidal Flood Risk Analysis.
- **Ref. 7:** Natural Resources Wales. 2021. *Flood Risk Map Viewer*. [Online]. Retrieved from [REDACTED]
[REDACTED]
- **Ref. 8:** *Welsh Government 2021*. Flood Consequences Assessments: Climate change allowances. [Online]. Retrieved from <https://gov.wales/climate-change-allowances-and-flood-consequence-assessments>.
- **Ref. 19:** *Environment Agency, 2011*. Coastal flood boundary conditions for the UK: Update 2018, Technical Summary Report. [Online]. Retrieved from <https://www.gov.uk/government/publications/coastal-flood-boundary-conditions-for-uk-mainland-and-islands-design-sea-levels>.
- **Ref. 10:** Welsh Government Guidance – Statutory standards for sustainable drainage systems (designing, constructing, operating and maintaining surface water drainage systems) – 2018.
- **Ref. 11:** *Welsh Government 2018*. Guidance for Pre-Application Approval and Full Application Approval of SuDS on new developments in accordance with The Sustainable Drainage (Approval and Adoption Procedure (Wales) Regulations. [Online]. Retrieved from

<https://gov.wales/Sites/default/files/publications/2019-06/statutory-national-standards-for-sustainable-drainage-systems.pdf>.

- **Ref. 12:** UK Government 2010. Building Regulations (2015 Edition). [Online]. <https://www.gov.uk/government/publications/2010-to-2015-government-policy-building-regulation/2010-to-2015-government-policy-building-regulation>.
- **Ref. 13:** *Water UK* 2018. Sewers for Adoption 7th Edition'.
- **Ref. 14:** *Welsh Government* 2018. Planning Policy Wales Edition 11.
- **Ref. 15:** *Welsh Government* 2012. Welsh Ministers Standards for Foul Sewers and Lateral Drains. [Online]. Retrieved from <https://gov.wales/Sites/default/files/publications/2019-06/standards-for-new-sewers-and-lateral-drains.pdf>.
- **Ref. 16:** *CIRIA* 2015. Sustainable Drainage Systems (SuDS) Manual C753. [Online]. Retrieved from [REDACTED]
- **Ref. 17:** *Natural Resources Wales*. 2022. Interactive Map Viewer. Retrieved from: https://maps.cyfoethnaturiolcymru.gov.uk/Html5Viewer210/Index.html?configBase=https://maps.cyfoethnaturiolcymru.gov.uk/Geocortex/Essentials/REST/sites/External_Map_Browser/viewers/EMB_Address/virtualdirectory/Resources/Config/Default&locale=en-gb.
- **Ref. 18:** *OS Mapping*. 2022. Retrieved from: [REDACTED]
- **Ref. 19:** *Welsh Government Lle Portal*: 1m DTM LiDAR data download. Retrieved from: <http://lle.gov.wales/catalogue/item/lidarcompositedataset?lang=en>
- **Ref. 20:** *BGS GeoIndex online database*. Retrieved from: [REDACTED]
- **Ref. 21:** *Utility Search* (2021).

Annex A

SITE LOCATION PLANS

Annex B

ENGAGEMENT

Annex C

FLOOD DEFENCES

Annex D

FLUVIAL FLOOD MAPS

Annex E

SURFACE WATER MAPS

Annex F

WATERCOURSE CROSSINGS

Annex G

DEVELOPMENT ADVICE MAPS

Annex H

TAN15 CHECKLIST

