Pell Frischmann

Church Stoke Sewage Treatment Works

Flood Consequence Assessment & Drainage Strategy

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Contents

Figures

Tables

Appendices

1 Introduction

Pell Frischmann have been appointed by Hafren Dyfrdwy (HD) to undertake a Flood Consequence Assessment (FCA) in accordance with Planning Policy Wales (PPW) and Technical Advice Note 15 (TAN15). This FCA has been prepared to support a planning application for the replacement and provision of additional treatment capacity and works to meet future requirements at Church Stoke Sewage Treatment Works (STW), Church Stoke, Powys.

1.1 Scope of Works

The following scope of works has been undertaken to provide a Flood Consequence Assessment to meet the requirements set out in the Planning Policy Wales (PPW), Technical Advice Note 15 (TAN15) and local policy:

- Collate and undertake a desk-based review of publicly available flood risk information, such as National Resource Wales (NRW) mapping, local data, policy and guidance;
- Undertake a desktop review of other data that has been made available, such as topographic surveys, existing drainage plans and proposed layout plans;
- Provide outline advice on flood mitigation measures including sustainable drainage systems (SuDS) opportunities for the proposed development; and
- Provide a FCA based on the above information.

1.2 Sources of Information

A review of the relevant information from a range of sources has been undertaken and includes the following:

- Planning Policy Wales (PPW) Edition 11, February 2021;
- Technical Advice Note 15: Development and Flood Risk (TAN15), July 2004;
- Severn Preliminary Flood Risk Assessment (PFRA), December 2018;
- Powys County Council Preliminary Flood Risk Assessment (PFRA) Addendum Report, October 2017; and
- Powys County Council Strategic Flood Consequence Assessment Stage 1, March 2012.

1.3 Environment Agency Data

The following information has been gathered from Natural Resources Wales's Spatial Data Catalogue, data.gov.uk (accessed July 2022):

- Rivers Flood Zones – Flood Zone 2;
- Rivers Flood Zones – Flood Zone 3;
- Surface Water and Small Watercourses – Flood Zone 2;
- Surface Water and Small Watercourses – Flood Zone 3;
- TAN15 Defended Zones;
- Development Advice Maps – Zone B
- Development Advice Maps – Zone C2
- Flood Risk from Reservoirs;
- Main River Map;
- Recorded Flood Extents; and
- LiDAR Composite DTM (1m).

2 The Site

The site, Church Stoke Sewage Treatment Works, is located circa 600m north of the village of Church Stoke in Powys. The site is situated in between the A490, boarding the western site boundary and the River Camlad to the east. The approximate centre of the site is positioned at National Grid Reference 327255, 294710.

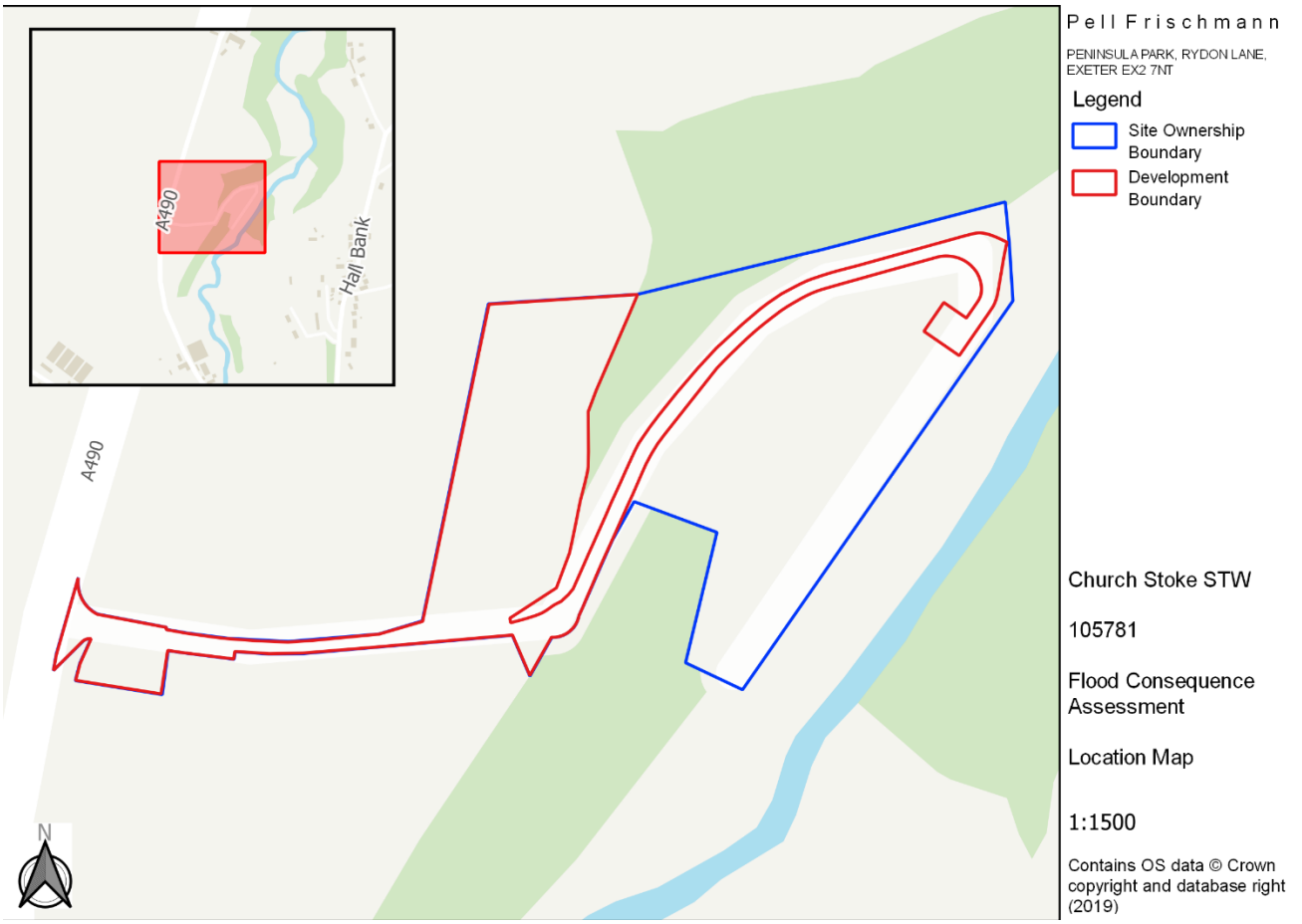

Figure 1 Site location plan

2.1 Site Description

The total area of the STW is 1 ha, with the development area of 0.4 ha, as defined by the development boundary shown in Figure 1 above. The sewage treatment facilities are located along the eastern boundary of the site, adjacent to the River Camlad. The western half of the site is predominantly green space with the access road from the A490 crossing to the works. The treatment works currently comprise primary settlement, biofilters, pebble clarifiers, sludge beds and tanks, reed beds and a pumping station.

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2.2 Topography

Figure 2 below shows the local topography around the site. The ground levels generally fall west to east across the site towards the River Camlad. The fall is quite shallow for the western part of the site, the grassed area, before dropping more steeply towards the treatment works area. The ground levels off again through the STW area.

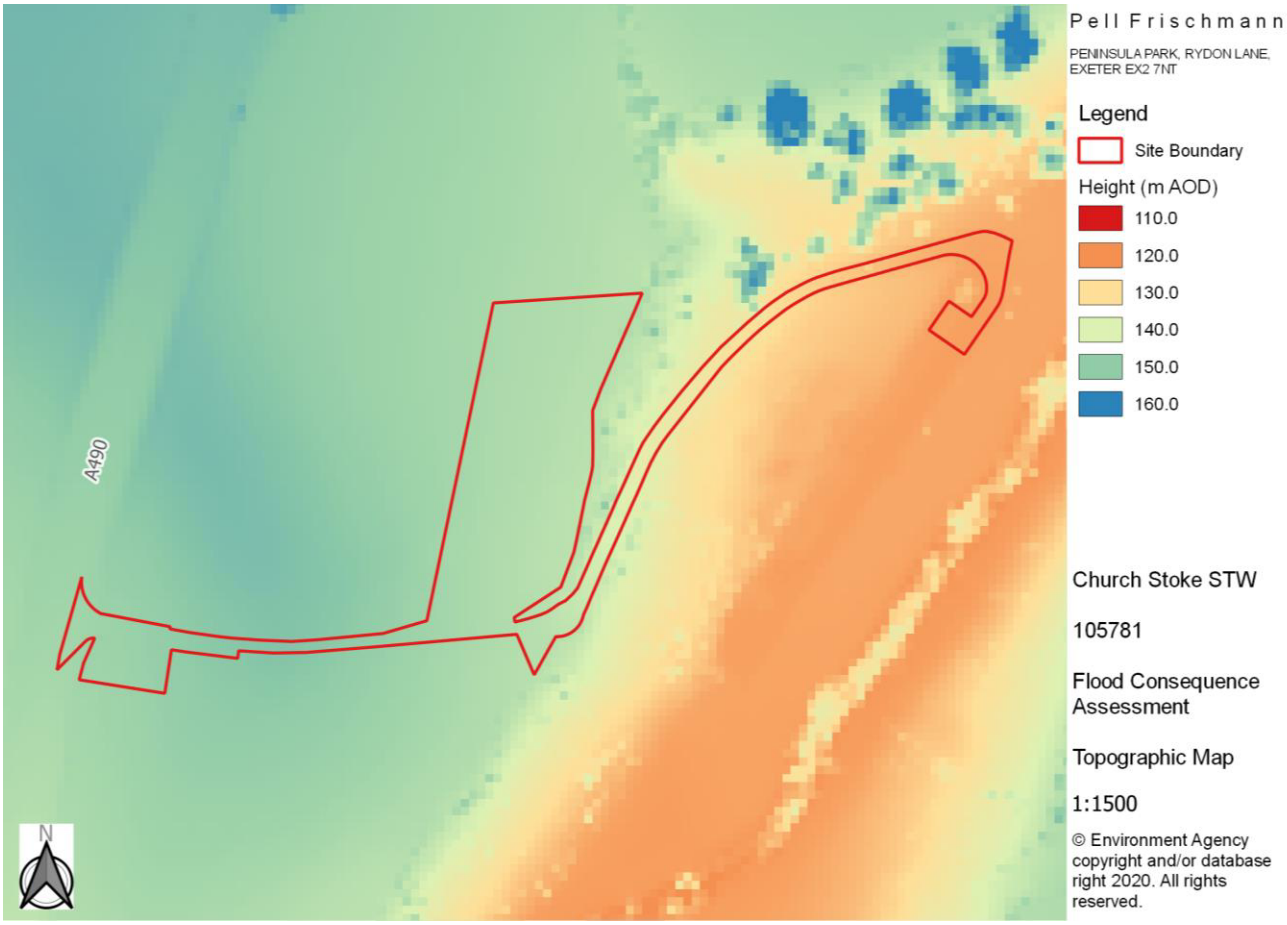

Figure 2 Site topography

Topographical surveys were carried out in August 2020 and April 2021, and the drawings are included in **Appendix A**.

2.3 Watercourses

The River Camlad is located on the eastern boundary of the site and is classified as Main River. The river flows north, before joining the River Severn, approximately 10km north west of the site.

There are no formal flood defences along the River Camlad adjacent to the site.

Figure 3 Site watercourses and flood defence

2.4 Geology

The online 'Geology of Britain' viewer published by the British Geological Survey (BGS) shows the bedrock at a scale of 1:50,000 to be the Hagley Shale Formation, which is comprised of mudstone. There are two superficial deposits associated with the site with Till present at the western part of the site and Alluvium present at the eastern part.

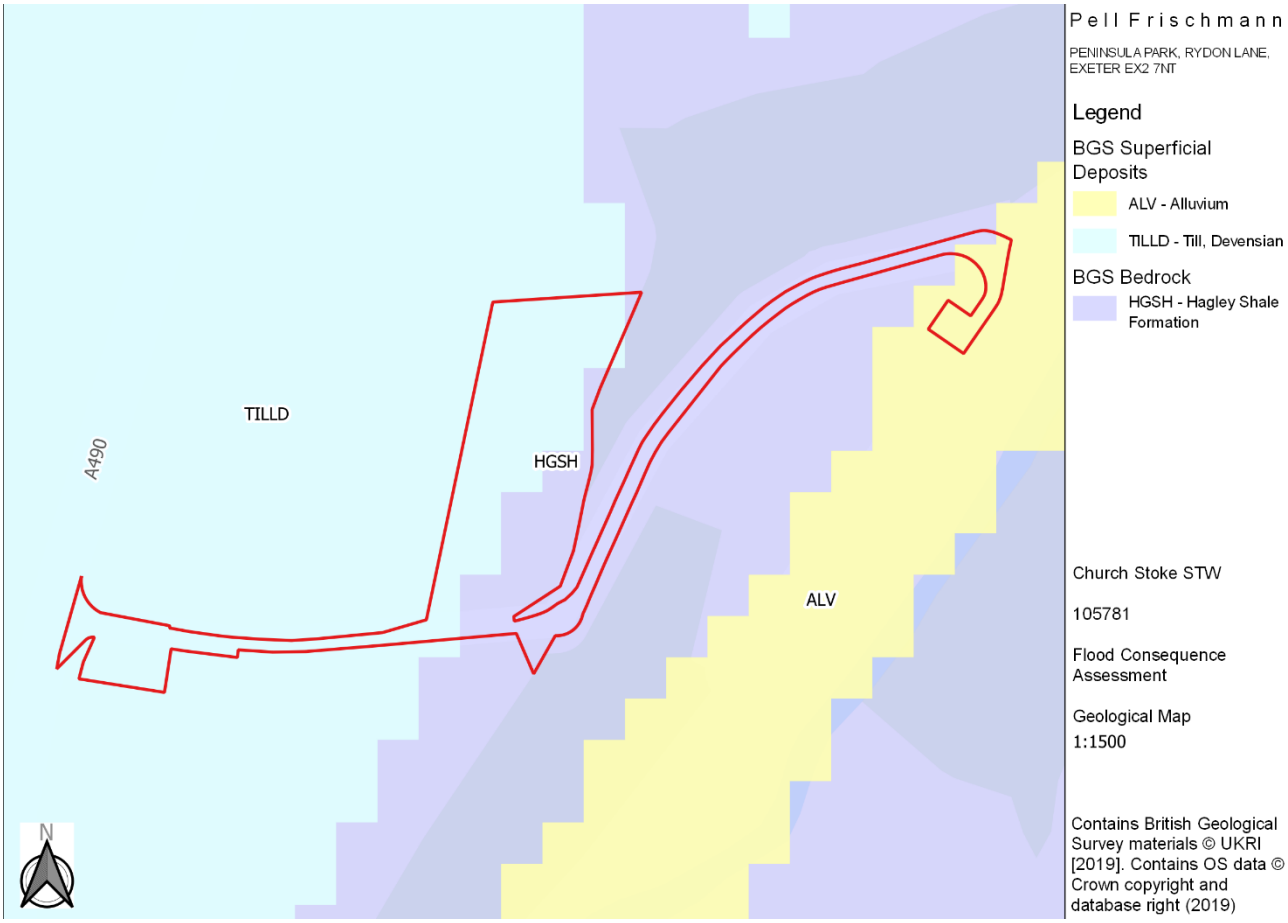

Figure 4 Site geology

2.5 Proposed Development

The proposed development updates and increases the existing treatment capacity of Church Stoke Sewage Treatment Works (STW) which is due to receive a new, more onerous, 1.5 mg/l Phosphorus consent parameter in Asset Management Period 7 (AMP7), driven by the Water Framework Directive programme. The STW catchment is also experiencing growth which this project will cater for to the 2026 design horizon.

The project will involve a combination of upgrades undertaken within the current curtilage of the STW, parts of which will be undertaken under permitted development rights. In addition, there will be expansion into a new area of land, vehicle access upgrades and new kiosks within the existing site, which fall within the scope of the planning permission application. In summary the following works are proposed:

Permitted Development:

- Inlet works modifications
- A new primary settlement tank
- A new humus settlement tank
- Additional final effluent monitoring equipment
- Associated infrastructure with the above

Works subject to planning permission:

- Establishing a new area of STW operational land
- A new Ferric Sulphate reception, storage and dosing plant
- A new sludge consolidation tank
- Vehicular access road to the assets in the new site
- Widening and surfacing the existing vehicular access from the A490
- Relocation of the access gate further from the edge of the A490
- A new MCC kiosk within the existing operational area
- A new laboratory and washwater kiosk within the existing operational area
- Associated sustainable drainage systems

A plan is provided in **Appendix A**.

3 Existing Flood Risk

3.1 Fluvial Flood Risk (Rivers and Sea)

The Natural Resources Wales's flood risk data indicates the site is predominantly within Flood Zone 1, land having a less than 0.1% annual probability of river or sea flooding. The most eastern part of the site however, falls within Flood Zone 3, land having been shown to be at a 1% or greater probability of flooding from rivers or 0.5% or greater probability of flooding from the sea.

Figure 5 NRW Flood Zone map

3.2 Flood Risk from Surface Water

The risk of surface water flooding has been assessed by viewing the Natural Resources Wales's Surface Water and Small Watercourse Mapping. The mapping indicates that the majority of the site is within Flood Zone 1, land having been shown to be at a 0.1% or less probability of flooding from surface water and/or surface water. However, the eastern part of the site falls within Flood Zone 2 (areas with 0.1% to 1% chance of flooding from surface water and/or small watercourses in a given year) and Flood Zone 3 (areas with more than 1% chance of flooding from surface water and/or small watercourses in a given year).

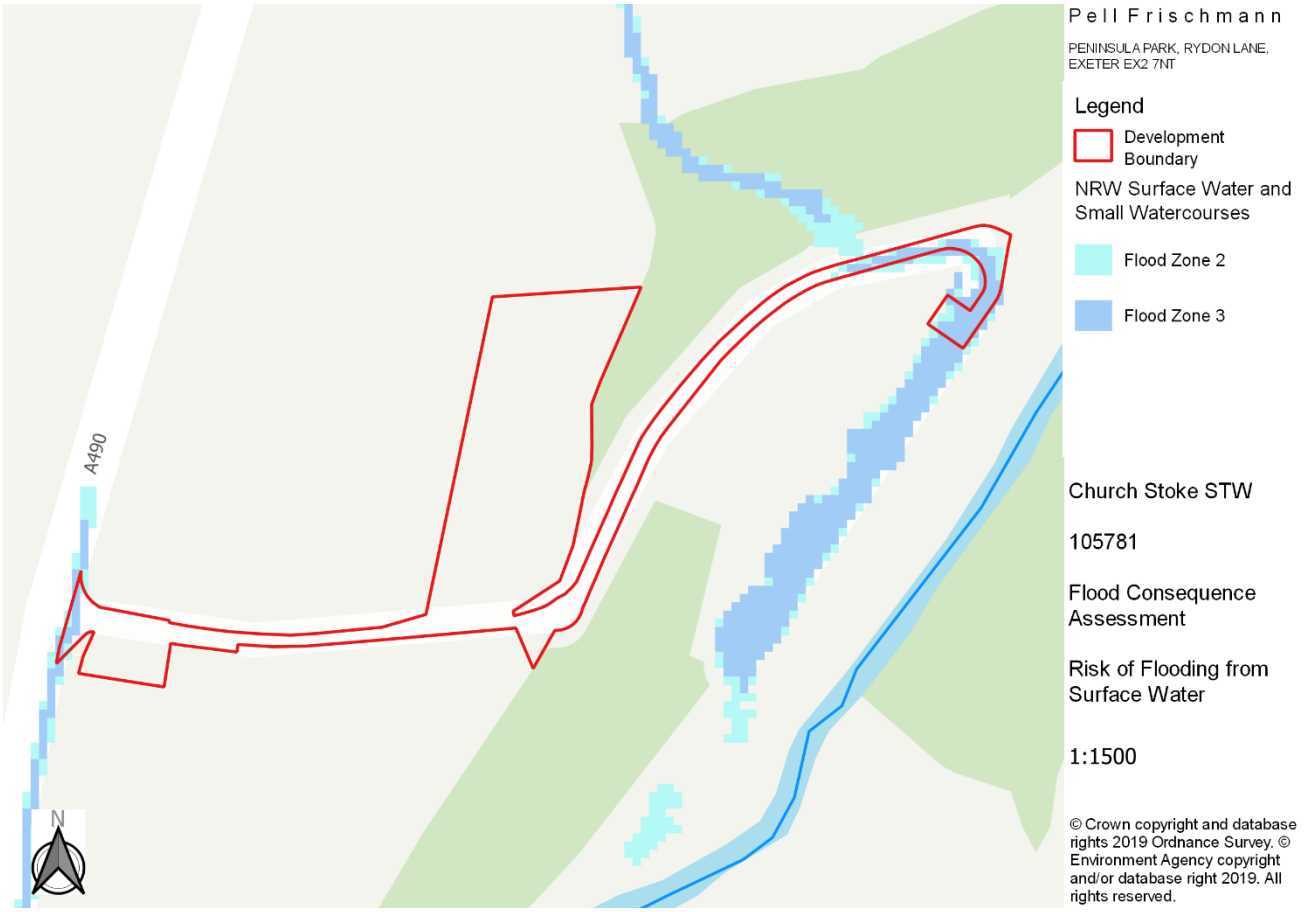

Figure 6 NRW Surface Water and Small Watercourses Flooding

3.3 Groundwater Flooding

The Severn PFRA states: *"Groundwater flood events in Wales are rare. The geology (underlying rock type) and topography (steep sided valleys) mean that groundwater flooding is very unlikely to occur. Due to the history of mining in certain areas of Wales, flooding recorded as groundwater may actually be from disused mine workings. Whilst this is becoming more of a concern for some LLFAs it still remains a very low likelihood and very low frequency".*

The Powys County Council SFCA Stage 1 states *"There is no local information on historic groundwater flooding, which suggests that the risk of groundwater flooding in Powys is low."*

3.4 Sewer Flooding

Sewer flooding can occur due to sewer infrastructure failure or due to an increased flow and volume of water entering a sewer system which exceeds its hydraulic capacity, causing the system to surcharge. If sewer outfall points are either blocked or submerged due to high water levels, water can back up in a sewer system and cause flooding.

There has no been recorded flooding relating to surcharging sewers at the site.

3.5 Artificial Sources

The Natural Resources Wales's *'Flood Risk from Reservoirs'* dataset indicates that the site is not at risk of flooding related to reservoirs.

3.6 Historic Flooding

The Natural Resources Wales's 'Recorded Flood Extents' show flooding along the River Camlad but does not infringe on the site. However, anecdotal evidence recorded at the site shows the lower access road flooding fairly regularly.

3.7 Summary

The below table provides a summary of the five sources of flood risk for the site. Overall, the site can be considered to have a lmeduim flood risk.

Table 1 Existing flood risk summary

Flood Sources	Flood Risk		
	Low	Medium	High
Fluvial		✓	
Pluvial		✓	
Groundwater	✓		
Sewers	✓		
Artificial	✓		

4 Planning Policy and Guidance

4.1 Planning Policy Wales

Planning Policy Wales (PPW) and associated Technical Advice Notes (TAN) provide guidance on which this FCA has been based. TAN 15 provides technical guidance which supplements the policy set out in PPW in relation to development and flooding. It advises on development and flood risk as this relates to sustainability principles (Section 2.2 PPW) and provides a framework within which risks arising from both river and coastal flooding, and from additional run-off from development in any location, can be assessed.

4.2 Flood Risk Vulnerability Classification

TAN 15 outlines how flood risks should be assessed in relation to development. It is supported by Development Advice Maps (DAMs), which *'are based on the best available information considered sufficient to determine when flood risk issues need to be taken into account in planning future development'*. DAMs classify areas across Wales into three different development advice zones, each of which requires different planning actions. Figure 7 below shows that the site falls predominantly falls within Zone A (considered to be at little or no risk or fluvial or tidal/coastal flooding) however the eastern extents fall within Zone C2 (areas of floodplain without significant flood defence infrastructure).

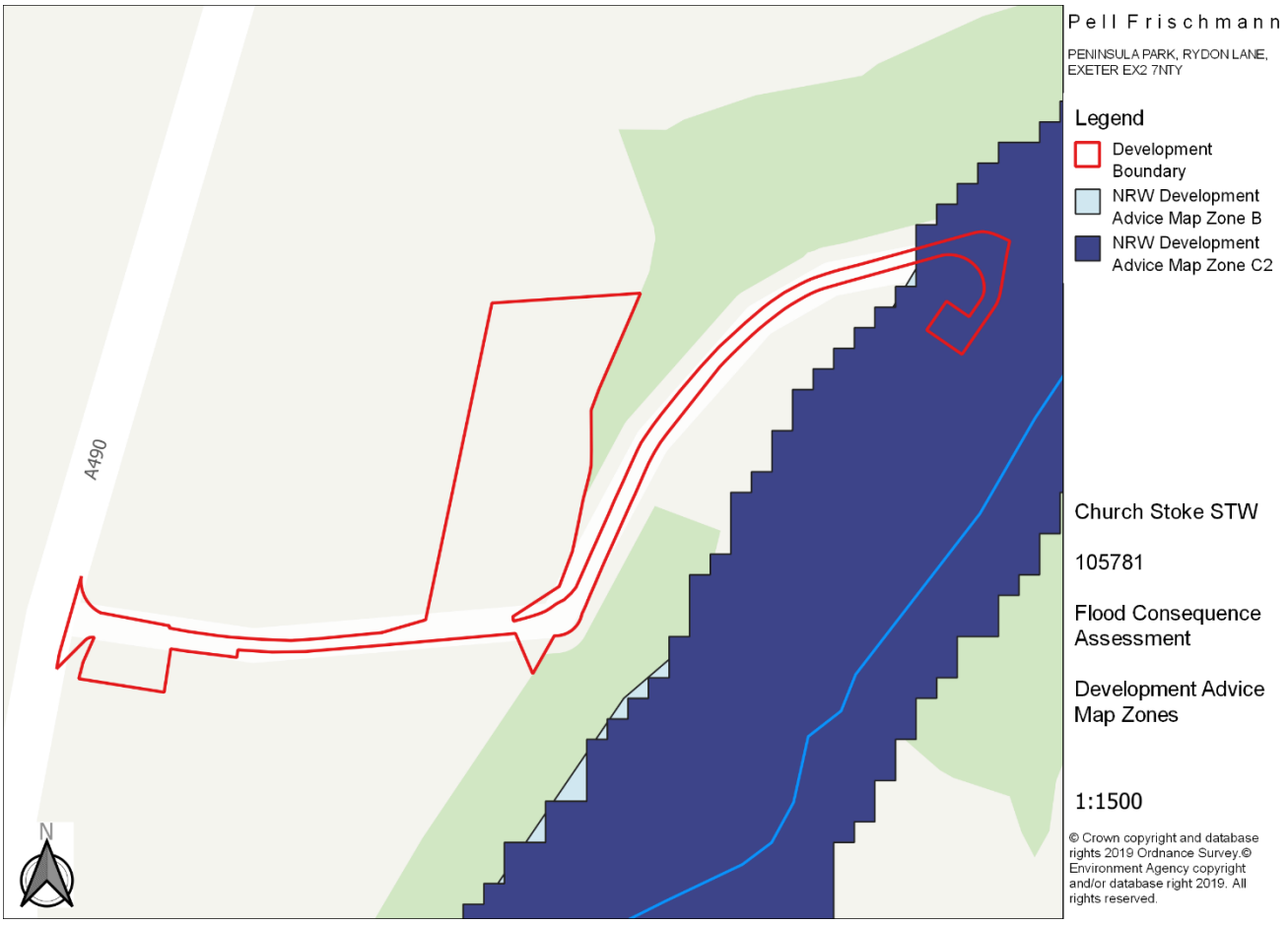

Figure 7 NRW Development Advice Map

The flooding consequence considered acceptable is dependent on the type of development proposed. TAN 15 classifies developments into three vulnerability classifications. In accordance with TAN 15, the Church Stoke STW proposal is classified as a *'less vulnerable development'*.

Table 2 below outlines the appropriate planning requirements and acceptability criteria that TAN 15 has established when considering different types of development in different DAM Zones.

Table 2 Flood risk vulnerability classification

DAM	Development Type	Planning Requirements	Acceptability Criteria	Development Advice
C2	Emergency service Highly vulnerable development	The flooding consequences associated with Emergency Services and highly vulnerable development are not considered to be acceptable. Plan allocations should not be made for such development and planning applications not proposed.		
	Less vulnerable development	• Application of justification test (section 6) , including acceptability of consequences (section 7 and appendix 1) • Refer to surface water requirements	• 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	Plan allocations or applications for less vulnerable development can only proceed subject to justification in accordance with section 6 and acceptability of consequences in accordance with section 7 and Appendix 1.
	Other	• Application of acceptability of consequences (section 7 and appendix 1) • Refer to surface water requirements	• Flood resistant design • No increase in flooding elsewhere • Acceptable consequences for nature of use • Occupiers aware of flood risk • Effective flood warning provided • No increase in flooding elsewhere	Plan allocations and applications for development should only be made if considered acceptable in accordance with section 7 and Appendix

4.2.1 Justifying the Location of a Development

Section 6 of TAN 15 outlines the process behind justifying the location of a development within DAM Zone C. Section 6 states: *"Much urban development in Wales has taken place alongside rivers and in the coastal plain. It is therefore inevitable, despite the overall aim to avoid flood risk areas, that some existing development will be vulnerable to flooding and fall within zone C. Some flexibility is necessary to enable the risks of flooding to be addressed whilst recognising the negative economic and social consequences if policy were to preclude investment in existing urban areas, and the benefits of reusing previously developed land. Further development in such areas, whilst possibly benefiting from some protection, will not be free from risk and could in some cases exacerbate the consequences of a flood event for existing development and therefore a balanced judgement is required.*

New development should be directed away from zone C and towards suitable land in zone A, otherwise to zone B, where river or coastal flooding will be less of an issue. In zone C the tests outlined in sections 6 and 7 will be applied, recognising, however, that highly vulnerable development and Emergency Services in zone C2 should not be permitted. All other new development should only be permitted within zones C1 and C2 if determined by the planning authority to be justified in that location. Development, including transport infrastructure, will only be justified if it can be demonstrated that:

i. Its 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 ; or,
ii. 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;
and,
iii. It concurs with the aims of PPW and meets the definition of previously developed land (PPW fig 2.1);
and,

iv. *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".*

4.2.2 Assessing Flooding Consequences

Section 7 of TAN 15 outlines how to assess the flooding consequences of a development, It states: "*If a development proposal in zone C1, or in C2 if it is defined as being of low vulnerability, meets the test outlined in section 6, the justification will be in the knowledge that those developments will flood and will need to be planned accordingly. This section will apply in zone C, and those parts of zone B where flooding has been identified as a material consideration to allow for localised problems. 8 1 Regeneration initiatives will be comprehensive, multi-approach and form part of an integrated suite of initiatives which have been subject to public consultation. Local authority strategy will be the development plan for the area (deposit version as minimum).*

Whether a development should proceed or not will depend upon whether the consequences of flooding of that development can be managed down to a level which is acceptable for the nature/type of development being proposed, including its effects on existing development. It would certainly not be sensible for people to live in areas subject to flooding (even in two storey buildings) where timely flood warnings cannot be provided and where safe access/egress cannot be achieved.

Where development is justified the assessment can be used to establish whether suitable mitigation measures can be incorporated within the design to ensure that development is as safe as possible and there is:

- *minimal risk to life;*
- *minimal disruption to people living and working in the area,*
- *minimal potential damage to property;*
- *minimal impact of the proposed development on flood risk generally; and,*
- *minimal disruption to natural heritage."*

5 Development Location and Flooding Consequences

5.1 Justification of Location

In determining the site layout the options are limited by the existing structures, the proposed site layout is shown in **Appendix A**.

The majority of the development, the sludge holding tanks and the ferric sulphate storage and dosing plant are placed in Zone A. However, the humus settlement tanks, sludge return pumping station and associated controls are located within the existing STW development footprint, which falls within Zone C2. Due to nature of the development and the required hydraulic connectivity requirements to the existing plant it is not possible to locate these assets outside Zone C2.

In regard to the TAN 15 location justification requirements the expansion and improvements works are required to allow the STW to meet its Water Framework Directive licensing consents and to meet the requirements for the expected growth in the catchment. It is therefore considered to have passed part *i* of the justification criteria.

The site is currently used as a sewage treatment works and the proposed development is the upgrade and improvements to the current plant, therefore the development can be considered as previously developed land, meeting the requirements of part *iii* of the justification requirements.

As discussed in Section 3 of this report the site is predominantly at risk from fluvial and surface water flooding and the flooding consequences of the development have been considered based on these flooding sources. During fluvial flooding events the water backs up through the pipework before filling chambers and spilling on to the site. During surface water flooding the water flows down the grassed slope and wooded area and floods the site. Based on previous flooding events the worst case flood level has been estimated as 122.5m AOD

Due to the nature of the development the majority of the proposed structure are resilient to flooding and the impact of flooding at the site is considered insignificant. However, there are some critical mechanical and electrical assets, including the pumping station control kiosks, that it is recommended to be set above the anticipated 122.5m AOD flood level. The threshold level of the control kiosks are currently set at 123.1m AOD, 600mm higher than the flood level.

Previously, when the sludge tanks required emptying the tankers had to drive down to the bottom of the site, within Zone 2C. During flood events the access road becomes impassable and the tankers cannot access the tanks. The proposal involves relocation the sludge tanks to the top of the site, meaning the desludging process is outside of the flood risk area.

It is recommended that the site is registered with the NRW's flood warning service, if not already, which allows site management to receive automatic alerts in the event flood warning/severe flood warnings are issued. In addition, it is recommended that a Flood Warning and Evacuation Plan (FWEP) is prepared to set out the procedures that site management and site staff should follow in the event a flood warning is issued.

Based on the above, it is considered that part *iv* has been passed.

6 Managing Flood Risk

6.1 Flood Mitigation

Due to the nature of the development the majority of the proposed structures are resilient to flooding and the impact of flooding at the site is considered insignificant. However, there are some critical mechanical and electrical assets, including the pumping station control kiosks, that are to be placed above the anticipated 122.5m AOD flood level.

It is recommended that the site is registered with the NRW's flood warning service, if not already, which allows site management to receive automatic alerts in the event flood warning/severe flood warnings are issued. In addition, it is recommended that a Flood Warning and Evacuation Plan (FWEP) is prepared to set out the procedures that site management and site staff should follow in the event a flood warning is issued.

6.2 Surface Water Management

6.2.1 Existing Surface Water Drainage

The site is current developed and the surface water positively drained. The site can be split into three separate drainage areas, see Figure 8 below. The first section (shaded yellow on the plan) is the existing access road on the eastern boundary of the site, between the STW plant and the river. The surface water in this section is collected via gullies and flows to the existing pumping station to be collected within the sewage treatment process.

The second section (shaded red on the plan) of the site is the existing access road from the high point falling eastwards towards the works. The surface water along this section of road is collected via gullies and discharged into the river uncontrolled.

The final section (shaded blue on the plan) of the site is the small section of existing access road falling from the high point westwards towards the A490. The section of access road does not have any gullies, instead the water is allowed to flow towards the road where the site entrance is crushed stone and the water allowed to infiltrate into the ground. However, it is possible that the water flows directly on to the highway, to be picked up by the highway drains, as the site entrance is heavily compact minimising the voids and infiltration testing has showed that the infiltration at the site is very slow.

Figure 8 Existing Drainage Area

6.2.2 Surface Water Drainage Post Development

Post development the overall area of impermeable surfacing has increase and therefore additional surface water management is required.

In terms of a means of disposal of surface water the Surface Water Hierarchy is to be considered. This requires consideration to be given in order of priority to:

- disposal to the ground;
- disposal to a watercourse;
- disposal to a public surface water sewer; or
- disposal to a combined sewer.

Infiltration testing on the site was carried out July 2022 by Tetra Tech, see **Appendix B**. The infiltration was so slow that it was not possible to determine an infiltration rate. Therefore infiltration techniques were deemed unfeasible for the site.

The new impermeable area on the site is associated with the sludge holding tanks and the ferric sulphate storage and dosing plant and access. Due to the potential risk of contamination related to the sludge tank and dosing plant the majority of the runoff from the new impermeable area will be collected and passed through the treatment works. Drainage from these 'dirty' areas will be kept separated from 'clean' areas of the site, with kerb and speed hump containment. During chemical deliveries, drainage will also be diverted to an interceptor tank in case of spillage within the contained area.

The surface water discharge from the circa 170m^2 'clean' section of the new access road to the dosing plant will be collected in a small pond to attenuate before being discharged at greenfield runoff rates into the existing surface water network down the existing access road (Drainage Area 2). The greenfield runoff for the site has been calculated as 6 l/s per hectare, using the ICP SUDS (FSR) Method in MicroDrainage, see **Appendix C**. The greenfield runoff rate for the new area of access road would be less than 0.1 l/s and, due to the required orifice size and the risk of blockage, this rate is not achievable. The smallest rate that is currently achievable is 2 l/s. Using the MicroDrainage Quick Storage Calculation, attenuation storage of between 2.5 - 5.4m^3 is required to limit the discharge to 2 l/s.

As part of the works the bell mouth at the site entrance will be widened and formalised with an impermeable road construction. As previously mentioned, the surface water is supposed to flow towards the existing permeable bell mouth and infiltrate into the ground, however, given the infiltration rates this is highly unlikely to work efficiently and in reality, the water will flow unrestricted off the site onto the A490 and collected by the highway drainage. Post development it is proposed to collect and attenuate the surface water off the access road and formally discharge it into the highway drains at a lower, controlled rate. As the water will be discharged at a controlled rate this is considered to be betterment on the existing regime. The surface water will be attenuated using a below ground tank due to the level requirements.

The area on the access road to drainage is 250m^2, the associated greenfield runoff rate with this area is only 0.2 l/s and unachievable. Using the MicroDrainage Quick Storage Calculation, attenuation storage between 5.0 - 9.7m^3 is required to limit the discharge to the 2 l/s rate.

6.2.3 Surface Water Drainage Design

The strategy was developed further and details on the design can be found in **Appendix D**. The detailed design refines the storage requirements to a 6m^3 storage tank and 5m^3 attenuation pond.

6.2.4 Pollution Control

In accordance with NRW's planning requirements the development should not have a detrimental impact on the environment, including the water environment.

The SuDS Manual 2015 provides guidance on the treatment of surface water runoff for the form of land use and sensitivity of the receiving water body. The sources of runoff from the site come from the a low trafficked road, with traffic movements limited to less than 5 per week. Table 3 is extracted from the SuDS Manual and rates the pollution hazard from the development as low.

Table 3 Pollution hazard indices for different land use classifications [Extracted from Table 26.2 CIRIA SuDS Manual 2015]

Land use	Pollution hazard level	Total suspended solids	Metals	Hydrocarbons
Individual property driveways, residential car parks, low traffic road (e.g. cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements/ day	Low	0.5	0.4	0.4

The method of water quality treatment may require a single mitigation system, or combination of mitigation components depending on the pollution hazard rating. A single SuDS component with a high capacity for removal of pollutants can be suitable.

The simple index approach requires that the mitigation indices for the mitigation proposed exceeds the pollution hazard indices for the pollution hazard level. Table 4 provides information on pollution hazard indices and mitigation indices.

Table 4 Indicative SuDS mitigation indices for discharge to surface water [Extracted from Table 26.3 CIRIA SuDS Manual 2015]

Types of SuDS component	Mitigation Indices		
	Total suspended solids	Metals	Hydrocarbons
Pond	0.7	0.7	0.5

It is therefore demonstrated that pond is adequate to provide adequate water quality treatment for the access road for the dosing plant as the mitigation indices are higher than the pollution hazard indices.

For access from the A490, the gulley used to collect the surface water and the tank used to attenuate the discharge do not offer any additional pollution mitigation measure, however the pollution hazard is considered low. The proposal matches the existing regime, discharging the surface water into the existing highway drainage along the A490, therefore it can be considered that the risk of pollution has not been increased.

7 Conclusion and Recommendation

This FCA has been prepared to support a planning application for the replacement and provision of additional treatment capacity and works to meet future water quality requirements at Church Stoke Sewage Treatment Works (STW), Church Stoke, Powys.

- The development site is partially situated within Flood Zones 3 and Development Advice Map Zone C2;
- The development site is at low to high risk of surface water flooding;
- The site does not benefit from any formal local flood defences;
- The site is shown to be at no or very low risk of flooding from reservoirs and other artificial sources;
- The development is classed as a 'less vulnerable' development under the TAN15 guidance. A Justification of Location Test was required and shown to be passed;
- The nature of the proposed works means that the proposed development will increase the impermeable area and therefore surface water drainage improvements are required; and
- Infiltration testing showed that infiltration SuDS techniques are not feasible at the site. Therefore the proposals are to attenuate the surface water runoff and discharge at greenfield runoff rates to match the current regime.

This FCA provided an overview of flood risk on the site and it can be concluded that overall, there is a medium chance of flood risk. Despite the site being partially within DAM Zone C2 it is concluded that the development is suitable at this location.

8 Uncertainties and Limitations

This report has been prepared by Pell Frischmann with reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client in accordance with the agreed scope of services.

This report has been prepared solely for the use of the Client. The report may not be relied upon by other parties without written consent from Pell Frischmann. Pell Frischmann disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

The report details the findings of work carried out by Pell Frischmann during a study period in September / October 2022. The report has been prepared on the basis of available information obtained during that study period. Information provided by the referenced third parties has been used in good faith and is taken at face value; however, Pell Frischmann cannot guarantee its accuracy or completeness.

Although every reasonable effort has been made to gather all relevant information within the context of the agreed scope of work, all potential flood risk constraints or liabilities associated with the site may not have been revealed. Should additional Information become available (including new legislation and changed practices), after the date of the report submission, Pell Frischmann reserves the right to reconsider the recommendations and alter the report accordingly.