

**Archimedean Screw
Hydropower scheme at
Guyzance Meander**

**FLOOD RISK ASSESSMENT
including Land Drainage**

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Executive summary

The Coquet is a medium-baseflow river which has been subject to known high flood events. For the highest historic flood event, in September 2008, the corresponding peak flood level close to the proposed site has been established, and this has influenced the flood exclusion design of the scheme. The scheme demonstrates no increased flood risk in terms of its presence and operation, therefore the development is not considered to increase third party detriment.

Flood Risk Assessment

The Coquet is classed as a “main river”, meaning that the EA is the Lead Local Flood Authority. The EA’s flood map for this location was consulted, revealing that the proposed location is in Flood Zone 3. This confirms that the site of works may be affected by a flood that has a 1% (1 in 100) or greater chance of happening each year.

<https://flood-map-for-planning.service.gov.uk/confirm-location?eastings=421050&northings=603150>

“Water-compatible” development, such as water transmission plant, is permitted in Flood Zone 3. Low-head hydropower is by definition “water-compatible” development, as it must and can only be developed within the watercourse, and is designed for this environment. The EA has accepted this commonsense position in all recent cases. This applies both to the functional floodplain (Zone 3b) as well as to other “Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding” albeit not defined as floodplain (Zone 3a):

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table 3 - Flood risk vulnerability and flood zone compatibility .pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone_compatibility_.pdf)

While the installation is “water-compatible development”, any such new structures in such a location could themselves be at risk of flooding, or could potentially exacerbate flood risk. For developments at risk of flooding from the river, and specifically for those in Flood Zone 3, a proportionate level of Flood Risk Assessment (FRA) must be undertaken. This is required as supporting evidence for the planning application (to which the EA is a statutory consultee for purposes including flood risk) and for the EA’s own Environmental Permitting process for flood risk activities on main rivers (formerly known as Flood Defence Consent).

The present document constitutes a Flood Risk Assessment of proportionate scale, to be submitted with the Planning Application and the EA Environmental Permitting application. Via qualitative assessment this demonstrates that the proposed development does not increase the risk or extent of flooding; and by establishing a peak local flood level datum, it is confirmed that the development itself is water-compatible and designed to tolerate flood levels.

For this rural location, the EA is unable to provide “Product 4” flood risk data to inform analysis. Assessment is instead based upon locally known past flood levels.

The worst flood on record occurred on 6th September 2008, where the level is seen from photographs to have reached a point which has been surveyed as 19.51 mAOD at Guyzance Hall's West Lodge (NGR NU2077003761). Peak flow gauged at Morwick, reduced by ratio, gives 507.4 m³/s as an indicative peak value at site.

<https://nrfa.ceh.ac.uk/data/station/peakflow/22001>

This 2008 historic maximum flood event was confirmed as exceeding all local floodmarks, such as those at nearby Guyzance Mill (NGR NU2063503489) where the high flood events of 1839, 1752 and others are recorded as marks on a wall.

Property identification references for these comments:

http://mapservices.historicengland.org.uk/printwebservicehle/StatutoryPrint.svc/276439/HLE_A4L_Grade%7CHLE_A3L_Grade.pdf

http://mapservices.historicengland.org.uk/printwebservicehle/StatutoryPrint.svc/47233/HLE_A4L_Grade%7CHLE_A3L_Grade.pdf

Flood risk to the development

The proposed turbine site is some 1km downstream of West Lodge, along a constricted channel form which will incur some head loss even in flood conditions. Therefore the West Lodge historic peak flood level is a conservative proxy for flood levels at the turbine site. As a precaution against future rises in extreme flood levels, the proposed building design has added an additional freeboard of 600mm to this already conservative indicator of worst historic level. Thus the proposed installation tolerates a worst flood level of 20.11 mAOD.

The proposed installation is designed in such a way as to protect its own equipment from foreseeable flood levels as well as to minimise its impact on wider flood risk. The control equipment is located within a watertight concrete envelope which is dimensioned and engineered to exclude the worst predicted flood level, any penetrations being sealed by proven suitable marine doors or glands. All operational tools and stores are also secured within this flood-resistant enclosure. Those parts of the installation which are outside this envelope (the screw, sluice gates, intake, etc) are resilient to flood conditions by design.

Flood risk effects of the development

A new development could exacerbate flood risk, and the potential for increased risk of detrimental impacts on properties would be of concern. In the case of a new run-of-river

hydropower scheme, there is potential for impacts along the reach of the flood zone between all new or changed structures, plus any area upstream where the river level will be raised, in cases where the new scheme will cause this.

This project **does not create any raised water levels** at any point in the river. Conversely, when operating, it causes a slight net lowering of river levels between the intake and discharge areas. When not operating, it has no net impact on water levels.

Flood Risk Assessment consists in detail of answering the following questions on specific impacts which have potential to cause detriment.

1. Will the proposed scheme reduce the flood flow capacity of the river, either by reducing the cross section or by slowing flows?

Not to any significant extent. The new above-ground volume of the proposed powerhouse (up to the flood exclusion level) is similar to the volume of material to be removed to accommodate the works. The screw itself is largely a void which will accommodate rising floodwaters. The weir and the existing main river channel will not be modified (e.g. narrowed or raised) at any point. On balance there is no net reduction in capacity.

2. Does the scheme propose any alterations to structures or construction of new structures in the river (such as weirs, dams, culverts or outfalls) or alterations to existing flood defences (such as embankments or walls)?

Yes. An intake structure will be created in the right bank at the upstream corner of the meander, feeding a buried pipe. The intake aperture will be screened to exclude debris and ingress, but during operation (in in-bank conditions only), the intake will admit water with small flotsam and suspended sediment. At or before bank-full conditions, flow into the intake pipe will be closed off by the sluice gate passively falling closed via a failsafe control. The upper part of the intake structure extends slightly beyond bank gradient to retain adjacent earth and provide safe access. This extension from the bank slope is kept to a minimum and will have no significant effect on flood behaviour. (Refer to drawings.)

At the downstream end of the new piped culvert, where the new screw turbine enters the tailwater, the machine is set on a concrete foundation which occupies a niche cut back into the existing line of the bank. The new works do not materially extend into the channel and will have no net effect on flood behaviour. (Refer to drawings.)

There are no adopted flood defences or known unadopted flood defences in the area of the development.

3. Does the scheme propose to create new channels or change the flow path in any way?

Yes, during in-bank flows only. Application has been made to the EA to license a regime which will redistribute flows between the main river channel and the intake, at all times remaining in favour of the main channel, with a minority taken into the intake. The regime agreed with the EA through licensing must have regard for conditions in the depleted reach of the main river. Under all flow conditions, all water reunites at the discharge point.

During operation, including when water levels rise at the onset of a high flow event, the system will conduct more flow than at present into the intake sluice and through the hydropower system. However this effect ceases before the tailwater rises to bank-full (as the fall at the turbine becomes low or zero, making the system physically unable to operate). Once the system cannot productively operate, the new intake sluice is designed to fall closed passively (failsafe) to protect the equipment. At or before bank-full at the turbine, the intake is always closed. Therefore the conveyance routes remain as at present during all conditions which are out-of-bank.

4. Does the scheme propose to deepen any existing channels?

No, except insofar as accumulated gravels and/or sediment would be removed from the riverbed in the immediate vicinity of the intake and discharge locations to achieve the desired velocity profile at these areas. Scope is limited to grading the bed within a few meters of these points (<10m at most).

5. Is the scheme in the floodplain as shown on the Environment Agency's flood map? Does the scheme reduce the available floodplain area or block potential overland flow?

Yes, the scheme is - and can only be - in the floodplain. (As per planning guidance on water-compatible development.) The reduction in overland flood flow or floodplain area is limited only to the footprint of the powerhouse, which in this context and in the absence of nearby receptors, forms no significant obstruction to rising flood levels.

6. Will the scheme change the available access to the river or adjacent flood defences for maintenance, including by construction of fences or walls around new structures, or of overhead cables?

No. No flood defences are present on site. No fencing or walling is proposed, and there is no net reduction in access to the riverbank. The proposed overhead cable at the installation is of minimal length to safely span the channel, and will not preclude maintenance. Its continuation east away from the river will be buried beneath an existing trackway. Other local cables on site will be buried in the new works.

7. Could the cumulative impact of current proposal along with others increase flood risk?

No. As set out above, the proposed development does not in itself increase flood risk. Therefore this proposal also does not add cumulative adverse effects to flood impacts. The necessary Environmental Permits must be and will be formally applied for, during which the proposed works are subject to appropriate consideration by the EA. Any potential flood risk impacts arising from and mitigated by this hydropower scheme and its works are anticipated to meet the EA's requirements for a development in this location.

Land drainage impacts of the development

A similar question may be posed specifically in terms of impacts on land drainage.

8. Could the individual impact or the cumulative impact of the current proposal along with others adversely affect land drainage?

No. The proposed scheme does not raise any existing river levels, does not create new open channels, and does not block drainage routes to the river, does not make any other changes with potential to adversely affect land drainage, and creates no wastewater. Rainwater on the new works infiltrates directly to ground and thence to the river. Therefore this application does not add individual or cumulative adverse effects to land drainage.

NB: EA records of current licensed discharge consents have been consulted, identifying six small-volume consents which connect to the potentially affected reach. These inflows are at locations distant from the works, and the scheme makes no changes which affect their ability to discharge.

EA EP reg#	Type	Premises	Grid ref#
NE/223/A/1018/001	Private sewage	(GUYZANCE HALL) WEST LODGE	NU2077003760
NE/223/0913/001	Private sewage	GUYZANCE HALL / BARNHILL FM	NU2128003700
NE/223/0913*/001	Private sewage	GUYZANCE HALL / BARNHILL FM	NU2150003600
NE/223/0634/001	Private sewage	GUYZANCE VILLAGE	NU2110004000
NE/223/0930/001	Private sewage	BANKHOUSE FARM	NU2095005050
NE/223/F/0446/001	Private sewage	BRAINSHAUGH FARM	NU2025003250

Application is made to the EA for Environmental Permits which are a legal prerequisite for the project. This includes consideration of drainage impacts of the project. It is anticipated that the EA will confirm no net impact on land drainage is to be expected from this project.