



Farchynys Flood Bank

Design Appraisal

CPF 7174



Document Control Sheet

Document Title:	Farchynys Control Structure Design Appraisal
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Project Ref / Title:	CPF7174 – Farchynys Flood Bank
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Revision History

Date	Version No.	Summary of Changes
11/02/2022	0.01	Initial draft version
	0.02	Draft revision following review
	0.10	Draft revision following comments from project sponsor
	1.00	Final draft to project sponsor for acceptance

Reviews

Name	Title	Date	Version
Eifion Glyn Davies	Senior Environmental Officer	23/02/2022	0.01

Approvals

Name	Title	Date	Version
			1.00

Distribution

Name	Title	Date	Version
			1.00

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ISO9001:2015
FS526386



ISO14001:2015
EMS 526388



ISO45001
OHS 526389

Contents

Contents3

Executive Summary.....4

Site Information4

Design Appraisal.....4

 Site Access 4

 Sheet Piling 6

 Culvert7

 Headwalls..... 8

 Flood Gate 9

 Foundation..... 9

Executive Summary

It is recommended that the Farchynys control structure be replaced with a precast concrete structure, with side hung flap doors. The culvert may comprise either a single rectangular box unit, or several concrete pipe structures. Their size will be dependent on the end slope, but preliminary sizing indicates a **2.4x1.5m box culvert** would provide sufficient cross-sectional area. The structure may be founded on spread footings, negating the requirement for excessive excavation.

Accessing the site from the highway is difficult, and transportation of heavy plant and equipment would require substantial temporary works. It is recommended that the majority of heavy works be transported and conducted from the water, utilising jack-up barges and pontoons.

It is recommended that a sheet pile cofferdam be created around the working site in order to construct the structure independent of tidal and weather conditions.

Site Information

The levee is approximately 1km long, and is located immediately south of the village of Bontddu. Bontddu is 7km west of Dolgellau along the A496 towards Abermaw (Barmouth).

The levee comprises is situated on the northern bank of the Mawddach estuary at grid reference 266735 318108. See Figures 1 and 2 below. It is approximately 1km in length and up to 4mAOD in height. It is likely to have been constructed in some form before 1889, this being the earliest indication on old mapping. Drainage of the marshland to the northern side of the flood bank is via a series of drainage channels and ditches and into the Afon Mawddach via an outlet culvert.

The flood bank itself is man-made and its core is thought to be generally cohesive and fine grained in nature consisting of firm to stiff silty clay, softened in areas. Large elongate angular cobbles and boulders make up part of the embankment thought to be for erosion protection of the core. The core is likely to have been constructed of site-won materials and therefore consisting of re-worked tidal flat deposits, built by hand and is over 130 years in age. The source of the coarser material is unknown.

Design Appraisal

Site Access

The breached section of flood bank is not accessible by vehicles. It may be feasible to construct a track from a nearby National Park car park to the North West, or alternatively a track along the levee from the Tyddyn Du campsite. Both routes would need to cross ditches, and there are also environmental risks. Using tracked machinery along the top of the levee bank would also risk further damage to the structure. Many of the following design options are recommended due to the nature of the site.

It is recommended that a pontoon/ barge be utilised, with plant machinery being loaded at Abermaw (Barmouth). This would avoid the need for significant temporary enabling works, and allow to be more independent of tidal conditions. The Barmouth Railway bridge may restrict access up river, and alternative options may be required. There's a small quay at Aberamffra – see Figure 3 below.



Fig. 1: View of Abermaw and surrounding area



Fig. 2: Railway Bridge, looking East



Fig. 3 Aberamffra harbour quay wall

Heavy components such as precast headwall units may be craned into place rapidly. This would reduce the risks associated with working in excavations that are within the tidal area.

Alternative loading locations may be suitable, such as off fields near Farchynys, reducing time spend travelling to site. Choosing a suitable loading location should be done in cooperation with the contractor, as their experience and knowledge about any size restrictions will be dependant on their own equipment.

Sheet Piling

The site is not easily accessible from the highway, and the tidal marine environment introduces other considerations. Underwater construction is possible, and underwater concreting methods do exist, however these are specialist skills, and maintaining good quality is difficult. Isolating the site from the tidal conditions provides a safe working area, and significantly reduces the reliance on good weather conditions.

In order to construct suitable foundations and safely install the new control structure it is recommended that the site be isolated from the Afon Mawddach during the course of the construction phase.

It is recommended that sheet piling is installed from a jack-up vessel, to create a cofferdam surrounding the work site. The sheet piles can be installed temporarily to create a dry working area.

Water and any remaining soil material will need to be removed to allow the construction of the foundation. Local ground conditions will need to be established to allow for the sheet pile design, and limit piping of water underneath the structure.



Fig. 4 Example of Jack-Up rig and Marine Sheet Piling

Culvert

Hydrology for the site was calculated as 5.474 m³/s for a 1 in 100 + Climate change event. In order to accommodate the flow, a concrete box culvert is recommended for the replacement structure. The site survey has not given a slope for the culvert, but a preliminary sizing indicates that it would be approximately 2400mm wide and 1500mm in height. The length of the culvert would be approximately 10m in total, comprising at least five precast units that are 2m in length.



Fig. 5 Example of precast culvert under construction

The culverts would be constructed off-site in a factory, allowing for better quality control during manufacture. There are also health and safety considerations, where the culverts would be manufactured under more controlled conditions, reducing the requirement to pour concrete within a tidal excavation.

With the use of pontoons and jack-up barges, heavy lift capability would already exist on site, allowing transportation of the culvert units to the site from a suitable harbour. The Precast units provide a longer design life than light weight options, such as plastic or coated steel may offer.

Using precast units would also reduce the time on site, and subsequently reduce construction risks, weather and tidal conditions would also be reduced due to the shorter construction phase. The culvert may be a rectangular box structure, or round pipe.

Headwalls

It is recommended that a precast concrete headwall be installed at either end of the culverts, these would be transported and installed in the same manner as the culvert units, via barge or pontoon. The precast headwalls will need to be designed to prevent silt from disrupting the operation of the tidal flap gates.

NRW may have specific requirements for the headwall and culvert to maintain the ability for marine life to traverse the structure. This might be glass eel matting, or pre-installed baffles within the structure. This will have to be discussed with NRW prior to the design stage.

Their design will be similar to the precast culvert units, but a significant apron may be required at the toe of the headwall to protect the structure foundations from scour or undermining.

Flood Gate

NRW are likely to request that any flood door be fish friendly. This reduces the available options, with requests from previous schemes for side hung doors. These doors are mounted onto the headwall via a steel frame. The door themselves are constructed from light weight polymer, with floatation tanks mounted to assist in closing.



Fig. 6 Example of twin leaf HDPE side hung door

Foundation

Existing ground conditions are considered suitable for a box concrete culvert on spread footings. The culvert will require a blinding layer for the correct placement of the pre-cast units. Geotechnical design of the foundation will have to be undertaken following detailed design of the culvert.