

Technical Note

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1. Introduction & aims of the study

The objective of this technical note is to summarise the design approach for the proposed sea defences to meet the planning requirements of *Welsh Government: Technical Advice Note (TAN) 15: Development and Flood Risk (2004)* at the location of the proposed educational building.

A topographic survey of the sea defences and foreshore was undertaken in September 2016 and this was used as a basis for analysing the overtopping requirements along the frontage of the sea defence.

2. Design Criteria

2.1. Overtopping

For coastal structures quantification of overtopping, i.e. the discharge of water over the crest, dictates the crest elevation required. Overtopping is dependent upon the crest level relative to sea water levels, wave conditions and other structure parameters such as the slope of the revetment, the revetment roughness, the presence of any berms or wave walls.

The usual practice is to design structures to defend at least against those conditions that would damage the structure itself. However, given the nature of the land use or development behind, it is necessary to provide higher standards for safety reasons and to prevent damage to property.

An important consideration is that buildings or infrastructure that lie behind a defence will not withstand significant wave overtopping and the sea defence is to be designed to have regard to the infrastructure's capability to withstand any wave loading and also the ability to drain away water that overtops the defence.

2.2. Safety

Account should be taken of safety under overtopping conditions. In particular, it is necessary to assess likely damage to other structures behind the line of the coastal defence, such as buildings, and safety of the public and vehicles on the crest of a structure or any footway or roadway immediately landward of the structure. Meeting these criteria necessitates larger sea defences than would otherwise be required to prevent structural damage alone.

At the proposed educational building location, it is feasible that pedestrians would be in proximity to the sea defence and therefore the criteria used for the overtopping assessment will need to take account of this.

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2.3. TAN 15 requirements

Natural Resources Wales (NRW) will assess the consequences of flooding against guidance given in Technical Advice Note, TAN15, Development and Flood Risk.

Over the development lifetime – taken to be 100 years for residential or 75 years for less vulnerable development (as a guide), it must be demonstrated that:

- Development is flood free for a 0.5% chance tidal event (i.e. 200 to 1 chance of occurring in any given year) to comply with Appendix A1.14 of TAN15.
- The consequences of flooding during a 0.1% chance tidal event (1000 to 1 chance of occurring in any given year) must meet the acceptance criteria for depth, velocity and rate of rise given in TAN15 Appendix A1.15. This includes the requirement that flood depth should not exceed 0.6m.

The existing outline planning permission (ref P2010/0222) accepted a design for coastal defences to year 2040 because of two factors:

1. There was uncertainty regarding the coastal geomorphology and whether the beach was accreting or eroding and that this would have an impact upon the required design of the rock revetment. It was therefore agreed that a monitoring condition (Condition 56) would be attached to the permission (P2010/0222) and that at the end of the monitoring period there would be a far better understanding of the works required.
2. There was a degree of uncertainty at the time of the outline planning permission regarding the likelihood of the implementation of the Tidal Lagoon which if constructed would shelter the University sea frontage from the worst effects of storm conditions. If the Tidal Lagoon is delivered then this would dramatically reduce the requirements for the rock revetment.

In view of this, the design approach this note details is a design to year 2040. This design takes account of the coastal and tidal regime in the short and medium term. The implications of the proposed Tidal Lagoon, which are likely to be favourable with respect to coastal defence, are not accounted for at this stage.

2.4. Criteria used in the analysis:

The calculations for the overtopping assessments were completed with the following assumptions:

- A roughness factor of 0.55 - which is associated with two layers of rock armour with an impermeable core (EurOtop 2007, Table 6.2);
- A raised still water level increased to account for projected climate change to 2040 (Welsh Government memo CL-03-16 'Guidance on Climate Change Allowances for Planning Purposes, 23 August 2016 and Flood and Coastal Defence Project Appraisal Guidance (FCDPAG 3) Economic Appraisal).
- A 5% increase in wave height for projected climate change up until 2040 (guidance indicates a 10% increase for years subsequent to 2055) (Flood and Coastal Defence Project Appraisal Guidance (FCDPAG 3) Economic Appraisal).
- Wave attack is perpendicular to the shore (an obliquity of 0°).
- Overtopping limits (EurOtop 2007, Table 3.2) as shown below:
 - 0.1 l/s/m for pedestrian safety up to the 1 in 200 year event;
 - 10 l/s/m for trained staff up to the 1 in 1000 year event.

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Table 3.2: Limits for overtopping for pedestrians

Hazard type and reason	Mean discharge	Max volume ⁽¹⁾
	q (l/s/m)	V _{max} (l/m)
Trained staff, well shod and protected, expecting to get wet, overtopping flows at lower levels only, no falling jet, low danger of fall from walkway	1–10	500 at low level
Aware pedestrian, clear view of the sea, not easily upset or frightened, able to tolerate getting wet, wider walkway ⁽²⁾ .	0.1	20–50 at high level or velocity

⁽¹⁾ Note: These limits relate to overtopping velocities well below $v_c \approx 10$ m/s. Lower volumes may be required if the overtopping process is violent and/or overtopping velocities are higher.

⁽²⁾ Note: Not all of these conditions are required, nor should failure of one condition on its own require the use of a more severe limit.

2.5. Design of revetment for proposed education building

It was noted from Atkins visual survey of the rock revetment (ref. 5104896-SBC-OUT-0181), dated 19 August 2016 (in the location of the proposed educational building) that behind the existing rock revetment progressive erosion had occurred to the dunes since prior inspections in 2012 and 2014. Also, the amount of rock revetment in this location is minimal, is at a low level (relative to high tide levels) and does not currently provide an effective sea defence and effectively it is only the natural dunes which provide any form of flood defence. With the proposals for a new building situated relatively close to the dunes and given the readily erodible form of defence, there will be a need to provide a formal sea defence structure to provide embankment stability, to prevent future erosion and to reduce overtopping.

The design approach includes for a new rock revetment to be constructed over the extent of the frontage of the proposed building and also that ties into the existing rock revetment sea defence formalised as part of the Phase 1 development.

By utilising a raised rock revetment to a level of 9.1mAOD in conjunction with retaining the upper portion of the dunes at a minimum level of 11.0mAOD, the amount of overtopping floodwater is significantly reduced and attains acceptable levels for pedestrian safety. This design has been found to be suitable for the full TAN 15 requirements for flooding as well as providing the benefit for pedestrian safety up to the 0.5%, 200 to 1 chance event to design year 2040. At the 0.1%, 1000 to 1 chance event the overtopping threshold is reduced to that for trained staff and it is reasonable to expect that pedestrians would not be close to the shoreline in such an extreme storm.

The design also provides for being able to:

- Store the flood volumes from overtopping of the sea defences.
- Disperse flood water quickly.
- Limit the depth of flood water within the site to a maximum of 600mm in the 0.1%, 1000 to 1 chance tidal events.

The design solution provides a swale which temporarily stores surplus overtopping flood-water during the extreme 0.1%, 1000 to 1 chance tidal event and prevents movement of overland flows towards the proposed building. The volume of water collected is small and may be dealt with by percolation into the sandy ground or alternatively can be dealt with by the site drainage system, using the swale as flood attenuation with a restricted outflow velocity (via hydrobrake or orifice control). The swale will have a natural landscape form which will be empty of water, apart from at time of flood.

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2.5.1. Building levels

It has been calculated for the planning requirements that the flooding of depth of 600mm maximum is not exceeded. The building layout should also ensure that there is a safe route of exit that avoids the flooded area. Gradients should be formed behind the temporarily attenuated flood-water that prevents the flow of flood water towards any building.

The proximity of the proposed educational building to existing buildings is likely to require a finished floor level similar to the existing buildings at 7.6-7.8m AOD. The final form of the construction of the swale and dune will be subject to landscaping design. However, the underlying principle of maintaining a minimum of 600mm flood storage depth must be maintained.

The level (elevation) of the swale is relative can be altered relative to other site levels providing a storage depth of a minimum of 600mm is provided.

The design is shown conceptually in Figure 1 below.

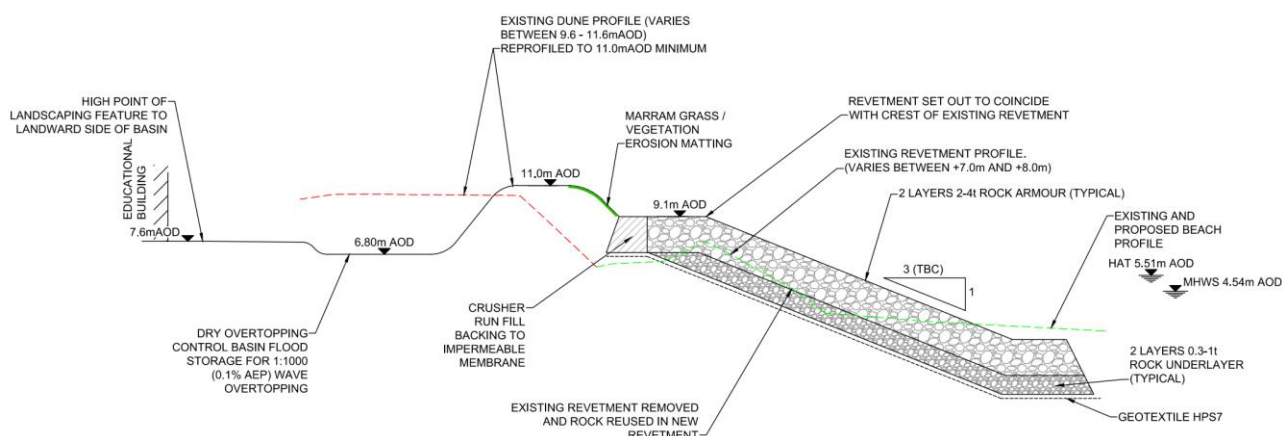


Figure 1 – Phase 1 – year 2040 design solution to meet planning and pedestrian safety requirements.

2.5.2. Form of revetment structure

Concept designs for the rock revetment have been more fully detailed on separate Atkins drawings ref 51048960-ATK-00-SK-Z-3000 and 3001. Whilst the level of the revetment and dune crest are critical parameters for the design, the concept design does not reflect the final construction which will be subject to contractor design for buildability and cost optimisation.

Optimisation of the design is anticipated to affect moderately the size of the rock armour used, the depth of the rock armour layers and selection of the appropriate slope, which will range between a 1 in 2.5 slope to a 1 in 3 slope or slacker.