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ATKINS

Sully Sports and Social Club

Flood Consequence Assessment

For St. Modwen Homes Ltd

2 June 2016

Plan Design Enable

Notice

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Document history

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Rev 1.3	Third issue – Client, Masterplan Updated	BW	PJ	RS	MP	15 Apr 16
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1. Introduction

Atkins Limited has been commissioned to undertake a Flood Consequence Assessment (FCA) on behalf of St. Modwen Homes Ltd (St. Modwen) to support an outline planning application for the development of a residential area involving construction of up to 200 houses and a detailed planning application for the renovation of sports club and pitches in Sully. This report describes the proposals, the implications of the development in terms of flood risk (to and from the proposed development), how the proposed works satisfy the requirements of the Planning Policy Wales and where necessary, provides an appraisal of possible mitigation measures to reduce the flood risks to acceptable levels. The drainage proposals for foul and surface water have been discussed separately in the Drainage Strategy Report (Atkins 2016) Ref: 5133321-DG-R&C002 Rev 1.4.

1.1. Sources of Data

The following data and information was obtained as part of this study:

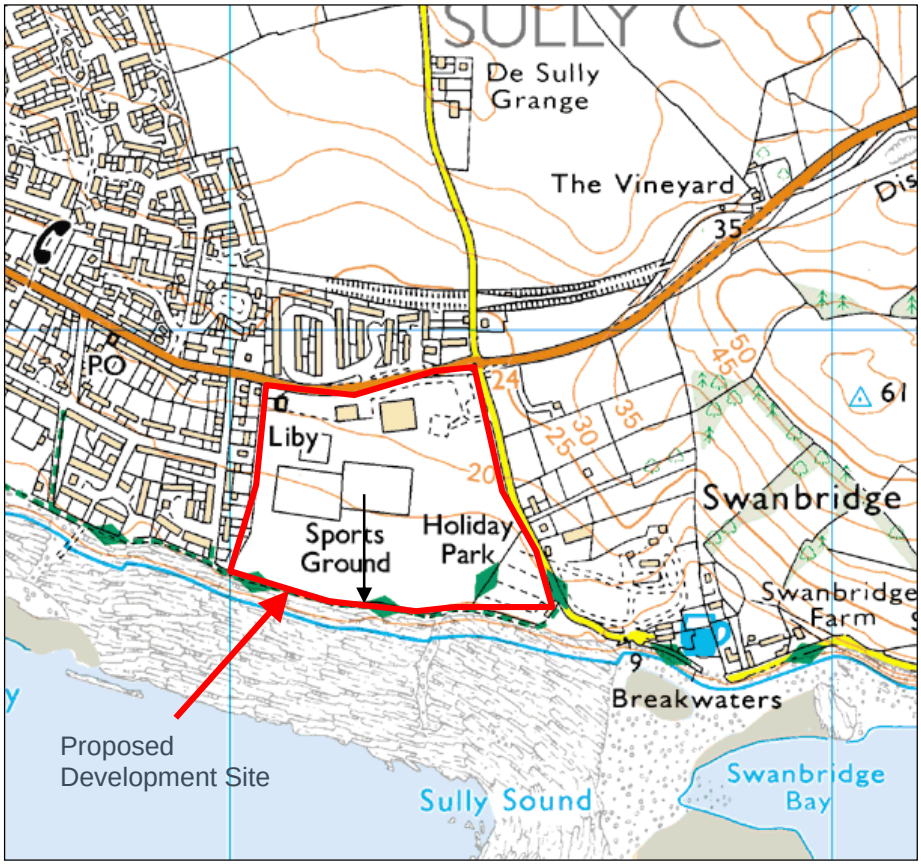
- Site information and conceptual master plan provided by the client, St. Modwen.
- Development Advice Maps for Sully Sports Club (http://data.wales.gov.uk/apps/floodmapping/)
- Topographic survey of existing ground levels at the site (August, 2014)
- Flood zone, surface water flooding, groundwater protection zones, groundwater vulnerability mapping on the Natural Resources Wales website
- Geology (solid and drift) maps at a scale of 1:50 000 and BGS scanned bore-hole data downloaded from the British Geological Survey website.
- Sully Sports and Social Club Geo-environmental Interpretative Report (Atkins,2014) Ref: 5133321 Rev 1.0
- Cranfield Soil and Agrifood Institute Soilscapes http://www.landis.org.uk/soilscapes/

2. Site Description

2.1. Location and Existing Land Use

Sully Sports and Social Club (post code CF64 5SD) is located near South Road (B4267), Sully, between Sully and Swanbridge in the Vale of Glamorgan. It is situated on the corner of South Road and Beach Road located approximately 11.3km south-west of Cardiff. Figure 1 illustrates the location of the site.

Figure 1: Development Site Location



The site is bounded by Island View Caravan Park to the south-east, South Road (B4267) to the north (with residential development beyond), an existing residential development to the west, a Welsh Water Pumping Station in the south-west, and the coastline to the south. The site is next to the sea, situated on the top of the cliff.

The site is approximately 350m by 400m wide at the widest point.

The existing land usage at Sully Sports and Social Club is depicted in Figure 2.The total site area is approximately 14.6 hectares. Of this area, approximately 0.9ha consists of existing developed surfaces namely a library (north-west corner), indoor bowling area (central-north of the site), the existing clubhouse (left of indoor bowling area), outdoor bowls club and 72 existing car park spaces (north of indoor bowling area).

The remaining site area is greenfield, comprising mainly of the club's existing sports pitches.

Figure 2: Existing Land Use at Sully Sports & Social Club

2.2. Topography

The site drops approximately 10m to 15m from South Road towards the southern boundary of the site near the coastline. The ground levels within the site range from 24.0mAOD (near South Road) to 11.06mAOD near the southern edge of the site.

It was noted during the site visit that the site is approximately 5m higher than the beach/ bedrock formation along the coast adjacent to southern boundary. A topographic survey of the site is included in Appendix A.

2.3. Geology/Ground Conditions

Inspection of available geology information held on the Cranfield Soil and Agrifood Institute Soilscapes website (Cranfield University) as shown in Figure 3, illustrates that the superficial layer of the soil on this site is freely draining slightly acid but base rich soils. The texture of the soil is described as loamy. The bedrock geology is identified as Mercia Mudstone as shown in Figure 4.

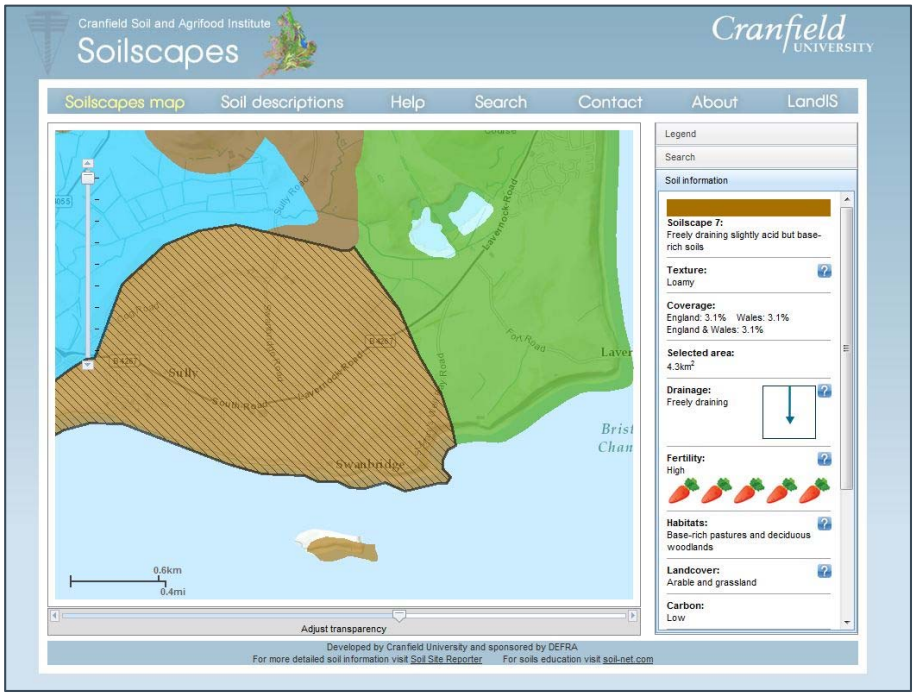


Figure 3: Cranfield Institute Soils Map

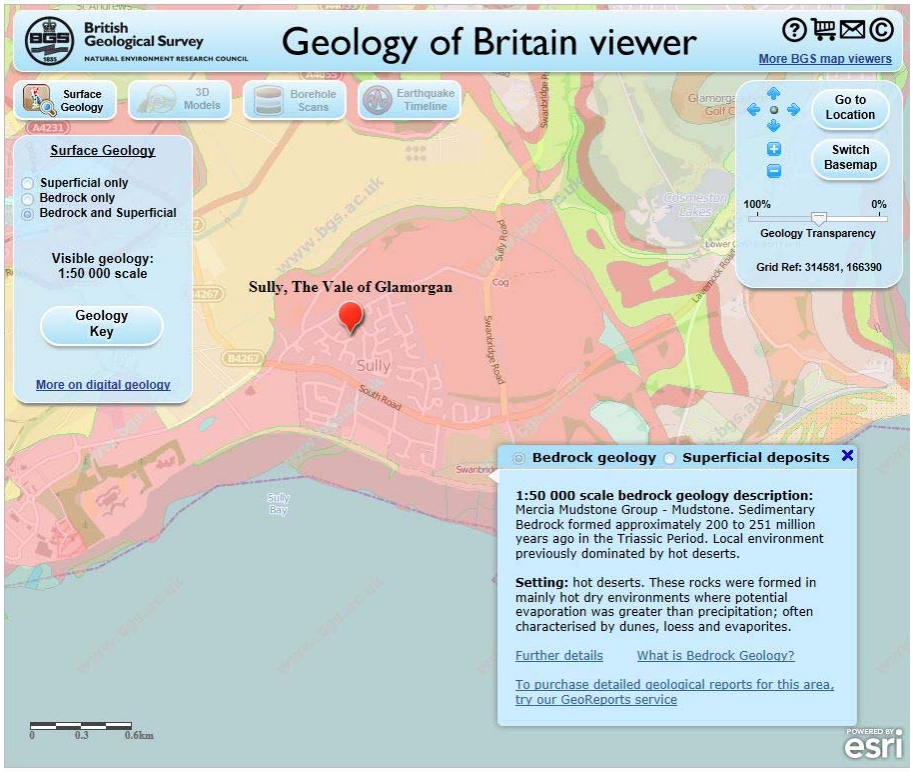


Figure 4: Bedrock Geology

2.4. Flood Defences

There are no known flood defences sited in this area although the site is defended from the sea by merit of its cliffs and ground levels.

2.5. Development Proposals

The following developments have been proposed at Sully Sports and Social club:

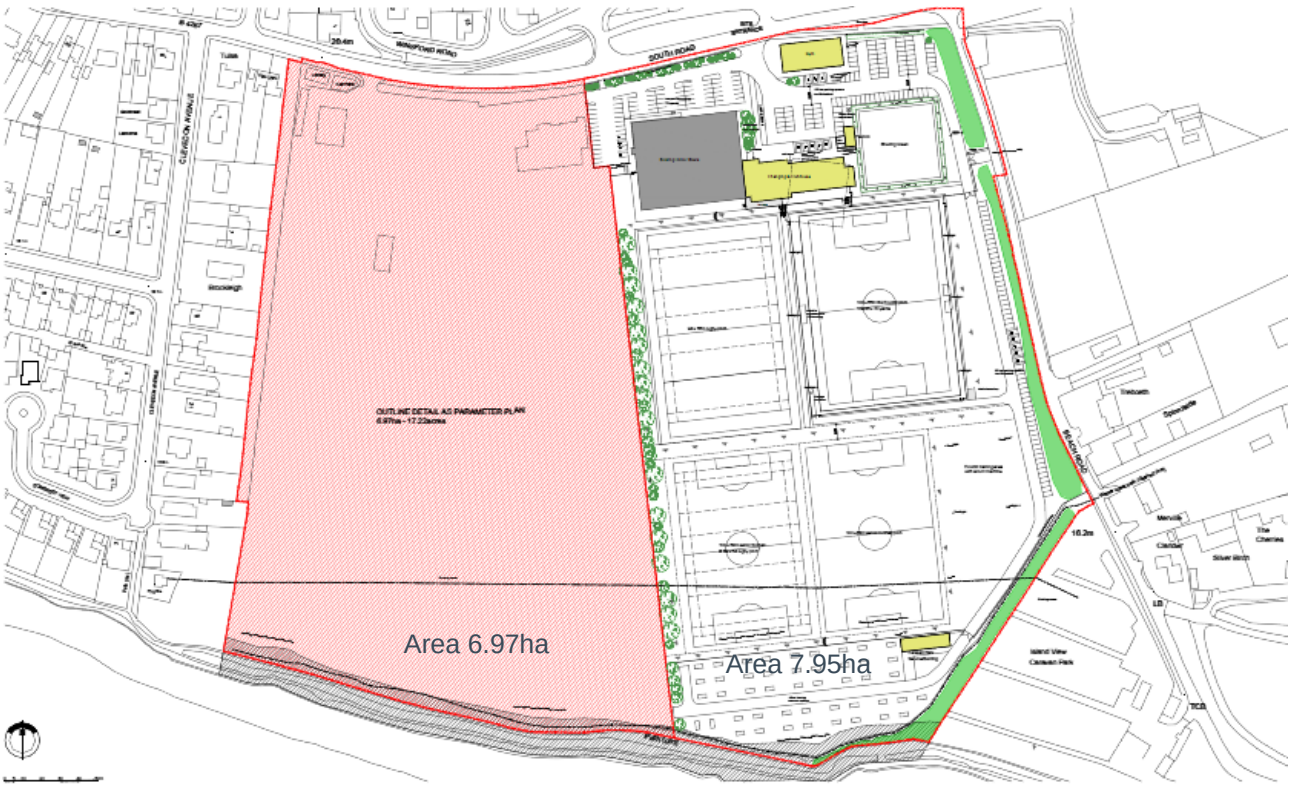
- The housing development proposal (6.97ha western site shown in Figure 5) involves construction of up to 200 houses. At this stage, the site masterplan is still to be finalised for the residential layout but it is envisaged that the residential development will include medium density houses along the northern boundary, low density houses along the western and southern boundary, a pocket park as focus for residential area acting as a gateway space and accommodating a new play area with links to the sports club and car park/vehicular loop to help create a low speed environment. It should be noted that the layout of these features may change as the masterplan evolves but the nature of the development is likely to be as described.

- The sports development (7.95ha eastern site shown in Figure 5) is to comprise of the relocated clubhouse adjacent to the existing indoor bowling area, four sports pitches and an associated training area, a new gym, 238 parking spaces and a touring caravan site with 46 pitches.

- A gym and parking spaces have been proposed in the north-east corner of the site, on an area of previously developed land.

The layout of the proposed development is shown in Figure 5.

Figure 5: Proposed developments at Sully Sports and Social Club



3. Policy Context

3.1. Planning Policy Wales

This study has been carried out in accordance with Planning Policy Wales. In relation to development in areas at risk from flooding, Planning Policy Wales (PPW) advises that local planning authorities should adopt a precautionary approach in the determination of planning applications and also in the preparation of development plans via the avoidance of development in areas defined as being at risk from flooding.

3.2. Technical Advice Note 15: Development and Flood Risk

Welsh Government Technical Advice Note "*TAN15 Development and Flood Risk*" advises setting out a precautionary framework to guide planning decisions with regard to new development in areas at risk of flooding. The overarching aim of the precautionary framework is to:

- direct new development away from those areas which are at high risk of flooding; and
- where development has to be considered in high risk areas (Zone C), only those developments that can be justified on the basis of the tests set out in the TAN should be located in these areas.

The detail and complexity of a FCA should reflect the level of risk to the proposed development. This guidance is available on the Welsh Government website: http://wales.gov.uk/topics/planning/policy/ppw/?lang=en. The guidance is based on the requirements for different development scenarios, based on the size of the development and the location within the flood plain.

3.3. Indicative Flood Risk

3.3.1. Development Advice Maps-Flood Zone Classification

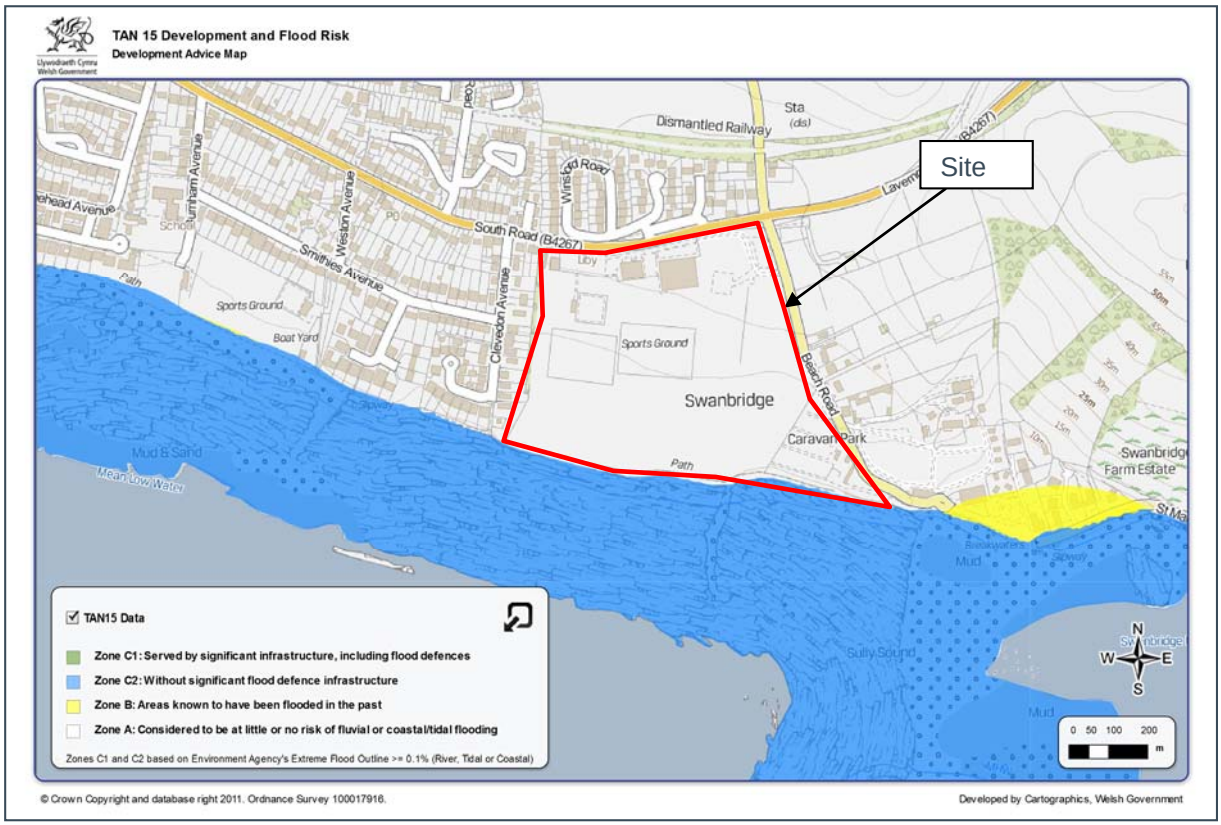
TAN15 uses Development Advice Maps which are based on the best available information considered sufficient to determine when flood risk issues need to be taken into account in planning future development. The development advice zones are attributed different planning actions as stated below:

- Flood Zone A: Considered to be at little or no risk of fluvial or coastal/tidal flooding
- Flood Zone B: Areas known to have been flooded in the past
- Flood Zone C2: Areas of the floodplain without significant flood defence
- Flood Zone C1: Areas of the floodplain which are developed and served by significant infrastructure, including flood defences.

An extract of the Welsh Government Development Advice Maps is provided in Figure 6. It illustrates that the proposed development is located in Flood Zone A, indicating that the site is at little or no risk of tidal and fluvial flooding.

However, the site is just adjacent to a C2 zone (the coastline & foreshore), hence, potentially susceptible to the risk of tidal flooding (as would be expected for a coastal location). This risk at the proposed development has been assessed in detail in Section 4.

Figure 6: Welsh Government Development Advice Map (TAN 15 Development and Flood Risk)



3.4. Nature of development or land use

The vulnerability of the proposed development or land use must be taken into account as the consequences of flooding may not be acceptable for particular types of development.

The proposed development involves the construction of up to 200 new houses, a clubhouse, gym, sports pitches, car parking and a caravan site. The TAN15 Guidance defines the Flood Risk Vulnerability for different development types. In the guidance, residential premises and caravan sites are classified as "Highly Vulnerable" although gyms and car parking are classes as "Less Vulnerable". As high vulnerability is the worst case of the two, this classification has been applied to the proposed development at Sully Sports and Social Club.

3.5. Acceptability Criteria

The summary of Policy requirements in the TAN 15 guidelines states the only acceptability criteria required for highly vulnerable developments in Flood Zone A is to ensure that there is no increase in flooding elsewhere. It also states for such developments no justification test and constraints relating to river or coastal flooding are required. However, surface water requirements needs to be considered.

The letter published by Chief Planning Officer dated 9th January, 2014 titled "*Flood Risk and Insurance Industry Changes*" reinforces national planning policy on flood risk. This letter summarises the sections of TAN 15 guidelines and emphasises that "*A proposed development must provide a safe and secure living and/or working environment throughout its life and that an assessment should include a flood event which has a 0.1% (or 1 in 1000 chance) probability of occurrence in any year."* It also states that the lifetime of development for residential development is 100 years.

Therefore, it is necessary to take account of the potential impact of climate change over the lifetime of development including a flood event which has a 0.1% probability of occurrence.

The "*Summary of what TAN15 requires for highly vulnerable development (houses) to be considered acceptable*", published along with this letter states that a Flood Consequence Assessment should be produced to demonstrate that the potential consequences of a flood event up to the extreme flood event (1 in 1000 chance of occurring in any year) have been considered and escape/evacuation routes are shown to be operational under all conditions. With respect of the residual risk to the development, it should be designed so that over its lifetime in an extreme (1 in 1000 chance) event there would be less than 600mm of water on access roads and within properties, the velocity of any water flowing across the development would be less than 0.3 m/second on access roads and 0.15m/second in properties, and the maximum rate of rise of floodwater would not exceed 0.1m/hour.

4. Assessment of Flood Risk

4.1. Overview

The Flood Consequence Assessment has the following objectives;

- Assessment of the consequences of flooding on the development.
- The consequences (i.e. the overall impacts) of the development on flood risk elsewhere within the catchment for a range of potential flooding scenarios up to that flood having a probability of 0.1%.
- The assessment can be used to establish whether appropriate mitigation measures can be incorporated within the design of the development to ensure that development minimises risk to life, damage to property and disruption to people living and working on the site or elsewhere in the floodplain.

4.2. Sources of Flood Risk

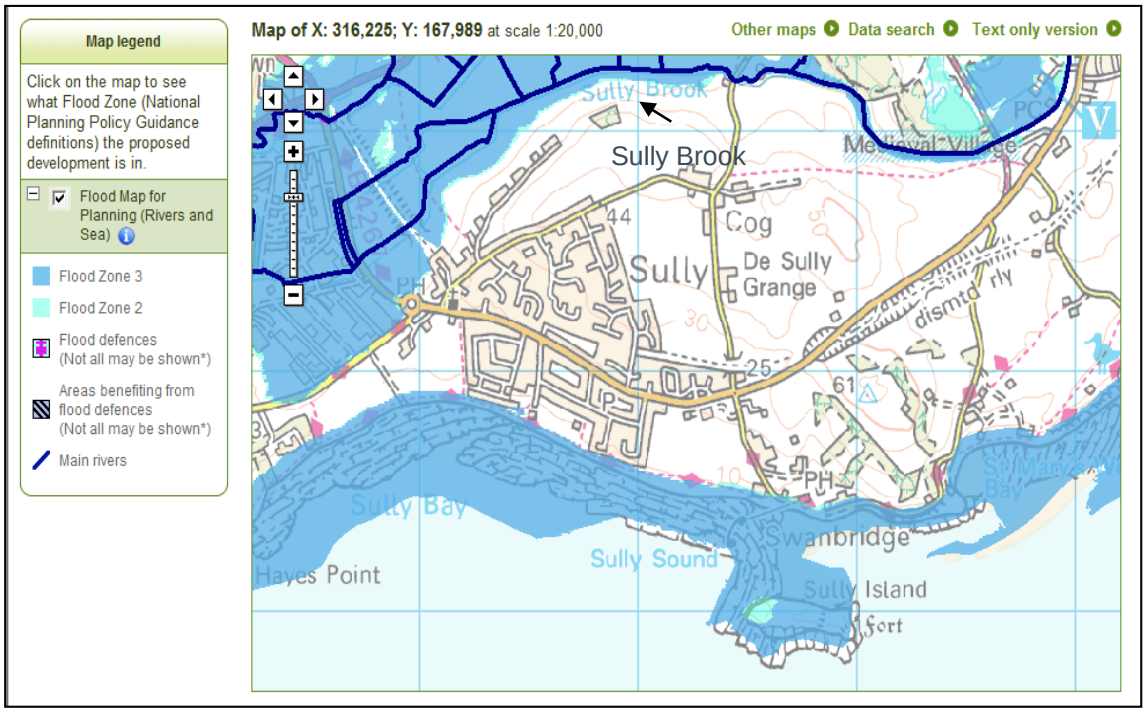
There are several sources of flood risk and flood mechanisms which have been investigated as part of this FCA. The primary forms of flood risk, which have been investigated, are:

- Fluvial flooding
- Surface water flooding
- Tidal flooding
- Sewer flooding
- Groundwater flooding
- Other sources of flooding

4.2.1. Fluvial Flood Risk

As discussed in Section 3.3.1, assessment of the Development Advice Maps has shown that the site is at very little risk of fluvial flooding which is attributed to its presence in Flood Zone A. Moreover, there are no watercourses in the close proximity of the site, with Sully Brook at a distance of 1.5km from the site. The Natural Resources Wales Flood Zone Map depicts that there is no fluvial flood risk at the site due to the Sully Brook (Figure 7).

Figure 7: Natural Resources Wales Flood Risk Map



Therefore, the site is not subject to fluvial flooding at least up to the 0.1% AEP event, with no known watercourse in the near vicinity of the site. Hence, this source of flood risk has been scoped out for any detailed assessment.

4.2.2. Tidal Flooding

Since the site lies in Flood Zone A, it is at very low risk of tidal flooding. However, the site is in close proximity to flood zone C2, making it potentially susceptible to flooding from the sea should conditions change in the future due to climate change and sea level rise.

In order to confirm the risk of tidal flooding, peak sea levels have been obtained from Defra / Environment Agency research Report "*SC060064/TR4: Practical guidance design sea levels: Coastal flood boundary conditions for UK mainland and islands*." This report provides extreme peak sea levels (relative to Ordnance Datum) of annual exceedance probability ranging from 100 to 0.01 around the open UK coastline. Each point is referenced to its chainage position in kilometres; the zero chainage point is at Newlyn.

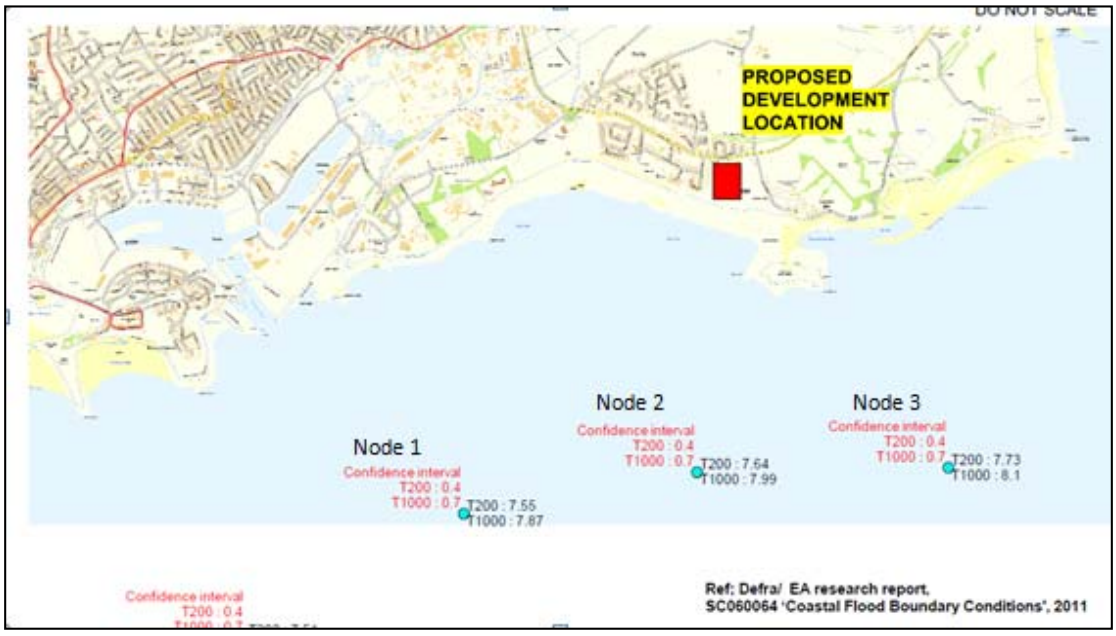
The extreme tide levels obtained from this report for 200 and 1000 year return periods for three nodes in close proximity to the site are depicted in Figure 8 and tabulated in Table 4–1.

Table 4–1: Predicted Extreme Tide Levels

Return Period	Extreme Tide Level (mAOD)		
	Node 1 (Chainage 424)	Node 2 (Chainage 422)	Node 3 (Chainage 420)
T200	7.95	8.04	8.13
T1000	8.57	8.69	8.80

**These levels include confidence allowance limits 0.4m (T200) and 0.7m (T1000)*

Figure 8: Sully Sports and Social Club - Extreme Tide Levels



4.2.2.1. Impact of Climate change

Projections of relative mean sea levels for any location around the whole UK coast are provided within UKCP09. Relative sea level rise projections account for future land level movements and regional oceanographic effects. These regional effects arise from the difference in change in sea level for the region immediately surrounding the UK compared to the global mean.

It is understood that the current Natural Resources Wales position with regard to the consideration of the lifetime of the development is to look ahead 100 years from the date that the development has been completed. Considering 95%ile confidence limit based on UKCP09, high emissions scenario provides approximately 1m of potential sea level rise over the next 100 years. Therefore, the extreme tide levels considering 1m of climate change allowance at the above discussed three nodes are tabulated in Table 4–2.

Table 4–2: Predicted Extreme Tide Levels including Climate Change

Return Period	Extreme Tide Level including Climate Change (mAOD)		
	Node 1 (Chainage 424)	Node 2 (Chainage 422)	Node 3 (Chainage 420)
T200	8.95	9.04	9.13
T1000	9.57	9.69	9.80

The estimated flood level from a 0.1% AEP tidal event plus climate change allowance of is 9.8mAOD. The lowest topographic level near the southern boundary at the site is approximately 10.4mAOD (the development site is typically 12mAOD, or higher), thus providing in excess of a 1 in 1000 annual chance plus climate change standard of protection for 100% area of the site. Therefore, the site is not susceptible to tidal flooding for a 0.1% AEP plus climate change tidal event.

However, these extreme tidal levels are still water levels only and do not include any wave overtopping. Hence, there may be an issue of splash during extreme storm events; however, the probability of this occurring is considered to be low.

4.2.2.2. Coastal erosion

The site is positioned above a small cliff face. Visual inspection during a site visit did not identify signs of significant instability, or erosion of the cliff face. There have been instability issues further along the coastline, with high profile collapses last year. Further investigation should be carried out by geotechnically qualified staff to ensure that any risk of instability and erosion over the development lifetime has been considered and understood.

Current guidance advises between 0 – 20m coastal erosion over the development lifetime with a “No active intervention” maintenance policy (Lavernock Point to St Ann’s Head Shoreline Management Plan (SMP2), 2013).

4.2.3. Groundwater Flooding

Emergence of groundwater at the surface (and subsequent overland flows) or into subsurface voids as a result of abnormally high groundwater levels is referred to as groundwater flooding. This can have a direct impact on buildings and services, as well as an indirect impact by increasing infiltration of groundwater into sewers and soakaways, reducing their capacity to convey surface water runoff.

Cranfield Soil and Agrifood Institute Soilscapes (Figure 3) indicate the surface layer at Sully Sports Club is typically a freely draining, slightly acidic soil. It is identified to be loamy in texture and have a mix of sand, silt and clay-sized particles. Freely draining soils absorb rainfall readily and allow it to drain to underlying layers. An extract of the 1:50000 British Geological Survey Maps (Figure 4) depicts that the bedrock underlying the site is Mercia Mudstone. This is in agreement with the geotechnical investigations undertaken at the site (Sully Sports and Social Club Geo-environmental Interpretative Report, Atkins, 2014) Ref: 5133321 Rev 1.0

Atkins were informed during the site visit by the Club's Director / ground staff that groundwater issues at the southern boundary of the site are approximately 4ft (1m) below the top surface during winter. This was however considered to be water percolating through the surface soils and running along the impermeable horizon, which is preventing further infiltrating, as opposed to sub-surface groundwater.

The site is thus considered to be at low risk of groundwater flooding.

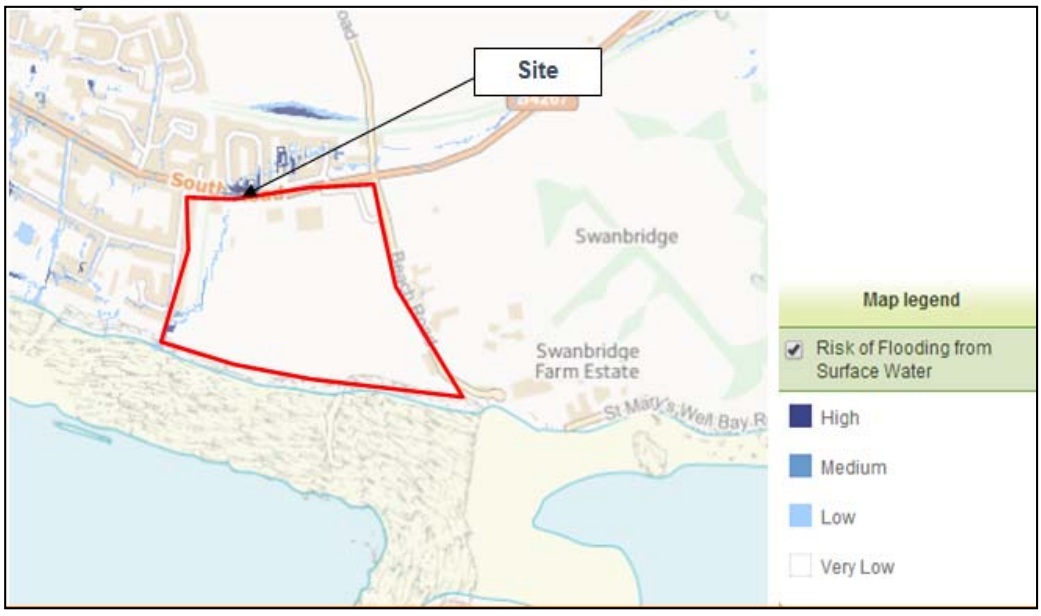
4.2.4. Surface Water Flood Risk

Flooding from the land can be caused by overland flow / runoff (known as pluvial flooding), and includes water flowing over the ground that has not reached a natural or artificial drainage channel. Very high intensity rainfall may result in flooding of the site either because the rainfall intensity exceeds the infiltration capacity of the ground or because the ground is already saturated. Excess surface water runoff can originate either from on-site or from adjacent sites.

The Natural Resources Wales "Risk of Flooding from Surface Water" (or Surface Water Flooding - SWF) Map has been inspected in order to ascertain the potential level of risk posed by surface water flooding in the area. The SWF map (Figure 9) depicts that the development site is at low to very low risk for surface water flooding, indicating a chance of flooding of less than 1 in 1000 (0.1%) from surface water.

The topographic levels on the site and the SWF map suggests that surface water flows naturally from the north-western to south-western corners on the site and a very small area on the south-western edge is susceptible to high risk of surface water flooding.

Figure 9: Natural Resources Wales Indicative Surface Water Flood Risk Map



4.2.5. Existing Drainage

To inform this FCA, an existing drainage plan was procured from Welsh Water and is included in Appendix B. This plan indicates that there is no existing public surface water drainage network within the site boundary.

From the site visit, and further inspection using Google Street view, gully traps have been noticed on the South Road (Figure 10). The gullies are located on the far side (north) of the highway, with cross fall of the road away from the site entrance. It is assumed that this is a highway drainage asset. The South Road slopes down from 24.3mAOD at the junction of South Road and Beach Road from the north eastern corner of the site to 20.78mAOD near the existing junction into the site, and continues to fall along the highway to the west.

Figure 10: View of the South Road adjacent to the Site depicting gully trap

Overland flows from sites adjacent to South Road could be conveyed to the development site within the road corridor, however it is expected that the highway drains associated with this road will route flows parallel to the site following the down-slope towards west. This is evident from the Natural Resources Wales Surface water Flood Map depicting South Road at high risk of surface water flooding while the site at low risk.

The outfall from an existing surface water drain discharging to the coastal frontage has been observed adjacent to the southern boundary of the site on the cliff face (Figure 11). This drain is not understood to be connected to the existing site systems. From discussions with the local authority drainage officer it is believed that this drain collects runoff from part of the residential area to the north of the site, however, its exact route and details are not recorded.

Figure 11: Outfall headwall from unidentified surface water outfall

Although the site is at very low risk of surface water flooding, the proposed residential area development tends to increase the surface area of impermeable ground, thus reducing percolation and increasing the rapid surface runoff. Therefore, the increase in surface water runoff needs to be managed to ensure no increased flood risk downstream of the site. Moreover, the surface water flow path is also expected to be obstructed due to the proposed development which may cause off-site impacts.

To ensure that the proposed development does not increase flood risk or have any off-site impacts, suitable mitigation measures needs to be adopted as discussed in Section 5.

4.2.6. Sewer Flood Risk

Flooding from sewers is caused by exceedance of sewer capacity and / or a blockage in the sewer network. In areas with a combined sewer network system there is a risk that land and infrastructure could be flooded with contaminated water.

The existing drainage plan procured from Welsh Water illustrate that there are no surface water or combined sewers on the existing site, although a foul network runs from the east to the west of the site and outfalls into the existing Welsh Water pumping station adjacent to the south-west corner of the site. A gravity sewer also runs along the site's western boundary to the pumping station. A rising main is present along the western boundary originating from the pumping station and pumping to the north and away from the site.

The proposed development involves construction of up to 200 houses which will cause a significant increase in foul discharges. The provision of a new clubhouse, gym and a caravan site will add further foul flows from the site.

The increase in domestic waste water due to the proposed residential development has been determined using the design flow rate for dwellings of 4000 litres per dwelling per day in accordance with Sewers for Adoption (7th Edition). This equates to a design flow of 11.6l/s. The additional waste water from the gym, clubhouse and caravan site is estimated to be 9.4l/s. Therefore the estimated design foul water flow rate for the whole development is expected to be approximately 21l/s. The detailed calculations are included in the Drainage Strategy Report (Atkins 2016) Ref: 5133321-DG-R&C002 Rev 1.4.

4.2.7. Flooding from Other Sources

There is no risk of flooding from the failure of reservoirs, canals or other artificial infrastructure.

5. Mitigation of Flood Risk

5.1. Tidal Flooding

As discussed in Section 4.2.2, the site is not susceptible to tidal flooding for a 0.1% AEP plus climate change tidal event. However, the extreme tidal levels adopted from Defra / Environment Agency research Report "*SC060064/TR4: Practical guidance design sea levels: Coastal flood boundary conditions for UK mainland and islands*." are still water levels only and do not include any wave overtopping. Hence, there may be an issue of splash during extreme storm events. Hence, it is recommended to keep the residential development zone away from the southern edge of the site.

5.2. Sewer Flood Risk

The additional foul load of 21.1l/s due to the proposed development (this assumes 250 houses but we note that the development will be no more than 200 houses, hence this adds a level of conservatism) and other elements requires the detailed design of a new foul water drainage system. This new system is expected to connect to the existing foul network (Appendix B) and outfall into the Welsh Water Pumping Station, situated adjacent to the south-west corner of the site. However, alterations or extensions to the existing drainage network needs to consider the type of drainage system in use, drains and sewer loading, details and positions of appliances connected to the system and condition assessment of the existing pipework. Most importantly, the capacity of the Welsh Water pumping station to cater for this additional load needs to be considered.

Therefore, the capacity and performance of the existing and proposed systems and the pumping station should be assessed to confirm that they continue to operate effectively and do not pose an increased flood risk due to insufficient system capacity.

5.3. Surface Water Runoff

Since the proposed development is on a mostly greenfield site, the increased runoff from the site would normally need to be managed to ensure flood risk is not increased downstream. However, the surface water system will outfall to coastal waters, and thus any increased runoff peak flows and volumes will not increase flood risk downstream.

Consequently subject to design in accordance with current standards there should not be any change in surface water flood risk to the site or adjacent areas as a result of the planned development. The detailed selection and design criteria for the surface water system have been considered in the Drainage Strategy Report, Atkins, 2016 Ref: 5133321-DG-R&C002 Rev 1.4.

5.4. Escape Routes and Emergency Evacuation

The southern boundary of the site is located adjacent to the coastline. However, from inspection of the extreme tide levels and ground levels near the southern edge of the site it is evident that the entire site is flood resilient to 0.1% AEP plus climate change tidal event.

The site is accessed via South Road which is located further north of the site, at a level of around 20-24.0mAOD (hence over 10m higher than the maximum tidal event allowed for). Therefore the site is not considered to be at risk of becoming cut-off from the access road by tidal flooding in the future.

With regards to pluvial flooding, as discussed in section 4.2.5 the highway drainage associated with South Road will route flows parallel to the site following the down-slope towards west, with a very small area on the road (down the slope) close to the library shown to be flooded. As a result access in case of emergency during extreme rainfall events is possible to the site.

6. Conclusions & Recommendations

6.1. Conclusions

Following this Flood Consequence Assessment Study for Sully Sports & Social Club, it is concluded that:

- The site is not subject to fluvial flooding at least up to the 0.1% AEP event, with no known watercourse in the near vicinity of the site.
- The estimated level from a 0.1% AEP tidal event plus climate change allowance is 9.8mAOD, which is around 0.6m below the lowest topographic level recorded at the southern edge of the site providing a 1 in 1000 year plus climate change standard of protection for 100% area of the site.
- The risk of groundwater flooding is expected to be low.
- The risk of surface water flooding is low, either from off-site sources or as a consequence of the proposed development. Surface water runoff from the site can be discharged to coastal waters, and therefore the potential increased peak runoff and volumes does not need to be attenuated.
- There will be an additional foul load of up to 21.1l/s due to the proposed residential development and other features of the site, which will require the design of a new drainage system and is expected to connect to the existing foul network and outfall into the existing Welsh Water pumping station (subject to reviewing capacity).

The only residual risks identified at the site are

- Splash flooding during extreme storm events.
- Investigation should be carried out by geotechnically qualified staff to ensure that any risk of instability and erosion over the development lifetime has been considered and understood.

This Flood Consequence Assessment has demonstrated that the potential consequences of a flood event up to the extreme flood event (1 in 1000 chance of occurring in any year) have been considered and have been able to meet the acceptability criteria as specified in "*Summary of what TAN15 requires for highly vulnerable development (houses) to be considered acceptable*."

6.2. Recommendations

- The residents are made aware of the residual risk related to splash flooding during extreme storm events.
- Detailed geotechnical investigations should be undertaken to consider the stability of the cliff over the lifetime of the residential development.
- The detailed development plan for the proposed development should be provided for accurate assessment of the hardstanding areas and thus surface water drainage system.
- The existing foul drainage system should be checked for capacity to cater the additional foul load generated from the new development. Moreover, the capacity of Welsh Water pumping station to cater the additional foul flows should be assessed.

7. References

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Appendices

Appendix A. **Topographical Survey**

Appendix B. **Welsh Water Existing Sewer Map**

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