

PDZ 10 DYFI:



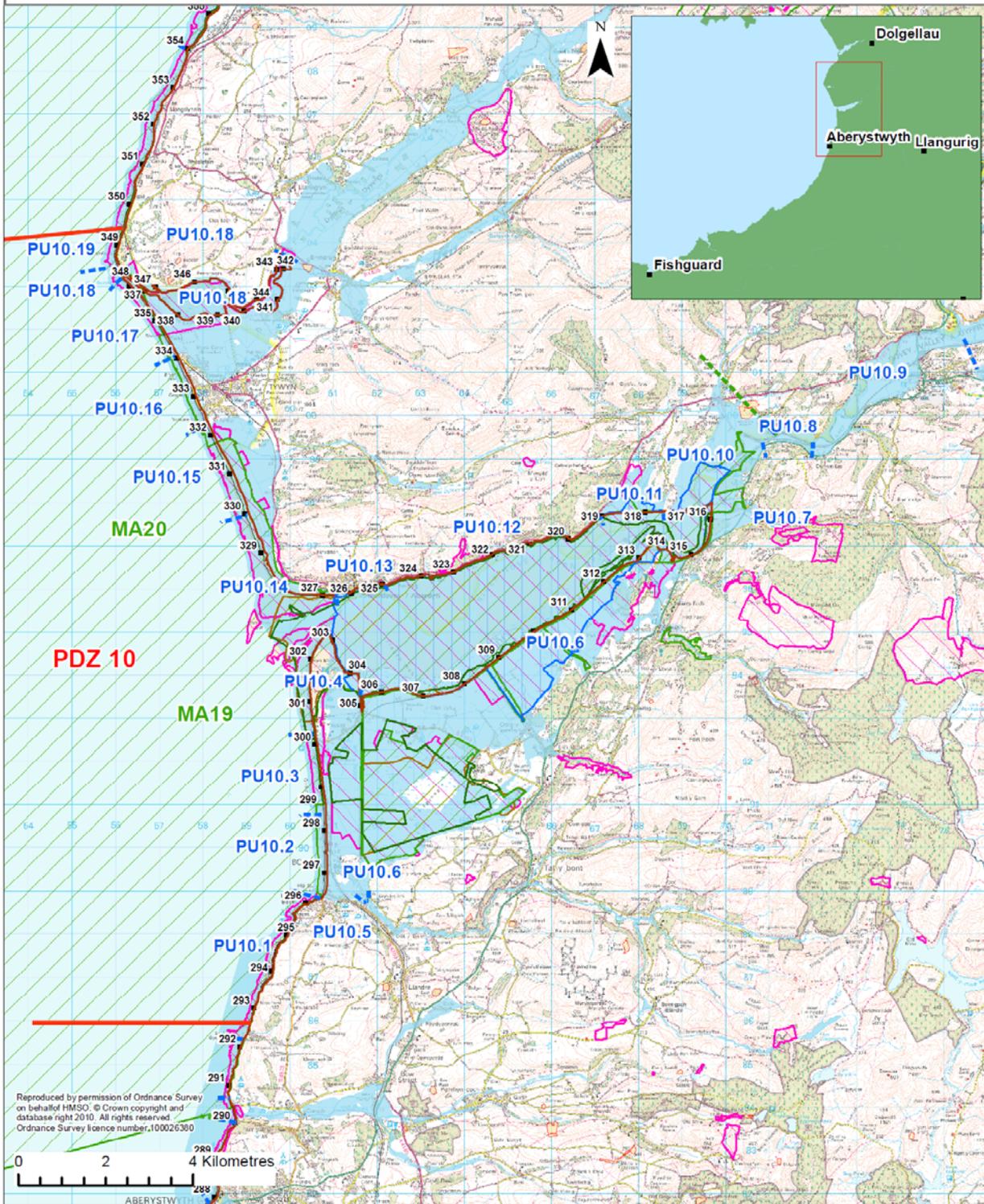
Borth and The Dyfi Estuary

Sarn Gynfelyn to Tonfanau.

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**Shoreline Management Plan Sub Cell 9
Baseline Location Map
Policy Development Zone 10 - Dyfi**



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Definitions of Scenarios Considered in Policy Development

This section defines the various scenarios that are used throughout the discussion of the Policy Development Zone.

Sea Level Rise

It is recognised that there is a continuing uncertainty with respect to Sea Level Rise (SLR). Taking different SLR scenarios may affect the scale of impact or the timing of some changes, either in terms of sustainable management or in terms of impacts. In the discussion below of the baseline and alternative management scenarios, the Defra guidance on SLR has generally been used. Where, in any specific area, the impact of SLR is felt to be significant and may change the context of management this discussion is held within a separate box, relevant to that section of text.

Management scenarios;

Unconstrained Scenario

Under this scenario, the behaviour of the coast is considered as if there were no man made defences, effectively if they were suddenly not there. Although recognised to be a totally theoretical scenario it does provide a better understanding of how we are influencing the coastal behaviour and therefore the stresses and broader scale impact that are introduced. This assists in assessing first how the coast might wish to change, but also in defining the limits of interaction which the SMP should be considering.

Baseline Scenarios

- **No Active Intervention (NAI) – Scenario 1**, where there would be no further work to maintain or replace defences. At the end of their residual life, structures would fail. There would be no raising of defences to improve standards of protection.
- **With Present Management (WPM)– Scenario 2**. This scenario applies the policies set in SMP1 or, where relevant, takes updated or clarified policies, if subsequent work has been undertaken e.g. studies or strategies. In many locations, the approach to management defined by SMP1 only covers a 50 year period. Where this is so, the intent of how the coast is being managed has been assumed to apply into the future. It should be noted that WPM does not necessarily imply a Hold The Line approach throughout the zone, in many areas present management may be for a No Active Intervention approach or one of Managed Realignment.

The aim of the No Active Intervention is to identify what is at risk if defences were not maintained. In a similar way, With Present Management aims to examine how the coast may develop, identifying where there are benefits in this management approach or where there may be issues arising in the future.

At the end of this sub-section a brief summary and comparison of the economic risk for each of the baseline scenarios is provided, based on the MDSF analysis undertaken during the SMP (including other study findings where relevant). The baseline scenarios are also assessed in terms of how they address the overall objectives for the Zone. This comparison between the baseline scenarios sets the scene for discussing possible alternative management scenarios which better address all the issues. This discussion is provided in the subsequent sub-section.

1

Local Description

The zone covers the coast between the cliffs at Upper Borth through to the start of the cliffs north of the Dysynni.

The initial assessment, provided in the introduction to the broader coastal area, highlighted the general open beach nature of the whole zone, anchored in the south and north by the hard rock headlands and in the centre by the emerging harder raised boulder clay control point of Tywyn. This long stretch of open coast is cut through by the Dyfi Estuary and to the north by the strongly constrained mouth of the Dysynni. With the local exceptions of higher ground at Ynyslas, Aberdyfi and Tywyn, the barrier beach, shingle ridges and dunes are backed by low lying land, much of it below normal tidal levels.

Within the estuaries, both the Dyfi and the Dysynni, have large areas of defended flood plain.



In the Dyfi a large proportion of the defended land, which also includes the exceptional natural raised bog feature of the Cors Fochno (SAC), is protected along part of the defence to each flood compartment by the main railway line to Borth and Aberystwyth. This defended land, which generally comprises agriculture and natural marsh, also has within it the B4353, which runs across the flood plain to Ynyslas and down the seafront of Borth. There are several properties, including farms, within this defended flood plain. This main area of defence is to the southern shoreline of the estuary, effectively enclosing much of the wedge of land behind the open coast ridge that holds the entrance to the estuary to the north of the valley. There are significant areas of saltmarsh in front of the defences.

Further up stream, the funnel shaped estuary narrows, with the channel meandering within the flat sediment filled valley between the higher ground at Glan Dyfi and the rock hill of Penmaen Isaf. It is within this flat valley floor that the railway divides, running south across the Dyfi plain and north along the harder steeper edge to the estuary, through to Aberdyfi. The station of Dyfi Junction sits upon the low valley floor. The main A487 comes to the estuary edge at Glan Dyfi and runs along the edge through to Machynlleth. Even in this area the valley floor is over 1km wide and the Afon Llyfnant Valley runs into the Dyfi close to Dyfi Junction.

The Dyfi valley narrows rapidly some 2km north of Dyfi Junction through a steeply sided valley between two large ridges, between Llugwy and Morben Hall. Just before the valley narrows is the Cefn-Caer Roman Site (SAM). The normal tidal limit (the limit to which the river ceases to be affected by the tidal flow) of the estuary is at Morben Hall, effectively where the valley narrows. Some distance further upstream the channel emerges from the narrow gorge and widens to the broader river valley. The town of Machynlleth sits on its rocky mound just 1km north of the narrow valley; with its sewage works and Abattoir down on at the edge of the valley floor within the lower part of the town. The road and railway run alongside the main river channel through the narrow section of the valley.

On the northern side of the valley, downstream of the narrow section, lies the village of Pennal and with the A493 bridge across the Afon Pennal. There is the small medieval Tomen Las Castle Mound (SAM) within the Pennal valley. West of Pennal, along the main road, is a small disused railway halt at Gogarth and the small valley of Nant Cwmsylwi. The northern railway line runs across the broad mouth of this valley.

The road and railway then run together along the steep rocky northern edge of the valley



through to Trefri and Penhelig at the eastern end of Aberdyfi. The railway runs behind the main road into the village, with the road running along the waterfront at a level of typically 6m to 7m AOD. In front of the road there are various old waterside properties (including the Library and Literary Institute), slipways and quays, through to the area of the Harbour, National Park Centre and new main car park. Aberdyfi is recognised as one of the iconic images of Wales and is an essential

feature of tourism in the area, not merely for its waterfront and harbour, its golf course and other facilities and many listed buildings, but as a centre for tourism for southern Snowdonia.

The whole estuary up to the narrows above Dyfi Junction is designated SAC with the SPA designation covering the same general area but also extending over large areas of farmland south of the railway.

On the open coast at the southern end of the zone are the high slowly eroding cliffs to the village of Upper Borth. The B4572 runs steeply downhill through the upper village to



the southern end of the sea front Here it is joined by the B4353, linking to the main A487 at Bow Street. The railway line follows the route of the B4353 following the upper valley of the Afon Leri. The location where the roads meet at the southern end of the sea front is one of the lower points of land in the village at just below 5m AOD. The Leri diverts slightly in land at this point behind the Ynysfergi hill and is then canalised all the way north, behind Borth through to Ynyslas, where it flows out to the Dyfi.

Borth is built largely upon the shingle ridge at the back of the wide sandy intertidal foreshore. At the southern end, principally, there is the old submerged forest beds exposed over the lower foreshore. The lifeboat station and slipway is at this southern end of the village. The central section of the village, south of the railway station, was certainly built up by the 1890s, but north of the railway station and possibly the area to the south of the village was developed later during the 20th century. The main village is built on both sides of the road with a row of over 50 houses constructed on the crest of the shingle ridge. The whole sea front, the wide expanse of beach and the upper shingle

bank is important to the village and one of its key attractions for tourism. The frontage is used for traditional family beach use, for water sports including wind surfing and surfing and for more general walking of the open 4km of beach.

At the northern end of Borth is a small holiday park and beyond that the long narrow area occupied principally by the golf course. The area to the west of the railway is generally pasture with some reed beds. It has been reported that over the fairway of the golf course, between the road and the timber defences, the surface of grass has been known to lift and fall to a small degree during very heavy storms when the whole shingle bank is under pressure from wave attack. Halfway along the golf course, which runs on the seaward side of the road right through to the dunes at the northern end, the main coast road divides to run up to and across the Afon Leri at Pont Leri. The railway line runs parallel to the road some 100m further in land. At the division of the road is the old Aberlerry farm cottages, formerly known as Aber Leri. This appears to mark the point where the Leri used to run sea ward of where the railway line is now and out to sea through the shingle ridge before it was canalised. The old course of the stream is marked by a freshwater pond which provides irrigation for the greens of the golf course.

The small hamlet of Ynyslas sits back from the coast on slightly higher hard rock ground. The road, continuing north, runs out onto the wide firm sandy beach landward of the dunes. The beach area is used as a popular car park area. There is a visitor centre, situated within the dunes at this point. The dunes have developed considerably compared to early maps, around the time when the railway was constructed. The dunes now run almost continuously through to the harder outcrop of Carrigypenhryn, which has always marked the southern edge of the entrance channel to the Dyfi.

The main road runs across the hard rock outcrop of Ynyslas, over the bridge at Pont Leri, where there is a small boat building works and a quay. The road crosses behind the railway line and runs across the defended flood plain to rejoin the A487 at Trer-ddol. At its lowest point the road is at a level of 2m AOD. The minor road where the B4353 joins is at the much higher level of 12m AOD.

To the west of Aberdyfi, the dunes extend to the south to form the northern entrance to the Dyfi. A sandy spit of dunes runs through into the mouth of the estuary and regular dredging to the harbour is undertaken. (This involves the removal of the wind blown sand at low water, by conventional plant) Current practice, since the 1990s has been to use the dredged sand to nourish the dunes further north. In the past, the main entrance channel to the Dyfi, on occasion, ran out more to the north and, with changes in the position of the channel, the nose of the shoreline has grown or eroded back.

Within the wide nose of dunes is the Aberdyfi Golf course, with the club house just



seaward of the railway line by Aberdyfi station. The Golf course extends some 2km north behind the dune line. Towards the northern end of the golf course, the higher, steeply rising relic coastline of hard rock sets back to create the broad low lying land of Penllyn marshes. The dunes along this frontage are low, compared to the dunes further south, and form no more really than a dune cap to the steep eroding shingle backshore. The front scrub dune

to the marsh is part of the SAC and this designation covers all the area of the golf Course dunes to the south. The main road and railway run to the back of the marshes over the slightly rising land behind. The Afon Dyffryn-gwyn runs across the marsh to its northern seaward corner where it is sluiced (controlled by tidal gates) through a low embankment and the shingle foreshore.

North of the Penllyn Marshes are the southern outskirts of Tywyn. The town sits over a higher ridge of land running down from the high ground of Graig Fach goch behind. The main core of town is set back from the coast, although runs down closer to the shoreline of the Dysynni to the north. The important sea front and recently improved promenade is situated central to the town. The promenade is flanked, to north and south, by large



caravan parks. There is a relatively wide, but low, intertidal sandy beach, backed by a higher shingle beach, in front of the promenade. At low water there is a slightly raise harder sea bed, seemingly in line with the ridge upon which the town sits. The town is an important centre for the hinterland area, as well as being a notable sea side destination. To the north the higher ridge narrows rapidly to merge into the 2km shingle ridge that closes off the valley of the Dysynni.

The railway line, which runs well back from the seafront through the town, follows along



this narrow ridge to cross the Afon Dysynni at the northern edge of the valley. The canalised northern entrance to the estuary flows out behind a much wider ridge of shingle, turning sharply south were it meets, at its northern end, the hard boulder platform of the shoreward root of the Sarn y Bwch at Tonfanau. The Tonfanau headland comprises a broad plateau rising to the back to the high harder rock of Tal y gareg, where the Tonfanau dolerite quarry is situated. This plateau is protected naturally by the

boulder platform at low water.

Behind the narrow ridge across the Dysynni valley is the Tywyn and Aberdyfi's sewage treatment works. The Dysynni has a very wide area of low lying land behind the artificially maintained shoreline ridge. To the northern side of this is a large intertidal area of sand banks and mud flats of Broad Water. The heavily accreted flat valley narrows some 2.5km in land of the shoreline at Ynysynmaengwyn. The valley continues past Bryncrug, where the main A493 coastal road crosses the valley and on up to Pont y Garth. It is only here, some 8.5km from the coast that the low valley narrows slightly and starts to climb more steeply in land. Over much of the lower valley the valley floor is very flat. The relatively narrow river channel meanders through this wider valley floor, with high embankments protecting the Dysynni low level drainage system and outfall north of Tywyn.

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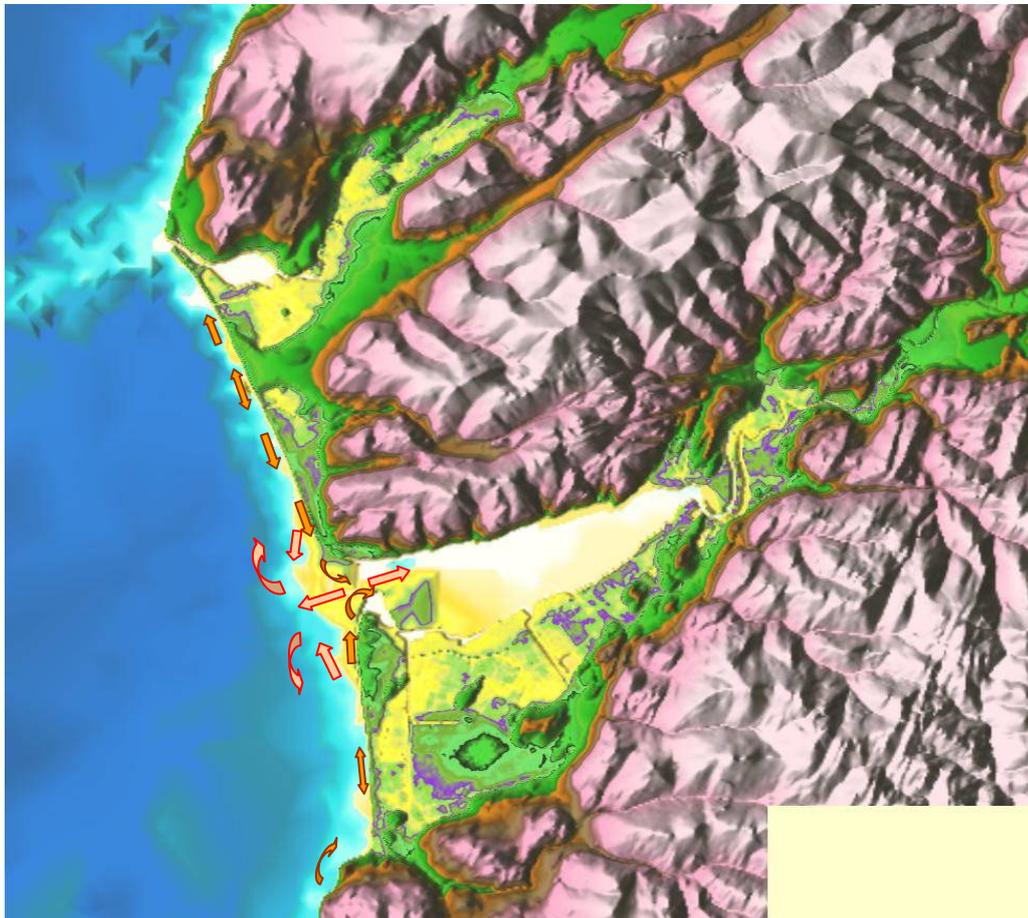
Coastal Processes

The offshore wave climate is dominated by energy from the southwest to west, although, particularly to the southern end along the Borth frontage there is significant exposure to waves from more northerly directions. As discussed in the introduction to the whole coastal area the whole frontage acts as an open barrier beach bay between the hard headlands to either end.

There has been significant modelling of both the frontages to the south and north of the Dyfi. All studies have shown the high degree of sensitivity of sediment transport to small change in wave climate. The consensus of study information, however, indicates that: in terms of the upper beach:

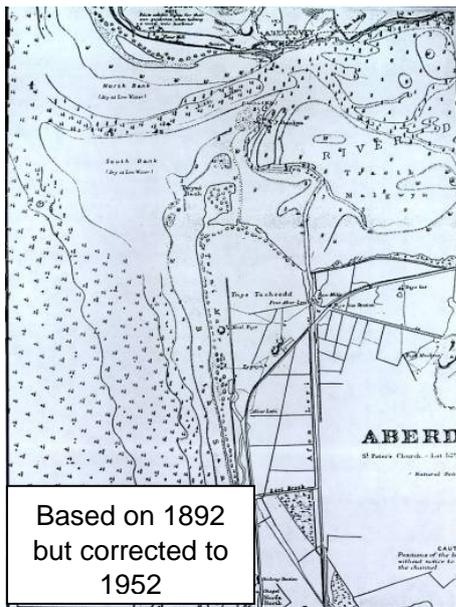
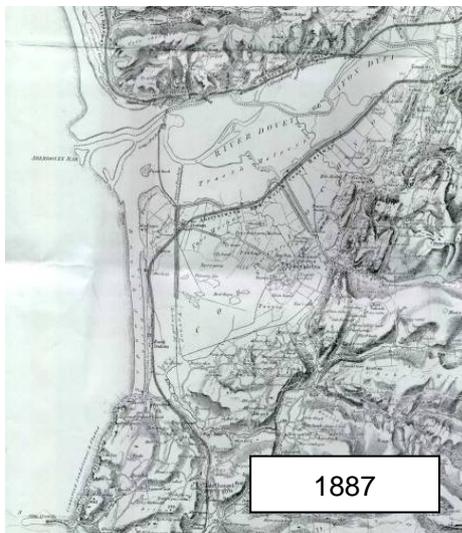
- Along the main Borth village frontage there is transport both north and south but little net transport. When shingle is moved north it then moves into the Ynyslas system where there is more persistent movement to the north. There is therefore net loss of sediment which is only partly compensated for by the supply from the southern cliffs.
- Along the Penllyn frontage there is a weak net drift to the south, with very little supply.
- Over the slightly forward position of Tywyn, there is no net drift but this is a drift divided. There is evidence that this frontage is also steepening as the lower foreshore erodes.
- North of Tywyn there is a net drift to the north and that this feeds the relatively stable northern area of shingle. There is little sediment feed to this section of the heavily modified backshore.

This general pattern of sediment movement is shown in the plot below.



At the mouth of the Dyfi, sediment movement both along the backshore and over the intertidal area is far more complex. In general terms, the backshore is protected to some degree by the nearshore ebb delta banks. This is often not picked up well in sediment modelling based on wave climate. Typically, therefore, as the backshore shoreline curves back in to the estuary sediment modelling tends to predict greater drift potential than is often seen in reality. The backshore of the spit of Ynyslas does quite clearly show movement of sediment into the estuary but from the evidence on erosion considerably less so than might be predicted. There is also clear movement along the intertidal area but this is dominated by tidal flow.

At the northern shore, there is very clear evidence of sediment movement into the estuary and this is both driven by wave and current action. However, the change in position of the nose is, from historical evidence, very strongly linked to the orientation of flow into and out of the estuary. The images below attempt to show the variation in configuration of the estuary mouth rather than a trend of long term development.

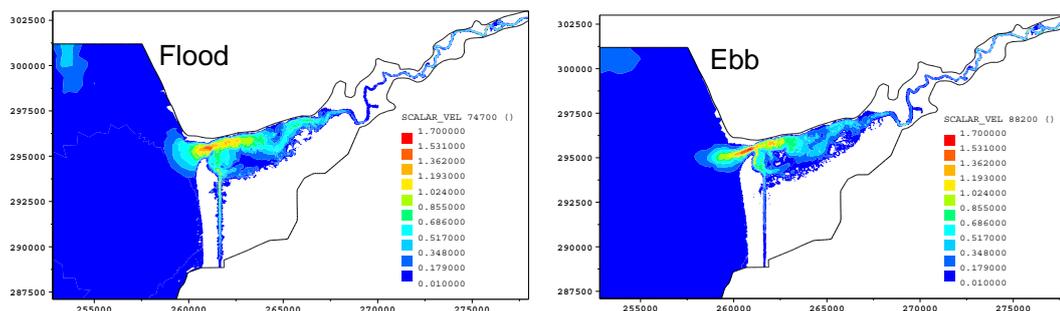


The following points are highlighted:

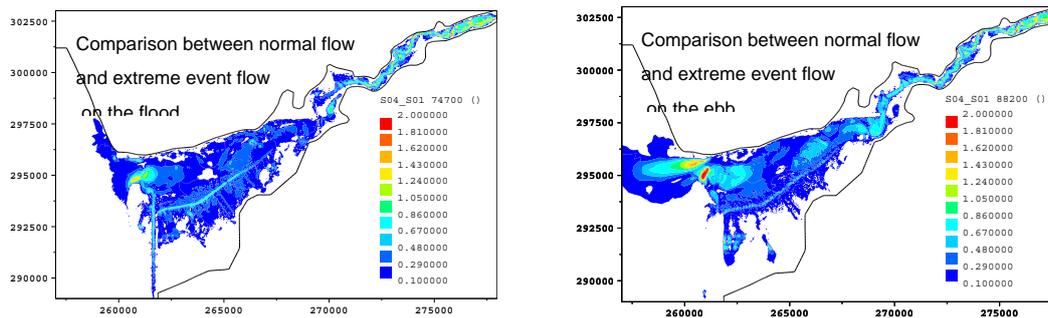
- The general position and orientation of the main channel can vary; this has been seen not just from charts and air photography but also in the position of the channel in relation to Aberdyfi harbour. In the plot, nominally of 1952, the strong sweep of the channel to the north appears to have broadened the north nose, moving the main area protected by the north bank further north.
- The southern channel, seen clearly on the air photograph, close to the Ynyslas Spit increases flood erosion on the northern side of the estuary, seen in the curious sharply embayed forms where southerly wave driven sediment is cut back by tidal flow. This channel can increase and decrease in significance.
- While over the upper intertidal shore of Ynyslas, the southern channel suggests a strong flood dominance, the lower channel through the southern bank shows strong ebb features feeding the southern bank
- The lower shoreline along the Ynyslas frontage shows a tendency for ridges to orientate in a direction facing out to the southwest, demonstrating the tendency for the lower shore to be held forward by the south ebb bank. This is seen as a repeated feature from the monitoring of the frontage.
- A similar feature is seen on the northern shoreline in terms of the ebb banks holding the lower foreshore, but here the northern shoreline is held more in a north south orientation, while the backshore sweeps around into the estuary.

Recent modelling (undertaken by the Centre for Applied Marine Sciences, Bangor University, commissioned by CCW) looks at the current and possible future management and condition scenarios in terms of affect on the Dyfi estuary regime.

Plots taken from this report, shown below, highlight changes between flood and ebb flows under present normal tide and river flow conditions, within the estuary. It may be seen that the pattern and regions of high flow vary significantly over the tide as suggested from the geomorphological commentary above. On both of the ebb and the flood, the highest flow is shown to be over the narrow entrance channel, maintaining the deep geologically constrained estuary entrance. On the flood there is a broad spread of accelerating flow over the nearshore area, with high flows extending and spreading quite broadly over the widening inner estuary. On the ebb, flow is shown to focus more along the Aberdyfi frontage acting as a narrow jet some distance over the nearshore area.



Plots comparing the change in flow between the average tidal conditions with average river flow and the extreme 1:100 river flow with a storm surge are shown below. It is seen that the largest change occurring on the flood is the increased velocity around Ynyslas. On the ebb, much larger change is seen in terms of flow out into the nearshore area.



It may be concluded that more extreme events may still significantly change conditions over the nearshore area in the future.

Geomorphically, the open coast is erosive, in that the coast is continuing to roll back. The central length of the coast is controlled by: the natural hard point at Tywyn (and increasingly by the railway revetment to the north), in part by the natural, harder higher ground of Ynyslas (but more dominantly in this area by the influence of the estuary). This process has in effect, (weakly at present), divided the coast into three developing embayments; along the Borth frontage, along the Penllyn Dyfi estuary frontage and between Tywyn and Tonfanau. These bays have possibly developed more significantly over the last few centuries as the coast has rolled back. In particular, over the northern bays, the more marked change in drift and behaviour has tended to put significantly greater pressure on the defences.

This pressure for the coast to roll back will increase with sea level rise, as will the pressure on defences where this movement is constrained by linear defence.

Over the lower foreshore, the processes are more connected over the whole frontage. Typically, it would be anticipated that, with this type of open coastal frontage, sediment tends to move towards the centre of the bay. With the strong influence of the Dyfi on this lower tidal area, sediment fed into the centre is carried both into the Dyfi, as the regime has developed an equilibrium, but also is thrown out into the nearshore area as the ebb bank delta. Sediment is then redistributed within the nearshore to feed sediment back to the shoreline. The indication that low water mark to the north is retreating inland suggests that the main redistribution of sediment is more local to the southern section of the overall bay and more limited to the north. This may also be an affect of the southern area gaining greater protection from large swell as a result of the southerly Gynfelyn Sarn.

Although the coast as a whole is moving, or rolling back landward, there is the potential for the shoreline to be fed by sediment from the nearshore area; the dominant underlying process is for sediment to move towards the shore. It is only where the shoreline has been allowed to setback: roll in land, that width is created for this to happen.

In terms of estuary processes, the Dyfi has tended to accrete, although not significantly over the recent past. The saltmarsh in front of the railway line, while eroding in areas, has tended to remain relatively stable. The modelling for CCW has tended to show that there is slight flood dominance over the larger lower area of the estuary. Upstream of Glan Dyfi, there is potentially weak ebb dominance. The modelling suggests that the

defence along the southern side of the estuary tends to focus flow in a more easterly direction, tending to increase flow as the estuary narrows. This may increase the impact of tidal locking of the river in the upper estuary. However, in modelling an unconstrained scenario, where the full estuary flood plain is developed, the indication of the affect of increasing the tidal prism (the volume of water flowing into the estuary) is that tidal levels may increase further up the estuary. With sea level rise the tidal influence moves upstream of the narrow section of the valley. This scenario is discussed further below in the section on flooding. The flat expanse of land to the south of the estuary has a significant affect on the way in which the tidal prism would develop if this area was undefended. At present the modelling report suggests that the tidal prism of the estuary would increase by somewhere in the order of 12% if defences were not present. Because the defended area has not been allowed to warp up naturally, unconstrained flooding under more extreme surge conditions would increase the prism by some 22%. This step in increased tidal volume would be similar with sea level rise.

The Dysynni acts as much like a lagoon as a fully active estuary, interacting with its



shoreline. This may in part be due to the heavily constrained entrance channel, but also in that, from a geomorphological perspective, the estuary may always have been constrained by a large barrier ridge as the coast developed over thousands of years. Sarn y Bwch would have held a larger width of sediment in front of the river entrance. This large barrier system at the coast has allowed substantial infilling of the old valley floor, creating the very uniform and flat land extending well into the valley.

With sea level rise, this plateau would flood, significantly increasing the potential tidal prism. If the shoreline barrier were allowed to breach then it is possible that a new active estuary mouth would develop. If the entrance channel remains fixed to the north, the increased flow will attempt to widen and deepen the channel.

POTENTIAL BASELINE EROSION RATES

A distinction is made between basic erosion of the shoreline and cliff recession, affecting the crest of cliffs and coastal slopes. This only applies in the zone to the cliffs at Upper Borth.

Sea level rise (SLR) will be a significant factor in future development of the shoreline, very slow erosion of the main hard headlands will still control the overall shape of the coast and they would be largely unaffected. Where there are softer cliffs or shorelines suffering erosion, the rate of erosion is likely to increase with SLR. This might be by a factor of 1.7 to 2.5 times the existing base erosion rate over the 100 years. Where there are more stable features, such as fully developed shingle ridges, there would be a natural roll back of the beach, potentially in the order of 10m to 40m, depending on the nature of beach and the coast behind.

Location	NAI Base Rate (m/yr)	Notes	100yr. Erosion range (m)
Upper Borth	0.1	Slow erosion of cliff	15
Borth	0.2	The main factor would be roll back with sea level rise	30 - 100
Ynyslas south	0.5	This will be influenced by the Dyfi	20 - 70
Ynyslas Dunes	0	This will be influenced by the Dyfi	15 - 30
Aberdyfi Dunes	0.1	This will be influenced by the Dyfi	15 - 40
Penllyn	0.3 to 1	Erosion would appear to have increased over the last 30 years	50 - 150
Tywyn	0.3	Defended clay cliff	30 - 80
Dysynni ridge	0.5	Roll back of shingle ridge	20 - 50
Tonfanau	0.1	Low lying land behind Sarn y Bwch	15 - 40

Base rates have been assessed from monitoring and historical data. The range of potential erosion is assessed in terms of variation from the base rate and sensitivity in potential sea level rise. Further detail on erosion rates together with erosion maps are provided in Appendix C.

FLOODING

Flooding is a significant risk in this area. At Borth there has been a history of wave overtopping affecting the village and the golf course to the north. In 1990, waves overtopped the shingle ridge running between the front line of properties and flooding the road and property behind. The back of the village is protected against flooding by the embankment along the Leri. Plots of normal tidal flooding (MHWS) without defences are shown below, comparing areas at risk at present day and with 0.36m SLR (nominal 50 years) and with 1m (nominal 100 years) and the more extreme 2m SLR scenario.

It may be seen that at present, while there is significant risk under extreme storm surges, that tidal flooding, even with predicted sea level rise in 50 years, would only marginally affect the main village area. In the future with 1m sea level rise, there would be risk of normal tidal flooding within the village, to the road and across the railway embankment.



It is significant that even with 1m sea level rise, the main area of the Cors Fochno raised bog would be above normal tidal flooding. The bog would be affected by saline intrusion of the surrounding land if the area was undefended.

Impact of different Sea Level Rise Scenarios

Under a 2m SLR scenario, the flood risk area would increase substantially to include much of Borth village. The core area of Cors Fochno would still be above normal tide levels. Only limited areas of Ynyslas would be affected.

The extensive areas of flooding shown above continue under the different sea level scenarios further along the southern shore of the Dyfi. This would affect areas along the north shore around Dyfi Junction as well as the area around the railway station. The railway station would only be at risk from normal tidal flooding under the 1m scenario, although it remains now at risk under extreme events. Sections of the railway line and the main road would be at risk with sea level rise at Pont Llyfnant, south of Glan Dyfi and at Gogarth.

With 1m sea level rise the tidal limit would extend further upstream above where the valley widens out below Machynlleth. This could well affect fluvial flooding to the town with the joint probability of high river flows and normal tide locking being more significant. The basic assessment of water levels, undertaken as part of the SMP, for the upper estuary, accord well with the modelling undertaken for CCW. The modelling shows normal tidal limits potentially up to the main bridge.

Impact of different Sea Level Rise Scenarios

Under a 2m SLR scenario, but only with an extreme surge conditions, would the lower parts of the town of Machynlleth be affected.

Only limited areas of the Penllyn marshes are below MHWS at present. With a 1:10 year surge much of the marsh and golf course are however at risk. The risk increases slightly with the nominal 50 year sea level rise. With 1m sea level rise significant areas of land close to the club house would be below MHWS.

Impact of different Sea Level Rise Scenarios

Under a 2m SLR scenario, the areas currently at risk under a 1:10 year water level would be typically below MHWS.

On the Dysynni, a large area of the valley is already below MHWS. This area would only increase slightly with the nominal 50 year sea level rise. With the 1m sea level rise there would be a substantial increase in area as normal tidal levels exceed the threshold of the flat sediment in-filled land covering the floor of the valley. Drainage issues would significantly increase with defended land becoming increasingly difficult to drain.



Impact of different Sea Level Rise Scenarios

Under a 2m SLR scenario, the areas at risk from flooding would not substantially increase over that predicted for 1m SLR; however, the depth below normal tide levels would be substantially greater. This would mean that land drainage by sluicing would be very difficult.

Under none of the sea level rise scenarios does the MHWS flood risk substantially extend into the core north part of Tywyn. There are local flood issues on more extreme water levels and under the 2m scenario the area around the sewage works and Morfa Camp could be below normal high water. This area is already at risk under present day 1:50 year event.

UNCONSTRAINED SCENARIO

As identified above the whole shoreline would, if unconstrained, roll back. This would lead to the loss of Borth, and the sea front at Tywyn as well as loss of the railway line across the Dysynni. The erosion at the Penllyn marshes appears to have become more rapid over the last thirty years but the reasons for this are uncertain. It seems probable that in part this has been associated with changes in configuration at the entrance to the Dyfi, which may still be cyclical. It may also be associated with the emergence of the Tywyn as more of a headland, tending to separate the Penllyn marsh frontage from the main behaviour of the overall bay and reducing sediment to the frontage. This Penllyn frontage, and the manner in which it is developing, suggest that it may breach rather than roll back in a uniform manner. It would wish to re-establish a barrier beach, but quite possibly there is insufficient material to allow this to happen. It may, therefore, form more as an over-washed shingle ridge, with regular flooding to the marsh behind. This would impose greater flood risk to the area to the south behind the dunes and within the golf course at Aberdyfi.

Within the Dyfi, under this scenario there would be no defences. In the area behind Borth, in the area of Cors Fochno, the natural flood plain would develop. This would increase the tidal prism, which may well increase the ebb delta effect at the entrance and could be beneficial for both Ynyslas and the Aberdyfi dunes; and potentially improve the situation along the Penllyn marshes. However, with this scenario the road through the southern flood plain of the Dyfi would be lost, together with the railway line. With the increased tidal prism, it is suggested; but not confirmed by the modelling, that water levels in the upper estuary may increase, however the velocity of the tidal wave apparently decreases. It is probable that over time the new flood plain would warp up with sediment, attempting to re-establish equilibrium.

There would be critical areas around the estuary: at Pont Llyfnant and at Gogarth where there would be increased flooding, and along the northern shore where in the absence of defence the road would be lost.

Within the Dysynni, the main impacts, apart from the loss of the railway line along the ridge, would be flooding of the Tywyn sewage works and loss of pasture land. Without the constraint of defences at the shoreline, the estuary may force a new entrance as sea level rise increases the tidal prism. This could have a beneficial effect on the way in which the shoreline develops. The low lying land within the estuary has the potential to warp up as sediment is redistributed.

KEY INTERACTION WITH DEFENCES

The defence at Borth has been based on an approach of strengthening the natural shingle ridge rather than fully anchoring the system. This is having a greater impact now as the shingle wishes to roll back and as there has been a loss of sediment generally. The proposed future management approach aims to increase the effective width of defence and as such works with the ability of the coast to adapt. However, without shingle beach recharge, this approach could limit sediment moving north along the shingle ridge and this would impact on the behaviour of Ynyslas, with increased set back of this frontage.

The works at present at Tywyn have reinforced the natural headland but have as a consequence reduced sediment supply to either side. These frontages would have had to set back anyway to gain benefit from such a sediment supply. The proposed approach to management aims to restore some sediment through recharge and, by increasing the width of the defence system, attempting to provide a more natural transition between the artificially maintained headland and the shoreline to either side. The defence does however reinforce the natural trend for separation between the Penllyn and the Dysynni frontages.

Locally the defence of the sluice at Penllyn is imposing an artificial constraint on the behaviour of the frontage and will, in time, be as significant as any works at Tywyn in stopping a more naturally resilient barrier developing across the marshes.

The defence along the Dysynni both stops the natural behaviour of the rolling back of the shingle bank and has started to create almost a new headland which is further dividing the natural bay across the Dysynni. This is likely to hold more sediment in front of Tywyn but as a linear defence is also decreasing the opportunity to allow the shoreline to adjust naturally.

Within the estuaries the defence of the southern marshes to the Dyfi, principally as a result of the railway line but also as a result of other defences in the area, constrains the natural development of the estuary flood plain. This is possibly influencing the mouth of the estuary. Within the Dysynni the impact of defences over the flood plain stops the natural development of the estuary and the ability of the flood plain to accrete.

3 Management Scenarios

3.1 No Active Intervention – Baseline Scenario 1

This scenario differs from that of the unconstrained case in that, while no further work would be undertaken to maintain structures or manage the coast, the existing defences would still have a significant residual impact.

At Borth, the existing defence relies mainly on the timber groynes and breastwork, strengthening and retaining the shingle ridge. The residual life of these structures, in general, is no more than 10 to 15 years. In epoch 1, therefore, these defences would fail, either slowly deteriorating or under the impact of a major storm. The defences would initially fail in sections and this would result in specific local breaches in the overall line of the ridge. This would cause weak points that would form as overwash fans, with shingle being spread over the hinterland behind. The result would be a breakdown in the overall coherence of the ridge. As the residual impact of the defences diminished, it is probable that the shingle ridge would be re-constituted over time and would again form a coherent barrier that rolls back naturally with sea level rise. The village of Borth would be lost very rapidly as defences failed in this patchwork manner. There would be little time for adaptation and it is possible that the village could be lost over a single storm by the end of epoch 1.

The defences to the Leri would fail over the same period of time and this would allow flooding to the rear of Borth and to the Cors Fochno area. The failure of the Leri defences, coupled to the spread of sediment from the shoreline could result in the Leri re-establishing its old course to the open coast perhaps during epoch 2. The railway line and road through Borth could be lost during epoch 1, if a major storm occurred, but almost certainly by the end of epoch 2. The increased flows into the undefended hinterland would in any event result in erosion through the various drainage channels and the embankment to the railway would be under greater pressure. The embankment would be increasingly, regularly overtopped, as sea level rises, and the flows over the embankment, although mitigated to a degree by the fact that there would be water behind the line, would tend to be washed out. The modelling work for the estuary suggests that some sections of the railway embankment are lower than the defences elsewhere on the Leri. During a large surge event, it might be such sections that are overtopped first. In this case the very high flow into the defended hinterland could well cause a failure and breach of the embankment.

Due to the sudden failure of the defence system over much of the area, there would be little chance for the important habitats to the rear to adapt, there would be saline intrusion into the raised bog and, because of the sudden change, this may result in extensive damage to the designated features. It is uncertain as to how this ecological system would then adapt. However, it is noted that the water table of parts of Cors Fochno is too far below the surface due to past drainage. Raising the water table requires management of the drainage around the bog and it is this, rather than maintenance of sea defences, which is required to increase the resilience of the bog to saline intrusion. A high water table and surface waterlogging is necessary for Favourable Conservation Status of Cors Fochno SAC.

Further within the estuary, there would be progressive failure of defences and, again, with little time to adapt, there would be serious consequences in terms of land use and habitat. The main road and railway line, both to the north and south, could be lost in epoch 3. The impact on flooding further upstream beyond the narrow section of the

valley is uncertain. However, there would be increased flooding eventually to Machynlleth in the long term.

Along the northern shore of the Dyfi there would be local loss of defence to the railway line and road. In particular there could be loss at Trefri and Penhelig, which would result in loss of both transport routes. This would isolate Aberdyfi. There is little scope in this area to move the road and railway back due to the steep land behind. The economic viability of Aberdyfi as a local and regional centre would suffer.

On the open coast, the failure at Borth, and the retreating shingle ridge would provide little additional shingle supply to Ynyslas as much of the impact would be that the shingle would be lost as overwash fans to the area behind the ridge. The Golf course would be lost and access to Ynyslas would be cut. The Ynyslas dunes would still be supplied with sand from the foreshore and as part of the larger ebb delta system.

On the northern shore to the Dyfi system, it is quite probable that the increasing tidal prism would hold naturally and sustain the dunes to the west of Aberdyfi. This in turn might provide some greater resilience to the front shore ridge of the Penllyn marshes. However, before this change occurred the present ridge would have breached and the marshes would be increasingly subject to inundation. This would change, but could create valuable habitat as an overwash brackish lagoon behind a low shingle barrier. Unmanaged, the area of the golf course would also become increasingly brackish, eventually forming a saline lagoon behind the dunes.

At Tywyn, prior to the recent works, would have failed during the first or second epoch. There would have been a period of increased erosion and the promenade and significant number of properties and the caravan parks would have been lost. This erosion would have imposed greater pressure on the railway frontage to erode. The rock revetment would not fail totally until possibly the second epoch, but the deterioration of the structure would allow increased overtopping and the use of the railway might be lost in epoch 1. The main road, even though it might be subject to increased flooding in the longer term would be the main and only principle access to both Tywyn and Aberdyfi.

With the flooding to the rear of Tywyn, and then the eventual failure of the shingle ridge, the sewage works to the town would be lost. Relocation of this infrastructure would be difficult with limited low land in the area which was above sea level. With the failure of the shingle bank by epoch 3, it is quite probable that the estuary would flow out to the centre of the valley. This could well create a sediment fan, which would increase the stability of the ridge to the north and allow sediment to build in front of Tywyn. There would be continued slow erosion of the Tonfanau frontage. This would impact only in the long term on the disused military heritage features of the area.

As sea level rises and as overtopping of defences within the Dysynni occurs, there would be sudden failure of defence to the pasture land behind. There is at present no opportunity for land levels to warp up (accrete) and the failure of the banks would result in a sudden change in the nature of the land, with little time for adaptation.

Impact of different Sea Level Rise Scenarios

There would be longer term influence in terms of areas affected by flooding. The main impact would be in increased rates of erosion and roll back on the coast and in bring forward possible failure of embankments generally. There would be increased flood risk to Machynlleth.

3.2 With Present Management – Baseline Scenario 2

Table below sets out the present management policies under SMP1. These policies were developed for a 50 year period. However, in terms of considering this scenario, the approach identified by SMP1 and as subsequently developed by strategies is extended over a period of 100 years.

SMP 1 No.	Management Unit	Policy	Subsequent Management Approach
Ceredigion			
16.1	Borth Cliffs	R	
16.2	Borth	HTL	Strategy for hold the line
16.3	Borth to Ynyslas	HTL	
16.4	Ynyslas	R	
17.1	Ynyslas Dunes	R	
17.2	Twyni Bach	R	
17.3	Aberdyfi		
17.4	Aberdyfi Dunes		
18.1	Borth Bog	HTL	
18.2	Dyfi Junction	HTL	
18.3	Dyfi northern shore		
Gwynedd			
1.1	Dyfi Junction to Gogarth Halt	DN	
1.2	Gogarth Halt to Penhelig	HTL	
2.1	Aberdyfi	HTL	
2.2	Aberdyfi Golf Course	R	
2.3	Penllyn	R	
2.4	Tywyn	HTL	Strategy for hold the line
2.5	Morfa Gwylt	HTL	
3.1	Tonfannau	DN	

The following information and policy is abstracted from the North West Wales CFMP Draft Plan. The policy units covering this section of the coast are Policy Unit 11, which takes in the southern side of the Dyfi and Policy Unit 7, which covers the northern half of the Dyfi and the Dysynni.

Preferred policies for Policy Unit 11 – Borth

Policy unit 11 Borth	This unit covers the coastal area between Borth and the Dyfi Estuary and includes Borth town and the Cors Fochno SAC and Ramsar site.
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Physical characteristics:

The policy unit is mostly rural with Cors Fochno (designated as a NNR, SAC, Ramsar and SSSI) covering a large central portion of the policy unit.

The town of Borth is located on the coast.

The catchment includes the Afon Leri and its tributaries and smaller rivers and streams flowing into the Dyfi Estuary.

The soils are predominantly brown soils and peat soils, which are sandy and loamy and well drained.

The underlying geology of the Borth area is predominantly sandstone and siltstone.

Contains the Borth Bog Internal Drainage District.

Flood mechanism:

Tidally influenced fluvial flooding in the Afon Leri catchment.

Receptor:

People, property and infrastructure in the urban areas along the coast.

Caravan parks, camping sites and cycle network.

Important railway lines.
Small sections of locally important A roads.
Environmental designations - SPAs, SACs, Ramsars, SSSIs and NNRs.
Historic designations – Listed buildings

The flood risk is likely to increase in the future. Climate change is expected to bring about wetter winters with more frequent and more severe storms. As the tidally influenced fluvial flooding increases as a result of the sea level rise. Flood damages are expected to increase by approximately 40% from £15.6 million to £22 million.

Policy selected

Policy 5 - Take further action to reduce flood risk.

Borth is at risk from tidally influenced fluvial flooding from the Afon Leri. The town and the Cors Fochno designated site are currently protected up to a 2% AEP flood event. However, once the floodwater overtops the raised flood defences during a 1% AEP fluvial flood event or greater, more than 1,000 people are at risk of flooding from the Afon Leri. In addition a fire station, police station, electricity substation and a sewage and water treatment works are also at risk of flooding from a 1% AEP fluvial flood event. The Cors Fochno SAC is also vulnerable to flooding and saline floodwaters could be detrimental to this important designation.

The policy unit objectives are to reduce the number of people and properties at risk and reduce the flood damages in Borth. In order to achieve this, a policy 5 has been selected. This means we intend to take further action to reduce the flood risk in this policy unit by looking to improve the flood defences and improve the flood resilience measures for individual properties. A policy 5 will also ensure that the flood risk does not increase to the internationally designated site, Cors Fochno, which is dependent on the raised defences.

A policy 1, 2, 3 would mean maintaining or allow the current risk to increase and would not reduce the number of people or properties at risk or reduce the flood damages. Therefore policy 1, 2 or 3 would not meet the objectives. Although a policy 4 would mitigate the affects of climate change, the overall risk would only be maintained at the current level and there would still be over 1,000 people at risk from a 1% AEP flood event.

As the Cors Fochno site covers a large proportion of the policy unit, there are no suitable locations to increase the frequency of flooding, therefore a policy 6 is not considered feasible in this policy unit.

Opportunities:

Reduce flood risk by influencing and informing the planning process.

To improve the sustainability of the flood risk management along the coastline and estuaries through influencing and informing the second generation of the Shoreline Management Plans.

- Reduce flood risk through improved flood warning and emergency response.

Constraints:

Government and international legislation, environmental management policies, plans and strategies for the catchment should be complied with, such as accommodating new housing within the catchment as detailed in the Wales Spatial Plan and compliance with the Habitats Regulations.

CFMP objectives must compliment those of the Cardigan Bay Shoreline Management Plan.

Historic development and some heritage designations present permanent physical obstructions in floodplains.

Tourism, leisure and recreation amenities are vital to the economy of the area.

Strategy Plans

Work with others to look at ways to conserve the Cors Fochno conservation site and reduce the flood risk to people and properties in Borth.

Strategic influencing

Seek funding to carry out flood resistance and resilience in Borth;

Produce a Strategic Flood Consequence Assessment.

Flood risk mapping and modelling

Undertake a flood risk mapping study for the Afon Leri in Borth;
Undertake an appropriate hydrologic and hydraulic modelling study.

Asset management/maintenance

Develop a System Asset Management Plan (SAMP);
Continue maintenance of the flood defences on the Afon Leri;
Continue with channel maintenance in the Afon Leri.

Urban drainage

Provide development control advice;
Promote and support the implementation of Sustainable Drainage Systems (SuDS) in all new developments.

Flood awareness

Provide information about how the communities can help themselves before, during and after a flood.

Flood forecasting and warning

Investigate the potential to introduce a flood warning area to include the Afon Leri and Borth;
Investigate the potential to install flow/level gauges on the Afon Leri to increase the efficiency of flood warning.

Flood incident response

Work with the Local Flood Planning Group to develop a Multi Agency Flood Plan;
Produce a local community flood plan for Borth.

Tidal flooding

Carry out a more detailed study to investigate the current tidal flood risks and future flood risks to Borth;
Encourage the second generation of Shoreline Management Plans to consider the tidal flooding problem in Borth.

Preferred policies for Policy Unit 7 – Coastal Lowlands**Policy unit 7
Coastal
Lowlands**

This unit covers the coastal strip from Cardigan Bay to Barmouth. The main towns are Fairbourne, Tywyn and Barmouth

Physical characteristics:

The policy unit is mostly rural, mostly low grade 4-5 agricultural land.
Urban areas are mainly located along the coast.
Low lying areas on the coastal strip of west Wales.
The catchment includes the lower reaches of the Afon Artro, Afon Dysynni, Afon Dyfi, Afon Ysgethin and their tributaries and smaller rivers and streams.
The soils are predominantly brown soils, which are sandy and loamy and well drained.
Contains five Internal Drainage Districts.
Variable geology including Ordovician, Cambrian and Silurian mudstones and shales with St Angus Sand formation strata on the coast.

Flood mechanism:

Tidally influenced fluvial flooding in the Afon Dyfi, Afon Dysynni, and in the town of Tywyn.
Sewer flooding in some of the urban areas

Receptor:

People, property and infrastructure in the urban areas along the coast.
Caravan park/camping sites.
Medium to low grade agricultural land.
Important railway lines.
Large sections of locally important A roads which link the coastal area to the rest of Wales.
Landscape designations – Snowdonia National Park.
Environmental Designations - SPAs, SACs, Ramsars, SSSIs and NNRs
Historic Designations – Listed buildings Scheduled Monuments, Historic Landscape Areas and Registered Parks and Gardens.

Climate change is unlikely to have a significant affect on the number of people and properties at risk of flooding in the coastal lowlands.
The flood zone modelling only showed a small increase in flood risk across the coastal lowlands, however further studies on the tidal affects from sea level rise will need to be carried out in more detail to assess the actual risk.

Policy selected

Policy 3 - Continue with existing or alternative actions to manage flood risk at the current level.

Flood risk in the coastal lowlands primarily derives from tidally influenced river flooding. Floodwaters are shallow, low velocity and short-lived, limiting the level of disruption caused. Climate change does not significantly increase the flood risk in this policy unit. As there is no significant increase in flood risk expected as a result of climate change, a policy 3 has been selected. This means we will continue to maintain the channels and local flood defences and retain the small area of flood warning on the downstream end of the Afon Dyfi to ensure the current level of risk is sustained. Stopping or reducing the existing flood risk management actions would allow existing flood defences to fall into a state of disrepair. The number of properties at risk would also increase. This would not meet the policy unit objectives and therefore policies 1 and 2 are unsuitable. However as there is no significant increase in flood risk due to climate change, a policy 4 and 5 is not required.

Although policy 6 provides opportunities for environmental benefits, on balance there is no evidence to support any social and economic gains from supporting and informing the agri-environmental land management initiatives as a way of reducing surface water run-off in the upper catchments and improving water storage in the lower catchments.

Opportunities:

To provide flood storage and enhance conservation value and biodiversity by restoring rivers to a naturally functioning state through the removal of Environment Agency owned and maintained structures.

Ensure no increase in run-off from the new developments proposed in the Wales Spatial Plan through development control.

Reduce future flood risk by influencing and informing the planning process.

Help meet national biodiversity action plan (BAP) targets through flood risk management activities.

To improve water level management, meeting the needs of flood risk management as well as enhancing wetland habitats through development of Water Level Management Plans (WLMPs).

To reduce flood risk and improve water quality by promoting and encouraging the appropriate use of SuDS in the proposed urban developments in the Wales Spatial Plan.

To improve the sustainability of flood risk management along the coastline and estuaries through influencing the second generation of Shoreline Management Plans.

To reducing surface water run-off and sediment loss in the upper catchments and improving water storage in the lower catchments through supporting and informing existing and developing environmental and land management initiatives, such as Tir Cynnal, Tir Gofal and Catchment Sensitive Farming.

Reduce flood risk throughout the CFMP area through initiatives and actions that will enhance the character of the landscape and increase amenity opportunities for recreation, tourism and leisure activities within the National Park and Areas of Outstanding Natural Beauty.

Reduce run-off from upper catchments through working with the Forestry Commission Wales and their Better Woodlands for Wales project.

Reduce peak discharge rates in rivers through restoration of watercourses to a good geomorphological river status (i.e. naturally functioning watercourse) in accordance with the Water Framework Directive.

Reduce flood risk through improved flood warning and emergency response.

Constraints:

Government and international legislation, environmental management policies, plans and strategies for the catchment should be complied with, such as accommodating new

hosing within the catchment as detailed in the Wales Spatial Plan and compliance with the Habitats Regulations.

Some environmentally designated habitats are susceptible to changes in flood frequency, flood water chemistry, groundwater levels and drainage system maintenance.

Visual impact of flood risk management activities within the National Park.

CFMP objectives must compliment those of the Cardigan Bay Shoreline Management Plan (SMP).

Presence of protected species with specific water level, water quality and habitat requirements, such as freshwater pearl mussels and water voles.

Large number of river catchments operating individually.

Historic development and some heritage designation present permanent physical obstructions in floodplains.

No degradation of existing fish passage and habitats.

Some exposed and subsurface archaeological sites in the floodplain are susceptible to changes in water level, flood frequency and water chemistry

Strategic influencing

Continue with the review of the management of Internal Drainage Districts;

Encourage the up take of flood resistance and resilience measures by people at risk from all sources of flooding.

Flood risk mapping and modelling

Develop an understanding of flood risk in Tywyn;

Undertake an appropriate hydrologic and hydraulic modelling study.

Asset management/maintenance

Develop a System Asset Management Plan to review management regimes to maintain current level of flood risk into the future;

Continue maintenance of flood defences in, Tywyn;

Continue maintenance of the main rivers for flood risk benefits;

Continue to monitor and record asset data.

Urban drainage

Provide development control advice;

Promote and support the implementation of Sustainable Drainage Systems (SuDS) in all new developments.

Flood awareness

Provide information about how the communities can help themselves before, during and after a flood.

Flood forecasting and warning

Continue work on the flood warning project.

Flood incident response

Produce a local community flood plan for Tywyn.

Tidal flooding

Carry out an appropriate study to identify the future flood risk as a result of sea level rise, in Tywyn;

Encourage the second generation of Shoreline Management Plans to consider the tidal flooding problems in Tywyn.

The Catchment Flood Management Plan (CFMP) for this region examines principally the fluvial flood risks. This plan identifies the main areas at flood risk, in the future as well as present flood risk is to the Borth area. The preferred policy option is different on the south and north of the Dyfi. Policy 5 is adopted for the southern side, this aims to increase the level of flood defence principally along the Leri to prevent damage at Borth and to the internationally designated sites. This would be supported by increased effort in terms of flood resilience and flood warning. Policy 3 is adopted for the north of Dyfi, this would aim to maintain defences but not increase these with sea level rise. This would be supported by improved flood warning and efforts to maintain flood storage to reduce high peak flows.

In general the policy intent of SMP1 to Hold the Line to the Borth and the southern part of the estuary and it would be consistent with the policy of the CFMP to raise defences behind Borth. The SMP policy to hold the line to Tywyn and Morfa Gwylt is not inconsistent with the CFMP policy to maintain but not raise defences within the Dysynni.

Taking the above approach as defining in general terms the With Present Management scenario, each area of the PDZ is discussed below.

At Borth, and in relation to the low lying land behind, the risk is both from erosion or roll back of the shoreline and in relation to the flood risk management of the hinterland. In terms of the coastal strategy, which is being taken forward as a scheme for management, the approach recognises the difficulty of continuing to defend the shoreline, but also the significant damages that would arise if the coast were not managed. The strategy has, therefore, put forward an approach which aims to increase the resilience of the shoreline through control structure and beach recharge. This approach, which also considers how use of the frontage can be improved in terms of better beaches and the introduction of a multi-purpose reef, moves away from the linear approach that has been adopted in the past. It was recognised that, while the linear management of the shingle ridge has worked adequately in the past, this approach would be difficult to maintain in the future. With continued loss of beach volume and, with sea level rise and increasing wish for the shingle ridge to roll back, the long term sustainable management of the frontage would be in question. There would have had to have been ever increasing effort in maintaining the shingle ridge in its present position, with more massive linear defences in the future. The threat of sudden failure would increase, in addition to destroying much of the interaction between the village and the important use of the shoreline. This will be unsustainable with sea level rise.

Even so the strategy still recognises that in the future with sea level rise there will be a need for further beach recharge and in the long term a greater risk of overtopping and potential flooding. It has been assessed based on sea level rise guidance that the level of defence and protection may be sustainable for some 75 years. Even leading up to and beyond this time, the control of the coastal form, effectively increasing the width of the beach will continue to provide significant protection and retention of sediment as a barrier at the shoreline. The defence approach is more akin to managed realignment over the third epoch, in that there would be the expectation that properties would, in the future, become gradually more at risk and to defend totally would mean having to resort to higher unsustainable artificial defence at the crest of the beach. There is the expectation, therefore, that over the 100 year period, properties would be vacated. The basic shoreline position and the opportunity for continued advantage to be taken of the shoreline would be maintained but the community of lower Borth would need to adapt and migrate to higher land that could be defended more sustainably. This general approach to management is continued along the whole frontage, with the northern section of the shingle ridge possibly allowed greater freedom to retreat over time. The approach would sustain the road and potentially the railway line in to epoch 3. This would continue to provide access to Ynyslas over that period of time.

Impact of different Sea Level Rise Scenarios

Under a 2m sea level rise scenario the need to consider adaptation would be brought forward in time. The With Present Management approach along the shoreline both maintains the flexibility to adapt and provides resilience to the frontage so that appropriate decisions may be made at the time, based on improved evidence of sea level rise.

Over the southern flood risk area, the policy approach under the CFMP would be to raise defences and from SMP1 to hold the line of the railway. Technically this would be feasible, potentially over epoch 2, without undue effort. Into epoch 3, and towards the end of epoch 3, there would be significant risk of overtopping of the railway line, unless very substantial improvements were made in raising the level of defence.

Beyond the period of the SMP this policy would need to continue to realise the economic benefits in raising defences over epochs 2 and 3. Overtopping would not only become more frequent but the disparity between the level of the embankment and the level of land behind would increase. The modelling undertaken for CCW has indicated that flow rates over the embankment when overtopped would be very large. Not only would the embankment have to be raised but the form of the embankment would have to be changed to avoid catastrophic failure. Continued defence under this approach would place the important habitat behind at a significant risk. Clearly, maintaining the transport route to Aberystwyth is a major consideration, potentially one of over riding public interest, if there was no feasible way in which to relocate the railway. However, the policy in terms of maintaining the nature conservation value of the area and from the point of view of allowing natural function of the estuary is not considered as a sustainable approach. There are potentially significant benefits in allowing the estuary to function more naturally in terms of management of the coast and interests at Ynyslas and Aberdyfi.

Further up the estuary there are similar concerns in relation to continued defence at Dyfi Junction and across the estuary at Gogarth. However, in these areas management of the significantly smaller flood compartments could be managed more effectively without quite the same long term sustainability issues. Clearly management of these areas would need to be considered in conjunction with management of the Cors Fochno area.

The main road could be defended without significant impact on the estuary. Similarly future flood risk to the lower lying land around Machynlleth would be sustainable well into the future.

Along the northern side of the estuary, the defences to the road and railway would be sustainable, and necessary to maintain access to Aberdyfi and Tywyn. The full justification for maintaining these protection works would depend obviously on maintaining defence at Dyfi Junction.

The defence of Aberdyfi is considered sustainable, although there will be a need to examine in detail how defence of the harbour is managed with future sea level rise. This would sustain the village and the many associated benefits of the village as a local and regional centre.

Under this scenario, it has been taken that the defence to the south side of the estuary would be continued. This continues to constrain the way in which the estuary behaves and could result in a smaller ebb delta system which would then impose greater pressure on the dunes to the west of Aberdyfi. This may result in the long term in loss of important habitat and greater risk to the Golf club. Under this scenario the dunes would be allowed to retreat.

North of the dunes the policy is also for retreat. Here the SMP policy is explained as constructing a set back bund for defence of the farmland, railway and the road. In the policy unit to the south the intent would be to establish a bund stopping flooding to the golf course. While such a policy would be technically achievable there would be concern

that drainage may become an issue over the main marsh area with sea level rise. As such defining an absolute line of retired defence may become unsustainable in the long term. It does under the 1m scenario seem practical for defence of the golf course but only if the policy for retreat of the dune line maintains a suitably robust defence from the open coast.

Impact of different Sea Level Rise Scenarios

Under a 2m sea level rise scenario the defence of the golf course against normal tidal flooding would become more difficult and may result in significant costs in terms of drainage and potential damage to the nature conservation of the area.

Current practise in terms of the management of the Penllyn, appears to be very much one of holding the line until it is no longer possible to do so, and then, under the SMP policy, presumably, to move the defence back to a new line. This becomes more unsustainable and potentially impacts on the ability of the shoreline to adapt progressively in setting back.

At Tywyn, the latest strategy, being taken forward in terms of a scheme, is in the form of strategic control of the frontage with lengths of linear defence and control structures. There is also the recognised need for beach recharge. In the same way as for Borth, the strategy has recognised the difficulty of maintaining a strictly linear approach to defence, recognising also the benefits to the amenity in retaining a beach. The approach here is somewhat different, however from that at Borth, in that the intent is also to reinforce the headland being created so as to provide control of the frontage through to the long term. The approach is justified economically and is seen as being sustainable over the 100 years without substantially increasing the vulnerability of assets behind. This approach also considers a more transitional approach in managing the coast to the south and to the north.

To the north, however, the approach being taken in response to the Hold the Line policy is to continue to reinforce the linear defence. In the future with sea level rise there will be significant erosion at the toe of the defence and the defence will need to be raised and reinforced further. The Network Rail rock armour defence is founded on the shingle ridge. As this shingle erodes, the toe of the defence would need to be extended down to and in to the clay underlying the shingle. The approach may technically be feasible and necessary to maintain the very important regional railway. However, the long term sustainability is questionable. The headland being created will help to sustain sediment to the Tywyn frontage and will limit the development of the bay to the north.

The justification for management of the railway line would also mean that the entrance channel to the Dysynni would need to be constrained further. Upstream within the Dysynni, despite the policy to only maintain defences, it is understood that private works have been undertaken to significantly improve defences to the agricultural land. This is taken as the With Present Management approach. Under this scenario for future improvement and raising of defences, there would also be the need to improve drainage, quite probably resorting to pumped drainage in the future as sea level rises further. The approach also starts to constrain future fluvial discharge with the potential for further need to raise defences further up the valley. This would be exacerbated by sea level rise. It confines the ability of the estuary to develop naturally and as such would not comply with the Water Framework Directive and, although outside of the Broadwater SSSI, constrains the ability for features of this SSSI to migrate in line with sea level rise. Given the increasing vulnerability of defences to sudden failure and the consequence this would have on the agricultural value of the land to adapt, this approach is not seen as being sustainable.

The following tables set out the estimated economic damages that would occur under the two baseline scenarios and the second table assesses each scenario against the broad level objectives.

4 Summary Comparison and Assessment of Baseline scenarios.

Table 1 compares the economic damages that might arise under the two baseline scenarios. Table 2 provides a summary comparison in terms of the overall objectives based on the key issues identified in the introduction to this Coastal Area.

Erosion damages and those associated with flooding are identified separately in Table 1. The aim of this table is to demonstrate the potential economic damage that might arise from either flooding or erosion. As such properties that might be lost in the future due to erosion are not discounted from the assessment of flooding. Similarly, properties whose value may have been written off due to regular flood damage are still included within the assessment of erosion. Such an approach is clearly not strictly in line with normal economic appraisal at strategy or scheme level. It is however, considered appropriate at the higher level of the SMP assessment where the essential aim is in identifying potential different forms of risk in assessing different scenarios. Where this is felt to disproportionately distort the economic assessment then this is identified in appendix H and the economic case adjusted accordingly.

The assessment of economic damage is made using a simplified Modelling Decision Support Framework (MDSF). In the case of erosion, this GIS based tool takes the predicted erosion distance for any section of the coast based on the assessment of erosion by the end of each epoch. It is then taken that there would be a linear erosion rate between these timelines (e.g. a property located midway between the epoch 1 timeline (20 years) and that for epoch 2 (50 years) would be taken as being lost in 35 years). Each property is defined by a single point rather than by its full footprint. No account is taken in the assessment of loss of access or loss of services, although this is discussed in the text where critical. The MDSF method then draws information from a property data base, providing general information with respect to that property. The value of the property is discounted in terms of when that property may be lost.

In the case of flooding, the open coast water levels are assessed against threshold levels for individual properties based again on the property point source data base. No detailed modelling has been undertaken to assess flow paths and or possible increase in water levels due to estuary processes. It is taken that, when a flood defence fails or is overtopped, the whole flood area behind a defence is open to flooding and that flooding would occur to the full extent of the potential flood plain, over a single high water period. Damages are assessed in relation to the depth of flooding that would occur based on the type of property identified in the data base. From this assessment of potential flood damage for any specific water level condition, annual average flood damages are determined during each epoch. An average annual average damage value is taken between the present (2010) and 50 years time (2060) and between 2060 and 2110. This average value is taken in determining an estimate of discounted Present Value (PV) Damages over the period of the SMP. This simplified approach allows consideration of flood risk under different sea level rise predictions for different scenarios.

Table 1. Economic Assessment

The following table provides a brief summary of erosion damages determined by the SMP2 MDSF analysis for the whole PDZ. Further details are provided in Appendix H. Where further, more detailed information is provided by studies, this is highlighted. The table aims to provide an initial high level assessment of potential damages occurring under the two baseline scenarios.

ASSESSMENT OF EROSION DAMAGES

Epoch	0 -20 year		20 – 50 years			50 – 100 years			50 – 100 years (2m SLR)		PV Damages (£x1000)	
No Active Intervention	No. of properties:		Value x £k	No. of properties:		Value x £k	No. of properties:		Value x £k	No. of properties		
Location	Res.	Com.		Res.	Com.		Res.	Com.		Res.	Com.	
Borth	0	0	0	59	14	8,268	193	35	27,618	293	51	5,449
Afon Leri/Ynyslas	0	0	0	0	1	5	18	1	2,437	20	3	216
Aberdyfi	0	0	0	3	1	436	6	1	715	13	3	241
Tywyn	0	0	0	6	0	649	69	8	9,237	129	21	1,191
Total for PDZ1											7,101	
With Present Management	No. of properties		Value x £k	No. of properties		Value x £k	No. of properties		Value x £k	No. of properties		PV Damages (£x1000)
Location	Res.	Com.		Res.	Com.		Res.	Com.		Res.	Com.	
Borth	0	0	0	0	0	0	0	0	0	0	0	0
Afon Leri/Ynyslas	0	0	0	0	0	0	0	0	0	0	0	0
Aberdyfi	0	0	0	0	0	0	0	0	0	0	0	0
Tywyn	0	0	0	0	0	0	0	0	0	0	0	0
Total for PDZ1											0	
Notes: PVD determined for 1m SLR in 100 yrs.												
Other information: Damages at Tywyn are assessed prior to completion of recent defences. No value has been allowed for loss of caravan parks or golf courses.												

The following flood damages have been determined through use of MDSF. These figures are aimed to indicate the level and impact of flood risk rather than being a detailed economic appraisal. In many areas substantial numbers of properties would be liable to flooding on the more frequent events both under NAI and WPM, a nominal write off value has been allowed in the table for properties at frequent risk; this generally excludes values at risk at present on a 1:1 year event, in 50 years time for the 1:10 year event and in 100 year time the 1:50 year event.

ASSESSMENT OF POTENTIAL FLOOD RISK

No Active Intervention	Flood risk tidal 2010			Flood risk tidal 2060			Flood risk tidal 2110			tidal risk 2m SLR		PVD (£x1000)
	No. of properties		AAD x £k	No. of properties		AAD x £k	No. of properties		AAD x £k	No. of properties		
	<1:10 yr.	>1:10 yr		<1:10 yr.	>1:10 yr		<1:10 yr.	>1:10 yr		<1:10 yr.	>1:10 yr	
<i>Location</i>												
Borth	0	423	326	0	439	387	435	20	16023	465	18	59389
Llancynfelyn	0	22	21	0	23	115	23	4	1194	27	2	5119
Lodge Farm	0	5	2	0	2	19	6	0	183	6	0	766
Ysgubor-y-coed	0	0	0	0	0	0	0	0	0	1	3	0
Dovey Junction	0	3	14	0	3	16	3	4	120	14	26	771
Pant-Eidal	0	0	0	0	0	0	0	0	0	0	0	0
Aber Tafol	0	0	0	0	0	0	0	1	0	1	0	0.01
Trefri (northern bank)	0	0	0	0	0	0	0	2	0.13	2	0	0.42
Aberdyfi and Penllyn Marsh	0	217	198	0	264	369	0	365	900	435	76	9609
North Dysynni	0	0	0	0	0	0	0	1	0.01	3	1	0.02
Total for PDZ10											75655	
With Present Management	No. of properties		AAD x £k	No. of properties		AAD x £k	No. of properties		AAD x £k	No. of properties		PVD (£x1000)
<i>Location</i>	<1:10 yr.	>1:10 yr		<1:10 yr.	>1:10 yr		<1:10 yr.	>1:10 yr		<1:10 yr.	>1:10 yr	
Borth	0	423	166	0	439	193	0	455	492	0	483	6214
Llancynfelyn	0	22	11	0	23	13	0	27	35	0	29	418
Lodge Farm	0	5	2	0	6	2	0	6	5	0	6	66
Ysgubor-y-coed	0	0	0	0	0	0	0	0	0	0	3	0
Dovey Junction	0	3	3	0	3	3	0	7	4	0	40	94
Pant-Eidal	0	0	0	0	0	0	0	0	0	0	0	0
Aber Tafol	0	0	0	0	0	0	0	1	0	0	1	0.01
Trefri (northern bank)	0	0	0	0	0	0	0	2	0.13	0	2	0.42
Aberdyfi and Penllyn Marsh	0	217	36	0	264	57	0	365	216	0	511	1821
North Dysynni	0	0	0	0	0	0	0	1	0.01	0	4	0.02
Total for PDZ10											8613	

Table 2. General Assessment of Objectives

The following table provides an overall assessment of how the two baseline scenarios impact upon the overall objectives. Specific objectives are set out in more detail within Appendix E. The table aims to provide an initial high level assessment of the two baseline scenarios, highlighting potential issues of conflict. These issues are discussed in the following section, examining alternative management scenarios from which SMP2 policy is then derived.

STAKEHOLDER OBJECTIVE	NAI			WPM		
	Fails	Neutral	Acceptable	Fails	Neutral	Acceptable
Reduce risk to life						
Protect properties from flood and erosion loss						
Identify communities at risk and allow opportunity for adaptation						
Minimise the need for increasing effort and management of coastal defences						
Avoid reliance on defence particularly where there is a risk of catastrophic failure						
Highlight areas long term sustainability issue and where there may need to be relocation						
Maintain connectivity along the estuaries to main centres in land						
Maintain connectivity between local communities along the coast						
Maintain recreational use of beaches and bays						
Maintain access to the coast including car parking and facilities						
Maintain access for boat use and associated water sport activity						
Maintain the opportunity for sustainable adaptation of the main Golf Courses						
Maintain the opportunity for sustainable adaptation of the main Holiday centres.						
Maintain character and integrity of coastal communities						
Maintain the ability for adaptation and opportunity fro economic growth of small communities						
Maintain agricultural value of rural community						
Identify risk and reduce risk of loss of heritage features where possible						
Maintain historic landscape						
Prevent disturbance or deterioration to historic sites and their setting						
Maintain or enhance the condition or integrity of the international (SAC, SPA) designated sites and interest features within the context of a dynamic coastal system.						
Maintain or enhance the condition or integrity of the national (SSSI) designated sites and interest features within the context of a dynamic coastal system.						
Maintain and enhance educational and scientific understanding of geology and geomorphology						
Avoid damage to and enhance the natural landscape.						
Maintain the human landscape and character of communities						
Maintain the critical road network						

STAKEHOLDER OBJECTIVE	NAI			WPM		
	FAILS	Neutral	Acceptable	FAILS	Neutral	Acceptable
Maintain the critical rail network.						

5 Discussion and Detailed Policy Development

Along the two frontages of Borth and Tywyn, the approach being taken to defence has progressed significantly since SMP1, moving away from that simply of taking a linear approach to Hold the Line. In both areas there has been a recognised need to work more effectively with the coastal processes.

In the case of Borth the approach is very much of increasing the resilience of the shoreline but to allow flexibility for change in management in the future. There is the need in the future to adapt use of the lower village and the very probable need to relocate people in the future as sea level rises. The approach to defence does not pre-empt this decision but allows time for such adaptation as the understanding of sea level rise improves. As use changes, and as the need to relocate the community approaches, then the defence would maintain the integrity of the foreshore such that it may still be used and may still provide an important function in village life. The approach allows for gradually reducing management further north along the shoreline allowing a transitional approach to future management of the whole area. This will mean that eventually, possibly toward the end of epoch 2, the golf course is likely to be lost in its present extent and form.

In part, this large scale, long term transformation of the coastal edge will only be possible through maintaining defence along the Leri over the next 50 years. This defence ideally would then be allowed to fail. This raises issues of access to Ynyslas, which may not be at substantial risk itself, but would suffer if it lost its access. It also raises significant issues in relation to management of risk to the railway at a national scale and to the important nature conservation feature of Cors Fochno. Raising the water table requires management of the drainage around the bog and it is this, rather than maintenance of sea defences, which is required to increase the resilience of the bog to saline intrusion. A high water table and surface waterlogging is necessary for Favourable Conservation Status of Cors Fochno SAC.

The assessment of the Hold the Line policy for the whole southern extent of the Dyfi indicates strongly that to attempt to maintain the defence of the railway would involve very considerable investment in the future, potentially towards the end of epoch 2, certainly during epoch 3, and continuing beyond this time. Therefore, to maintain this line and the defence it provides is not seen as being sustainable in the broadest sense. It would result in potentially negative impacts of the Cors Fochno designated area and more generally throughout the estuary system. The potential relocation of the railway needs to be considered. This goes beyond the remit of the SMP to investigate this option further. The other major issue is that, in not maintaining the railway, Cors Fochno would still potentially suffer considerable damage. This might be mitigated to some degree if the area was allowed to change more over an extending period of time. As noted above, it is ensuring that water levels in the area of the Bog are allowed rise and the Bog allowed to adapt over time that is the essential point, not the maintenance of the defences. Even so, there would be a probable need to compensate for the damage that is likely to occur. This in itself is an issue, as there are no identified sites where such compensation could sensibly be achieved. Despite this and the uncertainty associated with the railway line, for sustainable management of the area, which is the underlying principle upon which the SMP is being developed, the overall long term intent is for change and managed realignment of the whole south west area and coast of the Dyfi system. The policies would be to Hold the Line in epoch 1 and 2, and for managed realignment in epoch 3. This has to be read in the context of an overall intent to adapt over time rather than being considered as distinct time step changes.

The following important caveats are however made with respect to this:

- That the issue of damage to Cors Fochno and the associated designated areas are taken forward as part of developing the management of the area; recognising that to attempt to maintain defence to the feature would in itself damage the feature or make it increasingly vulnerable to more significant damage. It is suggested that this caveat is the mechanism for compensation rather than taking a potentially unrealistic expectation that might be suggested by an epoch 3 policy of Hold the Line.
- That the implications of relocating the railway line through to Aberystwyth are considered at a regional and national level and that the outcome of this would ultimately determine the intent of management for the area.
- That the future change in land use, together with the mechanisms for relocation and change in land use and access, is developed at a spatial planning level, involving the local communities and other people and bodies with a direct interest in the area. It is recognised that in relation to the coast and the hinterland the SMP policy has consequences well beyond that covered by the remit of the SMP.

However, from the perspective of the SMP, the starting point for all discussions above should be that of future managed realignment, rather than that of a precautionary Hold the Line.

The decisions identified would have consequences for decision making elsewhere.

In terms of management at Glan Dyfi and Dyfi Junction, it is recognised that the Junction is likely to be a strategic location if the railway is to be relocated. It is also strategically important in terms of maintaining the main road. The intent of management would be to accept the need for defence in this area but to be developed with an intent to allow realignment as far as possible in support of the designated habitat. It is envisaged that the main road would be defended on its existing line. The policy would be Hold the Line for epochs 1 and 2, with Management Realignment in epoch 3, as far as possible to allow and to restore the natural function of the estuary while still maintaining opportunity for sustainable management of the transport network.

Through the narrow section of the estuary the policy would be for Hold the Line.

Over the northern part of the estuary, the intent would be to sustain the transport routes. Within the Pennal valley the policy would be for managed realignment but with the intent to maintain defence to the village and the road. Over the railway frontage at Gogarth the policy would be for Hold the Line. The policy for the rest of the frontage to Aberdyfi and including Aberdyfi would be for Hold the Line.

Actual management of the dunes to the west of Aberdyfi would be dependent on the management of the flood plain within the estuary. However, it is recognised that there is potential conflict between nature conservation and continued management of the golf course. The policy in this area would be for Managed Realignment. There are potentially significant risks in terms of long term flood risk to the golf course, such that even if the dune is maintained there could be issues in relation to drainage. It will, however, be important to the continued management of the golf course that the width and integrity of a naturally functioning dune system is maintained. It is from this perspective as much as that of the important designated habitat that the golf course should look to how it can adapt. There needs to be an agreed local management approach taken.

There is risk of flooding from the Penllyn marsh through to the golf course. As identified in SMP1, the most appropriate manner for managing this would be in developing a retired flood bank. This would be considered to fall within the Managed Realignment of the Aberdyfi dunes. Also, as part of this intent would be to allow the dune line at the northern end of the golf course to set back. This would involve relocation of one the 12th green. To attempt to hold the line at this point would impact on the natural functioning behaviour of the shoreline and would quite probably result in weakening the defence to the golf course.

Over the Penllyn Marsh there is an EA/CCW agreement to Hold the Line until 2020 to allow hinterland habitat to be relocated. However, continuing to defend the Dyffryn Gwyn outfall and sluice is seen as already starting to influence the resilience of the natural defence, potentially making a breach more likely. The long term intent over this frontage is to allow the frontage to behave naturally. It may not be practical to maintain defence of this area through to the end of epoch 1, with the possible flooding of the area. The approach to managed realignment should be implemented in terms of allowing the frontage to retreat, rather than defining any specific retired defence that would be held in the long term. The intent would, however, be to allow defence of the railway line and through this also to provide defence to the road. In terms of the main frontline at the coast, the policy would develop in epoch 2 to one of No Active Intervention.

At Tywyn the intent to Hold the Line has been tested through the strategy assessment. In terms of SMP policy, holding this headland is not seen as being detrimental to management of the broader area of the coast. As such the SMP policy confirms that of the strategy for Hold the Line over the three epochs. Works are currently being progressed in delivering this strategic approach.

The railway presents a difficult issue for management of the frontage to the north of Tywyn. The frontage is clearly under significant pressure and the approach to defence is to continue to reinforce the existing line. While such an approach, given the importance of the railway to the whole region, may be technically sustainable over the first two epochs, the degree to which the defence would need to be reinforced in the future, even during epoch 2, would be considerable. This is not seen in the long term as sustainable. There is possibly no scope for relocation of the railway due to the alignment through the town.

Continued defence of the railway needs to be linked through to that providing coast protection to the Tywyn frontage, such that the whole frontage is considered as a necessary headland in management of the whole area. This would be seen as being compatible with the current scheme being developed for Tywyn. In taking a different approach, it would also be possible to limit the need for extending the defence of the railway further north, allowing this northern frontage to behave more as a natural shingle backed bay. It is probable that recharge would be required to maintain both the railway defence and the northern bay. In taking this approach still further, and recognising that the tidal prism of the Dysynni will increase with sea level rise, increasing pressure on the entrance and the railway bridge, consideration could be given to creating a new cut through to the Dysynni, developing a more functional estuary mouth. This would require a new railway bridge.

The potential benefits of this are in using the Dysynni and its ebb shingle banks as part of the defence system. This would need to be considered further. However, in taking this approach there is potential to incorporate better defence to the sewage works and also potentially to the lagoon and Morfa Camp.

The policy for the frontage would be to Hold the Line but with a consideration of Managed Realignment in epoch 2 or 3.

Within the Dysynni, the plan intent would be for Managed Realignment of defences. This would need to be developed with local land owners, recognising that even through private funding the approach of increasing defences is not considered to be sustainable.

6 Management Summary.

The whole zone is seen as having important interlinking issues. The most significant is in the policy for future realignment of the southern shore and rear defence to the Dyfi. Still recognising this, the area is divided into two general Management Areas. Policy summary for these areas is shown in the tables below.

MA 19 DYFI SOUTH: From Upper Borth through to Machynlleth.

Policy Unit		Policy Plan			
		2025	2055	2105	Comment
10.1	Upper Borth	MR	MR	MR	A suitable buffer zone would be established to allow future cliff recession.
10.2	Borth Village	HTL	HTL	MR	Increase width and resilience of the shoreline behaviour
10.3	Borth Golf Course	HTL	MR	MR	Manage the transition between the southern section of the shoreline and the Ynyslas dunes.
10.4	Ynyslas	MR	NAI	NAI	
10.5	Afon Leri	HTL	HTL	MR	Manage flood defence initially with the intention of allowing failure in the third epoch, subject to caveats given in the text.
10.6	Cors Fochno	HTL	HTL	MR	Manage flood defence initially with the intention of allowing failure in the third epoch, subject to caveats given in the text.
10.7	Dyfi Junction	HTL	HTL	MR	With the intent to maintain the transport routes.
10.8	Morben Hall	HTL	HTL	HTL	
10.9	Machynlleth	HTL	MR	MR	
Key: HTL - Hold the Line, A - Advance the Line, NAI – No Active Intervention MR – Managed Realignment					

MA 20 DYFI NORTH, TYWYN AND THE DYSYNNI: From Pennal to Tonfanau.

Policy Unit		Policy Plan			
		2025	2055	2105	Comment
10.10	Pennal valley	MR	MR	MR	.
10.11	Gogarth	HTL	HTL	HTL	
10.12	Dyfi North	HTL	HTL	HTL	Management of road and rail defences
10.13	Aberdyfi	HTL	HTL	HTL	
10.14	Aberdyfi Dunes	MR	MR	MR	Support natural dune defence and adapt use within the Golf Course

10.15	Penllyn	MR	MR	MR	Allow natural function of the seaward face. Maintain defence to the railway line and road.
10.16	Tywyn	HTL	HTL	HTL	
10.17	Dysynni railway	HTL	HTL	HTL	Consideration of future managed realignment to entrance to the Dysynni
10.18	Dysynni Estuary	HTL	MR	MR	Developed with land owners
10.19	Tonfanau	MR	MR	NAI	
Key: HTL - Hold the Line, A - Advance the Line, NAI – No Active Intervention MR – Managed Realignment					

PDZ10
Management Area Statements

MA 19 Dyfi South
Upper Borth to Pennal, including Machynlleth

MA 20 Dyfi north Tywyn and the Dysynni
Pennal to Tonfanau

Location reference:	Dyfi South
Management Area reference:	M.A. 19
Policy Development Zone:	PDZ10

* Note: Predicted shoreline mapping is based on a combination of monitoring data, analysis of historical maps and geomorphological assessment with allowance for sea level rise. Due to inherent uncertainties in predicting future change, these predictions are necessarily indicative. For use beyond the purpose of the shoreline management plan, reference should be made to the baseline data.

The following descriptions are provided to assist interpretation of the map shown overleaf.

100 year shoreline position:

The following maps aim to summarise the anticipated position of the shoreline in 100 years under the two scenarios of “With Present Management” and under the “Draft Preferred Policy” being put forward through the Shoreline Management Plan.

-  In some areas the preferred policy does not change from that under the existing management approach. In some areas where there are hard defences this can be accurately identified. In other areas there is greater uncertainty. Even so, where the shoreline is likely to be quite clearly defined by a change such as the crest of a cliff the estimated position is shown as a single line.
- Where there is a difference between With Present Management and the Draft Preferred Policy this distinction is made in showing two different lines:

-  With Present Management.
-  Draft Preferred Policy.

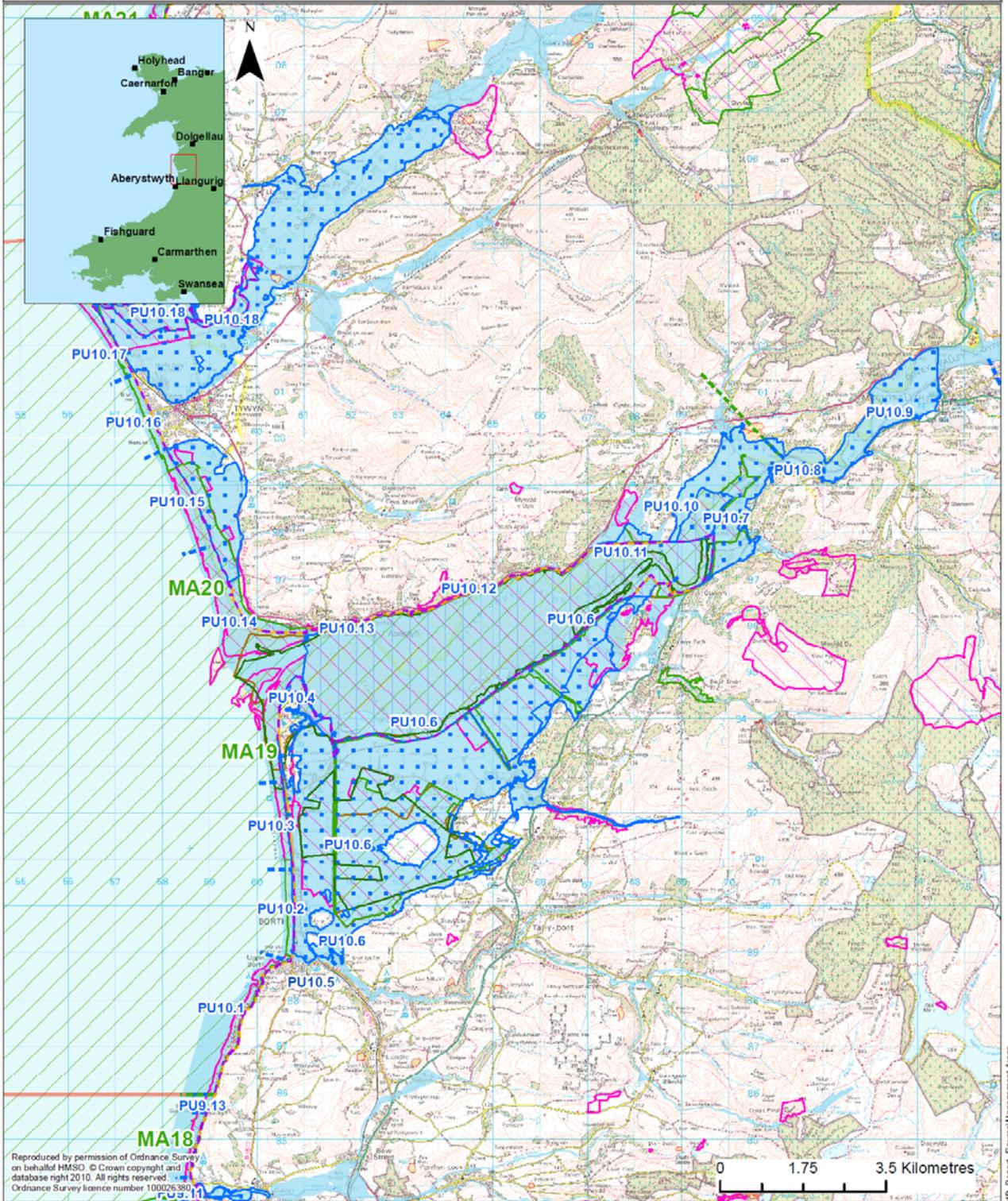
Flood Risk Zones

-  General Flood Risk Zones. The explanation of these zones is provided on the Environment Agency’s web site www.environment-agency.gov.uk. The maps within this Draft SMP document show where SMP policy might influence the management of flood risk.
-  Indicate areas where the intent of the SMP draft policy is to continue to manage this risk.
-  Indicate where over the 100 years the policy would allow increased risk of flooding.

The maps should be read in conjunction with the text within the Draft SMP document.

**Shoreline Management Plan Sub Cell 10
Baseline Location Map
Management Area 19 & 20**

- Management Area
- Policy Unit
- Scheduled Monument
- Policy Development Zone



- Key**
- 100 Year Shoreline Position:
 - Preferred Policy would be the same as With Present Management
 - With Present Management where this differs from the Preferred Policy
 - Preferred Policy where this differs from the With Present Management

- Ramsar
- SAC
- SPA
- SSSI
- NNR

- Existing Indicative EA Flood Zone 3
- EA Flood Risk Zone 2 where under the SMP policy there would be increased probability of flooding



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SUMMARY OF PREFERRED PLAN RECOMMENDATIONS AND JUSTIFICATION

INTENT OF THE PLAN:

This is a complex area with many potentially conflicting issues and values. Key features are the important designated and non designated habitat areas, the railway line and road; agricultural land, the village of Borth and the associated communities at Ynys Las and within the Dyfi Valley.

There will be increasing difficulty in managing defences in a sustainable manner in the future with sea level rise. The defence of large areas to the south of the Dyfi Valley would interfere with the natural function of the estuary and would result in damage to the important ecological function.

The overall intent of the plan is to support adaptation in the management of the area; to allow adaptation to develop over time so that use of the area in the future is placed on a more sustainable foundation. However, on-going management, even where policies are for Holding the Line, need to be considered and undertaken in a manner that is consistent with the longer term intent. In particular at Borth, in managing the seafront the intention is to build in resilience within the coastal system. Specially, while the village is defended during epochs 1 and 2; and quite probably over much of epoch 3, the defence system would, with sea level rise, provide a reducing standard of protection in the long term. This means that there would be the need for the early planning for and adequate provision for the relocation of property and infrastructure and a gradual change in property usage and land use. Further north along the shoreline, the intent would be to allow greater realignment over a shorter time frame. This needs to be a continuous process of management and adaptation rather than one strictly determined by the nominal periods associated with the current SMP epochs.

Similarly, management of the large flood plain behind Borth requires an on-going management of change. In this respect the strict application of policies set out by the current epochs within the SMP could be misleading. The intent would be to continue to manage defences along the Leri and along the main estuary frontage such that change is not sudden, mitigating the impact on the communities and the land use as well as upon the significant ecological value of the area. Equally, this transitional management has to be considered a continuous process, not a step change from one epoch to the next. Early planning of this process of change is essential; such that there would be scope for allowing saline intrusion and sediment build up within the currently defended areas, particularly allowing development of a more robust ecological system and the development of transitional habitat consistent while maintaining the overall integrity of the site. Specific within this adaptation planning would need to be consideration how any sudden breach in existing defences is subsequently managed, addressing such issues as sediment loss or development of an erosive creek system. Due both to the uncertainty associated with sea level rise and the capacity for existing habitat and land use to change, there may be scope or the possibility that the change in policy, from an overall intent to maintain existing defences to the longer term intent for realignment, may occur during epoch 2, rather than in epoch 3. These decisions would need to be based on monitoring and through discussion with landowners.

Management of this area would depend significantly on the continued need to sustain the railway line, albeit not necessarily in the same location. The SMP highlights that, as sea level rise continues, there would be key moments when substantial investment decisions would need to be considered and made. It seems probable that at such times,

the opportunity is taken to consider relocating the railway line to a more long term sustainable position. The decision making processes needs to be considered both with respect to the overall local management issues and at a more strategic national scale considering sustainable transport for the whole region. Within the plan it is envisaged that defence of the transport networks would be sustained but that, along the main inner estuary frontage, the railway line would need to be relocated within epoch 3. The impact on the local highway network will also need to be considered in the long term.

In terms of the Leri, the SMP is not able to define fully, in detail, the long term management of the river course. However, the SMP recognises the potential benefit to management of the shoreline in re-establishing the river back to its original course through to the sea. This could have benefits in terms of establishing a more sustainable shoreline and could have benefits in terms of the way in which defence to the rear of Borth would then be achieved. This needs further consideration, alongside all other aspects of the area discussed above.

Within the upper estuary, and specifically with respect to the Hold the Line policies at Dyfi Junction and Morben Hall, the focus of management is in sustaining the function of the railway and road. Its is not intended within the plan that additional defence be undertaken to other areas nor would it be intended to defend areas currently affected by saline intrusion. Within the policy unit covering Machynlleth, the SMP highlights and would propose management to sustain the regionally important road and rail links.

The long term intent of the plan is to support change, creating a more sustainable approach to risk management and use of the whole area. The aim is to allow change over time such that people and the natural values of the area are not faced with sudden catastrophic change, driven purely by extreme events.

KEY ISSUES/RISK AND UNCERTAINTY:

There are uncertainties in terms of timing of the proposed changes and the need for change. There is also a need for a detailed planned response to change which needs to be developed from the present. It will be important to relate this to national monitoring of sea level rise and more general climate change and to monitoring of physical change within the estuary and change in ecology.

Funding of change is an issue and a significant uncertainty. This cannot be considered solely in terms of FCERM funding, but will have to be developed in a collaborative manner. Without these aspects being planned, there is a significant risk that decision making would be determined by events. This would have very serious consequences for the whole area.

ACTIONS:

ACTION	PARTNERS
Shoreline monitoring	CSC
Habitat monitoring	CCW
Adaption planning for the whole area	CSC Communities CCW EA Powys CC
Review national transport planning	Highways Network Rail Landowners
Assess in detail potential impact on historic environment	WAG Highways Network Rail

DELIVERY OF THE PLAN

SUMMARY OF SPECIFIC POLICIES

Policy Unit		Policy Plan			Comment
		2025	2055	2105	
10.1	Upper Borth	MR	MR	MR	A suitable buffer zone would be established to allow future cliff recession.
10.2	Borth Village	HTL	HTL	MR	Increase width and resilience of the shoreline behaviour
10.3	Borth Golf Course	HTL	MR	MR	Manage the transition between the southern section of the shoreline and the Ynyslas dunes.
10.4	Ynyslas	MR	NAI	NAI	Responsive measures to works to the south.
10.5	Afon Leri	HTL	HTL	MR	Manage flood defence initially moving towards an integration of Borth Bog with the wider estuary. with the intention of allowing failure in the third epoch, subject to caveats given in the text.
10.6	Cors Fochno	HTL	HTL	MR	Manage flood defence initially moving towards an integration of Borth Bog with the wider estuary. Manage flood defence initially with the intention of allowing failure in the third epoch, subject to caveats given in the text.
10.7	Dyfi Junction	HTL	HTL	MR	With the intent to maintain the transport routes.
10.8	Morben Hall	HTL	HTL	HTL	With the intent to maintain the transport routes.
10.9	Machynlleth	HTL	MR	MR	
Key: HTL - Hold the Line, A - Advance the Line, NAI – No Active Intervention MR – Managed Realignment					

PREFERRED POLICY TO IMPLEMENT PLAN:	
From present day	Improve defences at Borth. Review and develop strategy for management of the Leri defences. Maintain other defences. Increase saline intrusion to Cors Fochno in line with habitat adaption plan. Develop adaptation planning. Develop funding plan. Review transport planning
Medium term	Maintain defences while moving towards adaptive management
Long term	Implement adaptive management.

IMPLICATIONS OF THE PLAN

CHANGES FROM PRESENT MANAGEMENT

In considering the longer timescale for management there are significant changes in the overall approach to management of the estuary and shoreline. The intent of management remains substantially in line with SMP 1 over epoch 1 with changes being taken forward in epochs 2 and 3.

ECONOMIC SUMMARY

Economics (£k PV)	by 2025	by 2055	by 2105	Total £k PV
NAI Damages	4,543.8	7,699.8	59,496.1	71,739.6
Preferred Plan Damages	2,268.6	2,185.4	4,982.8	9,436.9
Benefits	2,275.1	5,514.4	54,513.2	62,302.7
Costs	16,578.4	1,542.5	955.5	19,076.5

FLOOD AND EROSION RISK MANAGEMENT

POTENTIAL LOSS

Would be significant loss of property and change in use of the area over the full period of the plan. This would be minimised during epochs 1 and 2 but with the aim of planning changes during epoch 2 and into epoch 3.

BENEFITS OF THE PLAN

The plan provides a longer term sustainable approach to defence, maintaining the opportunity for people to adapt over a 50 to 75 year period. Although in the long terms this will result in loss of property and change in use, the plan still provides a reduced risk to communities over epochs 1 and 2 and establishes a longer term sustainable management of risk in the future. Some 300 properties benefit from reduction in risk due to erosion and including these properties some 450 properties benefit from reduced flood risk.

SUMMARY OF STRATEGIC ENVIRONMENTAL ASSESSMENT (INCLUDING HRA)

PDZ 10

SEA Objective	Impact of Preferred Policy for each Epoch			
	1	2	3	Mitigation
Policy Units 10.1 to 10.19				
To support natural processes, maintain and enhance the integrity of internationally designated nature conservation sites. Maintain / achieve favourable condition of their interest features (habitats and species).	Red	Red	Red	Habitat creation
To avoid adverse impacts on, conserve and where practical enhance the designated interest of nationally designated nature conservation sites. Maintain/achieve favourable condition.	Light Green	Light Green	Light Green	Habitat creation
To avoid adverse impacts on, conserve and where practical enhance national and local BAP habitats.	Dark Green	Dark Green	Dark Green	Habitat creation
To support natural processes and maintain geological exposures throughout nationally designated geological sites.	Light Blue	Light Blue	Light Blue	
To conserve and enhance nationally designated landscapes in relation to risks from coastal flooding and erosion and avoid conflict with AONB and National Park Management Plan Objectives.	Light Green	Light Green	Light Green	
To minimise coastal flood and erosion risk to scheduled and other internationally and nationally important cultural heritage assets, sites and their setting.	Light Blue	Light Green	Red	Excavation and recording
To minimise the impact of policies on marine operations and activities.	Light Blue	Light Green	?	
To minimise coastal flood and erosion risk to critical infrastructure and maintain critical services.	Light Blue	Dark Green	Dark Green	Relocation or realignment
To minimise coastal flood and erosion risk to agricultural land and horticultural activities.	Light Blue	Orange	Orange	
To minimise coastal flood and erosion risk to people and residential property.	Light Blue	Light Green	Light Green	Relocation
To minimise coastal flood and erosion risk to key community, recreational and amenity facilities.	Light Blue	Light Green	Light Green	
To minimise coastal flood and erosion risk to industrial, commercial, economic and tourism assets and activities.	Light Blue	Light Green	Light Green	

Mitigation associated with the impacted features of the historic environment may include excavation and recording and monitoring of erosion rates.

This table provides a summary of the SEA (appendix E) and reference should be made to the Appendix for full details of the assessment.

These next two sections provide a headline summary of the findings of the HRA (Appendix G) and the WFA (Appendix H). Reference should be made as appropriate to these Appendices for full details.

HRA SUMMARY

Anticipated Habitat Loss in PDZ 10 as a result of SMP Policy

Designated Site	PU	Habitat Type	Extent of Loss of Habitat (ha)			
			Epoch 1	Epoch 2	Epoch 3	Total
Llyn Peninsula and the Sarnau SAC	10.3	Intertidal sandflat	0.47			0.47
	10.6	Intertidal sandflat of which	2.30	150.20		152.51
	10.6	Saltmarsh	1.84	120.16		122.01
Dyfi Estuary SPA	10.6	Improved grassland			289.00	289.00
Llyn Peninsula and the Sarnau SAC	10.7	Intertidal sandflat	0.87	13.09		13.96
	10.8	Intertidal sandflat	0.00	0.35	0.00	0.35

Pen Llyn a'r Sarnau/ Llyn Peninsula and the Sarnau SAC: It is concluded that there would be an **adverse effect on the integrity** of the intertidal habitat (sandflats and saltmarsh) within the boundary of the SAC as a result of the SMP2 policies. There will however, be **no adverse effect on the integrity** of the other SAC features.

Cors Fochno SAC: **no adverse effect on the integrity.**

Dyfi Estuary / Aber Dyfi SPA: It is concluded that there would be an **adverse effect on the integrity** of the intertidal habitat (sandflats, saltmarsh, and grassland) within the boundary of the SPA as a result of the SMP2 policies. There will however, be **no adverse effect on the integrity** of the other SPA features.

Cors Fochno and Dyfi Ramsar: It is concluded that there would be an **adverse effect on the integrity** of the intertidal habitat (sandflats and saltmarsh) within the boundary of the Ramsar site as a result of the SMP2 policies. There will however, be **no adverse effect on the integrity** of the terrestrial/bog habitats.

Preventative/mitigation measures: The issue of damage to the Cors Fochno Ramsar site (bogs) and the associated designated areas are taken forward as part of developing the management of the area; recognising that to attempt to maintain defence to the feature would in itself damage the feature or make it increasingly vulnerable to more significant damage, therefore the preferred policy would be to HTL in epochs 1 and 2 and allow the defence to fail in epoch 3.

Potentially move defences landward where feasible where there is constraint on the intertidal habitats to allow mudflats to roll back in time with sea level rise; and potentially investigate providing additional support to the dune system under MR in epochs 2 and 3 to reduce the speed to erosion.

Risks/Assumptions: The habitat loss is considered precautionary, and where any works are to be undertaken detailed study would provide an accurate identification of whether habitat would be lost and the extent. Potentially, given the worst case

assumptions, further detail of the likely actions and site specific study may conclude no habitat loss, given the worst case scenario used in this assessment. The areas of potential habitat loss are very large, and this is exacerbated by the fact that such low lying areas would show a large scale change, but this does not take into account accretion of sediments within the estuary, nor can it take into account at this strategic level the likely relocation and movement of saltmarsh communities given the very large scale mapping and extraction. Consequently, the assumptions used to determine loss are expected to have resulted in much greater extents of habitat loss than would occur.

SUMMARY CONCLUSION FROM THE WATER FRAMEWORK ASSESSMENT

Water body (and relevant PDZ)	Environmental Objectives met?				WFD Summary Statement required?	Achievement of Any South East RBMP Mitigation Measures?	Details on how the specific South East RBMP Mitigation Measures have been attained (dark green = achieved; light green = partly achieved & red = not achieved)
	WFD 1	WFD2	WFD3	WFD4			
<p>Cardigan Bay North (Coastal)</p> <p>(PDZs 9, 10, 11, part 12, part 13 and 14.) (MAN 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, part 26, 33, 34, 35, 36 and 37)</p>	N/A	x (PDZ 10, 11)	x (PDZ 10, 11)	✓	Yes – Environmental Objectives WFD 2 and 3 may not be met because of the SMPs policy in PDZ 10 (MAN 20), PDZ 11 (MAN 21).	There were no relevant measures to the SMP2 for this water body, though there are for the affected FWBs.	<p>Mitigation measures for the FWB (GB110064048310), of which none have been implemented within the SMP2:</p> <ul style="list-style-type: none"> • Increase in-channel morphological diversity; • Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works; • Operational and structural changes to locks, sluices, weirs, beach control, etc; • Selective Vegetation Control Regime; • Appropriate Vegetation Control Technique; • Appropriate timing (Vegetation control); • Appropriate Techniques (Invasive Species); and • Retain marginal aquatic and riparian habitats (channel alteration).
<p>Dyfi & Leri (Transitional)</p> <p>(PDZ part 10) (MAN part 19 and part 20)</p>	N/A	x (PDZ 10)	✓	✓	Yes – Environmental Objective WFD2 may not be met because of the SMPs policy in PDZ 10 (MANs 19 & 20).	There were no relevant measures to the SMP2 for this water body.	N/A

Location reference:	Dyfi North, Tywyn and the Dysynni
Management Area reference:	M.A. 20
Policy Development Zone:	PDZ10

* Note: Predicted shoreline mapping is based on a combination of monitoring data, analysis of historical maps and geomorphological assessment with allowance for sea level rise. Due to inherent uncertainties in predicting future change, these predictions are necessarily indicative. For use beyond the purpose of the shoreline management plan, reference should be made to the baseline data.

The following descriptions are provided to assist interpretation of the map shown overleaf.

100 year shoreline position:

The following maps aim to summarise the anticipated position of the shoreline in 100 years under the two scenarios of “With Present Management” and under the “Draft Preferred Policy” being put forward through the Shoreline Management Plan.

-  In some areas the preferred policy does not change from that under the existing management approach. In some areas where there are hard defences this can be accurately identified. In other areas there is greater uncertainty. Even so, where the shoreline is likely to be quite clearly defined by a change such as the crest of a cliff the estimated position is shown as a single line.
- Where there is a difference between With Present Management and the Draft Preferred Policy this distinction is made in showing two different lines:

-  With Present Management.
-  Draft Preferred Policy.

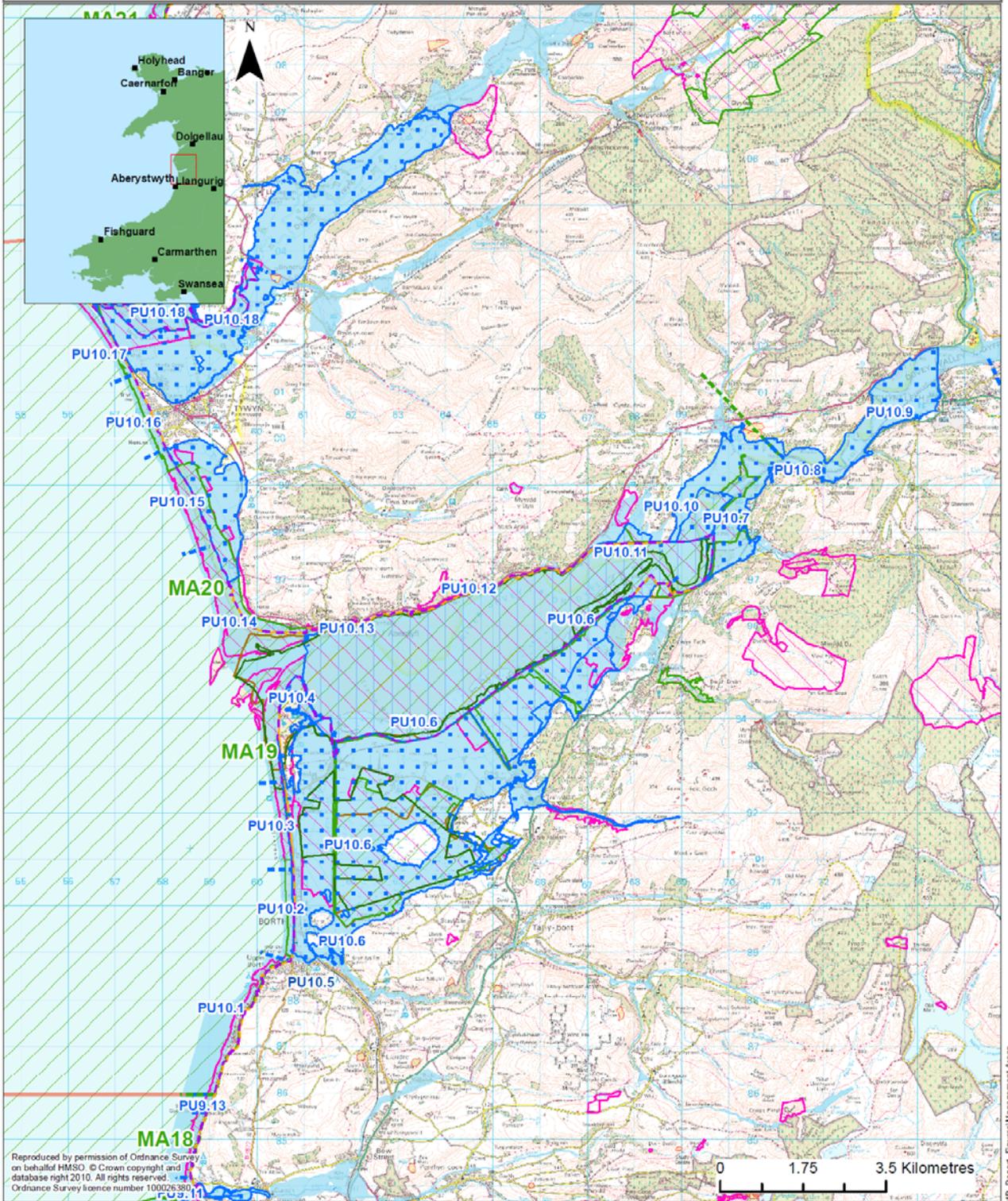
Flood Risk Zones

-  General Flood Risk Zones. The explanation of these zones is provided on the Environment Agency’s web site www.environment-agency.gov.uk. The maps within this Draft SMP document show where SMP policy might influence the management of flood risk.
-  Indicate areas where the intent of the SMP draft policy is to continue to manage this risk.
-  Indicate where over the 100 years the policy would allow increased risk of flooding.

The maps should be read in conjunction with the text within the Draft SMP document.

**Shoreline Management Plan Sub Cell 10
Baseline Location Map
Management Area 19 & 20**

- Management Area
- Policy Unit
- Scheduled Monument
- Policy Development Zone



- Key**
- 100 Year Shoreline Position:
 - Preferred Policy would be the same as With Present Management
 - With Present Management where this differs from the Preferred Policy
 - Preferred Policy where this differs from the With Present Management

- Ramsar
- SAC
- SPA
- SSSI
- NNR

- Existing Indicative EA Flood Zone 3
- EA Flood Risk Zone 2 where under the SMP policy there would be increased probability of flooding



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SUMMARY OF PREFERRED PLAN RECOMMENDATIONS AND JUSTIFICATION

INTENT OF THE PLAN:

The principal towns of Tywyn and Aberdyfi would continue to be defended under the plan. There would need to be some adaption in response to sea level rise at the seafront and harbour area at Aberdyfi. The recently completed scheme at Tywyn provides a basis for continued defence of this area.

The important transport network through the area would be sustained. There is concern that continued linear defence to the railway across the Dysynni is going to become difficult to sustain and may present issues in terms of providing a coherent approach to that taken at Tywyn to the south. The plan recommends that this approach to sustaining the railway is reconsidered with the beneficial development opportunity of a more naturally functioning estuary mouth and reduce impacts on foreshore habitat loss.

There are opportunities for managed realignment across the Pennal valley within the upper Dyfi, while still maintaining defence to the road and property. Along the Aberdyfi dunes frontage, in front of the golf course, the approach in the plan is for managed realignment. This could benefit from allowing greater tidal volume within the estuary as set out as the plan in Management Area 19. The golf course would be at greater flood risk, principally from ground water rather than direct flooding across the dunes. The Penllyn marsh area would be subject to increased flood risk as the frontage is allowed to respond naturally. There would need to be consideration of local or set back defences to the railway line, road and the golf course. Management of the dunes would benefit from continued recharge of sediment derived from dredging to maintain Aberdyfi Harbour.

Within the Dysynni, the policy for defence would be to reduce defences over epochs 1 and 2 to avoid increasing use of the area in the future based on the impression of defence (which will become increasingly fragile with a lower standard of protection). This would need to be developed in consultation with landowners but with the clear intent to allow the estuary to function in a more natural manner. Then there is potential, especially if the entrance to the estuary is allowed to adapt, for increased sedimentation and natural raising of land levels around the estuary.

KEY ISSUES/RISK AND UNCERTAINTY:

There are uncertainties in terms of timing of the proposed changes. There is also a need for a detailed planned response to change. It will be important to relate this to national monitoring of sea level rise and more general climate change and to continued monitoring of the shoreline.

Funding of defence at Aberdyfi is likely to require a collaborative approach. Decisions as to the future management of the railway line needs to be considered in terms of the regional benefits in sustaining the important transport route.

ACTIONS:

ACTION	PARTNERS
Shoreline monitoring	GC
Adaption planning	GC
▪ Pennal Valley.	▪ Aberdyfi Communities Highways
▪ Penllyn	▪ Dysynni Network Rail CCW
	EA
Assess in detail potential impact on historic environment	
Assess opportunities and plan for habitat creation	GC CCW

DELIVERY OF THE PLAN

SUMMARY OF SPECIFIC POLICIES

Policy Unit		Policy Plan			Comment
		2025	2055	2105	
10.10	Pennal valley	MR	MR	MR	.
10.11	Gogarth	HTL	HTL	HTL	
10.12	Dyfi North	HTL	HTL	HTL	Management of road and rail defences
10.13	Aberdyfi	HTL	HTL	HTL	
10.14	Aberdyfi Dunes	MR	MR	MR	Support natural dune defence and adapt use within the Golf Course
10.15	Penllyn	MR	MR	MR	Allow natural function of the seaward face. Maintain defence to the railway line and road.
10.16	Tywyn	HTL	HTL	HTL	
10.17	Dysynni railway	HTL	HTL	HTL	This is based on the need to maintain the railway line. Consideration of future managed realignment to entrance to the Dysynni
10.18	Dysynni Estuary	HTL	MR	MR	Developed with land owners
10.19	Tonfanau	MR	MR	NAI	
Key: HTL - Hold the Line, A - Advance the Line, NAI – No Active Intervention MR – Managed Realignment					

PREFERRED POLICY TO IMPLEMENT PLAN:	
From present day	Maintain existing defences to the main communities. Agree and implement management plan for MR at Aberdyfi dunes and Penllyn.
Medium term	Maintain existing defences to the main communities. Implement management plan for MR at Aberdyfi dunes and Penllyn. Discuss and develop plans for MR within Dysynni Estuary and plan future management of railway frontage.
Long term	Maintain existing defences to the main communities. Implement management plan for MR sites.

IMPLICATIONS OF THE PLAN

CHANGES FROM PRESENT MANAGEMENT

The plan develops on the existing management set out in SMP1. More specific plans are identified for managed realignment.

ECONOMIC SUMMARY

Economics (£k PV)	by 2025	by 2055	by 2105	Total £k PV
NAI Damages	2,480.6	3,479.5	5,083.9	11,044.0
Preferred Plan Damages	450.5	517.3	854.2	1,822.0
Benefits	2,030.1	2,962.2	4,229.7	9,222.0
Costs	17.1	4,603.3	4,418.3	9,038.7

FLOOD AND EROSION RISK MANAGEMENT

POTENTIAL LOSS

Would be continued residual risk of flooding to property but the plan aims to minimise this. There would be increased flooding to the golf course and to agricultural land within the Dysynni.

BENEFITS OF THE PLAN

The plan provides a longer term sustainable approach to defence, maintaining defence to the core community areas. As such the plan aims to reduce risk to some 94 properties at risk from erosion and would provide reduce risk of flooding to some 350 properties.

SUMMARY OF STRATEGIC ENVIRONMENTAL ASSESSMENT (INCLUDING HRA)

PDZ 10

SEA Objective	Impact of Preferred Policy for each Epoch			
	1	2	3	Mitigation
Policy Units 10.1 to 10.19				
To support natural processes, maintain and enhance the integrity of internationally designated nature conservation sites. Maintain / achieve favourable condition of their interest features (habitats and species).				Habitat creation
To avoid adverse impacts on, conserve and where practical enhance the designated interest of nationally designated nature conservation sites. Maintain/achieve favourable condition.				Habitat creation
To avoid adverse impacts on, conserve and where practical enhance national and local BAP habitats.				Habitat creation
To support natural processes and maintain geological exposures throughout nationally designated geological sites.				
To conserve and enhance nationally designated landscapes in relation to risks from coastal flooding and erosion and avoid conflict with AONB and National Park Management Plan Objectives.				
To minimise coastal flood and erosion risk to scheduled and other internationally and nationally important cultural heritage assets, sites and their setting.				Excavation and recording
To minimise the impact of policies on marine operations and activities.			?	
To minimise coastal flood and erosion risk to critical infrastructure and maintain critical services.				Relocation or realignment
To minimise coastal flood and erosion risk to agricultural land and horticultural activities.				
To minimise coastal flood and erosion risk to people and residential property.				Relocation
To minimise coastal flood and erosion risk to key community, recreational and amenity facilities.				
To minimise coastal flood and erosion risk to industrial, commercial, economic and tourism assets and activities.				

Opportunity for habitat creation would be considered at Penllyn and within the Dysynni estuary.

This table provides a summary of the SEA (appendix E) and reference should be made to the Appendix for full details of the assessment.

These next two sections provide a headline summary of the findings of the HRA (Appendix G) and the WFA (Appendix H). Reference should be made as appropriate to these Appendices for full details.

HRA SUMMARY

Anticipated Habitat Loss in PDZ 10 as a result of SMP Policy

Designated Site	PU	Habitat Type	Extent of Loss of Habitat (ha)			
			Epoch 1	Epoch 2	Epoch 3	Total
Llŷn Peninsula and the Sarnau SAC	10.11	Intertidal sandflat	1.13	72.33	108.90	182.36
	10.12	Intertidal sandflat	0.00	3.19	1.92	5.11
	10.13	Intertidal sandflat	0.00	0.72	0.51	1.23
	10.17	Intertidal sandflat	0.29	6.39	1.59	8.27
	10.18	Intertidal sandflat	0.00			0.00

Pen Llŷn a'r Sarnau/ Llŷn Peninsula and the Sarnau SAC: It is concluded that there would be an **adverse effect on the integrity** of the intertidal habitat (sandflats and saltmarsh) within the boundary of the SAC as a result of the SMP2 policies. There will however, be **no adverse effect on the integrity** of the other SAC features.

Preventative/mitigation measures

Potentially move defences landward where feasible where there is constraint on the intertidal habitats to allow mudflats to roll back in time with sea level rise; and potentially investigate providing additional support to the dune system under MR in epochs 2 and 3 to reduce the speed of erosion.

Risks/Assumptions: The habitat loss is considered precautionary, and where any works are to be undertaken detailed study would provide an accurate identification of whether habitat would be lost and the extent. Potentially, given the worst case assumptions, further detail of the likely actions and site specific study may conclude no habitat loss, given the worst case scenario used in this assessment. The areas of potential habitat loss are very large, and this is exacerbated by the fact that such low lying areas would show a large scale change, but this does not take into account accretion of sediments within the estuary, nor can it take into account at this strategic level the likely relocation and movement of saltmarsh communities given the very large scale mapping and extraction. Consequently, the assumptions used to determine loss are expected to have resulted in much greater extents of habitat loss than would occur.

SUMMARY CONCLUSION FROM THE WATER FRAMEWORK ASSESSMENT

Water body (and relevant PDZ)	Environmental Objectives met?				WFD Summary Statement required?	Achievement of Any South East RBMP Mitigation Measures?	Details on how the specific South East RBMP Mitigation Measures have been attained (dark green = achieved; light green = partly achieved & red = not achieved)
	WFD 1	WFD2	WFD3	WFD4			
Cardigan Bay North (Coastal) (PDZs 9, 10, 11, part 12, part 13 and 14.) (MAN 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, part 26, 33, 34, 35, 36 and 37)	N/A	x (PDZ 10, 11)	x (PDZ 10, 11)	✓	Yes – Environmental Objectives WFD 2 and 3 may not be met because of the SMPs policy in PDZ 10 (MAN 20), PDZ 11 (MAN 21).	There were no relevant measures to the SMP2 for this water body, though there are for the affected FWBs.	Mitigation measures for the FWB (GB110064048310), of which none have been implemented within the SMP2: <ul style="list-style-type: none"> • Increase in-channel morphological diversity; • Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works; • Operational and structural changes to locks, sluices, weirs, beach control, etc; • Selective Vegetation Control Regime; • Appropriate Vegetation Control Technique; • Appropriate timing (Vegetation control); • Appropriate Techniques (Invasive Species); and • Retain marginal aquatic and riparian habitats (channel alteration).
Dysynni (Transitional) (PDZ part 10) (MAN part 20)	N/A	✓	✓	✓	No - not necessary as delivery of the WFD Environmental Objectives will not be prevented by the SMP policies and in some cases will ensure they	Yes (partly) – One of the seven relevant mitigation measures for this water body has been implemented, which then provides	<ul style="list-style-type: none"> • Managed realignment of flood defence – MR where there are defences both public and private (PU 10.18) will allow the estuary to roll back and create further intertidal habitats. • Remove obsolete structure – if there are obsolete structures in place along the MR

Water body (and relevant PDZ)	Environmental Objectives met?				WFD Summary Statement required?	Achievement of Any South East RBMP Mitigation Measures?	Details on how the specific South East RBMP Mitigation Measures have been attained (dark green = achieved; light green = partly achieved & red = not achieved)
	WFD 1	WFD2	WFD3	WFD4			
					are of benefit.	potential for other measures to be put in place.	<p>location these could be removed.</p> <ul style="list-style-type: none"> • Retain marginal aquatic and riparian habitat – MR will result in creating marginal habitats. • Increase morphological diversity – MR will result in this measure inadvertently being put in place. • Removal of hard bank reinforcement or replace with soft engineering – the former option may be required as part of the MR. • Offsetting measures – not considered. • Operation and structural changes to locks etc – not feasible.