Christchurch Bay and Harbour Flood and Coastal Erosion Risk Management Study

Technical Annex 1: Option Appraisal and Economic Assessment for Christchurch Harbour

Prepared by

New Forest District Council

for the Christchurch Bay Coastal Sub-Group

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Christchurch Bay and Harbour
Flood and Coastal Erosion Risk Management Study

Technical Annex 1: Option Appraisal and Economic Assessment

for Christchurch Harbour

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft	Sept 2006	P Ferguson
2	1	Revised Draft	2008	P Ferguson
3	2	Revised Draft	May 2012	A Colenutt
4	3	Final Draft	Sept 2012	A Colenutt

Contents

1 Christchurch Harbour CHB1 to CHB5

1.1 Introduction

Formed during rising sea-levels in the late Holocene, Christchurch Harbour estuary comprises the lower portion of the flood plains of the Rivers Avon and Stour. The extent of the Harbour is between Mudeford Spit to the south east and Mudeford Quay to the north, only separated by a narrow entrance known as the run. From Mudeford Quay, moving northwards then westwards around the Harbour are the residential settlements of Christchurch, Mudeford, Stanpit & Purewell. The two main Rivers Stour & Avon presently converge to the northwest of the Harbour; the minor tributaries of the River Mude and Bure Brook also discharge into the northeast sector of harbour. The tidal limit of the River Avon is the weir, north of the A35 Road Bridge; the tidal limit of the River Stour is Iford Bridge. The western side of Purewell is located on the banks of the River Avon and merges with the centre of Christchurch in the north-west corner of the Harbour. The shopping centre is situated between the confluence of the River Avon and the River Stour. The district of Wick and the eastern part of Southbourne are located south of the River Stour. To the east of Southbourne is the undeveloped area of Warren Hill (bordered by Double Dykes), with the Hengistbury Head promontory beyond.

Flood defences that exist along the perimeter of the Harbour are mostly in the form of concrete floodwalls and embankments. The defences are owned and maintained by either private individuals or Christchurch Borough Council and run along the edge of the harbour. The condition of the defences varies along the frontage. The cottages on the quayhead are protected by a floodwall and gates.

The extent of tidal flooding within Christchurch Harbour is confined to the low lying land and sand-spit forming the margins around the Harbour and to the floodplains located along the lower banks of the two rivers. These low lying areas around the perimeter of the Harbour are significantly developed with residential property; much of this property is located within the 1:200 year return period tidal flooding event zone. As a consequence a number of flood defences are present mainly consisting of seawalls, but revetments and embankments are also present. Flood defences form parts of the river bank on both sides of the River Stour at Wick (south of the river) and Twynham (to the north). The defences along the northern banks extend along the Quomps to Priory Quay. The Avon flows through to the east of Christchurch town centre and is defended along both river banks and around Avon Island. Parts of the northern & eastern banks of the Harbour are defended (the defences around Mudeford are privately owned). The existing defences vary regarding the current condition of the defence, the current standard of service and who it is currently maintained by / owned by.

The Harbour is an important nature reserve with extensive habitats for breeding, migrant and wintering wetland birds and numerous national and international conservation designations:

- Dorset Heaths SAC
- Christchurch Harbour SSSI
- Avon Valley Ramsar

The geography of the Harbour, combined with the distribution of existing flood defences has resulted in the formation of a number of independent flood areas. It is therefore necessary to produce a separate benefit/cost analysis for each area, within each management unit (CHB1 to CHB5) as defined in the Shoreline Management Plan.

The Administrative Authorities are Bournemouth Borough Council (CHB1 and 2) and Christchurch Borough Council (CHB3 to 5). A map of Christchurch Harbour identifying the location of the management units is highlighted in Figures 1.1 & 1.2.

The tidal extreme water level data at Priory Quay and Iford Bridge have been used to model what the likely extent of flooding will be, should these levels be reached. Tidal extreme water level data is presented in Table 1.1.

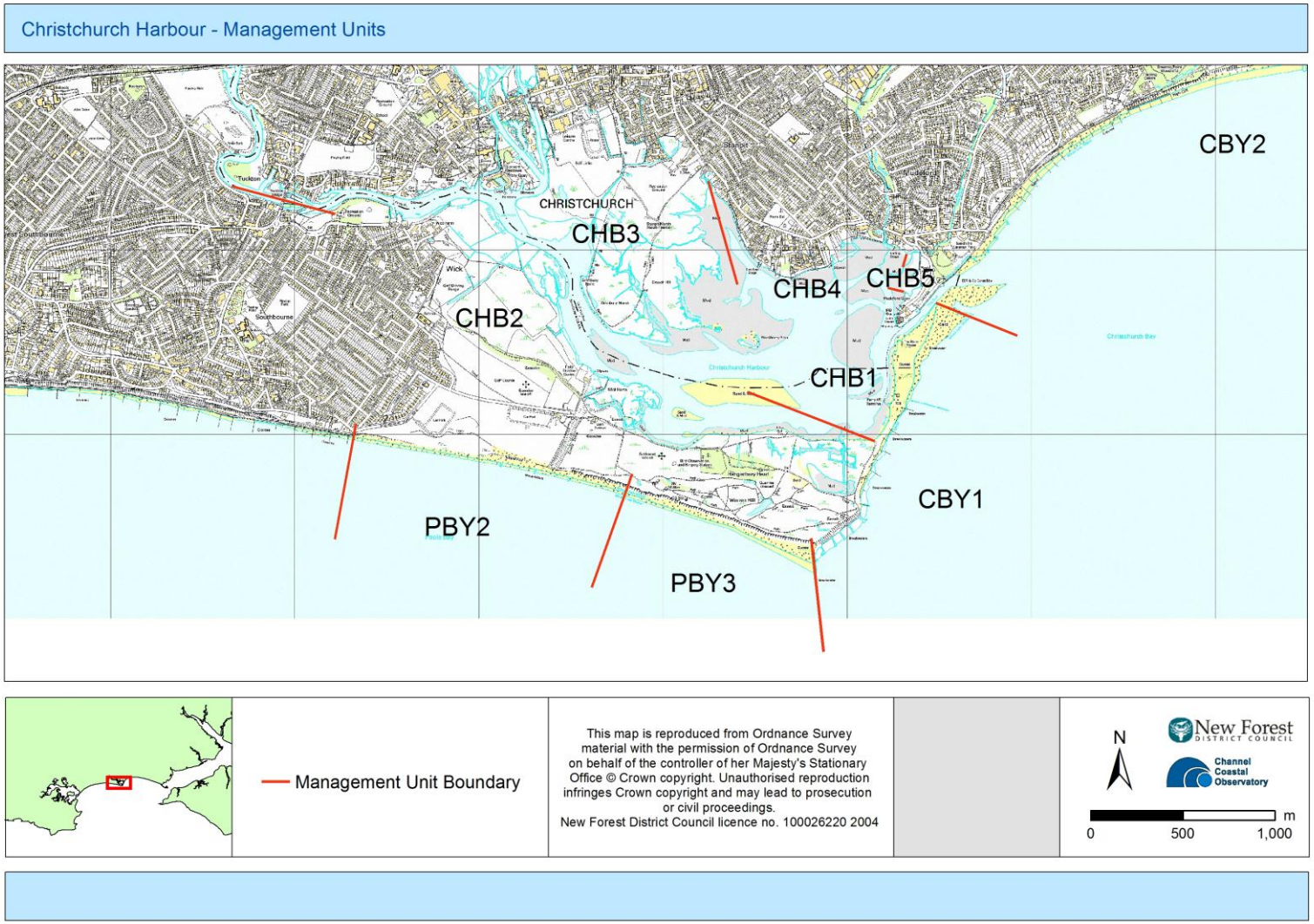

Figure 1.1 Ordnance Survey Map of Christchurch Harbour: Location of Management Units. *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

Figure 1.2 Aerial Photograph of Christchurch Harbour: Location of Management Units. *© Microsoft Corporation © Getmapping plc.*

Return Period (2002)	Tidal Still Water Level m (OD)	
	PRIORY QUAY (SZ 158 923)	IFORD BRIDGE (SZ 137 936)
MLWS	-0.11	-
MWL	0.33	-
MHWS	0.89	-
1-Year	1.39	1.39
5-Year	1.57	1.57
10-Year	1.65	1.65
25-Year	1.75	1.75
50-Year	1.83	1.83
100-Year	1.91	1.91
200-Year	1.99	1.99
500-Year	2.09	2.09
1000-Year	2.17	2.17

Table 1.1 Tidal extreme water level return period data (Environment Agency South West Region Report on Extreme Tide Levels 2003)

1.2 Assessment Method

1.2.1 Tidal Flooding Areas

In 2005 the Environment Agency completed a national flood risk assessment and published a flood map for Christchurch Harbour. The flood map indicated the areas at risk from fluvial flooding 1:100 year, and tidal flooding 1:200 year. Although these maps establish the specific area at risk from flooding, the likely damages to any property cannot be identified without knowing the actual ground elevation. Once the ground elevation is established the likely property damages can be established corresponding to each return period event.

The Environment Agency 1:200 year flood zone map area is used as the basis for property identification. The 1:200 year map is produced using a combination of input factors such as historical flooding records / historical flood maps / aerial photographs etc. The flood zone map indicates the extent of flooding without the presence of any flood defences, and does not identify the specific depth of flooding (corresponding to a particular return period flood event). Note: only property currently located within the flood zone map area have been included in the tidal flooding analysis.

Using the contour lines generated from the Lidar data enabled the extent of flooding to be calculated with respect to each specific extreme return period flood event (1:1 1:5 1:10 1:50 1:100 1:200) and a flood area created for each area. Using GIS, property located within each area could be identified and the specific depth of flooding could be identified with respect to each return period flood event. A number of the areas within the flood zone map are currently defended; therefore the flood zone maps are accompanied by a 1:200 year defended area.

1.2.2 Existing Defences

The majority of the flood defences are currently either maintained by the Environment Agency or the Local Authority; however some defences are also maintained privately. The integrity of all the defences relies on regular maintenance, without which structures become increasingly vulnerable to failure during periods of tidal extreme water level events. Due to the topography of the land & location of the defence, the specific sections of defence which become active will vary corresponding to the level of the extreme flood water level. Therefore defence failure scenarios are introduced in order to assess the extent of flooding in the defended area in the event of a failure occurring to an active section of defence. In instances where several separate sections become active, the consequences of a breach occurring from any of the active sections will result in flooding affecting a particular area. This is governed by the location of the breach and the topography of the land. A number of flooding scenarios are therefore modelled for each flood area to assess the extent of flooding during an extreme flood event, in the event of the defences remaining intact, and in the event of a failure occurring.

In the areas that are currently defended, during an extreme flood event the elevation of the flood water will rise until there comes a point when flood water intersects the line of the flood defences, resulting in the defences becoming 'active' (i.e. the defence actively preventing water from entering the defended area.) If the defences are adequately maintained, floodwater will be prevented from penetrating through the structure and the extent of flooding will be limited.

The Strategy covers a 100 year period; therefore looking ahead into the future all flood defences will require maintenance & replacement over the next 100 years. Without maintenance, flood defences will therefore become increasingly vulnerable to failure during an extreme flood event.

The 2006 Environment Agency maintenance budget for Environment Agency flood defences in the Lower Avon & The Quomps (Lower Stour) is estimated to be 31.5k (this figure includes anticipated emergency responses). This equates to an annual maintenance budget of approximately £5 per metre of flood defence. The condition of flood defence structures in Christchurch Harbour is regularly inspected in order to determine the current condition & residual life of the structure and this information is recorded on the National Flood & Coastal Defence Database (NFCDD). This data is used to determine future flood defence requirements, such as when the defences would require replacement. The future requirements of defences are also considered with regard to the impact of rising sea levels over the next 100 years.

In undefended areas, flooding scenarios are created for each extreme return period flood event and the property identified for each event. In defended areas the flooding scenarios are created in terms of defence failure occurring during an extreme return period flood event.

1.3 Environmental Designations

There are a number of designated areas within the Christchurch Harbour. The designations that currently exist are:

(a) Statutory Designations:

- Christchurch Harbour SSSI – saltmarsh ecology
- Hengistbury Head LNR – range of habitats
- Dorset Heathland SPA – heath ecology
- Bronze Age Barrows 2x SMs - archaeological sites
- Hengistbury Head x17 – archaeological sites

(b) Non Statutory Designations:

- Stanpit Marsh LNR – grazing marsh
- Hengistbury Head SNCI – coastal habitats
- River Avon ESA – chalk stream ecology
- Poole Bay and Isle of Purbeck SMA – marine ecology
- Stanpit Marsh SNCI – grazing marsh
- Stanpit SNCI – grassland ecology

The distribution of Environmental designations are highlighted in Figures 1.3 & 1.4

Figure 1.3 Map of Christchurch Harbour: Location of Christchurch Harbour SSSI – saltmarsh ecology.

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Figure 1.4 Map of Christchurch Harbour: Location of Christchurch Harbour SSSI – saltmarsh ecology

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2 CHB1 Harbour side of Mudeford Sandbank

2.1.1 CHB1 – Strategic Management Plan Coastal Management Policy
The SMP states that the long term preferred option (2005 to 2049) is Hold the Existing Line (in unison with a Hold policy for Management Unit CBY1b)

2.1.2 CHB1 – Administrative Authority
Bournemouth Borough Council leases the spit landholding to Christchurch Borough Council

2.1.3 CHB1 – Frontage Length
Defended Frontage length 0m

2.1.4 CHB1 – Environmental Designations
(a) Statutory Designations:

- Christchurch Harbour SSSI – Saltmarsh Ecology
- Hengistbury Head LNR – Range of Habitats
- Hengistbury Head x17 – Archaeological sites

(b) Non Statutory Designations:

- Hengistbury Head SNCI – Coastal Habitats
- Poole Bay and Isle of Purbeck SMA – Marine Ecology

2.1.5 CHB1 – Extent of Frontage
The unit frontage is 553m long and consists of mixed sand & shingle beaches fronted by areas of mudflats, which characterise the eastern side of the Harbour. The Sandbank forms an important coastal defence function against erosion and flooding of Christchurch Harbour. The area contained within CHB1 is presented in Figure 2.1.

2.1.6 CHB1 – Existing Defences
Mudeford sandbank is maintained by Christchurch Borough Council who operates the Christchurch Sandbank Beach Management Plan (2001). The defences consist of a series of rock groynes with a reinforced concrete promenade and wall running down the spine of the spit. At the northern end a small rock revetment protects the southern channel adjacent to The Run. The sand-shingle beach provides the main line of defence along the frontage to the wave climate generated within the Harbour. The sandbank is a low lying area and there are no specific flood defences along the frontage. The inner foreshore will therefore become increasingly vulnerable to future flooding.

2.1.7 CHB1 – Property at Risk
Mudeford Sandbank is colonised with 350 wooden beach huts, 5 toilet blocks, mains drainage, a beach café and the Black House holiday apartments. The wooden beach huts are large; the approximate footprint area of each Hut is 17m^3. Each hut usually contains a living area, kitchen and a sleeping area (on a separate level). The beach huts are constructed on wooden stilts; therefore the living area (threshold level) is located above beach level. Although the distances vary from one hut to the next, for the purpose of the assessment it is estimated that the threshold level of each of the huts is a distance of approximately 500mm above beach level. The 1:200 year flood zone map indicates that 211 properties are currently located within the current 1:200 year flood zone area.

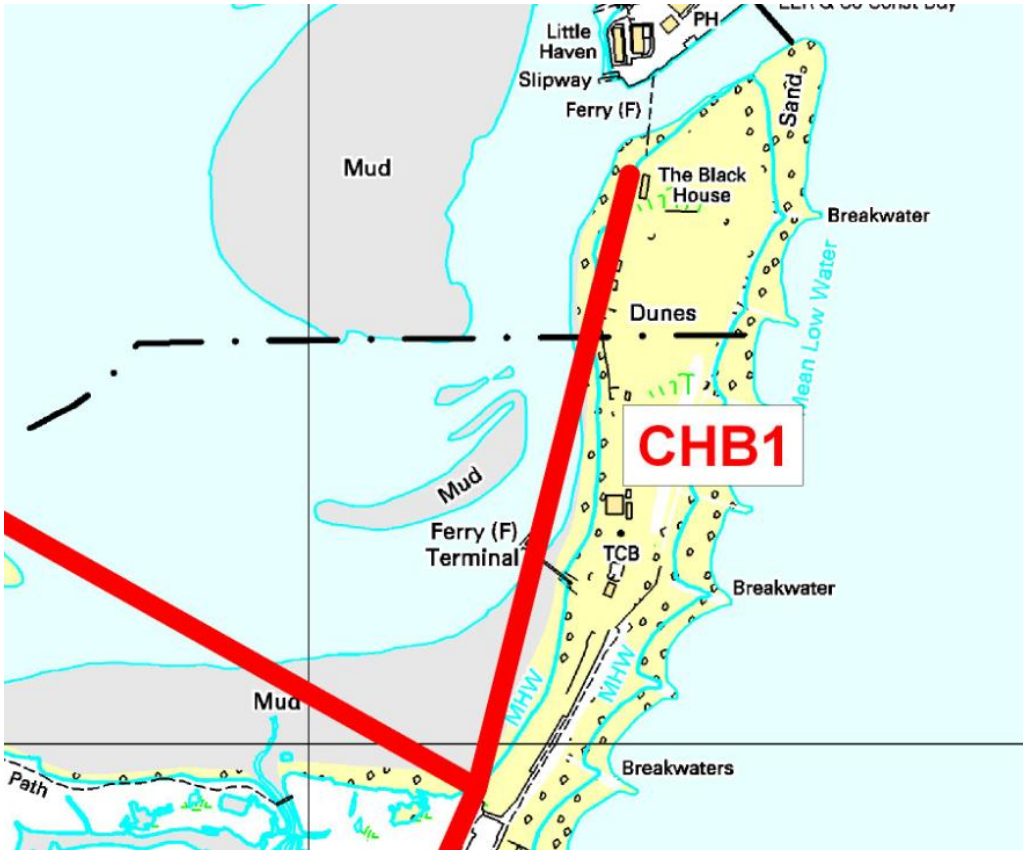

Figure 2.1 Map of Christchurch Harbour: Location of CHB1 © *Crown copyright and database rights 2012 Ordnance Survey 100026220 2012*

2.1.8 CHB1 – Flood Areas

The CHB1 inner foreshore is undefended with respect to extreme flood events. The area that comprises CHB1 is presented in Table 2.1.

AREA	LOCATION (Sector)	SOURCE OF FLOODING	DESCRIPTION
CHB1.01	Mudeford Sandbank	Christchurch Harbour	Eastern Fringe of Christchurch Harbour

Table 2.1 Location & description of potential flood areas within CHB1

Flood modelling exercises were carried out to assess the extent of flooding under tidal extreme water levels during six different flood levels corresponding to a 1:1; 1:5; 1:10; 1:50; 1:100 & 1:200 year return period flood events within Area CHB1 and are illustrated as flood-maps. As properties, which are currently located in the EA 1:200 year tidal extreme flood map area, are affected by flooding, the colour of the property turns from clear to red in colour. The flood-maps are presented in Annex 1, CHB1.

2.2 Flood Area 1.01 (CHB1 – Christchurch Sandbank)

Flood area 1.01 is highlighted in orange in Figure 2.2 (aerial photograph of Christchurch Harbour). Figure 2.3 is a smaller scale aerial photograph of the outlined area. Figure 2.4 illustrates the 1:200 year tidal flooding area without the presence of flood defences.

Figure 2.2 Aerial photograph of Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

Figure 2.3 Aerial photograph of Area CHB 1.01 in Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

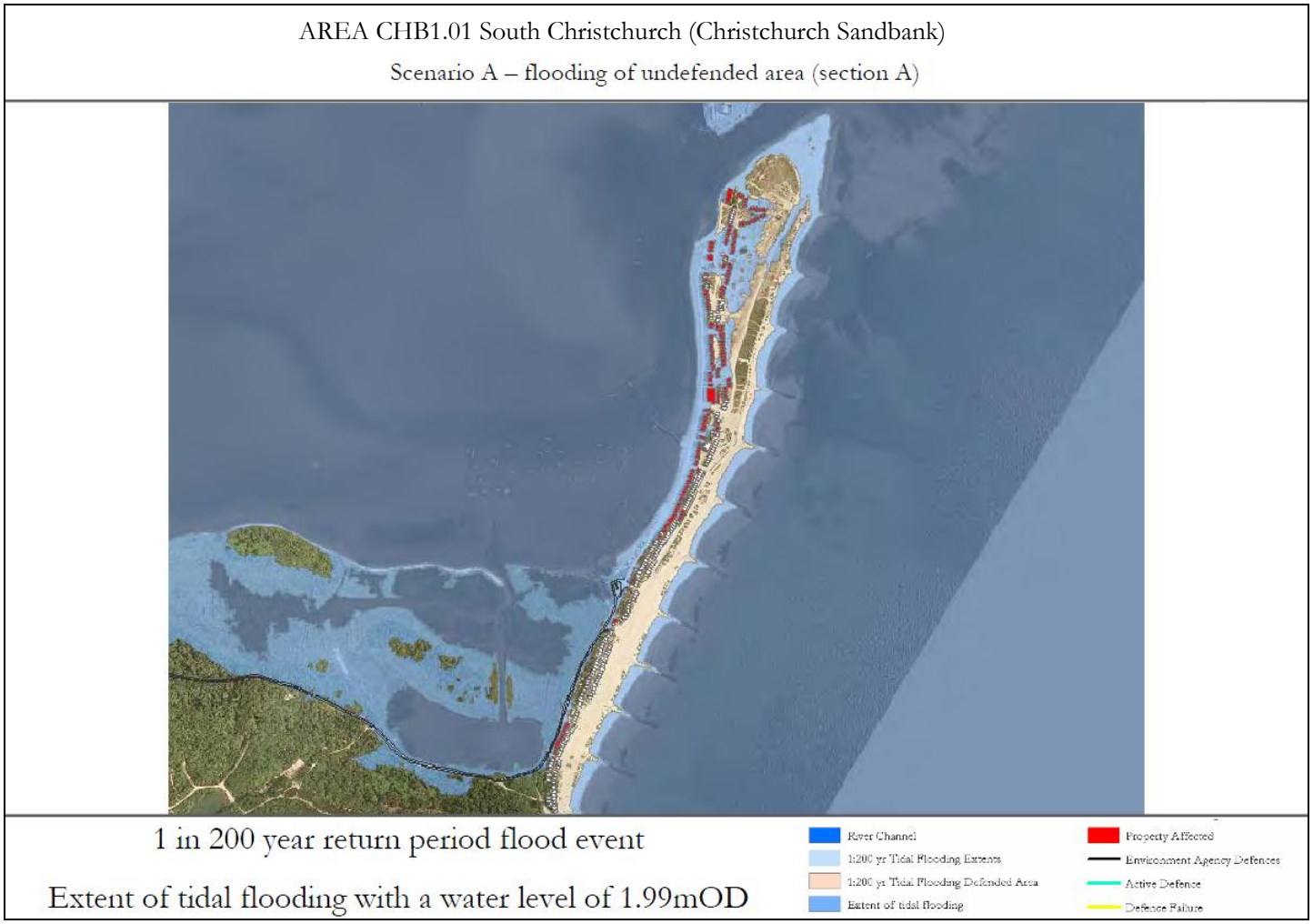

Figure 2.4: Area CHB1.01 *© Crown copyright and database rights 2011 Ordnance Survey 100026220*

2.2.1 Flooding Scenarios 1.01

A flood modelling exercise was carried out to assess the extent of flooding under tidal extreme water levels within Area 1.01.

The number of properties at risk (both residential & non-residential), with respect to each return period event, were calculated and these are presented in Table 2.2 below:

CHB1-01			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	**1.39**	78	0
5 YEAR	**1.57**	112	0
10 YEAR	**1.65**	138	0
25 YEAR	**1.75**	179	0
50 YEAR	**1.83**	192	0
100 YEAR	**1.91**	197	0
200 YEAR**	**1.99**	211	0

* taken for all property 1.4m OD and below
** taken for all property 2m OD and below

Table 2.2 Flood scenarios identified within Area 1.01

3 CHB2 South side of Christchurch Harbour (to Grimbury Point)

3.1.1 CHB2 – Strategic Management Plan Coastal Management Policy
The SMP states that the long term preferred option (2005 to 2049) is Do Nothing (Limited intervention at Double Dykes).

3.1.2 CHB2 – Administrative Authority
Bournemouth Borough Council and Christchurch Borough Council

3.1.3 CHB2 – Frontage Length
Defended Frontage length 420m floodbank and 130m timber revetment

3.1.4 CHB2 – Environmental Designations
(a) Statutory Designations:

- Dorset Heathland SPA – heath ecology
- Christchurch Harbour SSSI – saltmarsh ecology
- Bronze Age Barrows 2x SMs - archaeological sites
- Hengistbury Head 17 SMs - archaeological sites

(b) Non Statutory Designations:

- Stanpit Marsh LNR – grazing marsh
- Hengistbury Head LNR – range of habitats
- River Avon ESA – chalk stream ecology
- Poole Bay and Isle of Purbeck SMA – marine ecology
- Stanpit Marsh SNCI – grazing marsh

3.1.5 CHB2 – Extent of Frontage
The unit extends between Mudeford Sandbank and the lower reaches of the river Stour. The frontage contains a wide range of habitats including saltmarsh, reed beds, mudflats and grasslands, which characterise Hengistbury Head Nature Reserve. The area contained within CHB2 is presented in Figures 3.1 & 3.2.

3.1.6 CHB2 – Existing Defences
Between Mudeford Sandbank and the River Stour the majority of the frontage is undefended, with the exception of a timber revetment (along the River Stour), and an embankment, which are owned and maintained by the Environment Agency.

3.1.7 CHB2 – Property at Risk
The unit is completely undeveloped for most of its length. Flooding along this section would mainly affect marshland, farmland and a highway. However there is a developed area in Wick, situated between the southern banks of the river Stour and the western perimeter of the Harbour. Property located here are mainly residential houses (some large and detached). At present 32 properties (all residential) are currently positioned within the current 1:200 year flood zone area; of these 12 are currently defended.

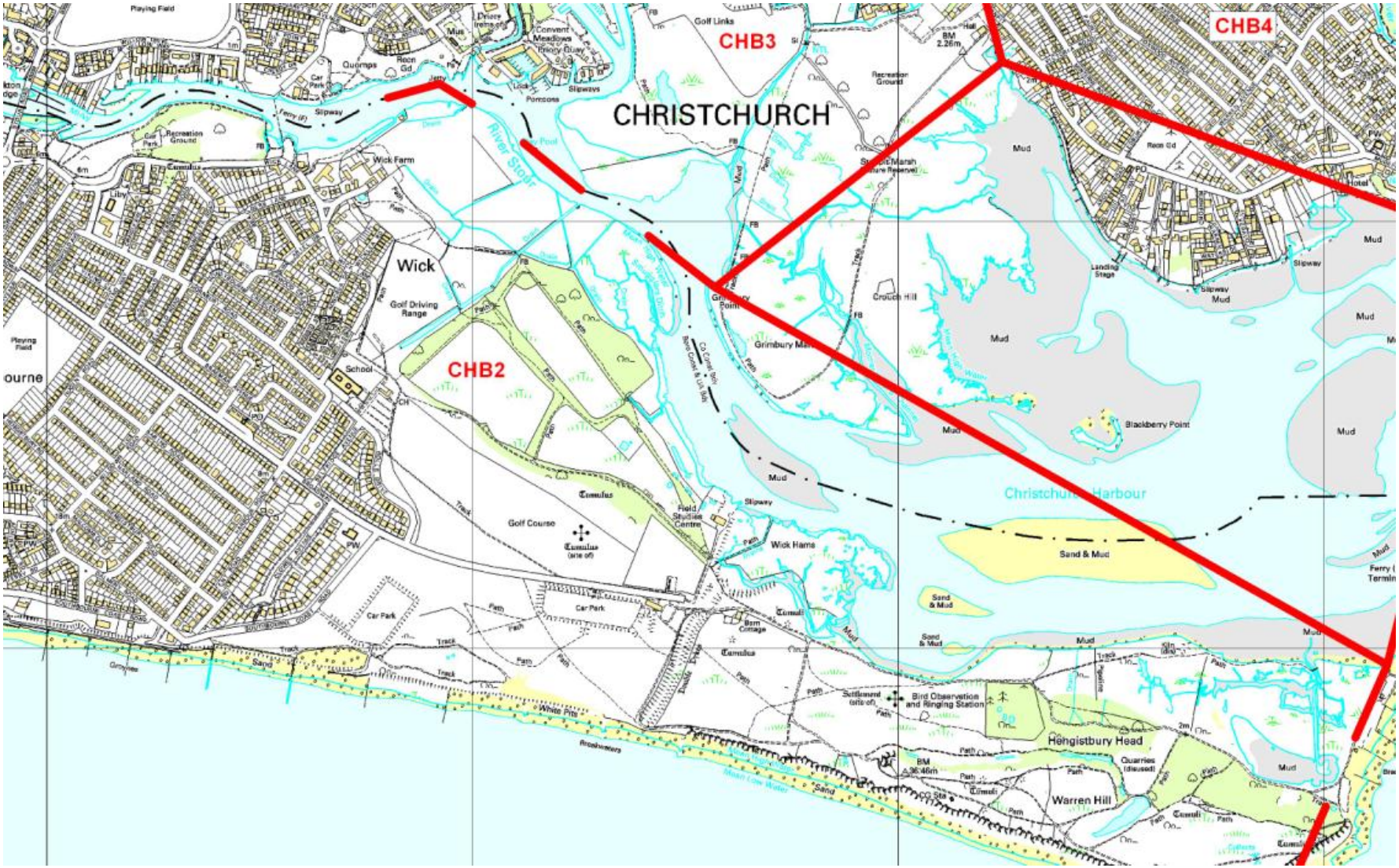

Figure 3.1 Map of Christchurch Harbour: Location of CHB2. *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

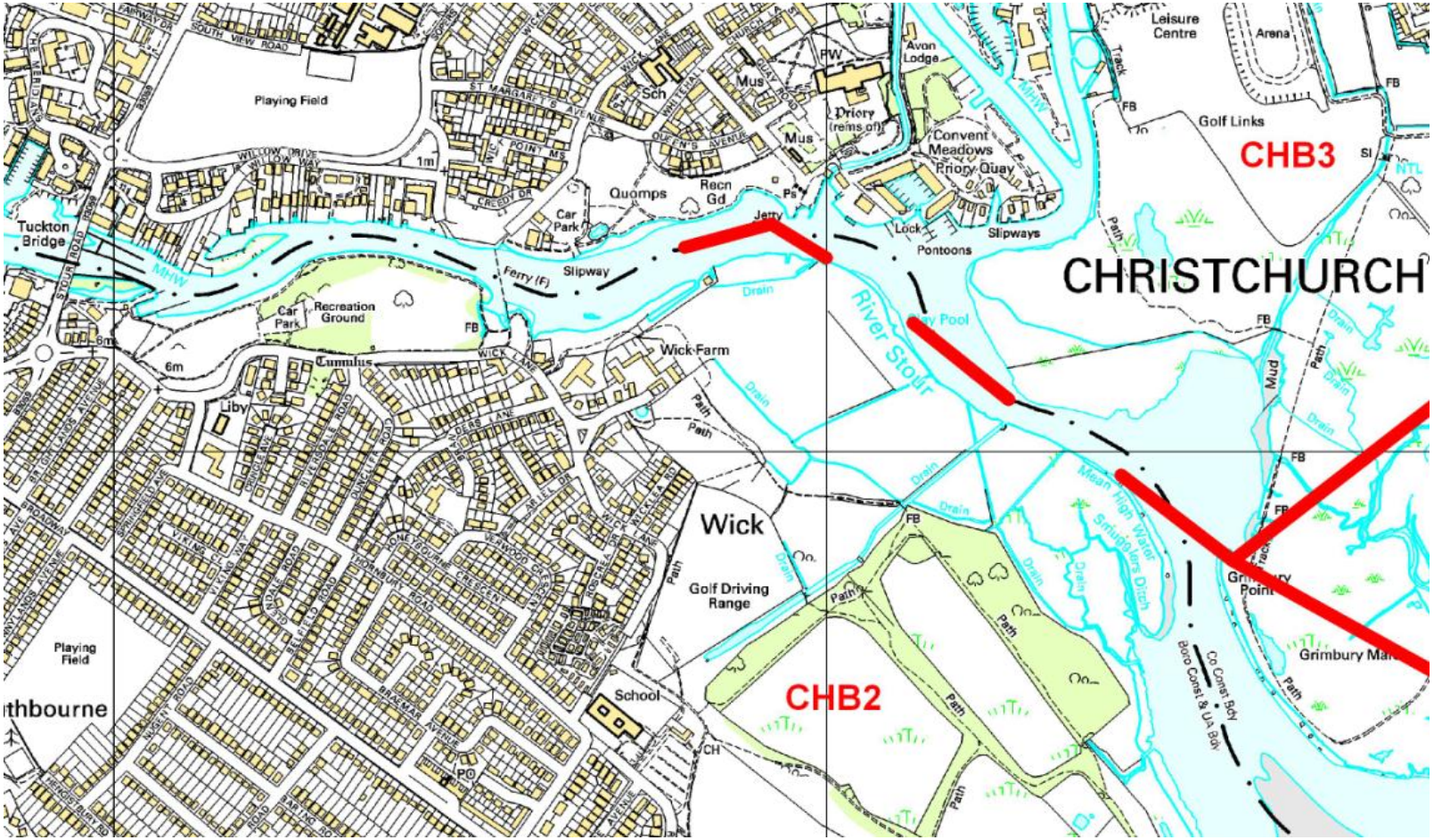

Figure 3.2 Map of Christchurch Harbour: CHB2 (Wick and surrounding area). *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

3.1.8 CHB2 – Flood Areas

Flood protection varies along the frontages in CHB2, equating to there being property which benefit from **limited** flood protection from the floodbank east of Wick Farm which offers some protection to a number of properties. Under extreme conditions, property would therefore be flooded whether the defences functioned or not.

AREA	LOCATION (Sector)	SOURCE OF FLOODING	DESCRIPTION
CHB2.01	West Christchurch Wick / East Bournemouth	Stour	Southern banks of River Stour

Table 3.1 Location & description of potential flood areas within CHB2

Flood modelling exercises were carried out to assess the extent of flooding under tidal extreme water levels during six different flood levels corresponding to a 1:1; 1:5; 1:10; 1:50; 1:100 & 1:200 year return period flood events within Area CHB2 and are illustrated as flood-maps. As properties, which are currently located in the EA 1:200 year tidal extreme flood map area, are affected by flooding, the colour of the property turns from clear to red in colour. The flood-maps are presented in Annex 1, CHB2.

3.2 Flood Area 2.01 (CHB2 - Wick)

Area 2.01 is highlighted in orange in Figure 3.3 (aerial photograph of Christchurch Harbour). Figure 3.4 is a smaller scale aerial photograph of the outlined area. Figure 3.5 illustrates the 1:200 year tidal flooding area without the presence of flood defences.

Figure 3.3 Aerial photograph of Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

Figure 3.4 Aerial photograph of Area CHB 2.01 in Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

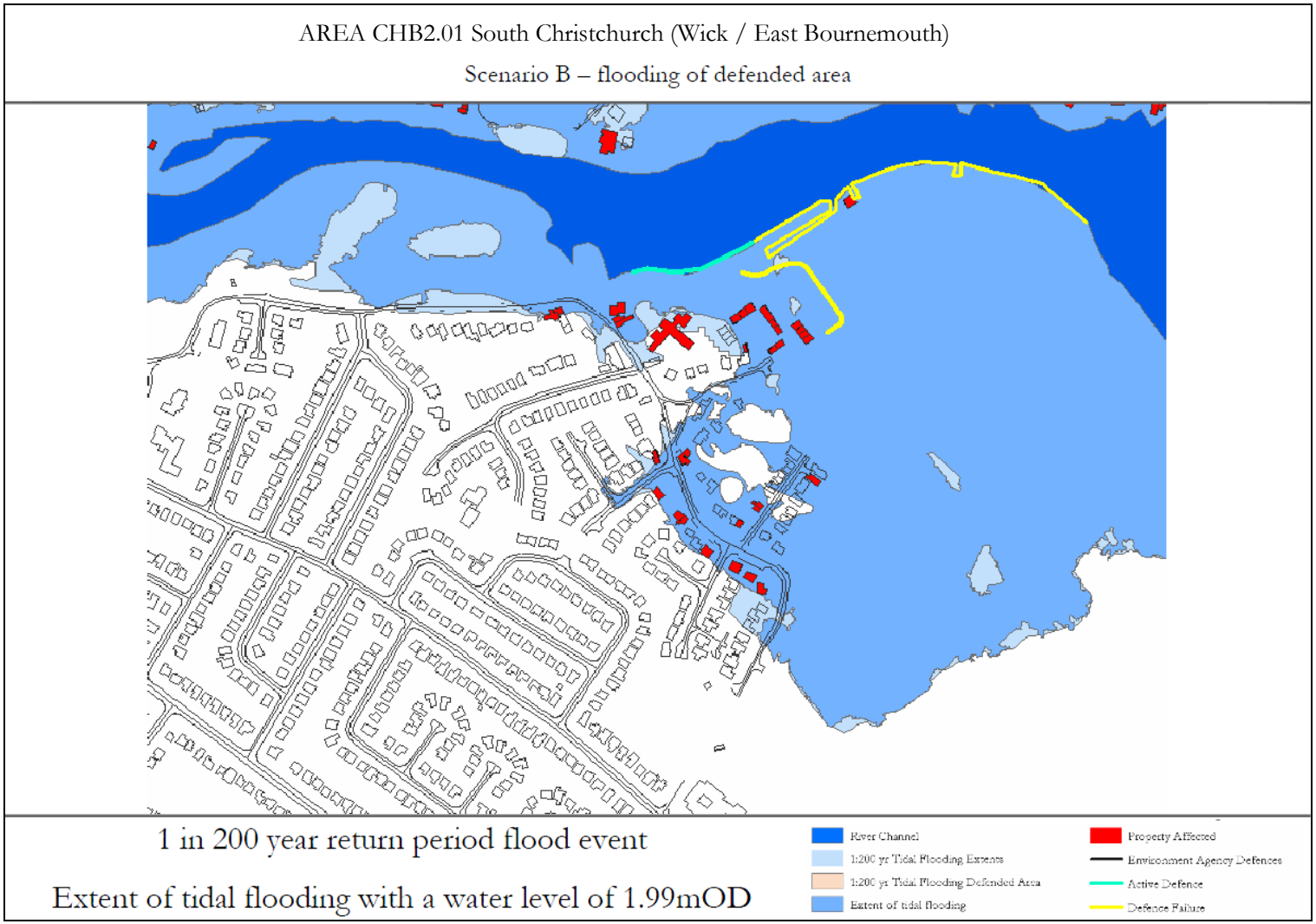

Figure 3.5: Area CHB2.01 South Christchurch - Wick / East Bournemouth *© Crown copyright and database rights 2011 Ordnance Survey 100026220*

3.2.1 Flooding Scenarios 2.01

SCENARIO REFERENCE NO.	SCENARIO	SECTORS FLOODED
FLOOD DEFENCES FUNCTIONING		
CHB2.01A	Existing flood conditions	Southern banks of River Stour (with defences intact)
DEFENCE FAILURE SCENARIOS		
CHB2.01B	Existing flood conditions	Southern banks of River Stour (with defence failure)

Table 3.2 Flood scenarios identified within Area 2.01

3.2.2 Scenario A (Figure 4.9) – Present day (Defences intact)

The flood maps indicate that during a 1:200 year return period event, 20 undefended properties in the vicinity of Wick Lane and Wicklea Road are at risk from flood damage during an extreme flooding event. In addition, the flood defences which protect the Wick Farm area to the south of the river become increasingly active as the tidal extreme water level rises.

3.2.3 Scenario B (Figure 4.10) – Failure of Defence (section 1)

The flood maps indicate that during a 1:200 year return period event, in addition to the undefended property, an additional 12 properties in the vicinity of Wick Farm are at risk from flood damage following defence failure during an extreme flooding event.

CHB2-01			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	2	2
5 YEAR	1.57	5	5
10 YEAR	1.65	15	15
25 YEAR	1.75	20	20
50 YEAR	1.83	25	25
100 YEAR	1.91	31	31
200 YEAR**	1.99	32	32

* all property with an elevation of 1.4m OD and below
** all property with an elevation of 2m and below

Table 3.3 Flood scenarios identified within Area 2.01

4 CHB3 Stanpit to Grimbury Marshes

4.1.1 CHB3 – Strategic Management Plan Coastal Management Policy
The SMP states that the long term preferred option (2005 to 2049) is Selective Retreat the Existing Line (subject to future survey results).

4.1.2 CHB3 – Administrative Authority
Christchurch Borough Council

4.1.3 CHB3 – Frontage Length
Defended Frontage length 3100m

4.1.4 CHB2 – Environmental Designations
(a) Statutory Designations:

- Christchurch Harbour SSSI – saltmarsh ecology

(b) Non Statutory Designations:

- Stanpit SNCI – grassland ecology
- River Avon ESA – chalk stream ecology
- Poole Bay and Isle of Purbeck SMA – marine ecology

4.1.5 CHB3 – Extent of Frontage
The description of the Unit in the SMP is limited to the entirely undeveloped and undefended area which consists chiefly of grazing marsh of national nature conservation importance which has been designated a LNR and SSSI for its saltmarsh and mudflat habitats. The marshes forma sink for fluvial material, which enters the Harbour from the Rivers Stour and Avon. To the north of the marsh is a historic landfill site. In addition this study has also investigated the tidal flooding risk to large areas of developed land located north of the marshes on the banks of the two rivers. The area contained within CHB3 is presented in Figure 4.1 (Figures 4.2 to 4.4) highlight the area in greater detail.

4.1.6 CHB3 – Existing Defences
The type of defences range from natural river banks to manmade structures such as embankments, stone revetments, floodwalls & sheet piles walls. The location and purpose of the defences vary from forming part of the river bank (Avon Island) to being positioned on higher ground and set back from the river bank, only becoming active during extreme flooding events. A number of defences also form part of buildings (Avon Island and Christchurch Borough Council Offices) Full details of all the defences in CHB3 are presented in Appendix B (Section 11).

4.1.7 CHB3 – Property at Risk
The area around Christchurch (within these areas) consists of a large residential areas, schools, industrial units, marina developments, holiday apartments, a newly built hotel, pubs, a small number of boat yards & sailing clubs and Place Mill. Along the frontage of the River Avon in Central Christchurch and on Avon Island (a river island) there are Marina Style developments, residential houses (some large and detached) shops businesses, restaurants, and a number of offices including Christchurch Borough Council Civic Offices. The unit also includes high value amenity land and recreational benefits.

A total of 501 properties are at risk of flooding in the CHB3 area during a 1:200 year event. At present 382 properties are defended (324 residential) and 119 are undefended (98 residential).

There are areas within Christchurch Harbour which are inundated with flood water when a tidal surge coincides with a high spring tide (for example the Quomps area on the River Stour), however this does not generally result in a high level of property damage occurring due to the 1:100 year flood defence walls.

A number of the properties in the area have been designed to take into account the risk of flooding, such as bedrooms being on the ground floor and the level of the ground floor constructed approximately 0.5m above ground level.

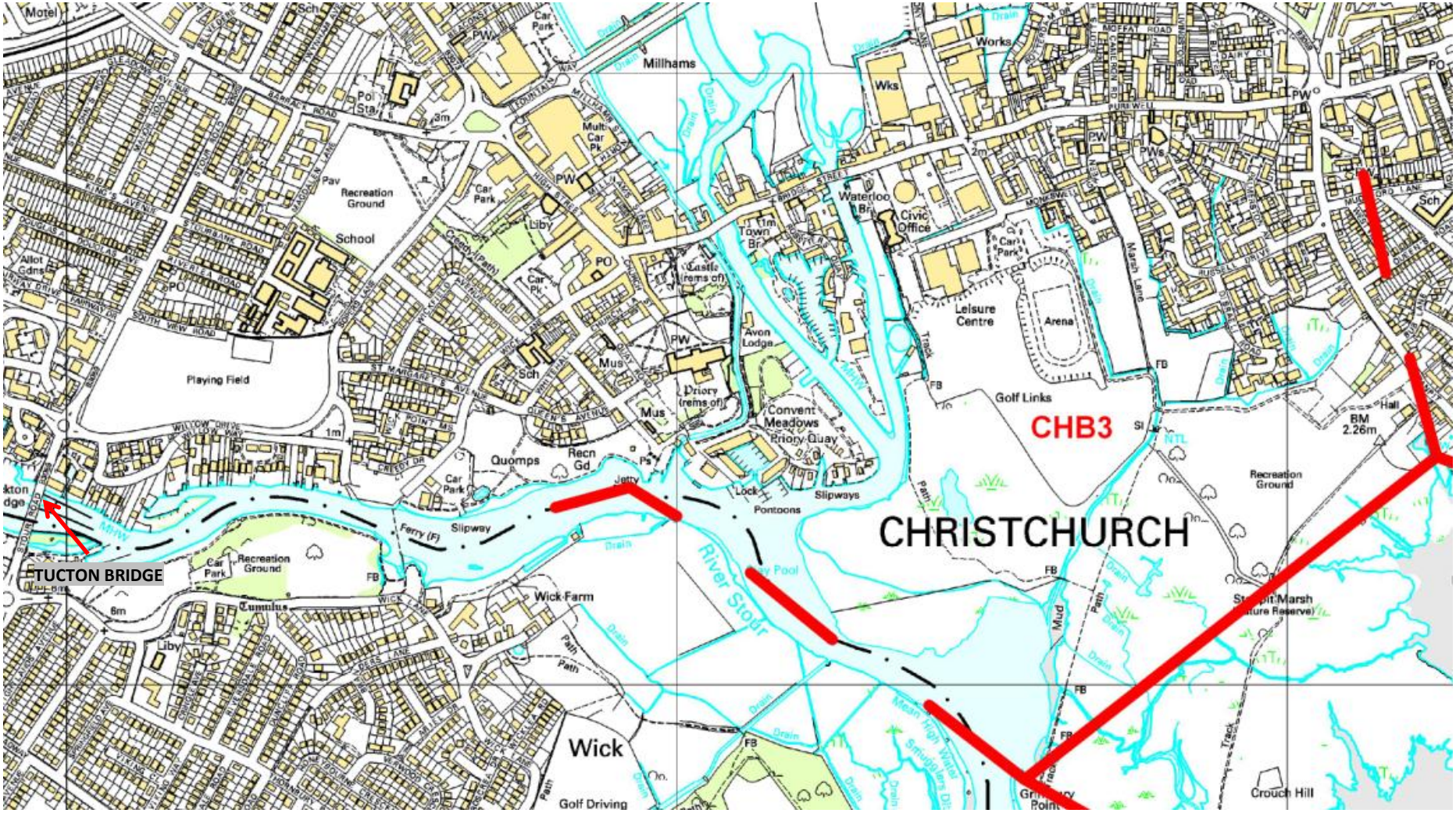

Figure 4.1 Map of Christchurch Harbour: Location of CHB3. *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

4.1.8 CHB3 – Flood Areas

The degree of flood protection varies along the frontages in CHB3, which equates to there being a number of (separate) defended and undefended areas. Within CHB3, 5 areas have been identified as being at risk from flooding. Within these 5 areas, 7 individual areas have been identified. The areas and areas that comprise CHB3 are presented in Table 4.1.

AREA	LOCATION (Area)	SOURCE OF FLOODING	DESCRIPTION
CHB3.01U	West Christchurch (Twynham (South))	Stour	Undefended banks of River Stour
CHB3.01D	West Christchurch (Twynham (North))	Stour	Defended areas north of River Stour
CHB3.02	West Christchurch (Priory)	Avon & Stour (& Millstream)	Area situated between River Stour, River Avon & Millstream
CHB3.03	Central Christchurch (Castle Street)	Avon	West of Avon Island (Adjacent to High Street)
CHB3.04D	Central Christchurch (Avon Island (North))	Avon	Avon Island (North) (Located within River Avon)
CHB3.04U	Central Christchurch (Avon Island (South))	Avon	Avon Island (South) (Located within River Avon)
CHB3.05	Central Christchurch (Purewell)	Avon	East of Avon Island

Table 4.1 Location & description of potential flood areas within CHB3

Flood modelling exercises were carried out to assess the extent of flooding under tidal extreme water levels during six different flood levels corresponding to a 1:1; 1:5; 1:10; 1:50; 1:100 & 1:200 year return period flood events within Area CHB3 and are illustrated as flood-maps. As properties, which are currently located in the EA 1:200 year tidal extreme flood map area, are affected by flooding, the colour of the property turns from clear to red in colour. The flood-maps are presented in Annex 1, CHB3.

4.2 Flood Area 3.01 (CHB3 – Twynham)

Flood area 3.01 is situated on the northern banks of the River Stour. The area is highlighted in orange in Figure 4.2 (aerial photograph of Christchurch Harbour). Figure 4.3 is a smaller scale aerial photograph of the outlined area.

Figure 4.2 Location of CHB3.01 within Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

Area 3.01 comprises both undefended and defended areas. Flood defences built to an elevation of 2.55m OD run adjacent to the line of the river (protecting property to the north). In some places the flood defences are set back from the riverbank. A number of undefended properties are situated south of the flood wall and north of the river and at present the natural bank of the River Stour (and a shallow gradient) provide the only protection to flooding. Adjacent to Tuckton Bridge are marina developments which incorporate flood defences. Figure 4.4 illustrates the 1:200 year tidal flooding extents of the undefended area (with defences functioning), and Figure 4.5 illustrates the 1:200 year tidal flooding extents, in the absence of flood defences.

Figure 4.3 Aerial photograph of CHB3.01. © Microsoft Corporation © Getmapping plc.

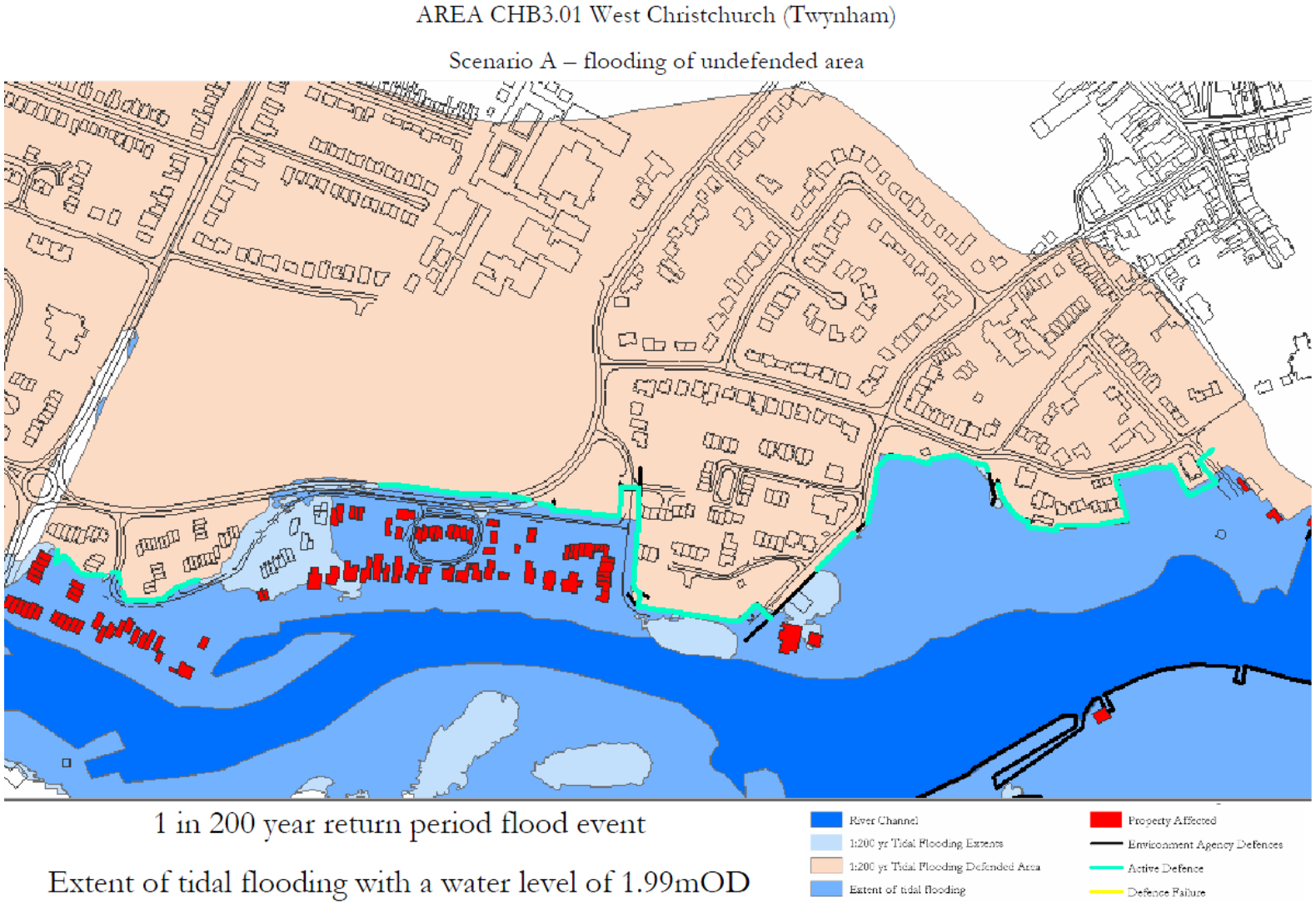

Figure 4.4: Area CHB3.01 U *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

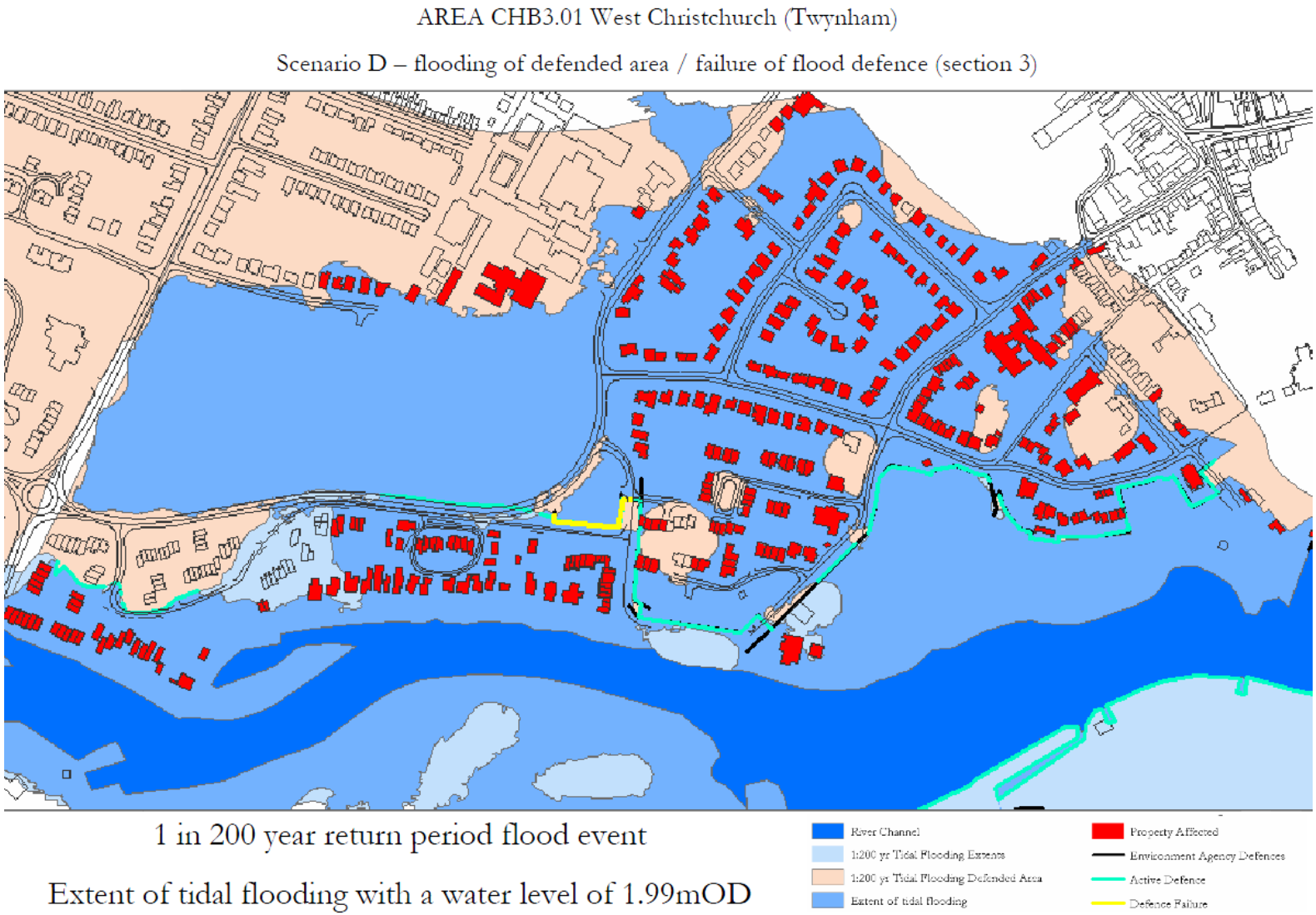

Figure 4.5: Area CHB3.01 D

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4.2.1 Flooding Scenarios 3.01

SCENARIO REFERENCE NO.	SCENARIO	AREAS FLOODED
FLOOD DEFENCES FUNCTIONING		
CHB3.01U	Existing flood conditions	Undefended areas (south of flood defences)
DEFENCE FAILURE SCENARIOS		
CHB3.01D	Breach of flood defences	Undefended areas (south of flood defences)
		Defended areas (currently defended by existing defences)

Table 4.2 Flood scenarios identified within Area 3.01

4.2.2 Scenario A – Defences intact (flooding of undefended area 3.01U)

The flood-map highlights that a large number of undefended riverside property between The Quomps and Tuckton Bridge is at risk from flood damage. A number of properties to the west of Area 3.01 are located within a marina complex which incorporates flood defences. Much of the property along the northern bank of the River Stour has been adapted to limit flood damage.

4.2.3 Scenario B ((Scenario A) – Defence failure (flooding of defended area 3.01D)

The flood map identifies that 4 sections of wall become active during an extreme tidal flooding event. If failure should occur to any of these sections during this period of "activity", extensive flooding would occur to a number of areas. The specific location of the areas which will flood and the evolution of the flood with respect to the return period events and location of breach are presented in the flood maps. Table 4.3 indicates the total property at risk during a 1:200 year event regardless of the location of the failure.

CHB3-01U			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	8	7
5 YEAR	1.57	25	24
10 YEAR	1.65	28	27
25 YEAR	1.75	30	29
50 YEAR	1.83	35	34
100 YEAR	1.91	39	38
200 YEAR**	1.99	49	48

* all property with an elevation of 1.4m OD and below
** all property with an elevation of 2m and below

Table 4.3 Property at risk of flooding in Area 3.01U

CHB3-01D			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	12	12
5 YEAR	1.57	77	74
10 YEAR	1.65	136	131
25 YEAR	1.75	163	157
50 YEAR	1.83	183	176
100 YEAR	1.91	197	190
200 YEAR**	1.99	216	208

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 4.4 Property at risk of flooding in Area 3.01D (Scenario B)

4.3 Flood Area 3.02 (CHB3 – Priory Quay)

Flood area 3.02 is situated between the northern banks of the River Stour and the western banks of the river Avon. The area is highlighted in orange in Figure 4.6 (aerial photograph of Christchurch Harbour). Figure 4.7 is a smaller scale aerial photograph of the outlined area.

Figure 4.6 Location of CHB3.02 within Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

Area 3.02 is largely undefended; however there are flood defences in the form of flood walls, which offer protection to the marina development located at Priory Quay, however these have been classed by the Environment Agency as non-flood defence structures. The only defences that exist east and west of the marina are the natural banks of the river Avon area therefore these areas remain undefended. Figure 4.8 illustrates the 1:200 year tidal flooding extents, in the absence of flood defences.

Figure 4.7 Aerial photograph of CHB3.02. *© Microsoft Corporation © Getmapping plc.*

AREA CHB3.02 West Christchurch (Priory)

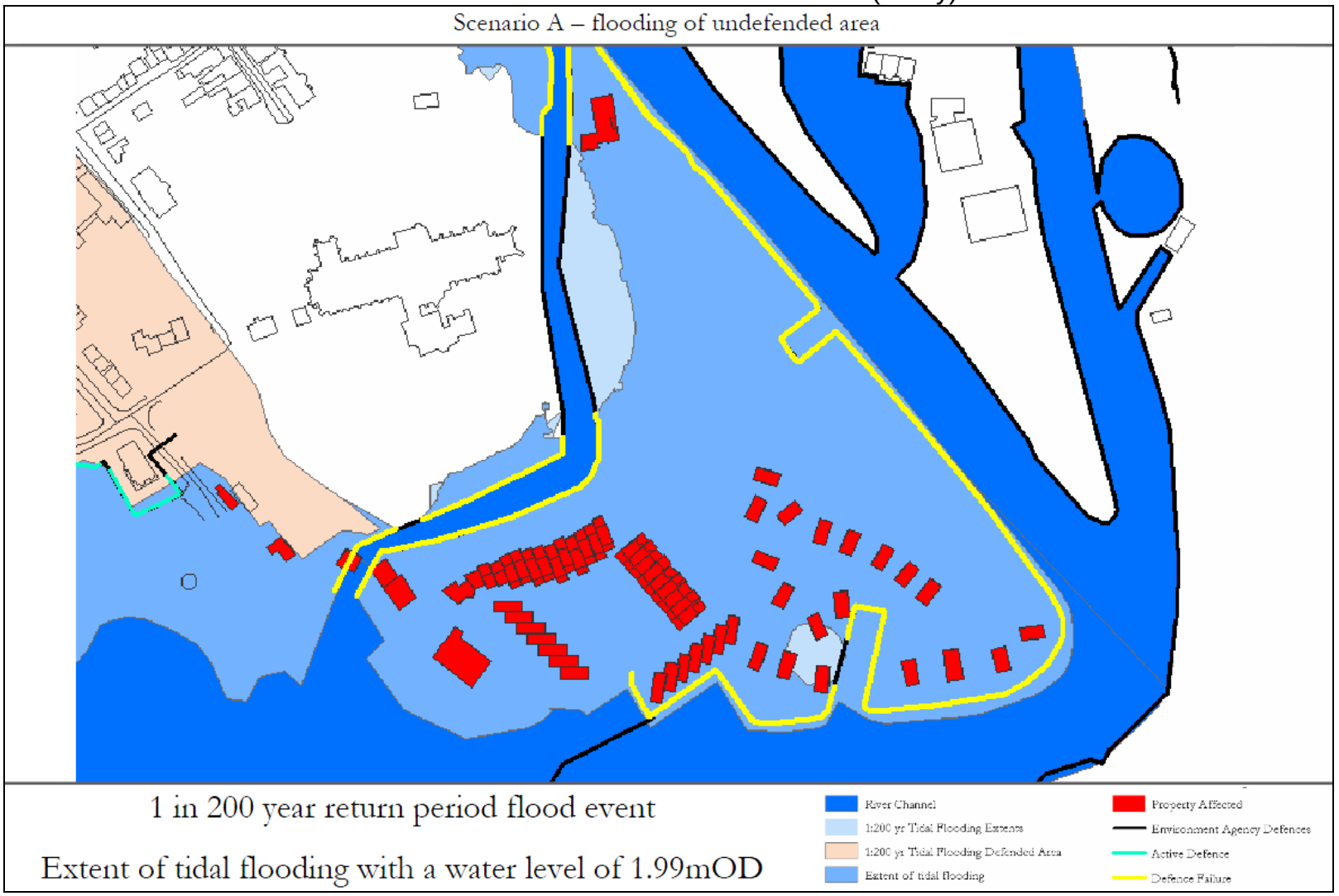

Figure 4.8 Area CHB3.02

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4.3.1 Flooding Scenarios 3.02

SCENARIO REFERENCE NO.	SCENARIO	AREAS FLOODED
DEFENCE FAILURE SCENARIOS		
CHB3.02	Flooding of undefended area	Undefended areas (This includes the marina development in Priory Quay)*

* Priory Quay marina has been included in the undefended area.

Table 4.5 Flood scenarios identified within Area 3.02

4.3.2 Scenario A – Flooding of undefended area

The flood map highlights that a large number of undefended riverside property in the vicinity of Priory Quay is at risk from flood damage during the incidence of a 1:1 year event. At present the property located within Priory Marina will be protected from a 'degree' of flooding due to the presence of flood defences; in addition the properties are constructed with flood adaptations i.e. living areas are located on the upper floors. Over half the residential park properties located at Convent Meadows are vulnerable to flooding during a 1:1 year event; however a number of these are adapted to withstand flooding as the threshold level of the ground flood approximately 750mm from ground level.

CHB3-02			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	46	33
5 YEAR	1.57	51	35
10 YEAR	1.65	52	36
25 YEAR	1.75	52	36
50 YEAR	1.83	53	37
100 YEAR	1.91	54	38
200 YEAR**	1.99	54	38

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 4.6 Property at risk of flooding in Area 3.02 (Scenario A)

4.4 Flood Area 3.03 (CHB3 – Central Christchurch: Castle Street)

Flood area 3.03 is situated on the banks of the River Avon in the centre of Christchurch. The area is highlighted in orange in Figures 4.9 (aerial photograph of Christchurch Harbour). Figure 4.10 is a smaller scale aerial photograph of the outlined area.

Figure 4.9 Location of CHB3.03 within Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

Area 3.03 lies to the west of the River Avon and forms a central part of Christchurch. The area also contains the Millstream (a man-made waterway originally dug to supply running water from Avon River to Place Mill on the Quay). The majority of Area 3.03 is defended by raised walls along the banks of the river; however in many areas, the original walls of the Millstream still form the banks of the stream and sections of the river are fronted by the natural riverbank giving rise to undefended areas. Figure 4.11 illustrates the 1:200 year tidal flooding extents, in the absence of flood defences.

Figure 4.10 Aerial photograph of CHB3.03. © Microsoft Corporation © Getmapping plc.

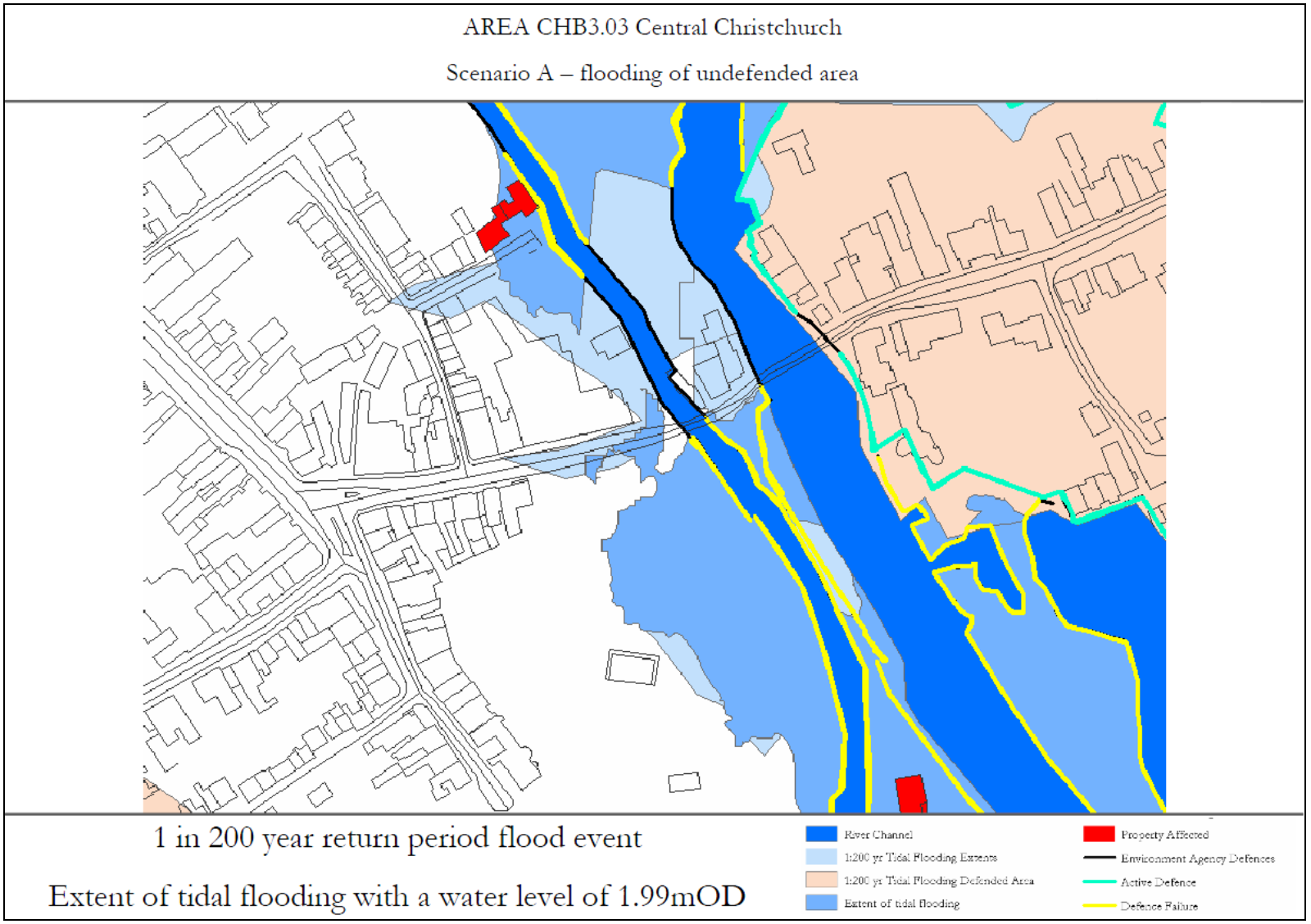

Figure 4.11 Area CHB3.03 *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

4.4.1 Flooding Scenarios 3.03

SCENARIO REFERENCE NO.	SCENARIO	AREAS FLOODED
DEFENCE FAILURE SCENARIOS		
CHB3.03A	Flooding of undefended area	Undefended areas

Table 4.7 Flood scenarios identified within Area 3.03

4.4.2 Scenario A – Flooding of undefended area

The flood map highlights that a small number of properties (1 property identified) in Ducking Stool Lane which are vulnerable to flooding during a 1:200 year flooding event.

CHB3-03			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	0	0
5 YEAR	1.57	0	0
10 YEAR	1.65	0	0
25 YEAR	1.75	1	1
50 YEAR	1.83	1	1
100 YEAR	1.91	1	1
200 YEAR**	1.99	1	1

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 4.8 Property at risk of flooding in Area 3.03 (Scenario A)

4.5 Flood Area 3.04 (CHB3 – Central Christchurch: Avon Island)

Flood area 3.04 is situated on Avon Island, a river island within the River Avon in the centre of Christchurch. The area is highlighted in orange in Figure 4.12 (aerial photograph of Christchurch Harbour). Figure 4.13 is a smaller scale aerial photograph of the outlined area.

Figure 4.12 Aerial photograph of Christchurch Harbour. *© Microsoft Corporation Getmapping plc.*

Area 3.04 is comprised of a number of defended areas. Flood defences built to an elevation of 2.55m OD form the banks of the River Avon and protect property located on Avon Island. Figure 4.14 illustrates the 1:200 year tidal flooding extents, in the absence of flood defences.

Figure 4.13 Aerial photograph of CHB3.04. © Microsoft Corporation © Getmapping plc.

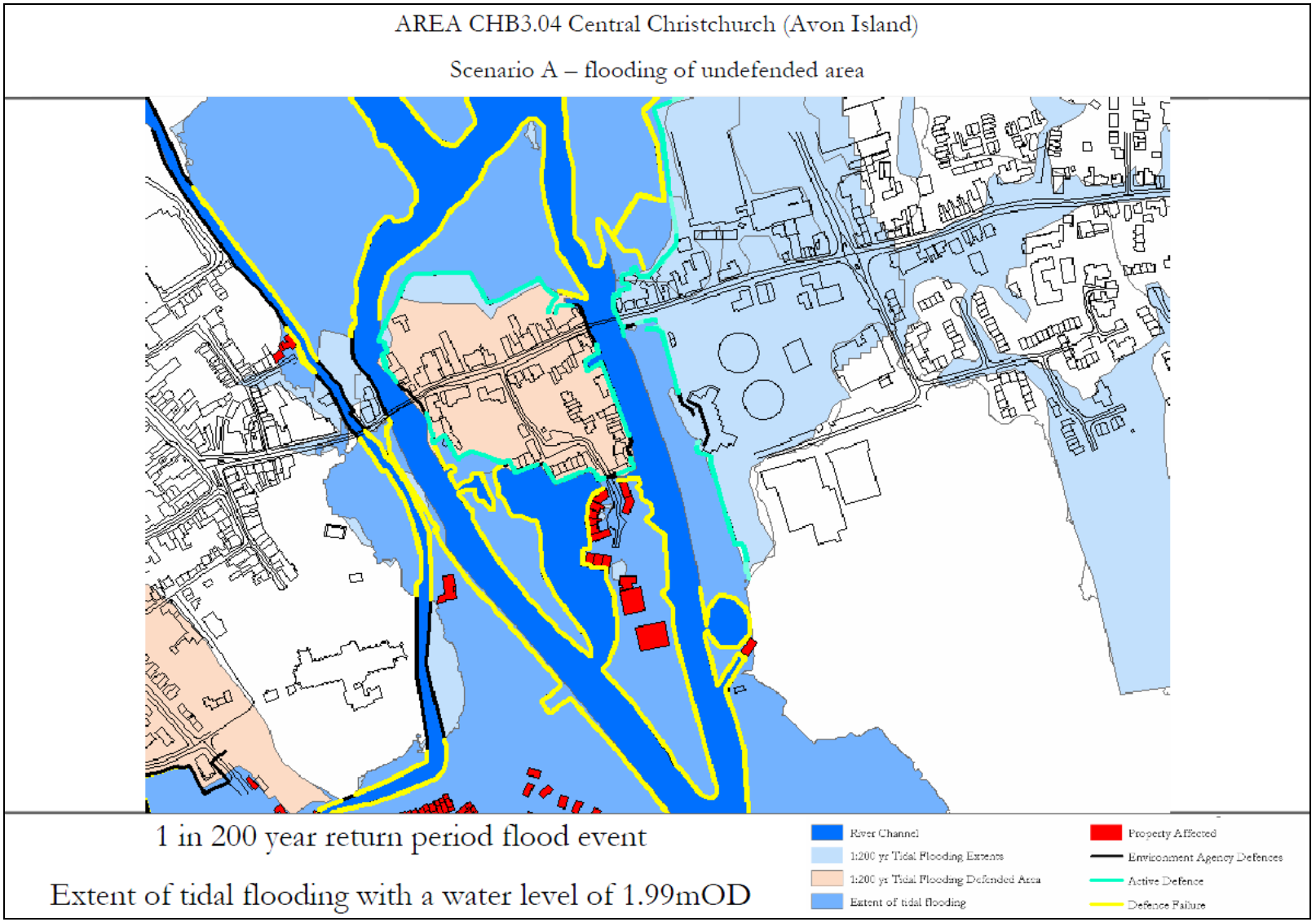

Figure 4.14 Area CHB3.04

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4.5.1 Flooding Scenarios Area CHB3.04

SCENARIO REFERENCE NO.	SCENARIO	AREAS FLOODED
FLOOD DEFENCES FUNCTIONING		
CHB3.04A	Existing flood conditions with flood defences intact	Undefended areas, located to the north and south of centrally defended area on Avon Island
DEFENCE FAILURE SCENARIOS		
CHB3.04B	Breach of flood defences in defended area	Undefended areas (included in CHB3.04A) plus defended central area of Avon Island

Table 4.9 Flood scenarios identified within Area 3.04

4.5.2 Scenario A – Present day (Defences intact)

The flood map identifies that during an extreme tidal flooding event the majority of the flood defences become active. The flood map highlights that the undefended area in the southern part of Avon Island is likely to flood during an extreme tidal flooding event, leading to the flooding of a number of properties. A number of these properties have been adapted to limit flood damage.

CHB3-04D			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	37	24
5 YEAR	1.57	46	32
10 YEAR	1.65	50	34
25 YEAR	1.75	53	36
50 YEAR	1.83	56	38
100 YEAR	1.91	56	38
200 YEAR**	1.99	65	47

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 4.10 Property at risk of flooding in Area 3.04 (Scenario A)

4.5.3 Scenario B – (Defences failure)

The flood map indicates that if failure should occur to any flood defence during a period of "activity", extensive flooding would occur to the Avon Island area. Due to the location and elevation of the Island, the areas where flooding is likely to occur will be similar, regardless of the location where beaching occurs. The flood map indicates that the majority of the property located within Avon Island will be at risk of flooding in the event of a breach occurring.

CHB3-04U			
RETURN PERIOD EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	15	15
5 YEAR	1.57	15	15
10 YEAR	1.65	15	15
25 YEAR	1.75	15	15
50 YEAR	1.83	15	15
100 YEAR	1.91	15	15
200 YEAR**	1.99	15	15

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 4.11 Property at risk of flooding in Area 3.04 (Scenario B)

4.6 Flood Area 3.05 (CHB5 - Purewell)

Flood area 3.05 is situated to the east of Avon Island on the eastern banks of the river Avon. The area is highlighted in orange in Figure 4.15 (aerial photograph of Christchurch Harbour). Figure 4.16 is a smaller scale aerial photograph of the outlined area.

Figure 4.15 Aerial photograph of Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

Area 3.05 is a defended area protected by flood defences built to an elevation of 2.55 OD which adjacent to the line of the river. In some places the flood defences are set back from the riverbank or are tied onto buildings. Figure 4.17 illustrates the existing 1:200 year tidal flooding extents, without the presence of flood defences.

Figure 4.16 Aerial photograph of Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

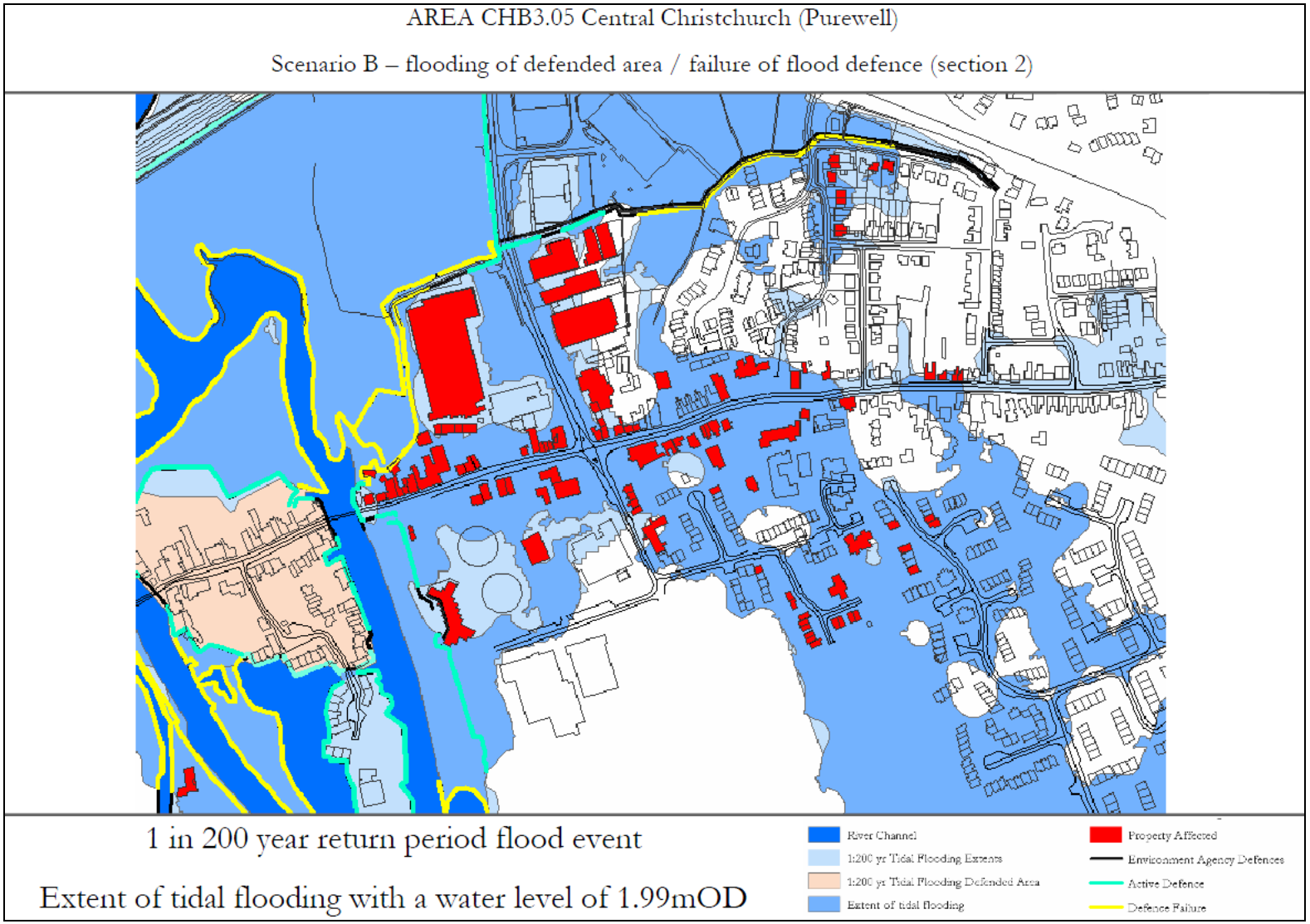

Figure 4.17 GIS ArcMap image of CHB3.05.

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4.6.1 Flooding Scenarios Area CHB3.05

SCENARIO REFERENCE NO.	SCENARIO	AREAS FLOODED
DEFENCE FAILURE SCENARIOS		
CHB3.05	Breach of flood defences	Defended areas

Table 4.12 Flood scenarios identified within Area 3.05

4.6.2 Scenario A – Defences failure

The flood map indicates that if either of the 2 sections of wall (which become active during an extreme tidal flooding event) fails, extensive flooding would occur to a number of areas. The specific location of the areas which will flood and the evolution of the flood with respect to the return period events and location of breach are presented in the flood maps.

CHB3-05			
EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	21	5
5 YEAR	1.57	22	6
10 YEAR	1.65	37	15
25 YEAR	1.75	46	22
50 YEAR	1.83	58	31
100 YEAR	1.91	94	63
200 YEAR**	1.99	101	69

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 4.13 Property at risk of flooding in Area 3.05 (Scenario A)

5 CHB4 Mudeford Town Frontage

5.1.1 CHB4 – Strategic Management Plan Coastal Management Policy
The SMP states that the long term preferred option (2005 to 2049) is Hold the Existing Line.

5.1.2 CHB4 – Administrative Authority
Christchurch Borough Council

5.1.3 CHB4 – Frontage Length
Defended Frontage length 1150m

5.1.4 CHB4 – Environmental Designations
(a) Statutory Designations:

- Christchurch Harbour SSSI – saltmarsh ecology

(b) Non Statutory Designations:

- Stanpit Marsh LNR – grazing marsh
- Poole Bay and Isle of Purbeck SMA – marine ecology

5.1.5 CHB4 – Extent of Frontage
The unit frontage is 1730m long and extends along the Northern perimeter of Christchurch Harbour between Mudeford (west) & Mudeford sandbank. The area contained within CHB2 is presented in Figures 3.1 & 3.2.

5.1.6 CHB4 – Property
Along the edge of the Harbour there are mainly residential houses (some large and detached), village halls, a scout hut, some small offices, public houses, small food outlets a small number of boat yards & sailing clubs. At present 76 properties are defended (73 residential) and 8 are undefended (3 residential). The unit also includes high value amenity land and recreational benefits.

5.1.7 CHB4 – Existing Defences
The types of defences are mostly in the form of concrete floodwalls and embankments. The defences are privately owned and maintained and are mainly located along the edge of the harbour. The condition of the defences varies along the frontage with a number of the defences currently being in poor condition.

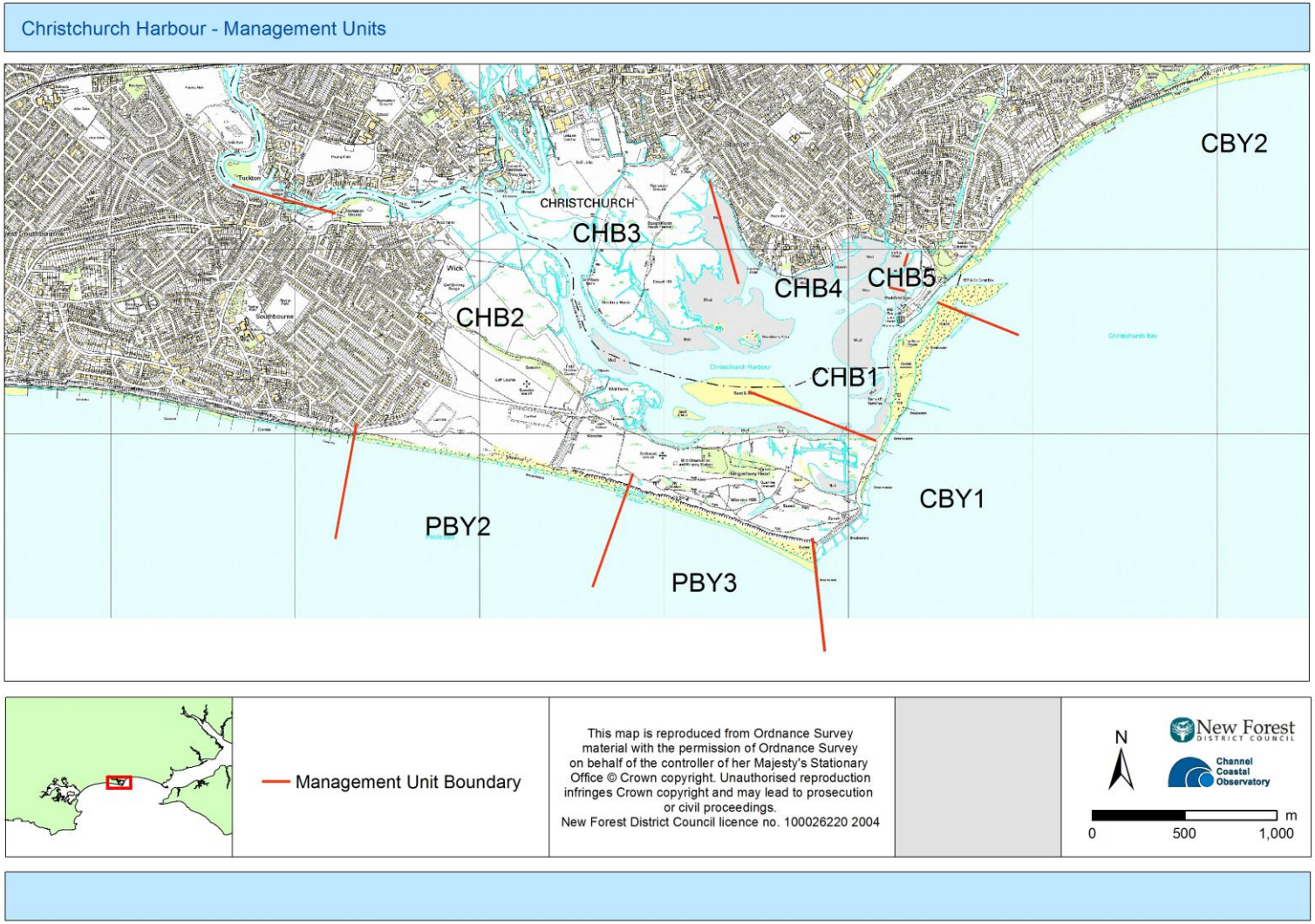

Figure 5.1 Map of Christchurch Harbour. *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

5.1.8 CHB4 – Flood Areas

The degree of flood protection varies along the frontages in CHB4, which equates to there being a defended and an undefended area. Within CHB4 the areas and areas that comprise CHB4 are presented in Table 5.1.

AREA	LOCATION (Area)	SOURCE OF FLOODING	DESCRIPTION
CHB4.01	Stanpit	Christchurch Harbour	Northern Fringe of Christchurch Harbour (Stanpit)
CHB4.02	Mudeford West	Christchurch Harbour	Northern Fringe of Christchurch Harbour (West Mudeford)

Table 5.1 Location & description of potential flood areas within CHB4

Flood modelling exercises were carried out to assess the extent of flooding under tidal extreme water levels during six different flood levels corresponding to a 1:1; 1:5; 1:10; 1:50; 1:100 & 1:200 year return period flood events within Area CHB4 and are illustrated as flood-maps. As properties, which are currently located in the EA 1:200 year tidal extreme flood map area, are affected by flooding, the colour of the property turns from clear to red in colour. The flood-maps are presented in Annex 1, CHB4.

5.2 Flood Area 4.01 (CHB4 – Stanpit)

Flood area 4.01 is situated on the northern banks of Christchurch Harbour. The area is highlighted in orange in Figure 5.2 (aerial photograph of Christchurch Harbour). Figure 5.3 is a smaller scale aerial photograph of the outlined area.

Figure 5.2 Aerial photograph of Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

Although there are a variety of (informal) private defences along this frontage, the Environment Agency has classified this area as undefended. Figure 5.4 illustrates the 1:200 year tidal flooding extents, without the presence of flood defences.

Figure 5.3 Aerial photograph of Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

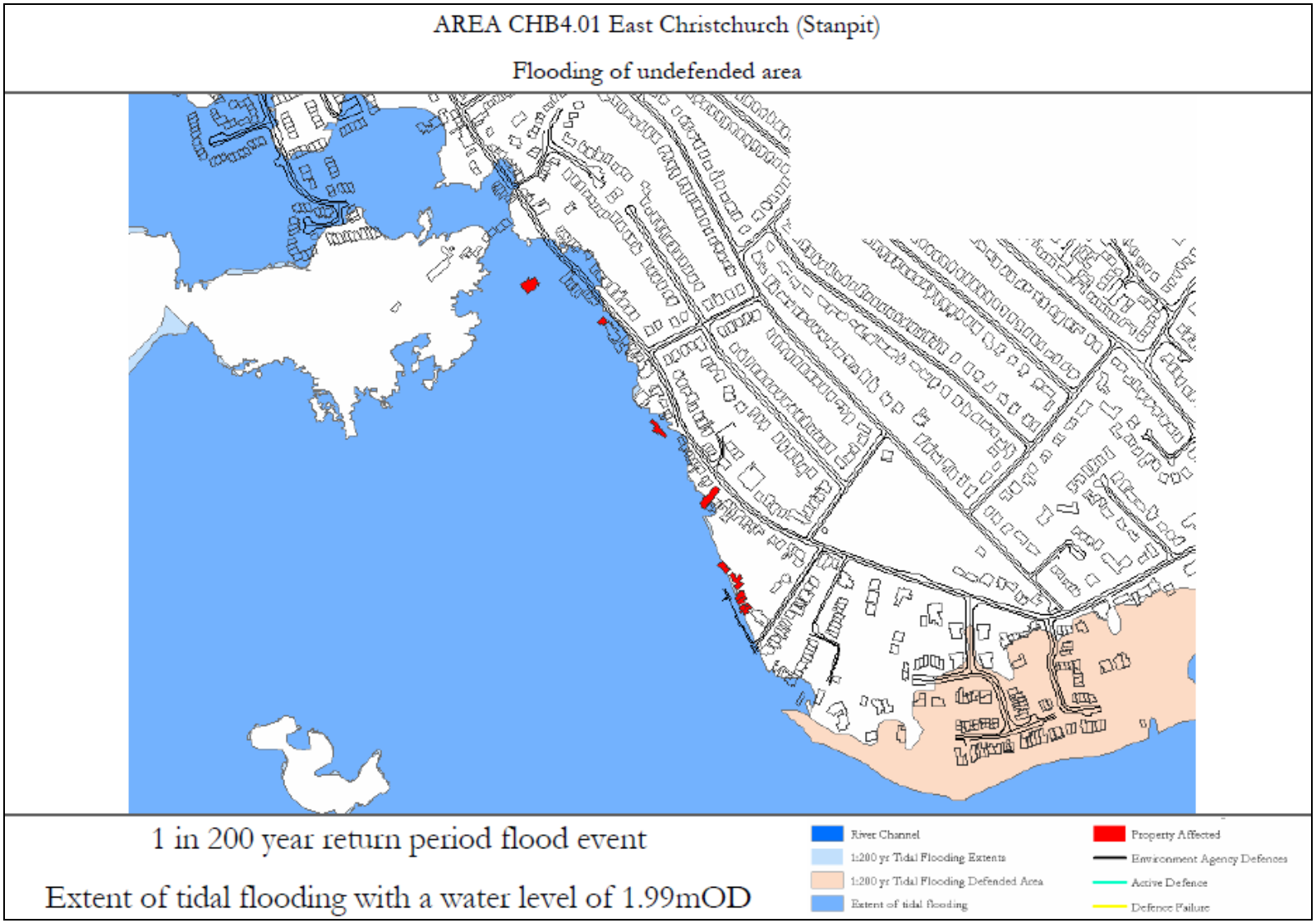

Figure 5.4: Area CH4.01 *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

5.2.1 Flooding Scenarios Area CHB4.01

SCENARIO REFERENCE NO.	SCENARIO	AREAS FLOODED
FLOOD DEFENCES FUNCTIONING		
CHB4.01A	Existing flood conditions	Undefended property around the northern fringe of Christchurch Harbour

Table 5.2 Flood scenarios identified within Area 4.01

5.2.2 Scenario A – (Flooding of undefended area)

The flood map indicates during an extreme tidal flooding event, an area along the perimeter of the Harbour would be exposed to flooding resulting in a small number of properties being affected.

CHB4-01			
EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	7	4
5 YEAR	1.57	8	5
10 YEAR	1.65	8	5
25 YEAR	1.75	8	5
50 YEAR	1.83	8	5
100 YEAR	1.91	8	5
200 YEAR**	1.99	8	5

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 5.3 Property at risk of flooding in Area 4.01 (Scenario A)

5.3 Flood Area 4.02 (CHB4 – Mudeford west)

Flood area 4.02 is situated on the northern banks of Christchurch Harbour. The area is highlighted in orange in Figure 5.6 (aerial photograph of Christchurch Harbour). Figure 5.7 is a smaller scale aerial photograph of the outlined area.

Figure 5.6 Aerial photograph of Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

Flood Area 4.02 is classified as defended by the Environment Agency. The defences along the frontage are comprised of a number of floodwalls and embankments. Figure 5.8 illustrates the 1:200 year tidal flooding extents, in the absence of flood defences.

Figure 5.7 Aerial photograph of Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

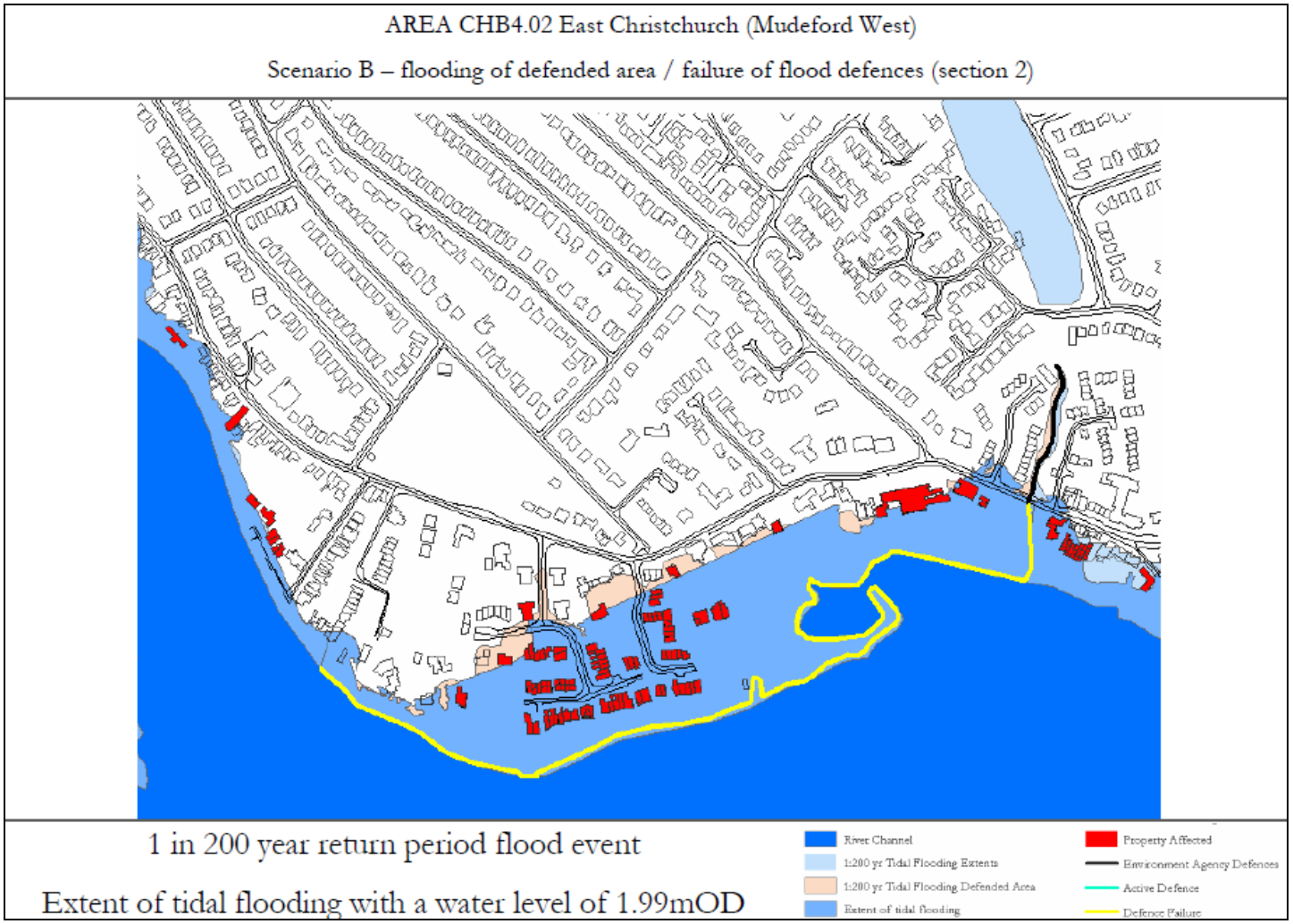

Figure 5.8 Area CHB4.02

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5.3.1 Flooding Scenarios Area CHB4.02

SCENARIO REFERENCE NO.	SCENARIO	AREAS FLOODED
DEFENCE FAILURE SCENARIOS		
CHB4.02A	Breach of flood defences	Defended areas

Table 5.4 Flood scenarios identified within Area 4.02

5.3.2 Scenario A – (Defences failure)

The flood map indicates that if failure occurs to the western section of wall (which becomes active during an extreme tidal flooding event) extensive flooding would initially occur to properties located to western side of area 4.02 before extending across the area.

CHB4-02			
EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	3	3
5 YEAR	1.57	8	7
10 YEAR	1.65	21	18
25 YEAR	1.75	35	32
50 YEAR	1.83	42	39
100 YEAR	1.91	67	64
200 YEAR**	1.99	76	73

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 5.5 Property at risk of flooding in Area 4.02 (Scenario A)

6 CHB5 Mudeford Quay

6.1.1 CHB5 – Strategic Management Plan Coastal Management Policy
The SMP states that the long term preferred option (2005 to 2049) is Hold the Existing Line (possible retreat the existing line).

6.1.2 CHB5 – Administrative Authority
Christchurch Borough Council

6.1.3 CHB5 – Frontage Length
Defended Frontage length 150m

6.1.4 CHB5 – Environmental Designations
(a) Statutory Designations:

Christchurch Harbour SSSI – saltmarsh ecology

(b) Non Statutory Designations:

- Mudeford Quay SNCI – grassland ecology
- Poole Bay and Isle of Purbeck SMA – marine ecology

6.1.5 CHB5 – Extent of Frontage
The unit frontage is 362m long and extends along the north-eastern corner of the Harbour between Mudeford (east) & Mudeford Quay. The Area is designated as a Conservation Area due to historical interest. The area contained within CHB5 is presented in Figure 6.1.

6.1.6 CHB5 – Property
Along the edge of the Harbour there are mainly residential houses (some large and detached), a caravan park, a public house, a car park and a yacht haven. The unit also includes high value amenity land and recreational benefits. There is also a cluster of small cottages on the quayhead.

6.1.7 CHB5 – Existing Defences
Flood defences that exist along the perimeter of the Harbour are mostly in the form of concrete floodwalls and embankments. The defences are owned and maintained by either private individuals or Christchurch Borough Council and run along the edge of the harbour. The condition of the defences varies along the frontage. The cottages on the quayhead are protected by a floodwall and gates. See Technical Annex 8 Assessment of Standards of Service for further details.

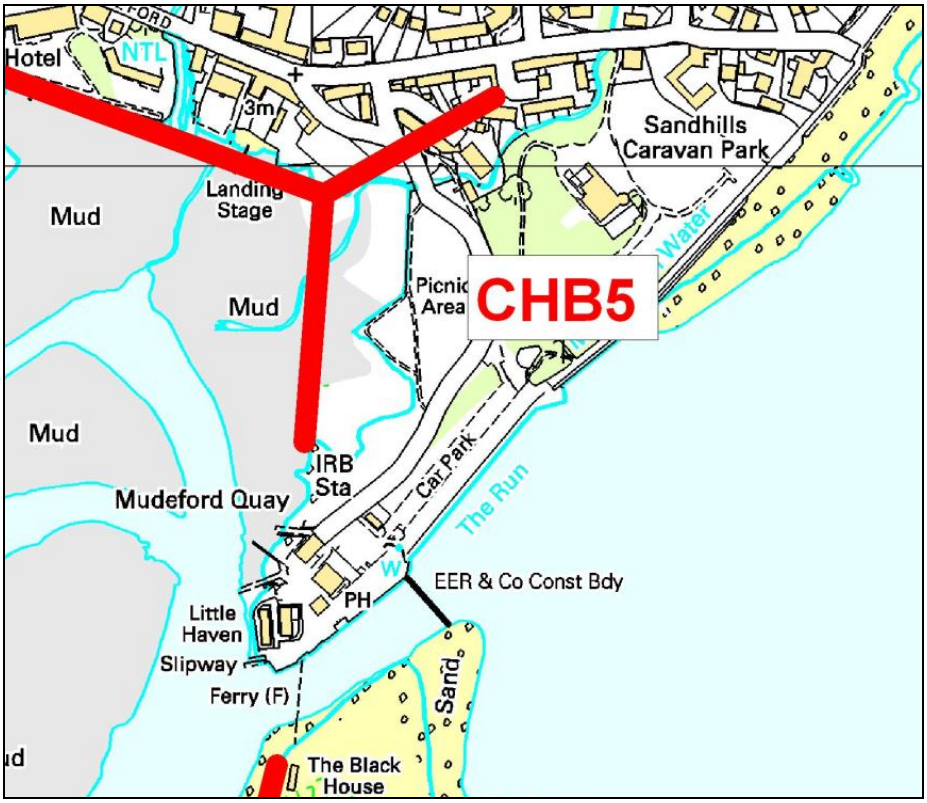

Figure 6.1 Map of Christchurch Harbour. *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

6.1.8 CHB5 – Flood Areas

Flood defences surround the frontages in CHB5; however the elevation and condition of the defences vary and are low enough for the tide to overtop in places during high spring tides. Details of the potential flood areas are presented in Table 6.1.

AREA	LOCATION (Sector)	SOURCE OF FLOODING	DESCRIPTION
CHB5.01	Mudeford East	Christchurch Harbour	Eastern Fringe of Christchurch Harbour
CHB5.02	Mudeford Quay	Christchurch Harbour	Mudeford Harbour Entrance

Table 6.1 Location & description of potential flood areas within CHB5

Flood modelling exercises were carried out to assess the extent of flooding under tidal extreme water levels during six different flood levels corresponding to a 1:1; 1:5; 1:10; 1:50; 1:100 & 1:200 year return period flood events within Area CHB4 and are illustrated as flood-maps. As properties, which are currently located in the EA 1:200 year tidal extreme flood map area, are affected by flooding, the colour of the property turns from clear to red in colour. The flood-maps are presented in Annex 1, CHB5.

6.2 Flood Area 5.01 (CHB5 – Mudeford (east))

Flood area 5.01 is situated on the northern banks of Christchurch Harbour. The area is highlighted in orange in Figure 6.2 (aerial photograph of Christchurch Harbour). Figure 6.3 is a smaller scale aerial photograph of the outlined area.

Figure 6.2 Aerial photograph of Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

Flood Area 5.01 is classified as undefended by the Environment Agency. There are a number of walls which form the perimeter of the Harbour; however the elevation of the wall is only constructed to a level of 1m OD which is marginally above MHWS. Overtopping of the low wall can occur on a regular basis. Figure 6.5 illustrates the 1:200 year tidal flooding area.

Figure 6.3 Aerial photograph of Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

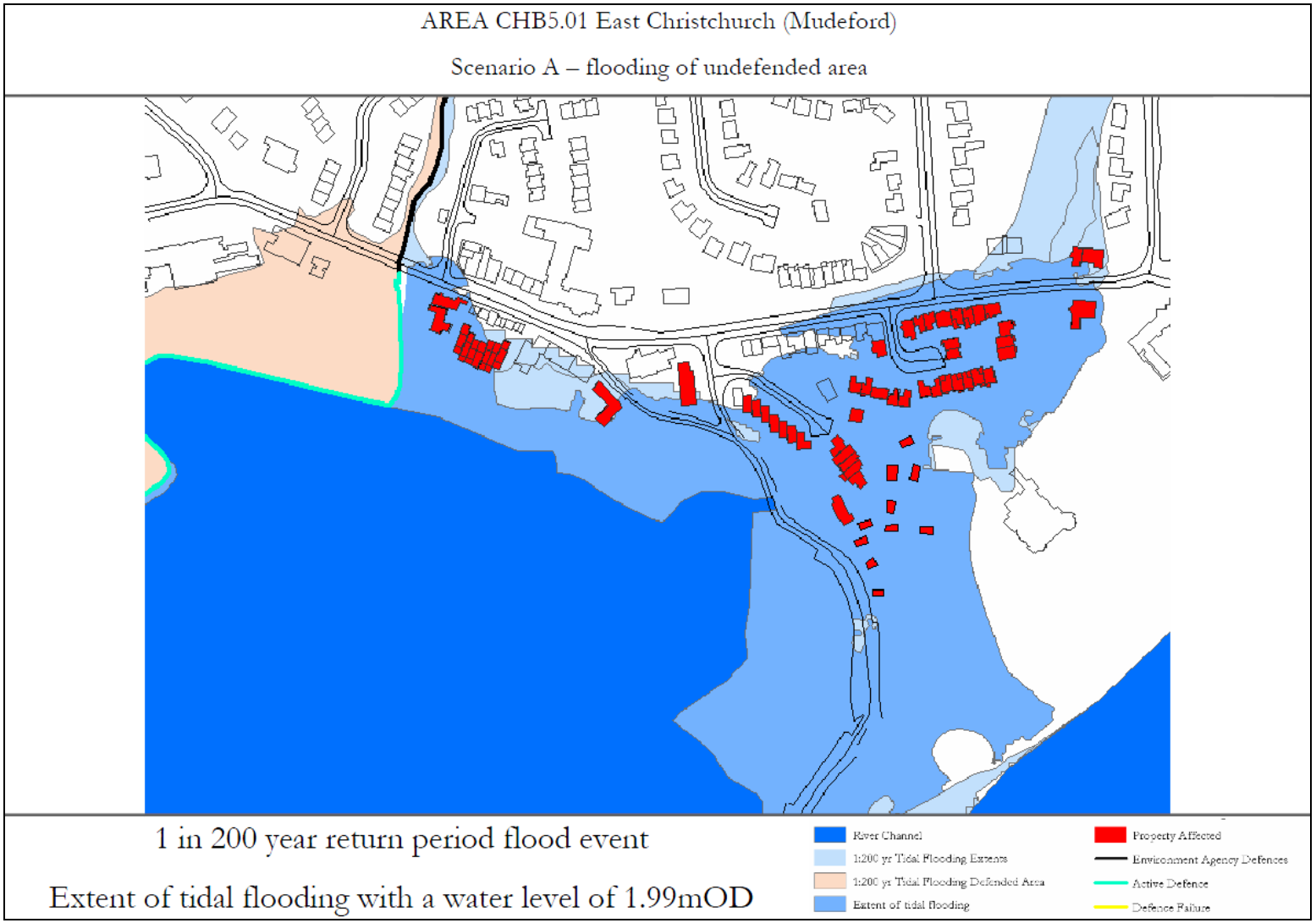

Figure 6.4 GIS ArcMap image of CHB5. *© Crown copyright and database rights 2012 Ordnance Survey 100026220*

6.2.1 Flooding Scenarios Area CHB5.01

SCENARIO REFERENCE NO.	SCENARIO	SECTORS FLOODED
FLOOD DEFENCES FUNCTIONING		
CHB5.01A Figure 6.5	Existing flood conditions	Undefended property around the north-eastern fringe of Christchurch Harbour

Table 6.2 Flood scenarios identified within Area 5.01

6.2.2 Scenario A – (Flooding of undefended area)

The flood map indicates during an extreme tidal flooding event, an area along the perimeter of the Harbour would be exposed to flooding resulting in a number of properties becoming affected. The floodwater would extend across the caravan park to the residential area located beyond the caravan to the north east.

CHB5-01			
EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	9	8
5 YEAR	1.57	19	17
10 YEAR	1.65	30	23
25 YEAR	1.75	36	29
50 YEAR	1.83	57	47
100 YEAR	1.91	58	48
200 YEAR**	1.99	62	52

* all property with an elevation of 1.4m OD and below

** all property with an elevation of 2m and below

Table 6.3 Property at risk of flooding in Area 5.01 (Scenario A)

6.3 Flood Area 5.02 (CHB5 - Mudeford)

Flood area 5.02 is situated on the northern banks of Christchurch Harbour. The area is highlighted in orange in Figure 6.6 (aerial photograph of Christchurch Harbour). Figure 6.7 is a smaller scale aerial photograph of the outlined area.

Figure 6.6 Aerial photograph of Christchurch Harbour. © Microsoft Corporation © Getmapping plc.

The tip of Mudeford Harbour within Flood Area 5.02 is classified as defended by the Environment Agency. The defended area encompasses a number of residential properties on the quayhead. The defences are comprised of a number of floodwalls and gates. Figure 6.8 illustrates the existing 1:200 year tidal flooding defended area & the 1:200 year tidal flooding extents.

Figure 6.7 Aerial photograph of Christchurch Harbour. *© Microsoft Corporation © Getmapping plc.*

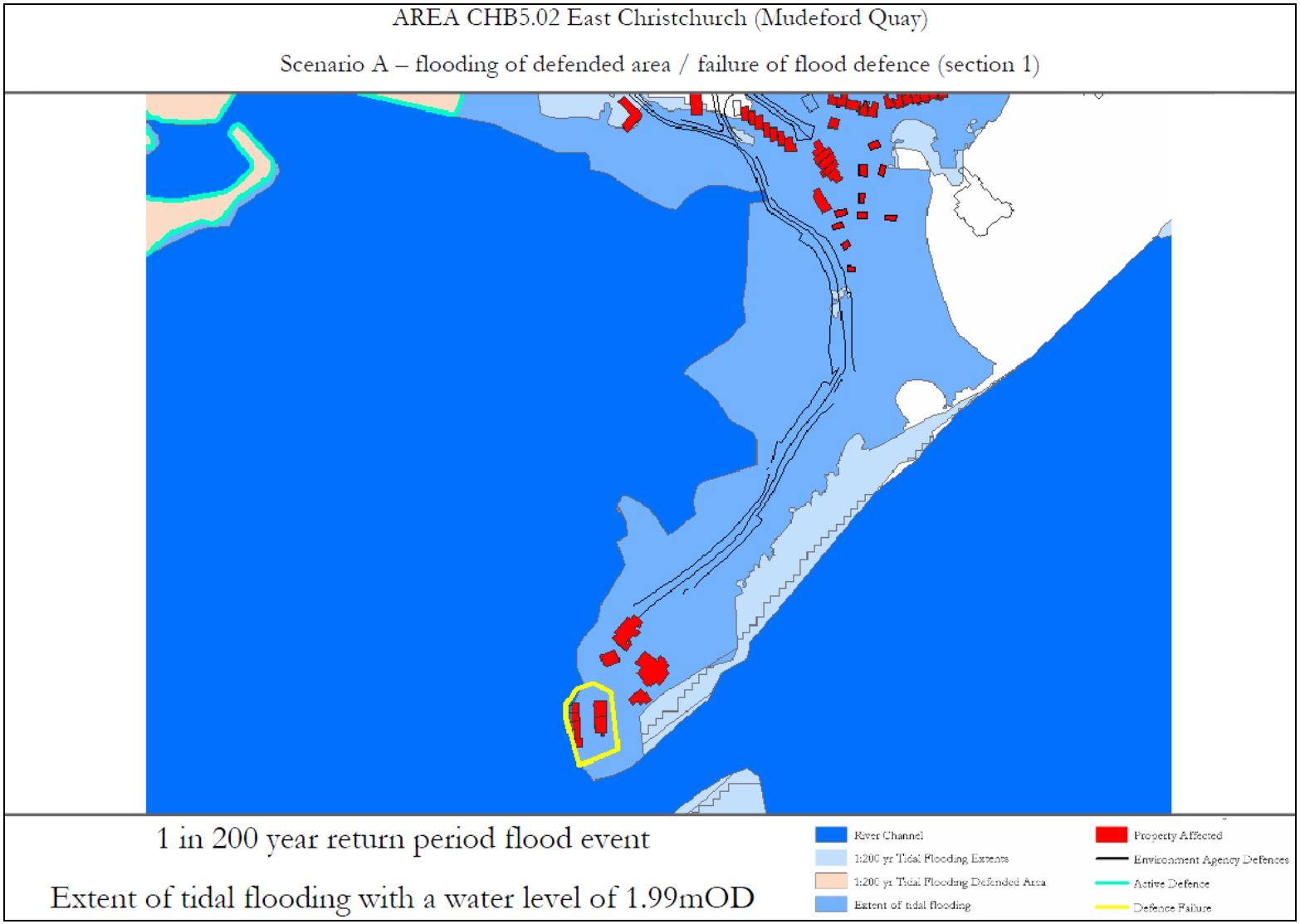

Figure 6.8 GIS ArcMap image of CHB5.

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6.3.1 Flooding Scenarios 5.02

A flood modelling exercise is carried out to assess the extent of flooding under tidal extreme water levels within Area 5.02 (summarised in Table 6.4). Flood maps illustrated in Figure 11.5.2.1 (which include defence failure scenarios) in Appendix A (Section 11) are produced to illustrate each flood scenario in terms of six different flood levels corresponding to a 1:1; 1:5; 1:10; 1:50; 1:100 & 1:200 year return period flood event. As property becomes flooded the colour of the property turns from clear to red in colour. Figure 11.4.2.1 illustrates that during a 1:200 year extreme flood event, a majority of the flood defences are active.

SCENARIO REFERENCE NO.	SCENARIO	SECTORS FLOODED
DEFENCE FAILURE SCENARIOS		
CHB5.02A	Breach of flood defences	Defended Areas

Table 6.4 Flood scenarios identified within Area 5.02

6.3.2 Scenario A – (Flooding of defended area)

During an extreme tidal flooding event, the flood defences forming the defended area become active. Should there be a failure, a submersible pumping station would activate to prevent build of floodwater inside the floodwall.

CHB5-02			
EVENT	m (OD)	TOTAL PROPERTIES	RESIDENTIAL
1 YEAR *	1.39	5	5
5 YEAR	1.57	6	6
10 YEAR	1.65	6	6
25 YEAR	1.75	6	6
50 YEAR	1.83	6	6
100 YEAR	1.91	6	6
200 YEAR**	1.99	6	6

* all property with an elevation of 1.4m OD and below

Table 6.5 Property at risk of flooding in Area 5.02 (Scenario A)

7 Intervention Options

7.1 Introduction

The following sections identify and cost the defence intervention options which have been considered in the benefit/cost analysis. Although specific to the particular sites, the options which have generally been considered are

i) Do Nothing (Monitor)
ii) Maintenance of the existing defences
iii) Raising the level of existing defences (taking into account the effect of predicted sea level rise)
iv) Future replacement of existing defences (including provision for predicted sea level rise).

7.2 Economic Assessment

Once the property has been identified, the likely damages under tidal flooding are calculated in accordance with the guidance and damage calculations in the Multi-coloured Manual (MCM) 2005 (The benefits of Flood and Coastal Defence: Techniques and Data for 2005; Middlesex University, Flood Hazard Research Centre). Each property is identified relative a specific category and depending on this category is assigned a damage figure, based on flooding depth and duration of flooding. The total damages (benefits) are then calculated for each return period event.

The options considered at each site are discussed in section 7.5. The options which are available vary depending on the specific location of the area at risk. Each location will also vary in terms of the timing of specific works. As a result between 4 and 7 schemes are generated for each location and an economic analysis is carried out for each individual scheme. The guidance provide by DEFRA suggests that for a Strategy Study a starting value of 60% should be used for the Optimism Bias factor. The costs for each scheme are evaluated, an optimum bias of 60% is added, and the benefit/cost ratio calculated.

The People score and the Environmental score are calculated for each location and added to the benefit/cost score to generate the Priority Score.

7.3 Sea Level Rise

Note: The relevant regional sea level rise allowances as stated in UKCIP06 (as per Defra guidance 2008) have since been superseded by those stated in UKCIP09 (as per Defra guidance 2011). A sensitivity test has been undertaken to compare the extent of flood risk using UKCIP06 and UKCIP09 sea level rise allowances flood maps. Minor differences have been observed but these are not considered to sufficiently significant to alter the benefit-cost assessment carried out in this report. A summary of the comparisons are presented in Annex 5.

With reference to the Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts Report published by DEFRA in October 2006, the climate change policy for flood and coastal management has been updated. The current sea level rise allowances are highlighted in Table 7.1.

‘Net sea level rise allowances are sensitive to assumptions about thermal expansion of the oceans, melt from land glaciers and ice caps, melt from Antarctica and Greenland, climate model sensitivity, greenhouse gas emissions, and vertical adjustments of the land. The precautionary allowances for global mean sea level rise will be reviewed in 2007 in the light of the Fourth Assessment Report (AR4) of the IPCC’ (DEFRA 2006).

Future rises in sea level will have a direct effect on the extreme flood period return period events. This is due to the fact that the future still water level has to be factored into future return period event levels, resulting in extreme water levels potentially occurring more frequently. Alternatively extreme flood events will be characterised by higher water levels and therefore greater property affected (Figure 7.1). Table 7.2 highlights the predicted level of extreme flood return period events in 2052 & 2172 with respect to 2002; these levels are also highlighted in Figure 7.1.

Administrative or Devolved Region	Assumed vertical land movement (mm year^{-1})	Year				Previous Allowances
		1990 - 2025	2025 - 2055	2055 – 2085	2085 - 2115	
East of England, East Midlands, London, SE England (south of Flamborough Head)	-0.8	4	8.5	12	15	6mm/year* constant
South West and Wales	-0.5	3.5	8	11.5	14.5	5mm/year* constant
NW England, NE England, Scotland (north of Flamborough Head)	0.8	2.5	7	10	13	4mm/year* constant

*Updated figures now reflect an exponential curve, and replace the previous straight line graph representations

Table 7.1 Sea level rise allowances taken from Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts Report (DEFRA 2006)

Return Period Event	Year		
	2002	**2052**	**2072**
	Water Level m (OD)		
(MWL)	0.33	0.63	0.85
1 - YEAR	1.39	1.69	1.91
5 - YEAR	1.57	1.87	2.09
10 - YEAR	1.65	1.95	2.17
25 - YEAR	1.75	2.05	2.27
50 - YEAR	1.83	2.13	2.35
100 - YEAR	1.91	2.21	2.43
200 - YEAR	1.99	2.29	2.51
	Highlighting that a 1:1 year return period event in 2052 is equivalent to between a 1:10 & 1:25 year period event in 2002		
	Highlighting that a 1:1 year return period event in 2072 is equivalent to a 1:100 year period event in 2002		

Table 7.2 Comparison of tidal flood levels associated with extreme flooding events in year 2002, 2052 & 2072

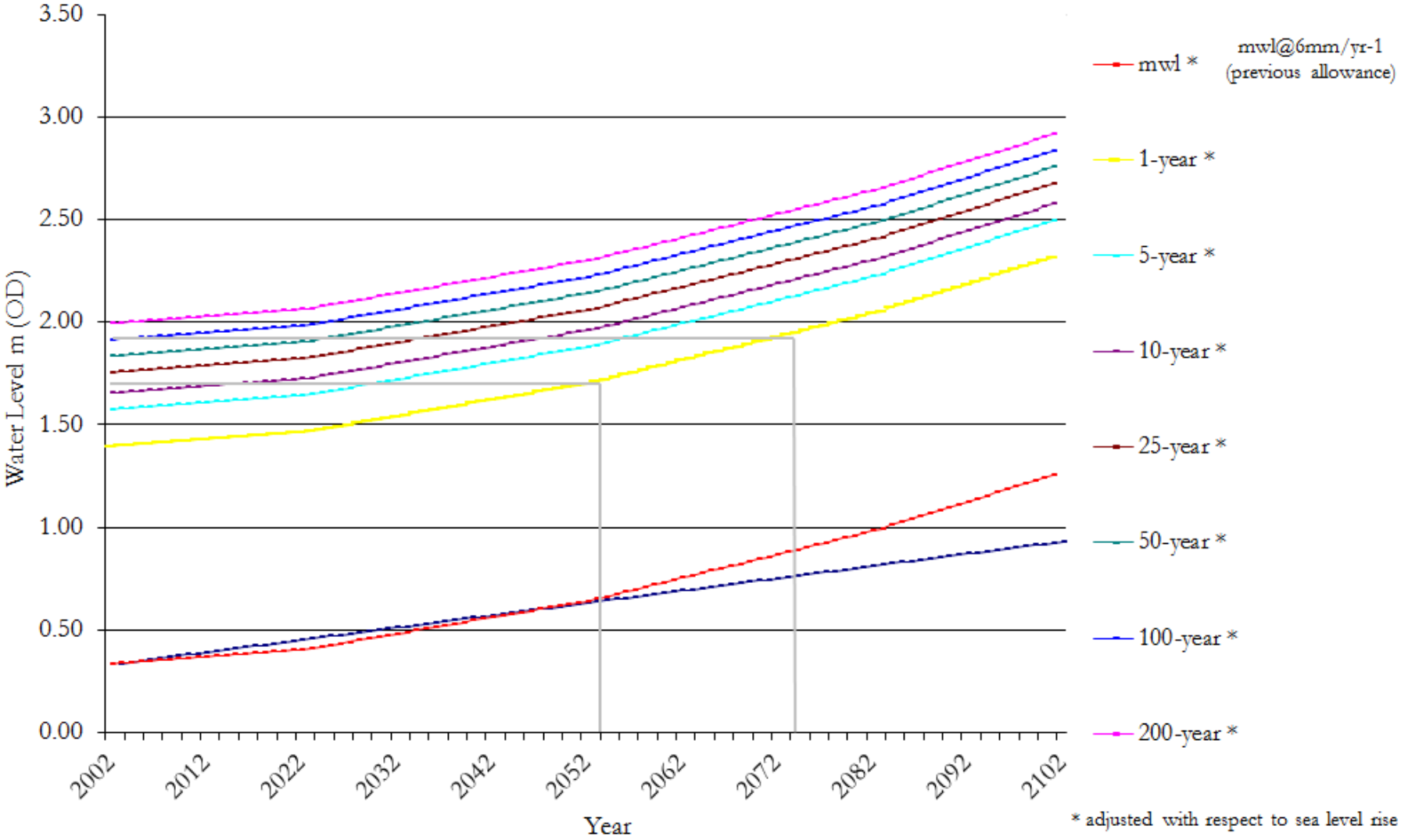

Figure 7.1 Effect of predicted mean water level rise on extreme return period flood water levels in Christchurch Harbour (existing extreme return period events data combined with Sea level rise allowances taken from Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts Report (DEFRA 2006)

In terms of the justifying (future) flood defences around Christchurch Harbour, future rises in the still water level will increase the potential flood area and the (potential) number of property affected. The predicted future still water level will increase in the future and the elevation of the extreme return period flood event will increase accordingly. If flood defences are not raised, this will result in a steady reduction in the standard of service level (highlighted in Figure 7.2).

In terms of the economic benefits of any future flood defences, present guidance in the MCM states that only present day benefits may be included in the economic assessment. Therefore, the flooding assessment of Christchurch Harbour has been carried out using extreme flooding events, based on present day still water levels.

In order to maintain the future standard of service level, existing defences will need to be raised. The future cost of raising (or renewing & raising) the existing defences will be greater than the cost of replacement only. In terms of building a primary floodwall (for example), there is a significant difference between the cost of building a wall to 2.55m OD (£2,125 per metre) and the cost of building a wall to 3.55m OD (£2,362 per metre). The increased cost of the wall in this example is 11%. The increased elevation of the wall will protect a greater number of properties as sea level rises in the future. However despite the increased cost implication of raising the level of the wall in the future, only properties which lie within the existing (present day) 1:200 year flood event area can be included in the economic assessment. Property which is likely to flood in the future has therefore not been included as a benefit.

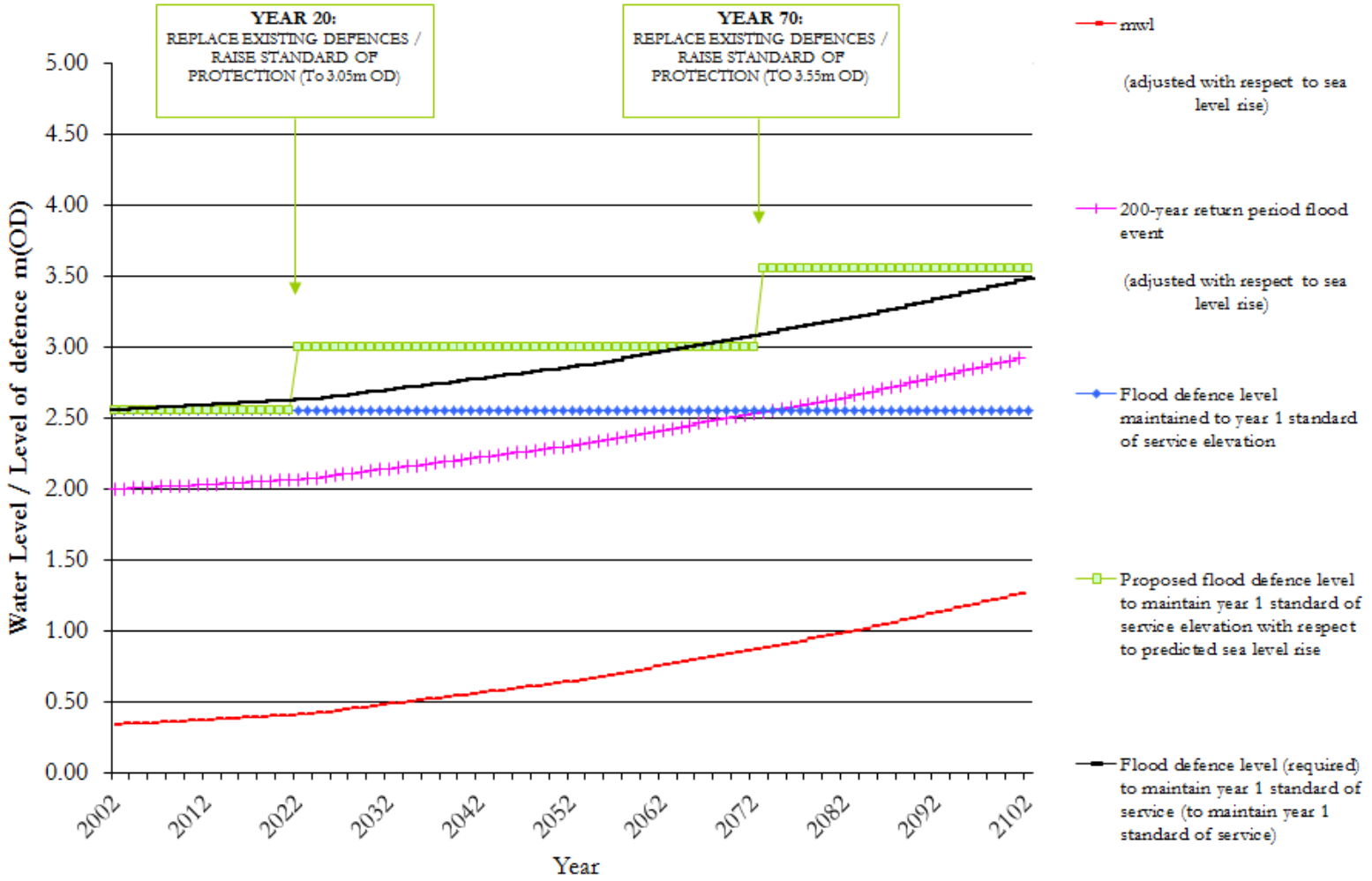

Figure 7.2 Implementation of defences with respect to the effect of predicted mean water level rise on extreme return period flood water levels in Christchurch Harbour (existing extreme return period events data combined with Sea level rise allowances taken from Flood and Coastal Defence Appraisal Guidance FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts Report (DEFRA 2006).

7.4 Coastal Squeeze

Coastal squeeze is the term applied to the situation where the coastal margin is squeezed between a fixed landward boundary (artificial or otherwise) and rising sea levels. Coastal squeeze is most often applied to tidal habitats, such as eroding saltmarshes.

7.4.1 Compensation habitat is required when there is:

(a) A need to maintain the existing defence line; and
(b) The habitats being squeezed/lost are protected by nature conservation designations; and
(c) There is potential to recreate the habitats being lost behind the man-made defence that is contributing to the loss of the designated habitats.

Planning and investment in flood risk management and coastal protection needs to be consistent with the requirements of the European Birds and Habitats Directives and associated legislation.

Where coastal squeeze is occurring and the plan or project is likely to have a significant effect on a European site, either alone or in combination with other plans or projects *and* is not directly connected with or necessary for the management of the site, an Appropriate Assessment must be made. A plan or project may only proceed if:

(d) There are no alternative solutions, and
(e) It is necessary for imperative reasons of overriding public interest, and
(f) Any necessary compensatory measures are secured to ensure that the overall coherence of Natura 2000 is protected.

Any compensatory measures necessary to protect the overall coherence of Natura 2000 must be secured before undertaking works or granting consent, permission or any other authorisation. Such measures are likely to include habitat creation to offset or replace habitat losses from European sites.

7.5 Options Considered

In areas identified as at risk from flooding, all available options have to be considered to be technically and environmentally suitable. The options which are available are as follows:

1. Do Nothing
2. Maintain existing defences (if defences already exist)
3. Construct new defences (to current standard of service level) *
4. Construct new defences above existing service level (raise level of protection) *
5. Replace existing defences and increase standard of service (raise level of protection) *
6. Raise level of existing defences (raise level of protection) *
7. Remove defences
8. Construct new (future) defences (to current standard of service level) *
9. Construct new (future) defences above existing service level (raise level of protection) *

* with respect to sea level rise

The type of defence varies depending on the location however typically the defences are either floodwalls (concrete / stone / sheet piling / natural bank) or flood embankments (sealed with clay layers etc.). There are also examples where flood defences are tied into existing buildings, such as the Civic Offices in Bridge Street in Christchurch.

7.6 Option Costs

The costs which are detailed in the FCDPAG3 sheets in Appendix C (Section 11) have been produced from actual estimated replacement costs, provided by the Environment Agency, with additional cross-sections drawn and costed using supply & place estimates from Dean & Dyball.

Full details regarding the calculations of the specific elements which make up the work items are given in Appendix B (Section 11), while Table 7.3 (below) summaries the rates that have been used for the cost estimates.

PRIMARY / FRONTLINE DEFENCES			
Rate Code	**Work**	**Additional Details**	**Rate (per metre)**
P1	Maintenance of Flood Defences		£5
P2	Raise Floodwall by 0.5m (from 2.55m OD to 3.05m OD)	-	£881
P3	Raise Floodwall by 1m (from 2.55m OD to 3.55m OD)	-	£1018
P4	Raise Floodwall by 0.5m (from 3.05m OD to 3.55m OD)	-	£692
P5	Construct Floodwall to 2.55m OD	-	£2125*
P6	Construct Floodwall to 3.05m OD	-	£2252*
P7	Construct Floodwall to 3.55m OD	-	£2362*
P8	Timber Revetment	-	£1596
P9	Shingle recharge	(imported material)	£15 m3

* Denotes average cost based on two method of concrete supply (pre-cast or poured)

Table 7.3 Summary of option costs for primary / frontline defences within Christchurch Harbour

SECONDARY / SETBACK DEFENCES			
Rate Code	**Work**	**Additional Details**	**Rate (per metre)**
P1	Maintenance of Flood Defences		£5
P10	Construct Embankment to 2m OD	4m wide	£760
P12	Construct Embankment to 2.55m OD	4m wide	£992
P13	Construct Embankment to 3.05m OD	4m wide	£1331
P14	Construct Embankment to 3.55m OD	4m wide	£1633
P15	Raise Embankment by 0.55m to 2.55m OD (original level 2m OD)	4m wide	£520
P16	Raise Embankment by 1m to 3.05m OD (original level 2m OD)	4m wide	£859
P17	Raise Embankment by 1.5m to 3.55m OD (original level 2m OD)	4m wide	£1161
P18	Raise Embankment by 0.50m to 3.05m OD (original level 2.55m OD)	4m wide	£822
P19	Raise Embankment by 1m to 3.55m OD (original level 2.55m OD)	4m wide	£980
P20	Raise Embankment by 0.50m to 3.55m OD (original level 3.05m OD)	4m wide	£690
P21	Raise Embankment to 3.05m OD (original level 2.55mOD)	9m wide (to carry roadway)	£1525
P22	Raise Embankment to 3.55m OD (original level 3.05mOD)	9m wide (to carry roadway)	£1646
P23	Raise Embankment to 3.55m OD (original level 2.55mOD)	9m wide (to carry roadway)	£1936
P24	Construct Embankment to 3.55m OD	9m wide (to carry roadway)	£3025
P25	Construct Floodwall to 2.55m OD	-	£1367
P26	Raise Floodwall by 0.5m (from 2.55m OD to 3.05m OD)	-	£777
P27	Raise Floodwall by 0.5m (from 3.05m OD to 3.55m OD)	-	£722
P28	Raise Floodwall by 1m (from 2.55m OD to 3.55m OD)	-	£1017
P29	Construct Floodwall to 3.55m OD	-	£2036

Table 7.4 Summary of option costs for secondary / setback defences within Christchurch Harbour

7.7 Timescales

Inspection information contained on the National Flood and Coastal Defence Database (NFCDD) indicates that the majority of flood defences in the Harbour have a residual life of between 11 and 20 years. Should defences be replaced in year 20, the effect of sea level rise will mean that new defences will have to be built to a higher elevation in order to maintain the current (year 1) standard of service level. Subsequently, with a 50 year lifespan, the defences constructed in year 20 will need replacement in year 70. At this point in time, the elevation of the defences will again need to be increased in order to maintain the year 1 standard of service level. This criterion has been considered with respect to the options for each Management Unit.

7.8 Option Summary

In summary, the options put forward for each area are as follows:

1) Monitor Defences
2) Maintain Only
3) Maintain / raise standard of service:
   a) If there are no defences, option would be to construct in year 1 (to 2.55m OD), raise in year 20 (to 3.05m OD), replace in year 50 (built to 3.5m OD)
   b) If defences are in place, the options would be to raise in year 20 (to 3.05m OD) and replace in year 50 (built to 3.55m OD), **OR** replace in year 20 (built to 3.05m OD), raise in year 70 (built to 3.55m OD).

Overall this would enable the standard of service to be maintained to current (year 1) level of service. Although over the period of 100 years, the standard of service will, in effect, vary as sea level rises and the level of flood defences increases.

The suitable options available for each CBU have been combined to produce a number of options, relevant to the location.

7.8.1 CHB1- Mudeford Sandbank

(a) CHB1-01

Notwithstanding the natural gradient across Mudeford Sandbank, which forms the perimeter of the Harbour along its eastern flank, CHB1-01 is undefended from flooding. The options for this location are to construct a frontline floodwall along the Sandbank (a length of 2.2km) to protect property (mostly beach huts) along Christchurch Sandbank or to recharge the beach and raise the level by 1m (a volume of 146 300m3 would be required and a number of beach huts would also have to be raised). Costs of the relevant flood defence options are presented in Table 7.5.

7.8.2 CHB2 – South side of Christchurch Harbour (Wick Frontage)

(a) CHB2-01

The total number of property affected in CHB2-01 is 32 (32 of these are residential). Flood protection, is currently in the form of a 130m timber revetment and a secondary flood bank built to a level of 2m OD, which offers protection to approximately 20 properties in CHB2. The options for this location are to increase the length of the flood bank to 575m, which would offer protection to a total of 32 properties and maintain / raise the standard of protection. The cost of the relevant flood defence options are presented in Table 7.6.

7.8.1 CHB3 - Stanpit to Grimbury Marshes

(a) CHB3-01-U

Notwithstanding the river bank (River Stour), and the natural gradient of the land, area CHB3-01-U is currently undefended. The options for this location are to construct a frontline floodwall along 550m of riverbank to protect the riverside property. Table 7.7 summarises the main options for CHB3-01-U relate to the specific timing of when flood defences are constructed.

(b) CHB3-01-D

CHB3-01-D is currently defended by a series of flood walls and floodbanks. The total length of flood defences is 1750m which comprises: 1270m of secondary floodwalls; 400m of floodbank (including asphalt roadway which carries traffic) & 100m of frontline defences which borders the River Stour. The majority of the defences are secondary setback defences and will only become active during extreme flooding events. The options for this area are to maintain the existing defences and to replace the defences in the future & increase the standard of service level to keep in line with rises in sea level. The cost of the relevant flood defence options are presented in Table 7.8.

(c) CHB3-02

Notwithstanding the river bank (River Avon), and the natural gradient of the land, the majority of CHB3-02 is currently undefended. A number of measures have however been incorporated into the marina devolvement at Priory Quay which offers increased protection. The options for this location are to construct a 1320m frontline floodwall along the riverbank to protect riverside property. The cost of the relevant flood defence options are presented in Table 7.9.

(d) CHB3.03

Notwithstanding the river bank (River Avon), and the natural gradient of the land, CHB3-03 is currently undefended. The options for this location are to construct a 62m frontline floodwall along the riverbank to protect the single riverside property which is affected. The cost of the relevant flood defence options are presented in Table 7.10.

(e) CHB3.04U

Notwithstanding the river bank (River Avon), and the natural gradient of the land, CHB3-04-U is currently undefended. However there are a number of private defences in the form of floodwalls which protect private property. In order to improve flood protection, the options for this location are to construct a frontline floodwall along 690m of the riverbank to protect the riverside property and businesses. Costs of relevant flood defence options are presented in Table 7.11.

(f) CHB3.04D

CHB3-04-D is defended with a variety of frontline flood walls along the bank of the River Avon. The options for this location are to replace / raise the entire 817m of existing frontline floodwalls at a time in the future to maintain the current level of flood protection to riverside property and businesses. The cost of the relevant flood defence options are presented in Table 7.12

(g) CHB3.05

CHB3-05 is defended with a combination of both frontline and setback flood walls along the bank of the River Avon. The options for this location are to replace / raise the entire 1043m of existing floodwalls at a time in the future to maintain the current level of flood protection to riverside property and businesses. Costs of relevant flood defence options are presented in Table 7.13.

7.8.1 CHB4 – Mudeford Town Frontage

(a) CHB4-01

Notwithstanding the natural perimeter of the harbour, and the natural gradient of the land, CHB4-01 is currently undefended. The options for this location are to construct a frontline floodwall along 700m of the riverbank to protect the harbour side property. The cost of the relevant flood defence options are presented in Table 7.14.

(b) CHB4-02

CHB4-02 is currently defended by a number of floodwalls, which are privately owned and maintained. The Avonmouth Hotel currently has planning permission for the construction of a new extension and bistro which includes a private flood defence. The Environment Agency has

advised that it should be presumed that this development will proceed. Therefore damages and potential options have not been assessed for existing or proposed properties at this location.

The option for this location are to replace the entire length of existing floodwalls (estimated to be 1150m in length) at a time in the future to maintain the current level of flood protection to harbour side property. Costs of the relevant flood defence options are presented in Table 7.15.

7.8.2 CHB5 – Mudeford Quay

(a) CHB5-01

A wall forming the perimeter of the harbour, together with the natural gradient of the land, provide a degree of flood protection to property in CHB5-01, The options for this location are to construct a 550m frontline floodwall along the harbour perimeter, to protect harbour side property. The cost of the relevant flood defence options are presented in Table 7.16.

(b) CHB5-02

A small number of properties at the tip of Christchurch Harbour are protected by a 150m long floodwall which encloses and protects the property. The option is to either replace or raise the floodwall to maintain the future standard of service.

Option	CHB1-01 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£300,000	£89,438	**17.1**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£300,000	£89,438	**0.23**
		1	Construct frontline floodwall (2200m) (built to 2.55m OD)	**P5**	£4,675,000	£4,516,908	
		20	Raise frontline floodwall (2200m) (2.55 to 3.05m OD)	**P2**	£1,938,200	£974,073	
		50	Construct frontline floodwall (2200m) (built to 3.55m OD)	**P7**	£5,196,400	£1,025,056	
				TOTAL OPTION 3	**£12,109,600**	**£6,605,475**	
4	Maintain / Raise existing standard of service	**20 - 100**	Maintain defences*	**P1**	£300,000	£45,308	**0.57**
		20	Construct frontline floodwall (2200m) (built to 3.05m OD)	**P6**	£4,954,400	£2,489,912	
		70	Raise frontline floodwall (2200m) (3.05m to 3.55m OD)	**P4**	£1,522,400	£166,276	
				TOTAL OPTION 3	**£6,776,800**	**£2,701,496**	
5	Maintain / Raise existing standard of service	**20 - 100**	Maintain defences*	**P1**	£300,000	£45,308	**0.60**
		20	Construct frontline floodwall (2200m) (built to 3.05m OD)	**P6**	£4,954,400	£2,489,912	
				TOTAL OPTION 3	**£5,254,400**	**£2,535,220**	
6	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£300,000	£89,438	**0.86**
		1	Recharge Beach (146 300m3 material) (raise beach level by 1m)	**P9**	£1,755,600	£1,696,232	
				TOTAL	**£2,055,600**	**£1,785,670**	
6	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£300,000	£89,438	**0.16**
		20	Recharge Beach (146,300m3 material) (raise beach level by 1m)	**P9**	£1,755,600	£882,305	
				TOTAL	**£2,055,600**	**£971,743**	

***100 year maintenance cost @£5 per metre run (£3,000 pa)**

NOTE: PV – Present Value C-B Ratio – Cost Benefit Ratio

Table 7.5 Summary of option costs for CHB1-01

Option	CHB2-01 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£352,500	£105,089	**23.81**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£352,500	£105,189	**1.23**
		1	Extend existing floodbank* (420m) (built to 2m OD)	**P10**	£319,200	£308,406	
		20	Renew timber revetment (130m)	**P8**	£207,480	£104,272	
			Raise floodbank (575m) (2m to 2.55m OD)	**P15**	£299,000	£150,267	
		60	Renew timber revetment (130m)	**P8**	£207,480	£30,454	
		70	Raise floodbank (575m) (2.55m to 3.0m OD)	**P18**	£472,650	£51,622	
				TOTAL	**£1,818,310**	**£750,210**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£352,500	£105,189	**1.25**
		1	Extend existing floodbank* (420m) (built to 2m OD)	**P10**	£319,200	£308,406	
		20	Renew timber revetment (130m)	**P8**	£207,480	£104,272	
			Raise floodbank (575m) (2m to 3m OD)	**P16**	£493,925	£248,230	
		60	Renew timber revetment (130m)	**P8**	£207,480	£30,454	
		70	Raise floodbank (575m) (3m to 3.5m OD)	**P20**	£396,750	£43,333	
				TOTAL	**£1,977,335**	**£839,884**	
5	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£352,500	£105,189	**1.45**
		20	Renew timber revetment (130m)	**P8**	£207,480	£104,272	
			Construct floodbank (420m) (3m OD)	**P13**	£559,020	£280,944	
			Raise floodbank (175m) (2m to 3m OD)	**P16**	£150,325	£77,548	
		60	Renew timber revetment (130m)	**P8**	£207,480	£30,454	
		70	Raise floodbank (575m) (3m to 3.5m OD)	**P20**	£396,750	£43,333	
				TOTAL	**£1,873,555**	**£641,740**	

***100 year maintenance cost @£5 per metre run (£3,525 pa)**

Table 7.6 Summary of option costs for CHB2-01

Option	CHB3-01U Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance Only	**1 - 100**	Maintain defences*	**P1**	£275,000	£81,984	**38.71**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£275,000	£81,984	**1.85**
		1	Construct frontline floodwall (550m) (built to 2.55m OD)	**P5**	£1,168,750	£1,129,227	
		20	Raise frontline floodwall (550m)(2.55m to 3.05m OD)	**P2**	£484,550	£243,518	
		50	Construct frontline floodwall (550m) (built to 3.55m OD)	**P7**	£1,299,100	£256,264	
				TOTAL	**£3,227,400**	**£1,710,993**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£275,000	£81,984	**4.13**
		20	Construct frontline floodwall (550m) (built to 3.05m OD)	**P6**	£1,238,600	£622,478	
		70	Raise frontline floodwall (550m)(2.55 to 3.55m OD)	**P3**	£584,100	£63,795	
				TOTAL	**£2,097,700**	**£768,257**	

***100 year maintenance cost @£5 per metre run (£2,750 pa)**

Table 7.7 Summary of option costs for CHB3-01U

Option	CHB3-01D Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£875 000	£260,860	**64.4**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£875 000	£260,860	**9.3**
		20	Raise setback floodwall (1250m) (2.55m to 3.05m OD)	**P26**	£971,250	£488,117	
		20	Raise frontline floodwall (100m) (2.55m to 3.05m OD)	**P2**	£88,100	£44,276	
		20	Raise setback floodbank (400m) (highway) (2.55m to 3.05m OD)	**P21**	£610,000	£306,565	
		50	Construct frontline floodwall (100m) (built to 3.55m OD)	**P7**	£236,200	£46,593	
		70	Raise setback floodwall (1250m) (3.05m to 3.55m OD)	**P20**	£862,500	£94,202	
		70	Raise setback floodbank (400m) (highway) (3.05m to 3.55m OD)	**P22**	£658,400	£71,910	
				TOTAL	**£3,426,450**	**£1,312,523**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£875 000	£260,860	**8.4**
		20	Raise setback floodwall (1250m) (2.55m to 3.05m OD)	**P26**	£971,250	£488,117	
		20	Raise frontline floodwall (100m) (2.55m to 3.05m OD)	**P2**	£88,100	£44,276	
		20	Raise setback floodbank (400m) (highway) (2.55m to 3.05m OD)	**P21**	£610,000	£306,565	
		50	Construct frontline floodwall (100m) (built to 3.55m OD)	**P7**	£236,200	£46,593	
		50	Raise setback floodwall (1250m) (3.05m to 3.55m OD)	**P20**	£862,500	£170,139	
		50	Raise setback floodbank (400m) (highway) (3.05m to 3.55m OD)	**P22**	£658,400	£129,878	
				TOTAL	**£3,426,450**	**£1,446,428**	

***100 year maintenance cost @£5 per metre run (£8750 pa)**

Table 7.8 Summary of option costs for CHB3-01D

Option	CHB3-02 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£660,000	£196,763	**20.26**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£660,000	£196,763	**0.97**
		1	Construct frontline floodwall (1320m) (built to 2.55m OD)	**P5**	£2,805,000	£2,710,145	
		20	Raise frontline floodwall (1320m) (2.55m to 3.05m OD)	**P2**	£1,162,920	£584,444	
		50	Construct frontline floodwall (1320m) (built to 3.55m O	**P7**	£3,117,840	£615,034	
		TOTAL OPTION 3			**£7,745,760**	**£4,106,385**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£660,000	£196,763	**2.23**
		20	Construct frontline floodwall (1320m) (built to 3.05m OD)	**P6**	£2,972,640	£1,493,947	
		70	Raise frontline floodwall (1320m) (3.05m OD to 3.55m OD)	**P4**	£913,440	£99,766	
		TOTAL OPTION 4			**£4,546,080**	**£1,790,476**	
5	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£660,000	£196,763	**4.91**
		50	Construct frontline floodwall (1320m) (built to 3.55m OD)	**P7**	£3,117,840	£615,034	
		TOTAL OPTION 5			**£3,777,840**	**£811,796**	

***100 year maintenance cost @£5 per metre run (£6600 pa)**

Table 7.9 Summary of option costs for CHB3-02

Option	CHB3-03 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£31,000	£9,242	**3.32**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£31,000	£9,242	**0.15**
		1	Construct frontline floodwall (62m)(built to 2.55m OD)	**P5**	£131,750	£127,295	
		20	Raise frontline floodwall (62m)(to 3.05m OD)	**P2**	£54,622	£27,451	
		50	Construct frontline floodwall (62m) (built to 3.55m OD)	**P7**	£146,444	£28,888	
		TOTAL OPTION 3			**£363,816**	**£192,876**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£31,000	£9,242	**0.35**
		20	Construct frontline floodwall (62m)(built to 3.05m OD)	**P6**	£139,624	£70,170	
		70	Raise frontline floodwall (62m) (to 3.55m OD)	**P4**	£42,904	£4,686	
		TOTAL OPTION 4			**£213,528**	**£84,098**	

***includes PV cost of maintaining defences for 100 years (£310 pa)**

Table 7.10 Summary of option costs for CHB3-03

Option	CHB3-04U Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£345,000	£102,853	**77.2**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£345,000	£102,853	**3.7**
		1	Construct frontline floodwall (690m)(built to 2.55m OD)	**P5**	£1,466,250	£1,416,666	
		20	Raise frontline floodwall (690m)(to 3.05m OD)	**P2**	£607,890	£305,504	
		50	Construct frontline floodwall (690m) (built to 3.55m OD)	**P7**	£1,629,780	£321,495	
		TOTAL OPTION 3			**£4,048,920**	**£2,146,520**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£345,000	£102,853	**8.5**
		20	Construct frontline floodwall (690m)(built to 3.05m OD)	**P6**	£1,553,880	£780,927	
		70	Raise frontline floodwall (690m) (to 3.55m OD)	**P4**	£477,480	£52,150	
		TOTAL OPTION 4			**£2,376,360**	**£935,931**	

***includes PV cost of maintaining defences for 100 years (£3,450 pa)**

Table 7.11 Summary of option costs for CHB3-04U

Option	**CHB3-04D Options**	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	1 - 100	Monitor defences				
2	Maintenance Only	1 - 100	Maintain defences*	**P1**	£408,500	£121,784	**95.3**
3	Maintain / Raise existing standard of service	1 - 100	Maintain defences *	**P1**	£408,500	£121,784	**13.4**
		20	Raise frontline floodwall (817m)(to 3.05m OD)	**P2**	£719,777	£361,735	
		50	Construct frontline floodwall (817m) (built to 3.55m OD)	**P7**	£1,929,754	£380,669	
		TOTAL OPTION 3			**£3,058,031**	**£864,188**	
4	Maintain / Raise existing standard of service	1 - 100	Maintain defences*	**P1**	£408,500	£121,784	**10.5**
		20	Construct frontline floodwall (817m) (built to 3.05m	**P6**	£1,839,884	£924,663	
		70	Raise frontline floodwall (817m)(to 3.55m OD)	**P4**	£565,364	£61,749	
		TOTAL OPTION 4			**£2,813,748**	**£1,108,196**	

***100 year maintenance cost @£5 per metre run (£4,085 pa)**

Table 7.12 Summary of option costs for CHB3-04D

Option	CHB3-05 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance Only	**1 - 100**	Maintain defences*	**P1**	£521,500	£155,472	**95.92**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences *	**P1**	£521,500	£155,472	**13.52**
		20	Raise frontline floodwall (1043m)(to 3.05m OD)	**P2**	£918,883	£461,799	
		50	Construct frontline floodwall (1043m) (built to 3.55m OD)	**P7**	£2,463,566	£485,969	
		TOTAL OPTION 3			**£3,903,949**	**£1,103,241**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£521,500	£155,472	**10.54**
		20	Construct frontline floodwall (1043m) (built to 3.05m OD)	**P6**	£2,348,836	£1,180,445	
		70	Raise frontline floodwall (1043m)(to 3.55m OD)	**P4**	£721,756	£78,830	
		TOTAL OPTION 4			**£3,592,092**	**£1,414,747**	

***100 year maintenance cost @£5 per metre run (£5,215 pa)**

Table 7.13 Summary of option costs for CHB3-05

Option	CHB4-01 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 -**	Monitor defences				
2	Maintenance Only	**1 - 100**	Maintain defences*	**P1**	£350,000	£100,844	**15.59**
3	Maintain / Raise existing standard of service	**1 -**	Maintain defences*	**P1**	£350,000	£104,344	**0.75**
		1	Construct frontline floodwall (700m)(built to 2.55m OD)	**P5**	£1,487,500	£1,437,198	
		20	Raise frontline floodwall (700m)(to 3.05m OD)	**P2**	£616,700	£309,932	
		50	Construct frontline floodwall (700m) (built to 3.55m OD)	**P7**	£1,653,400	£326154	
		TOTAL OPTION 3			**£3,757,600**	**£2,177,628**	
4	Maintain / Raise existing standard of service	**1 -**	Maintain defences*	**P1**	£350,000	£104,344	**1.71**
		20	Construct frontline floodwall (700m)(built to 3.05m OD)	**P6**	£1,576,400	£792,245	
		70	Raise frontline floodwall (700m) (to 3.55m OD)	**P4**	£484,400	£52,906	
		TOTAL OPTION 4			**£2,060,800**	**945,495**	

***100 year maintenance cost @£5 per metre run (£3,500 pa)**

Table 7.14 Summary of option costs for CHB4.01

Option	CHB4-02 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance Only	**1 - 100**	Maintain defences*	**P1**	£575,000	£171,422	**20.06**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£575,000	£171,422	**2.83**
		20	Raise frontline floodwall (1150m)(to 3.05m OD)	**P2**	£1,013,150	£509,175	
		50	Construct frontline floodwall (1150m) (built to 3.55m OD)	**P7**	£2,716,300	£535,825	
		TOTAL OPTION 3			**£4,304,450**	**£1,216,422**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£575,000	£171,422	**2.20**
		20	Construct frontline floodwall (1150m)(built to 3.05m OD)	**P6**	£2,589,800	£1,301,545	
		70	Raise frontline floodwall (1150m) (to 3.55m OD)	**P4**	£795,800	£86,917	
		TOTAL OPTION 4			**£3,960,600**	**£1,559,884**	

***100 year maintenance cost @£5 per metre run (£5,750 pa)**

Table 7.15 Summary of option costs for CHB4.02

Option	CHB5-01 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£275,000	£81,985	**36.98**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£275,000	£81,985	**1.77**
		1	Construct frontline floodwall (550m)(built to 2.55m OD)	**P5**	£1,168,750	£1,129,227	
		20	Raise frontline floodwall (550m)(to 3.05m OD)	**P2**	£484,550	£243,518	
		50	Construct frontline floodwall (550m) (built to 3.55m OD)	**P7**	£1,299,100	£256,264	
		TOTAL OPTION 3			**£2,308,900**	**£1,710,994**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£275,000	£81,985	**4.06**
		20	Construct frontline floodwall (550m)(built to 3.05m OD)	**P6**	£1,238,600	£622,478	
		70	Raise frontline floodwall (550m)(to 3.55m OD)	**P4**	£380,600	£41,569	
		TOTAL OPTION 4			**£1,894,200**	**£746,032**	

***100 year maintenance cost @£5 per metre run (£2,750 pa)**

Table 7.16 Summary of option costs for CHB5-01

Option	CHB5-02 Options	Year	Elements	Rate Code	Cash Cost	PV Cost	C-B Ratio
1	Do Nothing	**1 - 100**	Monitor defences				
2	Maintenance	**1 - 100**	Maintain defences*	**P1**	£75,000	£22,359	**100.18**
3	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£75,000	£22,359	**14.12**
		20	Raise frontline floodwall (150m)(to 3.05m OD)	**P2**	£132,150	£66,414	
		50	Construct frontline floodwall (150m) (built to 3.55m OD)	**P7**	£354,300	£69,890	
		TOTAL OPTION 3			**£561,450**	**£158,663**	
4	Maintain / Raise existing standard of service	**1 - 100**	Maintain defences*	**P1**	£75,000	£22,359	**11.01**
		20	Construct frontline floodwall (150m)(built to 3.05m OD)	**P6**	£337,800	£169,767	
		70	Raise frontline floodwall (150m)(to 3.55m OD)	**P4**	£103,800	£11,337	
		TOTAL OPTION 4			**£516,600**	**£203,465**	

***100 year maintenance cost @£5 per metre run (£750 pa)**

Table 7.17 Summary of option costs for CHB5-02

8 Annexes

8.1 Annex 1

8.1.1 Flood maps

Flood modelling exercises were carried out to assess the extent of flooding under tidal extreme water levels during six different flood levels corresponding to a 1:1; 1:5; 1:10; 1:50; 1:100 & 1:200 year return period flood events within all identified areas with each Management Unit (CBH1 to CHB5) and are illustrated as flood-maps. As property becomes flooded the colour of the property turns from clear to red in colour.

For certain areas (particularly CHB3), there are a number of different scenarios presented, depending on the specific location of defence failure and extent of associated flooding.

The flood maps (Figure 8.1 to 8.19) are presented as animations within PowerPoint and are included on the accompanying CD (*© Crown copyright and database rights 2012 Ordnance Survey 100026220).*

8.2 Annex 2

8.2.1 Project Summary Sheets

Project Summary Sheet

Client/Authority		Prepared (date)	01/08/2007
New Forest District Council		Printed	01/06/2012
Project name		Prepared by	PF
Christchurch Bay Strategy Study		Checked by	
Project reference	CHB1.01 (sheet 1)	Checked date	
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	**OPTION 1**
PV costs from estimates	0	89,438	6,605,475	2,701,496	2,535,221
Optimism bias adjustment	0	53,663	3,963,285	1,620,898	1,521,132
Total PV Costs for appraisal PVc	0	143,100	10,568,760	4,322,394	4,056,353
PV damage PVd	2,450,070				
PV damage avoided		2,450,070	2,450,070	2,450,070	2,450,070
PV assets Pva					
PV asset protection benefits		0	0	0	0
Total PV benefits PVb		2,450,070	2,450,070	2,450,070	2,450,070
Net Present Value NPV		2,306,970	-8,118,690	-1,872,324	-1,606,282
Average benefit/cost ratio		17.1	0.232	0.567	0.604
Incremental benefit/cost ratio			0.0	0.0	0.0
		Highest b/c	-	-	-

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Construct Seawall to 2.55m OD year1 / raise seawall to 3.05 OD year 20 / construct seawall to 3.55m OD year 50
Option 4	Construct Seawall to 3.05m OD year20 / raise seawall to 3.55 OD year 70
Option 5	Construct Seawall to 3.05m OD year20

Table 8.1 Project Summary Sheet CHB1.01 (sheet 1)

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
	CHB1.01	Checked date	
Project reference	(sheet 2)		
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
			OPTION 6	**OPTION 7**	
PV costs from estimates	0	89,438	1,785,670	971,742	
Optimism bias adjustment	0	53,663	1,071,402	583,045	
Total PV Costs for appraisal PVc	0	143,100	2,857,071	1,554,788	
PV damage PVd	2,450,070				
PV damage avoided		2,450,070	2,450,070	2,450,070	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		2,450,070	2,450,070	2,450,070	
Net Present Value NPV		2,306,970	-407,001	895,283	
Average benefit/cost ratio		17.1	0.858	1.576	
Incremental benefit/cost ratio			0.0	0.0	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Recharge Beach (raise level by 1m) Year 1
Option 4	Recharge Beach (raise level by 1m) Year 20

Table 8.2 Project Summary Sheet CHB1.01 (sheet 2)

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB2.01**	Checked date	
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	**OPTION 5**
PV costs from estimates	0	105,089	750,112	735,512	637,457
Optimism bias adjustment	0	63,054	450,067	441,307	382,474
Total PV Costs for appraisal PVc	0	168,143	1,200,178	1,176,819	1,019,931
PV damage PVd	1,475,318				
PV damage avoided		1,475,318	1,475,318	1,475,318	1,475,318
PV assets Pva					
PV asset protection benefits		0	0	0	0
Total PV benefits PVb		1,475,318	1,475,318	1,475,318	1,475,318
Net Present Value NPV		1,307,175	275,139	298,498	455,386
Average benefit/cost ratio		23.81	1.23	1.25	1.45
Incremental benefit/cost ratio			0.0	0.0	0.0
		Highest b/c	-	-	-

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Maintain existing standard of service. Extend existing floodbank (built to 2m OD) (year 1) / renew timber revetment in (year 20 & year 60) / raise all floodbanks (to 2.55m OD) (year 20) / raise all floodbanks (to 3.05m OD) (year 70)
Option 4	Maintain existing standard of service. Extend existing floodbank (built to 2m OD) (year 1) / renew timber revetment in (year 20 & year 60) / raise all floodbanks (to 3.05m OD) (year 20) / raise all floodbanks (to 3.55m OD) (year 70)
Option 5	Raise existing standard of service. Extend existing floodbank (built to 3.05m OD) (year 20) / renew timber revetment in (year 20 & year 60) / raise all floodbanks (to 3.05m OD) (year 20) / raise all floodbanks (to 3.05m OD) (year 70)

Table 8.3 Project Summary Sheet CHB2.01

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	SC
Project reference	CHB3.01U	Checked date	16/05/2005
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	81,984	1,710,994	768,258	
Optimism bias adjustment	0	49,191	1,026,596	460,955	
Total PV Costs for appraisal PVc	0	131,175	2,737,590	1,229,212	
PV damage PVd	5,077,866				
PV damage avoided		5,077,866	5,077,866	5,077,866	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		5,077,866	5,077,866	5,077,866	
Net Present Value NPV		4,946,691	2,340,276	3,848,654	
Average benefit/cost ratio		38.71	1.85	4.13	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance
Option 3	Construct frontline floodwall (to 2.55m OD) (year 1) / Raise frontline floodwall (to 3.05m OD) (year 20) / Construct frontline floodwall (to 3.55m OD) (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20) / Raise floodwall (to 3.55m OD) (year 70)

Table 8.4 Project Summary Sheet CHB3.01U

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
		Checked date	
Project reference	**CHB3.01D**		
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	260,860	1,312,524	1,446,428	
Optimism bias adjustment	0	156,516	787,514	867,857	
Total PV Costs for appraisal PVc	0	417,376	2,100,038	2,314,286	
PV damage PVd	19,497,744				
PV damage avoided		19,497,744	19,497,744	19,497,744	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		19,497,744	19,497,744	19,497,744	
Net Present Value NPV		19,080,368	17,397,706	17,183,458	
Average benefit/cost ratio		46.7	9.3	8.4	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	increase level of frontline defences to 3.05m OD (year 20) / increase level of floodbank (to 3.05m OD) including asphalt roadway (year20) /construct frontline defences (to 3.55m OD) (year 50) / increase level of setback defences (to 3.55m OD) (year 70) / increase level of floodbank (to 3.55m OD) including asphalt roadway (year 70)
Option 4	increase level of frontline defences to 3.05m OD (year 20) / increase level of floodbank (to 3.05m OD) including asphalt roadway (year20) /construct frontline defences (to 3.55m OD) (year 50) / increase level of setback defences (to 3.55m OD) (year 50) / increase level of floodbank (to 3.55m OD) including asphalt roadway (year 50)

Table 8.5 Project Summary Sheet CHB3.01D

Project Summary Sheet

Client/Authority		Prepared (date)	01/08/2007
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB3-02**	Checked date	16/08/2007
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	**OPTION 5**
PV costs from estimates	0	196,763	4,106,385	1,790,476	811,796
Optimism bias adjustment	0	118,058	2,463,831	1,074,285	487,078
Total PV Costs for appraisal PVc	0	314,820	6,570,216	2,864,761	1,298,874
PV damage PVd	6,377,403				
PV damage avoided		6,377,403	6,377,403	6,377,403	6,377,403
PV assets Pva					
PV asset protection benefits		0	0	0	0
Total PV benefits PVb		6,377,403	6,377,403	6,377,403	6,377,403
Net Present Value NPV		6,062,582	-192,814	3,512,642	5,078,529
Average benefit/cost ratio		20.26	0.97	2.23	4.91
Incremental benefit/cost ratio			0.0	0.0	0.0
		Highest b/c	-	-	-

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Construct Floodwall (to 2.55m OD) (year 1) / Raise floodwall (to 3.05m OD) (year 20) / Construct floodwall (to 3.55m OD) (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20) / Raise floodwall (to 3.55m OD) (year 70)
Option 5	Construct Floodwall (to 3.55m OD) (year 50)

Table 8.6 Project Summary Sheet CHB3.02

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB3-03**	Checked date	16/08/2007
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	9,242	192,876	84,098	
Optimism bias adjustment	0	5,545	115,725	50,459	
Total PV Costs for appraisal PVc	0	14,787	308,601	134,557	
PV damage PVd	47,632				
PV damage avoided		47,632	47,632	47,632	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		47,632	47,632	47,632	
Net Present Value NPV		32,845	-260,969	-86,925	
Average benefit/cost ratio		3.22	0.15	0.35	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance
Option 3	Construct Floodwall (to 2.55m OD) (year 1) / Raise defences to 3.05m OD (year 20) / Construct Floodwall (to 3.55m OD) (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20) / Raise defences to 3.55m OD (year 50)

Table 8.7 Project Summary Sheet CHB3.03

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB3-04U**	Checked date	
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	102,853	2,146,520	935,931	
Optimism bias adjustment	0	61,712	1,287,912	561,558	
Total PV Costs for appraisal PVc	0	164,565	3,434,431	1,497,489	
PV damage PVd	12,709,755				
PV damage avoided		12,709,755	12,709,755	12,709,755	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		12,709,755	12,709,755	12,709,755	
Net Present Value NPV		12,545,190	9,275,324	11,212,266	
Average benefit/cost ratio		77.2	3.7	8.5	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Construct Floodwall (to 2.55m OD) (year 1) / Raise floodwall (to 3.05m OD) (year 20) / Construct Floodwall (to 3.55m OD) (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20) / Raise floodwall (to 3.55m OD) (year 70)

Table 8.8 Project Summary Sheet CHB3.04U

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
		Checked date	
Project reference	**CHB3-04D**		
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	121,784	864,188	1,108,196	
Optimism bias adjustment	0	73,071	518,513	664,918	
Total PV Costs for appraisal PVc	0	194,855	1,382,701	1,773,114	
PV damage PVd	18,573,659				
PV damage avoided		18,573,659	18,573,659	18,573,659	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		18,573,659	18,573,659	18,573,659	
Net Present Value NPV		18,378,804	17,190,958	16,800,546	
Average benefit/cost ratio		95.3	13.4	10.5	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Raise defences by 0.5m to 3.05m OD (year 20) / construct frontline defences to 3.55m OD (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20)/Raise defences by 0.5m to 3.55m OD (year 70)

Table 8.9 Project Summary Sheet CHB3.04D

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
		Checked date	
Project reference	**CHB3-05**		
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	155,472	1,103,241	1,414,747	
Optimism bias adjustment	0	93,283	661,945	848,848	
Total PV Costs for appraisal PVc	0	248,756	1,765,186	2,263,595	
PV damage PVd	23,861,526				
PV damage avoided		23,861,526	23,861,526	23,861,526	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		23,861,526	23,861,526	23,861,526	
Net Present Value NPV		23,612,770	22,096,339	21,597,930	
Average benefit/cost ratio		95.92	13.52	10.54	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Raise defences to 3.05m OD (year 20) / construct frontline defences to 3.55m OD (year 50)
Option 4	Construct new defence to 3.05m OD (year 20) / increase level of frontline defences to 3.55m OD (year 70)

Table 8.10 Project Summary Sheet CHB3.05

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB4.01**	Checked date	
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	104,344	2,177,629	949,495	
Optimism bias adjustment	0	62,606	1,306,577	569,697	
Total PV Costs for appraisal PVc	0	166,950	3,484,206	1,519,192	
PV damage PVd	2,603,099				
PV damage avoided		2,603,099	2,603,099	2,603,099	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		2,603,099	2,603,099	2,603,099	
Net Present Value NPV		2,436,149	-881,106	1,083,908	
Average benefit/cost ratio		15.59	0.75	1.71	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Construct Floodwall (to 2.55m OD) (year 1) / Raise floodwall (to 3.05m OD) (year 20) / Construct Floodwall (to 3.55m OD) (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20) / Raise floodwall (to 3.55m OD) (year 70)

Table 8.11 Project Summary Sheet CHB4.01

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB4.02**	Checked date	16/05/2005
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	171,422	1,216,421	1,559,884	
Optimism bias adjustment	0	102,853	729,853	935,931	
Total PV Costs for appraisal PVc	0	274,275	1,946,274	2,495,815	
PV damage PVd	5,501,014				
PV damage avoided		5,501,014	5,501,014	5,501,014	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		5,501,014	5,501,014	5,501,014	
Net Present Value NPV		5,226,738	3,554,739	3,005,199	
Average benefit/cost ratio		20.06	2.83	2.20	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Raise floodwall (to 3.05m OD) (year 20) / Construct Floodwall (to 3.55m OD) (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20) / Raise floodwall (to 3.55m OD) (year 70)

Table 8.12 Project Summary Sheet CHB4.02

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB5.01**	Checked date	16/05/2005
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	81,984	1,710,994	746,032	
Optimism bias adjustment	0	49,191	1,026,596	447,619	
Total PV Costs for appraisal PVc	0	131,175	2,737,590	1,193,651	
PV damage PVd	4,850,448				
PV damage avoided		4,850,448	4,850,448	4,850,448	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		4,850,448	4,850,448	4,850,448	
Net Present Value NPV		4,719,273	2,112,858	3,656,798	
Average benefit/cost ratio		36.98	1.77	4.06	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Construct Floodwall (to 2.55m OD) (year 1) / Raise floodwall (to 3.05m OD) (year 20) / Construct Floodwall (to 3.55m OD) (year 50)
Option 4	Construct Floodwall (to 3.05m OD) (year 20) / Raise floodwall (to 3.55m OD) (year 70)

Table 8.13 Project Summary Sheet CHB5.01

Project Summary Sheet

Client/Authority		Prepared (date)	
New Forest District Council		Printed	28/05/2012
Project name		Prepared by	PF
Christchurch Bay Study		Checked by	
Project reference	**CHB5.02D**	Checked date	16/05/2005
Base date for estimates (year 0)	Jan-2004		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Principle land use band	A	(A to E)	
Initial Discount Rate	3.5%		
Optimism bias adjustment factor	60.0%		

Costs and benefits of options

	Costs and benefits £				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	
PV costs from estimates	0	22,359	158,664	203,463	
Optimism bias adjustment	0	13,416	95,198	122,078	
Total PV Costs for appraisal PVc	0	35,775	253,862	325,541	
PV damage PVd	3,584,029				
PV damage avoided		3,584,029	3,584,029	3,584,029	
PV assets Pva					
PV asset protection benefits		0	0	0	
Total PV benefits PVb		3,584,029	3,584,029	3,584,029	
Net Present Value NPV		3,548,254	3,330,167	3,258,488	
Average benefit/cost ratio		100.18	14.12	11.01	
Incremental benefit/cost ratio			0.0	0.0	
		Highest b/c	-	-	

Brief description of options:

Option 1	Do nothing
Option 2	Maintenance of existing structures
Option 3	Raise floodwall (to 3.05m OD) (year 20) / Construct Floodwall (to 3.55m OD) (year 50)
Option 4	Construct new defence to 3.05m OD (year 20) / increase level of frontline defences to 3.55m OD (year 70)

Table 8.14 Project Summary Sheet CHB5.02D

8.3 Annex 3

8.3.1 Construction Costs

8.3.2 Table 8.1: Summary of costs calculated to build / raise flood defences within Christchurch Harbour

8.3.3 Table 8.2: All calculated costs (including detailed breakdown) to build / raise flood defences within Christchurch Harbour

(a) Costings

- Inclusive costings & estimates (supply & place) for all elements of the wall were supplied to NFDC by Dean & Dyball Ltd.
- (Existing estimates of replacement / rebuild costs supplied by the Environment Agency (presented in Appendix E)).
- Quarry waste £30.00 / m3
- Excavation and Deposition on Site £6.00 / m3
- Excavation and removal from site £20.00 / m3
- Sheet Piling £130.00 / m2
- Granular Fill £35.00 / m3
- Concrete £110.00 / m3
- Formwork £40.00 / m2
- Reinforcement £900.00 / tonne (assume 0.15 tons/m3)
- Pre-cast concrete all inclusive £600.00 / m3

Primary Flood Defence - Floodwall

Construct Primary Floodwall

Works	Crest Level m(OD)	Cost per m run	Average Cost per m run
Construct primary floodwall (POURED ON SITE)	2.55	£1,915	£2125
Construct primary floodwall (PRE-CAST)	2.55	£2,335	
Construct primary floodwall (POURED ON SITE)	3.05	£2,023	£2252
Construct primary floodwall (PRE-CAST)	3.05	£2,481	
Construct primary floodwall (POURED ON SITE)	3.55	£2,098	£2362
Construct primary floodwall (PRE-CAST)	3.55	£2,626	

Raise Primary Floodwall

Works	Crest Level m (OD)		Cost per m run
	Original	Raised	
Raise primary floodwall	2.55	3.05	£881
Raise primary floodwall	2.55	3.55	£1062
Raise primary floodwall	3.05	3.55	£692

Secondary Flood Defence - Floodwall

Construct Secondary Floodwall

Works	Design Level m(OD)	Cost per m run	Average Cost per m run
Construct secondary floodwall (POURED ON SITE)	2.55	£1,153	£1366
Construct secondary floodwall (PRE-CAST)	2.55	£1,580	
Construct secondary floodwall (POURED ON SITE)	3.05	£1,377	£1692
Construct secondary floodwall (PRE-CAST)	3.05	£2,009	
Construct secondary floodwall (POURED ON SITE)	3.55	£1,575	£2036
Construct secondary floodwall (PRE-CAST)	3.55	£2,497	

Raise Secondary Floodwall

Works	Crest Level m (OD)		Cost per m run
	Original	Raised	
Raise primary floodwall	2.55	3.05	£777
Raise primary floodwall	2.55	3.55	£1,018
Raise primary floodwall	3.05	3.55	£722

Re-build Secondary Floodwall

Works	Crest Level m (OD)		Cost per m run
	Original	Raised	
Re-build primary floodwall	2.55	3.05	£891
Re-build primary floodwall	2.55	3.55	£1,132
Re-build primary floodwall	3.05	3.55	£737

Secondary Flood Defence - Embankment

Construct Secondary Embankment (4m wide crest)

Works	Design Level m(OD)	Cost per m run
Construct secondary embankment	2.00	£760
Construct secondary embankment	2.55	£992
Construct secondary embankment	3.05	£1,331
Construct secondary embankment	3.55	£1,634

Raise Secondary Embankment (4m wide crest)

Works	Crest Level m (OD)		Cost per m run
	Original	Raised	
Raise secondary embankment	2.00	2.55	£520
Raise secondary embankment	2.00	3.05	£859
Raise secondary embankment	2.00	3.55	£1162
Raise secondary embankment	2.55	3.05	£823
Raise secondary embankment	2.55	3.55	£980
Raise secondary embankment	3.05	3.55	£690

Construct Secondary Embankment (9m wide crest)

Works	Design Level m(OD)	Cost per m run
Construct secondary embankment	3.55	£3,025

Raise Secondary Embankment (9m wide crest)

Works	Crest Level m (OD)		Cost per m run
	Original	Raised	
Raise secondary embankment	2.55	3.05	£1,525
Raise secondary embankment	2.55	3.55	£1,936
Raise secondary embankment	3.05	3.55	£1,646

Table 8.15 Summary of costs calculated to build / raise flood defences within Christchurch Harbour

PRIMARY FLOOD DEFENCES - FLOODWALL

CONSTRUCT PRIMARY FLOODWALL

CONSTRUCT PRIMARY FLOODWALL TO 2.55m OD

(OPTION - 1 CONCRETE FLOODWALL BUILT ON SITE)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.7	110	187
FORMWORK (m2)	6.4	40	256
REINFORCEMENT (m3)	1.7	135	229.5
SHEET PILING (m2)	7	130	910
ADDITIONAL MATERIALS (10% OF TOTAL)			158.25
FEES (10%)			174.075
TOTAL COST (PER METRE RUN)			**1914.825**

(OPTION - 2 PRE-CAST CONCRETE WALL)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.7	600	1020
SHEET PILING (m2)	7	130	910
ADDITIONAL MATERIALS (10% OF TOTAL)			193
FEES (10%)			212.3
TOTAL COST (PER METRE RUN)			**2335.3**

AVERAGE (OPTION 1 & 2)	**2125**

CONSTRUCT PRIMARY FLOODWALL TO 3.05m OD

(OPTION - 1 CONCRETE WALL BUILT ON SITE)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.9	110	209
FORMWORK (m2)	7.4	40	296
REINFORCEMENT (m3)	1.9	135	256.5
SHEET PILING (m2)	7	130	910
ADDITIONAL MATERIALS (10% OF TOTAL)			167.15
FEES (10%)			183.87
TOTAL COST (PER METRE RUN)			**2022.5**

(OPTION - 2 PRE-CAST CONCRETE WALL)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.9	600	1140
SHEET PILING (m2)	7	130	910
ADDITIONAL MATERIALS (10% OF TOTAL)			205
FEES (10%)			225.5
TOTAL COST (PER METRE RUN)			**2481**

AVERAGE (OPTION 1 & 2)	**2252**

CONSTRUCT PRIMARY FLOODWALL TO 3.55m OD

(OPTION - 1 CONCRETE WALL BUILT ON SITE)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	2.1	110	231
FORMWORK (m2)	8.4	40	336
REINFORCEMENT (m3)	1.9	135	256.5
SHEET PILING (m2)	7	130	910
ADDITIONAL MATERIALS (10% OF TOTAL)			173.35
FEES (10%)			190.7
TOTAL COST (PER METRE RUN)			**2098**

(OPTION - 2 PRE-CAST CONCRETE WALL)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	2.1	600	1260
SHEET PILING (m2)	7	130	910
ADDITIONAL MATERIALS (10% OF TOTAL)			217
FEES (10%)			238.7
TOTAL COST (PER METRE RUN)			**2625.7**

AVERAGE (OPTION 1 & 2)	**2362**

RAISE PRIMARY FLOODWALL

RAISE PRIMARY FLOODWALL TO 3.05m OD

(ORIGINAL LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.4	110	154
FORMWORK (m2)	6.5	40	260
REINFORCEMENT (m3)	1.4	135	189
FIXTURES (DOWL BARS) (estimate)			75
EXCAVATION (m3)	2.5	20	50
ADDITIONAL MATERIALS (10% OF TOTAL)			72.8
FEES (10%)			80.08
TOTAL COST (PER METRE RUN)			**880.88**

RAISE PRIMARY FLOODWALL TO 3.55m OD

(ORIGINAL LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.9	110	209
FORMWORK (m2)	7.5	40	300
REINFORCEMENT (m3)	1.9	135	256.5
FIXTURES (DOWL BARS) (estimate)			75
EXCAVATION (m3)	2.5	20	50
ADDITIONAL MATERIALS (10% OF TOTAL)			81.55
FEES (10%)			89.705
TOTAL COST (PER METRE RUN)			**1061.755**

RAISE PRIMARY FLOODWALL TO 3.55m OD

(ORIGINAL LEVEL 3.05m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	0.6	110	66
FORMWORK (m2)	7.5	40	300
REINFORCEMENT (m3)	0.6	135	81
FIXTURES (DOWL BARS) (estimate)			75
EXCAVATION (m3)	2.5	20	50
ADDITIONAL MATERIALS (10% OF TOTAL)			57.2
FEES (10%)			62.92
TOTAL COST (PER METRE RUN)			**692.12**

SECONDARY FLOOD DEFENCES - FLOODWALL

CONSTRUCT SECONDARY FLOODWALL

CONSTRUCT SECONDARY FLOODWALL TO 2.55m OD

(OPTION - 1 CONCRETE WALL BUILT ON SITE)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.67	110	183.7
FORMWORK (m2)	6	40	240
REINFORCEMENT (m3)	1.67	135	225.45
FIXTURES (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	5.2	20	104
ADDITIONAL MATERIALS (10% OF TOTAL)			95.315
FEES (10%)			104.8465
TOTAL COST (PER METRE RUN)			**1153.312**

(OPTION - 2 PRE-CAST CONCRETE WALL)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.67	600	1002
FIXTURES (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	5.2	20	104
ADDITIONAL MATERIALS (10% OF TOTAL)			130.6
FEES (10%)			143.66
TOTAL COST (PER METRE RUN)			**1580.26**

OPTION 1 & 2 AVERAGE	**1366.786**

CONSTRUCT SECONDARY FLOODWALL TO 3.05m OD

(OPTION - 1 CONCRETE WALL BUILT ON SITE)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	2.26	110	248.6
FORMWORK (m2)	7	40	280
REINFORCEMENT (m3)	2.26	135	305.1
FIXTURES (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	5.2	20	104
ADDITIONAL MATERIALS (10% OF TOTAL)			113.77
FEES (10%)			125.147
TOTAL COST (PER METRE RUN)			**1376.617**

(OPTION - 2 PRE-CAST CONCRETE WALL)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	2.26	600	1356
FIXTURES (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	5.2	20	104
ADDITIONAL MATERIALS (10% OF TOTAL)			166
FEES (10%)			182.6
TOTAL COST (PER METRE RUN)			**2008.6**

OPTION 1 & 2 AVERAGE	**1692.609**

CONSTRUCT SECONDARY FLOODWALL TO 3.55m OD

(OPTION - 1 CONCRETE WALL BUILT ON SITE)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	3.05	110	335.5
FORMWORK (m2)	8	40	320
REINFORCEMENT (m3)	3.05	135	411.75
FIXTURES (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	1.7	20	34
ADDITIONAL MATERIALS (10% OF TOTAL)			130.125
FEES (10%)			143.1375
TOTAL COST (PER METRE RUN)			**1574.513**

(OPTION - 2 PRE-CAST CONCRETE WALL)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	3.05	600	1830
FIXTURES (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	1.7	20	34
ADDITIONAL MATERIALS (10% OF TOTAL)			206.4
FEES (10%)			227.04
TOTAL COST (PER METRE RUN)			**2497.44**

OPTION 1 & 2 AVERAGE	**2035.976**

AVON WHARF / AVON ISLAND (BASED ON EA ESTIMATED REPLACEMENT COST)

ELEMENT	cost (£)
CONSTRUCT FLOODWALL TO 2.6M	**1200**

RAISE SECONDARY FLOODWALL

RAISE SECONDARY FLOODWALL TO 3.05m OD

(ORIGINAL LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	0.75	110	82.5
FORMWORK (m2)	5.7	40	228
REINFORCEMENT (m3)	0.75	135	101.25
FIXTURES (DOWEL BARS) (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	1.5	20	30
ADDITIONAL MATERIALS (10% OF TOTAL)			64.175
FEES (10%)			70.5925
TOTAL COST (PER METRE RUN)			**776.5175**

RAISE SECONDARY FLOODWALL TO 3.55m OD

(ORIGINAL LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.4	110	154
FORMWORK (m2)	6.7	40	268
REINFORCEMENT (m3)	1.4	135	189
FIXTURES (DOWEL BARS) (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	1.5	20	30
ADDITIONAL MATERIALS (10% OF TOTAL)			84.1
FEES (10%)			92.51
TOTAL COST (PER METRE RUN)			**1017.61**

RAISE SECONDARY FLOODWALL TO 3.55m OD

(ORIGINAL LEVEL 3.05m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	0.6	110	66
FORMWORK (m2)	6	40	240
REINFORCEMENT (m3)	0.6	135	81
FIXTURES (DOWEL BARS) (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	0.5	20	10
ADDITIONAL MATERIALS (10% OF TOTAL)			59.7
FEES (10%)			65.67
TOTAL COST (PER METRE RUN)			**722.37**

REBUILD SECONDARY FLOODWALL

REBUILD SECONDARY FLOODWALL TO 3.05m OD

(ORIGINAL LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	1.5	110	165
FORMWORK (m2)	5.7	40	228
REINFORCEMENT (m3)	0.75	135	101.25
CONCRETE REMOVAL (m3)	0.75	20	15
FIXTURES (DOWL BARS) (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	1.5	20	30
ADDITIONAL MATERIALS (10% OF TOTAL)			72.425
FEES (10%)			79.6675
TOTAL COST (PER METRE RUN)			**891.3425**

REBUILD SECONDARY FLOODWALL TO 3.55m OD

(ORIGINAL LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	2.12	110	233.2
FORMWORK (m2)	6.7	40	268
REINFORCEMENT (m3)	1.4	135	189
CONCRETE REMOVAL (m3)	0.75	20	15
FIXTURES (DOWL BARS) (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	1.5	20	30
ADDITIONAL MATERIALS (10% OF TOTAL)			93.52
FEES (10%)			102.872
TOTAL COST (PER METRE RUN)			**1131.592**

REBUILD SECONDARY FLOODWALL TO 3.55m OD

(ORIGINAL LEVEL 3.05m OD)

ELEMENT	m2	rate (£)	cost (£)
CONCRETE WALL (m3)	0.6	110	66
FORMWORK (m2)	6	40	240
REINFORCEMENT (m3)	0.6	135	81
CONCRETE REMOVAL (m3)	0.75	20	15
FIXTURES (DOWL BARS) (estimate)			50
STONE CLADDING (estimate)			150
EXCAVATION (m3)	0.5	20	10
ADDITIONAL MATERIALS (10% OF TOTAL)			59.7
FEES (10%)			65.67
TOTAL COST (PER METRE RUN)			**737.37**

SECONDARY FLOOD DEFENCES - EMBANKMENT

CONSTRUCT SECONDARY EMBANKMENT (4m CREST)

CONSTRUCT SECONDARY EMBANKMENT (2m OD / 4m WIDE CREST)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	13	30	390
CLAY	5.96	40	238.4
ADDITIONAL MATERIALS (10% OF TOTAL)			62.84
FEES (10%)			69.124
TOTAL COST (PER METRE RUN)			**760.364**

CONSTRUCT SECONDARY EMBANKMENT (2.55m OD / 4m WIDE CREST)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	18	30	540
CLAY	7	40	280
ADDITIONAL MATERIALS (10% OF TOTAL)			82
FEES (10%)			90.2
TOTAL COST (PER METRE RUN)			**992.2**

CONSTRUCT SECONDARY EMBANKMENT
(3.05m OD / 4m WIDE CREST)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	26	30	780
CLAY	8	40	320
ADDITIONAL MATERIALS (10% OF TOTAL)			110
FEES (10%)			121
TOTAL COST (PER METRE RUN)			**1331**

CONSTRUCT SECONDARY EMBANKMENT
(3.55m OD / 4m WIDE CREST)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	33	30	990
CLAY	9	40	360
ADDITIONAL MATERIALS (10% OF TOTAL)			135
FEES (10%)			148.5
TOTAL COST (PER METRE RUN)			**1633.5**

RAISE LEVEL OF SECONDARY EMBANKMENT
(4m CREST)

RAISE LEVEL OF SECONDARY EMBANKMENT BY 0.5m
(EXISTING CREST LEVEL 2m OD)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	5	30	150
CLAY	7	40	280
ADDITIONAL MATERIALS (10% OF TOTAL)			43
FEES (10%)			47.3
TOTAL COST (PER METRE RUN)			**520.3**

RAISE LEVEL OF EMBANKMENT BY 1m
(EXISTING CREST LEVEL 2m OD)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	13	30	390
CLAY	8	40	320
ADDITIONAL MATERIALS (10% OF TOTAL)			71
FEES (10%)			78.1
TOTAL COST (PER METRE RUN)			**859.1**

RAISE LEVEL OF EMBANKMENT BY 1.5m

(EXISTING CREST LEVEL 2m OD)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	20	30	600
CLAY	9	40	360
ADDITIONAL MATERIALS (10% OF TOTAL)			96
FEES (10%)			105.6
TOTAL COST (PER METRE RUN)			**1161.6**

RAISE LEVEL OF EMBANKMENT BY 0.5m

(EXISTING CREST LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	12	30	360
CLAY	8	40	320
ADDITIONAL MATERIALS (10% OF TOTAL)			68
FEES (10%)			74.8
TOTAL COST (PER METRE RUN)			**822.8**

RAISE LEVEL OF EMBANKMENT BY 1m

(EXISTING CREST LEVEL 2.55m OD)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	15	30	450
CLAY	9	40	360
ADDITIONAL MATERIALS (10% OF TOTAL)			81
FEES (10%)			89.1
TOTAL COST (PER METRE RUN)			**980.1**

RAISE LEVEL OF EMBANKMENT BY 0.5m

(EXISTING CREST LEVEL 3.05m OD)

ELEMENT	m2	rate (£)	cost (£)
QUARRY FILL (m3)	7	30	210
CLAY	9	40	360
ADDITIONAL MATERIALS (10% OF TOTAL)			57
FEES (10%)			62.7
TOTAL COST (PER METRE RUN)			**689.7**

CONSTRUCT SECONDARY EMBANKMENT (9m CREST) TO CARRY HIGHWAY			
CONSTRUCT EMBANKMENT (3.55m OD / 9M WIDE CREST)			
ELEMENT	**m2**	**rate (£)**	**cost (£)**
QUARRY FILL (m3)	50	30	1500
CLAY	11.5	40	460
LAY ASPHALT HIGHWAY	9	60	540
ADDITIONAL MATERIALS (10% OF TOTAL)			250
FEES (10%)			275
TOTAL COST (PER METRE RUN)			**3025**

RAISE SECONDARY EMBANKMENT (9m CREST) INCLUDING RAISING HIGHWAY			
RAISE LEVEL OF EMBANKMENT BY 0.5m			
(EXISTING CREST LEVEL 2.55m OD)			
ELEMENT	**m2**	**rate (£)**	**cost (£)**
QUARRY FILL (m3)	10	30	300
CLAY	10.5	40	420
RE-LAY ASPHALT HIGHWAY	9	60	540
ADDITIONAL MATERIALS (10% OF TOTAL)			126
FEES (10%)			138.6
TOTAL COST (PER METRE RUN)			**1524.6**

RAISE LEVEL OF EMBANKMENT BY 1m			
(EXISTING CREST LEVEL 2.55m OD)			
ELEMENT	**m2**	**rate (£)**	**cost (£)**
QUARRY FILL (m3)	20	30	600
CLAY	11.5	40	460
LAY ASPHALT HIGHWAY	9	60	540
ADDITIONAL MATERIALS (10% OF TOTAL)			160
FEES (10%)			176
TOTAL COST (PER METRE RUN)			**1936**
RAISE EMBANKMENT TO 3.55mOD			
(EXISTING CREST LEVEL 3.05m OD)			
ELEMENT	**m2**	**rate (£)**	**cost (£)**
QUARRY FILL (m3)	12	30	360
CLAY	11.5	40	460
RE-LAY ASPHALT HIGHWAY	9	60	540
ADDITIONAL MATERIALS (10% OF TOTAL)			136
FEES (10%)			149.6
TOTAL COST (PER METRE RUN)			**1645.6**

Table 8.16: Breakdown of costs to build / raise flood defences within Christchurch Harbour

8.4 Annex 4

8.4.1 Property Flood Details per Management Unit Area

The Ground elevation of property (as identified in the flood modelling exercise) for each area within each Management Unit is presented in Annex 4 (contained on accompanying CD). These are property located within the FZ3 flood zone which have a ground elevation which is at or below the 1:200 return period event flood level.

8.5 Annex 5

8.5.1 Summary update of Christchurch CDS

The economic assessments and priority scores previously calculated for the harbour and bay frontages are being reviewed. The harbour assessments are being revised before we can begin to determine the Flood & Coastal Erosion Resilience Partnership Funding contribution estimates to inform Christchurch BC and the CIL process. This has included a review of active and passive defence lengths, number and type of properties, beach nuts, caravan/chalets potentially at risk, depth of flood damage for 2002 and 2102 for each return period water level. The review of economics for the open coast focuses mainly on erosion risk. As previously discussed, it is proposed that once the economic appraisals for both the harbour and open coast have been completed, the Priority Scores will be converted to Resilience Partnership scores.

A sensitivity test has been undertaken to compare the extent of flood risk using UKCIP06 and UKCIP09 sea level rise allowances. Table 8.17 details the mm/year sea level rise rates that have been used, and indicates that when applying the UKCIP09 allowances the flood risk by 2102 would be approx. 2cms less than when using UKCIP06 rates. The UKCIP06 and UKCIP09 allowances were then applied to determine flood risk areas. Figure 8.20 indicates the marginal difference in extent between flood risk areas.

No of years (from 2002 to 2102)	UKCIP06		UKCIP09	
	SW region mm/year	Total mm	mm/year	Total mm
23	0.0035	0.0805	0.004	0.092
30	0.008	0.24	0.007	0.21
30	0.0115	0.345	0.011	0.33
17	0.0145	0.2465	0.015	0.255
Total sea level rise from **2002** to **2102**		0.912		0.887
1:200 year return period water level **2002**		1.99		1.99
Predicted 1:200 year return period water level in **2102**		2.902		2.877

Table 8.17 Sensitivity test between UKCIP06 and UKCIP09

Within the harbour the review and appraisal of flood risk under different sea level rise rates also enables a review of the costs of defence works and number and type of assets potentially at risk from flood risk in the long-term, and a revision of the economic appraisal for the harbour to be undertaken.

The National Property Dataset was then overlain to identify number and location of residential and commercial properties at risk; the analysis resulted in 31 fewer properties deemed at flood risk in 2102 if UKCIP09 rates were applied.

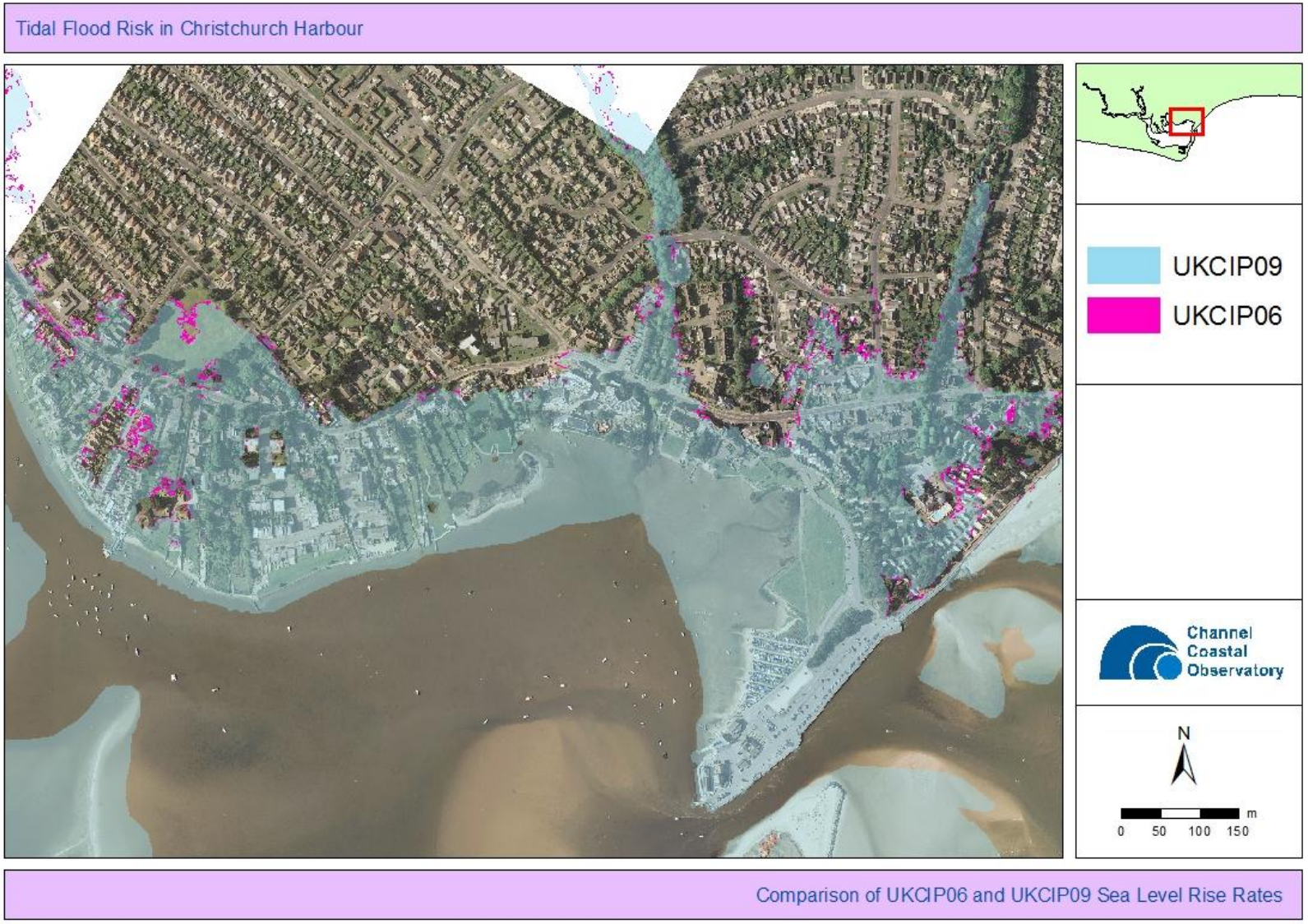

Figure 8.20 Comparison of UKCIP06 and UKCIP09 Sea Level Rise Rates