Bexhill to Hastings Link Road

Flood Risk Assessment

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East Sussex County Council
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0 Summary

0.1.1 East Sussex County Council wishes to promote the construction of a new link road between Bexhill and Hastings to ease congestion on the existing road network. The proposed route was selected following a comprehensive study of various alignments and crosses through two main river catchments; the Egerton Stream and the Combe Haven.

0.1.2 In 2003, Bullen Consultants Ltd (BCL) was appointed to model the two watercourses and evaluate the effects of the new road on extreme water levels. For both models the design condition is the predicted 100year event plus an allowance of 20% extra flow, in accordance with PPG25 (current at the time).

0.1.3 In 2006 and following a review of the initial modelling, Faber Maunsell (now incorporating BCL) was commissioned to carry out further investigations in order to clarify the potential effect that the proposed road could have on various areas.

0.1.4 As part of the studies for the proposed link road, Faber Maunsell was commissioned in March 2007 to carry out a Flood Risk Assessment in accordance with the guidelines set out in Planning Policy Statement 25 (PPS25), issued in December 2006.

0.1.5 This document contains a brief description of the modelling process carried out by Faber Maunsell since 2006 and an assessment of the flood risk associated with the proposed link road.

0.1.6 The sources of flooding analysed and our assessment of the risk they pose is summarised below:

0.2 Watercourses (Egerton Stream and Combe Haven with their tributaries)

0.2.1 Egerton Stream. Our assessment to PPS25 establishes the need to provide a water storage tank with a nominal capacity of 7,250m³. This tank is to be placed underneath the proposed link road by the Bexhill High School site and should provide protection for the design event (100yr + 20%) during the design life of the project (2070). This is further explained in Chapter 9 Section 5 of the Environmental Statement [Appendix B].

0.2.2 Combe Haven. A summary of the main conclusions drawn from our assessment of the Combe Haven catchment is included below and further explained in Chapter 9 Section 5 of the Environmental Statement [Appendix B]:

- The refinement of the model indicated that the Crowhurst Gauging Station creates a lower and upper pond for events with a return period of up to 1 in 50 years but is overtopped during events with a greater return period. A single pond with a maximum water level of 3.11mOD during the design event (100yr+20%) is recorded throughout the lower parts of the catchment.
- The creation of the floodplain branch for the Powdermill following the alignment of the valley line produces an increase in water levels of the order of 50 to 60mm in the lower parts of the catchment during the design event, reaching a level of 3.16mOD. This is as a result of the peaks flows from the main tributaries arriving to the lower parts of the catchment at almost the same time.
- The addition of the road to the model produced no significant changes in water levels throughout the lower parts of the catchment, when mitigating measures such as clear span bridges and large culverts were incorporated. Therefore, it can be concluded that the road does not have a detrimental effect on water levels throughout the river system. Furthermore, according to East Sussex County Council, the total flood storage increases by approximately 31,000m^3 in the design event as a result of the scheme.
- A possible future groundwater control weir could be located just downstream of Filsham Nature Reserve which would raise water levels for the Reserve. A fixed structure could potentially have detrimental effects downstream if it stops flows from backing up to the lower reaches of the Watermill and Powdermill Streams and the Decoy Pond during times of high tide. Alternatively a more sophisticated structure linked to downstream water levels could improve the flood risk to properties in Bulverhythe.
- The removal of Crowhurst Gauging station decreases groundwater levels upstream by up to 100mm during times of low flow. Consequently it is concluded that the gauging station has a significant influence on local groundwater levels.
- A local reduction in water levels occurs when the embankment separating Watermill Stream and its floodplain branch is removed. However, this was only noticeable during low return period events.
- Water levels along the new Powdermill branch are largely governed by the Watermill Stream.
- The extension of the model built to analyse flooding problems in Crowhurst was verified by residents' accounts of previous flooding incidents.
- The culverts through Crowhurst have a maximum capacity to cope with events of between 5 and 10 years return period.
- Banks are overtopped along the upper reaches of the Powdermill and the Rackwell during events with return periods in excess of 2 years.
- The Rackwell has only a minor influence on the flooding situation at Crowhurst and therefore there is no real benefit in making any modifications to this watercourse.

- The preferred flood alleviation option for further possible study for the Crowhurst area was found to be raising bank levels around the most affected area by means of earth bunds and concrete retention walls. To achieve the desired protection banks must be raised by between 250mm and 1m depending on local topography. This option will produce a loss of flood storage of the order of 6000m^3 during the design event which will have to be compensated for upstream on the Powdermill.
- A spillway will be used to reinstate the original Powdermill branch. This spillway will operate during return periods between 2 years and the design event.

0.2.3 The Environment Agency have indicated that they will not object to the proposed link road even if protection of Crowhurst cannot be included as part of the Scheme.

0.2.4 In conclusion, the proposed road will not have a detrimental effect on water levels in the wider floodplain. However, the proposed floodplain branch for the Powdermill will potentially increase water levels, in a localised area due to the more formalised stream channel, by up to 60mm during the design event due to the peaks of the main tributaries of the Combe Haven coinciding. This is a consequence of the reinstatement of the Powdermill to its original course and not due to the road construction.

0.3 Sea

0.3.1 The effects are included as part of the hydraulic modelling of both catchments, as they discharge to the foreshore below Mean High Water level. Sea level rise has been included in accordance with Planning Policy Statement 25 (PPS 25). Tidal flooding is prevented by flap gates on the outfalls and by defences considered by the Environment Agency (EA) to have a Standard of Service in excess of 200years.

0.4 Groundwater

0.4.1 A groundwater monitoring programme was implemented as part of the studies for the proposed link road. A comprehensive description of the groundwater assessment is carried out as part of the Environmental Statement, Chapter 9 Section 4 [Ref 1; Appendix B].

0.4.2 Groundwater survey data for the route is included as Appendix C. The depth to groundwater is predominantly at or very close to the ground surface, especially in low lying ground adjacent to surface water courses.

0.4.3 Nonetheless, the elevations of the Bexhill-Hastings Link Road are higher than ground levels for the entire route as it is to be built on an embankment.

0.4.4 The analysis suggests that if all the necessary prevention measures described in Chapter 9 Section 5 of the Environmental Statement are followed, groundwater is unlikely to pose a risk in terms of flooding to the area

0.5 Runoff

0.5.1 An analysis of the effects of the increase in runoff following construction of the proposed link road was carried out as part of the Environmental Statement.

0.5.2 Our assessment suggests that if runoff is treated as described in Chapter 9 Section 5 of the Environmental Statement, it would not pose a risk in terms of flooding to the proposed link road or surrounding areas.

0.6 Sewers

0.6.1 These are non existent for the majority of the alignment of the proposed link road due to its rural nature. In urban areas (Bexhill and Hastings), it is envisaged that the proposed road drainage would not have a detrimental effect on the existing sewer network.

0.7 Artificial Sources

0.7.1 The only significant artificial sources of flooding are likely to be the proposed flood attenuation ponds. Their design must ensure that populated areas or the road itself are not at risk of flash flooding from this source.

0.7.2 In conclusion, provided all the attenuation measures described in Chapter 9 Section 5 of the Environmental Statement are implemented, the proposed link road is deemed not to increase the risk of flooding in the area and should be able to remain flood-free during the design event.

1 Introduction and Background

1.1 Introduction

1.1.1 Faber Maunsell (FM) was commissioned by East Sussex County Council (ESCC) to undertake an assessment of flood risk in accordance with the Government's Planning Policy Statement 25 Development and Flood Risk (PPS25), published in December 2006, for the proposed Bexhill to Hastings Link Road (BHLR) in East Sussex.

1.1.2 This report provides a flood risk assessment for the proposed road and has been based on:

- A catchment wide analysis of the area;
- Site visits, topographic survey data, LIDAR data and sketches of structures along the main watercourses;
- Consultations with the Environment Agency (EA), ESCC and other key partners in the project;
- Hydrological assessment based on Flood Estimation Handbook (FEH) methodologies;
- Hydraulic modelling assessment using MIKE 11; and
- Investigations carried out for the preparation of the Environmental Statement.

1.1.3 This report provides an analysis of the likely sources of flooding and the risk they pose to the proposed link road and surrounding areas. The sources considered are as detailed below:

1.2 Background

1.2.1 The existing A259 coast road between Bexhill and Hastings is the only major trunk road serving traffic in the east-west direction. It is severely congested and there have been a number of proposals over recent years to improve the road network. The most recent was in the early 1990s when a bypass to Bexhill was designed and taken to public consultation. The preferred route crossed the Combe Haven along the line of a disused railway line and through a Site of Special Scientific Interest (SSSI). The project was proposed by the Highways Agency but was rejected by the Department of the Environment, Transport and the Regions (DETR).

1.2.2 ESCC now wishes to promote the construction of a link road between Bexhill and Hastings to ease congestion on the existing road network by the review of potential route alignments that minimise impacts on the SSSI. Following wide ranging public consultations on 14 potential routes the options were reduced to three options all passing to the north of the SSSI, but through the Combe Haven valley.

1.2.3 Options avoiding the Combe Haven valley were rejected on landscape and visual grounds together with their effect on the village of Crowhurst as described in Chapter 13 Sections 5 and 6 of the Environmental Statement.

1.2.4 In order to investigate the impact of the new proposed road on the hydraulic behaviour of the area Bullen Consultants Limited (BCL) were appointed in December 2003 to construct a series of hydraulic models to investigate flood issues, and investigate water quality issues. In July and September 2004, BCL issued their Hydraulic Modelling and Water Quality Reports respectively.

1.2.5 On review of the initial modelling, Faber Maunsell (now incorporating BCL) was commissioned to carry out further investigations in order to clarify the potential effect that the proposed road could have on various areas. This Flood Risk Assessment comprises the information obtained during the study process and analyses it in accordance with the guidelines set out in PPS25 [Ref 1].

1.3 Study Area

1.3.1 The proposed route of the new link road is shown in Figure 1. It follows the alignment of the Egerton Stream, running approximately north from Bexhill then north-east into the Combe Haven catchment. The Egerton Stream and Combe Haven catchments are shown in Figures 2 and 3. This route was selected following comprehensive studies of various alternatives put forward during the initial stages of the process.

1.3.2 The Egerton Stream is in a highly urbanised area of Bexhill and for long lengths is within a series of culverts. The route of the proposed road is adjacent to, and sometimes over, the stream.

1.3.3 The Combe Haven has a number of significant tributaries. The valley contains a Site of Special Scientific Interest (SSSI), Sites of Nature Conservation Interest (SNCI) and a Local Nature Reserve (LNR). The Combe Haven valley is at potential risk of tidal and fluvial flooding. The risk due to tidal inundation is small as the area is protected to a relatively high standard by tidal flood defences. The area however floods on a regular basis due to fluvial flooding.

1.4 Previous Projects

1.4.1 In 1990 HR Wallingford investigated the effects of a wide range of route alignments, on flood levels in the Combe Haven valley, for the Bexhill Bypass scheme. The analysis concentrated on the 100year return period event and did not include any mitigation measures. Their data have been made available for this study.

1.5 Other Studies

1.5.1 The hydraulic analyses carried out by Faber Maunsell and BCL are only part of the investigations for the scheme. Highway engineering is being carried out by Owen Williams. Overall management of the investigations is by Mott MacDonald on behalf of ESCC.

2 Additional Investigations

2.1 Egerton Stream

Catchment

2.1.1 The Egerton Stream catchment extends over an area of 4.2km^2 and is shown in Figure 2. It is predominantly urban in nature lying almost entirely within the Bexhill development area. Drainage of the area is the responsibility of Southern Water and is naturally divided into 9 sub-catchments, also shown in Figure 2. Sewer records obtained from Southern Water indicate that Bexhill is served largely by a network of foul and combined sewers (both foul and surface water use the same pipes) with a smaller number of surface water sewers. At high stormwater flows excess water is discharged into Egerton Stream via 20 outfalls, 5 from the combined system and 15 from the surface water system. The locations of the outfalls have been taken from the sewer records.

2.1.2 Egerton Stream rises to the north-west of Bexhill in the Sidley area of the town and flows south-east through the gardens of residential properties until it joins the route of the disused and abandoned railway. A secondary tributary joins from the northern end of the catchment along the old railway cutting. It then flows south following the old railway alignment. Adjacent to the school immediately north of the A259, Little Common Road, the stream flows into a culvert, approximately 450m in length and constructed by the Southern Water Authority in the early 1980s. Following this culvert the stream flows along a short stretch of open channel before entering another series of culverts conveying the watercourse a further 1km to an outfall on the foreshore, 50m beyond the seawall. The sea is prevented from flowing up the Egerton Stream by 2No. flapgates in a chamber adjacent to Egerton Park pond.

2.1.3 Egerton Stream is a “Main River” under the Land Drainage Act and is under the jurisdiction of the Environment Agency from its seaward end to the bridge crossing at Woodsgate Park Road. Upstream of the bridge the watercourse is the responsibility of Rother District Council.

Hydrology

2.1.4 The latest method of flood estimation uses a methodology established by the Institute of Hydrology, Wallingford, known as the Flood Estimation Handbook (FEH) [Ref 2]. Data on all the major catchments of England and Wales are provided digitally. In theory the FEH methodology is applicable for rural catchments with an urbanisation of up to 50%. FEH describes the Egerton Stream Catchment to have an urban extent fractionally below 50%, although as stated above, and as shown in Figure 2, it can be seen that the entire catchment is governed by the urban drainage system.

2.1.5 The urban drainage system is the responsibility of Southern Water Plc.

Return Period

2.1.6 The Department for the Environment, Food and Rural Affairs (DEFRA) is the Government Department responsible for overseeing all flood related issues. Their guidance is that generally fluvial floodplains should be considered to be the land affected by a 100year return period event. The Environment Agency therefore currently requires that all new developments must demonstrate that the flood risk to properties in the vicinity of the development must not be increased during the 100year design event.

2.1.7 Planning Policy Statement 25 “Development and Flood Risk” (PPS25) [Ref 1] requires new developments to examine the potential effects of climate change on the flood risk. For schemes affecting fluvial watercourses, such as Egerton Stream, the developer must demonstrate the consequences of a 20% increase in peak flow for the design life of the scheme (2070).

Downstream Control

2.1.8 Water levels within the Egerton Stream are controlled by 2No. 1.4m x 1.8m rectangular flap gates housed in a concrete chamber adjacent to Egerton Park, approximately 160m upstream of the outfall. The outfall discharges onto the foreshore at approximately Ordnance Datum, below the high tide level, and is therefore tide locked for approximately half the tidal cycle. An allowance for sea level rise has been included in accordance with the recommendations of PPS 25.

Structures

2.1.9 There are several minor structures, mostly small pedestrian footbridges, between the origin of the watercourse in the Sidley area and Buxton Road crossing a short distance upstream of the proposed works.

2.1.10 Buxton Road crosses the stream via an embankment at an average level of 16.4mOD. The watercourse runs through a 0.6m diameter, 44m long concrete pipe, which has an invert level of 14.35mOD upstream and 13.40mOD downstream.

2.1.11 A further 30m downstream the watercourse flows through 2No. pipe culverts under what is considered to be the remains of the disused railway embankment. The main culvert is a 0.6m diameter masonry pipe, 19m in length, and has an invert level of 12.65mOD upstream and 12.50mOD downstream. A 0.45m diameter concrete relief culvert runs parallel at an upstream invert of 13.00mOD and discharges at an invert of 12.70mOD.

2.1.12 A footpath crosses the stream behind Honies Court on London Road. The stream flows through a 0.675m diameter clay pipe under an earth embankment at a level of 14.0mOD.

2.1.13 Woodsgate Park Road embankment passes over the stream as it rises to the old railway overbridge, now serving as a pedestrian underpass. The watercourse is maintained through a masonry 1.1m x 1.3m arched culvert which has an upstream invert of 10.69mOD and downstream invert of 9.55mOD. The bank and underpass flooding threshold is approximately 13mOD.

2.1.14 A pedestrian footpath crosses the stream upstream of the Bexhill High School at a level of 10.5mOD. The bridge is of masonry arch construction with a width between the springing of 2.5m and a height to the extrados of approximately 1.3m.

2.1.15 The stream enters a 1.5m diameter, 450m long, concrete pipe culvert at the Chapel Path Footbridge off London Road that discharges into a short length of open channel behind the car park on the Beeching Close Industrial Estate.

2.1.16 The downstream length is culverted from the Industrial Estate to the sea, approximately 900m, except for a very short section of open channel as the watercourse appears on the south side of the railway embankment. The culverts are of various size and form.

2.1.17 The stream discharges onto the foreshore via a 50m long, concrete box outfall at a level of 0.0mOD. Approximately 130m upstream of the seawall, adjacent to Egerton Park, the sea is prevented from flowing upstream by a pair of timber, vertically hung, 1.4m x 1.8m flap gates.

Existing Problems

2.1.18 Discussions with the Environment Agency indicate that there are currently no reported flooding problems due to the Egerton Stream.

2.1.19 At the downstream end of the catchment there are a number of local drainage problems where surface water is unable to discharge into the culverted stream. This leads to localised flooding of gardens and open spaces but no flooding of residential properties.

Available Data

2.1.20 There is no verification data for the Egerton Stream.

2.1.21 The culverts south of Bexhill High School are described on a Southern Water Authority (SWA) drawing, dated 1983, as “proposed” and their capacity at a number of locations is given. Discussions with the Environment Agency, who have taken over responsibility for these structures, indicate that they were probably designed for a 50 year return period event. How the flows were calculated is not known. A comparison between the SWA proposed capacities and our current predictions for a 1 in 100 year return period storm are given in the next section.

2.1.22 Information on the dimensions and character of the flap gates has been obtained from an inspection report by Halcrow, dated July 2003, and from the Environment Agency.

Hydraulic Model

Previous Studies

2.1.23 A MIKE11 hydraulic model was produced by Bullen Consultants Ltd as part of the studies for the proposed link road. Their report [Ref 3] provides a detailed explanation of the modelling process.

Further Studies

2.1.24 Following the publication of the modelling report in July 2004, a series of flood attenuation options were put forward by ESCC and explored by Faber Maunsell using the MIKE11 hydraulic model created by BCL.

Flood Attenuation Options Analysed

2.1.25 In January 2006 and following discussions between the various parties involved in the studies for the proposed link road, it was deemed necessary to explore options to reduce the amount of storage required by the Bexhill High School site.

2.1.26 The following options were modelled:

- Provision of pumps at the downstream end of the catchment
- Reduction of the friction factor applied to the culverts
- Creation of online storage
- Removal of sub-catchments by creating additional storage at sub-catchment level

Provision of Pumps at the Downstream end of the Catchment

2.1.27 The reasoning behind this option was to discharge flows seawards during times of high tide when and if necessary. For this effect, a series of level controlled pumps were placed immediately upstream of the 2No. rectangular flap gates (downstream control).

2.1.28 The pumps produced a reduction in water levels immediately upstream of their location. However, this was relatively insignificant. The conclusion drawn from this process was that the amount of flow that can be pumped out of the river system is limited by the capacity of the existing rectangular culvert (culvert 1) that runs for 450m and originates just downstream of Bexhill High School.

Reduction of the Friction Factor Applied to the Culverts

2.1.29 Even though the values adopted as friction coefficients in the original model appeared to be appropriate, we reduced them significantly to establish the effect on water levels by the school site. The results of the modelling indicated that a maximum reduction of 100mm would be achieved. Therefore, it was concluded that the benefit is not sufficiently significant and investigating this option further is unfeasible.

Creation of Online Storage

2.1.30 For this option the various cross sections in the model between Buxton Drive and the entrance to culvert 1, just downstream of Bexhill High School, were modified to maximise their storage capacity as per land use restrictions. Additionally, a series of weirs were installed in between sections to optimise the use of this increased capacity.

2.1.31 The initial runs showed that a significant reduction in water levels by the school site could be achieved. However upstream of the weirs a considerable increase in water levels was evident and in places this increase meant that water levels were higher than road levels.

2.1.32 The conclusion was that it is not feasible to produce a significant reduction in water levels by the school site without compromising water levels elsewhere within the catchment.

Removal of Sub-catchments by Creating Additional Storage at Sub-catchment Level

2.1.33 The possibility of reducing the flows arriving to Egerton Stream by providing storage areas at sub-catchment level was investigated. For this effect, the various sub-catchments feeding Egerton Stream were removed one at the time to gain a better understanding of their influence on water levels at the school site.

2.1.34 The results showed that the removal of sub-catchment A, to the north-east of the catchment area, produced the biggest reduction (420mm). Preliminary investigations showed it to be impractical to remove this sub-catchment from the system as significant, long term pumping would be required.

Flood Attenuation Proposal

2.1.35 Having analysed the various possibilities for the Bexhill High School site, it was concluded that the most feasible solution to provide the necessary storage is a water storage tank to be situated beneath / adjacent to the proposed link road.

2.1.36 The proposed tank will have a nominal capacity of 7,250m^3 and should be adequate to cope with the demands resulting from climate change during the design life of the project (2070) and the design flow event (100year + 20%).

2.2 Combe Haven

Catchment

2.2.1 The Combe Haven lies to the north-east of Bexhill and to the west of Hastings. Its catchment is predominantly rural in nature and covers an area of 51.5km^2 as shown in Figure 3. The catchment comprises 10 sub-catchments including its tributaries; the Watermill Stream, Powdermill Stream, Decoy Stream, Spring Ditch, Pebsham Stream and Hollington Stream. The contributing areas for the different sub-catchments are given in Figure 3.

2.2.2 Although the Combe Haven is the main river, its tributaries the Watermill and Powdermill Streams are the main contributors of water, with catchment areas of 13.92km^2 and 17.52km^2 respectively, equivalent to approximately 61% of the total. The Powdermill drains the area to the north of the catchment and is the only major tributary with any significant urban settlement; the village of Crowhurst.

2.2.3 Combe Haven drains from the west to east being joined by the Watermill and Powdermill Streams from the north. The Combe Haven is generally cut into the natural valley floor with little, if any, embankments. The Watermill and Powdermill Streams however are both embanked. The Watermill Stream joins from the north-west and runs parallel to the Combe Haven for approximately 700m before its confluence with the Powdermill Stream. They both then flow parallel to the Combe Haven for a distance of a further 100m before their confluence with the Combe Haven at Crowhurst Gauging Weir. The weir, used by the Environment Agency to monitor low flows, retains the tributaries about 1m higher than the natural water level in the Combe Haven. The flood bank between the Watermill/Powdermill Stream and the Combe Haven is at a level of approximately 3.1mOD.

2.2.4 An 18” (460mm) diameter concrete pipe links the flood plains north and south of the Watermill approximately 200m upstream of its confluence with the Powdermill, although it is reported that the pipe is partially blocked.

2.2.5 The Combe Haven flows through a series of small flap gates designed to prevent upstream flow. These are generally not functioning and it is likely that water overtops the structures, flowing overland even under relatively low return period events.

2.2.6 Further east the tributaries of Decoy Stream and Spring Ditch also drain from the north. The outflow from the Decoy Stream exits through a flapgate, preventing water from the Combe Haven flowing upstream under most circumstances. Only in extreme conditions can water overtop the embankment and utilise the Decoy Stream floodplain.

2.2.7 The only tributary from the south/west is Pebsham Stream, with Hollington Stream being the most downstream tributary. The Hollington Stream is principally an urban sub-catchment but is throttled upstream of its confluence with the Combe Haven, restricting its flow to 1.13cumecs.

2.2.8 Large areas of the valley floor are below the level of high tide. The watercourse discharges to the sea at Bulverhythe via an outfall with a tidal flapgate to prevent tidal flooding of the valley. Flows from the stream are therefore restricted to periods of low tide with excess water, during heavy or prolonged rainfall, being stored in the valley.

2.2.9 The most downstream reach, south of the A259 "coast road", is relatively narrow and flows through residential and commercial areas.

2.2.10 All the streams, within the study area, are "Main River" and are therefore subject to the direct jurisdiction of the Environment Agency. Tributaries to the streams, such as Gorringe Stream, are Inland Drainage Board watercourses and also come under the jurisdiction of the Environment Agency, albeit indirectly.

Hydrology

2.2.11 The Combe Haven catchment is much larger than the Egerton Stream catchment; at 51.5km^2 compared to 4.2km^2 respectively, and therefore responds more slowly. The critical storm duration is therefore much longer for the Combe Haven.

2.2.12 The critical storm duration has been calculated, using the Flood Estimation Handbook (FEH), to be of the order of 8½hours (510minutes).

2.2.13 The corresponding hydrographs for the various streams have been calculated by the Flood Studies Method (FSR) produced by the Institute of Hydrology, Wallingford.

Return Period

2.2.14 The Department for the Environment, Food and Rural Affairs (DEFRA) is the Government Department responsible for overseeing all flood related issues. Their guidance is that generally fluvial floodplains should be considered to be the land affected by a 100year return period event. The Environment Agency therefore currently requires that all new developments must demonstrate that the flood risk to properties in the vicinity of the development must not be increased during the 100year design event.

2.2.15 Planning Policy Statement 25 “Development and Flood Risk” (PPS25) [Ref 1] requires new developments to examine the potential effects of climate change on the flood risk. For schemes affecting fluvial watercourses, such as the Combe Haven and tributaries, the developer must demonstrate the consequences of a 20% increase in peak flow for the design life of the scheme (2070).

Downstream Control

2.2.16 The Combe Haven discharges to the sea by gravity at low tide via a short outfall onto the foreshore. The discharge level is approximately –2.1mOD.

2.2.17 The sea is prevented from flowing upstream by two sets of tidal flap gates, near Bulverhythe. The seaward set consists of a pair of gates in series each approximately 3m wide by 2m high, contained in a chamber beneath the promenade. Approximately 100m inland is a pair of gates in parallel each 2m wide by 3m high, beneath the railway.

Structures

2.2.18 Most of the structures on the Combe Haven are located towards the downstream end of the catchment. These include:

- The outfall flap gate
- Flapgates beneath the railway
- Bulverhythe Road bridge
- Sheepwash Bridge on A259

2.2.19 Upstream of the A259 crossing the only significant structures affecting flow in the river system are:

- The flap gate at the confluence of the Decoy Stream and Combe Haven. Backflow from the Combe Haven is prevented by a flapgate during normal events. At high water levels in the Combe Haven the gate is overtopped and the Decoy Stream floodplain is used as storage for the rest of the system.
- The confluence of the Watermill/Powdermill Streams and the Combe Haven is constrained by an Environment Agency gauging weir, Crowhurst Weir. The weir is used to monitor low flows but is submerged at high flows and due to settlement is now unreliable even at low flows. The weir retains water in the Watermill and Powdermill Streams artificially high, by approximately 1m.

2.2.20 Other structures include various farm access bridges and pedestrian bridges on rights of way.

Existing Problems

2.2.21 The Combe Haven floodplain is flooded regularly, every couple of years, to a relatively shallow depth, but no definitive levels are available.

2.2.22 The Hollington Stream passes beneath White Bridge before its confluence with Combe Haven. The A259 at White Bridge, together with adjacent roads and properties, floods regularly. To reduce the effect of flows from Hollington Stream, Hastings Borough Council constructed a throttle on the stream limiting flows into the Combe Haven to 1.13cumecs.

Available Data

2.2.23 Water levels are recorded continuously at Sheepwash Bridge on the Combe Haven, between the tributaries of the Pebsham Stream and Hollington Stream. The maximum recorded flood level here was 2.83mOD in 1960. During the extensive flooding throughout the South-east in 2000/2001 the highest recorded level at Sheepwash Bridge was approximately 2.71mOD in early November 2000.

2.2.24 Information on the dimensions and character of the flap gates has been obtained from an inspection report by Halcrow, dated July 2003, and from the Environment Agency.

2.2.25 The results of an investigation by Hydraulics Research, Wallingford (now HR Wallingford), together with their background data, has been made available to us. Their report [Ref 4] describes the effects on the 100year flood level, for various possible road routes across the valley. Their predicted 100year water level at Sheepwash Bridge was between 2.94mOD and 3.00mOD.

2.2.26 A digital terrain model, obtained from aerial photography, has been made available from ESCC.

2.2.27 The Environment Agency supplied detailed photogrammetry topographic data of the valley below the 5mOD contour at 0.25m intervals.

2.2.28 Results of a topographical survey of the Crowhurst area carried out in 2004.

2.2.29 Topographical data from a survey carried out by Faber Maunsell in July 2006 covering the upper reaches of the Powdermill and including the Rackwell Stream.

Hydraulic Model

Previous Studies

2.2.30 A MIKE11 hydraulic model was produced by Bullen Consultants Ltd as part of the studies for the proposed link road. Their report [Ref 3] provides a detailed explanation of the modelling process.

Further Studies

2.2.31 Following the publication of the modelling report in July 2004, a series of additional investigations have been requested by ESCC and explored by Faber Maunsell using the MIKE11 hydraulic model created by BCL.

2.2.32 The following investigations were carried out:

- Existing Refined: Original model extended and improved
- Design 5: Creation of additional floodplain branch for the Powdermill.
- Design 6: Design 5 with proposed link road included.
- Design 7: Design 6 with Groundwater Control weir.
- Design 8: Cross sections of the Powdermill Stream enlarged
- Design 9: Design 5 but removing embankments
- Design 10: Design 5 with enlarged cross sections
- Design 11: Powdermill stream extended and Rackwell Stream Branch included.

Existing Refined: Original Model Extended and Improved

2.2.33 The objective of this scenario was to refine the original model by reviewing the cross sections and structures along the Powdermill stream using more up-to-date data. Additionally, the Powdermill Stream was extended further upstream.

2.2.34 Finally, a review of the hydrology of the Powdermill catchment was carried out incorporating an inflow from the Rackwell Stream.

2.2.35 The results obtained for this scenario show a single pond being formed throughout the lower parts of the catchment with a maximum water level of 3.11mOD during the design event (100yr+20%). The results also suggest that the Crowhurst Gauging Station creates a lower and upper pond for events with a return period of up to 1 in 50 years. If the pipe described in Section 2.2.4 was working it would reduce the impact of the Crowhurst Gauging Station in creating lower and upper ponds, however we understand this pipe to be currently partially blocked. The effect of the station is, however, negligible during the design event as it is overtopped.

Design 5: Creation of Additional Floodplain Branch for the Powdermill.

2.2.36 The aim of this scenario was to create a floodplain branch for the Powdermill running to the west of the stream. This new branch connects the Powdermill and Watermill following the natural topography (in almost a straight line) while maintaining the current alignment of the Powdermill for low flows to satisfy the needs of farms in the area.

2.2.37 The results obtained for this scenario show an increase in water levels throughout the lower parts of the catchment of the order of 50 to 60mm when compared to the existing scenario during the design event (100yr+20%). This brings the level of this lower area “pond” to between 3.16 and 3.17mOD. This increase is produced as a result of the most direct route provided for the flood flows arriving from the Powdermill sub-catchment through the new floodplain branch.

2.2.38 The timing of the peak flows arriving to the lower part of the catchment from the main tributaries coincide thus raising water levels.

Design 6: Design 5 with Proposed Link Road Included.

2.2.39 The objective of this scenario was to determine the effect that the road has on the Design 5 scenario. For this effect, the same structures used for the BCL model were used at points where the proposed link road crosses the various watercourses.

2.2.40 Two options were studied for the crossing between the proposed link road and the new Powdermill floodplain branch. These involved by means of an irregular shape culvert and via a series of pipes. Following discussions with ESCC and the Environment Agency, it was established that the preferred option is the use of a clear span structure.

2.2.41 The results obtained for this scenario show insignificant changes in water levels throughout the lower parts of the catchment when compared to the Design 5 (without road) scenario during the design event (100yr+20%). Therefore, it can be concluded that the road does not have a detrimental effect on water levels throughout the river system.

Design 7: Design 6 with Groundwater Control Weir.

2.2.42 The purpose of this scenario was to explore the possibility of maintaining relatively high groundwater levels along the middle reaches of the Combe Haven for the benefit of the Filsham Local

Nature Reserve. For this effect, a weir was added to the lower reaches of the Combe Haven, just downstream of the Nature Reserve.

2.2.43 The results of the modelling process indicate that the weir raises water levels upstream, as desired, but potentially could have a detrimental effect downstream if it stops flows from backing up to the lower reaches of the Watermill and Powdermill Streams and the Decoy Pond during times of high tide. A variable height weir linked to downstream water levels could however negate the adverse effects of a fixed structure and improve the flood risk to properties in Bulverhythe. This would require further investigation.

2.2.44 Additionally, a comparison of the length of time that it would take the system to get back to normal following a storm event was made between the Design 5, 6 and 7 scenarios. The following table summarises the results of this analysis.

Table 1: Length of Normalisation Time Following a Storm Event

Scenario	2 Year Return Period	50 year Return Period
Design 5	14 days	5 to 6 weeks
Design 6	21 days	6 to 7 weeks
Design 7	30 days	6 to 8 weeks

2.2.45 Finally, it was deemed necessary to establish the effect that the Crowhurst Gauging Station had on groundwater levels. This was achieved by running a long duration base flow only regime with and without the Gauging Station. The results of the modelling process showed that the groundwater level ranges between 1.52 and 1.92 for the "without" scenario. This is 0.1m lower than the "with" scenario. A minor reduction is also noticed along the Combe Haven when the Gauging Station is removed.

Design 8: Cross Sections of the Powdermill Stream Enlarged.

2.2.46 This scenario looked at the effect of widening the existing Powdermill branch downstream of Crowhurst culvert. The enlargement of the sections involved widening of the channel and deepening the bed by 100mm.

2.2.47 The results showed a reduction in the overtopping at the Powdermill branch, as expected. It was also noticed that the existing bund between the Watermill Stream and the Watermill left floodplain was creating a division (a lower and a higher part) during most storm events. Constant supervision of the bund would be required to maintain this division which was considered impractical by the key stakeholders as the objective is to create a system as maintenance-free as possible.

2.2.48 A new set of runs was carried out to account for the removal of this bund. The results showed that a single "pond" was created in the lower reaches of the Watermill, Powdermill floodplain and Watermill floodplain for most return periods.

Design 9: Design 5 but Removing Embankments

2.2.49 Following discussions with ESCC, it was deemed necessary to investigate the effect of a breach in the embankment separating Watermill Stream and its floodplain branch.

2.2.50 The results showed that water levels would be reduced locally during relatively low return period events but no significant change in water levels was recorded for the design event.

Design 10: Design 5 with Enlarged Cross Sections

2.2.51 This scenario was created to estimate the cross section required along the new branch of the Powdermill to contain events with a return period of up to 1 in 20 years.

2.2.52 The analysis of the results showed that water levels along the new branch of the Powdermill are largely governed by the Watermill and it was concluded that it would be impractical to raise the banks to contain the spilling.

Design 11: Powdermill Stream Extended and Rackwell Stream Branch Included.

2.2.53 This scenario was created to attain a better understanding of the flooding problems at Crowhurst and test various flood alleviation options for this part of the catchment.

2.2.54 New topographical information was added to the model following the survey carried out by Faber Maunsell in July 2006. This data enabled the creation of a new branch "Rackwell Stream" and the extension upstream of the existing Powdermill Stream branch.

2.2.55 The hydrology of the Powdermill Stream catchment was reviewed as a result of these modifications in accordance with the current best practice.

2.2.56 A series of floodplain branches were also created for the upstream section of the Powdermill and for the Rackwell Stream.

2.2.57 Once the model for this part of the catchment was completed, it was calibrated by comparing the results obtained with residents' accounts of flooding events in the area. It was found that the results of the model for various return periods matched the description provided thus validating to certain extent the new section of the MIKE 11 model.

2.2.58 The conclusions drawn from the Crowhurst area under the existing scenario are summarised below:

Powdermill (Upstream Post Office's Culvert)

2.2.59 River banks along this stretch of the Powdermill are generally overtopped during the 5yr return period event. However, some localised flooding is identified during the 2 year event; particularly in the area immediately upstream of the culvert.

2.2.60 The Post Office's culvert is unable to cope with a 10 year return period. Therefore, its capacity is between 5 and 10 years.

Powdermill (Between Post Office's Culvert and Crowhurst Culvert)

2.2.61 Banks are generally overtopped from midway between the two culverts to the downstream culvert during a 5 year event. However, localised flooding is noticed in the area between the Rackwell – Powdermill confluence and the downstream culvert during the 2 year event.

2.2.62 Crowhurst culvert also has a capacity of between 5 and 10 years.

2.2.63 The stretch of the Powdermill stream immediately downstream from the Post Office's culvert is overtopped during 20yr storm events or higher.

Rackwell Stream

2.2.64 The downstream part of the Rackwell which has a southwards flow shows general overtopping of the banks during a 5 year event. This is reduced to 2 years for the area immediately upstream of the confluence with the Powdermill.

2.2.65 The upstream part of the Rackwell which has a south-eastwards flow shows overtopping of the banks during the 10 year event and above.

2.2.66 Figure 4 shows the flooding mechanism under the existing scenario at Crowhurst.

2.2.67 Once the existing flooding situation at Crowhurst was identified, a series of options were investigated to establish the most appropriate alternative to attenuate the flooding problems in the area. These options are shown in the table below.

Table 2: Flood Alleviation Options Analysed for the Crowhurst Area

Option	Proposal
Option 1	Bund d/s end Powdermill Stream around the back garden of houses
Option 2	Weir u/s Rackwell Stream
Option 3	Weir u/s Powdermill Stream
Option 4	Widened sections u/s Post Office's culvert
Option 1+2	Bund d/s end Powdermill around back garden houses and weir u/s Rackwell
Option 1+3	Bund d/s end Powdermill around back garden houses and weir u/s Powdermill
Option 2+3	Weir u/s Powdermill and weir u/s Rackwell
Option 3+4	Weir u/s Powdermill and widened sections u/s Post office's culvert
Option 5	Weir u/s Powdermill and bund around it
Option 6	Culvert and weir u/s Powdermill

2.2.68 The results of the modelling showed that there was no real benefit to the most affected area (u/s of Crowhurst culvert) in constricting the flow at the upstream ends of the Powdermill (u/s of the Post Office’s culvert) or Rackwell (existing embankment). It was also noticed that the influence of the Rackwell is relatively insignificant when compared with the effect that the Powdermill has on the system. Therefore, there is no real benefit in making any modifications to the Rackwell.

2.2.69 There was some local benefit in widening the Powdermill channel upstream of the Post Office’s culvert; however, this has no real effect on water levels upstream of Crowhurst culvert.

2.2.70 The recommended option, No. 1, is to raise bank levels around the most affected area by building earth bunds. There is also a relatively low area to the west of Crowhurst culvert which will require a concrete structure to provide the desired protection to the property in which it lies as the building is very close to the stream at this point.

2.2.71 The amount by which the banks must be raised to provide the desired protection (1 in 100yr + 20%) ranges from around 250mm to about 1 metre depending on the local topography.

2.2.72 As a result of the construction of this protection bund/wall, the loss of flood storage during a design event (1 in 100years + 20%) will be of the order of 6000m^3.

2.2.73 During a meeting held in the Environment Agency's offices in Worthing on 30th October 2006, the EA confirmed that they would not object to the proposed link road on the grounds that Crowhurst could not be protected as part of the scheme.

Flood Attenuation Proposal

2.2.74 Having analysed the various possibilities for the catchment, the consensus of the key stakeholders was towards returning the Powdermill to its original course, following the valley line. The existing course is to be maintained for ecological and drainage reasons but will be limited primarily to base flows with the majority of flood flow being directed towards the reinstated floodplain branch. The crossing of the proposed link road through the reinstated branch was modelled by Faber Maunsell assessing 3 No. 2.5m diameter pipes. However, the EA has requested a clear span bridge as it would provide greater capacity and ecological advantages.

2.2.75 The modelling process showed insignificant changes in water levels as a result of the proposed link road during the design life of the project (2070) and the design event (100year + 20%).

2.2.76 The original Powdermill course will be reinstated by means of a spillway which will operate during events with a return period greater than 2 years (Water level >5.0mOD) and will cope with events with return periods of up to 1 in 100years + 20% (Water level 5.8mOD approx)

2.2.77 The proposed spillway is to be located approximately 265m downstream of Crowhurst culvert as shown in Figure 5.

2.3 Groundwater

2.3.1 Groundwater in the area constitutes an important source of baseflow to the streams and to the man-made drainage channels in low lying areas. The depth to groundwater is predominantly at or very close to the ground surface, especially in low lying ground adjacent to surface watercourses.

2.3.2 A groundwater monitoring programme was implemented as part of the studies for the proposed link road. Figure 6 shows the locations where groundwater monitoring was implemented. Details of the studies carried out in this field are included in Chapter 9 Section 4 of the Environmental Statement document prepared for the project [Ref 1, see also Appendix B]. However, the conclusions of this study are included below:

- The road would have little or no impact on groundwater resources.
- The road would have little or no impact on groundwater quality.
- The site is not in a sensitive location with respect to groundwater and the Scheme would undergo comprehensive mitigation measures during both the construction and operational phases.

2.3.3 Therefore, it is concluded that groundwater is unlikely to pose a risk in terms of flooding to the road or its vicinity.

3 Flood Risk to the Site

3.1 Historical Flooding

3.1.1 The Combe Haven floodplain floods regularly, every couple of years, to a relatively shallow depth. Farmland is mostly affected by the flooding but it has also flooded some residential properties over the years, mainly in the Bulverhythe area. This flooding is as a result of the Combe Haven overtopping its banks due to tide locking.

3.1.2 Discussions with the EA suggest that there are currently no reported property flooding problems due to the Egerton Stream. A number of local drainage problems leading to localised flooding of gardens and open spaces have been identified at the downstream end of Egerton Stream.

3.2 Existing Flood Risk

Flooding from Rivers and Sea

3.2.1 The area identified for the construction of the proposed link road is formed by zones with varying level of flood risk, as shown in Figure 7. However, as the proposed alignment will cut across various main rivers, it must be deemed to be within flood zone 3b “functional floodplain”.

3.2.2 The functional floodplain is identified as the area which would flood with an annual probability of 1 in 20 (5%) or greater in any given year irrespective of any flood defences.

3.2.3 Figure 8 shows the current design event (100year + 20%) outline for the Combe Haven catchment.

3.2.4 A table showing maximum predicted water levels along the intended route of the Link Road, for both pre- and post-development scenarios, is included as Appendix D.

3.2.5 The approved draft of Hastings Borough Council Strategic Flood Risk Assessment indicates that overtopping occurs in the Bulverhythe area. Nonetheless, the area affected is sufficiently far from the route of the road that overtopping is not considered a flood risk to the area.

Flooding from Land

3.2.6 The area is largely permeable and generally used for farming purposes.

3.2.7 There are a number of relatively steep slopes in the area that could potentially bring about flash overland flooding. A number of properties in Crowhurst flood on a regular basis.

3.2.8 Ground conditions suggest that a soil with medium infiltration potential is predominant in the area (Soil Type 3 – Winter Rainfall Acceptance Potential Map), see Figure 9.

Flooding from Groundwater

3.2.9 The depth to groundwater is predominantly at or very close to the ground surface, especially in low lying ground adjacent to surface watercourses. However, there are no records of flooding incidents due to groundwater in the area.

3.2.10 It can be concluded that the existing risk of flooding due to groundwater along the proposed alignment of the link road is generally low with the exception of low lying areas in close proximity to watercourses.

Flooding from Sewers

3.2.11 The majority of the proposed link road would cross rural areas currently used for farming purposes and consequently with no sewer networks in the area.

3.2.12 Outfalls from the sewer network in Bexhill discharge to the Egerton Stream in times of high rainfall.

Flooding from Reservoirs, Canals and Artificial Sources

3.2.13 No significant artificial sources have been identified in the area. Therefore the risk of flooding posed by these sources is deemed to be insignificant.

3.3 Post-Development Flood Risk

Flooding from Rivers and Sea

3.3.1 The proposed link road crosses areas identified as functional floodplain (Flood zone 3b). PPS25 establishes that essential transport infrastructure is appropriate for this flood zone provided the exception test is passed (see Section 5 Table 5). The sequential and exception tests for the proposed link road are included in Section 5.

3.3.2 The hydraulic modelling carried out shows that the addition of the road would produce no significant changes in water levels along the Combe Haven and its tributaries. However, the proposed floodplain branch for the Powdermill will potentially increase water levels locally by up to 60mm during the design event (100yr + 20%). This is due to the reinstatement of the river, during flood events, to its former course. Figure 10 shows the design event post-development outline for the Combe Haven catchment.

3.3.3 A water storage tank will be required underneath the proposed link road by the Bexhill High School site to provide protection from flooding from the Egerton Stream. This tank will have a nominal capacity of 7,250m^3 and will protect against the design event (100yr + 20%) during the design life of the project (2070). Flood modelling of the post-development outline for the Egerton Stream catchment, revealed that the Egerton Stream does not over top the bank for the design event (100yr + 20%)

3.3.4 In conclusion, the proposed road will not have a detrimental effect on water levels. However, it is essential that the proposed flood storage attenuation works are incorporated into the scheme to ensure the level of flood risk remains manageable. Details of these proposals are included in Chapter 9 Section 5 of the Environmental Statement [Appendix B].

Flooding from Land

3.3.5 It is envisaged that rainfall runoff will increase as a result of the construction of the link road. The entire runoff from the road, approximately 3,000m^3 (design event), would be treated before it is discharged into the local watercourses. Details are provided in Chapter 9 Section 5 of the Environmental Statement.

3.3.6 It is proposed that reed beds and balancing ponds would provide flood compensation in the flood plains. This attenuation would be larger than the necessary volume for road drainage purposes, as described in Chapter 9 Section 5 of the Environmental Statement.

3.3.7 Chapter 3B Section 3 of the Environmental Statement [Ref 6] details the proposed stages of incremental drainage measures for each catchment to attenuate and treat highway runoff [see Figures 3B.2 and 3B.4]. This includes kerbs and gullies (in the urban areas) or grassed swales (for rural sections), followed by carrier drains, sediment traps, by-pass petrol interceptors, and bunded earth embanked dissipation basins with reed-beds and sediment traps. A storage tank is also proposed for Egerton Stream to reduce discharge rate but would also have some pollutant attenuation benefits.

3.3.8 Therefore, it is concluded that if runoff is treated as described in Chapter 9 Section 5 of the Environmental Statement, it would not pose a risk in terms of flooding to the proposed link road or surrounding areas.

3.3.9 Additionally, it is not envisaged that steep slopes would be constructed as a result of the proposed link road. Therefore the risk of flash overland flooding is likely to remain unchanged.

Flooding from Groundwater

3.3.10 A groundwater monitoring programme was implemented as part of the studies for the proposed link road. A comprehensive description of the groundwater assessment is carried out as part of the Environmental Statement.

3.3.11 The analysis suggests that if all the necessary prevention measures described in Chapter 9 Section 5 of the Environmental Statement are followed, groundwater is unlikely to pose a risk in terms of flooding to the area.

Flooding from Sewers

3.3.12 The majority of the proposed link road would cross rural areas currently used for farming purposes and consequently with no sewer networks in the area.

3.3.13 On the other hand, the relatively small section of the proposed link road alongside the Egerton Stream in Bexhill would cross the path of sewer networks and the flows from the outfalls will need to be accommodated.

3.3.14 It is envisaged that the proposed road drainage would not have a detrimental effect on the existing sewer network in urban areas while providing a natural and sustainable approach in rural areas. Details of these proposals can be found in Chapter 9 Section 5 of the Environmental Statement. The two systems will be separate with no interconnection.

Flooding from Reservoirs, Canals and Artificial Sources

3.3.15 The flood attenuation ponds are located at a lower level than the road and not in the vicinity of any populated areas. Any breach in the bund surrounding the ponds will therefore not place any populated area or the road itself at risk of flash flooding.

3.3.16 No other significant artificial sources have been identified in the area.

4 Attenuation Measures

4.1 Managing Surface Water

4.1.1 Flooding can result both from sources external to the development site and from rain falling onto and around the site. PPS25 identifies the need for sustainable management of this rainfall (surface water), as an essential element of reducing future flood risk to both the site and its surroundings

4.1.2 The proposed route of the Link Road consists of predominantly undeveloped land; relying on natural drainage to convey or absorb rainfall with water either soaking into the ground or flowing across the surface into watercourses and existing ponds. The proposals will involve a significant reduction in the permeability of land along the route of the new Link Road. Specific measures should be taken to ensure the volume of water that runs off the site and the peak run-off flow rate does not increase following the construction of the road.

4.1.3 To satisfactorily manage flood risk in new development, appropriate surface water drainage arrangements are required. Surface water arising from the proposals should, as far as is practicable, be managed in a sustainable manner to mimic the existing drainage regime. In order to address the issue of sustainable management of surface water from the site, Owen Williams Consultants was commissioned to investigate Surface Water Drainage and Sustainable Drainage Systems for the Bexhill to Hastings Link Road.

4.2 Sustainable Drainage Systems (SUDS)

4.2.1 In May 2006, Owen Williams Consultants carried out a Preliminary Drainage Design as part of the scheme. A brief summary of the different SUDS techniques to be employed in the scheme is presented below, whilst a more detailed description is given in Chapter 9 Section 5 of the Environmental Statement [Appendix B].

4.2.2 *Grass Swales*. The term swale refers to a series of vegetated, open channel practices that are designed specifically to treat and attenuate storm water runoff for a specified water quality volume. As storm water runoff flows through the channels, it is filtered by the vegetation in the channel and thus treated; filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales are well-suited to treat highway runoff because of their linear nature, and are often installed as part of a drainage network connecting to a pond or wetland, prior to discharge to a natural watercourse.

4.2.3 *Retention Ponds*. Ponds can be designed to accommodate considerable variations in water levels during storms, thereby enhancing flood-storage capacity. These would create habitats attractive to wildlife and thus enhance the environmental and visual amenity value of the scheme. Ponds can be fed by swales which will also be adopted for the development.

4.2.4 *Petrol Interceptor*. Although not a type of SUDS, petrol interceptors are nonetheless to be incorporated into the proposed drainage system. A petrol interceptor is a trap installed on a surface water drainage system used to filter out hydrocarbon pollutants from rainwater runoff. It is typically used in road construction to prevent fuel contamination of streams carrying away the runoff.

4.2.5 A detailed assessment of the SUDS identified for use in the Bexhill to Hastings Link Road, with accompanying calculations as carried out by Owen Williams Consultants, is included as Appendix E.

4.3 Flood Water Storage

4.3.1 Flood water storage capacity within the scheme boundary, as calculated by ESCC, indicates the flood water storage capacity of the catchment increases as a result of the scheme. This is due to the incorporation of mitigating measures, including clear span bridges and large culverts, into the design of the BHLR together with extensive landscaping, including lakes and washlands. Details of the flood water storage are provided in Table 3 below.

Table 3: Flood Water Storage (source: ESCC)

Water Level (mAOD)	**Existing Condition (m^3)**	**With-road Condition (m^3)**	**Increase (m^3)**
2.00	17,695	26,171	8,476
2.10	52,074	67,838	15,764
2.20	88,539	110,513	21,974
2.30	127,118	154,228	27,110
2.40	167,841	199,017	31,176
2.50	210,735	244,910	34,175
2.60	259,904	293,716	33,812

Water Level (mAOD)	Existing Condition (m^3)	With-road Condition (m^3)	Increase (m^3)
2.70	310,861	343,286	32,425
2.80	363,698	393,626	29,928
2.90	418,782	445,717	26,935
3.00	476,133	499,832	23,699
3.10	537,576	556,956	19,380
3.17 (Design Event)	**581,909**	**597,715**	15,806

4.3.2 In addition to the 15,800m^3 of additional flood storage generated during the design event (100 yr +20%), an estimated further 15,300m^3 of additional storage is provided by the Combe Haven Ponds. The total flood storage following the construction of the BHLR scheme therefore represents an increase in storage of approximately 31,100m^3 against existing conditions. Refer to Chapter 9 Section 5 of the Environmental Statement for more information [Appendix B]

5 Strategic Assessment of Flood Risk

5.1.1 PPS25 incorporates flood risk into the planning process. This is done by adopting a sequential risk-based approach when determining the suitability of land for development in flood risk areas. The aim of the sequential approach is to establish acceptable uses of the land for the various flood risk zones identified and direct new development away from the areas deemed at most risk in a sequential approach.

5.2 The Sequential and Exception Test

The Sequential Test

5.2.1 PPS25 makes emphasis on the analysis of flood risk at the early stage of planning applications. To facilitate the demonstration of the application of this test to new developments, a series of questions summarised in the following table must be answered.

Table 4: EA Checklist for the demonstration of the application of the Sequential Test to planning applications

Question	Answer Yes/No	Sequential Test – passed or failed?
1. Is this application consistent in scale, development type and location, with a site allocation that has already been sequentially tested and included in the Local Development Document (LDD)?	If yes, state which allocation and the location in the development plan. **If the answer is 'No' go to Question 2.**	If the answer is 'Yes' the Sequential Test has been passed - FINISH HERE
2. Does the application site fall within an area identified for 'windfall' development that has been agreed as part of the LDD in association with a Strategic Flood Risk Assessment (SFRA)?	If yes, state the location in the LDD. **If the answer is 'No' or there are no such areas identified in the LDD, go to Question 3.**	If the answer is 'Yes' the Sequential Test has been passed – FINISH HERE

Question	Answer Yes/No	Sequential Test – passed or failed?
3. Do the LDD or background documents contain reasonably available, alternative site allocations that are situated in a lower flood risk zone?	If yes, state which allocation(s) and the location in the development plan. **If the answer is 'No' go to Question 4.**	If the answer is 'Yes' the Sequential Test has been passed – FINISH HERE
4. Does the development plan or background documents contain reasonably available, alternative site allocations that are within the same Flood Zone and subject to a lower probability of flooding *from all sources* as detailed by the SFRA?	If yes, state which allocation(s) and the location in the development plan.	**If the answer is 'No' to Questions 3 and 4 the Sequential Test has been passed.** **If the answer is 'Yes' to Question 4, the Sequential Test has been failed – FINISH HERE**

Answers:

5.2.2 1. NO, the Local Development Frameworks for Rother District Council and Hastings Borough Council are currently being prepared. However, it is envisaged that this will be the only development of its kind in the area.

5.2.3 2. NO, this proposal has been identified as necessary by East Sussex County Council and a significant amount of time and effort has been put into selecting the best option. Additionally, the Strategic Flood Risk Assessments for Rother District Council and Hastings Borough Council are being prepared and therefore are not available for this process.

5.2.4 3. NO, following a detailed analysis of various possible alignments, the preferred route was selected. Due to the number of watercourses in the area, it would not be feasible to produce a link road scheme that does not fall within flood zone 3b (functional floodplain).

5.2.5 4. NO, the preferred route has been selected following a detailed analysis of a number of factors including flood risk.

5.2.6 In conclusion, the sequential test has been passed and the flood risk vulnerability and Flood Zone compatibility can now be examined.

Flood Risk Vulnerability and Flood Zone Compatibility

5.2.7 The proposed link road crosses flood zone 3b (functional floodplain), and falls into the essential infrastructure classification of PPS25.

5.2.8 The following table shows the compatibility of land uses with the various flood zones and the requirements to satisfy the planning process.

Table 5: Flood Risk Vulnerability and Flood Zone Compatibility (*source PPS25, Table D.3*)

Flood Risk Vulnerability classification*		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone**	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b 'Functional Floodplain'	Exception Test required	✓	×	×	×

Key:
✓ Development is appropriate
× Development should not be permitted
*Refer to PPS25 Table D.2
**Refer to PPS25 Table D.1

5.2.9 The construction of essential infrastructure within the functional floodplain requires further analysis by means of the application of the exception test, as described below.

The Exception Test

5.2.10 In exceptional situations, there may be well-founded reasons for a development type which is not entirely compatible with the level of flood risk at a particular site to nevertheless be considered. In these circumstances, it will be necessary for the Local Planning Authority or developer to demonstrate that the site qualifies for development in the manner proposed by passing all elements of the Exception Test.

5.2.11 The Exception Test should only be applied following application of the Sequential Test. There are three rigorous conditions, all of which must be fulfilled before the Exception Test can be passed. These conditions are as follows:

a) "it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the Local Development Document (LDD has reached the 'submission' stage [see Figure 4.1 of PPS12: Local Development Frameworks – Ref 7] the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal (SA) [see also PPS1: Delivering sustainable Development – Ref 8] ;

b) the development must be on developable (as defined in PPS3: Housing) previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land; and

c) a site-specific Flood Risk Assessment must demonstrate that the development will be safe, "without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall".

5.2.12 When considering part a) of the test, if a planning application fails to score favourably against the aims and objectives of the Sustainability Appraisal, the Local Planning Authority should consider whether the use of planning conditions and/or Section 106 Agreements of the Town and Country Planning Act, 1990, could make it do so. Where this is not possible the Exception Test has not been satisfied and planning permission should be refused.

5.2.13 In the absence of a Sustainability Appraisal, the developer/Local Planning Authority will have to provide a sound justification explaining in detail how the planning application provides wider sustainability benefits to the community that outweigh flood risk. Local Planning Authorities may consider the use of a sustainability checklist for this purpose.

5.2.14 Assistance on the consideration of part b) of the test can be found within Planning Policy Statement 3: Housing.

5.2.15 With regard to part c) it is the responsibility of the developer to propose a comprehensive flood risk management strategy for the site.

Exception Test Part a) - Sustainability

5.2.16 It is deemed that the proposed link road will provide significant sustainability benefits to the wider community without having a noticeable detrimental effect in terms of flood risk thus satisfying part a) of the Exception test.

5.2.17 This aspect of the project is discussed in Chapter 8 of the Project Sustainability Appraisal Report, part of the Environmental Statement [Ref 9]. Further information indicating the need for the scheme is provided in Chapter 2 Section 3 of the Environmental Statement [Ref 10].

Exception Test Part b) - Land

5.2.18 Due to the nature of the project, there is no alternative previously developed land that could be used and the preferred alignment is deemed to provide the best alternative in terms of land use. Therefore, it is concluded that the proposed link road satisfies part b) of the exception test. For more information please refer to Chapter 3 of the Project Sustainability Appraisal Report, part of the Environmental Statement [Ref 11].

Exception Test Part c) – Flood Risk Assessment

5.2.19 This FRA complies with the requirements set out in PPS25, and addresses the issues of safety and flood risk.

5.2.20 In conclusion, the Exception Test has been passed as all three conditions of the Test have been fulfilled.

5.3 Strategic Flood Risk Assessment (SFRA)

5.3.1 SFRAs provide valuable information in terms of flood risk at a strategic level. The SFRAs for Rother District Council and Hastings Borough Council (local Planning Authorities) are currently being undertaken and therefore the final drafts of these documents were not available for this study. Nonetheless, Faber Maunsell is responsible for the production of the Hastings SFRA and has been involved in the early development stage of the North East Bexhill Development and as such, knowledge gained from these two projects was incorporated into the current FRA.

5.4 Residual Risk of Flooding

5.4.1 Residual risk is defined as the risk which remains after all risk avoidance, reduction and mitigation measures have been implemented. A brief assessment of the residual risk of flooding at the site is given below:

5.4.2 *Flood Risk from Tidal Breach*. The residual flood risk from this source is deemed to be low. The lowest elevation of the new road will be

5.75mAOD. This elevation is higher than the currently predicted 1000 year return period sea level. It also exceeds the 20 year return period sea level in 2070, taking predicted climate change into account – see Table 6.

Table 6: Predicted Sea Levels for Hastings

	Predicted Water Levels (mAOD)			
Return	**2007**	**2060**	**2070**	**2115**
20 years	5.2	5.6	5.7	6.4
200 years	5.4	5.8	5.9	6.6
1000 years	5.6	6.0	6.1	6.8

5.4.3 Whilst the maximum predicted water levels with sea level rise for higher return periods are higher than the lowest level of the road, the location of the road is well inland and brief periods of tidal breach are not expected to place the BHLR at flood risk.

5.4.4 *Flood Risk from Overtopping*. Whilst overtopping is a problem in the Bulverhythe area (that will worsen with sea level rise), the route of the BHLR is sufficiently far inland that the flood risk to the BHLR from overtopping is deemed to be low.

5.4.5 *Flood Risk from the Extreme Fluvial Flood (1 in 1000years)*. The modelled water levels for the extreme flood event are shown in Appendix D. The average water level during the extreme flood at the various locations where the road crosses the floodplain is 3.87mAOD. The water levels for the extreme flood event are thus significantly lower than the lowest level of the BHLR (5.75mAOD). The residual flood risk from the extreme flood is therefore deemed to be low.

5.5 Escape Route in Times of Flooding.

5.5.1 The new road will improve the emergency access and egress routes between Bexhill and Hastings during times of flooding. The lowest elevation of the road will be 5.75mAOD, which is higher than the 1 in 1000 year sea level (5.6mAOD in 2007) and the 1 in 1000 year fluvial water level (3.87mAOD where the road crosses the floodplain). The lowest elevation of the road is also higher than the 1 in 20 year sea level for the 2070 projection and only slightly below the 1 in 200 year sea level for 2070.

6 References

Ref 1: Environmental Statement for Bexhill to Hastings Link Road, Chapter 9 Section 4 Water Quality and Drainage, Mott MacDonald, April 2007.

Ref 2: Planning Policy Statement 25 "Development and Flood Risk" (PPS25), the Office for Communities and Local Government (the former Office of the Deputy Prime Minister), December 2006.

Ref 3: Flood Estimation Handbook, Institute of Hydrology, 1999.

Ref 4: Bexhill to Hastings Link Road – Hydraulic Modelling, Bullen Consultants Ltd, Report 103C028/01/A, July 2004.

Ref 5: A259 Bexhill and Hastings Western Bypass – Effect on Flood Levels in the Combe Haven Valley, Hydraulics Research, Wallingford (now HR Wallingford), March 1990

Ref 6: Environmental Statement for Bexhill to Hastings Link Road, Chapter 3B Section 3 Construction Strategy, Mott MacDonald, April 2007.

Ref 7: Planning Policy Statement 12 "Local Development Frameworks" (PPS12), the Office of the Deputy Prime Minister, September 2004.

Ref 8: Planning Policy Statement 1 "Delivering sustainable Development" (PPS1), the Office of the Deputy Prime Minister, January 2005.

Ref 9: Environmental Statement for Bexhill to Hastings Link Road, Application Reports, Project Sustainability Appraisal, Chapter 8, Mott MacDonald, April 2007.

Ref 10: Environmental Statement for Bexhill to Hastings Link Road, Chapter 2 Section 3 Purpose of the Scheme, Mott MacDonald, April 2007.

Ref 11: Environmental Statement for Bexhill to Hastings Link Road, Application Reports, Project Sustainability Appraisal, Chapter 3, Mott MacDonald, April 2007.

Appendix A: Figures

Appendix B: Environmental Statement for Bexhill to Hastings Link Road, Chapter 9

Appendix C: Groundwater Levels

Appendix D: Estimated Water Levels

Appendix E: Preliminary Drainage Design and SUDS