JACOBS BABTIE

Kingston Coastal Defences

Phase 1 Report – High Level Business Case

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Executive Summary

The purpose of this report is to provide an initial high-level review of the business case for the implementation of coastal defence solutions to provide protection to the village of Kingston. This report builds upon the work undertaken previously using a 'Gateway' approach to allow the Council to determine at each step whether it was worthwhile to continue with the scheme development.

A high level economic appraisal has been undertaken to confirm the potential economic viability of undertaking works at Kingston. The maximum value of the assets lies in the range £12.6m to £13.3m. Based upon the consideration of a number of scenarios the scheme benefits over a 100 year appraisal period are likely to lie within the range £6.5m to £11m Present Value.

Outline costs estimates have been developed for both breakwater and beach recharge options. An allowance for Optimism Bias of 60% has been included within the cost estimates in line with Scottish Executive guidance. Scheme costs for the breakwater options are likely to lie within the range £4.8m to £5.5m PV over a 100 year appraisal period.

Sources for beach recharge material are scarce. The nearest licensed site with suitably sized material is in the Humber estuary. It may be possible to re-establish a site within the Moray Firth. This could achieve significant cost savings. It is likely that repeat renourishment exercises will be required over the 100 year appraisal period to maintain the defence standards. Present Value costs are likely to lie in the range £22.8m to £37.8m (material obtained from the Humber estuary). Reactivation of the Moray Firth site could reduce these costs to £13.9m to £22.5m.

The outline assessment identifies that a breakwater scheme is likely to achieve a benefit cost ratio between 1 and 2 and may therefore be potentially viable under current guidance. A recharge scheme is unlikely to achieve a benefit cost ratio greater than unity, however there may be opportunities to combine recharge with local recycling which may allow a ratio closer to unity. An defence based on recharge is the preferred approach identified by Scottish Natural Heritage.

A review if the existing coastal process data has been undertaken and the works required to develop the outline business case defined. This element of work will provide a much greater level of certainty in both the potential benefits and risks to Kingston village. This exercise has identified that a level of additional data purchase will be required to complete this exercise.

The site lies within an internationally designated site, this report clearly identifies that any proposed development would require Environmental Assessment and is also likely to require an Appropriate Assessment. The level of information obtained at this stage will enable a scoping rather than a screening report to be developed under Phase 2, bringing forward elements of work previously programmed to follow the completion of the outline business case. This will allow greater engagement with the environmental issues prior to the completion of the outline business case.

The review indicates that there is the potential for a business case to implement defence works at Kingston; Phase 2 of the works should now be progressed to provide the outline business case and an environmental scoping report for the potential scheme (Gateway 2).

Contents

1 Introduction

1.1 Report Background

The 1993 report Spey Bay Geomorphological Review and Monitoring Strategy looked at the state of the beach along the Kingston frontage. From the analysis it concluded that there was a net loss of material from the beach thus increasing the chances of breach during a storm event. Further monitoring from 1994 to 2003 confirmed that not only was material being lost, the crest was also migrating inland.

Two possible management approaches to address the problem were identified in the 1993 report. These were:

- To affirm the performance of an offshore breakwater structure and to 'fine tune' the design to allow improved protection immediately in front of Kingston whilst allowing sufficient supply of shingle to the west
- To confirm the practical limitations of a beach recharge option such that this can be discussed further with Scottish Natural Heritage (SNH) and agreement can be reached that the offshore breakwater is the preferred option for management of the frontage.

A review in 2004 confirmed that these two approaches were valid and should be taken to the next stage (Gateway Approval 1) - with the development of a business case. The proposal by Jacobs Babtie in 2005 recommended that this element be split into two phases, with the initial phase reviewing the costs and benefits at a high level to confirm whether there was likely to be a business case for progressing the works. A site visit and meeting in November 2005 by members of the Jacobs Babtie project team and representatives from Moray Council presented an opportunity to discuss the key issues. This phase also included a review of the existing data to refine and clarify the approach to defining the flood and erosion risks. The environmental data has also been collated with the key issues and drivers identified. This report contains the findings of the initial phase.

2 Costs

As identified in the 2004 Recommendation report, from the previous investigations the preferred option was the construction of a low-level offshore breakwater. The earlier investigations did include some preliminary discussions with Scottish Natural Heritage (SNH). SNH indicated that, at that time, they favoured beach recharge as a means of improving defences at Kingston, as set out in their report of Survey and Monitoring Report No.57, 2001. Whilst this option has not been discounted, it was concluded that there are practical difficulties with implementation, including sourcing of suitable and sufficient volumes of material, and the environmental impacts of this approach.

The existing capital costs for the schemes have been revisited and revised. This phase of works will not provide a detailed assessment of the potential costs but will

provide an indication of the likely magnitude of the construction costs so that the potential viability of a business case can be clarified.

Jacobs Babtie has enlisted the help of Contractors Van Oord in developing the cost proposals. Van Oord has considerable experience in both the use of rock in marine construction and in the supply of beach recharge material. The cost estimates used have a price base of February 2006.

Recent guidance from Scottish Executive has altered the way that risk is included within the economic appraisal process. The changes instigated by the Treasury with regard to the discount rate have led to a requirement for the inclusion of a risk element within the costs. This is addressed by consideration of Optimism Bias. In accordance with this guidance an Optimism Bias factor of 60% has been included within the option costs developed. This level is appropriate for the outline level to which these costs have been developed.

Whole life costs for the options considered have been developed based upon the ongoing need for maintenance as well as the initial capital construction costs. The following discount rates have been used in assessing whole life costs:

- 3.5% for years 0-30;
- 3.0% years 31-75;
- and 2.5% thereafter.

2.1 Construction Costs – Breakwater

The 1998 Design Development Report identified that the preferred option for the coast protection of Kingston was the construction of long submerged breakwater. The structure would be between 400m and 500m in length with a crest height of 3mAOD, placed offshore of Kingston. The outline design developed for the 1998 report has been used as the basis for this cost estimate. It is acknowledged that this design will require further development to optimise its performance.

In developing the costs consideration has been given to the potential sources of rock armour. Local sources have been considered however it would appear likely that given the quantities of material required, the most cost effective source is likely to be rock delivered by sea from the coastal quarries in Norway. The cost estimates used within this report are based upon the use of Norwegian rock.

Capital Costs.
The capital costs for the construction of the breakwater have been developed based upon both 400m and 500m long structure. An allowance has also been included for recycling of beach material to be placed on the beach landwards of the breakwater, to mitigate for the initial loss of sediment transport. The table below outlines the potential capital costs (including Optimism Bias).

Option	Capital Cost (£k)	Optimism Bias (@ 60% - £k)	Total construction cost (£k)
400m Long submerged breakwater	2,676	1,605	4,281
500m Long submerged breakwater	3,182	3,182	5,091

Table 2-1 – Potential Capital Costs

To develop the whole life costs, allowances for maintenance have been included over a 100 year appraisal period. It has been assumed that initially (for the first 10 years subsequent to construction) there will be a need to recycle material within the vicinity of the breakwater to address localised erosion whilst the system establishes itself in equilibrium with the local coastal processes. A reduced allowance for recycling is included after these 10 years. Allowances have also been included to undertake minor repairs and adjustments to the breakwater structure, replacement of rocks etc.

The proposed defences provide protection from the coast against both erosion and flooding, however, there will still be a need to manage the path of the River Spey to prevent the course changing dramatically and flowing through Kingston village. An allowance has been included within the costs for undertaking river management activities. These costs are applicable to both the breakwater and recharge options.

Whole life scheme costs expressed as Present Values (PV) are provided in the tables below.

Option	Whole Life Cost PV (£k)
400m Long submerged breakwater	4,753
500m Long submerged breakwater	5,510

Table 2-2 – Whole Life Scheme Costs for offshore breakwater

2.2 Construction Costs – Beach Recharge

The use of beach recharge is the approach preferred by Scottish National Heritage. It is believed that SNH would like to use a material similar in geological composition to that existing within the region. Previous studies have considered potential sources for the material. These have been revisited for this phase of works.

The use of the licensed aggregate site 5km offshore in the Moray Firth was previously identified as a potential source. This site has now been closed. It had been established to provide material to be used to cover marine pipelines but was never really used. It is believed that this site was licensed for the extraction of 30,000m^3 of material per annum

The licensed operator, Nash Dredging, no longer exist as a company, having been through a series of acquisitions the remnants of the company now reside within Van Oord BV. If there are any "rights" to that area, Van Oord, may have inherited them though it's various mergers.

Following a discussion with the Crown Estates agents for marine aggregates, it would appear that it would need a formal Government View approach to reactivate this site or create a new site. To undertake this procedure, under the new Statutory Regulations would need an administration handling fees (£20k-£80k), and surveys and Environmental studies, likely to be in the order of £50k - £250k. This can be a slow process, usually taking years to obtain the licence.

There is a licensed site in the Firth of Forth but material size obtained from here would be likely to be too small to be useful as beach recharge for Kingston.

The nearest available marine aggregate sites with suitable sized material would appear to be those off the Humber Estuary. This material would have a different

geological composition to that currently on the beach at Kingston and would significantly increase transport costs.

Land based sources had previously been considered with local quarries identified as being able to supply suitable material. This would require road based delivery causing access problems through Kingston and Garmouth due to the number of vehicle movements required. A typical 20 tonne truck could supply about 10m^3 of material. Concern was raised in the 1996 report that two bridges may require strengthening or replacement before any large scale import could be undertaken. Given the potential volumes required road delivery is not considered viable here both in economic terms and with respect to the environmental impacts. The aggregates could be transported to a local quayside, and then loaded onto a vessel for marine delivery to the site, this would involve double handling of the material leading to high costs values but could be explored at a later date.

Costs estimates have been developed based upon using material obtained from the Humber estuary (the nearest licensed source of suitable sized material) and also based upon the assumption that a licensed site can be re-established in the Moray Firth (this significantly reduces transportation costs). An allowance has been included within these options for undertaking the Government view procedures necessary to licence the site (£300,000). The quantity of material required to provide suitable beach profiles is uncertain at this stage, a range of volumes have been use to give an indication of the potential range of costs. It is important to note that these costs relate to a one off capital works exercise.

Option	Capital Cost (£k)	Optimism Bias (@ 60% - £k)	Total construction cost (£k)
Sourced from Humber Estuary			
70,000m^3 of recharge material	4,525	2,715	7,240
120,000m^3 of recharge material	7,032	4,219	11,251
160,000m^3 of recharge material	9,038	5,423	14,460
Sourced from Moray Firth			
70,000m^3 of recharge material	3,018	1,811	4,828
120,000m^3 of recharge material	4,251	2,551	6,802
160,000m^3 of recharge material	5,238	3,143	8,382

Table 2-3 - costs of beach recharge material

To develop the whole life costs, allowances for maintenance works have been included over a 100 year appraisal period to enable comparisons with the breakwater option. As there are no proposed structures to control the movement of the beach, an allowance has been made for recycling material within the system, to redistribute the material to where it is required to maintain the standard of protection. River management costs have been included on the same basis as used for the Breakwater option.

It is considered likely that material will be regularly lost from the system and it will require additional future renourishment exercises to maintain the standard of

protection. The frequency of this is yet to be determined. Historically large amounts of material have been lost from the frontage and to provide an indication of the range of whole life costs, scenarios have been developed where the renourishment exercise occurs every 10 years and every 20 years.

Whole life scheme costs for these scenarios, expressed as Present Values (PV), are provided in the tables below.

Option	Whole Life Cost PV (£k)
Sourced from Humber Estuary	
120,000m^3 of recharge material replaced every 10 years	37,857
120,000m^3 of recharge material replaced every 20 years	22,723
Sourced from Moray Firth	
120,000m^3 of recharge material replaced every 10 years	22,457
120,000m^3 of recharge material replaced every 20 years	13,969

Table 2-4 – Whole life scheme costs for beach recharge

There is also the potential that material could be recycled from the downdrift areas, subsequent to the initial recharge. There is a much less of a requirement in defence terms to the west of Kingston, and with the shape of the bay, may allow material to accumulate in this area. The potential for this has not been fully evaluated, but could lead to a reduction in PV of the costs to around £10m - £11m.

The financial advantages in using an aggregate source based within the Moray Firth are significant. If a beach recharge option is developed further, it would be important to confirm the viability for reactivating (or identifying a new) a licensed site within the area. The site could be established for long term supply of beach nourishment material. The 1996 report identified that the material available from the former site could meet the grading requirements. It is also considered likely that the geological composition would be similar to that already existing on the beaches. This would help to meet SNH requirements.

3 Benefits

3.1 Valuation of Assets

The purpose of this exercise is to provide a more robust estimate of the potential values of property that could be at risk and their spatial location. The report sets out to identify the maximum benefits that could be obtained.

Previous benefit/cost assessments indicated that Kingston contains 100 residential properties. Enquiries on property values in the Moray area yielded an average property value of £60,000. This gives a total value of property asset of around £6.2m.

To obtain an estimate of current property values within the area, three different sources of indices of house prices have been considered:

- Office of Deputy Prime Minister (ODPM)
  It uses lending information from about fifty lenders, which is collected through the Survey of Mortgage Lenders. It does not contain information on cash purchases (which account for about a quarter of the market). It also bases the values on total amount spent rather than total amount borrowed. Information is provided on a regional basis.
  http://www.odpm.gov.uk/index.asp?id=1156109

- Nationwide House Price Index
  Nationwide derive their house price information from lending data, excluding cash purchases. The website calculates percentage change and from this gives a current house prices for different regions, in this case Scotland. The prices are mixed adjusted to give a price of a 'typical' house rather than giving an average price that may be influenced by extreme values.
  http://www.nationwide.co.uk/hpi

- Halifax House Price Index
  Again, the Halifax house prices are derived from their mortgage data and is also standardised to represent a 'typical' house that can be tracked over time. It also omits cash purchases. The Halifax provides data for Region (Scotland) and by postal town (Elgin).
  http://www.hbosplc.com/economy/housingresearch.asp

These indices were then used to update the local property values obtained from two sources:

Council Tax Band Information An assessment of house price value had to be made to band the properties. The Census information of 1991 was used to provide an idea of value but was updated in 1993 taking into account location and physical state. Therefore this information is assumed to be a representation of house price on 1st April 1993.

Actual Sold Prices – these were obtained from www.upmystreet.com and show addresses of individual properties that have been sold and date and price of sale. The data is supplied by Registers of Scotland, the agency of the Scottish Executive that maintains public registers relating to property.

Both sources of property value data were then combined with the various indices to provide the asset value for Kingston updated to the third quarter 2005. The table below shows the results of this exercise.

Council Tax Band	Number of properties in each band	Nationwide Method A - Sold Prices Scotland	ODPM Method B - Sold Prices Scotland	Halifax Method C Sold Prices Scotland	Nationwide Method D Tax Band Scotland	ODPM Method E - Tax Band Scotland	Halifax Method F Tax Band Scotland	Halifax Method G Tax Band Postal Town Elgin	Halifax Method H Sold Prices Postal Town Elgin
A	11	£1,015,831	£1,040,097	£1,014,745	£667,448	£597,626	£579,975	£541,887	£1,051,866
B	23	£1,562,306	£1,764,149	£1,822,075	£1,602,325	£1,434,705	£1,392,328	£1,300,895	£1,762,611
C	23	£1,617,069	£2,065,173	£2,121,298	£2,067,516	£1,851,233	£1,796,576	£1,678,574	£2,030,162
D	23	£4,347,368	£4,261,245	£4,329,750	£2,661,927	£2,383,462	£2,313,087	£2,161,164	£4,167,235
E	19	£3,909,136	£3,600,375	£3,847,120	£2,946,210	£2,638,006	£2,560,117	£1,785,309	£3,489,328
F	1	£208,999	£187,135	£181,610	£155,064	£187,135	£181,610	£181,610	£169,682
G	-								
H	-								
Total Number of Properties	100	£12,660,708	£12,918,174	£13,316,598	£10,100,490	£9,092,168	£8,823,693	£7,649,439	£12,670,884

Table 3-1 Total asset value at Kingston derived from differing methods -

The analysis provides a range of results, but there is also a consistency between the indices when using similar methods. The results based on property sold values, are higher than those derived from the initial Council Tax bands. Comparing current market values of property currently for sale within the Kingston area would appear to suggest that a valuation based upon the sold prices reflects the current market position. This provides a current value for the assets at Kingston in the range of £12.6m to £13.3m.

3.2 Other potential benefits

There is no significant commercial activity currently within the Kingston area. The infrastructure services within the area are associated with the residential property. There are no additional benefits that can be obtained through loss of services.

3.3 Comparison of 2005 results with 1996 report

To provide an indication of the likely levels of benefits that may be achieved, comparisons were made with the previous erosion assessment. The 1996 report identified that are approximately 31 properties are considered to be at direct risk of erosion damage or frequent flooding should a breach of the lagoon and adjacent defences occur. It based an assessment on a breach occurring after 3 years. Should no intervention be carried out in the event of a breach then it may be expected that the frequency of flooding would be sufficient to effectively write-off the remaining property in Kingston after a period of a further 2 years from the breach occurring. This provided an estimate of total Present Value damages of £5.2m (1996 using a Discount Rate of 6%, Treasury guidance now uses 3.5%). This is considered below as scenario 1.

Scenario 1 has been revisited based upon the current market values of the property (the lower bound of the cost estimate based upon sold prices), and the revised discount rates now being used. Sensitivity analysis has also been undertaken as to the potential timing of the breach to provide an indication of the range of values within which the benefits are likely to lie. The proposed works in phase 2 will provide a more detailed assessment. These are shown in the table below. The 1996 values are included in the table for comparison purposes. These have been highlighted in grey.

Year	Total Assets	Value (£m)
1996	Total Property Asset	£6.2m
2005	Total Property Asset	£12.6m
	Erosion Scenario under No Active Intervention	
	Scenario 1 - 31 properties lost due to erosion/frequent flooding year 3, rest of Kingston lost 2 years later (no active intervention)	Present Value (PV £m)
1996	Scenario 1	£5.2m
2005	Scenario 1	£10.9m
	Sensitivity tests	
2005	Scenario 1 delayed by 5 years i.e first loss year 8	£9.2m
2005	Scenario 1 delayed by 10 years i.e first loss year 13	£7.7m
2005	31 properties lost year in 3 as Scenario 1, but rest lost in year 10	£9.7m
2005	Initial 31 properties lost in year10, rest lost in year 23	£6.5m

Table 3-2 sensitivity analysis undertaken on previous benefit analysis

As can be seen from Table 3-2 the maximum value of damage that could occur is £12.6m. This could only be achieved in a scenario where all property was lost in the first year. The likely value of benefits will be less than this, the sensitivity analysis undertaken outlines that this is likely to lie within the range £6.5m- £11m. It should be noted that the sensitivity is based upon simple breach scenarios and property right off. This may not fully reflect the actual value and timing of damage avoided. It is likely that some flood damage would be incurred on a no active intervention prior to the write off of the property occurring, this would lead to higher PV values than those shown. The detailed assessment proposed in the phase 2 works would further refine this value. It is important to note however that the level of potential benefits, will be capped at the maximum value of £12.6m.

4 Economic Assessment

The purpose of this initial phase is to provide greater levels of confidence and understanding of the potential values of the issues, particularly the assets at risks and provide a more robust estimate of the potential management costs. There have been significant increases in the value of the assets within Kingston since the previous assessment was undertaken. Current cost estimates have been developed to provide outline costs for potential schemes. These assessments have incorporated Optimism Bias at a rate of 60% in line with the guidance from the Scottish Executive and the Treasury.

The table below identifies the likely ranges of values, which may be achieved for the options based upon the analysis undertaken:

Scenario	PV Cost (£m)	PV Benefit (£m)	Benefit / Cost Ratio
No Active Intervention			
Maximum value	12.6	-	-
High Value	10.9	-	-
Low value	6.5	-	-
Offshore Breakwater			
Best case	5.5	10.9	2.0
Worst case	6.2	6.5	1.0
Beach Recharge*			
Best case	14.0	10.9	0.8
Worst case	22.5	6.5	0.2
Best case + recycling	10.9	10.9	1.0

Table 4-1 Benefit cost assessment scenarios

*based upon use of Moray Firth source for aggregates

From the assessment identified above, it would appear that the benefit cost ratio for a breakwater scheme is likely to lie between 1 and 2; this would make the implementation of the scheme viable under the current Scottish Executive guidance. The breakwater options have the potential to be the most economically efficient.

From the analysis it would appear that an approach based upon beach recharge is unlikely to achieve a benefit cost ratio of greater than unity.

It is important to note that the above costs and benefits have been derived in a relatively simplistic manner; the detailed work proposed in Phase 2 will provide a more definitive answer.

5 Data Review (Coastal Processes and Hydrodynamics)

This section of the report assesses the quality, quantity and suitability of data available in supplying further technical assessments of the risk of flooding to Kingston-on-Spey. It considers:

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- field data originating from monitoring
- synthetic data from previous modelling activities.

Based on this review, it is subsequently intended to undertake an assessment of the flood risk, and to provide information for the benefit-cost assessment that will be submitted to the Scottish Executive at Stage 2 – Grant in Aid Application stage. Therefore this section will also provide:

- a description of the proposed methods for the assessment of flood risk
- the derivation of information to assist in the development of the benefit-cost analysis and assisting the optimisation of the scheme design.

5.1 Existing data

5.1.1 River Flows

SEPA previously provided river flow data consisting of mean daily flow values measured on the River Spey at Boat o' Brig for the years 1996 to 2002 inclusive. It is assumed that this historical data set can be extended to the present. This flow data will be required for the assessment and analysis of the joint probability of high tidal levels with high river flows.

5.1.2 Tidal and Surge Water Levels

The National Tidal and Sea Level Facility (NTSLF) retain tidal water level records for Wick, Moray Firth and Aberdeen. The records are freely available on the web site of the British Oceanographic Data Centre (BODC) and contain total water levels accompanied by estimates of surge residuals. Table 5-1 shows the extent of the available data sets.

Location	Duration of data set years inclusive
Wick	1965-1970 and 1972 to present
Moray Firth	1994 to present
Aberdeen	1930-36, 1946-58, 1960-2, 1965-5, 1967-75, 1980 to present

Table 5-1 Extent of tidal water level data available to the project

The gauge in the Moray Firth is nearest to Kingston. The highest spring tide water levels are also recorded here. As the Moray Firth records only begin in 1994 records from Wick and Aberdeen will also be used so that a larger data set (in terms of time) can be developed. This data set will then be used to determine extreme water levels (i.e. storm events) and waves that could overtop the beach. And/or storm damage to the shingle defences.

5.1.3 Wave Data

Previously two models have been used to predict wave conditions. The first model (Hindwave) generates wave conditions in the offshore environment based on fetch lengths and angle of the wind. This information is the input for the second model (Outray) which transfers the offshore sea conditions into an inshore environment.

Fetch lengths in this area extend northwards beyond Iceland. Whilst it is true that extreme sea conditions can occur from this direction, a prediction method based upon fetch lengths (such as Hindwave) is unlikely to be capable of modelling the wind variations across such a large area. Therefore, it is recommended for the next phase of work that the Met Office European Wave model is used to generate the offshore conditions. This model is based on hourly surface wind data obtained from Met Office Numerical Weather Prediction Model (NWP) combined with a numerical weather prediction model. Unlike previous models which generate wave heights by fetch, the Met Office model uses a variety of parameters; energy input from the wind, dissipation of energy through the breaking of waves and transfer of energy within the wave field. The model takes boundary data from the global wave model, allowing swell from the Atlantic to be incorporated. It is recommended that 10 years of data be purchased from the Met Office at a cost of £3875.

5.1.4 Bathymetry

High quality Lidar data at 4m resolution are available for the shingle ridge and the hinterland. Where the Lidar finishes, bathymetry data will start and extend seaward to provide coverage for the nearshore area. This data will come from from the latest Admiralty Charts, and a previous nearshore survey. This will provide sufficient data to enable a numerical wave model to be built of the near and inshore area. The Lidar data are of sufficient quality to enable profiles to be made of the shingle ridge for use in further numerical modelling. Figure 5-1 below shows the relief plots of the Lidar data across the ridge in general and also adjacent to Kingston.

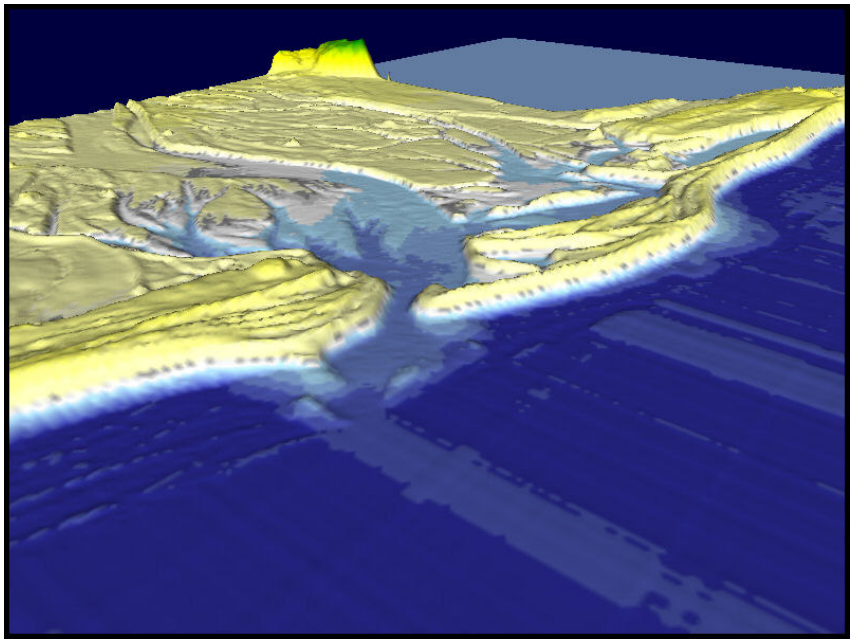


Figure 5-1 Relief plot of the Lidar data for the shingle ridge and associated hinterland of the tidal inlet.

If a combined extreme fluvial and tidal event is modelled, then additional bathymetry information may be required for the River Spey mouth including the lagoon. It is assumed that the inlet position shown in the Lidar plots will be maintained since it provides the safest scenario as far as exposure of Kingston to wave attack is concerned. However, the risk to Kingston of flooding from the side and behind due to combined river flow and high tidal level remains an issue.

5.1.5 Sediment Samples

Previous modelling of sediment transport was undertaken using the software Cosmos. Cosmos is capable of describing the behaviour of non cohesive sediment (i.e. shingle) up to 2mm diameter, under the action of waves. This work was further supported by the US Army Corps of Engineers software Genesis, which modelled the shoreline response to an offshore breakwater and designed to encourage the development of a tombolo. Consequently, previous modelling work was not connected with the stability of the shingle ridge.

One element of Phase 2 will be predicting the resistance of the shingle ridge to overtopping and breaching. For this purpose, details of the existing grain size along the shingle ridge will be required. Limited grading information, from samples taken in 1990 exists, however it is known that the grain size varies widely across the shingle

ridge. To enable a robust analysis (and provide the level of detail required for considering beach recharge options) it is proposed to undertake a sampling exercise along the shingle ridge, accompanied by size distribution analysis. Samples will be taken in lines down predetermined profiles, positioned in the locations that are of prime interest.

5.2 Methods

5.2.1 Water Level Modelling

Using the NTSLF tide gauge data a long time series of water levels will be built for Kingston, to enable the prediction of extreme events at the site including breaching and overtopping of the shingle ridge. It will also be used in the prediction of joint return period values of high river discharges and tidal levels. It is unlikely that tidal numerical modelling will be required to create this data set
This is for 2 reasons:

1. The tidal levels at the three sites are well correlated.
2. The Moray Firth time series already extends from 1994 to the present day and consequently, with the exception of the need to patch the gaps empirically, it is of sufficient duration for use in joint probability analysis of water levels, waves and river flows.

However, a better estimate of extreme return period water levels can almost certainly be made by extending the Moray data set back to 1980 by interpolation assisted from Wick and Aberdeen. The method of interpolation will be determined from an analysis of the data at the three sites, with some possible support from methods described in Dixon and Tawn (1997).

5.2.2 Wave Modelling

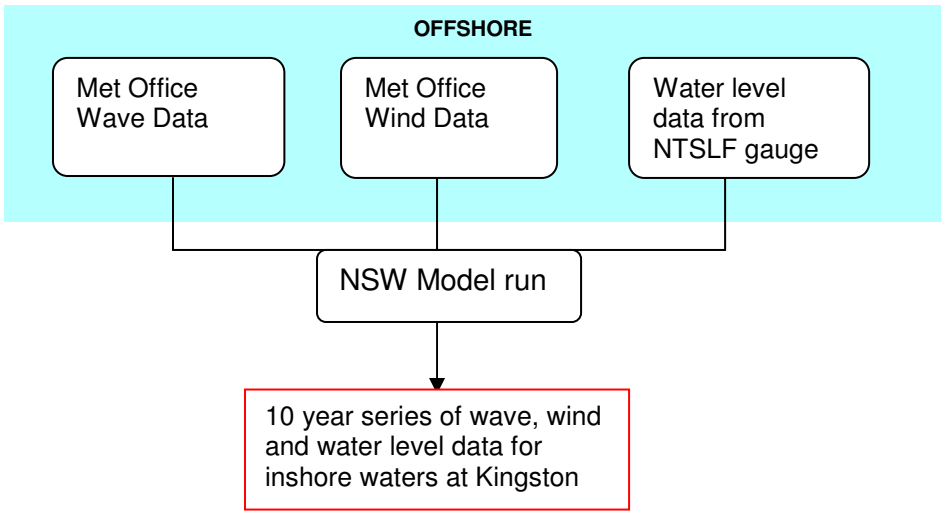
Knowledge is required of the inshore wave climate for the following purposes:

- Prediction of the extreme return period wave heights and period at the shingle ridge;
- Assessment of the joint probability of wave heights and water levels;
- Prediction of extreme return period overtopping rates;
- Assessment of the behaviour of the shingle ridge under wave activity.

Data will be purchased for the nearest offshore wave model location point in the Met Office European Wave Model. It will then be transferred inshore to the study area using a wave model built for the purpose by ABPmer, using the Danish Hydraulic Institute (DHI) wave module Nearshore Spectral Waves (NSW). The NSW module describes the behaviour of waves under the action of shoaling, refraction, bed frictional dissipation, wind-wave growth and breaking. This method transfers the wave spectrum in the nearshore boundary into the onshore environment. At the same time, the model also describes the contribution from wind to wave growth across the area.

The NSW model will be run using the Met Office time series wave data on the boundary and winds also from the Met Office time series to describe wind-wave growth across the model domain. A simultaneous time series of water levels built from the NTSLF gauge data at Moray Firth and supported by the Aberdeen and Wick gauges will also be used, to accompany the wave and wind time series that will drive the NSW model. The output from the model run will be a 10-year time

series of simultaneous wave, wind and water level data, at inshore locations required for the study.



Data on wave climate will be produced at the following two types of inshore locations:

- At the closure depth required for modelling the behaviour of the shingle ridge;
- At the base of the shingle ridge for subsequent use in overtopping prediction.

5.2.3 Modelling of the Shingle Ridge

The modelling of the shingle ridge will be performed using a DHI model, Litprof, part of a collection of models in the Litpack suite. Slopes of shingle behave in a way that is sensitive not only to the height and period of the incoming waves, but also to their direction. An oblique angle of wave attack can extend the disturbance area generated by the waves and in particular can push it further back up the slope, leading to overtopping and damage, if the sea state condition persists. It is likely that better predictions of wave direction can be obtained from the Met Office wave model giving further reason for using this model in preference to a hindcasting programme such as Hindwave.

The Litprof model will be run using initial conditions obtained from the beach profiles generated from the Lidar data and the data obtained from the NSW model run. The simulation will be used to describe the long term evolution of the shingle ridge under combined waves and water level variations, to identify areas that are likely to be at risk from wave/water level damage. Furthermore, Litprof runs will be made under extreme conditions as required for the assessment of the risk of breaching of the shingle ridge.

Using the inshore water level and wave information, an assessment will be made of the threshold for movement of various shingle grain sizes.

Consideration will also be given to the capability of storm conditions to transport the shingle ridge material by wave action in the intertidal zone. For this purpose, the Litdrift module of the DHI Litpack suite will be applied. It has the ability to predict the motion of shingle particles taking into consideration the fluid drag around the sediment, and inertial forces transmitted by the waves as well as the self-weight components exerted by the shingle on the slope.

5.2.4 Joint Probability Analysis and Overtopping Predictions

The software suite Join-Sea will be used to undertake analysis of the joint probability of waves and water levels. It would be expected that there is some correlation between wave and water level as both are influenced by the same local weather conditions.

Application of the suite has four stages:
1. Extreme water levels and wave height prediction based on real data;
2. Look for a correlation between the two variables (wave and water)
3. Generation of a long synthetic time series based upon the original real data using the correlation co-efficient found in Step 2
4. From the long series of data, extract the joint return period contours for wave height and water level

In this study, the first three stages will be progressed. From the data set in Step 3, a corresponding overtopping time series can also be obtained, from which overtopping rates will be derived.

In addition to extreme return period estimates of overtopping discharge rates, analysis will also be made of the duration of storm events, thus enabling a prediction to be made of the volume of extreme overtopping.

A further joint probability issue of direct relevance to the River Spey is that of tidal water levels and river discharges. There is a need to establish the level of risk associated with the joint occurrence of high tidal levels and large river discharges. It is a reasonable supposition that there will be a significant correlation between these two variables due to the influence of low-pressure fronts upon tidal surge and upon precipitation. What needs to be considered is the frequency of occurrence of such events around the time of High Water. This issue will be investigated using the joint probability analysis software.

If it is found that the probability of extreme combinations of river flows and tide-surge levels is high, thus compromising the standard of protection provided by the shingle ridge, it is proposed that a 2D hydrodynamic (HD) model be built. This would include the estuary and associated channel behind the shingle ridge. It would estimate the water levels that could build up behind and adjacent to Kingston, under such an event. The decision to undertake such additional modelling will be made after the results of the joint probability analysis have been obtained.

The HD model will be built upon the premise that the tidal inlet will be maintained in its existing state as indicated by the Lidar survey. In addition to the data from the Lidar survey, it will be necessary to acquire bed levels in cross sections of the river, in order to build the HD model. The output from the HD model will be an assessment of extreme return period water levels and tributary-river flows adjacent to the site of Kingston village.

6 Environmental Review

6.1 Legislation, Planning and Policy

The River Spey and its estuary, on which the rural community of Kingston is situated, has multiple designations for its natural environment. It is of national importance for its geomorphology and is an internationally important wetland area that provides valuable habitat for waterbirds. The interaction of the river with the coastline creates an environment with features that are unique to both Scotland and the UK. Any of the proposed schemes could have an impact on the environment and landscape character of the area.

6.1.1 Legislative Background

The proposed scheme would require an Environmental Impact Assessment (EIA) under The Environmental Impact Assessment (Scotland) Regulations 1999, Schedule 2, Section 10 Infrastructure Projects Part (m):
'Coastal work to combat erosion and maritime works capable of altering the coast through the construction, for example, of dykes, moles, jetties and other sea defence works, excluding the maintenance and reconstruction of such works;'

The site is designated as a Special Area of Conservation (SAC) and Special Protection Area (SPA) and as such is protected under The Conservation (Natural Habitats and Conservation) Regulations 1994, the 'Habitats Regulations'. The Habitats Regulations place a statutory duty on planning authorities and other competent authorities to meet the requirements of the Habitats Directive.

The site is also designated a Ramsar site and a Site of Special Scientific Interest (SSSI). The Ramsar Convention was signed in 1971 and is an intergovernmental treaty providing the framework for national action and international co-operation for the conservation and wise use of wetlands and their resources. Wetlands of International importance are designated as Ramsar sites.

SSSI are protected under Part II of the Wildlife and Countryside Act, 1981. The Countryside and Rights of Way (CRoW) Act, 2000 amended the Wildlife and Countryside Act. This included greater protection for SSSIs. In 2004, The Nature Conservation (Scotland) Act 2004 came into force. Chapter 1 of Part 2, and Schedules 1 and 5, of the Act supersedes the SSSI provisions of the Wildlife and Countryside Act, 1981.

The competent authority will determine whether the development proposal is likely to have a significant effect on the site, and this being the case, will request an Appropriate Assessment. This would assess the effects on the conservation interests for which the site is designated and can be undertaken in parallel with the EIA.

6.1.2 Policies and Plans

Kingston-on-Spey falls under the district of Moray which is covered by the Moray Structure Plan (approved by Scottish Ministers in November 1999) and the Moray Local Plan 2000 (adopted by Moray Council in April 2000). Key policies relating to the site are summarised in the Table 6-1 below.

Table 6-1 Moray Local Plan Policies of relevance to the site

Policy	Statement
L/ENV1: Statutory Nature Conservation Sites, International Designations	Development proposals which adversely affect a designated or proposed SAC, SPA or Ramsar site should be assessed in terms of its implications for the site's conservation properties and it will only be permitted where it will not adversely affect the integrity of the site or there is no alternative solution and there are imperative reasons of over-riding public interest for the development. Where a priority habitat or species would be affected, prior consultation with the European Commission is required unless the development is necessary for public health or safety reasons. National designations – Development proposals which may adversely affect SSSIs or NNRs will only be permitted where:- 1) The objectives of the designation and overall integrity of the site will not be compromised. 2) Any significant adverse effects on the qualities for which the site has been designated are clearly outweighed by social or economic benefits of National Importance
L/ENV2: Non Statutory Nature Conservation Sites and Local Designations	Development proposals which will have an adverse effect on LNRs, SINS or conflict with the objectives of Local Biodiversity Action Plans will only be permitted if they incorporate specific measures to minimise impact and conserve the site's ecological interest and moreover, where significant impacts are involved, a location must be clearly established.
L/ENV/15 Conservation Areas	Sets development criteria for development within Kingston-on-Spey village.

6.2 Baseline Environment

The baseline environment has been established through a desk-top review of available literature, an internet search and a site visit undertaken in November 2005.

6.2.1 Human Beings

(a) Socio-economic

Kingston is a small village community comprising 100 properties (Figure 1 in Appendix 1 shows the location and study area). The nearest communities are Garmouth, to the south and Nether Dallachy to the south east. Previous benefit/cost assessments indicated that the total value of properties in Kingston was around £6.2m, this has increased this figure to £12.6m based on current market values.

(b) Local Amenities

Key local amenities include schools, post offices and banks. This is summarised in the Table 6-2 below.

Table 6-2 Key Local Amenities within the study area

Amenity	Location	Distance from Kingston
Primary School	Mosstodloch	3 miles to the south
High School	Fochaber	4 miles to the south-east
Nearest Post Office	Garmouth	1 mile to the South
Garage ('Colin Bowie')	Fochaber	4 miles to the south-east
Bank – Bank of Scotland	Fochaber	4 miles to the south-east
Newsagents	Buchie	6 miles to the east
Train Station	Elgin	8 miles to the south-west
Airport	Inverness Dalcross Airport	40 miles

(c) Recreation

Key recreational features at Kingston include a park and recreation ground within the village itself. Footpaths include 'The Speyside Way' which runs to the east of the village. The footpath continues further east to Portgordon and beyond and south from the Moray Firth Wildlife Centre alongside the River.

One of the National Cycle Network Routes (Route 1) runs through Garmouth to the south and continues to Inverness in the west or Aberdeen in the east. Garmouth and Kingston Golf Course lies to the east of the B9015.

6.2.2 Biodiversity

The site has six nature conservation designations directly associated with it: Three SSSIs, a SAC; and the estuarine section of Spey Bay is part of a SPA; and a Ramsar wetland site. The Nature Conservation Designations are shown on Figure 2 in Appendix 1.

(a) Spey Bay SSSI

Spey Bay SSSI (designated 1986) runs along the coast from the sands at Lossiemouth in the west to Porttannacy in the east, covering an area of some 492ha. The SSSI boundary extends inwards at Kingston and is within the site boundary. It was notified primarily for its outstanding coastal geomorphology and has been described as one of the most important coastal physiographic sites in Britain (NCC, 1986). Particular features that make it stand out are:

- Active shingle ridge providing evidence of dynamic coastal process
- Highly active and changeable River Spey mouth
- Delta and braided channel formations

(b) Lower River Spey SSSI

The Lower River Spey SSSI was designated in 1988 and covers an area of some 230ha. The northern limit of the SSSI is the Speymouth Railway viaduct to the south. The SSSI is an actively braided gravel-bed river displaying a degree of large scale divided channel adjustment that is unique in Scotland (Gemmell et al, 2001).

(c) River Spey SSSI

The main length of the River Spey was designated an SSSI in 1999, covering an area of some 1960ha. This designation is on account of its important populations of Atlantic salmon (*Salmo salmar*), Sea lamprey (*Petromyzon marinus*), otter (*Lutra lutra*) and freshwater pearl mussel (*Margaritifera margaritifera*).

(d) Lower River Spey – Spey Bay SAC

The Lower River Spey – Spey Bay SAC covers an area of 653 ha and is designated due to the presence of two Annex I habitats:

- Habitat 1220: Perennial vegetation of stony banks (vegetated shingle)
- 91E0: Alluvial forests with (*Alnus glutinosa*) and (*Fraxinus excelsior*) (*Alno-Padion*, *Alnion incanae*, *Sailcion albae*).

The vegetated shingle supports a wide variety of plant communities and the Lower River Spey – Spey Bay and Culbin Bar are, individually, the two largest shingle sites in Scotland and together form a shingle complex unique in Scotland (www.jncc.gov.uk).

(e) River Spey SAC

The main length of the River Spey, covering an area of 5729ha is also designated a SAC. This is on account of the presence of Atlantic salmon, Sea lamprey, otter and freshwater pearl mussel as described for the River Spey SSSI above.

(f) Moray and Nairn Coast SPA/Ramsar

The site also falls under the Moray and Nairn Coast SPA and Ramsar wetland site (classified in 1997). The Spey Bay part of the designation supports “a large range of shingle-related habitats reflecting the succession from presently mobile, unstable conditions to those which have been stable for considerably longer” (Information Sheet on Ramsar Wetlands, JNCC,2004).

The site qualifies as a Ramsar site by meeting criteria 1,2,5 and 6 and as a SPA under Articles 4.1 and 4.2 of the Directive (79/409/EEC). These are summarised in the Table below:

Qualification Reference	Qualifying Features
Ramsar Criterion 1	Important wetland features including good examples of intertidal flats, saltmarsh and floodplain alter, (*Alnus glutinosa)* woodland
Ramsar Criterion 2	Presence of four nationally scarce aquatic plants: sea centaury (*Centarium littorale*) and three species of eelgrass (*Zostera noltii*, *Z.angustifolia* and *Z.marina).* Two British Red Data Book invertebrates are present, as well as the following mammals: common seal (*Phoca vitulina)* and otter (*Lutra lutra).* Fish fauna include salmon (*Salmo salar)* and sea lamprey (*Petromyzon marinus).*
Ramsar Criterion 5: Assemblages of International importance	Overwintering waterfowl
Ramsar Criterion 6: Species occurring at levels of international importance	Greylag goose Anser anser, Pink-footed goose *Anser brachyrhynchus* and Redshank *Tringa totanus*.
Article 4.1 of Directive (79/409/EEC)	Populations of European importance: During the breeding season: Osprey *Pandion haliaetus*, Overwinter: Bar-tailed godwit *Limosa lapponica*
Article 4.2 of Directive (79/409/EEC)	Populations of European importance of the following migratory species: Greylag goose, (*Anser anser)*, pink-footed goose, (*Anser brachyrhynchus)*, Redshank, (*Tringa tetanus)* A wetland of international importance by regularly supporting at least 20,000 waterfowl.

Table 6-3 Qualifying Features for Moray and Nairn Coast SPA and Ramsar site.

6.2.3 Fisheries

The River Spey is important for fisheries and is known to support important populations of Atlantic Salmon (*Salmo salmar*), Brown trout/sea trout (*Salmo trutta*) and sea lamprey (*Petromyzon marinus*). The Spey Fisheries Board was established under the 1860s Salmon Fisheries legislation (now the Salmon Act, 1986) and is responsible for the management, protection, enhancement and conservation of salmon and sea trout stocks in the river. The Spey Fisheries Board will be a key consultee if further work is required.

6.2.4 Landscape and Visual Amenity/Land Use

The landscape in and around Kingston is shaped by the River Spey and the dynamic and high energy coast of Spey Bay. The mouth of the River Spey is a constantly changing system. In the more stable parts of the system wet woodland occurs. This is dominated by species such as alder (*Alnus glutinosa*) and willows (*Salix spp*)., with ash (*Fraxinus excelsior*) and bird cherry (*Prunus padus*). Such woodlands include Culriach and Warren Woods to the south-east of the village.

Aside from this the surrounding area has a distinctly rural feel dominated by small communities and agricultural fields.

Key infrastructure in the village includes the B9015 which runs south from Kingston to the main A96 road. A dismantled railway runs west to east, crossing the River Spey just south of Garmouth via the Spey Viaduct.

6.2.5 Surface Water

The key surface water feature in the study area is the River Spey, the second longest river in Scotland. Water quality in the river (monitored by the Scottish Environmental Protection Agency) is graded as either 'good' or 'excellent' for its entire length and the river is considered to be one of the cleanest in Scotland (River Spey Catchment Management Plan, 2003).

6.2.6 Cultural Heritage, Archaeology and Material Assets

The village of Kingston originated around the boat building industry in the late eighteenth century and was named after Kingston- upon-Hull in East Yorkshire. Garmouth was established for wood processing but Kingston was developed to be able to build boats of up to 500 tons. Unfortunately a great storm in 1829 (*Muckie Spate)* swept away many of the properties. The growth of steel built ships lead to the decline of the boat building industry in this area.

There are still several listed properties in Kingston and the village itself is a Conservation Area, as designated by Moray District Council. This aims to safeguard and enhance the sense of place, character and appearance of Scotland's most valued historic places. The village of Garmouth to the South is also designated a Conservation area.

Information on Kingston village has been obtained from Historic Scotland's 'Past Mapping' website service. The details are tabulated below.

Table 6-4 Cultural Heritage Features within Kingston-on-Spey Village

Feature Type	Reference Number	Address	Details
Listed Building	14848	Kingston, Lein Road, Pebble Cottage	N/A
Listed Building	14843	Kingston, Beech Road, 'The Rocket House'	N/A
Listed Building	14847	Kingston, Lein Road, Spey Village	N/A
Listed Building	14849	Kingston, Lein Road, Sunnybank	N/A
Listed Building	14850	Kingston, Lein Road, The Yews	N/A
Listed Building	14866	Kingston, Lein Road, Morvern	N/A
Listed Building	14844	Kingston, 'Burnside', Burnside Road	N/A
Listed Building	14846	Kingston, Kingston Road, 'Dumfermline House and Garage'	N/A
Listed Building	14867	Kingston, Millbank	N/A
Moray Sites and Monumennts Record (SMR)	NJ36NW0004	N/A	Kingston (Village), Post-Medieval (from 1560), Urqhart
Moray SMR	NJ36NW0003	N/A	Kingston (Manors), Medieval (from 1100AD), Urqhart
Moray SMR	NJ36NW0005	N/A	West End Cottage, Kingston, Post-Medieval (from 1560)

The Table highlights the importance of the village from a cultural heritage perspective. Much cultural heritage is also associated with the River Spey, particularly the bridges crossing the river. This includes the Gartmouth viaduct, built in 1886. Cultural heritage features are shown on Figure 3 in Appendix 1.

6.2.7 Geology, Soils, Hydrogeology and Geomorphology

(a) Drift Geology

The Institute of Geological Sciences (IGS) Drift Geology Sheet, Elgin (Sheet 95) indicates Kingston to be directly underlain by a cover of storm beach deposits. These deposits are likely to be of granular composition with the shear strength typically increasing with depth due to self weight compaction. It is also possible that silt deposits are present due to close proximity of water features (i.e. North Sea and River Spey).

In addition to the storm beach deposits, alluvium of flood plains and undifferentiated alluvium are illustrated. These deposits are likely to be associated with the flood plains of the nearby River Spey.

The storm beach is characterised by gravel ridges, typically running parallel with the coastline. Behind the beach are mature shingle ridges that were developed during the Holocene period.

The coastline is located immediately north of Kingston with beach deposits present. However a former coastline is depicted approximately 0.5km south of Kingston centre and generally mirrors the current coastline. This would appear to indicate that the Kingston area is located on recent deposits or has possibly been dredged.

This is further evident as the former coastline marks a boundary in the superficial deposits with deposits to the south shown as consisting of glacial sands and gravels with localised deposits of boulder clay.

Although not depicted on the drift map a review of the British Geological Society (BGS) map service illustrates a peat deposit east of Cadgers Road approximately 250m south of Kingston. The extents and depth of the potential peat deposits are not known.

Similarly the exact depths and properties of the superficial deposits both north and south of the former coastline boundary are not known due to limited available information. A review of the BGS database has revealed there to be a single borehole (BGS reference NJ36NWS) within the Kingston area and a borehole approximately 1km south of Kingston at Garmouth (BGS reference NJ36SW34).

Borehole NJ36NWS extends to a depth of 17.8mbgl and is located within the area of known storm beach deposits. However it is not known if the presented depth represents superficial deposits or a combination of drift and solid deposits. Borehole NJ36SW34 extends to a depth of 1.98mbgl and is located within the area of known glacial deposits. The depth of the borehole would suggest that shallow bedrock is present. However it is possible that the borehole may have been terminated due to an obstruction etc.

It should be noted that a review of borehole logs has not been conducted at this stage. However it is recommended that review of the logs be undertaken to establish the exact composition and depths of the deposits. Additionally it is

recommended that prior to any construction or works at the site a ground investigation that reflects the proposed works be considered.

(b) Solid Geology

Examination of the IGS Solid Geology Sheet (Sheet 95) indicates that the solid geology below the site consists of sedimentary rocks from the upper Devonian age. The deposit typically consists of Scaat Craig Beds of the Upper Old Red Sandstone.

The nearest known fault is located approximately 4.5km due south of Kingston trending in west to north-east direction.

(c) Hydrology and Hydrogeology

The 1:625,000 BGS Groundwater Map of Scotland indicates the drift deposits to be of highly permeability.

The Hydrogeological Map also indicates the presence of both significant and insignificant aquifers within the area. An aquifer can be defined as a deposit of rock, permeable by groundwater, which may be used to supply groundwater abstraction wells and may also support springs and be in hydraulic continuity with the rivers or other aquifers.

The granular beach deposits are indicated as being aquifers formed by quaternary deposits (coastal and river alluvium). These deposits are of limited potential and will seldom produce large quantities of water for abstraction. However they can be important for local supplies and in supplying base flow to rivers.

A significant aquifer is noted below the areas of the beach and glacial deposits. The aquifer is again shown to be of quaternary sands and gravels and is defined as being locally important with intergranular flow being significant. It is likely that these deposits will provide groundwater capable of significant abstraction.

6.3 Impact of Schemes on Environment

The next phase of the study will consider in detail the impact of the different schemes on the natural environment. The table below gives an indication of the likely and significant impacts at this stage:

Table 6-5 – Main Environmental Impacts

	Main Environmental Impact
Offshore Breakwater	▪ the natural evolution of the coastline would be influenced ▪ the health of vegetated shingle requires fresh supply of material, the offshore breakwater would interrupt this supply
Beach recharge	▪ Use of imported shingle (i.e. not sourced locally) would be of a different composition ▪ Method of recharge and recycling will involve heavy machinery to move the shingle which may disturb/damage the vegetated shingle and create an artificial profile ▪ Regular recycling/renourishment would cause disturbance to bird life

6.4 Data Gaps and Uncertainty

The following additional information and data would be required to inform the environmental study further:
Further information on the features for which each protected site is designated (e.g. through consultation with SNH and SEPA);

- Additional fisheries data/reports through discussions with The Spey Fisheries Board and others;
- Surface and groundwater quality data. This will be obtained from SEPA; and
- Additional archaeological and cultural heritage information (including a full SMR search) from Historic Scotland and Moray District Council.
- Improved understanding of drift geology and solid geology
- Assessment of ground water salinity

6.5 Consultation

Initial contact has been made with the development control representatives from Moray District Council, SEPA and SNH. It is proposed to have a meeting at Phase 2 with key members of the Local Authority, SNH and SEPA to discuss the issues in more detail and to collect any additional, relevant environmental data. Contact will also be made with other relevant stakeholders such as the Spey Fishery Board during the subsequent phases

6.6 Next Steps

The next stage will involve further data collection through desk-top research and consultation with key stakeholders. An assessment will be made of the coastal defence option resulting in the publication of a scoping report which will be submitted to the local authority. It was considered that a formal screening report was not required due to the detailed information collected to date. This will be confirmed with Moray Council before progression to Phase 2.

7 Conclusions

The purpose of the Phase 1 study was to undertake activities to provide greater levels of confidence and understanding of the potential values of the issues, particularly the assets at risks and providing a more robust estimate of the potential management costs. The opportunity was also taken to review the existing information and develop a methodology for taking the project forward.

The outline review has identified that there are three potential viable solutions for the future of flood and erosion risk management at Kingston, these are:

- The construction of an offshore breakwater;
- The use of Beach recharge, combined with recycling of existing material;
- Undertaking a No Active Intervention approach, i.e no longer maintaining the existing defences and allowing Kingston to become vulnerable to the coastal processes. This would eventually lead to the loss of the village.

From the outline economic analysis, it would appear that there is the potential for an economically viable scheme to be developed based around the use of a submerged

breakwater. The economic case for a management strategy based upon the use of beach recharge would appear to be economically inefficient, with very limited potential to achieve a benefit cost ratio of unity.

8 Recommendations / Way forward

8.1 Phase 2

The works proposed for phase 2 remain broadly as set out in our September 2005 proposal. Part of the output from phase 1 was to refine the approach and costs for this second phase of work. This has built upon the understanding of the nature of the problem and the data available. The level of information obtained in Phase 1 shows there is a definite need for a full environment assessment. Therefore it is proposed that Phase 2 of the works will include a full environmental scoping report rather than a screening note. This will give a better understanding of the issues to inform the business case.

The assessment work that is recommended and as described in Section 5.2.will provide a robust assessment of flood risk to the village of Kingston-on-Spey due to potential overtopping or breaching of the shingle ridge. This will be achieved through the application of a range of techniques to understand and quantify the various processes driving flood risk and the shingle ridge behaviour during extreme events.

Based upon these considerations the costs as set out in our September 2005 proposal have been revised. The table below sets out both the initial and revised costs.

Item	September 2005 proposal	Revised Costs Feb 2006
Numerical modelling	£10,323	£14,561
Data Purchase		£3,875
Beach sampling		£6,000
Economic Assessment	£3,984	£4,241
Environmental Scoping Report	£4,139	£4,787
Investigation into feasibility of Moray Firth aggregate site		£2,674
Business Case Report	£4,526	£4,787
Disbursements		£790
Contingency (@25%)	£5,743	£7,669
Total	£28,715	£49,009
Potential HD estuary modelling		3,722
Additional items not previously included		

Table 8-1 Revised costs for Phase 2

The main element of change relates to the numerical modelling works. This reflects the increased scope of work activities now defined. In addition, a sum of £3875 has been added to acquire Met Office wave model data required to undertake the

proposed approach. An allowance (£6,000) has also been made for the sediment sampling exercise. Note the costs for this are based upon our staff undertaking the works. Using Council Staff or a local contractor to undertake this exercise could reduce these costs. Recent initial contact with contractor LDG Grampian Soil Survey indicates that these costs could potentially be halved.

An item has also been included for the investigation into the potential to re-establish the licensed aggregate site within the Moray Firth. The cost exercise identified that if the site could be re-established, it would significantly reduce the cost of beach recharge schemes. It might also address the concerns of SNH regarding the geological composition of the material. This element will be undertaken as a desk based study, with no allowances included for any field investigations.

The costs have also been adjusted to reflect the increase in staff costs to 2006 staff rates relative to that originally specified.

An additional cost of £3722 for the HD modelling has also been identified if the joint analysis of extreme river flows and tide-surge levels indicate that this combination will result in a compromise of the level of protection that the shingle ridge provides to the village of Kingston. The requirement for this will be dependent upon the outcome of the phase 2 studies

At the completion of Phase 2 a report will be produced drawing together the elements of work undertaken during both phases of Stage 1 to provide the outline business case for the long term management of the Kingston frontage and identify those issues that could effectively prevent the management scheme going forward either due to environmental issues or economic viability. An Environmental Impact Assessment Scoping Report will be produced to accompany this report.

Figure 8-1 below, previously shown in the Kingston Coastal Management Recommendation Report (April 2004), shows the Gateway steps identified in scheme development. This shows the necessary steps to scheme implementation. Phase 2 of these initial works will take the process to Gateway 2.

It is anticipated that the works can be completed within a 4 month period with the findings presented to the Council to enable the decisions to be made at Gateway 2 to proceed to the next stage or consider an alternative approach.

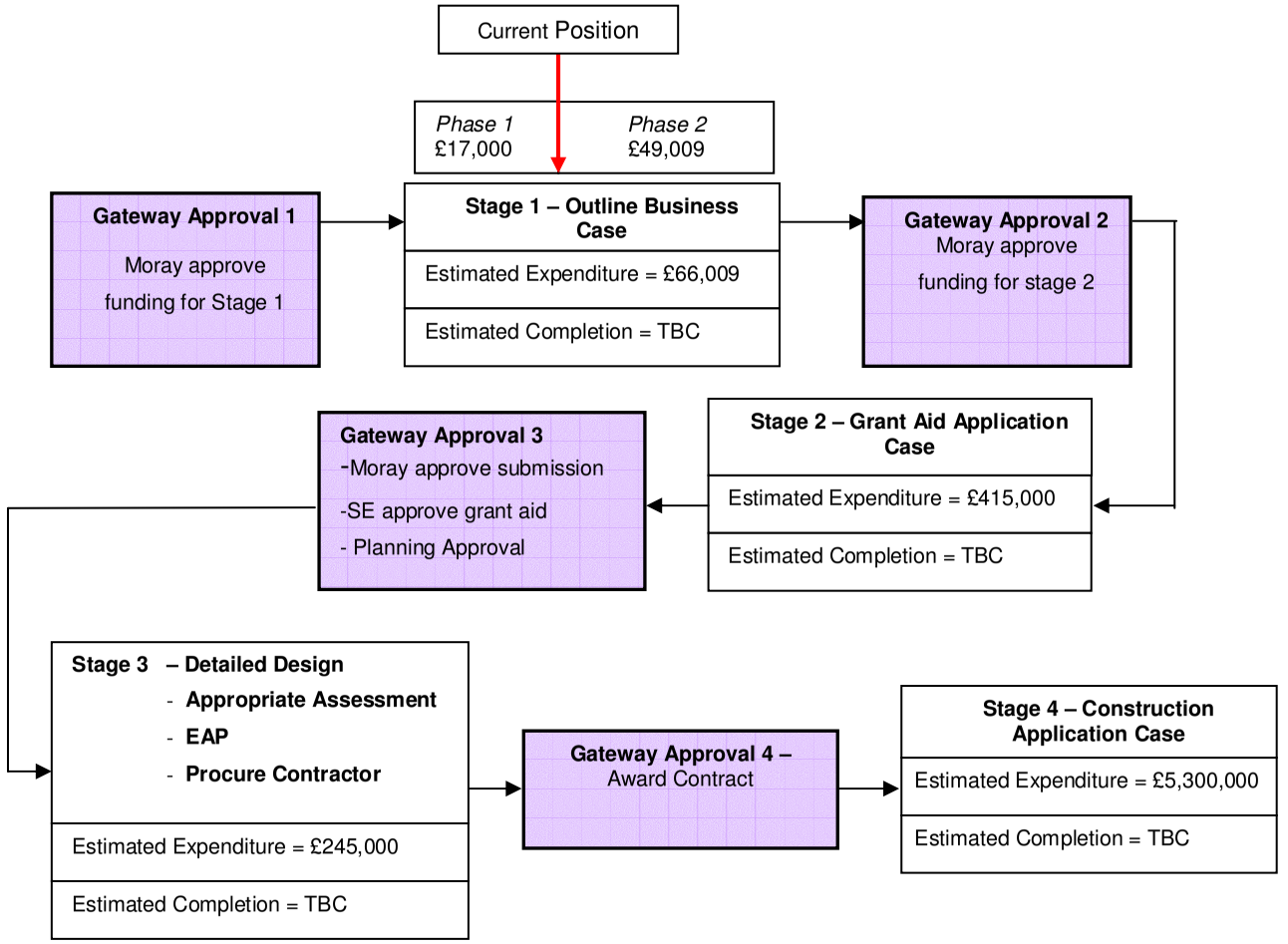
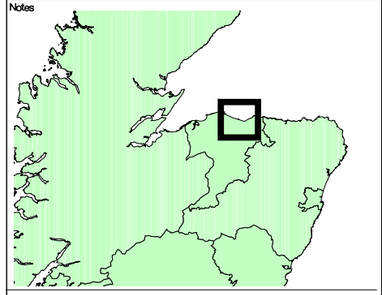


Figure 8-1 Key Stages and Approval Gateways

Appendix A - Figures

Drawing Number: 12082/D3/CR/001

Notes



KEY

Study Area

N

Do not scale this drawing

Rev	Date		Checked

JACOBS BABTIE

Client	
Project	Kingston Coastal Defences
Title	Figure 1 - Location Plan
Drawing No	12082/D3/CR/001
Scale	1:25000 Date: 30/01/08
	Drawn EE Checked JY Approved RT

Maps produced by Jacobs Babtie
95 Bothwell Street
Glasgow, G2 7HX
This map should NOT be rescaled.

Key

- Lower River Spey Site of Special Scientific Interest (SSSI)
- Spey Bay Site of Special Scientific Interest (SSSI)
- River Spey Site of Special Scientific Interest (SSSI)

Spey Bay SSSI

River Spey SSSI

Lower River Spey SSSI

Key

- Special Protection Area and Ramsar
- Special Area of Conservation

Spey Bay SAC

Moray & Nairn Coast SPA & Ramsar

River Spey SAC

Lower River Spey SAC

Drawing Number: 12082/D3/CR/002

Notes

KEY

N

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Rev	Date	Checked

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Client: moray

Project: Kingston Coastal Defences

Title: Figure 2 - Nature Conservation Designations

Drawing No	12082/D3/CR/002		
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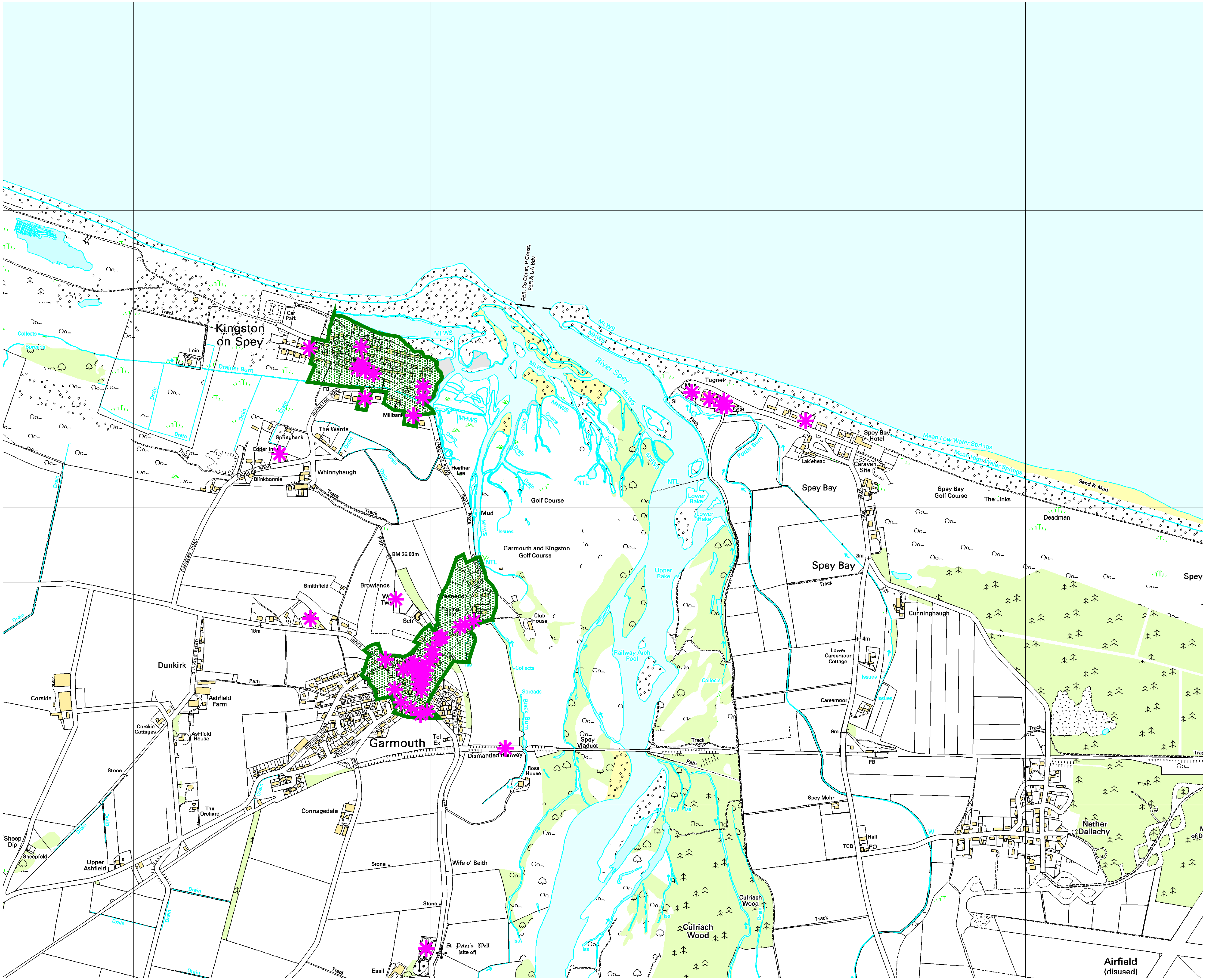

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Drawing Number: 12082/D3/CR/003

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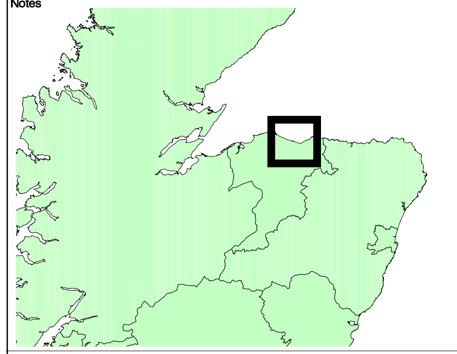

KEY

- Listed Building
- Conservation Area

N

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Rev	Date			Checked

JACOBS BABTIE

Client

Project: Kingston Coastal Defences

Title: Figure 3 - Cultural Heritage and Archaeological Features

Drawing No	12082/D3/CR/003
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