Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

The Moray Council

November 2007
Final Report
9S9650

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1 INTRODUCTION

1.1 Aim of the Study

In October 2007 The Moray Council (the Council) commissioned Royal Haskoning to undertake a Pre-Feasibility Study for a Flood Alleviation Scheme (FAS) at Garmouth.

In accordance with the Council's original brief (*ref letter dated 3rd September 2007 Council ref G.02.01*) and the agreed proposal (*MFA430 October 2007*), the aim of this study is to identify the potential for further investment in a grant eligible FAS for Garmouth. This study concentrates on determining the feasibility of a 1 in 100 year standard FAS for Garmouth. This study addresses the fluvial flood risk presented by the River Spey, but does not consider flood risk from other sources, for example coastal or pluvial.

1.2 The Study Area

1.2.1 General Description

Garmouth is a small rural settlement located in Moray approximately 10 miles east of Elgin. Garmouth consists of approximately 220 households and 500 people *(Moray Local Plan 2000)* and is located on the west bank of the River Spey just 1km inland from Spey Bay. *Figure 1* shows Garmouth's proximity to the River Spey and the Moray Firth. Garmouth is surrounded by agricultural land, except to the east where Garmouth Golf Course separates the village from the River Spey. The Golf Course Club House and the village sewage treatment works are located on the golf course east of the village. The southern extent of the village is defined by the dismantled railway line that runs in an east - west direction and spans the River Spey. Ross House, at Queenshaugh, is a single isolated property located south of the dismantled railway line.

1.2.2 Flood History

Garmouth is located at the downstream end of the River Spey Catchment. The River Spey is a major watercourse and ranks 7th in the UK in terms of estimated peak flow, 8th in terms of mean annual discharge and 9th in terms of catchment area (2988km^2) *(River Spey Catchment Management Plan 2003).*

The vast majority of Garmouth is elevated above the River Spey's natural floodplain. However a small number of properties, located at the north east end of the village, are located at a lower elevation on the edge of the River Spey's floodplain. *Figure 2* shows

the topography of the River Spey valley and Garmouth area. Garmouth's close proximity to the River Spey has meant it has suffered from repeated flooding.

To determine Garmouth's flood history a flood chronology was produced utilising the following sources:

- British Hydrological Society's (BHS) "Chronology of Hydrological Events in the United Kingdom"; *www.dundee.ac.uk/geography/cbhe;*
- Consultation with Council Officers;
- Previous work undertaken to develop the Rothes Flood Chronology;
- The River Spey – Flooding at Garmouth. Engineer's Report and Proposals. *Babtie, Shaw and Morton*. 1995, and;
- An Investigation into the Flooding of Garmouth, Speyside. *Aberdeen University Engineering Services*. October 1993.

The full flood chronology can be found in *Appendix A*. The flood chronology for the River Spey identifies 44 flood events that have occurred in the past 252 years, between 1755 and 2007. This equates to an indicative flood frequency of once every six years. Considering more recent events only, the flood chronology details 20 flood events that have occurred in the last 18 years, between 1989 and 2007. This equates to an indicative flood frequency of more than one event each year.

The apparent increase in flood frequency could be associated with an increase in properties being constructed on the River Spey's floodplain such that there is an increased occurrence of residential flooding and reporting of flooding. Alternatively, the gradual degradation of the existing flood defences may have resulted in a gradual reduction in standard of protection and subsequently an increase in flood frequency.

1.2.3 Existing Flood Risk

The existing flood risk to Garmouth has been assessed by combining a basic steady state HEC-RAS hydraulic model with local flood knowledge. The model consists of eight cross sections (developed using available LiDAR data) and extends 1.5 km south of Garmouth to 0.5 km north of the village. The extent of the model is shown on *Figure 1*. The railway embankment is represented in the model (including the two gaps) but the model does not take into account any tidal affect. The extreme flows used in the model were derived using the Annual Maxima gauged series at SEPA's Boat O' Brig gauge station (MFA075) and are given in *Table 1* below:

Table 1: River Spey Flood Frequency Estimation

Return Period (years)	Peak Flow (m^3/s)
5	734
10	897
25	1143
50	1363
100	1621
200	1926

The model provides an estimate of the water level – return period relationship upon which flood risk can be estimated.

Figures 3 – 8 show the estimated existing flood risk to Garmouth at the 5, 10, 25, 50, 100 & 200 year return periods. There is good correlation between the flood extents estimated during this study and SEPA's 1 in 100 year fluvial flood risk map, given in *Appendix B*.

The key flood mechanism at the lower return periods (5 and 10 years) appears to be the River Spey breaking its left bank upstream of the railway embankment. The floodwater then flows across the floodplain inundating Ross House and surrounding fields, before flowing through two gaps in the railway embankment. Flood water then follows the line of the Black Burn before flooding the north east area of Garmouth. Specific flood mechanisms above the 10 year return period are less clear as the depth of water is sufficient to flood the whole River Spey valley. 2D hydrodynamic modelling would be required to determine additional flood mechanisms, the interaction between fluvial flow and the tidal effect and key risks such as flow velocity.

Local knowledge gained through consultation with Council officers indicates that parts of Garmouth village flood on an annual basis. *Figure 9* shows the indicative annual flood extent based on local knowledge. Two properties (Ross House and Willowbank) are known to have flooded annually in recent years. A comparison of *Figures 3* and *9* shows there is a good correlation between the observed annual flood extent and the estimated 5 year return period flood extent.

Table 2 shows the number of properties at flood risk for the range of return periods.

Table 2: Number of Properties at flood risk in Garmouth

Return Period (years)	Residential Properties	Other Properties
1	2	-
5	6	The Church Hall & Village Hall
10	6	The Church Hall & Village Hall
25	6	The Church Hall, Village Hall & Golf Club House
50	6	The Church Hall, Village Hall & Golf Club House
100	6	The Church Hall, Village Hall & Golf Club House
200	6	The Church Hall, Village Hall & Golf Club House

Table 2 shows that six residential properties are estimated to be at flood risk in Garmouth. All six properties are at flood risk from the 1 in 5 year return period, as are the Church Hall & Village Hall. The Golf Club House is estimated to be at risk from return periods above 1 in 10 years.

1.2.4 Environment

A Baseline Environment Study has been undertaken to identify all the key environmental issues and their potential implications on the development a FAS. The baseline study has been used to inform the wider team of the environmental issues and has influenced the option development. The Baseline Environment Study is provided in full in *Appendix C*.

In summary, the River Spey catchment and Spey Bay are very heavily designated for a wide range of habitats, species and landforms. Environmental designations within the study area include several international, European, national and local designations. Specific designations include; Special Areas of Conservation (SAC's) designated under the EC Habitats Directive (1992), Special Protection Areas (SPA's) designated under the EC Birds Directive (1979) and Sites of Special Scientific Interest (SSSI's) notified under the Wildlife and Countryside Act (1981). The River Spey SAC designation is based on the presence of four international SAC qualifying species. These are Atlantic salmon, sea lamprey, otter and freshwater pearl mussel. The most significant habitat in the area is the vegetated shingle habitats. The baseline study identifies several of the six residential properties at flood risk and the railway embankment as listed buildings.

1.2.5 Geomorphology

A Baseline Geomorphological Study has been prepared to identify the primary geomorphological processes, historical trends and likely future trends. The study was undertaken in consultation with representatives of Scottish Natural Heritage (SNH) and Scottish Environmental Protection Agency (SEPA) who have a detailed knowledge of the current geomorphological processes. The baseline study provided a platform of knowledge on which to assess the likely impacts of any proposed flood alleviation options or management strategies on the geomorphological processes within the application area. The Baseline Geomorphological Study is provided in full in *Appendix D*.

In summary, the Lower River Spey and Spey Bay are of high geomorphological value and highly geomorphologically active. There are three SSSI's underpinning the area's SAC designations; the Lower River Spey, The River Spey and Spey Bay. The Lower River Spey designation cites fluvial geomorphology as one of its defining characteristics. The area is also designated a Site of Interest for Natural Science (SINS) for its geomorphological interest.

2 BASELINE FLOOD DAMAGE ASSESSMENT

2.1 Introduction

A baseline flood damage assessment has been undertaken to provide an estimate of potential "do nothing" flood damages in Garmouth. The "do nothing" flood damage estimate will then be set against a cost estimate for each identified option to provide an outline benefit-cost ratio. The baseline flood damage assessment is primarily based on the six residential properties at flood risk.

Two estimates of baseline damages have been undertaken to provide a comparison. The first estimate utilises previous MFA work to provide an estimate of 'Do Nothing Present Value Damage (PVD)' per property. The second method recognises the Scottish Government's requirement to cap residential flood damages at the market value of the property.

2.2 Estimate 1: MFA Experience

Table 3 below shows the PVD per property for the Elgin (MFA473), Rothes (MFA355) and Forres (Burn of Mosset) FAS (MFA178 & 236):

Table 3: PVD per property for other Moray FAS

FAS	PVD per property (£)
Elgin	38,585
Rothes	51,643
Forres (Burn of Mosset)	55,237
Average	48,490

Key influences on PVD that may account for the variation in individual schemes includes frequency of flooding, depth of flooding and property type and value.

Using the average PVD per property from previous MFA schemes, an indicative baseline flood damage estimate for Garmouth is calculated as 6 x £48,490 = £296,940. Allowing for some additional flood damages to the Church Hall, Village Hall and the Golf Course Club House flood damages are likely to be of the order of £350,000.

2.3 Estimate 2: Capped Market Value:

The Scottish Government requires the flood damages for any individual property to be capped at the estimated market value of the property. The market value of the properties in Garmouth therefore provides an upper limit to potential flood damages in Garmouth.

Property value websites were researched to establish an average property value in Garmouth based on recent sale prices. This resulted in an average property value in Garmouth of £116,000. With six residential properties at flood risk, the upper limit of flood damages in Garmouth is estimated to be £700,000.

2.4 Summary

The indicative baseline flood damages in Garmouth are therefore estimated to be £350,000.

3 FLOOD RISK MANAGEMENT OPTIONS

3.1 Introduction

An optioneering workshop was held on the 1st November 2007 with the aim of generating initial flood alleviation ideas. Seven members of the project team were present, including representatives of the Council and Royal Haskoning. Project team members present at the workshop spanned the key project disciplines; engineering, environment and geomorphology.

3.2 Options

The team was encouraged to take a catchment approach and the following initial ideas were identified:

- Do nothing;
- Maintain existing practice;
- Catchment management;
  - Land use management / Afforestation.
- Flood storage;
  - Online and Offline storage.
- Channel diversion;
- Channel dredging;
- Culvert River Spey underground to Spey Bay;
- Temporary and / or demountable defences, and;
- Flood Embankments.

Each of the flood alleviation ideas identified is discussed below.

3.2.1 Do Nothing

The 'true' do nothing scenario involves walking away from a problem and not undertaking any works at all. The 'Flood Prevention and Drainage (Scotland) Act 1961' (amended in 1997) places duties on Local Authorities to assess the condition of watercourses from 'time to time' to determine if the watercourse is likely to cause flooding of non agricultural land, and exercise their powers to reduce flood risk if a risk is identified. The Council prioritises maintenance based on risk assessment and budget constraints (i.e. maintenance issues are identified and ranked according to potential flood risk severity). As many as possible of the top ranking maintenance issues are then dealt with within the budgetary constraints. Therefore, a do nothing scenario may occur if the flood risk maintenance issues at Garmouth are not significant enough to be prioritised within the budgetary constraints. A do nothing option does not provide increased flood protection to Garmouth.

3.2.2 Maintain Existing Practice

At present the Council undertakes minor ad-hoc works as the need arises. The works are identified during routine watercourse inspections, during post flood event inspections or through notification of need by the community. The works are prioritised under the risk assessment system described above and undertaken if budgetary constraints allow. The majority of recent works involve erosion protection, vegetation clearance from drainage ditches and drainage network repairs *(The Moray Council Biennial Report 2005)*. Maintaining existing practises does not provide increased flood protection to Garmouth.

3.2.3 Catchment Management

A catchment management approach identifies specific areas of land in the catchment where a change in land use would improve the attenuation characteristics of the area and reduce peak flows reaching Garmouth. Catchment management methods may include;

- Afforestation (increasing the tree cover in the catchment, including wet woodlands) to increase rainfall interception and slow the catchments hydrological response;
- Replacing arable land for grassland to increase infiltration & reduce runoff;
- Reducing intensive grazing (particularly sheep) to improve catchment infiltration;
- Improving moorland management through construction of strategic "moorland grips" to reduce runoff.

A catchment management approach would require the co-operation of landowners who would be required to change or limit their existing land use practices.

Whilst catchment management is a sustainable method of reducing flood risk, the hydrological and flood risk benefits generally take a number of years to be realised. For example, catchment experiments within the UK have demonstrated that afforestation (70% afforested catchments) can reduce peak flows by up to 15% *(Institute of Hydrology 1976)*. However, further studies have demonstrated that the time taken for the canopy to reach maturity to offer this 15% reduction is approximately 18 years (Robinson et al 1998).

The Council would have difficulty in promoting such an approach as a structured flood alleviation strategy. The Scottish Government has stated that such an approach would not be grant eligible. The Council would therefore have to fund 100% of the costs associated with implementing a catchment management approach. The estimated costs associated with afforestation for various proportions of the River Spey's catchment are shown in *Table 4 below*. In addition, the Council has very little control over the stewardship of land in private ownership.

Table 4: Estimated River Spey Catchment Afforestation Costs*

Proportion of River Spey Catchment	Area (km^2)	Cost of Afforestation (£ Million)
¼	747	62.2
1/3	996	83.0
½	1494	124.5
¾	2241	186.7

* based on a cost estimate of £83,300 per km^2 (MFA016)

3.2.4 Flood storage

Flood storage involves the retention and controlled release of flood water upstream of the flood risk area and can take the form of online or offline storage.

Online storage involves storing flood water upstream of an impounding structure that spans the river valley and releases flow in a controlled manner. Online storage is not considered a viable option for the River Spey for a number of reasons:

- The volume of water requiring storage to achieve a 1 in 100 year standard of defence is of the order of 10 mn m^3. The construction cost of such a scheme would far exceed the baseline flood damage estimate outlined in *Section 2*.
- Online flood storage would significantly alter the hydrological and geomorphological regime of the river and very likely have significant impacts on several important sites with environmental designations, and;
- The River Spey is known to have a highly mobile, coarse sediment load. Any storage site would be subject to a high rate of sedimentation and subsequent loss of storage volume. A high maintenance regime for sediment removal would therefore be required.

Offline storage involves diverting floodwaters from the main channel to a controlled flood area (adjacent floodplain or storage reservoir) thereby reducing peak flows and volumes. The stored flood water is then released back into the main channel in a controlled manner when water levels have dropped. The removal of flood embankments protecting agricultural land is often an effective way of reconnecting the watercourse with its natural floodplain and increasing upstream attenuation. A detailed study of potential offline storage sites within the River Spey catchment is beyond the scope of this study, but an

initial review of the Ordnance Survey maps of the catchment suggests there may be a number of potential sites. Despite this it is very unlikely that an offline storage scheme would be economically viable as landowner compensation would almost certainly greatly exceed the baseline flood damage estimate outlined in *Section 2*.

3.2.5 Channel Diversion

Channel diversion alleviates flooding by diverting flood flows around or away from the problem area. The high natural topography around Garmouth prohibits channel diversion to the west as a means of flood alleviation from the River Spey, see *Figure 2*. The location of Bogmoor and Spey Bay villages on the eastern floodplain makes diversion of the River Spey to the east unfeasible. Furthermore, and most significantly, the high geomorphological activity of the River Spey would make a channel diversion extremely difficult to maintain and subsequently expensive.

3.2.6 Channel Dredging

Channel dredging as a means of increasing channel capacity and hence, reducing flood risk, is unsustainable. As discussed above, The River Spey is known to have a highly mobile coarse sediment load and any dredged channel would simply fill back up with sediment. The unsustainable nature of this idea means it is contrary to the objectives of the Water Framework Directive and subsequently if promoted would be very unlikely to obtain the necessary environmental licenses under the Controlled Activities Regulations (2005).

3.2.7 Culvert River Spey underground to Spey Bay

This idea is not considered technically feasible.

3.2.8 Flood Barriers

Flood barrriers prevent flood inundation by acting as a physical barrier to flow. The barriers could take the form of permanent flood embankments or walls or alternatively temporary and / or demountable defences.

Temporary and / or demountable defences are non-permanent flood defences assembled and used only during high flow events. Temporary and / or demountable defences require sufficient flood warning lead time in order to be mobilised and erected. Consultation with SEPA officers (Derek Fraser – SEPA Aberdeen) indicated that due to

the large size of the Spey catchment (2988km^2) and the good network of river level gauge stations within the catchment, flood warning lead times are often in the region of 24 hours.

Temporary and / or demountable defences have a high operational requirement with trained teams required to be on call on a permanent basis. This high operational requirement is undesirable for the Council.

Several alignments of potential flood embankments that would offer protection to Garmouth were identified during the optioneering workshop. The embankment alignments identified are listed and discussed below:

Alignment 1: Set-back flood embankment around Garmouth;
Alignment 2: Embankment on west bank of River Spey protecting all*;*
Alignment 3: Embankment on west bank of River Spey north of the railway embankment plus infilling of railway embankment;
Alignment 4: Localised ring fencing of properties, and;
Alignment 5: Infill railway embankment gaps.

Alignment 1 – Set-Back Flood Embankment around Garmouth.

Description:

This option involves the construction of a 0.8km flood embankment around the eastern perimeter of Garmouth. Alignment 1 is shown on *Figure 10*. The embankment would be set-back as far as possible from the River Spey to maximise the use of the River Spey's natural floodplain and limit embankment height. The maximum embankment height for a 1 in 100 year standard of protection would be approximately 2.5m.

Issues & Risks:

- Does not provide protection to Ross House, the golf course club house or the Scottish Water wastewater treatment facility;
- Road crossings are required for the Kingston Road & the golf course access track;
- The local surface deposits are highly permeable alluvial sands and gravels, likely to affect the geotechnical design of the embankment;
- Some tree and vegetation removal would be required, and;
- Several of the houses adjacent to the embankment are listed. Care would need to be taken not to affect their foundations. Furthermore the embankment may cause a visual impact for the protected residents.

Benefits:

- Alignment 1 provides protection to five residential properties;
- The set back embankment limits the impact on the River Spey's natural hydrological and geomorphological regime as well as reducing embankment erosion risk, and;
- The impact on the golf course is minimised.

Cost Estimate:

Utilising flood embankment cost estimates from the River Findhorn FAS (developed by Morrison Construction Services Ltd), the indicative cost of a representative flood embankment is approximately £835 per metre. This cost estimate is based on the 'North Forres' embankment which is similar in nature to the embankment discussed above (set back from the river). The cost of the flood embankment outlined in Alignment 1 would therefore be approximately £670,000. Allowing additional expense for crossing the Kingston Road and golf course track, land negotiation and operation and maintenance, the whole life cost of Alignment 1 is likely to exceed £1 million.

Alignment 2 – Flood Embankment on West Bank of River Spey Protecting All.

This option involves the construction of a 1.5km flood embankment to the north and east of Garmouth to protect all properties at risk of flooding. Alignment 2 is shown on *Figure 11*. This option would not be economically justifiable as the cost of the flood embankment alone would be approximately £1.25mn.

Alignment 3 – Flood Embankment on West Bank of River Spey with Infilling of Railway Embankment.

This option involves the construction of a 1km flood embankment to the north and east of Garmouth to protect all properties north of the dismantled railway embankment. Alignment 3 is shown on *Figure 12*. The embankment would tie into the existing railway embankment with the two gaps in the dismantled railway embankment, known to be flow routes during high flow events, in-filled.

This option would not be economically justifiable as the cost of the flood embankment alone would be approximately £835,000.

Alignment 4 – Localised Defences around Properties

This option involves constructing localised defence structures around individual properties and clusters of properties. Alignment 4 is shown on *Figure 13*. The total length of embankment required is approximately 1km. The Kingston Road would need to be raised over a length of approximately 250m and form part of the embankment.

Again, this option would not be economically justifiable as the cost of the flood embankment alone would be approximately £835,000.

Alignment 5: Infill railway embankment gaps

This option would be to block the two gaps in the left hand side of the railway embankment. The gaps are known to act as a flow route for flood water into Garmouth. This option would be significantly cheaper than any of the above embankment options but would be unlikely to achieve a 1 in 100 standard of protection. 2D hydraulic modelling would be required to determine the standard of protection provided by this option and the knock on hydrological and geomorphological consequences of blocking this flow route.

3.2.9 Summary of Options

Table 5 provides a summary of the flood risk management options discussed above:

Table 5: Summary of Flood Risk Management Options

Option	Standard of Defence (yrs)	Technically Feasible	Economic	Sustainable
Do Nothing	< 5	-	-	-
Maintain Existing Practice	< 5	-	-	-
Catchment Management	100	Y	N	Y
Flood Storage				
On line	100	Y	N	N
Off line	100	Y	N	Y
Channel Diversion	100	Y	N	N
Channel Dredging	100	Y	N	N
Culvert River Spey	100	N	N	N
Flood Embankments				
Temporary /Demountables	100	Y	N	Y
Alignment 1	100	Y	N	Y
Alignment 2	100	Y	N	Y
Alignment 3	100	Y	N	Y
Alignment 4	100	Y	N	Y
Alignment 5	< 100	Y	?	Y

Table 5 demonstrates that whilst there may be technically feasible 1 in 100 year standard flood alleviation options none are economically justifiable.

3.3 Flood Risk Management Strategies

3.3.1 Introduction

At present there are a number of people and properties at flood risk from the River Spey. The River Spey is a powerful watercourse that has the potential to cause considerable damage, with structural damage to property and loss of life a serious risk during a major flood event. This situation is likely to be exacerbated by climate change. There is a range of long term flood risk management strategies that could be implemented that would reduce the existing flood risk in Garmouth. These are described below:

3.3.2 Development Control

The Moray Local Plan (2000) states 'whilst Garmouth may appear to have reached it's optimal size, gap site development continues'. With specific reference to flood risk the Local Plan states 'Flooding risk and sewage capacity have been a constraint to development and the Council is investigating a detailed flood risk policy in relation to specific types of development proposals'. The relevant extract for Garmouth from The Moray Local Plan (2000) is given in *Appendix E*.

MFA and the Council's Development Control team should review the existing flood risk policy, strengthen development control in the village and ensure no further properties are built in the River Spey's floodplain.

3.3.3 Progressive Retreat

The properties identified to be at flood risk from the River Spey are listed in *Appendix F*. As and when these properties are placed on the market for sale, the Council could buy them and remove them from the floodplain. This strategy would gradually reduce the number of people and properties at flood risk and, if pursued long enough, would *eliminate* the risk of flooding from the River Spey to Garmouth. Although not grant eligible, the cost of this strategy would be spread over several years. This strategy is in line with UK national flood risk management policy 'Making Space for Water' (DEFRA 2004) and could eliminate flood risk rather than just reduce it.

3.3.4 Removal of Properties

A more direct approach than the 'progressive retreat' strategy would be to compulsory purchase the six residential properties currently at flood risk and remove them from the floodplain.

This strategy would eliminate flood risk in Garmouth within a relatively short time period, but may encounter community and resident resistance and objection.

3.3.5 Flood Proof Properties

The six residential properties at flood risk could be flood proofed to make them more tolerant to flooding. Simple and relatively low cost flood proofing techniques include;

- Preventing water from entering the property by installing flood gates, removing ground level air vents / bricks;
- Ensuring there is a flow route through the property so that flood water can exit the building, rather than ponding in it;
- Changing interior ground floor surfaces to hard surfaces such as flagstones. Hard surfaces are much more resistant to flooding than traditional soft floor coverings (carpets etc) and can be washed down following a flood event, and;
- Raising the electric circuits and wiring to above the estimated flood level.

3.3.6 Improved Flood Warning

Regardless of what flood alleviation measures or strategies are proposed for Garmouth, there is benefit to increasing the length of flood warning time for the River Spey issued prior to a flood event. The greater the flood warning lead time the more time people have to prepare for the onset of flooding and the more time the emergency services and responsible authorities have to react in preparation for an event. Consultation with SEPA officers (Derek Fraser – SEPA Aberdeen) indicated that due to the large size of the Spey catchment (2988km^2) and the good network of river level gauge stations within the catchment flood warning lead times are often in the region of 24 hours and that this is unlikely to be improved significantly. Improvements should therefore focus on the effective dissemination of the flood warning and reaction of those at risk. This is best achieved through community education discussed below.

3.3.7 Community Education

Raising the community's awareness of the flood risk, how to obtain flood warnings and how to effectively respond to a flood warning could significantly reduce the risk to life and

property in Garmouth. Raising community awareness could be easily and cost effectively achieved through holding individual meetings with those at flood risk.

3.3.8 Emergency Planning

Flood events are difficult, stressful scenarios to deal with. However a rapid, effective response can significantly reduce the risk to life and property and greatly reduce the overall impact of a flood event. Having a comprehensive emergency plan that is readily available and easy to understand and communicate will significantly increase the chance of an effective flood response. Emergency Plans can be tailored towards either the residents at risk of flooding or the responsible authorities. A comprehensive emergency plan for residents may include information on:

- Flood warnings and what to do when you receive one;
- Emergency contact numbers;
- Developing a Family Flood Plan;
- Local Emergency Accommodation;
- Cleaning up after a flood, and;
- Useful telephone numbers, websites etc.

A comprehensive emergency plan for responsible authorities may include information on:

- Roles and Responsibilities;
- Flood risk areas;
- Contact information for residents at risk;
- Identified access routes, and;
- Local Emergency Accommodation.

4 CONCLUSIONS

The conclusions that can be drawn from this report include:

- The River Spey has a long history of flooding Garmouth with recorded events dating back to 1755;
- 44 flood events have been identified over the past 252 years which is equivalent to an indicative flood frequency of once every six years;
- Over the past 18 years, 20 flood events have been recorded which is an indicative flood frequency of more than one event a year;
- Six residential properties, the church hall, village hall and the golf course club house are currently at flood risk in Garmouth;
- The six residential properties, church hall and village hall are estimated to be at flood risk at the 1 in 5 year return period;
- Two residential properties within Garmouth regularly flood on an annual basis;
- Present Value flood damages in Garmouth are approximately £350,000;
- Whilst it might be technically possible to develop a FAS for Garmouth with a 1 in 100 year standard of protection the scheme would not be economically justifiable;
- A range of long term flood risk management strategies exist that, if adopted by the Council, would reduce and possibly eliminate the fluvial flood risk from the River Spey to properties in Garmouth.

5 RECOMMENDATIONS

Based on the findings of this report it is recommended that:

1 The Council **does not** invest further in the development of a 1 in 100 year capital flood alleviation scheme as it is highly unlikely that a positive benefit – cost ratio could be achieved;

2 The Council **does** invest further in developing a range of long term flood risk management strategies that over time would reduce the flood risk in Garmouth. It is recommended that The Council invest in the following activities to manage flood risk in Garmouth:

- i Consultation between the Council's Development Control Team and Royal Haskoning to disseminate flood risk information and knowledge and ensure no further development occurs on the River Spey floodplain;
- ii Undertake 2D hydrodynamic modelling of the River Spey and Spey Bay to better understand the flood risk and hazards to Garmouth. This would be achieved through a better understanding of the flood mechanisms, fluvial / tidal interaction and potential flow velocities during extreme events[1];
- iii Hold a 2 day workshop (site visit and workshop) to develop further the following long term flood risk management strategies for Garmouth:
  - Progressive retreat from the floodplain;
  - Removal of property from the floodplain;
  - Flood proofing properties, and;
  - Enhanced emergency planning.

3 Once the appropriate flood risk management strategy for Garmouth has been determined, undertake a programme of community education involving individual meetings with property owners at flood risk too discuss future options.

[1] This level of hazard mapping is likely to be required under the EU Floods Directive.

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12. MFA236 Burn of Mosset FPO Technical Report. June 2005.
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15. MFA430 "Garmouth Flood Alleviation Scheme Pre-Feasibility Study – Proposal Supporting Information*" October 2007*.
16. MFA473 Flood Damages and Scheme Benefits, Version 2. November 2007.

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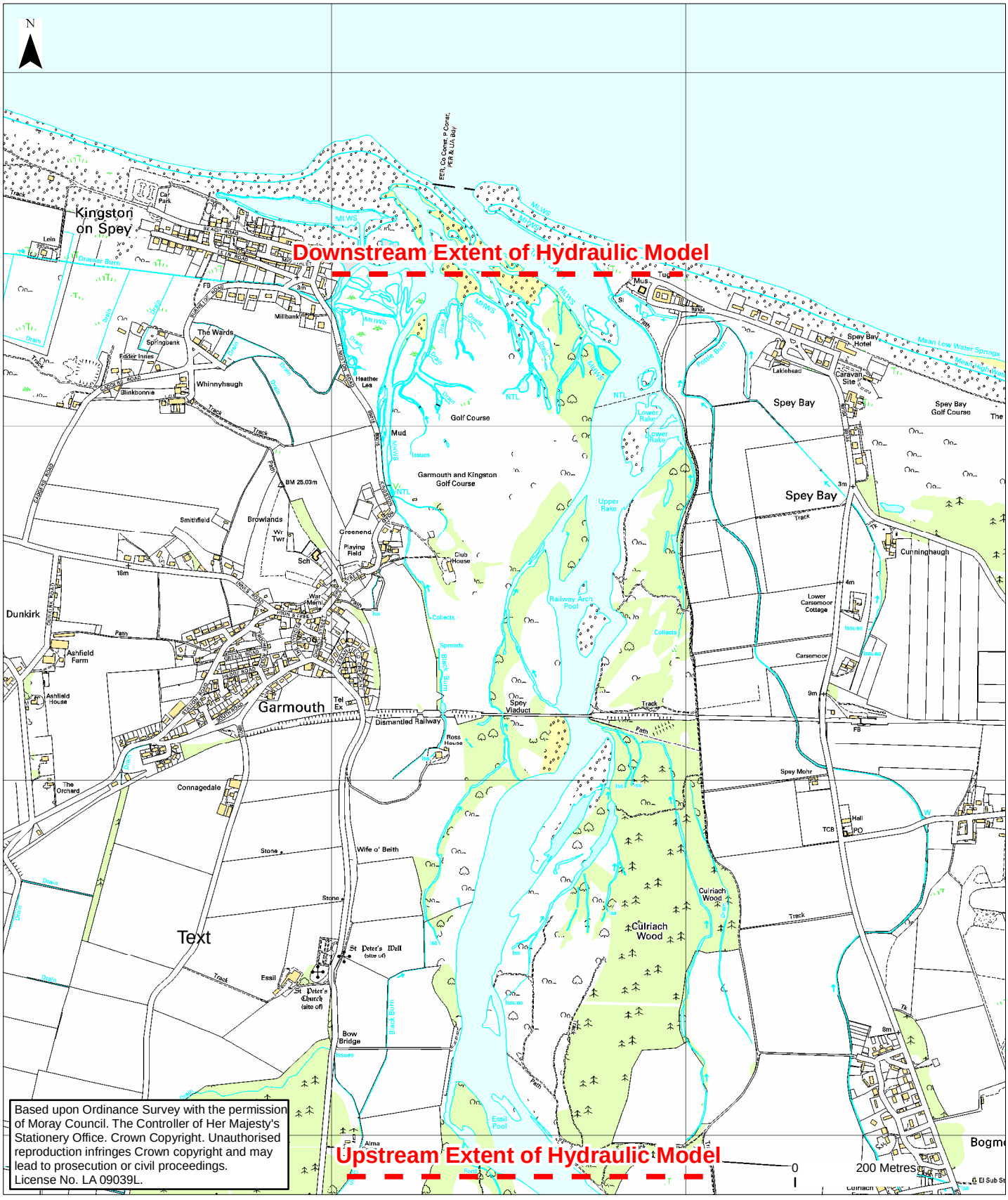
FIGURES



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Project:
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Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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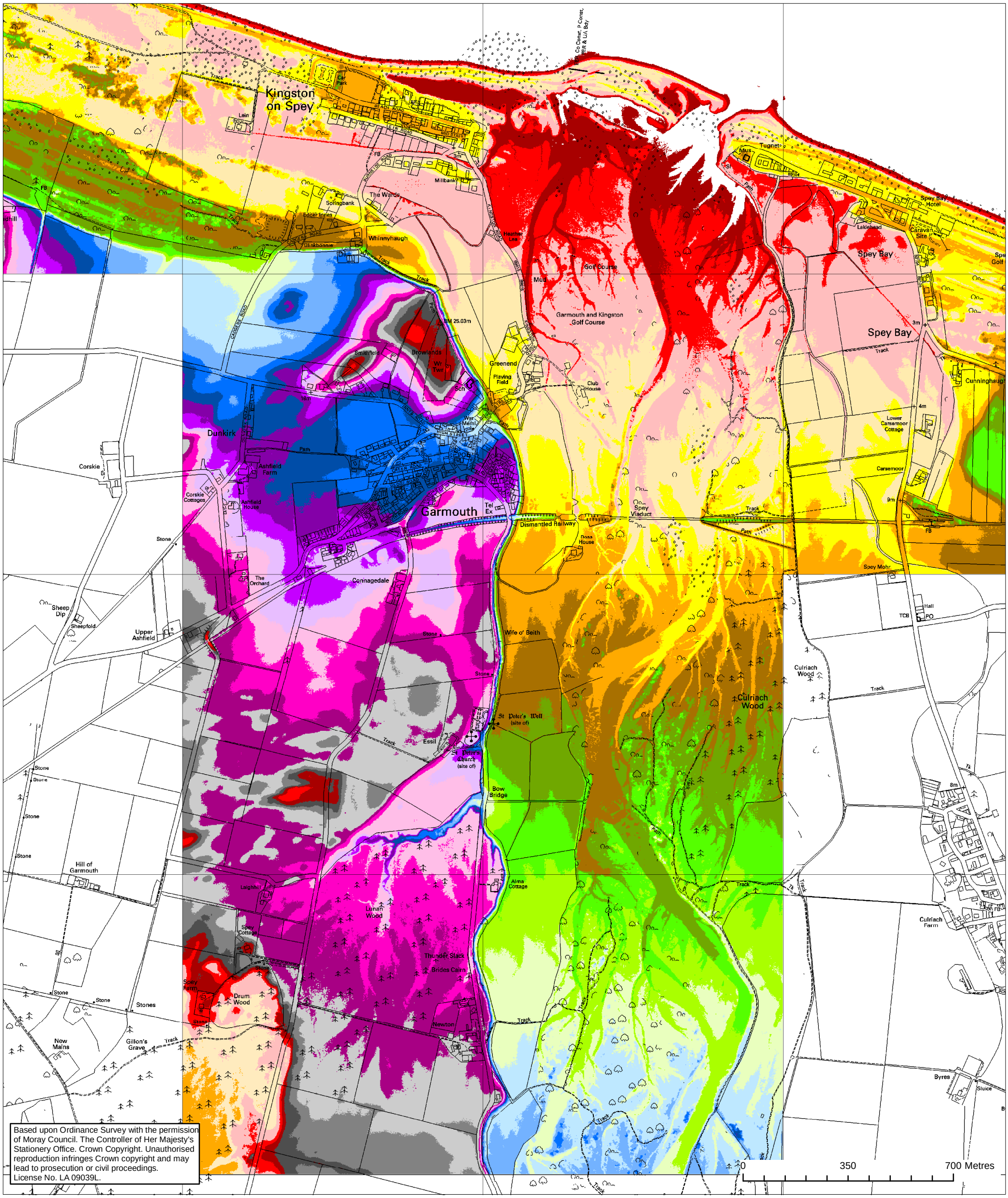

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Project:
Garmouth Flood Alleviation Scheme Pre-Feasibility Study

Client:
The Moray Council

Figure:
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Date:
November 2007

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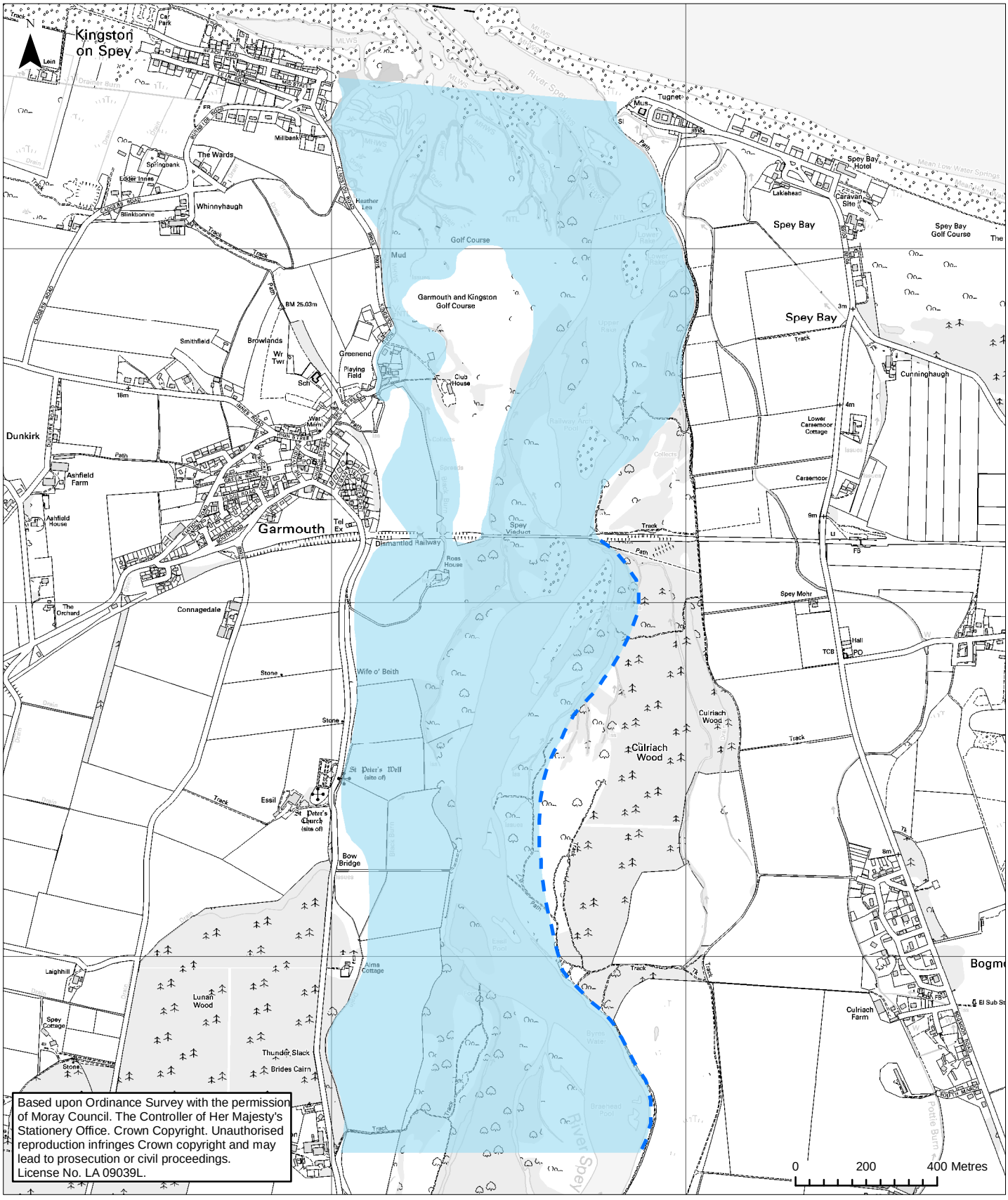

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Area of Lower Confidence

Flood Extent

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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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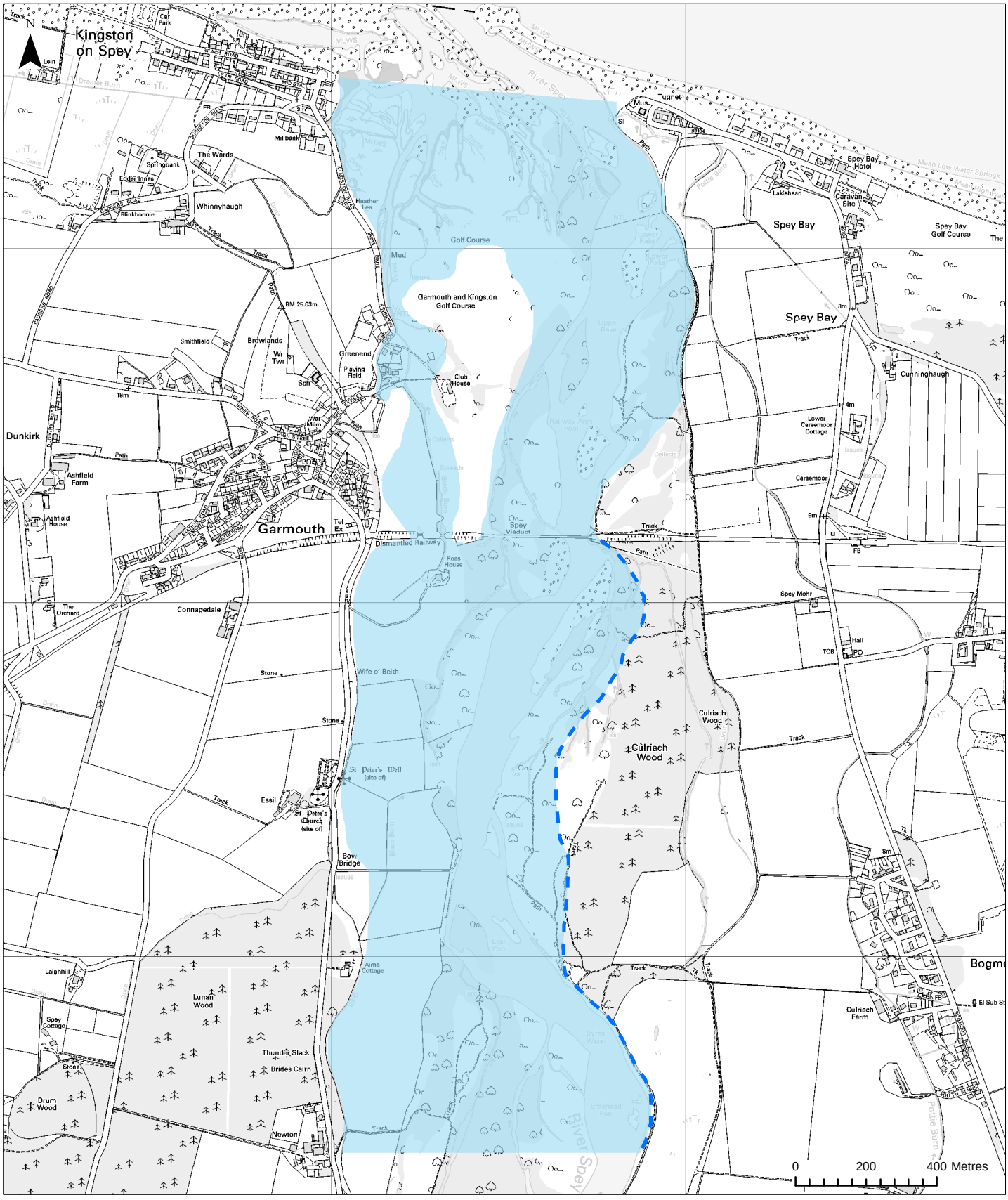

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Area of Lower Confidence

Flood Extent

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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Figure:
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Date:
November 2007

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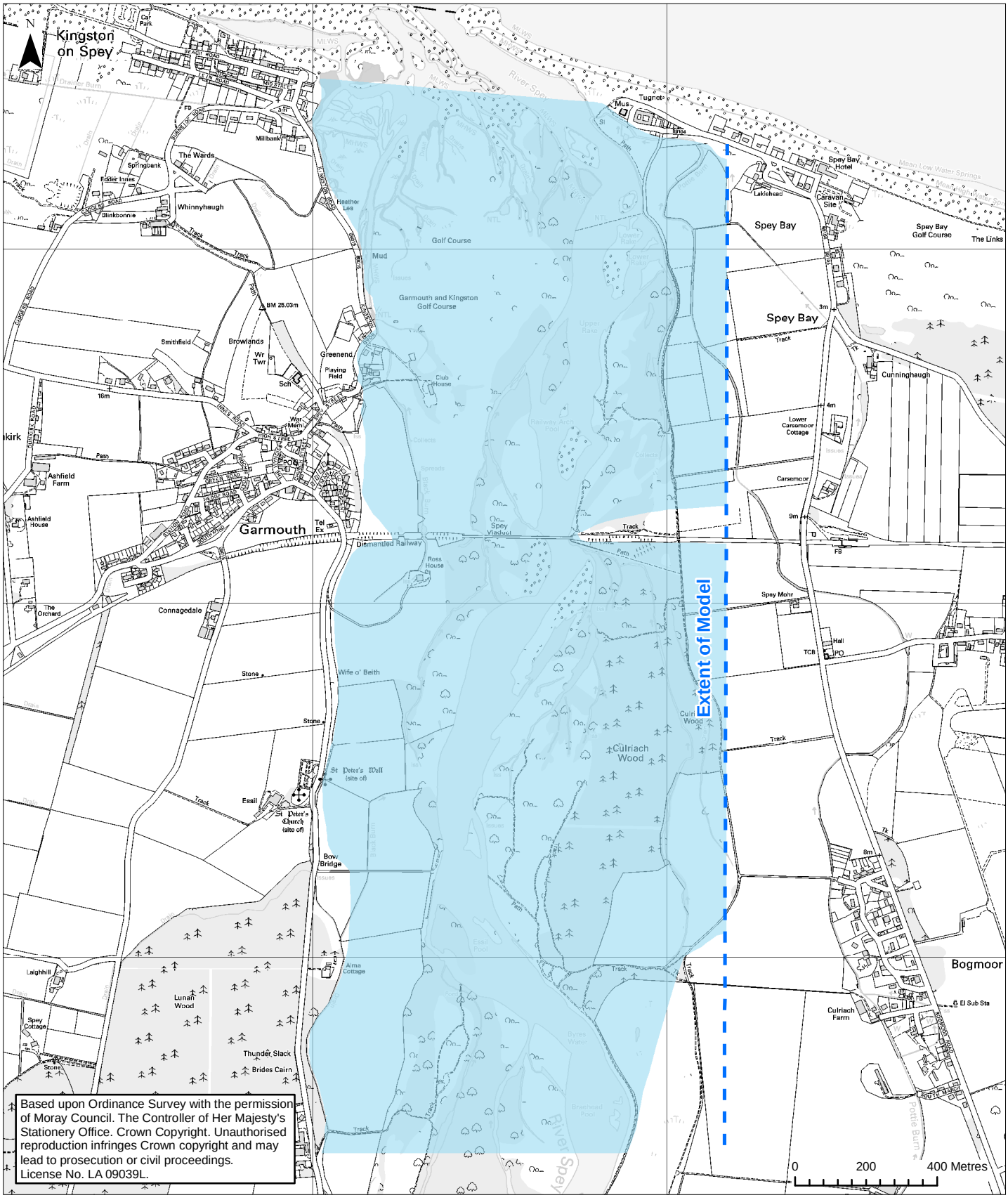

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Source:

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Title:
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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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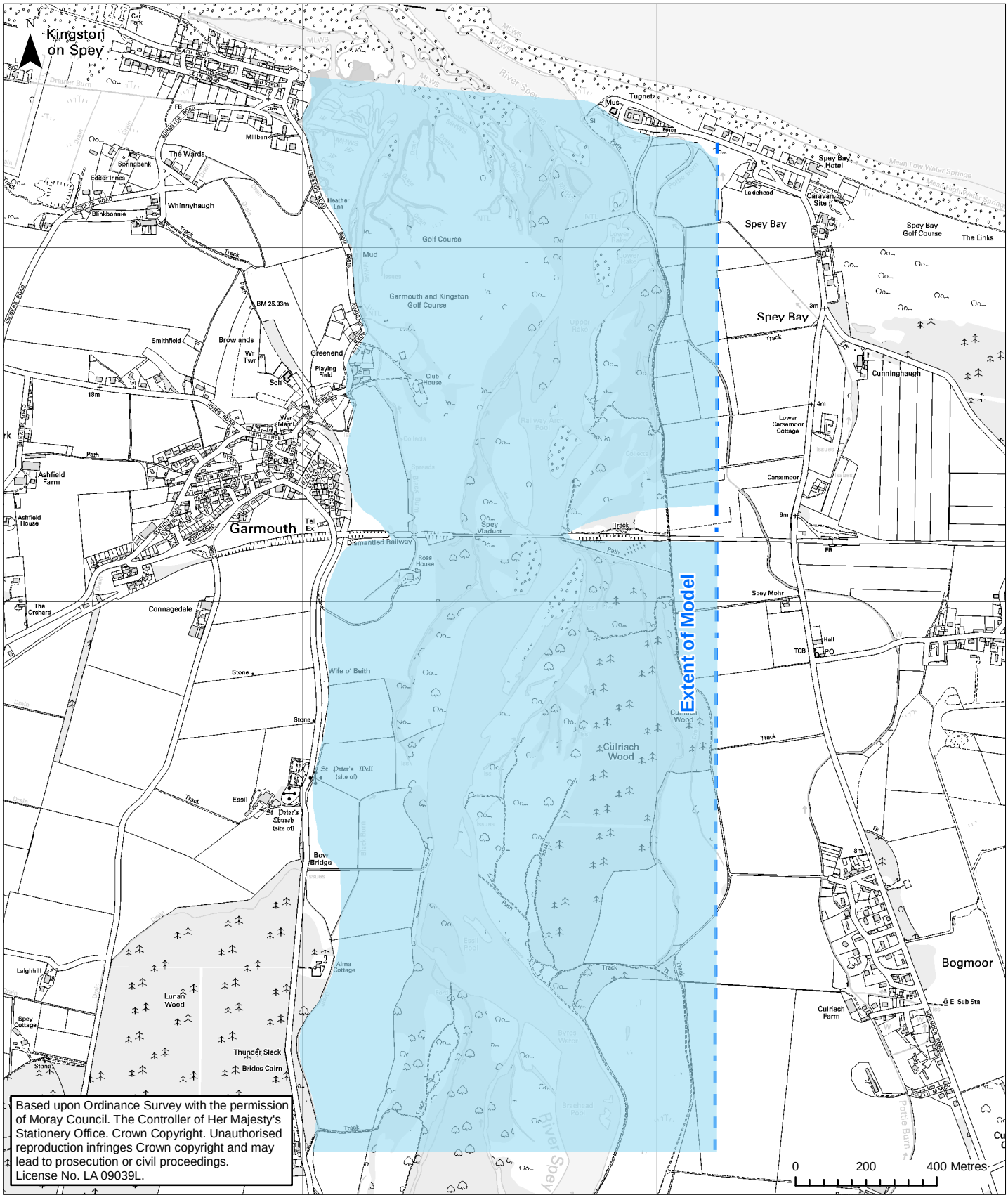

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Area of Lower Confidence

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Project:
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Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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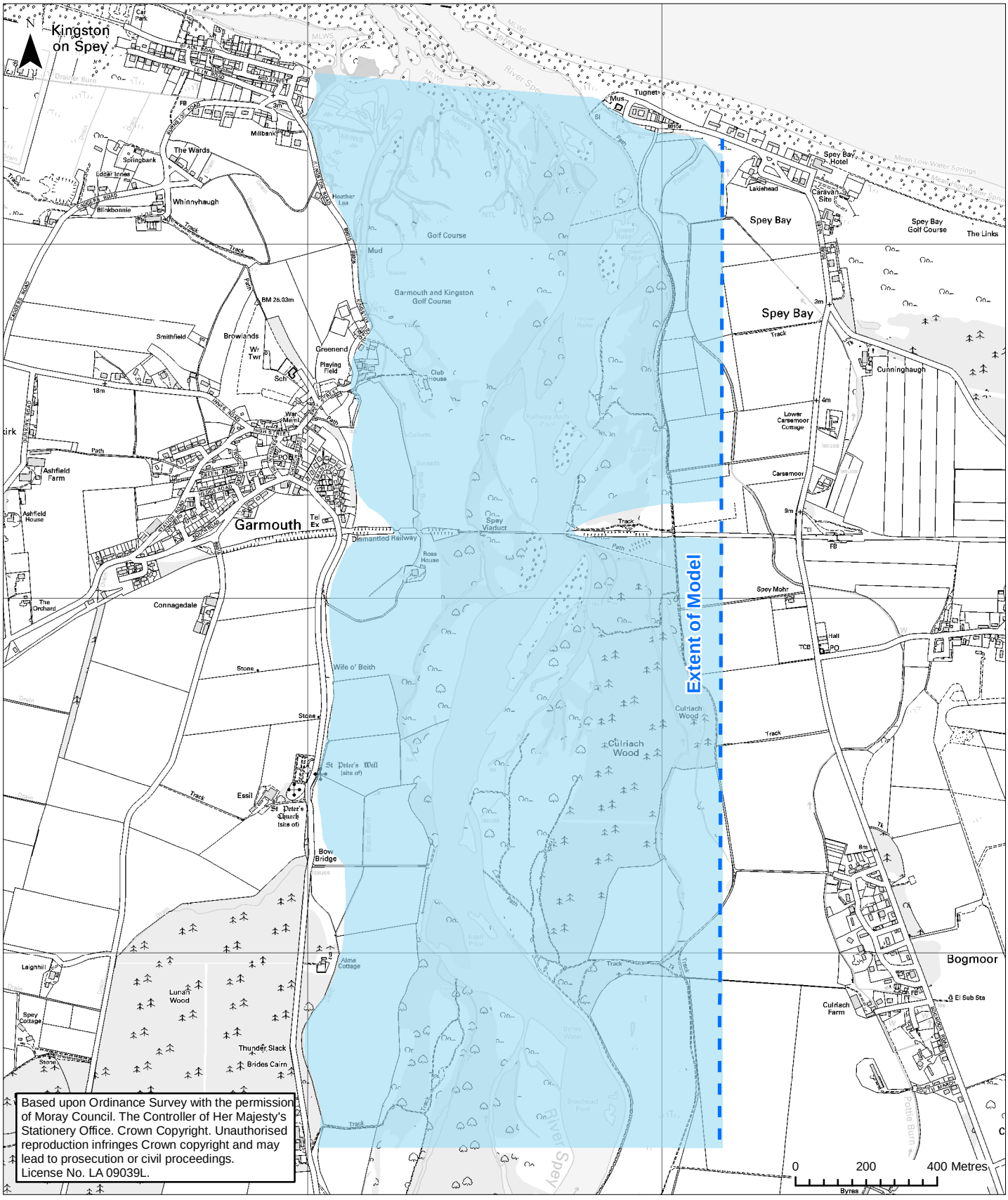

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Area of Lower Confidence

Flood Extent

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Indicative 100 Year Return Period Flood Extent

Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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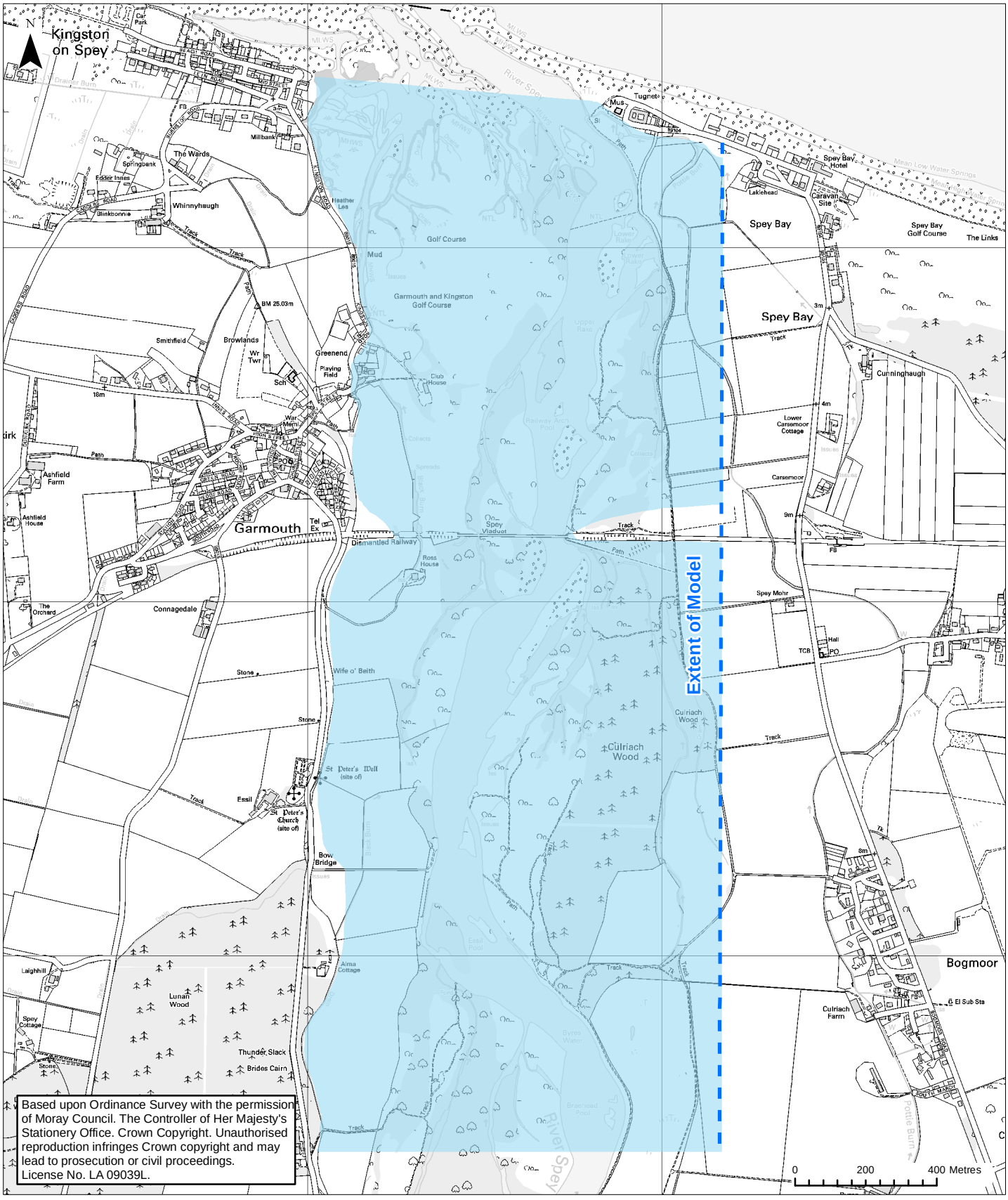

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Area of Lower Confidence

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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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Key:

Flood Extent Based on Local Knowledge

Source: Ian Robertson - The Moray Council

D:\Projects\Garmouth\Projects

Title:
Indicative Annual Flood Extent Based on Local Knowledge

Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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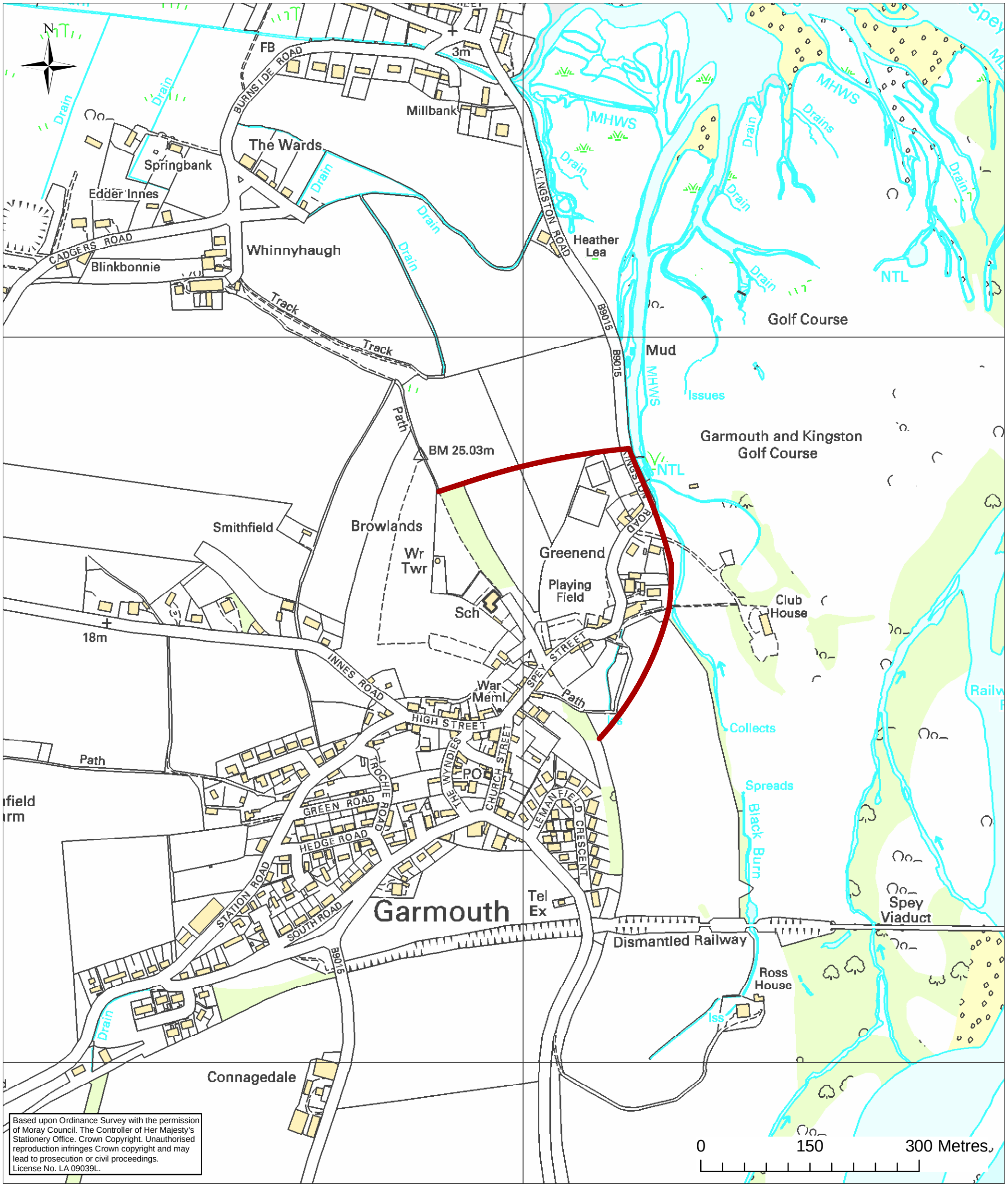

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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Figure:
10

Date:
November 2007

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1:5,000

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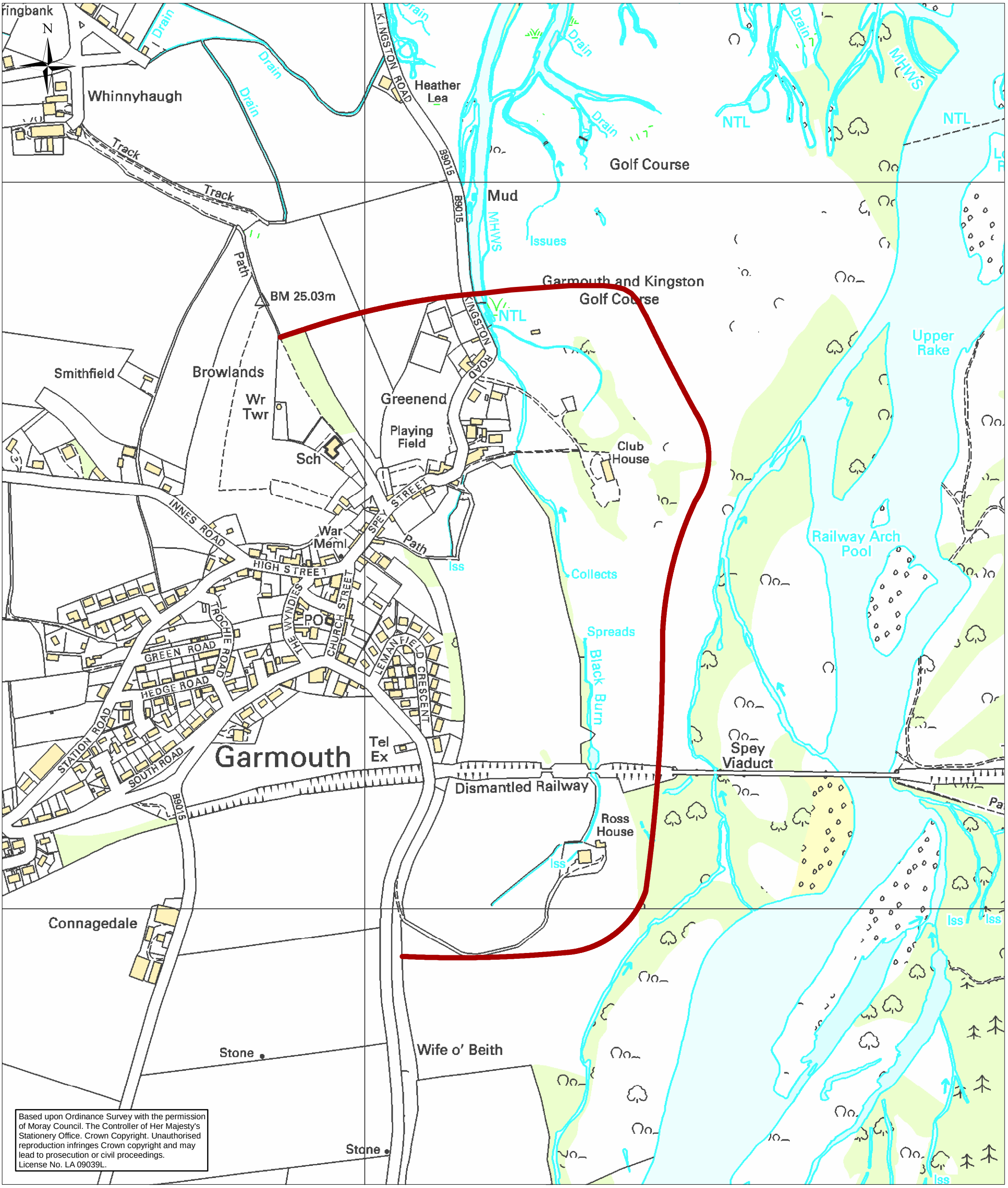

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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

Scale:
1:5,000

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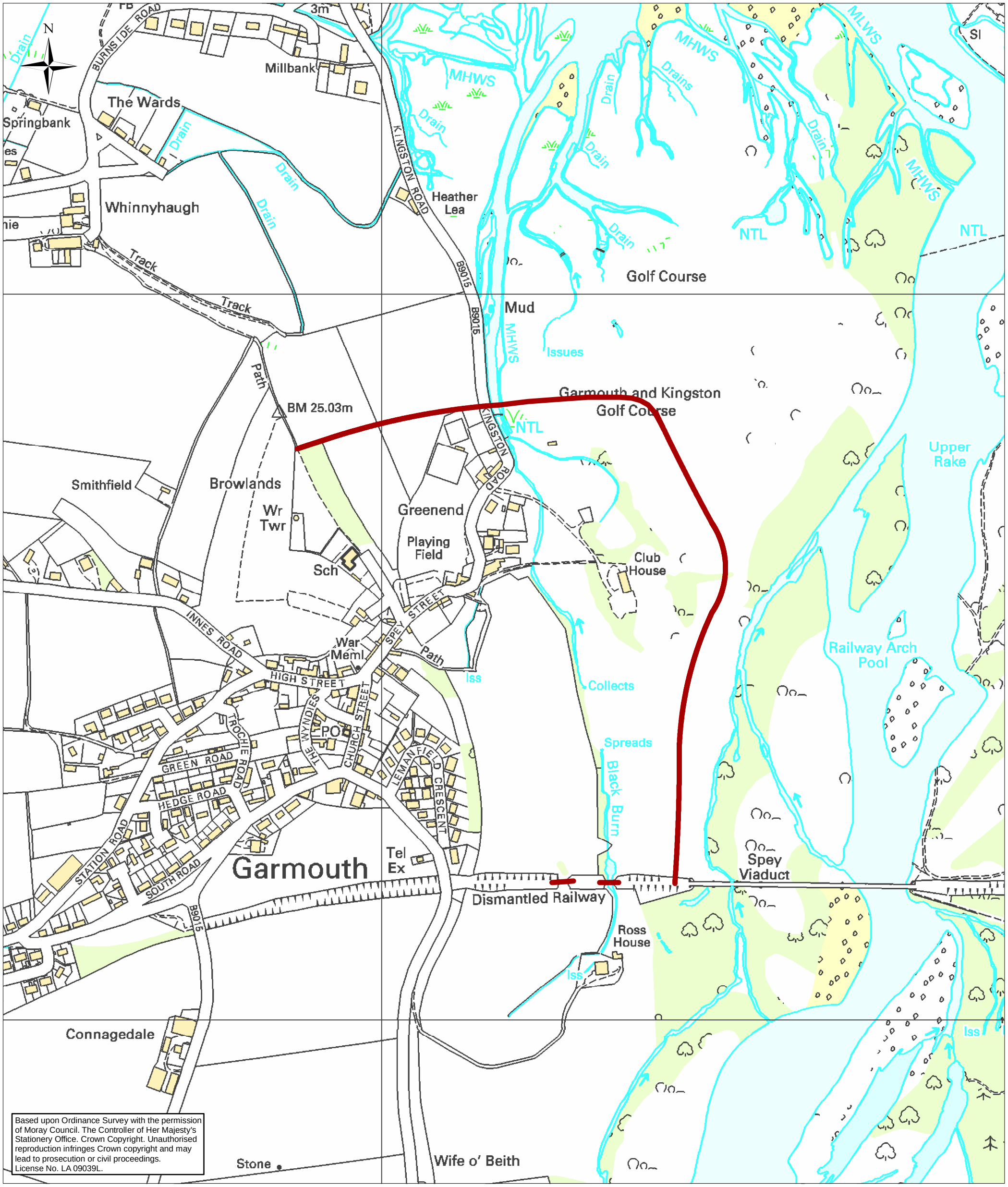

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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Figure:
12

Date:
November 2007

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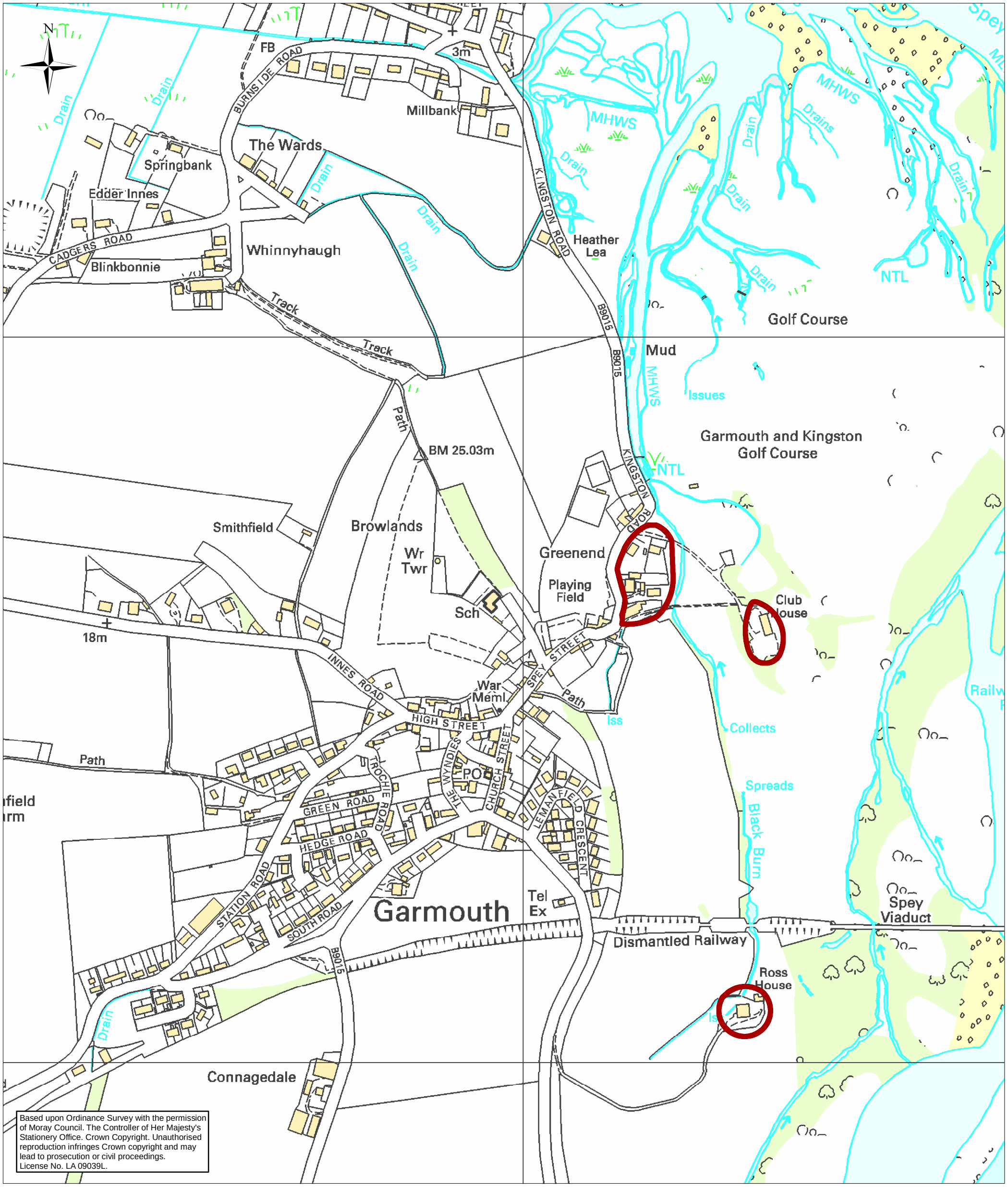

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Embankment Alignment

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Project:
Garmouth Flood Alleviation Scheme
Pre-Feasibility Study

Client:
The Moray Council

Date:
November 2007

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APPENDIX A
Garmouth Flood Chronology

River Spey Flood Chronology

Year	Month	Day	Peak Flow (m^3s^{-1})	Description
1755	September	11		This event was reported as taking place due to the "...greatest fall of rain ever known in the north of England (sic) which swelled all the rivers and did a great deal of damage to the neighbouring fields. The rivers of Spey and Findhorn rose above twelve feet perpendicular more than usual, and carried off a great deal of timber, grain, cattle etc."
1768	August			"...in Scotland, besides what has been already related, the country from Inverness to Perth has been flooded in an uncommon manner..."
1829	August		1917	The exceptionally violent and damaging floods that swept down the River Spey in 1829 are known as the Muckle Spate Flood described by Lauder and also by Nairne which "bore away the most part of the Bridge of Fochabers." This refers to Telford's sandstone bridge over the Spey at Fochabers that was partially swept away. The River Spey was described on the 4th August as "one vast undulating expanse of dark-brown water, from the foot of the hill of Benagen, on the one hand to the sea on the other, about ten miles in length, and in many places more than two miles broad." Peak discharges of the great 1829 flood have been estimated by Dr. Prus-Cacinski of C.H. Dobbie and Partners as 1917m^3s^{-1}, approximately thirty times the long-term average. The following eye-witness account describes the scene that presented itself at the mouth of the River Spey in Morayshire. "For several miles along the beach, crowds of were employed in endeavouring to save the wood and other wreck with which the heavy rolling tide was loaded; whilst the margin of the sea was strewed with the carcasses of domestic animals, and with millions of dead hares and rabbits. Thousands of living frogs, also, swept from the fields, no-one can say how far off, were observed leaping among the wreck." *(Sir T.D. Lauder's account of the Great Floods in Morayshire, August 1829, p312, Second Ed.)*. Many houses and other buildings in Kingston were destroyed in the Muckle Spate.
1832	October			"On Monday night last, in consequence of heavy rains that fell throughout the day, the small brooks that wash the village of Rothes, swelled to a considerable size, and occasioned no small degree of confusion and alarm among the inhabitants. In the course of the night they burst their banks, entered several of the houses, and laid part of corn land and potatoes under water. When the rain ceased, the water subsided and no further inconvenience was sustained."
1852	October			"In Scotland, where similar visitations are usually attended with such destructive consequences, the floods were more extensive and more disastrous than have been known since the great floods of 1829. The terrific rains were attended by many great storms at sea, by which many vessels were wrecked. In

Year	Month	Day	Peak Flow (m^3s^{-1})	Description
				Inverness-shire, the Deveron, the Spey, and the Findhorn came down with their characteristic violence, committing great havoc, bearing with them trees torn up by the roots, planking, and the ruins of farm buildings. On all the streams numerous bridges were swept away. The Spey rose eight feet in a few hours, and bore on its waters evidences of its devastating powers. In Morayshire the damage was considerable."
1856	October			Disastrous flood: From Speyside: corn was swept away from fields adjacent of the River Spey. Sheep and pigs were observed to floating down the Spey.
1861	September			"The Spey was on only two occasions as high since 1829. About Rothes, several of the villagers have lost their crops with Spey.
1862	June			
1864	October			"The rivers are in higher flood than they have been since 1829. The Spey, the Findhorn, the Lossie, and smaller streams, are roaring from bank to brae, and in many instances are over their banks, and flood the haugh lands along their courses."
1868	February			"…the river rose within 19 inches of memorable flood of August, 1829…"
1873	September			"The rivers in the south of Banff, more highly flooded than for the farmers." [Spey]
1874	August			"The Spey also overflowed on the Haugh of Rothes, and did great damage to potatoes and crops."
1882	September			"Inundations by the rising of the Lossie and Spey, N. Scotland; bridge is broken and other damage"
1888	January			Spey Flood: not much damage done
1894	February			Disastrous floods, caused by sudden thaw
1906	March			Rainfall observer for Kingussie noted "Highest flood in the Spey for thirty years."
1915	September	26		This event was preceded by 40 hours of extreme rainfall combined with strong winds. Water discharged over the lower land that spread out into extensive lakes and submerged large tracts of agricultural land. The most extensive flooding from this event occurred in the lower reaches of the Spey. It was noted that, "the immense damage caused by this flood surpassed any that had been experienced since the great flood of 1829."
1915	October			The immense damage suffered in the north-east of Scotland as a result of this great rain storm. Certainly surpassed any experienced in the district since the historic "Moray Floods" of 1829. A large proportion of the precipitation found its way into the Findhorn valley, and the Spey was also seriously affected, and the most extensive floods appear to have occurred in the lower reaches of these two rivers."
1924	October			Floods in the Spey, not as bad as in 1915
1928	February	9		Flooding in the Spey Valley was extensive on the 9th with the river bursting its banks at Garmouth.
1953				River Spey flooded in Green Street, Rothes

Year	Month	Day	Peak Flow (m^3s^{-1})	Description
1956	August			Occluded fronts associated with depressions moving in a NNE direction produced heavy rains. The torrential summer downpours resulted in general flooding over Speyside.
1960	August			Rainstorm caused flooding of Spey; not so severe
1970	August	16-18	1675	The Spey in spate in 1970 had a flow rate of $1675m^3s^{-1}$, which was more than three times higher than the mean peak annual discharge since 1952 and approximately twenty-six times the average discharge since 1952. This episode resulted form the coincidence and superposition of two thunderstorms over the Spey catchment. Between 48 and 60mm of rainfall occurred in the 48-hour period to 0900 on the 18th August. The torrential summer downpours resulted in general flooding over Speyside. The ferocity of the spate washed away part of the B9104 and the Gordon Estate Wall.
1989				Major flood occurred.
1990	February			Moray hit by floodwater catastrophe: Not as bad as 1970
1990				Major flood occurred. An estimated $5545.4m^3$ of topsoil had been stripped from the North Field at Queens Haugh by the tractive force of the flowing water.
1993	January	16	690	The area around Garmouth experienced serious flooding. Snow was general over the region for days preceding this date. Warm winds caused a sudden increase in temperature that brought about a rapid thaw. The resultant melt waters were unable to penetrate the frozen ground and the consequent runoff led to a rapid rise in the river level, which peaked at $681.1m^3s^{-1}$, measured at Boat o'Brig gauging station, over a period of 56 hours subsiding over the next 36 hours before increasing to a second max of $690.3m^3s^{-1}$. This was the highest flow rate in January and the highest monthly flow peak since October 1981. It is estimated that the peak flow of 55 to 84 cumecs overtopped the west bank of the River Spey upstream of the viaduct. This flow inundated the fields surrounding Ross House on route towards the railway viaduct. At the railway viaduct, flood plain flows are restricted to passage through two arch openings each approximately 6m wide. The arches had insufficient capacity to convey the peak flows from the January 1993 flood event and the flows moved into storage in the upstream field. A survey undertaken by BSM (Babtie Shaw and Morton) identified a flood wrack mark at the openings at a level of 6.0m OD. At this level, the combined discharge has been estimated through the openings has been estimated to be 30 to 51 cumecs. This range represents a lower and upper bound estimate for partial blockage by storm debris and free flow conditions, respectively. This flood water level exceeds the level of the land to the east and therefore a proportion of the remaining discharge will pass back into the River Spey. This has been estimated to be between 25 and 33 cumecs depending on the condition and

Year	Month	Day	Peak Flow (m^3s^{-1})	Description
				density of bank vegetation. The remainder of the incoming discharge will move into storage in the upstream field until flood waters in the Spey subside at which time the field will drain via the viaduct openings and pathways into the main river channel. Flows that pass through the easterly opening in the railway embankment, approximately 14 to 24 cumecs at the storm's peak) feed into the Black Burn. Flows that pass through the westerly opening of the railway embankment, 27 cumecs maximum, spill across the field to the west of the Black Burn passing down the westerly side of this field. The footpath at the bottom end of this field falls towards the footbridge across the Black Burn and flood discharges will tend to pass along this and into the Burn. However, high water levels from flood waters in the Black Burn cause flows from the westerly field to back-up and consequently a proportion of this discharge is carried along the main road and into Garmouth. The flows that pass along the main road re-enter the Black Burn by passing down the entrance track to the Golf Course.
1993	September			This was a similar event to the January 1993 event but on a smaller scale. After the spate of September 1993, the Spey cut approx 10 metres into the west bank over a reach of 30 metres, bringing it into very close proximity with the northern portion of the golf course. This exposed a small channel that flows directly into the lagoon formed from the old course of the river.
1995	September	10	700	With the Spey in full spate, serious flooding meant that the 16th green, 17th tee and fairway at Garmouth and Kingston Golf Course were washed away.
1997	July	01	678	POT Data.
2000	April	26	554	The Tugnet ice house was flooded in spring 2000, presumably by the Spey rather than the sea washing in.
2000	October	12	546	POT Data.
2000	November	08	684	The Spey flooded the floodplain woods of Culriach Wood.
2001				Part of the new replacement 17th fairway created following the 1995 floods was lost when the river again altered its course.
2002	November	15-17	757	See 4th biennial report. "River Spey burst through the west bank and inundated several homes in its path."
2004	January	19	458	POT Data.
2004	June	24	560	POT Data.
2005	January	10	426	POT Data.
2005	March	16	433	POT Data.
2005	October	11	471	POT Data. Garmouth and Kingston Golf Course flooded three times during October 2005.
2005	November	26	647	POT Data.
2006	December	01-06		Water flooded through breach in river bank upstream of Queenshaugh. Flooded fields, golf course and threatened Willow Cottage (SEPA Flood Watch). Flooding of Ross House commenced on 2nd December and was

Year	Month	Day	Peak Flow (m^3s^{-1})	Description
				at its highest (bout 150mm in the house) through to the following Sunday when it subsided. There was a repeat flooding on Monday 4th December and it remained high until 6th when it started to subside.
2006	December	12-14		Flooding to Willowbank Cottage – see Moray Council photographs 14/10/2006. Peak Over Threshold data from Boat o Brig gauge station recorded as 402.444 cumecs on 13/12/2006. Ross House was flooded on 14th December and there was between 150mm and 225mm of water in the property. Water subsided a couple of days after that, leaving the access road into Queenshaugh wrecked and the kitchen full of water. The rear of the house is higher than the front and has concrete floors. The front of the house is lower than the rear and contains the kitchen which has timber floors.

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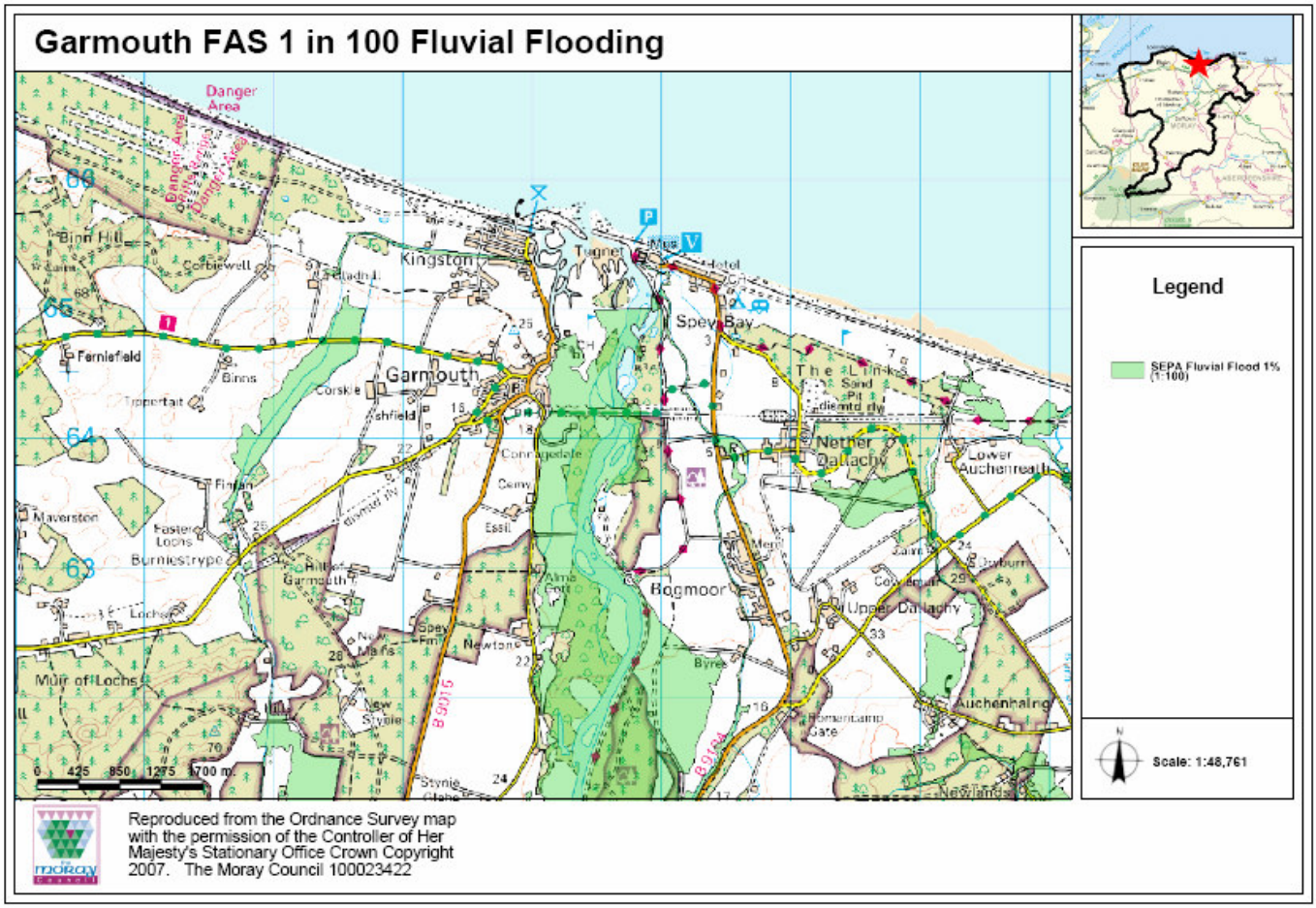
Appendix B
SEPA 1 in 100 Year Fluvial Flood Risk Map

SEPA 1 in 100 Year Fluvial Flood Risk Map



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Appendix C
Environmental Baseline Study

Garmouth Environmental Baseline Study

7 November 2007
MFAG 568

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HASKONING UK LTD.
ENVIRONMENT

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Document title	Garmouth Environmental Baseline Study
Document short title	Garmouth Environmental Baseline Study
Status	Final
Date	7 November 2007
Project name	
Project number	9S9650
Author(s)	Joanna Girvan
Client	The Moray Council
Reference	/R/303628/Edin

Drafted by	Joanna Girvan
Checked by	
Date/initials check	
Approved by	
Date/initials approval	

SUMMARY

CONTENTS

1 INTRODUCTION

This report provides environmental and general information on the area being investigated for the potential Garmouth flood alleviation scheme (FAS). The aim of the scheme is to offer flood alleviation to the village of Garmouth which is situated approximately 1.3 Km upstream of the mouth of the River Spey. The village is small with a population of 494 people occupying some 200 properties, 7 of which are at risk from flooding from the Spey at the 1:100 return period. The area covered by the initial investigation is outlined in red in Figure 1 below. The study area contains the channel and banks of the Spey from a point 1.2 Km upstream of the Spey viaduct down to the river mouth. The western part of the village lies on high ground where flooding is not an issue, therefore only the eastern end of the village is included in the study area. Although Garmouth lies very close to the point where the Spey discharges into the Moray Firth, tidal flooding will not be considered as part of this scheme which will be restricted to fluvial flooding only. Figures 2 and 3 show SEPA flood maps illustrating the extent of fluvial and coastal flooding at the 1:100 return period.

Figure 1. Map showing the lower River Spey, the villages of Garmouth and Kingston, the golf course, the viaduct and the initial study area for Garmouth FAS (outlined in red)

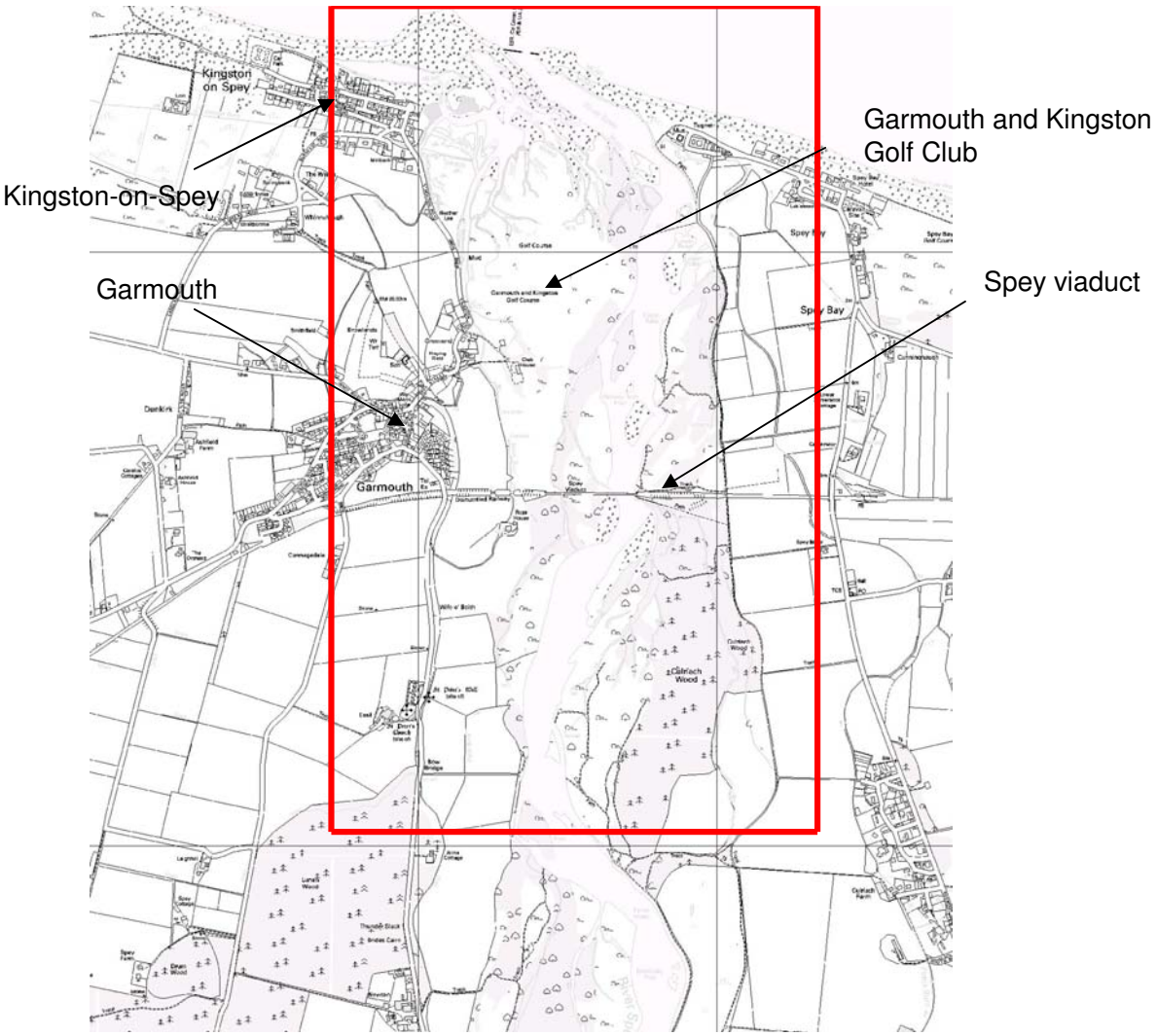


Figure 2. SEPA flood map of Garmouth area showing estimated extent of fluvial flooding at the 1:100 return period. Study area outlined in red

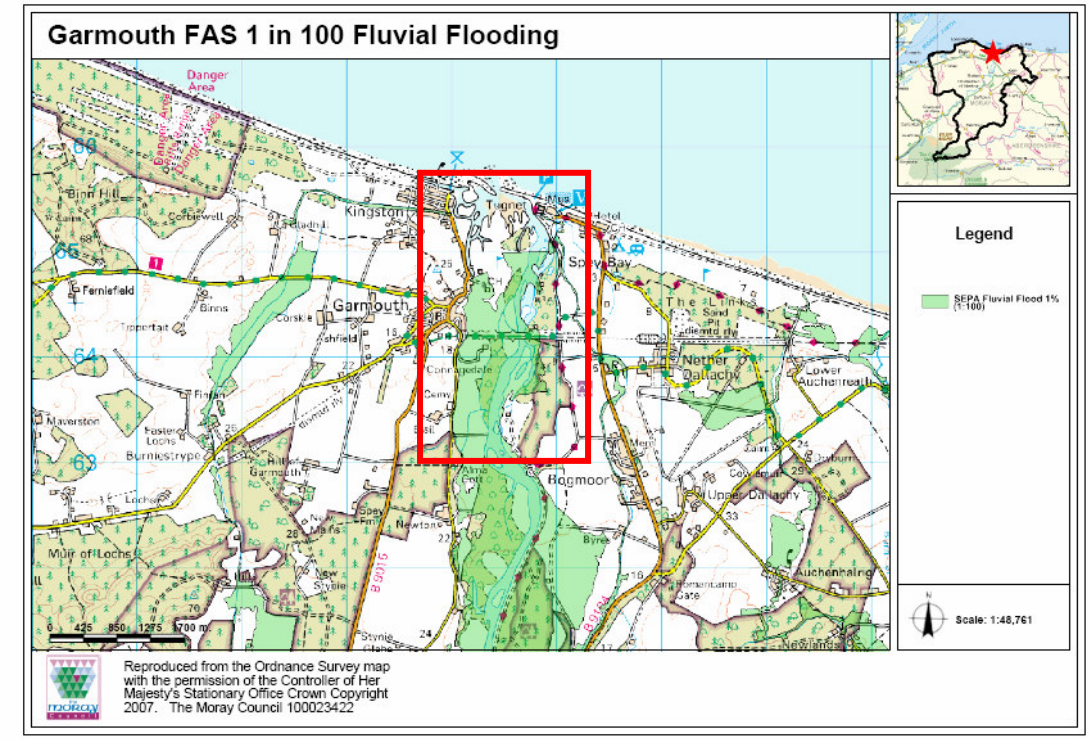
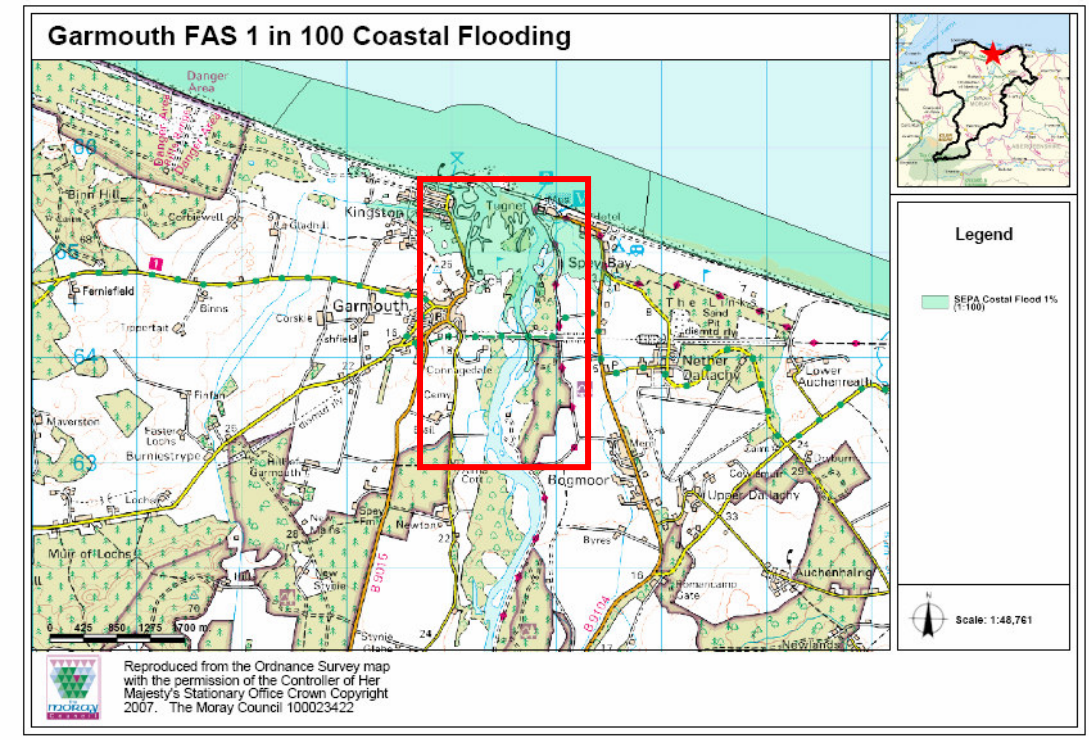


Figure 3. SEPA flood map of Garmouth area showing estimated extent of coastal flooding at the 1:100 return period. Study area outlined in red



2 ENVIRONMENTAL DESIGNATIONS

Consideration must be given to designated sites in the area of any potential FAS. If special protection is given to a site or species under local, national or European legislation, it is important to be aware of any restrictions this will impose on works and adopt good practise measures to minimise impacts on the protected features. In addition, any works that affect a designated site may be subject to an appropriate assessment under the Habitat Regulations (1994). It should be borne in mind that designated sites that are not contained within a FAS area may still be affected by it, for example in-stream FAS works may have an impact on downstream areas, or disturbances to ground water may affect ground water dependent habitats off-site.

The study area for the Garmouth FAS encompasses a 2.5 Km stretch of the lower River Spey. This part of the Spey has several international, European, national and local designations associated with it including Special Areas of Conservation (SAC's) designated under the EC Habitats Directive (1992), Special Protection Areas (SPA's) designated under the EC Birds Directive (1979) and Sites of Special Scientific Interest (SSSI's) notified under the Wildlife and Countryside Act (1981). The designations are listed in Table 1 and outlined below:

Table 1. Environmental designations affecting the River Spey and Garmouth area

Designation type	International, European, national or local?	Name	Could be impacted by FAS?
SSSI	National	Lower River Spey	Yes
SSSI	National	River Spey	Yes
SSSI	National	Spey Bay	Yes
SAC	European	Lower River Spey & Spey Bay	Yes
SAC	European	River Spey	Yes
SPA	European	River Spey Insh marshes	No
RAMSAR	International	River Spey Insh marshes	No
SSSI	National	River Spey Insh marshes	No
SAC	European	Insh Marshes	No
SPA	European	Moray and Nairn Coast	Yes
RAMSAR	International	Moray and Nairn Coast	Yes
SAC	European	Moray Firth	Unlikely
SWT Nature Reserve	Local	Spey Bay Wildlife Reserve	Yes
Sites of Interest to Natural Science	Local	Lower River Spey and Spey Bay SINS	Yes
Coastal Protection Zone	Local	Spey Bay CPZ	Yes

2.1 SAC's

The River Spey SAC is based on the presence of four international SAC qualifying species. These are Atlantic salmon, *Salmo salar*, sea lamprey, *Petromyzon marinus*, otter, *Lutra lutra* and freshwater pearl mussel (FWPM), *Margaritifera margaritifera*. The two fish species and the FWPM require very high water quality to survive, and have correspondingly high regulatory standards set for them under the WFD. The mid to lower reaches of the Spey support an internationally important, viable, population of FWPM. It is becoming increasingly rare to find large populations that are viable i.e. with recruiting juveniles, and so the Spey requires protection from siltation, in-channel disturbance and deterioration in water quality. The stretch of the river at Garmouth, however, may be too far downstream to provide habitat for the mussels as it is influenced by the tide and may therefore be brackish – a condition that the mussels are unable to tolerate. The mid to lower stretches of the river offer excellent lamprey spawning and migratory habitat, with larvae being widely distributed in the marginal silts of this area. The upper catchment provides good nursery habitat for salmon which benefit from unimpeded migratory routes and absence of flow modifications such as impoundments and abstractions.

The Lower River Spey and Spey Bay SAC (Figure 4) is based not on priority species but on habitats. There are two priority habitats that are a primary reason for site selection – perennial vegetation of stony banks and alluvial forests with alder and bird cherry. The stony banks refer to the widespread shingle habitats of this area. These are part of the same shingle aggregation as Culbin Bar near the mouth of the River Findhorn, and are shaped by the same processes. Individually they are the two largest shingle sites in Scotland, and together form a unique vegetated shingle complex. Species-rich dry heath occurs on the shingle ridges while the damper hollows contain wet-heath and vegetation comparable to dune slacks. The habitat is heavily dependent on the coastal and fluvial depositional processes that sustain it. Shingle enters the system from the Spey while coastal dynamics move and shape the shingle along the coast. Any disturbance to sediment dynamics should be avoided. Alluvial forest is found on the more stable, damper parts of the braided channel, and comprises valley alder, willow, ash and bird cherry.

The River Spey discharges into the Moray Firth, just outside the eastern limits of the Moray Firth SAC. The Firth has been designated on the basis of the presence of bottlenose dolphins and sandbanks that are always covered by sea. These features are influenced primarily by marine and coastal processes, and so are unlikely to be affected by any FAS works of the potential scale of Garmouth.

2.2 SSSI's

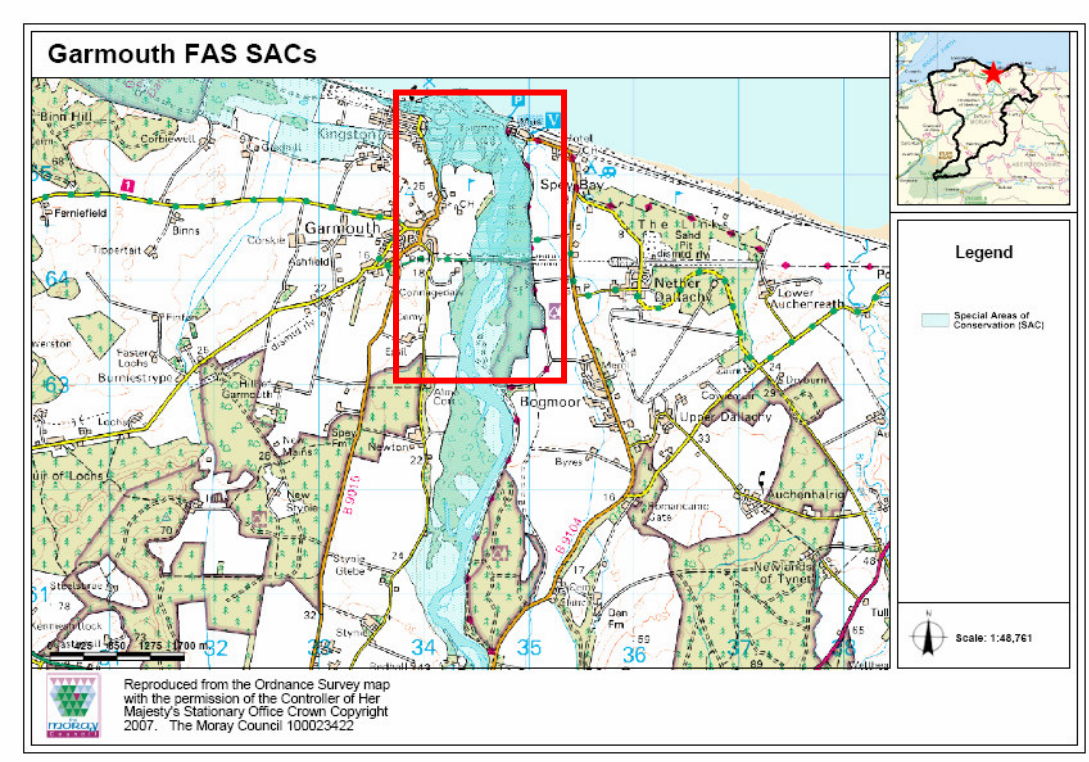
There are three SSSI's underpinning the SAC designations – the Lower River Spey, The River Spey and Spey Bay. The Lower River Spey cites the common tern, fluvial geomorphology, river shingle / sand and wet woodland as qualifying features. The River Spey SSSI cites Atlantic salmon, freshwater pearl mussel, sea lamprey and otter as notified features while the Spey Bay SSSI is designated on the strength of shingle, scrub, saltmarsh, coastal geomorphology of Scotland and hydromorphological mire range.

2.3 SPA's / RAMSAR sites

The Moray and Nairn Coast SPA and RAMSAR site includes the areas of Findhorn Bay, and Culbin Bar to the west, and the Lower River Spey corresponding to the study area. As mentioned earlier, these aggregations are part of the same unique shingle complex, and are shaped by the same processes. The shingle of the Lower Spey provides feeding and breeding habitat for migratory waterfowl including a schedule 1 species and winter foraging for resident passerines. Bird species that forage in the area include bar-tailed godwit, common scoter, dunlin, greylag goose, long-tailed duck, oystercatcher, pink-footed goose, redshank and wigeon. The area is also an important breeding and feeding site for osprey.

There is also a SPA on the River Spey at Insh Marshes which is located just south of Aviemore. The site is also RAMSAR, SSSI and SAC designated for its breeding birds and mire habitat. However, since the Insh Marshes lie approximately 100 Km upstream of the study area it is very unlikely that there will be an impact from any proposed FAS at Garmouth.

Figure 4. Lower River Spey – Spey Bay SAC (transparent blue areas on map). Study area outlined in red



2.4 Spey Bay Wildlife Reserve

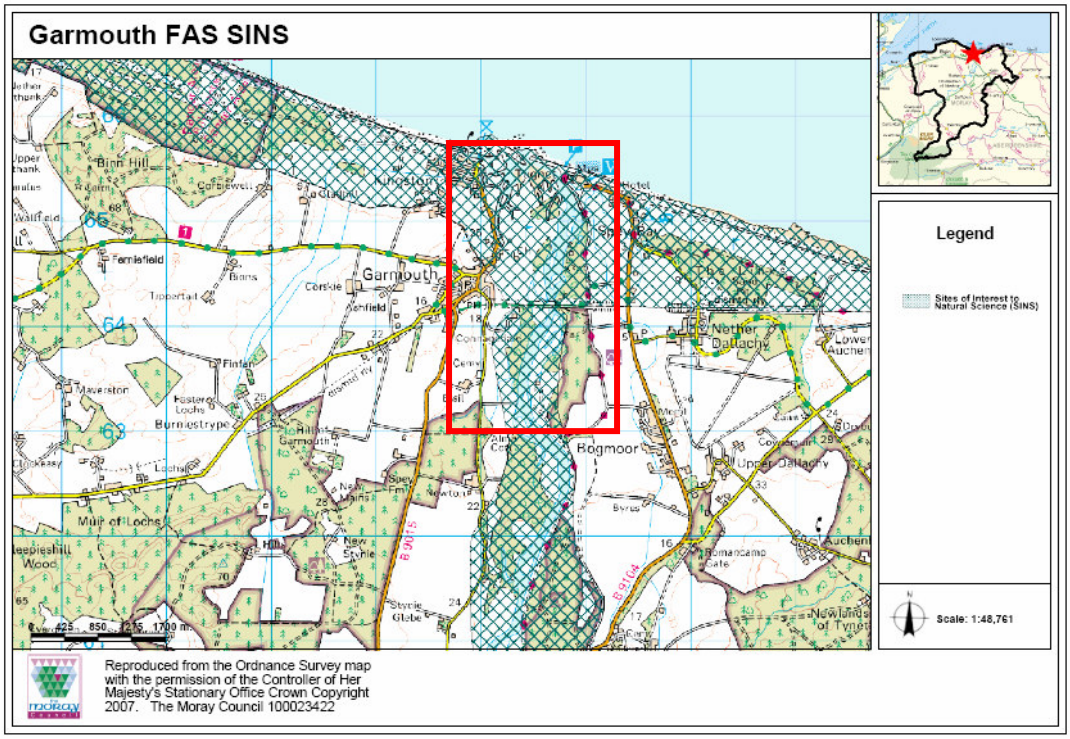
Spey Bay Wildlife Reserve is a Scottish Wildlife Trust nature reserve. The reserve includes the shingle beach and the river estuary and supports a diversity of plants and invertebrates. The area represents an example of clear ecological succession from bare shingle to young woodland. Management of the site involves the gradual spot clearing of

trees and whin that are invading the area from a conifer plantation to the west. This allows the development of a mosaic of small heath habitats resulting in increased structural and species diversity.

2.5 Sites of Interest to Natural Science (SINS)

This is a local designation put in place by Aberdeenshire Council. SINS's are identified by the Council as sites of regional importance for geology, geomorphology, botany, entomology, ornithology and freshwater biology. The Spey Bay SINS is designated for its geomorphological interest, and is shown by the hatched area in Figure 5 below.

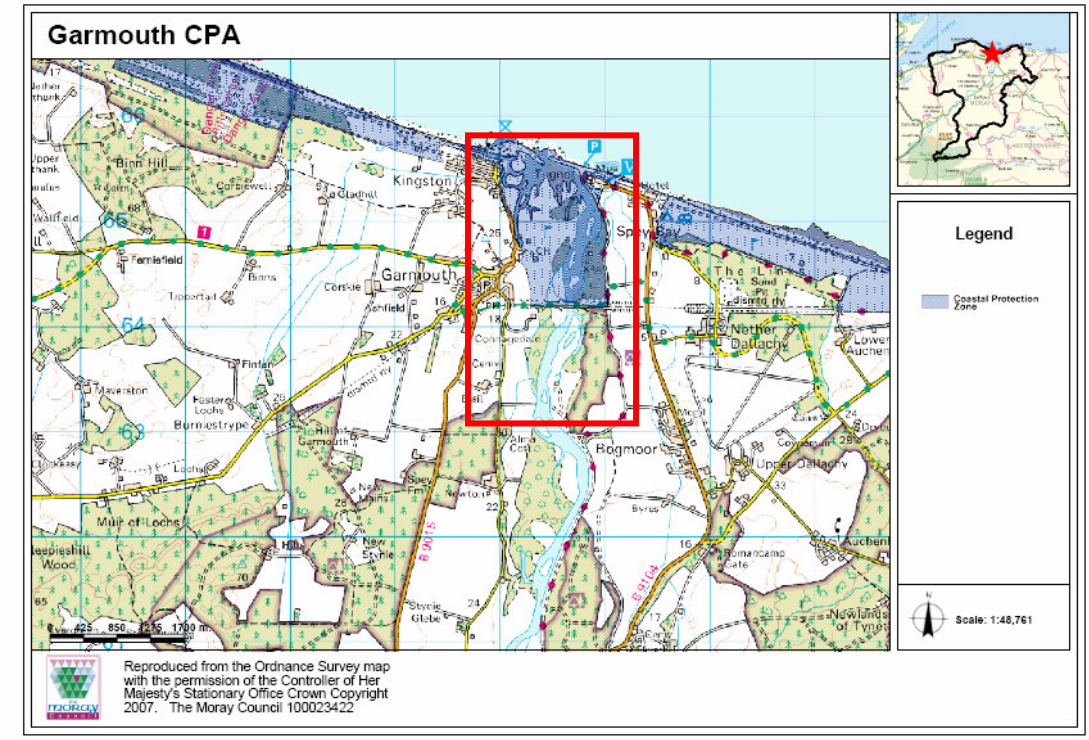
Figure 5. Area of the Lower River Spey and Spey Bay SINS (shown by hatched area on map). Study area outlined in red



2.6 Coastal Protection Zone (CPZ)

A Coastal Protection Zone has been designated by Moray Council along the southern coast of the Moray Firth. This includes the Spey mouth and estuary, and Spey Bay (Figure 6). The area has been designated in line with National Guidance (NPPG13 'Coastal Planning') to protect undeveloped coastline in the face of development pressures. Only certain types of development will be allowed in the CPZ, and these must be sensitively designed and located to ensure that there is no damage to the coastal environment.

Figure 6. Spey Bay Coastal Protection Zone (transparent blue area on map). Study area outlined in red



3 PRIORITY SPECIES AND HABITATS

The UK Biodiversity Action Plan (UKBAP, 1994) is the UK's response to the Convention on Biological Diversity (1992). The UKBAP has identified national priority habitats and species, and has developed targets and plans to help protect and restore them. While there are no legal protections arising from the UKBAP, local and national plans have been prepared to promote improvements in these priority species and habitats. In general, national species and habitat steering groups have developed broad guidance for approaching the conservation of these priorities while local authorities have been responsible for producing small-scale plans which enable action to be taken 'on the ground'. Any local BAP (LBAP) plans affecting the study area should be carefully considered to avoid or reduce any detriment due to FAS works. The study site for Garmouth FAS lies within the area of the North East Scotland LBAP. The LBAP is contributed to by a range of organisations including Aberdeen, Aberdeenshire and Moray Councils, SEPA, SNH and SWT, Forestry Commission, University of Aberdeen and RSPB. The partnership carried out an audit of priority species and habitats in 1998.

3.1 Species

Species that are of particular concern to the LBAP are the water vole, *Arvicola terrestris*, and the red squirrel, *Sciurus vulgaris*. The LBAP carries out activities such as surveying, obtaining funding for small projects, and promoting and facilitating research on these species. The presence / absence of a species in an area is denoted using a grid with each square measuring 10 Km^2. In 1998, red squirrels were present in the 10 Km square containing the study area (Alexander *et al*., 1998), and current data provided on the NESBReC (North East Scotland Biological Records Centre) website suggests that this is still the case. A red squirrel survey may therefore be necessary.

Both data sources indicate that the nearest known population of water voles is located near Aberlour (around 30 Km south of Garmouth). However, it is possible that there is suitable water vole habitat within the study area e.g. along the Black Burn, and so this should be investigated as a survey may need to be carried out.

Other species recorded in the 10 Km square of the study area include pipistrelle bats, brown hares, otters and grey partridge. Freshwater pearl mussels are present in the mid to lower reaches of the River Spey, but they may not be present near Garmouth as the water may here may begin to become brackish as it is affected by the tidal zone.

Badgers are not a priority species under the UKBAP, but they are covered by the Protection of Badgers Act (1992), and need to be taken into account by any potential FAS. According to NESBReC data, they are widely distributed throughout Moray, and may have quite dense populations in the study area. A survey is therefore likely to be necessary and a licence under the Act may be required.

Otter, red squirrel and pipistrelle bats are protected under the Wildlife and Countryside Act (1981), and if they are present in the study area, a licence under the Act may be needed for any works that may disturb them or their habitats.

3.2 Habitats

The main priority habitat found within the study area is coastal vegetated shingle. 19% of Scotland's coastal shingle is found in North East Scotland, and is represented here by two of the best examples of this habitat in the country - Spey Bay and Findhorn Bay / Culbin Bar. Shingle may arrive from rivers or glacial outwash, or may be redistributed from the sea bed by long shore drift along the coastline. While there are many shingle beaches in the UK, few shingle bars are stable enough to support perennial (permanent) vegetation. On the seaward side of stable shingle structures, plants such as sea kale, *Crambe maritime*, sea pea, *Lathyrus japonicus*, and sea campion, *Silene uniflora*, are common pioneers, but further upstream, as in the mouth of the River Spey, the vegetation may tend towards alder, *Alnus glutinosa*, willows, *Salix* spp., ash, *Fraxinus excelsior*, dry and wet heath species and scrub. Shingle structures are very important for many species, supporting breeding birds and diverse invertebrate communities, with some species entirely restricted to shingle habitats.

4 CULTURAL HERITAGE

There are many listed buildings, archaeological sites and conservation areas located in the proposed study area. The locations of these features are illustrated in Figures 7 to 10. While there are numerous archaeological sites, they are generally not considered to be of regional significance and are not scheduled. This includes various cairns, crop marks and wells that are no longer traceable and are not known locally. However, there are several listed buildings that are of national importance.

4.1 Listed buildings

Listed buildings are any building or structure of architectural or historic importance which is included in the List of Buildings of Special Architectural or Historic Interest compiled by Historic Scotland. They are divided into three categories:

A. Buildings of national or international importance
B. Buildings of regional importance
C. Buildings of local importance

There are several 'Category A' listed buildings at Tugnet on the eastern shore of the Spey mouth (Figure 7, no. 1). This includes Tugnet ice house which is the largest industrial ice house remaining in Scotland. It was built circa 1830, replacing an earlier ice house dating from the 1790's, and used to store ice for preserving fish at the height of the salmon fishing industry. Now it serves as a museum for the Wildlife Centre located there. The salmon fishing station itself is also a 'Category A' listed building, including the courtyard square, associated dwellings and fish house. Tugnet cottage and steading, built circa 1800, are 'Category B' listed and the late 19th century Tugnet House is 'Category C' listed.

4.2 Conservation areas

Conservation areas are areas of special historic and architectural interest, the character and appearance of which it is desirable to preserve of enhance. Most conservation areas contain groups of buildings extending over areas of villages or towns, although they can also cover battlefields, parks or designed landscapes. Development is not precluded in a conservation area, but planning permission will only be granted as long as it can be shown that the character and appearance of the area will not be harmed. If any trees are present, they are considered as contributing to the character of the area and may not be removed without permission. In some cases, a Tree Preservation Order may be issued by the planning authority, in which case consent to remove the trees must be obtained.

There are two conservation areas in the study area. They are the village of Kingston, and the eastern end of Garmouth i.e. the low-lying part that is prone to flooding (Figure 8). Many of the original buildings remain in Garmouth, including clay-bool constructed cottages and the Garmouth Hotel and church which date from the 18th century. There are no tree preservation orders in the study area.

Figure 7. Listed buildings in the Garmouth area (indicated by blue squares). Study area outlined in red

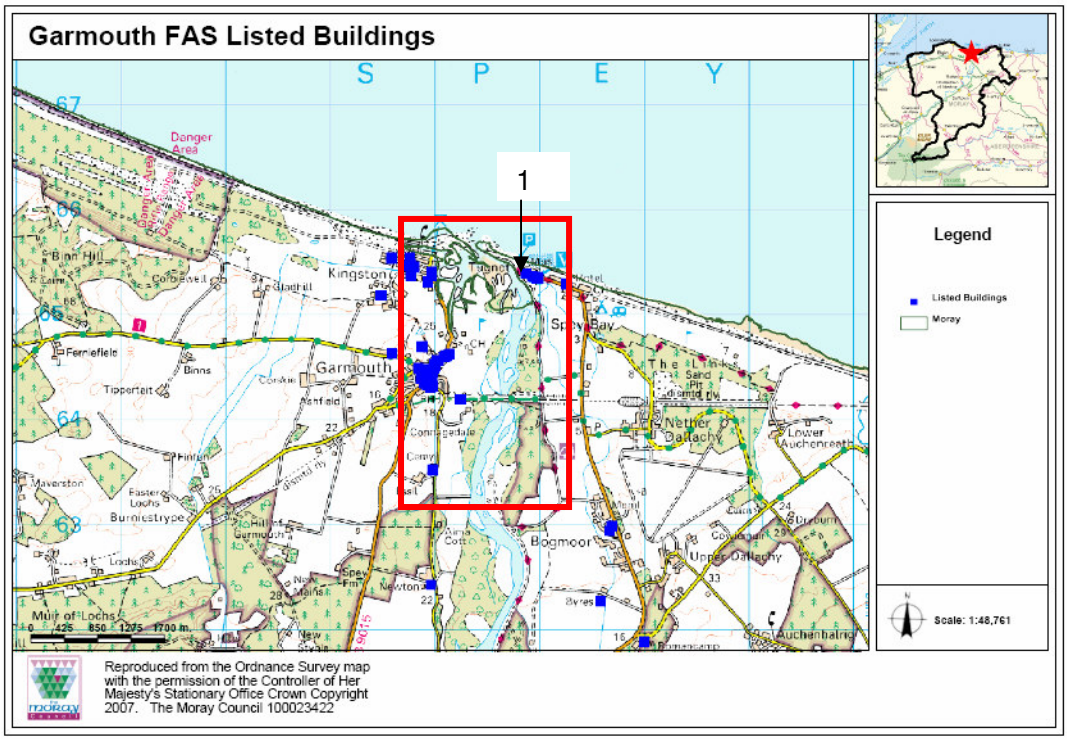
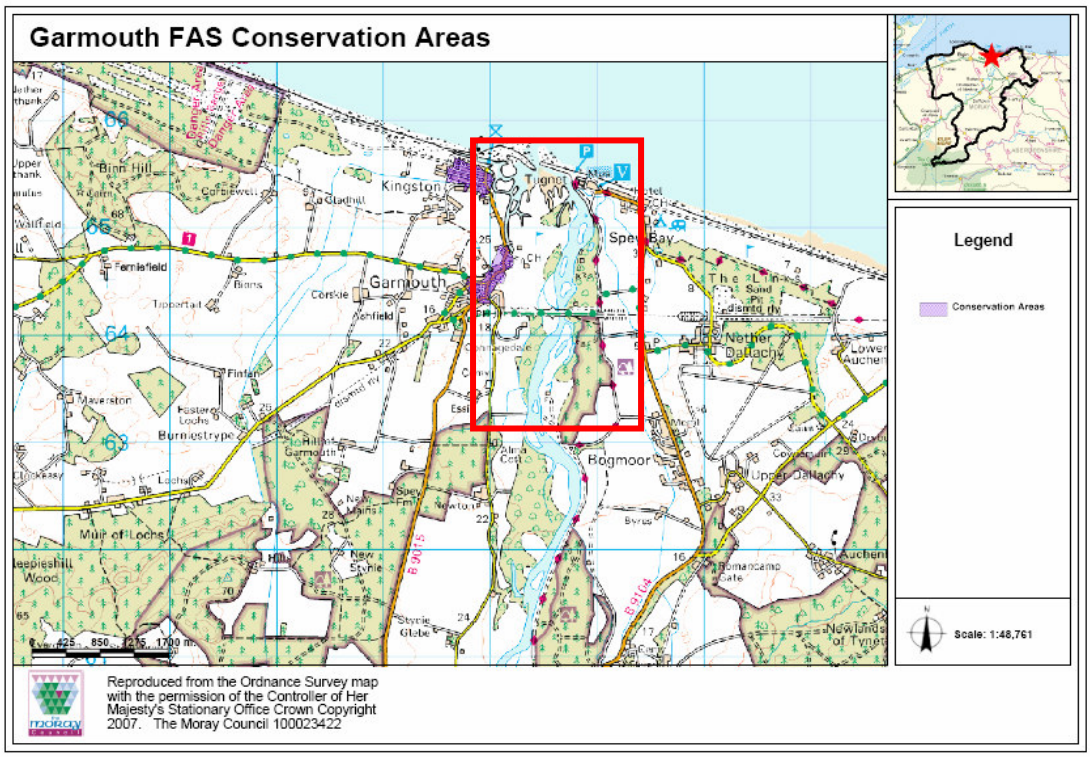


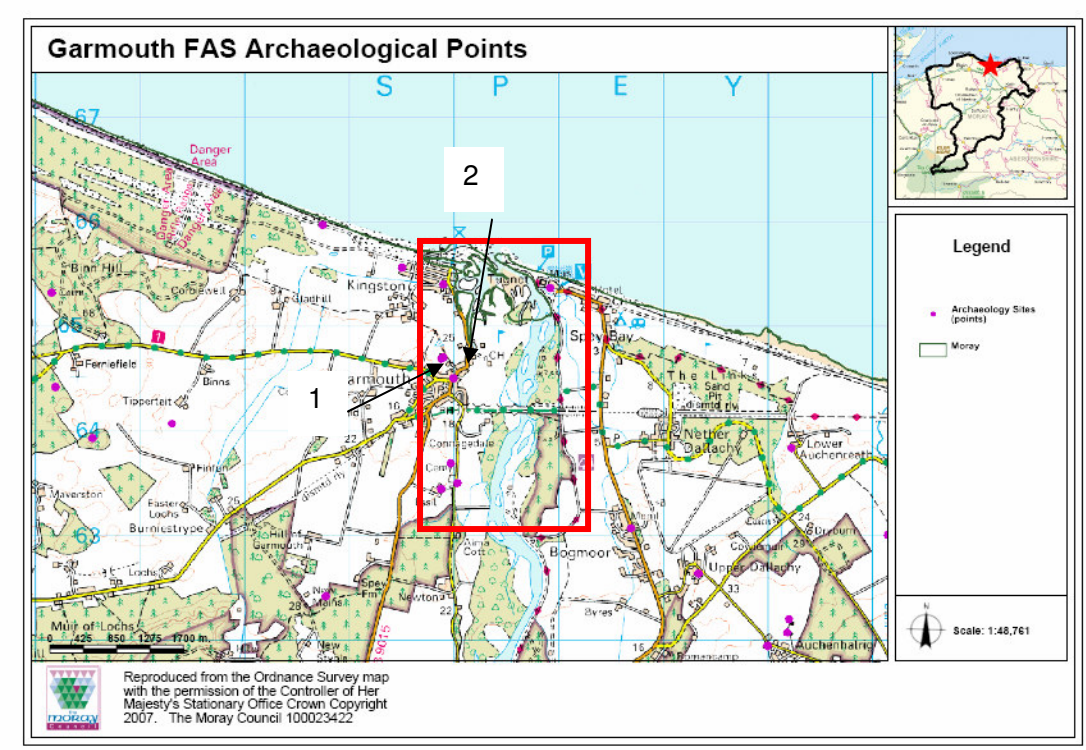
Figure 8. Conservation areas around Garmouth (indicated by purple polygons). Study area outlined in red



4.3 Archaeological sites

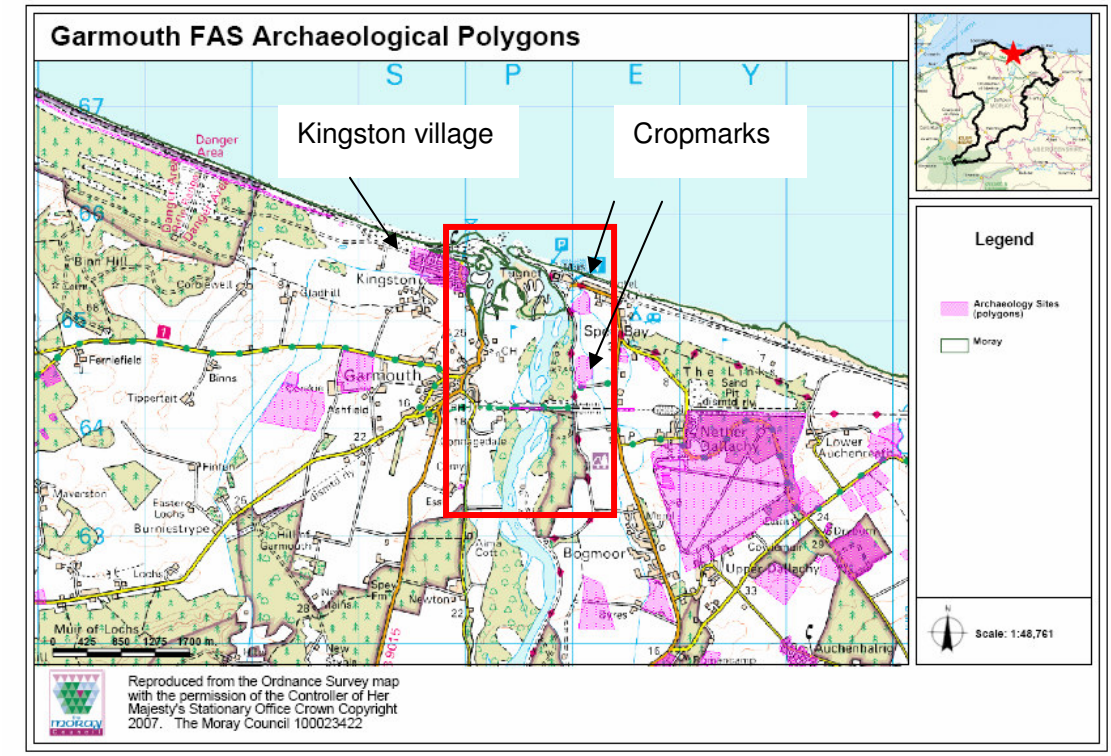
While there are numerous archaeological sites, they are generally not considered to be of regional significance and are not scheduled. There are, however, two features of note. The first is a stone circle located at Browland (Figure 9, no. 1), just north of Garmouth village. It consists of four boulders set in the ground, and may have archaeological significance although this has not yet been confirmed. The second is the Garmouth water tower (Figure 9, no. 2) which is located on the hill on the northern boundary of the village. It dates from the late 19th century, and is no longer used, however, the Garmouth and Kingston Amenities Association lease it and are currently restoring it. While it is not a scheduled monument, it is considered to have some significance at the national level.

Figure 9. Archaeological sites in the Garmouth area (indicated by purple points). Study area outlined in red



While discrete structures such as the water tower, wells or cairns are represented by points (Figure 9), sites covering larger areas are depicted by polygons (Figure 10). There are three archaeological polygons in the study area. These are the village of Kingston and two cropmarks (Figure 10), but they are not considered to be of local, regional or national significance.

Figure 10. Archaeological areas in the Garmouth area (indicated by purple polygons). Study area outlined in red



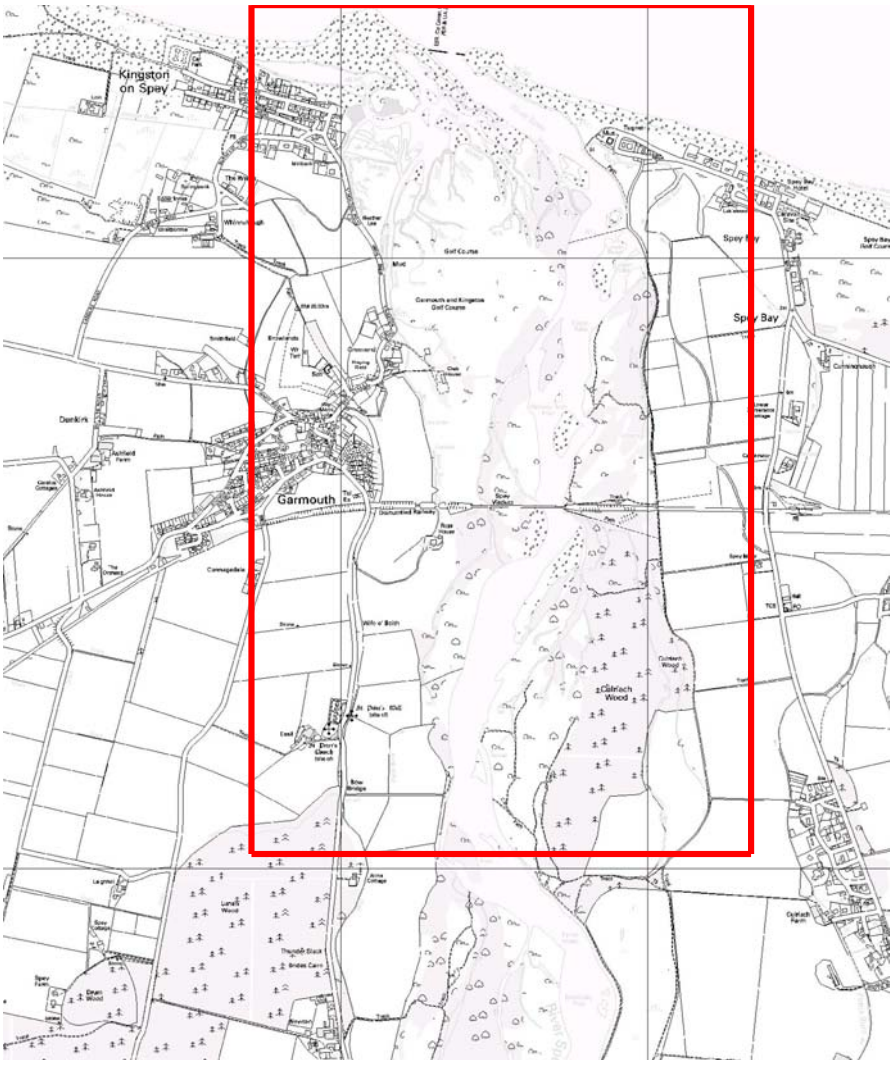
5 LAND-USE AND LOCAL COMMUNITIES

Land-use in the study area comprises (in order of decreasing area) agriculture, forestry, an urban centre (Garmouth), recreational and amenity areas including a large golf course, and several rural communities (Tugnet and The Wards).

5.1 Agriculture

The land around Garmouth is widely used for agriculture, primarily arable farming for cereal production. However, vegetables, cattle and pigs are also produced. The soils of the area are predominantly podzols derived from acid parent materials. Since podzols tend to be low in nutrients, it is likely that fertilisers are relied upon heavily. There are no areas of Prime Agricultural Land in the study area. Agricultural activities are important not only to the social and economic well being of the area, but also contribute to its landscape value. There are around 35 fields contained within the study area (Figure 11).

Figure 11. Map showing field boundaries within the area of Garmouth FAS. Study area outlined in red

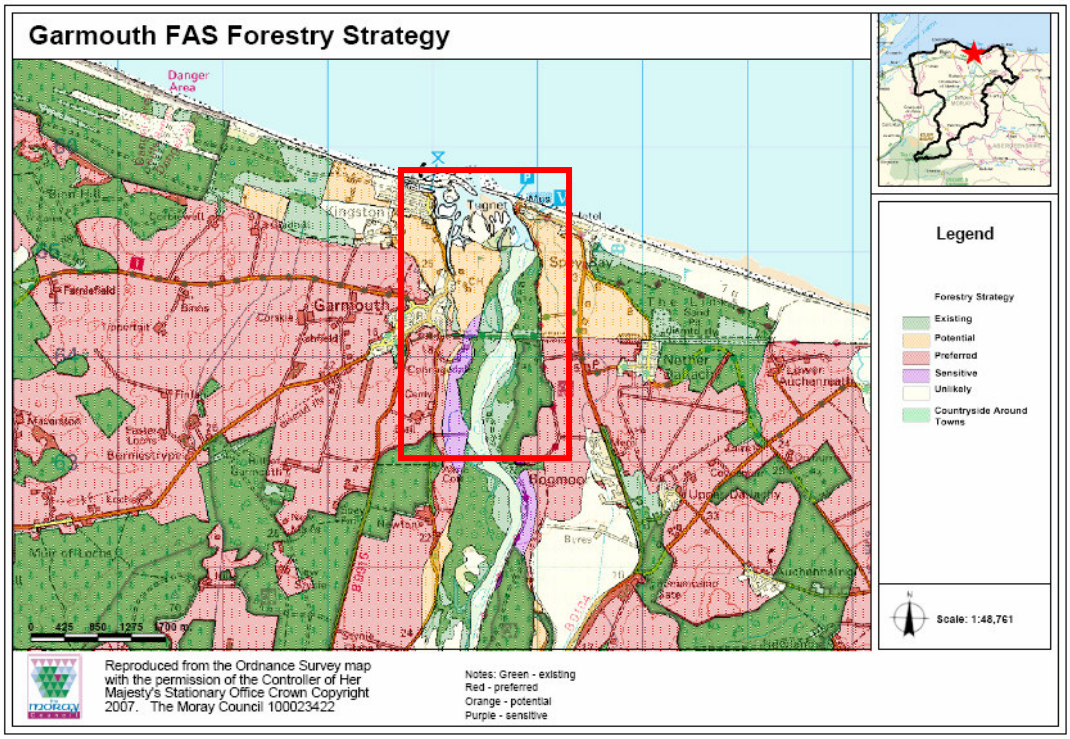


5.2 Forestry and woodland

Moray Council, SNH and the Forestry Commission produced the Moray Forestry Strategy in 2002. The strategy, which is currently being updated, aims to promote sustainable forestry in Moray. A large proportion of the land area of Moray is covered by woodland. The national average forest cover is 17% whereas in Moray, the figure is closer to 27%. Forestry is therefore of particular important to the economic, social and environmental character of the area.

Figure 12 shows that there are substantial pockets of forestry in the study area (dark green areas on map). The banks of the river in the study area are well planted, and there are large areas of agricultural land that have been identified in the Moray Forestry Strategy as being suitable for planting native woodland (red = preferred, and orange = potential sites for planting).

Figure 12. Map showing existing, potential, preferred and sensitive areas of forestry according to the Moray Forestry Strategy. Study area outlined in red

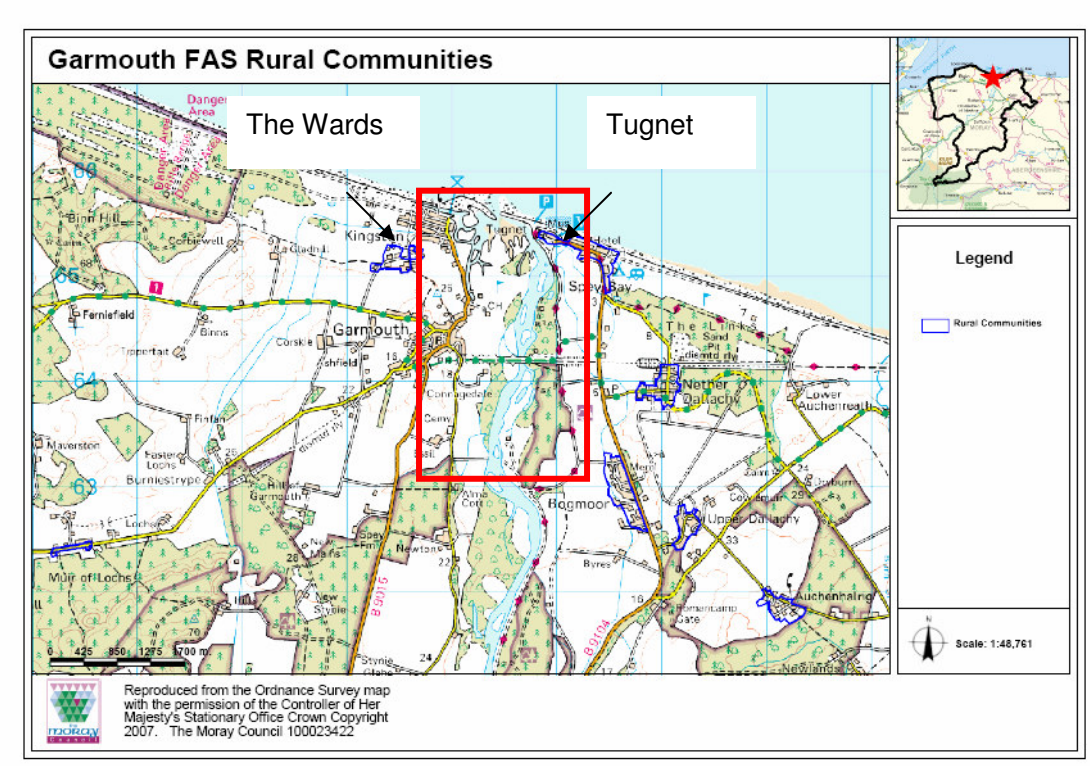


5.3 Urban and Rural Communities

There are two urban centres contained partially within the study area. These are the twin villages of Kingston-on-Spey and Garmouth. Garmouth has a population of 494 people occupying 200 properties while Kingston has 208 people in 82 households (2001 census).

Figure 13 shows rural community areas as defined by Moray Council (outlined in blue). The rural community at Tugnet falls within the study area, and the rural community at The Wards, on the outskirts of Kingston may also be affected as it is very close to the study area.

Figure 13. Rural communities in the area of Garmouth (outlined in blue). Study area outlined in red



6 RECREATION AND AMENITY

6.1 Angling

The River Spey is protected at a national and European level because of its Atlantic salmon population. It provides excellent habitat for salmon, and is a world class angling river. It is the 7th largest catchment in the UK at 2998 Km^2 with a main river stem of 157 Km in length. The lower stretches of the river are unusually fast flowing therefore providing many miles of excellent salmon fishing waters. It is thought that angling on the Spey generates £11.8m in revenue yearly and supports 367 jobs. The annual catch on the river has been in the region of 10,000 fish in recent years, and in addition, around 2000 sea trout are also taken. The lower reaches are where the best salmon angling is concentrated, while sea trout and brown trout angling occurs mainly in the upper and middle stretches of the river.

6.2 Garmouth and Kingston golf course

Garmouth and Kingston golf course is located on the west bank of the River Spey between the villages of Garmouth and Kingston–on-Spey (Figure 1). It is of extremely high importance to the local economy and community, drawing visitors into the area. Due to its location on the bank of the river, it is very prone to flooding, and the club house is one of the 7 buildings vulnerable at the 1:100 return period. Flooding of the course itself may result in loss of revenue if it becomes unplayable, and may subsequently require costly rehabilitation.

6.3 Watersports

Watersports on the River Spey generate £1.7m for the local economy and support 42 jobs. Activities include kayaking, canoeing and rafting and a canoeing. While these activities take place predominantly in sections of the river far upstream of the study area, there is one canoeing access point within it, at the eastern shore of the river mouth near Tugnet.

6.4 Cycling

A section of the Sustrans (sustainable transport charity) National Cycle Route passes through Garmouth, joining the old railway path and crossing the Speyside viaduct. The Moray Council Development Plan for Garmouth proposes that the cycle path, which is part of the Cullen to Garmouth route, should be protected from development.

6.5 Walking

'Walk in Scotland' features several walking routes around Garmouth, taking in the old railway line and bridge, the beach, the banks of the Spey and the Moray Firth Wildlife Centre at Tugnet. The Moray coastal trail also passes through Garmouth crossing the beach and shingle and using forest tracks to head inland before crossing the viaduct and turning north up the east bank towards Spey Bay. The Spey Bay Reserve is renowned for the long and short walks located within it.

The Speyside Way is one of four official long distance routes in Scotland (the others are the West Highland Way, the Great Glen Way and the Southern Upland Way). The

Speyside Way links the Moray coast with the Grampian Mountains and follows the valley of the River Spey. In the Garmouth area, the route approaches the mouth of the Spey from the east using old railway and forest paths, it passes Tugnet ice house before turning south along the eastern bank of the Spey.

6.6 Wildlife

There is a wildlife centre at the mouth of the Spey where sightings of bottlenose dolphins, seals, otters, ospreys and wildfowl are frequent. The centre was previously known as the Moray Firth Wildlife Centre which was developed in partnership with the Whale and Dolphin Conservation Society (WDCS). The society now runs the centre full time, and it is now referred to as the WDCS Wildlife Centre.

The Spey Bay Wildlife Reserve and the Lower River Spey are centres for large numbers of bird watchers attracted to the area by the wide diversity of water fowl that are found there.

6.7 Public Amenity and Development

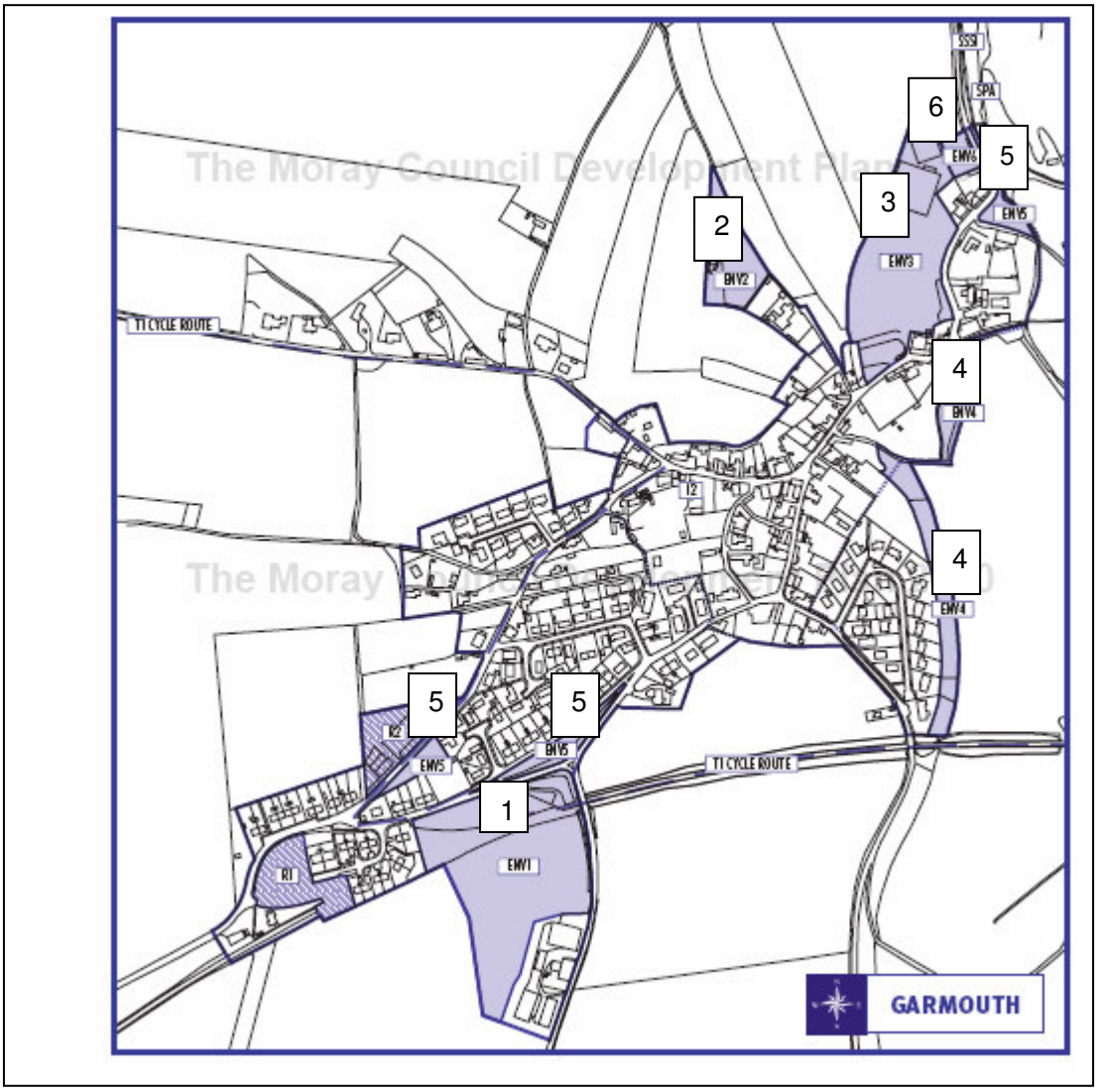
Recently, Garmouth has been growing at a slow rate as the Council has considered that further significant development would be detrimental to the character of the village and inappropriate to the structure of its narrow streets and lanes. It is planned that any development will only be permitted if it sustains and enhances the environment of the village.

Under their Public Amenity and Open Spaces policy (L/ENV18), the Moray Council has identified 6 areas in Garmouth that contribute to the amenity and environment of the village (Moray Local Plan, 2000 – under review). The site descriptions are as follows;

1. Railway sidings and community woodland – with car park, picnic facilities and public footpaths giving access to old railway line and woodland
2. Old water tower – landmark served by footpath
3. Playing field and tennis courts – to be maintained for recreational use and open space
4. East of orchard and natural woodland bank – on the terrace of the Spey and prone to flooding
5. Open spaces on South Road, Station Road and Kingston Road
6. Bowling club car park - can be used for adjacent recreational facilities

See Figure 14 below for map locations. The purpose of policy L/ENV18 is to protect these areas from inappropriate development or any activities that could compromise their contribution to the amenity of the area. Other policies central to the Moray Council's plan for Garmouth's environment are L/ENV10 (settlement boundaries) to prevent urban sprawl into rural areas surrounding the village, and L/IMP1 (development in built up areas).

Figure 14. Six amenity areas identified by Moray Council in Garmouth (Moray Local Plan, 2000)



7 STAKEHOLDER CONCERNS

Stakeholders in the Garmouth area (listed in Table 2) were contacted by letter on the 15th October 2007. Responses were requested by the 9th November and these are still being received. Any concerns raised will be addressed in full after that date.

Table 2. List of Garmouth stakeholders approached and issues raised

Scottish Environment Protection Agency
Aberdeenshire Council Archaeological Services
Garmouth and Kingston Golf Club
Garmouth and Kingston Amenities Association
SUSTRANS
River Spey District Salmon Fisheries Board
Forest Enterprise
Forestry Commission
Historic Scotland
North East Biodiversity Partnership
Moray Council (Air, Noise)
Moray Council (Contaminated Land)
Moray Council (Estates)
Moray Council (Planning)
Moray Council (Access Manager)
Moray Council (Environmental Protection)
Moray Ramblers
RSPB
Scottish Executive Development Department
Scottish Executive Protected Species Unit
Scottish Native Woodlands
Scottish Wildlife Trust
WWF Scotland
Transport Scotland
Scottish Natural Heritage

8 CONCLUSIONS

There are many environmental designations to consider in the area of the potential Garmouth Flood Alleviation Scheme. The primary concerns are maintaining passage and habitat for Atlantic salmon and sea lamprey, and maintaining the integrity of the vegetated shingle habitats. Due to the presence of species reliant on the channel substrate, the fragility of the shingle habitat and the immense volume of water discharging from the River Spey, in-channel works are unlikely to be technically, economically or environmentally viable. On land, licences are likely to be required for works involving disturbance to otter, water voles, badgers, red squirrel and bats as these species may all be present in the study area. Surveys for these species are therefore likely to be required. Garmouth and Kingston golf club is very heavily affected by flooding, and will probably constitute the main parcel of land involved in any flood alleviation scheme.

9 RELEVANT LEGISLATION

- The Convention on wetlands of international importance especially as wildfowl habitat (Ramsar convention, 1975)
- Convention of Biological Diversity, 1992
- Council Directive 92/43/EEC on the Conservation of natural habitats and of wild flora and fauna (EC Habitats Directive, 1992)
- Council Directive 79/409/EEC on the conservation of wild birds (EC Birds Directive, 1979)
- Directive 2000/60/EC of the European parliament and of the council establishing a framework for the community action in the field of water policy (EU Water Framework Directive, 2000)
- Biodiversity: the UK Action Plan, 1994
- The Water Environment and Water Services (Scotland) Act, 2003
- The Conservation (Natural Habitats, &C.) Regulations, 1994
- Wildlife and Countryside Act, 1981
- Nature Conservation (Scotland) Act, 2004
- Protection of Badgers Act, 1992

10 REFERENCES

- Alexander, G., Leaper, G., Francis, I. & Tulloch, M. (1998) Biodiversity in North-east Scotland: an audit of priority habitats and species. North-east Scotland Local Biodiversity Action Plan Steering Group
- Moray Local Plan (2000 / 2006)

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Appendix D
Geomorphology Baseline Study

Garmouth Flood Alleviation Scheme

Geomorphological Desk Study

Moray Council

22 November 2007
Final Report
9S9650

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Document title	Garmouth Flood Alleviation Scheme
Document short title	Geomorphological Desk Study
Status	Final Report
Date	22 November 2007
Project name	Garmouth Flood Alleviation Scheme
Project number	9S9650
Author(s)	Matthew Hardwick
Client	Moray Council
Reference	9S9650/R/302046/PBor

CONTENTS

1 INTRODUCTION

In October 2007, the Moray Council commissioned Moray Flood Alleviation to undertake, a study to assess the feasibility of a flood alleviation scheme for protecting the village of Garmouth. As part of the baseline assessment for the development of future options, a desk-based Geomorphological Assessment was requested to outline the main geomorphological issues, both locally and further-a-field. Selected proposals and maps, and initial thoughts on questions posed by Paul Hart (Scheme Project Manager for Garmouth FAS) were supplied.

Instructions were issued for a short report to be prepared to:

- Comment on sediment-related problems which may pose a risk the development of a flood alleviation scheme.
- Comment on the wider geomorphological reach scale implications of channel alteration and waters edge construction.

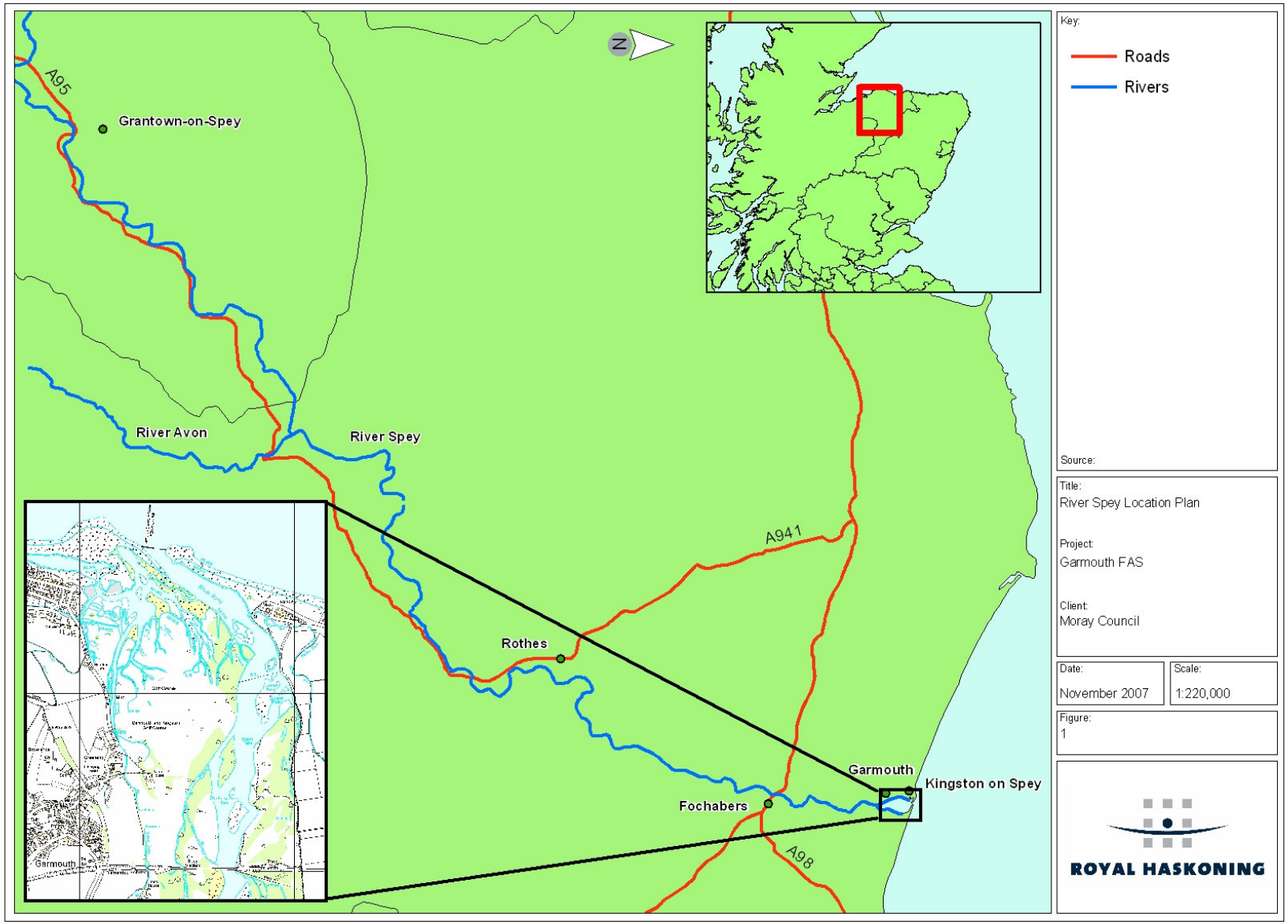
This document presents the findings of the desk based study.

1.1 Catchment Characteristics

The river system in the middle Spey exhibits a meandering pattern with a mean gradient of 1:1200. Downstream of Grantown, the gradient steepens to 1:380 giving rise to the most extensive area of braided river in Britain. Steepening in this location in the lower course is unusual for a British River. It results from a general elevation of the Moray coast due isostatic recovery following recession of an ice sheet about 10 000 years ago.

The 2988 km^2 catchment of the Spey, which ranks ninth in Britain in area, drains the northern slopes of the Cairngorms and eastern slopes of the Monadhlaith Mountains. Peak discharges rank seventh highest in Britain, and Inter-basin transfers of water, from the upper parts of the catchment to the Great Glen, reduce the flow in the River Spey and have an attenuating effect on flood flows within upper/middle parts of the catchment. However, many of the floods in the lower catchment are the result of the flashy hydrology of the Spey and also the River Avon (major tributary confluencing downstream of Grantown-on-Spey) which is not affected by impoundments (Figure 1). More generally, the tendency for flash floods is related to the low permeability of the rocks comprising of Cairngorm and Monadhliath. Overall the most notable flood events within the Spey catchment occurred in 1829, known as the Great Moray Floods, and in 1970. The return period estimated for these are 150 years and 45 years, respectively. Flooding was widespread, affecting Tugston, Garmouth and Kingston.

The Spey Bay estuary and coastline encompass a whole host of interests. The area is designated as a Site of Special Scientific Interest (SSSI). Commercial salmon fishery in the Spey has been important for many years, the fishery ranking among the top five rivers in Scotland. In addition, there is extensive Forestry Commission land and two golf courses in the area, in particular Garmouth Golf Club, making it one of high amenity and recreational value.


N
A95
Grantown-on-Spey
River Avon
River Spey
A941
Rothes
Garmouth
Kingston on Spey
Fochabers
A98
Key:
Roads
Rivers
Source:
Title:
River Spey Location Plan
Project:
Garmouth FAS
Client:
Moray Council
Date:
November 2007
Scale:
1:220,000
Figure:
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2 HISTORICAL ANALYSIS

2.1 Lower Spey

In the lower reaches of the River Spey, the river exhibits some braided reaches, which is indicative of the high flow energy present in this part of the fluvial system. Lewin and Weir (1977) found that the pattern and intensity of braiding are different to those which prevailed in the late 1800s, attributing the changes to human constraints on channel evolution and to extensive afforestation in the catchment, which has affected sediment supply and discharge characteristics. The ability of the River Spey to transport material downstream to its mouth is evident from historical accounts, including one describing the Great Moray Floods of 1829. It was reported at the time that some of the stones forming part of the bridge over the Spey at Fochabers were carried downstream following collapse of the bridge, and were removed from the shore at the mouth four days later. The high sediment delivery to the estuarine area significantly affects the development and changes to planform and spit development at the mouth of the Spey.

In addition, the history of channel change in the lower Spey relates to the ability of the river to erode its banks and, in doing so, transport sediment. These depend heavily on channel gradient, discharge and the sediment size, and also, more importantly in gravel bed rivers such as the River Spey, the process of bed armouring. Armouring affects the overall transport rate, whereby grains are transported away by the flow and the remaining material is protected from erosion by the larger grains, which accumulate to form a coarse layer at the surface of the bed (Thorne *et al.,* 1987).

2.2 Reach scale – Spey Bay (Railway Viaduct to Mouth of River Spey)

The geomorphology of Spey Bay is the result of a complex interaction between fluvial flows in the River Spey and the coastal wave climate. Historically, the major morphological feature resulting from this interaction has been a spit across the mouth of the river. Changes in the position of the river mouth are shown in Figure 3, which is based on cartographic records analysed by Grove (1955) and OS mapping/aerial surveys performed in a 1990-1992 study (Riddell and Fuller, 1995).

There appears to be a tendency for the river mouth to shift westwards towards Kingston, due to westward migration of the spit formation under the action of long shore drift, with the most significant migration being 1.2 km west from a location centred on the axis of the estuary in the past (Figure 3). However, the westward trend in shifting of the mouth has reversed several times, due to the natural breaching of the spit (Figure 3). Events of this type were recorded in 1829, 1981 and 1989. Breaching results in a realignment of the course of the river to a position central between the coastal villages of Kingston and Tugnet.

The potential for large and rapid changes in this part of the Lower Spey, is significantly illustrated at the site of the now disused Spey Bay Railway Viaduct, at the upstream limit of our study reach (Figure 1). Analysis of historical maps and aerial photographs shows that, here, the main channel has moved nearly 200m to the east since the bridge was

constructed, with flows passing via the minor, easterly spans for most of the bridge's life. The path of the main channel between the railway viaduct and the mouth has undergone considerable change during this century (Figure 2*)*. It is this reach of the river which has received the most attention in the past, owing to the scale of the changes observed and its close proximity to people and property, such as the village of Garmouth, and recreational amenities, such as Garmouth Golf Course (Figure 2).

Based on the historical nature of the estuary and its ability to change constantly, rapidly and unpredictively, together with the high conservation/recreational importance of this area, it is recommended that engineering intervention should be minimised. It is recommended that any engineering works should be set back, as far as is possible away from the channel, allowing the estuary to adapt to change within a wide morphologically-active corridor.

Interestingly, analysis of available sources revealed a significant relationship between the bridge span through which the main channel flows and the channel planform between the bridge and the mouth. Recent aerial photographs show that since the early-1990s the River Spey has occupied the western span of the Railway Viaduct, whereas it had flowed through the eastern span for the majority of the bridge's existence (Plate 1 and 2). This channel shift may be attributed to the majority of the eastern and middle bridge spans currently being block by sediment and vegetation, influencing the path taken by flows approaching the bridge. This sediment accumulation appears to have been exposed above the low flow elevation for a considerable period of time, allowing vegetation to colonise it and forming a stabilised, semi-permanent bar that directly influences the position and orientation of flows entering the study reach.

Incidentally, analysis of both historical maps and aerial photos shows that when the flow was routed through the eastern part of the bridge, the channel planform was less sinuous than at present, with the river active corridor of the river being much narrower than it is currently. Since the main channel has occupied the western span of the railway viaduct, the planform downstream has become much more sinuous, adopting a 'wandering' configuration that involves the channel shifting across a much wider morphologically-active corridor. It is the larger meander loops which have developed in the active channel that are responsible for widening the corridor. These are now resulting in progressive erosion of the area occupied by Garmouth Golf course, especially in areas where the natural resistance to erosion due to fluvial attack has been reduced due to destruction of the floodplain forest and breaching of the wooded riparian fringe at the edge of the morphologically-active corridor. Plate 3 shows the area of erosion at the 17th/18th holes on the Garmouth Golf Course resulting from the growth and migration of large meander loops in the active channel, coupled with development of active back channels in the wandering planform of the river.

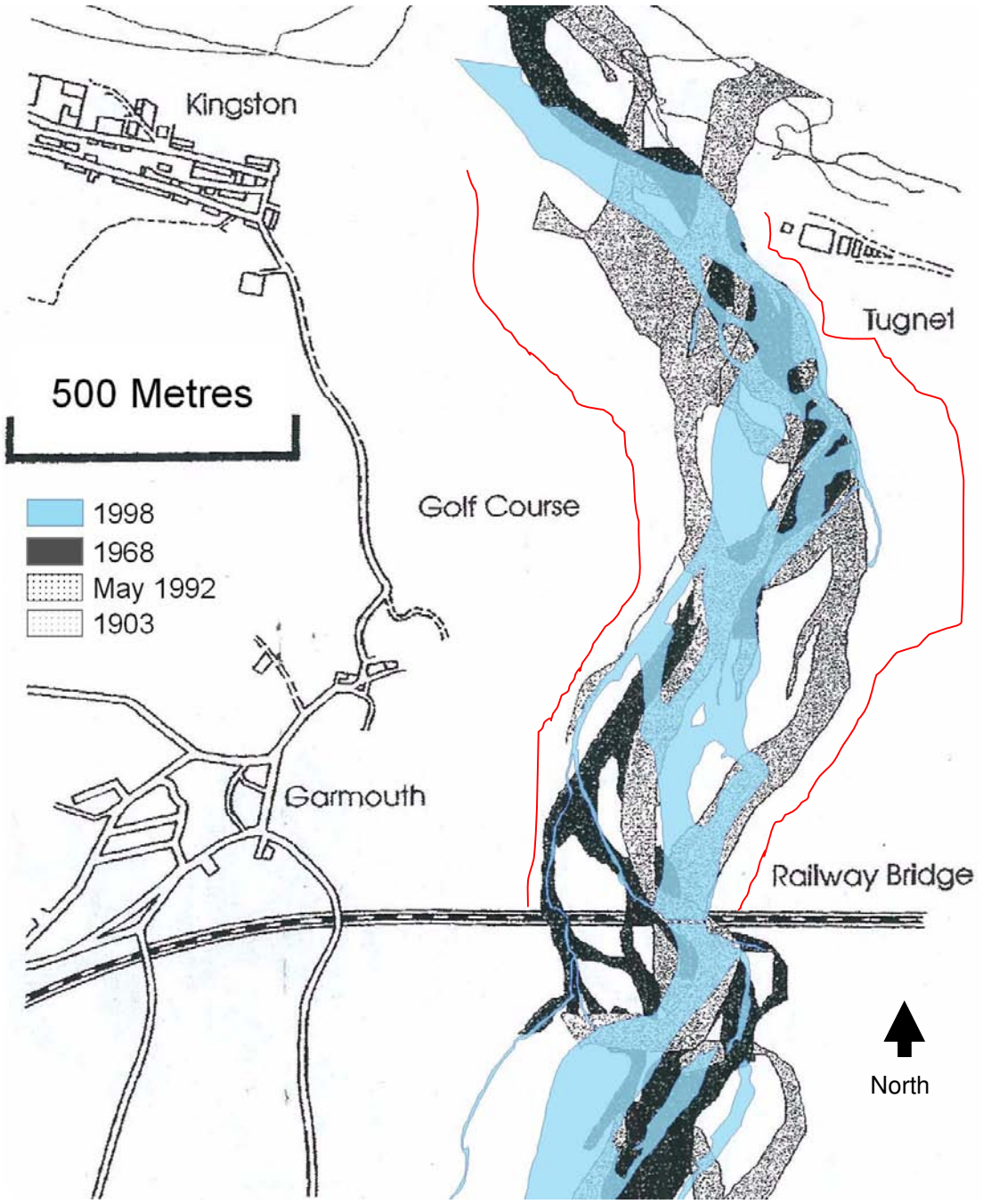

Figure 2 Historical channel changes between the Railway Viaduct and mouth of the River Spey.

Plate 1 Main channel flowing through eastern span of the Railway Bridge (1991)

Plate 2 Main channel flowing through western span of Railway Viaduct (1998)

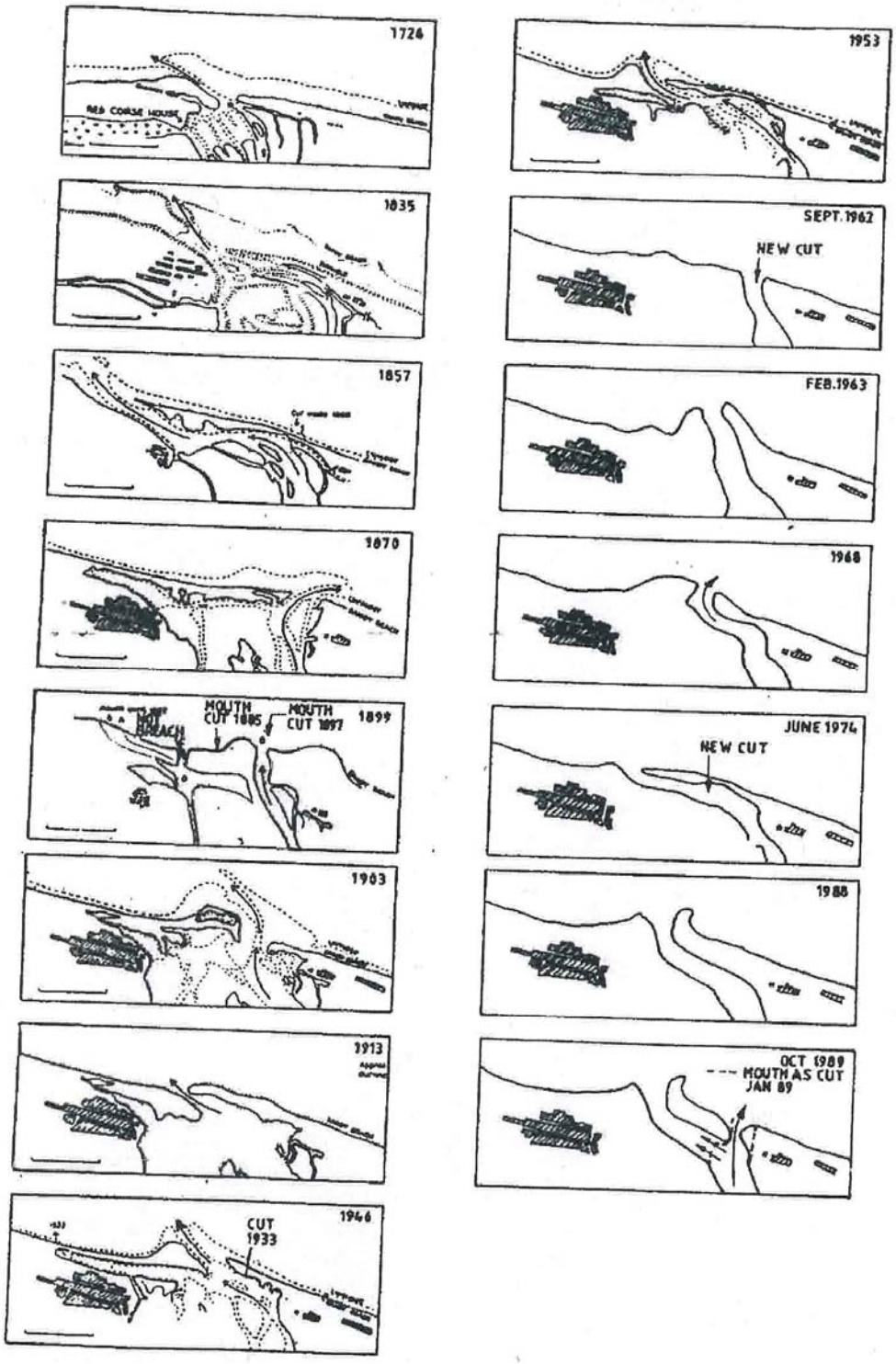

Figure 3 Evolution of the mouth of the River Spey between 1726 and 1989

Plate 3 Arrow marks the area where Garmouth Golf Club is currently experiencing major bank erosion and the loss of their 17th/18th hole. The area highlighted in red is the approximate area lost since this photo was taken in 2000, due to development of meander loop through bank erosion coupled with the active back channel.

3 OVERVIEW OF GEOMORPHOLOGICAL ISSUES

Morphological response of the estuary to engineering intervention

The underlying philosophy for the management strategy is to implement methods that are in sympathy with the environment and that avoid or minimize disturbance to the area. Training the course of the river downstream of the railway viaduct using hard structures would be contrary to the aim of preserving the landscape of the area, and would be inappropriate given the high mobility of the river channel, as demonstrated by the number and extent of channel changes observed during the last century.

A more appropriate solution to reducing flood risk in the village of Garmouth, and simultaneously accommodating the high channel mobility and high sediment loads delivered to the estuary, is to allow the planform of the river to develop naturally, but within tolerable boundaries. The rapid geomorphological assessment reported above has allowed us to identify the boundaries to the morphologically-active river corridor and formulate a management strategy which will prevent damage property in the form of erosion and flooding, while allowing the river/estuary to retain its natural morphological functions, forms and features. Figure 2 shows the boundary extents (marked in red) for the active estuarine corridor, which should be maintained to allow the river to adapt naturally and in accord to future changes in the flow and sediment regimes. The boundaries tend to reflect the current channel planform to a high degree as this is responsible for generating the widest active corridor observed during the period of record. This is the case because it is in its present configuration that the river generates the highest meander amplitude and greatest number of morphologically-active back channels observed during the last 100 years.

Meander development and bank erosion at Garmouth Golf course (principally (17th and 18th holes)

The meander geometry and pattern downstream of the Railway viaduct is still evolving and is controlled primarily by three factors: discharge regime, meander bend curvature and bank composition/bank protection.

The main process of river bank erosion on the area concerned is hydraulic action. As discharge increases so does the flow velocity, and this leads to an increase in shear stress exerted on the channel boundary (bank and bed). As shear stress increases, sediment particles are entrained from the channel boundary resulting in bank erosion. However, this rate of erosion is also significantly influenced by the meander bend curvature and bank protection. Currently the meander loop currently attacking the golf course area has a very large amplitude which will continue through bank erosion.

Furthermore, the rate at which bank erosion occurs on the apex of the bend is exacerbated by the shear strength of the bank materials reducing the effectiveness of hydraulic action. The banks of the Spey are composed of coarser grained sediment (sands and gravels) forming non-cohesive banks which erode more easily. Recent available sources of historical maps and aerial photographs from the last 20 years show the presence of active back (chute) channels running parallel to the golf course and also the progressive loss of vegetation, which acts of a natural protection against fluvial

attack. *It is not clear as to whether the loss of vegetation has been induced by natural processes or by human induced changes.*

Bank erosion along the left bank adjacent to the golf course is posing a serious management issue because the meander loop is used for recreational use (Plate 3). Although the meander lies within an SSSI, intervention to reduce bank erosion and/or flooding is required in the very near future to ensure the golf course can continue to operate. The possibility of encouraging vegetation growth along the riparian fringe could increase protection against fluvial attack, prolonging the recreational use of the land for a significant period of time.

Formulation of integrated coastal zone, estuarine and fluvial strategy

Due to the complex interaction of fluvial flow, tides and wave climate, and the impact on sediment transport, there is significant uncertainty as to how the geometry and pattern of meanders will evolve in the near future. It is therefore recommended that an integrated Spey Bay strategy study, which links the morphological development of the River Spey with the development of the River Spey mouth and coastal zone, is carried out. This could be conducted through the utilisation of a detailed geomorphological dynamics assessment, perhaps coupled with investigation of sediment transport pathways and associated loads a 2-dimensional morphological model such as DHI's MIKE-21.

4 REFERENCES

Grove, A.T. (1955). The mouth of the River Spey. *The Scottish Geographical Magazine.* ***71*** *(2), September.*

Lewin, J. and Weir, J.M.C (1977). Morphology and recent history of the Lower Spey. *The Scottish Geographical Magazine.*

Thorne, C.R., Hey, R.D. and Bathurst, J.C (1887). *Sediment Transport in Gravel-Bed Rivers.* J. Wiley and sons, Chichester.

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Appendix E
Garmouth extract from Moray Local Plan (2000)

GARMOUTH

THE PLANNING BACKGROUND

Garmouth has experienced a relatively slow rate of growth during the period of the 1993-98 Local Plan, reflecting the shift in policy that further significant development would be detrimental to the character of the village and inappropriate for the limitations of the road structure. The former Haulage Contractor's business on Station Road was identified in the 1993-98 Plan as an Opportunity Site with potential for residential development and a planning application for the development of 11 house plots was approved in July 1997. Gap site development meanwhile has continued.

The nature of Garmouth, with its narrow streets and lanes suggests that the village may have reached its optimum size. Flooding risk and sewage capacity have been a constraint to development and the Council is investigating a detailed flood risk policy in relation to specific types of development proposals.

CHARACTER OF THE VILLAGE

Garmouth functions essentially as a commuter village, principally for Elgin. It is still small enough to maintain a village character which so many places of similar size have lost in recent years. The Conservation Area centred on High Street, Spey Street and Church Street, has been successful in maintaining and enhancing the attractiveness of the village, derived from its narrow streets, irregular building lines and a variety of architectural styles. Outwith the Conservation Area the village has a mix of local authority housing to the west end and more contemporary bungalow developments at Northfield Place and Lemanfield Crescent.

OBJECTIVES

(i) To safeguard the existing quality of the village by restricting further expansion of the village on the grounds of its Conservation Area character and road structure.

(ii) To only permit development which sustains and enhances the environment of the village.

POLICIES AND PROPOSALS

In addition to the site specific requirements identified below and in development briefs, all developments must meet the terms of the Implementation policies (L/IMP1-8) in Chapter 8 (relating to siting, layout and design, character impact, landscaping, drainage, environmental and traffic impact). Subject to the scale of the development having a measurable impact on local community facilities, amenities or infrastructure, funding policies L/F1 Developer Contributions and L/F2 'Commuted Payments' in Chapter 7 may also apply.

BUSINESS ACTIVITIES

The Local Plan policies for business development are contained in Chapter 1 'Economic Development'.

All sizeable commercial and industrial enquiries will be directed to the industrial sites in Lhanbryde and Mosstodloch.

TOURISM

The governing policies for Tourism are L/ED16 and 17 in Chapter 1 (Tourist Facilities and Accommodation and Roadside Signs). The Economic Development policies in Chapter 1 apply where relevant and policy L/CF4 in Chapter 5 safeguards established routes for walking, cycling, trails and cross-country skiing.

T1 SUSTRANS Cycle Network
The Council is promoting the Moray section of the SUSTRANS National Cycle Network and will consequently protect the route through Garmouth.

ENVIRONMENT

The policies for the maintenance and enhancement of the environment are found in Chapter 2 (Environment).

The principal policies for the local environment are L/ENV10 'Settlement Boundaries' and L/ENV18 'Public Amenity and Open Spaces' in Chapter 2, and L/IMP1 'Development in Built Up Areas' in Chapter 8.

Under the terms of policy L/ENV18 (Public Amenity and Open Spaces) a number of spaces have been identified which contribute to the environment and amenity of the town. The purpose of policy L/ENV18 is to protect the integrity of these spaces from inappropriate development and to ensure that their contribution to the amenity of the built up area is not compromised.

Population 524

ENV1 Railway Sidings/Community Woodland
Car park, picnic facilities and public footpaths providing access to the disused railway line and community woodland. This area is to be maintained as open space for public recreational use.

ENV2 Old Water Tower
Site of the original water tower serving Garmouth and Kingston areas. This local landmark occupies an elevated site on the northern boundary of the village and is served by a public footpath.

ENV3 Playing Field/Tennis Courts
Area to be retained for recreational use and open space.

ENV4 East of Orchard/Woodland Bank
Wooded area on the terrace of the River Spey and east of the burn. The area in the vicinity of the burn is subject to flooding when the Spey is in spate. The natural woodland should be retained.

ENV5 Open Space: South Road, Station Road & Kingston Road
Small landscaped areas which should be maintained as amenity land for the adjoining housing.

ENV6 Bowling Club Car Park
Area to be retained as informal car park for adjacent recreational facilities.

There are wider environmental designations relating to areas of local, national and international scientific importance and to areas of high scenic and landscape quality which in most cases may relate to areas just beyond the settlement boundary. Where sites of scientific importance are found within settlement boundaries, these are designated as ENV in the Proposals Map.

CPZ **The designation of the Coastal Protection Zone includes the banks of the River Spey as far as the viaduct. Much of this area is susceptible to flooding and erosion so the Council will investigate flood prevention and alleviation measures along with monitoring of both the River Spey and Spey Bay coastline (see L/ENV26).**

SSSI **The Spey estuary Site of Special Scientific Interest designation extends to the northern edge of the village. The estuarine section of Spey Bay is part of a Special Protection Area and Ramsar wetland site. The SSSI is also currently part of a candidate Special Area of Conservation (SAC).**

SINS **A Site of Interest to Natural Science area abutting the northern and eastern boundaries of the village is designated for its geomorphological interest.**

Detailed maps of all the above are held by The Moray Council.

Conservation Area

The governing local plan policy for development within Conservation Areas is L/ENV15 in Chapter 2. (Listed Buildings are controlled under policy L/ENV14).

The boundary remains unchanged. There will be a policy to restrict sub-division within the Conservation Area, on grounds of character, amenity, access and servicing. (See detailed maps held in the Council Environmental Services Department offices).

HOUSING

The main governing local plan policy for new housing developments is L/H3 in Chapter 3 (Servicing and Layout of new Housing Developments). Policy L/H7 in Chapter 3 (Affordable Housing provision) may also apply depending on the size and location of the development.

R1 Station Road
The remainder of the Station Road site is designated for specialist housing (see policy L/H8 in Chapter 3). The existing Council development already contains a number of houses specifically designed for the elderly and it is considered that an additional provision on this site would be compatible with this development. Access as existing via "The Sidings".

R2 Haulage Contractor's Yard, Station Road
The site has been vacated and the industrial buildings recently removed, prior to the development of 11 house plots.

UTILITIES AND SERVICES

Waste Water Treatment

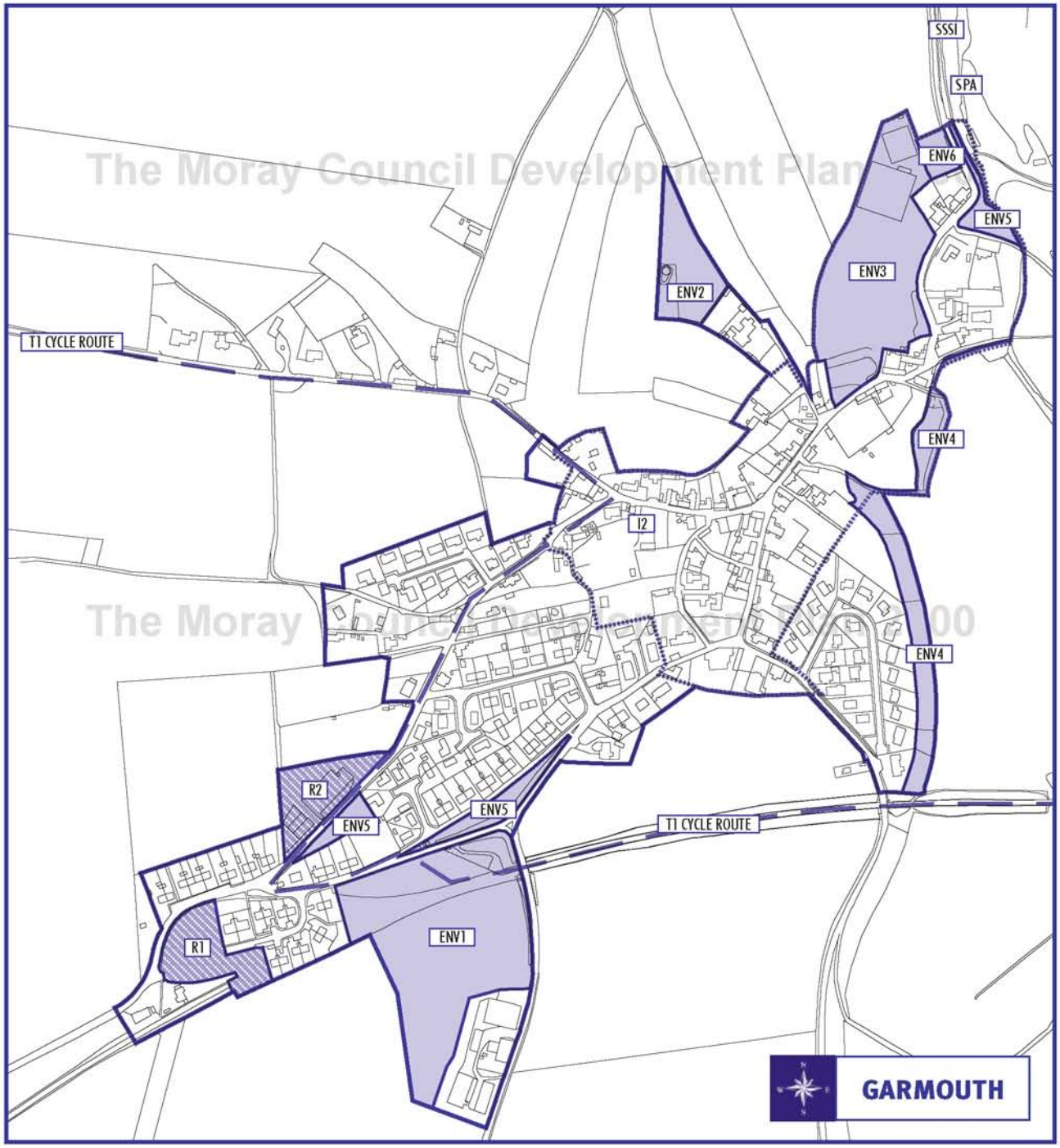
The North of Scotland Water Authority are confident that the public sewer is able to manage waste from existing housing land allocations. The village settling tank has a limited capacity at present and a new system will be required before any further development beyond that designated can be permitted. NOSWA are listed as a statutory consultee for any planning applications with associated drainage problems.

Flood Risk

Parts of the village are subject to a persistent flood risk from the River Spey and developments within these areas will be subject to assessment under terms of policy L/ENV26 'Control of Development in Flood Risk Areas'.

Flood Prevention Scheme

The Moray Council will pursue the preparation of a Flood Prevention Scheme for Garmouth and Kingston under the terms of the Flood Prevention (Scotland) Act 1961 as amended. This scheme will be prepared in line with statutory process under the Act, require extensive hydrological research and will be subject to public consultation and environmental assessment.



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Appendix F
Properties at Flood Risk in Garmouth

Figure E.1: Properties at Flood Risk in Garmouth

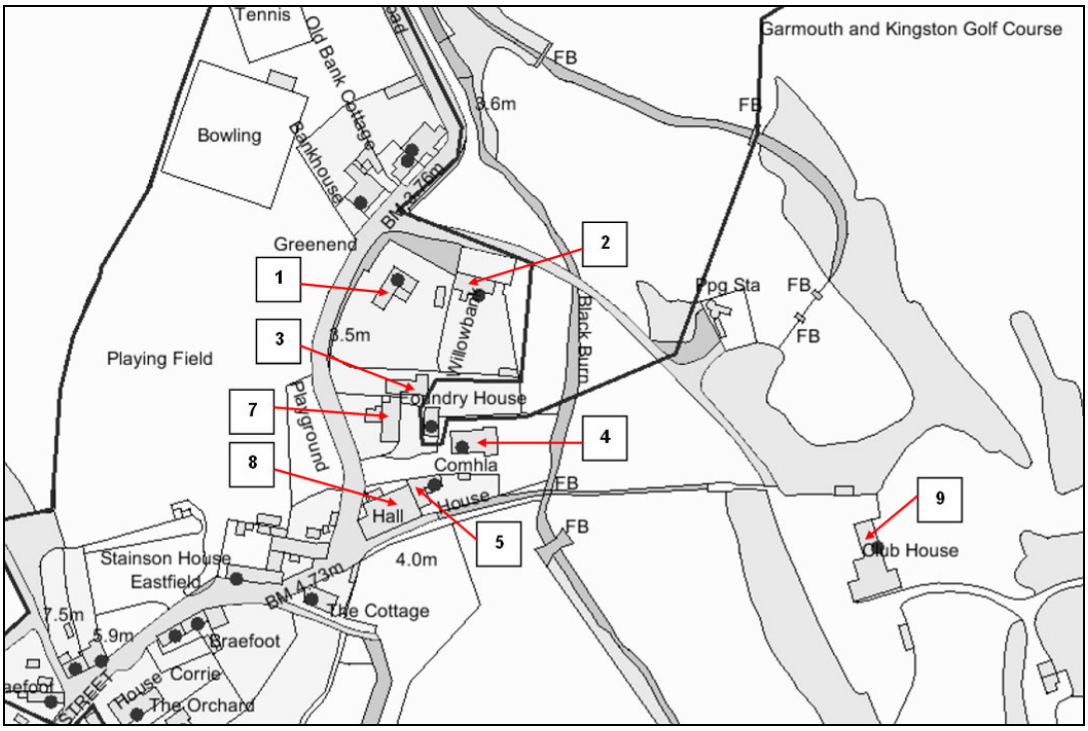
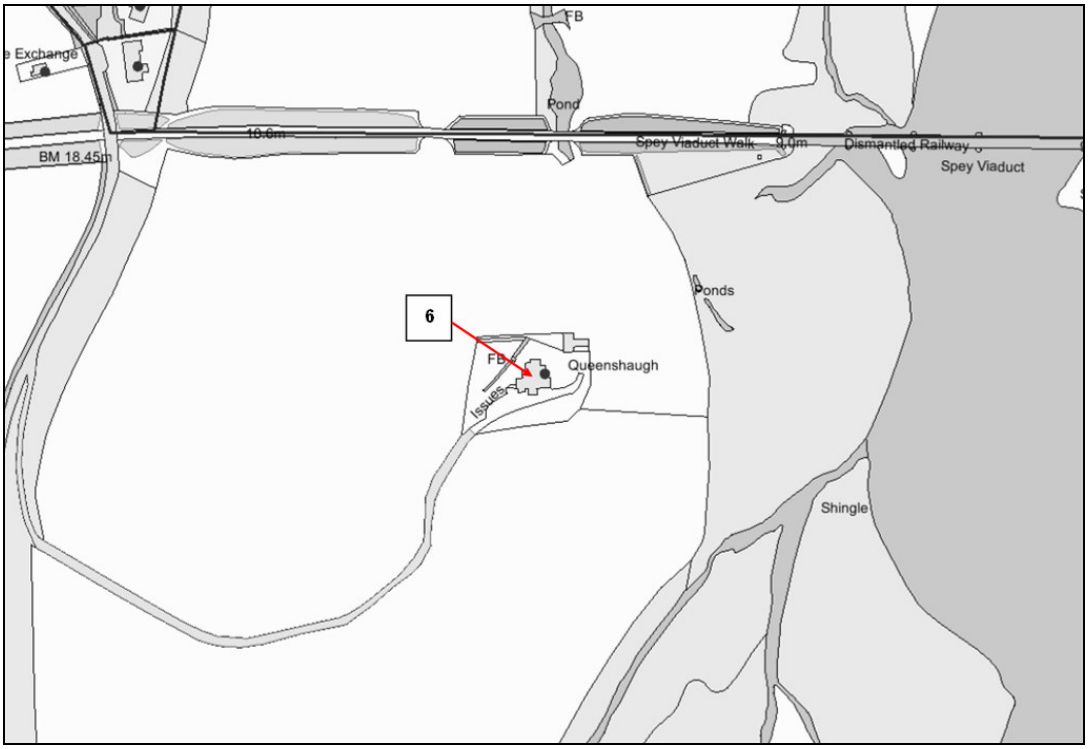


Figure E.2: Properties at Flood Risk in Garmouth



Property 1

Address: Greenhead House, Spey Street, Garmouth, Fochabers, IV32 7NJ

Property 2

Address: Willowbank Cottage, Spey Street, Garmouth, Fochabers, IV32 7NJ

Property 3

Address: Foundry House, Kingston Road, Garmouth, Fochabers, IV32 7NT

Property 4

Address: Comhla, Spey Street, Garmouth, Fochabers, IV32 7NJ

Property 5

Address: Marshall House, Spey Street, Garmouth, Fochabers, IV32 7NJ

Property 6

Address: Ross House, Garmouth, Fochabers, IV32 7LE

Owner: Mrs. Molly Duncan

Photograph unavailable

Property 7

Address: The Church of Scotland Parish Hall, Spey Street, Garmouth, Fochabers, IV32 7NJ

Property 8

Address: Village Hall, Spey Street, Garmouth Fochabers, IV32 7NJ

Property 9

Address: Club House, Garmouth and Kingston Golf Course, Spey Street, Garmouth, Fochabers, IV32 7NJ

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Appendix G
Garmouth Photos

Garmouth Flood Event – 14/12/2006

Plate F.1:

Plate F.2:

Plate F.3:

Plate F.4:

Plate F.5:

Plate F.6:

Plate F.7:

Plate F.8:

Plate F.9:

Plate F.10:

Plate F.11:

Plate F.12:

Plate F.13:

Plate F.14:

Plate F.15:

Plate F.16:

Plate F.17:

Plate F.18:

Plate F.19:

Plate F.20: