Moray Coastal Change Adaptation Plan

Kingston to Lower Auchenreath Coast

Final

September 2023

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Revision History

Revision Ref/Date	Amendments	Issued to
March 2023 -P01	Draft Report	Will Burnish Leigh Moreton
September 2023 – P02	Final report after Moray Council comments	Will Burnish Leigh Moreton

Contract

This report describes work commissioned by Will Burnish, on behalf of Moray Council, by a letter dated 9 August 2022. Moray Council's representative for the contract was Will Burnish. Jenny Shadrick, Doug Pender, and Angus Pettit of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

JBA and Moray Council would like to acknowledge the contributions of Steve McFarland (SEPA) and Dr Alistair Rennie (Nature Scot and Dynamic Coast) for provision of data and advice during the project planning phase.

Thanks also go to Prof Larissa Naylor and Dr Martin Hurst of the University of Glasgow for their valuable input throughout, and peer review of the draft report.

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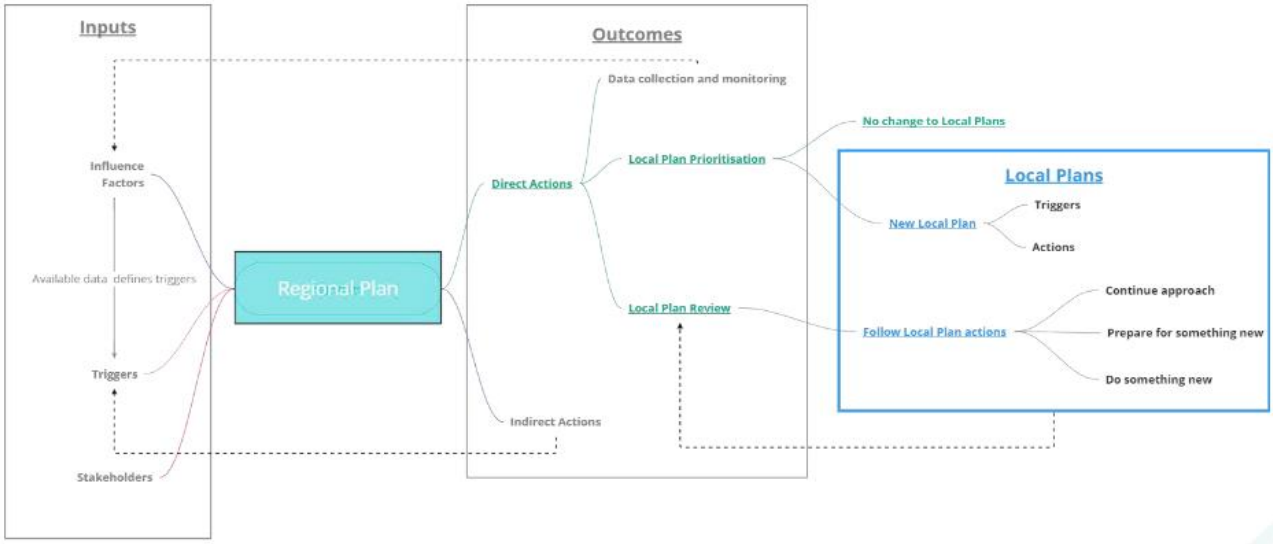
Executive summary

The report documents the Coastal Change Adaptation Plan (CCAP) for the Kingston to Lower Auchenreath Coast Community Area (CA) in Moray. It forms one of the eleven Local Plans, for the Moray Council region.

It aligns with the wider Regional Plan[1] and forms the highest level of detail of the overall Coastal Change Adaptation Planning process adopted by Moray Council.



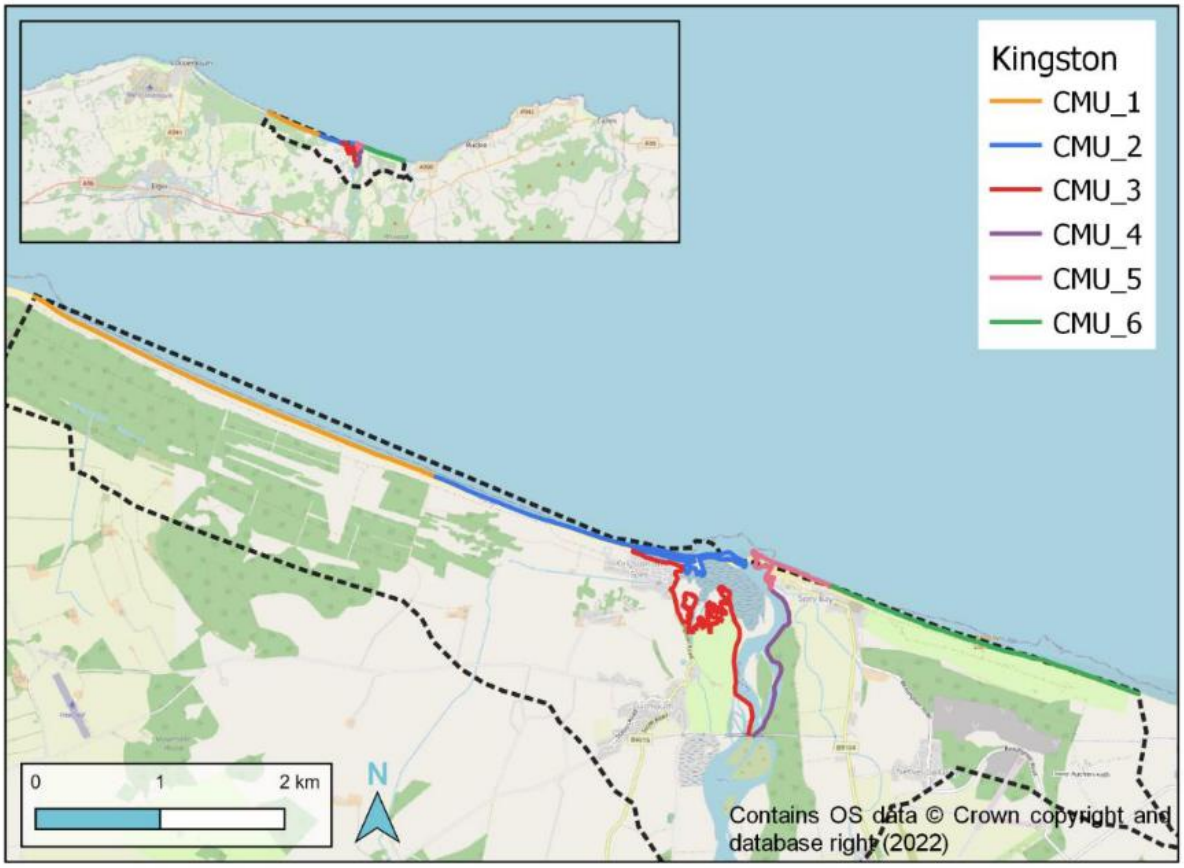
The CCAP provides an overview of the coastal flood and erosion risks to Kingston to Lower Auchenreath Coast, which are used to underpin development of possible Adaptation Pathways for this community. These are presented, along with a framework to support proactive coastal risk management, enable implementation of climate change adaptation actions and link with climate resilient development planning along Moray's coast.

The Plan has been developed using available, datasets from Moray Council, SEPA and the Dynamic Coast Project. It aims to directly support statutory and non-statutory Moray Council policies, plans and strategies and aligns with key coastal climate change adaptation guidance and resources within and beyond Moray Council.

This Plan documents the Phase 0 starting point of adaptation, meaning that no definitive preferred Adaptation Pathway and associated Action Plan have been developed. Rather this Plan sets out a framework and process for Moray Council to implement to effectively plan and support sustainable adaptation.

To develop Adaptation Pathways, the coast of the CA was classified into Coastal Management Units (CMUs) defined by 1) classification of coastal landform type, and 2) risk associated with coastal flooding and erosion. A total of six CMUs were identified, and six associated Adaptation Pathways were developed for each CMU.

1 Moray Coastal Change Adaptation Plan: Regional Plan - IRR-JBAU-XX-XX-RP-MO-0001-S4-P03-Regional_Plan



The framework is to be delivered through the defined Implementation Plan by defining Triggers and setting associated Actions against these. A single Implementation Plan is applied to the entire CA, where the outcome of the process determines what direction will be followed within the Adaptation Pathway. The Implementation Plan has three key stages:

1) Monitoring and Triggers
2) Actions
3) Outcomes

Trigger points are identified and set following a risk-based approach and will be identified through repeat monitoring of available data that informs coastal flood and erosion risk.

Realisation of Triggers signal a need for review or change of the Adaptation Pathway. Actions bridge the gap between Triggers and Outcomes and define what processes need to be implemented before an appropriate Outcome is identified. Adaptation interventions are potential measures that can be applied. There are four possible categories:

1) No intervention
2) Enhance natural features
3) Protect
4) Create Space

A set of Phase 0 Actions have been identified, that require immediate attention because of Triggers being met in this iteration of the Kingston to Lower Auchenreath Coast CCAP. Furthermore, this initial stage of the adaptation planning process has identified several knowledge gaps and opportunities for activities to be undertaken upfront to support coastal change adaptation at Kingston to Lower Auchenreath Coast.

The current iteration of the Kingston to Lower Auchenreath Coast CA plan is at Phase 0. Triggers met in Phase 0 and associated Actions for each CMU are summarised in the table below. These will be delivered during the first cycle.

Full details of the Phase 0 Actions are included in Appendix C and documented in Section4.4.

CMU	Trigger	Action
1	No current Triggers	No current Actions
2	Erosion buffer exceeded	Increase monitoring and plan for assessment.
3	Flooding threshold exceeded	Undertake assessment and plan intervention.
4	Flooding threshold exceeded	Undertake assessment and plan intervention.
5	No current Triggers	No current Actions
6	No current Triggers	No current Actions

As well as Triggers and Actions that correspond directly to the Adaptation Pathway and specified CMUs, Proactive Actions that support the whole of the Kingston to Lower Auchenreath Coast are summarised below:

1) Investigate opportunities for shingle recycling.
2) Develop modelling framework to support future assessments.
3) Establish coordinated and consistent beach monitoring plan for Natural CMUs.
4) Adaptation and resilience workshop with local community and stakeholders.
5) Identify landownership and safeguarding space.

Again, these will be delivered during this first cycle.

Contents

List of Figures

List of Tables

Abbreviations

CCAP	Coastal Change Adaptation plan
CA	Community Area
CMU	Coastal Management Unit
DC	Dynamic Coast
mAOD	meters Above Ordinance Datum
MHWS	Mean High Water Spring
NFRA	National Flood Risk Assessment
NRP	Non-residential Property
RCP	Representative Concentration Pathways
RP	Residential Property

SEPA	Scottish Environment Protection Agency
SLR	Sea Level Rise

Glossary

Accretion*	The build-up of sediment resulting in the seaward movement of the coast/ Mean High Water Springs.
Actions*	A plan or policy option that promotes an adaptive approach to coastal change that makes use of long term or resilient solutions such as preserving natural features.
Action Plan*	The proposed strategy or course of action to be taken depending on trigger point reached.
Adaptation*	The adjustment in economic, social or natural systems in response to actual or expected climate change, to limit harmful consequences and exploit beneficial opportunities.
Adaptation Pathways*	A flexible way of managing future uncertainty by planning for multiple scenarios without rigid timelines responding to the nature of future changes as they unfold.
Asset*	An item, such as a building, that is deemed to have an economic, social, or cultural value (or combination of).
Decision point*	A management action based on a trigger being reached.
Erosion*	The removal of sediment resulting in the landward movement of the coast (Mean High Water Springs)
Hard coast*	Coast that is comprised mainly of materials resistant to erosion such as hard rock types or artificial structures.
Implementation Plan	The framework developed in this first iteration, or Phase 0 of the Adaptation Pathway to support Moray Council in the development of Action Plans for each CMU.
Implementation Plan Actions	Actions that Moray Council will deliver in response to a Trigger being met and will determine the Outcome of the phase of the Adaptation pathway.
Outcomes	Outcomes of the Implementation Plan determines the current path of the Adaptation Pathway.
Soft coast*	A coast composed of unconsolidated sediments, which is not inherently resilient to erosion, but relies on the balance of natural processes to maintain its shape in response to storms and everyday processes.
Triggers*	Either a physical process or an enabler/inhibitor that when reached or a threshold crossed.

*Term definitions from Scottish Government Coastal Change Adaptation Plan Guidance **Error! Bookmark not defined.**

1 Introduction

1.1 Coastal Change Adaptation Planning in Moray

Our climate is changing and throughout history, our coast has responded to changes in sea level, storms, and other climate parameters. This means that the current position of Moray's coast is not fixed but is dynamic and will continue to evolve as our climate changes.

We can no longer use traditional, engineered, coastal risk management approaches in isolation protect society against these risks. Instead, we must, as a society, become more resilient and adapt to our changing coast through combined coastal risk management with climate resilient development planning on land near the coast. To enable this, we must be proactive in making combined coastal risk and land management decisions which provide long-term space for the coast to naturally respond to coastal climate change risks.

Developing and implementing an Adaptive Framework now to address how society responds to the current and future risks can help to reduce costs and negative impacts such as assets eroding into the sea or suffering repeat, frequency flooding. More positively, a proactive approach to adaptation and climate resilient development planning now can generate wider benefits and opportunities for coastal communities and the ecosystems which sustain and support them.

The Coastal Change Adaptation Plans (CCAPs) provide a key first step in this process; they are a practical mechanism to enable proactive engagement with and involvement of communities to co-develop a shared vision for long-term societal resilience to coastal climate change risk and impacts.

To support this adaptation journey in Moray the coast has been subdivided into Community Areas (CAs) (Figure 1-1). Kingston is one of the CAs with the highest priority for a local adaptation plan, due to the rapidly changing coast and risk of flooding, and as recognised in the Regional Coastal Change Adaptation Plan (CCAP). The entire coast of the Kingston CA is made up of soft material susceptible to moderate to high levels of erosion. Into the future, the Dynamic Coast has, for example, projected as much as 190 m of shoreline retreat could be realised by 2100 at the Spey Bay Golf Club. In addition, the communities of Kingston on Spey and Spey Bay are already at risk from coastal flooding, which will increase in the future.

This provides the justification for a more detailed, local, CCAP which is contained in this document.

The entire Coastal Change Adaptation Plan for Moray is contained within a series of documents, the following should be consulted alongside this CCAP to provide context on the overall process.

- IRR-JBAU-XX-XX-RP-MO-0001-S4-P03-Regional_Plan
    - Provides the region wide plan and process to deliver coastal adaptation across Moray.
- IRR-JBAU-XX-XX-RP-MO-0007-S4-P03-Coastal_Change_Adaptation
    - Provides information on the concept of coastal change adaptation and how this has been applied to the Moray Coastal Change Adaption Plan.

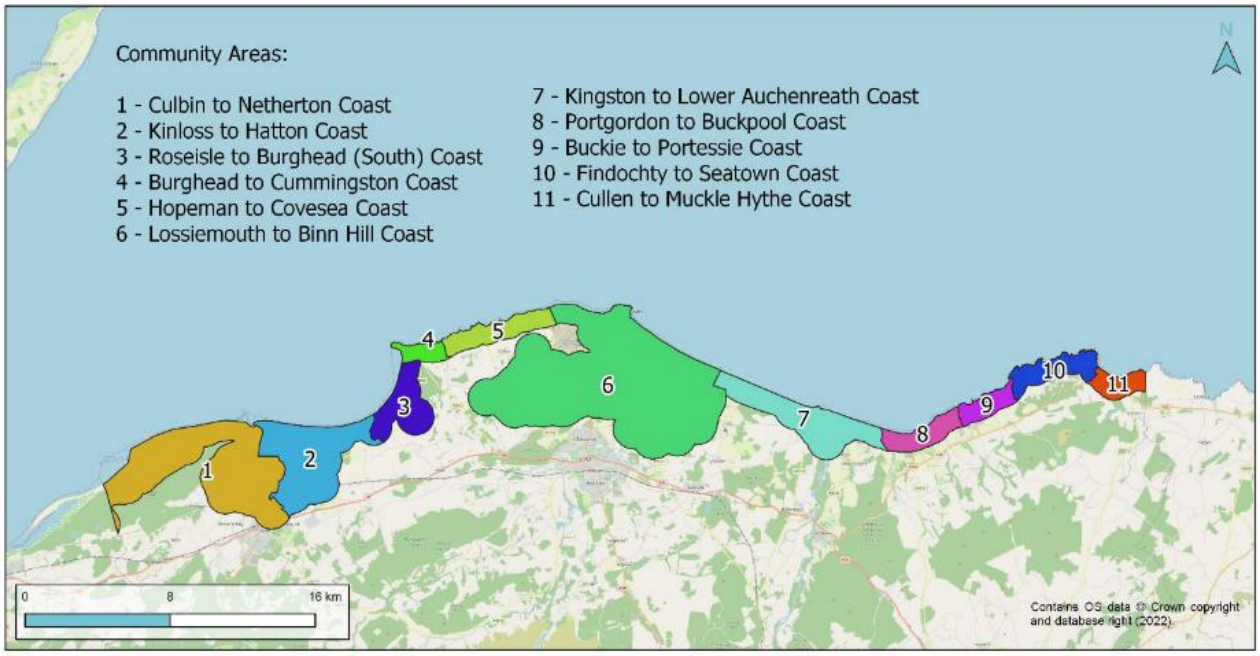


Figure 1-1: Extent and location of CAs within Moray

1.2 What is a Local CCAP?

A Local CCAP follows the same principle as the Regional CCAP but is assessed and developed at a finer level of detail for a specified CA. A local CCAP is developed where a CA has been identified as a high priority, based on risk, development, management and socio-economic Influence Factors (see Regional Plan for more details). It divides the coast of the CA into individual Coastal Management Units (CMUs) and presents Adaptation Pathways for each. See section 2.2 for more details on CMUs and CMU classification.

1.3 What are adaptation pathways?

Adaptation Pathways are flexible tools that can be used by local authorities, politicians, local businesses and residents to make current and future decisions across all involved sectors to accommodate coastal change and associated uncertainty.

As well as the traditional management, they should identify opportunities to work with natural processes, enhance the environment and include necessary supportive steps to **create space** (e.g. accommodate erosion through land safeguarding) in preparation for inevitable future sea level rise and associated increases in erosion and flooding.

1.4 What do adaptation pathways do?

Adaptation Pathways aim to identify climate resilient risk management and development pathways for each or CMU; the phases in the pathways, provide flexibility for decisions at various points on the pathway to be modified dynamically through time.

Triggers are used in Adaptation Pathways to signal when the current management approach should be reviewed, and possibly changed, in response to updated information or change of circumstance i.e., risk has increased.

1.5 Where are we on the adaptation journey?

Adapting to coastal and climate change requires two parallel streams:

1. Land-based initiatives to **prevent** new future risk.
2. Management initiatives to **reduce** current and future risk.

The Local CCAP presented here focuses only the management initiatives but, only by considering these in parallel with those land-based will result in a sustainable adaptation journey for Moray. This should identify both the need and practical steps required to safeguard land to support where areas of retreat may be considered in the future.

1.6 Where are we on the adaptation journey?

The aim of this first CCAP is to consolidate our understanding of the physical risks and how these interact with communities and their assets to identify the present day and future hazards of our changing coast for Kingston. It then identifies and promotes a process that, when implemented by Moray Council, will support community adaptation to coastal change.

The adaptation journey is a multiphase, multiyear process and aims to transition communities into a more sustainable and resilient future. We are currently at **Phase 0**, meaning that no definitive preferred Adaptation Pathway and associated Action Plan have been developed.

1.7 What is the Phase 0 Adaptation Framework?

The overall aim of the framework set out in this Local CCAPs is to:

Guide Moray Council towards development of detailed Adaptation Pathways and associated Action Plans for the Kingston CA.

To achieve this goal the following objectives have been set for Phase 0:

- Identify and characterise local CMUs within the CA suitable for development future Adaptation Pathways.
- Present coastal flood and erosion risk for each CMU.
- Develop an Implementation Plan to be used by Moray Council to support adaptive decision making, future action planning and evaluation of adaptation options.
- Identify CA and CMU specific Triggers that will influence adaptation decision making.
- Identify and set Proactive Actions that will support delivery of the CCAP in each CMU.
- Inform and support the Local Development Plan[4] and Local Planning Policy. These should be implemented in parallel to avoid future risk by making space for change.

1.8 How has this framework been developed?

The approach to coastal change adaptation in Moray is presented in the Regional Plan which distils the Scottish Government guidance[2] into **four key pillars of adaptation** (Figure 1-2). Development and implementation of the CCAP Implementation Plan should align with these principles.

2 Scottish Government (2023) Coastal Change Adaptation Plan Guidance – Interim https://www.dynamiccoast.com/files/ccapg_2023feb.pdf

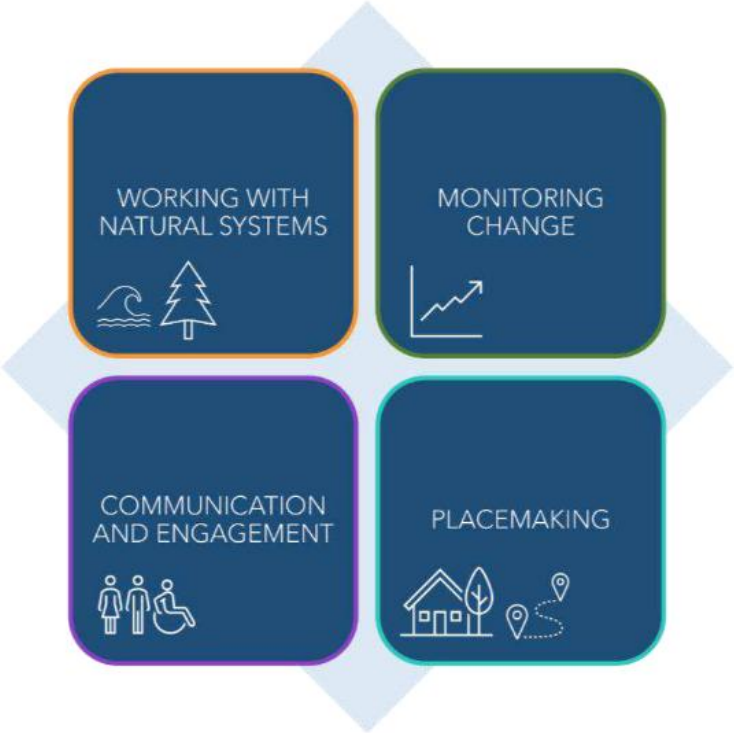


Figure 1-2: Four pillars of coastal adaptation for Moray

1.9 How does the Local CCAP link to the Regional CCAP?

The Regional CCAP links to the Local CCAP in the following key ways:

1. Defines the **prioritisation** of Local CCAP with risk, development, management, and socio-economic Influence Factors (see Regional Plan for more details).
2. Sets wide **Proactive Actions** that, when implemented, should be used to support Local CCAP Action Plans.
3. Provides the links between the **land-based** components of the Adaptation Planning process. This includes links with the LDP and delivery of necessary regional actions required to effectively support and plan for adaptation at a local level e.g. land safeguarding.

2 Plan Overview

2.1 Plan Area and Characteristics

The Kingston to Lower Auchenreath Coast CA covers an area of ca. 14.6 km^2 and is located between the Lossiemouth to Binn Hill Coast CA and Portgordon to Buckpool Coast CA (Figure 1-1). The CA includes a range of coastal environments and land use areas. The CA also sits within SEPA Potentially Vulnerable Area (PVA) due to the flood risk identified in the Flood Risk Management Plan[3] (Figure 2-1).

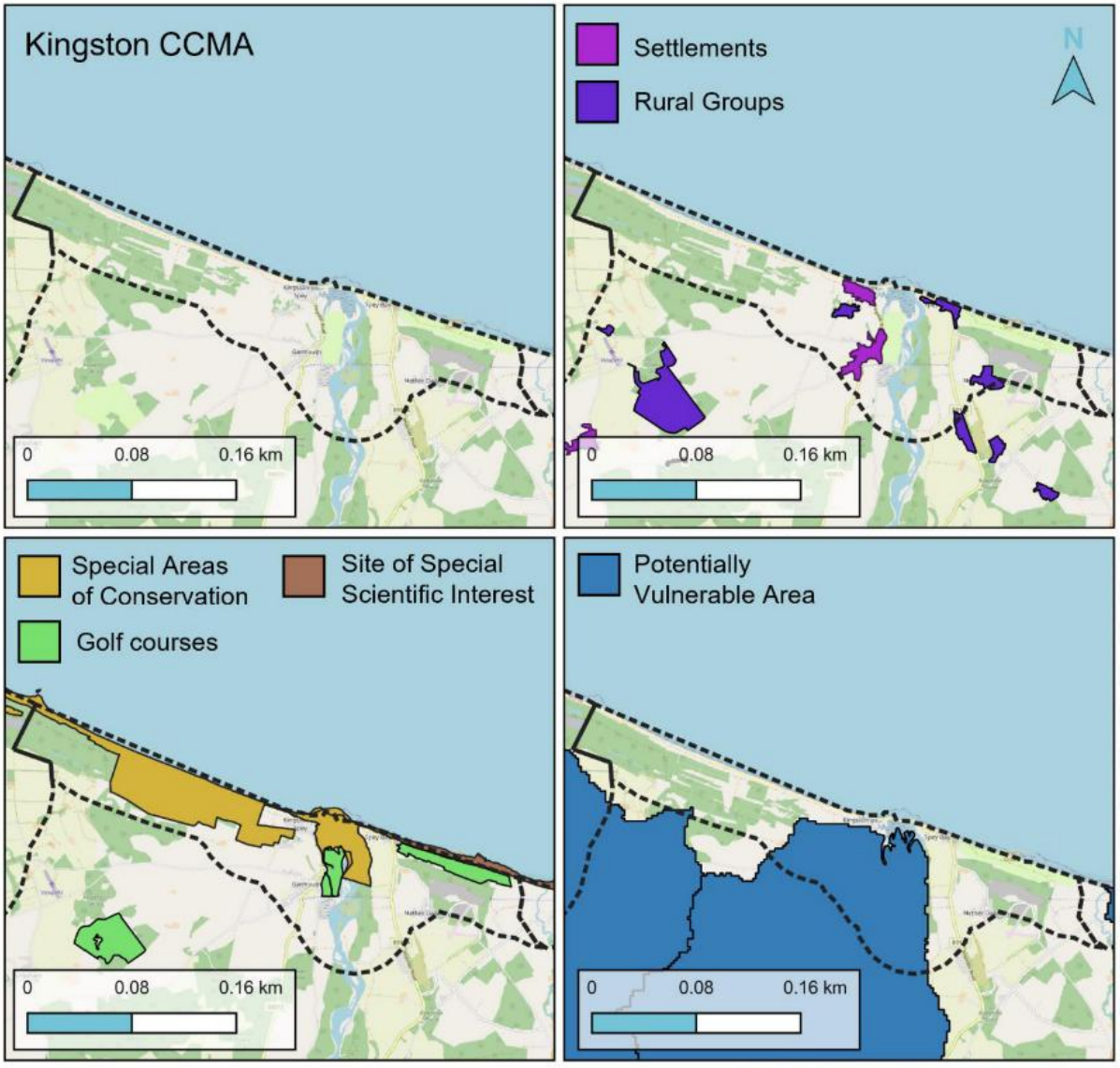


Figure 2-1: Kingston to Lower Auchenreath Coast CA, showing settlements, greenspace and environment and special consideration areas.

3 Moray Council. 2016. Findhorn, Nairn and Speyside Local Flood Risk Management Plan. Section 2.4.4. http://www.moray.gov.uk/downloads/file105636.pdf

Settlements:

The Kingston to Lower Auchenreath Coast CA includes the settlements or Kingston on Spey and Garmouth and rural groups Spey Bay, Nether Dallachy and the northern part of Bogmuir. Kingston on Spey has a population of approximately 200 with 85 households[4]. The Moray Council Local Development Plan[5] has identified designation areas for specific land use in these settlements and rural groups.

Greenspace and Environment:

The entire coast of the CA is a NatureScot designated Site of Special Scientific Interest (SSSI) or Special Area of Conservation (SAC). The coastal waters offshore of the CA coastline are a NatureScot designated Special Protection Area (SPA). There are two golf courses in the CA: Garmouth and Kingston Golf Course on the west of the River Spey, and Spey Bay Golf Course on the coast to the east of the mouth of River Spey.

Special consideration areas:

The CA contains part of the Spey Bay Potentially Vulnerable Area (PVA) as identified in the Nairn and Speyside Local Flood Risk Management Plan (LPD05)[6]. This PVA encompasses Garmouth and Fochabers entirely, the south part of Kingston on Spey and a large area to the southwest of the mouth of River Spey.

Habitats:

There are three key habitats along the coastal extent identified by Nature Scot (Figure 2-2). These include coastal vegetated shingle, unvegetated mobile shingle and unvegetated shores with mobile sediment.

4 Moray Council. 2020. Moray Local Development Plan. Volume 2: Settlement Statements. http://www.moray.gov.uk/moray_standard/page_133431.html
5 Moray Council. 2020. Moray Local Development Plan. Volume 3: Rural Groupings.
6 Moray Council. 2016. Findhorn, Nairn and Speyside Local Flood Risk Management Plan. http://www.moray.gov.uk/downloads/file105636.pdf

Figure 2-2: Coastal habitats at Kingston to Lower Auchenreath Coast as identified by NatureScot.

2.2 Coastal Management Units

To facilitate the development of this Local CCAP, the coast of the CA is classified into Coastal Management Units (CMUs) defined by:

1. Classification of coast type.
    a. Natural – beaches, cliffs, dunes, saltmarshes, etc.
    b. Built Structures – formal engineered structures.
    c. Hybrid – combination of a and b
2. Risk associated with coastal flooding and erosion.
    a. Risk and Hazard
    Assets present in CMU, which are at risk of flooding/erosion hazard
    b. Risk and unknown Hazard
    Assets present in CMU, no data on flood/erosion risk available
    c. No Risk and Hazard
    No assets present in CMU, no flooding/erosion hazard
    d. No risk and no Hazard
    No assets present in CMU, no flooding/erosion hazard

Assets referred to in the risk classification include residential properties, key roads and infrastructure.

Following this, the Kingston to Lower Auchenreath Coast CA coast has been subdivided into six CMUs (Figure 2-3). The CMUs are described below including a summary of the coastal change and flood risk. Full details of with each CMU are provided in Appendix A.

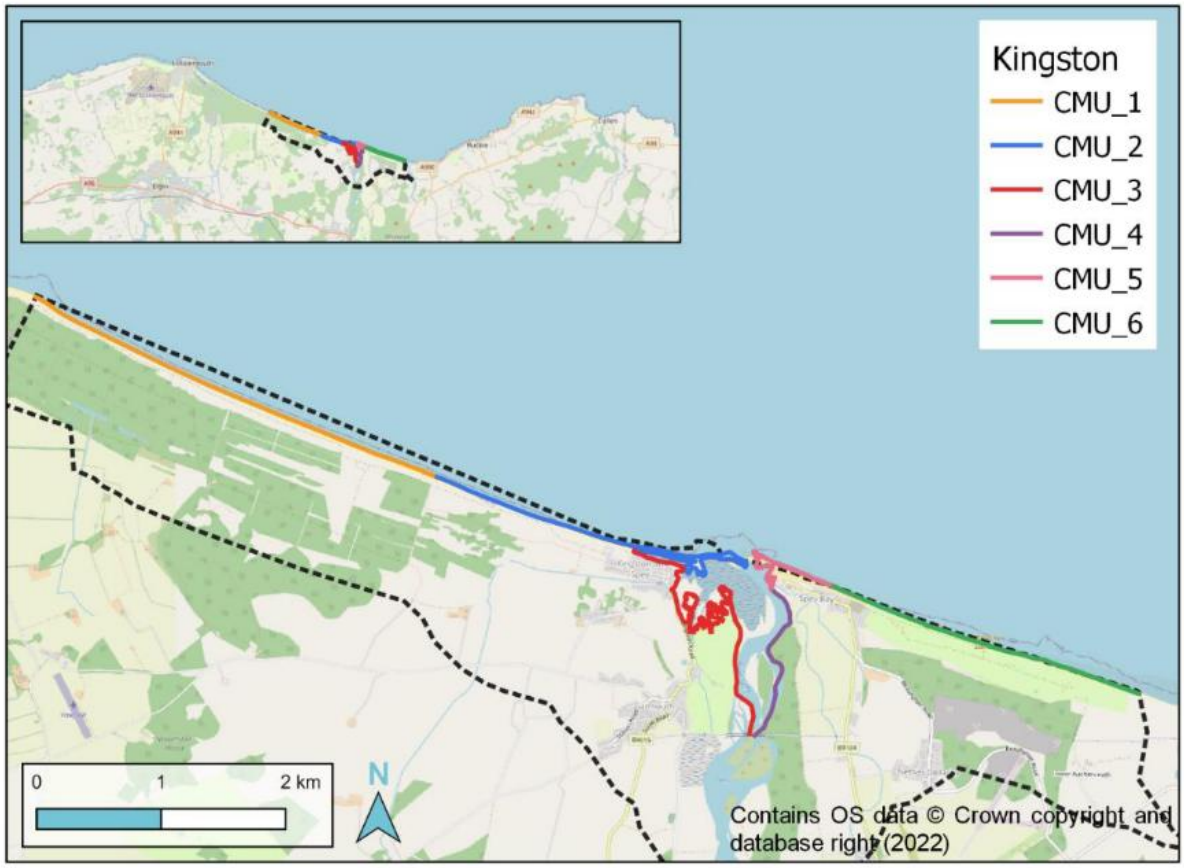


Figure 2-3: Kingston to Lower Auchenreath Coast CMA divided coastal extents.

2.2.1 CMU 1: Beach west – natural

The coast is fronted by a natural shingle beach backed by vegetated sediment and forestry land. SEPA flood maps and NFRA datasets show negligible risk from coastal flooding. Historic coastal retreat (from ca. 1967 to 2011) has been gradual but low (<0.5 meters per year). Dynamic Coast future erosion rates project maximum shoreline retreat of 99 m by 2100. This poses a potential risk to one non-residential property, if realised.

2.2.2 CMU 2: Shingle ridge west – natural

The coast is fronted by a natural shingle barrier beach backed by vegetated sediment and a lagoon at the eastern end. The area inland comprises forestry land, agricultural land, Lein nature reserve and the main Kingston on Spey settlement.

SEPA flood maps show that the shingle barrier provides a degree of flood protection to Kingston on Spey from flooding directly along the coast.

Historic coastal retreat (from ca. 1973 to 2015) has been gradual but low (<0.5 meters per year), however recent dynamic change to barrier volume and geometry has occurred. LiDAR and topography data show a 1 m vertical lowering of the barrier crest and retreat rates of 1.9–3.1 m/yr between 2014 and 2022.

The Dynamic Coast future erosion projections estimate maximum potential landward retreat of the shoreline of 116 m by 2100. This poses a substantial risk to the community, specifically to five non-residential properties, 30 residential properties, approximately 660 m of Beach Road, and 33 clean water assets.

The topographic survey data from 2021 and 2022 suggests however, that parts of the barrier are retreating up to ten times faster than assumed in the historic Dynamic coast rates. Should this be sustained, it could lead to 100 m of shoreline retreat by as soon as 2072.

2.2.3 CMU 3: Riverbank west – natural

The coast contains the natural intertidal western bank of the River Spey mouth. Saltmarsh habitat is present in this CMU. SEPA flood maps shows extensive present-day flooding during a 1 in 200-year event with sea level alone reaching approximately 1 km inland along the Drainer Burn and into the low-lying area south of Kingston on Spey, as well as along the west bank of River Spey across a large area of Garmouth and Kingston Golf Course and Kingston Road. Flooding poses a risk to two residential properties, three non-residential properties, and sections of Burnside Road, Kingston Road, and a secondary road.

Under climate change, flood extents extend further south on the golf course. This extends the present-day risk to an additional five residential properties, three non-residential properties, approximately 1 km of paths, sections of Lein Road and Kingston Road, and four wastewater and water treatment assets.

2.2.4 CMU 4: Riverbank east – hybrid

The coast is hybrid, with natural intertidal eastern bank of the River Spey mouth, that contains saltmarsh habitat with some rock revetement present towards the River mouth. The area inland contains forestry and agricultural land. Dynamic Coast data shows negligible risk from coastal erosion.

Flood risk spans a large proportion of this unit under a 1 in 200-year flood event. SEPA flood maps show flooding reaches approximately 1 km inland on the east bank of the River Spey and poses a risk to approximately 140 m of the B9104 road and 340 m of a footpath. Flood extents increase in a 1 in 200-year plus climate change event and pose a risk to one non-residential property, an additional 60 m of the B9104 road, and the forest adjacent to the east bank of the River Spey.

2.2.5 CMU 5: Beach east - Hybrid

The coast is fronted by a natural shingle beach enhanced with rock armour. There is a spit at the east of the River Spey mouth. SEPA flood maps show flooding to the sand spit under 1 in 200-year and 1 in 200-year plus climate change flooding events, however the risk to properties or assets at Spey Bay town is negligible.

High (>1 m/yr) historic shoreline accretion (from ca. 1973 to 2015) has occurred whereby the spit has moved offshore. Dynamic Coast data projects erosion of the spit by 2100 of up to 70 m, however this is not expected to pose a risk to any properties or assets.

2.2.6 CMU 6: Beach east - natural

The coast is fronted by a natural shingle beach backed by vegetated sediment and Spey Bay Golf Course. Although this unit is undefended, the flood risk is minimal. In the present-day a 1 in 200-year event inundates only a small area at the eastern end of Spey Bay Golf Course.

Steady (0.5–1 m/yr) historic shoreline retreat (from ca. 1966 to 2003) has occurred with Dynamic Coast projecting increased erosion rates leading to extensive retreat of up to 196 m by 2100. This poses a risk to two non-residential properties, six residential properties, Spey Bay Golf Course, a surface water gravity pipe, and a surface water rising main.

2.3 CMU categorisation for local adaptation plan

Review of the characteristics and risk associated with each CMU led to the classifications summarised in Table 2-1. These were used to develop initial Adaptation Pathways, Triggers, and an associated Implementation Plan.

Table 2-1: Kingston to Lower Auchenreath Coast CMU categorisation.

CMU	Coastal Type Classification	Risk Classification
1	Natural	Risk and Hazard
2	Natural	Risk and Hazard
3	Natural	Risk and Hazard
4	Hybrid	Risk and Hazard
5	Hybrid	No Risk and Hazard
6	Natural	Risk and Hazard

3 Adaptation Pathways

Development of Adaptation Pathways for each CMU are based on the classification presented in Table 2-1. This aims to provide a flexible approach to adaptation that works towards a defined and desirable end outcome for the CMU and CA.

Details of this outcome are however, not defined at this stage, and will ultimately be dependent on monitoring changes to the following factors at the coast and on land adjacent to the coast:

- **Natural systems**
  - Habitat.
  - Greenspace.
- **Climate**
  - Climate change guidance.
  - SEPA flood maps or risk assessments.
  - Coastal flood occurrence.
  - Coastal erosion risk.
- **Risk exposure**
  - Change in defence condition.
  - Update to SEPA flood warning system.
  - Erosion risk buffer exceeded.
  - Flood risk threshold exceeded.
- **Socio-economics**
  - Changes of asset ownership.
  - Changes of land ownership.
  - Community pressures.
  - Tourism.

Adaptation Pathways for each CMU are presented in the following sections.

3.1 CMU 1, 2, 3 and 6 Adaptation Pathways

CMU 1, 2, 3 and 6 are classified as natural coasts and have been assigned an adaptation pathway for natural coastlines with risk from erosion, flooding, or both (Figure 3-1):

- **CMU 1 = Natural with risk and hazard**
- **CMU 2 = Natural with risk and hazard**
- **CMU 3 = Natural with risk and hazard**
- **CMU 6 = Natural with risk and hazard**

Phase 0 of the adaptation pathway (1st column) is the current action undertaken by Moray Council in respect of these CMUs. Here this is **No Intervention**. This means that there will be no coastal and/or erosion risk management interventions during this phase.

For the adaptation pathway to move to Phase 1 (2nd column of potential actions) a pre-defined Trigger must be realised. Then, depending on the outcome of any Implementation Plan Actions, this may or may not result in a change to the management approach adopted for the CMU.

Consultation of the CCAP Implementation Plan (Section 4.1) will guide the process and ultimately the pathway to adaptation.

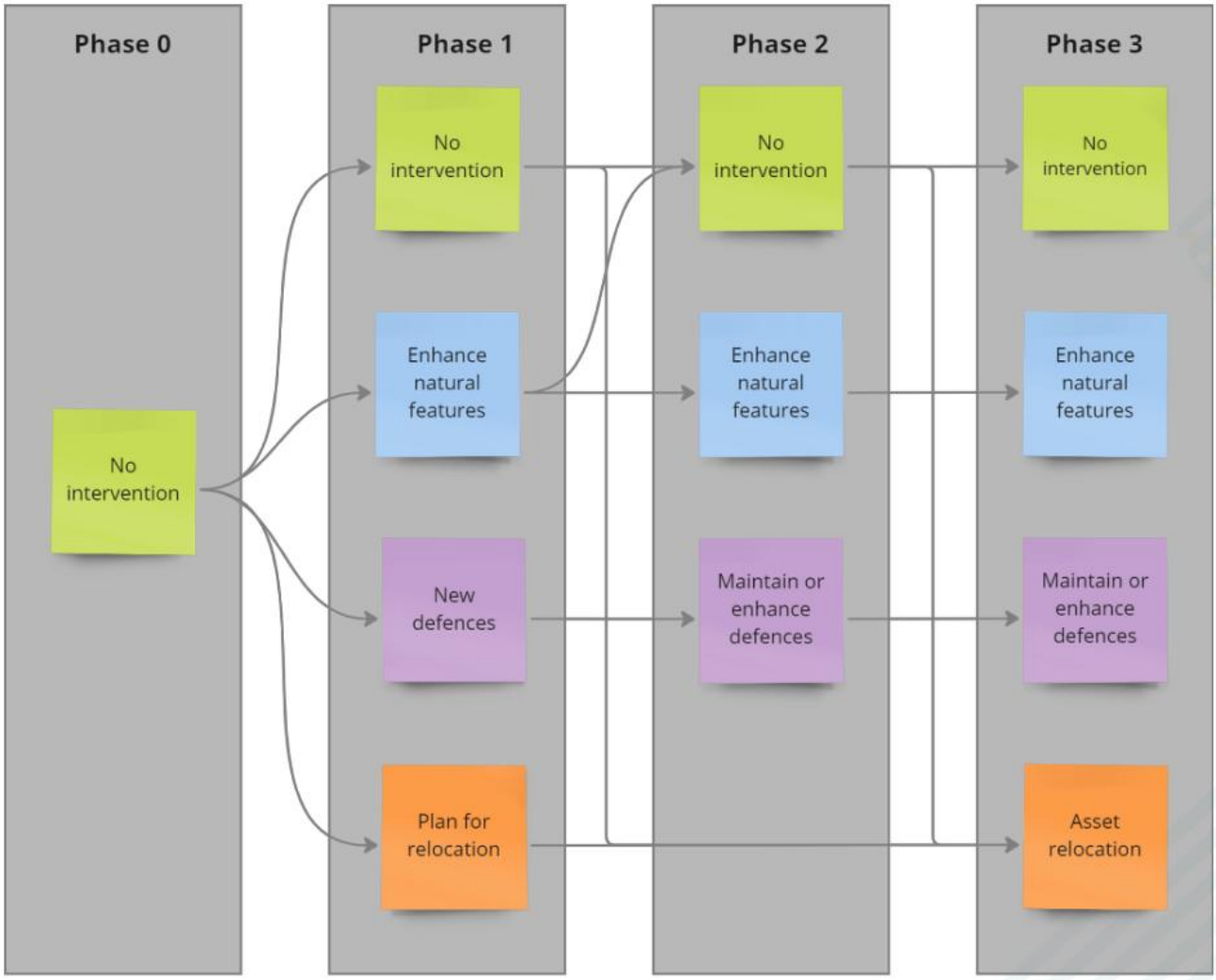


Figure 3-1: Adaptation Pathway for CMUs 1, 2, 3and 6 (natural coast). Grey lines represent possible future pathways.

3.2 CMU 4 and 5 Adaptation Pathway

CMU 4 and 5 are classified as hybrid coastlines (Figure 3-2). CMU 4 and CMU 5 are both predominantly natural coasts, which are enhanced with rock armour. At CMU 4 there is risk of flooding. At CMU 5, there is both flooding and erosion hazard present, but no assets are at risk (Figure 3-2).

- **CMU 4 = Hybrid with risk and hazard**
- **CMU 5 = Hybrid with no risk and hazard**

Phase 0 of the adaptation pathway (1st column) is the current actions undertaken by Moray Council in respect of these CMUs. Here this is **No Intervention** as Moray Council are not obligated to maintain the rock armour structure in the CMU. This means that there will be no coastal and/or erosion risk management interventions, nor maintenance of existing structures during this phase.

For the adaptation pathway to move to Phase 1 (2nd column of potential actions) a pre-defined Trigger must be realised. Then, depending on the outcome of any Implementation Plan

Actions, this may or may not result in a change to the management approach adopted for the CMU.

Consultation of the CCAP Implementation Plan (Section 4.1) will guide the process and ultimately the pathway to adaptation.

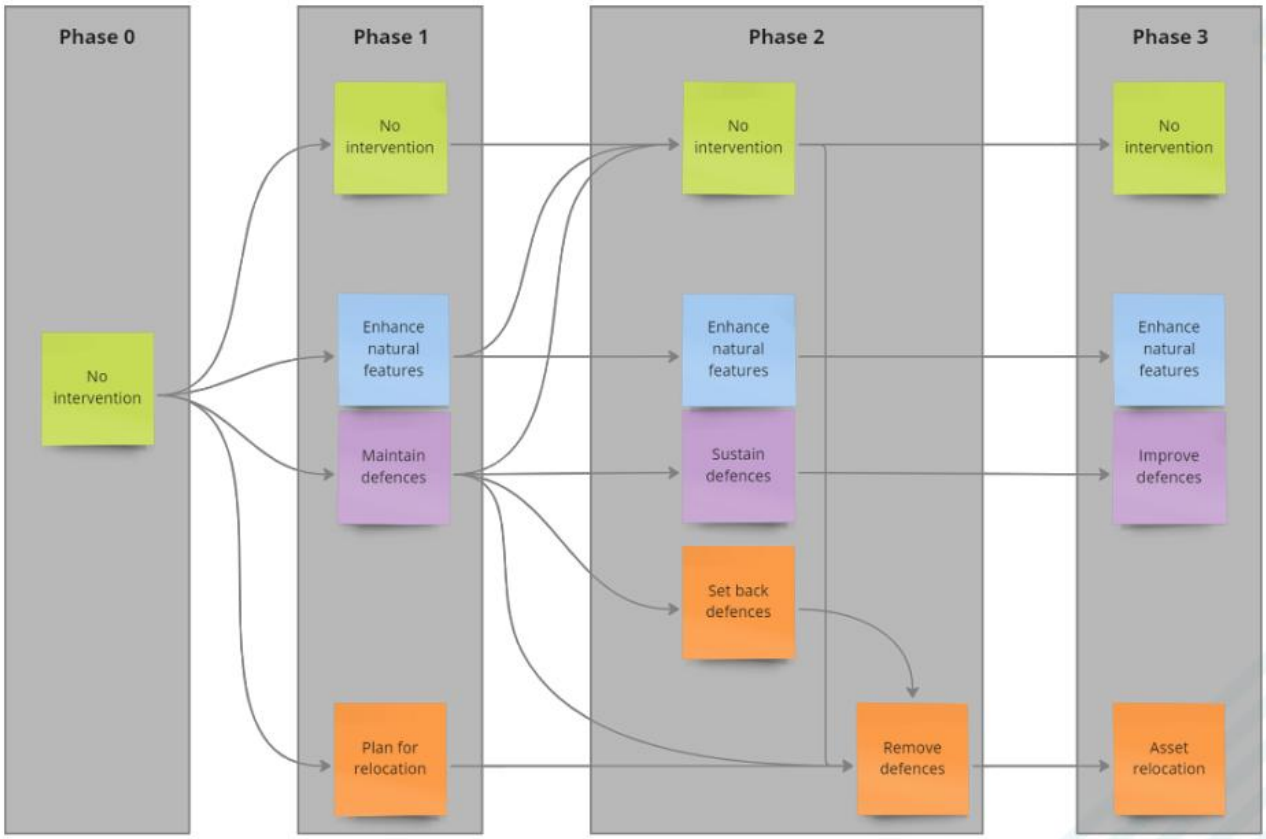


Figure 3-2: Adaptation Pathway for CMU 4 and CMU 5 (hybrid coast). Grey lines represent possible future pathways.

4 Adaptation Process

4.1 Implementation Plan

To support the delivery of the Adaptation Framework, a single Implementation Plan is applied to the entire Kingston to Lower Auchenreath Coast CA with generic triggers and actions set that are relevant across the CA. Specific triggers and actions are then assigned to each CMU based on the Risk Assessment. Outcomes of the Implementation Plan link to the Adaptation Pathway specific to each CMU.

Delivery of the Implementation Plan has three stages (Figure 4-2):

1) Monitoring and Triggers (Section 4.3)
2) Actions (Section 4.4)
3) Outcomes (Section 4.5)

The outcome of the Implementation Plan determines what path will be followed within the Adaptation Pathway when moving to a new phase.

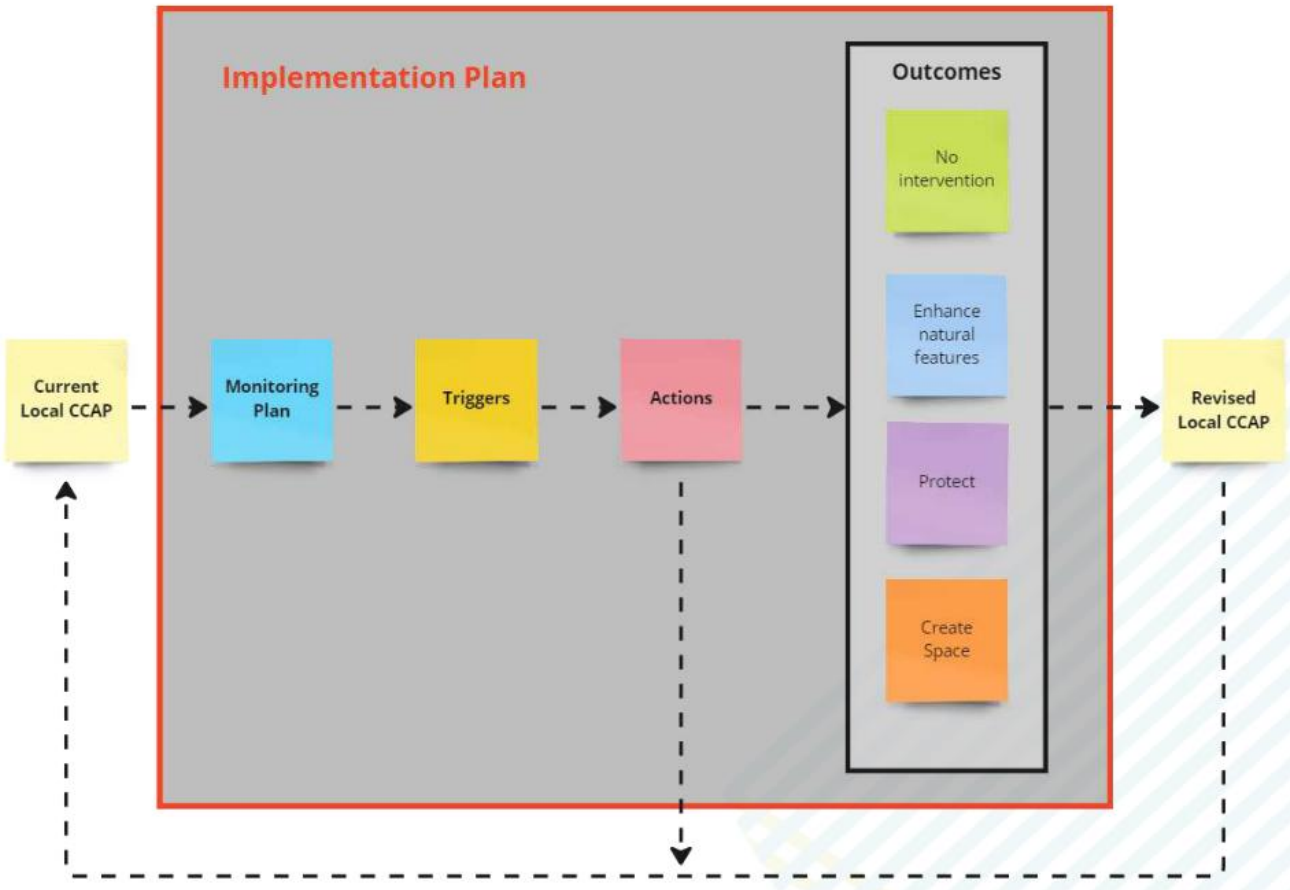


Figure 4-1: High-level Implementation Plan.

4.2 Monitoring and Triggers

4.2.1 Monitoring

Triggers are realised through monitoring of available data that informs risk of flooding and erosion. Triggers signal the requirement to deliver the Implementation Plan, which may lead to a review of the Risk Assessment and potential change to the Adaptation Pathway.

Triggers are categorised as:

- Natural systems triggers.
- Climate triggers.
- Risk exposure triggers.
- Socio-economic triggers.

These are subsequently grouped into categories with each requiring a plan for monitoring within the CA:

- Third party data and information.
- Moray Council data and information.
- Moray Council monitoring.
- External pressure.

4.2.2 Trigger Classification

Classification of the triggers falls into two parts.

1. Generic triggers applicable to the entire CA.
2. Bespoke triggers applicable to individual CMUs.

Climate, natural system, and socio-economic triggers are generic for the whole CA (Table 4-5), but risk exposure triggers related to physical flooding, erosion and overtopping thresholds are specific to each CMU. For the Kingston to Lower Auchenreath Coast CA these are summarised in Table 4-5.

Effective review of these requires development of a monitoring plan of risk for each CMU as follows:

- CMU 1: monitoring of erosion risk.
- CMU 2: monitoring of erosion risk and overtopping risk.
- CMU 3: monitoring of flood risk.
- CMU 4: monitoring of flood risk.
- CMU 5: monitoring of erosion risk.
- CMU 6: monitoring of erosion risk.

4.2.3 CMU-specific flooding trigger

Based on SEPA's NFRA data, where there is risk of flooding, the elevation of assets at risk are compared to sea levels taken from the SEPA tide gauge at Buckie. Assets considered at risk from flooding include:

- Residential properties.
- Key roads.
- Coastal defences.

Where flood risk is present in a CMU, the lowest elevation of a residential property (minus 300mm freeboard) or key road is used to determine a frequency of exceedance using the tide gauge levels (Table 4-1).

At Kingston to Lower Auchenreath Coast, current SEPA maps indicate a flood risk at CMU 3 and CMU 4.

Exceedance Frequency is the number of events that exceed the asset threshold in a 10-year period.

The CMU-specific flooding trigger is realised if the exceedance frequency increases beyond specified criteria. There are two levels to this Trigger realisation that result in different actions. These also vary depending on the type of asset at risk of flooding:

- **Residential properties**
  1. Exceedance frequency of **two** or more in a **ten-year window**.
     - Increase monitoring and plan for assessment.
  2. Exceedance frequency of **five** or more in a **ten-year window**.
     - Undertake assessment and plan for intervention.
- **Key Roads**
  1. Exceedance frequency of **five** or more in a **ten-year window**.
     - Increase monitoring and plan for assessment.
  2. Exceedance frequency of **ten** or more in a **ten-year window**.
     - Undertake assessment and plan for intervention.
- **Coastal Defences (note no MC defences at Kingston to Lower Auchenreath Coast)**
  1. Exceedance frequency of **one** or more in a **ten-year window**.
     - Increase monitoring and plan for assessment.
  2. Exceedance frequency of **two** or more in a **ten-year window**.
     - Undertake assessment and plan for intervention.

Locations of these assets used to define the flooding triggers are shown in Figure 4-3. Currently, flooding trigger level 2 has been met at CMU 3 and CMU 4 (Table 4-1).

Table 4-1: CMU-specific flooding triggers for Kingston to Lower Auchenreath Coast properties and roads. Cells shaded red indicate that the flooding trigger has already been met.

CMU	Lowest level of Property (mOD)		Property – Freeboard (mOD)	Current 10-year frequency	Flooding trigger level 1 Exceedance Frequency:	Flooding trigger level 2 Exceedance Frequency:
3	Property	3.1	2.8	2.3	2	5
CMU	**Lowest level of Road (mOD)**			**Current 10-year frequency**	**Flooding trigger level 1 Exceedance Frequency:**	**Flooding trigger level 2 Exceedance Frequency:**
3	Kingston Road	2.5		39.0	5	10
4	B9104	2.6		13.9	5	10

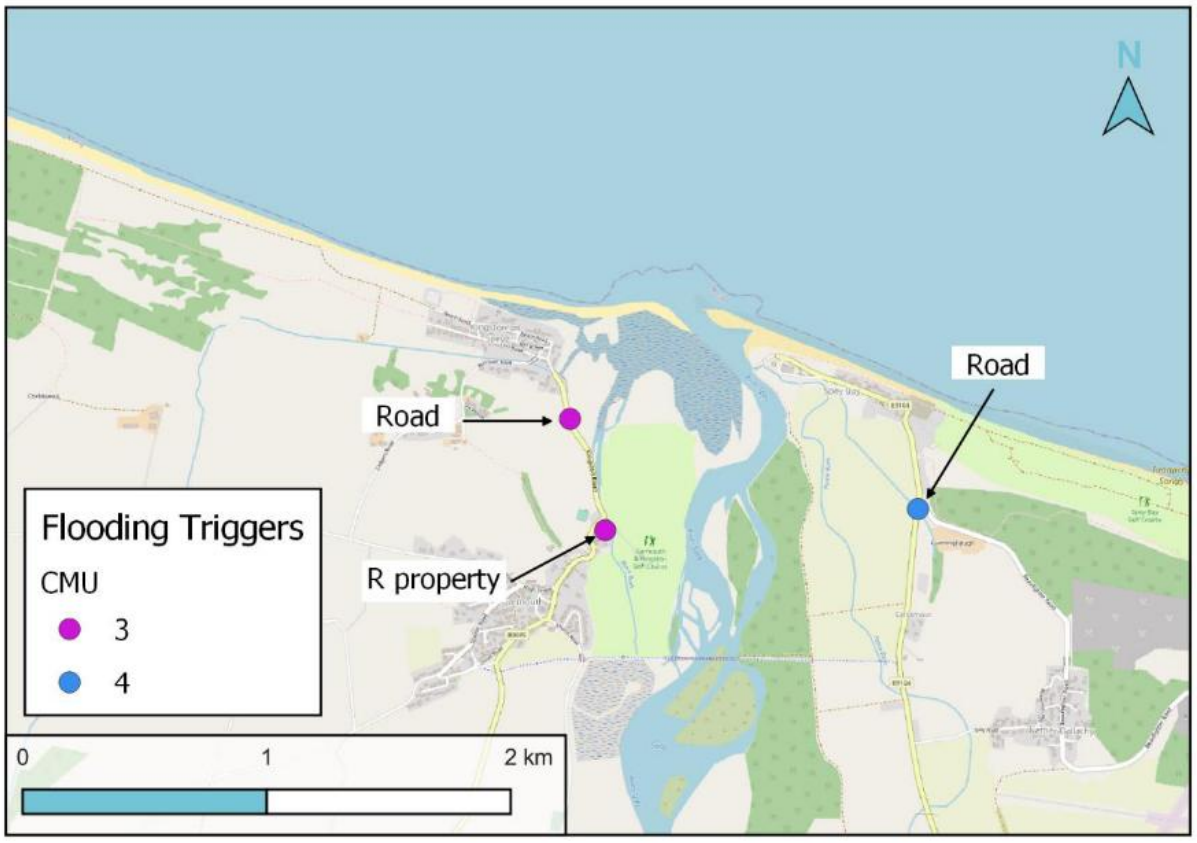


Figure 4-2: Kingston to Lower Auchenreath Coast flooding trigger locations.

4.2.4 CMU-specific overtopping triggers

Where there is risk of flooding from wave overtopping (not currently accounted for in SEPA NFRA data), an overtopping risk assessment has been undertaken. This has been used to develop threshold levels based on extreme return periods. To enable proactive planning, the overtopping risk assessment has been undertaken for four SLR scenarios:

- 0.0 m (present-day)
- +0.2 m
- +0.5 m
- +1.0 m

The maximum and minimum overtopping volumes have been extracted for each return period to produce an envelope of potential overtopping under each sea level rise scenario (Appendix A). This has been undertaken for the natural shingle barrier ridge in CMU 2.

An overtopping trigger is realised once overtopping volume during the 1 in 2-year and 1 in 30-year return period events exceed given threshold levels[7]. There are two levels to the trigger realisation that require different actions:

1. Level 1: overtopping volume exceeds 50 l/s/m during a 1 in 30-year event.
    - Increase monitoring and plan for assessment.
2. Level 2: overtopping volume exceeds 30 l/s/m during a 1 in 2-year event.
    - Undertake assessment and plan for intervention.

7 It should be noted that thresholds are based primarily on judgement, tolerable limits in guidance and associated consequence in the immediate vicinity of the beach crest. A more detailed assessment of when overtopping volume results in flooding to properties is recommended.

Overtopping results from the risk assessment (Table 4-2) show that triggers are not being met now (2023 present-day), with 0.0 m of sea level rise. Level 1 and 2 overtopping triggers will be met after 0.2 m of sea level rise and therefore climate change data should be monitored to understand when action is required.

Table 4-2: Overtopping triggers for CMU 2. Cells shaded red indicate that an overtopping trigger has been met.

Sea Level Rise	Overtopping Trigger Level 1: Maximum 1 in 30-year overtopping rate (l/s/m)	Overtopping Trigger Level 2: Maximum 1 in 2-year overtopping rate (l/s/m)
0.0 m (present-day)	46	18
0.2 m	69	30
0.5 m	107	57
1.0 m	152	108

4.2.5 CMU-specific erosion trigger

Where there is risk of erosion, the distance from the asset at risk to the coast is used to define the Trigger. For properties, roads and other features, the coast is defined by the landward extent of the natural feature e.g. beach, barrier, spit or cliff. Assets considered at risk from erosion include:

- Residential properties.
- Key roads.
- Other features, such as carparks and golf courses.

To note, if two assets are in the same location (e.g. a road and property) only the most seaward asset is used to define the Trigger for that CMU.

As with the other CMU-specific triggers, a two-level approach is defined using buffers around the asset at risk. The associated action is, again, dependent on the consequence and asset at risk.

Erosion buffer distances (metres) for each level are defined as follows:

- **Residential properties**
    1. Maximum of historic erosion rate multiplied by 20 or 20m.
        - Increase monitoring and plan for assessment.
    2. Maximum of historic erosion rate multiplied by 10 or 10m.
        - Undertake assessment and plan for intervention.
- **Roads and other features**
    1. Maximum of historic erosion rate multiplied by 5 or 5m.
        - Increase monitoring and plan for assessment.
    2. Maximum of historic erosion rate multiplied by 2 or 2m.
        - Undertake assessment and plan for intervention.

Level 1 erosion trigger has been met for the property in CMU 2 (Table 4-3). Location of all assets used for erosion triggers are shown in Figure 4-3 and Table 4-4.

Table 4-3: CMU-specific erosion triggers for Kingston to Lower Auchenreath Coast properties, roads and features. Cells shaded red indicate that the erosion trigger has been met.

CMU	Maximum historical change rate (m/year)	Present-day distance of Property to coast (m)		Erosion trigger level 1: Coast X m from property	Erosion trigger level 2: Coast X m from property
1	-0.4	NRP	80	20	10
2	-2.0	RP	34	40	20
5	+1.0	RP	40	20	10
6	-1.0	RP	25	20	10
CMU	**Maximum historical change rate (m/year)**	**Present-day distance of Road to coast (m)**		**Erosion trigger level 1: Coast X m from road**	**Erosion trigger level 2: Coast X m from road**
5	+1.0	B9104	25	5	2
6	-1.0	B9104	62	5	2
CMU	**Maximum historical change rate (m/year)**	**Present-day distance of feature to coast (m)**		**Erosion trigger level 1: Coast X m from feature**	**Erosion trigger level 2: Coast X m from feature**
2	-2.0	Carpark	21	10	4
5	+1.0	Carpark	15	5	2
6	-1.0	Golf Course	0	5	2

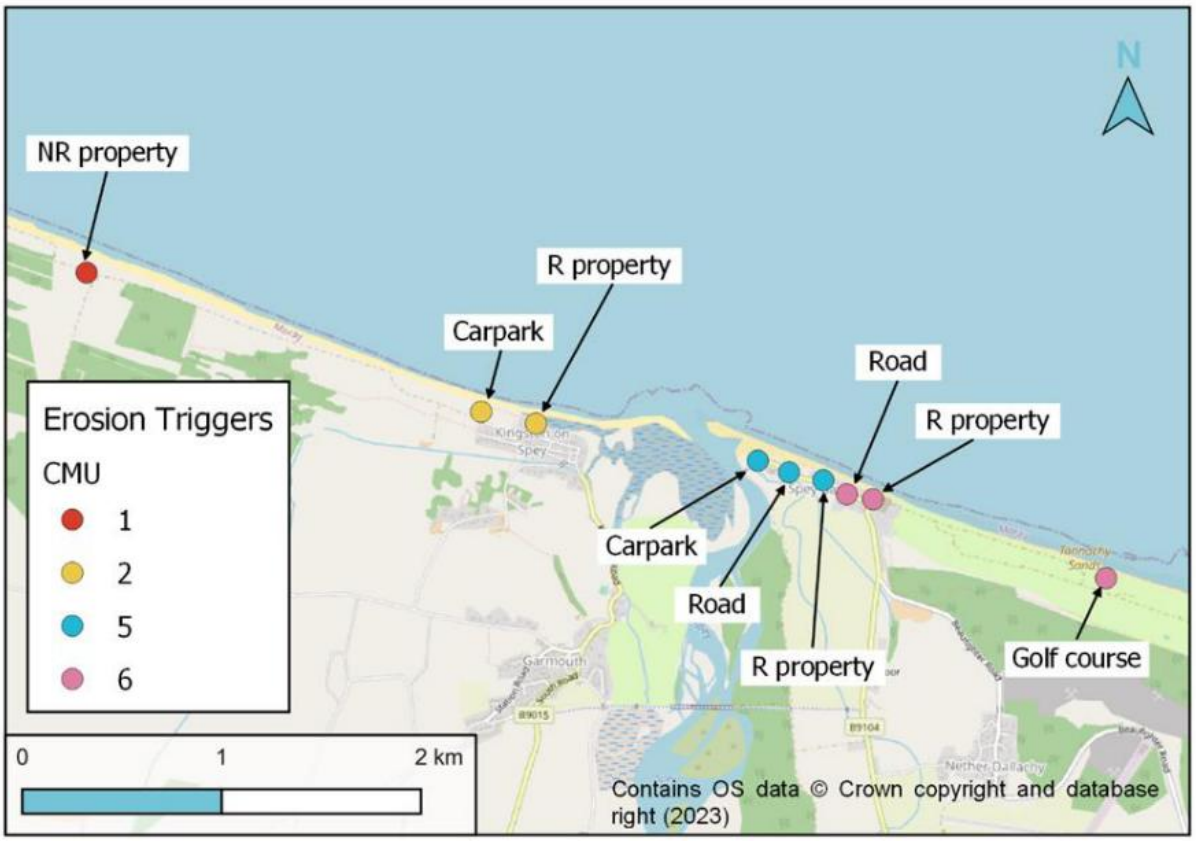
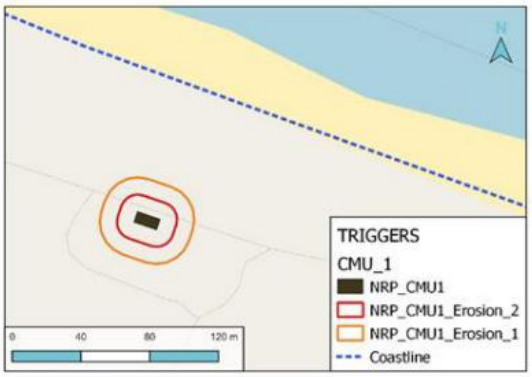
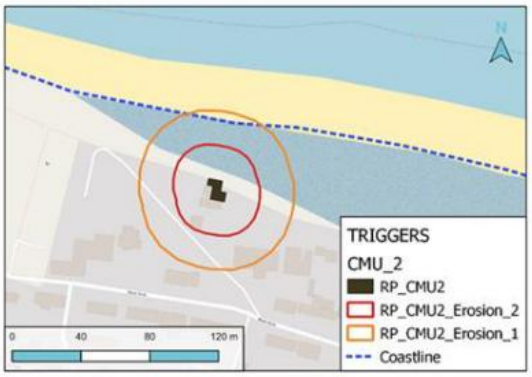
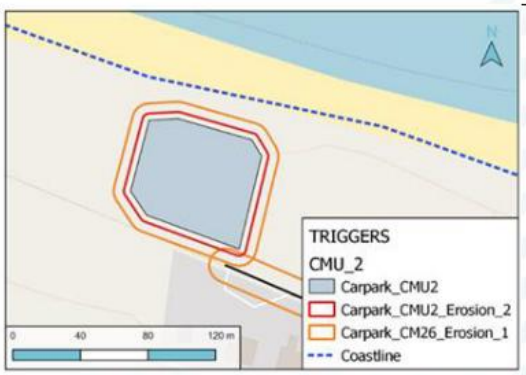
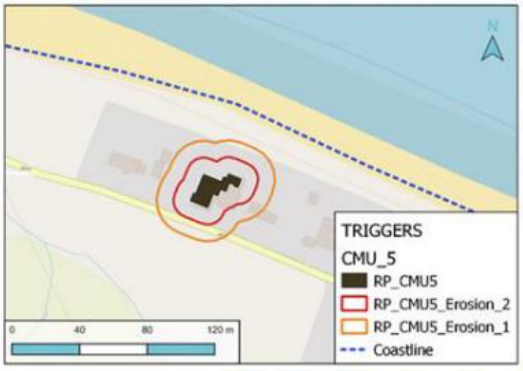
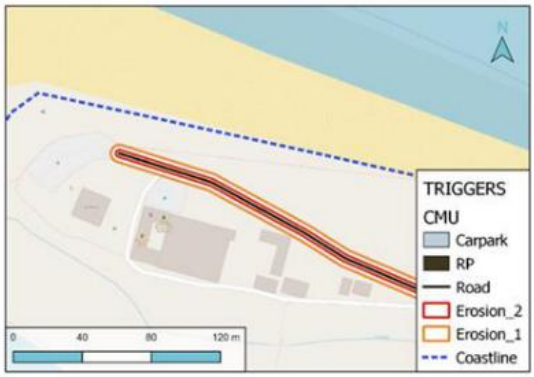
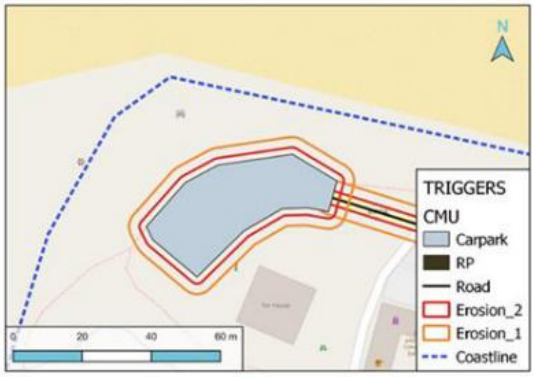
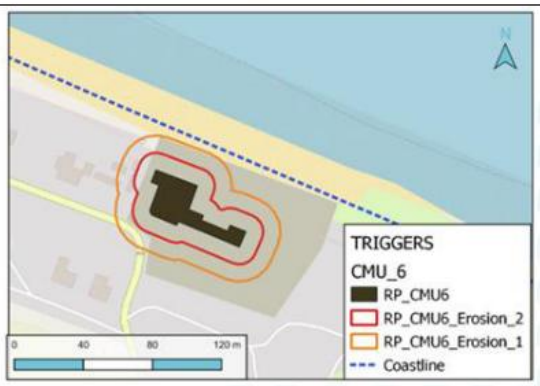
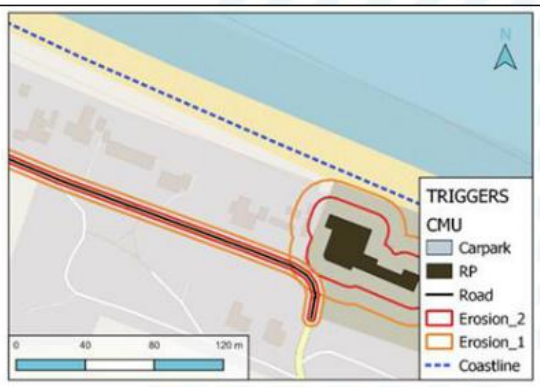
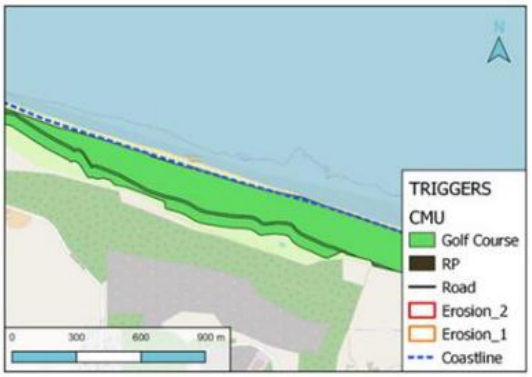


Figure 4-3: Kingston to Lower Auchenreath Coast erosion trigger locations for residential property (R property), non-residential property (NR property), roads and other key features.

Table 4-4: Kingston to Lower Auchenreath Coast erosion triggers

CMU	Asset	Trigger Met	Erosion Trigger
1	NR Property	No	
2	R Property	Yes	
2	Carpark	No	
5	R property	No	

5	Road	No	
5	Carpark	No	
6	R property	No	
6	Road	No	

6	Golf course	No	

4.3 Actions

Actions, like Triggers, are also applied to the entire CA, or to specific CMUs where the risk of flooding and/or erosion is identified. Actions will be specific to CMUs where, for example, a coastal defence is present; a natural protective feature is present; the risk of flooding/erosion is localised; assets are at risk of flooding/erosion.

Actions applicable to all and specific CMUs in Kingston to Lower Auchenreath Coast CA have been identified in Table 4-4. These are based on the Phase 0 Triggers only and it is possible that more will be required as a reactive response to change. Delivery of the Regional Plan[8] Proactive are also required to support.

Review risk assessment:

- Involves a review of available data and associated risk assessment. Increased monitoring, planning, and implementing an assessment, and planning for intervention because of the erosion and flooding triggers are included in the review risk assessment action.

Community engagement:

- **Places**: Involves local groups, such as Councillors and community groups.
- **Practice**: Involves third party stakeholders, such as SEPA, Scot Gov, Nature Scot etc.
- **Asset**: Includes private defences and harbours and utilities specific to built structures or hybrid CMUs.

Post flood data collection:

- Involve community engagement, surveys, photographs etc.

New risk assessment:

- Following a review of the current risk assessment and/or community engagement, a new risk assessment may be required. Should a new assessment be deemed necessary this should follow appropriate guidance[9] and include all necessary components to develop a preferred Adaptation Pathway and associated Action Plan for delivery. E.g. risk, economics, social, environment, engineering, land use planning etc.

Actions bridge the gap between Triggers and Outcomes and define what processes need to be implemented before the most appropriate Outcome is recognised and delivered for each CMU. Actions linked to specific triggers and relevant to Kingston to Lower Auchenreath Coast

8 Moray Coastal Change Adaptation Plan: Regional Plan - IRR-JBAU-XX-XX-RP-MO-0001-S4-P03-Regional_Plan
9 Scottish Government. 2016. Flood protection appraisals: guidance for SEPA and responsible authorities https://www.gov.scot/publications/guidance-support-sepa-responsible-authorities/pages/2/

CMU is included in Table 4-5. These highlight what may be delivered during the Phase 0 cycle and are dependent on the associated Trigger being realised.

Table 4-5: Triggers, trigger categories and associated actions for each Kingston to Lower Auchenreath Coast CMU.

Category	Trigger	Action	CMU
Natural Systems	Changes to habitat	Community engagement (places)	All
	Changes to greenspace	Community engagement (places)	All
Climate	Update to climate guidance	Review risk assessment Community engagement (practice)	All
	Update to SEPA flood maps	Review risk assessment Community engagement (practice)	All
	Coastal flood occurrence	Review risk assessment Community engagement (places, asset) Post flood survey	All
Risk exposure	Defence condition	Community engagement (asset)	CMU 4 CMU 5
	Update to SEPA flood warning	Review risk assessment Community engagement (places, practice)	All
	Erosion buffer exceeded	Review risk assessment Community engagement (places)	CMU 1 CMU 2 CMU 5 CMU 6
	Flood risk threshold exceeded	Review risk assessment Community engagement (places)	CMU 3 CMU 4
	Update to Dynamic Coast	Review risk assessment Community engagement (practice)	All
Socio-economic	Changes of asset use	Community engagement (asset)	All
	Changes of asset owner	Community engagement (asset)	All
	Community pressure	Review risk assessment Community engagement (places)	All

4.4 Phase 0 Actions

Phase 0 Actions require immediate attention and have been identified by triggers realised through the development process of this initial CCAP for Kingston to Lower Auchenreath Coast. These are outlined below:

- CMU 2:
  - Trigger 1: Erosion buffer exceeded (level 1)
    - **Action 1**: Increase monitoring and plan for assessment.
- CMU 3:
  - Trigger 1: Flooding risk threshold exceeded (level 1)
    - **Action 1**: Increase monitoring and plan for assessment.
  - Trigger 2: Flooding risk threshold exceeded (level 2)
    - **Action 2**: Undertake assessment and plan for intervention.
- CMU 4:
  - Trigger 1: Flooding risk threshold exceeded (level 1)
    - **Action 1**: Increase monitoring and plan for assessment.
  - Trigger 2: Flooding risk threshold exceeded (level 2)
    - **Action 2**: Undertake assessment and plan for intervention.

An overall summary of all CMUs, Triggers, buffers and Phase 0 Actions is provided as a standalone record in Appendix C for clarity.

4.5 Supporting Steps and Proactive Actions

The nature of adaptation means that future decisions and directions are unknown and will be affected by external changes not necessarily under Moray Council's influence. It is critical that proactive supporting steps and Proactive Actions are undertaken to enable effective decision making in the future.

Proactive Actions are defined as those whereby there should only be benefit. Undertaking these can therefore only have a positive impact on supporting adaptation or increasing resilience.

At this stage in the adaptation planning process six such actions have been identified. These have been developed focusing on the key pillar identified previously and through review and understanding of key knowledge gaps. They therefore aim to close these knowledge gaps at this stage and support alignment with wider aspects of the adaptation plan for the region.

A summary of these actions is provided in **Error! Reference source not found.**, with further details on each included in Appendix **Error! Reference source not found.**. These are designed to complement the wider Proactive Actions identified in the Regional CCAP.

Table 4-6: Local Proactive Actions.

Action	Details	Pillars
1	Investigate opportunities for shingle recycling	Working with Natural Processes 

2	Develop modelling framework to support future assessments	Working with Natural Processes	
3	Establish coordinated and consistent beach monitoring plan for Natural CMUs	Monitoring Change	
4	Adaptation and resilience workshop with local community and stakeholders	Community and Engagement	
5	Identify landownership and safeguarding space. This should link with Regional Proactive Action 6 to identify and define local opportunities.	Place Making	

4.6 Outcomes

Outcomes are the potential intervention measures that will be implemented after a trigger is realised and the associated actions, defined in the Implementation Plan, have been undertaken. There are four possible outcome categories:

1) No intervention.
2) Enhance natural features.
3) Protect.
4) Create Space.

These Categories however are general and nuances and variations may result upon completion of any more detailed study.

As the Implementation Plan is applied at CMU level, the ultimate outcome is dependent on the CMU and the associated Adaptation Pathway. Table 4-5 summarises the general and specific CMU outcomes for the Kingston to Lower Auchenreath Coast CA.

Table 4-7: Kingston to Lower Auchenreath Coast CA possible outcomes.

Category	Outcome	Kingston CMU
No intervention	No intervention	All
Enhance natural features	Enhance natural features	All
Protect	Maintain defences	CMU 4 CMU 5
	Sustain* defences	CMU 4 CMU 5

	Improve** defences	All
Create space	Remove defences	CMU 4 CMU 5
	Set back defences	CMU 4 CMU 5
	Relocate assets	CMU 2 CMU 3 CMU 4 CMU 5
*standard of performance is sustained into the future in response to climate change **standard of performance is improved beyond the current and then maintained in response to climate change		

The complete Implementation Plan for Kingston to Lower Auchenreath Coast is shown in (Figure 4-5); structured using the three stages: 1) Monitoring and Triggers, 2) Actions, and 3) Outcomes.

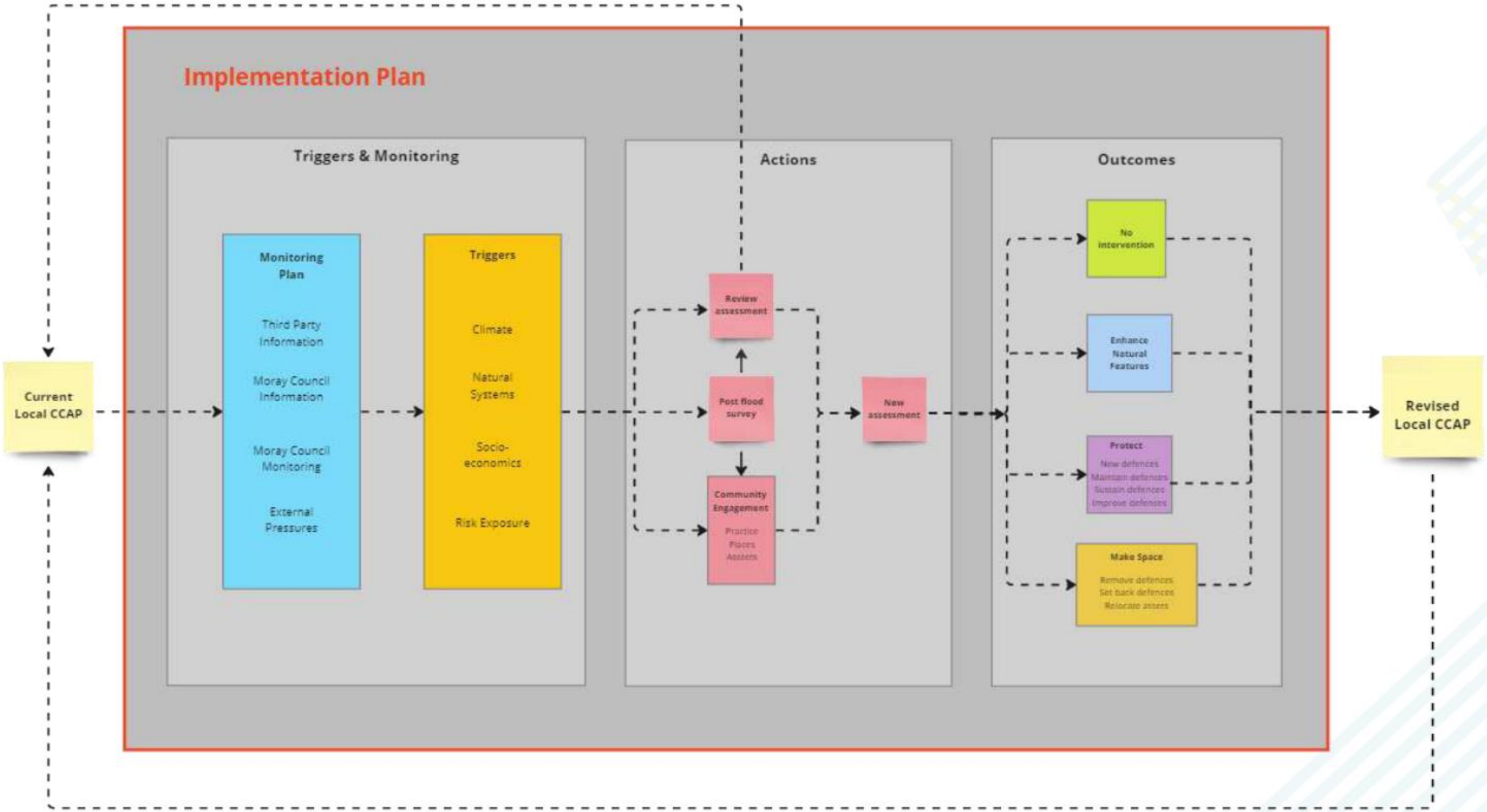


Figure 4-4: Complete Implementation Plan for Kingston to Lower Auchenreath Coast CA.

4.7 Example application

Figure 4-5 provides a schematic describing an example application of the Implementation Plan and how it fits in with the wider Adaptation Framework for Kingston to Lower Auchenreath Coast. The red box highlights the processes described in this iteration of the CCAP.

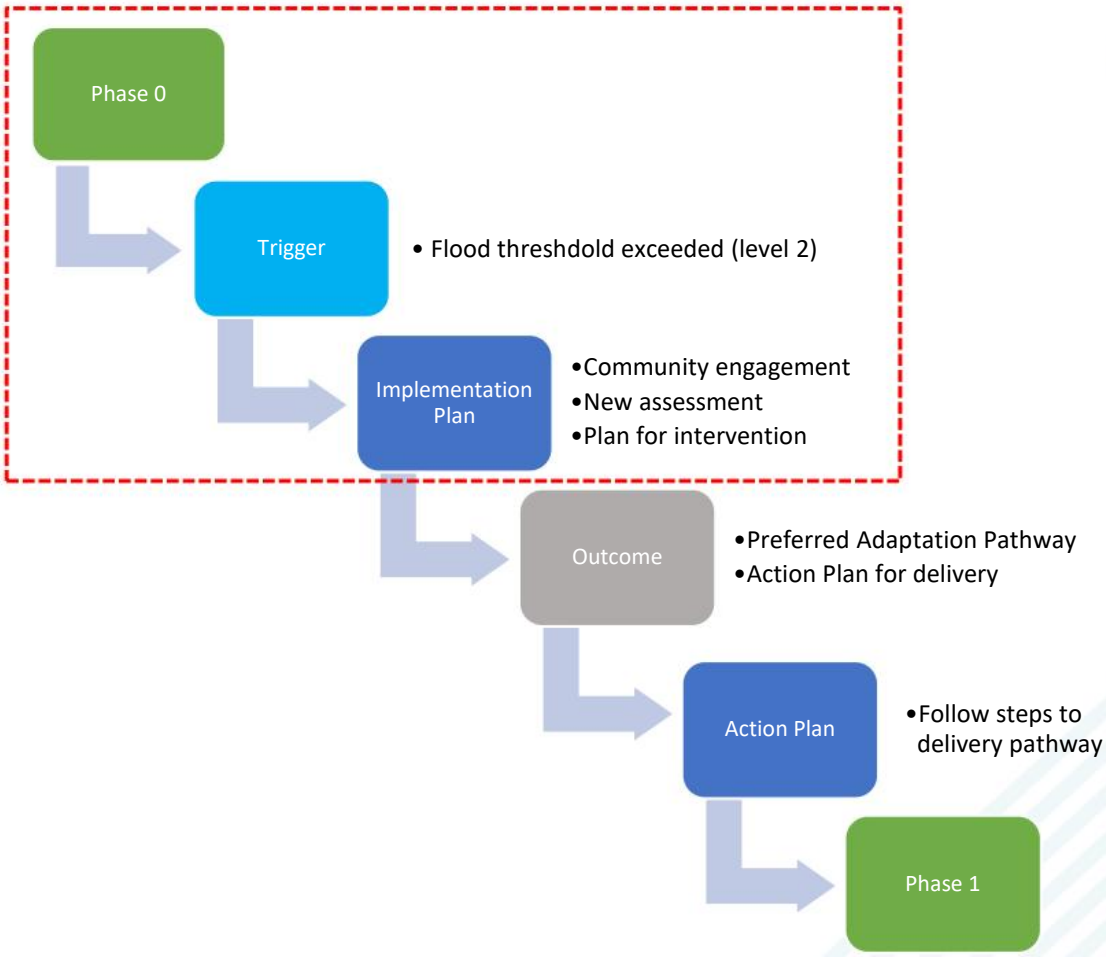


Figure 4-5: Example application of Phase 0 to Phase 1 of the adaptation process and how the Implementation Plan works with Adaptation Pathways and Action Plans.

5 Summary and Next Steps

5.1 Approach

This document presents the local CCAP for Kingston to Lower Auchenreath Coast. It is the first iteration and will be subject to ongoing review and update to effectively guide the adaptation process. The approach for developing the Plan makes use of available, national information, on coastal flood and erosion risk, and combines these with relevant local datasets.

Adaptation in Moray has been has steered by relevant published documentation and the Scottish Governments interim guidance on CCAPs. These have been used to develop a CCAP. This has been simplified into four key pillars of adaptation:

1) **Working with Natural Processes**
2) **Monitoring Change**
3) **Community and Engagement**
4) **Climate Resilient Placemaking**

This local Plan builds on the Regional Plan by focusing on these pillars to develop an Adaptation Framework that can effectively support Kingston to Lower Auchenreath Coast preparing for the impact that climate change will have on the coast. This will be delivered by following the Implementation Plan, presented here, that outlines Triggers and associated actions to develop detailed Adaptation Pathways and an action Plan for the Kingston to Lower Auchenreath Coast CA. This will happen when the process moves into Phase 1.

5.2 Coastal Management Units and Risks

The Kingston to Lower Auchenreath Coast CA was subdivided into six CMUs. For each of these a refined assessment was undertaken to determine coastal type and associated current and future flood and erosion risk. These are summarised as:

- CMU1 – Natural with Risk and Hazard
- CMU2 – Natural with Risk and Hazard
- CMU3 – Natural with Risk and Hazard
- CMU4 – Hybrid with Risk and Hazard
- CMU5 – Hybrid with No Risk and Hazard
- CMU6 – Natural with Risk and Hazard

These were then taken forward to develop Adaptation Pathways and an Implementation Plan with Triggers and Actions associated with each CMU.

5.3 Adaptation Pathways

To enable effective implementation of this CCAP across the Kingston to Lower Auchenreath Coast CA, each CMU has been assigned a generic Adaptation Pathway. This is specific to the CMU classification.

The adaptation journey is a multiphase, multiyear process and aims to transition communities into a more sustainable and resilient future. We are currently at **Phase 0**, meaning that no definitive preferred Adaptation Pathway and associated Action Plan have been developed. To move to Phase 1 of the Adaptation Pathway, a trigger must be realised that results in New Assessment and a preferred pathway and associated Action Plan must be identified:

1. **Phase 0**:
    - Development of the Implementation Plan
    - Delivery of Phase 0 Actions (Appendix C)
    - Delivery of Phase 0 Proactive Actions (Appendix B)
2. **Phase 1**:
    - Implementation Plan outcomes:
        - Preferred Adaptation Pathway
        - Action Plan for delivery
    - Delivery of Phase 1 No Regrets Actions
3. **Phase 2+**:
    - Implementation Plan outcomes:
        - Preferred Adaptation Pathway (Continue or revise Phase 1)
        - Action Plan for delivery (Continue or revise Phase 1)
    - Delivery of Phase 2 No Regrets Actions

While ultimately the Adaptation Pathways have a desired outcome, what that looks like and how it will be reached cannot be defined at this stage. Effective monitoring against the set triggers will enable the CCAP to evolve through Phases and support Moray Council decision making to aim to achieve this end-outcome.

A detailed summary of Phase 0 Actions are included in Appendix C.

5.4 Implementation Plan

The Implementation Plan was developed by defining Triggers and setting Actions against these. Implementation of the Plan will result in end outcomes that will ultimately influence the direction of the Adaptation Pathways in the Kingston to Lower Auchenreath Coast CA.

At this stage the pathways do not result in definitive end points. Triggers, while tangible, provide markers whereby Moray Council will undertake actions, guided by the Action Plan. The Outcomes of these however, are unknown and the direction of the pathway in the future therefore cannot be defined.

Triggers focus on the updates to the data and documentation that has underpinned the development of the plan, and bespoke flooding or erosion thresholds being exceeded, through monitoring of physical processes.

As well as Actions that rely on Triggers being realised. This initial stage of the adaptation planning process has identified several knowledge gaps and opportunities for activities to be undertaken upfront. These are defined as Proactive Actions, whereby undertaking these will only benefit and support Moray's adaptation to coastal change.

In total, five Proactive Actions have been set.

5.5 Next Steps

Adaptation to coastal change will be a continual journey and it is therefore important that the process is ongoing. Here, the following key steps require implementing by Moray Council to support this journey and follow CCAP:

- Implement internal governance processes to review and monitor Triggers.
- Deliver local Phase 0 Actions.
- Deliver local Proactive Actions.

Appendices

A CMU Risk Assessment

A.1 Data and overview

Coastal parameters and associated datasets summarising wave, tide and sea level conditions for Kingston to Lower Auchenreath Coast are summarised in Table A-.

Table A-1: Coastal dataset summary for Kingston to Lower Auchenreath Coast CA.

Coastal Data		Details	Data source
Hindcast wave height	0.62 m	50th percentile	CMEMS
	0.96 m	75th percentile	
	2.69 m	99th percentile	
Tide levels	HAT	2.5	TotalTide
	MHWS	2.0	
	MHWN	1.1	
	MSL	-	
	MLWN	-0.5	
	MLWS	-1.6	
	LAT	-2.0	
Extreme Sea Levels	2.03 m	MHWS	CFB (Buckie: 3084)
	2.65 m	2-year	
	2.94 m	50-year	
	3.00 m	100-year	
	3.06 m	200-year	
	3.21 m	1000-year	
Sea level rise projections	0.15 m	2050 70th percentile	UKCP18
	0.20 m	2050 95th percentile	
	0.59 m	2100 70th percentile	
	0.84 m	2100 95th percentile	

An overview of coastal flood and erosion hazards is provided for Kingston to Lower Auchenreath Coast CA (Figure A-1). This has been produced using SEPA flood mapping for 1 in 200-year and 1 in 200-year plus climate change flood events as well as Dynamic Coast erosion projections for 2020 to 2100. The data has been analysed for each CMU individually and has been used to identify receptors at risk.

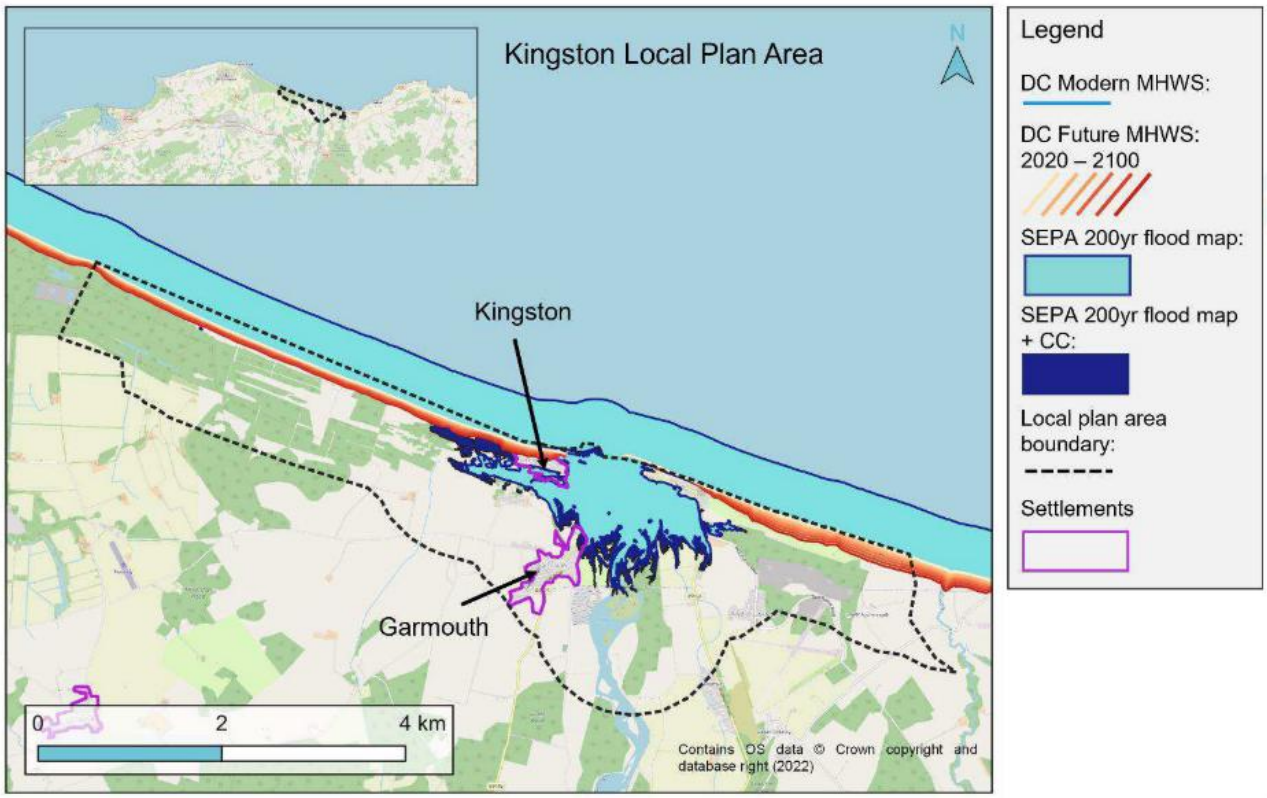


Figure A-1: Kingston to Lower Auchenreath Coast CA coastal flood and erosion hazard overview.

A.2 CMU 1: Beach west - natural

CMU 1 is fronted by a natural shingle beach and is undefended. SEPA flood maps and NFRA datasets show negligible risk from coastal flooding in this unit to the land and to assets.

Results from Dynamic coast show there is little risk from coastal erosion. Dynamic Coast data shows that historically (from ca. 1967 to 2011), this area of Kingston to Lower Auchenreath Coast CA eroded at a maximum rate of 0.4 m/yr. Maximum future erosion rates are expected to increase to 0.95 m/yr by 2050 and to 1.79 m/yr by 2100. This would result in a maximum 96.66 m of land loss caused by shoreline retreat by 2100. Table A-2 summarises Dynamic coast data for CMU 1. There is one asset within the Dynamic Coast erosion extent:

- One NRP at risk from erosion: 80 m from present-day shoreline

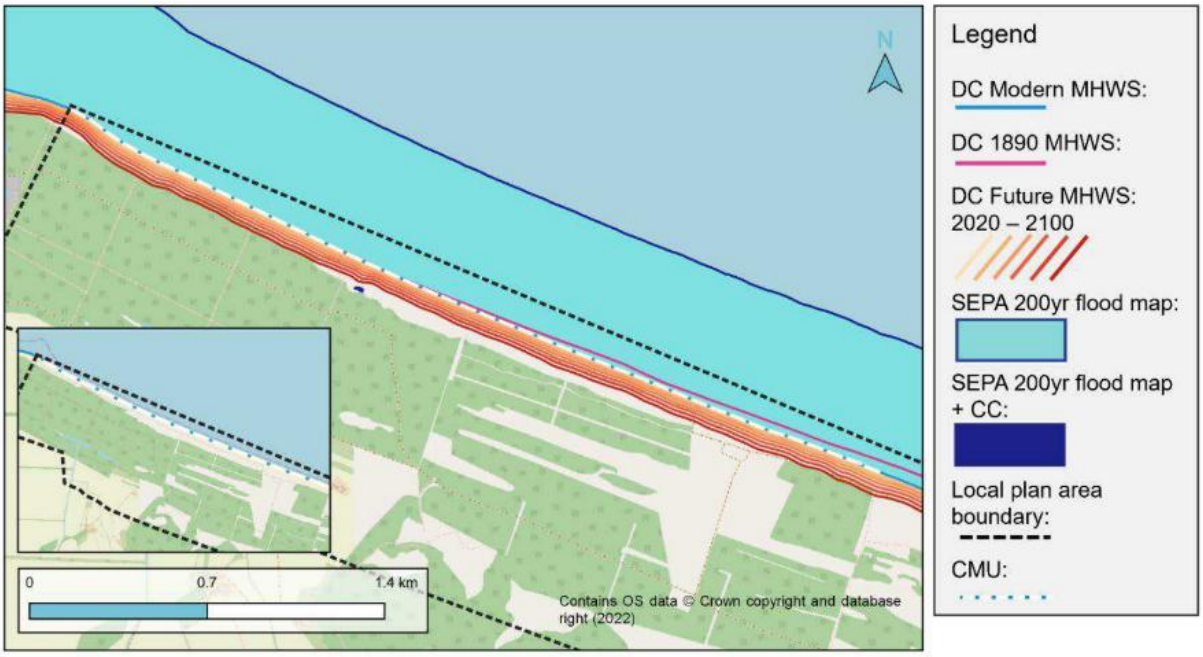


Figure A-2: CMU 1: Beach West coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows unit without coastal hazards.

Table A-2: CMU 1 Dynamic coast erosion summary data.

Dynamic Coast calculation	Results	
Historical rate	0.4 m yr^{-1}	Maximum
	0.1 m yr^{-1}	Median
2050 rate	0.95 m yr^{-1}	Maximum
	0.78 m yr^{-1}	Median
2050 distance	23.46 m	Maximum
	17.70 m	Median
2100 rate	1.79 m yr^{-1}	Maximum
	1.55 m yr^{-1}	Median
2100 distance	96.66 m	Maximum
	83.84 m	Median

A.3 CMU 2: Shingle ridge west - natural

A.3.1 Dynamic Coast and SEPA

This coast is formed of a shingle barrier located seawards of Kingston on Spey. Under a 1 in 200-year flood event, SEPA flood mapping shows that the shingle barrier acts as a natural defence for the town by protecting most of Kingston on Spey from flooding directly along the coastal front.

Results from Dynamic coast show there is substantial risk from coastal erosion. Dynamic Coast data shows that this area of Kingston to Lower Auchenreath Coast CA has historically (from ca. 1973 to 2015) eroded at a maximum rate of 0.3 m/yr. Maximum future erosion

rates are expected to increase to 1.11 m/yr by 2050 and to 2.14 m/yr by 2100. This would result in a maximum 115.81 m of land loss caused by shoreline retreat by 2100. Table A-3 summarises Dynamic coast data for CMU 2.

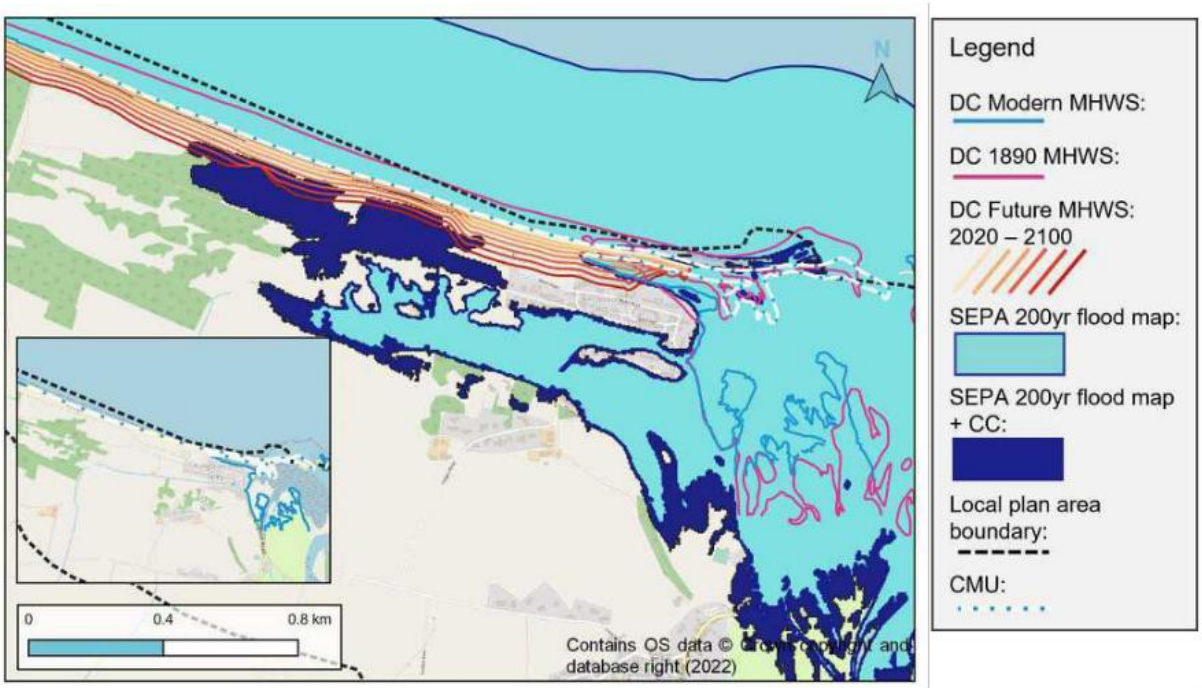


Figure A-3: CMU 2: Shingle Ridge West coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows unit without coastal hazards.

Table A-3: CMU 2 Dynamic coast erosion data summary.

Dynamic Coast calculation	Results	
Historical rate	0.3 m yr^{-1}	Maximum
	0.2 m yr^{-1}	Median
2050 rate	1.11 m yr^{-1}	Maximum
	0.95 m yr^{-1}	Median
2050 distance	25.9 m	Maximum
	21.61 m	Median
2100 rate	2.14 m yr^{-1}	Maximum
	1.85 m yr^{-1}	Median
2100 distance	115.81 m	Maximum
	100.55 m	Median

Assets within the Dynamic Coast erosion extent under the RCP8.5 scenario are located within Kingston on Spey town and are summarised below:

- Five NRPs: minimum of 97 m from present-day shoreline
- 30 RPs: minimum of 57 m from present-day shoreline

- Beach Road (~659 m): minimum of 120 m from present-day shoreline
- 33 clean water points: minimum of 120 m from present-day shoreline

A.3.2 Kingston barrier topographic surveys

In 2021 and 2022, Moray Council collected topographic survey data on the shingle barrier fronting Kingston on Spey. A LiDAR survey from 2014 by the Scottish Government (phase 2) is also considered here[10]. Analysis of this data will be used to assess risk and define specific triggers and actions for Kingston to Lower Auchenreath Coast CMU 2.

A difference plot of the 2021 and 2022 surveys (Figure A-4) shows that in just one year the elevation of the mid-section of the gravel barrier fronting the lagoon at Kingston on Spey has lowered by as much as 2 m, whereas the section to the east has accreted by as much as 2 m.

Barrier crest heights were calculated across 62 cross-sections along the shingle barrier corresponding to the 2022 topographic survey (Figure A-5). Minimum crest heights of <4 m are located in the same mid-section of the barrier that showed the greatest change in elevation between 2021 and 2022 (Figure A-4) and to the eastern section of the spit. Maximum crest heights are currently located west of the lagoon.

For profiles 3, 13 and 26, cross shore profiles are shown for the years 2014, 2021 and 2022 in Figure A-6. The crest location for the 3 profiles has moved landwards by approximately 15-25 m respectively between 2014 and 2022; this corresponds to an average retreat rate of 1.9–3.1 m/yr. Dynamic coast data says that historic rates of shoreline retreat between 1973 and 2015 were maximum 0.3 m/yr at the Kingston gravel barrier. These topographic surveys suggest that recent retreat of the barrier is up to 10 times greater than the rates Dynamic coast suggests. Using a retreat rate of 2.0 m/yr, in line with topographic survey evidence, shoreline positions have been projected for the years 2032 (+10 years), 2042 (+20 years), 2072 (+50 years) (Figure 3-6). If recent retreat rates are maintained into the future, even without consideration of accelerated sea level rise, shoreline positions are projected to move landward by approximately 20 m, 40 m and 100 m by 2032, 2042 and 2072 respectively (Figure A-6).

As well as landward barrier retreat, profile 3 shows that the crest height to the west of the lagoon has lowered by approximately 1 m between 2014 and 2022 (Figure A-6)

10 LiDAR for Scotland Phase 2 – DTM (2014) Scottish Government

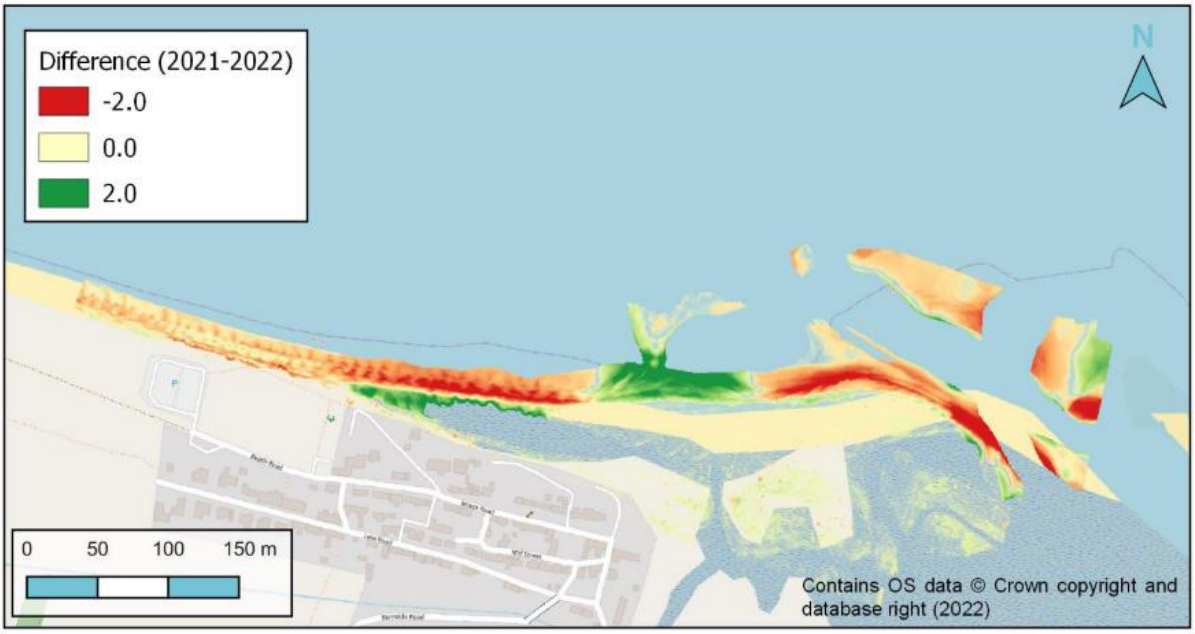


Figure A-4: Kingston barrier different plot (m) from 2021 to 2022 using Moray Council topographic survey data. Red areas indicate negative change and green areas indicate positive change.

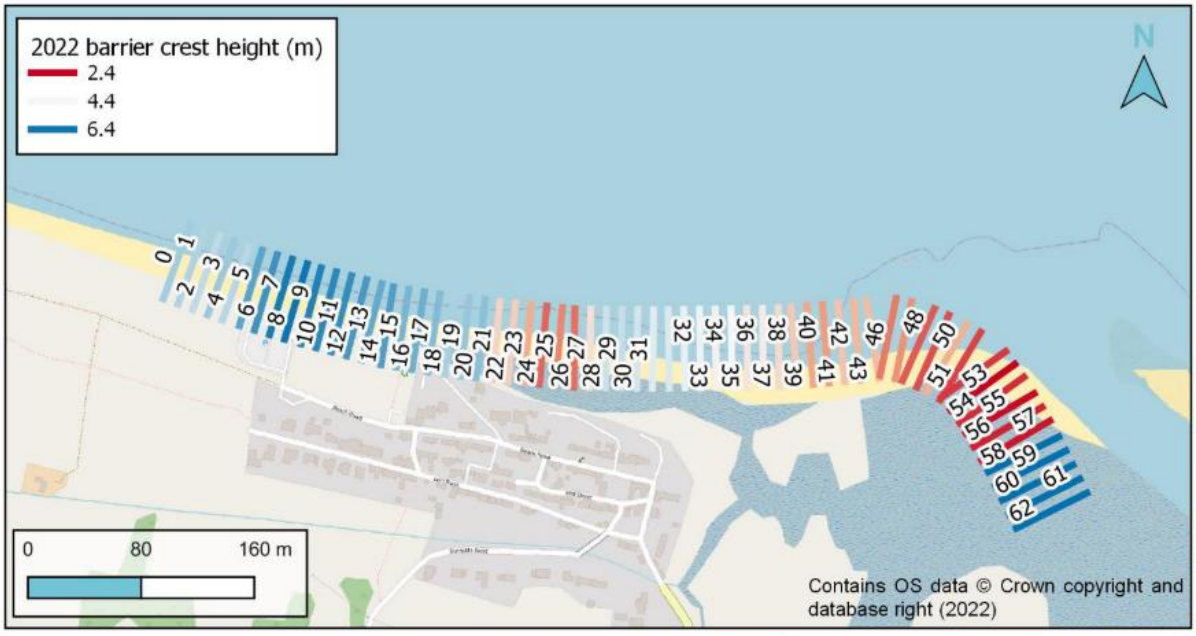


Figure A-5: Cross section profiles (numbers correspond to profile ID) and colour-coded crest heights in 2022. Red profiles indicate lower crest heights, blue profiles indicate higher crest heights.

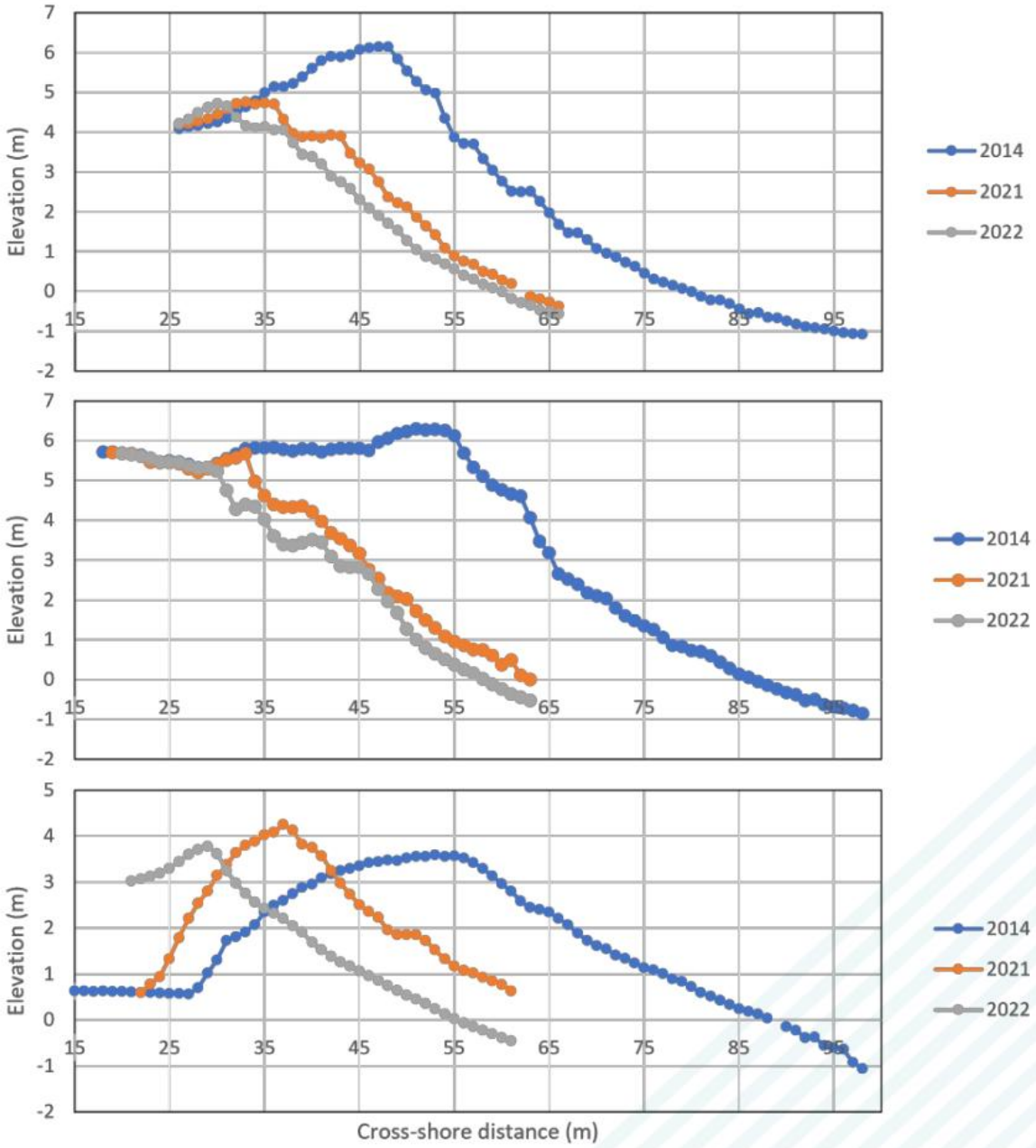


Figure A-6: Cross sections for profiles 3, 13 and 26 as shown in Figure 3-5 for years 2014 (LiDAR), 2021 and 2022 (Moray Council topographic survey).

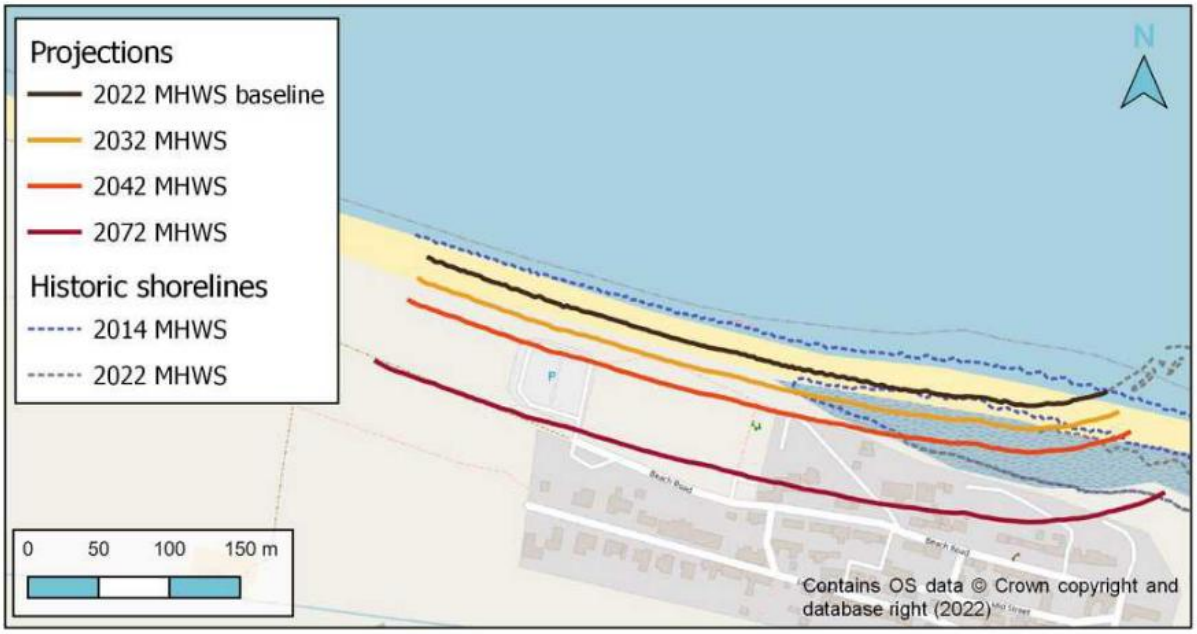


Figure A-7: Historic and future projected shorelines for 10-year, 20-year and 50-year periods based on a retreat rate of 2 m/yr.

A.3.3 Kingston barrier overtopping assessment

The overtopping assessment has been undertaken for the natural shingle barrier ridge in CMU 2. At this location, overtopping volumes have been calculated based on the following beach profile schematisations:

- Cross-sectional beach profile (no. 10 Figure A-5) from 2022 survey (5.9 mAOD crest level, 0.1 mAOD toe level)
- Cross-sectional beach profile (no. 10 Figure A-5) from 2022 survey with lowering at the toe (5.9 mAOD crest level, -1.0 mAOD toe level)
- Average profile based on all cross-sectional beach profiles from 2022 survey (4.4 mAOD crest level, 1:8 slope)

Results from the overtopping assessment for all 4 sea level rise scenarios are shown in Figure A-8 to A-11 and correspond to Table 4-2 in the main text.

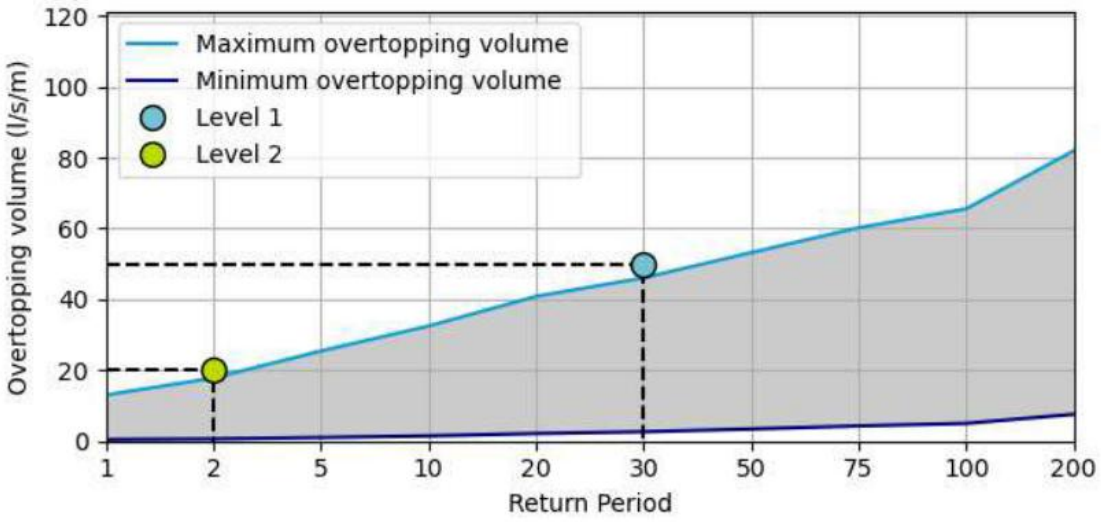


Figure A-8: Upper and lower overtopping volume estimates for the gravel barrier beach in CMU 2 at present day (i.e. a 0.0 m sea level rise projection). Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

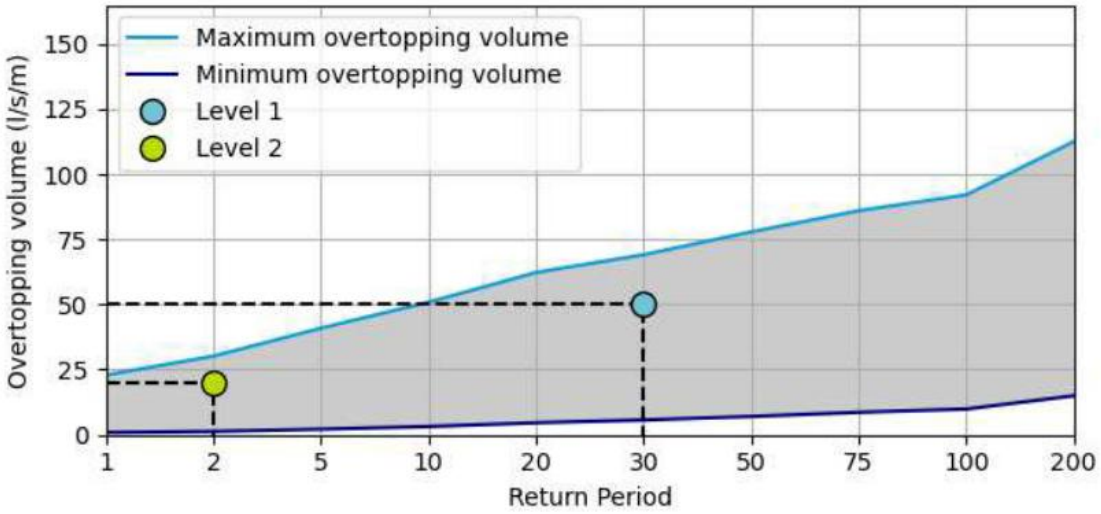


Figure A-9: Upper and lower overtopping volume estimates for the gravel barrier beach in CMU 2 with a 0.2 m sea level rise projection (present-day). Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

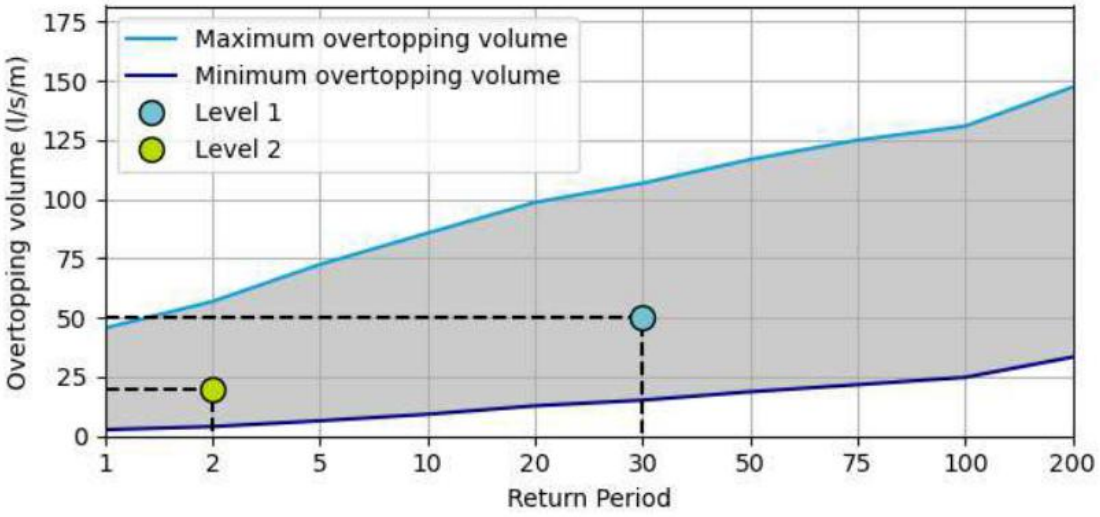


Figure A-10: Upper and lower overtopping volume estimates for the gravel barrier beach in CMU 2 with a 0.5 m sea level rise projection (present-day). Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

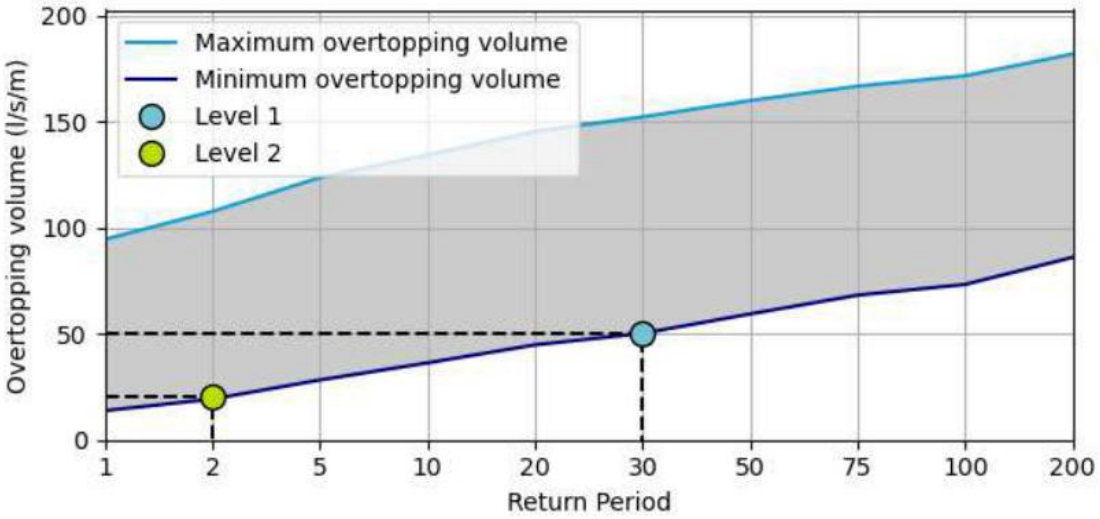


Figure A-11: Upper and lower overtopping volume estimates for the gravel barrier beach in CMU 2 with a 1 m sea level rise projection (present-day). Overtopping triggers plotted for 1 in 30-year and 1 in 2-year return period events.

A.4 CMU 3: Riverbank west – natural

This CMU comprises the west bank of the River Spey. The risk to assets is exclusively from flooding. The 1 in 200-year flooding extent follows the Drainer Burn water course, flooding

the low-lying area to the south of Kingston on Spey. The flooding extent reaches approximately 1 km inland following the Drainer Burn. The 1 in 200-year plus climate change event increases flood extents a further 100 m along the Drainer Burn.

Under a 1 in 200-year event, flooding along the west bank of River Spey also extends across a large area of Garmouth and Kingston Golf Course and Kingston Road. Under a 1 in 200-year flood plus climate change event, the flooded area extends by as much as ~283 m across the golf course, following the Black Burn water course. The 1 in 200-year flood plus climate change also floods the low-lying area to the west of Kingston.

Assets at risk from a 1 in 200-year flooding event are summarised below:

- Two RP: minimum elevation 3.1 m
- Three NRPs: minimum elevation 2.6 m
- Burnside Road (~393 m): minimum elevation 2.3 m
- Kingston Road (~590 m): minimum elevation 2.5 m
- Secondary road (~110 m): minimum elevation 2.5 m

Assets at risk from a 1 in 200-year flooding plus climate change event include assets at risk from a 1 in 200-year flooding event (shown above) plus assets summarised below:

- Five RPs
- Three NRPs
- Lein Road (~57 m)
- ~1 km of pathways
- Kingston road (~207 m)
- Four wastewater and water treatment utility points

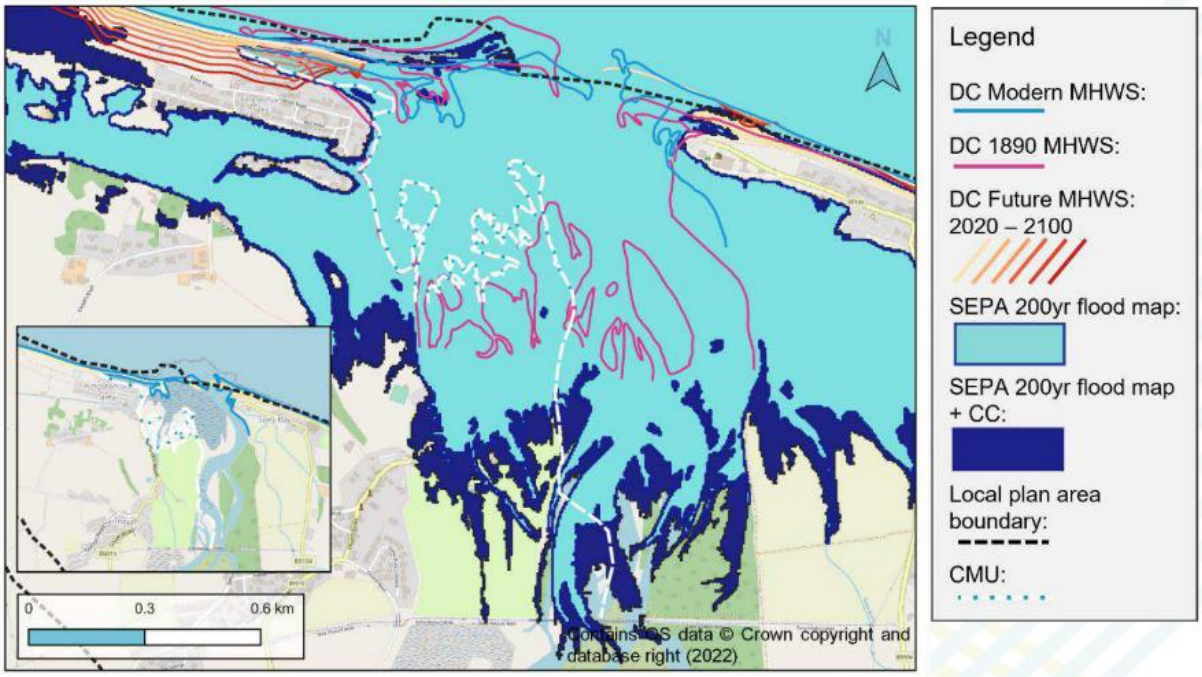


Figure A-12: CMU 3: Riverbank West coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows unit without coastal hazards.

A.5 CMU 4: Riverbank east – hybrid

CMU 4 comprises of the east bank of the River Spey. As with CMU 3, the risk to assets is exclusively from flooding. In some sections, the east riverbank is enhanced with rock revetment. Under a 1 in 200-year flood event, the flooding along the east bank of the River Spey extends a large distance of up to ~1 km and includes ~140 m of the B9104 road and beyond into forestry land. Approximately 340 m of footpath adjacent to the River Spey east bank is at risk of flooding under a 1 in 200-year event. Flooding from the east bank of River Spey extends to but does not include Spey Bay Town. Under a 1 in 200-year flood event plus climate change, flood extents increase and cover a further ~300 m maximum along the forest adjacent to the River Spey east bank. One property in Spey Bay town is at risk of flooding under a 1 in-200 year plus climate change flood event and the length of the B9104 road flooded increases to ~400 m. Utilities, as assessed by Dynamic Coast, are not at risk.

Assets at risk from a 1 in 200-year flooding event are summarised below:

- B9104 road (~140 m): minimum elevation 2.6 m
- Footpath (~340 m): minimum elevation 2.6 m

Assets at risk from a 1 in 200-year flooding plus climate change event include assets at risk from a 1 in 200-year flooding event (shown above) plus assets summarised below:

- One NRP
- B9104 road (~400 m)

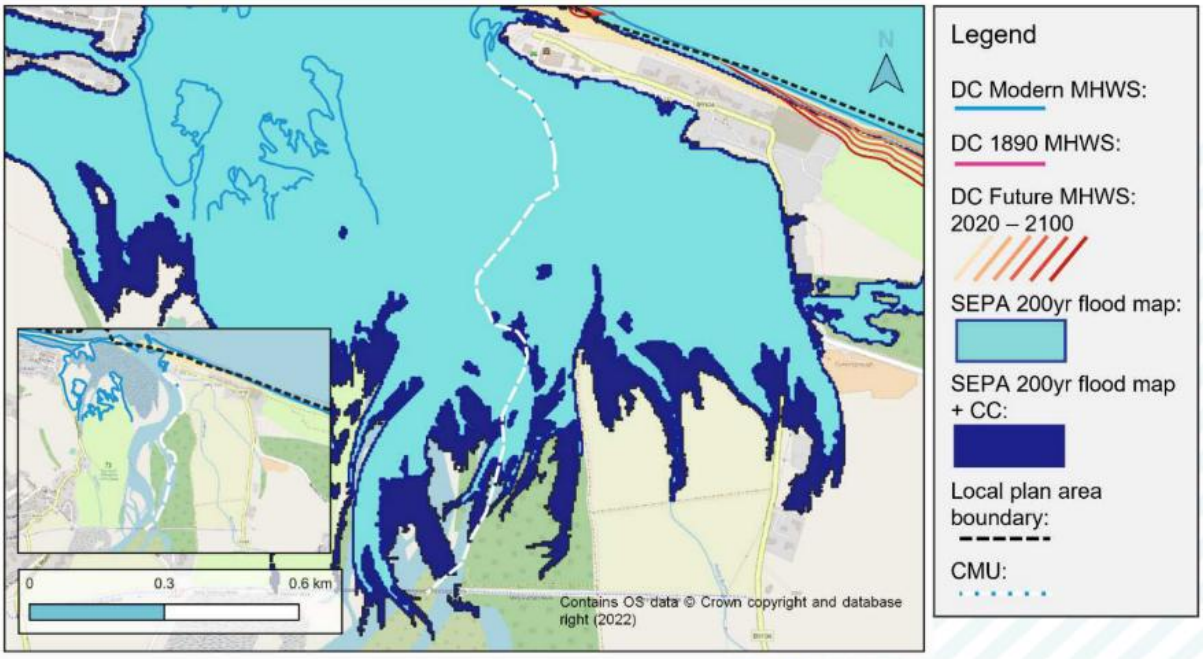


Figure A-13: CMU 4: Riverbank East coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows unit without coastal hazards.

A.6 CMU 5: Beach east – hybrid

CMU 5 comprises the beach and spit the east of the River Spey mouth. The unit contains part of Spey Bay town, which is defended with a rock revetment along the coast. There is a risk of both flooding and erosion within this unit. Under 1 in 200-year and 1 in 200-year plus climate change flooding events, the sand spit is flooded but the flooding extent does not reach properties or assets at Spey Bay town. The greatest flooding extent occurs at the east bank of the River Spey, south of Spey bay town in CMU 4.

Dynamic Coast results indicate, with positive coastal change results, that historically (from ca. 1973 to 2015) the spit at unit 5 has moved further offshore at a maximum rate of 0.98 m/yr. By 2050, the median rate of coastal change is projected to be accreting at a rate of 0.23 m/yr but there is a projected rate of coastal erosion of maximum 0.55 m/yr. By 2100, the spit is projected to be entirely eroding in CMU 5, with a maximum rate of 1.5 m/yr and maximum eroded distance of 69.94 m.

There are no assets at risk from coastal erosion. Table A-4 summarises Dynamic coast data for this unit.

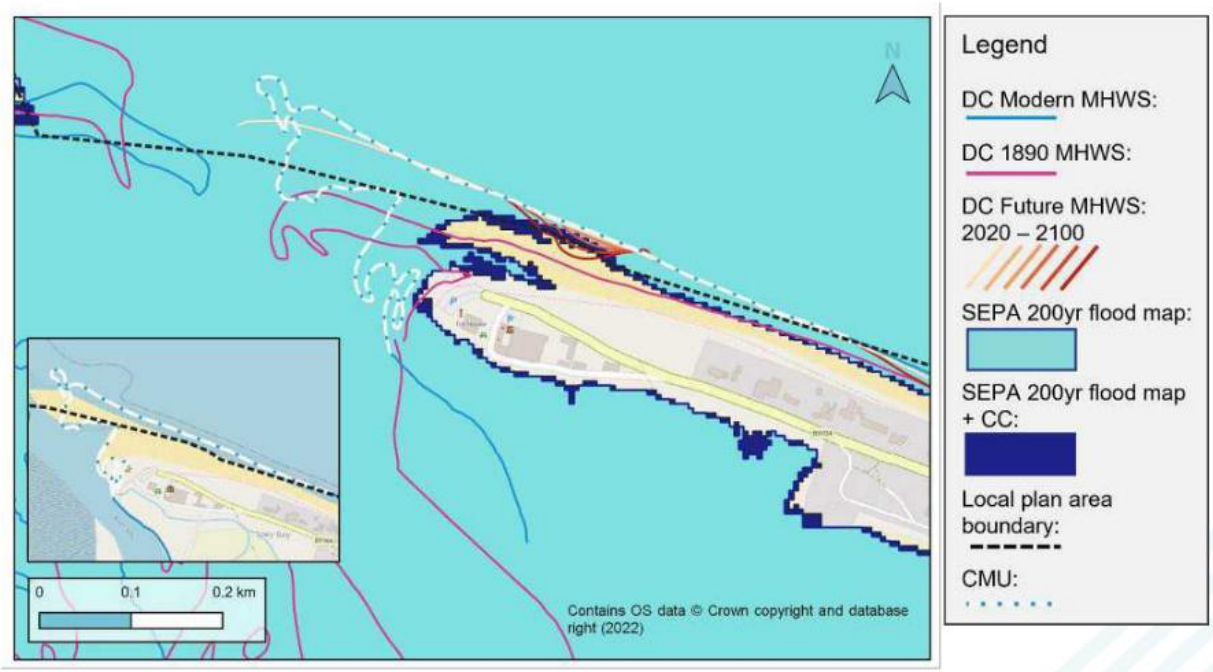


Figure A-14: CMU 5: Beach East Built Structures coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows unit without coastal hazards.

Table A-4: CMU 5 Dynamic coast erosion data summary.

Dynamic Coast calculation	Results	
Historical rate	(Accretion) 0.98 m yr^{-1}	Maximum
	(Accretion) 0.86 m yr^{-1}	Median
2050 rate	0.55 m yr^{-1}	Maximum
	(Accretion) 0.23 m yr^{-1}	Median
2050 distance	9.9 m (Erosion)	Maximum
	21.74 m (Accretion)	Median
2100 rate	1.5 m yr^{-1}	Maximum

	0.73 m yr^{-1}	Median
2100 distance	69.94 m (Erosion)	Maximum
	13.81 m (Erosion)	Median

A.7 CMU 6: Beach east – natural

There is minimal risk of flooding along the coast. A small area at the eastern end of Spey Bay golf is projected to flood under a 1 in 200-year event.

There is considerable coastal erosion projected along Spey Bay. Spey Bay Golf Course is central to the projected future erosion area, with a maximum eroded distance of 195.9 m by 2100. Historically (from ca. 1966 to 2003), erosion rates were a maximum of 1 m/yr; maximum erosion rates are projected to increase to 3.38 m/yr by 2100. Table A-5 summarises Dynamic coast data for CMU 6.

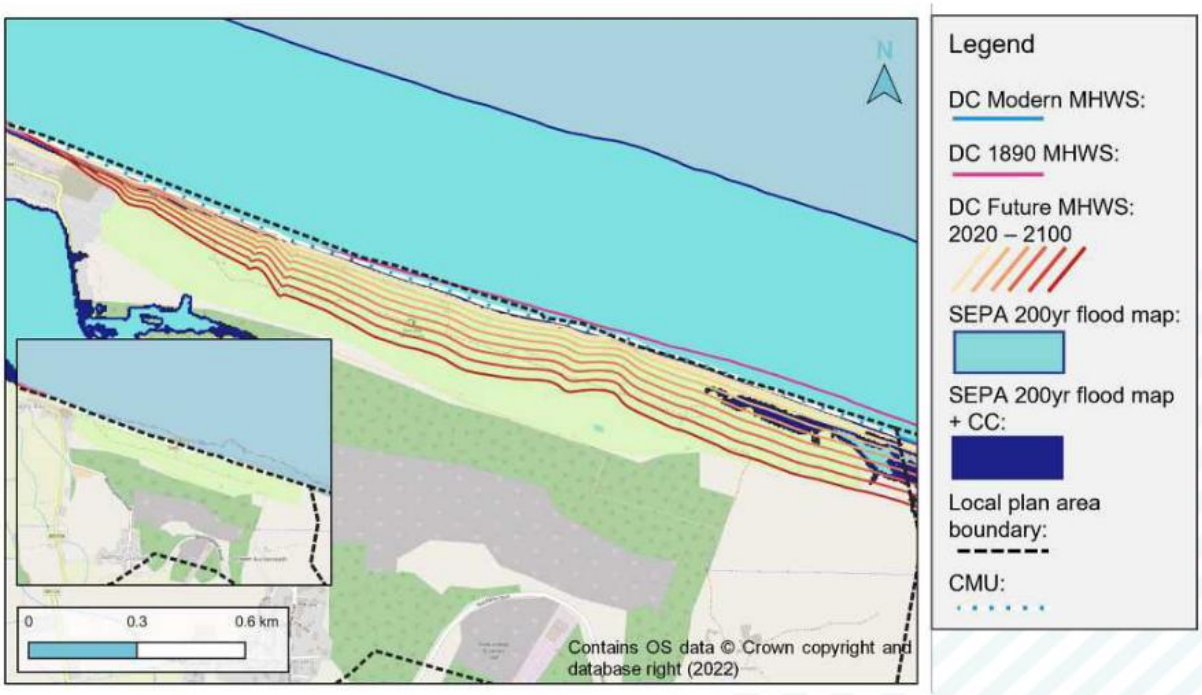


Figure A-15: CMU 6: Beach East undefended coastal hazards map showing SEPA flooding extents and Dynamic Coast (DC) past and future erosion. Inset shows unit without coastal hazards.

Table A-5: CMU 6 Dynamic coast erosion data summary.

Dynamic Coast calculation	Results	
Historical rate	1 m yr^{-1}	Maximum
	0.7 m yr^{-1}	Median
2050 rate	2.06 m yr^{-1}	Maximum
	1.76 m yr^{-1}	Median
2050 distance	52.46 m	Maximum

	43.38 m	Median
2100 rate	3.38 m yr^{-1}	Maximum
	3.01 m yr^{-1}	Median
2100 distance	195.9 m	Maximum
	173.78 m	Median

Assets within the Dynamic Coast erosion extent under the RCP8.5 scenario are located in Spey Bay town and are summarised below:

- Two NRPs: minimum of 37 m from present-day shoreline
- Six RPs: minimum of 37 m from present-day shoreline
- SW gravity pipe: minimum of 56 m from present-day shoreline
- SW rising main: minimum of 99 m from present-day shoreline

B Proactive Actions

Action 1 – Investigate opportunities for shingle recycling.

The shingle barrier in CMU2 provides one of the major defences against coastal flooding to Kingston to Lower Auchenreath Coast. Analysis of the data has shown this to be retreating rapidly. It is likely that future storm events would result in over wash and inundation of the landward areas. While the volume required to flood properties is unknown, this is a potential risk. To delay this from being realised opportunities for shingle recycling and barrier re-profiling should be explored.

This should primarily involve the practice aspects around licensing, source identification and contracting works to achieve as resilient a barrier. It should aim to minimise the impacts on the wider environment and geomorphology and limit the legislative barriers that may be come across in traditional beach recharge projects.

Action 2 – Develop modelling framework to support future assessments

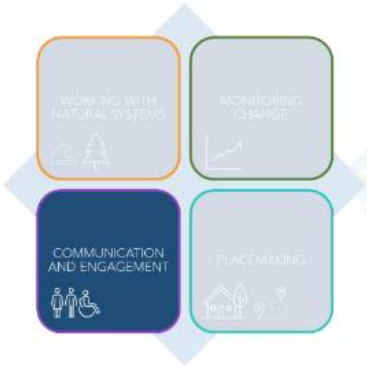
Implementation of effective future risk assessments will require investment in numerical (or similar) modelling tools that can effectively and efficiently quantify flood and erosion risk. A modelling framework should be developed that includes:

- Statistical extremes
- Wave transformation
- Morphodynamics and erosion
- Flood inundation

Action 3 – Establish coordinated and consistent beach monitoring plan for Natural CMUs.

The requirements for monitoring the beach systems in the CA should be reviewed in the context of a wider Regional monitoring plan. Information should be collected through monitoring that is specific to support future risk assessments and compared to CMU specific erosion triggers. It should focus across the entire CA but increase in frequency and detail for CMU2 where predicted risk associated with erosion and coastal change is greatest.

Action 4 – Adaptation and resilience workshop with local community and stakeholders



Adaptation to coastal change is not solely about physical interventions in coastal communities. Community and individual responsibility to increase resilience and adapt to coastal hazards is of paramount importance.

The outcomes of this initial phase of the CCAP should be presented to the community and stakeholders alongside consideration for wider support and education around climate awareness and flood resilience.

Action 5 – Identify landownership and safeguarding

To work with natural processes and make space for coastal change it is inevitable that existing land will be lost. To adapt effectively it is therefore important that land and asset ownership within the CA is fully understood to enable safeguarding of areas. This should feed into revisions of the wider Moray Council Local Development Plan.

C Trigger and Action Database

Table C- 1: Phase 0 Trigger and Action database for Kingston to Lower Auchenreath Coast.

Community Area (CA)	CMU	Coast Type	Trigger Type	Asset Affected	Asset Description	Trigger Level	Trigger Exceeded?	Trigger Buffer Flooding (Freq/10 yr)	Trigger Buffer Overtopping (SLR m)	Trigger Buffer Erosion (m)	Action	Owner	Delivery Partners	Timescale	Cost
Kingston to Lower Auchenreath Coast	1	Natural	Erosion	Property		1	N			60	None	NA	NA	NA	NA
						2	N			70	None	NA	NA	NA	NA
	2	Natural	Erosion	**Property**		**1**	**Y**			-6	**Increase monitoring and plan for assessment.**	**Moray Council**	**None**	**Short**	**Low**
						2	N			14	None	NA	NA	NA	NA
				Other	Carpark	1	N			11	None	NA	NA	NA	NA
						2	N			17	None	NA	NA	NA	NA
			Overtopping	Defence	Shingle barrier	1	N		0.2		None	NA	NA	NA	NA
						2	N		0.2		None	NA	NA	NA	NA
	3	Natural	Flood	**Property**		**1**	**Y**	-0.3			**Increase monitoring and plan for assessment.**	**Moray Council**	**None**	**Short**	**Low**
						2	N	2.7			None	NA	NA	NA	NA
				Road		**1**	**Y**	-34.0			**Increase monitoring and plan for assessment.**	**Moray Council**	**None**	**Short**	**Low**
						2	**Y**	-29.0			**Undertake assessment and plan for intervention.**	**Moray Council**	**Scot. Gov.**	**Medium**	**Medium**
	4	Natural	Flood	**Road**		**1**	**Y**	-8.9			**Increase monitoring and plan for assessment.**	**Moray Council**	**None**	**Short**	**Low**
						2	**Y**	-3.9			**Undertake assessment and plan for intervention.**	**Moray Council**	**Scot. Gov.**	**Medium**	**Medium**
	5	Hybrid	Erosion	Property		1	N			20	None	NA	NA	NA	NA
						2	N			30	None	NA	NA	NA	NA
				Road		1	N			20	None	NA	NA	NA	NA
						2	N			23	None	NA	NA	NA	NA
				Other	Carpark	1	N			10	None	NA	NA	NA	NA
						2	N			13	None	NA	NA	NA	NA
	6	Natural	Erosion	Property		1	N			5	None	NA	NA	NA	NA
						2	N			10	None	NA	NA	NA	NA
				Road		1	N			57	None	NA	NA	NA	NA
						2	N			60	None	NA	NA	NA	NA
				Other	Golf Course	1	N			2	None	NA	NA	NA	NA
						2	N			5	None	NA	NA	NA	NA

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