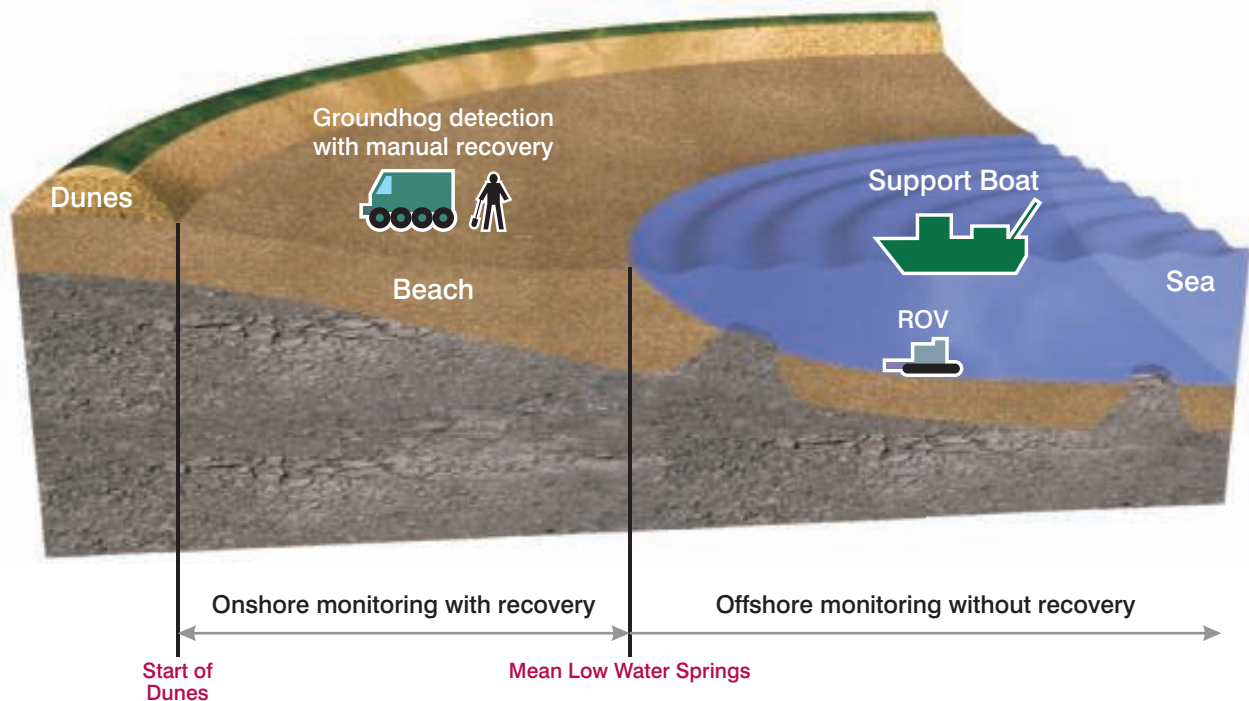


Onshore monitoring with recovery plus offshore monitoring without recovery

OPTION: 2 + 10

Current Practice



Option 2 - Onshore Monitoring with Recovery

This option involves the periodic surveying of beaches and foreshore areas. Particles would be manually removed from the environment when detected and returned to Dounreay for disposal.

Option 10 - Offshore Monitoring Without Recovery

This option involves the periodic surveying of areas of seabed using a Remotely Operated Vehicle (ROV). The current ROV* has the capability to detect and map radiation but not particle retrieval. No further work would be conducted to recover particles.

* Non recovery of particles denoted by grey ROV

Indicative characteristics

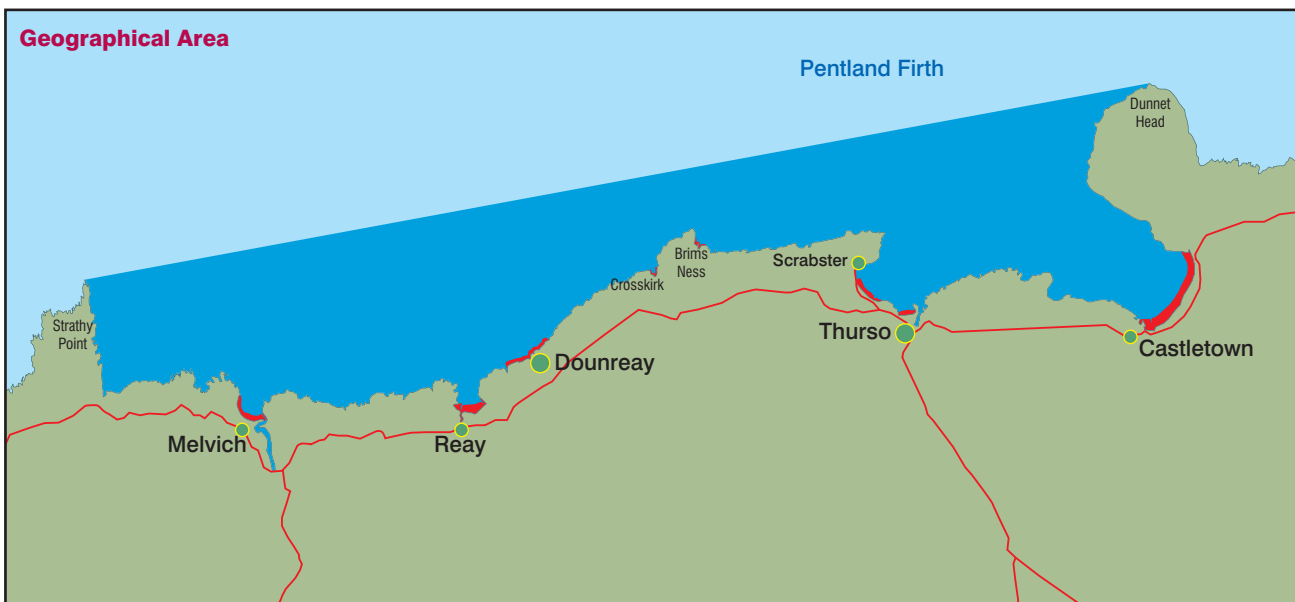
Environmental Impact: **MEDIUM** (due to the length of time required to complete the monitoring task).

Time to Complete Task: 300 years (for significant particles (of 10^8 Bq) to decay to minor particles) with regular review of monitoring locations and frequencies depending upon the extent and location of particle finds.

Option Lifetime Cost: £10 - 100 million.

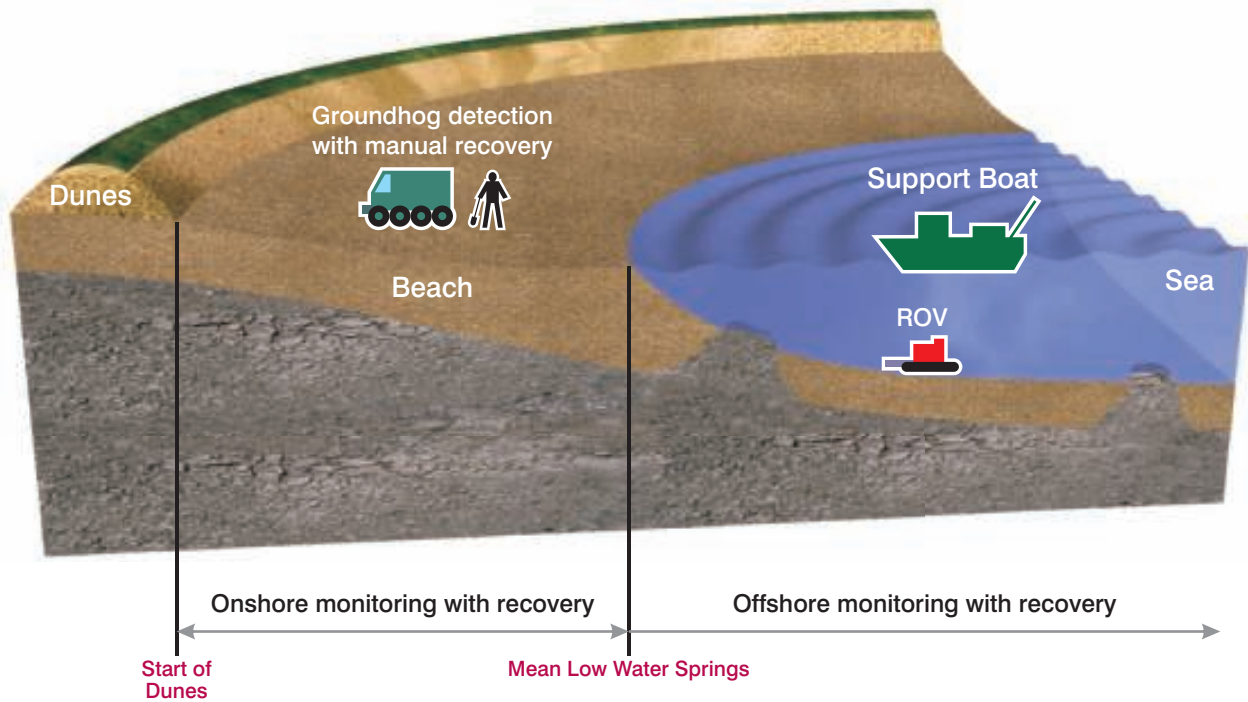
Geographical Area: Onshore: local beaches – Melvich, Sandside, Crosskirk, Brims Ness, Scrabster, Thurso and Dounreay Foreshore.
Offshore: between Strathy Point and Dunnet Head to inshore.

Geographical Area



Onshore monitoring with recovery plus offshore monitoring with recovery

OPTION: 2 + 11



Option 2 - Onshore Monitoring with Recovery

This option involves the periodic surveying of beaches and foreshore areas. Particles would be manually removed from the environment when detected and returned to Dounreay for disposal.

Option 11 - Offshore Monitoring with Recovery

This option involves the periodic surveying of areas of seabed using an ROV. The current ROV has the capability to detect and map radiation but not particle retrieval. As part of on-going research and development, work is underway to enable particle retrieval by the ROV* from offshore sediments.

* Recovery of particles denoted by red ROV

Indicative characteristics

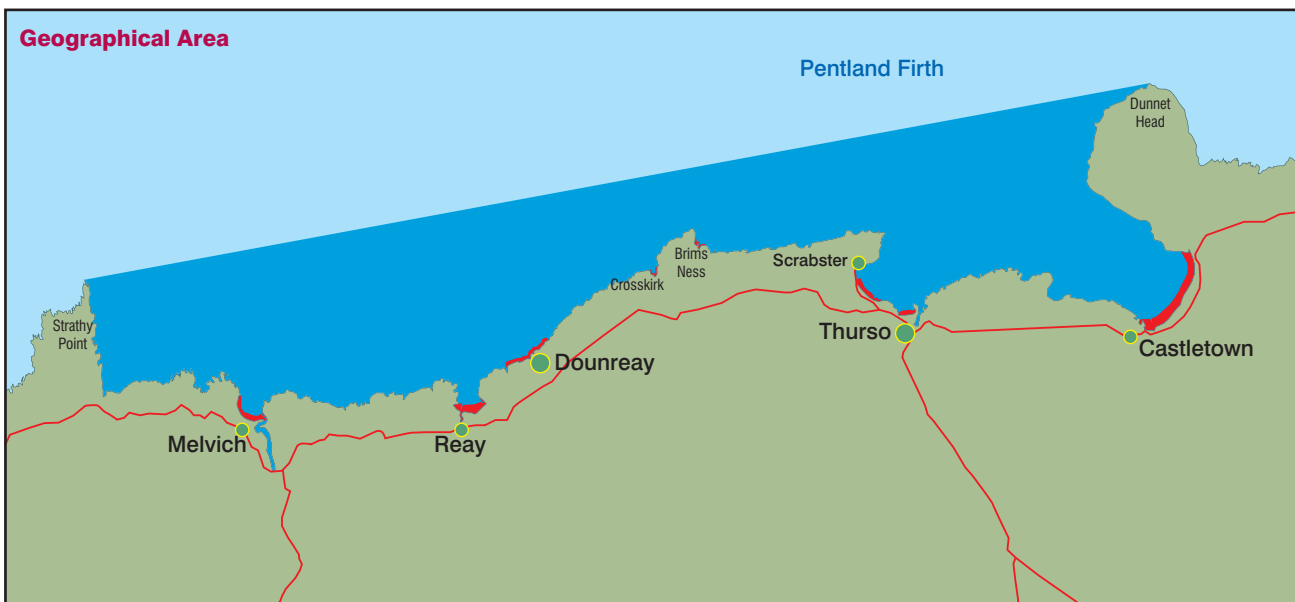
Environmental Impact: **LOW** (Detection and collection methods are only slightly invasive).

Time to Complete Task: 20 years with regular review of monitoring locations and frequencies depending upon the extent and location of particle finds. A reduction in the number of beach 'finds' may warrant a decrease in beach monitoring.

Option Lifetime Cost: £10 - 100 million.

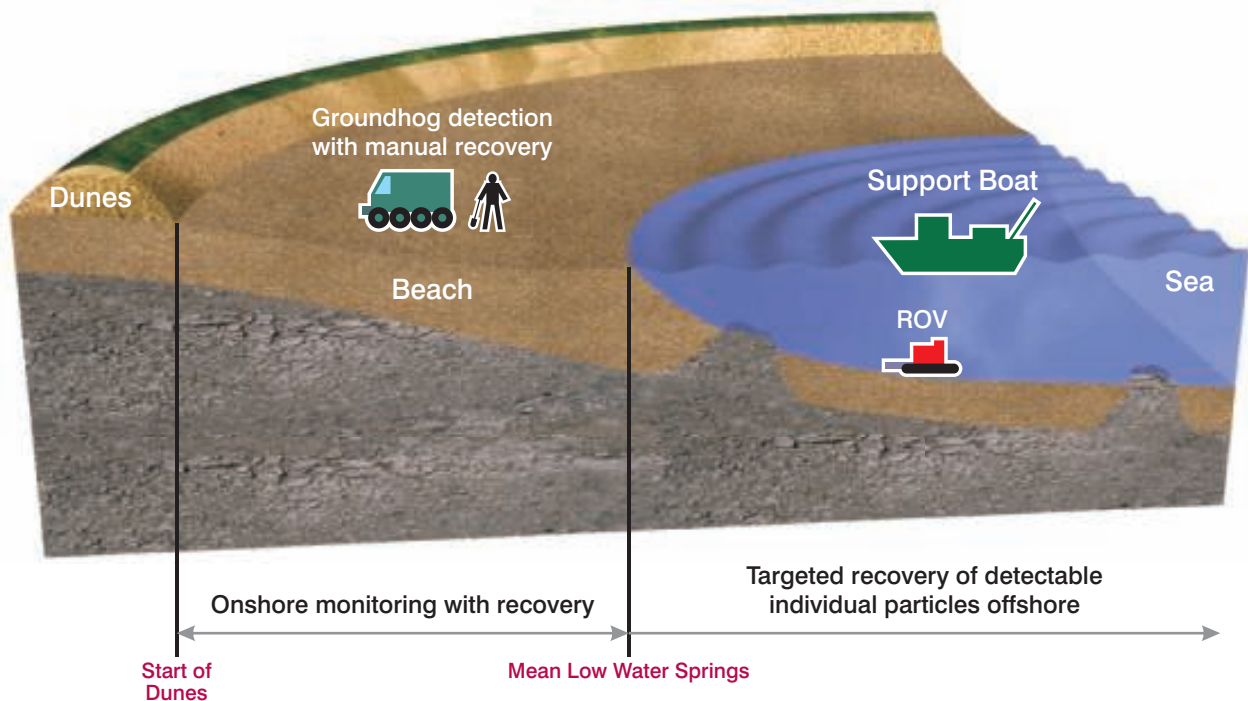
Geographical Area: Onshore: local beaches – Melvich, Sandside, Crosskirk, Brims Ness, Scrabster, Thurso and Dounreay Foreshore.
Offshore: between Strathy Point and Dunnet Head to inshore.

Geographical Area



Onshore monitoring with recovery plus targeted recovery of detectable individual particles offshore

OPTION: 2 + 13



Option 2 - Onshore Monitoring with Recovery

This option involves the periodic surveying of beaches and foreshore areas. Particles would be manually removed from the environment when detected and returned to Dounreay for disposal.

Option 13 - Targeted Recovery of Detectable Individual Particles Offshore

There are three possible variations on this option. One or more of the following approaches may be used:

1. Recover only significant particles in a more localised area close to the diffuser. [Within the 'plume'].
2. Recovery of significant and relevant particles from areas of high particle population density. ['Plume' outer area].
3. Recovery of all particles from offshore areas close to land. This would mitigate the migration of particles onshore. [Shoreline].

Indicative characteristics

Environmental Impact:
Time to Complete Task:

LOW (Detection and collection methods are only slightly invasive)
Onshore: Same as 'Offshore' option, plus 5 years follow-up monitoring
Offshore:

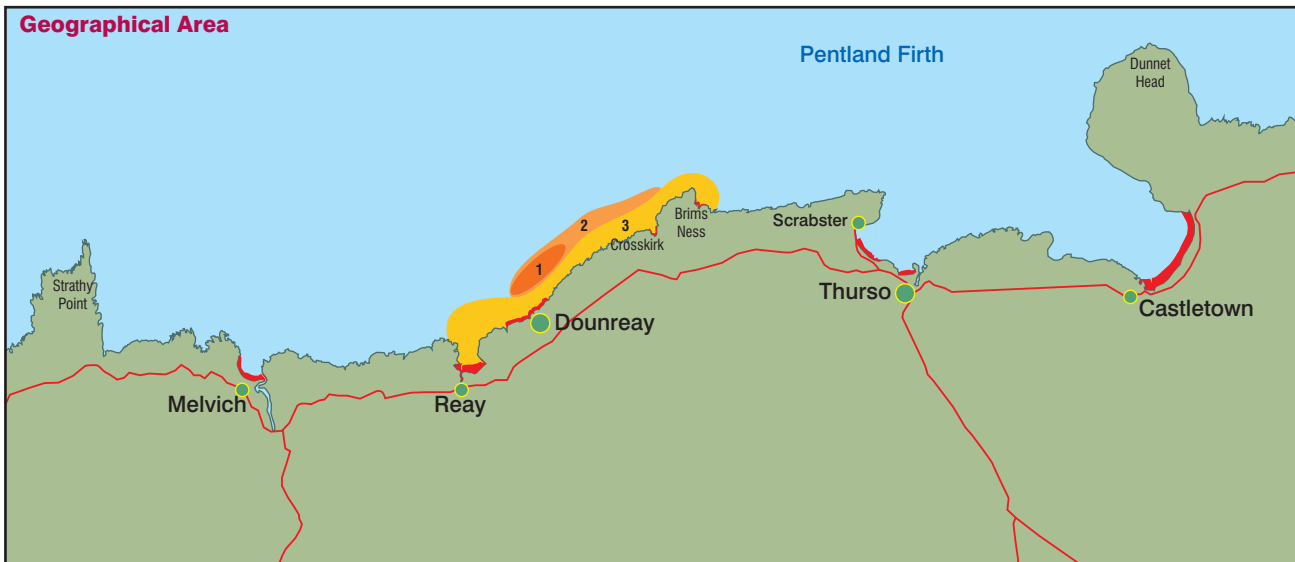
1. 6 years offshore work within 'plume'
2. Additional 10 years for 'plume' outer area
3. Additional 10 years for shoreline area

The method chosen would involve regular review of beach monitoring locations and frequencies depending upon the extent of particle finds. A reduction in the number of beach 'finds' may warrant a decrease in beach monitoring.

Option Lifetime Cost:
Geographical Area:

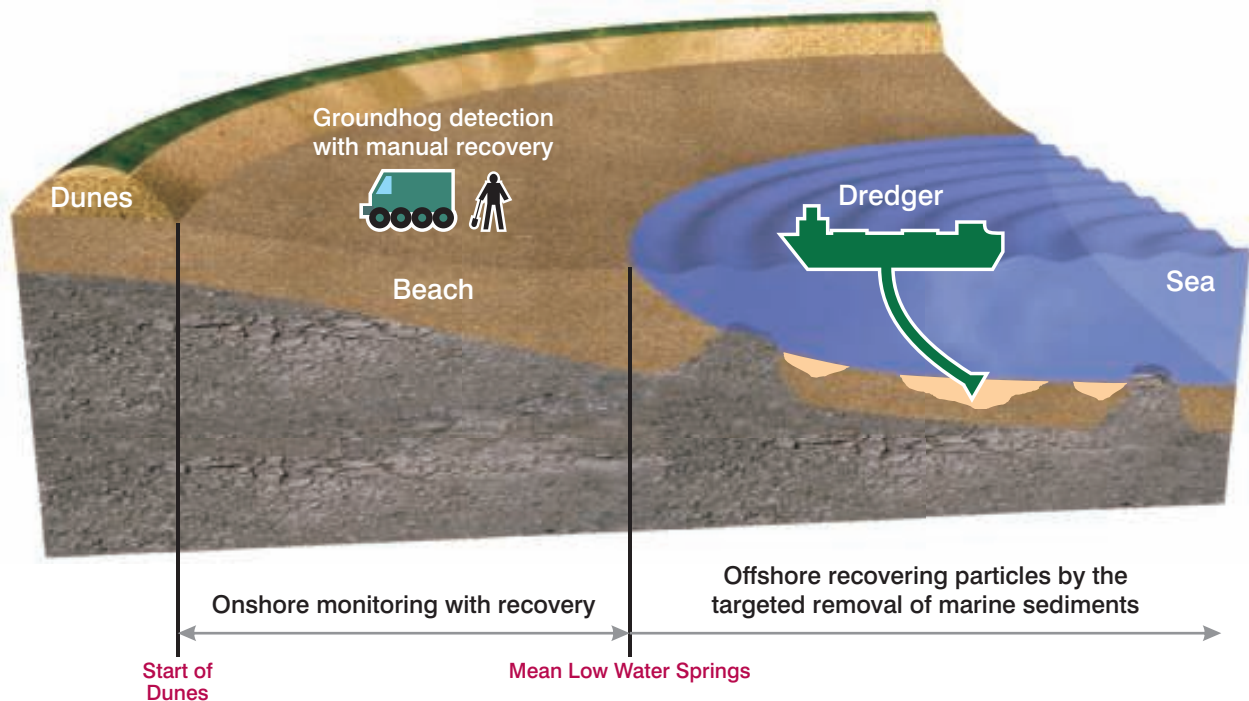
£10 - 100 million.
Onshore: local beaches – Melvich, Sandside, Crosskirk, Brims Ness, Scrabster, Thurso and Dounreay
Foreshore.
Offshore: the main offshore 'Plume' and offshore areas of high particle concentration close to shore depending upon the option chosen.

Geographical Area



Onshore monitoring with recovery plus recovering offshore particles by the targeted bulk removal or marine sediments

OPTION: 2 + 15



Option 2 - Onshore Monitoring with Recovery

This option involves the periodic surveying of beaches and foreshore areas. Particles would be manually removed from the environment when detected and returned to Dounrey for disposal.

Option 15 - Recovering Offshore Particles by the Targeted Bulk Removal of Marine Sediments

Involves dredging the seabed, to recover and monitor sediments from targeted areas. The objective is to remove large numbers of the particles detected in the sediment onboard the dredger.

Effort would be concentrated in areas of:

1. High activity particles and
2. High concentrations of particles.

Indicative characteristics

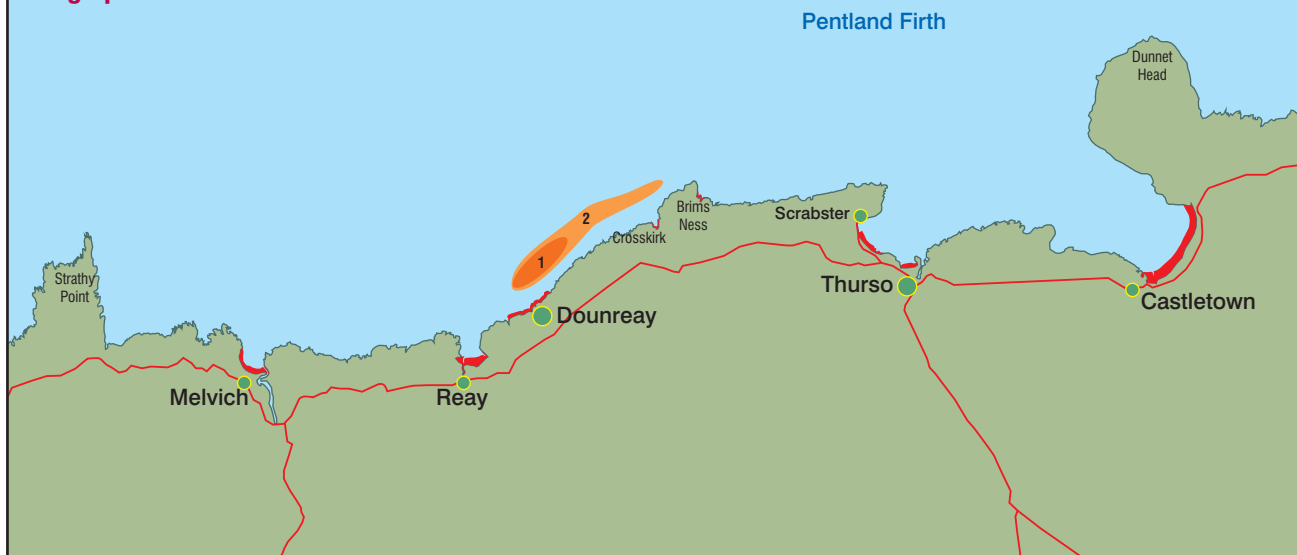
Environmental Impact: **HIGH** (due to the resulting damage to the seabed in the dredge area and as a result of returning the sand).

Time to Complete Task: Onshore: 20 years (A reduction in the number of beach 'finds' may permit a decrease in beach monitoring).

Option Lifetime Cost: Offshore: 3 seasons to dredge the seabed
£10 - 100 million.

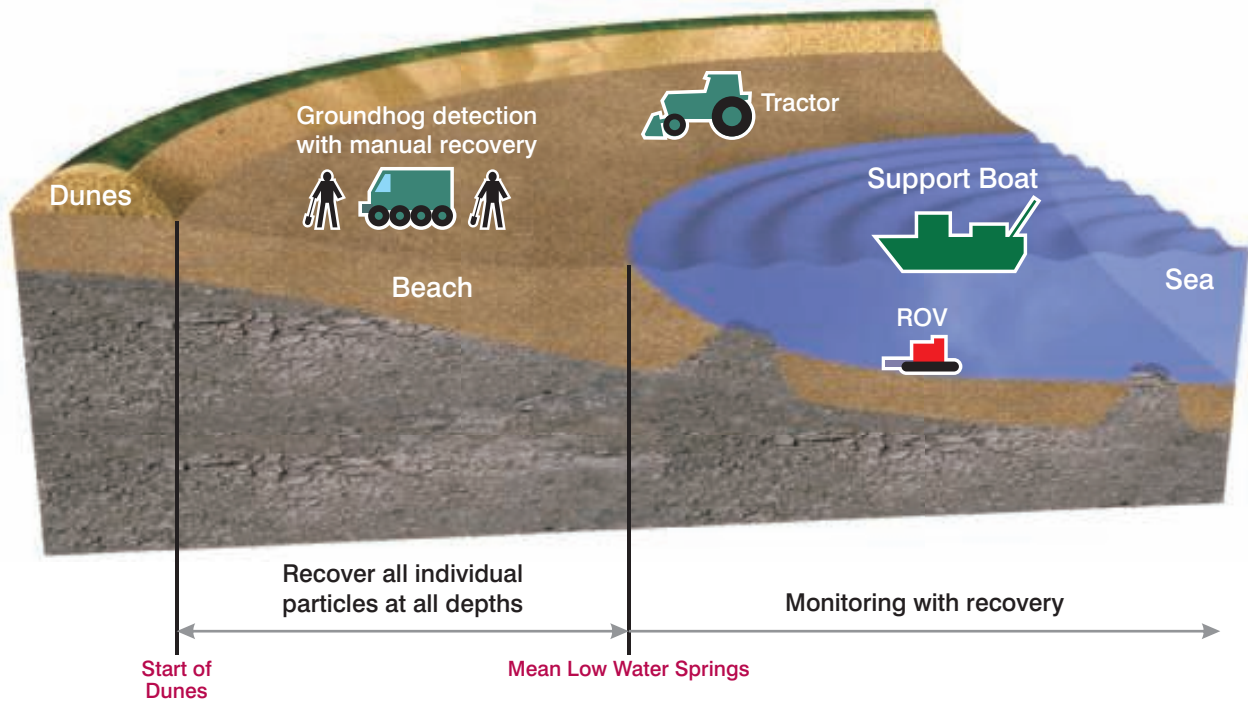
Geographical Area: Onshore: local beaches –Melvich, Sandside, Crosskirk, Brims Ness, Scrabster, Thurso and Dounrey Foreshore.
Offshore: the main offshore 'Plume'.

Geographical Area



Recover all individual particles at all depths onshore plus offshore monitoring with recovery

OPTION: 3 + 11



Option 3 - Recover all Individual Particles at all Depths Onshore

This option could involve actively over-turning the beach sediment to ensure that all particles could be detected and subsequently recovered.

The option could be implemented as a one-off project but does not necessarily reduce the need for routine beach monitoring due to the potential for recontamination.

Option 11 - Offshore Monitoring with Recovery

This option involves the periodic surveying of areas of seabed using an ROV. The current ROV has the capability to detect and map radiation but not particle recovery. As part of on-going research and development, work is underway to enable remote particle recovery by the ROV from offshore sediments.

Indicative characteristics

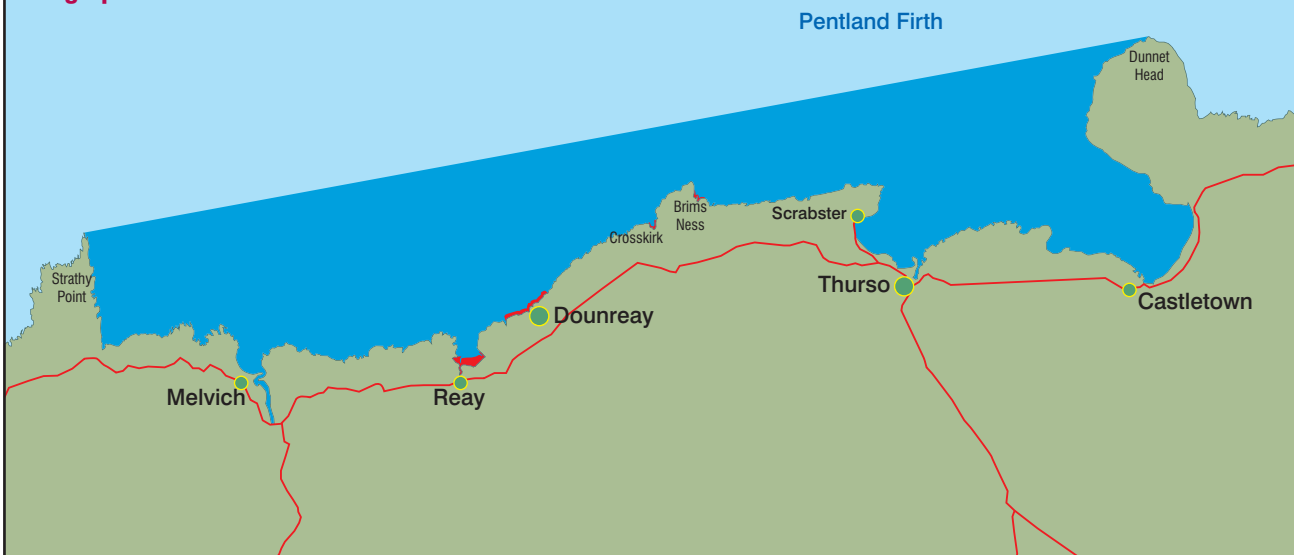
Environmental Impact: MEDIUM (turning over the beaches would only be slightly environmentally damaging).

Time to Complete Task: Onshore: 1 season (with follow-up monitoring of the beaches for 5 years)
Offshore: 20 years with regular review of seabed monitoring locations and frequencies depending upon the extent of particle finds.

Option Lifetime Cost: £100 - 1000 million.

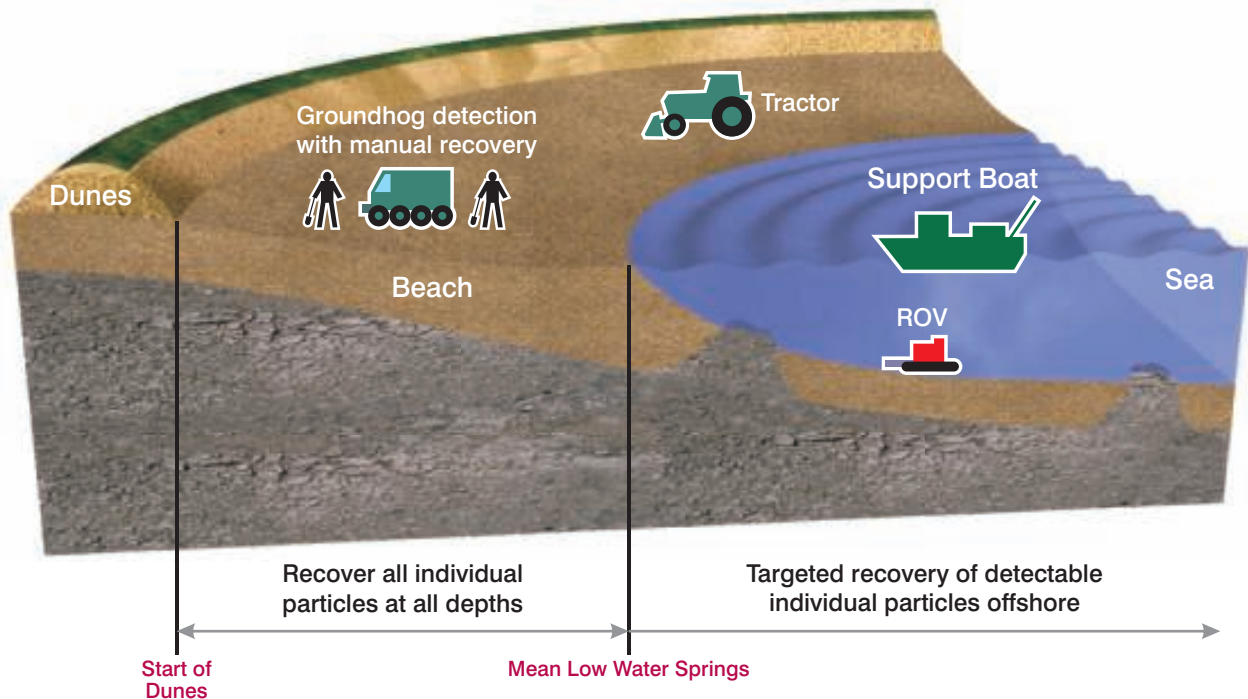
Geographical Area: Onshore: local beaches – Sandside, Crosskirk, Brims Ness and Dounreay Foreshore.
Offshore: between Strathy Point and Dunnet Head to inshore.

Geographical Area



Recover all individual particles at all depths onshore plus targeted recovery of detectable individual particles offshore

OPTION: 3 + 13



Option 3 - Recover all Individual Particles at all Depths Onshore

This option could involve actively over-turning the beach sediment to ensure that all particles could be detected and subsequently recovered.

The option could be implemented as a one-off project but does not necessarily reduce the need for routine beach monitoring due to the potential for recontamination.

Option 13 - Targeted Recovery of Detectable Individual Particles Offshore

There are three possible variations on this option. One or more of the following approaches may be used:

1. Recover only significant particles in a more localised area close to the diffuser. [Within the 'plume'].
2. Recovery of significant and relevant particles from areas of high particle population density. ['Plume' outer area].
3. Recovery of all particles from offshore areas close to land. This would mitigate the migration of particles onshore. [Shoreline].

Indicative characteristics

Environmental Impact: MEDIUM

Time to Complete Task: Onshore: Same as 'Offshore' option, plus 5 years follow-up monitoring
Offshore:

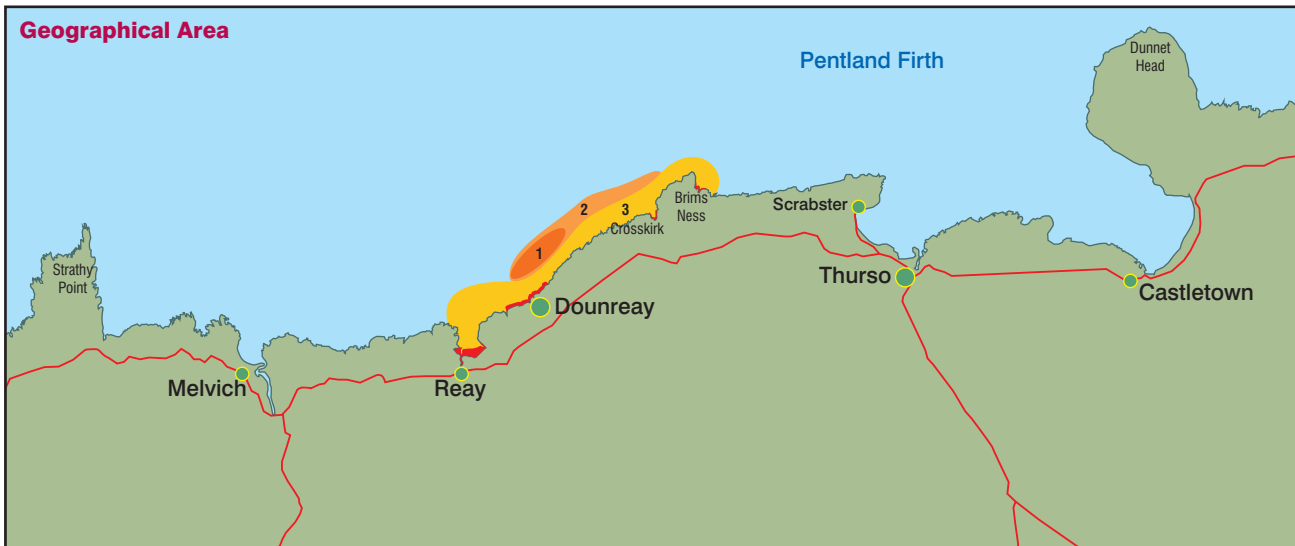
1. 6 years offshore work within 'plume'
2. Additional 10 years for 'plume' outer area
3. Additional 10 years for shoreline area

The method chosen would involve regular review of beach monitoring locations and frequencies depending upon the extent of particle finds. A reduction in the number of beach 'finds' may warrant a decrease in beach monitoring.

Option Lifetime Cost: £100 - 1000 million.

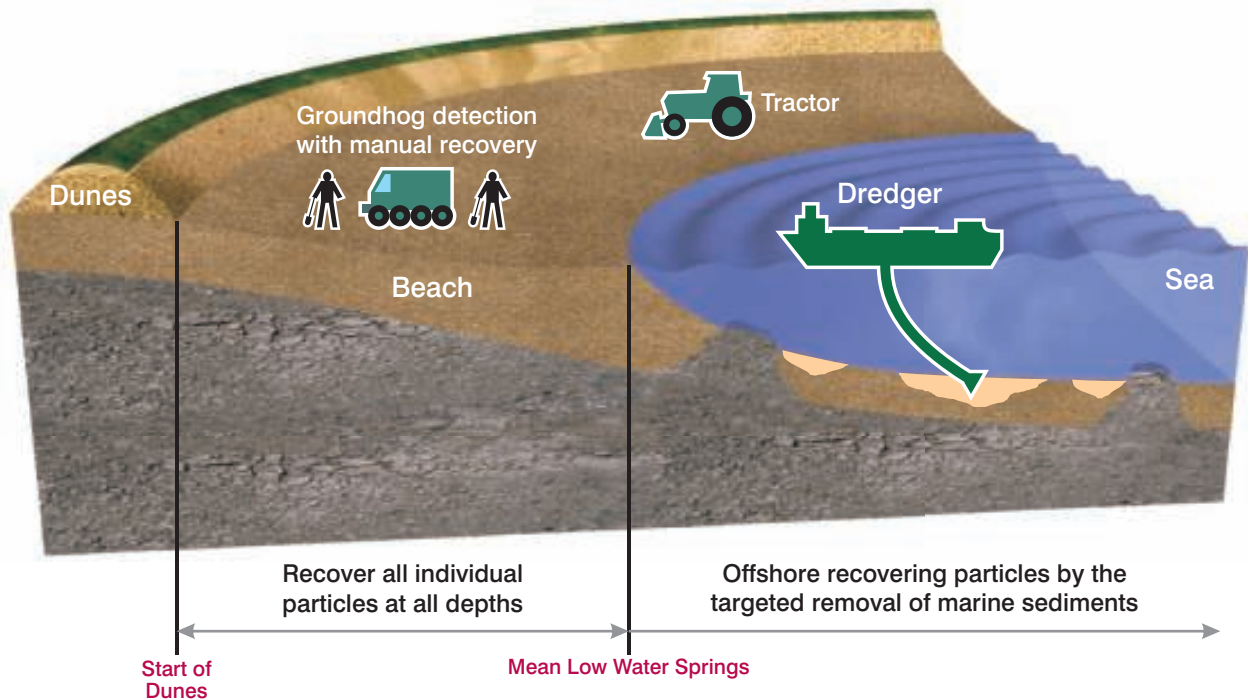
Geographical Area: Onshore: local beaches – Sandside, Crosskirk, Brims Ness and Dounreay Foreshore.
Offshore: the main offshore 'Plume' and offshore areas of high particle concentration close to shore depending upon the option chosen.

Geographical Area



Recover all individual particles at all depths onshore plus recovering offshore particles by the targeted bulk removal of marine sediment

OPTION: 3 + 15



Option 3 - Recover all Individual Particles at all Depths Onshore

This option could involve actively over-turning the beach sediment to ensure that all particles could be detected and subsequently recovered.

The option could be implemented as a one-off project but does not necessarily reduce the need for routine beach monitoring due to the potential for recontamination.

Option 15 - Recovering Offshore Particles by the Targeted Bulk Removal of Marine Sediments

Involves dredging the seabed, to recover and monitor sediments from targeted areas. The objective is to remove large numbers of the particles detected in the sediment onboard the dredger.

Effort would be concentrated in areas of:

1. High activity particles and
2. High concentrations of particles.

Indicative characteristics

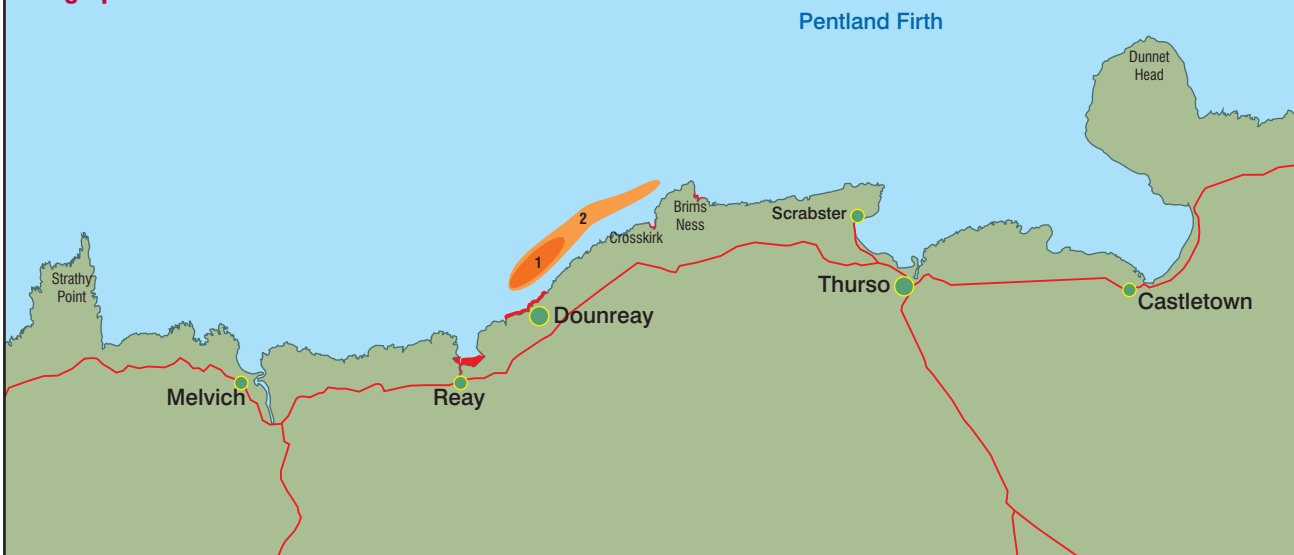
Environmental Impact: **HIGH** (High impact due to dredging the seabed and turning over the beach).

Time to Complete Task: Onshore: 20 years. (A reduction in the number of beach 'finds' may permit a decrease in beach monitoring).
Offshore: 3 seasons to dredge the seabed.

Option Lifetime Cost: £100 - 1000 million.

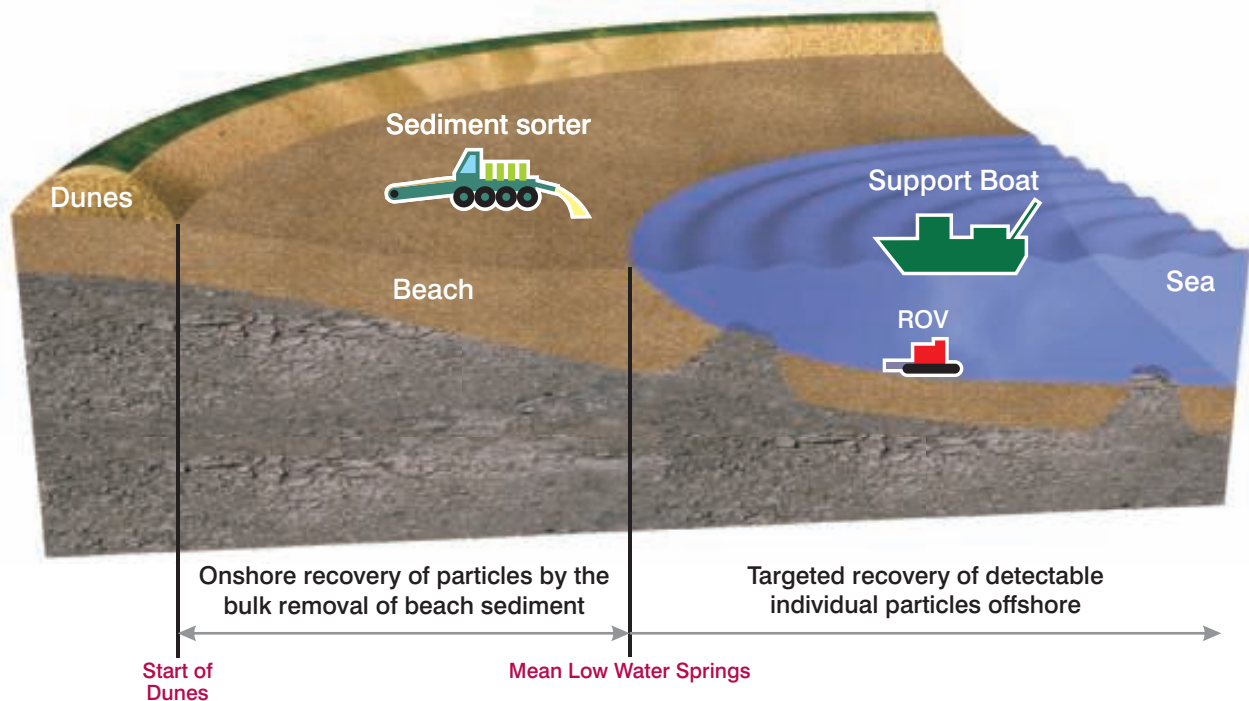
Geographical Area: Onshore: local beaches – Sandside, Crosskirk, Brims Ness and Dounreay Foreshore.
Offshore: the main offshore 'Plume'.

Geographical Area



Onshore monitoring with recovery plus recovering offshore particles by the targeted bulk removal or marine sediments

OPTION: 4 + 13



Option 4 - Bulk Removal of Beach Sediments

- This option involves excavating and removing all sediment from the beaches and shorelines contaminated by particles. De-watering, or isolation of sub-tidal areas, may be required to facilitate shoreline excavation.
- It is assumed that particles recovered from the excavated sediment would be disposed of as intermediate-level waste on the Dounreay site. The "clean" sediment could then be returned to the excavation.
- Owing to scale of engineering work involved in this strategy, it is assumed that it would be implemented as a one-off project. The option does not necessarily reduce the need for routine beach monitoring due to the potential for recontamination.

Option 13 - Targeted Recovery of Detectable Individual Particles Offshore

There are three possible variations on this option. One or more of the following approaches may be used:

- Recover only significant particles in a more localised area close to the diffuser. [Within the 'plume'].
- Recovery of significant and relevant particles from areas of high particle population density. ['Plume' outer area].
- Recovery of all particles from offshore areas close to land. This would mitigate the migration of particles onshore. [Shoreline].

Indicative characteristics

Environmental Impact:

MEDIUM (sorting through the sand on the beach will disturb the ecology of the area).

Time to Complete Task:

Onshore: one season, plus 5 years follow-up monitoring

Offshore:

- 6 years offshore work within 'plume'
- Additional 10 years for 'plume' outer area
- Additional 10 years for shoreline area

The method chosen would involve regular review of beach monitoring locations and frequencies depending upon the extent of particle finds. A reduction in the number of beach 'finds' may warrant a decrease in beach monitoring.

Option Lifetime Cost:

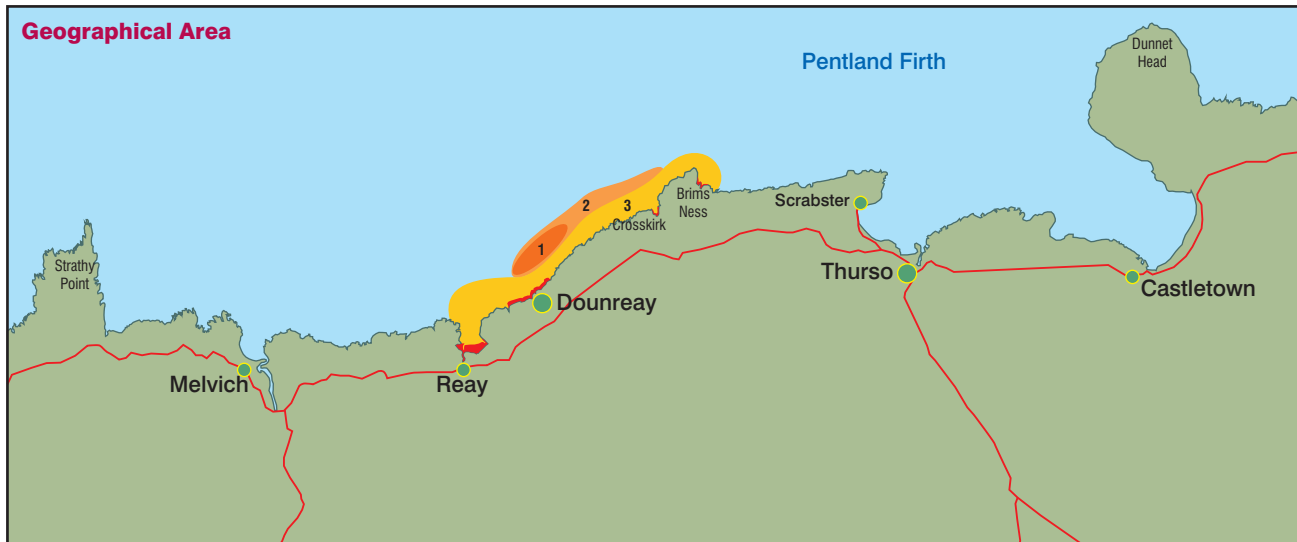
£100 - 1000 million.

Geographical Area:

Onshore: local beaches – Sandside and Dounreay Foreshore, but including Crosskirk and Brims Ness depending upon the option chosen.

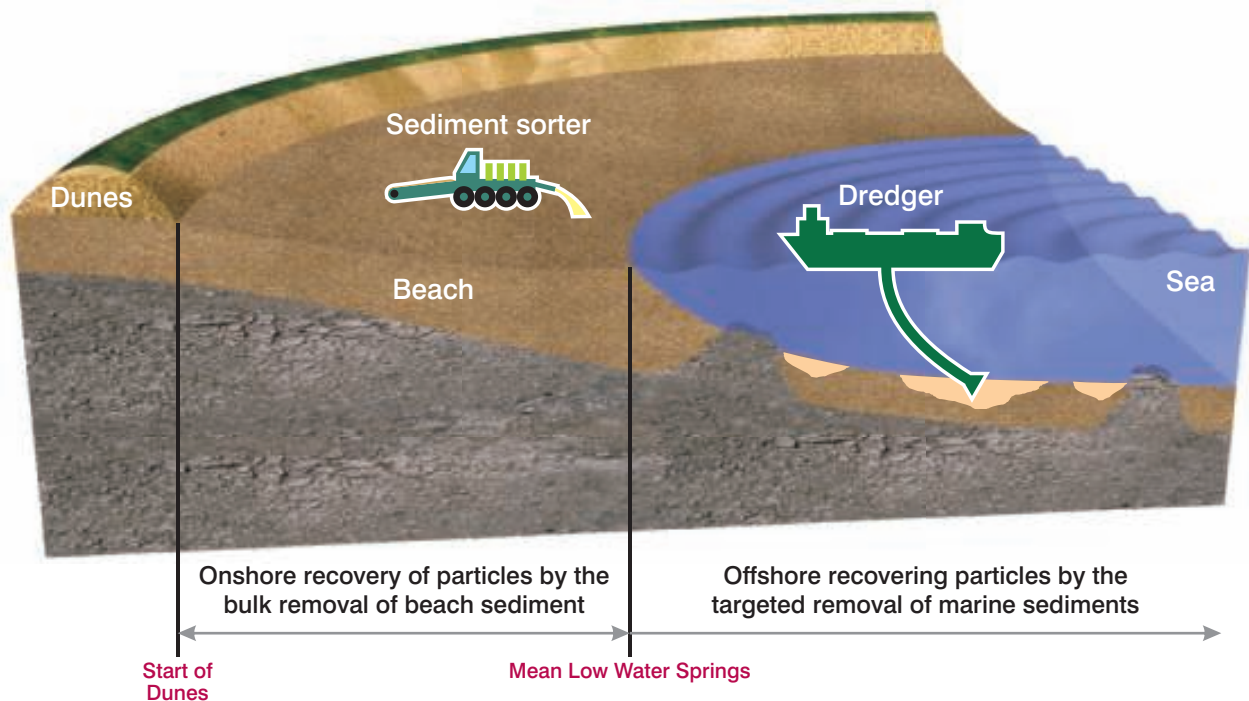
Offshore: the main offshore 'Plume' and offshore areas of high particle concentration close to shore depending upon the option chosen.

Geographical Area



Bulk removal of beach sediments plus recovering offshore particles by the targeted bulk removal of marine sediments

OPTION: 4 + 15



Option 4 - Bulk Removal of Beach Sediments

- This option involves excavating and removing all sediment from the beaches and shorelines contaminated by particles. De-watering, or isolation of sub-tidal areas, may be required to facilitate shoreline excavation.
- It is assumed that particles recovered from the excavated sediment would be disposed of as intermediate-level waste on the Dounreay site. The "clean" sediment could then be returned to the excavation.
- Owing to scale of engineering work involved in this strategy, it is assumed that it would be implemented as a one-off project. The option does not necessarily reduce the need for routine beach monitoring due to the potential for recontamination.

Option 15 - Recovering Offshore Particles by the Targeted Bulk Removal of Marine Sediments

Involves dredging the seabed, to recover and monitor sediments from targeted areas. The objective is to remove large numbers of the particles detected in the sediment onboard the dredger.

Effort would be concentrated in areas of:

1. High activity particles and
2. High concentrations of particles.

Indicative characteristics

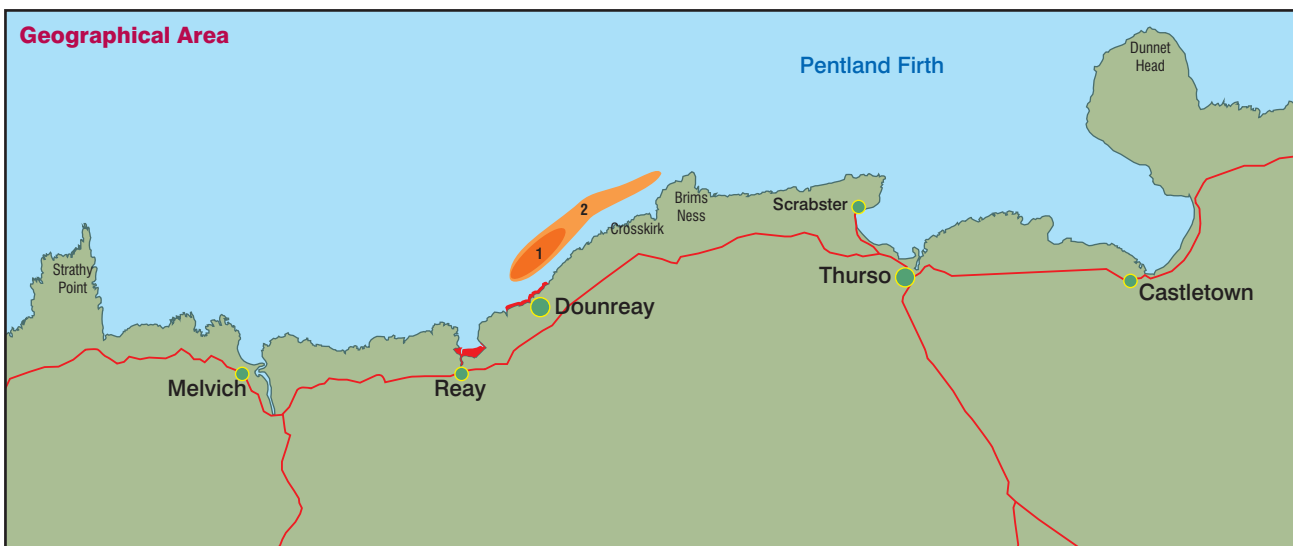
Environmental Impact: HIGH (seabed and beach ecology severely disrupted by dredging and overturning).

Time to Complete Task: Onshore: 1 year, bulk beach sediment removal [plus routine beach monitoring for 15 years with review to reduce the level of beach monitoring with reduction of offshore particle numbers].
Offshore: 3 seasons to dredge the seabed.

Option Lifetime Cost: £100 - 1000 million.

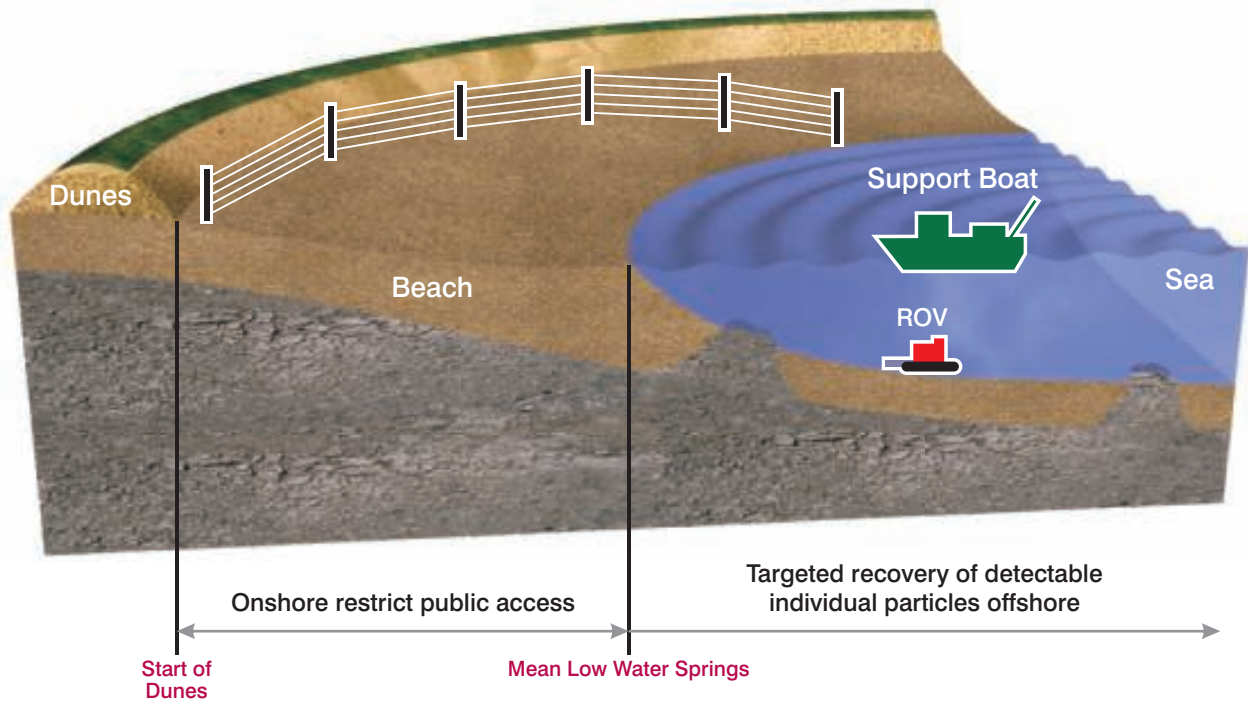
Geographical Area: Onshore: local beaches – Sandside and Dounreay Foreshore
Offshore: the main offshore 'Plume'.

Geographical Area



Restricted public access plus targeted recovery of detectable individual particles offshore

OPTION: 7 + 13



Option 7 - Restrict Public Access

This option restricts public access to beaches or foreshore areas contaminated by particles by the use of barriers and other security measures.

Option 13 - Targeted Recovery of Detectable Individual Particles Offshore

There are three possible variations on this option. One or more of the following approaches may be used:

1. Recover only significant particles in a more localised area close to the diffuser. [Within the 'plume'].
2. Recovery of significant and relevant particles from areas of high particle population density. ['Plume' outer area].
3. Recovery of all particles from offshore areas close to land. This would mitigate the migration of particles onshore. [Shoreline].

Indicative characteristics

Environmental Impact:

MEDIUM (due to the length of time required to maintain the beach fence).

Time to Complete Task:

Onshore: 100 years (removing all detectable significant particles from the seabed will still potentially allow relevant particles to come ashore into the fenced area for up to 100 years).

Offshore:

1. 6 years offshore work within 'plume'
2. Additional 10 years for 'plume' outer area
3. Additional 10 years for shoreline area

The method chosen would involve regular review of beach monitoring locations and frequencies depending upon the extent of particle finds. A reduction in the number of beach 'finds' may warrant a decrease in beach monitoring.

Option Lifetime Cost:

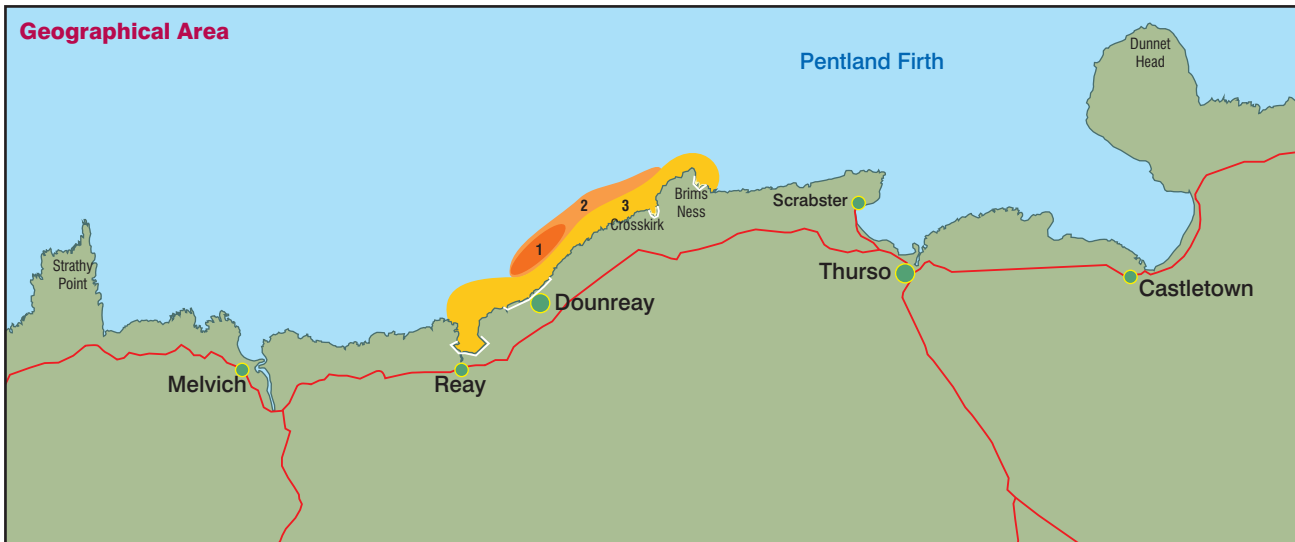
£10 - 100 million.

Geographical Area:

Onshore: local beaches – Sandside and Dounreay Foreshore, but including Crosskirk and Brims Ness depending upon the option chosen.

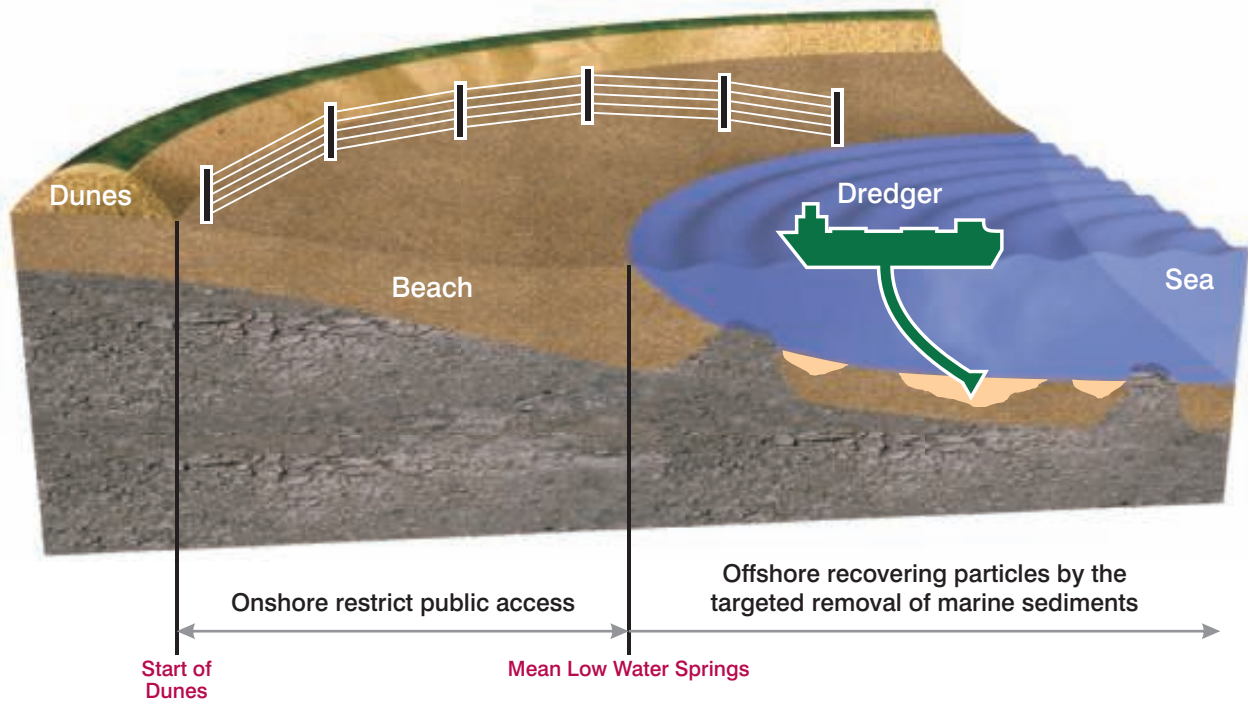
Offshore: the main offshore 'Plume' and offshore areas of high particle concentration close to shore depending upon the option chosen.

Geographical Area



Restrict public access plus recovering offshore particles by the targeted bulk removal of marine sediments

OPTION: 7 + 15



Option 7 - Restrict Public Access

This option restricts public access to beaches or foreshore areas contaminated by particles by the use of barriers and other security measures.

Option 15 - Recovering Offshore Particles by the Targeted Bulk Removal of Marine Sediments

Involves dredging the seabed, to recover and monitor sediments from targeted areas. The objective is to remove large numbers of the particles detected in the sediment onboard the dredger.

- Effort would be concentrated in areas of:
1. High activity particles and
 2. High concentrations of particles.

Indicative characteristics

Environmental Impact: MEDIUM (due to the length of time required to maintain the beach fence).

Time to Complete Task: 100 years (removing all detectable significant particles from the seabed will still potentially allow relevant particles to come ashore into the fenced area for up to 100 years).

Option Lifetime Cost: £10 - 100 million.

Geographical Area: Onshore: local beaches – Sandside, Crosskirk, Brims Ness, Thurso and Dounreay Foreshore. Offshore: the main offshore 'Plume'.

Geographical Area

