



# Zone 4 Options Study

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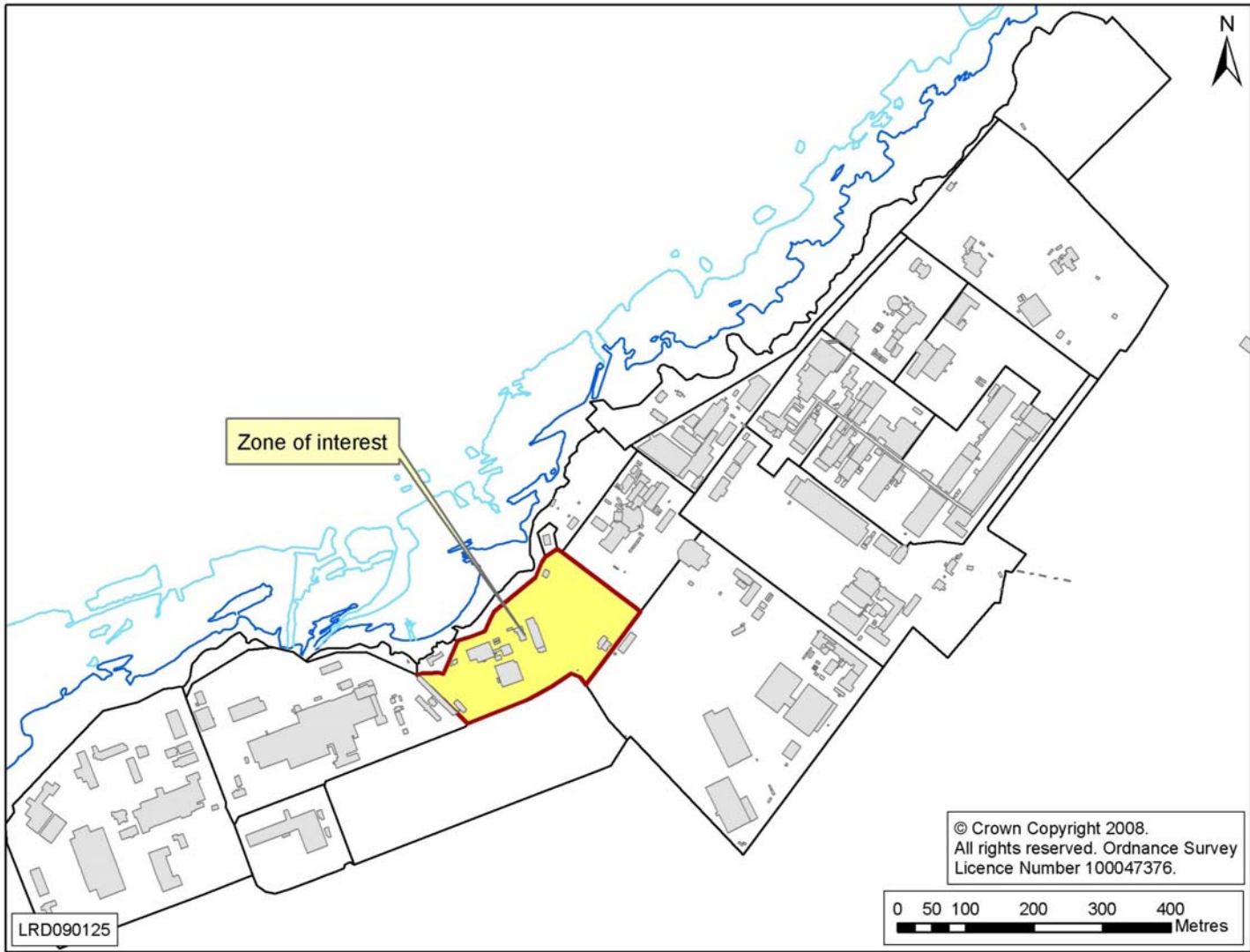
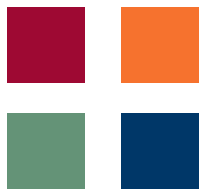
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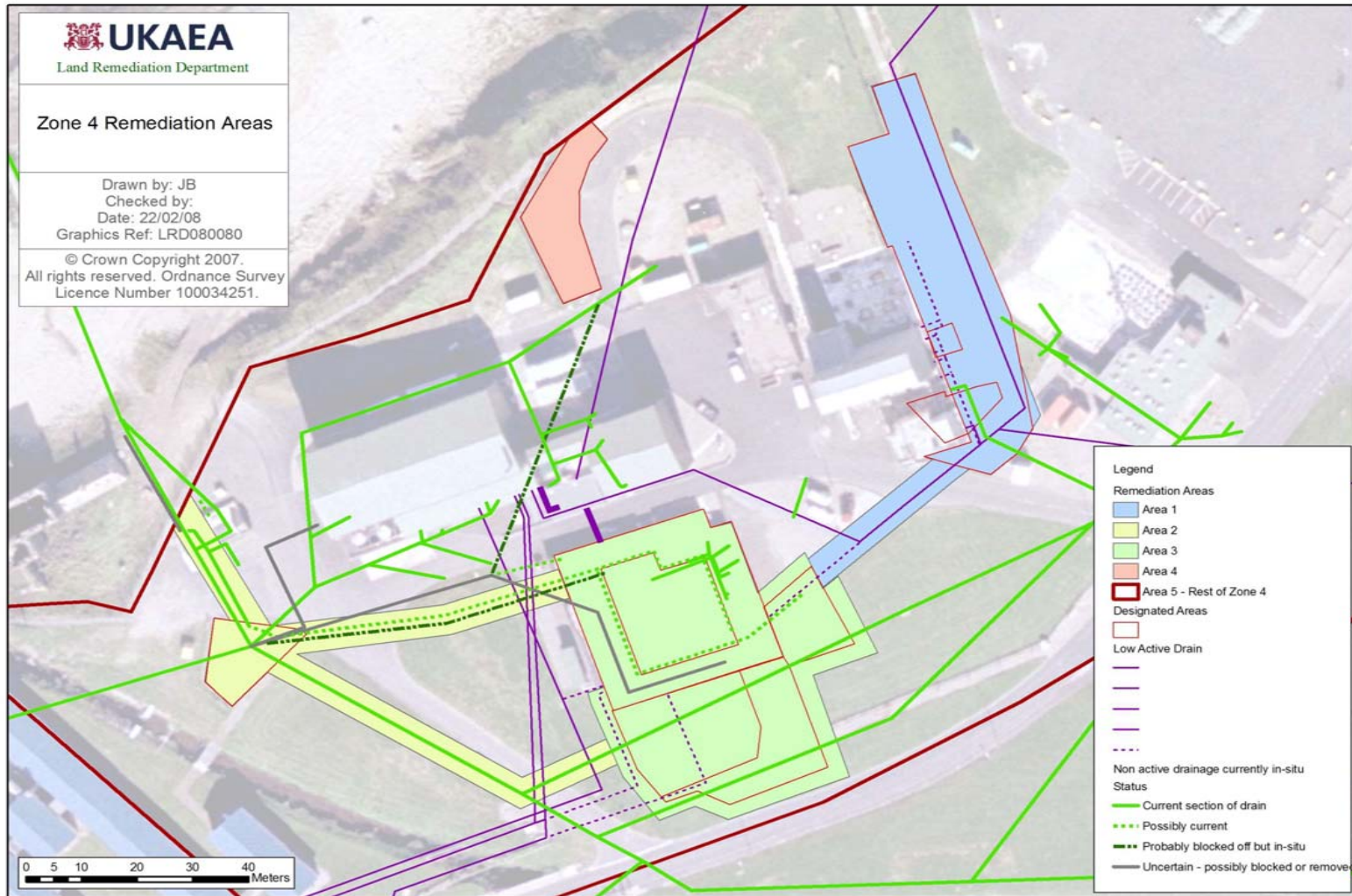
## Outline of the Problem:

- Zone 4 has multiple areas of contamination.
- There are two points at which radioactive groundwater would discharge to the environment without authorisation were this water not captured and pumped for authorised discharge. Continually pumping water is not consistent with the description of the Site Interim End Point (IEP).
- A number of areas of contaminated land in Zone 4 are managed as Controlled Areas under the Ionising Radiations Regulations (“Barriered Areas”).





# Areas of Contamination in Zone 4





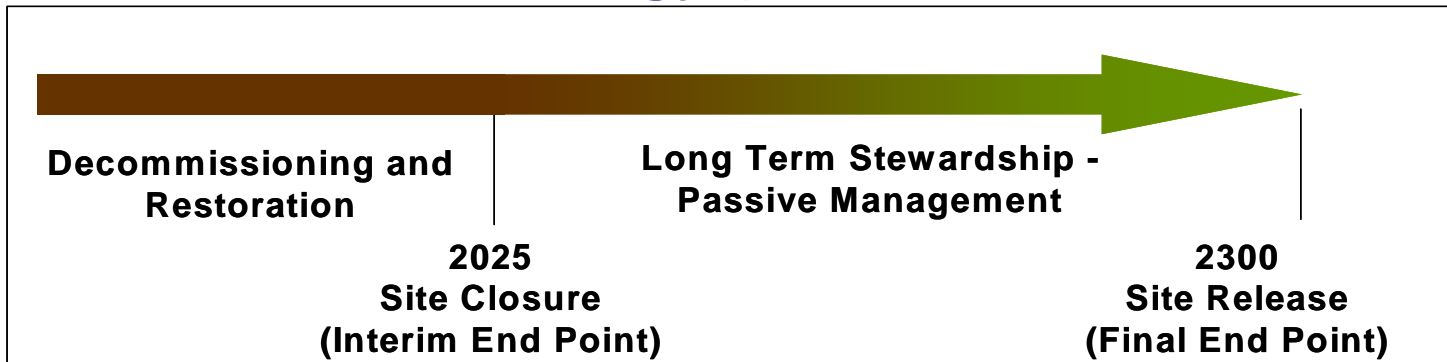
# Optioneering Study:

Assess contaminated land management solutions which will be consistent with:

- current regulatory requirements,
  - the decommissioning strategy for the site, and
  - the Interim End Point clean-up target.
- **Wide stakeholder consultation had previously been carried out on the end state for the site.**



# Restoration Strategy (End State Consultation)



## By Interim End Point

- Site cleaned-up to a state where in general passive measures, such as land use control with monitoring, are sufficient to achieve the required standard of safety.
- Residual hazards will remain in the ground (thus the condition at this point does not enable these areas to be delicensed under the criteria required by HSE NII).

## Interim End Point – Final End Point

- The control regime will remain in place for up to 300 years by which time radioactive decay and chemical degradation should ensure that the site has reached a state at which it can be released for unrestricted use with no controls – the Final End Point (FEP)





# High Level Remediation Goals for Zone 4

**Goal 1:** must satisfy the current regulatory requirements for the site with respect to contaminated land (notably ensuring that health, safety and environmental impacts comply with the UK nuclear site licence conditions and discharge authorisations);

**Goal 2:** must consider the goals of the Dounreay Contaminated Land Strategy to achieve by 2025 the interim end state condition for the site agreed by public consultation;

**Goal 3:** must ensure that post-2025, any land contamination left in the ground can be managed passively during a period of institutional control or long term stewardship;

**Goal 4:** must marry with other activities identified by the Dounreay Life Time Plan as part of the site decommissioning schedule.

**Goal 5:** must ensure radioactive wastes are kept to a minimum in the short term until on-site waste disposal facilities become available. In the medium to long term, must ensure wastes are minimised to avoid excessive cost and exceeding the capacity of the waste disposal facility.



# Approach

Review conceptual site model

Sub-divide the zone into contam source areas (5)

Identify decommissioning and restoration constraints in each area

List assumptions which impact on potential remediation solutions

Identify generic remedial solutions for each area – taking into account the **timeframe** for application

Screen out options which are not applicable or conflict with constraints and assumptions

Hold options appraisal workshop with site stakeholders and use MADA to score potential solutions:

Criteria • technology • health and safety • environmental • financial  
• socio-economic

Decide weights – based on relative significance and importance

Discuss the outcome with stakeholders







# Timeframes for Implementation of Remedial Solution

<b>Short Term</b> (Pre-decom)	<b>Now to 2011</b>	Before the on-set of major decommissioning or infrastructure enabling works (e.g. Waste Treatment Plant). A waste disposal route is <u>not</u> available however limited waste storage is a possibility.
<b>Med Term</b> (During decom)	<b>2012 to 2020</b>	Concurrent with major works in Zone 4, e.g. decommissioning of D1211, and major enabling groundworks for the construction of D3200 (which will also involve the removal of most of the LAD east of the Silo).
<b>Long Term</b> (Post-decom)	<b>2020 to 2025</b> (IEP)	Final decommissioning and site restoration in preparation for IEP, e.g. decommissioning of D3200.



# Types of Options

## **Provisional measures:**

Options which have a limited period of effectiveness - but which could be applied say in the short or medium term as holding measures until more permanent solutions can be implemented;

## **Durable solutions:**

Options will enable the remediated ground to meet the Interim End State criteria and are sustainable with respect to the long term stewardship of the site (ie options which when implemented require only passive management of the remediated ground).

## **Overall Remedial Solution**

The remedial solution for Zone 4 might be a sequence of solutions involving a combination of provisional and durable solutions.



# Provisional and Durable Solutions

**Now**

**IEP**

**Pre-  
Decommissioning  
Period**

**Decommissioning  
Period**

**Post Decom –  
Pre IEP Period**

Short Term Options

Medium Term Options

Long Term Options

Implemented in the short term, to be effective until post IEP

Implemented in the short term, to be effective until long term

Implemented in the long term, to be effective until post-IEP

Implemented in the short term, to be effective until medium term

Implemented in the medium term, to be effective until post-IEP

Implemented in the short term, to be effective until medium term

Implemented in the medium term, to be effective until long term

Implemented in the long term, to be effective until post-IEP

“Provisional” Options

“Durable” Options





# Options Considered

**Illegal !!**

**Do Nothing (at all)**

**Durable**

**Excavate All**

(radioactively and chemically contaminated soil with waste sentencing/minimisation, eg soil washing, detector based segregation)

**Excavate the Most Hazardous**

(radioactively and chemically contaminated soil with waste sentencing/ minimisation, eg soil washing, detector based segregation)

**In-situ Removal**

(using technologies such as electrokinetic remediation, phytoremediation and soil flushing).

**In-situ Immobilisation**

(in-ground solidification/stabilisation or vitrification)

**Provisional**

**Do Nothing (More)**

(do nothing more than current interception and discharge under Authorisation)

**Cover/cap**

Membranes, tarmac, concrete, clay, multilayer

**Hydraulic Controls – Active**

(e.g. pumping and treating, pumping and discharging via alternative discharge point)

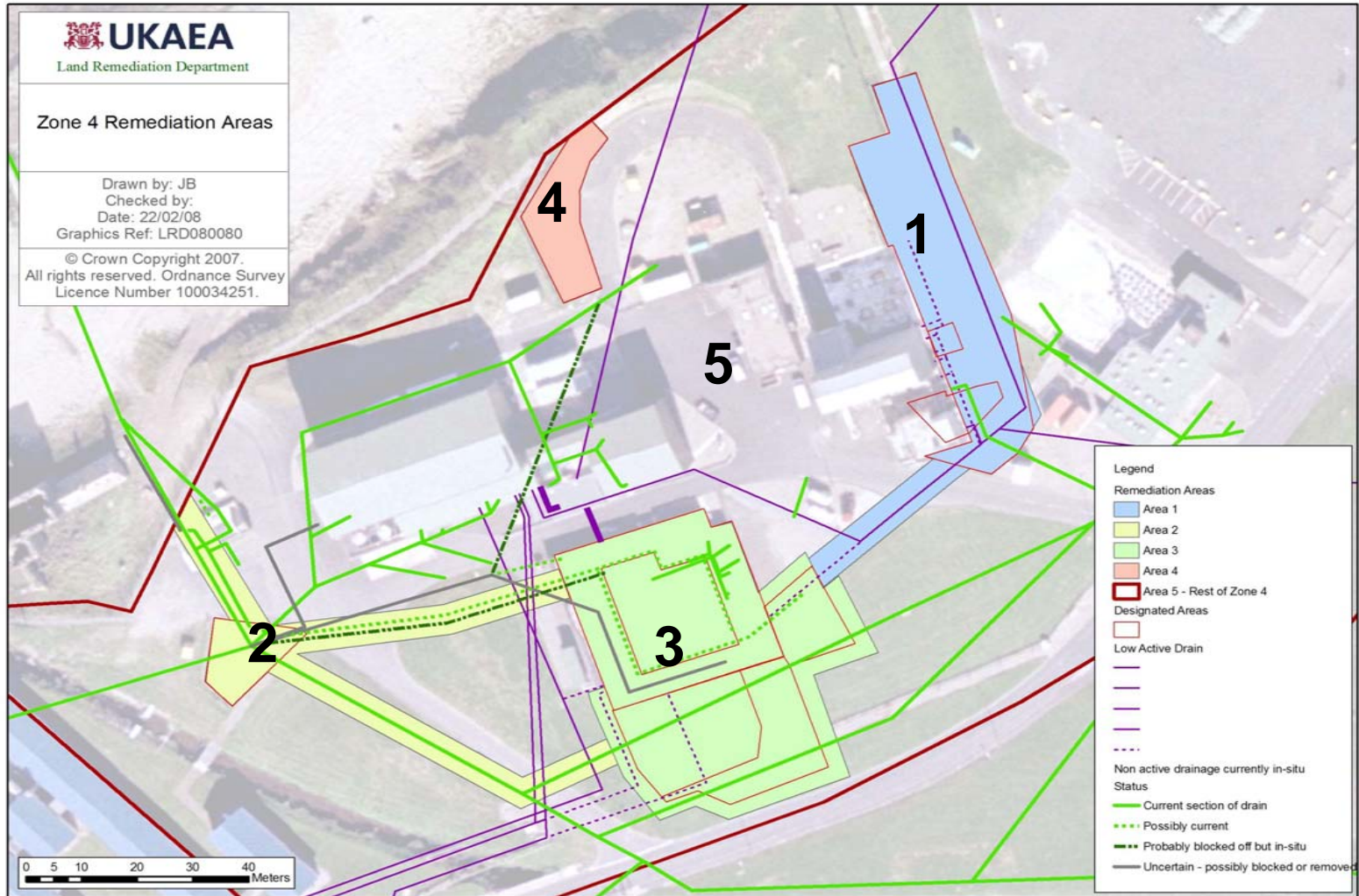
**Hydraulic Controls – Passive**

(e.g. using permeable reactive barriers)

**In-situ Isolation**

(with in-ground barriers)

# Source Areas in Zone 4



**ILLEGAL !!**

**Do Nothing (at all)** *PRE-SCREENED OUT - illegal*

**DURABLE**

**Excavate All**

(radioactively and chemically contaminated soil with waste sentencing/minimisation, eg soil washing, detector based segregation).

**Excavate the Most Hazardous**

(radioactively and chemically contaminated soil with waste sentencing/ minimisation, eg soil washing, detector based segregation).

**In-situ Removal** *PRE-SCREENED OUT – pilot scale trials shows these technologies are not feasible*

(using technologies such as electrokinetic remediation, phytoremediation and soil flushing).

**In-situ Immobilisation**

(solidification/stabilisation or vitrification). **Not practical in short and med term for Areas 1 & 5.**

**PROVISIONAL  
(not suitable  
solutions in  
the long term  
– require  
active  
management)**

**Do Nothing (More)**

(do nothing more than current interception and discharge under Authorisation)

**Cover/cap**

Membranes, tarmac, concrete, clay, multilayer **Not applicable to Area 1 in short + med term due to development work for D3200..**

**Hydraulic Controls – Active**

(e.g. pumping and treating, pumping and discharging via alternative discharge point) **Not practical at all in Area 5, dispersed contamination not readily intercepted.**

**Hydraulic Controls – Passive**

(e.g. using permeable reactive barriers). **Not practical in short, med, long terms for Areas 4 & 5**

**In-situ Isolation** *PRE-SCREENED OUT – permeable base, ineffective*

(with in-ground barriers or FIRS)



# Assessment Criteria

<b>Group</b>	<b>Attribute</b>
<b>Human health and safety</b>	Public health and safety (individuals)
	Remediation Worker health and safety (individuals)
	Site Occupant health and safety (individuals)
<b>Environmental impact</b>	Physical environment
	Flora and fauna
<b>Technical</b>	Viability
	Flexibility
	Inherent safety
<b>Socio-economic</b>	Local community
<b>Financial cost</b>	Overall cost



# Weighting Factors

Two types of factors used:

Significance” and “Importance” weighting factors.

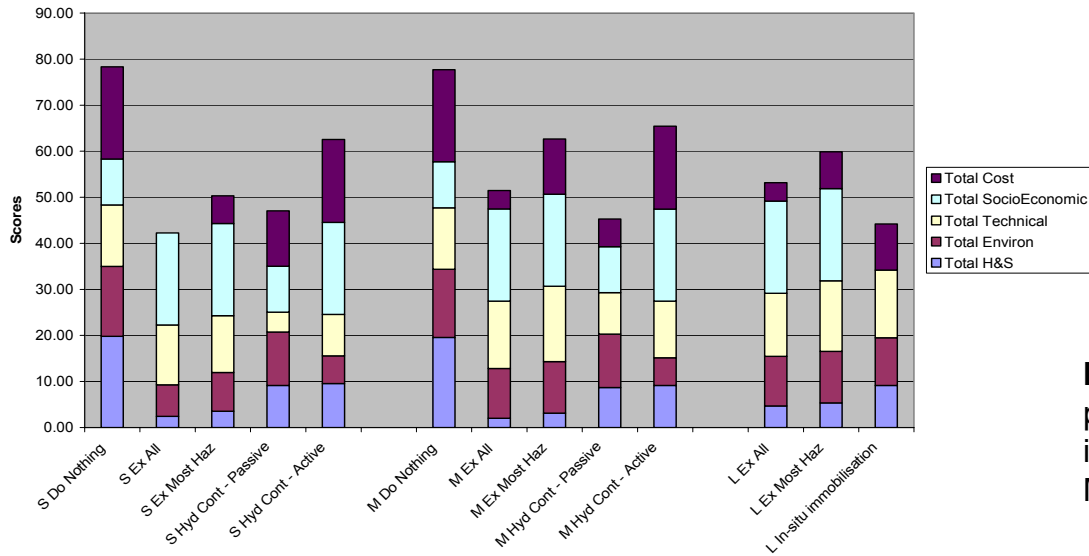
**“Significance”** is considered to be an indication of the “swing” of the relative difference between the options. For example, if the difference in dose to the public from the best to the worst option was only very small, then this would lead to a low scoring “swing weighting”, e.g. 1 (on a scale 1-10). Conversely, if the difference in cost between the best and the worst option was very large, then the “swing weighting” would also be large e.g. 10 (on a scale 1-10).

**“Importance”** is a judgemental score of how individual panel members regarded the relative importance of particular attributes (for example making the Environmental Attribute more important than the others).



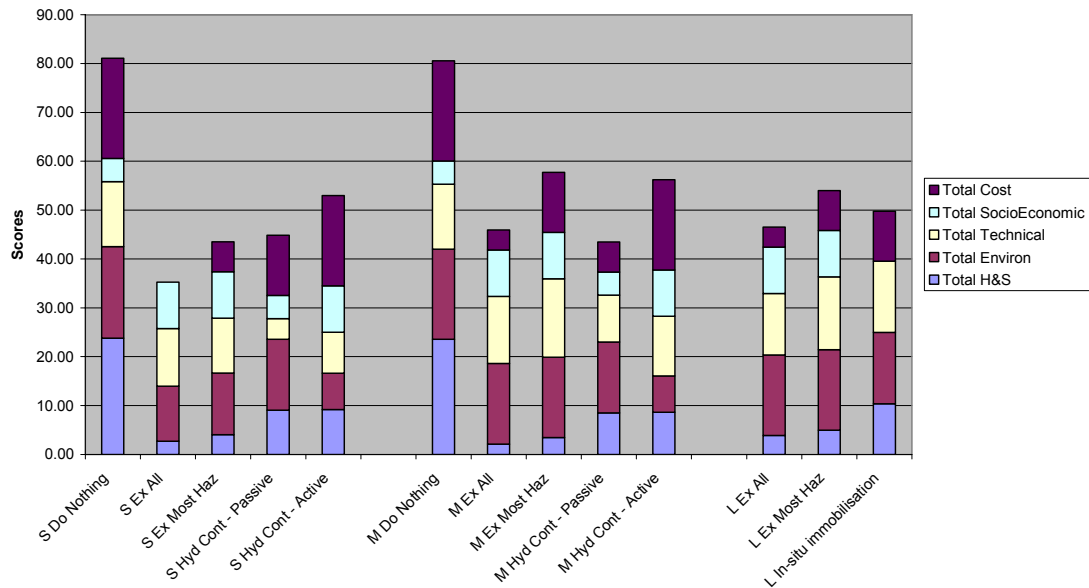
# Assessment Scores – Area 1

Area 1: Unweighted Scores



**Note:** In these plots “Do Nothing” is “Do Nothing More”

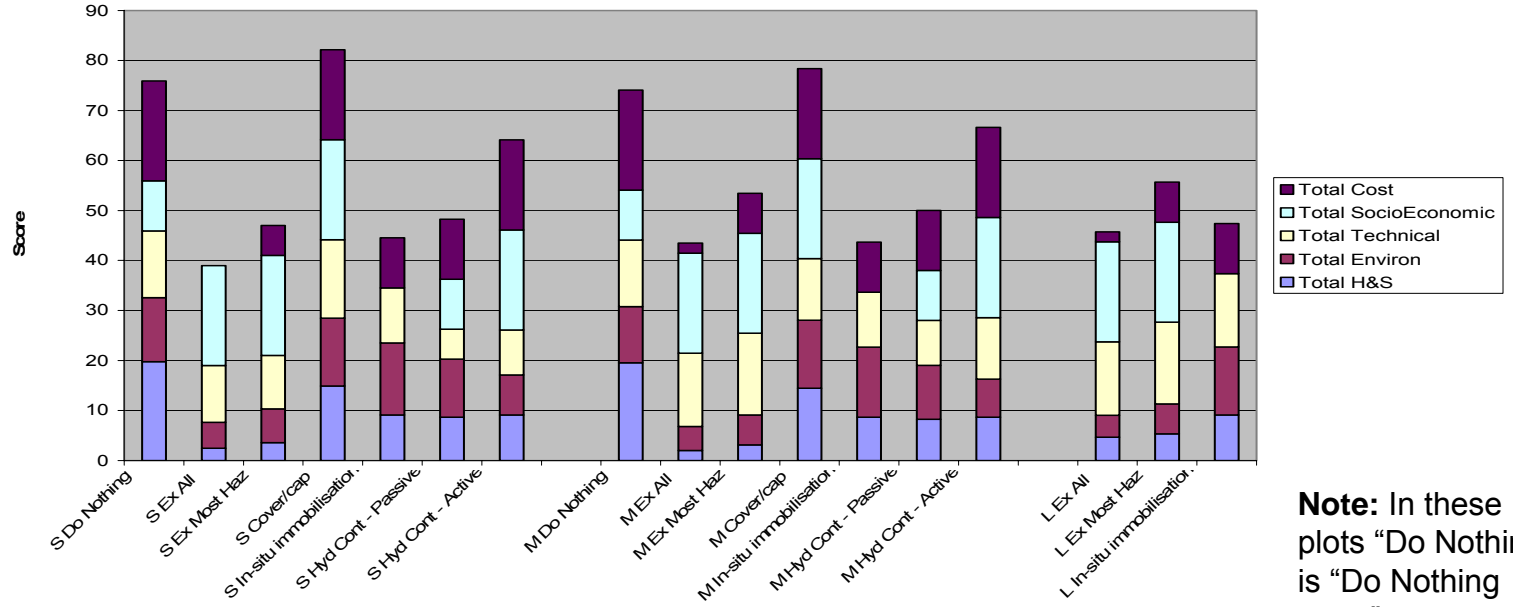
Area 1: Weighted Scores





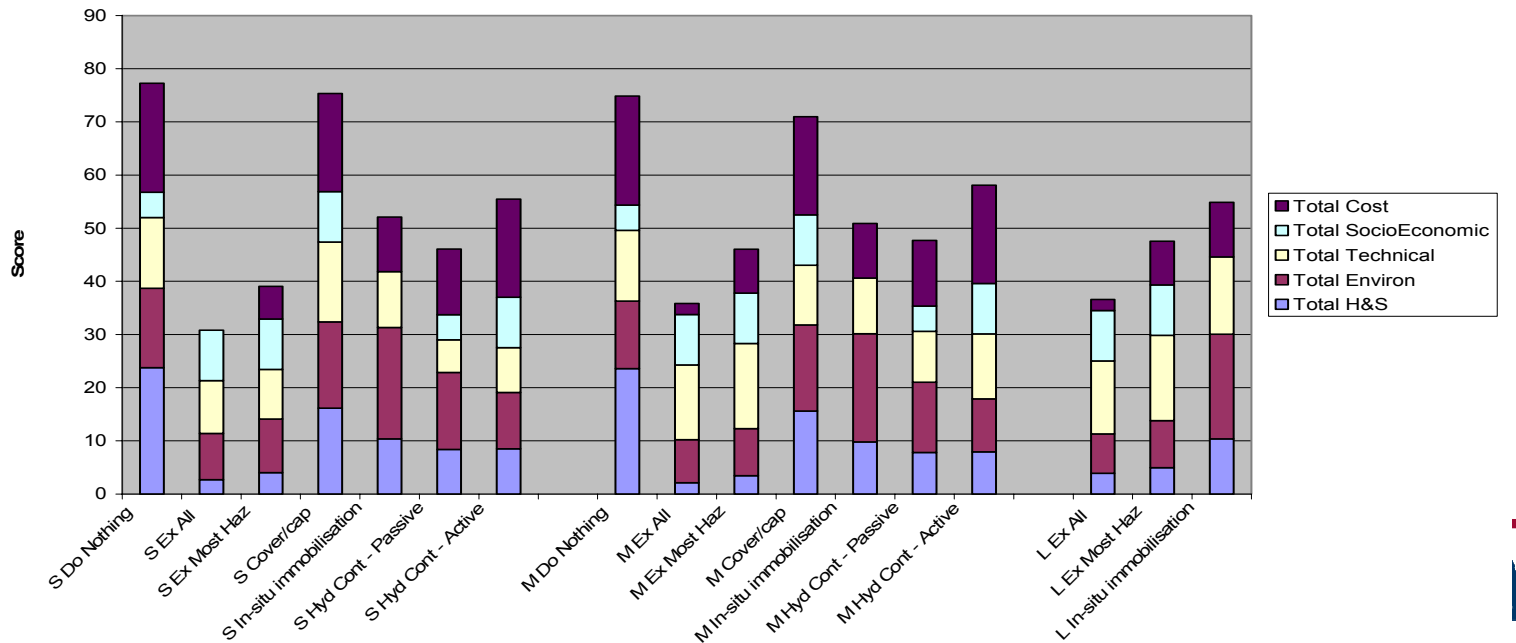
# Area 3

Area 3: Unweighted



**Note:** In these plots “Do Nothing” is “Do Nothing More”

Area 3: Weighted



# Preferred Remedial Solutions

**In General:** Provisional solutions favoured in the short term.

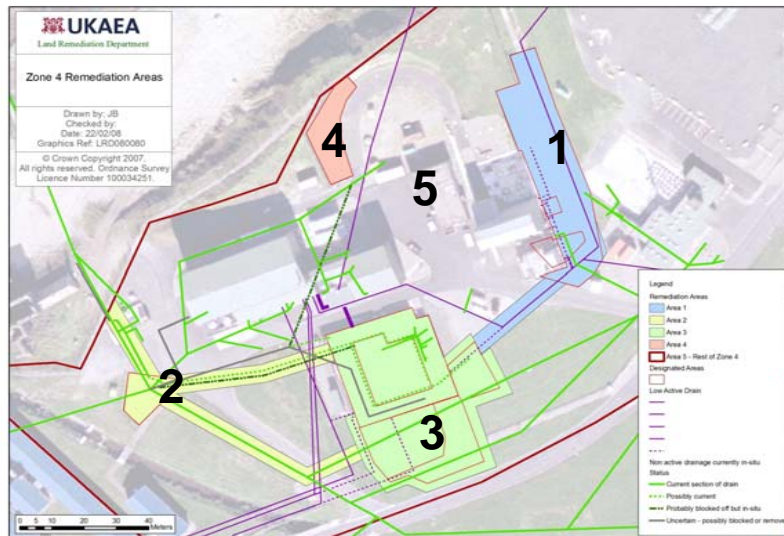
Most favoured durable solution (for implementation in medium or long term) is Excavate Most Hazardous.

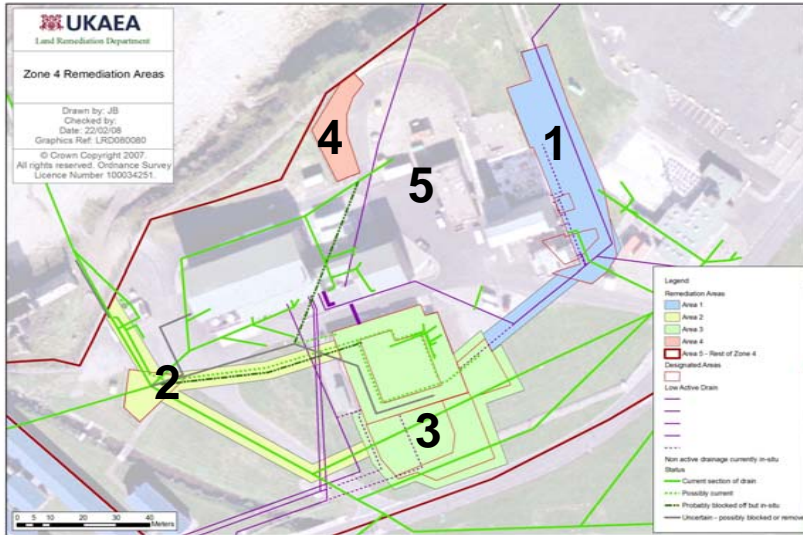
## Area 1:

Short term – Do Nothing More – as a holding measure (Provisional Option).

Medium Term – As part of planned construction, Excavate the Most Hazardous Material, a durable solution to meet the requirements of the post-IEP land condition, or excavate some of the most hazardous.

Long Term – nothing further required if all of the most hazardous contamination is removed in the medium term. However if the Silo wall integrity restricts the depth of excavations then in the long term the remaining most hazardous material should be excavated or immobilised in-situ.





## Area 2:

Short and medium term - Provisional measures with “Do Nothing (More)” being the best option and “Active Hydraulic Controls” the next best option.

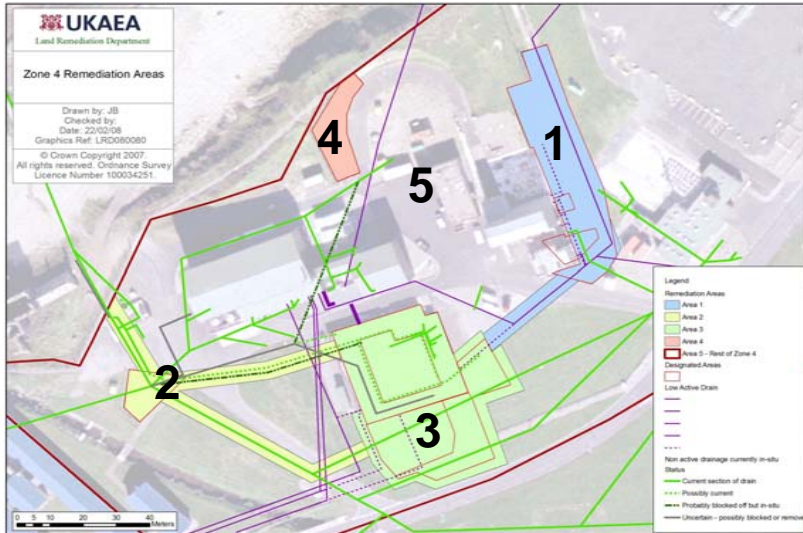
Long Term - Excavate the most hazardous.

## Area 3:

Short term – provisional solutions with “Cover/cap” and “Do Nothing More” scoring the best;

Medium term – “Do Nothing More” or “Excavate Most Hazardous”;

Long term – “Excavate Most Hazardous” if not carried out in the medium term.



## Area 4:

Short term – provisional solution - “Do Nothing More” (in this source area monitoring data shows that contamination is not migrating in groundwater);

Medium term – provisional solution – “Do Nothing More”, or durable options “Excavate All” or depending on further research, “In-situ immobilisation”;

Long term – “Excavate All” or “In-situ immobilisation” if these are not implemented in the medium term.

## Area 5:

Short-medium term – “Do Nothing (More)”.

Long term – “Excavate Most Hazardous” (likely to be hot-spots), or possibly localised “In-situ immobilisation”.



## Lessons Learned:

- The conceptual site model was important in the study as it provided the focus to where remedial options were to be applied (ie 5 source areas) and the constraints specific to those source areas.
- The options considered are “generic descriptions” rather than specific descriptions of technologies (suggestions were made of technologies for each generic description although later phases of optioneering will need to consider which of these is “best” relative to the objective of the generic description).
- Remedial solutions were developed **relative to a number of timeframes** - which enabled the integration of these remedial solutions with the decommissioning strategy for the site. As a consequence “provisional” holding measures could be considered to control the impacts of the contamination until more permanent solutions could be implemented
- Remedial solutions were developed which took account of the overall land condition objectives for the interim and final end states for the site (which had been previously decided during extensive external and internal stakeholder consultation)
- Remedial solutions were developed which took into account Dounreay stakeholder concerns.





Thank you