

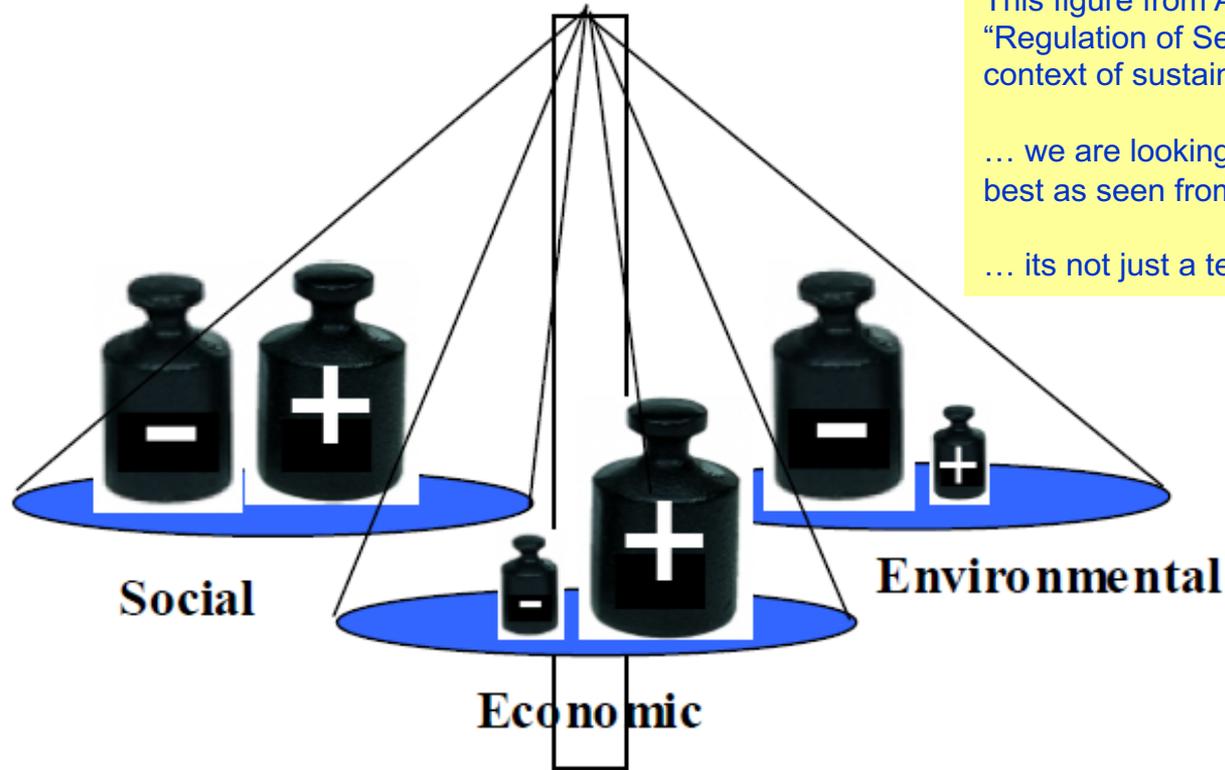
Risk Management for Legacy Sites
and Wastes: **Implications for
Proportionate Risk
Management and a Graded
Approach to Risk Assessment**

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Outline

- A little history of optimisation
- Update on ethics
- Examples of attempts at achieving optimisation through analysis of options
- Some recent experience:
 - Sellafield, legacy wastes/fuel particles on beach
 - LLWR, LLW disposal facility
 - Little Forest
 - Andreeva Bay
- Key results from NEA Expert Group on Legacy Management
 - Proportionate risk management
 - Graded approach to assessment
- *Some suggestions and questions for EAN 😊*

Optimisation is tricky



This figure from Aston 2014, Thesis on “Regulation of Sellafield discharges in context of sustainable development”

... we are looking for balance, not the best as seen from one perspective;

... its not just a technical issue...

Figure 4 Diagram illustrating the balanced interpretation of Sustainable Development as a scale

Was Dr Ashton being smart?

“In recent years, there has been an increasing emphasis on the quantitative assessment of risk following exposure to radiation. {...} It has generally been assumed that this trend will contribute to the formulation of policy and standards in the field of radiation protection. ***The difficulties of achieving this contribution have, perhaps, been underestimated because the problem has been seen too often as an exercise in science rather than as a combined operation involving, in addition, the skills of management, government and sociology.***”

➤ Dunster and McLean (IRPA, Brighton, 1970)

Another perspective on have we been getting it right!

“Despite its wide scope, the Health and Safety at Work Act, 1974, is written as though the only problems is worker protection.

As matters have developed **the real issue is about protection of workers, the public and the environment from the consequences of industrial technology, and about the risks we need to take, or ought to tolerate, in the interests of creating wealth and happiness. We are in as great a confusion as in 1974. *Why does government choose to deal separately with the harms done by processes, by products and by wastes, when industry can neither see them as separate, nor so deal with them?*”**

- **Near quote from former director of the HSE (1999)** essentially calling for a holistic policy and regulatory approach

NB: Holistic approach to risk highlighted at EAN 1997!!

ICRP on optimisation.. a reminder

- Justification
- Dose limitation
- Optimisation

Use of effective dose for all kinds of exposure

Nominal risk coefficients which, not for individuals but on average, allow you to address deontological and utilitarian components of an ethically base system of protection.

Since ICRP 26 (1977)

ICRP 138 (2018), reminds/updates ethical foundations

- Beneficence and non-maleficence
- Prudence
- Justice
- Dignity

Example application:
Holistic and balanced?

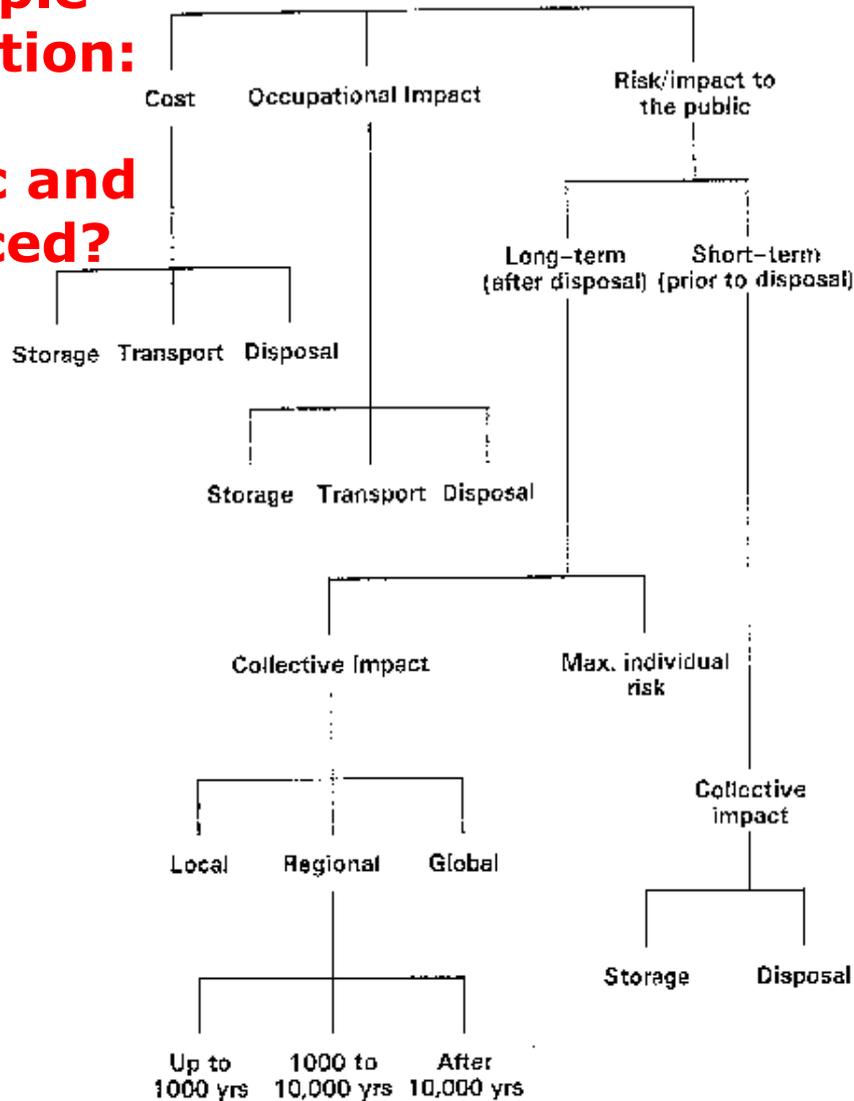


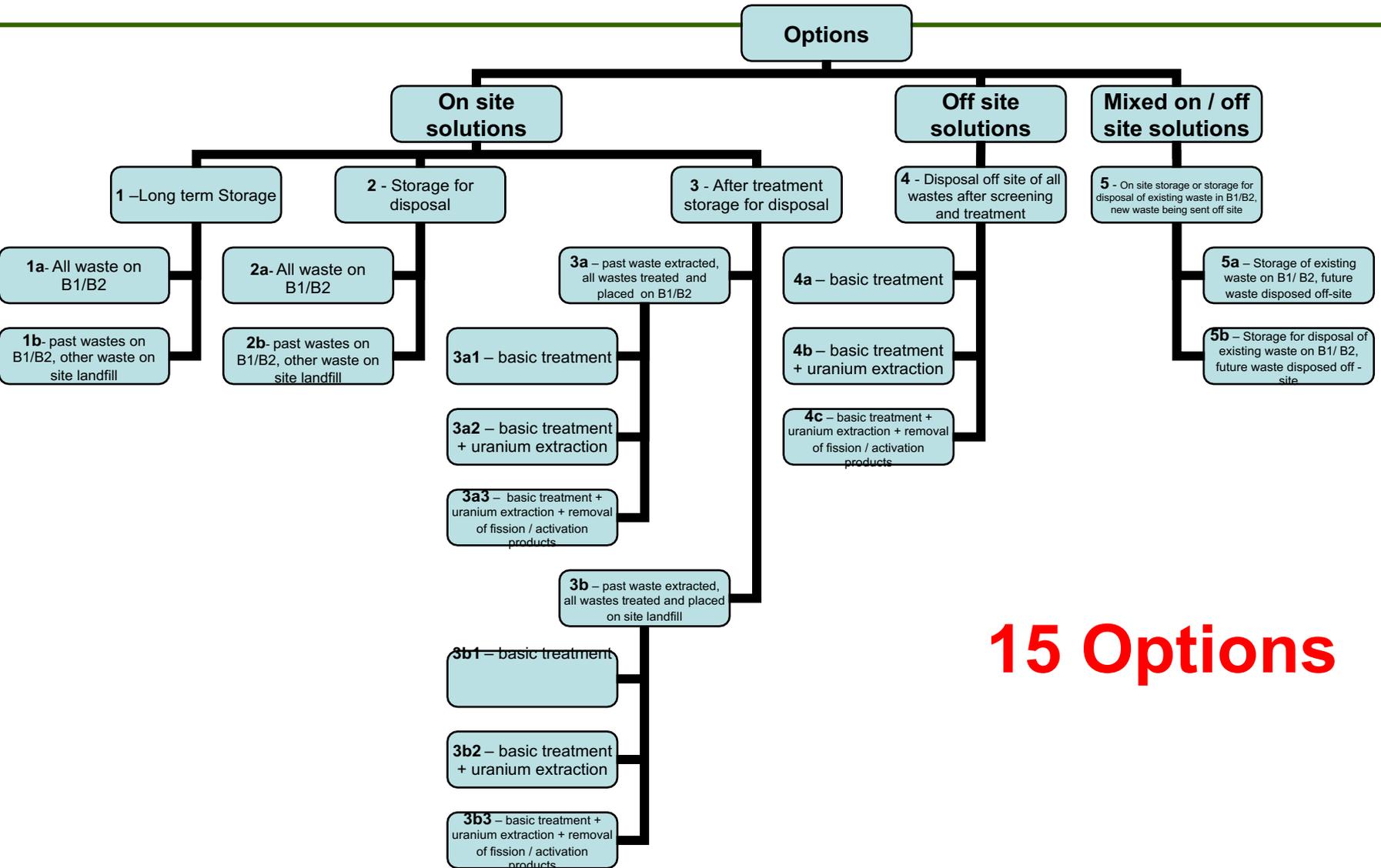
Figure 3. A structure for the economic and radiological impacts pertinent to comparative assessments of waste management options

Best Practical Environmental Option for L/ILW management in the UK, 1986.

Attributes evaluated for a range of logistical dynamic strategies.

Weighted from 4 societal perspectives!

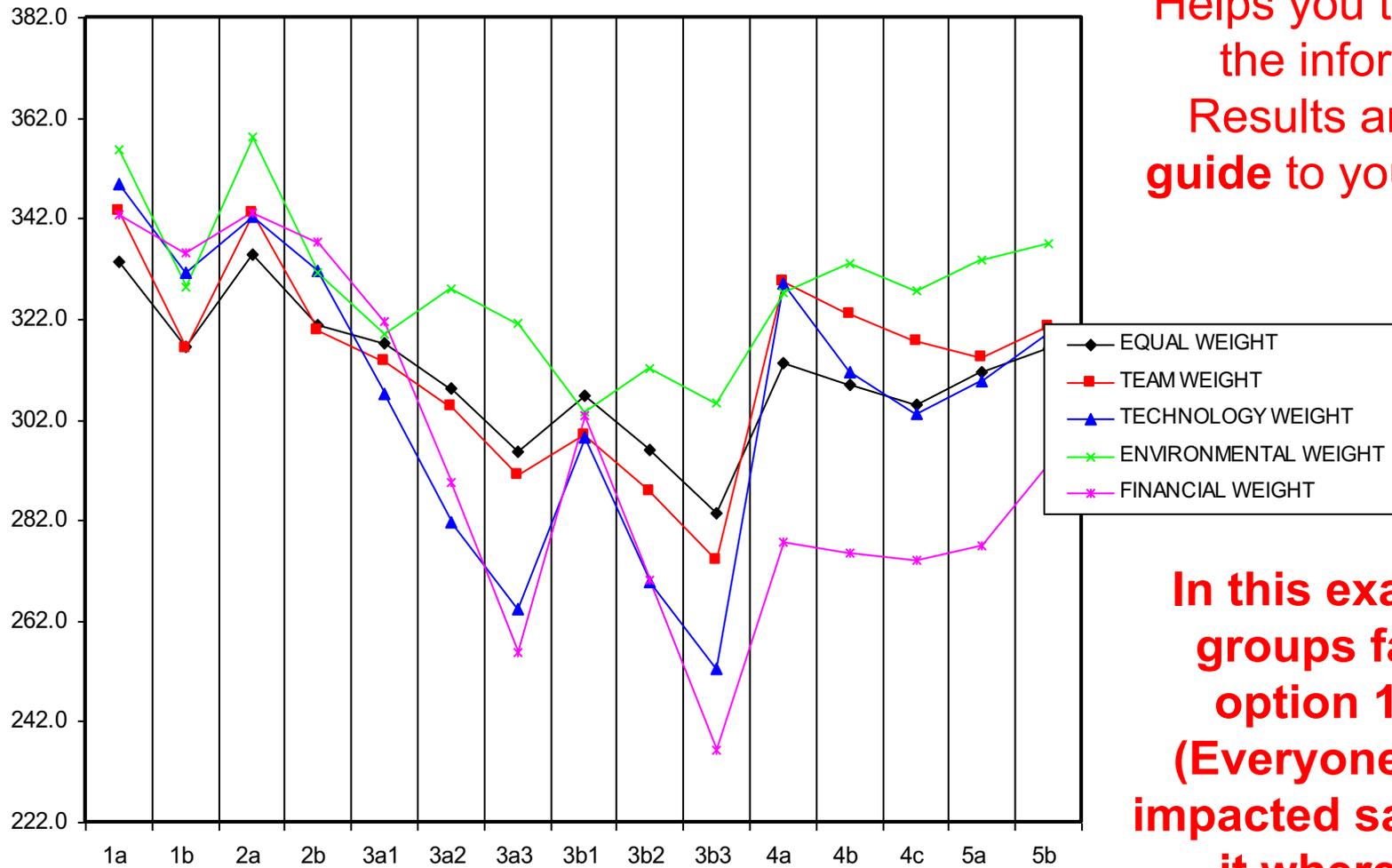
Example: remediation of a NORM site



43 attributes organised in 7 main groups

- ✓ **Group A: Health and Safety**
- ✓ **Group B: Environmental impact**
- ✓ **Group C: Environmental policy**
- ✓ **Group D: Technical aspects**
- ✓ **Group E: Socio-economical aspects**
 - ✓ **Group F: Stakeholders**
 - ✓ **Group G: Financial aspects**

Sum over all attributes and weightings, for each weighting set



Helps you to organise the information.
Results are **only a guide** to your thinking.

In this example, all groups favoured option 1a or 2a (Everyone actually impacted said, "Leave it where it is!")

US NRC on using collective dose

- US NCRP's Guidance on Collective Dose
<https://www.ncrppublications.org/Reports/121>
 - **NRC's dollar per person-rem guidance, this is draft awaiting for the Commission to approve, but the technical basis is in described within.**
<https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1530/r1/index.html>
 - NRC information on back-fitting and regulatory analysis.
<https://www.nrc.gov/about-nrc/regulatory/crgr/related-info.html>
 - Information on **dose truncation** used in severe accident analyses. <https://www.nrc.gov/about-nrc/regulatory/research/soar/soarca-health-effects.html>
 - NCRP committee discussing the differences in risk management approaches used by the EPA and NRC in cleaning up radioactively contaminated sites. **The EPA approach applies to chemicals too.**
<http://www.ncrppublications.org/Reports/146>
-

Sellafield: history of operations



1940s/50s

- Nuclear build begins
- Initially a military programme
- Later civil programme begins

1960s/70s

- Waste stored safely – pending treatment
- Storage capacity extended incrementally
- Coarse segregation of waste arising from process
- Magnox reprocessing starts

1980s

- Main expansion of site
- Major waste treatment focus
- Environmental impact substantially reduced

1990s

- Commercialisation of reprocessing — Thorp comes online
- Waste arising from processes treated in 'real time'
- Product waste forms compatible with disposal concepts

2000s

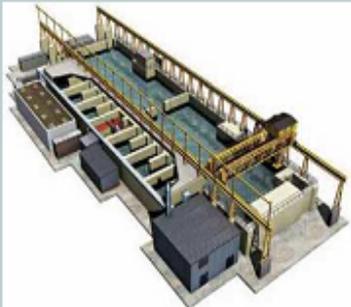
- NDA formed
- Stop start progress in Decommissioning
- Calder Hall ceased generating power after 47 years in operation

2010s

- Decision taken to end Thorp reprocessing
- Vitrification of all overseas Highly Active Waste complete
- Decommissioning gathering pace
- First sludge exports from FGMSP

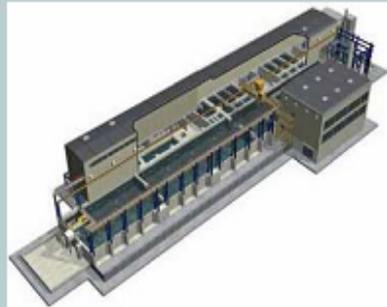
Legacy Ponds & Silos

Pile Fuel Storage Pond



- Constructed 1948-1952 to store Windscale fuel for reprocessing. Waste consists of sludge, fuel, intermediate and low level level waste.

First Generation Magnox Storage Pond



- Constructed in 1950s and 1960s to store Magnox fuel for reprocessing. Waste consists of sludge, fuel, intermediate and low level level waste.

Magnox Swarf Storage Silos



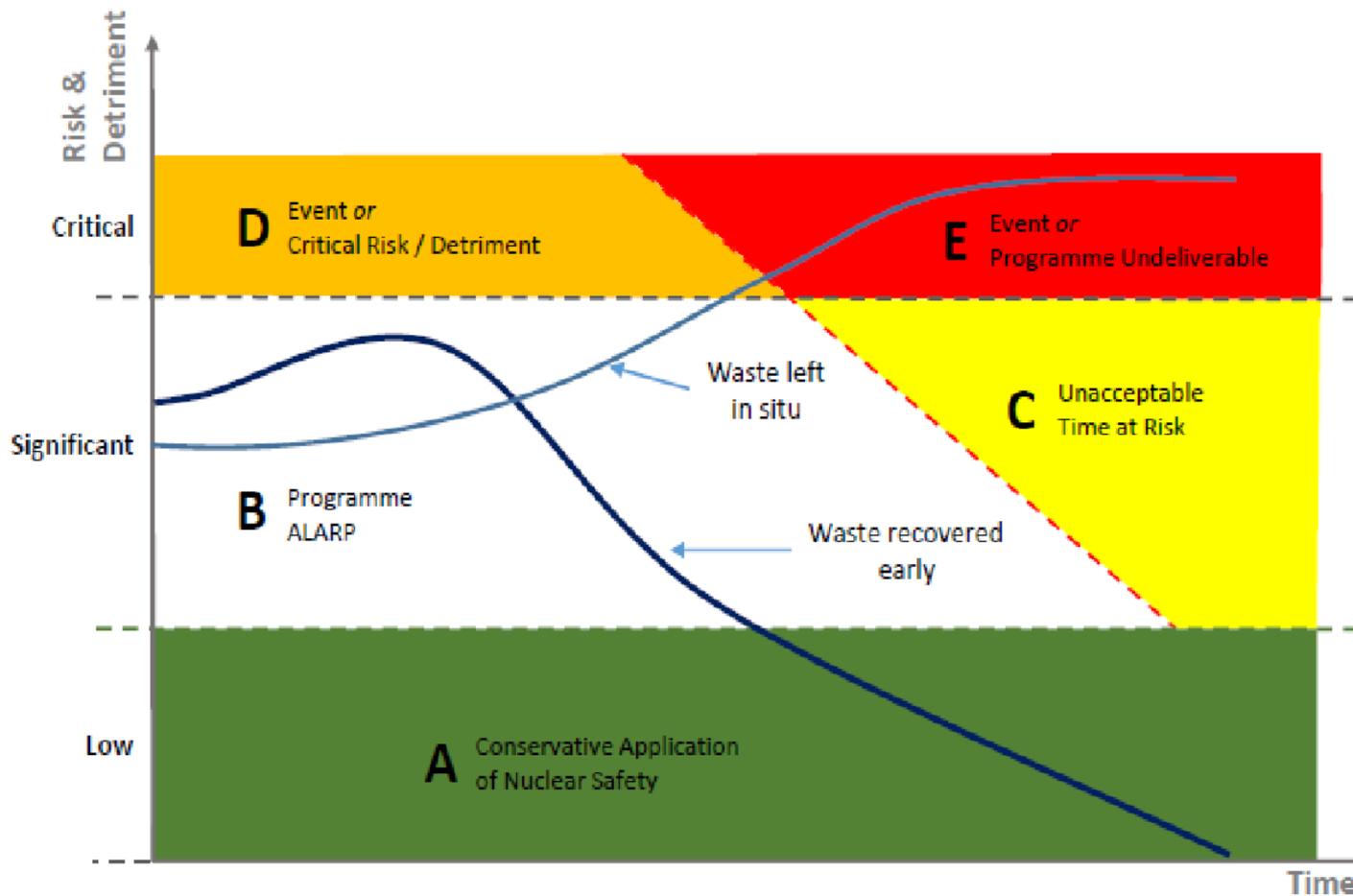
- Constructed 1960s-1980s to hold irradiated fuel canning waste. Received waste until 2000.

Pile Fuel Cladding Silo



- Commissioned in 1952, 1st storage facility for intermediate level waste constructed at Sellafield. The silo was filled by 1964.

NDA Risk Management Framework



Finding balance:

Act before you know how to or
Delay until after something dramatic has done wrong ?

Focus on hazard reduction!

Adaptability of regulation!

LLWR Near surface disposal, near Sellafield, UK then



1973-1979
Trench 3
opened

Requirement to use best practical means “to minimise waste generated on site and ensure radiological impacts are ALARA”

Q2: Can you do both at once?

NEA answer “the minimisation of one detrimental impact is always likely to result in something else detrimental not being minimised.” NEA report 7305

Certifica
Authorise
gra

1950s

1959
Under UKAEA
Management

1960
Authorisation
under RSA 60

- Limits set on daily averages of alpha and beta/gamma disposals
- Restriction on surface dose rates (RWMAC, 1995)

1971
Under BNFL
Management

Revised
Authorisation
under RSA 60

- Limits set on individual and groups of radionuclides disposed annually e.g. Ra-226, U, Th-232, other α , C-14 & H-3.
- BPM applied to compact waste and limit radionuclide migration from waste
- Enhanced waste sampling and environmental monitoring. (RWMAC, 1995)

1981
Railway
opened

1988
Revised
Authorisation
under RSA 60

1993
Revised
Authorisation
under RSA 93

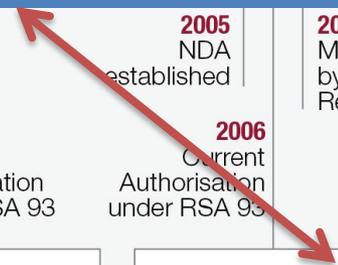
- Existing sites disposal limits set (TBq/y):
- | | |
|----------------|------|
| U | 0.30 |
| Ra-226 & Th-23 | 0.03 |
| Other α | 0.30 |
| C-14 | 0.05 |
| I-129 | 0.05 |
| H-3 | 10.0 |
| Co-60 | 2.0 |

2005
NDA
established

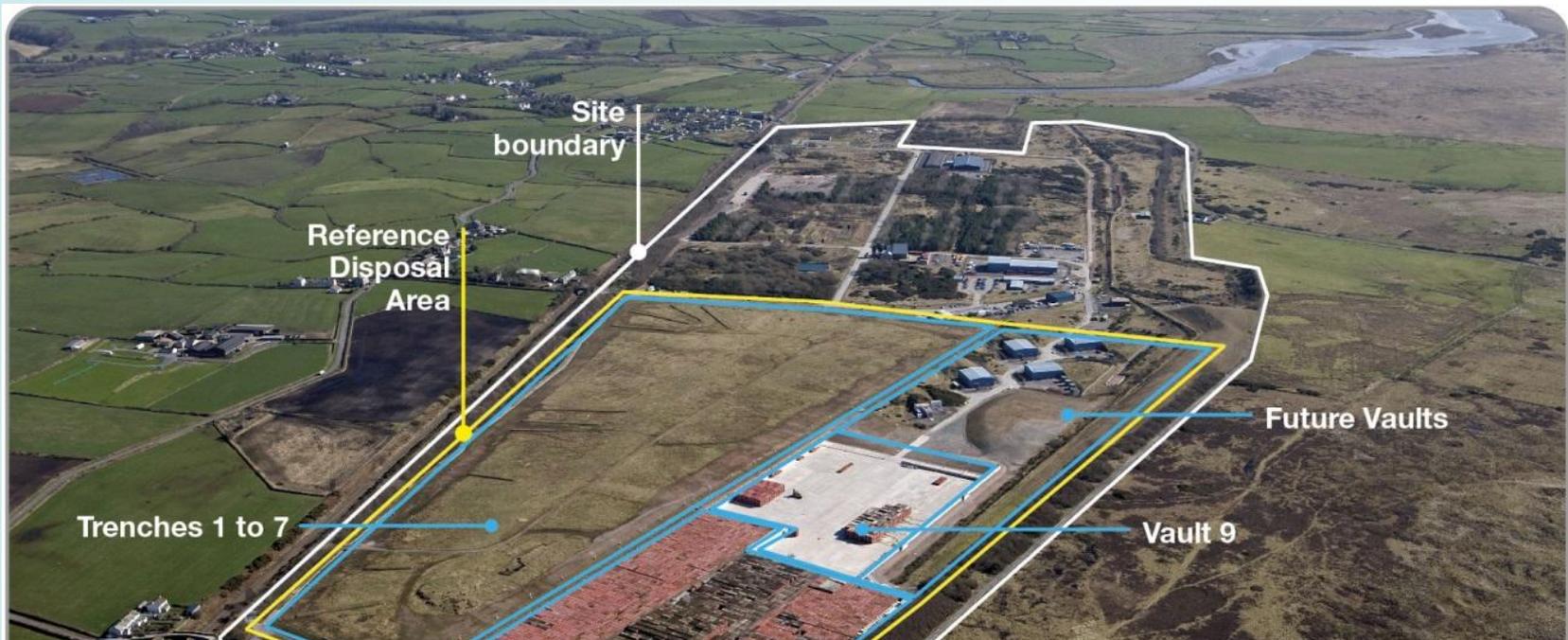
2006
Current
Authorisation
under RSA 93

- BPM requirements to minimise waste generated on site and ensure radiological impacts are ALARA.
- Existing site annual disposal limits for vault 8 unchanged.
- Exclusions of VLLW, liquids, toxic materials, oxidising agents, complexing agents.

2007
Managed
by LLW
Repository Ltd



... and a bit later, ...

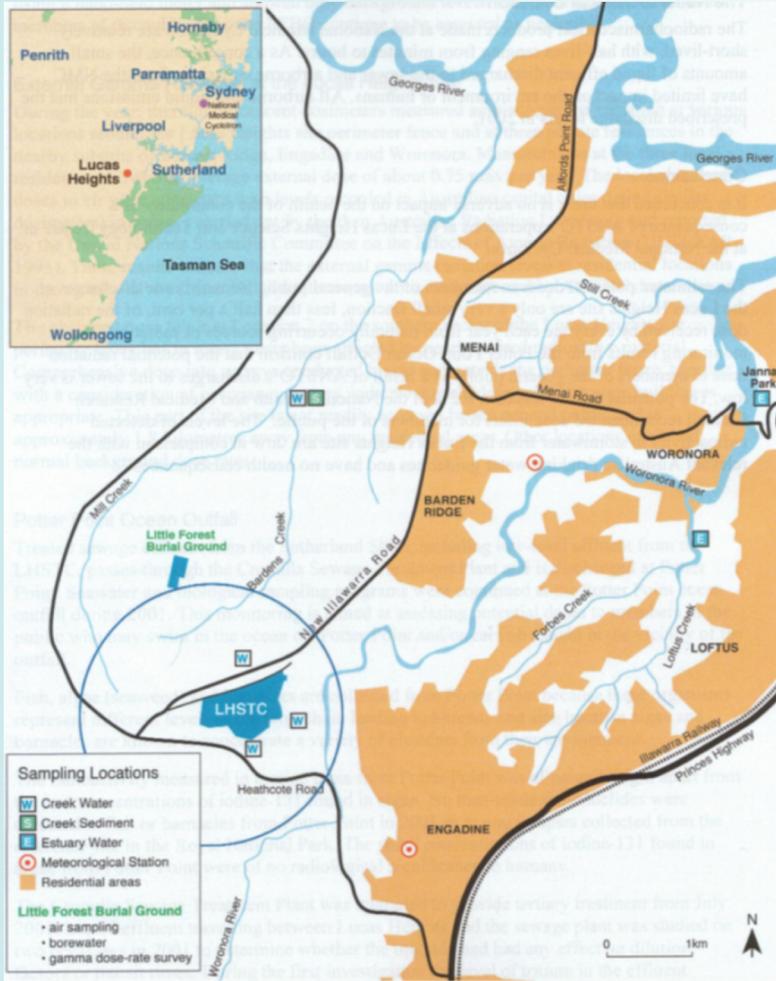


Asbestos is the highest risk – exceeds the guidance level for the site, but..... regulatory legal advice is accept the waste ...

**Optimisation story told fully at
<https://www.gov.uk/government/publications/llwr-the-2011-environmental-safety-case-main-report-llwrescr1110016>**

EAN WS #18: ALARA for decommissioning and site remediation

Little Forest Legacy Site, Sydney



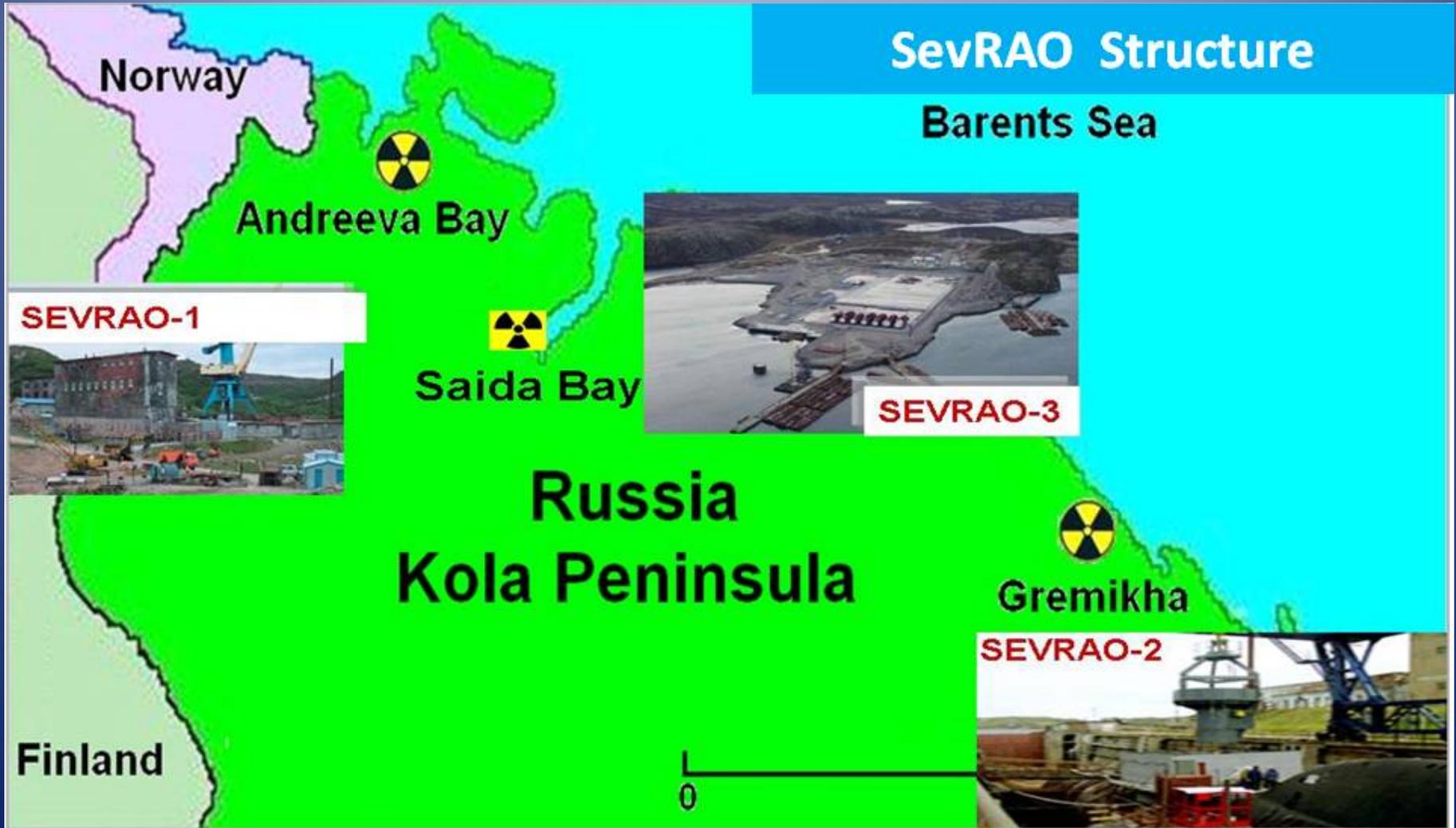
LLW disposal from
1960 to 1968

Encroachment of the
Sydney suburbs.

Major hazard
beryllium.

But managed as a
nuclear legacy...

Spent fuel stores in NW Russia



Progress at Andreeva Bay 2004

SF store remediation

- Unsatisfactory condition of SNF and RAW storage facility
- Lack of sufficient information on radiation and health conditions
- Inadequate coordination between the regulator, operator and the emergency medical response

2014

- The then upcoming SNF extraction was the most demanding part of the remediation
- **Required enhancement of regulatory process, rules and guidance, regulatory adaptability!**

2017

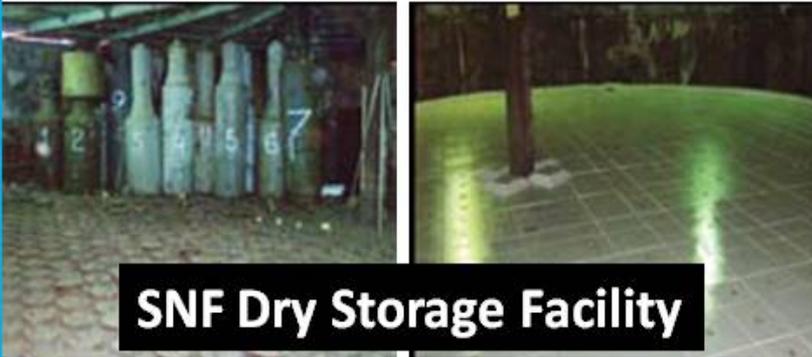
- First major SNF recovery and shipment to Mayak for reprocessing

Threat Assessment



Site

Site



SNF Dry Storage Facility

Regulatory guidance on management of residual VLLW, to be managed under rules for hazardous waste management with overlay of RP issues.

In English at StrålevernRapport • 2008:7
see www.dsa.no

2



Radiation Safety Office

2014 – 10 years later



RAW classification system has also suffered certain changes. The Federal Law «On the Radioactive Waste Management ...» established new RW classification system according to which all radioactive wastes are divided into two groups: **special and removable**. Resolution of the Government of the Russian Federation №1069 specifies the criteria used to define waste as special or removable. According to the resolution, RW can be defined as **special RW if it meets the following criteria:**

- **collective effective dose for the whole period of RW potential hazard and the risk of potential exposure associated with operations on RW removal are greater than the collective effective dose for the whole period of RW potential hazard and the risk of potential exposure associated with in situ disposal of such waste;**
- **costs of RW removal (including the costs for RW discharge, processing, conditioning, transportation to the disposal site and disposal itself) are greater than the aggregate possible damage inflicted to the environment in case of such waste disposal in situ and the costs for the RW disposal in situ (including the costs associated with transition of the RW storage facility to RW disposal facility, its operation and closure, as well as safety provision for the whole period of RW potential hazard);**
- **RW disposal facility and its sanitary-protection zone are located outside the borders of settlements, designated conservation areas, coastal buffer zones and water conservation zones, as well as other exclusive and protected areas established under the Russian legislation.**

Key remarks from NEA EGLM

- Legacies may present mixed radiation exposure situations as well as other non-radiation related hazards that do not fit readily into existing management and regulatory arrangements.
- In developing an effective and efficient regulatory framework, it is of particular interest to achieve a balance between:
 - the need for regulatory flexibility that allows easy adaptation of the regulations to a wide variety of prevailing and evolving circumstances and technology, and
 - the need to include appropriately precise and detailed requirements and criteria that provide clarity to and confidence in the safety standards, and that facilitate demonstration that the standards are being met.

Proportionate risk management

- An holistic approach to management and regulation of the hazards and risks is warranted in order to achieve proportionate risk management and overall optimisation.
- This implies the need to consider chemical and other hazards alongside the radiological, adopting proportionate health, safety and risk management strategies and applying corresponding regulatory requirements based on common protection objectives.

Graded approach to risk assessment

An important corollary is that assessment methods should be graded, so as to support and promote proportionate approaches to demonstrating or confirming regulatory compliance in line with the common protection objectives.

(Don't sweat the small stuff...)

Linked up strategic thinking

- Strategies for management and regulation of legacies should take account of strategies for radioactive waste management, and vice versa. This is especially important for legacies which involve large volumes of contaminated wastes, which incorporate old disposal facilities, or which have contamination in underground structures, for which in situ disposal may be an appropriate management option.

It is not all bad news!

- It is broadly necessary, and of long-term advantage, to involve all stakeholders in the process to manage and resolve legacy sites as soon as the legacy has been recognised.
- It should be expected that a staged process is likely to be needed since (except in trivial cases) it will not be possible to achieve an appropriate end-state in one step.
- The Case Studies and Site Visits show that there has been significant practical progress to resolve the issues mentioned above, including the scope for avoiding development of a legacy altogether. This experience is of potential relevance at other sites.

Preliminary Framework

- A Preliminary Framework is presented in the report for the design of a process for a logical progression of activities leading to selection and achievement of an appropriate end-state.
- However, arrangement of the interactions among relevant organisations and interested parties is a complex and dynamic activity in itself. Recommendations have therefore been provided to support the testing and extension of the Preliminary Framework into an effective and sustainable guiding instrument.
- Scope implies reaching out from radiation protection community to the OECD Environment Directorate, the United Nations Environment Programme and the World Health Organisation and to chemical regulators, to share experiences to work cooperatively and develop guidance on holistic optimisation.