Summary of Independent Peer Review and Analysis of SLCs' Technical Baseline and Underpinning Research & Development (TBuRD) Submissions from March 2014

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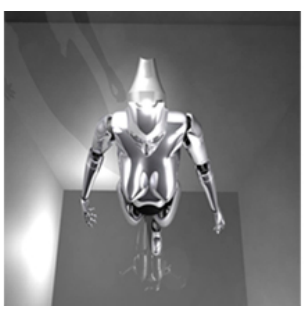
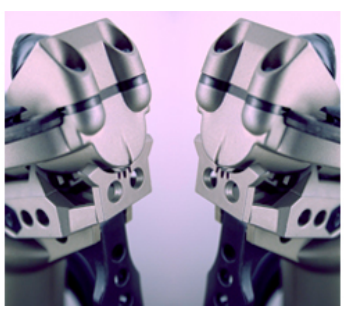


Preface

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Colour Coding Key:

The colours depicted in this report reflect those adopted by the NDA for the Strategic Themes:

Pink – Site Restoration
Pale Blue – Spent Fuels
Orange – Integrated Waste Management
Green – Nuclear Materials

Executive Summary

Site Licence Companies (SLCs) are required to demonstrate that their Lifetime Plans are underpinned by sufficient and appropriate Research and Development (R&D). Each SLC submits a TBuRD (Technical Baseline and Underpinning Research & Development) that describe their R&D programme. The requirements for TBuRDs are set out in the NDA procedure EGG10 (ref 1). This report summarises a review of compliance of TBuRDs against EGG10 and the subsequent analysis of the TBuRD information.

The review of TBuRDs shows that all SLCs had good compliance with the requirements set out in EGG10. There were some general areas where improvements but all SLCs could demonstrate that their Lifetime Plans were underpinned by sufficient and appropriate Research and Development (R&D).

Analysis of the 2014 TBuRD data showed that:

- Almost £800m will be spent on R&D tasks across the NDA estate over the next 20 years.
- The vast majority of R&D expenditure (over 90%) will take place at Sellafield.

Most of the R&D is taking place in the strategic themes of Integrated Waste Management and Site Restoration. The majority of R&D is in the treatment & conditioning of ILW.

There are a number of areas where there is potential for collaboration:

Waste Packaging & Storage

- ILW Stores – design, operation, monitoring
- 'Raw Waste' containerisation
- Graphite
- Mercury contained waste
- Sorting & segregation of miscellaneous items
- Sludges
- LoC applications

Characterisation

- In-situ characterisation techniques - waste management & decommissioning
- Sr-90 analysis
- Modular laboratories

Decommissioning

- Vents, ducting, pipelines – characterisation and dismantling
- Decontamination – techniques & waste management
- Remote / robotics – characterisation, deplant, demolition
- Heels and residues – retrieval
- Size reduction – concrete, metal
- Demonstration facilities

Land Quality

- In-situ remediation of land
- Ex-situ remediation of groundwater
- Long-term modelling & monitoring

Contents

1 Introduction

This report analyses the 2014 TBuRDs issued to NDA by the Site Licence Companies (SLCs).

The Site Licence Companies (SLCs) who submitted 2014 TBuRDs were:

- DSRL – Dounreay Site Restoration Limited
- LLWR – Low Level Waste Repository Limited
- MXL – Magnox Limited
- RSRL – Research Sites Restoration Limited
- SL – Sellafield Limited

A TBuRD comprises five separate elements:

1. SLC Technical Management Summary
2. SLC Annual Technical Report
3. Process Wiring Diagram
4. R&D Table
5. SLC Technology Map

The first element of analysis was compliance with the NDA specification for TBuRDs, EGG10 (Technical Baseline and Underpinning Research and Development Requirements, Rev 5).

Thereafter, analysis carried out was based on the R&D Table with the main objective to assess the extent of R&D across the NDA Estate and the potential for collaboration between SLCs.

2 Compliance with EGG10

All of the SLCs had good compliance with the requirements set out in EGG10.

The methodology to assess compliance was that all the requirements stated in the NDA specification (EGG10, Ref 1) were listed and grouped under their respective section headings. There were six sections and 25 requirements in total. Each requirement was given a textual scale, which ranged from no compliance to full compliance with intermediate points available. The submission from each SLC was scored against how well it met each requirement. Then, using multi-attribute utility theory (MAUT), the scores were converted to a value scale and the mapped & weighted values were aggregated to provide an overall rating for each submission. For the purposes of this evaluation, equal weights for each requirement were used and the utility curve for value mapping was based on an s-curve where a much higher value was given for meeting (or almost meeting) requirements.

There were some general areas where improvements could be made including:

- Using consistent units for expenditure (£ rather than £k)
- Using consistent date fields rather than text
- Using the preset lists for content rather than creating additional ones
- Clarifying whether gaps in tables are zero or not known
- Using additional fields for explanatory text rather than extending preset fields

However, all SLCs could demonstrate that their Lifetime Plans are underpinned by sufficient and appropriate Research and Development (R&D).

The improvement from the previous review in 2011/12 was significant, helped by improvements to the spread sheet template and the use of verification checklists.

Figure 1 shows the overall results by SLC. DSRL, LLWR, RSRL and Magnox all achieved 90% or greater compliance.

Figure 1: Compliance with EGG10

Figure 2 shows the results per section by SLC. The SLC Technical Management Summary was omitted since it is only required if there are significant changes to governance and assurance arrangements. This shows, in more detail, the sections of least compliance. This shows why SL performed least well – their compliance with PWDs (process wiring diagrams) was below those of the other SLCs. In this case, SL required an extra level of detail sitting above the roadmaps and below the facility wiring diagrams to meet the requirements set out in EGG10.

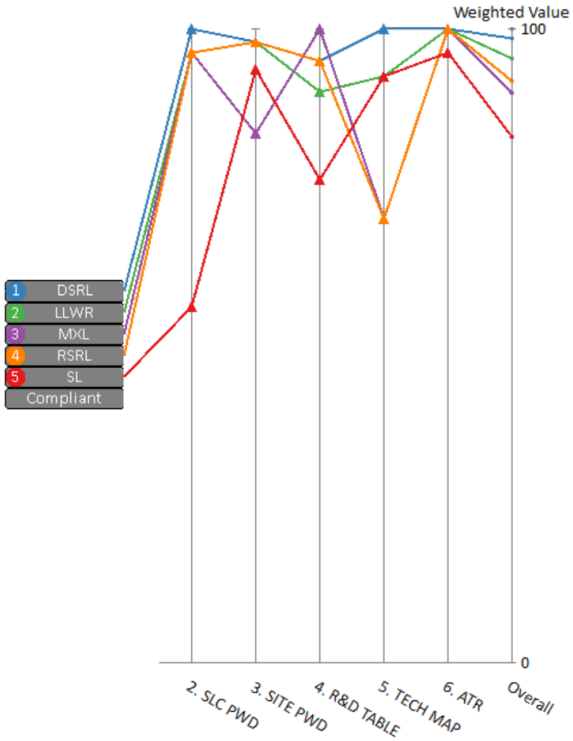

Figure 2: Compliance with EGG10 sections

3 Data Analytics

This section analyses the information provided in the TBuRDs at the estate-wide level. The analytics that follow use data provided by the SLCs. Conclusions are therefore dependent on the quality of the input data. It should be noted that, for research and development activities, future expenditure and associated schedules are difficult to estimate with accuracy, particularly in the medium to longer time horizons.

3.1 Analysis of Expenditure

The overall expenditure on R&D over the next 20 years or so is nearly £770m. Of this by far the largest proportion (90%) is with Sellafield Limited (SL). This means that SL dominates the analysis.

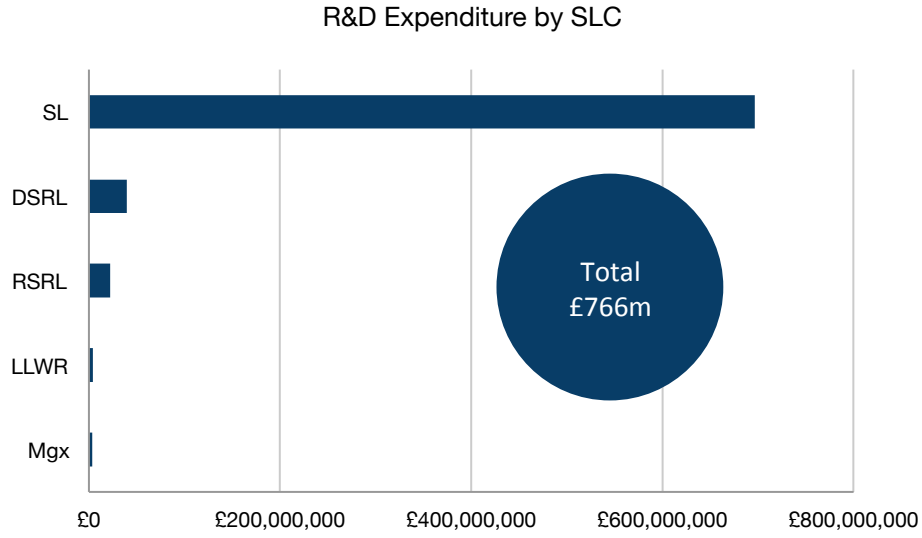

Figure 3: R&D expenditure by SLC

To put this into context, SL has 18 programme areas that make up their total programme. Five of those programme areas have a larger R&D expenditure than DSRL and the other SLCs are towards the lower end of estate expenditure on R&D. Figure 4 presents this data as a tree-map where the area of each block represents the total expenditure. The light blue colour blocks are all SL programme areas.

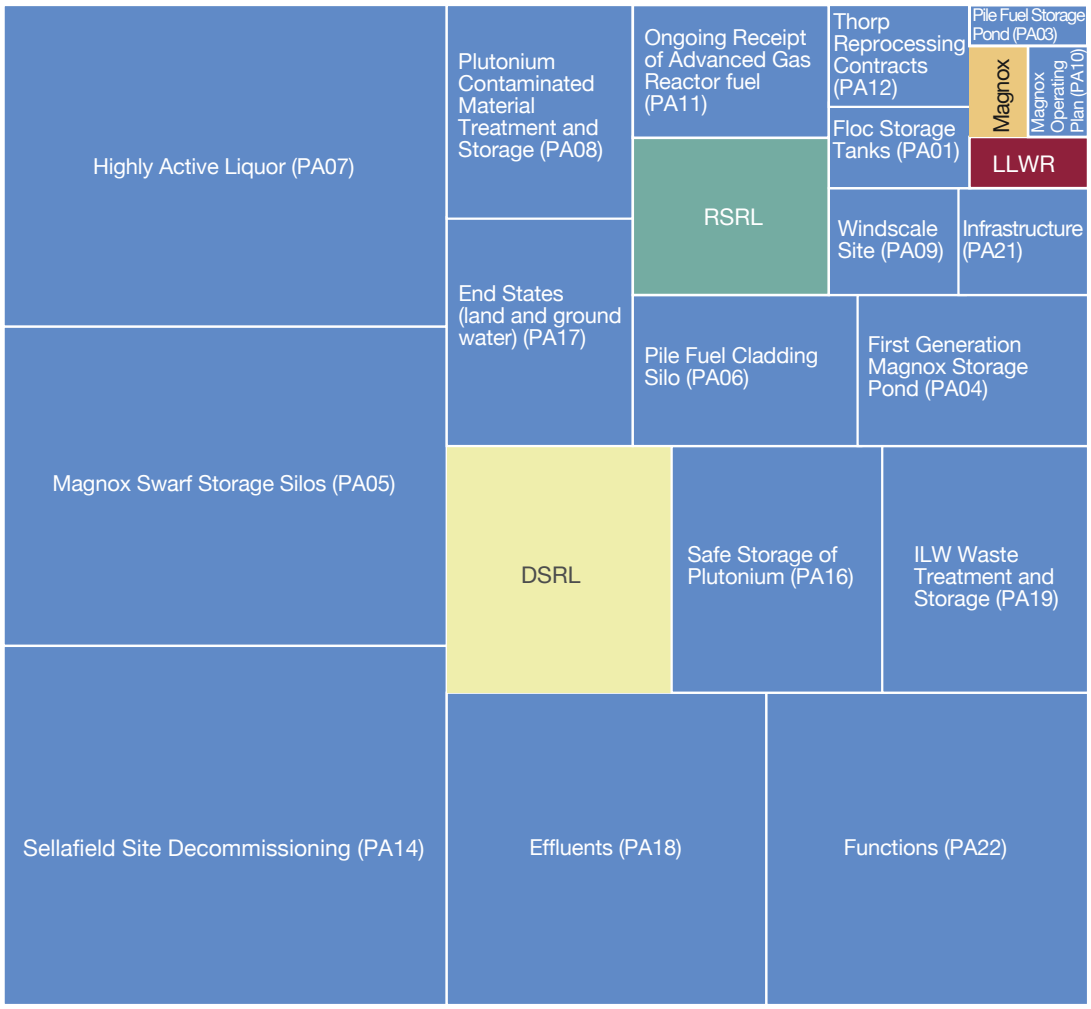

Figure 4: SL R&D expenditure in context

The expenditure profile of R&D (figure 5) shows an increase over the next 4 years followed by a reduction thereafter. Although the graph finishes at 2031, work continues far out into the future with low, consistent expenditure.

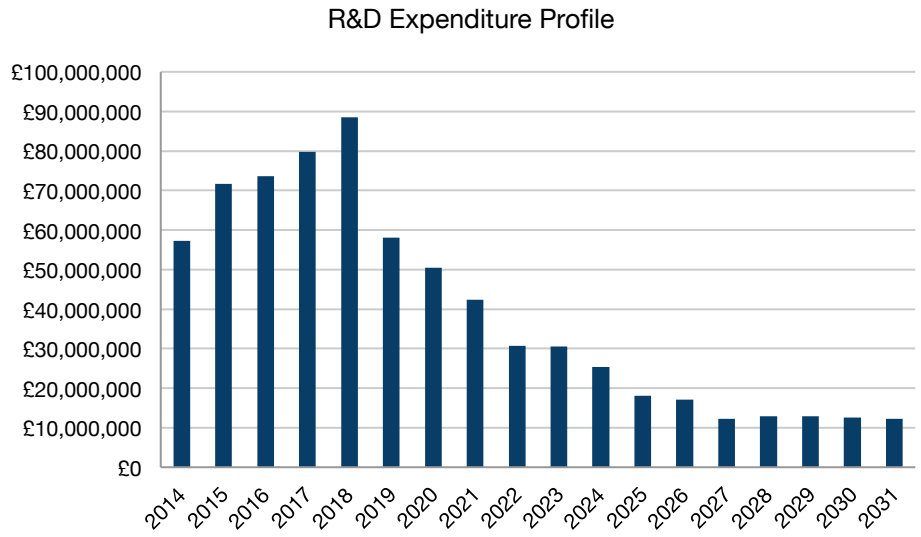

Figure 5: R&D expenditure profile

3.2 Analysis by Strategic Themes

Integrated Waste Management has the largest R&D expenditure (nearly £400m) with Site Restoration slightly less at just over £300m.

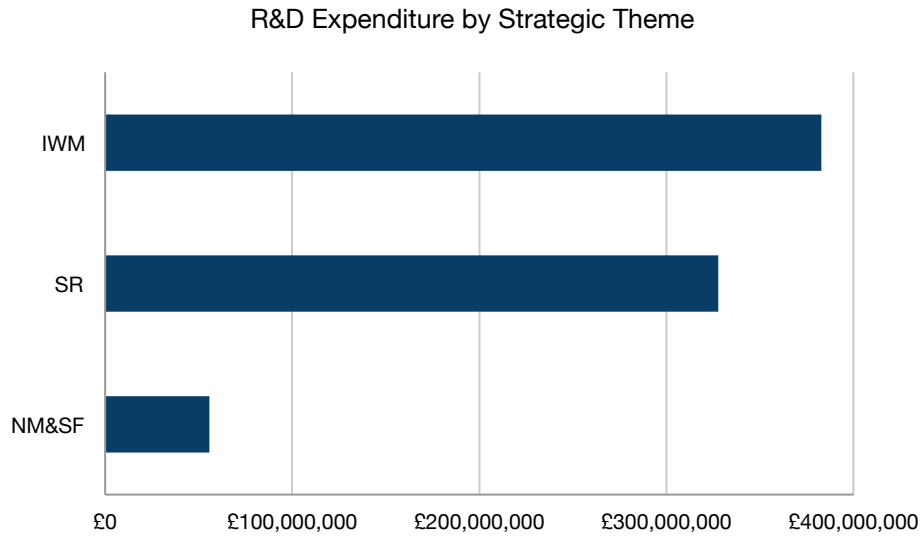

Figure 6: R&D expenditure by strategic theme

3.3 Needs, Risks and Opportunities

Figure 7 shows the breakdown between needs, risks and opportunities. Most of the R&D expenditure is for Needs with a smaller amount for opportunities and risks.

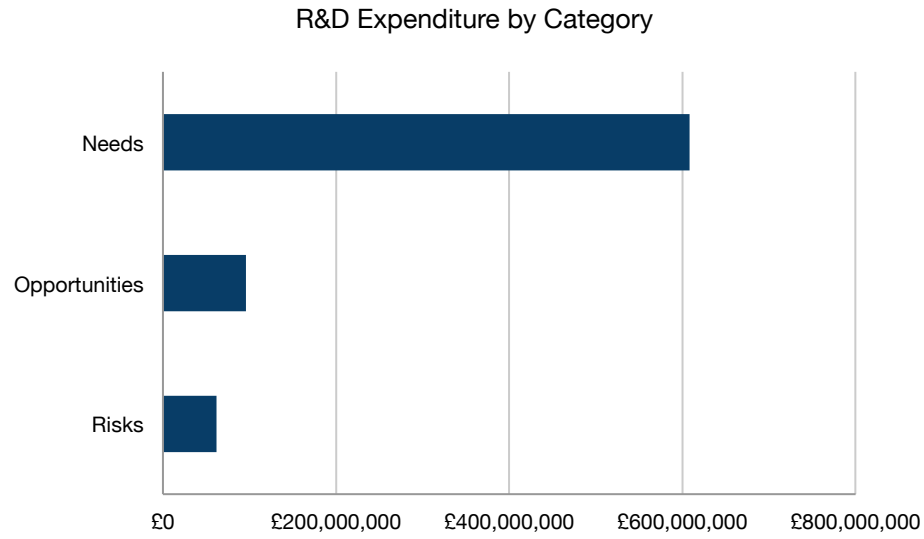

Figure 7: R&D expenditure by category

3.4 Waste/Material

The most significant areas of R&D expenditure are in wet / potentially mobile ILW and solid immobile ILW. There is a significant spend also in Higher Activity Wastes and HLW. R&D on plutonium wastes is also a major work area.

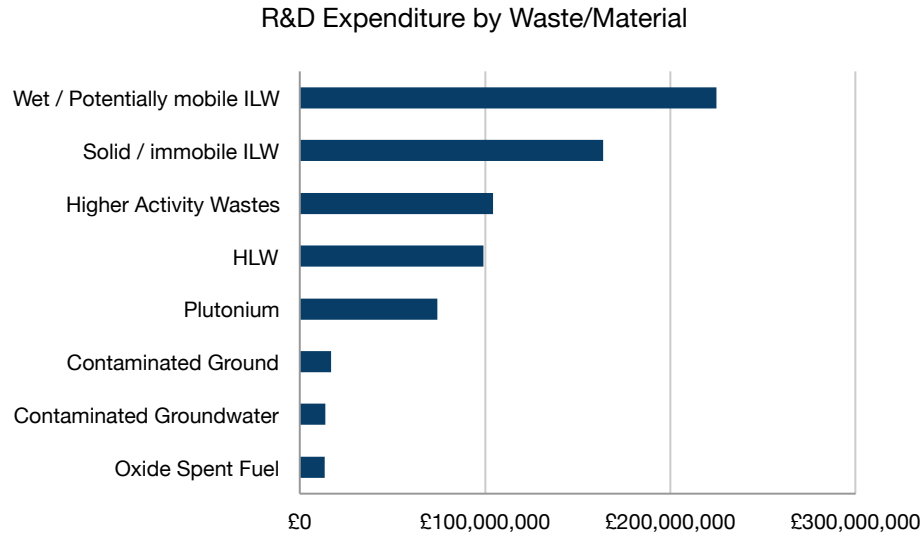

Figure 8: R&D expenditure by waste/material

Analysis of the number of tasks by waste/material is shown in figure 9. As for R&D expenditure, the top areas for number of tasks of expenditure are in wet / potentially mobile ILW.

The category “Higher Activity Wastes” is used for generic wastes whereas the others in that category (wet/potentially mobile ILW, solid/immobile ILW and HLW) are more for more specific wastes.

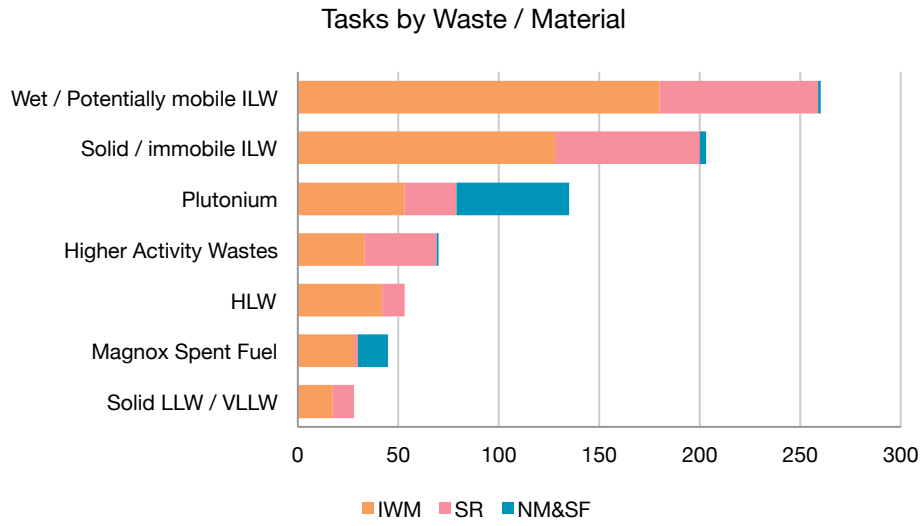

Figure 9: Number of tasks by waste / material

3.5 Process Steps

The most significant area of R&D expenditure is associated with process, treatment and conditioning. Deplant and dismantle is the next most significant.

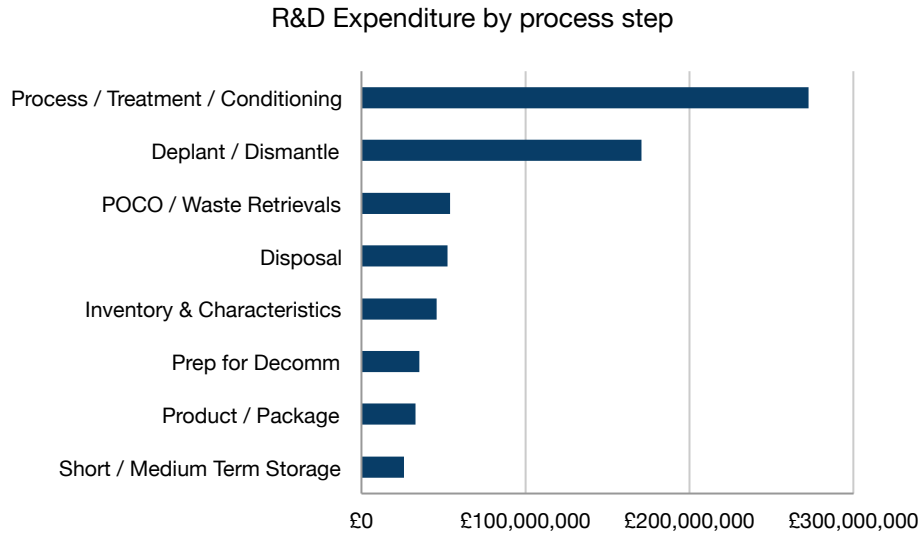

Figure 10: R&D expenditure by process step

3.6 Building Type

The most significant area of R&D expenditure is for rad treatment and handling facilities. Rad storage is next and N/A is third. N/A (not applicable) is where the building type has not been specified in the R&D Table mainly because the work will cover a number of different building types. N/A is the term used in the TBuRDs.

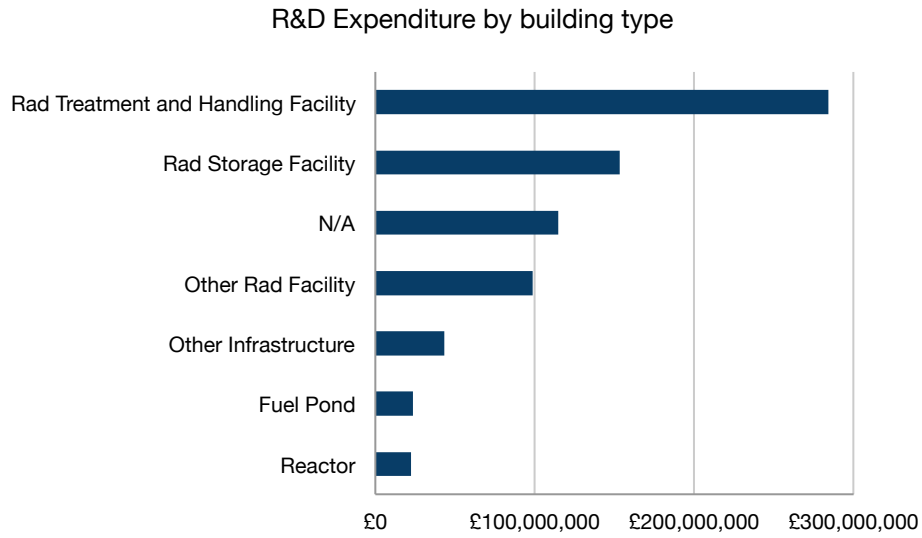

Figure 11: R&D expenditure by building type

3.7 Technology Readiness Levels

Technology Readiness Level (TRL) is the metric used to determine how ready equipment is for use, now, in an operating plant. This is further described on the NDA document “Guide to Technology Readiness Levels for the NDA Estate and its Supply Chain” (ref 2).

Analysis of the TBuRDs shows that the majority of tasks are currently at the low range of technology readiness levels (TRL 2 to TRL 4). This indicates a relatively low maturity for the R&D programme although it should be noted that not all the tasks are planned to reach the full maturity of TRL9, and not all tasks have particularly complex technology to be matured.

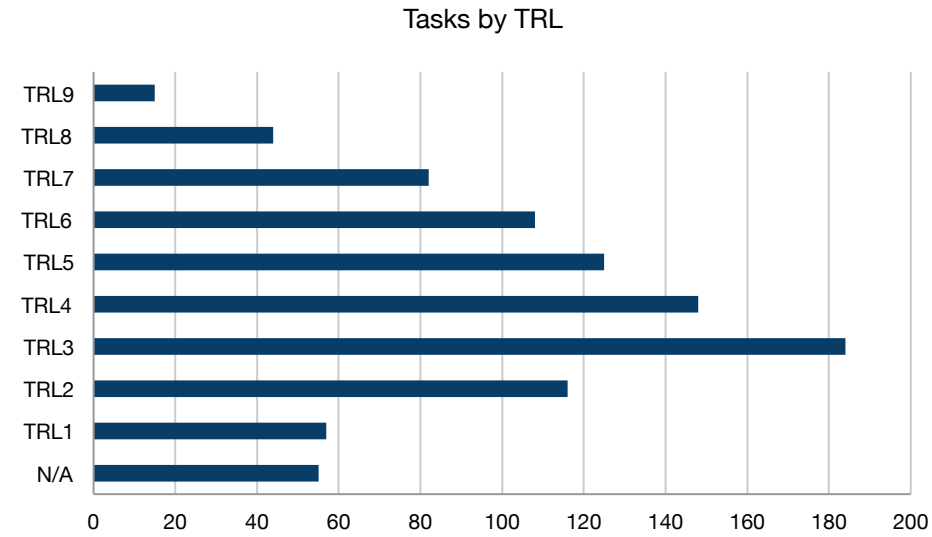

Figure 12: Number of tasks by TRL

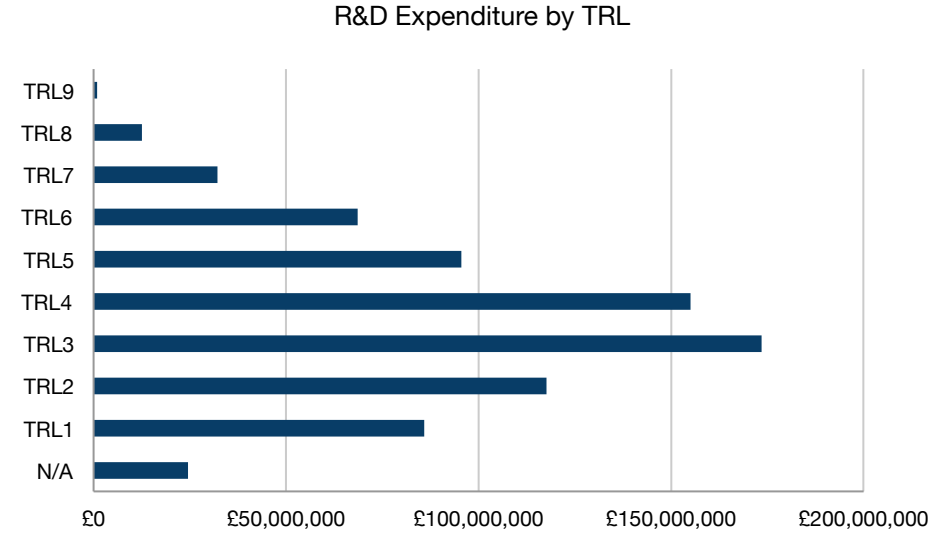

Figure 13: R&D Expenditure by TRL

N/A reflects data that were assigned "N/A" in the submitted TBuRDs. For TRLs, an N/A is likely to mean that the activity cannot be assigned a TRL because it is a work package not associated with the development of a piece of technology.

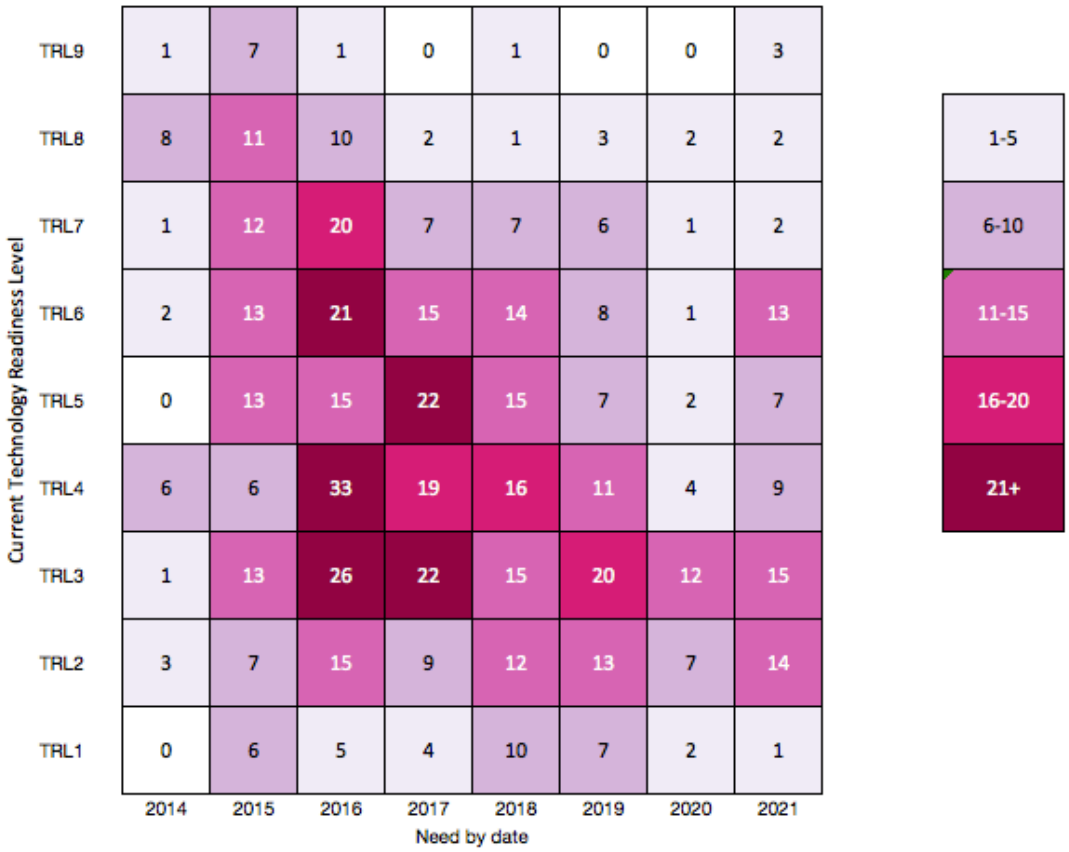

Figure 14: Heat map of current TRL compared to need by date

Figure 14, above illustrates the number of tasks that are currently at a particular TRL and the date when they are needed. Developing a technology from a very low level of maturity such as 1-3, to a high level of maturity such as 7-9 in a short space of time may be challenging and result in increased cost, increased risk and/or delays.

3.8 Tasks

Figure 16, below shows the need by dates for R&D. This shows a steep rise in 2016 with a subsequent reduction in future years.

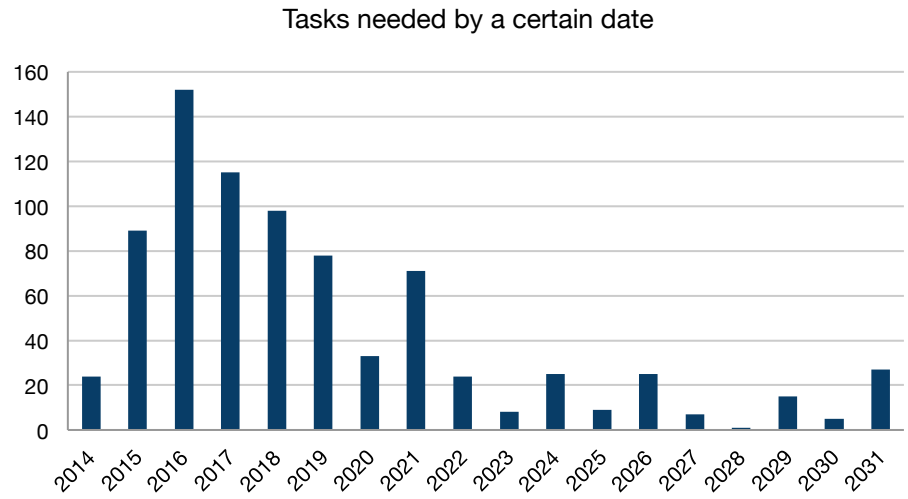

Figure 15: Need by dates

Figure 16, below illustrates the number of new starts with the activities dropping off in the next two years.

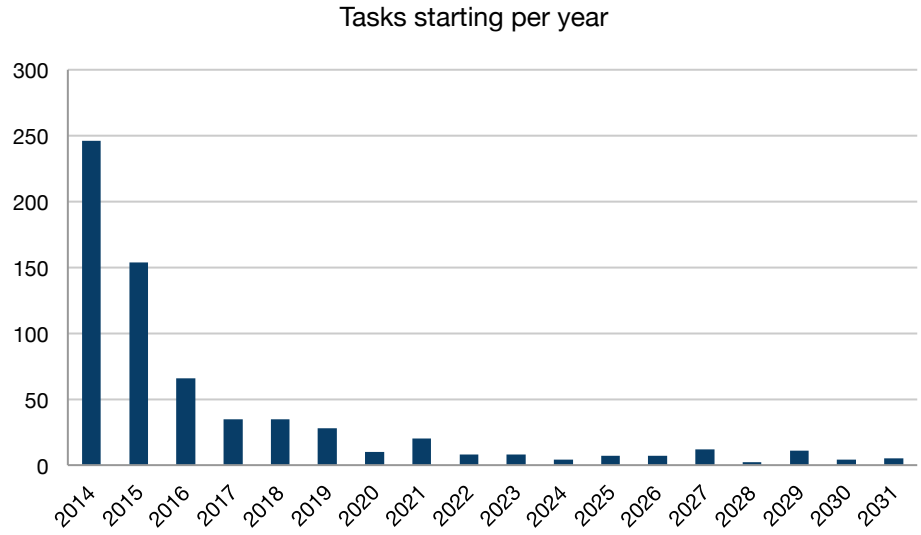

Figure 16: Start dates

3.9 Technology Maps

The diagrams below represent the Technology Maps broken down by R&D expenditure per block across the NDA Estate.

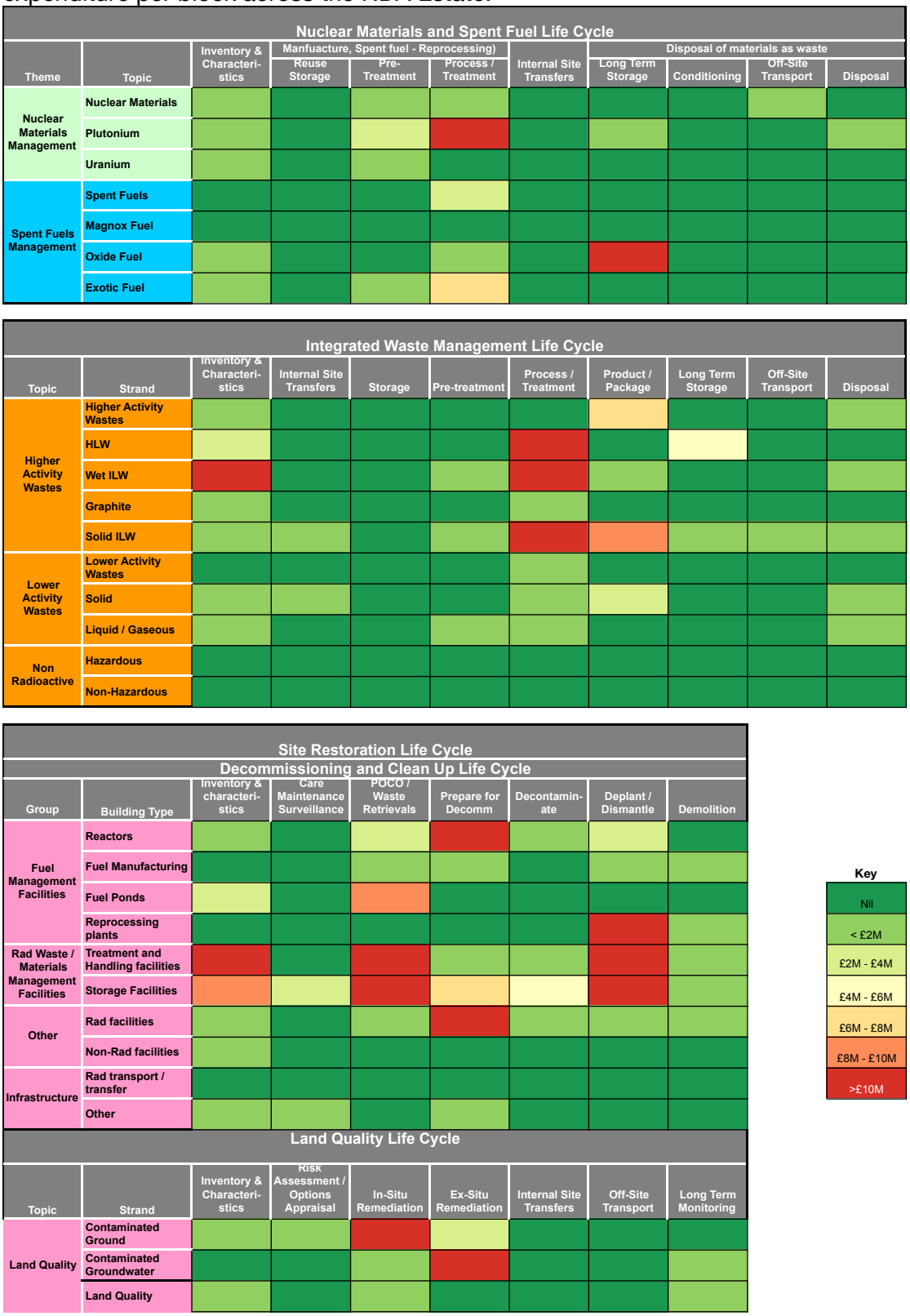

Figure 17: Technology Map – Needs + Risks

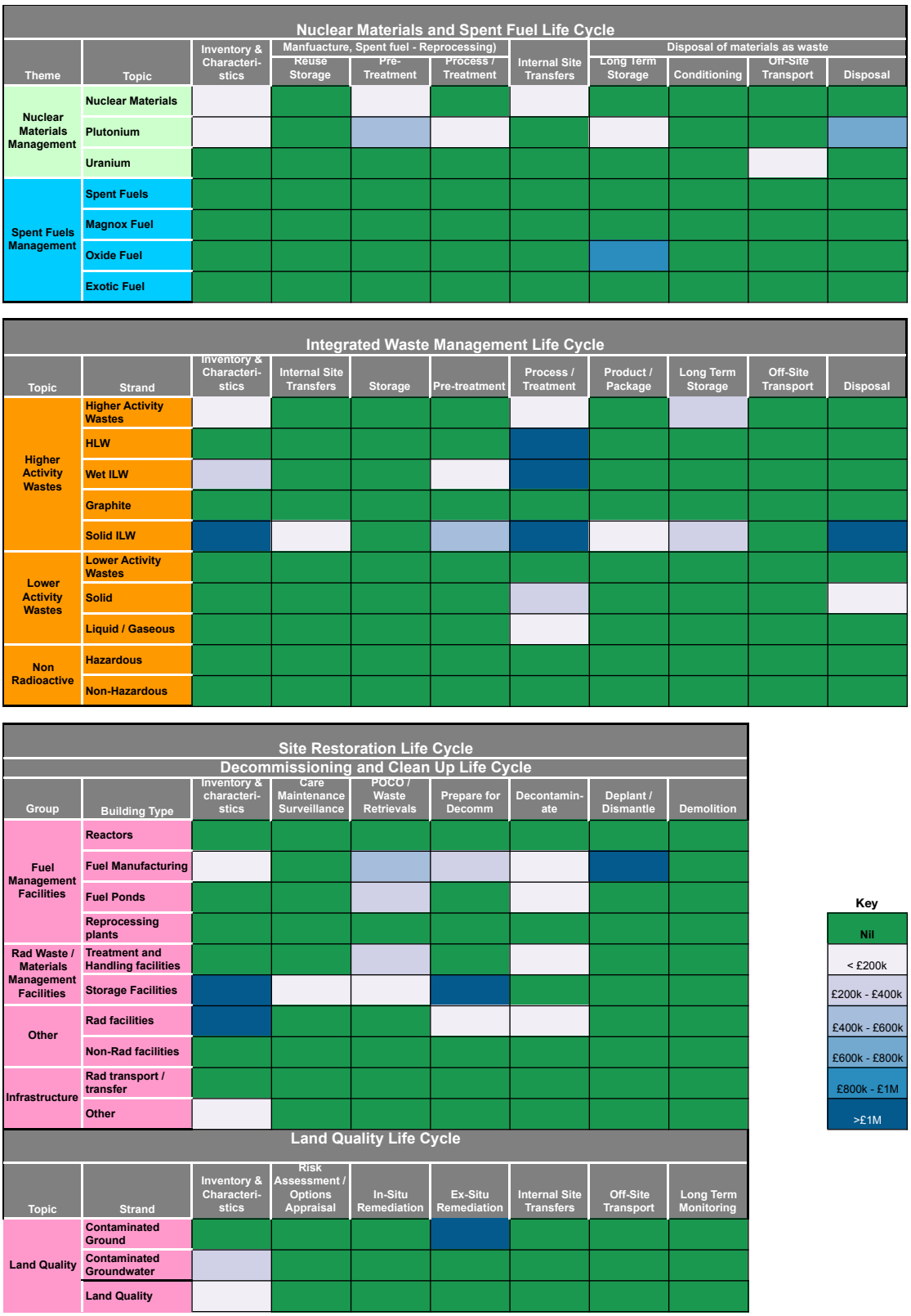

Figure 18: Technology Map - Opportunities

Figure 17 is the technology map looking at Needs + Risks. There are 16 areas of R&D expenditure over £10m, the top five of which are:

1. Process / treatment of wet ILW
2. Process / treatment of HLW
3. Process / treatment of solid ILW
4. Deplant/dismantle of storage facilities
5. POCO / Waste retrieval of storage facilities

Figure 18 is the technology map looking at Opportunities. These have a lower level of R&D expenditure compared to addressing needs and risks. There are 10 areas of R&D expenditure over £1m, the top five of which are:

1. Disposal of solid ILW is by far the largest group of opportunities
2. Process / treatment of wet ILW
3. Process / treatment of HLW
4. Inventory & characteristics of storage facilities
5. Inventory & characteristics of solid ILW

3.10 Synergies

Figure 19 illustrate potential synergies between SLCs across the NDA Estate. The width of the lines indicates the R&D expenditure in each strategic theme. Since Sellafield Limited (SL) has 90% of total R&D expenditure; it is that SLC that dominate the data.

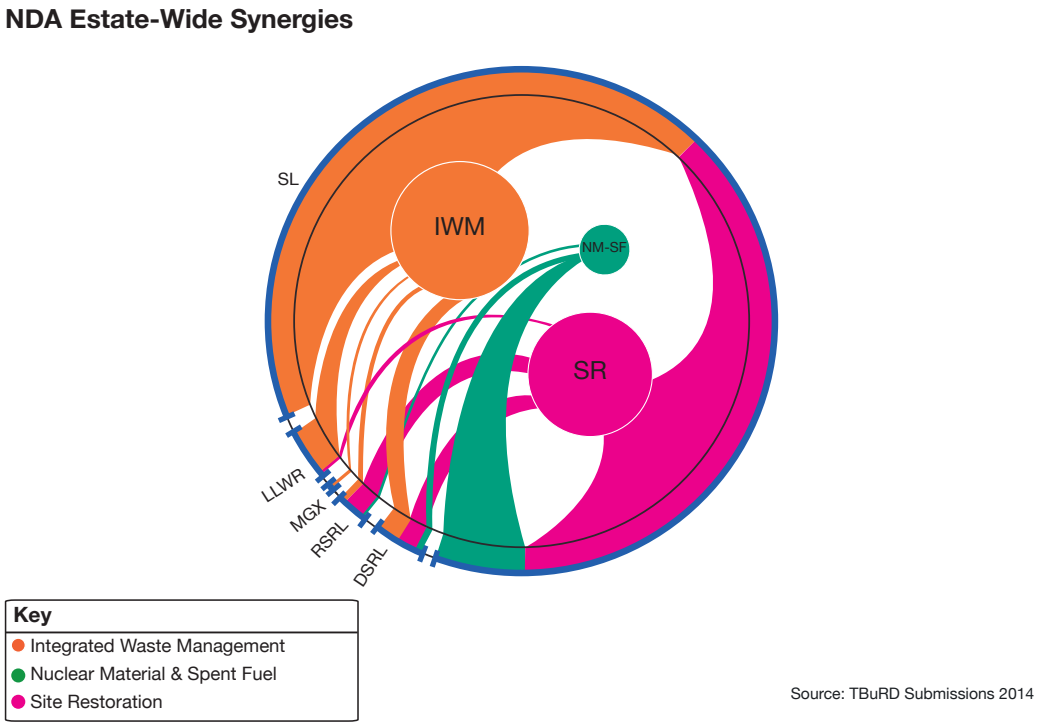

Figure 19: Synergies across the NDA Estate

From analysis of the R&D Tables, the areas for collaboration between SLCs are:

Waste Packaging & Storage

- ILW Stores – design, operation, monitoring
- 'Raw Waste' containerisation
- Graphite
- Mercury contained waste
- Sorting & segregation of miscellaneous items
- Sludges
- LoC applications

Decommissioning

- Vents, ducting, pipelines – characterisation and dismantling
- Decontamination – techniques & waste management
- Remote / robotics – characterisation, deplant, demolition
- Heels and residues – retrieval
- Size reduction – concrete, metal
- Demonstration facilities

Characterisation

- In-situ characterisation techniques - waste management & decommissioning
- Sr-90 analysis
- Modular laboratories

Land Quality

- In-situ remediation of land
- Ex-situ remediation of groundwater
- Long-term modelling & monitoring

4 Conclusions

The review of TBuRDs shows that all SLCs had good compliance with the requirements set out in EGG10. There were some general areas where improvements could be made including:

- Using consistent units for expenditure (£ rather than £k)
- Using consistent date fields rather than text
- Using the preset lists for content rather than creating additional ones
- Clarifying whether gaps in tables are zero or not known
- Using additional fields for explanatory text rather than extending preset fields

All SLCs could demonstrate that their Lifetime Plans were underpinned by sufficient and appropriate Research and Development (R&D).

Analysis of the 2014 TBuRD data shows that:

- Almost £800m will be spent on R&D tasks across the NDA estate over the next 20 or so years.
- The vast majority of expenditure (over 90%) will take place at Sellafield.

The majority of work is taking place in the following areas:

- Strategic Themes of Integrated Waste Management and Site Restoration
- Treatment & conditioning of ILW (wet potentially mobile & solid immobile) in rad treatment & handling facilities

There are a number of areas where there is potential for collaboration:

Waste Packaging & Storage

- ILW Stores – design, operation, monitoring
- 'Raw Waste' containerisation
- Graphite
- Mercury contained waste
- Sorting & segregation of miscellaneous items
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5 References

1. “Technical Baseline and Underpinning Research and Development Requirements”, Rev 6. NDA Doc No EGG 10

2. “Guide to Technology Readiness Levels for the NDA Estate and its Supply Chain”. NDA Document Livelink ref: 22515717

6 Abbreviations

ATR Annual Technical Report
DSRL Dounreay Site Restoration Limited
HAL Highly Active Liquor
HAW Higher Activity Waste
HLW High Level Waste
ILW Intermediate Level Waste
IWM Integrated Waste Management
LAW Lower Activity Waste
LLW Low Level Waste
LLWR Low Level Waste Repository Limited
LoC Letter of Compliance
MAUT Multi Attribute Utility Theory
MXL Magnox Limited
N/A Not applicable
NDA Nuclear Decommissioning Authority
NM Nuclear Materials
PA Programme Area
PCM Plutonium Contaminated Material
POCO Post Operational Clean Out
PWD Process Wiring Diagram
R&D Research & Development
RSRL Research Sites Restoration Limited
SF Spent Fuels
SL Sellafield Limited
SLC Site Licence Company
SR Site Restoration
TBuRD Technical Baseline and underpinning R&D
TMS Technical Management Summary
VLLW Very Low Level Waste