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Remedial Options Study
Hydro Aluminium Smelter Kurri Kurri

Prepared for:
Hydro Aluminium Kurri Kurri Pty Ltd

Prepared by:
ENVIRON Australia Pty Ltd

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Contents

EXECUTIVE SUMMARY

The Hydro Aluminium Kurri Kurri Smelter is located on Hart Road, Loxford near Kurri Kurri in New South Wales, Australia. The area subject to this study (herewith described as "the site") incorporates the former smelter area and the surrounding Hydro owned lands comprising approximately 2000 hectares.

Smelting activities ceased at the site in September 2012 and the site is currently in care and maintenance pending a decision on the future of the facility. In the event that site closure occurs, Hydro intends to divest the site in a manner that optimises employment opportunities, retains or improves environmental qualities and is economically viable to Hydro.

Hydro has a policy to accept responsibility for environmental issues at their facilities and to meet their statutory and social obligations to manage environmental legacies.

In addition, Hydro has determined that remediation to render land suitable for the proposed use will be undertaken as part of the overall closure process. This would both reduce the potential for future liability and optimise land value.

For the purpose of this report, five sources of materials requiring remediation, management or disposal (herewith described as material streams) have been identified:

1. Capped waste stockpile (formerly known as the Alcan Mound) Wastes.
2. SPL in storage and in pots.
3. Contaminated soils on the smelter site.
4. Contaminated soils, smelter wastes and other municipal wastes incorporating all Hydro owned land outside the smelter site.
5. Demolition wastes generated during the site demolition.

Groundwater down-gradient of the capped waste stockpile has also been considered for remediation. Impacted groundwater is considered a secondary source of contamination. Contamination of the groundwater is occurring from the capped waste stockpile, which is the primary source.

The objective of the study is to identify and evaluate appropriate remediation and management strategies to enable Hydro to make an informed decision regarding a remedial strategy for the site.

The study included the following methodology:

- A preliminary review of remedial options to identify those options that are applicable and feasible for each material stream.
- A detailed review of the feasible remedial options for each material stream using the following criteria to identify a preferred remediation option:
    - Likelihood of approval.
    - Remediation Cost.
    - Timeframe to complete.

  - Legacy, legal liability and required contingencies.
  - Risk.
- An assessment of the key remediation options for all material streams against these criteria to identify a preferred overall remediation strategy.
- Further development of select combined options that optimise the most suitable remediation for the materials present.
- Conducting a workshop with Hydro personnel to evaluate the options and discuss in detail the most suitable option, or options.
- Outline the next steps in developing a Remedial Action Plan and obtaining planning approval for the proposed strategy.

The remedial options study workshop was held over two days in February 2014. Representatives of Hydro (from Norway and Kurri Kurri), ENVIRON (Newcastle, Germany and USA) and Gilbert and Tobin (Sydney) attended the workshop.

The objectives of the workshop were:

1) To provide an overview of the remedial options considered and identify if other options should be considered.
2) Understand the option evaluation criteria considered and if other criteria should be considered.
3) Develop weighting factors for the criteria for the purpose of ranking the options.
4) Rank the combined options using the criteria and the weighting to determine a preferred option or options.
5) Outline the next steps in the remediation planning process.

The workshop team concluded that remedial options study identified the most likely feasible options for the site.

In addition to the five criteria identified in the study, the workshop team identified corporate responsibility (incorporating social impact, environmental impact and climate change impact) as a potential key differentiator between the options. This was added to the options assessment process, with a carbon footprint analysis of the two preferred options undertaken following the workshop.

The workshop team undertook weighting sensitivity analysis to determine which criteria were the process drivers, and how changes in priorities affected the weighting criteria. Options G4 (a new containment cell excluding spent pot lining and municipal waste) and G5 (a new containment cell including spent pot lining and excluding municipal waste) were found to be the two preferred options throughout this analysis.

The result of the analysis with a focus on the two key criteria for Hydro (remedial cost and risk) identified Option G5 as the preferred option.

Hydro and ENVIRON will now progress with planning for a new purpose built containment cell constructed within the site, which would include any remaining stored spent pot lining (and processing of stored spent pot lining would then cease).

This planning includes undertaking the following:

- Discussion of the remedial objectives and the preferred option with the Department of Planning and Infrastructure and the Environment Protection Authority to understand the regulatory position;
- Development of a Remedial Action Plan that outlines the proposed strategy for remediation. Assessment of remediation data gaps forms part of this planning step;
- Development of a Preliminary Environmental Assessment that summarises the proposal and a preliminary assessment of potential environmental issues. This would be submitted to the Department of Planning and Infrastructure to inform their preparation of the Director-General's Requirements for the Environmental Impact Statement;
- Preparation of an Environmental Impact Statement for the proposal for submission to the Department of Planning and Infrastructure in accordance with the Director-General's Requirements.

1 Introduction

This remedial options study has been prepared at the request of Mr. Richard Brown, Managing Director, Hydro Aluminium Kurri Kurri Pty Limited (Hydro).

The Hydro Aluminium Kurri Kurri Smelter is located on Hart Road, Loxford near Kurri Kurri in New South Wales, Australia. The area subject to this study (herewith described as “the site”) incorporates the former smelter area and the surrounding Hydro owned lands comprising approximately 2000 hectares.

Smelting activities ceased at the site in September 2012 and the site is currently in care and maintenance pending a decision on the future of the facility. In the event that site closure occurs, Hydro intends to divest the site in a manner that optimises employment opportunities, retains or improves environmental qualities and is economically viable to Hydro.

Site divestment options include future use of the site in four main categories:

1. Residential land, including rural residential land
2. Employment land
3. Conservation protection land
4. Rural land

To reduce the potential for future liability and to optimise land value, Hydro has determined that remediation to render land suitable for the proposed use will be undertaken as part of the overall closure process.

Contaminated land investigations of the site commenced in 2012 and are ongoing. These investigations have identified areas within the site that are not suitable for the proposed land use without remediation. Additionally, during decommissioning and demolition of the site, materials will arise that are defined as non-reusable and non-recyclable (unwanted) and will require disposal. Unwanted materials have been incorporated in this study due to the similarities between unwanted materials and other contaminated materials in terms of options for management or disposal.

To identify the best remediation approach to manage contaminated soils and unwanted materials, ENVIRON is undertaking this remedial options study.

1.1 Objective

The objective of the study is to identify and evaluate appropriate and feasible remediation and management strategies to enable Hydro to make an informed decision regarding a remedial strategy for the site.

2 Background

The Kurri Kurri Aluminium Smelter has operated at Hart Road Loxford, New South Wales since commissioning by Alcan in 1969. The site comprises a smelter area and surrounding Hydro owned lands, including land identified as a buffer zone to the smelter area.

Activities during site operations that may have given rise to contamination of land and groundwater included:

- Storage and emplacement of smelter wastes including Spent Pot Lining (SPL). Specifically this includes the capped waste stockpile (formerly the Alcan Mound) wastes and impacts to groundwater that have occurred down-gradient of the capped waste stockpile.
- Smelter operations including operation of a bake furnace, onsite diesel storage and use, onsite raw materials storage and use, stormwater management on the smelter footprint.
- Deposition to land of aerial particulates from stack emissions, particularly this relates to fluoride.
- Activities within Hydro owned land including unauthorised dumping by external parties, demolition of houses containing bonded asbestos cement building materials, pesticides use, historical landfilling (from smelter and other sources) and agricultural activities.

Investigations of these contaminant sources commenced in 2012 and are ongoing. Further detail regarding these investigations is available in other reports (and will be provided in detail in the final Remedial Action Plan for the site, however it is only provided in summary here).

During demolition and site decommissioning a range of materials will be generated that are neither reusable nor recyclable. A detailed schedule of quantities of these material is yet to be undertaken however they are likely to include:

- Asbestos containing products.
- Building materials contaminated with pitch or similar.
- Dusts including filter bags, and bagged dusts.
- General unsuitable building wastes, such as plasterboard, carpet, timber, vinyl, light fittings.

Additionally, Hydro maintains a contract for the treatment and external reuse of SPL that is currently stored within sheds on the site. The viability of this program is variable due to low demand for treated products and differences in demand for first and second cut SPL products. SPL is also retained in pots within the facility and this SPL is currently not under contract for treatment. As such alternative options for SPL treatment, disposal and management are also considered in this study.

For the purpose of this report, five sources of materials requiring remediation, management or disposal (herewith described as material streams) have been identified:

1. Wastes with the capped waste stockpile.
2. Spent Pot Lining in storage and remaining within pots.
3. Contaminated soils on the smelter site.
4. Contaminated soils, smelter wastes and other municipal wastes incorporating all Hydro owned land outside the smelter site (herewith described as contaminated soils and materials in the buffer zone).
5. Demolition wastes generating during the site demolition.

Additionally, remediation of groundwater down-gradient of the capped waste stockpile has also been considered. Impacted groundwater is considered a secondary source of contamination. Contamination of the groundwater is occurring from the capped waste stockpile, which is the primary source.

3 Preliminary Review of Remedial Options

The objectives of site remediation are to render the site suitable for the proposed land use and to remove environmental risks and legacies in a cost-effective, sustainable and socially and environmentally acceptable manner.

A number of options can be applied for the remediation of the materials streams identified at the site. A high level overview of potential options for the contaminants and materials present was undertaken and identified the options that are considered to be applicable, feasible (i.e. the option can achieve the remediation objective), permissible and in line with Hydro's environmental policies. These options are presented in **Table 3.1**. Those that failed these considerations were not assessed further.

The remedial options for each material can be implemented independently of each other, with limited interdependence occurring. When evaluating an overall site remediation approach, all combinations of all options should be considered. However, combining these options together to determine the best overall site approach realises over 600 remediation scenarios and is not practical to evaluate.

As such consideration of all possible combinations of all options is neither practical nor technically feasible. A more practical approach is to evaluate each material requiring remediation in isolation to determine the best options for that material. The next step is to combine options together to develop a short list of reasonable and feasible combined strategies.

Table 3.1 Contaminant Streams and Potential Remedial Options

Remediation Options	Capped waste stockpile	SPL in storage	Contaminated Soils in Smelter Footprint	Contaminated Soils and Materials in Buffer Zone	Demolition Wastes	Impacted groundwater (Capped waste stockpile)
No remediation	✓	×	×	×	×	✓
Continue existing treatment/management	✓	✓	N/A	N/A	N/A	✓
Encapsulate in-situ	✓	N/A	✓	✓	×	✓
Move to specifically designed containment cell adjacent to the capped waste stockpile	N/A	✓	✓	✓	✓	N/A
Treat and move to specifically designed containment cell adjacent to the capped waste stockpile	N/A	✓	✓	✓	✓	N/A
Encapsulate in purpose built containment cell	✓	✓	✓	✓	✓	N/A
Treat and encapsulate in purpose built containment cell	✓	✓	✓	✓	✓	N/A
Dispose off site	✓	✓	✓	✓	✓	✓
Treat and dispose off site	✓	✓	✓	✓	✓	✓
Alternative onsite treatment (destruction)	✓	✓	✓	✓	✓	N/A

× – not feasible and/ or permissible
✓ – feasible and permissible
N/A – does not apply

4 Regulatory Framework

As discussed in Chapter 3, the preliminary review of remediation options identified those options that were not permissible or were highly unlikely to be approved (as they would be considered unfavourable by relevant agencies or not complying with Hydro environmental standards). Those that were considered to have potential for approval were considered in detail.

Table 4.1 outlines the implications of Commonwealth, NSW and local government legislation and regulations applicable that are key to the approval of remediation and demolition activities on the site. Any planning approval submission would be required to address some or all of the regulations and legislation in order to achieve planning approval.

Appendices A to G provide a detailed description of the implications of the key legislation and regulations that would influence the likelihood of approval of each option.

The options considered in Appendices A to G (and summarised in Chapter 6) have varying degrees of likelihood for approval. Those considered to have a low likelihood of approval could still be approved.

However, to achieve approval for those with a low likelihood of approval could potentially require significantly more time and cost due to:

- The additional time and costs for additional specialist studies required to address government agency concerns and justify the proposed method as the reasonable and feasible option.
- Additional time and costs associated with extended negotiations with government agencies.
- The importance that government agencies place upon community and stakeholder concerns could result in additional studies, community consultation requirements and a range of extensive and expensive mitigation measures (if approved).
- In the event that approval of the proposed option was rejected by the relevant approval body, additional time and costs would be required to either: amend the proposed development and resubmit for approval (potentially recommencing the planning approval process); or challenge the decision in the NSW Land and Environment Court.

Therefore consideration of likelihood of approval in this context reflects the level of effort in time and cost to achieve approval.

Maintaining a good working relationship with government agencies and stakeholders through the approval process for the remediation and demolition activities is an important objective to achieving sustainable outcomes for the site land use rezoning and redevelopment process that would be occurring concurrently.

Table 4.1 Key Relevant Legislation and Regulations

Legislation or Regulation	Relevance
Commonwealth	
Protection of the Environment and Biodiversity Conservation Act 1999 (Commonwealth) (EPBC Act)	Approval of the Commonwealth Minister for the Environment is required for an action which has, would have or is likely to have a significant impact on "matters of National Environmental Significance" (NES matters). Potentially applicable NES matters include: • Listed nationally threatened species and ecological communities. • Listed migratory species. If there is a potential for a significant impact on NES matters, a referral would be submitted to the Commonwealth Department for the Environment to determine if it is "controlled action". This would require approval of the Commonwealth Minister for the Environment. A bilateral agreement between the Commonwealth and NSW Governments accredits the NSW approval system to consider the EPBC Act issues.
New South Wales	
Environmental Planning and Assessment Act 1979 (EP&A Act)	The EP&A Act is the principal law overseeing the assessment and determination of development proposals in NSW. Part 4 of the EP&A Act provides control for development requiring development consent from a consent authority. This includes consent for local and regional development, but also includes the approval process for state significant development.
Environmental Planning and Assessment Regulation 2000 (EP&A Regulation)	Schedule 1 of the EP&A Regulation identifies a number of activities as "designated development" requiring preparation of an environmental impact statement (EIS) as the assessment document. This includes "Waste management facilities or works" and "Contaminated soil treatment works", which are potentially applicable to a number of the remediation options.
State Environmental Planning Policy 55 – Remediation of Land (SEPP 55)	Under SEPP 55 remediation work are permissible in any zone, regardless of any provision in another environmental planning instrument (such as a local environmental plan). SEPP 55 also establishes: • Category 1 remediation works: remediation that required development consent. This includes remediation that is: designated development; likely to have a significant impact on ecological values; deemed as requiring development consent by another SEPP; within a sensitive land zone under

Table 4.1 Key Relevant Legislation and Regulations

Legislation or Regulation	Relevance
	a local environmental plan; or not consistent with a contaminated land planning guideline made by the relevant council. • Category 2 remediation works: remediation which does not require development consent. This is any remediation that is not deemed category 1 remediation works.
SEPP (State and Regional Development) 2011 (SRD SEPP)	The key implications of the SEPP (S&RD) are: • It identifies particular developments that meet location or scale criteria to be defined as state significant development. • It defines what activities are defined as "regional development" and therefore approved by regional panels. Schedule 1 of the S&RD SEPP includes "Waste and resource management facilities" as a category of state significant development. This is applicable to developments that include the placement of more than 1000 tonnes of untreated SPL into a landfill or containment cell. The works would be deemed regional development if they have a capital investment value of more than $20 million. Below this value approval responsibility remains with Council.
Protection of the Environment Operations Act 1997 (POEO Act)	The POEO Act is the primary legislation for the management and control of pollution of the environment. Schedule 1 of the POEO Act identifies specific developments (scheduled activities) that require an Environment Protection Licence (EPL) issued by the Environment Protection Authority (EPA). Two EPLs currently apply to the site: one to Hydro for operation of the smelter; and one for Regain's treatment of SPL. Schedule 1 includes "contaminated soil treatment" and "Waste disposal (application to land)" which are potentially applicable to a number of options.
Environmentally Hazardous Chemicals Act 1985	A Chemical Control Order was issued under the act in relation to aluminium smelter wastes containing fluoride and/ or cyanide and its disposal, processing, storage, transportation, selling and use. In general a licence from the EPA is required to undertake such activities. A licence was granted in 1993 to place the untreated SPL in the capped waste stockpile, provided the capping was installed to prevent the escape of leachate and wind-blown dust.

Table 4.1 Key Relevant Legislation and Regulations

Legislation or Regulation	Relevance
	Any option that includes the management of SPL (treated or untreated) can only be implemented if it is granted a licence from the EPA, or is consistent with the existing licence applicable to the capped waste stockpile.
Cessnock Local Environmental Plan 2011 (Cessnock LEP)	The Cessnock LEP is the key local land use planning document for the Cessnock local government area. It establishes: • The land use zonings throughout the local government area. • The activities within these zones that are either permissible without consent, permissible with consent, or prohibited. • Development that is exempt or complying development. The Cessnock LEP is applicable to the vast majority of the site.
Maitland Local Environmental Plan 2011 (Maitland LEP)	The Maitland LEP is the key local land use planning document for the Maitland local government area. As with the Cessnock LEP, it establishes development controls. The Maitland LEP is applicable to the northeast corner of the site.

It should be noted that the regulatory framework advice in this report is based on the legislation in place as of 1 May 2014. The NSW Government has tabled the Planning Bill 2013, which would replace the EP&A Act as the planning legislation in NSW. This may be enacted prior to commencing or during any planning approval process for remediation at the site. Based on information available at the time of preparing this report, the approval process that would potentially apply to the remedial options under the bill is generally consistent with that currently under the EP&A Act.

Concurrent to attaining planning approval for remediation and demolition activities, Hydro is preparing a rezoning application for the site. The majority of the site (including the smelter area) is currently zoned RU2 (Rural Landscape) Zone under the Cessnock LEP. The remediation and demolition options considered are all permitted within this zone. The rezoning proposes the smelter area being zoned IN1 (General Industrial) and IN3 (Heavy Industrial). Under the Cessnock LEP, “Waste disposal facilities” are permissible with development consent. This means that any options that include placement of materials within a landfill or containment cell within the proposed new zones would be permitted with development consent. Similarly, remediation works are permissible within the proposed new zones.

5 Basis for Evaluation

5.1 Evaluation Criteria

Chapter 3 provided an initial evaluation of the remediation options for each of the five material streams (and groundwater) to determine which were applicable and feasible at a high level. This evaluation focused on the applicability of technology and likelihood of approval. Any remaining option is therefore considered to be able to be approved and has applicable technology. These options are therefore considered feasible for the material streams at the site.

Those feasible remedial options for each material stream have been subjected to evaluation against the criteria listed and defined in **Table 5.1.**

These key criteria have been selected for evaluation of the options due to the following:

- Remediation costs are likely to be a significant investment for Hydro. Therefore it is integral to the consideration of each option.
- In addition to the upfront remediation costs, legacy costs could potentially pose a significant future financial responsibility to Hydro, and therefore it is important to understanding the overall cost implications.
- Hydro needs to understand the duration of its direct association with the site during the remediation activities, as well as the potential implications it may have on the redevelopment/ future use of the site.
- Due to the significant time and cost implications associated with the approval process it is critical that only those options that are permissible with a likelihood of approval are considered. The environmental, health and economic risk associated with the potential failure of the solution to meet, and to continue to meet, the remediation objectives due to technical and engineering issues could potentially offset any cost benefits of an option.

Appendices A to F provide a description of each remedial option for each material stream (including groundwater), as well as a detailed discussion of the implications of the criteria listed in **Table 5.1**. A summary of this information is provided in **Chapter 6**.

Table 5.1 Remedial Option Evaluation Criteria

Criteria	Description
Likelihood of approval	Likelihood of approval is evaluated following a review of key legislation, regulations and policies. Key legislation considered for all options are outlined in **Table 4.1.** Other key regulations or policies are considered where it is critical to the approval of a particular option. In the event that any element of an option is not permissible or has a low likelihood of approval, this option was ruled out of further investigation.
Remediation Cost	Remediation costs were determined for each option on the basis of the option description and a set of assumptions made about the option. Assumptions are listed in the Appendices. Cost is determined quantitatively for each option and is considered to be approximate. A range is provided for each cost estimate and includes an estimation of accuracy. At this stage the accuracy is estimated to be +30/-50% for all costing presented within this document. Remediation cost for the option includes all engineering, planning, implementation and validation costs, unless otherwise stated. Costs are calculated in 2014 Australian dollars. Costs for demolition of structures at the site are not included. For example, removal of the SPL in the existing pots.
Timeframe to complete	The evaluation of timeframe is quantitative and incorporates estimates of times based on professional experiences for each section of the project. Timeframes for the option includes: • Approvals • Investigation/ Design/ Tender • Construction/ Implementation • Future Monitoring/ Maintenance • Reporting Time ranges are provided for each option and outline an approximate duration for each element. In some cases, the tasks are able to work in parallel and this has been incorporated when providing the overall project timeline.

Table 5.1 Remedial Option Evaluation Criteria

Criteria	Description
Legacy, legal liability and required contingencies	Legacy is defined as the potential long term liability that may be incurred by Hydro for the life of the project. Legacy cost is determined quantitatively for each option. Legacy relates to both future management costs and liability provisioning represented by occurrence of a future event. Future management and monitoring costs and the likelihood of these occurring can reasonably be evaluated for most remediation strategies. The extent to which liability is evaluated is governed by the cost of the event that may occur; the likelihood of it occurring and the timeframe in which it occurs. These factors are uncertain and a number of assumptions are required. To provide an assessment that is meaningful ENVIRON has adopted the following approach:- • The event is described as the most significant (in terms of cost and potential for prosecution) event that could occur; • Costs for the event are determined for a reasonable case, rather than a reasonable worse case approach; • Likelihood is evaluated as a percentage, and that percentage is used to calculate the fraction of costs to provision. For example, if the event has a 10% likelihood of occurring, then the provisions cost is 10% of the remediation cost. • Event frequencies are estimated: for example, is likely to occur once in 30 years. These timeframes are used to determine the net present value cost for the event. • For maintenance a period of 100 years has been evaluated in net present value. A 100 year timeframe is conservative and in excess of the 30 year timeframe recommended by the USEPA. However, this length of provisioning was incorporated to allow Hydro to fully evaluate the legacy cost implications. • A discount rate of 3%, based on the Australian long term inflation rate (and it is conservative), has been adopted for the calculation of net present value. • All costs are presented in Australian Dollars ($AUD).
Risk	The evaluation of risk is qualitative. The evaluation considers the risk of events occurring in the future post-remediation stage that may require investigation, and possibly restoration or upgrading of controls or management measures. This event is referred to as a ‘failure’ in the options study, referring to the failure of the solution to continue to meet the remediation objectives. The event or failure could comprise a number of factors, such as cap failure, liner failure, treatment solution failure or business unit failure. The relevant risks are described in each section however are not likely to be exhaustive, and is designed to capture only those risks considered to be most significant to the project. Risk is evaluated in terms of technological, environmental and financial consequence and the likelihood of the consequence occurring. The method for calculating the risk ranking is described in the following tables.

Table 5.1 Remedial Option Evaluation Criteria

Criteria	Description

	Environmental Consequence	Commercial Consequence
Catastrophic	Significant irreversible damage. Significant remediation actions required. Potential for regulatory prosecution.	≥$10mil
Major	Major effect, but long term reversible. Significant remediation actions required.	≥$5mil - <$10mil
Moderate	Serious effect, but short term reversible. Remediation actions required.	≥$0.5mil - <$5mil
Minor	Medium effect	≥$0.1mil - <$0.5mil
Insignificant	Minor effect	<$0.1mil

	Likelihood
Rare	May occur only in exceptional circumstances
Unlikely	Could occur at some time
Possible	Might occur at some time
Likely	Will probably occur in most circumstances
Almost Certain	Is expected to occur in most circumstances

Risk Ranking Matrix

Catastrophic	5	10	15	20	25
Major	4	8	12	16	20
Moderate	3	6	9	12	15
Minor	2	4	6	8	10
Insignificant	1	2	3	4	5
	Rare	Unlikely	Possible	Likely	Almost certain

Criteria that could be considered in further review of shortlisted remediation options (if required) include:

- Sustainability of each remediation strategy. Sustainability has not been undertaken as this is not considered a key differentiator between the options.
- Revenue and saleability of the sites. This aspect of site saleability, depreciation or appreciation following remediation has not been considered.

As discussed in Section 7.2.2 Corporate Responsibility was identified during the remedial options study workshop in February 2014 as an additional criterion for assessment of the options.

5.2 Cost Estimate Limitations

Cost estimates are based on the best available information regarding the remedial alternatives. Changes are likely to occur as a result of new information, fluctuations in the market conditions over time, economies of scale, and engineering design. This cost estimates is based on our project knowledge, which contains inherent uncertainties, standard rates and fees including vendor estimates and conceptual remediation designs.

Cost estimates should be considered as “Legacy”. American Society for Testing and Materials (ASTM) Standard E2620 defines Order of Magnitude as being accurate to within plus 50% or minus 30%.

As discussed previously, the process is to be iterative with the remedial options study defining the scope of further investigation through which the costs of the preferred remedial option are further refined.

All costs provided are in 2014 Australian Dollars and exclude applicable tax.

5.3 Comparing the criteria

Options can be considered by comparing the actual value of each of the criteria (cost, time, risk and legacy) for each option. A presentation of sample data is presented in **Figure 5.1**. However, this figure shows that it is difficult to identify a preferred option, as the significance of each of the criteria is not considered. For example, option 1, is favoured for remediation cost, but has the highest risk level and legacy cost. Option 3 performs well across all criteria, though only one of the four criteria is the lowest for the options considered.

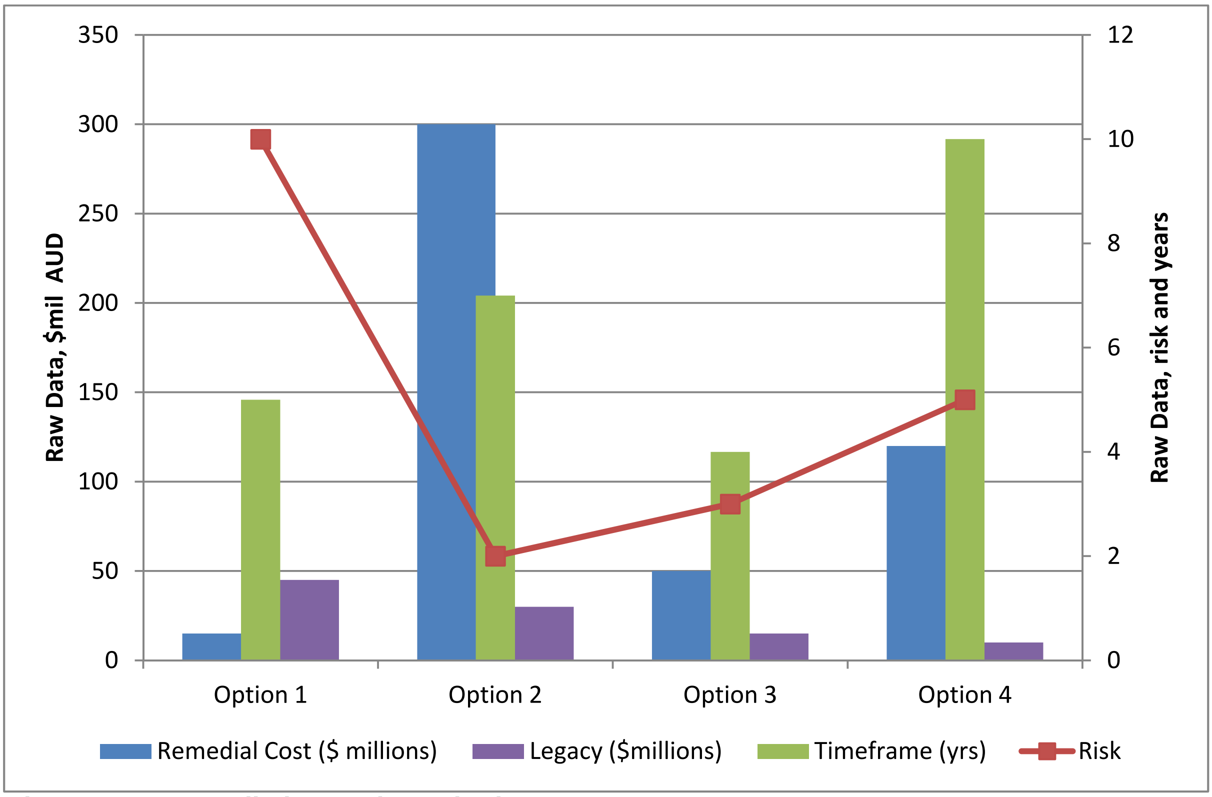

Figure 5.1 – Remediation Option Criteria, Raw Data

To provide a comparison between the criteria, data was normalized on a scale of 1 to 10 where increasing numbers reflected worsening performance. The normalization is shown in **Figure 5.2** for the sample data set. In this example, Option 1 would not be the preferred option, having the highest score for three of the four criteria.

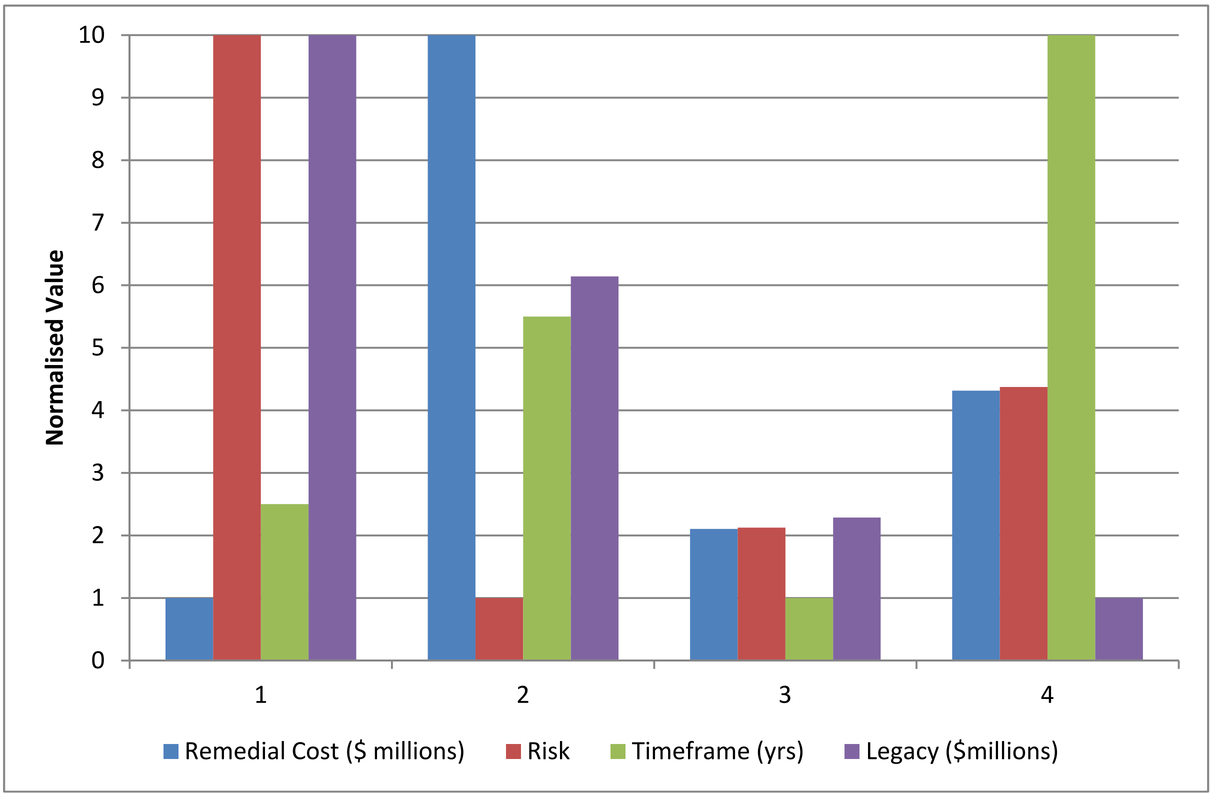

Figure 5.2 – Remediation Option Criteria, Normalised

To develop the relationship between the data, the data was weighted using weightings. The weightings were developed by Hydro in consultation with ENVIRON at a workshop held in February 2014. Representation of this data in a cumulative bar chart is then able to identify the preferred option or options.

The weightings for each option total to 10, and therefore the theoretical maximum normalised weighted ranking is 100. A presentation of sample normalized weighted data is presented in **Figure 5.3**. On this basis, Option 3 would be preferred. In some cases, a number of options may perform similarly. Using the same methodology, these options can be compared against each other to provide a more accurate comparison.

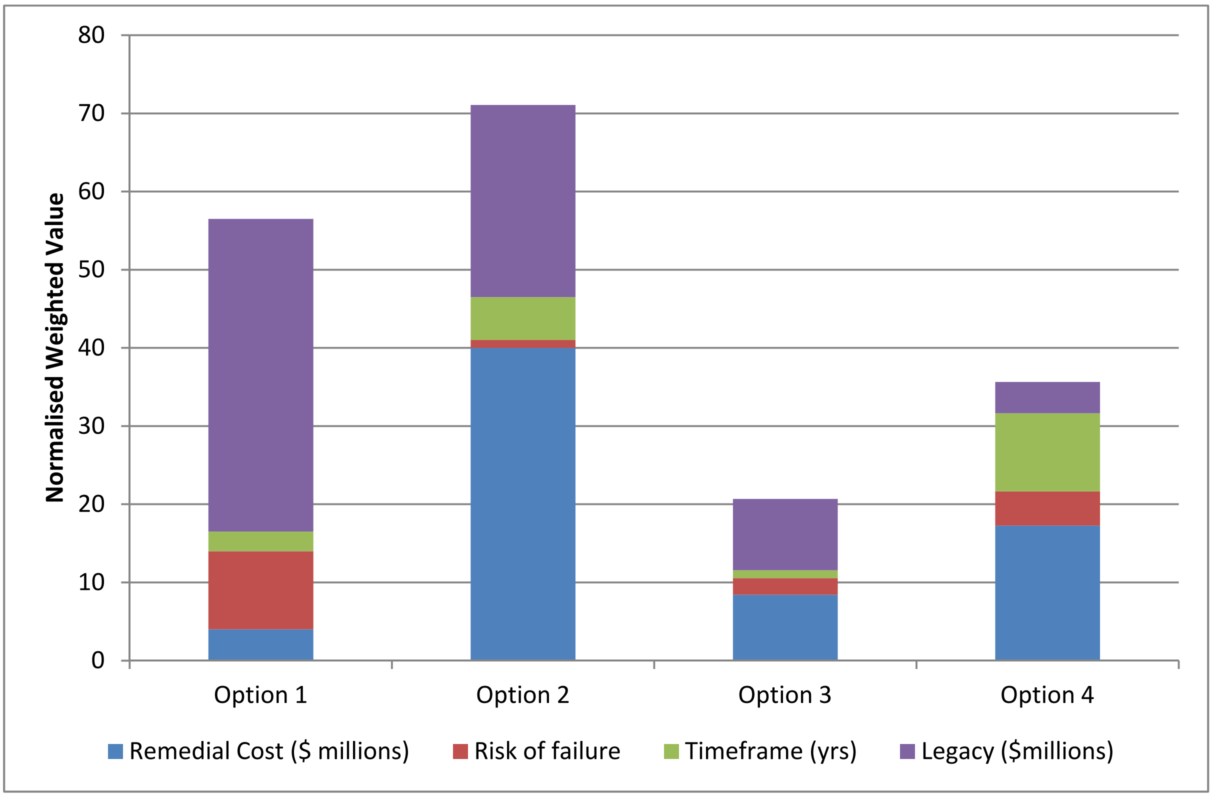

Figure 5.3 Remediation Option Criteria, Normalised and Weighted

6 Evaluation of Remediation Options

The detailed options evaluation using the basis of evaluation described in Chapter 5 is presented in Appendices A to F. This includes a detailed description of each option and a detailed evaluation of the likelihood of approval and the remediation criteria.

Tables 6.1 to **6.6** provide a summary of the evaluation of the remediation options for the five material streams (and groundwater) using the methodology described in **Chapter 5**. This includes:

- A description of the type and quantity of the materials in the material source.
- A brief description of the remediation methodology.
- The likelihood of approval.
- Remediation costs.
- Legacy costs.
- Timeframe to completion.
- Risk of failure.
- The remediation option criteria normalised and weighted shown in a cumulative bar chart.

6.1 Capped waste stockpile

Table 5.1 Capped waste stockpile

Volume m^3	84,000 – 126,000	**Tonnage (T)**	151,200-226,800	**Description of materials:**	SPL and other materials including anode materials were stockpiled in the eastern portion of the site for the period 1969 to 1992. Mixed smelter wastes comprising spent pot lining and to a lesser extent amounts of other solid wastes generated at the smelter including cryolite, alumina, floor sweepings (alumina, cryolite carbon) shot blast dust (carbon, steel shot), cement, potlining mix and small amounts of other materials including plastic, wood and steel. This material was capped in 1993, using the following strategy: • A gas control layer of 150mm thickness. • A hydraulic barrier of 900mm thickness with permeability of 1 x 10-7cm/s. • A general fill layer of 450mm thickness. • A vegetation layer of 150mm thickness.

Option	Brief Description	Likelihood of Approval	Remediation Costs ($M AUD)	Legacy Costs ($M AUD)	Timeframe (years)	Risk Ranking
A1. Continue existing treatment/ management	Continuation of the existing treatment and management and no physical remediation or improvement works.	Low to very low	0.4	4.7	3 - 4years	20
A2. Encapsulate in-situ – improve the current capped waste stockpile	Installation of a vertical cutoff wall around the mound and connecting in to the underlying clays at depths of around 6m to 15m.	Moderate to high	4.8	2.4	3 - 4 years	10
A3. Encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell.	Moderate to high	16.6	1.5	3 - 4 years	3
A4. Treat and encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell in combination with a pre-treatment step	Moderate to high	66.0	1.0	8 – 9 years	2
A5. Landfill off site	Disposal of the 'as is' waste off site to licensed landfill facility (in New South Wales, Queensland or international)	NSW – Moderate QLD - Moderate Int'l – Very low (not considered further)	NSW – 284 QLD – 246 Int'l – N/A	Nil	NSW – 5 - 6 years QLD – 5 - 6 years Int'l – N/A	1 1 N/A
A6. Treat and landfill off site	Disposal of the treated SPL with mixed smelter waste off site to licensed landfill facility (in New South Wales or Queensland) following treatment at the site	Moderate to high	NSW – 184 QLD – 210	Nil	NSW – 16 - 17 years QLD – 16 - 17 years	1 1
A7. On site Treatment to Achieve Complete Destruction	The processing of mixed wastes to remove fluorides and cyanides, followed by carbon value capitalisation in a waste to energy process.	Moderate	108	Nil	17 - 19	12

6.2 SPL in Storage

Table 5.2 SPL in Storage

Volume m^3	1st cut: 27,800 2nd cut: 27,800	Tonnage (T)	1st cut: 50,000 2nd cut: 50,000	Description of materials:	Spent potlining (SPL) is stored in sheds within the Smelter area of the site and remains in pots.

Option	Brief Description	Likelihood of Approval	Remediation Costs ($M AUD)	Legacy Costs ($M AUD)	Timeframe (years)	Risk Ranking
B1. Continue existing treatment/ management	Hydro currently has a contract with the service provider Regain to treat SPL stored within sheds in the Smelter area of the site. Regain would continue to treat SPL until completion.	High	53	Nil	8 - 9 years	6
B2. Alternative local treatment option	Weston Aluminium has declared an interest in treating the SPL at its facility.	Moderate	60	Nil	8 - 10 years	12
B3. Move to specifically designed landfill adjacent to the capped waste stockpile	The material would be placed in a cell adjacent and adjoining the capped waste stockpile.	Low	6.5	1.4	3 - 4 years	15
B4. Treat and move to specifically designed landfill adjacent to the capped waste stockpile	The material would be treated prior to placement in a cell adjacent and adjoining the capped waste stockpile	Low	71.7	1.1	8 - 9 years	6
B5. Encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell.	Low	6.7	0.9	3 - 4 years	10
B6. Treat and encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell in combination with a pre-treatment step to remove PAH's cyanides and fluorides from the contaminated soils	Moderate to high	75.3	1.1	8 – 9 years	6
B7 Landfill off site	Disposal of the 'as is' SPL off site to licensed landfill facility (in New South Wales, Queensland or international)	Low to very low	NSW – 98.5 QLD – 85.3 Int'l – 72.2M	Nil	NSW – 3 - 4years QLD – 3 - 4 years Int'l - – 10 - 11 years	1 1 1
B8. Treat and landfill off site	Disposal of the SPL off site to licensed landfill facility (in New South Wales or Queensland) following treatment at the site	High	NSW - 103 QLD – 107	Nil	NSW – 6- 7 years QLD – 6 - 7 years	1 1
B9. Treat internationally	Transport the untreated SPL for treatment internationally	Moderate	58.3	Nil	10 – 11 years	1
B10. On site treatment to achieve complete destruction	Processing of the SPL to remove fluorides and cyanides, followed by carbon value capitalisation in a waste to energy process.	Moderate to high	50.8	Nil	11 - 13	12

6.3 Contaminated Soils in Smelter Footprint

Table 5.3 Contaminated Soils in Smelter Footprint

Volume m^3	14,000 – 41,000	**Tonnage (T)**	23,500 – 69,600	**Description of materials:**	Contaminated soils within the smelter footprint are: • Sediment within the dams and drainage lines • Onsite soils contaminated with PAHs and TPH and/or fluoride • Fluoride impacted soils between the Pot Lines

Option	Brief Description	Likelihood of Approval	Remediation Costs ($M AUD)	Legacy Costs ($M AUD)	Timeframe (years)	Risk Ranking
C1. Encapsulate in-situ	Encapsulation barriers could include surface filling, hardstands, roads and buildings. For the cost estimate, it has been assumed that the barrier is formed by the placement of 0.5m of clean soil over the contaminant footprint.	High	$5.8	0.5	2 to 3years	6
C2. Move to specifically designed landfill adjacent to the capped waste stockpile	The material would be placed in a cell adjacent and adjoining the capped waste stockpile.	Moderate to high	3.6	1.4	2 - 3 years	15
C3. Treat and move to specifically designed landfill adjacent to the capped waste stockpile	The material would be treated prior to placement in a cell adjacent and adjoining the capped waste stockpile	Moderate to high	38.9	1.5	4 - 5years	6
C4. Encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell.	High	2.5	0.9	2 - 3 years	4
C5. Treat and encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell in combination with a pre-treatment step to remove PAH's cyanides and fluorides from the contaminated soils	High	36.7	1.0	3 - 4 years	2
C6. Dispose off site	Material would be removed and transported to a licensed waste management facility	High	32.8	Nil	1 - 2 years	1
C7. On site treatment to achieve complete destruction	Processing of the wastes to contaminants, followed by carbon value capitalisation in a waste to energy process.	Moderate to high	25.3	Nil	7 – 9 years	12

6.4 Contaminated Soils and Materials in Buffer Zone

Table 5.4 Contaminated Soils and Materials in Buffer Zone

Volume m^3	19,455 – 58,245	**Tonnage (T)**	35,924 – 115,236	**Description of materials:**	Contaminated soils in the Buffer Zone are at the following locations and types: • Dickson Road Landfill: Smelter related waste; contaminated soils; and general municipal waste. • Glen Main Landfill: Smelter related waste; contaminated soils; and general municipal waste. • Former Municipal Landfill: Municipal Waste. • Other Hydro owned land: General Asbestos (bonded) in soils; and general refuse. • Clay borrow pit: buried refractory brick waste; and stockpiled bake oven refractory, concrete and asphalt in mixed stockpiles.

Option	Brief Description	Likelihood of Approval	Remediation Costs ($M AUD)	Legacy Costs ($M AUD)	Timeframe (years)	Risk Ranking
D1. Encapsulate in-situ	Encapsulation barriers could include surface filling, hardstands, roads and buildings. For the cost estimate, it has been assumed that the barrier is formed by the placement of 0.5m of clean soil over the contaminant footprint.	High	4.1	2.0	2 – 3 years	9
D2. Move to specifically designed landfill adjacent to the capped waste stockpile	The material would be placed in a cell adjacent and adjoining the capped waste stockpile.	Moderate to high	7.6	1.4	3 -4 years	15
D3. Treat and move to specifically designed landfill adjacent to the capped waste stockpile	The material would be treated prior to placement in a cell adjacent and adjoining the capped waste stockpile	Moderate to high	16.6	1.5	3 -4 years	6
D4. Encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell.	Moderate to high	8.0	0.9	3 -4 years	2
D5. Treat and encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell in combination with a pre-treatment step to remove PAH's cyanides and fluorides from the contaminated soils	Moderate to high	18.4	0.9	3 -4 years	2
D6. Landfill off site	Material would be removed and transported to a licensed waste management facility	High	42.1	Nil	1 - 2years	1
D7. Combination off site and on site disposal	Separation of municipal waste and the offsite disposal of these materials combined with the onsite retention of contaminated soils and smelter related wastes within a properly design containment cell located within the Hydro owned lands.	High	11.7	1.0	3 - 4 years	2
D8. On site treatment to achieve complete destruction	Processing of the wastes to contaminants, followed by carbon value capitalisation in a waste to energy process.	Moderate to high	45.7	Nil	10 – 12 years	12

6.5 Demolition Waste

Table 5.5 Demolition Waste

Volume m^3	Unknown, allow 20,000 – 40,000	**Tonnage (T)**	Unknown, allow 14,000 – 26,000	**Description of materials:**	Non-recyclable or non-reusable materials from demolition of smelter structures

Option	Brief Description	Likelihood of Approval	Remediation Costs ($M AUD)	Legacy Costs ($M AUD)	Timeframe (years)	Risk Ranking
E1. Move to specifically designed landfill adjacent to capped waste stockpile	The material would be placed in a cell adjacent and adjoining the capped waste stockpile.	Moderate to high	2.8	0.7	3 – 4 years	15
E2. Encapsulate in purpose built containment cell	Encapsulation on site within a purpose built containment cell.	Moderate to high	3.0	0.9	1 – 2 years	10
E3. Dispose off site	Material would be removed and transported to a licensed waste management facility	High	8.9	Nil	1 – 2 years	1
E4. On site treatment to achieve complete destruction	Processing of the wastes to contaminants, followed by carbon value capitalisation in a waste to energy process.	Moderate to high	11.3	Nil	6 – 8 years	12

6.6 Groundwater

Table 5.6 Groundwater						
Litres (ML) 54	**Description of materials:**	The leachate impacted water that may require treatment comprises: • Ex-filtrating groundwater that is discharging from the capped waste stockpile from the surface and near surface groundwater that is considered to be ephemeral and has the potential to discharge to the surface. • Potential leachate contained within the capped waste stockpile. • Leachate impacted groundwater beneath and extending from the capped waste stockpile in a north east direction.				
Option	**Brief Description**	**Likelihood of Approval**	**Remediation Costs ($M AUD)**	**Legacy Costs ($M AUD)**	**Timeframe (years)**	**Risk Ranking**
F1. No remediation	No physical remediation of the site but would require on-going groundwater monitoring for a period of approximately 5 years.	Low	2.4	0.2	13 - 15	10
F2. Continue existing treatment/ management	The interception of shallow perched leachate down gradient of the capped waste stockpile by two interception trenches and storage of the leachate in on-site ponds for evaporation	Moderate	2.4	1.6	10 - 12	9
F3. Remove groundwater by pumping	The removal of leachate via collection and storage of water in site ponds followed by chemical treatment designed by ENVIRON, then disposal of treated effluent by evaporation.	Moderate - high	4.5	0.6	7 - 8	9

7 Combined Options

The evaluation undertaken in Chapter 6 identified the preferred remediation options for each material stream when considered in isolation. However, as all materials need to be managed, the next step was to evaluate options for disposal of all materials as one activity. This included consideration of:

- The potential for, and feasibility of, the preferred remediation options occurring concurrently.
- The economies of scale associated with treatment of materials using one method (for example, placement multiple material streams in a containment cell).

Such a review included consideration of the potential economies of scale and other synergistic benefits, meaning that the option that has the best weighted score for a particular material stream (when considered in isolation) may not be the best for the overall strategy.

Table 7.1 examines the options that were subject to the preliminary review (as described in Chapter 3) and identifies those options that are, following the detailed options review, considered as potential options as part of an overall strategy, and those that have been excluded from further consideration.

For all options it is assumed that all recyclable or reusable demolition waste would not be disposed of on site, that clay borrow pit materials are segregated for recycling, and that municipal waste from the Glen Main Landfill (within Residential Parcel 1) are disposed off-site (as it is easily separated from other wastes).

Table 7.2 summarises the evaluation of the remediation options for the five material streams. This evaluation also uses the methodology described in Chapter 5.

The detailed combined options evaluation is presented in **Appendix G**.

Table 7.1 Contaminant Streams and Potential Remedial Options (Following Detailed Review)

Remediation Options	Capped waste stockpile Waste	SPL in storage	Contaminated Soils in Smelter Footprint	Contaminated Soils and Materials in Buffer Zone	Demolition Wastes	Impacted groundwater (Capped waste stockpile)
No remediation	×	×	×	×	×	✓
Continue existing treatment/management	✓	✓	N/A	N/A	N/A	✓
Encapsulate in-situ	✓	N/A	✓	✓	×	×
Move to specifically designed containment cell adjacent to the capped waste stockpile	N/A	✓	✓	✓	✓	N/A
Treat and move to specifically designed containment cell adjacent to the capped waste stockpile	N/A	✓	×	×	×	N/A
Encapsulate in purpose built containment cell	✓	✓	✓	✓	✓	N/A
Treat and encapsulate in purpose built containment cell	×	✓	×	×	×	N/A
Dispose off site	✓	✓	✓	✓	✓	×
Treat and dispose off site	×	×	×	×	×	✓
Alternative onsite treatment (destruction)	✓	✓	✓	✓	✓	N/A

× – not feasible and/ or permissible (preliminary review)
× – not feasible and/ or permissible (following options review)
✓ – feasible and permissible
N/A – does not apply

7.1 Potential Combined Material Streams Management Strategies

Option	Combined Options	Likelihood of Approval	Remediation Costs ($M AUD)	Timeframe (years)	Legacy Costs ($M AUD)	Risk
G1: Upgrade the capped waste stockpile and move all wastes except municipal and SPL stored and in pots to specifically designed containment cell adjacent to the capped waste stockpile. Includes groundwater treatment via the existing trench and interception method.	A2+B1+C2+D5+E1+F2	Moderate to high	60	6 – 8	4.5	12
G2: Upgrade the Capped waste stockpile and move all wastes including SPL but excluding municipal waste to a containment cell adjacent the capped waste stockpile. Includes groundwater treatment via the existing trench and interception method.	A2+ B3+C4 +D4 +E2+F2	Moderate	34	7 – 9	5.1	15
G3: Upgrade the capped waste stockpile and construct a containment cell for all other wastes excluding SPL and municipal waste in another area of the Hydro site. Includes groundwater treatment via the existing trench and interception method.	A2+B1+C4+D4+E2+F2	Moderate	60	7 – 9	4.9	12
G4: Move and encapsulate the capped waste stockpile and other wastes excluding SPL and municipal waste in purpose built containment cell within the Hydro site. Includes groundwater treatment by removal (pumping).	A3+B1+C4 +D4 +E2+F3	Moderate to high	76	7 – 9	2.2	3
G5: Move and encapsulate the capped waste stockpile and all wastes including SPL but excluding municipal waste in purpose built containment cell within the Hydro site. Includes groundwater treatment by removal (pumping).	A3+B1/B5+C4 +D4 +E2+F3	Moderate	50	8 – 10	2.3	4
G6: Disposal of all wastes off site and treatment of groundwater by removal (pumping).	A5b+B7A+C6+D6+E3+F3	Moderate	390	9 – 11	0.8	1
G7: Treat and destroy all site wastes using plasma arc technology and treatment of groundwater via the existing trench and interception method.	A7+B10+C4 +D4 +E2+F2	Moderate	215	17 - 19	0.8	12

7.2 Remedial Options Study Workshop

The remedial options study workshop was held over two days in February 2014. The workshop was attended by Hydro representatives Mr Bernt Malme (Norway), Mr Edgar Sagen (Norway), Ms Kristin Mørkved (Kurri Kurri), Mr Richard Brown (Kurri Kurri), Mr Kerry McNaughton (Kurri Kurri) and ENVIRON personnel Ms Fiona Robinson (Newcastle), Mr Shaun Taylor (Newcastle), Mr Mark Travers (USA) and Mr Chris Keller (Germany). A representative of Gilbert and Tobin (Hydro's legal advisors), Ben Fuller (Sydney) attended the second day of the workshop.

The objectives of the workshop were.

1) To provide an overview of the remedial options considered and identify if other options should be taken into account.
2) Understand the option evaluation criteria considered and if other criteria should be taken into account.
3) Develop weighting factors for the criteria for the purpose of ranking the options.
4) Rank the combined options (Options G1-G7) using the criteria and the weighting to determine a preferred option or options.
5) Outline the next steps in the remediation planning process.

The workshop outcomes for objectives 1 to 4 are discussed in the following. Objective 5 (the next steps) is discussed in **Section 7.2.4**.

7.2.1 Objective 1

In response to objective 1 it was recognized that other remedial options or a combination of options could apply and that the evaluation cannot be exhaustive. It was concluded that the process applied has been effective in identifying the most likely feasible options for the site. No further feasible options were identified that were considered to warrant investigation.

7.2.2 Objective 2

In response to objective 2 the nominated evaluation criteria were considered to be the most important criteria that act as differentiators between the options. Additional criteria were identified to include corporate responsibility.

Corporate responsibility was considered a potential key differentiator between options and therefore was further explored. A round table evaluation of corporate responsibility and Hydro's corporate responsibility policy identified the key components for this study to be: social impacts; environmental impact; and climate change impacts. Options G1 to G7 were evaluated in terms of these factors in a qualitative evaluation. Each of the three sub items were scored from 1 to 5 with low scores being preferable and total maximum score of 15.

During this evaluation it was identified by the workshop participants that climate impacts could not adequately be evaluated in the absence of a carbon footprint analysis. This analysis was subsequently undertaken by ENVIRON following the workshop and included an evaluation of two options being Option G4 and G5 (which were identified as the two preferable options following the evaluation process described in Section 7.2.3). The findings are presented in Appendix H. **Table 7.2** has been updated since the workshop to reflect the findings of the carbon footprint study.

Table 7.2 Evaluation of Corporate Responsibility

Option and description	Social impact	Environ-mental impact	Climate impact	TOTAL SCORE
Option G1 Upgrade Capped Waste Stockpile and create an adjacent containment cell	4	3	1	**8**
Option G2 Upgrade Capped Waste Stockpile, including SPL and create an adjacent containment cell	5	4	2	**11**
Option G3 Improve Capped Waste Stockpile in-situ and encapsulate all wastes excluding municipal wastes and SPL in a purpose built containment cell. Remediate groundwater.	3	3	3	**9**
Option G4 Encapsulate all wastes including Capped Waste Stockpile but excluding municipal wastes and SPL in a purpose built containment cell. Remediate Capped Waste Stockpile footprint including groundwater.	2	2	2	**6**
Option G5 Encapsulate all wastes including Capped Waste Stockpile and SPL in a purpose built containment cell. Remediate Capped Waste Stockpile footprint including groundwater.	3	3	3	**7**
Option G6 Dispose of all wastes off-site	5	5	5	**15**
Option G7 Onsite Destruction using plasma arc technology	1	1	4	**6**

7.2.3 Objectives 3 and 4

Objective 3 was addressed by initially considering weighting values for each of the evaluation criteria. These criteria now include corporate responsibility, as outlined in objective 2.

Rather than developing specific weighting criteria, the team looked at a weighting sensitivity analysis to determine which criteria were the process drivers, and how changes in priorities affected the weighting criteria.

Firstly, the raw data were compared and this is presented in **Figure 7.1**.

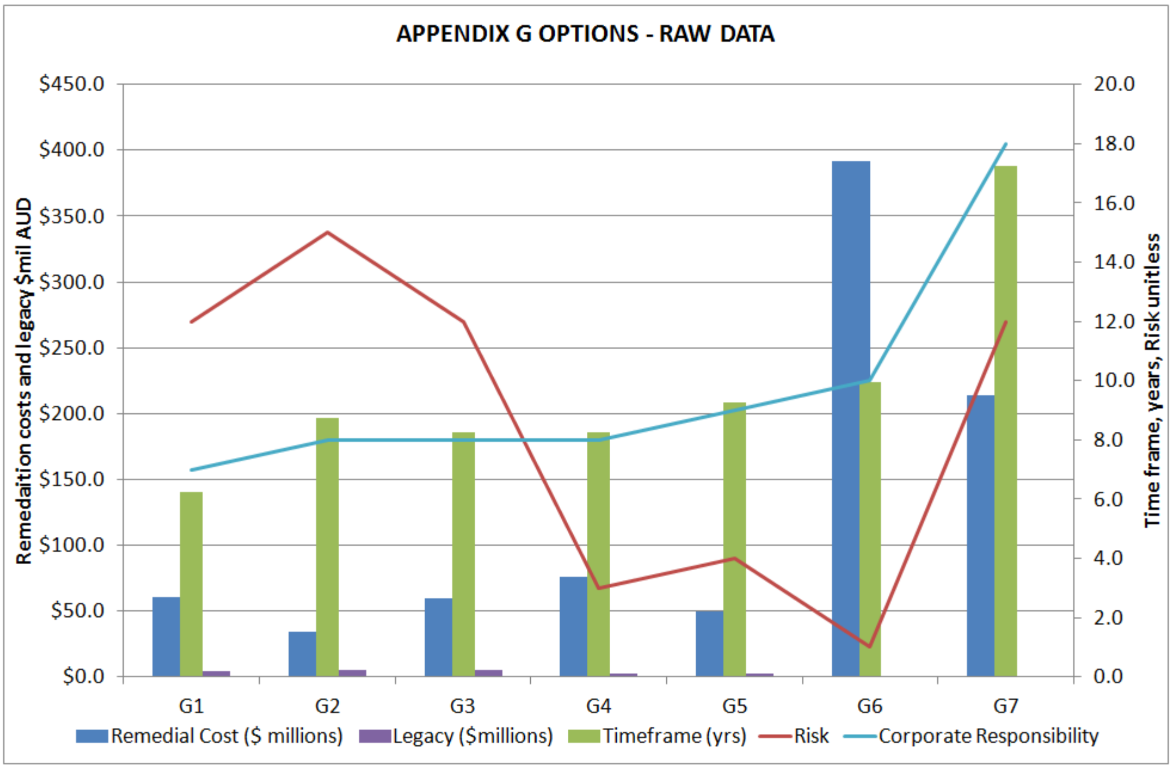

Figure 7.1 Raw Data for combined options

Data was then scaled and given an equal weighting as shown in **Figure 7.2**.

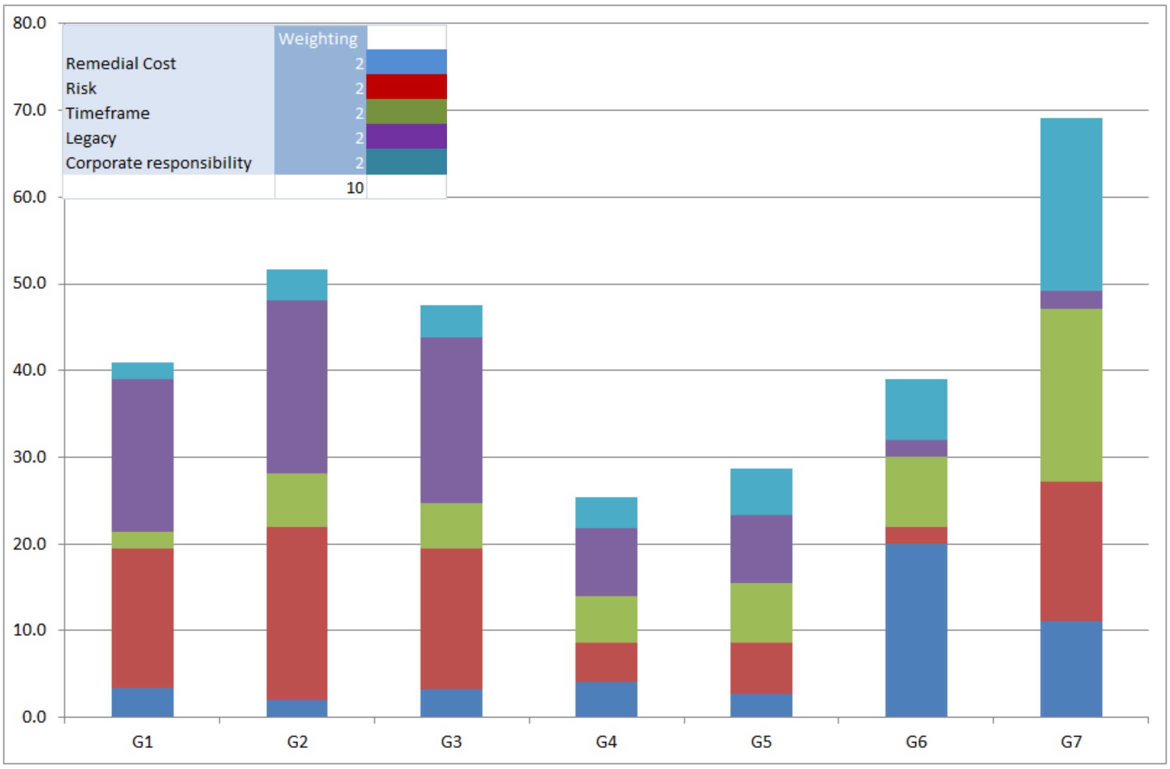

Figure 7.2 Raw Data for combined options

Figure 7.3 heavily weights cost and risk, compared to other criteria. Timeframe is weighted zero and excluded from the evaluation.

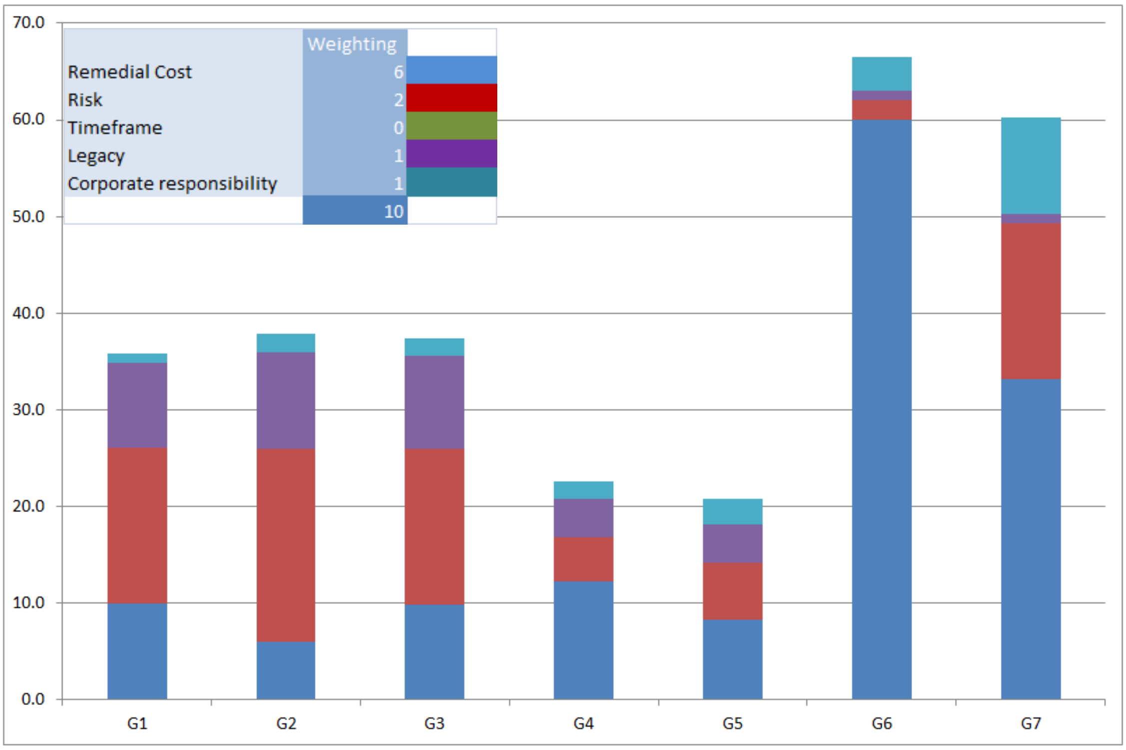

Figure 7.3 Cost and risk focus

Figure 7.4 focuses on cost and corporate responsibility, with lower weighting on other factors.

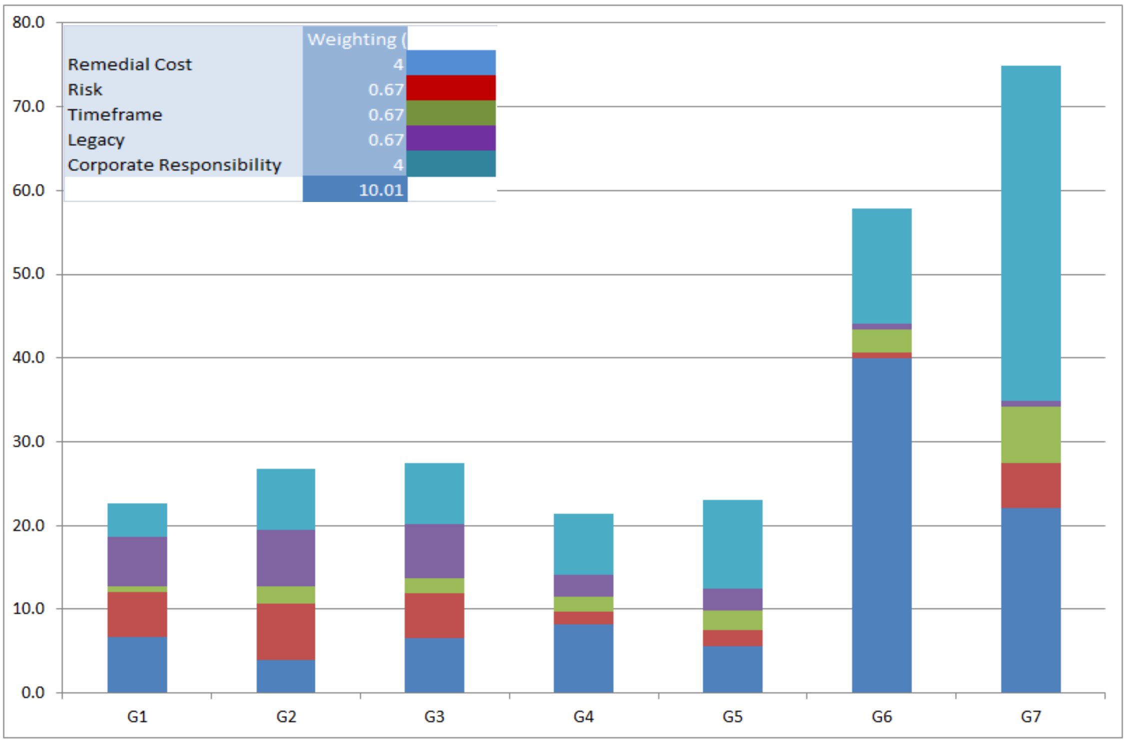

Figure 7.4 Cost and corporate responsibiltiy focus

Figure 7.5 presents a corporate responsibility focus, with remedial cost as the next highest ranked criteria.

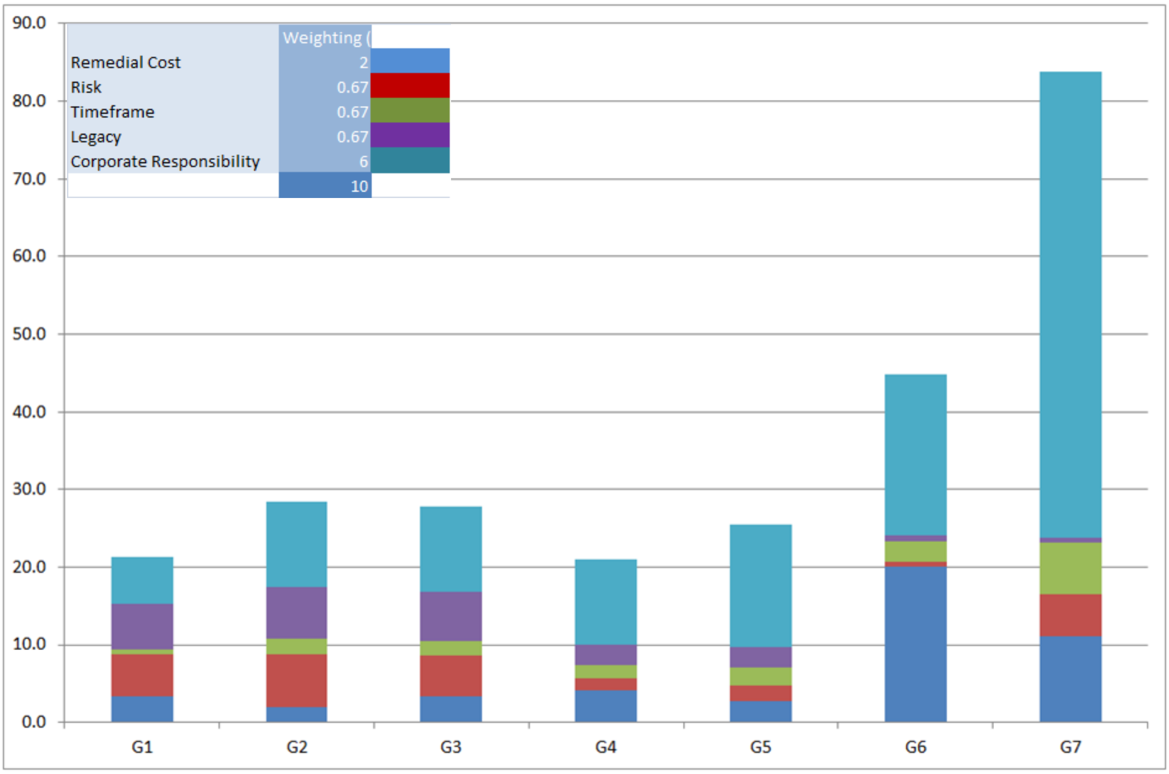

Figure 7.5 Corporate responsibiltiy focus

The evaluation presented in **Figures 7.2 to 7.5** identified that options G4 and G5 had the most favourable results of all options for the weightings considered important by the workshop team. Option G5 was considered a preferred option when evaluating cost and risk combined. When focusing on cost, the expected remediation costs for Option G5 are $25mil AUD lower than Option G4. This cost reduction results from the inclusion of SPL within the landfill and the removal of the SPL treatment costs.

Further qualitative analysis of options G1 to G7 was undertaken to review the quantitative evaluation. This was undertaken in the workshop through evaluation of the advantages and disadvantages of each option. A summary of this discussion is presented in the following.

Options G1 to G3 were not considered favourable on the basis that:

- Shallow and dynamic groundwater is presented beneath the capped waste stockpile and interacts with the base of the waste mound.
- The base of the capped waste stockpile is unsealed with concrete present over only a small portion, approximately a third, of the base.
- The upgrade of landfills can be technically difficult to achieve and there are many examples where upgraded landfills have not performed adequately over time.
- Higher legacy risks and costs are associated with the management of an upgraded landfill.
- The location of the capped waste stockpile would sterilise a central area of proposed industrial park from development.

- Upgrading the capped waste stockpile in-situ is considered to have adverse social impacts and community perception.
- Problems with the capped waste stockpile would potentially have adverse impacts on an adjoining containment cell (Options G1 and G2).
- Option G3 would potentially sterilise two areas within the site from development.

Option G6 was not considered favourable on the basis that it:

- Had a significantly higher cost.
- Requires hazardous materials to be transported off site, including through local community.
- Presents high carbon emissions (road transportation).
- Presents a potential adverse impact on capacity of local landfills

Option G7 was not considered favourable on the basis that it represents:

- Unproven technology with only limited trials on aluminium smelter waste having previously been undertaken.
- Additional time (minimum 12 months) to undertake trials to determine if it the technology is applicable, the operational costs and the quality of the slag.
- An unknown market for the treated slag output.
- A potential requirement to landfill material after treatment if not inert/ reusable exists and disposal costs could negate any cost benefit achieved from treatment.
- A high carbon footprint.

Options G4 and G5 were considered advantageous over all other options as these options allow:

- Best practice cell design, controls during implementation, leachate detection systems including early warning systems.
- Consolidation of all other wastes and contaminated soils in one location, in a cell that includes segregated compartments.
- Active removal of leachate in the capped waste stockpile source area.
- Recycling of some materials, and reduction of landfill and containment cell volumes through coarse sorting of waste repositories.
- Inclusion of a low vegetation cover to offset carbon footprint, and also reduce long term maintenance and monitoring requirements.
- Inclusion of onsite materials (concrete) as the drainage layers and as a subsurface fauna barrier to protect capping layers.
- Remediation and redevelopment of the former Alcan Mound footprint within the proposed industrial site.
- Construction of the containment cell within an area of the site that is favourable from a site re-use and environmental aspect.

- Avoidance of off site transport of hazardous wastes and associated local community impacts

G4 and G5 were considered to be the most favourable options and a direct comparison between these options was undertaken and is presented in **Figure 7.6**.

ADVANTAGES

Option G4

- Continues treatment and reuse of SPL which is aligned with corporate responsibility policies and community acceptance.

Option G5

- Avoids treatment costs of SPL.
- Comparatively less (to Option G4) CO2 and energy consumption from avoiding SPL treatment (Lifecycle analysis to be completed to determine net carbon footprint).

DISADVANTAGES

Option G4

- Increased cost with SPL treatment.
- Risk of Regain performance and uncertainty that an alternate treatment provider can be found for both first and second cut SPL.
- Comparatively higher (to option G5) CO2 emissions and energy consumption from the SPL treatment (Lifecycle analysis to be completed to determine net carbon footprint).

Option G5

- Onsite containment of SPL is less consistent with corporate responsibility policies.
- Increased complexity and risk of not obtaining approval from inclusion of SPL within the containment cell, conflicts with Chemical Control Order and existing development consents.
- Weston and Regain likely to campaign against on-site containment of SPL.
- Likely more difficult to gain community acceptance due to on-site containment of SPL.
- Higher risk profile (compared to Option G4) under environmental law due to leachable components of SPL.

Figure 7.6 Direct Comparisons of Options G4 and G5

On the basis of the evaluation above, both options G4 and G5 are considered valid and appropriate for remediation of the site. Option G4 realises a significant cost saving and is therefore considered the preferred option.

7.2.4 Objective 5: Next Steps

Consistent with the objectives of the workshop, the next steps in the program were identified as follows.

- Discuss the remedial objectives and the preferred option with the Department of Planning and Infrastructure and the Environment Protection Authority to understand the regulatory position.
- Develop a Remedial Action Plan that outlines the proposed strategy for remediation. Assessment of remediation data gaps forms part of this planning step.

- Develop a Preliminary Environmental Assessment that summarises the proposal and a preliminary assessment of potential environmental issues. This would be submitted to the Department of Planning and Infrastructure to inform their preparation of the Director-General’s Requirements for the Environmental Impact Statement.
- Prepare an Environmental Impact Statement for the proposal for submission to the Department of Planning and Infrastructure in accordance with the Director-General’s Requirements.

8 Conclusions

Hydro and ENVIRON have completed the identification, description and evaluation of remedial options available for the range of material streams present at the Hydro Kurri Kurri Aluminium Smelter. This included attendance at a two day workshop by key Hydro and ENVIRON personnel to review the options, finalise the evaluation and determine the preferred option.

The result of the evaluation identified Option G5 as the preferred option. Option G5 comprises the following elements:

- Construct a purpose built containment cell with segregated areas to allow separate containment of site waste categories.
- Excavate and relocate site waste, including some limited sorting, from within the site including the Capped Waste Stockpile and other buried wastes.
- Place untreated SPL within the containment cell.
- Place demolition wastes within the containment cell.
- Cap the containment cell and manage the containment cell footprint in perpetuity.
- Remediate groundwater at the former Capped Waste Stockpile site for a period of time until risks are effectively managed.

Hydro and ENVIRON will now progress with planning for a new purpose built containment cell constructed within the site, which would include any remaining stored spent pot lining (and processing of stored spent pot lining would then cease).

Hydro and ENVIRON will implement the actions described in **Section 7.2.4** to progress the design and approval processes for the preferred option.

9 Limitations

ENVIRON Australia prepared this report in accordance with the scope of work as outlined in our proposal to Hydro Aluminium Kurri Kurri Pty Ltd dated 5 September 2013 and in accordance with our understanding and interpretation of current regulatory standards.

The conclusions presented in this report represent ENVIRON's professional judgment based on information made available during the course of this assignment and are true and correct to the best of ENVIRON's knowledge as at the date of the assessment.

ENVIRON did not independently verify all of the written or oral information provided to ENVIRON during the course of this investigation. While ENVIRON has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to ENVIRON was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

9.1 User Reliance

This report has been prepared exclusively for Hydro Aluminium and may not be relied upon by any other person or entity without ENVIRON's express written permission.

Appendix A

Capped Waste Stockpile Remediation Detailed Options Review

A Capped waste stockpile

Capped waste stockpile Statistics		
Volume m^3	**Tonnage (t)**	**Description**
84000 – 126,000	151,200-226,800 A bulk density of 1.8 t/m^3 has been assumed	Spent pot lining (SPL) and other smelter wastes including anode materials were stockpiled in the eastern portion of the site for the period 1969 to 1992. Mixed smelter wastes comprising SPL and to a lesser extent amounts of other solid wastes generated at the smelter including cryolite, alumina, floor sweepings (alumina, cryolite, carbon), shot blast dust (carbon, steel shot), cement, potlining mix and small amounts of other materials including plastic, wood and steel. In 1993, in response to contaminated leachate generation, the stockpile was capped under a planning approval from Cessnock City Council. The development application included an Environmental Impact Statement prepared in 1993 by Dames and Moore. The EIS stated that the capping of the waste stockpile was considered an appropriate means to eliminate risk to the environment by minimizing infiltration and leachate generation within the stockpiled waste materials. The capping strategy comprised (ordered from bottom to top): • A gas control layer of 150 mm thickness; • A hydraulic barrier of 900 mm thickness with permeability of 1 x 10^{-9}m/s; • A general fill layer of 450 mm thickness; • A vegetation layer of 150 mm thickness. [1] No base layer was included in the strategy, or installed as part of its implementation. Groundwater clean up and remediation following removal of the Capped waste stockpile is considered in Option F, and not include here.
Remediation Options A1 Continue existing treatment/management A2 Encapsulate in-situ – improve the current capped waste stockpile		

[1] Dames and Moore, Environmental Impact Statement, Upgrades to the Waste Storage Facilities, Alcan Australia Limited, Kurri Kurri Smelter, 1992.

A3 Encapsulate in purpose built containment cell within the Hydro site
A4 Treat and encapsulate in purpose built containment cell within the Hydro site
A5 Landfill off site
A6 Treat and dispose off site
A7 On site Treatment to Achieve Complete Destruction

A1 Continue existing treatment/management

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[2]	Risk Ranking
Low to very low	0.4	3 - 4	$4.7	20

A1.1 Description of the option

This option continues the existing material management option and does not include any physical remediation or improvement works. Investigations would be required to demonstrate that the current site status does not represent a risk of harm to human health or the environment, and that this situation is not likely to worsen in the future. The existing cap is in accordance with the existing planning approval and it could be argued that no further consent is required.

The process would require a human health and environmental risk assessment and probably the development of a management plan for the maintenance of the cap. The outcome of the risk assessment and management plan will require acceptance by the regulators.

The tasks required are therefore:-

1) Undertake fate and transport modelling to verify clean-up criteria applicable to the site in conjunction with the findings of the ecological and health risk assessment;

2) Demonstrate that the existing cap of the capped waste stockpile sufficiently reduces infiltration through the waste and that no improvements to the capped waste stockpile capping are required. This would require further testing and modelling than has been undertaken to date;

3) Develop a management plan for the ongoing management of the capped waste stockpile;

4) Prepare the above documentation in a validation report suitable for review by a Contaminated Land Auditor. This report would include evaluation assessments, for example net environmental assessments, to demonstrate the cost benefit of remediation. Following review by the auditor achieve signoff from the contaminated land auditor that no further remedial works are required (it is likely that this Auditor review and agreement would be required by the EPA; however this is not an Audit under the Contaminated Land Management Act);

[2] Net Present Value using a discount rate of 3%

5) Present the above to the EPA to achieve licence surrender (or removal of the component of the license relevant to the capped waste stockpile);

6) Monitor groundwater concentrations for a period of time (e.g. 10 years) to demonstrate declining concentrations;

7) Hold site in perpetuity or sell site.

A1.2 Likelihood of approval

This option is considered to have a low to very low likelihood of approval based on the evidence of leachate down gradient of the capped waste stockpile which indicates that capped waste stockpile is has not been fully remediated. Therefore it is unlikely that the EPA would permit the continuing use of the capped waste stockpile without upgrades that would prevent the escape of leachate (as described in Option A2).

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10 mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind-blown dust*". Capping of the capped waste stockpile was subsequently undertaken to meet this requirement.

Planning Approval

A planning approval issued in 1993 for an upgrade to the smelter permits the use and management of the capped waste stockpile. Hydro has obtained legal advice which provides that:

- the 1993 planning approval arguably allows the capped waste stockpile to continue to be used indefinitely, because the approval does not place any express time limit on Hydro's obligation to monitor, manage and maintain the capped waste stockpile;
- there is a risk that the 1993 planning approval may also oblige Hydro to comply with statements in the Environmental Impact Statement (which forms part of the planning approval) to continue indefinitely to research, and implement, any viable treatment technology for the SPL within the capped waste stockpile when it becomes available. There is a risk that the Department of Planning and Infrastructure (or any other person) could take steps to enforce such an obligation; and in light of the above, it may be difficult to pursue option A1 as a long term strategy (as Hydro would retain an indefinite legacy or commitment that could potentially extend to treating SPL within the stockpile).

To avoid a requirement to continue to research and implement any viable treatment technology for the SPL with mixed smelter wastes in the capped waste stockpile, as well as indefinite management and monitoring, Hydro would be required to apply for a modification to the 1993 consent to remove these requirements. However, there is a low likelihood of such a modification being approved without Hydro providing substantial evidence that the capped waste stockpile in its current form would not pose a risk of harm to human health and / or the environment any time in the future. This could be difficult based on the existing evidence of impact within the nearby vegetation and the results of recent groundwater monitoring. It could be argued that the leachate generation will lessen with time but it is unlikely that the timeframe is acceptable to the regulator.

If it can be demonstrated that (a) the leachate plume does not represent a risk of harm to the environment and human health and/ or (b) that the leachate would reduce over time (or the capped waste stockpile upgraded to avoid the leachate escaping the capped waste stockpile, refer to Section A1.1.2) then Hydro would also need to show that permanently leaving the SPL with mixed smelter wastes in the capped waste stockpile is, and would continue to be, the most reasonable and feasible option.

Environment Protection Licencing

Environment Protection Licence (EPL) 1548 is held by Hydro. The scheduled activity covered by the EPL is: “Metallurgical activities” (aluminium production and metal waste generation).

“Waste disposal (application to land)” is a scheduled activity requiring an EPL (Clause 39 of Schedule 3). However, the definition for this activity states that it applies to waste “*received from* ***off site***”. As the SPL with mixed smelter wastes was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL with mixed smelter wastes.

Likelihood of Approval

Due to the issues with leachate management, the likelihood of retention of the capped waste stockpile without any improvements is low to very low.

A1.3 Cost

The cost estimate for this option is $0.4mil AUD NPV.

Refer to the attached costing for details.

A1.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Investigations and Reporting	0.1 – 1.25	To undertake risk assessment and further monitoring
Auditor review	0.5 – 0.75	
Approvals (note that the likelihood of achieving approvals is considered low to very low)	1.5 -2	Planning approval and EPA modification of the licence condition
Total Estimated Timeframe	3 - 4	

A1.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate and gas monitoring will be required on an annual basis for a period of 10 years and include annual reporting;
2) Maintenance of the capping layer will be required for a period of 100 years and involves general maintenance including mowing, watering if required, weed and tree control, and visual inspection of the cap integrity and the replacement of cover soil once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell is considered likely to fail in a 100 year timeframe, and following failure will require significant remediation. For this evaluation therefore the likelihood of requiring remediation is assigned 100% (i.e. remediation will be required at some point in the timeframe). For the purpose of calculating a net present value, it was assumed that a significant event, causing the containment cell to require substantial remediation would occur after 25 years. The costs for remediation have been assigned as for Option A2, which includes retrofitting of a cutoff wall and liner cap. These costs were estimated to be approximately $40,000 AUD NPV.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $4.7mil AUD NPV.

A1.6 Risk

The capped waste stockpile without modification has a high risk of failure due to the semi-consolidated nature of the original fill. Erosion of the cap occurred previously during a significant storm event (2007). It is understood that during a high intensity rain event (in excess of 1 in 100 years) a slippage occurred in the south-eastern corner of the existing capped waste stockpile containment cell. Stabilisation of the area was undertaken with earth moving equipment and the capping layers were reinstated. The chance of failure occurring is therefore considered to be ‘likely’. In the event of failure, due to the proximity of shallow groundwater and the absence of a cell base there is a direct conduit to the surrounding receiving environment for leachate generation, the consequence of failure could be ‘catastrophic’ due to the risk of prosecution and cost of remediation. Remediation following failure could include removal of the wastes or construction of an improved containment cell. On this basis the risk ranking is ‘20’.

A2 Encapsulate in-situ – improve the current capped waste stockpile

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[3]	Risk Ranking
Moderate to high	4.8	3 - 4	2.4	10

A2.1 Description of the option

The capped waste stockpile was constructed without a low permeability base layer and investigations have shown that there is a direct connection between groundwater beneath the capped waste stockpile and groundwater down gradient of the capped waste stockpile, and that a leachate pathway to the environment currently exists. The capped waste stockpile was capped in 1993 and investigations have shown that this capping layer is of 1×10^{-8} m/s permeability or better[4] which is in accordance with the design parameters. For this option, remediation of the capped waste stockpile without removal or excavation of the capped waste stockpile is proposed. To remediate the capped waste stockpile *in-situ* the migration of leachate through the base of the capped waste stockpile requires containment. This can be achieved by installing a vertical subsurface barrier wall around the capped waste stockpile and connecting in to the underlying clays at depths of around 6 - 15 m. The excavation and replacement of the capping layer is also proposed to (1) improve the capping layer placement and (2) key the capping layer in to the vertical barrier wall.

This option would involve:

1) A geotechnical investigation to confirm the depth to the clay aquitard, currently estimated to be between 6 m and 15 m below ground surface. Undertake feasibility trials using leachate to assess the permeability performance with high ion water.
2) Evaluate the existing capping layer performance;
3) Design a barrier wall, capping layer improvements and a validation specification. Preparation of specification and tender documents. Tendering / contractor award;
4) Appropriate planning and approvals as described in Section A2.2;

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[3] Net Present Value using a discount rate of 3%
[4] RCA Geotechnical Assessment of Landfill Cover, Hydro Aluminium Kurri Kurri Pty Ltd, May 2013

5) Preparation of required documentation for site remedial works including a detailed Remedial Works Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;

6) Slurry wall construction including trenching to appropriate depths and placement of a wall. The composition of the slurry wall is likely to comprise a bentonite and soil mix, or a bentonite, soil and cement mix. The final composition will be dependent on laboratory testing of bentonite response to high ion leachate;

7) Remove existing overlying cap elements and segregate. Costing has assumed that removal of 150 mm vegetation layer can be segregated for reuse, 450 mm general fill layer can be segregated for reuse and 400 mm of the 950 mm existing clay cap can be segregated for reuse. The remaining 550 mm clay cap thickness and underlying gas drainage layer will remain. This will prevent full exposure of the underlying wastes to workers and the environment during the cap rework. Also, preventing cross contamination of what are expected to be clean cap materials from potential contaminated materials lower in the profile;

8) Replacement of the capping layer to comprise:

   - Install a 150 mm sand gas collection layer;
   - Replacement of the 400 mm of clay compacted to achieve 1 x 10-9 m/s permeability;
   - Install a 1.5 mm thick HDPE liner for the cell cap;
   - Install a sand drainage layer of 300 mm thickness;
   - Install a filter fabric layer;
   - Install a general fill layer of 300 mm comprising general fill previously removed;
   - Install topsoil for cell cap comprising topsoil previously removed of 150 mm depth;
   - Seed, fertilise and mulch the call cap and maintain for a period of 6 months;

9) Establish groundwater monitoring wells to complement the existing monitoring network;

10) Establish gas monitoring wells;

11) Validation and establish ongoing monitoring and management requirements including the development and implementation of an environmental management plan for the site;

12) Prepare a report suitable for the Contaminated Land Auditor and the EPA;

13) Surrender license condition;

14) Hydro to retain in perpetuity.

A2.2 Likelihood of approval

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10 mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind-blown dust*". Capping of the capped waste stockpile was subsequently undertaken to meet this requirement.

If the proposed improvements can be shown to stop the generation of leachate that exceeds the noted criteria, the upgraded capped waste stockpile would be in compliance with the Chemical Control Order exemption, and the associated licence that applies to the capped waste stockpile.

Planning Approval

A planning approval issued in 1993 for an upgrade to the smelter permits the use and management of the capped waste stockpile. Hydro has obtained legal advice which provides that:

- the 1993 planning approval arguably allows the capped waste stockpile to continue to be used indefinitely, because the approval does not place any express time limit on Hydro's obligation to monitor, manage and maintain the capped waste stockpile;
- there is a risk that the 1993 planning approval may also oblige Hydro to comply with statements in the Environmental Impact Statement (which forms part of the planning approval) to continue indefinitely to research, and implement, any viable treatment technology for the SPL within the capped waste stockpile when it becomes available; and
- in light of the above, it may be difficult to pursue option A2 as a long term strategy (as Hydro would retain an indefinite legacy or commitment that could potentially extend to treating SPL within the stockpile).

A planning approval issued in 1993 for an upgrade to the smelter permits the use and management of the capped waste stockpile. Hydro has obtained legal advice that:

- that the 1993 planning approval arguably allows the capped waste stockpile to continue to be used indefinitely, because the approval does not place any express time limit on Hydro's obligation to monitor, manage and maintain the capped waste stockpile;

- there is a risk that the 1993 planning approval may also oblige Hydro to comply with statements in the Environmental Impact Statement (which forms part of the planning approval) to continue indefinitely to research and implement any viable treatment technology for the SPL within the capped waste stockpile when it becomes available. There is a risk that the Department of Planning and Infrastructure (or any other person) could take steps to enforce such an obligation; and in light of the above, it may be difficult to pursue this approach as a long term strategy (as Hydro would retain an indefinite legacy or commitment that could potentially extend to treating SPL within the stockpile).

To allow the improvements to be completed, and to avoid a requirement to continue to research and implement any viable treatment technology for the SPL with mixed smelter wastes in the capped waste stockpile, as well as the indefinite management and monitoring, Hydro would need to apply for a modification to the 1993 consent to remove these requirements. A modification to the existing consent could be granted if DoPI accepts that the improvements result in minimal environmental impact, and that it is substantially the same development as that approved in 1993.

The modification (and supporting documents) would need to show that the improvements to the capped waste stockpile would not pose a risk of harm to human health and the environment any time in the future (and during the improvement works).

If it can be demonstrated that the existing leachate plume has stabilised and represents an acceptable risk, and monitoring shows that the improvements have stopped leachate escaping from the capped waste stockpile, then potentially DoPI and the EPA may accept that ongoing monitoring and management is no longer required. Hydro would also need to show that permanently leaving the untreated SPL with mixed smelter wastes in the capped waste stockpile is, and would continue to be, the most reasonable and feasible option. However, due to the upgrade and the changes to monitoring, research and reporting requirements, it is unlikely that the DoPI would accept that the development is substantially the same as that approved in 1993.

The alternative is that the 1993 planning approval is surrendered and a new development application submitted for the upgrade and the retention of the capped waste stockpile. This would include an alternative management approach that removes the need for indefinite management and monitoring, and an acceptance that untreated SPL with mixed smelter wastes would remain in the capped waste stockpile.

If this approach was taken, the upgraded capped waste stockpile would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the upgraded capped waste stockpile would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

"(5) Development for the purpose of hazardous waste facilities that transfer, ***store or dispose*** *of solid or liquid waste classified in the* ***Australian Dangerous Goods Code*** *or medical, cytotoxic or quarantine waste that handles more than* ***1,000 tonnes per year of waste****.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the retention of the untreated SPL with mixed smelter wastes in the upgraded capped waste stockpile would result in the containment cell being deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality;
- Construction traffic;
- Construction phase management of contaminants;
- Soil and water management (including hydrology and geotechnical conditions);
- Aesthetics and visual impacts;
- Community and social impacts (including health);
- Consideration of alternatives to the upgrade of the capped waste stockpile;
- Ongoing containment cell management strategy (particularly leachate management and cell stability);
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting compliance with the existing site-specific Chemical Control Order immobilization exemption (as discussed earlier in this section);
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works;
- That retaining untreated SPL with mixed smelter wastes in the upgraded capped waste stockpile is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council;
- Environment Protection Authority (EPA);

- NSW Office of Water (NOW);
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act);
- Department of Planning and Infrastructure;
- Local Members of Parliament;
- The local community (including residents and local community and environmental groups);
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Environment Protection Licence (EPL) 1548 is held by Hydro. The scheduled activity covered by the EPL is: “Metallurgical activities” (aluminium production and metal waste generation).

“Waste disposal (application to land)” is a scheduled activity requiring an EPL (Clause 39 of Schedule 3). However, the definition for this activity states that it applies to waste “received from **off site**”. As the wastes within the capped waste stockpile were generated on site, Hydro would not require an EPL for the capped waste stockpile to continue as a waste disposal facility. This is possibly why waste disposal is not currently a scheduled activity on EPL 1548.

However, the upgrade of the encapsulation to the capped waste stockpile could be deemed a scheduled activity by meeting the definition of “contaminated soil treatment”. Clause 15 of Schedule 1 of the POEO Act defines the following as a scheduled activity:

“(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site, or

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(i) to incinerate more than 1,000 cubic metres per year of contaminated soil, or

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil, or

(iii) to disturb more than an aggregate area of 3 hectares of contaminated soil."

The EPA may deem the upgraded capped waste stockpile as contaminated soil treatment as the upgraded lining would be a form of treatment of the contaminated soils within the capped waste stockpile, thereby requiring an EPL (or a variation to Hydro's existing EPL to include the scheduled activity).

Likelihood of Approval

The likelihood of approval is dependent upon the development, and acceptance by the EPA and DoPI, of evidence that the upgraded capped waste stockpile would permanently stop leachate escaping. There is a moderate to high likelihood of approval if this can be demonstrated; however, there is potential that any approval may have a number of conditions, including a long term validation monitoring program.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the improved capped waste stockpile.

A2.3 Cost

The cost estimate for this option is $4.8mil AUD NPV.

Refer to the attached costing for details.

A2.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comment
Pre-Design Activities	0.25 – 0.5	Treatability trials for performance of clay with high ion leachate
Preparation of RAP and Planning Approval (EIS)	1.25 – 1.5	Includes subconsultancy studies
Approvals	0.75	
Project Engineering Tasks	0.2 – 0.4	Wall design
Implementation	0.6	Construction of wall and cap placement
Final Reporting	0.25	
Total Estimated Timeframe	**3 - 4**	

A2.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate and gas monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general maintenance including mowing, watering if required, weed and tree control, and visual inspection of the cap integrity and the replacement of cover soil once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity or failure of the vertical barrier wall (for example contaminant breakthrough). The containment cell is considered to have a low likelihood of failure in a 100 year timeframe, and therefore is assigned a low probability of 1%, or once in 100 years. The timeframe for failure was assumed to occur at 50 years. The costs for remediation in the event of failure were assumed to be cap replacement and capture and treatment of entrained leachate (extraction wells). These costs were estimated to be approximately $0.9mil AUD NPV.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $2.4mil AUD NPV.

A2.6 Risk

The proposed cap upgrade includes improvement of the existing cap and placement of a second cap layer comprising a HDPE liner. This approach significantly reduces the likelihood of failure by increasing the engineering controls around the construction and introducing a dual layer system; however, an inherent risk remains because of the inability to remove and compact the waste (which would be technically difficult to achieve), therefore failure of the cap could occur through uncontrolled waste consolidation. Failure of the vertical barrier wall is also considered unlikely on the basis of laboratory trialing to verify material performance with high ion leachate and validation protocols during construction. On this basis the likelihood of failure of the cap and wall is considered 'unlikely', but could occur at some time.

In the event of failure, due to the proximity of shallow groundwater there is a direct conduit to the receiving surrounding environment for leachate generation. It is considered that the risk of prosecution is low due to the demonstrated attempts to remediate the site; however, the cost of remediation may be high requiring cap improvements or removal and treatment of entrained leachate. On this basis the consequence is considered to be 'catastrophic'. The risk ranking is therefore '10'.

A3 Encapsulate in purpose built containment cell within the Hydro site

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[5]	Risk Ranking
Moderate to high	16.6	3 - 4	1.5	3

A3.1 Description of the option

This option would address the capped waste stockpile by constructing a containment cell at a more appropriate location on the site and applying best practice containment cell design and construction under a Planning approvals process.

This option would involve the following steps:

1. *Pre-construction*

- Assess existing Hydro site to identify the optimum location for placement of new cell to accept capped waste stockpile wastes. Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Undertake laboratory testing to evaluate performance of liner materials with high ion leachate water.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- The planning approvals process (as discussed in Section A3.2).
- Design of “best practice” containment cell to suit site conditions while also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

2. *Construction*

- Construction of containment cell includes:-
  - Excavation of the area to a depth of 3 m to allow for below ground placement of the materials;
  - The cell base liner will comprise (ordered from vertically upwards):

[5] Net Present Value using a discount rate of 3%

  - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
  - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - Filter fabric overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer including drains connected to a sump system;
  - Overlain by filter fabric.
- Placement of capped waste stockpile wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has been included as an option prior to placement to permit some level of compaction to be achieved.
- The cell cap liner will comprise (ordered from vertically upwards):
  - A 0.6 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.15 m sand gas collection layer overlain by;
  - A 0.3 m protection layer comprising general fill overlain by;
  - A 0.15 m topsoil layer, seeded and mulched.
- Deconstruction and remediation of the capped waste stockpile by progressive removal of existing capping materials. This materials will be used as daily cover manage gas emissions and exposure to moisture. Leachate will be managed by retaining the outer bunded. Treatment of leachate is included in the combined options in Appendix G.

Construction will specifically need to consider:

- Nature of liner (clay reportedly reacts with F-/CN leachate thus degrading impermeable nature of clay) and testing will be required to confirm suitability of the material with the anticipate leachate constituents;
- Sufficient protective layer for HDPE (or similar) liner to prevent puncture/damage;

3. *Post construction*

- Ongoing monitoring and maintenance for containment cell likely involving:
  - Installation and regular monitoring of groundwater and gas monitoring wells installed around the new facility for a period of time;
  - Ongoing physical maintenance of the cell to maintain integrity of the cap;
  - Ongoing leachate monitoring.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

A3.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) prohibits the disposal of such waste containing leachable fluoride and/or leachable cyanide. It also requires a licence for the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

Placing untreated SPL with mixed smelter would require a site-specific licence allowing macro-encapsulation by showing that the emplacement process stops the SPL leaching fluoride and/ or cyanide. This is the approach approved prior to 1993 for the capped waste stockpile. It is likely to require justification to the EPA (including this report, the Remedial Action Plan and the Environmental Impact Statement) that macro-encapsulation is a viable leaching control methodology and therefore an exemption to be issued.

Further justification could be presented to the EPA by highlighting the the mixed nature of the waste making reuse or treatment of the SPL difficult and costly due to material handling; and the inability to locate and secure a local market for the treated by-products of SPL with mixed smelter wastes.

Planning Approval

Placement of the capped waste stockpile waste in a containment cell would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when in operation it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the placement of the untreated SPL with mixed smelter wastes currently within the capped waste stockpile in the containment cell would result in the containment cell being deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell requires disturbance of adjacent areas currently containing native vegetation);
- Aboriginal heritage (if the containment cell requires disturbance of adjacent areas of limited disturbance);
- Construction noise and air quality;
- Construction traffic;
- Construction phase management of contaminants;
- Soil and water management (including containment cell location hydrology and geotechnical conditions);
- Aesthetics and visual impacts;
- Community and social impacts (including health);
- Consideration of alternatives;
- Ongoing capped waste stockpile management strategy (particularly leachate management and cell stability);
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption (as discussed earlier in this section);

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works; and
- That disposal of untreated SPL with mixed smelter wastes to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council;
- Environment Protection Authority (EPA);
- NSW Office of Water (NOW);
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act);
- Department of Planning and Infrastructure;
- Local Members of Parliament;
- The local community (including residents and local community and environmental groups);
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
    - Crushing, grinding or separating
    - Waste storage
    - Waste processing (non-thermal treatment)

- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
  - Metallurgical activities (aluminium production and metal waste generation).

"Waste disposal (application to land)" is a scheduled activity requiring an EPL (Clause 39 of Schedule 3 of the POEO Act). However, the definition for this activity states that it applies to waste "*received from off site*". As the SPL was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL.

However, it is likely that removal of the capped waste stockpile (and remediation of residual soils) would be a scheduled activity based on the definition of "Contaminated soil treatment" under Clause 15 of Schedule 1 of the POEO Act., which states:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Therefore an EPL would be required to undertake the removal of the capped waste stockpile wastes and the remediation of residual soils. As the containment cell would form part of the remediation works, there are likely to be licence conditions associated with the management and monitoring of the cell.

Likelihood of Approval

A purpose built containment cell (for macro-encapsulation of the SPL with mixed smelter waste) could be deemed as an acceptable immobilization option. Highlighting the mixed nature of the waste making reuse difficult and costly due to material handling and the inability to locate and secure a local market for the treated by-products of SPL would further enhance the likelihood of receiving the exemption and therefore planning approval. Preliminary discussions with the EPA have indicated that containment of site wastes within a purpose built onsite containment cell is an acceptable solution.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

A3.3 Costs

The estimated cost for this option is $16.6 mil AUD NPV.

Refer to the attached costing for details.

A3.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comment
Pre-Design Activities	0.25 – 0.5	Treatability trials for performance of clay with high ion leachate
Preparation of RAP and Planning Approval Documents	1.25 – 1.5	Includes subconsultancy studies
Approvals	0.75	
Project Engineering Tasks	0.2 – 0.4	Cell design
Implementation	0.6	Construction of cell, material placement and cap placement
Final Reporting	0.25	
Total Estimated Timeframe	**3 - 4**	

A3.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate and gas monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general maintenance including mowing, watering if required, weed and tree control, and visual inspection of the cap integrity and the replacement of cover soil once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should such an event occur the costs are proposed to be consistent with the initial capital costs for the construction of the cap, which is considered to be conservative. It is not proposed that removal of the wastes will be required. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

These costs were estimated to be approximately $3,000 AUD NPV.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $1.5mil AUD NPV.

A3.6 Risk

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘rare’ that this could occur only in some extreme circumstances, such as severe weather. Should breaches occur, the containment cell is situated in an area with a depth to groundwater in excess of 10 m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the chemical composition of wastes within the capped waste stockpile in leachate, the consequence of failure is considered to require remediation works, although it is unlikely that impacts would result due to the depth to groundwater. As such, the consequence category is considered to be ‘moderate’, causing localized impacts and clean up costs between $0.5mil AUD and $5mil AUD. On this basis the risk ranking is ‘3’.

A4 Treat and encapsulate in purpose built containment cell

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[6]	Risk Ranking
Moderate to high	66	8 – 9	1.0	2

A4.1 Description of the option

This option would address the capped waste stockpile by constructing a containment cell at a more appropriate location on the site and applying best practice containment cell design and construction. In addition, prior to disposal, the capped waste stockpile would be sorted and SPL components treated prior to placement within the new cell. In this option it is assumed that a 30% reduction in volume is achieved by sorting and recycling the anode wastes. Consequently, this assumes that the anodes have not been contaminated through co-disposal with SPL. Sorting is achieved manually, although studies may show it is more economical to sort by mechanical and optical means which could achieve cost efficiencies..

This option would involve the following steps:

1. *Pre-construction*

- Assess existing Hydro site to identify the optimum location for placement of new cell to accept capped waste stockpile wastes. Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Works Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- The planning approvals process (as discussed in Section A4.2)
- Design of “best practice” containment cell to suit site conditions and address consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

[6] Net Present Value using a discount rate of 3%

2. *Construction*

- Construction of containment cell includes:-
  - Excavation of the area to a depth of 3 m to allow for below ground placement of the materials;
  - The cell base liner will comprise (ordered from vertically upwards)
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - Filter fabric overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer including drains connected to a sump system;
    - Overlain by filter fabric.
  - Excavation and manual sorting of capped waste stockpile wastes. Sorting by manual means and standard earth moving equipment. Deconstruction and remediation of the capped waste stockpile by progressive removal of existing capping materials. This materials will be used as daily cover manage gas emissions and exposure to moisture. A depth of 2m below the capped waste stockpile footprint is additionally proposed for remediation. Leachate will be managed by retaining the outer bund. Treatment of leachate is included in the combined options in Appendix G;
  - Treatment of SPL component through the Regain facility;
  - Placement of capped waste stockpile wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has been included as an option prior to placement to permit some level of compaction to be achieved.
  - The cell cap liner will comprise (ordered from vertically upwards):

- A 0.6 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
- A 1.5 mm thick HDPE liner overlain by;
- Filter fabric to provide protection to the HDPE overlain by;
- A 0.15 m sand gas collection layer overlain by;
- A 0.3 m protection layer overlain by;
- A 0.15 m topsoil layer, seeded and mulched.

Construction will specifically need to consider:

- Nature of liner (clay reportedly reacts with F-/CN leachate thus degrading impermeable nature of clay) and testing will be required to confirm suitability of the material with the anticipate leachate constituents;
- Sufficient protective layer for HDPE (or similar) liner to prevent puncture/damage;

3. *Post construction*

- Ongoing monitoring and maintenance for containment cell likely involving:
  - Installation and regular monitoring of groundwater monitoring wells installed around the new facility for a period of time;
  - Ongoing physical maintenance of the cell to maintain integrity of the cap;
  - Ongoing leachate monitoring;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

A4.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) requires a licence for the processing of aluminium smelter wastes containing leachable fluoride and/or leachable cyanide, and the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

As this option includes treatment of the SPL prior to encapsulation in the containment cell, it would be permissible subject to the issue of a licence from the EPA.

Planning Approval

This advice is based on the assumption that SPL separated from the mixed smelter wastes from the capped waste stockpile would be treated through the existing Regain treatment facility (or similar) incorporating a renegotiated contract that allows Hydro to retain the treated SPL onsite. The SPL would continue to be treated in accordance with the 2005 planning approval.

Placement of the treated capped waste stockpile waste in a containment cell would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*”.

Development for the purposes of a ‘waste or resource management facility’ (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As a ‘waste or resource management facility’ is not specified as ‘permitted without consent’ or ‘prohibited’ it follows that a ‘waste or resource management facility’ is permissible with consent.

It should be noted that the LEP prohibits “heavy industrial storage establishment“. This includes a “hazardous storage establishment” which is defined by the LEP as:

“*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

The Project would be deemed as "designated development" under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of "*Contaminated soil treatment works*" under clause 15 of Schedule 3 of the regulation. This includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

It is likely that more than 30,000 m^3 of contaminated soil is within the capped waste stockpile, and therefore its treatment and subsequent encapsulation in the containment cell would be seen as contaminated soil treatment works.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011). It is assumed that treatment of the SPL within the capped waste stockpile prior to placement in the containment cell would result in it no longer being deemed "Aluminium smelting by-product" and therefore it would not be deemed a state significant development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be ‘regional development’ as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as “*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* “, but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While Cessnock City Council would assess the DA, the consent authority for the works will be the Hunter and Central Coast Regional Panel.

The EIS will be required to address a number of key issues that will be the focus of the consent authority’s considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the containment cell is located in an area currently containing native vegetation);
- Aboriginal heritage (particularly if the containment cell is located in an area of limited disturbance);
- Construction noise and air quality;
- Construction traffic;
- Construction phase management of contaminants;
- Soil and water management (including containment cell location hydrology and geotechnical conditions);
- Aesthetics and visual impacts;
- Community and social impacts (including health);
- Consideration of alternatives to the containment cell;
- Ongoing containment cell management strategy (particularly leachate management and cell stability);
- Sustainability and carbon management.

In addition to assessing the construction and operation of the containment cell, the EIS would also need to assess the methodology for opening the capped waste stockpile, and the removal and relocation of this material. This would include the proposed environmental management strategies (such as management of stormwater runoff) and the remediation of the capped waste stockpile location.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works;
- That disposal of treated SPL and other wastes to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council;
- Environment Protection Authority (EPA);
- NSW Office of Water (NOW);
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act);
- Department of Planning and Infrastructure;
- Local Members of Parliament;
- The local community (including residents and local community and environmental groups);
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
    - Crushing, grinding or separating
    - Waste storage

- Waste processing (non-thermal treatment)

- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
  - Metallurgical activities (aluminium production and metal waste generation).

This advice assumes that the SPL in the capped waste stockpile would be treated in accordance with EPL 13268, and therefore there are no new or additional licensing requirements.

“Waste disposal (application to land)” is a scheduled activity requiring an EPL (Clause 39 of Schedule 3). However, the definition for this activity states that it applies to waste “*received from off site*”. As the SPL was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL.

It is likely that removal of the capped waste stockpile (and remediation of residual soils) would be a scheduled activity based on the definition of “Contaminated soil treatment” under Clause 15 of Schedule 1 of the POEO Act., which states:

“(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil”.

Therefore an EPL would be required to undertake the removal of the capped waste stockpile wastes and the remediation of residual soils. As the containment cell would form part of the remediation works, there are likely to be licence conditions associated with the management and monitoring of the cell.

Likelihood of Approval

Provided that: the materials comply with the Chemical Control Order; the EIS shows that the option would not pose a significant impact to the factors listed above; and that the location has been selected based on an acceptable depth to groundwater, tight surrounding soils (preferably clays) that are demonstrated to be geologically consistent, surface water diversion and best practice containment cell design, the likelihood of approval is moderate to high.

This likelihood can be further enhanced (and the approval timeframe potentially reduced) through implementation of the stakeholder consultation program.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

A4.3 Costs

The estimated cost for this option is $66 mil AUD NPV.

Refer to the attached costing for details.

A4.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.25
Preparation of RAP and Planning Approval	1 – 1.5
Approvals	0.75 – 1.
Sorting	0.0
Treatment at 20000t/year	4.7 - 5
Project Engineering Tasks	0.2 – 0.4
Implementation	0.5 – 0.7
Total Estimated Timeframe	**8 - 9**

A4.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate and gas monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that the soil has been treated prior to placement;;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general maintenance including mowing, watering if required, weed and tree control, and visual inspection of the cap integrity and the replacement of cover soil once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital cost. It is not proposed that removal of the wastes will be required. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

These costs were estimated to be approximately $2,000 AUD NPV.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $1.0mil AUD NPV.

A4.6 Risk

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘rare’ that this would occur and only in some extreme circumstances, such as severe weather. Should breaches occur the containment cell is situated in an area with a depth to groundwater in excess of 10 m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the reduced chemical composition of wastes achieved by pre-treatment, and the depth to the groundwater table, the consequence of failure is likely to require minimum remediation and unlikely to result in prosecution or clean up of surrounding areas. The consequence category is therefore considered to be ‘minor’. On this basis the risk ranking is ‘2’.

A5 Landfill off site

Sub Option	Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[7]	Risk Ranking
1) NSW	Moderate	284	5 - 6	0	1
2) QLD	Moderate	246	5 - 6	0	1
3) Internationally	Very low	-	-	-	-

A5.1 Description of the option

This option would involve the off-site disposal of the 'as is' capped waste stockpile wastes at a licensed landfill facility. Landfills in New South Wales, Queensland and internationally have been considered in this option.

The capped waste stockpile will be deconstructed by progressive removal of existing capping materials. This materials will be used as daily cover manage gas emissions and exposure to moisture. A depth of 2m below the capped waste stockpile footprint is additionally proposed for remediation. Leachate will be managed by retaining the outer bund. Treatment of leachate is included in the combined options in Appendix G.

1) New South Wales Landfill

For the NSW disposal option we have assumed disposal in a purpose built cell at the SITA facility in Sydney. Immobilisation of leachable concentrations would be by macro encapsulation, i.e. within a purpose built containment cell.

As a waste under a chemical control order, any excavation and/or transport would require approval/s from the NSW EPA and the NSW DPI and tracking under the Controlled Waste NEPM via an on-line waste tracking system.

Transport would be required between Kurri Kurri and Sydney (150 km).

2) Queensland Landfill

This option has been explored primarily due to the lower landfill levies associated with waste disposal in Queensland compared to NSW.

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[7] Net Present Value using a discount rate of 3%

This option assumes the same conditions for New South Wales disposal discussed above, i.e. the material would be loaded and transferred "as is" for disposal in a specialised containment cell for macro-encapsulation within a cell that is suitably constructed to mitigate leachate generation.

As a waste under a chemical control order, any excavation and/or transport would require approval/s from the NSW EPA and the NSW DPI and tracking in NSW under the Controlled Waste NEPM (via an on-line waste tracking system). Queensland adopts a similar on-line waste tracking system and will also require approvals for placement of hazardous waste. The criteria for placement of (fluoride contaminated) waste are also between five and ten times more conservative than NSW with respect to leachable concentrations. On this basis, approval likelihood is lower than for NSW.

Transport would be required between Kurri Kurri and Queensland (estimated as 800 km).

3) Internationally

Any international export would be executed under the Basel Convention. Export for processing/reuse is a known scenario; however, we are not aware of any cases where export has been undertaken with the aim to landfill. We assume approval of this is very unlikely both from exporting as well as importing authorities. This option has not been considered further.

A5.2 Likelihood of approval

Chemical Control Orders and Dangerous Goods Code

1) General

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011) (the Dangerous Goods Code). This waste is classified as Class 4.3 - substances which in contact with water emit flammable gases.

The Dangerous Goods Code places a number of restrictions on how the waste can be transported, including:

- The size and type of wrapping/ container for the inner package and the outer package;
- The specifications for Intermediate Bulk Containers that house these packages (e.g. use metal or rigid plastic containers, or place other types of containers in closed transport units);

- If transported in a portable tank or bulk containers, the specifications for such tanks (such as thickness, pressure and pressure relief) and containers (watertight).

2) New South Wales

The waste materials are regulated through the Chemical Control Order (CCO) under the *Environmentally Hazardous Chemicals Act 1985.* Section 2.2 of the CCO states that the conveying of smelter wastes containing leachable fluoride and leachable cyanide requires a licence issued by the regulator. Therefore transport of SPL with mixed smelter wastes from the site could only be undertaken following approval from the regulator.

Also under the CCO, the disposal of aluminium smelter wastes containing leachable fluoride and leachable cyanide is a prescribed activity and is prohibited. Therefore, disposal to landfill without treatment would not be possible. The proposed treatment would be by macro-encapsulation whereby the waste is contained within a purpose built containment cell provided certain criteria can be achieved. While this is the approach approved in 1993 for the capped waste stockpile, it may now not be acceptable to the EPA.

3) Queensland

The CCO requires that waste leaving a site must meet the leachability criteria or that specific approval has been obtained for transport without treatment. Waste can be exported off-site under licence from the NSW EPA.

All Australian jurisdictions require tracking of certain wastes under the Controlled Waste National Environment Protection Measure (NEPM). The Controlled Waste NEPM is for the movement of wastes between states of Australia, and processed SPL would most likely meet the requirements of the Controlled Waste NEPM.

Similar to waste tracking requirements in NSW, a Consignment Authorisation (CA) would be required prior to exporting the waste. In the case of transporting waste between NSW and Queensland, the CA would need to be produced by the Queensland Department of Environment and Heritage Protection. The facility receiving the waste would need to be known at the time of application and appropriately identified on the application form.

In Queensland, waste is classified as “general waste”, “limited regulated waste” or “regulated waste” in accordance with definitions provided in Schedule 7 of the *Environment Protection Regulations (EPR) (2008)* and Schedule 1 of *Environment Protection (Waste Management) Regulations (EPRWM) (2000)* defines “trackable wastes”. Under the EPR, (processed) SPL with mixed smelter wastes would be classified as regulated waste due to cyanide and fluoride content. Note that there are no analytical limits defined in the Queensland regulations, as there are in the NSW Waste Classification Guidelines.

The analytical criteria for 'regulated waste' are not defined. The acceptance criteria for the receiving landfill are defined in the *Landfill Siting, Design, Operation and Rehabilitation Guideline* (EM2319). For a double lined landfill, these criteria are as follows:

- Cyanide, Toxicity Characteristic Leaching Procedure (TCLP) of 5 mg/L
- Fluoride, TCLP of 150 mg/L.

ENVIRON consider the likelihood of approval for off-site disposal options to Queensland is very low to low largely due to unproven regulatory requirements around the treatment of SPL by macro encapsulation.

Planning Approval

Removal of the capped waste stockpile would be classified as "remediation works". However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works are permissible with consent.

The removal of the capped waste stockpile (including likely contaminated residual soils below the capped waste stockpile) would not be deemed a designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of "Contaminated soil treatment works" under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil,* ***but excluding excavation for treatment at another site****):*

If all contaminated soil was excavated and transported for treatment (including disposal) to a site that holds all the required approvals for receiving and treating (including disposal) of the contaminated soils, then an EIS would not be required.

The remediation works would be considered category 2 remediation works under State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) as the works are unlikely to meet the criteria for category 1 remediation works (as identified in Clause 9 of SEPP 55). Therefore the works can be undertaken without planning approval.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice;
- A brief description of the remediation work;
- An explanation as to why the work is category 2 remediation work;
- Reference to the property description and street address (if any) for the land on which the work is to be carried out;
- A location map of the land;
- Estimates of the dates for the commencement and completion of the work.

Environment Protection Licencing

Removal of the capped waste stockpile (and remediation of residual soils) is unlikely to be a scheduled activity based on the definition of "Contaminated soil treatment" under Clause 15 of Schedule 1 of the POEO Act., which states:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil ***but excluding excavation for treatment at another site****).*

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

As any contaminated soils are to be excavated and transported off site, an EPL would not be required to undertake the removal of the capped waste stockpile wastes.

However, there is a scheduled activity of "transport of trackable waste" (under clause 48 of Schedule 1 of the POEO Act). Trackable waste is defined in the Protection of the Environment Operations (Waste) Regulation 2005. Treated SPL with mixed smelter wastes meets the definition of trackable waste and therefore an EPL to transport the material within NSW is required.

Likelihood of Approval

Due to the issues associated with the Chemical Control Order (and associated interstate and international permits) this option has a low likelihood of approval.

A5.1 Cost

The cost for these sub-options are estimated to be:

Disposal location	Estimated cost ($mil AUD NPV)
New South Wales, Australia	284
Queensland, Australia	246

Refer to the attached costing for details.

A5.2 Timeframe to complete

	Time Estimate (years)		Comment
Task	New South Wales, Australia	Queensland, Australia	
Approvals	0.5 – 0.7	0.5 – 0.7	
Investigations/tender/contract negotiations	0.2 – 0.4	0.2 – 0.4	
Implementation	0.2 – 0.3	0.2 – 0.3	
Transportation	3.5 – 4.5	3.5 – 4.5	Assumes 300 t/day carted
Validation Reporting	0.2 – 0.3	0.2 – 0.3	
Total	5 - 6	5 - 6	

A5.3 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented. [

A5.4 Risk

The risk associated with this disposal option is associated with the waste causing an unacceptable risk to human health or the environment at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated the likelihood of an incident occurring is considered to be ‘rare’ (may occur only in exceptional circumstances’). The consequence to Hydro, is considered to be ‘insignificant’ as it is a remote risk that the consequence will be the responsibility of Hydro if certain mitigation and management measures are implemented. This evaluation of risk is based on legal advice obtained by Hydro.

A6 Treat and dispose off site

Sub Option	Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[8]	Risk
1 NSW	Moderate to high	184	16 - 17	0	1
2 QLD	Moderate to high	210	16 - 17	0	1

A6.1 Description of the option

This option would involve the following steps:

1) The capped waste stockpile will be deconstructed by progressive removal of existing capping materials. This materials will be used as daily cover manage gas emissions and exposure to moisture. A depth of 2m below the capped waste stockpile footprint is additionally proposed for remediation. Leachate will be managed by retaining the outer bund. Treatment of leachate is included in the combined options in Appendix G.

2) Excavate and sort waste material to stockpiles. Sorting has assumed to be by manual means but could potentially be more economically achieved through mechanical and optical means.

3) Treat SPL waste components through the existing Regain treatment facility (or similar) incorporating a renegotiated contract that allows Hydro to retain the treated SPL onsite.

4) Dispose of the treated SPL and remaining Alcan Wastes as solid waste to facilities licensed to accept solid wastes.

Steps involved in this option include:

- Treatment of SPL by the Regain process (or similar) prior to off-site disposal at a licensed landfill facility. Treatment would be undertaken to reduce leachable fluoride and cyanide and render the treated waste as non-hazardous;
- Transport of the waste to a landfill licensed to accept solid waste. Australian destinations have only been considered, international destinations are costs prohibitive and have not been considered further.

[8] Net Present Value using a discount rate of 3%

A6.2 Likelihood of approval

Chemical Control Orders and Dangerous Goods Code

The following is based on the assumption that the treatment of waste prior to transporting off-site (i.e. by reducing fluoride and cyanide levels to below the criteria) results in the SPL material complying with the Chemical Control Order (CCO), and no longer being deemed as Dangerous Goods under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011) (the Dangerous Goods Code).

1) New South Wales

The waste materials (SPL) are regulated through the CCO under the *Environmentally Hazardous Chemicals Act 1985*. Section 2.2 of the CCO states that the conveying of smelter wastes containing leachable fluoride and leachable cyanide requires a licence issued by the regulator. However, as the SPL will be treated prior to transportation such a licence is not required

2) Queensland

All Australian jurisdictions require tracking of certain wastes under the Controlled Waste National Environment Protection Measure (NEPM). The Controlled Waste NEPM is for the movement of wastes between states of Australia and processed SPL would most likely meet the requirements of the Controlled Waste NEPM.

Similar to waste tracking requirements in NSW, a Consignment Authorisation (CA) would be required prior to exporting the waste. In the case of exporting waste to Queensland, the CA would need to be produced by the Queensland Department of Environment and Heritage Protection. The facility receiving the waste would need to be known at the time of application and identified on the application form.

Planning Approval

As previously noted it is assumed that the receiving location holds the necessary approvals to receive the material. Therefore the requirement for planning approval would be limited to the removal of the capped waste stockpile.

Removal of the capped waste stockpile would be classified as "remediation works". However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP.

As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works permissible with consent.

The removal of the capped waste stockpile and treatment of materials (including soils within and below the capped waste stockpile) would be deemed a designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of “Contaminated soil treatment works” under clause 15 of Schedule 3 of the regulation. This definition includes:

“*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil”.

It is likely that more than 30,000m^3 of contaminated soils would be within and directly below the capped waste stockpile requiring treatment.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General’s Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as ‘regional development’ as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as “*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* “, but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While Cessnock City Council would assess the DA, the consent authority for the works will be the Hunter and Central Coast Regional Panel.

The EIS will be required to address a number of key issues that will be the focus of the consent authority’s considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality;
- Construction traffic;
- Construction phase management of contaminants;
- Soil and water management;
- Aesthetics and visual impacts;
- Community and social impacts (including health);
- Consideration of alternatives to the transporting untreated offsite;
- Sustainability and carbon management.

Environment Protection Licencing

1) New South Wales

It is likely that removal of the capped waste stockpile (and remediation of residual soils) would be a scheduled activity based on the definition of "Contaminated soil treatment" under Clause 15 of Schedule 1 of the POEO Act., which states:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Therefore an EPL would be required to undertake the removal of the capped waste stockpile wastes and the remediation of residual soils.

With regard to the transportation of the material, there is a scheduled activity of "transport of trackable waste". Trackable waste is defined in the *Protection of the Environment Operations (Waste) Regulation 2005*. Treated SPL with mixed smelter wastes does not meet the definition of trackable waste and therefore an EPL to transport the material within NSW is not required.

2) Queensland

In Queensland, waste is classified as "general waste", "limited regulated waste" or "regulated waste" and these definitions are provided in Schedule 7 of the *Environment Protection Regulations (EPR) (2008)* and Schedule 1 of *Environment Protection (Waste Management) Regulations (EPRWM) (2000)* defines "trackable wastes". Under the EPR, treated SPL with mixed smelter wastes would be classified as regulated waste due to cyanide and fluoride content. Note that there are no analytical limits defined in the Queensland regulations, as there are in the NSW Waste Classification Guidelines.

The analytical criteria for 'regulated waste' are not defined. The acceptance criteria for the receiving landfill are defined in the *Landfill Siting, Design, Operation and Rehabilitation Guideline* (EM2319). For a double lined landfill, these are as follows:

- Cyanide, TCLP of 5 mg/L
- Fluoride, TCLP of 150 mg/L.

As previously noted it is assumed that the receiving landfill has the necessary approvals to receive the material.

Likelihood of Approval

This option has a high likelihood of approval as it pre-treats the wastes (including the SPL so that it complies with the Chemical Control Order) and contaminated soils, and then removes them from the site.

A6.3 Cost

The cost ranges for these sub-options are:

Disposal location	Estimated cost ($mil AUD NPV)
New South Wales, Australia	184
Queensland, Australia	210

Refer to the attached costing for details.

A6.4 Timeframe to complete

	Time Estimate (years)		Comment
Task	**New South Wales, Australia**	**Queensland, Australia**	
Approvals	1 – 1.5	1 – 1.5	
Investigations/tender/contract negotiations	0.2 – 0.4	0.2 – 0.4	
Implementation	0.2 – 0.3	0.2 – 0.3	
Treatment and transport (20000t/yr)	14 - 15	14 - 15	Assumes 20,000 t/yr treated and carted
Validation Reporting	0.2 – 0.4	0.2 – 0.4	
Total	16 - 17	16 - 17	

A6.5 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented. [

A6.6 Risk

The risk associated with this disposal option is associated with the waste causing an unacceptable risk to human health or the environment at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated the likelihood of an incident occurring is considered to be ‘rare’ (may occur only in exceptional circumstances’). The consequence to Hydro, is considered to be ‘insignificant’ as it is a remote risk that the consequence will be the responsibility of Hydro if certain mitigation and management measures are implemented. This evaluation of risk is based on legal advice provided obtained by Hydro.

However, due to the mixed nature of the capped waste stockpile waste, there is a risk that it is technically unfeasible to separate the untreated SPL from the remaining waste in a condition and quality suitable for treatment.

A7 On site Treatment to Achieve Complete Destruction

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[9]	Risk
Moderate	108	TBA	17-19	12

A7.1 Description of the option

This option would involve the processing of mixed wastes to remove fluorides and cyanides, followed by carbon value capitalisation in a waste to energy process. Research of global technologies identified that plasma arc gasification pilot scale trials have been successfully undertaken on first and second cut SPL. The applicability of this process to the capped waste stockpile wastes is not known and is the subject of further evaluation. This process would require a pilot project prior to full scale treatment.

A7.2 Likelihood of approval

Chemical Control Order

As previously discussed, the Chemical Control Order (CCO) applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) will likely require treatment/processing of the waste prior to disposal. As this option includes treatment of the SPL component of the waste it is likely to meet the CCO conditions and the EPA's requirements, with a licence issued under the Act.

Resource Recovery Exemption

The by-products of the plasma arc gasification process include synthetic gases, base metals and vitrified rock-like material (slag). The synthetic gases can be used in energy generation, while the base metals and slag have potential reuse opportunities (e.g. granulated slag can be used as a construction base material).

A resource recovery exemption would need to be issued in accordance with the *Protection of the Environment Operations Act 1997* permitting the reuse of these materials. The exemption would be issued if it could be demonstrated that the waste material is of benefit in its proposed use and poses minimal risk of harm to the environment or human health. This includes providing evidence that the material is homogenous in physical and chemical quality, that it is stable and would not result in the leaching of contaminants into soils and groundwater, and that there is a genuine re-use opportunity for the material.

[9] Net Present Value using a discount rate of 3%

If a resource recovery exemption could not be gained, these materials would need to be disposed to a licensed landfill. However the following planning and licensing advice is based on the assumption that approval for disposal to landfill does not form part of this option and that reuse is possible.

Planning Approval

Treatment of the wastes using this approach would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*”.

Development for the purposes of a ‘waste or resource management facility’ (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As a ‘waste or resource management facility’ is not specified as ‘permitted without consent’ or ‘prohibited’ it follows that a ‘waste or resource management facility’ is permissible with consent.

The Project would be deemed as “designated development” under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of “Waste management facilities or works” under clause 32 of Schedule 3 of the regulation. This definition includes:

“(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or

The works would be classified as ‘designated development’ as it triggers sub-clause 32(1)(a)(i) (whereby “Aluminium smelting by-product” is registered as a dangerous good under the “Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition” (National Transport Commission, 2011)). An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General’s Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as 'regional development' as they would have a capital investment value (CIV) of more than $20 million (note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) Council will assess the DA and the consent authority for the works will be the Hunter and Central Coast Regional Panel.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the treatment facility is located in an area currently containing native vegetation);
- Aboriginal heritage (particularly if the treatment facility is located in an area of limited disturbance);
- Treatment phase noise and air quality;
- Treatment phase management of contaminants;
- Community and social impacts (including health);
- Consideration of alternatives to the treatment;
- Sustainability and carbon management.

It should be noted that Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the treatment of the SPL with mixed smelter wastes may be deemed part of the disposal process and therefore the activity deemed a ‘state significant development’, requiring approval from the Minister for Planning (or a delegate).

If this was the case, an EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General’s Requirements). An application to receive the DGRs is to be supported by a PEA.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works;
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council;
- Environment Protection Authority (EPA);
- NSW Office of Water (NOW);
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act);
- Department of Planning and Infrastructure;
- Local Members of Parliament;
- The local community (including residents and local community and environmental groups);
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

"Waste disposal (thermal treatment)" is a scheduled activity under clause 40 of Schedule 1 of the *Protection of the Environment Operations Act 1997*. This includes "*thermal treatment of hazardous and other waste, meaning the **receiving** of hazardous waste, restricted solid waste, liquid waste or special waste **from off site** and its processing by thermal treatment*." Assuming that the plasma arc gasification treatment plant would be located on-site, it would not meet this definition as the material would not be received from off-site.

However, in the event that the process also includes the generation of energy, "Energy recovery" is a scheduled activity under Clause 18 of Schedule 1. Its definition includes:

"***energy recovery from hazardous and other waste*** (meaning other than general waste)*, meaning the receiving from **on site** or off site of, and the recovery of energy from, hazardous waste, restricted solid waste, liquid waste or special waste*."

If the facility did recover energy through the process, it would require an EPL.

Likelihood of Approval

As noted the plasma arc gasification process is a new technology, and is still proceeding through trial programs globally. Agencies may be reluctant to approve such a facility unless data from trials of similar technologies can provide greater certainty about performance. Consultation could be undertaken with agencies to discuss the opportunity for a trial (with monitoring to confirm its performance) prior to a full scale facility.

If sufficient information and evidence could be provided to the agencies on the environmental performance of plasma arc gasification, and the resource recovery exemptions for the by-products are granted, agencies are likely to look favourably on such a process and therefore it would have a high likelihood of approval.

A7.3 Cost

The estimated cost for this option is $108mil AUD NPV.

A7.4 Legacy

A legacy value is not assigned due to the complete reuse of the wastes. It was assumed that this option would only be selected if pilot scale testing demonstrated the end product was able to be reused.

A7.5 Timeframe to complete

The estimated timeframe to complete this option is 17 to 19 years allowing for pilot studies and planning approvals.

Activity	Estimated timeframe (years)
Pilot Trial	1
RAP/EIS	1
Approvals	1.75
Investigations/tender/contract negotiations	0.5
Construction/commissioning	1
Assumes treatment at 15000tpa	12.6
Validation Reporting	0.2
Total Estimated Timeframe	**17 - 19**

A7.6 Risk Ranking

The risk associated with this option is a technological risk from the unproven technology and the possibility that an alternate remediation solution will require implementation. The likelihood of this technology not being able to treat the site wastes economically or technically into a condition that can be re-used without additional treatment (and therefore needing to landfill) is ‘likely’. Potential issues associated with the applicability of the treatment to the capped waste stockpile wastes are considered to be equally valid. Risks include those associated with the pre-treatment requirements for the capped waste stockpile and the extent to which crushing and sorting is required.

The material is currently not qualified as inert and therefore it cannot be used without limitation as fill material. Also, no technical specification of material strength has been determined, (the physical properties are currently unknown). If it cannot be utilised as inert fill material, one of Options A1 to A6 would need to be implemented. In addition, as of 23 January 2014 there are no known estimates of the difference between input volume / weight, and volume / weight of the vitrified material (it is unknown how much of the processed material would be generated).

The consequence of the technology not being applicable to the site will require an alternate solution is considered ‘moderate’. The alternate solution for remediation is comparable in cost to those presented in Options A1 to A6. It would also result in a loss in time prior to being able to implement a solution. On this basis this option is given a risk ranking of ‘12’.

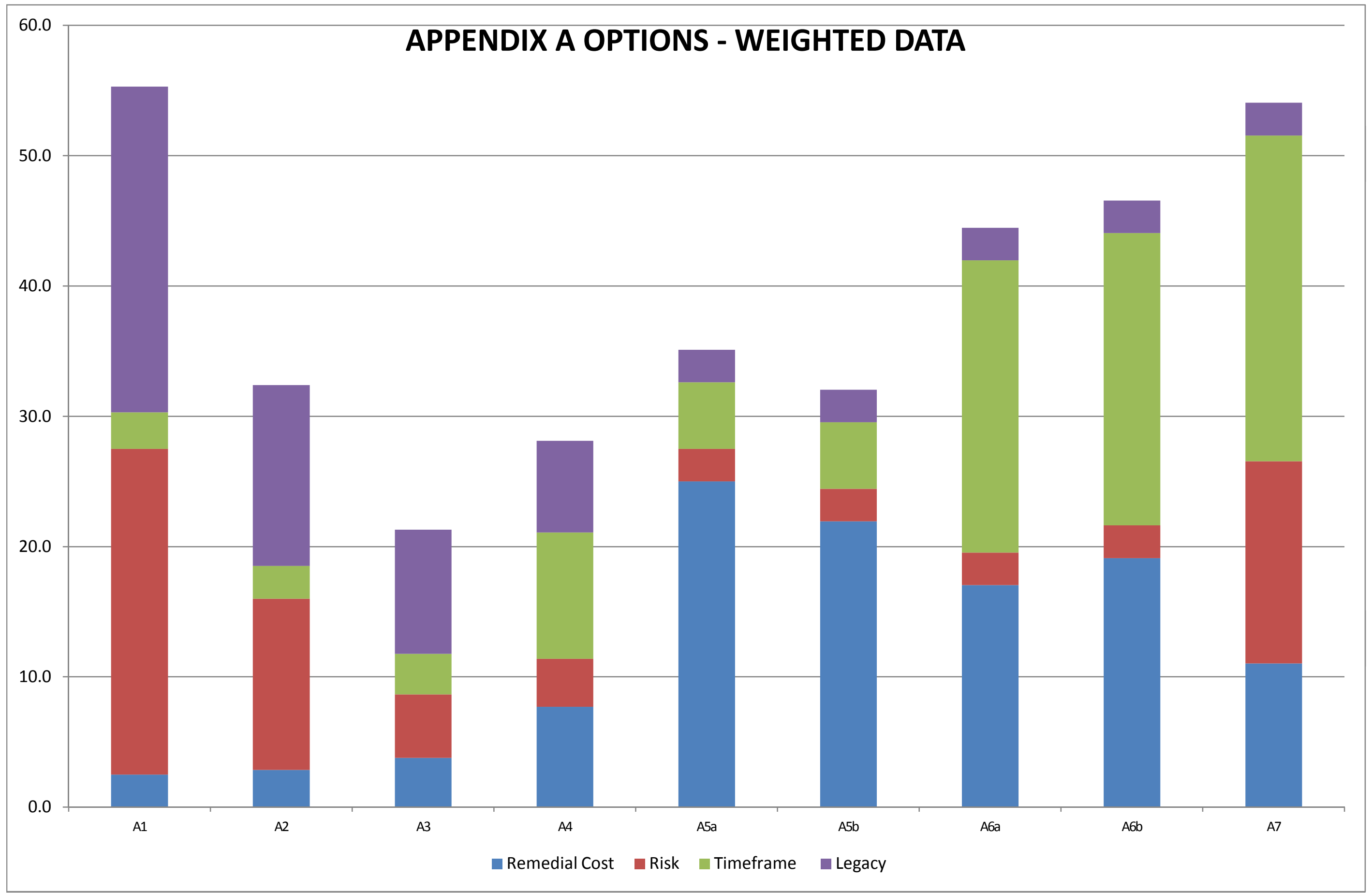
Type	estimate	accuracy %	Volume estimates (m3) Range low	high	Bulk Density (T/m3)	Mass estimates (T) Range low	high
Capped Waste Stockpile	105000	20	84000	126000	1.8	151200	226800

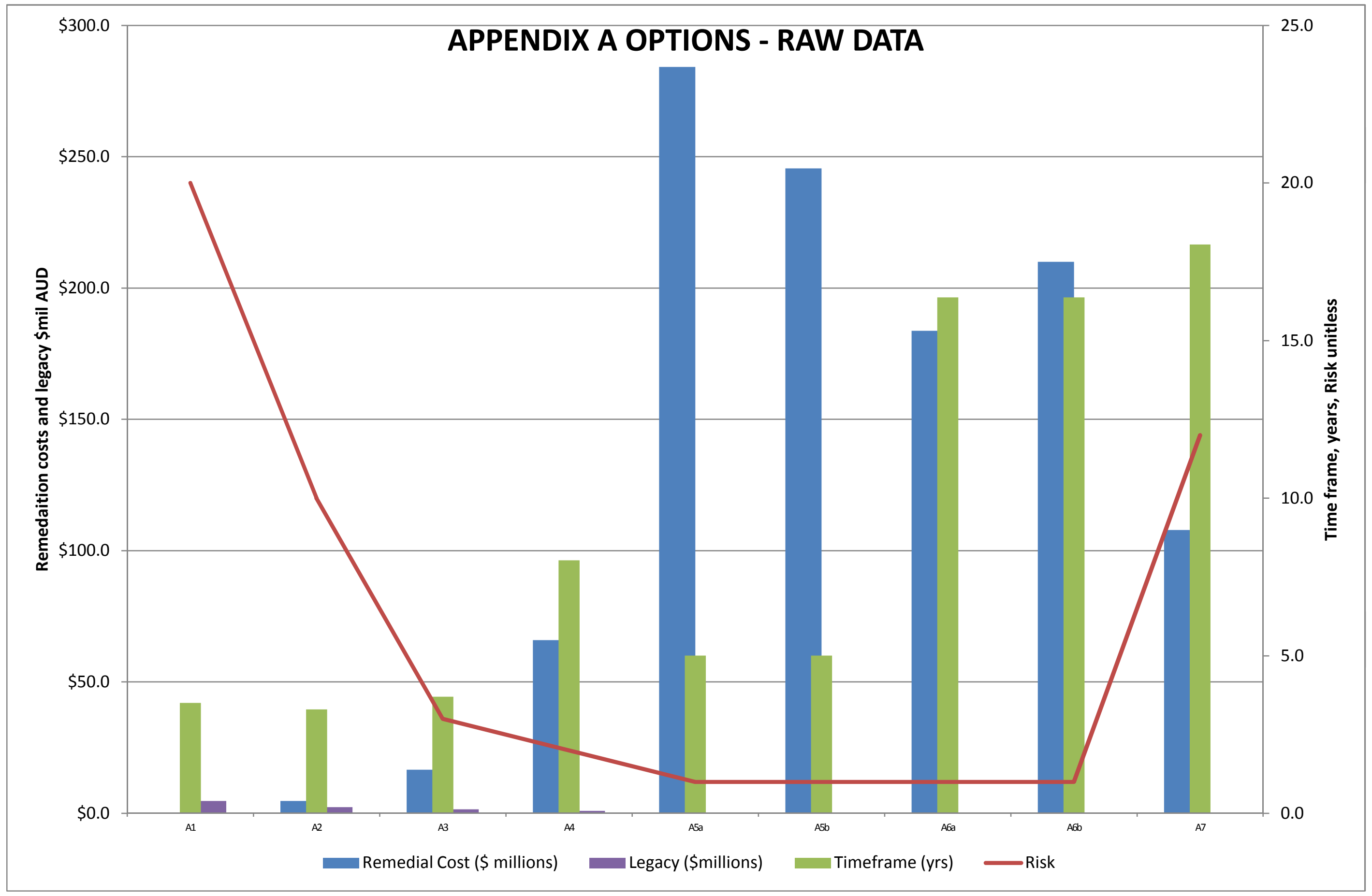
73500

Description	Remediation Cost $mil	Legacy $ mil	TIME (Years)	RISK (1 to 25, 25 high)
Option A1 Do nothing	$0.4	$4.7	3.5	20
Option A2 Install barrier wall and cap	$4.8	$2.4	3.3	10
Option A3 - Place within a purpose built containment cell with t	$16.6	$1.5	3.7	3
Option A4 - Treat and place within a purpose built containment	$66.0	$1.0	8.0	2
Option A5 Dispose off site to landfill				
Option A5a Disposal in NSW	$284.1	$0.0	5.0	1
Option A5b Disposal in Queensland	$245.5	$0.0	5.0	1
Option A6 Treatment prior to disposal				
Option A6a Treatment and disposal in NSW	$183.7	$0.0	16.4	1
Option A6b Treatment and disposal in Queensland	$210.0	$0.0	16.4	1
Option A7 Onsite Destruction	$108	$0	18.1	12

Appendix A - Capped Waste Stockpile

Weighting Factors	
	Weighting (sums to 10)
Remedial Cost	2.5
Risk	2.5
Timeframe	2.5
Legacy	2.5
	10





Option A1 Do nothing	
Description	**Undertake a risk assessment to demonstrate no remediation is required**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Investigations and reporting**						
		Fate and transport modelling	1	each	$0	$0	Forms part of already commissioned work	ENVIRON experience
		Investigations of the Capped Waste Stockpile performanc	1	each	$150,000	$150,000	To evaluate migraiton pathways and infiltrtaion rat	ENVIRON experience
		Development of a management plan	1	each	$30,000	$30,000	For the long term management of the site	ENVIRON experience
		Prepare overall report	1	each	$100,000	$100,000	Includes benefit evaluation of remediation	ENVIRON experience
		Contaminated Land Auditor Review	1	each	$0	$50,000		ENVIRON experience
		Negotiations with the EPA	1	each	$50,000	$15,000	Licence surrender/modification	ENVIRON experience
		SUBTOTAL initial investigation and risk assessment				**$345,000**		
		Subtotal				$345,000		
		Contingency 10%				$34,500	10% Scope	
		CAPITAL COSTS				**$379,500**		
		Low Estimate of Cost (-25%)				**$284,625**		
		High Estimate of Cost (+25%)				**$474,375**		

NOTES Assumes all investigations demonstrate that remediation of the Capped Waste Stockpile is not required
Assumes EPA and Auditor agree with the report findings

Legacy Cost	Description	QTY		units	UNIT COST	TOTAL	NOTES	Source
	Environmental Monitoring	10		annual	$150,000	$1,500,000		Based on two events per year for 5 years
	Maintenance	1		annual	$18,000	$565,885		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year		each	$257,203		no cost in year 0	
			1	each	$122,841	$122,841.44	year 25	Using a discount rate of 3%
			1	each	$28,021	$28,021.00	year 50	Using a discount rate of 3%
			1	each	$3,053	$3,052.75	year 75	Using a discount rate of 3%
			1	each	$159	$158.84	year 100	Using a discount rate of 3%
						$2,219,959		
	Legacy potential liability provisioning	100%		event	NPV	$2,498,355	assumes occurs after 25 years	Using a discount rate of 3%
						$2,498,355	Includes costs for Option A2, retrofit of landfill cell	
						$4,718,314		

RISK	Comment		20
	Catastroph	Due to risk of prosecution and likely remedial costs that could include removal	
	Likely	It is probable that a cap breach would occur under most circumstances	

Time	Investigations and reporting	1.5	years
	Auidtor Review	0.5	years
	Approvals	1.5	years
	Time	**3.5**	**years**

Option A2 Install barrier wall and cap	
Description	**Construct a barrier wall to contain leachate migration, remove and reinstate the capping layers**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		Geotechnical Borings & Testing	12	EA	$17,000	$204,000		Vendor estimate
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in cont	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$219,000**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$150,000	$150,000		ENVIRON experience
		CLMA Auditor			$60,000	$60,000	Assumes Auditor will be required b	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		Sub-total preliminary documentation				**$510,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$167,000		USEPA Remediation Engineering
		Remedial Design			8%	$267,000		USEPA Remediation Engineering
		Construction Management			6%	$200,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$67,000		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$701,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$200,000	$200,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$70,000	$70,000		Vendor Estimate/ENVIRON Experience
		Work pad construction	1	LS	$160,000	$160,000		
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$456,000**		
	5	**Slurry Wall Construction**						
		Borrow material	1	LS	$150,000	$150,000		Vendor estimate
		Slurry Wall Construction	1	LS	$840,000	$840,000		Vendor estimate
		Trench cap	1	LS	$30,000	$30,000		Vendor estimate
		SUBTOTAL Slurry Wall Construction				**$1,020,000**		
	6	**Cap upgrades**						
		Remove existing cap 150mm veg layer and stockpile	3,630	m3	$8	$30,677	Excavate, transport<1km and depo:	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	10,891	m3	$9	$100,745	Excavate, transport<1km and depo:	Rawlinsons 2013 p 673
		Remove 400mm clay and stockpile	9,681	m3	$12	$120,047	Excavate, transport<1km and depo:	Rawlinsons 2013 p 673
		Grade, Compact surface	24,203	m2	$3	$66,558	Level and grade, no compaction or	Rawlinsons 2013 p 675
		Install Sand Drainage Layer (15cm) for gas drainage	2,670	m3	$10	$26,033		
		Replace existing 400mm of clay and compact	9,681	m3	$15	$148,122	Excavate, transport<1km and comp	Rawlinsons 2013 p 674
		Install 1.5mm HDPE Liner for Cell Cap	24,203	m2	$20	$490,111		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	7,379	m3	$10	$72,683		Rawlinsons 2013 p 674
		Install Filter Fabric for Cell Cap	24,203	m2	$4	$96,812		Vendor estimate
		Install General Fill (30 cm)	7,379	m3	$26	$191,854	Includes existing material	Rawlinsons 2013 p 674
		Install Topsoil for Cell Cap (15 cm)	3,690	m3	$17	$63,579	Utilises removed materials	Rawlinsons 2013 p 674
		Seed, Fertilize, and Mulch Cell Cap	24,203	m2	$8	$193,624		Rawlinsons 2013 p228
		Supply and Install Fencing	780	m	$56	$43,680	1800mm chain mesh fence	Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	10	ea	$2,018	$20,180	Well depth 10m	Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	10	ea	$1,500	$15,000	Well depth 5m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$1,679,705**		
	7	**Final Reporting**						
		Validation report		each	allow	$80,000		ENVIRON experience
		EMP		each	allow	$50,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$170,000**		
		Subtotal				$4,755,705		
		Contingency 10%				$475,570	10% Scope	
		CAPITAL COSTS				**$5,231,275**		
		Low Estimate of Cost (-25%)				**$3,923,457**		
		High Estimate of Cost (+25%)				**$6,539,094**		

NOTES

Assumes volumes of material are as presented in Appendix A of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Refer to Appendix A for a description of capping requirements and assumptions made
Assumes soils are fine sand, silty sand, silty clay to gravelly sandy clay
Key formation is a high plasticity clay approximately 10 meters below the ground surface
Perimeter length is 650 meters
Groundwater depth is 1-2 meters
Building are located within 8 meters of southern toe of the landfill
Cap upgraded to USEPA Hazardous Waste Regulation cap
Includes allowance for grading and compacting to 0.5m of Capped Waste Stockpile before installation of cap.
Capped Waste Stockpile capping dimensions are approximate based on the "Notification Area" figure from RPS Australia East PTY LTD dated 17th July 2012

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years
							Based on 12 events per year for 100 years, using
	Maintenance	1	annual	$18,000	$567,844		a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$257,203		no cost in year 0	
		1	each	$122,841	$122,841	year 25	Using a discount rate of 3%
		1	each	$28,021	$28,021	year 50	Using a discount rate of 3%
		1	each	$3,053	$3,053	year 75	Using a discount rate of 3%
		1	each	$159	$159	year 100	Using a discount rate of 3%
					$1,471,918		
	Legacy potential liability provisioning	1%	event	NPV	$3,878	assumes occurs in once in 100 year:	Using a discount rate of 3%
		1%	event	NPV	$912,428	assumes occurs in once in 100 year:	Using a discount rate of 3%
					$916,306		
					$2,388,224		

RISK			Value
	Comment		10
	Catastrophic	Prosecution could result remedial costs between 0.5m and 5mil likely	
	Unlikely	Could occur at some time	

Time			
	Pre-Design Activities	0.25	years
	Preparation of RAP and Planning Approval (EIS)	1.25	years
	Approvals	0.75	years
	Project Engineering Tasks	0.2	years
	Implementation	0.6	years
	Final Reporting	0.25	years
	Time	**3.3**	**years**

Option A3 - Place within a purpose built containment cell with the Hydro site

Description	**Placement within a purpose built containment cell within the Hydro site**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	21	EA	$1,100	$23,100	1 CPT per 1000 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	15	EA	$7,200	$108,000	5 borings per 10000m2.	ENVIRON Estimate.
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leachate	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$146,100**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$598,000		USEPA Remediation Engineering
		Remedial Design			8%	$957,000		USEPA Remediation Engineering
		Construction Management			6%	$718,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$239,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$2,512,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct temporary haul roads	1,500	LM	$149	$223,800	From site to containment cell location	Rawlinsons 2013 p678
		SUBTOTAL Site Preparation				**$449,800**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	28,091	m2	$2	$56,182		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	14,045	ha	$1,020	$14,326.31	Assumes area largely cleared (60%)	Rawlinsons 2013 p211
		Excavate and grade Consolidation Cell (3 m)	84,272	m3	$12	$1,028,123		Rawlinsons 2013 p214 (cut to fill)
		Construct Clay Liner (1 metre)	23,852	m3	$24	$572,448		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	23,816	m2	$20	$482,274		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	23,816	m2	$4	$95,264		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	7,288	m3	$25	$182,200		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	23,816	m2	$20	$482,274		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	23,816	m2	$4	$95,587		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	7,288	m3	$25	$182,200		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,152	m	$128	$147,456		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	23,816	m2	$4	$95,587		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$3,443,920**		
	6	**Excavation Capped Waste Stockpile**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Transport and place waste compact	105,000	m3	$14	$1,512,000	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		Crush	105,000	m3	$25	$2,625,000		
		Excavate and transport 2m of underlying soils	55,778	m3	$12	$691,647		
		Soil Validation Works	1	EA	$60,000	$60,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	55,778	m3	$25	$1,394,450		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavation Works for Capped Waste Stockpile				**$6,435,476**		
	7	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	2,670	m3	$10	$26,033		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	14,522	m2	$26	$377,567		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	7,379	m3	$10	$71,945		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	24,203	m2	$20	$484,060		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	7,379	m3	$10	$71,945		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	24,203	m2	$4	$96,812		Rawlinsons 2013 p677
		Install General Fill (30 cm)	7,379	m3	$26	$191,854		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	3,690	m3	$17	$63,579		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	24,203	m2	$8	$193,624		Rawlinsons 2013 p228
		Supply and Install Fencing	720	m	$56	$40,320		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	8	ea	$2,018	$16,144		Vendor Estimate/ENVIRON Experience
		Total Cell Construction and Cap Construction				**$1,633,882**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		Sub-total reporting				**$125,000**		
		Subtotal				$15,136,179		
		Contingency 10%				$1,513,618	10% Scope	
		CAPITAL COSTS TOTAL				**$16,649,797**		

NOTES

- Assumes volumes of material are as presented in Appendix A of the Remedial Options Summary
- Assumes further investigation does not identify other not known contamination
- Assumes program can be achieved through the use of standard excavating equipment
- Refer to Appendix A for a description of capping requirements and assumptions made
- Assumes the clay borrow pit is a suitable location for the containment cell
- Assumes a cell 10m above ground level is acceptable
- Sand and general fill won from the deconstruction of the Capped Waste Stockpile is suitable for daily cover
- Groundwater treatment is included in Appendix F, and combined options in Appendix G

Legacy Cost

Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
Groundwater Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 2 years
Maintenance	1	each	NPV	$567,844		Based on 12 events per year for 100 years, using a discount rate of 3%
Topsoil replacement and reseeding battered perimeter	Base year	each	$257,203			
	1	each	$122,841	$122,841.44	year 25	Using a discount rate of 3%
	1	each	$28,021	$28,021.00	year 50	Using a discount rate of 3%
	1	each	$3,053	$3,052.75	year 75	Using a discount rate of 3%
	1	each	$159	$158.84	year 100	Using a discount rate of 3%
				$1,471,918		
Legacy potential liability provisioning	1%	event	NPV	$3,650	Occurring once in 100 years and at Year 50	Using a discount rate of 3%
				$3,650		
Legacy provision				**$1,475,567**		

Risk

		Value
Ranking		3
Moderate	Localised impacts and clean up costs between $0.5mil and $5mil.	
Rare	may occur only in exceptional circumstances	

Timing

Pre-Design Activities	0.25	years
Preparation of RAP and Planning Approval	1.25	years
Approvals	0.75	years
Project Engineering Tasks	0.2	years
Implementation	1	years
Final Reporting	0.25	years
Time	**3.7**	**years**

Option A4 - Treat and place within a purpose built containment cell

Description	**Placement within a purpose built containment cell within the Hydro site after sorting and treating SPL components**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	11	EA	$1,100	$12,100	1 CPT per 1000 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	10	EA	$7,200	$72,000	5 borings per 10000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$84,100**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$300,000	$280,000	Assumes EIS for JRPP approval	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$370,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$2,454,000		USEPA Remediation Engineering
		Remedial Design			8%	$3,926,000		USEPA Remediation Engineering
		Construction Management			6%	$2,945,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$982,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$10,307,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct temporary haul roads	1,500	LM	$149	$223,800	From site to containment cell location	Rawlinsons 2013 p678
		SUBTOTAL Site Preparation				**$449,800**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	14,520	m2	$2	$30,202		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	7,260	ha	$1,020	$7,405.20	Assumes area largely cleared (60%)	Rawlinsons 2013 p211
		Excavate and grade Consolidation Cell (3 m)	43,560	m3	$12	$531,432		Rawlinsons 2013 p214 (cut to fill)
		Construct Clay Liner (1 metre)	12,393	m3	$24	$297,432		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	12,393	m2	$20	$250,958		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	12,393	m2	$4	$49,572		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	3,806	m3	$25	$95,150		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	12,393	m2	$20	$250,958		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	12,393	m2	$4	$49,740		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	3,806	m3	$25	$95,150		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	3,829	m	$128	$490,112		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	3,806	m2	$4	$14,273		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$2,172,384**		
	6	**Sorting, placement and treatment of Capped Waste Stockpile wastes**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Transport and place waste compact	105,000	m3	$14	$1,512,000	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		Sorting manual	262,500	hrs	$64	$16,800,000	Assumes 2.5 labour hours to sort 1 cum	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Treatment SPL component	47,250	t	$530	$25,042,500	Assumes 50% is SPL	Hydro
		Transport and place waste compact	105,000	m3	$14	$1,512,000	Does not allow for recycling of any components	Rawlinsons 2013
		Crush	21,000	m3	$25	$525,000	Does not include SPL as this is already crushed, or anode	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Placement of SPL				**$45,543,879**		
	7	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	1,910	m3	$10	$18,623		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	10,508	m2	$26	$273,218		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	3,829	m3	$10	$37,333		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	12,557	m2	$20	$254,279		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	12,557	m2	$4	$50,228		Rawlinsons 2013 p677
		Install General Fill (30 cm)	3,829	m3	$26	$99,554		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	1,915	m3	$17	$32,995		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	12,557	m2	$8	$100,205		Rawlinsons 2013 p228
		Supply and Install Fencing	514	m	$56	$28,762		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	8	ea	$2,018	$16,144		Vendor Estimate/ENVIRON Experience
		Total Cell Construction and Cap Construction				**$911,341**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		Sub-total reporting				**$125,000**		
		Subtotal				$59,963,503		
		Contingency 10%				$5,996,350	10% Scope	
		CAPITAL COSTS				**$65,959,854**		

NOTES
Assumes volumes of material are as presented in Appendix A of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Refer to Appendix A for a description of capping requirements and assumptions made
Assumes the clay borrow pit is a suitable location for the containment cell
Assumes a cell 10m above ground level is acceptable
Assumes treatment can be achived at the rates currently provided by Regain
Assumes 50% of waste comprises SPL and is treated
Assumes sorting can be achieved manually and using standard machinery
Sand and general fill won from the deconstruction of the Capped Waste Stockpile is suitable for daily cover
Assumes Regain current price of $530/t applies to SPL sorted from the Capped Waste Stockpile mixed wastes
Groundwater treatment is included in Appendix F, and combined options in Appendix G

Legacy Cost

	QTY	units	UNIT COST	TOTAL	NOTES	Source
Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
Maintenance	1	each	NPV	$567,844		Based on 12 events per year for 100 years, using a discount rate of 3%
Topsoil replacement and reseeding battered perimeter	Base year	each	$133,200			
	1	each	$63,617	$63,617.21	year 25	Using a discount rate of 3%
	1	each	$14,512	$14,511.54	year 50	Using a discount rate of 3%
	1	each	$1,581	$1,580.96	year 75	Using a discount rate of 3%
	1	each	$82	$82.26	year 100	Using a discount rate of 3%
				$947,636		
Legacy potential liability provisioning	1%	event	NPV	$2,053	Occurring once in 100 years and at Year 50	Using a discount rate of 3%
Legacy provision				$949,689		

Risk

Ranking		Value 2
Minor	minor remediation/management required.	
rare	May occur only in exceptional circumstances	

Timing

Pre-Design Activities	0.25	years	
Preparation of RAP and Planning Approval	1.25	years	
Approvals	0.75	years	
Sorting	0.0	years	Treatment, rather than sorting is the constraint
Treatment at 20000t/year	4.7	years	
Project Engineering Tasks	0.2	years	
Implementation	0.6	years	
Final Reporting	0.25	years	
Time	**8.025**	**years**	

Option A5 Dispose off site to landfill	
Description	**Transport all materials as-is for disposal off site to landfill**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Development application			$15,000	$15,000	Assumes category 2 remediation and therefor	ENVIRON experience
		Sub-total preliminary documentation				**$70,000**		
	2	**Project Tasks**						
		Project Management			5%			
		Sub-total Technical Tasks Capital Cost				**included below**		
	3	**Site Preparation**						
		Environmental controls	0			0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each	$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each	$15,000	$30,000		
		Sub-total site preparation				**$56,000**		
	4	**Excavation Capped Waste Stockpile**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Excavate and transport 2m of underlying soils	55,778	m3	$12	$691,647		
		Soil Validation Works	1	EA	$60,000	$60,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	55,778	m3	$25	$1,394,450		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavation Works for Capped Waste Stockpile				**$2,298,476**		
	5	**Loading costs**						
		Capped Waste Stockpile Wastes including 2m of underlying soils	160778	m3	$5	$739,579	assume sand & < 1m	Rawlinsons
		Sub-total excavation costs				**$739,579**		
	6	**Transport costs**						
		NSW	160778	m3	$84	13,521,430	Sydney	Rawlinsons, based on 150km
		QLD	160778	m3	$461	74,134,736	Brisbane	Rawlinsons, based on 800km
		Sub-total disposal costs				**included below**		
	7	**Disposal Costs**						
		NSW	289400	t	$800	231,520,320	Untreated	Vendor supplied
		QLD	289400	t	$475	137,465,190	Untreated	Vendor supplied
						included below		
	8	**Final Reporting**						
		Validation report		each	allow	$30,000		ENVIRON experience
		EMP		each	allow	$15,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		Sub-total reporting				**$85,000**		
		Subtotal						
		NSW						
		Subtotal				$258,288,445		
		Contingency 10%				$25,828,845		
		CAPITAL COSTS				**$284,117,290**		
		Queensland						
		Subtotal				$223,174,530		
		Contingency 10%				$22,317,453		
		CAPITAL COSTS				**$245,491,983**		

NOTES

Assumes volumes of material are as presented in Appendix A of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes transport rates of 1500t/wk for movements within Australia

Legacy Cost		
	Legacy provision	$0

RISK			Value
	Comment	rare	1
		insignificant	

Time			
NSW	Approvals	0.5	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.25	years
	Transport (assumes 10 trucks per day, 30t per truck)	4	years
	Validation Reporting	0.2	years
	TOTAL	5.008672	years
QLD	Approvals	0.5	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.25	years
	Transport (assumes 10 trucks per day, 30t per truck)	3.858672	years
	Validation Reporting	0.2	years
	TOTAL	5.008672	years

Option A6 Treatment prior to disposal	
Description	**Onsite treatment and transport all materials for disposal off site to landfill**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Planning approval			$250,000	$250,000	Assumes EIS for JRPP approv	ENVIRON experience
		Sub-total preliminary documentation				**$300,000**		
	2	**Project Tasks**						
		Project Management			5%			USEPA July 2000
		Sub-total Technical Tasks Capital Cost				**Included below**		
	3	**Site Preparation**					Site sheds, machinery compising backhoe and roller	
		Environmental controls	0			0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each	$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each	$2,000	$4,000		
		Sub-total site preparation				**$30,000**		
	4	**Excavation Capped Waste Stockpile**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km anc	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km anc	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km anc	Rawlinsons 2013 p 673
		Excavate and transport 2m of underlying soils	55,778	m3	$12	$691,647		
		Soil Validation Works	1	EA	$60,000	$60,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	55,778	m3	$25	$1,394,450		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavation Works for Capped Waste Stockpile				**$2,298,476**		
	5	**Placement of SPL**						
		Excavating and placing to stockpile	105,000	m3	$8	$840,000		Rawlinsons 2013 p673, for light soil
		Sorting manual	262,500	hrs	$64	$16,800,000	Assumes 2.5 labour hours to	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Treat SPL to inert product	94,500	t	$530	$50,085,000	Assumes treatment cost is ec	Hydro, Regain contract
						$67,725,000		
	6	**Loading costs**						
		All wastes	160778	m3	$5	$739,579	assume sand & < 1m	Rawlinsons
		Sub-total excavation costs				**$739,579**		
	7	**Transport costs**						
		NSW	160778	m3	$3	466,256	Cessnock	Rawlinsons, based on 10km
		QLD	160778	m3	$461	74,134,736	Brisbane	Rawlinsons, based on 800km
		Sub-total disposal costs				**included below**		
	7	**Disposal Costs**						
		NSW	289400	t	$310	89,714,124	Assumes treated to solid was	Cessnock landfill
		QLD	289400	t	$134	38,779,654	Brisbane area fees	Willawong Landfill
						included below		
	8	**Final Reporting**						
		Validation report		each	allow	$30,000		ENVIRON experience
		EMP		each	allow	$15,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		Sub-total reporting				**$85,000**		
		NSW						
		Subtotal				$166,997,957		
		Contingency 10%				$16,699,796		
		CAPITAL COSTS				**$183,697,753**		
		Queensland						
		Subtotal				$190,868,667		
		Contingency 10%				$19,086,867		
		CAPITAL COSTS				**$209,955,533**		

NOTES

Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contaminatior
Assumes program can be achieved through the use of standard excavating equipment
Assumes transport rates are governed by treatment rates.
Assumes treatment rates of 20000t/yr
Assumes treatment costs as for Regain contrac.
Assumes 50% of Capped Waste Stockpile is SPL and able to be treated

Legacy Cost		
	Legacy provision	$0

RISK		Value
Comment		
	rare	1
	insignificant	

Time			
NSW	Approvals	1.3	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.3	years
	Treatment and transport (rate 20000 t/year)	14.5	years
	Validation Reporting	0.2	years
	TOTAL	16.4	years
QLD	Approvals	1.3	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.3	years
	Treatment and transport (rate 20000 t/year)	14.5	years
	Validation Reporting	0.2	years
	TOTAL	16.4	years

Option A7 Onsite Destruction	
Description	**Onsite Waste to Energy**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Planning approval			$350,000	$350,000	EIS required	ENVIRON experience
		Sub-total preliminary documentation				**$400,000**		
	2	**Pilot Trial**						
		Allow				$100,000		Estimate
		Sub-total pilot trial				**$100,000**		
	3	**Project Tasks**						
		Project Management			5%	$597,000	Does not include treatment f	USEPA Remediation Costs
		Sub-total Technical Tasks Capital Cost				**$597,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Sorting, placement and treatment of Capped Waste Stockpile wastes**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km anc	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km anc	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km anc	Rawlinsons 2013 p 673
		Excavation	189,000	t	$20	$3,780,000	Includes surcharge for handling	
		Screening	189,000	t	$20	$3,780,000	Estimate, requires evaluation of equipment and suitability	
		Sorting manual	54,432	hrs	$64	$3,483,648	Assumes 2.5 labour hours to	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Treatment through plasma gasification	189,000	t	$450	$85,050,000	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL Placement of SPL				**$96,246,027**		
	6	**Final Reporting**						
		Validation report		each	allow	$500,000	includes confirmatory testing	ENVIRON experience
		Sub-total reporting				**$500,000**		
		Subtotal				$98,069,027		
		Contingency 10%				$9,806,903	10% Scope	
		CAPITAL COSTS				**$107,876,000**		

NOTES
- Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
- Assumes further investigation does not identify other not known contamination
- Assumes program can be achieved through the use of standard excavating equipment
- Assumes by-products are approved by NSW regulators for reuse and do not require landfilling. 80% plasma rock is estimated to be generated.
- Rate of treatment per tonne provided by Tetronics includes a rate of return and profit margin. This rate could be negotiated. Applies to 15000 tpa plant

Legacy Cost		
	Legacy provision	$0

Risk			Value	
	Likely	Will probably occur		
	moderate	Remedaition clean up less than $5M	12	relates to technological risk and risk of unuseable slag

Time		
Pilot Trial	1	years
RAP/EIS	1	
Approvals	1.75	years
Investigations/tender/contract negotiations	0.5	years
Construction/commissioning	1	years
Assumes treatment at 15000tpa	12.6	years
Validation Reporting	0.2	years
TOTAL	18.05	years

Appendix B

SPL in Storage and Pots Detailed Options Review

B SPL in Storage Sheds and Pots

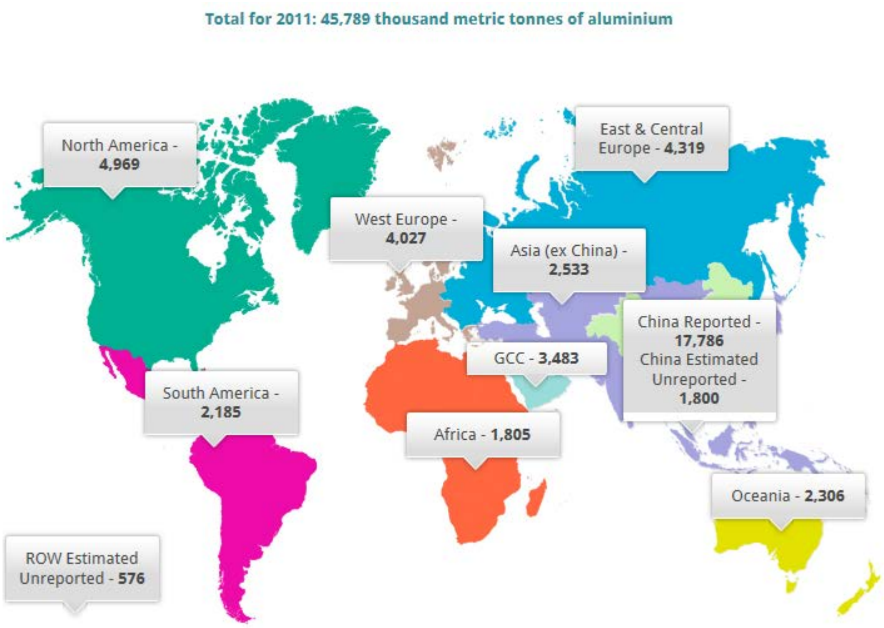
SPL in Storage Statistics		
Volume m^3	**Tonnage (t)**	**Description**
27,800	50,000	First cut SPL, bulk density estimated to be $1.8t/m^3$
27,800	50,000	Second cut SPL, bulk density estimated to be $1.8t/m^3$

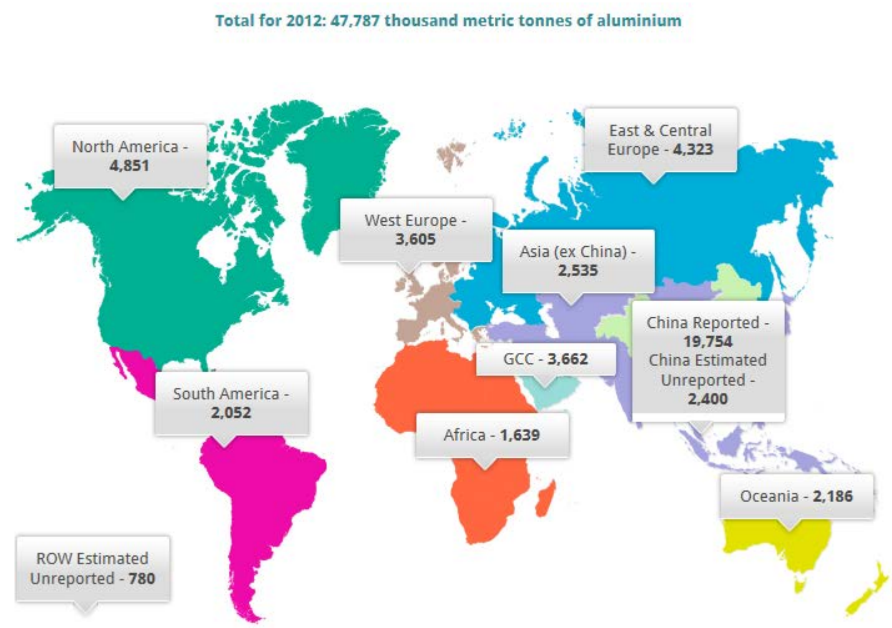
Remediation Options

B1	Continue existing treatment/management (contract with Regain)
B2	Enter into new local treatment contract
B3	Move to specifically designed containment cell adjacent to the capped waste stockpile
B4	Treat and move to specifically designed containment cell adjacent to the capped waste stockpile
B5	Encapsulate in purpose built containment cell
B6	Treat and encapsulate in purpose built containment cell within the Hydro owned land
B7	Dispose off site, NSW, Queensland, International
B8	Treat and dispose off site NSW, Queensland, International
B9	Treatment Internationally
B10	On site Treatment to Achieve Complete Destruction

SPL Review of existing treatment methods

According to Wikipedia there are currently world-wide 232 primary aluminum smelters active with a total theoretical annual capacity of 58.7M tonnes of aluminum metal. The total production reported by the International Aluminum Institute for 2011 was 45.8M tonnes of aluminum, and for 2012 47.8 M tonnes of aluminum.





Source: International Aluminium Institute, (http://www.world-aluminium.org/statistics/)

Information on the total spent potlining (SPL) generated is not published by any of the major industry operators. The exact amount of SPL generated is unknown, and depends largely on the average life time and geometry of a pot, both of which are proprietary data. The variability provided in published documents is a lifetime of between four to seven years for an average pot. It was noted however that SPL solid waste landfilled reduced by 45% over the last 10 years through improved recycling of the respective SPL-carbon and SPL-refractory fractions.

The most common SPL management practice is landfilling in hazardous waste landfills. All other trials to treat the material have resulted in far higher costs per tonne for the recycling effort and have thus not been implemented as a standard SPL treatment.

The methodologies applied exclude low temperature methods as they generate fluoric water which is extremely corrosive. Instead, a thermal treatment is utilized in a variety of approaches from relatively low temperatures of about 600 °C (Regain method) to plasma arc methods (such as the Tetronics plasma-enhanced vitrification technology) and temperatures above 1200 °C. These methods have been tested in pilot scale installations (i.e. below one tonne per day or per batch) and are largely batch methods, except for the Regain method, which is currently working on an industrial scale at the Tomago Aluminium smelter in NSW. The high temperature methods are targeted to recycle some valuable parts of the SPL (Fluorine gas, Cryolite) or are geared at immobilising constituents, and hence make the residual material usable as fill or reduce hazardous waste levels to reduce disposal costs.

The only other avenue of use for SPL has been by the cement industry. The SPL material can be used in cement kilns as a fuel (carbon content) and having an advantageous effect ("clinkering") on the cement quality. However, this has been prohibited in some jurisdictions, such as NSW. This is due to the hazardous nature of the SPL during transport, in particular the cyanide and fluoride content, and the potential to generate methane (explosion risk). Where it has been used, the material has been shown to be effectively utilized with next to no residual constituents remaining for disposal.

Regain has taken a NSW specific approach by thermally treating the mixed SPL material and removing the cyanide and methane components. This allows the product to comply with the NSW regulations and therefore be transported. Regain has attempted to sell their product, however market response has not been favourable. The consequence is that Regain has to largely recoup their treatment cost from the originator of the SPL.

There is potential that the carbon content of the SPL could become of significant interest as a substitute fuel component. A recent example of this was in Germany when a household waste repository (which closed prior to 1980) was re-opened to utilize the previously unsorted waste for its energy value in a close-by waste incinerator. Other contents of the SPL are also of interest if they can be retrieved / recycled in an economic way.

The following table summarises the SPL treatment options used in Australia.

Smelter	**SPL Treatment(s)**
Tomago Aluminium	Onsite treatment by Regain Services of First cut and some Second cut Export untreated SPL to Europe (Befesa) - mainly Second cut
Alcoa Point Henry	Landfill onsite (legacy) Onsite treatment Regain Services – First and Second cut
Alcoa Portland	Offsite (transport to Point Henry) for treatment by Regain Services - First and Second cut
RTA Bell Bay	Untreated SPL transported to local cement kiln for processing
Boyne Smelters Limited	Untreated SPL transported to local cement kiln for processing Onsite treatment using COMTOR process

B1 Continue existing treatment/management

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
High	53	8 - 9	$0	6

B1.1 Description of the option

Hydro currently has a contract with the service provider Regain to treat SPL stored within sheds on the Smelter Site. Regain treat both first and second cut SPL and produce for sale a non-hazardous uniform material with a calorific value. The Regain process removes cyanides from the SPL and retains the carbon content as well other useable components such as alumina and silica. The reactivity of the SPL is reduced so that leachability and the potential for gas generation is removed and the end product is considered inert. The end use markets are typically the cement industry both in Australia and internationally. SPL is currently treated by Regain at a rate of approximately 5000 tonnes per year. The existing contract is based on a treatment capacity of 12,000 tonnes per year, but Regain has confirmed that investments and construction of additional treatment steps is likely to happen in the coming year to ensure contract rate processing. In the event that Regain is unable to continue treatment for whatever reason (e.g. insolvency) the SPL will remain the property of Hydro and will have to be treated in alternative method.

The site of the Regain treatment facility is owned by Hydro and is currently leased to Regain under a lease contract that includes a ‘make good clause’. At the completion of treatment Regain will remove the facility and return the site to baseline conditions to the satisfaction of Hydro. At that time the site can be divested.

The land occupied by the SPL storage sheds is owned by Hydro and will remain Hydro property until such time as treatment of SPL is completed. This land can then be investigated, remediated if necessary, and divested.

B1.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) requires a licence for the processing of aluminium smelter wastes containing leachable fluoride and/or leachable cyanide, and the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

As this option includes treatment of the SPL prior to further management, it would be permissible if a licence is issued from the EPA.

Planning Approval

The 2005 development consent provides approval for operation of the SPL treatment facility. This facility meets a requirement of the 2002 development consent, which requires Hydro to implement a proposal to treat spent pot lining generated by the smelter. Hydro has obtained legal advice that the combined effect of the 2002 and 2005 development consents is that:

- Hydro is obliged to treat all SPL in the storage sheds using this facility; and
- Hydro must continue to treat the SPL until such time as the consents are modified, surrendered or replaced; and
- the SPL must be treated before any additional use (such as transporting the SPL off site).

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
    - Crushing, grinding or separating.
    - Waste storage.
    - Waste processing (non-thermal treatment).
- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
    - Metallurgical activities (aluminium production and metal waste generation).

The SPL storage and treatment could continue in accordance with EPL 13268.

Likelihood of Approval

The activity does not require any additional approvals, and therefore there are no approval issues.

B1.3 Cost

Costs for treatment are $ 530 /t. Total costs for the remaining 100 000 tonnes are $53mil AUD NPV.

B1.4 Timeframe to complete

The remaining contract duration with Regain is four years. Regain's actual, proposed and theoretical processing rates are following:

- Existing rate: approximately 5000 tonnes per year – timeframe 20 years.
- Contractually agreed (but not achieved) rate: 12,000 tonnes per year – timeframe 8.3 years.
- Theoretical rate (proposed by Regain): 20,000 tonnes per year – timeframe 5 years.

It should be noted that Regain has not yet achieved the contractually agreed volume. It should also be added that Regain has claimed that they can increase treatment capacity up to 20,000 tonnes per year, resulting in a timeframe of 5 years. However the validity of this claim has not been proven.

B1.5 Legacy

There is no legacy as all SPL is treated and removed from the site.

B1.6 Risk Ranking

The risk of this option is considered moderate, on the basis of poor performance from Regain since commencement of operations. However, the treatment methodology is proven and the operation has bee inn operation at the site for the past 7 years. The contract is still valid for 4 years and Regain will continue to process and sell this volume of treated SPL. If the total contract volume is met they will at the end of the agreed period have treated 60,000 tonnes of SPL. This would leave 40,000 tonnes that would have to be treated in either an alternative scheme or in a prolonged agreement with Regain. To date the market for the product and thereby the actual offtake has been below expectations. Although Regain is stating that their marked outlook is improving, it is still to be seen that the contract volumes are moved. Hydro therefore has to consider that an alternate and/or supplement treatment or disposal option may be needed.

The risk is therefore associated with the requirement and ability for Hydro to find an alternate treatment or disposal option. Based on the above, ENVIRON consider it 'unlikely' that this will be required due to Regain's demonstrated commitment to the enterprise. Should this occur however, alternate treatment options are not currently available locally, refer to the following section, and the consequence is considered to be 'moderate'. This would mean that approvals would be required to establish the treatment program outlined below. On this basis the risk ranking is '6'.

B2 Alternative local treatment option

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
Moderate	60	8-10	$0	12

B2.1 Description of the option

Hydro is aware that the local company Weston Aluminium has performed trials to treat Second Cut SPL and produces for sale a non-hazardous uniform material that could be reused in other industries. The technical details of the process is not known, however it includes a form of heat treatment to remove cyanides while retaining the main carbon content as well as some other useable components such as alumina and silica. It is not clear what the end-use industry is, but we have heard unconfirmed information that trial use in the ceramic industry has been unsuccessful due to the fluoride content of the material.

Weston Aluminum still has a declared interest to perform a SPL treatment service, however our interpretation is that the challenge lies in the market off-take of the end product more than the actual technical processing. As discussed in Section B2.2 under its current approval Weston is limited treating Second Cut SPL.

Weston Aluminium has indicated a first-hand (non-negotiated) price of $600 AUD per tonne.

B2.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) requires a licence for the processing of aluminium smelter wastes containing leachable fluoride and/or leachable cyanide, and the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

The 2012 "Environmental Assessment: Spent Potlining Processing" (AECOM, 2012) does not refer to the *Environmentally Hazardous Chemicals Act 1985* and whether Weston Aluminium has (or has applied for) the licence required under the Chemical Control Order applicable to aluminium smelter waste for the processing of aluminium smelter wastes containing leachable fluoride and/or leachable cyanide, and the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

As this option includes treatment of the SPL prior to further management, it would be permissible if a licence is issued from the EPA.

Planning Approval

Weston Aluminium received planning approval (via a modification to its existing approval) from the Department of Planning and Infrastructure (DoPI) in September 2012 for the commercial processing of SPL at its facility. Weston Aluminium is permitted to process no more than a combined total of 40,000 tonnes of Second Cut SPL and dross aluminium (the processing of both materials uses the same facility, but are treated separately). No more than a combined total of 5,000 tonnes of Second Cut SPL and dross aluminium can be stored at the Weston Aluminium facility at one time. These limits are consistent with the permitted capacities for treatment and storage that Weston Aluminium has for dross aluminium only. The Environmental Assessment (EA) states that Weston Aluminium currently only treats 10,000 to 15,000 tonnes of aluminium dross, and anticipates ultimately treating up to 15,000 to 25,000 tonnes of SPL.

This commercial scale treatment followed two trial phases of SPL treatment (following approval from DoPI), the first from August 2010 (treatment of 40 tonnes of SPL) and a second over three months from November 2011 (treatment of 200 tonnes over three months).

The EA for the 2012 application notes "*Processed SPL material generated from Weston Aluminium's previous trials was aimed at developing end use market opportunities for the Second Cut treated material. Product markets are now emerging with increasing demand for greater quantities of processed material*" and "*The large scale 200 tonne trial recently completed at the existing facility has allowed prospective end-use customers to determine the suitability of the material within different industrial processes. Feedback from these customers has allowed Weston to develop treated material specifically to these customer's specifications*". However it does not specify what the potential markets for the treated SPL are, and it does not estimate the potential market demand for the treated SPL.

The approval does not permit treatment of First Cut SPL however the EA notes treatment of First Cut SPL as a potential future second stage. The EA noted that Weston Aluminium proposes a trial program similar to that implemented for the Second Cut SPL, and would then subsequently seek approval (with modification to its existing project approval likely to again be the approval process) for commercial scale processing of First Cut SPL.

Therefore to be able to treat all SPL in storage at the site, Weston Aluminium (and/ or Hydro) would need to undertake the trial program, confirm that there is a market available for the treated First Cut SPL, and then seek and gain approval for commercial scale processing of First Cut SPL.

In addition, Weston Aluminium currently only has approval to store 5,000 tonnes of Second Cut SPL and dross aluminium at one time. Therefore the SPL would need to continue to be stored at the Hydro site and transported to the Weston Aluminium facility, or approval sought to allow the material to be stored at Weston Aluminium (or an alternative location) prior to treatment.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

"(5) Development for the purpose of hazardous waste facilities that transfer, ***store*** *or dispose of solid or liquid waste classified in the* ***Australian Dangerous Goods Code*** *or medical, cytotoxic or quarantine waste that handles more than* ***1,000 tonnes per year of waste.***"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the storage of the SPL would be deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

The original Weston Aluminium development was assessed and approved as a state significant development. This storage could be assessed and approved against the existing modification if it was shown to be substantially the same as the approved development with minimal environmental impact. However the amount of SPL to be stored is unlikely to be considered substantially the same as the approved development and potentially minimal environmental impacts. Therefore it is likely that a new development application would be required for any location.

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the facility is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the facility is located in an area of limited previous disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including containment cell location hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).

- Consideration of alternatives, and an explanation as to why ceasing the current treatment of the SPL, and implementing the alternative process is the most reasonable and feasible option.
- Ongoing management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management

Environment Protection Licensing

Weston Aluminium has an Environment Protection Licence (EPL) No. 6423 for its operations. The EPL includes “Recovery of hazardous and other waste” and “Waste storage – hazardous, restricted solid, liquid, clinical and related waste and asbestos waste” as fee based activities.

The 2012 Environmental Assessment noted that construction and operation of the SPL treatment infrastructure would not require substantial changes to the EPL, with only cyanide to be added to its air quality monitoring and water sampling regimes.

Likelihood of Approval

While the treatment of SPL would be positively viewed by agencies, the lack of a market for the treated SPL would reduce the likelihood of approval.

The establishment of a new untreated SPL storage facility (i.e. remove the material from the site to either the Weston Aluminium facility or a new facility) would need to justify how this is a more reasonable or feasible option than maintaining the current facility and transporting to the Weston Aluminium facility. The likelihood of approval for such a facility is moderate.

In any event, it is unlikely that Weston Aluminium would take responsibility for all of the SPL currently stored on the Hydro site, and the management responsibilities for the new storage facility.

B2.3 Cost

Indicative cost for treatment is $600 AUD per tonne, non-negotiated. The total costs to treat 100,000 tonnes are $60mil AUD NPV.

B2.4 Legacy

There is no legacy as all SPL is treated and removed from the site.

B2.5 Timeframe to complete

The real processing capacity is not defined, but it is assumed that minimum 5 year processing time is needed. Additionally, a timeframe for approvals and treatment plant upgrade might be needed. It is reasonable to assume that the approval timeframe would be in the order of several years. Timeframe is therefore reasonably likely to be between 8 and 10 years.

B2.6 Risk Ranking

The risk of this option is considerably higher than for the Option B1 (Regain). The treatment process is demonstrated in trials for second cut SPL, but no actual proof of off-take market has been presented, and no evaluation of first cut SPL has been evaluated. Approval process is another uncertainty factor. It is therefore considered that the likelihood of approval is ‘possible’, i.e. it might occur at some time. The consequence to Hydro, of approval not occurring is considered to be ‘major’ as another alternate treatment option has not been identified to date. A risk ranking of ‘12’ has therefore been adopted.

Key risk relates to time: there is no guarantee that Weston has the market for the treated SPL, and therefore there is no guarantee on the timing of treatment. Plus, as Weston can only hold 5,000 tonnes at a time, the SPL would still need to be stored at Hydro (or another approved storage location) for the duration of the treatment period.

B3 Move to specifically designed containment cell adjacent to the capped waste stockpile

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
Low	6.5	3 - 4	$1.4	15

B3.1 Description of the option

The capped waste stockpile comprises mixed waste smelter materials including SPL. The capped waste stockpile is situated within the eastern areas of the Smelter Site and has surrounding undeveloped land. To consolidate waste disposal on the site, a cell adjacent and adjoining the capped waste stockpile can be constructed for placement of the SPL. The cell construction is described below. No improvements to the capped waste stockpile have been included here as these are presented in Appendix A and Appendix G which discusses combined improvements to the capped waste stockpile and placement of the SPL.

For the option of placing SPL adjacent to the existing capped waste stockpile, the process would comprise the following steps:

1. *Pre-construction*

- Investigation would assess the area surrounding the existing capped waste stockpile and determine a geotechnically suitable area for additional waste placement. It is likely that the most suitable area would be to the west of the existing capped waste stockpile, where anode butts are currently stored. The reasons for this assumption are the constraints present in the other directions:
  - to the north is the existing Eastern Surge Pond which will be required for site use minimum until the end of a remediation and demolition phase
  - to the south is the Regain plant and the SPL storage sheds which would require relocation and double handling of SPL prior to placement within the containment cell
  - to the east is a flood plain area that would require modification by filling in order to be a viable option.
- Detailed investigations would include boreholes/cone penetrometers assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Design of “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Completion of tendering / contractor award;

  1. Undertake the necessary environmental assessments and attain required approvals;

2. *Construction*

- Preparation of the containment cell footprint by clearing and grubbing of land, grading and consolidation of the surface;
- Construction of containment cell.
  - The cell base liner will comprise (ordered from vertically upwards)
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.15 m sand gas collection layer overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.3 m topsoil layer, seeded and mulched.
- Issues include:
  - Nature of liner (clay reportedly reacts with F-/CN leachate degrading the impermeable nature of clay)
  - Sufficient protective layer for HDPE (or similar) liner to prevent puncture/damage;

- – Sourcing of low permeability material (i.e., clay) from the site (identify in feasibility investigations);
- – Need for crushing of materials to make uniform and allow for some certainty in compaction of the SPL during placement.

3. Post Construction

- Ongoing monitoring and maintenance for containment cell likely involving:
  - – Installation and regular monitoring of groundwater monitoring wells and gas wells installed around the new facility;
  - – Ongoing physical maintenance of the cell to maintain integrity of the cap;
  - – Ongoing leachate treatment;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the EPL for the containment cell – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

B3.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) prohibits the disposal of such waste containing leachable fluoride and/or leachable cyanide. It also requires a licence for the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

Emplaced untreated waste would require a site-specific licence allowing macro-encapsulation by showing that the emplacement process stops the SPL leaching fluoride and/ or cyanide. This is the approach approved prior to 1993 for the capped waste stockpile. It is likely to require extensive work and evidence to be provided to the EPA justifying that macro-encapsulation is a viable leaching control methodology and therefore an exemption to be issued.

Further justification could be presented to the EPA by highlighting that treatment of the SPL is costly due to material handling; and the inability to locate and secure a local market for the treated by-products of SPL.

Planning Approval

As noted, planning approval for this option would not be issued if the site-specific Chemical Control Order immobilization exemption was not issued. However, the following is prepared on the assumption that such an exemption could be issued.

The 2005 development consent provides approval for operation of the SPL treatment facility. This facility meets a requirement of the 2002 development consent, which requires Hydro to implement a proposal to treat spent pot lining generated by the smelter. Hydro has obtained legal advice that the combined effect of the 2002 and 2005 development consents is that:

- it is obliged to treat all SPL in the storage sheds (but not within the capped waste stockpile) using this facility; and
- the SPL must be treated before any additional use.

Therefore if Hydro were to place the untreated SPL into a containment cell, this existing development consent would need to be surrendered or replaced and a new planning approval sought. The following addresses the implications associated with a new planning approval.

Placement of the untreated SPL in a containment cell would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when in operation it did not pose a significant risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

"(5) Development for the purpose of hazardous waste facilities that transfer, ***store or dispose*** *of solid or liquid waste classified in the* ***Australian Dangerous Goods Code*** *or medical, cytotoxic or quarantine waste that handles more than* ***1,000 tonnes per year of waste****.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the retention of the untreated SPL in a containment cell would result in the containment cell being deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the containment cell is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the containment cell is located in an area of limited previous disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including containment cell location hydrology and geotechnical conditions).
- Aesthetics and visual impacts.

- Community and social impacts (including health).
- Consideration of alternatives to the containment cell, and an explanation as to why ceasing the current treatment of the SPL, and placing untreated SPL into a containment cell is the most reasonable and feasible option.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- Justification that the cessation of treating the SPL and placement of the untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Environment Protection Authority (EPA)
- NSW Office of Water (NOW)
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure
- Local Members of Parliament
- The local community (including residents and local community and environmental groups)

- Key Aboriginal stakeholder groups

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
  - Crushing, grinding or separating
  - Waste storage
  - Waste processing (non-thermal treatment)
- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
  - Metallurgical activities (aluminium production and metal waste generation).

"Waste disposal (application to land)" is a scheduled activity requiring an EPL (Clause 39 of Schedule 3). However, the definition for this activity states that it applies to waste "*received from* ***off site***". As the SPL was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL.

Likelihood of Approval

There are potential issues due to possible difficulties with attaining a site-specific Chemical Control Order immobilization exemption, and potential difficulties in getting agencies to agree that ceasing the current SPL treatment is reasonable and feasible. As such, the likelihood of approval is low.

The likelihood for approval could possibly be increased by consulting with the EPA and DoPI presenting detailed justification, but this would likely lead to an increase in the approval process timeframes.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

B3.3 Cost

The estimated cost for this option is $6.5mil AUD NPV.

Refer to the attached costing for details.

B3.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.2 – 0.4
Preparation of RAP and Planning Approval	0.75 – 1.25
Approvals	0.75 - 1
Project Engineering Tasks	0.2 – 0.3
Implementation	0.4 – 0.6
Final Reporting	0.2 – 0.4
Total Estimated Timeframe	**3 - 4**

B3.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate and gas monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years;

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. A percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital costs. It is not proposed that removal of the SPL will be required. Costs are therefore estimated to be 2% of the total capital costs and determined on a net present value for an event occurring at year 50.

These costs were determined to be $40,000.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $1.4mil AUD NPV.

B3.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from the proximity to the capped waste stockpile, which has not benefitted from the same levels of engineering and contains fill placed in an uncontrolled manner. There is an additional risk that the placement of this cell adjacent and connected to the existing capped waste stockpile could affect the integrity of the existing capped waste stockpile. The chance of failure occurring is therefore considered to be ‘possible’, it might occur at some time. In the event of failure, due to the proximity of shallow groundwater and the known discharge of shallow groundwater to the surface, the consequence of failure could be ‘catastrophic’ due to the risk of prosecution and cost of remediation. On this basis the risk ranking is ‘15’.

B4 Treat and move to specifically designed containment cell adjacent to capped waste stockpile

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
Low	71.7	8 - 9	$1.1	6

B4.1 Description of the option

This option includes treatment of the SPL to remove cyanides and reduce reactivity prior to placement within a purpose built containment cell adjacent to the capped waste stockpile. Treatment prior to disposal reduces the consequence of leachate in the event of failure and reduces the duration of monitoring required for gas generation and groundwater. The containment cell would be designed similarly to Option B3, however due to treatment of the SPL the containment cell construction will not require a gas venting layer.

This option would involve the following steps:

1) Treat SPL through the existing Regain treatment facility (or a similar treatment process) incorporating a renegotiated contract that allow Hydro to retain the treated SPL onsite;

2) Preconstruction

- Assess the area surrounding the existing capped waste stockpile and determine a geotechnically suitable area for additional waste placement. It is likely that the most suitable area would be to the west of the existing capped waste stockpile, where anode butts are currently stored. The reasons for this assumption are the constraints present in the other directions:
  - to the north is the existing Eastern Surge Pond which will be required for site use minimum till the end of a remediation and demolition phase
  - to the south is the Regain plant and the SPL storage sheds which would require relocation and double handling of SPL prior to placement within the containment cell
  - to the east is a flood plain area that would require modification by filling in order to be a viable option.
- Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;

- Design of "best practice" containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award;
- Approvals process through local government/NSW planning/regulators;

3) Construction

- Construction of containment cell.
  - The cell base liner will comprise (ordered from vertically upwards)
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.15 m sand gas collection layer overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.3 m topsoil layer, seeded and mulched.
- Treatment of the SPL would be undertaken through the existing Regain process (or a similar treatment process) to achieve an inert material. It is envisaged that a negotiated cost for treatment of less than the current rate through Regain of $530/tonne could be agreed, however these discussions have not been held with

Regain (or another processor) at this time. It is not proposed that Hydro develop an independent on site treatment process as this will require lengthy delays to achieve project planning approval. However, it is noted that the costs for these treatment system is relatively low, and could be in the order of $100/tonne.

- Issues include:
  - Sufficient protective layer for HDPE (or similar) liner to prevent puncture/damage;
  - Sourcing of low permeability material (i.e., clay) from the site (identify in feasibility investigations);
  - Crushing is not required as SPL will be crushed as part of the treatment process.

4) Post Construction

- Ongoing monitoring and maintenance for containment cell likely involving:
- – Installation and regular monitoring of groundwater monitoring wells installed around the new facility;
- – Ongoing physical maintenance of the cell to maintain integrity of the cap ;
- – Ongoing leachate evaluation for a period of time to demonstrate performance;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the environmental protection licence – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan. The site can be divested and long term liability managed through a contract of sale. However, it is unlikely that Hydro can permanently and completely remove liability. For example, if the purchaser was to become insolvent and remediation of the containment cell required, this responsibility would default to Hydro as the owner of the contamination.

B4.2 Likelihood of approval

Planning Approval

This advice is based on the assumption that SPL treatment would continue through the existing Regain treatment facility (or a similar treatment process) incorporating a renegotiated contract that allows Hydro to retain the treated SPL onsite. The SPL would continue to be treated in accordance with the 2005 development consent.

Placement of the treated SPL in a containment cell would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or* *activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when in operation it did not pose a significant risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Schedule 3 of the Environmental Planning and Assessment Regulation 2000 includes "Waste management facilities or works" under clause 32 of Schedule 3 of the regulation as designated development. This definition includes:

"(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

> *(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or*
>
> *ii) that comprises more than 100,000 tonnes of "clean fill" (such as soil, sand, gravel, bricks or other excavated or hard material) in a manner that, in the opinion of the consent authority, is likely to cause significant impacts on drainage or flooding*,"

Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011). It is assumed that treatment of the SPL prior to placement in the containment cell would result in it no longer being deemed "Aluminium smelting by-product" and therefore it is not classified as a designated development.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

"(5) Development for the purpose of hazardous waste facilities that transfer, ***store or dispose*** *of solid or liquid waste classified in the* ***Australian Dangerous Goods Code*** *or medical, cytotoxic or quarantine waste that handles more than* ***1,000 tonnes per year of waste.***"

As noted previously, it is assumed that treatment of the SPL prior to placement in the containment cell would result in it no longer being deemed "Aluminium smelting by-product" and therefore it would not be deemed a state significant development.

The works would be classified as 'regional development' as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application (DA) for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While the Cessnock City Council will assess the DA, the consent authority for the works would be the Hunter and Central Coast Regional Panel.

A Statement of Environmental Effects (SEE) is required to support a development application to Council. The SEE will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the containment cell is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the containment cell is located in an area of limited disturbance).
- Construction noise and air quality.
- Construction traffic.

- Construction phase management of contaminants.
- Soil and water management (including containment cell location hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives to the containment cell, and an explanation as to why placing treated SPL into a containment cell is the most reasonable and feasible option.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption.
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- Justification that the placement of the treated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).

- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
  - Crushing, grinding or separating
  - Waste storage
  - Waste processing (non-thermal treatment)
- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
  - Metallurgical activities (aluminium production and metal waste generation).

This advice assumes that the SPL would continue to be treated in accordance with EPL 13268, and therefore there are no new or additional licensing requirements.

"Waste disposal (application to land)" is a scheduled activity requiring an EPL (Clause 39 of Schedule 3). However, the definition for this activity states that it applies to waste "*received from off site*". As the SPL was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL.

Likelihood of Approval

The key factors influencing the likelihood of approval would be whether the SEE could show that:

- It would not have a significant impact on the factors listed previously.

- The location had an acceptable depth to groundwater, tight surrounding soils (preferable clays) demonstrated to be geologically consistent, surface water design and best practice containment cell design. This would also influence whether the site-specific Chemical Control Order immobilization exemption would be issued.
- It can be shown to be the most reasonable and feasible option.

The groundwater in the vicinity of the capped waste stockpile is known to be shallow, and on that basis it is unlikely that adjacent to the capped waste stockpile would be viewed as an appropriate location. Therefore likelihood of approval is low.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

B4.3 Costs

The estimated cost range for this option is $71.7mil AUD NPV.

Refer to the attached costing for details.

B4.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.2 – 0.4
Preparation of RAP and Planning Approval	0.75 – 1.25
Approvals	0.5 – 0.75
Project Engineering Tasks	0.2 – 0.3
Treatment time at 20,000 t/year[1]	4.5 – 5.5
Implementation	0.4 – 0.6
Final Reporting	0.2 – 0.4
Total Estimated Timeframe	8 - 9

1 Regain theoretical rate of 20,000 t/year.

B4.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate and gas monitoring will be required for a period of two years on an annual basis and include annual reporting. A reduced timeframe is applicable as the material is treated prior to placement and therefore the potential for gas generation and leachate impact is removed;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. However, should an event occur, remediation may not be required given that leachability of the SPL has been reduced. Therefore the likelihood of requiring remediation is considered to occur once in 100 years and assigned a 1% probability of occurring at 50 years.

The ongoing legacy cost attributable only to ongoing monitoring is estimated to be $1.1mil AUD NPV.

B4.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from the proximity to the capped waste stockpile, which has not benefitted from the same levels of engineering and contains fill placed in an uncontrolled manner. There is an additional risk that the placement of this cell adjacent and connected to the existing capped waste stockpile could affect the integrity of the existing capped waste stockpile. The chance of failure occurring is therefore considered to be ‘possible’, it might occur at some time. In the event of failure, due to the pretreatment of the SPL, the consequence of failure is considered to be ‘minor’ requiring minor remediation works. On this basis the risk ranking is ‘6’.

B5 Encapsulate in purpose built containment cell within the Hydro Site

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
Low	6.7	3 - 4	$0.9	10

B5.1 Description of the option

This option would manage the SPL by placement of the SPL within a purpose built containment cell constructed at a more appropriate location on the larger Kurri Kurri site and applying best practice containment cell design and construction.

This option would involve the following steps:

1. *Pre-construction*

- Assess existing Hydro site to identify the optimum location for placement of new cell to accept site SPL. Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Approvals process through local government/NSW planning/regulators.
- Design of "best practice" containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

2. *Construction*

- Construction of containment cell includes:-
  - The cell base liner will comprise (ordered from vertically upwards)
    - A 1 m thick clay liner of permeability 1×10^{-9} m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;

    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.15 m sand gas collection layer overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.3 m topsoil layer, seeded and mulched.

Construction will specifically need to consider:

  - Nature of liner (clay reportedly reacts with F-/CN leachate degrading the impermeable nature of clay) and testing will be required to confirm suitability of the material with the anticipate leachate constituents;
  - Sufficient protective layer for HDPE (or similar) liner to prevent puncture/damage;
  - Placement of SPL wastes into new storage cell, followed by capping and finishing works to control stormwater and leachate.Sourcing of low permeability material (i.e. clay) from the site (identify in feasibility investigations);

- Placement of SPL wastes into new storage cell, followed by capping and finishing works to control stormwater and leachate. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and likelihood that an effective compaction will be achieved this may require an engineered solution, (for example, a geotextile). Major issues include:

3. *Post construction*

- Ongoing monitoring and maintenance for containment cell likely involving:
  - Installation and regular monitoring of groundwater and gas monitoring wells installed around the new facility;

  - Ongoing physical maintenance of the cell to maintain integrity of the cap ;
  - Ongoing leachate treatment (in conjunction with groundwater plume treatment);
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Closure – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan. The site can be divested and long term liability managed through a contract of sale. However, it is unlikely that Hydro can permanently and completely remove liability. For example, if the purchaser was to become insolvent and remediation of the containment cell is required, this responsibility would default to Hydro as the owner of the contamination.

B5.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) prohibits the disposal of such waste containing leachable fluoride and/or leachable cyanide. It also requires a licence for the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

Emplaced untreated waste would require a site-specific licence allowing macro-encapsulation (i.e. placement into a waste specific, containment cell). This is the approach approved prior to 1993 for the capped waste stockpile. It is likely to require extensive work and evidence to be provided to the EPA justifying that macro-encapsulation is a viable leaching control methodology and therefore an exemption to be issued.

Further justification could be presented to the EPA by highlighting the inability to locate and secure a local market for the treated by-products of SPL.

If this approach was not accepted by the EPA, planning approval would not be issued.

Planning Approval

The 2005 development consent provides approval for operation of the SPL treatment facility. This facility meets a requirement of the 2002 development consent which requires Hydro to implement a proposal to treat spent pot lining generated by the smelter.. Hydro has obtained legal advice that the combined effect of the 2002 and 2005 development consents is that it is obliged to treat all SPL in the storage sheds (but not within the capped waste stockpile) using this facility.

In any event, development for the purposes of 'remediation work' is permissible with consent in the RU2 Zone under Cessnock City Council Local Environmental Plan. Based on legal advice obtained by Hydro, the combined effect of the 2002 and 2005 development consents is that the SPL would need to be treated before any additional use. Therefore if Hydro were to place the untreated SPL into a containment cell, this existing development consent would need to be surrendered and a new planning approval sought. The following addresses the implications associated with a new planning approval.

Placement of the untreated SPL in a containment cell would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when in operation it did not pose a significant risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

"(5) Development for the purpose of hazardous waste facilities that transfer, ***store or dispose*** *of solid or liquid waste classified in the* ***Australian Dangerous Goods Code*** *or medical, cytotoxic or quarantine waste that handles more than* ***1,000 tonnes per year of waste.***"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the retention of the untreated SPL in a containment cell would result in the containment cell being deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements,). The works are likely to be 'regional development' because they will have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the containment cell is located in an area currently containing native vegetation);
- Aboriginal heritage (particularly if the containment cell is located in an area of limited disturbance);
- Construction noise and air quality;
- Construction traffic;
- Health, safety and environmental management plan for the construction;
- Consideration of alternatives to the containment cell;
- Future containment cell management strategy for the ongoing management of the new cell (particularly leachate management and cell maintenance);
- This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works;
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).

4. Commonwealth Department of the Environment (if the containment cell location triggers a potential impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*)

- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
    - Crushing, grinding or separating
    - Waste storage
    - Waste processing (non-thermal treatment)
- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
    - Metallurgical activities (aluminium production and metal waste generation).

“Waste disposal (application to land)” is a scheduled activity requiring an EPL (Clause 39 of Schedule 3). However, the definition for this activity states that it applies to waste “*received from off site*”. As the SPL was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL.

Likelihood of Approval

There are potential issues due to possible difficulties with attaining a site-specific Chemical Control Order immobilization exemption, and potential difficulties in getting agencies to agree that ceasing the current SPL treatment and replacing with containment is reasonable and feasible. As such, the likelihood of approval is low.

The likelihood for approval could possibly be increased by consulting with the EPA and DoPI presenting detailed justification, but this would likely lead to an increase in the approval process timeframes.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

B5.3 Costs

The estimated cost for this option is $6.7mil AUD NPV.

Refer to the attached costing for details.

B5.4 Timeframe to complete

Activity	**Estimated timeframe (years)**
Pre-Design Activities	0.2 – 0.4
Preparation of RAP and Planning Approval	0.75 – 1.25
Approvals	0.75 - 1
Project Engineering Tasks	0.2 – 0.3
Implementation	0.4 – 0.6
Final Reporting	0.2 – 0.4
Total Estimated Timeframe	**3 - 4**

B5.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

- Groundwater, leachate and gas monitoring will be required for a period of 5 years on an annual basis and include annual reporting;
- Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years;

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. Given that the containment cell is purpose built in an area determined as suitable, the likelihood of the event occurring is considered to be once in 100 years and assigned a 1% probability of occurring at 50 years.

The ongoing legacy cost attributable only to ongoing monitoring is estimated to be $0.9mil AUD NPV.

B5.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘unlikely’ that this could occur except in some extreme circumstances, such as severe weather. Should breaches occur the containment cell is situated in an area with a depth to groundwater in excess of 10 m (in the area of the containment cell) and away from surface water receptors, therefore the risk to the environment is minimised. In the event of failure, due to the chemical composition of SPL in leachate, the consequence of failure is considered to require remediation works, possibly restoration of surrounding areas and possible prosecution. The consequence category is therefore considered to be ‘catastrophic’. On this basis the risk ranking is ‘10’.

B6 Treat and encapsulate in purpose built containment cell

Likelihood of Approval	Cost $mil AUD	Timeframe yrs	Legacy $mil AUD	Risk Ranking
Moderate to high	75.3	8 - 9	$1.1	6

B6.1 Description of the option

This option incorporates encapsulation on site within a purpose built containment cell in combination with a pre-treatment step to remove cyanides and reduce leachability of the SPL.

This option would involve the following steps:

1) Treat SPL through the existing Regain treatment facility (or a similar treatment process) incorporating a renegotiated contract that allow Hydro to retain the treated SPL onsite

2) Dispose of the treated SPL in a purpose built containment cell within the Hydro site.

Steps involved in this option are detailed in the following.

1. *Pre-construction*

- Assess existing Hydro site to identify the optimum location for placement of new cell to accept site SPL. Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Approvals process through local government/NSW planning/regulators.
- Design of “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

2. *Construction*

- Construction of containment cell.

- The cell base liner will comprise (ordered from vertically upwards)
  - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
  - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer.
- The cell cap liner will comprise (ordered from vertically upwards)
  - A 0.6 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
  - A 1.5mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.15 m sand gas collection layer overlain by;
  - A 0.3 m protection layer overlain by;
  - A 0.3 m topsoil layer, seeded and mulched.

Construction will need to specifically include:

- Nature of liner (as leachable concentrations of cyanide and fluoride have been reduced the adopted liner does not include additional requirements)
- Sufficient protective layer for HDPE (or similar) liner to prevent puncture/damage;

- Treatment of the waste through the existing Regain process (or a similar treatment process) to remove cyanides and immobilise fluorides;
- Placement of treated SPL wastes into new containment cell, followed by capping and finishing works to control stormwater and leachate. Compacting within the cell will be required to minimize settlement of the capping layers. As the waste will be treated, compaction of the layers can be achieved and a consistent low permeability capped placed.

3. *Post Construction*

- Ongoing monitoring and maintenance for containment cell likely involving:
  - Installation and regular monitoring of groundwater monitoring wells installed around the new facility;
  - Ongoing physical maintenance of the cell to maintain integrity of the cap ;
  - Ongoing leachate treatment;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Licence surrender which will be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan. The site can be divested and long term liability managed through a contract of sale. However, it is unlikely that Hydro can permanently and completely remove liability. For example, if the purchaser was to become insolvent and remediation of the containment cell required, this responsibility would default to Hydro as the owner of the contamination.

B6.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) requires a licence for the processing of aluminium smelter wastes containing leachable fluoride and/or leachable cyanide, and the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

As this option includes treatment of the SPL prior to encapsulation in the containment cell, it would be permissible subject to the issue of a licence from the EPA for the disposal.

Planning Approval

This advice is based on the assumption that SPL treatment would continue through the existing Regain treatment facility (or a similar treatment process) incorporating a renegotiated contract that allow Hydro to retain the treated SPL onsite. The SPL would continue to be treated in accordance with the 2005 development consent.

Placement of the treated SPL in a containment cell would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or* *activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when in operation it did not pose a significant risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Schedule 3 of the Environmental Planning and Assessment Regulation 2000 includes "Waste management facilities or works" under clause 32 of Schedule 3 of the regulation as designated development. This definition includes:

"(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

> *(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or*
>
> *ii) that comprises more than 100,000 tonnes of "clean fill" (such as soil, sand, gravel, bricks or other excavated or hard material) in a manner that, in the opinion of the consent authority, is likely to cause significant impacts on drainage or flooding*,"

Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011). It is assumed that treatment of the SPL prior to placement in the containment cell would result in it no longer being deemed "Aluminium smelting by-product" and therefore it is not classified as a designated development.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

"(5) Development for the purpose of hazardous waste facilities that transfer, ***store or dispose*** *of solid or liquid waste classified in the* ***Australian Dangerous Goods Code*** *or medical, cytotoxic or quarantine waste that handles more than* ***1,000 tonnes per year of waste.***"

As noted previously, it is assumed that treatment of the SPL prior to placement in the containment cell would result in it no longer being deemed "Aluminium smelting by-product" and therefore it would not be deemed a state significant development.

The works would be designated as 'regional development' as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While Cessnock City Council would assess the DA, the consent authority for the works will be the Hunter and Central Coast Regional Panel.

A Statement of Environmental Effects (SEE) is required to support a development application to Council. The SEE will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the containment cell is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the containment cell is located in an area of limited disturbance).
- Construction noise and air quality.
- Construction traffic.

- Construction phase management of contaminants.
- Soil and water management (including containment cell location hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives to the containment cell.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council and Maitland City Council
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).

- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
  - Crushing, grinding or separating
  - Waste storage
  - Waste processing (non-thermal treatment)
- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
  - Metallurgical activities (aluminium production and metal waste generation).

This advice assumes that the SPL would continue to be treated in accordance with EPL 13268, and therefore there are no new or additional licensing requirements.

“Waste disposal (application to land)” is a scheduled activity requiring an EPL (Clause 39 of Schedule 3). However, the definition for this activity states that it applies to waste “*received from off site*”. As the SPL was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL.

Likelihood of Approval

Provided that the treatment complies with the Chemical Control Order; the SEE shows that the option would not pose a significant impact to the factors listed above; and that the site has been selected based on an acceptable depth to groundwater, tight surrounding soils (preferably clays) that are demonstrated to be geologically consistent, surface water diversion and best practice containment cell design, the likelihood of approval is moderate to high. Evidence would also need to be provided that it is not reasonable or feasible to continue having the treated SPL removed from the site (i.e. that there is not a market for the material).

This likelihood can be further enhanced (and the approval timeframe potentially reduced) through implementation of the stakeholder consultation program.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

B6.3 Costs

The estimated cost for this option is $75.3mil AUD NPV.

Refer to the attached costing for details.

B6.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.2 – 0.4
Preparation of RAP and Planning Approval	0.75 – 1.25
Approvals	0.25 – 0.5
Project Engineering Tasks	0.2 – 0.3
Treatment	4.5 – 5.5
Implementation	0.75 – 1.25
Final Reporting	0.2 – 0.4
Total Estimated Timeframe	**8 - 9**

B6.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate and gas monitoring will be required for a period of 2 years on an annual basis and include annual reporting. The monitoring time is reduced from 5 years due to the treatment of the SPL prior to placement which reduces the likelihood of unacceptable leachate generation;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to only occur under rare circumstances such as severe event weather events or an earthquake. Given that the containment cell is purpose built in an area determined as suitable, the likelihood of the event occurring is considered to be once in 100 years and assigned a 1% probability of occurring at 50 years.

The ongoing legacy cost attributable only to ongoing monitoring is estimated to be $1.1million NPV.

B6.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered 'unlikely' that this could occur except in some extreme circumstances, such as severe weather. Should breaches occur the containment cell would be located in an area with a depth to groundwater in excess of 10m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the pretreatment of the SPL, the consequence of failure is considered to be 'moderate' requiring minor remediation works. Prosecution is not considered likely due to the low likelihood of environmental harm occurring. On this basis the risk ranking is '6'.

B7 Landfill off site

Sub Option	Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
1) NSW	Low	98.5	3 - 4	$0	1
2) QLD	Low	85.3	3 - 4	$0	1
3) Internationally	Very low	72.2	10 - 11	$0	1

B7.1 Description of the option

This option would involve disposal of the ‘as is’ SPL off site to a licensed landfill facility. Landfills in New South Wales, Queensland and internationally have been considered in this option.

1) New South Wales Landfill.

For the NSW disposal option we have assumed disposal in a purpose built cell at the SITA facility in Sydney can be achieved. Immobilisation of leachable concentrations would be by macro encapsulation, i.e. within a purpose built landfill cell.

Transport is between Kurri Kurri and Sydney (150 km).

2) Queensland Landfill

This option has been explored primarily due to the lower landfill levies associated with waste disposal in Queensland.

This option assumes the conditions for New South Wales disposal above, i.e., the material would be loaded and transferred “As Is” for disposal in a specialised landfill (macro-encapsulation by placement within a cell that is suitably constructed to mitigate leachate generation).

As a waste under a chemical control order any excavation and/or transport would require approval/s from the NSW EPA (OEH) and the NSW DPI and tracking under the Controlled Waste NEPM and in NSW and on-line waste tracking system.

Queensland has a similar on-line waste tracking system and will also require approvals for placement of hazardous waste. The criterium for placement of (fluoride contaminated) waste is also between five and ten times more conservative than NSW with respect to leachable concentrations. On this basis, approval likelihood is lower than for NSW.

Transport is between Kurri Kurri and Queensland (estimate 800 km).

3) Internationally

Any international export would be executed under the Basel Convention. Export for processing/reuse is a known scenario, however we are not aware of any cases where export has been undertaken with the aim to landfill. We assume approval of this is very unlikely both from exporting as well as importing authorities.

B7.2 Likelihood of approval

Chemical Control Orders and Dangerous Goods Code

1) General

The SPL (as Aluminium smelting by-product") is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011) (the Dangerous Goods Code). It is a Class 4.3 good (Substances which in contact with water emit flammable gases).

The Dangerous Goods Code places a number of restrictions on how the SPL can be transported, including:

- The size and type of wrapping/ container for the inner package and the outer package.
- The specifications for Intermediate Bulk Containers that house these packages (e.g. use metal or rigid plastic containers, or place other types of containers in closed transport units).
- If transported in a portable tank or bulk containers, the specifications for such tanks (such as thickness, pressure and pressure relief) and containers (watertight).

2) New South Wales

The waste materials (SPL) are regulated through the chemical control order (CCO) under the *Environmentally Hazardous Chemicals Act 1985.* Section 2.2 of the CCO states that the conveying of smelter wastes containing leachable fluoride and leachable cyanide requires a licence issued by the regulator. Therefore transport of SPL from the site could only be undertaken following approval from the regulator.

Also under the CCO, the disposal of aluminium smelter wastes containing leachable fluoride and leachable cyanide is a prescribed activity and is prohibited. Therefore, disposal to landfill without treatment would not be possible. The proposed treatment would be by macro encapsulation whereby the waste is contained within a purpose built containment cell provided certain criteria can be achieved. While this is the approach approved in 1993 for the capped waste stockpile, it may now not be acceptable to the EPA.

ENVIRON consider the likelihood of approval of this option to be low on the basis that other alternatives exist for the treatment of SPL.

3) Queensland

The CCO requires that waste leaving sites must meet the leachability criteria or that specific approval is obtained for transport without treatment, before it can be exported offsite under licence from the NSW EPA.

All Australian jurisdictions require tracking of certain wastes under the Controlled Waste National Environment Protection Measure (NEPM). The Controlled Waste NEPM is for the movement of wastes between states of Australia and processed SPL would most likely meet the requirements of the Controlled Waste NEPM.

Similar to waste tracking requirements in NSW, a Consignment Authorisation (CA) would be required prior to exporting the waste. In the case of exporting waste between states, the CA would need to be produced by the Queensland Department of Environment and Heritage Protection. The facility receiving the waste would need to be known at the time of application and identified on the application form.

In Queensland, waste is classified as “general waste”, “limited regulated waste” and “regulated waste” and these definitions are provided in Schedule 7 of the *Environment Protection Regulations (EPR) (2008).* Schedule 1 of *Environment Protection (Waste Management) Regulations (EPRWM) (2000)* defines the “trackable wastes”. Under the EPR, (processed) SPL would be classified as regulated waste due to cyanide and fluoride content. Note that there are no analytical limits defined in the regulations, as there are in the NSW Waste Classification Guidelines.

The analytical criteria for ‘regulated waste’ are not defined. The acceptance criteria for the receiving landfill are defined in the *Landfill siting, design, operation and rehabilitation* Guideline (EM2319). For a double lined landfill, these are as follows:

- Cyanide, Toxicity characteristic leaching procedure (TCLP) of 5 mg/L
- Fluoride, TCLP of 150 mg/L.

4) International

Australia is a signatory to the Basel Convention and the enabling legislation is the Commonwealth Hazardous Waste (Regulation of Exports and Imports) Act 1989.

SPL meets the definition of a hazardous waste under Annex 1 of the Basel Convention as it contains inorganic fluorides and cyanides and therefore can only be exported under a permit.

Application for permits can be made to the Commonwealth Department of the Environment.

It is theoretically possible to transport to Norway and landfill. However, there is one privately owned landfill in Norway licensed to receive SPL and they have declined to accept the material. Other options may exist in other countries and the cost base for Norway has been adopted for this evaluation.

If the SPL is to be subject to beneficial reuse then the likelihood of approval is greater.

Planning Approval

Loading and transportation of the untreated SPL to a licensed facility (assumed to be operating in accordance with a planning approval) or to an export facility does not require planning approval.

The 2005 development consent provides approval for operation of the SPL treatment facility. This facility meets a requirement of the 2002 development consent that requires Hydro to implement a proposal to treat spent pot lining generated by the smelter. Hydro has obtained legal advice that the combined effect of the 2002 and 2005 development consents is that it is obliged to treat all SPL in the storage sheds (but not within the capped waste stockpile) using this facility before any additional use. This would include its transportation off site.

If Hydro wished to transport the material prior to treatment, it would have to modify, surrender or replace its 2005 development consent to remove the requirement to treat the stored SPL. This would require justification to DoPI (the consent authority for the 2005 consent) and the EPA that cessation of SPL treatment is reasonable and feasible.

Environment Protection Licencing

“Transport of trackable waste” is a scheduled activity under clause 48 of Schedule 1 of the POEO Act. Trackable waste is defined in the Protection of the Environment Operations (Waste) Regulation 2005. SPL meets the definition of trackable waste and therefore an EPL to transport the material within NSW is required.

Likelihood of Approval

Due to the issues associated with the Chemical Control Order (and associated interstate and international permits) and the requirements for treatment under the 2005 development consent (and the unlikelihood of DoPI agreeing that treatment is not required) this option has a very low likelihood of approval.

B7.3 Cost

The estimated cost for these sub-options are:

Disposal location	Estimated cost ($mil AUD NPV)
New South Wales, Australia	98.5
Queensland, Australia	85.3
International	72.2

Refer to the attached costing for details.

B7.4 Timeframe to complete

	Time Estimate (years)		
Task	New South Wales, Australia	Queensland, Australia	International
Approvals	1 – 0.3	1 – 0.3	0.75 – 1.25
Investigations/tender/contract negotiations	0.2 – 0.3	0.2 – 0.3	0.4 – 0.7
Implementation	0.25 – 0.5	0.25 – 0.5	0.25 – 0.5
Transportation	1 – 1.5	1 – 1.5	8 - 9
Validation Reporting	0.2 – 0.4	0.2 – 0.4	0.2 – 0.5
Total	3 - 4	3 - 4	10 - 11

B7.1 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented.

B7.2 Risk

The risk associated with this disposal option is associated with the waste causing an unacceptable risk to human health or the environment at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated the likelihood of an incident occurring is considered to be 'rare' (may occur only in exceptional circumstances'). The consequence to Hydro, is considered to be 'insignificant' as it is a remote risk that the consequence will be the responsibility of Hydro if certain mitigation and management measures are implemented. The risk evaluation is therefore '1'. This evaluation of risk is based on legal advice obtained by Hydro.

B8 Treatment Prior to Landfilling off site

Sub Option	Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
NSW	Low	103	6- 7	$0	1
QLD	Low	107	6- 7	$0	1

B8.1 Description of the option

This option would involve the following steps:

1) Treat SPL through the existing Regain treatment facility (or similar) incorporating a renegotiated contract that allows Hydro to manage the treated material.

2) Dispose of the treated SPL as solid waste to landfills licensed to accept solid wastes.

Steps involved in this option are detailed in the following.

- This option includes treatment by the Regain process (or similar) prior to offsite disposal at a licensed landfill facility. Treatment would be undertaken to reduce leachable fluoride and cyanide and render the treated waste as non-hazardous;
- Transport of the SPL to a landfill licensed to accept solid waste. Australian destinations have only been considered, international destinations are cost prohibitive and have not been considered further.

B8.2 Likelihood of approval

It is assumed that the SPL treatment would continue in accordance with the existing approval and EPL, and that the receiving location is approved for the receipt of treated SPL. Therefore no planning approvals are required.

However, there is a scheduled activity of “transport of trackable waste” (under clause 48 of Schedule 1 of the POEO Act). Trackable waste is defined in the Protection of the Environment Operations (Waste) Regulation 2005. Treated SPL meets the definition of trackable waste and therefore an EPL to transport the material within NSW is required.

Likelihood of approval for domestic disposal is considered to be high. As the waste is treated to reduce leachable concentrations, the waste can be transported as standard solid waste and will not require tracking or monitoring under the Chemical Control Order.

B8.3 Cost

The estimated cost for these sub-options are:

Disposal location	Estimated cost $mil AUD
New South Wales, Australia	103
Queensland, Australia	107

Refer to the attached costing for details.

B8.4 Timeframe to complete

	Time Estimate (years)	
Task	**New South Wales, Australia**	**Queensland, Australia**
Approvals	0.5 – 0.7	0.5 – 0.7
Investigations/tender/contract negotiations	0.2 – 0.4	0.2 – 0.4
Implementation	0.2 – 0.4	0.2 – 0.4
Treatment and transport (12,000t/yr)	4.5 – 5.5	4.5 – 5.5
Validation Reporting	0.2 – 0.4	0.2 – 0.4
Total	6 - 7	6 - 7

B8.5 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented.

B8.6 Risk

The risk associated with this disposal option is associated with the waste causing an unacceptable risk to human health or the environment at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated the likelihood of an incident occurring is considered to be ‘rare’ (may occur only in exceptional circumstances’). The consequence to Hydro, is considered to be ‘insignificant’ as it is a remote risk that the consequence will be the responsibility of Hydro if certain mitigation and management measures are implemented. The risk evaluation is therefore ‘1’. This evaluation of risk is based on legal advice obtained by Hydro.

B9 Treatment Internationally

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
Moderate	58.3	10 - 11	0	1

B9.1 Description of the option

This option involves transport of untreated SPL to an international destination for treatment or reuse. Treatment solution would be based on the same principals as for the local Australian treatment options (Regain or similar) and include a heat treatment step to remove hazardous components and produce an inert material. Reuse alternatives are more sustainable as the fuel or raw material is used directly in industrial applications without pre-treatment. All reuse scenarios are based on an incineration step that removes fluoride and cyanide and uses the carbon content as an alternative fuel. Other components such as alumina, silica and fluoride are a valued input either complementing raw materials or providing a process benefit such as fluxing. For example, Hydro's smelters in Norway are all exporting the carbon fraction of their SPL to Germany for reuse as alternative fuel in the glass wool industry, and at Hydro's smelter in Brazil both carbon and refractory fractions are used as fuel and raw material supplement in the cement industry. SPL as a resource to the cement industry is also well established in other countries including US, France and Spain.

B9.2 Likelihood of approval

Australia is a signatory to the Basel Convention and the enabling legislation is the Hazardous Waste (Regulation of Exports and Imports) Act 1989 (Commonwealth). SPL meets the definition of a hazardous waste under Annex 1 of the Basel Convention as it contains inorganic fluorides and cyanides and therefore can only be exported under a permit. Application for permits can be made to the Commonwealth Department of the Environment (DOE). The DOE has a technical advisory service available to potential applicants.

Applicants must have the following:

- A written contract or chain of contracts covering all movements, starting with the notifier and terminating at the disposal facility. The person specified in the contract is responsible for the management of the wastes including their return, if necessary.
- Appropriate insurance.
- Evidence of financial viability.
- Detailed evidence that the waste will be managed in an environmentally sound manner.

DOE permits are only granted to persons within Australian jurisdiction. The DOE must respond to applications within 40 days.

The likelihood of approval would depend on the proposed fate for the SPL, but under Section 18A of the Act, export permits for final disposal (meaning incineration or landfill) will only be granted in exceptional circumstances. The Act describes some exceptional circumstances, including:

- whether there will be a significant risk of injury or damage to humans or the environment if the Minister decides not to grant the permit;
- whether the waste is needed for research into improving the management of hazardous waste; and
- whether the waste is needed for testing for the purposes of improving the management of hazardous waste.

If the SPL is to be subject to beneficial reuse in other industries the likelihood of approval is greater.

Planning Approval

Loading and transportation of the untreated SPL to an existing international treatment facility (assumed to be operating in accordance with necessary approvals in its jurisdiction) does not require planning approval.

The 2005 development consent provides approval for operation of the SPL treatment facility. This facility meets a requirement of the 2002 development consent, which requires Hydro to implement a proposal to treat spent pot lining generated by the smelter. Hydro has obtained legal advice that the combined effect of the 2002 and 2005 development consents is that it is obliged to treat all SPL in the storage sheds (but not within the capped waste stockpile) using this facility before any additional use. This would include transportation of SPL off site.

If Hydro wished to transport the material prior to treatment, it would have to modify, replace or surrender its 2005 development consent. This would require justification to DoPI (the consent authority for the 2005 consent) and the EPA that cessation of SPL treatment on site, and the new treatment methodology (including transportation overseas) is reasonable and feasible.

Environment Protection Licencing

“Transport of trackable waste” is a scheduled activity under clause 48 of Schedule 1 of the POEO Act. Trackable waste is defined in the Protection of the Environment Operations (Waste) Regulation 2005. SPL meets the definition of trackable waste and therefore an EPL to transport the material within NSW is required.

Likelihood of Approval

The approval likelihood is considered low when SPL is proposed to be exported for treated and landfilling. However, where SPL is to be treated and reused the approval likelihood is considered moderate to high. ENVIRON is aware that export permits have been granted to another aluminium smelter to allow transport to Europe for treatment and reuse.

B9.3 Cost

The estimated cost for this option is $58.3mil AUD NPV.

Refer to the attached costing for details.

B9.1 Timeframe to complete

Task	Time estimate (years)
Approvals	0.75 – 1.25
Investigations/tender/contract negotiations	0.4 – 0.6
Implementation	0.2 – 0.4
Transport	8 - 9
Validation Reporting	0.2 – 0.4
Total	10 - 11

B9.2 Legacy

A legacy value is not assigned due to the complete reuse of the SPL.

B9.3 Risk Ranking

International treatment is given a low to moderate risk ranking of between 1 and 2. It is considered that there are unlikely to be any consequences that would not be insignificant.

B10 On site Treatment to Achieve Complete Destruction

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
Moderate to high	51	11 - 13	0	12

B10.1 Description of the option

This option would involve the processing of the SPL to remove fluorides and cyanides, in conjunction with carbon value capitalisation in a waste to energy process. Research of global technologies identified that plasma gasification pilot scale trials have been undertaken on first and second cut SPL. By-products of this process include SYN gas, vitirified rock (slag) and elemental metal. All by-products may be demonstrated as suitable for a beneficial further use.

It is envisaged that this process would require pilot studies prior to full scale treatment.

B10.2 Likelihood of approval

Chemical Control Order

As previously discussed, the Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) will likely require treatment/processing of the waste prior to disposal. As this option includes treatment of the SPL it is likely to meet the Chemical Control Order, and the EPA's, requirements.

Resource Recovery Exemption

The by-products of the plasma gasification process include synthetic gases, base metals and vitrified rock-like material (slag). The synthetic gases can be used in energy generation, while the base metals and slag have potential reuse opportunities (for example granulated slag can be used as a construction base material).

A resource recovery exemption would need to be issued in accordance with the *Protection of the Environment Operations Act 1997* permitting the reuse of these materials. The exemption would be issued if it could be demonstrated that the waste material is of benefit in its proposed use and poses minimal risk of harm to the environment or human health. This includes providing evidence that the material is homogenous in physical and chemical quality, that it is stable and would not result in the leaching of contaminants into soils and groundwater, and that there is a genuine re-use opportunity for the material.

If a resource recovery exemption could not be gained, these materials would need to be disposed to a licensed landfill. Note however, that the following planning and licensing advice is based on the assumption that approval for disposal to landfill does not form part of this option.

Planning Approval

Treatment of the SPL using this approach would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*”.

Development for the purposes of a ‘waste or resource management facility’ (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As a ‘waste or resource management facility’ is not specified as ‘permitted without consent’ or ‘prohibited’ it follows that a ‘waste or resource management facility’ is permissible with consent.

The Project would be deemed as “designated development” under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of “Waste management facilities or works” under clause 32 of Schedule 3 of the regulation. This definition includes:

“(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

> *(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or*

The works would be designated development as it is triggers sub-clause 32(1)(a)(i) (“Aluminium smelting by-product” is registered as a dangerous good under the “Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition” (National Transport Commission, 2011)). An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General’s Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as ‘regional development’ as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as “all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment “, but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application (DA) for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While the Cessnock City Council will assess the DA, the consent authority for the works would be the Hunter and Central Coast Regional Panel.The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the treatment facility is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the treatment facility is located in an area of limited disturbance).
- Treatment phase noise and air quality.
- Treatment phase management of contaminants.
- Community and social impacts (including health).
- Consideration of alternatives to the treatment.
- Sustainability and carbon management.

It should be noted that Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the treatment of the SPL may be deemed part of the disposal process and therefore the activity deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

If this was the case, an EIS would be required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

"Waste disposal (thermal treatment)" is a scheduled activity under clause 40 of Schedule 1 of the *Protection of the Environment Operations Act 1997*. This includes "*thermal treatment of hazardous and other waste, meaning the* ***receiving*** *of hazardous waste, restricted solid waste, liquid waste or special waste* ***from off site*** *and its processing by thermal treatment*." Assuming that the plasma gasification treatment plant would be located on site, it would not meet this definition as the material would not be received from off site.

However, in the event that the process also includes the generation of energy, "Energy recovery" is a scheduled activity under Clause 18 of Schedule 1. Its definition includes:

"***energy recovery from hazardous and other waste*** (meaning other than general waste)*, meaning the receiving from* ***on site*** *or off site of, and the recovery of energy from, hazardous waste, restricted solid waste, liquid waste or special waste*."

Likelihood of Approval

As noted the plasma gasification process is a new technology, and is still proceeding through trial programs globally. Agencies may be reluctant to approve such a facility unless data from trials of similar technologies can provide greater certainty about performance. Consultation could be undertaken with agencies to discuss the opportunity for a trial (with monitoring to confirm its performance) prior to a full scale facility.

If sufficient information and evidence could be provided to the agencies on the environmental performance of plasma gasification, and the resource recovery exemptions for the by-products are granted, agencies are likely to look favourably on such a process and therefore it would have a high likelihood of approval.

B10.1 Cost

The estimated cost for this option is $51mil AUD NPV.

B10.2 Legacy

A legacy value is not assigned due to the complete reuse of the SPL. It was assumed that this option would only be selected if pilot scale testing demonstrated the end product was able to be reused.

B10.3 Timeframe to complete

The estimated timeframe to complete this option is 11 to 12 years allowing for pilot studies and planning approvals.

Activity	Estimated timeframe (years)
Pilot Trial	1
RAP/EIS	1
Approvals	1.75
Investigations/tender/contract negotiations	0.5
Construction/commissioning	1
Assumes treatment at 15000tpa	6-7
Validation Reporting	0.2
Total Estimated Timeframe	**11-12**

B10.4 Risk Ranking

The risk associated with this option is a technological risk from the unproven technology and the possibility that an alternate remediation solution will require implementation. The likelihood of this technology not being able to treat the SPL economically or technically into a condition that can be re-used without additional treatment (and therefore needing to landfill) is ‘likely’. Potential issues associated with the applicability of the treatment to the capped waste stockpile wastes are considered to be equally valid. Risks include those associated with the pre-treatment requirements for the capped waste stockpile and the extent to which crushing and sorting is required.

The material is currently not qualified as inert and therefore it cannot be used without limitation as fill material. Also, no technical specification of material strength has been determined, (the physical properties are currently unknown). If it cannot be utilised as inert fill material, one of Options B1 to B9 would need to be implemented. In addition, as of 23 January 2014 there are no known estimates of the difference between input volume / weight, and volume / weight of the vitrified material (it is unknown how much of the processed material would be generated).

The consequence of the technology not being applicable to the site will require an alternate solution is considered ‘moderate’. The alternate solution for remediation is comparable in cost to those presented in Options B1 to B9. It would also result in a loss in time prior to being able to implement a solution. On this basis this option is given a risk ranking of ‘12’.

Volume

SPL in storage sheds and pots	Volume cum	Mass tonnes	Bulk Density	Source
SPL first cut	28000	50000	1.8	Hydro
SPL second cut	28000	50000	1.8	Hydro
TOTALs	56000	100000		

Description	**Remediation Cost $mil AUD**	**Legacy $mil AUD**	**TIME (Years)**	**RISK (1 to 9, 9 high)**
Option B1 - Continue existing treatment/management	$53	$0	8.3	6
Option B2 - Alternate Treatment and Management	$60	$0	8.3	12
Option B3 - Move to specifically designed landfill adjacent to the	$7	$1	3.3	15
Option B4 - Treat and move to specifically designed landfill adjac	$72	$1	8.1	6
Option B5 - Place within a purpose built containment cell	$7	$1	3.3	10
Option B6 - Treat and place within a purpose built containment c	$76	$1	8.0	6
Option B7 Dispose off Site				
Option B7a - NSW	$98	$0	3.0	1
Option B7b - Queensland	$85	$0	3.0	1
Option B7C - International	$72	$0	10.3	1
Option B8 - Treat and dispose off site NSW, Queensland, International				
Option B8a - NSW	$103	$0	6.2	1
Option B8b - Queensland	$107	$0	6.2	1
Option 9 - Treatment internationally	$59	$0	10.0	1
Option 10 - Waste to Energy onsite	$51	$0	12.1	12

Option B1 - Continue existing treatment/management	
Description	**Existing treatment by Regain**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Currency	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
Cost								
	Treatment by Regain					Cost		
		First cut SPL, bulk density estimated to be 1.8T/m3	50000	t	$530	$26,500,000	Treatment includes transport and any pretreatment/processing	Hydro
		Second cut SPL, bulk density estimated to be 1.8T/m^3	50000	t	$530	$26,500,000	Treatment includes transport and any pretreatment/processing	Hydro
		Total Cost				**$53,000,000**		

NOTES

Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary

Assumes further investigation does not identify other not known contamination

Assumes rate costs include all pre-treatment and transport requirements

Assumes existing contract extend to include all first and second cut SPL

RISK	Moderate	6
	unlikely	

Legacy Cost			No reasonable or foreseeable legacy event. No allocation can be provided
	Legacy provision	0	

Time	Description	Quantity	Unit	Unit rate	Total		Source
	Processing through REGAIN plant, current contract	100000	12000	t/yr	8.3		Hydro
	Time				8.3	years	

Option B2 - Alternate Treatment and Management	
Description	**Treatment by alternate provider, Weston Aluminium**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Currency	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
Cost								
	Treatment by alternate provider					Cost		
		First cut SPL, bulk density estimated to be 1.8T/m3	50000	t	$600	$30,000,000	Treatment includes transport and any pretreatment/processin	Hydro
		Second cut SPL, bulk density estimated to be 1.8T/r	50000	t	$600	$30,000,000	Treatment includes transport and any pretreatment/processin	Hydro
		Total Cost				**$60,000,000**		

NOTES

Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes rate costs include all pre-treatment and transport requirements
Assumes alternate provider can treat both first and second cut SPL.

RISK	possible		12				
	major						
Legacy Cost							
	Legacy provision		0			No reasonable or foreseeable legacy event. No allocation can be provided	
Time	**Description**	Quantity		Unit	Unit rate	Total	
	Processing through Weston plant, current contract		100000	12000	t/yr	8.3 Throughput unknown	Hydro
	Time					8.3 years	

Option B3 - Move to specifically designed landfill adjacent to the Alcan Mound

Description	**Treat and Move all materials to the existing Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	12	EA	$1,100	$13,200	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	5	EA	$7,200	$36,000	5 borings per 5000m2.	ENVIRON Estimate.
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leachate	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$64,200**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		Sub-total preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$226,000		USEPA Remediation Engineering
		Remedial Design			8%	$362,000		USEPA Remediation Engineering
		Construction Management			6%	$147,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$90,000		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$825,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	6,680	m2	$2	$13,894		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	1,500	ha	$1,020	$153.00	Assumes area largely cleared (99.9%)	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	6,680	m3	$8	$53,106		Rawlinsons 2013 p675
		Filling of Eastern Surge Pond	4,590	m3	$25	$114,750	Approximate area determined from aerial photo	Rawlinsons 2013 p675
		Construct Clay Liner (1 meter)	8,898	m3	$24	$209,103		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	8,898	m2	$20	$180,185		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	8,898	m2	$4	$33,368		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	2,729	m3	$25	$68,225		Vendor Estimate/ENVIRON Experience
		Install 60 ML HDPE Liner	8,898	m2	$17	$146,817		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	8,898	m2	$4	$33,368		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	2,729	m3	$25	$68,225		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	8,898	m2	$4	$33,368		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,156,944**		
	6	**Placement of SPL**						
		Transport and place SPL, compact to 90%	56,000	m3	$12	$672,000	Assumes transport less than 500m	Rawlinsons 2013
		Crush	56,000	m3	$25	$1,400,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Placement of SPL				**$2,072,000**		
	7	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	2,795	m3	$10	$27,251		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	9,319	m3	$26	$242,294		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	18,637	m2	$20	$377,399		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	5,591	m3	$10	$54,513		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	18,637	m2	$4	$74,548		Rawlinsons 2013 p677
		Install General Fill (30 cm)	5,591	m3	$26	$145,369		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	5,591	m3	$17	$96,335		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	2,842	m2	$8	$22,679		Rawlinsons 2013 p228
		Supply and Install Fencing	296	m	$56	$16,598		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108	Well depth 10m	Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$1,064,232**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		
		Subtotal				$5,923,377		
		Contingency 10%				$592,338	10% Scope	
		CAPITAL COSTS				**$6,515,715**		

NOTES

Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Refer to Appendix B for a description of capping requirements and assumptions made

Legacy Cost

	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years
	Maintenance	1	annual	$18,000	$568,780		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$119,014		no cost in year 0	
		1	each	$56,842	$56,841.66	year 25	Using a discount rate of 3%
		1	each	$12,966	$12,965.99	year 50	Using a discount rate of 3%
		1	each	$1,413	$1,412.58	year 75	Using a discount rate of 3%
		1	each	$74	$73.50	year 100	Using a discount rate of 3%
					$1,390,074		
	Legacy potential liability provisioning	2%	event	NPV	$29,654	assumes occurs in twice in 100 years	Using a discount rate of 3%
					$29,654		
					$1,419,728		

Risk

Value
15

Ranking

Catastophic If a breaching of the capping layer occurs, reinstatement of the cap would be requried and whilst it is unlikely that significant harm would occur, cost implications are high and prosecution could result
Possible It is possible that during future site use a cap breach would occur.

Timing

Pre-Design Activities	0.25	years
Preparation of RAP and Planning Approval	1.25	years
Approvals	0.75	years
Project Engineering Tasks	0.2	years
Implementation	0.6	years
Final Reporting	0.25	years

Option B4 - Treat and move to specifically designed landfill adjacent to the Alcan Mound

Description	**Treat and Move all materials to the existing Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	12	EA	$1,100	$13,200	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	5	EA	$7,200	$36,000	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$49,200**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$280,000	$280,000	Assumed EIS for JRRP approval	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$370,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$2,803,000		USEPA Remediation Engineering
		Remedial Design			8%	$4,485,000		USEPA Remediation Engineering
		Construction Management			6%	$144,000		USEPA Remediation Engineering
		Environmental Audit of works (Validatin)			2%	$1,121,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$8,553,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Cell Construction**						
		Clear & Grub for Consolidation Cell	1,500	ha	$1,020	$153	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	2,795	m3	$8	$22,220		Rawlinsons 2013 p675
		Filling of Eastern Surge Pond	4,590	m3	$25	$114,750	Approximate area determined from aerial photo	Rawlinsons 2013 p675
		Construct Clay Liner (1 meter)	8,898	m3	$24	$209,103		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	8,898	m2	$20	$180,185		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	8,898	m2	$4	$33,368		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	2,729	m3	$25	$68,225		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	8,898	m2	$17	$146,817		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	8,898	m2	$4	$33,368		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	2,729	m3	$25	$68,225		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	8,898	m2	$4	$33,368		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,112,164**		
	6	**Placement of SPL**						
		Treat SPL to inert product	100,000	t	$530	$53,000,000	Assumes treatment rate is equal to current Regain rate	Hydro, Regain contract
		Transport and place SPL, compact to 90%	56,000	m3	$12	$672,000	Assumes transport less than 500m	Rawlinsons 2013
		SUBTOTAL SPL Treatment and Placement				**$53,672,000**		
	7	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	2,795	m3	$10	$27,251		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	9,319	m3	$26	$242,294		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	18,637	m2	$20	$377,399		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	5,591	m3	$10	$55,911		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	18,637	m2	$4	$74,548		Rawlinsons 2013 p677
		Install General Fill (30 cm)	5,591	m3	$26	$145,369		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	5,591	m3	$18	$100,640		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	2,842	m2	$8	$22,679		Rawlinsons 2013 p228
		Supply and Install Fencing	296	m	$56	$16,598		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108		Vendor Estimate/ENVIRON Experience
		Supply and install gas vents	6	ea	$1,500	$9,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$1,056,546**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL Reporting				**$125,000**		
		Subtotal				$65,163,910		
		Contingency 10%				$6,516,391	10% Scope	
		CAPITAL COSTS				**$71,680,301**		

NOTES
Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Refer to Appendix B for a description of capping requirements and assumptions made
Assumes rates for treatment are equal to the current Regain contract. Lower rates can potentially be negotiated

Legacy Cost

Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
Maintenance	1	each	NPV	$568,780		Based on 12 events per year for 100 years, using a discount rate of 3%
Topsoil replacement and reseeding battered perimeter	Base year	each	$123,319			
	1	each	$58,898	$58,897.82	year 25	Using a discount rate of 3%
	1	each	$13,435	$13,435.01	year 50	Using a discount rate of 3%
	1	each	$1,464	$1,463.68	year 75	Using a discount rate of 3%
	1	each	$76	$76.16	year 100	Using a discount rate of 3%
				$942,653		
Legacy potential liability provisioning	1%	event	NPV	$163,553	ocurring once in 100 years at Year 50	Using a discount rate of 3%
Legacy provision				$1,106,206		

Risk

Ranking		Value
		6
Minor	If a breaching of the capping layer occurs, reinstatement of the cap would be requried and it is unlikely that significant harm would occur, though cost implications are high and prosecution could result	
Possible	It is possible that during future site use a cap breach would occur.	

Timing

Pre-Design Activities	0.25	years
Preparation of RAP and Planning Approval	1	years
Approvals	0.75	years
Project Engineering Tasks	0.2	years
Treatment at 20000t/year	5	years
Implementation	0.6	years
Final Reporting	0.25	years
Time	**8.05**	**years**

Option B5 - Place within a purpose built containment cell

Description	**Placement within a purpose built containment cell within the Hydro site**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	12	EA	$1,100	$13,200	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	5	EA	$7,200	$36,000	5 borings per 5000m2.	ENVIRON Estimate.
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leachate	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$64,200**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$226,000		USEPA Remediation Engineering
		Remedial Design			8%	$362,000		USEPA Remediation Engineering
		Construction Management			6%	$271,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$90,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$949,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		
		SUBTOTAL Site Preparation				**$688,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	9,604	m2	$2	$19,976		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	9,604	ha	$1,020	$979.61	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	9,604	m3	$8	$76,352		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	9,902	m3	$24	$232,697		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	9,866	m2	$20	$199,787		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	9,866	m2	$4	$36,998		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	3,035	m3	$25	$75,875		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	9,866	m2	$20	$199,787		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	9,866	m2	$4	$36,998		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	3,035	m3	$25	$75,875		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	445	m	$128	$56,960		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	9,866	m2	$4	$36,998		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,059,280**		
	6	**Placement of SPL**						
		Transport and place SPL, compact to 90%	56,000	m3	$12	$672,000	Assumes transport less than 1500m	Rawlinsons 2013
		Crush	56,000	m3	$25	$1,400,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Placement of SPL				**$2,072,000**		
	7	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	1,520	m3	$10	$14,820		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	5,981	m3	$26	$155,506		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	3,039	m3	$10	$29,630		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	9,967	m2	$20	$199,340		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	3,039	m3	$10	$29,630		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	9,967	m2	$4	$39,868		Rawlinsons 2013 p677
		Install General Fill (30 cm)	3,039	m3	$26	$79,014		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	1,520	m3	$17	$26,190		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	9,967	m2	$8	$79,537		Rawlinsons 2013 p228
		Supply and Install Fencing	427	m	$56	$23,923		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	8	ea	$2,018	$16,144		Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389		Vendor Estimate/ENVIRON Experience
		Total Cell Construction and Cap Construction				**$701,171**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		Sub-total reporting				**$125,000**		
		Subtotal				$6,048,651		
		Contingency 10%				$604,865	10% Scope	
		CAPITAL COSTS				**$6,653,516**		

NOTES
Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Refer to Appendix B for a description of capping requirements and assumptions made

Legacy Cost

Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
Maintenance	1	each	NPV	$567,844		Based on 12 events per year for 100 years, using a discount rate of 3%
Topsoil replacement and reseeding battered perimeter	Base year	each	$105,726			
	1	each	$50,495	$50,495.45	year 25	Using a discount rate of 3%
	1	each	$11,518	$11,518.37	year 50	Using a discount rate of 3%
	1	each	$1,255	$1,254.87	year 75	Using a discount rate of 3%
	1	each	$65	$65.29	year 100	Using a discount rate of 3%
				$931,178		
Legacy potential liability provisioning	1%	event	NPV	$15,283	Occurring once in 100 years and at Year 50	Using a discount rate of 3%
Legacy provision				$946,461		

Risk

10

Ranking
Catastrophic If a breaching of the capping layer occurs, reinstatement of the cap would be requried, restoration works of the surrounding area may be required and prosecution could result.
unlikely It is unlikely that during future site use a cap breach would occur.

Timing

Pre-Design Activities	0.25	years
Preparation of RAP and Planning Approval	1.25	years
Approvals	0.75	years
Project Engineering Tasks	0.2	years
Implementation	0.6	years
Final Reporting	0.25	years
Time	**3.3**	**years**

Option B6 - Treat and place within a purpose built containment cell

Description	**Placement within a purpose built containment cell following treatment to reduce leachable components**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	12	EA	$1,100	$13,200	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	5	EA	$7,200	$36,000	5 borings per 5000m2.	ENVIRON Estimate.
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leachate	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$64,200**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	Assumed EIS for JRRP approval	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$2,805,000		USEPA Remediation Engineering
		Remedial Design			8%	$4,488,000		USEPA Remediation Engineering
		Construction Management			6%	$3,366,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$1,122,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$11,781,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		
		SUBTOTAL Site Preparation				**$688,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	9,604	m2	$2	$19,976		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	9,604	ha	$1,020	$979.61	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	9,604	m3	$8	$76,832		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	9,902	m3	$24	$237,648		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	9,866	m2	$20	$199,787		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	9,866	m2	$4	$36,998		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	3,035	m3	$25	$75,875		Vendor Estimate/ENVIRON Experience
		Install1.5mm HDPE Liner	9,866	m2	$20	$199,787		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	9,866	m2	$4	$36,998		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	3,035	m3	$25	$75,875		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	445	m	$128	$56,960		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	9,866	m2	$4	$36,998		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,064,711**		
	6	**Placement of SPL**						
		Treat SPL to inert product	100,000	t	$530	$53,000,000	Assumes treatment rate is equal to current Regain rate	Hydro, Regain contract
		Transport and place SPL, compact to 90%	56,000	m3	$12	$672,000	Assumes transport less than 1500m	Rawlinsons 2013
		SUBTOTAL SPL Placement				**$53,672,000**		
	7	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	1,520	m3	$10	$14,820		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	5,981	m3	$26	$155,506		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	9,967	m2	$20	$201,832		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	3,039	m3	$10	$29,630		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	9,967	m2	$4	$39,868		Rawlinsons 2013 p677
		Install General Fill (30 cm)	3,039	m3	$26	$79,014		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (30 cm)	1,520	m3	$17	$26,190		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	9,967	m2	$8	$79,537		Rawlinsons 2013 p228
		Supply and Install Fencing	427	m	$56	$23,923		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	8	ea	$2,018	$16,144		Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$674,033**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL Reporting				**$125,000**		
		Subtotal				$68,458,944		
		Contingency 10%				$6,845,894	10% Scope	
		CAPITAL COSTS				**$75,304,838**		

NOTES

Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Refer to Appendix B for a description of capping requirements and assumptions made
Assumes rates for treatment are equal to the current Regain contract. Lower rates can potentially be negotiated

Legacy Cost

	QTY	units	UNIT COST	TOTAL	NOTES	Source
Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
Maintenance	1	each	NPV	$568,780		Based on 12 events per year for 100 years, using a discount rate of 3%
Topsoil replacement and reseeding battered perimeter	Base year	each	$105,726			
	1	each	$50,495	$50,495.45	year 25	Using a discount rate of 3%
	1	each	$11,518	$11,518.37	year 50	Using a discount rate of 3%
	1	each	$1,255	$1,254.87	year 75	Using a discount rate of 3%
	1	each	$65	$65.29	year 100	Using a discount rate of 3%
				$932,114		
Legacy potential liability provisioning	1%	event	NPV	$171,765	Occuring at 50 years	Using a discount rate of 3%
Legacy provision				$1,103,879		

Risk

		Value
Ranking		6
Moderate	If a breaching of the capping layer occurs, reinstatement of the cap would be requried and it is unlikely that significant harm would occur, though cost implications are high	
unlikely	It is unlikely that during future site use a cap breach would occur.	

Timing

Pre-Design Activities	0.25	years
Preparation of RAP and Planning Approval	1	years
Approvals	0.25	years
Project Engineering Tasks	0.2	years
Treatment at 20000t/year	5	years
Implementation	1	years
Final Reporting	0.25	years
Time	**8**	**years**

Option B7 Dispose off Site	
Description	**Transport all materials for disposal off site to landfill**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units		UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**							
		RAP preparation				$50,000	$50,000		ENVIRON experience
		Development application				$100,000	$100,000	Modification application requ	ENVIRON experience
		Sub-total preliminary documentation					**$150,000**		
	2	**Project Tasks**							
		Project Management				5%			
		Sub-total Technical Tasks Capital Cost					**included below**		
	3	**Site Preparation**							
		Environmental controls	0				0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each		$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each		$15,000	$30,000		
		Sub-total site preparation					**$56,000**		
	4	**Loading costs**							
		SPL	56000	m3		$5	$257,600	assume sand & < 1m	Rawlinsons
		Sub-total excavation costs					**$257,600**		
	5	**Transport costs**							
		NSW	56000	m3		$84	4,709,600	Sydney	Rawlinsons, based on 150km
		QLD	56000	m3		$461	25,821,600	Brisbane	Rawlinsons, based on 800km
		International	100000	t		$500	50,000,000	Transport to Norway	Hydro (K Morkved)
		Sub-total disposal costs					**included below**		
	6	**Disposal Costs**							
		NSW	100000	t		$800	80,000,000	Untreated	Vendor supplied
		QLD	100000	t		$475	47,500,000	Untreated	Vendor supplied
		International	100000	t		$120	12,000,000	Norway disposal, price rise e	Hydro (K Morkved)
							included below		
	7	**Final Reporting**							
		Validation report		each	allow		$30,000		ENVIRON experience
		EMP		each	allow		$15,000		ENVIRON experience
		Site Auditor signoff		each	allow		$40,000		ENVIRON experience
		Sub-total reporting					**$85,000**		
		NSW							
		Subtotal					$89,513,610		
		Contingency					$8,951,361		
		CAPITAL COSTS					**$98,464,971**		
		Queensland							
		Subtotal					$77,556,210		
		Contingency					$7,755,621		
		CAPITAL COSTS					**$85,311,831**		
		International							
		Subtotal					$65,668,530		
		Contingency					$6,566,853		
		CAPITAL COSTS					**$72,235,383**		

NOTES
Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes transport rates of 1500t/wk for Australia and 12000t/yr for international movement

Legacy Cost

Legacy provision	$0

RISK			Value
	Comment	NSW	1
		QLD	1
		International	1

Time			
NSW	Approvals	1.0	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.3	years
	Transport (assumes 10 trucks per day, 30t per truck)	1.3	years
	Validation Reporting	0.2	years
	TOTAL	3.0	years
QLD	Approvals	1.0	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.3	years
	Transport (assumes 10 trucks per day, 30t per truck)	1.3	years
	Validation Reporting	0.2	years
	TOTAL	3.0	years
International	Approvals	1.0	years
	Investigations/tender/contract negotiations	0.5	years
	Implementation	0.3	years
	Transport (assumes 1000t per month)	8.3	years
	Validation Reporting	0.2	years
	TOTAL	10.3	years

Option B8 Dispose off Site	
Description	**Onsite treatment and transport all materials for disposal off site to landfill**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST		SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**							
		RAP preparation				$50,000	$50,000		ENVIRON experience
		Development application				$15,000	$15,000	Assumed approval limited to EPA consı	ENVIRON experience
		Sub-total preliminary documentation					**$70,000**		
	2	**Project Tasks**							
		Project Management				5%			Rawlinsons?
		Sub-total Technical Tasks Capital Cost							
	3	**Site Preparation**						Site sheds, machinery compising backhoe and roller	
		Environmental controls	0				0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each		$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each		$2,000	$4,000		
		Sub-total site preparation					**$30,000**		
	4	**Placement of SPL**							
		Treat SPL to inert product	100,000	t	$530		$53,000,000	Assumes treatment rate is equal to cur	Hydro, Regain contract
							$53,000,000		
	5	**Loading costs**							
		SPL	56000	m3		$5	$257,600	assume sand & < 1m	Rawlinsons
		Sub-total excavation costs					**$257,600**		
	6	**Transport costs**							
		NSW	56000	m3		$84	4,709,600	Sydney	Rawlinsons, based on 150km
		QLD	56000	m3		$461	25,821,600	Brisbane	Rawlinsons, based on 800km
		Sub-total disposal costs					**included below**		
	7	**Disposal Costs**							
		NSW	100000	t		$310	31,000,000	Treatment to solid waste	Cessnock landfill
		QLD	100000	t		$134	13,400,000	Brisbance area fees	Willawong Landfill
							included below		
	8	**Final Reporting**							
		Validation report		each	allow		$30,000		ENVIRON experience
		EMP		each	allow		$15,000		ENVIRON experience
		Site Auditor signoff		each	allow		$40,000		ENVIRON experience
		Sub-total reporting					**$85,000**		
		Subtotal							
					NSW				
					QLD				
		NSW							
		Subtotal					$93,606,310		
		Contingency					$9,360,631		
		CAPITAL COSTS					**$102,966,941**		
		Queensland							
		Subtotal					$97,293,910		
		Contingency					$9,729,391		
		CAPITAL COSTS					**$107,023,301**		

NOTES
Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes transport rates are governed by treatment rates.
Assumes treatment rates of 12000t/yr
Assumes treatment costs as for Regain contrac.

Legacy Cost		
	Legacy provision	$0

RISK			Value
	Comment		
	rare	NSW	1
	minor	QLD	1

Time			
NSW	Approvals	0.5	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.25	years
	Treatment and transport (rate 20000 t/year)	5	years
	Validation Reporting	0.2	years
	TOTAL	6.15	years
QLD	Approvals	0.5	years
	Investigations/tender/contract negotiations	0.2	years
	Implementation	0.25	years
	Treatment and transport (rate 20000 t/year)	5	years
	Validation Reporting	0.2	years
	TOTAL	6.15	years

Option B9 Dispose off Site	
Description	**onsite treatment and transport all materials for disposal off site to landfill**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Development application			$100,000	$100,000	Modification application requ	ENVIRON experience
		Sub-total preliminary documentation				**$150,000**		
	2	**Project Tasks**						
		Project Management			5%			USEPA Remediation Costs
		Sub-total Technical Tasks Capital Cost				**$2,518,630**		
	3	**Site Preparation**					Site sheds, machinery compising backhoe and roller	
		Environmental controls	0			0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each	$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each	$2,000	$4,000		
		Sub-total site preparation				**$30,000**		
	4	**Loading costs**						
		SPL	56000	m3	$5	$257,600	assume sand & < 1m	Rawlinsons
		Sub-total excavation costs				**$257,600**		
	5	**Transport costs**						
		International	100000	t	$500	50,000,000	Transport to Norway	Hydro (K Morkved)
		Sub-total disposal costs				**$50,000,000**		
	6	**Reciever Costs**						
		International	100000	m3	$0	0	Europe	Hydro (K Morkved)
						$0		
	7	**Final Reporting**						
		Validation report		each	allow	$30,000		ENVIRON experience
		EMP		each	allow	$15,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		Sub-total reporting				**$85,000**		
		Subtotal				$53,041,230		
		Contingency				$5,304,123		
		CAPITAL COSTS				**$58,345,353**		

NOTES
- Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
- Assumes further investigation does not identify other not known contamination
- Assumes program can be achieved through the use of standard excavating equipment
- Assumes fees in Europe for treatment/reuse are zero
- Assumes transport rates of 12000t/yr

Legacy Cost		
	Legacy provision	$0

Risk			Value
	Comment	International	1

Time			
International	Approvals	0.8	years
	Investigations/tender/contract negotiations	0.5	years
	Implementation	0.3	years
	Transport, assumes 1000t/mth	8.3	years
	Validation Reporting	0.2	years
	TOTAL	10.0	years

Option B10 Onsite Destruction	
Description	**Onsite Waste to Energy**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Planning approval			$350,000	$350,000	EIS required	ENVIRON experience
		Sub-total preliminary documentation				**$400,000**		
	2	**Pilot Trial**						
		Allow				$100,000		Estimate
		Sub-total pilot trial				**$100,000**		
	3	**Project Tasks**						
		Project Management			5%	$37,000	Does not include treatment	USEPA Remediation Costs
		Sub-total Technical Tasks Capital Cost				**$37,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Sorting, placement and treatment of Alcan Mound wastes**						
		Treatment through plasma gasification	100,000	t	$450	$45,000,000	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL Placement of SPL				**$45,000,000**		
	6	**Final Reporting**						
		Validation report		each	allow	$500,000	includes confirmatory testin	ENVIRON experience
		Sub-total reporting				**$500,000**		
		Subtotal				$46,263,000		
		Contingency 10%				$4,626,300	10% Scope	
		CAPITAL COSTS				**$50,890,000**		

NOTES

Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes by-products are approved by NSW regulators for reuse and do not require landfilling. 80% plasma rock is estimated to be generated.
Rate of treatment per tonne provided by Tetronics includes a rate of return and profit margin. This rate could be negotiated. Applies to 15000 tpa plant

Legacy Cost		
	Legacy provision	$0

Risk		Value
Comment	Likely moderate	12

Time		
Pilot Trial	1.0	years
RAP/EIS	1.0	
Approvals	1.8	years
Investigations/tender/contract negotiations	0.5	years
Construction/commissioning	1.0	years
Assumes treatment at 15000tpa	6.7	years
Validation Reporting	0.2	years
TOTAL	12.1	years

Appendix C

Contaminated Soils in Smelter Footprint Detailed Options Review

C Contaminated Soils in Smelter Footprint

Contaminated soils within the smelter footprint are described as follows

Table C1 Contaminated Soils In Smelter Footprint Statistics

Volume (m^3)	Tonnage (t)	Description[1]
3000-9000	4500 -13,500	• Sediment within the dams and drainage lines – Elevated benzo(a)pyrene (BaP) concentrations ranging between >40 mg/kg and 85.6 mg/kg in sediment in drainage line adjacent to Anode Waste Pile above the site guidelines of 40 mg/kg applicable for an industrial site use – Fluoride concentrations in sediment ranging from 5850 mg/kg to 38,500 mg/kg in the West Surge Pond. Concentrations applicable to fluoride are not published under Australian regulations. A site specific human health risk assessment identified that an acceptable concentration for fluoride is 17,000 mg/kg for industrial land use
5000-15,000	9000-26,000	• Onsite soils contaminated with PAHs and TPH and/or fluoride as follows: – Fluoride concentrations in fill samples range between 1010 mg/kg and 47,100 mg/kg to a depth of 0.6 m between the pot lines and at the Anode Waste Pile – Elevated BaP concentrations ranging between >40 mg/kg and 101 mg/kg in shallow fill material above the site guidelines at the diesel spray area and at the western end of the carbon plant
6000-17,000	10,000-30,000	• Fluoride impacted soils between the Pot Lines – Fluoride concentrations in shallow fill ranging from 13,400 mg/kg and 41,900 mg/kg from

[1] Revised guidelines applicable to the site were adopted by the NSW EPA in 2013. The site characterisation has been updated to reflect the guideline revision.

Table C1 Contaminated Soils In Smelter Footprint Statistics		
Volume (m^3)	**Tonnage (t)**	**Description[1]**
		surface to 0.05 m depth
Unknown	Unknown	• Potentially contaminated soils below structures for demolition and removal. • Quantity of soils requiring remediation following confirmation of demolition approach and soils can be accessed for investigation.
Remediation Options C1 Encapsulate *in-situ* C2 Move to specifically designed containment cell adjacent to the capped waste stockpile C3 Treat and move to specifically designed containment cell adjacent to the capped waste stockpile C4 Encapsulate in purpose built containment cell C5 Treat contaminated soils and encapsulate in purpose built containment cell C6 Dispose off-site C7 On site Treatment to Achieve Complete Destruction**Error! Reference source not found.**		

C1 Encapsulate in-situ

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
High	5.8	2 - 3	0.5	6

C1.1 Description of the option

This option reduces human health and environmental risks by restricting access to contaminants through the placement of physical barriers. Such barriers could include surface filling, hardstands, roads and buildings. For the purpose of providing a cost estimate, it has been assumed that the barrier is formed by the placement of 0.5 m of clean soil over the contaminant footprint and covered with a bituminous two-coat seal. This approach does not apply to sediments and therefore the following has been assumed:

1) East and West Surge Ponds are decommissioned and filled with a clean soil cap of minimum 0.5 m depth. Dams are re-shaped to promote surface water runoff. Contained stormwater is discharged off site following current procedures and no treatment is required
2) Drainage line east of the current Anode Waste Pile is decommissioned and filled with a clean soil cap of minimum 0.5 m depth
3) Northern Dams 1 and 2 are retained and no remediation is undertaken. It is considered likely that a net ecosystem benefit analysis would demonstrate that the ecological risks represented by the contaminants are minimal in comparison to the habitat benefits provided by retention of the sediment dams. Costs for undertaking this assessment have been incorporated.

Based on the relatively immobile nature of the contaminants present it is not considered likely that monitoring of groundwater will be required during or following capping.

The process of capping the site involves the following elements:

1) Soil and groundwater investigations to identify the extent of contaminants present;
2) Preparation of a Remedial Action Plan and category 2 remediation work notification to Council for the remediation. Likely that this will be undertaken in conjunction with a contaminated land site auditor and therefore costs have been factored to include this review;
3) Tender document preparation for the contractor and tender process including geotechnical specification for placement of the cap;
4) Contractor mobilization to site and implementation of environmental controls;

5) Cap placement comprising initial placement of a marker layer (orange plastic or similar); placement and compaction of clay capping layer as described in the geotechnical specification; placement of a cover layer of 0.1 m and grass seeding;
6) Survey of the final cap areas;
7) Demobilise from site;
8) Validation documentation and preparation of an Environmental Management Plan. Site Auditor sign-off on suitability of the land for use. Registration of the EMP on the Section 149 certificate with Council.

C1.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that the capping of the soils within the smelter footprint is managed in isolation from other demolition and remediation activities.

Capping of the contaminated soils would be “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works would be permissible with consent.

The works would not meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of “*Contaminated soil treatment works*” under clause 15 of Schedule 3 of the regulation includes:

“*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil”.

Based on the estimates for all three locations, there is an estimated 26,980 m^3 of contaminated soil to be treated.

The remediation works would be considered category 2 remediation works under State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) as the works are unlikely to meet the criteria for category 1 remediation works (as identified in Clause 9 of SEPP 55). Therefore the works can be undertaken without planning approval.

However, the capping would need to be designed so that the contaminated soils are not "*likely to have a significant effect on a critical habitat or a threatened species, population or ecological community*" (clause 9(c) of SEPP 55) that is within or downstream of the remediation works. If this was triggered it would be deemed a category 1 remediation work and would require planning approval.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice;
- A brief description of the remediation work;
- An explanation as to why the work is category 2 remediation work;
- Specify, by reference to its property description and street address (if any), the land on which the work is to be carried out;
- Provide a map of the location of the land;
- Provide estimates of the dates for the commencement and completion of the work.

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The criteria includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all three locations, there is an estimated 26,980 m^3 of contaminated soil to be treated. Therefore the works do not require an Environment Protection Licence.

Other Approvals

A controlled activity approval (CAA) is required under the *Water Management Act 2000* to undertake certain activities in, on or under waterfront land. Waterfront land includes the bed of any river (including any natural perennial or intermittent watercourse) and within 40 metres of the highest bank of a river. Activities requiring a CAA include the removal of material and the deposition of material within waterfront land.

While the works are in or within 40 metres of watercourses, the water courses are are not natural (i.e. the drainage line and dams are artificial) and therefore a CAA is unlikely to be required.

Likelihood of Approval

Due to the scale, type and location of the works, planning approval is unlikely to be required (subject to confirmation that they are unlikely to have a significant effect on a critical habitat or a threatened species, population or ecological community). An environment protection licence is also unlikely to be required.

However, it should be noted that any future development on these properties would be subject to planning approval, and the consent authority would want to understand how the potential impacts during construction and post-construction would be addressed.

C1.3 Cost

The estimated cost for this option is $5.8mil AUD NPV.

Refer to the attached costing for details.

C1.4 Timeframe to complete

Activity	Estimated timeframe (years)
Initial investigations and risk assessment	0.75 – 1.25
Preparation of RAP and Planning Approval	0.4 – 0.7
Approvals (notification only)	0.1 – 0.2
Implementation	0.4 – 0.6
Final Reporting and auditor signoff	0.4 – 0.6
Total Estimated Timeframe	2 - 3

C1.5 Legacy

Once capped, the site will be suitable for the proposed land use and can be divested. Responsibility for the maintenance of the cap can be transferred to the buyer including indemnity provisions that protect Hydro from actions of the buyer that result in exacerbation of contamination.

However, despite contractual arrangements for transfer of liability, under the *Contaminant Land Management Act 1997,* Hydro remain the 'pollluter' in perpetuity. Should clean-up be required by a regulator, the regulator is able to issue a notice to the polluter to undertake the clean-up. In the event that clean-up is required in this instance, this is likely to require removal of the contamination and placement within a properly design landfill, likely off site. However, should this event occur, remediation may not be required given that mobility of the contaminants is low. Therefore the likelihood of requiring remediation is considered to occur once every 25 years and has been assigned a cost of 10% of the initial capital cost.

The legacy cost is estimated to be $0.5mil AUD NPV.

C1.6 Risk Ranking

The risk level is contingent on the additional investigations and the proposed end use of the site. For evaluation of the risk ranking we have assumed that the capped sites will be for industrial land use, i.e. hard stand or similar will be placed above the capping soils. On this basis the risk of issues arising from the capping is considered to be:

1) Minor – in the instance of cap breach or failure, leaching of contaminants to groundwater may occur. Remediation such as localised groundwater clean-up and repair of the cap breach may be required, or soils disposed off site. As discussed in Section C1.5 this responsibility may fall to the buyer.

2) Possible – it is possible that during construction or operation of the site a cap breach may occur.

As a result the risk ranking is estimated to be ‘6’.

C2 Move to specifically designed containment cell adjacent to the capped waste stockpile

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
Moderate	3.6	2 - 3	$1.4	15

C2.1 Description of the option

The capped waste stockpile comprises mixed waste smelter materials including SPL. The capped waste stockpile is situated within the eastern area of the Smelter Site and is surrounded by undeveloped land. To consolidate waste disposal on the site, a cell adjacent and adjoining the capped waste stockpile can be constructed for placement of the contaminated soils from the smelter footprint. The cell construction is described below. No improvements to the capped waste stockpile have been included here as these are presented in Appendix A and Appendix G.

For the option of placing contaminated soils adjacent to the existing capped waste stockpile, the process would comprise:

1) *Preconstruction*

- Assess the area surrounding the existing capped waste stockpile and determine a geotechnically suitable area for additional waste placement. It is likely that the most suitable area would be to the west of the existing capped waste stockpile, where anode butts are currently stored. The reasons for this assumption are the constraints present in the other directions:
  - North is the existing East Surge Pond which will be required for site use at least until the end of the remediation and demolition phase.
  - South is the Regain plant and the SPL storage sheds
  - East is a flood plain area that would require modification by filling in order to be a viable option
- Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan

- Design of a "best practice" containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award
- Undertake environmental assessment and attain the required approvals.

2) Construction

- Construction of the containment cell

– The cell base liner will comprise (ordered from vertically upwards):

  - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
  - A 1.5 mm high density polyethylene (HDPE) liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - A 1.5 mm HDPE overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer;

– Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Crushing has not been included as it is not likely that this will be required due to the expected size of the waste materials

– The cell cap liner will comprise (ordered from vertically upwards):

  - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
  - A 1.5 mm HDPE overlain by;
  - A 0.3 m thick sand drainage layer;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m protection layer overlain by;
  - A 0.15 m topsoil layer, seeded and mulched.

3) Post Construction

- Ongoing monitoring and maintenance for the containment cell likely involving:
  – Installation and regular monitoring of groundwater monitoring wells installed around the new facility;
  – Ongoing physical maintenance of the cell to maintain integrity of the cap;
  – Ongoing leachate evaluation for a period of time to demonstrate performance;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the environmental protection licence – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan. The site can be divested and long term liability managed through a contract of sale. However, it is unlikely that Hydro can permanently and completely remove liability. For example, if the purchaser was to become insolvent and remediation of the landfill required, this responsibility would default to Hydro as the owner of the contamination.

C2.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that only the soils within the smelter footprint would be placed in the containment cell.

Capping of the contaminated soils would be classified as “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works are permissible with consent.

The works in their entirety potentially trigger criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000.

The definition of "*Contaminated soil treatment works*" under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all three locations, there is an estimated 26,980 m^3 of contaminated soil to be treated (via placement in the containment cell). As such, it is not a "*Contaminated soil treatment works*" designated development.

However, "Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"*(1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

The groundwater in the vicinity of the capped waste stockpile is known to be shallow; therefore it is likely that a containment cell adjacent to the capped waste stockpile would be deemed as designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

Developments are classified as 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking planning approval for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Non-indigenous heritage (determine if any structures to be demolished have heritage value)
- Construction noise and air quality
- Construction traffic
- Construction phase management of contaminants
- Soil and water management (including hydrology and geotechnical conditions)
- Aesthetics and visual impacts
- Community and social impacts (including health)
- Consideration of alternatives
- Sustainability and carbon management

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council
- Environment Protection Authority (EPA)
- NSW Office of Water (NOW)

- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure
- Local Members of Parliament
- The local community (including residents and local community and environmental groups)
- Key Aboriginal stakeholder groups

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site)

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the maximum estimates for all three locations, there is a maximum of 25,350 m^3 of contaminated soil to be treated (via the containment cell). Therefore the works do not require an Environment Protection Licence.

It should be noted that "Waste disposal (application to land)" is a scheduled activity. However it only applies to waste received from off site. As the contaminated soils are generated from on site, this does not apply.

Likelihood of Approval

The works would have a moderate to high likelihood of approval, provided it could be shown that placement of the contaminated soil in the containment cell would not have an adverse impact on the groundwater, which is known to be shallow in the vicinity of the capped waste stockpile.

C2.3 Cost

The estimated cost for this option is $3.6mil AUD NPV.

Refer to the attached costing for details.

C2.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.2 – 0.3
Preparation of RAP and Planning Approval	0.75 – 1.25
Approvals	0.5 – 0.7
Project Engineering Tasks	0.2
Implementation	0.4 – 0.6
Final Reporting	0.2 – 0.4
Total Estimated Timeframe	2 - 3

C2.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances, such as severe weather events or an earthquake. A percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital costs. It is not proposed that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 2% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $1.5mil AUD NPV.

C2.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from the proximity to the capped waste stockpile, which has not benefitted from the same levels of engineering and contains fill placed in an uncontrolled manner. There is an additional risk that the placement of this cell adjacent and connected to the existing capped waste stockpile could affect the integrity of the existing capped waste stockpile. The chance of failure occurring is therefore considered to be ‘possible’, it might occur at some time. In the event of failure, due to the proximity of shallow groundwater and the known discharge of shallow groundwater to the surface, the consequence of failure could be ‘catastrophic’ due to the risk of prosecution and cost of remediation. On this basis the risk ranking is ‘15’.

C3 Treat and move to specifically designed containment cell adjacent to the capped waste stockpile				
Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
Moderate - High	38.9	4 - 5	$1.5	6

C3.1 Description of the option

This option would involve the following steps:

1) Excavation of impacted materials and treatment by cement stabilisation (or similar) to reduce leachable content. Treatment would be undertaken by a temporary facility on site;

2) *Pre-construction.*

- Assess the area surrounding the existing capped waste stockpile and determine a geotechnically suitable area for additional waste placement. It is likely that the most suitable area would be to the west of the existing capped waste stockpile, where anode butts are currently stored. The reasons for this assumption are the constraints present in the other directions:
  - North is the existing Eastern Surge Pond which will be required for site use at least until the end of a remediation and demolition phase.
  - South is the Regain plant and the SPL storage sheds
  - East is a flood plain area that would require modification by filling in order to be a viable option
- Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Design of “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award;

- Approvals process through local government/NSW planning/regulators.

3) Construction

- Construction of the containment cell.
  - The cell base liner will comprise (ordered from vertically upwards):
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm HDPE overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Crushing has not been included as it is not likely that this will be required due to the expected size of the waste materials.
  - The cell cap liner will comprise (ordered from vertically upwards):
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm HDPE overlain by;
    - A 0.3 m thick sand drainage layer;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.15 m topsoil layer, seeded and mulched.

4) Post Construction

- Ongoing monitoring and maintenance for the containment cell likely involving:
  - Installation and regular monitoring of groundwater monitoring wells installed around the new facility;
  - Ongoing physical maintenance of the cell to maintain integrity of the cap;
  - Ongoing leachate evaluation for a period of time to demonstrate performance;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the environmental protection licence – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan. The site can be divested and long term liability managed through a contract of sale. However, it is unlikely that Hydro can permanently and completely remove liability. For example, if the purchaser was to become insolvent and remediation of the containment cell required, this responsibility would default to Hydro as the owner of the contamination.

C3.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that only the soils within the smelter footprint would be placed in the containment cell.

Capping of the contaminated soils would be “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works are permissible with consent.

The works in their entirety potentially trigger criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000.

The definition of "*Contaminated soil treatment works*" under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the maximum estimates for all three locations, there is a maximum of 25,350 m^3 of contaminated soil to be treated (via placement in the containment cell). As such, it is not a "*Contaminated soil treatment works*" designated development.

However, "Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"*(1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

The groundwater in the vicinity of the capped waste stockpile is known to be shallow; therefore it is likely that a containment cell adjacent to the capped waste stockpile would be deemed as designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be 'regional development' as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

A development application for regional development is lodged with, and assessed by, the local council but is determined by the relevant Joint Regional Planning Panel (JRPP). Hydro would need to lodge a development application with Cessnock City Council (Council) seeking planning approval for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Non-indigenous heritage (determine if any structures to be demolished have heritage value)
- Construction noise and air quality
- Construction traffic
- Construction phase management of contaminants
- Soil and water management (including hydrology and geotechnical conditions)
- Aesthetics and visual impacts
- Community and social impacts (including health)
- Consideration of alternatives
- Sustainability and carbon management

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council
- Environment Protection Authority (EPA)

- NSW Office of Water (NOW)
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure
- Local Members of Parliament
- The local community (including residents and local community and environmental groups)
- Key Aboriginal stakeholder groups

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all three locations, there is an estimated 26,980 m^3 of contaminated soil to be treated. Therefore the works do not require an Environment Protection Licence.

It should be noted that "Waste disposal (application to land)" is a scheduled activity. However it only applies to waste received from off site. As the contaminated soils are generated from on site, this does not apply.

Likelihood of Approval

The works would have a moderate to high likelihood of approval, provided it could be shown that placement of the contaminated soil in the containment cell would not have an adverse impact on the groundwater, which is known to be shallow in the vicinity of the capped waste stockpile.

C3.3 Cost

The estimated cost for this option is $38.9mil AUD NPV.

Refer to the attached costing for details.

C3.4 Timeframe to complete

Activity	**Estimated timeframe (years)**
Pre-Design Activities	0.2 – 0.4
Preparation of RAP and Planning Approval	1 – 1.25
Approvals	0.5 – 0.75
Project Engineering Tasks	0.2 – 0.4
Implementation	1 – 1.5
Final Reporting	0.2 – 0.4
Auditor Sign-off	0.2 – 0.4
Total Estimated Timeframe	4 - 5

C3.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that the soil has been treated prior to placement;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. However, due to the proximity to the capped waste stockpile, a percentage likelihood of 1% was applied (i.e. once in a 100 year timeframe).

Should such an event occur the costs are proposed to be consistent with the initial capital costs. It is not proposed that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $1.5mil AUD NPV.

C3.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from the proximity to the capped waste stockpile, which has not benefitted from the same levels of engineering and contains fill placed in an uncontrolled manner. There is an additional risk that the placement of this cell adjacent and connected to the existing capped waste stockpile could affect the integrity of the existing capped waste stockpile. The chance of failure occurring is therefore considered to be ‘possible’, it might occur at some time. In the event of failure, due to the treatment of soils prior to emplacement within the facility, the consequence is considered to be ‘minor’, i.e. some minor remediation works may be required. On this basis the risk ranking is ‘6’.

C4 Encapsulate in purpose built containment cell

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
High	2.5	2 - 3	$0.9	4

C4.1 Description of the option

This option would manage the contaminated soil by placement within a purpose built containment cell constructed at an appropriate location on the site and applying best practice containment cell design and construction.

This option would involve the following steps:

1) *Pre-construction*

- Investigation/s of the site to identify the optimum location for placement of a contaminated soil containment cell. The investigation would comprise detailed investigations including boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Remediation notification process with Cessnock City Council.
- Design of “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

2) *Construction*

- Construction of containment cell.
  - The cell base liner will comprise (ordered from vertically upwards):
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;

    - A 1.5 mm high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm HDPE overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Crushing has not been included as it is not likely that this will be required due to the expected size of the waste materials.
  - The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm HDPE overlain by;
    - A 0.3 m thick sand drainage layer;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.15 m topsoil layer, seeded and mulched.

3) Post construction

- Ongoing monitoring and maintenance for containment cell likely involving:
  - Installation and regular monitoring of groundwater and leachate sump wells installed around the new facility.
  - Ongoing physical maintenance of the cell to maintain integrity of the cap.
  - Ongoing leachate treatment.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions).

- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies.
- Long term management of the site in perpetuity through an Environmental Management Plan. The site can be divested and long term liability managed through a contract of sale. However, it is unlikely that Hydro can permanently and completely remove liability. For example, if the purchaser was to become insolvent and remediation of the containment cell required, this responsibility would default to Hydro as the owner of the contamination.

C4.2 Likelihood of Approval

Planning Approval

The following advice is based on the assumption that only the soils within the smelter footprint would be placed in the containment cell.

Capping of the contaminated soils would be classified as "remediation works". However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works are permissible with consent.

The works in their entirety would not meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of "*Contaminated soil treatment works*" under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all three locations, there is an estimated 26,980 m^3 of contaminated soil to be treated (via placement in the containment cell).

It should be noted that "Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"(*1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

It has been assumed that a location for the containment cell would be found that does not trigger these criteria, and therefore would not be deemed a designated development.

The remediation works would be considered category 2 remediation works under State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) as the works are unlikely to meet the criteria for category 1 remediation works (as identified in Clause 9 of SEPP 55). Therefore the works can be undertaken without planning approval.

However, the containment cell would need to be located and designed so that it is not "*likely to have a significant effect on a critical habitat or a threatened species, population or ecological community*" (clause 9(c) of SEPP 55) that is within or downstream of the containment cell footprint. If this was triggered it would be deemed a category 1 remediation work and would require planning approval.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice
- A brief description of the remediation work
- An explanation as to why the work is category 2 remediation work

- Specify, by reference to its property description and street address (if any), the land on which the work is to be carried out
- Provide a map of the location of the land
- Provide estimates of the dates for the commencement and completion of the work

Environment Protection Licencing

“Contaminated soil treatment” that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

“(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil”.

Based on the maximum estimates for all three locations, there is a maximum of 25,350 m^3 of contaminated soil to be treated (via the containment cell). Therefore the works do not require an Environment Protection Licence.

Likelihood of Approval

Due to the scale, type and location of the works, they are unlikely to require planning approval (subject to confirmation that they are unlikely to have a significant effect on a critical habitat or a threatened species, population or ecological community) or an environment protection licence.

C4.3 Cost

The estimated cost for this option is $2.5mil AUD NPV.

Refer to the attached costing for details.

C4.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.25
Preparation of RAP and Planning Approval	0.75 - 1
Approvals	0.2 – 0.4
Project Engineering Tasks	0.2 – 0.4
Implementation	0.4 - 0.6
Final Reporting	0.2 – 0.4
Total Estimated Timeframe	2 - 3

C4.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that soils and wastes placed within the cell have low mobility and the containment cell is specifically engineered to minimize leachate generation.

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe event weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital costs. It is not proposed that material placed in the containment cell would require excavation and off site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $0.9mil AUD NPV.

C4.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘unlikely’ that this could occur in some extreme circumstances, such as severe weather. Should breaches occur the containment cell would be situated in an area with a depth to groundwater in excess of 10 m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the low solubility of the wastes it is likely that remediation would require cap replacement and not result in prosecution. The consequence category is therefore considered to be ‘minor’. On this basis the risk ranking is ‘4’.

C5 Treat contaminated soils and encapsulate in purpose built containment cell

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
High	36.7	3 - 4	$1.0	2

C5.1 Description of the option

This option incorporates encapsulation on site within a purpose built containment cell in combination with a pretreatment step to remove PAHs cyanides and fluorides from the contaminated soils.

This option would involve the following steps:

1) Excavation of contaminated soils and validation that all soils have been removed.

2) Sorting wastes and treatment of the contaminated soil component in an on-site treatment facility. An appropriate treatment method is cement stabilization, however further evaluation of options and pilot trials would be required to verify the most suitable method. For the purpose of this evaluation, cement stabilization has been assumed.

4) Pre construction of the containment cell

- Investigation/s of the site to identify the optimum location for placement of a contaminated soil containment cell. The investigation would comprise detailed investigations including boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Remediation notification process with Cessnock City Council.
- Design of “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

5) Construction

- Construction of containment cell.
  - The cell base liner will comprise (ordered from vertically upwards):
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm HDPE overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Crushing has not been included as it is not likely that this will be required due to the expected size of the waste materials.
  - The cell cap liner will comprise (ordered from vertically upwards):
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm HDPE overlain by;
    - A 0.3 m thick sand drainage layer;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.15 m topsoil layer, seeded and mulched.

3) Post construction

- Ongoing monitoring and maintenance for containment cell likely involving:
  - Installation and regular monitoring of groundwater and leachate sump wells installed around the new facility
  - Ongoing physical maintenance of the cell to maintain integrity of the cap
  - Ongoing leachate treatment
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions)
- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies
- Long term management of the site in perpetuity through an Environmental Management Plan. The site can be divested and long term liability managed through a contract of sale. However, it is unlikely that Hydro can permanently and completely remove liability. For example, if the purchaser was to become insolvent and remediation of the landfill required, this responsibility would default to Hydro as the owner of the contamination.

C5.2 Likelihood of Approval

Planning Approval

The following advice is based on the assumption that only the soils within the smelter footprint would be placed in the containment cell.

Capping of the contaminated soils would be classified as “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works are permissible with consent.

The works in their entirety would not meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of “*Contaminated soil treatment works*” under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all three locations, there is an estimated 26,980 m^3 of contaminated soil to be treated.

It should be noted that "Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"(*1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

It has been assumed that a location for the containment cell would be found that does not trigger these criteria, and therefore would not be deemed a designated development.

The remediation works would be considered category 2 remediation works under State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) as the works are unlikely to meet the criteria for category 1 remediation works (as identified in Clause 9 of SEPP 55). Therefore the works can be undertaken without planning approval.

However, the containment cell would need to be located and designed so that it is not "*likely to have a significant effect on a critical habitat or a threatened species, population or ecological community*" (clause 9(c) of SEPP 55) that is within or downstream of the containment cell footprint. If this was triggered it would be deemed a category 1 remediation work and would require planning approval.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice
- A brief description of the remediation work
- An explanation as to why the work is category 2 remediation work
- Specify, by reference to its property description and street address (if any), the land on which the work is to be carried out
- Provide a map of the location of the land
- Provide estimates of the dates for the commencement and completion of the work

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the maximum estimates for all three locations, there is a maximum of 25,350 m^3 of contaminated soil to be treated. Therefore the works do not require an Environment Protection Licence.

Likelihood of Approval

Due to the scale, type and location of the works, they are unlikely to require planning approval (subject to confirmation that they are unlikely to have a significant effect on a critical habitat or a threatened species, population or ecological community) or an environment protection licence.

C5.3 Cost

The estimated cost for this option is $36.7mil AUD NPV.

Refer to the attached costing for details.

C5.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.25
Preparation of RAP	0.75 – 1.25
Approvals	0.1 – 0.3
Project Engineering Tasks	0.2 – 0.4
Sorting and treatment	0.75 – 1.25
Containment cell construction and placement	0.5 – 0.7
Final Reporting	0.2 – 0.4
Total Estimated Timeframe	3 - 4

C5.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that the soil has been treated prior to placement;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe event weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should such an event occur the costs are proposed to be consistent with the initial capital cost. It is not proposed that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $1mil AUD NPV.

C5.6 Risk Ranking

The risk associated with this disposal option is associated with the waste causing an effect at the disposal site in the future. Given that the wastes will be disposed of in a properly designed containment cell that is appropriately situated the likelihood of an incident occurring is considered to be ‘rare’ (may occur ‘only in exceptional circumstances).

The consequence to Hydro is considered to be ‘insignificant’ as the consequence will be the responsibility of the third party, if the site is divested. However, under the *Contaminated Land Management Act 1997* the ‘polluter’ remains the responsible party. Therefore, whilst the disposal contract can include an agreement that passes the liability to the waste receiver, in the event that the waste receiver is unable to fulfill their obligations, Hydro will remain responsible. Therefore, under this scenario, there remains a consequence to Hydro. Given that the wastes will be treated prior to disposal, the consequence is considered to be ‘minor’. On this basis, the risk ranking is considered to be ‘2’.

C6 Dispose off-site

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk Ranking
High	32.8	1 - 2	$0	1

C6.1 Description of the option

Soils with PAH contamination are not able to be disposed to a local landfill without treatment due to the concentrations of benzo(a)pyrene. Costs for disposal to a soil facility, such as Transpacific who undertake soil stabilisation prior to landfilling, have therefore been included.

C6.2 Likelihood of approval

Planning Approval

Removal and transporting the contaminated soils offsite would be classified as "remediation works". However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works are permissible with consent.

The works in their entirety would not meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of "*Contaminated soil treatment works*" under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all three locations, there is an estimated 26,980 m^3 of contaminated soil to be treated. In addition, the only activity to occur on site is removal of the contaminated soils (no treatment). The definition states that excavation for treatment at another site is excluded. It is assumed that any receiving location would have existing approvals permitting the receipt of the soils.

The remediation works would be considered category 2 remediation works under State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) as the works are unlikely to meet the criteria for category 1 remediation works (as identified in Clause 9 of SEPP 55). Therefore the works can be undertaken without planning approval.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice
- A brief description of the remediation work
- An explanation as to why the work is category 2 remediation work
- Specify, by reference to its property description and street address (if any), the land on which the work is to be carried out
- Provide a map of the location of the land
- Provide estimates of the dates for the commencement and completion of the work

Environment Protection Licencing

“Contaminated soil treatment” that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

“(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the maximum estimates for all three locations, there is a maximum of 25,350 m^3 of contaminated soil to be treated. Therefore the works do not require an Environment Protection Licence.

Likelihood of Approval

Due to the scale, type and location of the works, they are unlikely to require planning approval (subject to confirmation that they are unlikely to have a significant effect on a critical habitat or a threatened species, population or ecological community) or an environment protection licence.

C6.3 Cost

The cost range for this option is $32.8mil AUD NPV.

Refer to the attached costing for details.

C6.4 Timeframe to complete

Activity	Estimated timeframe (years)
Pre-Design Activities	0.2
Preparation of RAP	0.5 - 1
Approvals	0.1 – 0.3
Excavate, transport and disposal	0.4 – 0.6
Final Reporting and auditor signoff	0.2 – 0.4
Total Estimated Timeframe	1 - 2

C6.1 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented.

C6.2 Risk Ranking

The risk associated with this disposal option is associated with the waste causing an effect at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated, the likelihood of an incident occurring is considered to be ‘rare’ (may occur ‘only in exceptional circumstances’). The consequence to Hydro is considered to be ‘insignificant’ as it is a remote risk that the consequence will be the responsibility of Hydro if certain mitigation and management measures are implemented. On this basis the risk ranking is ‘1’. This evaluation is based on legal advice obtained by Hydro.

C7 On site Treatment to Achieve Complete Destruction

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
Moderate to high	24	7 - 9	0	12

C7.1 Description of the option

This option would involve the processing of the wastes to remove hazardous components including hydrocarbons, fluorides and cyanides, in conjunction with carbon value capitalisation in a waste to energy process. Research of global technologies identified that plasma gasification pilot scale trials have been undertaken on first and second cut SPL. By-products of this process include SYN gas, vitirified rock (slag) and elemental metal. All by-products may be demonstrated as suitable for a beneficial further use.

It is envisaged that this process would require pilot studies prior to full scale treatment.

C7.2 Likelihood of approval

Chemical Control Order

As previously discussed, the Chemical Control Order applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) will likely require treatment/processing of the waste prior to disposal. As this option includes treatment of the SPL it is likely to meet the Chemical Control Order, and the EPA's, requirements.

Resource Recovery Exemption

The by-products of the plasma gasification process include synthetic gases, base metals and vitrified rock-like material (slag). The synthetic gases can be used in energy generation, while the base metals and slag have potential reuse opportunities (for example granulated slag can be used as a construction base material).

A resource recovery exemption would need to be issued in accordance with the *Protection of the Environment Operations Act 1997* permitting the reuse of these materials. The exemption would be issued if it could be demonstrated that the waste material is of benefit in its proposed use and poses minimal risk of harm to the environment or human health. This includes providing evidence that the material is homogenous in physical and chemical quality, that it is stable and would not result in the leaching of contaminants into soils and groundwater, and that there is a genuine re-use opportunity for the material.

If a resource recovery exemption could not be gained, these materials would need to be disposed to a licensed landfill. Note however, that the following planning and licensing advice is based on the assumption that approval for disposal to landfill does not form part of this option.

Planning Approval

Treatment of the SPL using this approach would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*”.

Development for the purposes of a ‘waste or resource management facility’ (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As a ‘waste or resource management facility’ is not specified as ‘permitted without consent’ or ‘prohibited’ it follows that a ‘waste or resource management facility’ is permissible with consent.

The Project would be deemed as “designated development” under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of “Waste management facilities or works” under clause 32 of Schedule 3 of the regulation. This definition includes:

“(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or

The works would be designated development as it is triggers sub-clause 32(1)(a)(i) (“Aluminium smelting by-product” is registered as a dangerous good under the “Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition” (National Transport Commission, 2011)). An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General’s Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as ‘regional development’ as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as “all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment “, but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application (DA) for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While the Cessnock City Council will assess the DA, the consent authority for the works would be the Hunter and Central Coast Regional Panel.The EIS will be required to address a number of key issues that will be the focus of the consent authority’s considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the treatment facility is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the treatment facility is located in an area of limited disturbance).
- Treatment phase noise and air quality.
- Treatment phase management of contaminants.
- Community and social impacts (including health).
- Consideration of alternatives to the treatment.
- Sustainability and carbon management.

It should be noted that Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes “Waste and resource management facilities” as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*“(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*”

“Aluminium smelting by-product” is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the treatment of the SPL may be deemed part of the disposal process and therefore the activity deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

If this was the case, an EIS would be required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.

- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

"Waste disposal (thermal treatment)" is a scheduled activity under clause 40 of Schedule 1 of the *Protection of the Environment Operations Act 1997*. This includes "*thermal treatment of hazardous and other waste, meaning the* ***receiving*** *of hazardous waste, restricted solid waste, liquid waste or special waste* ***from off site*** *and its processing by thermal treatment*." Assuming that the plasma gasification treatment plant would be located on site, it would not meet this definition as the material would not be received from off site.

However, in the event that the process also includes the generation of energy, "Energy recovery" is a scheduled activity under Clause 18 of Schedule 1. Its definition includes:

"***energy recovery from hazardous and other waste*** (meaning other than general waste)*, meaning the receiving from* ***on site*** *or off site of, and the recovery of energy from, hazardous waste, restricted solid waste, liquid waste or special waste*."

Likelihood of Approval

As noted the plasma gasification process is a new technology, and is still proceeding through trial programs globally. Agencies may be reluctant to approve such a facility unless data from trials of similar technologies can provide greater certainty about performance. Consultation could be undertaken with agencies to discuss the opportunity for a trial (with monitoring to confirm its performance) prior to a full scale facility.

If sufficient information and evidence could be provided to the agencies on the environmental performance of plasma gasification, and the resource recovery exemptions for the by-products are granted, agencies are likely to look favourably on such a process and therefore it would have a high likelihood of approval.

C7.3 Cost

The estimated cost for this option is $51mil AUD NPV.

C7.4 Legacy

A legacy value is not assigned due to the complete destruction of the wastes. It was assumed that this option would only be selected if pilot scale testing demonstrated the end product was able to be reused.

C7.5 Timeframe to complete

The estimated timeframe to complete this option is 11 to 12 years allowing for pilot studies and planning approvals.

Activity	**Estimated timeframe (years)**
Pilot Trial	1
RAP/EIS	1
Approvals	1.75
Investigations/tender/contract negotiations	0.5
Construction/commissioning	1
Assumes treatment at 15000tpa	3-4
Validation Reporting	0.2
Total Estimated Timeframe	**7-9**

C7.6 Risk Ranking

The risk associated with this option is a technological risk from the unproven technology and the possibility that an alternate remediation solution will require implementation. The likelihood of this technology not being able to treat the SPL economically or technically into a condition that can be re-used without additional treatment (and therefore needing to landfill) is ‘likely’. Potential issues associated with the applicability of the treatment to the capped waste stockpile wastes are considered to be equally valid. Risks include those associated with the pre-treatment requirements for the capped waste stockpile and the extent to which crushing and sorting is required.

The material is currently not qualified as inert and therefore it cannot be used without limitation as fill material. Also, no technical specification of material strength has been determined, (the physical properties are currently unknown). If it cannot be utilised as inert fill material, one of Options B1 to B9 would need to be implemented. In addition, as of 23 January 2014 there are no known estimates of the difference between input volume / weight, and volume / weight of the vitrified material (it is unknown how much of the processed material would be generated).

The consequence of the technology not being applicable to the site will require an alternate solution is considered ‘moderate’. The alternate solution for remediation is comparable in cost to those presented in Options C1 to C6. It would also result in a loss in time prior to being able to implement a solution. On this basis this option is given a risk ranking of ‘12’.

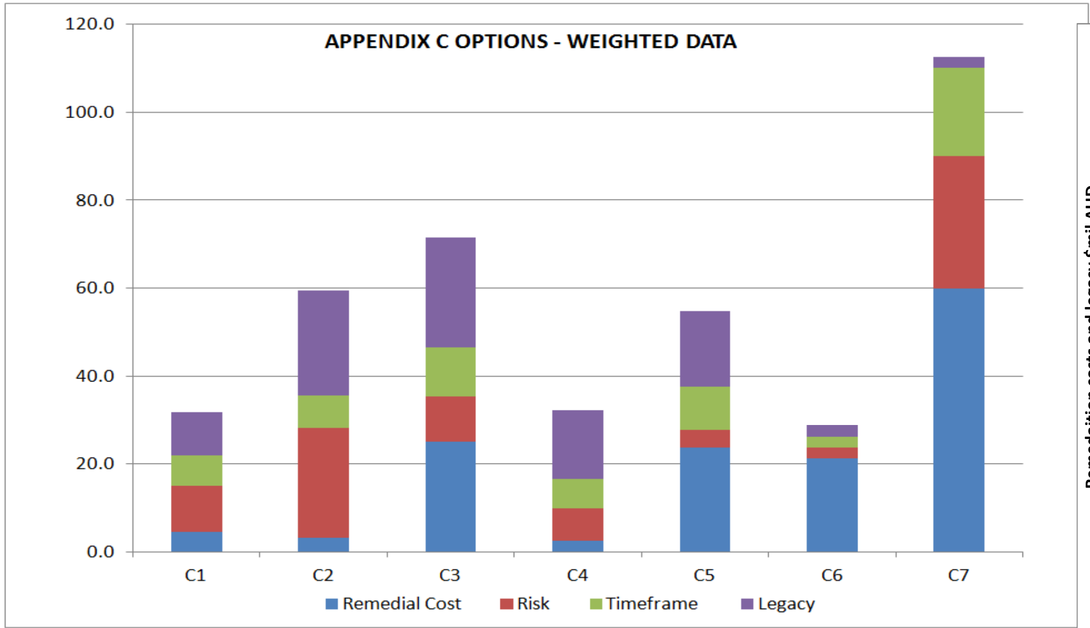
Volume									
Type	Volume estimates (m3)				Bulk Density (T/m3)		Mass estimates (T)		Notes
			Range				Range		
	estimate	accuracy %	low	high			low	high	
Dam sediment	5985	*50*	2993	8978	*1.5*	*8977.5*	4489	13466	Drainage line adjacent anode pile
									East surge pond
									Northern Dams 1 and 2
On site soils (PAHs)	9724	*50*	4862	14586	*1.8*	*17503.2*	8752	26255	Beneath the anode pile
									Diesel spray area
									carbon plant
									cathode washdown area
Pot lines F soils	11271	*50*	5636	16907	*1.8*	*20287.8*	10144	30432	Between Pot lines
Totals	26980		13490	40470		46769	23384	70153	

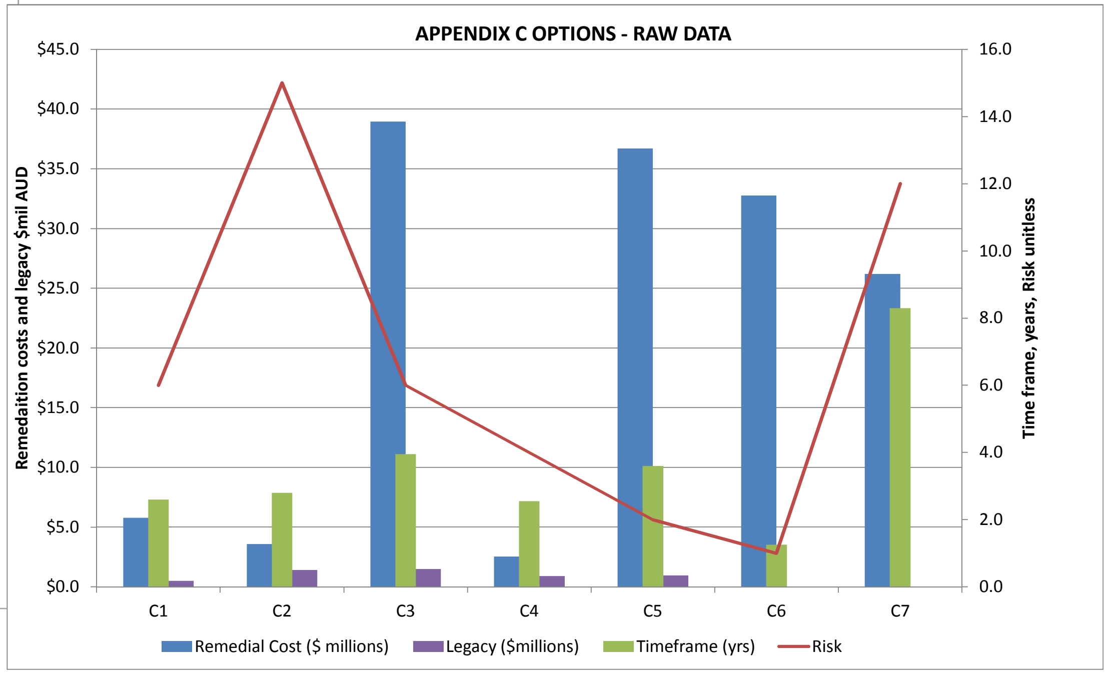
Description	**Remediation Cost $mil**	**Legacy $ mil**	**TIME (Years)**	**RISK (1 to 10, 10 high**
Option C1 Encapsulate Insitu	$5.8	$0.5	2.6	6
Option C2 Move to Alcan Mound	$3.6	$1.4	2.8	15
Option C3 Treat and Move to Alcan Mound	$38.9	$1.5	4.0	6
Option C4 Encapsulate in Containment Cell	$2.5	$0.9	2.6	4
Option C5 Treat and Encapsulate in Containment Cell	$36.7	$1.0	3.6	2
Option C6 Dispose off Site	$32.8	$0.0	1.3	1
Option C7 Onsite destruction	$25.3	$0.0	8.3	12

Appendix C - Contaminated Soils in Smelter Footprint

Weighting Factors

	Weighting (sums to 10)
Remedial Cost	2.5
Risk	2.5
Timeframe	2.5
Legacy	2.5
	10





Option C1 Encapsulate Insitu	
Description	**Encapsulate all materials in-situ on site**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Initial Investigations/risk assessment**						
		Drainage line adjacent anode pile	1	each	$15,000	$15,000	Delineaton and assessment of impacts to groundw	ENVIRON experience
		East surge pond	1	each	$25,000	$25,000	Delineaton and assessment of impacts to groundw	ENVIRON experience
		Northern Dams 1 and 2	1	each	$30,000	$30,000	No investigations. ERA, NEBA required	ENVIRON experience
		Beneath the anode pile	1	each	$30,000	$30,000	Delineaton and assessment of impacts to groundw	ENVIRON experience
		Diesel spray area	1	each	$0	$0	Previously investigated	ENVIRON experience
		Carbon Plant	1	each	$50,000	$50,000	Requirements unknown, could be extensive	ENVIRON experience
		Cathode washdown area	1	each	$10,000	$10,000	Limited expected based on site history	ENVIRON experience
		Between Pot lines	1	each	$10,000	$20,000	Surface F sampling	ENVIRON experience
		SUBTOTAL initial investigation and risk assessment				**$180,000**		
	2	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$80,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Development application			$30,000	$30,000	Assumes category 2 development approval and th	ENVIRON experience
		SUBTOTAL preliminary documentation				**$150,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$210,000.00		USEPA Remediation Engineering
		Remedial Design			8%	$335,000.00		USEPA Remediation Engineering
		Construction Management			6%	$252,000.00		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$84,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$881,000**		
	4	**Site Preparation**					Site sheds, machinery compising backhoe and roller	
		Environmental controls	0			0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each	$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each	$15,000	$30,000		Vendor estimate/ENVIRON experience
		SUBTOTAL Site preparation				**$56,000**		
	5	**Encapsulation**						
		Placement of marker layer	161934	m2	$3	$558,672		Rawlinsons 2013
		Filling of east surge pond and drainage line	9090	cum	$25	$227,250		Rawlinsons 2013
		Placement of a capping layer of 0.5m thick, geotech contr	80967	cum	$24	$1,943,208		Rawlinsons 2013
		Placement of seal coat	161934	m2	$7	$1,149,731	Sprayed bituminous two coat seal	Rawlinsons 2013
		Survey	allow			$15,000	Survey of capped areas and provision of a plan	ENVIRON experience
		SUBTOTAL Construction				**$3,893,862**		
	6	**Final Reporting**						
		Validation report		each	allow	$30,000		ENVIRON experience
		EMP		each	allow	$15,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL Reporting				**$85,000**		
		Subtotal				$5,245,862		
		Contingency 10%				$524,586	10% Scope	
		CAPITAL COSTS				**$5,770,448**		

NOTES

- Assumes the extent of capping outlined in Appendix C
- Assumes further investigation does not identify other not known contamination
- Assumes program can be acheived through the use of standard excavating equipment
- Refer to Appendix C for a description of capping requirements and assumptions made
- Ground preparation (e.g. removal of structures and curbing) is undertaken as part of a demolition process and no costs have been allocated.
- Remediation of sediments in North Dams 1 and 2 is shown to not be required.
- Clean fill is won locally and placed with a permeability of not less than 1 x 10-9 m/s.
- Capping is undertaken independently of other site activities
- All works are undertaken in one mobilisation

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Legacy potential liability provisioning	10%	event	NPV	$275,578	Occuring once every 25 years	Using a discount rate of 3%
		10%	event	NPV	$131,618	Occuring at 50 years	Using a discount rate of 3%
		10%	event	NPV	$62,861	Occuring at 75 years	Using a discount rate of 3%
		10%	event	NPV	$30,023	Occuring at 100 years	Using a discount rate of 3%
					$500,081		
	Legacy provision				**$500,081**		

RISK		
Comment		6
Minor	If a breaching of the capping layer occurs, reinstatement of the cap would be required and it is unlikely that significant harm would occur	
Possible	It is possible that during future site use a cap breach would occur.	

Time		
Initial Investigations/risk assessment	1	years
Preparation of RAP and DA	0.5	years
Approval	0.1	years
Engineering works	0.5	years
Final Reporting	0.25	years
Site Auditor signoff	0.25	years
Time	**2.6**	**years**

Option C2 Move to Alcan Mound	
Description	**Move all materials to a cell adjacent the existing Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	7	EA	$1,100	$7,348	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	3	EA	$7,200	$21,600	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$28,948**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$230,000	$230,000	Assumes EIS for Council approval	ENVIRON experience
		Sub-total preliminary documentation				**$320,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$115,000		USEPA Remediation Engineering
		Remedial Design			8%	$183,000		USEPA Remediation Engineering
		Construction Management			6%	$138,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$46,000		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$482,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	3,340	m2	$2	$6,947		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	1,670	ha	$1,020	$170	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	3,340	m3	$8	$26,553		Rawlinsons 2013 p675
		Filling of Eastern Surge Pond	4,590	m3	$25	$114,750	Approximate area determined from aerial photo	Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	5,352	m3	$24	$125,772		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,352	m2	$20	$108,378		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,352	m2	$4	$20,070		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	1,648	m3	$25	$41,200		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,352	m2	$20	$108,378		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,352	m2	$4	$20,070		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	1,648	m3	$25	$41,200		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	5,352	m2	$4	$20,070		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$835,943**		
	5	**Excavation Works**						
		Dam sediments.	5985	m3	$12	$74,214	Excavate, transport<1km and deposit	Rawlinsons
		On-site soil PAH	9724	m3	$12	$120,578	Excavate, transport<1km and deposit	Rawlinsons
		Pot-line F Soils	11271	m3	$12	$139,760	Excavate, transport<1km and deposit	Rawlinsons
		Soil Validation Works	1	EA	$40,000	$40,000	including laboratory analysis	ENVIRON Experience
		SUBTOTAL Excavation Works				**$374,552**		
	7	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	7,071	m3	$26	$183,846		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	14,141	m2	$20	$286,355		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	4,312	m3	$10	$42,042		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	14,141	m2	$4	$56,564		Rawlinsons 2013 p677
		Install General Fill (30 cm)	4,312	m3	$26	$112,112		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	2,156	m3	$17	$37,148		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	14,141	m2	$8	$112,845		Rawlinsons 2013 p228
		Supply and Install Fencing	248	m	$56	$13,910		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$856,931**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		
		Subtotal				$3,249,373		
		Contingency 10%				$324,937	10% Scope	
		CAPITAL COSTS				**$3,574,311**		

NOTES

Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix C for a description of capping requirements and assumptions made

Legacy Cost	Description	QTY		units	UNIT COST	TOTAL	NOTES	Source
	Environmental Monitoring	5		annual	$150,000	$750,000		Based on two events per year for 5 years
	Maintenance	1		annual	$18,000	$567,844		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year		each	$149,993		no cost in year 0	
			1	each	$71,638	$71,637.52	year 25	Using a discount rate of 3%
			1	each	$16,341	$16,341.03	year 50	Using a discount rate of 3%
			1	each	$1,780	$1,780.28	year 75	Using a discount rate of 3%
			1	each	$93	$92.63	year 100	Using a discount rate of 3%
						$1,407,695		
	Legacy potential liability provisioning	2%		event	NPV	$16,196	assumes occurs in twice in 100 years	Using a discount rate of 3%
						$16,196		
						$1,423,891		

RISK			Value
	Comment		15
	Catastrophic	Due to the presence of shallow groundwater, proximity of an adjacent waterway and risk of prosecution	
	Possible	It is possible that during future site use a cap breach would occur.	

Time			
	Pre-Design Activities	0.25	years
	Preparation of RAP and Planning Approval	1	years
	Approvals	0.5	years
	Project Engineering Tasks	0.2	years
	Implementation	0.6	years
	Final Reporting	0.25	years
	Time	**2.8**	**years**

Option C3 Treat and Move to Alcan Mound	
Description	**Treat and Move all materials to the existing Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	7	EA	$1,100	$7,348	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	3	EA	$7,200	$21,600	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$28,948**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$250,000	$250,000	Assumes EIS for JRRP approval	ENVIRON experience
		Sub-total preliminary documentation				**$340,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$1,443,000		USEPA Remediation Engineering
		Remedial Design			8%	$2,308,000		USEPA Remediation Engineering
		Construction Management			6%	$1,731,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$577,000		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$6,059,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	3,340	m2	$2	$6,947		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	1,670	ha	$1,020	$170	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	3,340	m3	$8	$26,553		Rawlinsons 2013 p675
		Filling of Eastern Surge Pond	4,590	m3	$25	$114,750	Approximate area determined from aerial photo	Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	5,352	m3	$24	$125,772		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,352	m2	$20	$108,378		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,352	m2	$4	$20,070		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	1,648	m3	$25	$41,200		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,352	m2	$20	$108,378		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,352	m2	$4	$20,070		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	1,648	m3	$25	$41,200		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	5,352	m2	$4	$20,070		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$835,943**		
	5	**Excavate, transport and place**						
		Dam sediments.	5985	m3	$12	$74,214	Excavate, transport<1km and deposit	Rawlinsons
		On-site soil PAH	9724	m3	$12	$120,578	Excavate, transport<1km and deposit	Rawlinsons
		Pot-line F Soils	11271	m3	$12	$139,760	Excavate, transport<1km and deposit	Rawlinsons
		Soil Validation Works	1	ea	$40,000	$40,000	including laboratory analysis	ENVIRON Experience
						$374,552		
	6	**Soil Treatment**						
		Pilot trials	1	ea	$20,000	$40,000	Treatability trials	ENVIRON Experience
		Treatment	46769	t	$575	$26,891,888		Vendor estimate
		SUBTOTAL Soil Treatment				**$26,931,888**		
	7	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	1,882	m3	$10	$18,350		
		Grade, Compact surface & Inst. 600mm - Cell Cap	7,071	m3	$26	$183,846		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	14,141	m2	$20	$286,355		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	4,312	m3	$10	$42,042		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	14,141	m2	$4	$56,564		Rawlinsons 2013 p677
		Install General Fill (30 cm)	4,312	m3	$26	$112,112		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	2,156	m3	$17	$37,148		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	14,141	m2	$8	$112,845		Rawlinsons 2013 p228
		Supply and Install Fencing	248	m	$56	$13,910		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$856,931**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		
		Subtotal				$35,403,709		
		Contingency 10%				$3,540,371	10% Scope	
		CAPITAL COSTS				**$38,944,080**		

NOTES

Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix C for a description of capping requirements and assumptions made
Assumes soil treatment acehived by cement stabilisation for all contaminants

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years
	Maintenance	1	annual	$18,000	$562,722		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$149,260		no cost in year 0	
			1 each	$71,287	$71,287.35	year 25	Using a discount rate of 3%
			1 each	$16,261	$16,261.15	year 50	Using a discount rate of 3%
			1 each	$1,772	$1,771.57	year 75	Using a discount rate of 3%
			1 each	$92	$92.18	year 100	Using a discount rate of 3%
					$1,402,134		
	Legacy potential liability provisioning	1%	event	NPV	$88,734	assumes occurs in twice in 100 years	Using a discount rate of 3%
					$88,734		
					$1,490,868		

Risk			Value
	Comment		6
	Minor	If a breaching of the capping layer occurs, reinstatement of the cap would be required and it is unlikely that significant harm would occur	
	Possible	It is possible that during future site use a cap breach would occur.	

Time			
	Pre-Design Activities	0.25	years
	Preparation of RAP and Planning Approval	1	years
	Approvals	0.5	years
	Project Management	0.2	years
	Implementation including treatment	1.5	years
	Final Reporting	0.25	years
	Site Auditor signoff	0.25	years
	Time	3.95	years

Option C4 Encapsulate in Containment Cell	
Description	**Encapsulate in Containment Cell**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	7	EA	$1,100	$7,348	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	3	EA	$7,200	$21,600	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$28,948**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Development application			$15,000	$15,000	Assumes category 2remediation and only Cou	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$105,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$16,000		USEPA Remediation Engineering
		Remedial Design			8%	$26,000		USEPA Remediation Engineering
		Construction Management			6%	$19,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$6,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$67,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		
		SUBTOTAL Site Preparation				**$688,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	5,329	m2	$2	$11,084		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	5,329	ha	$1,020	$544	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	5,329	m3	$8	$42,366		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	5,560	m3	$24	$130,660		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,524	m2	$20	$111,861		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,524	m2	$4	$20,715		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	1,712	m3	$25	$42,800		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,524	m2	$20	$111,861		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,524	m2	$4	$20,715		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	1,712	m3	$25	$42,800		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	256	m	$128	$32,768		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	5,524	m2	$4	$20,715		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$598,888**		
	6	**Excavate, transport and place**						
		Transport and place contaminated materials, compact to 90%	26,980	m3	$12	$323,760	Assumes transport less than 1500m	Rawlinsons 2013
		SUBTOTAL Placement of SPL				**$323,760**		
	7	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	3,298	m3	$26	$85,748		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	5,496	m2	$20	$111,294		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	1,676	m3	$10	$16,341		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	5,496	m2	$4	$21,984		Rawlinsons 2013 p677
		Install General Fill (30 cm)	1,676	m3	$26	$43,576		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	838	m3	$17	$14,439		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	5,496	m2	$8	$43,968		Rawlinsons 2013 p228
		Supply and Install Fencing	307	m	$56	$17,203		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cell Construction and Cap Construction				**$366,661**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		
		Subtotal				$2,303,257		
		Contingency 10%				$230,326	10% Scope	
		CAPITAL COSTS				**$2,533,583**		

NOTES

Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix C for a description of capping requirements and assumptions made

Legacy Cost							
	Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
	Maintenance	1	each	NPV	$568,780		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$29,311			
			1 each	$13,999	$13,999.14	year 25	Using a discount rate of 3%
			1 each	$3,193	$3,193.30	year 50	Using a discount rate of 3%
			1 each	$348	$347.90	year 75	Using a discount rate of 3%
			1 each	$18	$18.10	year 100	Using a discount rate of 3%
					$886,339		
	Legacy potential liability provisioning	1%	event	NPV	$5,703	Occurring once in 100 years and at Year 50	Using a discount rate of 3%
				Legacy provision	**$892,041**		

Risk

		Value
Ranking		4
Minor	If a breaching of the capping layer occurs, reinstatement of the cap would be requried, given the low solubility of contaminants present it is unlikely that a risk of harm or prosecution would result	
unlikely	It is unlikely that during future site use a cap breach would occur.	

Time			
	Pre-Design Activities	0.25	years
	Preparation of RAP and Planning Approval	1	years
	Approvals	0.25	years
	Project Engineering Tasks	0.2	years
	Implementation	0.6	years
	Final Reporting	0.25	years
	Time	2.55	years

Option C5 Treat and Encapsulate in Containment Cell	
Description	**Treat and move all materials to containment cell**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	7	EA	$1,100	$7,348	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	3	EA	$7,200	$21,600	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$28,948**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Development application			$15,000	$15,000	Assumes category 2 remediation and	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$105,000**	only Council notification required	
	3	**Project Engineering Tasks**						
		Project Management			5%	$1,373,000		USEPA Remediation Engineering
		Remedial Design			8%	$2,198,000		USEPA Remediation Engineering
		Construction Management			6%	$1,648,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$549,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$5,768,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		
		SUBTOTAL Site Preparation				**$688,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	5,329	m2	$2	$11,084		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	5,329	m2	$1,020	$543.56	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	5,329	m3	$8	$42,366		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	5,560	m3	$24	$130,660		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,524	m2	$20	$111,861		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,524	m2	$4	$20,715		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	1,712	m3	$25	$42,800		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	5,524	m2	$20	$111,861		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	5,524	m2	$4	$20,715		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	1,712	m3	$25	$42,800		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	256	m	$128	$32,768		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	5,524	m2	$4	$20,715		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$598,888**		
	6	**Excavate, transport and place**						
		Excavate, transport and place contaminated materials, compact to 90%	26,980	m3	$12	$323,760	Assumes transport less than 1500m	Rawlinsons 2013
		SUBTOTAL Excavate, transport and place				**$323,760**		
	7	**Sorting and treatment of contaminated soils**						
		Treatability trials	1	ea	$40,000	$40,000	Treatability trials	ENVIRON Experience
		Excavating and placing to stockpile	26,980	m3	$8	$215,840		Rawlinsons 2013 p673, for light soil
								Estimate, labour rate Group 4 Rawlinsons
		Sorting manual	5,396	hrs	$64	$345,344	Assumes 5 m3 sorted in one labour hour	2013 pg 695
		Treat contaminated soil component to inert product	46,769	t	$530	$24,787,305	Assumes treatment cost is equal to current Regain ra	Hydro, Regain contract
		SUBTOTAL Sorting and treatment of contaminated soils				**$25,388,489**		
	8	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	3,298	m3	$26	$85,748		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	5,496	m2	$20	$111,294		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	1,676	m3	$10	$16,341		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	5,496	m2	$4	$21,984		Rawlinsons 2013 p677
		Install General Fill (30 cm)	838	m3	$26	$21,788		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (30 cm)	838	m3	$17	$14,439		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	5,496	m2	$8	$43,858		Rawlinsons 2013 p228
		Supply and Install Fencing	307	m	$56	$17,203		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cell Construction and Cap Construction				**$344,763**		
	9	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		
		Subtotal				$33,370,848		
		Contingency 10%				$3,337,085	10% Scope	
		CAPITAL COSTS				**$36,707,933**		

NOTES
Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix C for a description of capping requirements and assumptions made

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
							Based on 12 events per year for 100 years,
	Maintenance	1	each	NPV	$561,604		using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$29,311			
		1	each	$13,999	$13,999.14	year 25	Using a discount rate of 3%
		1	each	$3,193	$3,193.30	year 50	Using a discount rate of 3%
		1	each	$348	$347.90	year 75	Using a discount rate of 3%
		1	each	$18	$18.10	year 100	Using a discount rate of 3%
					$879,162		
	Legacy potential liability provisioning	1%	event	NPV	$83,715	Occurring once in 100 years and at Year 50	Using a discount rate of 3%
				Legacy provision	**$962,877**		

			Value
RISK	Comment		2
	Minor	In the event that it does occur, due to pretreatment, remedial works required are likley to be minor	
	Rare	Only occuring under extreme circumstances	

Time	Pre-Design Activities	0.25	years
	RAP preparation	1	years
	Approvals	0.25	years
	Project Management	0.25	years
	Sorting and treatment	1	years
	Landfill construction and placement	0.6	years
	Final Reporting	0.25	years
	Time	3.6	years

Option C6 Dispose off Site	
Description	**Excavate all materials and dispose off site to landfill**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Development application			$15,000	$15,000	Assumes category 2 develop	ENVIRON experience
		SUBTOTAL preliminary documentation				**$70,000**		
	2	**Project Tasks**						
		Project Management			5%	$1,414,690		
		SUBTOTAL Technical Tasks Capital Cost				**$1,414,690**		
	3	**Site Preparation**					Site sheds, machinery compising excavator and truck	
		Environmental controls	0			0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each	$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each	$15,000	$30,000		
		SUBTOTAL site preparation				**$56,000**		
	4	**Loading costs**						
		Contaminated soils	26980	m3	$5	$124,108	assume sand & < 1m	Rawlinsons
		SUBTOTAL excavation costs				**$124,108**		
	5	**Transport costs**						
		to newcastle	56000	m3	$20	1,136,800	Newcastle, Kooragang	Rawlinsons, based on 40km
		SUBTOTAL Transport costs				**$1,136,800**		
	6	**Disposal Costs**						
		NSW	46769	t	$575	26,891,888	Untreated	Vendor supplied
		SUBTOTAL Disposal costs				**$26,891,888**		
	7	**Final Reporting**						
		Validation report		each	allow	$30,000		ENVIRON experience
		EMP		each	allow	$15,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL Reporting				**$85,000**		
		Subtotal				$29,778,485		
		Contingency 10%				$2,977,849	10% Scope	
		CAPITAL COSTS				**$32,756,334**		

NOTES
Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Assumes transport at 1500t/week

Legacy Cost		
	Legacy provision	$0

			Value
RISK	Comment		1
	Insignificant	No remediation consequences to Hydro	
	Rare	Not likely to occur	

Time			
	Pre-Design Activities	0.2	years
	Preparation of RAP	0.1	years
	Approvals	0.1	
	Excavation, transport and disposal at 1500t/week	0.60	years
	Reporting and auditor signoff	0.26	years
	Time	1.3	years

Option C7 Onsite Destruction	
Description	**Onsite Waste to Energy**
Base Year	**2013**
Date	**12/2013**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Planning approval			$350,000	$350,000	EIS required	ENVIRON experience
		Sub-total preliminary documentation				**$400,000**		
	2	**Pilot Trial**						
		Allow				$100,000		Estimate
		Sub-total pilot trial				**$100,000**		
	3	**Project Tasks**						
		Project Management			5%	$37,000	Does not include treatment P	USEPA Remediation Costs
		Sub-total Technical Tasks Capital Cost				**$37,000**		
	4	**Excavate, transport and place**						
		Excavate, transport and place contaminated materials, compact to 90%	47,000	m3	$12	$564,000	Assumes transport less than :	Rawlinsons 2013
		SUBTOTAL Excavate, transport and place				**$564,000**		
	5	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	6	**Sorting, placement and treatment of Alcan Mound wastes**						
		Treatment through plasma gasification	47,000	t	$450	$21,150,000	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL Placement of SPL				**$21,150,000**		
	7	**Final Reporting**						
		Validation report		each	allow	$500,000	includes confirmatory testing	ENVIRON experience
		Sub-total reporting				**$500,000**		
		Subtotal				$22,977,000		
		Contingency 10%				$2,297,700	10% Scope	
		CAPITAL COSTS				**$25,275,000**		

NOTES
Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes by-products are approved by NSW regulators for reuse and do not require landfilling. 80% plasma rock is estimated to be generated.
Rate of treatment per tonne provided by Tetronics includes a rate of return and profit margin. This rate could be negotiated. Applies to 15000 tpa plant.

Legacy Cost		
	Legacy provision	$0

Risk		Value
	Likely	
Comment	moderate	12

Time		
Pilot Trial	1.0	years
RAP/EIS	1.0	
Approvals	1.8	years
Investigations/tender/contract negotiations	0.5	years
Construction/commissioning	1.0	years
Assumes treatment at 15000tpa	3.1	years
Validation Reporting	0.2	years
TOTAL	8.6	years

Appendix D

Contaminated Soils and Waste Materials in Buffer Zone Detailed Options Review

D Contaminated Soils and Waste Materials in the Buffer Zone

Contaminated soils and waste materials within the buffer zone are described as follows:

Contaminated Soils in the Buffer Zone		
Volume (m^3)	**Tonnage (t)**	**Description**
Dickson Road Containment cell		
1750 - 3250	3150 - 5850	Smelter Related Waste. May include refractory brick, spent anodes, waste oils and general refuse. Contaminants of potential concern could include the following: Aluminium, fluoride and cyanide, PAH, Heavy Metals, Petroleum Hydrocarbons.
3920 - 7280	7056 - 13104	Contaminated Soils. Soil analytical results indicate that soil around the waste material contains concentrations of fluoride, benzo(a)pyrene, PAHs and total TPH.
4200 - 7800	1260 - 2340	Municipal Waste General municipal waste.
Glen Main Containment cell		
1120 - 2900	2016 - 3744	Smelter Related Waste. May include refractory brick, spent anodes, waste oils and general refuse. Contaminants of potential concern could include the following: Aluminium, fluoride and cyanide, PAH, Heavy Metals, Petroleum Hydrocarbons.
560 - 1040	1008 - 1872	Contaminated Soils
280 - 520	84 - 156	Municipal Waste
Former Municipal Containment cell		
4,200 – 12,600	4,200 – 12,600	Municipal Waste, predominately glass and asbestos
Hydro Owned Land (other)		
6700 - 13400	12060 - 24120	General Asbestos (bonded) in Soils
Not included[1]	Not included	General Refuse, assumed removed to landfill under buffer zone maintenance program
Not included	Not included	Recyclables (e.g. car bodies), assumed removed to landfill or recyclers under buffer zone maintenance program

[1] Assumed included under Buffer Zone Management budget

Clay borrow pit		
6375 - 19125	17850 - 53550	Buried – repository for refractory brick waste
1250 - 3750	3500 - 10500	Stockpiled - comprise bake oven refractory, concrete and asphalt in mixed stockpiles
TOTAL		
19,455 – 58,245	35,924 – 115,236	

Remediation Options

- D1 Encapsulate in-situ
- D2 Move to specifically designed containment cell adjacent to the capped waste stockpile
- D3 Treat and move to specifically designed containment cell adjacent to the capped waste stockpile
- D4 Encapsulate in purpose built containment cell
- D5 Treat contaminated soils and encapsulate all in purpose built containment cell
- D6 Dispose off site
- D7 Combination off site and onsite disposal
- D8 On site Treatment to Achieve Complete Destruction

D1 Encapsulate in-situ

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD NPV[2]	Risk Ranking
Moderate to high	4.1	2 - 3	2.0	9

D1.1 Description of the option

This option reduces human health and environmental risks by restricting access to contaminants through the placement of physical barriers. Such barriers could include surface filling, hardstands, roads and buildings. For the purpose of providing a cost estimate, it has been assumed that the barrier is formed by the placement of 0.5m of clean soil over the contaminant footprint. The surface area determined for each contamination footprint is presented in the following table.

Identifier	Surface Area (m^2)
Dickson Road Landfill	9500
Glen Main landfill	1300
Former Municipal Landfill	5600[3]
Other Hydro owned land	45,000
Clay borrow pit	30,000
Total area	91,000

Other Hydro owned land refers to land parcels within the buffer zone that have been identified as contaminated, predominantly this refers to asbestos fragment contamination of the near surface materials. This area is being refined at the time of preparing this options study and will be later revised.

D1.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that the encapsulation of the contaminated soils in the buffer zone within the smelter footprint is managed in isolation from other demolition and remediation activities.

[2] Net Present Value using a discount rate of 3%
[3] Updated following December 2013 fieldwork

Capping of the contaminated soils would be classified as “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP) or in the Maitland Local Environmental Plan 2011 (the Maitland LEP).

Remediation works are permissible with consent in the RU2 Zone under the Cessnock LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works are permissible with consent.

However, as remediation works are not specified as permitted with consent or without consent in the RU1 Primary Production Zone under the Maitland LEP, it is technically prohibited within the zone (it could be argued that the works would be “environmental protection works” which are defined in the Maitland LEP as “*works associated with the rehabilitation of land towards its natural state or any work to protect land from environmental degradation, and includes bush regeneration works, wetland protection works, erosion protection works, dune restoration works and the like, but does not include coastal protection works*”). This prohibition issue is resolved by clause 8(1) of State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) which permits remediation work to be undertaken on any land “*despite any provision to the contrary in an environmental planning instrument*”.

The definition of “*Contaminated soil treatment works*” under clause 15 of Schedule 3 of the regulation includes:

“*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(b) that treat more than 1,000 cubic metres per year of contaminated soil not originating from the site on which the development is located,”

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil”.

Based on the estimates for all seven locations, there is an estimated of 47,250 m^3 of contaminated soil to be treated (note that for the purpose of approval, all material within the soil would be deemed part of the contaminated soil). Based on the estimates, managing all sites as one remediation project would result in the works being a designated development.

The definition of “*Contaminated soil treatment works*” under clause 15 of Schedule 3 of the regulation also includes:

“(a) that treat or store contaminated soil not originating from the site on which the development is proposed to be carried out and are located:

(i) within 100 metres of a natural waterbody or wetland, or

(ii) in an area of high watertable or highly permeable soils, or

(iii) within a drinking water catchment, or

(iv) on land that slopes at more than 6 degrees to the horizontal, or

(v) on a floodplain, or

(vi) within 100 metres of a dwelling not associated with the development, or

(b) that treat more than 1,000 cubic metres per year of contaminated soil not originating from the site on which the development is located,"

If each site was managed individually, and there is more than 1,000 m^3 of contaminated soil deemed to have come from off site to be encapsulated, or any of the other criteria are applicable, this would also trigger a designated development. As this is the case, the works would be managed as one remediation project and assessed by one EIS, rather than (up to) seven separate EIS.

In the event that any of the potential triggers for designated development are met, an EIS is required to support a development application. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Cessnock City Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking development consent for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the works require disturbance of adjacent areas currently containing native vegetation).

- Aboriginal heritage (if the works require disturbance of adjacent areas of limited disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.
- Ongoing capping management strategy (particularly leachate management and capping stability).
- Sustainability and carbon management.

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council and Maitland City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site, or

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

An Environment Protection Licence (EPL) would be required in the following conditions:

- At each of those locations where more than 1,000 m^3 of contaminated soil that was deemed to be received from off site (this would not be triggered if the buffer zone and smelter were deemed as part of one site).
- If the works were managed as one remediation project and it was deemed that the buffer zone and smelter were part of one site (resulting in more than 30,000 m^3 being treated).

Likelihood of Approval

Encapsulation has been accepted as a form of contaminated soil remediation throughout the Lower Hunter Region. If the agencies can be satisfied that the capping design minimises the potential for impacts to human health and environment, and is appropriate for the proposed land use, there is a moderate to high likelihood of approval.

D1.3 Cost

The estimated cost for this option is $4.1 AUD NPV.

Refer to the attached costing for details.

D1.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Preparation of RAP and Planning Approval	0.75 – 1.25	Local council notification required only
Approvals	0.2 – 0.5	30 day notification period
Implementation	0.5 – 0.75	Earthworks, can operate concurrently
Final Reporting and auditor signoff	0.2 – 0.5	
Total Estimated Timeframe	2 - 3	

D1.5 Legacy

Once capped, the site will be suitable for the proposed land use and can be divested. Responsibility for the maintenance of the capped areas can be transferred to the buyer including indemnity provisions that protect Hydro from actions of the buyer that result in exacerbation of contamination.

However, despite contractual arrangements for transfer of liability, under the *Contaminant Land Management Act 1997,* Hydro remain the 'pollluter' in perpetuity. Should clean-up be required by a regulator, the regulator is able to issue a notice to the polluter to undertake the clean-up. In the event that clean-up is required in this instance, this is likely to require removal of the contamination and placement within a properly designed containment cell, likely off site. However, should this event occur, remediation may not be required given that mobility of the contaminants is low and the sites are likely to be used for industrial land use. The exception to this is the Glen Main site where residential land use may occur and Dickson Road where contaminants have higher mobility. For the purpose of legacy costing it has been assumed that there is a 10% chance that offsite disposal of the capped materials will be required after 25 years.

The legacy cost is estimated to be approximately $2.0mil AUD NPV.

D1.6 Risk Ranking

The risk level is contingent on the additional investigations and the proposed end use of the site. For evaluation of the risk ranking we have assumed that the capped sites will be for industrial land use, i.e. hard stand or similar will be placed above the capping soils.

In the instance of cap breach or failure, leaching of contaminants to groundwater may occur. Remediation such as localised groundwater clean-up and repair of the cap breach may be required, or soils disposed off site. For the purpose of assessing risk, it has been assumed that off-site disposal of all materials has a 10% chance of occurring, and that costs incurred would be between $0.5milAUD, and $5milAUD, but that prosecution is unlikely. On this basis the consequence is considered to be ‘moderate’. The likelihood of the event occurring is considered ‘possible’, i.e. breaches could possibly occur during construction or operation of the site.

On this basis the risk ranking is estimated to be ‘9’.

D2 Move to specifically designed containment cell adjacent to the capped waste stockpile

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD NPV[4]	Risk Ranking
Moderate to high	7.6	3 - 4	1.5	15

D2.1 Description of the option

The capped waste stockpile comprises mixed waste smelter materials including SPL. The capped waste stockpile is situated within the eastern area of the Smelter Site and is surrounded by undeveloped land. To consolidate waste disposal on the site, a cell adjacent and adjoining the capped waste stockpile can be constructed for placement of the contaminated soils from the buffer zone. The cell construction is described below. No improvements to the capped waste stockpile have been included here as these are presented in Appendix A and Appendix G.

For the option of placing contaminated soils adjacent to the existing capped waste stockpile, the process would comprise:

1) Preconstruction

- Assess the area surrounding the existing capped waste stockpile and determine a geotechnically suitable area for additional waste placement. It is likely that the most suitable area would be to the west of the existing capped waste stockpile, where anode butts are currently stored. The reasons for this assumption are the constraints present in the other directions:
  - North is the existing Eastern Surge Pond which will be required for site use minimum till the end of a remediation and demolition phase
  - South is the Regain plant and the SPL storage sheds.
  - East is a flood plain area that would require modification by filling in order to be a viable option.
- Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;

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[4] Net Present Value using a discount rate of 3%

- Design of "best practice" containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award;
- Approvals process through local government/NSW planning/regulators.

2) Construction

- Construction of the containment cell.
  - The cell base liner will comprise (ordered from vertically upwards)
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has not been included as it is not likely that this will be required due to the expect size of the waste materials.
  - The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - A 0.3 m thick sand drainage layer;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m protection layer overlain by;

- A 0.15 m topsoil layer, seeded and mulched.

3) Post Construction

- Ongoing monitoring and maintenance of the containment cell likely involving:
- – Installation and regular monitoring of groundwater monitoring wells installed around the new facility;
- – Ongoing physical maintenance of the cell to maintain integrity of the cap ;
- – Ongoing leachate evaluation for a period of time to demonstrate performance;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the environmental protection licence – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

D2.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that only contaminated soils from the buffer zone would be placed in the containment cell.

Encapsulating the contaminated soils in a containment cell would be classified as “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works permissible with consent.

If the buffer zone and the smelter are deemed part of one site, the works would meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of “*Contaminated soil treatment works*” under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all seven locations, there is a maximum of 47,250 m^3 of contaminated soil to be treated via encapsulation in the containment cell (note that for the purpose of approval, all material within the soil would be deemed part of the contaminated soil). Based on these quantities the works would trigger designated development.

It should also be noted that "Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"*(1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

The groundwater in the vicinity of the capped waste stockpile is known to be shallow; therefore it is likely that a containment cell adjacent to the capped waste stockpile would be deemed designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Cessnock City Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking development consent for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.

- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

It should be noted that the EIS would only be required for the placement of the contaminated soils in the containment cell. Excavation for treatment at another site is excluded from the "Contaminated soil treatment works" designated development definition. Therefore the soils can be removed from their current location and stockpiled prior to approval being received for the containment cell. However removal of contaminated soils is deemed remediation under SEPP 55. Such removal would be deemed category 2 remediation works and therefore the notification requirements previously described would need to be implemented. It should be noted however that if the buffer zone is deemed off site from the smelter there is a limit (2,500 m^3) on how much material could be temporarily stored before triggering the need for an Environment Protection Licence (as "waste storage"). This is not an issue if the buffer zone and smelter are deemed one site.

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all seven locations, there is a maximum of 47,250 m^3 of contaminated soil to be treated. Therefore the works would require an Environment Protection Licence (EPL).

Likelihood of Approval

Placing the contaminated soil in a containment cell would trigger the requirement for planning approval and an EPL. If sufficient evidence can be provided to show that the containment cell would not impact human health and the environment, likelihood of approval is moderate to high.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

D2.3 Cost

The estimated cost for this option is $7.6mil AUD NPV.

Refer to the attached costing for details.

D2.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.2 – 0.3	Containment cell design and site testing
Preparation of RAP and Planning Approval	0.75 – 1.25	Preparation of EIS
Approvals	0.5 - 1	
Project Engineering Tasks	0.2 – 0.4	
Implementation	0.9 – 1.2	Assumes 300t/day
Final Reporting	0.2 – 0.4	Assumes completed concurrent with implementation stages
Total Estimated Timeframe	3 - 4	

D2.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe event weather events or an earthquake. A percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital cost. It is not proposed that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 2% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $1.5mil AUD NPV.

D2.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from the proximity to the capped waste stockpile, which has not benefitted from the same levels of engineering and contains fill placed in an uncontrolled manner. There is an additional risk that the placement of this cell adjacent and connected to the existing capped waste stockpile could affect the integrity of the existing capped waste stockpile. The chance of failure occurring is therefore considered to be ‘possible’, it might occur at some time. In the event of failure, due to the proximity of shallow groundwater and the known discharge of shallow groundwater to the surface, the consequence of failure could be ‘catastrophic’ due to the risk of prosecution and cost of remediation. On this basis the risk ranking is ‘15’.

D3 Treat and move to specifically designed containment cell adjacent to the capped waste stockpile

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD NPV[5]	Risk Ranking
Moderate to high	16.6	3 - 4	1.5	6

D3.1 Description of the option

This option would involve the following steps:

1) Excavation of impacted materials and treat by cement stabilisation (or similar) to reduce leachable content. Treatment would be undertaken by a temporary facility on site. Treatment applies only to hydrocarbon and fluoride impacted materials. Soils impacted with asbestos have been excluded from treatment options;

2) Preconstruction

- Assess the area surrounding the existing capped waste stockpile and determine a geotechnically suitable area for additional waste placement. It is likely that the most suitable area would be to the west of the existing capped waste stockpile, where anode butts are currently stored. The reasons for this assumption are the constraints present in the other directions:
  - North is the existing Eastern Surge Pond which will be required for site use as a minimum until the end of the remediation and demolition phase.
  - South is the Regain plant and the SPL storage sheds.
  - East is a flood plain area that would require modification by filling in order to be a viable option.
- Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;

[5] Net Present Value using a discount rate of 3%

- Design of "best practice" a containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award;
- Approvals process through local government/NSW planning/regulators;

3) Construction

- Construction of the containment cell.
  - The cell base liner will comprise (ordered from vertically upwards)
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
  - Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has not been included as it is not likely that this will be required due to the expect size of the waste materials.
  - The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - A 0.3 m thick sand drainage layer;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m protection layer overlain by;

- A 0.15 m topsoil layer, seeded and mulched.

4) Post Construction

- Ongoing monitoring and maintenance of the containment cell likely involving:
– Installation and regular monitoring of groundwater monitoring wells installed around the new facility;
– Ongoing physical maintenance of the cell to maintain integrity of the cap ;
– Ongoing leachate evaluation for a period of time to demonstrate performance;
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the environmental protection licence – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

D3.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that only contaminated soils from the buffer zone would be treated and placed in the containment cell.

Treating and encapsulating the contaminated soils in a containment cell would be “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works permissible with consent.

The works would meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of “*Contaminated soil treatment works*” under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all seven locations, there is a maximum of 47,250 m^3 of contaminated soil to be treated and placed in the containment cell (note that for the purpose of approval, all material within the soil would be deemed part of the contaminated soil). Based on these quantities the works would trigger designated development.

It should also be noted that "Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"*(1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

The groundwater in the vicinity of the capped waste stockpile is known to be shallow; therefore it is likely that a containment cell adjacent to the capped waste stockpile would be deemed designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Cessnock City Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking development consent for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.

- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

It should be noted that the EIS would only be required for the placement of the contaminated soils in the containment cell. Excavation for treatment at another site is excluded from the "Contaminated soil treatment works" designated development definition. Therefore the soils can be removed from their current location and stockpiled prior to approval being received for the containment cell. However removal of contaminated soils is deemed remediation under SEPP 55. Such removal would be deemed category 2 remediation works and therefore the notification requirements previously described would need to be implemented. It should be noted however that if the buffer zone is deemed off site from the smelter there is a limit (2,500 m^3) on how much material could be temporarily stored before triggering the need for an Environment Protection Licence (as "waste storage"). This is not an issue if the buffer zone and smelter are deemed one site.

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all seven locations, there is a maximum of 47,250 m^3 of contaminated soil to be treated. Therefore the works would require an Environment Protection Licence (EPL).

Likelihood of Approval

Treating the contaminated soil and placement in a containment cell would trigger the requirement for planning approval and an EPL. If sufficient evidence can be provided to show that the containment cell would not impact human health and the environment, likelihood of approval is moderate to high.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

D3.3 Cost

The cost range for this option is $16.6AUD NPV.

Refer to the attached costing for details.

D3.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.2 – 0.3	Containment cell design and site testing, treatability study
Preparation of RAP and Planning Approval	0.75 – 1.25	Preparation of EIS
Approvals	0.5 – 0.75	
Project Engineering Tasks	0.2 – 0.4	
Implementation, including treatment	0.9 – 1.2	Assumes 300t/day
Final Reporting	0.2 – 0.4	Assumes completed concurrent with implementation stages
Total Estimated Timeframe	3 - 4	

D3.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

3) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that the soil has been treated prior to placement;

4) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. However, due to the proximity to the existing capped waste stockpile a percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe.

Should such an event occur the costs are proposed to be consistent with the initial capital costs. It is not proposed that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $1.5mil AUD NPV.

D3.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from the proximity to the capped waste stockpile, which has not benefitted from the same levels of engineering and contains fill placed in an uncontrolled manner. There is an additional risk that the placement of this cell adjacent and connected to the existing capped waste stockpile could affect the integrity of the existing capped waste stockpile. The chance of failure occurring is therefore considered to be ‘possible’, it might occur at some time. In the event of failure, due to the treatment of soils prior to emplacement within the facility, the consequence is considered to be ‘minor’, i.e. some minor remediation works may be required. On this basis the risk ranking is ‘6’.

D4 Encapsulate in purpose built containment cell

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD NPV[6]	Risk Ranking
Moderate to high	8.0	3 - 4	0.9	2

D4.1 Description of the option

This option would manage the waste materials by placement within a purpose built containment cell constructed at an appropriate location on the site and applying best practice containment cell design and construction.

This option would involve the following steps:

1) Pre construction

- Investigation/s of the site to identify the optimum location for placement of a contaminated soil containment cell. The investigation would comprise detailed investigations including boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Remediation notification process with Cessnock City Council.
- Design of a “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

2) Construction

- Construction of the containment cell.
  - The cell base liner will comprise (ordered from vertically upwards):
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;

[6] Net Present Value using a discount rate of 3%

- A 1.5 mm thick, high density polyethylene (HDPE) liner overlain by;
- Filter fabric to provide protection to the HDPE overlain by;
- A 0.3 m sand leachate detection layer overlain by;
- A 1.5mm thick HDPE liner overlain by;
- Filter fabric to provide protection to the HDPE overlain by;
- A 0.3 m gravel drainage layer.

– Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has not been included as it is not likely that this will be required due to the expect size of the waste materials.

– The cell cap liner will comprise (ordered from vertically upwards)

- A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
- A 1.5 mm thick HDPE liner overlain by;
- A 0.3 m thick sand drainage layer;
- Filter fabric to provide protection to the HDPE overlain by;
- A 0.3 m protection layer overlain by;
- A 0.15 m topsoil layer, seeded and mulched.

3) Post construction

- Ongoing monitoring and maintenance of the containment cell likely involving:
  - Installation and regular monitoring of groundwater and leachate sump wells installed around the new facility.
  - Ongoing physical maintenance of the cell to maintain integrity of the cap.
  - Ongoing leachate treatment.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions).

- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies.
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

D4.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that only contaminated soils from the buffer zone would be placed in the containment cell.

Encapsulating the contaminated soils in a containment cell would be classified as "remediation works". However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works permissible with consent.

The works would meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of "*Contaminated soil treatment works*" under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

"*(b) treat more than 1,000 cubic metres per year of contaminated soil not originating from the site on which the development is located*".

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all seven locations, there is a maximum of 47,250 m^3 of contaminated soil to be treated via encapsulation in the containment cell (note that for the purpose of approval, all material within the soil would be deemed part of the contaminated soil). Therefore the works would be deemed designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Cessnock City Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking development consent for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell construction requires disturbance of adjacent areas currently containing native vegetation).
- Aboriginal heritage (if the containment cell construction requires disturbance of adjacent areas of limited disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

It should be noted that the EIS would only be required for the placement of the contaminated soils in the containment cell. Excavation for treatment at another site is excluded from the "Contaminated soil treatment works" designated development definition. Therefore the soils can be removed from their current location and stockpiled prior to approval being received for the containment cell. However removal of contaminated soils is deemed remediation under SEPP 55. Such removal would be deemed category 2 remediation works and therefore the notification requirements previously described would need to be implemented. It should be noted however that if the buffer zone is deemed off site from the smelter there is a limit (2,500 m^3) on how much material could be temporarily stored before triggering the need for an Environment Protection Licence (as "waste storage"). This is not an issue if the buffer zone and smelter are deemed one site.

Environment Protection Licencing

"Contaminated soil treatment" that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site,"

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all seven locations, there is a maximum of 47,250 m^3 of contaminated soil to be treated. Therefore the works would require an Environment Protection Licence (EPL).

Likelihood of Approval

Placing the contaminated soil in a containment cell would trigger the requirement for planning approval and an EPL. If sufficient evidence can be provided to show that the containment cell would not impact human health and the environment, likelihood of approval is moderate to high.

Offering a security payment to be available as a contingency to remediate any future failure may help to ameliorate agency concerns.

D4.3 Cost

The estimated cost for this option is $8mil AUD NPV.

Refer to the attached costing for details.

D4.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.2 – 0.3	Containment cell design and site testing, treatability study
Preparation of RAP and Planning Approval	0.75 – 1.25	Preparation of EIS
Approvals	0.5 – 0.75	
Project Engineering Tasks	0.2 – 0.4	
Implementation	0.9 – 1.2	Assumes 300 t/day
Final Reporting	0.2 – 0.4	Assumes completed concurrent with implementation stages
Total Estimated Timeframe	3 - 4	

D4.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that soils and wastes placed within the cell have low mobility and the containment cell is specifically engineered to minimize leachate generation;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe event weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital cost. It is not likely that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $0.9mil AUD NPV.

D4.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘unlikely’ that this could occur in some extreme circumstances, such as severe weather. Should breaches occur the containment cell is situated in an area with a depth to groundwater in excess of 10m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the low solubility of the wastes it is likely that remediation would require cap replacement and not result in prosecution. The consequence category is therefore considered to be ‘rare’. On this basis the risk ranking is ‘2’.

D5 Treat contaminated soils and encapsulate all in purpose built containment cell

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD NPV[7]	Risk Ranking
Moderate to high	18.4	3 - 4	0.9	2

D5.1 Description of the option

1) Excavation of contaminated soils and validation that all soils have been removed.

2) Sorting wastes and treatment of the contaminated soil component in an on-site treatment facility. An appropriate treatment method is cement stabilization, however further evaluation of options and pilot trials would be required to verify the most suitable method. For the purpose of this evaluation, cement stabilization has been assumed.

3) Pre construction of the containment cell

- Investigation/s of the site to identify the optimum location for placement of a contaminated soil containment cell. The investigation would comprise detailed investigations including boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Remediation notification process with Cessnock City Council.
- Design of “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

4) Construction

- Construction of containment cell.
  - The cell base liner will comprise (ordered from vertically upwards):

[7] Net Present Value using a discount rate of 3%

  - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
  - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer.

- Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has not been included as it is not likely that this will be required due to the expect size of the waste materials.
- The cell cap liner will comprise (ordered from vertically upwards):
  - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - A 0.3 m thick sand drainage layer;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m protection layer overlain by;
  - A 0.15 m topsoil layer, seeded and mulched.

3) Post construction

- Ongoing monitoring and maintenance for containment cell likely involving:
  - Installation and regular monitoring of groundwater and leachate sump wells installed around the new facility.
  - Ongoing physical maintenance of the cell to maintain integrity of the cap.
  - Ongoing leachate treatment.

- Ongoing documentation/reporting (as a requirement of consent/EPL conditions).
- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies.
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

D5.2 Likelihood of approval

Planning Approval

The following advice is based on the assumption that only contaminated soils and wastes from the buffer zone would be placed in the containment cell.

Treating and then encapsulating the contaminated soils in a containment cell would be classified as “remediation works”. However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works are permissible with consent.

The works would meet the criteria for designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of “*Contaminated soil treatment works*” under clause 15 of Schedule 3 of the regulation includes:

“*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil, but excluding excavation for treatment at another site):*

“*(b) treat more than 1,000 cubic metres per year of contaminated soil not originating from the site on which the development is located*”.

(c) that treat contaminated soil originating exclusively from the site on which the development is located and:

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil”.

Based on the estimates for all seven locations, there is a maximum of 47,250 m^3 of contaminated soil to be treated, including encapsulation in the containment cell (note that for the purpose of approval, all material within the soil would be deemed part of the contaminated soil). Therefore the works would be deemed designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Cessnock City Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking development consent for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell construction requires disturbance of adjacent areas currently containing native vegetation).
- Aboriginal heritage (if the containment cell construction requires disturbance of adjacent areas of limited disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.

- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

It should be noted that the EIS would only be required for the treatment and placement of the contaminated soils in the containment cell. Excavation for treatment at another site is excluded from the “Contaminated soil treatment works” designated development definition. Therefore the soils can be removed from their current location and stockpiled prior to approval being received for the containment cell. However removal of contaminated soils is deemed remediation under SEPP 55. Such removal would be deemed category 2 remediation works and therefore the notification requirements previously described would need to be implemented. It should be noted however that if the buffer zone is deemed off site from the smelter there is a limit (2,500 m^3) on how much material could be temporarily stored before triggering the need for an Environment Protection Licence (as “waste storage”). This is not an issue if the buffer zone and smelter are deemed one site.

Environment Protection Licencing

“Contaminated soil treatment” that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the POEO Act. The definition includes:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site,"

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Based on the estimates for all seven locations, there is an estimated 47,250 m^3 of contaminated soil to be treated. Therefore the works would require an Environment Protection Licence (EPL).

Likelihood of Approval

Placing the contaminated soil in a containment cell would trigger the requirement for planning approval and an EPL. If sufficient evidence can be provided to show that the containment cell would not impact human health and the environment, likelihood of approval is moderate to high.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the containment cell.

D5.3 Cost

The estimated cost for this option is $18.4mil AUD NPV.

Refer to the attached costing for details.

D5.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.2 – 0.3	Containment cell design and site testing, treatability study
Preparation of RAP and Planning Approval	0.75 – 1.25	Preparation of EIS
Approvals	0.5 – 0.75	
Project Engineering Tasks	0.2 – 0.4	
Implementation including treatment	1.2 – 1.5	Assumes 300 t/day
Final Reporting	0.2 – 0.4	
Total Estimated Timeframe	3 - 4	

D5.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that the soil has been treated prior to placement;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should such an event occur the costs are proposed to be consistent with the initial capital cost. It is not proposed that containment celled materials would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $1mil AUD NPV.

D5.6 Risk Ranking

The risk associated with this disposal option is associated with the waste causing an effect at the disposal site in the future. Given that the wastes will be disposed of in a properly design containment cell that is appropriately situated the likelihood of an incident occurring is considered to be ‘rare’ (may occur only in exceptional circumstances).

The consequence to Hydro, is considered to be ‘insignificant’ as the consequence will be the responsibility of the third party. However, under the *Contaminated Land Management Act 1997* the ‘polluter’ remains the responsible party. Therefore, whilst the disposal contract can include an agreement that passes the liability to the waste receiver, in the event that the waste receiver is unable to fulfill their obligations, Hydro will remain responsible. Therefore, under this scenario, there remains a consequence to Hydro. Given that the wastes will be treated prior to disposal, the consequence is considered to be ‘minor’. On this basis, the risk ranking is considered to be ‘2’.

D6 Dispose off site

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD NPV[8]	Risk Ranking
High	42.1	1 - 2	0	1

D6.1 Description of the option

This option involves sorting the waste into waste streams and disposing off site. The waste streams and disposal destination are described in the following table.

Soils with PAH contamination are not able to be disposed to a local landfill without treatment due to the concentrations of benzo(a)pyrene. Costs for disposal to a soil facility who undertake soil stabilisation prior to landfilling, have therefore been included.

Location	Waste Type	Approximate volume (m^3)	Approximate mass (t)	Destination
Dickson Road Landfill	Smelter related wastes	2500	4500	Sydney, hazardous waste containment cell
	contaminated soils	5600	10080	Local soil treatment and disposal
	municipal wastes	6000	1800	Local solid waste containment cell
Glen Main Landfill	Smelter related wastes	1600	2880	Sydney, hazardous waste containment cell
	contaminated soils	800	1440	Local soil treatment and disposal
	municipal wastes	400	120	Local solid waste containment cell
Former Municipal Landfill	municipal wastes	8400	8400	Local solid waste containment cell
Other Hydro owned land	Asbestos (bonded) in soils, based on depth of 0.15 m	6700	12,060	Local solid waste containment cell

[8] Net Present Value using a discount rate of 3%

Location	Waste Type	Approximate volume (m^3)	Approximate mass (t)	Destination
	General refuse	Not included	Not included	Not included
	Recyclables (eg car bodies)	Not included	Not included	Not included
Clay borrow pit	Buried	12,750	35,700	Local solid waste containment cell
	Stockpiled	2500	7000	Local solid waste containment cell

D6.2 Likelihood of approval

This advice is based on the assumption that the disposal location already has the required planning approval and Environment Protection Licence.

Planning Approval

State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) defines remediation as "removing, dispersing, destroying, reducing, mitigating or containing the contamination of any land". Therefore the excavation of the material would be deemed remediation under SEPP 55.

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works permissible with consent.

However, as remediation works are not specified as permitted with consent or without consent in the RU1 Primary Production Zone under the Maitland LEP, it is technically prohibited within the zone (it could be argued that the works would be "environmental protection works" which are defined in the Maitland LEP as "*works associated with the rehabilitation of land towards its natural state or any work to protect land from environmental degradation, and includes bush regeneration works, wetland protection works, erosion protection works, dune restoration works and the like, but does not include coastal protection works*"). This prohibition issue is resolved by clause 8(1) of State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) which permits remediation work to be undertaken on any land "*despite any provision to the contrary in an environmental planning instrument*".

As the removal of these soils would not to be deemed category 1 remediation work, they would be deemed category 2 remediation works under SEPP 55 and would not require development consent.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council or Maitland City Council (as appropriate) at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice.
- A brief description of the remediation work.
- An explanation as to why the work is category 2 remediation work.
- Specify, by reference to its property description and street address (if any), the land on which the work is to be carried out.
- Provide a map of the location of the land.
- Provide estimates of the dates for the commencement and completion of the work.

Excavation of contaminated soils for treatment (including disposal) at another location is excluded from the definition of contaminated soil treatment works under the Environmental Planning and Assessment Regulation 2000. Therefore the removal could not be deemed a designated development.

Environment Protection Licencing

Excavation of contaminated soils for treatment (including disposal) at another location is not deemed remediation works under the *Protection of the Environment Operations Act 1997*. Therefore it is not a scheduled activity and does not require an Environment Protection Licence.

Likelihood of Approval

No approvals are required to dispose of the material off site (provided the disposal site already holds the necessary planning approval and environment protection licence).

D6.3 Cost

The estimated cost for this option is $42.1mil AUD NPV.

Refer to the attached costing for details.

D6.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Preparation of RAP and Planning Approval	0.2 – 0.3	No planning approval or EPL expected
Excavate, transport and disposal	1.3 – 1.5	Estimated at 1500 t/wk
Final Reporting and auditor signoff	0.2 – 0.3	
Total Estimated Timeframe	1 - 2	

D6.1 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented.

D6.2 Risk Ranking

The risk associated with this disposal option is associated with the waste causing an effect at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated, the likelihood of an incident occurring is considered to be ‘rare’ (may occur ‘only in exceptional circumstances’). The consequence to Hydro is considered to be ‘insignificant’ as it is a remote risk that the consequence will be the responsibility of Hydro if certain mitigation and management measures are implemented. On this basis the risk ranking is ‘1’. This evaluation is based on legal advice obtained by Hydro.

D7 Combination off site and onsite disposal

Likelihood of Approval	Cost $mil AUD	Timeframe yrs	Legacy $mil AUD NPV[9]	Risk Ranking
Moderate to high	11.7	3 - 4	1.0	2

D7.1 Description of the option

This option involves the separation of municipal waste and the offsite disposal of these materials combined with the onsite retention of contaminated soils and smelter related wastes. The onsite disposal will be within a properly design containment cell located within the Hydro owned lands.

The option involves the following steps:

1) Excavation of contaminated soils and validation that all soils have been removed.

2) Sorting wastes and offsite disposal of municipal wastes at Cessnock landfill facility.

3) Pre-construction of the containment cell.

- Investigation/s of the site to identify the optimum location for placement of a contaminated soil containment cell. The investigation would comprise detailed investigations including boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Remediation notification process with Cessnock City Council.
- Design of “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

[9] Net Present Value using a discount rate of 3%

4) Construction

- Construction of containment cell.
  - The cell base liner will comprise (ordered from vertically upwards):
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3m gravel drainage layer.
  - Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has not been included as it is not likely that this will be required due to the expect size of the waste materials.
  - The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - A 0.3 m thick sand drainage layer;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.15 m topsoil layer, seeded and mulched.

3) Post construction

- Ongoing monitoring and maintenance for containment cell likely involving:

- Installation and regular monitoring of groundwater and leachate sump wells installed around the new facility.
- Ongoing physical maintenance of the cell to maintain integrity of the cap.
- Ongoing leachate treatment.

- Ongoing documentation/reporting (as a requirement of consent/EPL conditions).
- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies.
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

D7.2 Likelihood of approval

This advice is based on the assumption that the disposal location already has the required approval and licence.

Planning Approval

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as ‘permitted without consent’ or ‘prohibited’ it follows that remediation works permissible with consent.

However, as remediation works are not specified as permitted with consent or without consent in the RU1 Primary Production Zone under the Maitland LEP, it is technically prohibited within the zone (it could be argued that the works would be “environmental protection works” which are defined in the Maitland LEP as “*works associated with the rehabilitation of land towards its natural state or any work to protect land from environmental degradation, and includes bush regeneration works, wetland protection works, erosion protection works, dune restoration works and the like, but does not include coastal protection works*”). This prohibition issue is resolved by clause 8(1) of State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) which permits remediation work to be undertaken on any land “*despite any provision to the contrary in an environmental planning instrument*”.

The treatment of the contaminated soils (including encapsulation in a containment cell) would be deemed contaminated soil treatment works under the Environmental Planning and Assessment Regulation 2000 (and therefore a category 1 remediation work), and therefore designated development due to the following trigger in clause 15(c)(ii) of the regulation:

“*(c) that treat contaminated soil originating exclusively from the site on which the development is located and:*

(ii) treat otherwise than by incineration and store more than 30,000 cubic metres of contaminated soil, "

Clause 15 could also be triggered if the central treatment location is deemed to be located on a different site as the source locations and:

"*(b) that treat more than 1,000 cubic metres per year of contaminated soil not originating from the site on which the development is located*".

With removal of the municipal waste, there would be an estimated 38,850 m^3 of material to be placed in the containment cell. Therefore it would be deemed designated development. Agencies are likely to include the removal of the municipal waste as part of the contaminated soil treatment and therefore part of the designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Cessnock City Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking development consent for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell construction requires disturbance of adjacent areas currently containing native vegetation).
- Aboriginal heritage (if the containment cell construction requires disturbance of adjacent areas of limited disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).

- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

Environment Protection Licencing

If the central treatment location is deemed to be located on a different site as the source locations, it would be a scheduled activity if the following is triggered:

"(a) *in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site*"

However, if the central treatment location is deemed to be located on the same site as the source locations, it would be a scheduled activity if the following is triggered:

"(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Likelihood of Approval

It is considered that this option has a moderate to high likelihood of approval.

D7.3 Cost

The estimated cost for this option is $11.7mil AUD NPV.

Refer to the attached costing for details.

D7.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.2 – 0.4	
Preparation of RAP and Planning Approval	0.75 – 1.25	Category 1 planning approval
Approvals	0.5 – 0.75	
Project Engineering Tasks	0.2 – 0.4	
Implementation	0.6 – 0.8	Estimated at 1500 t/wk
Final Reporting	0.2 – 0.4	
Total Estimated Timeframe	3 - 4	

D7.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

3) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that soils and wastes placed within the cell have low mobility and the containment cell is specifically engineered to minimize leachate generation;

4) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe event weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital cost. It is not likely that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $1mil AUD NPV.

D7.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘rare’ that this could occur in some extreme circumstances, such as severe weather. Should breaches occur the containment cell is situated in an area with a depth to groundwater in excess of 10 m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the low solubility of the wastes it is likely that remediation would require cap replacement and not result in prosecution. The consequence category is therefore considered to be ‘minor’. On this basis the risk ranking is ‘2’.

D8 On site Treatment to Achieve Complete Destruction

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
Moderate to high	46	7 - 9	0	12

D8.1 Description of the option

This option would involve the processing of the wastes to remove hazardous components including hydrocarbons, fluorides and cyanides, in conjunction with carbon value capitalisation in a waste to energy process. Research of global technologies identified that plasma gasification pilot scale trials have been undertaken on first and second cut SPL and municipal wastes. By-products of this process include SYN gas, vitirified rock (slag) and elemental metal. All by-products may be demonstrated as suitable for a beneficial further use.

It is envisaged that this process would require pilot studies prior to full scale treatment.

D8.2 Likelihood of approval

Resource Recovery Exemption

The by-products of the plasma gasification process include synthetic gases, base metals and vitrified rock-like material (slag). The synthetic gases can be used in energy generation, while the base metals and slag have potential reuse opportunities (for example granulated slag can be used as a construction base material).

A resource recovery exemption would need to be issued in accordance with the *Protection of the Environment Operations Act 1997* permitting the reuse of these materials. The exemption would be issued if it could be demonstrated that the waste material is of benefit in its proposed use and poses minimal risk of harm to the environment or human health. This includes providing evidence that the material is homogenous in physical and chemical quality, that it is stable and would not result in the leaching of contaminants into soils and groundwater, and that there is a genuine re-use opportunity for the material.

If a resource recovery exemption could not be gained, these materials would need to be disposed to a licensed landfill. Note however, that the following planning and licensing advice is based on the assumption that approval for disposal to landfill does not form part of this option.

Planning Approval

Treatment of the wastes using this approach would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other* *means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

The Project would be deemed as "designated development" under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of "Waste management facilities or works" under clause 32 of Schedule 3 of the regulation. This definition includes:

"(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or

The works would be designated development as it is triggers sub-clause 32(1)(a)(i) ("Aluminium smelting by-product" is registered as a dangerous good under the "Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition" (National Transport Commission, 2011)). An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as 'regional development' as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application (DA) for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While the Cessnock City Council will assess the DA, the consent authority for the works would be the Hunter and Central Coast Regional Panel.The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the treatment facility is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the treatment facility is located in an area of limited disturbance).
- Treatment phase noise and air quality.
- Treatment phase management of contaminants.
- Community and social impacts (including health).
- Consideration of alternatives to the treatment.
- Sustainability and carbon management.

It should be noted that Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the treatment of the SPL may be deemed part of the disposal process and therefore the activity deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

If this was the case, an EIS would be required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The key factor to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

"Waste disposal (thermal treatment)" is a scheduled activity under clause 40 of Schedule 1 of the *Protection of the Environment Operations Act 1997*. This includes "*thermal treatment of hazardous and other waste, meaning the* ***receiving*** *of hazardous waste, restricted solid waste, liquid waste or special waste* ***from off site*** *and its processing by thermal treatment*." Assuming that the plasma gasification treatment plant would be located on site, it would not meet this definition as the material would not be received from off site.

However, in the event that the process also includes the generation of energy, "Energy recovery" is a scheduled activity under Clause 18 of Schedule 1. Its definition includes:

"***energy recovery from hazardous and other waste*** (meaning other than general waste)*, meaning the receiving from* ***on site*** *or off site of, and the recovery of energy from, hazardous waste, restricted solid waste, liquid waste or special waste*."

Likelihood of Approval

As noted the plasma gasification process is a new technology, and is still proceeding through trial programs globally. Agencies may be reluctant to approve such a facility unless data from trials of similar technologies can provide greater certainty about performance. Consultation could be undertaken with agencies to discuss the opportunity for a trial (with monitoring to confirm its performance) prior to a full scale facility.

If sufficient information and evidence could be provided to the agencies on the environmental performance of plasma gasification, and the resource recovery exemptions for the by-products are granted, agencies are likely to look favourably on such a process and therefore it would have a high likelihood of approval.

D8.3 Cost

The estimated cost for this option is $46mil AUD NPV.

D8.4 Legacy

A legacy value is not assigned due to the complete destruction of the wastes. It was assumed that this option would only be selected if pilot scale testing demonstrated the end product was able to be reused.

D8.5 Timeframe to complete

The estimated timeframe to complete this option is 10 to 12 years allowing for pilot studies and planning approvals.

Activity	Estimated timeframe (years)
Pilot Trial	1
RAP/EIS	1
Approvals	1.75
Investigations/tender/contract negotiations	0.5
Construction/commissioning	1
Assumes treatment at 15000tpa	5-6
Validation Reporting	0.2
Total Estimated Timeframe	**10-12**

D8.6 Risk Ranking

The risk associated with this option is a technological risk from the unproven technology and the possibility that an alternate remediation solution will require implementation. The likelihood of this technology not being able to treat the SPL economically or technically into a condition that can be re-used without additional treatment (and therefore needing to landfill) is 'likely'. Potential issues associated with the applicability of the treatment to the capped waste stockpile wastes are considered to be equally valid. Risks include those associated with the pre-treatment requirements for the capped waste stockpile and the extent to which crushing and sorting is required.

The material is currently not qualified as inert and therefore it cannot be used without limitation as fill material. Also, no technical specification of material strength has been determined, (the physical properties are currently unknown). If it cannot be utilised as inert fill material, one of Options B1 to B9 would need to be implemented. In addition, as of 23 January 2014 there are no known estimates of the difference between input volume / weight, and volume / weight of the vitrified material (it is unknown how much of the processed material would be generated).

The consequence of the technology not being applicable to the site will require an alternate solution is considered 'moderate'. The alternate solution for remediation is comparable in cost to those presented in Options D1 to D7. It would also result in a loss in time prior to being able to implement a solution. On this basis this option is given a risk ranking of '12'.

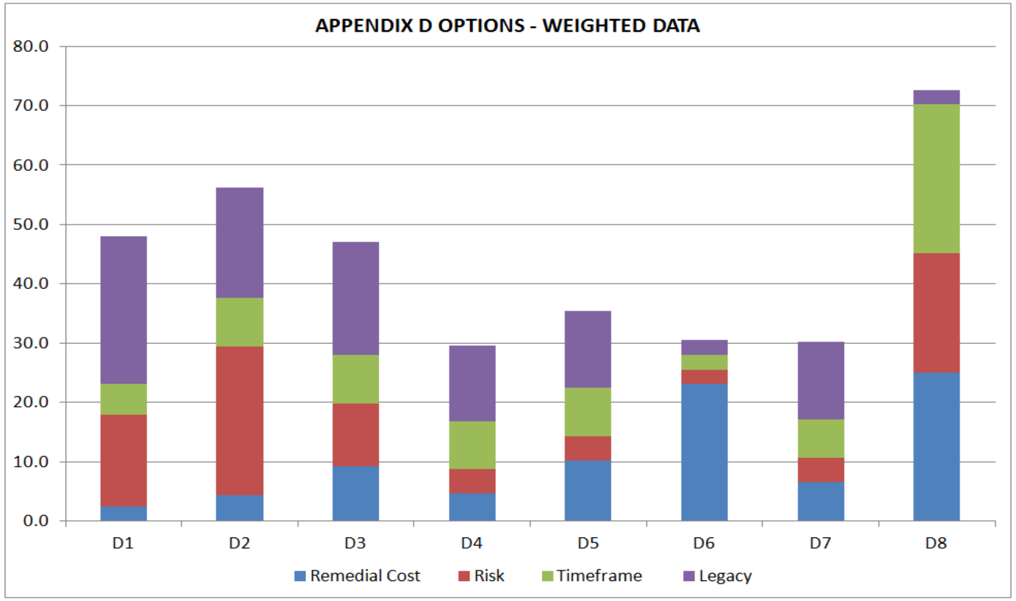
Location	Type	Volume estimates (m3)				Bulk Density (T/m3)	Mass esimate (t)	Mass estimates (T)	
				Range				Range	
		estimate	accuracy %	low	high			low	high
Dickson Road Landfill	**Smelter related wastes**	2500	*30*	1750	3250	*1.8*	*4500*	3150	5850
	contaminated soils	5600	*30*	3920	7280	*1.8*	*10080*	7056	13104
	municipal wastes	6000	*30*	4200	7800	*0.3*	*1800*	1260	2340
		14100					*16380*		
Glen Main landfill	**Smelter related wastes**	1600	*30*	1120	2080	*1.8*	*2880*	2016	3744
	contaminated soils	800	*30*	560	1040	*1.8*	*1440*	1008	1872
	municipal wastes	400	*30*	280	520	*0.3*	*120*	84	156
		2800					*0*		
Former Municipal Landfill	**municipal wastes**	8400	unknown	unknown	unknown	*1*	*8400*	unknown	unknown
							0		
Other Hydro owned land	**Asbestos (bonded) in soils, base**	6700	*100*	0	13400	*1.8*	*12060*	0	24120
	General refuse	unknown	*unknown*	unknown	unknown	*0.3*		unknown	unknown
	Recyclables (eg car bodies)	unknown	*unknown*	unknown	unknown	*0.3*		unknown	unknown
Clay borrow pit	**Buried**	12750	*50*	6375	19125	*2.8*	*35700*	17850	53550
	Stockpiled	2500	*50*	1250	3750	*2.8*	*7000*	3500	10500
TOTALS		47250					83980	35924	115236

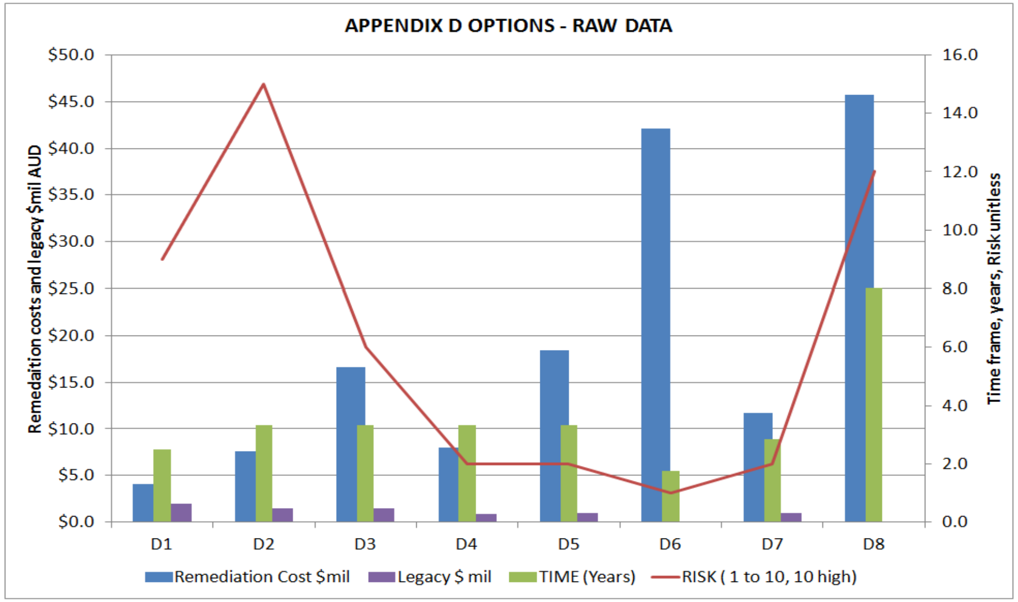
Description	**Remediation Cost $mil**	**Legacy $ mil**	**TIME (Years)**	**RISK (1 to 10, 10 high**
Option D1 Encapsulate Insitu	$4.1	$2.0	2.5	9
Option D2 Move to Alcan Moun	$7.6	$1.4	3.3	15
Option D3 Treat and move to Al	$16.6	$1.5	3.3	6
Option D4 Encapsulate in Conta	$8.0	$0.9	3.3	2
Option D5 Treat and encapsulat	$18.4	$0.9	3.3	2
Option D6 Dispose off Site	$42.1	$0.0	1.8	1
Option D7 Combination onsite a	$11.7	$0.9	2.9	2
Option D8 Onsite Destruction	$45.7	$0.0	8.0	12

Appendix D - Contaminated Soils in Buffer Zone

Weighting Factors

	Weighting (sums to 10)
Remedial Cost	2.5
Risk	2.5
Timeframe	2.5
Legacy	2.5
	10





Option D1 Encapsulate Insitu	
Description	**Encapsulate all materials in-situ**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Initial Investigations/risk assessment**						
		Dickson Road Landfill	1	each	$15,000	$15,000		ENVIRON experience
		Glen Main landfill	1	each	$15,000	$15,000		ENVIRON experience
		Former Municipal Landfill	1	each	$30,000	$30,000		ENVIRON experience
		Other Hydro owned land	1	each	$20,000	$20,000		ENVIRON experience
		Clay borrow pit	1	each	$0	$0	Completed through previous work	ENVIRON experience
		Sub-total initial investigation and risk assessment				**$80,000**		
	2	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$250,000	$250,000	EIS for Council approval	ENVIRON experience
		Sub-total preliminary documentation				**$340,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$127,461		USEPA Remediation Engineering
		Remedial Design			8%	$203,937		USEPA Remediation Engineering
		Construction Management			6%	$152,953		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$50,984		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$535,335**		
	4	**Site Preparation**					Site sheds, machinery compising backhoe and roller	
		Environmental controls	0			0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each	$26,000	$26,000		Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each	$15,000	$30,000		
		Sub-total site preparation				**$56,000**		
	5	**Encapsulation**						
		Placement of marker layer	90927	m2	$3	$313,698		Rawlinsons 2013 p677
		Placement of a capping layer of 0.5m thick, geotech cont	45463.5	cum	$26	$1,182,051		Rawlinsons 2013 p677
		Topsoil supply and placement (0.15m)	13639.05	cum	$17	$231,864		Rawlinsons 2013 p228
		Seed, fertilise and mulch for a period of 6 months	90927	m2	$8	$745,601		Rawlinsons p228
		Survey	allow			$20,000	Survey of capped areas and provision of a plan	ENVIRON experience
		Sub-total construction				**$2,493,214**		
	7	**Final Reporting**						
		Validation report		each	allow	$120,000	Multiple sites	ENVIRON experience
		EMP		each	allow	$40,000	Multiple sites	ENVIRON experience
		Site Auditor signoff		each	allow	$70,000	Multiple sites	ENVIRON experience
		Sub-total reporting				**$230,000**		
		Subtotal				$3,734,549		
		Contingency 10%				$373,455	10% Scope	
		CAPITAL COSTS				**$4,108,004**		

NOTES

Assumes the extent of capping outlined in Appendix D, though noting further work is currently being undertaken to refine these estimate
Assumes further investigation does not identify other not known contaminatior
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix D for a description of capping requirements and assumptions made
Ground preparation (e.g. removal of structures and vegetation) is undertaken as part of a demolition process and no costs have been allocatec
Clean fill is won locally and placed with a permeability of not less than 1 x 10-9 m/s
Capping is undertaken independently of other site activities
All works are undertaken in one mobilisation

Legacy Cost

Legacy potential liability provisioning	10%	event	NPV	$2,009,287	Capital cost determined from Option D6, off site disposa Off site disposal occuring at year 25	Using a discount rate of 3%
				$2,009,287		
Legacy provision				**$2,009,287**		

RISK	Comment		**Value**
	Moderate	Costs for remediation may be significant (disposal costs of $2.3mil NPV)	**9**
	Possible	It is possible that during future site use a cap breach would occur.	

Time	Description		
	Preparation of RAP and DA	1	years
	Approval	0.5	years
	Implementation	0.5	years
	Validation report	0.25	years
	Sub-total reporting	0.25	years
	Time	**2.5**	**years**

Option D2 Move to Alcan Mound	
Description	**Move all materials to the existing Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	17	EA	$1,100	$18,370	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	9	EA	$7,200	$64,800	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$83,170**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be requi	ENVIRON experience
		Planning approval and EIS			$250,000	$300,000	Assumes state approval requi	ENVIRON experience
		Sub-total preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$252,000		USEPA Remediation Engineering
		Remedial Design			8%	$403,000		USEPA Remediation Engineering
		Construction Management			6%	$302,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$101,000		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$1,058,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	8,350	m2	$2	$17,368		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	1,670	ha	$1,020	$170	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	8,350	m3	$8	$66,383		Rawlinsons 2013 p675
		Filling of Eastern Surge Pond	4,590	m3	$25	$114,750	Approximate area determinec	Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	10,671	m3	$24	$250,769		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	10,671	m2	$20	$216,088		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	10,671	m2	$4	$40,016		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	3,270	m3	$25	$81,750		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	10,635	m2	$20	$215,359		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	10,635	m2	$4	$39,881		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	3,270	m3	$25	$81,750		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	10,635	m2	$4	$39,881		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,366,549**		
	6	**Excavation Works**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Dickson Road Landfill	14100	m3	$12	$174,840	Excavate, transport<1km and	Rawlinsons
		Glen Main landfill	2800	m3	$12	$34,720	Excavate, transport<1km and	Rawlinsons
		Former Municipal Landfill	8400	m3	$12	$104,160	Excavate, transport<1km and	Rawlinsons
		Other Hydro owned land	6700	m3	$12	$83,080	Excavate, transport<1km and	Rawlinsons
		Clay borrow pit	15250	m3	$12	$189,100	Excavate, transport<1km and	Rawlinsons
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	47250	m3	$25	$1,181,250		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavation Works				**$2,179,150**		
	7	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	10,442	m3	$26	$271,492		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	20,884	m2	$20	$422,901		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	6,368	m3	$10	$62,088		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	20,884	m2	$4	$83,536		Rawlinsons 2013 p677
		Install General Fill (30 cm)	6,368	m3	$26	$165,568		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	3,184	m3	$17	$54,860		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	20,884	m2	$8	$166,654		Rawlinsons 2013 p228
		Supply and Install Fencing	521	m	$56	$29,165		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$1,268,372**		
	8	**Final Reporting**						
		Validation report		each	allow	$150,000	Mulitple sites plus containme	ENVIRON experience
		EMP		each	allow	$60,000	Mulitple sites plus containme	ENVIRON experience
		Site Auditor signoff		each	allow	$100,000	Mulitple sites plus containme	ENVIRON experience
		SUBTOTAL reporting				**$310,000**		
		Subtotal				$6,881,241		
		Contingency 10%				$688,124	10% Scope	
		CAPITAL COSTS				**$7,569,365**		

NOTES

Assumes volumes of material are as presented in Appendix D of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix D for a description of capping requirements and assumptions made
Assumes containment cell is constructed in the clay borrow pit footprint
Assumes all cell construction, excavation and placement is within one campaign

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years
	Maintenance	1	annual	$18,000	$532,672		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$221,515		no cost in year 0	
		1	each	$105,797	$105,796.63	year 25	Using a discount rate of 3%
		1	each	$24,133	$24,132.96	year 50	Using a discount rate of 3%
		1	each	$2,629	$2,629.17	year 75	Using a discount rate of 3%
		1	each	$137	$136.80	year 100	Using a discount rate of 3%
					$1,415,367		
	Legacy potential liability provisioning	2%	event	NPV	$34,444	assumes occurs in twice in 10	Using a discount rate of 3%
					$34,444		
					$1,449,812		

RISK	Comment		Value
			15
	Catastrophic	Due to the presence of shallow groundwater, proximity of an adjacent waterway and risk of prosecution	
	Possible	It is possible that during future site use a cap breach would occur.	

Time	Pre-Design Activities		0.25	years
	Preparation of RAP and Planning Approval		1	years
	Approvals		0.5	years
	Project Engineering Tasks		0.2	years
	Implementation	Assumes 300 tonnes/day, 250 days per year	1.1	years
	Final Reporting		0.25	years
	Time		**3.3**	**years**

Option D3 Treat and move to Alcan Mound	
Description	**Treat and move all materials to the existing Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	17	EA	$1,100	$18,370	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	9	EA	$7,200	$64,800	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$83,170**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be requ	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	EIS for Council approval	ENVIRON experience
		Sub-total preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$591,000		USEPA Remediation Engineering
		Remedial Design			8%	$945,000		USEPA Remediation Engineering
		Construction Management			6%	$709,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$236,000		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$2,481,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cel	8,350	m2	$2	$17,368		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cel	1,670	ha	$1,020	$170	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	8,350	m3	$8	$66,383		Rawlinsons 2013 p675
		Filling of Eastern Surge Ponc	4,590	m3	$25	$114,750	Approximate area determine	Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	10,671	m3	$24	$250,769		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	10,671	m2	$20	$216,088		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	10,671	m2	$4	$40,016		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	3,270	m3	$25	$81,750		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	10,635	m2	$20	$215,359		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	10,635	m2	$4	$39,881		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	3,270	m3	$25	$81,750		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	10,635	m2	$4	$39,881		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,366,549**		
	6	**Excavate, transport and place**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Dickson Road Landfill	14100	m3	$13	$182,313	Excavate, transport<2km anc	Rawlinsons p673
		Glen Main landfil	2800	m3	$16	$45,108	Excavate, transport<8km anc	Rawlinsons p673
		Former Municipal Landfill	8400	m3	$13	$113,064	Excavate, transport<3km anc	Rawlinsons p673
		Other Hydro owned land	6700	m3	$13	$90,182	Excavate, transport<3km anc	Rawlinsons p673
		Clay borrow pit	15250	m3	$12	$189,100	Excavate, transport<1km anc	Rawlinsons p673
		Soil Validation Works	1	ea	$200,000	$200,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	47250	m3	$25	$1,181,250		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavate, transport and place				**$2,313,017**		
	7	**Soil treatment by stablisation**						
		Pilot trials	1	ea	$20,000	$20,000	Treatability trials	ENVIRON Experience
		Soil treatment by stablisatior	11520	t	$575	$6,624,000		Vendor estimate
		SUBTOTAL Excavation Works				**$6,644,000**		
	8	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	10,442	m3	$26	$271,492		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	20,884	m2	$20	$422,901		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	6,368	m3	$10	$62,088		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	20,884	m2	$4	$83,536		Rawlinsons 2013 p677
		Install General Fill (30 cm)	6,368	m3	$26	$165,568		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	3,184	m3	$17	$54,860		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	20,884	m2	$8	$166,654		Rawlinsons 2013 p228
		Supply and Install Fencing	521	m	$56	$29,165		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$1,268,372**		
	9	**Final Reporting**						
		Validation report		each	allow	$150,000	Mulitple sites plus containme	ENVIRON experience
		EMP		each	allow	$60,000	Mulitple sites plus containme	ENVIRON experience
		Site Auditor signoff		each	allow	$100,000	Mulitple sites plus containme	ENVIRON experience
		SUBTOTAL reporting				**$310,000**		
		Subtotal				$15,082,108		
		Contingency 10%				$1,508,211	10% Scope	
		CAPITAL COSTS				**$16,590,319**		

NOTES

Assumes volumes of material are as presented in Appendix D of the Remedial Options Summar
Assumes further investigation does not identify other not known contaminatio
Assumes program can be acheived through the use of standard excavating equipmen
Refer to Appendix D for a description of capping requirements and assumptions mad
Assumes all cell construction, excavation and placement is within one campaig

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years
							Based on 12 events per year for 100 years,
	Maintenance	1	annual	$18,000	$532,672		using a discount rate of 3%
	Topsoil replacement and reseeding battered perimete	Base year	each	$221,515		no cost in year 0	
		1	each	$105,797	$105,796.63	year 25	Using a discount rate of 3%
		1	each	$24,133	$24,132.96	year 50	Using a discount rate of 3%
		1	each	$2,629	$2,629.17	year 75	Using a discount rate of 3%
		1	each	$137	$136.80	year 100	Using a discount rate of 3%
					$1,415,367		
	Legacy potential liability provisioning	2%	event	NPV	$75,732	assumes occurs in twice in 1(	Using a discount rate of 3%
					$75,732		
					$1,491,099		

RISK	Comment		Value
			6
	Minor	Due to the presence of shallow groundwater, proximity of an adjacent waterway and risk of prosecutio	
	Possible	It is possible that during future site use a cap breach would occur	

Time	Activity		Duration	
	Pre-Design Activities		0.25	years
	Preparation of RAP and Planning Approva		1	years
	Approvals		0.5	years
	Project Engineering Tasks		0.2	years
	Implementation including treatment	Limited by placement rate of 300t/day, 250 days per year	1.1	years
	Final Reporting		0.25	years
	Time		3.3	**years**

Option D4 Encapsulate in Containment Cell	
Description	**Encapsulate in Containment Cell**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	4	EA	$1,100	$4,409	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	3	EA	$7,200	$21,600	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$26,009**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulato	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	EIS for Council approval	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$116,000		USEPA Remediation Engineering
		Remedial Design			8%	$185,000		USEPA Remediation Engineering
		Construction Management			6%	$139,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$46,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$486,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		Vendor estimate
		SUBTOTAL Site Preparation				**$688,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	17,689	m2	$2	$36,793		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	10,613	ha	$1,020	$1,083	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	17,689	m3	$8	$140,628		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	18,079	m3	$24	$424,857		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	18,043	m2	$20	$365,371		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	18,043	m2	$4	$67,661		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	5,528	m3	$25	$138,200		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	18,043	m2	$20	$365,371		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	18,043	m2	$4	$67,661		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	5,528	m3	$25	$138,200		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	868	m	$128	$111,104		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	5,528	m2	$4	$20,730		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,887,658**		
	6	**Excavate, transport and place**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Dickson Road Landfill	14100	m3	$13	$182,313	Excavate, transport<2km and deposit	Rawlinsons p673
		Glen Main landfill	2800	m3	$16	$45,108	Excavate, transport<8km and deposit	Rawlinsons p673
		Former Municipal Landfill	8400	m3	$13	$113,064	Excavate, transport<3km and deposit	Rawlinsons p673
		Other Hydro owned land	6700	m3	$13	$90,182	Excavate, transport<3km and deposit	Rawlinsons p673
		Clay borrow pit	15250	m3	$12	$189,100	Excavate, transport<1km and deposit	Rawlinsons p673
		Soil Validation Works	1	EA	$200,000	$200,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	47250	m3	$25	$1,181,250		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavate, transport and place				**$2,313,017**		
	7	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	10,996	m3	$26	$285,896		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	18,326	m2	$20	$371,102		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	5,588	m3	$10	$54,483		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	18,326	m2	$4	$73,304		Rawlinsons 2013 p677
		Install General Fill (30 cm)	5,588	m3	$26	$145,288		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	2,794	m3	$17	$48,141		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	18,326	m2	$8	$146,608		Rawlinsons 2013 p228
		Supply and Install Fencing	624	m	$56	$34,944		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cell Construction and Cap Construction				**$1,171,873**		
	8	**Final Reporting**						
		Validation report		each	allow	$150,000	Mulitple sites plus containment cell	ENVIRON experience
		EMP		each	allow	$60,000	Mulitple sites plus containment cell	ENVIRON experience
		Site Auditor signoff		each	allow	$100,000	Mulitple sites plus containment cell	ENVIRON experience
		SUBTOTAL reporting				**$310,000**		
		Subtotal				$7,272,557		
		Contingency 10%				$727,256	10% Scope	
		CAPITAL COSTS				**$7,999,812**		

NOTES

Assumes volumes of material are as presented in Appendix D of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix D for a description of capping requirements and assumptions made

Legacy Cost								
	Groundwater Monitoring	2		annual	$150,000	$300,000		Based on two events per year for 2 years
	Maintenance	1		each	NPV	$568,780		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year		each	$47,052			
			1	each	$22,472	$22,472.25	year 25	Using a discount rate of 3%
			1	each	$5,126	$5,126.08	year 50	Using a discount rate of 3%
			1	each	$558	$558.46	year 75	Using a discount rate of 3%
			1	each	$29	$29.06	year 100	Using a discount rate of 3%
						$896,966		
	Legacy potential liability provisioning	1%		event	NPV	$18,249	Occurring once in 100 years and at Year 50	Using a discount rate of 3%
					Legacy provision	**$915,215**		

Risk

Ranking		**Value**
Minor	If a breaching of the capping layer occurs, reinstatement of the cap would be requried, given the low solubility of contaminants present it is unlikely that a risk of harm or prosecution would result	**2**
Rare	only occuring in extreme circumstances	

Time			
Pre-Design Activities		0.25	years
Preparation of RAP and Planning Approval		1	years
Approvals		0.5	years
Project Engineering Tasks		0.2	years
Implementation including treatment	Limited by placement rate of 300t/day, 250 days per year	1.1	years
Final Reporting		0.25	years
	Time	**3.3**	**years**

Option D5 Treat and encapsulate in Containment Cell	
Description	**Treat and encapsulate in Containment Cell**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	4	EA	$1,100	$4,409	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	3	EA	$7,200	$21,600	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$26,009**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulato	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	EIS for Council approval	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$390,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$671,000		USEPA Remediation Engineering
		Remedial Design			8%	$1,073,000		USEPA Remediation Engineering
		Construction Management			6%	$805,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$268,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$2,817,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$250,000	$250,000	Mulitple sites outside the smelter footprint	Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		Vendor estimate
		SUBTOTAL Site Preparation				**$912,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	17,689	m2	$2	$36,793		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	10,613	ha	$1,020	$1,082.57	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	17,689	m3	$8	$140,628		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	18,079	m3	$24	$424,857		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	18,043	m2	$20	$365,371		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	18,043	m2	$4	$67,661		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	5,528	m3	$25	$138,200		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	18,043	m2	$20	$365,371		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	18,043	m2	$4	$67,661		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	5,528	m3	$25	$138,200		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	868	m	$128	$111,104		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	5,528	m2	$4	$20,730		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,887,658**		
	6	**Excavate, transport and place**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Dickson Road Landfill	14100	m3	$13	$182,313	Excavate, transport<2km and deposit	Rawlinsons p673
		Glen Main landfill	2800	m3	$16	$45,108	Excavate, transport<8km and deposit	Rawlinsons p673
		Former Municipal Landfill	8400	m3	$13	$113,064	Excavate, transport<3km and deposit	Rawlinsons p673
		Other Hydro owned land	6700	m3	$13	$90,182	Excavate, transport<3km and deposit	Rawlinsons p673
		Clay borrow pit	15250	m3	$12	$189,100	Excavate, transport<1km and deposit	Rawlinsons p673
		Soil Validation Works	1	EA	$200,000	$200,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	47250	m3	$25	$1,181,250		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavate, transport and place				**$2,313,017**		
	7	**Sorting and treatment of contaminated soils**						
		Treatability trials	1	ea	$40,000	$40,000	Treatability trials	ENVIRON Experience
		Excavating and placing to stockpile	47,250	m3	$8	$378,000		Rawlinsons 2013 p673, for light soil
		Sorting manual	9,450	hrs	$64	$604,800	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Treat contaminated soil component to inert product	11,520	t	$530	$6,105,600	Assumes treatment cost is equal to current F	Hydro, Regain contract
		SUBTOTAL Sorting and treatment of contaminated soils				**$7,128,400**		
	8	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	10,996	m3	$26	$285,896		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	18,326	m2	$20	$371,102		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	5,588	m3	$10	$54,483		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	18,326	m2	$4	$73,304		Rawlinsons 2013 p677
		Install General Fill (30 cm)	5,588	m3	$26	$145,288		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	2,794	m3	$17	$48,141		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	18,326	m2	$8	$146,608		Rawlinsons 2013 p228
		Supply and Install Fencing	624	m	$56	$34,944		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cell Construction and Cap Construction				**$1,171,873**		
	9	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		
		Subtotal				$16,770,957		
		Contingency 10%				$1,677,096	10% Scope	
		CAPITAL COSTS				**$18,448,052**		

NOTES

Assumes volumes of material are as presented in Appendix D of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix D for a description of capping requirements and assumptions made

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
	Maintenance	1	each	NPV	$566,879		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$47,052			
		1	each	$22,472	$22,472.25	year 25	Using a discount rate of 3%
		1	each	$5,126	$5,126.08	year 50	Using a discount rate of 3%
		1	each	$558	$558.46	year 75	Using a discount rate of 3%
		1	each	$29	$29.06	year 100	Using a discount rate of 3%
					$895,065		
	Legacy potential liability provisioning	1%	event	NPV	$41,972	Occurring once in 100 years and at Year 50	Using a discount rate of 3%
				Legacy provision	**$937,037**		

Risk				
			Value	
	Ranking		2	
	Minor	If a breaching of the capping layer occurs, reinstatement of the cap would be requried, given the low solubility of contaminants present it is unlikely that a risk of harm or prosecution would result		
	Rare	Only occuring on exceptional circumstances		

Time				
Time	Pre-Design Activities		0.25	years
	Preparation of RAP and Planning Approval		1	years
	Approvals		0.5	years
	Project Engineering Tasks		0.2	years
	Implementation including treatment	Limited by placement rate of 300t/day, 250 days per year	1.1	years
	Final Reporting		0.25	years
	Time		**3.3**	**years**

Option D6 Dispose off Site	
Description	**Excavate all materials and dispose off site to landfill**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be requ	ENVIRON experience
		Development application			$15,000	$15,000	Assumes category 2 developr	ENVIRON experience
		SUBTOTAL preliminary documentation				**$105,000**		
	2	**Project Tasks**						
		Project Management			5%	$1,907,106.75		Rawlinsons?
		SUBTOTAL Project tasks						
	3	**Site Preparation**					Site sheds, machinery compising backhoe and roller	
		Erosion Control Measures	1	LS	$250,000	$250,000	Mulitple sites outside the sm	Vendor Estimate/ENVIRON Experience
		Mobilisation/demobilisation	2	each	$2,000	$4,000		
		SUBTOTAL Site preparation				**$254,000**		
	4	**Excavation Works**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Dickson Road Landfill						
		Smelter related wastes	2500	m3	$8	$20,000		Rawlinsons 2013 p673, for light soil
		contaminated soils	5600	m3	$8	$44,800		Rawlinsons 2013 p673, for light soil
		municipal wastes	6000	m3	$8	$48,000		Rawlinsons 2013 p673, for light soil
		Sorting manual	2820	hrs	$64	$180,480	Assumes 5 m3 sorted in one l	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Glen Main landfill						Rawlinsons 2013 p673, for light soil
		Smelter related wastes	1600	m3	$8	$12,800		Rawlinsons 2013 p673, for light soil
		contaminated soils	800	m3	$8	$6,400		Rawlinsons 2013 p673, for light soil
		municipal wastes	400	m3	$8	$3,200		Rawlinsons 2013 p673, for light soil
		Sorting manual	560	hrs	$64	$35,840	Assumes 5 m3 sorted in one l	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Former Municipal Landfill						Rawlinsons 2013 p673, for light soil
		municipal wastes	8400	m3	$8	$67,200		Rawlinsons 2013 p673, for light soil
		Other Hydro owned land						Rawlinsons 2013 p673, for light soil
		Asbestos (bonded) in soils	6700	m3	$8	$53,600		Rawlinsons 2013 p673, for light soil
		Clay borrow pit						Rawlinsons 2013 p673, for light soil
		Buried	12750	m3	$8	$102,000		Rawlinsons 2013 p673, for light soil
		Stockpiled	2500	m3	$8	$20,000		Rawlinsons 2013 p673, for light soil
		Soil reinstatement	50630	m3	$25	$1,265,750		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavation Works				**594,320**		
	5	**Field Soil Validation**						
		Soil validation and reporting	1	ea	$200,000	$200,000	includes laboratory fees	ENVIRON Experience
		SUBTOTAL Validation Works				**$200,000**		
	6	**Loading costs**						
		All wastes	47250	m3	$5	$217,350	assume sand & < 1m	Rawlinsons
		Sub-total excavation costs				**$217,350**		
	7	**Transport costs**						
		Cessnock landfill	21950	m3	$3	$63,655	Cessnock	Rawlinsons, based on 10km
		Newcastle	6400	m3	$15	$92,800	Newcastle	Rawlinsons, based on 30km
		Sydney	4100	m3	$84	$344,810	Sydney	Rawlinsons, based on 150km
		Sub-total disposal costs				**$501,265**		
	8	**Disposal Costs (Cessnock/ NSW Landfill)**						
		Cessnock landfill, municipal wastes	10320	t	$315	$3,250,800	Municipal wastes/domestic v	Cessnock landfill Rates 2013-2014
		Cessnock landfill, special wastes	54760	t	$370	$20,261,200	Asbestos and contaminated s	Cessnock landfill Rates 2013-2014
		Newcastle	11520	t	$585	$6,739,200	Untreated, hazardous waste	Newcastle, Transpacific
		Sydney	7380	t	$800	$5,904,000	Untreated, hazardous waste	SITA facility in Sydney or Veolia
		Sub-total disposal costs				**36,155,200**		
	9	**Final Reporting**						
		Validation report		each	allow	$100,000	Mulitple sites	ENVIRON experience
		EMP		each	allow	$40,000	Mulitple sites	ENVIRON experience
		Site Auditor signoff		each	allow	$80,000	Mulitple sites	ENVIRON experience
		Sub-total reporting				**$220,000**		
		Subtotal				$38,247,135		
		Contingency 10%				$3,824,714	10% Scope	
		ALTERNATIVE 2 CAPITAL COSTS				**$42,071,849**		

NOTES

Assumes volumes of material are as presented in Appendix D of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment

Legacy Cost			
	Legacy provision	**$0**	All materials disposed off site

RISK			
	Comment	**Value**	
		1	
Insignificant	Remediation costs not liable to Hydro		
Rare	Not likely to occur		

Time		
Approval	0.2	years
Excavation, transport and disposal at 1500t/week	1.3	years
Reporting and auditor signoff	0.25	years
Time	**1.8**	**years**

Option D7 Combination onsite and off site disposal	
Description	**Combination of on site and off site disposal**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	15	EA	$1,100	$17,037	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	8	EA	$7,200	$57,600	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$74,637**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be requ	ENVIRON experience
		Development application			$150,000	$150,000	Category 1, small EIS	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$240,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$436,000		USEPA Remediation Engineering
		Remedial Design			8%	$500,000		USEPA Remediation Engineering
		Construction Management			6%	$375,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$129,000		ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$1,440,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		Vendor estimate
		SUBTOTAL Site Preparation				**$688,000**		
	4	**Excavation Works**						
		Dickson Road Landfill						
		Smelter related wastes	2500	m3	$8	$20,000		Rawlinsons 2013 p673, for light soil
		contaminated soils	5600	m3	$8	$44,800		Rawlinsons 2013 p673, for light soil
		municipal wastes	6000	m3	$8	$48,000		Rawlinsons 2013 p673, for light soil
		Sorting manual	2820	hrs	$64	$180,480	Assumes 5 m3 sorted in one	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Glen Main landfill						Rawlinsons 2013 p673, for light soil
		Smelter related wastes	1600	m3	$8	$12,800		Rawlinsons 2013 p673, for light soil
		contaminated soils	800	m3	$8	$6,400		Rawlinsons 2013 p673, for light soil
		municipal wastes	400	m3	$8	$3,200		Rawlinsons 2013 p673, for light soil
		Sorting manual	560	hrs	$64	$35,840	Assumes 5 m3 sorted in one	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Former Municipal Landfill						Rawlinsons 2013 p673, for light soil
		municipal wastes	8400	m3	$8	$67,200		Rawlinsons 2013 p673, for light soil
		Other Hydro owned land						Rawlinsons 2013 p673, for light soil
		Asbestos (bonded) in soils	6700	m3	$8	$53,600		Rawlinsons 2013 p673, for light soil
		Clay borrow pit						Rawlinsons 2013 p673, for light soil
		Buried	12750	m3	$8	$102,000		Rawlinsons 2013 p673, for light soil
		Stockpiled	2500	m3	$8	$20,000		Rawlinsons 2013 p673, for light soil
		SUBTOTAL Excavation Works				**$594,320**		
	5	**Field Soil Validation**						
		Soil validation and reporting	1	ea	$200,000	$200,000	includes laboratory fees	ENVIRON Experience
		SUBTOTAL Validation Works				**$200,000**		
	6	**Disposal of municipal waste to landfill**						
		Transport	14800	m3	$3	$42,920	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, municipal wastes	10320	t	$315	$3,250,800	Municipal wastes/domestic v	Cessnock landfill Rates 2013-2014
		Sub-total disposal costs				**3,293,720**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	7,744	m2	$2	$16,108		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	4,646	ha	$1,020	$473.93	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	7,744	m3	$8	$61,565		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	7,979	m3	$24	$187,507		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	8,015	m2	$20	$162,304		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	8,015	m2	$4	$30,056		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	2,460	m3	$25	$61,500		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	7,979	m2	$20	$161,575		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	7,979	m2	$4	$29,921		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	2,460	m3	$25	$61,500		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	395	m	$128	$50,560		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	7,979	m2	$4	$29,921		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$862,990**		
	6	**Load, transport and place**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Dickson Road Landfill	8100	m3	$13	$104,733	Excavate, transport<2km and	Rawlinsons p673
		Glen Main landfill	2400	m3	$16	$38,664	Excavate, transport<8km and	Rawlinsons p673
		Other Hydro owned land	6700	m3	$13	$90,182	Excavate, transport<3km and	Rawlinsons p673
		Clay borrow pit	15250	m3	$12	$189,100	Excavate, transport<1km and	Rawlinsons p673
		Soil Validation Works	1	EA	$200,000	$200,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	61716	m3	$25	$1,542,900		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavate, transport and place				**$2,477,579**		
	7	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	8,028	m3	$26	$208,728		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	8,028	m2	$20	$162,567		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	2,448	m3	$10	$23,868		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	8,028	m2	$4	$32,112		Rawlinsons 2013 p677
		Install General Fill (30 cm)	2,448	m3	$26	$63,648		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	1,224	m3	$17	$21,090		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	8,028	m2	$8	$64,224		Rawlinsons 2013 p228
		Supply and Install Fencing	408	m	$56	$22,848		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cell Construction and Cap Construction				**$611,192**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		

Subtotal			$10,607,438	
Contingency 10%			$1,060,744	10% Scope
CAPITAL COSTS			**$11,668,182**	

NOTES

Assumes volumes of material are as presented in Appendix D of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Assumes Cessnock Landfill will accept special waste

Legacy Cost

Groundwater Monitoring	2	annual	$150,000	$300,000		Based on two events per year for 2 years
Maintenance	1	each	NPV	$566,879		Based on 12 events per year for 100 years, using a discount rate of 3%
Topsoil replacement and reseeding battered perimeter	Base year	each	$87,072			
	1	each	$41,586	$41,586.07	year 25	Using a discount rate of 3%
	1	each	$9,486	$9,486.08	year 50	Using a discount rate of 3%
	1	each	$1,033	$1,033.46	year 75	Using a discount rate of 3%
	1	each	$54	$53.77	year 100	Using a discount rate of 3%
				$919,038		
Legacy potential liability provisioning	1%	event	NPV	$24,179	Occurring once in 100 years a	Using a discount rate of 3%
			Legacy provision	**$943,218**		

RISK

Comment		Value
		2
Minor	Costs associated with clean up are expected to be minor remedial works	
Rare	May occur only in exceptional circumstances	

Time

Pre-Design Activities	0.25	years
Preparation of RAP and Planning Approval	1	years
Approvals	0.5	years
Project Engineering Tasks	0.25	years
Implementation	0.6	years
Final Reporting and auditor sign off	0.25	years
Time	2.85	years

Option D8 Onsite Destruction	
Description	**Onsite Waste to Energy**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Planning approval			$350,000	$350,000	EIS required	ENVIRON experience
		Sub-total preliminary documentation				**$400,000**		
	2	**Pilot Trial**						
		Allow				$100,000		Estimate
		Sub-total pilot trial				**$100,000**		
	3	**Project Tasks**						
		Project Management			5%	$37,000	Does not include treatment	USEPA Remediation Costs
		Sub-total Technical Tasks Capital Cost				**$37,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Load, transport and place**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Dickson Road Landfill	8,100	m3	$13	$104,733	Excavate, transport<2km an	Rawlinsons p673
		Glen Main landfill	2,400	m3	$16	$38,664	Excavate, transport<8km an	Rawlinsons p673
		Other Hydro owned land	6,700	m3	$13	$90,182	Excavate, transport<3km an	Rawlinsons p673
		Clay borrow pit	15,250	m3	$12	$189,100	Excavate, transport<1km an	Rawlinsons p673
		Soil Validation Works	1	EA	$200,000	$200,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	61,716	m3	$25	$1,542,900		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavate, transport and place				**$2,477,579**		
	6	**Sorting, placement and treatment of Alcan Mound wastes**						
		Treatment through plasma gasification	84,000	t	$450	$37,800,000	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL Placement of SPL				**$37,800,000**		
	7	**Final Reporting**						
		Validation report		each	allow	$500,000	includes confirmatory testin	ENVIRON experience
		Sub-total reporting				**$500,000**		
		Subtotal				$41,540,579		
		Contingency 10%				$4,154,058	10% Scope	
		CAPITAL COSTS				**$45,695,000**		

NOTES
Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes by-products are approved by NSW regulators for reuse and do not require landfilling. 80% plasma rock is estimated to be generated.
Rate of treatment per tonne provided by Tetronics includes a rate of return and profit margin. This rate could be negotiated. Applies to 15000 tpa plant

Legacy Cost		
	Legacy provision	$0

Risk		Value
Comment	Likely moderate	12

Time		
Pilot Trial	1	years
RAP/EIS	1	
Approvals	1.75	years
Investigations/tender/contract negotiations	0.5	years
Construction/commissioning	1	years
Assumes treatment at 15000tpa	5.6	years
Validation Reporting	0.2	years
TOTAL	11.05	years

Appendix E

Demolition Wastes Detailed Options Review

E Demolition Wastes

Demolition wastes are described as follows

SPL in Storage Statistics		
Volume (m^3)	**Tonnage (t)**	**Description**
Unknown, allow 20,000 – 40,000	Unknown, allow 14,000 – 26,000	Demolition Wastes - demolition wastes are currently unknown and will be finalised following consultation with demolition contractor. A conservative allowance has been made here. This is based on contractor estimates of concrete and steel volumes being 50,000 t, which make up the majority of the demolished structures.
Remediation Options E1 - Move to specifically designed landfill adjacent to capped waste stockpile E2 - Encapsulate in purpose built containment cell E3 - Dispose off site E4 - On site Treatment to Achieve Complete Destruction		

E1 Move to specifically designed landfill adjacent to capped waste stockpile

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)	Risk Ranking
Moderate to high	2.8	3 - 4	0.7	15

E1.1 Description of the option

The capped waste stockpile comprises mixed waste smelter materials including SPL. The capped waste stockpile is situated within the eastern area of the Smelter Site and is surrounded by undeveloped land. To consolidate waste disposal on the site, a cell adjacent and adjoining the capped waste stockpile can be constructed for placement of demolition wastes. The cell construction is described below. No improvements to the capped waste stockpile have been included here as these are presented in Appendix A and Appendix G.

For the option of placing contaminated soils adjacent to the existing capped waste stockpile, the process would comprise:

1) *Pre-construction*

- Assess the area surrounding the existing capped waste stockpile and determine a geotechnically suitable area for additional waste placement.
- Detailed investigations would include boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Design of "best practice" containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award;
- Attain the required planning approval for construction and operation.

2) *Construction*

- Construction of the containment cell.

- The cell base liner will comprise (ordered from vertically upwards)
  - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;
  - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer.
- Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required.
- The cell cap liner will comprise (ordered from vertically upwards)
  - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - A 0.3 m thick sand drainage layer;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m protection layer overlain by;
  - A 0.15 m topsoil layer, seeded and mulched.

3) Post construction

- Ongoing monitoring and maintenance of the containment cell likely involving:
  - Installation and regular monitoring of groundwater monitoring wells installed around the new facility;

    - Ongoing physical maintenance of the cell to maintain integrity of the cap;
    - Ongoing leachate evaluation for a period of time to demonstrate performance.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the environmental protection licence – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

E1.2 Likelihood of approval

Planning Approval

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the upgraded capped waste stockpile would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

"*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*."

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

"(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment"

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

It is assumed that the demolition activities and construction operation of the containment cell would be addressed in one development application.

"Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"*(1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

The groundwater in the vicinity of the capped waste stockpile is known to be shallow; therefore it is likely that a containment cell adjacent to the capped waste stockpile would be deemed as designated development.

An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

Developments are classified as 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking planning approval for the works.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Non-indigenous heritage (determine if any structures to be demolished have heritage value)
- Demolition and construction noise and air quality
- Demolition and construction traffic

- Soil and water management (including hydrology and geotechnical conditions)
- Aesthetics and visual impacts
- Community and social impacts (including health)
- Consideration of alternatives
- Sustainability and carbon management

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council
- Environment Protection Authority (EPA)
- NSW Office of Water (NOW)
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure
- Local Members of Parliament
- The local community (including residents and local community and environmental groups)
- Key Aboriginal stakeholder groups

Environment Protection Licencing

Waste disposal (application to land)" is a scheduled activity. However, it only applies to waste received from off site. As the demolition wastes are generated from on site, this does not apply.

Likelihood of Approval

This option has a moderate to high likelihood of approval.

E1.3 Cost

The estimated cost for this option is $2.8mil AUD NPV.

Refer to the attached costing for details.

E1.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.2 – 0.3	Containment cell design and site testing
Preparation of RAP and Planning Approval	0.75 – 1.25	Preparation of EIS
Approvals	0.5 - 1	
Project Engineering Tasks	0.2 – 0.4	
Implementation	1 – 2	Dependent on rate of demolition
Final Reporting	0.2 – 0.4	Assumes completed concurrent with implementation stages
Total Estimated Timeframe	3 - 4	

E1.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe event weather events or an earthquake. A percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital cost. It is not proposed that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 2% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $0.7mil AUD NPV.

E1.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from the proximity to the capped waste stockpile, which has not benefitted from the same levels of engineering and contains fill placed in an uncontrolled manner. There is an additional risk that the placement of this cell adjacent and connected to the existing capped waste stockpile could affect the integrity of the existing capped waste stockpile. The chance of failure occurring is therefore considered to be ‘possible’, it might occur at some time. In the event of failure, due to the proximity of shallow groundwater and the known discharge of shallow groundwater to the surface, the consequence of failure could be ‘catastrophic’ due to the risk of prosecution and cost of remediation. On this basis the risk ranking is ‘15’.

E2 Encapsulate in purpose built containment cell

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)	Risk Ranking
Moderate to high	3.0	1 – 2	0.9	10

E2.1 Description of the option

This option would manage the waste materials by placement within a purpose built containment cell constructed at an appropriate location on the site and applying best practice containment cell design and construction.

This option would involve the following steps:

1) Pre-construction

- Investigation/s of the site to identify the optimum location for placement of a contaminated soil containment cell. The investigation would comprise detailed investigations including boreholes/test pits assessing depth to groundwater and nature and suitability of underlying soil profile.
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Remediation notification process with Cessnock City Council.
- Design of a “best practice” containment cell to suit site conditions and also addressing consent conditions. Preparation of specification and tender documents. Tendering / contractor award.

2) Construction

- Construction of the containment cell.
  - The cell base liner will comprise (ordered from vertically upwards):
    - A 1 m thick clay liner of permeability 1 x 10^{-9} m/s overlain by;

  - A 1.5 mm thick, high density polyethylene (HDPE) liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer.
- Placement of the wastes into the new storage cell. Compacting within the cell will be required to minimize settlement of the capping layers. Given the large void spaces and low likelihood that an effective compaction will be achieved an engineered solution, (for example, a geotextile) may be required. Crushing has not been included as it is not likely that this will be required due to the expect size of the waste materials.
- The cell cap liner will comprise (ordered from vertically upwards)
  - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - A 0.3 m thick sand drainage layer;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m protection layer overlain by;
  - A 0.15 m topsoil layer, seeded and mulched.

3) Post construction

- Ongoing monitoring and maintenance of the containment cell likely involving:
- Installation and regular monitoring of groundwater and leachate sump wells installed around the new facility.
- Ongoing physical maintenance of the cell to maintain integrity of the cap.

- Ongoing leachate treatment.

- Ongoing documentation/reporting (as a requirement of consent/EPL conditions).
- Licence surrender – to be determined in negotiation with EPA and other regulatory agencies.
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

E2.2 Likelihood of approval

Planning Approval

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the upgraded capped waste stockpile would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

"*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*."

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

"(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment"

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

It is assumed that the demolition activities and construction operation of the containment cell would be addressed in one development application.

"Waste management facilities or works" are designated development under Schedule 1 of the Environmental Planning and Assessment regulation 2000. The definition of such works includes the following:

"*(1) Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(d) that are located:

(i) in or within 100 metres of a natural waterbody, wetland, coastal dune field or environmentally sensitive area, or

(ii) in an area of high watertable, highly permeable soils, acid sulphate, sodic or saline soils"

It has been assumed that a location for the containment cell would be found that does not trigger these criteria, and therefore would not be deemed a designated development. Therefore a Statement of Environmental Effects (SEE) is required to support a development application for the proposed development.

Developments are classified as 'regional development' if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking planning approval for the works.

The SEE will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell requires disturbance of adjacent areas currently containing native vegetation)
- Aboriginal heritage (if the containment cell requires disturbance of adjacent areas of limited disturbance)
- Non-indigenous heritage (determine if any structures to be demolished have heritage value)
- Demolition and construction noise and air quality
- Demolition and construction traffic

- Soil and water management (including hydrology and geotechnical conditions)
- Aesthetics and visual impacts
- Community and social impacts (including health)
- Consideration of alternatives
- Sustainability and carbon management

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council
- Environment Protection Authority (EPA)
- NSW Office of Water (NOW)
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure
- Local Members of Parliament
- The local community (including residents and local community and environmental groups)
- Key Aboriginal stakeholder groups

Environment Protection Licencing

Waste disposal (application to land)" is a scheduled activity. However, it only applies to waste received from off site. As the demolition wastes are generated from on site, this does not apply.

Likelihood of Approval

This option has a moderate to high likelihood of approval.

E2.3 Cost

The estimated cost for this option is $3.0mil AUD NPV.

Refer to the attached costing for details.

E2.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Implementation	1 – 2	Dependent on rate of demolition
Total Estimated Timeframe	1 - 2	

E2.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater and leachate monitoring will be required for a period of 2 years on an annual basis and include annual reporting. A reduced monitoring timeframe (compared to 5 years) is expected on the basis that soils and wastes placed within the cell have low mobility and the containment cell is specifically engineered to minimize leachate generation;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur under rare circumstances such as severe weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe.

Should this event occur the costs are proposed to be consistent with the initial capital cost. It is not likely that materials placed in the containment cell would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be approximately $0.9mil AUD NPV.

E2.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘unlikely’ that this could occur in some extreme circumstances, such as severe weather. Should breaches occur the containment cell is situated in an area with a depth to groundwater in excess of 10 m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the low solubility of the wastes it is likely that remediation would require cap replacement and not result in prosecution. The consequence category is therefore considered to be ‘insignificant’. On this basis the risk ranking is ‘10’.

E3 Dispose off site

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD NPV)[1]	Risk Ranking
High	8.9	1 - 2	0	1

E3.1 Description of the option

This option involves disposing of the demolition waste at an off-site location. Sorting of waste has not been included and all waste will be disposed of as special waste, allowing for contamination of wastes or asbestos containing materials. This approach is considered conservative.

Cost analysis includes loading of trucks, transport to landfill and landfill disposal fees.

E3.2 Likelihood of approval

This advice is based on the assumption that the chosen disposal location already has the required planning approval and Environment Protection Licence.

Planning Approval

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

"*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*."

[1] Net Present Value using a discount rate of 3%

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

“(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment”

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

The development application for demolition activities would need to describe the proposed disposal/ management methods for the demolition waste. Therefore the disposal off site would form part of the planning approval. However, it is unlikely that Council would raise an issue regarding the disposal of (non-recyclable or non-reusable) demolition waste.

Developments are classified as ‘regional development’ if they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as “*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* “, but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

As the CIV is below this figure, approval responsibility would be retained by Council. Hydro would need to lodge a development application with Cessnock City Council (Council) seeking planning approval for the works. A Statement of Environmental Effects (SEE) is required to support a development application for the proposed development.

The SEE will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Non-indigenous heritage (determine if any structures to be demolished have heritage value)
- Demolition noise and air quality
- Traffic
- Soil and water management
- Aesthetics and visual impacts
- Community and social impacts (including health)
- Consideration of alternatives
- Sustainability and carbon management

Environment Protection Licencing

It is assumed that there would be no waste streams that would trigger "Transport of trackable waste" (a scheduled activity under clause 48 of Schedule 1 of the POEO Act). Therefore an Environment Protection Licence would not be required for the transportation of the waste to a licensed facility.

Likelihood of Approval

There is a high likelihood of approval of this option.

E3.3 Cost

The estimated cost for this option is $8.4mil AUD NPV.

Refer to the attached costing for details.

E3.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Preparation of RAP and Planning Approval	0.2 – 0.3	No planning approval or EPL expected
Excavate, transport and disposal	1.3 – 1.5	Estimated at 1500 t/wk
Final Reporting and auditor signoff	0.2 – 0.3	
Total Estimated Timeframe	1 - 2	

E3.5 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented.

E3.6 Risk Ranking

The risk associated with this disposal option is associated with the waste causing an effect at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated, the likelihood of an incident occurring is considered to be ‘rare’ (may occur ‘only in exceptional circumstances’). The consequence to Hydro is considered to be ‘insignificant’ as it is a remote risk that the consequence will be the responsibility of Hydro if certain mitigation and management measures are implemented. On this basis the risk ranking is ‘1’. This evaluation is based on legal advice obtained by Hydro.

E4 On site Treatment to Achieve Complete Destruction

Likelihood of Approval	Cost $mil AUD	Timeframe (yr)	Legacy $mil AUD	Risk
Moderate to high	11.3	6 – 8	0	12

E4.1 Description of the option

This option would involve the processing of the wastes to remove hazardous components including hydrocarbons, fluorides and cyanides, in conjunction with carbon value capitalisation in a waste to energy process. Research of global technologies identified that plasma gasification pilot scale trials have been undertaken on first and second cut SPL and municipal wastes. By-products of this process include SYN gas, vitirified rock (slag) and elemental metal. All by-products may be demonstrated as suitable for a beneficial further use.

It is envisaged that this process would require pilot studies prior to full scale treatment.

E4.2 Likelihood of approval

Resource Recovery Exemption

The by-products of the plasma gasification process include synthetic gases, base metals and vitrified rock-like material (slag). The synthetic gases can be used in energy generation, while the base metals and slag have potential reuse opportunities (for example granulated slag can be used as a construction base material).

A resource recovery exemption would need to be issued in accordance with the *Protection of the Environment Operations Act 1997* permitting the reuse of these materials. The exemption would be issued if it could be demonstrated that the waste material is of benefit in its proposed use and poses minimal risk of harm to the environment or human health. This includes providing evidence that the material is homogenous in physical and chemical quality, that it is stable and would not result in the leaching of contaminants into soils and groundwater, and that there is a genuine re-use opportunity for the material.

If a resource recovery exemption could not be gained, these materials would need to be disposed to a licensed landfill. Note however, that the following planning and licensing advice is based on the assumption that approval for disposal to landfill does not form part of this option.

Planning Approval

Treatment of the wastes using this approach would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

The Project would be deemed as "designated development" under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of "Waste management facilities or works" under clause 32 of Schedule 3 of the regulation. This definition includes:

"(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or

The works would be designated development as it is triggers sub-clause 32(1)(a)(i) ("Aluminium smelting by-product" is registered as a dangerous good under the "Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition" (National Transport Commission, 2011)). An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as 'regional development' as they have a capital investment value (CIV) of more than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application (DA) for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP) if the CIV is more than $20 million. While the Cessnock City Council will assess the DA, the consent authority for the works would be the Hunter and Central Coast Regional Panel. The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the treatment facility is located in an area currently containing native vegetation).
- Aboriginal heritage (particularly if the treatment facility is located in an area of limited disturbance).
- Treatment phase noise and air quality.
- Treatment phase management of contaminants.
- Community and social impacts (including health).
- Consideration of alternatives to the treatment.
- Sustainability and carbon management.

It should be noted that Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

"(5) Development for the purpose of hazardous waste facilities that transfer, ***store or dispose*** *of solid or liquid waste classified in the* ***Australian Dangerous Goods Code*** *or medical, cytotoxic or quarantine waste that handles more than* ***1,000 tonnes per year of waste****.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the treatment of the SPL may be deemed part of the disposal process and therefore the activity deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

If this was the case, an EIS would be required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The key factor to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the Act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

"Waste disposal (thermal treatment)" is a scheduled activity under clause 40 of Schedule 1 of the *Protection of the Environment Operations Act 1997*. This includes "*thermal treatment of hazardous and other waste, meaning the* ***receiving*** *of hazardous waste, restricted solid waste, liquid waste or special waste* ***from off site*** *and its processing by thermal treatment*." Assuming that the plasma gasification treatment plant would be located on site, it would not meet this definition as the material would not be received from off site.

However, in the event that the process also includes the generation of energy, "Energy recovery" is a scheduled activity under Clause 18 of Schedule 1. Its definition includes:

"***energy recovery from hazardous and other waste*** (meaning other than general waste)*, meaning the receiving from* ***on site*** *or off site of, and the recovery of energy from, hazardous waste, restricted solid waste, liquid waste or special waste*."

Likelihood of Approval

As noted the plasma gasification process is a new technology, and is still proceeding through trial programs globally. Agencies may be reluctant to approve such a facility unless data from trials of similar technologies can provide greater certainty about performance. Consultation could be undertaken with agencies to discuss the opportunity for a trial (with monitoring to confirm its performance) prior to a full scale facility.

If sufficient information and evidence could be provided to the agencies on the environmental performance of plasma gasification, and the resource recovery exemptions for the by-products are granted, agencies are likely to look favourably on such a process and therefore it would have a high likelihood of approval.

E4.3 Cost

The estimated cost for this option is $46mil AUD NPV.

E4.4 Legacy

A legacy value is not assigned due to the complete destruction of the wastes. It was assumed that this option would only be selected if pilot scale testing demonstrated the end product was able to be reused.

E4.5 Timeframe to complete

The estimated timeframe to complete this option is 10 to 12 years allowing for pilot studies and planning approvals.

Activity	Estimated timeframe (years)
Pilot Trial	1
RAP/EIS	1
Approvals	1.75
Investigations/tender/contract negotiations	0.5
Construction/commissioning	1
Assumes treatment at 15000tpa	5-6
Validation Reporting	0.2
Total Estimated Timeframe	**10-12**

E4.6 Risk Ranking

The risk associated with this option is a technological risk from the unproven technology and the possibility that an alternate remediation solution will require implementation. The likelihood of this technology not being able to treat the SPL economically or technically into a condition that can be re-used without additional treatment (and therefore needing to landfill) is 'likely'. Potential issues associated with the applicability of the treatment to the capped waste stockpile wastes are considered to be equally valid. Risks include those associated with the pre-treatment requirements for the capped waste stockpile and the extent to which crushing and sorting is required.

The material is currently not qualified as inert and therefore it cannot be used without limitation as fill material. Also, no technical specification of material strength has been determined, (the physical properties are currently unknown). If it cannot be utilised as inert fill material, one of Options B1 to B9 would need to be implemented. In addition, as of 23 January 2014 there are no known estimates of the difference between input volume / weight, and volume / weight of the vitrified material (it is unknown how much of the processed material would be generated).

The consequence of the technology not being applicable to the site will require an alternate solution is considered 'moderate'. The alternate solution for remediation is comparable in cost to those presented in Options D1 to D7. It would also result in a loss in time prior to being able to implement a solution. On this basis this option is given a risk ranking of '12'.

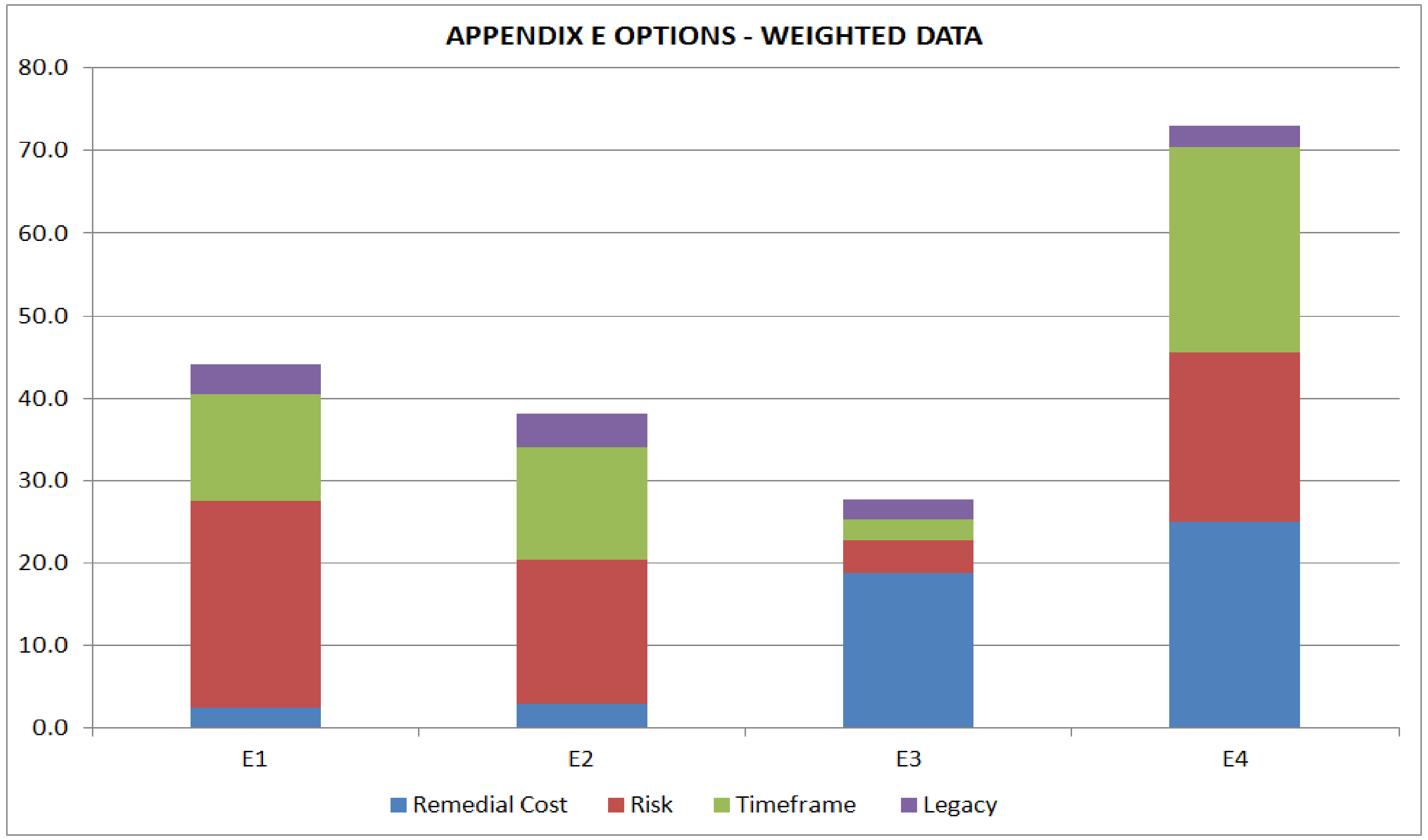
Type	Volume estimates (m3)	Mass estimate (t)	Accuracy %	Volume Range		Mass Range	
				Low	High	Low	High
Demolition wastes	29000	20000	30%	20300	37700	14000	26000

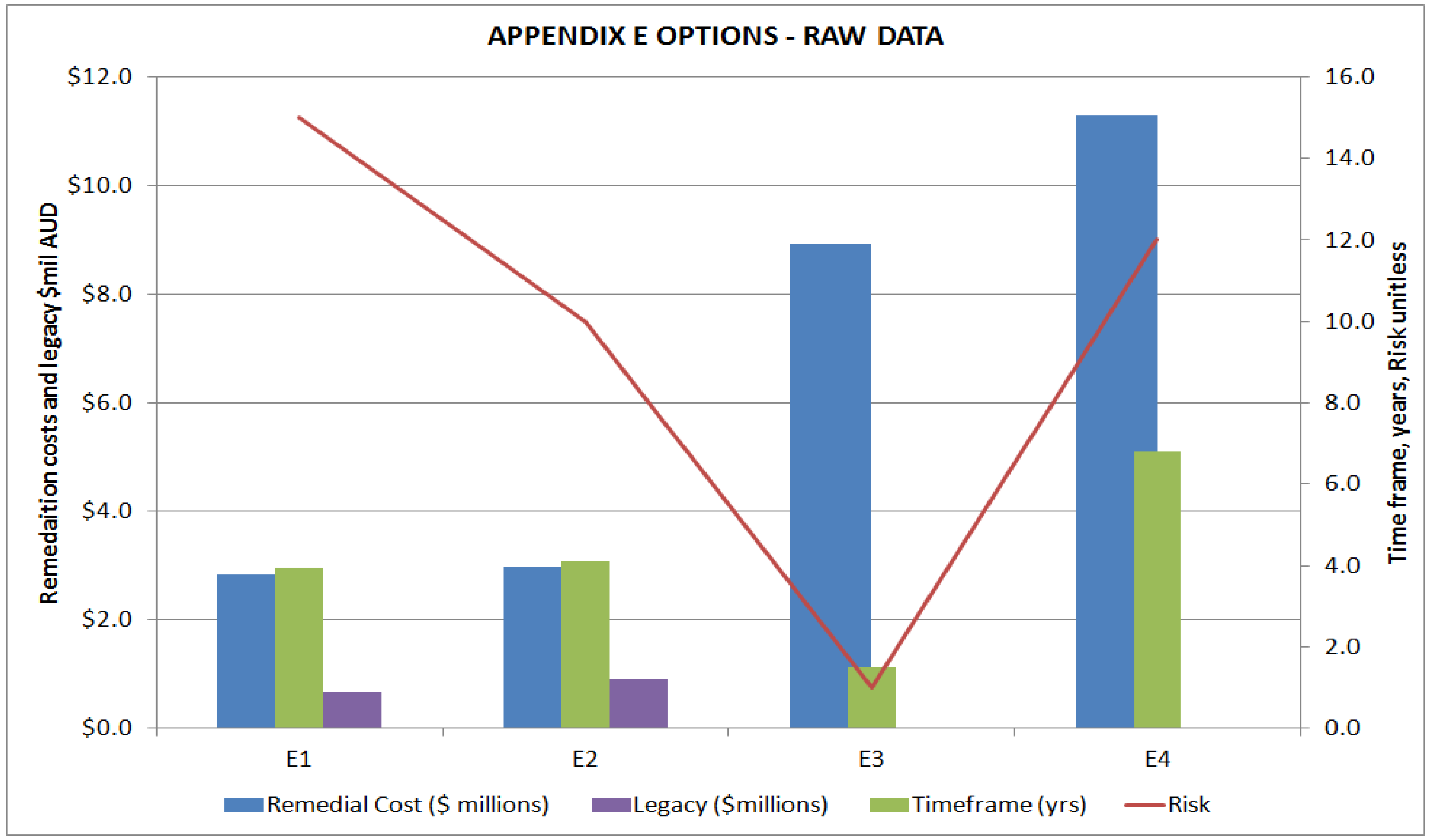
Description	**Remediation Cost $mil**	**Legacy $ mil**	**TIME (Years)**	**RISK (1 to 10, 10 high**
Option E1 - Move to specifically designed landfill adjacent to th	$2.8	$0.7	4.0	15
Option E2 - Place within a purpose built containment cell	$3.0	$0.9	4.1	10
Option E3 Dispose off Site	$8.9	$0.0	1.5	1
Option E4 Onsite Destruction	$11.3	$0.0	6.8	12

Appendix E - Demolition Waste

Weighting Factors

	Weighting (sums to 10)
Remedial Cost	2.5
Risk	2.5
Timeframe	2.5
Legacy	2.5
	10





Option E1 - Move to specifically designed landfill adjacent to the Alcan Mound

Description	**Treat and Move all materials to the existing Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Pre-Design Activities**						
		CPT Soundings	6	EA	$1,100	$6,600	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	3	EA	$7,200	$18,036	5 borings per 5000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$24,636**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		CLMA Auditor			$40,000	$40,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Development application			$150,000	$150,000	Category 1, small EIS	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$240,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$91,000		USEPA Remediation Engineering
		Remedial Design			8%	$145,000		USEPA Remediation Engineering
		Construction Management			6%	$109,000		USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$36,000		ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$381,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	2,505	m2	$2	$5,210		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	1,503	ha	$1,020	$153.31	Assumes area largely cleared (99.9%)	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	2,505	m3	$8	$19,915		Rawlinsons 2013 p675
		Filling of Eastern Surge Pond	4,590	m3	$25	$114,750	Approximate area determined from aerial photo	Rawlinsons 2013 p675
		Construct Clay Liner (1 meter)	4,429	m3	$24	$104,082		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	4,429	m2	$20	$89,687		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	4,429	m2	$4	$16,609		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	1,378	m3	$25	$34,450		Vendor Estimate/ENVIRON Experience
		Install 60 ML HDPE Liner	4,429	m2	$17	$73,079		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	4,429	m2	$4	$16,609		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	1,378	m3	$25	$34,450		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	4,429	m2	$4	$16,609		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$727,986**		
	6	**Placement of Demolition Wastes**						
		Placement at no cost	29,000	m3	$0	$0	Assumes at no cost	
		SUBTOTAL Placement of SPL				**$0**		
	7	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	7,811	m3	$26	$203,086		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	13,018	m2	$20	$263,615		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	3,969	m3	$10	$38,698		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	13,018	m2	$4	$52,072		Rawlinsons 2013 p677
		Install General Fill (30 cm)	3,969	m3	$26	$103,194		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	1,985	m3	$17	$34,202		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	13,018	m2	$8	$103,884		Rawlinsons 2013 p228
		Supply and Install Fencing	838	m	$56	$46,906		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$857,763**		
	8	**Final Reporting**						
		Validation report		each	allow	$60,000		ENVIRON experience
		EMP		each	allow	$25,000		ENVIRON experience
		Site Auditor signoff		each	allow	$40,000		ENVIRON experience
		SUBTOTAL reporting				**$125,000**		
		Subtotal				$2,582,385		
		Contingency 10%				$258,238	10% Scope	
		CAPITAL COSTS				**$2,840,623**		

NOTES
Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Refer to Appendix B for a description of capping requirements and assumptions made

Legacy Cost		QTY	units	UNIT COST	TOTAL	NOTES	Source
	Maintenance	1	annual	$18,000	$567,844		Based on 12 events per year for 100 years, usin
	Topsoil replacement and reseeding battered perimeter	Base year	each	$138,085		no cost in year 0	
		1	each	$65,950	$65,950.26	year 25	Using a discount rate of 3%
		1	each	$15,044	$15,043.72	year 50	Using a discount rate of 3%
		1	each	$1,639	$1,638.94	year 75	Using a discount rate of 3%
		1	each	$85	$85.28	year 100	Using a discount rate of 3%
					$650,562		
	Legacy potential liability provisioning	2%	event	NPV	$13,002	assumes occurs in twice in 100 years	Using a discount rate of 3%
					$13,002		
					$663,564		

Risk

			Value
Ranking			15
Catastrophi	Due to cost and prosecution from breaching of adjoining Alcan Mound		
Possible	Might occur at some time		

Timing

Pre-Design Activities	0.25	years
Preparation of RAP and Planning Approval	1	years
Approvals	0.75	years
Project Engineering Tasks	0.2	years
Implementation	1.5	years
Final Reporting	0.25	years
Time	**3.95**	**years**

Option E3 Dispose off Site	
Description	**Transport all materials for disposal off site to landfill**
Base Year	**2014**
Date	**01/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Project Tasks**						
		Project Management			5%	$507,605		
		Sub-total Technical Tasks Capital Cost				**$507,605**		
	2	**Site Preparation**						
		Environmental controls	0			0	nil on site as managed under existing stormwater management conditions	
		Environmental controls around stockpiled materials	1	each	$26,000	$0	nil on site as managed under	Vendor estimate/ENVIRON experience
		Mobilisation/demobilisation	2	each	$15,000	$0	nil on site as managed under existing stormwater management conditions	
		Sub-total site preparation				**$0**		
	4	**Loading costs**						
		Demolition wastes	29000	m3	$5	$133,400	allow	Rawlinsons
		Sub-total excavation costs				**$133,400**		
	6	**Disposal of municipal waste to landfill**						
		Transport	29000	m3	$3	$84,100	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, municipal wastes	20000	t	$370	$7,400,000	Special wastes (conservative)	Cessnock landfill Rates 2013-2014
		Sub-total disposal costs				**7,484,100**		
		Subtotal				$8,125,105		
		Contingency 10%				$812,511	10% Scope	
		CAPITAL COSTS				**$8,937,616**		

NOTES

Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes transport rates of 1500t/wk for Australia and 12000t/yr for international movement

Legacy Cost		
	Legacy provision	$0

RISK			Value
	Comment	rare	1
		insignificant	

Time			
NSW	Approvals	0	years
	Investigations/tender/contract negotiations	0	years
	Implementation	1.5	years
	Transport (assumes 10 trucks per day, 30t per truck)	0	years
	Validation Reporting	0	years
	TOTAL	1.5	years

Option E4 Onsite Destruction	
Description	**Onsite Waste to Energy**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Planning approval			$350,000	$350,000	EIS required	ENVIRON experience
		Sub-total preliminary documentation				**$400,000**		
	2	**Pilot Trial**						
		Allow				$100,000		Estimate
		Sub-total pilot trial				**$100,000**		
	3	**Project Tasks**						
		Project Management			5%	$37,000	Does not include treatment I	USEPA Remediation Costs
		Sub-total Technical Tasks Capital Cost				**$37,000**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	4	**Sorting, placement and treatment of Alcan Mound wastes**						
		Treatment through plasma gasification	20,000	t	$450	$9,000,000	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL Placement of SPL				**$9,000,000**		
	5	**Final Reporting**						
		Validation report		each	allow	$500,000	includes confirmatory testing	ENVIRON experience
		Sub-total reporting				**$500,000**		
		Subtotal				$10,263,000		
		Contingency 10%				$1,026,300	10% Scope	
		CAPITAL COSTS				**$11,290,000**		

NOTES
Assumes volumes of material are as presented in Appendix B of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes by-products are approved by NSW regulators for reuse and do not require landfilling. 80% plasma rock is estimated to be generated.
Rate of treatment per tonne provided by Tetronics includes a rate of return and profit margin. This rate could be negotiated. Applies to 15000 tpa plant

Legacy Cost		
	Legacy provision	$0

Risk		Value
Comment	Likely moderate	12

Time		
Pilot Trial	1.0	years
RAP/EIS	1.0	
Approvals	1.8	years
Investigations/tender/contract negotiations	0.5	years
Construction/commissioning	1.0	years
Assumes treatment at 15000tpa	1.3	years
Validation Reporting	0.2	years
TOTAL	6.8	years

Appendix F

Groundwater Detailed Options Review

F Groundwater

Groundwater considered requiring treatment is described in the following. This option considers only groundwater treatment and no other remediation steps. Refer to Appendix G for combined options.

capped wast Leachate Groundwater Statistics	
Volume ML	**Description**
Presented in the relevant options	The stockpiling of mixed wastes including SPL within the capped waste stockpile (see Appendix A) has led to the generation of contaminated leachate that has impacted shallow groundwater and surface water down gradient of the capped waste stockpile within the buffer zone. The leachate is contaminated with elevated concentrations of fluoride, cyanide and dissolved salts (salinity). The shallow leachate plume extends approximately 300m north east of the capped waste stockpile and observable impacts to vegetation are evident in the areas of leachate impact. The capped waste stockpile and area of impact was notified to NSW EPA as land that is potentially contaminated under Section 60 of the *Contaminated Land Management Act 1997*. The EPA has advised that under the existing land use the site is not going to be regulated under the *Contaminated Land Management Act 1997*. The leachate impacted water that may require treatment comprises: 1) Ex-filtrating groundwater that is discharging from the surface and near surface groundwater that is considered to be ephemeral and has the potential to discharge to the surface and to surface water bodies; 2) Potential leachate contained within the capped waste stockpile fill materials themselves, i.e. perched water; 3) Leachate impacted groundwater beneath and extending from the capped waste stockpile in a north east direction.

Remediation Options

Option F1 No remediation

Option F2 Continue existing treatment/management

Option F3 Remove Groundwater by Pumping

Other options are discussed elsewhere within the Remedial Options Study as follows:

- Containment (capped waste stockpile) – This option is discussed in Appendix A, Option A2. This option is not discussed within this appendix.

It should be noted that a specific option for remediation of the leachate impacted groundwater plume located to the northeast of the capped waste stockpile has not been included. Based on investigations completed to date, it is anticipated that the fate and transport modelling, in conjunction with the ecological and health risk assessment, will conclude that targeted remediation is not required, and that options that address the source of the contamination (including the options described below) would be sufficient.

F1 No remediation

Likelihood of Approval	Cost $mil AUD	Timeframe yrs	Legacy $mil AUD	Risk Ranking
Low	2.4	13 - 15	0.2	6

F1.1 Description of the option

This option would involve no physical remediation of the site but would require on-going groundwater monitoring for a period of approximately 5 years to demonstrate that the leachate plume is not expanding beyond its current known extent. A risk assessment would be required to demonstrate that the current site status does not represent a risk of harm to human health or the environment, and that this situation will not worsen in the future. The outcome of the risk assessment and monitoring plan will require acceptance by the regulators.

The tasks required are therefore:-

1) Undertake fate and transport modelling to identify clean-up criteria applicable to the site in conjunction with the findings of the ecological and health risk assessment;
2) Develop an environmental management plan (EMP) that details ongoing monitoring requirements and any restrictions to land use;
3) Achieve Contaminated Site Auditor sign off on the above monitoring program and management plan.
4) Review and revise as necessary any monitoring conditions.

F1.2 Likelihood of approval

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*". The purpose of capping of the capped waste stockpile was to meet this requirement.

However, the evidence of leachate down gradient of the capped waste stockpile indicates that this requirement has not been achieved. Therefore doing nothing and allowing this situation to occur would be in contravention of the Chemical Control Order licence.

Planning Approval

A development consent issued in 1993 for an upgrade to the smelter applies to the use and management of the capped waste stockpile. The EIS that was submitted to achieve planning approval reflected the previous statement regarding the Chemical Control Order licence (required to prevent the escape of leachate).

Therefore the Department of Planning and Infrastructure (DoPI) may consider doing nothing as non-compliance with the planning approval.

Likelihood of Approval

Three is a low likelihood of this option gaining approval, due to the existing impacts on the environment, and the potential non-compliance with the Chemical Control Order and the 1993 planning approval.

F1.3 Cost

The estimated costs for this option are $2.4mil AUD NPV.

Refer to the attached costing for details.

F1.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Investigations and Reporting	0.1 – 1.25	To undertake risk assessment and further monitoring
Auditor review	0.5 – 0.75	
Approvals (note that the likelihood of achieving approvals is considered low to very low)	1.5 -2	Modification to the existing planning approval and EPA modification of the licence condition
Monitoring	10	
Final report and EPA licence amendment	1 – 2	
Total Estimated Timeframe	13 – 15	

F1.5 Legacy

Legacy costs associated with this option could include the initiation of other remedial options that address the source contamination as outlined in Option F2, F3, Appendix A or Appendix G. For the purpose of evaluation, it has been assumed that option F2 has a 10% chance of requiring implementation after a 10 year monitoring period. This legacy provision is estimated to be approximately $0.2mil AUD NPV.

F1.6 Risk

The risk associated with this option arises from the monitoring showing an increasing trend to the point at which a remedial action is required. The likelihood of this occurring is considered ‘unlikely’ as data demonstrates decreasing trends with time. The consequence, should this event occur, would be the initiation of other remedial options that address the source contamination as outlined in Option F2, Appendix A or Appendix G. Any of these options are considered at least ‘moderate’ as costs in excess of $0.5mil AUD are likely. There is the additional risk of prosecution due to pollution and therefore the consequence is considered ‘catastrophic’. On this basis the risk ranking is ‘6’.

F2 Continue existing treatment/management

Likelihood of Approval	Cost $mil AUD	Timeframe yrs	Legacy $mil AUD	Risk Ranking
Moderate	2.4	10 - 12	1.6	5

F2.1 Description of the option

This option involves the interception of shallow perched leachate down gradient of the capped waste stockpile and storage of the leachate in on-site ponds for evaporation. One trench, which currently exists, will intercept leachate when it rises towards the ground surface (i.e. in high rainfall conditions). A second trench, which has yet to be constructed, would intercept leachate impacted shallow groundwater up gradient of the current trench.

This option would involve the following steps:

1) Identify the location of interception trench. This has been identified in ENVIRON (November 2013) Leachate Interception Trench, capped waste stockpile, capped waste stockpile Notification Area, Kurri Kurri. The new interception trench is to be located along the eastern toe of the capped waste stockpile and it will intercept and capture shallow groundwater to a depth of approximately 3m. This trench is varies in design from the existing trench which sits above the water table and captures only groundwater rising following rainfall.
2) Provision of a simple pumping schematic for implementation by a plumbing contractor.
3) Develop a plan of management for the operation of this system and a proposal for cessation of the treatment plant assisted by fate and transport modelling.
4) Disposal of groundwater via evaporation from on-site dams. It is assumed that this disposal option will be available in the longer term.
5) Continue operation of the leachate management until such time as concentration levels are found to be acceptable. Allowed 10 years. The annual volume of water intercepted is estimated to be approximately 5ML per year. For the installed leachate interception trench a volume of 0.4ML per year has been captured.
6) Document the work undertaken to the satisfaction of the contaminated land auditor and achieve approval from the regulator to cease interception.

7) Amend license requirements, if necessary.

This option does not include treatment of sediments at the completion of evaporation. These have been included as a legacy item.

F2.2 Likelihood of approval

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*". The purpose of capping of the capped waste stockpile was to meet this requirement.

While the capture and treatment stops the escape of leachate downstream of the trench, it needs to be confirmed that the EPA is satisfied that it meets the requirement for the SPL "*to be stored at the smelter in a manner that prevents the escape of leachate*" and therefore would comply with the Chemical Control Order licence.

Planning Approval

A development consent issued in 1993 for an upgrade to the smelter applies to the use and management of the capped waste stockpile. The EIS referenced a licence associated with the Chemical Control Order allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*".

The works (if successful) would allow Hydro to be compliant with the 1993 planning approval by preventing the escape of leachate. Therefore the Department of Planning and Infrastructure would likely consider them a modification to the existing capped waste stockpile approval, provided it shows that there is minimal environmental impact. This applies to both the interception trench and the management of the dams that would hold the retrieved groundwater, as well as the disposal or storage of the material excavated for the trench.

An environmental assessment is required to support an application for the modification. The modification application will need to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality.
- Soil and water management (including surface water and groundwater, and geotechnical conditions).
- Ongoing management strategy.
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That the treatment of groundwater is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

Environment Protection Licensing

Schedule 1 of the *Protection of the Environment Operations Act 1997* includes the following:

"*15A Contaminated groundwater treatment*

(1) This clause applies to contaminated groundwater treatment meaning the treatment of contaminated water.

(2) The activity to which this clause applies is declared to be a scheduled activity if it has the capacity to treat more than 100 megalitres per year of contaminated water."

The groundwater treatment would be less than 100 megalitres per year, therefore this scheduled activity is not triggered. There are no other scheduled activities that would be triggered.

Other Approvals

Under Section 91F of the *Water Management Act 2000*, works that intercept groundwater require a water supply works approval from the NSW Officer of Water (NOW).

Likelihood of Approval

There is a moderate likelihood of this option gaining approval. While it does treat groundwater, it does not stop the ongoing generation of leachate, and it only treats that newly generated at the capped waste stockpile - it does not treat existing contaminated groundwater downstream of the trench.

F2.3 Cost

The estimated costs for this option are $2.4mil AUD NPV.

Refer to the attached costing for details.

F2.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Investigations and Reporting	0.1 – 1.25	To undertake risk assessment and further monitoring
Auditor review	0.5 – 0.75	
Approvals	0.25 – 0.5	EPA modification of the licence condition
Water treatment	10	
Total Estimated Timeframe	10 – 12	Timeframe is dependent on results of monitoring

F2.5 Legacy

For this option, the legacy risks are associated with ongoing leachate management being required. An allowance for a further 10 years of leachate management has been included. The legacy cost for this component is estimated to be approximately $0.2mil AUD NPV.

In addition, sediments within the dam sedimentation structure may require treatment. To allow for this a 50% likelihood of requiring treatment has been adopted. These costs were determined based on a $500/tonne treatment cost and a sludge generation of 20T per ML of water treated. The legacy cost for this component is estimated to be approximately $1.6mil AUD NPV.

F2.6 Risk

The risk associated with this option arises from the in ability to satisfy the remediation triggers. The likelihood of this occurring is considered 'possible'. Data to data demonstrates decreasing trends with time, however the aquifer is highly complex. The consequence, should this event occur, would be the initiation of further interception of leachate by options such as Option F3 (following). This consequence is considered ‘moderate’ on the basis of the likely costs and that it is unlikely prosecution would result as controls have been implemented. On this basis the risk ranking is ‘5’.

F3 Remove Groundwater by Pumping				
Likelihood of Approval	Cost $mil AUD	Timeframe yrs	Legacy $mil AUD	Risk Ranking
High	4.5	7 - 8	0.6	6

F3.1 Description of the option

This option would involve the removal of leachate via collection and storage of water in site ponds followed by chemical treatment designed by ENVIRON, then disposal of treated effluent by evaporation. ENVIRON (December 2012) *Stage 2 Water Treatment Options Report, Alcan Mound Notification Area (report AS130323)* provides volume estimates for the volume of leachate below the capped waste stockpile and the volume of leachate within the plume beneath the capped waste stockpile, as follows:

- Ephemeral groundwater rising to the surface following rain fall is predicted to generate <1ML/year. This volume is consistent with the trench performance since April 2013, where 0.25ML has been captured to December 2013;
- Leachate was assumed to be present perched within the northeast corner of the capped waste stockpile, measuring 60m by 60m in extent. A depth of 2.0m and porosity within the strata of 50% were assumed. This equates to 11ML of leachate; and
- The capped waste stockpile footprint comprises an area of approximately 17,000m^2. Assuming a depth of impact of 5m, and a porosity of 30% the volume of water impacted is estimated to be approximately 25ML. Three pore volumes were assumed to require treatment which approximates to 75ML of groundwater.

Other treatment options were assessed in ENVIRON (December 2012) and it was identified that once volumes of water are in excess of 1ML, treatment via evaporation with pre-treatment of the effluent using an ENVIRON-designed process for removal of dissolved fluoride and cyanide contaminants provides a cost effective solution. As such, other treatment options including disposal by a waste contractor and treatment using a process designed by the University of Newcastle have not been included in this options study.

This option would involve the following steps:

1) Undertake fate and transport modelling to identify clean-up criteria applicable to the site in conjunction with the findings of the ecological and health risk assessment; (as in Option F1).

2) Install a pumping well network that will remove the leachate stored within the capped waste stockpile wastes, estimated to be approximately 11ML total leachate, and remove impacted groundwater from within aquifer underlying the capped waste stockpile footprint, estimated to be approximately 75ML. The current aquifer information estimates that pumping rates are likely to achieve the required volumes in 4 to 5 years.
3) Treat fluoride and cyanide concentrations within the North Dam prior to evaporation. The treatment system designed by ENVIRON is described in ENVIRON (December 2012).
4) Monitor groundwater conditions until remedial triggers are achieved.
5) Provide an assessment of contaminant status including ongoing contributions of contaminants to the aquifer.

F3.2 Likelihood of approval

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*". The purpose of capping of the capped waste stockpile was to meet this requirement.

While this option treats the leachate in the capped waste stockpile, newly generated contaminated groundwater beyond the capped waste stockpile and the existing contaminated groundwater plume. The treatment of the existing leachate in the capped waste stockpile and any contaminated groundwater that escapes the capped waste stockpile is likely to be considered by EPA to meet the requirements for the SPL "*to be stored at the smelter in a manner that prevents the escape of leachate*" and therefore would comply with the Chemical Control Order licence.

Planning Approval

A development consent issued in 1993 for an upgrade to the smelter applies to the use and management of the capped waste stockpile. The EIS referenced a licence associated with the Chemical Control Order allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*".

The works (if successful) would allow Hydro to be compliant with the planning approval by preventing the escape of leachate. Therefore the Department of Planning and Infrastructure would likely consider them a modification to the existing capped waste stockpile approval, provided it shows that there is minimal environmental impact. This applies to both the groundwater interception and the management of the pond that would hold the groundwater.

An environmental assessment is required to support an application for the modification. The modification application will need to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality.
- Soil and water management (including hydrology and geotechnical conditions).
- Ongoing management strategy.
- Sustainability and carbon management.

The key factors to be addressed to facilitate approval of the modification application for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That the treatment of groundwater is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

Environment Protection Licensing

Schedule 1 of the *Protection of the Environment Operations Act 1997* includes the following:

"*15A Contaminated groundwater treatment*

(1) This clause applies to contaminated groundwater treatment meaning the treatment of contaminated water.

(2) The activity to which this clause applies is declared to be a scheduled activity if it has the capacity to treat more than 100 megalitres per year of contaminated water."

The groundwater treatment would be below 100 megalitres per year, therefore this scheduled activity is not triggered. There are no other scheduled activities that would be triggered.

Other Approvals

Under Section 91F of the *Water Management Act 2000*, works that intercept groundwater require a water supply works approval from the NSW Officer of Water (NOW).

Likelihood of Approval

There is a moderate to high likelihood of this option gaining approval as it treats leachate within the capped waste stockpile, contaminated groundwater generated from the capped waste stockpile, and the existing contaminated groundwater plume.

F3.1 Cost

The estimated cost for this option is $4.5mil AUD NPV.

Refer to the attached costing for details.

F3.2 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Investigations and Reporting	0.1 – 1.25	To undertake risk assessment and further monitoring
Auditor review	0.5 – 0.75	
Approvals	0.25 – 0.5	Modification to the existing planning approval and EPA modification of the licence condition
Plant construction and commissioning	0.6 – 1	
Water treatment	5	
Total Estimated Timeframe	7 - 8	Timeframe is dependent on results of monitoring

F3.3 Legacy

For this option, the legacy risks are associated with ongoing leachate treatment being required. An allowance for a further 86ML of treatment over a period 5 years has been assumed and a 10% likelihood of this being required has been adopted. This legacy cost associated with this item is estimated to be $0.2mil AUD NPV.

In addition, sediments within the dam sedimentation structure may require treatment. To allow for this a 10% likelihood of requiring treatment has been adopted. The reduced likelihood is on the basis that pretreatment to remove fluorides and cyanides is included in this option and therefore there is a lower likelihood (compare to Option F2) that remediation will be required. This legacy cost associated with this item is estimated to be approximately $0.4mil AUD NPV.

The combined legacy provision is therefore estimated to be $0.6mil AUD NPV.

F3.4 Risk

The risk associated with this option arises from the triggers to cease pumping not being reached within the volumes of water proposed for treatment. The likelihood of this occurring is considered ‘possible’ due to the complexities within the groundwater aquifer. There is also an additional technological risk surrounding the water treatment plant and it is considered ‘unlikely’ that treatment would not be feasible through the treatment plant. The consequence of the first risk ‘moderate’ requiring further pumping of the groundwater table. The consequence of the second risk is also ‘moderate’ requiring further design modifications to the treatment plant. On this basis the risk ranking is ‘6’.

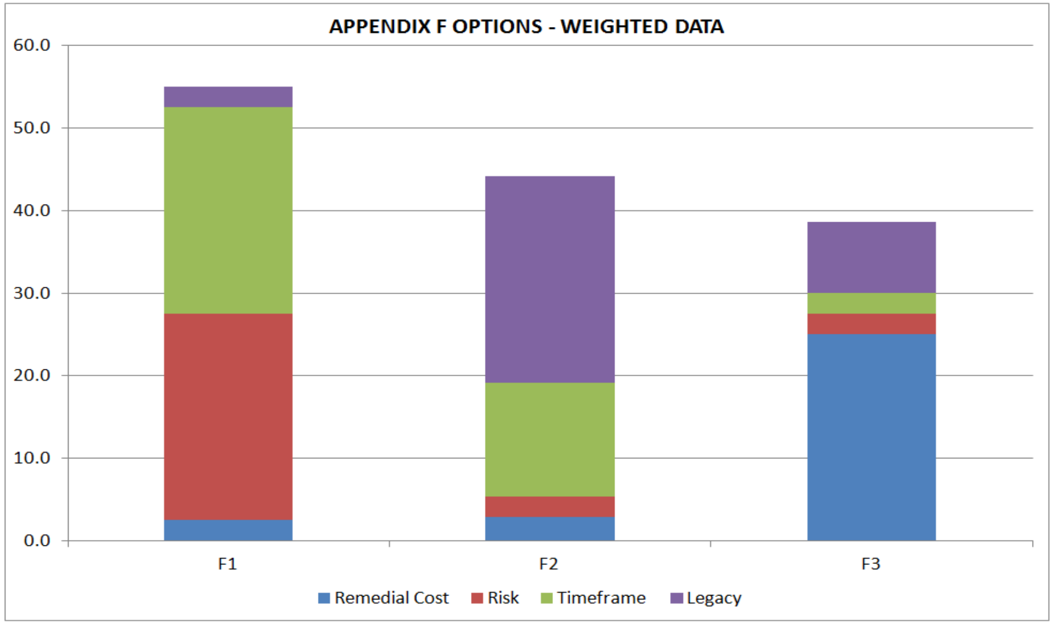
Volume
Presented in the relevant section of the text

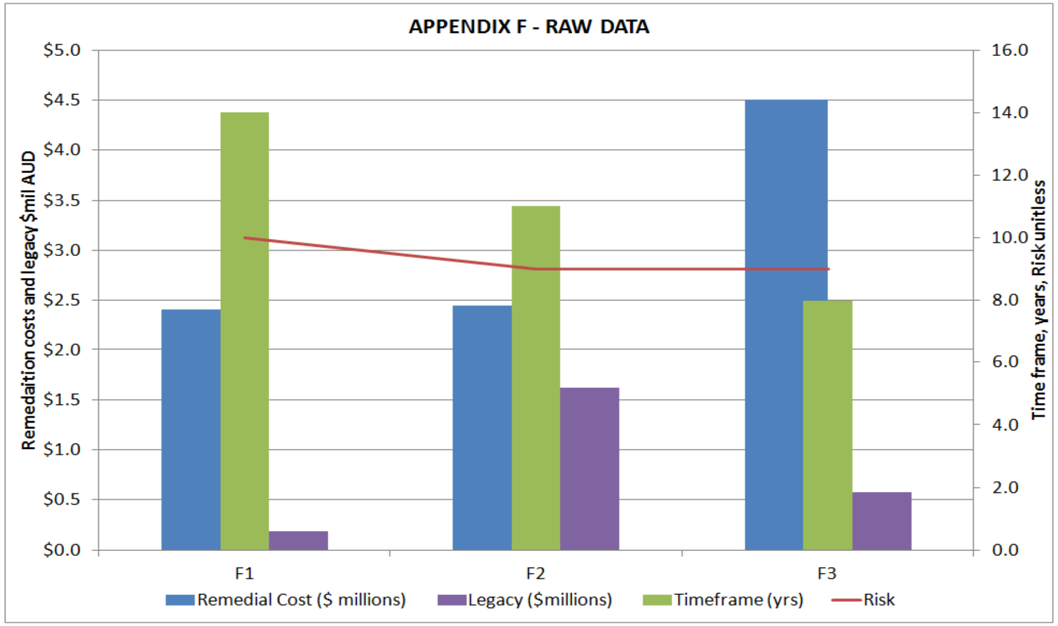
Description	**Remediation Cost $mil**	**Legacy $ mil**	**TIME (Years)**	**RISK (1 to 10, 10 high**
Option F1 Do nothing	$2.4	$0.2	14	10
Option F2 Continue existing leachate capture	$2.4	$1.6	11	9
Option F3 Active removal of defined volume	$4.5	$0.6	8	9

Appendix F - Groundwater

Weighting Factors

	Weighting (sums to 10)
Remedial Cost	2.5
Risk	2.5
Timeframe	2.5
Legacy	2.5
	10





Option F1 Do nothing	
Description	**Undertake a risk assessment to demonstrate no remediation is required**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Investigations and reporting**						
		Fate and transport modelling	1	each	$0	$0	Forms part of already commissioned work	ENVIRON experience
		Development of a management plan	1	each	$30,000	$30,000	For the long term management of the site	ENVIRON experience
		Prepare overall report	1	each	$50,000	$50,000	Includes benefit evaluation of remediation	ENVIRON experience
		Contaminated Land Auditor Review	1	each	$50,000	$50,000		ENVIRON experience
		Negotiations with the EPA	1	each	$50,000	$15,000	Licence surrender/modification	ENVIRON experience
		SUBTOTAL initial investigation and risk assessment				**$145,000**		
	2	**Monitoring costs in NPV**						
		Monitoring	10	annual	$150,000	$1,936,000		
		Reporting at the completion of monitoring				$60,000		
		Auditor signoff				$38,000		
		EPA negotiation				$12,000		
						$2,046,000		
		Subtotal				$2,191,000		
		Contingency 10%				$219,100	10% Scope	
		CAPITAL COSTS				**$2,411,000**		

NOTES Does not include remediation of primary sources. Applicability of this solution is contingent on other remediation management solutions adopted.
Assumes EPA and Auditor agree with the report findings

Legacy Cost	Implementation of leachate interception consistent with 10%	event	NPV	$175,606	assumes occurs 10% chance of implementing leac	Using a discount rate of 3%,
				$175,606		

RISK	Comment		10
	Catastroph	Due to the risk of prosecution	
	Unlikely	AN increaseing trenc in groundwater concentrations, that results in the need for remediation could occur at some time.	

Time	Investigations and reporting	1	years
	Auditor Review	0.5	years
	Approvals	1.5	years
	Monitoring	10	
	Reporting	1	
	Time	**14**	**years**

Option F2 Continue existing leachate capture	
Description	**Continue and expand on existing surficial leachate capture**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Investigations and reporting**						
		Fate and transport modelling	1	each	$0	$0	Forms part of already commissioned work	ENVIRON experience
		Development of a management plan	1	each	$30,000	$30,000	For the long term management of the site	ENVIRON experience
		Final report	1	each	$20,000	$20,000		
		SUBTOTAL initial investigation and risk assessment				**$50,000**		
	2	**Construction of the interception trench**						
		Constrctor to install trench, pipe work and pumping scher	1	each	$40,000	$40,000		Vendor price
		Documentation	1	each	$5,000	$8,000	As built designs	ENVIRON experience
		SUBTOTAL construction of interception trench				**$48,000**		
	3	**Operational costs over a 10 year period in NPV**						
		Water treatment	4	ML	$20,000	$171,000	Based on $5000 per ML	ENVIRON previous assessment, AS130323
		Monitoring and system mainteance	10	annual	$206,880	$1,765,000	Includes laboratory fees and supervision of plant	Annual for 10 years at a discount rate of 3%
		Reporting at the completion of monitoring				$60,000		
		Auditor signoff				$38,000		
		EPA negotiation				$12,000		
		SUBTOTAL operational costs				**$2,046,000**		
		Subtotal				$2,144,000		
		Contingency 10%				$214,400	10% Scope	
		CAPITAL COSTS				**$2,359,000**		

NOTES
Does not include remediation of primary sources. Applicabiltiy of this solution is contingent on other remediation management solutions adopted
Assumes EPA and Auditor agree with the report findings
Assumes the onsite stormwater management system continues and that costs for that system continuing, eg pond mainteance, are captured in a site management budge
Does not include improvements to the existing stormwater infrastructre (ie East Surge Pond, Noth Dam 1 and 2). These are not expected to be required from the inflow of this water.

Legacy Cost							
	Additional 10 years of leachate capture and treatment	10	annual	$206,880	$131,400		
	Removal and treatment of sediment within the sediment	50%	event	NPV	$1,488,188	assumes occurs after 10 years, and has a 50% char	Using a discount rate of 3%, Assumes 20 Tonnes of sludge generate per ML
					$1,619,588		

RISK	Comment		9
	moderate	Costs associated with further treatment are <$5mil	
	Possible	Due to aquifer complexities	

Time	Investigations and reporting	1	years
	Auditor review	0.5	
	Approvals and licence amendments	0.5	
	Water treatment (commenced prior to the above)	9	
	Time	**11**	**years**

Option F3 Active removal of defined volume	
Description	**Install and groundwtaer pump and treat system to remove groundwater from within and immediately surrounding the Alcan Mound**
Base Year	**2013**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
	1	**Investigations and reporting**						
		Fate and transport modelling	1	each	$0	$0	Forms part of already commissioned work	ENVIRON experience
		Detailed water treatment plant design	1	each	$20,000	$20,000	Preliminary designs exist	ENVIRON experience
		Pumping tests to understand pumping rates	1	each	$20,000	$25,000		ENVIRON experience
		SUBTOTAL investigation and reporting				**$45,000**		
	2	**Operation costs for water treatment using ENVIRON plant**						
		Well installation	20	each	$15,000	300,000		ENVIRON experience
		Plant set up	1	each	$1,000,000	1,000,000		ENVIRON experience
		Water treatment	86	ML	$16,100	$1,384,600	Based on $11000 per ML	ENVIRON previous assessment, AS130323
		Monitoring and system mainteance	5	annual	$206,880	$1,034,400		Annual for 5 years at a discount rate of 3%
		Sludge treatment from treatment plant	86	ML	$2,200	$189,200		
		Reporting at the completion of monitoring				$60,000		
		Auditor signoff				$38,000		
		EPA negotiation				$12,000		
		SUBTOTAL initial investigation and risk assessment				**$4,018,200**		
		Subtotal				$4,063,200		
		Contingency 10%				$406,320	10% Scope	
		CAPITAL COSTS				**$4,470,000**		

NOTES

Does not include remediation of primary sources. Applicabiltiy of this solution is contingent on other remediation management solutions adopted.
Assumes the onsite stormwater management system continues and that costs for that system continuing, eg pond maintenance are captured in a site management budget
Does not include improvements to the existing stormwater infrastructre (ie East Surge Pond, Noth Dam 1 and 2). These are not expected to be required from the inflow of this water.
Sediment removal from teh settling ponds is included as a legacy item,

Legacy Cost	Description	QTY	units	UNIT COST	TOTAL	NOTES	Source
	Additional leachate capture and treatment	5	annual	$206,880	$140,700	Assumes additional 86ML over a 5 year period	Using a discount rate of 3%,
	Removal and treatment of sediment within the sediment 10%		event	NPV	$433,892	assumes occurs after 10 years, and has a 50% char	Using a discount rate of 3%, Assumes 20 Tonnes of sludge generate per ML
					$574,592		

RISK	Comment	9
	Moderate	Costs associated with ongoing pumping are less than $5mil
	Possible	it is possible that further treatment is required beyond current estimates due to aquifer comlexities

Time			
	Investigations and reporting	1	years
	Auditor review	0.5	
	Plant construction and commissioning	1	
	Approvals and licence amendments	0.5	
	Water treatment (commenced prior to the above)	5	
	Time	**8**	**years**

Appendix G

Combined Options Detailed Options Review

G Combined Options

This section presents cost evaluation for a selection of combined options that address all waste material streams within the Hydro owned lands. The combined options presented here were selected for two reasons: firstly, because they were identified as suitable options when considering the individual waste stream, and secondly, because combining waste materials streams realise economies of scale. The waste material quantities and descriptions considered in this Appendix are presented in the following table. A brief description of the combined options selected follows and further detailed descriptions are presented within the relevant sections of this Appendix.

Contaminated Soils and Waste Volumes and Tonnages Mass Located on Hydro Owned Land		
Volume (m^3)	**Tonnage (t)**	**Description**
84,000-126,000	151,200 – 226,800	Capped waste stockpile, SPL and other wastes including anode materials were stockpiled in the eastern portion of the site for the period 1969 to 1992. Mixed smelter wastes comprising spent pot lining and to a lesser extent amounts of other solid wastes generated at the smelter including cryolite, alumina, floor sweepings (alumina, cryolite, carbon), shot blast dust (carbon, steel shot), cement, potlining mix and small amounts of other materials including plastic, wood and steel.
14,000 – 41,000	23,500 – 69,500	Onsite smelter soils – soils within the smelter footprint that have been impacted by contaminants during the operation of the site. This includes soil and sediments impacted with fluoride and PAHs.
11,550 – 34,870	14,690 – 51,030	Contaminated soils and materials within the buffer zone that have arisen during the operations of the Smelter. This includes fill in the Glen Main mine subsidence area, the Dickson Road Landfill area and soil contamination and wastes on other Hydro owned lands (including asbestos). This category does NOT include municipal wastes at the Glen Main Landfill or the Clay Borrow Pit materials.
280 – 520	80 - 160	Municipal wastes - wastes that are sources from non-smelter related activities and are able to be sorted from mixed wastes. Includes municipal wastes within the Glen Main mine subsidence area. For all options municipal wastes have been disposed to landfill.
12,000 – 14,670	21,600 – 26,400	First and second cut SPL in storage (sheds) and in pots at the smelter site that will be treated in the next 2 years under the existing Regain contract. Based on 12,000 tpa.
38,000 – 46,440	68,400 – 83,600	First and second cut SPL in storage (sheds) and in pots at the smelter site that will be remaining at the anticipated time of commencement.

Contaminated Soils and Waste Volumes and Tonnages Mass Located on Hydro Owned Land		
Volume (m^3)	**Tonnage (t)**	**Description**
7,600 – 22,900	21,200 – 64,000	Clay borrow pit - refractories, concrete and bitumen currently stored within the clay borrow pit area. For all options these materials are assumed to be crushed and available for recycling off site. Any cost savings from recycling within the construction of the containment cell have not been considered at this time.
Unknown, allow 20,000 – 40,000	Unknown, allow 14,000 – 26,000	Demolition Wastes - demolition wastes are currently unknown and will be finalised following consultation with demolition contractor. A conservative allowance has been made here. This is based on contractor estimates of concrete and steel volumes being 50000t, which make up the majority of the demolished structures.

Combined Remediation Option Summary	**Combination of primary options**
Option G1: Upgrade the capped waste stockpile and move all wastes except municipal and SPL stored and in pots to specifically designed containment cell adjacent to the capped waste stockpile. This option allows for upgrade of the capped waste stockpile in-situ and the creation of an encapsulation cell adjacent to the existing capped waste stockpile for all wastes from Hydro owned lands excluding SPL stored and in pots. SPL stored and in pots is treated through the existing Regain process (or a similar treatment process). Municipal wastes are segregated where it is practical to do so and disposed to local solid waste landfill. Clay borrow pit materials are segregated for recycling. The capped waste stockpile wastes are retained *in-situ* and a barrier wall is vertically placed in the subsurface around the perimeter to reduce leachate migration. The capped waste stockpile capping layers are partially removed and replaced allowing integration with the adjoining cell. Groundwater treatment downgradient of the capped waste stockpile is included. Reinstatement of all excavations is included.	This option combines primary options A2+B1+C2+D5+E1+F2
Option G2: Upgrade the capped waste stockpile and move all wastes including SPL to a containment cell adjacent the capped waste stockpile. This option is consistent with Option G1, but also includes disposal of untreated SPL stored and in pots within the containment cell. Municipal waste is disposed to local landfill. Clay borrow pit materials are segregated for recycling. A cutoff wall is installed in the capped waste stockpile and its capping layers are upgraded. Groundwater treatment by interception of leachate is undertaken down gradient of the capped waste stockpile. Validation and reinstatement of all excavations is included. This option includes a provision for two years of SPL treatment under the existing Regain contract. This is on the basis that the remediation commencement date will occur in approximately two years' time and the Regain treatment (or a	This option combines primary options A2+B3 +C4 +D4 +E2+F2

Combined Remediation Option Summary	**Combination of primary options**
similar treatment process).of SPL will continue until then.	
Option G3: Upgrade the capped waste stockpile and construct a containment cell for all other wastes excluding SPL in another area of the Hydro site._This option allows for upgrade of the capped waste stockpile in-situ and the construction of a containment cell in another area of the site for all wastes from Hydro owned lands excluding SPL stored and in pots. SPL stored and in pots is treated through the existing Regain process (or a similar treatment process). Municipal wastes are segregated where it is practical to do so and disposed to local solid waste landfill. Clay borrow pit materials are segregated for recycling. The capped waste stockpile wastes are retained *in-situ* and a barrier wall is vertically placed in the subsurface around the perimeter to reduce leachate migration. The capped waste stockpile capping layers are partially removed and replaced allowing integration with the adjoining cell. Groundwater treatment down gradient of the capped waste stockpile is included. Reinstatement of all excavations is included.	This option combines primary options A2+B1+C4+D4+E2+F2
Option G4: Move and encapsulate the capped waste stockpile and other wastes excluding SPL in purpose built containment cell within the Hydro site. This option relocates all wastes excluding municipal and SPL stored and in pots to a new purpose built containment cell within the Hydro footprint. Municipal wastes are segregated where it is practical to do so and disposed to local solid waste landfill. SPL is treated through the existing Regain process (or a similar treatment process). Clay borrow pit materials are segregated for recycling. The capped waste stockpile wastes are excavated and relocated without sorting or crushing to the new containment cell. All other wastes are excavated and moved to the containment cell. The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure and would be segregated for waste separation allowing possible reclamation of waste as a resource in the future. Groundwater treatment of an allocated volume of leachate from the base of the capped waste stockpile following relocation removal is undertaken. Validation and reinstatement of all excavations is included. Groundwater treatment of an allocated volume of leachate from the footprint of the capped waste stockpile following relocation removal is undertaken. Validation and reinstatement of all excavations is included.	A3+B1+C4 +D4 +E2+F3

Combined Remediation Option Summary	**Combination of primary options**
Option G5: Move and encapsulate the capped waste stockpile and all wastes including SPL in purpose built containment cell within the Hydro site. This option is consistent with Option G3 but also includes disposal of untreated SPL stored and in pots within the containment cell. The capped waste stockpile will be removed and a limited volume of leachate impacted groundwater treated following removal . The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure and would be segregated for waste separation allowing possible reclamation of waste as a resource in the future. Municipal wastes will be disposed to local landfill. . SPL wastes are crushed prior to placement within the containment cell. Clay borrow pit materials are segregated for recycling. All other wastes are excavated and moved to the containment cell. Validation and reinstatement of all excavations is included.	A3+B5+C4 +D4 +E2+F3
Option G6 Disposal of all wastes off site. This option considers the disposal of all wastes off site. Excavation sites are validated and reinstated. Impacted natural soils beneath the capped waste stockpile are excavated and include in the disposal. Groundwater beneath and within the capped waste stockpile that is impacted by leachate is removed.	A5B+B7A+C6+D6+E3+F3
Option G7 Treat and destroy all site wastes using plasma arc technology. This option considers the complete destruction of all waste materials, including municipal wastes, SPL stored and in pots, and mixed waste in the capped waste stockpile. Clay borrow pit materials are segregated for recycling. Research has identified that plasma arc technology may provide a suitable option for the site and laboratory treatment trials of SPL have been successfully undertaken. The greatest potential advantage of this technology is the ability to treat the mixed wastes within the capped waste stockpile. Pilot studies would be required to assess feasibility and capital and operation costs for this treatment and therefore the technological risk is high. For this option only limited information is currently available.	A3+B10+C4 +D4 +E2+F2

G1 Upgrade the capped waste stockpile and move all wastes except municipal and SPL stored and in pots to specifically designed containment cell adjacent to the capped waste stockpile

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD)[1]	Risk Ranking
Moderate to high	60.3	6 – 8	3.1	5

G1.1 Description of the option

This option includes the following key elements.

1) Installation of a vertical barrier wall around the perimeter of the existing capped waste stockpile. The capped waste stockpile was constructed without a low permeability base layer and investigations have shown that there is a direct connection between groundwater beneath the Capped waste stockpile and groundwater down gradient of the capped waste stockpile and that a leachate pathway to the environment exists.
2) Removal and replacement of part of the existing capping layer of the capped waste stockpile. The capped waste stockpile was capped in 1993 and investigations have shown that this capping layer is of 1 x 10^{-8} m/s permeability or better[2] which is in accordance with the design parameters. However, improvements and increased engineering of the existing capping layers can be applied by removing the upper soil layers (topsoil, 0.15 m and general fill, 0.45 m) and half of the clay cap (0.45m). Improvements in the cap would be achieved by placement of a 1.5 mm thick high density polyethylene (HDPE) liner overlain by compacted clay and soil layers.
3) Construction of a containment cell adjoining the existing capped waste stockpile to accommodate contaminated soils generated from on-site, contaminated soils and smelter wastes generated from within the buffer zone, materials from the clay borrow pit (concrete, bitumen, refractories) and wastes generated during the demolition process.
4) Treatment of SPL stored and in pots through the existing Regain contract (or a similar treatment process). This assumes that the Regain contract can be renegotiated (or a contract with a new processor negotiated) to incorporate all SPL stored and in pots, including both first and second cut.
5) Disposal of municipal wastes to Cessnock Landfill.

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[1] Net present value using a discount rate of 3%
[2] RCA Geotechnical Assessment of Landfill Cover, Hydro Aluminium Kurri Kurri Pty Ltd, May 2013

6) Excavation, sorting and crushing of clay borrow pit materials and make suitable for recycling.

For the purpose of providing an evaluation of this option the following steps were considered to be required to achieve remediation.

1) Improvements to the capped waste stockpile, including:
   - A geotechnical investigation to confirm the depth to the clay aquitard, currently estimated to be between 6 m and 15 m below ground surface. Undertake feasibility trials using leachate to assess the permeability performance with high ion water. Evaluate the existing capping layer performance;
   - Design a barrier wall, capping layer improvements and a validation specification. Preparation of specification and tender documents. Tendering / contractor award;
   - Appropriate planning and approvals as described in Section G1.2;
   - Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
   - Barrier wall construction including trenching to appropriate depths and placement of a wall. The composition of the barrier wall is likely to comprise a bentonite and soil mix, or a bentonite, soil and cement mix. The final composition will be dependent on laboratory testing of bentonite response to high ion leachate;
   - Remove existing overlying cap elements and segregate. Costing has assumed that removal of 0.15 m vegetation layer can be segregated for reuse, 0.45 m general fill layer can be segregated for reuse and 0.4 m of the 0.950 m existing clay cap can be segregated for reuse. The remaining 0.55 m clay cap thickness and underlying gas drainage layer will remain. This will prevent full exposure of the underlying wastes to workers and the environment during the cap rework. Also, prevents cross contamination of what are expected to be clean cap materials from potentially contaminated materials lower in the profile.
2) Construction of a containment cell adjacent to the capped waste stockpile, including:
   - Investigations to determine the most geotechnically suitable area for the containment cell;
   - Preliminaries and site preparatory works;
   - Construction of the cell base liner comprising:

    - A 1 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
- Excavation of all waste materials proposed for the containment cell and transport to the containment cell for emplacement. Validation that all impacted soils have been removed from the sources sites;
- Construction of the cell cap to also extend over the existing capped waste stockpile. The cell cap liner will comprise (ordered from vertically upwards):
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.15 m sand gas collection layer overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.3 m topsoil layer, seeded and mulched.

3) Disposal of municipal wastes at Cessnock Landfill.
4) Continued treatment of SPL stored in pots and sheds by the Regain process (or a similar treatment process).
5) Excavate, sort and crush clay borrow pit materials. Sorted materials are segregated for off site use by a third party.
6) Treatment of surficial leachate impacted groundwater downgradient of the capped waste stockpile for a period of five years. Groundwater will be captured through the existing and an additional leachate interception trenches and will be treated through the existing on site evaporation and irrigation system.

7) Post construction monitoring of the containment cell including:

- Installation and regular monitoring of groundwater monitoring wells and gas wells installed around the new facility;
- Ongoing physical maintenance of the cell to maintain integrity of the cap;
- Ongoing leachate monitoring.
- Ongoing documentation/reporting (as a requirement of planning approval/ EPL conditions);
- Surrender of the EPL for the containment cell – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

G1.2 Likelihood of approval

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order (CCO) allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*". Capping of the capped waste stockpile was subsequently undertaken to meet this requirement.

If the proposed improvements to the capped waste stockpile capping can be shown to stop the generation of leachate that exceeds the noted criteria, the upgraded capped waste stockpile would be in compliance with the existing licence issued to Hydro under the CCO.

Planning Approval

To allow the improvements to the capped waste stockpile to be completed (while removing the potential requirement of the 1993 planning approval to continue to research and implement any viable treatment technology for the SPL in the capped waste stockpile, as well as indefinite management and monitoring) and construction of the new containment cell, Hydro would need to submit a development application. This would include an alternative management approach that removes the need for indefinite management and monitoring, and an acceptance that untreated SPL would remain in the capped waste stockpile (i.e. no researching or implementation of viable treatment technologies).

If this approach was taken, the upgraded capped waste stockpile and new adjacent containment cell would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*”.

Development for the purposes of a ‘waste or resource management facility’ (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As a ‘waste or resource management facility’ is not specified as ‘permitted without consent’ or ‘prohibited’ it follows that a ‘waste or resource management facility’ is permissible with consent.

It should be noted that the LEP prohibits “heavy industrial storage establishment” in the RU2 Zone. This includes a “hazardous storage establishment” which is defined by the LEP as:

“*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment.”

This advice is based on the assumption that the upgraded capped waste stockpile would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a “heavy industrial storage establishment“.

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

“*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*.”

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

“(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment”

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes “Waste and resource management facilities” as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*“(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*”

“Aluminium smelting by-product” is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence the waste facility (due to the retention of the untreated SPL in the upgraded capped waste stockpile) would be deemed a ‘state significant development’, requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives to the upgrade of the capped waste stockpile.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption.
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL with mixed smelter waste to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Environment Protection Licence (EPL) 1548 held by Hydro covers the scheduled activity of "Metallurgical activities" (aluminium production and metal waste. The upgrade of the encapsulation to the capped waste stockpile and the new adjacent containment cell would be deemed a scheduled activity by meeting the definition of "contaminated soil treatment". Clause 15 of Schedule 1 of the POEO Act defines the following as a scheduled activity:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site, or

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(i) to incinerate more than 1,000 cubic metres per year of contaminated soil, or

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil, or

(iii) to disturb more than an aggregate area of 3 hectares of contaminated soil."

The EPA would deem the upgraded capped waste stockpile and the adjacent containment cell as contaminated soil treatment, as encapsulation is a form of treatment of the contaminated soils. As such, a new EPL (or a variation to Hydro's existing EPL) would be required for this scheduled activity.

Likelihood of Approval

The likelihood of approval is dependent upon the development, and acceptance by the EPA and DoPI of evidence that the upgraded capped waste stockpile would permanently reduce leachate escaping, and that containment of the materials within the containment cell is a reasonable and feasible option that minimises impacts on the environment.

There is a moderate to high likelihood of approval if this can be demonstrated; however, there is potential that any approval may have a number of conditions, including a long term validation monitoring program.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the improved capped waste stockpile.

G1.3 Cost

The estimated cost for this option is $60.3mil AUD NPV and includes an allocation of $41.9mil AUD NPV for treatment of SPL stored and in pots.

Refer to the attached costing for details.

G1.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.25-0.5	Containment cell design and site testing
Preparation of RAP and Planning Approval (EIS)	1-1.5	Preparation of EIS
Approvals	1-1.5	
Project Engineering Tasks	0.5	
Treatment of SPL	4	Assumes a rate of 20000t/yr. Is in parallel with other processes so is not included in the total time.
Removal and disposal of municipal wastes	0.25-0.5	Is in parallel with other processes so is not included in the total time.
Excavate, sort and crush clay borrow pit materials	0.5	Is in parallel with other processes so is not included in the total time.
Capped waste stockpile barrier wall install and partial cap removal	0.5-1	
Containment cell construction	0.5-1	
Relocation of wastes	0.5 - 1	Based on 600t/day
Closure of the containment cell	0.25-0.5	Undertaken progressively
Final Reporting	0.25-0.5	
Approximate Time Estimate	6 – 8 years	

G1.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur only under rare circumstances, such as severe weather events or an earthquake. A percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe. Should such an event occur, the costs are proposed to be consistent with the initial capital costs. It is not proposed that contained materials would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 2% of the total capital costs and determined on a net present value for an event occurring at Year 50.

There is an additional risk that groundwater treatment down gradient of the capped waste stockpile will be required continue. Consistent with Option F2 (groundwater treatment) a legacy cost of $1.6mil AUD NPV was applied.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $3.2mil AUD NPV.

G1.6 Risk Ranking

The proposed capped waste stockpile upgrades include improvements of the existing cap and placement of a second cap layer that includes a HDPE liner, and the placement of a vertical barrier wall. This approach significantly reduces the likelihood of failure by increasing the engineering controls around the construction and introducing a dual layer system: however, an inherent risk remains because of the inability to remove and compact the waste (which would be technically difficult to achieve), therefore failure of the cap could occur through uncontrolled waste consolidation. Failure of the vertical barrier wall is also considered unlikely on the basis of laboratory trialing to verify material performance with high ion leachate and validation protocols during construction. The containment cell adjacent to the capped waste stockpile would be highly engineered with levels of redundancy to minimise the risk of failure. On this basis the likelihood of failure of the cap and wall is considered ‘unlikely’, it could occur at some time.

In the event of failure, due to the proximity of shallow groundwater there is a direct conduit to the receiving surrounding environment for leachate generation. Impacts to the environment are reduced due to the inclusion of groundwater treatment in the remediation works for a period of 5 years and the exclusion of SPL stored and in pots from the cell (which has the highest leachable potential). However, the cost of remediation may be high requiring cap improvements or removal and treatment of entrained leachate with costs of between $5mil and $10mil. It is considered that the risk of prosecution is low due to the demonstrated attempts to remediate the site. On this basis the consequence is considered to be ‘major’. The risk ranking is therefore ‘5’.

G2 Upgrade the capped waste stockpile and move all wastes including SPL to a containment cell adjacent the capped waste stockpile

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD) [3]	Risk Ranking
Moderate	33.9	7 – 9	3.2	6

G2.1 Description of the option

The capped waste stockpile comprises mixed waste smelter materials including SPL. The capped waste stockpile is situated within the eastern area of the Smelter Site and is surrounded by undeveloped land. To consolidate waste disposal on the site, a cell adjacent and adjoining the capped waste stockpile can be constructed for placement of the contaminated soils and waste materials from the smelter and from within the buffer zone. For this option, containment on-site was considered for all waste materials including SPL stored and in pots but NOT municipal wastes. Refractories, concrete and asphalt within the clay borrow pit are excavated and crushed for off site or on site reuse. Groundwater treatment by interception of leachate is undertaken downgradient of the capped waste stockpile. Validation and reinstatement of all excavations is included.

This option includes the following key elements.

1) Installation of a vertical barrier wall around the perimeter of the existing capped waste stockpile. The capped waste stockpile was constructed without a low permeability base layer and investigations have shown that there is a direct connection between groundwater beneath the Capped waste stockpile and groundwater down gradient of the capped waste stockpile and that a leachate pathway to the environment exists.

2) Removal and replacement of part of the existing capping layer of the capped waste stockpile. The capped waste stockpile was capped in 1993 and investigations have shown that this capping layer is of 1 x 10^{-8} m/s permeability or better[4] which is in accordance with the design parameters. However, improvements and increased engineering of the existing capping layers can be applied by removing the upper soil layers (topsoil, 0.15 m and general fill, 0.45 m) and half of the clay cap (0.45m). Improvements in the cap would be achieved by placement of a 1.5 mm thick high density polyethylene (HDPE) liner, overlain by compacted clay and soil layers.

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[3] Net present value using a discount rate of 3%
[4] RCA Geotechnical Assessment of Landfill Cover, Hydro Aluminium Kurri Kurri Pty Ltd, May 2013

3) Construction of a containment cell adjoining the existing capped waste stockpile to accommodate contaminated soils generated from onsite, contaminated soils and smelter wastes generated from within the buffer zone, materials from the clay borrow pit (concrete, bitumen, refractories), wastes generated during the demolition process and SPL stored and in pots. SPL wastes stored and in pots are included in a segregated containment cell. The purpose of the segregation is to allow for later resource recovery of the SPL should future opportunities arise.

4) Disposal of municipal wastes to Cessnock Landfill.

5) Excavate, sort and crush clay borrow pit materials to make suitable of off site use by a third party. Opportunities for reuse of these materials within the containment cell, and any cost benefits, have not been considered at this stage.

For the purpose of providing an evaluation of this option the following steps were considered to be required to achieve remediation.

1) Improvements to the capped waste stockpile including:

- A geotechnical investigation to confirm the depth to the clay aquitard, currently estimated to be between 6 m and 15 m below ground surface. Undertake feasibility trials using leachate to assess the permeability performance with high ion water. Evaluate the existing capping layer performance;
- Design a barrier wall, capping layer improvements and a validation specification. Preparation of specification and tender documents. Tendering / contractor award;
- Appropriate planning and approvals as described in Section G2.2;
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Barrier wall construction including trenching to appropriate depths and placement of a wall. The composition of the barrier wall is likely to comprise a bentonite and soil mix, or a bentonite, soil and cement mix. The final composition will be dependent on laboratory testing of bentonite response to high ion leachate;
- Remove existing overlying cap elements and segregate. Costing has assumed that removal of 0.15 m vegetation layer can be segregated for reuse, 0.45 m general fill layer can be segregated for reuse and 0.45 m of the 0.95 m existing clay cap can be segregated for reuse. The remaining 0.45 m clay cap thickness and underlying gas drainage layer will remain. This will prevent full

exposure of the underlying wastes to workers and the environment during the cap rework. Also, prevents cross contamination of what are expected to be clean cap materials from potentially contaminated materials lower in the profile.

2) Construction of a containment cell adjacent to the capped waste stockpile, including:

- Investigations to determine the most geotechnically suitable area for the containment cell;
- Preliminaries and site preparatory works;
- Construction of the cell base liner comprising:
    - A 1 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
- Construction of two segregated cells within the containment cell to allow containment of SPL separate to all other wastes.
- Excavation of all waste materials proposed for the containment cell, including SPL stored and in pots, and transport to the containment cell for emplacement. Validation that all impacted soils have been removed from the sources sites.
- Construction of the cell cap to also extend over the existing capped waste stockpile. The cell cap liner will comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.15 m sand gas collection layer overlain by;

- A 0.3 m protection layer overlain by;
- A 0.3 m topsoil layer, seeded and mulched.

3) Disposal to landfill of municipal wastes at Cessnock Landfill:
4) Provision for treatment of 24000t of stored SPL by Regain. This is based on the amount of SPL processed by Regain under the existing contract prior to the commencement of site remediation.
5) Excavate, sort and crush clay borrow pit materials and stockpile for off site reuse by a third party.
6) Treatment of surficial leachate impacted groundwater downgradient of the capped waste stockpile for a period of five years. Groundwater will be captured through the existing and an additional leachate interception trenches and will be treated through the existing on site evaporation and irrigation system.
7) Post construction monitoring of the containment cell, including:

- Installation and regular monitoring of groundwater monitoring wells and gas wells installed around the new facility;
- Ongoing physical maintenance of the cell to maintain integrity of the cap;
- Ongoing leachate monitoring.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the EPL for the containment cell – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

G2.2 Likelihood of approval

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order (CCO) allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*". Capping of the capped waste stockpile was subsequently undertaken to meet this requirement.

If the proposed improvements to the capped waste stockpile capping can be shown to stop the generation of leachate that exceeds the noted criteria, the upgraded capped waste stockpile would be in compliance with the CCO (and the associated licence). Similarly, if the containment cell containing the untreated SPL can be shown to not generate leachate that exceeds the noted criteria, this would comply with the requirements of the CCO and the associated licence (via an amendment to the existing licence or a new licence).

Planning Approval

A new development application would be required to undertake the improvements to the capped waste stockpile (including removing the requirement of the 1993 planning approval to research and implement any viable treatment technology for the SPL in the capped waste stockpile, as well as indefinite management and monitoring); to establish the new containment cell and cease the treatment of the stored SPL (which is required by a 2005 planning approval). This would include an alternative management approach that removes the need for indefinite management and monitoring, and an acceptance that untreated SPL would be placed in the containment cell (including no research or implementation of viable treatment technologies for SPL in the capped waste stockpile, and cessation of treatment of the SPL currently in storage).

If this approach was taken, the upgraded capped waste stockpile and new adjacent containment cell would be deemed a “waste disposal facility” under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as “*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*”.

Development for the purposes of a ‘waste or resource management facility’ (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as ‘permitted without consent’ or ‘prohibited’ is permitted with consent in the RU2 Zone under Cessnock LEP. As a ‘waste or resource management facility’ is not specified as ‘permitted without consent’ or ‘prohibited’ it follows that a ‘waste or resource management facility’ is permissible with consent.

It should be noted that the LEP prohibits “heavy industrial storage establishment” in the RU2 Zone. This includes a “hazardous storage establishment” which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the upgraded capped waste stockpile and the adjacent containment cell would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

"*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*."

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

"(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment"

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence the waste facility (due to the untreated SPL) would be deemed a 'state significant development', requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives to the upgrade of the capped waste stockpile.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).

- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption.
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Environment Protection Licence (EPL) 1548 held by Hydro covers the scheduled activity of "Metallurgical activities" (aluminium production and metal waste. The upgrade of the encapsulation to the capped waste stockpile and the new adjacent containment cell would be deemed a scheduled activity by meeting the definition of "contaminated soil treatment". Clause 15 of Schedule 1 of the POEO Act defines the following as a scheduled activity:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site, or

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(i) to incinerate more than 1,000 cubic metres per year of contaminated soil, or

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil, or

(iii) to disturb more than an aggregate area of 3 hectares of contaminated soil."

The EPA would deem the upgraded capped waste stockpile and the adjacent containment cell as contaminated soil treatment because encapsulation is a form of treatment of contaminated soils. As such, a new EPL (or a variation to Hydro's existing EPL) would be required for this scheduled activity.

Likelihood of Approval

The likelihood of approval is dependent upon the development and acceptance by the EPA and DoPI of evidence that the upgraded capped waste stockpile would permanently stop leachate escaping, that containment of the materials within the containment cell is a reasonable and feasible option that minimises impacts on the environment, and that placing the untreated SPL in the cell is the most reasonable and feasible option.

There is a moderate likelihood of approval if this can be demonstrated; however, there is potential that any approval may have a number of conditions, including a long term validation monitoring program.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the improved capped waste stockpile.

G2.3 Cost

The estimated cost for this option is $33.9mil AUD NPV which includes a provision of $12.3mil AUD NPV for treatment of SPL over a two year period by Regain.

Refer to the attached costing for details.

G2.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.25-0.5	Containment cell design and site testing
Preparation of RAP and Planning Approval (EIS)	1 – 1.5	Preparation of EIS
Approvals	1 – 1.5	
Project Engineering Tasks	0.5	
Removal and disposal of municipal wastes	0.25 – 0.5	Is in parallel with other processes so is not included in the total time.
Excavate, sort and crush clay borrow pit materials	0.5	Is in parallel with other processes so is not included in the total time.
Capped waste stockpile barrier wall install and partial cap removal	0.5 – 1	
Containment cell construction	0.5 – 1	
Relocation of wastes, including SPL	2 – 3	Based on 600t/day
Closure of the containment cell	0.25 – 0.5	Undertaken progressively
Final Reporting	0.25 – 0.5	
Approximate Time Estimate	7 – 9 years	

G2.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, gas, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur only under rare circumstances, such as severe weather events or an earthquake. A percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe. Should such an event occur, the costs are proposed to be consistent with the initial capital costs. It is not proposed that contained materials would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 2% of the total capital costs and determined on a net present value for an event occurring at Year 50.

There is an additional risk that groundwater treatment down gradient of the capped waste stockpile will be required continue. Consistent with Option F2 (groundwater treatment) a legacy cost of $1.6mil was applied.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $3.2mil AUD NPV.

G2.6 Risk Ranking

The proposed capped waste stockpile upgrades include improvements of the existing cap and placement of a second cap layer that includes a HDPE liner, and the placement of a vertical barrier wall. This approach significantly reduces the likelihood of failure by increasing the engineering controls around the construction and introducing a dual layer system: however, an inherent risk remains because of the inability to remove and compact the waste (which would be technically difficult to achieve), therefore failure of the cap could occur through uncontrolled waste consolidation. Failure of the vertical barrier wall is also considered unlikely on the basis of laboratory trialing to verify material performance with high ion leachate and validation protocols during construction. The containment cell adjacent to the capped waste stockpile would be highly engineered with levels of redundancy to minimise the risk of failure. On this basis the likelihood of failure of the cap and wall is considered ‘unlikely’, it could occur at some time.

In the event of failure, due to the proximity of shallow groundwater there is a direct conduit to the receiving surrounding environment for leachate generation. Impacts to the environment are reduced due to the inclusion of groundwater treatment in the remediation works for a period of 5 years and the exclusion of SPL stored and in pots from the cell (which has the highest leachable potential). However, the cost of remediation may be high requiring cap improvements or removal and treatment of entrained leachate with costs in excess of $5mil. It is considered that the risk of prosecution is high due to placement of untreated SPL within the landfill. On this basis the consequence is considered to be ‘catastrophic’. The risk ranking is therefore ‘6’.

G3 Upgrade the capped waste stockpile and construct a containment cell for all other wastes excluding SPL in another area of the Hydro site.

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD) [5]	Risk Ranking
Moderate	59.3	7 – 9	4.1	5

G3.1 Description of the option

This option allows for upgrade of the capped waste stockpile in-situ and the construction of a containment cell in another area of the site for all wastes from Hydro owned lands excluding SPL stored and in pots. SPL stored and in pots is treated through the existing Regain process (or a similar treatment process). Municipal wastes are segregated where it is practical to do so and disposed to local solid waste landfill. Clay borrow pit materials are segregated for recycling. The capped waste stockpile wastes are retained *in-situ* and a barrier wall is vertically placed in the subsurface around the perimeter to reduce leachate migration. The capped waste stockpile capping layers are partially removed and replaced allowing integration with the adjoining cell. Groundwater treatment downgradient of the capped waste stockpile is included. Reinstatement of all excavations is included.

This option includes the following key elements.

1) Installation of a vertical barrier wall around the perimeter of the existing capped waste stockpile. The capped waste stockpile was constructed without a low permeability base layer and investigations have shown that there is a direct connection between groundwater beneath the capped waste stockpile and groundwater down gradient of the capped waste stockpile and that a leachate pathway to the environment exists.

2) Removal and replacement of part of the existing capping layer of the capped waste stockpile. The capped waste stockpile was capped in 1993 and investigations have shown that this capping layer is of 1×10^{-8} m/s permeability or better[6] which is in accordance with the design parameters. However, improvements and increased engineering of the existing capping layers can be applied by removing the upper soil layers (topsoil, 0.15 m and general fill, 0.45 m) and half of the clay cap (0.45m). Improvements in the cap would be achieved by placement of a 1.5 mm thick high density polyethylene (HDPE) liner, overlain by compacted clay and soil layers.

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[5] Net present value using a discount rate of 3%
[6] RCA Geotechnical Assessment of Landfill Cover, Hydro Aluminium Kurri Kurri Pty Ltd, May 2013

3) Construction of a new containment cell in a suitable area of the Hydro site to accommodate contaminated soils generated from onsite, contaminated soils and smelter wastes generated from within the buffer zone and wastes generated during the demolition process.

4) Disposal of municipal wastes to Cessnock Landfill.

5) Treat SPL wastes through the existing Regain process (or a similar treatment process).

6) Excavate, sort and crush clay borrow pit materials to make suitable for off site use by a third party. Opportunities for reuse of these materials within the containment cell, and any cost benefits, have not been considered at this stage.

For the purpose of providing an evaluation of this option the following steps were considered to be required to achieve remediation.

1) Improvements to the capped waste stockpile including:

- A geotechnical investigation to confirm the depth to the clay aquitard, currently estimated to be between 6 m and 15 m below ground surface. Undertake feasibility trials using leachate to assess the permeability performance with high ion water. Evaluate the existing capping layer performance;
- Design a barrier wall, capping layer improvements and a validation specification. Preparation of specification and tender documents. Tendering / contractor award;
- Appropriate planning and approvals as described in Section G2.2;
- Preparation of required documentation for site remedial works including Remedial Action Plan and Construction Environmental Management Plans (incorporating surface water, groundwater, air quality – dust/odour/volatiles, noise, traffic management for the remedial works) and long term Environmental Management Plan;
- Barrier wall construction including trenching to appropriate depths and placement of a wall. The composition of the barrier wall is likely to comprise a bentonite and soil mix, or a bentonite, soil and cement mix. The final composition will be dependent on laboratory testing of bentonite response to high ion leachate;
- Remove existing overlying cap elements and segregate. Costing has assumed that removal of 0.15 m vegetation layer can be segregated for reuse, 0.45 m general fill layer can be segregated for reuse and 0.45 m of the 0.95 m existing clay cap can be segregated for reuse. The remaining 0.45 m clay cap thickness and underlying gas drainage layer will remain. This will prevent full

exposure of the underlying wastes to workers and the environment during the cap rework. Also, prevents cross contamination of what are expected to be clean cap materials from potentially contaminated materials lower in the profile.

- Place a HDPE liner followed by replacement of the capping layer elements outlined above.

2) Construction of a containment cell in a suitable area of the Hydro site, including:

- Investigations to determine the most geotechnically suitable area for the containment cell;
- Preliminaries and site preparatory works;
- Construction of the cell base liner comprising:
  - A 1 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
  - A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer.
- Excavation of all waste materials proposed for the containment cell, including SPL stored and in pots, and transport to the containment cell for emplacement. Validation that all impacted soils have been removed from the sources sites.
- Construction of the cell cap to also extend over the existing capped waste stockpile. The cell cap liner will comprise (ordered from vertically upwards)
  - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.15 m sand gas collection layer overlain by;
  - A 0.3 m protection layer overlain by;

- o A 0.3 m topsoil layer, seeded and mulched.

3) Disposal to landfill of municipal wastes at Cessnock Landfill:
4) Excavate, sort and crush clay borrow pit materials and stockpile for off site reuse by a third party.
5) Treatment of surficial leachate impacted groundwater downgradient of the capped waste stockpile for a period of five years. Groundwater will be captured through the existing and an additional leachate interception trenches and will be treated through the existing on site evaporation and irrigation system.
6) Post construction monitoring of the containment cell, including:

- Installation and regular monitoring of groundwater monitoring wells and gas wells installed around the new facility;
- Ongoing physical maintenance of the cell to maintain integrity of the cap;
- Ongoing leachate monitoring.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the EPL for the containment cell – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the two sites in perpetuity through an Environmental Management Plan or divestment of the sites through various divestment options.

G3.2 Likelihood of approval

Chemical Control Order

The *EIS: Upgrades to Waste Storage Facilities at the Alcan Australia Limited, Kurri Kurri Smelter* (Dames and Moore, 1992) noted that the then State Pollution Control Commission (now the EPA) issued a licence associated with the Chemical Control Order (CCO) allowing *"those wastes which generate more than 150 mg/L fluoride and/or 10mg/L cyanide when leached under specific laboratory conditions*" (which includes SPL) "*to be stored at the smelter in a manner that prevents the escape of leachate or wind blown dust*". Capping of the capped waste stockpile was subsequently undertaken to meet this requirement.

If the proposed improvements to the capped waste stockpile capping can be shown to stop the generation of leachate that exceeds the noted criteria, the upgraded capped waste stockpile would be in compliance with the CCO (and the associated licence).

Planning Approval

This advice is based on the assumption that the upgrade to the capped waste stockpile and the construction and operation of a new containment cell in another area of the Hydro site would be addressed within one planning approval process.

A new development application would be required to undertake the improvements to the capped waste stockpile (including removing the requirement of the 1993 planning approval to research and implement any viable treatment technology for the SPL in the capped waste stockpile, as well as indefinite management and monitoring); to establish the new containment cell and cease the treatment of the stored SPL (which is required by a 2005 planning approval). This would include an alternative management approach that removes the need for indefinite management and monitoring, and an acceptance that untreated SPL would be placed in the containment cell (including no research or implementation of viable treatment technologies for SPL in the capped waste stockpile, and cessation of treatment of the SPL currently in storage).

If this approach was taken, the upgraded capped waste stockpile and new adjacent containment cell would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the upgraded capped waste stockpile and the adjacent containment cell would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

"*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*."

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

"(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment"

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence the waste facility (due to the SPL within the mixed smelter waste in the capped waste stockpile) would be deemed a 'state significant development', requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell requires disturbance of adjacent areas currently containing native vegetation).
- Aboriginal heritage (if the containment cell requires disturbance of adjacent areas of limited disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives to the upgrade of the capped waste stockpile.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).

- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption.
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Environment Protection Licence (EPL) 1548 held by Hydro covers the scheduled activity of “Metallurgical activities” (aluminium production and metal waste. The upgrade of the encapsulation to the capped waste stockpile and the new adjacent containment cell would be deemed a scheduled activity by meeting the definition of “contaminated soil treatment”. Clause 15 of Schedule 1 of the POEO Act defines the following as a scheduled activity:

“(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(a) in any case, it has the capacity to treat more than 1,000 cubic metres per year of contaminated soil received from off site, or

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(i) to incinerate more than 1,000 cubic metres per year of contaminated soil, or

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil, or

(iii) to disturb more than an aggregate area of 3 hectares of contaminated soil.”

The EPA would deem the upgraded capped waste stockpile and the containment cell as contaminated soil treatment because encapsulation is a form of treatment of contaminated soils. As such, a new EPL (or a variation to Hydro’s existing EPL) would be required for this scheduled activity.

Likelihood of Approval

The likelihood of approval is dependent upon the development and acceptance by the EPA and DoPI of evidence that the upgraded capped waste stockpile would permanently stop leachate escaping; and that containment of the materials within the containment cell is a reasonable and feasible option that minimises impacts on the environment.

There is a moderate likelihood of approval if this can be demonstrated; however, there is potential that any approval may have a number of conditions, including a long term monitoring program.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the improved capped waste stockpile and containment cell.

G3.3 Cost

The estimated cost for this option is $59.3mil AUD NPV and includes $41.9mil AUD NPV for treatment of SPL through the Regain process (or a similar treatment process).

Refer to the attached costing for details.

G3.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.25-0.5	Containment cell design and site testing
Preparation of RAP and Planning Approval (EIS)	1 – 1.5	Preparation of EIS
Approvals	1 – 1.5	
Project Engineering Tasks	0.5	
Removal and disposal of municipal wastes	0.25 – 0.5	Is in parallel with other processes so is not included in the total time.
Excavate, sort and crush clay borrow pit materials	0.5	Is in parallel with other processes so is not included in the total time.
Treatment of SPL	4	Based on 20000t/yr, occurs concurrently so not included
Capped waste stockpile barrier wall install and partial cap removal	0.5 – 1	
Containment cell construction	0.5 – 1	
Relocation of wastes	2 – 3	Based on 600t/day, occurs concurrently so not included
Closure of the containment cell	0.25 – 0.5	Undertaken progressively
Final Reporting	0.25 – 0.5	
Approximate Time Estimate	7 – 9 years	

G3.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, gas, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting. Monitoring will be required at two locations;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years. Maintenance will be required at two locations.

The potential for liability is considered to occur from an event that affects containment cell cap integrity at either site and resulting in leachate generation. Upgrades to the capped waste stockpile will reduce the risk of breach. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur only under rare circumstances, such as severe weather events or an earthquake. However, due to the unconsolidated nature of the landfill a percentage likelihood of 2% was applied, i.e. twice in a 100 year timeframe. The probability was considered to be lower for the purpose built containment cell due to the allowance for compaction of the waste and engineering controls during construction and therefore a 1% probability of a breach was assigned.

Should such an event occur, the costs are proposed to be consistent with the initial capital costs. It is not proposed that contained materials would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1 and 2% of the total capping costs and determined on a net present value for an event occurring at Year 50.

There is an additional risk that groundwater treatment down gradient of the capped waste stockpile will be required continue. Consistent with Option F2 (groundwater treatment) a legacy cost of $1.6mil was applied.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $4.1mil AUD NPV.

G3.6 Risk Ranking

Risks associated with capped waste stockpile are considered higher than the purpose built containment cell and therefore these have been evaluated here. Risks are not cumulative. The proposed capped waste stockpile upgrades include improvements of the existing cap and placement of a second cap layer that includes a HDPE liner, and the placement of a vertical barrier wall. This approach significantly reduces the likelihood of failure by increasing the engineering controls around the construction and introducing a dual layer system. However, an inherent risk remains because of the inability to remove and compact the waste (which would be technically difficult to achieve), therefore failure of the cap could occur through uncontrolled waste consolidation. Failure of the vertical barrier wall is also considered unlikely on the basis of laboratory trialing to verify material performance with high ion leachate and validation protocols during construction. The containment cell adjacent to the capped waste stockpile would be highly engineered with levels of redundancy to minimise the risk of failure. On this basis the likelihood of failure of the cap and wall is considered ‘unlikely’, it could occur at some time.

In the event of failure, due to the proximity of shallow groundwater there is a direct conduit to the receiving surrounding environment for leachate generation. Impacts to the environment are reduced due to the inclusion of groundwater treatment in the remediation works for a period of 5 years and the exclusion of SPL stored and in pots from the cell (which has the highest leachable potential). However, the cost of remediation may be high requiring cap improvements or removal and treatment of entrained leachate with costs of between $5mil and $10mil. It is considered that the risk of prosecution is low due to the demonstrated attempts to remediate the site. On this basis the consequence is considered to be ‘major’. The risk ranking is therefore ‘5’.

G4 Move and encapsulate the capped waste stockpile and other wastes excluding SPL in purpose built containment cell within the Hydro site

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD) [7]	Risk Ranking
Moderate to high	75.5	7 – 9	2.2	3

G4.1 Description of the option

This option would manage the waste materials by placement within a purpose built containment cell constructed at an appropriate location on the site and applying best practice containment cell design and construction. The cell would be segregated to allow waste separation allowing possible reclamation of waste as a resource in the future. Two cells will be created to allow for the segregated emplacement of the capped waste stockpile materials and all other wastes (noting that municipal wastes and SPL stored and in pots are not proposed for disposal in this option). Municipal waste is proposed to be disposed to Cessnock Landfill and SPL stored and in pots is proposed to be treated under a continued Regain contract (or a similar treatment process). Refractories, concrete and asphalt within the clay borrow pit are excavated and crushed for off site or on site reuse. Groundwater treatment of an allocated volume of leachate from the footprint of the capped waste stockpile following relocation removal is undertaken.

This option would involve the following steps:

1) Construction of the containment cell

- Investigations to determine the most geotechnically suitable area for the containment cell.
- Treatability trials to evaluate liner performance with high ion leachate.
- Preliminaries and site preparatory works.
- Construction of the cell base liner comprising:
    - o A 1 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - o A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;

[7] Net present value using a discount rate of 3%

  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m sand leachate detection layer overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.3 m gravel drainage layer.
- Construction of two segregated cells within the containment cell to allow containment of SPL separate to all other wastes.

2) Excavation, transport and placement of wastes

- Excavation of capped waste stockpile wastes is proposed to be direct excavation and loading, without sorting or crushing. Daily cover materials are proposed at both the source site and the emplacement site to manage gas emissions and exposure to moisture. Daily cover materials will be sourced from the existing overlying capping layers. Leachate will be managed by retaining the outer bunded of the existing landfill and pumping from the bunded through the water treatment system described at dot point 7.
- Excavation of all other waste materials proposed for the containment cell and transport to the containment cell for emplacement. Validation that all impacted soils have been removed from the sources sites.

3) Construction of the final capping layers

- The cell cap liner will likely comprise (ordered from vertically upwards)
  - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
  - A 1.5 mm thick HDPE liner overlain by;
  - Filter fabric to provide protection to the HDPE overlain by;
  - A 0.15 m sand gas collection layer overlain by;
  - A 0.3 m protection layer overlain by;
  - A 0.3 m topsoil layer, seeded and mulched.

4) Disposal of municipal wastes at Cessnock Landfill

5) Treatment of SPL stored and in pots by Regain (or a similar treatment process).

6) Excavate, sort and crush clay borrow pit materials and stockpile for off site reuse by a third party
7) Treatment of leachate and leach impacted groundwater from within the capped waste stockpile. This step allows for the establishment of a water treatment plant for the removal of fluorides and cyanides followed by treatment of salinity by evaporation. Further details are provided in Option F3. Treatment of leachate can be undertaken from a leachate collection area constructed and maintained within the capped waste stockpile perimeter bunded. Following removal of the capped waste stockpile materials and underlying impacted soils, continued treatment of groundwater could be undertaken from an open excavation, or extraction wells, or a combination of both.
8) Post construction monitoring of the containment cell, including:

- Installation and regular monitoring of groundwater monitoring wells and gas wells installed around the new facility;
- Ongoing physical maintenance of the cell to maintain integrity of the cap;
- Ongoing leachate monitoring.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the EPL for the containment cell – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

G4.2 Likelihood of approval

Chemical Control Orders

The Chemical Control Order (CCO) applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) prohibits the disposal of such waste containing leachable fluoride and/or leachable cyanide. It also requires a licence for the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

Emplaced untreated waste would require a site-specific licence allowing macro-encapsulation by showing that the emplacement process stops the SPL with mixed smelter wastes leaching fluoride and/ or cyanide. This is the approach approved prior to 1993 for the capped waste stockpile. It is likely to justification to the EPA (including this report, the Remedial Action Plan and the Environmental Impact Statement) that macro-encapsulation is a viable leaching control methodology and therefore an exemption to be issued.

Further justification could be presented to the EPA by highlighting the the mixed nature of the waste making reuse or treatment of the SPL difficult and costly due to material handling; and the inability to locate and secure a local market for the treated by-products of SPL.

Planning Approval

Placement of the capped waste stockpile waste in a containment cell would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

In addition, removal of the contaminants from the capped waste stockpile and contaminated soils (and remediation of these locations) would be "remediation works". However, remediation works are not defined under the Cessnock LEP. Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works are permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a “heavy industrial storage establishment“.

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

“*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*.”

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

“(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment”

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes “Waste and resource management facilities” as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the placement of the untreated SPL with mixed smelter wastes currently within the capped waste stockpile in the containment cell would result in it being deemed a state significant development, requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell requires disturbance of adjacent areas currently containing native vegetation).
- Aboriginal heritage (if the containment cell requires disturbance of adjacent areas of limited disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including containment cell location hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.
- Ongoing containment cell management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption.
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL with mixed smelter wastes to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:

  - Crushing, grinding or separating
  - Waste storage
  - Waste processing (non-thermal treatment)
- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
  - Metallurgical activities (aluminium production and metal waste generation).

"Waste disposal (application to land)" is a scheduled activity requiring an EPL (Clause 39 of Schedule 3 of the POEO Act). However, the definition for this activity states that it applies to waste "*received from off site*". As the SPL was generated on site, Hydro would not require an EPL to establish a containment cell for the SPL.

However, it is likely that removal of the capped waste stockpile (and remediation of residual soils) would be a scheduled activity based on the definition of "Contaminated soil treatment" under Clause 15 of Schedule 1 of the POEO Act., which states:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Therefore an EPL would be required to undertake the removal of the capped waste stockpile wastes and the remediation of residual soils. As the containment cell would form part of the remediation works, there are likely to be licence conditions associated with the management and monitoring of the cell.

Likelihood of Approval

There are potential issues due to possible difficulties with attaining a site-specific Chemical Control Order immobilization exemption. However, as a purpose built containment cell, this (macro-encapsulation) could be deemed as an acceptable immobilization option. The other issues identified (the mixed nature of the waste making reuse difficult and costly due to material handling; and the inability to locate and secure a local market for the treated by-products of SPL with mixed smelter wastes) would further enhance the likelihood of receiving the exemption and therefore planning approval.

Preliminary discussions with the EPA have indicated that containment of site wastes within a purpose built onsite containment cell is an acceptable solution.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the improved capped waste stockpile.

G4.3 Cost

The estimated cost for this option is $75.5mil AUD NPV. This includes a cost estimate of $41.9mil AUD NPV for treatment of SPL stored and in pots.

Refer to the attached costing for details.

G4.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.25-0.5	Containment cell design and site testing
Preparation of RAP and Planning Approval (EIS)	1 – 1.5	Preparation of EIS
Approvals	1 – 1.5	
Project Engineering Tasks	0.5	
Treatment of SPL by Regain (or a similar treatment process).	5	Assumes 20000t/yr. Occurs in parallel and is not included in the timeframe.
Removal and disposal of municipal wastes	0.25 – 0.5	Is in parallel with other processes so is not included in the total time.
Excavate, sort and crush clay borrow pit materials	0.5	Is in parallel with other processes so is not included in the total time.
Capped waste stockpile barrier wall install and partial cap removal	0.5 – 1	
Containment cell construction	0.5 – 1	
Relocation of wastes, including SPL	2 – 3	Based on 600t/day
Closure of the containment cell	0.25 – 0.5	Undertaken progressively
Final Reporting	0.25 – 0.5	
Approximate Time Estimate	7 – 9 years	

G4.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, gas, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur only under rare circumstances, such as severe weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe. Should such an event occur, the costs are proposed to be consistent with the initial capital costs. It is not proposed that contained materials would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

There is an additional risk that additional groundwater treatment at the footprint of the capped waste stockpile following removal will be required continue. Consistent with Option F3 (groundwater treatment) a legacy cost of $0.6mil AUD NPV was applied.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $2.2mil AUD NPV.

G4.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered ‘rare’ that this could occur only in some extreme circumstances, such as severe weather. Should breaches occur, the containment cell is situated in an area with a depth to groundwater in excess of 10 m and away from surface water receptors, therefore the risk to the environment is minimized. In the event of failure, due to the chemical composition of wastes within the capped waste stockpile in leachate, and the exclusion of SPL stored and in pots, the consequence of failure is considered to require remediation works, although it is unlikely that impacts would result due to the depth to groundwater. As such, the consequence category is considered to be ‘moderate’, causing localized impacts and clean up costs between $0.5mil AUD and $5mil AUD. On this basis the risk ranking is ‘3’

G5 Move and encapsulate the capped waste stockpile and all wastes including SPL in purpose built containment cell within the Hydro Site

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD) [8]	Risk Ranking
Moderate	49.3	8 – 10	2.2	5

G5.1 Description of the option

This option would manage the waste materials by placement within a purpose built containment cell constructed at an appropriate location on the site and applying best practice containment cell design and construction. The cell would be segregated to allow waste separation allowing possible reclamation of waste as a resource in the future. Four segregated cells have been adopted to allow for the segregated emplacement of the capped waste stockpile materials, the SPL stored and in pots (separated into First Cut and Second Cut), and all other wastes (noting that municipal wastes are not proposed for disposal in this option). Municipal waste is proposed to be disposed to Cessnock Landfill. Refractories, concrete and asphalt within the clay borrow pit are excavated and crushed for off site or on site reuse. Groundwater treatment of an allocated volume of leachate from the footprint of the capped waste stockpile following relocation removal is undertaken.

This option would involve the following steps:

1) Construction of the containment cell

- Investigations to determine the most geotechnically suitable area for the containment cell.
- Treatability trials to evaluate liner performance with high ion leachate.
- Preliminaries and site preparatory works.
- Construction of the cell base liner comprising:
    - o A 1 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - o A 1.5 mm thick high density polyethylene (HDPE) liner overlain by;
    - o Filter fabric to provide protection to the HDPE overlain by;

[8] Net present value using a discount rate of 3%

    - A 0.3 m sand leachate detection layer overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.3 m gravel drainage layer.
- Construction of four segregated cells within the containment cell to allow containment of SPL separate to all other wastes.

2) Excavation, transport and placement of wastes

- Excavation of capped waste stockpile wastes is proposed to be direct excavation and loading, without sorting or crushing. Daily cover materials are proposed at both the source site and the emplacement site to manage gas emissions and exposure to moisture. Daily cover materials will be sourced from the existing overlying capping layers. Leachate will be managed by retaining the outer bunded of the existing landfill and pumping from the bunded through the water treatment system described at dot point 6.
- Excavation of all other waste materials proposed for the containment cell and transport to the containment cell for emplacement. Validation that all impacted soils have been removed from the sources sites.

3) Construction of the final capping layers

- The cell cap liner will likely comprise (ordered from vertically upwards)
    - A 0.6 m thick clay liner of permeability 1 x 10-9 m/s overlain by;
    - A 1.5 mm thick HDPE liner overlain by;
    - Filter fabric to provide protection to the HDPE overlain by;
    - A 0.15 m sand gas collection layer overlain by;
    - A 0.3 m protection layer overlain by;
    - A 0.3 m topsoil layer, seeded and mulched.

4) Disposal of municipal wastes at Cessnock Landfill

5) Excavate, sort and crush clay borrow pit materials and stockpile for off site reuse by a third party

6) Treatment of leachate and leach impacted groundwater from within the capped waste stockpile. This step allows for the establishment of a water treatment plant for the removal of fluorides and cyanides followed by treatment of salinity by evaporation. Further details are provided in Option F3. Treatment of leachate can be undertaken from a leachate collection area constructed and maintained within the capped waste stockpile perimeter bunded. Following removal of the capped waste stockpile materials and underlying impacted soils, continued treatment of groundwater could be undertaken from an open excavation, or extraction wells, or a combination of both.

7) Post construction monitoring of the containment cell, including:

- Installation and regular monitoring of groundwater monitoring wells and gas wells installed around the new facility;
- Ongoing physical maintenance of the cell to maintain integrity of the cap;
- Ongoing leachate monitoring.
- Ongoing documentation/reporting (as a requirement of consent/EPL conditions);
- Surrender of the EPL for the containment cell – to be determined in negotiation with EPA and other regulatory agencies;
- Long term management of the site in perpetuity through an Environmental Management Plan or divestment of the site through various divestment options.

G5.2 Likelihood of approval

Planning Approval

Chemical Control Orders

The Chemical Control Order (CCO) applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) prohibits the disposal of such waste containing leachable fluoride and/or leachable cyanide. It also requires a licence for the disposal of aluminium smelter wastes (not containing leachable fluoride and/or leachable cyanide).

Emplaced untreated SPL would require a site-specific licence allowing macro-encapsulation by showing that the emplacement process stops the SPL leaching fluoride and/ or cyanide. This is the approach approved prior to 1993 for the capped waste stockpile. It is likely to require justification to the EPA (including this report, the Remedial Action Plan and the Environmental Impact Statement) that macro-encapsulation is a viable leaching control methodology and therefore an exemption to be issued.

Further justification could be presented to the EPA by highlighting the the mixed nature of the waste making reuse or treatment of the SPL in the capped waste stockpile difficult and costly due to material handling; and the inability to locate and secure a local market for the treated by-products of all of the SPL.

Planning Approval

Placement of the material in a containment cell would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

In addition, removal of the contaminants from the capped waste stockpile and contaminated soils (and remediation of these locations) would be "remediation works". However, remediation works are not defined under the Cessnock LEP. Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works permissible with consent.

It should be noted that the LEP prohibits "heavy industrial storage establishment" in the RU2 Zone. This includes a "hazardous storage establishment" which is defined by the LEP as:

"*a building or place that is used for the storage of goods, materials or products and that would, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the building or place from existing or likely future development on other land in the locality), pose a significant risk in the locality:*

(a) to human health, life or property, or

(b) to the biophysical environment."

This advice is based on the assumption that the containment cell would be designed so that when completed it did not pose an unacceptable risk to human health or the environment. Therefore it would not be deemed a "heavy industrial storage establishment".

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

"*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*."

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

"(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment"

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore development approval is required for the demolition of the smelter and associated structures.

Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**.*"

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the placement in the containment cell of the untreated SPL with mixed smelter wastes currently within the capped waste stockpile and the untreated SPL in storage and the pots would result in it being deemed a 'state significant development', requiring approval from the Minister for Planning (or a delegate).

An EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (if the containment cell requires disturbance of adjacent areas currently containing native vegetation).
- Aboriginal heritage (if the containment cell requires disturbance of adjacent areas of limited disturbance).
- Construction noise and air quality.
- Construction traffic.
- Construction phase management of contaminants.
- Soil and water management (including containment cell location hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).
- Consideration of alternatives.
- Ongoing capped waste stockpile management strategy (particularly leachate management and cell stability).
- Sustainability and carbon management.

In addition to assessing the construction and operation of the containment cell, the EIS would also need to assess the methodology for opening the capped waste stockpile, and the removal and relocation of this material. This would include the proposed environmental management strategies (such as management of stormwater runoff) and the remediation of the capped waste stockpile location (including groundwater treatment for leachate). It would also address remediation of the sources of contaminated soils.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence supporting a site-specific Chemical Control Order immobilization exemption.
- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works.
- That disposal of untreated SPL (both SPL with mixed smelter wastes and the SPL in storage and pots) to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council.
- Environment Protection Authority (EPA).
- NSW Office of Water (NOW).
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act).
- Department of Planning and Infrastructure.
- Local Members of Parliament.
- The local community (including residents and local community and environmental groups).
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Two Environment Protection Licences (EPL) currently apply to part of the site, and specific activities including SPL management:

- EPL 13268 is held by Regain Services Pty Ltd (Regain) for the treatment of SPL. The scheduled activities covered by the EPL are:
  - Crushing, grinding or separating
  - Waste storage
  - Waste processing (non-thermal treatment)
- EPL 1548 is held by Hydro. The scheduled activities covered by the EPL are:
  - Metallurgical activities (aluminium production and metal waste generation).

"Waste disposal (application to land)" is a scheduled activity requiring an EPL (Clause 39 of Schedule 3 of the POEO Act). However, the definition for this activity states that it applies to waste "*received from off site*". As the waste was generated on site, Hydro would not require an EPL to establish a containment cell.

However, it is likely that removal of the capped waste stockpile (and remediation of residual soils) would be a scheduled activity based on the definition of "Contaminated soil treatment" under Clause 15 of Schedule 1 of the POEO Act., which states:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

Therefore an EPL would be required to undertake the removal of the capped waste stockpile wastes and the remediation of residual soils. As the containment cell would form part of the remediation works, there are likely to be licence conditions associated with the management and monitoring of the cell.

Likelihood of Approval

There are potential issues due to possible difficulties with attaining a site-specific Chemical Control Order immobilization exemption. However, as a purpose built containment cell, this (macro-encapsulation) could be deemed as an acceptable immobilization option. The other issues identified (the mixed nature of the capped waste stockpile waste makes reuse of the SPL within it difficult and costly due to material handling; and the inability to locate and secure a local market for the treated by-products of all the SPL) would further enhance the likelihood of receiving the exemption and therefore planning approval.

Preliminary discussions with the EPA have indicated that containment of site wastes within a purpose built onsite containment cell is an acceptable solution.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the improved capped waste stockpile.

G5.3 Cost

The estimated cost for this option is $49.3mil AUD NPV and includes a cost estimate of approximately $12.7mil AUD NPV for treatment of SPL over a two year period.

Refer to the attached costing for details.

G5.4 Timeframe to complete

Activity	Estimated timeframe (years)	Comments
Pre-Design Activities	0.25-0.5	Containment cell design and site testing
Preparation of RAP and Planning Approval (EIS)	1 – 1.5	Preparation of EIS
Approvals	1 – 1.5	
Project Engineering Tasks	0.5	
Removal and disposal of municipal wastes	0.25 – 0.5	Is in parallel with other processes so is not included in the total time.
Excavate, sort and crush clay borrow pit materials	0.5	Is in parallel with other processes so is not included in the total time.
Capped waste stockpile barrier wall install and partial cap removal	0.5 – 1	
Containment cell construction	0.5 – 1	
Relocation of wastes, including SPL	3 – 4	Based on 600t/day
Closure of the containment cell	0.25 – 0.5	Undertaken progressively
Final Reporting	0.25 – 0.5	
Approximate Time Estimate	8 – 10 years	

G5.5 Legacy

For this option legacy includes ongoing monitoring and management costs and a liability cost.

Monitoring and management costs were determined on the basis of the following assumptions:

1) Groundwater, gas, leachate monitoring will be required for a period of 5 years on an annual basis and include annual reporting;

2) Maintenance of the capping layer will be required for a period of 100 years and involves general gardening and the replacement of topsoils once every 25 years.

The potential for liability is considered to occur from an event that affects containment cell cap integrity resulting in leachate generation. The containment cell will be designed with levels of redundancy for most events and therefore the liability event is expected to occur only under rare circumstances, such as severe weather events or an earthquake. A percentage likelihood of 1% was applied, i.e. once in a 100 year timeframe. Should such an event occur, the costs are proposed to be consistent with the initial capital costs. It is not proposed that contained materials would require excavation and off-site disposal or treatment. Costs are therefore estimated to be 1% of the total capital costs and determined on a net present value for an event occurring at Year 50.

There is an additional risk that additional groundwater treatment at the footprint of the capped waste stockpile following removal will be required continue. Consistent with Option F3 (groundwater treatment) a legacy cost of $0.6mil was applied.

Combined with ongoing monitoring and management requirements, the total legacy cost is estimated to be $2.2mil AUD.

G5.6 Risk Ranking

The containment cell would be highly engineered with levels of redundancy to minimise the risk of failure. Risk arises from failure of the base liner or the capping layer and it is considered 'rare' that this could occur only in some extreme circumstances, such as severe weather. Should breaches occur the containment cell is situated in an area with a depth to groundwater in excess of 10 m (in the area of the containment cell) and away from surface water receptors, therefore the risk to the environment is minimised. In the event of failure, due to the chemical composition of SPL in leachate, the consequence of failure is considered to require remediation works, possibly restoration of surrounding areas and possible prosecution. The consequence category is therefore considered to be catastrophic. On this basis the risk ranking is '5'.

G6 Disposal of all wastes off site

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD) [9]	Risk Ranking
Moderate	391	9 – 11	0.6	1

G6.1 Description of the option

This option considers the disposal of all wastes off site to landfill. All wastes would be disposed of 'as is' to a New South Wales landfill. Disposal costs were calculated in each primary option as shown below.

Waste Material	Destination	Primary Option Reference	Estimate
Capped waste stockpile Wastes	Disposal to private landfill in QLD	Option A5b	$183,700,000
SPL stored and in pots	Disposal to private landfill in QLD	Option B7A	$85,300,000
Smelter contaminated soils	Disposal to Newcastle Private receiver	Option C6	$32,800,000
Buffer Zone Soils	Disposal to Newcastle Private receiver and Cessnock Landfill	Option D6	$42,100,000
Demolition wastes	Disposal to Cessnock Landfill	Option E3	$8,100,000
Total excluding Option F3 for water treatment and contingency			**$352,000,000**

This option includes reinstatement of voids, an allowance for the removal of impacted soils beneath the capped waste stockpile, as well as treatment of groundwater beneath the capped waste stockpile (Option F3) and validation and reporting.

G6.2 Likelihood of Approval

Chemical Control Orders and Dangerous Goods Code

1) General

The SPL (as Aluminium smelting by-product") is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011) (the Dangerous Goods Code). It is a Class 4.3 good (Substances which in contact with water emit flammable gases).

[9] Net present value using a discount rate of 3%

The Dangerous Goods Code places a number of restrictions on how the SPL can be transported, including:

- The size and type of wrapping/ container for the inner package and the outer package.
- The specifications for Intermediate Bulk Containers that house these packages (e.g. use metal or rigid plastic containers, or place other types of containers in closed transport units).
- If transported in a portable tank or bulk containers, the specifications for such tanks (such as thickness, pressure and pressure relief) and containers (watertight).

2) Queensland

The CCO requires that waste leaving sites must meet the leachability criteria or that specific approval is obtained for transport without treatment, before it can be exported offsite under licence from the NSW EPA.

All Australian jurisdictions require tracking of certain wastes under the Controlled Waste National Environment Protection Measure (NEPM). The Controlled Waste NEPM is for the movement of wastes between states of Australia and processed SPL would most likely meet the requirements of the Controlled Waste NEPM.

Similar to waste tracking requirements in NSW, a Consignment Authorisation (CA) would be required prior to exporting the waste. In the case of exporting waste between states, the CA would need to be produced by the Queensland Department of Environment and Heritage Protection. The facility receiving the waste would need to be known at the time of application and identified on the application form.

In Queensland, waste is classified as “general waste”, “limited regulated waste” and “regulated waste” and these definitions are provided in Schedule 7 of the *Environment Protection Regulations (EPR) (2008).* Schedule 1 of *Environment Protection (Waste Management) Regulations (EPRWM) (2000)* defines the “trackable wastes”. Under the EPR, (processed) SPL would be classified as regulated waste due to cyanide and fluoride content. Note that there are no analytical limits defined in the regulations, as there are in the NSW Waste Classification Guidelines.

The analytical criteria for ‘regulated waste’ are not defined. The acceptance criteria for the receiving landfill are defined in the *Landfill siting, design, operation and rehabilitation* Guideline (EM2319). For a double lined landfill, these are as follows:

- Cyanide, Toxicity characteristic leaching procedure (TCLP) of 5 mg/L
- Fluoride, TCLP of 150 mg/L.

Planning Approval

This advice is based on the assumption that all locations receiving wastes hold the required planning approvals and licences.

Contaminated soils (capped waste stockpile, Smelter Contaminated Soils and Buffer Zone Contaminated Soils and Materials

Removal of the contaminants with the capped waste stockpile, and the contaminated soils within the smelter and in the buffer zone would be classified as "remediation works". However, remediation works are not defined under the Cessnock Local Environmental Plan 2011 (Cessnock LEP).

Remediation works are permissible with consent in the RU2 Zone under the LEP. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As there are no activities related to remediation works that are specified as 'permitted without consent' or 'prohibited' it follows that remediation works are permissible with consent.

The removal of the contaminants with the capped waste stockpile, and the contaminated soils within the smelter and in the buffer zone would not be deemed a designated development under Schedule 3 of the Environmental Planning and Assessment Regulation 2000. The definition of "Contaminated soil treatment works" under clause 15 of Schedule 3 of the regulation includes:

"*Contaminated soil treatment works (being works for on-site or off-site treatment of contaminated soil, including incineration or storage of contaminated soil,* ***but excluding excavation for treatment at another site****):*

If all contaminated soil was excavated and transported for treatment (including disposal) to a site that holds all the required approvals for receiving and treating (including disposal) of the contaminated soils, then an EIS would not be required.

The remediation works would be considered category 2 remediation works under State Environmental Planning Policy No 55—Remediation of Land (SEPP 55) as the works are unlikely to meet the criteria for category 1 remediation works (as identified in Clause 9 of SEPP 55). Therefore the works can be undertaken without planning approval.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice;

- A brief description of the remediation work;
- An explanation as to why the work is category 2 remediation work;
- Reference to the property description and street address (if any) for the land on which the work is to be carried out;
- A location map of the land;
- Estimates of the dates for the commencement and completion of the work.

SPL in Storage and in Pots

Loading and transportation of the untreated SPL to a licensed facility (assumed to be operating in accordance with a planning approval) or to an export facility does not require planning approval.

The 2005 development consent provides approval for operation of the SPL treatment facility. This facility meets a requirement of the 2002 development consent, which requires Hydro to implement a proposal to treat spent pot lining generated by the smelter. Hydro has obtained legal advice that the combined effect of the 2002 and 2005 development consents is that it is obliged to treat all SPL in the storage sheds (but not within the capped waste stockpile) using this facility before any additional use. This would include its transportation off site.

If Hydro wished to transport the material prior to treatment, it would have to modify, surrender or replace its 2005 development consent to remove the requirement to treat the stored SPL. This would require justification to DoPI (the consent authority for the 2005 consent) and the EPA that cessation of SPL treatment is reasonable and feasible.

Demolition Wastes

Demolition requires planning approval under Section 2.7 of the Cessnock LEP. This section does have the following note:

"*If the demolition of a building or work is identified in an applicable environmental planning instrument, such as this Plan or State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, as exempt development, the Act enables it to be carried out without planning approval*."

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (E&CDC SEPP) states the following with regard to demolition:

- Clause 2.25 deems demolition of structures that would be deemed exempt development if they were being constructed as exempt development (therefore not requiring any consent). This generally relates to minor structures (such as balconies of a particular size, farm buildings and structures, fences) but not industrial buildings.
- Part 7 of the E&CDC SEPP is the Demolition Code. Clause 7.1(1) specifies that demolition of an industrial building, or a commercial building that would be complying development under the General Commercial and Industrial Code if it were being constructed.

However, Clause 9 of State Environmental Planning Policy No 60—Exempt and Complying Development (SEPP 60) states that:

"(*3) Complying development cannot be carried out on:*

(b) a site that has at any time previously been used:

(v) for waste storage or waste treatment"

As waste has been and continues to be stored and treated at the site, the demolition works cannot be complying development. Therefore planning approval is required for the demolition of the smelter and associated structures. The development application would need to identify the proposed disposal location for the demolition waste.

As the works would have a capital investment value (CIV) of less than $20 million (please note that capital investment value is defined in the EP&A Regulation 2000 as "all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government) a development application would be lodged with, and assessed by Cessnock City Council as the consent authority.

A Statement of Environmental Effects (SEE) is required to support a development application to Council. The SEE will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Demolition noise and air quality.
- Demolition traffic.
- Demolition phase management of contaminants (around and below buildings).

- Soil and water management (including containment cell location hydrology and geotechnical conditions).
- Aesthetics and visual impacts.
- Community and social impacts (including health).

Environment Protection Licencing

"Contaminated soil treatment" is a scheduled activity under Clause 15 of Schedule 1 of the POEO Act and states:

"(1) This clause applies to contaminated soil treatment, meaning the on site or off site treatment of contaminated soil (including, in either case, incineration or storage of contaminated soil but excluding excavation for treatment at another site).

(2) The activity to which this clause applies is declared to be a scheduled activity if:

(b) where it treats contaminated soil originating exclusively on site, it has a capacity:

(ii) to treat (otherwise than by incineration) and store more than 30,000 cubic metres of contaminated soil".

As the contaminated soils are being excavated for treatment off-site an Environment Protection Licence is not required.

"Transport of trackable waste" is a scheduled activity under clause 48 of Schedule 1 of the POEO Act. Trackable waste is defined in the Protection of the Environment Operations (Waste) Regulation 2005. SPL (including in mixed smelter wastes) meets the definition of trackable waste and therefore an EPL to transport the material within NSW is required.

Likelihood of Approval

Approval of the demolition of the structures and its disposal at the Cessnock waste facility has a high likelihood of approval. Similarly, disposal of contaminated soils would also have a high likelihood of approval.

However, there is a low to moderate likelihood of approval that the Department of Planning would approve a modification to the current planning approval to stop the treatment of SPL in storage and to dispose of at an offsite landfill.

G6.3 Cost

The estimated cost for this option is $391mil AUD NPV.

Refer to the attached costing for details.

G6.4 Timeframe to complete

Task	Time Estimate (years)
Pre-Design Activities	0.2 – 0.4
Preparation of RAP and Planning Approval	1 – 1.5
Approvals	0.75 – 1
Project Engineering Tasks	0.2 – 0.3
Construction	1.5 – 2.5
Waste Relocation	4 - 5
Closure	0.75 – 1.5
Validation Reporting	0.4 – 0.6
Total	9 - 11

G6.5 Legacy

Hydro has obtained legal advice that the risk of it retaining any environmental liability if it pursued this option is remote provided certain mitigation and management measures are implemented.

There is a remaining legacy associated with the groundwater remediation inaccordance with Option F3. For this option, the legacy risks are associated with ongoing leachate treatment being required. An allowance for a further 86ML of treatment over a period 5 years has been assumed and a 10% likelihood of this being required has been adopted. This legacy cost associated with this item is estimated to be $0.2mil AUD NPV.

In addition, sediments within the dam sedimentation structure may require treatment. To allow for this a 10% likelihood of requiring treatment has been adopted. The reduced likelihood is on the basis that pretreatment to remove fluorides and cyanides is included in this option and therefore there is a lower likelihood (compare to Option F2) that remediation will be required. This legacy cost associated with this item is estimated to be approximately $0.4mil AUD NPV.

The combined legacy provision is therefore estimated to be $0.6mil AUD NPV.

G6.6 Risk Ranking

The risk associated with this disposal option is associated with the waste causing an effect at the disposal site in the future. Given that the wastes will be disposed of in a properly design landfill cell that is appropriately situated, the likelihood of an incident occurring is considered to be ‘rare’ (may occur ‘only in exceptional circumstances’). The consequence to Hydro is considered to be ‘insignificant’ as the consequence will be the responsibility of the third party. On this basis the risk ranking is ‘1’.

The risks associated with the groundwater treatment are not considered, as the groundwater treatment component is a minor part of this option.

G7 Treat and destroy all site wastes using plasma arc technology

Likelihood of Approval	Cost ($mil AUD)	Timeframe (yr)	Legacy ($mil AUD) [10]	Risk Ranking
Moderate	TBC	11 - 17	TBC	5

G7.1 Description of the option

This option would involve the processing of all wastes to remove hazardous components including fluorides, cyanides, hydrocarbons and asbestos by plasma arc exposure. Research of global technologies identified that plasma arc gasification pilot scale trials have been undertaken on SPL and on municipal wastes and have shown the technology to be applicable to these wastes. This process has the additional benefit of carbon value capitalisation in a waste to energy process. The process produces elemental metals, and a vitrified slag residue. The suitability for other uses is currently being evaluated; however the material has not been determined as unconditionally ready for fill use both for leachate and material strength reasons.

The applicability of this process to the site wastes, including the capped waste stockpile mixed wastes, is not known and is the subject of further evaluation. This process would require piloting prior to full scale treatment. Further investigations are being undertaken at this stage; however, it is envisaged that the process would involve the following components:

1) Concept evaluation to understand cost and suitability of the process

2) Laboratory scale testing of capped waste stockpile wastes to assess applicability and understand capital and operational expenses. Assess the quality of the by-products and if the vitrified rock can be re-used in Australia under a resource reuse exemption. If proven feasible, then advance to the next stage. This step includes representative sampling of capped waste stockpile which has a risk component with regards to breaching the cap and health and safety management requirements. The volume of material required for laboratory / small scale testing is likely to be in the order of 500 kg to 1000 kg. It has been learned that the material needs to be /broken / ground to a certain grain-size prior to batch processing.

3) Obtain planning approvals to undertake pilot scale testing. Based on positive results from the laboratory small scale testing, the method needs to have an evaluation of the performance in a pilot plant and determine if this option is acceptable for the site. If acceptable then advance to the next stage.

[10] Net present value using a discount rate of 3%

4) Obtain planning approval for construction and operation of a plant at the site. It is envisioned that the plant is designed to process 30,000 t/a, but test results may indicate that an alternate size is optimal.

5) Construct and commission the plant and commence stockpiling of all wastes within the Hydro site and implement interim management measures for these stockpiles and the capped waste stockpile. Waste treatment times may be in the order of 10 years and therefore interim waste management measures will be required.

6) Establish reuse opportunities for the vitrified rock by-product.

   The potential risks associated with the reuse opportunities for the by-product is discussed in Section G7.6.

7) If feasible, commence treatment including the progressive deconstruction of the capped waste stockpile.

8) Undertake groundwater treatment of groundwater from within the capped waste stockpile footprint.

9) Decommission the plant or transfer to a third party for ongoing operation at the site.

G7.2 Likelihood of approval

Chemical Control Order

As previously discussed, a licence issued under the Chemical Control Order (CCO) is applicable to aluminium smelter waste (under the *Environmentally Hazardous Chemicals Act 1985*) at the site, applying to its storage, handling, disposal and treatment. As this option includes treatment of the SPL component of the waste a licence would be required. As the material is treated through this process, it is anticipated this would be an acceptable process to the EPA.

Resource Recovery Exemption

The by-products of the plasma arc gasification process include synthetic gases, base metals and vitrified rock-like material (slag). The synthetic gases can be used in energy generation, while the base metals and slag have potential reuse opportunities (e.g. granulated slag can be used as a construction base material).

A resource recovery exemption would need to be issued in accordance with the *Protection of the Environment Operations Act 1997* permitting the reuse of these materials. The exemption would be issued if it could be demonstrated that the waste material is of benefit in its proposed use and poses minimal risk of harm to the environment or human health. This includes providing evidence that the material is homogenous in physical and chemical quality, that it is stable and would not result in the leaching of contaminants into soils and groundwater, and that there is a genuine re-use opportunity for the material.

If a resource recovery exemption could not be gained, these materials would need to be disposed to a licensed landfill. However the following planning and licensing advice is based on the assumption that approval for disposal to landfill does not form part of this option and that reuse is possible.

Planning Approval

Pilot Scale Testing

As noted above, the volume of material required for the pilot scale testing is likely to be in the order of 1000 tonnes. As the treatment of the material would be remediating part of the site, it would be deemed remediation works under State Environmental Planning Policy 55 – Remediation of Land (SEPP 55). It would be deemed category 2 remediation works as:

- The works are not designated development (it would not treat sufficient contaminated soils from within the site to be deemed "*Contaminated soil treatment works*" under clause 15 of Schedule 3 of the Environmental Planning and Assessment Regulation 2000.
- It would not be carried out on land declared to be a critical habitat.
- It is unlikely to have a a significant effect on a critical habitat or a threatened species, population or ecological community.
- It would not be located in an area or zone classified as environmentally sensitive under an environmental planning instrument.
- Cessnock City Council does not have a policy made under the contaminated land planning guidelines that classifies it as category 1 remediation work.

As category 2 remediation works under SEPP 55 the trial would not require development consent.

In accordance with clause 16 of SEPP 55, written notification of the remediation work is to be provided to Cessnock City Council at least 30 days prior to the commencement of work. The written notice must include:

- The name, address and telephone number of the person who has the duty giving the notice.
- A brief description of the remediation work.

- An explanation as to why the work is category 2 remediation work.
- Specify, by reference to its property description and street address (if any), the land on which the work is to be carried out.
- Provide a map of the location of the land.
- Provide estimates of the dates for the commencement and completion of the work.

Main Project

Treatment of the wastes using this approach would be deemed a "waste disposal facility" under the Cessnock Local Environmental Plan 2011 (Cessnock LEP). The LEP defines a waste disposal facility as "*a building or place used for the disposal of waste by landfill, incineration or other means, including such works or activities as recycling, resource recovery and other resource management activities, energy generation from gases, leachate management, odour control and the winning of extractive material to generate a void for disposal of waste or to cover waste after its disposal*".

Development for the purposes of a 'waste or resource management facility' (which includes a waste disposal facility) is permissible with consent in the RU2 Zone under. More specifically, the land use table provides that any development that is not specified as 'permitted without consent' or 'prohibited' is permitted with consent in the RU2 Zone under Cessnock LEP. As a 'waste or resource management facility' is not specified as 'permitted without consent' or 'prohibited' it follows that a 'waste or resource management facility' is permissible with consent.

The Project would be deemed as "designated development" under Schedule 3 of the Environmental Planning and Assessment Regulation 2000, as it would meet the definition of "Waste management facilities or works" under clause 32 of Schedule 3 of the regulation. This definition includes:

"(1) *Waste management facilities or works that store, treat, purify or dispose of waste or sort, process, recycle, recover, use or reuse material from waste and:*

(a) that dispose (by landfilling, incinerating, storing, placing or other means) of solid or liquid waste:

(i) that includes any substance classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste, or

The works would be classified as 'designated development' as it triggers sub-clause 32(1)(a)(i) (whereby "Aluminium smelting by-product" is registered as a dangerous good under the "Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition" (National Transport Commission, 2011)). An EIS is required to support a development application for designated development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a Preliminary Environmental Assessment (PEA).

The works would be classified as 'regional development' as they would have a capital investment value (CIV) of more than $20 million (note that capital investment value is defined in the EP&A Regulation 2000 as "*all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment* ", but excludes any land purchasing, marketing or selling costs; GST; activities covered by a separate approval; or development contributions or levees required to be paid to Council or the NSW government).

While a development application for regional development is lodged with, and assessed by, the local council it is actually determined by the relevant Joint Regional Planning Panel (JRPP). Council will assess the DA and the consent authority for the works will be the Hunter and Central Coast Regional Panel.

The EIS will be required to address a number of key issues that will be the focus of the consent authority's considerations, and influence approval (including consent conditions). These are likely to include (in no particular order):

- Flora and fauna (particularly if the treatment facility is located in an area currently containing native vegetation);
- Aboriginal heritage (particularly if the treatment facility is located in an area of limited disturbance);
- Treatment phase noise and air quality;
- Treatment phase management of contaminants;
- Community and social impacts (including health);
- Consideration of alternatives to the treatment;
- Sustainability and carbon management.

It should be noted that Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (S&RD SEPP) includes "Waste and resource management facilities" as a category of state significant development. Clause 23 of Schedule 1 includes the following:

*"(5) Development for the purpose of hazardous waste facilities that transfer, **store or dispose** of solid or liquid waste classified in the **Australian Dangerous Goods Code** or medical, cytotoxic or quarantine waste that handles more than **1,000 tonnes per year of waste**."*

"Aluminium smelting by-product" is registered as a dangerous good under the *Australian Code for the Transport of Dangerous Goods by Road & Rail, Seventh Edition* (National Transport Commission, 2011)). As a consequence, the treatment of the SPL (SPL with mixed smelter wastes and the SPL in storage and pots) may be deemed part of the disposal process and therefore the activity deemed a 'state significant development', requiring approval from the Minister for Planning (or a delegate).

If this was the case, an EIS is required to support a development application for state significant development. The EIS is to be prepared in accordance with the EIS requirements issued by the Director-General of the Department of Planning and Infrastructure (DoPI) (known as the Director-General's Requirements). An application to receive the DGRs is to be supported by a PEA.

The key factors to be addressed to facilitate planning approval for this option are:

- To provide evidence that the option would not pose a significant impact to the factors listed above. This is either by the nature of the works, or as a result of the mitigation measures to be implemented as part of the works;
- That disposal of untreated SPL to the containment cell is a reasonable and feasible option (i.e. there is not a more reasonable or feasible alternative).

To reduce the potential for political and community issues during the approval process, a stakeholder consultation program is recommended to be commenced during the Remedial Action Plan/ concept design development phase. Consultation and communication with stakeholders will minimise the potential for misinformation entering the public space and causing issues. Such stakeholders would include:

- Cessnock City Council;
- Environment Protection Authority (EPA);
- NSW Office of Water (NOW);
- Commonwealth Department of the Environment (if the containment cell location triggers a potential significant impact on matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such matters include threatened species, migratory species, ecological communities and heritage items listed under the act);
- Department of Planning and Infrastructure;

- Local Members of Parliament;
- The local community (including residents and local community and environmental groups);
- Key Aboriginal stakeholder groups.

Environment Protection Licencing

Pilot Scale Testing

As noted above, the volume of material required for the pilot scale testing is likely to be in the order of 1000 tonnes. “Contaminated soil treatment” that meet certain criteria are a scheduled activity (and therefore require an Environment Protection Licence) under Clause 15 of Schedule 1 of the *Protection of the Environment Operations Act 1997* (POEO Act). “Waste disposal (thermal treatment)” that meets certain criteria is a scheduled activity under clause 40 of Schedule 1. As it is not anticipated that the trial would be recovering energy for use, it is not anticipated that it would be deemed “Energy recovery” as defined by Clause 18 of Schedule 1.

The pilot scale testing is below the threshold that would make it a scheduled activity, and therefore would not require an Environment Protection Licence.

Main Project

“Waste disposal (thermal treatment)” is a scheduled activity under clause 40 of Schedule 1 of POEO Act. This includes “*thermal treatment of hazardous and other waste, meaning the* ***receiving*** *of hazardous waste, restricted solid waste, liquid waste or special waste* ***from off site*** *and its processing by thermal treatment*.” Assuming that the plasma arc gasification treatment plant would be located on-site, it would not meet this definition as the material would not be received from off-site.

However, in the event that the process also includes the generation of energy, “Energy recovery” is a scheduled activity under Clause 18 of Schedule 1. Its definition includes:

“***energy recovery from hazardous and other waste*** (meaning other than general waste)*, meaning the receiving from* ***on site*** *or off site of, and the recovery of energy from, hazardous waste, restricted solid waste, liquid waste or special waste*.”

If the facility did recover energy through the process, it would require an EPL.

Likelihood of Approval

As noted, the plasma arc gasification process is a new technology, and is still proceeding through trial programs globally. Agencies may be reluctant to approve such a facility unless data from trials of similar technologies can provide greater certainty about performance. Consultation could be undertaken with agencies to discuss the opportunity for a trial (with monitoring to confirm its performance) prior to a full scale facility.

If sufficient information and evidence could be provided to the agencies on the environmental performance of plasma arc gasification, and the resource recovery exemptions for the by-products are granted, agencies are likely to look favorably on such a process and therefore it would have a high likelihood of approval.

The EPA may require the establishment of a security payment (such as a bond) as a contingency to remediate any future failure of the improved capped waste stockpile.

G7.3 Cost

Costs for the plasma arc gasification process have been requested from one technology provider (Tetronics). It is anticipated cost estimates would be provided in time for discussion at the workshop.

G7.4 Timeframe to complete

The following provides an estimate of timeframes based on our current understanding of the process and planning environment. Further details on the timeframe have been requested from Tetronics and are anticipated to be available for discussion at the workshop.

Activity	Estimated timeframe (years)	Comments
Conceptual Study	0.5	
Feasibility testing	0.5 – 1.25	Dependent on location, approvals could take approximately one year if undertaken in Australia
Planning for pilot scale testing	0.25 – 0.5	Assuming undertaken in Australia.
Pilot scale testing and assessment of results	0.5	
EIS and Planning approval for full scale operations	1.5 - 2	
Plant construction and commissioning	2	
Treatment (plant size 30000tpa)	7 – 10	Depends on final waste volume for disposal. Requirements for blending with other wastes will increase this timeframe.

Water treatment	0.5 to 1	Occurs concurrently
Total Estimated Timeframe	11 to 17 years	

G7.5 Legacy

If the material can be successfully treated and confirmed as inert, it can be reused off site or as appropriate on site without limitations. Therefore there would not be any legacy (including monitoring and management requirements).

However, as discussed in Section G7.6 the material is currently not qualified as inert and therefore it cannot be used without limitation as fill material and information is not available on its physical properties, or the quantity generated. As a result the legacy would be similar to those described in Options G1 to G5.

G7.6 Risk Ranking

The risk associated with this option is a technological risk from the unproven technology and the possibility that an alternate remediation solution will require implementation. The likelihood of this technology not being able to treat the site wastes economically or technically into a condition that can be re-used without additional treatment (and therefore needing to landfill) is ‘possible’. Potential issues associated with the applicability of the treatment to the capped waste stockpile wastes are considered to be equally valid. Risks include those associated with the pre-treatment requirements for the capped waste stockpile and the extent to which crushing and sorting is required.

The material is currently not qualified as inert and therefore it cannot be used without limitation as fill material. Also, no technical specification of material strength has been determined, (the physical properties are currently unknown). If it cannot be utilised as inert fill material, one of Options G1 to G5would need to be implemented. In addition, as of 23 January 2014 there are no known estimates of the difference between input volume / weight, and volume / weight of the vitrified material (it is unknown how much of the processed material would be generated).

The consequence of the technology not being applicable to the site will require an alternate solution is considered ‘moderate’. The alternate solution for remediation is comparable in cost to those presented in Options G1 to G5. it would also result in a loss in time prior to being able to implement a solution. On this basis this option is given a risk ranking of ‘5’.

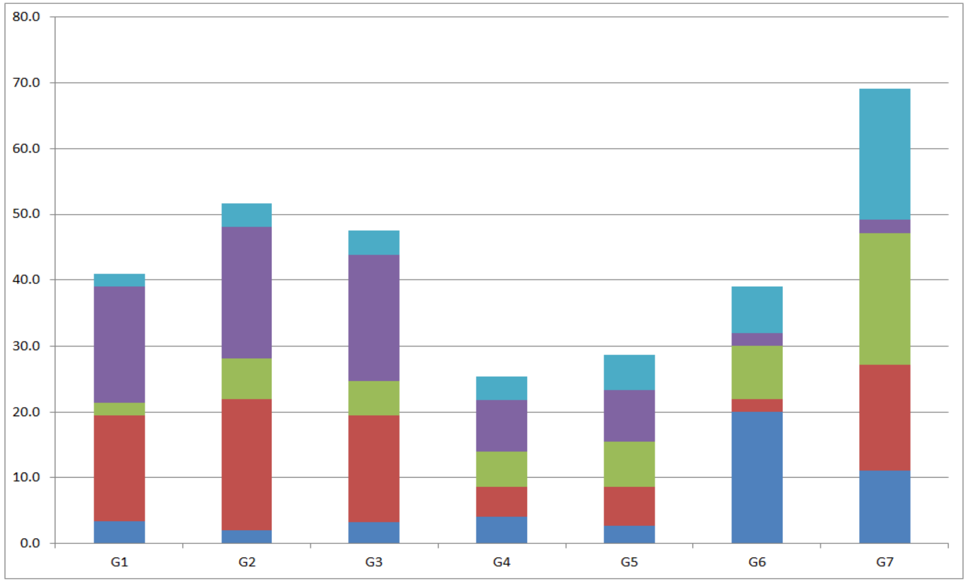
Type	Volume estimates (m3)	Mass estimate (t)	Accuracy %	Volume Range		Mass Range	
				Low	High	Low	High
Alcan Mound	105000	189000	20%	84000	126000	151200	226800
Onsite smelter soils	16900	26670	50%	8450	25350	13335	40005
Buffer zone materials	31600	39360	30%	22120	41080	27552	51168
Municipal Wastes (Glen Main)	400	120	30%	280	520	84	156
SPL stored and in pots that will be treated by Regain in the next 2 years	13400	24000	10%	12060	14740	21600	26400
SPL stored and in pots that will be remaining at commencement of remediation 1	30600	55000	20%	24480	36720	44000	66000
Clay Borrow pit refractories, bitumen and concrete	15250	42700	20%	12200	18300	34160	51240
Demolition wastes	29000	20000	30%	20300	37700	14000	26000
TOTALS	226900	396850		184000	301000	306000	488000
1) Subtracts the 21000 processed as of January 2014	213500	354150					

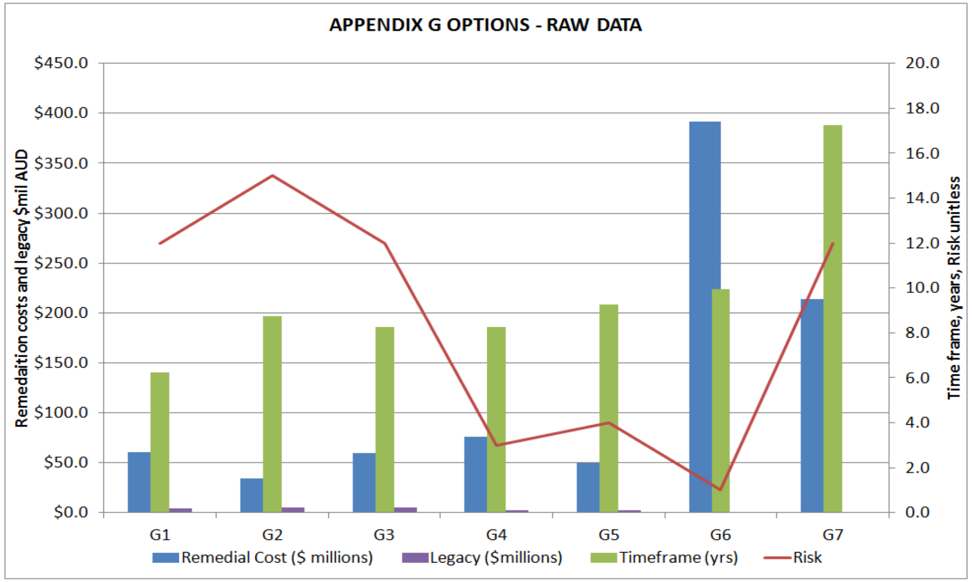
Description	**Remediation Cost $mil**	**Legacy $ mil**	**TIME (Years)**	**ISK (1 to 10, 10 high**
Option G1 Upgrade Alcan Mound and create an adjacent containment cell	$60.3	$4.5	6.3	12
Option G2 Upgrade Alcan Mound, including SPL and create an adjacent containment cell	$33.9	$3.6	8.8	15
Option G3 Improve Alcan Mound in-situ and encapsulate all wastes excluding municipal wastes and SPL in a purpose	$59.3	$4.9	8.3	12
Option G4 Encapsulate all wastes including Alcan Mound but excluding municipal wastes and SPL in a purpose built c	$75.5	$2.2	8.3	3
Option G5 Encapsulate all wastes including Alcan Mound and SPL in a purpose built containment cell. Remediate Alc	$49.9	$2.3	9.3	4
Option G6 Dispose of all wastes off-site	$391.6	$0.8	10.0	1
Option G7 Onsite Destruction	$213.7	$0.0	17.3	12

Appendix G - Combined Options

Weighting Factors

	Weighting
Remedial Cost	2
Risk	2
Timeframe	2
Legacy	2
Corporate responsibility	2
	10





Option G1 Upgrade Alcan Mound and create an adjacent containment cel	
Description	**Upgrade Alcan Mound, move all wastes adjacent to Alcan Mound excluding municipal wastes, treat SPL through the current regain process, option F2 groundwater treatment.**
Base Year	**2014**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
Alcan Mound Improvements								
	1	**Pre-Design Activities**						
		Geotechnical Borings & Testing	12	EA	$17,000	$204,000		Vendor estimate
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leach	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$219,000**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$150,000	$150,000		ENVIRON experience
		CLMA Auditor			$60,000	$60,000	Assumes Auditor will be required by regulato	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		Sub-total preliminary documentation				**$510,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$484,027	Does not include SPL treatment	USEPA Remediation Engineering
		Remedial Design			8%	$774,443	Does not include SPL treatment	USEPA Remediation Engineering
		Construction Management			6%	$580,832	Does not include SPL treatment	USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$193,611	Does not include SPL treatment	ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$2,032,912**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$200,000	$200,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$70,000	$70,000		Vendor Estimate/ENVIRON Experience
		Work pad construction	1	LS	$160,000	$160,000		
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$456,000**		
	5	**Slurry Wall Construction**						
		Borrow material	1	LS	$150,000	$150,000		Vendor estimate
		Slurry Wall Construction	1	LS	$840,000	$840,000		Vendor estimate
		Trench cap	1	LS	$30,000	$30,000		Vendor estimate
		SUBTOTAL Slurry Wall Construction				**$1,020,000**		
	6	**Alcan Mound cap preparatory works**						
		Remove existing cap 150mm veg layer and stockpile	2,620	m3	$8	$22,137	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	7,859	m3	$9	$72,699	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 400mm clay and stockpile	6,986	m3	$12	$86,627	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Grade, Compact surface	17,465	m2	$3	$48,029	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		SUBTOTAL Alcan Mound cap preparatory works				**$229,492**		
Adjacent Containment cell								
	7	**Pre-Design Activities**						
		CPT Soundings	44	EA	$1,100	$48,400	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	22	EA	$7,200	$158,400	5 borings per 5000m2.	ENVIRON Estimate.
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leach	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$221,800**		
	8	**Site Preparation**						
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$100,000**		
	9	**Cell Construction**						
		General Site Preparation for Consolidation Cel	11,522	m2	$2	$23,966		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cel	11,522	ha	$1,020	$1,175.24	Assumes area largely cleared (60%)	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	11,522	m3	$8	$91,600		Rawlinsons 2013 p675
		Filling of Eastern Surge Ponc	4,590	m3	$25	$114,750	Approximate area determined from aerial photo	Rawlinsons 2013 p675
		Construct Clay Liner (1 meter)	11,522	m3	$24	$270,767		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	11,522	m2	$20	$233,321		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	11,522	m2	$4	$43,208		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	3,540	m3	$25	$88,500		Vendor Estimate/ENVIRON Experience
		Install 60 ML HDPE Liner	11,522	m2	$17	$190,113		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	11,522	m2	$4	$43,208		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	3,540	m3	$25	$88,500		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	11,522	m2	$4	$43,208		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,434,698**		
	10	**Excavation Works**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Onsite smelter soils	16900	m3	$12	$209,560	Excavate, transport<1km and deposit	Rawlinsons
		Buffer zone materials	31600	m3	$12	$391,840	Excavate, transport<1km and deposit	Rawlinsons
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	48500	m3	$25	$1,212,500		Vendor Estimate/ENVIRON Experience
		Demolition wastes	29000	m3	$0	$0	No charge, assumes costs are in demolition contract	
		SUBTOTAL Excavation Works				**$2,225,900**		
	11	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	3,787	m3	$10	$36,922		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	15,148	m3	$26	$393,835		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	25,246	m2	$20	$511,228		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	7,574	m3	$20	$151,475		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	25,246	m2	$4	$100,983		Rawlinsons 2013 p677
		Install General Fill (30 cm)	7,574	m3	$26	$196,918		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	3,787	m3	$17	$65,248		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	25,246	m2	$8	$201,462		Rawlinsons 2013 p228
		Supply and Install Fencing	934	m	$56	$52,282		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	10	ea	$2,018	$20,180	Well depth 10m	Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$1,752,923**		
Disposal of municipal wastes to landfill								
	12	**Disposal of municipal wastes**						
		Excavation (assumes in conjunction with other wastes	400	m3	$8	$3,200		Rawlinsons 2013 p673, for light soi
		Sorting manual	80	hrs	$64	$5,120	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Loading	400	m3	$5	$1,840	assume sand & < 1m	Rawlinsons
		Transport to Cessnock landfill	400	m3	$3	$1,160	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, special wastes (due to asbestos content	120	t	$370	$44,400	Asbestos and contaminated soils	Cessnock landfill Rates 2013-2014
		Soil Validation Works	1	EA	$30,000	$30,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	400	m3	$25	$10,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Disposal of Municipal Waste to Landfill				**$95,720**		
Treatment of SPL								
	13	**Continued treatment of SPL by Regain**						
		SPL remaining in storage and in pots at the commencement of remediation	79000	t	$530	$41,870,000	Treatment includes transport and any pretreatment/processing requried	
		SUBTOTAL SPL treatment				**$41,870,000**		
Crushing and sorting of clay borrow pit materials								
	14	**Crushing and sorting of clay borrow pit materials**						
		Excavate and stockpile	15,250	m3	$8	$128,863	Excavate, transport<1km and deposit	Rawlinsons 2013 p673, for light soi
		Sorting manual	3050	hrs	$64	$195,200	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Crushing	15250	m3	$25	$381,250		
		Loading and transport to second stockpile	15250	m3	$8	$114,375	assume sand & < 1m	Rawlinsons
		Stockpile provisions	1	LS	$26,000	$26,000		
		Soil Validation Works	1	EA	$70,000	$70,000	including laboratory analysis	ENVIRON Experience
		SUBTOTAL Clay Borrow Pit				**$915,688**		
Groundwater treatment in accordance with Option F2								
	15	**Groundwater treatment by leachate interception trench**						
		Treatability testing	1	ea	$50,000	$50,000	Refer to Option F2	
		Construction of the interception trench	1	ea	$48,000	$48,000	Refer to Option F2	
		Operational costs over a 10 year period in NPV	1	ea	$2,046,000	$2,046,000	Refer to Option F2	
		SUBTOTAL Groundwater treatment				**$2,144,000**		
	16	**Final Reporting**						
		Validation report	1	each	allow	$250,000	Multiple sites	ENVIRON experience
		EMP	1	each	allow	$60,000	Multiple sites	ENVIRON experience

	Site Auditor signoff			each	allow	$200,000	Multiple sites	ENVIRON experience
	Sub-total reporting					**$510,000**		
	Subtotal					$54,822,444		
	Contingency 10%					$5,482,244	10% Scope	
	CAPITAL COSTS TOTAL					**$60,304,689**		

NOTES

Assumes the extent of capping outlined in Appendix G, though noting further work is currently being undertaken to refine these estimat
Assumes further investigation does not identify other not known contaminatio
Assumes program can be acheived through the use of standard excavating equipmen
Refer to Appendix G for a description of capping requirements and assumptions mad
Ground preparation (e.g. removal of structures and vegetation) is undertaken as part of a demolition process and no costs have been allocate
Clean fill is won locally and placed with a permeability of not less than 1 x 10-9 m/s
Capping is undertaken independently of other site activitie
All works are undertaken in one mobilisatior
Assumes demolition wastes are placed with the cell by the demolition contractor at no cos

Legacy Cost	Environmental Monitoring	5		annual	$150,000	$750,000		Based on two events per year for 5 years
	Maintenance	1		annual	$18,000	$416,066		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimete	Base year		each	$266,710		no cost in year 0	
			1	each	$127,382	$127,382	year 25	Using a discount rate of 3%
			1	each	$39,050	$39,050	year 40	Using a discount rate of 3%
								Using a discount rate of 3%
								Using a discount rate of 3%
						$1,332,498		
						$2,938,469		
	Legacy potential liability provisioning	50%		event	NPV	$647,801	Has a 50% chance of occuring once in 40 year tin Cost of cap replacement	Using a discount rate of 3%
	Legacy potential liability provisioning	refer to option F2		event	NPV	$2,540,000	assumes occurs after 10 years, and has a 50% ch Cost of ongoing water treatment and sediment treatmen	Using a discount rate of 3%,
						$3,187,801		
						$4,520,298		

			Value
RISK	Comment		12
	Major	Prosecution unlikely, costs between $5mil and $10mi	
	Possible	Might occur at some time	

Time	Pre-Design Activities	0.25	years	
	Preparation of RAP and Planning Approval (EIS)	1.25	years	
	Approvals	1.25	years	
	Project Engineering Tasks	0.5	years	
	Treatment of SPL	3.95	years	Occurs in parallel, has been excludec
	Disposal of municipal wastes	0.25	years	Assumes 1500t/wk
	Excavate, crush and sort clay borrow pit	0.5	years	Occurs in parallel, has been excludec
	Construction	0.75	years	
	Relocation of wastes	0.75	years	based on 600t/day, concurrent with demolitior
	Closure	1	years	
	Final Reporting	0.5	years	
	Time	**6.25**	**years**	

Option G2 Upgrade Alcan Mound, including SPL and create an adjacent containment cel

Description	**Upgrade Alcan Mound, move all wastes adjacent to Alcan Mound including SPL but excluding municipal wastes, option F2 groundwater treatment.**
Base Year	**2014**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
Alcan Mound Improvements								
	1	**Pre-Design Activities**						
		Geotechnical Borings & Testing	12	EA	$17,000	$204,000		Vendor estimate
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leacha	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$219,000**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$150,000	$150,000		ENVIRON experience
		CLMA Auditor			$60,000	$60,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Planning approval and EIS			$300,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		Sub-total preliminary documentation				**$510,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$657,782	Does not include SPL treatment	USEPA Remediation Engineering
		Remedial Design			8%	$1,052,452	Does not include SPL treatment	USEPA Remediation Engineering
		Construction Management			6%	$789,339	Does not include SPL treatment	USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$263,113	Does not include SPL treatment	ENVIRON experience
		Sub-total Engineering/Technical Tasks Capital Cost				**$2,762,686**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$200,000	$200,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$70,000	$70,000		Vendor Estimate/ENVIRON Experience
		Work pad construction	1	LS	$160,000	$160,000		
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$456,000**		
	5	**Slurry Wall Construction**						
		Borrow material	1	LS	$150,000	$150,000		Vendor estimate
		Slurry Wall Construction	1	LS	$840,000	$840,000		Vendor estimate
		Trench cap	1	LS	$30,000	$30,000		Vendor estimate
		SUBTOTAL Slurry Wall Construction				**$1,020,000**		
	6	**Alcan Mound cap preparatory works**						
		Remove existing cap 150mm veg layer and stockpile	2,620	m3	$8	$22,137	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	7,859	m3	$9	$72,699	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 400mm clay and stockpile	6,986	m3	$12	$86,627	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Grade, Compact surface	17,465	m2	$3	$48,029	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		SUBTOTAL Alcan Mound cap preparatory works				**$229,492**		
Adjacent Containment cell								
	7	**Pre-Design Activities**						
		CPT Soundings	44	EA	$1,100	$48,400	1 CPT per 500 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	22	EA	$7,200	$158,400	5 borings per 5000m2.	ENVIRON Estimate.
		Remediation Pilot Project	1	EA	$15,000	$15,000	Testing of clay performance in contact with leacha	ENVIRON Experience
		SUBTOTAL Pre-Design Activities				**$221,800**		
	8	**Site Preparation**						
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$100,000**		
	9	**Cell Construction**						
		General Site Preparation for Consolidation Cel	32,801	m2	$2	$68,226		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	32,801	ha	$1,020	$3,345.70	Assumes area largely cleared (99.9%)	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	32,801	m3	$8	$260,768		Rawlinsons 2013 p675
		Filling of Eastern Surge Pond	4,590	m3	$25	$114,750	Approximate area determined from aerial photo	Rawlinsons 2013 p675
		Construct Clay Liner (1 meter)	32,801	m3	$24	$770,824		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	32,801	m2	$20	$664,220		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	32,801	m2	$4	$123,004		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	10,028	m3	$25	$250,700		Vendor Estimate/ENVIRON Experience
		Install 60 ML HDPE Liner	32,801	m2	$17	$541,217		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	32,801	m2	$4	$123,004		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	10,028	m3	$25	$250,700		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,503	m	$128	$192,384		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	32,801	m2	$4	$123,004		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$3,496,145**		
	10	**Excavation Works**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Onsite smelter soils	16900	m3	$12	$209,560	Excavate, transport<1km and deposit	Rawlinsons
		Buffer zone materials	31600	m3	$12	$391,840	Excavate, transport<1km and deposit	Rawlinsons
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	48500	m3	$25	$1,212,500		Vendor Estimate/ENVIRON Experience
		Demolition wastes	29000	m3	$0	$0	No charge, assumes costs are in demolition contract	
		SUBTOTAL Excavation Works				**$2,225,900**		
	11	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	6,979	m3	$10	$68,043		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	27,915	m3	$26	$725,788		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	46,525	m2	$20	$942,128		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	13,957	m3	$20	$279,149		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	46,525	m2	$4	$186,099		Rawlinsons 2013 p677
		Install General Fill (30 cm)	13,957	m3	$26	$362,894		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	6,979	m3	$17	$120,243		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	46,525	m2	$8	$371,268		Rawlinsons 2013 p228
		Supply and Install Fencing	1,222	m	$56	$68,410		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	10	ea	$2,018	$20,180	Well depth 10m	Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$3,166,591**		
Disposal of municipal wastes to landfill								
	12	**Disposal of municipal wastes**						
		Excavation (assumes in conjunction with other wastes)	400	m3	$8	$3,200		Rawlinsons 2013 p673, for light soi
		Sorting manual	80	hrs	$64	$5,120	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Loading	400	m3	$5	$1,840	assume sand & < 1m	Rawlinsons
		Transport to Cessnock landfill	400	m3	$3	$1,160	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, special wastes (due to asbestos content)	120	t	$370	$44,400	Asbestos and contaminated soils	Cessnock landfill Rates 2013-2014
		Soil Validation Works	1	EA	$30,000	$30,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	400	m3	$25	$10,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Disposal of Municipal Waste to Landfill				**$95,720**		
Crushing and sorting of clay borrow pit materials								
	13	**Crushing and sorting of clay borrow pit materials**						
		Excavate and stockpile	15,250	m3	$8	$128,863	Excavate, transport<1km and deposit	Rawlinsons 2013 p673, for light soi
		Sorting manual	3050	hrs	$64	$195,200	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Crushing	15250	m3	$25	$381,250		
		Loading and transport to second stockpile	15250	m3	$8	$114,375	assume sand & < 1m	Rawlinsons
		Stockpile provisions	1	LS	$26,000	$26,000		
		Soil Validation Works	1	EA	$70,000	$70,000	including laboratory analysis	ENVIRON Experience
		SUBTOTAL Clay Borrow Pit				**$915,688**		
Treatment of SPL (two years)								
	11	**Continued treatment of SPL by Regain**						
		SPL remaining in storage and in pots at the commencement of remediatior	24000	t	$530	$12,720,000	Treatment includes transport and any pretreatment/processing requried	
		SUBTOTAL SPL treatment				**$12,720,000**		
Groundwater treatment in accordance with Option F2								
	14	**Groundwater treatment by leachate interception trench**						
		Investigations and reporting	1	ea	$50,000	$50,000	Refer to Option F2	
		Construction of the interception trench	1	ea	$48,000	$48,000	Refer to Option F2	
		Operational costs over a 10 year period in NPV	1	ea	$2,046,000	$2,046,000	Refer to Option F2	
		SUBTOTAL Groundwater treatment				**$2,144,000**		
	15	**Final Reporting**						
		Validation report	1	each	allow	$250,000	Multiple sites	ENVIRON experience
		EMP	1	each	allow	$60,000	Multiple sites	ENVIRON experience
		Site Auditor signoff		each	allow	$200,000	Multiple sites	ENVIRON experience
		Sub-total reporting				**$510,000**		
		Subtotal				$30,793,022		
		Contingency 10%				$3,079,302	10% Scope	
		CAPITAL COSTS TOTAL				**$33,872,325**		

NOTES Assumes the extent of capping outlined in Appendix G, though noting further work is currently being undertaken to refine these estimates

Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix G for a description of capping requirements and assumptions made
Ground preparation (e.g. removal of structures and vegetation) is undertaken as part of a demolition process and no costs have been allocated
Clean fill is won locally and placed with a permeability of not less than 1 x 10-9 m/s
Capping is undertaken independently of other site activities
All works are undertaken in one mobilisation
Assumes demolition wastes are placed with the cell by the demolition contractor at no cost
Assumes clay borrow pit materials are suitable for recycling.
Assumes SPL is permitted to be encapsulated with treatment by macro encapsulation

Legacy Cost								
	Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years
	Maintenance	1	annual	$18,000	$416,066		Based on 12 events per year for 100 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$491,512		no cost in year 0	
		1	each	$234,749	$234,749	year 25	Using a discount rate of 3%
		1	each	$71,964	$71,964	year 50	Using a discount rate of 3%
					$1,472,779		
					$3,390,234		
	Legacy potential liability provisioning	50%	event	NPV	$1,064,165	Has a 50% chance of occuring once in 40 year time Cost of cap replacement	Using a discount rate of 3%
	Legacy potential liability provisioning	refer to option F2	event	NPV	$2,540,000	assumes occurs after 10 years, and has a 50% char Cost of ongoing water treatment and sediment treatment	Using a discount rate of 3%,
					$3,604,165		
					$5,076,943		

			Value
RISK	Comment		15
	Catastrophic	Prosecution could result remedial costs between 0.5m and 5mil likely	
	Possible	Might occur at some time	

Time	Pre-Design Activities	0.25	years	
	Preparation of RAP and Planning Approval (EIS)	1.25	years	
	Approvals	1.25	years	
	Project Engineering Tasks	0.5	years	
	Disposal of municipal wastes	0.25		Assumes 1500t/wk
	Excavate, crush and sort clay borrow pit	0.5	years	Occurs in parallel, has been excluded
	Construction	2	years	
	Relocation of wastes, including SPL	2.5	years	based on 600t/day, concurrent with demolition
	Closure	0.5	years	
	Final Reporting	0.5	years	
	Time	**8.75**	**years**	

Option G3 Improve Alcan Mound in-situ and encapsulate all wastes excluding municipal wastes and SPL in a purpose built containment cell. Remediate groundwater.

Description	**Improve the Alcan Mound in-situ. Construct a new containment cell, move and encapsulate all wastes excluding municipal wastes, continue to treat SPL through the current Regain process, option F2 groundwater treatment.**
Base Year	**2014**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
Construction containment cell								
	1	**Pre-Design Activities**						
		CPT Soundings	7	EA	$1,100	$7,776	1 CPT per 5000 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	18	EA	$7,200	$127,238	5 borings per 10000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$135,014**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$150,000		ENVIRON experience
		CLMA Auditor			$40,000	$60,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Development application			$15,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$510,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$555,757	Not included on SPL treatment	USEPA Remediation Engineering
		Remedial Design			8%	$889,211	Not included on SPL treatment	USEPA Remediation Engineering
		Construction Management			6%	$666,908	Not included on SPL treatment	USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$222,303	Not included on SPL treatment	ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$2,334,179**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		Vendor estimate
		SUBTOTAL Site Preparation				**$688,000**		
Alcan Mound Upgrades								
	5	**Slurry Wall Construction**						
		Borrow material	1	LS	$150,000	$150,000		Vendor estimate
		Slurry Wall Construction	1	LS	$840,000	$840,000		Vendor estimate
		Trench cap	1	LS	$30,000	$30,000		Vendor estimate
		SUBTOTAL Slurry Wall Construction				**$1,020,000**		
	6	**Alcan Mound Cap Replacement**						
		Remove existing cap 150mm veg layer and stockpile	2,620	m3	$8	$22,137	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	7,859	m3	$9	$72,699	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 400mm clay and stockpile	6,986	m3	$12	$86,627	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Grade, Compact surface	17,465	m2	$3	$48,029	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		Install 1.5mm HDPE Liner for Cell Cap	17,465	m2	$20	$353,669		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	5,240	m3	$20	$104,791		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	17,465	m2	$4	$69,861		Rawlinsons 2013 p677
		Install General Fill (30 cm)	5,240	m3	$26	$136,228		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	2,620	m3	$17	$45,139		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	17,465	m2	$8	$139,372		Rawlinsons 2013 p228
		Supply and Install Fencing	802	m	$56	$44,890		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	10	ea	$2,018	$20,180	Well depth 10m	Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Alcan Mound cap preparatory works				**$1,166,010**		
Cell Construction								
	7	**Cell Construction**						
		General Site Preparation for Consolidation Cell	15,323	m2	$2	$31,871		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	7,661	ha	$1,020	$781	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	30,433	m3	$8	$241,941		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	13,070	m3	$24	$307,145		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	13,070	m2	$20	$264,668		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	13,070	m2	$4	$49,013		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	4,012	m3	$25	$100,300		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	13,070	m2	$20	$264,668		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	13,070	m2	$4	$49,013		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	4,012	m3	$25	$100,300		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	624	m	$128	$79,872		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	1	ea	$10,000	$10,000		Rawlinsons 2013 p482
		Install Filter Fabric	13,070	m2	$4	$49,013		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$1,548,583**		
	8	**Excavation Works excluding Alcan Mound**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Onsite smelter soils	16900	m3	$12	$209,560	Excavate, transport<1km and deposit	Rawlinsons
		Buffer zone materials	31600	m3	$12	$391,840	Excavate, transport<1km and deposit	Rawlinsons
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	48500	m3	$25	$1,212,500		Vendor Estimate/ENVIRON Experience
		Demolition wastes	29000	m3	$0	$0	No charge, assumes costs are in demolition contract	
		SUBTOTAL Excavation Works				**$2,225,900**		
	9	**Cap Construction**						
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	7,950	m3	$26	$206,700		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	13,249	m2	$20	$268,292		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	4,040	m3	$20	$80,800		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	13,249	m2	$4	$52,996		Rawlinsons 2013 p677
		Install General Fill (30 cm)	4,040	m3	$26	$105,040		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	2,020	m3	$17	$34,805		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	13,249	m2	$8	$105,727		Rawlinsons 2013 p228
		Supply and Install Fencing	528	m	$56	$29,568		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	6	ea	$2,018	$12,108	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$896,036**		
Disposal of municipal wastes to landfill								
	10	**Disposal of municipal wastes**						
		Excavation (assumes in conjunction with other wastes)	400	m3	$16	$6,400		Rawlinsons 2013 p673, for light soil
		Sorting manual	80	hrs	$64	$5,120	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Loading	400	m3	$5	$1,840	assume sand & < 1m	Rawlinsons
		Transport to Cessnock landfill	400	m3	$3	$1,160	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, special wastes (due to asbestos content)	120	t	$370	$44,400	Asbestos and contaminated soils	Cessnock landfill Rates 2013-2014
		Soil Validation Works	1	EA	$30,000	$30,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	400	m3	$25	$10,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Disposal of Municipal Waste to Landfill				**$98,920**		
Treatment of SPL								
	11	**Continued treatment of SPL by Regain**						
		SPL remaining in storage and in pots at the commencement of remediation	79000	t	$530	$41,870,000	Treatment includes transport and any pretreatment/processing requried	
		SUBTOTAL SPL treatment				**$41,870,000**		
Crushing and sorting of Clay Borrow Pit Materials								
	12	**Crushing and sorting of clay borrow pit materials**						
		Excavate and stockpile	15,250	m3	$8	$128,863	Excavate, transport<1km and deposit	Rawlinsons 2013 p673, for light soil
		Sorting manual	3050	hrs	$64	$195,200	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Crushing	15250	m3	$25	$381,250		
		Loading and transport to second stockpile	15250	m3	$8	$114,375	assume sand & < 1m	Rawlinsons
		Stockpile provisions	1	LS	$26,000	$26,000		
		Soil Validation Works	1	EA	$70,000	$70,000	including laboratory analysis	ENVIRON Experience
		SUBTOTAL Clay Borrow Pit				**$915,688**		
Groundwater treatment in accordance with Option F2								
	13	**Groundwater treatment by leachate interception trench**						
		Treatability testing	1	ea	$50,000	$50,000	Refer to Option F2	
		Construction of the interception trench	1	ea	$48,000	$48,000	Refer to Option F2	
		Operational costs over a 10 year period in NPV	1	ea	$2,046,000	$2,046,000	Refer to Option F2	
		SUBTOTAL Groundwater treatment				**$2,144,000**		
	14	**Final Reporting**						
		Validation report	1	each	allow	$250,000	Multiple sites	ENVIRON experience
		EMP	1	each	allow	$60,000	Multiple sites	ENVIRON experience
		Site Auditor signoff		each	allow	$200,000	Multiple sites	ENVIRON experience
		Sub-total reporting				**$510,000**		
		Subtotal				$53,876,319		
		Contingency 10%				$5,387,632	10% Scope	
		CAPITAL COSTS TOTAL				**$59,263,951**		

NOTES Assumes the extent of capping outlined in Appendix G, though noting further work is currently being undertaken to refine these estimates
Assumes further investigation does not identify other not known contamination

dard excavating equipment

Refer to Appendix G for a description of capping requirements and assumptions made
Ground preparation (e.g. removal of structures and vegetation) is undertaken as part of a demolition process and no costs have been allocated.
Clean fill is won locally and placed with a permeability of not less than 1 x 10-9 m/s.
Capping is undertaken independently of other site activities
All works are undertaken in one mobilisation
Assumes demolition wastes are placed with the cell by the demolition contractor at no cost
Assumes clay borrow pit is a suitable location
Assumes a 10m high cell is acceptable

Legacy Cost								
	Environmental Monitoring	5	annual	$225,000	$1,125,000		Based on two events per year for 5 years
	Maintenance	1	annual	$36,000	$832,132		Based on 12 events per year for 40 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year	each	$325,042		no cost in year 0	
		1	each	$155,242	$155,242	year 25	Using a discount rate of 3%
		1	each	$47,590	$47,590	year 40	Using a discount rate of 3%
					$2,159,964		
	Legacy potential liability provisioning				$3,160,743		
	Upgrades to Alcan Mound	50%	event	NPV	$174,962	Has a 50% chance of occuring once in 40 year time	Using a discount rate of 3%
	Upgrades to Containment cell	1%	event	NPV	$5,000	Has a 1% chance of occuring once in 40 year time frame	
	Treatment of leachate impacted groundwater (option F2)	refer to option F2	event	NPV	$2,540,000	assumes occurs after 10 years, and has a 50% chance of occuring	
					$2,719,962	Cost of ongoing water treatment and sediment treatment	
					$4,879,926		

			Value
RISK	Comment		12
	Major	prosecution unlikely, clean up costs between $5mil and $10mil	
	Possible	Might occur at some time	

Time	Pre-Design Activities		0.25	years	
	Preparation of RAP and Planning Approval (EIS)		1.25	years	
	Approvals		1.25	years	
	Project Engineering Tasks	`	0.5	years	
	Treatment of SPL		3.95	years	Occurs in parallel, has been excluded
	Disposal of municipal wastes		0.25	years	Assumes 1500t/wk
	Excavate, crush and sort clay borrow pit		0.5	years	Occurs in parallel, has been excluded
	Construction		1	years	
	Relocation of wastes		3	years	based on 600t/day, concurrent with demolition
	Closure		0.5	years	
	Final Reporting		0.5	years	
	Time		**8.25**	**years**	

Option G4 Encapsulate all wastes including Alcan Mound but excluding municipal wastes and SPL in a purpose built containment cell. Remediate Alcan Mound footprint including groundwater.	
Description	**Construct a new containment cell, move and encapsulate all wastes excluding municipal wastes, continue to treat SPL through the current Regain process, option F3 groundwater treatment.**
Base Year	**2014**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
Construction containment cell								
	1	**Pre-Design Activities**						
		CPT Soundings	7	EA	$1,100	$7,776	1 CPT per 5000 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	18	EA	$7,200	$127,238	5 borings per 10000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$135,014**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$150,000		ENVIRON experience
		CLMA Auditor			$40,000	$60,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Development application			$15,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$510,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$1,080,421	Not included on SPL treatment	USEPA Remediation Engineering
		Remedial Design			8%	$1,728,674	Not included on SPL treatment	USEPA Remediation Engineering
		Construction Management			6%	$1,296,506	Not included on SPL treatment	USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$432,169	Not included on SPL treatment	ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$4,537,770**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		Vendor estimate
		SUBTOTAL Site Preparation				**$688,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	42,413	m2	$2	$88,219		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	42,413	ha	$1,020	$4,326	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	35,344	m3	$8	$280,985		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	50,680	m3	$24	$1,190,980		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	35,844	m2	$20	$725,841		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	10,956	m2	$4	$41,085		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	10,956	m3	$25	$273,900		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	35,844	m2	$20	$725,841		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	50,680	m2	$4	$190,050		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	10,956	m3	$25	$273,900		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	1,790	m	$128	$229,120		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	2	ea	$10,000	$20,000		Rawlinsons 2013 p482
		Install Filter Fabric	35,844	m2	$4	$134,415		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$4,178,662**		
	6	**Excavation Works excluding Alcan Mound**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Onsite smelter soils	16900	m3	$12	$209,560	Excavate, transport<1km and deposit	Rawlinsons
		Buffer zone materials	31600	m3	$12	$391,840	Excavate, transport<1km and deposit	Rawlinsons
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	48500	m3	$25	$1,212,500		Vendor Estimate/ENVIRON Experience
		Demolition wastes	29000	m3	$0	$0	No charge, assumes costs are in demolition contract	
		SUBTOTAL Excavation Works				**$2,225,900**		
	7	**Excavation Alcan Mound**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Transport and place waste compact	105,000	m3	$14	$1,512,000	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		Crush	105,000	m3	$25	$2,625,000		
		Excavate and transport 2m of underlying soils	55,778	m3	$12	$691,647		
		Soil Validation Works	1	EA	$60,000	$60,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	55,778	m3	$25	$1,394,450		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavation Works for Alcan Mound				**$6,435,476**		
	8	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	5,551	m3	$10	$54,122		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	21,848	m3	$26	$568,048		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	36,413	m2	$20	$737,363		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	11,102	m3	$20	$222,040		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	36,413	m2	$4	$145,652		Rawlinsons 2013 p677
		Install General Fill (30 cm)	11,102	m3	$26	$288,652		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	5,551	m3	$17	$95,644		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	36,413	m2	$8	$290,576		Rawlinsons 2013 p228
		Supply and Install Fencing	859	m	$56	$48,115		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	10	ea	$2,018	$20,180	Well depth 10m	Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$2,492,781**		
Disposal of municipal wastes to landfill								
	9	**Disposal of municipal wastes**						
		Excavation (assumes in conjunction with other wastes)	400	m3	$16	$6,400		Rawlinsons 2013 p673, for light soil
		Sorting manual	80	hrs	$64	$5,120	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Loading	400	m3	$5	$1,840	assume sand & < 1m	Rawlinsons
		Transport to Cessnock landfill	400	m3	$3	$1,160	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, special wastes (due to asbestos content)	120	t	$370	$44,400	Asbestos and contaminated soils	Cessnock landfill Rates 2013-2014
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	400	m3	$25	$10,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Disposal of Municipal Waste to Landfill				**$168,920**		
Treatment of SPL								
	10	**Continued treatment of SPL by Regain**						
		SPL remaining in storage and in pots at the commencement of remediation	79000	t	$530	$41,870,000	Treatment includes transport and any pretreatment/processing requried	
		SUBTOTAL SPL treatment				**$41,870,000**		
Crushing and sorting of Clay Borrow Pit Materials								
	11	**Crushing and sorting of clay borrow pit materials**						
		Excavate and stockpile	15,250	m3	$8	$128,863	Excavate, transport<1km and deposit	Rawlinsons 2013 p673, for light soil
		Sorting manual	3050	hrs	$64	$195,200	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Crushing	15250	m3	$25	$381,250		
		Loading and transport to second stockpile	15250	m3	$8	$114,375	assume sand & < 1m	Rawlinsons
		Stockpile provisions	1	LS	$26,000	$26,000		
		SUBTOTAL Clay Borrow Pit				**$845,688**		
Groundwater treatment in accordance with Option F2								
	12	**Groundwater treatment of volume of water beneath Alcan Mound**						
		Investigations and reporting	1	ea	$45,000	$45,000	Refer to Option F2	
		Operational costs over a 5 year period in NPV	1	ea	$4,018,000	$4,018,000	Refer to Option F2	
		SUBTOTAL Groundwater treatment				**$4,063,000**		
	13	**Final Reporting**						
		Validation report	1	each	allow	$250,000	Multiple sites	ENVIRON experience
		EMP	1	each	allow	$60,000	Multiple sites	ENVIRON experience
		Site Auditor signoff		each	allow	$200,000	Multiple sites	ENVIRON experience
		Sub-total reporting				**$510,000**		
		Subtotal				$68,661,210		
		Contingency 10%				$6,866,121	10% Scope	
		CAPITAL COSTS TOTAL				**$75,527,331**		

NOTES

Assumes the extent of capping outlined in Appendix G, though noting further work is currently being undertaken to refine these estimates
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix G for a description of capping requirements and assumptions made
Ground preparation (e.g. removal of structures and vegetation) is undertaken as part of a demolition process and no costs have been allocated.
Clean fill is won locally and placed with a permeability of not less than 1 x 10-9 m/s.
Capping is undertaken independently of other site activities
All works are undertaken in one mobilisation
Assumes demolition wastes are placed with the cell by the demolition contractor at no cost
Assumes clay borrow pit is a suitable location
Assumes a 10m high cell is acceptable

Legacy Cost								
		Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years

	Maintenance	1		annual	$18,000	$416,066		Based on 12 events per year for 40 years, using a discount rate of 3%
	Topsoil replacement and reseeding battered perimeter	Base year		each	$386,219		no cost in year 0	
			1	each	$184,461	$184,461	year 25	Using a discount rate of 3%
			1	each	$56,548	$56,548	year 40	Using a discount rate of 3%
						$1,407,074		
	Upgrades to Containment cell	1%		event	NPV	$14,000	Has a 1% chance of occuring once in 40 year time frame Cost of cap replacement	
	Treatment of leachate impacted groundwater (option F3)	10%		event	NPV	$800,692	Legacy costs for additional water treatment, Option F3	
						$814,692		
						$2,222,000		

			Value
RISK	Comment		3
	Moderate	prosecution unlikely, clean up costs less than $5mil	
	Rare	May occur only in exceptional circumstances	

Time	Pre-Design Activities	0.25	years	
	Preparation of RAP and Planning Approval (EIS)	1.25	years	
	Approvals	1.25	years	
	Project Engineering Tasks	0.5	years	
	Treatment of SPL	1.2	years	Occurs in parallel, has been excluded
	Disposal of municipal wastes	0.25	years	Assumes 1500t/wk
	Excavate, crush and sort clay borrow pit	0.5	years	Occurs in parallel, has been excluded
	Construction	1	years	
	Relocation of wastes	3	years	based on 600t/day, concurrent with demolition
	Closure	0.5	years	
	Final Reporting	0.5	years	
	Time	**8.25**	**years**	

Option G5 Encapsulate all wastes including Alcan Mound and SPL in a purpose built containment cell. Remediate Alcan Mound footprint including groundwater.

Description	**Construct a new containment cell, move and encapsulate all wastes excluding municipal wastes, option F3 groundwater treatment**
Base Year	**2014**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	TOTAL	NOTES(2)	Source
Construction containment cell								
	1	**Pre-Design Activities**						
		CPT Soundings	7	EA	$1,100	$7,776	1 CPT per 5000 m2 of cell.	ENVIRON Estimate
		Geotechnical Borings & Testing	18	EA	$7,200	$127,238	5 borings per 10000m2.	ENVIRON Estimate.
		SUBTOTAL Pre-Design Activities				**$135,014**		
	2	**Preparation of RAP and Planning Approval**						
		RAP preparation			$50,000	$150,000		ENVIRON experience
		CLMA Auditor			$40,000	$60,000	Assumes Auditor will be required by regulator	ENVIRON experience
		Development application			$15,000	$300,000	Asumes EIS for SSD required	ENVIRON experience
		SUBTOTAL Preliminary documentation				**$510,000**		
	3	**Project Engineering Tasks**						
		Project Management			5%	$1,320,497	Not included on SPL treatment	USEPA Remediation Engineering
		Remedial Design			8%	$2,112,795	Not included on SPL treatment	USEPA Remediation Engineering
		Construction Management			6%	$1,584,596	Not included on SPL treatment	USEPA Remediation Engineering
		Environmental Audit of works (Validation)			2%	$528,199	Not included on SPL treatment	ENVIRON experience
		SUBTOTAL Engineering/Technical Tasks Capital Cost				**$5,546,087**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		Construct haul roads	1,500	LM	$308	$462,000		Vendor estimate
		SUBTOTAL Site Preparation				**$688,000**		
	5	**Cell Construction**						
		General Site Preparation for Consolidation Cell	48,000	m2	$2	$99,840		Rawlinsons 2013 p211
		Clear & Grub for Consolidation Cell	48,000	ha	$1,020	$4,896	Assumes area largely cleared	Rawlinsons 2013 p211
		Grade Consolidation Cell (1 m)	40,000	m3	$8	$318,000		Rawlinsons 2013 p675
		Construct Clay Liner (1 metre)	103,608	m3	$24	$2,434,788		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	72,052	m2	$20	$1,459,053		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	21,995	m2	$4	$82,481		Vendor Estimate/ENVIRON Experience
		Install Leachate Detection Layer (30 cm sand)	21,995	m3	$25	$549,875		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner	72,052	m2	$20	$1,459,053		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric	103,608	m2	$4	$388,530		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Layer (30 cm Sand)	21,995	m3	$25	$549,875		Vendor Estimate/ENVIRON Experience
		Install Leachate Collection Drains	2,101	m	$128	$268,928		Rawlinsons 2013 p675
		Install Leachate Collection Sump System	2	ea	$10,000	$20,000		Rawlinsons 2013 p482
		Install Filter Fabric	72,052	m2	$4	$270,195		Rawlinsons 2013 p487
		SUBTOTAL Cell Construction				**$7,905,514**		
	6	**Excavation Works excluding Alcan Mound**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Onsite smelter soils	16900	m3	$12	$209,560	Excavate, transport<1km and deposit	Rawlinsons
		Buffer zone materials	31600	m3	$12	$391,840	Excavate, transport<1km and deposit	Rawlinsons
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	48500	m3	$25	$1,212,500		Vendor Estimate/ENVIRON Experience
		Demolition wastes	29000	m3	$0	$0	No charge, assumes costs are in demolition contract	
		SUBTOTAL Excavation Works				**$2,225,900**		
	7	**Excavation Alcan Mound**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km and deposit	Rawlinsons 2013 p 673
		Transport and place waste compact	105,000	m3	$14	$1,512,000	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		Transport and place remaining SPL	30,600	m3	$14	$440,640	Level and grade, no compaction or excavatin	Rawlinsons 2013 p 675
		Crush	105,000	m3	$25	$2,625,000		
		Excavate and transport 2m of underlying soils	55,778	m3	$12	$691,647		
		Soil Validation Works	1	EA	$60,000	$60,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	55,778	m3	$25	$1,394,450		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Excavation Works for Alcan Mound				**$6,876,116**		
	8	**Cap Construction**						
		Install Sand Drainage Layer (15cm) for gas drainage	6,275	m3	$10	$61,181		
		Grade, Compact surface & Inst. 600mm Clay - Cell Cap	24,698	m3	$26	$642,148		Vendor Estimate/ENVIRON Experience
		Install 1.5mm HDPE Liner for Cell Cap	41,163	m2	$20	$833,551		Vendor Estimate/ENVIRON Experience
		Install Sand Drainage Layer (30cm) for Cell Cap	12,550	m3	$20	$251,000		Vendor Estimate/ENVIRON Experience
		Install Filter Fabric for Cell Cap	41,163	m2	$4	$164,652		Rawlinsons 2013 p677
		Install General Fill (30 cm)	24,698	m3	$26	$642,148		Vendor Estimate/ENVIRON Experience
		Install Topsoil for Cell Cap (15 cm)	6,275	m3	$17	$108,118		Rawlinsons 2013 p228
		Seed, Fertilize, and Mulch Cell Cap	41,163	m2	$8	$328,481		Rawlinsons 2013 p228
		Supply and Install Fencing	946	m	$56	$52,954		Rawlinsons 2013 p226
		Supply and Install Monitoring Wells	10	ea	$2,018	$20,180	Well depth 10m	Vendor Estimate/ENVIRON Experience
		Supply and Install Gas Vents	15	ea	$1,500	$22,389	Well depth 10m	Vendor Estimate/ENVIRON Experience
		SUBTOTAL Cap Construction				**$3,126,802**		
Disposal of municipal wastes to landfill								
	9	**Disposal of municipal wastes**						
		Excavation (assumes in conjunction with other wastes)	400	m3	$16	$6,400		Rawlinsons 2013 p673, for light soil
		Sorting manual	80	hrs	$64	$5,120	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Loading	400	m3	$5	$1,840	assume sand & < 1m	Rawlinsons
		Transport to Cessnock landfill	400	m3	$3	$1,160	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, special wastes (due to asbestos content)	120	t	$370	$44,400	Asbestos and contaminated soils	Cessnock landfill Rates 2013-2014
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	400	m3	$25	$10,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Disposal of Municipal Waste to Landfill				**$168,920**		
Crushing and sorting of Clay Borrow Pit Materials								
	10	**Crushing and sorting of clay borrow pit materials**						
		Excavate and stockpile	15,250	m3	$8	$128,863	Excavate, transport<1km and deposit	Rawlinsons 2013 p673, for light soil
		Sorting manual	3050	hrs	$64	$195,200	Assumes 5 m3 sorted in one labour hour	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Crushing	15250	m3	$25	$381,250		
		Loading and transport to second stockpile	15250	m3	$8	$114,375	assume sand & < 1m	Rawlinsons
		Stockpile provisions	1	LS	$26,000	$26,000		
		SUBTOTAL Clay Borrow Pit				**$845,688**		
Treatment of SPL								
	11	**Continued treatment of SPL by Regain**						
		SPL remaining in storage and in pots at the commencement of remediation	24000	t	$530	$12,720,000	Treatment includes transport and any pretreatment/processing requried	
		SUBTOTAL SPL treatment				**$12,720,000**		
Groundwater treatment in accordance with Option F2								
	12	**Groundwater treatment of volume of water beneath Alcan Mound**						
		Investigations and reporting	1	ea	$45,000	$45,000	Refer to Option F2	
		Operational costs over a 5 year period in NPV	1	ea	$4,018,000	$4,018,000	Refer to Option F2	
		SUBTOTAL Groundwater treatment				**$4,063,000**		
	13	**Final Reporting**						
		Validation report	1	each	allow	$250,000	Multiple sites	ENVIRON experience
		EMP	1	each	allow	$60,000	Multiple sites	ENVIRON experience
		Site Auditor signoff		each	allow	$200,000	Multiple sites	ENVIRON experience
		Sub-total reporting				**$510,000**		
		Subtotal				$45,321,041		
		Contingency 10%				$4,532,104	10% Scope	
		CAPITAL COSTS TOTAL				**$49,853,145**		

NOTES

Assumes the extent of capping outlined in Appendix G, though noting further work is currently being undertaken to refine these estimates
Assumes further investigation does not identify other not known contamination
Assumes program can be acheived through the use of standard excavating equipment
Refer to Appendix G for a description of capping requirements and assumptions made
Ground preparation (e.g. removal of structures and vegetation) is undertaken as part of a demolition process and no costs have been allocated.
Clean fill is won locally and placed with a permeability of not less than 1 x 10-9 m/s
Capping is undertaken independently of other site activities
All works are undertaken in one mobilisation
Assumes demolition wastes are placed with the cell by the demolition contractor at no cost
Assumes clay borrow pit is a suitable location
Assumes a 10m high cell is acceptable

Legacy Cost		Environmental Monitoring	5	annual	$150,000	$750,000		Based on two events per year for 5 years
		Maintenance	1	annual	$18,000	$410,548		Based on 12 events per year for 100 years, using a discount rate of 3%
		Topsoil replacement and reseeding battered perimeter	Base year	each	$436,599		no cost in year 0	
			1	each	$208,522	$208,522	year 25	Using a discount rate of 3%
			1	each	$63,924	$63,924	year 40	Using a discount rate of 3%
								Using a discount rate of 3%
								Using a discount rate of 3%
						$1,432,994		
		Upgrades to Containment cell	1%	event	NPV	$18,000	Has a 1% chance of occuring once in 40 year time frame	
							Cost of cap replacement	
		Treatment of leachate impacted groundwater (option F3)	10%	event	NPV	$800,692	Legacy costs for additional water treatment, Option F3	
						$818,692		
						$2,252,000		
			Value					
RISK	Comment		4					
	Major	significant remediation required						
	Rare	Only occuring in extreme circumstances						
Time		Pre-Design Activities				0.25	years	
		Preparation of RAP and Planning Approval (EIS)				1.25	years	
		Approvals				1.25	years	
		Project Engineering Tasks				0.5	years	
		Disposal of municipal wastes				0.25	years	Assumes 1500t/wk, occurs in parallel
		Excavate, crush and sort clay borrow pit				0.5	years	Occurs in parallel, has been excluded
		Construction				1	years	
		Relocation of wastes				4	years	based on 600t/day, concurrent with demolition
		Closure				0.5	years	
		Final Reporting				0.5	years	
		Time				**9.25**	**years**	

Option G6 Dispose of all wastes off-site								
Description	Dispose of all wastes off-site, option F3 groundwater treatment.							
Base Year	2014							
Date	03/2014							
Phase	RAP							
Revision	1							
Units	$AUD							
Capital Costs	Item	Description	Option	Cost $mil AUD				
	1	**Landfill disposal off site**						
		Alcan Mound Wastes	Disposal to private landfill in QLD	Option A5b		$183,698,000		
		SPL stored and in pots	Disposal to private landfill in QLD	Option B7A		$85,312,000		
		Smelter contaminated soils	Disposal to Newcastle Private receiver	Option C6		$32,757,000		
		Buffer Zone Soils	Disposal to Newcastle Private receiver and Cessno	Option D6		$42,072,000		
		Demolition wastes	Disposal to Cessnock Landfill	Option E3		$8,100,000		
						$351,939,000		
	2	**Groundwater treatment of volume of water beneath Alcan Mound**						
		Investigations and reporting	1	ea	$45,000	$45,000	Refer to Option F2	
		Operational costs over a 5 year period in NPV	1	ea	$4,018,000	$4,018,000	Refer to Option F2	
		SUBTOTAL Groundwater treatment				**$4,063,000**		
		Subtotal				$356,002,000		
		Contingency 10%				$35,600,200	10% Scope	
		CAPITAL COSTS TOTAL				**$391,602,200**		
NOTES	Assumes disposal to QLD acceptable							
	Assumes volumes of material are as presented in Appendix G of the Remedial Options Summar							
	Assumes further investigation does not identify other not known contaminatior							
	Assumes program can be achieved through the use of standard excavating equipmen							
	Assumes transport rates of 1500t/wk							
Legacy Cost								
		Additional leachate capture and treatment					Assumes additional 86ML over a 5 year period	Using a discount rate of 3%,
		Removal and treatment of sediment within the sediment basins					assumes occurs after 10 years, and has a 50% cha	Using a discount rate of 3%,
							Assumes 20 Tonnes of sludge generate per ML	
						$800,692	See appF_appG sheet	
			Value					
RISK	Comment		1					
	Insignificant	Prosecution could result remedial costs between 0.5m and 5mil likely						
	Rare	Not likely to occur under most circumstances						
Time		Pre-Design Activities				0.25	years	
		Preparation of RAP and Planning Approval (EIS)				1.25	years	
		Approvals				0.75	years	
		Project Engineering Tasks				0.2	years	
		Construction				2	years	
		Relocation of wastes				4.0	years	Based on 500m3/day
		Closure				1	years	
		Final Reporting				0.5	years	
		Time				**10.0**	**years**	

Option G7 Onsite Destruction	
Description	**Onsite Waste to Energy**
Base Year	**2014**
Date	**03/2014**
Phase	**RAP**
Revision	**1**
Units	**$AUD**

Capital Costs	Item	Description	QTY	units	UNIT COST	SUBTOTAL	NOTES(2)	Source
	1	**Preparation of RAP and DA**						
		RAP preparation			$50,000	$50,000		ENVIRON experience
		Planning approval			$350,000	$350,000	EIS required	ENVIRON experience
		Sub-total preliminary documentation				**$400,000**		
	2	**Pilot Trial**						
		Allow				$100,000		Estimate
		Sub-total pilot trial				**$100,000**		
	3	**Project Tasks**						
		Project Management			5%	$22,682,512	Does not include treatment PM	USEPA Remediation Costs
		Sub-total Technical Tasks Capital Cost				**$22,682,512**		
	4	**Site Preparation**						
		Mobilization/Demobilization	1	LS	$150,000	$150,000		Vendor Estimate/ENVIRON Experience
		Site Preparation	1	LS	$50,000	$50,000		Vendor Estimate/ENVIRON Experience
		Erosion Control Measures	1	LS	$26,000	$26,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Site Preparation				**$226,000**		
	5	**Excavation Works excluding Alcan Mound**						
		Erosion Control Measures	12	LS	$26,000	$312,000		Vendor Estimate/ENVIRON Experience
		Onsite smelter soils	16900	m3	$12	$209,560	Excavate, transport<1km and dep	Rawlinsons
		Buffer zone materials	31600	m3	$12	$391,840	Excavate, transport<1km and dep	Rawlinsons
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	48500	m3	$25	$1,212,500		Vendor Estimate/ENVIRON Experience
		Demolition wastes	29000	m3	$0	$0	No charge, assumes costs are in demolition contract	
		Treatment through plasma gasification	86,030	t	$450	$38,713,500	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL Excavation Works				**$40,939,400**		
	6	**Sorting, placement and treatment of Alcan Mound wastes**						
		Remove existing cap 150mm veg layer and stockpile	1,378	m3	$8	$11,642	Excavate, transport<1km and dep	Rawlinsons 2013 p 673
		Remove existing 450mm general fill and stockpile	4,133	m3	$9	$38,233	Excavate, transport<1km and dep	Rawlinsons 2013 p 673
		Remove 900mm clay and stockpile	8,267	m3	$12	$102,505	Excavate, transport<1km and dep	Rawlinsons 2013 p 673
		Excavation	189,000	t	$20	$3,780,000	Includes surcharge for handling	
		Screening	189,000	t	$20	$3,780,000	Estimate, requires evaluation of equipment and suitability	
		Sorting manual	54,432	hrs	$64	$3,483,648	Assumes 2.5 labour hours to sort	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Treatment through plasma gasification	189,000	t	$450	$85,050,000	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL Placement of SPL				**$96,246,027**		
Disposal of municipal wastes to landfill								
	9	**Disposal of municipal wastes**						
		Excavation (assumes in conjunction with other wastes)	400	m3	$16	$6,400		Rawlinsons 2013 p673, for light soil
		Sorting manual	80	hrs	$64	$5,120	Assumes 5 m3 sorted in one labo	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Loading	400	m3	$5	$1,840	assume sand & < 1m	Rawlinsons
		Transport to Cessnock landfill	400	m3	$3	$1,160	Cessnock	Rawlinsons, based on 10km
		Cessnock landfill, special wastes (due to asbestos content)	120	t	$370	$44,400	Asbestos and contaminated soils	Cessnock landfill Rates 2013-2014
		Soil Validation Works	1	EA	$100,000	$100,000	including laboratory analysis	ENVIRON Experience
		Soil reinstatement	400	m3	$25	$10,000		Vendor Estimate/ENVIRON Experience
		SUBTOTAL Disposal of Municipal Waste to Landfill				**$168,920**		
Treatment of SPL								
	10	**Continued treatment of SPL by Regain**						
		SPL remaining in storage and in pots at the commencement of remediation	55000	t	$450	$24,750,000	Includes crushing to 6mm	Tetronics, includes ROR, profit
		SUBTOTAL SPL treatment				**$24,750,000**		
Crushing and sorting of Clay Borrow Pit Materials								
	11	**Crushing and sorting of clay borrow pit materials**						
		Excavate and stockpile	42,700	m3	$8	$360,815	Excavate, transport<1km and dep	Rawlinsons 2013 p673, for light soil
		Sorting manual	42700	hrs	$64	$2,732,800	Assumes 5 m3 sorted in one labo	Estimate, labour rate Group 4 Rawlinsons 2013 pg 695
		Crushing	42700	m3	$25	$1,067,500		
		Loading and transport to second stockpile	42700	m3	$8	$320,250	assume sand & < 1m	Rawlinsons
		Stockpile provisions	1	LS	$26,000	$26,000		
		SUBTOTAL Clay Borrow Pit				**$4,507,365**		
Groundwater treatment in accordance with Option F2								
	12	**Groundwater treatment of volume of water beneath Alcan Mound**						
		Investigations and reporting	1	ea	$45,000	$45,000	Refer to Option F2	
		Operational costs over a 5 year period in NPV	1	ea	$4,018,000	$4,018,000	Refer to Option F2	
		SUBTOTAL Groundwater treatment				**$4,063,000**		
	13	**Final Reporting**						
		Validation report	1	each	allow	$250,000	Multiple sites	ENVIRON experience
		EMP	1	each	allow	$60,000	Multiple sites	ENVIRON experience
		Site Auditor signoff		each	allow	$200,000	Multiple sites	ENVIRON experience
		Sub-total reporting				**$510,000**		
		Subtotal				$194,243,224		
		Contingency 10%				$19,424,322	10% Scope	
		CAPITAL COSTS TOTAL				**$213,667,547**		

NOTES

Assumes volumes of material are as presented in Appendix C of the Remedial Options Summary
Assumes further investigation does not identify other not known contamination
Assumes program can be achieved through the use of standard excavating equipment
Assumes by-products are approved by NSW regulators for reuse and do not require landfilling. 80% plasma rock is estimated to be generated.
Rate of treatment per tonne provided by Tetronics includes a rate of return and profit margin. This rate could be negotiated. Applies to 15000 tpa plant.

Legacy Cost

	Legacy provision	$800,692	See appF_appG sheet

Risk

			Value	
Comment				
Likely	Will probably occur			
moderate	Remedaition clean up less than $5M		12	relates to technological risk and risk of unuseable slag

Time

Pilot Trial	1	years
RAP/EIS	1	
Approvals	1.75	years
Investigations/tender/contract negotiations	0.5	years
Construction/commissioning	1	years
Assumes two parrallel treatment plants at 15000tpa	11.805	years
Validation Reporting	0.2	years
TOTAL	17.255	years

Appendix H

Carbon Footprint Evaluation of Options G4 and G5

EVALUATION OF CARBON FOOTPRINT, OPTIONS G4 and G5

Introduction

ENVIRON was engaged by Hydro Aluminium to map the carbon emissions associated with two disposal options for a stockpile of ‘clean’ spent potlining (SPL) generated by the aluminium production process.

The scope of work focused on consumption of materials and inputs to the key activities for each disposal option. The two disposal options and boundaries for the carbon emissions assessment included:

Option	Description	Assessment Boundary
G4	SPL containment on site (disposal within a containment cell)	The boundary includes the stockpiling of the SPL, construction of the containment cell, loading and transport of the SPL to the containment cell and landfilling of the SPL within the containment cell.
G5	SPL treatment by Regain Pty Limited (Regain).	The boundary includes the stockpiling of the SPL, treatment by Regain to convert the SPL to HiCal30 by-product, transport and ship the HiCal 30 by-product to a cement manufacturer in Asia. The emissions associated with cement production using the HiCal30 have not been estimated. Instead the expected energy savings through the use of HiCal30 has been assessed.

Approach

The overall approach taken for the work included:

- Mapping the activities associated with each disposal option.
- Estimating the basic carbon metrics and applying assumptions.
- Estimating the quantities consumed for inputs to each activity.
- Reviewing information provided by Regain on the life cycle of Regain products and estimated energy and emissions savings.
- Calculating the emissions for each activity by applying relevant emission, conversion or other relevant factors to the consumption quantities.

Information was provided by Hydro Aluminium in relation to the SPL disposal volume and typical vehicle types used on-site. Regain provided information on the Regain process and a life cycle assessment of this process.

Findings

Key Activities

The key activities that are likely to generate carbon emissions and for which emissions have been calculated included:

Option G4 – SPL Containment on-site

- Construction of containment cell.
- Loading and transporting the SPL stockpile to the containment cell.
- Landfilling the SPL stockpile within the containment cell.

Option G5 – SPL treatment by Regain

- Treatment of the SPL using the Regain process comprising SPL preparation (i.e. crushing and grinding), SPL detoxification, HiCal30 production using the detoxified SPL.
- Transport and ship the Regain by-product (HiCal30) to a cement manufacturer.
- Cement production including coal mining (open-cut) to supply coal required as a raw material to the cement production process. Note the emissions associated with these processes has not been included in this assessment as the intent of the assessment is to demonstrate the estimated emissions savings from using the Regain product compared to the ‘typical’ inputs to the cement production process.

Sources of information and assumptions

The key sources of information and assumptions made for the carbon footprint assessment included:

- Emission factors for electricity, natural gas, diesel and waste were obtained from the Australian National Greenhouse Accounts Factors, July 2013.
- Emission and fuel efficiency factors for vehicles and equipment use has been obtained by researching manufacturer specifications and other publicly available sources of information.
- Emission intensities and consumption rates for the Regain process was sourced from a Regain publication “Indicative Life Cycle Assessment of Regain Products which are Derived from By-products of Primary Aluminium Smelting (version 111_163 v0.2)”, and for the cement production industry from the European Cement Association’s website (CEMBUREAU http://lowcarboneconomy.cembureau.eu/index.php?page=where-is-the-sector-now).
- Regain reports in their Life Cycle Assessment document that 3.8 tonnes of carbon dioxide equivalent (tCO_2e) per tonne of HiCal30 used is saved in the cement manufacturing process when compared to the ‘typical’ process. For the purposes of this assessment, ENVIRON has assumed that one tonne of SPL is the same as one tonne of HiCal30 (after the Regain treatment process). For approximately 30,600 m^3 of SPL (55,080 tonnes) the estimated emissions savings is 210,000 tCO_2e. ENVIRON reviewed the Regain assessment and concluded that the energy and

emissions savings calculations presented to be reasonable assuming the stated figures are factually accurate.

- Transport of the Regain by-product (HiCal30) for use in a cement plant included road transport from the Hydro Aluminium site to a port in Sydney, shipping from Sydney to a port in Manila and the road transport to the cement plant. The distance for road transport is assumed to be 30 km for each trip. The emissions for shipping one tonne of cargo from Sydney to Manila were taken as the average emissions intensity stated by OOCL and Hanjin Shipping.
- An emission factor for the SPL was not readily available. SPL has been assumed to comprise predominantly 'brick' and for the purposes of calculating emissions from the landfilling of brick waste, an emissions factor for brick has been used. The UK Department for Environment Food and Rural Affairs (DEFRA) website provides a default emissions factor for brick waste as 2.0 kgCO_2e/tonne brick waste.

Emissions

The carbon emissions from Option G5 were estimated to be higher than Option G4:

- Option G4 (SPL containment on-site) was approximately 438 tCO_2e.
- Option G5 (SPL treatment by Regain) was approximately 11,800 tCO_2e with an estimated emissions saving of 206,550 tCO2e by using Regain HiCal30 in the cement production process compared to using ‘typical’ raw materials.

The emissions broken down by key activity is summarised as follows:

Activity	Emissions (tCO_2e)
Option 1 - SPL Containment on Site (Landfill)	
Construction of cell	195
Load & transport SPL to cell	133
Landfill	110
TOTAL - Option G4	**438**
Option 2 - SPL Treatment by Regain	
Regain treatment	7,322
Transport and Ship HiCal30	4,558
Cement production – emissions saved by using Regain HiCal30 in cement production	206,550
TOTAL - Option G5	**-194,670**
Emissions Savings using Regain HiCal30 product in cement production	**206,550**

For Option G5, the emissions savings through the use of HiCal30 in the cement production stage represents a significantly larger proportion than the emissions generated from the other two activities in this disposal option.

The cement industry is emissions, energy and material intensive and Regain notes that by using HiCal30 as a raw material emissions and energy consumption can be reduced.