CLINICAL WASTE TREATMENT OPTIONS

High Level Options Study

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1.0 INTRODUCTION AND BACKROUND

1.1 Introduction

The Department for Infrastructure (DfI) of the States of Jersey (SoJ) is responsible for managing a range of services including solid waste management both municipal and clinical.

SLR Consulting Limited (SLR) has been commissioned by DfI to undertake a high level options review to assist in the determination of a preferred way forward with respect to ongoing clinical waste treatment.

SLR is a major international consultancy, employing over 1100 full-time staff worldwide and recognised as a leading independent company within the waste and waste to energy sector.

1.2 Background

Jersey currently produces approximately 450 tonnes per annum of clinical waste. The clinical waste contains domestic and offensive/hygiene waste, infectious waste and hazardous waste. Until recently, all clinical waste produced in Jersey has been disposed of at the Bellozanne clinical waste incinerator (CWI) at an annual cost of approximately £450,000 per annum.

The CWI has been operational for 18 years (since 1998) and has the capacity to treat 200 kg/hr of clinical waste. The plant has a number of operational and risk issues, including:

- weekly boiler cleaning;
- refractory lining failures;
- combustion control malfunctions;
- maintaining the furnace at a steady temperature; and,
- achieving the 1000°C temperature requirement under WID (waste incineration directive).

CWI experienced a catastrophic software failure in 2013 which shutdown the plant for three weeks, resulting in the upper and lower fridges being filled to maximum capacity. DfI continue to operate with the same if not greater risk as the programmable logic controller (PLC) is no longer manufactured or supported.

The service life of the refractory lining has become unpredictable due to the overall deterioration of anchors supporting material which makes up the sub frame of the incinerator. A survey in 2010 highlighted refractory anchorage failure which was not visible during shutdown maintenance works; this was seen as introducing a significant risk of fire within the building putting both staff & the building at risk. Funds were subsequently made available for a major upgrade/refurbishment of the existing facility to minimise the identified risks.

It was later decided that the CWI should be replaced with new technology and funds that were made available for the earlier refurbishment works were reallocated to the new replacement project. A further decision was made to relocate the solid waste services (including the CWI) to La Collette and expand the liquid waste services at Bellozanne as part of the Master Plan

The sewage treatment works is now in the process of being upgraded/redeveloped and so the site of the existing and aging CWI has to be cleared.

As such there is an urgent requirement to identify a suitable alternative means of processing the clinical waste generated in Jersey once the existing facility is closed and decommissioned.

The implementation of a recent initiative to segregate the domestic and offensive/hygiene waste from the clinical (hazardous and infectious) waste has proved successful and although in the early stages, is resulting in a revised projection of just 150 to 180 tonnes per annum of hazardous and infectious waste. Of this volume, 100 – 120 tonnes per annum could be pre-treated with the remaining 50 – 60 tonnes per annum requiring high temperature incineration.

A number of options have already been explored with some predicated on the assumption that some or all of the clinical waste could be exported to the UK following the acceptance of a ‘duly reasoned request’ (DRR) by the Environment Agency (EA). However, DfI is now in possession of a refusal notice from the EA which leaves them with little option but to seek an alternative cost effective means of treating this waste stream on island.

This report therefore considers proven treatment options available to DfI for the processing of between 150 and 180 tonnes per annum of hazardous and infectious medical wastes.

2.0 PROJECT DEFINITION

2.1 General

In order to determine the most cost effective solution to dispose of the projected waste streams it is necessary to fully understand the background and related issues which define the project.

2.2 Waste Arisings and Projections

Jersey currently produces approximately 450 tonnes per annum of clinical waste. Clinical waste contains domestic and offensive/hygiene waste, infectious waste and hazardous waste. The implementation of a recent initiative to segregate the domestic and offensive/hygiene waste from the clinical (hazardous and infectious) waste has proved successful and the current waste arisings and sub-categories requiring pre-treatment and/or high temperature incineration (or alternative) are scheduled below. This is anticipated to be the worst case and a lower quantity of 150,000kg per annum is being targeted.

Category/Definition	Kg per annum	Kg per week (rounded)
Infectious (treatable)	119,686	2,302
Infectious (non-treatable)	1,647	32
Anatomical	2,211	43
Sharps	40,296	775
Cytotoxic	425	8
Medicinal	18,858	363
Totals	**183,123**	**3,523**

2.3 Project Drivers

The main drivers behind the development of an alternative clinical waste treatment strategy are:

- poor performance of the existing clinical waste facility;
- ever increasing risk to DfI of a catastrophic failure due to the age of the plant;
- lack of ongoing support from the manufacturer due to the sale and restructuring of the company;
- Bellozanne being formally designated as the Liquid Waste Site;
- land requirement for the new sewage treatment works (STW) while the existing STW continues to remain in service;
- Need to relocate CWI to La Collette as the Solids Waste site; and,
- DRR refusal

2.4 Project Constraints

- The Bellozanne Waste Management Services site will be required for the new STW and the enabling works has already commenced in 2015.
- Planning & Environmental Impact Assessment (EIA) requirements at the La Collette site.
- Regulatory requirements.
- Programme & Budget.

2.5 Environmental Compliance

The existing incinerator is licenced under the Waste Management (Jersey) Law 2005 by the Department of the Environment of SoJ. Conditions of the licence are set out in Waste Management Licence WML005 - Healthcare waste incinerator - The Incineration of controlled waste in an incineration plant. The total quantity of waste accepted at the site is limited to less than 900 tonnes a year and with the exception of environmental emissions the WM licence appears fairly standard when compared to other small thermal treatment plants in the UK. The licence itself does not include any prescribed limits of emissions to land, water or air and refers to the Local Working Plan (LWP)

There is a statement within the LWP as follows:
There is currently no local legislation to regulate emissions from this facility other than the nuisance laws; however, the clinical waste incinerator is operated, as a requirement of its planning permit to the standards set out within the UK's process guidance note PG5/1(95).

Assuming that the Department of the Environment of SoJ take a similar view it is likely that any replacement facility will be required to comply with current UK process guidance notes.

While the SoJ does not fall under the jurisdiction of the European Union or the demands of the UK's Environment Agency there is a clear intent to demonstrate best practice and general compliance with equivalent European standards and environmental permitting regulations. In this respect there are two principal guidance documents which would be relevant to this particular project.

The EA's current guidance on Clinical Waste (EPR 5.07) (Version 1.1 January 2011)

EPR 5.07 sets out the standards and measures for the management of clinical wastes. In most cases these are required to meet both the requirements of the Waste Framework Directive and represent indicative Best Available Techniques (BAT).

The EA's guidance on The Incineration of Waste (EPR 5.01)

Within a section on "key issues" the guidance note states *"Unless your installation is an excluded plant or a plant which burns only halogenated gases, you must comply with the requirements of the Waste Incineration Directive.*

The Waste Incineration Directive (WID, 2000/76/EC) is implemented by the Waste Incineration Regulations (S.I. 2002 No. 2980), and applies to the majority of Installations including the incineration of clinical wastes.

The most significant environmental impacts are likely to be on ground level air quality and global warming, which have to be addressed particularly within any assessment of environmental impacts.

The note explains that many wastes vary in terms of physical and chemical composition. The nature of the waste to be treated is an important factor in determining what is BAT for an individual installation. Without prejudicing the outcome of a formal BAT assessment, which is likely to be required, the following report assumes the selection process used will form part of the assessment ruling out initial options.

Since BAT includes the continuous monitoring of most of the prescribed substances and emissions this is likely to be the single largest difference between the current and any new facility.

2.6 Energy Recovery

There is a requirement under EPR 5.01 to describe how the heat generated during the incineration process is recovered as far as practicable, for example through combined heat and power, the generating of process steam or district heating.

The detail design of this facility should consider all such opportunities but given the remoteness of the site and the scale of the plant, which is likely to be discontinuous, then CHP options and export of heat are unlikely to be cost effective solutions.

Consideration should be given to possible use of heat including the use of Absorption Chillers for maintaining cold room temperatures when the incineration plant is operational.

2.7 Staffing/Resourcing

The existing CWI is operated on day shift pattern with three operatives:

Ramsey Blair — Chargehand

Tommy Querns — Technician

Ian Martin — Labourer

The operatives, and Ramsey in particular, have gained valuable experience of operating the existing CWI and should find a transition to operating another similar plant straight forward. Notwithstanding this there will be a requirement to ensure appropriate training on the specific operation and environmental compliance of a new plant.

It is understood that Ramsey is approaching retirement age in which case it is important to develop a succession plan that allows another operator to be employed and trained while the DfI have the benefit of Ramsey's considerable knowledge and experience of the process.

3.0 INITIAL OPTIONEERING

3.1 Relocation of Existing

Relocating the existing process plant is a possibility though the cost of doing this is unknown and likely to be quite significant when considering the time and effort required to decommission the plant and dismantle it carefully. Besides, significant investment in refurbishment will be required in order to continue its operation. There would be a requirement to completely renew all refractory work, sections of pipework and ducting and of course all of the electrical distribution and control system. Since the existing plant does not have continuous emissions monitoring this too may be a requirement which would have to be included.

To relocate the existing plant would result in a significant period of time where SoJ had no treatment facility on the island. As a minimum this would be 6 to 8 months and beyond the possibility of being able to store wastes while the project was underway. There is a further potential risk in that it is unlikely that a preferred contractor would warrant the performance of the refurbished facility to the same degree of a new replacement facility would have.

Given the uncertainty and risks in terms of outturn cost and lack of warranty of this option plus the inevitable long period of having no operational plant this option is not considered viable.

3.2 Overview of treatment options

The following provides a high level review of available technologies and considers their suitability for treating between 150 and 180 tonnes per annum of infectious and hazardous clinical wastes.

3.2.1 Pyrolysis

In contrast to combustion or even gasification, pyrolysis is the thermal degradation of a substance in the absence of oxygen. This process requires an external heat source to maintain the temperature required to drive the chemical reactions and liberation of gas. Typically, relatively low temperatures of between 300ºC to 850ºC are used during pyrolysis of materials such as RDF. The products from pyrolysing materials are a solid residue and a synthetic gas – commonly known as syngas. The solid residue (sometimes described as a char) is a combination of non-combustible materials and carbon.

Whilst there has been a significant increase in the interest and further development of pyrolysis technologies, and some success witnessed on plants processing a very high quality RDF, the technology is not suited to processing hazardous and infectious wastes unless followed by post combustion of both the solid char and off-gases.

3.2.2 Gasification

Gasification can be defined as the partial thermal degradation of a substance in the presence of insufficient oxygen to oxidise the fuel completely. The resultant off-gases produced through such a process are typified by a combination of oxides of carbon (both carbon monoxide and carbon dioxide), methane, water and hydrogen.

A typical high temperature gasification process will avoid the formation of significant quantities of higher hydrocarbons through the temperature and extent of oxygen added to the process. The avoidance of such higher hydrocarbons in the process reduces the issues associated with tars and oils forming and impacting on downstream processes such as boiler tubes.

The quality of gas anticipated and the fine controls required to manage gas quality plus the variant designs of the core gasification technology has led to the emergence of further sub-classifications. These can be classified as: i) staged or two-stage combustion; ii) batch gasification (which as the name implies is a non-continuous operation and not suited to processing large quantities of waste); and iii) continuous gas generating technologies which are designed to maximise power generation.

It is recommended that both two-stage combustion (semi-pyrolytic) and batch gasification (or batch semi-pyrolytic) processes be further considered for this project given the nature and quantity of clinical waste to be thermally treated.

3.2.3 Combustion

There are many types of conventional or "combustion" technologies, including rotary and oscillating kilns, fixed hearth, fluidised bed (FB) and various types of moving grate.

Waste combustion can be considered to be the total thermal degradation of a substance with sufficient oxygen to oxidise the waste material (and/or fuel) completely.

a) Rotary Kilns:

Rotary kilns are often considered to be the most flexible type of incineration equipment available. In addition to general solid wastes the technology is equally suitable for destroying slurries, sludges and liquids (including chemical waste), abattoir wastes and also pharmaceutical and clinical/medical wastes. They have the ability to deal with many different types of waste at the same time. However, by the very nature of design and the continuously tumbling waste stream, a high particulate loading is generated which results in heat recovery boilers becoming fouled and requiring regular on-line and off-line cleaning. Where large high pressure steam tube boilers are employed this may not be such an issue since there is generally a radiation drop out section and provision for on line rappers and soot blowers to maintain and keep the heat transfer areas relatively clean. On smaller applications however where low pressure smoke tube package boilers are employed, the fouling issue is significant and boilers are very difficult to clean resulting in frequent off-line manual cleaning being required.

In addition to the above issues rotary kilns are best suited to continuous 24/7 operations and are not recommended for intermittent operations.

For the foregoing reasons and given the relatively small quantities of wastes for this particular project we do not believe that rotary kiln is an appropriate technology.

b) Fluidised Bed:

Fluidised Bed incinerators have been used for many years for the destruction of many lower CV slurry and semi-solid wastes. It is commonly the preferred technology for the destruction of waste water treatment plant sludge. In recent years the technology has also been used for the treatment of RDF and other refined and more homogenous feedstocks.

The technology is suited to larger quantities of waste and continuous 24/7 operation over long periods.

This technology is therefore not considered appropriate for the waste streams or quantities of this particular project.

c) Moving Grate and Stepped Grate:

The incineration of mixed MSW has for many years been successfully carried out using “mass burn” or “grate” based technology. The process requires little or no pre-processing of the waste feedstock, except for the removal of large incombustible objects or hazardous items.

There are many designs of grate incinerator technology but all have the fundamental function of providing sufficient underfire air to the burning mass and to agitate and traverse the material through its reaction phases of drying, pyrolysis, combustion and final burn out resulting in a fine grate ash.

In addition to the underfire air (primary combustion air), secondary and tertiary air is added in a controlled manner to ensure good mixing of the gas phase products and complete conversion of the hydrocarbons to exit gases of carbon dioxide and water vapour. The acidic gases which are formed are removed within the flue gas treatment (FGT) section.

While the technology is often used in “mass burn” applications there are a number of stepped hearth grate technologies that have been used for the treatment of clinical waste. Notwithstanding this the technology is fundamentally designed for continuous operation over prolonged periods and therefore would not be suitable to deal with the small quantities of waste of this project.

3.2.4 Plasma

Plasma arc techniques have been used extensively for many years in the production of special metal alloys and in the manufacture of chemicals where extremely high temperatures are required. Fundamentally a high voltage electric arc travels from one electrode to another passing through a plasma gas. The high temperature plasma dissociates molecules of any matter which passes through it.

The system has been used in many industries over many years and more recently introduced to vitrify ash residues within the waste industry to render them harmless. The ash passes through the plasma which instantly turns molten and is then quenched in a water bath. The glass like vitrified beads which result can be used within the construction industry as aggregate since the product is stable and will not leach out any of its component parts (e.g. metals). When waste is treated using this technology it is heated to around 2000degC which destroys all of the organic compounds and again produces a vitrified stable glass residue together with dissociated off-gases which have to be treated in a separate chamber as they may contain vapourised heavy metals and particulates.

An advantage of the technology is that the plasma arc correctly located within the output gaseous stream can effectively clean the syngas of remaining tars and oils, so that a clean syngas (plasma clean-up) is created. An alternative and increasingly more popular form of the technology utilises a simple gasifier as the thermal reactor with the plasma employed to clean-up the syngas and upgrade the calorific value (plasma enhanced gasification).

The energy consumption to volatilise and to vitrify waste is high, particularly when adding demand of integrated support systems. Some facilities are reporting a parasitic demand as high as 30% to 40% of generated power compared to a conventional waste to energy plant with a typical parasitic demand of 12% of generated power.

Whilst there has been a significant increase in interest in plasma based technologies and further developments witnessed on pilot and trial based plants, there are still, to our knowledge, no global reference plants processing clinical waste or quantities of MSW on a commercial basis.

Those plants which are operating and treating hazardous waste streams are believed to require a gate fee in excess of £1,500 per tonne to be commercially viable.

While there may be a possible opportunity in the future for SoJ to consider this technology at a smaller scale and treating the APCRs from the EfW facility it is not considered a viable option for dealing with the current quantities of clinical wastes.

3.2.5 Autoclave

Autoclaves are in themselves not a final treatment solution and can only be considered as a pre-treatment option for the infectious waste component. Where there are larger quantities of clinical waste it may be possible to first treat the infectious wastes in an autoclave in order to de-rate the classification such that the resulting fibre can be burned within an incinerator. It should be noted however that the fibre material is inherently wet, often 50% moisture content, which results in a very low calorific value fuel.

Given the small quantities of infectious and hazardous wastes to be treated we would not recommend a two staged approach of pre-treatment and then combustion as in our experience the energy balance, logistics and costs would not be as competitive as simply combusting the total waste stream in one stage.

4.0 SHORTLIST OF PREFERRED OPTION

4.1 General

Of the options considered within the previous section it would appear that only two-stage combustion (semi-pyrolytic) and batch gasification (or batch semi-pyrolytic) processes are shortlisted.

Given the nature and small quantity of clinical waste to be thermally treated it is recommended that tenders be invited for both technologies and based on a detailed technical specification to safeguard SoJ by guaranteeing the ongoing performance of a new treatment plant.

5.0 SIZING OF THE FACILITY

Hazardous and infectious waste is generated and collected daily but SoJ has the benefit of cold store rooms which allows the storage of this waste for up to 20 days. It is understood that a new transfer station is being designed and planned for construction on a site close to the existing EfW facility at La Collette. SoJ will need to consider the redesign of this facility to instead accommodate a new treatment plant which would include further cold storage rooms.

Given the quantities of wastes arising and the ability to store the waste it would appear prudent to design and build a CWI plant that offered maximum flexibility to catch back after prolonged shut downs, for whatever reason, and to allow normal day time shift operation.

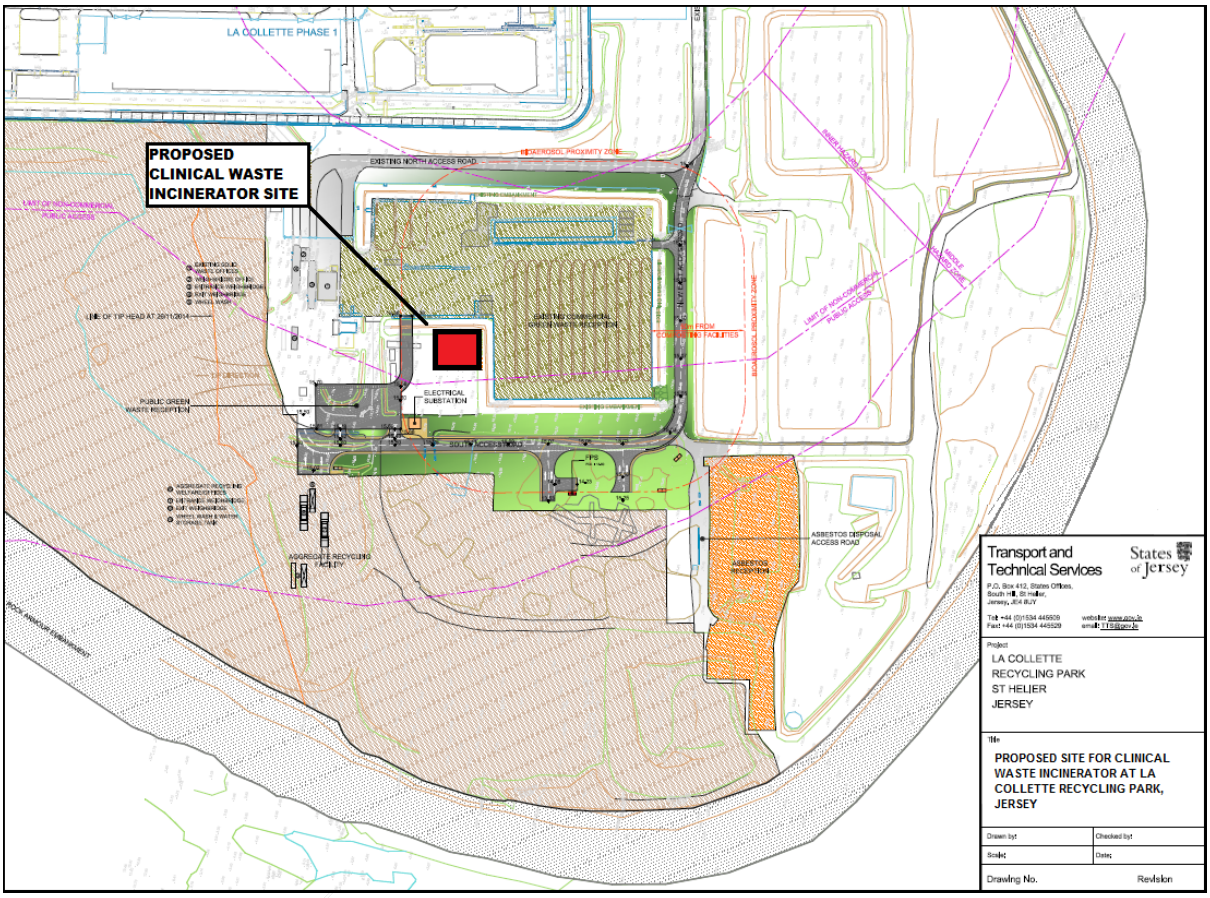
For these reasons we would suggest a process that was capable of treating 150 to 200kg/hr of waste. This would allow a 4 day operation with 6 hours per day dedicated to plant loading, monitoring and cleaning. If the preferred technology was a batch plant the operatives would commence their day with checking the overnight burn-down record and requesting an automated de-ash procedure to commence when satisfied. On completion of the day the operative would select the automated “burn down cycle” which would ensure all of the combustible material is incinerated and a good quality and cooled ash produced by morning.

We would strongly recommend that if this option were to be pursued that there be a CCTV and fire and smoke alarm link to the EfW control room plus a relay of the CEMs output once this has been established.

6.0 SITE IDENTIFICATION

The site identified as most suitable for the location of the proposed new Clinical Waste Incinerator is at La Collette Reclamation Site & Recycling Park. This is an area of land previously identified for a Waste Handling Station had the DRR had been successful and is located adjacent to the organics recycling site.

The proposed site is indicated on the sketch and two photographs below. The photographs show the site in both existing condition and also as an artist impression for a completed healthcare waste processing building.



The reasons for the selection of this site are as follows:

- Close proximity to existing services installed during recent enabling works reduces cost of construction of the permanent facility.
- Good access routes have recently been installed to the Recycling Park area
- Site provides good medium-long term solution given the location within future recycling park (see 2020 long term plan)
- The site is currently clear and at a level suitable for construction to start immediately on approval of a planning application.
- The site is within an area of established waste management activities.

Proposed Site - Existing

Proposed Site – Artists Impression

7.0 PROCUREMENT

Following discussions with some thermal treatment manufacturers SLR understands that it may be possible to install and commission a small CWI within 40 to 50 weeks of placement of an order. This period allows for the detail design, procurement of materials and sub-components and pre-assembly before shipping. This period does not account for shipping time which of course will be dependent on the country of origin.

In order to ensure that the best value for money and technically compliant process is procured SLR would recommend that competitive tenders be invited from a number of known CWI suppliers.

Prior to placing an order for a new process it will be necessary to ensure that a detailed specification is prepared which clearly defines *inter alia*:-

- the characteristics and quantities of wastes to be treated
- the regulation and standards required
- details of the location and facility in which the plant will be placed
- details of utilities and connection points
- standard form of contract including special conditions
- schedule of any planning restrictions or constraints
- schedule of responsibilities of the contractor
- schedule of responsibilities of the client
- schedule of performance tests to be completed prior to Takeover

Once an order has been placed with the successful tenderer there will be a period of design development to ensure that the building, foundations and drainage etc is designed to accommodate the proposed plant effectively and that all interfaces have been appropriately considered and designed for. This would include a period to finalise the design of the cold storage areas.

In order to expedite the overall procurement and construction phases SLR would recommend a separate design and build contract be let for the building and civils work (including related M&E). In this way it would be possible to commence ground works and utility supplies with the detail of, for example the stack base foundation, being defined and formed once the CWI provider has provided such BWIC detail

8.0 INDICATIVE PROGRAMME TO COMPLETION

The following provides an indicative programme to completion.

- Prepare technical specifications (process and civils)
- Prepare commercial contract documents (process and civils)
- Prepare BAT/IPPC documents (compliance with WID/IED)
- Invite tenders (suggest 4 weeks for return)
- Review tenders and place orders (suggest 2 to 3 weeks)
- Process: (42 to 52 weeks to include testing)
  - Design
  - Procurement
  - installation
  - Commissioning
  - Performance Tests
  - Takeover
- Civils and Building
  - It is believed that the building and civils design and construction could be dovetailed within the above programme with careful programming.

Assuming that all of the preliminary documentation and contracts would be completed within 4 to 6 weeks of the project being given a green light we would envisage the overall project being no less than 52 to 65 weeks in duration – subject to formal procurement procedures. This would require very careful planning and close management to achieve.

It is understood that post segregation and with a reduced quantity of waste requiring thermal treatment that cold storage of up to 4-6 weeks would be possible.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Of the options considered within this report only two-stage combustion (semi-pyrolytic) and batch gasification (or batch semi-pyrolytic) processes have been short listed.

Given the nature and small quantity of clinical waste to be thermally treated it is recommended that tenders be invited for both technologies and be based on a detailed technical specification.

In order to expedite the project programme it is suggested that the civils and buildings package be designed and procured separately to the process package.

Assuming that all of the preliminary documentation and contracts would be completed within 4 to 6 weeks of the project being given a green light we would envisage the overall project being no less than 52 to 65 weeks in duration subject to SoJ procurement procedures. This however would require very careful planning and close management to achieve and it would be important to ensure sound contingency plans have been determined.

It is recommended that during the next period a detailed project scope be developed which would include a project execution plan (PEP). This would identify roles and responsibilities of all parties and define key documents which have to be developed and reviewed by certain milestones. This may include:-

- Application for new/revised WM licence
- Revised planning drawings and application including an EIA
- BAT statement in line with EPR 5.01 and EPR 5.07 guidance
- Final review of the core technology and its ability to process and perform as specified
- Review of a functional design specification and operational documentation;
- Review of controls philosophy and strategy;
- Review of functional safety of the systems and hardware in accordance with IEC 61508;
- Verification of the heat up, operational and cooling phases of the process while in compliance with necessary IED/WID requirements;
- Safe operation and maintenance of the plant;
- HAZOP and other H&S reviews and studies to determine any H&S issues very early in the process;
- Fire prevention and safety reviews;

It is recommended that a stage 1 and 2 HAZID study be convened in order to determine and design out any potential risks at an early stage. The HAZID study should also schedule out all of the studies necessary to complete a safe and efficient design of the process plant and overall facility.

10.0 CLOSURE

This report has been prepared by SLR Consulting Limited with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Department for Infrastructure (DfI) of the States of Jersey; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

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