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Attention: Deanne Pitts/ Chris Ritchie/ Sally Munk

Re: Energy from Waste Facility, Eastern Creek, NSW – Review of Health Risk Related Matters Covered in the Proposal

1 Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been commissioned by NSW Planning and NSW EPA to review the Human Health Risk Assessment (HHRA) (provided as Appendix O of a Response to Submissions Report Dated October 2017) for the proposed Energy from Waste Facility, Honeycomb Drive, Eastern Creek. The report was prepared by AECOM on behalf of The Next Generation NSW Pty Ltd.

This facility has been the subject of a number of rounds of assessment which have been dated:

- Late 2014 (EIS)
- March 2015 (EIS)
- Oct/Nov 2015 (RTS)
- Dec 2016 (Revised EIS)
- Oct/Dec 2017 (RTS)

The latest assessment applies to a facility half the size of the original proposal. A range of other documents forming part of the EIS and the Response to Submissions have also been provided to assist in the review:

- Appendix O, Human Health Risk Assessment (prepared by AECOM, dated 28/09/17)
- Appendix N, Air Quality and Greenhouse Gas Assessment (prepared by Pacific Environment Ltd, dated 20/11/17)
- Response to Submissions, Main Report by Urbis dated 14/12/17

Previous versions of this risk assessment and AQIA used for input were reviewed for adequacy and while on public exhibition at various times in 2014, 2015, 2016 and 2017.

These reviews highlighted a number of issues with each of the risk assessments:

- the earlier ones were not done in accordance with Australian guidance
- the more recent ones did not provide a detailed enough explanation for the chemicals chosen to be assessed and the way concentrations were assessed
- errors in some of the calculations did not provide confidence in the risk estimates

New versions of the air quality modelling and the risk assessment were provided in late 2017 and this most recent version of the HHRA has now been reviewed and comments are provided in this letter report.

2 Overview

Many facilities have emissions to air because they are burning some sort of fuel to produce energy, generate heat, destroy waste or a mix. Facilities like power stations use coal or gas as their fuel. Wood burning stoves use wood as their fuel. Brick making kilns or cement kilns have used coal, gas or wood as their fuel. Cars are another example where petrol or diesel are used as fuels. There is familiarity with the emissions from such combustion processes using such fuels and how to manage them using relevant pollution control equipment.

This proposal involves a combustion process but it uses a mix of waste materials as the fuel. This makes the emissions more variable and more difficult to predict than for a single fuel facility but the emissions are still similar, in the main, to those coming from the other fuels and the existing pollution control engineering is still relevant.

The assessment of the potential for health risks from this facility is based on estimating what chemicals might be emitted from the facility and what concentrations of each chemical emitted might be present at ground level around the facility where people live and breathe.

Determining which chemicals might be present in the emissions depends on:

- Types of waste proposed to be used in the plant
- How the various types of waste are combined (proportions and thoroughness of mixing)
- Controls on conditions inside the combustion chamber
- Efficiency of the pollution control equipment to remove particular chemicals

Once the chemicals that might be present in the emissions have been identified then the concentrations of them in air at ground level around the plant need to be estimated. The concentrations depend on the factors listed above and, in addition:

- How the stack has been engineered
- Dispersion of the stack emissions around the facility which depends on the meteorology in the area and the topography surrounding the plant

Having sufficient information about each of these aspects means that estimates of the ground level concentrations can be made with appropriate confidence for decision making. However, if there are some aspects that are not known with confidence that limits the confidence in the estimates of the concentrations and means the human health risk assessment may not be as robust as would be normally expected.

There are aspects of each of these lists that are known with some confidence, as discussed.

- The engineering of the different types of equipment used in the plant can be understood (combustion chamber, pollution control equipment, stack) and is similar to plants using waste as fuel already operating in Europe and other combustion facilities like power stations using other materials as fuel.
- Air dispersion modelling of emissions from a stack is well developed and can be robust if there is sufficient understanding of the meteorological conditions and background air quality in the area.
- Understanding the capabilities of the pollution control equipment to remove particular chemicals and with what efficiency is also possible based on the history of these types of equipment and the use of similar technologies in plants in Europe.

The difficult areas for this facility that limit the confidence in estimates of ground level concentrations of particular chemicals are whether or not there can be sufficient understanding at this time of:

- types of waste that will be used by this facility
- proportions of each waste type that will be included in the mix
- how the mix will vary across days, weeks, months, years

- variation in the characteristics of each type of waste processed at another facility
- variation in the characteristics of a waste type not subjected to much processing where the mix of materials in it can vary over time (e.g. commercial/industrial waste – proportion of paper vs plastics vs other materials will vary through time or construction/demolition waste – proportion of concrete, brick, plastics, metals etc will vary through time depending on what is being demolished)
- how each waste type behaves in the combustion chamber (in particular, the more unusual waste types proposed for use in this facility)
- whether the presence of one type of waste affects the reaction of waste type inside the combustion chamber or the pollution control equipment
- impact of all this variability on the actual emissions from the facility

There are plants that are similarly engineered (combustion chamber with pollution control equipment and stack) operating in Europe and information is available about the concentrations of chemicals in emissions from these plants which use waste as fuel.

It is also noted that when a single fuel source is used in a combustion process like this (e.g. coal only, gas only, one type of waste that is well controlled etc), the emissions are relatively consistent and a robust assessment can be undertaken. It is normal practice for an EIS to use information about similar facilities and their emissions as the basis for understanding what will occur at a new facility.

However, the mix of wastes to be used as a fuel source for this facility is somewhat different than the facilities which are similarly engineered in Europe. Additional information on the proposed mix of wastes to be used to fuel this plant has been provided in the Response to Submissions. This information has been reviewed by relevant experts.

3 Fuel Composition

Other experts reviewing this proposal (NSW EPA, NSW Planning, ARUP) have undertaken detailed reviews of the information supplied about the proposed fuel composition. It has been determined that the most recently proposed fuel mix for this plant is not entirely consistent with the plant being used as a reference facility – Ferrybridge Waste to Energy Facility.

This HHRA makes use of data from UK plants (including Ferrybridge) (Scenario 1) to demonstrate acceptable risk (as well as regulatory limits) so this difference in materials used for fuel is important.

The waste streams not covered in the permits for the UK plants have the potential to:

- include additional amounts of pollutants that are normally present in waste streams used at the UK plants
- add pollutants not already present in the fuel mix.

As a result, the data from the UK plants do not provide sufficient evidence that this HHRA adequately covers the mix of pollutants and the concentrations of pollutants that might be present in the stack.

Alternatively, Scenario 4 was based on the stack limits specified in the EU Industrial Emissions Directive – i.e. not specifically based on the fuel mix for this plant or any reference plant. It is appropriate to assume that such limits include all the pollutants considered critical for such a facility and applies appropriate limits to those pollutants.

The issue for this assessment is that there is insufficient evidence that the proposed fuel mix will result in emissions that comply with either the EU IED or the measurements from the UK plants. So, while the HHRA indicates that risks should be acceptable, that is only the case if the emissions comply with the values used in the calculations.

Some of the waste types proposed for use at this facility are similar to those used at Ferrybridge and other UK plants but other waste types – particularly floc waste – are not.

This review has focused on evaluating the appropriateness of the risk assessment – whether it has covered all the relevant exposure pathways and the sorts of chemicals that are driving the risk estimates – given this uncertainty.

4 Modelled Scenarios - Inputs

In response to previous comments, these versions of the AQIA and HHRA have used modelled ground level concentrations for five scenarios:

- Scenario 1 – use of measured stack concentrations from other similar facilities in the UK ("likely" emissions)
- Scenario 2 – use of NSW EPA regulatory limits for stack concentrations (worst case)
- Scenario 3 – upset conditions based on Scenario 1 (measured stack concentrations at other facilities)
- Scenario 4 – use of EU Industrial Emissions Directive (IED) in-stack concentrations as these levels are proposed as licence limits for the facility
- Scenario 5 – startup/emergency when diesel generators are in use

Scenario 3 and 5 have not been specifically discussed further in this review as they only apply to upset/emergency situations which should only occur rarely, if at all, so they make a minimal contribution to long term risk. They have also not been assessed to the same level of detail as the other scenarios.

4.1 Background

Air dispersion modelling takes the estimated concentrations in the stack and applies information about the engineering of the emissions when they leave the stack (flow velocity, height above ground, temperature etc), the terrain around the facility (buildings, hills, flat areas) and the weather (wind, temperature and rainfall) to estimate what the concentration of the various chemicals will be at ground level across a grid surrounding the facility (i.e. not just in one direction).

A detailed review of the air quality modelling was undertaken by experts in the NSW EPA in late 2017 due to some issues identified in the initial review. A reporting error was identified which has now been corrected. The detailed review did not identify any additional issues with the modelling. The use of appropriate air quality modelling allows the assessment of risk due to the emissions to be undertaken with more confidence than in previous versions.

4.2 Worst Case

It is normal to consider worst case input data first and assess potential risks and, if risks could be elevated, then more refined modelling using more site-specific input data is undertaken. If risks for the worst case are low then no further work may be needed.

It is, also, noted that the NSW Approved Methods for the Modelling and Assessment of Air Pollutants states: *"Emissions from the premises must be demonstrated to comply with the requirements of the Regulation before progressing through the other stages of the air quality impact assessment."*

Consequently, the first scenario to be evaluated is Scenario 2. This scenario assumes that the stack concentrations could be the relevant limits listed in the Protection of the Environment Operations (Clean Air) Regulation 2010. These limits are never to be exceeded numbers and so no plant could operate legally with stack concentrations at this level in NSW nor would they operate close to these values because the plant would be at great risk of breaching limits which could lead to prosecution. There are only a limited set of parameters for which such limits are published.

Following comments on previous versions of the HHRA for this proposal, this version of the HHRA has been updated to include an assessment of the risks when the chemicals listed in the Clean Air Regulation are emitted at the regulatory limits and other chemicals not listed in the Regulation are emitted at the maximum measured concentrations at similar UK facilities.

The regulatory limits for a facility of this type that apply to the concentrations inside the stack just prior to emission are provided in **Table 1**.

Table 1 POEO Clean Air Regulation Limits

Emission Parameter		POEO Regulatory Limit (mg/Nm^3)#	Values Adjusted for HHRA (mg/Nm^3)#
Nitrogen oxides		500	500
Carbon monoxide		125	125
Particles – PM10		50	50
Particle – PM2.5		50	50
Fluorine compounds (HF equivalents)		50	50
Cadmium		0.2	0.2
Mercury		0.2	0.2
Dioxin-like compounds		$1x10^{-7}$	$1x10^{-7}$
Type 1and 2 Substances (in aggregate)		1	--
Type 1 and 2 Substances (separated out)	Arsenic	1	0.04
	Antimony	1	0.02
	Lead	1	0.29
	Beryllium	1	
	Chromium III	1	0.15
	Chromium VI	1	0.00022
	Nickel	1	0.37
	Manganese	1	0.1
Volatile organic compounds (as n-propane)		40	71
Vanadium		--	0.01

\# Reference conditions defined as dry, 273.15 K, 101.3 kPa and 7% O_2 for all air impurities when burning a solid fuel, with the exception of dioxins and furans where the required O_2 concentration is 11% for waste incineration

It is noted that in the AQIA it is assumed that each of the Type 1 and 2 Substances is present at the concentration that applies to the group as a whole in case only one of these substances was present. This is not likely to occur as many of these substances are found together in waste materials. For the HHRA the assumed values for some of these substances have been modified to more likely (but conservative) values.

In addition to these substances at these emission concentrations, the scenario also includes a range of other substances reported in these types of plants in Europe at the maximum reported concentration, the same as used in Scenario 1 calculations.

Modelling of this scenario is now in line with what would be expected for a worst case, given the regulatory framework in NSW.

4.3 Expected Case

It is also normal for such an assessment to model a more realistic case to show what would be the most likely risk estimate for the facility. For this assessment, this has been undertaken using the maximum measured concentration at similar facilities or the maximum values listed in the relevant UK Environment Agency Guidance Note (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/532474/LIT_7349.pdf).

These maximum concentrations are the maximum value measured at a facility during an individual monitoring event – i.e. they do not reflect daily averages or annual averages or other statistics reflecting more long term exposures. It is noted that the average values listed in the UK Environment Agency Note are between 4 and 30% of the maximum values used in this assessment. Also, average concentrations would be more reflective of long term exposure concentrations which are most relevant for chronic long term exposures covered by this assessment so using the maximum value should overestimate risks.

Table 2 Expected Case Emission Concentrations (Scenario 1)

Emission Parameter		Scenario 1 (mg/Nm^3)#	Scenario 2 Values##
Nitrogen oxides		120	500
Sulfur oxides		27	--
Carbon monoxide		23	125
Particles – PM10		1	50
Particle – PM2.5		1	50
Fluorine compounds (HF equivalents)		0.5	50
HCl		9	--
Cadmium		0.009	0.2
Mercury		0.004	0.2
Dioxin-like compounds		$1x10^{-8}$	$1x10^{-7}$
Type 1 and 2 Substances (separated out)	Arsenic	0.025	0.04
	Antimony	0.0148	0.02
	Lead	0.172	0.29
	Beryllium	0.000007	
	Chromium III	0.092	0.15
	Chromium VI	0.00013	0.00022
	Nickel	0.22	0.37
	Manganese	0.06	0.1
Volatile organic compounds (as n-propane)		1.2	71
Benzene		0.015	Same value used
Toluene		0.03	Same value used
Xylenes		0.01	Same value used
Ammonia (NH_3)		2	Same value used
Hydrogen sulfide (H_2S)		1	Same value used
Polycyclic aromatic hydrocarbons (PAHs)		0.0005	Same value used
Dichloromethane		0.02	Same value used
Acetone		0.018	Same value used
Trichloroethene		0.005	Same value used
Silver		0.00034	Same value used
Zinc		0.037	Same value used
Copper		0.0163	Same value used
Thallium		0.0009	Same value used
Cobalt		0.006	Same value used
Vanadium		0.006	0.01
Phenol		0.005	Same value used
Hexane		0.005	Same value used

\# Reference conditions defined as dry, 273.15 K, 101.3 kPa and 7% O_2 for all air impurities when burning a solid fuel, with the exception of dioxins and furans where the required O_2 concentration is 11% for waste incineration

\## The cells in column 3 are coloured to indicate values in Scenario 2 that are higher than Scenario 1. It is noted that all parameters that have values listed for both Scenario 1 and 2 have higher values in Scenario 2 (i.e. blue colour) as would be expected given Scenario 2 is worst case and 1 is expected case.

4.4 EU Industrial Emissions Directive Based Limits (Proposed licence limits – Scenario 4)

A new scenario was added into this version of the AQIA and HHRA. This scenario was added as the proponent requested that the licence limits for the proposed facility be based on the EU Industrial Emissions

Directive. This is the regulatory framework that applies in Europe and is the one under which the plants in the UK are designed. It is also the design basis being used for this plant.

These limits are more stringent than those listed in the POEO Clean Air Regulation and the equipment has been shown to comply with the IED limits at the plants in the UK. As for Scenario 2, not all the chemicals measured in the European facilities are specifically mentioned in the Directive, so the same approach has been taken (use of the maximum measured concentrations from Scenario 1 for those chemicals not specifically listed).

Table 3 EU IED Concentrations (Scenario 4)

Emission Parameter		Scenario 4 (mg/Nm^3)#	Scenario 1 Values	Scenario 2 Values
Nitrogen oxides		200	120	500
Sulfur oxides		50	27	--
Carbon monoxide		50	23	125
Particles – PM10		10	1	50
Particle – PM2.5		10	1	50
Fluorine compounds (HF equivalents)		1	0.5	50
HCl		10	9	--
Cadmium		0.04	0.009	0.2
Mercury		0.05	0.004	0.2
Dioxin-like compounds		$1x10^{-7}$	$1x10^{-8}$	$1x10^{-7}$
Type 1 and 2 Substances (separated out)	Arsenic	0.01	0.025	0.04
	Antimony	0.01	0.0148	0.02
	Lead	0.09	0.172	0.29
	Beryllium	0.000007	0.000007	--
	Chromium III	0.07	0.092	0.15
	Chromium VI	0.0004	0.00013	0.00022
	Nickel	0.12	0.22	0.37
	Manganese	0.13	0.06	0.1
Volatile organic compounds (as n-propane)		10	1.2	71
Benzene		0.015	0.015	--
Toluene		0.03	0.03	--
Xylenes		0.01	0.01	--
Ammonia (NH_3)		2	2	--
Hydrogen sulfide (H_2S)		1	1	--
Polycyclic aromatic hydrocarbons (PAHs)		0.0005	0.0005	--
Dichloromethane		0.02	0.02	--
Acetone		0.018	0.018	--
Trichloroethene		0.005	0.005	--
Silver		0.00034	0.00034	--
Zinc		0.037	0.037	--
Copper		0.06	0.0163	--
Thallium		0.01	0.0009	--
Cobalt		0.01	0.006	--
Vanadium		0.006	0.006	0.01
Phenol		0.005	0.005	--
Hexane		0.005	0.005	--

\# Reference conditions defined as dry, 273.15 K, 101.3 kPa and 7% O_2 for all air impurities when burning a solid fuel, with the exception of dioxins and furans where the required O_2 concentration is 11% for waste incineration

\## The cells in column 3 and 4 are coloured to indicate values in Scenario 4 that are different from Scenario 1 or 2. Blue indicates the value listed in the column is higher than the value used for Scenario 4. Orange indicates the value listed in the column is less than the value used for Scenario 4 and purple indicates the values are the same.

It is noted that a subset of parameters (arsenic, antimony, lead, chromium III and nickel) for Scenario 1 have higher stack concentrations than those used for Scenario 4 which is not expected and the impact will be discussed further below.

5 Modelled Scenarios – Risk Estimates

5.1 Introduction

Using the stack concentrations described in **Section 4** and established procedures for air dispersion modelling, has allowed the ground level concentrations to be determined for use in the risk assessment. For the Scenario 1,2 and 4 calculations, the maximum annual average concentrations at the nearest residential development and/or the nearest commercial/industrial development and the grid maximum were used in the HHRA.

The grid maximum is the location where the highest ground level concentration outside the boundary is located. This may be a location along the fence line of the facility or the road immediately adjacent to the facility rather than a location where people live or work. This discussion of the results is based on the risks estimated for the grid maximum concentrations in order to understand the potential risks posed by the facility into the future (if land uses change over time).

The risk assessment has been undertaken considering the following pathways of exposure:

- Inhalation of gaseous chemicals
- Inhalation of chemicals attached to particles
- Incidental ingestion of soil where particles from the emissions have deposited
- Dermal contact with soil where particles from the emissions have deposited
- Ingestion of chemicals taken up into home grown fruit and vegetables from soil where particles from the emissions have deposited
- Ingestion of chemicals taken up into home grown eggs from soil where particles from the emissions have deposited
- Ingestion of chemicals taken up into home grown meat from soil where particles from the emissions have deposited

This is known as a multi-pathway assessment. This process was developed by the USEPA for facilities that may have agricultural activities in the area surrounding such a facility. It is recognised that the area surrounding this facility is highly urbanised so uptake into home grown meat is unlikely to be a relevant pathway but uptake into eggs or fruits and vegetables is possible for low density residential areas. These pathways are also unlikely to be relevant for medium to high density residential areas or commercial/industrial areas.

The assessment has used standard approaches as outlined in national guidance and has used exposure assumptions that are considered appropriate for Australia – generally, the approach taken and assumptions used are as provided in:

- National Environment Protection (Assessment of Site Contamination) Measure Schedule B4 and B7 (NEPC 1999 amended 2013a, 1999 amended 2013b)
- enHealth Environmental Health Risk Assessment Guidelines (enHealth 2012a)
- enHealth Exposure Factors Guide (enHealth 2012b)

5.2 Scenario 2 (worst case)

The estimated risks for Scenario 2 – grid maximum concentrations – are listed in **Table 4**.

Table 4 Risk Estimates (Scenario 2)

Exposure Pathways	Threshold Risks		Non-Threshold Risks
	Adult	Child	
Inhalation	0.37		$1x10^{-6}$
Incidental ingestion of soil	0.0002	0.002	$5x10^{-12}$
Dermal contact with soil	0.00007	0.0001	$9x10^{-12}$
Ingestion of home grown fruit and vegetables	0.05	0.1	$6x10^{-9}$
Ingestion of home grown eggs	0.005	0.009	$1x10^{-12}$
Ingestion of home grown meat	0.008	0.015	$1x10^{-10}$
Cumulative Total	**0.44**	**0.52**	**$1x10^{-6}$**

These results indicate a number of matters:

- The total risk esimates for this scenario are compliant with the relevant guidance on "acceptable" risks provided in national guidance documents - <1 for chemicals that act via threshold mechanisms and $<1x10^{-5}$ for chemicals that act via non-threshold mechanisms
- While compliant, concentrations could vary only 2 fold before they would not be compliant – this is considered too small a margin of safety given the level of uncertainty in this assessment (uncertainty in stack concentrations, air dispersion modelling, exposure assumptions)
- 70-84% of the risk for chemicals that act via threshold mechanisms and 99% of the risk for chemicals that act via non-threshold mechanisms come from inhaling air containing the emissions from the facility
- The chemicals that contribute the highest to risk for inhalation are cadmium (60%) and nickel (28%)
- The next highest contributing pathway is ingestion of home grown fruit and vegetables when grown in soil affected by particles from this facility
- The chemicals that contribute the highest to risk for home grown fruit and vegetables are cadmium (35%), chromium (10%) and mercury (31%). Overall this pathway contributes only 20% of the total risk
- The chemicals that contribute the highest to risk for home grown eggs are dioxins (74%) and mercury (25%). Overall this pathway contributes only 2% of the total risk
- The chemicals that contribute the highest to risk for home grown meat are dioxins (71%) and mercury (28%). Overall this pathway contributes only 3% of the total risk
- The chemicals that contribute the highest to risk for direct contact with soil are cadmium (35%), dioxins (5%), chromium (10%), thallium (8%) and mercury (31%). Overall this pathway contributes only 0.4% of the total risk

5.3 Scenario 1 (expected case)

The estimated risks for Scenario 1 – grid maximum concentrations – are listed in **Table 5**.

Table 5 Risk Estimates (Scenario 1)

Exposure Pathways	Threshold Risks		Non-Threshold Risks
	Adult	Child	
Inhalation	0.12		$2x10^{-7}$
Incidental ingestion of soil	0.00007	0.0006	$5x10^{-12}$
Dermal contact with soil	0.000006	0.00001	$9x10^{-12}$
Ingestion of home grown fruit and vegetables	0.015	0.03	$6x10^{-9}$
Ingestion of home grown eggs	0.0004	0.0008	$8x10^{-10}$

Exposure Pathways	Threshold Risks		Non-Threshold Risks
	Adult	Child	
Ingestion of home grown meat	0.0008	0.001	$1x10^{-8}$
Cumulative Total	**0.13**	**0.15**	**$2x10^{-7}$**

These results indicate a number of matters:

- The total risk esimates for this scenario are compliant with the relevant guidance on "acceptable" risks provided in national guidance documents - <1 for chemicals that act via threshold mechanisms and <$1x10^{-5}$ for chemicals that act via non-threshold mechanisms
- Concentrations could vary 10 fold before they would not be compliant – this is considered a more reasonable margin of safety given the level of uncertainty in this assessment (uncertainty in stack concentrations, air dispersion modelling, exposure assumptions)
- 80-92% of the risk for chemicals that act via threshold mechanisms and 90% of the risk for chemicals that act via non-threshold mechanisms come from inhaling air containing the emissions from the facility
- The chemicals that contribute the highest to risk for inhalation are cadmium (12%) and nickel (76%)
- The next highest contributing pathway is ingestion of home grown fruit and vegetables when grown in soil affected by particles from this facility
- The chemicals that contribute the highest to risk for home grown fruit and vegetables are cadmium (8%), chromium (29%), thallium (28%), arsenic (7%) and lead (14%). Overall this pathway contributes only 20% of the total risk
- The chemicals that contribute the highest to risk for home grown eggs are dioxins (84%) and mercury (8%). Overall this pathway contributes only 0.5% of the total risk
- The chemicals that contribute the highest to risk for home grown meat are dioxins (76%), thallium (12%) and mercury (8%). Overall this pathway contributes only 0.7% of the total risk
- The chemicals that contribute the highest to risk for direct contact with soil are cadmium (7%), nickel (12%), lead (13%), arsenic (7%), dioxins (2%), chromium (27%), thallium (26%) and mercury (3%). Overall this pathway contributes only 0.4% of the total risk

5.4 Scenario 4 (proposed licence limits case)

The estimated risks for Scenario 4 – grid maximum concentrations – are listed in **Table 6**.

Table 6 Risk Estimates (Scenario 4)

Exposure Pathways	Threshold Risks		Non-Threshold Risks
	Adult	Child	
Inhalation	0.13		$3x10^{-7}$
Incidental ingestion of soil	0.0002	0.002	$5x10^{-12}$
Dermal contact with soil	0.00002	0.00005	$9x10^{-12}$
Ingestion of home grown fruit and vegetables	0.04	0.09	$6x10^{-9}$
Ingestion of home grown eggs	0.004	0.008	$1x10^{-12}$
Ingestion of home grown meat	0.007	0.01	$1x10^{-10}$
Cumulative Total	**0.19**	**0.25**	**$3x10^{-7}$**

These results indicate a number of matters:

- The total risk esimates for this scenario are compliant with the relevant guidance on "acceptable" risks provided in national guidance documents - <1 for chemicals that act via threshold mechanisms and <$1x10^{-5}$ for chemicals that act via non-threshold mechanisms

- Concentrations could vary 4-5 fold before they would not be compliant – this may be considered an acceptable margin of safety given the level of uncertainty in such an assessment (uncertainty in stack concentrations, air dispersion modelling, exposure assumptions) depending on the location of the facility, other sources of air pollution in the surrounding area and confidence in procedures for managing the quality of the waste and how it is mixed for use
- 52-68% of the risk for chemicals that act via threshold mechanisms and 98% of the risk for chemicals that act via non-threshold mechanisms come from inhaling air containing the emissions from the facility
- The chemicals that contribute the highest to risk for inhalation are cadmium (49%) and nickel (37%)
- The next highest contributing pathway is ingestion of home grown fruit and vegetables when grown in soil affected by particles from this facility
- The chemicals that contribute the highest to risk for home grown fruit and vegetables are cadmium (13%), chromium (8%), thallium (50%), mercury (14%), dioxins (10%)and lead (2%). Overall this pathway contributes only 36% of the total risk
- The chemicals that contribute the highest to risk for home grown eggs are dioxins (88%) and mercury (10%). Overall this pathway contributes only 3% of the total risk
- The chemicals that contribute the highest to risk for home grown meat are dioxins (82%) and mercury (11%). Overall this pathway contributes only 4% of the total risk
- The chemicals that contribute the highest to risk for direct contact with soil are cadmium (13%), dioxins (7%), chromium (8%), thallium (51%) and mercury (14%). Overall this pathway contributes only 0.8% of the total risk

5.5 Discussion of Risk Estimates

All of these results indicate that, while there are many chemicals included in the list used to model the emissions from this facility, only a small number of them contribute significantly to the risk calculations which assists in understanding the potential impacts of the uncertainties in this assessment.

- Cadmium
  - The stack concentrations used in this assessment vary from 0.009 to 0.2 mg/Nm^3 and the risks due to inhalation of cadmium from these emissions vary from 0.015 to 0.2. UK facilities have measured stack concentrations ranging from 0.0009 to 0.009 mg/Nm^3 with an average of 0.003 mg/Nm^3. If this facility emitted at 0.003 mg/Nm^3 instead of 0.009 mg/Nm^3 then the risk would decrease to 0.005. This would reduce the risk for Scenario 4 for the inhalation pathway from 0.13 to 0.07. Just this change would reduce the total estimated risk for a child from 0.25 to 0.19. Reducing cadmium to the average concentration from UK plants would also reduce risk in the other pathways. The values chosen for inclusion in this assessment were based on either the maximum individual measurement at similar UK facilities or relevant regulatory limits. It is likely that the actual emissions of this metal will be more in line with the measured values, particularly the average concentrations. However, there is uncertainty in the emissions from this fuel mix.
- Nickel
  - The maximum stack concentration listed in the UK Environment Agency note was used for nickel in Scenario 1. The stack concentrations used in this assessment varied from 0.12 to 0.37 mg/Nm^3. The risk estimates for nickel in Scenario 1,2 and 4 ranged from 0.05 to 0.1. The UK guidance includes a note that the maximum value (listed in the Guidance Note) was an outlier measured at one plant on one occasion – a more realistic input concentration was 0.053 mg/Nm^3 – 25% of the value used in this assessment. This value is 2-7 times lower than the values used in this assessment. If this lower value was used the risk estimates for these Scenarios would be lower and, it is possible, that the lower risk would be more reflective of

the actual measurements in the UK. However, there is uncertainty in the emissions from this fuel mix.

- Arsenic, Antimony, Lead, Nickel, Chromium III
  - As discussed in **Section 4.4**, there are a number of chemicals for which the stack concentrations used for Scenario 1 (expected case) are higher than those used for Scenario 4 (licence limits case). It is not clear why this is the case. If the higher values from Scenario 1 are used in Scenario 4 instead, this would increase the total risk to around 0.3. This increase is not large and does not change the conclusions of this review. However, this varying stack concentrations may be important to consider when setting licence limits.

It is also important to understand the conservative assumptions that are built into this risk assessment.

- Inhalation – the risk calculations assume people breathe the air at the grid maximum concentrations 24 hours / day, 365 days / year for 35 years. It assumes those maximum stack concentrations are present 100% of the time and that the worst case weather occurs all the time.
- Ingestion of fruit and vegetables – the risk calculations assume the maximum deposition rate occurs all year round at one location, that emissions (dust that gets deposited on the soil) get mixed into the top 15 cm of soil where fruit and vegetables are grown to contribute 10% of daily intake every day of the year for 35 years.
- Ingestion of eggs – the risk calculations assume the maximum deposition rate occurs all year round at one location, that emissions get mixed into the top 1 cm of soil where chickens are kept to contribute 10-20% of daily intake every day of the year for 35 years.
- Ingestion of meat – the risk calculations assume the maximum deposition rate occurs all year round at one location, that emissions get mixed into the top 1 cm of soil where cattle are kept and that the meat is used by the farmer at home to contribute 100% of daily intake every day of the year for 35 years.
- Ingestion of soil – the risk calculations assume the maximum deposition rate occurs all year round at one location, that emissions get mixed into the top 1 cm of soil and that adults incidentally consume 50 mg / day and children 100 mg / day and that they do that every day of the year for 35 years (6 as a child and 29 as adult).

All of these assumptions are relatively conservative and are designed to overestimate the risks posed by the facility.

6 Conclusions

The most recent version of the HHRA for this facility has been reviewed.

The HHRA has assessed a range of scenarios covering different options for estimating the emissions from the plant, given that the plant doesn't currently exist and actual measurements of emissions cannot be undertaken at this time.

The scenarios cover 3 different ways of estimating emissions during normal operations:

- Maximum individual measurements from similar plants in the UK (scenario 1)
- Stack concentrations based on the POEO (Clean Air Regulation) limits (scenario 2)
- Stack concentrations based on the EU Industrial Emissions Directive limits (scenario 4)

There are also 2 different options for considering upset conditions.

In NSW, the environment protection regulatory framework means that no such facilities can legally operate emitting pollutants in excess of the POEO (Clean Air Regulation) limits. The same applies in Europe for the

Industrial Emissions Directive. These are, therefore, good estimates to use to assess the maximum risks this plant could pose during normal operation.

However, the use of uncommon waste streams as part of the fuel mix for such a facility does bring some uncertainty as to whether or not these legal limits or the maximum measured values from the UK facilities can be complied with/ are relevant for this assessment.

The NSW EPA included in the Waste to Energy Policy a requirement for comparison of any proposed facility with reference facilities using similar waste streams as fuel to provide further support that the estimated emissions used to assess risk are appropriate. That has been done in Scenario 1 which used the maximum individual measurements from similarly engineered facilities in the UK.

The proposed fuel mix for this facility, however, limits confidence that the values used in Scenario 1 are appropriate for this risk assessment due to the inclusion of unusual waste streams in the fuel mix compared to the UK plants being used for reference. The plants in the UK have used a range of waste streams and have been operating for some time so it is considered that the maximum measured results provide an appropriate and conservative estimate of emissions (and allow a robust HHRA) when those waste streams are used for fuel given the engineering of such facilities.

The unusual waste streams proposed for use at this facility do not have that some level of evidence. There is potential that these unusual waste streams could contribute:

- higher levels of critical pollutants already present in the emissions
- new pollutants not already covered in the assessment or
- the emissions could still be within the range already known for the proposed reference facilities.

It is difficult to know which of these options applies for this facility. This means that even with the use of these various scenarios it is difficult to know whether the risk assessment is appropriate and sufficiently conservative.

The risk assessment for Scenario 1 is based on plants that burn a narrower scope of waste types than those used at the reference facilities. The use of the proposed broader range of proposed waste streams may produce a different result than covered by the measured concentrations at the proposed reference facilities.

The risk assessment has used conservative choices for the exposure assessment assumptions and the air dispersion modelling used to estimate ground level concentrations was appropriate for this purpose.

Considerations in regard to the types of waste streams to be used as fuel for this facility will limit how this HHRA can be used for decision making. If the inputs used in each of the scenarios are considered relevant given the proposed fuel mix then this HHRA is appropriate for use in decision making.

7 Limitations

Environmental Risk Sciences has prepared this report for the use of NSW Planning and NSW EPA in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

The methodology adopted and sources of information used are outlined in this letter report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions.

This report was prepared in February 2018 and is based on the information provided and reviewed at that time. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

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

If you require any additional information or if you wish to discuss any aspect of this letter, please do not hesitate to contact Therese on (02) 9614 0297 or 0487 622 551.

Yours sincerely,

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