Human Health Risk Assessment – EMRC Red Hill APCr Immobilisation Project

Talis Consultants

Revised report

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We acknowledge the Traditional Custodians of Country throughout Australia and their connections to land, sea and community.

We pay respect to Elders past and present and in the spirit of reconciliation, we commit to working together for our shared future.

Caring for Country The Journey of JBS&G
Artist: Patrick Caruso, Eastern Arrernte

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Appendix B **PM_{10} GLCs at all receptors (from EAQ 2024)**

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Abbreviations

Term	Definition
AGV	Air guideline value (from DWER 2019)
APAC	Air pollution assessment criteria (from EPAV 2022)
APCr	Air Pollution Control residue
COPC	Chemical of Potential Concern
DWER	Department of Water and Environmental Regulation
Dioxins/furans	Polychlorodibenzo-*p*-dioxins and polychlorodibenzofurans
EAQ	Environmental & Air Quality Consulting Pty Ltd
EMRC	Eastern Metropolitan Regional Council
EPAV	Environmental Protection Authority (Victoria)
GLC	Ground level concentration
HHRA	Human Health Risk Assessment
PM_{10}	Airborne particles of effective aerodynamic diameter of 10 microns
$PM_{2.5}$	Airborne particles of effective aerodynamic diameter of 2.5 microns
TEF	Toxic equivalency factor (for dioxins/furans)
TEOM	Tapered element oscillating microbalance (PM_{10} monitoring instrument)
TEQ	Toxic equivalency (for dioxins/furans)
WMF	Waste Management Facility (EMRC Red Hill)
WtE	Waste to Energy

1. Introduction

The Eastern Metropolitan Regional Council (EMRC) is currently seeking regulatory approvals to construct and operate an Immobilisation Plant at the Red Hill Waste Management Facility (WMF), on Toodyay Rd, Red Hill. The EMRC propose to receive Air Pollution Control residue (APCr) from the East Rockingham and Kwinana Waste to Energy (WtE) plants, currently under construction and/or commissioning, for processing in an Immobilisation Plant and placement in a dedicated landfill cell. APCr is the solid material recovered from the baghouses installed on the air pollution control systems at these plants. It contains the fine solids entrained in the exhaust gases from the heat recovery processes that originate from the combustion chambers. Those solids include minerals and carbonaceous residues from the combustion processes (fly ash), as well as reaction products from downstream addition of lime (which removes acid gases), and any unreacted lime. Activated carbon is also added to the exhaust gases to capture metals, and dioxins and furans, and that material is also recovered from the baghouse in the APCr.

APCr is currently considered a waste which requires disposal in a secure facility to mitigate the potential for adverse environmental impacts. The EMRC propose to install an immobilisation plant (the Plant) at the Red Hill WMF that combines the APCr with cement and water to produce a slurry which is then placed in a dedicated WMF Class IV landfill monocell.

The emissions to air from the Plant have been assessed via an Operational Management and Air Quality Impact Assessment conducted by Environmental & Air Quality Consulting Pty Ltd (EAQ). The EAQ assessment has included dispersion modelling of dust emissions from the Plant, which has provided predictions of ground level concentrations of dust emissions. As part of the approvals process, the EPA has requested the EMRC to conduct a Human Health Risk Assessment (HHRA) on the emissions from the Plant. To that end, Talis Consultants (on behalf of EMRC) has commissioned JBS&G to conduct a HHRA, with the methodology and findings described in this report.

2. Approach and methodology

2.1 Approach

A number of approaches can be considered for a HHRA of air emissions impacts. Guidance is provided by Western Australian and federal regulators, with the following guidelines consulted:

- Health Risk Assessment in Western Australia, WA Department of Health, (DOH, 2006).
- Health Risk Assessment (Scoping) Guidelines, WA Department of Health, (DOH, 2010).
- Environmental Health Risk Assessment, enHealth (2012).

The enHealth guidelines describes a tiered approach to Environmental Health Risk Assessment. A Tier 1 assessment involves an initial screening evaluation of risks that uses conservative exposure estimates and comparisons against published heath-based guidelines. For air emissions impacts, a Tier 1 assessment would be limited to inhalation exposures only. Tier 2 and Tier 3 assessments involve use of additional exposure data such as indirect exposures to pollutants through deposition to soil and uptake into crops and livestock that become food for human consumption, as well as more detailed analysis of dose-response factors, analysis of animal study findings and translation into human equivalent dose estimates (enHealth 2012).

A decision on the appropriate level of assessment was made from consideration of the Immobilisation Facility Management and Monitoring Framework, prepared by EAQ as part of the modelling study (EAQ 2024).

Note that the assessment is limited to potential impacts at off-site locations (sensitive receptors) and does not include occupational health and safety impacts at the Red Hill WMF from operation of the Immobilisation Plant and placement of the APCr/cement slurry in the dedicated landfill monocell.

2.2 Immobilisation Facility Management and Monitoring Framework

The environmental performance and associated risk to human health from emissions from the Immobilisation Facility can be informed by the management and monitoring practices that will be implemented for operation of the facility. EAQ has described such a framework in the form of a risk assessment in Table 4-2 of the modelling report (EAQ, 2024). A copy of that assessment is shown in Appendix A of this report.

The Facility Management and Monitoring Framework considers all activities associated with operation of the facility, emissions sources and pathways, controls for the activities (to mitigate risk of emissions), any monitoring proposed for the activities and controls, corrective actions for when controls are not effective and contingency actions if the corrective actions are unsuccessful. The overall effectiveness of the management and monitoring activities is assessed via a consequence and likelihood risk assessment, with the residual risks for adverse impacts from the activities determined for both on and off-site locations.

The framework addresses the hazard identification and assessment aspects of the health risk assessment process described by WA Department of Health (2006) and enHealth (2012). The framework essentially informs the sources, pathway and receptors that are considered for the assessment.

A summary of findings from the framework assessment that are directly related to airborne emissions from the Immobilisation Plant is presented below (Table 2.1).

Table 2.1: Summary of findings from assessment of the APCr Management and Monitoring Framework

Activity	Emissions source/pathway	Residual air emissions risk with controls in place-onsite	Residual air emissions risk with controls in place – offsite (sensitive receptors)
Waste Receival of Raw Feedstock	Closed system pneumatic transfer of fly-ash from WtE plant(s)	Low	Low
Storage Silos Operations for Transfer of Raw Feedstock and Cement.	Low-level Fugitive losses of dusts and contaminants from transfer of materials.	Medium	Low
Storage Silos Operations for Controlling “Overfill”	Increased emissions from overloading of Dust Filtration System.	Medium	Low
Transfer of APCr and cement to Loss of Weight Hopper	Negligible emissions due to enclosed system	Medium	Low
Mixing of APCr, Cement and Water for Immobilisation	Negligible emissions due to enclosed system	Low	Low
Transfer of APCr/cement slurry to agitator trucks	No risk of airborne emissions (wet slurry)	Low	Low
Burial of APCr/cement in dedicated Class IV Landfill monocell	No risk of airborne emissions (wet slurry)	Low	Low

The assessment concluded that the Management and Monitoring Framework provided Low risk from off-site emissions impacts for all activities, with Medium risk ratings assigned for some of the activities at on-site locations. Those locations are within the Immobilisation Plant operating area or the immediate vicinity of that area. Those risks are managed by occupational health and safety regulations and are outside the scope of this assessment of human health impacts at off-site locations.

Importantly, the control and contingency measures identified in the framework (see Appendix A) are appropriate and represent best practice for mitigation of airborne emissions and associated inherent risk of harm to the health of the neighbouring community. As such, the HHRA has assessed the residual risk after implementation of the control and contingency measures as described in the framework.

2.3 HHRA methodology

The low risk ratings from the Management and Monitoring Framework for off-site locations that include sensitive receptors suggests that a Tier 1 screening type assessment is appropriate to identify the potential for health impacts. In the event that the Tier 1 assessment concludes risks to health are anything other than Low rating, then a Tier 2 assessment could be indicated. In that event, the conservatism in the EAQ modelling study would be examined to determine if a Tier 2 assessment is warranted.

A Tier 1 assessment has been carried out utilising the screening methodology published by the WA Department of Water and Environmental Regulation (DWER 2019). This involves a comparison of the maximum predicted ground level concentrations (GLCs) of chemicals of potential concern (COPC) from modelling of the Immobilisation Plant air emissions, with air guideline values (AGVs) provided by DWER. The AGVs are ambient air concentrations of substances, derived from approved health guidelines of WA Department of Health and NSW EPA (2016) that have been determined as protective of human health from airborne exposures in short (hourly and daily) and long term (annual) time frames.

The DWER (2019) guidelines includes methodology for calculation of screening concentrations (SCs) which are conservative estimates of GLCs that do not consider all aspects of atmospheric dispersion of emissions. That approach has been superseded by the study carried out by EAQ, which has provided GLCs from use of an approved model (CALPUFF) that includes all aspects of atmospheric dispersion.

Screening tolerances are provided by DWER (2019) to determine if the predicted GLCs are likely to be significant, which will require a more detailed assessment to determine the health risk, or insignificant where the health risk can be concluded as low and no further assessment is required. The screening tolerances are:

- < 10% of AGV for 1-hour average GLC.
- < 3% of AGV for 24-hour average GLC.
- < 1% of AGV for 1-hour average GLC.

If the maximum predicted GLC of a COPC are below the tolerances for the relevant time average, then the emissions of that substance are considered insignificant, otherwise further investigation is required.

In addition to the assessment against the DWER AGVs, an additional assessment has been carried out utilising the EPA Victoria (EPAV) guidelines (EPAV 2022). These include air pollution assessment criteria (APACs) which are the equivalent of the DWER AGVs for assessment of airborne pollutant health impacts. The APACs were developed after consultation of air quality standards from Australian and international jurisdictions and as such, are likely to provide the most up to date criteria for assessment of health impacts from air pollution.

The APACs utilised in this assessment are all prescribed for cumulative impacts. This means the predicted GLC of a COPC from the emission source of interest combined with the background concentration of the substance is compared with the APAC to determine the risk of health impacts. Screening tolerances are not provided by EPAV. For the purposes of this assessment, a cumulative ambient concentration that is below the APAC is considered to present a low health risk, whereas a concentration above the APAC requires further investigation.

In the event that background air quality data are not available for a COPC, then the assessment can only consider the direct impact from the COPC emitted from the Immobilisation Plant.

3. Sensitive receptors

The EAQ modelling study described predicted GLCs at 27 sensitive receptors, which are rural residences located nearby the Red Hill WMF. Other sensitive receptors considered in this assessment are schools, due to the potentially increased sensitivity of children to exposure to air pollution compared with adults. A map showing locations of sensitive receptors is shown in Figure 4.1. The elderly residents at aged care facilities may also have greater sensitivity to air pollutant exposures, however the nearest facilities are in Midland and Greenmount, well removed from the WMF site and unlikely to be affected by any emissions from the Immobilisation Plant.

The nearest rural residence (R27) is located on Hidden Valley Rd, approximately 950 m SE from the Immobilisation Plant. Residences to the east are approximately 2,000-2,500 m from the Plant (along the eastern boundary of the WMF site). Rural residences along Toodyay Rd are approximately 1,500 to 2,500 m NNE to NE from the Plant.

The nearest schools are located on Roland Rd, approximately 4,900 to 5,100 m SE from the Plant. Other schools are located in Middle Swan and Swan View (6,500 m and 7,000 m SW from the Plant, respectively), and Gidgegannup (10,400 m NE from the Plant). The Red Hill Auditorium is located approximately 1,300 m west of the Plant (900 m from the WMF boundary) but is a less sensitive receptor since exposures to any emissions from the Immobilisation Plant are limited to times when persons attend that facility.

4. Background air quality

4.1 Overview

Ambient air quality monitoring was conducted by EMRC in 2011 in support of assessments carried out for a proposed waste to energy project at the Red Hill WMF, which did not proceed. The monitoring included measurements of ambient concentrations of a wide range of pollutants including PM_{10} and $PM_{2.5}$, combustion gases (NOx, CO, SO_2), volatile organic compounds (VOCs), acid gases (HCl and HF), metals, PAHs, dioxins and furans. The monitoring provided a comprehensive assessment of the background air quality in the Red Hill area.

Of relevance to the HHRA for the Immobilisation Plant emissions are background levels of particulates, metals, dioxins and furans. Existing sources of those pollutants include operations at the Red Hill WMF (particulates and associated metals only), vehicle traffic on Toodyay Rd and smoke from biomass burning (wood fired heating, wood waste burn-off, controlled burns). The Red Hill WMF operations are essentially unchanged in respect of the activities carried out which suggests the current (and future) emissions are likely to be similar to 2011. Current vehicle traffic count data collected from Toodyay Rd, nearby Roland Rd (essentially opposite the Red Hill WMF property) show around 9000 vehicles per day pass by the site, with heavy vehicles that generate the higher particulate emissions comprising 16% of the traffic (Main Roads 2024a). Historical data from 2019 onwards shows somewhat consistent traffic volumes (8600 – 8900 vehicles per day) with heavy vehicles comprising 14-15% of the traffic (Main Roads 2024b). A road safety review report from 2013 (Traffic Safety Consultants 2013) indicated nominal 6000 vehicles per day traffic volumes on Toodyay Rd east of Stoneville Rd (3.7 km east of Roland Rd), which suggests traffic volumes have increased by as much as 50% since that time.

Aerial photographs suggest that the surrounding land-uses are unchanged since 2011 which suggests current levels of smoke particles from biomass burning are similar to those from 2011. Importantly, no other industrial activities have commenced in the area that could impact on the background levels of these pollutants.

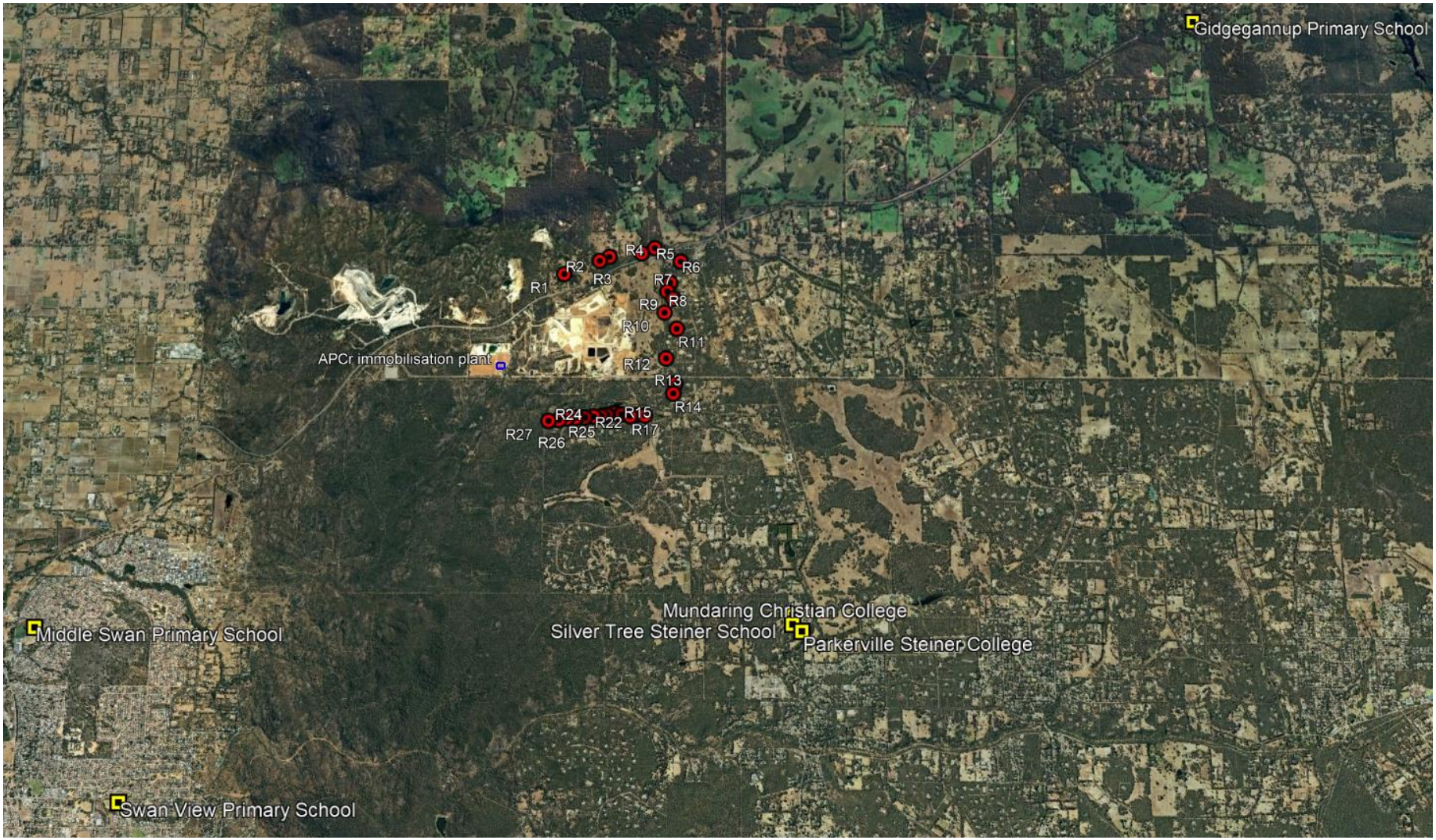


Figure 4.1: Locations of nearest rural residences and schools (sensitive receptors)

Overall, this analysis has suggested traffic derived emissions may have increased since the monitoring was conducted in 2011 whereas emissions from the Red Hill WMF and biomass burning are likely to have remained the same. In the absence of more recent data, the monitoring data from the 2011 program has been utilised to inform the baseline air quality for comparison with the predicted impacts from the Immobilisation Plant, with consideration given that the 2011 concentrations may underestimate current concentrations as a consequence of increase traffic volumes.

4.2 Background pollutant concentrations

A summary of the measured particulate, metal and dioxins concentrations from the 2011 monitoring program is presented in Table 4.1(particulates), Table 4.2 (metals) and Table 4.3 (dioxins), respectively. The particulate concentrations were obtained from continuous monitoring (using TEOM instruments), at two locations being a residence on Toodyay Rd immediately north of the Red Hill WMF and the other being on Lot 12 of the WMF property (on the eastern boundary). The metals and dioxins concentrations were determined from high volume sampling (24 hour periods) at these two locations and a third location on the western end of Hidden Valley Rd. A total of 12 samples were collected and analysed for each of metals and dioxins from the three locations.

Table 4.1: Ambient particulate concentrations (April-July 2011)

Parameter	Statistic	Toodyay Rd residence µg/m³, 24-hour	Lot 12 EMRC Red Hill µg/m³, 24-hour
PM_{10}	Minimum	2.6	3.1
	Average	11.3	10.2
	Maximum	29.8	27.1
$PM_{2.5}$	Minimum	-0.2	-0.7
	Average	2.9	1.6
	Maximum	8.3	11.6

Table 4.2: Ambient metal concentrations (April-July 2011) – all sites

Parameter	Minimum µg/m³, 24-hour	Average µg/m³, 24-hour	Maximum µg/m³, 24-hour
Antimony	<0.01	<0.01	<0.01
Arsenic	<0.01	<0.01	<0.01
Barium	<0.10	<0.10	<0.10
Beryllium	<0.01	<0.01	<0.01
Cadmium	<0.005	<0.005	<0.005
Chromium	<0.003	0.004	0.007
Cobalt	<0.010	<0.010	<0.010
Copper	0.003	0.005	0.008
Lead	<0.01	0.010	0.010
Manganese	0.004	0.008	0.016
Mercury	<0.01	<0.01	<0.01
Nickel	<0.01	<0.01	<0.01
Vanadium	<0.01	<0.01	<0.01
Zinc	0.018	0.035	0.057

Table 4.3: Maximum ambient dioxins concentrations (April-July 2011)

Parameter	Lot 12 EMRC ng I-TEQ/m³, 24-hour	Toodyay Rd ng I-TEQ/m³,' 24-hour	Hidden Valley ng I-TEQ/m³, 24-hour
Total TEQ lower bound	0.00000067	0.00000020	0.00000099
Total TEQ middle bound	0.000092	0.000093	0.000091
Total TEQ upper bound	0.00018	0.000185	0.00018

These data have been considered as part of the assessment of potential cumulative impacts from the Immobilisation Plant emissions and background levels of these pollutants. Note that the PM_{10}, metals, dioxins and furans sampling were conducted over 24 hour periods. Therefore, the reported concentrations have been adjusted to provide 1-hour and annual averages for the cumulative assessments, which include regulatory guideline values for a range of time averages. The dispersion modelling has provided GLCs for those time averages and as such can inform the factors for adjustment of the measured 24-hour average concentrations to 1-hour and annual averages. Those factors are 21.83 for adjustment of 24 hour to 1-hour concentrations and 0.061 for 24-hour to annual concentrations, based on maximum GLCs predicted at R27.

5. PM_{10}, metals and dioxins/furans emission rates

As discussed above, the EAQ modelling has provided predicted GLCs for PM_{10} at 27 receptor locations. GLCs for metals and dioxins/furans have been derived from the WTE project approvals supporting documentation that described the metals composition of APCr and dioxins in stack emissions, scaled for PM_{10} concentrations and PM_{10} GLCs. Details of the metals and dioxins emission rates calculated for the Immobilisation Plant silos are shown in Table 5.1.

Table 5.1: PM_{10}, metals and dioxins emission rates

Parameter	APCr silo emission rate g/s	Cement silo emission rate g/s	Total emission rate (4 x APCr silos + 1 x cement silo) g/s
PM_{10}	5.00E-03	5.00E-03	2.500E-02
Aluminium	6.00E-05	-	2.40E-04
Antimony	1.15E-06	-	4.60E-06
Arsenic	1.60E-07	2.44E-10	6.40E-07
Barium	6.00E-07	-	2.40E-06
Beryllium	1.25E-09	2.80E-11	5.03E-09
Boron	3.10E-07	-	1.24E-06
Cadmium	8.00E-07	-	3.20E-06
Chromium	2.60E-07	1.67E-09	1.04E-06
Chromium(VI)	1.25E-09	-	5.00E-09
Cobalt	5.00E-08	-	2.00E-07
Copper	2.40E-06	-	9.60E-06
Iron	1.50E-05	-	6.00E-05
Lead	6.00E-06	6.28E-10	2.40E-05
Lithium	6.50E-08	-	2.60E-07
Manganese	2.35E-06	6.74E-09	9.41E-06
Mercury	5.00E-08	-	2.00E-07

Parameter	APCr silo emission rate g/s	Cement silo emission rate g/s	Total emission rate (4 x APCr silos + 1 x cement silo) g/s
Molybdenum	2.50E-08	-	1.00E-07
Nickel	1.25E-07	2.41E-09	5.02E-07
Phosphorus	7.50E-09	-	3.00E-08
Silver	5.50E-08	-	2.20E-07
Tin	1.60E-06	-	6.40E-06
Vanadium	1.15E-07	-	4.60E-07
Zinc	5.00E-05	-	2.00E-04
Dioxins/furans (I-TEQ)	5.00E-11	-	2.00E-10

Note: " - " indicates no data were available for the source

6. Summary of dispersion modelling results

The modelling results are summarised in Table 6.1**Error! Reference source not found.** as the highest 1-hour PM_{10} GLCs predicted at the 27 sensitive receptors, with those values reported as a percentage of the respective AGVs. Results for 24-hour and annual average GLCs are reported in Table 6.2 and Table 6.3, respectively. Isopleths for the 1-hour average PM_{10} GLCs are shown in Figure 6.1 to demonstrate the spatial extent of emissions from the Immobilisation Plant.

Predicted GLCs for all parameters at all receptors are provided in Appendix A.

Table 6.1: Maximum predicted 1-hour average GLCs at sensitive receptors

Parameter	Highest 1-hour GLC (µg/m³)	Receptor	AGV 1-hour (µg/m³)	Highest 1-hour GLC as % of AGV
PM_{10}	5.21E+00	R27	-	-
Aluminium	5.00E-02	R27	-	-
Antimony	9.58E-04	R27	0.82	0.12%
Arsenic	1.33E-04	R27	0.09	0.15%
Barium	5.00E-04	R27	9	0.006%
Beryllium	1.05E-06	R27	-	-
Boron	2.58E-04	R27	275	0.00009%
Cadmium	6.66E-04	R27	0.018	3.70%
Chromium	2.17E-04	R27	9	0.002%
Chromium(VI)	1.04E-06	R27	0.09	0.001%
Cobalt	4.16E-05	R27	-	-
Copper	2.00E-03	R27	18	0.011%
Iron	1.25E-02	R27	90	0.014%
Lead	5.00E-03	R27	-	-
Lithium	5.41E-05	R27	-	-
Manganese	1.96E-03	R27	-	-
Mercury	4.16E-05	R27	0.55	0.008%
Molybdenum	2.08E-05	R27	-	-
Nickel	1.05E-04	R27	0.18	0.058%
Phosphorus	6.25E-06	R27	-	-
Silver	4.58E-05	R27	1.8	0.003%
Tin	1.33E-03	R27	-	-
Vanadium	9.58E-05	R27	-	-
Zinc	4.16E-02	R27	-	-
Dioxins/furans (I-TEQ)	4.16E-08	R27	0.000002	2.08%

Note: " - " indicates no data were available for the parameter

Table 6.2: Maximum predicted 24-hour average GLCs at sensitive receptors

Parameter	Highest 24-hour GLC (µg/m³)	Receptor	AGV 24-hour (µg/m³)	Highest 24-hour GLC as % of AGV
PM_{10}	3.53E-01	R1	46	0.77%
Aluminium	3.39E-03	R1	-	-
Antimony	6.50E-05	R1	-	-
Arsenic	9.05E-06	R1	0.027	0.034%
Barium	3.39E-05	R1	-	-
Beryllium	7.11E-08	R1	-	-
Boron	1.75E-05	R1	-	-
Cadmium	4.52E-05	R1	-	-
Chromium	1.47E-05	R1	0.46	0.003%
Chromium(VI)	7.07E-08	R1	-	-
Cobalt	2.83E-06	R1	0.092	0.003%
Copper	1.36E-04	R1	0.92	0.015%
Iron	8.48E-04	R1	-	-
Lead	3.39E-04	R1	-	-
Lithium	3.67E-06	R1	-	-
Manganese	1.33E-04	R1	0.14	0.095%
Mercury	2.83E-06	R1	-	-
Molybdenum	1.41E-06	R1	11	0.00001%
Nickel	7.10E-06	R1	0.14	0.005%
Phosphorus	4.24E-07	R1	-	-
Silver	3.11E-06	R1	-	-
Tin	9.04E-05	R1	-	-
Vanadium	6.50E-06	R1	0.92	0.001%
Zinc	2.83E-03	R1	46	0.006%
Dioxins/furans (I-TEQ)	2.83E-09	R1	-	-

Note: " - " indicates no data were available for the parameter

Table 6.3: Maximum predicted annual GLCs at sensitive receptors

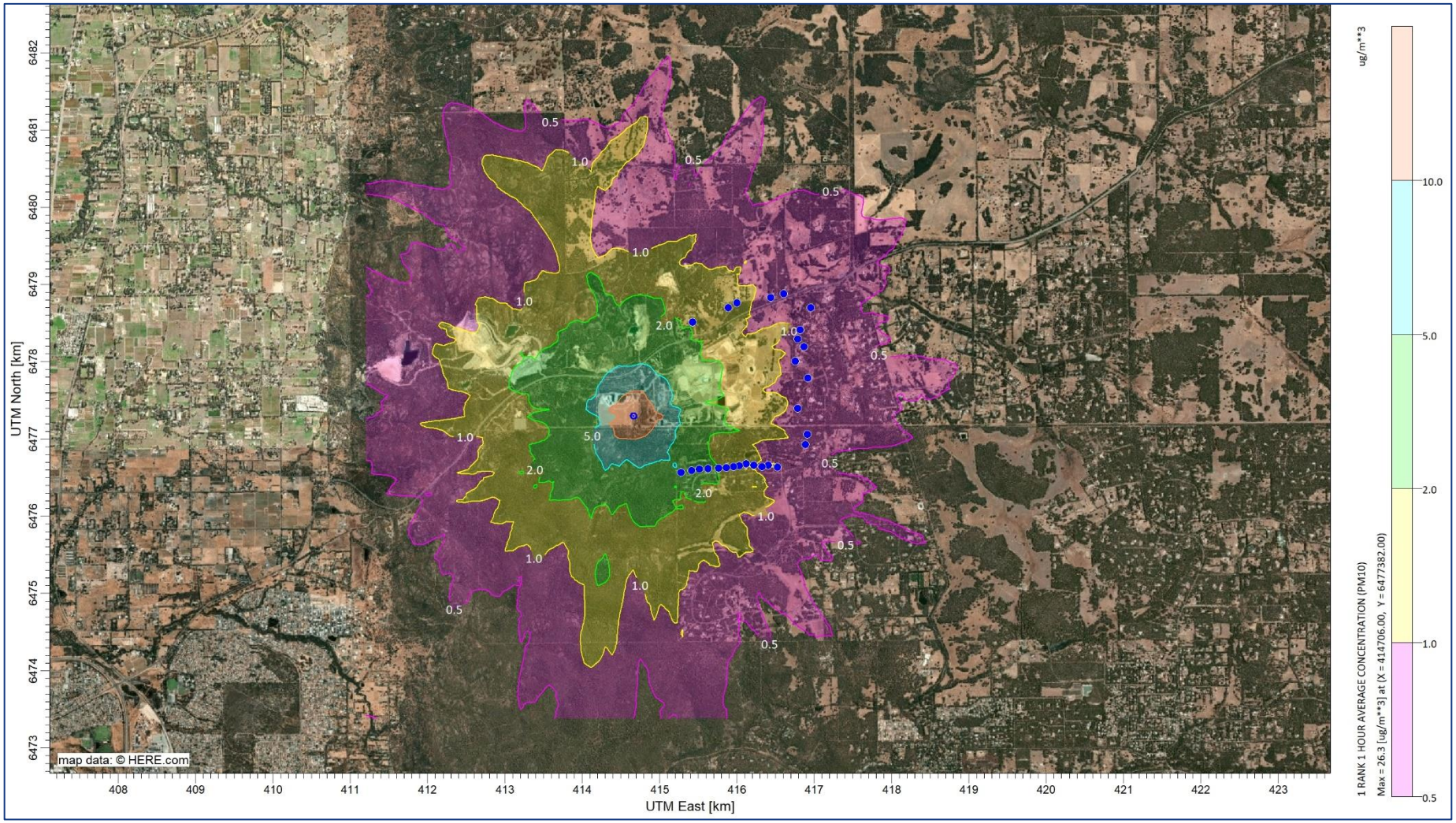
Parameter	Highest GLC annual (µg/m³)	Receptor	AGV annual (µg/m³)	Highest GLC as % of AGV
PM_{10}	1.46E-02	R27	23	0.063%
Aluminium	1.40E-04	R27	-	-
Antimony	2.69E-06	R27	0.027	0.010%
Arsenic	3.74E-07	R27	0.0027	0.014%
Barium	1.40E-06	R27	-	-
Beryllium	2.94E-09	R27	0.004	0.00007%
Boron	7.24E-07	R27	-	-
Cadmium	1.87E-06	R27	-	-
Chromium	6.08E-07	R27	-	-
Chromium(VI)	2.92E-09	R27	0.00018	0.002%
Cobalt	1.17E-07	R27	0.092	0.0001%
Copper	5.61E-06	R27	-	-
Iron	3.50E-05	R27	-	-
Lead	1.40E-05	R27	0.46	0.003%
Lithium	1.52E-07	R27	-	-
Manganese	5.49E-06	R27	-	-
Mercury	1.17E-07	R27	0.18	0.00006%
Molybdenum	5.84E-08	R27	-	-
Nickel	2.93E-07	R27	0.003	0.010%
Phosphorus	1.75E-08	R27	-	-
Silver	1.28E-07	R27	-	-
Tin	3.74E-06	R27	-	-
Vanadium	2.69E-07	R27	-	-
Zinc	1.17E-04	R27	-	-
Dioxins/furans (I-TEQ)	1.17E-10	R27	-	-

Note: " - " indicates no data were available for the parameter

Maximum predicted 1-hour GLCs at locations along the boundaries of the Red Hill WMF are summarised in Table 6.4, with those concentrations reported as percentages of the AGVs in Table 6.5. The locations of greatest potential impact of emissions from the Immobilisation Plant are those at the western boundary and western end of the southern boundary. However, people do not continuously reside at the WMF boundaries and are unlikely to visit a boundary location on a frequent basis that could present an equivalent exposure risk as a residential receptor.

Maximum predicted 24-hour average GLCs are also presented for boundary locations (Note: " - " indicates no data were available for the parameter

Table 6.6) as well as concentrations as a percentage of the AGVs (Table 6.7). Annual average concentrations are presented in Table 6.8 and as percentages of AGVs in Table 6.9. As noted above for the hourly exposures, it is unlikely that people will be present at boundary locations to be exposed to emissions over a 24-hour period and even less likely on an annual basis.



Note: Blue dots are receptor locations considered in the assessment

Figure 6.1: Isopleths for 1-hour average PM_{10} GLCs (µg/m³).

Table 6.4: Maximum predicted 1-hour average GLCs (µg/m³) along the Red Hill WMF boundaries from Immobilisation Plant emissions

Parameter	West boundary (µg/m³)		North boundary, western end (µg/m³)		North boundary, middle (µg/m³)		North boundary, eastern end (µg/m³)		East boundary (µg/m³)		South boundary, eastern end (µg/m³)		South boundary, middle (µg/m³)		South boundary, western end (µg/m³)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PM_{10}	5	10	5	10	2	5	0.5	2	0.5	1	1	2	2	5	5	20
Aluminium	5E-02	1E-01	5E-02	1E-01	2E-02	5E-02	5E-03	2E-02	5E-03	1E-02	1E-02	2E-02	2E-02	5E-02	5E-02	2E-01
Antimony	9E-04	2E-03	9E-04	2E-03	4E-04	9E-04	9E-05	4E-04	9E-05	2E-04	2E-04	4E-04	4E-04	9E-04	9E-04	4E-03
Arsenic	1E-04	3E-04	1E-04	3E-04	5E-05	1E-04	1E-05	5E-05	1E-05	3E-05	3E-05	5E-05	5E-05	1E-04	1E-04	5E-04
Barium	5E-04	1E-03	5E-04	1E-03	2E-04	5E-04	5E-05	2E-04	5E-05	1E-04	1E-04	2E-04	2E-04	5E-04	5E-04	2E-03
Beryllium	1E-06	2E-06	1E-06	2E-06	4E-07	1E-06	1E-07	4E-07	1E-07	2E-07	2E-07	4E-07	4E-07	1E-06	1E-06	4E-06
Boron	2E-04	5E-04	2E-04	5E-04	1E-04	2E-04	2E-05	1E-04	2E-05	5E-05	5E-05	1E-04	1E-04	2E-04	2E-04	1E-03
Cadmium	6E-04	1E-03	6E-04	1E-03	3E-04	6E-04	6E-05	3E-04	6E-05	1E-04	1E-04	3E-04	3E-04	6E-04	6E-04	3E-03
Chromium	2E-04	4E-04	2E-04	4E-04	8E-05	2E-04	2E-05	8E-05	2E-05	4E-05	4E-05	8E-05	8E-05	2E-04	2E-04	8E-04
Chromium(VI)	1E-06	2E-06	1E-06	2E-06	4E-07	1E-06	1E-07	4E-07	1E-07	2E-07	2E-07	4E-07	4E-07	1E-06	1E-06	4E-06
Cobalt	4E-05	8E-05	4E-05	8E-05	2E-05	4E-05	4E-06	2E-05	4E-06	8E-06	8E-06	2E-05	2E-05	4E-05	4E-05	2E-04
Copper	2E-03	4E-03	2E-03	4E-03	8E-04	2E-03	2E-04	8E-04	2E-04	4E-04	4E-04	8E-04	8E-04	2E-03	2E-03	8E-03
Iron	1E-02	2E-02	1E-02	2E-02	5E-03	1E-02	1E-03	5E-03	1E-03	2E-03	2E-03	5E-03	5E-03	1E-02	1E-02	5E-02
Lead	5E-03	1E-02	5E-03	1E-02	2E-03	5E-03	5E-04	2E-03	5E-04	1E-03	1E-03	2E-03	2E-03	5E-03	5E-03	2E-02
Lithium	5E-05	1E-04	5E-05	1E-04	2E-05	5E-05	5E-06	2E-05	5E-06	1E-05	1E-05	2E-05	2E-05	5E-05	5E-05	2E-04
Manganese	2E-03	4E-03	2E-03	4E-03	8E-04	2E-03	2E-04	8E-04	2E-04	4E-04	4E-04	8E-04	8E-04	2E-03	2E-03	8E-03
Mercury	4E-05	8E-05	4E-05	8E-05	2E-05	4E-05	4E-06	2E-05	4E-06	8E-06	8E-06	2E-05	2E-05	4E-05	4E-05	2E-04
Molybdenum	2E-05	4E-05	2E-05	4E-05	8E-06	2E-05	2E-06	8E-06	2E-06	4E-06	4E-06	8E-06	8E-06	2E-05	2E-05	8E-05
Nickel	1E-04	2E-04	1E-04	2E-04	4E-05	1E-04	1E-05	4E-05	1E-05	2E-05	2E-05	4E-05	4E-05	1E-04	1E-04	4E-04
Phosphorus	6E-06	1E-05	6E-06	1E-05	2E-06	6E-06	6E-07	2E-06	6E-07	1E-06	1E-06	2E-06	2E-06	6E-06	6E-06	2E-05
Silver	4E-05	9E-05	4E-05	9E-05	2E-05	4E-05	4E-06	2E-05	4E-06	9E-06	9E-06	2E-05	2E-05	4E-05	4E-05	2E-04
Tin	1E-03	3E-03	1E-03	3E-03	5E-04	1E-03	1E-04	5E-04	1E-04	3E-04	3E-04	5E-04	5E-04	1E-03	1E-03	5E-03
Vanadium	9E-05	2E-04	9E-05	2E-04	4E-05	9E-05	9E-06	4E-05	9E-06	2E-05	2E-05	4E-05	4E-05	9E-05	9E-05	4E-04
Zinc	4E-02	8E-02	4E-02	8E-02	2E-02	4E-02	4E-03	2E-02	4E-03	8E-03	8E-03	2E-02	2E-02	4E-02	4E-02	2E-01
Dioxins/furans (I-TEQ)	4E-08	8E-08	4E-08	8E-08	2E-08	4E-08	4E-09	2E-08	4E-09	8E-09	8E-09	2E-08	2E-08	4E-08	4E-08	2E-07

Table 6.5: Maximum predicted 1-hour average GLCs (as % of AGVs) along the Red Hill WMF boundaries from Immobilisation Plant emissions

Parameter	AGV (µg/m³)	W boundary (% of AGV)		N boundary, western end (% of AGV)		N boundary, middle (% of AGV)		N boundary, eastern end (% of AGV)		E boundary (% of AGV)		S boundary, eastern end (% of AGV)		S boundary, middle (% of AGV)		S boundary, western end (% of AGV)	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PM_{10}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	0.82	0.11%	0.22%	0.11%	0.22%	0.04%	0.11%	0.01%	0.04%	0.01%	0.02%	0.02%	0.04%	0.04%	0.11%	0.11%	0.45%
Arsenic	0.09	0.14%	0.28%	0.14%	0.28%	0.06%	0.14%	0.01%	0.06%	0.01%	0.03%	0.03%	0.06%	0.06%	0.14%	0.14%	0.57%
Barium	9	0.01%	0.01%	0.01%	0.01%	0.00%	0.01%	0.001%	0.002%	0.001%	0.001%	0.001%	0.002%	0.002%	0.01%	0.01%	0.02%
Beryllium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	275	0.0001%	0.0002%	0.0001%	0.0002%	0.00004%	0.0001%	0.00001%	0.00004%	0.00001%	0.00002%	0.00002%	0.00004%	0.00004%	0.0001%	0.0001%	0.0004%
Cadmium	0.018	3.6%	7.1%	3.6%	7.1%	1.4%	3.6%	0.4%	1.4%	0.4%	0.7%	0.7%	1.4%	1.4%	3.6%	3.6%	14.2%
Chromium	9	0.002%	0.005%	0.002%	0.005%	0.001%	0.002%	0.0002%	0.001%	0.0002%	0.0005%	0.0005%	0.001%	0.001%	0.002%	0.002%	0.009%
Chromium(VI)	0.09	0.001%	0.002%	0.001%	0.002%	0.0004%	0.001%	0.0001%	0.0004%	0.0001%	0.0002%	0.0002%	0.0004%	0.0004%	0.001%	0.001%	0.004%
Cobalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	18	0.01%	0.02%	0.01%	0.02%	0.004%	0.01%	0.001%	0.004%	0.001%	0.002%	0.002%	0.004%	0.004%	0.01%	0.01%	0.04%
Iron	90	0.01%	0.03%	0.01%	0.03%	0.01%	0.01%	0.001%	0.01%	0.001%	0.003%	0.003%	0.01%	0.01%	0.01%	0.01%	0.05%
Lead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lithium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.55	0.01%	0.01%	0.01%	0.01%	0.003%	0.01%	0.001%	0.003%	0.001%	0.001%	0.001%	0.003%	0.003%	0.01%	0.01%	0.03%
Molybdenum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	0.18	0.06%	0.11%	0.06%	0.11%	0.02%	0.06%	0.01%	0.02%	0.01%	0.01%	0.01%	0.02%	0.02%	0.06%	0.06%	0.22%
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	1.8	0.002%	0.005%	0.002%	0.005%	0.001%	0.002%	0.000%	0.001%	0.000%	0.000%	0.000%	0.001%	0.001%	0.002%	0.002%	0.010%
Tin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dioxins/furans (I-TEQ)	2.00E-06	2.0%	4.0%	2.0%	4.0%	0.80%	2.00%	0.20%	0.80%	0.20%	0.40%	0.40%	0.80%	0.80%	2.0%	2.0%	8.0%

Note: " - " indicates no data were available for the parameter

Table 6.6: Maximum predicted 24-hour average GLCs (µg/m³) along the Red Hill WMF boundaries from Immobilisation Plant emissions

Parameter	West boundary (µg/m³)		North boundary, western end (µg/m³)		North boundary, middle (µg/m³)		North boundary, eastern end (µg/m³)		East boundary (µg/m³)		South boundary, eastern end (µg/m³)		South boundary, middle (µg/m³)		South boundary, western end (µg/m³)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PM_{10}	5E-01	1E+00	5E-01	5E-01	2E-01	5E-01	1E-01	1E-01	1E-01	1E-01	1E-01	1E-01	2E-01	5E-01	5E-01	1E+00
Aluminium	1E-03	2E-03	1E-03	5E-04	5E-04	1E-03	2E-04	2E-04	2E-04	2E-04	2E-04	2E-04	5E-04	1E-03	1E-03	2E-03
Antimony	5E-04	1E-03	5E-04	2E-04	2E-04	5E-04	1E-04	1E-04	1E-04	1E-04	1E-04	1E-04	2E-04	5E-04	5E-04	1E-03
Arsenic	5E-06	1E-05	5E-06	2E-06	2E-06	5E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	2E-06	5E-06	5E-06	1E-05
Barium	2E-04	4E-04	2E-04	8E-05	8E-05	2E-04	4E-05	4E-05	4E-05	4E-05	4E-05	4E-05	8E-05	2E-04	2E-04	4E-04
Beryllium	4E-06	8E-06	4E-06	2E-06	2E-06	4E-06	8E-07	8E-07	8E-07	8E-07	8E-07	8E-07	2E-06	4E-06	4E-06	8E-06
Boron	2E-06	4E-06	2E-06	8E-07	8E-07	2E-06	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	8E-07	2E-06	2E-06	4E-06
Cadmium	1E-05	2E-05	1E-05	4E-06	4E-06	1E-05	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	1E-05	1E-05	2E-05
Chromium	6E-07	1E-06	6E-07	2E-07	2E-07	6E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	6E-07	6E-07	1E-06
Chromium(VI)	4E-06	9E-06	4E-06	2E-06	2E-06	4E-06	9E-07	9E-07	9E-07	9E-07	9E-07	9E-07	2E-06	4E-06	4E-06	9E-06
Cobalt	1E-04	3E-04	1E-04	5E-05	5E-05	1E-04	3E-05	3E-05	3E-05	3E-05	3E-05	3E-05	5E-05	1E-04	1E-04	3E-04
Copper	9E-06	2E-05	9E-06	4E-06	4E-06	9E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	9E-06	9E-06	2E-05
Iron	4E-03	8E-03	4E-03	2E-03	2E-03	4E-03	8E-04	8E-04	8E-04	8E-04	8E-04	8E-04	2E-03	4E-03	4E-03	8E-03
Lead	4E-09	8E-09	4E-09	2E-09	2E-09	4E-09	8E-10	8E-10	8E-10	8E-10	8E-10	8E-10	2E-09	4E-09	4E-09	8E-09
Lithium	5E-05	1E-04	5E-05	1E-04	2E-05	5E-05	5E-06	2E-05	5E-06	1E-05	1E-05	2E-05	2E-05	5E-05	5E-05	2E-04
Manganese	2E-03	4E-03	2E-03	4E-03	8E-04	2E-03	2E-04	8E-04	2E-04	4E-04	4E-04	8E-04	8E-04	2E-03	2E-03	8E-03
Mercury	4E-05	8E-05	4E-05	8E-05	2E-05	4E-05	4E-06	2E-05	4E-06	8E-06	8E-06	2E-05	2E-05	4E-05	4E-05	2E-04
Molybdenum	2E-05	4E-05	2E-05	4E-05	8E-06	2E-05	2E-06	8E-06	2E-06	4E-06	4E-06	8E-06	8E-06	2E-05	2E-05	8E-05
Nickel	1E-04	2E-04	1E-04	2E-04	4E-05	1E-04	1E-05	4E-05	1E-05	2E-05	2E-05	4E-05	4E-05	1E-04	1E-04	4E-04
Phosphorus	6E-06	1E-05	6E-06	1E-05	2E-06	6E-06	6E-07	2E-06	6E-07	1E-06	1E-06	2E-06	2E-06	6E-06	6E-06	2E-05
Silver	4E-05	9E-05	4E-05	9E-05	2E-05	4E-05	4E-06	2E-05	4E-06	9E-06	9E-06	2E-05	2E-05	4E-05	4E-05	2E-04
Tin	1E-03	3E-03	1E-03	3E-03	5E-04	1E-03	1E-04	5E-04	1E-04	3E-04	3E-04	5E-04	5E-04	1E-03	1E-03	5E-03
Vanadium	9E-05	2E-04	9E-05	2E-04	4E-05	9E-05	9E-06	4E-05	9E-06	2E-05	2E-05	4E-05	4E-05	9E-05	9E-05	4E-04
Zinc	4E-02	8E-02	4E-02	8E-02	2E-02	4E-02	4E-03	2E-02	4E-03	8E-03	8E-03	2E-02	2E-02	4E-02	4E-02	2E-01
Dioxins/furans (I-TEQ)	4E-08	8E-08	4E-08	8E-08	2E-08	4E-08	4E-09	2E-08	4E-09	8E-09	8E-09	2E-08	2E-08	4E-08	4E-08	2E-07

Table 6.7: Maximum predicted 24-hour average GLCs (as % of AGVs) along the Red Hill WMF boundaries from Immobilisation Plant emissions

Parameter	DWER 2019 AGV (µg/m³)	W boundary (% of AGV)		N boundary, western end (% of AGV)		N boundary, middle (% of AGV)		N boundary, eastern end (% of AGV)		E boundary (% of AGV)		S boundary, eastern end (% of AGV)		S boundary, middle (% of AGV)		S boundary, western end (% of AGV)	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PM_{10}	46	1.1%	2.2%	1.1%	1.1%	0.4%	1.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.4%	1.1%	1.1%	2.2%
Aluminium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	0.027	0.05%	0.09%	0.05%	0.05%	0.02%	0.05%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%	0.05%	0.05%	0.09%
Barium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	0.46	0.005%	0.009%	0.005%	0.005%	0.002%	0.005%	0.0009%	0.0009%	0.0009%	0.0009%	0.0009%	0.0009%	0.002%	0.005%	0.005%	0.009%
Chromium(VI)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	0.092	0.0004%	0.0009%	0.0004%	0.0004%	0.0002%	0.0004%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0002%	0.0004%	0.0004%	0.0009%
Copper	0.92	0.02%	0.04%	0.02%	0.02%	0.008%	0.02%	0.004%	0.004%	0.004%	0.004%	0.004%	0.004%	0.008%	0.02%	0.02%	0.04%
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lithium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	0.14	0.13%	0.27%	0.13%	0.13%	0.05%	0.13%	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	0.05%	0.13%	0.13%	0.27%
Mercury	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	11	0.00002%	0.00004%	0.00002%	0.00002%	0.00001%	0.00002%	0.000004%	0.000004%	0.000004%	0.000004%	0.000004%	0.000004%	0.00001%	0.00002%	0.00002%	0.00004%
Nickel	0.14	0.01%	0.01%	0.01%	0.01%	0.003%	0.01%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.003%	0.007%	0.01%	0.01%
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	0.92	0.001%	0.002%	0.001%	0.001%	0.0004%	0.0010%	0.0002%	0.0002%	0.0002%	0.0002%	0.0002%	0.0002%	0.0004%	0.001%	0.001%	0.002%
Zinc	46	0.01%	0.02%	0.01%	0.01%	0.003%	0.01%	0.00%	0.002%	0.002%	0.002%	0.002%	0.002%	0.003%	0.01%	0.01%	0.02%
Dioxins/furans (I-TEQ)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: " - " indicates no data were available for the parameter

Table 6.8: Maximum predicted annual average GLCs (µg/m³) along the Red Hill WMF boundaries from Immobilisation Plant emissions

Parameter	West boundary (µg/m³)		North boundary, western end (µg/m³)		North boundary, middle (µg/m³)		North boundary, eastern end (µg/m³)		East boundary (µg/m³)		South boundary, eastern end (µg/m³)		South boundary, middle (µg/m³)		South boundary, western end (µg/m³)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PM_{10}	1E-01	1E-01	5E-02	5E-02	2E-02	5E-02	1E-02	1E-02	1E-02	1E-02	1E-02	1E-02	2E-02	5E-02	5E-02	1E-01
Aluminium	1E-03	1E-03	5E-04	5E-04	2E-04	5E-04	1E-04	1E-04	1E-04	1E-04	1E-04	1E-04	2E-04	5E-04	5E-04	1E-03
Antimony	2E-05	2E-05	9E-06	9E-06	4E-06	9E-06	2E-06	2E-06	2E-06	2E-06	2E-06	2E-06	4E-06	9E-06	9E-06	2E-05
Arsenic	3E-06	3E-06	1E-06	1E-06	5E-07	1E-06	3E-07	3E-07	3E-07	3E-07	3E-07	3E-07	5E-07	1E-06	1E-06	3E-06
Barium	1E-05	1E-05	5E-06	5E-06	2E-06	5E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	2E-06	5E-06	5E-06	1E-05
Beryllium	2E-08	2E-08	1E-08	1E-08	4E-09	1E-08	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	4E-09	1E-08	1E-08	2E-08
Boron	5E-06	5E-06	2E-06	2E-06	1E-06	2E-06	5E-07	5E-07	5E-07	5E-07	5E-07	5E-07	1E-06	2E-06	2E-06	5E-06
Cadmium	1E-05	1E-05	6E-06	6E-06	3E-06	6E-06	1E-06	1E-06	1E-06	1E-06	1E-06	1E-06	3E-06	6E-06	6E-06	1E-05
Chromium	4E-06	4E-06	2E-06	2E-06	8E-07	2E-06	4E-07	4E-07	4E-07	4E-07	4E-07	4E-07	8E-07	2E-06	2E-06	4E-06
Chromium(VI)	2E-08	2E-08	1E-08	1E-08	4E-09	1E-08	2E-09	2E-09	2E-09	2E-09	2E-09	2E-09	4E-09	1E-08	1E-08	2E-08
Cobalt	8E-07	8E-07	4E-07	4E-07	2E-07	4E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	4E-07	4E-07	8E-07
Copper	4E-05	4E-05	2E-05	2E-05	8E-06	2E-05	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-06	2E-05	2E-05	4E-05
Iron	2E-04	2E-04	1E-04	1E-04	5E-05	1E-04	2E-05	2E-05	2E-05	2E-05	2E-05	2E-05	5E-05	1E-04	1E-04	2E-04
Lead	1E-04	1E-04	5E-05	5E-05	2E-05	5E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	2E-05	5E-05	5E-05	1E-04
Lithium	1E-06	1E-06	5E-07	5E-07	2E-07	5E-07	1E-07	1E-07	1E-07	1E-07	1E-07	1E-07	2E-07	5E-07	5E-07	1E-06
Manganese	4E-05	4E-05	2E-05	2E-05	8E-06	2E-05	4E-06	4E-06	4E-06	4E-06	4E-06	4E-06	8E-06	2E-05	2E-05	4E-05
Mercury	8E-07	8E-07	4E-07	4E-07	2E-07	4E-07	8E-08	8E-08	8E-08	8E-08	8E-08	8E-08	2E-07	4E-07	4E-07	8E-07
Molybdenum	4E-07	4E-07	2E-07	2E-07	8E-08	2E-07	4E-08	4E-08	4E-08	4E-08	4E-08	4E-08	8E-08	2E-07	2E-07	4E-07
Nickel	2E-06	2E-06	1E-06	1E-06	4E-07	1E-06	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	1E-06	1E-06	2E-06
Phosphorus	1E-07	1E-07	6E-08	6E-08	2E-08	6E-08	1E-08	1E-08	1E-08	1E-08	1E-08	1E-08	2E-08	6E-08	6E-08	1E-07
Silver	9E-07	9E-07	4E-07	4E-07	2E-07	4E-07	9E-08	9E-08	9E-08	9E-08	9E-08	9E-08	2E-07	4E-07	4E-07	9E-07
Tin	3E-05	3E-05	1E-05	1E-05	5E-06	1E-05	3E-06	3E-06	3E-06	3E-06	3E-06	3E-06	5E-06	1E-05	1E-05	3E-05
Vanadium	2E-06	2E-06	9E-07	9E-07	4E-07	9E-07	2E-07	2E-07	2E-07	2E-07	2E-07	2E-07	4E-07	9E-07	9E-07	2E-06
Zinc	8E-04	8E-04	4E-04	4E-04	2E-04	4E-04	8E-05	8E-05	8E-05	8E-05	8E-05	8E-05	2E-04	4E-04	4E-04	8E-04
Dioxins/furans (I-TEQ)	8E-10	8E-10	4E-10	4E-10	2E-10	4E-10	8E-11	8E-11	8E-11	8E-11	8E-11	8E-11	2E-10	4E-10	4E-10	8E-10

Table 6.9: Maximum predicted annual average GLCs (as % of AGVs) along the Red Hill WMF boundaries from Immobilisation Plant emissions

Parameter	DWER 2019 AGV (µg/m³)	W boundary (% of AGV)		N boundary, western end (% of AGV)		N boundary, middle (% of AGV)		N boundary, eastern end (% of AGV)		E boundary (% of AGV)		S boundary, eastern end (% of AGV)		S boundary, middle (% of AGV)		S boundary, western end (% of AGV)	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
PM_{10}	23	0.43%	0.43%	0.22%	0.22%	0.087%	0.22%	0.043%	0.043%	0.043%	0.043%	0.043%	0.043%	0.087%	0.22%	0.22%	0.43%
Aluminium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	0.027	0.068%	0.068%	0.034%	0.034%	0.014%	0.034%	0.007%	0.007%	0.007%	0.007%	0.007%	0.007%	0.014%	0.034%	0.034%	0.068%
Arsenic	0.0027	0.095%	0.095%	0.047%	0.047%	0.019%	0.047%	0.009%	0.009%	0.009%	0.009%	0.009%	0.009%	0.019%	0.047%	0.047%	0.095%
Barium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	0.004	0.0005%	0.0005%	0.0003%	0.0003%	0.0001%	0.0003%	0.00005%	0.00005%	0.00005%	0.00005%	0.00005%	0.00005%	0.0001%	0.0003%	0.0003%	0.0005%
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium(VI)	0.00018	0.011%	0.011%	0.006%	0.006%	0.002%	0.006%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.002%	0.006%	0.006%	0.011%
Cobalt	0.092	0.0009%	0.0009%	0.0004%	0.0004%	0.0002%	0.0004%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0001%	0.0002%	0.0004%	0.0004%	0.0009%
Copper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	0.46	0.021%	0.021%	0.010%	0.010%	0.004%	0.010%	0.002%	0.002%	0.002%	0.002%	0.002%	0.002%	0.004%	0.010%	0.010%	0.021%
Lithium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.18	0.0004%	0.0004%	0.0002%	0.0002%	0.00009%	0.0002%	0.00004%	0.00004%	0.00004%	0.00004%	0.00004%	0.00004%	0.00009%	0.0002%	0.0002%	0.0004%
Molybdenum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	0.003	0.067%	0.067%	0.033%	0.033%	0.013%	0.033%	0.007%	0.007%	0.007%	0.007%	0.007%	0.007%	0.013%	0.033%	0.033%	0.067%
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dioxins/furans (I-TEQ)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: " - " indicates no data were available for the parameter

7. Risk Assessment

7.1 Overview

The five stages of an environmental health risk assessment are described by enHealth (2012) as:

- Issue identification
- Hazard identification
- Dose-response assessment
- Exposure assessment for the relevant population
- Risk characterisation.

As previously discussed in Section 2.2, the Facility Management and Monitoring Framework prepared by EAQ has addressed the first two stages (issue and hazard identification) of the assessment process. The dose-response and exposure assessments are addressed by the use of the AGVs and APACs as benchmarks for acceptable population dose-rate and exposures to the COPCs associated with the Immobilisation Plant particulate emissions. Those regulatory criteria provide the basis for the screening assessment, in that the concentration limits reflect conservative dose-response and exposure outcomes.

7.2 Comparison of predicted GLCs with DWER AGVs – direct impacts

As described above, the screening level assessment has utilised the maximum predicted GLCs for COPCs from all 27 receptor locations to identify potential risks to human health from the Immobilisation Plant emissions. The predicted GLCs have been compared with the draft DWER 2019 AGVs and the screening tolerances for those AGVs. Table 1 of the DWER 2019 draft guidelines specifies that GLCs for 'Criteria' pollutants (in this case, PM_{10} and Lead) are assessed against AGVs at all sensitive receptors in the modelling domain, whereas GLCs for 'Principal Toxic Substances' and 'Individual Toxic Substances' are assessed at all locations within the modelling domain, excluding industrial premises.

The results of the assessment are summarised in Table 7.1 (1-hour averages), Table 7.2 (24-hour averages) and Table 7.3 (annual averages). These represent the incremental impacts of emissions from the Immobilisation Plant, and does not include background pollutant concentrations. An assessment of cumulative impacts is presented in Section 7.3.

Table 7.1: Maximum predicted 1-hour GLCs at sensitive receptors – DWER screening criteria < 10% of AGV

Parameter	Highest GLC 1-hour (µg/m³)	Location	AGV 1-hour (µg/m³)	% of AGV	Significance of emissions
PM_{10}	5.21E+00	R27	-	-	-
Aluminium	1.92E-01	Boundary	-	-	-
Antimony	3.68E-03	Boundary	0.82	0.45%	Insignificant
Arsenic	5.12E-04	Boundary	0.09	0.57%	Insignificant
Barium	1.92E-03	Boundary	9	0.021%	Insignificant
Beryllium	4.02E-06	Boundary	-	-	-
Boron	9.92E-04	Boundary	275	0.0004%	Insignificant
Cadmium	2.56E-03	Boundary	0.018	14.2%	Insignificant
Chromium	8.33E-04	Boundary	9	0.009%	Insignificant
Chromium(VI)	4.00E-06	Boundary	0.09	0.004%	Insignificant
Cobalt	1.60E-04	Boundary	-	-	-
Copper	7.68E-03	Boundary	18	0.043%	Insignificant
Iron	4.80E-02	Boundary	90	0.053%	Insignificant
Lead	5.00E-03	R27	-	-	-
Lithium	2.08E-04	Boundary	-	-	-
Manganese	7.53E-03	Boundary	-	-	-
Mercury	1.60E-04	Boundary	0.55	0.029%	Insignificant
Molybdenum	8.00E-05	Boundary	-	-	-
Nickel	4.02E-04	Boundary	0.18	0.22%	Insignificant
Phosphorus	2.40E-05	Boundary	-	-	-
Silver	1.76E-04	Boundary	1.8	0.01%	Insignificant
Tin	5.12E-03	Boundary	-	-	-
Vanadium	3.68E-04	Boundary	-	-	-
Zinc	1.60E-01	Boundary	-	-	-
Dioxins/furans (I-TEQ)	1.60E-07	Boundary	4.16E-06	8.0%	Insignificant

Note: "-" indicates no AGV assigned for the parameter at the indicated time average

Table 7.2: Maximum predicted 24-hour GLCs – DWER screening criteria < 3% of AGV

Parameter	Highest GLC 24-hour (µg/m³)	Location	AGV 24-hour (µg/m³)	% of AGV	Significance of emissions
PM_{10}	3.53E-01	R1	46	0.77%	Insignificant
Aluminium	9.60E-03	Boundary	-	-	-
Antimony	1.84E-04	Boundary	-	-	-
Arsenic	2.56E-05	Boundary	0.027	0.095%	Insignificant
Barium	9.60E-05	Boundary	-	-	-
Beryllium	2.01E-07	Boundary	-	-	-
Boron	4.96E-05	Boundary	-	-	-
Cadmium	1.28E-04	Boundary	-	-	-
Chromium	4.17E-05	Boundary	0.46	0.009%	Insignificant
Chromium(VI)	2.00E-07	Boundary	-	-	-
Cobalt	8.00E-06	Boundary	0.092	0.009%	Insignificant
Copper	3.84E-04	Boundary	0.92	0.042%	Insignificant
Iron	2.40E-03	Boundary	-	-	-
Lead	3.39E-04	R1	-	-	-
Lithium	1.04E-05	Boundary	-	-	-
Manganese	3.76E-04	Boundary	0.14	0.27%	Insignificant
Mercury	8.00E-06	Boundary	-	-	-
Molybdenum	4.00E-06	Boundary	11	0.00004%	Insignificant
Nickel	2.01E-05	Boundary	0.14	0.014%	Insignificant
Phosphorus	1.20E-06	Boundary	-	-	-
Silver	8.80E-06	Boundary	-	-	-
Tin	2.56E-04	Boundary	-	-	-
Vanadium	1.84E-05	Boundary	0.92	0.002%	Insignificant
Zinc	8.00E-03	Boundary	46	0.017%	Insignificant
Dioxins/furans (I-TEQ)	8.00E-09	Boundary	-	-	-

Note: "-" indicates no AGV assigned for the parameter at the indicated time average

Table 7.3: Maximum predicted annual GLCs – DWER screening criteria < 1% of AGV

Parameter	Highest GLC annual (µg/m³)	Location	AGV annual (µg/m³)	% of AGV	Significance of emissions
PM_{10}	1.46E-02	R27	23	0.063%	Insignificant
Aluminium	9.60E-04	Boundary	-	-	-
Antimony	1.84E-05	Boundary	0.027	0.068%	Insignificant
Arsenic	2.56E-06	Boundary	0.0027	0.095%	Insignificant
Barium	9.60E-06	Boundary	-	-	-
Beryllium	2.01E-08	Boundary	0.004	0.0005%	Insignificant
Boron	4.96E-06	Boundary	-	-	-
Cadmium	1.28E-05	Boundary	-	-	-
Chromium	4.17E-06	Boundary	-	-	-
Chromium(VI)	2.00E-08	Boundary	0.00018	0.011%	Insignificant
Cobalt	8.00E-07	Boundary	0.092	0.0009%	Insignificant
Copper	3.84E-05	Boundary	-		-
Iron	2.40E-04	Boundary	-		-
Lead	1.40E-05	R27	0.46	0.003%	Insignificant
Lithium	1.04E-06	Boundary	-	-	-
Manganese	3.76E-05	Boundary	-	-	-
Mercury	8.00E-07	Boundary	0.18	0.0004%	Insignificant
Molybdenum	4.00E-07	Boundary	-	-	-
Nickel	2.01E-06	Boundary	0.003	0.067%	Insignificant
Phosphorus	1.20E-07	Boundary	-	-	-
Silver	8.80E-07	Boundary	-	-	-
Tin	2.56E-05	Boundary	-	-	-
Vanadium	1.84E-06	Boundary	-	-	-
Zinc	8.00E-04	Boundary	-	-	-
Dioxins/furans (I-TEQ	8.00E-10	Boundary	-	-	-

Note: "-" indicates no AGV assigned for the parameter at the indicated time average

The maximum predicted 1-hour GLC for cadmium was 14.2% of the AGV at a boundary location, which exceeds the screening criteria of 10% of the AGV. The maximum predicted 1-hour GLC for that metal was 3.7% of the AGV at the nearest sensitive receptor (R27). Predicted GLCs for all other parameters for all time averages were below the screening criteria at all locations in the modelling domain.

Aside from cadmium, these findings indicate that the predicted emissions of fine particles (as PM_{10}), metals and dioxins/furans from the Immobilisation Plant are insignificant in respect of potential adverse human health impacts from direct exposures to the emissions.

Note that AGVs are not prescribed for any of the time averages for some of the COPCs measured in the APCr. These include aluminium, lithium, iron, tin and phosphorus. An assumption is made that the absence of an AGV indicates a low inhalation toxicology of those COPCs. The primary health risk is likely to be from inhalation of particulates comprised of those COPCs, which is assessed against the 24-hour and annual standards for PM_{10} from the National Environment Protection (Ambient Air Quality) Measure.

As indicated, the predicted maximum 1-hour GLC for cadmium exceeds the screening level criteria at a boundary location. The DWER draft 2019 guidelines advise that a 'Detailed Analysis' is therefore required to assess the risk for that parameter. That requirement assumes that a screening level analysis was conducted using generic screening concentrations for GLCs, which is a conservative position. However, this assessment

has utilised dispersion modelling which, in effect, constitutes a Detailed Analysis in accordance with the DWER draft 2019 guideline.

7.2.1 Cadmium risk assessment

The maximum predicted 1-hour GLC for cadmium exceeded the screening criteria at a boundary location. However, that concentration (0.0026 µg/m^3) is only 14.2% of the AGV (0.018 µg/m^3). As such, the risk of adverse impacts to human health at that location is low. Furthermore, this assessment utilised the maximum 1-hour average, which DWER considers is 'worst-case modelling' that ensures a 'conservative approach' when compared with the 99.9th percentile GLCs preferred for Principal and Individual Toxic Substances.[1] As previously discussed, it is unlikely that people will be present at the boundary location at times when the Immobilisation Plant is operating and prevailing winds would direct residual emissions from the APCr silo filters to that location to present an exposure risk.

The above considerations indicate a low health risk can be assigned to cadmium emissions from the Immobilisation Plant.

7.3 Comparison of predicted GLCs with EPAV APACs – cumulative impacts

As previously indicated, the HHRA has also considered comparison of the predicted GLCs for COPCs combined with ambient concentrations against the EPAV air pollution assessment criteria (APACs). A conservative approach has been adopted whereby the maximum measured ambient concentrations have been added to the maximum predicted GLCs from the respective sensitive receptors, and detection limit concentrations have been used for non-detect results, for comparison with the cumulative APACs. The results of those comparisons are show in Table 7.4 (1-hour averages), Table 7.5 (24-hour averages) and Table 7.6 (annual averages). Ambient Cr(VI) concentrations are conservatively assumed to be 100% of total Cr concentrations. Upper bound dioxins/furans concentrations have been used to also provide a conservative estimate of cumulative impacts.

[1] See Section 10.1 of DWER (2019)

Table 7.4: Maximum predicted 1-hour GLCs – compared with EPAV cumulative APACs

Parameter	Highest predicted GLC 1-hour (µg/m³)	Background 1-hour (µg/m³)	Cumulative 1-hour (µg/m³)	APAC 1-hour (µg/m³)	% of APAC
PM_{10}	5.21E+00	592	5.97E+02	-	-
Aluminium	5.00E-02	Not measured	5.00E-02	-	-
Antimony	9.58E-04	2.18E-01	2.19E-01	-	-
Arsenic	1.33E-04	2.18E-01	2.18E-01	9.9	2.2%
Barium	5.00E-04	1.00E+00	1.00E+00	-	-
Beryllium	1.05E-06	2.18E-01	2.18E-01	-	-
Boron	2.58E-04	Not measured	2.58E-04	-	-
Cadmium	6.66E-04	1.00E-02	1.07E-02	18	0.06%
Chromium	2.17E-04	1.53E-01	1.53E-01	-	-
Chromium(VI)	1.04E-06	1.53E-01	1.53E-01	1.3	11.8%
Cobalt	4.16E-05	2.18E-01	2.18E-01	-	-
Copper	2.00E-03	1.75E-01	1.77E-01	100	0.18%
Iron	1.25E-02	Not measured	1.25E-02	-	-
Lead	5.00E-03	2.18E-01	2.23E-01	-	-
Lithium	5.41E-05	Not measured	5.41E-05	-	-
Manganese	1.96E-03	3.49E-01	3.51E-01	9.1	3.86%
Mercury	4.16E-05	2.18E-01	2.18E-01	-	-
Molybdenum	2.08E-05	Not measured	2.08E-05	-	-
Nickel	1.05E-04	2.18E-01	2.18E-01	0.2	109%
Phosphorus	6.25E-06	Not measured	6.25E-06	-	-
Silver	4.58E-05	Not measured	4.58E-05	-	-
Tin	1.33E-03	Not measured	1.33E-03	-	-
Vanadium	9.58E-05	2.18E-01	2.18E-01	-	-
Zinc	4.16E-02	1.24E+00	1.29E+00	20	6.43%
Dioxins/furans (I-TEQ)	4.16E-08	3.93E-03	3.93E-03	-	-

Note: "-" indicates no APAC assigned for the parameter at the indicated time average

Table 7.5: Maximum predicted 24-hour GLCs – compared with EPAV cumulative APACs

Parameter	Highest predicted GLC 24-hour (µg/m³)	Background 24-hour (µg/m³)	Cumulative 24-hour (µg/m³)	APAC 24-hour (µg/m³)	% of APAC
PM_{10}	3.53E-01	2.98E+01	3.02E+01	50	60.31%
Aluminium	3.39E-03	Not measured	3.39E-03	-	-
Antimony	6.50E-05	1.00E-02	1.01E-02	1.0	1.01%
Arsenic	9.05E-06	1.00E-02	1.00E-02	-	-
Barium	3.39E-05	1.00E-01	1.00E-01	10	1.00%
Beryllium	7.11E-08	1.00E-02	1.00E-02	-	-
Boron	1.75E-05	5.00E-03	5.02E-03	-	-
Cadmium	4.52E-05	7.00E-03	7.05E-03	0.03	23.5%
Chromium	1.47E-05	1.00E-02	1.00E-02	-	-
Chromium(VI)	7.07E-08	1.00E-02	1.00E-02	-	-
Cobalt	2.83E-06	1.00E-02	1.00E-02	-	-
Copper	1.36E-04	8.00E-03	8.14E-03	-	-
Iron	8.48E-04	Not measured	8.48E-04	-	-
Lead	3.39E-04	1.00E-02	1.03E-02	-	-
Lithium	3.67E-06	Not measured	3.67E-06	-	-
Manganese	1.33E-04	1.60E-02	1.61E-02	-	-
Mercury	2.83E-06	1.00E-02	1.00E-02	-	-
Molybdenum	1.41E-06	Not measured	1.41E-06	-	-
Nickel	7.10E-06	1.00E-02	1.00E-02	-	-
Phosphorus	4.24E-07	Not measured	4.24E-07	-	-
Silver	3.11E-06	Not measured	3.11E-06	1.0	0.0003%
Tin	9.04E-05	Not measured	9.04E-05	-	-
Vanadium	6.50E-06	1.00E-02	1.00E-02	-	-
Zinc	2.83E-03	5.70E-02	5.98E-02	-	-
Dioxins/furans (I-TEQ)	2.83E-09	1.80E-04	1.80E-04	-	-

Note: "-" indicates no APAC assigned for the parameter at the indicated time average or parameter was not measured in ambient monitoring program

Table 7.6: Maximum predicted annual GLCs – compared with EPAV cumulative APACs

Parameter	Highest predicted GLC annual (µg/m³)	Background annual (µg/m³)	Cumulative annual (µg/m³)	APAC annual (µg/m³)	% of APAC
PM_{10}	1.46E-02	1.82E+00	1.83E+00	25	7.33%
Aluminium	1.40E-04	Not measured	-	-	-
Antimony	2.69E-06	6.10E-04	6.13E-04	0.3	0.20%
Arsenic	3.74E-07	6.10E-04	6.10E-04	0.015	4.07%
Barium	1.40E-06	6.10E-03	6.10E-03	-	-
Beryllium	2.94E-09	6.10E-04	6.10E-04	0.02	3.05%
Boron	7.24E-07	Not measured	-	-	-
Cadmium	1.87E-06	3.05E-04	3.07E-04	0.005	6.14%
Chromium	6.08E-07	4.27E-04	4.28E-04	-	-
Chromium(VI)	2.92E-09	4.27E-05	4.27E-05	0.005	8.45%
Cobalt	1.17E-07	6.10E-04	6.10E-04	-	-
Copper	5.61E-06	4.88E-04	4.94E-04	-	-
Iron	3.50E-05	Not measured	-	-	-
Lead	1.40E-05	6.10E-04	6.24E-04	0.5	0.12%
Lithium	1.52E-07	Not measured	-	-	
Manganese	5.49E-06	9.76E-04	9.81E-04	0.15	0.65%
Mercury	1.17E-07	6.10E-04	6.10E-04	1.0	0.06%
Molybdenum	5.84E-08	Not measured	-	-	-
Nickel	2.93E-07	6.10E-04	6.10E-04	0.09	0.68%
Phosphorus	1.75E-08	Not measured	-	-	-
Silver	1.28E-07	Not measured	-	-	-
Tin	3.74E-06	Not measured	-	-	-
Vanadium	2.69E-07	6.10E-04	6.10E-04	-	-
Zinc	1.17E-04	3.48E-03	3.59E-03	2.0	0.18%
Dioxins/furans (I-TEQ)	1.17E-10	1.10E-05	1.10E-05	0.00004	27.5%

Note: "-" indicates no APAC assigned for the parameter at the indicated time average or parameter was not measured in ambient monitoring program

Key findings from the assessment of cumulative impacts against the EPAV APACs are as follows:

- Aside from nickel, all cumulative GLCs from combination of maximum predicted GLCs from modelling of the Immobilisation Plant emissions and highest measured ambient concentrations were below the respective APACs for the relevant time averages.
- The cumulative GLCs are driven by the background ambient air concentrations, with the contribution from the Immobilisation Plant at least an order of magnitude smaller than the background.
- The predicted nickel cumulative concentration was 109% of the APAC for 1-hour average. The reasons for this result are:
    - Nickel was not detected in the ambient monitoring program, with a detection limit of <0.01 µg/m³ reported for a 24-hour average sampling period.

- The detection limit concentration was adjusted for a 1-hour average (0.22 µg/m^3) for the cumulative assessment and added to the highest predicted 1-hour average GLC from the modelling (0.0001 µg/m^3) to give a cumulative GLC of 0.2201 µg/m^3), which is 9% higher than the APAC.
- This assessment is highly conservative, in that the actual ambient concentration of nickel is lower than the value derived from the use of the detection limit concentration.
- The incremental contribution from the Immobilisation Plant nickel emissions is 3 orders of magnitude below the conservative ambient concentration.

- The next most significant cumulative COPCs was PM_{10} (60.3% of the 24-hour APAC), dioxins/furans (27.5% of the annual APAC) and cadmium (23.5% of the 24-hour APAC).
- All of these results were driven by the ambient concentrations of these COPCs.

Overall, the cumulative assessment has shown a low risk of adverse health impacts from the Immobilisation Plant air emissions combined with the background levels of emissions in the area.

7.4 Sensitivity assessment – cumulative impacts

As previously discussed in Section 4.1, the ambient monitoring data utilised for the above assessment were obtained in 2011 and levels of pollutants from road traffic emissions have likely increased since that time. As such the cumulative assessment may reflect an underestimate of the current and likely future levels of pollutants in the area.

Traffic count data has suggested a 50% increase in traffic on Toodyay Road has occurred in the past 13 years (Main Roads 2024a and 2024b, Traffic Safety Consultants 2013). Assuming a direct correlation of traffic and emissions, with associated increase in ambient levels, then the predicted cumulative GLCs could be increased by that factor. Aside from nickel (1-hour average) the predicted cumulative GLCs of COPCs remain below the respective APACs. The nickel cumulative GLC increases to 125% of the APAC if a 50% increase in traffic volumes applies.

As discussed above, the nickel GLCs reflect the conservatism in the analysis and actual background nickel GLCs will be lower than measured. Furthermore, the maximum predicted 1-hour GLC from the modelling has been used for the cumulative assessment. That reflects the model prediction for a single hour in a year, assuming operation of the Immobilisation Plant for 8760 hours per year. A coincident occurrence of the maximum GLC from the Immobilisation Plant operation (which is only during business hours) with peak ambient background concentration is a very low probability event. As such a conclusion is made that nickel (and all other COPC) emissions from the Immobilisation Plant present a low risk to human health at nearby receptor locations.

8. Conclusions

A screening level human health risk assessment has been carried out of air emissions predicted from the proposed APCr Immobilisation Plant at the EMRC Red Hill WMF. That assessment has considered the screening methodology prescribed by DWER (2019) that utilises AGVs to inform potential for environmental (including human health) impacts. A modification was made to the assessment in that the predicted GLCs of chemicals of concern were determined using dispersion modelling instead of the calculation of generic screening concentrations as described for a screening analysis.

Aside from cadmium, the predicted GLCs of all COPC in the emissions from the Plant were found to be within the screening criteria limits for the respective time averages (hourly, daily and annual) that apply to the AGVs. The maximum 1-hour cadmium GLC at a boundary location was 14.2% of the AGV, which exceeded the screening criteria limit 10%.

The DWER (2019) screening criteria limits are based on the use of generic screening concentrations which are inherently conservative. The analysis conducted for this study using dispersion modelling found that the cadmium GLC did not exceed the AGV at any location in the modelling domain. Furthermore, it is unlikely that people would be present at the boundary of the WMF in close proximity to the Immobilisation Plant at a time when the Plant is operating and prevailing winds direct any emissions to that location. This means the likelihood of exposure to emissions (including cadmium) at that location is low.

Overall, this HHRA has found that the emissions from the Immobilisation Plant do not provide a significant risk to human health.

A secondary assessment was also carried out utilising the more recent guidelines from EPA Victoria. In this case, APACs are provided by EPA Victoria for a cumulative impact assessment for the COPCs. This involved the addition of predicted GLCs of the COPC emissions from the Immobilisation Plant to the background concentrations of these substances, for comparison with the APACs. Aside from nickel, all cumulative GLCs were found to be below the APACs. The cumulative GLCs were largely a consequence of background concentrations with the incremental contribution from the Immobilisation Plant emissions being very small. The nickel cumulative GLCs were found to reflect the conservatism in the analysis, in that the assumed ambient background concentration was based on the detection limit concentration from the monitoring. The actual nickel ambient concentrations would be lower than the detection limit and, therefore, unlikely to result in an exceedance of the APAC.

Overall, this assessment has found a low risk to human health at sensitive receptors is predicted for air emissions from the proposed Immobilisation Plant and the subsequent placement of cement stabilised APCr in a dedicated landfill cell at the EMRC Red Hill WMF.

9. Limitations

Scope of services

This report ("the report") has been prepared by JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. JBS&G has also not attempted to determine whether any material matter has been omitted from the data. JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to JBS&G. The making of any assumption does not imply that JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made, including to any third parties, and no liability will be accepted for use or interpretation of this report by any third party.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A APCr Immobilisation Facility Management and Monitoring Framework (Table 4-2 from EAQ 2024)

Table 4-2: EMRC Red Hill WMF APCr Facility Management and Monitoring Framework

Activity	Emission Source / Pathway	Process Description	Process Control	Proposed Monitoring	Corrective Actions	Contingency Actions	Residual Emissions Impact Potential (Risk assessment)			
							Consequence	Likelihood	Potential (onsite)	Potential (receptor)
APCr Immobilisation Facility Design.	Unloading of raw feedstocks to Silos, Loss of Weight Hoppers, Mixer and Loading Areas all located Undercover and within a designated Concrete Hardstand Bund. Bunded area has drainage pathways to underground sumps.									
Waste Acceptance Criteria Review	n/a	Determination that the raw feedstock from the WtE plant(s) meets the acceptance criteria.	EMRC to refuse the acceptance of the raw feedstocks where they fail to meet criteria.	**Periodic** laboratory testing of raw feedstock APCr to satisfy the "ash characterisation plan" at specified intervals and prior to receivals at the WMF.	Reprocessing of the raw feedstocks by the WtE plant(s), and/or disposal of the feedstock into an appropriate class landfill.	Refusal to receive raw feedstocks	Slight	Rare	Low	Low
Waste Receival of Raw Feedstock.	Closed system pneumatic transfer of fly-ash from WtE plant(s).	WMF is notified of an impending delivery from the WtE plant(s). Delivery of raw feedstock using 27-tonne capacity pneumatic dry powder tanker trailers. Delivery over weighbridge to undergo waste acceptance criteria checks. Categorised waste delivery to APCr Facility via designated internal route.	Administration and Control Room for the Facility have a line-of-sight to the key activity's areas at the Facility. Surface water and Process Spills contained and drained to sumps within the concrete hardstand bund. Manual connections of the pipework (hoses) from pneumatic dry powder tanker to Silo(s) prior to engagement of the pneumatic pump for materials delivery.	Nil.	Damaged transfer hoses (truck-to-silo) are off-the-shelf and immediately replaceable. Spills are contained within the concrete hardstand bund and subsequently contained within drainage sumps. Damaged Silo transfer points can be isolated and repaired as required.	Alternative Silos for transfer.	Slight	Rare	Low	Low
Storage Silos' Operations for Transfer of Raw Feedstock and Cement.	Low-level Fugitive losses of dusts and contaminants from transfer of materials.	Pneumatic transfer of raw feedstock and cement via a closed hose connection.	Lids of Silos are domed and sloping to alleviate water ponding. Internally fitted drainpipe from the silo lid. Fill pipe design set to create cyclone effect internally. Reverse Jet-Pulse Dust Filter fitted to each Silo. Ensure receiving Silo has the capacity to receive the raw feedstock prior to transfer of materials.	**Periodic** sampling and analysis of dust and particle emissions during filling of Silos to monitor the efficacy of the Dust Filtration System in delivering compliant emissions for dust and particles of < 10 milligrams per normal cubic metre (mg/Nm^3).	New dust filter bag installed as required. Dust filter bags are disposed of back into the APCr Facility.	Immediate cessation of Silo filling if "visible" dust emissions are present. Diversion of feedstock to alternate Silo.	Minor	Unlikely	Medium	Low

Activity	Emission Source / Pathway	Process Description	Process Control	Proposed Monitoring	Corrective Actions	Contingency Actions	Residual Emissions Impact Potential (Risk assessment)			
							Consequence	Likelihood	Potential (onsite)	Potential (receptor)
Storage Silos' Operations for Controlling "Overfill".	Overfilling of Silos risks emission losses due to overburden of Dust Filtration System.	Pneumatic transfer of raw feedstock and cement via a closed hose connection.	An overfill protection system comprising: • Audible alarm, • Strobe light, • Test circuit facility, • High level probe mounted on lid of Silos; and • 100mm air actuated butterfly valve at inlet end of fill pipe.	Not required given the Overfill Controls. Inspection of Dust Filtration System for regular changeout of filter bags as required.	Immediate cessation of Silo filling if "visible" dust emissions are present. Diversion of feedstock to alternate Silo.	Diversion of feedstock to alternate Silo.	Moderate	Rare	Medium	Low
Transfer of raw feedstock and cement to Loss of Weight Hopper.	Negligible pathways for fugitive emissions given the closed system and enclosed screw discharge of materials.	Transfer of raw feedstock and cement into separate Loss of Weight Hoppers for subsequent transfer of materials to the APCr mixer (immobilisation). Loss of Weight Hopper measures changes in materials weight and controls the materials by accepting/feeding the materials to/from the Hoppers at the required dosing rates.	Reverse Jet-Pulse Dust Filter fitted to the Hoppers to capture and mitigate dust and particle emission losses.	Regular inspection of the screw transfer system to ensure no blockages.	Cessation of materials transfers to Hoppers and maintenance and/or replacement of breakdown components.	Sufficient contingency volume within the Hoppers to allow periodic cessation of materials transfers.	Minor	Unlikely	Medium	Low
Mixing of Raw Feedstock, Cement and Water for APCr Immobilisation.	Limited fugitive emissions given the closed system transfers.	Materials transfer from Loss of Weight Hoppers to Mixing Chamber.	Soft start paddle mixer within enclosed fill and mixing chamber.	Regular inspection of the mixing chamber to ensure efficient working parameters.	Cessation of materials transfers and mixing of the APCr as required for maintenance and/or replacement of breakdown components.	Sufficient contingency volume within the Hoppers to allow periodic cessation of materials transfers.	Minor	Rare	Low	Low
Transfer of Immobilised APCr to Agitator Trucks for landfill burial	No risk of airborne missions.	Transfer of "wet" APCr into awaiting agitator truck as per normal transfer of, for example, wet cement into agitator truck.	Normal materials transfer route from Facility to agitator truck.	Not required other than general and routine maintenance.	Not required for airborne emissions.	Not required.	Slight	Rare	Low	Low
Burial of APCr to Class IV Landfill		APCr transported to Class IV landfill via designated internal route.	Materials discharge of immobilised APCr into Class IV Landfill as per normal pipework transfer from truck to landfill.	Not required regarding airborne emissions. Normal inspection of landfill liner and leachate capture system.						

Appendix B PM_{10} GLCs at all receptors (from EAQ 2024)

Receptor	Maximum 1-hour GLC (µg/m³)	Maximum 24-hour GLC (µg/m³)	Annual GLC (µg/m³)
R-1	1.84	0.35	0.010
R-2	1.21	0.13	0.007
R-3	1.16	0.12	0.006
R-4	0.83	0.16	0.005
R-5	0.79	0.16	0.004
R-6	0.89	0.11	0.004
R-7	0.80	0.08	0.005
R-8	0.74	0.08	0.005
R-9	1.00	0.09	0.004
R-10	0.80	0.12	0.005
R-11	0.62	0.10	0.004
R-12	0.88	0.12	0.005
R-13	0.87	0.09	0.006
R-14	0.72	0.10	0.005
R-15	1.04	0.15	0.005
R-16	1.00	0.16	0.005
R-17	0.83	0.16	0.005
R-18	0.88	0.17	0.006
R-19	0.94	0.17	0.006
R-20	1.19	0.16	0.007
R-21	1.80	0.15	0.007
R-22	2.04	0.15	0.008
R-23	1.79	0.14	0.009
R-24	2.13	0.18	0.010
R-25	2.96	0.18	0.010
R-26	2.18	0.20	0.011
R-27	5.21	0.24	0.015

Appendix C Predicted GLCs (µg/m^3) for particulates, metals and dioxins at sensitive receptors

1-hour

Receptor	Al	Sb	As	Ba	Be	B	Cd	Cr	CrVI	Co	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	P	Ag	Sn	V	Zn	Dioxins/ furans
R_1	1.8E-02	3.4E-04	4.7E-05	1.8E-04	3.7E-07	9.1E-05	2.4E-04	7.7E-05	3.7E-07	1.5E-05	7.1E-04	4.4E-03	1.8E-03	1.9E-05	6.9E-04	1.5E-05	7.4E-06	3.7E-05	2.2E-06	1.6E-05	4.7E-04	3.4E-05	1.5E-02	1.5E-08
R_2	1.2E-02	2.2E-04	3.1E-05	1.2E-04	2.4E-07	6.0E-05	1.6E-04	5.1E-05	2.4E-07	9.7E-06	4.7E-04	2.9E-03	1.2E-03	1.3E-05	4.6E-04	9.7E-06	4.8E-06	2.4E-05	1.5E-06	1.1E-05	3.1E-04	2.2E-05	9.7E-03	9.7E-09
R_3	1.1E-02	2.1E-04	3.0E-05	1.1E-04	2.3E-07	5.7E-05	1.5E-04	4.8E-05	2.3E-07	9.3E-06	4.5E-04	2.8E-03	1.1E-03	1.2E-05	4.4E-04	9.3E-06	4.6E-06	2.3E-05	1.4E-06	1.0E-05	3.0E-04	2.1E-05	9.3E-03	9.3E-09
R_4	8.0E-03	1.5E-04	2.1E-05	8.0E-05	1.7E-07	4.1E-05	1.1E-04	3.5E-05	1.7E-07	6.6E-06	3.2E-04	2.0E-03	8.0E-04	8.6E-06	3.1E-04	6.6E-06	3.3E-06	1.7E-05	1.0E-06	7.3E-06	2.1E-04	1.5E-05	6.6E-03	6.6E-09
R_5	7.6E-03	1.5E-04	2.0E-05	7.6E-05	1.6E-07	3.9E-05	1.0E-04	3.3E-05	1.6E-07	6.3E-06	3.0E-04	1.9E-03	7.6E-04	8.3E-06	3.0E-04	6.3E-06	3.2E-06	1.6E-05	9.5E-07	7.0E-06	2.0E-04	1.5E-05	6.3E-03	6.3E-09
R_6	8.5E-03	1.6E-04	2.3E-05	8.5E-05	1.8E-07	4.4E-05	1.1E-04	3.7E-05	1.8E-07	7.1E-06	3.4E-04	2.1E-03	8.5E-04	9.3E-06	3.4E-04	7.1E-06	3.6E-06	1.8E-05	1.1E-06	7.8E-06	2.3E-04	1.6E-05	7.1E-03	7.1E-09
R_7	7.7E-03	1.5E-04	2.0E-05	7.7E-05	1.6E-07	4.0E-05	1.0E-04	3.3E-05	1.6E-07	6.4E-06	3.1E-04	1.9E-03	7.7E-04	8.3E-06	3.0E-04	6.4E-06	3.2E-06	1.6E-05	9.6E-07	7.0E-06	2.0E-04	1.5E-05	6.4E-03	6.4E-09
R_8	7.1E-03	1.4E-04	1.9E-05	7.1E-05	1.5E-07	3.7E-05	9.4E-05	3.1E-05	1.5E-07	5.9E-06	2.8E-04	1.8E-03	7.1E-04	7.7E-06	2.8E-04	5.9E-06	2.9E-06	1.5E-05	8.8E-07	6.5E-06	1.9E-04	1.4E-05	5.9E-03	5.9E-09
R_9	9.6E-03	1.8E-04	2.6E-05	9.6E-05	2.0E-07	5.0E-05	1.3E-04	4.2E-05	2.0E-07	8.0E-06	3.9E-04	2.4E-03	9.6E-04	1.0E-05	3.8E-04	8.0E-06	4.0E-06	2.0E-05	1.2E-06	8.8E-06	2.6E-04	1.8E-05	8.0E-03	8.0E-09
R_10	7.7E-03	1.5E-04	2.0E-05	7.7E-05	1.6E-07	4.0E-05	1.0E-04	3.3E-05	1.6E-07	6.4E-06	3.1E-04	1.9E-03	7.7E-04	8.3E-06	3.0E-04	6.4E-06	3.2E-06	1.6E-05	9.6E-07	7.0E-06	2.0E-04	1.5E-05	6.4E-03	6.4E-09
R_11	5.9E-03	1.1E-04	1.6E-05	5.9E-05	1.2E-07	3.1E-05	7.9E-05	2.6E-05	1.2E-07	5.0E-06	2.4E-04	1.5E-03	5.9E-04	6.4E-06	2.3E-04	5.0E-06	2.5E-06	1.2E-05	7.4E-07	5.4E-06	1.6E-04	1.1E-05	5.0E-03	5.0E-09
R_12	8.4E-03	1.6E-04	2.3E-05	8.4E-05	1.8E-07	4.4E-05	1.1E-04	3.7E-05	1.8E-07	7.0E-06	3.4E-04	2.1E-03	8.4E-04	9.1E-06	3.3E-04	7.0E-06	3.5E-06	1.8E-05	1.1E-06	7.7E-06	2.2E-04	1.6E-05	7.0E-03	7.0E-09
R_13	8.3E-03	1.6E-04	2.2E-05	8.3E-05	1.7E-07	4.3E-05	1.1E-04	3.6E-05	1.7E-07	6.9E-06	3.3E-04	2.1E-03	8.3E-04	9.0E-06	3.3E-04	6.9E-06	3.5E-06	1.7E-05	1.0E-06	7.6E-06	2.2E-04	1.6E-05	6.9E-03	6.9E-09
R_14	6.9E-03	1.3E-04	1.8E-05	6.9E-05	1.5E-07	3.6E-05	9.2E-05	3.0E-05	1.4E-07	5.8E-06	2.8E-04	1.7E-03	6.9E-04	7.5E-06	2.7E-04	5.8E-06	2.9E-06	1.4E-05	8.7E-07	6.3E-06	1.8E-04	1.3E-05	5.8E-03	5.8E-09
R_15	1.0E-02	1.9E-04	2.7E-05	1.0E-04	2.1E-07	5.2E-05	1.3E-04	4.3E-05	2.1E-07	8.3E-06	4.0E-04	2.5E-03	1.0E-03	1.1E-05	3.9E-04	8.3E-06	4.2E-06	2.1E-05	1.2E-06	9.1E-06	2.7E-04	1.9E-05	8.3E-03	8.3E-09
R_16	9.6E-03	1.8E-04	2.6E-05	9.6E-05	2.0E-07	5.0E-05	1.3E-04	4.2E-05	2.0E-07	8.0E-06	3.8E-04	2.4E-03	9.6E-04	1.0E-05	3.8E-04	8.0E-06	4.0E-06	2.0E-05	1.2E-06	8.8E-06	2.6E-04	1.8E-05	8.0E-03	8.0E-09
R_17	8.0E-03	1.5E-04	2.1E-05	8.0E-05	1.7E-07	4.1E-05	1.1E-04	3.5E-05	1.7E-07	6.7E-06	3.2E-04	2.0E-03	8.0E-04	8.7E-06	3.1E-04	6.7E-06	3.3E-06	1.7E-05	1.0E-06	7.3E-06	2.1E-04	1.5E-05	6.7E-03	6.7E-09
R_18	8.5E-03	1.6E-04	2.3E-05	8.5E-05	1.8E-07	4.4E-05	1.1E-04	3.7E-05	1.8E-07	7.1E-06	3.4E-04	2.1E-03	8.5E-04	9.2E-06	3.3E-04	7.1E-06	3.5E-06	1.8E-05	1.1E-06	7.8E-06	2.3E-04	1.6E-05	7.1E-03	7.1E-09
R_19	9.0E-03	1.7E-04	2.4E-05	9.0E-05	1.9E-07	4.7E-05	1.2E-04	3.9E-05	1.9E-07	7.5E-06	3.6E-04	2.3E-03	9.0E-04	9.8E-06	3.5E-04	7.5E-06	3.8E-06	1.9E-05	1.1E-06	8.3E-06	2.4E-04	1.7E-05	7.5E-03	7.5E-09
R_20	1.1E-02	2.2E-04	3.0E-05	1.1E-04	2.4E-07	5.9E-05	1.5E-04	4.9E-05	2.4E-07	9.5E-06	4.6E-04	2.8E-03	1.1E-03	1.2E-05	4.5E-04	9.5E-06	4.7E-06	2.4E-05	1.4E-06	1.0E-05	3.0E-04	2.2E-05	9.5E-03	9.5E-09
R_21	1.7E-02	3.3E-04	4.6E-05	1.7E-04	3.6E-07	8.9E-05	2.3E-04	7.5E-05	3.6E-07	1.4E-05	6.9E-04	4.3E-03	1.7E-03	1.9E-05	6.8E-04	1.4E-05	7.2E-06	3.6E-05	2.2E-06	1.6E-05	4.6E-04	3.3E-05	1.4E-02	1.4E-08
R_22	2.0E-02	3.8E-04	5.2E-05	2.0E-04	4.1E-07	1.0E-04	2.6E-04	8.5E-05	4.1E-07	1.6E-05	7.8E-04	4.9E-03	2.0E-03	2.1E-05	7.7E-04	1.6E-05	8.2E-06	4.1E-05	2.5E-06	1.8E-05	5.2E-04	3.8E-05	1.6E-02	1.6E-08
R_23	1.7E-02	3.3E-04	4.6E-05	1.7E-04	3.6E-07	8.9E-05	2.3E-04	7.4E-05	3.6E-07	1.4E-05	6.9E-04	4.3E-03	1.7E-03	1.9E-05	6.7E-04	1.4E-05	7.1E-06	3.6E-05	2.1E-06	1.6E-05	4.6E-04	3.3E-05	1.4E-02	1.4E-08
R_24	2.0E-02	3.9E-04	5.4E-05	2.0E-04	4.3E-07	1.1E-04	2.7E-04	8.9E-05	4.3E-07	1.7E-05	8.2E-04	5.1E-03	2.0E-03	2.2E-05	8.0E-04	1.7E-05	8.5E-06	4.3E-05	2.6E-06	1.9E-05	5.4E-04	3.9E-05	1.7E-02	1.7E-08
R_25	2.8E-02	5.5E-04	7.6E-05	2.8E-04	6.0E-07	1.5E-04	3.8E-04	1.2E-04	5.9E-07	2.4E-05	1.1E-03	7.1E-03	2.8E-03	3.1E-05	1.1E-03	2.4E-05	1.2E-05	6.0E-05	3.6E-06	2.6E-05	7.6E-04	5.5E-05	2.4E-02	2.4E-08
R_26	2.1E-02	4.0E-04	5.6E-05	2.1E-04	4.4E-07	1.1E-04	2.8E-04	9.1E-05	4.4E-07	1.7E-05	8.4E-04	5.2E-03	2.1E-03	2.3E-05	8.2E-04	1.7E-05	8.7E-06	4.4E-05	2.6E-06	1.9E-05	5.6E-04	4.0E-05	1.7E-02	1.7E-08
R_27	5.0E-02	9.6E-04	1.3E-04	5.0E-04	1.0E-06	2.6E-04	6.7E-04	2.2E-04	1.0E-06	4.2E-05	2.0E-03	1.2E-02	5.0E-03	5.4E-05	2.0E-03	4.2E-05	2.1E-05	1.0E-04	6.2E-06	4.6E-05	1.3E-03	9.6E-05	4.2E-02	4.2E-08

24-hour

Receptor	Al	Sb	As	Ba	Be	B	Cd	Cr	CrVI	Co	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	P	Ag	Sn	V	Zn	Dioxins/ furans
R_1	3.4E-03	6.5E-05	9.0E-06	3.4E-05	7.1E-08	1.8E-05	4.5E-05	1.5E-05	7.1E-08	2.8E-06	1.4E-04	8.5E-04	3.4E-04	3.7E-06	1.3E-04	2.8E-06	1.4E-06	7.1E-06	4.2E-07	3.1E-06	9.0E-05	6.5E-06	2.8E-03	2.8E-09
R_2	1.3E-03	2.4E-05	3.4E-06	1.3E-05	2.6E-08	6.5E-06	1.7E-05	5.5E-06	2.6E-08	1.1E-06	5.1E-05	3.2E-04	1.3E-04	1.4E-06	5.0E-05	1.1E-06	5.3E-07	2.6E-06	1.6E-07	1.2E-06	3.4E-05	2.4E-06	1.1E-03	1.1E-09
R_3	1.2E-03	2.3E-05	3.1E-06	1.2E-05	2.5E-08	6.1E-06	1.6E-05	5.1E-06	2.5E-08	9.8E-07	4.7E-05	2.9E-04	1.2E-04	1.3E-06	4.6E-05	9.8E-07	4.9E-07	2.5E-06	1.5E-07	1.1E-06	3.1E-05	2.3E-06	9.8E-04	9.8E-10
R_4	1.6E-03	3.0E-05	4.2E-06	1.6E-05	3.3E-08	8.2E-06	2.1E-05	6.9E-06	3.3E-08	1.3E-06	6.3E-05	4.0E-04	1.6E-04	1.7E-06	6.2E-05	1.3E-06	6.6E-07	3.3E-06	2.0E-07	1.4E-06	4.2E-05	3.0E-06	1.3E-03	1.3E-09
R_5	1.6E-03	3.0E-05	4.1E-06	1.6E-05	3.3E-08	8.0E-06	2.1E-05	6.7E-06	3.2E-08	1.3E-06	6.2E-05	3.9E-04	1.6E-04	1.7E-06	6.1E-05	1.3E-06	6.5E-07	3.3E-06	1.9E-07	1.4E-06	4.1E-05	3.0E-06	1.3E-03	1.3E-09
R_6	1.0E-03	2.0E-05	2.7E-06	1.0E-05	2.2E-08	5.3E-06	1.4E-05	4.5E-06	2.1E-08	8.6E-07	4.1E-05	2.6E-04	1.0E-04	1.1E-06	4.0E-05	8.6E-07	4.3E-07	2.2E-06	1.3E-07	9.4E-07	2.7E-05	2.0E-06	8.6E-04	8.6E-10
R_7	7.8E-04	1.5E-05	2.1E-06	7.8E-06	1.6E-08	4.0E-06	1.0E-05	3.4E-06	1.6E-08	6.5E-07	3.1E-05	2.0E-04	7.8E-05	8.5E-07	3.1E-05	6.5E-07	3.3E-07	1.6E-06	9.8E-08	7.2E-07	2.1E-05	1.5E-06	6.5E-04	6.5E-10
R_8	7.6E-04	1.5E-05	2.0E-06	7.6E-06	1.6E-08	3.9E-06	1.0E-05	3.3E-06	1.6E-08	6.3E-07	3.0E-05	1.9E-04	7.6E-05	8.2E-07	3.0E-05	6.3E-07	3.2E-07	1.6E-06	9.5E-08	7.0E-07	2.0E-05	1.5E-06	6.3E-04	6.3E-10
R_9	8.7E-04	1.7E-05	2.3E-06	8.7E-06	1.8E-08	4.5E-06	1.2E-05	3.8E-06	1.8E-08	7.3E-07	3.5E-05	2.2E-04	8.7E-05	9.4E-07	3.4E-05	7.3E-07	3.6E-07	1.8E-06	1.1E-07	8.0E-07	2.3E-05	1.7E-06	7.3E-04	7.3E-10
R_10	1.2E-03	2.2E-05	3.1E-06	1.2E-05	2.4E-08	6.0E-06	1.6E-05	5.0E-06	2.4E-08	9.7E-07	4.7E-05	2.9E-04	1.2E-04	1.3E-06	4.6E-05	9.7E-07	4.8E-07	2.4E-06	1.5E-07	1.1E-06	3.1E-05	2.2E-06	9.7E-04	9.7E-10
R_11	9.4E-04	1.8E-05	2.5E-06	9.4E-06	2.0E-08	4.9E-06	1.3E-05	4.1E-06	2.0E-08	7.9E-07	3.8E-05	2.4E-04	9.4E-05	1.0E-06	3.7E-05	7.9E-07	3.9E-07	2.0E-06	1.2E-07	8.7E-07	2.5E-05	1.8E-06	7.9E-04	7.9E-10
R_12	1.2E-03	2.2E-05	3.1E-06	1.2E-05	2.4E-08	6.0E-06	1.5E-05	5.0E-06	2.4E-08	9.7E-07	4.6E-05	2.9E-04	1.2E-04	1.3E-06	4.6E-05	9.7E-07	4.8E-07	2.4E-06	1.5E-07	1.1E-06	3.1E-05	2.2E-06	9.7E-04	9.7E-10
R_13	8.8E-04	1.7E-05	2.4E-06	8.8E-06	1.9E-08	4.6E-06	1.2E-05	3.8E-06	1.8E-08	7.4E-07	3.5E-05	2.2E-04	8.8E-05	9.6E-07	3.5E-05	7.4E-07	3.7E-07	1.9E-06	1.1E-07	8.1E-07	2.4E-05	1.7E-06	7.4E-04	7.4E-10
R_14	9.6E-04	1.8E-05	2.6E-06	9.6E-06	2.0E-08	5.0E-06	1.3E-05	4.2E-06	2.0E-08	8.0E-07	3.9E-05	2.4E-04	9.6E-05	1.0E-06	3.8E-05	8.0E-07	4.0E-07	2.0E-06	1.2E-07	8.8E-07	2.6E-05	1.8E-06	8.0E-04	8.0E-10
R_15	1.4E-03	2.7E-05	3.8E-06	1.4E-05	3.0E-08	7.4E-06	1.9E-05	6.2E-06	3.0E-08	1.2E-06	5.7E-05	3.6E-04	1.4E-04	1.5E-06	5.6E-05	1.2E-06	5.9E-07	3.0E-06	1.8E-07	1.3E-06	3.8E-05	2.7E-06	1.2E-03	1.2E-09
R_16	1.5E-03	2.9E-05	4.1E-06	1.5E-05	3.2E-08	7.8E-06	2.0E-05	6.6E-06	3.2E-08	1.3E-06	6.1E-05	3.8E-04	1.5E-04	1.6E-06	6.0E-05	1.3E-06	6.3E-07	3.2E-06	1.9E-07	1.4E-06	4.0E-05	2.9E-06	1.3E-03	1.3E-09
R_17	1.5E-03	3.0E-05	4.1E-06	1.5E-05	3.2E-08	8.0E-06	2.1E-05	6.7E-06	3.2E-08	1.3E-06	6.2E-05	3.9E-04	1.5E-04	1.7E-06	6.1E-05	1.3E-06	6.4E-07	3.2E-06	1.9E-07	1.4E-06	4.1E-05	3.0E-06	1.3E-03	1.3E-09
R_18	1.6E-03	3.1E-05	4.3E-06	1.6E-05	3.3E-08	8.3E-06	2.1E-05	6.9E-06	3.3E-08	1.3E-06	6.4E-05	4.0E-04	1.6E-04	1.7E-06	6.3E-05	1.3E-06	6.7E-07	3.3E-06	2.0E-07	1.5E-06	4.3E-05	3.1E-06	1.3E-03	1.3E-09
R_19	1.7E-03	3.2E-05	4.4E-06	1.7E-05	3.5E-08	8.6E-06	2.2E-05	7.2E-06	3.5E-08	1.4E-06	6.6E-05	4.1E-04	1.7E-04	1.8E-06	6.5E-05	1.4E-06	6.9E-07	3.5E-06	2.1E-07	1.5E-06	4.4E-05	3.2E-06	1.4E-03	1.4E-09
R_20	1.5E-03	2.9E-05	4.1E-06	1.5E-05	3.2E-08	7.9E-06	2.0E-05	6.6E-06	3.2E-08	1.3E-06	6.1E-05	3.8E-04	1.5E-04	1.7E-06	6.0E-05	1.3E-06	6.3E-07	3.2E-06	1.9E-07	1.4E-06	4.1E-05	2.9E-06	1.3E-03	1.3E-09
R_21	1.5E-03	2.8E-05	4.0E-06	1.5E-05	3.1E-08	7.7E-06	2.0E-05	6.4E-06	3.1E-08	1.2E-06	5.9E-05	3.7E-04	1.5E-04	1.6E-06	5.8E-05	1.2E-06	6.2E-07	3.1E-06	1.9E-07	1.4E-06	4.0E-05	2.8E-06	1.2E-03	1.2E-09
R_22	1.4E-03	2.7E-05	3.7E-06	1.4E-05	2.9E-08	7.2E-06	1.9E-05	6.1E-06	2.9E-08	1.2E-06	5.6E-05	3.5E-04	1.4E-04	1.5E-06	5.5E-05	1.2E-06	5.8E-07	2.9E-06	1.7E-07	1.3E-06	3.7E-05	2.7E-06	1.2E-03	1.2E-09
R_23	1.4E-03	2.7E-05	3.7E-06	1.4E-05	2.9E-08	7.1E-06	1.8E-05	6.0E-06	2.9E-08	1.2E-06	5.5E-05	3.5E-04	1.4E-04	1.5E-06	5.4E-05	1.2E-06	5.8E-07	2.9E-06	1.7E-07	1.3E-06	3.7E-05	2.7E-06	1.2E-03	1.2E-09
R_24	1.8E-03	3.4E-05	4.7E-06	1.8E-05	3.7E-08	9.1E-06	2.3E-05	7.6E-06	3.7E-08	1.5E-06	7.0E-05	4.4E-04	1.8E-04	1.9E-06	6.9E-05	1.5E-06	7.3E-07	3.7E-06	2.2E-07	1.6E-06	4.7E-05	3.4E-06	1.5E-03	1.5E-09
R_25	1.7E-03	3.3E-05	4.6E-06	1.7E-05	3.6E-08	8.8E-06	2.3E-05	7.4E-06	3.6E-08	1.4E-06	6.8E-05	4.3E-04	1.7E-04	1.8E-06	6.7E-05	1.4E-06	7.1E-07	3.6E-06	2.1E-07	1.6E-06	4.6E-05	3.3E-06	1.4E-03	1.4E-09
R_26	1.9E-03	3.6E-05	5.1E-06	1.9E-05	4.0E-08	9.8E-06	2.5E-05	8.3E-06	4.0E-08	1.6E-06	7.6E-05	4.8E-04	1.9E-04	2.1E-06	7.5E-05	1.6E-06	7.9E-07	4.0E-06	2.4E-07	1.7E-06	5.1E-05	3.6E-06	1.6E-03	1.6E-09
R_27	2.3E-03	4.4E-05	6.1E-06	2.3E-05	4.8E-08	1.2E-05	3.1E-05	9.9E-06	4.8E-08	1.9E-06	9.2E-05	5.7E-04	2.3E-04	2.5E-06	9.0E-05	1.9E-06	9.5E-07	4.8E-06	2.9E-07	2.1E-06	6.1E-05	4.4E-06	1.9E-03	1.9E-09

Annual

Receptor	Al	Sb	As	Ba	Be	B	Cd	Cr	CrVI	Co	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	P	Ag	Sn	V	Zn	Dioxins/ furans
R_1	9.2E-05	1.8E-06	2.5E-07	9.2E-07	1.9E-09	4.8E-07	1.2E-06	4.0E-07	1.9E-09	7.7E-08	3.7E-06	2.3E-05	9.2E-06	1.0E-07	3.6E-06	7.7E-08	3.8E-08	1.9E-07	1.2E-08	8.4E-08	2.5E-06	1.8E-07	7.7E-05	7.7E-11
R_2	6.2E-05	1.2E-06	1.7E-07	6.2E-07	1.3E-09	3.2E-07	8.3E-07	2.7E-07	1.3E-09	5.2E-08	2.5E-06	1.6E-05	6.2E-06	6.8E-08	2.4E-06	5.2E-08	2.6E-08	1.3E-07	7.8E-09	5.7E-08	1.7E-06	1.2E-07	5.2E-05	5.2E-11
R_3	5.8E-05	1.1E-06	1.5E-07	5.8E-07	1.2E-09	3.0E-07	7.7E-07	2.5E-07	1.2E-09	4.8E-08	2.3E-06	1.4E-05	5.8E-06	6.2E-08	2.3E-06	4.8E-08	2.4E-08	1.2E-07	7.2E-09	5.3E-08	1.5E-06	1.1E-07	4.8E-05	4.8E-11
R_4	4.5E-05	8.6E-07	1.2E-07	4.5E-07	9.5E-10	2.3E-07	6.0E-07	2.0E-07	9.4E-10	3.8E-08	1.8E-06	1.1E-05	4.5E-06	4.9E-08	1.8E-06	3.8E-08	1.9E-08	9.4E-08	5.6E-09	4.1E-08	1.2E-06	8.6E-08	3.8E-05	3.8E-11
R_5	4.1E-05	7.9E-07	1.1E-07	4.1E-07	8.6E-10	2.1E-07	5.5E-07	1.8E-07	8.6E-10	3.4E-08	1.7E-06	1.0E-05	4.1E-06	4.5E-08	1.6E-06	3.4E-08	1.7E-08	8.6E-08	5.2E-09	3.8E-08	1.1E-06	7.9E-08	3.4E-05	3.4E-11
R_6	3.8E-05	7.4E-07	1.0E-07	3.8E-07	8.0E-10	2.0E-07	5.1E-07	1.7E-07	8.0E-10	3.2E-08	1.5E-06	9.6E-06	3.8E-06	4.2E-08	1.5E-06	3.2E-08	1.6E-08	8.0E-08	4.8E-09	3.5E-08	1.0E-06	7.4E-08	3.2E-05	3.2E-11
R_7	4.3E-05	8.3E-07	1.2E-07	4.3E-07	9.1E-10	2.2E-07	5.8E-07	1.9E-07	9.0E-10	3.6E-08	1.7E-06	1.1E-05	4.3E-06	4.7E-08	1.7E-06	3.6E-08	1.8E-08	9.0E-08	5.4E-09	4.0E-08	1.2E-06	8.3E-08	3.6E-05	3.6E-11
R_8	4.3E-05	8.3E-07	1.2E-07	4.3E-07	9.1E-10	2.2E-07	5.8E-07	1.9E-07	9.0E-10	3.6E-08	1.7E-06	1.1E-05	4.3E-06	4.7E-08	1.7E-06	3.6E-08	1.8E-08	9.0E-08	5.4E-09	4.0E-08	1.2E-06	8.3E-08	3.6E-05	3.6E-11
R_9	4.1E-05	7.9E-07	1.1E-07	4.1E-07	8.6E-10	2.1E-07	5.5E-07	1.8E-07	8.6E-10	3.4E-08	1.7E-06	1.0E-05	4.1E-06	4.5E-08	1.6E-06	3.4E-08	1.7E-08	8.6E-08	5.2E-09	3.8E-08	1.1E-06	7.9E-08	3.4E-05	3.4E-11
R_10	4.5E-05	8.6E-07	1.2E-07	4.5E-07	9.5E-10	2.3E-07	6.0E-07	2.0E-07	9.4E-10	3.8E-08	1.8E-06	1.1E-05	4.5E-06	4.9E-08	1.8E-06	3.8E-08	1.9E-08	9.4E-08	5.6E-09	4.1E-08	1.2E-06	8.6E-08	3.8E-05	3.8E-11
R_11	4.0E-05	7.7E-07	1.1E-07	4.0E-07	8.4E-10	2.1E-07	5.4E-07	1.8E-07	8.4E-10	3.4E-08	1.6E-06	1.0E-05	4.0E-06	4.4E-08	1.6E-06	3.4E-08	1.7E-08	8.4E-08	5.0E-09	3.7E-08	1.1E-06	7.7E-08	3.4E-05	3.4E-11
R_12	4.8E-05	9.2E-07	1.3E-07	4.8E-07	1.0E-09	2.5E-07	6.4E-07	2.1E-07	1.0E-09	4.0E-08	1.9E-06	1.2E-05	4.8E-06	5.2E-08	1.9E-06	4.0E-08	2.0E-08	1.0E-07	6.0E-09	4.4E-08	1.3E-06	9.2E-08	4.0E-05	4.0E-11
R_13	5.4E-05	1.0E-06	1.4E-07	5.4E-07	1.1E-09	2.8E-07	7.2E-07	2.3E-07	1.1E-09	4.5E-08	2.2E-06	1.3E-05	5.4E-06	5.8E-08	2.1E-06	4.5E-08	2.2E-08	1.1E-07	6.7E-09	4.9E-08	1.4E-06	1.0E-07	4.5E-05	4.5E-11
R_14	5.0E-05	9.6E-07	1.3E-07	5.0E-07	1.0E-09	2.6E-07	6.7E-07	2.2E-07	1.0E-09	4.2E-08	2.0E-06	1.2E-05	5.0E-06	5.4E-08	2.0E-06	4.2E-08	2.1E-08	1.0E-07	6.2E-09	4.6E-08	1.3E-06	9.6E-08	4.2E-05	4.2E-11
R_15	4.6E-05	8.8E-07	1.2E-07	4.6E-07	9.7E-10	2.4E-07	6.1E-07	2.0E-07	9.6E-10	3.8E-08	1.8E-06	1.2E-05	4.6E-06	5.0E-08	1.8E-06	3.8E-08	1.9E-08	9.6E-08	5.8E-09	4.2E-08	1.2E-06	8.8E-08	3.8E-05	3.8E-11
R_16	4.9E-05	9.4E-07	1.3E-07	4.9E-07	1.0E-09	2.5E-07	6.5E-07	2.1E-07	1.0E-09	4.1E-08	2.0E-06	1.2E-05	4.9E-06	5.3E-08	1.9E-06	4.1E-08	2.0E-08	1.0E-07	6.1E-09	4.5E-08	1.3E-06	9.4E-08	4.1E-05	4.1E-11
R_17	5.0E-05	9.6E-07	1.3E-07	5.0E-07	1.0E-09	2.6E-07	6.7E-07	2.2E-07	1.0E-09	4.2E-08	2.0E-06	1.2E-05	5.0E-06	5.4E-08	2.0E-06	4.2E-08	2.1E-08	1.0E-07	6.2E-09	4.6E-08	1.3E-06	9.6E-08	4.2E-05	4.2E-11
R_18	5.4E-05	1.0E-06	1.4E-07	5.4E-07	1.1E-09	2.8E-07	7.2E-07	2.3E-07	1.1E-09	4.5E-08	2.2E-06	1.3E-05	5.4E-06	5.8E-08	2.1E-06	4.5E-08	2.2E-08	1.1E-07	6.7E-09	4.9E-08	1.4E-06	1.0E-07	4.5E-05	4.5E-11
R_19	5.9E-05	1.1E-06	1.6E-07	5.9E-07	1.2E-09	3.0E-07	7.8E-07	2.5E-07	1.2E-09	4.9E-08	2.3E-06	1.5E-05	5.9E-06	6.3E-08	2.3E-06	4.9E-08	2.4E-08	1.2E-07	7.3E-09	5.4E-08	1.6E-06	1.1E-07	4.9E-05	4.9E-11
R_20	6.3E-05	1.2E-06	1.7E-07	6.3E-07	1.3E-09	3.3E-07	8.4E-07	2.8E-07	1.3E-09	5.3E-08	2.5E-06	1.6E-05	6.3E-06	6.9E-08	2.5E-06	5.3E-08	2.6E-08	1.3E-07	7.9E-09	5.8E-08	1.7E-06	1.2E-07	5.3E-05	5.3E-11
R_21	7.1E-05	1.4E-06	1.9E-07	7.1E-07	1.5E-09	3.7E-07	9.5E-07	3.1E-07	1.5E-09	5.9E-08	2.8E-06	1.8E-05	7.1E-06	7.7E-08	2.8E-06	5.9E-08	3.0E-08	1.5E-07	8.9E-09	6.5E-08	1.9E-06	1.4E-07	5.9E-05	5.9E-11
R_22	8.0E-05	1.5E-06	2.1E-07	8.0E-07	1.7E-09	4.1E-07	1.1E-06	3.5E-07	1.7E-09	6.6E-08	3.2E-06	2.0E-05	8.0E-06	8.6E-08	3.1E-06	6.6E-08	3.3E-08	1.7E-07	1.0E-08	7.3E-08	2.1E-06	1.5E-07	6.6E-05	6.6E-11
R_23	8.6E-05	1.7E-06	2.3E-07	8.6E-07	1.8E-09	4.5E-07	1.2E-06	3.8E-07	1.8E-09	7.2E-08	3.5E-06	2.2E-05	8.6E-06	9.4E-08	3.4E-06	7.2E-08	3.6E-08	1.8E-07	1.1E-08	7.9E-08	2.3E-06	1.7E-07	7.2E-05	7.2E-11
R_24	9.2E-05	1.8E-06	2.5E-07	9.2E-07	1.9E-09	4.8E-07	1.2E-06	4.0E-07	1.9E-09	7.7E-08	3.7E-06	2.3E-05	9.2E-06	1.0E-07	3.6E-06	7.7E-08	3.8E-08	1.9E-07	1.2E-08	8.4E-08	2.5E-06	1.8E-07	7.7E-05	7.7E-11
R_25	1.0E-04	1.9E-06	2.7E-07	1.0E-06	2.1E-09	5.2E-07	1.3E-06	4.3E-07	2.1E-09	8.3E-08	4.0E-06	2.5E-05	1.0E-05	1.1E-07	3.9E-06	8.3E-08	4.2E-08	2.1E-07	1.2E-08	9.2E-08	2.7E-06	1.9E-07	8.3E-05	8.3E-11
R_26	1.1E-04	2.1E-06	2.9E-07	1.1E-06	2.3E-09	5.6E-07	1.4E-06	4.7E-07	2.3E-09	9.0E-08	4.3E-06	2.7E-05	1.1E-05	1.2E-07	4.3E-06	9.0E-08	4.5E-08	2.3E-07	1.4E-08	9.9E-08	2.9E-06	2.1E-07	9.0E-05	9.0E-11
R_27	1.4E-04	2.7E-06	3.7E-07	1.4E-06	2.9E-09	7.2E-07	1.9E-06	6.1E-07	2.9E-09	1.2E-07	5.6E-06	3.5E-05	1.4E-05	1.5E-07	5.5E-06	1.2E-07	5.8E-08	2.9E-07	1.8E-08	1.3E-07	3.7E-06	2.7E-07	1.2E-04	1.2E-10

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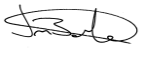
Rev 1	P. Forster	J. Bailes	J. Bailes		16 April 2025

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