RE: APPEAL BY FCC RECYCLING (UK) LTD PURSUANT TO REGULATION 31 OF THE ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2016 REGARDING DANESHILL SOIL TREATMENT FACILITY AT DANESHILL LANDFILL SITE AND 3C WASTE LIMITED PURSUANT TO REGULATION 31 OF THE ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2016 REGARDING MAW GREEN SOIL TREATMENT FACILITY AT MAW GREEN LANDFILL SITE

APPEAL REFERENCE APP/EPR/636 AND APP/EPR/651 (DANESHILL)

APPEAL REFERENCE APP/EPR/652 (MAW GREEN)

ENVIRONMENTAL PERMIT REFERENCE EPR/NP3538MF (DANESHILL)

ENVIRONMENTAL PERMIT REFERENCE EPR/BS7722ID (MAW GREEN)

REBUTTAL PROOF OF EVIDENCE OF SIMON JAMES COLE

Report Reference: 28480-HYD-XX-XX-RP-GE-0008

March 2024

Contents

List of Tables

Appendices

Hydrock

1. Summary

1.1.1 This document provides a Rebuttal Proof of Evidence to specific aspects of the Proof of Evidence of Paul Barker of the Environment Agency, and should be read in conjunction with my Proof of Evidence (reference 28480-HYD-XX-XX-RP-GE-0001 dated February 2024) [CD6/1/B].

1.1.2 In Section 3 I respond to the differences between off-site exposure from mobile plant permitted activities compared to permitted installations. A comparison between the cumulative off-site exposure from a mobile plant operating at the maximum permissible emission levels for up to 12 months and a soil treatment facility operating using the precautionary emission assumptions I adopted in my proof of evidence for the Daneshill and Maw Green sites shows that the offsite exposure risk from the mobile plant is potentially higher than that from the soil treatment facility.

1.1.3 In Section 4, I address whether the monitoring at Maw Green and ERQ accounts for reasonable worst-case and whether it is reasonable to assume that far higher asbestos sin soil concentrations could be consistently processed for an extended period of time. My conclusion, based on a comparison of the soil acceptance and validation data for Maw Green and ERQ, and data for the UK published by the Society of Brownfield Risk Assessment (SoBRA) in 2020 based on a survey of UK laboratories, is that the Maw Green and ERQ soil data is consistent with what is normally encountered at brownfield sites in the UK. To reach the acceptance and validation limits for loose, free fibres in soil set by Provectus would be a rare occurrence and would require very significant levels of asbestos containing materials to have been/be present in the soil to create such high free fibre concentrations.

1.1.4 In Section 5 I provide additional clarification on the location of the air monitoring samples reported for ERQ, based on further details provided by Provectus, in response to Environment Agency concerns that all monitoring locations were by doorways and therefore the results not truly representative of conditions in the building. In fact, two monitoring locations are in/close to doorways, whilst the remaining two locations are within the centre of the building located at the ends of the two internal bay walls.

2. Introduction

2.1 Terms of reference

2.1.1 My name is Simon James Cole and I am instructed by FCC Recycling (UK) Ltd (FCC) and 3C Waste Limited to provide evidence with respect to the potential fugitive emission of airborne asbestos fibres and associated health risk relating to the proposed treatment of asbestos contaminated soils at the Daneshill Landfill Site and Maw Green Landfill Site.

2.1.2 This document provides a Rebuttal Proof of Evidence to specific aspects of the Proof of Evidence of Paul Barker of the Environment Agency, and should be read in conjunction with my Proof of Evidence (reference 28480-HYD-XX-XX-RP-GE-0001 dated February 2024) [CD6/1/B].

2.1.3 The three aspects of Paul Barker's Evidence that I deal with here are that (a) there is a difference in the risk profile of mobile plant operated for less than 12 months under the deployment of a standard rules permit for mobile treatment, and the same plant operated as part of a Soil Treatment Facility, (b) that the air monitoring carried out at the ERQ and Maw Green Soil Treatment Facilities has not captured worst-case from a maximum asbestos in soil concentration perspective, and (c) that the monitoring locations within the ERQ building may not represent true conditions in the building.

2.2 Qualifications and experience

2.2.1 I am a Technical Director in Hydrock's Geo Division and the Practice Lead for Geoenvironment. I have a degree and PhD in Environmental Engineering and over 25 years' experience in environmental consultancy, with a specific focus on the risk assessment of land contamination. Further details of my qualifications and experience are set out in my Proof of Evidence.

2.3 Statement of truth

2.3.1 The evidence which I have prepared and provide for this appeal in this Evidence is true and has been prepared and is given in accordance with the guidance of my professional institutions and I confirm that the opinions expressed are my professional opinions unless otherwise attributed.

3. The differences between mobile plant permitted activities and Installations

3.1.1 In paragraphs 51 and 52 of Paul Barker's evidence it is stated that "mobile plant are very different in nature and scale compared to Installations" and that the short duration of the deployment (up to 12 months) minimises the level of risk and therefore the control measures required. The upshot being that the risk-profile of a mobile plant is not the same as that for a Soil Treatment Facility.

3.1.2 The health risk from exposure to airborne asbestos fibres is driven by cumulative exposure (i.e. point of exposure concentration x duration of exposure). If a soil processing activity involving asbestos contaminated soil was carried out for 12 months, and the identical activity carried out for 6-10 years, with the same control measures in place and the same air emissions, the relative exposure risk from the longer duration activity would be higher, assuming no change in receptor behaviour during that time period. In this case, with all other things being equal, the risk from the mobile plant operation would be at 6-10 times lower than that for the Soil Treatment Facility. This is relative risk comparison. I have already indicted in my Proof of Evidence that the off-site exposure risk from the operation of the Soil Treatment Facility is likely to be negligible.

3.1.3 Taking the comparison further, and based on the characterisation of the Soil Treatment Facility as set out in my Proof of Evidence, if the operational lifetime of the Soil Treatment facility is 6-10 years, the near-source emission concentration is not expected to exceed 500 f/m^3 on average, and the dispersion factor to off-site receptors is 1000, the long-term average off-site air concentrations are estimated to be less than 0.5f/m^3, and the associated health risk is less than 1 in 30 million (assuming off-site exposure is for 8 hrs per day, 365 days per year, for 10 years, and the asbestos type is amosite on a precautionary basis). The calculations for this are provided in Appendix A.

3.1.4 The permissible operation of a mobile plant is typically up to 12 months based on the standard deployment of a standard rules permit, although it can be extended beyond 12 months. The maximum boundary emission concentration set by the Environment Agency for these deployments is 0.01f/ml, based on the guidance in Environment Agency guidance M17. Assuming the same minimum off-site dispersion factor of 1000 applies, the estimated off-site concentration would be 10f/m^3. The estimated health risk, based on 12 months exposure to 10f/m^3 for 8 hrs per day for 365 days (asbestos type assumed to be amosite on a precautionary basis) is approximately 1 in 10 million. The calculations for this are provided in Appendix B.

3.1.5 The permissible risk associated with the deployment of a mobile plant is therefore in theory higher than that associated with the operation of a Soil Treatment Facility where control measures reduce boundary air concentrations well below the permitted limit.

3.1.6 As noted above, asbestos health risk is a function of cumulative dose (concentration x time). The risk is also a function of the age of first exposure (the greater the risk the younger you are). The risk estimation models are approximately linear, and the health risk from asbestos is cumulative (i.e. 2 years of exposure represents twice the risk of just 1 years' exposure).

3.1.7 The off-site risk from the boundary AEL of 0.01f/ml of 1 in 10 million (assuming a maximum of 12 months exposure and worst-case assumptions on exposure frequency and asbestos type) is minimal. The risk from the longer operation of the STF with boundary concentrations less than the AEL is lower still, and is a direct result of the lower air concentrations measured at the STF.

3.1.8 The STF boundary air concentrations are expected to be, on average, less than 500f/m^3 (as measured by SEM). The PCOM equivalent concentration (PCMe) - the measurement type that is consistent with the Environment Agency's M17 guidance - will be at least half this value due to the ability of SEM to detect more fibres than is possible using PCOM. If it is assumed that the STF boundary concentrations are 250f/m^3 (PCMe), this is 40x lower than the AEL. The monitoring at Maw Green suggests the boundary concentrations could be <50f/m^3 by SEM (<25f/m^3 by PCOM), 400x lower than the AEL. There is therefore a considerable margin between the estimated potential cumulative exposure from the operation of the Soil Treatment Facility and what is theoretically permitted for a mobile plant deployment.

4. Worst-case soil concentration scenario

4.1.1 In paragraphs 65 and 68 of Paul Barker's evidence it is stated that there is "*doubt on whether the air monitoring results can be relied on as representative of a worst-case scenario*", and whether they "*reflect real operational worst-case conditions*".

4.1.2 The pre- and post- processed soil data for the ERQ and Maw Green STFs suggests that the majority of the soil sampled did not contain identifiable asbestos, and that soil concentrations are typically less than the standard method limit of quantification (0.001%wt/wt or 10 mg/kg). The datasets are summarised in Table 4.1 below for reference.

Table 4.1: Summary of soil datasets for the soil treated at ERQ and Maw Green

Parameter	ERQ	Maw Green
Pre-processed soil samples with no detectable asbestos	77%	58%
Pre-processed soil samples with concentrations >LOQ	17%	34%
Median concentration	<LOQ	<LOQ
90th percentile concentration	0.003%wt/wt	0.008%wt/wt

Maximum concentration	4.7%wt/wt	0.5%wt/wt
Post-processed soil samples with no detectable asbestos	74%	48%
Post-processed soil samples with concentrations >LOQ	14%	30%
Median concentration	<LOQ	<LOQ
90th percentile concentration	0.002%wt/wt	0.008%wt/wt
Maximum concentration	0.09%wt/wt	0.075%wt/wt

4.1.3 For comparison, the soil acceptance and validation criteria set for the operation of the STFs are:

» <0.1% wt/wt chrysotile
» <0.01%wt/wt amphibole

4.1.4 Where reception (acceptance) soil sample data based on gravimetric laboratory testing exceeds these thresholds, the soil is either rejected, is further inspected, and/or is submitted for further loose, free fibre laboratory testing. The intention of the material acceptance criteria is to only accept soil material containing fragments of bound asbestos-type materials (i.e. bonded asbestos-containing materials that predominantly contain chrysotile asbestos and not amphibole asbestos).

4.1.5 It is common for soil contaminated with fragments of asbestos containing materials (ACM) to contain relatively low concentrations of detectable loose, free fibres. Published evidence from Dutch studies (RIVM, 2003) indicate that the presence of loose, free fibres varies greatly with the form of the asbestos debris in the soil. The fraction of asbestos present in the soil that is loose, free fibres (and specifically respirable-sized fibres) is reported to be up to 25% for highly friable forms of asbestos such as sprayed asbestos, but rapidly drops below 5% for the majority of other asbestos forms. For bound asbestos such as asbestos cement, the fraction of respirable fibres in the soil is report as 'nil', and 'as a rule less than 0.1%, even for weathered materials'.

4.1.6 SoBRA undertook a survey of UK soil laboratory soil test results, published in March 2020 (SoBRA, 2020). Based on the results from approximately 175,000 soil samples submitted to the five laboratories that took part for asbestos testing, asbestos was detected in 1-20% of the samples, with quantifiable levels of asbestos typically only reported in approximately 10-30% of samples submitted for quantitative analysis. The percentage of samples with concentrations greater than 0.01%wt/wt is less than 10%.

4.1.7 The expectation therefore is that the majority of asbestos contaminated soils that are excavated and removed from brownfield redevelopment sites are removed because of the presence of infrequent, dispersed fragments within the soil and/or asbestos concentrations that do not meet stricter site acceptance criteria (such as 'no asbestos detected' (NAD), or 0.001%wt/wt. High levels of heterogeneity in the distribution of asbestos within contaminated soil is common, and therefore it is expected that a high proportion of soil samples can be reported with no asbestos detected even though asbestos has been detected in other samples. Consistently elevated asbestos concentrations greater than 0.01%wt/wt would be expected to be associated with substantial visible ACM contamination. Without work at the site of origin to remove that ACM, such soil would not meet the STF acceptance criteria and would be rejected upon visual inspection.

4.1.8 Soil that is received at the STF, is stockpiled with soil from other sites, once it has met the acceptance criteria. As part of the process of excavating and transporting the soil, of stockpile management, and the movement of soil for processing, there will inevitably be an element of mixing of soil from different sites/locations of origin, and as a result a 'dilution' of discrete volumes that might contain more elevated asbestos concentrations than the remainder of the soil.

4.1.9 Based on the extensive soil acceptance and validation data available, the likelihood of soil with more elevated asbestos concentrations being repeatedly treated for extended periods of time is very low. The asbestos soil concentrations from over 1,250 samples of soil from approximately 300 different sites across the UK, appear to be consistent with what is typically found at brownfield sites, with relatively low levels of asbestos contamination that nevertheless are unsuitable to be retained on the site of origin.

4.1.10 This does not preclude the discovery of more highly contaminated sites in the future but this would be the exception to the norm. The amount of asbestos removed from the 120,000 tonnes of treated soil at ERQ and Maw Green to date is estimated to be approximately 40 tonnes. This would equate to an equivalent average pre-treatment soil concentration of 0.03%wt/wt. It seems to be an extremely remote possibility that sufficient soil could be sourced that was substantially more contaminated than that received at ERQ and Maw Green for the past 3+ years, such that cumulative emissions from the STF would be expected to significantly increase from those already measured.

4.1.11 Moreover, the absence of quantifiable loose, free fibres in pre- and post- treatment soil samples demonstrates that the acceptance protocols adopted by Provectus are effective in limiting soil acceptance to low-risk soils.

5. ERQ monitoring locations

5.1.1 In the last bullet point of paragraph 65 of Paul Barker's evidence it is stated that the monitoring locations at ERQ "*may not be representative of true conditions in the building as the[y] appear to be in doorways where there is likely to be turbulent air…*".

5.1.2 It is correct that two of the four monitoring locations agreed with the Environment Agency as part of the Dust and Emissions Management Plan (DEMP) are located in or close to doorways. The remaining two monitoring locations are at the ends of the two internal walls that make up the internal bays. The four locations are shown in the annotated plan provided in Appendix C.

5.1.3 The air samples may not therefore pick up localised maximum air concentrations at the back of the bays, however, in the context of looking at what concentrations could be present at the boundary of the STF work area and be subject to wind-blown dispersion off-site, the locations appear reasonable.

5.1.4 Air flow in the building is expected to be relatively low at the back of the building and potentially higher at the front of the building given the two doorways located on the southwest corner of the south facing side of the building, and the southeast corner of the east facing side of the building. It is expected therefore that dust is unlikely to be blown around inside the building within the bays and be rapidly dispersed from the activity emission area.

5.1.5 Monitoring point 1 is in an external doorway to the building, and monitoring point 4 is located next to an external wall and close to an external doorway. These locations would only be expected to pick up airborne asbestos fibres if they were being emitted from the building.

5.1.6 The Environment Agency is correct that no monitoring was undertaken at the back of the bays. There are evident practicality and safety issues around attempting to locate a monitoring point within an active stockpiling and material processing area where the soil is backed up against the back and side walls of the internal bay.

6. References

EA, 2013. Monitoring of particulate matter in ambient air around waste facilities. Technical Guidance Document (Monitoring) M17. Environment Agency, Bristol, 2013 [CD1/N]

RIVM, 2003. Assessment of the risks of soil contamination with asbestos, F.A Swartjes, P.C Tromp, J.M Wezenbeek, RIVM report 711701034/2003 [CD1/R]

SoBRA, 2020. The Distribution of Asbestos in Soil – what can the data mining of sample results held by UK laboratories tell us? Society of Brownfield Risk Assessment, March 2020

Appendix A SoBRA Excel spreadsheet exposure risk calculations for a STF

Calculation Sheet for risk from cumulative exposure to asbestos in air

Based on The quantitative risks of mesothelioma and lung cancer in relation to asbestos exposure, John T. Hodgson and Andrew Darnton, Ann Occup Hyg (2000) 44 (8): 565-601 , and personal communication with Andrew Darnton and should be read in conjunction with SoBRA's Discussion Paper on Guidelines for Airborne Concentrations of Asbestos Fibres in Ambient Air: Implications for Quantitative Risk Assessment (SoBRA, 2021)

Default parameters

Asbestos type	Amosite
Mesothelioma model	Linear
Lung cancer model	Non-Linear
Lung cancer base risk population	All - population average
Receptor expected lifetime	Lifetime 80 years
Lung cancer age adjustment	Age adjustment based on Latency

Concentration in air

Assumes exposure to constant average asbestos exposure

		Amosite		
Concentration in air	f/ml	5.00E-07	Equivalent to	0.5 f/m3

Exposure over five year tranches

	Age	Concentration in air	Exposure			Exposure time hrs per year	Exposure over each 5 year tranche (Includes adjustment to occupational years (equal to 2000hrs of exposure per year))	X- Cumulative exposure in f/ml.yr =Concentration in air x Exposure time hrs per year x Time period /2000 (hrs in an occupational year) to top of age group
0		f/ml	Days per year	Hours per day	Years (Actual)	hrs/year	f/ml.yr	X - Cumulative exposure in f/ml.yr
1	0-5	5.00E-07	365	8	5	2.92E+03	3.65E-06	3.65E-06
2	5-10	5.00E-07	365	8	5	2.92E+03	3.65E-06	7.30E-06
3	10-15	5.00E-07				0.00E+00	0.00E+00	7.30E-06
4	15-20	5.00E-07				0.00E+00	0.00E+00	7.30E-06
5	20-25	5.00E-07				0.00E+00	0.00E+00	7.30E-06
6	25-30	5.00E-07				0.00E+00	0.00E+00	7.30E-06
7	30-35	5.00E-07				0.00E+00	0.00E+00	7.30E-06
8	35-40	5.00E-07				0.00E+00	0.00E+00	7.30E-06
9	40-45	5.00E-07				0.00E+00	0.00E+00	7.30E-06
10	45-50	5.00E-07				0.00E+00	0.00E+00	7.30E-06
11	50-55	5.00E-07				0.00E+00	0.00E+00	7.30E-06
12	55-60	5.00E-07				0.00E+00	0.00E+00	7.30E-06

Mesothelioma Risk

$$P_M = A_{pl}X^r + A_{pr}X^t$$

$$\hat{O}_M = \frac{\left(A_{pl}X^r + A_{pr}X^t\right)E_{Adj}}{100}.$$

P_M Percent excess mortality from Mesothelioma (in percent)
A_{pl} Constant of proportionality for Pleural risk
A_{pr} Constant of proportionality for peritoneal risk
X Cumulative exposure in f/ml.yr
r Pleural slope of exposure response (on a log-log scale)
t Peritoneal slope of exposure response (on a log-log scale)

O_M the observed meso deaths
E_{adj} the expected mortality from all causes adjusted to an age at start of exposure of 30.

Risk estimate based on a 30 year old worker exposed for a five year period with cumulative exposure above.
Reference: Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000

Best Estimate		
Asbestos type	Amosite	Reference
A_{pl}	0.1	H&D 2000 Table 1 Mesothelioma risk expressed as percentage total expected mortality per f/ml.yr - Adjusted for age at first exposure.
r_meso	1	Linear model
A_{pr}	0.0006	H&D 2000 Table 8 Best estimate slope (r=0.75, t=2.1)
t	2.1	H&D 2000 Table 8 Best estimate slope (r=0.75, t=2.1)
Expected mortality from all causes adjusted to an age at start of exposure of 30	0.7	H&D 2000 p. 584 "Absolute risk estimates can therefore be derived from the PM value for a given exposure by multiplying by a factor of 0.7."

0	Age	Age adjustment Factor for mesothelioma risk Lifetime 80 years	Reference	P_M (%)*	Risk	Risk age adjuested assuming Lifetime 80 years
1	0-5	7	WATCH 2010 -2 Annex 3 - Contribution from a WATCH member following the February 2010 WATCH meeting (for 80 years). CIRIA C733 used for adjustment for ages 35+	3.7E-07	2.6E-09	1.8E-08
2	5-10	5.3		3.7E-07	2.6E-09	1.4E-08
3	10-15	4		0.0E+00	0.0E+00	0.0E+00
4	15-20	3		0.0E+00	0.0E+00	0.0E+00
5	20-25	2.1		0.0E+00	0.0E+00	0.0E+00
6	25-30	1.5		0.0E+00	0.0E+00	0.0E+00
7	30-35	1		0.0E+00	0.0E+00	0.0E+00
8	35-40	0.6		0.0E+00	0.0E+00	0.0E+00
9	40-45	0.4		0.0E+00	0.0E+00	0.0E+00
10	45-50	0.3		0.0E+00	0.0E+00	0.0E+00
11	50-55	0.2		0.0E+00	0.0E+00	0.0E+00
12	55-60	0.1		0.0E+00	0.0E+00	0.0E+00

* To get the contribution to the risk for the second period alone the risk due to the cumulative dose from the first period is subtracted... and so on.
Developing risk estimates consistent with Table 11 for extended periods, Hodgson and Darnton 2000

			Lifetime 80 years
Cumulative risk		Amosite	3.1E-08

Lung Cancer

$$P_L = A_L X^r$$

P_L Percentage excess of expected lung cancer mortality
A_L Constant of proportionality for lung cancer risk
r Lung cancer slope of exposure response (on a log-log scale)
X Cumulative exposure in f/ml.yr

$$\text{Predicted excess risk} = O_L - E_L = \frac{A_L X^r E_L}{100}$$

E_L Proportion of the specific population that will die of lung cancer between age 40-79

Risk estimate based on a 30 year old worker exposed for a five year period with cumulative exposure above.
Reference: Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000

Best Estimate		
	Amosite	Reference
A_L	1.6	H&D 2000 Table 10 Best (r=1.3)
r_lung	1.3	H&D 2000 Table 10 Best (r=1.3)
Proportion of the specific population that will die of lung cancer between age 40-79	0.033	Based on Average 2016-2018 populations statistics

0	Age	Age adjustment	Age adjustment reference	P_L (%)	Risk (age adjusted)
1	0-5	1	Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000	1.4E-07	4.5E-11
2	5-10	1		2.0E-07	6.5E-11
3	10-15	1		0.0E+00	0.0E+00
4	15-20	1		0.0E+00	0.0E+00
5	20-25	1		0.0E+00	0.0E+00
6	25-30	1		0.0E+00	0.0E+00
7	30-35	1		0.0E+00	0.0E+00
8	35-40	1		0.0E+00	0.0E+00
9	40-45	1		0.0E+00	0.0E+00
10	45-50	0.75		0.0E+00	0.0E+00
11	50-55	0.5		0.0E+00	0.0E+00
12	55-60	0.25		0.0E+00	0.0E+00

Cumulative risk	Amosite	1.1E-10

Cumulative lifetime Risk Estimate

Asbestos type	Amosite				
Risk from Mesothelioma	Lifetime 80 years	Linear	3.1E-08		
Risk from Lung Cancer	All - population average	Non-Linear	1.1E-10		
TOTAL			3.2E-08	1 in ... risk	3.2E+07

Appendix B SoBRA Excel spreadsheet exposure risk calculations for a mobile plant

SoBRA The Society of Brownfield Risk Assessment

Calculation Sheet for risk from cumulative exposure to asbestos in air

Based on The quantitative risks of mesothelioma and lung cancer in relation to asbestos exposure, John T. Hodgson and Andrew Darnton, Ann Occup Hyg (2000) 44 (8): 565-601 , and personal communication with Andrew Darnton and should be read in conjunction with SoBRA's Discussion Paper on Guidelines for Airborne Concentrations of Asbestos Fibres in Ambient Air: Implications for Quantitative Risk Assessment (SoBRA, 2021)

Default parameters

Asbestos type	Amosite
Mesothelioma model	Linear
Lung cancer model	Non-Linear
Lung cancer base risk population	All - population average
Receptor expected lifetime	Lifetime 80 years
Lung cancer age adjustment	Age adjustment based on Latency

Concentration in air

Assumes exposure to constant average asbestos exposure

		Amosite		
Concentration in air	f/ml	1.00E-05	Equivalent to	10 f/m3

Exposure over five year tranches

	Age	Concentration in air	Exposure			Exposure time hrs per year	Exposure over each 5 year tranche (Includes adjustment to occupational years (equal to 2000hrs of exposure per year))	X- Cumulative exposure in f/ml.yr =Concentration in air x Exposure time hrs per year x Time period /2000 (hrs in an occupational year) to top of age group
0		f/ml	Days per year	Hours per day	Years (Actual)	hrs/year	f/ml.yr	X - Cumulative exposure in f/ml.yr
1	0-5	1.00E-05	365	8	1	2.92E+03	1.46E-05	1.46E-05
2	5-10	1.00E-05				0.00E+00	0.00E+00	1.46E-05
3	10-15	1.00E-05				0.00E+00	0.00E+00	1.46E-05
4	15-20	1.00E-05				0.00E+00	0.00E+00	1.46E-05
5	20-25	1.00E-05				0.00E+00	0.00E+00	1.46E-05
6	25-30	1.00E-05				0.00E+00	0.00E+00	1.46E-05
7	30-35	1.00E-05				0.00E+00	0.00E+00	1.46E-05
8	35-40	1.00E-05				0.00E+00	0.00E+00	1.46E-05
9	40-45	1.00E-05				0.00E+00	0.00E+00	1.46E-05
10	45-50	1.00E-05				0.00E+00	0.00E+00	1.46E-05
11	50-55	1.00E-05				0.00E+00	0.00E+00	1.46E-05
12	55-60	1.00E-05				0.00E+00	0.00E+00	1.46E-05

Mesothelioma Risk

$$P_M = A_{pl}X^r + A_{pr}X^t$$

P_M Percent excess mortality from Mesothelioma (in percent)
A_{pl} Constant of proportionality for Pleural risk
A_{pr} Constant of proportionality for peritoneal risk
X Cumulative exposure in f/ml.yr
r Pleural slope of exposure response (on a log-log scale)
t Peritoneal slope of exposure response (on a log-log scale)

$$\hat{O}_M = \frac{(A_{pl}X^r + A_{pr}X^t)E_{Adj}}{100}.$$

O_M the observed meso deaths
E_{adj} the expected mortality from all causes adjusted to an age at start of exposure of 30.

Risk estimate based on a 30 year old worker exposed for a five year period with cumulative exposure above.
Reference: Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000

Best Estimate		
Asbestos type	Amosite	Reference
A_{pl}	0.1	H&D 2000 Table 1 Mesothelioma risk expressed as percentage total expected mortality per f/ml.yr - Adjusted for age at first exposure.
r_meso	1	Linear model
A_{pr}	0.0006	H&D 2000 Table 8 Best estimate slope (r=0.75, t=2.1)
t	2.1	H&D 2000 Table 8 Best estimate slope (r=0.75, t=2.1)
Expected mortality from all causes adjusted to an age at start of exposure of 30	0.7	H&D 2000 p. 584 "Absolute risk estimates can therefore be derived from the PM value for a given exposure by multiplying by a factor of 0.7."

	Age	Age adjustment Factor for mesothelioma risk Lifetime 80 years	Reference	P_M (%)*	Risk	Risk age adjuested assuming Lifetime 80 years
0						
1	0-5	7	WATCH 2010 -2 Annex 3 - Contribution from a WATCH member following the February 2010 WATCH meeting (for 80 years). CIRIA C733 used for adjustment for ages 35+	1.5E-06	1.0E-08	7.2E-08
2	5-10	5.3		0.0E+00	0.0E+00	0.0E+00
3	10-15	4		0.0E+00	0.0E+00	0.0E+00
4	15-20	3		0.0E+00	0.0E+00	0.0E+00
5	20-25	2.1		0.0E+00	0.0E+00	0.0E+00
6	25-30	1.5		0.0E+00	0.0E+00	0.0E+00
7	30-35	1		0.0E+00	0.0E+00	0.0E+00
8	35-40	0.6		0.0E+00	0.0E+00	0.0E+00
9	40-45	0.4		0.0E+00	0.0E+00	0.0E+00
10	45-50	0.3		0.0E+00	0.0E+00	0.0E+00
11	50-55	0.2		0.0E+00	0.0E+00	0.0E+00
12	55-60	0.1		0.0E+00	0.0E+00	0.0E+00

* To get the contribution to the risk for the second period alone the risk due to the cumulative dose from the first period is subtracted... and so on.
Developing risk estimates consistent with Table 11 for extended periods, Hodgson and Darnton 2000

			Lifetime 80 years
Cumulative risk		Amosite	7.2E-08

Lung Cancer

$$P_L = A_L X^r$$

$$\text{Predicted excess risk} = O_L - E_L = \frac{A_L X^r E_L}{100}$$

P_L Percentage excess of expected lung cancer mortality
A_L Constant of proportionality for lung cancer risk
r Lung cancer slope of exposure response (on a log-log scale)
X Cumulative exposure in f/ml.yr

E_L Proportion of the specific population that will die of lung cancer between age 40-79

Risk estimate based on a 30 year old worker exposed for a five year period with cumulative exposure above.
Reference: Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000

Best Estimate		
	Amosite	Reference
A_L	1.6	H&D 2000 Table 10 Best (r=1.3)
r_lung	1.3	H&D 2000 Table 10 Best (r=1.3)
Proportion of the specific population that will die of lung cancer between age 40-79	0.033	Based on Average 2016-2018 populations statistics

0	Age	Age adjustment	Age adjustment reference	P_L (%)	Risk (age adjusted)
1	0-5	1	Developing risk estimates consistent with Table 11 for extended exposures, Hodgson and Darnton 2000	8.3E-07	2.7E-10
2	5-10	1		0.0E+00	0.0E+00
3	10-15	1		0.0E+00	0.0E+00
4	15-20	1		0.0E+00	0.0E+00
5	20-25	1		0.0E+00	0.0E+00
6	25-30	1		0.0E+00	0.0E+00
7	30-35	1		0.0E+00	0.0E+00
8	35-40	1		0.0E+00	0.0E+00
9	40-45	1		0.0E+00	0.0E+00
10	45-50	0.75		0.0E+00	0.0E+00
11	50-55	0.5		0.0E+00	0.0E+00
12	55-60	0.25		0.0E+00	0.0E+00

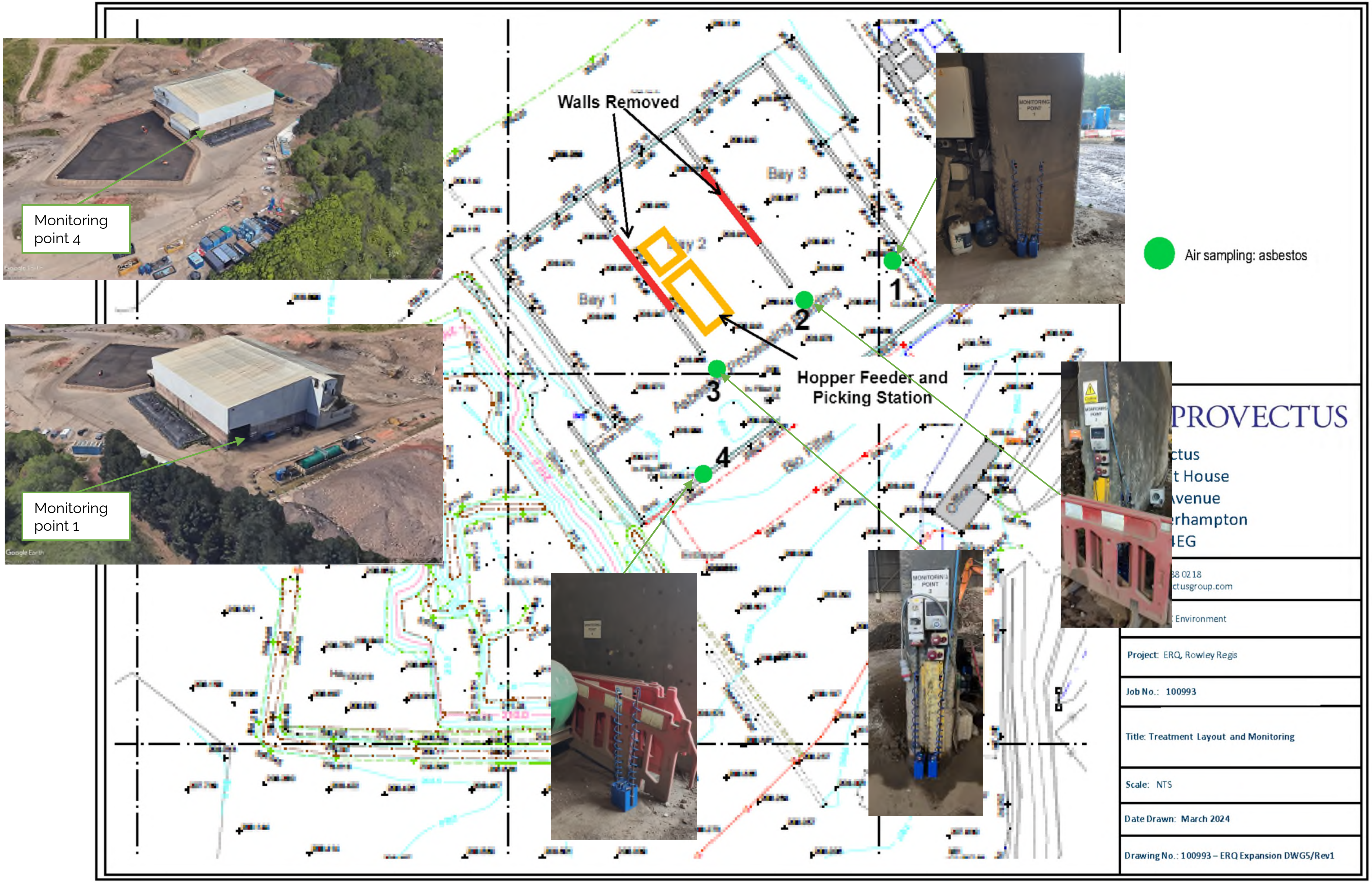
Cumulative risk	Amosite	2.7E-10

Cumulative lifetime Risk Estimate

Asbestos type	**Amosite**		
Risk from Mesothelioma	**Lifetime 80 years**	**Linear**	**7.2E-08**
Risk from Lung Cancer	**All - population average**	**Non-Linear**	**2.7E-10**
TOTAL			**7.2E-08**

1 in … risk 1.4E+07

Appendix C ERQ monitoring locations


Monitoring point 4
Monitoring point 1
Walls Removed
Bay 3
Bay 2
Bay 1
Hopper Feeder and Picking Station
1
2
3
4
MONITORING POINT
Air sampling: asbestos
PROVECTUS
ctus
t House
venue
rhampton
EG
Environment
Project: ERQ, Rowley Regis
Job No.: 100993
Title: Treatment Layout and Monitoring
Scale: NTS
Date Drawn: March 2024
Drawing No.: 100993 – ERQ Expansion DWG5/Rev1
Google Earth