UK DEFRA Blood Lead and Soil Lead Levels

By Elizabeth O'Brien, Lead Scientist and Lead Advisor, orchestrated by Ian Smith, Systems Analyst, using OpenClaw on top of Claude AI and Ollama local AI models where possible, on solar-powered infrastructure. *© The LEAD Group Inc. November 2026*

Two numbers have done a great deal of work in the assessment for the proposal by Bowdens Silver for new lead mine at Lue, New South Wales (NSW). The human health risk assessment (HHRA) prepared by Environmental Risk Sciences Pty Ltd (EnRisks) benchmarks lead against blood lead levels of 3.5 micrograms per decilitre (µg/dL) for children and 1.6 µg/dL for adults, and the NSW Department of Planning, Housing and Infrastructure (the Department) has told the Independent Planning Commission (IPC) NSW that this choice makes the assessment conservative. Both blood lead numbers come from the United Kingdom Department for Environment, Food and Rural Affairs (UK DEFRA).

The obvious question is why is the UK DEFRA low blood lead level for adults lower than the one for children? Adults are bigger, and lead's worst effects are on the developing brain, so why would the adult number be the lower of the two? The answer is in DEFRA's own documents, and it is not what the pairing implies. Once you read them, two further things follow: the pair was never DEFRA's pair, and the purpose those numbers were built for is close to the opposite of the purpose they are being used for at Lue.



2022 Volcano Art Prize (VAP) Entry. Artist: Max Taylor (Age 11). Title: Max's Chickens. Lead-Safety Message: "Lead in the dirt contaminates our eggs." Description of Work: Photograph. https://volcanoartprize.com/portfolio-item/maxs-chickens/ [LID 22909]

What DEFRA actually built

DEFRA research project SP1010, run by the consortium Contaminated Land: Applications in Real Environments (CL:AIRE) between 2012 and 2013 at a cost of £181,111, produced Category 4 Screening Levels (C4SLs) for six substances. Lead is Appendix H.

The project exists because of Part 2A of the UK Environmental Protection Act 1990, the regime for land already contaminated, mostly by industries that closed decades ago. Revised statutory guidance in 2012 sorted such land into four categories, Category 1 being clearly unacceptable risk and Category 4 being acceptably low risk. A C4SL is the line below which a regulator can stop: land under it is "suitable for use and definitely not contaminated land", so the regulator can turn to the sites that matter.

DEFRA is explicit about why it wanted that line drawn in a more relaxed place than the old Soil Guideline Values (SGVs). Over-cautious screening values cause "property blight, anxiety over possible health risks and the effects on house prices", and there is "growing evidence that stress-related health impacts of regulatory intervention could outweigh any health

benefits of investigating and remediating land where there is only a low/hypothetical risk" (Welsh Government 2014). The C4SLs were to be "more pragmatic (but still strongly precautionary)" than the values they replaced.

That is the design brief. It is a tool for releasing historic land from unnecessary remediation, written by a department balancing health against property blight and public money. **UK DEFRA's SP1010 is not a tool for deciding how much fresh lead a new mine should be allowed to add to a community that does not have a lead problem today.**

The three options, and where each number came from

Appendix H does not produce one blood lead level. It produces a menu, and it says so: "Given that there are some significant risk management choices to make in the evaluation of lead, a range of options are provided, rather than make a single LLTC recommendation."

LLTC is DEFRA's term, Low Level of Toxicological Concern, and the word "low" is doing careful work. An LLTC is deliberately not a minimal-risk value. It is the level DEFRA judged, in 2014, before the past dozen years of research into lead's harms at lower and lower blood lead levels, to be of low enough concern to stop looking. In UK DEFRA (and Environment Agency) toxicology and chemical risk assessment documents, BMD stands for Benchmark Dose and BMDL stands for Benchmark Dose Lower Confidence Limit. The number after the letters is the size of the effect being modelled: a BMD01 is the blood lead level estimated to cause a 1 per cent effect (for IQ, the loss of one IQ point; for blood pressure, a 1 per cent rise), and a BMD10 is the level estimated to cause a 10 per cent effect.

Three of lead's health effects had usable dose-response data, drawn from the European Food Safety Authority's (EFSA's) 2010 opinion on lead in food:

- Loss of intelligence quotient (IQ) in children, from the pooled analysis of seven cohorts by Lanphear et al (2005), including Port Pirie. Benchmark dose modelling put the lower confidence limit for a one-point IQ loss (the BMDL01) at 1.2 µg/dL, and the central estimate (the BMD01) at 1.8 µg/dL on one model and 5.6 µg/dL on another. The median of those two central estimates, 3.7 µg/dL (with only two models, the median is simply their average), is the children's figure DEFRA later used to justify its 3.5 µg/dL option.
- Chronic kidney disease in adults, measured as a reduced estimated glomerular filtration rate (eGFR) in 14,778 American adults (Navas-Acien et al 2009). The blood lead "dose" for a 10 per cent increase in disease prevalence (the BMD10) was 1.6 µg/dL.
- A 1% increase in systolic blood pressure in adults, pooled from four studies, giving an average BMDL01 of 3.6 µg/dL and an average BMD01 of 6.1 µg/dL.

From that spread, Appendix H offers three LLTC options: 1.6 µg/dL, 3.5 µg/dL and 5 µg/dL.

Here is the heart of the matter. **Each option is a single number meant to cover everybody: children and adults.**

DEFRA sets out:

- Option (a), 1.6 µg/dL, as the adult kidney figure chosen precisely because it also protects children: it "is slightly lower than the BMD01 for neurobehavioural effects in children and is protective of all effects". A footnote repeats the point: 1.6 µg/dL is below the children's BMD01 (decrease of one IQ point) blood lead level of 1.8 µg/dL, and "the value is chosen to be protective of both effects".
- Option (b), 3.5 µg/dL, is likewise justified against all three endpoints at once. It sits slightly below the adult blood pressure BMDL01 of 3.6 µg/dL; it sits below 3.7 µg/dL, the median BMD01 for a one-point IQ loss in children across the two models (1.8 µg/dL on the piecewise linear model and 5.6 µg/dL on the linear model); and it approximates the BMD20 for adult kidney effects, a figure Appendix H says is of questionable accuracy because the model fit is poor, and which it would be "a risk management decision" to accept. This is the option DEFRA finally adopted (see below), and it is the reason EnRisks used 3.5 µg/dL for children.
- Option (c), 5 µg/dL, is the then United States Centers for Disease Control and Prevention blood lead reference level (or “action level”), included "for illustration".

So the answer to the question is this: The adult number is lower than the children's number because it is measuring a different disease, by a different method, at a different severity. The children's figures come from a one-point IQ shift downwards, the most sensitive flicker the data can detect. The adult kidney figure comes from a 10 per cent rise in the prevalence of chronic kidney disease, which is a far grosser injury. According to CL:AIRE, it takes more lead to nudge a child's IQ down by one point than it takes to give 10 per cent more adults kidney disease, and the arithmetic that follows is an artefact of what each study was looking for. In numbers: on the central estimates, a one-point IQ loss appears at a blood lead level of 1.8 µg/dL, while a 10 per cent rise in adult kidney disease appears at 1.6 µg/dL, so the adult figure comes out lower; had CL:AIRE compared the lower confidence limit for IQ loss (1.2 µg/dL) instead, the order would have reversed. The ranking depends on which statistic and which size of effect is picked. It says nothing whatever about adults being more vulnerable than children. DEFRA treats a number below 1.8 µg/dL as the one that protects children, and chooses 1.6 µg/dL for that reason.

There is a further caution DEFRA states plainly and nobody since has repeated: there are no quantitative data at all for blood pressure or kidney disease in children, and on both adult endpoints the appendix notes "these effects could also occur in children at lower levels".



2024 Volcano Art Prize (VAP) Entry. Artist: Aidan Hannigan. Title: Chicken Feed Lead. Lead-Safety Message: "Tell the humans there is lead in some commercial chicken feed that can get into our eggs along with the soil lead from our backyard chicken run!" Description of Work: Watercolour and graphite pencil. https://volcanoartprize.com/portfolio-item/chicken-feed-lead/ [LID 28156]

What DEFRA chose, and the soil levels that followed

The menu was resolved by government, not by the consultants at CL:AIRE. The Welsh Government's Policy Companion Document of December 2014 records the decision: the LLTC for lead is 3.5 µg/dL. The 1.6 µg/dL option was rejected as "considered to be too close to minimal risk to support its use in the derivation of the more pragmatic C4SLs". The 5 µg/dL option was rejected as "not considered suitably precautionary".

DEFRA's own Policy Companion Document for England, also dated December 2014, records the same decision in almost the same words: "It is Defra's view that a Low Level of Toxicological Concern of 3.5µg/dL should be chosen to derive Category 4 Screening Levels for lead" (DEFRA 2014b). For commercial land, where an adult is the critical receptor, DEFRA recommends the United States Environmental Protection Agency Adult Lead Methodology to convert that blood lead level into a soil screening level (DEFRA 2014b), so DEFRA's blood lead level for adults is 3.5 µg/dL as well, not 1.6 µg/dL.

Read that twice. In DEFRA's framework, 1.6 µg/dL was turned down for being too protective to serve a screening tool whose purpose was to release land for sale. It was not adopted as an adult standard, because the whole framework has no adult standard separate from a child one.

The 3.5 µg/dL figure was then converted into daily lead intakes, using the Integrated Exposure Uptake Biokinetic (IEUBK) model where a child is the critical receptor and the United States Environmental Protection Agency Adult Lead Methodology where an adult is the critical receptor, and run through the Contaminated Land Exposure Assessment (CLEA) model to produce soil concentrations. The final C4SLs for lead are:

- **200** milligrams per kilogram (mg/kg) for residential land where home-grown produce is eaten,
- **310** mg/kg for residential land without produce,
- **80** mg/kg for allotments*,
- **2,300** mg/kg for commercial land, and
- **630** and **1,300** mg/kg for the two public open space scenarios: green space close to housing, from which soil is tracked back into the home, and a park far enough from

housing that negligible soil is tracked back, respectively.

*An allotment in the UK is a small plot of land that individuals rent, usually annually from a local council, parish council, community group, or private landlord, to grow fruit, vegetables, flowers, and other plants.

Those are the numbers the whole exercise was built to deliver. The blood lead levels are an intermediate step on the way to a soil figure. They were never published as health goals for individuals (either for children or adults), and the soil lead levels themselves are low: **200** mg/kg in a suburban backyard with vegetables is stricter than the Australian residential soil guideline (Health Investigation Level A, or HIL A) of 300 mg/kg, and DEFRA notes that for several land uses (residential with home-grown produce, residential without home-grown produce, allotments, and public open space close to housing) the C4SL sits below the normal background concentration of lead in English and Welsh urban soils (820 mg/kg in England and 890 to 1,300 mg/kg in Wales).

Two features of those soil levels deserve attention from anyone quoting them in Australia.

First, DEFRA's own probabilistic modelling shows what sitting at a C4SL means. At the residential soil lead screening level with home-grown produce (**200** mg/kg), the probability that a randomly chosen person in the critical receptor group exceeds the Low Level of Toxicological Concern (LLTC) is about 30 per cent. For allotments (soil lead above **80** mg/kg) the probability of a person exceeding the LLTC is 44 to 46 per cent. A C4SL is not a level at which exposure stays below the health benchmark. It is a level at which a large minority of people exceed the benchmark and DEFRA has decided, for the sake of proportionate regulation of historic land, that this is tolerable.

Second, DEFRA says the screening level is never the end of the obligation:

"Since the adverse effects of lead are thought to have no threshold, it might be necessary to apply the 'As Low As Reasonably Practicable' (ALARP) principle in relation to its remediation at specific sites. The principle of ALARP automatically applies to the regulation and management of non-threshold chemicals in the UK. It is important to note that ALARP remains the overriding principle even when a margin of exposure or minimal risk level or LLTC suggests there is a minimal/low concern for human health."

ALARP is the thing DEFRA says overrides the number. It has not survived the trip to Lue.

Did EnRisks use the DEFRA approach as DEFRA intended?

Partly, and partly not and the departures all run the same way.

The pairing is not DEFRA's. EnRisks took the children's benchmark from option (b) and the adult benchmark from option (a), producing a combination that appears nowhere in Appendix H. On the adult side this is stricter than DEFRA's final choice, and the Department is entitled to say so. On the children's side it is the figure DEFRA explicitly declined to call protective of children on its own terms, since DEFRA's own reasoning puts the protective line for children below 1.8 µg/dL.

The purpose is inverted. Every word of SP1010 is about land already contaminated, where the lead is in the ground, the cost of removing it is large, and the alternative to a pragmatic screening level is property blight.

Bowdens is the opposite case: lead that is not yet in the soil of Lue, which no one need pay to remove, and which can be prevented at no cost to any resident by not creating it.

A tool calibrated to tolerate a 30 to 46 per cent exceedance rate for the sake of not digging up old gardens has no business setting the acceptable dose from a new lead contamination source.

ALARP is absent. DEFRA says the principle overrides the screening value even where the value suggests low concern. The Bowdens framework contains no equivalent duty, and as The LEAD Group set out to the Commission in our Objection dated 11 November 2026, it contains no enforceable lead limit of any kind.

The percentages conceal their own base. EnRisks reports that total lead intake at the worst affected property is less than 40 per cent of the adult toxicity reference value (TRV) and less than 31 per cent of the children's. Those fractions are fractions of an intake that DEFRA designed to be exceeded by a large minority of the exposed population. A third of a number that a third of people exceed is not the reassurance it sounds like.

Neither the Bowdens proposal nor its HHRA sets any soil lead level not to be exceeded, whether based on the DEFRA blood lead levels or on anything else. EnRisks used the DEFRA blood lead levels only to derive daily lead intake limits: 1.4 micrograms per kilogram of body weight per day (µg/kg/day) for children, from 3.5 µg/dL, and 0.6 µg/kg/day for adults, from 1.6 µg/dL (EnRisks 2020). When the peer reviewer raised DEFRA's purpose, EnRisks replied that "The end use of the LLTCs determined by DEFRA (i.e. in the derivation of soil guidelines that may be used for remediation) is not considered relevant" (EnRisks 2021). The only soil criterion in the HHRA is the Australian HIL A of 300 mg/kg, which rests on a blood lead level of 10 µg/dL and is used only to screen existing soil and dust data. The HHRA predicts that 70 years of dust deposition from the mine would add 3.2 to 3.8 mg/kg of lead to the surface soil at the worst affected residence, but compares that increase with no soil criterion at all. For comparison, the soil level DEFRA itself derived from 3.5 µg/dL for a backyard with home-grown produce is 200 mg/kg, and at that level DEFRA's modelling still puts about 30 per cent of the critical receptor group above the LLTC.

And the UK model does not cover everything that can be found in an Australian backyard. CLEA's home-grown produce pathway covers green vegetables, root vegetables, tuber vegetables and three classes of fruit. There are no chickens in it, and therefore no eggs. In lead-affected Australian communities, including lead-mining and smelting towns, every inner-city area and even older rural areas including farm houses and other buildings built prior to 1997, backyard eggs are a well-recognised exposure route, because hens forage in surface soil all day and pass the lead they swallow into their eggs (Yazdanparast et al 2022). A

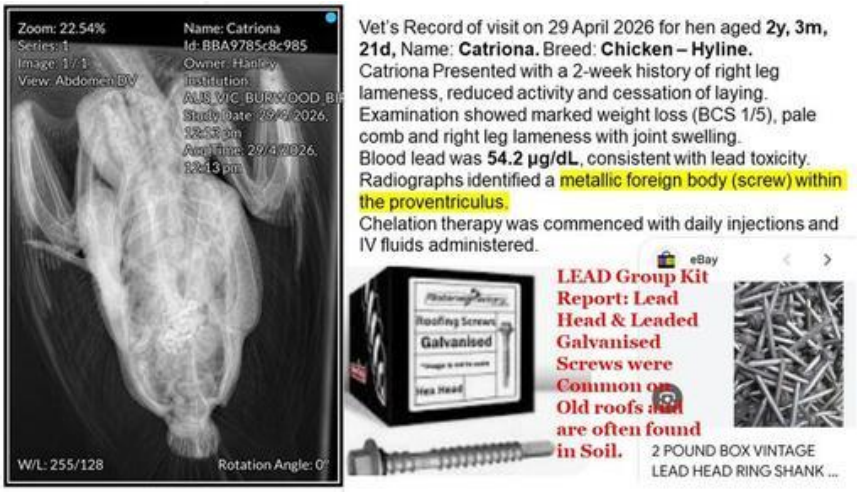
screening tool written for English allotments simply has no term for it.

Yazdanparast et al (2022) sampled 69 backyard chickens from 55 Sydney urban gardens, found that soil lead was a strong predictor of both chicken blood lead and egg lead, and concluded in "Lead poisoning of backyard chickens: Implications for urban gardening and food production" that:

- almost one in two of the chickens (31 of 69) had a blood lead level above 20 µg/dL;
- for chicken blood lead (PbB) to be less than 20 µg/dL, soil lead (SPb) needs to be less than 166 mg/kg;
- for egg lead (EPb) to be less than 100 micrograms per kilogram (µg/kg), a food safety benchmark, SPb needs to be less than 117 mg/kg, well below the Australian residential soil guideline of 300 mg/kg; thus
- a large number of inner-city homes may not be suitable for keeping chickens.

Port Pirie, the South Australian lead smelter town, gives a picture of what this means for a lead industry community. Zariff et al (2019) found that locally produced eggs from Port Pirie had a median lead concentration of 90 µg/kg (range 30 to 190 µg/kg), against 2 µg/kg in eggs from a control area, and estimated that for a two-year-old "a diet rich in eggs could more than double the child's daily lead exposure from dietary sources". We have not found a published study of backyard eggs in Broken Hill.

Indeed, through having to write comments and make recommendations about actions to reduce egg lead lab results that I report to purchasers of LEAD Group Kits, and by researching previous Australian and US and New Zealand backyard egg lead studies, I had, at least 9 years prior to reading Yazdanparast et al in July 2022, decided that backyard poultry is one of the most sensitive populations to try to protect from soil lead contamination, and had advised every backyard poultry-keeper who tested an egg via a LEAD Group Kit to ensure their chickens' / ducks' / quails' soil lead (SPb) level never exceeded 30 mg/kg.



2026 Volcano Art Prize (VAP) Entry. Artist: Poultry Keeper. Title: Leaded Chicken. Lead-Safety Message: "Despite being the smartest chicken I've ever had, my Catriona found a screw in the yard and swallowed it and had to be treated for lead poisoning. To warn others, LEAD Group Kit comments on egg lead results reports are from now on going to include the warning: Lead head and leaded galvanised screws were common on old roofs and are often found in soil so be sure to run a fine rake over your backyard and remove all metal items found, before letting poultry use your chicken run and free range area." Description of Work: Collage of x-ray, vet and LEAD Group Kit reports and Google results. https://volcanoartprize.com/portfolio-item/leaded-chicken/ [LID 29956]

Did the Department understand what it was relying on?

The Department's Supplementary Advice of 15 September 2026 describes the DEFRA approach to the Commission in a single sentence. The benchmarks were selected, it says, "based on an approach developed by the UK Department for Environment, Food and Rural Affairs (DEFRA), which was based on a review of studies that informed the lowest blood lead levels that have been associated with the most sensitive health effects".

That sentence is not right, and the error matters. The lowest blood lead level associated with the most sensitive health effect, in DEFRA's own tables, is 1.2 µg/dL, the BMDL01 for IQ loss in children. The figure used for children at Bowdens is 3.5 µg/dL, which DEFRA reached by weighing three endpoints together, accepting an approximate benchmark dose for a 20 per cent effect on adult kidney function whose model fit the appendix itself describes as poor, and making what the appendix calls "a risk management decision". The Welsh Government then adopted 3.5 µg/dL while recording that stakeholders had raised concerns about whether it was sufficiently precautionary. A description that converts a negotiated, deliberately pragmatic screening value into a finding about the lowest level at which harm has been seen is not a small slip. It presents a ceiling as though it were a floor.

The Department's second move is to compare the DEFRA values with Australian ones:

- the National Health and Medical Research Council's (NHMRC's) 2015 investigation level of 5 µg/dL,
- the Australian Drinking Water Guidelines' blood lead goal not to be exceeded of 5 µg/dL, and
- the Australian soil contamination guideline built on a blood lead ceiling of 10 µg/dL.

Against those, it concludes, "the selection of TRVs [toxicity reference values] based on the DEFRA approach results in a more conservative assessment than the use of screening values in other Australian guidelines."

The comparison is accurate but almost beside the point. It establishes that Australian guidance is older and weaker, which is an argument about Australian guidance, not a demonstration that the chosen benchmark is protective. The relevant comparators are the ones the Department does not mention:

- the United States Centers for Disease Control and Prevention (CDC) blood lead reference value of 3.5 µg/dL for children, which is a population surveillance threshold (97.5% of US pre-schoolers had a blood lead level less than 3.5 µg/dL at the time the CDC chose the level) rather than a safe level and is intended to fall as exposure to lead falls;
- the Australian NHMRC's own position, that no safe blood lead level (apart from zero) has been identified;
- and the World Health Organization's statement that there is no known safe level of lead exposure (WHO 2026).

Measured against those, a benchmark of 3.5 µg/dL for a child is not conservative. It is the

number at which the United States starts investigating.

A third criticism is one of omission. Having relied on DEFRA, the Department does not tell the Commission what DEFRA's levels are for, that DEFRA rejected 1.6 µg/dL as too protective for the job, that the resulting soil levels carry a 30 to 46 per cent exceedance probability by DEFRA's own modelling, or that DEFRA treats ALARP as overriding. Each of those facts is in the documents the Department is citing. Each of them cuts against the use being made of them.



2025 Volcano Art Prize (VAP) Entry. Artist: Tony Lennon. Title: Growing Garlic. Lead-Safety Message: "Grow your own garlic for maximum health benefits and minimum food travel miles! Near the winter solstice, plant good organic (not imported bleached Chinese) garlic cloves tip-upwards just below the surface 10 cm apart in deep rich well-drained elevated soil and water in well." Description of Work: Smart phone photos collaged together. https://volcanoartprize.com/portfolio-item/growing-garlic/ [LID 28958]

What follows for the Commission

None of this requires a view about whether the EnRisks modelling is arithmetically sound. Take its numbers as given. The question is what they are being compared against, and the comparison has been built out of a British instrument for releasing old industrial land, pointed at a new Australian lead source, with the half of the instrument that says "and keep reducing the soil lead screening level anyway" left behind.

The LEAD Group's position to the Commission is that consent should be refused, and that if it is not, the consent must carry a blood lead action level of greater than 1 µg/dL, the level three professors of our Technical Advisory Board have advised us to use since 2012, together with the surface dust, soil and drinking water criteria that achieving it requires. The gap between that figure and 3.5 µg/dL is not a quibble between experts. It is the difference between a standard designed to prevent exposure and a standard designed to decide when an authority may stop worrying about exposure that has already happened.

Lead in a child does not know which document authorised it.



2026 Volcano Art Prize (VAP) Entry. Artist: Grandma Lead. Title: Farm Produce. Lead-Safety Message: "There's nothing quite like harvesting your own organic leafy greens, herbs and lemons, and making beans and greens soup plus lemon delicious for lunch while watching Landline on ABC TV on Sunday to see how real farmers adapt to climate change and take care of

country while making a living from farming. So grateful!!" Description of Work: Selfies and photo collaged in Powerpoint and Paint. https://volcanoartprize.com/portfolio-item/farm-produce/ [LID 30001]

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