# Greywater Reuse Policy

# Factsheet (Part 2)– Technical Addendum

## Mount Isa City Council

# Appendix 3: Example of land application area calculations

The following calculations are included as an example how to determine whether a homeowner has sufficient application area to soak up all the greywater generated within the home after taking into consideration the necessary setbacks. The calculations are based on the estimates provided in the QPW code for greywater use in sewered area from a house with three bedrooms and four occupants (see Table 3, **Appendix 4**).

To calculate whether the homeowner has sufficient land, you must first estimate:

- Step 1. area available - the area of land available for greywater irrigation
- Step 2. greywater generated - the volume of greywater generated by the household
- Step 3. area needed - the area of land needed to soak up all of the greywater generated.

| | |
|---|---|
| **Step 1.**<br><br>Calculate the area of land available for greywater irrigation using a scaled site plan. | Property Type: House<br><br>Bedrooms: 3<br><br>Land Size: 825m² (approx.)<br><br>Dwelling = 185m²<br><br>• Mark out the greywater application area on a plan taking into consideration the required setback distances (Tables in **Appendix 4**).<br><br>• Available greywater irrigation area = **130m²** |
| **Step 2.**<br><br>Calculate the volume of greywater generated by the household. | • Daily greywater flow from bathroom and laundry = **95litres/person/day** (Table 3, **Appendix 4**).<br><br>• Greywater from bathroom and laundry combined (four occupants and 7 days a week) = 95 litres/person/day x four(4) persons x seven (7) days = **2660litres/week** |
| **Step 3.**<br><br>Calculate the area of land needed to soak up all of the greywater generated | The ability of the soil to soak up greywater will depend on the type of soil that is present onsite.<br><br>The value **2 mm/day** can be used in calculations as a conservative value of design irrigation rate (for medium to heavy clays, AS/NZS 1547:2012 table M1).<br><br>In this scenario, assume the soil is medium to heavy clay with a design irrigation rate (DIR) of 2 mm x 7 days = **14mm/week**.<br><br>• Area needed ($m^2$) = volume (litres/week)/DIR (mm/week) = 2,660/14 = **190m²** |
| **Step 4.**<br><br>Compare the area needed with available greywater irrigation area | • Compare the area needed in this example 190m² with available greywater irrigation area 130m².<br><br>In this scenario, the homeowner does **not** have sufficient area of land needed to distribute all the greywater from the bathroom and laundry. |
| **Step 5.** | Repeat **Step 2.** |

| | |
|---|---|
| Where the area available for irrigation is not sufficient, you may consider limiting the sources of greywater to just one source, such as greywater from the laundry or the bathroom. | • Daily greywater flow from bathroom only = 60 litres/person/day<br>• Greywater from bathroom (four occupants and 7 days a week) = 60 litres/person/day x four(4) persons x seven (7) days = 1680 litres/week<br>Repeat **Step 3.**<br>• Area needed ($m^2$) = volume (litres/week)/DIR (mm/wk) = 1680/14 = 120$m^2$<br>Repeat **Step 4.**<br>• Compare the area needed in this example 120$m^2$ with available greywater irrigation area 130$m^2$.<br>In this case the homeowner does have sufficient area of land needed to distribute all the greywater from bathroom. |

# Appendix 4: Look up tables

**Table 1 - Potential end uses of greywater where a greywater treatment plant is installed on premises generating less than 3kL (<3kL) per day**

| Potential End Uses | Parameter | Effluent Compliance Value |
|---|---|---|
| End uses with a medium level of human contact including<br>• Lawn and garden spray irrigation | Biochemical oxygen demand (BOD5) | ≤20mg/L |
| | Total suspended solids (TSS) | ≤30mg/L |
| | Thermo-tolerant organisms (org/100ml) | ≤30 cfu/100ml |
| | pH | 6.5 – 8.5 |
| | Turbidity | < 5NTU (95%ile) |
| | Disinfection | Cl: 0.2-1.0 mg/L residual (where used as primary disinfection) |
| End uses with a low level of human contact, including:<br>• Lawn and garden drip or subsurface irrigation (no pooling on surface) | Biochemical oxygen demand (BOD5) | ≤240mg/L |
| | Total suspended solids (TSS) | ≤180mg/L |
| | pH | n/a |
| | Turbidity | n/a |
| | Disinfection | n/a |

Source: adapted from Table T1A, QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 2 - Potential end uses of greywater where a greywater treatment plant is installed on premises generating greater than 3kL (>3kL) per day**

| Potential End Uses | Parameter | Effluent Compliance Value |
|---|---|---|
| End uses with a medium level of human contact including<br>• Lawn and garden spray irrigation | Biochemical oxygen demand (BOD5) | ≤10mg/L |
| | Total suspended solids (TSS) | ≤10mg/L |
| | Escherichia coli (95% of samples taken over a 12 month period) | ≤10 cfu/100ml |
| | Escherichia coli (maximum) | <100 cfu/100ml |
| | pH | 6.5 – 8.5 |
| | Turbidity | < 5NTU (95%ile) |
| End uses with a low level of human contact, including:<br>• Lawn and garden drip or subsurface irrigation (no pooling on surface) | Biochemical oxygen demand (BOD5) | ≤20mg/L |
| | Total suspended solids (TSS) | ≤30mg/L |
| | Escherichia coli (95% of samples taken over a 12 month period) | ≤100 cfu/100ml |
| | Escherichia coli (maximum) | <1000 cfu/100ml |

Source: adapted from Table T1B, QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 3 - Estimate of greywater generated by an average house in a sewered area (3-bedroom home and four occupants)**

| Greywater flow | Litres/person/day |
|---|---|
| Daily greywater flow from bathroom | 60 |
| Daily greywater flow from laundry | 35 |
| Total for bathroom and laundry | 95 |

Source: Table T2, QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 4 - Estimate of greywater generated by an average house in an unsewered area**

| Greywater flow total for bathroom and laundry | Bedrooms | Litres/ /day |
|---|---|---|
| 1-5 | 3 | 600 |
| 6-7 | 4 | 840 |
| 8 | 5 | 960 |
| 9-10 | 6 | 1200 |

Source: Table T3, QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 5 - Setback distances for subsurface land application area for a greywater treatment plant**

| Feature | Horizontal Separation Distance (metres) | | |
|---|---|---|---|
| Distance from the edge of trench/bed excavation or subsurface irrigation distribution pipework to the nearest point of the feature | Up slope | Down slope | Level |
| Property boundaries, pedestrian paths, footings of buildings, walkways, recreation areas, retaining wall footings. | 2 | 4 | 2 |
| In ground swimming pools. | 6 | 6 | 6 |
| In ground potable water tank. | 6 | 6 | 6 |

Source: Table T4 (modified), QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 6 - Setback distances for surface irrigated land application area for a greywater treatment plant**

| Feature | Horizontal Separation Distance (metres) |
|---|---|
| Property boundaries, pedestrian paths and walkways. | 2 |
| Water edge of a swimming pool. | 6 |
| Dwellings, recreation areas. | 10 |
| The separation distances are based on a spray plume with a diameter not exceeding 1 m or a plume height not exceeding 0.3 m above the finished surface level. Distances are given in metres from the edge of the irrigated wetted area to any point of the feature. | |

Source: Table T5 (modified), QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 7 - Setback distances from a greywater diversion device**

| Feature | Setback Distance (metres) |
|---|---|
| Property boundaries, pedestrian paths, and driveways. | 1.0 |
| Footings of buildings. | 1.5 |
| Retaining wall footing. | 1.0 |
| In ground swimming pool surrounds. | 1.0 |
| In ground potable water tank. | 6.0 |
| Bores intended for human consumption. | 50 |

Source: Table T6, QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 8 - Setback distances for greywater use system (Protection of surface water and groundwater)**

| Feature | Separation Distance (metres) | | |
|---|---|---|---|
| Level of human contact (from Table 1 or Table 2) | High | Medium | Low |
| Top of bank of permanent water course; or<br>Top of bank of Intermittent water course; or<br>Top of bank of a lake, bay or estuary or,<br>Top water level of a surface water source used for agriculture, aquaculture or stock purposes or;<br>Easement boundary of unlined open stormwater drainage channel or drain.<br>Bore or a dam used or likely to used for human and or domestic consumption | 10 | 30 | 50 |
| Unsaturated soil depth to a permanent water table (vertically) | 0.3 | 0.6 | 1.2 |

Source: Table T7 (modified), QUEENSLAND PLUMBING AND WASTEWATER CODE

**Table 9 - Site assessment checklist**

| Site feature | Minor limitation | Moderate limitation | Major limitation | Problem |
|---|---|---|---|---|
| **Flood potential** | Below 1:100 year usage | Below 1:20 year usage | | High runoff and contamination risk |
| **Exposure** | High sun and wind exposure | | Low sun and wind exposure | Poor evapo-transpiration |
| **Slope percentage** | 0–10 | 10–20 | >20 | Run-off, erosion |
| **Landform** | Hill crest, convex side slows and plains | Concave side slopes& foot slopes | Drainage plains and incised channels | Groundwater pollution hazard Resurfacing hazard |
| **Run-on and upslope seepage** | None–low | Moderate | High–diversion not practicable | High runoff and contamination risk |
| **Erosion potential** | No signs of erosion potential present | | Signs of erosion, e.g. rills, mass movement and slope failure, present | Soil degradation and transport, system failure |

| Site feature | Minor limitation | Moderate limitation | Major limitation | Problem |
|---|---|---|---|---|
| **Site drainage** | No visible signs of surface dampness | | Visible signs of surface dampness, such as moisture–tolerant vegetation(sedges and ferns), and seepages, soaks and springs | Groundwater pollution hazard Resurfacing hazard |
| **Fill** | No fill | Fill present | | Subsidence, variable permeability |
| **Buffer distance** | See Tables | | | Health and pollution |
| **Land area** | Area is available | | Area is not available | Health and pollution risks |
| **Rocks and rock outcrops(percentage of land surface containing rocks >200mm diameter)** | <10% | 10–20% | >20% | Limits system performance |
| **Geology/ regolith** | | | Major geological discontinuities, fractured or highly porous regolith | Groundwater pollution hazard |

Source: Table 1.3.3, Greywater guidelines for Queensland councils

**Table 10 - Soil assessment checklist**

| Soil Feature | Minor limitation | Moderate limitation | Major limitation[1] | Restrictive feature |
|---|---|---|---|---|
| **Depth to bedrock or hardpan (m)** | >1.0 | 0.5 – 1.0 | <0.5 | Indicates potential for excessive runoff and/or waterlogging |
| **Depth to high episodic/ or seasonal watertable (m)** | >1.0 | 0.5 – 1.0 | <0.5 | Groundwater pollution hazard, resurfacing hazard |
| **Soil permeability Category[2]** | 2b, 3 and 4 | 2a, 5 | 1 and 6 | Excessive runoff, water logging and percolation |
| **Bulk density (g/cm3)**<br><br>**Sandy loam**<br>**Loam & clay loam**<br>**Clay** | <br><br><1.8<br><1.6<br><1.4 | | <br><br>>1.8<br>>1.6<br>>1.4 | Indicates permeability |
| **Electrical conductivity(dS/m)** | < 4 | 4 – 8 | > 8 | Excessive salinity undesirable |

1. Sites with these properties are generally not suitable.
2. See Table 1.3.5 of Greywater guidelines for Queensland councils
3. Because of the elevated levels of sodium in domestic greywater, gypsum should be put on application areas each year.
Soil absorption systems should also be dosed on a regular basis.

Source: Table 1.3.4, Greywater guidelines for Queensland councils

# Appendix 5: Assessing greywater applications

All applications for greywater diversion and greywater treatment will be assessed against the Queensland Plumbing and Wastewater Code and council's greywater policy.

When assessing the application council will consider the following requirements:

| | |
|---|---|
| Regulatory Requirements for Application | • From 1 January 2008, in sewered areas greywater systems can be used with all classes of building. For example, hotels and motels can treat and re-use greywater where previously they were unable to do so.<br>• From 1 July 2010, following changes to the *Water Supply (Safety and Reliability) Act 2008* and the *Plumbing and Drainage Act 2002* through the *South-East Queensland Water (Distribution and Retail Restructuring) and Other Legislation Amendment Act 2010*, approvals of large greywater treatment systems (capable of treating 50 kL or more greywater per day) as well as greywater treatment plant capable of treating less than 50 kL greywater per day are regulated under the *Plumbing and Drainage Act 2002*.<br>• the greywater diversion can be installed at the premises generating up to 3000 litres of greywater per day<br>• a greywater treatment plant must be installed for premises generating more than 3000 litres per day<br>• wastewater from kitchen or toilet plumbing must not be diverted to a greywater system<br>• in unsewered areas, wastewater from kitchen must be connected to a grease arrestor before diverting to the greywater treatment plant.<br>• a licensed plumber must obtain written approval form the council prior to starting work.<br>• homeowners can install their own irrigation systems providing these comply with the approved plans for the system.<br>• a greywater diversion device must be certified under the Water Mark Product Certification Scheme before installation<br>• A greywater treatment plant must be an approved Greywater treatment system. A list of approved Greywater treatment systems can be found on the Department of Housing and Public Works website: http://dlgp.qld.gov.au/plumbing/greywater-treatment-plants.html. |
| System Design | **Greywater diversion devices** must meet the following requirements:<br>• greywater can be manually diverted to the sewer<br>• the system must automatically overflow to the sewer if the filtering or irrigation system does not work<br>• untreated greywater is **not** permitted for internal uses<br>• untreated greywater is diverted to a subsurface irrigation system or covered drip irrigation system (at least 100mm below the surface of soil or mulch). For further information, AS/NZS 1547:2012 outlines in details information on the design, installation and maintenance of subsurface and surface irrigation system check.<br>• greywater must be screened as it enters the tank and the coarse screens cleaned regularly and the tank flushed periodically.<br>• diversion devices must incorporate a surge tank to temporarily hold large flows from washing machines and bathtubs before distribution by a pump to a land application area; |

| | |
|---|---|
| | Surge tanks must be:<br>• vented<br>• fitted with an overflow line connected to the sewer<br>• fitted with a scour line that is connected to the sewer<br>• have all access openings sealed and vermin proof<br>• fitted with a hopper floor sloped to the scour line<br>• designed based on household fixture ratings of AS/NZS 3500.2, section 6.1, where note 1 under table 6.1 specifies the maximum discharge from any fixture to be 500 litres.<br>**Greywater treatment plants** must meet the following requirements:<br>• greywater treatment plants must be operated and maintained in accordance with the designer's or manufacturer's instructions.<br>• a licensed plumber must install a greywater treatment plants<br>• homeowners must obtain a written approval from Council prior to installation of a greywater treatment plants.<br>• treated greywater is **not** permitted for internal uses<br>• treated greywater can be used for cleaning vehicles, fences or footpaths and spray irrigation of lawns and gardens. However, these uses are **not recommended** by council for households with young children.<br>• greywater quality is appropriate for its potential end use as listed in the Tables 1 and 2, Appendix 4<br>Materials:<br>• All subsurface irrigation pipework and fittings must comply with AS 1477—PVC Pipes and fittings for pressure applications or AS 2698.2—perforated effluent pipe and associated fittings for sewerage applications. |
| Land application area | The requirements are as follows:<br>• sufficient area of land is available to soak up all the greywater generated within the home after taking into consideration the necessary setbacks (Table 1 Greywater Reuse Policy Factsheet or Appendix 4 Technical Addendum)<br>• where the area available for irrigation is not sufficient, council may consider limiting diversion times or sources of greywater to just one source, such as greywater from the laundry or the bathroom<br>• the size of the greywater application area is determined by calculating the daily volume of greywater generated under normal circumstances at the premises.<br>• Estimates of greywater generated are included in AS/NZS 1547:2000 On-site Domestic Wastewater Management. Recommended estimates for greywater generated by an average house provided in Appendix 4 Technical Addendum) and based on AS/NZS 1547:2000 and QPAWC. |
| Land suitability | • A site-and soil evaluation may be carried out under AS/NZS 1547 in order to obtain detailed site specific information relating to the land suitability.<br>• When assessing the suitability of land for greywater irrigation councils should take into account flood potential, exposure, slope, landform, potential for run-off, upslope seepage, site drainage, fill, buffer distances and geology. An explanation is provided Appendix 6 Technical Addendum. |

| | |
|---|---|
| | • Soil assessment: a checklist of critical factors for soil assessment is provided in Appendix 4 Technical Addendum. |
| Position | • The land application area and any pump or motor must not be located adjacent to bedrooms, living rooms or recreational areas of the premises or neighbouring properties to prevent noise and odour nuisance. |
| Ongoing Performance and Maintenance | • it is the owner of a greywater system responsibility to ensure that the system is maintained and does not compromise public health or the environment<br>• greywater diversion devices and irrigation systems will require regular maintenance, such as cleaning or replacing of filters, as well as regular servicing in accordance with the manufacturer's specifications<br>• greywater treatment plants must be maintained by an authorised service person in accordance with the manufacturer's specifications<br>• A minimum annual inspection is required to be conducted as part of the maintenance requirements<br>• Each annual inspection a service report must be completed by the service person. The original shall be given to the owner, the duplicate forwarded to the Council and the triplicate retained by the service contractor<br>• council must maintain a Register of the approved greywater diversion devices and greywater treatment plants for auditing purposes<br>• Inspection programs: council may undertake random audits on greywater systems installed in its area<br>• Audits: councils may undertake audit in response to complaints about the operation of greywater systems, such as odour problems, or greywater run-off to neighbouring properties. |

# Appendix 6: Explanation of soil and siting parameters

This explanation is extracted from the Greywater guidelines for Queensland councils.

**Soil depth**

Soil depth of less than 0.5 metres to bedrock might not have enough capacity to filter nutrients and pathogens. Shallow soils also incur a risk of effluent resurfacing near the land application area. The recommended minimum soil depth will vary depending on the type of land application system used and the site and soil characteristics. The values given in table 1.3.4 are based on ideal site and soil conditions. If these conditions are less than ideal the minimum soil depth requirement should be increased.

**Depth to episodic/seasonal water table**

Attention should be given to groundwater protection, particularly if the groundwater is used or may be used for potable or irrigation water supplies. Once a particular contaminant has reached the groundwater, the rate of transport may be much greater than in the unsaturated zone and movement will be in the direction of the regional groundwater movement. Micro-organisms can be carried substantial distances in this zone.

Minimum depths from the greywater infiltrative surface to the minimum periodic water table or gravel layer in a floodplain adjoining a river or stream are recommended to maintain aerobic conditions in the soil prevent surface ponding and prevent contamination of groundwater. These minimum depths will vary, depending on the type of application system proposed and the site and soil characteristics of the site.

The values given in table 1.3.4 are a recommended minimum, based on ideal site and soil conditions. If conditions are less than ideal, the minimum depth to the water table should be increased.

**Soil permeability**

Permeability is a measure of the ability of a soil to transmit water and is quoted as the value for the least permeable layer of a soil profile. It is affected by soil properties like structure, texture and porosity.

In general, highly permeable soils such as gravels and sands can allow wastewater to percolate rapidly through the soil profile, possibly allowing the transport of pathogens and nutrients to groundwater and off-site. Low permeability soils, such as medium and heavy clays, can encourage water logging and surfacing of the applied wastewater.

Permeability can be estimated by a field assessment of soil texture and structure, where the properties of a soil are correlated with a certain indicative permeability.

***Table 1.3.5: Soil permeability categories based on soil texture and structure***

| Soil permeability category | Soil structure | Soil texture |
|---|---|---|
| 1 | | Gravels and sands |
| 2a<br>2b | Weakly pedal<br>Massive | Sandy loams |
| 3a<br>3b | Highly or moderate pedal<br>Weakly pedal or massive | Loams |
| 4a<br>4b<br>4c | Highly or moderate pedal<br>Weakly pedal<br>Massive | Clay loams |
| 5a<br>5b<br>5c | Highly pedal<br>Moderately pedal<br>Massive | Light clays |
| 6a<br>6b<br>6c | Highly pedal<br>Moderately pedal<br>Massive | Medium to heavy clays |

### Soil texture

Soil texture refers to the field behaviour characteristics of a soil when it is manipulated. It relates to the relative proportions of clay (< 0.002mm diameter), silt (0.002–0.05mm diameter) and sand (0.05–2.0mm diameter) in the soil as well as its chemical characteristics. Soil texture can have a significant effect on the ability of the soil to transmit or retain irrigated greywater.

### Bulk density

Bulk density is the mass of dry soil per unit bulk volume. It is a measure of soil porosity and structure. Specific soil textures have a critical bulk density. The bulk densities for the specified soil textures for land application areas:

| Soil feature | Grams per cubic centimetre |
|---|---|
| Sandy loam | < 1.8 |
| Loam and clay loam | < 1.6 |
| Clay | < 1.4 |

### pH

The pH value of a soil influences soil conditions and vegetation growth. Soil pH affects the solubility and fixation of some nutrients in soils. Soils with a pH of between 4.5 and 8.5 should pose no constraints for land application areas.

### Climate

Climate influences the amount of greywater used for all types of land application systems. Areas with high evaporation compared with precipitation are preferred for land application systems, as they allow greater use of the hydraulic load. Areas using irrigation and experiencing periods when rainfall exceeds evaporation must revert greywater to the sewer during periods of wet weather. Applying greywater during wet weather could make pollutants leach to groundwater, or the greywater could surface, with consequent environmental and health risks. Councils may wish to use water balance data (historical precipitation and evaporation) to determine whether or not greywater irrigation is appropriate for local climate conditions or to provide advice on design of irrigation systems.

**Flood potential**

It is best to locate all the components of greywater use facilities above the one in 100 year probability flood contour, but the one in 20 year probability contour may be used as a limit for land application areas. Electrical components, vents and inspection openings of wastewater treatment devices should be sited above the one in 100 year probability flood contour.

**Exposure**

Sun and wind exposure on land application areas should be maximised to enhance evaporation. Factors affecting exposure include the geographical aspect of the area, vegetation and buildings near the proposed application area. Evaporation may be reduced by up to two-thirds in some locations by a poor aspect or overshadowing and sheltering by topography, buildings or vegetation.

**Slope**

Excessive slope might pose problems for installing systems and create difficulties in evenly distributing the treated wastewater to land, resulting in run-off from surface land application areas. The recommended maximum slope will vary depending on the type of land application system used and the site and soil characteristics. The values given in table 1.3.3 are based on ideal site and soil conditions. If these conditions are less than ideal the maximum slope requirement should be reduced.

**Run-on and up-slope seepage**

Run-on of precipitation to the land application area from up-gradient areas should be avoided. Run-on should be diverted around any land application area by using earthworks or a drainage system approved by council. Up-slope seepage can be at least partly controlled by installing groundwater cut-off trenches, provided the lowest level of the trench is above the level at which effluent can enter the land application area.

**Erosion potential**

Greywater use facilities should not be put on land that shows evidence of erosion or that has potential for mass movement or slope failure.

**Site drainage**

Greywater use facilities should not be installed on damp sites. Poor drainage and surface dampness are often indicated by the type of vegetation growing on the site. Sedges and ferns are likely to grow in damp conditions. Seepage springs and soaks are also indications of poor site drainage. Site drainage can best be determined by inspecting the soil at the site.

**Fill**

Fill can be described as soil resulting from human activities that have led to modification, truncation or burial of the original soil or the creation of new soil parent material by a variety of mechanisms. Fill often has highly variable properties, such as permeability. Fill can be prone to subsidence and could contain material that might not be suitable for plant growth or for constructing land application systems. Fill can be removed, but if this is not possible, a detailed assessment of the fill might be needed. Fill less than 0.3 metres deep could be suitable, depending on the nature of the material and the suitability of the underlying soil.

**Buffer distances**

Buffer zones should be kept between greywater use facilities and sensitive environments on- and off-site, to ensure protection of community health, the environment and community amenity. A buffer distance should be left between greywater use facilities (particularly land application areas) and features like boundaries of premises, driveways, buildings and swimming pools.

See Tables T4, T5, T6 and T7 of the QPW code for setback distances. These setback distances may be varied under performance where the council is satisfied that the performance criteria are satisfied. See section 8B of the SPDR.

**Rocks and rock outcrops**

The presence of rock outcrops usually indicates highly variable bedrock depths and can be associated with preferential pathways (short circuits) for effluent to flow along rock fissures and surface elsewhere. The presence of rocks can limit evaporation and interfere with drainage. Rocks can also interfere with trench and pipe installations. Cobbles and larger stones can collapse into installations causing problems with even effluent distribution.

**Geology/regolith**

Land application areas should not be installed near major geological discontinuities, fractured or highly porous regolith, as these structures can provide preferential pathways for wastewater to groundwater.

Greywater guidelines for Queensland councils

# Appendix 7: Lead Exposure Estimates

## 1.1 Background

Regulatory agencies such as World Health Organisation (WHO) and the United States Environmental Protection Agency (USEPA) are the primary sources of the toxicity criteria for chemicals. Toxicity information from these sources has been used to estimate the potential health risk from exposure to lead from greywater reuse.

'Health effects associated with exposure to inorganic lead and compounds include, but are not limited to, neurotoxicity, developmental delays, hypertension, impaired hearing acuity, impaired hemoglobin synthesis, and male reproductive impairment. Importantly, many of lead's health effects may occur without overt signs of toxicity. Lead has particularly significant effects in children, well before the usual term of chronic exposure can take place. Children under 6 years old have a high risk of exposure because of their more frequent hand-to-mouth behaviour.' Source: http://toxnet.nlm.nih.gov

## 1.2 Tolerable daily intake (TDI) and Blood lead levels or BLLs

RIVM[1] has derived a tolerable daily lead intake (TDI) of 3.6E-3 mg/kg-day for developmental and central nervous system effects. RIVM based its TDI on the provisional tolerable weekly intake (PTWI) of 25 µg/kg-week derived by the FAO/WHO (1993; IPCS, 1995). The PTWI refers to lead intake from all sources and was set to prevent a net accumulation of blood lead levels above 50 µg/L in children and infants. The FAO/WHO determined that this PTWI would be valid for all humans, i.e., children and adults (published by the IPCS [1995]). RIVM divided the PTWI by 7 to adjust from a weekly to a daily intake level, resulting in the TDI of 3.6 µg/kg-day. Source: http://toxnet.nlm.nih.gov

Blood lead levels or BLLs, represent aggregate exposure from all routes and all sources, including exposure from environmental media, consumer products, and lead remobilized from bone.

## 1.3 Health risks from soil, dust, air and food

Based on a number of overseas studies and reports, however very limited specific data for Mt Isa, it is assumed that the major potential sources of lead in Mt Isa are dust, soil and air from home renovations, contaminated people, clothes, cars or items and food (rain water is not allowed to be used in the area).

The major exposure pathways may include:

- incidental ingestion of surface soil, dust/particulates and soil adhering to home-grown produce
- indoor and outdoor inhalation of dust particulates
- consumption of home-grown produce (including vegetables and fruit)
- dermal contact with surface soil and dust/particulates
- indoor and outdoor inhalation of vapours derived from soil.

[1] The National Institute for Public Health and the Environment (RIVM) is a specialised Dutch government agency.

## 1.4 Health risks from drinking water

The contribution of lead in drinking water to blood lead level, is not significant, unless specific data exists, showing that concentration of lead may be above the ADWG. The Australian Drinking Water Guidelines (ADWG) notes that lead concentrations in drinking water range up to 0.01 mg/L with typical concentrations less than 0.005 mg/L. Drinking water guidelines have been derived based on available data which indicates that approximately 80% of the daily intake of lead is from the ingestion of food, dirt and dust. The average Australian adult dietary intake of lead is approximately 0.1 mg per day.

Assuming the maximum concentration of lead in drinking water is below ADWG=0.01mg/L, the maximum daily intake derived for a young child (consuming 1L/day of water and a body weight of 13 kg) is approximately 0.77 µg/kg/day

$$\frac{0.01\text{mg/L} \times 1\text{L/day}}{13\text{kg}} = 0.0007692 \text{ mg/kg/day} = 0.77 \text{ µg/kg/day}$$

## 1.5 Health risks from exposure using greywater

The public may potentially be exposed to lead by using greywater for car washing, hard surface cleaning or spray irrigation. The major route of exposure is expected to be from ingestion (accidental), dermal contact with greywater or inhalation of aerosols. Dermal absorption of lead is expected to be minimal because the dermal route is the least efficient method of absorption. Exposure may also be reduced if gloves are worn, and no aerosols are produced during greywater reuse. There is a potential for secondary exposure from surfaces. Assuming the maximum concentration of lead in greywater is 0.097mg/L (based on the maximum level detected in Mount Isa sewage wastewater over a specific sampling period), the additional intake derived for a young child (consuming 100ml of greywater accidently based on the Australian Guidelines for Water Recycling Phase 1 and a body weight of 13kg) is approximately

$$\frac{0.097\text{mg/L} \times 0.1\text{L/day}}{13\text{kg}} = 0.0007461 \text{ mg/kg/day} = 0.75 \text{ µg/kg/day}$$

Comparing with a tolerable daily intake of 0.0036 mg/kg-day, intake from accidental ingestion of greywater may be up to 20 % of total tolerable daily intake. This proportion represents an additional risk of exceeding target safe blood levels of lead 'less than 10mcg/dL' for children.

It is important to note that the values identified above are an estimate based on generic values from guidelines and limited data from sewage effluent (not greywater). Specific data may be used to accurately calculate the intakes from other sources such as air, soil and food. An objective of the Greywater Reuse Policy objective is to reduce the exposure to lead by encouraging the community to minimise bare soil patches and dust, whilst not compromising the health of children, particularly children under 6 years old with a low body weight and frequent hand-to-mouth behaviour.

## 1.6 Additional information

### 1.6.1 IEUBK model

Child exposure to lead can also be estimated using the integrated exposure uptake biokinetic model for lead in children (IEUBKwin1_1 Build11) developed by the US EPA.

The IEUBK model comprises separate components for exposure, absorption and the biokinetic transfer of lead to all tissues of the body and calculates age-specific blood lead concentrations for children aged between 0 and 7 years. The components of the IEUBK model include exposure estimates intake from soil, dust, water, air and food. The estimate is based on data input by the user. The model provides default estimates for circumstances where site-specific information is not available. These default estimates may not be directly applicable to Mt Isa.

Data from Report 'TOXICOLOGICAL PROFILE FOR LEAD' by the U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES Public Health Service Agency for Toxic Substances and Disease Registry August 2007

Table 4: Media concentrations for three sites; A, B and C

| | **Site** | | |
|---|---|---|---|
| **Media** | A | B | C |
| **Soil (mg/kp)** | 290 | 768 | 580 |
| **Dust (mg/kg)** | 383 | 580 | 560 |
| **Air (µg/m$^3$)** | 0.06*0.2 | 0.06-0.2 | 0.06-0.2 |
| **Water (µg/L)** | 1 | 1 | 1 |
| **Food (µg/day)** | 5 | 5 | 5 |

Table 5: Contribution of blood level lead for three sites; A, B and C

| | **Site** | | |
|---|---|---|---|
| **Media** | A (contribution of PbB (µg/dL) | B (contribution of PbB (µg/dL) | C (contribution of PbB (µg/dL) |
| **Soil** | 1.1-2.8 | 3-7.4 | 2.3-5.6 |
| **Dust** | 1.7-3.8 | 2.6-5.7 | 2.5-5.5 |
| **Air** | 0.1-0.2 | 0.1-0.2 | 0.1-0.2 |
| **Water** | 0.26 | 0.26 | 0.26 |
| **Food** | 1.2 | 1.2 | 1.2 |
| **Predicted range of PbB (µg/dL)** | 4.4-8.3 | 7-14.8 | 1.2 |
| **Actual PbB** | 4.8 | 10.6 | 13.1 |