



Water quality protection note 50

April 2015

Soil amendment using industrial by-products

Purpose

The Department of Water supports the appropriate use of fit-for-purpose industrial by-products to improve soils, making them more productive for vegetation growth while ensuring they do not pose a significant environmental contamination risk. Reuse of solid waste can help avoid sterilisation of land used to indefinitely store industrial by-products and limit the proliferation of landfills. Waste minimisation principles strongly support the reuse of industrial by-products, as does the principle of conservation of natural resources, where alternative source materials are available.

Soil amendment can be well suited to both leached sand or heavy clay soils. It may correct deficiencies in fertility (e.g. lack of carbon and trace elements), assist in the retention of moisture and otherwise mobile contaminants such as nutrients, improve soil structure by the addition of biomass or changed porosity, alter soil pH and assist in ion exchange. Industrial soil amendment materials are generally the by-products of activities such as water treatment, mineral processing, energy conversion, food product processing or crop harvest by-products.

Environmental contamination risks from soil amendment include altered soil and/or water acidity or alkalinity; increased salinity; mobile nutrients, adverse effects of any entrained radioactive materials, metals, petroleum hydrocarbons, pesticide or surfactant residues and disease-causing micro-organisms. Physical risks to water resources include changes to soil hydrology, discolouration, increased sedimentation and turbid waters, litter, odour generation and attraction of insects and vermin.

This note provides advice on water resource management matters to those considering approval for the application of industrial by-products used for broad area soil amendment. It also highlights issues that should be considered by users of soil amendment materials. The recommendations describe the criteria which may be used by this department to advise on the in-principle use of amendment materials.

The Department of Water is responsible for managing and protecting the state's water resources. It is also a lead agency for water conservation and reuse. This note offers:

- our current views on amending soils to improve their suitability for cropping, pasture, recreational turf or sustaining native vegetation
- guidance on acceptable practices used to protect the quality of the state's water resources a basis for the development of a multi-agency code or guidelines to

balance the views of industry, government and the community, while sustaining a healthy environment.

Appendices provide additional background and technical advice as follows:

- A. Information on sensitive water resources, note limitations and updates.
- B. Relevant statutes and administering agencies, followed by references and further reading, note disclaimer and how to provide feedback.

Scope

This note applies solely to the land application of granular, powdered or slurried industrial by-products that can be demonstrated to improve soil characteristics without causing significant contamination risks. These materials are added to natural soils to enhance their chemical and/or physical properties resulting in improved crop yield or plant growth for other purposes. The by-products may contain carbon-rich humus (material that enhances water retention and desirable microbial activity), essential plant nutrients, trace minerals, or components that alter soil structure or pH. If added to the soil surface or incorporated as a homogenous blend into topsoil, the amending material can provide a balanced soil medium that improves vegetation productivity.

Potential soil amendment materials include:

- animal waste (stabilised)
- bauxite processing residues (red mud, red sand, Alkaloam™)
- cement kiln dust
- coal-fired power station fly and bottom ash
- mineral sands processing residue
- paper processing pulp
- residue from forest product processes (such as bark, trimmings and sawdust).

This note does not apply to materials that may be applied to land for reasons other than improving soil fertility, mixed and/or dangerous waste, products that are purpose manufactured or materials that are customarily used as soil amendments on urban lots.

The application of the following materials to land are not addressed in this note's recommendations (as some present health or environmental risks which may outweigh potential gains in soil fertility or conflict with the regulatory roles of other agencies):

- acid sulfate soils (typically acidic peat from past wetlands)
- animal manures (raw or unstable) - controlled under state Health Act provisions
- green waste and/or compost (see *Australian standard 4454*)
- chemical fertilisers, such as superphosphate (acidulated rock phosphate)
- hazardous wastes (as defined by the European Union Directive 2000/532/EC –as amended)
- mixed material (containing undefined or variable content)
- substances classified under the *Australian code for the transport of dangerous goods by road and rail 2007*

- substances required to neutralise, immobilise or contain contaminated sites
- substances with excessive concentrations of mobile (water-soluble) contaminants likely to cause health or environmental problems if leached by rainfall, flooding or irrigation
- materials used in stormwater systems, such as contaminant filters or hydraulic barriers, see the *Stormwater management manual for Western Australia* (reference 4c)
- medical or veterinary wastes (resulting in a health risk)
- municipal waste (household refuse)
- construction wastes (e.g. asbestos, cement, coatings, packaging, insulation, masonry, metals, plaster board, plastics and timber)
- naturally occurring 'clean' soil materials, such as inert peat, loams or sands (that present a low contamination risk)
- sewage biosolids -untreated or treated, that are covered in the *Western Australian guidelines for direct land application of biosolids and biosolids products* (reference 4b)
- soil-wetting agents (a low contamination risk if used as recommended by supplier).

The following information recommends a process for gaining acceptance of soil amendment materials. It also outlines water resource protection issues for consideration by government environmental regulators when responding to proposals to use industrial by-products for soil amendment and development applications involving amended soils.

Advice and recommendations

The following steps are recommended when considering the use of a soil amendment material (SAM) anywhere in Western Australia or if applying for approval to use a SAM.

Our recommendations on soil amendment material are divided into two parts:

Part 1 - Information for existing and potential SAM suppliers

- Identify the SAM's beneficial properties and any threats posed to the environment.
- Define areas of the state where benefits may be gained from the application of the SAM to soils needing supplements to improve their fertility.
- Undertake field trials involving the use of SAM to determine its effectiveness and inform on appropriate application constraints.
- Prepare a detailed scientific evaluation report on the field trials.
- Attain written acceptance from appropriate regulatory agencies for the widespread use of the SAM (if applicable).
- Prepare and publish instructions or a code of practice for the safe use of the SAM.

Part 2 - Information for the end users of SAM (typically farmers)

- Define the properties of the SAM suited to the application site and the target vegetation.
- Ensure the risks posed by use of the SAM to the local environment are assessed.

- Devise protective measures to safeguard sensitive local water resources.
- Gain site-specific approval from regulatory agencies to use the SAM.
- Apply SAM under controlled conditions to maximise soil fertility benefits and avoid erosive loss or contaminant leaching.
- Implement monitoring, record keeping and reporting protocols.

Part 1 - Information for existing and potential SAM suppliers

SAM properties and its effects on soil fertility and productivity

- 1 The following properties of SAM may assist in improving soil structure or fertility:
 - a Stabilised organic (carbon-rich) matter such as sawdust or ash.
 - b Materials containing balanced levels of nutrients in forms suited to fostering plant growth such as oxidised nitrogen, ortho-phosphate and potassium.
 - c Fine clays and silt components that, blended with coarse sandy soil, help retain water and nutrients.
 - d Material containing small quantities of essential trace/ minor elements matched to crop needs (such as boron, cobalt, copper, iron, magnesium, manganese, molybdenum, selenium and zinc oxides).
 - e Materials that are used to correct natural or induced imbalances in soil minerals such as lime or sulfur-rich matter.
 - f Materials that improve an essential element retention capacity of a soil (such as increased phosphorus retention index or cation exchange capacity).
 - g Materials that can increase either water percolation or absorbency of Western Australian soils.
- 2 The following SAM properties may be detrimental to soil fertility or produce other adverse results:
 - a Excessive salts.
 - b Degradable material, such as blood and bone (that may cause odours, breed flies, attract vermin or strip dissolved oxygen if washed into surface waters).
 - c Material that clogs soil pores blocking air or water movement, such as grease.
 - d Material with excessive acidity or alkalinity.
 - e Imbalances in the concentration of nutrients or trace elements needed for plant growth.
 - f Radioactive substances.
 - g Material that influences clay soil permeability, such as sodium.
 - h Materials toxic to plants or animals (including soil microbes).
 - i Material containing pathogens.
 - j Sharp residues (metal or glass) that may harm people or animals.

Laboratory analyses

- 3 The potential benefits and risks associated with the use of the SAM should be defined via laboratory analyses certified by the National Association of Testing Authorities (NATA) that define concentrations of SAM constituents and followed by field trials. Initial contaminant leaching trials should be conducted on the SAM using the procedures described in Australian Standard 4439 (reference 8b).
- 4 The following data should be certified as representative of the SAM:
 - a The bulk density (kg or cubic m) and moisture content range.
 - b Representative analyses of the physical, chemical and any microbiological constituents.
 - c A statement of the maximum probable variability (%) of constituent materials from analysis results.
 - d Details of stabilisation processes applied, such as screening, de-watering, biological stabilisation, material blending, storage duration, heat, and/or chemical conditioning (where applicable).
 - e Contaminant leaching potential determined using AS 4439 and AS 4454 (reference 8). Leaching test results should be compared against the Department of Environment Regulation's *Landfill waste classification and waste definitions* (reference 3b).
 - f Preparation and publication of a material safety data sheet (in the absence of an existing sheet for the SAM).

Locations and vegetation types suited to soil amendment

- 5 The SAM supplier should define soil types where the product could potentially be used to improve soil structure or fertility. SAM application may benefit land used for rural, silviculture or recreational activities where the soil has natural deficiencies in humus, nutrients or trace elements that affect water retention and fertility. There may also be environments where soil acidity or alkalinity may affect vegetation growth, or where the amendment may be used to assist in attaining desired environmental management objectives within a degraded catchment. This note does not apply to soil amendment in urban areas (private lots, public open space or recreational land).
- 6 The types of vegetation and plant production systems intended to benefit from soil amendment should be defined. These may include land revegetation, plantation timber, horticulture, turf, pasture, cereal crops, orchards or vineyards. Care should be taken to ensure that toxic components (if present in the SAM) are not taken up into plant or animal tissues if they pose a significant risk to the end product when used for human consumption.
- 7 Any areas where it may be unsuitable to apply the product should be identified such as areas with acidic or alkaline soil (pH that may mobilise metals in the SAM); and areas prone to waterlogging (soil anoxia might cause redox reactions that could mobilise metals in soils).

Sensitive water resources

Sensitive water resources (see Appendix A) may be harmed where the application of SAM disrupts local ecosystems (due to change of hydrology) or adds sufficient contaminants via leaching or erosion to harm the water resource quality.

- 8 Setback buffers, constraints on the use and application quantities of SAM may be required near sensitive water resources. For online information on the locations of sensitive waters see <www.water.wa.gov.au> *Contact us* and seek advice from our local regional office.
- 9 See Part 2, *Constraints near sensitive water resources* for other constraints.

Trials involving the use of amended soils

- 10 The supplier should demonstrate that there will not be short term (seasonal) or long-term (cumulative) harm caused by application of the SAM material to human health or the environment (via direct exposure or consumption of tainted products). Clearly presented laboratory and field research is recommended to evaluate potential impacts. Representative and locally applicable data drawn from interstate or overseas may be cited if available.
- 11 For previously unused products, research involving pilot trials may involve a period of up to five years. The first two years allows for stakeholder consultation, project formulation and the collection of baseline environmental data. This suggested timeframe may be reduced if other studies have already been undertaken on the SAM. The relevant regulatory agency should advise on what data is gathered, collection methods, sampling frequency and analytical criteria. Once baseline data has been collated, the amended soil trials over at least three years may commence. Scientific data should be collated annually for review and response by the regulatory agencies.
- 12 This department should be consulted if any field trial sites are selected within any public drinking water source area or near any waterways and wetlands, as constraints may be necessary to limit potential risks to water quality. Appropriate separation distances to sensitive environmental features should be determined. Research on all variants of the material is needed to permit the assessment of SAM, as well as representative water body types present in the area where the material will be applied.
- 13 To safeguard groundwater, wetlands and waterways, the following scientifically valid information is needed to conduct an effective assessment of field trial sites:
 - a Does the amendment site have any remnant native vegetation or plants normally associated with streams or wetlands, such as paperbarks, reeds, *Eucalyptus Bullich* or flooded gums?
 - b What historical land uses have occurred at the site? Have these activities caused the soil to become contaminated?
 - c Given the chemical composition of the amendment material, what reactions are expected to occur between the SAM and local soils? (see references 6 and 8).
 - d What elements/chemicals may be released when the material breaks down under operational conditions? Will the resultant concentration in leachate or runoff cause the contamination threshold levels for receiving water resources to be exceeded?

- e With rainfall or irrigation (under either aerobic or anaerobic conditions), what contaminants may leach and migrate into the environment?
 - f What changes, (chemical or microbiological reactions), are likely to occur to contaminants during soil or water movement between the amended soil site and sensitive environmental features such as waterways and wetlands?
 - g What reactions would result if leached elements/chemicals enter a water body or an adjoining riparian zone?
 - h What effects are anticipated on the physical properties of downstream water bodies, such as changes to colour, oxygen concentration, salinity or turbidity?
 - i What effects are anticipated on the chemistry of the downstream water body such as pH (expected pH changes in the water column and sediments), metal ions and electrical conductivity?
 - j What are the anticipated effects of any induced water quality changes on the downstream ecosystem ecology (aquatic flora and fauna)?
 - k How do observed and predicted changes in nearby water-bodies (such as water chemistry, turbidity, salinity) compare to environmental values protection criteria given in the national water quality management strategy (NWQMS) Paper 4 *Australian and New Zealand guidelines for fresh and marine water quality* and Paper 6 *Australian drinking water guidelines* (references 1a and 1b)?
 - l What are the predicted changes during effective life of the amendment, to nearby water-bodies (such as hydrology, water chemistry, turbidity, salinity and sediment accumulation) and how may these affect the values of the water-body?
- 14 The following issues should be addressed in assessing whether there will be any short or long-term impacts caused by the application of SAM:
- a The impact that the application rates will have on the soil's infiltration capacity. Is there potential for changed water infiltration rates/water holding capacity from widespread SAM application? It is unacceptable if widespread SAM use changes the local hydrology to the extent of significantly reducing groundwater availability, increasing the risk of soil erosion or flooding, damages ecosystems or disrupts the pursuits of the surrounding community.
 - b What limits on application rates and repeat applications are needed to avoid environmental harm (in tonnes or cubic metres per hectare)? How could this be controlled? Are future amendments likely to be necessary (to replace constituents either taken up by plants, leached, eroded or otherwise lost from the site)? Describe the methods planned to assess the need for any repeat soil amendment (including assessment of soil contaminant retention resulting from repeat SAM applications).
 - c Define the effects of the SAM on the capacity of the soil to buffer various parameters such as pH and phosphorus.
 - d Leaching tests conducted in accordance with *Australian standards 4439 and 4454* should be performed on representative samples of the natural soil–SAM blend to assess the leaching potential of entrained constituents.
 - e Tests should be performed on at least 5 samples that represent material taken at different times from the source, and also consider any quality changes due to

material weathering or storage. Where there is any significant variability of results between tests this should be recorded.

Evaluation report following field trials

- 15 The proponent should arrange for an independent qualified and experienced consultant or academic institution to evaluate the results of the field trials and prepare an authoritative report on their findings.
- 16 The report should effectively address the following matters:
 - a description of the location where the trials took place
 - b the physical properties of the trial site
 - c the nature of any crops/plants that were grown
 - d details of the amendment application (tonnes per ha and soil incorporation depth where applicable)
 - e the area, seasonal timing and duration of the trials
 - f quantities of inputs used during the trials, including irrigation water, fertilisers, pH adjustors or pesticides
 - g the weather conditions experienced during the trials and their influence on the results
 - h describe any controls (measurements at unamended sites) that were used to benchmark SAM performance
 - i describe the tests that were conducted to determine any environmental effects resulting from the trials, including plant growth, leaf tissue or soils analysis, lysimeter results (for leached fluid collection), runoff or bore water analyses, dust generation, impacts on local microfauna and radiological risk analysis (if applicable)
 - j the proposed minimum and maximum frequencies for repeat additions of SAM, defining any long-term risk of creating a contaminated site (if relevant)
 - k any occupational health and safety issues predicted for farmers using the SAM
 - l describe the conclusions and recommendations resulting from the field trials.
- 17 An electronic version of this report should be submitted to the Department of Water.

Regulatory agency acceptance

- 18 Under Part IV of the *Environmental Protection Act 1986*, proposals that have the potential to cause a significant effect on the environment should be referred to the Western Australian Environmental Protection Authority (EPA). The EPA will determine the required level of assessment.
- 19 All proposals for initial large-scale (>4 ha) or widespread application of SAM, if not previously approved, should be referred to the EPA for assessment and response.

Note: The use of bauxite processing residues within the Peel-Harvey catchment has been previously approved by the EPA, following formal assessment via an Environmental Review. Advice should be sought from the Office of the EPA on their requirements for the additional use of this material in that catchment.

- 20 The Minister for the Environment may determine whether or not and in what manner the proposal may be implemented, and any conditions associated with the approval that may be set. As an example the proponent may be requested to prepare a *Code of Practice* for use of the SAM. See the EPA's *Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002* (reference 5) for information on the regulatory process.
- 21 Proposals to apply 1000 tonnes or more of solid waste in any 12 month period to any property via direct land application are regulated by the Department of Environment Regulation under the Environmental Protection Regulations 1987.
- 22 Proponents should contact the Department of Agriculture and Food (DAFWA) for advice on any SAM information needs and assessment procedures related to the department's responsibilities and interests.
- 23 A detailed submission to regulatory agencies addressing the recommendations made in this note should demonstrate how the amendment could be undertaken so that enhanced plant growth occurs, without allowing significant escape of contaminants to the surrounding environment, risk of harm or discomfort to the surrounding community. Any beneficial effects of the amendment on the environment (such as reduced nutrient leaching) should also be described in the submission.

Supplier instructions/code of practice

- 24 The SAM supplier should prepare detailed usage instructions or a code of practice (COP) in consultation with this department and relevant stakeholders including representatives of intended end users of the SAM. The document should describe the properties of the by-product, provide guidance on its use to minimise environmental impacts and highlight any application constraints that may apply. It should outline the procedures to be followed in its distribution, storage and use. As an example, see the WA Department of Agriculture and Food's *Code of practice for the distribution and application of AlkaloamTM (bauxite residue) for broad acre agriculture and horticulture in the Peel-Harvey Coastal Plain Catchment*. Recommended COP content is given below.

Roles and responsibilities of the SAM supplier and user defined

- 25 The instructions or COP should describe the roles and responsibilities for the various activities involved with the SAM including compliance auditing, loading, production and storage, distribution, application, occupational safety, health and training issues, development and implementation of a strategy which makes it available for broad-hectare agricultural, horticultural and silvicultural use.

Constraints on land application

- 26 The instructions/COP should detail any constraints identified during the preliminary investigations (see section on *Locations and vegetation types suited to soil amendment*).
- 27 There are exclusion zones within proclaimed public drinking water source areas within designated P1 and P2 areas and buffer zones to unconfined aquifers; and near conservation-valued wetlands and rivers.
- 28 If the results from the research programs indicate the SAM may leach contaminants such as heavy metals under acidic conditions, as found in many wetlands, precautions

may be required. The instructions/code should describe all materials that may leach out in significant concentrations under a range of likely environmental conditions.

- 29 Other site considerations may include exposure to wind effects (dust can create problems) and local government (council) zoning of potential sites.
- 30 Recommendations should be made on the frequency of repeat applications of SAM and how to determine when reapplications are necessary.

Operation and management practices

- 31 Describe how the SAM should be stored to prevent dust generation, leaching of contaminants into water resources, odours, stockpile erosion or vermin attraction.
- 32 Recommend methods to reduce migration of SAM or its constituents following its application, using drainage controls and controlled irrigation techniques (if applicable).
- 33 Define safe handling, loading and distribution practices for the SAM (including relevant information in the material safety data sheet for the product).

Monitoring and reporting practices

- 34 If research determines a potential risk of SAM causing environmental problems, a regular monitoring program for trial application sites should be proposed to detect any contamination of water resources, erosion, dust problems or vermin attraction.
- 35 The instructions/COP should outline any necessary contingency measures to address issues arising during abnormal circumstances such as storm events, fires or chemical spills.
- 36 Regular updates and summaries of any research undertaken on constituents and performance of amended soils should be submitted to this department as soon as it becomes available.

Audit forms for processing and distribution

- 37 Templates should be provided for audit forms necessary for quality assurance tracking of the distribution and application process.

Part 2 - Information for users of SAM (typically farmers)

Properties of the SAM suited to the application site and crop defined

38 The SAM should come from a known source and have defined and consistent properties, as determined by laboratory analyses of representative samples accredited by NATA (see part 1, recommendation 3). The product should be chosen to perform its intended purpose without causing any significant hazard to soil productivity, the person applying it, nuisance to neighbours or risks to the surrounding environment.

39 The SAM should not be mixed or diluted with any other material (other than natural soil) once it has left the control of the original supplier, as it may change the characteristics of the product. Further soil testing may be required if fertilisers or other chemicals have been applied to the land within the previous three years.

40 If initial analyses by the supplier indicated significant concentrations of contaminants such as metals (based on the information gained as a result of above recommendations), the following additional test may be necessary:

The potential to leach contaminants, such as metals over time should be determined for these materials. The application of other materials to amended soils such as acidic fertiliser, may influence leaching results. NATA certified soil testing of the pre-existing soil condition should be undertaken as a control. Various SAM mixing rates with soils should be analysed to determine their leaching potential.

Constraints near sensitive water resources

Is the soil amendment site located within a PDWSA i.e. a proclaimed water reserve, catchment area or underground water pollution control area?

41 Soil amendment is incompatible with this department's source protection policy within priority 1 (P1) and priority 2 (P2) areas, wellhead protection zones (up to 500 m radius around public drinking water supply production bores) and reservoir protection zones (up to 2 km radius around drinking water source reservoirs). This department will oppose the application of SAM in these areas due to the increased risk to the quality of water resources from contaminant leaching, intensification of land use and potential changes to local hydrology. These areas and zones are shown in drinking water source protection plans available online at <www.water.wa.gov.au> select *managing water* > *drinking water*.

42 Soil amendment may be approved in PDWSA with source protection conditions compatible with the recommendations made in this note within designated P3 areas.

Is the amendment area located close to private water sources used for human or stock drinking or any waters used for aquaculture or food processing?

43 For SAM application within 200 m of any water source, the proponent should:

- a demonstrate how contamination risks will be managed to prevent harm to these water sources
- b commit to an effective environmental monitoring program.

Is the amended site located within 200 m of any wetland, waterway or estuary?

44 Site specific studies of the local environment and anticipated amended land usage should be used to devise appropriate separation buffers wherever practical. The

conservation significance of the wetland/ waterway and the benefits of a protective buffer will be considered in determining an optimal width. A minimum 200 m buffer should normally be applied between any amended soils and damp land-dependent (riparian) vegetation. A minimum 20 m buffer (setback) should apply to any drain discharging surface runoff or groundwater into a wetland, waterway or estuary.

- 45 Vegetated buffers should be used to limit the impacts of the intensified land use on the water body, lower the risk of contaminants attached to soil particles being washed into the water body and to prevent environmental harm, such as smothering of native vegetation. For more information see *Position statement – Wetlands* (reference 3a), our Water note *Wetland buffers* (reference 4e) and our Water quality protection note (WQPN) 6 *Vegetated buffers to sensitive water resources* (reference 4d).

Steep terrain

- 46 Erosion prone or steep land (exceeding a slope of one in 10) should not be amended unless effective measures are installed to control surface drainage. This is particularly important for land that is subject to seasonal cropping, as a storm event may cause significant erosion when soils are disturbed and comparatively bare.

Other issues

- 47 The proponent should also consider any social issues such as dust, impact on organic farms, and changes to local hydrology that may arise from the use of the SAM in a particular setting. Consultation with potentially affected community members and local governments is recommended. Records should be kept of the consultation process and its outcomes.

Protective measures proposed to safeguard sensitive downstream water resources

Is there is a risk of environmental harm? Risk is determined by the procedures previously outlined. How does the applicant plan to prevent the SAM from washing off the property or entering water-bodies?

- 48 Describe any controls that are proposed for drainage of land that is amended, such as diversion channels or re-contouring.
- 49 A minimum buffer of 2 m should be maintained between the maximum seasonal water table and the base of amended soils. This is to allow for contaminant filtering and aerobic microbiological processes to occur before stormwater and any leached contaminants enter the water table. The buffer between the soil base and water table may be reduced, for example, if the amendment material acts to reduce phosphorus release rates under anoxic conditions or a scientific risk assessment (Australian Standard 4360) has demonstrated the water contamination risk is low or negligible.
- 50 Land that is subject to flooding at an average recurrence interval of under five years should not be amended.
- 51 Describe method of SAM application (if different from recommendations made in the SAM supplier instructions or code of practice):
- a Describe the method of application, such as dump and back blade or specialty spreader. The SAM should be evenly applied across the area of land, unless

different areas/plantings warrant different application rates. Describe whether application is intended as a top dressing or will be blended into soil. How deep will SAM be incorporated into the soil profile?

- b Describe when (time of year) amendment will be applied. How will rainfall affect the application regime?

52 Describe planned weekly (dry season) water application rate and how irrigation needs are determined.

53 Describe the documented security system for transport, handling and application of the SAM material if exposure may be harmful to the broader environment.

54 Define the expected effective life of the amendment, before reapplication is needed.

55 Describe plants to be grown. If cropping, what is the crop rotation period?

56 What fertiliser/trace elements will be applied? How often is it applied?

57 Will the amendment material be stockpiled on site prior to spreading? If so, where/how?

58 If stockpiled, for how long will the material be stored before spreading?

Site specific approval of SAM application

59 Site specific approval is considered necessary for the application of the SAM in the following circumstances:

- a where a regulatory agency advises that the properties of the SAM are such that site-specific assessment and approval is required
- b where its use is near to a sensitive waters (Appendix A) and/or the Environmental Protection Authority or this department confirms the need for specific assessment
- c where the user intends to depart from either the licence conditions or the recommendations made in the approved SAM supplier's code of practice.

60 This department will advise on the suitability of the material for particular purposes and if accepted for soil amendment, may recommend conditions on its use and reference relevant research data. Information needed when seeking this department's approval to apply a SAM onto land:

- a name of site owner/occupier
- b site location details where SAM application is planned
- c provide summary details of supplier or copy of the supply agreement
- d provide copy of the SAM approval for widespread use and a statement on the suitability for the intended land use. The land owner/ operator should have a copy of the approved COP for controlled use of the SAM (if available from the supplier)
- e if the SAM contains any human or animal waste, provide a copy of the Department of Health's approval letter
- f provide a copy what conditions, if any, the local government imposed
- g A description of the application site including:
 - present vegetation cover on the site to be amended

- use of the land, historical and present, such as cereal cropping, grazing, tree growing
- any areas where it may be unsuitable to apply the SAM (swampy land where low soil pH may mobilise metals in the SAM), see Appendix A, sensitive water resources
- information on any previous soil amendment and fertiliser regime. Does the soil presently contain sufficient nutrients for optimal plant growth? Are there presently significant contamination risks to local sensitive water resources?
- the soil phosphorus retention index at the proposed application rate, determined in a soils laboratory
- (Note: consider other factors that may influence phosphorus export, such as iron oxides/ clay in soil that can bind phosphate. If the soil becomes anoxic (no free oxygen), the soil bound phosphate could be released)
- on-site soil conditions and strata to a depth of at least 2 m below the soil surface. Soils information may be available from the Department of Agriculture and Food in agricultural areas or this department elsewhere
- the slope of the land, providing extracts from contour maps where available
- surface water-bodies (lakes, dams, streams and swamps) on the site, including the wet area's relationship to amended area
- any areas subject to periodic flooding and approximate frequency (annually, once in ten years or year last flooded)
- depth to groundwater table present beneath the site, describing and showing on a map any bores or wells located on the site to be amended
- the surrounding land uses (within 500 m of proposed amendment site)
- existing or proposed vegetation buffers between the amended site and water-bodies/ neighbouring residences
- measures to be employed during storage and spreading to avoid dust generation, odours, erosion, leaching or attraction of vermin.

SAM application under controlled conditions to maximise benefits and avoid erosive loss or leaching

- 61 The SAM should be applied using equipment that ensures an even application to land (expressed as tonnes per hectare) or as a layer of a specific depth (typically 50 to 75 mm) with an acceptable application tolerance (such as 20 mm).
- 62 If the SAM has a tendency to clump together it should be broken up or effectively screened prior to application (where necessary).
- 63 Where there is a SAM erosion risk or soil mixing is necessary, as soon as practical after application the SAM should be incorporated into the soil to produce a homogenous layer matched to the crop root depth, typically incorporated to a finished depth of 300 mm. Several passes of a rotary hoe or similar equipment may be necessary to ensure even mixing. Amended soil samples (at least three per hectare) should be sent to a soils laboratory for particle analysis to confirm an even SAM distribution has been achieved through the soil profile.

Monitoring, record keeping and reporting

- 64 If preliminary investigations indicated a residual risk to water resource quality, monitoring should be undertaken in accordance with *Australian guidelines for water quality monitoring and reporting* (reference 1c). The following issues should be addressed:
 - a Details of irrigation water application rates and extent of SAM amended land.
 - b Detailed reports where requested (such as leached water quality sampling results obtained using lysimeters), rather than just investigation summaries, should be provided annually to the Department of Water to enable further assessment of the potential contamination risk to water resources.
 - c Outline the need for leachate or runoff monitoring facilities (bores, present or planned) for the site. Where are they located, how are they constructed and how will they be utilised?
 - d Baseline monitoring for relevant parameters (contaminants known to be present in the SAM) in groundwater, wetlands, waterways and soils should be conducted in the proposed application areas.
 - e Trials should determine observed and predicted water quality parameters and compare these to appropriate NWQMS guidelines (i.e. for protection of aquatic systems, public and private drinking water and water used for agricultural purposes).
 - f A contingency plan proposed for use if monitoring suggests that the amended soil is posing a risk to the environment or water resources.
- 65 When considering application of additional SAM to a site (due to depletion of applied constituents), the site operator should arrange for laboratory analysis of representative soil samples to confirm the present soil qualities and the amount of SAM necessary to make up for any deficient elements.
- 66 If applied near wetlands, a monitoring program approved by this department should incorporate:

- a A definition of wetland location and category (reference 3).
- b Baseline water quality data should be collected before the application of a soil amendment product including: pH, electrical conductivity, biochemical oxygen demand (BOD₅), chlorophyll-a, + metals, Gilvin, total nitrogen (N), N as nitrate, N as ammonia, total phosphorus (P), P as orthophosphate, and turbidity.
- c Monitoring of water quality indicator parameters at an adequate frequency with additional parameters relevant to the SAM should be included. Advice from an independent, qualified and experienced wetland scientist should be sought.
- d Monitoring of invertebrates and/ or other appropriate ecological indicators at an adequate frequency may be necessary.
- e Monitoring the water quality parameters at outlets entering and leaving wetlands, with sentinel sampling points at adequate distances from the wetland.

Appendix A: Information on sensitive water resources, note limitations and updates

Sensitive water resources

Our water resources sustain ecosystems, aquatic recreation and aesthetic values as well as providing drinking, industry and irrigation supplies. Along with breathable air, uncontaminated water is essential for viable communities. Natural water resources should remain within defined quality limits to retain their ecological, social and economic values. Hence they require appropriate protection measures to minimise contamination risks.

Information on water quality parameters and processes to maintain water values are published in the Australian Government's national water quality management strategy papers. These papers are available online at <www.environment.gov.au> select *water* > *water policy and programs* > *water quality*.

The Department of Water strives to improve community awareness of catchment protection measures (for both surface water and groundwater) as part of a multi-barrier protection approach to sustain acceptable water resource quality. Human activity and many land uses pose a risk to water quality if contaminants in significant quantities are washed or leached into water resources.

Sensitive waters include estuaries, natural waterways, wetlands and groundwater. These waters support one or more of the environmental values described below.

Public drinking water sources

Overview

Public drinking water source area (PDWSA) is the collective name given to any area proclaimed to manage and protect a community drinking water source.

PDWSA include underground water pollution control areas, water reserves and catchment areas administered by the Department of Water under the provisions of the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.

For online information on the location of PDWSA, see the Department of Water's Geographic Data Atlas, available < www.water.wa.gov.au >.

Within PDWSA, priority areas are defined (P1, P2 or P3) via publicly consulted drinking water source protection plans or land use and water management strategies. Priority areas are used to guide land planning, rezoning and development approval processes. Priority areas are assigned considering the current local planning scheme zoning, land tenure, the water source's strategic value and its vulnerability to harm. Each priority area is managed using a specific risk-based strategy to provide for effective water resource protection. The Department of Water develops these documents in consultation with other government agencies, landowners, industry and the community.

P1 areas are defined to ensure human activity does not degrade a water source. These areas are declared over land where the provision of high-quality drinking water for public use is the primary beneficial land value. P1 areas typically cover land controlled by the state government or one of its agencies. These areas are managed under the principle of *risk avoidance*, so most land development and human activity is normally opposed.

P2 areas are defined to ensure there is *no increased risk of pollution* to the water source once a source protection plan has been published. These areas are declared over land where low-intensity development exists (involving rural usage such as dry land grazing or cropping). Protection of public water supply sources is a high priority in P2 areas. These areas are managed in accordance with the principle of *risk minimisation*, and so the intensity of development should be restricted (via management conditions) and activities with a low water contamination risk are normally considered acceptable.

P3 areas are defined to *manage the risk of pollution* to the water source. These areas are declared over land where public water supply sources must co-exist with other land uses such as residential, commercial and/or light industrial development. Protection of P3 areas is mainly achieved through land use management measures e.g. contamination barriers. Environmental guidance (such as these notes) or site-specific development approval conditions are used to limit the water resources contamination risk from the land use or activity. If, however, the water source becomes contaminated, then water supplied from P3 sources may need to be more intensively treated or an alternative water supply source commissioned.

Additional protection zones are defined close to the point where drinking water is extracted or stored. These zones are called *wellhead protection zones (WHPZ)* and *reservoir protection zones (RPZ)*. Statutory land use constraints apply to activities within these zones surrounding sources to safeguard these waters most vulnerable to contamination.

WHPZ are assigned around water production wells based on hydrological factors. Statutory land use restrictions apply within these zones as groundwater moves rapidly towards wells due to aquifer depressurisation by pumping. Any contaminants leaching from the ground surface in a WHPZ could rapidly migrate into scheme water supplies (before effective remedial action can occur). In sedimentary basins, WHPZ are usually circular, with a radius of 500 m in P1 areas and 300 m in P2 and P3 areas. These zones do not extend outside PDWSA boundaries.

RPZ are defined over and around public water supply storage or pipe-head reservoirs. Statutory access and land use restrictions apply in RPZ. The aim is to restrict the likelihood of contaminants being deposited or washing into water sources in any runoff.

RPZ are normally within state-controlled areas encompassing land up to 2 km measured outward from the reservoir top water-level and include the inundated area when the reservoir is full.

For additional explanatory information on PDWSA, see our Water quality protection note (WQPN) 25 *Land use compatibility in public drinking water source areas*, WQPN 36 *Protecting public drinking water source areas*, WQPN 75 *Proclaimed public drinking water source areas*, note 76 *Land use planning in PDWSA* and WQPN 77 *Risk assessment in PDWSA*. These notes are available online at <www.water.wa.gov.au>.

Established activities within PDWSAs

Many land use activities were approved and established before publication of a source protection plan or land use and water management strategy.

Activity operators should ensure that modern environmental facilities and practices are progressively implemented and maintained so that the water resource contamination risk is minimised (within practicable and economic constraints).

New or expanded activities in PDWSA

Any development proposals that could affect a drinking water source should be referred to this department's local regional office with detailed supporting information for an assessment and written response.

The development proposal may be:

- approved (with or without conditions)
- delayed pending receipt of additional information before a decision is made; or
- opposed due to a statutory or policy conflict or inadequate protective measures provided to safeguard the water source.

To assist the assessment, operators should demonstrate that under all operating conditions the facilities and processes used on-site do not pose a significant water contamination risk.

Buffers to water supply sources

Native vegetation buffers should be used to separate compatible land use areas from the sources of drinking water including the full supply margins of reservoirs, their primary feeder streams and/or production bores.

Advice on suitable buffer forms and dimensions is provided in our WQPN 6 *Vegetated buffers to sensitive water resources*.

Within clearing control catchments

Controls on vegetation clearing for salinity management in country areas are provided under part IIA of the *Country Areas Water Supply Act 1947*.

These controls apply in the Wellington Dam, Harris River Dam, Mundaring Weir and Denmark River catchment areas and the Kent River and Warren River water reserves.

Details of clearing controls may be obtained from our regional offices, see online information at <www.water.wa.gov.au>, select *Contact us*.

Private water supply sources

Private water sources vulnerable to contamination include:

- drinking water sources for people or domesticated animals
- commercial or industrial water supply sources (requiring specific qualities that support activities such as aquaculture, cooling, food and mineral processing or crop irrigation)
- urban or municipal irrigation sources (where water quality may affect vegetation performance or people's health and wellbeing).

Underground ecosystems

Important underground ecological functions that may be at risk of contamination include groundwater- and cave-dwelling animals and microorganisms (generally located within soils that have open pore spaces such as sand, gravel and limestone).

Waterway ecological and social values

Waterways that have high social and conservation significance are described in the Western Australian Environmental Protection Authority (EPA) Guidance statement 33 *Environmental guidance for planning and development*, section B5.2.2. This statement is available online at <www.epa.wa.gov.au> select *policies and guidelines > environmental assessment guidelines > guidance statements*.

The Department of Water manages natural waterways under Section 9 of the *Water Agencies (Powers) Act 1984* and the *Rights in Water and Irrigation Act 1914*. More information is available <www.water.wa.gov.au>. Apart from aquatic ecosystems and water sources, waterways provide social values including aesthetic appeal, drainage pathways and recreational opportunities for watercraft use, fishing, tourism, swimming and related aquatic activities.

This department also administers the *Waterways Conservation Act 1976* which defines Western Australian waterways subject to specific regulatory controls. Currently proclaimed waterways include the Avon River, Peel-Harvey Inlet, Leschenault Inlet, Wilson Inlet and Albany waterways management areas.

Within the Swan-Canning Estuary catchment

The Swan River Trust is responsible for the protection and management of the Swan-Canning River system. The Trust safeguards ecological and social values under the *Swan and Canning Rivers Management Act 2006*. Written approval is needed for any land- or water-based development within the Swan, Canning, Helena or Southern Rivers and their associated foreshore areas within the *Swan River Trust development control area (DCA)*. Human activity and development close to these areas are likely to have an effect on the waters of the river system. Development proposals within or abutting the DCA should be referred to the Trust for assessment.

Developments outside the DCA, but near river tributaries or drainage systems should also be referred to the Trust for assessment and advice. This is because water quality within the area may be affected by chemicals leached into groundwater flow. For detailed information, see online advice at <www.swanrivertrust.wa.gov.au>, phone 9278 0900 or email: planning@swanrivertrust.wa.gov.au .

Wetland ecology

Many important wetlands have been given conservation status under the Ramsar convention (described online at <www.ramsar.org>), Japan and Australia migratory bird agreement (JAMBA), China and Australia migratory bird agreement (CAMBA), and Republic of Korea and Australia migratory bird agreement (ROKAMBA).

Wetlands are also protected under various national and Western Australian government policies. Conservation wetland data to guide land planning and development activities is provided via the following publications:

- *Directory of important wetlands in Australia* defines wetlands scheduled by the Australian Government. It is available online at <www.environment.gov.au> select *water > water topics > wetlands*.
- Wetlands with defined high conservation significance are described in the EPA (WA) guidance statement 33 *Environmental guidance for planning and development* (section B4.2.2). This statement is available online at <www.epa.wa.gov.au> select *policies and guidelines > environmental assessment guidelines > guidance statements*.

The Department of Parks and Wildlife is the custodian of the state wetland datasets, and is responsible for maintaining and updating relevant information. See <www.dpaw.wa.gov.au> for more information.

Wetlands datasets identified for conservation value or for resource enhancement include:

- *Geomorphic wetlands of the Swan Coastal Plain*
- *South coast significant wetlands*
- *Geomorphic wetlands Augusta to Walpole* (this dataset awaits detailed evaluation).

Wetlands that are highly disturbed by land use, or have been landscaped to provide a social amenity or drainage control function in urban settings, may not be assigned conservation values unless they are actively managed to maintain these values.

Note limitations

Many Western Australian aquifers, waterways and wetlands await detailed scientific evaluation, present data on their quality is sparse and their values remain unclassified. Unless demonstrated otherwise, any natural waters that are slightly disturbed by human activity are considered to have sensitive environmental values. Community support for these water values, the setting of practical management objectives, provision of sustainable protection services and effective implementation are vital to protecting or restoring water resources for both current needs and those of future generations.

This note provides a general guide on environmental issues, and offers solutions based on data searches, professional judgement and precedents. Recommendations made in this note do not override any statutory obligation or government policy statement. Alternative practical environmental solutions suited to local conditions may be considered. This note's recommendations shall not be used as this department's policy position on a specific matter, unless confirmed in writing. In addition, regulatory agencies should not use this note's recommendations in place of site-specific development conditions based on a project's assessed environmental risks. Any regulatory conditions should consider local environmental values, the safeguards in place and take a precautionary approach.

Where a conflict arises between this note's recommendations and any activity that may affect a sensitive water resource, this note may be used to assist stakeholder negotiations. The negotiated outcome should not result in a greater water quality contamination risk than would apply if the recommended protection measures were used.

Water quality protection note updates

This note will be updated as new information is received, industry/activity standards change and resources permit.

Appendix B: Statutory approvals relevant to this note include:

What's regulated?	Western Australian statutes	Regulatory office
Acceptability of SAM application on crop or pastoral land	<i>Soil and Land Conservation Act 1945</i>	Department of Agriculture and Food www.agric.wa.gov.au
Regulation of activities or premises that could pollute	<i>Environmental Protection Act 1986, Part V</i> Environmental regulation	Department of Environment Regulation < www.der.wa.gov.au >
Prohibited discharge of specified contaminants	Environmental Protection (unauthorised discharges) Regulations 2004	
Management of human or animal wastes Community health and amenity issues	<i>Health Act 1911</i>	Department of Health < www.health.wa.gov.au > Local government
Licence to take surface water, groundwater or disturb waterways	<i>Rights in Water and Irrigation Act 1914</i>	Department of Water regional office < www.water.wa.gov.au >
Impacts on managed waterways	<i>Waterways Conservation Act 1976</i>	
Amendment of soils in proclaimed public drinking water source areas	<i>Metropolitan Water Supply, Sewerage and Drainage Act 1909</i> <i>Country Areas Water Supply Act 1947</i>	
Emergency response planning	<i>Fire and Emergency Services Authority of WA Act 1998</i>	Department of Fire and Emergency Services < www.dfes.wa.gov.au >
Statutory policies covering wetlands, drinking water catchments and estuaries	<i>Environmental Protection Act 1986, Part III</i> Environmental protection policies	Minister for the Environment advised by the Office of the Environmental Protection Authority < www.epa.wa.gov.au >
Impact of significant development proposals on the values and ecology of land or natural waters	<i>Environmental Protection Act 1986, Part IV</i> Environmental impact assessment	
Potential impacts on the Swan-Canning Estuary	<i>Swan and Canning Rivers Management Act 2006</i>	Swan River Trust < www.swanrivertrust.wa.gov.au >

What's regulated?	Western Australian statutes	Regulatory office
Discharge to sewer (industrial waste permit) or to main drain	<i>Metropolitan Water Supply, Sewerage and Drainage Act 1909</i> <i>Country Towns Sewerage Act 1948</i>	Water Corporation < www.watercorporation.com.au > Designated water services provider
Land zoning and development approval	<i>Planning and Development Act 2005</i>	Western Australian Planning Commission Department of Planning < www.planning.wa.gov.au > Local government

Relevant statutes are available from the *State Law Publisher* at <www.slp.wa.gov.au>.

References and further reading

- 1 Australian government - National water quality management strategy, available online at <www.environment.gov.au> select *water* > *water policy and programs* > *water quality* > *National water quality management strategy*
 - a Paper 4 *Australian and New Zealand guidelines for fresh and marine water quality, 2000*
 - b Paper 6 *Australian drinking water guidelines, 2011*
 - c Paper 7 *Australian guidelines for water quality monitoring and reporting, 2000*.
- 2 Department of Agriculture and Food (WA) 2000, publication, available online at <www.agric.wa.gov.au>, and search <*title*> *Code of Practice for the distribution and application of AlkaloamTM (bauxite residue) for broad acre agriculture and horticulture in the Peel-Harvey Coastal Plain Catchment*.
- 3 The previous Department of Environment and Conservation (WA) publications, available online at <www.der.wa.gov.au> and/or <www.dpaw.wa.gov.au>:
 - a Wetlands policy and guidelines, select *management and protection* > *wetlands* > *publications*
 - *Position statement: Wetlands, WRC 2001*
 - b Waste management, select *pollution prevention* > *waste management* > *publications*
 - *Landfill waste classification and waste definitions, as amended*
 - c Environmental regulation
 - Western Australian guidelines for biosolids management, 2012.
- 4 Department of Water (WA) publications, available online at <www.water.wa.gov.au> select *publications* > *find a publication* > *series browse*
 - a Policy
 - Foreshore policy 1 *Identifying the foreshore area, 2002*.
 - b Stormwater management
 - Stormwater management manual for Western Australia*.

- c Water quality protection notes (WQPNs):
 - WQPN 06 *Vegetated buffers to sensitive water resources*
 - WQPN 20 *Industry - general and heavy*
 - WQPN 22 *Irrigation of vegetated land with nutrient-rich wastewater*
 - WQPN 25 *Land use compatibility in public drinking water source areas*
 - WQPN 33 *Nutrient and irrigation management plans.*
 - e Waterway management guidelines:
 - Water note 04 *Wetland buffers*
 - Water note 10 *Protecting riparian vegetation*
 - Water note 11 *Identifying the riparian zone*
 - Water note 23 *Determining foreshore reserves.*
- 5 Environmental Protection Authority (WA) publication, available online at <www.epa.wa.gov.au>
Environmental impact assessment (Part IV Division 1) - administrative procedures.
- 6 Energy research centre of the Netherlands - *pH dependence leaching test horizontal standard*, see online information at:
www.ecn.nl/docs/society/horizontal/hor_desk_23_annex3.pdf.
- 7 National Transport Commission publication, see <www.ntc.gov.au>
Australian code for the transport of dangerous goods by road and rail 7th edition 2007.
- 8 Standards Australia publications, available for purchase at <www.saiglobal.com> select *publications*
- a AS/NZS 4360 *Risk Management* and HB 436 *Risk management guidelines*
 - b AS 4439 *Wastes, sediments and contaminated soils*
 - c AS 4454 *Composts, soils conditioners and mulches*
 - d AS 5667 *Water quality sampling.*

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Feedback

We welcome your thoughts on this note. Feedback will help us prepare future versions. To comment on this note or seek any clarification, please contact our water source protection planning branch (details below), citing the note topic and version.

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