Draft for public consultation

Guidelines for construction specifications and reports

For landfills, leachate ponds, composting facilities and wastewater lagoons

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This draft has been released for public consultation. Comments are sought on the guideline, including areas where you think it might be improved. To assist us in reviewing and improving the guideline, please:

- Identify issue/s of concern and reference the relevant section/s and page number/s in the guideline.
- Succinctly provide information regarding your issue/s of concern.
- Provide suggestions on how your issue/s of concern could be addressed.
- Provide any other information that you deem necessary to be included or excluded from the guideline.

Responses should be sent to the project manager:

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Free call (country): 1800 623 445

Email: epainfo@epa.sa.gov.au (please mark it to the attention of Patrick Nganga)

Closing date for comments is 5 pm, 24 December 2009.

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Disclaimer

This publication is a guide only and does not necessarily provide adequate information in relation to every situation. This publication seeks to explain your possible obligations in a helpful and accessible way. In doing so, however, some detail may not be captured. It is important, therefore, that you seek information from the EPA itself regarding your possible obligations and, where appropriate, that you seek your own legal advice.

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Summary

The Environment Protection Authority (EPA) has prepared this guideline to provide details on the preparation of the following construction documents:

- Technical Specifications
- As Constructed Reports (ACR).

In general, Technical Specifications consists of Design Drawings of the project, a Construction Quality Assurance (CQA) Plan and a Construction Management Plan (CMP). The drawings provide the project conceptual model to all stakeholders. The CQA Plan ensures that quality measures are implemented and documented during construction, whereas the CMP provides a means of managing potential environmental impacts during construction and potential risks to people that may come into contact with the project.

The ACR provides details on project initiation, construction methodology and the testing regime of all the materials used during the construction. The ACR documents the activities and quality assurance undertaken in relation to the construction of the project.

Projects of environmental significance are required to submit the Technical Specifications document to the EPA for assessment and approval prior to construction, and the ACR immediately after construction. The proponent should receive written approval from the EPA that the ACR is satisfactory and before the facility is ready to be used.

This guideline has been prepared to assist project proponents, consultants, engineers, construction companies and others in preparing Technical Specifications and the ACR for landfills, leachate ponds, composting pad liners and wastewater lagoons.

This guideline is meant to promote the principles of ecologically sustainable development as provided in Part 2 of the *Environment Protection Act 1993*.

1 Introduction

The design of landfill cells, leachate ponds, composting facilities and wastewater lagoons depends on the proposed capacity, site geology, separation distances to sensitive receptors, costs, etc. The types of materials used to construct the various facilities and the testing regime varies accordingly. Despite the variability in the levels of design, construction methodologies and materials used, it is the role of the EPA to ensure that the required standards necessary to protect human health and the environment are met.

The purpose of this guideline is to provide consistency in the preparation of Technical Specifications and As Constructed Reports (ACR). It has been developed to address large-scale developments and some of the details may not be applicable to small-scale and low-risk developments.

The scope and detail of the reports will depend on the nature and complexity of the project. If the scale of the project is such that Technical Specifications and ACR documents are required, then the relevant elements provided in this guideline should be addressed.

1.1 Intended users

The intended users of this guideline are project proponents, consultants, engineers, construction companies and others associated with the design and construction of:

- new landfill cells
- leachate ponds
- composting pad liners
- wastewater lagoons.

The above listed entities are hereafter referred to as facilities.

1.2 Further guidance

The guideline has been developed with due regard to the following standards and guidelines:

- Australian Standard AS 3798–2007 *Guideline on earthworks for residential and commercial developments*.
- EPA 2006, Draft landfill survey requirements (unpublished).
- EPA 2007, *Draft guidelines for composting works in South Australia*[1]
- EPA 2007, *Environmental management of landfill facilities (municipal solid waste and commercial and industrial general waste)*[2]
- EPA 2009, Draft *Guidelines for Wastewater and evaporation lagoon construction*[3].

1 <www.epa.sa.gov.au/xstd_files/Waste/Public%20consultation/composting_guidelines.pdf>

2 <www.epa.sa.gov.au/xstd_files/Waste/Guideline/guide_landfill.pdf>

3 In preparation.

2 Key elements of the Technical Specifications document

The preparation of Technical Specifications documents related to the design, construction and commissioning of facilities is outlined in Figure 1. At a minimum, the document should include:

- design drawings
- a Construction Quality Assurance (CQA) Plan
- a Construction Management Plan (safety/risk management plan and environmental management plan).

The level of adherence to the Technical Specifications ultimately determines the quality of the project and influences the performance and the constructed facility.

The Technical Specifications document should be submitted to the EPA at least three months prior to the proposed construction commencement date to allow sufficient time for review, amendments where required and approval. Sufficiently clear and comprehensive detail needs to be provided to the EPA to allow meaningful review and to assist in reducing the likelihood of further information requests and potential for resulting delays.

The Technical Specification document should be submitted to the EPA for assessment and approval prior to commencing construction of the facility.

2.1 Design drawings

Final design drawings for construction contain all the information necessary for the contractor to bid and build a particular project (Choi 2004).

Design drawings are to be provided within the Technical Specifications document and should show details on layout, measurements, cross-sectional and vertical profiles. This information is required as scale drawings of the facility to be constructed. Design concepts should be presented in such a way that:

- the project can easily be understood
- they visually communicate the concept to the facility owner and the contractor
- they are legible
- they include all information from previous revisions and updates.

Design drawings need to demonstrate to the EPA and other stakeholders that the project design complies with the minimum requirements for the specific facility[4] to be built to protect human health and the environment.

The engineering design drawings should include the following aspects:

- site layout and the location of the facility to be constructed
- plan views
- detailed designs and cross-sectional profiles of the facility
- dimensions and units

[4] For example details on the design requirements for landfill cells are provided in the *Environmental management of landfill facilities (municipal solid waste and commercial and industrial general waste)* [EPA 2007].

- gradients
- titles and scales that meet the required standards and units
- adequate labelling
- all elevations should be referenced to metres Australian Height Datum (mAHD)
- be dated and signed by the designer.

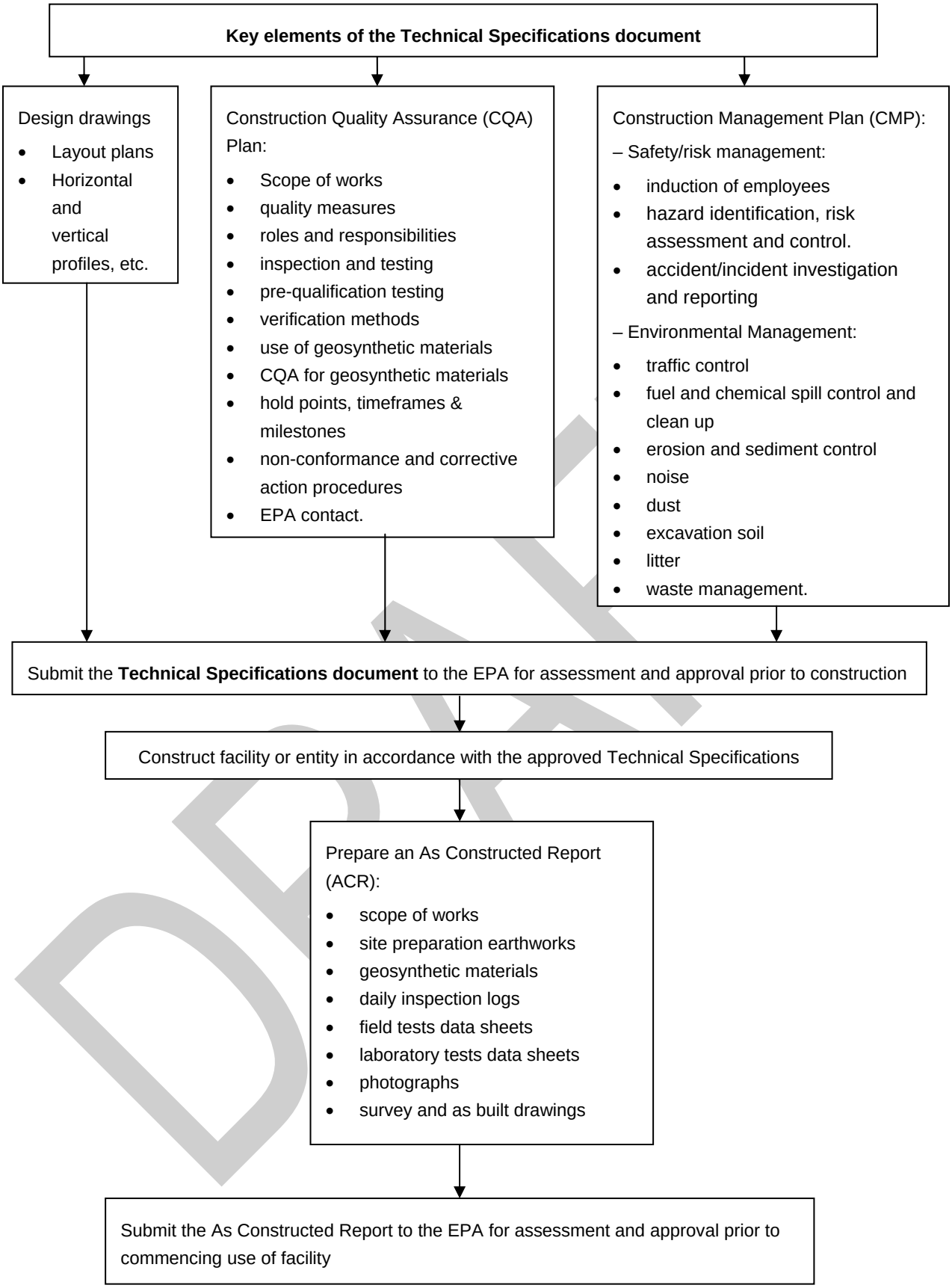

Figure 1 Documentation and process for design, construction and commissioning of facilities

2.2 Construction Quality Assurance (CQA) Plan

A CQA Plan provides a means of managing quality during construction and demonstrating to the stakeholders (owner, contractors, consultants, regulator, and the general public) that the construction complies with the project requirements. The CQA Plan ensures that the materials used, construction methods and completed works will be able to achieve the required outcomes for the facility in line with the Technical Specifications, the relevant standards and EPA Guidelines.

2.2.1 Scope of works

A brief description of the project should be provided that includes the scope of the construction works. The main undertakings of the project that will determine hold points should be listed.

2.2.2 Quality measures

The CQA Plan should be developed to reflect the best quality management measures. The standards of the measures should mirror those in other quality documents for example:

- Civil Contractors Federation (CCF)—*CCF Civil Construction Management Code for the Civil Construction Industry*, TQCS International Pty Ltd, 2002.
- *ISO 9001:2000 Quality Management Systems–Requirements.*
- Project-specific Australian Standards, eg AS3798–2007 *Guidelines on earthworks for commercial and residential developments* [5], and other standards for specific test methods.

2.2.3 Roles and responsibilities

The CQA Plan should define clear roles, responsibilities and communication lines for implementation of the plan and for contact with the EPA.

2.2.4 Inspection and testing

Inspection and testing requirements for earthworks are provided in the Australian Standard AS 3798–2007 Guidelines on earthworks for commercial and residential developments. The guidelines provide that the earthworks for a project should be inspected and tested at regular and appropriate intervals to assess whether the quality of materials and workmanship provided on a project are consistent with the design requirements. The level of inspection and testing required will depend on the scale and scope of the project and the nature of the materials used.

Most earthworks will require Level 1 or Level 2 inspection and testing to be carried out by a Geotechnical Inspection and Testing Authority (GITA). The GITA is usually a person independent from the company doing the works. The owner of the project should retain a suitably qualified independent professional to regularly inspect the project during construction. The EPA is however prepared to accept inspection and testing conducted by someone working for the owner of the project provided it is undertaken in accordance with the standard and agreed plans. This person needs to be suitably qualified and experienced to be able to conduct the requisite sampling, testing, record keeping including daily logs and standard of reporting expected and associated with the requirements of the project.

The EPA requires Level 1 GITA supervision and testing at all projects that use clay as construction material for barrier systems including liners and capping layers. The EPA reiterates that Level 1 supervision is a full-time commitment to having the GITA or their representative on site at all times while earthwork operations are undertaken. The frequency and

[5] Available from <www.saiglobal.com>

nature of inspections and testing required for the project should be clearly stated. The standard also provides minimum testing rates and examples of forms to be used.

Level 2 inspection and testing is similar to Level 1 except that a geotechnical testing authority (GTA) will be appointed to carry out sampling and testing as required or specified. The Level 2 GTA may or may not be required to provide a report at the completion of the project. The EPA may require Level 2 GTA supervision on small projects that require a limited level of reporting but are not large enough to warrant Level 1 GITA supervision.

The requirements for Level 1 or 2 geotechnical authority inspections and testing will be determined by the nature of the project, construction materials to be used and construction methodology. The testing and inspection plan should document the nature of work activity and work performed during the inspection. The ACR report prepared by the GITA/GTA needs to provide sufficient details, evidence, certification and sign-off by the GITA/GTA that the works have been constructed in accordance with the Technical Specifications.

2.2.5 Pre-qualification testing

Materials testing should be undertaken prior to use to determine suitability for purpose. In the case of clay construction, clay properties (Atterberg limits, plasticity, liquid limit, particle size distribution, Emerson class, permeability, calcium carbonate content, acid solubility, clay content, etc) need to be provided in the design specifications and to the EPA for assessment **prior to construction**.

2.2.6 Verification methods

The methods and procedures to verify compliance with the project plans and specifications need to be stated in the CQA Plan including:

- verification procedures and/or standards to be used
- persons responsible to carry out the verification
- frequency of verification, eg daily, weekly, etc
- reporting.

2.2.7 Use of geosynthetic materials[6]

Geosynthetics may be defined as synthetic materials, mostly plastic, which are commonly used in place of, or enhance the function of, natural soil materials (Sharma and Lewis 1994). The three types of geosynthetics commonly used in landfills or wastewater lagoons are geomembranes, geosynthetic clay liners (GCLs) and geotextiles.

Geomembranes are flexible, polymeric sheets that have extremely low permeability and are typically used as liquid or vapor barriers (Daniel and Koerner 1995). Base lining systems typically use a High-Density Polyethylene (HDPE) geomembrane.

GCLs are very low permeability barriers consisting of a layer of unhydrated, loose granular or powdered bentonite which is chemically or mechanically adhered to a geotextile or geomembrane (Sharma and Lewis 1994). GCLs are typically 5–10 mm thick and have approximately 5 kg/m^2 of bentonite (Daniel and Koerner 1995). The rolls are 4–5 m wide, 30–60 m long, weigh up to 1,800 kg each and are wrapped in the factory to prevent premature hydration.

[6] The use of geosynthetic materials in landfills is also provided in *Guidelines for environmental management of landfill facilities (municipal solid waste and commercial and industrial general waste)* [EPA 2007].

Geotextiles are permeable textiles made from polymeric fibres. They are used for various functions including filtration above leachate collection systems, separation between clay liners and leak detection geonets, or for protection of geomembranes beneath leachate collection or leak detection gravel.

Geosynthetic materials may be considered as an alternative or supplement to a compacted clay liner as part of an engineered barrier layer especially in locations where low permeability clays are not readily available. Geosynthetics used as part of the barrier system may include:

- geomebranes in conjunction with a compacted clay liner
- a geosynthetic clay liner (GCL) in conjunction with a compacted clay liner
- a geomembrane in conjunction with a GCL
- exclusive use of geosynthetic liner materials.

2.2.8 CQA for geosynthetic materials

The EPA requires that the installation of geosynthetic materials be undertaken or supervised by a person experienced in installing such materials. Site conditions, material quality and installation procedures followed will determine the overall field performance of the facility.

Most GCL manufacturers, for example, recommend the following factors to be considered as a means of improving GCL field performance:

- compatibility/hydraulic performance with fluid to be contained
- compatibility with cover materials/gradation of cover materials
- gradient impacts on performance
- proper cover material thickness/confining pressure
- subgrade preparation/gradation
- construction/installation practices and detail construction
- physical damage during or subsequent to installation
- stability (while full/during draw-down)
- control over GCL hydration/desiccation
- hydraulic performance under site specific conditions
- design/product selection
- proper GCL selection, suitable subgrade materials, proper orientation of the GCL, geotextiles, diligent installation techniques and reliance upon manufacturer experience are essential in project success.

Further information on the use and construction quality assurance requirements including for geosynthetic materials used in landfill base liners and capping is provided in Chapters 7, 10 and 11 in the EPA's Guidelines for Environmental management of landfill facilities (municipal solid waste and commercial and industrial general waste) [EPA 2007].

2.2.9 Hold points, timeframes and milestones

The project should be broken down into the main phases or activities to allow evaluations and amendments that might be required at the end of each phase. A timeframe for completing the main phases should be provided in the form of a Gantt chart or other similar charts. The main phases in the construction of a landfill cell, for example, include:

- establishment of the cell layout
- bulk excavations
- sub-grade preparation

- clay liner or composite liner construction
- leachate drainage layer construction.

The above referenced hold points allow the survey to be undertaken for comparison with design levels and to ascertain the thicknesses of the clay liner and drainage aggregate. The hold points also allow corrective measures to be undertaken.

2.2.10 Non-conformance and corrective action procedures

The CQA Plan needs to provide procedures for identifying non-conformance and for corrective action. The plan should state that the project will at least address the following:

- the nature of the non-conformance and its level of effect on the project
- determination if the non-conformance is an isolated incident or a recurring problem
- how amendments to procedures to prevent future occurrences of the non-conformance will be implemented
- the nature of corrective action to be applied to rectify that specific non-conformance (eg re-compaction and testing)
- the procedures and persons to be notified of the non-conformance and corrective measures
- procedures for reporting to the EPA major exceptions/variations to the approved technical specifications.

2.2.11 EPA contact

The EPA should be provided with the opportunity to monitor and inspect elements of the construction. Notification should occur at least two weeks prior to commencement of the key elements of the works, including set out, subgrade preparation and construction of the other project elements.

2.3 Construction management plan (CMP)

The CMP provides a means of managing potential risks to people that may come into contact with the project during construction and pollution management. Prior to commencement of construction activities, construction personnel and others directly involved with the project should be inducted on the CMP plan which consists of:

- a risk management plan, and
- an environmental management plan.

2.3.1 Safety/risk management

Project proponents should determine from SafeWork SA the required safeguards that should be implemented and observed during construction.

2.3.2 Induction of employees

All employees, labour hire workers and subcontractors should be inducted prior to the start of a project on the following:

- environmental management plans
- occupational health, safety and wellness (OHS&W)
- accidents/incident investigation and reporting
- hazard identification, risk assessment and control.

2.3.3 Hazard identification, risk assessment and control

Hazard identification is the process for identifying things that have the potential to cause human injury, ill health and/or damage to property or the environment. Risk assessment defines the process of evaluating the severity and the

probability (likelihood) of harm or damage occurring from exposure to a hazard and the likely consequence of that harm or damage. The hazard management process includes:

- identifying the hazard
- assessing the risks
- evaluating risks
- controlling the risks
- monitoring and review.

2.3.4 Accident/incident investigation and reporting

Prior to commencement of a project, a plan should be developed and implemented that deals with the management of accidents/incidents. Accidents/incidents involving actual (or near misses) should be reported, recorded and investigated followed by remedial action to ensure that such accidents/incidents do not re-occur.

2.3.5 Environmental Management Plan (EMP)

Obligations on the general environmental duty are provided under section 25(1) of the *Environment Protection Act 1993* as follows:

> A person should not undertake an activity that pollutes, or might pollute, the environment unless the person takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

An EMP provides a means of managing environmental aspects and impacts to reduce potential pollution and should include the following:

Traffic control

Traffic will be expected to increase during the construction phase of a project. The project contractor or superintendent should ensure that a traffic control plan is developed and communicated to all personnel. Appropriate safety signs including barricades should be understandable, visible and well positioned to provide clear directions and a safe working environment.

Fuel and chemical spill control and clean up

If fuel or chemicals are to be stored on site, it should be in a bunded area as outlined in EPA Guideline, *Bunding and spill management* (EPA 2007)[7].

Erosion and sediment control

Site preparation works, excavations and the movement of traffic will erode and size-reduce in-situ materials and, in particular, weathered soils. Fine-grained particles resulting from these activities thereafter become easily transported or washed away as sediment in stormwater. In order to avoid sediment transport during rainfall periods, excavated areas should remain open for the least amount of time. An erosion and sediment control plan should be developed prior to starting a construction project. Such a plan should include a site sketch indicating the pathways and fate of stormwater. Erosion and sediment control measures include but not limited to:

- sediment fences
- designated paths for traffic

[7] <www.epa.sa.gov.au/xstd_files/Waste/Guideline/guide_bunding.pdf>

- stormwater drains around work areas and ponds
- stabilisation of uncovered areas with vegetation or erosion mats.

The above measures would minimise the amount of disturbance to the in-situ soils and to aid in the separation of contaminated stormwater. More information on erosion and sediment control can be obtained from the *Code of practice for the building and construction industry* (EPA 1999)[8].

Noise

Noise resulting from construction-related activities should be managed in accordance with the South Australian *Environment Protection (Noise) Policy 2007*. Noise-generating construction activities, include for example, site preparation work, demolition work, building maintenance or repair work, the operation of vehicles within, entering, or leaving, a construction site, and any activities at or within the immediate vicinity of a construction site that is connected with work at the site.

Dust

Dust management measures should be planned for areas and activities that are likely to be sources of dust during the construction phase. Dust control measures should include:

- the use of dust suppressants in all dust generating areas
- minimising dust generating activities especially during periods of hot dry weather
- educating contractors and site personnel on measures to minimise dust
- monitoring of non-compliances and complaints regarding dust
- applying corrective measures.

Excavation soil

The soils referred to here are the naturally occurring soils resulting from bulk excavations and earthworks. Stockpiles should be located at least 10 m from drainage swales. The EPA generally requires that maximum stockpile heights for material management or resource recovery activities be in the range of 3–5 metres as provided in the *Guideline for stockpile Management: waste and waste derived products for recycling and reuse* (EPA 2009)[9]. The management of waste soils that result from bulk excavations are covered in this guideline.

Litter

Litter is defined as a disorderly accumulation of objects that may include carelessly discarded refuse, paper, bottles, cigarette butts, etc. The contractor or the person responsible for the construction project should ensure that a litter management plan is developed and implemented during the duration of the project.

Waste management

Construction activities normally generate extraneous mixed waste that needs to be properly managed. The EPA encourages waste resulting for construction or other activities to be managed with due regard to the waste hierarchy; avoid, reduce, reuse, recycle. Waste reduction should be made a priority from the start to completion of a project. Containers should be provided and clearly labelled for materials to be recycled and for disposal. Waste should be removed for recycling or disposal on a regular basis.

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8 <www.epa.sa.gov.au/xstd_files/Water/Code%20of%20practice/bccop1.pdf>

9 <www.epa.sa.gov.au/xstd_files/Waste/Guideline/guidelines_stockpile.pdf>

3 As Constructed Report

The ACR is a documentation of activities during the construction of a project. It should be submitted for assessment once construction has been completed and approval received before the facility is commissioned (Figure 1). It is the role of the GITA or the person appointed by the project proponent to prepare the ACR document which should confirm that the facility was constructed in accordance with the technical specifications.

3.1 Scope of works

The ACR should include sufficient information to demonstrate that the approved technical specification has been complied with, including the following:

- Identification of the engineering components that were constructed including:
  - a comparison of the constructed components to the technical specification
  - a summary of how the construction was impacted by the weather and other difficulties
  - a description of measures undertaken to ensure that constructed components were not damaged during construction.
- Results of all observations, testing, and calculations necessary to comply with the technical specifications.
- All alterations that deviate from the approved technical specification as follows:
  - a listing of all alterations and corresponding alternatives
  - all alteration requests and supporting documentation
  - detail of any reworking required and resulting tests to demonstrate ultimate compliance.
- Results of all surveys and survey maps as outlined in the Draft landfill survey requirements (unpublished).
- Exceptions and corrective actions.
- Report of independent Geotechnical Inspection and Testing Authority (GITA) in accordance with AS 3798–2007.
- A definitive statement by the GITA to confirm that the facility has been constructed in accordance with the technical specification.
- A statement from an independent organisation that the construction complies with the specifications and drawings.

3.2 Site preparation earthworks

Details regarding site preparation earthworks should be provided, for example:

- Methods used to clear the site.
- Plant and equipment used, ie compactors, graders, excavators, etc.
- The fate of cover materials removed.
- Sub-grade preparation—the condition of the subgrade and if any improvements are required before liner construction, HDPE or GCL installation.
- Sub-grade compaction requirements are provided in the relevant guidelines referenced in section 1.2.
- Sub-grade testing frequency.
- Survey level of the subgrade and its position relative to the groundwater table.
- Clay liner construction:
  - liner construction methodology including that of key-in and overlap sections, placement of layers, etc.
  - moisture conditioning

- compaction methodology and caliber of equipment used
- moisture-density relationships.

3.3 Geosynthetic materials

If geosynthetic materials are used in any part of the construction, then the following information should be provided in the ACR:

- Extent of the works.
- Preparation and condition of the subgrade prior to geosynthetic material installation.
- Geosynthetic material properties.
- To-scale as-built drawings with panel layout showing areas and types of HDPE placed including roll numbers, sample, tests and repair locations.
- Sourcing, delivery and storage procedures.
- Labelling of rolls—roll number, batch number, product identification, thickness of material and types (eg smooth or textured for the case of HDPEs), roll dimensions, direction to unroll and manufacturer's name.
- Details on the construction of anchor trenches.
- Geosynthetic materials deployment procedures—works should be undertaken by an experienced geomembrane installation specialist.
- Panel seams welding procedures (for HDPEs) or overlap construction procedures of GCLs.
- Manufacturer's test certificates and specifications data:
  - Quality Control (QC) certificates of the resin used to make the geomembrane
  - A QC certification that property values given in the properties sheet are guaranteed by the geomembrane manufacturer. The QC certificate shall include roll numbers and identification, resin lot, batch numbers, sampling procedures and quality control tests.

3.4 Daily inspection logs

The geotechnical professional appointed by the licensee shall keep records of daily inspections that detail visual observations including weather conditions, field testing, sampling, and other information pertaining to construction activities. These logs should be provided as one of the appendices in the ACR or otherwise upon the request of the EPA.

3.5 Field test data sheets

All field sampling and tests should be recorded in the daily inspection logs. Testing and sampling locations and the nature of the tests should be clearly indicated on a site map.

3.6 Laboratory tests data sheets

Laboratory test results and the corresponding Australian Standards used should be provided for each construction material and related tests as required.

3.7 Photographs

Photographs should be taken before, during and after completion of construction works and provided in a digital format in the ACR. Photographs should be taken periodically during the entire duration of the construction and additional pictures should be taken of items of specific interest. The captions of all photographs should contain the name of the project, the date on which the photograph was taken and the identity of the feature being photographed.

3.8 Survey and as built drawings

Surveys of constructed profiles (eg top of subgrade, base of sump, top of finished liner, top of drainage aggregate, etc) need to be provided in order to:

- verify conformance to the engineering design drawings in relation to dimensions, units, tolerances and special positions
- provide a record from which measurement of work or material volumes can be determined.

3.8.1 Qualifications of surveyor

Surveys need to be certified as being correct by a licensed or registered surveyor in accordance with the *Survey Act 1992* and Regulations (Part 3—Licensing and Registration, Division 2: Licences and Registrations), or a person who is a full member of the Institution of Surveyors, Australia Incorporated. All drawings shall include a statement of certification signed by the licensed/registered surveyor.

3.8.2 Features to be surveyed, density of data

A survey should be a true and accurate representation of the feature(s) being surveyed. The density and location of points need to be determined by the surveyor on site and selected appropriately to achieve this accuracy. Where the surveyor determines that the surface being surveyed is not sufficiently regular (eg a gravel surface that has not been closely levelled to limit damage to the underlying liner, or the surface of a sump), a greater density of points should be used to characterise the surface. Notwithstanding the above, to ensure the quality of each survey, the following should be performed as a minimum:

- The grid density used should be of no fewer points than typically 10 m x 10 m.
- All changes of grade need to be picked up by a survey string of points, with a minimum 10-m point spacing along the strings. Changes of grade result from (but are not limited to) sumps, crest lines, drainage lines, interfaces with side slopes, etc.
- A survey string defining the outer extent/limit of the survey should be included.
- All levels need to be in metres AHD. Drawings should state clearly the coordinate system that has been used for the project. Levels and isopach values should be to two decimal places, eg 2.34 m.

4 Approval and commissioning

Once the EPA is satisfied that the ACR satisfies the requirements of the project-specific technical specification, it will provide written confirmation to permit commissioning of the facility. The proponent may not operate the facility until such written approval is provided.

5 References

Australian Standard AS 3798-2007, *Guideline on earthworks for residential and commercial developments.*

Choi, Ying-Kit 2004, *Principles of applied civil engineering design*, American Society of Civil Engineers, ASCE Press, New York, 208 pp.

Civil Contractors Federation (CCF) 2002, *CCF Civil Construction Management Code for the Civil Construction Industry*, TQCS International Pty Ltd.

Daniel, DE and RM Koerner 1995, *Waste containment facilities –Guidance for construction, Quality Assurance and Quality Control of Liner and Cover Systems*, American Society of Civil Engineers, ASCE Press, New York, 354 pp.

Das BM 2002, *Principles of Geotechnical Engineering*, Brooks/Cole Thomson Learning, United States.

Environment Protection Act 1993 <www.legislation.sa.gov.au>.

Environment Protection Authority 1999, *Code of practice for the building and construction industry*, viewed 20 November 2009, EPA, Adelaide, <www.epa.sa.gov.au/xstd_files/Water/Code%20of%20practice/bccop1.pdf>.

——2007, *Draft guidelines for composting works in South Australia*, viewed 20 November 2009, EPA, Adelaide, <www.epa.sa.gov.au/xstd_files/Waste/Public%20consultation/composting_guidelines.pdf>.

——2007, *Environmental management of landfill facilities (municipal solid waste and commercial and industrial general waste)*, viewed 20 November, EPA, Adelaide, <www.epa.sa.gov.au/xstd_files/Waste/Guideline/guide_landfill.pdf>.

——2007, Bunding and spill management, viewed 20 November, EPA, Adelaide, <www.epa.sa.gov.au/xstd_files/Waste/Guideline/guide_bunding.pdf>.

——2009,*Guideline for stockpile management: Waste and waste derived products for recycling and reuse*, viewed 20 November 2009, EPA, Adelaide, <www.epa.sa.gov.au/xstd_files/Waste/Guideline/guidelines_stockpile.pdf>.

Environment Protection (Noise) Policy 2007 <www.legislation.sa.gov.au>.

Sharma HD and PL Sangeeta 1994, *Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation,* John Wiley & Sons, New York.

Stam TG 2000, *Geosynthetic Clay Liner–Field Performance,* Bentofix Technologies Inc, Serrot International Inc, Henderson, NV, USA..

US Environment Protection Agency 1999, *Voluntary Guide for Industrial Waste Management*, Chapter 7B–Designing and Installing Liners–Technical Considerations for New Surface Impoundments, Landfills, and Waste Piles, USEPA.

6 Glossary

AHD	Australian Height Datum, the datum (adopted by the National Mapping Council of Australia) to which all vertical control for mapping is to be referred, where mean sea level is set as an elevation of 0 metres.
Atterberg limits[10]	The moisture content, in percent, at which the transition from solid to semi-solid takes place is defined as the *shrinkage limit*. The moisture content at the point of transition from semisolid to plastic state is the *plastic limit*, and from plastic to liquid state is the *liquid limit*. These parameters are also known as *Atterberg limits*.
Geosynthetics[5]	Fabric-like materials made from polymers such as polyester, polyethylene, polypropylene, polyvinyl chloride (PVC), nylon, chlorinated polyethylene, and others.
As Constructed Report	An 'As Constructed Report' is a documentation of work performance, Construction Quality Control (CQC) and Construction Quality Assurance (CQA) associated with a construction project.
Composting Works	The conduct of works at which mushroom or other compost is produced or is capable of being produced at a rate exceeding 200 tonnes per year.
Construction Quality Control (CQC)	CQC are measures taken by the installer or contractor to ensure compliance with the installation specifications.
Construction Quality Assurance (CQA)	CQA is third party verification of quality. The objective of a CQA Plan is to ensure that the construction materials used, construction methods and completed works comply with the approved Technical Specifications.
Isopachytes (also known as isopachs)	Contours showing lines of equal difference between two sets of data.
Leachate[11]	Liquid that has percolated through or drained from solid waste or other man-emplaced materials and contains soluble, partially soluble, or miscible components removed from such waste.
	The final document should emphasise that areas of responsibility and/or authority were clearly defined, understood, and accepted by all parties involved in the project.

10 Das BM, 2002

11 Daniel ED and RM Koerner, 1995

Level 1 GITA Supervision: AS 3798 (2007)[12]

The primary objective of Level 1 Geotechnical Inspection and Testing is for the Geotechnical Inspection and Testing Authority (GITA) to be able to express an opinion on the compliance of the work. The GITA is responsible for ensuring that the inspection and testing is sufficient for this purpose.

The superintendent should agree on a suitable inspection and testing plan prior to the commencement of the works.

On completion of the earthworks, the GITA will usually be required to provide a report setting out the inspections, sampling and testing it has carried out, and the locations and results thereof. Unless very unusual conditions apply, the GITA should also be able to express an opinion that the works (as far as it has been able to determine) comply with the specification and drawings.

Level 2 GTA

A Geotechnical Testing Authority (GTA) officer will be appointed to carry out sampling and testing as required or specified. The GTA is responsible for selecting the location of sampling and testing operations within each visit made to the site. The superintendent is responsible for advice as to when such visits are required and is responsible for ensuring that sufficient samples and tests are taken over the project.

On completion of the earthworks, the GTA may be required to provide a report, setting out the sampling and testing it has carried out, and the locations and results thereof. The GTA will not be in a position to express any opinion beyond this as to the compliance of the works with the specification or their suitability for any particular purpose.

Suitably qualified consultant

A person, who holds relevant qualifications, has demonstrated professional experience and expertise encompassing an appropriate range of competencies and is either a full member or is eligible for full membership of one of the following or equivalent professional organizations:

1 The institution of Engineers Australia

2 The Association of Consulting Engineers Australia

3 The Australian Contaminated Land Consultants Association Incorporated.

[12] Detailed information on Level 1 and Level 2 supervision is provided in Australian Standard AS 3798-2007 Guideline on earthworks for residential and commercial developments.