



**NSW  
Resources  
Regulator**

EXPLORATION CODE OF PRACTICE

# **PRODUCED WATER MANAGEMENT, STORAGE AND TRANSFER**



## Document control

Published by NSW Resources Regulator

Title: Exploration Code of Practice: Produced Water Management, Storage and Transfer

First published: July 2015

Authorised by: NSW Resources Regulator, Department of Regional NSW

CM9 reference: INT17/185151/DOI

### AMENDMENT SCHEDULE

Date	Version	Amendment
July 2015	1.0	First published
April 2017	2.0	First scheduled review
September 2017	3.0	Clarified when the Code applies to the transfer of petroleum prospecting titles – refer to “When this Code applies”
June 2021	4.0	Updated department names to refer to the NSW Resources Regulator within the Department of Regional NSW.  Updated references to legislation, standards and guideline documents that have been updated/changed since September 2017.  Document template updated.

© State of New South Wales through Regional NSW 2021. You may copy, distribute, display, download and otherwise freely deal with this publication for any purpose, provided that you attribute Regional NSW as the owner. However, you must obtain permission if you wish to charge others for access to the publication (other than at cost); include the publication in advertising or a product for sale; modify the publication; or republish the publication on a website. You may freely link to the publication on a departmental website.

Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (June 2021) and may not be accurate, current or complete. The State of New South Wales (including Regional NSW), the author and the publisher take no responsibility, and will accept no liability, for the accuracy, currency, reliability or correctness of any information included in the document (including material provided by third parties). Readers should make their own inquiries and rely on their own advice when making decisions related to material contained in this publication.

## Contents

Part A: Introduction .....	4
Regulatory purpose.....	4
When this Code applies.....	5
Compliance requirements.....	5
Interaction of this Code with other regulation.....	6
Approvals .....	6
Land access arrangements .....	7
Public disclosure .....	7
Contact details .....	7
Review .....	8
Part B: Mandatory requirements.....	9
Objective.....	9
What are the risks? .....	9
Mandatory requirements.....	10
1. Preparation of a Produced Water Management Plan .....	10
2. Produced water storage.....	11
3. Trigger Action Response Plan .....	12
4. Review of the Plan.....	13
5. Record keeping.....	14
Appendix 1: Guidance.....	16
Preparation of a Produced Water Management Plan .....	16
Assessment of environmental impacts .....	16
Risk assessment .....	17
General Information in PWMP.....	18
Produced water storage.....	18
Prohibited use of evaporation ponds .....	18
General.....	19

Compatibility of storage containment with produced water.....	19
Design life.....	20
Measures to prevent overfilling .....	21
Secondary containment .....	21
Leak detection.....	22
Storage tanks.....	22
Storage ponds.....	22
Considerations specific to storage ponds .....	23
Considerations specific to geomembranes.....	24
Pond security and safety requirements.....	24
Pipelines used to convey produced water.....	25
Trigger Action Response Plan.....	26
Appendix 2: Additional information and considerations for various produced water storage containments types .....	27
Appendix 3: Interpretation and definitions .....	33

## Part A: Introduction

### Regulatory purpose

Exploration licences, special prospecting authorities and assessment leases for all resources (prospecting titles) are granted with the objective of encouraging ecologically sustainable development, social responsibility and building economic wealth for the people of NSW.

Certain activities may result in the extraction of naturally occurring groundwater. This extracted groundwater is colloquially referred to as 'produced water'. Produced water can be highly variable in quality, and contain naturally occurring minerals (mainly inorganic) including chloride, carbonates, bicarbonates, sodium and other metals. Organic compounds (typically hydrocarbons) may also occur in relatively low concentrations.

These naturally occurring substances in produced water may cause harm to the environment at certain concentrations. Untreated produced water may also adversely impact vegetation and soil structure due to increased salinity (additional salt loading), sodicity (increase in sodium ratios) and alkalinity (increase in soil pH, associated with carbonates).

This Code of Practice (this Code) sets out **mandatory requirements (Part B)** and provides title holders with related guidance (**Appendix 1**) about the expected performance for the management, storage and transfer of produced water.

This Code serves three purposes. It:

1. provides upfront information to industry and the community
2. facilitates the assessment of exploration activities consistent with Part 5 of the *Environmental Planning and Assessment Act 1979*
3. sets out enforceable mandatory requirements related to produced water management, storage and transfer.

This Code enables industry to:

- adopt a risk-based approach to ensure compliance with mandatory requirements related to produced water
- commit to measurable performance outcomes
- monitor performance and take corrective action if these outcomes are not being achieved
- keep and maintain relevant records of activities and/or actions.

This approach allows title holders to adopt innovative solutions and best practice techniques to meet the expected performance for the management of produced water. The foundation of this Code is the development of a Produced Water Management Plan (PWMP).

The assessment of the environmental impact of the fate (beneficial reuse, disposal) of the produced water and approval by the relevant approval authority is a separate process not covered by this Code.

Produced water management, storage and transfer is typically required for exploration activities regulated by the *Petroleum (Onshore) Act 1991*, such as those required for coal seam gas exploration and appraisal. In some circumstances, exploration activities regulated by the *Mining Act 1992* may also require the management, storage and transfer of produced water (such as hydrogeological pump tests). This Code will apply to exploration activities when the NSW Resources Regulator identifies a need to manage produced water in connection with a proposed exploration activity.

## When this Code applies

This Code only applies if imposed as a term of an activity approval. Title holders should refer to the terms imposed by the NSW Resources Regulator on the grant of an activity approval or renewal or transfer of a prospecting title to determine whether this Code applies.

## Compliance requirements

This Code applies to the extent provided for under the conditions of a prospecting title or the terms of an activity approval.

The guidance outlined in **Appendix 1** provides context to the mandatory requirements and options for the type of controls that could be used by explorers, where relevant, to meet these requirements. The type of controls the title holder applies to achieve the mandatory requirements, should be developed and implemented and monitored as part of a risk assessment (e.g. *AS/NZS ISO 31000:2018 Risk Management – Guidelines*) that is continuously evaluated over the term of a prospecting title.

If compliance with this Code is required by the conditions of a prospecting title or the terms of an activity approval, then a breach of this Code will be an offence under section 378D of the *Mining Act 1992* or section 125E of the *Petroleum (Onshore) Act 1991* (as relevant).

From 1 July 2015, under the NSW Gas Plan, the Environment Protection Authority is the lead authority to regulate compliance with and enforcement of all conditions (excluding work health and safety) contained within petroleum titles. This includes any terms imposed in relation to specific activity approvals.

The NSW Resources Regulator is responsible for regulating all other matters relating to prospecting titles under the *Petroleum (Onshore) Act 1991* and the *Mining Act 1992*. The NSW Resources Regulator's approach to compliance and enforcement is set out in the Compliance and Enforcement Policy available on the website.

Compliance with this Code is not a defence to actions taken under any legislation or statutory instrument.

Compliance with the mandatory requirements within this Code will not be required to the extent that they duplicate or are consistent with the conditions of an Environment Protection Licence or the provisions of the *Protection of the Environment Operations Act 1997*<sup>1</sup>.

## Interaction of this Code with other regulation

### Approvals

Certain approvals issued by other regulators are not required for activities carried out under prospecting titles. However, depending on the nature of an exploration activity or its location, the following subsequent approvals may be required:

- an environment protection licence (EPL) under the *Protection of the Environment Operations Act 1997* for petroleum exploration, regulating noise, air, water and waste pollution (NSW Environment Protection Authority)<sup>2</sup>
- approvals under the *Water Management Act 2000* and/or the *Water Act 1912*, for activities that involve the take or use of water (Natural Resources Access Regulator and/or WaterNSW)
- development consent for development to which the *State Environmental Planning Policy No 14—Coastal Wetlands* or *State Environmental Planning Policy No 26—Littoral Rainforests* applies
- approvals under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth Department of Agriculture, Water and the Environment).

---

<sup>1</sup> The intention of this provision is to not require compliance with a mandatory requirement of this Code if the matter regulated by that mandatory requirement is already regulated by an Environment Protection Licence.

<sup>2</sup> EPL's will generally specify environmental monitoring requirements for produced water activities. In order to reduce duplication of regulation, this Code does not require monitoring, which will be required under as part of the EPL. If an EPL will not be required, then separate monitoring requirements may be imposed.

Title holders may also be required to comply with any directions and/or orders issued by Dam Safety NSW under the *Dam Safety Act 2015*, for ponds (or dams) that are labelled 'declared dams' in accordance with that Act.

## Land access arrangements

Under section 140 of the *Mining Act 1992* and section 69C of the *Petroleum (Onshore) Act 1991*, the holder of a prospecting title may only carry out prospecting operations in accordance with an access arrangement with the landholder(s) of the land. Section 141 of the *Mining Act 1992* and section 69(D) of the *Petroleum (Onshore) Act 1991* set out the matters that the access arrangement may make provision for, including conditions to be observed during prospecting.

As specified by the mandatory requirements of this Code, the title holder must submit rehabilitation objectives and completion criteria to the NSW Resources Regulator following consultation with relevant landholders. The development of rehabilitation objectives and completion criteria set out in this Code should be addressed as part of land access arrangements. The Mining, Exploration and Geoscience website ([www.resourcesandgeoscience.nsw.gov.au](http://www.resourcesandgeoscience.nsw.gov.au)) sets out information which may assist landholders and title holders negotiate and agree access arrangements to facilitate compliance with this Code, including the following:

- *Exploration Code of Practice: Petroleum Land Access*, (Department of Industry, December 2016)
- *Guideline: Land Access Arbitration Procedure* (Department of Industry, December 2016)
- *Exploration Guideline: Petroleum Land Access* (Department of Industry, July 2015)

## Public disclosure

Prospecting title decisions will be publicly disclosed as consistent with the *Government Information (Public Access) Act 2009*. However, geological information will be kept confidential in accordance with the provisions of, and regulations made under the *Mining Act 1992* and *Petroleum (Onshore) Act 1991*.

The Produced Water Management Plan required under this Code will be publicly disclosed.

## Contact details

NSW Resources Regulator

516 High Street Maitland NSW 2320

PO Box 344, Hunter Region Mail Centre NSW 2310

Telephone 1300 814 609

Email [nswresourcesregulator@service-now.com](mailto:nswresourcesregulator@service-now.com)

Website [www.resourcesregulator.nsw.gov.au](http://www.resourcesregulator.nsw.gov.au)

## **Review**

This Code will be reviewed after the first year of publication, and then every five years. The effectiveness of this Code will be monitored on an ongoing basis.

## Part B: Mandatory requirements

### Objective

It is essential that title holders appropriately manage produced water to ensure:

- methodologies for management of produced water are adopted to avoid, control, abate or mitigate potential harm to the environment, and prevent pollution
- the risk of unintended produced water discharges are minimised by setting minimum standards for the location, design, construction, operation and monitoring of produced water storages and containment infrastructure
- the adoption of best practice standards to ensure regular review of management practice.

### What are the risks?

Without adequate controls, produced water associated with exploration activities has the potential to cause adverse impacts to the environment. These potential impacts will depend on the likely risk, type, spatial/temporal scale and duration of exploration activities. These impacts must be assessed, controls must be planned for, implemented, and evaluated for their effectiveness, and the potential for impacts must be monitored to actively and continuously manage environmental performance during the term of a prospecting title.

Potential risks may include:

- inadequate planning prior to extraction of produced water, resulting in inadequate storage
- poor design or construction and quality control of produced water storage facilities, resulting in storage failure or release of produced water
- inability to detect leakage from the storage facility.

To prevent or mitigate the risk of these potential impacts occurring, the following mandatory requirements apply to NSW exploration activities.

## Mandatory requirements

### 1. Preparation of a Produced Water Management Plan

- 1.1 The title holder **must** prepare a Produced Water Management Plan (PWMP) prior to commencing:
- petroleum exploration which requires the management of produced water, or
  - activities which require produced water to be stored on site (excluding the management of incidental groundwater mixed with drilling fluids that can be temporarily contained in drilling sumps or above ground tanks).

The PWMP **must**:

- set out a description of the activities associated with produced water to be carried out by the title holder
  - set out a description of management controls for those activities which are reasonable to prevent (or where that is not practicable mitigate so far as practicable)-the risks associated with produced water activities, and
  - set out measures which demonstrate compliance with the mandatory requirements of this Code and the requirements of any other relevant legislation.
- 1.2 The title holder **must** implement and comply with the PWMP, as revised from time to time in accordance with this Code.
- 1.3 The PWMP **must** set out how identified risks will be managed and mitigated, including the characterisation, consideration of beneficial reuse and the fate of the produced water.
- 1.4 The PWMP **must** set out a site specific water balance to be maintained during activities. When multiple produced water activities are conducted under a single prospecting title, or as part of a broader exploration project area (under more than one prospecting title), the PWMP **must** provide a water balance model showing how these activities interrelate.<sup>3</sup>
- 1.5 The title holder **must** provide a copy of the PWMP to the Secretary<sup>4</sup> no later than 14 days prior to conducting the activities set out in the PWMP.
- 1.6 The PWMP **must** be made available at the site of the produced water activities to all persons involved in those activities.

---

<sup>3</sup> Further information regarding a water balance model is outlined in **Appendix 1: Guidance**.

<sup>4</sup> Submission to the Secretary must be as per the Contact Details in **Part A: Introduction**.

## 2. Produced water storage

- 2.1 Evaporation ponds **must** not be used to manage produced water in connection with activities carried out under a prospecting title for petroleum.
- 2.2 If the produced water being stored may have an adverse impact on the environment if released:
- a. the produced water storage containment **must**:
    - i. not have its structural integrity compromised by the chemistry of the produced water being stored
    - ii. not absorb the produced water being stored, and
    - iii. incorporate measures to prevent any overflowing or draining to the environment of the produced water being stored
  - b. the title holder **must** not operate a produced water storage facility beyond its intended design life without prior approval from the Secretary. Materials utilised in the construction **must** have performance characteristics that exceed the anticipated conditions and length of time that the facility is intended to be in operation
  - c. produced water storage facilities with the capacity to store more than five (5) cubic metres (m<sup>3</sup>) of produced water **must** have a secondary containment, and
  - d. the produced water storage facility **must** have the capability to detect leaks of produced water through the primary containment (such as a tank or liner material) within one (1) month of the compromising event occurring.<sup>5</sup>
- 2.3 If ponds are used to store produced water:
- a. the design and installation of the pond **must** comply with the requirements specified in a Construction Quality Assurance (CQA) program. The CQA program **must** be prepared by a person certified by Engineers Australia to provide those services, or such other organisation approved by the Secretary
  - b. the pond **must** maintain an environmental containment freeboard capable of containing inflow from events up to and including a 1 in 100 year Annual Exceedance Probability (AEP) 72 hour rainfall event, without discharge, unless the operation of a freeboard for that pond is authorised by an EPL

---

<sup>5</sup> Note: Any detection of a leak will trigger the requirement to implement the Trigger Action Response Plan referred to in mandatory requirement 3.3 below.

- c. the ponds **must** be located and designed to be structurally stable in all events up to and including the probable maximum flood
- d. the ponds **must** not be located in any area that will increase flood risk to surrounding land unless controls are implemented to effectively mitigate that risk
- e. the ponds **must** have spillway or overflow levels located above the 1 in 100 year Annual Recurrence Interval (ARI) flood level
- f. if geomembrane liners are used in the construction of the pond:
  - i. liner seams and joins **must** be watertight and seamed over their full length in accordance with the manufacturer's standard procedures and any site-specific recommendations by a person certified by Engineers Australia to provide those services, or such other organisation approved by the Secretary
  - ii. quality control testing **must** be conducted over the full length of seams and joins prior to storing any produced water in the pond
  - iii. liners **must** be installed on a stable soil sub-base, free of protrusions that have the potential to compromise the liner. The underside of the lowest liner (secondary containment) **must** be at least two (2) metres above the highest seasonal groundwater level, unless effective under-drainage measures are installed to prevent upward water pressure on the liner, and
  - iv. controls must be implemented to limit as far as practical the entry of terrestrial fauna that have the potential to damage the liner from entering the pond.

#### 2.4 If pipelines are used to convey produced water:

- a. the pipelines **must** be constructed and installed in accordance with *AS2885*, *AS/NZS2566* or the *APGA Code of Practice for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry*. The licence holder **must** carry out field pressure testing to verify pipe integrity prior to commissioning the pipe, and
- b. computational pipeline monitoring (or some other leak detection system that provides equivalent or better leak detection than computational pipeline monitoring) **must** be implemented for any pipeline which conveys produced water at flow rates greater than one (1) megalitre per day.

## 3. Trigger Action Response Plan

- 3.1 The PWMP **must** include a Trigger Action Response Plan (TARP) that addresses the risks identified in mandatory requirement 1.3 of this Code which require ongoing management controls.

- 3.2 The TARP **must** be implemented if any risks or events set out in the TARP occur.
- 3.3 At a minimum, the TARP **must** set out the specific procedures to be followed and actions to be taken in each of the following events:
- a. any detection of leakage through primary containment
  - b. detection of leakage through a primary containment of a pond that exceeds a leakage rate of two holes per hectare each having a diameter no greater than 2 millimetre (known as the action leakage rate)
  - c. detection of a pipeline leakage
  - d. inclement weather which leads to a substantial risk of a breach of freeboard requirements, rising groundwater levels or flooding of the site or land surrounding the site, and
  - e. any other breach of regulatory requirements, including non-compliance with the PWMP.
- 3.4 The TARP **must** set out the contact details of the key individuals and secondary individuals who:
- a. are responsible for activating the TARP
  - b. are authorised to notify relevant authorities in the event of an incident which requires activation of the TARP, and
  - c. are responsible for managing the response to an incident which requires activation of the TARP.
- 3.5 The TARP **must** set out the contact details of each authority to be notified in the event of an incident.
- 3.6 The TARP **must** set out the details of the mechanisms for reporting and providing updates to the Secretary for responses triggered by the TARP.

## 4. Review of the Plan

- 4.1 The title holder **must** review and update the PWMP as required (including if necessary to ensure the PWMP meets the requirements of this Code):
- a. in accordance with any direction from the Minister or the NSW Environment Protection Authority
  - b. if changes to the way in which produced water is managed under the relevant authority or prospecting title requires additional assessment under the *Environmental Planning and Assessment Act 1979*

- c. before making any significant change to the design or operation of the produced water storage or transfer facility. If there is ambiguity in relation to whether there is a significant change, the title holder **must** consult with the Secretary to determine whether the PWMP **must** be reviewed
  - d. in the event that the TARP is activated in accordance with mandatory requirement 3.2, and
  - e. otherwise at intervals of no longer than one year, to reflect any developments in the management of produced water.<sup>6</sup>
- 4.2 The title holder **must** provide a copy of any updated PWMP to the Secretary:
- a. if there is a significant change to the design or operation of the produced water storage or transfer facility, no later than 14 days prior to commencing operation of the changed facility
  - b. if the PWMP is revised for any other reason, no later than 14 days after that revision is complete.

## 5. Record keeping

- 5.1 The title holder **must** keep and maintain the records set out in the following table (as applicable).<sup>7</sup>

---

<sup>6</sup> This means that if a review was triggered by mandatory requirements 4.1 (a) to (d), the PWMP should be reviewed and updated (as required) no later than one (1) year after that review.

<sup>7</sup> The records required to be kept and maintained according to this Code should be kept from the time this Code applies as a term imposed on an activity approval. Records are to be kept in a legible form for production to any inspector for a period of four years following the expiry or termination of a prospecting title (sections 163D and 163E of the *Mining Act 1992* and sections 97D and 97E of the *Petroleum (Onshore) Act 1991*).

Other records associated with surface disturbing activities may be required under other Codes of Practice, including the *Exploration Code of Practice: Environmental Management* and *Exploration Code of Practice: Rehabilitation*.

MANDATORY REQUIREMENT	RECORD TYPE
2.2(d)	Records of leak detection monitoring (if applicable)
2.3(a)	Records of Construction Quality Assurance (CQA) program (if applicable)
2.3(a) & (f)(i)	Name of person and records to demonstrate that they are certified by Engineers Australia to provide those services, or such other organisation approved by the Secretary (if applicable)
2.3(b), (c), (d) & (e)	Records of pond design (including location) and installation (if applicable)
2.3(f)	Record of standards and quality control testing used for seam joining of geomembrane liners (if applicable)
2.3(f)(iii)	Records groundwater levels or under-drainage measures (if applicable)
2.4(a)	Name of standard or code that is utilised for construction of pipeline and records of field pressure testing (if applicable)
2.4(b)	Record of pipeline leak detection testing
3.2	Records of any implementation of the TARP
4.1	Records of any review of the PWMP

**Note:** Guidance for each mandatory requirement is provided in **Appendix 1** and **Appendix 2**. The interpretation and definitions used for this Code are provided in **Appendix 3**.

## Appendix 1: Guidance

This Appendix provides assistance to title holders on how they may achieve compliance with mandatory requirements. The information in this Appendix should be used as a guide only and should not be interpreted as imposing any additional mandatory requirements. The applicability of certain parts of this guidance will vary depending on the likely risk, type and scale, phase and duration of exploration activities.

Title holders should note that any standards and guidelines outlined below (as amended or replaced from time to time), in addition to any new published standards taken to set out best practice relating to the management of produced water, may be used to measure and assess the appropriateness of the methods are set out in the PWMP for compliance and enforcement purposes during the term of a prospecting title.

### Preparation of a Produced Water Management Plan

The purpose of a Produced Water Management Plan (PWMP) is to describe how produced water will be managed in a way that minimises and mitigates environmental impacts. A PWMP is required when activities have been identified that have the potential to generate produced water. The detail and scope of the required produced water management plan will depend on the volume of produced water generated and its quality.

### Assessment of environmental impacts

The assessment of the environmental impact of the fate (reuse, disposal) of the produced water and approval by the relevant approval authority is a separate process not covered by the Produced Water Code of Practice.

The assessment **must** be undertaken in a manner consistent with NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). For exploration projects, this would typically be undertaken in accordance with Part 5 of the EP&A Act and a Review of Environmental Factors (or in some cases an Environmental Impact Statement — EIS) would be required as part of this process. In some circumstances, the assessment of the fate of the produced water may have been undertaken under Part 3A (now repealed) or Part 4 (for projects that are state significant development) of the EP&A Act (typically associated with a centralised produced water management facility).

The PWMP **must** summarise the impact assessment undertaken for the activity, including the characterisation (both proposed volumes and water quality) and the fate of the produced water. Reference **must** be made to relevant approval documents.

A calculation of the likely volume of produced water **should** be undertaken using a site specific water balance.

## Risk assessment

A risk assessment is a fundamental part of the environmental assessment required as part of the activity approval process. For exploration activities, this may be documented as part of the Review of Environmental Factors, and in some cases formed part of the Environmental Impact Statement.

The PWMP **must** provide an overview of the risk assessment, outlining what risks were identified and associated controls. The overview **should** also nominate what sections of this Code apply to controls being used to manage the identified risk. The identified risks will also be used in the development of a Trigger Action Response Plan (TARP).

The risk assessment to determine environmental impacts associated with the activity approval process **must** be undertaken in a manner consistent with *Environmental Planning and Assessment Act 1979* (EP&A Act). For exploration projects, this would typically be undertaken in accordance with Part 5 of the EP&A Act and a Review of Environmental Factors (or in some cases an Environmental Impact Statement — EIS) would be required as part of this process. In some circumstances, the assessment of the fate of the produced water may have been undertaken under Part 3A (now repealed) or Part 4 (for projects that are state significant development) of the EP&A Act (typically associated with a centralised produced water management facility).

The PWMP **must** summarise the risk assessment undertaken for the activity, including the characterisation (both proposed volumes and water quality) and the fate of the produced water. Reference **must** be made to relevant approval documents.

However, the risk assessment of the environmental impact of the fate (beneficial reuse, disposal) of the produced water and approval by the relevant approval authority is a separate process, and not covered by this Code of Practice. This means the PWMP does not need to set out a risk assessment dealing with the impact of the fate of the produced water, only a summary of what the intended fate will be.

A risk assessment **should** be used to not only establish a basis for managing risk when planning an activity, but it **should** also be used and updated (as required) to continuously evaluate risk and the effectiveness of controls used to prevent or minimise impacts to the environment.

Title holders may choose to carry out risk assessments on a broad basis, considering a wide range of factors (e.g. environmental management, drilling, community consultation, rehabilitation). Alternatively, separate risk assessments can be undertaken in consideration of individual factors.

Title holders **should** use *AS/NZS ISO 31000:2018 Risk Management – Guidelines* to support risk assessments.

## General Information in PWMP

The PWMP **should** include an overview of the exploration project, including a description of all produced water management infrastructure required across the exploration licence.

A calculation of the likely volume of produced water **should** be undertaken using a site specific water balance.

The water balance model **should** show expected volumes of over a nominated time period (typically annual) for:

- produced water generated
- storage facilities
- transport
- disposal/reuse, and
- other incidental gains and losses (such as precipitation gains, evaporation losses). This would typically be undertaken during the impact assessment and therefore an overview schematic is considered sufficient for meeting this requirement.

This would typically be undertaken during the risk assessment and therefore an overview schematic is considered sufficient for meeting this requirement.

The relationship between these produced water facilities located within a title or exploration project area (for when activities are related and conducted over multiple titles) **should** also be shown with a water balance model. This **should** be done by providing an overview schematic (flow diagram) providing a clear understanding of the transport, management and treatment of water and waste products throughout the exploration project.

## Produced water storage

To meet the mandatory requirement for the PWMP and effectively manage the environmental risks associated with the storage of produced water, the following **should** be considered.

### Prohibited use of evaporation ponds

Although the use of evaporation ponds in connection with petroleum activities is prohibited, the use of evaporation as a management option that doesn't principally rely on a storage pond may be permitted (such as enhanced evaporation systems). This will be considered by the NSW Resources Regulator on a case by case basis during the activity approval process.

## General

When determining produced water storage requirements, the title holder **should** consider:

- the quality of the produced water requiring storage
- the volume of produced water expected to be maintained in storage throughout the project
- the design life of the produced water facility
- the compatibility of the storage containment with the produced water
- local environmental conditions.

The mandatory requirement 2.2 may not apply if the produced water being stored is of good quality, and as such, will not have an adverse impact on the environment if released. This **should** be verified through an appropriate environmental impact assessment undertaken during the activity approval process.

## Compatibility of storage containment with produced water

When determining the compatibility of the storage containment with the produced water, title holders **must** first determine the type of storage system to be utilised. Storage of produced water typically involves the use of either tanks or lined ponds. Ponds are typically lined with geomembrane liners manufactured from synthetic liner materials made from various polymers.

Commonly used geomembrane liner materials include:

- high density polyethylene (HDPE)
- low density polyethylene (LDPE)
- polyvinyl chloride (PVC)
- composite materials, such as fibre-reinforced plastics, combinations of polypropylene mats and bentonite, and chloro-sulfonated polyethylene
- other materials, such as flexible polypropylene (FPP), chloro-sulfonated polyethylene (CSPE) marketed as Hypalon® and ethylene propylene diene terpolymer (EPDM).

Additional information and considerations for each of these storage types and references to appropriate standard is provided in **Appendix 2**.

The selection of any containment system **should** consider:

- volume of storage required
- compatibility of the containment system (liner or tank material) with the type of produced water intended to be stored

- factors that may cause deterioration while in service (such as resistance to ultraviolet solar radiation where liner is exposed)
- tensile strength and elasticity, taking into account potential shear forces that are likely to be encountered during the design life of the storage facility, typically associated with differential settlement, reactive soils (shrink-swell)
- thermal stability
- puncture, shear resistance and abrasion resistance
- design life.

A minimum permeability of  $10^{-14}$  metres per second (m/s) **should** be demonstrated to verify that the selected containment does not absorb the produced water. Verification of the permeability of the selected containment **should** be provided by the manufacturer. Testing methods **should** be in accordance with American Society of Testing and Materials (ASTM) method D4716/D4716M.

Compatibility of the containment with the type of produced water intended to be stored **should** be evaluated before determining the liner specification. Advice **should** be sought from the liner manufacturer to ensure that the material is suitable for the intended purpose. If title holders are unsure of liner chemical resistance, it is recommended that the *Standard Practice for Tests to Evaluate the Chemical Resistance of Geomembranes to Liquids ASTM D5747/D5747M* is applied.

As natural and modified soils (including clay) tend to have greater permeability and may potentially react with produced water (due to its chemical composition), natural and modified soils are generally not acceptable for a primary containment. Natural and modified soils are acceptable as secondary containment, when required.

## Design life

Title holders **must** demonstrate that the produced water storage time does not exceed the design life of the produced water facility. Design life is a key consideration when designing and selecting components to be used as part of produced water storages. The service life of the liner, tank and container construction materials can vary significantly based on the exposure conditions.

Title holders **should** consider the advantages and disadvantages of using certain properties, including UV resistance, chemical resistance, ability to maintain integrity under localised differential settlement without puncturing, tearing, or cracking, shearing and multi-axial extensibility. Additionally, general wear due to operations and maintenance (e.g. walking on/cleaning) may affect material properties.

In some extenuating circumstances, a limited extension past the design life period may be requested by title holders. Approval to use a facility past the design life will be determined on a case-by-case basis by the NSW Resources Regulator.

## Measures to prevent overfilling

When required, a measure to prevent overfilling **should** be incorporated into the produced water storage facility. The PWMP **should** provide information on the system selected. Examples of measures to prevent the overfilling of tanks, containers and ponds include auto-shutoff devices, high level alarms, two-stage alarms, and visual indicators measures. The PWMP **should** document procedures that are required to return storages to their maximum operating levels in the event of inclement weather.

It is recommended that tanks and containers are covered to avoid direct rainfall contributing to additional water that requires management as produced water.

Covered tanks **should** maintain a freeboard of at least 0.2 m and 10% capacity (air space) below tank overflow unless an operation freeboard has been nominated in an Environment Protection Licence issued by the Environment Protection Authority.

If tanks or containers are unable to be covered, then an emergency discharge and 'environmental containment freeboard' sufficient to contain inflow from the 1 in 100 year AEP 72 hour rainfall event without spilling in addition to normal operating conditions **should** also be considered.

## Secondary containment

When required, secondary containment measures for storage tanks or containers may include one or more of the following:

- bunded areas sized to accommodate a minimum of 110% of tank and container volume within the bunded area
- double-walled tanks.

Secondary containment for storage ponds typically involves the use of an additional geomembrane or modified soil (clay) liner. A modified soil (clay) liner may be considered as a secondary containment liner for ponds if they allow the installation of effective leak detection (refer to leak detection section below). When utilised, modified soil (clay) liners **should** have a permeability of less than  $10^{-9}$  m/s and minimum thickness of 300 mm for pond depths up to 2 m. The design and construction of a modified soil (clay) liner **must** be undertaken in accordance with a construction quality assurance (CQA, refer to the 'quality assurance and quality control' section below.)

Highly permeable or reactive soils are generally not suitable for bunded areas. Prior to developing bunded areas for secondary containment, soils **should** be tested to determine if they have a suitable permeability of less than  $10^{-9}$  m/s.

If the bunded area requires a liner, reference **should** be made to 'Considerations specific to geomembranes' section below for further guidance on appropriate liner material selection.

Bunded areas **should** be graded to a sump/collection pit, and **must** not drain to the surrounding area or have openings. Bunded areas **must** be maintained in good condition.

Bunded and lined contaminants **must** have stormwater control facilities to minimise bank erosion in accordance with the *Managing Urban Stormwater: Soils and Construction Volume 2E, Mines and Quarries* (DECC 2008b).

## Leak detection

When required, leak detection systems alert infrastructure operators to potential leaks. They are incorporated into the design of the facility and provide operators the ability to determine if the primary containment has been compromised.

## Storage tanks

Leak detection of storage tanks can be undertaken via visual inspection if the following considerations are incorporated into the design:

- storage tanks are located above ground to allow visual inspection of all side walls and hose/pipe connections points
- storage tanks are positioned on a foundation or impermeable layer that provides an indication that the base has been compromised and is leaking.

Leak detection inspections **should** be undertaken monthly and records retained to verify compliance. Otherwise, leakage detection using methods similar to those described for storage ponds **should** be utilised, as described below.

## Storage ponds

Leak detection systems typically comprise a leak detection layer between the primary and secondary containments, which provides an engineered seepage pathway to a sump. Continuous monitoring or regular sample collection and analysis of the sump **should** be undertaken, and allowance for this monitoring needs to be considered in the design of these facilities.

Leak detection systems **should** be monitored monthly. If leakage is suspected, further monitoring is typically required to determine leakage rate, followed by corrective measures if a predetermined action leakage rate threshold is reached (refer to Trigger Action Response Plan). When leakage is suspected, samples collected from the seepage (leachate) **should** be analysed regularly to indicate pond contents, recording the quantity collected or pumped back to the pond. By reviewing leakage volumes, comparing leakage chemistry to pond chemistry, and any trends, the amount of actual leakage can be estimated.

For long-term facilities (i.e. periods exceeding one year) it is also recommended that monitoring bores be installed around the pond circumference to monitor groundwater affecting the pond and any secondary containment breaches. This would typically be a requirement nominated in an Environment Protection Licence issued by the Environment Protection Authority (EPA).

## Considerations specific to storage ponds

Construction quality assurance (CQA) and construction quality control are widely recognised as critically important factors in overall quality management for storage pond facilities. The CQA program **must** be prepared by a suitably qualified person certified by Engineers Australia or similar approved organisation. The pond **must** then be constructed in accordance with the CQA program. The PWMP **should** document the CQA program and its implementation.

Any overflow **should** be treated as produced water and be captured on site or treated to minimise the escape of pollutants. Provision **should** be made for storm event overflow via a trickle pipe or non-erodible spillway to minimise the risk of damage to pond banks. This **should** allow for a discharge rate to avoid containment failure. Rainfall and runoff **should** be estimated in accordance with procedures set out in *Australian Rainfall and Runoff—A Guide to Flood Estimation* (Engineers Australia, 2019).

The capacity of the pond **should** be such that, in addition to the stored produced water arising from an average year's net inflow and discharge, it has sufficient capacity for direct rainfall and runoff from contributing pond catchment areas.

Clean stormwater runoff into the pond from other areas **should** be minimised by appropriate diversion to avoid unnecessary flows into the pond.

Generally, ponds **should** not be located in areas:

- that would increase the risk of flooding to neighbouring properties or where damage caused by overland flow or floodwaters may compromise the integrity of the storage
- where groundwater or other local environmental conditions (soil type, sub-soil stability, flora, fauna) have the potential to affect or compromise pond liners or pond operation.

The location of the storage pond **should** be located on a level, stable site avoiding potential settlement (including differential settlement) from unconsolidated foundation materials. Potential intrusions including vegetation, rock and anthropogenic materials **must** be avoided or removed from the subject area.

If groundwater is encountered during excavation, precautions **should** be taken to ensure that placement and compaction of the liner is not adversely affected. Consideration **must** be given to effective under-drainage measures to prevent upward pressure on the liner.

The title holder **should** also consult with Dam Safety NSW to determine if the proposed pond is a declared dam under the *Dam Safety Act 2015*.

If significant quantities of sludges are expected to accumulate, provision **should** be made for appropriate access for desludging that avoids liner damage. If desludging equipment is to be used within the pond, care **must** be taken to avoid liner damage and repair any damage sustained.

Design pond volume **should** also allow for design accumulated sludge.

## Considerations specific to geomembranes

For geomembranes (geosynthetic) materials, manufacturing quality assurance (MQA) and manufacturing quality control (MQC) of the geomembrane is important and would typically form part of the CQA. The MQA/CQA plan **should** include a detailed description of all MQA/CQA activities that will be used during material manufacturing and construction to manage the installed quality of the facility. The MQA/CQA plan **should** be tailored to the specific facility to be constructed and be completely integrated into the project plans and specifications.

When onsite seaming/joining of the geomembrane is required, quality control testing **must** be conducted over the full length of seams and joins prior to produced water storage. Refer to **Appendix 2** for acceptable standards for quality control testing of geomembrane seams.

Liners **should** not be constructed on gradients steeper than 1 in 3, unless appropriate engineering methods are used to prevent liner slippage.

Penetrations of the liner by transfer pipes **should** be avoided with preference given to directing pipes over the pond wall and liner. Pipe anchors **should** be utilised to avoid excessive movement over the liner system and assist in maintaining liner integrity.

## Pond security and safety requirements

Controls **must** be implemented to limit as far as practical the entry of terrestrial fauna that have a potential to damage the liner from entering the storage compound. This may be achieved by installing suitable fencing around the perimeter (e.g. chain wire fencing). If avian fauna have the potential to cause damage to the liner, controls **should** also be considered to prevent their access to the storage compound.

It is recommended that safety provisions are considered on a site by site basis. At a minimum, ladders or other non-slip provisions **should** be installed in ponds. The purpose of ladder installation is to enable safe exit of fauna and people as lined pond banks may be slippery. Alternatively, a textured rub-sheet may be installed, to assist with person/fauna safe exit.

## Pipelines used to convey produced water

### *AS 2885 (2012-2020) Pipelines – Gas and liquid petroleum*

These standards apply to steel pipelines that transmit single-phase and multi-phase hydrocarbon fluids, such as natural and manufactured gas, liquefied petroleum gas, natural gasoline, crude oil, natural gas liquids and liquid petroleum products. In special circumstances the standard may also apply to pipelines designed and constructed from fibreglass materials, from corrosion resistant alloys or from other materials; and for pipelines transporting other fluids (for example non-hydrocarbon gases and slurries).

The objective of AS 2885.5:2020 is to set out methods for the determination of the strength and the leak tightness of a pipeline test section. Standards apply to design and leak testing that follows pipeline strength testing.

### *AS/NZS 2566 (1998-2002) Buried Flexible Pipelines*

These standards apply to flexible pipes conveying low pressure gas, water, wastewater, stormwater or slurry for pressure or non-pressure applications, or for flexible pipes serving as conduits for the later installation of cables or pipes.

Field pressure testing for pressurised pipelines is included as part of AS/NZS 2566:2002 to determine that the pipeline will sustain a pressure greater than its design pressure without leakage. Field hydrostatic testing for pressure pipelines test methods are also described.

### *APGA Code of Practice for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry*

This code has been developed by the Australian Gas and Pipelines Association and is applicable to polyethylene pipelines that are typically used for coal seam gas.

Field pressure testing prior to commissioning the pipeline **must** be carried out using the methods in either the *AS 2885 (2012-2020)*, *AS/NZS 2566 (1998-2002)* or the *APGA Code of Practice for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry*.

### *Computational pipeline monitoring or CPM*

An algorithmic monitoring tool that alerts the pipeline controller to respond to a detectable pipeline hydraulic anomaly (perhaps both while the pipeline is operating or shut-in), which may be indicative of a fluid release.

CPM use field based measurement sensors to perform readings of pressure, temperature, viscosity, density, flow rate, product sonic velocity, and product interface location. Calculations are then performed to estimate the state of the fluids within the pipe.

Each CPM leak detection system installed on a produced water pipeline transporting liquid in single phase (without gas in the liquid) **should** comply with *API RP 1130 Computational Pipeline Monitoring for Liquids* in operating, maintaining, testing, record keeping, and dispatcher training of the system.

Alternatively, a leak detection system other than CPM can be implemented that provides equivalent leak detection. The PWMP **must** document what system is implemented and a justification for the selection.

## Trigger Action Response Plan

Trigger Action Response Plan (TARP) is a functional management tool that identifies planned actions when certain triggers are reached. The TARP **should** also identify the required monitoring to achieve this.

The TARP **should** set out a response plan for the detection of leakage through a primary containment. In particular, the TARP **should** provide a specific response to leakage through the primary containment that exceeds a leakage rate of two holes per hectare each having a diameter no greater than 2mm (known as the action leakage rate).

This Action Leakage Rate (ALR) is commonly accepted in international jurisdictions as the amount of leakage that could occur through primary containment geomembrane liner that was constructed with good construction quality assurance. The TARP **should** include specific operational controls and corrective measures to be implemented both before and after the ALR is exceeded.

## Appendix 2: Additional information and considerations for various produced water storage containments types

CONTAINMENT TYPE		PLASTIC TANK/ CONTAINER	STEEL TANK/ CONTAINER	HDPE LINER	LDPE LINER	PVC LINER	COMPOSITE LINER [g]	OTHER LINER MATERIALS [h]	CLAY LINER
<b>Containment function</b>		<b>Primary</b>	<b>Primary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Secondary</b>
<b>Containment selection</b>	<b>Suggested usage</b>	Lower volumes of produced water. When site disturbance associated with pond (excavations) are to be avoided.		For most applications.	If soils are subject to differential movement (settling).		The use of these materials should be considered on a case-by-case basis, based on their suitability for the intended containment use, operational life and the local environmental setting.		Secondary barrier only or when produced water being stored will not have an adverse impact on the environment if released.
	<b>Suitability</b>	Suitable for most applications. May not be economically feasible for larger volumes of produced water requiring storage.		Not suitable if soils are subject to differential movement (settling).	Not suitable if abrasion or UV is an issue.	Not suitable if exposed to sunlight and operational life greater than three years.			Not suitable as a primary barrier for produced water that will have an adverse impact on the

# EXPLORATION CODE OF PRACTICE

Produced water management, storage and transfer

CONTAINMENT TYPE		PLASTIC TANK/ CONTAINER	STEEL TANK/ CONTAINER	HDPE LINER	LDPE LINER	PVC LINER	COMPOSITE LINER [g]	OTHER LINER MATERIALS [h]	CLAY LINER
<b>Containment function</b>		<b>Primary</b>	<b>Primary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Secondary</b>
						Not suitable if rodent or termite attack cannot effectively be mitigated.			environment if released.
	<b>Leak detection</b>	Leakage detection method selected must be capable of detecting a compromised primary containment within one month. Visual inspection acceptable.		Leakage detection method selected must be capable of detecting a compromised primary containment within one month. This is typically achieved by incorporating a leak detection layer, between primary and secondary barriers (liners). Regular monitoring of leak detection layer required.					
	<b>CQA program required?</b>	No	No	Yes	Yes	Yes	Yes	Yes	Yes
<b>Materials specification</b>	<b>General</b>	Meets AS/NZS 4766:2020 <sup>[a][c]</sup>	Meets AS/NZS 2179.1:2014 <sup>[b][c]</sup>	Meets minimum requirement of GM13 <sup>[d]</sup>	Meets minimum requirement of GM17 <sup>[e]</sup>	—	—	—	—
	<b>Coefficient of permeability</b>	Watertight (10 <sup>-14</sup> m/s)		Watertight (10 <sup>-14</sup> m/s)	Watertight (10 <sup>-14</sup> m/s)	Watertight (10 <sup>-14</sup> m/s)	Watertight (10 <sup>-14</sup> m/s)	Watertight (10 <sup>-14</sup> m/s)	< 2 x 10 <sup>-9</sup> m/s

CONTAINMENT TYPE		PLASTIC TANK/ CONTAINER	STEEL TANK/ CONTAINER	HDPE LINER	LDPE LINER	PVC LINER	COMPOSITE LINER [g]	OTHER LINER MATERIALS [h]	CLAY LINER
Containment function		Primary	Primary	Primary & secondary	Primary & secondary	Primary & secondary	Primary & secondary	Primary & secondary	Secondary
	<b>Thickness</b>	—		>1.5 mm (min. av.) <sup>[f]</sup>	>1.5 mm (min. av.) <sup>[f]</sup>	>0.75 mm (min. av.) <sup>[f]</sup>	—	>0.75 mm (min. av.) <sup>[f]</sup>	At least 300 mm for ponds up to 2m, increased thickness required to correspond with increase in storage depth.
	<b>Density</b>	NA		>0.940 g/ml	>0.939 g/ml				NA
	<b>Puncture resistance</b>	NA		480 N (min. av.)	370 N (min. av.)				NA
	<b>Shear resistance</b>	NA		Liner shear resistance must be verified to adequately resist shear forces.					NA
	<b>Welding materials</b>	NA		Any membrane welding materials should be supplied by the liner manufacturer, and should be identical with the liner membrane.					NA
	<b>Shape and fabrication</b>	NA		The liner should be fabricated to form the shape of excavation.					NA

## EXPLORATION CODE OF PRACTICE

Produced water management, storage and transfer

CONTAINMENT TYPE		PLASTIC TANK/ CONTAINER	STEEL TANK/ CONTAINER	HDPE LINER	LDPE LINER	PVC LINER	COMPOSITE LINER [g]	OTHER LINER MATERIALS [h]	CLAY LINER
<b>Containment function</b>		<b>Primary</b>	<b>Primary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Primary &amp; secondary</b>	<b>Secondary</b>
	<b>Seams and joins</b>	NA		Must be watertight and seamed over full length in accordance with manufacturer's standard procedures and any site-specific recommendations.				NA	
<b>Quality control testing</b>	<b>Seams and joins</b>	NA		All seams and joins must be constructed and tested as watertight over their full length using a vacuum test unit, air pressure testing, electronic testing or other approved method used in the HDPE membrane industry such as: <sup>[i]</sup>  ASTM D7002-16 Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Water Puddle System.  ASTM D7007-16 Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earthen Materials.				—	
	<b>Materials</b>	<b>Chemical resistance:</b> U.S. EPA (1992), Method 9090A Compatibility Test for Wastes and Membrane Liners, Revision 1, July 1992.		<b>Chemical resistance:</b> Standard Practice for Tests to evaluate the Chemical Resistance of Geomembranes to Liquids ASTM D5747/5747M. <b>Materials specification and Test Frequency:</b> As specified in CQA program.				—	
<b>Other considerations</b> Use of UV stabilised material or coatings.		Consider covers to prevent rainfall ingress.		Pond floor should grade at not less than 1 in 100 to sump(s). Sumps should be connected to accessible monitoring or recovery wells to permit seepage collection by gravity.					
		Corrosion prevention (such as cathode protection)		When liners are used, pond design should avoid gradients of steeper than 1:3 unless appropriate engineering methods that meet manufacturer specifications are used to prevent liner slippage. Penetrations of liner avoided or designed by an engineer in accordance with QCA program,					

### Notes:

NA Not applicable

- a. Rotationally moulded plastic rainwater tanks – *AS/NZS 4766:2020, Rotationally moulded buried, partially buried and non-buried storage tanks for water and chemicals.*
- b. Metal rainwater tanks – *AS/NZS 2179.1:2014, Specifications for rainwater goods, accessories and fasteners – Metal shape or sheet rainwater goods, and metal accessories and fasteners.*
- c. If tanks or containers are not applicable to be certified under AS/NZS 4766:2020 or AS/NZS 2179.1:20414 (e.g. in situ tanks, underground tanks, flexible water storage tanks), tanks should be demonstrated to be structurally sound and watertight. In situ and underground rainwater tanks may be certified in accordance with the specified test method, performance requirements, pressure testing and objectives of AS/NZS 1546.1, AS/NZS 4766 and be designed, inspected and signed off by a qualified structural engineer. All fittings should be in accordance with AS 5200.000 and the Plumbing Code of Australia.
- d. Geosynthetic Institute, *GRI Test Method GM13: Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.*
- e. Geosynthetic Institute, *GRI Test Method GM17: Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.*
- f. Consideration should be given to site-specific advice.
- g. Composite liner systems involve ‘sandwiches’ made up of several different materials. They include polypropylene mesh encasing bentonite (absorbent aluminium silicate clay) commonly referred to as a geo-synthetic clay liner (GCL), ethylene inter-polymer alloy with high strength reinforcing fibres and fibre reinforced plastics.
- h. Other synthetic membranes available include reinforced chlorinated polyethylene (CPE), ethylene propylene diene monomer (EPDM), butyl rubber and polyurethane coated geo-textile. Each membrane exhibits differing tensile strength, elasticity, resistance to degradation and chemical attack characteristics.
- i. Other current leak detection standards for consideration are listed below.

ASTM D7006-03(2013) Standard Practice for Ultrasonic Testing of Geomembranes.

ASTM D7703-16 Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Water Lance Method.

ASTM D7953-20 Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method.

ASTM D4437/D4437M-16(2018) Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

ASTM D7240-18 Standard Practice for Electrical Leak Location Using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test).

- j. NSW EPA (2016) *Environmental Guidelines: Solid Waste Landfills* ISBN 978-1-76039-350-2, EPA 2016/0259.

## Appendix 3: Interpretation and definitions

In this Code:

1. reference to a document is a reference to that document as amended or replaced from time to time
2. words have the meaning given to those terms in a prospecting title, unless otherwise defined in the table below
3. terms in column 1 of the following table have the meaning set out in column 2.

COLUMN 1 (TERM)	COLUMN 2 (MEANING)
<b>Action leakage rate</b>	The amount of leakage that would occur through a geomembrane liner that was constructed with good construction quality assurance
<b>Activity</b>	Any activity carried out in connection with exploration including: <ul style="list-style-type: none"> <li>■ the use of land</li> <li>■ means of accessing land</li> <li>■ the carrying out of a work</li> </ul>
<b>Activity approval</b>	An approval to carry out assessable prospecting operations granted under the <i>Mining Act 1992</i> or the <i>Petroleum (Onshore) Act 1991</i>
<b>Annual Exceedance Probability (AEP)</b>	The chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually, usually expressed as a percentage
<b>Annual Recurrence Interval (ARI)</b>	The average, or expected, value of the periods between exceedances of a given rainfall total accumulated over a given duration
<b>Assessable prospecting operation</b>	Any prospecting operation that is not exempt development within the meaning of clause 10 of <i>State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007</i>
<b>Construction Quality Assurance (CQA)</b>	Measures taken by the CQA organisation to assess if the installer or contractor is in compliance with the plans and specifications for a project  Construction quality assurance includes inspections, verifications, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility.

COLUMN 1 (TERM)	COLUMN 2 (MEANING)
<b>Construction Quality Control (CQC)</b>	Measures taken by a person (normally a geosynthetics installer or, for natural soil materials, an earthwork contractor) to achieve quality in the constructed or installed system, and determine compliance with the requirements for materials and workmanship stated in the plans and specifications for the project
<b>Computational pipeline monitoring</b>	An algorithmic monitoring tool that alerts the pipeline controller to respond to a detectable pipeline hydraulic anomaly (perhaps both while the pipeline is operating or shut-in), which may be indicative of a release
<b>Design life</b>	The period of time during which the item is expected by its designers to work within its specified parameters; in other words, the life expectancy of the item
<b>Department</b>	The Department of Regional NSW
<b>Drilling</b>	The perforation of the earth’s surface crust by mechanical means to form a hole, whether the hole caused by the perforation is vertical, inclined or horizontal, and includes all operations for preventing collapse of the sides of any such hole or for preventing it from being filled with extraneous materials including water
<b>Drilling fluid</b>	Any liquid or gaseous fluid, or mixture of fluids and solids (as solid suspensions, mixtures and emulsions of liquids, gases and solids) used in operations to drill boreholes into the earth
<b>Environmental containment freeboard</b>	The vertical distance between the operational pond limit and the spillway crest level
<b>EPL</b>	An environment protection licence issued under the <i>Protection of the Environment Operations Act 1997</i> in respect of the activity involving produced water
<b>Evaporation pond</b>	A pond designed in such a way that the principal method of removing (extracting) the liquid being stored is via evaporation Evaporation ponds are relatively large and shallow and may incorporate methods to accelerate the evaporation process (such as mechanical diffusers or sprays).

COLUMN 1 (TERM)	COLUMN 2 (MEANING)
<b>Exempt development</b>	Has the same meaning as it has in <i>State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007</i>
<b>Exploration</b>	Has the same meaning as it has in the <i>State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007</i>
<b>Fate</b>	The disposal and/or reuse of produced water
<b>Flowback water</b>	Fluids actively extracted from a petroleum well following fracture stimulation, in preparation for a subsequent phase of fracture stimulation or clean-up prior to dewatering of produced water
<b>Fracture stimulation</b>	The process by which target hydrocarbon bearing formations are ‘stimulated’ when fluids or gases are forced at high pressure
<b>Groundwater</b>	Water that occurs beneath the ground surface in the saturated zone
<b>Manufacturing Quality Assurance (MQA)</b>	<p>A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract plans</p> <p>MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organisation to determine if the manufacturer is in compliance with the product certification and contract plans for a project.</p>
<b>Manufacturing Quality Control (MQC)</b>	<p>A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated</p> <p>MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract plans.</p>
<b>Petroleum well</b>	<p>A hole made by drilling or boring in connection with prospecting for petroleum or operations for the recovery of petroleum, but excludes:</p> <ul style="list-style-type: none"> <li>■ sampling and coring using hand held equipment</li> </ul>

COLUMN 1 (TERM)	COLUMN 2 (MEANING)
	<ul style="list-style-type: none"> <li>■ a hole constructed and operated for the following purposes where the operation of that hole does not involve fracture stimulation or the recovery of petroleum:                             <ul style="list-style-type: none"> <li>□ stratigraphic definition</li> <li>□ seismic (for example shot holes, geophone, tilt meters bores)</li> <li>□ water monitoring</li> <li>□ environmental assessment</li> </ul> </li> </ul>
<b>Pond</b>	A structure that has the purpose of storing produced water that predominantly uses earthworks to form the required shape (e.g. excavation and shaping)
<b>Primary containment</b>	The first barrier (or liner) in direct contact with the produced water being stored
<b>Probable Maximum Flood</b>	The largest flood that could conceivably occur within a catchment
<b>Produced water</b>	Any form of groundwater that is actively extracted from a borehole, petroleum well or excavation, excluding incidental groundwater mixed with drilling fluids
<b>Prospect</b>	Has the same meaning as it has in the <i>Mining Act 1992</i> and the <i>Petroleum (Onshore) Act 1991</i> (as relevant)
<b>Prospecting title</b>	An exploration licence, assessment lease or special prospecting authority granted under the <i>Mining Act 1992</i> or the <i>Petroleum (Onshore) Act 1991</i>
<b>Secondary containment</b>	A second barrier (or liner) that is not in direct contact with the produced water being stored, but provides an additional barrier if the primary containment is compromised
<b>Secretary</b>	The Secretary of the Department of Regional NSW
<b>Significant change</b>	A change that requires variation to an activity approval granted in respect of a produced water activity, or changes the accuracy of a risk assessment for a produced water activity
<b>Site</b>	The land on which an activity is located

COLUMN 1 (TERM)	COLUMN 2 (MEANING)
<b>Sump</b>	Storage location for fluids commonly required for drilling This is usually a hole dug for the purpose but may be an above ground storage unit.
<b>Terms</b>	In relation to activity approvals, means the terms imposed by the decision-maker on the grant of an activity approval
<b>Title holder</b>	A person or company to whom a prospecting title has been issued
<b>Waste</b>	Has the same meaning as it has in the <i>Protection of the Environment Operations Act 1997</i>
<b>Well</b>	Has the same meaning as it has in the <i>Petroleum (Onshore) Act 1991</i>