GOVERNMENT OF WESTERN AUSTRALIA

Department of **Mines, Petroleum and Exploration**

# Application for declaration of identified greenhouse gas storage formation

**Guideline**

**In relation to the *Petroleum, Geothermal Energy and Greenhouse Gas Storage Act 1967* and the *Petroleum* and *Greenhouse Gas Storage (Submerged Lands) Act 1982***

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# Purpose

The purpose of this guideline is to provide information on applications for the declaration of identified greenhouse gas (GHG) storage formations under the *Petroleum, Geothermal Energy and Greenhouse Gas Storage Act 1967* (PGEGGSA) and the *Petroleum and Greenhouse Gas Storage (Submerged Lands) Act 1982* (PGGS(SL)A); together, "the Acts".

The declaration of an identified GHG storage formation is requirement to be able to apply for a GHG retention lease or a GHG injection licence.

Potential applicants should engage early with the Department of Mines, Petroleum and Exploration (DMPE) to better understand the requirements for making an application under the Acts.

# Overview of a GHG storage formation

A GHG storage formation must be deemed capable of permanently storing an injected GHG substance. In this context, permanent storage is considered as storage over geological timeframes.

The size and/or spatial extent of a GHG storage formation depends not only upon geological factors, but also factors under the control of the registered holder of the GHG title such as (but not limited to):

- the amount of GHG substance to be injected;
- the rate of injection;
- the period over which injection is to take place; and
- the location of injection points.

The Acts establish three categories of GHG storage formation that reflect the technical understanding of the formation:

### Potential

A potential GHG storage formation relates to a part of a geological formation where it is reasonably foreseeable that it is suitable for the permanent storage of a GHG substance. Further exploration will be required to undertake the detailed analysis of the potential GHG storage formation to allow it to be consider an eligible GHG storage formation.

### Eligible

An eligible GHG storage formation is a part of a geological formation that is suitable for the permanent storage of a particular amount (at least 100,000 tonnes) of a GHG substance, injected at a particular point (or points) over a particular period of time, per section 6C of PGEGGSA or section 4B of PGGS(SL)A.

### Identified

An identified GHG storage formation is one that has been declared to be a GHG storage formation by the Minister formation under section 69E of PGEGGSA or section 74AE of PGGS(SL)A.

A single geological formation may contain multiple storage formations, spatially separate from each other, and a storage formation may comprise multiple parts or whole geological formations.

A declaration of an identified GHG storage formation retains its significance over the life of the GHG storage project. This is because the injection and storage activities to be carried out under an injection licence need to be consistent with the declared estimate of the spatial extent and with the declared fundamental suitability determinants.

## Fundamental suitability determinants

Sections 69B(3)(b)(i) of PGEGGSA and 74AB(3)(b)(i) of PGGS(SL)A require that an application to the Minister seeking the declaration of an identified GHG storage formation must set out the fundamental suitability determinants of the relevant eligible GHG storage formation.

Fundamental suitability determinants of an eligible GHG storage formation have the meaning given by section 6C of PGEGGSA and section 4B of PGGS(SL)A:

a) the particular amount of GHG substance that can be stored, noting that it must be at least 100,000 tonnes;
b) the particular GHG substance which the storage formation is suitable to store;
c) the proposed injection point(s), such as well(s);
d) the proposed period of which injection is intended; and
e) the effective sealing feature or attribute of the storage formation that enables permanent storage.

Applicants must analyse and describe the geological features of the eligible storage formation in sufficient detail to accurately define and address each of the fundamental suitability determinants.

# Applying for a declaration of an identified GHG storage formation

Pursuant to section 69B of PGEGGSA, an application to the Minister to declare an identified GHG storage formation can be made by the registered holder of:

- a GHG exploration permit;
- a petroleum retention lease or production licence; or
- a geothermal retention lease or production licence.

Pursuant to section 74AB of PGGS(SL)A, an application to the Minister to declare an identified GHG storage formation can be made by the registered holder of:

- a GHG exploration permit; or
- a petroleum retention lease or production licence.

An application can be made if the registered holder has reasonable grounds to believe that a part of a geological formation wholly situated in the title area is an eligible GHG storage formation.

The application requirements are the same for all GHG, petroleum and geothermal titles.

It is possible to have a second or subsequent identified GHG storage formation (more than one) declared in a GHG title, petroleum retention lease, geothermal retention lease, petroleum production licence or geothermal production licence, provided each eligible GHG storage formation is wholly situated within the title area. The Minister's declaration will be in accordance with the requirements of section 69E of PGEGGSA or 74AE of PGGS(SL)A.

A registered holder may apply to the Minister for the declaration of a part of a geological formation as an identified GHG storage formation, if they have reasonable grounds to believe that the part of a geological formation is an eligible GHG storage formation, and that part is wholly situated in the title area per section 69B of PGEGGSA and section 74AB of PGGS(SL)A.

Applications for a declaration of identified storage formation are made online via the Petroleum, Geothermal and Greenhouse Gas Register (PGGGR).

Detail on the information that needs to be included in an application is set out in Part 2 and Schedule 1 of the Petroleum, Geothermal Energy and Greenhouse Gas Storage (Greenhouse Gas Injection and Storage) Regulations 2025 and the Petroleum and Greenhouse Gas Storage (Submerged Lands) (Greenhouse Gas Injection and Storage) Regulations 2025; together, "the GHG Regulations". This is further explained in Appendix 1 of this guideline. See Appendix 2 of this guideline for suggested information to support an application for a declaration of an identified GHG storage formation.

In accordance with sections 69B(3)(a)-(c) and (4) of PGEGGSA and sections 74AB(3)(a)-(c) and (4) of PGGS(SL)A, the application must detail, with supporting information, the following:

a) the reasons for believing that a part of a geological formation is an eligible GHG storage formation;
b) assuming that the part is an eligible GHG storage formation, the fundamental suitability determinants of the eligible GHG storage formation;
c) assuming that the part is an eligible GHG storage formation, an estimate of the spatial extent of the eligible GHG storage formation – an estimate of spatial extent must comply with the requirements specified in Schedule 1 Division 3 of the GHG Regulations; and
d) such other information as is specified in Schedule 1 Division 2 and Division 4 of the GHG Regulations.

The application should present the fundamental suitability determinants in a table such as the example provided below. Details of the greenhouse gas substance may be provided as the minimum percentage of carbon dioxide. The proposed injection point or points can be provided as GPS co-ordinates or referenced to a fixed location on the surface. In general, the injection point is taken to be the point on the earth's surface directly above the subsurface injection point and may not be the location of the well head. A small degree of uncertainty may be ascribed to the location and contingent injection points may be included provided that these do not materially impact the other fundamental suitability determinants or spatial extent.

**Fundamental suitability determinants example**

| | | |
|---|---|---|
| Subsection 6C/4B (9)(a) | The amount of GHG substance that is suitable to store | 20 million tonnes |
| Subsection 6C/4B (9)(b) | The GHG substance that is suitable to store | >95mol% $CO_2$ |
| Subsection 6C/4B (9)(c) | The injection point or points | • Base case, 1 primary injection well located approximately 500m south of the XX 1 well<br>• Contingent well approximately 4000m south of the primary injection well |
| Subsection 6C/4B (9)(d) | The period of injection | 20 years |
| Subsection 6C/4B (9)(e) | The effective sealing feature or attribute that enables the permanent storage | Structural trapping beneath the Kockatea Shale seal in a depleted gas field |

The Minister may, by written notice, require the applicant to give further information in connection with the application, or to carry out further analysis of information as specified in the notice, under section 69C(1) of PGEGGSA or section 74AC(1) of PGGS(SL)A. If the applicant fails to provide the further information or analysis, the Minister may refuse to progress the application per section 69C(2) of PGEGGSA or section 74AC(2) of PGGS(SL)A.

If the Minister is satisfied that, using the fundamental suitability determinants set out in the application:

- the part of a geological formation is an eligible GHG storage formation; and
- the estimate of the spatial extent set out in the application is a reasonable estimate of the spatial extent of the eligible GHG storage formation;

the Minister must, by writing:

- declare that part of a geological formation to be an identified GHG storage formation;
- declare the spatial extent of the identified GHG storage formation is the spatial extent estimated in the application; and
- declare that the fundamental suitability determinants specified in the application are the fundamental suitability determinants of the identified GHG storage formation.

If an application has been lodged, the Minister must, by writing, advise the applicant of refusal to declare an identified GHG storage formation if the Minister is **not** satisfied that, using the fundamental suitability determinants set out in the application:

- the part of a geological formation is an eligible GHG storage formation, and/or
- the estimate of the spatial extent set out in the application is a reasonable estimate of the spatial extent of the eligible GHG storage formation.

Declarations of identified GHG storage formations made under section 69E of PGEGGSA or 74AE of PGGS(SL)A, are published in the Western Australian *Government Gazette*.

## Assessment timing

Given the detailed level of analysis that is required in assessing an application of this type, it is recommended that the registered holder allow at least 120 business days for a decision to be made, noting any requests for further information are likely to extend this process.

# Variation of an application for a declaration of an identified GHG storage formation

Section 69D of PGEGGSA and section 74AD of PGGS(SL)A provide that at any time before the Minister makes a decision on an application under section 69E (PGEGGSA) or 74AE (PGGS(SL)A) an application can be made to vary that application. A variation of the application can be requested by the applicant or the Minister to vary any or all of the fundamental suitability determinants or the spatial extent estimated in the application. A variation of an application must set out the proposed variation and specify the reasons and provide supporting evidence. The variation must be made in an approved manner by form via PGGGR.

# Variation of a declaration of identified GHG storage formation

If a declaration is in force under section 69E of PGEGGSA or section 74AE of PGGS(SL)A, the Minister may at any time, by instrument in writing, vary the declaration under section 69G of PGEGGSA or section 74AG of PGGS(SL)A, either on application by the registered holder or on the Minister's own initiative. Before varying a declaration on the Minister's own initiative, the Minister must consult with the relevant registered holder per section 69G(6) of PGEGGSA or section 74AG(6) of PGGS(SL)A. Matters that can be varied include:

- any or all the fundamental suitability determinants specified in the declaration; or
- the spatial extent estimated in the declaration.

An application by a registered holder to vary a declaration must be made in an approved manner and set out the proposed variation and specify the reasons and provide supporting evidence. In deciding whether to vary the declaration the Minister must have regard to any new information, analysis, relevant scientific or technological developments and any other matters as the Minister considers relevant.

A copy of a variation must be published in the Western Australian *Government Gazette*.

# Revocation of declaration of identified GHG storage formation

If a declaration is in force under section 69E of PGEGGSA or section 74AE of PGGS(SL)A, the Minister may at any time revoke the declaration if the Minister is satisfied that, using any set of fundamental suitability determinants, the part of the formation is not suitable for the permanent storage of a GHG substance, per section 69H of PGEGGSA or section 74AH of PGGS(SL)A. This may be, for example, because of new information about the integrity of the storage formation.

The Minister must consult with the registered holder before revoking the declaration per section 69H(3) of PGEGGSLA or 74AH(3) of PGGS(SL)A.

Before revoking the declaration, the Minister must consider whether the declaration should instead be varied under section 69G of PGEGGSA and 74AG of PGGS(SL)A.

A copy of a revocation must be published in the Western Australian *Government Gazette*.

# Other matters

The information in an application for a declaration of an identified GHG storage formation will form the basis of the information required by components of Part A and Part B of the Site Plan under Schedule 2 of the GHG Regulations, in particular the integrity of the storage formation and plume migration modelling, respectively. This information may need to be revised for the purposes of the Site Plan if, for example, it is necessary to vary the declaration of identified GHG storage formation.

# Appendix 1 – Explanatory notes on requirements of Schedule 1 of the GHG Regulations

The purpose of this Appendix is to provide further explanation of the contents of Schedule 1 of the GHG Regulations, which specifies the information that must be set out in an application for the declaration of a part of a geological formation as an identified GHG storage formation, assuming the part is an eligible GHG storage formation. This information is found in Divisions 2 and 4 of Schedule 1. Division 3 specifies requirements with respect to providing the estimate of the spatial extent of the eligible GHG storage formation.

## Geological features of the geological formation

Clause 2 requires an application to include a description and detailed analysis of the geological features of the geological formation, including the effective sealing feature or attribute. The term geological formation is defined in the Acts to include any seal or reservoir and any associated geological attributes or features. In the context of GHG storage, an effective seal refers to a geological feature or attribute that prevents the escape of the injected GHG substances outside of the storage formation.

## Understanding of the subsurface environment

Subsurface information must be set out in sufficient detail to demonstrate that the applicant's understanding of the subsurface environment is sufficient to allow the applicant to identify all risks relating to:

- the containment of the greenhouse gas substances to be stored;
- the geotechnical integrity of the formation or structure; and
- the displacement of the formation fluids.

Risk management is an iterative process that parallels the life cycle of the project. For a declaration of identified GHG storage formation, the applicant must be able propose strategies for the reduction of all risks identified, to as low as reasonably practicable, and strategies for the management of those risks. An applicant is not required to provide the actual strategies for reducing and managing risks; rather, they must show sufficient understanding of the subsurface to be able to identify risks and propose strategies. The applicant must explain how they can identify risks and propose strategies on the basis of that information. The applicant must consider subsurface risks (geological and legacy wells – Clause 3) and, if proposed, any risks associated with engineering enhancements per Clause 12.

Further guidance can be found below under the geological information, legacy well information and engineering enhancement sections.

## Geological information

A description and detailed analysis of the geological features of the part of the geological formation, including the effective sealing feature or attribute. The information provided should include sufficient information of the surrounding area and geological formations to inform subsequent static and dynamic modelling and risk management.

Schedule 1, subclauses 3(3)(a)-(i) set out the minimum geological information that is required. Additional information may be required on a case-by-case basis.

This includes:

- stratigraphy, structure, rock types, and depositional model of the storage formation (both reservoir and seal rocks);
- identification of faults in either the reservoir or seal rocks;
- porosity and permeability of the storage formation and seal rocks;
- reactivity of rock types in both the reservoir and seal rocks with the GHG substance proposed to be stored;
- geomechanical assessment of the local stress regime, fracture gradients, fault stability and the geomechanical response of the storage formation to injection;
- reservoir fluid parameters, including chemical composition, pressure and temperature;
- seismicity, including the history of earthquake activity in the area; and/or
- conduct of any previous exploration and development (petroleum and GHG) activities, if any, in the area.

## Legacy well information

Legacy wells refer to any pre-existing well at the time of application and includes wells drilled for the purpose of petroleum, geothermal energy, GHG or water. Schedule 1, subclause 3(3)(j) sets out the minimum legacy well information that is required

This includes**:**

- the location of each well;
- its construction history;
- how it was plugged (if applicable);
- the kind of cement used to plug it (if applicable); and/or
- any other aspect of its nature that is relevant.

Some wells in the area might not have been plugged yet because they are awaiting plug and abandonment, currently in use, shut-in or suspended. The nature of these (unplugged) wells should be described, including the current operator and, if known, the future plans for plugging.

### Model of reservoirs and seal rocks

The subsurface information gathered in the steps above, and any other relevant information, should be used to construct a three-dimensional static geological earth model or a set of models as per Clause 4. Model(s) input to dynamic modelling should be a suitable size and resolution to demonstrate that estimates of spatial extent are soundly based and the applicant is able to identify risks and propose strategies for the reduction and management of those risks. The application should include justification of the selected model properties with reference to the uncertainty range of input parameters.

Different models may be created to achieve different aims (for example, a mechanical earth model). The models themselves are not submitted during the initial online application; however, the applicant should retain all models referred to in the application in case the Minister requires further information or analysis.

### Dynamic modelling

The characterisations and assessment of the storage dynamic behaviour shall be based on dynamic modelling, comprising a variety (multiple) of simulations of the injection of greenhouse gas substances into the storage formation. The input for the numerical simulation should include the three-dimensional static geological earth model(s) described above and the dynamic parameters appropriate to model the injection into the storage formation.

The applicant should provide details of the modelling used including:

- types of models
- methodology and software
- spatial resolution
- any assumptions
- selected dynamic properties in relation to the uncertainties in the input parameters.

The applications should demonstrate that, consistent with the fundamental suitability determinants and estimates of spatial extent, the storage formation is suitable and capable of permanently storing a particular amount of an injected GHG substance. There is no requirement to perform or provide dynamic simulation results of the full range of parameter and static model combinations for a declaration of identified GHG storage formation.

The combination of dynamic simulations and static models must demonstrate that estimates of spatial extent are soundly based (discussed further below). These predictions should be provided at intervals over the life of the project and in the longer term, and should include at least (for the purposes of Clause 6):

- five years after injection is expected to cease; and
- the time when the GHG substance has effectively stabilised in the subsurface.

The applicant must also provide information of the associated pressure behaviour in response to injection at the wells and spatially. This should be provided as a combination of representative graphs and maps. The pressure behaviour may inform risk management associated with containment (including legacy wells), geotechnical integrity and displacement of formation fluids. The applicant must also ascertain the potential interaction with other subsurface resource projects in the area and demonstrate an understanding of any other parameter of change that, if relevant, would impact these risks, such as changes in temperature or displacement of formation fluids.

### Spatial extent

The applicant must provide an evidence-based estimate of the spatial extent of the eligible GHG storage formation, which is the vertical and horizontal extent of the expected migration pathway(s) of the injected GHG substance. The estimate of the spatial extent must be based on relevant parameters, including the expected plume migration pathways (all those which have a 10 per cent or greater probability of occurring, per section 6C of PGEGGSA or 4B of PGGS(SL)A), the fundamental suitability determinants and any engineering enhancements. These should be demonstrated by the information and modelling provided in relation to Division 2 of Schedule 1.

The graticular blocks constituting the spatial extent must include all blocks in the migration pathways referred to above. An explanation must also be included of the three-dimensional extent of the effective sealing feature or attribute within the spatial extent of the storage formation.

### Information on engineering enhancement, associated risk assessment and mitigation of risks

Schedule 1, Division 4 sets out the required information for engineering enhancements if any are proposed in the application. An engineering enhancement is an action taken by a person (as opposed to natural features) to facilitate storage of a greenhouse gas substance in an identified GHG storage formation. This may include remediation of a well, an operation for managing formation pressure (such as injection and/or extraction of water), an operation to increase injectivity potential or any other operation taken for that purpose.

The declaration of a part of geological formation as an identified GHG storage formation does not authorise the proposed operations.

The applicant must provide sufficient detail about any proposed engineering enhancements including:

- a description of the proposed engineering enhancements in relation to the storage formation; and
- demonstrating that any risks are likely to be acceptable, taking into account the proposed engineering enhancements.

The application must identify risks associated with containment, geotechnical integrity and displacement of formation fluids in relation to the storage formation or any other geological formation (e.g. injection of formation fluids into a shallower geological formation). The applicant must propose strategies for the reduction and management of those risks to as low as reasonably practicable.

# Appendix 2 – Information to support an application for a declaration of identified GHG storage formation

The purpose of this Appendix is to propose supporting information the applicant may consider when submitting an application. The applicant may provide details of all data used in assessing the storage formation, including a justification of the suitability of the datasets for the identification of all risks to the integrity of the storage formation. Figures in the text should be at a sufficient resolution so that all relevant features are clearly legible. If this is not possible, figures are to be supplied separately as a high-resolution file.

The following may be included where relevant:

## Geological overview

a) A regional map showing the location of the title and storage formation.

b) A detailed map of the eligible storage formation, showing all wells, relevant infrastructure and petroleum fields (including depleted fields).

c) A relevant stratigraphic column.

d) Well logs and stratigraphic correlations.

e) Hydrogeology, as it relates to the containment of GHG substances and potential displacement of formation fluid.

## Structural framework

f) Two-way time and depth structure maps of all key reservoir and seal horizons, including wells and faults, with the location of any seismic lines and cross-sections used annotated. Detail of the velocity model(s) used for depth conversion.

g) Maps and cross-sections showing all known material geological faults within and around the storage formation.

h) Fault juxtaposition relationship across major geological faults in and around the storage formation.

## Well information

i) Detailed well schematics that include information that identifies the position within the storage formation, particularly of any identified high-risk wells, to support discussion of the risks.

j) Well data (well performance and well testing) in the area. Estimated or observed reservoir injectivity (for example, field test, calculation, simulation).

k) Results of special core analysis including $CO_2$ displacement, geomechanical and reactivity with the GHG substance, as available.

### Static and dynamic model

l) Map of the eligible storage formation extent, incorporating all scenarios where the expected plume migration pathway has been estimated to have a greater than 10 per cent probability of occurring.

m) Maps and cross-sections in an appropriate format that provide an accurate representation of the distribution of porosity, permeability (including fault permeability), water saturation, residual hydrocarbon saturation (if applicable), salinity and any other relevant parameters used in plume migration modelling, including cross-sections through potential spill and/or leakage points.

n) Maps of plume migration from the model at several time steps: from the start of injection, through the injection period, injection cessation and post-injection. These maps should be able to demonstrate the anticipated time the GHG substance has effectively stabilised in the subsurface.

o) Pressure changes (both graphs and maps) in response to the injected greenhouse gas substance should be for a number of time steps from the start of injection, through the injection period, injection cessation and should provide pressure distribution at reservoir datum from the dynamic modelling.

p) Figures, as required, representing any other parameter of change that has a significant impact on the suitability of the declared identified GHG storage formation (for example, a series of time step cross-sections at a well showing estimates of temperature changes in the storage formation).

q) Trapping mechanisms considered in the simulation (for example, capillary, solubility, mineral trapping), along with a technical justification for the values used.

r) A summary report for static and dynamic modelling which includes how the models were constructed, assumptions made and how these have been used to demonstrate the requirements of the regulations.

**Note:** Whilst the input models and simulation result themselves are not submitted, the applicant is expected to retain of all the simulation cases with results referred to in the application in case the Minister requires further information or analysis.

Government of Western Australia

**Department of Mines, Petroleum and Exploration**

8.30am – 4.30pm

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