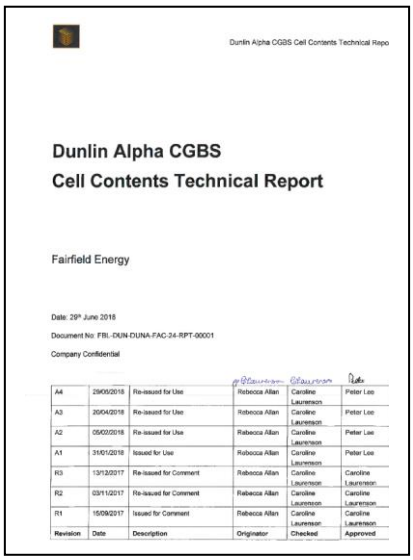
Dunlin Alpha - Cell Contents

Fairfield's proposed management option for the CGBS storage cell contents is to leave the cell contents in situ with no further recovery or remediation.

1. What are cell contents?


Dunlin Alpha CGBS Cell Contents Technical Repo

Dunlin Alpha CGBS
Cell Contents Technical Report

Fairfield Energy

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The majority of material present in the Dunlin Alpha Concrete Gravity Base (CGBS) storage cells will have originated from the reservoir, brought in as components of the produced fluids. These components can be broadly characterised as residual hydrocarbons (gas, oil and wax), sediments (sand and clay) and scale (created by the mixing of water from the reservoir and seawater). Other materials associated with these components include organic and inorganic compounds, metals and naturally occurring radioactive material.

The internal volume of the storage cells is in the region of 237,000 m^3, of which approximately 96.0% (by volume) is water (the majority of which is mobile, with a small proportion held up in the gaps between the sediment particles), 2.9vol% is free gas (a mixture of light end hydrocarbons, carbon dioxide and hydrogen sulphide), 0.8vol% is hydrocarbons (present as a very thin mobile oil layer and as wax adhered to the walls and within the sediments on the floors) and 0.2vol% is solid material (consisting of sand, clay and scale within the floor sediment layers).

The *Cell Contents Technical Report* - Sections 1 and 2 contains further details regarding the production history and current inventory of the CGBS storage cells.

2. What is Attic Oil and what was the Attic Oil Recovery Project (AORP)?

The pipework used to export oil from the Dunlin Alpha storage cells is positioned below the top of the ceiling of the cells. As a result, there was an inaccessible volume of oil above this pipework which could not be extracted by the existing platform pumps. The term "attic oil" is used to describe the oil sitting in the upper 'attic' spaces of the cell compartments.

In 2007, an Attic Oil Recovery Project (AORP) was successfully undertaken to recover the attic oil remaining in the cells. The project was able to use Carbon Dioxide (CO_2) gas to push the oil down and make it accessible via the pipework. Pumping was performed by a new set of temporary pumps that were able to draw off the oil at the low flow rates required. As a result, over 97% of the attic oil within the Dunlin Alpha storage cells has been recovered.

The *Cell Contents Technical Report* - Sections 1, 2 and 3 contains further details regarding the AORP and its efficacy.

3. What approach has been taken to quantify and characterise the residual cell contents?

An extensive review of the residual cell contents has been undertaken in order to quantify and characterise the materials currently present in the storage cells. The information used for the cell contents assessment is based on evidence gathered from operational records, analysis of historical samples, use of analogous data, and the application of proven scientific principles. The assessment process has been shared and discussed with a number of stakeholders to ensure the methodology is acceptable. A *Cell Contents Technical Report* has been compiled, detailing the body of work that has been undertaken to inform Fairfield's understanding of the cell contents and support management options. Sections 1 and 2 of the report contain further details regarding the production history and current inventory of the CGBS storage cells.

4. How much uncertainty is there regarding the cell contents? What steps are being taken to reduce this?

The *Cell Contents Technical Report* has drawn upon data and information from a wide range of sources to quantify and characterise the cell contents, and various analytical techniques and calculation methods have been used. The AORP has been a key area of investigation. To better understand the oil recovery mechanisms a dynamic model recreating the operations was produced to examine the behaviour of the chemicals and fluids.

Uncertainties associated with the base data have been assessed to ensure that the data is fit for purpose and acceptable for informing cell contents management options. Where appropriate, conservative (worst-case) assumptions have been applied to ensure the environmental impacts are not underestimated. A full description of the uncertainty analysis undertaken as part of the cell contents assessment is discussed in Section 3 of the *Cell Contents Technical Report*.

A number of survey and physical sampling options have been undertaken from the Dunlin Alpha topsides in order to validate the cell contents inventory assessment and reduce uncertainty. Despite significant technical challenges associated with restricted access, limitations of the tooling, the integrity of the system and management of the hazardous gases within the cells Fairfield has retrieved a suite of physical samples of the water and oil from the cells to analyse their composition and physical characteristics. In addition, it was possible to recover a further 97m^3 of mobile oil from within the cells. A summary of the oil recovery and investigative work undertaken is provided in the *Cell Contents Technical Report* - Section 3. The full details of these operations can be found in the Topsides Based Cell Survey Sample Activities Close-out Report. This report also includes details of the overall sampling strategy and where proposed validation scopes failed or were found to be technically not feasible and therefore not further matured.

5. What options are there for further recovery of cell contents?

The only option for completely removing the residual cell contents would require the full deconstruction and recovery of the CGBS, including full removal of the Dunlin Alpha drill cuttings pile. These activities have the potential to result in some release of contaminants to the environment and would require careful consideration in the deconstruction work to minimise impact. The comparative assessment of CGBS decommissioning options concluded that full removal of the CGBS was the least

preferred option when considered against safety, environmental, technical and economic criteria. Further details are provided in the *Dunlin Alpha Comparative Assessment Report*.

Over 70 alternative options for the long term management of the residual cell contents were initially identified as part of the Cell Contents comparative assessment. These included further cell contents recovery, in situ active bioremediation, and the use of capping material as a further barrier to the contaminants within the sediment layer. All options considered, assumed execution post removal of the platform topsides, with new external penetrations created subsea to access the cells.

The investigations into the cell contents have seen significant evidence of ongoing natural bioremediation processes. The gases present in the cells contain high concentrations of hydrogen sulphide which is a by-product of microbial digestion activity under anaerobic conditions. These processes will over time breakdown the residual hydrocarbons to gaseous products.

Assessment of the options identified that technical challenges associated with further recovery would limit the quantity of material that could be removed due to the physical restrictions of the cell compartments, the ability to adapt and upscale technology and the physical properties of the materials to be recovered. As a result, while further recovery may reduce the quantity of contents released or exposed to the environment in the future, the overall reduction in environmental impact would be indiscernible. This is largely because the inventory has already been significantly reduced through recovery of the attic oil in 2007 and there is a law of diminishing returns as the residual oil layer thins and becomes more difficult to recover. The oil within the cells is now a very thin layer, but spread over a very large area of approximately 8500m^2.

The comparative assessment of the Cell Contents management options concluded that leaving the residual cell contents *in situ* was the most preferred option when considered against safety, environmental, technical and economic criteria. Details of the Cell Contents comparative assessment are provided in Chapter 4 of the *Cell Contents Technical Report*.

6. **What are the environmental impacts of leaving the cell contents in situ**?

Fairfield is committed to ensuring that the Dunlin Alpha cell contents are decommissioned in a manner that does not result in unacceptable environmental impact. Environmental impacts associated with gradual releases (arising from long-term degradation of the CGBS) and unplanned instantaneous releases (arising from a high energy impact) have therefore been assessed to inform cell contents management decisions.

The assessments consider the key receptors that could be affected (i.e. seabed species, seabirds and habitats), the pathways for potential impact, and the magnitude of potential releases. Release modelling has been undertaken using conservative (worst-case) scenarios, and assessments have considered both short-term and long-term impacts, including whether there is potential for impact to the food chain due to bioaccumulation. For all scenarios, the environmental impacts were assessed to be not significant. *Dunlin Alpha CGBS Modelling Report* and *Dunlin Alpha Decommissioning Environmental Appraisal Report* provide full details of the environmental assessments undertaken.