Itumbula West-1
Rukwa Basin, Onshore Tanzania
Competent Persons Report

Prepared For: Helium One Ltd

By: ERC Equipoise Ltd

Date: June 2025

Sproule ERCE

Approved by:	Adam Law
Publish Date:	24 June 2025

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24 June 2025

The Directors
Helium One Global Ltd
171 Main Street
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To Whom it May Concern,

Re: Competent Person's Report – Southern Rukwa Mining Licence

In accordance with your instructions, ERC Equipoise Ltd ("Sproule ERCE") has prepared a Competent Person's Report ("CPR") for the helium Contingent Resources and Prospective Resources held by Helium One Global Ltd ("Helium One") within the Southern Rukwa Mining Licence, Rukwa Basin, onshore Tanzania (southern Rukwa ML). The resources, net and gross, stated in this report assume the southern Rukwa ML has been signed and awarded to Helium One before publication of this report.

The effective date of this report is 1 June 2025 ("Effective Date"). For the preparation of this CPR Sproule ERCE was provided with data and information by Helium One up to 14 May 2025.
Helium One has provided written representations that no new data or information has been acquired between the Effective Date and the publication date of this CPR that would materially affect the opinions expressed in this CPR.

Sproule ERCE has carried out this work in accordance with the June 2018 SPE/WPC/AAPG/SPEE/SEG/SPWLA/EAGE Petroleum Resources Management System ("PRMS") as the standard for classification and reporting. A summary of the PRMS is found in Appendix 1 of the report. The full text can be downloaded from:-

https://www.spe.org/en/industry/petroleum-resources-management-system-2018/

Nomenclature that may be used in this CPR is summarised in Appendix 2.

Use of the Report.

This CPR is produced solely for the benefit of and on the instructions of Helium One Global Ltd., and not for the benefit of any third party. Any third party to whom Helium One discloses or makes available this report shall not be entitled to rely on it or any part of it.

Helium One agrees to ensure that any publication or use of this report which makes reference to Sproule ERCE shall be published or quoted in its entirety and Helium One shall not publish or use extracts of this report or any edited or amended version of this report, without the prior written consent of Sproule ERCE. In the case that any part of this report is delivered in digital format, Sproule ERCE does not accept any responsibility for edits carried out by the client or any third party or otherwise after such material has been sent by Sproule ERCE to the client.

Disclaimer

Sproule ERCE has made every effort to ensure that the interpretations, conclusions and recommendations presented in this report are accurate and reliable in accordance with good industry practice. Sproule ERCE does not, however, guarantee the correctness of any such interpretations and shall not be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation or recommendation made by any of its officers, agents or employees.

Sproule ERCE has used standard evaluation techniques in the generation of this report. These techniques combine geophysical and geological knowledge with assessments of porosity and permeability distributions, fluid characteristics, production performance and reservoir pressure. There is uncertainty in the measurement and interpretation of basic data. Sproule ERCE has estimated the degree of this uncertainty and determined the range of recoverable helium volumes, discovered or undiscovered. In applying these procedures and tests, nothing came to the attention of Sproule ERCE that would suggest that information provided by Helium One was not complete and accurate. Sproule ERCE reserves the right to review all calculations referred to or included in this report and to revise the estimates in light of erroneous data supplied or information existing but not made available which becomes known subsequent to the preparation of this CPR.

The accuracy of any Contingent Resources or Prospective Resources is a function of the quality and quantity of available data and of engineering interpretation and judgment. While the Contingent Resources and Prospective Resources presented herein are considered reasonable, the estimates should be accepted with the understanding that reservoir performance subsequent to the date of the estimate may justify revision, either upward or downward.

In the case of Contingent Resources presented in this report, there is no certainty that it will be commercially viable to produce any portion of the resources.

In the case of undiscovered resources (Prospective Resources) presented in this report, there is no certainty that any portion of the resources will be discovered. If discovered, there is no certainty that it will be commercially viable to produce any portion of the resources.

No site visits were undertaken in the preparation of this CPR.

Professional Qualifications

Sproule ERCE is an independent consultancy specialising in geoscience evaluation, engineering and economic assessment. Sproule ERCE will receive a fee for the preparation of this report in accordance with normal professional consulting practices. This fee is not dependent on the findings of this CPR and Sproule ERCE will receive no other benefit for the preparation of this CPR.

Neither Sproule ERCE nor the Competent Person who is responsible for authoring this CPR, nor any Directors of Sproule ERCE have at the date of this report any shareholding in Helium One Global Ltd. Consequently, Sproule ERCE, the Competent Person and the Directors of Sproule ERCE consider themselves to be independent of the Helium One, its directors and senior management.

Sproule ERCE has the relevant and appropriate qualifications, experience and technical knowledge to appraise professionally and independently the assets.

The preparation of this report has been supervised by Dr Adam Law, employee of Sproule ERCE and the Competent Person. Adam is a postgraduate in Geology, a Fellow of the Geological Society and a member of the Society of Petroleum Evaluation Engineers.

Yours faithfully

Dr Adam Law

For and on behalf of, Sproule ERCE

1. Executive Summary

In 2015, Helium One was awarded a number of exploration (prospecting) licences onshore Tanzania including PL 10712, PL 10713 and PL 10727. These licences completed the second renewal period in 2022 and expired in September 2024. Following a helium discovery at ITW-1 in July 2024, Helium One completed a feasibility study and applied for a Mining Licence (ML 01132/2025). In February 2025, Helium One was offered the southern Rukwa Mining Licence (ML 0795/2025) which is 480km^2 in size and encompasses the Itumbula and Tai wells. It incorporates areas of the former PL licences. Helium One is in receipt of a "Notification of Grant of Mineral Rights", in which the government working interest in ML 0795/2025 is agreed at 17%. Helium One expects an official signing ceremony and execution of all relevant documents for ML 0795/2025 to occur before the end of June 2025. Therefore, for the purposes of this CPR, Sproule ERCE has assumed that, once completed, Helium One will receive an 83% interest in the Mining Licence and will be Operator.

The term of the licence is ten years. Precedent in country indicates that further extensions to the mining licence can be to be granted beyond this in ten year increments.

Well Itumbula West-1, drilled in January 2024 and tested in July 2024, found quantities of helium gas within aquifer waters in both the Karoo Formation and the basement rocks.

Helium One plans a phased development of the discovered helium; first with a five-well Early Production System ("EPS"), which will also serve to further appraise the area and then an expansion to a further 15-well program if the EPS proves successful.

Unlike conventional gas discoveries, the helium is accumulated, transported and stored in water aquifers and as such no specific trap is defined. It is possible that gas-water ratio and helium concentrations will decline with water production over time. However, it is impossible to estimate if and how this will occur at present.

The SPE has recently acknowledged the application of the PRMS principles for the assessment of helium resources (https://www.spe.org/en/industry/reserves/non-hydrocarbons/). Accordingly, Sproule ERCE has applied these principles to the estimation of total gas and helium Contingent and Prospective Resources.

A summary of Helium One's licence interest is summarised in Table 1-1.

Table 1-1: Helium One's Licence Interest

Country	Block	Company	Working Interest	Licence Expiry	Field(s)	Licence Area (km^2)
Tanzania	Southern Rukwa Mining Licence	Helium One Global Ltd	83%**	May 2035*	Itumbula West	480

*Mining licence award not fully completed as of date of issue but expected by end of May 2025

** Assuming government share is 17% pending regulatory framework finalisation

Contingent Resources

Contingent Resources *are those quantities of gas estimated, as of a given date, to be potentially recoverable from known accumulations, but the applied project(s) are not yet considered mature enough for commercial development due to one or more contingencies. Contingent Resources may include, for example, projects for which there are currently no viable markets, or where commercial recovery is dependent on technology under development, or where evaluation of the accumulation is insufficient to clearly assess commerciality. Contingent Resources are further categorised in accordance with the level of certainty associated with the estimates as 1C, 2C and 3C.*

Sproule ERCE has assessed Contingent Resources by developing type curves and a well schedule for the EPS and the later development, the Central Production Facility ("CPF"). Sproule ERCE has assigned Contingent Resources, sub-class Development on Hold to the EPS for the first period of the mining licence (ten years). Further production beyond this period is assigned to the sub-class Development Unclarified, as licence extension will be required to continue, on the same terms.

Sproule ERCE has attributed Contingent Resources, sub-class Development Unclarified to the CPF for its entire production stream, as it is dependent on the success of the EPS. Sproule ERCE volumes are shown in Table 1-2.

Table 1-2: Gross Helium Contingent Resources as of 31 May 2025

Contingent Resource Category	Gross Helium Contingent Resource (Mscf)			Working Interest (%)	Net Helium Contingent Resources (Mscf)		
	1C	2C	3C		1C	2C	3C
Development on Hold - EPS - Initial 10 year licence period (May 2035)	2,674	22,414	98,922	83	2,219	18,604	82,105
Development Unclarified - CPF - Initial 10 year licence period (May 2035)	6,816	56,254	248,232		5,657	46,691	206,033
Development Unclarified - EPS - Second 10 year licence period (May 2045)	2,528	24,339	110,950		2,098	20,201	92,088
Development Unclarified - CPF - Second 10 year licence period (May 2045)	7,753	73,544	332,849		6,435	61,042	276,264
Development Unclarified - EPS + CPF - After second licence period to January 2058	10,910	119,246	554,638		9,055	98,975	460,350

Notes

1. Company working interest is based on a working interest of 83 percent assuming government share of 17 percent.
2. Company net entitlement Contingent Resources require a full economic evaluation which has not been done as part of this CPR and hence are not presented.
3. There is precedent that mining licences are extended, and on the same terms unless there is a change in government legislation. However, other mining licences have been awarded for mineral extraction

rather than via aquifer production, and thus this project is unique. Given the precedence, it is expected that the licence would be renewed unless there is a change in legislation.

4. Quantifying the chance of development (COD) requires consideration of both economic contingencies and other contingencies, such as legal, regulatory, market access, political, social license, internal and external approvals and commitment to project finance and development timing. As many of these factors are out-with the knowledge of Sproule ERCE they must be used with caution.
5. Totals are added arithmetically which means statistically there is a greater than 90% chance of exceeding the Total 1C and less than a 10% chance of exceeding the Total 3C.

Prospective Resources *are those quantities of gas estimated, as of a given date, to be potentially recoverable from undiscovered accumulations by application of future development projects. Prospective Resources have both an associated chance of geologic discovery and a chance of development. Prospective Resources are further categorized in accordance with the range of uncertainty associated with recoverable estimates, assuming discovery and development. For Prospective Resources the estimates are categorised as 1U, 2U and 3U. Prospective Resources may be sub-classified as Prospects, Leads and Plays. A Prospect is a potential accumulation that is sufficiently well defined to represent a viable drilling target. A Lead is a potential accumulation that is currently poorly defined and requires more data acquisition and/or evaluation in order to be classified as a prospect. A Play is a prospective trend of potential prospects, but which requires more data acquisition and/or evaluation in order to define specific leads or prospects.*

Sproule ERCE has determined the number of wells that can be placed within the mining licence and outside the Contingent Resources development

Table 1-3: Gross Helium Prospective Resources and COS as of 31 May 2025

	Gross Helium Prospective Resources (Mscf) (Unrisked)			COS	Working Interest (%)	Net Helium Prospective Resources (Mscf) (Unrisked)		
	1U	2U	3U			1U	2U	3U
Prospective Resources	72,977	709,239	3,227,556	50%	83	60,571	588,668	2,678,872

Notes

1. COS is the chance of geological success.
2. Company working interest is based on a working interest of 88 percent assuming government share of 17 percent.
3. These resources are not risked for chance of development and there is no certainty that if they are discovered they will be developed.

2. Introduction

2.1. Data Provided

Sproule ERCE has relied upon data made available by Helium One in the preparation of this report. These include seismic data, well results, petrophysics and geochemistry reports.

Sproule ERCE has reviewed data made available to 14 May 2025 and the effective date of this report is 1 June 2025. Helium One has confirmed to Sproule ERCE that there have been no material changes with respect to the properties assessed between the effective date and the date of this report.

No site visit was undertaken in the preparation of this report.

2.2. Work Completed

Sproule ERCE has used standard evaluation techniques in the generation of this report. These techniques combine geophysical and geological knowledge with assessments of porosity and permeability distributions, fluid characteristics, production performance and reservoir pressure. There is uncertainty in the measurement and interpretation of basic data. Sproule ERCE has estimated the degree of this uncertainty and determined the range of contingent and prospective helium gas volumes. In applying these procedures and tests, nothing came to the attention of Sproule ERCE that would suggest that information provided by Helium One was not complete and accurate unless where stated in this report. Sproule ERCE reserves the right to review all calculations referred to or included in this report and to revise the estimates in light of erroneous data supplied or information existing but not made available which becomes known subsequent to the preparation of this report.

In the case of Contingent Resources presented in this report, there is no certainty that it will be commercially viable to produce any portion of the resources.

In the case of undiscovered resources (Prospective Resources) presented in this report, there is no certainty that any portion of the resources will be discovered. If discovered, there is no certainty that it will be commercially viable to produce any portion of the resources.

2.3. Summary of Results

Sproule ERCE has independently assessed the helium Contingent and Prospective Resources, plus Geological Chance of Success (COS), for the Itumbula West discovery and surrounding areas. The SPE has recently acknowledged the application of the PRMS principles for the assessment of helium resources (https://www.spe.org/en/industry/reserves/non-hydrocarbons/). Accordingly, Sproule ERCE has applied these principles to the estimation of total gas and helium Contingent and Prospective Resources.

The Itumbula West mining licence contains two main prospective reservoir intervals, the Karoo Formation and the basement. Sproule ERCE has estimated helium Contingent and

Prospective Resources for the Karoo and basement intervals. Unlike conventional gas discoveries, helium is accumulated, transported and stored in water aquifers and as such no specific trap is defined.

Table 1-2 summarises Sproule ERCE's estimates of Contingent Resources.

Table 1-3 summarises Sproule ERCE's estimates of unrisked total gas and helium Prospective Resources, both gross and net to Helium One, and the Geological Chance of Success (COS) for the prospective reservoir intervals in the Southern Rukwa Mining Licence.

3. Southern Rukwa Mining Licence – The Itumbula Discovery

3.1. Summary and Description

In 2015, Helium One was awarded a number of exploration licences onshore Tanzania; including PL 10712, PL 10713 and PL 10727. These licences completed the second renewal period in 2022 and expired in September 2024. Following a helium discovery at ITW-1 in July 2024, Helium One completed a feasibility study and applied for a Mining Licence (ML 01132/2025). In February 2025, Helium One was offered the southern Rukwa Mining Licence (ML 0795/2025) which is 480km^2 in size and encompasses the Itumbula and Tai wells. It incorporates areas of the former PL licences. Helium One is in receipt of a "Notification of Grant of Mineral Rights", in which the government working interest in ML 0795/2025 is set at 17%. Helium One expects an official signing ceremony and execution of all relevant documents for ML 0795/2025 to occur before the end of June 2025. Therefore, for the purposes of this CPR, Sproule ERCE has assumed that, once completed, Helium One will receive an 83% interest in the Mining Licence and will be Operator.

The term of the licence is ten years. Precedent in country indicates that further extensions to the mining licence can be granted beyond this in ten year increments.

Well Itumbula West-1 was drilled into a horst block some 13km southeast of Wells Tai-1/-1A and Tai-2 which were drilled by Helium One in 2021, and 15km southeast of Well Tai-3 which was drilled by Helium One in 2023. Wells Tai-1/-1A, Tai-2 and Tai-3 wells are situated in the southwestern corner of the Rukwa Rift Basin in southern Tanzania, within prospecting license PL0712 (Figure 3.1). Well Itumbula West-1 discovered concentrations of helium gas within formation waters in the Karoo Formation and basement rock.

Satellite data and surface helium seep studies show higher than background helium concentrations in the area (Danabalan et al., 2022). The Itumbula and Ivuna salt ponds contain active surface helium seeps, with measured concentrations up to 10.2% helium.

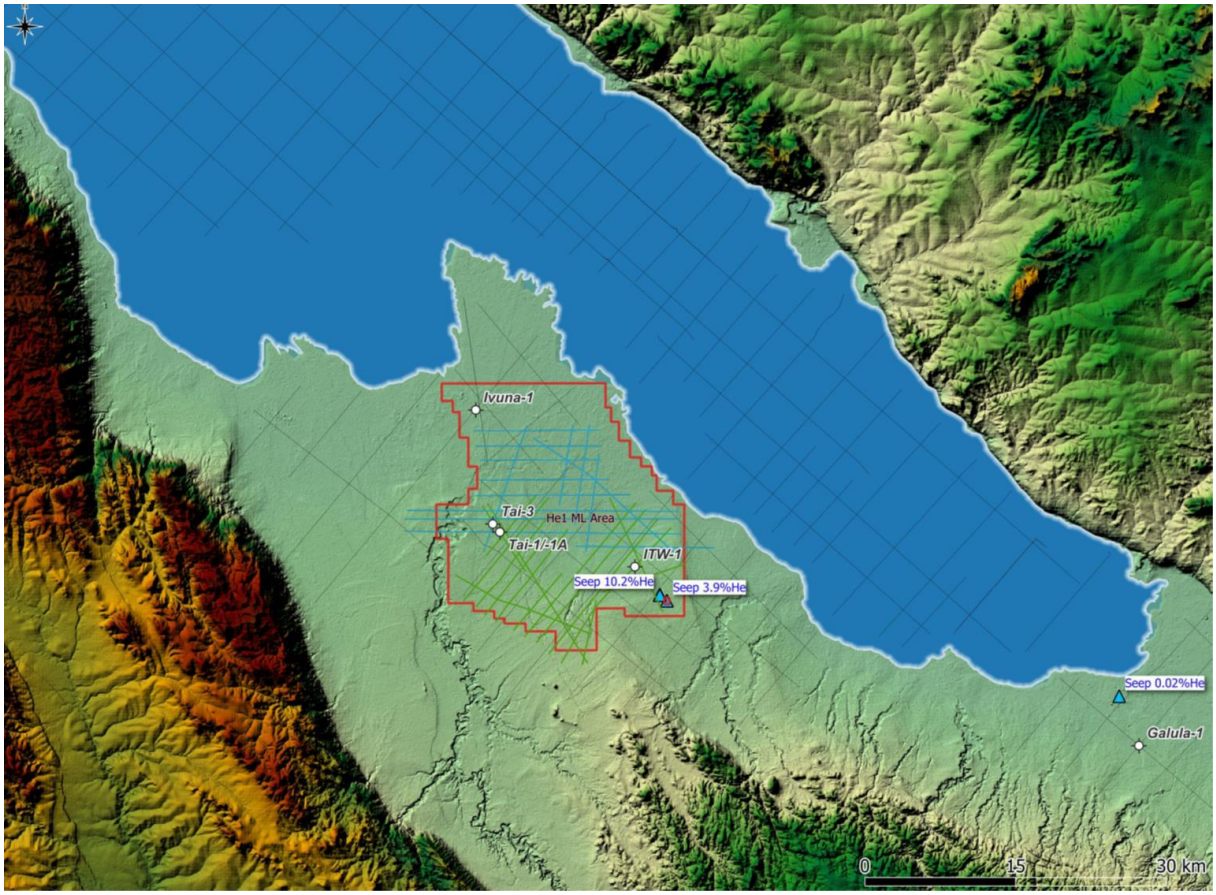

Figure 3.1: Location map with Southern Rukwa Mining Licence & Itumbula West-1 (ITW-1)

(Source: Helium One)

Table 3-1 shows the exploration activity undertaken by Helium One in the area since 2015. This includes the acquisition of airborne gravity data, the acquisition of infill 2D seismic data and the reprocessing of vintage 2D seismic data acquired by Amoco in the 1980s.

Several noble gas geochemistry sampling campaigns have occurred since 2015 and have recorded helium at surface. Wells Tai-1/-1A were drilled in 2021 within PL10712/2015. Tai-1/-1A reached a total depth of 1121 MDGL (-287 mTVDSS). Logging of Tai-1/-1A was largely unsuccessful but a QEMSCAN study was performed on the cuttings retrieved while drilling. Well Tai-3 was drilled in Q3 2023 to test for the presence of helium within the Karoo, Lake Beds and Basement and obtain gas samples from all gas bearing reservoirs. Low concentrations of helium were found in gas and fluid samples. The target reservoirs were water-bearing.

The work program after the results of Well Tai-3 drilling involved the drilling of Well Itumbula West-1 to prove the presence of helium in the Itumbula West prospect.

The geological setting for the Itumbula discovery is a fault-bounded basement horst with a thin sedimentary overburden comprising Karoo Sandstone, the Nsungwe Formation and Lake

Beds formation. Elevated helium concentrations were found in the Karoo and Basement intervals within formation water. Note, there is no structural or stratigraphic closure present, and the helium is diffuse within the aquifer. The main reservoir interval is the weathered/crystalline basement interval and is estimated to be Pre-Cambrian in age and at a depth of ~900 mMD. Karoo sandstones are Permian in age and are at a depth of ~550 mMD.

The Well Itumbula West-1 location was identified on seismic line RUK-21P1-03, acquired by Helium One in April 2021 with the aim of identifying target locations near the Itumbula West marginal fault. Well Itumbula West-1 was drilled as a vertical exploration well in PL10727 that sought to investigate the helium prospectivity of two faults, namely the Itumbula West Main Fault between the RSG and the Karoo, and the Itumbula West Upper Fault at the top of the RSG, as well as prospectivity of the Karoo Group.

Table 3-1: Licence Activity 2015 to 2022

(Source: Helium One, modified by Sproule ERCE)

Year	Activity
2015	Reprocess Amoco 2D seismic data AGG Falcon survey
2016	Soil gas surveys
2015-2022	Basin interpretation
2021-2022	Phase I & Phase II infill 2D seismic Seismic processing and interpretation Lead and prospect generation
2021	Phase 1 drilling Tai-1/1A QEMSCAN study DiRT Exploration
2022	ERT shallow geophysical survey Continued seismic interpretation Planning Phase 2 drilling
2023	Tai-3 well drilled to test the Tai prospect
2024	Itumbula West-1 well drilled to test Itumbula West prospect

The well was spudded on 6th January 2024 and reached a total depth (TD) of 961.5m MD (-121.5m TVDSS) in Pre-Cambrian basement on the 24th January 2024. Helium and hydrogen gas shows were observed in all primary and secondary target intervals. A full suite of wireline logs, including an image log were run at TD, and three open-hole drill stem tests (DST) were conducted over three separate intervals. Downhole samples were taken on each DST and the associated gases analysed at the wellsite.

There are two other wells in the southern Rukwa region, Wells Ivuna-1 and Galula-1, that were drilled in the 1980s as part of a hydrocarbon exploration campaign by Amoco. Both these wells

were dry (for hydrocarbons) and plugged and abandoned. Geophysical log data were acquired in these wells.

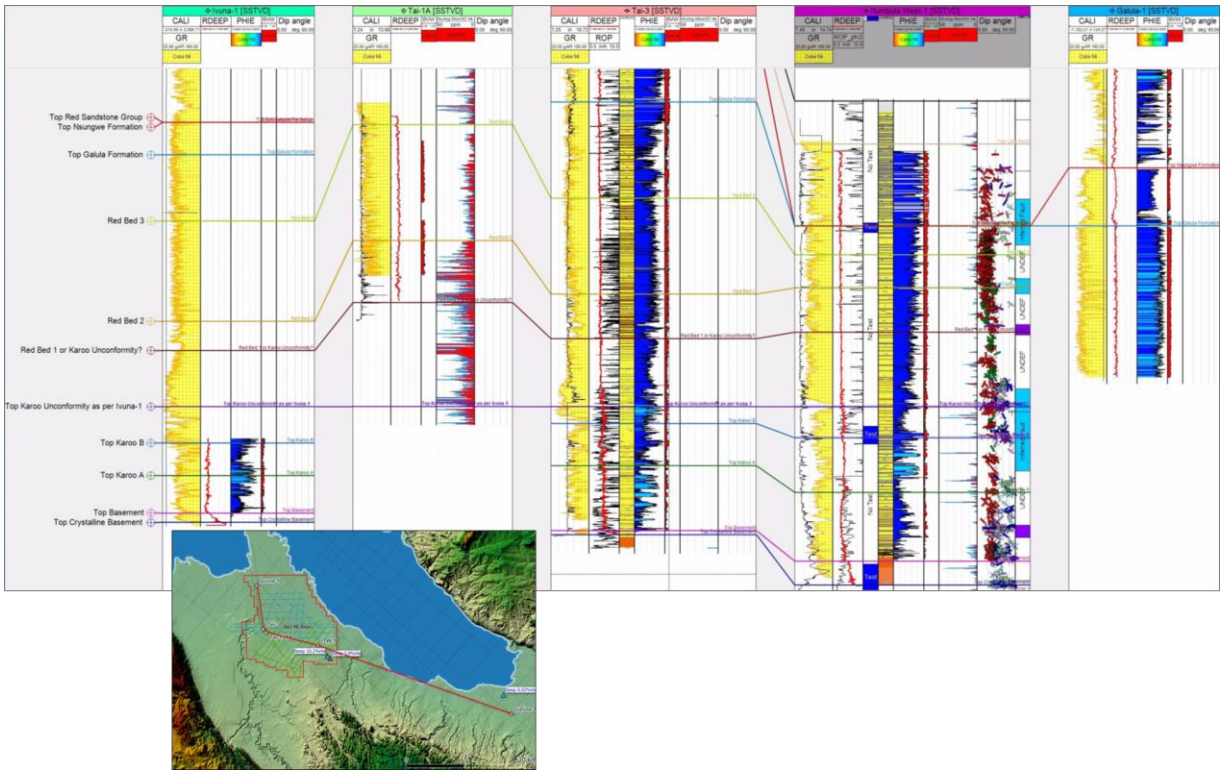

Figure 3.2: Well correlation panel

(Source: Helium One)

3.2. Reservoir, Source and Seal Characterisation

There are a number of potential reservoir rock intervals in the area, drilled by Well Tai-3: the Permian Karoo Sandstone, the Tertiary to Quaternary Lake Beds, which could contain multiple stacked reservoirs based on offset well data, the Oligocene Nsungwe Formation of the Red Sandstone Group and the Pre-Cambrian weathered basement (Figure 3.3). Two of these reservoirs, the Karoo Sandstone and the weathered basement (Basement or Basement rock) are the reservoirs to be produced within the Itumbula West-1 development and are described in more detail below.

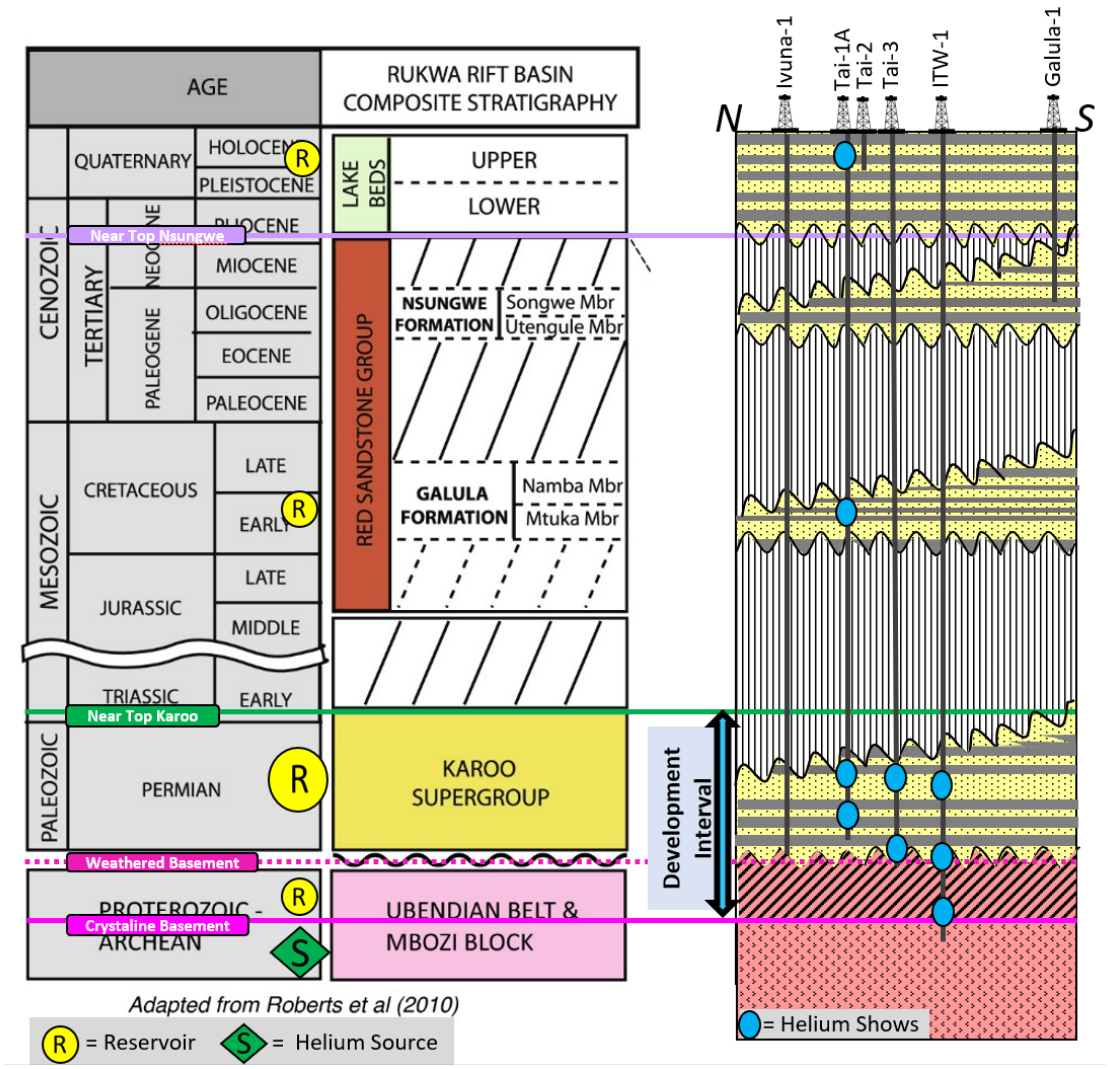

Figure 3.3: Regional Stratigraphic Column.

(Source: Helium One)

3.2.1. Karoo Sandstone Reservoir and Seal

The Karoo Sandstone within Well Ivuna-1 consists of a series of coarsening up claystones, siltsones and sandstones ranging from 2 m to 30 m in thickness over a 700 m interval. In some intervals the sands are cemented and are red to brown in colour. In Well Ivuna-1 the Karoo

has been interpreted to represent fluvial to fluvial-deltaic sandstones deposited within a floodplain environment.

In the Itumbula West-1 Well the Karoo sequence is dominated by sandstone, siltstone and shale, though shales and coal dominate in the Mid Karoo. The Tai-3 wells encoutered a series of sandstone and shales, with shales being thicker in the Mid Karoo section.

Reservoir quality in the Karoo Sandstone in the Rukwa rift is likely to vary dependent on the environment of deposition and position within the fluvial-deltaic system.

The proposed top seal for the Karoo Sandstone is formed by shales above the Top Karoo Unconformity. Regional 2D seismic data shows the seal would likely be continuous but of variable thickness.

3.2.2. Weathered Basement Reservoir and Seal

The weathered basement was a primary target for Well Itumbula West-1. The Crystalline basement rocks in this region are metamorphic rocks from the Pre-Cambrian. They have been subjected to multiple phases of tectonism that resulted in uplift and erosion. As a result, the basement rocks are typically fractured and, in many places, also weathered. Both fracturing and weathering can significantly enhance porosity and permeability of these rocks, that otherwise, have almost zero primary porosity. The most recent tectonic phase that affected and still affects the basement rocks is the East African Rift System. Normal faults with displacements of several hundred meters or higher are not uncommon. Such high-throw faults typically result in wide damage zones and therewith a high fracture intensity that can further enhance permeability. Such fracture zones are the target in helium exploration.

Well Tai-3 encountered 26m of weathered biotite gneiss before TD and reported losses throughout this section. Well Itumbula West-1 encountered 20m weathered quartzite before drilling through 41m of weathered fractured granite rocks.

3.2.3. Helium Source Rock Potential and Migration

Conventional hydrocarbon play systems can be used to characterise a helium play system, with the elements of the play system identified as source rock, reservoir, seal and migration pathway. Figure 3.4 (after Danabalan, 2017), compares the elements of petroleum systems with those of a helium system.

Stage	Petroleum System	Helium System
Source	Organic matter	U^{238}, U^{235} and Th^{232} decay in the crust produce alpha particles
Maturation	Burial and consequential heating	Time to accumulate (stable crust) vs volume of stable crust
Primary migration	Pressure driven (phase change from solid kerogen to fluid petroleum results in volume increase)	Heating to above mineral closure temperatures, fracturing of rocks and minerals, mineral dissolution
Secondary migration	Buoyancy driven	Groundwater/buoyancy driven/stripping
Accumulation in reservoir	Beneath caprock, capillary entry pressure seal	Exsolution in presence of existing gas phase beneath caprock/degassing of oversaturated groundwater/direct input into trap of a free gas phase
Trap integrity & longevity	Microseepage, capillary failure, fracture failure, tectonic destruction of trap	Microseepage, capillary failure, fracture failure, tectonic destruction of trap

Figure 3.4: Comparison of Helium and Petroleum Systems

(Source Danabalan, 2017)

Inert gases originate from a variety of sources. Radiogenic decay and primordial helium (from the Earth's formation) are the main sources of helium (Mamyrin andTolstikhin, 1984). For high concentrations of helium to be generated source rocks need to be old or especially rich in uranium and thorium, due to the rate of radioactive decay.

The play model for the area prognoses generation of helium by the radiogenic decay of uranium and thorium within Pre-Cambrian basement (specifically the metamorphic and granitic rocks of the Mbozi block and Ubendian belt). A specific thermal regime is required for the liberation of helium. In the Rukwa area of the western East African Rift, upwelling of a mantle plume is the primary cause of rifting and in the play model these thermal perturbations of the stable craton could have allowed the release of and migration of helium through the overlying sediments into the area. The released helium results in increased helium concentrations within the aquifer, with Helium One prognosing increases in helium concentration with both depth and proximity to basement penetrating faults.

Surface seep data across Tanzania are dominated by nitrogen gas (N_2 - typically 90% by volume) with helium concentrations ranging from 1 % to 10% in the Rukwa area (Ballentine and Barry, 2016). In addition, there are helium shows recorded within the gas log of Wells Tai-1/1A, Tai-3 and ITW-1.

3.3. Seismic Interpretation and Depth Conversion

Seismic interpretation has been performed by Helium One. There are multiple 2D seismic surveys (RUK-21-P1 and -P2, TVZ-13, TVZ-23, ES 2018 Repro TVZ). Seismic data quality is fair to good for the shallow overburden (comprising the sequences Lake Beds, Red Sandstone Group, Upper and Lower Karoo). However, data quality is poor for the basement and the Top Basement marker is challenging to map. Likewise, fault interpretation is more confident in the overburden but challenging at basement level. Gravity data was also used to guide the location and orientation of the main bounding faults that offset the Top Basement. Faults within the overburden are guided by deeper basement faults, hence the presence of faults in the overburden can be a guide for mapping basement faults.

The following horizons with fault polygons were mapped by Helium One:

- Near Top Nsungwe
- Near Top Karoo
- Lower Karoo (Figure 3.5)
- Near Top Basement (Figure 3.7)

Sproule ERCE has reviewed the seismic interpretation and considers it acceptable for the purposes of this report. However, due to poor data quality Sproule ERCE recognises that there is potential for alternative interpretations, particularly at the Lower Karoo and Top Basement level and their associated fault polygons. No depth conversion was carried out as the horizon and fault interpretation was done on the depth stretched seismic data.

The area shows a complex tectonic history since the Pre-Cambrian, with multiple phases of rifting, uplift and erosion. Faults were subject to reactivation associated with intense fracturing which may create a wide damage zone around the faults, that could enhance reservoir quality.

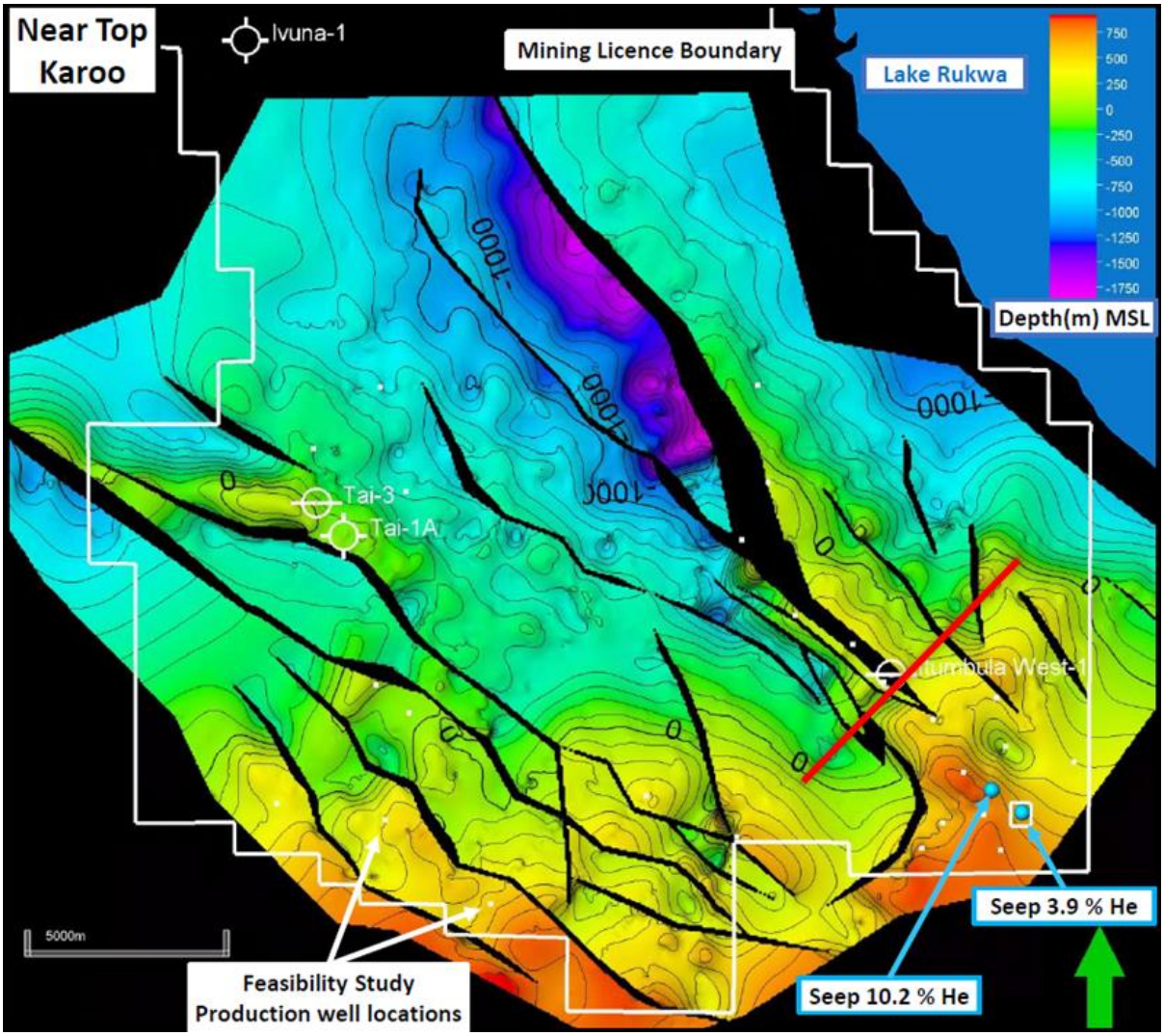

Figure 3.5: Top Karoo depth structure map

(Source: Helium One)

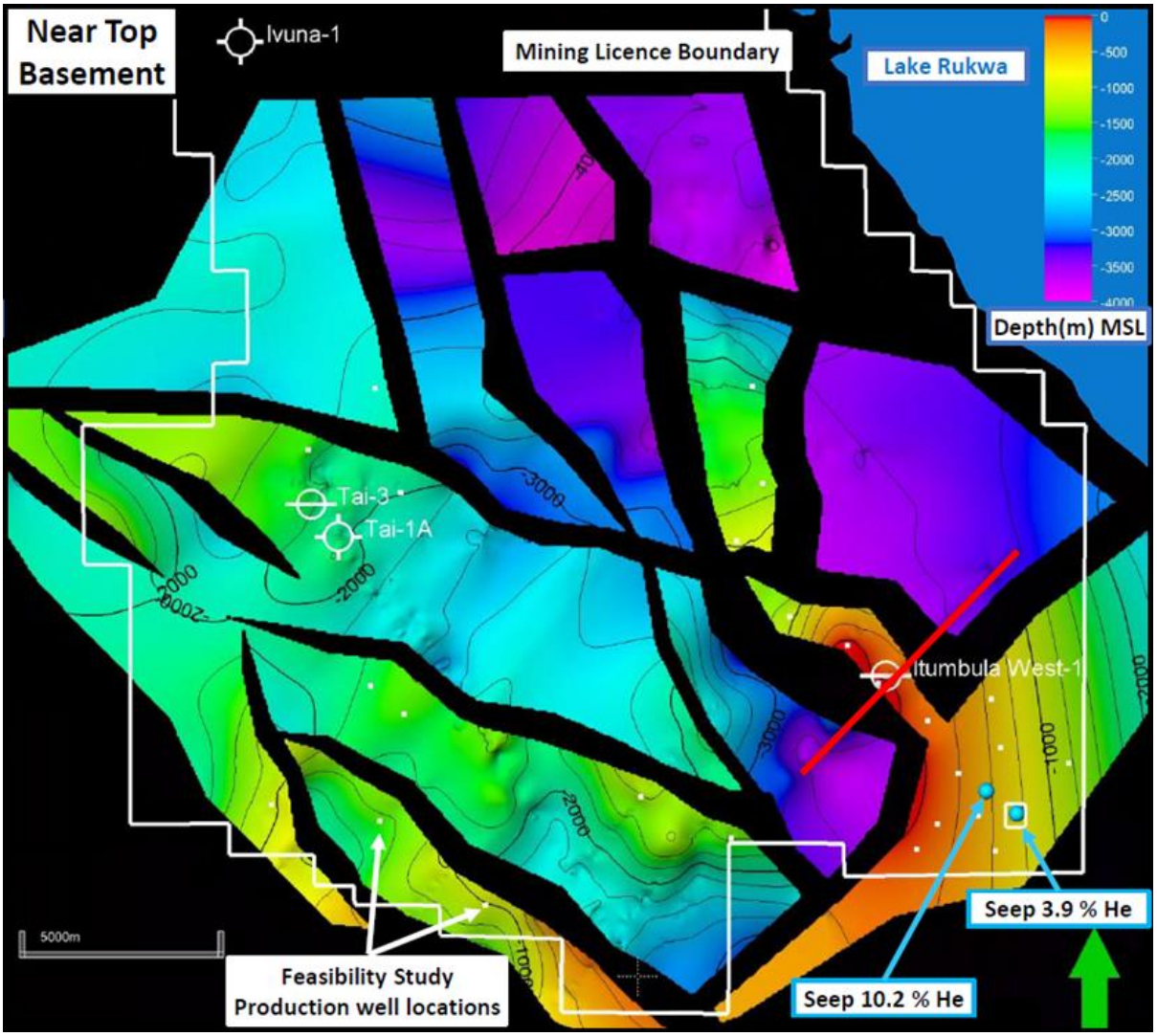

Figure 3.6: Top Basement depth structure map

(Source: Helium One)

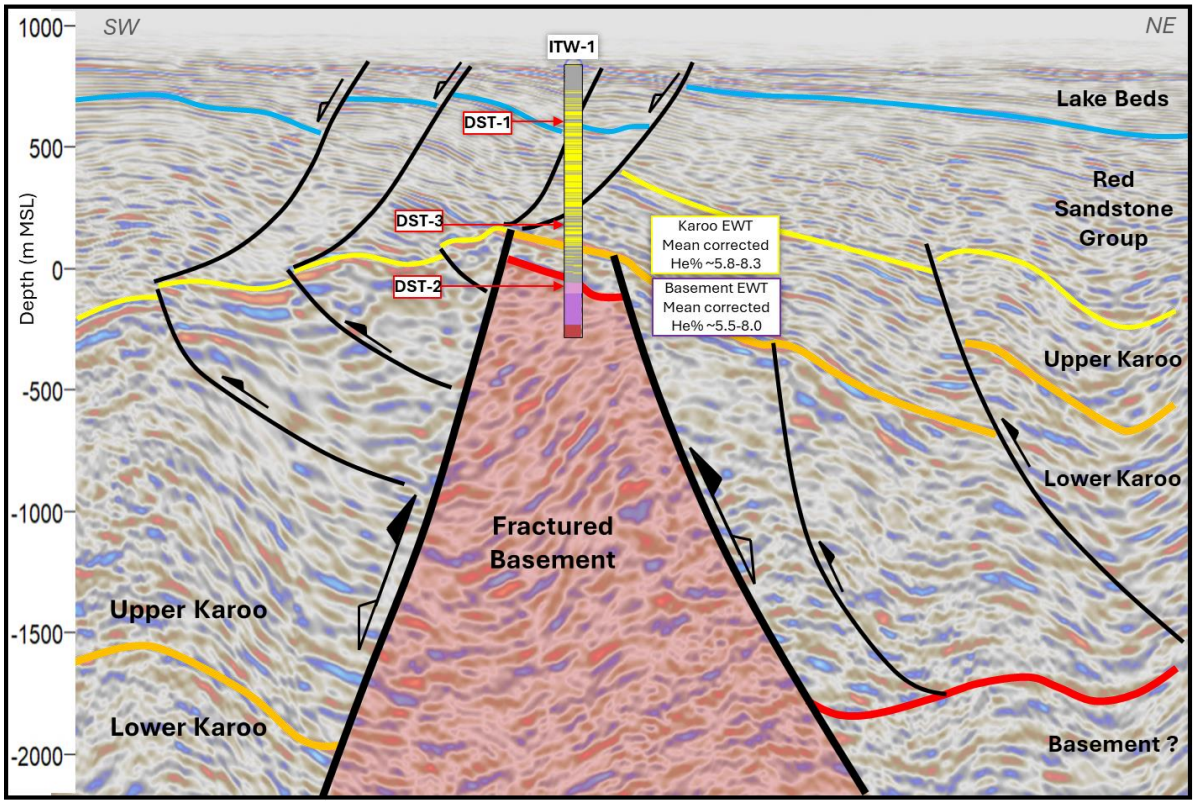

Figure 3.7: Interpreted seismic section through Itumbula-1 Well.

(For location see figure above. Modified after Helium One)

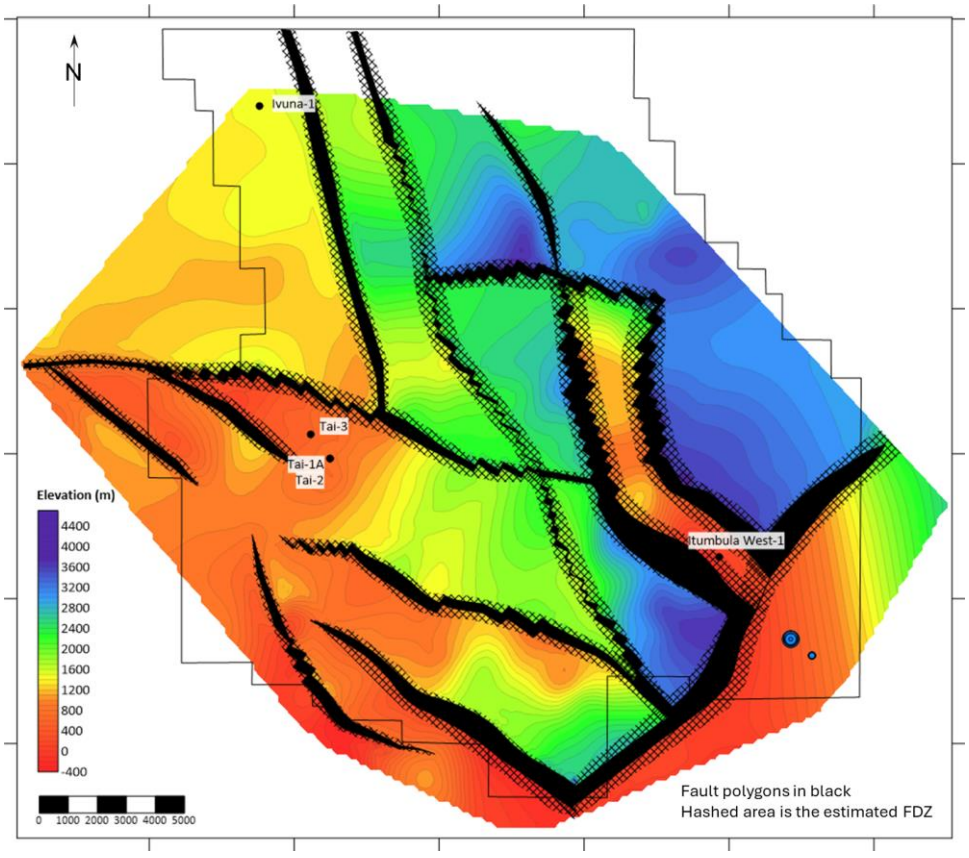

Figure 3.8: Top Basement depth structure map (based on Helium One) with Fault Damage Zones (FDZ).

3.4. Petrophysics

3.4.1. Reservoir Parameters

Two exploration wells, Well Ivuna-1 and Galula-1 were drilled in 1987 by Amoco to explore for hydrocarbons in the Rukwa basin area. In 2021 Helium One drilled an exploration Well Tai-1/-1A. The original Tai-1 wellbore was abandoned due to a lost drill pipe at 485 m. Sidetrack, Well Tai-1/-1A, was drilled to 1121 mMD but failed to reach basement due to deteriorating hole conditions. In 2024 Helium One drilled two more wells, Wells Tai-3 and Itumbula West-1.

Well Ivuna-1 was drilled to a TD of 2318m and Well Galula-1 to 1525m. No significant hydrocarbon shows were reported, and the wells were plugged and abandoned as dry. Conventional logging suites were acquired on the two wells but due to poor hole conditions only partial sections of the logs are suitable for formation evaluation.

Sproule ERCE has undertaken an independent evaluation of the geophysical logs in these wells using conventional petrophysical techniques and found the results to be in good agreement with those supplied by the Operator. Computer Processed Interpretations (CPIs) for Wells Ivuna-1 and Galua-1 are shown in Figure 3.9 and Figure 3.10 respectively.

A partial suite of geophysical logs was acquired in Well Tai-1A, but only over the interval 520-860 mMD (which covers the lower Red Sandstone Group and the Karoo shale). Below this depth hole conditions were poor, and no logs were recorded. Generally, insufficient or poor geophysical log data were acquired in Well Tai-1/1A to enable a formation evaluation to be completed over the prospective reservoir intervals of the Tai prospect.

A comprehensive suite of wireline data was acquired in Wells Tai-3 and Itumbula West-1 and the data was interpreted by Islay Petrophysics. Sproule ERCE has reviewed this interpretation. CPI plots are shown in Figure 3.11 and Figure 3.12.

Karoo

The reservoir sands of the Karoo sequence show NTG ranging from 31 to 74%. Porosities vary between 13 and 20%. Permeabilities could not be determined in most wells but analogue and mobility data for Well Itumbula West-1 indicate permeabilities around 10mD (or possibly 1 to 100mD).

Basement

The basement is a Pre-Cambrian Gneiss which is fractured and also weathered. Porosities in the gneiss are unknown due to poor or lack of log data. There was lost circulation due to fractures.

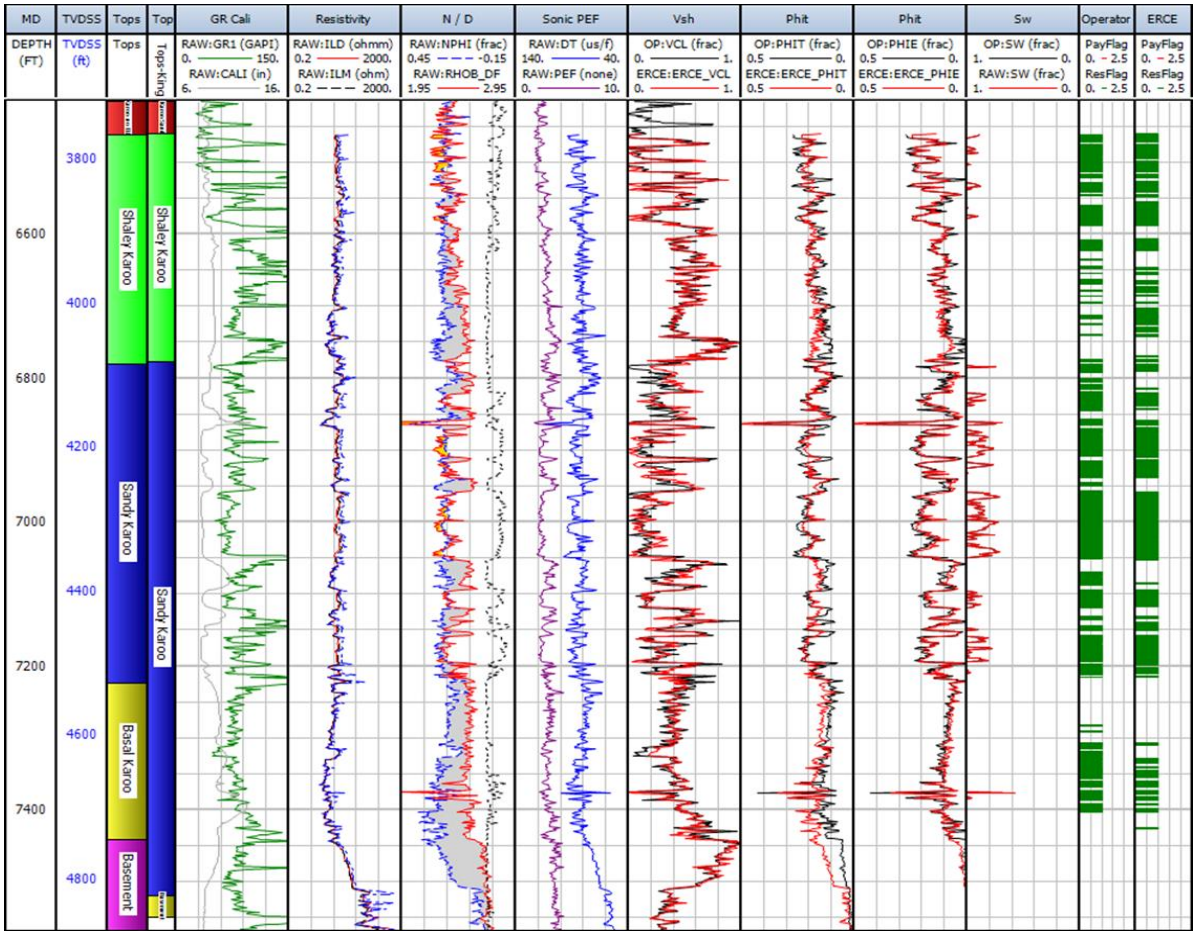

Figure 3.9 Well Ivuna-1 CPI (ERCE interpretation-red, Operator interpretation-black)

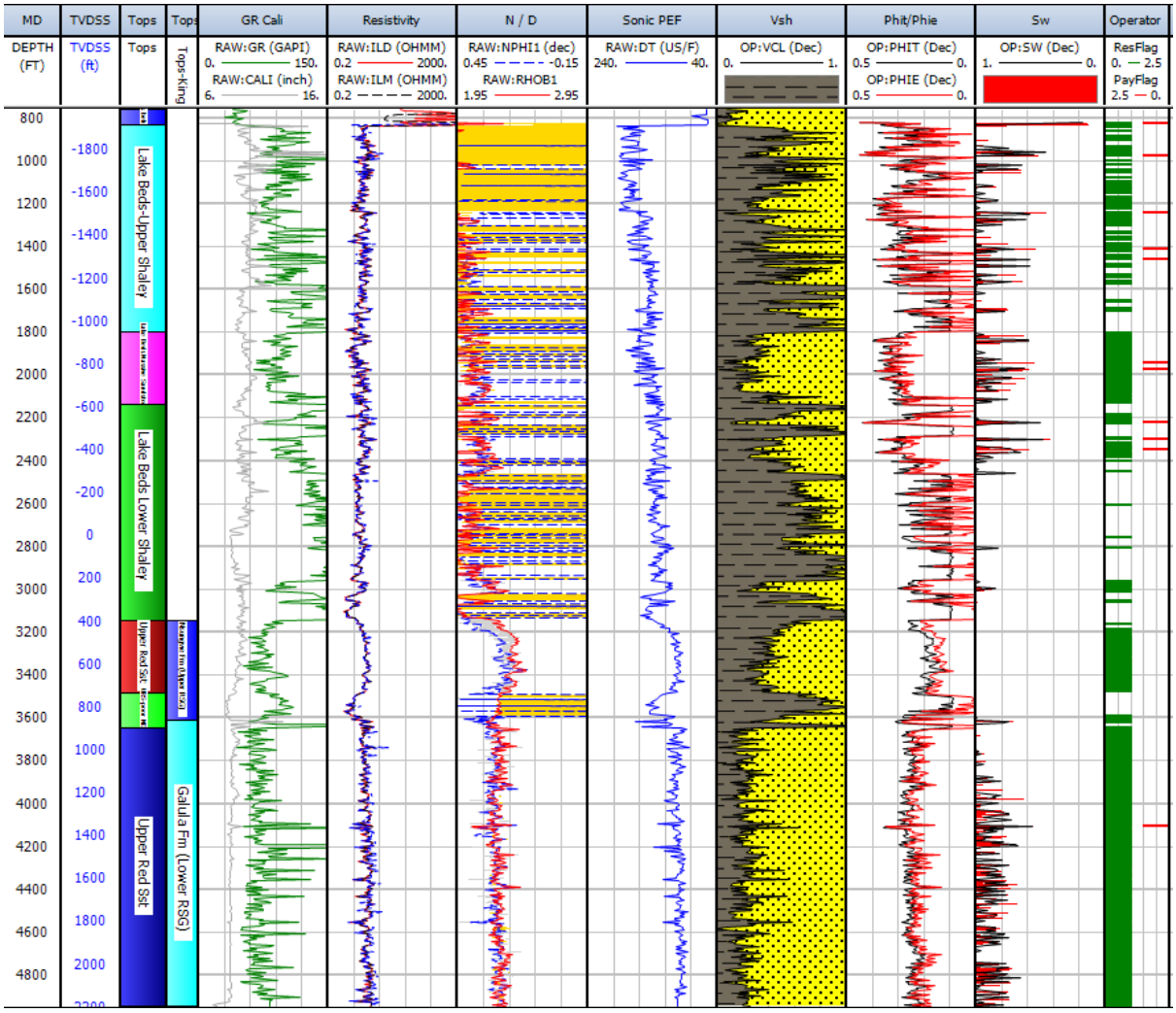

Figure 3.10: Well Galula-1 CPI

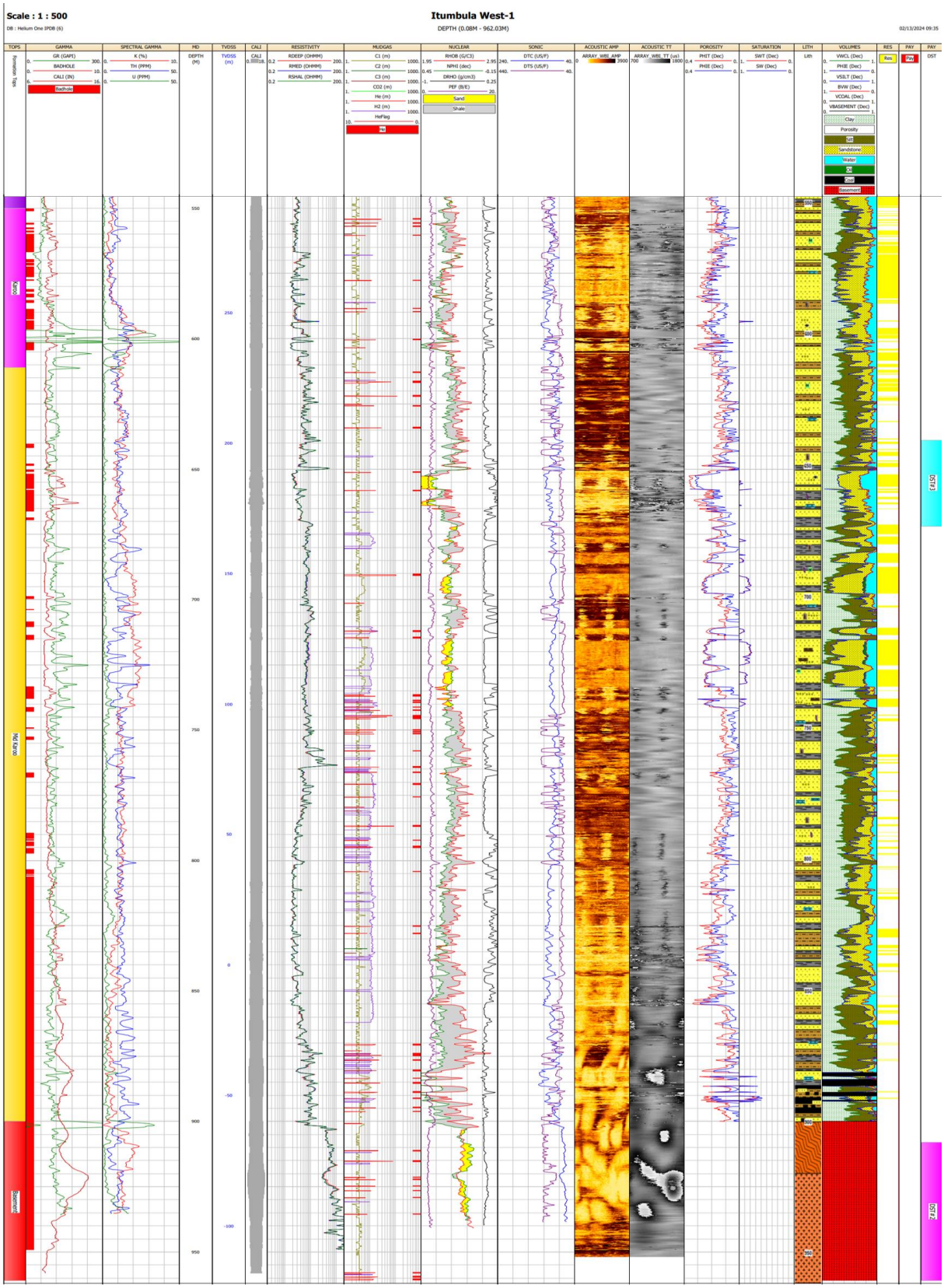

Figure 3.11: Itumbula West-1 CPI (Karoo and Basement only)

(source: Helium One)

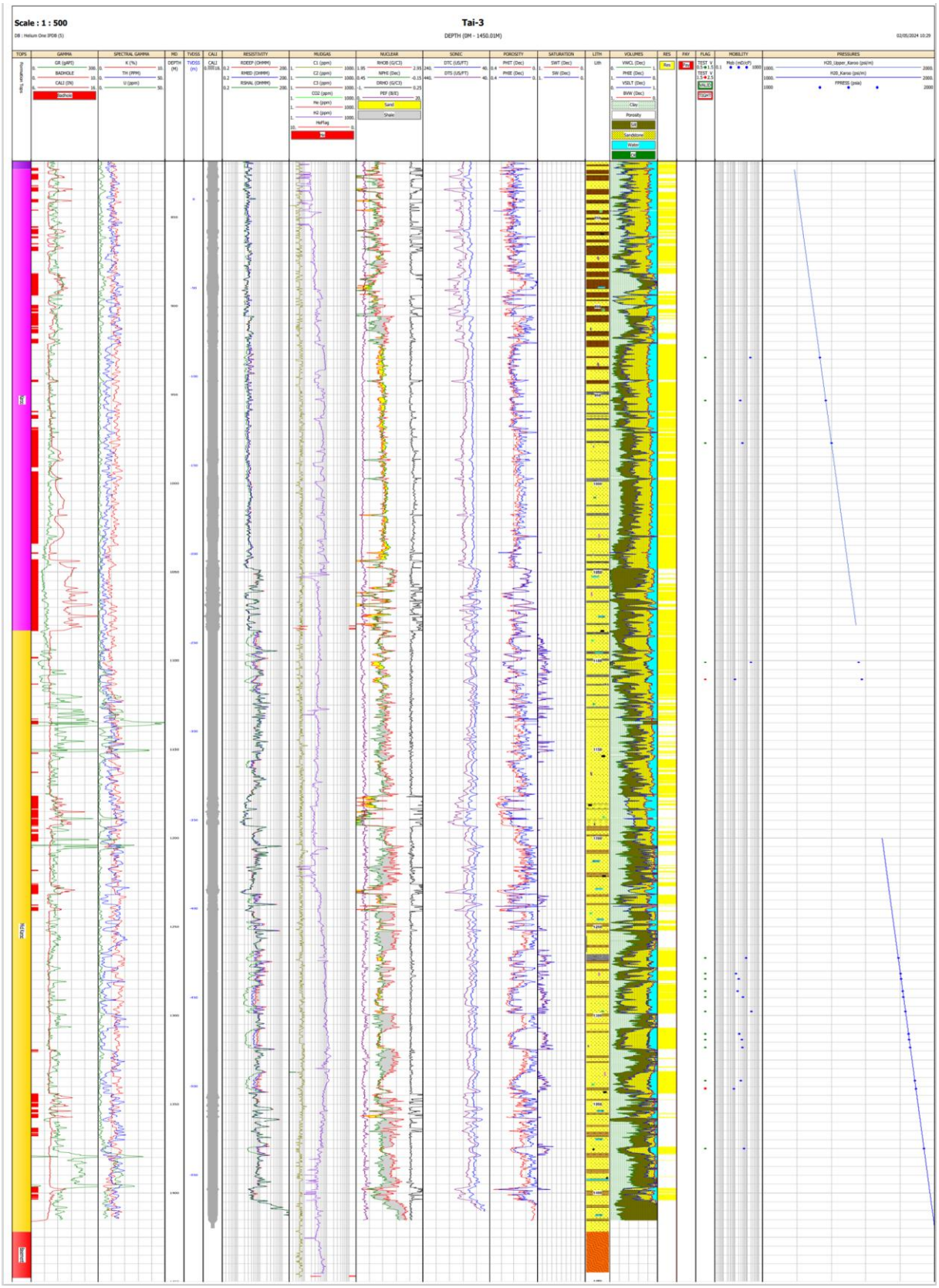

Figure 3.12: Tai-3 CPI (Karoo and Basement only)

(source: Helium One)

3.4.2. Helium Gas Indicators

Conventional gas logs and helium logs have been run throughout the drilling of the well. There are indications of concentrations of helium throughout the drilled section. Average helium concentrations for the Karoo and Basement have been measured by Helium One and reported as follow:

Karoo

Tai-1/-1A: 366 ppm (whilst drilling)

Tai-3: 8,319 ppm (water sample, uncorrected)

ITW-1: 57,377 ppm (water sample, air corrected)

Basement

Tai-3: 27 ppm (whilst drilling)

ITW-1: 50,239 ppm (water sample, air corrected)

3.5. Reservoir Engineering

Sproule ERCE has taken a well based approach to the estimation of helium resources for the Itumbula West area. Firstly, a type well is built using a series of type production curves to estimate uncertainty in water and helium production and general well performance. Then, resources are estimated on the basis of the number of wells assigned to the various phases of the development plan put forward by Helium One, cross-checking well spacing and well locations using the available maps and reservoir simulations.

There are three main uncertainties for the production of helium: liquid production rate, gas-water ratio, and helium concentration. These are discussed in the next three sections.

3.5.1. Liquid Production Rate

Helium One plans to use Electric Submersible Pumps ("ESPs") in their subsurface production wells. These pumps are designed to deliver 20,000 bbl/d of water. Helium One has used a dynamic model to model the production rate by varying subsurface properties. A large aquifer is also modelled. Sproule ERCE finds this model suitable for scenario planning, recognising the large uncertainties associated with the subsurface at present. If the wells are far enough apart, the model indicates that the liquid rate does not decrease with time—it remains constant at 20,000 bbl/d per well. Helium One models a low case at a lower initial liquid rate, 12,300 bbl/d, which decreases with time (Figure 3.13), with which Sproule ERCE agrees.

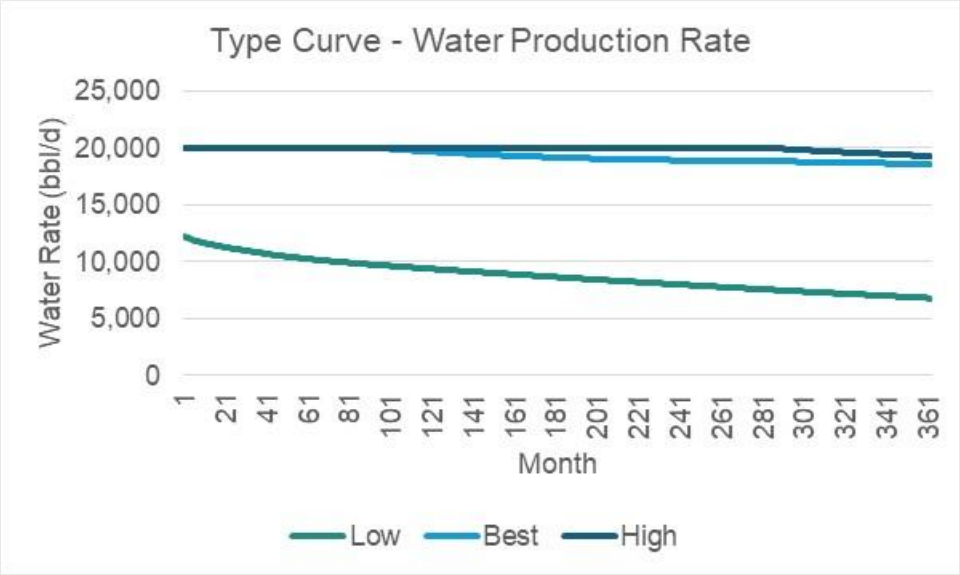

Figure 3.13: Low – best – high water production rate type curve

As there is no plan to reinject the produced liquid, reservoir pressure could fall quicker than expected and, therefore, liquid rates will decrease. If reservoir pressure fell quicker than expected, there would be a CAPEX risk for re-injection and a risk of helium concentration dilution as the re-injected depleted fluid reaches the producer wells. The EPS attempts to mitigate some of these risks before larger scale development is entered into.

It is possible that GWR and helium concentrations will decline with water production over time. However, it is impossible to estimate if and how this will occur at present, which is reflected in Sproule-ERCE's estimates of both GWR and He%.

Sproule ERCE believes the low-best-high liquid rates generated by the dynamic model are a fair range of possible outcomes and has adopted them in generating its own production profiles.

3.5.2. Gas-Water Ratio

Sproule ERCE has reviewed the available Gas-Water Ratio ("GWR") data and determined its own GWR range for forecasting. The majority of GWR data points come from samples collected in the pipeline and from separator flow rates. Sproule ERCE believes the associated data are still uncertain, with large variations in collected data points. Using cumulative probability plots, Sproule ERCE has determined a P90-P50-P10 GWR range of 0.04-0.25-0.99 sm^3/sm^3. There is an unquantifiable bias in the collection of the GWR data. This is due to the possibility of gas and water flowing separately in the pipeline when sampled, as well as gas found in the water train exiting the separator (suggesting GWR is greater than data suggests). Further appraisal is recommended to better understand the aquifer GWR.

3.5.3. Helium Concentrations

Helium concentration ("He%") is the percentage of the produced gas that is helium. Helium concentration has been measured during the well test and from seeps at the surface. Sproule ERCE has reviewed all of the available data and determined a P90-P50-P10 He% range of 3.3%-5.2%-8.3%. The He% data points collected are highly variable, and therefore, further appraisal is recommended, as with the GWR.

3.6. Development Plans and Resources Estimation

3.7. Type Curves and Technically Recoverable Resources

Sproule ERCE has generated type curves for a typical well by first determining water production forecasts, using outputs from the Helium One dynamic model. The average liquid rates from these are then probabilistically multiplied by the GWR and He% ranges (Table 3-2), as outlined in Sections 3.5.2 and 3.5.3 respectively, to determine a P90-P50-P10 ranges for a type well (Figure 3.14). Sproule ERCE then uses this type well to generate a multi-well development production profile. The resultant profile is then constrained to the facility's capacity.

Table 3-2: Sproule ERCE GWR and He% ranges

	P90	P50	P10
GWR (sm3/sm3)	0.04	0.25	0.99
He%	3.3%	5.2%	8.3%

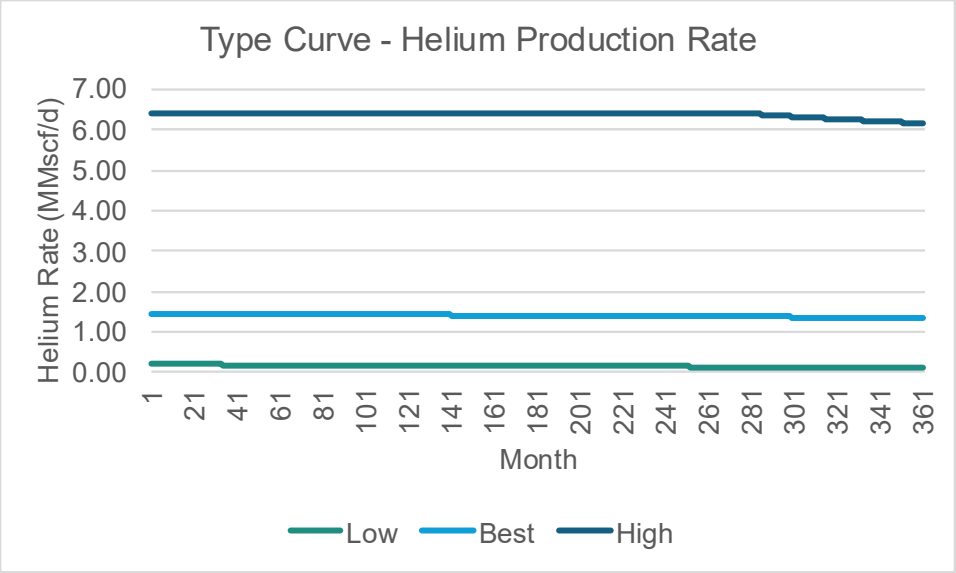

Figure 3.14: Low – best – high helium production rate type curve

3.8. Facilities

Sproule ERCE has reviewed the proposed development plans for Itumbula West. Helium One has provided development plans for a full-scale development of the concession, and also for an early production system. In this development plan, wells are located proximal to the basement faults as mapped (Figure 3.6), as Helium One prognose an increase in reservoir quality within the Basement rock close to these faults, within the fault damage zone (FDZ).

3.8.1. Early Production System

The early production system (EPS) is conceptually similar to the full development, but with lower initial capital investment. Production wells will be tied back to a central early production facility (EPF), where produced fluids will be processed into sales helium for export, and wastewater for disposal, with waste gases vented on site. The concept is shown in Figure 3.15.

Helium One has advised Sproule ERCE that FEED studies have been completed to define the production facilities, with a number of options available on sizing, capacity, and cost. Helium One has also advised that this included engagement with equipment vendors who have provided quotations and timeline for delivery. The development schedule provided by Helium One assumes start-up in Q3 2026.

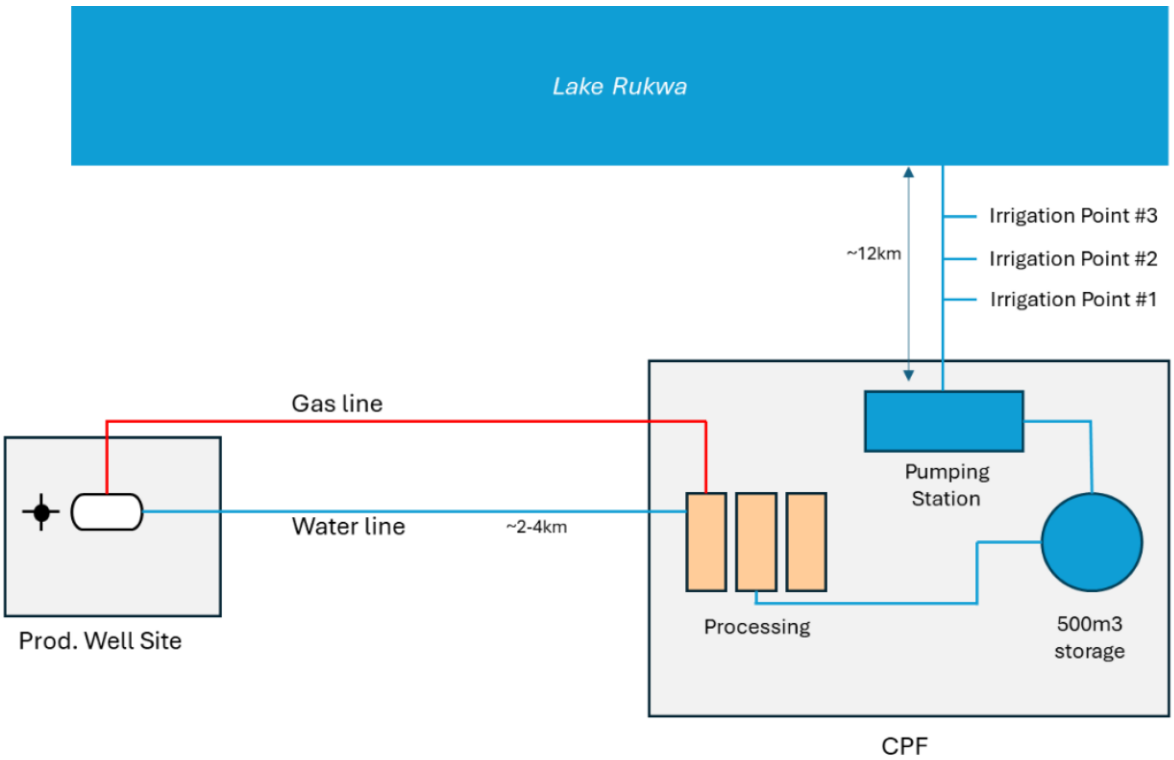

Figure 3.15: Schematic of production system layout (NB diagram shows only one wellsite, but there will be multiple)

(Source: Helium One)

Five production wells are planned for the EPS, with drilling to commence in Q4 2025. Helium One has advised that there is an onshore drilling rig ready to deploy, and that each well would require 4 to 6 weeks for sequential drilling. Sproule ERCE considers this a realistic estimate for drilling time based on onshore drilling benchmarks. On this schedule, all five wells are expected to be ready before the EPF comes online in Q3 2026.

The inlet capacity of the EPS is stated as 600 Mscf/d of inlet gas, and 100 mmbbl/d of inlet water (Figure 3.17 and Figure 3.18). Sproule ERCE understands the process flowsheet to be similar to that of the Central Production Facility (CPF) shown in Figure 3.16, but with units sized for smaller capacity. The helium product yield is also assumed to be the same, at 4.591% of inlet gas (standard volume basis).

Due to low complexity and proven nature of helium separation technology, a ramp-up period is not required (i.e. nameplate capacity is available after commissioning is complete). Sproule ERCE assumes production efficiency factor of 95%.

3.8.2. Full Development

The EPS is assumed to operate for six months before the full development project is commenced. FID for the full development is assumed to be taken at the end of December 2026, with drilling for the full development commencing in February 2027 and the full CPF coming on stream in November 2027, with inlet capacities of 1,400 Mscf/d of inlet gas and 300,000 bbl/d of inlet water (Figure 3.17 and Figure 3.18).

The production efficiency assumption of 95% is also applied to the CPF development. The original flowsheet describing the CPF process is shown in Figure 3.16. Note that the flows will be split between EPS/CPF (diagram shows full development flow rates across both).

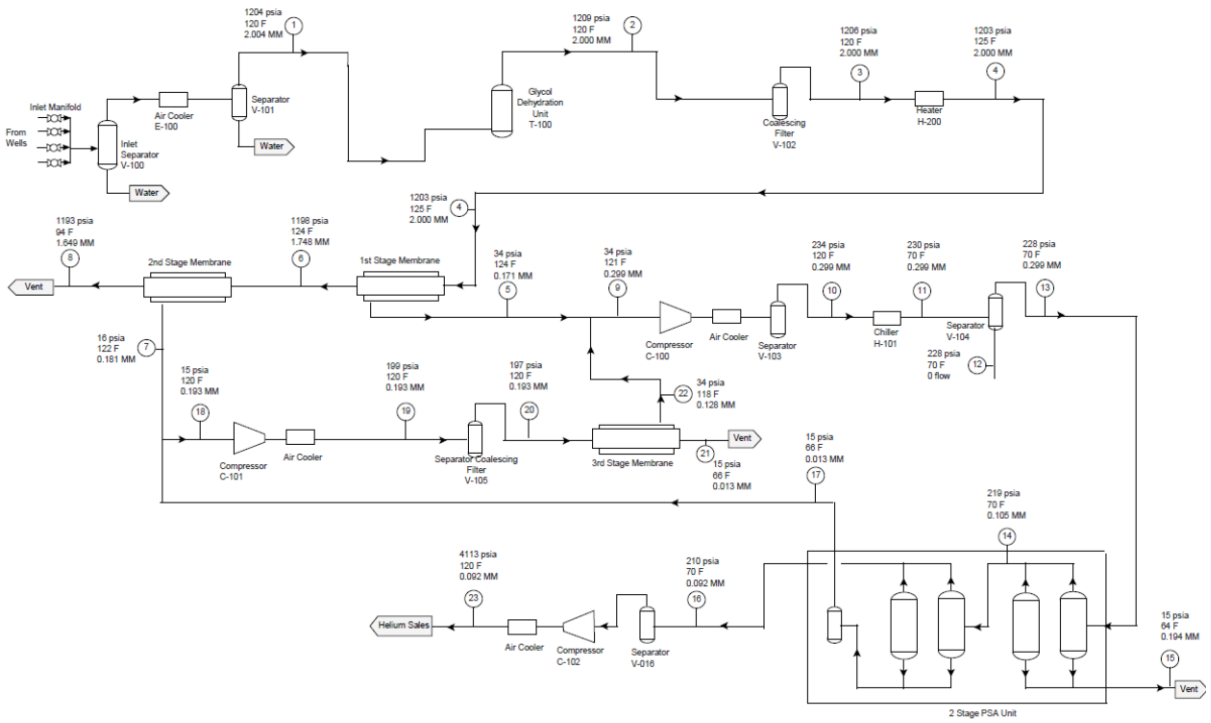

Figure 3.16: Process flowsheet for Central Production Facility (CPF)

(Source: Helium One)

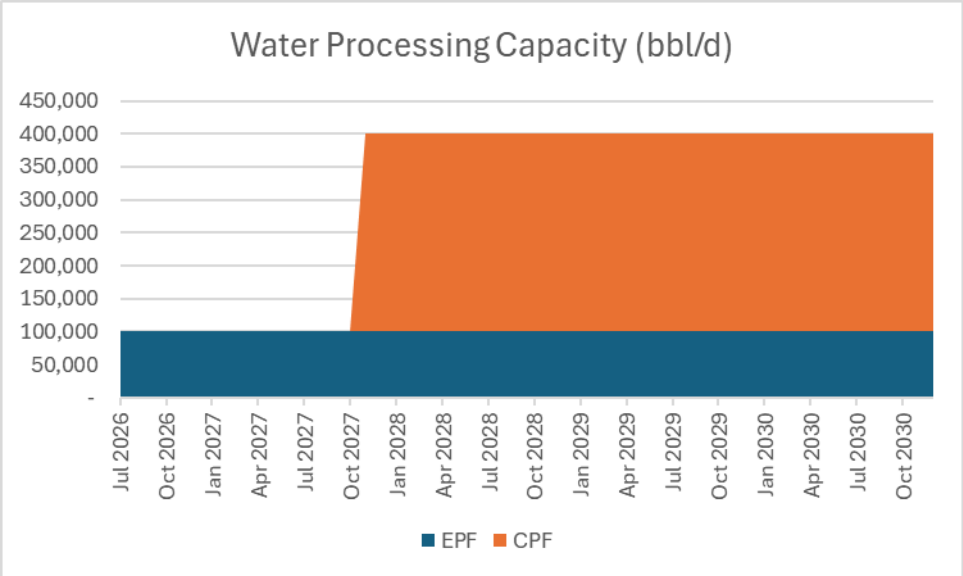

Figure 3.17 Water Processing Capacity Schedule

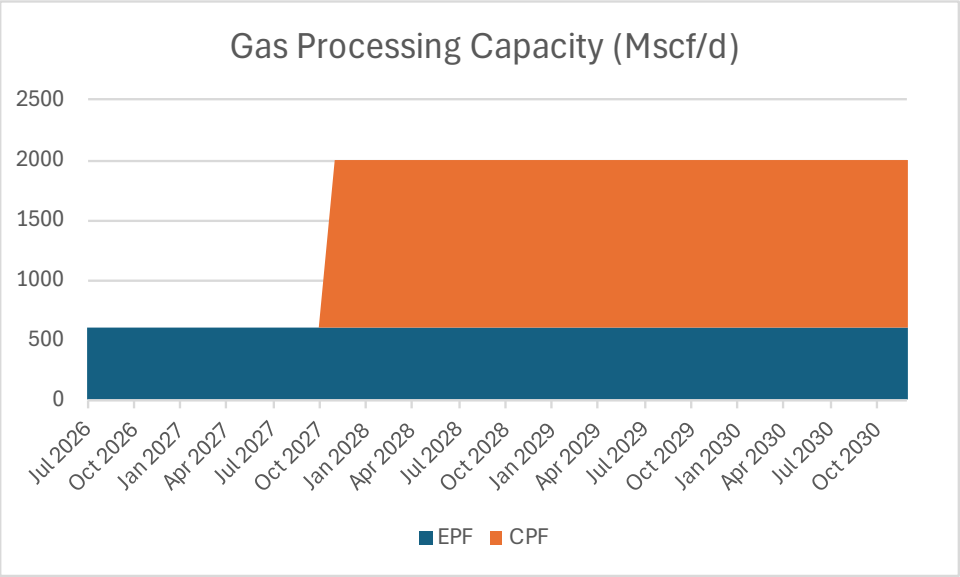

Figure 3.18 Gas Processing Capacity Schedule

4. Contingent Resources

Using the type curves described in Section 3.7 and the development schedule, Sproule ERCE has developed field-wide production profiles and uses the cumulative product of these to estimate Contingent Resources.

Well locations are still to be finalised by Helium One. For the purposes of estimating Contingent Resources, Sproule ERCE assumes wells will be targeted within the FDZ of the mapped basement faults (as per Helium One's development plan). Sproule ERCE estimates well spacing using Helium One's reservoir simulator to determine average spacing to avoid well interference and has then cross checked the well count within each phase of the Helium One development plan to ensure sufficient wells can be drilled without interference occurring (Figure 4.1).

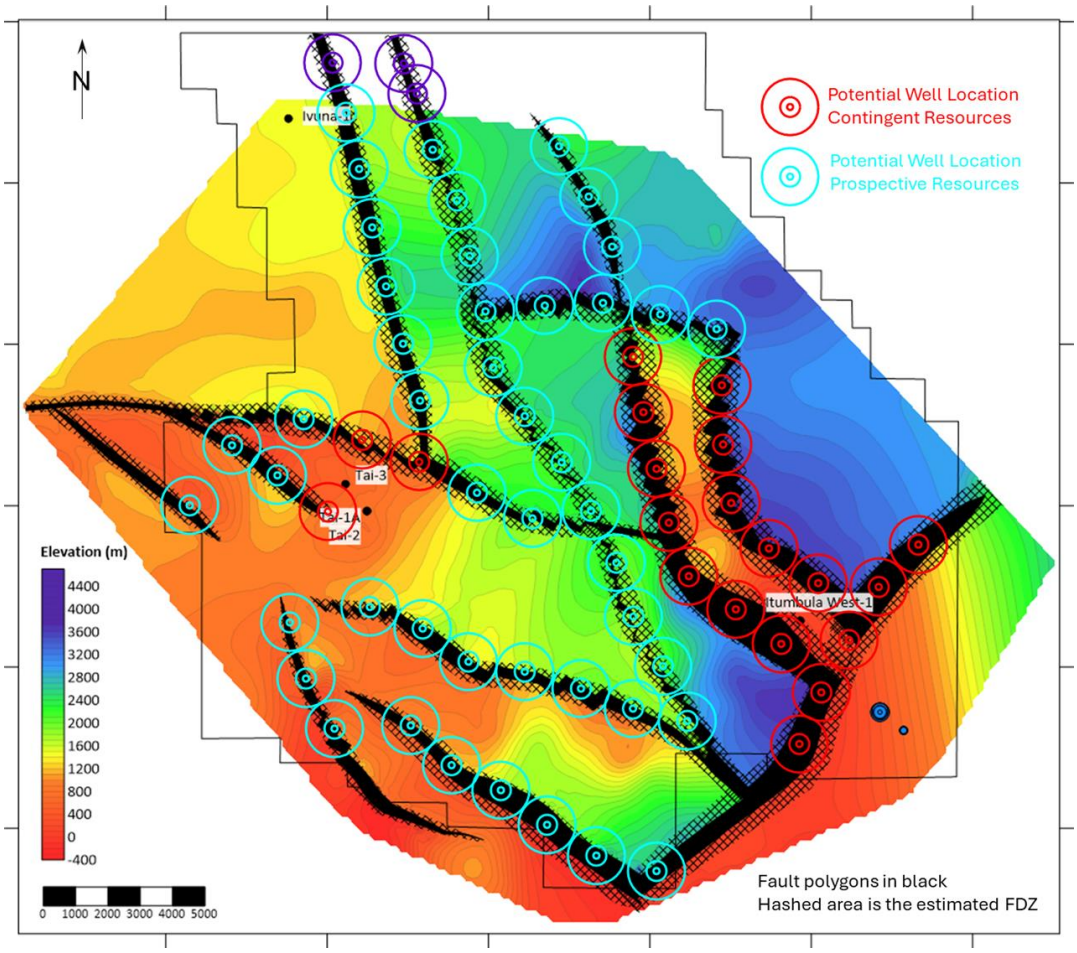

Figure 4.1: Top Basement depth map with potential well locations

Sproule ERCE has assigned Contingent Resources, sub-class Development on Hold to the EPS for production within the ten year mining licence period. Sproule ERCE has attributed Contingent Resources, sub class Development Unclarified, to the CPF for the first mining licence period, as well as to production from the EPFS and CPF outwith the ten year period of

the licence, assuming further licence extensions will be granted. A summary of the Contingent Resources estimates is shown in Table 4-1.

Table 4-1: Gross Contingent Resources

Contingent Resource Category	Gross Helium Contingent Resource (Mscf)			Working Interest (%)	Net Helium Contingent Resources (Mscf)		
	1C	2C	3C		1C	2C	3C
Development on Hold - EPS - Initial 10 year licence period (May 2035)	2,674	22,414	98,922	83	2,219	18,604	82,105
Development Unclarified - CPF - Initial 10 year licence period (May 2035)	6,816	56,254	248,232		5,657	46,691	206,033
Development Unclarified - EPS - Second 10 year licence period (May 2045)	2,528	24,339	110,950		2,098	20,201	92,088
Development Unclarified - CPF - Second 10 year licence period (May 2045)	7,753	73,544	332,849		6,435	61,042	276,264
Development Unclarified - EPS + CPF - After second licence period to January 2058	10,910	119,246	554,638		9,055	98,975	460,350

Notes

1. Company working interest is based on a working interest of 83 percent assuming government share of 17 percent.
2. Company net entitlement Contingent Resources require a full economic evaluation which has not been done as part of this CPR and hence are not presented.
3. There is precedent that mining licences are extended, and on the same terms unless there is a change in government legislation. However, other mining licences have been awarded for mineral extraction rather than via aquifer production, and thus this project is unique. Given the precedence, it is expected that the licence would be renewed unless there is a change in legislation.
4. Quantifying the chance of development (COD) requires consideration of both economic contingencies and other contingencies, such as legal, regulatory, market access, political, social license, internal and external approvals and commitment to project finance and development timing. As many of these factors are out-with the knowledge of Sproule ERCE they must be used with caution.
5. Totals are added arithmetically which means statistically there is a greater than 90% chance of exceeding the Total 1C and less than a 10% chance of exceeding the Total 3C.

5. Prospective Resources

Sproule ERCE has assigned Prospective Resources to the mapped basement fault areas (Figure 4.1) that are not currently targeted by the EPS or the CPF development. Prospective Resources are estimated in a similar method to Contingent Resources, using Sproule ERE's type well and assigning further drilling in the prospective areas. Again, well spacing is derived using Helium One's reservoir simulator as an average spacing, avoiding well interference in the model.

There are further areas of the mining licence that are not covered by seismic data at present (Figure 3.6, Figure 4.1). Sproule ERCE has not quantified Prospective Resources in these areas as they are seen as being at Lead or Play sub-class.

5.1. Risking

Sproule ERCE has evaluated the geological chance of success (COS) of the Prospective Resources and assigns a COS of 50%. The relevant risking parameters for Helium resources are source (generation and migration) and reservoir (presence and efficacy), with reservoir efficacy being the greatest risk.

Source (Presence and Migration)

The area is an active continental rift, where helium is generated by radioactive decay of rocks in the crystalline continental crust and brought to surface via deep seated faults. As helium is generated from the basement, it is assumed that any fault that offsets the basement has access to a helium source. As all mapped faults have a large displacement of several hundred meters to a few kilometres, the faults are likely to tap directly into Helium-generating rocks, with direct migration pathways towards the overburden. However, there is a risk that this has not occurred and thus there is a risk to helium migration. The source is present in the basement and generating and thus presence risk is low.

Reservoir (Presence and Efficacy)

The Karoo Formation and basement are mappable throughout the licence area. However, little is understood about reservoir efficacy away from the current well stock, particularly in the basement, which likely requires fault damage to generate reservoir quality. Thus, there is risk to reservoir efficacy away from the current drilled area.

5.2. Prospective Resources

Sproule ERCE's estimates of helium Prospective Resources and COS are presented in Table 5-1 below. Note that there is uncertainty around the rate of helium concentration depletion through time and this is reflected in the large Prospective Resources range.

Table 5-1: Helium Prospective Resources

	Gross Helium Prospective Resources (Mscf) (Unrisked)			COS	Working Interest (%)	Net Helium Prospective Resources (Mscf) (Unrisked)		
	1U	2U	3U			1U	2U	3U
Prospective Resources	72,977	709,239	3,227,556	50%	83	60,571	588,668	2,678,872

Notes

1. COS is the chance of geological success.
2. Company working interest is based on a working interest of 83 percent assuming government share of 17 percent.
3. These resources are not risked for chance of development and there is no certainty that if they are discovered they will be developed.

Appendix 1: SPE PRMS Guidelines

This report references the SPE/WPC/AAPG/SPEE/SEG/SPWLA/EAGE Petroleum Reserves and Resources Classification System and Definitions, as revised in June 2018 (PRMS). The full text of the PRMS document can be viewed at:

https://www.spe.org/en/industry/petroleum-resources-management-system-2018/

Definitions of the key PRMS Reserves and resources classes, categories and a glossary of related terms can be found at the above address.

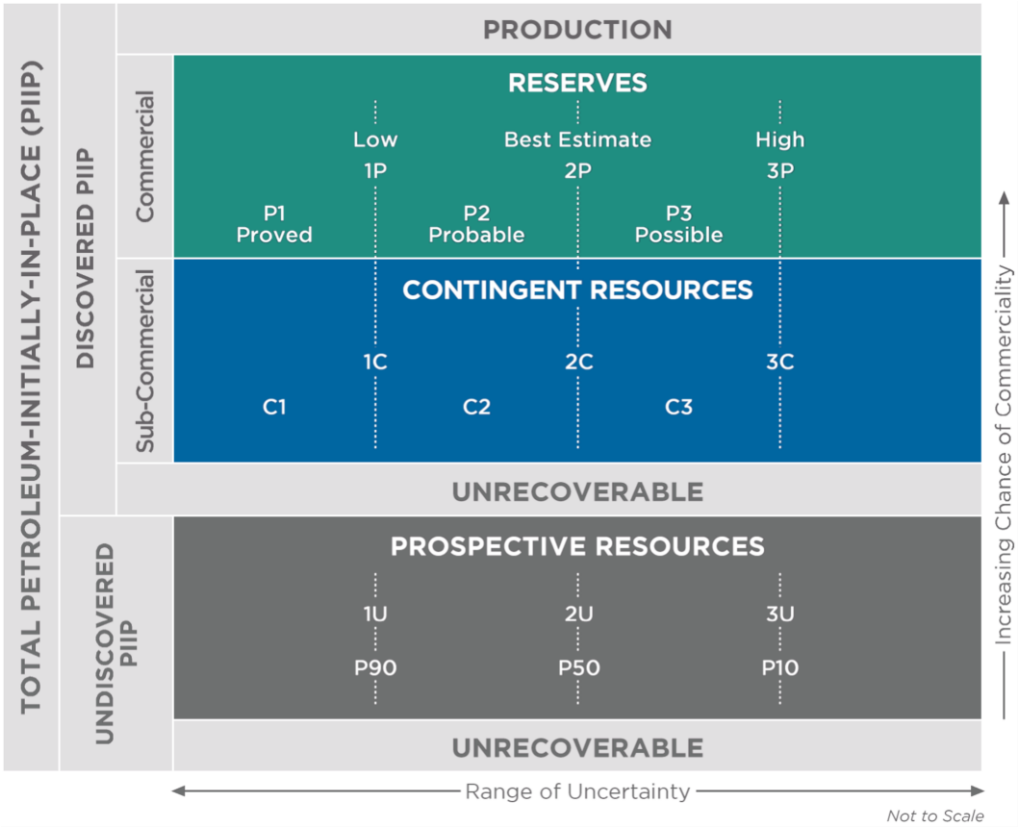

Figure A: PRMS Resources classification framework

(Modified from Petroleum Resources Management System (PRMS) Revised June 2018, page 8, Figure 1.1)

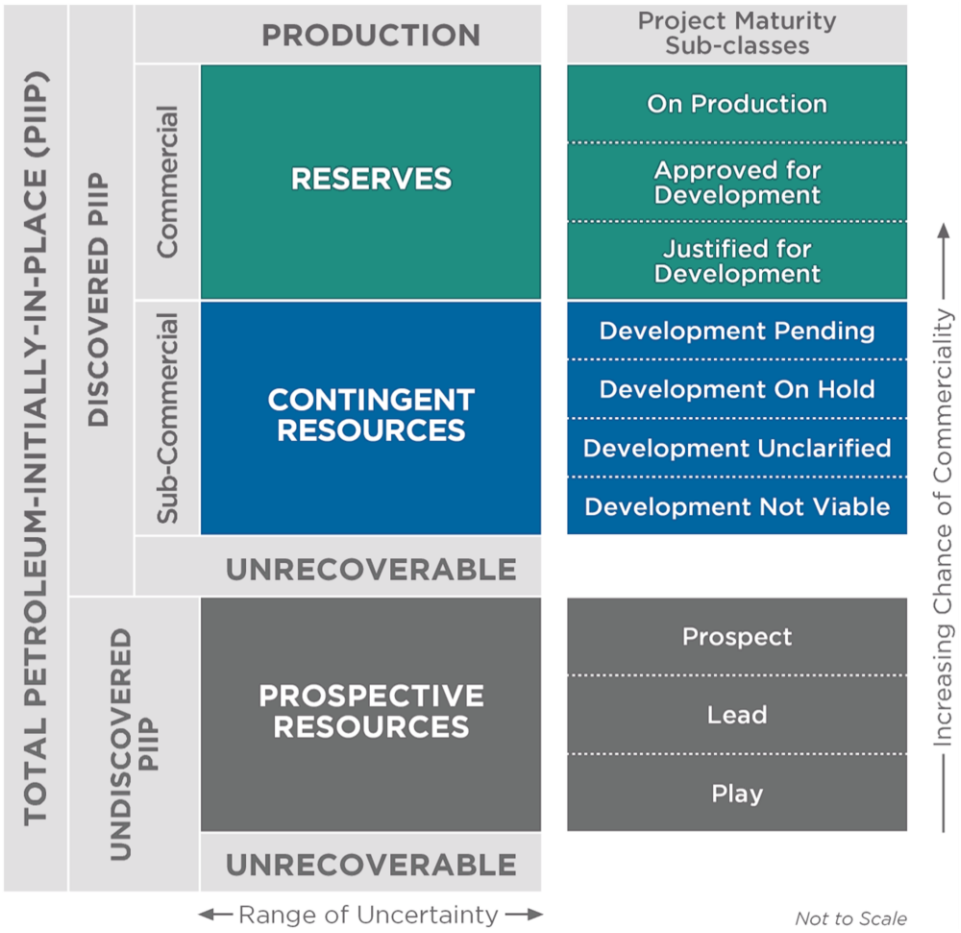

Figure B: PRMS Resources sub-classes

(Modified from Petroleum Resources Management System (PRMS) Revised June 2018, page 8, Figure 2.1)

Table 1: PRMS Recoverable Resources Classes and Sub-Classes

Classes/Sub-classes	Definition	Guidelines
Reserves	Reserves are those quantities of petroleum or other anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions.	Reserves must satisfy four criteria: discovered, recoverable, commercial, and remaining based on the development project(s) applied. Reserves are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by the development and production status. To be included in the Reserves class, a project must be sufficiently defined to establish its commercial viability (see Section 2.1.2, Determination of Commerciality). This includes the requirement that there is evidence of firm intention to proceed with development within a reasonable time-frame. A reasonable time-frame for the initiation of development depends on the specific circumstances and varies according to the scope of the project. While five years is recommended as a benchmark, a longer time-frame could be applied where, for example, development of an economic project is deferred at the option of the producer for, among other things, market- related reasons or to meet contractual or strategic objectives. In all cases, the justification for classification as Reserves should be clearly documented. To be included in the Reserves class, there must be a high confidence in the commercial maturity and economic producibility of the reservoir as supported by actual production or formation tests. In certain cases, Reserves may be assigned on the basis of well logs and/or core analysis that indicate that the subject reservoir is hydrocarbon-bearing and is analogous to reservoirs in the same area that are producing or have demonstrated the ability to produce on formation tests.

Classes/Sub-classes	Definition	Guidelines
On Production	The development project is currently producing or capable of producing and selling petroleum or other to market.	The key criterion is that the project is receiving income from sales, rather than that the approved development project is necessarily complete. Includes Developed Producing Reserves. The project decision gate is the decision to initiate or continue economic production from the project.
Approved for Development	All necessary approvals have been obtained, capital funds have been committed, and implementation of the development project is ready to begin or is under way.	At this point, it must be certain that the development project is going ahead. The project must not be subject to any contingencies, such as outstanding regulatory approvals or sales contracts. Forecast capital expenditures should be included in the reporting entity's current or following year's approved budget. The project decision gate is the decision to start investing capital in the construction of production facilities and/or drilling development wells.
Justified for Development	Implementation of the development project is justified on the basis of reasonable forecast commercial conditions at the time of reporting, and there are reasonable expectations that all necessary approvals/contracts will be obtained.	To move to this level of project maturity, and hence have Reserves associated with it, the development project must be commercially viable at the time of reporting (see Section 2.1.2, Determination of Commerciality) and the specific circumstances of the project. All participating entities have agreed and there is evidence of a committed project (firm intention to proceed with development within a reasonable time-frame}) There must be no known contingencies that could preclude the development from proceeding (see Reserves class). The project decision gate is the decision by the reporting entity and its partners, if any, that the project has reached a level of technical and commercial maturity sufficient to justify proceeding with development at that point in time.

Classes/Sub-classes	Definition	Guidelines
Contingent Resources	Those quantities of petroleum or other estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects, but which are not currently considered to be commercially recoverable owing to one or more contingencies.	Contingent Resources may include, for example, projects for which there are currently no viable markets, where commercial recovery is dependent on technology under development, where evaluation of the accumulation is insufficient to clearly assess commerciality, where the development plan is not yet approved, or where regulatory or social acceptance issues may exist. Contingent Resources are further categorized in accordance with the level of certainty associated with the estimates and may be sub- classified based on project maturity and/or characterized by the economic status.
Development Pending	A discovered accumulation where project activities are ongoing to justify commercial development in the foreseeable future.	The project is seen to have reasonable potential for eventual commercial development, to the extent that further data acquisition (e.g., drilling, seismic data) and/or evaluations are currently ongoing with a view to confirming that the project is commercially viable and providing the basis for selection of an appropriate development plan. The critical contingencies have been identified and are reasonably expected to be resolved within a reasonable time-frame. Note that disappointing appraisal/evaluation results could lead to a reclassification of the project to On Hold or Not Viable status. The project decision gate is the decision to undertake further data acquisition and/or studies designed to move the project to a level of technical and commercial maturity at which a decision can be made to proceed with development and production.

Classes/Sub-classes	Definition	Guidelines
Development on Hold	A discovered accumulation where project activities are on hold and/or where justification as a commercial development may be subject to significant delay.	The project is seen to have potential for commercial development. Development may be subject to a significant time delay. Note that a change in circumstances, such that there is no longer a probable chance that a critical contingency can be removed in the foreseeable future, could lead to a reclassification of the project to Not Viable status. The project decision gate is the decision to either proceed with additional evaluation designed to clarify the potential for eventual commercial development or to temporarily suspend or delay further activities pending resolution of external contingencies.
Development Unclarified	A discovered accumulation where project activities are under evaluation and where justification as a commercial development is unknown based on available information.	The project is seen to have potential for eventual commercial development, but further appraisal/evaluation activities are ongoing to clarify the potential for eventual commercial development. This sub-class requires active appraisal or evaluation and should not be maintained without a plan for future evaluation. The sub-class should reflect the actions required to move a project toward commercial maturity and economic production.
Development Not Viable	A discovered accumulation for which there are no current plans to develop or to acquire additional data at the time because of limited production potential.	The project is not seen to have potential for eventual commercial development at the time of reporting, but the theoretically recoverable quantities are recorded so that the potential opportunity will be recognized in the event of a major change in technology or commercial conditions. The project decision gate is the decision not to undertake further data acquisition or studies on the project for the foreseeable future.
Prospective Resources	Those quantities of petroleum or other that are estimated, as of a given date, to be potentially recoverable from undiscovered accumulations.	Potential accumulations are evaluated according to the chance of geologic discovery and, assuming a discovery, the estimated quantities that would be recoverable under defined development projects. It is recognized that the development programs will be of significantly less detail and depend more heavily on analog developments in the earlier phases of exploration.

Classes/Sub-classes	Definition	Guidelines
Prospect	A project associated with a potential accumulation that is sufficiently well defined to represent a viable drilling target.	Project activities are focused on assessing the chance of geologic discovery and, assuming discovery, the range of potential recoverable quantities under a commercial development program.
Lead	A project associated with a potential accumulation that is currently poorly defined and requires more data acquisition and/or evaluation to be classified as a Prospect.	Project activities are focused on acquiring additional data and/or undertaking further evaluation designed to confirm whether or not the Lead can be matured into a Prospect. Such evaluation includes the assessment of the chance of geological discovery and, assuming discovery, the range of potential recovery under feasible development scenarios.
Play	A project associated with a prospective trend of potential prospects, but that requires more data acquisition and/or evaluation to define specific Leads or Prospects.	Project activities are focused on acquiring additional data and/or undertaking further evaluation designed to define specific Leads or Prospects for more detailed analysis of their chance of geological discovery and, assuming discovery, the range of potential recovery under hypothetical development scenarios.

Table 2: PRMS Reserves Status Definitions and Guidelines

Status	Definition	Guidelines
Developed Reserves	Expected quantities to be recovered from existing wells and facilities.	Reserves are considered developed only after the necessary equipment has been installed, or when the costs to do so are relatively minor compared to the cost of a well. Where required facilities become unavailable, it may be necessary to reclassify Developed Reserves as Undeveloped. Developed Reserves may be further sub-classified as Producing or Non-producing.
Developed Producing Reserves	Expected quantities to be recovered from completion intervals that are open and producing at the effective date of the estimate.	Improved recovery Reserves are considered producing only after the improved recovery project is in operation.
Developed Non-Producing Reserves	Shut-in and behind-pipe Reserves.	Shut-in Reserves are expected to be recovered from (1) completion intervals that are open at the time of the estimate but which have not yet started producing, (2) wells which were shut-in for market conditions or pipeline connections, or (3) wells not capable of production for mechanical reasons. Behind-pipe Reserves are expected to be recovered from zones in existing wells that will require additional completion work or future re-completion before start of production with minor cost to access these reserves. In all cases, production can be initiated or restored with relatively low expenditure compared to the cost of drilling a new well.
Undeveloped Reserves	Quantities expected to be recovered through future significant investments.	Undeveloped Reserves are to be produced (1) from new wells on undrilled acreage in known accumulations, (2) from deepening existing wells to a different (but known) reservoir, (3) from infill wells that will increase recovery, or (4) where a relatively large expenditure (e.g., when compared to the cost of drilling a new well) is required to (a) recomplete an existing well or (b) install production or transportation facilities for primary or improved recovery projects.

Table 3: PRMS Reserves Category Definitions and Guidelines

Category	Definition	Guidelines
Proved Reserves	Those quantities of petroleum or other that, by analysis of geoscience and engineering data, can be estimated with reasonable certainty to be commercially recoverable from a given date forward from known reservoirs and under defined economic conditions, operating methods, and government regulations.	If deterministic methods are used, the term "reasonable certainty" is intended to express a high degree of confidence that the quantities will be recovered. If probabilistic methods are used, there should be at least a 90% probability (P90) that the quantities actually recovered will equal or exceed the estimate. The area of the reservoir considered as Proved includes (1) the area delineated by drilling and defined by fluid contacts, if any, and 2) adjacent undrilled portions of the reservoir that can reasonably be judged as continuous with it and commercially productive on the basis of available geoscience and engineering data. In the absence of data on fluid contacts, Proved quantities in a reservoir are limited by the LKH as seen in a well penetration unless otherwise indicated by definitive geoscience, engineering, or performance data. Such definitive information may include pressure gradient analysis and seismic indicators. Seismic data alone may not be sufficient to define fluid contacts for Proved. Reserves in undeveloped locations may be classified as Proved provided that: A. The locations are in undrilled areas of the reservoir that can be judged with reasonable certainty to be commercially mature and economically productive. B. Interpretations of available geoscience and engineering data indicate with reasonable certainty that the objective formation is laterally continuous with drilled Proved locations. For Proved Reserves, the recovery efficiency applied to these reservoirs should be defined based on a range of possibilities supported by analogs and sound engineering judgment considering the characteristics of the Proved area and the applied development program.
Probable Reserves	Those additional Reserves that analysis of geoscience and engineering data indicates are less likely to be recovered than Proved Reserves but more certain to be recovered than Possible Reserves.	It is equally likely that actual remaining quantities recovered will be greater than or less than the sum of the estimated Proved plus Probable Reserves (2P). In this context, when probabilistic methods are used, there should be at least a 50% probability that the actual quantities recovered will equal or exceed the 2P estimate. Probable Reserves may be assigned to areas of a reservoir adjacent to Proved where data control or interpretations of available data are less certain. The interpreted reservoir continuity may not meet the reasonable certainty criteria. Probable estimates also include incremental recoveries associated with project recovery efficiencies beyond that assumed for Proved.

Possible Reserves	Those additional reserves that analysis of geoscience and engineering data indicates are less likely to be recoverable than Probable Reserves.	The total quantities ultimately recovered from the project have a low probability to exceed the sum of Proved plus Probable plus Possible (3P), which is equivalent to the high-estimate scenario. When probabilistic methods are used, there should be at least a 10% probability (P10) that the actual quantities recovered will equal or exceed the 3P estimate. Possible Reserves may be assigned to areas of a reservoir adjacent to Probable where data control and interpretations of available data are progressively less certain. Frequently, this may be in areas where geoscience and engineering data are unable to clearly define the area and vertical reservoir limits of economic production from the reservoir by a defined, commercially mature project. Possible estimates also include incremental quantities associated with project recovery efficiencies beyond that assumed for Probable.
Probable and Possible Reserves	See above for separate criteria for Probable Reserves and Possible Reserves.	The 2P and 3P estimates may be based on reasonable alternative technical interpretations within the reservoir and/or subject project that are clearly documented, including comparisons to results in successful similar projects. In conventional accumulations, Probable and/or Possible Reserves may be assigned where geoscience and engineering data identify directly adjacent portions of a reservoir within the same accumulation that may be separated from Proved areas by minor faulting or other geological discontinuities and have not been penetrated by a wellbore but are interpreted to be in communication with the known (Proved) reservoir. Probable or Possible Reserves may be assigned to areas that are structurally higher than the Proved area. Possible (and in some cases, Probable) Reserves may be assigned to areas that are structurally lower than the adjacent Proved or 2P area. Caution should be exercised in assigning Reserves to adjacent reservoirs isolated by major, potentially sealing faults until this reservoir is penetrated and evaluated as commercially mature and economically productive. Justification for assigning Reserves in such cases should be clearly documented. Reserves should not be assigned to areas that are clearly separated from a known accumulation by non-productive reservoir (i.e., absence of reservoir, structurally low reservoir, or negative test results); such areas may contain Prospective Resources. In conventional accumulations, where drilling has defined a highest known oil elevation and there exists the potential for an associated gas cap, Proved Reserves of oil should only be assigned in the structurally higher portions of the reservoir if there is reasonable certainty that such portions are initially above bubble point pressure based on documented engineering analyses. Reservoir portions that do not meet this certainty may be assigned as Probable and Possible oil and/or gas based on reservoir fluid properties and pressure gradient interpretations.

Table 4: Glossary of Terms Used in PRMS

Term	Definition
1C	Denotes low estimate of Contingent Resources.
2C	Denotes best estimate of Contingent Resources.
3C	Denotes high estimate of Contingent Resources.
1P	Denotes low estimate of Reserves (i.e., Proved Reserves). Equal to P1.
2P	Denotes the best estimate of Reserves. The sum of Proved plus Probable Reserves.
3P	Denotes high estimate of reserves. The sum of Proved plus Probable plus Possible Reserves.
1U	Denotes the unrisked low estimate qualifying as Prospective Resources.
2U	Denotes the unrisked best estimate qualifying as Prospective Resources.
3U	Denotes the unrisked high estimate qualifying as Prospective Resources.
Abandonment, Decommissioning, and Restoration (ADR)	The process (and associated costs) of returning part or all of a project to a safe and environmentally compliant condition when operations cease. Examples include, but are not limited to, the removal of surface facilities, wellbore plugging procedures, and environmental remediation. In some instances, there may be salvage value associated with the equipment removed from the project. ADR costs are presumed to be without consideration of any salvage value, unless presented as "ADR net of salvage."
Accumulation	An individual body of naturally occurring petroleum or other fluid in a reservoir.
Aggregation	The process of summing well, reservoir, or project-level estimates of resources quantities to higher levels or combinations, such as field, country or company totals. Arithmetic summation of incremental categories may yield different results from probabilistic aggregation of distributions.
Appraisal	The phase that may follow successful exploratory drilling. Activities to further evaluate the discovery, such as seismic acquisition, geological studies, and drilling additional wells may be conducted to reduce technical uncertainties and commercial contingencies.
Approved for Development	All necessary approvals have been obtained, capital funds have been committed, and implementation of the development project is underway. A project maturity sub-class of Reserves.
Analog	Method used in resources estimation in the exploration and early development stages (including improved recovery projects) when direct measurement is limited. Based on evaluator's assessment of similarities of the analogous reservoir(s) together with the development plan.
Analogous Reservoir	Reservoirs that have similar rock properties (e.g., petrophysical, lithological, depositional, diagenetic, and structural), fluid properties (e.g., type, composition, density, and viscosity), reservoir conditions (e.g., depth, temperature, and pressure) and drive mechanisms, but are typically at a more advanced stage of development than the reservoir of interest and thus may provide insight and comparative data to assist in estimation of recoverable resources.

Assessment	See Evaluation.
Best Estimate	With respect to resources categorization, the most realistic assessment of recoverable quantities if only a single result were reported. If probabilistic methods are used, there should be at least a 50% probability (P50) that the quantities actually recovered will equal or exceed the best estimate.
C1	Denotes low estimate of Contingent Resources. C1 is equal to 1C.
C2	Denotes Contingent Resources of same technical confidence as Probable, but not commercially matured to Reserves.
C3	Denotes Contingent Resources of same technical confidence as Possible, but not commercially matured to Reserves.
Chance	Chance equals 1-risk. Generally synonymous with likelihood. (See Risk)
Chance of Commerciality	The estimated probability that the project will achieve commercial maturity to be developed. For Prospective Resources, this is the product of the chance of geologic discovery and the chance of development. For Contingent Resources and Reserves, it is equal to the chance of development.
Chance of Development	The estimated probability that a known accumulation, once discovered, will be commercially developed.
Chance of Geologic Discovery	The estimated probability that exploration activities will confirm the existence of a significant accumulation of potentially recoverable petroleum or other.
Commercial	A project is commercial when there is evidence of a firm intention to proceed with development within a reasonable time-frame. Typically, this requires that the best estimate case meet or exceed the minimum evaluation decision criteria (e.g., rate of return, investment payout time). There must be a reasonable expectation that all required internal and external approvals will be forthcoming. Also, there must be evidence of a technically mature, feasible development plan and the essential social, environmental, economic, political, legal, regulatory, decision criteria, and contractual conditions are met. .
Committed Project	Project that the entity has a firm intention to develop in a reasonable time-frame. Intent is demonstrated with funding/financial plans, but FID has not yet been declared (See also Final Investment Decision.)
Completion	Completion of a well. The process by which a well is brought to its operating status (e.g., producer, injector, or monitor well). A well deemed to be capable of producing petroleum, or used as an injector, is completed by establishing a connection between the reservoir(s) and the surface so that fluids can be produced from, or injected into, the reservoir.
Completion Interval	The specific reservoir interval(s) that is (are) open to the borehole and connected to the surface facilities for production or injection, or reservoir intervals open to the wellbore and each other for injection purposes.

Concession	A grant of access for a defined area and time period that transfers certain entitlements to produced hydrocarbons from the host country to an entity. The entity is generally responsible for exploration, development, production, and sale of hydrocarbons that may be discovered. Typically granted under a legislated fiscal system where the host country collects taxes, fees, and sometimes royalty on profits earned. (Also called a license.)
Confidence Level	A measure of the estimated reliability of a result. As used in the deterministic incremental method, the evaluator assigns a relative level of confidence (high/moderate/low) to areas/segments of an accumulation based on the information available (e.g., well control and seismic coverage). Probabilistic and statistical methods use the 90% (P90) for the high confidence (low value case), 50% (P50) for the best estimate (moderate value case), and 10% (P10) for the low (high value case) estimate to represent the chances that the actual value will equal or exceed the estimate.
Constant Case	A descriptor applied to the economic evaluation of resources estimates. Constant-case estimates are based on current economic conditions being those conditions (including costs and product prices) that are fixed at the evaluation date and held constant, with no inflation or deflation made to costs or prices throughout the remainder of the project life other than those permitted contractually.
Contingency	A condition that must be satisfied for a project in Contingent Resources to be reclassified as Reserves. Resolution of contingencies for projects in Development Pending is expected to be achieved within a reasonable time period.
Contingent Project	A project that is not yet commercial owing to one or more contingencies that have not been resolved.
Contingent Resources	Those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects, but which are not currently considered to be commercially recoverable owing to one or more contingencies.
Cost Recovery	Under a typical production-sharing agreement, the contractor is responsible for the field development and all exploration and development expenses. In return, the contractor recovers costs (investments and operating expenses) out of the production stream. The contractor normally receives an entitlement interest share in the petroleum production and is exposed to both technical and market risks.
Cumulative Production	The sum of petroleum quantities that have been produced at a given date. (See also Production). Production is measured under defined conditions to allow for the computation of both reservoir voidage and sales quantities and for the purpose of voidage also includes non-petroleum quantities.
Current Economic Conditions	Economic conditions based on relevant historical petroleum prices and associated costs averaged over a specified period. The default period is 12 months. However, in the event that a step change has occurred within the previous 12-month period, the use of a shorter period reflecting the step change must be justified and used as the basis of constant-case resources estimates and associated project cash flows.
Defined Conditions	Forecast of conditions to exist and impact the project during the time period being evaluated. Forecasts should account for issues that impact the commerciality, such as economics (e.g., hurdle rates and commodity price); operating and capital costs; and technical, marketing, sales route, legal, environmental, social, and governmental factors.

Deposit	Material laid down by a natural process. In resources evaluations, it identifies an accumulation of hydrocarbons in a reservoir. (See Accumulation.)
Deterministic Incremental Method	An assessment method based on defining discrete parts or segments of the accumulation that reflect high, moderate, and low confidence regarding the estimates of recoverable quantities under the defined development plan.
Deterministic Method	An assessment method based on discrete estimate(s) made based on available geoscience, engineering, and economic data and corresponds to a given level of certainty.
Deterministic Scenario Method	Method where the evaluator provides three deterministic estimates of the quantities to be recovered from the project being applied to the accumulation. Estimates consider the full range of values for each input parameter based on available engineering and geoscience data, but one set is selected that is most appropriate for the corresponding resources confidence category. A single outcome of recoverable quantities is derived for each scenario.
Developed Reserves	Reserves that are expected to be recovered from existing wells and facilities. Developed Reserves may be further sub-classified as Producing or Non- Producing.
Developed Producing Reserves	Developed Reserves that are expected to be recovered from completion intervals that are open and producing at the effective date. Improved recovery reserves are considered producing only after the improved recovery project is in operation.
Developed Non-Producing Reserves	Developed Reserves that are either shut-in or behind-pipe. (See also Shut-In Resources and Behind-Pipe Reserves.)
Development On Hold	A discovered accumulation where project activities are on hold and/or where justification as a commercial development may be subject to significant delay. A project maturity sub-class of Contingent Resources.
Development Not Viable	A discovered accumulation for which there are contingencies resulting in there being no current plans to develop or to acquire additional data at the time due to limited commercial potential. A project maturity sub-class of Contingent Resources.
Development Pending	A discovered accumulation where project activities are ongoing to justify commercial development in the foreseeable future. A project maturity sub-class of Contingent Resources.
Development Plan	The design specifications, timing, and cost estimates of the appraisal and development project(s) that are planned in a field or group of fields. The plan will include, but is not limited to, well locations, completion techniques, drilling methods, processing facilities, transportation, regulations, and marketing. The plan is often executed in phases when involving large, complex, sequential recovery and/or extensive areas.
Development Unclarified	A discovered accumulation where project activities are under evaluation and where justification as a commercial development is unknown based on available information. This sub-class requires appraisal or study and should not be maintained without a plan for future evaluation. The sub-class should reflect the actions required to move a project toward commercial maturity. A project maturity sub-class of Contingent Resources.

Discovered	A gas accumulation where one or several exploratory wells through testing, sampling, and/or logging have demonstrated the existence of a significant quantity of potentially recoverable hydrocarbons and thus have established a known accumulation. In this context, "significant" implies that there is evidence of a sufficient quantity of petroleum to justify estimating the in-place volume demonstrated by the well(s) and for evaluating the potential for technical recovery. (See also Known Accumulation.)
Discovered Petroleum Initially-In-Place	Quantity of petroleum that is estimated, as of a given date, to be contained in known accumulations before production. Discovered PIIP may be subdivided into commercial, sub-commercial, and the portion remaining in the reservoir as Unrecoverable.
Discovered Unrecoverable	Discovered gas resources that are evaluated, as of a given date, as not able to be recovered by the commercial and sub-commercial projects envisioned.
Economic	A project is economic when it has a positive undiscounted cumulative cash flow from the effective date of the evaluation, the net revenue exceeds the net cost of operation (i.e., positive cumulative net cash flow at discount rate greater than or equal to zero percent).
Economic Interest	Interest that is possessed when an entity has acquired an interest in the minerals in-place or a license and secures, by any form of legal relationship, revenue derived from the extraction of the mineral to which he must look for a return.
Economic Limit	Defined as the time when the maximum cumulative net cash flow (see Net Entitlement) occurs for a project.
Economically Not Viable Contingent Resources	Those quantities for which development projects are not expected to yield positive cash flows under reasonable forecast conditions. May also be subject to additional unsatisfied contingencies.
Economically Viable Contingent Resources	Those quantities associated with technically feasible projects where cash flows are positive under reasonable forecast conditions but are not Reserves because it does not meet the other commercial criteria
Economically Producible	Refers to the situation where the net revenue from an ongoing producing project exceeds the net expenses attributable to a certain entity's interest. The ADR costs are excluded from the determination.
Effective Date	Resource estimates of remaining quantities are "as of the given date" (effective date) of the evaluation. The evaluation must take into account all data related to the period before the "as of date."
Entitlement	That portion of future production (and thus resources) legally accruing to an entity under the terms of the development and production contract or license.
Entity	A legal construct capable of bearing legal rights and obligations. In resources evaluations, this typically refers to the lessee or contractor, which is some form of legal corporation (or consortium of corporations). In a broader sense, an entity can be an organization of any form and may include governments or their agencies.
Established Technology	Methods of recovery or processing that have proved to be successful in commercial applications.

Evaluation	The geosciences, engineering, and associated studies, including economic analyses, conducted on a petroleum (or other non-hydrocarbon fluid) exploration, development, or producing project resulting in estimates of the quantities that can be recovered and sold and the associated cash flow under defined forward conditions. (Also called assessment.)
Evaluator	The person or group of persons responsible for performing an evaluation of a project. These may be employees of the entities that have an economic interest in the project or independent consultants contracted for reviews and audits. In all cases, the entity accepting the evaluation takes responsibility for the results, including its resources and attributed value estimates.
Exploration	Prospecting for undiscovered gas using various techniques, such as seismic surveys, geological studies, and exploratory drilling.
Field	In conventional reservoirs, a field is typically an area consisting of a single reservoir or multiple reservoirs all grouped on, or related to, the same individual geological structural feature and/or stratigraphic condition. There may be two or more reservoirs in a field that are separated vertically by intervening impermeable rock, laterally by local geologic barriers, or both. The term may be defined differently by individual regulatory authorities. For unconventional reservoirs without hydrodynamic influences, a field is often defined by regulatory or ownership boundaries as necessary.
Final Investment Decision (FID)	Project approval stage when the participating companies have firmly agreed to the project and the required capital funding.
Flare Gas	The total quantity of gas vented and/or burned as part of production and processing operations (but not as fuel).
Flow Test	An operation on a well designed to demonstrate the existence of recoverable fluid in a reservoir by establishing flow to the surface and/or to provide an indication of the potential productivity of that reservoir (such as a wireline formation test). May also demonstrate the potential of certain completion techniques, particularly in unconventional reservoirs.
Fluid Contacts	The surface or interface in a reservoir separating two regions characterized by predominant differences in fluid saturations. Because of capillary and other phenomena, fluid saturation change is not necessarily abrupt or complete, nor is the surface necessarily horizontal.
Forecast Case	A descriptor applied to a scenario when production and associated cash-flow estimates are based on those conditions (including costs and product price schedules, inflation indexes, and market factors) forecast by the evaluator to reasonably exist throughout the evaluation life (i.e., defined conditions). Inflation or deflation adjustments are made to costs and revenues over the evaluation period.
Gas Balance	In gas production operations involving multiple working interest owners, maintaining a statement of volumes attributed to each, depending on each owner's portion received. Imbalances may occur that must be monitored over time and eventually balanced in accordance with accepted accounting procedures.
Gas Cap Gas	Free natural gas that overlies and is in contact with crude oil in the reservoir. It is a subset of associated gas.

Gas Hydrates	Naturally occurring crystalline substances composed of water and gas, in which a solid water lattice accommodates gas molecules in a cage-like structure or clathrate. At conditions of standard temperature and pressure, one volume of saturated methane hydrate will contain as much as 164 volumes of methane gas. Gas hydrates are included in unconventional resources, but the technology to support commercial maturity has yet to be developed.
Gas/Oil Ratio	Ratio that is calculated using measured natural gas and crude oil volumes at stated conditions. The gas/oil ratio may be the solution gas/oil ratio, Rs ; produced gas/oil ratio, Rp ; or another suitably defined ratio of gas production to oil production.
Geostatistical Methods	A variety of mathematical techniques and processes dealing with the collection, methods, analysis, interpretation, and presentation of large quantities of geoscience and engineering data to (mathematically) describe the variability and uncertainties within any reservoir unit or pool, specifically related here to resources estimates.
High Estimate	With respect to resources categorization, this is considered to be an optimistic estimate of the quantity that will actually be recovered from an accumulation by a project. If probabilistic methods are used, there should be at least a 10% probability (P10) that the quantities actually recovered will equal or exceed the high estimate.
Hydrates	See Gas Hydrates.
Hydrocarbons	Hydrocarbons are chemical compounds consisting wholly of hydrogen and carbon molecules.
Injection	The forcing, pumping, or natural flow of substances into a porous and permeable subsurface rock formation. Injected substances can include either gases or liquids.
Justified for Development	A development project that has reasonable forecast commercial conditions at the time of reporting and there are reasonable expectation that all necessary approvals/contracts will be obtained. A project maturity sub-class of Reserves.
Known Accumulation	An accumulation that has been discovered.
Lead	A project associated with a potential accumulation that is currently poorly defined and requires more data acquisition and/or evaluation to be classified as a Prospect. A project maturity sub-class of Prospective Resources.
Likelihood	Likelihood (the estimated probability or chance) is equal (1- risk). (See Probability and Risk.)
Low/Best/High Estimates	Reflects the range of uncertainty as a reasonable range of estimated potentially recoverable quantities.
Low Estimate	With respect to resources categorization, this is a conservative estimate of the quantity that will actually be recovered from the accumulation by a project. If probabilistic methods are used, there should be at least a 90% probability (P90) that the quantities actually recovered will equal or exceed the low estimate.
Market	A consumer or group of consumers of a product that has been obtained through purchase, barter, or contractual terms.
Marketable Quantities	Those quantities of hydrocarbons that are estimated to be producible from petroleum accumulations and that will be consumed by the market. (Also referred to as marketable products.)

Mean	The sum of a set of numerical values divided by the number of values in the set.
Measurement	The process of establishing quantity (volume, mass, or energy content) and quality of petroleum products delivered to a reference point under conditions defined by delivery contract or regulatory authorities.
Mineral Lease	An agreement in which a mineral owner (lessor) grants an entity (lessee) rights. Such rights can include (1) a fee ownership or lease, concession, or other interest representing the right to extract oil or gas subject to such terms as may be imposed by the conveyance of the lease; (2) royalty interests, production payments payable in oil or gas, and other non-operating interests in properties operated by others; and/or (3) those agreements with foreign governments or authorities under which a reporting entity participates in the operation of the related properties or otherwise serves as producer of the underlying reserves (as opposed to being an independent purchaser, broker, dealer, or importer).
Monte Carlo Simulation	A type of stochastic mathematical simulation that randomly and repeatedly samples input distributions (e.g., reservoir properties) to generate a resulting distribution (e.g., recoverable petroleum quantities).
Multi-Scenario Method	An extension of the deterministic scenario method. In this case, a significant number of discrete deterministic scenarios are developed by the evaluator, with each scenario leading to a single deterministic outcome. Probabilities may be assigned to each discrete input assumption from which the probability of the scenario can be obtained; alternatively, each outcome may be assumed to be equally likely.
Net Entitlement	That portion of future production (and thus resources) legally accruing to an entity under the terms of the development and production contract or license. Under the terms of PSCs, the producers have an entitlement to a portion of the production. This entitlement, often referred to as "net entitlement" or "net economic interest" is estimated using a formula based on the contract terms incorporating costs and profits.
Net Revenue Interest	An entity's revenue share of petroleum sales after deduction of royalties or share of production owing to others under applicable lease and fiscal terms. (See also Entitlement and Net Entitlement)
Netback Calculation	Term used in the hydrocarbon product price determination at reference point to reflect the revenue of one unit of sales after the costs associated with bringing the product to a market (e.g., transportation and processing) are removed.
Non-Hydrocarbon Gas	Associated gases such as nitrogen, carbon dioxide, hydrogen sulfide, and helium that are present in naturally occurring petroleum accumulations.
Non-Sales	That portion of estimated recoverable or produced quantities that will not be included in sales as contractually defined at the reference point. Non-sales include quantities CiO, flare, and surface losses, and may include non- hydrocarbons.
On Production	A project maturity sub-class of Reserves that reflects the operational execution phase of one or multiple development projects with the Reserves currently producing or capable of producing. Includes Developed Producing and Developed Non-Producing Reserves.
P1	Denotes Proved Reserves. P1 is equal to 1P.
P2	Denotes Probable Reserves.
P3	Denotes Possible Reserves.

Penetration	The intersection of a wellbore with a reservoir.
Petroleum	Defined as a naturally occurring mixture consisting of hydrocarbons in the gaseous, liquid, or solid phase. Petroleum may also contain non-hydrocarbon compounds, common examples of which are carbon dioxide, nitrogen, hydrogen sulfide, and sulfur. In rare cases, non-hydrocarbon content of petroleum can be greater than 50%.
Petroleum Initially-in-Place (PIIP)	The total quantity of petroleum that is estimated to exist originally in naturally occurring reservoirs, as of a given date. Crude oil in-place, natural gas in-place, and natural bitumen in-place are defined in the same manner.
Pilot Project	A small-scale test or trial operation used to assess technology, including recovery processes, for commercial application in a specific reservoir.
Play	A project associated with a prospective trend of potential prospects, but which requires more data acquisition and/or evaluation to define specific Leads or Prospects. A project maturity sub-class of Prospective Resources.
Possible Reserves	An incremental category of estimated recoverable quantities associated with a defined degree of uncertainty. Possible Reserves are those additional reserves that analysis of geoscience and engineering data suggest are less likely to be recoverable than Probable Reserves. The total quantities ultimately recovered from the project have a low probability to exceed the sum of Proved plus Probable plus Possible (3P), which is equivalent to the high estimate scenario. When probabilistic methods are used, there should be at least a 10% probability that the actual quantities recovered will equal or exceed the 3P estimate.
Primary Recovery	The extraction of petroleum from reservoirs using only the natural energy available in the reservoirs to move fluids through the reservoir rock to other points of recovery.
Probability	The extent to which an event is likely to occur, measured by the ratio of the favorable cases to the whole number of cases possible. PRMS convention is to quote cumulative probability of exceeding or equaling a quantity where P90 is the small estimate and P10 is the large estimate. (See also Uncertainty.)
Probabilistic Method	The method of estimation of resources is called probabilistic when the known geoscience, engineering, and economic data are used to generate a continuous range of estimates and their associated probabilities.
Probable Reserves	An incremental category of estimated recoverable quantities associated with a defined degree of uncertainty. Probable Reserves are those additional Reserves that are less likely to be recovered than Proved Reserves but more certain to be recovered than Possible Reserves. It is equally likely that actual remaining quantities recovered will be greater than or less than the sum of the estimated Proved plus Probable Reserves (2P). In this context, when probabilistic methods are used, there should be at least a 50% probability that the actual quantities recovered will equal or exceed the 2P estimate.
Production	The cumulative quantities of petroleum that have been recovered at a given date. Production can be reported in terms of the sales product specifications, but project evaluation requires that all production quantities (sales and non-sales), as measured to support engineering analyses requiring reservoir voidage calculations, are recognized.

Production Forecast	A forecasted schedule of production over time. For Reserves, the production forecast reflects a specific development scenario under a specific recovery process, a certain number and type of wells and particular facilities and infrastructure. When forecasting Contingent or Prospective Resources, more than one project scope (e.g., wells and facilities) is frequently carried to determine the range of the potential project and its uncertainty together with the associated resources defining the low, best, and high production forecasts. The uncertainty in resources estimates associated with a production forecast is usually quantified by using at least three scenarios or cases of low, best, and high, which lead to the resources classifications of, respectively, 1P, 2P, 3P and 1C, 2C, 3C or 1U,2U and 3U.
Production-Sharing Contract (PSC)	A contract between a contractor and a host government in which the contractor typically bears the risk and costs for exploration, development, and production. In return, if exploration is successful, the contractor is given the opportunity to recover the incurred investment from production, subject to specific limits and terms. Ownership of petroleum in the ground is retained by the host government; however, the contractor normally receives title to the prescribed share of the quantities as they are produced. (Also termed production-sharing agreement (PSA).
Project	A defined activity or set of activities that provides the link between the petroleum accumulation's resources sub-class and the decision-making process, including budget allocation. A project may, for example, constitute the development of a single reservoir or field, an incremental development in a larger producing field, or the integrated development of a group of several fields and associated facilities (e.g. compression) with a common ownership. In general, an individual project will represent a specific maturity level (sub-class) at which a decision is made on whether or not to proceed (i.e., spend money), suspend, or remove. There should be an associated range of estimated recoverable resources for that project. (See also Development Plan.)
Property	A defined portion of the Earth's crust wherein an entity has contractual rights to extract, process, and market specified in-place minerals (including petroleum). In general, defined as an area but may have depth and/or stratigraphic constraints. May also be termed a lease, concession, or license.
Prospect	A project associated with an undrilled potential accumulation that is sufficiently well defined to represent a viable drilling target. A project maturity sub-class of Prospective Resources.
Prospective Resources	Those quantities of petroleum estimated, as of a given date, to be potentially recoverable from undiscovered accumulations by application of future development projects.
Proved Reserves	An incremental category of estimated recoverable quantities associated with a defined degree of uncertainty. Proved Reserves are those quantities of petroleum that, by analysis of geoscience and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known reservoirs and under defined economic conditions, operating methods, and government regulations. If deterministic methods are used, the term "reasonable certainty" is intended to express a high degree of confidence that the quantities will be recovered. If probabilistic methods are used, there should be at least a 90% probability that the quantities actually recovered will equal or exceed the estimate.

Qualified Reserves Auditor	A reserves evaluator who (1) has a minimum of ten years of practical experience in petroleum engineering or petroleum production geology, with at least five years of such experience being in responsible charge of the estimation and evaluation of Reserves information; and (2) either (a) has obtained from a college or university of recognized stature a bachelor's or advanced degree in petroleum engineering, geology, or other discipline of engineering or physical science or (b) has received, and is maintaining in good standing, a registered or certified professional engineer's license or a registered or certified professional geologist's license, or the equivalent, from an appropriate governmental authority or professional organization. (see SPE 2007 "Standards Pertaining to the Estimating and Auditing of Oil and Gas Reserves Information")
Qualified Reserves Evaluator	A reserves evaluator who (1) has a minimum of five years of practical experience in petroleum engineering or petroleum production geology, with at least three years of such experience being in the estimation and evaluation of Reserves information; and (2) either (a) has obtained from a college or university of recognized stature a bachelor's or advanced degree in petroleum engineering, geology, or other discipline of engineering or physical science or (b) has received, and is maintaining in good standing, a registered or certified professional engineer's license or a registered or certified professional geologist's license, or the equivalent, from an appropriate governmental authority or professional organization. (modified from SPE 2007 "Standards Pertaining to the Estimating and Auditing of Oil and Gas Reserves Information")
Range of Uncertainty	The range of uncertainty of the in-place, recoverable, and/or potentially recoverable quantities; may be represented by either deterministic estimates or by a probability distribution. (See Resources Categories.)
Raw Production	All components, whether hydrocarbon or other, produced from the well or extracted from the mine (hydrocarbons, water, impurities such as non-hydrocarbon gases, etc.).
Reasonable Certainty	If deterministic methods for estimating recoverable resources quantities are used, then reasonable certainty is intended to express a high degree of confidence that the estimated quantities will be recovered. Typically attributed to Proved Reserves or 1C Resources quantities.
Reasonable Expectation	Indicates a high degree of confidence (low risk of failure) that the project will proceed with commercial development or the referenced event will occur. (Differs from reasonable certainty, which applies to resources quantity technical confidence, while reasonable expectation relates to commercial confidence.).
Recoverable Resources	Those quantities of hydrocarbons that are estimated to be producible by the project from either discovered or undiscovered accumulations.
Reference Point	A defined location within a petroleum extraction and processing operation where quantities of produced product are measured under defined conditions before custody transfer (or consumption). Also called point of sale, terminal point, or custody transfer point.
Report	The presentation of evaluation results within the entity conducting the assessment. Should not be construed as replacing requirements for public disclosures under guidelines established by regulatory and/or other government agencies.
Reserves	Those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions. Reserves must satisfy four criteria: they must be discovered, recoverable, commercial, and remaining (as of a given date) based on the development project(s) applied.

Reservoir	A subsurface rock formation that contains an individual and separate natural accumulation of petroleum that is confined by impermeable barriers, pressure systems, or fluid regimes (conventional reservoirs), or is confined by hydraulic fracture barriers or fluid regimes (unconventional reservoirs).
Resources	Term used to encompass all quantities of petroleum (recoverable and unrecoverable) naturally occurring in an accumulation on or within the Earth's crust, discovered and undiscovered, plus those quantities already produced. Further, it includes all types of petroleum whether currently considered conventional or unconventional. (See Total Petroleum Initially-in-Place.)
Resources Categories	Subdivisions of estimates of resources to be recovered by a project(s) to indicate the associated degrees of uncertainty. Categories reflect uncertainties in the total petroleum remaining within the accumulation (in-place resources), that portion of the in-place petroleum that can be recovered by applying a defined development project or projects, and variations in the conditions that may impact commercial development (e.g., market availability and contractual changes). The resource quantity uncertainty range within a single resources class is reflected by either the 1P, 2P, 3P, Proved, Probable, Possible, or 1C, 2C, 3C or 1U, 2U, 3U resources categories.
Resources Classes	Subdivisions of resources that indicate the relative maturity of the development projects being applied to yield the recoverable quantity estimates. Project maturity may be indicated qualitatively by allocation to classes and sub-classes and/or quantitatively by associating a project's estimated likelihood of commerciality.
Resources Type	Describes the accumulation and is determined by the combination of the type of hydrocarbon and the rock in which it occurs.
Revenue-Sharing Contract	Contracts that are very similar to the PSCs with the exception of contractor payment in these contracts, the contractor usually receives a defined share of revenue rather than a share of the production.
Risk	The probability of loss or failure. Risk is not synonymous with uncertainty. Risk is generally associated with the negative outcome, the term "chance" is preferred for general usage to describe the probability of a discrete event occurring.
Risk Service Contract (RSC)	Agreements that are very similar to the production-sharing agreements in that the risk is borne by the contractor but the mechanism of contractor payment is different. With a RSC, the contractor usually receives a defined share of revenue rather than a share of the production.
Sales	The quantity of petroleum and any non-hydrocarbon product delivered at the custody transfer point (reference point) with specifications and measurement conditions as defined in the sales contract and/or by regulatory authorities.
Split Classification	A single project should be uniquely assigned to a sub-class along with its uncertainty range, For example, a project cannot have quantities categorized as 1C, 2P, and 3P. This is referred to as "split classification." If there are differing commercial conditions, separate sub-classes should be defined.

Split Conditions	The uncertainty in recoverable quantities is assessed for each project using resources categories. The assumed commercial conditions are associated with resource classes or sub-classes and not with the resources categories. For example, the product price assumptions are those assumed when classifying projects as Reserves, and a different price would not be used for assessing Proved versus Probable reserves. That would be referred to as "split conditions."
Stochastic	Adjective defining a process involving or containing a random variable or variables or involving likelihood or probability, such as a stochastic simulation.
Sub-Commercial	A project subdivision that is applied to discovered resources that occurs if either the technical or commercial maturity conditions of project have not yet been achieved. A project is sub-commercial if the degree of commitment is such that the accumulation is not expected to be developed and placed on production within a reasonable time-frame. Sub-commercial projects are classified as Contingent Resources.
Taxes	Obligatory contributions to the public funds, levied on persons, property, or income by governmental authority.
Technical Forecast	The forecast of produced resources quantities that is defined by applying only technical limitations (i.e., well-flow-loading conditions, well life, production facility life, flow-limit constraints, facility uptime, and the facility's operating design parameters). Technical limitations do not take into account the application of either an economic or license cut-off. (See also Technically Recoverable Resources).
Technical Uncertainty	Indication of the varying degrees of uncertainty in estimates of recoverable quantities influenced by the range of potential in-place hydrocarbon resources within the reservoir and the range of the recovery efficiency of the recovery project being applied.
Technically Recoverable Resources	Those quantities of petroleum producible using currently available technology and industry practices, regardless of commercial or accessibility considerations.
Technology Under Development	Technology that is currently under active development and that has not been demonstrated to be commercially viable. There should be sufficient direct evidence (e.g., a test project/pilot) to indicate that the technology may reasonably be expected to be available for commercial application.
Uncertainty	The range of possible outcomes in a series of estimates. For recoverable resources assessments, the range of uncertainty reflects a reasonable range of estimated potentially recoverable quantities for an individual accumulation or a project. (See also Probability.)
Undeveloped Reserves	Those quantities expected to be recovered through future investments: (1) from new wells on undrilled acreage in known accumulations, (2) from deepening existing wells to a different (but known) reservoir, (3) from infill wells that will increase recovery, or (4) where a relatively large expenditure (e.g., when compared to the cost of drilling and completing a new well) is required to recomplete an existing well.
Undiscovered Petroleum Initially-in-Place	That quantity of petroleum estimated, as of a given date, to be contained within accumulations yet to be discovered.

Unrecoverable Resources	Those quantities of discovered or undiscovered PIIP that are assessed, as of a given date, to be unrecoverable by the currently defined project(s). A portion of these quantities may become recoverable in the future as commercial circumstances change, technology is developed, or additional data are acquired. The remaining portion may never be recovered owing to physical/chemical constraints represented by subsurface interaction of fluids and reservoir rocks.
Upgrader	A general term applied to processing plants that convert extra-heavy crude oil and natural bitumen into lighter crude and less viscous synthetic crude oil. While the detailed process varies, the underlying concept is to remove carbon through coking or to increase hydrogen by hydrogenation processes using catalysts.
Wet Gas	Natural gas from which no liquids have been removed before the reference point. The wet gas is accounted for in resources assessments, and there is no separate accounting for contained liquids. It should be recognized that this is a resources assessment definition and not a phase behavior definition.
Working Interest	An entity's equity interest in a project before reduction for royalties or production share owed to others under the applicable fiscal terms.

Appendix 2: Nomenclature

3D	three dimensional
ABEX	abandonment cost
API	American Petroleum Institute
bbl	barrel (42 US gallons)
Bg	gas formation volume factor, in scf/rcf
BH	bottom hole
BHA	bottom hole assembly
Bscf	thousands of millions of standard cubic feet
C&P	cased and perforated
CO_2	carbon dioxide
CoP	cessation of production
COS	geological chance of success
CPI	computer processed interpretation
d	day
DST	drill stem test
Eg	gas expansion factor
ELT	economic limit test
FBHP	flowing bottom hole pressure
FDP	field development plan
FMB	flowing material balance
FPSO	floating production storage and offloading vessel
ft	feet
FTHP	flowing tubing head pressure
FVF	formation volume factor
FWL	free water level
GDT	gas down to
GEF	gas expansion factor
GIIP	gas initially in place
GRV	gross rock volume
GSA	gas sales agreement
GWC	gas water contact
H_2S	hydrogen sulphide

HLV	Heavy Lift Vessel
HPHT	high pressure, high temperature
ICV	interval control valve
kh	permeability thickness
km	kilometres
Kr	relative permeability
LTC	long term compression
m	metre
M MM	thousands and millions respectively
MD	measured depth
md or mD	millidarcy
MDRKB	measured depth below Kelly Bushing
MDT	modular dynamic tester
MSL	mean sea level
mss	metres subsea
N_2	nitrogen
NAG	non-associated gas
NBP	National Balancing Point
NPV xx	net present value at xx discount rate
NTG	net to gross ratio
NUI	normally unmanned installation
OPEX	operating cost
P90	low case (probabilistic) estimate (there should be a 90% probability of exceeding this estimate)
P50	mid or best case (probabilistic) estimate (there should be a 50% probability of exceeding this estimate)
P10	high case (probabilistic) estimate (there should be a 10% probability of exceeding this estimate)
Pb	saturation, or bubble point, pressure
PBU	pressure-build-up
Phi	porosity
Phie	effective porosity
Phit	total porosity
PI	productivity index, in stb/d/psi for oil or MMscf/d/psi or Mscf/d/psi for gas
POD	plan of development
PSA	production sharing agreement

PSC	production sharing contract
psi	pressure, measured in pounds per square inch
psia	absolute pressure, measured in pounds per square inch
psig	gauge pressure which is the pressure above atmospheric pressure, measured in pounds per square inch
PSDM	post stack depth migration
PSTM	post stack time migration
PVT	pressure volume temperature experiment
rb	reservoir barrels
RCA	routine core analysis
rcf	cubic feet at reservoir conditions
RFT	repeat formation tester
scf	standard cubic feet measured at 14.7 pounds per square inch and 60 degrees Fahrenheit
SNA	sum of negative amplitudes
ss	sub-sea
stb	stock tank barrel (42 US gallons measured at 14.7 pounds per square inch and 60 degrees Fahrenheit)
Sw	water saturation
Swc	connate water saturation
TD	total depth
THP	tubing head pressure
TVD	true vertical depth
TVDSS	true vertical depth sub-sea
TWT	two way time
WGR	water gas ratio
WUT	water up to

Appendix 3: References

Chris Ballentine and Pete Barry, 2016. Oxford University Seep Study, internal study, unpublished.

Diveena Danabalan, 2017. Helium Exploration Methodology for a Strategic Resource. PhD Thesis, Durham University.
https://etheses.dur.ac.uk/12573/1/Full_Thesis_Danabalan_2017_with_corrections.pdf?DDD15+

Diveena Danabalan; Jon G. Gluyas; Colin G. Macpherson; Thomas H. Abraham-James; Josh J. Bluett; Peter H. Barry; Chris J. Ballentine, 2017. The principles of helium exploration. Petroleum Geoscience (2022) 28 (2).

Mamyrin, B.A. and Tolstikhin, I.N., 1984. Helium Isotopes in Nature. Vol. 3, Developments in Geochemistry. Amsterdam: Elsevier.